

**The Relocation of Waste Trench #54 at the Port Granby  
Waste Management Facility, Municipality of Clarington, Ontario, Canada - 11280**

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**ABSTRACT - 11280**

The Port Granby Waste Management Facility received low-level radioactive waste from a conversion facility located in Port Hope, Ontario from 1955 to 1988. The facility was closed to the receipt of wastes in 1988 and since that time Cameco Corporation has managed the facility. The transfer of the site to the federal government is anticipated in 2011/2012. However, Cameco Corporation must maintain the site until this transfer occurs.

The facility is licensed by the Canadian Nuclear Safety Commission and has an indefinite Waste Nuclear Substance License. The facility is located along the northern shore of Lake Ontario and is subjected to geotechnical inspections twice annually.

During the 2008 geotechnical inspections conducted by Golder Associates Ltd., it was observed that the active erosion scarp on the north face of the East Gorge was in close proximity to waste Trench #54. A plan was developed by Cameco Corporation to remove the buried wastes located in Trench #54 to preclude an inadvertent exposure of waste should further erosion occur in this area. This plan was submitted to and approved by the Canadian Nuclear Safety Commission.

Between October 20, 2009 and November 2, 2009, approximately 800 m<sup>3</sup> of low-level radioactive waste was removed from Trench #54. The waste consisted of industrial refuse and uranium contaminated calcium fluoride. The waste excavation area was backfilled with crushed limestone and capped with clean topsoil. The wastes were relocated overtop of other waste trenches in the Northern Plateau area, at a minimum set-back of 23 m from the erosion scarp. The relocated wastes were placed within an engineered above ground disposal mound that was capped with clean soil cover and graded to provide surface drainage.

**The Site**

The Port Granby Waste Management Facility (PGWMF) is located along the north shore of Lake Ontario approximately 80 km east of Toronto in Ontario, Canada. The 18 ha secured site is situated within a rural area. The property consists of a relatively flat plain (known locally as the Central Plateau), which terminates abruptly in steep bluffs falling approximately 35 m to the shore of the lake. An approximate 20 m wide beach area extends from the base of the bluffs to the lake. Two deep valleys, known as the East and West Gorges, cut through the bluffs on either side of the site and extend about 170 m into the Central Plateau.

## **Historical Context**

In 1932, Eldorado Gold Mines Limited (Eldorado) constructed a radium refinery in Port Hope, Ontario. In 1933, the facility began processing crushed radium ore from Port Radium on Great Bear Lake. The firm later expanded into uranium processing, and the Port Hope refinery formed the nucleus for the current Port Hope Conversion Facility (PHCF). By 1942, the strategic importance of uranium extraction and processing was apparent and the federal cabinet authorized the purchase of Eldorado shares. In 1944, Eldorado was fully nationalized. From 1933 to 1948, Low Level Radioactive Waste (LLRW) from the Eldorado Port Hope refinery were deposited at several waste management sites within the Port Hope area. These distributed sites were replaced in 1948 by the Welcome Waste Management Facility (WWMF). Placement of LLRW at the WWMF continued until 1955, at which time the WWMF was closed and the PGWMF was opened. The PGWMF received LLRW between 1955 and 1988.

In 1988, the merger of the federal Crown Corporation, Eldorado, and a provincial Crown Corporation, Saskatchewan Mining Development Corporation formed Cameco Corporation (Cameco). In accordance with the intent of the merger, Cameco subsequently became fully private. Under the terms of the agreement that created Cameco, the federal government took responsibility for the LLRW located at the PGWMF and the WWMF. Cameco agreed to manage the facilities on behalf of the federal government, until the implementation of a long-term management plan. Accordingly, Cameco has managed the PGWMF for over 20 years.

Though closed to the receipt of wastes, the PGWMF is licensed by the Canadian Nuclear Safety Commission (CNSC) (WNSL-W1-2338.0/indf). Further, the CNSC, Environment Canada and Ontario Ministry of Environment routinely monitor site integrity and water collection and treatment operations.

