Lessons Learned in Implementation of Radiological Investigations of Small-Scale Sites in Port Hope, Ontario - 16534

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ABSTRACT

The Port Hope Area Initiative is a $1.28 billion project for the remediation of historic low-level radioactive waste resulting from the operation of Eldorado Nuclear Limited and its private-sector predecessors between 1932 and 1988 in Port Hope and Port Granby, Ontario, approximately 100 km east of Toronto. Included in the project is the investigation of all 4,800 privately and publicly owned properties in Port Hope in order to identify and remediate an estimated 375 properties containing LLRW exceeding clean-up criteria. This paper discusses the progress of the investigations, the development of clean-up criteria, methodologies used to identify historic LLRW, and lessons learned to date. This paper will be of greatest interest to future project managers of similar investigations.

INTRODUCTION

Project History and Background

Over 90% of Canada's historic low-level radioactive waste (LLRW) is located in the Port Hope area, the result of the activities of the former federal Crown Corporation, Eldorado Nuclear Limited, and its private-sector predecessors. Between 1932 and 1988, when Eldorado was dissolved and its assets were merged with those of the former Saskatchewan Mining and Development Corporation to form Cameco Corporation, waste mainly consisting of process residues containing radium and uranium were deposited and stored in several locations within the Municipality of Port Hope and in the southeastern section of the Municipality of Clarington.

In Port Hope, the waste is located in 17 identified locations as well as approximately 150 road allowance sections. In addition, a significant component of the project is the investigation of all 4,800 properties in the community, in order to identify and remediate an estimated 375 properties containing historic LLRW exceeding the project clean-up criteria. These sites are termed Small-Scale Sites (SSS).

SSS have been impacted by historic LLRW through a variety of mechanisms:

1. Unrecorded, unmonitored or unauthorized diversion of contaminated fill, building materials and reclaimed materials;
2. Stack deposition from the Eldorado plant; and
3. Wind and water erosion from sites contaminated with historic LLRW.

The areal distribution and depth of historic LLRW sourced from Item 2 is generally uniform and predictable. Item 1 is less uniform and predictable as its existence on a property is a function of the practices of the property owner(s). The identification and remediation of the soil materials are made complex by this random distribution throughout the community, and even on an individual property. The complexity is also increased by the additional placement of other types of contaminated soil materials, such as coal ash and other industrial wastes, e.g., those from a ceramics manufacturer in Port Hope.

At the time of placement, the contaminated materials were viewed as beneficial in terms of the structural qualities of the soil-like tailings and the cost, which was free. Uses included filling low areas in yards or building roads. After 1960, the use of LLRW on properties decreased because processes at the plant changed, and it had less desirable physical characteristics for use as fill. Inclusion of contaminated components in the structure of a building is less common, however, they are very difficult to delineate and remediate once identified.

From 1976 to 1981, radiological investigations were conducted at approximately 3,500 properties within Port Hope, which resulted in the cleanup of 100,000 m^3 of contaminated material from 350 properties. The larger volumes of contaminated soil in vacant areas, ravines and in the sediments of the Port Hope Harbour, estimated at 500,000 m^3, were left in place for clean up at a later date. This earlier program effectively remediated much of the radioactive contamination from homes. Criteria used for this cleanup were based on the prevention of unacceptable levels of radon-222 in indoor air in homes adjacent to LLRW-bearing soils and on the prevention of unacceptable external gamma radiation exposure rates from surface soils. The "primary criteria" were 0.02 Working Levels (WL) for indoor radon and 0.1 mR/h at 1 m above bare ground. The current investigation by the PHAI uses different clean-up criteria, based on concentrations of Contaminants of Potential Concern (COPCs), which now results in the identification of historic LLRW soils that did not exceed 0.02 WL 35 years previously and often have radium-226 concentrations not failing the current clean-up criteria.

A Legal Agreement was signed between the Federal government and local municipalities in 2001, which outlines Canada's commitment to undertake the remediation and the municipalities' commitment to host the waste. The Legal Agreement is the basis of the current clean-up program.

