# Remediation of Highland Drive Landfill: Technical Challenges of Segregating Co-Mingled LLRW and Municipal Solid Waste in an Urbanized Area – 13319

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## ABSTRACT

Highland Drive Landfill is an inactive Municipal Solid Waste (MSW) Landfill which received waste from the 1940s until its closure in 1991. During a portion of its active life, the Landfill received low-level radioactive waste (LLRW) which currently exists both in a defined layer and co-mingled with MSW. Remediation of this site to remove the LLRW to meet established cleanup criteria, forms part of the Port Hope Project being undertaken by Atomic Energy Canada Limited (AECL) and Public Works and Government Services Canada (PWGSC) as part of the Port Hope Area Initiative (PHAI). The total volume of LLRW and co-mingled LLRW/MSW estimated to require removal from the Highland Drive Landfill is approximately 51,900 cubic metres ($m^3$). The segregation and removal of LLRW at the Highland Drive Landfill presents a number of unique technical challenges due to the co-mingled waste and location of the Landfill in an urbanized area. Key challenges addressed as part of the design process included: delineation of the extent of LLRW, development of cut lines, and estimation of the quantity of co-mingled LLRW in a heterogeneous matrix; protection of adjacent receptors in a manner which would not impact the use of adjacent facilities which include residences, a recreational facility, and a school; coordination and phasing of the work to allow management of six separate material streams including clean soil, MSW, co-mingled LLRW/MSW, LLRW, unimpacted water, and impacted water/leachate within a confined environment; and development of a multi-tiered and adaptive program of monitoring and control measures for odour, dust, and water including assessment of risk of exceedance of monitoring criteria. In addition to ensuring public safety and protection of the environment during remedy implementation, significant effort in the design process was paid to balancing the advantages of increased certainty, including higher production rates, against the costs of attaining increased certainty. Many of these lessons may be applicable to other projects.

## INTRODUCTION

Port Hope is a municipality of just over 16,000 residents located approximately 100 kilometres (km) east of the city of Toronto in Ontario, Canada. The historic LLRW and industrial contaminated soil located at various sites around the community are the result of waste handling practices involving the refining of radium and uranium by a former federal Crown Corporation, Eldorado Nuclear Limited. Waste placement within Port Hope occurred between the early 1930s and mid-1950s. These waste materials contain radium-226, uranium, arsenic and other contaminants resulting from the refining process.

Over the years, the waste has been managed and monitored by the Canadian Federal government and a final solution to LLRW waste management in Port Hope has been under development since the mid-1970s. A primary part of the activities to date is the monitoring and inspection of waste sites to ensure the waste does not pose a risk to health or the environment.

The current Port Hope Area Initiative (PHAI) is a community-based program directed at the development and implementation of a safe, local, long-term management solution for the historic LLRW in Port Hope. It is the result of an agreement established in 2001 between the Government of Canada and the affected Municipalities of Port Hope and Clarington for safe cleanup, transportation, isolation and long-term management of historic LLRW in each of the respective municipalities. The PHAI includes two undertakings: i) the Port Hope Long-Term Low-Level Radioactive Waste Management Project (the Port Hope Project); and, ii) the Port Granby Long-Term Low-Level Radioactive Waste Management Project (the Port Granby Project located in the Municipality of Clarington). Only the Port Hope Project will be discussed herein.

The Port Hope Project consists of the construction and development of a new Long-Term Waste Management Facility (LTWMF) and the remediation of contaminated sites in the Municipality of Port Hope with transfer of the contaminated material to the LTWMF. At the site of the new LTWMF, the existing waste at the Welcome WMF will be remediated and placed into the new facility. There are thirteen LLRW sites including the Port Hope Harbour and five industrial sites, as well as numerous small-scale remediation sites still being identified through a survey of all properties within the municipality. The total volume is estimated at 1.2 million $m^3$. Remediation sites include temporary storage sites, ravines, beaches, parks, private commercial and residential properties, and vacant industrial sites all within the urban area of Port Hope. In addition, Cameco Corporation (Cameco) which purchased the assets of Eldorado Nuclear Limited in 1988 and currently operates the Port Hope uranium conversion facility, and has been allocated 150,000 $m^3$ of space at the new LTWMF for wastes on their site attributable to the former Eldorado operation.

