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Annual Program Report

Rapport annuel sur les programmes

**Regulatory Oversight
Report for Uranium
Mines and Mills in
Canada: 2019**

**Rapport de surveillance
réglementaire pour les
mines et usines de
concentration d'uranium
au Canada : 2019**

Public Meeting

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Summary

This Commission Member Document (CMD) is on the *Regulatory Oversight Report for Uranium Mines and Mills in Canada: 2019*.

There are no actions requested of the Commission. This CMD is for information only.

Résumé

Le présent document à l'intention des commissaires (CMD) porte sur le *Rapport de surveillance réglementaire des mines et usines de concentration d'uranium au Canada : 2019*.

Aucune mesure n'est requise de la Commission. Ce CMD est fourni à titre d'information seulement.

Signed/signé le

October 2, 2020

A handwritten signature in black ink, appearing to read "Kavita M", is centered on the page. The signature is fluid and cursive.

Kavita Murthy

Director General

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PLAIN LANGUAGE SUMMARY

The *Regulatory Oversight Report for Uranium Mines and Mills in Canada: 2019* provides information about the work of the Canadian Nuclear Safety Commission (CNSC) to ensure the safety and protection of people and the environment around operating uranium mines and mills in Canada, all of which are located in northern Saskatchewan. These uranium mines and mills continued to operate safely in 2019, and monitoring shows that the country foods and water surrounding the mines and mills remained safe to eat and drink. There were no releases that could have harmed human health or the environment.

This report provides information on the following uranium mines and mills in Saskatchewan:

- Cigar Lake – operating uranium mine
- McClean Lake – operating uranium mill
- McArthur River – uranium mine in care and maintenance
- Rabbit Lake – uranium mine and mill in care and maintenance
- Key Lake – uranium mill in care and maintenance

When in a state of care and maintenance, a mine and/or mill is not mining, milling or processing uranium ore, and is not producing uranium concentrate (yellowcake). These facilities still have sufficient staff to complete ongoing maintenance and water treatment and to protect employees, the public and the environment.

Each year, CNSC inspectors conduct inspections at uranium mines and mills. The number of inspections and their focus depend on performance and operating status of the mine or mill. The CNSC uses a risk-informed approach when planning inspections. In 2019, CNSC staff performed a total of 20 inspections across the five mining/milling facilities. These inspections resulted in the issuance of 23 notices of non-compliance, which were all related to issues identified as low risk. The operators have addressed all items of non-compliance noted during the inspections, to the CNSC's satisfaction.

The CNSC evaluates operating nuclear facilities across 14 functional areas. However, this report focuses on the following three functional areas as these provide a good overview of safety performance at uranium mine and mill sites:

- **Radiation protection:** In 2019, the maximum individual radiation dose to a worker at any of the five uranium mine and mill facilities was only 9 percent of the annual regulatory limit.
- **Environmental protection:** CNSC licensees are required to report any unauthorized releases of hazardous substances or nuclear materials to the environment, to the CNSC and other regulatory authorities. In 2019, there were 11 unauthorized releases reported. This is lower than the number of releases for uranium mines and mills in previous years. All the causes for releases were investigated and corrected by the mine or mill operators. There were no lasting impacts to the environment as a result of these releases.

Each mine and mill facility uses water as part of the mining and milling process. All water used in the operation must be treated before being discharged back to the environment. All discharged water met the federal or provincial discharge requirements, ensuring the safety of persons near the facility.

- **Conventional health and safety:** All mining and milling operations must report any workplace-related lost-time injuries to the CNSC and provincial agencies. In 2019, there were four lost-time injuries reported (see appendix G).

Indigenous and Community Engagement:

As an agent of the Government of Canada, the CNSC recognizes and understands the importance of building relationships with Indigenous peoples in Canada. The CNSC's goal is to build partnerships and trust with Indigenous communities through collaborative ongoing engagement activities related to CNSC-regulated facilities and activities of interest within their traditional and/or treaty territories. The uranium mines and mills discussed in this report lie within the traditional territories of many Indigenous communities.

In 2019, the efforts of CNSC staff supported their ongoing commitment to meeting consultation and accommodation obligations, and to continuing to build relationships with Indigenous peoples with interests in Canada's uranium mines and mills.

In 2019, as a result of recommendations from the Commission, CNSC staff took the initiative to meet with Indigenous groups and their leaders from communities in northern Saskatchewan. This was done before the public consultation period for this regulatory oversight report, in order to provide information and to seek opportunities for improvement.

In summary:

- Workers at each facility were safe and properly protected.
- There were no releases that could have harmed the environment or health and safety of people.
- Airborne radiation was not increased as a result of these facilities.
- All water released from the facility was safe.
- Fish and plants harvested near these facilities were safe to eat.
- The health and safety of people near these facilities and the surrounding environment continues to be protected.

1 INTRODUCTION

Through the application of the *Nuclear Safety and Control Act* (NSCA), and its associated Regulations, the Canadian Nuclear Safety Commission (CNSC) regulates Canada's nuclear industry to protect the health and safety of persons and the environment and to implement Canada's international commitments on the peaceful use of nuclear energy. The CNSC also disseminates objective scientific, technical and regulatory information to the public. Licensees are responsible for operating their facilities safely and are required to implement programs that make adequate provision for meeting legislative and regulatory requirements. This Regulatory Oversight Report (ROR) for operating uranium mines and mills provides an overview of the CNSC's regulatory efforts related to mine and mill sites operated by Cameco Corporation (Cameco) and Orano Canada Inc. (Orano) for the 2019 calendar year.

The facilities covered by this report are:

- Cigar Lake Operation (uranium mine - operating)
- McArthur River Operation (uranium mine - care and maintenance)
- Rabbit Lake Operation (uranium mine and mill - care and maintenance)
- Key Lake Operation (uranium mill - care and maintenance)
- McClean Lake Operation (uranium mine and mill – operating)

The report focuses on three safety and control areas (SCAs), namely radiation protection, environmental protection, and conventional health and safety, as they provide a good overview of safety performance at uranium mine and mill sites. The report also includes information on public information programs, engagement with Indigenous groups and communities, and reportable events for each facility.

2 URANIUM MINES AND MILLS

This section of the report focuses on the performance of the five uranium mines and mills (UMM) in Canada in 2019. CNSC staff reports on historic and decommissioned sites every three years and will be included in the report for 2020.

The facilities are located within the Athabasca Basin of northern Saskatchewan and are shown in figure 2.1. Three of the five facilities remained in a state of care and maintenance during 2019. The two operating facilities are displayed in red.

Figure 2.1: Location of uranium mines and mills in Saskatchewan



2.1 Cigar Lake Operation

Cameco Corporation (Cameco) is the operator of the Cigar Lake Operation, which is located approximately 660 kilometres north of Saskatoon, Saskatchewan.

The Cigar Lake Operation consists of an underground uranium mine with surface facilities for loading ore slurry into trucks, waste management facilities, a water treatment plant, surface freeze plants, administration offices and warehouses. For more general information please visit:

<http://www.nuclearsafety.gc.ca/eng/uranium/mines-and-mills/nuclear-facilities/cigar-lake/index.cfm>

The current CNSC licence, UML-MINE-CIGAR.00/2021, authorizes the operation of a nuclear facility for the mining of uranium ore and is valid until June 30, 2021. Mining of ore continued throughout 2019.

2.2 McArthur River Operation

Cameco operates the McArthur River mine which is located approximately 620 kilometres north of Saskatoon, Saskatchewan.

Facilities at the McArthur River Operation include an underground uranium mine, primary ore processing, ore slurry loading, waste management facilities, a water treatment plant, effluent storage ponds, surface freeze plants, administration offices and warehouse buildings. For more general information please visit:

<http://www.nuclearsafety.gc.ca/eng/uranium/mines-and-mills/nuclear-facilities/mcarthur-river-lake/index.cfm>

The current CNSC licence, UML-MINE-MCARTHUR.01/2023, authorizes the operation of a nuclear facility for the mining of uranium ore and is valid until 2023. During 2019, the mine remained in care and maintenance.

