SRB Technologies (Canada) Inc.

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2017 Annual Compliance and Performance Report

Reporting Period:	January 1 – December 31, 2017
Licence Number:	NSPFOL-13.00/2022
Licence Condition:	4.2

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SRB Technologies (Canada) Inc.

2017 Annual Compliance and Performance Report

Submission date: March 29, 2018

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Executive Summary

SRBT is pleased to provide this compliance and performance report to the Canadian Nuclear Safety Commission as part of our licensed activities.

Our facility continues to process tritium safely, responsibly and efficiently, and we are proud of the level of performance and degree of improvement that was achieved during 2017.

The ratio of the amount of tritium released to atmosphere versus the amount of tritium that we process once again decreased, with the achievement of a new low value of 0.08%, meaning that for every 1,000 units of tritium that goes into our product, less than one unit was eventually released as gaseous effluent.

We achieved this ratio despite an increase in tritium processing of over 17%. In 2017, SRBT processed 32,968,695 GBq of tritium into self-luminous light sources and safety devices; in comparison, in 2016, a total of 28,122,678 GBq of tritium was processed. The total amount of tritium released to the environment through the gaseous effluent pathway was lower this year (24,822 GBq) than the previous year (28,945 GBq), despite the increase in production.

Based upon projections, we expect that in 2018, the ratio of tritium released to atmosphere versus processed will fall below our established target of 0.13%, and that the annualized averaged weekly gaseous release will also fall below our established target of 650 GBq / week.

Controlled changes to tritium processing strategies and components, and several emission-reduction initiatives continue to pay dividends with respect to worker dose, public dose, and the environmental impact of our facility.

The collective dose to our staff once again reached an all-time low for a full processing year at 1.96 person-mSv, and no staff member exceeded 1 mSv for the year – a value that represents the dose limit to the public. This is a testament to the continued diligence of our workers in maintaining radiation exposures as low as reasonably achievable (ALARA).

The calculated public dose remains far less than 1% of the prescribed limit of 1 mSv, as derived from direct sampling and monitoring of the local environment. Groundwater tritium concentrations continue to respond favorably to modified and optimized processing practices.

Our facility continues to be subjected to several independent assessments during the year, and we have continued to conduct our internal compliance program to complement these audits. In 2017, CNSC staff performed two inspections at the facility, resulting in a total of three compliance items being identified, as well as eight recommendations being made; all of these items have since been fully addressed to the satisfaction of CNSC staff.

Throughout the year, SRBT provided CNSC staff revisions of several key documents associated with our licensing basis, including but not limited to the Safety Analysis Report, the Fire Protection Program, the Quality Manual, the Effluent Monitoring Program, the Waste Management Program and the Radiation Safety Program.

As well, SRBT developed and implemented new stand-alone programs focused on Groundwater Protection and Monitoring, as a result of the implementation plan associated with the set of CSA N288-set of standards.

Site specific requirements for payments to the decommissioning escrow account have continued to be met. This represents a completely self-funded vehicle that does not rely on insurance, letters of credit or third party resources in order to ensure funding availability for decommissioning.

In summary, 2017 represents a highly successful and safe year of operation for SRBT; however, continual improvements in compliance and safety is an ongoing mission. We will always strive to reduce and optimize safety and the effective doses to our workers and the public, and our operational impact on the environment.

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Acronyms and Abbreviations

ACR	Annual Compliance Report / Annual Compliance and Performance Report)
ALARA	As Low As Reasonably Achievable
Bq	Becquerel
BSI	British Standards Institute
CLC	Canada Labour Code
CLW	Clearance Level Waste
CN	Canadian National (railway)
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
CVC	Compliance Verification Criteria
dp	Differential Pressure
DSL	Dosimetry Service Licence
DU	Depleted Uranium
ECR	Engineering Change Request
EMP	Environmental Monitoring Program
EMS	Environmental Management System
ERA	Environmental Risk Assessment
ESDC	Employment And Social Development Canada
FASC	Facility Access Security Clearance
FPP	Fire Protection Program
GHS	Globally Harmonized System
GMP	Groundwater Monitoring Program
GTLS	Gaseous Tritium Light Source
GWMP	Groundwater Monitoring Program
HRSDC	Human Resources And Skills Development Canada

Acronyms and Abbreviations (cont'd)

HT	Elemental Tritium
HTO	Tritium Oxide
HVAC	Heating, Ventilation, Air Conditioning
IAEA	International Atomic Energy Agency
IATA	International Air Transportation Agency
ISO	International Organization For Standardization
IT	Information Technician
LCH	Licence Conditions Handbook
LLW	Low-Level Waste
LSC	Liquid Scintillation Counters / Counting
MDA	Minimum Detectable Activity
MOL	Ministry of Labour
MSP	Management System Procedure
MW	Monitoring Well
MWC	Muskrat Watershed Council
NBCC	National Building Code of Canada
NCR	Non-Conformance Report
NDR	National Dose Registry
NFCC	National Fire Code Of Canada
NIST	National Institute Of Standards And Technology
NSCA	Nuclear Safety And Control Act
NSPFOL	Nuclear Substance Processing Facility Operating Licence
OBT	Organically Bound Tritium
OFI	Opportunity For Improvement
OLC	Operating Limits And Conditions
PAS	Passive Air Sampler

Acronyms and Abbreviations (cont'd)

PDP	Preliminary Decommissioning Plan
PFD	Pembroke Fire Department
PIP	Public Information Program
PLC	Professional Loss Control
PTNSR	Packaging and Transport of Nuclear Substances Regulations
PUTT	Pyrophoric Uranium Tritium Trap
QA	Quality Assurance
QC	Quality Control
RDU	Remote Display Unit
REGDOC	Regulatory Document
RPD	Relative Percent Difference
RW	Residential Well
SAR	Safety Analysis Report
SAT	Systematic Approach To Training
SCA	Safety And Control Area
SRBT	SRB Technologies (Canada) Incorporated
SSC	Structure, System, And Component
SSR	Specific Safety Requirements
Sv	Sievert
TDG	Transportation Of Dangerous Goods
TSSA	Technical Standards And Safety Authority
UL	Underwriters' Laboratories
VLLW	Very Low-Level Waste
wc	Water Column
WHMIS	Workplace Hazardous Materials Information System
WMP	Waste Management Program
WSIB	Workplace Safety And Insurance Board

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1. Introduction

1.1 General Introduction

For the period of January 1 – December 31, 2017, SRB Technologies (Canada) Inc. (SRBT) operated a tritium processing facility in Pembroke, Ontario, under Canadian Nuclear Safety Commission (CNSC) Nuclear Substance Processing Facility Operating Licence NSPFOL-13.00/2022[1].

The facility was operated in compliance with the regulatory requirements of the Nuclear Safety and Control Act (NSCA), our operating licences, and all other applicable federal, provincial and municipal regulations throughout the review period. No new licensed activities were implemented since the previous compliance monitoring report.

Compliance was ensured by the continued implementation of our Management System and associated programs and procedures, coupled with a high level of independent internal and external oversight through audit and inspection activities.

During this period, there were no exceedances of environmental or radiation protection action levels, nor licence / regulatory limits associated with our operating licence. Three events occurred during the past year which were initially deemed to meet criteria for reporting to CNSC staff; however, in one case it was later determined that the event did not in fact meet reporting thresholds (see section 2.3.3 of this report for further details).

The SRBT operating licence includes conditions that require SRBT to prepare and submit an annual compliance report (ACR). This requirement is currently defined as part of the compliance verification criteria (CVC) in the Licence Conditions Handbook (LCH)[2] relating to condition 4.2 of NSPFOL-13.00/2022, which states:

> *The licensee shall submit an annual compliance report by March 31 of each year, covering the operation for the 12-month period from January 1 to December 31 of the previous year that includes at a minimum:*
>
> *a) Operational review including equipment and facility performance and changes, significant events/highlights that occurred during the year.*
> *b) Information on production including verification that limits specified in the licence was complied with.*
> *c) Modifications including changes in organization, administration and/or procedures that may affect licensed activities.*
> *d) Health physics information including operating staff radiation exposures including distributions, maxima and collective doses; review of action level or regulatory exceedance(s), if any, historical trending where appropriate.*

e) Environmental and radiological compliance including results from environmental and radiological monitoring, assessment of compliance with licence limits, historical trending where appropriate, and quality assurance/quality control results for the monitoring.
f) Facility effluents including gaseous and liquid effluent releases of nuclear substances from the facility, including unplanned releases of radioactive materials and any releases of hazardous substances.
g) Waste management including types, volumes and activities of solid wastes produced, and the handling and storage or disposal of those wastes.
h) Updates regarding activities pertaining to safety, fire protection, security, quality assurance, emergency preparedness, research and development, waste management, tritium mitigation and training (as applicable).
i) Compliance with other federal and/or provincial Regulations.
j) A summary of non-radiological health and safety activities, including information on minor incidents and lost time incidents.
k) A summary of stakeholder engagement activities, public opinion and information products, as committed to in the Public Information Program.
l) Forecast for coming year(s).

The purpose of this report is to provide the required information in order to meet the requirements of conditions 4.2 of Licence NSPFOL-13.00/2022, and the CVC in the associated LCH.

The information is reported in a format similar to that outlined in CNSC document *Annual Compliance Monitoring and Operational Performance Reporting Requirements for Class 1B Nuclear Facilities* (CNSC e-Doc 3471152)[3], and in consideration of regulatory feedback and comments regarding previous ACRs submitted over the past several years.

Where possible, information is presented in the most appropriate section / safety and control area, in such a way as to avoid duplication in other sections.

1.2 Facility Operation – Compliance Highlights and Significant Events

SRBT conducted its licenced activities in a safe and compliant manner throughout 2017.

1.2.1 Tritium Processing

In 2017, SRBT conducted 5,297 tritium processing operations (light source filling), with a total of 32,968,695 GBq of tritium being processed into gaseous tritium light sources (GTLS). Both of these values represent increases over 2016 processing statistics (5,031 operations, 28,122,678 GBq).

Please refer to section 1.4, ‘Production or Utilization’ for additional details on tritium processing in 2017.

1.2.2 Production and Distribution of Self-luminous Safety Products

In 2017, 970 shipments of our self-luminous safety products were made to customers in 23 different countries, including Canada.

Please refer to section 4.8, ‘SCA – Packaging and Transport of Nuclear Substances’ for additional details on the production and shipment of our products in 2017.

1.2.3 Acceptance of Expired Products

In 2017, a total of 18,977 expired (or otherwise removed from service) self-luminous safety ‘EXIT’ type signs were accepted by SRBT from Canadian and American sources, representing a total activity of 3,599.10 TBq of tritium.

These signs were disassembled safely and the light sources removed, packaged and shipped to a licenced radioactive waste management service provider. A very small number of these signs were evaluated as having light sources that could be reused in other self-luminous devices.

As well, an additional 1,412.73 TBq of tritium was accepted from international origins (i.e. other than Canada and the United States) in the form of expired tritium illuminated devices, such as aircraft signs, dials, gauges and other smaller equipment. These were also processed for shipment to a licenced waste management facility.

Please refer to section 4.5, ‘SCA – Waste Management’ and section 4.8, ‘SCA – Packaging and Transport of Nuclear Substances’ for additional details on the acceptance of expired self-luminous safety signs in 2017.

1.2.4 External Oversight

During the year, there were a total of 11 major inspections or audits conducted by stakeholders and external parties on our operations.

CNSC staff conducted compliance inspections or promotional visits on two occasions, with one inspection being focused on Radiation Protection, while the other assessed the SRBT Management System.

One Directive and two Action Notices were issued to SRBT as a result of these inspections, as well as eight recommendations. All compliance actions associated with these activities were addressed to the full satisfaction of CNSC staff.

Officers with Employment and Social Development Canada (ESDC) executed an unannounced inspection of SRBT over the course of two days, focused on Conventional Health and Safety. The inspection did not result in any items of non-compliance being raised, with several positive findings and best practices being noted by the officers at the inspection exit meeting.

BSI Management Systems, on behalf of the International Organization for Standardization (ISO), conducted a major audit of SRBT operations in September 2017. The audit was focused on verifying implementation of a quality management system aligned with the 2015 version of the ISO 9001 standard.

The audit resulted in 5 minor non-conformances and 3 opportunities for improvement being identified. A corrective action plan has been accepted by BSI, and is targeted to be fully completed by March 2018.

BSI concluded that SRBT continues to effectively manage our operations in a fashion that ensures the elements of the scope of our certification with ISO 9001 are effectively addressed, and certified SRBT to the 2015 version of ISO 9001.

A major customer of SRBT products also conducted a focused audit of our operations in October 2017, while Underwriters' Laboratories (UL) completed four quarterly audits as planned. Ontario Power Generation did not perform an audit of our facility in 2017.

Additional details on the above noted external oversight of SRBT operations can be found in section 2.1, 'SCA – Management System'.

In addition, two focused facility inspections were conducted relating to fire protection. The Pembroke Fire Department inspected the facility in June 2017, while Professional Loss Control (PLC) Fire Safety Solutions conducted a

N393-13 compliant facility condition inspection in October 2017. Details on these inspections can be found in section 4.4, 'SCA – Emergency Management and Fire Protection'.

1.2.5 Internal Oversight

Internally, there were 10 internal compliance audits conducted through the year, focused on all aspects of our operations and our organization. A total of 7 non-conformance reports (NCR) and 20 opportunities for improvement (OFI) were identified as a result of these activities, all of which have been addressed (or are in the process of being addressed) by the responsible managers.

Additional details on internal oversight of SRBT operations can be found in section 2.1, 'SCA – Management System'.

1.2.6 Reported Events

In line with our Regulatory Reporting Program, SRBT reported three events to CNSC staff in 2017, two of which were posted to the SRBT website within five days of the report. One report was not posted to the website, as it was determined soon after the preliminary report that, in fact, the event did not meet reporting thresholds.

Specific details on each of the reported events in 2017 can be found in section 2.3, 'SCA – Operating Performance'.

1.2.7 Summary of Significant Modifications

There were three significant modifications implemented in the facility which pertain to our licensed activities.

- SRBT undertook a research and development plan to investigate an increase in the number of cycles a tritium trap base could be safely used during tritium processing operations.
- SRBT has implemented a second research and development plan to investigate the feasibility of using a similar design of tritium trap base provided by an alternate manufacturer.
- The electrical power supply to the facility was increased from 200 ampere service to 600 ampere service, and the feed was isolated from the neighbouring building tenants so that the SRBT facility is fed directly from the municipal grid.

There were no changes to the production capacity of the facility in 2017.

All significant modifications to structures, systems and components associated with our licensed activities were conducted in accordance with our change control processes.

Please refer to section 3.2, ‘SCA – Physical Design’, for more information regarding facility modifications carried out in 2017.

1.2.8 Summary of Organizational Structure and Key Personnel

The organizational structure of SRBT remained the same through 2017 as in 2016.

At the conclusion of 2017, SRBT employs 44 full-time employees, managers and contracted staff.

Please refer to section 2.1, ‘SCA – Management System’ for details regarding SRBT’s organizational structure in 2017.

1.3 Summary of Compliance with Licence and OLCs

Throughout 2017, SRBT complied with the conditions of our operating licence, and possessed, transferred, used, processed, managed and stored all nuclear substances related to the operation of the facility in compliance with both the previous and renewed licence.

Specifically:

- All required programs have been implemented and maintained,
- The CNSC was notified as required of changes to the programs, processes and documents referenced in the management system / licensing basis,
- All required records have been established and maintained pursuant to the operating licence, the Nuclear Safety and Control Act and its regulations,
- All pertinent notifications were made, and written reports filed, within prescribed periods,
- An accepted decommissioning strategy continues to be maintained for future use,
- An accepted financial guarantee was maintained for decommissioning, and payments made in accordance with the relevant schedules,
- Cost recovery fees were paid on time and in full, and
- Limits on releases of tritium to the atmosphere and sewer, and radiation dose limits to the public and SRBT nuclear energy workers were not exceeded.

SRBT also remained in compliance with requirements of all other federal and provincial regulations as pertaining to the operation of the facility, including the Canada Labour Code and associated regulations, as well as provincial regulations with respect to the management of hazardous materials and waste.

The following summary report is provided respecting SRBT compliance with the Operating Limits and Conditions (OLC) established within our Safety Analysis Report (SAR) throughout the course of 2017.

Each applicable OLC is repeated below, with a statement of compliance.

1.3.1 Tritium Possession Limit

SRBT is authorized by licence to possess up to 6,000 TBq of tritium in any form.

SRBT possessed less than 6,000 TBq of tritium at all times during 2017.

Please refer to section 2.3, 'SCA – Operating Performance' for more details.

1.3.2 Tritium Processing – Permitted Hours of Operation

> Tritium processing operations consist of filling and sealing of gaseous tritium light sources (GTLS) on processing rigs, laser cutting of GTLS, or bulk splitting operations.
>
> Tritium processing operations are restricted to 0700h – 1900h, seven days a week, unless specifically approved by senior management.

All tritium processing operations were conducted between the hours of 0700h and 1900h during 2017. No processing occurred outside of this time period.

