Canada's Nuclear Regulator

CNSC Staff Report on the Performance of Uranium Mine and Mill Facilities: 2013





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CNSC Staff Report on the Performance of Uranium Mine and Mill Facilities: 2013

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Cover images

From left to right:
Cigar Lake Mine
McArthur River Mine
Rabbit Lake Mine and Mill
Key Lake Mill
McClean Lake Mill

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EXECUTIVE SUMMARY

This report, titled *CNSC Staff Report on the Performance of Uranium Mine and Mill Facilities: 2013*, presents the performance of the operating uranium mine and mill facilities regulated by the Canadian Nuclear Safety Commission (CNSC). The information covers the 2013 calendar year and, when applicable, shows trends and compares information to previous years.

The report focuses on the three safety and control areas (SCAs) of radiation protection, environmental protection, and conventional health and safety which cover the key performance indicators for these facilities. The report also highlights rating changes for all 14 SCAs, along with major events, significant facility modifications and areas of increased regulatory focus. The report describes measures taken by the licensees, the CNSC and other regulatory bodies to protect the environment, and the health and safety of the public and workers.

In 2013, the CNSC conducted licence renewal public hearings for several uranium mines and mills including Cameco’s Cigar Lake Operation (April 2013) and Cameco’s Key Lake, Rabbit Lake and McArthur River operations (October 2013). During those hearings, and in their subsequent *Record of Proceedings, Including Reasons for Decision*, the Commission provided direction and recommendations to further improve and strengthen the CNSC staff report on the performance of uranium mines and mills. CNSC staff re-structured this 2013 report to incorporate the Commission’s comments. As part of licensing processes that took place in 2013, Licence Conditions Handbooks were introduced at the five uranium mines and mills.

Evaluations conducted by CNSC staff concluded that the uranium mine and mill facilities in Canada operated safely during 2013. This conclusion was based on assessments of licensee activities, site inspections, review of reports submitted by licensees, event and incident reviews, licence renewal Commission hearings and ongoing exchanges of information with the licensees.

The 2013 report includes an introductory section on environmental risk assessments at uranium mine and mills, describing how these risk assessments relate and provide input to the facilities’ environmental monitoring programs.

CNSC staff conclude that, in 2013, the five facilities discussed in this report met performance expectations with respect to the health and safety of persons, the protection of the environment, and Canada’s international obligations.

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CNSC Staff Report on the Performance of Uranium Mine and Mill Facilities: 2013

1 Introduction

1.1 Background

The *CNSC Staff Report on the Performance of Uranium Mine and Mill Facilities: 2013* summarizes the Canadian Nuclear Safety Commission (CNSC) staff's assessment of the safety performance of operating uranium mine and mill facilities. The assessment aligns with the legal requirements of the *Nuclear Safety and Control Act* (NSCA) and its associated regulations, facility licenses, applicable standards and regulatory documents. The report highlights areas of regulatory focus for CNSC staff including information on requirements and expectations, and provides information on significant events, licence changes, major developments and overall performance. The report summarizes performance data on the safety and control areas (SCAs) of radiation protection, environmental protection and conventional health and safety. The information presented covers the 2013 calendar year and, when applicable, compares information to previous years.

The 2013 report has 11 appendices:

- Appendix A: Safety and Control Area Framework for Uranium Mines and Mills
- Appendix B: Rating Methodology and Definitions
- Appendix C: Trend in Safety and Control Area Ratings
- Appendix D: Financial Guarantees
- Appendix E: Worker Dose Data
- Appendix F: Decommissioning and Reclamation Activities
- Appendix G: Environmental Reportable Spills in 2013 and CNSC Spill Rating Definitions
- Appendix H: Lost-time Incidents in 2013
- Appendix I: Concentrations of Metals and Radionuclides in Soil
- Appendix J: Links to Provincial and Licensee Websites
- Appendix K: Acronyms

1.2 CNSC regulatory efforts

As part of its mandate, the CNSC regulates Canada's uranium mines and mills: to protect the health and safety and security of persons; to protect the environment; to ensure that Canada continues to implement its international commitments on the peaceful use of nuclear energy; and to disseminate objective scientific, technical and regulatory information to the public. The CNSC achieves part of this mission by ensuring licensee compliance through verification, enforcement and reporting.

CNSC staff establish compliance plans for each facility based on risk-informed regulatory oversight of the facility's activities to identify appropriate levels of regulatory monitoring and control. Modifications to the compliance plans are made on an ongoing basis in response to events, facility modifications and changes in licensee performance.

Inspections conducted by CNSC staff in 2013 covered various aspects of applicable safety and control areas, utilizing a risk-informed decision process for compliance activities, commensurate with the risk associated with these facilities. The inspections confirmed the following:

- Radiation protection measures were effective and results remained as low as reasonably achievable (ALARA). No worker at any uranium mine or mill facility exceeded the regulatory individual effective dose limit in 2013.
- Conventional health and safety programs continued to protect workers.
- The environmental protection program was effective and results remained ALARA. There were 14 environmental reportable spills, compared to 15 in 2012. All spills were of low significance and were cleaned up appropriately, with no residual impact to the environment.

CNSC staff also verify compliance through desktop reviews of reports, applications and licensee programs, which are supplemented with meetings, presentations, and facility visits.

The CNSC continues to apply an inspector training and qualification program. This program standardizes the core training courses required for inspectors to ensure uniform and consistent training throughout the CNSC as a whole. The CNSC also developed and implemented "conduct of inspections" and "on-the-job training" procedures for inspectors to maintain a consistent approach for both existing and new inspection personnel.

1.2.1 Fukushima

CNSC staff continued to analyze and apply the lessons learned from the 2011 nuclear accident at TEPCO's Fukushima Daiichi nuclear power plant in Japan. CNSC staff previously updated the Commission on CNSC's action plans on Fukushima. These updates were presented in 2012 and 2013, as referenced below:

- CMD 12-M56, *Status Update on the CNSC Action Plan: Lessons Learned from the Fukushima Accident*, October 2012
- CMD 13-M34, *Status Update on the CNSC Integrated Action Plan: Lessons Learned from the Fukushima Accident*, August 2013
- CNSC staff also provided updates in previous annual performance reports and during the licence renewal commission hearings for the uranium mines and mills

The uranium mine and mill facilities were required to re-examine safety cases for their facilities and to report on implementation plans for short-term and long-term measures to address any gaps discovered. For the uranium mine and mill facilities covered by this report, the licensee reviewed existing safety cases and emergency management programs against their ability to withstand extreme external events. As a result, the licensees developed facility-specific improvement initiatives, based on their facility's hazards and site characteristics, to address the recommendation to strengthen defense-in-depth.

Cameco conducted formal reviews of their emergency preparedness and response plans at their northern Saskatchewan facilities. In particular, the licensee evaluated capabilities to deal with multiple natural disaster scenarios, such as a forest fire and power outage. These reviews confirmed the appropriateness of the programs implemented to protect the health and safety of people and the environment during potential natural disaster situations.

AREVA conducted a multi-incident mock scenario, which included power loss, to evaluate the effectiveness of their emergency response. Corrective actions as a result of the exercise included identification of ways to summon the emergency response team without the use of radios, computers or a paging system. This exercise confirmed the appropriateness of the programs implemented to protect the health and safety of people and the environment during a potential power loss scenario.

CNSC staff reviewed and verified the licensees' reports and findings. CNSC staff concluded that the underlying defence-in-depth controls were in place to deal with natural disasters and severe accidents, and confirmed that the facilities were operating in a safe manner and that they continue to make improvements as part of ongoing operations

CNSC staff are satisfied that the uranium mine and mill facilities have completed their facility-specific improvement initiatives to address lessons learned from the Fukushima accident. There are no remaining actions for the uranium mines and mills.

Figure 1-1: Commission meeting involving CNSC staff

1.2.2 Continuous improvements

The CNSC is committed to ongoing continuous improvement taking into account changes in the environment (such as increased severity of weather patterns). At the time of writing this CMD, the breach of the tailings pond occurred at the Mount Polley mine. As an immediate response, the Executive Vice-President and Chief Regulatory Operations Officer requested CNSC licensees to review their facilities safety cases. CNSC inspectors have visited the sites where above-ground tailings are present. CNSC staff will update the Commission at the October meeting.

1.3 Environmental risk assessment and environmental monitoring programs

Of the 14 safety and control areas (refer to Appendix A), safety analysis is one of the more significant safety and control areas for major facilities such as uranium mines and mills as it is used at the start of any major project proposal and throughout the project lifecycle to assess the hazards and risks of the regulated facilities and activities. The design, engineering and administrative controls, and the safety and control programs for the regulated facilities and activities are optimized as a result of safety analyses.

Safety analyses are conducted using various tools such as risk assessments, hazard operability assessments, accident and malfunction assessments and change assessments. Environmental risk assessment (ERA) is the primary tool used by licence applicants, the CNSC and other federal and provincial regulators for assessing the potential risk to the environment from any proposed new mine or mill. It is the core tool in the conduct of environmental assessments and is routinely used during the project life to evaluate any major changes to the facility or activities that have the potential to adversely impact the environment.

The ERA process addresses four major points:

- entry of contaminants into the environment
- estimated exposure of biota (human and non-human) to contaminants of concern
- expected effects on biota at different levels of exposure
- quantification and characterization of risk

An ERA starts with an assessment of facilities and activities (e.g., mining and milling of uranium ore, tailings and waste rock management) to identify their potential to release hazardous substances to air, water and soil. From this assessment, a detailed inventory of these substances and their predicted concentration and quantity (e.g., loading) in effluents and at the point of release into the environment (e.g., outside air and surface water) is compiled. These are reviewed for potential environmental impacts using conservative quantitative criteria from authoritative sources (e.g., *Saskatchewan Surface Water Quality Objectives*, *Canadian Environmental Quality Guidelines*) to focus the ERA on a list of "contaminants of potential concern" (COPC).

Typically, out of a few hundred substances, only a small number are carried forward for detailed risk assessment as COPCs to further determine whether they pose a risk to humans and non-human biota. The facility design, engineering controls and facility programs are then optimized to ensure people and the environment are protected and risks are minimized in accordance with the ALARA principle.

Coupled with COPCs already identified in existing mine regulations such as the *Metal Mine Effluent Regulations*, the ERA will identify any additional facility specific releases of COPCs which must be controlled and monitored in effluents (e.g. stack emissions, end of pipe releases of treated water to streams and lakes) and the receiving environment (e.g. air, soil, water and biota). While the effluent monitoring program will monitor what goes into the environment, the environmental monitoring program will verify that the COPC behaves as predicted in the receiving environment (e.g., concentration, quantity, movement in the environment and uptake in biota) and that the public and the environment continue to be protected. The CNSC expects these monitoring programs to be implemented and updated as required for the entire project life including post decommissioning.

The predictions made in the ERA and the results of the effluent and environmental monitoring programs are reassessed by the licensee in a status of the environment report that is typically completed every five years. The CNSC and the Saskatchewan Ministry of Environment staff review licensee monitoring program results on a regular basis, and the status of the environment report(s) when released. These reports include a review of the environmental monitoring program results by licensees, the CNSC and other regulators to ensure the continued protection of the public and the environment. The licensees are expected to modify and improve their environmental protection program to address any findings.

The methodology for ERA, effluent monitoring and environmental monitoring have recently been documented in a series of environmental protection standards published by the Canadian Standards Association (CSA) for Class I facilities and uranium mines and mills. These include:

- CSA N288.4 (2010) – *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*
- CSA N288.5 (2011) – *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*
- CSA N288.6 (2012) – *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills*

All uranium mine and mill facility licenses include licence conditions for safety analysis and environmental protection programs. The associated licence conditions handbooks include references to the three CSA standards noted above. Through inspections and desktop reviews CNSC staff verifies that the licensees programs are in compliance with these standards and that the facility design, engineering and administrative controls, and programs continue to be effective in protecting the public and the environment.

1.4 Eastern Athabasca Regional Monitoring Program (EARMP) – Country Foods

The Eastern Athabasca Regional Monitoring Program (EARMP), which includes a community program, was established by the Province of Saskatchewan in 2011. The community program monitors the safety of traditionally harvested country foods including water, fish, berry and mammal chemistry from representative communities located in the region. The complete report is available at the Provincial website referenced in Appendix J.

The evaluation of the country food data (2011 and 2012 community program) showed that most chemical concentrations were below available guidelines and were similar to concentrations expected for the region. The results of the evaluation indicated that non-radiological exposures to residents from country food consumption were similar to exposures of the general Canadian population and were below values that are considered to be protective of health effects. Overall, the results indicated that traditional harvesting of country foods did not present health risks to Athabasca Basin residents. The information will also provide baseline data to compare future monitoring data of country foods to ensure that they continue to be safe for consumption.

Potential radiological exposure to residents in the communities of the Eastern Athabasca region from consumption of country foods is below the public dose limit of 1.0 mSv/year. CNSC staff conclude that the dose received from consumption of country foods is not a concern to human health.

CNSC staff agree with the provincial *Human Health Risk Assessment* (2013) that used the EARMP community data to confirm that country foods assessed were safe to consume.

Figure 1-2: Key Lake environmental sampling

2 Overview

This report focuses on the uranium mine and mill facilities currently operating in Canada. The facilities discussed are located within the Athabasca Basin of northern Saskatchewan. These facilities are:

- Cameco Corporation (Cameco): Cigar Lake Operation
- Cameco Corporation (Cameco): McArthur River Operation
- Cameco Corporation (Cameco): Rabbit Lake Operation
- Cameco Corporation (Cameco): Key Lake Operation
- AREVA Resources Canada Inc. (AREVA): McClean Lake Operation

The locations of the uranium mine and mill facilities are shown in figure 2-1 below:

Figure 2-1: Location of uranium mines and mills in Saskatchewan

In 2013, CNSC staff performed 20 planned inspections at these five uranium mines and mills. Other regulatory bodies including Saskatchewan's Ministry of Environment, Saskatchewan's Ministry of Labour Relations and Workplace Safety and Environment Canada also conduct inspections at these facilities. CNSC staff take into account the findings from other regulatory bodies when assessing the licensees' performance.

In the management of these facilities, the licensees are responsible for the health and safety of all workers on site. Table 2-1 shows the total number of nuclear energy workers (NEWs) monitored at each of the five operating mines for 2013. An individual worker who is required to work with a nuclear substance or in a nuclear industry is designated as a NEW if there is a reasonable probability of receiving an individual effective dose greater than the prescribed effective dose limit for a member of the public (1 mSv in a calendar year).

Table 2-1: Total number of NEWs at each of the five operating facilities, 2013

	2013				
	Cigar Lake	**McArthur River**	**Rabbit Lake**	**Key Lake**	**McClean Lake**
Total NEWs	3,039	1,302	1,178	1,321	308

At uranium mine and mill facilities, persons designated as NEWs are issued optically-stimulated luminescence dosimeters to directly monitor their gamma radiation dose (figure 2-2).

Figure 2-2: An optically-stimulated luminescence dosimeter

Appendix A describes the 14 safety and control areas (SCAs) used by the CNSC in its regulatory evaluations of each facility. The licensee’s requirements to satisfy each SCA depend on the risks posed by activities conducted at each facility. A discussion of rating methodologies and definitions can be found in Appendix B. Appendix C contains the SCA performance ratings for each facility from 2009 to 2013.

The 2013 SCA performance ratings for the uranium mines and mills facilities are presented below in table 2-2. In 2013, all SCAs were rated as “satisfactory” (SA). The conventional health and safety SCA for the Cigar Lake Operation, which was rated as “fully satisfactory” (FS) in 2012, has now been rated as “satisfactory” in 2013. This downward change in rating is due to four lost-time incidents in 2013.

Table 2-2: Uranium mines and mills – 2013 SCA performance ratings

Safety and control area	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

The 2013 uranium production data for the mine and mill facilities is shown in table 2-3 to provide a sense of the relative magnitude of mining and milling activities.

The top section of table 2-3 shows the mining production data for the three operating mines: Rabbit Lake, Cigar Lake and McArthur River. The bottom section of table 2-3 displays the milling production data for the two operating mills: Rabbit Lake and Key Lake. At Rabbit Lake the difference in the mine ore grade and the mill feed grade reflects the practice of blending stockpiled material with newly mined ore. At Key Lake, McArthur River ore is blended with stockpiled lower-grade material to produce a lower grade mill feed. CNSC staff verified that annual production at each facility remained within the licence production limits (shown on table 2-3). Production limits may be reviewed and revised, subject to regulatory reviews and approvals, including licence amendments.

Table 2-3: Uranium mines and mills – 2013 production data

Production data	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
Mining – ore tonnage (tonnes/year)	234	104,132	170,960	No mining	No mining
Mining – average ore grade mined (% U expressed as U_3O_8)	1.40%	8.83%	0.91%	No mining	No mining
Mining – U mined [expressed as U_3O_8 (kg)]	3,851	9,190,232	1,559,435	No mining	No mining
Mining – licence production limit [expressed as U_3O_8 (kg)]	10,908,000	9,551,887	Not applicable	Not applicable	Not applicable
Milling – mill ore feed (tonnes/year)	No milling	No milling	334,976	184,099	0
Milling – average mill feed grade (% U expressed as U_3O_8)	Not applicable	Not applicable	0.54%	5.03%	Not applicable
Milling – mill recovery (% of U)	Not applicable	Not applicable	97.2%	99.3%	Not applicable
Milling – U concentrate produced (kg U_3O_8)	Not applicable	Not applicable	1,871,649	9,132,199	0
Milling – licence production limit [expressed as U_3O_8 (kg)]	Not applicable	Not applicable	7,665,094	9,257,075	5,909,090

The Cigar Lake Operation was under construction for most of 2013. In December 2013, the first Jet Boring System (JBS) mining of one cavity was completed. The McClean Lake Operation continued under temporary shutdown for both mining and milling.

Figure 2-3: Underground drilling

Uranium mine and mill facilities are required to develop decommissioning plans which are reviewed and approved by CNSC staff. Each plan is accompanied by a financial guarantee that provides the funding necessary to complete the decommissioning work. The plans are based on a hypothetical "decommission tomorrow" scenario, and provide the current preferred methodology and schedule for decommissioning. Both the CNSC and the Saskatchewan Ministry of Environment require the decommissioning plan and financial guarantee for each facility to be reviewed at least every five years. The financial guarantee must be approved by the Commission and is provided through letters of credit that are held in trust by the Province of Saskatchewan. Appendix D lists the financial guarantees for the mine and mill facilities as of June 2014. They range from approximately C$43 million (at McClean Lake Operation) to C$220 million (at Key Lake Operation), with a total of approximately C$568 million for the five facilities.

During the 2013 licence renewals, the Commission asked licensees to prepare timeline estimates for the completion of each of the major reclamation and decommissioning activities planned at the mine and mill facilities. The timeline for a facility provides an estimate of the mine or mill's life based on current reserves, future production estimates and general reclamation and decommissioning plans. It is important to note that the timelines are estimates based on current information and are subject to change over time. Appendix F contains the timeline estimates for the completion of major reclamation and decommissioning activities for each of the five mine and mill facilities, as prepared by the licensees.

The goal of reclamation and decommissioning efforts are to return the site to an ecological and radiological condition as similar to the original environment as reasonably achievable. The facilities employ a progressive reclamation strategy intended to actively reclaim areas during the course of regular operations, where economically and operationally feasible.

2.1 Radiation protection

Uranium mines and mills in Canada are required to implement and maintain a comprehensive radiation protection program in accordance with section 4 of the *Radiation Protection Regulations*. For 2013, CNSC staff rated the radiation protection SCA at all five uranium mines and mills as "satisfactory".

Primary sources of radiation exposure at uranium mines and mills include:

- gamma radiation
- long-lived radioactive dust
- radon progeny
- radon gas

Activities conducted by CNSC staff to ensure compliance with radiation protection requirements at uranium mines and mills include regular inspections, as well as reviews of radiation protection programs, compliance reports, monitoring data and radiation dose statistics.

Workers are issued optically-stimulated luminescence dosimeters (from a CNSC-licensed dosimetry service provider), which measures external gamma radiation dose. Underground workers also wear personal alpha dosimeters to measure alpha radiation exposure from radon progeny and long-lived radioactive dust. Where direct monitoring through dosimeters is not practical, area/group monitoring and time cards are used for worker dose estimates.

The uranium mine and mill facilities have continued to maintain and implement comprehensive radiation protection programs based on the ALARA principle ("as low as reasonably achievable"). As part of the ALARA program, facilities set objectives to keep doses well below the regulatory limits.

Uranium mine and mill operations are remote from local populations. Radiological exposures measured at the licensed facility boundaries are maintained near background radiation levels, ensuring the public is protected.

In 2013, no worker at any uranium mine or mill facility exceeded the regulatory individual effective dose limits.

Radiation doses

The individual effective dose limit for a nuclear energy worker (NEW) is 50 mSv in a one-year dosimetry period and 100 mSv in a five-year dosimetry period. In addition, action levels have been developed, which, if exceeded, signify a potential loss of control of a portion of the radiation protection program. All the five uranium mine and mill facilities listed in this report have the same action levels of 1 mSv/week and 5 mSv/quarter of a year. Appendix E contains tables displaying the average individual effective dose and maximum individual effective dose for each operating facility during the 2009-2013 period. In 2013, all operating uranium mine or mill facilities were well below regulatory individual effective dose limits as shown in table 2-4.

Table 2-4: Individual effective dose data for nuclear energy workers

Facility	Average individual effective dose in 2013 (mSv/yr)	Maximum individual effective dose in 2013 (mSv/yr)	Regulatory limit
Cigar Lake Operation	0.27	2.21	**50 mSv/yr**
McArthur River Operation	0.89	7.58	
Rabbit Lake Operation	1.30	11.67	
Key Lake Operation	0.62	5.67	
McClean Lake Operation	0.36	3.44	

Figure 2-4 compares the average individual effective dose and maximum individual effective dose at each uranium mine and mill during the 2013 reporting period.

Figure 2-4: Uranium mines and mills – comparisons of average individual and maximum effective dose of NEWs in 2013

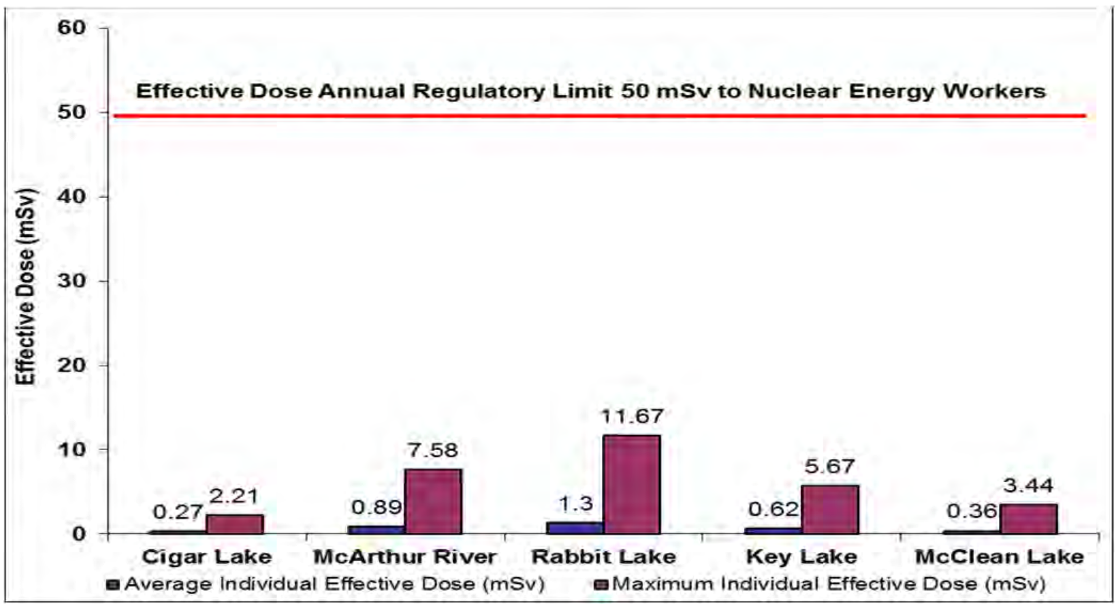


Figure 2-4 shows that the average individual effective doses and the maximum individual effective doses are well below the regulatory limit of 50 mSv/yr. CNSC staff were satisfied that uranium mine and mill licensees are controlling radiation doses to workers at levels well below the regulatory limits, keeping doses ALARA.

Cigar Lake Operation continued construction activities throughout 2013, but also conducted its first jet boring system mining activity in December. Worker exposures at Cigar Lake Operation were very low with the average individual effective dose of 0.27 mSv, and the maximum individual effective dose for a full-time Cigar Lake worker of 2.21 mSv.

The maximum individual effective dose in 2013 was 11.67 mSv, received by a worker at the Rabbit Lake facility. The Rabbit Lake and McArthur River facilities had higher average and maximum individual effective doses when compared to the remaining facilities, since underground mining work activities are conducted closer to the radioactive source than milling operations. Rabbit Lake and McArthur River operations recorded average individual effective dose of 1.30 and 0.89 mSv, and maximum individual effective dose exposures of 11.67 and 7.58 mSv, respectively. Rabbit Lake Operation includes both a mine and a mill, so the average individual effective dose shown in figure 2-4 includes both mine and mill workers. In 2013 at the Rabbit Lake Operation, the maximum individual effective dose to a mill worker was 5.40 mSv, while for an underground miner, the maximum individual effective dose was 11.67 mSv.

Key Lake Operation had an average individual effective dose of 0.62 mSv and a maximum individual effective dose of 5.67 mSv.

McClean Lake Operation remained in a state of temporary shutdown in 2013 with construction and maintenance upgrades as the main activities taking place in the mill. The maximum individual effective dose at McClean Lake Operation was 3.44 mSv.

Based on the outcome of inspections and reviews of the radiation protection program, work practices, monitoring results and effective doses, CNSC staff were satisfied that uranium mine and mill licensees are controlling radiation doses to workers at levels well below the regulatory limits, keeping doses ALARA.

2.2 Environmental protection

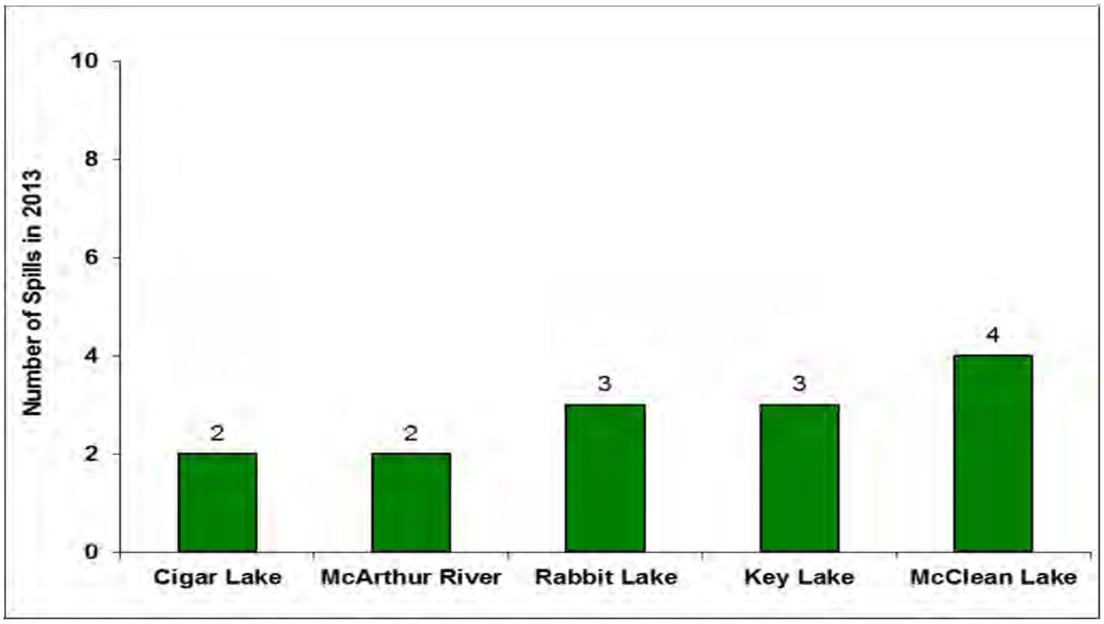
For 2013, CNSC staff rated the performance of all five uranium mine and mill facilities for the environmental protection SCA as “satisfactory”.

The environmental protection SCA covers programs that identify and monitor releases of nuclear and hazardous substances and their effects on the environment resulting from licensed activities. Licensees are required to develop and implement policies, programs and procedures to comply with applicable federal and provincial regulatory requirements to control the release of nuclear and hazardous substances into the environment. Licensees are also expected to have suitably trained and qualified staff to effectively develop, implement and maintain their environmental protection programs. These programs include an environmental management system (EMS) that is integrated into the facilities’ overall management systems. The environmental protection program includes environmental codes of practice that set out licensee administrative levels and action levels for effluent released to the environment.

Licensees are required to report to the CNSC any unauthorized release of hazardous or nuclear material to the environment. CNSC staff verified, and are satisfied, that the licensees’ reporting, communication and response to environmental spills and other environmental incidents was in conformance with regulatory requirements during 2013.

Figure 2-5 depicts the number of environmental reportable spills for uranium mine and mill facilities in 2013. The reported spills were remediated to a satisfactory level, resulting in negligible risk to personnel, the public or the environment.

Figure 2-5: Uranium mines and mills – environmental reportable spills, 2013



Appendix G further describes each reportable spill and the corrective action(s) taken by the licensee in response to the spill. The licensee investigated the causes of spills and implemented corrective actions to remediate and prevent a recurrence. CNSC staff reviewed licensee actions to ensure effective remediation and prevention, and were satisfied with actions taken by the licensee. CNSC rated the spills as low significance with no residual impact to the environment in accordance with table G-2 CNSC spill rating definitions of appendix G.

Figure 2-6: CNSC inspector discussing environmental performance

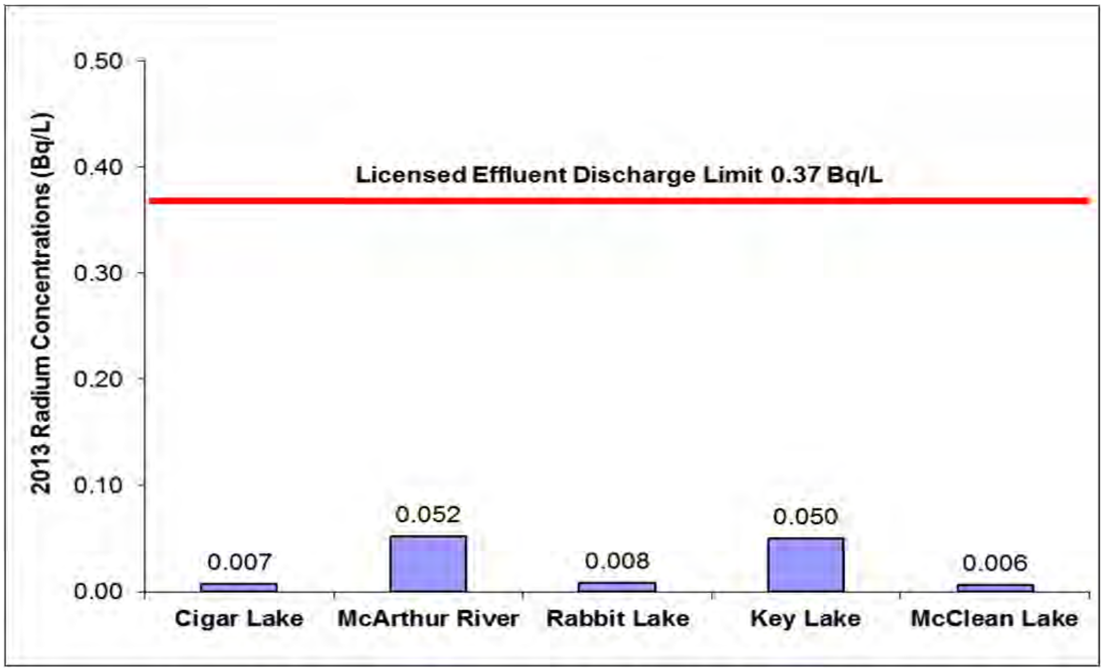
In 2013, all treated effluents released to the environment from licensed mining and milling activities met effluent discharge limits stipulated in the CNSC operating licences, except for a single incident of pH exceedance at Key Lake. This exceedance will be discussed in Key Lake Operation section 6.3 “Environmental protection”.

Effluent discharge is measured against the administrative levels and action levels specified in each licensee’s environmental code of practice. Exceedance of an administrative level indicates that operating performance is at the upper range of normal operations and triggers an internal review by the licensee. Exceedance of an action level indicates a potential loss of operational control which triggers actions that must be taken by the licensee to correct the problem. Administrative and action levels thus provide an early warning to minimize upsets and prevent an exceedance of a regulatory discharge limit. Facility administrative and/or action levels are determined through the identification and proper operation of available treatment technologies, as well as facility-specific environmental risk studies.

Environmental risk assessments conducted on uranium mine and mill facilities by the CNSC and the licensees, and environmental monitoring data collected prior to 2009, identified releases of molybdenum, selenium and uranium as constituents of potential concern. As a result, licensees were required to improve engineering controls and treatment technologies to reduce effluent releases of these contaminants. Subsequently, treatment technologies implemented continue to effectively keep these contaminant concentrations stable and at acceptable levels in 2013.

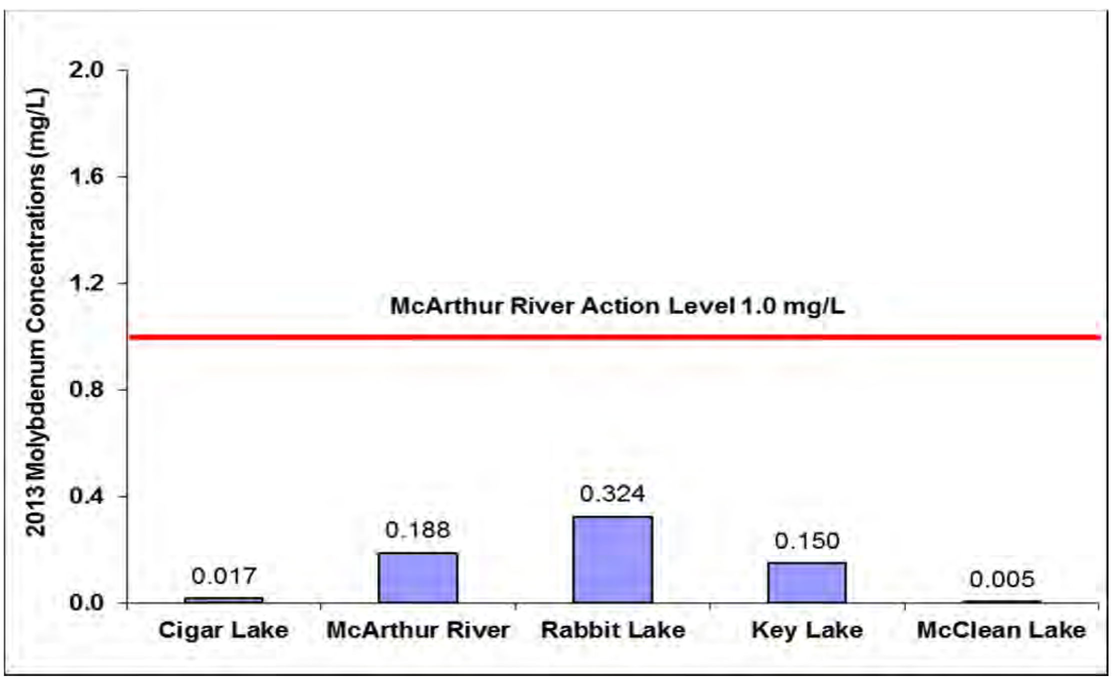
Treated effluent monitoring data provides an overview of the quality of the effluent released from these facilities. Figures 2-7 to 2-10 display the 2013 average annual effluent concentrations for radium-226, molybdenum, selenium and uranium at the five mine and mill facilities.

