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Written submission from Steve Lawrence

Mémoire de Steve Lawrence

In the Matter of the

À l'égard de

Cameco Corporation, Beaverlodge Project

Cameco Corporation, le projet de Beaverlodge

Application for the Licence Revocation and Transfer of Properties to Saskatchewan Institutional Control Program

Demande de révocation de permis et de transfert de propriétés au programme de contrôle institutionnel de la Saskatchewan

Commission Public Hearing

Audience publique de la Commission

January 30, 2025

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Canada

From: Steve Lawrence
Sent: December 10, 2024 3:46 PM
To: Interventions / Interventions (CNSC/CCSN)
Subject: Beaverlodge Intervention
Attachments: Beaverlodge remediation history Webster_M_et_al_BC_Mine_2013.pdf

For the public hearing on Cameco Corporation's application to release the final set of decommissioned Beaverlodge mine and mill site properties from CNSC licensing for acceptance into Saskatchewan's Institutional Control Program, resulting in the revocation of its waste facility operating licence.

Intervention submitted by Steve Lawrence on Dec 10, 2024.

For a very long time I have been bothered by total loading into the environment of radioactive materials. Call it a legacy of the atomic

bombs dropped on Japan, the atmospheric testing of nuclear bombs, the cold war, or the quantity of GreenHouse Gases put into the atmosphere from all sources to create the era of climate change we are now in. I would characterise the senseless legacy of things like the irresponsible management of uranium tailings in areas like Beaverlodge Lake as point source load - that needs to be dealt with. To me, total load is the total amount of contaminants that have been placed in the environment in a localized area and, therefore, the total amount of these contaminants that could reenter the local ecosystems, given conditions that might favour that.

'Pollutant Load' refers to the amount of pollutants, such as chemicals or microbes, that are discharged into a system, quantifying both the mass of the substance entering the system and the system's response to it. I would not characterise the introduction of radioactive materials into the environment as a pollutant. For me a pollutant is a substance that can be diluted to negate its effects, unless it is able to somehow reconcentrate itself somewhere else. Because of how radiation works, dilution does reduce, not eliminate, the danger immediate to its presence - instead it spreads the radiation over a larger area, therefore spreading the danger to a wider population. Consumption or breathing in of a radioactive material, even in low concentrations involves a risk that the radioactive substance will interact with a vital part of that organism. The other thing that separates radioactive discharges to the environment from other pollutants is the radioactive decay nature of the elements involved. The waste contains not only 5% of the unrecovered uranium, but 85% of the other radioactive elements that were not wanted. Their hazardous nature extends into a geologic time frame of at least hundreds of thousands (million?) of years. If you need an expert opinion - findings from the 1977 Report from the Joint federal Provincial Panel on mine development in northern Saskatchewan, concerning cumulative effects on operating mines as well as considerations for Midwest and Cigar Lake mines concluded "The tailings are going to have to be monitored into perpetuity". I take this statement very seriously.

Cameco completed over 20 studies, which narrowed options to nine, which have contributed to the development of a path forward. Cameco presented this remediation plan to the

Commission at the Beaverlodge licence renewal hearing in April 2013; reasonable options to support the natural recovery of the site were identified, in addition to other options which were considered but not selected for implementation. The selected remediation options were expected to result in localized improvements in water quality. However, due to the type of historical mining practices and legacy impacts associated with the operation of the facilities, the results of the studies showed that with the implementation of all the practical remedial options assessed, there was little effect on the enhanced recovery of Beaverlodge Lake, which contains elevated levels of selenium and uranium. There are other contaminants but these seem to be at the top of the monitoring list - should we be looking at others?

Forever is a long time. When I was growing up I learned that the responsible thing to do,when you create a mess, is to clean it up - properly! If you don't, it will come back to bite you. This mess is so extensive and its longevity is such that I feel things will go wrong in the future and that it is socially not acceptable to leave it up to future generations to clean that up. If this is so, there needs to be a very public statement made that this is the case and there isn't much they can do about it. The general public needs to be aware of the full impact of decisions made here at this time. Further it should make the public demand that a closer look be made at current operations to make sure we are not making the same mistakes. For example, at one location, Fookes Lake 5 million tons of tailings were dumped into the lake, with solids covering the entire lake bottom. Tailings were also placed back into the mine. Tailings were also left on the surface at Lower Ace !! Tailings are what is left, after we have taken what we want, when mineralized ore is taken into the mill ground up into a fine flour and then chemically treated to release their treasures. They may no longer be stably bonded to other minerals and the processed nature of these tailings makes them more mobile and subject to transport in groundwater. Tailings left on the surface that remain a hazard for a million years will be exposed to erosional forces during a time frame that wore down a mountain range! Mineralized waste rock is rock that contains some mineralization, such as uranium, but not high enough grade to warrant milling - it was left on the surface along with the rest of the waste rock. Apparently, all the waste rock did not contain enough

