Canadian Nuclear Safety Commission Independent Environmental Monitoring Program

SRB Technologies (Canada) Inc. Nuclear Substance Processing Facility (2015)

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EXECUTIVE SUMMARY

Under the *Nuclear Safety and Control Act*, licensees of nuclear facilities are required to implement an environmental monitoring program (EMP) to demonstrate that the public and the environment are protected from emissions related to the facility's nuclear activities. The results of these monitoring programs are submitted to the Canadian Nuclear Safety Commission (CNSC) to ensure compliance with applicable guidelines and limits, as set out in regulations that oversee Canada's nuclear industry.

SRB Technologies (Canada) Inc. (SRB) is licensed by the CNSC to operate a nuclear substance processing facility located in Pembroke, Ontario. SRB uses the nuclear substance tritium to make self-luminous lights for emergency exit signs, military applications (such as landmine markers) and other safety products not requiring batteries or other external sources of power. SRB implements and maintains a comprehensive environmental protection program to monitor and control nuclear substances released from the SRB facility to determine concentrations of contaminants in the environment and assess exposure to the public.

To complement ongoing compliance activities, the CNSC launched its Independent Environmental Monitoring Program (IEMP) to independently verify that the public and the environment around licensed nuclear facilities are safe. The IEMP involves taking samples from public areas around the facilities, and measuring and analyzing the amount of radiological (nuclear) and non-radiological (hazardous) substances in those samples. CNSC staff collect the samples and send them to the CNSC's state-of-the-art laboratory for testing and analysis.

The 2015 IEMP sampling plan for the SRB facility site focused on nuclear contaminants. A site-specific sampling plan was developed based on SRB's approved EMP, CSA Group standards and the CNSC's regulatory experience with the site. In 2015, samples were collected in publicly accessible areas outside the SRB facility site perimeter and included air, river water and soil as well as food such as milk and produce from local sources outside of the SRB facility perimeter.

The measured radioactivity in the water samples is below federal and provincial drinking water quality guidelines. Based on the measured radioactivity in the samples collected, no health impacts are expected as a result of exposure to the water sampled.

The radioactivity measured in the air, soil, milk and vegetation samples were below available federal/provincial guidelines and CNSC reference levels. CNSC reference levels are based on conservative assumptions about the exposure that would result in a dose of 0.1 mSv/year. Based on the radionuclide activity concentrations measured in the samples collected, no health impacts are expected.

The IEMP results indicate that the public and the environment in the vicinity of the SRB facility site are safe and that there are no health impacts. These results are consistent with the results submitted by SRB, demonstrating that the licensee's environmental protection program protects the health and safety of people and the environment.

TABLE OF CONTENTS

List of Tables

List of Figures

1. INTRODUCTION

The Canadian Nuclear Safety Commission (CNSC) regulates the use of nuclear energy and materials to protect health, safety, security and the environment and to implement Canada's international commitments on the peaceful use of nuclear energy; and to disseminate objective scientific, technical and regulatory information to the public. SRB Technologies (Canada) Inc. (SRB) uses the nuclear substance tritium to make self-luminous light sources for emergency exit signs, military applications (such as landmine markers) and other safety products not requiring batteries or other external sources of power.

As a condition of its licence, SRB implements and maintains a comprehensive environmental protection program (EPP) to monitor and control nuclear substances released from its nuclear substance processing facility located in Pembroke, Ontario. The CNSC conducts activities to verify compliance of licensees' programs. These activities include desktop reviews of licensees' results, which are submitted to the CNSC annually, as well as site inspections. CNSC staff review the licensees' monitoring results to ensure:

- the licensee is demonstrating adequate operational control of its facility
- environmental releases are below applicable limits
- principles of pollution prevention and ALARA (as low as reasonably achievable, with social and economic factors taken into account) are being applied
- humans and the environment are protected

The CNSC launched the Independent Environmental Monitoring Program (IEMP) to align with other Canadian and international regulatory bodies. The IEMP complements the CNSC staff reviews and approvals of licensees' environmental monitoring programs (EMPs) during licensing, as well as compliance activities to ensure licensees are adhering to the regulatory requirements, licence conditions and approved programs throughout the operation of nuclear facilities.

The IEMP is performed by CNSC staff in public areas and consists of sampling environmental media and analyzing radiological and non-radiological substances released from facilities in all areas of the nuclear fuel cycle: uranium mines and mills, processing facilities, power plants and research reactors, and waste management facilities. A summary of the results is made available on the CNSC website.