2.3 Rabbit Lake Operation

The Rabbit Lake Operation is located 750 kilometres north of Saskatoon, Saskatchewan. Operated by Cameco, the facility stretches across approximately 20 kilometres. The Eagle Point underground mine is located at the northern margin of the property. Moving southward, three mined-out pits, two reclaimed, A-Zone and D-Zone, and one flooded, B-Zone pit, all border Collins Bay of Wollaston Lake. The B-Zone pit remains isolated from Collins Bay by an intact dyke. In the central part of the property, the mined-out Rabbit Lake pit was converted to a tailings management facility (TMF). Adjacent to the in-pit TMF is the mill. South of the mill is the above ground TMF, which has not received tailings since 1985. At the southern margin, after passage through settling ponds, all treated effluent (which must meet federal and provincial discharge limits) is continuously discharged and eventually reaches Hidden Bay of Wollaston Lake. For more general information please visit:

<http://www.nuclearsafety.gc.ca/eng/uranium/mines-and-mills/nuclear-facilities/rabbit-lake/index.cfm>

The current CNSC licence, UMOL-MINEMILL-RABBIT.00/2023, which expires in 2023, authorizes the operation of a nuclear facility for the mining of uranium ore, the processing of high grade ore, the production of uranium concentrate and the disposal of tailings in a tailings management facility. During 2019, the mine and mill remained in care and maintenance.

2.4 Key Lake Operation

Located approximately 570 kilometres north of Saskatoon, Saskatchewan, the Key Lake Operation is operated by Cameco. The operation began with two open-pit mines and a mill complex. The Gaertner open pit was mined from 1983 to 1987, followed by the Deilmann open pit until 1997.

Milling of the stockpiled Deilmann ore continued until 1999, when the McArthur River Operation began supplying ore slurry to the Key Lake mill. The Key Lake Operation continues today as a mill operation that processes McArthur River ore slurry and residual special waste from previous mining at Key Lake.

After open-pit mining in the eastern pit of the Deilmann orebody was completed in 1995, the pit was converted into the engineered Deilmann TMF, while mining continued in other parts of the pit area. Mill tailings continue to be deposited into this facility today. For more general information please visit:

<http://www.nuclearsafety.gc.ca/eng/uranium/mines-and-mills/nuclear-facilities/key-lake/index.cfm>

The current CNSC licence, UML-MILL-KEY.01/2023, authorizes the operation of a nuclear facility for the milling of uranium ore, the production of uranium concentrate and the disposal of tailings in a tailings management facility, which expires in 2023. During 2019, the mine and mill remained in care and maintenance.

2.5 McClean Lake Operation

Orano Canada Inc. (Orano) is the operator of the McClean Lake Operation. The McClean Lake Operation is a uranium mine and mill facility located approximately 750 kilometres north of Saskatoon in the Athabasca Basin of northern Saskatchewan. The McClean Lake Operation includes the John Everett Bates (JEB) milling area, Sue mining area, JEB TMF and the undeveloped McClean, Midwest and Caribou ore deposits. For more general information please visit:

<http://www.nuclearsafety.gc.ca/eng/uranium/mines-and-mills/nuclear-facilities/mcclean-lake/index.cfm>

The current CNSC licence, UMOL-MINEMILL-McCLEAN.01/2027, which expires in 2027, authorizes the operation of a nuclear facility for the mining of uranium ore, the processing of high grade ore slurry from Cameco's Cigar Lake Operation, the production of uranium concentrate and the disposal of tailings at the JEB TMF. During 2019, the McClean Lake mill and JEB tailings management facility continued normal operation, processing ore from the Cigar Lake Operation into uranium concentrate.

3 CNSC'S REGULATORY OVERSIGHT OF UMM FACILITIES

The CNSC performs regulatory oversight of licensed facilities to verify compliance with the requirements of the NSCA and associated Regulations made under the NSCA, each facilities licence and licence conditions handbook (LCH), and any other applicable standards and regulatory documents. Regulatory oversight includes licensing, compliance verification and reporting to the Commission. CNSC staff conduct compliance verification of licensee programs, processes and reports through:

- inspections
- reviews of operational activities and documentation
- reviews of licensee reports and events.

If non-compliances with requirements are determined, corrective enforcement actions are issued and tracked to completion.

To ensure consistency, CNSC staff use the Safety and Control Area (SCA) framework to assess, evaluate, review, verify and report on licensee performance. The SCA framework includes 14 SCAs, which are subdivided into specific areas that define its key components. Further information on the CNSC's SCA framework can be found on the CNSC's website at:

<http://www.nuclearsafety.gc.ca/eng/resources/publications/reports/powerindustry/safety-and-control-areas.cfm>

3.1 Regulatory Activities

CNSC staff spent over 8,000 hours in 2019 working on licensing and compliance activities for UMM facilities.

Compliance

The CNSC ensures licensee compliance through verification, enforcement and reporting activities. CNSC staff implement compliance plans for each facility by conducting regulatory activities including onsite inspections, desktop reviews and technical assessments of licensee programs, processes and reports.

In 2019, CNSC staff spent in excess of 850 days on compliance activities. This included desktop reviews and technical assessments of licensee documents, and 20 multiday onsite inspections. Appendix A contains a list of CNSC inspections carried out at each UMM facility in 2019.

Licensing

In 2019, CNSC staff spent approximately 168 days on licensing activities, which included drafting new licences, preparing Commission member documents, and drafting or revising LCHs.

A summary of changes to UMM licences and LCHs during 2019 is shown in appendix B. As CNSC regulatory documents are published, CNSC staff update the LCHs as applicable for each facility, taking into consideration the licensee's implementation plans. CNSC staff verify the implementation as part of ongoing compliance verification activities.

Appendix C lists the CNSC regulatory documents that were published by 2019 that apply to the UMM facilities and their implementation status.

International Atomic Energy Agency Safeguards Activities

Under the terms of the Canada-International Atomic Energy Agency (IAEA) safeguards agreements, the IAEA has the right to perform independent verification activities at various types of facilities in Canada. IAEA activities are not CNSC compliance inspections, but CNSC staff accompany the IAEA in roughly 75 percent of their activities.

In 2019, the IAEA carried out activities at the Key Lake, McArthur River, and McClean Lake Operations to verify nuclear material inventories and assure the absence of undeclared nuclear material and activities. No issues were identified.

3.2 Performance Ratings, 2019

Performance ratings result from regulatory oversight activities. CNSC staff have revised the rating system used in this regulatory report and rate UMM performance in each SCA as either “satisfactory” (SA) or “below expectations” (BE). For 2019, CNSC staff rated all SCAs for all UMM facilities as “satisfactory”.

Appendix D provides SCA ratings for each facility from 2017 to 2019. All five facilities have been rated as satisfactory in each SCA during this time.

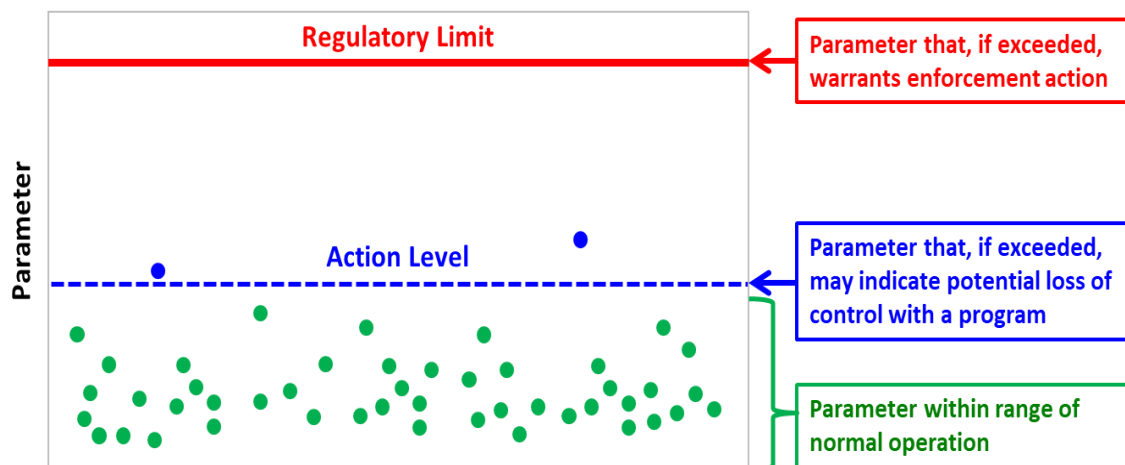
4 CNSC’S ASSESSMENT OF SAFETY AT UMM FACILITIES

The CNSC regulates all aspects of safety at nuclear operations in Canada, including risks to workers, the public and the environment. Information related to the SCAs of radiation protection, environmental protection and conventional health and safety are most representative of the overall safety performance of uranium mines and mills.