Figure 2-7: Annual average concentration of radium-226 in effluent released to the environment, 2013



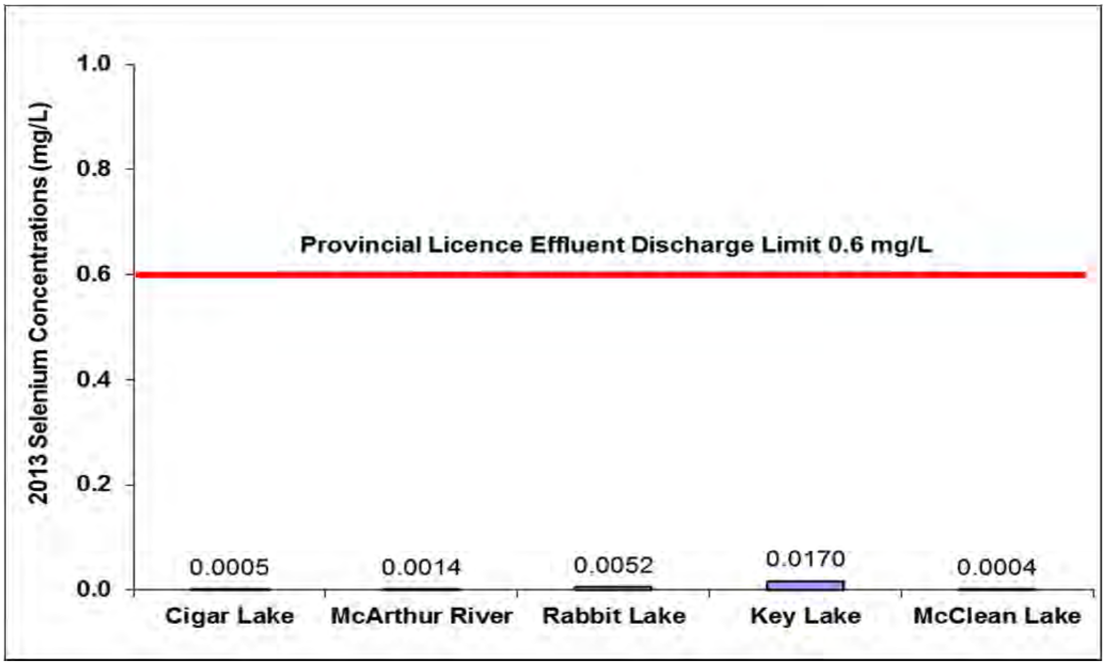
The 2013 radium-226 annual average effluent concentrations for the five facilities was well below the CNSC's licence-authorized effluent discharge limit, as shown in figure 2-7.

Figure 2-8: Annual average concentration of molybdenum in effluent released to the environment, 2013 (McArthur River action level is based on 10 consecutive ponds exceeding the administrative level of 1.0 mg/L for molybdenum and is shown for reference only)



In the absence of a federal or Province of Saskatchewan limit for molybdenum, the CNSC requires licensees to develop facility-specific effluent controls within their individual environmental codes of practice. For molybdenum effluent concentrations (figure 2-8), the McArthur River code of practice action level is shown for reference only and is based on 10 consecutive ponds exceeding the administrative level trigger of 1.0 mg/L. The 2013 molybdenum average effluent concentrations for the five facilities are well below the McArthur River code of practice action level.

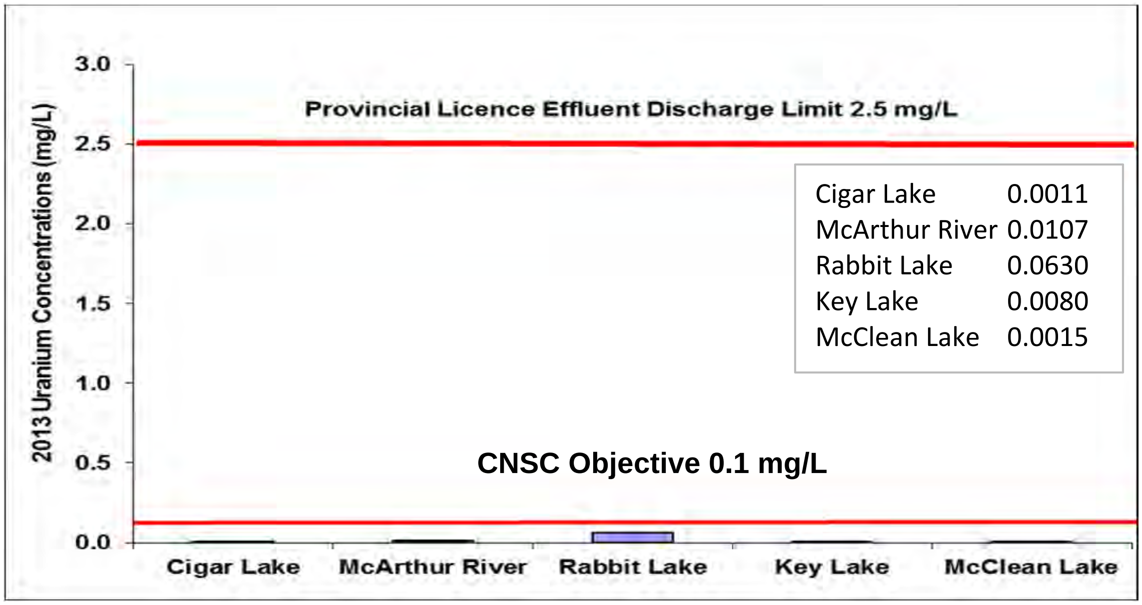
Figure 2-9: Annual average concentration of selenium in effluent released to the environment, 2013 (Province of Saskatchewan's licensed effluent discharge limit for selenium is shown for reference only)



The Province of Saskatchewan's licensed effluent discharge limits for selenium and uranium are shown in figures 2-9 and 2-10. These provincial limits are provided for reference only, as no federal limits are currently established. Nevertheless, the CNSC expects performance well below these limits, and requires licensees to continually try to reduce effluent contaminant concentrations to be as low as reasonably achievable (ALARA). Figures 2-9 and 2-10 demonstrate that both selenium and uranium concentrations in treated effluent released to the environment in 2013 remained well below the provincial licence limits.

The Saskatchewan provincial licence limit for uranium is a maximum monthly mean of 2.5 mg/L. However, the *Priority Substances List 2 Assessment* (Environment Canada and Health Canada, 2003) and Rabbit Lake Operation environmental investigations indicated that such limits were not adequately protective of the environment in all circumstances. In 2006, a review identified a concentration of uranium in effluent of 0.1 mg/L as a potential treatment design objective that could be achieved and is protective of the environment. The CNSC is using this value (0.1 mg/L uranium) as an interim objective for uranium mine and mill facilities which the five facilities met in 2013.

Figure 2-10: Annual average concentration of uranium in effluent released to the environment, 2013 (Province of Saskatchewan's licensed effluent discharge limit for uranium is shown for reference only. The CNSC objective is 0.1 mg/L)



Details on effluent release concentrations, with five-year trends, for molybdenum, selenium, and uranium are discussed in the facility-specific sections, 3.0 to 7.0, of this report.

In addition to concentration results of molybdenum, selenium, uranium and radium-226 in treated effluent released to the environment, the facilities also analyze for concentrations of arsenic, copper, lead, nickel, zinc, total suspended solids (TSS) and for pH. Table 2-5 displays the licensed discharge limits and the annual average parameter concentration values in effluent released in 2013 for these additional parameters. The annual average parameter concentration values for arsenic, copper, lead, nickel, zinc, TSS, and pH in effluent released to the environment are shown to be meeting licensed discharge limits.

Table 2-5: Annual average parameter concentration values in effluent released to the environment in 2013

Parameters	Licensed discharge limits	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
Arsenic (mg/L)*	**0.5**	0.0006	0.0017	0.0055	0.0080	0.0006
Copper (mg/L)	**0.3**	0.0032	0.0011	0.0045	0.0130	0.0030
Lead (mg/L)	**0.2**	0.0001	0.0001	0.0001	0.0100	0.0001
Nickel (mg/L)	**0.5**	0.0029	0.0012	0.0144	0.0067	0.0180
Zinc (mg/L)	**0.5**	0.0085	0.0014	0.001	0.009	0.0009
TSS	**15**	1.4	1.0	2.0	1.8	1.0
pH	**6.0-9.5**	7.2	7.2	7.2	6.3	7.2

* mg/L – milligram per litre

CNSC staff review the licensees' environmental monitoring results, as submitted in monthly, quarterly and annual reports. Each licensee also submits a *Status of the Environment Report* every five years providing CNSC staff with more detailed monitoring information and comparisons to environmental assessment predictions.

Uranium mines and mills environmental programs include monitoring the effects of the operations on the surrounding air and soil. All uranium mine and mill facilities measure airborne particulate levels using high volume air samplers, and measure the concentration of radon gas in the ambient air around each operation.

A high volume sampler is used to collect particles from the atmosphere by drawing in large volumes of air using a mechanical pump. This provides concentrations of total suspended particulates (TSP) in the air. The particles are collected on a filter and can later be analyzed for their physical and/or chemical properties such as concentrations of metal and radionuclides.

The radon track-etch detector is used to passively measure the radon concentration in air over a determined period of time. The detector consists of a sensitive material which is bombarded by the alpha particles released by radon gas as it decays. When the material is developed the tracks become visible. The number of tracks on the material is related to the radon concentration in the air.

Monitoring of contaminant concentrations in soil and terrestrial vegetation is completed by the licensee to verify acceptable operational impacts. Facilities with milling operations perform stack tests to monitor atmospheric emissions from yellowcake dryers, calciner operations and acid plants. The applicable Saskatchewan provincial ambient air standards include total suspended particulates and sulphur dioxide. Other measured parameters (e.g., ambient radon and stack testing for sulphur dioxide, uranium and heavy metals) verify facility design and evaluate the operations against predictions made in environmental risk assessments.

The operations have demonstrated good performance on mitigating and monitoring the effects of the operations on the surrounding air and soil. The monitoring results indicate negligible impacts from atmospheric releases and all uranium mines and mills are in compliance with their programs and provincial standards. All facilities conduct regular soil and vegetation monitoring to demonstrate that environmental impacts remain within acceptable levels. Generally, the results indicate that the facilities have slightly higher than background concentrations for some samples collected in the immediate vicinity of facility activities; however, the concentrations decrease to background levels within a short distance from the areas of activity. Overall, the results indicate that the operations have had a localized effect on vegetation in the areas of activity.

2.2.1 Treated mining/milling effluent: A comparison of the uranium mining sector to other metal mining sectors across Canada

Summary

The effluent quality of the uranium mine and mill facilities compares favorably to other mining sectors of base metal, precious metal and iron metal mines.

Basis for comparison

All metal mines and mills in Canada are subject to the *Metal Mining Effluent Regulations* (MMER) of the federal *Fisheries Act*. CNSC incorporates the effluent limit requirements of the MMER in uranium mine and mill licenses. Compliance with the MMER limits is a good environmental performance indicator across the metal mining industry.

MMER data from 2012 is used for comparison within this report since it is the most current sector-specific MMER information available. Effluent quality data for uranium mines and mills is compared to base metal, precious metal and iron mines.

The MMER specifies the maximum concentration limits in effluent for arsenic, copper, lead, nickel, zinc, radium-226, TSS and an allowable pH range. Effluents must also be non-toxic and pass the trout acute-lethality test.

The data used for analysis and comparison is acquired from Environment Canada's annual report titled *The Summary Review of Performance of Metal Mines Subject to the Metal Mining Effluent Regulations*. The mines reporting under the MMER are grouped into four metal mining sectors based on the primary metal produced. The metal mining sectors are:

- uranium – 5 mines
- base metals (such as copper, nickel, molybdenum or zinc) – 51 mines
- precious metals (such as gold or silver) – 55 mines
- iron – 6 mines

Performance indicators

The environmental performances of the four metal mining sectors are compared using the following performance indicators:

a) Compliance with the effluent concentration limits and pH at all times

For this comparison, a mine is "in compliance" if it adheres to all regulated parameters at all times (excluding toxicity tests). Table 2-6 displays the percentage of each mining sector that adheres to all regulated parameters (excluding toxicity tests) over the five years 2008 to 2012. The uranium sector maintained 100 percent compliance with the effluent contaminant concentrations and pH limits for the years 2008 to 2011, and reported 80 percent compliance for 2012.

Table 2-6: Percentage of mines in compliance with MMER by sector, 2008–2012

Mining sector	Year				
	2008	2009	2010	2011	2012
Uranium	100%	100%	100%	100%	80%
Base metal	60%	58%	65%	65%	84%
Precious metal	80%	79%	87%	70%	75%
Iron	67%	50%	20%	33%	67%
All metal mines	71%	69%	75%	67%	78%

As reported in the *CNSC Staff Report on the Performance of Uranium Fuel Cycle and Processing Facilities: 2012*, the McArthur River Operation had one regulatory effluent exceedance when pH and total suspended solids (TSS) levels reached 11.3 pH and 46 mg/L TSS. This exceeded McArthur River's licensed upper limits for pH of 9.5 and for TSS of 15 mg/L. The incident occurred at Shaft No.3 when concrete was inadvertently mixed with underground shaft water. Before the exceedance was identified 371 m^3 of this effluent was released to the environment. Both CNSC and Saskatchewan Ministry of Environment were appropriately notified of the incident.

Cameco investigated and implemented corrective actions that included a number of procedural amendments and installation of an online pH reader that would enable the Cameco control room staff to monitor pH levels. The environmental impacts from this incident were determined to be very low and water samples collected downstream were not elevated compared to background levels. CNSC staff reviewed the investigative report and verified the corrective actions taken in a follow-up inspection to ensure a similar incident does not recur. This exceedance meant that the McArthur River Operation was not "in compliance" at all times with all regulated parameters in 2012 (excluding toxicity tests). Therefore, only four of the five uranium mine and mill facilities were in full compliance with MMER resulting in an 80 percent compliance in 2012 (table 2-6).

b) Annual average effluent concentrations in the metal mining sectors

Table 2-7 presents the 2012 annual average effluent concentrations for parameters in comparison of the metal mine sectors. It is noteworthy that all metal mine sectors met the *Metal Mining Effluent Regulations* regulatory limits as shown in table 2-7. CNSC staff note that uranium mine and mill operations have similar concentrations for radium-226 compared to the base metal sector and lower compared to the precious metal sector.

Table 2-7: A sector comparison of average effluent parameter concentrations, 2012

Parameters	MMER limit	Uranium	Base metals	Precious metals	Iron
Arsenic (mg/L)	**0.5**	0.003	0.004	0.031	0.001
Copper (mg/L)	**0.3**	0.002	0.014	0.036	0.002
Lead (mg/L)	**0.2**	0.0004	0.0046	0.0040	0.0004
Nickel (mg/L)	**0.5**	0.024	0.057	0.033	0.004
Zinc (mg/L)	**0.5**	0.007	0.037	0.050	0.008
TSS (mg/L)	**15**	1.7	3.9	5.7	10.0
Radium-226 (Bq/L)*	**0.37**	0.02	0.02	0.08	0.01
pH low	**≥6.0**	6.9	7.6	7.4	7.4
pH high	**≤9.5**	7.2	8.0	7.8	7.7

* Bq/L – Becquerel per litre

c) Toxicity test results

Effluent toxicity is measured by using the acute-lethality test. Rainbow trout are used to routinely assess the toxicity of an effluent.

The rainbow trout acute-lethality test has become the world standard toxicity test for fresh-water cool-climate conditions. It has been part of Canadian regulations and guidelines for three decades. In this test, rainbow trout fingerlings or swim-up fry (0.3 to 2.5 g wet weight) are reared under controlled conditions. They are then placed in undiluted effluent for 96 hours (four days). If more than half of the fish die, the effluent is deemed acutely lethal. Effluent must be non-acutely lethal (i.e., pass the test) as a requirement of the MMER.

Table 2-8 shows the number of pass and fail results of the rainbow trout acute lethality tests for the metal mining sectors in 2012. The uranium mining metal sector passed all required tests in 2012.

Table 2-8: A sector comparison of pass/fail results of rainbow trout acute lethality tests in 2012

	MMER limit	Uranium	Base metals	Precious metals	Iron
Rainbow trout acute lethality test	**Pass**	32	452	339	108
	Fail	0	1	10	0

A mine is considered compliant if, throughout the year, the effluent passed all trout acute-lethality tests. As shown in table 2.9, the uranium mine and mill facilities met acute lethality requirements from 2008 to 2012 with one exception in 2008 at the Key Lake Operation.

Key Lake Operation had two trout acute lethality tests fail out of 14 tests completed in 2008. In the first instance, two containers of the same treated effluent were sent for testing; one container arrived in a damaged condition one day later with only 40 percent of the effluent remaining. The damaged container of effluent should not have been used because the sample had been compromised. However, it was used in the trout acute lethality test, which failed. Chemical analysis showed that all the measured parameters were within normal range. All follow-up trout acute lethality testing on treated effluent samples from the Key Lake Operation passed. The acute lethality test failure was attributed to a transportation and laboratory protocol error and the sample was deemed not representative of effluent quality. In a second trout acute lethality test failure, two containers of the same treated effluent were tested. One container passed the test and one failed. Chemical analysis showed that all the measured parameters were within the normal range. Follow-up tests and investigation by the Key Lake Operation were extensive but no cause for the trout acute lethality failure could be ascertained.

CNSC staff were satisfied with the investigations and the follow-up actions taken by Key Lake Operation, following the two trout acute lethality failures. Since 2008, all acute lethality tests have passed at the five operating uranium mine and mill facilities. Table 2-9 summarizes the performance of the metal mining sectors.

Table 2-9: Percentage of each metal mining sector passing all trout acute lethality tests, 2008-2012

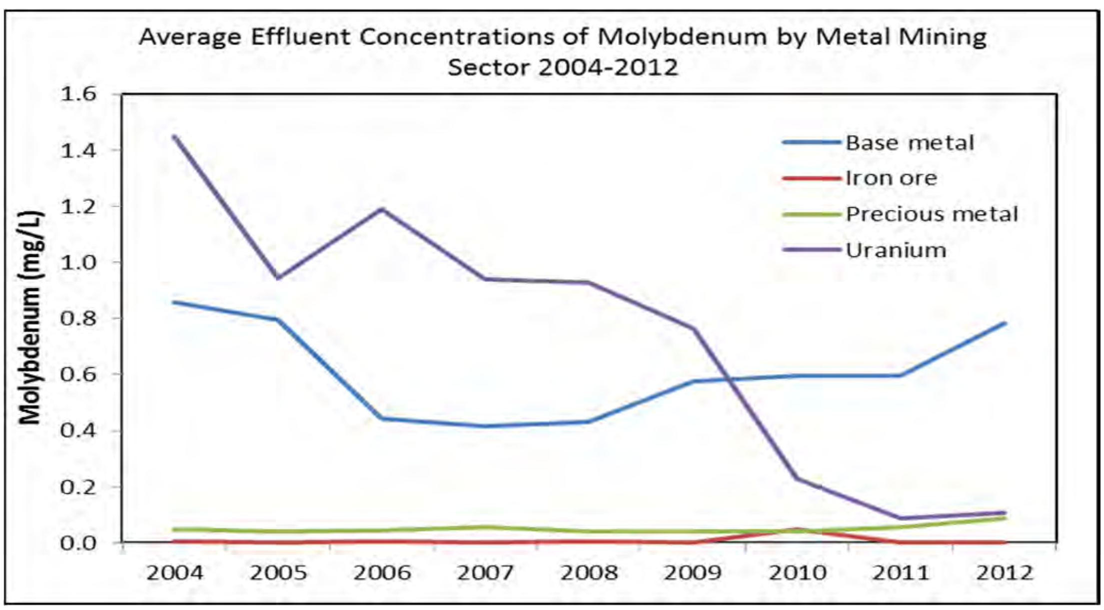
Metal mining sector	Year				
	2008	**2009**	**2010**	**2011**	**2012**
Uranium	80%	100%	100%	100%	100%
Base metals	86%	80%	90%	85%	98%
Precious metals	91%	96%	96%	96%	94%
Iron	67%	67%	80%	83%	100%

Figure 2-11: CNSC senior project officer presenting during community engagement

2.2.2 Comparative performance of molybdenum and selenium by metal mining sector

Molybdenum is a parameter requiring routine monitoring of treated effluent subject to the MMER. Figure 2-12 shows the continuous improvement by the uranium sector in reducing molybdenum in effluent. In 2012, molybdenum concentrations in uranium mining sector effluent were similar to those measured in the effluents of the precious metal and iron mines, and markedly less than in the effluents for the base metal mines.

Figure 2-12: Average treated effluent concentration of molybdenum by metal mining sector 2004-2012



In mid-2012, the MMER added the requirement for monitoring of selenium. Table 2-10 summarizes the average selenium concentration in treated effluent from each mining sector using data collected in the last half of 2012 and all of 2013.

Table 2-10: Selenium concentration (mg/L) in treated effluent by metal mining sector in 2012-2013

Metal mining sector	Selenium concentration (mg/L)
Uranium	0.003
Base metals	0.005
Precious metals	0.005
Iron	0.001

2.3 Conventional health and safety

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel. Uranium mines and mills must develop, implement, and maintain effective safety programs to promote a safe and healthy workplace and minimize incidences of occupational injuries and illnesses.

Licensees are expected to identify potential safety hazards, assess the associated risks, and put in place the necessary materials, equipment, programs and procedures to effectively manage, control and minimize these risks. CNSC staff work closely with Saskatchewan’s Ministry of Labour Relations and Workplace Safety to provide regulatory oversight of conventional health and safety in uranium mines and mills. CNSC staffs’ compliance verification activities include inspections, reviews of health and safety events and compliance reports.

A key performance measure for conventional health and safety is the number of lost-time incidents (LTIs) that occur per facility. An LTI is an injury that takes place at work and results in the worker being unable to return to work for a period of time. In reviewing LTIs, CNSC staff also consider the incidents’ severity and frequency rates. Table 2-11 shows the number of LTIs at the uranium mine and mill facilities along with severity and frequency rates, and the number of full-time equivalent (FTE) workers onsite during 2013.

Table 2-11: Total number of full-time equivalent (FTE) workers, number of lost-time incidents (LTIs), severity rate and frequency rate for the five operating facilities, 2013

Total number of FTE workers and lost-time incidents (LTI) statistics	2013				
	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
Total number of FTE workers[1]	1,570	914	744	679	348
Number of lost-time incidents (LTIs)[2]	4	0	0	0	0
Severity rate[3]	5.57	0	25.8	0	0
Frequency rate[4]	0.25	0	0	0	0

[1] **Total number of workers** (employees and contractors) expressed as full-time equivalents (FTE).
FTE = total person-hours / 2,000 hours worked per employee per year.

[2] **Lost-time incident -** an injury that takes place at work and results in the worker being unable to return to work for a period of time.

[3] **Severity rate -** the accident severity rate measures the total number of days lost to injury for every 200,000 person-hours worked at the site. Severity = [(# of days lost in last 12 months)/# of hours worked in last 12 months)] x 200,000

[4] **Frequency rate -** the accident frequency rate measuring the number of LTIs for every 200,000 person-hours worked at the site. Frequency = [(# of injuries in last 12 months) / # of hours worked in last 12 months)] x 200,000

During 2013, there were four LTIs at the Cigar Lake Operation and none at the other four uranium mine and mill facilities. Appendix H describes the 2013 LTIs and corrective actions taken by the licensee. CNSC staff and Saskatchewan's Ministry of Labour Relations and Workplace Safety monitor and review each reportable injury to ensure the cause is identified and satisfactory corrective actions are taken. When applicable, injury information is shared amongst the facilities to improve safety.

It should be noted in table 2-11 that Rabbit Lake had a severity rate of 25.8, however; there were no lost-time incidents. The severity rate in 2013 resulted from a lost-time incident that occurred in the latter part of 2012 and lost days continued into 2013. Further information on this incident is included in section 5.2 Rabbit Lake Operation - Radiation Protection.

CNSC staff confirm that the mine and mill facilities implement effective management of conventional health and safety in all of their activities. The incident statistics demonstrate satisfactory performance of the uranium mine and mill operations to keep workers safe from occupational injuries. For 2013, CNSC staff rated the conventional health and safety SCA at the uranium mine and mill facilities as "satisfactory".

Figure 2-13: Underground restricted access

2.3.1 Lost-time incidents - comparison of the uranium mines and mills' performance to other mining sectors

In 2013, the frequency rate of LTIs at the uranium mines and mills was amongst the lowest for mining sectors in Saskatchewan. The severity rate for uranium mines and mills was reduced from 9.1 in 2012 to 6.6 in 2013, while the number of LTIs and the frequency rate remained constant. The severity rate for all mining sectors may be influenced by carry-over of days lost due to an injury that occurred in a previous year.

Uranium mining and milling activities continue to exhibit good performance compared to other mining sectors. Table 2-12 compares the various safety statistics of mining sectors within Saskatchewan.

Table 2-12: Safety statistics of mining sectors in Saskatchewan in 2013
(sourced from Saskatchewan Ministry of Labour and Workplace Safety)

Mining sector	Number of LTIs	Frequency rate (200,000 person-hours)	Severity rate (200,000 person-hours)
Potash (underground)	4	0.1	3.5
Solution (potash)	3	0.6	10.7
Minerals (sodium sulphate, sodium chloride)	1	0.8	0.8
Hardrock (gold, diamond)	9	0.4	25.5
Coal (strip mining)	1	0.2	22.4
Uranium	4	0.1	6.6

Figure 2-14: Safety board statistics

Figure 2-15: Mandatory self-rescuer use area

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3 Cigar Lake Operation

The Cigar Lake Operation is a uranium mine operated by Cameco Corporation located approximately 660 kilometres north of Saskatoon, Saskatchewan. Cigar Lake is the world's second-largest known high-grade uranium deposit following Cameco's McArthur River Operation (figure 3-1).

The Cigar Lake ore body was discovered in 1981. The first mine shaft was completed in 1990 to support underground exploration and testing of mining methods. A construction licence was granted in late 2004 after the completion of an environmental assessment.

Figure 3-1: View of the Cigar Lake Operation facility

High-grade uranium ore will be mined using a Jet Boring System. Primary ore processing creates an ore slurry underground which is transferred to the surface. The ore slurry is loaded into containers meeting the IAEA standard for Type IP-2 packages and transported by truck to the McClean Lake Operation for milling.

Figure 3-2: First ore slurry shipment from Cigar Lake Operation to McClean Lake Operation

Following the water inflow events of 2006 and 2008, the water management strategy was redesigned to ensure continued safe access to the mine for the worst-case inflow scenario. This was achieved by assuring sufficient pumping, storage, water treatment and release capacity to manage the maximum water inflow.

The Commission approved the construction of Seru Bay pipelines for the Cigar Lake Water Inflow Management Project in 2011, following completion of an environmental assessment. The pipelines' construction was completed in 2012. In August 2013, the new treated mine effluent discharge pipeline to Seru Bay was put in operation and the treated mine effluent discharge to the Aline Creek system was discontinued.

A public Commission licence renewal hearing was held in Saskatoon, Saskatchewan on April 3, 2013. The Commission issued an eight-year licence, valid from July 1, 2013 to June 30, 2021.

In 2013, construction and installation for ore processing equipment was completed. Commissioning activities continued through 2013 and into 2014. As part of commissioning, one ore cavity was test mined with the Jet Boring System in December 2013. The testing recovered 234 tonnes of uranium ore with an average grade of 1.4% U_3O_8. Cigar Lake Operation submits status reports and readiness reviews for the commissioning process. CNSC staff reviewed the status reports, verified the readiness reviews during compliance inspections, and found them acceptable.

Table 3-1: Mining production data – Cigar Lake Operation, 2009–2013

Mining	2009	2010	2011	2012	2013
Ore tonnage (tonnes/year)	No mining	No mining	No mining	No mining	234
Average ore grade mined (% U_3O_8)	No mining	No mining	No mining	No mining	1.40%
U_3O_8 mined (kg)	No mining	No mining	No mining	No mining	3,851
Mining - licence production limit expressed as U_3O_8 (kg)	No mining	No mining	No mining	No mining	10,908,000

Surface construction activities completed in 2013 include a new surge pond pumphouse building, hazardous materials storage building, Shaft No.1 mine air heater building and the Shaft No.2 service winch building. The construction of a new maintenance building also began in 2013.

Figure 3-3: Jet Boring System machine set-up

3.1 Performance

During 2013, Cameco continued to focus on Cigar Lake mine development, construction and commissioning of the ore processing circuits.

Cameco has revised their Radiation Protection Program (RPP) and Radiation Code of Practice to align with mine operation requirements. The program describes how the site manages radiation protection risks, meets applicable regulatory requirements and keeps radiation exposures as low as reasonably achievable (ALARA), with social and economic factors considered. The RPP describes site radiological monitoring and exposure control.

The Radiation Code of Practice is an important ALARA tool and is based on correcting potential problems, prior to a situation becoming an exposure or dose concern. In 2013, radiation doses of workers were kept ALARA, and at levels below regulatory limits.

The radiation protection SCA was given a “satisfactory” rating.

CNSC determined that Cameco’s Cigar Lake Operation Occupational Health and Safety Program met regulatory requirements. The Cigar Lake Operation had four lost-time incidents in 2013. Appendix H provides a brief description of each incident, along with the actions taken by the licensee. Corrective actions taken by Cameco were acceptable to CNSC staff.

Cameco’s performance for Cigar Lake in the conventional health and safety SCA was rated as “satisfactory”.

Cameco updated their Environmental Management Program and Environmental Code of Practice to align with mine operation requirements following the change from construction activities. During 2013, parameter concentrations in effluent were low and remained below effluent discharge limits. There were no exceedances of the environmental action levels contained in the Environmental Code of Practice. Cigar Lake Operation maintains a terrestrial and air monitoring program to measure influence of atmospheric deposition of metals and radionuclides. Air monitoring shows impacts were negligible. Monitoring and control systems related to spill control operated effectively, with two minor reportable spills in 2013. Appendix G provides a brief description of each incident and the actions taken by the licensee. They were remediated with no residual impacts to the environment. The corrective actions taken by Cameco were acceptable to CNSC staff.

Cameco continued to protect the environment and received a “satisfactory” rating in the environmental protection SCA.

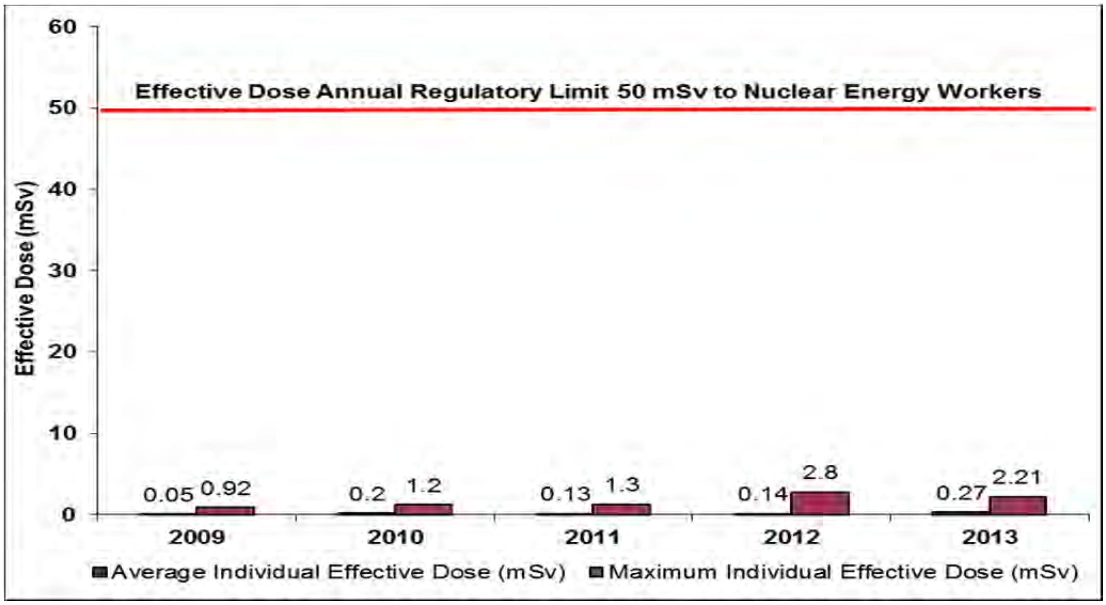
The Cigar Lake SCA ratings for the five-year period, 2009 to 2013, are shown in Appendix C. For 2013, CNSC staff rated all fourteen SCAs as “satisfactory”.

3.2 Radiation protection

The main source of radiological exposure at the Cigar Lake Operation was from the mining and processing of high grade uranium ore. The three primary effective dose contributors for workers are radon progeny, long-lived radioactive dust (LLRD), and gamma radiation. A design criterion for the Cigar Lake Operation was established during the early stages of the project to incorporate radiation protection requirements into all process ore handling areas, as well as ventilation design. This incorporates best practices and lessons learned from other operating sites (particularly McArthur River). All of the process equipment, piping, vessels, and ventilation are designed to meet the established criteria.

During the 2013 review period, most of the effective dose to workers at Cigar Lake was from exposure to radon progeny. Figure 3-4 displays the average individual effective dose to workers and the maximum individual effective dose for Cigar Lake’s nuclear energy workers (NEWs) from 2009 to 2013. In 2013, the average individual effective dose for workers was 0.27 mSv. The maximum individual effective dose in 2013 for a full-time Cigar Lake worker was 2.21 mSv. The annual individual effective dose to workers at the Cigar Lake Operation remains well below the 50 mSv/yr regulatory limit over the period 2009-2013.

Figure 3-4: Cigar Lake Operation – individual effective dose to NEWs, 2009–2013



All five of the uranium mine and mill facilities have the same action levels for worker effective dose of 1 mSv/week and 5 mSv/quarter of a year. There were no effective dose action level exceedances at Cigar Lake Operation in 2013.

During commissioning of the ore processing circuits, additional administrative controls were implemented:

- Training sessions were conducted emphasizing radiation protection program requirements for workers. Examples include job planning, job hazard analysis, contamination control, access control, ALARA, personal protective equipment requirements, and ventilation.
- Additional radiological monitoring was conducted upwind and downwind of the Jet Boring System for each phase of the cavity development and backfilling.
- Radiation personnel provided additional oversight and monitoring during commissioning.

CNSC staff will continue to monitor the licensee’s performance in maintaining radiation doses to personnel ALARA through site inspections and reviews of compliance reports.

3.3 Environmental protection

In accordance with Cigar Lake Operation’s Environmental Protection Program, effluent and environmental monitoring, site inspections, environmental awareness training and program implementation audits were carried out by Cameco or third-party consultants during 2013.

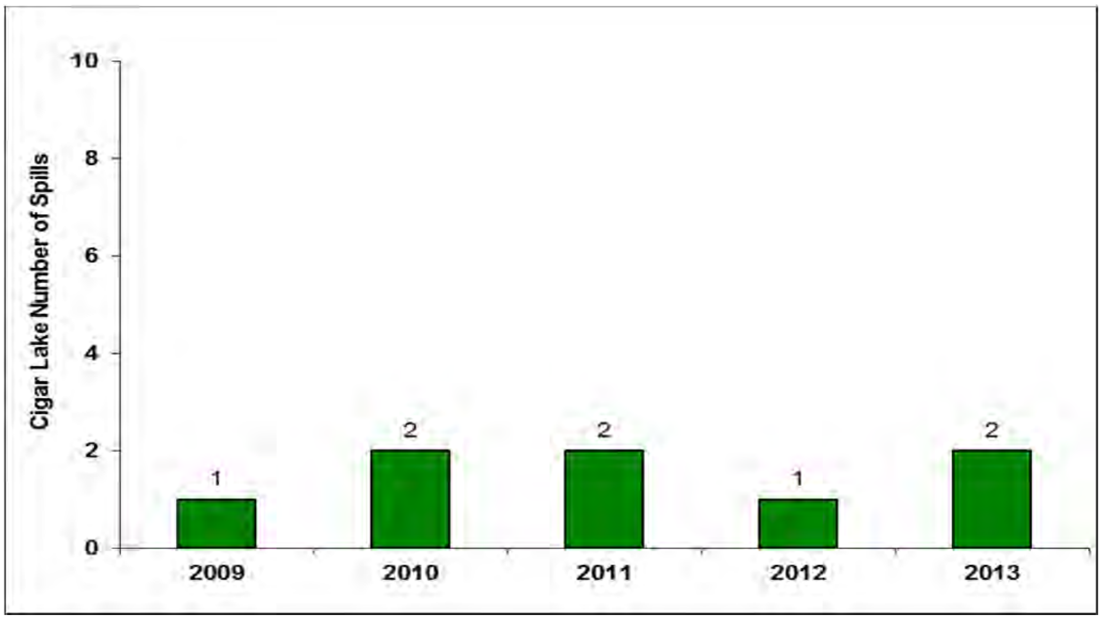
CNSC staff assessed that Cigar Lake Operation's environmental monitoring programs met regulatory requirements during 2013, and effluent discharged complied with licence requirements.

Figure 3-5 displays the number of environmental reportable spills from 2009 to 2013. CNSC staff were satisfied with Cameco's reporting of spills in a timely manner and the corrective actions taken. In 2013, two environmental spills were reported to CNSC staff:

- 40 L – 80 L (0.04 – 0.08 m^3) of propylene glycol/water mix (50/50) leaked to the ground because of a damaged ground thaw unit coupling.
- 6,000 L (6.0 m^3) of calcium chloride brine was spilled on the freeze drilling pad due to a ball valve and air plug not being completely closed.

Appendix G contains a brief description of the spills and corrective actions taken by the licensee. There was minimal impact to the environment due to the timely response and effective corrective actions implemented by Cigar Lake Operation. CNSC staff were satisfied with the corrective actions.

Figure 3-5: Cigar Lake Operation – environmental reportable spills, 2009–2013



Treated effluent released to the environment

The annual average parameter concentration values of the treated effluent at Cigar Lake were well below the regulatory limits and have been stable over the past five years. There were no treated effluent action level exceedances during the 2009–2013 review period.