## **The Wastes**

Most of the buried waste materials at the PGWMF were produced during the post 1955 period when relatively high purity uranium concentrates were processed at a local plant in the nearby community of Port Hope. The site contains approximately 235,000 m<sup>3</sup> of LLRW comprised of process residues, scrap equipment, demolition debris, general industrial refuse, limed raffinate, ammonium nitrate, magnesium fluoride, calcium fluoride and contaminated soils relating to former operations at the Port Hope plant. The LLRW has been deposited in trenches that were excavated in the natural soil and then covered by at least 1 m of clean soil. The surface cover of soil has been graded and vegetated. The location of the trenches is illustrated on Figure 1.

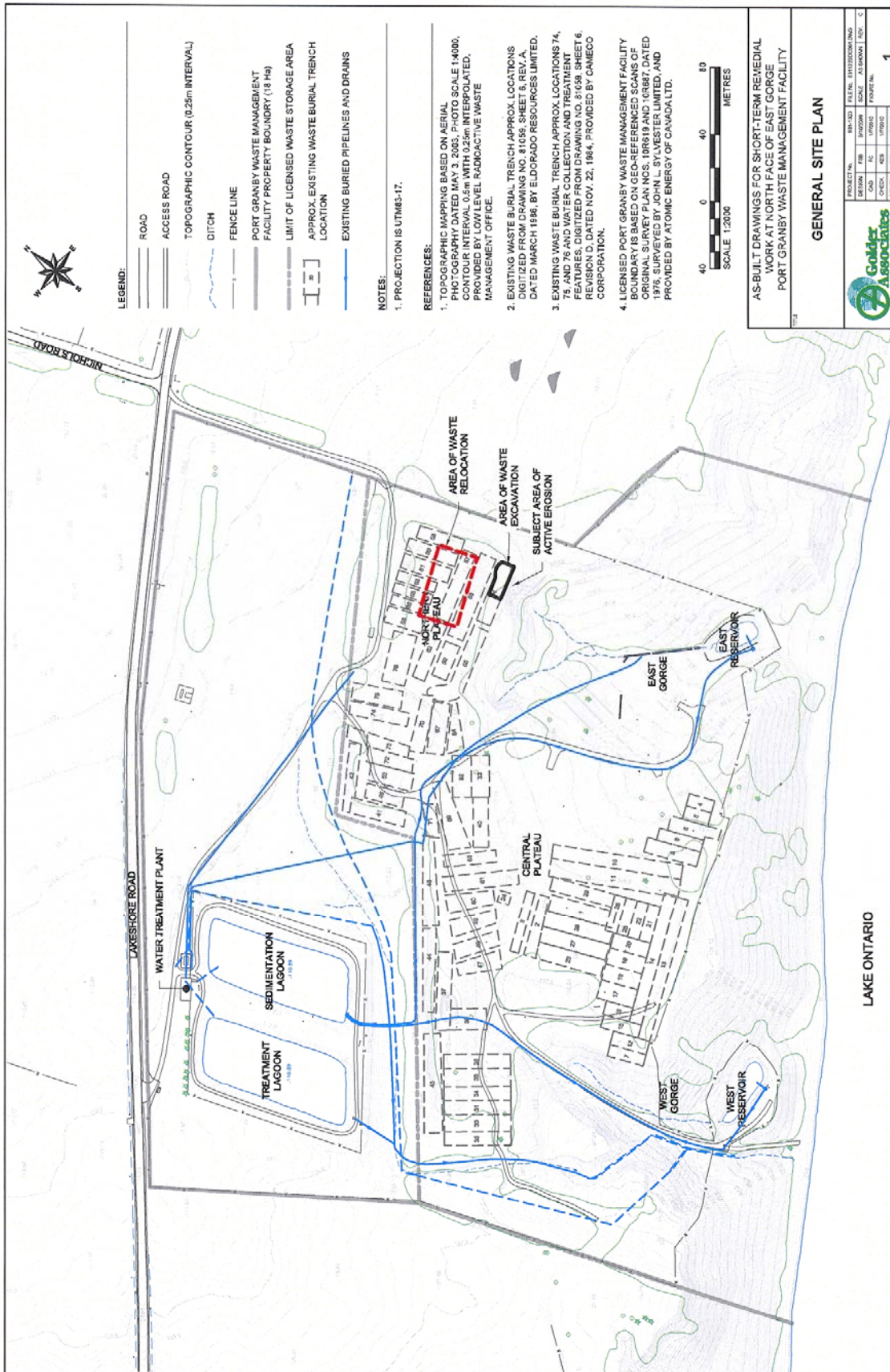


Fig. 1. General Site Plan of the Port Granby Waste Management Facility.