In particular, the SCAs of radiation protection and conventional health and safety are a good measure of the safety of workers at UMM sites, while the SCA of environmental protection is a good measure of the safety of the public and the environment.

For both the radiation protection and environmental protection SCAs, action levels are used. Action levels are a specific dose of radiation or other parameter that serve as an early warning to safeguard against exceedances of radiation dose limits and environmental release limits. Action level exceedances must be reported to the CNSC.

Figure 4.1: CNSC Regulatory limits and action levels



4.1 Environmental Protection

Protection of the environment and the public are included in the SCA of environmental protection, which covers programs that identify, control and monitor all releases of radioactive and hazardous substances and the effects on the environment from facilities or as a result of licensed activities.

Currently, all UMM facilities covered in this ROR continue to have acceptable environmental protection programs in place to ensure the protection of the public and the environment. For 2019, CNSC staff rated the environmental protection SCA at all UMM licensed facilities as “satisfactory”.

Appendix E provides the total annual releases of radionuclides for each UMM facility.

Environmental risk assessment

The CNSC uses facility-specific, licensee-developed environmental risk assessments (ERAs) as a regulatory tool throughout the lifecycle of uranium mine and mill facilities to confirm that the public and the environment are protected. Applicants use ERAs during initial environmental assessments for new facilities and for changes to existing facilities or activities at licensed operations where applicable. ERAs are updated and the risks to the public and the environment are reassessed every five years. ERAs are updated based on changes to operational activities, revised predictions, environmental monitoring data collected over the previous five years, and the latest science. In 2019, all UMM operations had ERAs that have been reviewed and accepted by CNSC staff. Table 4.1 outlines the timeframe of the current and upcoming ERAs.

Table 4.1: Current and upcoming Environmental Risk Assessments

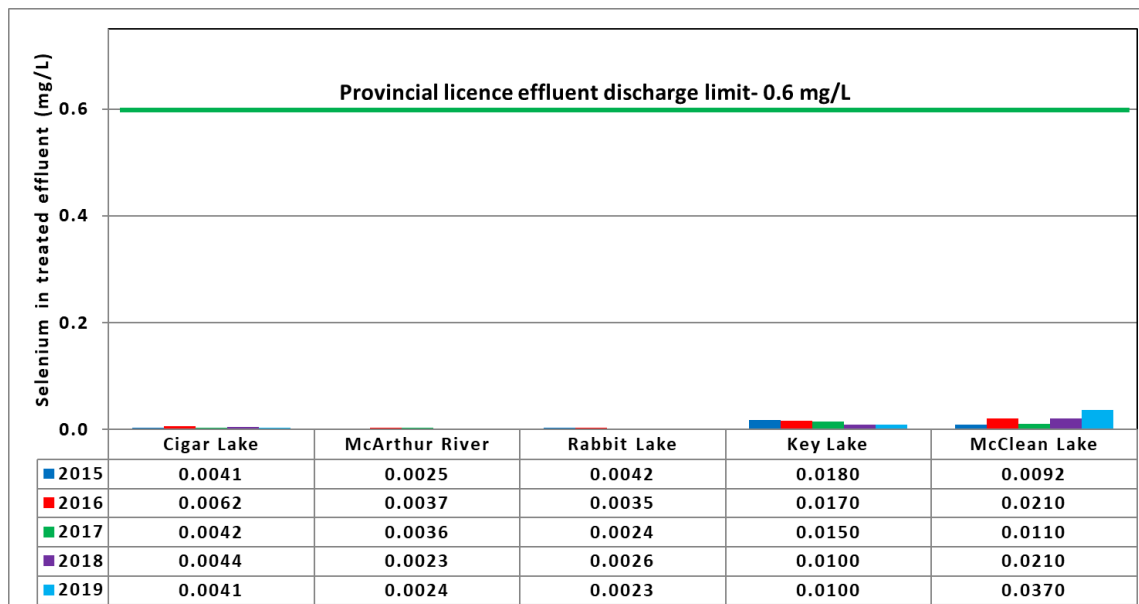
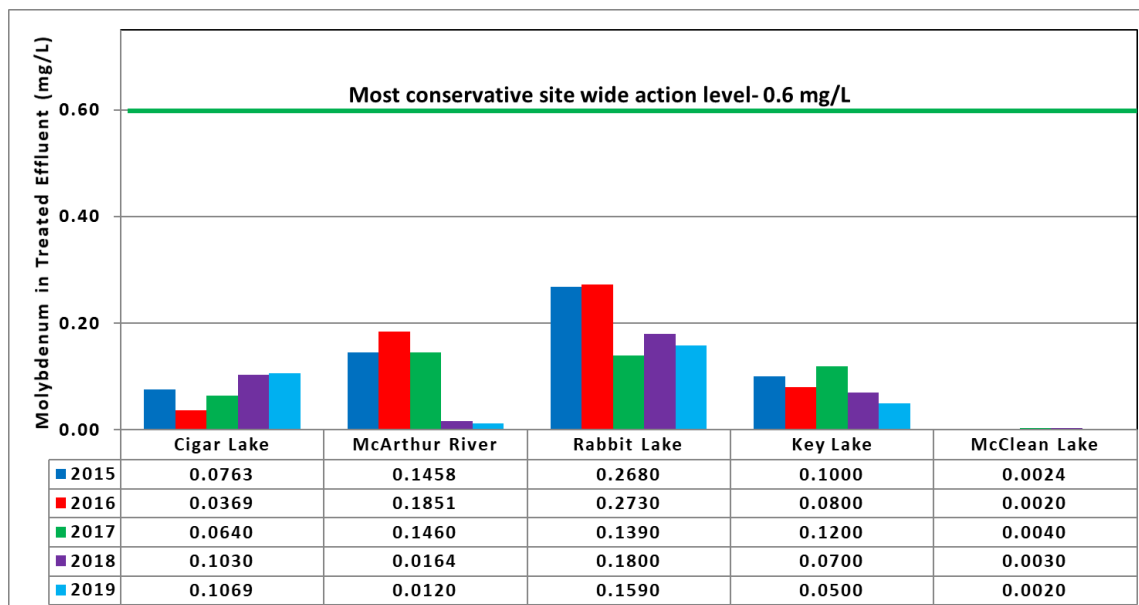
	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
Current ERA	2017	2015	2015	2015	2016
Upcoming ERA	2022	2021	2021	2021	2021

Effluent and emissions control at UMM facilities

Cameco and Orano implement effluent and environmental monitoring programs at all facilities included in this ROR. At all UMM facilities, airborne and waterborne releases of radioactive and hazardous substances remained below regulatory limits in 2019.

Two examples that have historically been the focus of discussions, selenium and molybdenum, are presented below in figures 4.2 and 4.3.

No action level exceedances occurred at UMM facilities for releases of radioactive or hazardous substances during this reporting period.

Figure 4.2: Selenium in treated effluent (mg/L), 2015 to 2019**Figure 4.3: Molybdenum in treated effluent (mg/L), 2015 to 2019**

Cameco and Orano's Environmental Management Systems

The CNSC requires that licensees develop and maintain an Environmental Management System (EMS) in order to provide a documented framework for integrated activities related to environmental protection. Cameco and Orano have established corporate EMSs which applies to all of their facilities in Canada. Through regular compliance verification activities, CNSC staff confirmed that Cameco and Orano have met the annual environmental objectives, goals and targets established in the EMS.