2. BACKGROUND

2.1 SRB site and facility

The SRB facility is located in Pembroke, Ontario, approximately 300 metres west of the Muskrat River and 150 kilometres northwest of Ottawa. It processes tritium gas to produce light sources and manufactures radiation devices to contain those sources.

SRB leases space in an industrial building similar to a strip mall. The closest residence is located approximately 255 metres northwest of the facility.

There are two stacks at the SRB facility that release tritium. The principle stack is known as the “rig stack” and is related to the processing of tritium. The other is known as the “bulk stack” and primarily handles the bulk transfer of tritium from the main tritium container to smaller pyrophoric units.

SRB also releases liquid effluent in batches to the municipal sewer system. These are sampled prior to discharge to ensure all applicable standards and guidelines are met.

The CNSC regulates SRB's activities at the SRB facility site under a Class 1B nuclear substance processing facility operating licence (NSPFOL-13.00/2022).

2.2 SRB environmental protection program

The EPP comprises two sub-programs: the effluent and emission monitoring program and the EMP. The effluent and emission monitoring program ensures releases to the environment from the facility are controlled and monitored. The EMP determines the level of contaminants in the environment as a result of the releases and assesses any environmental impacts.

2.2.1 SRB effluent and emission monitoring program

As part of its EPP, SRB has controls in place to minimize the releases of radiological substances into the environment. Such controls incorporate the principles of pollution prevention and ALARA to ensure releases are below prescribed limits. SRB implements a comprehensive air emission and liquid effluent monitoring program that regularly monitors radiological releases from the operations of the SRB facility.

Releases result from tritium transfer operations (where a bulk storage container is split into manageable sizes), filling glass tubes with tritium and the testing of tritium light sources. Tritium is the primary radiological substance released during SRB facility operations in atmospheric emissions and liquid effluent.

Per CNSC requirements, release limits (along with corresponding action levels) for airborne and waterborne radiological releases from the SRB facility site are prescribed in SRB's operating licence and the corresponding licence conditions handbook issued by the CNSC. These are in place to establish a framework to ensure releases are controlled and to ensure the protection of the health and safety of the public and the environment. The results from the SRB effluent and emissions monitoring program for radiological parameters are, in general, below the limits and guidelines. SRB's effluent and emission monitoring results are provided in SRB's annual safety report, *2015 Annual Compliance and Performance Report*. [1]

2.2.2 SRB environmental monitoring program

SRB maintains a comprehensive EMP for the its facility that consists of radiological components.

The radiological components of the EMP are conducted through the routine collection and analysis of environmental samples from numerous locations within the SRB facility site and the surrounding area. Monitored media include ambient air; foodstuffs such as milk, wine, fruits and vegetables; and river water, groundwater and other surface waters both onsite and offsite. The results from SRB’s EMP for radiological parameters are, in general, below the limits and guidelines.

SRB also conducts groundwater monitoring, focusing on groundwater quality within two kilometres of the SRB facility. The results from the EMP show that of the 34 monitoring wells, only two exceeded the *Ontario Drinking Water Quality Standards* limit of 7,000 Bq/L. [6] These wells, both of which are not drinking water wells, are located within 50 metres of the stack. The SRB monitoring and assessment results are provided in SRB's annual safety report, *2015 Annual Compliance and Performance Report*. [1]

3. INDEPENDENT ENVIRONMENTAL MONITORING PROGRAM

3.1 Objective

The objective of the IEMP is to independently verify that the public and the environment around nuclear facilities are safe and protected from releases from the facilities; it helps confirm the CNSC's regulatory position and support decision making. The results are independent of the facility's EMP.

The IEMP objective can be achieved by:

- directly measuring contaminant concentrations in the surrounding environment that are associated with nuclear activities
- comparing contaminant concentrations with available background values, environmental quality criteria and other available benchmarks
- assessing risk to the public and the environment associated with releases and concentrations of nuclear and hazardous substances in the environment

3.2 Program design

The IEMP for the SRB facility was informed by CSA standard N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*. [2] The site-specific sampling plan also took into consideration SRB’s approved EMP for the facility and the CNSC's regulatory experience with the SRB facility site.