1.3.3 Tritium Processing – Precipitation

> Tritium processing shall not occur during measurable periods of precipitation, as detected by the precipitation detection system or equivalent.

Tritium processing operations were only conducted during periods of zero precipitation during 2017.

Processing operations were ceased and equipment placed into a safe state when precipitation events occurred during operating hours.

1.3.4 Tritium Releases to Atmosphere – Tritium Oxide

> SRBT shall not release in excess of 6.72E+13 Bq of tritium oxide to atmosphere in any year.

The total amount of tritium oxide (HTO) released to atmosphere in 2017 was equal to 7.20E+12 Bq (7,198 GBq), representing 10.7% of this licenced limit.

Please refer to section 4.3 'SCA – Environmental Protection' for more details.

1.3.5 Tritium Releases to Atmosphere – Tritium Oxide + Elemental

> SRBT shall not release in excess of 4.48E+14 Bq of total tritium as tritium oxide and tritium gas to atmosphere in any year.

The total amount of combined HTO and elemental tritium (HT) released to atmosphere in 2017 was equal to 2.45E+13 Bq (24,822 GBq), representing 5.5% of this licenced limit.

Please refer to section 4.3 'SCA – Environmental Protection' for more details.

1.3.6 Minimum Differential Pressure Measurements for Tritium Processing

> Tritium processing operations shall not occur unless the following differential pressures are achieved, as measured by the gauges on each of the active ventilation system stacks:
>
> - Rig Stack: 0.27 inches of water column (wc)
> - Bulk Stack: 0.38 inches of water column
>
> These measurements correspond to an average effective stack height of 27.8 metres, assuming a wind speed of 2.2 m/s.

At no time did tritium processing occur during 2017 when the noted differential pressures (dp) were not being achieved, as measured daily prior to operations commencing.

Throughout the year, there was only one instance where the differential pressure limit was not met when checked (Rig Stack dp = 0.25” wc on December 6).

Tritium processing was prohibited until corrective maintenance was implemented to the sampling line between the pitot tube in the stack duct and the gauge. Please see section 3.3.2 for additional details.

1.3.7 Tritium Releases to Sewer – Water-soluble Tritium

> SRBT shall not release in excess of 2.00E+11 Bq of water soluble tritium to the municipal sewer system in any year.

The total amount of water soluble tritium released to the municipal sewer in 2017 was equal to 6.85E+9 Bq, representing 3.4% of this licenced limit.

Please refer to section 4.3 ‘SCA – Environmental Protection’ for more details.

1.3.8 PUTT Filling Cycles

> Any pyrophoric uranium tritium trap (PUTT) base is limited to 30 complete bulk splitter filling cycles, after which it is no longer permitted to be used for further tritium processing.

All tritium processing in 2017 was conducted using PUTTs that had been cycled 30 times or less on the bulk splitter.

Prior to the implementation of the research and development plan to investigate a cycle-limit increase on PUTT bases, no base was used beyond 13 cycles.

1.3.9 PUTT / Bulk Container Tritium Loading Limit

PUTTs are limited to less than 111,000 GBq of tritium loading at any time. Bulk containers are limited as follows: • SRBT shall request no more than 925,000 GBq per bulk container when submitting a purchase order to an approved supplier of tritium gas. • No bulk container shall exceed 1,000,000 GBq of tritium loading at any time.

In 2017, no PUTT was loaded with more than 111,000 GBq of tritium.

No bulk container was used in the facility in excess of the 1,000,000 GBq loading limit.

Previously, this limit was defined as 925,000 GBq, corresponding to the amount of tritium requested of our suppliers in any purchase order; however, it was identified in an internal audit that upon delivery, bulk containers can typically contain slightly more than the ordered amount.

As a result, the Safety Analysis Report was revised to include worst-case scenarios where a bulk container has 1,000,000 GBq., and the OLC was revised to reflect this condition which fully bounds all tritium loadings at delivery.

1.3.10 Bulk Container Heating Limit

Bulk tritium containers are limited to a heating temperature of approximately 550 °C, as measured by the thermocouple placed between the heating band and the container surface. Brief and small exceedances of this value are tolerable so long as they are not sustained, and the temperature is returned below this value as soon as possible.

Bulk tritium container heating operations were conducted in strict compliance with this limit throughout 2017.

1.3.11 On-site Depleted Uranium Inventory

The on-site physical inventory of depleted uranium (virgin, in use and decommissioned bases) is limited to 10 kg.

The on-site inventory of depleted uranium (DU) did not exceed 10 kg in 2017.

Please refer to section 2.3, ‘SCA – Operating Performance’, and section 4.5 ‘SCA – Waste Management’ for more details on inventory controls of DU in 2017.

1.3.12 Exceedances of Facility Action Levels

There were no exceedances of radiation protection or environmental protection action levels in 2017.

Facility action levels are next scheduled for review in 2019.

1.4 Production or Utilization

1.4.1 Tritium Processing

In 2017, at total of 32,968,695 GBq of tritium was processed. This represents an increase of slightly more than 17% from the 2016 value of 28,122,678 GBq.

The following table is presented to illustrate the five-year history of tritium processing at SRBT.

TABLE 1: TRITIUM PROCESSED – FIVE-YEAR HISTORY

Calendar Year	2013	2014	2015	2016	2017
Tritium Processed (GBq)	30,544,759	28,714,119	27,989,832	28,122,678	32,968,695

1.4.2 Tritium Possession

SRBT is restricted by licence to possess no more than 6,000 TBq of tritium in any form at the facility at any time.

Throughout 2017 this possession limit was not exceeded. The maximum tritium activity possessed at any time during 2017 was 4,451 TBq, in April. The monthly average inventory of tritium in the facility was 3,810 TBq.

At all times, unsealed source material was stored on tritium traps or in the handling volumes of tritium processing equipment.

The monthly data of tritium activity on site during calendar year 2017 can be found in **Appendix A** of this report.

1.5 Changes in Management System Documentation

In 2017, SRBT revised several key program-level documents associated with our licensing basis, following the change control provisions of our Licence Conditions Handbook.

These include:

- Safety Analysis Report,
- Radiation Safety Program,
- Fire Protection Program
- Fire Safety Plan,
- Emergency Plan,
- Hazard Prevention Program,
- Waste Management Program,
- Environmental Management System,
- Effluent Monitoring Program, and
- Quality Manual.

As well, SRBT developed and implemented three new stand-alone program documents as a result of the implementation plan associated with the set of CSA N288 set of standards:

- Environmental Protection Program,
- Groundwater Protection Program, and
- Groundwater Monitoring Program.

In line with our mission and policy of continual improvement, process and procedural revisions continued to be a managerial focus throughout the year. In total, 76 Engineering Change Requests (ECRs) were generated to control the revision and review of programs and procedures in 2017.

Specific details on the changes in documentation can be found in section 2.1, ‘SCA – Management System’.

2. Management SCAs

2.1 SCA – Management System

Throughout 2017, the SRBT management system was effectively implemented, and ensured that our operations continued to meet the requirements detailed in our LCH, including key elements such as organization and responsibilities, capability of personnel, use of experience, work planning and control, process and change control, independent verification, non-conformance and corrective action.

A total of 64 non-conformances and 70 opportunities for improvement were raised in different areas of the company operations.

As of the end of 2017, 54 out of the 64 non-conformance reports (NCRs) raised in 2017 had been addressed, reviewed for effectiveness and closed, with all having been evaluated as being effective in correcting the issue identified.

The remaining 10 NCRs are still in progress due to the relative longer timeframes for the actions that are to be taken to resolve the issues identified.

For opportunities for improvement (OFIs), 47 out of the 70 raised in 2017 have been addressed, reviewed for effectiveness and closed, with all having been evaluated as being effective in achieving the improvement identified.

The remaining 23 OFIs were assigned target completion due dates that have not yet been reached, and will be reviewed as per normal processes once the responsible individual addresses the OFI.

SRBT affirms that corrective actions and opportunities for improvement have been effective at resolving problems and promoting the concept of continual improvement within our management system in 2017.

Organizational Management Reviews were conducted in early 2017 by all program owners, including Benchmarking and Self-assessment activities, and submitted to the Compliance Manager in preparation for the annual Management Review.

A meeting of SRBT Senior Management and key organizational managers took place on March 1, 2017, to report and discuss the results of the Benchmarking and Self-assessment activities performed in the previous calendar year, and to define areas where improvements can be made in the various company safety programs.

The management system was found to be effective at meeting the current requirements of the NSCA, Regulations and conditions of the licence, as well as ISO 9001:2008 and customer requirements.

The 2017 Organizational Management Reviews are scheduled to take place in early 2018, followed by a meeting of the Executive Committee to discuss the outputs of the reviews, and identify any opportunities for improvements, or actions required to mitigate risks and compliance or performance issues.

2.1.1 Staffing and Organization

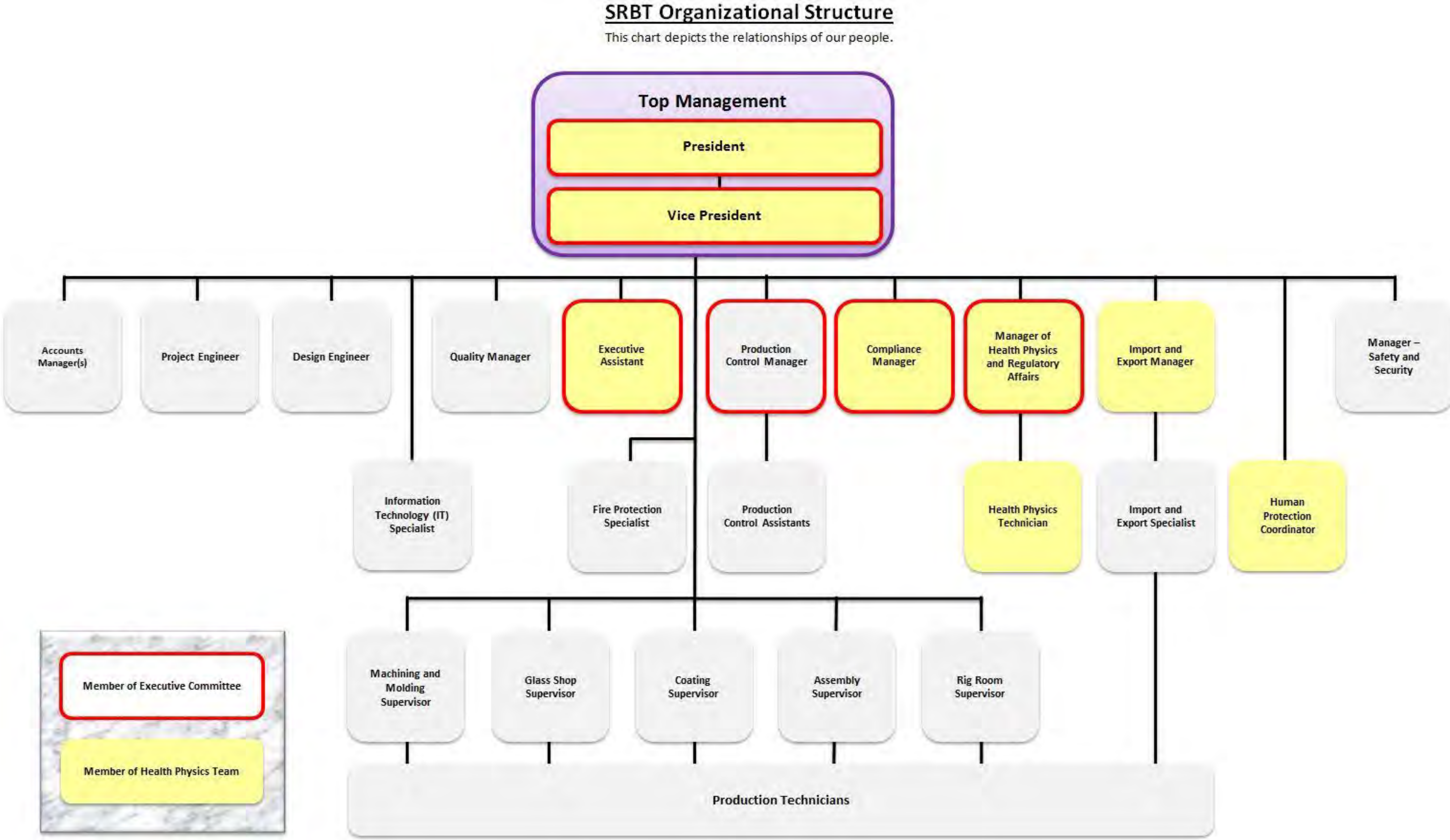
At the beginning of 2017, SRBT total staff complement stood at 43 employees,.

During the year, two employees left the employ of the company, while three new employees were hired, resulting in a stable trend of employment being maintained through the year.

As of the end of 2017, the total staff complement remains at 44 employees; there were no organizational structure changes implemented in 2017.

The following organizational chart represents the structure of the company, as of the end of 2017, that ensures SRBT meets the Nuclear Safety and Control Act, regulations and conditions of our operating licence.

FIGURE 1: ORGANIZATIONAL CHART



As of the end of 2017, a total of 44 employees work at the company, including 20 administrative employees and 24 production employees.

Administrative employees include two members of Top Management:

- President has the overall responsibility for the facility and ensures that all licensing requirements are met.
- Vice President assumes the full duties of the President in his absence or otherwise assists the President's in his duties.

Eleven individuals at the Organizational Management level:

- Quality Manager is mainly responsible for ensuring the quality of products, the satisfaction of customers, and adherence to the requirements of the Underwriters Laboratories (UL). They provide input ensuring that our management system meets the requirements of the ISO 9001 standard.
- Import and Export Manager is mainly responsible for the transport and receipt of radioactive materials, and the conduct of import and export activities.
- Executive Assistant is mainly responsible for providing administrative support to the President, and for ensuring meeting minutes are recorded.
- Production Control Manager is mainly responsible for all company purchasing and production planning activities.
- Project Engineer is mainly responsible for all company research and development activities, change control process, and the company maintenance program.
- Design Engineer is mainly responsible for certain key manufacturing processes, quality assurance of goods received, and developing specifications for components and material purchases.
- Account Managers (2) are mainly responsible for all company accounting activities.
- Manager – Safety and Security is mainly responsible for ensuring staff health and safety and ensuring compliance with the Occupational Health and Safety Regulations.
- Compliance Manager is mainly responsible for performing independent internal audits and further ensuring facility compliance with external and internal requirements.
- Manager of Health Physics and Regulatory Affairs is mainly responsible for oversight of all company Health Physics activities as well as communicating with CNSC staff to ensure deadlines are met.

Seven employees provide program oversight and/or directly assist individuals at the Management level,

- Import and Export Specialist assists the Import and Export Manager in their duties.
- Production Control Assistant assists the Production Control Manager in their duties.
- IT Specialist (2) manage and maintain the facility computer network and provide a wide range of technical and engineering support.
- Human Protection Coordinator provides advice to workers and contractors to ensure they are aware of the hazards associated with tritium and the methods of protecting themselves from these hazards. This individual is also responsible for implementation and verification of the outputs of several processes relating to the Radiation Safety Program.
- Fire Protection Specialist ensures that facility fire safety procedures are implemented.
- Health Physics Technician performs duties relating to radiation and environmental protection.

The twenty-four production employees include five Production Supervisors:

- Glass Shop Supervisor is responsible for all the activities within the Glass Shop Department.
- Coating Supervisor is responsible for all the activities within the Coating Department.
- Rig Room Supervisor is responsible for all the activities within the Rig Room Department.
- Assembly Supervisor is responsible for all the activities within the Assembly Department.
- Machining and Molding Supervisor is responsible for all the activities within the Machining and Molding Department.

These supervisors oversee the work of nineteen Production Technicians,

- Production Technicians who are responsible for performing production activities to company procedures.

2.1.2 Committees

In 2017, committees have continued to be instrumental in the development and refinement of company programs and procedures, identifying new safety initiatives and ensuring continuing effective communication at all organizational levels.

Committees use meeting results as an opportunity for improvement and make recommendations accordingly. In 2017, a total of 74 committee meetings took place at the company compared to 79 in 2016.

TABLE 2: COMMITTEE MEETINGS

COMMITTEE	NUMBER OF MEETINGS
OTHER COMMITTEE / STAFF MEETINGS	16
WORKPLACE HEALTH AND SAFETY COMMITTEE	12
HEALTH PHYSICS COMMITTEE	8
PRODUCTION COMMITTEE	8
MITIGATION COMMITTEE	6
EXECUTIVE COMMITTEE	5
MAINTENANCE COMMITTEE	4
PUBLIC INFORMATION COMMITTEE	4
FIRE PROTECTION COMMITTEE	4
TRAINING COMMITTEE	3
WASTE MANAGEMENT COMMITTEE	2
SAFETY CULTURE COMMITTEE	2
TOTAL	**74**

It is fully expected that Committee Meetings will continue to be a key force to improve all aspects of our operations, and safety in general.

2.1.3 Review of Quality Assurance and Management System Effectiveness

The SRBT management system is subject to both focused periodic review, as well as continuous review and improvement.