mineralization to be called mineralized waste rock and it was also considered relatively benign because of its carbonate nature. Uranium mining is moving into a new era of solution mining where we pump oxygen into the groundwater of an ore body. This oxygenated groundwater is able to dissolve the mineralization in the ore and this is pumped back to the surface for processing and then the tailings from this are disposed of. Dissolved (oxidized) radioactive minerals **"will"** spread through the environment. The Beaverlodge mines and mill operated from 1952 to 1982. There were no mine regulations in place until 1978, so there was no treatment or regulation of mine and mill wastes up to that time. I am very much concerned about the tailings in the lakes/reservoirs and the tailings put back underground and any tailings that might be on the surface.

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. 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. The 2009 worshop 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 Webster_M_et_al_BC_Mine_2013.pdf -- see attachment.

A TMDL (Total Mass DailyLoad) is the calculation of the maximum amount of a **pollutant** allowed **to enter** a waterbody so that the waterbody will meet and continue **to** meet water quality standards for that particular pollutant. This seems to be the criteria that Cameco concentrates on. A TMDL determines a pollutant reduction target and allocates load reductions necessary to the source(s) of the pollutant. The US EPA points out point sources include all sources subject to regulation under the National Pollutant Discharge Elimination

System (NPDES) program, e.g. wastewater treatment facilities, some stormwater discharges and concentrated animal feeding operations (CAFOs). For purposes of assigning LAs, nonpoint sources include all remaining sources of the pollutant as well as natural background sources. TMDLs must also account for seasonal variations in water quality, and include a margin of safety (MOS) to account for uncertainty in predicting how well pollutant reductions will result in meeting water quality standards. Disturbances of the sediments will increase the TMDL, perhaps significantly. It is these disturbances , in the long term, that will have potential significant local environmental and human impacts.

The monitoring that is taking place ensures surface water quality standards are met. Actually the monitoring is to ensure the drinking water quality has been stabilized or improving, not getting worse. The trick is to maintain that forever. The uranium that was dumped into the lakes does form a bond with the organic material on the lake bottom. It seems, as long as this balance is not interfered with, everything is good. Cameco wants to be rid of the problem as quickly as possible, before that balance is broken. It is in the process to be relieved of the responsibility of this mess and have it transferred to Saskathewan's Institutional Control Program (IC). We are in an era of climate change, so all bets are off on predicting what the future is going to be. Drought could lead to the dying off of the local forest and the forest fires that will result. It will also have an effect on the ground cover established over the surface tailings. Anything that was already naturally revegetated has been considered inaccessible for purposes of providing a tailings cover, even if they had high gamma readings, so these will be exposed. If lake levels are affected by lack of precipitation, lake levels will drop, exposing submerged tailings and exposing them to oxygen and the protection of binding with organic lake bottom material. This will release the uranium into the lake water, dramatically affecting surface water quality. How do you fix lake

levels during prolonged droughts? If there is excess precipitation, this will increase the rate of tailings erosion and water percolating through the tailings and mineralized waste rock, which will all contribute to increased runoff and contamination of the lakes. How much will these tailings be impacted, over the long term, by normal wave action, or by storms? Timing of monitoring should coincide with such events, not once every 5 years! How are the shorelines of affected lakes protected from wave action? Tailings and waste rock with high gamma, that were already naturally revegetated, were considered inaccessible and were not covered - how will this change in the event of a forest fire?