Assessment and monitoring

CNSC staff confirmed that Cameco and Orano, in accordance with their environmental protection and monitoring programs, successfully carried out required effluent and environmental monitoring, inspections, environmental awareness training and program implementation for the facilities covered by this ROR. Through compliance activities conducted during 2019, CNSC staff concluded that environmental monitoring conducted at, and discharge of treated effluent from, UMM facilities met regulatory requirements.

Protection of the Public

Cameco and Orano are required to demonstrate that the health and safety of the public are protected from exposures to hazardous substances released from their licensed operations. The effluent and environmental monitoring programs are used to verify that releases of hazardous substances do not result in environmental concentrations that may affect public health.

Protection of the public is also assessed in the ERA, which contains a human health risk assessment (HHRA). The concentrations of contaminants that a typical local resident may be exposed to (e.g., consumption) are assessed against human health benchmarks in the HHRA. In 2019, the HHRAs for all facilities confirmed that concentrations of contaminants for a typical local resident are well below concentrations that could cause health effects.

4.2 Protection of Workers

The mandate of the CNSC includes consideration of the safety of all workers at licensed facilities, including licensee staff, contractors, sub-contractors and visitors. The SCAs of radiation protection and conventional health and safety are the most direct measure of the licensee's performance in these areas.

4.2.1 Radiation Protection

The radiation protection SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. UMM facilities are required to implement and maintain a radiation protection program to ensure that contamination levels and radiation doses received by individuals are monitored, controlled and maintained as low as reasonably achievable (ALARA).

For 2019, CNSC staff rated the radiation protection SCA at all UMM licensed facilities as "satisfactory". It should be noted that the CNSC staff's rating system has changed, not our assessment of facility safety. The change to a binary system has resulted in McClean Lake's radiation protection performance being graded as "satisfactory" rather than "fully satisfactory" as in previous years. CNSC staff have not noted any negative changes in McClean Lake's radiation protection performance in 2019. The change in rating is a reflection of an administrative change to CNSC's reporting process.

Appendix F contains data on dose to workers for each UMM facility for 2019.

Application of ALARA

Application of ALARA within the radiation protection programs at all UMM facilities includes management commitment and oversight, personnel qualification and training, design analyses of facilities and systems, provision of protective equipment and ALARA assessments/reviews of radiological activities.

In 2019, UMM facilities continued to effectively implement ALARA programs. These programs integrate ALARA into design, planning, management and control of radiological activities, and are based on current industry best practices and operating experience. The ALARA principle is applied to activities and includes all potential exposures; direct, airborne and contamination.

Worker dose control

Workers, including employees and contractors, conducting work activities which present a reasonable probability that the worker may receive an occupational dose greater than 1 millisievert (mSv)/year are identified as Nuclear Energy Workers (NEWs). Workers whose job function do not present a reasonable probability of receiving an occupational dose greater than 1 mSv/year are considered non-NEWs.

In 2019, no worker at a UMM facility received a radiation dose in excess of the CNSC regulatory dose limits.

Radiation protection program performance

Radiation protection program performance at UMM facilities was assessed in 2019 through CNSC staff compliance activities.

In 2019, no radiation protection action levels were exceeded.

Radiological hazard control

Radiation and contamination monitoring programs continued to be implemented at UMM facilities in 2019, to control and minimize both direct and airborne radiological hazards and the spread of radioactive contamination. Dose rate measurements, and where appropriate, in-plant air monitoring, are routinely performed to confirm that radiation exposures are kept ALARA.

The radiological measurements taken in 2019 by CNSC staff did not identify any adverse results, and were consistent with expected radiological conditions.

4.2.2 Conventional Health and Safety

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and protect workers. UMM licenced facilities must develop, implement and maintain effective safety programs to promote safe and healthy workplaces and prevent incidences of occupational injuries and illnesses. Conventional health and safety is assessed by the CNSC as well as the provincial regulating authority.

For 2019, CNSC staff rated the conventional health and safety SCA at all UMM licenced facilities as “satisfactory”.

Practices

During 2019, CNSC staff verified UMM safety practices during compliance inspections, all of which incorporated the verification of aspects related to conventional health and safety, as well as during desktop reviews and technical assessments.

Performance

The industry standard key performance indicator for conventional health and safety for uranium mine and mill facilities is the total number of recordable incident rate (TRIR). The TRIR is derived from combining the number of safety incidents and total work hours of all employees with a standard employee group.

Appendix G contains health and safety information for each UMM facility for 2019.

5 EVENTS AND OTHER MATTERS OF REGULATORY INTEREST

5.1 Reportable Events

Detailed requirements for reporting to the CNSC unplanned situations or events at UMM licensed facilities are included in the applicable LCH. CNSC REGDOC-3.1.2 *Reporting Requirements for Non-Power Reactor Class I Facilities and Uranium Mines and Mills* came into force for applicable UMM licensees in January 2019. Over this reporting period, Cameco and Orano have complied with reporting requirements. For reportable events which occurred in 2019, CNSC staff are satisfied with Cameco and Orano's corrective actions. Table 5.1 displays the total number of reportable events that occurred at UMM facilities between 2015 and 2019.

Table 5.1: Reportable events at UMM facilities, 2015-2019

Year	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
2015	10	0	2	1	6
2016	5	1	2	1	8
2017	5	2	1	3	3
2018	5	2	2	5	6
2019	3	1	0	4	3

The following reportable events were all of low safety significance:

Cigar Lake:

- April 28, 2019, the total suspended particulate concentration exceeded Saskatchewan guidelines due to high winds. Corrective actions were taken. Safety Significance = Low.
- August 8, 2019, there was a leak of surge pond water into a secondary liner. There were no releases to the environment. Corrective actions were taken. Safety Significance = Low.

- October 15, 2019, there was a spill of ferric sulfate while offloading. Corrective actions were taken. Safety Significance = Low.

McArthur River:

- July 3, 2019, while unloading contaminated filter media (sand and gravel) from a vacuum truck onto Waste Pad #3, approximately 0.25 m³ of contaminated filter media was released to the ground. The release was cleaned up. A containment pad was constructed for unloading to prevent reoccurrence. Safety Significance = Low.

Key Lake:

- January 8, 2019, a leak was discovered coming from a valve on the vaporizer line on ammonia storage tank #3 by the mill. All liquid ammonia was transferred out of the tank in 2018 as part of the maintenance and repairs to the ammonia tanks. Although no release volume could be estimated, it is expected that it was very low. The likely cause was deterioration of the valve packing and gaskets caused by anhydrous ammonia absorbing water. Cameco implemented plans to replace all valves on all three ammonia tanks. Safety Significance = Low.
- March 3, 2019, a liquid propane distribution flexible hose failed on pump #2 leading from the acid plant propane tank farm to the vaporizer house. No release volume could be estimated. However, daily propane tank level checks indicated there was no increase in consumption compared with routine operation, which indicated that the release volume was relatively low. Cameco staff reviewed the event at a site-wide safety meeting. Safety Significance = Low.
- July 9, 2019, a leak developed on a propane regulator within the mill terrace vaporizer building. This resulted in propane gas levels exceeding the explosive limit localized around the regulator within the building. The leak duration was in excess of 10 minutes. No release volume could be estimated as there was no measurable decrease in propane tank volume. This event itself was considered to be of low significance by CNSC staff, however this event was also identified as a potential dangerous occurrence. Cameco staff reviewed the event at a site-wide safety meeting. Safety Significance = Low.
- November 16, 2019, a pressure relief valve failed on the mill terrace leaching vaporizer #2. The valve failure resulted in a release of approximately 198 m³ of propane gas to the atmosphere. The event itself was determined to be of low safety significance by CNSC staff; however, its potential as a dangerous occurrence was also identified. The event was reviewed at the site-wide safety meeting and by the site's Occupational Health Committee members. The pressure relief valve was replaced with a different model that will allow the vapour to vent upwards should the valve open. Two additional valves were also replaced so that the vent direction pointed upwards. Safety Significance = Low.