Based upon the following factors and the information presented in this report, it is concluded that the SRBT management system has been effective throughout the year:

- A low rate of lost-time injuries or incidents, with all injuries being non-serious in nature,
- Highest worker dose for 2017 is less than 1% of the regulatory limit,
- Maximum calculated public dose remains less than 1% of the regulatory limit,
- Continued decrease in ratio of tritium released vs. processed,
- All conditions of operating licence(s) met throughout the year,
- Continued improvement of several key programs and processes, and
- Certification to the latest revision of the ISO 9001 standard.

2.1.4 Audit Summary – Internal

The goal of SRBT's internal auditing process is to ensure that all licensed activities and company safety programs and procedures are being adhered to.

Internal audits are often specifically focused on the safety and control areas established by the CNSC.

The Compliance Manager implemented an audit schedule for 2017 that touched on all aspects of our operations.

A total of 10 internal audits were completed, focused in the following areas of our operations:

- Management System
- Production Departments
- Quality Department
- Engineering Department
- Maintenance
- Environmental Protection
- Shipping and Inventory Control
- Radiation Protection and Dosimetry Program
- Conventional Health and Safety
- Emergency Management and Fire Protection

Internal audits alone resulted in 7 non-conformances (NCR) and 20 opportunities for improvement (OFI) being identified in 2017. Corrective actions have been or are being taken in each case in order to drive compliance and continuous improvement.

2.1.5 Audit Summary – External

During the year, there were a total of 11 major inspections or audits conducted by stakeholders and external parties on our operations.

2.1.5.1 CNSC Inspections (2)

CNSC staff conducted compliance inspections on two occasions, focused on specific safety and control areas relating to our operations.

In February, CNSC staff conducted a compliance inspection (SRBT-2017-01) focused on the Radiation Protection safety and control area.

As a result of the inspection, one Directive, one Action Notice and six Recommendations were issued[4], which were addressed by SRBT within one month of receiving the inspection report[5]. CNSC staff closed the inspection file on June 20, 2017[6].

In March, CNSC staff conducted a compliance inspection (SRBT-2017-2) focused on the Management Systems safety and control area. The inspection was conducted over a period of two days.

This represented the first focused inspection on this area since the full implementation of SRBT's new management system, after a multi-year project towards compliance with CSA standard N286-12, *Management system requirements for nuclear facilities*.

As a result of the inspection, one Action Notice and two Recommendations were issued[7], which were addressed by SRBT within two months of receiving the inspection report[8]. CNSC staff closed the inspection file on August 11, 2017[9].

At the conclusion of 2017, there are no outstanding compliance actions associated with the SRBT operating licence.

2.1.5.2 ESDC Inspection of Conventional Health and Safety (1)

Officers with Employment and Social Development Canada (ESDC) executed a compliance inspection of SRBT over the course of two days, focused on Conventional Health and Safety.

The inspection began with an unannounced site visit on October 30, 2017, where ESDC officers conducted an assessment of programmatic documentation and health and safety-related records, including a comprehensive review of injury reports. The inspection concluded with a site visit and physical inspection on November 28, 2017.

Officers concluded that SRBT’s conventional health and safety program is compliant with the provisions of the Canada Labour Code and associated regulations, and made several positive notes on safety-related aspects of the facility and its management system.

2.1.5.3 ISO Certification Audits (1)

On behalf of the International Organization for Standardization (ISO), BSI Management Systems conducted an audit in September for calendar year 2017, as part of the maintenance of SRBT’s ISO 9001 certification.

This particular audit was focused on assessing the implementation of the 2015 revision of the ISO 9001 standard. The audit resulted in SRBT being certified to the standard, with five minor non-conformances and three opportunities for improvement being identified that have since been addressed, or are in the process of being addressed at the conclusion of 2017.

2.1.5.4 Customer-Led Audits (1)

Isolite Inc. (a customer of SRBT products) also conducted a focused audit of our operations in October 2017.

The audit concluded that SRBT is following our Quality Management System and regulatory requirements, and that the requirements of ISO 9001 are being met.

2.1.5.5 Underwriters Laboratories (4)

Underwriters Laboratories (UL) provides safety-related certification, validation, testing, inspection, auditing, advising and training services to a wide range of clients, including manufacturers.

UL performs quarterly visits of our facility. These visits are unannounced and are to ensure compliance that the products we produce which are listed with UL are manufactured using the materials, procedures and testing parameters required under the specific UL listing.

In 2017, UL performed inspections on March 9, June 28, September 19 and November 29, with no variation notices being raised through the year.

2.1.5.6 Fire Protection Inspections (2)

Two focused facility inspections were conducted relating to fire protection.

The Pembroke Fire Department inspected the facility in June 2017, with one minor violation being identified and corrected that same day, while Professional Loss Control (PLC) Fire Safety Solutions conducted a N393-13 compliant facility condition inspection in October 2017, with one opportunity for improvement being identified, which was implemented immediately.

Details on these inspections can be found in section 4.4, ‘SCA – Emergency Management and Fire Protection’.

2.1.5.7 SRBT Audits of Suppliers, Manufacturers or Service Providers

SRBT performed one audit of a service provider in 2017.

The Compliance Manager conducted an audit of field sampling activities conducted by technicians with Canadian Nuclear Laboratories in June 2017.

Two opportunities for improvement were identified and implemented shortly after the audit report was issued.

2.1.6 Benchmarking and Self-assessments

In 2017, individuals responsible for specific programs and procedures at SRBT regularly looked at process problems, corrective actions as well as trending and used this information to benchmark elsewhere in or out of the organization in order to improve the effectiveness of these programs and procedures and to help define where improvements could be made.

Benchmarking against other similar CNSC licensees was encouraged. Documents describing the performance of similar CNSC licensees were reviewed:

- Commission Member Documents
- Proceedings, Including Reasons for Decision
- Documents from other licensees, including annual compliance reports

Self-assessments are also performed by Organizational Managers to identify, correct and prevent problems that hinder the achievement of the company's vision, mission, goals, values and policy and to assess the adequacy and effectiveness of the Quality Management System.

Self-assessments were performed by review of:

- Analysis and trending of performance data against historical data
- Input from stakeholders (public, contractors, regulators, etc.)
- Workspace inspections or observations
- Routine communications with staff to determine whether expectations are understood
- Training and coaching results
- Corrective and preventive actions raised throughout the organization
- Internal audit results

Both Benchmarking and Self-assessment reports formed key inputs into the annual Management Review meeting conducted on March 1, 2017, leading to several actions to address issues and risks, as well as opportunities for improvement.

2.1.7 Programs and Procedures

2.1.7.1 Programs and Major Licensing Documents

In 2017, several key management system programs and plans were revised in line with SRBT's mission of continuous improvement.

On January 27, 2017, an updated **Emergency Plan** was submitted to CNSC staff[10]. Changes were generally administrative in nature, with new contact information being incorporated, updated organizational titles where applicable, as well as a revised reference to the latest Safety Analysis Report. The updated Emergency Plan was formally accepted by CNSC staff on September 22, 2017[11].

On February 24, 2017, a revised **Waste Management Program** was submitted to CNSC staff[12]. The purpose of the revision was to clarify the types of clearance-level waste streams managed under the program, and to address opportunities for improvement stemming from an internal audit. The revised Waste Management Program was accepted by CNSC staff on June 7, 2017[13].

CNSC staff accepted Revision E of the SRBT **Environmental Management System** document on March 31, 2017[14], after submission by SRBT on December 30, 2016[15].

As well, SRBT received comments from CNSC staff on the **Effluent Monitoring Program** on March 31, 2017[14], after submission of December 30, 2016[15]. SRBT addressed these comments and incorporated changes into a new revision of the program document, which was submitted to CNSC staff on May 29, 2017[16]. The revised program was accepted by CNSC staff on July 11, 2017[17].

On June 30, 2017, SRBT submitted both the **Groundwater Protection Program** and the **Groundwater Monitoring Program** documents to CNSC staff[18]. Both of these Environmental Management System documents were created to ensure compliance with CSA standard N288.7-15, *Groundwater protection programs for Class I nuclear facilities,* as part of the action plan associated with the *SRBT Gap Analysis of Regulatory Requirements and Standards for Environmental Management and Protection*[19]. These programs were accepted by CNSC staff on September 22, 2017[20].

SRBT also developed and implemented the **Environmental Protection Program** document under the Environmental Management System (EMS) and the above-noted action plan on July 10, 2017.

On June 30, 2017[21], SRBT submitted Revision J of the **Quality Manual** to CNSC staff. An administrative change was made to the scope statements in the manual to include specific text relating to the products manufactured by SRBT, in order to ensure the requirements of ISO 9001 were satisfactorily addressed. The descriptive Part 5 of the manual was also removed; this part had described in great detail the transition between Revision H and I of the manual as part of the N286-12 project. CNSC staff accepted the revised manual on August 17, 2017[22].

On August 23, 2017[23], SRBT submitted a revision of the **Hazard Prevention Program** to CNSC staff. The program was updated in line with actions stemming from internal audits, as well as to incorporate the hazard identification and training aspects of the program into a single document. CNSC staff accepted the revised program on September 22, 2017[24].

On August 25, 2017[25], SRBT submitted Revision 4 of the SRBT **Safety Analysis Report** (SAR) to CNSC staff. The revision incorporated recommendations and comments received from CNSC staff pertaining to Revision 3 of the report, as well as included a comprehensive review of the postulated initiating events and worst-case scenarios. For a more specific level of detail on the changes made to the SAR in 2017, please see section 3.1 of this report.

CNSC staff provided comments on Revision 4 of the SAR on October 31, 2017[26]. Based on this feedback, SRBT made additional changes and corrections to Revision 4, and resubmitted the SAR to CNSC staff on November 10, 2017[27].

On September 7, 2017[28], SRBT submitted a revised **Fire Protection Program** and **Fire Safety Plan** to CNSC staff. Changes to both of these documents reflected findings and recommendations of internal audits. CNSC staff accepted both revised documents on December 7, 2017[29].

On October 31, 2017[30], SRBT submitted a major revision of the **Radiation Safety Program** to CNSC staff. The purpose of the revision was to remove the majority of non-radiation protection related aspects of the program which are now fully and adequately captured within other programs and procedures in the current management system. Expanded and improved descriptions of processes were also incorporated into the document.

As well, on October 31, 2017, SRBT submitted a draft **Dosimetry Service Program** document to our CNSC Dosimetry Services Specialist with the Radiation Protection Division[31], in support of the renewal of our Dosimetry Service Licence 11341-3-18.3, which expires in May 2018.

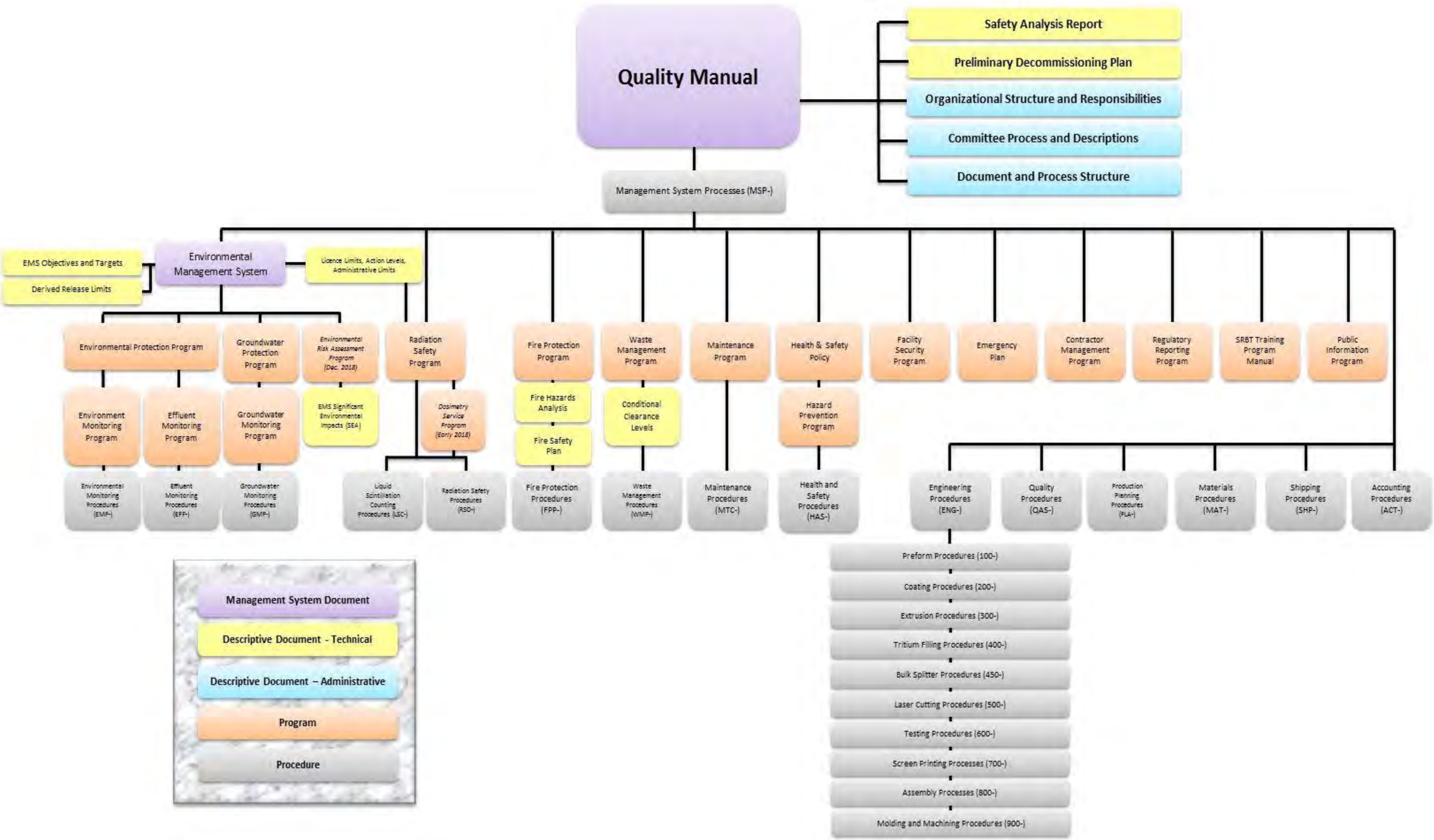
2.1.7.2 SRBT Management System Document Hierarchy

Figure 2 illustrates the Management System document hierarchy in place as of the end of 2017.

Note that the Dosimetry Service Program is not yet implemented, as it awaits acceptance as part of the licence renewal application for that activity.

As well, the Environmental Risk Assessment program document is scheduled to be drafted and implemented prior to the end of 2018 as part of the implementation of the N288-standards action plan.

FIGURE 2: MANAGEMENT SYSTEM DOCUMENTS



2.1.7.3 Procedures

In 2017, a total of 76 Engineering Change requests (ECR) were filed relating to procedural changes in the SRBT management system (compared to 69 in 2016). The breakdown of ECRs filed was as follows:

TABLE 3: PROCEDURAL ECR SUMMARY

PROGRAM / AREA	NUMBER OF ECRs
RADIATION SAFETY	17
FIRE PROTECTION	7
MAINTENANCE	7
PRODUCTION	6
EFFLUENT MONITORING	5
LIQUID SCINTILLATION COUNTING LAB	5
ENVIRONMENTAL MONITORING AND PROTECTION	5
GROUNDWATER MONITORING AND PROTECTION	4
WORK PLANNING	3
CONVENTIONAL HEALTH AND SAFETY	3
SHIPPING AND RECEIVING	2
ENGINEERING	1
WASTE MANAGEMENT	1
OTHER	10
TOTAL	**76**

Note that where appropriate, one ECR may encompass more than one procedural improvement.

Procedural changes were implemented for a variety of purposes. Many improvements have been incorporated as a result of the continuing, expanded oversight provided by SRBT's internal audit processes, as well as a dedicated managerial focus on improvement initiatives in each area.

2.2 SCA – Human Performance Management

Throughout the course of 2017, SRBT ensured that at all times a sufficient number of qualified workers were available to carry out licenced activities in a safe manner, and in accordance with the NSCA and associated regulations.

In 2017 our staff once again remained stable; by the end of the year, SRBT employed a total of 44 staff members, compared to 43 staff members in 2015 and 2016.

The average experience of our workforce stands just over 10 years, with an average age of just over 43 years old. The Health Physics Team possesses a combined 133 years of work experience with the company, while production supervisors average 20 years of experience with SRBT.

Careful consideration continues to be taken when appointing new staff to ensure continued nuclear safety.

The activities of five work areas (marked in yellow in Table 4) do not involve tasks that affect nuclear safety. Generally employees hired as Production Technicians are first appointed to one of these five work areas. These positions do not in any way impact the company's ability to ensure that the requirements of the Nuclear Safety and Control Act, Regulations and conditions of the licence[1] and LCH[2] are met.