Survey Progress to Date

To date, the project has prepared site-specific investigative work plans for all 4,800 properties, has completed investigations at approximately 465 properties and partially implemented (radon testing) investigations at 2,000 properties. Sixty properties with historic LLRW have been identified to date. The project has recently released a contract to investigate an additional 800 properties. The investigation of the remaining 3,500 properties is expected to occur over the next three years.

THE SURVEY PROCESS

Summary

The processes which lead to the identification of a property containing historic LLRW includes six steps, as listed below:

- Development of Clean-up Criteria;
- Data Gathering and Work Plan Preparation:
    - Historical File Review;
    - Decision Matrix;
    - Probability Map of historic LLRW presence; and
    - Site Survey Work Plan Development.
- Gaining Access to Property;
- Staging Strategy;
- Property Survey – Technical Details:
    - Radon gas measurements in the interiors of buildings;
    - Exterior gamma radiation surveys;
    - Exterior surface contamination surveys;
    - Soil sampling throughout the property;
    - Interior gamma radiation surveys; and
    - Interior surface contamination surveys.
- Delineation.

Clean-up Criteria

The survey includes results from the following tests to drive the identification of properties with historic LLRW:

- Interior radon;
- Interior and exterior gamma scanning;
- Objects and surface contamination; and
- Soil sampling and analysis.

Interior radon in itself does not have a clean-up criterion and is used only as a "trigger" to elevate the intensity of soil sampling around a building perimeter. Similarly the results of the exterior gamma testing are used as a trigger for more intensive soil sampling.

Testing of radon in basements is used as an indicator of potential Ra-226-bearing soils around the perimeter of a building. The development of the trigger is based on a maximum acceptable exposure above background:

Acceptable radon = background + incremental dose of 0.3 mSv/a

The Ontario Ministry of Environment and Climate Change defines the background concentration as the 97.5 percentile concentration. Using this method, the project reviewed the radon data from approximately 1,000 Port Hope homes with either demonstrated absence or very low likelihood of radium-226 in the soils, which indicated a background concentration of 204 Bq/m^3. Assuming an equilibrium factor of 0.4, the incremental radon concentration giving rise to an annual dose of 0.3 mSv is 14.5 Bq/m^3. This results in an indoor radon criterion of approximately 219 Bq/m^3. This exceeds 200 Bq/m^3, above which Health Canada recommends mitigation, therefore PHAI elected to use 200 Bq/m^3 as its trigger. In the Port Hope study group, 3.8% of the results were above 200 Bq/m^3. In a recent Health Canada study (1), an estimated 4.6% of homes in Ontario were found to exceed the guideline. In this regard, it appears that concentrations in Port Hope homes not impacted by LLRW are lower than those in other Ontario communities.

The exterior gamma trigger for enhanced investigation is 8 µR/h. This data is used by field crews to either adjust the location of planned boreholes or to add locations. The trigger is based on background in Port Hope of approximately 4 to 7 µR/h and years of investigations of properties in Port Hope which suggests a higher probability of LLRW presence when the trigger is exceeded.

The interior scanning criteria are summarized in Table I below:

Table I: Criteria for Contaminated Objects and Surfaces[(a)]

Contamination Criteria	Unit	Criteria
Dose Rate (at 50 cm) [(b)]	µR/h	80
Total Surface Contamination (averaged over 100 cm^2)	Bq/cm^2	1
Loose Alpha (averaged over 300 cm^2)	Bq/cm^2	0.04
Loose Beta & Gamma (averaged over 300 cm^2)	Bq/cm^2	0.4

a. Based on Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials
b. Dose rate: 0.5µSv/h is converted to µR/h by using conversion factor of 0.006 µSv/µR (i.e. 0.5/0.006 = 83.3µR/h ≈80µR/h)

The clean-up criteria for non-radioactive COPCs (18 in total) in soil have been developed based on Ontario Ministry of Environment and Climate Change Soil, Ground Water and Sediment Standards Table 3 (2) which have been designed to be protective against adverse effects to human health and ecological. These generic, conservative values were selected, with input from the Municipality, to facilitate possible future health and ecological reviews of the properties by property owners. The clean-up criteria for radioactive COPCs (radium-226, thorium-230 and thorium-232) have been developed to be protective of human health based on a dose constraint of 0.3 mSv/a, which included exposure, externally, to radioactivity in the ground and exposure, internally, through inhalation and ingestion.