4. SAMPLING AND ANALYTICAL METHODS

4.1 Sampling criteria

CNSC staff conduct IEMP sampling based on:

- **Contaminants of interest:** Contaminants are identified based on the operation of the site, releases to the environment and other factors identified in the facility environmental risk assessment.
- **Environmental samples:** Environmental samples are obtained from various media (e.g., water, air, soil, vegetation) and biota and foodstuffs (e.g., meat, fish, milk, produce), reflecting the exposure pathways linking releases from operation of the facility with human receptors (i.e., environmental transfer).
- **Location:** Locations are publicly accessible areas that are representative of areas of potential exposure based on exposure pathways, as well as reference locations for which there is no potential for exposure from the operations of the nuclear facility. Location selection will often consider distance from the operation as well as meteorological data, such as predominant wind direction and precipitation for atmospheric releases and water current for effluent discharges. In addition, sampling in areas not related to nuclear sites is also considered to determine reference or background values that are not always available.

4.2 Sample collection

The sampling locations were chosen taking into account possible dispersion of operational releases from the SRB facility site. Most locations are close to or at the SRB facility offsite sampling locations described in SRB's annual safety report, *2015 Annual Compliance and Performance Report*. [1] The samples were collected on public land at locations accessible by road, outside the SRB facility site perimeter. Tables 1 to 5 describe the sampling locations. Figures A-1 to A-3 (as applicable) in appendix A provide maps of these locations. A total of 16 samples of water, soil, sediment and vegetation plus five samples of foodstuff (21 samples total) were collected at 12 locations in July 2015. Sample collection techniques were grab sampling, shovelling and purchasing of locally produced dairy and meat from local stores.

Table 1: Description of air samples

Sample ID	Sampling location
SR03-A03	Behind SRB facility, on Upper Valley Drive
SR13-A05	Intersection of Sheppard Road and Moss Drive (Golfview Park)
SR17-A06	End of Hawthorne Lane

Table 2: Description of water samples

Sample ID	Sampling location	Sample description
SR10-W03	Underneath the bridge	Surface water
SR11-W04	Reference – Ottawa River, west of Muskrat River flow (marina)	Surface water
SR15-W05	Exposure – Ottawa River at Muskrat River flow	Surface water

Table 3: Description of soil samples

Sample ID	Sampling location	Sample description
SR01-S06	Boudens Gardens	Soil (0–5 cm)
SR02-S01	Upper Valley Drive, east of SRB facility	Soil (0–5 cm)
SR03-S02	Behind SRB facility, on Upper Valley Drive	Soil (0–5 cm)
SR05-S03	Corner of International Road and Upper Valley Drive (next to corn field)	Soil (0–5 cm)
SR13-S05	Intersection of Sheppard Road and Moss Drive (Golfview Park)	Soil (0–5 cm)

Table 4: Description of grass or wild vegetation samples

Sample ID	Sampling location	Sample description
SR01-V05	Boudens Gardens	Vegetation
SR02-V01	Upper Valley Drive, east of SRB facility	Vegetation
SR03-V02	Behind SRB facility, on Upper Valley Dr.	Vegetation
SR05-V03	Corner of International Road and Upper Valley Drive (next to cornfield)	Vegetation
SR13-V04	Intersection of Sheppard Road and Moss Drive (Golfview Park)	Vegetation

Table 5: Description of foodstuff samples

Sample ID	Sampling location	Sample description
SR01-F03	Boudens Gardens	Potatoes
SR01-F06	Boudens Gardens	Green peppers
SR12-F05	Brum's Dairy	Homogenized milk
SR14-F07	Off of Boundary Road, north of SRB facility site	Wild apples
SR14-F08	Off of Boundary Road, north of SRB facility site	Wild raspberries

4.3 Analytical techniques

The following sections discuss the analytical techniques used to analyse the samples collected around the SRB facility.

4.3.1 Radiological analyses

4.3.1.1 Air samples

Air samples were analyzed for tritiated water (HTO) and tritiated hydrogen (HT) using a liquid scintillation counter (LSC). The HTO and HT concentration was calculated using the volume of air (m^3) passed through a bubbler during the sample collection period.

4.3.1.2 Water samples

The water samples were purified using distillation and analyzed for HTO with a low-background PerkinElmer LSC.

4.3.1.3 Soil samples

Soil samples were analyzed for HTO and organically bound tritium (OBT). For HTO analysis, water was extracted from these samples using the freeze-drying method under a vacuum setup. The extracted water samples were analyzed for tritium using a low-background PerkinElmer LSC. For OBT analysis, the dried soil samples were combusted in a furnace. The extracted water was purified using distillation and measured with the LSC.

4.3.1.4 Foodstuff and vegetation samples

The foodstuff and vegetation samples were analyzed for HTO and OBT. For HTO analysis, water was extracted from food samples using the freeze-drying method under a vacuum setup. The extracted water samples were analyzed for HTO using a low-background PerkinElmer LSC. For OBT analysis, the dried food samples were combusted in an oxygen pressure vessel. The extracted water was purified using distillation and measured with the LSC.