TABLE 4: NUCLEAR SAFETY TASKS PERFORMED PER WORK AREA

WORK AREA	AVERAGE EXPERIENCE (IN YEARS)	RESPONSIBLE FOR PROGRAMS AND PROCEDURES THAT AFFECT NUCLEAR SAFETY	PROCESS TRITIUM	HANDLE SEALED TRITIUM SOURCES
ADMINISTRATION	**13.87**	✓	-	-
RIG ROOM	**10.91**	-	✓	✓
GLASS SHOP	**9.57**	-	-	-
ASSEMBLY	**6.47**	-	-	✓
MACHINING AND MOLDING	**8.77**	-	-	-
COATING	**7.72**	-	-	-
SHIPPING	**3.97**	-	-	-
CLEANING	**3.22**	-	-	-

The Rig Room is the department where tritium processing takes place, and has the highest average work experience with the company of any production department. The average work experience of the staff within this department is just under 11 years.

The Supervisor and another employee in this department have over 26 years of experience and perform or oversee all activities that involve tritium processing or handling of tritium sources.

The Assembly Department is where tritium sources are handled by staff for assembly into products or for packaging. The tritium is contained in the source at this stage and the possibility of tritium exposure is low. The Supervisor in this department has over 18 years of experience and performs or oversees all activities of four other staff members.

2.2.1 Training

2.2.1.1 Annual All-Staff Training Session

Once per calendar year, SRBT shuts down all manufacturing operations in order to conduct an all-day, all-staff training session.

The agenda for this training traditionally incorporates a wide variety of aspects of our operations. The majority of the day is dedicated to a refresher course in radiation protection, specifically oriented at the unique type of hazard present at SRBT.

This training was conducted on December 6, 2017, and included information with respect to natural radiation exposure, anticipated health effects from radiation exposure, tritium, proper handling of tritium throughout the facility, and equipment for personal radiation protection purposes.

As well, training is provided to all staff on fire safety, security, our supervisory awareness program, and the SRBT Workplace Hazardous Information Management System (WHMIS).

An information session was also conducted focused on work-level appropriate aspects of the SRBT Management System, including the management system processes for change control, non-conformances and opportunities for improvement.

Specific information on the radiation safety training provided by SRBT can be found in section 4.1, ‘SCA - Radiation Protection’.

2.2.1.2 Fire Extinguisher Training

Annual fire extinguisher training was conducted with the support of the Pembroke Fire Department on October 4, 2017. As in past years, the training was conducted using an electronic simulator, eliminating the risks associated with the controlled, repeated burning and extinguishing of liquid hydrocarbons as an environmentally-friendly measure.

The training also included a classroom-based session discussing personal safety when detecting a fire, the types of extinguishers available in the facility, and the proper and safe use of extinguishers when fighting fires.

2.2.1.3 Fire Code Administration Training

Throughout 2017, two SRBT employees (including the Fire Protection Specialist) continued a program of learning offered through Algonquin College in Ottawa, titled ‘Occupational Safety and Health: Fire Code Administration’.

This program of study began in 2016, and culminated in both employees successfully challenging the certification examination in December 2017.

2.2.1.4 Fire Responder Training

Training of fire responders occurred in two sessions in October 2017. The training included a tour of the facility and information with respect to the hazardous materials found on the site, with a focus on tritium and radiation protection aspects of the facility.

Responders were provided with guidance on the precautions to be taken during an emergency or fire response, and on the steps that are to be taken once the response has concluded, including the provision of bioassay samples.

2.2.1.5 TDG Training

Transportation of Dangerous Goods (TDG) training for shipping department staff is scheduled every two years. The training is conducted by an outside agency with expertise in the transport of dangerous goods.

Five employees were provided training in TDG on February 21, 2017. Training is scheduled to be next held in 2019.

2.2.1.6 Health and Safety Training

In March 2017, all employees of SRBT took part in and completed WHMIS 2015 Global Harmonized System (GHS) Awareness training.

The Manager - Safety and Security attended a Health & Safety Training Conference in Toronto on May 10th, 2017 and took part in training seminars that included:

- Federal Health and Safety Committee Effectiveness
- Workplace Accident Investigations: From Theory to Practice
- Internal Complaint Resolution Process and Refusal to Work
- Workplace Violence Prevention

The Manager - Safety and Security also attended another Health & Safety Training Conference in Ottawa on October 3rd & 4th 2017 and took part in training seminars that included:

- Active Shooter in the Workplace
- Beyond Prequalification and Training: How to Build Lasting Partnerships with Contractors
- CSA Standard for Machine Guarding\
- Beyond GHS: Stop the Confusion and Manage your Chemical Program Before the MOL Comes Knocking
- Mock Accident Investigation & Coroner's Inquest

In December 2017, all SRBT staff were given refresher training in WHMIS at the annual SRBT training day.

2.2.1.7 Security Training

In April, SRBT Information Technology Technicians attended a symposium focused on Cyber Security on April 12, 2017, in Vaughan, Ontario, as a learning opportunity in support of the Security Program.

2.2.2 Systematic Approach to Training Program

SRBT continues to implement a systematic approach to training (SAT) as part of our overall training program, and the Training Committee actively ensures that the processes described in the Training Program Manual are managed effectively and improved on an ongoing basis.

Three meetings of the Training Committee were held in 2017, with the annual program evaluation being held in May, the annual focused discussion on training change management being held in August, and the annual review of the qualification of SAT-based trainers being conducted in October.

Eight new activities were brought to the Training Committee for a categorization decision during the year, all of which were determined to be eligible for management as Category 1 training activities (non-SAT based).

At the conclusion of 2017, all seven originally categorized SAT-based activities have been processed through the design and development stages of the systematic cycle, and approved by the Committee for full implementation.

Qualification management processes continue to ensure that SAT-qualified staff members maintain their skills through frequency of performance requirements, and that the qualification of SAT-based trainers continues to be evaluated periodically.

A total of ten individual workers are qualified (or are in the process of qualification) in at least one of the seven SAT-based activities developed and implemented. This includes production technicians who perform tritium processing operations, as well as members of the Health Physics Team.

2.3 SCA – Operating Performance

SRBT has continued to operate the facility safely and in compliance with our operating license throughout 2017.

Our programs and processes have continued to evolve to meet or exceed regulatory requirements and expectations, with safety as an overriding priority in all aspects of our licensed activities.

A summary of compliance with operational limits and conditions can be found under section 1.3 of this report.

A summary of annual production / utilization data can be found in section 1.4 of this report.

A description of the internal and external audits conducted relating to licensed activities can be found under sections 2.1.4 and 2.1.5 of this report.

2.3.1 Ratio of Tritium Released to Processed

In 2017 our team continued to strive to minimize the amount of tritium released to the environment for every unit of tritium processed – we refer to this as the 'released to processed' ratio. This ratio is an excellent indicator of the overall effectiveness of our emission-reducing initiatives.

The following table illustrates how this ratio has trended since 2011.

TABLE 5: TRITIUM RELEASED TO PROCESSED RATIO (2011-2017)

DESCRIPTION	2011	2012	2013	2014	2015	2016	2017
TOTAL TRITIUM RELEASED TO ATMOSPHERE (GBq/YEAR)	55,584	29,905	78,875	66,161	56,237	28,945	24,822
TRITIUM PROCESSED (GBq/YEAR)	7,342,449	10,224,590	30,544,759	28,714,119	27,989,832	28,122,678	32,968,695
RELEASED / PROCESSED (%)	**0.76**	**0.29**	**0.26**	**0.23**	**0.20**	**0.10**	**0.08**
CHANGE IN RATIO INCREASE (+) / REDUCTION (-)	+38%	-62%	-10%	-12%	-13%	-50%	-20%

2.3.2 Objectives and Targets

SRBT performance against key objectives and targets for 2017 is tabled below.

TABLE 6: 2017 PERFORMANCE TARGETS

DESCRIPTION	2017 TARGET	PERFORMANCE
MAXIMUM DOSE TO NUCLEAR ENERGY WORKER	≤ 0.75 mSv	0.46 mSv
AVERAGE DOSE TO NUCLEAR ENERGY WORKER	≤ 0.060 mSv	0.045 mSv
CALCULATED DOSE TO MEMBER OF THE PUBLIC	≤ 0.0063 mSv	0.0034 mSv
WEEKLY AVERAGE TRITIUM RELEASES TO ATMOSPHERE	≤ 747 GBq	Average = 477 GBq 5 weeks > Target
RATIO OF TRITIUM EMISSIONS VS. PROCESSED	≤ 0.16%	0.08%
TOTAL TRITIUM EMISSIONS LIQUID EFFLUENT PATHWAY	≤ 6 GBq	6.85 GBq
ACTION LEVEL EXCEEDANCES ENVIRONMENTAL	≤ 1	0
ACTION LEVEL EXCEEDANCES RADIATION PROTECTION	≤ 1	0
CONTAMINATION CONTROL FACILITY-WIDE PASS RATE	≥ 95%	95.8%
LOST TIME INJURIES	0	3
MINOR INJURIES REPORTABLE TO ESDC	≤ 20	21

An assessment of the apparent causes of the missed targets for both liquid effluent, as well as minor and lost time injuries will be conducted and discussed during committee meetings and management review in early 2018.

2.3.3 Reported Events

In line with our Regulatory Reporting Program, SRBT reported three events to CNSC staff in 2017, two of which were posted to the SRBT website within five days of the report. One report was not posted, as it was determined soon after the preliminary report that, in fact, the event did not meet reporting thresholds.

Lost-time Injury

The first report described a workplace injury where an SRBT employee lacerated their hand during an assembly operation on Wednesday, January 25, 2017.

The worker required medical attention, and received three stitches at the Pembroke Regional Hospital that day. The attending physician recommended the worker return to work no sooner than the following Monday.

This event represented a lost-time injury, and was initially determined to be reportable pursuant to the *General Nuclear Safety and Control Regulations,* paragraph 29 (1) (h) as a serious injury incurred as a result of a licensed activity.

A combined preliminary / full report was submitted to CNSC staff the next day[32]; however, in consultation with the project officer in the days after the report was filed, it was noted that the injury did not in fact meet the definition of a ‘serious injury’ described in the recently published regulatory document REGDOC 3.6, *Glossary of CNSC Terminology*, and as such, a report was neither required nor expected.

As a result, SRBT has since relied on the definition of a serious injury in REGDOC 3.6 when assessing the reportability of injuries that require medical attention or time away from work.

Dangerous Occurrence - Damaged Package

The second reported event described the receipt of a damaged package containing a small amount of tritium-containing products at the facility on June 6, 2017.

The package was classified as UN2910 Excepted Package – Limited Quantity of Material, and had originally been shipped from the SRBT facility on June 1, 2017, destined for a customer located in Bulgaria. At some point in transit prior to export, it was discovered that the package had been damaged (punctured), and that shipment could not be completed.

The package was received at SRBT and a radiological assessment was immediately conducted. No airborne or surface contamination was detected during the assessment, and the products were visually inspected and confirmed as undamaged. The items were repackaged and the order was shipped out and received without incident.

SRBT provided a combined preliminary/full report on June 6, 2017[33], as the event was determined to meet the definition of a dangerous occurrence in the *Packaging and Transport of Nuclear Substances Regulations,* paragraph 35 (b). CNSC staff notified SRBT of the acceptance of the report on June 20, 2017[34].

Dangerous Occurrence – Lost Package

On Monday, November 20, 2017, SRBT was notified by a freight forwarder that they were unable to locate a package of SRBT self-luminous aircraft safety signs that was in transit from our facility to a customer in Germany. The package was classified as UN2911, Excepted Package, Instruments / Articles.

On Tuesday, November 21, 2017, the freight forwarder declared the package to be lost, at which point SRBT concluded that the event met the definition of a dangerous occurrence in the *Packaging and Transport of Nuclear Substances Regulations,* paragraph 35 (b).

SRBT made a verbal report by telephone to the CNSC Duty Officer shortly thereafter, and then immediately provided a written preliminary report to the CNSC Project Officer[35].

Through the next several weeks, SRBT made every effort to investigate the event with the freight forwarding and transportation agents involved. On December 6, 2017, it was noted that the package had been discovered in a warehouse in Munich, Germany in good condition. The package was finally delivered to the customer on December 14, 2017.

The full report of this event[36] was provided to CNSC staff on December 12, 2017.

2.3.4 Inventory Control Measures

2.3.4.1 Tritium

SRBT has continuously possessed, transferred, used, processed, managed and stored all nuclear substances related to the operation of our facility in compliance with the requirements of our licence.

A number of inventory control measures are in place to ensure that tritium on site does not exceed the possession limit prescribed by our operating licence.

The maximum amount of tritium possessed by SRBT at any one time during 2017 was 4,451 TBq, or approximately 74% of our possession limit. The average monthly inventory on site was 3,810 TBq.

Tritium on site is found in:

- Bulk containers and tritium traps ,
- New light sources,
- The exit signs for our facility,
- New product that contain light sources,
- Work in progress,
- Waste,
- Expired light sources taken out of product,
- Products that contain expired light sources, and
- Non-conforming product

Refer to **Appendix A** for additional details on tritium inventory in 2017.

2.3.4.2 Depleted Uranium

SRBT possessed a reported 5.91 kg of depleted uranium in metallic form at the beginning of 2017. This material is used for tritium traps as part of the production of gaseous tritium light sources.

As a result of a physical verification of bulk tritium containers owned by SRBT, it was determined that in the actual amount of depleted uranium contained within four 'Mark IV' design bulk containers owned and stored by SRBT had been historically recorded as containing 405 grams in error.

The correct amount of depleted uranium within these containers is 320 grams according to the design information on file. As such, the actual inventory of material kept on site has been over-reported by 340 grams for several years.

An adjustment was made to account for this error in April 2017, leading to a new total inventory of depleted uranium of 5.57 kg. This is the amount on site at the conclusion of 2017. A limit of 10 kg of this material in inventory is applied as part of the operating limits and conditions in the SAR. The breakdown of this inventory is as follows:

TABLE 7: DEPLETED URANIUM INVENTORY BREAKDOWN AT THE END OF 2017

QTY	DESCRIPTION	DEPLETED URANIUM IN EACH (GRAMS)	TOTAL DEPLETED URANIUM (GRAMS)
1	LOOSE FORM	NA	2,673
9	ACTIVE P.U.T.T.	30 +/- 1 GRAM	270
24	NON-ACTIVE P.U.T.T.	30 +/- 1 GRAM	705
6	AMERSHAM CONTAINERS	320	1,920
		TOTAL	**5,568**

2.3.4.3 Exempt Sources

SRBT possesses two Ba-133 external standard sources used in liquid scintillation counters (LSC). The activity of both sources falls below the exemption quantity for Ba-133.

A Cs-137 disc check source, with an original activity of 28 kBq is stored in the LSC lab for health physics-related testing. The activity of this source falls below the exemption quantity for Cs-137.

2.3.5 Liquid Scintillation Quality Assurance and Control

2.3.5.1 Routine Performance Testing

Routine Performance Testing is performed on both liquid scintillation counters on a quarterly basis, as required in section 4.2.3 of CNSC Regulatory Standard S-106, *Technical and Quality Assurance Requirements for Dosimetry Services* (Rev. 1).

Routine Performance Testing is performed to specifically demonstrate that liquid scintillation counting assays, including those conducted in support of the dosimetry service, are operated in a predictable and consistent way.

The testing was carried out every 3 months as required throughout 2017 on each of the two 'TriCarb 2910' units, with no failures reported.

2.3.5.2 Weekly LSC Performance Check

SRBT quality assurance requirements for liquid scintillation counting include weekly instrument performance checks using National Institute of Standards and Technology (NIST) traceable standards of a blank, H-3 and C-14 standards.

All tests have been performed on both TriCarb 2910 LSC units, and included an assessment of the instrument efficiency for tritium measurement, the figure of merit, the tritium background measurement, and a chi-square test. In all cases, both instruments met acceptability criteria on a weekly basis.

2.3.5.3 Assay Quality Control Tests

NIST traceable standards, certified to have an estimated accuracy of ± 1.2%, are prepared in-house, analyzed and checked against acceptability criteria with every batch of liquid scintillation counting samples being analyzed.

All tests were performed as required with every assay in order to ensure quality control of laboratory processes.

3. Facility and Equipment SCAs

3.1 SCA – Safety Analysis

Our operating practices and processes in 2017 have continued to be conducted in full alignment with the latest version of SRBT's Safety Analysis Report (SAR).

During the year, one operational change was implemented that had a direct bearing on the safety analysis. SRBT undertook a research and development plan to investigate an increase in the number of cycles a tritium trap base could be safely used during tritium processing operations.

Previously, bases were limited to 13 cycles of filling and use on the processing rigs when filling light sources, a restriction that was included as an Operational Limit & Condition in the in-force revision of the SAR (Revision 3). Further technical details on the rationale for implementing this change can be found in section 3.2 – 'SCA - Physical Design'.

This change was managed using the SRBT change control process, as described in MSP-007, *Change Control*. As well, CNSC staff were informed well in advance of the intent to conduct the research and development plan, which was safely and successfully executed over the year.