A Stanford University report summarized in Proceedings of the National Academy of Sciences (https://phys.org/news/2017-02-uranium-chemistry.html) points out that when uranium is bound to organic matter in sediments, generally in a stable tetravalent form, it is immobile under certain conditions. But this tetravalent uranium may become mobile if the water table drops and oxygen from the air enters spaces in the sediment that were formerly filled with water, particularly if the uranium is bound to organic matter in sediments rather than being stored in insoluble minerals. Under some conditions uranium can be more or less completely flushed out of sediment, the Stanford report notes; under other conditions it will remain in the sediment and stay out of the groundwater or water column. But under fluctuating conditions, neither happens completely. This may result in persistent plumes of uranium contamination in groundwater that are hard to predict and to model. With future, difficult-to-predict changes in precipitation, this would indicate that we should be cautious in relying on current monitoring data to project the future rate of release of uranium from sediments and marshy areas. It is also necessary to take into account both the grain size in specific sediments, which affects the rate of release of uranium, and also the effect of disturbance of sediment by wildlife.

Beaverlodge Lake is situated within the PreCambrian Shield. The PreCambrian Shield is an ancient mountain range that has almost been completely worn down by the forces of erosion. The runoff from this erosion and deposition of dissolved minerals in fault zones may well be the source of many of the ore we are currently mining in the Athabasca region. Mountains are created by enormous tectonic forces in the earth pushing crustal plates upward. While the Shield has been tectonically stable for a very long time, it is not beyond possibility that this will not happen again, remobilizing the radioactive waste. Whatever the earth's future, erosion plays a

very critical part in moving mineralizations. Have scenarios been created that would stabilize the contaminants into new, insoluble deposits that would reduce the impact of such events?

Over the millenia, human actions are also unpredictable. Will climate change force people north, exposing a larger population to the contamination in the lakes. I have witnessed the trout runs from Lake Athabasca up the Fondue Lac River, much as the pacific salmon moves from the Pacific Ocean up coastal streams and rivers to lay their eggs. What effect do these contaminated watersheds have on the trout and other species? Lake Athabasca could support a large fishery - is this still possible? Into the future? What will recreational opportunities bring - I know the presence of wake boats, for water skiers, in some of our southern recreational lakes stir up lake sediments - Is this a possibility in the shallower waters of Beaverlodge Lake, as it would be a disaster!?

There were two, 2-day meetings in Saskatoon in 2009 and 2012. I believe the participants were divided into working groups and there was some indigenous representation at the meetings. Time was short, not everything was discussed. The first workshop was to discuss possible ways of dealing with some 70 sites at the Beaverlodge group of mines and the mill. 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. Then Cameco assessed each remedial option as to its cost and its potential to reduce risk and/or provide a net environmental benefit commensurate with the cost, and be technically feasible. At the second meeting, options were discussed, although there wasn't time for them all and Cameco thought some of the options were not 'practical' and they were not discussed either. A plan forward was mapped out. In October 2012 there was a meeting held in Uranium City to let residents know what had been decided.

My feeling is that, when the Remediation Plan forward was created, by Cameco, they pretty much wrote off any reclamation of all the waste material that had been dumped into the lakes - too expensive to fix. However the consensus was they had to do something! Actually they did cover tailings that were exposed at the surface of the lake with 0.6m of waste rock in 1983/84 and when

pressure boils erupted it was covered by an additional 0.3m of sand. I don't fully understand the mechanics of boils (artesian??), so I have to trust that Cameco did, and this extra sand will stand the test of time!?? Some of the options , where they were unsure of the outcomes, were not done. The paths, they did consider, were those that would have very little impact on the environment and were a waste of money, and were mostly rejected for those reasons. They basically decided to do nothing and let nature take its course as most of the remediations considered would not affect the rate of recovery. What they did consider doing, because they were good engineering practice and were low cost had very little to do with improving the environment. The discussions were about the % difference each option would make, so I do not know the actual quantities that these would represent. What kind of quantities are we talking about? They capped the shaft holes and plugged some of the boreholes where upwelling from the mine pits was flowing from as well as those that were not flowing. They did divert one stream from going through a waste pile. They didn't attempt to cover tailings (covering tailings in the Lower Ace Creek area are seen to have a minimal effect on water quality in the immediate and downstream environment) and waste piles, particularly if revegetation had already started to regenerate itself - those areas were considered inaccessible, even if they had high gamma readings - not to be disturbed. As well there appears to have been limited sediment cover available and it would be costly. They had considered covering it with sand and waste rock which would have allowed rain and runoff to percolate through but, again, they felt this would have limited environmental benefit. Basically they are going to continue to monitor the site and as long as there are no further negative changes, they will consider it to be stable.