Four types of process wastes were deposited at the site. A description of these wastes is as follows:

**Limed raffinate** – a wet neutral residue produced during refining of mine concentrates to  $\text{UO}_3$  (uranium trioxide), consisting primarily of calcium sulphate and containing less than 0.5% unrecovered uranium and traces of radium and thorium. An estimated 65,000  $\text{m}^3$  of raffinate were buried at the PGWMF to 1980, when recycle of the raffinate began, to mines in northern Ontario where the traces of uranium were recovered for commercial value.

**Ammonium nitrate** – a dilute liquid produced during conversion of  $\text{UO}_3$  to  $\text{UO}_2$  (uranium dioxide). This material was sent to the PGWMF until 1977. Since then, it has been upgraded and sold for use as a fertilizer.

**Magnesium fluoride** – a slag generated during production of uranium metal, containing a few percent of unrecovered uranium. Approximately 2,000  $\text{m}^3$  of the slag were buried at the PGWMF to 1977, when it began to be stored in drums at the PHCF.

**Calcium fluoride** – an alkaline filter cake produced during the conversion of  $\text{UO}_3$  to  $\text{UF}_6$  (uranium hexafluoride), containing less than 0.5% uranium. Calcium fluoride was the only process waste still being placed at the PGWMF up to site closure on June 30, 1988. There are an estimated 27,000  $\text{m}^3$  of the cake buried at the site.

The site also contains an estimated 132,000  $\text{m}^3$  of a variety of other contaminated material consisting of:

- a) approximately 47,000  $\text{m}^3$  of process wastes and soils, which the company transferred to the PGWMF from older waste sites as part of its 1956 to 1975 remedial works programs, much of this material contains arsenic from the pre-1955 refining operations;
- b) an estimated 65,000  $\text{m}^3$  of crushed drums, scrap equipment and building rubble, soil from the company's  $\text{UF}_6$  plant expansion and miscellaneous garbage; and
- c) miscellaneous materials estimated at 20,000  $\text{m}^3$ .

Process wastes were placed in the East Gorge until 1966, while scrap, drums and other garbage were deposited up to 1970 in the West Gorge. The Central Plateau was used to bury both garbage and process wastes since 1960.

In the Central Plateau, the materials were placed in pits, 10 to 12 m wide and of variable length. The pits were excavated down to the water table generally 5 to 6 m below the ground surface. Initially, process wastes and garbage were buried in separate pits. More recently, process waste was placed in a pit until the pit was full, covered with a mixture of garbage and clean soil, and topped with more clean soil, which was then contoured and vegetated.

The total volume of process and other wastes at the PGWMF is approximately 235,000  $\text{m}^3$ . In addition to these materials, an estimated 150,000  $\text{m}^3$  of sub-soils at the site have become slightly contaminated by, or cannot be separated from, the wastes.

## **Geological Setting**

The PGWMF is located within the physiographic region known as the Iroquois Plain (Chapman and Putnam, 1984). The region corresponds with the area that was inundated by glacial Lake Iroquois during Late Wisconsinian glaciation. The surficial soils are generally comprised of lacustrine clay and sand plains that are reflective of a near-shore depositional environment. Alternating layers of glacial drift (till) underlie the shallow layers of clay and/or sand. Till deposits are generally comprised of a wide range of soil particles that vary from clay through to boulders in size. Previous investigations have indicated that the PGWMF is underlain by fifteen stratigraphic units, some of which are discontinuous. Five of these units consist of sand and/or silt which are considered to be highly erodible. Bedrock exists below the site at a depth of 45 m below the ground surface. The bedrock is limestone belonging to the Lindsay Formation which is Middle Ordovician in age. The bedrock is slightly fractured near the top. Groundwater generally follows the ground surface topography and flows from the northeast to the southwest.