Although the Licence, issued by the Canadian Nuclear Safety Commission for the Port Hope Project listed 21 COPCs, extensive testing over the past 35 years has indicated that four of these – arsenic, uranium, radium-226 and thorium-230 –

could be categorized as signature COPCs. This general observation was reinforced by two evaluations:

- A study of 633 samples of pure LLRW at the Port Granby and Port Hope waste management facilities showed that only one had an exceedance by the remaining 17 COPCs when at least one of the four signature COPCs did not exceed its criteria.
- Positive Matrix Factorization was used to develop signatures for background soils, LLRW and ceramic foundry wastes, which was used to evaluate data from waste sites in the Port Hope community. This demonstrated with 97% certainty that by testing only the four signature COPCs, the remaining 17 COPCs associated with any LLRW contamination would also be remediated to the Clean-up Criteria, provided the material was LLRW.

Therefore, the PHAI survey to identify LLRW is using only the four signature COPCs. This reduces false positive identification of LLRW and the identification of other waste types that the PHAI has no mandate to remediate.

The criteria for the four Signature COPCs are included in table below:

Table II - Clean-Up Criteria

Signature COPC	**Residential/ Parkland/ Institutional**	**Industrial/ Commercial/ Community**
Arsenic (μg/g)	18	18
Uranium (μg/g)	23	33
Radium-226 (Bq/g)	0.29*	0.97
Thorium-230 (Bq/g)	1.16	4.67

* Where radon attributed to LLRW is over 200 Bq/m^3, radium clean-up criteria is background (0.05 Bq/g).

The licence also identified a Special Circumstances provision where it may not be possible or practical to meet these criteria due to the following:
- Access Constraint: Access is not provided by property owner;
- Physical Constraint: Requirement to maintain structural integrity or stability;
- Operational Constraint: Cleanup to specified depth not reasonably feasible;
- Non-LLRW Constraint: Source of contamination not related to historic LLRW;
- Environmental Constraint: Removal of historic LLRW contamination will have a detrimental impact on an environmental feature; and
- Social/Heritage Constraint: High community impact with low safety benefit.

Implementation of the Special Circumstances protocol requires input from the property owner and the municipality and includes a dispute resolution process.

Data Gathering and Work Plan Preparation - Historical File Review

Property files for approximately 4,000 properties have been assembled over the past 40 years. These files include information on previous investigations and remediations, structures on the sites, correspondence with property owners, etc. These files were reviewed by a group of six separate consultants to assist in the development of preliminary Site Survey Work Plans. The files were reviewed in accordance with the procedures described in a PHAI-developed Guidance Manual to ensure a consistent approach between consultants and include the following steps:

- Review existing information from the historic property files;
- Identify the site location within Port Hope and determine its location with respect to major contaminated sites and contaminated road allowances;
- Review aerial site photos, including the property fabric; and
- Fill in a Historical File Review Management template provided by the PHAI which assembles information about each property in a uniform fashion in the preparation of the preliminary Site Survey Work Plan.

Some properties do not have historic files, however a Historical File Review Management template was still completed for each property, inputting any information that was available but relying mostly on the geographical location of the site relative to known or likely areas of contamination.

Data Gathering and Work Plan Preparation - Decision Matrix

A preliminary site classification (A though E) is determined using a standardized Decision Matrix and making use of the information assembled in the Historical File Review Management template.

The Decision Matrix includes evaluations along three separate paths:

- Interior radon;
- Exterior Soil Impacts; and
- Interior Impacts.

Included in the Decision Matrix are considerations of age of the property and location in the community (as discussed in next sub-section). In addition, those properties that have previously undergone remediation for radon, exterior soil impacts or interior impacts are specially designated for greater attention. All these factors will influence the intensity of the investigations to be implemented.