Molybdenum, selenium and uranium in effluent

Figures 3-6, 3-7 and 3-8 display concentrations of molybdenum, selenium and uranium in effluent discharged to the environment for the 2009–2013 period. Concentrations for these three contaminants remained low in 2013. As Cigar Lake Operation transitions from construction activities to operational activities, concentrations are expected to increase, but remain well below regulatory limits. CNSC staff will continue to review effluent quality results to ensure that the environment is protected.

Figure 3-6: Cigar Lake Operation – concentrations of molybdenum, 2009–2013
(McArthur River action level for molybdenum is shown for reference only)

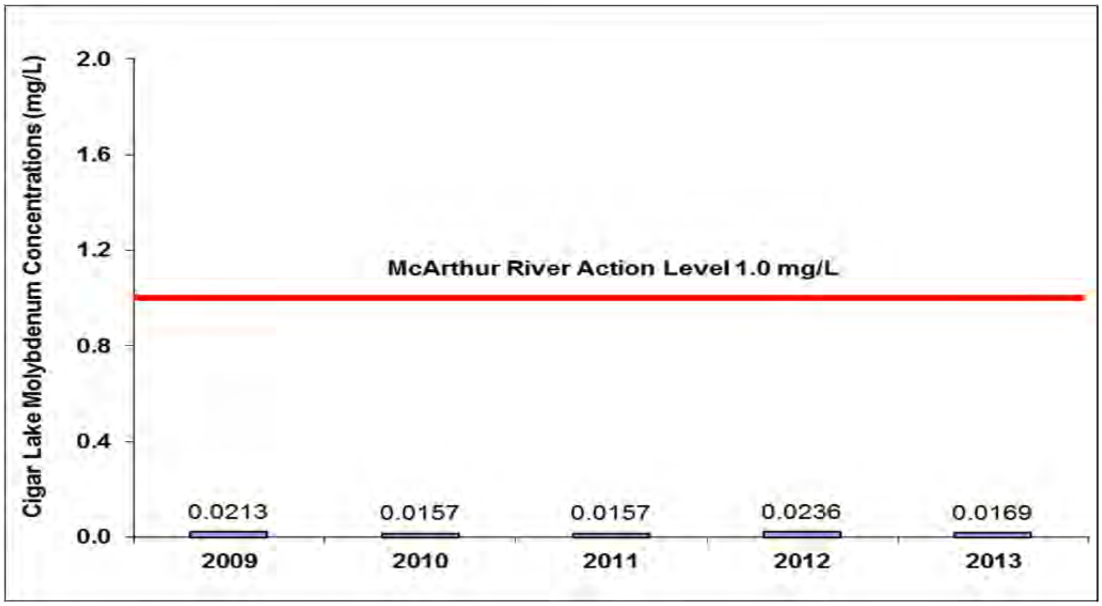


Figure 3-7: Cigar Lake Operation – concentrations of selenium, 2009–2013
(Province of Saskatchewan's discharge limit for selenium is shown for reference only)

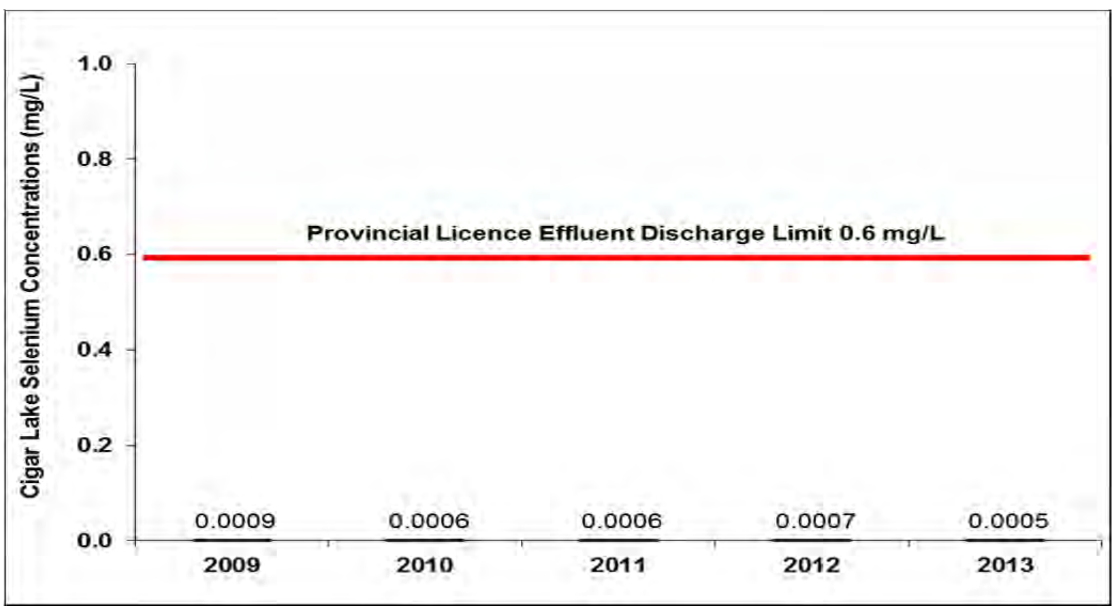
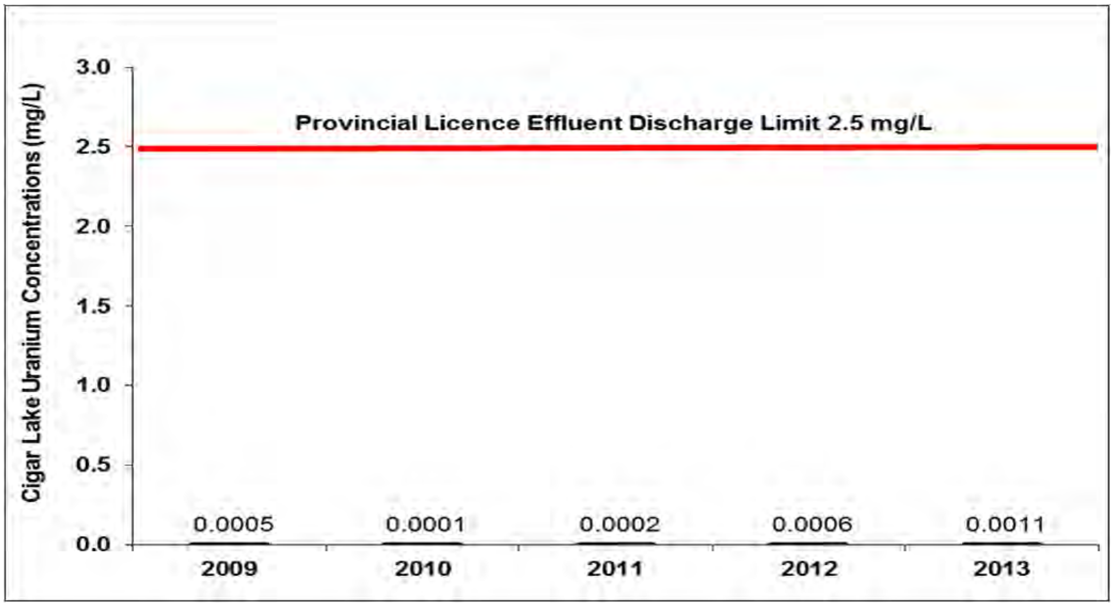


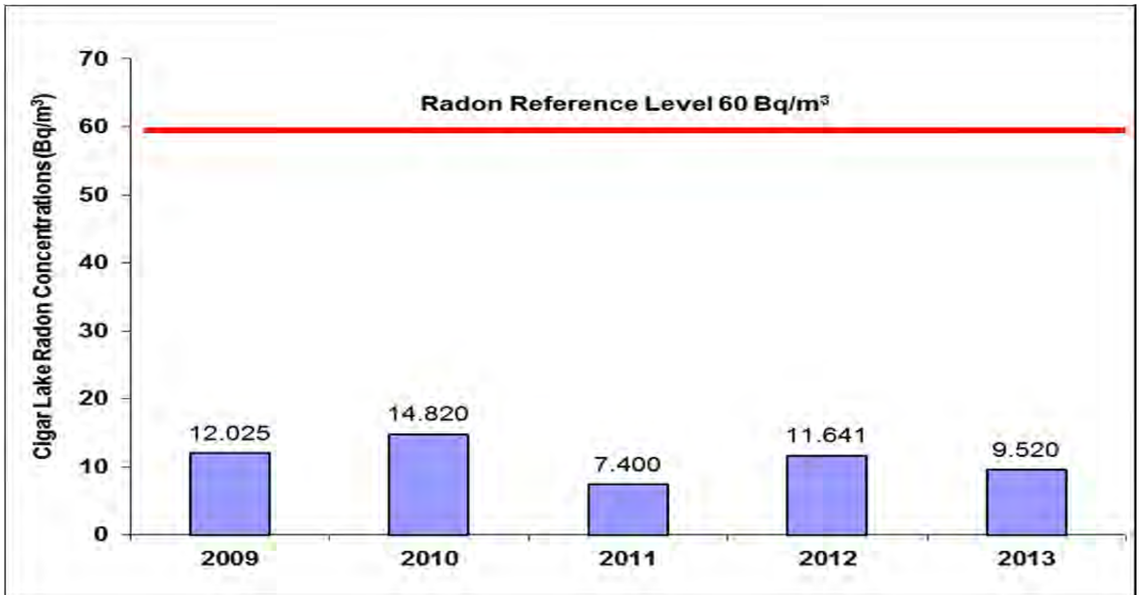
Figure 3-8: Cigar Lake Operation – concentrations of uranium, 2009–2013
(Province of Saskatchewan’s discharge limit for uranium is shown for reference only)



Atmospheric monitoring at Cigar Lake Operation includes ambient radon-222, total suspended particulates (TSP), soil sampling and lichen sampling to assess the impact of air emissions.

Environmental monitoring for radon-222 concentrations is conducted using the passive method of track-etched cups. Eight monitoring stations are located in four quadrants around the immediate mine site. In 2013, the radon concentrations ranged from < 7.4 Bq/m^3 to 22.2 Bq/m^3. These values are below the typical baseline range for the province of Saskatchewan (37 Bq/m^3 to 74 Bq/m^3) and within the regional baseline of < 7.4 Bq/m^3 to 25 Bq/m^3 typical of northern Saskatchewan. Figure 3-9 shows for the 2009 to 2013 period, the average concentrations of radon in ambient air are below the reference level.

Figure 3-9: Cigar Lake Operation – average concentrations of radon in ambient air 2009–2013 (reference level is derived from the *Radiation Protection Regulations**)



*The value of 60 Bq/m^3 has been derived from ICRP-65 as referenced in the *Radiation Protection Regulations* and approximates to an annual dose of 1 mSv.

A high volume air sampler (HVAS) is used to collect and measure TSP in air. The HVAS is located approximately 150 meters downwind from headframe No.1 and mine ventilation exhaust. The TSP levels are below Saskatchewan's *The Clean Air Regulations* standard (figure 3-10). TSP samples are also analyzed for concentrations of metals and radionuclides. The mean concentrations of metal and radionuclides adsorbed to TSP are low, and below the reference annual air quality levels identified in table 3-2.

Figure 3-10: Cigar Lake Operation – concentrations of total suspended particulates 2009–2013 (Province of Saskatchewan's standard is shown)

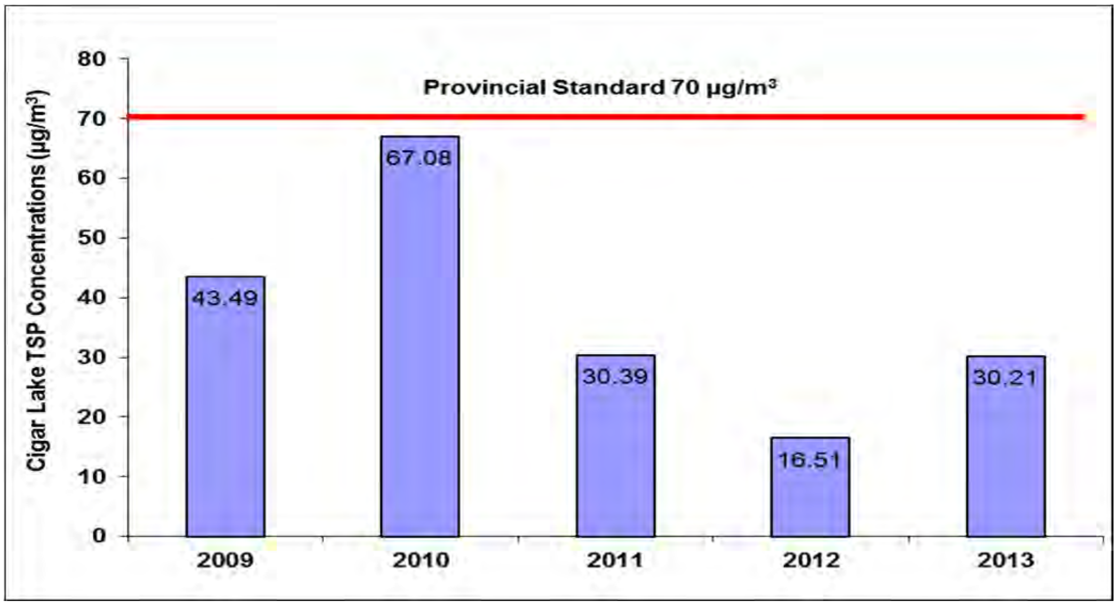


Table 3-2: Cigar Lake Operation – concentrations of metal and radionuclides in air, 2009–2013 (Province of Ontario and International Commission on Radiation Protection reference annual air quality levels are shown for reference only, as no federal or province of Saskatchewan limits are currently established)

Cigar Lake Operation						
Parameter	**Reference annual air quality levels**	**2009**	**2010**	**2011**	**2012**	**2013**
As (µg/m^3)	**0.06 (1)**	0.000023	0.00057	0.00038	0.00025	0.00025
Mo (µg/m^3)	**23 (1)**	0.00038	0.00023	0.00021	0.00028	0.00021
Ni (µg/m^3)	**0.04 (1)**	0.00128	0.00165	0.00124	0.00101	0.00104
Pb (µg/m^3)	**0.10 (1)**	0.0019	0.0017	0.0018	0.0016	0.0007
Se (µg/m^3)	**1.9 (1)**	0.00009	0.00010	0.00005	0.00004	0.00003
Pb^{210} (Bq/m^3)	**0.021 (2)**	0.000585	0.000745	0.000333	0.000338	0.000268
Po^{210} (Bq/m^3)	**0.028 (2)**	0.000155	0.000178	0.000106	0.000106	0.000074
Ra^{226} (Bq/m^3)	**0.013 (2)**	0.000003	0.000006	0.000014	0.000005	0.000004
Th^{230} (Bq/$m^{3)}$	**0.0085 (2)**	0.000006	0.000007	0.000008	0.000026	0.000011
U (µg/m^3)	**0.06 (1)**	0.00005	0.00019	0.00012	0.00009	0.00007

[1] Reference annual air quality levels derived from Ontario 24-hour *Ambient Air Quality Criteria* (OMOE 2012)
[2] Reference level from International Commission on Radiation Protection (ICRP 96)

Soil and terrestrial vegetation may be affected by atmospheric deposition of particulates which includes metals and radionuclides associated with onsite activities. A terrestrial monitoring program is in place to determine if there is influence from aerial deposition. This program includes triennial measurements of metals and radionuclides in lichen and in soil.

Lichen samples were collected in 2013, as required by the triennial sampling program. Lichen samples are analyzed to determine the level of airborne particulate contaminants deposited on the surface of the lichen as a means of ensuring that a significant level of contamination is not entering lichen consumers, such as caribou. The five lichen sampling stations are located: 2.7 km southeast, 3.7 km southeast, 4 km east, 7 km east and 9 km east of the mine site.

The concentrations of metals and radionuclides in lichen samples collected from exposure stations were similar to reference stations and historical data. CNSC staff concluded that the level of airborne particulate contaminants produced by Cigar Lake Operation is acceptable and does not pose a risk to the lichen consumers such as caribou.

Soil sampling stations are co-located in four quadrants around the immediate mine site. Soil samples were collected in 2013 as required by the triennial sampling program.

All of the soil metal parameter concentrations were below the *Canadian Environmental Quality Guidelines* for Industrial and Residential/Parkland land use. Appendix I displays three metal parameters (arsenic, nickel and uranium) measured in soil samples at Cigar Lake Operation to be well below *CCME Soil Quality Guideline* levels. Also shown in Appendix I, radionuclide concentrations in soils were low, generally near or at, background levels, and analytical detection limits. CNSC staff concluded that the level of airborne particulate contaminants produced by Cigar Lake Operation is acceptable and does not pose a risk to the environment.

3.4 Conventional health and safety

CNSC staff monitor the implementation of Cigar Lake Operation’s Safety and Health Management Program to ensure the protection of workers. In 2013, Cigar Lake Operation implemented a revised Safety and Health Management Program to enhance identification and mitigation of risks, and encourage continual strong safety performance and improvement. The program includes planned internal inspections, a safety permit system, occupational health committees, training, and incident investigations.

The conventional health and safety SCA is evaluated by CNSC staff through regular compliance activities. These compliance activities include inspections, reviews of incident reports and weekly reports regarding facility activities.

Cigar Lake Operation reported a total of six lost-time incidents (LTIs) from 2009 to 2013, with four LTIs in 2013 (table 3-3).

Table 3-3: Cigar Lake Operation – Total number of FTE workers and LTIs, severity rate and frequency rate, 2009–2013

Cigar Lake Operation					
Year	**2009**	**2010**	**2011**	**2012**	**2013**
Total number of FTE workers*	365	649	971	1,277	1,570
Number of LTIs*	1	0	1	0	4
Severity rate*	2.5	0.0	1.6	0.0	5.6
Frequency rate*	0.3	0.0	0.1	0.0	0.3

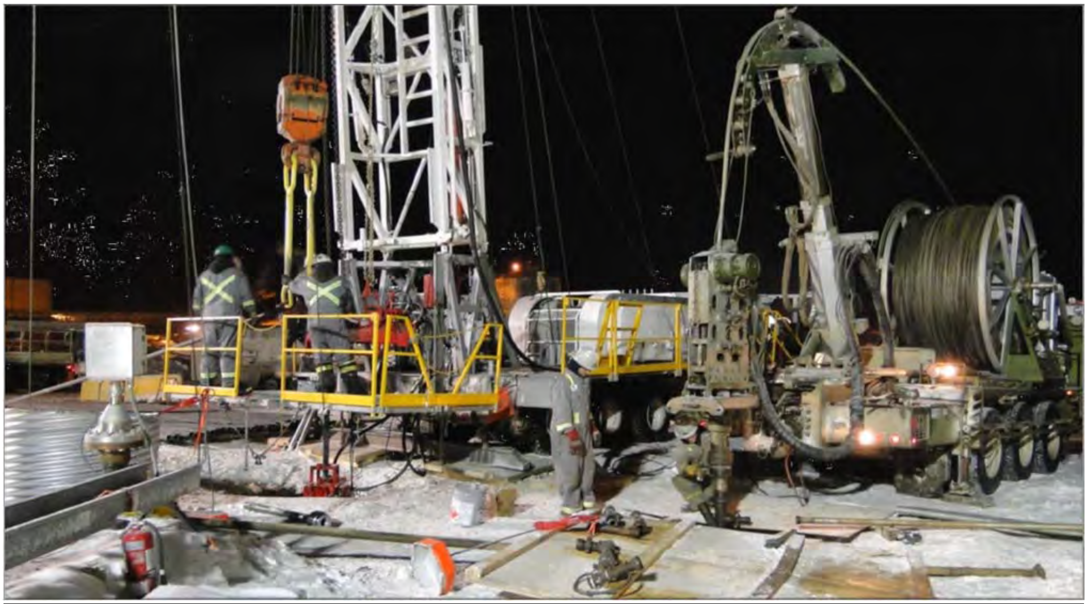
*Definitions of these terms are located in the Glossary.

In 2013, Cameco undertook additional efforts to promote the existing safety culture through management oversight and safety training in response to the increase in the number of onsite workers. Cigar Lake also promoted increased reporting and investigation of near-miss incidents within their incident reporting system providing the opportunity to identify preventative actions.

CNSC staff observed that Cigar Lake continues to strive for improvement in its overall safety program and to build upon its safety culture. The conventional health and safety SCA for Cigar Lake Operation, which was rated as “fully satisfactory” (FS) in 2012, has now been rated as “satisfactory” (SA) in 2013. This downward change in rating is due to Cigar Lake Operation having four lost-time incidents in 2013.

Figure 3-11: Development of the underground workings and mine at the Cigar Lake Operation

Figure 3-12: Surface rig and coil tubing rig outfitting surface freeze holes, Cigar Lake Operation



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4 McArthur River Operation

Cameco Corporation operates the McArthur River mine, located approximately 620 kilometres north of Saskatoon, Saskatchewan. McArthur River Operation is the world's largest high-grade uranium mine (figure 4-1).

Facilities at the McArthur River Operation include an underground uranium mine, primary ore processing, ore slurry loading, waste management facilities, a water treatment plant, surface freeze plants, administration offices and warehouse buildings.

Figure 4-1: McArthur River Operation

High-grade uranium ore is mined, then ground and mixed with water in a ball mill to form slurry which is pumped to the surface. The ore slurry is loaded into approved containers and transported to the Key Lake Operation for further processing (figure 4-2). Mineralized waste rock is also transported to Key Lake in covered haul trucks where these materials are blended with high-grade ore slurry to create the mill ore feed.

Figure 4-2: Ore slurry truck being loaded

The McArthur River mine was in operation for all 365 days in 2013, and production data for 2009-2013 is shown below in table 4-1.

Table 4-1: Mining production data – McArthur River Operation, 2009–2013

Mining	2009	2010	2011	2012	2013
Ore tonnage (tonnes/year)	65,195	78,003	80,162	115,107	104,132
Average ore grade mined (% U_3O_8)	12.89%	11.25%	11.17%	7.78%	8.83%
U_3O_8 mined (kg)	8,405,106	8,772,920	8,950,340	8,958,578	9,190,232
Mining - licence production limit expressed as U_3O_8 (kg)	8,490,566	9,551,887	9,551,887	9,551,887	9,551,887

In October 2013, the Commission issued a 10-year licence following a public hearing in La Ronge, Saskatchewan. Cameco's licence for the McArthur River Operation expires on October 31, 2023.

As of December 31, 2013, proven and probable ore reserves at McArthur River Operation were 1,037,400 tonnes at a grade of 15.76% U_3O_8 for a total of approximately 163.52 million kg U_3O_8.

4.1 Performance

In 2013, Cameco's Radiation Protection Program and Radiation Code of Practice at the McArthur River Operation continued to be effective in controlling radiological exposure to workers. CNSC staff were satisfied that the McArthur River Operation is adequately controlling radiation doses to workers, keeping levels below the regulatory limits, and conclude the radiation protection SCA remains "satisfactory".

CNSC staff determined that McArthur River Operation's Environmental Protection Program was effective in protecting the environment, and all treated effluent discharged complied with licence requirements. McArthur River Operation maintains a terrestrial and air monitoring program to measure influence of atmospheric deposition of metals and radionuclides. Air monitoring shows impacts were negligible. In 2013, two environmental spills were reported to CNSC staff. They were remediated with no residual impacts to the environment. McArthur River Operation continued to protect the environment, and received a "satisfactory" rating in the environmental protection SCA.

CNSC staff determined that McArthur River Operation's Occupational Health and Safety Program met regulatory requirements. The McArthur River Operation had no LTIs in 2013. CNSC staff's compliance verification activities confirmed McArthur River Operation's strong focus on the prevention of accidents. McArthur River Operation's performance in the conventional health and safety SCA was rated as "satisfactory".

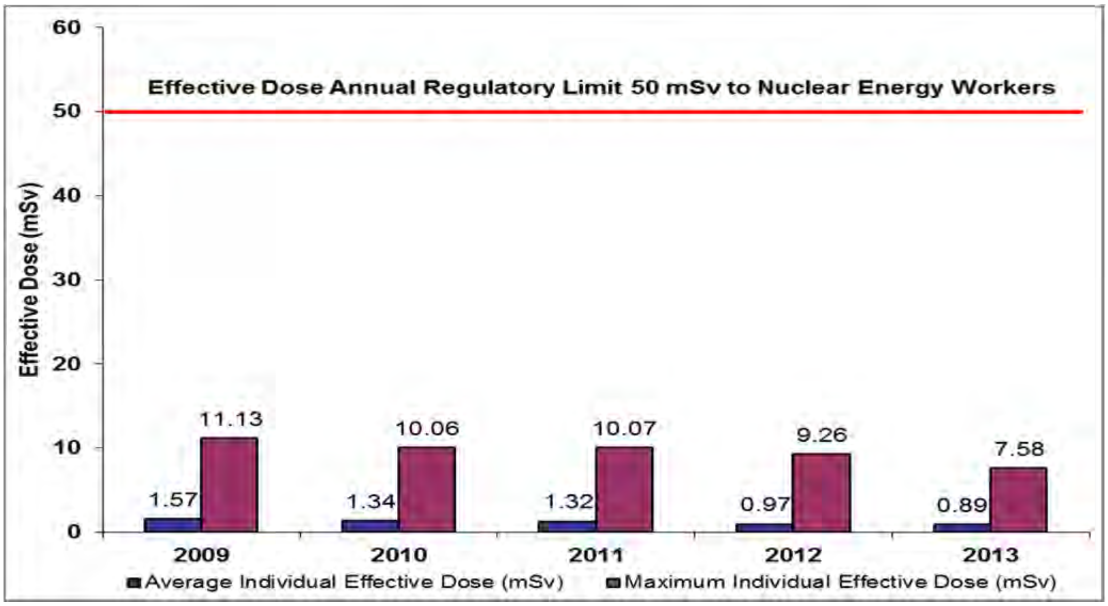
The McArthur River SCA ratings for the five-year period between 2009 and 2013 are shown in Appendix C. For 2013, CNSC staff continue to rate all SCAs as "satisfactory".

4.2 Radiation protection

The source of radiological exposure at the McArthur River Operation is from the mining and processing of high-grade uranium ore. The three primary effective dose contributors are gamma radiation, radon progeny and long-lived radioactive dust (LLRD). The greatest contributor to effective dose is from exposures to radon progeny which are controlled through the effective use of ventilation, and by capture/exhaust of high radon sources.

In 2013, the average individual effective dose to all NEWs was 0.89 mSv. Underground support workers were the group with the highest average effective dose, at 1.80 mSv. The maximum individual effective dose in 2013 was 7.58 mSv. As figure 4-3 shows, the average and maximum individual effective dose to NEWs from 2009 to 2013 was well below the annual regulatory limit of 50 mSv.

Figure 4-3: McArthur River Operation – individual effective dose to NEWs, 2009–2013



All five of the uranium mine and mill facilities have the same action levels for effective dose of 1 mSv/week and 5 mSv/quarter of a year.

There were no action level exceedances in 2013 at Cameco's McArthur River Operation.

4.3 Environmental protection

In accordance with McArthur River Operation's Environmental Protection Program, effluent and environmental monitoring, site inspections, environmental awareness training and program implementation audits were carried out by Cameco or third-party consultants during 2013.

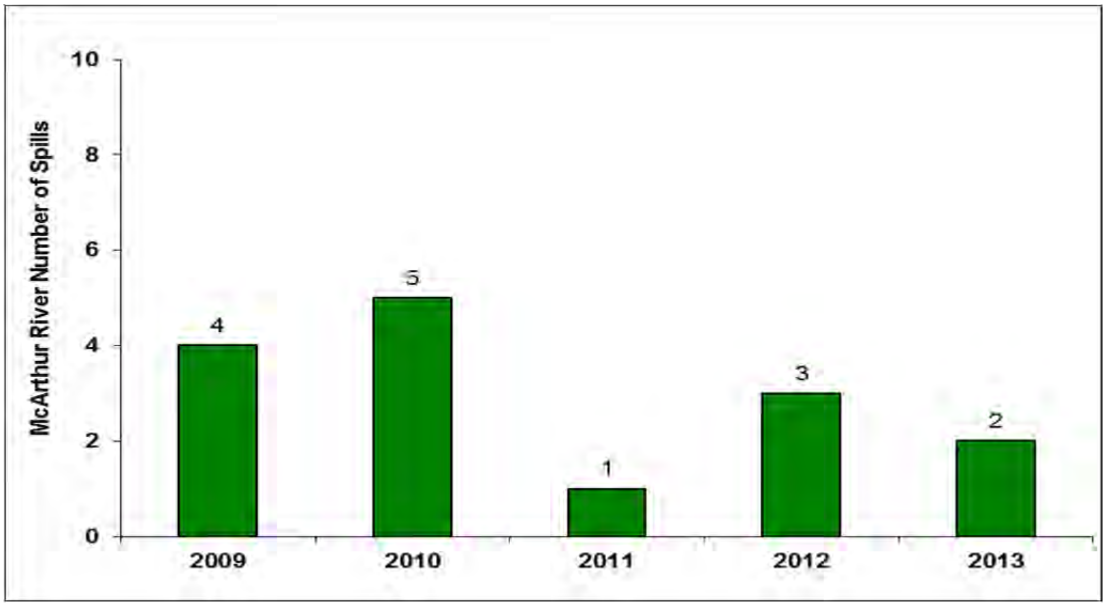
CNSC staff assessed that McArthur River Operation's Environmental Monitoring Program met all regulatory requirements during 2013, and all effluent discharged complied with licence requirements.

Figure 4-4 shows the number of reportable spills from the licensed activities at the McArthur River Operation from 2009 to 2013. In 2013, two environmental spills were reported to CNSC staff:

- 75 L (0.075 m^3) of contaminated water
- 20 L (0.020 m^3) of glycol

Both spills were immediately cleaned up and there was no measurable impact to the environment. The identified corrective actions undertaken by Cameco were acceptable to CNSC staff. A brief description of the two spills and corrective actions implemented are provided in Appendix G.

Figure 4-4: McArthur River Operation – environmental reportable spills, 2009–2013



Treated effluent released to the environment

In 2013, all effluent released to the environment met regulatory requirements.

Molybdenum, selenium and uranium in effluent

Molybdenum, selenium and uranium were identified as constituents of concern from treated effluent at uranium mines and mills. At the McArthur River Operation, molybdenum was the main constituent of concern. In response to CNSC staff concerns, Cameco implemented process changes to reduce molybdenum concentrations in treated effluent at the McArthur River Operation. In 2013, Cameco instituted a molybdenum concentration action level of 1.0 mg/L for release of treated effluent, (prior to 2013 Cameco had an internal objective to reduce molybdenum in effluent to below 1.0 mg/L). Molybdenum removal efficiency in treated effluent continued to improve every year decreasing from 1.15 mg/L in 2009 to 0.19 mg/L in 2013 (figure 4-5).

Figure 4-5: McArthur River Operation – concentrations of molybdenum, 2009–2013

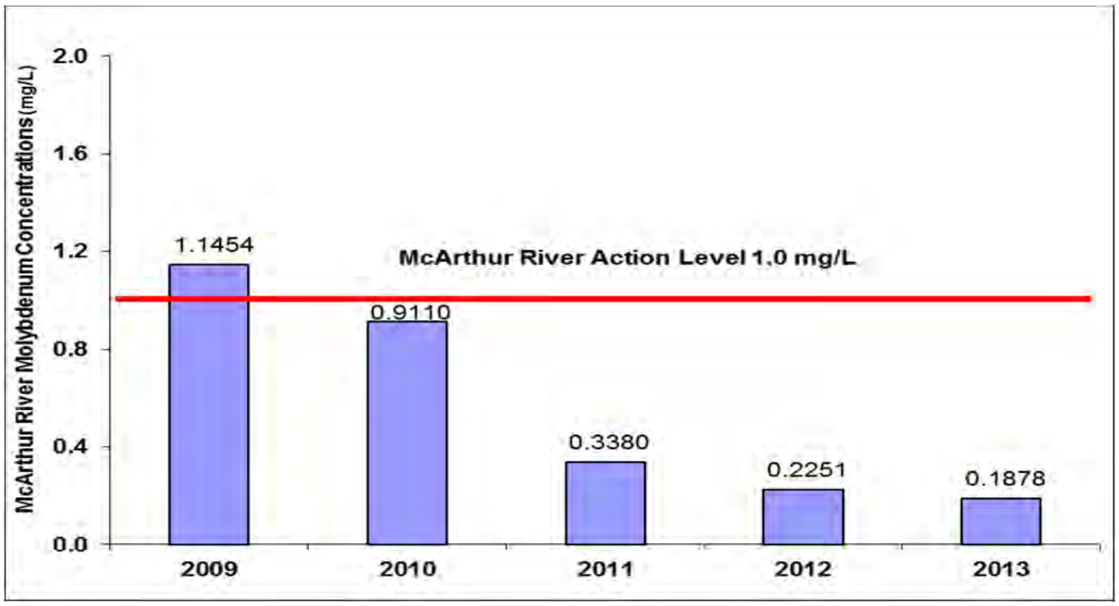


Figure 4-6 shows that the concentrations of selenium in treated effluent remained consistently well below the Province of Saskatchewan's licence effluent discharge limit of 0.6 mg/L.

Figure 4-6: McArthur River Operation – concentrations of selenium, 2009–2013
(Province of Saskatchewan's discharge limit for selenium is shown for reference only)

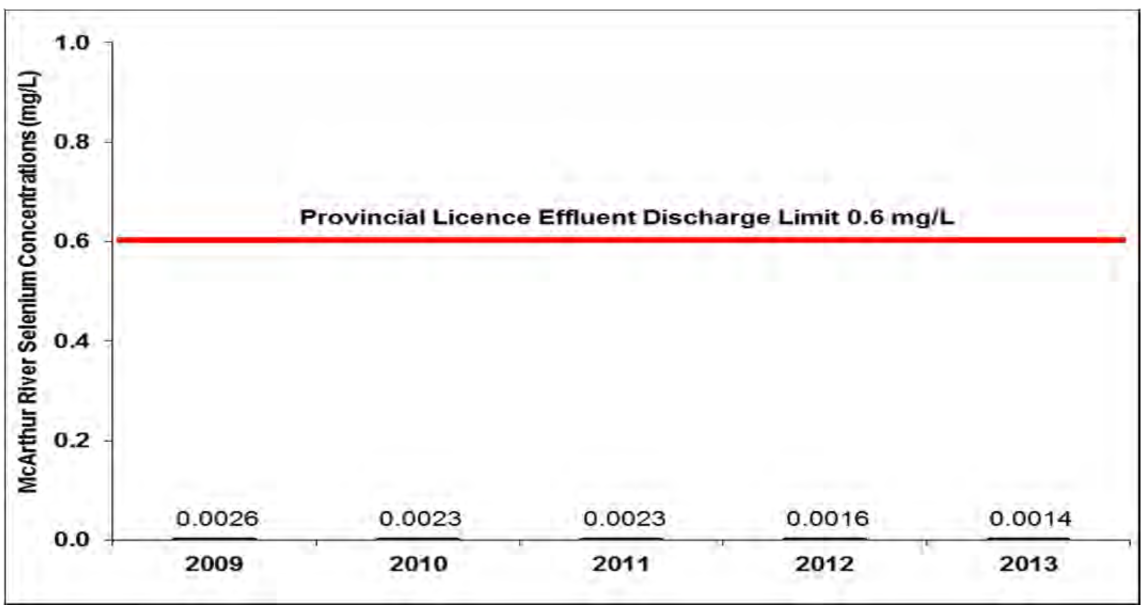
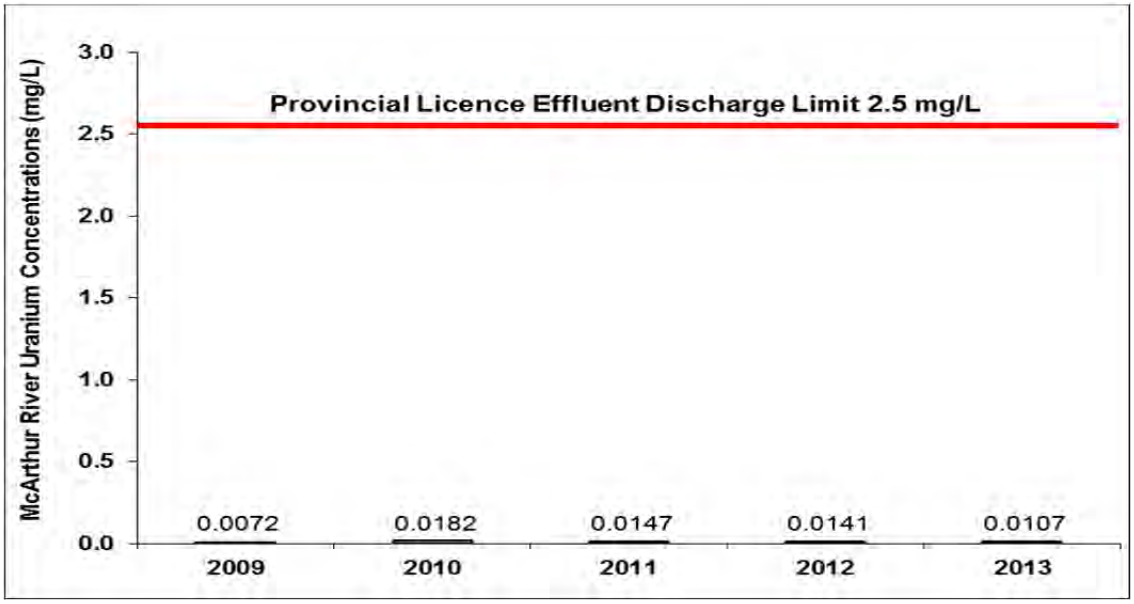


Figure 4-7 displays the average annual uranium concentrations in treated effluent from 2009 to 2013. Uranium concentrations remain well below the Province of Saskatchewan's regulatory limit of 2.5 mg/L and the CNSC interim objective of 0.1 mg/L.

