# BACKGROUNDER:

# URANIUM MINING IN CANADA

The Future is NU.
Canadian Nuclear Association

## What is Uranium?

Uranium is a silvery-white metal, roughly 70% denser than lead and is the only naturally occurring fissile element on earth. It occurs naturally in most rocks in concentrations of two to four parts per million and is as common in the Earth's crust as tin, tungsten and molybdenum, and about 40 times as common as silver. It is also found in the oceans, at an average concentration of 1.3 parts per billion. There are a number of locations in different parts of the world where it occurs in economically recoverable concentrations. These locations are where uranium is or can be mined.

### Peaceful Purposes

Canadian uranium has no military purpose. The Non-Proliferation Treaty (1970) and strong export controls ensure that Canadian uranium can be used only for peaceful purposes, typically for electrical generation.

## How Nuclear Power Works

Uranium mining and exploration is the first stage in the nuclear power fuel cycle.

Uranium is mined, milled and fabricated into fuel for nuclear reactors. Through controlled fission, the uranium fuel generates massive heat that boils water and creates steam to turn turbines that generate electricity.

Nuclear power represents 15 percent of Canada's electricity generation. In New Brunswick, nuclear has represented between 20% and 33% of the province's electrical supply. Ontario's nuclear fleet last year provided 59% of the province's electricity.

Nuclear energy provided about 12% of world electrical supply in 2012. The U.S. Energy Information Administration projects that nuclear electrical generation will more than double between 2010 an 2040 – an annual growth rate of 2.5%. Most of this growth will occur in Asia, notably in China and India.

Nuclear power offers clear benefits. In generating electricity, a nuclear power plant releases zero greenhouse gases (GHG), unlike fossil fuels, including natural gas and coal. A nuclear power plant is the most land-efficient means of electricity production, producing 47.6 MW/km$^2$. Solar and wind produce just 3.1 MW/km$^2$ and 1.6 MW/km$^2$ respectively.

Hydro also generates no GHG during generation, but it can require a tremendous amount of land. The James Bay hydro project, which can produce 15,244 MW of electricity, flooded 11,500 km$^2$ of land. In comparison, the Bruce Nuclear Generating Station, the largest nuclear

plant in the world, takes up just 9.3 $km^2$ of land. Bruce can generate 7,732 MW. In other words, the James Bay hydro stations produce twice the electricity of the Bruce station, but require more than 1,200 times as much land.

Nuclear's life-cycle carbon emissions are as low as renewable energy sources. Unlike wind and solar, nuclear energy can reliably provide around-the-clock power regardless of weather conditions. Unlike gas and oil, a nuclear power plant does not need pipelines or lengthy railway cars to deliver its fuel.

A single uranium fuel pellet the size of a fingertip contains as much energy as 17,000 $ft^3$ (481$m^3$) of natural gas, 1,780 pounds (807kg) of coal or 149 gallons (677l) of oil.

## Uranium Mining

Uranium mining technologies are very similar to those of other minerals and metals mines in Quebec.

There are two common types of uranium mines – open pit and underground. When the ore body is close to the surface, open pit mining is employed. When it's deeper, then underground mining is the norm. This is similar to the way other minerals are mined.

The key difference between uranium mining and other metals and minerals mining is radiation. Because of this difference, uranium mining has more oversight and regulation. This is beneficial, as uranium mining has a better health and safety record than other comparable mining industries.

> "I'm dismayed that recent statements and discussions over the safety of uranium mining have been based neither on fact nor science … claims that the public and the environment are at risk are fundamentally wrong … (regulatory) conclusions on the uranium mining industry are clearly based on decades of studies, research, and a rigorous licensing and inspection framework."
>
> 2011 open letter by CNSC President Michael Binder

Canada's uranium mining industry is regulated and licensed by the Canadian Nuclear Safety Commission (CNSC), an independent body that reports to Parliament. Its mission is to protect the health, safety and security of Canadians, to protect the environment and to respect Canada's international commitments on the peaceful use of nuclear energy.