As part of every licensee's environmental protection program, concentrations of contaminants in the environment must be determined

and the potential exposure routes to the public must be assessed and mitigated. I am not sure they succeeded in this regard. Before a licence can be granted or renewed, the CNSC must be satisfied that an applicant will make adequate provisions for the protection of the environment and the health and safety of the public. I guess they couldn't guarantee this last statement if they started working on the actual lakes and sediments - too much disturbance. I am not at all sure we got our money"s worth as there doesn't seem to be much consideration beyond the short time. Much of the work should have been done long ago to protect the current local inhabitants in the area but, I think we are headed for a lot of trouble in the future.

The CNSC IEMP results from 2023 are consistent with the results submitted by Cameco and SRC, supporting their assessment that the licensees' environmental protection programs are effective for current licensed activities. The results add to the body of evidence that people and the environment in the vicinity of the Beaverlodge, Gunnar and Lorado sites are protected and that there are no anticipated health impacts from the sites, provided the Saskatchewan *Healthy Fish Consumption Guideline* is followed regarding fish and water consumption. For me, this only represents current conditions and are predictive of the future.

One of the things we learn from going over our mistakes in the past, hopefully, is they must not be repeated. Although it is not the mandate of these hearings to consider modern operations, its intent should be to carry forward what we have learned before it is too late at other sites. The mess we have created in an open lake environment in the Beaverlodge lake area is obvious and remediation seems almost impossible, but something needs to be done and I feel we haven't scratched the surface here yet. The emphasis during the initial steps to find solutions was they had to be practical and they had to be cost effective. Clean up of the lakes must have been automatically ruled out because it is not even considered. Adherence to cost seems to be a main objective of

earlier discussions, but like climate change, if you don't find the money now for climate action, you will be paying a great deal more in the future, on many levels.

From reading the material on this, I don't have any feeling for what is considered for the sediment in the lakes. A careful, predictive, scientifically designed monitoring program needs to be set up for the sediments that uses equipment that can measure event horizons. The Beak study was used to determine the existing impacts on the environment to that date and whether they should continue with more Uranium mines. It was conducted in the waters of Hidden Bay in 1985 and utilized data collected since 1974 (under the watchful eye of Environmental departments of both the federal and provincial governments). There were at least four red flags that popped up. There was no consistency in how the data was collected or the way it was reported and many errors in sampling and analysis techniques were identified. Based on this, they eliminated most of the anomalous (high readings) data. To me if I got some particularly high levels in my data that would be cause to go back immediately and redo the monitoring at that location to confirm the results. Also, the fact that they were not more elevated readings should have been a concern, because if the pollutants, from spills and effluent, were not in Hidden Bay, the question should have been asked – where are they and where should they have been looking to verify this. Lake bottoms are very soft and mushy. The clamshell sampler used for grabbing up bottom sediment samples gushes water as it is brought to the surface and it would be difficult to define horizons when it is opened up to get a quality sample from a specific layer. There are samplers now available that will take a nice clean core sample that can be brought up intact, without releasing water, so that reliable data can be measured from a particular horizon. I believe Cameco, since 1998, began using TEK-OPS corers. Based on the quality of data available Beak concluded that they could not discern any trends,

and politicians interpreted this as "no problems" – expansion went forward on new mines. So what lake sediment sampling has been done in the Beaverlodge/Athabasca Lake systems in an attempt to determine the extent of the contaminated sediments and develop predictive models that could be verified to prove pathways and possibly other remediation that could/should be undertaken? From the data gathered it seems known, to some level of accuracy, how much contamination has entered the environment; modeling should tell us where we should expect to find it; and sediment sampling should verify our predictions - if not we need to go back to the drawing board on this project.