In November, after careful consideration of the data gathered to date, the Mitigation Committee concluded that extending the life of the trap bases to a maximum of 30 cycles did not increase emissions or result in additional safety risks to workers or the environment. As a result, the OLC in the SAR was revised, and Revision 4 of the SAR was finalized and submitted to CNSC staff on November 10, 2017[27].

CNSC staff had already been provided a draft copy of Revision 4 of the SAR on August 25, 2017[25], and had provided comments on this revision on October 31, 2017[26].

Revision 4 of the SAR was developed in order to incorporate previously received regulatory comments on Revision 3, including a comprehensive update on all hypothetical incident scenarios.

SRBT used HOTSPOT modelling software to verify the expected radiological consequences of several of the postulated worst-case accident scenarios. The modelling software was programmed to apply the latest radiological modelling parameters published by the CSA, as well as on-site weather data, in calculating the risk to the public in these scenarios. The modelled predictions using HOTSPOT were found to be in very good agreement with previously calculated risks in earlier versions of the SAR.

Other key improvements in the revised SAR:

- Discussion on the potential impacts of accident scenarios originating from other nearby industrial installations,
- Incorporation of references to the new SRBT management system, including Environmental Protection programs developed under the N288-series project,
- Updated footprint of the facility to include the 2016 expansion,
- Updated seismic, wind, and population data to include latest available information,
- Accounted for extreme environmental conditions for safety-related structures, systems and components (SSC),
- Changed the OLC for a minimum effective stack height to a minimum measured differential pressure in the active ventilation system stack ducts,
- Revised the OLC for the maximum total loading on any bulk container, and
- Administrative corrections and improvements in format.

In summary, the overall safety case for SRBT continues to be effectively validated and maintained. As always, SRBT will continue to respond to events in the nuclear industry and beyond that could influence or otherwise affect our safety analysis. It is not expected that our licensed activities and processes will change over the coming years; however, SRBT will continue to manage and improve the SAR in line with our management system processes, including ENG-022, *Safety Analysis Review Process.*

3.2 SCA – Physical Design

As a manufacturing company, SRBT owns and operates several pieces of equipment, several of which constitute structures, systems and components (SSCs) which have a bearing on safety and our licensed activities.

Such equipment includes the active ventilation systems and associated emissions monitoring equipment, fire detection and suppression systems, tritium processing rigs, tritium-in-air monitors, and liquid scintillation counters.

The overall facility design is also a key aspect of our operations, and must be managed and controlled safely. The SRBT change control process helps to ensure that modifications are controlled, reviewed, accepted, and recorded using an Engineering Change Request (ECR).

All significant modifications to structures, systems and components associated with our licensed activities were conducted in accordance with our change control processes.

Three significant changes in physical design of important facility systems or components took place in 2017, as described in the following sections.

These changes did not result in a negative impact on the ability of the facility and SSCs to meet and maintain their design function, and were within the licensing basis.

3.2.1 Tritium Trap Base Life Extension

SRBT undertook a research and development plan to investigate an increase in the number of cycles a tritium trap base could be safely used during tritium processing operations.

Previously, bases were limited to 13 cycles of filling and use on the processing rigs when filling light sources; however, with the application of a new type of valve design on the traps in 2016, it was hypothesized that the lower leakage rates would ultimately prolong the effective life of the depleted uranium adsorbent, without any significant safety issues or increase in emissions.

The formal research and testing plan was accepted and implemented under ECR-719, CNSC staff were notified of the controlled, provisional change to our operating limit for these components[37], and tritium bases began to be used beyond 13 cycles in early 2017.

Data was collected, trended and assessed through the following months, culminating in the determination by the Mitigation Committee in October 2017 that using bases up to a maximum of 30 full cycles had no deleterious effect on safety or the environment.

As such, a modification to the applicable operating limit was made, and CNSC staff were notified of this change with the implementation of the latest revision of the SRBT Safety Analysis Report[27].

3.2.2 Tritium Trap Base Design Change

SRBT has implemented a research and development plan to investigate the feasibility of using a similar design of tritium trap base provided by an alternate manufacturer.

The proposed new base design that can be provided by the alternate manufacturer (an approved supplier of materials to SRBT) is assessed as likely to provide an additional measure of resistance to integrity failure over the expected lifespan of the components, due to higher quality automated welds and materials, and the application of a more challenging pressure test after manufacture.

A prototype base was commissioned and put into service at the beginning of November 2017, and data continues to be collected and assessed in order to determine if the use of these bases presents any significant safety issues. The information to date suggests the new design is at least as robust as the design used previously, and that the change does not introduce any safety issues; however, the research project continues to be implemented. A final decision on any permanent design modification is expected in the first half of 2018.

3.2.3 Facility Electrical Upgrade

With the physical expansion of the facility being completed in 2016, SRBT began the process of preparing the new space to accommodate new plastics molding equipment and a 3D printer.

The electrical power requirements for the new equipment required an upgrade to the power supply to the facility. ECR-739 was raised, and qualified, third-party resources contracted to design and construct a modified power feed to the facility. This change resulted in an increase of the power available to SRBT from 200 ampere service to 600 ampere service, while at the same time separating the SRBT power supply from the rest of the building tenants.

The upgrades were installed over the late summer into the fall, and the new power system commissioned and activated on October 10, 2017. The upgrade project was completed with no safety-related events, issues or problems.

3.3 SCA – Fitness for Service

All equipment, including all safety-related equipment, is kept in a condition that is fit for service through the implementation of the Maintenance Program. The facility and equipment associated with the facility were effectively maintained and operated within all manufacturer requirements.

In 2017 there were no significant equipment failures that presented a safety concern, demonstrating the effectiveness of the Maintenance Program implemented by SRBT.

Documented maintenance meetings were initiated and held by the Maintenance Committee throughout 2017, while four additional procedures were developed and implemented under the Maintenance Program, further expanding the scope of controlled and documented activities in a graded fashion.

As part of management review processes, an annual review of 2017 activities will be conducted in the first quarter of 2018, including data pertaining to equipment failures, maintenance activity success rates, non-conformances, procedural revisions, and audit findings.

Maintenance records are kept on file including completed work orders of preventative maintenance activities. A maintenance schedule is created and managed by the Project Engineer, and effectively captures all safety-significant planned preventative maintenance activities, whether performed by SRBT personnel or an approved contractor, and includes maintenance inspections as required by the Fire Protection Program. As well, corrective maintenance was tracked, trended and reviewed to assess the performance of equipment, and to identify any preventative activities which may improve performance.

Preventative maintenance was scheduled and performed in 2017 on equipment as per **Appendix B** of this report.

The fitness for service of key individual structures, systems and components are summarized below:

3.3.1 Ventilation

The ventilation of the facility is such that the air from the facility flows to the area with greatest negative pressure in Zone 3 which has the highest potential for tritium contamination where all tritium processing takes place. This area and part of Zone 2 are kept at high negative pressure with the use of two air handling units which combined provide airflow of approximately 10,000 cubic feet per minute.

The air handling units are connected to a series of galvanized stainless steel ducts. In addition to providing ventilation for the facility these air handling units also provide local ventilation to a number of fume hoods which are used to perform activities that have a potential for tritium contamination and exposure.

All ventilation systems were maintained fit for service throughout 2017. Corrective and preventative maintenance was identified and performed according to the requirements of the Maintenance Program and operational procedures. Key equipment is maintained either on a quarterly or semi-annually basis, with most equipment maintenance being performed under contract with a fully licensed maintenance and TSSA-certified local heating, ventilation and air conditioning (HVAC) contract provider.

Ventilation equipment maintained in calendar year 2017 can be found in **Appendix C** of this report.

3.3.2 Stack Flow Performance

Stack maintenance is performed by a third party, in order to ensure effective performance of the ventilation system and minimize airflow reductions from the beginning to the end of the maintenance cycle to ensure accuracy of results.

Pitot tubes that were installed in the stacks are maintained by a third party to ensure stack airflow are at design requirements. This essentially allows for daily stack flow verification in addition to more detailed annual stack flow verification performed by a third party.

On one occasion where the differential pressure limit was found to not meet requirements when checked (Rig Stack dp = 0.25” wc on December 6; requirement to process tritium ≥ 0.27” wc), corrective maintenance was performed on the sampling line between the gauge and the pitot tube. Tritium processing was prohibited until corrective maintenance was completed, and the differential pressure was confirmed to meet processing requirements.

The annual stack flow performance verification was performed on September 26, 2017 by a third party. The inspection confirmed that the stacks were performing to design requirements, and that the airflow on both air handling units has remained consistent through the last several years. SRBT continues to monitor and trend the results of the annual stack performance verification.

3.3.3 Liquid Scintillation Counters

The two TriCarb 2910 liquid scintillation counters (LSC) were subjected to an annual preventive maintenance procedure on November 2, 2017. No significant concerns or issues were identified during the maintenance activity.

Two instances of corrective maintenance on one of the two units took place; a rack-jamming issue was corrected on February 15, 2017, while a shutter adjustment was implemented on March 7, 2017. In both cases, the issues and maintenance corrections had no bearing on measurements of tritium previously performed.

Both systems will continue to be preventively maintained and calibrated on an annual basis by a qualified service representative from the manufacturer of the equipment, to ensure their functionality, accuracy and reliability.

3.3.4 Portable Tritium-in-Air Monitors

Portable tritium-in-air monitors are maintained and made available throughout the facility. The portable units are used to investigate potential sources of tritium leakage, and for personnel protection.

In 2017 SRBT purchased two additional Overhoff 200SB units to bring the total available monitors to seven. Six of these monitors are used at the facility (one in Zone 1, two in Zone 2 and three in Zone 3), while the seventh is kept on emergency standby at the Pembroke Fire Hall as part of an emergency preparedness kit.

As required by our Radiation Safety Program, all in-service tritium-in-air monitors were calibrated and maintained at least once during 2017, with all records of the maintenance are kept on file.

One instance of corrective maintenance was performed in June 2017, where the outlet hose barb on one of the units was damaged and required replacement.

3.3.5 Stationary Tritium-in-Air Monitors

The ambient air in selected key areas of the facility is continuously monitored using stationary tritium-in-air monitors.

There continues to be five stationary tritium-in-air monitors available for airborne tritium monitoring at the facility, with an additional unit available on standby as a spare.

Three monitors are strategically located in Zone 3; one in the Rig Room where gaseous tritium light sources are filled and sealed, one in the Laser Room where a laser is used to cut and seal small gaseous tritium light sources and inspected, and one in the Tritium Laboratory where tritium is transferred from bulk supply containers to filling containers.

One stationary tritium-in-air monitor is located in Zone 2 in the Assembly Area, where gaseous tritium light sources are pre-packed in preparation for shipping or installed into device housings.

A stationary tritium-in-air monitor is located in the shipping area in order to provide an early warning signal of a problem should a light or device be damaged during packaging activities.

As required by our Radiation Safety Program all tritium-in-air monitors were calibrated and preventively maintained at least once during 2017. All five facility monitors functioned effectively and continuously throughout the year, with all records of maintenance retained on file.

3.3.6 Stack Monitoring Equipment

Stack monitoring equipment is incorporated for each of two main air-handling units. For each air-handling unit, the monitoring equipment includes:

- A tritium-in-air monitor connected to a real-time recording device,
- An alarming remote display unit (RDU) in Zone 3,
- A bubbler system for discriminately collecting HTO and HT in the sampled stream of effluent,
- A flow measurement device with elapsed time, flow rate and volume of the sampled stream of effluent, and
- A dedicated back-up power supply servicing the monitors, bubbler systems and flow meters, capable of providing several hours of uninterrupted power to the equipment during a power failure.

Each tritium-in-air monitor is connected to real-time recording devices (chart recorders) and was calibrated and preventively maintained at least once in 2017. Both of the chart recorders (analog and digital) and RDUs are included in calibration verification activities on a quarterly basis. Bubbler systems (and spare systems) were also maintained throughout the year, with a bi-monthly maintenance cycle being implemented on all in-service stack monitoring equipment.

As the calibration of the bubbler sample flow measurement device is only valid for one year, each device is replaced with a newly calibrated unit on an annual basis. Four newly calibrated units were placed into service on April 25, with the four units with expiring calibration validity being removed from service, and scheduled to be sent for calibration in early 2018.

One instance of corrective maintenance on this equipment was performed in April, where during daily equipment checks, the air flow was noted to have begun to drop on one of the two tritium-in-air monitors on the real-time stack monitoring system.

The unit was removed from service, and a spare monitor placed online. The unit in question was assessed, whereupon it was discovered that internal tubing had begun to loosen and separate from the connection point on the air pump of the unit. The tubing was reconnected and the connection tightened, correcting the issue.

3.3.7 Stack Monitoring Verification Activities

The annual verification activity for the bubbler systems was performed in February 2017, where independent third party measurements provided validation that SRBT bubblers continue to effectively measure weekly gaseous tritium emissions (both HTO and HT).

All results measured and derived by the third party were within the acceptance criteria of +/- 30% of SRBT measurements for both tritium forms, from both active ventilation trains.

3.3.8 Weather Station

Maintenance of the weather station is performed as per the manufacturer's recommendation, every two years.

Maintenance of the weather station was last performed on June 6, 2016. It is next scheduled to be performed in 2018.

3.3.9 Air Compressor

Process tasks at SRBT require the use of a compressed air system. The air compressor is subject to quarterly preventative maintenance activities, and semi-annual belt changes, all of which were carried out throughout 2017.

4. Core Control Processes SCAs

4.1 SCA – Radiation Protection

4.1.1 Dosimetry Services

During 2017, SRBT maintained a Dosimetry Service License (DSL), for the purpose of providing in-house dosimetry services for the staff of SRBT and contract workers performing services for SRBT where there existed potential exposure for uptake of tritium. The licence was amended on two occasions, both to update the list of Licence Documents in the Appendix to the DSL after SRBT implemented a revised Quality Manual.

All dosimetry results were submitted on a quarterly basis to Health Canada in a timely fashion for input to the National Dose Registry. A final annual report was also submitted as required. A total of 45 individual staff members were included in National Dose Registry (NDR) reports at some point in 2017.

SRBT participated in the annual Tritium Urinalysis Performance Test sponsored by the National Calibration Reference Centre for Bioassay, Radiation Surveillance and Health Assessment Division, Radiation Protection Bureau of Health Canada. The participation is a regulatory requirement for Dosimetry Service Providers.

SRBT received the Certificate of Achievement for successful participation in the Tritium Urinalysis Performance Test from the National Calibration Reference Centre for Bioassay and In Vivo Monitoring for the year 2017[38].

SRBT also submitted to an Annual Compliance Report to CNSC Dosimetry Services Specialists for the Dosimetry Service License[39].

4.1.2 Staff Radiation Exposures and Trends

Through the Dosimetry Service License 11341-3-18.3, SRBT assesses the radiation dose to its employees and to contract workers who may have exposure to tritium.

All SRBT staff members are classified as Nuclear Energy Workers and participate in the dosimetry program.

Persons who work in Zones 1 and 2 provide bioassay samples for tritium concentration assessment on a bi-weekly frequency due to the very low probability of uptake of tritium. Persons assigned to work in Zone 3 provide bioassay samples on a weekly frequency due to the higher probability of chronic uptake of tritium.

There were no occurrences of any personnel contamination events in 2017.

The assessment of dose to personnel, due to tritium uptake, is performed in accordance with the Health Canada Guidelines for Tritium Bioassay and CNSC Regulatory Standard S-106, *Technical and Quality Assurance Requirements for Dosimetry Services* (Rev. 1).

The maximum effective dose received by any person employed by SRBT in 2017 was 0.46 mSv, a value which is well within the regulatory limit for a nuclear energy worker of 50.0 mSv per calendar year.

The average effective dose all staff was calculated to be 0.045 mSv, while the collective dose continued to be extremely low at 1.96 person·mSv (for 45 persons total).

The tables found in **Appendix D** of this report provide the radiological dose data for workers at SRBT for 2017, as well as a comparison of dosimetry results for the past five years (2013-2017).

4.1.3 Action Levels for Dose and Bioassay Level

Dose and bioassay tritium concentration action levels are defined in SRBT's 'Licence Limits, Action Levels and Administrative Limits document[40]. They are as follows:

TABLE 8: ACTION LEVELS FOR RADIATION PROTECTION

PERSON	PERIOD	ACTION LEVEL
NUCLEAR ENERGY WORKER	CALENDAR QUARTER	1.0 mSv
	1 YEAR	3.0 mSv
	5 YEAR	15.0 mSv
PREGNANT NUCLEAR ENERGY WORKER	BALANCE OF THE PREGNANCY	2.0 mSv

PARAMETER	ACTION LEVEL
BIOASSAY RESULT	1,000 Bq / ml FOR ANY PERIOD

In 2017 there were no exceedances of an action level for dose or bioassay tritium concentration at SRBT.