For uranium mining, there are a number of steps that are taken to achieve these objectives, including a stringent regulatory framework, public consultations, measures to protect the public and the environment, and planning for a mine's eventual closure and remediation.

The CNSC issues licences for all phases in the life cycle of a uranium mine and mill, from site preparation, construction, operation, decommissioning and abandonment – a comprehensive, cradle-to-grave approach to regulation.

### Exploration in Quebec

There are currently 50 uranium exploration projects in Quebec, but very few have found ore bodies with viable concentrations of uranium. These include two projects in the Otish

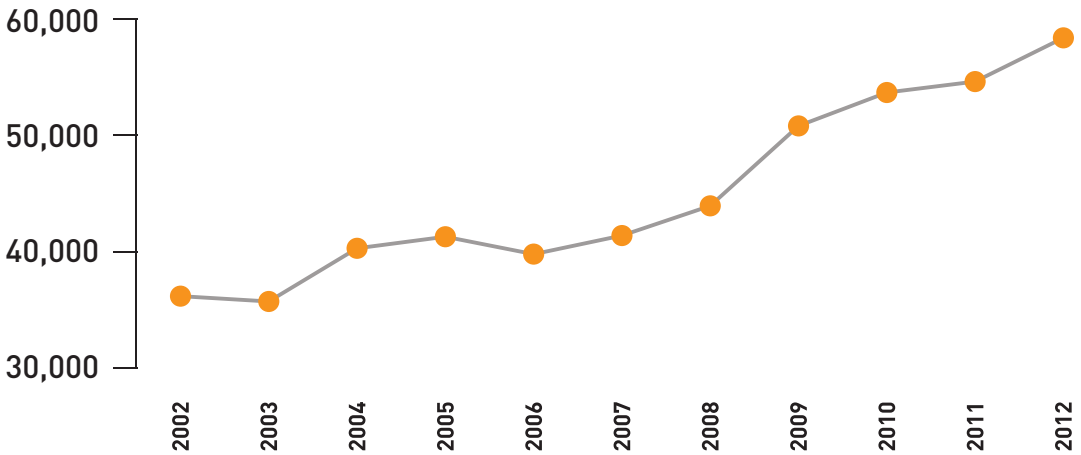
mountains 275 km northeast of Chibougamou: the Matoush project (Strateco Resources Inc.) and the Lavoie project (Abitex Resources Inc.).

There are also large quantities of uranium associated with other exploration projects, such as the Ashram (Eldor) rare-earth project (Commerce Resources Corp.) in the Labrador Trough region of northeastern Quebec.

## Uranium Mining Production

Despite nuclear reactor shutdowns in Japan and Germany, global uranium production continues to increase due to demand from China, India and other developing countries looking for a low-carbon alternative to coal.

**Global Uranium Production (tU)**




SOURCE: WORLD NUCLEAR ASSOCIATION

Canada is a world leader in the booming global uranium mining industry, second only to Kazakhstan in total production in 2012. Canada accounted for 15.4 per cent of total world uranium production in 2012.

**Uranium Production (tU)**

| | |
|---|---|
| Kazakhstan | 21,317 |
| Canada | 8,999 |
| Australia | 6,991 |
| Niger | 4,691 |
| Namibia | 4,495 |
| All other countries | 16,592 |