McClean Lake:

- January 31, 2019, during start-up of the sulphuric acid (SO₂) plant, the 1-hour average ambient SO₂ concentration exceeded both the maximum authorized concentration and the action level. The 24-hour average concentration, which uses a rolling average, also exceeded both the maximum authorized concentration and the action level. Corrective actions were taken. Safety Significance = Low.
- March 23, 2019, during repair work at the base of the cleanup thickener feed surge tank, it was noticed that the damage within the concrete slab extended down the side of the tank base. The damaged concrete was removed and the area sealed with new concrete to prevent future releases. Safety Significance = Low.
- August 25, 2019, treated effluent from Pond C was discharged into Sink Reservoir with a Total Suspended Solids (TSS) concentration of 18.9 mg/L. The action level for treated effluent discharge for TSS is 12.0 mg/L. The discharge was stopped and the remainder of the pond was recycled to the TMF. Corrective actions were taken. Safety Significance = Low.

CNSC staff have inspected all corrective actions and are satisfied that Cameco and Orano have responded appropriately to the incidents and implemented appropriate corrective actions in response to each event.

Update on previous reported event

Following up on a Key Lake groundwater report from December 2018, after a review of groundwater monitoring data, Cameco reported that an onsite monitoring well showed an increase in uranium concentrations. An investigation was completed and the contamination was confirmed. An initial event report was discussed at a Commission meeting on May 15, 2019. A complete facility assessment report was prepared and submitted to the CNSC in March 2020. The assessment confirmed that the contamination is limited in geographic extent; there have been no impacts and no immediate risks to the surrounding environment. The assessment is being used by Cameco to develop a corrective action plan which is expected to be submitted to the CNSC in late 2020.

5.2 Public Information and Disclosure Programs

CNSC REGDOC-3.2.1, *Public Information and Disclosure* sets out the requirements for public information and disclosure. The primary goal of the program is to ensure that information related to the health, safety and security of persons and the environment, and other issues associated with the lifecycle of nuclear facilities is shared with the public in a format relevant to the audience. The program includes a commitment and protocol for ongoing, timely dissemination of information related to the licensed facility.

CNSC staff determined that the public information and disclosure programs implemented by the licensees complied with REGDOC-3.2.1, and that licensees, Cameco and Orano, provided regular information on the status of their facilities to their audiences. CNSC staff met with both licensees to discuss elements of their programs and plans for future communications initiatives.

CNSC staff participated in various meetings and local community events in 2019 to offer two-way discussion, clarity and explanation of the regulatory process and scientific data to key audiences interested in the uranium mines and mills in northern Saskatchewan. In addition, CNSC staff regularly participate in meetings with the Northern Saskatchewan Environmental Quality Committee (EQC) as well as with various other communities.

Cameco and Orano continue to implement their respective public information and disclosure programs to ensure their audiences are receiving the appropriate information at the right time in a way that is meaningful to the community. In 2019, both licensees provided pertinent information related to health, safety and environment through various methods including face-to-face meetings, web updates, a social media presence and community tours.

5.3 Indigenous Consultation and Engagement

As an agent of the Government of Canada and as Canada's nuclear regulator, the CNSC recognizes and understands the importance of consulting and building relationships with Indigenous peoples in Canada. CNSC staff are committed to building long-term relationships with Indigenous groups who have an interest in CNSC-regulated facilities within their traditional and/or treaty territories. By pursuing informative and collaborative ongoing interactions, the CNSC's goal is to build partnerships and trust. The CNSC's Indigenous engagement practices, which include information sharing and funding support (through the CNSC's Participant Funding Program [PFP]) to assist Indigenous peoples to meaningfully participate in Commission proceedings and ongoing regulatory activities, are consistent with the principles of upholding the honour of the Crown and reconciliation.

CNSC consultation and engagement activities

The operating uranium mines and mills facilities in Canada fall within the traditional and/or treaty territories of many Indigenous communities (see the list below). CNSC staff efforts in 2019 supported the CNSC's ongoing commitment to meeting its consultation obligations and building relationships with Indigenous peoples with interests in Canada's uranium mines and mills. CNSC staff continued to work with Indigenous communities and organizations to identify opportunities for formalized and regular engagement throughout the lifecycle of these facilities, including meetings and facilitated workshops. CNSC staff met with Indigenous communities to discuss areas of interest including Cameco's McArthur River, Cigar Lake, Rabbit Lake and Key Lake Operations, as well as Orano's McClean Lake Operation.

In addition, CNSC staff carried out the following engagement activities with Indigenous groups in 2019, including:

- participation in meetings of the EQC on July 9 and 10, and September 4, 2019
- participation in the Saskatchewan Mining Association Annual Conference and environmental forum

- participation in meetings with the English River First Nation, Clearwater River Dene Nation, Behchoko and a meeting in Patuanak to listen to concerns related to the Key Lake groundwater spill
- hosting a meeting in Prince Albert, Saskatchewan with Indigenous communities and groups to provide information and seek feedback on the 2018 UMM ROR
- participation in meetings with Indigenous groups to provide information on the 2019 UMM ROR
- sending a notice of the PFP opportunity for the 2019 UMM ROR to all potentially interested Indigenous groups.

As a result of recommendations from the Commission, in 2019 CNSC staff took an additional initiative to meet with Indigenous groups and communities before the public consultation period to provide information and seek opportunity for improvement on the ROR. In addition, using feedback from the Indigenous engagement, a plain language overview was developed and included in the 2018 UMM ROR. First Nation and Métis communities with interest in Canada's uranium mines and mills will be provided a copy of this ROR for review. Through the CNSC's PFP, financial support will be made available for participation in the review of this report.

CNSC staff will continue to engage and update interested Indigenous communities on regulatory activities and are committed to continue meeting to provide key updates and answering any questions that Indigenous communities and groups may have regarding nuclear activities and projects in their territories of interest.

Licensee engagement activities

In 2019, CNSC staff continued to monitor the engagement work conducted by the UMM licensees (Cameco and Orano) to ensure that they actively engage and communicate with Indigenous groups who have interest in their facilities. CNSC staff confirm that the licensees have well-established Indigenous engagement and outreach programs and engage with Indigenous groups that have interests in their facilities.

Throughout this reporting period, UMM licensees continued to host meetings and to discuss their operations with Indigenous communities and invited them to participate on tours, information sessions and facilitated workshops. As well, they regularly participate at EQC meetings along with the Province of Saskatchewan and CNSC staff. Indigenous communities are heavily engaged in the activities associated with UMM operations as employees and suppliers, with northern mines being one of the largest employers of Indigenous peoples in Canada. CNSC staff continue to be satisfied with the level and quality of Indigenous engagement conducted by the licensees in relation to their UMM operations in northern Saskatchewan.

Indigenous communities and groups with traditional and/or treaty territories in proximity to operating uranium mine and mills facilities have been identified by CNSC staff:

- Athabasca Chipewyan First Nation (AB)
- Clearwater River Dene Nation (SK)
- English River First Nation (SK)
- Buffalo River Dene Nation (SK)

- Birch Narrows Dene Nation (SK)
- Lac La Ronge Indian Band (SK)
- Métis Nation-Saskatchewan (SK)
- Pinehouse Kineepik Métis Local (SK)
- Prince Albert Grand Council (SK)
- Hatchet Lake First Nation (SK)
- Black Lake First Nation (SK)
- Fond du Lac First Nation (SK)
- Ya'thi Néné Lands and Resources Office (SK)

5.4 CNSC Independent Environmental Monitoring Program

No Independent Environmental Monitoring Activities took place around the five operating mine and mill sites in 2019. Results from previous IEMP sampling campaigns are available on the CNSC's Web page:

<http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/index-iemp.cfm>

6 OVERALL CONCLUSIONS

CNSC staff conclude that the Cigar Lake, McArthur River, Rabbit Lake, Key Lake, and McClean Lake facilities operated safely in 2019. This conclusion is based on assessments of licensee activities that included site inspections, reviews of reports submitted by licensees, and event and incident reviews, supported by follow-up and general communication with the licensee.

