IAEA TECHNICAL COOPERATION PROJECT INT2019
INTERREGIONAL WORKSHOP ON CASE STUDY OF CONVENTIONAL URANIUM PRODUCTION FROM EXPLORATION TO CLOSURE

14-18 OCTOBER 2019
PRAGUE AND DOLNI ROZINKA, CZECH REPUBLIC

Case Studies
- Examples from Canada

Kevin Scissons October 2019
Outline

* Modern Practices
* Siting, Operations
* Waste rock, open pits
* Transportation
* Examples of Modern In-Pit Tailings Management, Effluent Treatment and Monitoring

“Start with the end in mind…. ”
Waste management techniques to minimize future ARD, Contamination

* Testing waste rock to determine ARD potential:
  * Static testing;
  * Kinetic testing.

* Segregating waste rock based on testing results, monitoring;

* Use of liners or drainage collection systems;

* Placement in layers or zones to encapsulate ARD:
  * With intent to provide neutralization or inhibit water/air access;

* Plan for wet or dry covers to restrict water/air access

* **KEY:** Large volumes of Waste Rock → Move only once!
JEB mined out pit, Converted to In-pit TMA

Sue C mined out pit, Converted to waste rock disposal site
Packaging and Transport

- Cameco
Uranium Mining in Canada
* Waste rock producing Acid Rock Drainage:
  * Relocate to open pits or lakes where they can be placed under water covers or,
  * Re-contour in place to reduce slope angles such that a dry cover may be installed

* Tailings producing contaminated leachate:
  * Synthetic liner, if any, is removed; tailings are dewatered and re-contoured; slopes stabilized with rock, if available; and a dry clay and soil cover is installed to prevent radon emissions

* If waste rock oxidation is advanced, relocation may release additional leachate.

* Relocation is costly
Wet and dry covers over waste rock

- Waste Rock Pile
- Cover Material
- Waste Rock Fill
Passive treatment of contaminated water

* Surface water - use of natural or constructed wetlands:
  * Treatment the result of bacterial sulphate reduction;
  * \[ \text{SO}_4^{2-} \rightarrow \text{S}^{2-} + \text{contaminant (i.e. Cu}^{2+}, \text{Zn}^{2+}, \text{Pb}^+, \text{U}^{6+}) + 2\text{O}_2 \]
  * Occurs naturally in an oxygen deficient environment with ample available carbon.

* Groundwater – permeable reactive barriers
  * Same process as above;
  * Contaminated groundwater plume must be identified/delineated
  * Reactive material placed in a trench intersecting groundwater flow.
Modern Tailings Management and Effluent Treatment Examples

-khs
Purpose Built Pit Proposed, shown decommissioned

Example of Below-Grade TMA

- Virginia Uranium

PROVIDED BY VIRGINIA URANIUM INC., USA
*Tailings Management - In-pit Technology Used at Key Lake, Rabbit Lake and McClean Lake*
Tailings and Waste Water Management Example

Tailings Preparation and Disposal

Combined WTP sludges

Raffinate
Leach residue
Mo eluant
Fe₂(SO₄)₃

Mix Tank

1st Stage pH 4

pH 1.5
Eh 675 mV
Mol Fe³⁺ / As Total = 3.0

U 3.0 mg/L
As 165 mg/L
Ni 92 mg/L
Mo 89 mg/L
Se 0.09 mg/L
²²⁶Ra 54 Bq/L

2nd Stage pH 7

Tailings Thickener

U 2.6 mg/L
As 0.22 mg/L
Ni 0.51 mg/L
Mo 26 mg/L
Se 0.02 mg/L
²²⁶Ra 19.5 Bq/L

Tailings Thickener

Reclaim pond water

U 0.17 mg/L
As 0.18 mg/L
Ni 0.25 mg/L
Mo 12.2 mg/L
Se 0.007 mg/L
²²⁶Ra 9.1 Bq/L

Tailings Thickener

Fe₂(SO₄)₃

BaCl₂

Mol Fe/Mo ~ 4

Radium arsenic removal

Radium polishing

TMF reclaim water

CaO

Hydroxide precipitation

pH 10.9

pH 4.1

pH 7.8

Sink Reservoir

Combined WTP sludges

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McClean Lake, Canada
Interceptor Wells

Reclaim Water Barge

Tailings injected

- AREVA
**Effluent Treatment**

- Treatment for additional contaminants
- Multi-stage chemical precipitation
- Filtration
- Batch discharge
- Membrane technologies
* Control releases
  • to the air
  • to surface water
  • to ground water

* Measure
  • Releases
  • Effects (based on EIA, Limits)

* Take action, when required

- Cameco
Decommissioning
Cluff Lake Mine Areas - DJ Pits

2003

- AREVA

2008
Purpose during all phases: Protection of the Environment

“Start with the end in mind....”
The Canadian Nuclear Safety Commission is Canada’s nuclear regulator, and responsible for licensing, compliance and enforcement of uranium mining industry in Canada:

* Improving environmental standards
  * Seek changes to milling, effluent treatment and tailings management facilities for improving results (in cooperation with the industry)
* Strong and effective licensing process, effective stakeholder engagement
* Cooperative approach with Provincial regulators
* Plan with decommissioning in mind, funding always in place.

Licensees must have high reliability performance, learn and continually improve through the ALARA process and self-report on events.

Further details can be found at: nuclearsafety.gc.ca
Questions?

CNSC Public Hearing, Saskatoon

Thank you!