Combining to form the Port Hope Area Initiative Management Office (PHAI MO), AECL is the Project Proponent and PWGSC is managing the procurement of services. The MMM Group

Limited – Conestoga-Rovers & Associates Joint Venture (MMM-CRA Joint Venture) is providing detailed design and construction oversight and administration services for the Project.

**Highland Drive Landfill**

Highland Drive Landfill (HDLF) is one of the thirteen LLRW sites being addressed as part of the Port Hope Project. The HDLF is an inactive MSW Landfill which received waste from the 1940s until its closure in 1991. Wastes disposed at the HDLF included both MSW and waste from local area industrial facilities. The HDLF is an unlined landfill. No leachate collection system is currently installed. During a portion of its active life, the HDLF received LLRW which now exists both in a defined layer and co-mingled with MSW. The radionuclides of concern at the HDLF include Ra-226 and uranium.

Fig. 1 presents the Site Plan. The extent of LLRW at concentrations above cleanup criteria is indicated by the toned area. The LLRW impacts extend to the east of the HDLF, under the Pine Street North Extension (PSNE) roadbed and Pine Street North Extension Consolidation Site. The LLRW impacted material will be removed from these areas concurrently with the HDLF remediation, however, only the HDLF remediation is discussed herein.

As shown on Fig. 1, adjacent land uses include a school property approximately 60 metres to the west of the HDLF and a public recreational complex (Jack Burger Sports Complex) located immediately south of the HDLF. A number of residences are also located proximate to the HDLF. As discussed in subsequent sections of this paper, the adjacent land uses within the urban setting of the site required significant emphasis on engineering controls and work practices to control potential air quality, noise, and odour impacts. The adjacent land uses are illustrated on Fig. 2.

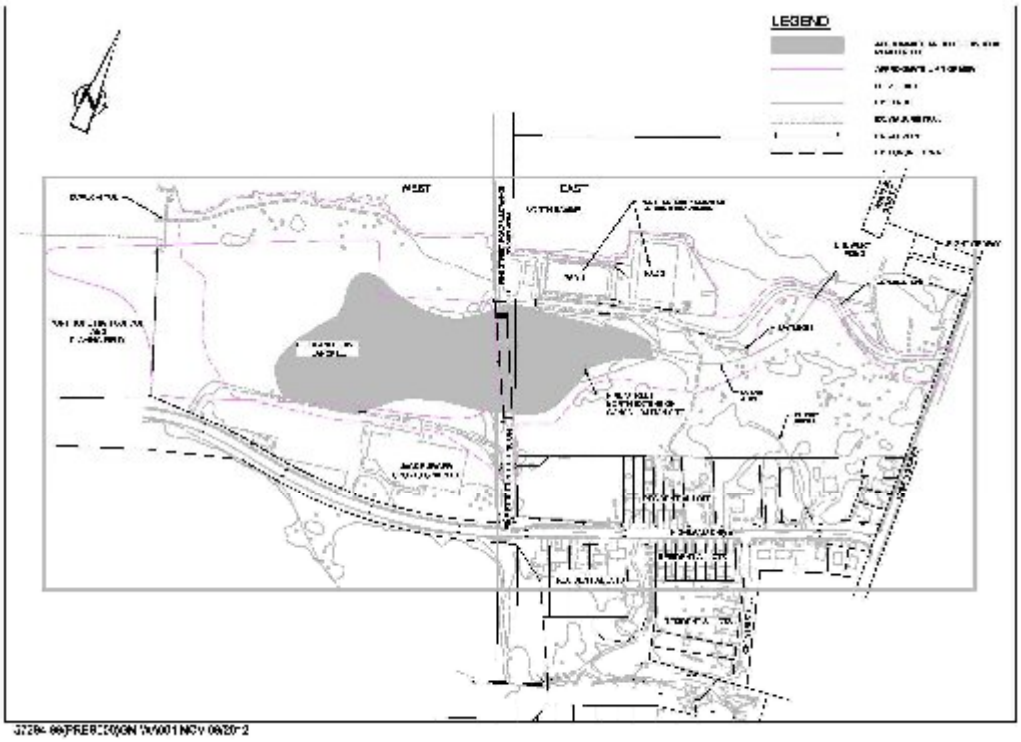


Fig. 1 – Highland Drive Landfill Site Plan [1]


Fig. 2 – Aerial Photograph of Highland Drive Landfill Area

## DESIGN BASIS FOR LLRW REMOVAL

A series of subsurface investigations were completed from 1980 through 2005 to determine the location and extent of LLRW impacted materials in the HDLF. These investigations identified that the LLRW impacted material was present in a layer toward the bottom of the landfill as shown in Fig. 3.