Environmental monitoring has to be done properly and must use a predictive process to determine the effectiveness of measures taken. I think they should have been measuring total loading into the environment, and not using surface water objectives which measure concentrations. Again, concentrations depend on volume of water, and in the case of radioactive elements, may not be a good measure of impact on the environment – dilution only spreads the radiation effects over a wider area. If the monitoring of emissions into the air and water are accurate, we will know the load into the environment and should be able to predict impacts. If the impacts are other than those expected or are not where we expected them to be, their model needs correcting - we need to find out what is happening in order to have any hope of dealing with it. The mine wastes were exposed to the air for a long time. Should we be looking at other biological indicators to assess damage that has been done by winds carrying radioactive dust over the last 75 years. We needed to look at pathways for radionuclides and heavy metals – air, surface water, ground water, vegetation, effects due to ingestion by humans, wildlife, and fish, public health, epidemiological studies. We should be looking at all the physical and chemical linkages to help determine aerial and aquatic extent, frequency, duration and certainty in predictions.

I have to emphasize that the quality of the monitoring is very important but the data collected must be analyzed using

scientific principles. The premise of whether sufficient money is available for decommissioning greatly depends on the decommissioning plan which ultimately depends on data collected. I think the original decommissioning cost was expected to be about $25M and the course of action was largely based on this amount - my feeling is that this was totally the wrong approach. Perhaps this will explain why - the CNSC identified a real problem in 2006. At the Key Lake and Rabbit Lake Mill sites there are effluent pipes that also go into the lake - hey, just like the old days. I also assumed that since Uranium was a heavy metal, it would settle out in the settling ponds before mill water was released to the environment. Again, it is my understanding that once reintroduced into the environment, uranium will have potential impacts in its receiving environment for perhaps millions of years. In 2006 the CNSC found that uranium and uranium compounds were entering into the environment at uranium mines and milling operations in concentrations that may have immediate or long term effects on the environment and biodiversity. At that time the effluent being released into the environment (Horseshoe) at the Rabbit Lake operations had averaged out at 1.7 metric tonnes of uranium per year. Also molybdenum, selenium and likely many other elements. (they knew how much was being dumped and seemed to be simply indifferent to their own data - the government asked them to monitor and collect data and that is all they did - no analysis). CNSC asked them to clean up their act and in 2007 CNSC Annual Report, the findings stated Cameco had managed to cut the uranium released back to 238 kg. – about an 80% reduction. Since 2006 the reduction in uranium has actually averaged out to about 61%, according to Cameco. This means that over just a 16 years period,about 20 metric tonnes of uranium, as well as quantities of other elements, have passed into the environment at this one location. This situation has existed for much longer. Key Lake was less successful in reducing releases. If this had been a one time release event there would have been hell to pay. If Cameco can not account for where it went, that's a problem! As it is, this is still a lot. It also concerns me that this much was being passed into the receiving environment and no concerns were being raised. We can collect a lot of data, but if it is not analyzed, it is of no use. I do not want us to experience another Beaverlodge scenario. If they have not done it already, they need to do a mass balance analysis, using sediment sampling, to see if the amount of these materials entering the receiving body is remaining there or is moving on. If it is not there, they need to revise their modelling and confirm where it has

actually ended up. This is reminiscent of the report on tar sands monitoring by Schindler, Kelly et al from 2010 and the follow up report made to the government, the conclusion was that monitoring was not done in a scientific manner.

If Cameco doesn't have a pretty good idea of the pathways and where contamination has ended up, how can they be given a passing grade on the remediation that has been done and what the future holds. Cameco, or someone who is independent of the interests in this project, needs to produce a total load map to show where it all went.

I also wonder about the health studies' conclusions. Cameco concludes that the health of the locals is comparable to the Canadian population. averages. I believe the majority of Canadians live in urban environments where the exposure to carbon pollutants and the levels of stress experienced by the population would be much higher. I would think the locals should be much healthier. If their diet was also based predominantly on wild foods, this should also contribute to a healthier population, if the environment was healthy. While I am thinking of the locals - do they fully understand that, while current data from monitoring stations seem stable or improving at the moment, this will likely have no relationship to the long term and future generations. If they understood this, I think they would be asking for much more to be done - or do they have a limited role at workshops and decision making? I think if you look at figure 5 of the Webster_M_et_al_BC_Mine_2013.pdf - (see attachment) there is quite a difference in the level of satisfaction expressed by each group in attendance at the second workshop.