4.1.4 Administrative Limits for Dose and Bioassay Level

Dose and bioassay tritium concentration administrative limits are defined in SRBT's 'Licence Limits, Action Levels and Administrative Limits document[40]. They are as follows:

TABLE 9: ADMINISTRATIVE LIMITS FOR RADIATION PROTECTION

PERSON	PERIOD	ADMINISTRATIVE LIMIT
NUCLEAR ENERGY WORKER	CALENDAR QUARTER	0.75 mSv
	1 YEAR	2.25 mSv

PARAMETER	ADMINISTRATIVE LIMIT
BIOASSAY RESULT	500 Bq / ml FOR ANY PERIOD IN ZONE 3 100 Bq / ml FOR ANY PERIOD IN ZONE 1 OR 2.

In 2017 there were no exceedances of an administrative limit relating to the effective dose or bioassay tritium concentration measured in any staff member.

4.1.5 Contractor Dose

In 2017, SRBT did not employ contract staff to perform work that presented a significant radiological hazard.

Five screening bioassay samples were obtained and measured from contracted tradespersons who provided maintenance support in areas other than Zone 1. None of these samples exceeded our internal screening criteria requiring the calculation of effective dose.

To summarize, no contractor received a recordable dose due to activities performed at our facility in 2017.

4.1.6 Discussion of Significance of Dose Control Data

A tabular summary of effective dose metrics for 2017 is provided in **Appendix D.**

4.1.6.1 Maximum Dose

The maximum effective dose to any staff member in 2017 was 0.46 mSv. This individual works in Zone 3 and performs tritium processing operations in Zone 3 as their primary duty. In 2016 the maximum dose to a staff member was 0.34 mSv; this represents a 35% increase in the maximum dose to a worker in 2017. The maximum individual dose for the current five-year dosimetry period (January 1, 2016 – December 31, 2020) is also 0.46 mSv.

The increase in maximum dose is attributed to an increase in production, as well as an increase in specific production processes which have historically been more dose-intensive, such as miniature light source manufacturing.

Despite the increase, a maximum dose of 0.46 mSv represents the achievement of our internal target for 2017 of less than 0.75 mSv. This supports the conclusion that the Radiation Safety Program and the Health Physics Team are achieving a high level of performance, and that workers are properly and adequately trained in safely conducting activities that may pose a radiation hazard. As well, this marks the third year in a row where no SRBT worker received an effective dose in excess of 1 mSv, despite a consistently high rate of production throughput.

SRBT continuously strives to lower the maximum dose to workers by using several strategies, including ensuring that no one worker exclusively performs dose-intensive activities, frequent and routine use of portable tritium in air monitors during processing operations, and the continuous oversight of the Health Physics Team during key activities on the shop floor.

In 2017, the maximum dose to an employee working primarily in Zone 2 was 0.06 mSv, a value which is 0.02 mSv lower than the maximum dose to an employee working primarily in Zone 2 in 2016. This decrease is not viewed as a significant change year over year for the type of operations conducted in Zone 2.

The maximum dose to an employee working primarily in Zone 1 was 0.01 mSv, a value that is 0.03 mSv lower than the maximum dose to an employee working primarily in Zone 1 in 2016. This is again not viewed as a significant change year over year based upon the magnitude of the actual dose being extremely low as expected.

In 2017, the maximum dose to an employee working primarily in administration was 0.01 mSv, a value which is 0.05 mSv lower than 2016. This is once more not viewed as a significant change year over year based upon the magnitude of the actual dose being extremely low as expected.

The maximum worker dose over the past seven years is trended below for comparison, as well as a distribution chart for worker doses:

FIGURE 3: MAXIMUM ANNUAL WORKER DOSE TREND

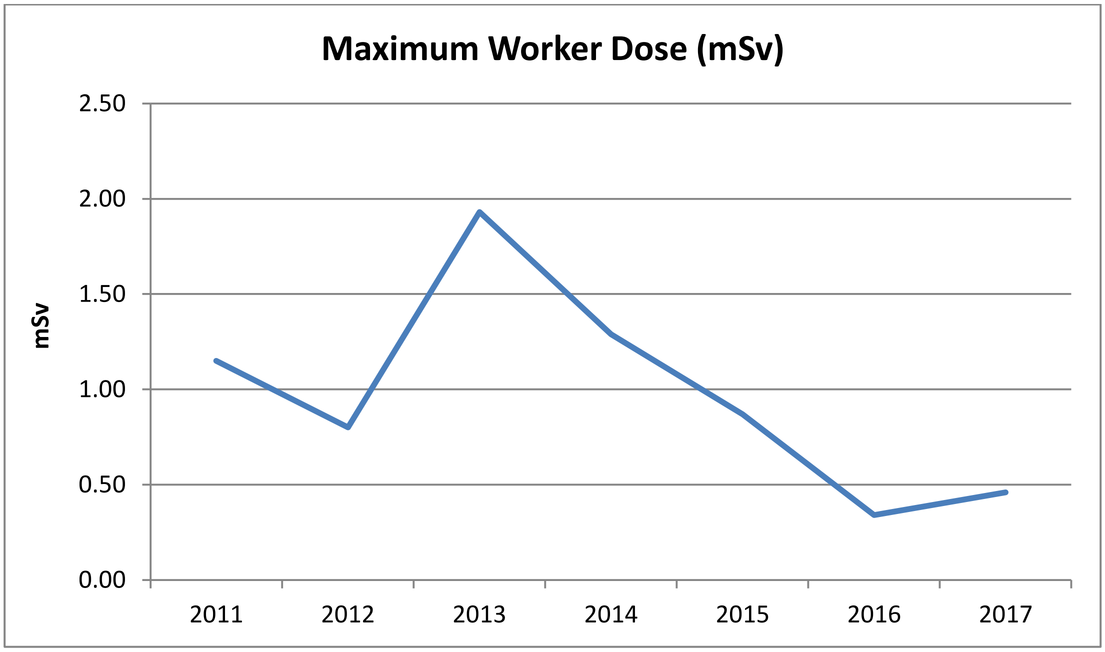
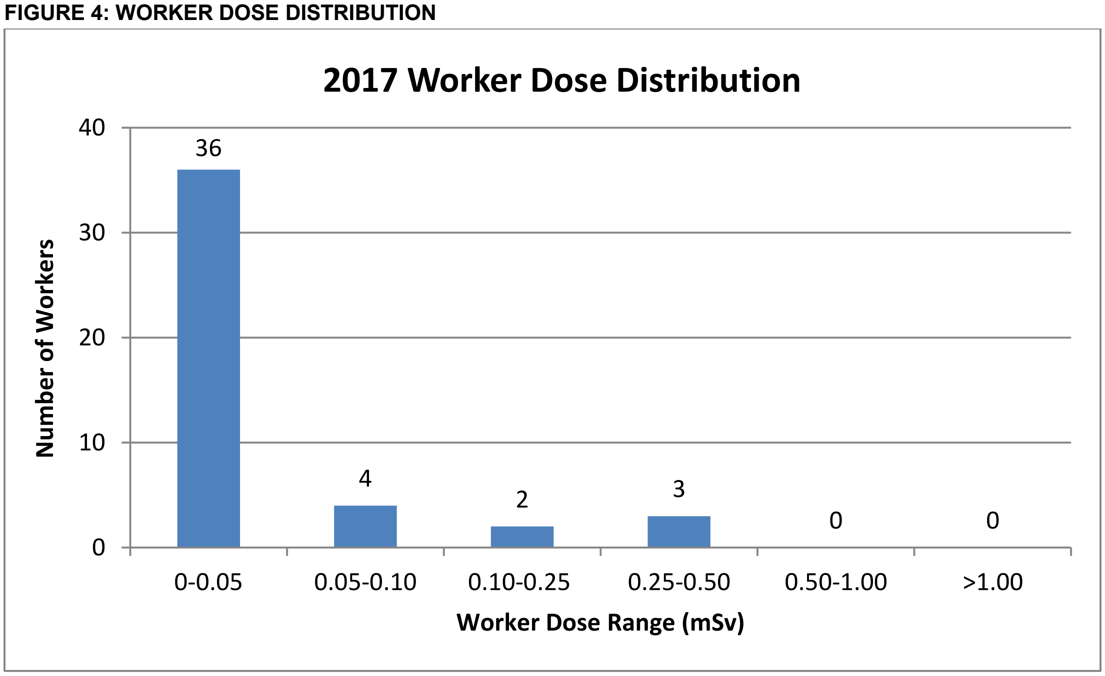


FIGURE 4: WORKER DOSE DISTRIBUTION



4.1.6.2 Average Dose

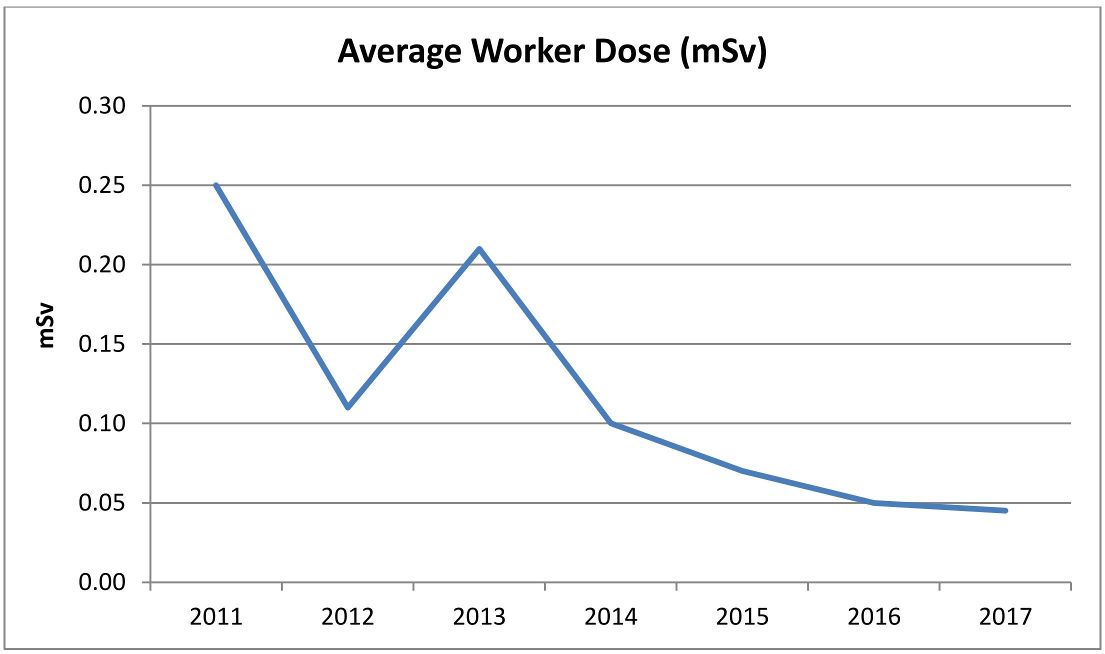
The average dose to workers at SRBT in 2017, including those workers whose dose value was zero, was 0.045 mSv. In 2016, this average was 0.049 mSv, thus 2017 represents approximately an 8.7% reduction in the average dose to staff.

This dose value is somewhat significant, as it is reliant not only on the radiation doses of individuals, but also the number of individuals working at SRBT.

A general trend can be taken over the past four years of data, as the total number of employees having worked or are working as NEWs during this time has been relatively stable, allowing for a direct comparison.

The average dose to workers at SRBT over the past seven years is trended below for comparison:

FIGURE 5: AVERAGE ANNUAL WORKER DOSE TREND



The average of all measurable doses, excluding workers with dose values of zero, was 0.10 mSv in 2017.

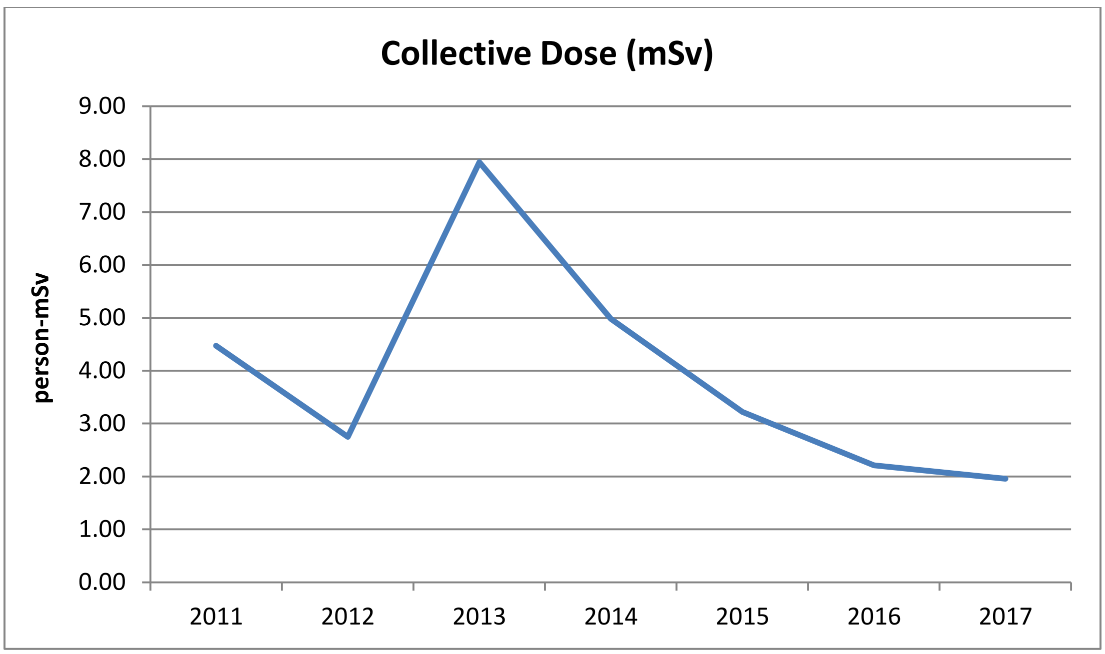
4.1.6.3 Collective Dose

The collective dose to workers at SRBT in 2017 was 1.96 person·mSv. In 2016, the collective dose was 2.21 person·mSv; the 2017 collective dose is thus approximately 11% less than the year previous.

As both the number of employees that were exposed to radiation hazards and the amount of tritium processed has remained relatively consistent between 2014 and 2016, and in 2017 the amount processed increased by a significant amount, the continued reduction in collective dose is viewed as another significant data point that demonstrates the continued effectiveness of the Radiation Safety Program to protect workers and maintain radiation doses as low as reasonably achievable.

The collective dose to workers at SRBT over the past seven years is trended below for comparison:

FIGURE 6: COLLECTIVE DOSE TREND



4.1.7 Contamination Control and Facility Radiological Conditions

Tritium contamination control is maintained by assessment of non-fixed tritium contamination levels throughout the facility by means of swipe method and liquid scintillation counting of the swipe material. SRBT has in place the following administrative surface contamination limits:

TABLE 10: ADMINISTRATIVE LIMITS FOR SURFACE CONTAMINATION

ZONE	SURFACES	ADMINISTRATIVE SURFACE CONTAMINATION LIMITS
1	ALL SURFACES	4.0 Bq/cm^2
2	ALL SURFACES	4.0 Bq/cm^2
3	ALL SURFACES	40.0 Bq/cm^2

An overview of contamination monitoring results for 2017 has been tabulated and is included in **Appendix E** of this report. A total of 8,168 assessments were performed in various work areas in 2017.

A total of 520 swipes were taken in Zone 1 resulting in a pass rate of 98.7% below the administrative level of 4 Bq/cm^2.

A total of 1,750 swipes were taken in Zone 2 resulting in a pass rate of 97.1% below the administrative level of 4 Bq/cm^2.

A total of 5,898 swipes were taken in Zone 3 resulting in a pass rate of 95.2% below the administrative level of 40 Bq/cm^2.

All swipe results are reported to the area supervisors. The area supervisor and the Health Physics Team reviews the results to determine where extra cleaning effort is necessary. A comparison of the data for the last several years is presented:

TABLE 11: PASS RATE FOR CONTAMINATION ASSESSMENTS

ZONE	2014 PASS RATE	2015 PASS RATE	2016 PASS RATE	2017 PASS RATE
1	97.8%	96.9%	98.4%	98.7%
2	93.5%	96.6%	94.7%	97.1%
3	93.7%	93.4%	91.3%	95.2%

Overall, routine contamination measurements conducted throughout the facility in 2017 fell below the administrative limits 95.8% of the time, meeting the internal target of ≥95%.

4.1.8 Discussion on the Effectiveness of Radiation Protection Program

Based upon the following factors and the overall evidence presented in this report, it is concluded that the SRBT radiation protection program has been effective throughout the year:

- Highest worker dose for 2017 of 0.46 mSv, or <1% of regulatory limit, and was for the third year in a row less than 1 mSv (representing the regulatory limit for a person who is not a nuclear energy worker).
- Collective dose and average dose continue to trend positively (i.e. a decrease compared to the previous year).
- Contamination control data demonstrates a high level of control and an intolerance for contamination in excess of administrative limits.
- Achievement of the target pass rate for contamination control, with no personnel contamination events.
- Radiation protection equipment issues are minimal, with an continuing investment in new equipment leading to an excellent track record of maintenance and fitness for service.
- Radiation protection training results demonstrate that staff has a good appreciation and knowledge of how to protect themselves from hazards.