4.3.2 Quality assurance and quality control

The principal objective of the laboratory analysis is to produce high-quality data. This is achieved through the use of analytical methods and procedures that are accurate and reliable.

Standard reference material obtained from the U.S. National Institute of Standards and Technology (NIST), written methods and standard operating procedures are used. In addition, the CNSC laboratory participates in proficiency testing (PT) offered by national organizations such as National Research Council Canada; the Quebec Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques; and international laboratories such as the International Atomic Energy Agency's Analytical Laboratories for the Measurement of Environmental Radioactivity and the Safeguards Analytical Laboratory.

The following sections provide an overview of the quality control (QC) elements that ensure the quality of the IEMP data.

4.3.2.1 Field protocol

IEMP sampling procedures were developed based on recognized and validated sampling methods. Sample preservation is conducted following best practices for applicable analytical methods. Samples are shipped to the CNSC laboratory using predetermined protocols for packaging and chain-of-custody (cooler for sample preservation and courier service). For the SRB facility, the samples were transported to the laboratory by the field sampling crew, who used coolers filled with ice to keep the samples cold to maintain sample integrity.

4.3.2.2 Radiological analyses

Selected standard reference materials traceable to NIST were used to calibrate the parameters of the counting instruments. For tritium analysis, a tritium NIST 4926e standard was used as the QC sample. All radiological sample batches included a blank sample for background detection. Samples for tritium were measured in duplicates. In addition, instrument performance and calibration were verified regularly using the same standards. The QC criterion specifies that the amount of variation of the set of data values of the QC checks must be within three standard deviations of the mean values of the calibration standard values. The laboratory also participates in PT exercises offered by external programs and has achieved passing results on analysis of tritium.

4.3.2.3 Minimum detectable concentration

As explained in the *Multi-Agency Radiation Survey and Site Investigation Manual*, a minimum detectable concentration (MDC) is the *a priori* net activity level above the critical level that an instrument can be expected to detect 95 percent of the time. [3] In addition, MDC is calculated from measured values of input quantities and will slightly change from sample to sample depending on test portion size and background level. For samples for which detectable activity was not found, we have reported the calculated MDC with the symbol <, as shown in appendix B.

5. RESULTS AND DISCUSSION

5.1 Interpretation criteria

Various sources are used to interpret the results, including comparisons with applicable background values and appropriate federal or provincial environmental quality criteria. For the SRB facility, the following criteria were used to interpret the results.

Federal environmental quality criteria used included Health Canada's *Guidelines for Canadian Drinking Water Quality*. [4][5]

For radiological parameters with no existing criteria, CNSC reference levels were established based on conservative assumptions and using the methodology found in CSA standard N288.1-14, *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities*. [7] The reference level for a particular radionuclide in a particular medium represents the activity concentration in that medium that would result in a whole-body effective dose of 0.1 mSv/year to a member of the public, based on the dominant exposure pathways (e.g., inhalation, ingestion, external immersion). The dose of 0.1 mSv/year was chosen to align with the approach used by the World Health Organization and Health Canada for drinking water standards. [4][5][8] It represents one-tenth of the CNSC's public dose limit of 1 mSv/year.

The licensee's data are also considered when assessing the IEMP results to verify that the licensee's data are within the range of what was measured in the IEMP. Accordingly, if an IEMP sample result is above the range reported by the licensee and has a potential for risk, an investigation would be launched and necessary actions to protect public health and the environment would be taken.

5.2 Radiological analyses

5.2.1 Air samples

Radionuclide activity concentrations in air samples collected around the SRB facility are provided in table B-1 of appendix B. Sample results for HTO and HT were compared with CNSC reference levels. In the air samples, the HTO and HT activity concentrations were more than 3.5 and 8,700 times lower than the reference levels, respectively, indicating inhalation and immersion levels do not pose a risk to human health.

The 2015 results for SR03-A03 are several orders of magnitude higher than past IEMP sampling results. The SRB facility emits non-continuously, which means the concentration in the air fluctuates. The concentrations measured in the 2015 IEMP campaign are within SRB's normal operating range.

Note that the sample results collected by SRB as part of its EMP are not directly comparable to the results collected by CNSC staff through the IEMP. The SRB facility collects samples over a whole month, providing an average concentration for that month. The IEMP program collects the sample over several hours, which provides a snapshot. Because the SRB facility emits non-continuously, these results may not align.