Finally, how do findings from this project reflect on what we are doing at more modern mine sites? The new mines that are now going forward are going to be solution mines. I haven't looked at their tailings facility - are they on the surface or undergrounde? With this process, which comes highly recommended from the states, the minerals will be chemically dissolved underground (oxygenated groundwater) and the mineralized solution brought to the surface for milling. It is likely going to be a very economical way to mine and mill. I just can't imagine an underground fracture zone, through which water flows, being chemically treated to dissolve the minerals, with no residual effect to the underground aquifers. Ditto, if the tailings go underground. Do we understand the pathways? I believe at the Dubya Lake they had difficulty determining the pathway that surface water was taking through the mine site and decided not to cap flowing boreholes because they were not sure of the outcome (perhaps it would contain water, that might have flowed into the abandoned mine, where it may affect the aquifer??) In view of this, how are they going to monitor and mitigate potential problems deep underground? They need to have a plan going in!

At Key and Rabbit Lakes, do we have more legacy projects in the making with no good decisions available to move forward? Where did all that contamination from the effluent pipes and spills go?

review: The quality of both water and sediments in Beaverlodge Lake were affected by effluent discharges and spills during the operating life of the mine. These spills must have been significant, to be on the record, as there were no environmental rules in place until 1978 and these mines operated since the 1950s. A lot of stuff went straight into the drainage areas and lake systems. Eldorado operated until 1982 and decommissioned the site in 1985. While they tore down some of the buildings, the waste rock and tailings were a mess. They covered over

existing streams and spilled into the lakes. The Beaverlodge mines and mill were operated by Eldorado mines started up after the war, in 1952. It had become a federal Crown Corporation in 1943 which merged with the Saskatchewan Mining and Development Corporation in 1988 to become Cameco, while financial responsibilities went to Eldor. Eldor receives money from the Canada Development Investment Corporation which pays for Cameco to do the remediation work, monitoring and taking care of the unexpected. They did sell large quantities of uranium to the United States Atomic Energy Commission until the early 1960s, and did so for the purpose of supplying the US military with uranium for the production of atomic weapons. The tailings and waste rock are still on the surface, vulnerable to the forces of erosion - forever. The lakes and sediments are still loaded. Perhaps go back to Stanford and try to figure out how the mineralization in the tailing can be rendered insoluble. We might have to build some cofferdams and suck (not dredge) sediments off the lake bottom so they can be treated. (Stanford - Crucial to planning of management of uranium in mine wastes is a discussion of the potential changes in chemical format that can occur under varying environmental conditions. These changes can affect the mobility of uranium in groundwater.)

The quantitative site model, QSM, was developed after 2009 to predict changes, in regards to different options, over 150 years and was tested for 2 years. Is there still faith in this model, did it track movement of sediments accurately, why wasn't a model developed for much longer time lines, to reflect the nature of the contamination. My feeling is we do not have a sufficient handle on the migration of contaminants, from the sediments, in the future in these watersheds. As such, the contaminants pose great risk and expense into the

future. Until a more thorough study of pathways and possible events in the future, and possibly a stabilization of the mineralization that is insoluble, we cannot move to Saskatchewan IC program as there is no way to predict further monitoring and remediation needed in the future or future events that will determines the funds needed to be made available .

For a more comprehensive discussion of the Beaverlodge Legacy and possible remediations not discused (10 pages), see:
https://policyalternatives.ca/sites/default/files/uploads/publications/Saskatchewan%20Office/2013/07/SKnotes_Govt_Legacy_Contamination_Watersheds.pdf

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).