4.1.9 Occupational Dose Targets

As described in the 2016 annual compliance report, the occupational dose targets for 2017 were set as 0.75 mSv (maximum dose to staff member) and 0.060 mSv (average dose to all staff).

Both of these targets were achieved, as described above. The maximum dose to any worker was 0.46 mSv, while the average dose to all workers was 0.045 mSv.

SRBT projects that in 2018 both the maximum and average dose to workers may rise slightly as production increases of miniature light sources is expected to increase.

As a result, in consideration of the low doses achieved in 2017, and the projected production increase, the occupational dose targets remain unchanged for 2018.

These targets are set as follows:

- Maximum dose: ≤ 0.75 mSv, and
- Average dose: ≤ 0.060 mSv

4.1.10 Summary of Radiation Protection Training and Effectiveness

All new staff members receive introductory training in radiation safety, even if they are not expected to handle nuclear substances as part of their responsibilities.

In 2017, three employees were hired and were provided with this initial indoctrination training that is required for declaration as a nuclear energy worker. Personnel performed well on the associated test, with no instances of remedial testing required.

On December 6, 2017, SRBT held its annual all-staff training session, which includes a comprehensive training presentation specifically regarding radiation protection concepts and requirements, specifically tailored to the type of hazard at SRBT.

Open dialogue was encouraged with a question and answer session, and a closed-book written test was provided to all participants.

A test is administered at the conclusion of the course; in 2017, all participants successfully challenged the test. Results averaged 94.6%, with no marks below the pass criterion of 75%. Any wrong answer on the test was also discussed in detail with all employees individually to ensure full understanding in the days following the training.

4.1.11 Summary of Radiation Protection Equipment Performance

In 2017, all equipment associated with radiation protection at SRBT performed acceptably, and all maintenance activities (including instrument calibration) were performed as required. Radiation protection equipment includes:

- Liquid scintillation counters
- Portable tritium in air monitors
- Stationary tritium in air monitors
- Portable radiation detectors ('RadEye' type alpha/beta/gamma detectors)

Two unscheduled corrective maintenance visits were conducted in 2017 by the manufacturer of the LSC units in order to resolve minor issues with rack jamming and the chamber shutter mechanism.

SRBT continues to ensure that all equipment relating to the protection of workers from the hazards associated with tritium are kept fit for service, as required by the Maintenance Program.

4.1.12 Summary of Radiation Protection Improvements

In 2017, the following improvements were implemented with respect to the Radiation Safety Program at SRBT:

- A major revision of the Radiation Safety Program was undertaken, with the majority of non-radiation protection aspects removed from the program as they are now fully and adequately captured within other management system programs and procedures.
- A new Dosimetry Service Program document was drafted as a subordinate component of the Radiation Safety Program, in order to capture all pertinent requirements in this area in a stand-alone document. The program was submitted for assessment to CNSC staff as part of the Dosimetry Service Licence renewal in late 2017.
- The process for obtaining dose histories when on-boarding workers, contractors and visitors was formalized in procedure RSO-004, *Bioassay Procedure,* based on a recommendation of from CNSC staff stemming from their inspection of the program in February.
- Forms associated with RSO-004, *Bioassay Procedure,* and RSO-011, *Instrument Calibration* were revised to incorporate improvements.
- Procedure *RSO-039, Planning for Unusual Situations* was revised to better describe how worker doses are assessed following an unusual

situation or unplanned event, based on a recommendation from CNSC staff stemming from their inspection of the program in February.

- A new procedure focused on the requirements pertaining to protective clothing for radiation safety purposes was implemented. RSO-041, *Protective Clothing for Radiation Safety* was developed as a result of a recommendation from CNSC staff stemming from their inspection of the program in February.
- Two more additional portable tritium-in-air monitors were procured for use by staff.
- SRBT achieved the target pass rate for facility contamination control after missing the target in 2016.
- The SAT-based training programs SAT-HP-01, *Advanced Health Physics Instrumentation* and SAT-HP-04, *Bioassay and Dosimetry* completed final development work, and were reviewed and accepted for implementation by the Training Committee.

Overall, SRBT's Radiation Safety Program continues to provide an effective level of radiological protection to our workers, and continues to be improved over time.

4.2 SCA – Conventional Health and Safety

4.2.1 Jurisdiction

SRBT is subject to federal jurisdiction thus, the Canada Labour Code Part II (CLC Part II) and the Canada Occupational Health and Safety regulations.

4.2.2 Industrial Health and Safety Program

Being under federal jurisdiction in 2017, the Health and Safety Program for the SRBT facility was compliant with the requirements of the CLC Part II & Canada Occupational Health and Safety regulations.

4.2.3 Workplace Health and Safety Committee

In accordance with Section 135 (1) of the CLC Part II, SRBT maintains a Workplace Health and Safety Committee.

The Committee is comprised of four representatives. Under section 135(10) of the CLC Part II the Committee is required to meet no less than 9 times per year.

The Committee met 12 times in 2017, with all meeting minutes kept on file.

4.2.4 Minor Incidents

Due to a policy change requiring all injuries (no matter how small) be reported by SRBT employees in 2017, there has been an increase in the amount of minor incidents / injuries recorded and reported compared to previous years.

There were 21 injuries reported in 2017 where an employee required first aid treatment; of those 21 injuries, 8 of these resulted in medical care being sought at the local hospital as a precautionary measure.

A breakdown of the type of minor injuries occurring in 2017 is provided:

- Minor Cuts – 7
- Glass shard in finger/hand – 5
- Burns (flame) – 4
- Cut requiring stitches - 1
- Acid exposure – 1
- Back injury – 1
- Chemical exposure to eye – 1
- Wrist injury - 1

All injuries requiring hospital care were reported to WSIB as required.

4.2.5 Lost Time Incidents

Of the 8 injuries which required medical attention and were reported to WSIB in 2017, 3 of these resulted in lost time at work (shoulder injury, back injury & cut requiring stitches).

The 3 lost time injuries were reported to ESDC safety officers as required. These injuries and the corrective actions taken in response to these occurrences were reviewed by officers with Employment and Social Development Canada during their inspection (see below). The officers concluded that the actions taken were appropriate, and did not express any further concerns or issues.

A summary of each individual lost-time injury is provided here:

Cut Requiring Stitches (two days lost time)

On January 25, 2017 (a Wednesday), a worker cut their hand when changing a knife blade used for production processes. The worker required stitches as a result of the injury, and was advised by the attending medical professional to return to work the following Monday.

An investigation determined that the worker did not adequately guard the blade when changing it. SRBT conducted a safety stand-down meeting with supervisors to discuss the event, and to ensure that the expectations with respect to handling sharps were emphasized in order to reduce the risk of injury.

Back Injury (one day lost time)

On August 10, 2017 (a Thursday), an employee reported that when kneeling down to pick up an item on the floor, their back ‘gave out’ suddenly, resulting in significant pain and stiffness. The worker was transported to the hospital for evaluation, and missed the next day of work due to this injury, returning the following week. Upon return, the worker was advised on the proper methodology for lifting items, including the avoidance of twisting the back when bending over.

Shoulder Injury (four days lost time)

An employee in the Coating Department experienced pain in their shoulder during work on October 16, 2017 (a Monday). The employee sought medical attention, and was advised to take a week off of work, followed by a return to modified duties. In response to this event, SRBT emphasized expectations with respect to job rotation in all production departments in order to reduce the risk of injuries associated with repetitive movements.

4.2.6 Inspection - Employment and Social Development Canada

In 2017, officers with Employment and Social Development Canada (ESDC) conducted an inspection of the facility over the course of two days, focused on Conventional Health and Safety, and compliance with the Canada Labour Code and regulations pursuant to the Code.

The inspection began with an unannounced site visit on October 30, 2017, where ESDC officers conducted an assessment of programmatic documentation and health and safety-related records, including a comprehensive review of injury reports. The inspection concluded with a site visit and physical inspection on November 28, 2017.

Officers concluded that SRBT’s conventional health and safety program is compliant with the provisions of the Canada Labour Code and associated regulations, and made several positive notes on safety-related aspects of the facility and its management system.

4.2.7 Reporting

In accordance with Section 15.10 (1) of Part XV of the Canada Occupational Health and Safety Regulations the Employer's Annual Hazardous Occurrence Report was submitted to Human Resources and Skills Development Canada (HRSDC) prior to March 1, 2017, as required

In accordance with Section 10 of the Safety and Health Committees and Representatives Regulations, the Work Place Committee Report was submitted to the Regional Safety Officer at Canada Labour prior to March 1, 2017, as required.

4.2.8 Health and Safety Training

In March 2017, all employees of SRBT took part in and completed WHMIS 2015 GHS Awareness training.

The Manager - Safety and Security attended a Health & Safety Training Conference in Toronto on May 10th, 2017 and took part in training seminars that included:

- Federal Health and Safety Committee Effectiveness
- Workplace Accident Investigations: From Theory to Practice
- Internal Complaint Resolution Process and Refusal to Work
- Workplace Violence Prevention

The Manager - Safety and Security also attended another Health & Safety Training Conference in Ottawa on October 3rd & 4th 2017 and took part in training seminars that included:

- Active Shooter in the Workplace
- Beyond Prequalification and Training: How to Build Lasting Partnerships with Contractors
- CSA Standard for Machine Guarding
- Beyond GHS: Stop the Confusion and Manage your Chemical Program Before the MOL Comes Knocking
- Mock Accident Investigation & Coroner's Inquest

In December 2017, all SRBT staff were given refresher training in WHMIS at the annual SRBT training day.

4.3 SCA – Environmental Protection

This section of the report will provide environmental and radiological compliance including results from environmental, effluent and groundwater monitoring, an assessment of compliance with any licence limits, historical trending where appropriate, and quality assurance/quality control results for the monitoring.

As part of ensuring compliance with the reporting requirements of several N288-series of standards, SRBT has committed to ensuring that the information required by each applicable in-force standard to be reported annually pertaining to the environmental monitoring, effluent monitoring and groundwater monitoring programs is included our annual compliance report.

A summary of the requirements of each of the applicable standards is provided here.

N288.4-10: Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills: Section 11.2.2 – "The report shall include":

TABLE 12: REPORTING REQUIREMENTS (N288.4-10)

	REQUIREMENT	REPORT SECTION
a	The results of the EMP, including measurements of the monitored hazardous and/or nuclear substances, physical stressors, and physical and biological parameters, including their statistical analyses (i.e. assessment of changes through space and time).	4.3.1 **Appendices F through N**
a	Radiation doses calculated as doses to receptors where this is required.	4.3.5 **Appendix S**
a	An assessment of the EMP results compared with the previous performance indicator targets.	4.3 Reference is made to previous years for performance indication.
a	Documentation and justification of any deviations from field sampling, and analytical and data management procedures.	4.3.1.10 4.3.1.11
b	A summary and assessment of the field and laboratory QA/QC results including any non-conformances.	4.3.1.12
c	A summary of the audit and review results and subsequent corrective actions.	4.3.7
d	A summary of any proposed modifications to the EMP.	4.3.8
e	Documentation, assessment and review of any supplementary studies that have been initiated, completed, or both.	4.3.1.13

N288.5-11: Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills: Section 11.2.2 – “The report shall include the results of the effluent monitoring program, including at least”:

TABLE 13: REPORTING REQUIREMENTS (N288.5-11)

	REQUIREMENT	REPORT SECTION
a	The amount or concentration of radioactive nuclear substances and hazardous substances released, as required to demonstrate compliance with regulatory limits and performance with respect to any other release target (e.g., action levels).	4.3.2 Action levels and other targets: 4.3.2.2, 4.3.2.4 and 4.3.2.5 **Appendices O and P**
b	The characteristics of the effluents.	4.3.2
c	The results of any toxicity testing conducted (if required).	Not applicable
d	A summary and assessment of the field and laboratory QA/QC results, including any non-conformance.	4.3.2.6
e	A statement of uncertainties inherent in the monitoring results and any dose estimates derived from them.	4.3.2.7 Dose estimates are derived using EMP data
f	A summary of the audit and review results and subsequent corrective actions.	4.3.7
g	A summary of any proposed modifications to the effluent monitoring program.	4.3.8
h	Documentation, assessment, and review of any supplementary studies that have been initiated or completed, or both.	4.3.2.8

N288.7-15: Groundwater protection programs at Class I nuclear facilities and uranium mines and mills: Section 11.1 – “A facility should prepare annual monitoring reports documenting the GWMP, which include the following”:

TABLE 14: REPORTING REQUIREMENTS (N288.7-15)

	REQUIREMENT	REPORT SECTION
a	The results of the GWMP including i) completeness of monitoring activities (identify if all planned activities were accomplished); ii) measurements of the monitored substances, biological, and hydrogeological parameters based on program objectives; and iii) data analysis and interpretations.	4.3.3 **Appendix Q**
b	Relevant groundwater and hydrogeological characteristics.	4.3.3 **Appendix R**
c	Doses calculated for the identified receptors (if doses have been calculated to aid in interpreting GWMP results).	Not applicable: GMP data does not contribute to dose calculations (residential wells fall within scope of EMP)
d	A summary and assessment of the field and laboratory QA results, including any non-conformances.	4.3.3.3
e	A statement of uncertainties inherent in the monitoring results and any dose estimates derived from them (where applicable).	4.3.3.4 4.3.5
f	Documentation of any supplementary studies that have been initiated, completed, or both (with references to the original studies).	4.3.3.5
g	An overall statement of data quality and discussion of results in terms of data performance and acceptance criteria.	4.3.3.6
h	Discussion of monitoring results in terms of program objectives and the conceptual site model.	4.3.3.7
Note 1	A summary of any audits performed, their results, and any corrective actions taken as a result of the audit’s findings may also be included in the reporting.	4.3.7

4.3.1 Environmental Monitoring

SRB Technologies (Canada) Inc. implements a comprehensive Environmental Monitoring Program (EMP)[41] that provides data for site-specific determination of tritium concentrations along the various pathways for exposure probabilities to the public due to the activities of the operations. Most samples are collected and analyzed by a third party contracted by SRBT.

4.3.1.1 Passive Air Monitoring

A total of 40 passive air samplers (PAS) are located throughout a two kilometer radius from the SRBT facility, in eight sectors, ranging in distance at 250, 500, 1,000, and 2,000 meters.

The samples were collected on a monthly basis by a third party laboratory for tritium concentration assessment by the third party laboratory, with a minimum detectable activity (MDA) ranging between 0.28 - 0.35 Bq/m^3.

Several duplicate samplers are included for quality assurance purposes. Several samplers are also located specifically to provide data for assessment of the defined critical group members. PAS results for 2017 can be found in the table in **Appendix F** of this report.

The table shows the tritium oxide (HTO) concentrations for the samplers located in each of the eight compass sectors. Tritium oxide in air concentrations for each month of 2017 are graphically represented for each of eight compass sectors and for each of the distances from the facility and are found in **Appendix G** of this report.

The PAS array represents the tritium exposure pathways for inhalation and skin absorption; results are used in the calculations for critical group annual estimated dose for 2017.

The sum of the average concentration for all 40 passive air samplers in 2017 was 38.85 Bq/m^3,a value that is slightly elevated when compared with the value observed in 2016 (33.44 Bq/m^3).