For 2019, the performance in all 14 SCAs were rated as “satisfactory”.

CNSC staff's compliance activities confirmed that at all UMM licenced facilities:

- radiation protection programs adequately controlled radiation exposures, keeping doses ALARA
- environmental protection programs were effective in protecting the public and the environment
- conventional health and safety programs continued to protect workers.

CNSC staff will continue to provide regulatory oversight at all UMM facilities to ensure that Cameco and Orano continue to make adequate provision to protect the health, safety and security of workers, Canadians and the environment, and continues to implement Canada's international obligations on the peaceful use of nuclear energy.

APPENDIX A: LIST OF INSPECTIONS AT UMM FACILITIES

UMM Inspections - 2019				
Facility	Inspection	Dates	SCAs Covered	Non-compliances
Key Lake Operation	CAMECO-KL-2019-01 Compliance Inspection - Care and Maintenance Activities	January 28-29	<ul style="list-style-type: none"> • Management System • Fitness for Service • Environmental Protection • Radiation Protection • Conventional Health and Safety • Human Performance Management • Emergency Management and Fire Protection • Waste Management 	2
	CAMECO-KL-2019-02 Compliance Inspection - General	April 1-4	<ul style="list-style-type: none"> • Fitness for Service • Operating Performance • Radiation Protection • Human Performance Management • Emergency Management and Fire Protection • Waste Management 	2
	CAMECO-KL-2019-03 Compliance Inspection - General	October 21-23	<ul style="list-style-type: none"> • Management System • Operating Performance • Fitness for Service • Radiation Protection • Conventional Health and Safety • Environmental Protection • Emergency Management and Fire Protection • Waste Management • Security • Packaging and Transport 	2
Rabbit Lake Operation	CAMECO-RL-2019-01 Compliance Inspection - General	February 26-28	<ul style="list-style-type: none"> • Operating Performance • Radiation Protection • Conventional Health and Safety • Environmental Protection 	0
	CAMECO-RL-2019-02 Compliance Inspection - Fitness for Service	April 9-11	<ul style="list-style-type: none"> • Fitness for Service 	0
	CAMECO-RL-2019-03 Compliance Inspection – General	August 27-29	<ul style="list-style-type: none"> • Environmental Protection • Waste Management 	0

UMM Inspections - 2019				
Facility	Inspection	Dates	SCAs Covered	Non-compliances
Cigar Lake Operation	CAMECO-CIG-2019-01 Compliance Inspection - General	February 19-21	<ul style="list-style-type: none"> • Fitness for Service • Safety Analysis • Physical Design • Waste Management • Operating Performance 	0
	CAMECO-CIG-2019-02 Compliance Inspection - General	March 18-20	<ul style="list-style-type: none"> • Management System • Fitness for Service • Radiation Protection • Conventional Health and Safety 	0
	CAMECO-CIG-2019-03 Compliance Inspection - General	May 21-23	<ul style="list-style-type: none"> • Environmental Protection • Radiation Protection • Conventional Health and Safety 	1
	CAMECO-CIG-2019-04 Compliance Inspection - Management System	August 13-15	<ul style="list-style-type: none"> • Management System 	1
	CAMECO-CIG-2019-05 Compliance Inspection - Radiation Protection	August 13-15	<ul style="list-style-type: none"> • Radiation Protection 	2
	CAMECO-CIG-2019-06 Compliance Inspection - General	October 22-24	<ul style="list-style-type: none"> • Fitness for Service • Conventional Health and Safety • Human Performance Management • Emergency Management and Fire Protection • Packaging and Transport 	2
McArthur River Operation	CAMECO-MR-2019-01 Compliance Inspection - Care and Maintenance Activities	January 30-31	<ul style="list-style-type: none"> • Management System • Fitness for Service • Environmental Protection • Radiation Protection • Conventional Health and Safety • Human Performance Management • Emergency Management and Fire Protection 	1
	CAMECO-MR-2019-02 Compliance Inspection - General	June 17-20	<ul style="list-style-type: none"> • Management System • Fitness for Service • Operating Performance • Physical Design • Radiation Protection • Conventional Health and Safety • Waste Management • Security 	0

UMM Inspections - 2019				
Facility	Inspection	Dates	SCAs Covered	Non-compliances
	CAMECO-MR-2019-03 Compliance Inspection - Waste Management	July 22-25	<ul style="list-style-type: none"> • Waste Management • Environmental Protection • Radiation Protection 	2
	CAMECO-MR-2019-04 Compliance Inspection - Training / Human Performance	December 2-5	<ul style="list-style-type: none"> • Human Performance Management • Fitness for Service • Conventional Health and Safety 	0
McClean Lake Operation	ORANO-ML-2019-01 Compliance Inspection - General	March 20-21	<ul style="list-style-type: none"> • Management System • Fitness for Service • Radiation Protection • Conventional Health and Safety 	1
	ORANO-ML-2019-02 Compliance Inspection - General	June 25-27	<ul style="list-style-type: none"> • Fitness for Service • Conventional Health and Safety • Packaging and Transport 	1
	ORANO-ML-2019-03 Compliance Inspection - Environmental Protection	July 16-18	<ul style="list-style-type: none"> • Environmental Protection 	1
	ORANO-ML-2019-04 Compliance Inspection - Emergency Management and Fire Protection	September 11-12	<ul style="list-style-type: none"> • Emergency Management and Fire Protection 	0

Compliance inspections at uranium mines and mills, 2014 to 2019

Year	Inspections	Non-compliances
2014	24	31
2015	30	37
2016	30	41
2017	30	23
2018	26	31
2019	20	18

APPENDIX B: LICENCE AND LICENCE CONDITIONS HANDBOOK CHANGES

This appendix presents information on any licence and licence conditions handbook (LCH) changes during 2019.

Facility	Licence	Licence Changes	LCH Changes
Cigar Lake Operation	UML-MINE-CIGAR.00/2021	No changes in 2019	No changes in 2019
McArthur River Operation	UML-MINE-MCARTHUR.01/2023	Licence amendment request to update financial guarantee granted, June 2019 (CMD 19-H105)	New LCH issued February 2020 to reflect licence issued in June 2019
Rabbit Lake Operation	UMOL-MINEMILL-RABBIT.00/2023	No changes in 2019	No changes in 2019
Key Lake Operation	UMLOL-MILL-KEY.00/2023	No changes in 2019	No changes in 2019
McClellan Lake Operation	UMOL-MINEMILL-McCLEAN.01/2027	No changes in 2019	No changes in 2019

APPENDIX C: REGULATORY DOCUMENT IMPLEMENTATION

Regulatory document	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
REGDOC-2.2.2, <i>Personnel Training, Version 2, December 2016</i>	To be implemented as part of 2021 licence renewal	Implementation to be completed June 2022	Implementation to be completed June 2022	Implementation to be completed June 2022	Implemented
REGDOC-2.10.1, <i>Nuclear Emergency Preparedness and Response, Version 2, February 2017</i>	To be implemented as part of 2021 licence renewal	To be implemented as part of next LCH update	To be implemented as part of 2020 licence amendment	To be implemented as part of 2020 licence amendment	Implemented
REGDOC-2.9.1, <i>Environmental Protection: Environmental Principles, Assessments and Protection Measures, Version 1.1, April 2017</i>	Implementation plan to be submitted in 2020	Implementation plan to be submitted in 2020	Implementation plan to be submitted in 2020	Implementation plan to be submitted in 2020	Implementation plan to be submitted in 2020
REGDOC-1.6.1, <i>Licence Application Guide: Nuclear Substances and Radiation Devices, Version 2, May 2017</i>	To be implemented as part of 2021 licence renewal	Implemented	To be implemented as part of 2020 licence amendment	To be implemented as part of 2020 licence amendment	Implemented
REGDOC-3.1.2, <i>Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills, January 2018</i>	To be implemented as part of 2021 licence renewal	Implemented	To be implemented as part of 2020 licence amendment	To be implemented as part of 2020 licence amendment	Implementation to be completed June 2022
REGDOC-2.13.1, <i>Safeguards and Nuclear Material Accountancy, February 2018</i>	To be implemented as part of 2021 licence renewal	To be implemented as part of next LCH update	To be implemented as part of 2020 licence amendment	To be implemented as part of 2020 licence amendment	Implemented
REGDOC-2.5.4, <i>Design of Uranium Mines and Mills: Ventilation Systems, March 2018</i>	To be implemented as part of 2021 licence renewal	Implemented	To be implemented as part of 2020 licence amendment	To be implemented as part of 2020 licence amendment	Implemented