Preliminary site classifications are determined for each path. Classifications range from Type A to E, with Type A sites indicating no expectation of exceedance of the clean-up criteria, up to Type E sites, which indicate the probability of requiring unique remediation plans. Type E properties may require remediation resulting from LLRW within the structure.

The majority of the SSS (92%) are expected to be Type A sites for all three pathways on the completion of the survey, however entering the survey only approximately 50% are classified as such, therefore requiring a higher intensity of survey until proven otherwise.

Data Gathering and Work Plan Preparation - Probability Map

A Probability Map in the Guidance Manual divides the community into four regions (1 to 4), each region progressively having a greater probability to include properties with LLRW. Probabilities have been based on the distance from Eldorado Nuclear, the influence of aerial deposition from the plant, the age of the property (and, therefore, the likelihood of having received uncontrolled waste from the plant) and the proximity to major LLRW sites. The Probability Map information is an input during the completion of the Decision Matrix. Through this approach, even properties with no historic property file can be classified.

Data Gathering and Work Plan Preparation - Site Survey Work Plan Development

A preliminary Site Survey Work Plan is prepared for each property, making use of the processes described above.

The intensity of the survey described in the preliminary Site Survey Work Plan is dependent upon the site classification. For example:

- Interior gamma scans at properties with low probability for LLRW only include scans at the centre and four corners of a room; higher probability buildings receive scans on a 1-m grid.
- When elevated radon is detected, additional boreholes are required within 3 m of the face of each side of the building (3 m was selected based on an Ontario Geologic Survey Report (3) indicating maximum travel distance by radon is normally less than 3 m, unless a highly permeable pathway exists).
- Additional soil sampling in areas of previous remediation is to be completed since the previous remediation was driven by gamma, which may not have removed all LLRW consistent with the current clean-up criteria.
- Areas of elevated gamma are areas of focused boreholes.
- Buildings constructed after 2008 do not receive interior surveys, as they are considered to have very low probability of containing LLRW.

All preliminary Site Survey Work Plans are reviewed by CNL to ensure accuracy and consistency between the various consultants preparing the Site Survey Work Plans and sometimes resulted in adjustments to the Guidance Manual.

The consultants implementing the preliminary Site Survey Work Plans fieldwork were also tasked with modifying the work plans based on new information such as:

- Location of buried utilities;
- Information gained following preparation of the Site Survey Work Plans;
- New radon information requiring additional boreholes around buildings; and

- Data identifying areas of unusual exterior gamma.

Gaining Access to Property

CNL is responsible for obtaining access agreements from property owners, and the consultants retained for implementing the surveys are tasked with scheduling the appointments. The level of success in obtaining access agreements is not only a function of the specific tactics employed in the months leading up to the need for access but also of the knowledge and support, which the project has developed within the community through years of communication and relationship building.

The specific tactics used in obtaining access agreements are constantly evolving based on lessons learned, but generally include the following:

- General
    - Issue a news release to local media at the start of each campaign;
    - Provide updates in the Port Hope Project newsletters to highlight the overall goals and progress of the survey program;
    - Place advertisements in local media outlets to help create widespread awareness about the survey;
    - Develop an array of printed and electronic information about the survey program for the public to access in the project's Public Information Exchange and online; and
    - Provide regular updates on the PHAI website, the LED sign in front of the office, Facebook and Twitter.
- Specific
    - Personally addressed letters to owners in the current focus area to be surveyed. Include a copy of the access consent form, scheduling form, self-addressed stamped envelope, map and property survey fact sheet approximately three months prior to need to gain access;
    - Follow up with a post card three weeks after the initial request;
    - Mail out second reminder letter with new forms approximately six weeks prior to need to gain access;
    - Place phone calls to property owners who have not submitted their access agreement and encourage them to sign and return; and
    - Visit remaining properties where phone numbers are unavailable or no contact has been possible through above tactics.