Based on the radionuclide activity concentrations measured in the samples collected, CNSC staff conclude there are no health impacts expected to members of the public as a result of exposure to the air sampled.

5.2.2 Water samples

Radionuclide activity concentrations in water samples collected around the SRB facility are provided in table B-2 of appendix B. The sample results were compared with Health Canada's *Guidelines for Canadian Drinking Water Quality*. [4][5] Levels of HTO in Muskrat River water were below the detection limit for two of the three samples; in the sample with a detectable level, the concentration was more than 2,200 times lower than the Health Canada standards. Based on the measured radioactivity in the water samples collected, CNSC staff conclude there are no health impacts expected to members of the public as a result of exposure to the water sampled.

5.2.3 Soil samples

Radionuclide activity concentrations in soil samples collected around the SRB facility are provided in table B-3 of appendix B. The sample results were compared with CNSC reference levels that consider both accidental soil ingestion and groundshine (i.e., external immersion) pathways. The measured radioactivity in soil samples was below CNSC reference levels. No health impacts are expected at this dose level.

5.2.4 Vegetation samples

Radionuclide activity concentrations in vegetation samples collected around the SRB facility are provided in table B-4 of appendix B. The measured levels of other radionuclides in vegetation samples collected around the SRB facility were below CNSC reference levels, which are reflective of a dose where no health impacts are expected. Based on the radionuclide activity concentrations measured in the samples collected, CNSC staff conclude there are no health impacts expected to members of the public as a result of exposure to the grass and wild vegetation sampled.

5.2.5 Foodstuffs samples

Radionuclide activity concentrations in milk, fruit and vegetable samples collected around the SRB facility are provided in appendix B in tables B-5, B-6 and B-7, respectively. Sample results for HTO and OBT were compared with CNSC reference levels, which are reflective of a dose where no health impacts are expected. In the milk sample, the HTO activity concentrations were more than 3,200 times lower than the reference level and the OBT activity concentrations were below the method's minimum detectable concentration. The HTO activity concentrations in the fruit samples were upwards of 1,200 times lower than the reference level and the OBT activity concentrations in the fruit were more than 2,800 times lower than the reference level. The HTO activity concentrations in vegetable samples were more than 13,000 times lower than the reference level and the OBT activity concentrations were below the method's minimum detectable concentration. Based on the radionuclide activity concentrations measured in the samples collected, CNSC staff conclude there are no health impacts expected to members of the public as a result of exposure to the foodstuffs sampled.

6. CONCLUSION

The radiological analyses of samples collected around the SRB facility were performed using appropriate and validated analytical methods.

The measured radioactivity in water is below the MDC, indicating that both the Muskrat River and Ottawa River are at safe levels to drink.

The measured radioactivity in soil and vegetation samples, as well as in the samples of milk, fruits and vegetables, were below CNSC reference levels and within available background levels. CNSC reference levels are based on conservative assumptions about the exposure that would result in a dose of 0.1 mSv/year, which represents one-tenth of the CNSC's public dose limit of 1 mSv/year. No health impacts are expected at this dose level.

The IEMP results indicate that the public and the environment in the vicinity of the SRB facility are protected and that there is no unreasonable risk to health and the environment. The IEMP results are consistent with the results submitted by SRB, demonstrating that the licensee's EPP protects the health and safety of people and the environment.

ACRONYMS

ALARA	as low as reasonably achievable
Bq	becquerel
CNSC	Canadian Nuclear Safety Commission
EMP	environmental monitoring program
HT	tritiated hydrogen
HTO	tritiated water
OBT	organically bound tritium
IEMP	Independent Environmental Monitoring Program
LSC	liquid scintillation counter
MDC	minimum detectable concentration
NIST	National Institute of Standards and Technology
PT	proficiency testing
SRB	SRB Technologies (Canada) Inc.

REFERENCES

1. SRB Technologies (Canada) Inc., *2015 Annual Compliance and Performance Report*

2. CSA Group, *N288.4-10: Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*, 2010

3. U.S. Nuclear Regulatory Commission, *Multi-Agency Radiation Survey and Site Investigation Manual*, NUREG-1575, revision 1, 2000, available at http://www.epa.gov/radiation/multi-agency-radiation-survey-and-site-investigation-manual-marssim

4. Health Canada, Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment, *Guidelines for Canadian Drinking Water Quality – Summary Table*, October 2014, available at http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/sum_guide-res_recom/index-eng.php

5. Health Canada, *Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Radiological Parameters,* 2009

6. Ontario Ministry of the Environment, *Ontario Regulation 169/03 – Ontario Drinking Water Quality Standards,* 2003, available at http://e-laws.gov.on.ca/html/regs/english/elaws_regs_030169_e.htm