SOURCE: WORLD NUCLEAR ASSOCIATION

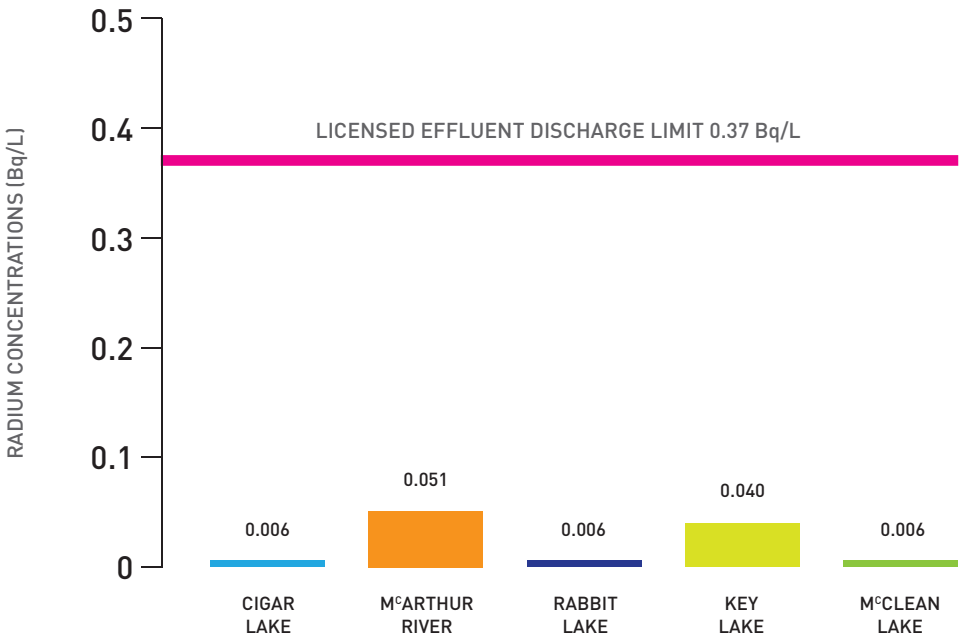
## Environmental Impact

Uranium exploration and extraction takes place with little impact to the environment, thanks to modern mining practices and stringent regulation by the federal and provincial governments.

Mine operators have made great improvements to water management at their sites. Extensive water treatment and water monitoring programs ensure that a mine's environmental impact does not extend beyond its operating boundary.

Tailings and waste rock are contained in engineered surface and near-surface waste management facilities located near the mines and mills. The tailings are similar to those from other forms of mining, whose ore bodies also have radiological aspects.

**Annual average concentration of radium-226 in effluent released to the environment, 2012**




SOURCE: CNSC STAFF REPORT ON THE PERFORMANCE OF URANIUM FUEL CYCLE AND PROCESSING FACILITIES: 2012

Currently, all of Canada's uranium mining is conducted in Saskatchewan. At two of the mines, the tailings are stored in a tailings management facility, which covers the tailings with water to shield their radiation to prevent the creation of dust.

## Worker Health and Safety

Worker health and safety is a critical part of uranium mining operations.

Because of the strategic importance of uranium, provincial governments, the CNSC and mining companies must put in place emergency planning measures for on-site accidents and to ensure that uranium is transported safely. Quebec has a substantial history and knowledge about mining safety, which can be directly applied to the uranium mining industry.

"Experiences from modern uranium mines show that in countries with the appropriate regulatory requirements and a regulatory agency staffed with qualified personnel, successful companies develop innovative strategies to manage all potential impacts of mining and processing on workers, communities and the environment."