The efforts noted above, combined with a concerted public awareness campaign netted a 93% rate of return on the consent forms for the first 500 properties. In terms of the pattern of response to each of the tactics noted, the first tactic – using personally addressed information packages – resulted in approximately 50% of owners returning consent forms within six weeks of the letters having been issued. The subsequent efforts saw the agreements continue to slowly flow in. When phoned or visited at their homes, the majority of residents have been supportive of the survey program and have told PHAI staff they either forgot to mail in the forms or, for a variety of personal reasons, could not make contact with the PHAI.

Of the 35 property owners who did not return their forms, the following reasons were identified:

- Selling homes and could not sign agreements for the future property owner;
- Property owners could never be contacted and/or reliable addresses (for properties owned by persons not living at the property) could not be found;
- Owner had died, and estate was not yet in a position to manage issue;
- Illness or other personal issues; and
- Opposition to the project, fear, etc.

Efforts to schedule appointments can be considerable, although staff have noted that the level of effort decreases as more surveys are completed and property owners gain knowledge from family, friends, co-workers and others who have already had the surveys completed on their properties. However, even once signed access agreements have been returned to the PHAI, approximately 5% of these owners have still refused access (usually because of personal circumstances such as illness) or could not be contacted when the consultants attempted to schedule appointments (often because of lengthy vacations).

STAGING STRATEGY

The survey program is being staged in five campaigns consistent with the following:

- Trial survey of 35 properties was conducted in 2010 in to develop procedures and staff capacity and familiarize community with the program.
- Campaign 1, started in 2012, was designed as a small campaign (450 properties) and included a broad variety of housing stock (age and geographical distribution) and probability of identifying LLRW. This provided an opportunity to gain experience, refine techniques for later campaigns and confirm assumptions on LLRW distribution.
- Campaigns 2 and 3 comprising approximately 2,000 properties are focussed around already identified major remediation sites. By identifying SSS requiring remediation around major sites, PHAI can develop remediation work plans that include both major sites and proximity SSS so that disturbance to neighbourhoods can be limited to one time period.
- Campaigns 2 and 3 include more houses with a higher probability of having LLRW so that they are identified earlier, allowing for their earlier remediation. Conversely, Campaigns 4 and 5 include a large percentage of properties with lower probability of LLRW.
- Campaigns 2 and 3 also include a number of vacant lots that may soon be developed in order that testing can be completed prior to development.
- Surveys are generally completed in blocks of properties bounded by roads, rivers or other natural or man-made features. This provides synergies in terms

of data from one property providing information to support directions or conclusions on neighbouring properties.

PROPERTY SURVEY – TECHNICAL DETAILS

Radon

The testing of radon precedes all other testing, as it is a long duration test that informs the borehole program. Radon testing is completed using Alpha Track monitors placed in the basement or the lowest level of a building. The monitor is left in the building for six months to span a heating and a cooling season, which exceeds the Health Canada recommendation for a test with a minimum duration of three months (4). Standard checklists are filled in when the monitor is installed, indicating, among other items, where the monitor is placed, the condition of the property (e.g., cracks in basement wall), type of wall (e.g., poured concrete), presence of an existing radon mitigation system, etc., to assist in interpreting the radon information. Other information that will assist in the follow-up gamma and drilling testing at the property is also recorded at this time, such as the presence of dogs, decks, sheds or swimming pools, which may be useful information for those implementing the gamma or borehole programs.

Use of radon to identify LLRW required careful communication with property owners to ensure they understand that radon is naturally occurring. The communication also needs to be timely, such that when radon exceeding the Health Canada guideline is identified, soil investigation occurs rapidly to determine whether the source was LLRW or natural, so that ownership of the mitigation could be identified.

Exterior Gamma

Gamma scanning is undertaken on a grid pattern, with the density dependent on the site size. Residential sites are assessed using a 1 m x 1 m grid and a 1 m x 3 m grid for open areas greater than 5,000 m^2. Measurements are taken at a height of 0.15 m for 1 m x 1 m grids and 0.15 and 1.0 m both for grids 1 m x 3 m. Exterior gamma testing is completed prior to soil sampling, as it informs borehole locations.

The horizontal position of the gamma survey measurement points are determined using Global Positioning System technology.

Measurements are not taken over more that 0.01 m of water or 0.1 m of snow.

