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Port Hope Waterworks Remediation Project

Peter Szabo[(1)], Steve Scandlen[(1)], Brian Whiffin[(1)], Glenn Case[(2)], Mark Gardiner[(2)], Michael Owen[(2)]

[(1)] CH2M HILL Canada Limited, 180 King Street South, Suite 600, Waterloo, Ontario N2J 1P8, 519-579-3500
[(2)] AECL, Low-Level Radioactive Waste Management Office, 5 Mill Street South, Port Hope, Ontario L1A 2S6, 905-885-9488

Abstract

The Port Hope Waterworks Remediation Project is one of the largest remediation projects to be initiated and completed by the Low-Level Radioactive Waste Management Office (LLRWMO) during the past ten years within the Municipality of Port Hope, Ontario. The waterfront property was remediated for productive reuse within the municipality, as the site for a major state-of-the-art waterworks infrastructure construction project. Approximately 17,500 cubic metres of low-level radioactive waste impacted soil was characterized and removed from the site in 2003 on an expedited basis and placed in temporary storage.

Background

In 1932, the Crown Corporation, Eldorado Gold Mines Ltd., began operating a radium refinery in the Town of Port Hope. Within a few years, the corporation shifted their operations from refining radium to refining uranium, with the eventual phase out of radium refining in the mid-1950s. Residues from these production processes were initially stored at the plant site, but beginning in 1939 and proceeding until 1988, residues were transported to storage facilities in various locations, first within the Town of Port Hope, then to a waste management facility (WMF) in Hope Township, and eventually to a WMF in Clarington Township. Since 1988, the small amounts of residue produced at the uranium conversion facility, now owned by Cameco Corporation (Cameco), have been recycled.

Radium, uranium, and arsenic (an incidental waste resulting from refining uranium ore from the Eldorado Port Radium mine in Canada's Northwest Territories) contaminated the soil and groundwater at various sites in the three municipalities, including some residential properties. Contamination spread a variety of ways—spills during waste transportation, unauthorized diversion of wastes for use as fill at development sites, and surface water runoff from the storage sites. In 2001, the Port Hope Area Initiative (PHAI) was officially launched by Natural Resources Canada (NRCan), and the LLRWMO was designated by NRCan as the proponent for the Initiative to develop long-term waste management facilities for the remaining low-level radioactive waste (LLRW) and marginally contaminated soils, approximately one million cubic metres, found at specific sites in the Port Hope area (LLRWMO, November 2001).

Over the past 20 years, following the initial cleanup activities in the late 1970s, efforts have been made to find an appropriate long-term management strategy for the remaining LLRW.

In 1997, coming on the heels of the lack of success by the federal Siting Task Force initiative to locate a willing LLRW host community in the province of Ontario, the three municipalities affected by the contamination developed their own community-based solutions for the long-term management of the wastes in their municipalities. In 2001, after much discussion with the federal government, a legal agreement was developed that set-out the terms and conditions under which three municipalities (Town of Port Hope, Township of Hope, Municipality of Clarington) would participate in a federally-sponsored program for the remediation and long-term management of the LLRW that existed within their respective municipalities. In March 2001, the agreement was signed by the Canadian Federal Government. On June 19, 2001, Members of Parliament for Northumberland and Durham announced the Federal Government's commitment to invest $260 million dollars over a ten-year period for the cleanup of affected sites and for the construction of long-term management facilities for the LLRW in the municipalities of Port Hope and Clarington. The objective of the PHAI is to cleanup wastes from contaminated sites and licensed interim LLRW facilities, and manage them in a suitably constructed, environmentally safe, socially acceptable, and appropriately controlled long-term waste management facility.

Within the framework of the PHAI, it is the role of the LLRWMO, as proponent, to conduct an environmental assessment of the proposed project, implement the necessary baseline and effects studies, design and implement a public consultation program, and seek the necessary licenses from the Canadian Nuclear Safety Commission (CNSC) for the construction and operation of the proposed LLRW facilities. It is anticipated that it will take five years to complete the planning, engineering, environmental studies, and public consultation required to define the LLRW management plans to be implemented by the PHAI. It is anticipated that it will take another five to seven years to construct the new long-term storage facilities, consolidate the wastes, clean up and restore impacted sites, and close existing storage sites. The Port Hope Waterworks Remediation Project provides valuable experience relevant to planning and executing the larger PHAI project.