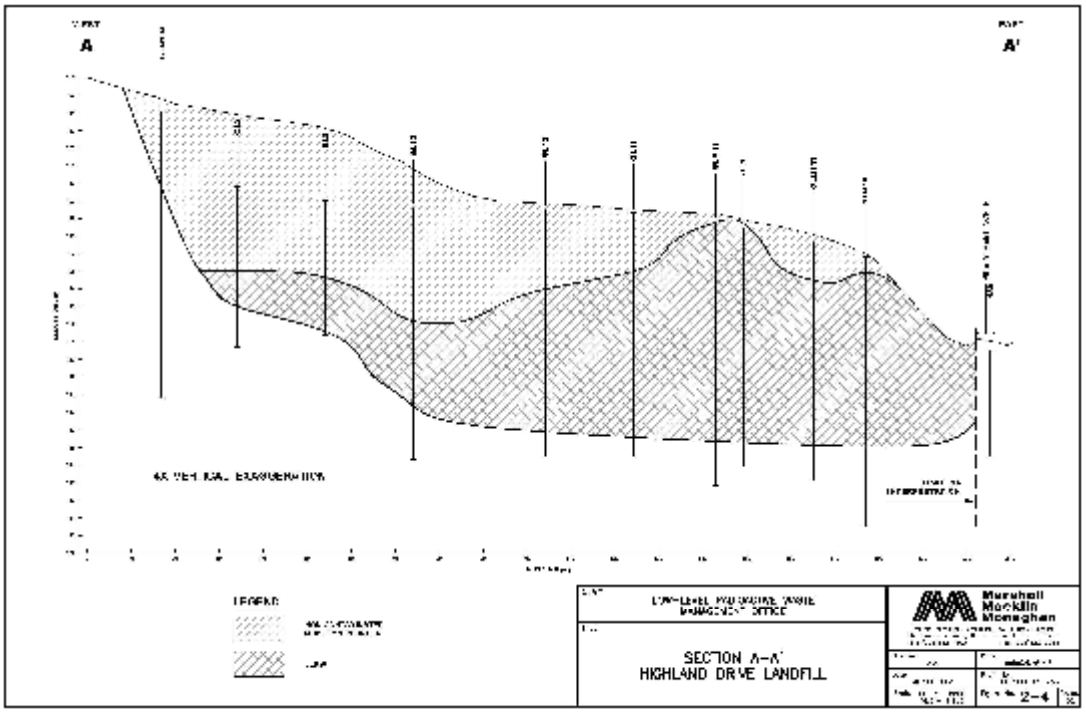


Fig. 3 – Cross Section Through the HDLF: Oriented East–West [2]

The investigations defined the extent of LLRW material, which is visually different from the MSW material in the landfill and assessed the extent of intermixing between MSW and LLRW at the material interface. A contingency factor was added to the volume estimate for each study to provide additional conservatism. Based on these evaluations, it was estimated that a total of approximately 51,900 $m^3$ of LLRW and co-mingled LLRW/MSW above the established cleanup criteria requires removal. This material is overlain by an estimated 133,200 $m^3$ of non-LLRW impacted MSW.[3] Groundwater impacts associated with historic LLRW and MSW are being addressed by other activities which are not included in this paper.

## SCOPE OF LLRW REMOVAL ACTIVITIES

Segregation of waste materials placed within a landfill is challenging under any circumstances due to the intermixing of waste streams during placement, subsequent migration of contaminants, the

need to manage multiple material streams, and the potential to encounter unknown and/or dangerous materials such as pressurized cylinders or unknown liquids. It is also difficult to pre-define the limits of material to be removed. Due to the heterogeneity of the waste, interpolating between investigative locations is significantly more uncertain than within a soil matrix, requiring use of a more conservative contingency factor than would typically be applied to a soil matrix. The segregation and removal of LLRW at the HDLF presents a number of unique technical challenges due to the co-mingled waste and location of the Landfill in an urbanized area. Key challenges addressed as part of the design process included:

- Protection of adjacent receptors in a manner which would not impact the use of adjacent facilities which include residences, a recreational facility, and a school;
- Coordination and phasing of the work to allow management of 6 separate material streams including clean soil, MSW, co-mingled LLRW/MSW, LLRW, unimpacted water, and impacted water/leachate within a confined environment. Each material stream must be managed independently to prevent cross-contamination. The total volume of clean soil and waste material to be managed within the 7 hectare site exceeds 185,000 m3;
- Development of a multi-tiered and adaptive program of monitoring and control measures for odour, dust, and water including assessment of risk of exceeding monitoring criteria;
- Verification sampling procedures which balance collection of sufficient information and impacts to production rates;
- Effective treatment of highly organic leachate with LLRW impacts;
- Evaluation of restoration alternatives including removal of MSW or placement of MSW back in the Landfill.