## **Geotechnical Monitoring**

A bi-annual (spring and fall) geotechnical inspection program has been implemented at the PGWMF since 1979. The purpose of the inspection program is to assess the geotechnical stability of the site and determine whether remedial action is required at any specific location. The inspection program is conducted by Golder Associates Ltd. (Golder) in conjunction with Cameco personnel. In general, significant changes in erosional activity, water levels and deformation were usually observed during spring inspections. Observations and readings made during fall inspections tended to be very similar to those observed during the previous spring inspection.

The geotechnical program consists of several tasks including: water level measurements at selected piezometers; reading of slope indicators installed in the East Gorge area; and mapping of areas of erosion/loss of vegetation along the bluffs. The work is complimented with a photographic record of pertinent features that is taken from approximately the same locations and vantage points. The photographic record continues to be compiled and compared with previous data.

The north face of the East Gorge showed signs of ongoing surface erosion associated with gullying and upslope retrogression of the scarp of the eroded area during the spring, 2008 inspection. Along the scarp, significant undercutting of the root mat was observed, similar to that observed during previous inspections. The greatest amount of scarp retrogression was at the eastern limit of the eroded area. The closest distance between the crest of the scarp and waste Trench #54 was estimated to be approximately several metres. Since the monitoring work detected that the scarp was encroaching upon the buried wastes within Trench #54, remedial work was required to address this situation proactively, before the wastes were exposed.

## **Remedial Excavation Work**

A work plan was developed to remove the buried wastes within Trench #54 to an area further away from the actively eroding slope. The strategy included moving the wastes to a temporary above grade disposal mound. Design drawings were developed by Golder and a local experienced contractor was employed to complete the earthworks. An important part of the

planned work activities was an occupational health and safety program developed and implemented by Cameco. The program consisted of personal protective equipment (PPE), air quality monitoring, bioassay of urine for uranium fluoride, and the use of dosimeters. The PPE included: protective clothing; safety vests; hard hats; safety boots; eye protection; gloves; and respirators. The excavation of the waste material commenced on October 20, 2009 and was completed on October 22, 2009.

In total, approximately 800 m<sup>3</sup> of buried waste material was removed, consisting of but not limited to filled garbage bags, drums at the upper portion of the trench and calcium fluoride at the lower portion. The excavation was carried out using an extended boom (John Deere Long Reach 330C LC) excavator depicted in Figure 2. This type of excavator provided a reach of approximately 18.3 m. The excavator was positioned at a safe distance away from the north crest of the excavation slope. The native soil wedge between the waste excavation and the erosion scarp was left in place.



**specialized extended boom excavator**



**excavation in progress**

Fig. 2. Excavating with the specialized extended boom excavator.

The work was implemented in a safe, staged manner, which maintained the stability of the natural slope during the excavation procedure. Portions of the excavation were limited to 5 m lengths and each portion was backfilled prior to proceeding to the next stage. The excavation face was contoured prior to backfilling and the natural slope was monitored to ensure that the stability of the embankment was maintained during the remedial work as depicted in Figure 2. All excavated material was kept away from the crest of the slope and deposited within the area of the new storage mound.

The length of the excavation upon completion was approximately 20 m (east-west) and the width at the top of the excavation was approximately 8 m (north-south). The width at the base of the excavation averaged 4.3 m. The excavation extended to a maximum depth of 5.2 m below the ground surface. Original, undisturbed soil was exposed along the entire south and east faces of the excavation. The west face of the excavation was advanced to a location where it was

determined that the remaining wastes in Trench #54 were not susceptible to exposure by the on-going erosion for the short term.

Backfill was placed in the excavation at the end of each day to cover exposed wastes and to stabilize the near vertical face along the south and east portions of the excavation. The backfill consisted of crushed limestone material (75 mm maximum particle size) from a local quarry. In total, approximately 600 m<sup>3</sup> of crushed limestone backfill was placed to approximately 0.6 m below the crest of the excavation slope and was capped with approximately 200 m<sup>3</sup> of topsoil (0.3 m thick). Backfilling of the excavation was completed by October 27, 2009. A shallow swale was excavated into the final cover to direct drainage from west to east towards an existing ditch along the east boundary of the PGWMF.