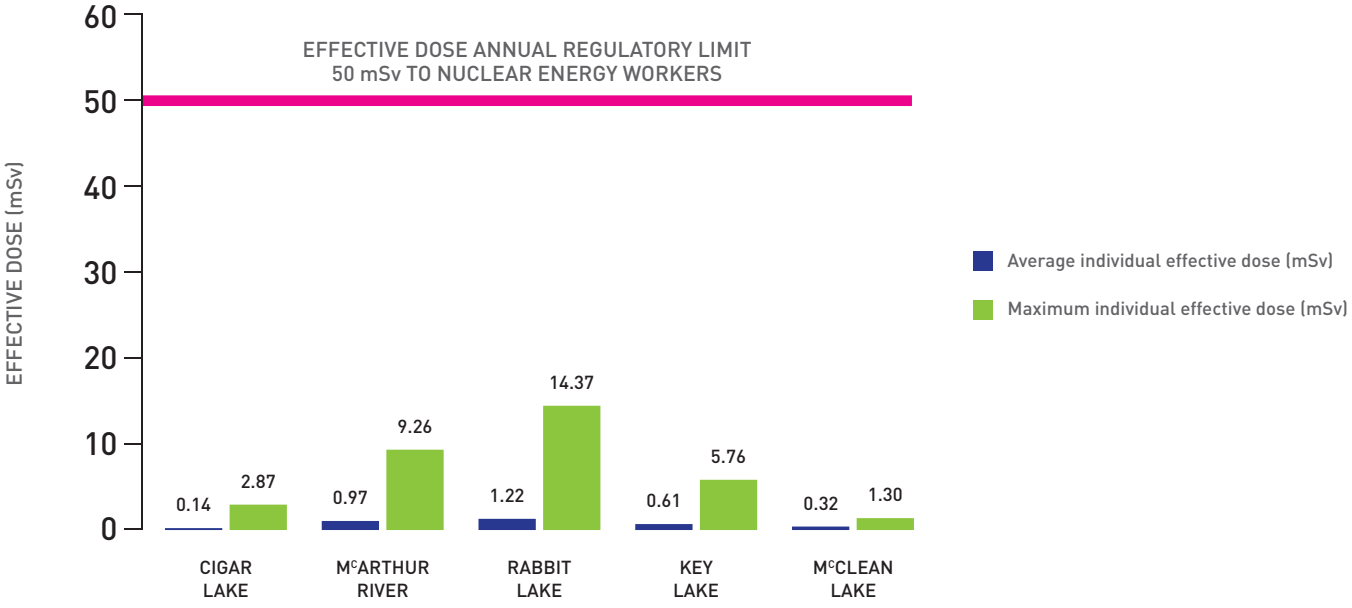
2014 report by the OECD's Nuclear Energy Agency

Safe working practices and modern ventilation technologies protect uranium industry workers from exposure to radon gas and radioactive dust. For nuclear workers, including uranium miners, the CNSC sets effective dose limits of 50 millisieverts (mSv) per year and 100 mSv over 5 years. For the public, the effective dose limit is one mSv per year. The limits derive from the recommendations of the International Commission on Radiological Protection (ICRP), which sets the framework for radiological protection.

For comparison, a dosage of 100 mSv per year is the lowest annual level at which an increase in cancer risk is evident, according to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). Above this, the probability of cancer occurrence is assumed to increase with dose. No harm has been demonstrated below this dose.

All occupational exposures at Canadian uranium mines and mills are significantly below the regulatory nuclear worker limit.

**Uranium mines and mills - comparisons of individual average and maximum effective dose to NEWs**




SOURCE: CNSC STAFF REPORT ON THE PERFORMANCE OF URANIUM FUEL CYCLE AND PROCESSING FACILITIES: 2012

Cameco's McArthur River mine in Saskatchewan protects its workers from radiation exposure by using remote control equipment underground. In 2010, Cameco received the John T. Ryan National Safety Trophy from the Canadian Institute of Mining Metallurgy and Petroleum

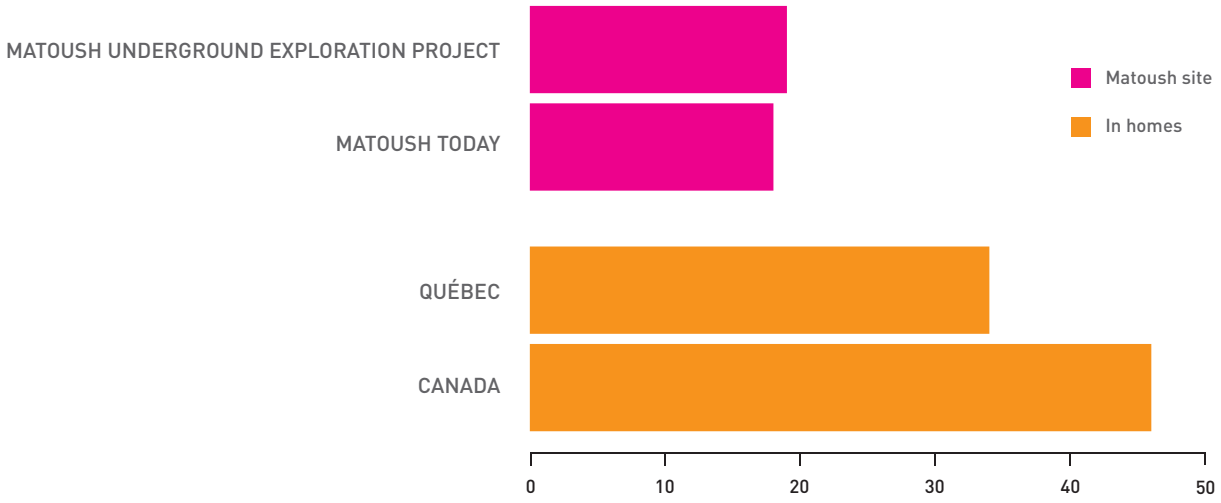
for having the best safety performance for a metal mine, with only two lost-time injuries in 1,425,518 working hours in 2009.