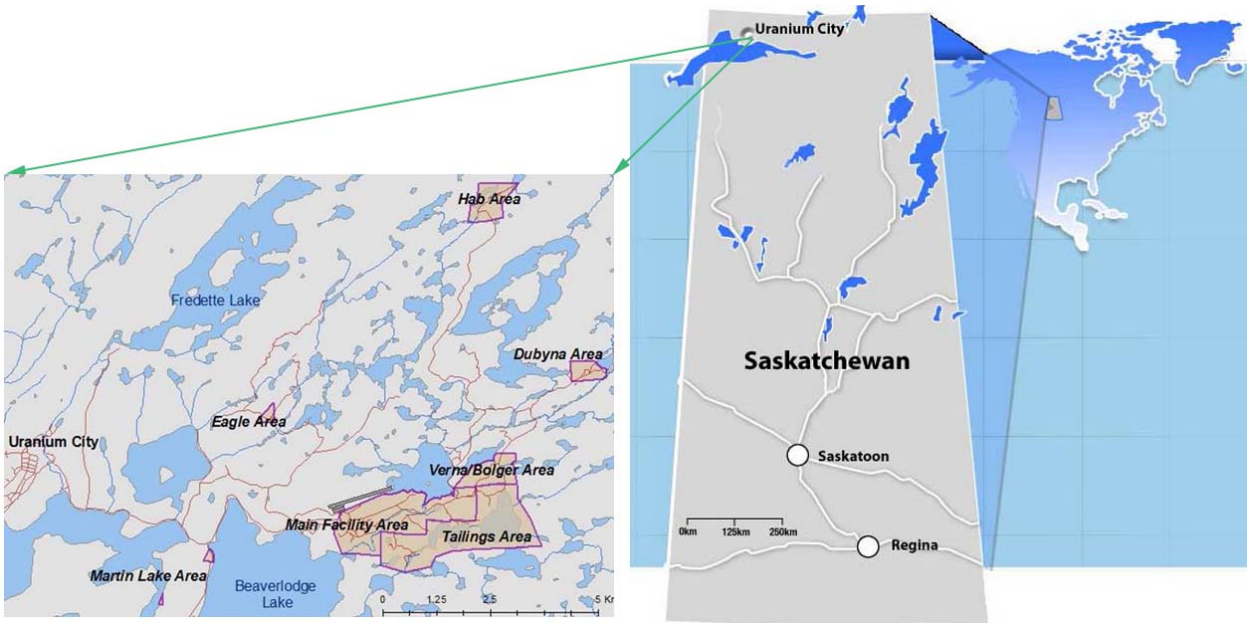

Figure 1 The Beaverlodge site is located north of Lake Athabasca in northern Saskatchewan

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.