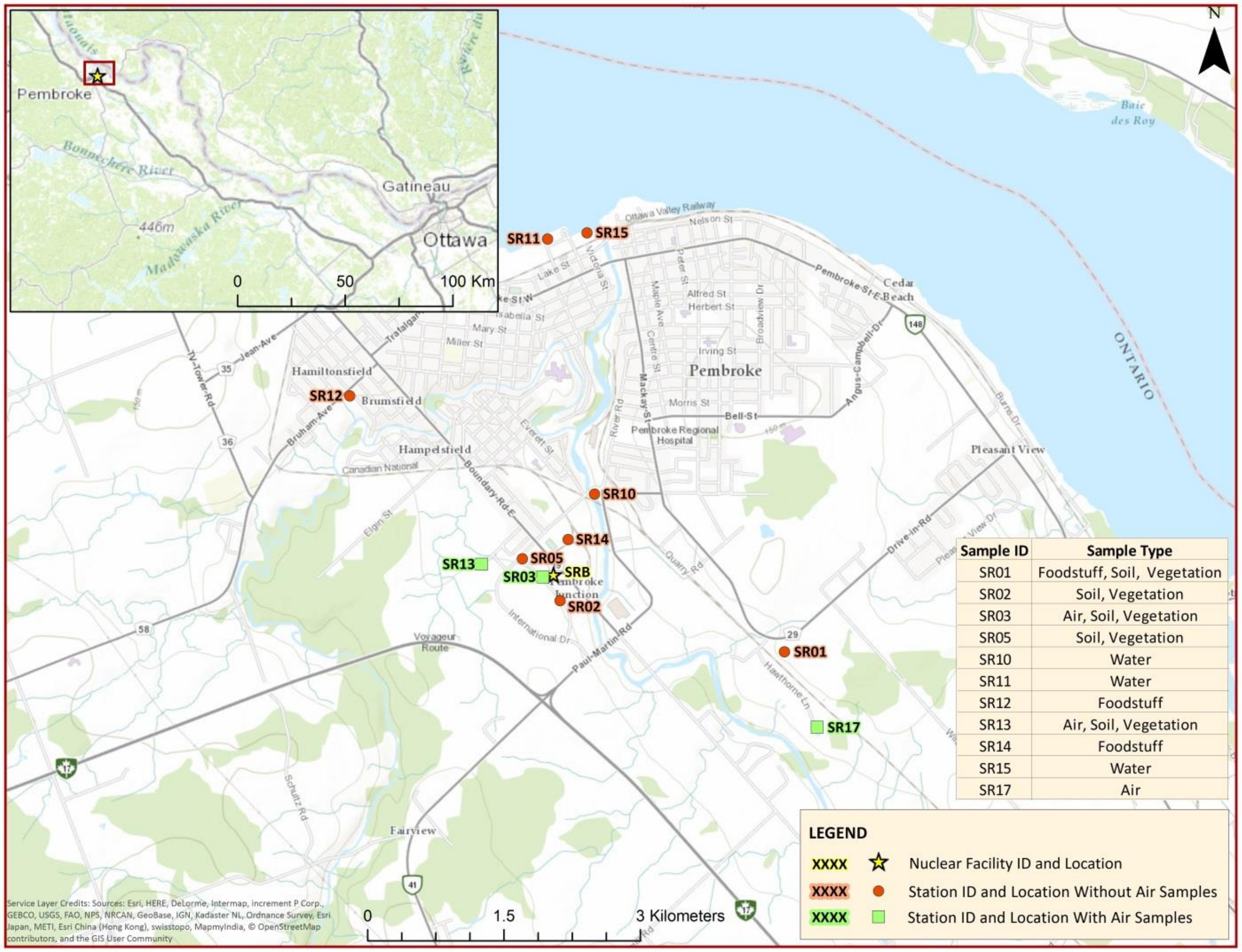
7. CSA Group, *N288.1-14: Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities,* 2014

8. World Health Organization, *Guidelines for Drinking-water Quality*, third edition, 2008, available at http://www.who.int/water_sanitation_health/dwq/fulltext.pdf

APPENDIX A: MAPS

For location descriptions for all maps, consult tables 1–5 as applicable in the main report.