Figure 4-7: McArthur River Operation – concentrations of uranium, 2009–2013

(Province of Saskatchewan's discharge limit for uranium is shown for reference only)



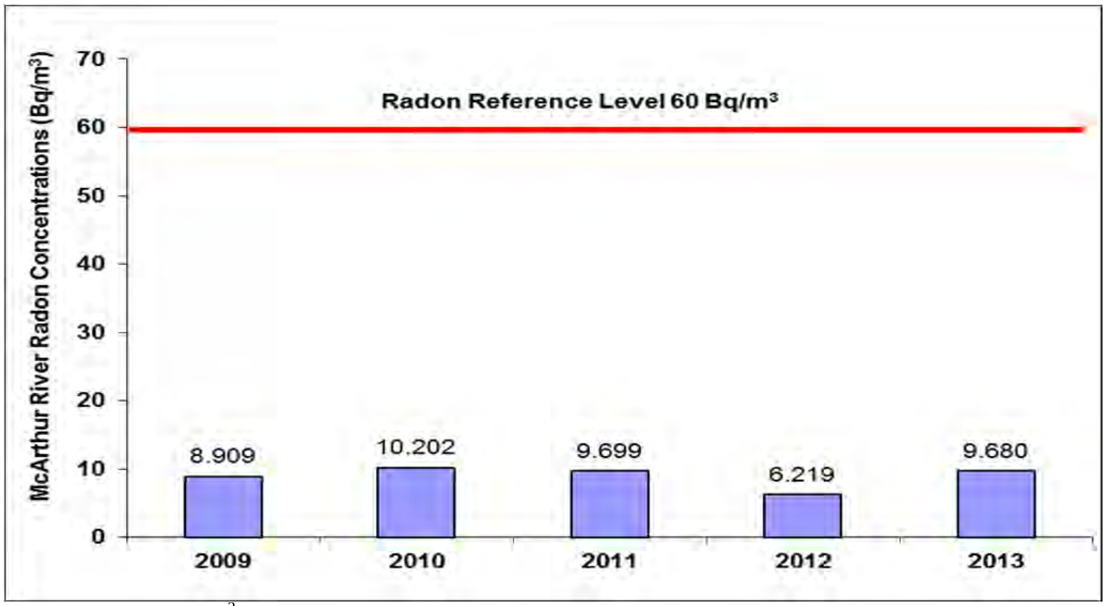
CNSC staff will continue to review the McArthur River Operation's treated effluent concentrations at the outflow (figure 4-8) and in the downstream environment.

Figure 4-8: Treated effluent from the McArthur River water treatment plant

Air quality monitoring at the McArthur River Operation consists of high volume air sampling, radon monitoring, blueberry twigs and stems sampling, and soil sampling.

A total of 12 monitoring locations are used for the monitoring of ambient radon using passive track-etched cups. In 2013, the radon concentrations were typical of past performance with all values below the typical baseline range for Saskatchewan (37 Bq/m^3 to 74 Bq/m^3) and within the regional baseline of < 7.4 Bq/m^3 to 25 Bq/m^3 typical of northern Saskatchewan. Figure 4-9 shows that the average concentrations of radon in ambient air for 2009 to 2013 are below the reference level for radon.

Figure 4-9: McArthur River Operation – concentrations of radon in ambient air 2009–2013 (reference level is derived from the *Radiation Protection Regulations**)



*The value of 60 Bq/m^3 has been derived from ICRP-65 as referenced in the *Radiation Protection Regulations* and approximates to an annual dose of 1 mSv.

Two high volume samplers are used to collect and measure total suspended particulate (TSP) in air. The samplers are located in the vicinity of the main camp residence and the second located approximately 250 meters northwest in a location representative of ambient conditions. From the average of the two stations, the TSP levels are less than Saskatchewan's *The Clean Air Regulations* standard (figure 4-10). TSP samples are also tested for concentrations of metals and radionuclides. The mean concentrations of metal and radionuclides adsorbed to TSP are low, and below reference annual air quality levels identified in table 4-2.

Figure 4-10: McArthur River Operation – concentrations of total suspended particulate 2009–2013 (Province of Saskatchewan's standard is shown)

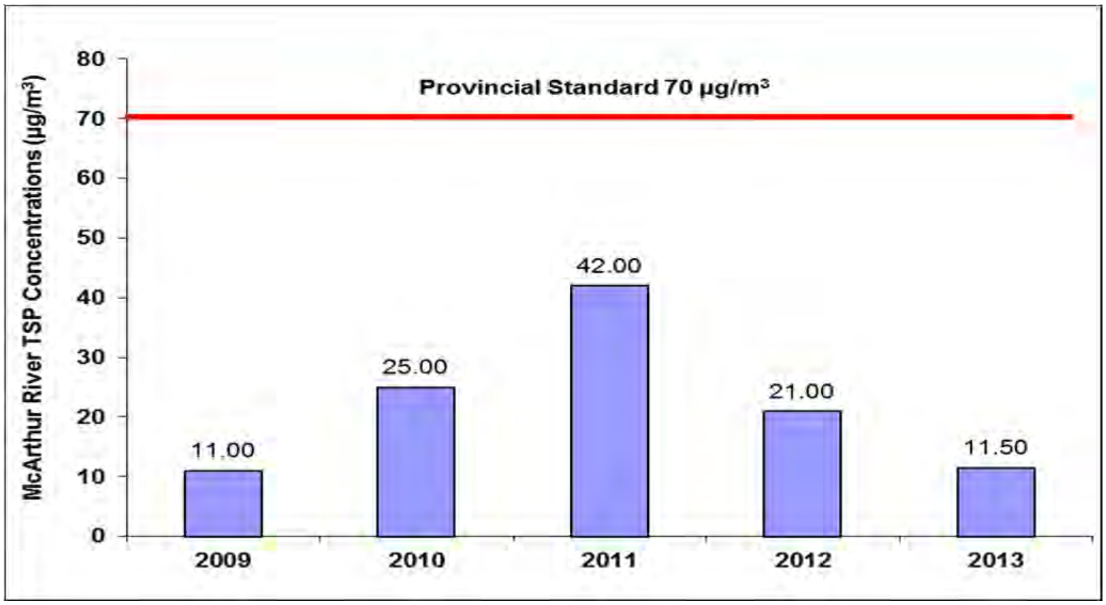


Table 4-2: McArthur River Lake Operation – concentrations of metal and radionuclides in air, 2009–2013(Province of Ontario and International Commission on Radiation Protection reference annual air quality levels are shown for reference only, as no federal or province of Saskatchewan limits are currently established)

McArthur River Operation						
Parameter	**Reference annual air quality levels**	**2009**	**2010**	**2011**	**2012**	**2013**
As (µg/m^3)	**0.06 (1)**	0.0012	0.0002	0.0003	0.0003	0.0001
Cu (µg/m^3)	**9.6 (1)**	0.4374	0.0075	0.0097	0.0119	0.0067
Ni (µg/m^3)	**0.04 (1)**	0.0037	0.0009	0.0016	0.0012	0.0007
Pb (µg/m^3)	**0.10 (1)**	0.0101	0.0020	0.0015	0.0018	0.0014
Se (µg/m^3)	**1.9 (1)**	0.00019	0.00006	0.00006	0.00005	0.00003
Zn (µg/m^3)	**23 (1)**	5.8185	0.0136	0.0247	0.7721	0.01065
Pb^{210} (Bq/m^3)	**0.021 (2)**	0.00092	0.00036	0.00043	0.00045	0.00034
Po^{210} (Bq/m^3)	**0.028 (2)**	0.00042	0.00015	0.00013	0.00012	0.0001
Ra^{226} (Bq/m^3)	**0.013 (2)**	0.00008	0.00007	0.00003	0.00004	0.00001
Th^{230} (Bq/m$^{3)}$	**0.0085 (2)**	0.00006	0.00005	0.00002	0.00001	0.00001
U (µg/m^3)	**0.06 (1)**	0.0044	0.0040	0.0021	0.0012	0.0005

1 Reference annual air quality levels derived from Ontario 24-hour *Ambient Air Quality Criteria* (OMOE 2012)
2 Reference level from International Commission on Radiation Protection (ICRP 96)

Soil and terrestrial vegetation may be affected by atmospheric deposition of particulates and adsorbed metals and radionuclides associated with onsite activities. A terrestrial monitoring program is in place to determine if there is influence from aerial deposition. This program includes triennial measurements of metals and radionuclides in soil and blueberry samples.

The most recent soil sampling was taken in 2012, as required by the triennial sampling program. Soil samples were not collected in 2013. All of the soil metal parameter concentrations were below the Canadian Council of Ministers of the Environment's *Canadian Environmental Quality Guidelines* for Industrial and Residential/Parkland land use. Near-field soil results showed greater variations than those observed at far-field stations, suggesting that effects due to dusting from mine-related activities are short-term and limited in extent. Appendix I displays three metal parameters (arsenic, nickel and uranium) measured in soil samples at McArthur River Operation to be well below *CCME Soil Quality Guideline* levels. Also shown in Appendix I, radionuclide concentrations in soils were low, generally near or at, background levels, and analytical detection limits. CNSC staff concluded that the level of airborne particulate contaminants produced by McArthur River Operation is acceptable and does not pose a risk to the environment.

Blueberry twigs were last collected in 2012 as required by the triennial sampling program. Blueberry twigs are monitored to determine if soil-born contaminants (if present) are being absorbed through the roots into the growing plant parts. The concentrations of metals and radionuclides in blueberry twigs have higher than background concentrations for some locations located in the vicinity of onsite waste rock pads. The concentrations decrease within a short distance of the waste rock pads. Compared with historical data, the concentrations are not increasing over time. Blueberry twigs collected near the site boundary are near, or at, background levels, and do not appear to have been affected by site activities.

4.4 Conventional health and safety

CNSC staff monitor the implementation of McArthur River Operation's Safety and Health Management Program to ensure protection of workers. To promote continued effective safety performance, Cameco has implemented a safety and health management program to identify and mitigate risks. The program includes planned internal inspections, a safety permit system, occupational health committees, training and incident investigations.

The conventional health and safety SCA is evaluated by CNSC staff through regular compliance activities. Compliance activities include inspections, reviews of incident reports, and health and safety reports. CNSC compliance verification activities confirmed Cameco's strong focus on the prevention of accidents, on reducing lost-time incidents (LTIs) and the number of injuries requiring medical treatment.

There were no lost-time incidents reported at the McArthur River Operation for 2013.

The 2013 LTI performance (table 4-3) shows an improvement in the severity rate over the past five years.

Table 4-3: McArthur River Operation – total number of FTE workers and LTIs, severity rate and frequency rate, 2009–2013

McArthur River Operation					
Year	**2009**	**2010**	**2011**	**2012**	**2013**
Total number of FTE workers*	713	835	966	1,017	914
Number of LTIs*	2	1	3	2	0
Severity rate*	56.9	45.1	14.4	8.0	0
Frequency rate*	0.3	0.1	0.3	0.2	0

*Definitions of these terms are located in the Glossary.

Cameco's incident reporting system includes reporting and investigation of near-misses. This originates from recognition that the reporting of incidents offers significant value in reducing future incidents that could cause injury. CNSC staff observed there was also an improved incident-reporting culture.

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5 Rabbit Lake Operation

Located 750 kilometres north of Saskatoon, Saskatchewan, the Rabbit Lake Operation is owned and operated by Cameco Corporation. The facility consists of an active underground mine (Eagle Point mine), one mined-out flooded pit, two mined out pits (now open to Collins Bay in Wollaston Lake), a mill (figure 5-1), and associated waste rock storage and tailings management facilities.

Figure 5-1: Rabbit Lake mill

Uranium mining operations first commenced in 1974. Based on results of ongoing exploration activities, Cameco expects the Eagle Point mine to operate until at least 2018. Rabbit Lake mining and milling data are provided in tables 5-1 and 5-2.

Table 5-1: Mining production data – Rabbit Lake Operation, 2009–2013

Mining	2009	2010	2011	2012	2013
Ore tonnage (tonnes/year)	193,006	199,026	197,397	225,282	170,960
Average ore grade mined (% U_3O_8)	0.90%	0.89%	0.91%	0.84%	0.91%
U_3O_8 mined (kg)	1,737,277	1,759,956	1,787,172	1,903,519	1,559,435

Table 5-2: Milling production data – Rabbit Lake Operation, 2009–2013

Milling	2009	2010	2011	2012	2013
Mill ore feed (tonnes/year)	216,389	234,076	209,040	260,299	334,976
Average annual mill feed grade (% U_3O_8)	0.82%	0.78%	0.83%	0.71%	0.54%
Percent uranium recovery	96.4%	96.8%	96.8%	96.8%	97.2%
Uranium concentrate (kg U_3O_8)	1,705,803	1,725,741	1,720,827	1,743,702	1,871,649
Milling - licence production limit expressed as U_3O_8 (kg)	7,665,094	7,665,094	7,665,094	7,665,094	7,665,094

For the last several years, ore from the Eagle Point mine is blended at the Rabbit Lake mill with previously mined low-grade material to supplement uranium concentrate production. As of December 31, 2013, proven ore reserves remaining at Rabbit Lake were 9.2 million kg U_3O_8. If mined at the current production rates, the reserves would be mined-out by the end of 2018.

In October 2013, the Commission issued a 10-year licence following a public hearing in La Ronge, Saskatchewan. Cameco's licence for the Rabbit Lake Operation expires on October 31, 2023.

5.1 Performance

Cameco's radiation protection, environmental protection, and occupational health and safety programs at the Rabbit Lake Operation met expectations and performed satisfactorily in 2013.

Based on site inspections, reviews of the licensee's Radiation Protection Program, work practices, monitoring results and effective dose calculations in 2013, CNSC staff were satisfied that Cameco's Rabbit Lake Operation adequately controlled radiation doses to workers. Radiation doses were kept below regulatory limits and ALARA. The radiation protection SCA was given a "satisfactory" rating.

Cameco's Environmental Protection Program at the Rabbit Lake Operation was effectively implemented and met all regulatory requirements during 2013. All effluent discharged complied with licence requirements. For previously identified contaminants of concern (uranium, molybdenum, and to a lesser extent, selenium), Cameco's effluent treatment system continues to meet performance expectations in reducing the concentrations of these parameters. Rabbit Lake Operation maintains a terrestrial and air monitoring program to monitor emissions and the effects of atmospheric deposition of metals and radionuclides. Air monitoring results indicate negligible impacts.

There were three reportable spills at the Rabbit Lake Operation in 2013. Appendix G provides a brief description of each incident and the actions taken by the licensee. The spills were remediated, with no residual impacts to the environment. The corrective actions taken by Cameco were acceptable to CNSC staff. Cameco continued to protect the environment and received a “satisfactory” rating in the environmental protection SCA.

CNSC staff verified that the occupational health and safety program at the Rabbit Lake Operation continued to be effective in managing health and safety risks. Cameco’s Rabbit Lake Operation reported no lost-time incidents in 2013. The conventional health and safety SCA was rated as “satisfactory”.

The Rabbit Lake SCA ratings for the five-year period, 2009 to 2013 are shown in Appendix C. For 2013, CNSC staff rated all 14 SCAs as “satisfactory”.

A previous licence condition required Cameco’s Rabbit Lake Operation to develop and implement a site reclamation plan. In 2013, Cameco continued reclamation work as follows:

- Reclamation activities made significant progress in the B-Zone area. The B-Zone waste rock pile was shaped, an engineered cover was put in place in 2012 and the pile was hydro-seeded. Drainage channels and environmental instrumentation were also installed to monitor the performance of the reclamation. In 2013, CNSC staff observed good initial growth in the vegetated cover.

Figure 5-2: Contoured, covered and re-vegetated B-Zone waste rock pile

- The flooded B-Zone pit remains isolated from Wollaston Lake. CNSC staff will review the reclamation plan for the pit when submitted by Cameco.
- The AGTMF operated between 1975 and 1985. A conceptual decommissioning plan was developed in 1993. As part of that plan, a program of consolidating the 6.3 million tonnes of tailings in the AGTMF was initiated. The majority of the ice lenses within the tailings have thawed. The bounding earth dams have been reshaped and armored for long-term stability. Placement of an interim till cover on the facility was completed in 2013. A portion of the surface has been hydro-seeded to protect the cover integrity and reduce water infiltration, while another portion of the facility

continues to be actively used for solid waste disposal. A final cover design will be submitted prior to decommissioning.

- In 2005 and 2010, respectively, the dykes that separated the A-Zone and D-Zone pits from Wollaston Lake were purposely breached. In 2013, the water quality in the A and D-Zone pits continued to be consistent with Wollaston Lake background values. The vegetation in the remediated areas of the pits is well established.
- The Link Lakes were affected during the early operation of the Rabbit Lake mine. Cameco's investigation concluded that natural recovery was the best remediation option. Monitoring of the recovery of the Link Lakes continued in 2013.

CNSC staff verified these 2013 reclamation activities through desktop reviews of applications and reports, and onsite inspections. The reclamation plan is updated annually and CNSC staff will continue to monitor and review Cameco's water management practices and reclamation activities to ensure that the environment is protected. The financial guarantee for the decommissioning of the site was updated to $202.7 million in 2013.

5.2 Radiation Protection

The source of radiological exposure at the Rabbit Lake Operation is mining at the Eagle Point underground mine and uranium ore milling at the Rabbit Lake mill. The three primary effective dose contributors are gamma radiation, radon progeny and long-lived radioactive dust (LLRD).

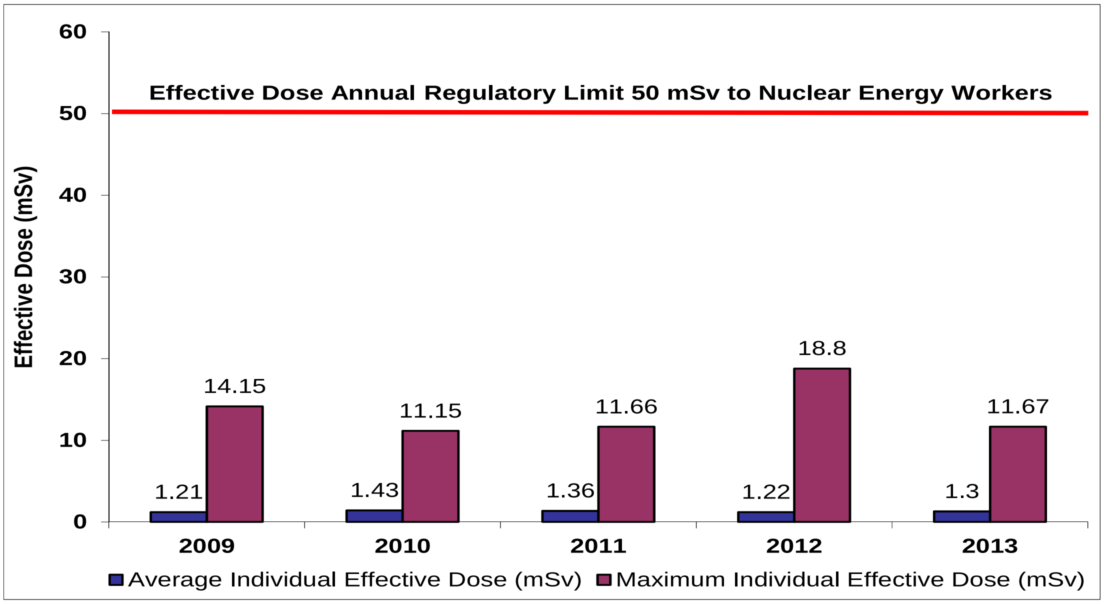
The effective dose to workers from exposures to radon progeny and LLRD are controlled through the effective use of ventilation, and by the capture/exhaust of high sources. Gamma radiation exposure is controlled through the application of time, distance and shielding. Radon progeny contributed approximately 50 percent of the total effective dose.

In 2013, as shown in figure 5-3, the average individual effective dose for all Rabbit Lake workers was 1.30 mSv, consistent over the last five years. The maximum individual effective dose in 2013 decreased to 11.67 mSv. Doses to workers continued to be below the annual regulatory dose limit of 50 mSv.

The average individual effective dose for the mill workers was 1.6 mSv in 2013, consistent with values measured since 2010. The average individual effective dose in 2013 for underground miners was 3.1 mSv, down from 4.3 mSv in 2012.

All five of the uranium mine and mill facilities have the same effective dose action levels for workers of 1 mSv/week and 5 mSv/quarter of a year.

Figure 5-3: Rabbit Lake Operation – individual effective dose to NEWs, 2009–2013



*In 2012, the maximum individual effective doses for 2010 and 2011 were modified from the previous *CNSC Staff Report on the Performance of Canadian Uranium Fuel Cycle and Processing Facilities: 2011*. These changes occurred as a result of dose changes approved through the National Dose Registry. The new values resulted from previously rejected personal alpha dosimeter results, which were accepted later, in early 2012 (2010 changed from 10.7 mSv to 11.15 mSv; 2011 changed from 11.4 mSv to 11.66 mSv).

*In 2013, the 2012 maximum individual effective dose has been modified from 14.37 to 18.8 mSv (as stated in the previous *CNSC Staff Report on the Performance of Canadian Uranium Fuel Cycle and Processing Facilities: 2012*), as a result of approved dose changes following an injury to an underground worker.

One action level exceedance was reported in 2013, concerning a worker cable bolting in the Eagle Point mine. The analysis of the worker's personal alpha dosimeter determined an exposer of 2.16 mSv over a two-week period, exceeding the weekly action level of 1.0 mSv/week. Two corrective actions were identified following the investigation (one related to worker habits, the second related to the work instructions for the mining activity of cable bolting). CNSC staff were satisfied with the actions taken by Rabbit Lake Operation to prevent the reoccurrence of a similar event.

As reported in the *CNSC Staff Report on the Performance of Uranium Fuel Cycle and Processing Facilities: 2012*, an underground mechanic at the Eagle Point mine was injured when struck by a scoop tram. During the accident, a small amount of radiological material was embedded in the mechanic's injured lower limbs, resulting in a radiological exposure. To estimate the mechanic's internal radiation dose from this radiological material, almost a year of uranium-in-urine analysis was necessary. In 2013, Cameco estimated the lifetime effective dose to be received by the mechanic, as a consequence of the accident, to be 16.1 mSv. Prior to the accident, the mechanic's dose from routine work activities was 2.7 mSv. When combined, the mechanic's total dose attributed for 2012 was 18.8 mSv. CNSC staff reviewed the provided data and agreed with the interpretation.

As previously reported in the *CNSC Staff Report on the Performance of Uranium Fuel Cycle and Processing Facilities: 2012*, the maximum individual effective dose was reported as 14.37 mSv. The mechanic's total dose of 18.8 mSv, as described above, is now the maximum individual effective dose for 2012 as shown in figure 5-3.

Figure 5-4: Rabbit Lake scoop tram

Improvements in radiation protection

Continual improvements to the Rabbit Lake Operation's Radiation Protection Program were made in accordance with subsection 4(a) of the *Radiation Protection Regulations* and CNSC guide document G-129, *Keeping Radiation Exposure and Doses "As Low as Reasonably Achievable"*.

Through compliance activities in 2013, CNSC staff observed improvements in the area of radiation protection consistent with the application of ALARA, two examples were:

- On a quarterly basis, the workers with the highest five individual effective doses at Rabbit Lake Operation are identified, and action plans were created with their supervisors to lower their future effective doses. In 2013, the licensee also improved the timely identification of the workers with the highest five individual effective doses.
- Reduction in radon in the mine air was attributed to improved control of the groundwater seepage and the grouting program at Eagle Point mine.

Figure 5-5: Grouting at Eagle Point Mine

5.3 Environmental protection

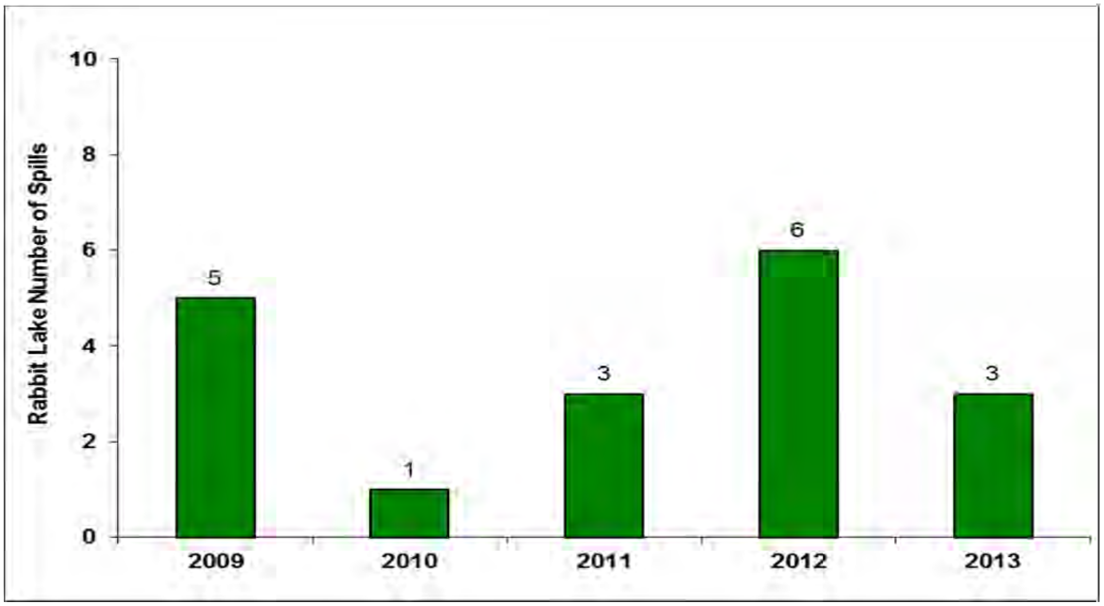
CNSC staff verified that the Rabbit Lake Operation's Environmental Monitoring Program were effective in environmental performance. CNSC staff assessed that Rabbit Lake's environmental monitoring programs met all regulatory requirements during 2013, and that all effluent discharged complied with licence requirements.

There were three spills in 2013:

- 1,000 L (1.0 m^3) of high pH water was released to the building apron.
- 4,000 L (4.0 m^3) of contaminated process water was incorrectly used to clean the mill roof, and pooled on the apron beside the mill.
- 365 m^3 of contaminated material was placed outside of the edge of the lined ore pad.

Appendix G further describes the above 2013 reportable spills and the corrective actions taken by the licensee. The licensee continues to report environmental spills in a timely manner and applies a lessons-learned approach to reduce such spills in the future. CNSC staff were satisfied with the remedial actions taken by the licensee, and concluded that environmental impacts from these spills were negligible.

Figure 5-6: Rabbit Lake Operation – environmental reportable spills, 2009–2013



The method of tailings placement into the Rabbit Lake In-Pit Tailings Management Facility was modified in the winter of 2013. With the incorporation of a till barrier between the tailings and the pervious surround, water is now ponded on the tailings surface. Tailings are now deposited under the ponded-water surface (subaqueous). It is anticipated that this change will prevent ice lens accumulation in the tailings mass, and reduce radon and dust. The active thaw program in the Rabbit Lake In-Pit Tailings Management Facility is currently planned to resume after tailings disposition in the facility.

Treated effluent released to the environment

Effluent from the Rabbit Lake Operation met regulatory requirements throughout 2013. Modifications to the treatment system included a temporary test on the bypassing of the final-stage sand filters. At the final discharge point, continuous monitoring of effluent quality with respect to total suspended solid concentrations was installed in 2013, to improve process control. The licensee plans to submit an application in 2014 to permanently bypass the filters.

Figure 5-7: Rabbit Lake Final Effluent Treatment

Molybdenum, selenium and uranium in effluent

Molybdenum, selenium and uranium have been identified as constituents of concern from treated effluent at uranium mines and mills. Uranium and molybdenum were the constituents of concern at Rabbit Lake Operation. Substantial water treatment modifications were completed at Rabbit Lake Operation since 2007 to improve the quality of the treated effluent released to the environment. The licensee installed additional chemical treatment processes to reduce molybdenum (figure 5-8), selenium (figure 5-9) and uranium (figure 5-10) concentrations. Molybdenum concentrations display continued reductions since additional effluent treatment processes were installed. Selenium concentrations have been generally stable.

Figure 5-8: Rabbit Lake Operation – concentrations of molybdenum, 2009–2013
(McArthur River action level for molybdenum is shown for reference only)

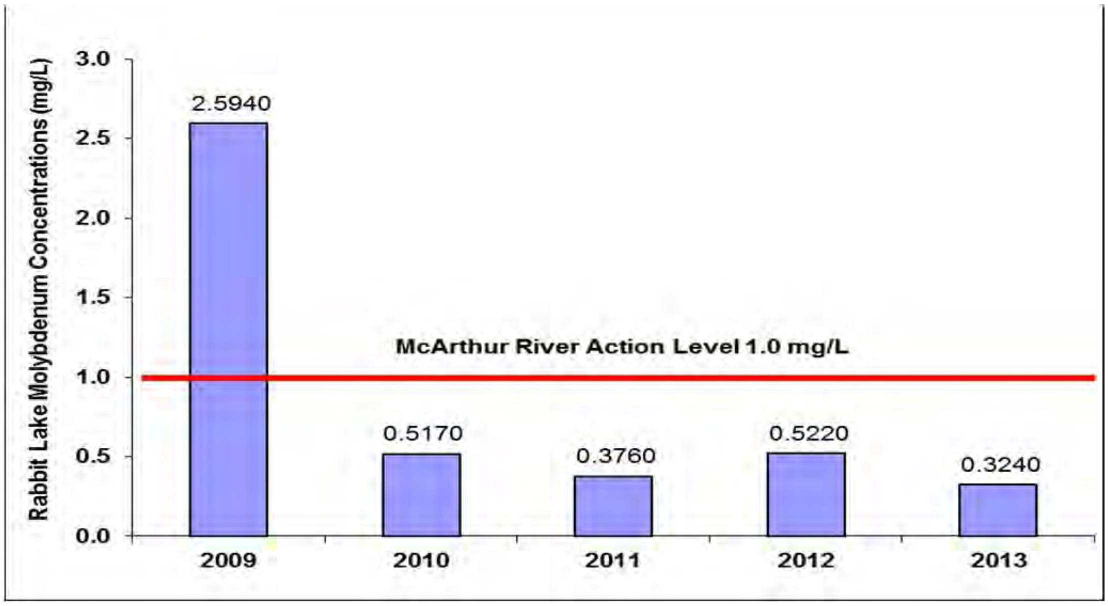
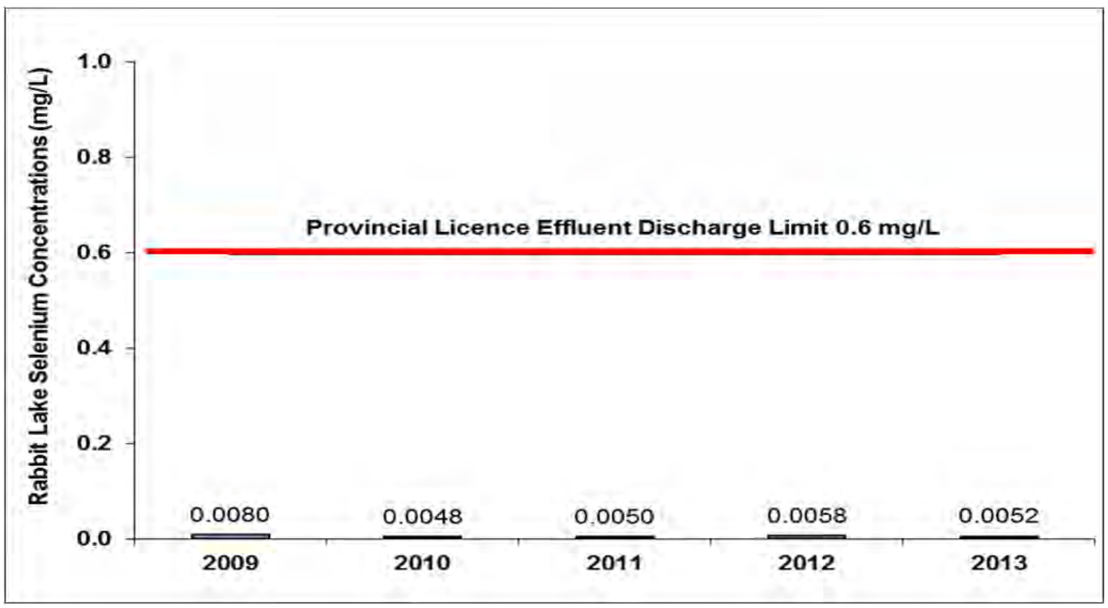


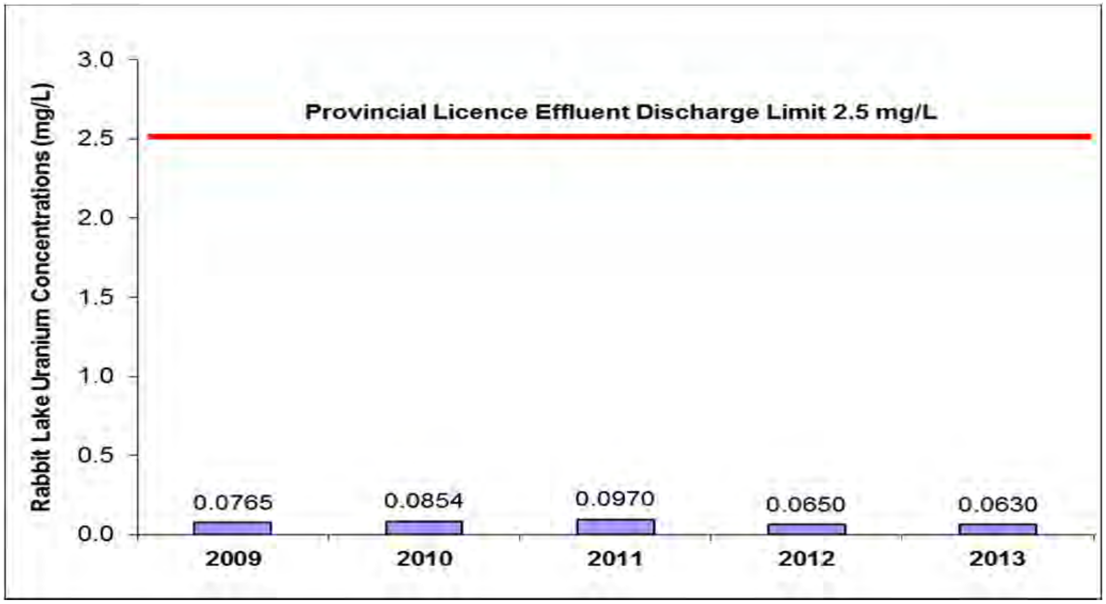
Figure 5-9: Rabbit Lake Operation – concentrations of selenium, 2009–2013
(Province of Saskatchewan's discharge limit for selenium is shown for reference only)



The Saskatchewan provincial licence limit for uranium is a maximum monthly mean of 2.5 mg/L. However, the *Priority Substances List 2 Assessment* (Environment Canada and Health Canada, 2003) and Rabbit Lake Operation environmental investigations indicated that such limits were not adequately protective of the environment in all circumstances. In 2006, a review identified a concentration of uranium in effluent of 0.1 mg/L as a potential treatment design objective that could be achieved that would be protective of the environment. The CNSC is using this value (0.1 mg/L uranium) as an interim objective for uranium mine and mill facilities.

In 2007, Rabbit Lake Operation implemented improvements, resulting in an 86 percent reduction of uranium in treated effluent. The treatment circuit modifications have been successful in meeting the uranium target objective of 0.1 mg/L.