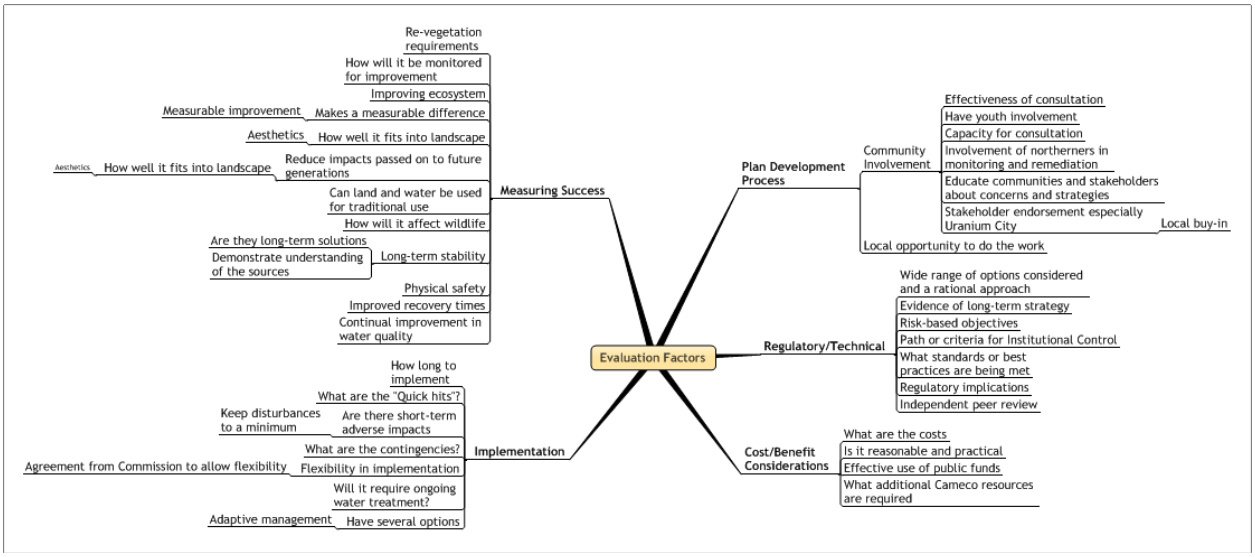

Figure 2 – Evaluation Factors to Consider for Remediation of Beaverlodge

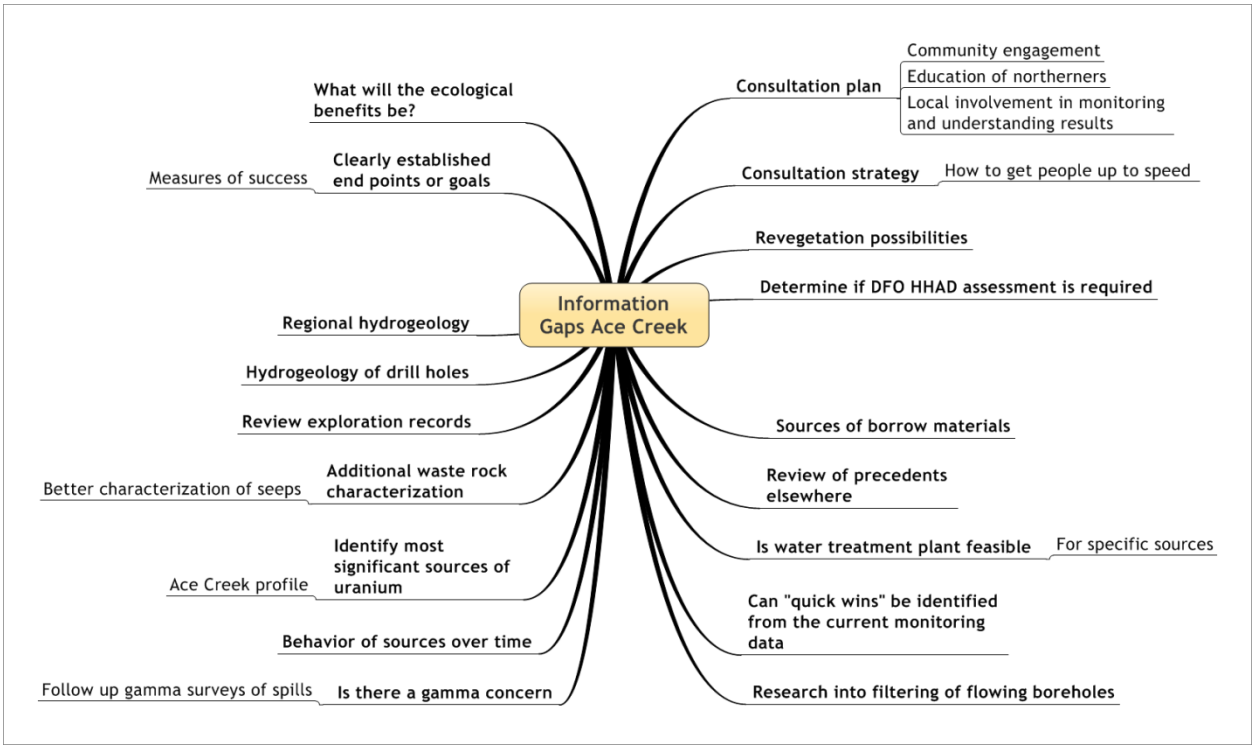

Figure 3 – Information Gaps Preventing Decisions

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.

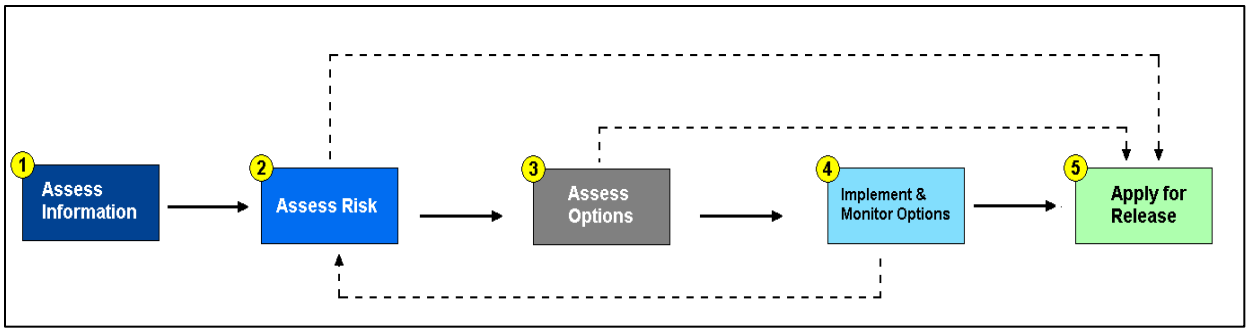

Figure 4 Simplified Beaverlodge management framework flowchart

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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