Today's uranium miner receives less radiation than the average international airline pilot. Uranium mining is also safer than many other jobs, including restaurants, catering, retail, teaching and telecommunications.

## Public Health and Safety

Uranium exploration and mining activities do not increase radon or radiation levels in the environment away from the mine site. "The level of radon near uranium mines is similar to natural radon levels monitored in background locations," according to the Canadian Nuclear Safety Commission. "Radon exposure to members of the public from CNSC-regulated activities is virtually zero."

**Average radon in homes compared to radon levels near Matoush's site**




SOURCE: CNSC STAFF PRESENTATION: MATOUSH UNDERGROUND EXPLORATION PROJECT REQUEST FOR LICENSING DECISION

## INSPQ Study

The *Institut national de santé publique du Quebec (INSPQ)* published a study in 2014 on uranium mining that missed many important facts, and introduced a number of errors into the public debate.

One example is the level of radiation exposure to general public, and the methods the INSPQ used to estimate the health hazards for people who live near a uranium mine. The INSPQ report used an epidemiological approach, which studies the patterns and effects of health and disease conditions to identify risk factors for disease.

The issue with this approach is causality – the ability to conclude that a specific factor has caused a specific result. In any area, such as a country, an epidemiological study might show that the people living closest to a mine are more likely than their fellow citizens to develop a

specific disease, but the study cannot blame the mine. Instead a scientific experiment would be required – one that compares an exposed population to a control group that has not been exposed, for example.

The INSPQ also failed to report that no person living near a Canadian uranium mine site has ever received a radiation exposure greater than 0.01 mSv – an amount equal to 0.01% of the dose at which cancer probabilities begin to rise measurably.

### Economic Benefits

Uranium mining offers significant economic benefits:

- Uranium miner Cameco is the largest industrial employer of aboriginal people in Canada.
- Recent studies have concluded that for every one aboriginal person Cameco hires, the number of aboriginal people employed in Saskatchewan increases by a total of two over time.
- In 2012, the uranium mining industry spent approximately $377 million on salaries, wages and benefits for its direct employees.
- Income tax remitted on behalf of mining industry direct employees was $91.2 million. Canada Pension Plan contributions were an additional $12.7 million and Canada Employment Insurance payments were another $5.1 million.

## Sources


Managing Environmental and Health Impacts of Uranium Mining (OECD Report 2014)
http://www.oecd-nea.org/ndd/pubs/2014/7062-mehium.pdf

Canadian Nuclear Safety Commission Mythbusters
http://www.nuclearsafety.gc.ca/eng/resources/mythbusters/index.cfm

Uranium Economic Impact (Saskatchewan Mining Association)
http://www.saskmining.ca/commodity-info/Commodities/30/uranium.html


### Resources


World Nuclear Association – Uranium in Canada
http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Canada--Uranium/

Canadian Nuclear Safety Commission Report on the Performance of Uranium Fuel Cycle and Processing Facilities
http://nuclearsafety.gc.ca/eng/resources/publications/reports/report-on-uranium-fuel-cycle-and-processing-facilities.cfm

Overview of Conventional Uranium Mining and Milling Technologies
http://www.geos.vt.edu/events/uranium/pdf/1515-1600_Chambers_Mining_&_Milling.pdf