Figure A-1: Location of the SRB facility and the 2015 sample locations



Sample ID	Sample Type
SR01	Foodstuff, Soil, Vegetation
SR02	Soil, Vegetation
SR03	Air, Soil, Vegetation
SR05	Soil, Vegetation
SR10	Water
SR11	Water
SR12	Foodstuff
SR13	Air, Soil, Vegetation
SR14	Foodstuff
SR15	Water
SR17	Air

Figure A-2: Location of the SRB facility and the 2015 samples near the facility

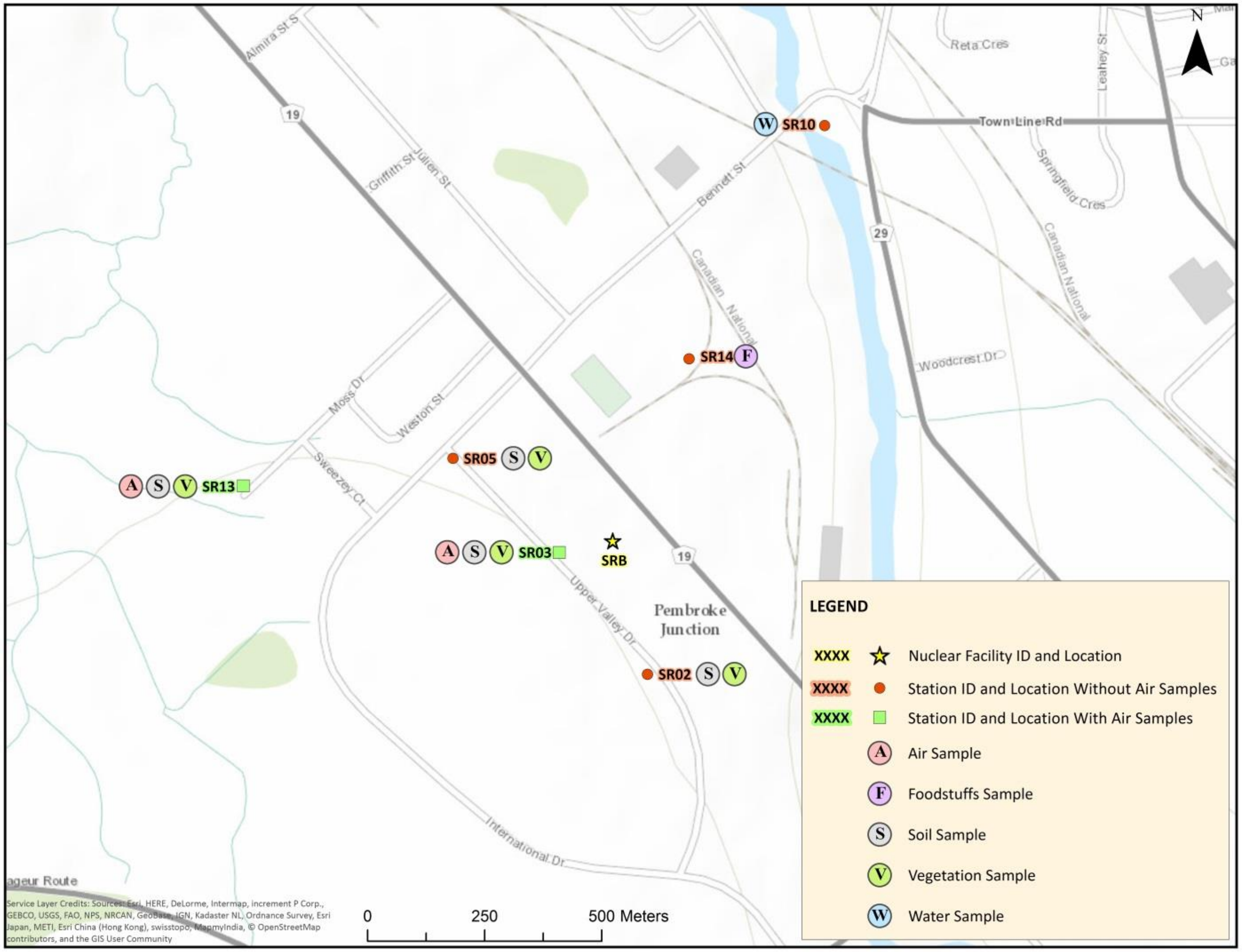


Figure A-3: Location of the SRB facility and the 2015 sample locations north of the facility

APPENDIX B: IEMP SAMPLE ANALYSIS RESULTS

Table B-1: Results of tritium concentration in air samples

Sample ID	Tritiated water (HTO) (Bq/m^3)	Tritiated hydrogen (HT) (Bq/m^3)
Reference level[1]	**340**	**5,100,000**
SR03-A03	46.7	581.7
SR13-A05	1.1	83.5
SR17-A06	96.4	2.0