Regulatory document	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
REGDOC-2.1.2, <i>Safety Culture</i> , April 2018	Implementation to be completed June 2022	Implementation to be completed June 2022	Implementation to be completed June 2022	Implementation to be completed June 2022	Implementation to be submitted in 2020
REGDOC-3.2.1, <i>Public Information and Disclosures</i> , May 2018	Implementation plan to be submitted in 2020	Implementation plan to be submitted in 2020	Implementation plan to be submitted in 2020	Implementation plan to be submitted in 2020	Implementation plan to be submitted in 2020
REGDOC-2.11.1, <i>Waste Management, Volume III: Assessing the Long-Term Safety of Radioactive Waste Management</i> , May 2018	Not applicable	Not applicable			Implementation plan to be submitted in January 2020
REGDOC-2.11.1, <i>Waste Management, Volume II: Management of Uranium Mine Waste Rock and Mill Tailings</i> , November 2018	To be implemented as part of 2021 licence renewal		To be implemented as part of 2020 licence amendment	To be implemented as part of 2020 licence amendment	Implementation plan to be submitted in January 2020

APPENDIX D: SAFETY AND CONTROL AREA RATINGS

Safety and control area summary, all mines: 2017-2019

Safety and control areas	2017	2018	2019
Management system	SA	SA	SA
Human performance management	SA	SA	SA
Operating performance	SA	SA	SA
Safety analysis	SA	SA	SA
Physical design	SA	SA	SA
Fitness for service	SA	SA	SA
Radiation protection	SA	SA	SA
Conventional health and safety	SA	SA	SA
Environmental protection	SA	SA	SA
Emergency management and fire protection	SA	SA	SA
Waste management	SA	SA	SA
Security	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA
Packaging and transport	SA	SA	SA

SA = satisfactory, BE = below expectations

APPENDIX E: ENVIRONMENTAL PERFORMANCE AT UMM FACILITIES

The following tables summarize information publicly available in licensee's annual reports. The numbers have been provided by the licensee's and were not directly measured by CNSC staff. The numbers reported amalgamate all five facilities in individual tables to provide an easy comparison of the annual load of key radionuclides directly released to the atmosphere or to surface waters from licensed UMM facilities operated by Cameco and Orano.

Over this reporting period, there have been no exceedances of licence limits.

Total Annual Release of Relevant Radionuclides to the Environment

Saskatchewan's licensed effluent maximum monthly mean discharge limits are 0.6 mg/L and 2.5 mg/L for selenium and uranium, respectively.

CNSC has identified an interim objective for uranium of 0.1 mg/L based on available technology. The interim objective for uranium in effluent is in place while the CNSC develops requirements release limits in REGDOC-2.9.2, which is currently undergoing internal CNSC review.

Selenium in treated effluent, 2019

Selenium (annual mean)	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
mg/L	0.0041	0.0024	0.0023	0.0100	0.0370
% regulatory limit*	0.7	0.4	0.4	1.7	6.2

* Provincial licence effluent discharge limit, 0.6 mg/L

Selenium in treated effluent (mg/L), 2014 to 2018

Year	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
2014	0.0010	0.0024	0.0042	0.0180	0.0007
2015	0.0041	0.0025	0.0042	0.0180	0.0092
2016	0.0062	0.0037	0.0035	0.0170	0.0210
2017	0.0042	0.0036	0.0024	0.0150	0.0110
2018	0.0044	0.0023	0.0026	0.0100	0.0210

Uranium in treated effluent, 2019*(CNSC Interim Objective 0.1 mg/L)*

Uranium (annual mean)	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
mg/L	0.0004	0.0086	0.0270	0.0243	0.0050
% regulatory limit*	< 1	< 1	1	1	< 1

* Provincial licence effluent discharge limit, 2.5 mg/L

Uranium in treated effluent (mg/L), 2014 to 2018

Year	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
2014	0.0166	0.0095	0.0460	0.0060	0.0018
2015	0.0594	0.0089	0.0520	0.0080	0.0042
2016	0.0063	0.0055	0.0730	0.0060	0.0040
2017	0.0018	0.0056	0.0700	0.0110	0.0040
2018	0.0005	0.0071	0.0320	0.0130	0.0070

In the absence of federal or provincial effluent discharge limits for molybdenum, the CNSC required licensees to develop facility-specific effluent controls within their environmental protection program codes of practice. The Key Lake action level of 0.6 mg/L for molybdenum is a stringent measure which the CNSC uses for the five operations. As a point of reference, for the last six years, including 2019, molybdenum average effluent concentrations for all five facilities were below the Key Lake code of practice action level.

Molybdenum in treated effluent, 2019*(Key Lake Action Level of 0.6 mg/L is used)*

Molybdenum	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
mg/L	0.1069	0.0120	0.1590	0.0500	0.0020

Molybdenum in treated effluent (mg/L), 2014 to 2018

Year	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
2014	0.0360	0.1865	0.2820	0.1600	0.0024
2015	0.0763	0.1458	0.2680	0.1000	0.0024
2016	0.0369	0.1851	0.2730	0.0800	0.0020
2017	0.0640	0.1460	0.1390	0.1200	0.0040
2018	0.1030	0.0164	0.1800	0.0700	0.0030

Uranium mine and mill facilities also analyze treated effluent for concentrations of other regulated contaminants and contaminants of potential concern (COPC) such as arsenic, copper, lead, nickel, zinc, total suspended solids (TSS) and pH. The *Metal and Diamond Mining Effluent Regulations* (MDMER) apply to all metal mines and mills in Canada under the federal *Fisheries Act*. The CNSC incorporates the effluent limit requirements of MDMER into uranium mine and mill licences.

Annual average COPC concentration in effluent, 2019

2019	MDMER discharge limits	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
Arsenic (mg/L)	0.5	0.0952	0.0009	0.0009	0.0075	0.058
Copper (mg/L)	0.3	0.0014	0.0010	0.0002	0.001	0.002
Lead (mg/L)	0.2	0.0002	0.0009	0.0001	0.0003	0.0006
Nickel (mg/L)	0.5	0.0013	0.0034	0.0013	0.142	0.0150
Zinc (mg/L)	0.5	0.0232	0.0033	0.0007	0.007	0.0030
TSS (mg/L)	15	2	1	1	2	2
pH	6.0–9.5	7.32	7.49	7.19	6.60	7.2

Annual average COPC concentration in effluent, 2018

2018	MDMER discharge limits	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
Arsenic (mg/L)	0.5	0.0603	0.0009	0.0009	0.0080	0.0300
Copper (mg/L)	0.3	0.0008	0.0010	0.0003	0.0050	0.0030
Lead (mg/L)	0.2	0.0002	0.0009	0.0001	0.0100	0.0028
Nickel (mg/L)	0.5	0.0009	0.0031	0.0015	0.2570	0.0130
Zinc (mg/L)	0.5	0.0271	0.0014	0.0006	0.0090	0.0030
TSS (mg/L)	15	1	1	1	2	2
pH	6.0–9.5	7.3	7.5	7.3	6.7	7.2

Operating uranium mines and mills in northern Saskatchewan have process waters, which require capture, treatment and release through a final point of control.

Releases for total uranium are reported as kilograms (kg) while releases of uranium U-238 progeny are reported in megabecquerels (MBq).