The LLRWMO and Construction Monitoring Program

The LLRWMO was established in 1982 by the federal government to carry out the responsibilities of government for LLRW management in Canada. It is operated by Atomic Energy Canada Limited (AECL) through a cost recovery agreement with Natural Resources Canada, the federal department, which provides funding and establishes national policy for LLRW management.

In 1989, the Municipality of Port Hope and the LLRWMO entered into a formal agreement that established the Port Hope Construction Monitoring Program (CMP). The purpose of the CMP was to minimize the possible spread of soil contaminated with historic LLRW during construction activities in the town and to minimize the potential effects of contaminated soil on indoor radon concentrations in newly constructed homes. Through the CMP, the LLRWMO has provided assistance to the community for over 2,000 construction projects. In approximately five percent of these projects, contaminated soils were found, remediated, and placed in temporary storage.

From the 1980s to present, the LLRWMO has undertaken remediation of various LLRW sites not only in Port Hope but across Canada including:

- Scarborough, Ontario (1995 to 1996): cleanup of about 60 residential and commercial properties contaminated by historic radium processing operations;
- Northern Transportation Route (1992 to 2003): cleanup of about 50,000 cubic metres of soil contaminated from historic shipment of uranium and radium ores transported along a 2200 kilometre long water route from the Port Radium Mine in the Northwest Territories to the railhead at Fort McMurray, Alberta; and
- Surrey, B.C. (1999 to 2000): cleanup of about 5,000 cubic metres of thorium-contaminated soil from the refining of niobium ores.

Objective of Port Hope Waterworks Remediation Project

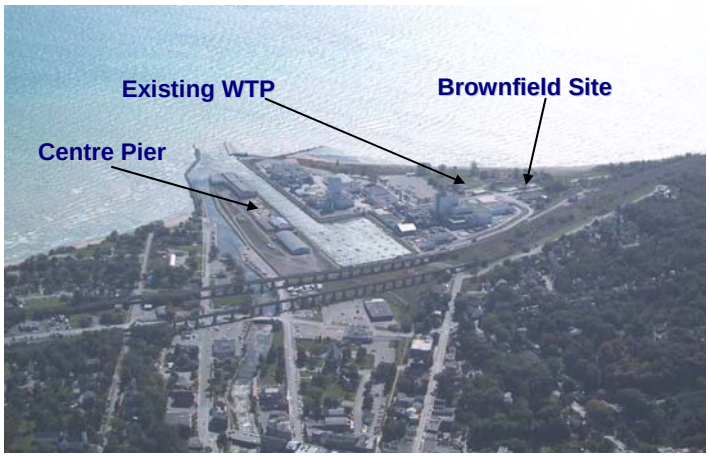
In response to the public outcry over the contaminated water disaster in Walkerton, Ontario, in 2000, the Ontario Ministry of the Environment (MOE) passed the Safe Drinking Water Act (2002), which contained stringent potable water treatment regulations. In Ward One of the newly amalgamated Municipality of Port Hope (former Town of Port Hope) the existing Water Treatment Plant (WTP) required upgrading to meet the new water treatment requirements prescribed by the MOE. The Municipality decided that it was not cost-effective to refurbish the existing WTP, and that a new facility constructed adjacent to the existing WTP would better serve the long-term needs of the community.

The site selected for the new water treatment facility was idle waterfront land that, during the 1930s, had been used as a residue storage area for low-level radioactive and non-radioactive residues produced by the Eldorado radium and uranium refinery. Over the past 50 years, several cleanup programs had been conducted at the site by both Eldorado and the Federal-Provincial Task Force on Radioactivity; however, one final cleanup of the 3.5-acre site to be used for the new water treatment facility was required to address the remaining contaminants. The opportunity to rehabilitate the waterfront land into productive reuse while minimizing the need for costly infrastructure development to connect the municipality's new WTP to the existing water distribution system was also regarded as a significant advantage of selecting this site.

Site Description and Environmental Investigations

The Waterworks site is located southwest of the intersection of Marsh and Choate Streets in Port Hope, Ontario. The portion of the site allocated for the new WTP was designated as the Construction Site Limit (CSL) and was partially developed with Marsh Street at the north, a lagoon in the east, an alum storage area in the southeast, and a recreational area in the west. Laydown areas used for stockpiling non-contaminated overburden material were located to the west and east of the CSL, respectively.