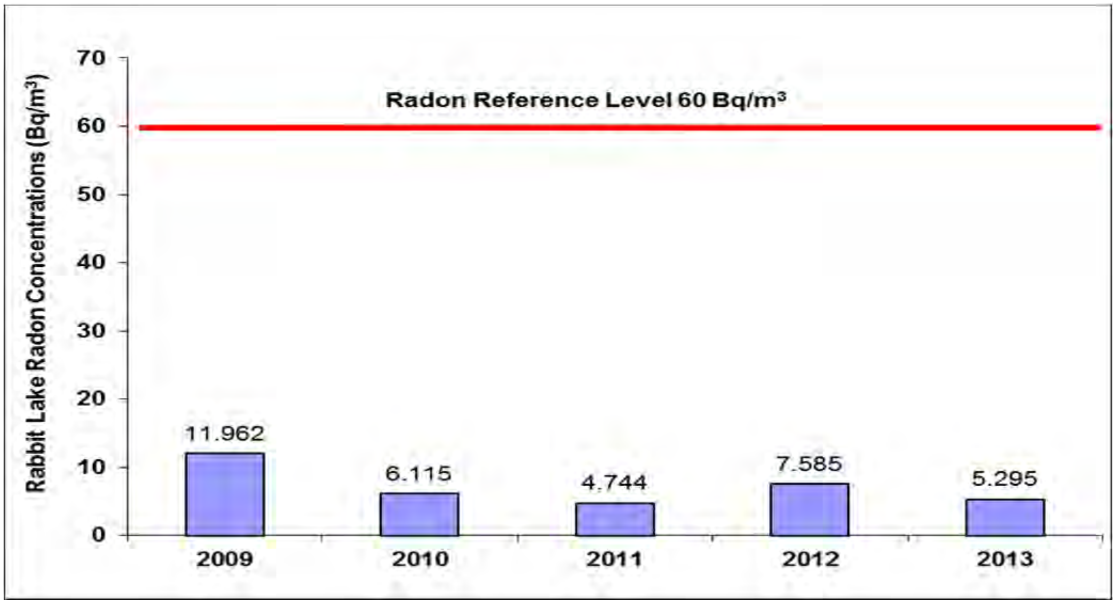
Figure 5-10: Rabbit Lake Operation – concentrations of uranium, 2009–2013
(Province of Saskatchewan's discharge limit for uranium is shown for reference only)



The atmospheric monitoring program at the Rabbit Lake Operation includes ambient monitoring for sulphur dioxide, radon-222, total suspended particulates (TSP), soil sampling and lichen sampling to assess air quality. Air emissions from the mill stacks are also included in the air quality monitoring program.

Twenty monitoring locations are used for the monitoring of ambient radon, using passive track-etched cups. In 2013, the radon concentrations ranged from < 3.7 Bq/m^3 to 33.3 Bq/m^3. These values are below the typical baseline range for the province of Saskatchewan (37 Bq/m^3 to 74 Bq/m^3) and generally within the regional baseline of < 7.4Bq/m^3 to 25 Bq/m^3 typical of northern Saskatchewan. Figure 5-11 shows that the average radon concentrations in the ambient air from 2009 to 2013 are below the reference level for radon.

Figure 5-11: Rabbit Lake Operation – concentrations of radon in ambient air, 2009–2013 (reference level is derived from the *Radiation Protection Regulations**)



* The value of 60 Bq/m³ has been derived from ICRP-65 as referenced in the *Radiation Protection Regulations* and approximates to an annual dose of 1 mSv.

Figure 5-12: Passive track-etched cup for measuring of ambient radon

Air quality at the Rabbit Lake Operation is monitored through direct measurement of emissions from the mill, ambient air quality near the operation, and indirectly through measurements of metal accumulations in the terrestrial environment. Three high volume air samplers (HVAS) were used to collect and measure total suspended particulates (TSP) in air. The HVAS units are located in the vicinity of the mill, B-Zone ore pad and the Eagle Point mine. The TSP levels, from the average of the three stations, are below Saskatchewan's *The Clean Air Regulations* standard (figure 5-13). TSP samples are also analyzed for concentrations of metals and radionuclides. The mean concentrations of metal and radionuclides adsorbed to TSP are low, and remain below the reference annual air quality levels identified in table 5-3.

Figure 5-13: Rabbit Lake Operation – concentrations of total suspended particulate 2009–2013 (Province of Saskatchewan's standard is shown)

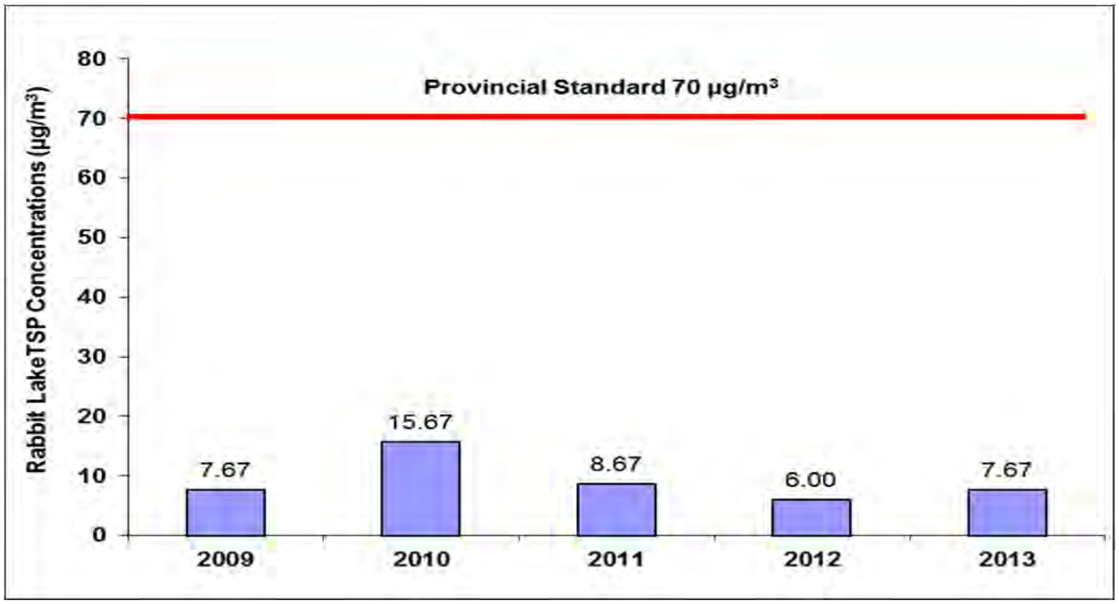


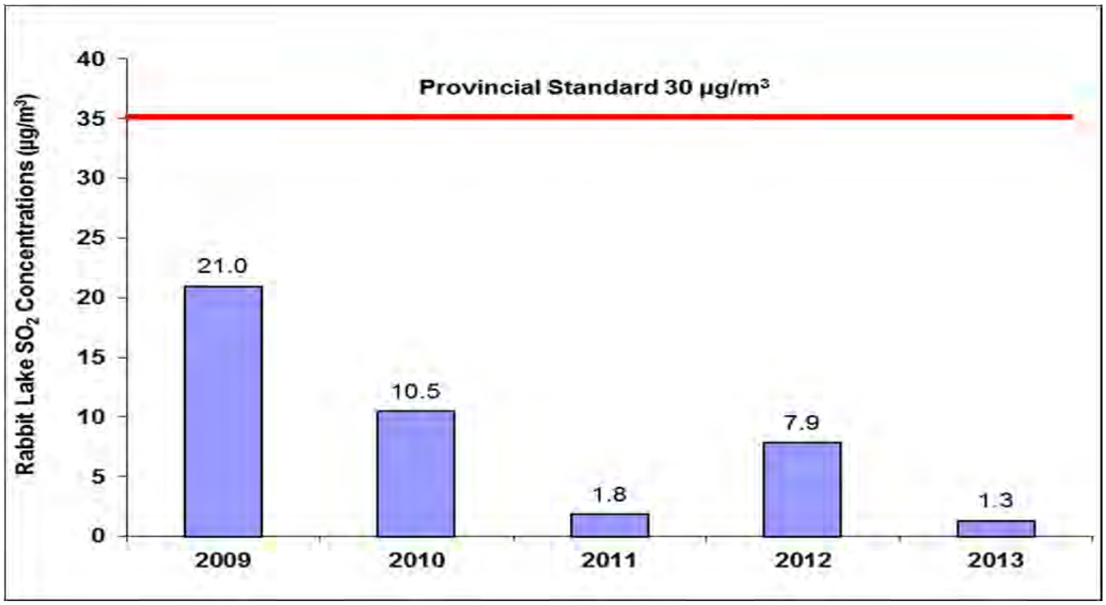
Table 5-3: Rabbit Lake Operation – concentrations of metal and radionuclides in air, 2009–2013 (Province of Ontario and International Commission on Radiation Protection reference annual air quality levels are shown for reference only, as no federal or province of Saskatchewan limits are currently established)

Rabbit Lake Operation						
Parameter	**Reference annual air quality levels**	**2009**	**2010**	**2011**	**2012**	**2013**
As (µg/m³)	**0.06 (1)**	0.00055	0.000533	0.000483	0.000233	0.000175
Ni (µg/m³)	**0.04 (1)**	0.00015	0.00085	0.0008	0.000033	0.000007
Pb^{210} (Bq/m³)	**0.021 (2)**	0.000176	0.000012	0.000017	0.000012	0.000010
Ra^{226} (Bq/m³)	**0.013 (2)**	0.000033	0.000004	0.000002	0.000000	0.000002
Th^{230} (Bq/m³)	**0.0085 (2)**	0.000048	0.000039	0.000003	0.000001	0.000001
U (µg/m³)	**0.06 (1)**	0.000833	0.0018	0.0015	0.000917	0.001033

1 Reference annual air quality levels derived from Ontario 24-hour *Ambient Air Quality Criteria* (OMOE 2012)
2 Reference level from International Commission on Radiation Protection (ICRP 96)

A sulphur dioxide (SO_2) sampler monitors ambient sulphur dioxide associated with mill operations. It is located approximately 450 meters southwest of the acid plant. Sulphur dioxide monitoring results (figure 5-14) show no exceedances of the annual standard of 30 µg/m³. The operations at Rabbit Lake do not appear to have an adverse effect on ambient sulphur dioxide levels at the site.

Figure 5-14: Rabbit Lake Operation – concentrations of ambient sulphur dioxide 2009–2013 (Province of Saskatchewan's standard is shown)



Soil and terrestrial vegetation may be affected by the atmospheric deposition of particulates and adsorbed metals and radionuclides associated with onsite activities. A terrestrial monitoring program is in place to determine if there is influence from aerial deposition. This program includes measurements of metals and radionuclides in soil and in lichen. Measurements of metals and radionuclides are taken in soil in the immediate vicinity of the mine.

Lichen samples were collected in 2013, as required by the triennial sampling program. A total of 13 sites were sampled. Lichen samples are analyzed to determine the level of airborne particulate contaminants deposited on the surface of the lichen as a means of ensuring that a significant level of contamination is not entering lichen consumers, such as caribou. The sites are located to detect both near and far field influences, with a control station providing information for comparison. The concentrations of metals and radionuclides in lichen were similar to historical data and in 2013 most lichen results were consistent with the control station with near field stations showing slightly elevated results, as expected. CNSC staff concluded that the level of airborne particulate contaminants produced by Rabbit Lake Operation is acceptable and does not pose a risk to the lichen consumers such as caribou.

The most recent soil samples were collected in 2008, as part of the *2005-2009 Integrated Environmental Risk Assessment and State of the Environment Report*. The next report is expected in 2015. In 2008, the soil metal parameter concentrations were below the *Canadian Environmental Quality Guidelines* for Industrial and Residential/Parkland land use. Appendix I displays three metal parameters (arsenic, nickel and uranium) measured in soil samples at Rabbit Lake Operation to be well below *CCME Soil Quality Guideline* levels. Also shown in Appendix I, radionuclide concentrations in soils were low, generally near or at, background levels, and analytical detection limits. CNSC staff concluded that the level of airborne particulate contaminants produced by Rabbit Lake Operation is acceptable and does not pose a risk to the environment.

Monitoring of the Rabbit Lake yellowcake dryer, yellowcake packaging and yellowcake area dust collector stacks is completed triennially. Overall, the stack emissions show results consistent with or better than past performance and verify that the controls are operating as designed.

Sulphur dioxide concentrations in the acid plant stack were monitored on a continuous basis. In 2010, several major components of the acid plant were replaced, resulting in approximately 70 percent reduction in sulphur dioxide emissions.

5.4 Conventional health and safety

CNSC staff monitors the implementation of Rabbit Lake Operation's Safety and Health Management Program to ensure the protection of workers. Cameco has implemented a safety and health management program to identify and mitigate risks. The program includes planned internal inspections, a safety permit system, occupational health committees, training and incident investigations.

The conventional health and safety SCA is evaluated by CNSC staff through regular compliance activities including inspections and reviews of incidents. Rabbit Lake Operation's safety objectives for 2013 included adherence to routine requirements, increased safety awareness and incident reduction. CNSC compliance verification activities confirmed Rabbit Lake Operation's strong focus on the prevention of accidents and injuries.

In 2013, there were no lost-time incidents (LTIs) at the Rabbit Lake Operation. The Rabbit Lake LTI performance for 2009 to 2013 is shown in table 5-4.

Table 5-4: Rabbit Lake Operation – Total number of FTE workers and LTIs, severity rate and frequency rate, 2009–2013

Rabbit Lake Operation					
Year	**2009**	**2010**	**2011**	**2012**	**2013**
Total number of FTE workers*	528	524	551	719	744
Number of LTIs*	7	0	2	1	0
Severity rate*	86.0	27.6	10.9	22.6	25.8
Frequency rate*	1.3	0.0	0.4	0.1	0.0

**Definitions of these terms are located in the Glossary.*

It should be noted that the "days lost" value used in the calculation of severity rates is recorded from the year in which they occur. Therefore, although the year 2010 had no lost-time incidents, it shows a severity rate of 27.6, as a result of a lost-time incident which occurred in 2009. An LTI also occurred in 2012 resulting in days lost in 2013;

therefore, although no lost-time incidents took place in 2013, the severity rate for the entire year was 25.8.

There were two noteworthy near-miss incidents at the Eagle Point mine in 2013:

1) On May 23, 2013, a scoop tram operator inadvertently drove the scoop down an open stope while creating a muck berm prior to backfilling. While no one was hurt from the incident, there was the potential for injuries. The event highlighted the importance of adhering to procedures, training and the effective use of safety tools in the workplace. Corrective actions arising from this event included improvements to the "Job-Task-Observation" and "5-Point Safety System", as well as the review and revision of training requirements for mining positions at Eagle Point. CNSC staff were satisfied with the follow-up actions taken by Rabbit Lake Operation.

2) On July 7, 2013, a contractor working in the Eagle Point underground mine drilled into a high voltage cable, severing the line; the cable was not present on the drawings provided to the contractor. Rabbit Lake Operation implemented three corrective actions: cross-referencing electrical cables to records to ensure completeness; the implementation of back-up means of verifying the presence of electrical cables on drawings; and 8 meter breakthrough notice circles around utility holes. CNSC staff were satisfied with the corrective actions taken by the licensee.

Cameco's incident reporting system includes reporting and investigation of near-misses. This originates from a facility-wide recognition that the reporting of incidents offers significant value in reducing future incidents that could cause injury. CNSC staff observed there was also an improved incident reporting culture.

6 Key Lake Operation

Located approximately 570 kilometres north of Saskatoon, Saskatchewan, the Key Lake Operation is owned and operated by Cameco Corporation. The Key Lake Operation began with two open pit mines and a mill complex. The Gaertner open pit was mined from 1983 to 1987, followed by mining of the Deilmann open pit until 1997. Milling of the Deilmann ore continued until 1999, when the McArthur River Operation began supplying ore slurry to the Key Lake mill (figure 6-1). The Key Lake Operation continues today as a mill operation processing McArthur River ore slurry.

Figure 6-1: Key Lake Operation

Figure 6-2: Ore slurry being transported from McArthur River Operation to the Key Lake Operation mill

After open pit mining of the eastern pit of the Deilmann ore body was completed in 1995, the pit was converted into the engineered Deilmann Tailings Management Facility (figure 6-3). Mill tailings continue to be deposited into this facility today. Cameco envisions the Key Lake Operation as a future "regional mill", offering milling services for a number of regional ore deposits.

In the Deilmann Tailings Management Facility a number of sand sloughing events occurred between 2001 and 2009. These pit-wall sloughing events threatened to create a potential facility design failure, loss of tailings capacity, and a health and safety risk to workers. A CNSC licence condition required a plan to stabilize the slope in a timely manner. The submitted and approved design included an excavation to flatten the slopes, and the installation of a toe buttress as shown in figure 6-3. The stabilization project was completed in October 2013.

Figure 6-3: Key Lake Operation's Deilmann Tailings Management Facility

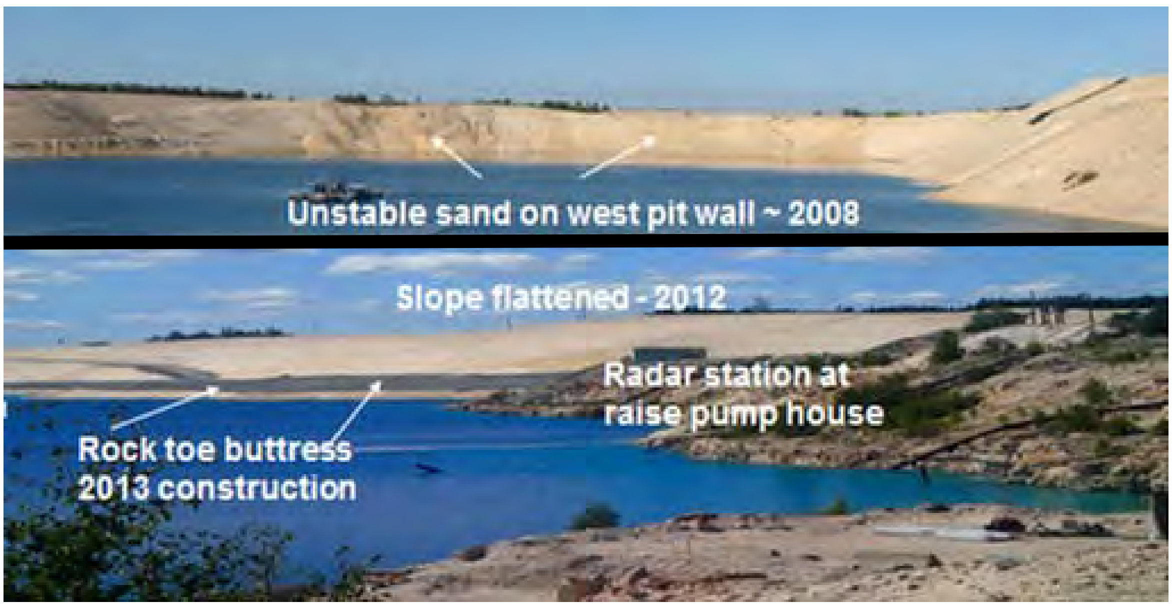


Table 6-1 provides the Key Lake milling production data from 2009 to 2013. It should be noted that while production of uranium concentrate has increased since 2008, the quality of mill effluent control has improved significantly.

Table 6-1: Milling production data – Key Lake Operation, 2009–2013

Milling	2009	2010	2011	2012	2013
Mill ore feed (tonnes/year)	186,981	196,180	189,821	193,511	184,099
Average annual mill feed grade (%U_3O_8)	4.68%	4.68%	4.85%	4.61%	5.03%
Percentage of uranium recovery	98.5%	98.4%	98.7%	98.9%	99.3%
Uranium concentrate produced (kg U_3O_8)	8,654,056	9,026,091	9,063,888	8,867,584	9,132,199
Milling - licence production limit expressed as U_3O_8 (kg)	9,257,075	9,257,075	9,257,075	9,257,075	9,257,075

In October 2013, the Commission issued a 10-year licence following a public hearing in La Ronge, Saskatchewan. Cameco's licence for the Key Lake Operation expires on October 31, 2023 and now includes a Licence Conditions Handbook (LCH). The LCH provides the licensing basis and authorized activities. Production limits are an annual average of 7.2 million kilograms of uranium (8.49 Mkg of U_3O_8), with production not to exceed 7.85 million kilograms of uranium (9.25 Mkg U_3O_8) per year.

6.1 Performance

Based on the outcome of inspections, reviews of the radiation protection program, work practices, monitoring results and effective doses in 2013, CNSC staff were satisfied that the Key Lake Operation was adequately controlling radiation doses to workers to levels below regulatory limits. CNSC staff conclude that the effective implementation of the radiation protection program maintained worker doses ALARA, and the radiation protection SCA was rated as "satisfactory".

CNSC staff concluded that Key Lake Operation's environmental program met regulatory requirements during 2013, with the exception of a single incident of pH exceedance. There was a short-term high pH limit exceedance of treated water released from the Reverse Osmosis Plant to Horsefly Lake in December 2013. There were no environmental effects as a result of the event. CNSC staff conducted a follow-up inspection to verify that effective corrective and preventative actions were implemented.

CNSC staff also concluded that mill effluent discharged to Wolf Lake in 2013 displayed stabilized concentrations of molybdenum and selenium and complied with licence requirements. There were three minor reportable spills at Key Lake Operation in 2013. The environmental protection SCA was rated as "satisfactory".

CNSC staff concluded that the Occupational Health and Safety Program at Key Lake Operation continues to be effective. CNSC staff verified that Cameco is committed to accident prevention, safety awareness, and an increased focus on safety culture. There were no lost-time incidents reported for Key Lake Operation in 2013. By the end of 2013, contractors had achieved over six years with no lost-time incidents. The conventional health and safety SCA was rated as "satisfactory".

The Key Lake SCA ratings for the five-year period, 2009 to 2013, are shown in Appendix C. For 2013, CNSC staff continue to rate all SCAs as “satisfactory”.

6.2 Radiation protection

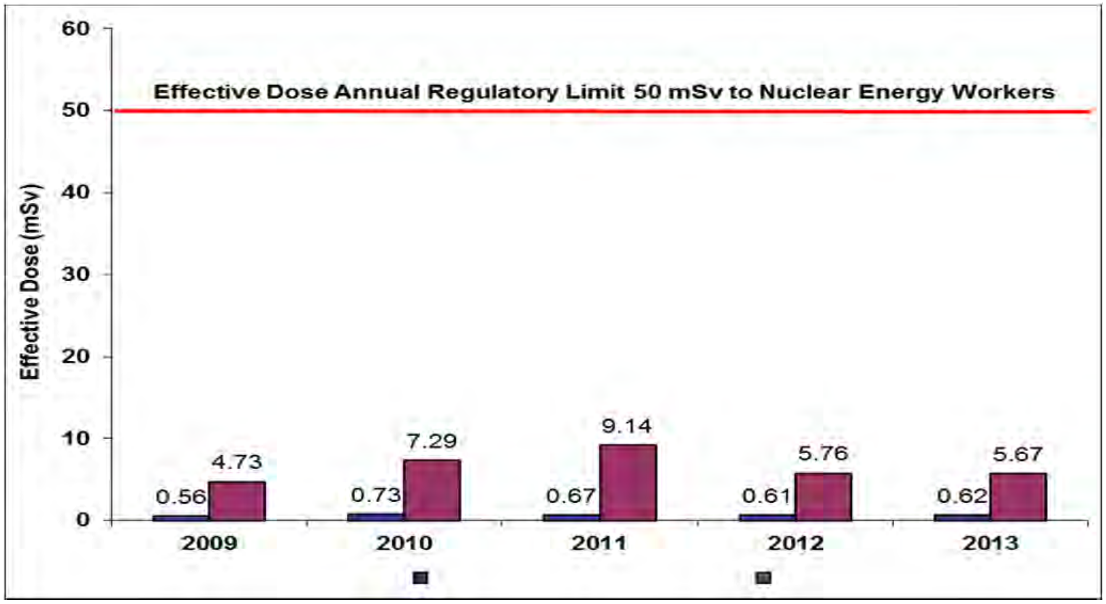
The source of radiological exposure at the Key Lake Operation is the milling of uranium ore received from the McArthur River mine. The three primary effective dose contributors are gamma radiation, radon progeny and long-lived radioactive dust (LLRD). During the 2013 review period, worker average individual effective dose at the Key Lake mill was primarily from gamma radiation. Gamma radiation is controlled through the effective use of time, distance and shielding. The maximum individual effective dose at Key Lake Operation over the last few years has been as a result of “inhalation of LLRD incidents” during calciner maintenance. Key Lake Operation is currently installing a new calciner, which will minimize these types of incidents.

The alpha nuclear prism instrument in figure 6-4 is used in uranium mines and mills to provide a real-time visual warning of potentially high working levels of radon progeny. The system incorporates three highly visible LED lamps of green, yellow and red. The green light, as shown in figure 6-4, indicates that it is safe to enter and work in the area.

Figure 6-4: A prism located in the leaching area of the Key Lake Operation

As seen in figure 6-5, the effective doses to workers remain well below the annual regulatory limit of 50 mSv, and have been consistently low from year-to-year. In 2013, the average individual effective dose was 0.62 mSv, while the maximum individual effective dose received was 5.67 mSv.

Figure 6-5: Key Lake Operation – individual effective dose to NEWs, 2009-2013



All five of the uranium mine and mill facilities have the same action levels for worker effective dose of 1 mSv/week and 5 mSv/quarter of a year.

One action level exceedance was reported in 2013. In April 2013, a mill worker had an uptake of calcined uranium concentrate while conducting routine cleaning and inspection of the vertical calciner. The worker was assigned an individual effective dose of 1.74 mSv, which exceeded the weekly action level of 1 mSv. The review resulted in the following three corrective actions:

- improved quality of personal protective equipment, specifically coveralls
- revision of the Powered Air Purifying Respirator Training Program to ensure a good seal between the hood of coveralls and the respirator
- heightened awareness reviews of the event and controls with the mill maintenance department

Improvements in radiation protection

The new rotary calciner construction is ongoing, and a commissioning plan is expected in the fall of 2015. It is anticipated that a new horizontal rotary calciner will lower maintenance requirements and minimize exposure risks.

In 2013, CNSC staff noted improved radiation training and the implementation of a radiation awareness campaign. The radiation awareness campaign targets Key Lake Operation workers, to enhance their knowledge and understanding of radiation.

Continual improvements to Key Lake Operation's Radiation Protection Program were made in accordance with subsection 4(a) of the *Radiation Protection Regulations* and CNSC guide document G-129, *Keeping Radiation Exposure and Doses "As Low as Reasonably Achievable"*.

Through desktop reviews and inspections, CNSC staff conclude that an effective radiation protection program exists at the Key Lake Operation.

6.3 Environmental protection

In accordance with Key Lake Operation's Environmental Protection Program, effluent and environmental monitoring, site inspections, environmental awareness training, and program implementation audits were all carried out by Cameco or third-party consultants during 2013.

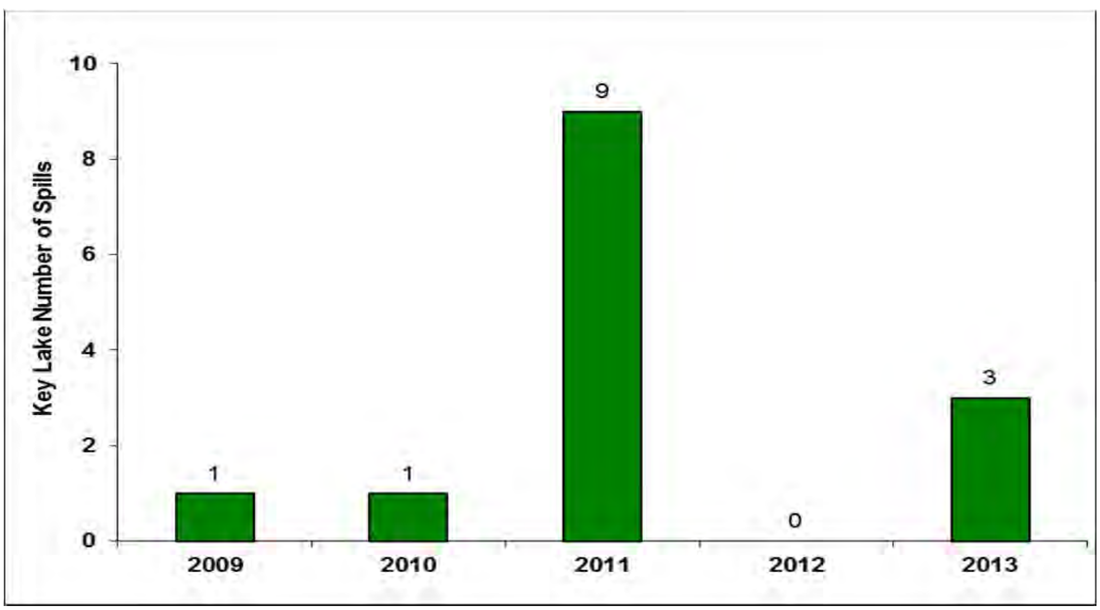
CNSC staff concluded that Key Lake Operation's Environmental Protection Program met regulatory requirements during 2013, except for a single incident of pH exceedance. There was a short-term high pH limit exceedance of treated water released from the Reverse Osmosis Plant to Horsefly Lake in December 2013. There were no environmental effects as a result of the event. CNSC staff conducted a follow-up inspection to verify effective corrective and preventative actions were implemented. Monitoring confirms that the Reverse Osmosis Plant effluent continues to be of very high quality.

Figure 6-6 shows the number of reportable spills from the licensed activities at the Key Lake Operation from 2009 to 2013. In 2013, three spills were reported to CNSC staff:

- 50 L (0.050 m^3) spill of raffinate solution from the solvent extraction facility
- 15 L (0.015 m^3) spill of tailings slurry from a tailings line valve house
- 80 L (0.080 m^3) of contaminated groundwater at a frozen wellhead

The spills were immediately cleaned up and there was no measurable impact to the environment. The identified corrective actions taken by Cameco were acceptable to CNSC staff. Brief descriptions of the three spills and corrective actions implemented are provided in Appendix G.

Figure 6-6: Key Lake Operation – environmental reportable spills, 2009–2013



At the Key Lake Operation, two effluent streams are processed in separate treatment facilities before being released to the environment:

- The mill effluent is processed with a treatment system of chemical precipitation and liquid/solid separation, and released to Wolf Lake in the David Creek system.
- Effluent from dewatering wells of the Gaertner Pit and Deilmann Pit hydraulic containment systems is treated with a reverse osmosis system before being released to Horsefly Lake in the McDonald Lake system.

The McDonald Lake system receives effluent from the reverse osmosis plant, and monitoring has verified that this effluent poses no environmental concern. The Key Lake treated effluent quality further discussed in this report refers only to the mill effluent as released to the David Creek system.

Molybdenum, selenium and uranium in effluent

In 2013, the licensed parameter concentration values in the treated mill effluent were well below the regulatory limits. There were also no exceedances of environmental action levels at the Key Lake Operation.

Molybdenum, selenium and uranium have been identified as contaminants of concern from treated effluent at uranium mines and mills. Molybdenum and selenium concentrations were the primary concerns at Key Lake, and Cameco targeted process changes to reduce concentrations in treated effluent.

Figure 6-7: Key Lake's effluent water treatment plant

Significant reductions of molybdenum and selenium occurred starting in 2009, and figures 6-8 and 6-9 show stable reduced concentrations of molybdenum and selenium concentrations in treated effluent from 2009 to 2013. CNSC staff also note that the stable reduced concentrations occurred during a period of increased uranium production. Continued monitoring of molybdenum and selenium in the receiving environment is expected to demonstrate stabilization and/or improvements over the coming years.

Figure 6-8: Key Lake Operation – concentrations of molybdenum, 2009–2013
(McArthur River action level for molybdenum is shown for reference only)

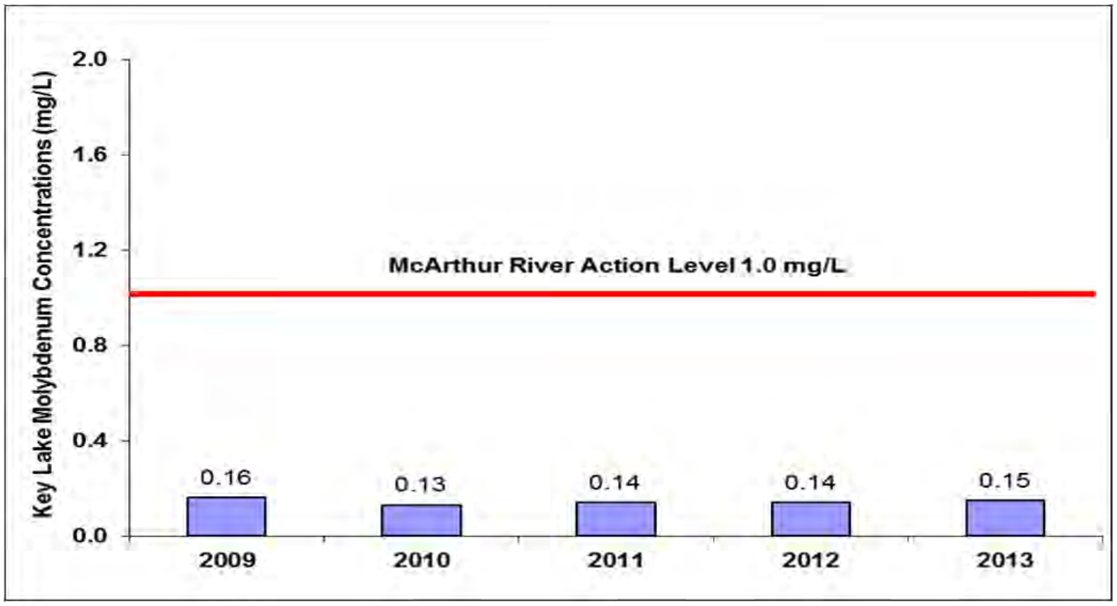


Figure 6-9: Key Lake Operation – concentrations of selenium, 2009–2013
(Province of Saskatchewan's discharge limit for selenium is shown for reference only)

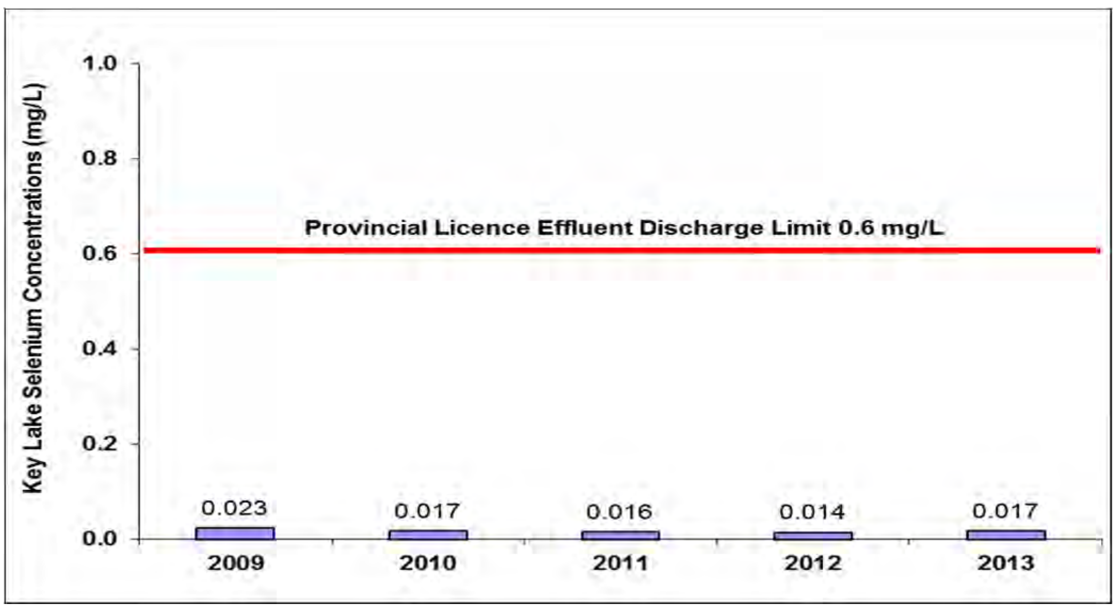
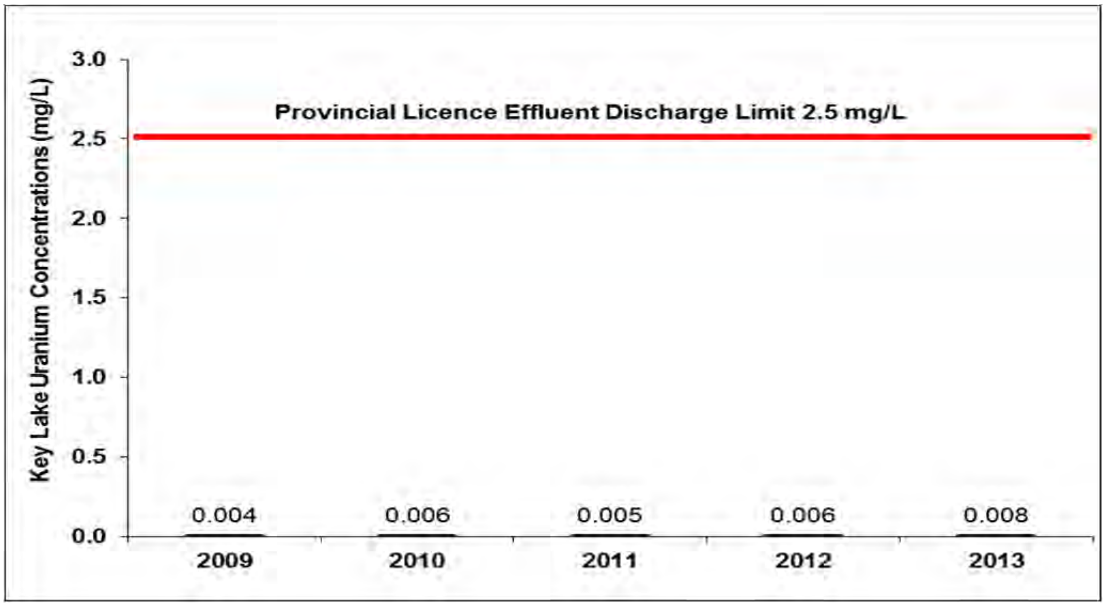


Figure 6-10 indicates that uranium concentrations in treated effluent released from the Key Lake mill remain low, and are effectively controlled.