Interior Gamma

Buildings built before 2008 are surveyed for interior gamma including a visual inspection for the presence of contaminated artifacts, tools and building materials. The interior survey includes floors and walls, with the intensity dependent on the preliminary classification of the property determined through the Decision Matrix.

Attics and crawl spaces are not surveyed unless LLRW in these areas is suspected.

Boreholes and Soil Sampling

Boreholes are drilled on properties at a density dependent on the classification it receives through the Decision Matrix. The density increases as the classification increases from A to D as follows:

- Type A and B with lot size less than 1,000 m^2: Minimum of one borehole;
- Type A and B Property with lot size more than 1,000 m^2: One borehole every 1,000 m^2 to a maximum of 20 boreholes per site;
- Type C Property with lot size less than 1,000 m^2: Minimum of two boreholes per property and a maximum of 10 boreholes per property;
- Type C with previous remediation: In previously remediated area, a maximum of three boreholes and in remainder, a minimum of two boreholes and a maximum of 10 boreholes;
- Type D Property: For lot size less than 1,000 m^2: Minimum of four boreholes and a maximum of 10 boreholes per property; and
- Type D with previous remediation: In previously remediated area, a maximum of three boreholes and in remainder, a minimum of four boreholes and a maximum of 10 boreholes.

As well, the results of testing on an adjacent property may influence the need for additional boreholes on a subject property. The impact of radon and elevated exterior gamma has been discussed previously.

Boreholes are advanced to a minimum depth of 1.2 m at least 0.5 m into native and are sampled continuously in 0.20 m intervals. Down-hole gamma logging, gamma scanning of the core, along with the XRF soil analysis, are used to inform the technicians on the selection of soil samples for analysis. Generally samples with very low or very high probability of LLRW are not analyzed, however if only one sample is analyzed, it will be the worst-case sample based on XRF and gamma.

Delineation

When LLRW is encountered in the soil or structure of a property during the initial survey, a delineation survey is conducted, in two stages as follows:

- As part of the initial survey program to provide a high-level indication of the extent of the LLRW; and
- During the design phase, when a more detailed understanding of the limits of the waste are required, to design the remediation of the property.

For both stages, delineation is performed using the four Signature COPCs.

The design of a delineation plan is site specific; therefore, consultants identifying the LLRW during the survey prepare a work plan for the initial delineation.

For LLRW in soil, additional boreholes are advanced by area and to depths to define a boundary of material not having exceedances of the clean-up criteria. Liberal use of the XRF and gamma scanning, in addition to laboratory analyses, are used to define materials exceeding the clean-up criteria. During the initial delineation, sufficient boreholes are advanced to provide a high-level, conservative indication of the extent of the LLRW and the cost to remove it, understanding that a more detailed investigation may be conducted during the design stage when there is a better understanding of the cost: benefit of additional investigation versus additional excavation. Delineation will define the limit of LLRW by the inner most sample not exceeding the clean-up criteria.

Delineation of LLRW in structures follows a similar strategy. Whereas the initial survey includes only scans of surfaces and objects, the delineation may include testing of unexposed areas, such as behind drywall or plaster, to verify the presence or absence of LLRW. As in the previous paragraph, the cost/benefit of carrying out extensive investigations during the delineation stage, which often involve destructive testing, must be carefully assessed.

The identification of LLRW involves a balance between the cost and benefit to investigate with the cost to remediate. As such there may be sufficient information to determine that the effort and/or structural damage required to complete the investigation exceeds that to remediate and that demolition might be the better solution. A decision to terminate an investigation and move directly to demolition can be made at several stages, specifically following the historical file review, the survey, the initial delineation, the final delineation, or remediation design.

In this case, a decision to demolish all or part of a structure and either rebuild it or purchase from the owner and sell the vacant property may be the most beneficial decision for CNL and the property owner.