Several key aspects of the design are presented in the following subsections.

**Excavation Phasing to Minimize Waste Exposure**

Given the limited size of the work area (7 hectares for the HDLF and approximately 11 hectares for the entire site including the PSNE Consolidation Site and PSNE Roadbed and adjacent areas), the proximity of adjacent receptor populations, and the size of the required excavation, the phasing of the work had to be carefully planned to manage clean soil, non-LLRW impacted MSW, LLRW and co-mingled LLRW/MSW. Staging areas for clean materials and mixed LLRW/MSW are shown to the west and north of the area to be excavated. LLRW which is not co-mingled with MSW will be directly loaded and transported to the LTWMF. Non-LLRW impacted MSW will be managed within the excavation area. In addition, surface water controls must be put in place to manage non-contact water and wastewater requiring treatment in a manner which ensures potentially impacted water is collected and treated to meet discharge criteria and non-contact water

does not become impacted.

Due to the depth and horizontal extent of waste materials, excavation will be carried out as a series of progressive benches approximately 4 m in height. MSW will be removed from these benches in lifts up to 4m per lift. Where LLRW is being segregated and removed, lift thicknesses will be reduced to approximately 150 mm. The removal of LLRW will progress in a sequence defined in the Contract Drawings. Fig. 4 and 5 present examples of these phasing drawings.

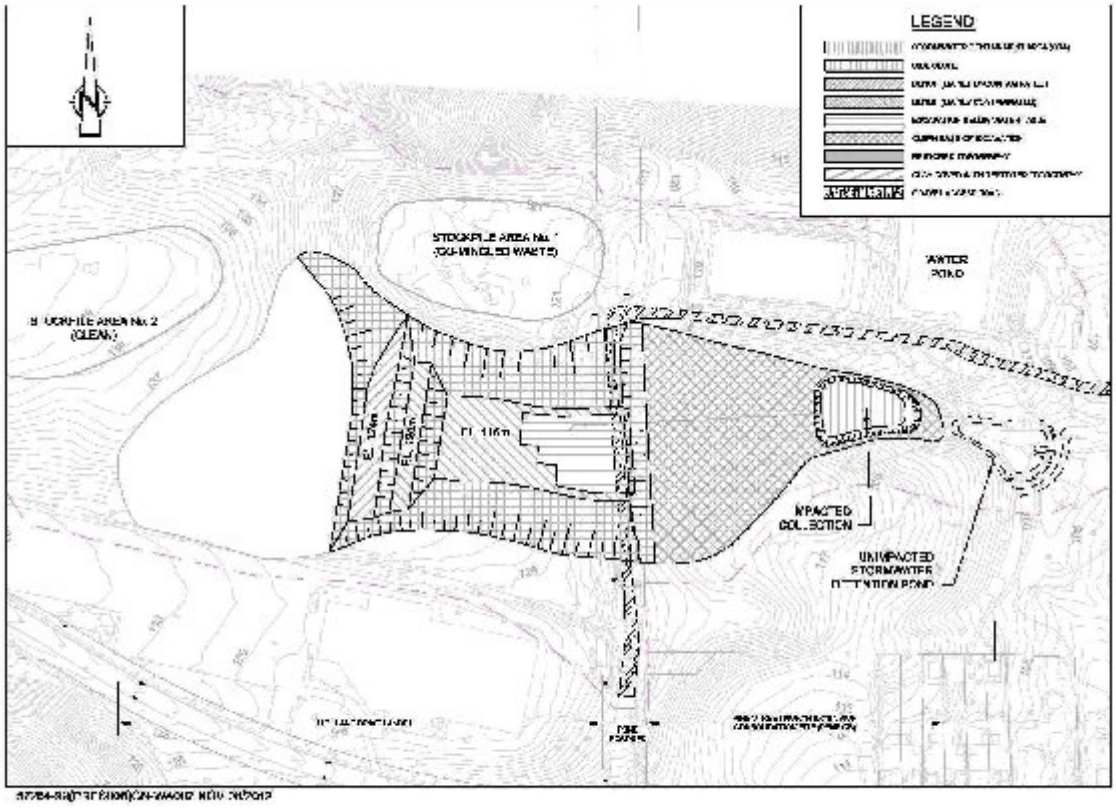


Fig. 4 – Removal Phasing Plan 7 [1]