1. The concentration required for a hypothetical person (most-exposed member of a critical group) to receive an effective whole body dose of 0.1 mSv/year due to exposure to the given radionuclide from air inhalation and immersion. The reference levels were calculated based on conservative assumptions using CSA standard N288.1-14. [7]

Table B-2: Results of tritium concentration in water samples

Sample ID	Tritiated water (HTO) (Bq/L)
Drinking water guidelines[1]	**7,000**
SR10-W03	3.1
SR11-W04	[2]<3
SR15-W05	<3

1. Health Canada *Guidelines for Canadian Drinking Water Quality*. [4][5]
2. The < symbol indicates that a result is below the provided minimum detectable concentration for laboratory analysis.

Table B-3: Results of tritium concentration in soil samples

Sample ID	Tritiated water (HTO) (Bq/kg fresh weight)	Organically bound tritium (OBT) (Bq/kg fresh weight)
Reference level[1]	**68,500,000**	**27,900,000**
SR01-S06	[2]<1.5	5.0
SR02-S01	23.6	30.5
SR03-S02	87.1	29.4
SR05-S03	38.0	42.5
SR13-S05	20.4	[2]<1.5

1. The concentration required for a hypothetical representative person (most-exposed member of a critical group) to receive an effective whole-body dose of 0.1 mSv/year due to exposure to the given radionuclide from accidental soil ingestion and groundshine. The reference levels were calculated based on conservative assumptions using CSA standard N288.1-14. [7]
2. The < symbol indicates that a result is below the provided minimum detectable concentration for laboratory analysis.

Table B-4: Results of tritium concentration in grass samples

Sample ID	Tritiated water (HTO) (Bq/kg fresh weight)	Organically bound tritium (OBT) (Bq/kg fresh weight)
Reference level[1]	**10,900**	**73,000**
SR01-V05	6.4	9.9
SR02-V01	61.8	245.5
SR03-V02	328.9	370.7
SR05-V03	111.1	292.4
SR13-V04	31.1	76.6

1. The concentration required for a hypothetical representative person (most-exposed member of a critical group) to receive an effective whole-body dose of 0.1 mSv/year due to exposure to the given radionuclide from ingestion of grasses and wild vegetation via meat consumption. The reference levels were calculated based on conservative assumptions using CSA standard N288.1-14. [7]

Table B-5: Results of tritium concentration in milk samples

Sample ID	Tritiated water (HTO) (Bq/kg fresh weight)	Organically bound tritium (OBT) (Bq/kg fresh weight)
Reference level[1]	**5,560**	**2,260**
SR12-F05	1.7	[2]<1.5

1. The concentration required for a hypothetical representative person (most-exposed member of a critical group) to receive an effective whole-body dose of 0.1 mSv/year due to exposure to the given radionuclide from milk ingestion. The reference levels were calculated based on conservative assumptions using CSA standard N288.1-14. [7]
2. The < symbol indicates that a result is below the provided minimum detectable concentration for laboratory analysis.

Table B-6: Results of tritium concentration in fruits

Sample ID	Tritiated water (HTO) (Bq/kg fresh weight)	Organically bound tritium (OBT) (Bq/kg fresh weight)
Reference level[1]	**123,000**	**50,300**
SR14-F07 (wild raspberries)	34.1	11.8
SR14-F08 (wild apples)	99.4	17.5

1. The concentration required for a hypothetical representative person (most-exposed member of a critical group) to receive an effective whole-body dose of 0.1 mSv/year due to exposure to the given radionuclide from fruit ingestion. The reference levels were calculated based on conservative assumptions using CSA standard N288.1-14. [7]

Table B-7: Results of tritium concentration in vegetables

Sample ID	Tritiated water (HTO) (Bq/kg fresh weight)	Organically bound tritium (OBT) (Bq/kg fresh weight)
Reference level[1]	**279,000**	**121,000**
SR01-F03 (potatoes)	4.9	[2]<1.5
Reference level[1]	**104,000**	**45,200**
SR01-F06 (green peppers)	7.5	[2]<1.5

1. The concentration required for a hypothetical representative person (most-exposed member of a critical group) to receive an effective whole-body dose of 0.1 mSv/year due to exposure to the given radionuclide from vegetable ingestion. The reference levels were calculated based on conservative assumptions using CSA standard N288.1-14. [7]
2. The < symbol indicates that a result is below the provided minimum detectable concentration for laboratory analysis.