CH2M HILL completed environmental investigations at the site in November 2002, prior to the remedial program, and periodically during the remedial program from February to August 2003 (CH2M HILL, August 2003a). The results of the investigations, in conjunction with radiological measurements undertaken by LLRWMO staff, were used to define the extent and depth of excavation within the CSL.



Aerial view of the Port Hope Harbour including Centre Pier, the existing WTP, and the Waterworks Remediation Project Site

During the site investigations, soil and groundwater samples were collected and analysed for contaminants, primarily radium^{226}, arsenic, and uranium. The samples were collected from a total of 113 boreholes, monitoring wells, test pits, surficial samples, and hand auger samples. Radium^{226} and arsenic were the primary soil contaminants identified above the remedial criteria within the CSL, while uranium was the primary groundwater contaminant identified above the remedial criteria within the CSL. The LLRW material was identified with the radiological monitoring techniques supplied by the LLRWMO and through laboratory analyses for other non-radioactive metals.

The contaminated material addressed during the cleanup phase was typically soils and other materials that had become marginally impacted by radium and uranium refining wastes that had been used as backfill at the site during the late 1930s.

Description of Work

Approximately 17,500 cubic metres of low-level radioactive impacted soil was removed from the site in 2003 and placed in temporary storage. In addition, through careful planning and execution, approximately 10,000 cubic metres of non-contaminated overburden was segregated and stored adjacent to the CSL for reuse (CH2M HILL, August 2003b). This effectively reduced the quantity of material going to long-term storage, together with the associated costs of building and maintaining long-term storage in perpetuity.

Verification soil sampling/laboratory analyses and gamma radiation surveys were conducted on the final surface of the excavation in accordance with the uranium, radium^{226}, and arsenic soil remediation criteria of 35 ppm, 20 ppm, 8 pCi/g, respectively.

Backfill meeting the soil remediation criteria was sloped against the perimeter walls of the excavation to reduce the potential for exposure to contaminated soils beyond the boundary of the CSL.

Localized dewatering activities undertaken during excavating did not result in the degradation of downgradient groundwater quality.

The planning and remediation tasks undertaken in support of and during the cleanup of the CSL are summarized below:

- Project Planning (Preparation of Soil Remediation Project Plan, Health and Safety Plan and Transportation and Emergency Response Plan, and application for Permits and Approvals)
- Site preparation activities
- Excavation dewatering, as required
- Sanitary sewer discharge of dewatered groundwater (via a temporary storage lagoon) and associated sampling and analysis of groundwater quality
- Downgradient groundwater monitoring and analytical program
- Excavation of impacted soil, including extensive radiological monitoring and decontamination of construction equipment
- Transfer of impacted soil to offsite temporary storage
- Segregation and stockpiling of clean overburden materials
- Extensive verification program
- Site restoration
- Comprehensive environmental, health and safety monitoring results for the radiological and non-radiological contaminants

Overcoming Project Challenges

The Port Hope Waterworks Remediation Project involved many challenges including characterization of the site to determine the extent of contamination present within the CSL, the identification of appropriate mixed waste cleanup criteria, development of a cost-effective work program that satisfied regulatory requirements at the federal, provincial, and municipal levels, and working collaboratively to meet the municipality's tight schedule for the construction and commissioning of the new WTP.

Soil excavation and transportation of impacted soil

Demands of Fast-Tracked Schedule: In order for the LLRWMO to support the municipality's requirement to construct a new WTP, an aggressive project schedule was implemented and adhered to by the LLRWMO and the project team. This required initial

project tasks such as site investigation, identification of mixed waste cleanup criteria, and the development of the soil remediation plan to be completed concurrently to meet the demands of the schedule.

Extent of Contamination: Impacted soil was found to be present within the 3.5-acre CSL in localized pockets to a maximum depth of approximately 3.5 metres. The radioactive elements, radium-226 and uranium, and the non-radioactive element arsenic were the primary contaminants of concern. This was determined through the detailed characterization program that delineated the areal and vertical extent of impacted materials. During this characterization program impacted soil was found both above and below the water table at the site.

Stockpiles of segregated clean soil

Project planning was based on early indications of the extent of the impacted soil. Detailed characterization found considerably greater impacts and plans were modified to address these findings. By the end of the project, over 17,500 cubic metres of impacted soil had been identified and removed from the CSL. Approximately 10,000 cubic metres of non-impacted soil was carefully segregated for reuse as fill during the cleanup operation, thereby minimizing the amount of excavated material requiring ultimate storage in a LLRW management facility. (Approximately 1,500 m^3 of the non-impacted soil was reused onsite primarily to construct temporary haul routes through the CSL.)