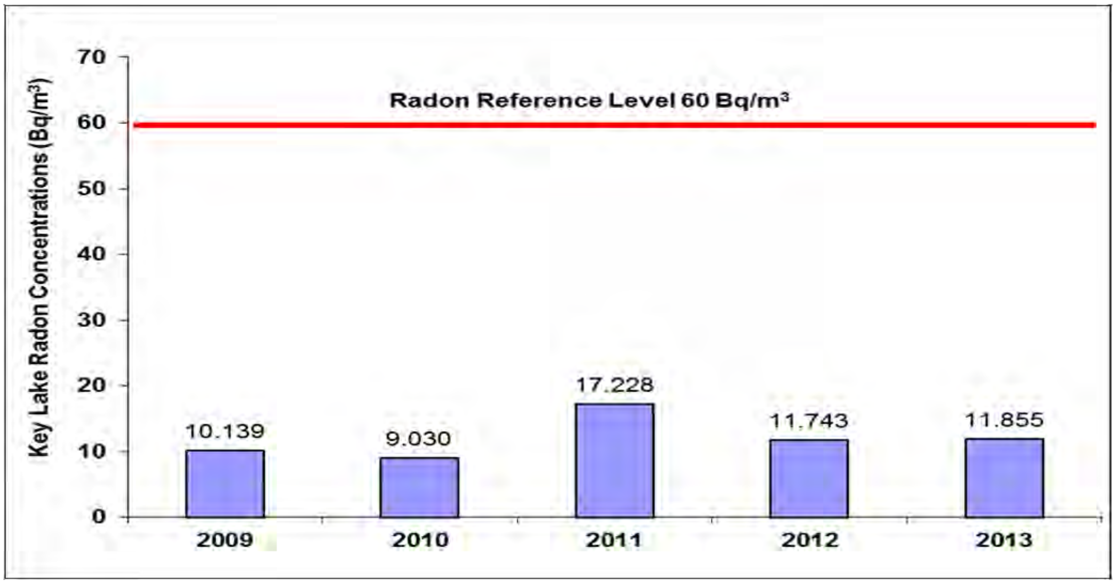
Figure 6-10: Key Lake Operation – concentrations of uranium, 2009–2013
(Province of Saskatchewan's discharge limit for uranium is shown for reference only)



The atmospheric monitoring program at the Key Lake Operation includes ambient monitoring for sulphur dioxide, radon-222, total suspended particulates (TSP), soil sampling and lichen sampling to assess air quality. Air emissions from the mill stacks are also included in the air quality monitoring program.

Five boundary monitoring locations and one boundary reference station are used for the monitoring of ambient radon, using passive track-etched cups. Between November 2012 and November 2013, radon activity ranged from < 7.4 Bq/m^3 to 122.1 Bq/m^3 at the five boundary stations. Radon activity at the Wheeler River background station was < 7.4 Bq/m^3. Other than one elevated value of 122.1 Bq/m3, the values are typical of the baseline range for the province of Saskatchewan (37 Bq/m^3 to 74 Bq/m^3) and the average radon concentration of 11.85 Bq/m^3 is within the northern Saskatchewan regional baseline of < 7.4 Bq/m^3 to 25 Bq/m^3. Figure 6-11 shows the average concentrations of radon in ambient air for 2009 to 2013 are below the reference level for radon.

Figure 6-11: Key Lake Operation – concentrations of radon in ambient air, 2009–2013 (reference level is derived from the *Radiation Protection Regulations**)



* The value of 60 Bq/m^3 has been derived from ICRP-65 as referenced in the *Radiation Protection Regulations* and approximates to an annual dose of 1 mSv.

Five high volume air samplers (HVAS) were used to collect and measure total suspended particulates (TSP) in air. The HVAS units are located downwind of the milling facility, downwind of the crusher, east and west of the Above Ground Tailings Management Facility, and in the vicinity of the main camp residence. The TSP levels are below Saskatchewan's *The Clean Air Regulations* standard (figure 6-12). TSP samples are also analyzed for concentrations of metals and radionuclides. The mean concentrations of metal and radionuclides adsorbed to TSP are low, and below the reference annual air quality levels identified in table 6-2.

Figure 6-12: Key Lake Operation – concentrations of total suspended particulate, 2009–2013 (Province of Saskatchewan's standard is shown)

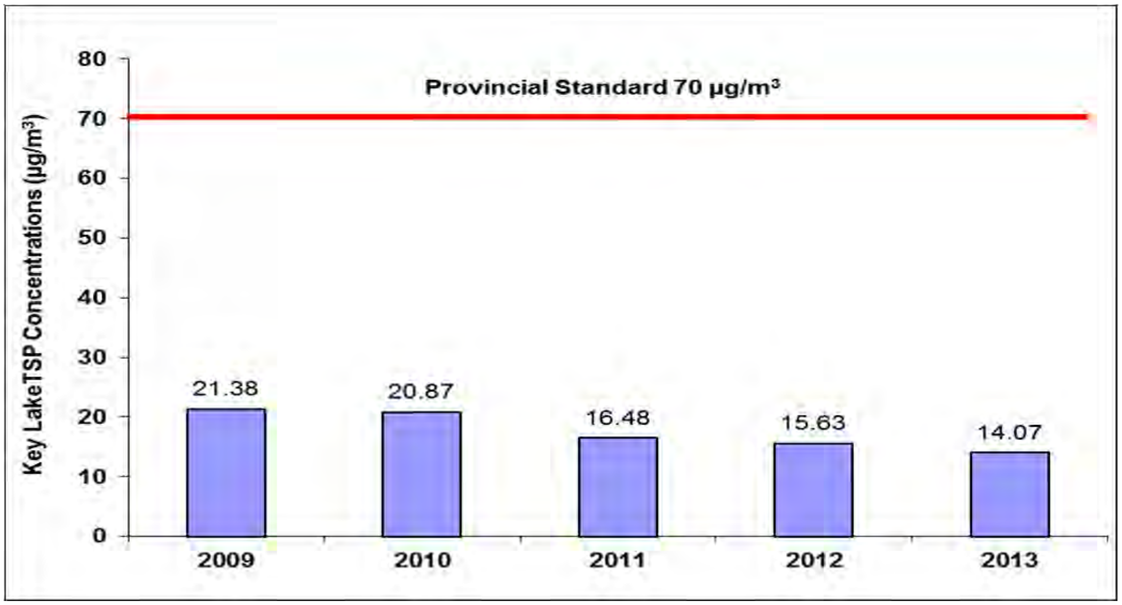


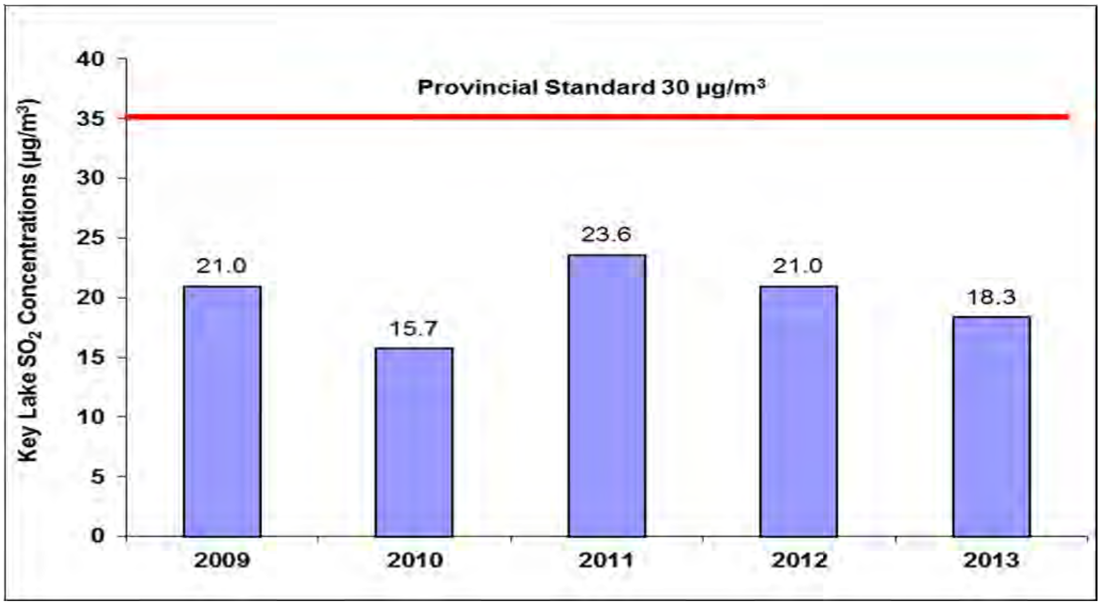
Table 6-2: Key Lake Operation concentrations of metal and radionuclides in air, 2009–2013 (Province of Ontario and International Commission on Radiation Protection reference annual air quality levels are shown for reference only, as no federal or province of Saskatchewan limits are currently established)

Key Lake Operation						
Parameter	**Reference annual air quality levels**	**2009**	**2010**	**2011**	**2012**	**2013**
As (µg/m^3)	**0.06 (1)**	0.0019	0.0015	0.00222	0.00266	0.00166
Ni (µg/m^3)	**0.04 (1)**	0.001633	0.00092	0.00186	0.00222	0.00118
Pb^{210} (Bq/m^3)	**0.021 (2)**	0.000367	0.00048	0.00038	0.00034	0.00032
Ra^{226} (Bq/m^3)	**0.013 (2)**	0.0001	0.0001	0.0001	0.0001	0.0001
Th^{230} (Bq/m$^{3)}$	**0.0085 (2)**	0.0001	0.0001	0.00014	0.00028	0.0001
U (µg/m^3)	**0.06 (1)**	0.0056	0.0046	0.01286	0.0074	0.00646

1 Reference annual air quality levels derived from Ontario 24-hour *Ambient Air Quality Criteria* (OMOE 2012)
2 Reference level from International Commission on Radiation Protection (ICRP 96)

A sulphur dioxide (SO_2) monitor is used to continuously measure the ambient sulphur dioxide associated with mill emissions. It is located approximately 300 meters downwind of the mill facility. The measured sulphur dioxide monitoring data (figure 6-13) shows no exceedances of the annual standard of 30 µg/m^3.

Figure 6-13: Key Lake Operation - concentrations of ambient sulphur dioxide, 2009–2013 (Province of Saskatchewan's standard is shown)



In addition to ambient air monitoring for sulphur dioxide, sulfate levels have been monitored in four lakes selected to measure the effects of sulphur dioxide emissions from the operation. The results of the 2013 lake sampling program continue to show that sulfate concentrations remain relatively unchanged, compared to historical data. The operations at Key Lake do not appear to be having an adverse effect on ambient sulphur dioxide levels at the site.

Soil and terrestrial vegetation may be affected by atmospheric deposition of particulates and adsorbed metals and radionuclides associated with onsite activities. A terrestrial monitoring program is in place to determine if there is influence from aerial deposition. This program includes measurements of metals and radionuclides in soil and in lichen. Measurements of metals and radionuclides were taken in soil in the immediate vicinity of the mine.

Lichen samples were collected in 2013, as required by the sampling program. A total of five sites, chosen to detect both near and far field influences including a control station, were sampled. Lichen samples are analyzed to determine the level of airborne particulate contaminants deposited on the surface of the lichen as a means of ensuring that a significant level of contamination is not entering lichen consumers, such as caribou. The concentrations of metals and radionuclides in lichen samples collected from exposure stations were similar to reference stations and historical data. CNSC staff concluded that the level of airborne particulate contaminants produced by Key Lake Operation is acceptable and does not pose a risk to the lichen consumers such as caribou.

The most recent soil samples were collected in 2013. The soil metal parameter concentrations were below the *Canadian Environmental Quality Guidelines* for industrial and residential/parkland land use. Appendix I displays three metal parameters (arsenic, nickel and uranium) measured in soil samples at Key Lake Operation to be well below *CCME Soil Quality Guideline* levels. Also shown in Appendix I, radionuclide concentrations in soils were low, generally near or at, background levels, and analytical detection limits. CNSC staff concluded that the level of airborne particulate contaminants produced by Key Lake Operation is acceptable and does not pose a risk to the environment.

Monitoring of the Key Lake calciner stack is completed annually. Overall, the stack emissions show results consistent with, or better than, past performance, and verify that the controls are operating as designed. A new calciner upgrade is currently under construction and expected to be commissioned in 2015. This will further improve stack emissions.

Sulphur dioxide concentrations from the acid plant stack are monitored on a daily basis. In 2012, a new acid plant was commissioned resulting in over 90 percent reduction in sulphur dioxide emissions. The new acid plant stack emissions are better than past performance and it is operating as designed.

6.4 Conventional health and safety

CNSC staff monitor the implementation of Key Lake Operation's Occupational Health and Safety Program to ensure protection of workers. Key Lake Operation has implemented a health and safety management program to identify and control risks. CNSC staff observed that the health and safety program at the Key Lake Operation continues to provide education, training, tools and support to workers. Key Lake Operation's approach is that safety is the responsibility of all individuals, and this is promoted by management, supervisors and workers. During inspections, discussions and review of incidents, CNSC staff verified that Key Lake Operation is committed to accident prevention and safety awareness. Through regular communication, management oversight of work and continually improving safety systems, Key Lake Operation's management and supervisors stress the importance of conventional health and safety.

There were a total of 11 lost-time incidents (LTIs) from 2009 to 2013 (table 6-3) at the Key Lake Operation. In 2013, there were no LTIs at the Key Lake Operation.

Table 6-3: Key Lake Operation – total number of FTE workers and LTIs, severity rate and frequency rate, 2009–2013

Key Lake Operation					
Year	**2009**	**2010**	**2011**	**2012**	**2013**
Total Number of FTE Workers*	489	786	886	736	679
Number of LTIs*	4	3	3	1	0
Severity rate*	13.8	26.0	13.1	21.6	8.5
Frequency rate*	0.8	0.4	0.3	0.1	0

*Definitions of these terms are located in the Glossary.

Contractor safety risks continue to be effectively managed. At the end of 2013, the site reported that contractors had no LTIs over the past six years.

The Key Lake site revitalization project continues to require increased manpower requirements, and three registered nurses maintain the occupational, chronic and acute care of workers with external health care providers. The workers received better quality care from the health care system as a result of the nurses' assistance.

Cameco's incident reporting system records health and safety related events and utilizes several layers of review in investigations. Corrective measures are tracked and assessed for effectiveness prior to closure. Key Lake continued its planned inspection program in 2013; any items of concern found during these inspections are included in Cameco's incident reporting system.

Cameco's incident reporting system includes investigation of near-misses. This offers significant value in reducing incidents that could cause injury. CNSC staff observed there was also an improved incident reporting culture.

7 McClean Lake Operation

The McClean Lake Operation is located about 750 kilometres north of Saskatoon, Saskatchewan and is operated by AREVA Resources Canada Inc. (AREVA). Construction of the McClean Lake Operation began in 1994. Mining and milling of uranium ore from five open-pit mines has been completed. Conventional mining has not been carried out at the McClean Lake Operation since 2008. No ore was mined in 2013 by the Surface Access Borehole Resource Extraction (SABRE) project. The CNSC was informed during the first quarter of 2014 that the SABRE project has been placed into care and maintenance for the foreseeable future.

Figure 7-1: McClean Lake Operation

Mill tailings resulting from the processing of ore from the open pit operations have been deposited within the McClean Lake Operation Tailings Management Facility which was constructed in the mined-out JEB open pit.

The McClean Lake Operation mill temporarily stopped producing uranium concentrate during July 2010. No uranium concentrate was produced in 2013. The only mill circuits operating in 2013 were the water treatment plants, the tailings preparation circuit and the utilities plant.

Restart of the mill has been delayed and the facility is expected to begin processing ore from the Cigar Lake Operation in late 2014. Testing of ore samples in 2012 and 2013 identified the release of higher-than-expected concentrations of hydrogen gas during the acid leaching of Cigar Lake ore. As a result, modifications are being made to the leaching circuit to ensure hydrogen gas concentrations are kept at safe levels. Modifications include:

- control of slurry level in leach tanks, to ensure head space volume is maintained
- minimization of the volume of high-point dead spaces, where hydrogen could accumulate
- addition of sufficient air sweep with back-up, to remove hydrogen as it evolves
- addition of a continuous gas monitoring system

- addition of a contingency nitrogen purge system, to create a safe headspace independent of hydrogen gas build-up

Ore slurry received from Cigar Lake Operation is stored in tanks in the Ore Slurry Receiving Circuit. The receipt of ore slurry shipments from Cigar Lake Operation began in March 2014. The delay in the McClean Lake Operation mill restart created a possible need for additional short-term ore slurry storage. Modifications were made to the JEB ore pad, to facilitate temporary storage of ore slurry.

CNSC staff concluded that workers and the environment would continue to be protected following implementation of these modifications.

Figure 7-2 McClean Lake workers

Tables 7-1 and 7-2 display the production data for mining and milling from 2009 to 2013.

Table 7-1: Mining production data – McClean Lake Operation, 2009-2013

Mining*	2009	2010	2011	2012	2013
Ore tonnage (tonnes/year)	759	360	No mining	1,022	No mining
Average ore grade mined (%U_3O_8)	7.43%	3.96%	No mining	4.76%	No mining
U_3O_8 mined (kg)	56,388	25,047	No mining	48,653	No mining

* The last ore from the Sue E pit was mined on March 15, 2008, and Sue B pit's last ore was mined on November 26, 2008. Mine production since then is from the SABRE Project.

Table 7-2: Milling production data – McClean Lake Operation, 2009–2013

Milling	2009	2010	2011	2012	2013
Mill ore feed (tonnes/year)	181,203**	97,167**	No milling*	No milling*	No milling*
Average annual mill feed grade (%U_3O_8)	0.97%	0.80%	No milling*	No milling*	No milling*
Percentage of uranium recovery	93.9%	95.7%	No milling*	No milling*	No milling*
Uranium concentrate produced (kg U_3O_8)	1,634,220**	784,309**	No milling*	No milling*	No milling*
Milling – Licence production limit expressed as U_3O_8 (kg)	3,629,300	3,629,300	3,629,300	5,909,090	5,909,090

* The McClean Lake Operation mill temporarily stopped producing uranium concentrate during July 2010.
** Ore that had been mined before the end of 2008 and ore extracted during the SABRE Project were processed by the McClean Lake Operation mill during 2009 and 2010.

The current licence, issued in July 2009, was amended on December 19, 2012 and expires on June 30, 2017. The amended licence authorizes:

- the operation of the ore slurry receiving circuit and high grade milling circuits in the McClean Lake Operation mill
- the processing of ore slurry from approved sources including Cigar Lake Operation and McArthur River Operation at the McClean Lake Operation mill
- an increase of the maximum annual uranium concentrate (U_3O_8) production from 3,629,300 kg to 5,909,090 kg

The amended licence included a Licence Conditions Handbook (LCH). Changes made to the LCH in July 2013 included modifications to the JEB mill to accommodate the licence amendments.

7.1 Performance

In 2013, there was no mining or milling at AREVA's McClean Lake Operation. Activities in 2013 focused on:

- hiring and training of staff in preparation for the restart of milling operations
- construction of the Yellowcake Drum and Reagent Storage Facility
- construction of a new solvent extraction building
- construction of foundations for the new powerhouse
- design and construction of modifications to the leaching circuit

CNSC staff verified AREVA is adequately controlling radiation doses to workers at the McClean Lake Operation to levels below the regulatory limits. CNSC staff conclude that the effective implementation of the radiation protection program maintained worker doses ALARA, and the radiation protection SCA was rated as "satisfactory".

CNSC staff concluded that McClean Lake Operation's Environmental Protection Program met regulatory requirements during 2013. There were four reportable spills at the McClean Lake Operation in 2013, which were remediated with no residual impacts to the environment. Corrective actions taken by McClean Lake Operation were acceptable to CNSC staff. The environmental protection SCA was rated as "satisfactory".

AREVA continues to maintain health and safety programs at the McClean Lake Operation to minimize occupational health and safety risks and to continually improve performance. AREVA has an effective Occupational Health and Safety Committee and completes regular reviews of its safety program. CNSC staff verified that the safety program at McClean Lake Operation continues to be effective. There were no lost-time incidents at the McClean Lake Operation in 2013. The conventional health and safety SCA was rated as "satisfactory".

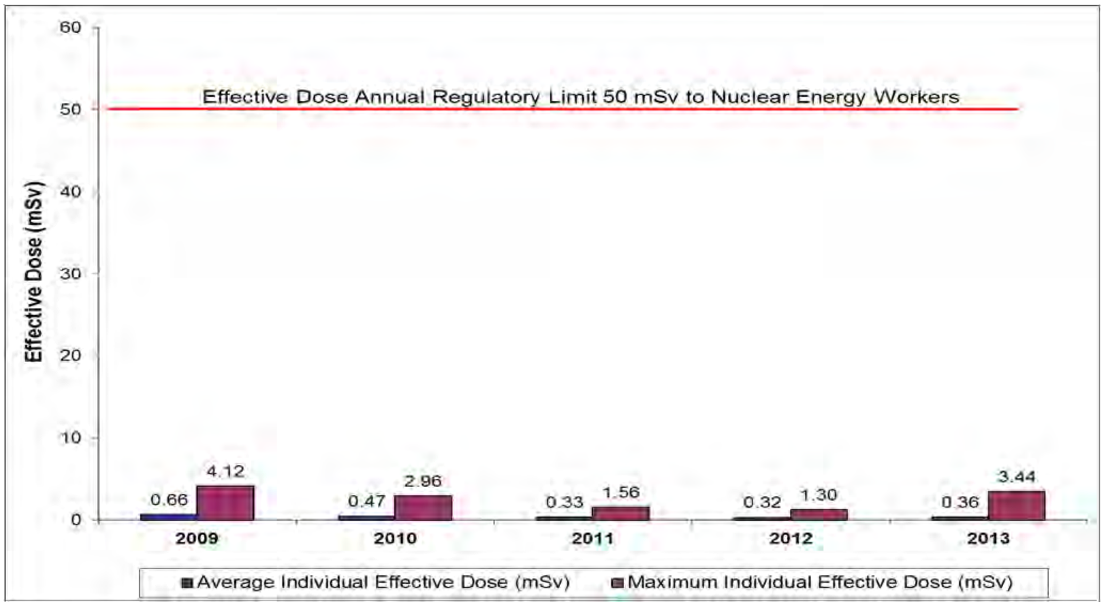
The McClean Lake Operation SCA ratings for the five-year period, 2009 to 2013, are shown in Appendix C. For 2013, CNSC staff continue to rate all SCAs as "satisfactory".

7.2 Radiation protection

The source of radiological exposure at the McClean Lake Operation comes from the radioactive decay of natural uranium in their milling operation. The three primary contributors to workers' effective doses are gamma radiation, radon progeny and long-lived radioactive dust (LLRD).

Figure 7-3 displays the average individual effective dose and the maximum individual effective doses for 2009 to 2013. The cessation of mining in 2008, and milling in 2010, resulted in reduced average and maximum individual effective doses. In 2013, construction and maintenance were the main activities taking place at the mill, and a metallurgical test program was conducted on high-grade Cigar Lake Operation ore. The average individual effective dose for all workers was 0.36 mSv, while the maximum individual effective dose received was 3.44 mSv. Annual effective doses to all workers at the McClean Lake Operation remain well below the annual regulatory dose limit of 50 mSv.

Figure 7-3: McClean Lake Operation – individual effective dose to NEWs, 2009–2013



The action levels for effective dose are 1 mSv/week and 5 mSv/quarter of a year. There were no exceedances of either action level during 2013.

Improvements in radiation protection

Continual improvements to AREVA's radiation protection program at the McClean Lake Operation were made in accordance with subsection 4(a) of the *Radiation Protection Regulations* and CNSC guide document G-129, *Keeping Radiation Exposure and Doses "As Low as Reasonably Achievable"*.

CNSC staff noted the following improvements to worker radiation protection in 2013:

- reduction of sump pit volumes to reduce the deposition of high grade ore slurry
- implementation of Bluetooth-compatible direct reading dosimeters which allow the workers to review a graph of gamma dose rates over the course of their shift
- implementation of the use of real-time LLRD monitoring during the metallurgical testing program
- installation of a new yellowcake packaging system that is designed to minimize drum contamination and worker exposure to LLRD

7.3 Environmental protection

In accordance with AREVA's environmental protection program, effluent and environmental monitoring, site inspections, environmental awareness training and program implementation audits were carried out by AREVA or third-party consultants during 2013.

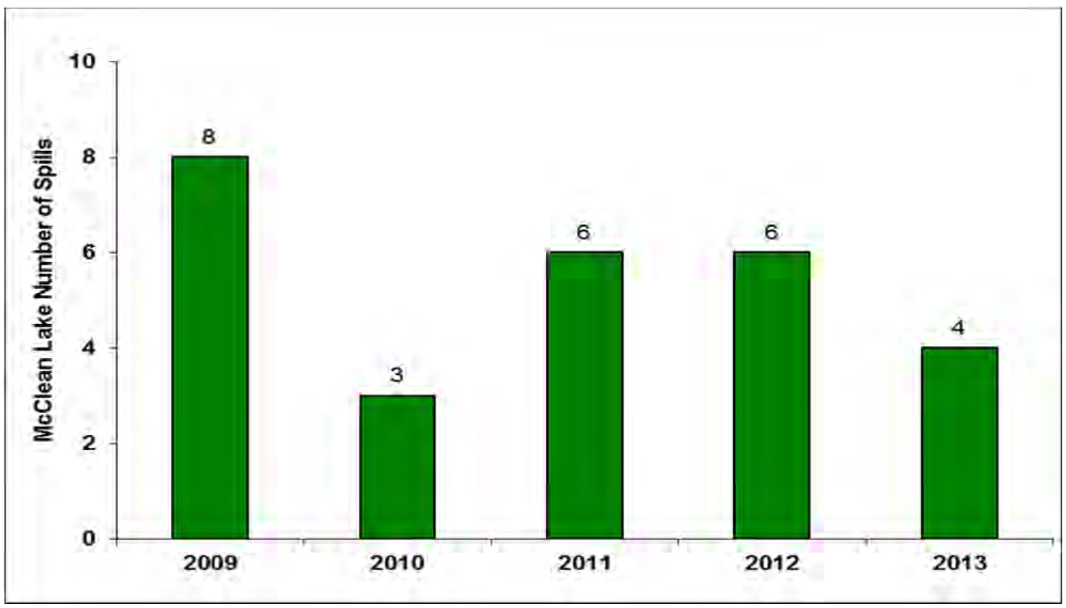
CNSC staff verified that McClean Lake Operation's environmental monitoring programs met regulatory requirements during 2013, and effluent discharged complied with licence requirements.

CNSC staff were satisfied with AREVA on its reporting of spills in a timely manner and the corrective actions taken. In 2013, four environmental spills (figure 7-4) were reported to CNSC staff:

- 1,000 L (1.0 m^3) of radiologically contaminated water that leaked through a torn liner in the laydown area for contaminated materials
- 5 L (0.005 m^3) of radiologically contaminated water leaked from a spill pallet
- 4,000 L (4.0 m^3) of radiologically contaminated ore pad runoff water spilled from a buried pipe
- 150 L (0.15 m^3) of hydraulic fluid leaked from machinery

The spill events were investigated by AREVA, and preventative and corrective measures were implemented. Appendix G further describes the spills and corrective actions. There was minimal impact to the environment due to the timely response and effective corrective actions applied by McClean Lake Operation. CNSC staff were satisfied with the corrective actions.

Figure 7-4: McClean Lake Operation – environmental reportable spills, 2009–2013



Treated effluent released to the environment

Contaminated waste water from the McClean Lake Operation is treated in the JEB Water Treatment Plant to remove dissolved metals and suspended solids (figure 7-5). The quality of the final treated effluent is monitored and if acceptable, discharged to the environment through the Sink/Vulture Treated Effluent Management System. There were no treated effluent regulatory discharge limit exceedances during 2013.

Figure 7-5: McClean Lake Operation's JEB Water Treatment Plant

Molybdenum, selenium and uranium in effluent

The McClean Lake Operation mill ceased normal operations in July 2010. Since then, the concentrations of molybdenum, selenium and uranium in treated effluent have decreased, and remain low compared to the previous operating years (figures 7-6, 7-7 and 7-8).

Figure 7-6: McClean Lake Operation – concentrations of molybdenum from JEB Water Treatment Plant, 2009–2013 (McArthur River action level for molybdenum is shown for reference only)

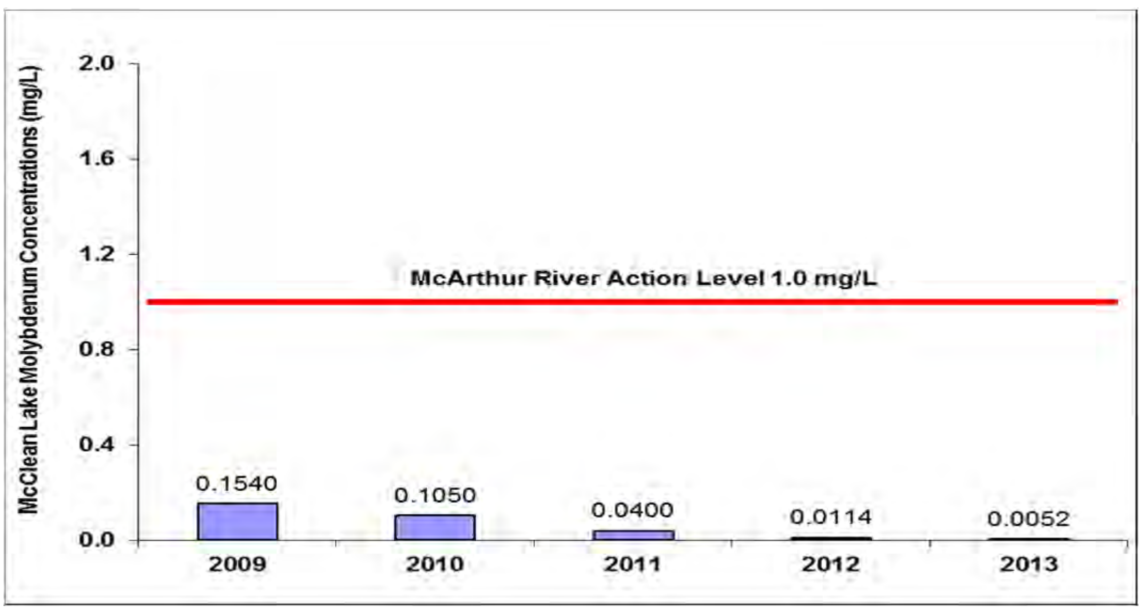


Figure 7-7 shows that selenium concentrations in treated effluent are well below the Saskatchewan Ministry of Environment's licensed limit of 0.6 mg/L.

Figure 7-7: McClean Lake Operation – concentrations of selenium from JEB water treatment plant, 2009–2013 (Province of Saskatchewan's selenium discharge limit is shown for reference only)

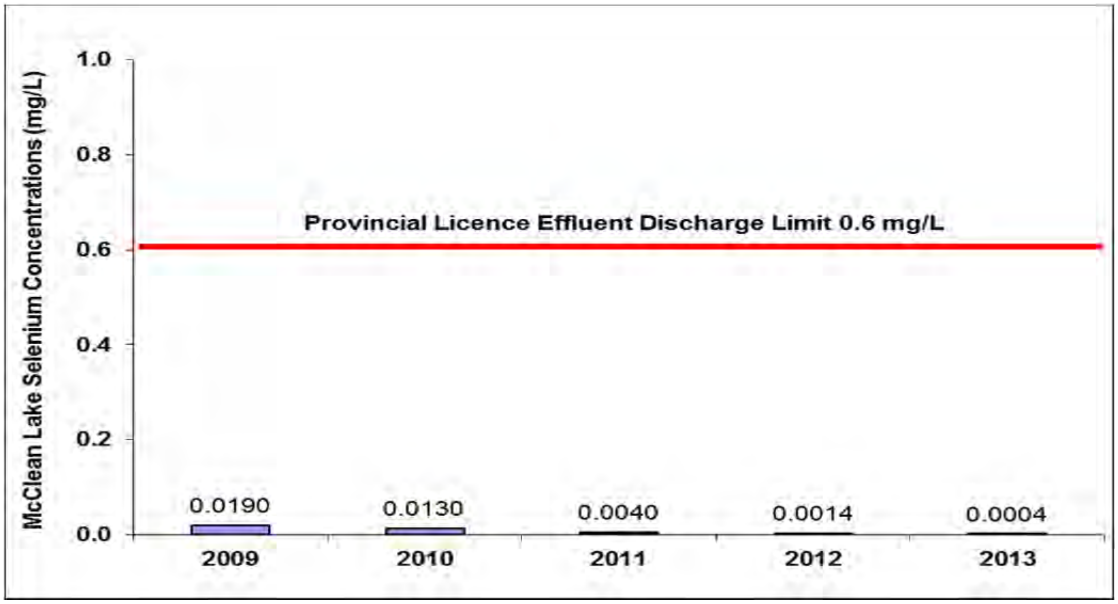
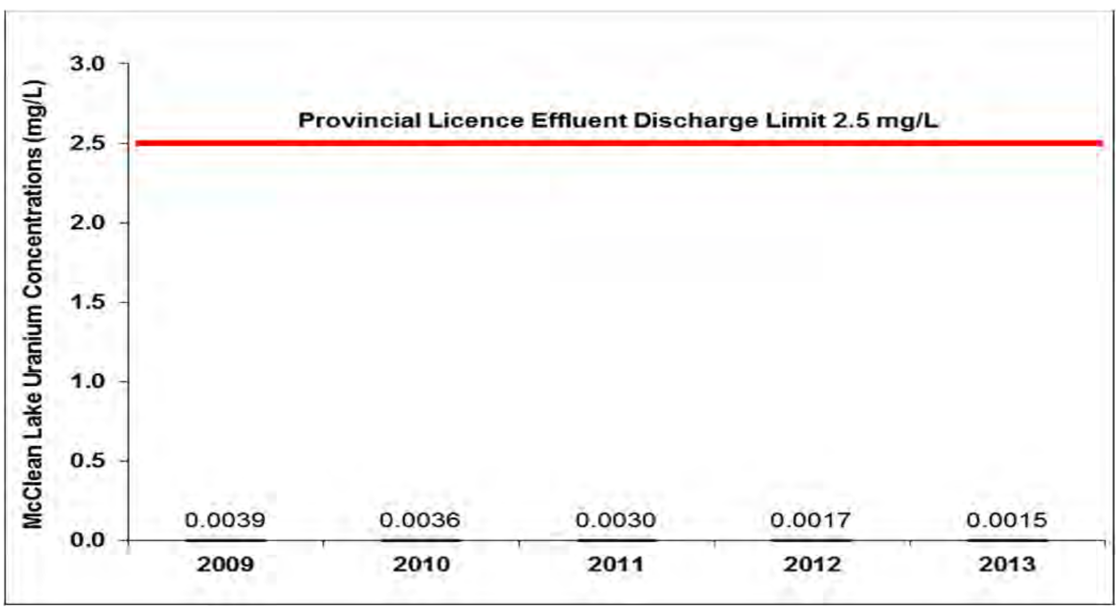


Figure 7-8 shows that reduced concentrations of uranium in treated effluent from 2009 to 2013 are well below the Saskatchewan Ministry of Environment's licensed limit of 2.5 mg/L and the CNSC's interim objective of 0.1 mg/L.