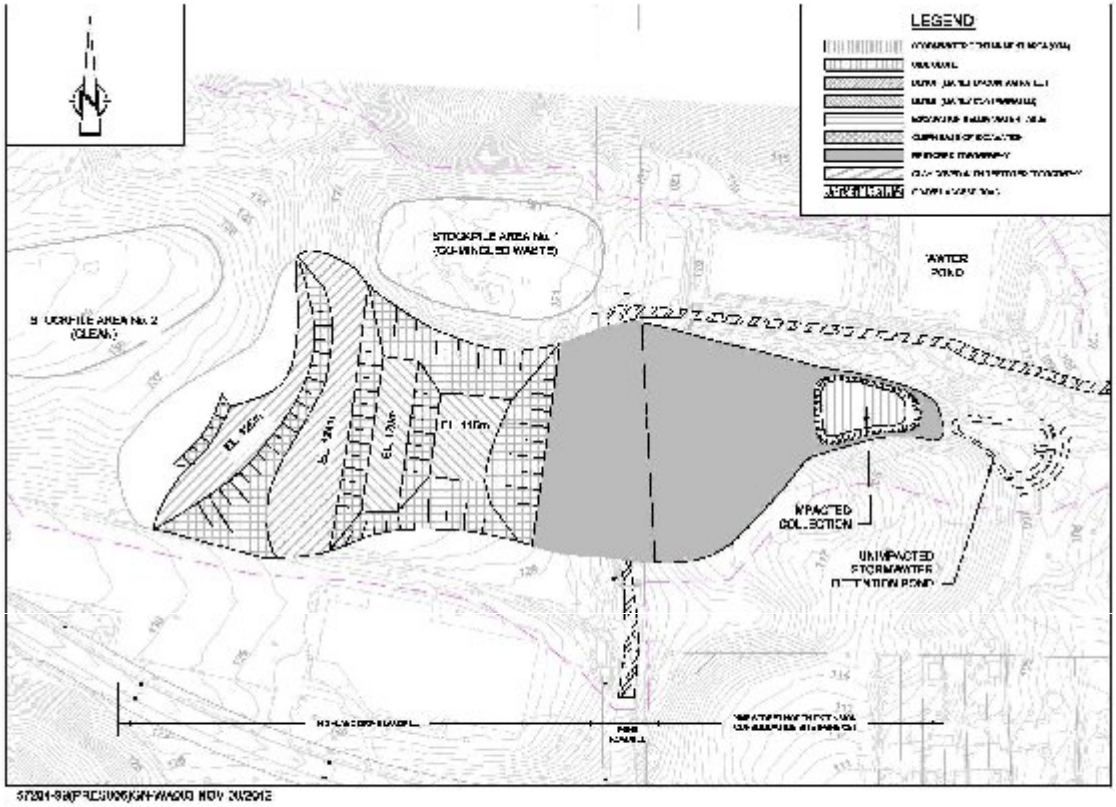


Fig. 5 – Removal Phasing Plan 8 [1]

At the end of each working day (and other non-working periods), all working faces will be covered with a thin layer of clean fill obtained from off-site or on-site stockpiled sources or other appropriate alternative material. As much as practicable, tarps may be deployed to ensure adequate cover of the exposed LLRW during non-working hours and minimize the clean soil used as cover since such material will subsequently require management as contaminated material. A layer of clean fill will also be placed on the benches as needed to ensure that haulage trucks are not travelling on contaminated surfaces. At the start of each day, cover placed on the working face the previous day will be removed with the material to be transported to the LTWMF.

Scheduling of the excavation must also allow for characterization of co-mingled waste to determine if it exceeds cleanup criteria as well as verifying cleanup criteria have been met in the excavation consistent with the procedures established under the Remediation Verification Standard Operating Procedure (RVSOP).

**Alternative Excavation Approaches**

Alternative approaches to the remediation were considered for the project including the potential to remove all excavated MSW off site to another landfill. A significant additional cost would be incurred to transport and dispose of the materials; however, the reduction in the volume of material to be managed on site would partially offset this cost. As much of the existing MSW material is located outside of the footprint of the LLRW to be removed, the benefits in risk reduction associated with this partial removal of MSW is very limited.