Since impacted soil was also found to extend below the water table, this necessitated consideration of alternative remediation techniques. This was compounded by the close proximity of the site to Lake Ontario to the south and the presence of groundwater seeps at the north. Construction techniques were augmented to address potential cost escalation for site dewatering.

Regulatory Liaison and Development of Cleanup Criteria: The Port Hope Waterworks Remediation project involved integrating and adapting criteria for remediation of radionuclides within the context of the ALARA (As Low As Reasonably Achievable, social and economic factors taken into consideration) principle for radioactive contaminant remediation. Background-based cleanup criteria initially proposed for the project were found to be overly conservative and prohibitively expensive to achieve, given the estimated large volume of marginally impacted material. Cleanup criteria based upon conventional risk reduction protocols were developed and implemented. Provincially-derived cleanup criteria for conventional contaminants from the *Guideline for Use at Contaminated Sites in Ontario* (MOE, 1997) were integrated with criteria for radionuclides to direct the cleanup.

Lack of Long-Term Management Facility and Licensing Considerations: A temporary storage solution was required to address the anticipated large volume of impacted soils excavated and removed from the Waterworks site. Plans were initially developed for onsite

temporary storage of the impacted soils; however, these plans were modified when a nearby industry (Cameco Corporation) offered a vacant portion of their Centre Pier property located near the project site, for use as a site for the temporary storage of the impacted soils.

Cameco Corporation holds a license from the Canadian Nuclear Safety Commission (CNSC), to store low-level radioactive waste within the limits of their Centre Pier property. The LLRWMO supported Cameco in its application to the CNSC to review the proposed storage facility design for the impacted soils from the Waterworks site. Following its review, the CNSC concurred that this temporary use was in accordance with the existing license for the facility. Their concurrence allowed the project to proceed in meeting the schedule.

Public Consultation: The Port Hope Waterworks Remediation Project was the first major LLRW cleanup to be undertaken by the LLRWMO in the Municipality of Port Hope in approximately 10 years. Management of LLRW is an important issue within the community and is addressed by the LLRWMO through the Interim Waste Management (IWM) Program. The LLRWMO was responsible for communicating with the various stakeholders and the public about the remediation efforts at the Waterworks site. The LLRWMO's consultation and public information program addresses public concerns, provides community access to information and resources, and provides balanced and objective information on specific projects to help residents of the community understand the impacts of the contamination and the benefits of the remediation programs.

Innovative Techniques and Environmental Solutions

The LLRWMO, in collaboration with CH2M HILL, encouraged and facilitated the use of innovative remediation techniques and environmental solutions in the Port Hope Waterworks Remediation Project.

The following innovative techniques supported the cleanup of the Waterworks site:

- Localized dewatering techniques involving temporary sumps and drainage ditches were used to excavate impacted soil below the water table. This technique was used instead of large-scale dewatering involving sheetpiling and larger quantities of impacted groundwater, thereby maintaining the original project schedule and reducing overall project costs.
- After the completion of a detailed evaluation of biosolids and effluent contaminant loading, moderately impacted groundwater was pumped to the local water pollution control plant (WPCP) in accordance with a prescribed protocol based on groundwater quality and measured discharge flow rates. Sampling of the discharge effluent was conducted daily and compared to effluent concentration criteria derived from biosolid chemical concentration limits. This innovative technique significantly reduced project costs, accelerated the project schedule by replacing the potential need to construct an onsite facility to treat the impacted water, and satisfied municipal and regulatory requirements.
- A comprehensive health and safety plan was implemented by the LLRWMO and CH2M HILL to monitor and safeguard the environment, workers on the project team, and residents of the community. In addition to use of conventional health and safety

measures, the program implemented for this project included a dust modelling assessment for arsenic in the soil and corresponding dust measurements, as well as radiation dose assessment. Health and safety meetings were conducted with the contractor crew on a daily basis.

In addition to the innovative techniques and environmental solutions applied specifically to the Port Hope Waterworks Remediation Project, the LLRMWO can also apply the following technical lessons to numerous other cleanup projects, planned as part of the PHAI. This knowledge transfer leads to capacity building to undertake similar brownfield projects, which is a key recommendation developed and put forth in the National Brownfield strategy released by the National Round Table on the Environment and the Economy (NRTEE) (2003).