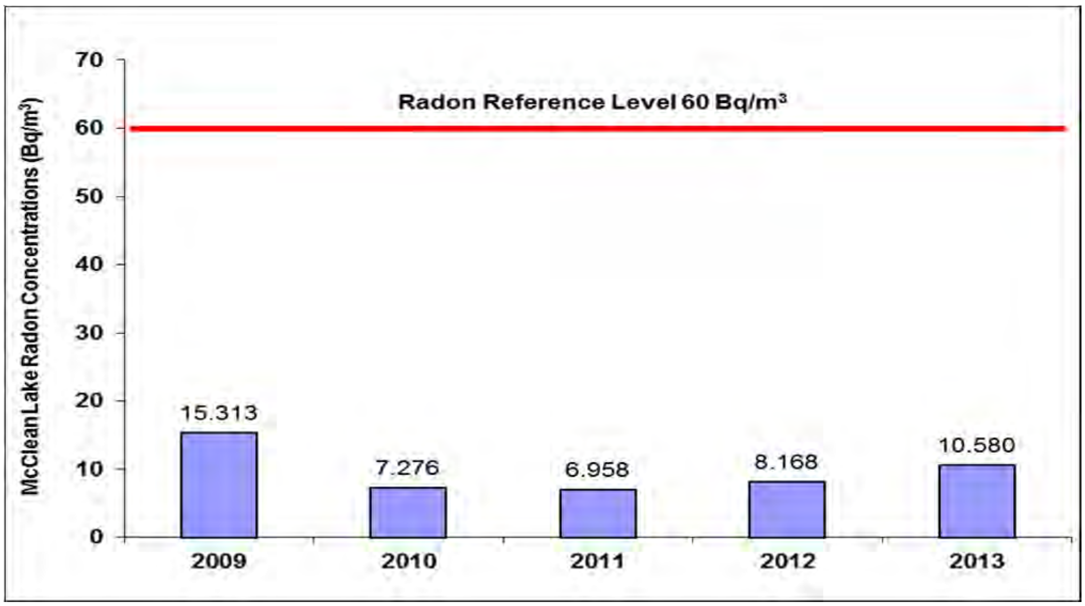
Figure 7-8: McClean Lake Operation – concentrations of uranium from JEB Water Treatment Plant, 2009–2013 (Province of Saskatchewan's uranium discharge limit is shown for reference only)



Air quality monitoring at McClean Lake Operation includes programs for ambient radon, total suspended particulates (TSP), sulphur dioxide and exhaust stack monitoring. Ambient sulphur dioxide and exhaust stack monitoring did not occur in 2013, as the mill was shut down.

Environmental monitoring for radon-222 concentrations is conducted using the passive method of track-etched cups. Twenty monitoring stations are located in various locations around the site-lease boundary. In 2013, the radon concentrations ranged from < 37 Bq/m^3 to 44.4 Bq/m^3. These values are below the typical baseline range for the province of Saskatchewan (37 Bq/m^3 to 74 Bq/m^3) and the 2013 annual average radon concentration of 10.58 Bq/m^3 is within the northern Saskatchewan regional baseline of < 7.4 Bq/m^3 to 25 Bq/m^3. Figure 7-9 shows that the average concentrations of radon in ambient air for 2009 to 2013 were below the reference level for radon.

Figure 7-9: McClean Lake Operation – concentrations of radon in ambient air 2009–2013 (reference level is derived from the *Radiation Protection Regulations**)



* The value of 60 Bq/m^3 has been derived from ICRP-65 as referenced in the *Radiation Protection Regulations* and approximates to an annual dose of 1 mSv.

Five high volume sampling units are located at various locations around the site, and are used to collect and measure TSP matter in air. The sampling units are located near the tailings management facility, downwind of the milling facility, near the main camp residence, south of Vulture Lake away from operational activity, and in the vicinity of the Sue pits. TSP samples are also analyzed for concentrations of metals and radionuclides. The mean concentrations of metal and radionuclides adsorbed to TSP are low, and below reference annual air quality levels identified in table 7-3.

Figure 7-10: McClean Lake Operation – concentrations of total suspended particulates, 2009–2013 (Province of Saskatchewan's standard is shown)

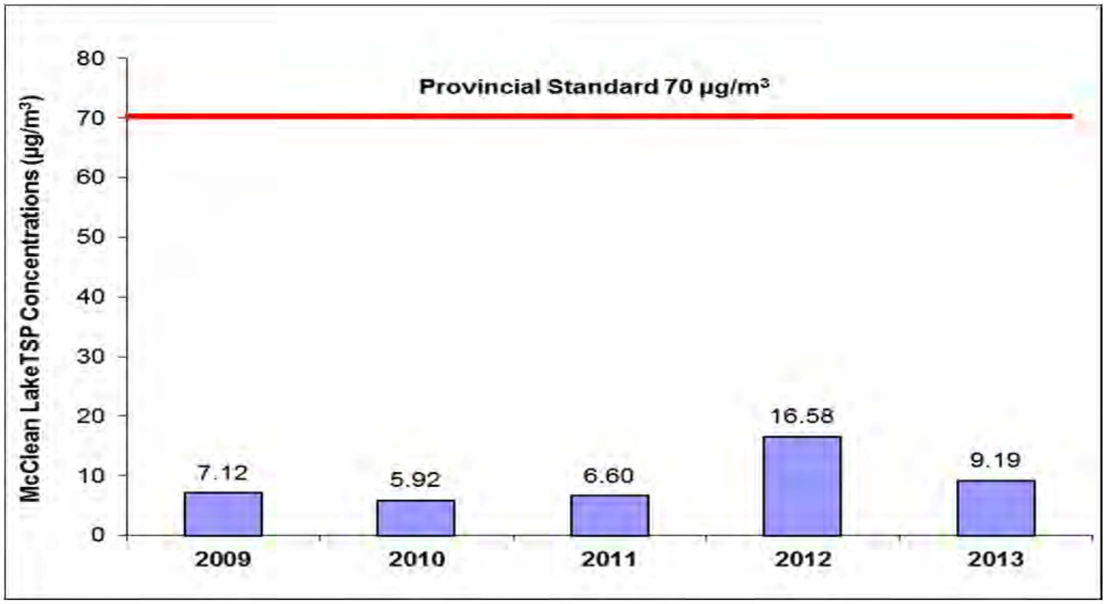


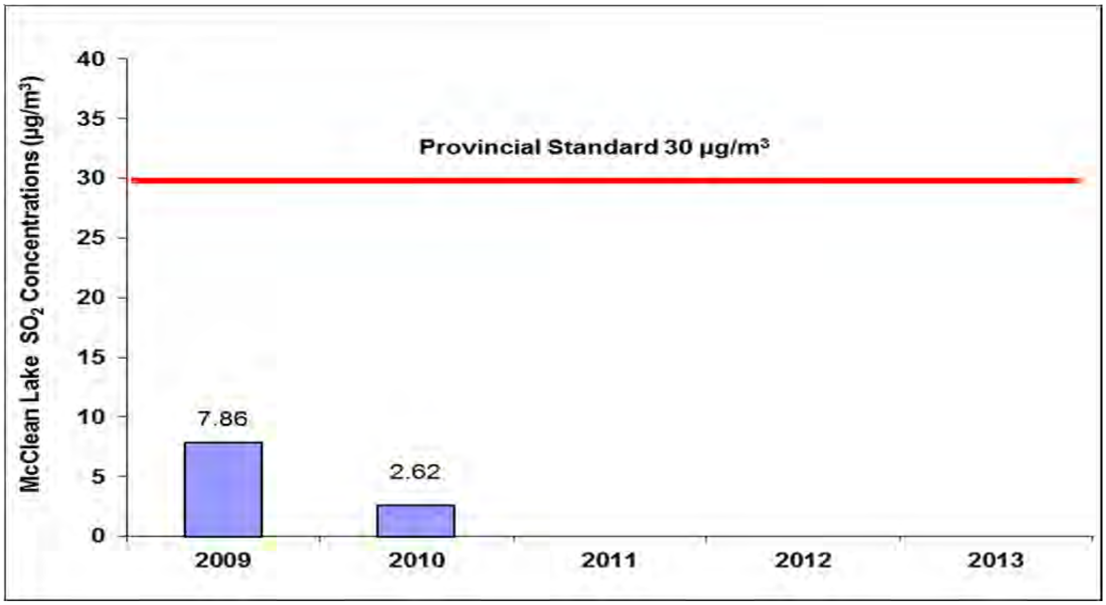
Table 7-3: McClean Lake Operation - concentrations of metal and radionuclides in air, 2009–2013 (Province of Ontario and International Commission on Radiation Protection reference annual air quality levels are shown for reference only, as no federal or province of Saskatchewan limits are currently established)

Parameter	Reference annual air quality levels	2009	2010	2011	2012	2013
As ($\mu g/m^3$)	0.06 [(1)]	0.001657	0.001343	0.000565	0.000350	0.000226
Cu ($\mu g/m^3$)	9.6 [(1)]	0.000021	0.000036	0.000025	0.016789	0.036192
Mo ($\mu g/m^3$)	23 [(1)]	0.000000	0.000000	0.000000	0.000061	0.000657
Ni ($\mu g/m^3$)	0.04 [(1)]	0.000001	0.000001	0.000000	0.000259	0.000258
Pb ($\mu g/m^3$)	0.10 [(1)]	0.000001	0.000001	0.000001	0.000453	0.000422
Zn ($\mu g/m^3$)	23 [(1)]	0.000006	0.000008	0.000002	0.006790	0.005896
Pb^{210} (Bq/m^3)	0.021 [(2)]	0.000439	0.000521	0.000588	0.000388	0.000763
Po^{210} (Bq/m^3)	0.028 [(2)]	0.000155	0.000185	0.000194	0.000130	0.000159
Ra^{226} (Bq/m^3)	0.013 [(2)]	0.000011	0.000008	0.000010	0.000008	0.000013
Th^{230} ($Bq/m^{3)}$)	0.0085 [(2)]	0.000008	0.000006	0.000003	0.000004	0.000000
U ($\mu g/m^3$)	0.06 [(1)]	0.003204	0.003183	0.000657	0.000444	0.000328

1 Reference annual air quality levels derived from Ontario 24-hour *Ambient Air Quality Criteria* (OMOE 2012)
2 Reference level from International Commission on Radiation Protection (ICRP 96)

A sulphur dioxide (SO_2) monitor is used to continuously measure ambient sulphur dioxide monitoring associated with mill emissions. The monitor is located approximately 200 meters downwind of the sulphuric acid plant stack. Ambient sulphur dioxide monitoring did not occur in 2013, and has not occurred since the facility went into temporary shutdown on July 4, 2010. Data measured for 2009 and the first half of 2010 (figure 7-11) showed no exceedances of the annual standard of 30 $\mu g/m^3$.

Figure 7-11: McClean Lake Operation – concentrations of ambient sulphur dioxide 2009–2013 (Province of Saskatchewan's standard is shown)



Soil and terrestrial vegetation may be affected by atmospheric deposition of particulates and adsorbed metals and radionuclides associated with onsite activities. AREVA's terrestrial monitoring program determines if there is influence from aerial deposition. This program includes measurements of metals and radionuclides in soil and vegetation.

The most recent soil samples were collected and reported on in 2008 for the *2005-2009 Integrated Environmental Risk Assessment and State of the Environment Report*. Samples collected in 2011 will be presented in the next report due in 2015. In 2008, the soil metal parameter concentrations were below the *Canadian Environmental Quality Guidelines* for Industrial and Residential/Parkland land use. Appendix I displays three metal parameters (arsenic, nickel and uranium) measured in soil samples at McClean Lake Operation to be well below *CCME Soil Quality Guideline* levels. Also shown in Appendix I, radionuclide concentrations in soils were low, generally near or at, background levels, and analytical detection limits. CNSC staff concluded that the level of airborne particulate contaminants produced by McClean Lake Operation is acceptable and does not pose a risk to the environment.

Vegetation sampling was last completed in 2008 and shows most parameters are within the range of concentrations previously measured in lichen, Labrador tea and blueberry twig samples. Blueberry twigs are monitored to determine if soil-born contaminants (if present) are being absorbed through the roots into the growing plant parts. Lichen samples are analyzed to determine the level of airborne particulate contaminants deposited on the surface of the lichen as a means of ensuring that a significant level of contamination is not entering lichen consumers, such as caribou.

The concentrations of metals and radionuclides in lichen, Labrador tea and blueberry twigs have higher than background concentrations for some samples located in the immediate vicinity of mining activity, although the concentrations decrease within a short distance. Overall, the results indicate that the McClean Lake Operation has had a localized effect on vegetation in areas of activity. CNSC staff concluded that the level of airborne particulate contaminants produced by McClean Lake Operation is acceptable and does not pose a risk to the lichen consumers such as caribou.

7.4 Conventional health and safety

CNSC staff monitors the implementation of McClean Lake Operation's Occupational Health and Safety Program to ensure protection of workers. McClean Lake Operation has implemented a health and safety program to identify and control risks. CNSC staff observed that the health and safety program at McClean Lake Operation continues to provide education, training, tools and support to ensure protection of workers. AREVA has an active Occupational Health Committee, and completes regular reviews of its safety program. During inspections, discussions and review of incidents, CNSC staff verified that McClean Lake Operation is committed to accident prevention and safety awareness.

In 2013, the McClean Lake Operation participated in a maintenance audit of the Occupational Health and Safety Assessment Series OHSAS 18001: 2007, verifying the adherence to the management system certification attained in 2008.

Table 7-4 shows that, from 2009 to 2013, AREVA reported two lost-time incidents (LTIs), with no LTIs in 2013.

Table 7-4: McClean Lake Operation – total number of FTE workers, LTIs, severity rate and frequency rate, 2009–2013

Year	2009	2010	2011	2012	2013
Total number of FTE workers*	308	225	163	249	348
Number of LTIs*	0	1	0	1	0
Severity rate*	4.1	13.3	0.0	1.2	0.0
Frequency rate*	0.0	0.4	0.0	0.4	0.0

* Definitions of these terms are located in the Glossary.

AREVA investigates safety concerns and incidents including near-miss events. In 2013, 50 employees including Occupational Health Committee members were trained on the use of Cause Mapping® to conduct incident investigations. This methodology employs collaborative group effort to identify a problem, analyze why it happened and determine the best solutions to correct the root causes.

Corrective actions are implemented and the effectiveness verified and documented by management. CNSC staff observed that AREVA strives to involve all levels of their organization in the health and safety program. Employees are encouraged and trained to continuously identify and assess risks, and propose solutions.

Figure 7-12: McClean Lake Operation – emergency response team

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Glossary

Commission

A corporate body of not more than seven members, established under the *Nuclear Safety and Control Act* and appointed by the Governor in Council, to perform the following functions:

- regulate the development, production and use of nuclear energy and the production, possession, use and transport of nuclear substances
- regulate the production, possession and use of prescribed equipment and prescribed information
- implement measures respecting international control of the development, production, transport and use of nuclear energy and nuclear substances, including those respecting the non-proliferation of nuclear weapons and nuclear explosive devices
- disseminate scientific, technical and regulatory information concerning the activities of the CNSC and the effects on the environment and on the health and safety of persons, of the development, production, possession, transport and uses referred to above

Commission Member Document (CMD)

A document prepared for Commission hearings and meetings by CNSC staff, proponents and interveners. Each CMD is assigned a specific identification number.

derived release limit (DRL)

A limit imposed by the CNSC on the release of a radioactive substance from a licensed nuclear facility, such that compliance with the derived release limit gives reasonable assurance that the regulatory dose limit is not exceeded.

effective dose

The sum of the products, in sieverts, obtained by multiplying the equivalent dose of radiation received by and committed to each organ or tissue set out in column 1 of an item of schedule 1 of the *Radiation Protection Regulations*, by the weighting factor set out in column 2 of that item.

equivalent dose

The product, in sieverts, obtained by multiplying the absorbed dose of radiation of the type set out in column 1 of an item of schedule 2 of the *Radiation Protection Regulations*, by the weighting factor set out in column 2 of that item.

frequency rate

The accident frequency rate measuring the number of LTIs for every 200,000 person-hours worked at the site. The frequency rate is calculated as follows:
Frequency = [(# of injuries in last 12 months) / # of hours worked in last 12 months)] x 200,000

full-time equivalent (FTE)

Total person-hours divided by 2,000 hours worked per employee per year.

International Atomic Energy Agency (IAEA)

An independent international organization related to the United Nations (UN) system. The IAEA, located in Vienna, works with its Member States and multiple partners worldwide to promote safe, secure and peaceful nuclear technologies. The IAEA reports annually to the UN General Assembly and, when appropriate, to the Security Council regarding non-compliance by States with their safeguards obligations, as well as on matters relating to international peace and security.

lost-time incident (LTI)

An injury that takes place at work and results in the worker being unable to return to work for a period of time.

root-cause analysis

An objective, structured, systematic and comprehensive analysis designed to determine the underlying reason(s) for a situation or event, which is conducted with a level of effort consistent with the safety significance of the event.

severity rate

The accident severity rate measures the total number of days lost to injury for every 200,000 person-hours worked at the site. Severity rate is calculated as follows:
Severity = [(# of days lost in last 12 months) / # of hours worked in last 12 months)] x 200,000

total number of workers

The total number of workers includes employees and contractors and is expressed as full-time equivalents (FTE).

triennial

Recurring every three years.

uranium concentrate (yellowcake)

Uranium concentrate, commonly referred to as U_3O_8, is the product created when uranium ore has been mined and milled.

Appendix A: Safety and Control Area Framework for Uranium Mines and Mills

The CNSC evaluates how well licensees meet regulatory requirements and CNSC performance expectations for programs in 14 safety and control areas (SCAs). The 14 SCAs are grouped according to their functional area as management, facility and equipment, or core control processes.

A.1 Safety and control framework

Safety and control area framework			
Functional area	**Safety and control area**	**Definition**	**Specific areas**
Management	**Management system**	Covers the framework that establishes the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture.	▪ Management system ▪ Organization ▪ Performance assessment, improvement and management review ▪ Operating experience (OPEX) ▪ Change management ▪ Safety culture ▪ Configuration management ▪ Records management ▪ Management of contractors ▪ Business continuity
	Human performance management	Covers activities that enable effective human performance through the development and implementation of processes that ensure a sufficient number of licensee personnel are in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.	▪ Human performance program ▪ Personnel training ▪ Personnel certification ▪ Initial certification examinations and requalification tests ▪ Work organization and job design ▪ Fitness for duty
	Operating performance	Includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.	▪ Conduct of licensed activity ▪ Procedures ▪ Reporting and trending ▪ Outage management performance ▪ Safe operating envelope ▪ Severe accident management and recovery ▪ Accident management and recovery
Facility and equipment	**Safety analysis**	Covers maintenance of the safety analysis that supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards.	▪ Deterministic safety analysis ▪ Hazard analysis ▪ Probabilistic safety analysis ▪ Criticality safety ▪ Severe accident analysis ▪ Environmental risk assessment ▪ Management of safety issues (including research and development programs)
	Physical design	Relates to activities that impact the ability of structures, systems and components to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.	▪ Design governance ▪ Site characterization ▪ Facility design ▪ Structure design ▪ System design ▪ Component design

Safety and control area framework			
Functional area	**Safety and control area**	**Definition**	**Specific areas**
	Fitness for service	Covers activities that impact the physical condition of structures, systems and components to ensure that they remain effective over time. This area includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.	▪ Equipment fitness for service / equipment performance ▪ Maintenance ▪ Structural integrity ▪ Aging management ▪ Chemistry control ▪ Periodic inspection and testing
Core control processes	**Radiation protection**	Covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. The program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled and maintained ALARA.	▪ Application of ALARA ▪ Worker dose control ▪ Radiation protection program performance ▪ Radiological hazard control ▪ Estimated dose to public
	Conventional health and safety	Covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.	▪ Performance ▪ Practices ▪ Awareness
	Environmental protection	Covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.	▪ Effluent and emissions control (releases) ▪ Environmental management system (EMS) ▪ Assessment and monitoring ▪ Protection of the public
	Emergency management and fire protection	Covers emergency plans and emergency preparedness programs that exist for emergencies and for non-routine conditions. This area also includes any results of participation in exercises.	▪ Conventional emergency preparedness and response ▪ Nuclear emergency preparedness and response ▪ Fire emergency preparedness and response
	Waste management	Covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This area also covers the planning for decommissioning.	▪ Waste characterization ▪ Waste minimization ▪ Waste management practices ▪ Decommissioning plans
	Security	Covers the programs required to implement and support the security requirements stipulated in the regulations, the licence, orders, or expectations for the facility or activity.	▪ Facilities and equipment ▪ Response arrangements ▪ Security practices ▪ Drills and exercises
	Safeguards and non-proliferation	Covers the programs and activities required for the successful implementation of the obligations arising from the Canada/International Atomic Energy Agency (IAEA) safeguards agreements, as well as all other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons*.	▪ Nuclear material accountancy and control ▪ Access and assistance to the IAEA ▪ Operational and design information ▪ Safeguards equipment, containment and surveillance ▪ Import and export

Safety and control area framework			
Functional area	**Safety and control area**	**Definition**	**Specific areas**
	Packaging and transport	Programs that cover the safe packaging and transport of nuclear substances to and from the licensed facility.	▪ Package design and maintenance ▪ Packaging and transport ▪ Registration for use

Other matters of regulatory interest
▪ Environmental assessment ▪ CNSC consultation – Aboriginal ▪ CNSC consultation – other ▪ Cost recovery ▪ Financial guarantees ▪ Improvement plans and significant future activities ▪ Licensee public information program ▪ Nuclear liability insurance

Appendix B: Rating Methodology and Definitions

Performance ratings used in this report are defined as follows:

Fully satisfactory (FS)

Safety and control measures implemented by the licensee are highly effective. In addition, compliance with regulatory requirements is fully satisfactory, and compliance within the SCA or specific area exceeds requirements and CNSC expectations. Overall, compliance is stable or improving, and any problems or issues that arise are promptly addressed.

Satisfactory (SA)

Safety and control measures implemented by the licensee are sufficiently effective. In addition, compliance with regulatory requirements is satisfactory. Compliance within the SCA or specific area meets requirements and CNSC expectations. Any deviation is only minor, and any issues are considered to pose a low risk to the achievement of regulatory objectives and CNSC's expectations. Appropriate improvements are planned.

Below expectations (BE)

Safety and control measures implemented by the licensee are marginally ineffective. In addition, compliance with regulatory requirements falls below expectations. Compliance within the SCA or specific area deviates from requirements or CNSC expectations, to the extent that there is a moderate risk of ultimate failure to comply. Improvements are required to address identified weaknesses. The licensee or applicant is taking appropriate corrective action.

Unacceptable (UA)

Safety and control measures implemented by the licensee are significantly ineffective. In addition, compliance with regulatory requirements is unacceptable, and is seriously compromised. Compliance within the overall SCA or specific area is significantly below requirements or CNSC expectations, or there is evidence of overall non-compliance. Without corrective action, there is a high probability that the deficiencies will lead to an unreasonable risk. Issues are not being addressed effectively, no appropriate corrective measures have been taken, and no alternative plan of action has been provided. Immediate action is required.

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Appendix C: Trends in Safety and Control Area Ratings

Table C-1: Cigar Lake Operation – safety and control area summary

Safety and control areas	2009 rating	2010 rating	2011 rating	2012 rating	2013 rating
Management system	SA	SA	SA	SA	SA
Human performance management	BE	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	FS	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-2: McArthur River Operation – safety and control area summary

Safety and control areas	2009 rating	2010 rating	2011 rating	2012 rating	2013 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	BE	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-3: Rabbit Lake Operation – safety and control area summary

Safety and control areas	2009 rating	2010 rating	2011 rating	2012 rating	2013 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	BE	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-4: Key Lake Operation – safety and control area summary

Safety and control areas	2009 rating	2010 rating	2011 rating	2012 rating	2013 rating
Management system	BE	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	BE	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-5: McClean Lake Operation – safety and control area summary

Safety and control areas	2009 rating	2010 rating	2011 rating	2012 rating	2013 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	BE	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

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Appendix D: Financial Guarantees

The following tables outline the current financial guarantees for the uranium mines and mills.

Table D: Uranium mines and mills – financial guarantees

Facility	Canadian dollar amount
Cigar Lake Operation	$49,200,000
McArthur River Operation	$48,400,000
Rabbit Lake Operation	$202,700,000
Key Lake Operation	$225,100,000*
McClean Lake Operation (includes Midwest)	$43,074,800
Total financial guarantee for the five facilities	$568,474,800

* Key Lake applied, in 2014, to reduce the financial guarantee to $218,300,000

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Appendix E: Worker Dose Data

The following table compares the maximum and average individual effective dose for all five operating uranium mines and mills.

Table E-1: Radiation dose data to nuclear energy workers at uranium mines and mills

Facility	Average individual effective dose in 2013 (mSv/yr)	Maximum individual effective dose in 2013 (mSv/yr)	Regulatory limit
Cigar Lake Operation	0.27	2.21	**50 mSv/yr**
McArthur River Operation	0.89	7.58	
Rabbit Lake Operation	1.30	11.67	
Key Lake Operation	0.62	5.67	
McClean Lake Operation	0.36	3.44	

The following tables provide a five-year trend (2009 to 2013) of the average and maximum effective annual doses received at the various operating uranium mines and mills.

Each table also identifies the maximum five-year dose for a worker at each operating uranium mine and mill. In 2013, no radiation dose at any operating uranium mine or mill exceeded a regulatory effective dose limit.

Table E-2: Cigar Lake Operation – worker effective dose

Dose data	2009	2010	2011	2012	2013	Regulatory limit
Total nuclear energy workers (NEWs)	792	1,266	1,932	2,420	3,039	**N/A**
Average individual effective dose (mSv)	0.05	0.20	0.13	0.14	0.27	**50 mSv/yr**
Maximum individual effective dose (mSv)	0.92	1.20	1.30	2.87	2.21	**50 mSv/yr**
Maximum five-year dose for an individual (mSv) 2011-2015	12.92					**100 mSv/5 yrs**

Table E-3: McArthur River Operation – worker effective dose

Dose data	2009	2010	2011	2012	2013	Regulatory limit
Total nuclear energy workers (NEWs)	993	1,189	1,253	1,276	1,302	**N/A**
Average individual effective dose (mSv)	1.57	1.34	1.32	0.97	0.89	**50 mSv/yr**
Maximum individual effective dose (mSv)	11.13	10.06	10.07	9.26	7.58	**50 mSv/yr**
Maximum five-year dose for an individual (mSv) 2011-2015	22.04					**100 mSv/5 yrs**

Table E-4: Rabbit Lake Operation – worker effective dose

Dose data	2009	2010	2011	2012	2013	Regulatory limit
Total nuclear energy workers (NEWs)	1,097	968	1,066	1257	1178	**N/A**
Average individual effective dose (mSv)	1.21	1.43	1.36	1.22	1.30	**50 mSv/yr**
Maximum individual effective dose (mSv)	14.15	11.15*	11.66*	18.8**	11.67	**50 mSv/yr**
Maximum five-year dose for an individual (mSv) 2011-2015	36.28					**100 mSv/5 yrs**

* In 2012, the maximum individual effective doses for 2010 and 2011 were modified from the previous *CNSC Staff Report on the Performance of Canadian Uranium Fuel Cycle and Processing Facilities: 2011*. These changes occurred as a result of dose changes approved through the National Dose Registry. The new values resulted from previously rejected personal alpha dosimeter results, which were accepted later, in early 2012 (2010 changed from 10.7 mSv to 11.15 mSv; 2011 changed from 11.4 mSv to 11.66 mSv).
** In 2013, the 2012 maximum individual effective dose has been modified from 14.37 (as stated in the previous *CNSC Staff Report on the Performance of Canadian Uranium Fuel Cycle and Processing Facilities: 2012*), as a result of approved dose changes following an injury to an underground worker (for further information see section 5.2 of this 2013 report).

Table E-5: Key Lake Operation – worker effective dose

Dose data	2009	2010	2011	2012	2013	Regulatory limit
Total nuclear energy workers (NEWs)	1,135	1,232	1,314	1,345	1,380	**N/A**
Average individual effective dose (mSv)	0.56	0.73	0.67	0.61	0.62	**50 mSv/yr**
Maximum individual effective dose (mSv)	4.73	7.29	9.14	5.76	5.67	**50 mSv/yr**
Maximum five-year dose for an individual (mSv) 2011-2015	15.11					**100 mSv/5 yrs**

Table E-6: McClean Lake Operation – worker effective dose

Dose data	2009	2010	2011	2012	2013	Regulatory limit
Total nuclear energy workers (NEWs)	343	219	120	174	308	**N/A**
Average individual effective dose (mSv)	0.66	0.47	0.33	0.32	0.36	**50 mSv/yr**
Maximum individual effective dose (mSv)	4.12	2.96	1.56	1.30	3.44	**50 mSv/yr**
Maximum five-year dose for an individual (mSv) 2011-2015	3.44					**100 mSv/5 yrs**

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Appendix F: Decommissioning and Reclamation Activities

Decommissioning and reclamation discussion: Cigar Lake Operation

The goal of reclamation and decommissioning efforts at Cigar Lake are to decommission and reclaim the site to an ecological and radiological condition as similar to the surrounding environment as reasonably achievable. Cigar Lake employs a progressive decommissioning and reclamation strategy intended to actively reclaim inactive areas during the course of regular operations where economically and operationally feasible.

Current progressive decommissioning and reclamation activities at Cigar Lake include the following:

- Campaign haulage of problematic waste rock from Cigar Lake to the mined out Sue C pit at the AREVA Resources Inc. (AREVA) McClean Lake Operation, as approved in the 2001 environmental impact statement.
- Contour and re-vegetation of the very few inactive areas of the site.

Decommissioning and reclamation of Cigar Lake, in its entirety, is reflected in the Cigar Lake *Preliminary Decommissioning Plan* (PDP) and *Preliminary Decommissioning Cost Estimate* (PDCE). These documents are based on a hypothetical “decommission tomorrow” scenario and provide the current preferred methodology and schedule for decommissioning and reclamation of the entire operation. The PDCE forms the basis for the financial guarantee; Cameco currently maintains the financial guarantee for Cigar Lake in the form of irrevocable standby letters of credit. The most recent updates to the Cigar Lake PDP and PDCE were completed in support of the operating licence renewal, in 2013.

The decommissioning schedule provided is based on current planned progressive decommissioning and reclamation activities coupled with the current preferred methodologies and assumed timelines from the PDP. The timelines provided are assumptions based on relevant industry and Cameco-specific experience. The timelines are subject to ongoing revision and update, as a result of changes in the preferred decommissioning and reclamation methodology or facility operation strategy including potential changes in mineral reserves

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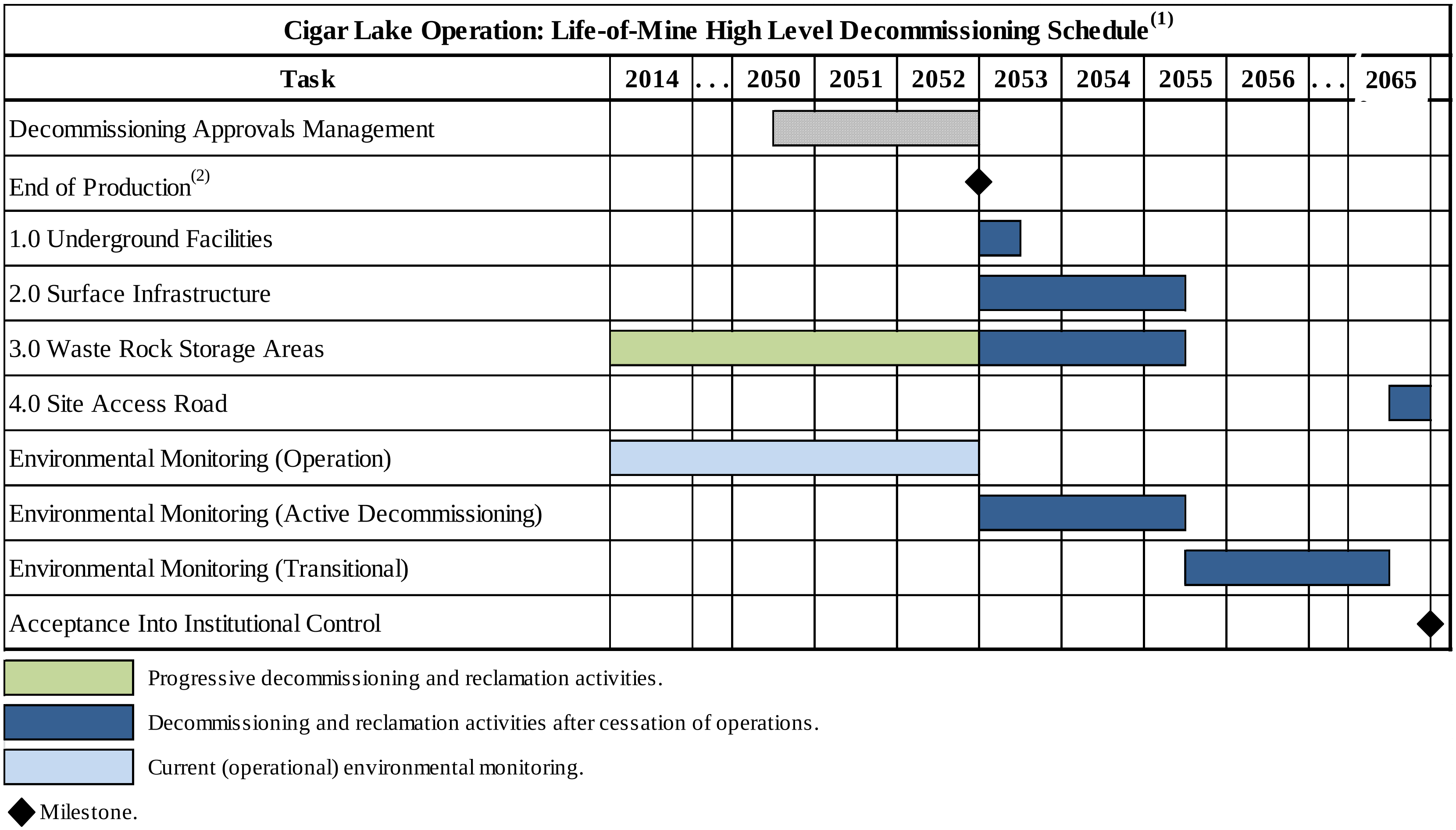


(1) Timelines are preliminary estimates based on the current PDP.

(2) Based on current mineral reserves and resources.

Decommissioning and reclamation discussion: McArthur River Operation

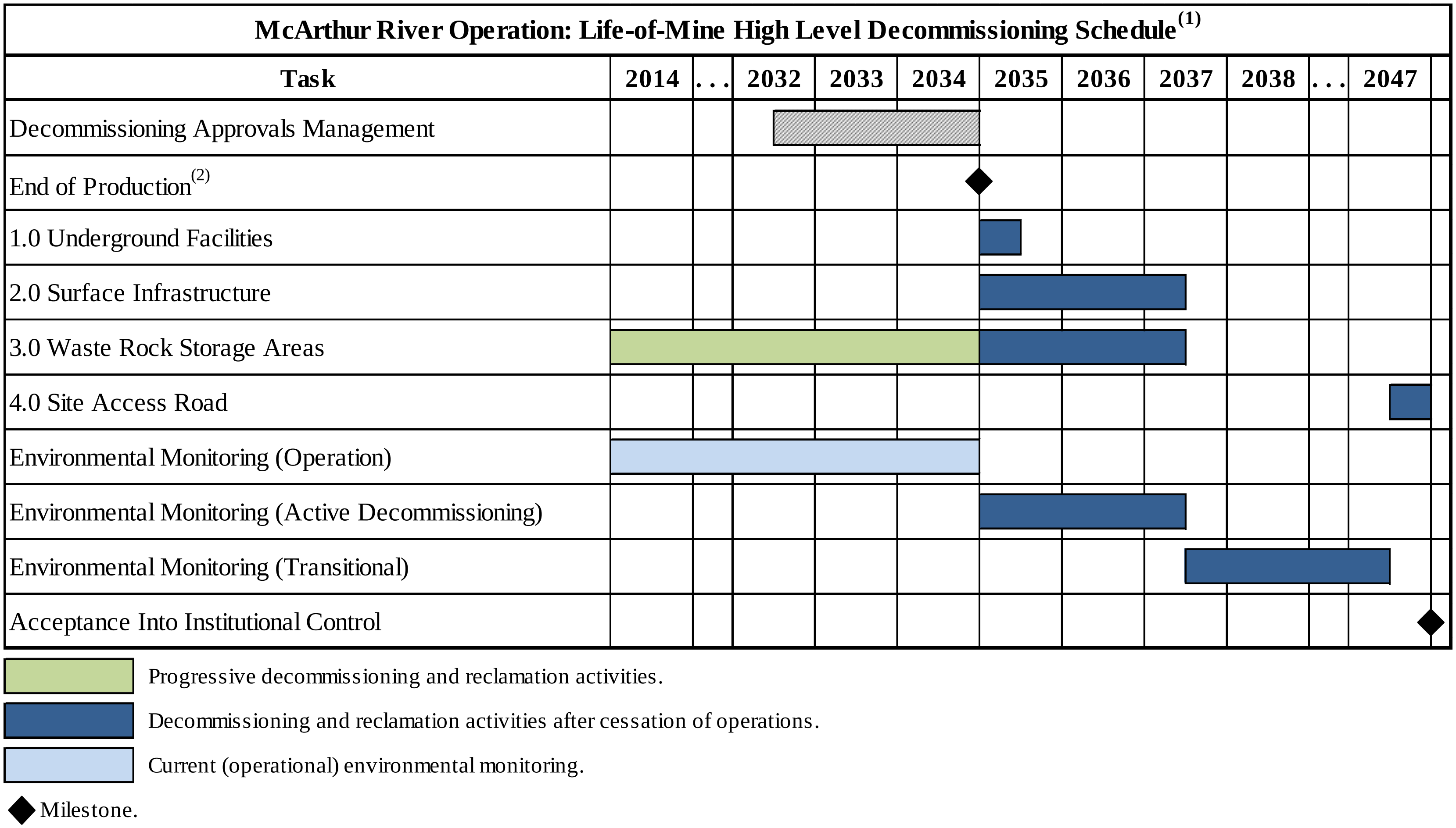
The goal of reclamation and decommissioning efforts at McArthur River are to decommission and reclaim the site to an ecological and radiological condition that is as similar to the surrounding environment as is reasonably achievable. McArthur River employs a progressive decommissioning and reclamation strategy intended to actively reclaim inactive areas during the course of regular operations where economically and operationally feasible.