Another consideration of this approach would be the increase in the number of trucks on the roads within Port Hope. The removal of this additional MSW would add approximately 6,500 truck trips to the project.

**Odour Control Procedures**

The odour management strategy for the site is an adaptive program which combines general practices and procedures with specific additional control measures. The HDLF remediation has been scheduled to be completed during winter months to limit exposure, as fewer people will be outside and windows will generally be closed. In addition to the requirements to maintain temporary cover over all inactive areas and minimize working faces, the odour management strategy for the site includes provisions to reduce production rates to further reduce odour and to apply odour controlling agents to limit odour generation. The effectiveness of odour controlling agents is very specific to the odour source. Therefore, the remediation contractor will be required to test the proposed odour controlling agents on waste from the HDLF and prove their efficacy prior to initiation work at the site.

**Air Monitoring Program**

Similar to the odour management strategy, the air monitoring program employs a multi-layered approach to provide a suitable level of assurance that no unacceptable impacts are occurring, and that work practices are revised in advance of exceeding applicable criteria. The Contractor is required to complete personnel monitoring to ensure the health and safety of workers. AECL will institute additional real time and high volume air sampling at the site perimeter to confirm air monitoring action levels are not exceeded and that impact predictions from the Environmental Assessment are not exceeded. In addition, there are long-term monitoring stations near the work area which will continue to be monitored throughout construction. The long-term record for these stations will be very beneficial in assessing the significance of any data obtained during remedy implementation to determine if the data reflects influences from the cleanup or if it is typical of seasonal variability.

### Wastewater Control and Management

Due to the duration of the project (exceeding 10 weeks) and the conservative approach to ensuring potentially impacted water is controlled, a 100-year return period was selected to size the temporary controls for both impacted and unimpacted water. Unimpacted water will be bypassed around the excavation by a series of perimeter trenches and buried pipes to a storm water management area sized to contain the 100-year return period event.

It is intended that the contractor will employ mobile treatment systems to manage water at the LLRW Remediation Sites and Industrial Remediation Sites. Potentially impacted water, including landfill leachate which enters the excavation area will be collected and treated prior to discharge to surface water. Due to the high organic loading and other constituents present in the landfill leachate, the water treatment facilities at the HDLF are anticipated to require either additional treatment components or a reduced treatment capacity to ensure performance of the treatment system.

## SITE CLOSEOUT

The County of Northumberland (County) is the operator of the Highland Drive Landfill and holder of the Certificate of Authorization issued by the Ontario Ministry of the Environment for the facility. The County is undertaking activities to complete final closure of the facility consistent with the requirements of the Certificate of Authorization. PHAI is working cooperatively with the County on the details of the remedy implementation and restoration planning to ensure that the work completed under the Port Hope Project will assist the County's final site closure activities.

## CONCLUSIONS

The design process for the removal of LLRW from the Highland Drive Landfill presented many challenges and risks. Key challenges included:

- Delineation of LLRW within the heterogeneous MSW matrix;
- Sensitivity of adjacent receptors (high school, recreational complex, and residential properties) to noise, odour, and dust;
- Management of multiple waste streams within a confined work area; and
- Coordination of LLRW removal activities with ongoing final site closure activities being undertaken by the County.

Project design challenges were addressed through the application of best management practices, engineering controls including establishing tiered control strategies for dust and odour, careful construction scheduling and phasing, and coordination with stakeholders. Implementation of this

remedy will provide a significant benefit to the residents of the municipality and allow the County to complete final site closure activities which could not otherwise be completed.

## REFERENCES

1. CONESTOGA-ROVERS & ASSOCIATES and MMM GROUP LTD., *Highland Drive Landfill Area – 100% Design Submission*, March 31, 2011.
2. MARSHALL MACKLIN MONAGHAN LTD., *Re-evaluation of LLRW Quantity at Highland Drive Landfill – LLRWMO-03701-ENA-12011*, Revision 0, March 2005.
3. CONESTOGA-ROVERS & ASSOCIATES and MMM GROUP LTD., *Analysis of Project Requirements Summary Report, Report 2 – Low-Level Radioactive Waste Remediation Sites & Industrial Waste Remediation Sites: RS1 – Analysis of Project Requirements, PHP-RS1.RPT-004*, May 2010.