### Encountered Wastes

The remedial excavation encountered 1 m of clean soil and then industrial waste to a depth of 5 m below the ground surface. There were no distinct layers or 'lifts' of refuse. The observed waste material included items such as old motors, drums, cans, plastic sample containers, garbage bags, cables, wiring, concrete rubble, bricks and metal fragments. A limited quantity of UF<sub>4</sub> and U<sub>3</sub>O<sub>8</sub> was also encountered, likely from the production of depleted uranium metal. A 0.4 to 0.6 m thick layer of white calcium fluoride was encountered near the base of the excavation. The material was alkaline and exhibited a 'paste' texture. Figure 3 depicts a typical view of the exposed wastes within Trench #54.



**waste material**



**white calcium fluoride**

Fig.3. Exposed refuse in Trench #54.

### Above Ground Storage Mound

The containment area for the excavated waste is located north of Trench #54, within the Northern Plateau area of the PGWMF. The containment area overlies other existing waste trenches. The upper portion of the existing cover soil was stripped from this area and the material used to form

a perimeter berm. Approximately 0.3 m of existing cover soil was left in place to prevent exposure of the underlying buried waste. Using the extended boom excavator, the waste excavated from Trench #54 was transferred to the containment area and roughly spread. The same excavator was then used to cover the waste at the end of each day using soil material stripped from the original cover. This process eliminated the need for trucks to haul and dump the wastes as well as the need for a bulldozer to spread the waste. This in turn minimized the potential contamination of equipment and transfer/spillage of waste materials outside the containment area.

An elevation survey of the top of the waste fill within the contaminated area was carried out by Golder on October 27, 2009. The placement of final cover soil over the waste containment area commenced on October 29, 2009. The cover soil material consisted of silty fine sand. Approximately 1,250 m<sup>3</sup> of the cover soil was placed to a minimum thickness of 1 m over the waste and graded to provide surface drainage. Approximately 190 m<sup>3</sup> of topsoil stripped from the original cover was then placed to a thickness of 0.3 m overtop the silty fine sand cover soil. A survey of the top of the final cover was carried out by Golder on November 2, 2009. The cover placement was completed on this same date. The surface of the excavation area and storage mound were seeded with grass in the spring of 2010, as depicted in Figure 4.



Fig. 4. Contoured surface of above ground storage mound before and after seeding with grass.

### **Occupational Health and Safety Program**

An important part of the planned work activities was an occupational health and safety program developed and implemented by Cameco. The program consisted of PPE, air quality monitoring, urine analyses, and the use of dosimeters. The PPE included: protective clothing; safety vests; hard hats; safety boots; eye protection; gloves; and respirators.

All contractors and Cameco employees were classified as Nuclear Energy Workers (NEW) for this project. All contractors and Cameco employees involved in this project went through a respiratory fit test and respirators were worn during the excavation and placement of wastes. Urine analysis data for the contractors and Cameco employees were typically <0.2 µg/L



uranium. Dosimeter data for the project participants ranged from 0.00 to 0.05 mSv body and 0.00 to 0.06 mSv skin. Cameco's administrative limits are 0.5 mSv body and 1.2 mSv skin.

### **Environmental Monitoring**

A high volume air sampler was utilized for monitoring during the excavation and waste placement phases of the project. The sampler was established within close proximity of the remedial work. Results obtained during the project ranged from 0.001 to 0.005  $\mu\text{gU}/\text{m}^3$  of air. Cameco's investigative level is 1.0  $\mu\text{gU}/\text{m}^3$ .

### **Conclusion**

The remedial work was completed safely and without incident. A proactive response from a team of experienced professionals avoided what could have been a complicated slope failure and environmental impact from exposed wastes. The results of the new above ground storage mound and slope stabilization is a short term solution that will provide several years of protective waste management.

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