- Higher uncertainty levels and change management are characteristic of large-scale remediation projects, more so than conventional construction projects. Project planning during the Port Hope Waterworks Remediation Project recognized the uncertain nature of these types of projects. The LLRWMO regularly consulted stakeholders to resolve changing conditions while continuing to move towards project completion. The Waterworks remediation project team was empowered to complete the project within a wide window of possible conditions, while still adhering to regulatory requirements.
- The complex range of conditions and contaminants present needs to be "operationalized" to guide the remediation. Identification of key contaminant markers, or surrogates, saves time and reduces project costs. For example, during the Port Hope Waterworks Remediation Project, it was determined that exceedances of radium-226 at the site were generally accompanied by an exceedance of arsenic, which served to guide remedial activities.

Improving the Community, Environment, and Economy

The cleanup of impacted soil at the Waterworks site positively improved the Municipality of Port Hope, the local environment, and the economy in a number of ways. The remediation project:

Construction of the foundations of the new WTP

- Supported the municipality's construction of a new WTP to meet the MOE's new potable water regulations, ensuring the continued provision of safe drinking water for the community
- Allowed for the reuse of existing waterworks infrastructure by the municipality—watermains and water intake line from Lake Ontario—with minimal disruption to the community, saving municipal tax dollars

- Removed a significant amount of historic waste from the Waterworks site which, although not an imminent human health risk, provides long-term human and ecological health benefits to the residents of the community which will continue to accrue as more sites are remediated under the PHAI
- Eliminated potential exposure to ecological receptors within the CSL; aquatic and sediment ecology in Lake Ontario will also benefit from the expected improvements in groundwater quality that reaches the lake
- Provided an economic boost to the local economy by creating job opportunities for local businesses, such as equipment operators and laboratories, as well as increasing business for the service sector
- Avoided the need to consume other waterfront properties for the new WTP while making productive use of the subject property and positively contributing to the municipality's land base

Overall, the effectiveness and resulting economic benefits of the Port Hope Waterworks Remediation Project on the community and surrounding businesses were very positive. The successful completion of the project supported the goals of the LLRWMO and its mandate to cleanup approximately one million cubic metres of LLRW and marginally impacted soil. In the long-term, the PHAI is anticipated to provide even more environmental and economic improvements for the community. Property values in the area are anticipated to increase, which in turn will continue to stimulate the local economy of the Port Hope area. The anticipated economic stimulus is supported by a recent report by the NRTEE (2003) which found that brownfield redevelopment has the "*highest output multiplier of any sector in the economy*". This attests to the positive benefits of this project and future brownfield redevelopments for the communities of Port Hope and Clarington.

The efforts the LLRWMO working together with CH2M HILL , the municipality and others were recognized when this project was selected as a finalist for the 2004 Globe Awards for Environmental Excellence under the category of Brownfield Redevelopment.

Conclusions

Through the collaborative efforts between the LLRWMO and the municipality and its engineering design consultants, CH2M HILL, that provided engineering, technical, and remediation oversight, supported by many stakeholders, the CSL was successfully remediated and turned over to the municipality for construction of the new WTP in August 2003. The new Water Treatment Plant is scheduled to be commissioned by the end of March 2005.

The Port Hope Waterworks Remediation Project parallels and sets the stage for the much larger project being driven by the LLRWMO, namely the PHAI. The root causes behind the need for the remediation, the technologies used, and the benefits experienced by the community and the environment, are common between the Port Hope Waterworks Remediation Project and PHAI. The lessons learned from this recent remediation project will be used in the design and implementation of the PHAI and the cleanup of the remaining historic low-level radioactive waste sites within the community of Port Hope.

References

AECL, LLRWMO, November 2001. The Port Hope Long-Term Radioactive Waste Management Project, Project Description.

CH2M HILL, August 2003a. Soil and Groundwater Investigation, Waterworks Property, Port Hope – Draft Report. Prepared for AECL, LLRWMO.

CH2M HILL, August 29, 2003b. Soil Excavation and Remedial Verification Program, Waterworks Property, Port Hope –Report. Prepared for AECL, LLRWMO.

National Round Table on the Environment and the Economy (NRTEE), 2003. Cleaning up the Past, Building the Future – A National Brownfield Redevelopment Strategy for Canada. Renouf Publishing Company Limited. Copyright 2003