LESSONS LEARNED

CNL and its consultants have conducted formal Lessons Learned processes on a number of sub-projects within the PHAI. CNL staff also visited the Grand Junction, Colorado, site that included the testing of approximately 10,000 properties in the late 1990s and the remediation of 5,000 of these properties. To date, PHAI formal lessons learned exceed 100, and several are documented below:

Selection of Unique COPCs

The Trial 35 program as well as Campaign 1 used the full list of 21 COPCs, however, although LLRW can have elevated concentrations of the 21 COPCs, they are not unique to LLRW. This has lead to the identification of non-LLRW waste at approximately 15 sites, which the PHAI has no mandate or funding to remediate. Based on this, the PHAI has worked with the regulator to limit the testing to the four signature COPCs, which reduces, although does not entirely eliminate, the false positive identification of LLRW.

Community-Specific Radon Trigger

Radon is used as a trigger to increase the level of soil sampling in the vicinity of buildings. The project initially made use of a trigger – 125 Bq/m^3 - that was developed from the study of radon levels in homes 100 km to the west of Port Hope, located in a different geological zone. However, the Health Canada Guideline is 200 Bq/m^3, therefore, the use of 125 Bq/m^3 resulted in more than 18% of properties with radon above the project trigger concentration, all properties then requiring enhanced soil investigations. Property owners were also unnecessarily concerned. Subsequent statistical analysis of radon data from properties in Port Hope not having LLRW determined that a more appropriate trigger should be 200 Bq/m^3. Only 4.5% of homes exceeded the new trigger.

Radon as a Tool to Identify LLRW

Since the Port Hope area was the subject of a gamma and radon-driven cleanup 35 years ago, soils with elevated radium have been removed from many residential areas. As such, remediations at most SSS are driven by arsenic and, less so, by uranium. Radon and radium as COPCs to drive remediations are less commonly seen in the survey. As well, since radon is a naturally occurring gas, its detection at concentrations exceeding the project trigger (200 Bq/m^3) is not a sure indicator of radium-226 and LLRW. Its use, interpretation of the data and communication with the public must be carefully planned. Prompt communication and mitigation when radon exceeds the Health Canada guideline by either the property owner (if natural) or by PHAI (if associated with LLRW) is important.

Staging of the Survey

Staging the survey in campaigns of ever increasing size provided multiple benefits to the project including increasing staff capacity, developing strategies for sampling and analysis, identifying opportunities to strengthen the program, and confirming assumptions about LLRW distribution in the community.

Benefits of Real-Time Soil Testing

The project makes use of the XRF soil analysis and gamma scans to identify samples for laboratory analysis, ultimately relying on laboratory analyses to confirm the presence or absence of LLRW. Although there has been extensive use of both instruments, the ability to replace laboratory analyses has not been achieved. Testing to date has demonstrated that scan time, moisture reduction and particle size reduction can all increase the accuracy of the XRF. These tools need to be refined before the project can have greater confidence in their use, which could result in a significant time and cost saving during investigations. The time and cost savings during remediation will be even more significant by eliminating delays associated with backfilling of excavations while awaiting data.

Data Management

The management of data from over 4,800 properties is significant, and is critical to the success of the project. The PHAI makes use of a Geographical Information System to manage data. Data can be uploaded to the system by multiple parties and readily retrieved and manipulated.

CONCLUSION

The paper describes the procedures used to identify LLRW exceeding clean-up criteria on properties in an urban environment. Procedures have been developed based on 35 years of experience in performing radiological surveys in Port Hope, as well as experiences at other projects. The survey is being staged to allow for increasing sizes of campaigns in order to incorporate lessons learned into the subsequent larger campaign. This strategy has proven to be very successful. Methods to identify LLRW soil include exterior gamma, radon, and borehole soil sampling, the former two, when elevated, acting as triggers for enhanced investigation by boreholes. Use of the radon tool requires clear and prompt communication with the property owners when the Health Canada guideline is exceeded and prompt action on determining the source of the radon (natural or LLRW). The balance between the benefits/costs of increased investigation to define in detail the limits of LLRW versus remediation which may include some non-LLRW if the LLRW limits are not precise is discussed. The importance of this consideration especially when properties contain LLRW within structural elements of buildings is highlighted. The project is successfully identifying LLRW in a complex urban environment and its procedures and lessons learned should be benchmark for other similar projects.

References

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