CNSC staff have commenced publishing annual releases of radionuclides to the environment from nuclear facilities on the CNSC Open Government Portal:

<https://open.canada.ca/data/en/dataset/6ed50cd9-0d8c-471b-a5f6-26088298870e>

Radionuclides in ambient air, 2019

2019	Reference annual air quality levels	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
Pb ²¹⁰ (Bq/m ³)	0.021 ¹	0.0003	0.0003	0.0002	0.0003	0.0003
Ra ²²⁶ (Bq/m ³)	0.013 ¹	0.0000	0.0000	0.0000	0.0001	0.0000
Th ²³⁰ (Bq/m ³)	0.0085 ¹	0.0000	0.0000	0.0000	0.0001	0.0000
U (µg/m ³)	0.06 ²	0.0010	0.0001	0.0001	0.0008	0.0025

Radionuclides in ambient air, 2014 to 2018

Cigar Lake	Reference annual air quality levels	2014	2015	2016	2017	2018
Pb ²¹⁰ (Bq/m ³)	0.021 ¹	0.00025	0.000315	0.000305	0.00036	0.00037
Ra ²²⁶ (Bq/m ³)	0.013 ¹	0.000008	0.000014	0.000020	0.000030	0.000026
Th ²³⁰ (Bq/m ³)	0.0085 ¹	0.00001	0.000014	0.000012	0.000023	0.000018
U (µg/m ³)	0.06 ²	0.00008	0.00055	0.00113	0.00151	0.00103

McArthur River	Reference annual air quality levels	2014	2015	2016	2017	2018
Pb ²¹⁰ (Bq/m ³)	0.021 ¹	0.00032	0.00032	0.0002	0.0004	0.0003
Ra ²²⁶ (Bq/m ³)	0.013 ¹	0.00002	0.00001	0.00004	0.00001	0.00001
Th ²³⁰ (Bq/m ³)	0.0085 ¹	0.00001	0.00002	0.0001	0.0001	0.00001
U (µg/m ³)	0.06 ²	0.0005	0.0003	0.0004	0.0003	0.0001

Rabbit Lake	Reference annual air quality levels	2014	2015	2016	2017	2018
Pb ²¹⁰ (Bq/m ³)	0.021 ¹	0.000013	0.000015	0.000011	0.000013	0.000015
Ra ²²⁶ (Bq/m ³)	0.013 ¹	0.000002	0.000001	0.000002	0.000004	0.0000002
Th ²³⁰ (Bq/m ³)	0.0085 ¹	0.000003	0.000001	0.000002	0.000004	0.0000003
U (µg/m ³)	0.06 ²	0.001960	0.002341	0.000899	0.000190	0.000277

Key Lake	Reference annual air quality levels	2014	2015	2016	2017	2018
Pb ²¹⁰ (Bq/m ³)	0.021 ¹	0.00044	0.0003	0.0003	0.0004	0.0002
Ra ²²⁶ (Bq/m ³)	0.013 ¹	0.00022	0.0001	0.0001	0.0003	0.0001
Th ²³⁰ (Bq/m ³)	0.0085 ¹	0.00022	0.0001	0.0001	0.0002	0.0001
U (µg/m ³)	0.06 ²	0.00794	0.0080	0.0076	0.0091	0.0012

McClean Lake	Reference annual air quality levels	2014	2015	2016	2017	2018
Pb ²¹⁰ (Bq/m ³)	0.021 ¹	0.000277	0.000271	0.000285	0.000309	0.000253
Ra ²²⁶ (Bq/m ³)	0.013 ¹	0.000010	0.000008	0.000009	0.000014	0.000022
Th ²³⁰ (Bq/m ³)	0.0085 ¹	0.000005	0.000005	0.000005	0.000006	0.000004
U (µg/m ³)	0.06 ²	0.000576	0.001319	0.003138	0.002029	0.001654

¹ Reference level is derived from International Commission of Radiological Protection (ICRP) Publication 96. *Protecting People Against Radiation Exposure in the Event of a Radiological Attack.*

² Reference annual air quality levels are derived from Ontario 24-hour Ambient Air Quality Criteria (2012).

For comparison and context within the broader context of mining in Canada, the following table summarizes environmental information compiled by Environment and Climate Change Canada. The same standards are used to regulate all mining sectors.

Treated effluent comparison to metal mining sectors in Canada, 2016*

Mining sector	# of mines	Number of mines out of compliance with at least one parameter	Number of mines out of compliance by parameter							
			Total Suspended Solids	Arsenic	Copper	Lead	Nickel	Zinc	Radium-226	pH Range
Uranium	5	0	0	0	0	0	0	0	0	0
Base metal	47	10	6	0	0	0	1	0	0	3
Precious metal	54	6	4	0	0	0	0	0	2	1
Iron	8	5	2	0	0	0	0	1	0	3

* Environment and Climate Change Canada, 2016 is the most current data available.

APPENDIX F: DOSES TO NUCLEAR ENERGY WORKERS AND NON-NUCLEAR ENERGY WORKERS AT UMM FACILITIES

This appendix presents information on doses to Nuclear Energy Workers (NEWs) at UMM facilities.

Average individual effective dose, 2019

(Annual regulatory limit is 50 mSv to NEWs)

Average	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
mSv	0.57	0.33	0.75	0.27	0.93
# of NEWS	875	136	119	260	323

Average individual effective dose (mSv), 2014 to 2018

Year	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
2014	0.16	1.03	1.35	0.63	0.37
2015	0.45	1.00	1.36	0.55	0.89
2016	0.39	0.85	0.85	0.62	1.04
2017	0.34	0.79	0.40	0.66	0.91
2018	0.47	0.15	0.46	0.19	0.90

Maximum individual effective dose, 2019

(Annual regulatory limit is 50 mSv to NEWs)

Maximum	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
mSv	3.70	2.82	2.73	1.64	4.70
% regulatory limit	7	6	5	3	9

Maximum individual effective dose (mSv), 2014 to 2018

Year	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
2014	2.04	7.91	8.84	6.21	2.03
2015	5.99	7.40	9.14	7.56	5.28
2016	5.53	7.02	4.95	5.37	6.94
2017	3.36	5.73	1.56	5.39	5.12
2018	7.28	2.67	1.70	2.02	5.50

APPENDIX G: TOTAL RECORDABLE INCIDENT FREQUENCY

This appendix contains information on the number, frequency and severity of recordable lost-time injuries at UMM facilities covered by this ROR.

Frequency and severity are calculated per 100 full-time workers (equivalent to 200,000 worker-hours per year) using the following formulas:

Frequency rate =

$$(\# \text{ of Lost-Time Injuries}) \times (200\,000 \text{ hours of exposure}) / (\text{person hours worked})$$

Severity rate =

$$(\# \text{ of Working Days Lost}) \times (200\,000 \text{ hours of exposure}) / (\text{person hours worked})$$

2019	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
Number of LTIs ¹	0	0	1	0	3
LTI Severity rate ²	0	0	100	0	48
LTI Frequency rate ³	0	0	1.05	0	0.90
Total Recordable Incident Frequency (TRIF) ⁴	1.67	2.12	2.10	2.22	3.15

2018	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClellan Lake
Number of LTIs ¹	0	0	0	0	1
LTI Severity rate ²	0	23.2	0	0	4.8
LTI Frequency rate ³	0	0	0	0	0.3
Total Recordable Incident Frequency (TRIF) ⁴	1.0	5.02	5.03	2.59	0.75

¹ An injury that takes place at work and results in the worker being unable to return to work for a period of time.

² A measure of the total number of days lost to injury for every 200,000 person-hours worked at the facility.
Accident severity rate = $[(\# \text{ of days lost in last 12 months}) / (\# \text{ of hours worked in last 12 months})] \times 200,000$.

³ A measure of the number of LTIs for every 200,000 person-hours worked at the facility.
Accident frequency rate = $[(\# \text{ of injuries in last 12 months}) / (\# \text{ of hours worked in last 12 months})] \times 200,000$.

⁴ A measure of the number of fatalities, lost-time injuries, and other injuries requiring medical treatment for every 200,000 person-hours worked at the facility.
Recordable incident rate = $[(\# \text{ incidents in last 12 months}) / \# \text{ hours worked in last 12 months}] \times 200,000$.