Current progressive decommissioning and reclamation activities at McArthur River include the following:

- Transport of mineralized waste rock to Key Lake to be added to the milling process.
- Contour and re-vegetation of the very few inactive areas of the site.

Decommissioning and reclamation of McArthur River, in its entirety, is reflected in the McArthur River *Preliminary Decommissioning Plan* (PDP) and *Preliminary Decommissioning Cost Estimate* (PDCE). These documents are based on a hypothetical “decommission tomorrow” scenario and provide the current preferred methodology and schedule for decommissioning and reclamation of the entire operation. The PDCE forms the basis for the financial guarantee; Cameco currently maintains the financial guarantee for McArthur River in the form of irrevocable standby letters of credit. The most recent updates to the McArthur River PDP and PDCE were completed in support of the operating licence renewal, in 2013.

The decommissioning schedule provided is based on current planned progressive decommissioning and reclamation activities coupled with the current preferred methodologies and assumed timelines from the PDP. The timelines provided are assumptions based on relevant industry and Cameco-specific experience. The timelines are subject to ongoing revision and update as a result of changes in preferred decommissioning and reclamation methodology or facility operation strategy including potential changes in mineral reserves.



(1) Timelines are preliminary estimates based on the current PDP.

(2) Based on current mineral reserves.

Decommissioning and reclamation discussion: Rabbit Lake Operation

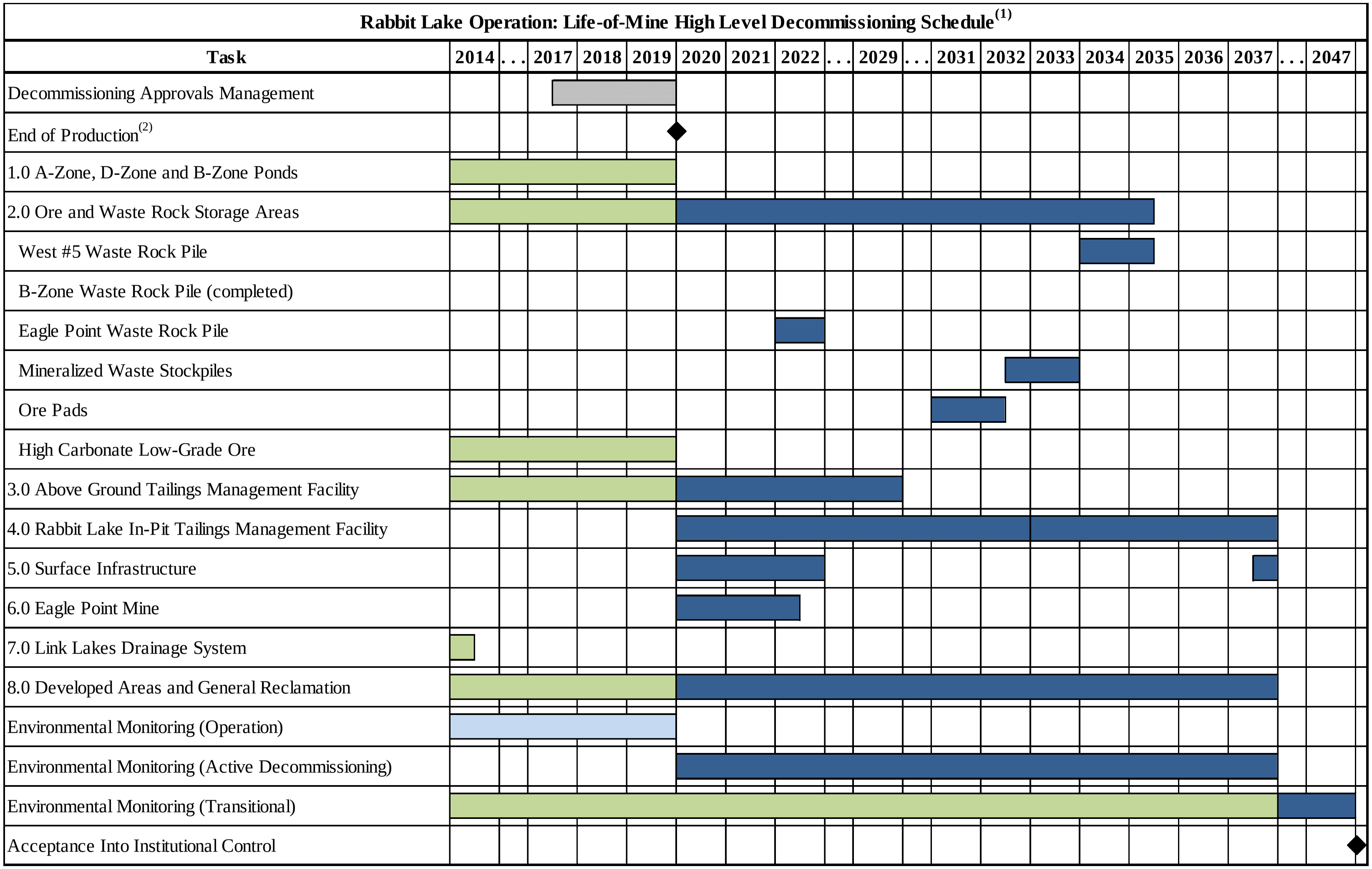
The goal of reclamation and decommissioning efforts at Rabbit Lake are to decommission and reclaim the site to an ecological and radiological condition that is as similar to the surrounding environment, as is reasonably achievable. The Rabbit Lake Operation employs a progressive decommissioning and reclamation strategy intended to actively reclaim inactive areas of the operation during the course of regular operations where economically and operationally feasible. Detailed information on the progressive decommissioning and reclamation strategy and plans are submitted in the *Rabbit Lake Site Wide Reclamation Plan*.

Current decommissioning and reclamation activities at Rabbit Lake include the following:

- Monitoring of the B-Zone pond to support application for dyke breaching.
- Placement of a cover and re-vegetation of the above-ground tailings management facility (AGTMF), along with continued studies to support further reclamation activities.
- Transitional monitoring of the B-Zone waste rock pile (active decommissioning and reclamation completed in 2013).
- Continued consumption (milling) of the high carbonate low-grade ore stockpile.
- Assessment of Link Lakes drainage system (completed in 2014) and ongoing monitoring of natural recovery of the system.

Decommissioning and reclamation of Rabbit Lake, in its entirety, is reflected in the Rabbit Lake *Preliminary Decommissioning Plan* (PDP) and *Preliminary Decommissioning Cost Estimate* (PDCE). These documents are based on a hypothetical “decommission tomorrow” scenario and provide the current preferred methodology and schedule for decommissioning and reclamation of the entire operation. The PDCE forms the basis for the financial guarantee; Cameco currently maintains the financial guarantee for Rabbit Lake in the form of irrevocable standby letters of credit. The most recent updates to the Rabbit Lake PDP and PDCE were completed in support of the operating licence renewal, in 2013.

The decommissioning schedule provided is based on current planned progressive decommissioning and reclamation activities, coupled with the current preferred methodologies and assumed timelines from the PDP. The timelines provided are assumptions based on relevant industry and Cameco-specific experience. The timelines are subject to ongoing revision and update as a result of changes in preferred decommissioning and reclamation methodology or facility operation strategy including potential changes in mineral reserves.



Progressive decommissioning and reclamation activities.

Decommissioning and reclamation activities after cessation of operations.

Current (operational) environmental monitoring.

◆ Milestone.

(1) Timelines are preliminary estimates based on the current PDP.

(2) Based on current mineral reserves at Eagle Point.

Decommissioning and reclamation discussion: Key Lake Operation

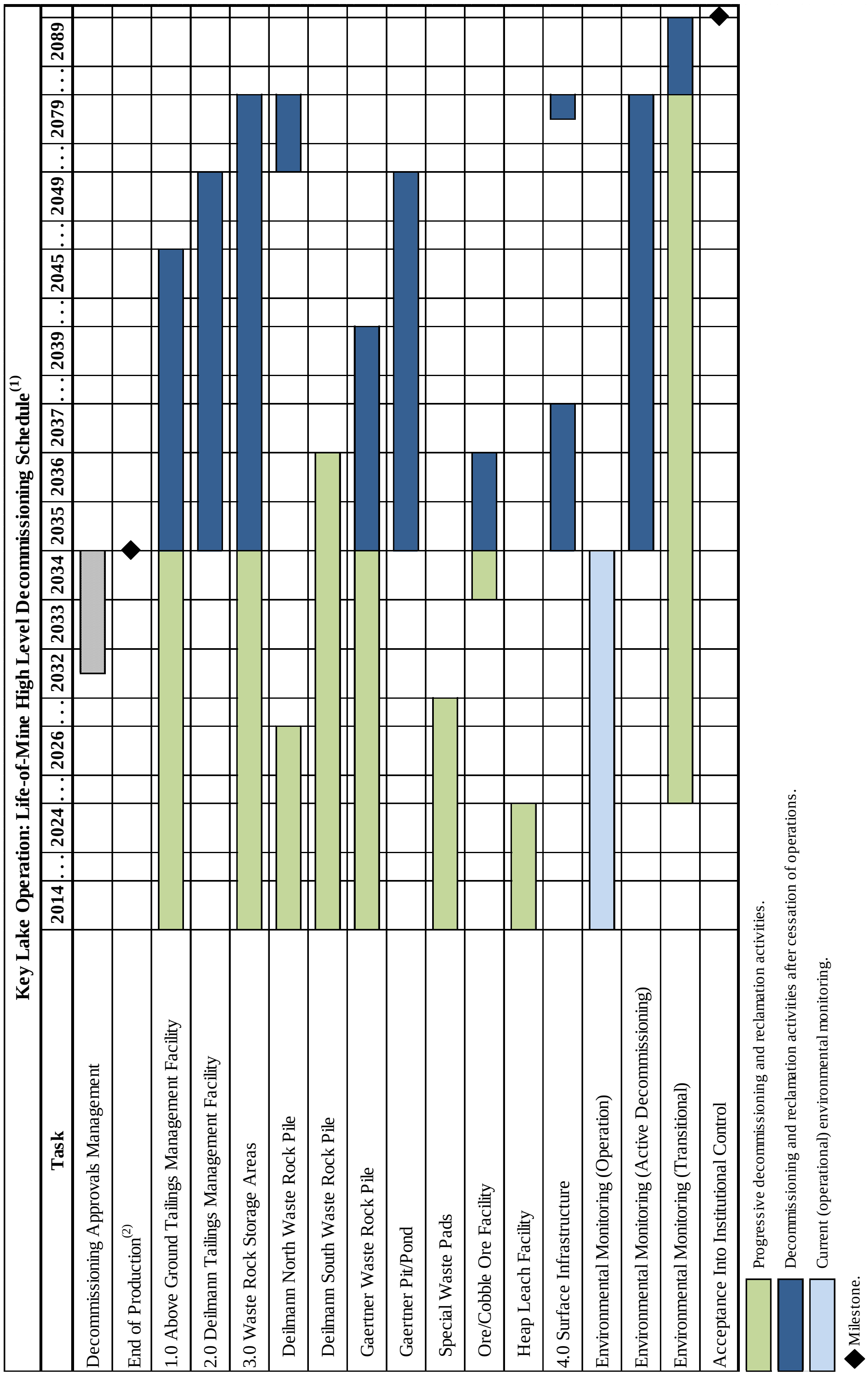
The goal of reclamation and decommissioning efforts at Key Lake are to return the site to a maintenance-free state, where natural, self-sustaining native vegetation develops to a similar level as existed prior to mining. Cameco’s preferred approach to reclaiming and decommissioning the site is to plan and undertake reclamation and decommissioning activities during the operating life of the facility (i.e., incremental/progressive decommissioning), where such an approach makes economic and operational sense. Additional information on progressive decommissioning and reclamation is available in the *Key Lake Site Wide Reclamation Plan*.

Current decommissioning and reclamation activities at Key Lake include the following:

- Monitoring test-cover performance on Deilmann North Waste Rock Pile.
- Maintenance and monitoring of vegetation plots and re-vegetated areas on Gaertner Waste Rock Pile.
- Consumption of Deilmann and Gaertner special waste as needed for blending.
- Decommissioning and reclamation of the heap leach facility.
- Placement of sand on side-slopes of Deilmann South Waste Rock Pile.
- Strategic waste placement and evaluation of thaw characteristics for the above-ground tailings management facility (AGTMF).

Decommissioning and reclamation of Key Lake, in its entirety, is reflected in the Key Lake *Preliminary Decommissioning Plan* (PDP) and *Preliminary Decommissioning Cost Estimate* (PDCE). These documents are based on a hypothetical “decommission tomorrow” scenario and provide the current preferred methodology and schedule for decommissioning and reclamation of the entire operation. The PDCE forms the basis for the financial guarantee; Cameco currently maintains the financial guarantee for Key Lake in the form of irrevocable standby letters of credit. The most recent updates to the Key Lake PDP and PDCE were completed in support of the Key Lake operating licence renewal, in 2013.

The decommissioning schedule provided is based on current planned progressive decommissioning and reclamation activities, coupled with the current preferred methodologies and assumed timelines from the PDP. The timelines provided are assumptions based on relevant industry and Cameco-specific experience. The timelines are subject to ongoing revision and update as a result of changes in preferred decommissioning and reclamation methodology or facility operation strategy including potential changes in mineral reserves at McArthur River.



(1) Timelines are preliminary estimates based on the current PDP.

(2) Based on current mineral reserves at McArthur River.

Decommissioning and reclamation discussion: McClean Lake Operation

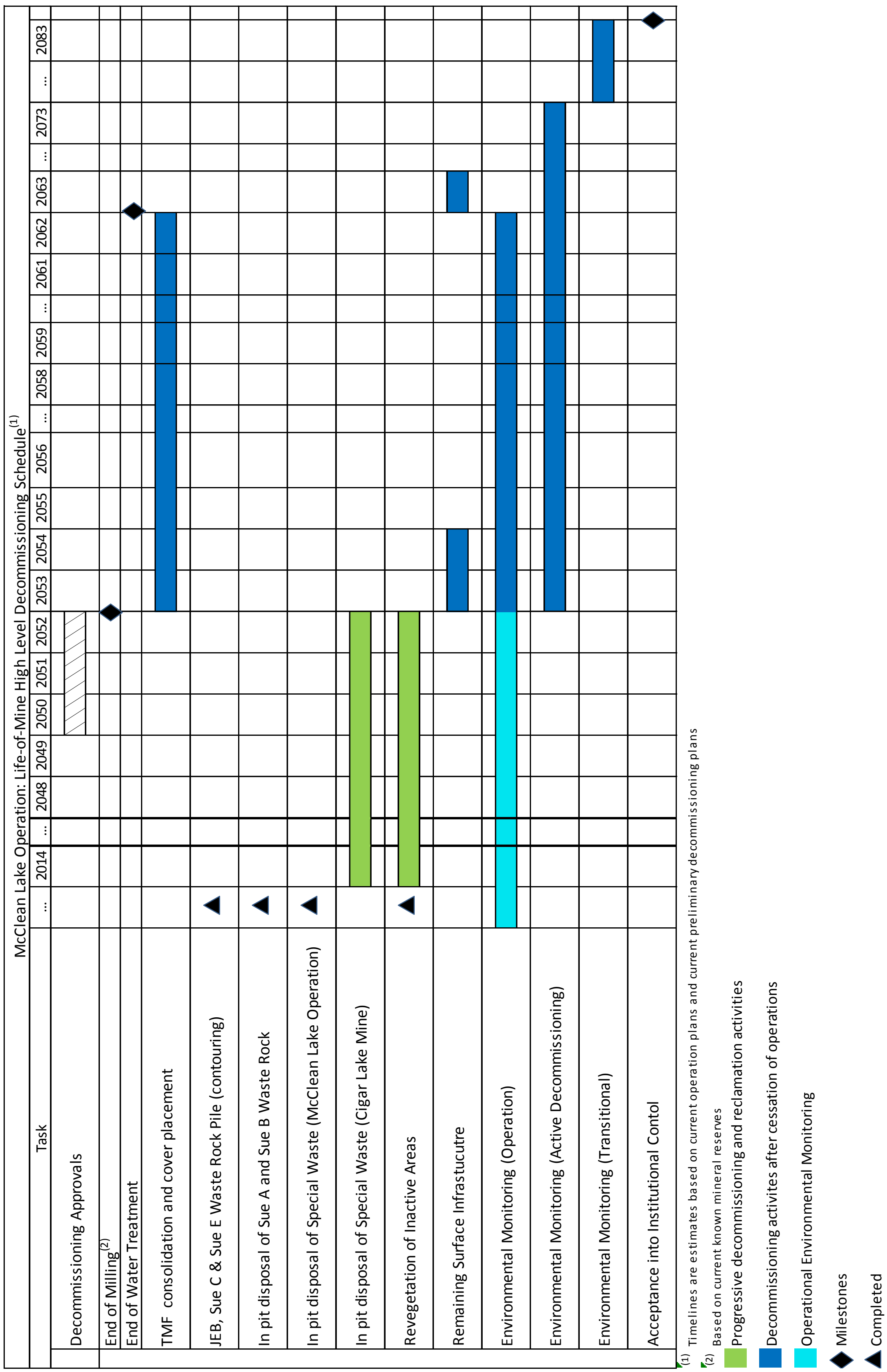
AREVA's key decommissioning objective is to remove, minimize, and control potential contaminant sources and thereby minimize the potential for adverse environmental effects associated with the decommissioned property. The decommissioning plan is designed to achieve an end-state of the properties that will be safe for human and non-human biota, be chemically and physically stable, allow utilization for traditional purposes, and that minimizes potential constraints on future land use planning decisions. AREVA believes that by progressively reclaiming the site as various mining areas are completed and addressing any environmental issues that arise within those areas during the operational phase, that the site can achieve a state of passive, perpetual care and long-term institutional control measures can be minimized.

Examples of progressive reclamation and decommissioning activities at the McClean Lake Operation include the following activities:

- Contouring of JEB, Sue C and Sue E clean waste rock piles (completed).
- In-pit disposal of Sue A and Sue B clean waste rock (completed).
- In-pit disposal of special waste rock generated during mining at the McClean Lake Operation (completed).
- In-pit disposal of special waste rock generated at the Cigar Lake mine (campaign haulage to occur over the life of the Cigar Lake mine).
- Re-vegetation of inactive areas (numerous areas completed, will continue during the life of the operation).

Decommissioning and reclamation of the McClean Lake Operation is described in the McClean Lake Operation *Preliminary Decommissioning Plan* (PDP) and *Financial Assurance* (FA). This plan assumes a "closure tomorrow" scenario, where AREVA would no longer be able to fulfill its obligation to decommission the site and the Saskatchewan provincial government would assume that role. The most recent updates to the McClean Lake Operation and FA were completed in 2010, following the 2009 McClean Lake Operation CNSC licence renewal process.

The decommissioning schedule provided is based on currently proposed decommissioning and reclamation activities, as well as current preferred methodologies and timelines provided in the PDP. The timelines provided are assumptions based on relevant industry and AREVA-specific experience, and are subject to ongoing revision, as a result of changes in methodology or best management practices.


McClean Lake Operation: Life-of-Mine High Level Decommissioning Schedule(1)
Task
... 2014 ... 2048 2049 2050 2051 2052 2053 2054 2055 2056 ... 2058 2059 ... 2061 2062 2063 ... 2073 ... 2083
Decommissioning Approvals
End of Milling(2)
End of Water Treatment
TMF consolidation and cover placement
JEB, Sue C & Sue E Waste Rock Pile (contouring)
In pit disposal of Sue A and Sue B Waste Rock
In pit disposal of Special Waste (McClean Lake Operation)
In pit disposal of Special Waste (Cigar Lake Mine)
Revegetation of Inactive Areas
Remaining Surface Infrastucutre
Environmental Monitoring (Operation)
Environmental Monitoring (Active Decommissioning)
Environmental Monitoring (Transitional)
Acceptance into Institutional Contol
(1) Timelines are estimates based on current operation plans and current preliminary decommissioning plans
(2) Based on current known mineral reserves
Progressive decommissioning and reclamation activities
Decommissioning activites after cessation of operations
Operational Environmental Monitoring
Milestones
Completed

Appendix G: Environmental Reportable Spills in 2013 and CNSC Spill Rating Definitions

Table G-1: Uranium mines and mills – environmental reportable spills

Operation	Incident details	Corrective actions	CNSC rating*
Cigar Lake Operation	On February 8, 2013, a damaged ground thaw unit coupling resulted in a spill of approximately 40 to 80 L (0.040 to 0.080 m^3) of propylene glycol/water mix (50/50) onto the ground.	To prevent reoccurrence, vehicle traffic over hoses from ground thaw units will be restricted, if restriction is not possible, sufficient guarding to protect the hose is to be used. CNSC staff were satisfied with the corrective actions taken.	Low
Cigar Lake Operation	On December 6, 2013, approximately 6 m^3 of calcium chloride brine reported to the ground on the freeze drilling pad. A leak was identified in the line that returns brine from the freeze holes (designed to freeze the 765 cross-cut to the freeze plant). Following work on the return line, a ball valve and air plug were not completely closed, which allowed brine to spill to the ground when the line was charged.	To prevent recurrence, the process department will ensure that all the details of complex plans are included in documentation (lockout and check list of valve positions at the start of the job, when items are isolated and at the completion of the job). An inventory list of all bleed valves on the freeze pad will also be kept. CNSC staff were satisfied with the corrective actions taken.	Low
McArthur River Operation	On October 28, 2013, a night shift operator used the vacuum truck to remove condensate water from the steam pad collection tank at the batch plant. The operator then traveled to the Pollock shaft and began discharging the truck's contents into the sump, following normal procedure. The operator believed that the truck was empty, and returned it to coverall D for the remainder of the night shift. The residual contents of the truck, estimated to be 75 L (0.077 m^3), were released to the soil.	Samples of the condensate water at the steam pad were collected and analyzed, and found to be between 0.19 and 0.27 Bq/L for radium-226. Triplicate soil samples were taken at the point of release, and triplicate water samples were also taken from the steam pad collection tank. The area where the release occurred was excavated and replaced with new material. The contaminated soil was moved to mineralized waste rock pad #4. Current preventative maintenance and training are	Low

Operation	Incident details	Corrective actions	CNSC rating*
		sufficient, and no changes are required. CNSC staff were satisfied with the corrective actions taken.	
McArthur River Operation	On November 10, 2013, an operator driving to Key Lake from McArthur River noticed steam rising from the engine compartment of his power unit. He immediately stopped the unit and, upon raising the hood, noticed a crack in the radiator hose, with antifreeze spraying out under pressure. The volume of released material was estimated to be 20 L (0.020 m^3).	The antifreeze was contained on the frozen surface of the road. There was approximately 20 L of ethylene glycol fluid released. Absorbent was applied, and all product and impacted soil were scraped up and disposed of on Pad 4. Current preventative maintenance and training are sufficient and no changes are required. CNSC staff were satisfied with the clean-up.	Low
Rabbit Lake Operation	On February 14, 2013, a night shift operator on routine inspections noticed ice extending approximately 20 m along the ground from the closed overhead door outside the high pH building. The water that escaped the building froze quickly due to the cold temperatures, limiting the extent of flow and preventing any infiltration. Upon investigation, it was found that the high pH premix tank overflowed and released premix slurry to the truck aisle below. Debris catchment baskets in the floor drains were clogged, preventing material from draining to the HPC basement. Material backed up to the closed overhead door, resulting in liquid escaping from underneath the door. The amount escaping to the environment was estimated to be 1,000 L (1.0 m^3).	The slurry was cleaned from the truck aisle, to prevent further water from escaping under the overhead door. Equipment and personnel were dispatched to recover the contaminated ice from the area outside the high pH building. The ice was disposed of in containment within the high pH building, and melt water was returned to the water treatment circuit. The debris catchment baskets were removed to improve drainage from the floor drains, and inspections were conducted to identify and address conditions that could result in similar events. Soil samples were later collected and compared, which showed that the area was not impacted. CNSC staff were satisfied with the actions taken.	Low

Operation	Incident details	Corrective actions	CNSC rating*
Rabbit Lake Operation	On June 10, 2013, in preparation for replacement of a portion of the mill annex roof, a contractor conducting the work incorrectly utilized a contaminated process water line to clean the roof. Contaminated process water was released from a drain pipe where it mixed with accumulated rainfall runoff and pooled in a low area immediately next to the mill. All released water was collected in this area. Approximately 4,000 L (4.0 m^3) of water was released from the drain pipe.	Work was immediately halted upon discovery of the release. A pump was dispatched to the area where runoff had pooled, and the water was captured and pumped into the mill for treatment. Samples of the recovered water and process water were collected for analysis. A gamma grid survey and soil sampling were also conducted to confirm clean-up of the area. A site-wide bulletin was sent to all employees and contractors, describing the event and listing specific actions for preventing similar events from occurring. CNSC staff were satisfied with the actions taken.	Low
Rabbit Lake Operation	On July 14, 2013, during routine cleaning of underground sumps at the Eagle Point mine, contaminated material was removed from underground sumps, transported to surface and placed on the ore pad for containment and handling. Due to limited storage capacity at the time, the available area on the ore pad was exceeded, and several truckloads (~365 m^3) of material were placed approximately 15 m outside the edge of the lined ore pad.	Mine personnel were contacted and hauling of material to surface was immediately suspended, to allow for clean-up and discussion with mine personnel. Material was recovered and placed on the ore pad. A gamma grid survey of the affected area was conducted to ensure clean-up. CNSC staff were satisfied with the corrective actions.	Low
Key Lake Operation	On July 11, 2013, following a power outage in Solvent Extraction (SX), a level indicator malfunctioned. The raffinate	The solution that was released to the ground was vacuumed back into the SX circuit. Spill kit pads were used to soak up the	Low

Operation	Incident details	Corrective actions	CNSC rating*
	pumpbox overflowed, resulting in approximately 50 L (0.050 m^3) of SX crud and raffinate solution leaking under man door 6A to the ground. The mill terrace outside of this door was breached for the construction of the new raffinate storage tank.	remaining solution, and the contaminated material was placed at the contaminated landfill at the above ground tailings management facility (AGTMF). The containment around the new raffinate tank was re-established, and an additional barrier was installed at the man door to prevent a reoccurrence. CNSC staff were satisfied with the actions taken.	
Key Lake Operation	On September 12, 2013, a main tailings line was put into service following the replacement of several sections. An air inlet valve was inadvertently left open, resulting in tailings slurry being released inside the valve house – which filled the sump and the floor. Approximately 15 L (0.015 m^3) of tailings slurry was released to the ground outside of the Valve House, through a previously unidentified small fault in the concrete containment wall.	The liquid and saturated soil were removed with the vacuum truck and disposed of at the AGTMF. The concrete containment wall at Valve House #1A was inspected and repaired. CNSC staff were satisfied with the actions taken.	Low
Key Lake Operation	On December 15, 2013, while conducting a routine well inspection at Gaertner Dewatering Well AA, a leak was observed on a butterfly valve on the well head, where water was running out of the well shelter. Approximately 80 L (0.080 m^3) of well water was released to the ground.	The well water released reports back to the Gaertner Pit through the cone of depression. The butterfly valve was replaced and the electric heater in Gaertner Dewatering Well AA was repaired. CNSC staff were satisfied with the actions taken.	Low

Operation	Incident details	Corrective actions	CNSC rating*
McClean Lake Operation	On May 9, 2013, a worker noticed the contaminated laydown area liner was torn in several places. It was determined that approximately 1,000 L (1.0 m^3) of run-off water (snowmelt) slightly elevated in radium-226 and uranium had breached the liner. Heavy equipment had damaged the liner during prior snow removal.	Melt water was diverted away from the torn portions, and the liner was repaired. Brightly visible markers were placed in front of the berms in the laydown area to prevent heavy equipment from working near the exposed liner in the future. The water released reports back to the TMF Pit through the cone of depression; the area will be remediated as required, as part of the decommissioning plan. CNSC staff were satisfied with the actions taken and planned.	Low
McClean Lake Operation	On July 27, 2013, a worker noticed a small amount of water seeping out of 2 small openings in a spill pallet. The 2 drums on the pallet contained tailings samples and water. Water from the drums splashed into the spill pallet. When this water reached the level of the small openings, approximately 5 L (0.005 m^3) of water trickled onto the ground. Analysis of the water showed slightly elevated concentrations of radium-226.	The openings in the spill pallet were plugged immediately. The ground in the path of the spilled material was scraped up, and disposed of on the ore pad. The drums containing the samples and water were moved into the mill. CNSC staff were satisfied with the clean-up.	Low
McClean Lake Operation	On August 13, 2013, a clamp connection on a pipeline used to transport ore pad ditch water failed, which resulted in the release of 4,000 L (4.0 m^3) of ore pad runoff water to the ground.	The contaminated soil was excavated and disposed of appropriately onsite. The single walled pipeline was replaced with a dual-walled pipeline to prevent future incidents. Additionally, an outdoor pipeline inspection and assessment program is planned for implementation in 2014. CNSC staff were satisfied with the actions taken and planned.	Low

Operation	Incident details	Corrective actions	CNSC rating*
McClean Lake Operation	On October 14, 2013, personnel noticed an equipment leak. A machine in a remote location developed a hydraulic oil leak, and approximately 150 L (0.050 m^3) of hydraulic oil leaked to the ground.	The affected soil was excavated and land farmed. The cleanup was verified both visually and with an organic vapor meter. The equipment was inspected, and the failed hoses and clamps replaced. CNSC staff were satisfied with the clean-up.	Low

Table G-2: CNSC spill rating definitions

Functional area	Radiation protection		Environmental protection	
SCA/Safety significance	RIBs definition	Directorate-specific examples	RIBs definition	Directorate-specific examples
High	Exposures to multiple workers in excess of regulatory limits. Widespread contamination to several persons or to a place.	Incident that results in or has reasonable potential for a worker to exceed regulatory limits. Example: ▪ NEW exceeding 20 mSv/year or 100 mSv/5 years ▪ Non-NEW exceeding 1 mSv	Nuclear or hazardous substances being released to the environment exceeding regulatory limits (including public exposure) or that results in significant impact to the environment.	Incident that results in – or has reasonable potential to have – a significant or moderate impacts or extensive future remediation. Example: Impairment of ecosystem functions ▪ effluent licence limit exceedance ▪ Spill into fish bearing water ▪ Fish kill
Medium	Exposure to a worker in excess of regulatory limits. An incident that would result in a licensee exceeding action level (section 6 of RPR). Limited contamination that could affect a few persons or limited area.	Incident that results in or has reasonable potential to exceed an action level Example: Dose to workers ▪ 1 mSv/week ▪ 5 mSv/quarter	Nuclear or hazardous substances being released to the environment exceeding action levels (including public exposure) or that results in impact to the environment outside the licensing basis.	Incident that results in or has reasonable potential to have a minor impact or requiring some future remediation Example: ▪ Effluent Action Level Exceedance ▪ Spills to environment (including atmosphere) with short-term or seasonal impacts

Low	Increased dose below reportable limits. Contamination that could affect a worker.	Incident that results in or has reasonable potential to exceed the highest administrative level	Release of hazardous or nuclear substances to the environment below regulatory limits.	Incident that results in or has reasonable potential to have negligible impact ▪ Effluent Administrative Level Exceedance ▪ Spills to environment (including atmosphere) with no future impacts

Appendix H: Lost-time Incidents in 2013

Table H-1: Uranium mines and mills – lost-time incidents

Facility	Lost-time incidents (LTI)	Corrective action
Cigar Lake Operation	On March 10, 2013, a worker was breaking apart two pieces of pipe using a 48-inch wrench. The wrench slipped while the worker was pulling it. The release of the wrench resulted in a sudden increase in force on his back leg, resulting in a fracture of one of the bones between the knee and ankle.	The Facility Level Risk Assessment (FLRA) and Job Hazard Analysis (JHA) for the task were reviewed to ensure all risks are being documented and have proper controls in place. The tool used to grip the piping was redesigned to reduce risk of slippage while force is applied. CNSC were satisfied with the actions taken.
Cigar Lake Operation	On April 27, 2013, while preparing an area for the installation of a ground thaw unit, a worker stepped on snow-covered ice, slipped, and broke a bone in the lower leg.	A subsequent investigation concluded that the individual was not using the controls identified as necessary within an FLRA. Cigar Lake immediately sanded this area and other work areas. The safety officer will conduct monthly assessments of contractor FLRAs to ensure: ▪ they are done in the field at the beginning of the job ▪ that the appropriate hazards and controls are identified ▪ that the appropriate personnel have signed off on the FLRA ▪ that the workers performing the tasks have implemented the recommended controls properly CNSC staff were satisfied with the corrective actions taken.
Cigar Lake Operation	On May 13, 2013, a worker on an aerial platform was manually guiding a pipe spool into place while it was being hoisted. The pipe spool was being lifted around an "I-beam" and while shifting back into position, the worker's hand was pinched between the spool and the "I-beam" injuring his finger.	The licensee discussed the incident with other iron workers, and reviewed the importance of proper identification of pinch points, as part of the pre-job FLRA process. CNSC were satisfied with the actions taken.

Facility	Lost-time incidents (LTI)	Corrective action
Cigar Lake Operation	On August 23, 2013, a worker was cleaning a pump which contained foam and catalyst. The hose slipped out of his hand; when it struck the ground, the valve opened, splashing chemicals under his protective face shield and glasses into his eyes.	The contractor implemented the use of goggles, in place of standard safety glasses, and a face shield when handling this product, as per the requirement of the *Material Safety Data Sheet* (MSDS). CNSC were satisfied with the actions taken.
McArthur River Operation	There were no LTIs at McArthur River in 2013.	Not applicable
Rabbit Lake Operation	There were no LTIs at Rabbit Lake in 2013.	Not applicable
Key Lake Operation	There were no LTIs at Key Lake in 2013.	Not applicable
McClean Lake Operation	There were no LTIs at McClean Lake Operation in 2013.	Not applicable

Appendix I: Concentrations of Metals and Radionuclides in Soil

Table I-1: Concentrations of Metals and Radionuclides in Soil (as taken from the status of the environment reports for the five facilities)

Parameters	Reference soil quality levels	Cigar Lake Operation	McArthur River Operation	Rabbit Lake Operation	Key Lake Operation	McClean Lake Operation
As (µg/g)	**12(1)**	1.12	0.21	1.10	0.44	1.83
Ni (µg/g)	**50(1)**	4.81	1.00	3.85	0.75	2.67
U (µg/g)	**23(1)**	0.94	0.29	1.13	0.20	1.13
Pb210 (Bq/g)	**0.06(2)**	0.08	0.04	0.02	0.04	0.04
Po210 (Bq/g)	**0.06(2)**	0.07	0.03	0.03	0.01	0.06
Ra226 (Bq/g)	**0.017(2)**	0.025	0.024	0.030	0.024	0.030
Th230 (Bq/g)	**0.015(2)**	0.028	0.020	0.030	0.020	0.030

[1] Reference soil quality levels from *CCME Soil Quality Guidelines*
[2] Reference soil quality levels are the average of background concentrations derived by the licensee

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Appendix J: Links to Provincial and Licensee Websites

Cameco Corporation – Cigar Lake Operation

cameco.com/businesses/uranium-operations/canada/cigar-lake/environment-safety

Cameco Corporation – McArthur River/Key Lake Operation

cameco.com/businesses/uranium-operations/canada/mcarthur-river-key-lake/environment-safety

Cameco Corporation – Rabbit Lake Operation

cameco.com/businesses/uranium-operations/canada/rabbit-lake/environment-safety

AREVA Resources Canada Inc. – McClean Lake Operation

us.areva.com/EN/home-457/areva-resources-canand-uranium-mining-and-production.html

Province of Saskatchewan – Eastern Athabasca Regional Monitoring Program

www.earmp.com/

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Appendix K: Acronyms

AGTMF	Above ground tailings management facility
ALARA	As low as reasonably achievable
AREVA	AREVA Resources Canada Inc.
Bq/L	Becquerel per litre
CMD	Commission Member Document
CNSC	Canadian Nuclear Safety Commission
COPC	Contaminants of potential concern
CSA	Canadian Standards Association
EARMP	Eastern Athabasca Regional Monitoring Program
EC	Environment Canada
ERA	Environmental risk assessment
FTE	Full-time equivalent
HVAS	High volume air sampler
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
JBS	Jet Boring System
LCH	Licence Conditions Handbook
LLRD	Long-lived radioactive dust
LTI	Lost-time incident
mg/L	Milligram per litre
mSv	Millisievert
MMER	*Metal Mining Effluent Regulations*
NEW	Nuclear energy worker
OMOE	Ontario Ministry of Environment
PDCE	Preliminary decommissioning cost estimate
PDP	Preliminary Decommissioning Plan
RPP	Radiation protection program
SABRE	Surface Access Borehole Resource Extraction
SCA	Safety and control area
TSP	Total suspended particulates
TSS	Total suspended solids