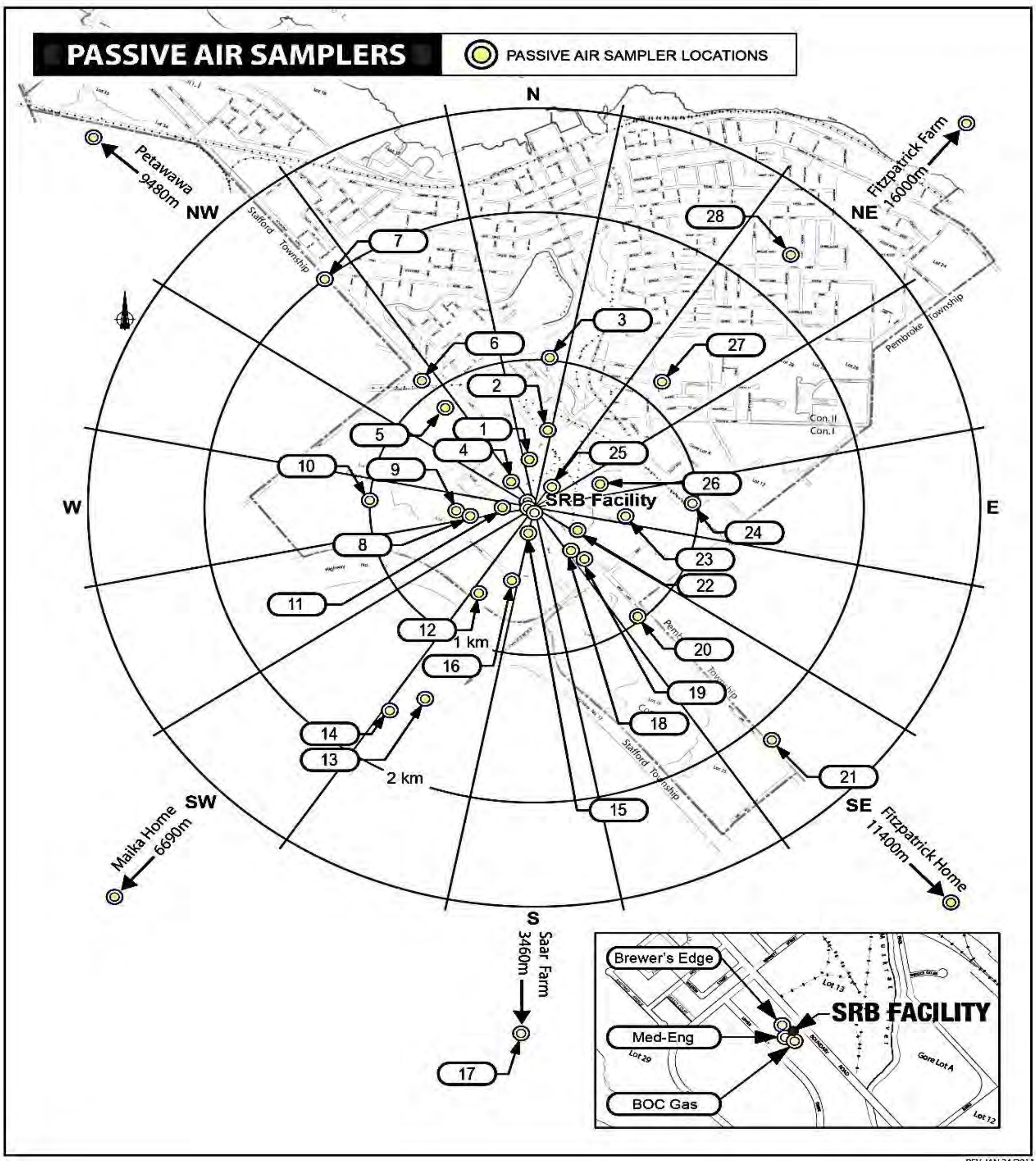
Total tritium emissions in 2017 were 24,822 GBq, or approximately 86% of the emissions in 2016 (28,945 GBq). The reduction in total emissions is due to several continuing initiatives that are discussed earlier in this report.

Facility emissions of HTO increased in 2017 (7,198 GBq) versus 2016 (6,293 GBq). The percentage increase of HTO emissions (an increase of approximately 14%) correlates very well with the observed increase in cumulative average of all PAS data (increase of approximately 16%), suggesting excellent correlation between these two parameters.

The data relating to PAS in 2017 continues to demonstrate that the environmental monitoring program collects data that consistently reflects the emissions from the facility.

The relative positioning of the PAS array used as part of the EMP is provided here:

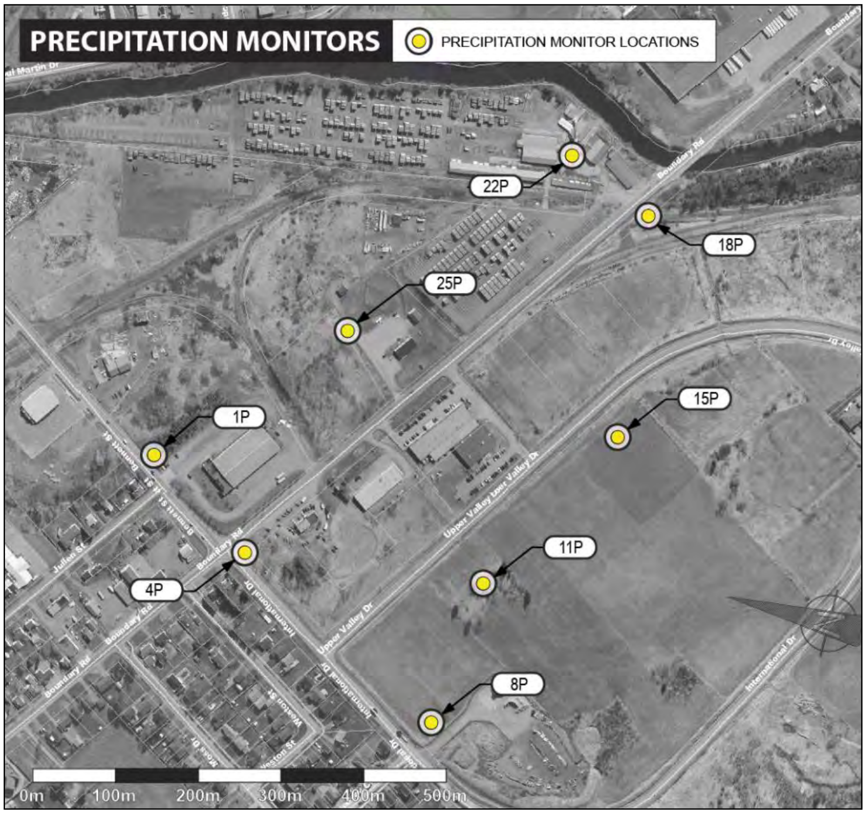
FIGURE 7: LOCATION OF PASSIVE AIR SAMPLERS



4.3.1.2 Precipitation Monitoring

Eight precipitation monitors are installed near existing air monitoring stations that are located approximately 250 m from the facility.

FIGURE 8: LOCATION OF PRECIPITATION MONITORS



The samples were collected on a monthly basis by SRBT and a third party laboratory for tritium concentration assessment by the third party laboratory. Average results in 2017 ranged between 20 Bq/L (samplers 15P and 25P) and 72 Bq/L (sampler 4P), with a MDA of between 5 - 6 Bq/L.

The average tritium concentration for all eight precipitation monitors in 2017 was 42 Bq/L, a slight increase when compared to the 2016 average of 25 Bq/L.

Precipitation monitoring results for 2017 and comparisons can be found in **Appendix H** of this report.

4.3.1.3 Receiving Waters Monitoring

Samples of receiving waters downstream from SRBT in the Muskrat River were collected and analyzed monthly by a third party laboratory.

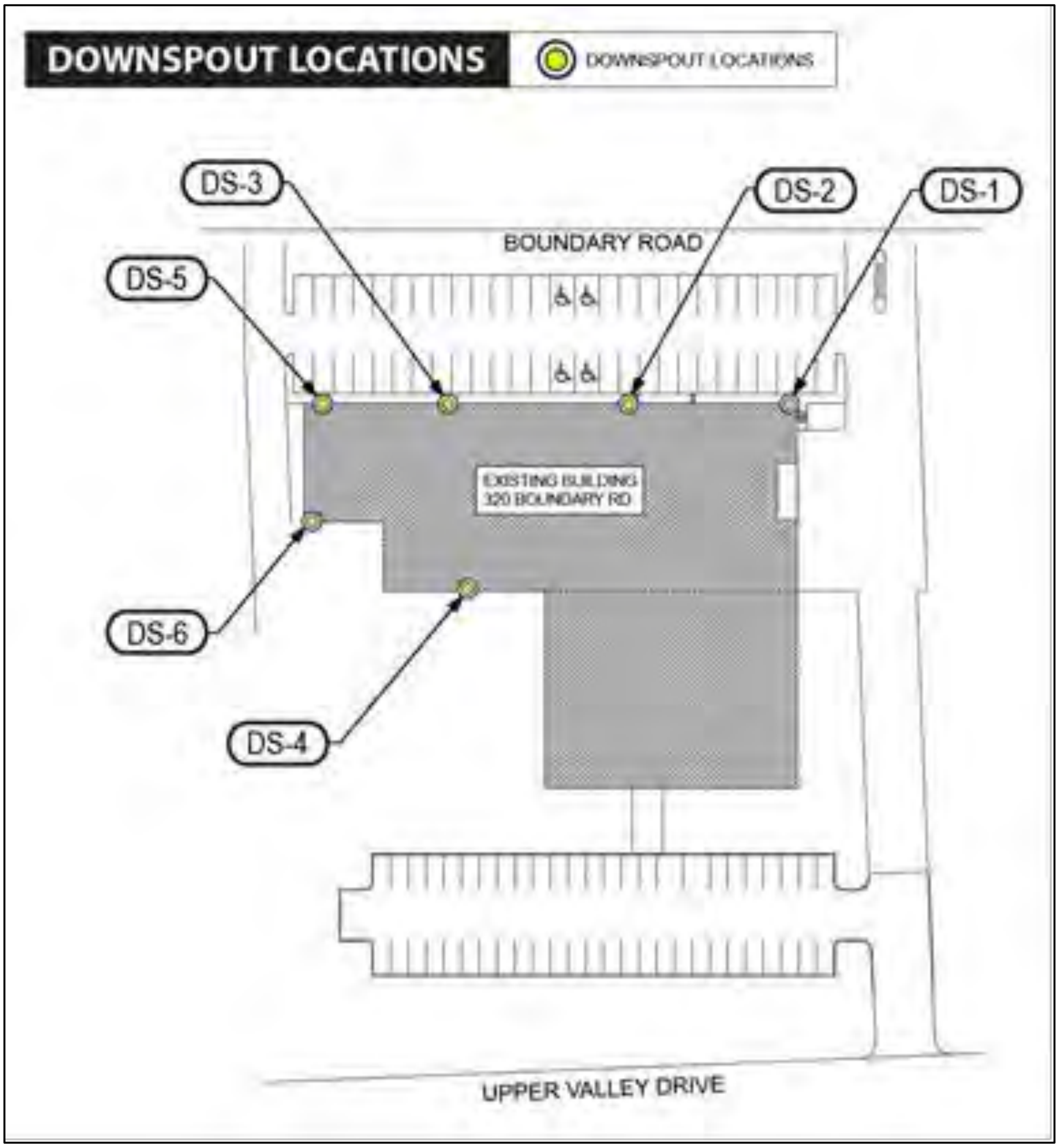
All obtained samples of receiving waters in 2017 fell below the MDA for tritium concentration (between 5 - 6 Bq/L).

Receiving waters monitoring results are trended in **Appendix I** of this report

4.3.1.4 Downspout Runoff Monitoring

Tritium concentrations are measured in all facility downspouts. The samples were collected periodically by SRBT for tritium concentration assessment.

FIGURE 9: LOCATION OF FACILITY DOWNSPOUTS



Runoff from downspouts was collected during four precipitation events throughout 2017, with a total of 21 samples being assessed. Of these, nine samples fell below minimum detectable activities (between 41 - 49 Bq/L), with seven measurements exceeding 100 Bq/L.

The average tritium concentration for all downspouts / facility runoff in 2017 was 172 Bq/L; in 2016, this value was 120 Bq/L.

Runoff monitoring results can be found in **Appendix J** of this report.

4.3.1.5 Produce Monitoring

Produce from a local market and from four local residential gardens were sampled in 2017. The samples were collected and assessed by a third party laboratory to establish free-water tritium concentration, as well as an assessment of organically-bound tritium (OBT) in specific samples (produce sample MDA = approximately 3.4 Bq/kg).

The official results were compiled and reported to the participating members of the public, and also posted on the web site. This data is also used in the calculations for critical group annual estimated dose for 2017.

The average free water tritium concentration in produce offered by local residents in 2017 was 43.7 Bq/kg, a value that is lower than the 2016 figure of 72 Bq/kg.

The average free water tritium concentration in produce offered by the local market was 7.8 Bq/kg, a measurement consistent with the 2016 value of 7.7 Bq/kg.

For OBT, samples of tomatoes from a nearby residential garden showed a concentration of 4 Bq/kg, while tomatoes from the commercial garden were measured at 3 Bq/kg.

Produce monitoring results and locations for calendar year 2017 can be found in **Appendix K** of this report, along with graphs comparing historical results of the program.

4.3.1.6 Milk Monitoring

Milk from a local producer and from a local distributor is sampled every four months. The samples were collected and analyzed for tritium concentration by a third party laboratory. This data is also used in the calculations for critical group annual estimated dose for 2017.

Milk monitoring results and locations for 2017 can be found in **Appendix L** of this report. Tritium concentrations in milk remained very low, with two-thirds of the samples being assayed as less than the MDA of 3.0 - 4.6 Bq/L, and no sample exceeding 5 Bq/L.

4.3.1.7 Wine Monitoring

Wine from a local producer is sampled once a year. The samples were collected and analyzed for tritium concentration by a third party laboratory (MDA = approximately 3.6 Bq/L).

Wine monitoring results for 2017 remains low at 11 Bq/L; annual data can be found in **Appendix M** of this report with a graph trending results from 2006 to 2017.

4.3.1.8 Weather Data

A weather station near the facility collects data on a continuous basis. See weather data for 2017 in **Appendix N**.

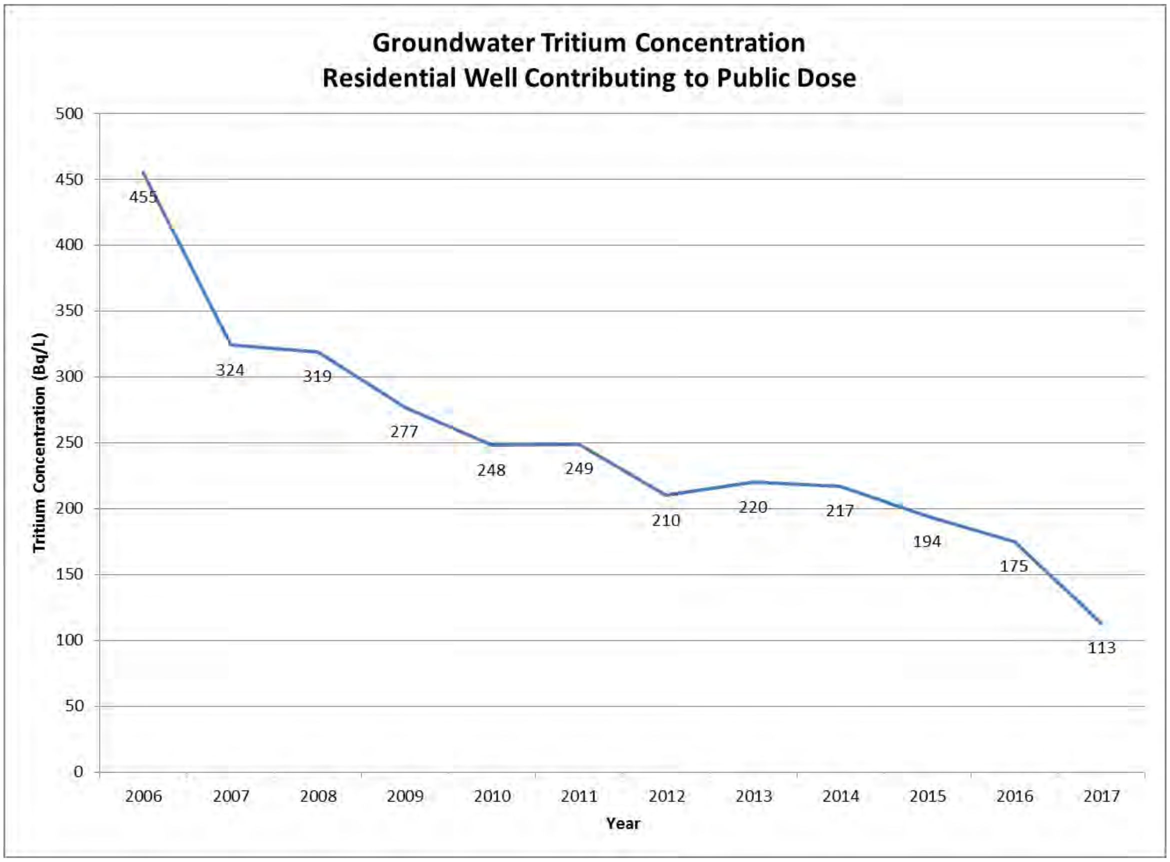
4.3.1.9 Residential Drinking Water

Several local residences permit SRBT to acquire samples three times annually, to provide additional data for our program.

An independent third party collects and analyzes residential drinking water samples (MDA = approximately 3 – 4 Bq/L).

In 2017, the highest average residential well tritium concentration value was RW-08, measured at 113 Bq/L, a value that continues trend downward, and remains far below the Ontario Drinking Water Quality Standard of 7,000 Bq/L.

FIGURE 10: RESIDENTIAL WELL TRITIUM CONCENTRATION TREND (2006-2017)



Derived public dose values attributed to residential well water consumption have decreased significantly over the past several years as a direct result of our efforts to minimize our environmental impact.

Residential well monitoring results for 2017 can be found in **Appendix Q** of this report.

4.3.1.10 Deviations from Field Sampling Procedures

In 2017, as a result of an internal compliance audit, there were four internally noted deviations from field sampling procedures and protocols by our third party independent laboratories conducting field work.

- Procedure EMP-004, *Receiving Water / River Monitoring – Field Sampling* stated that sample vials shall be rinsed once prior to obtaining the sample; however, the audit noted that technicians performing the sample in fact rinsed the vial three times.
- Procedure EMP-007, *Milk Monitoring – Field Sampling* stated that milk samples are transported in a cooler; however, the audit noted that this was in fact not standard practice.
- Procedures noted that collection vials are to be labelled in advance of sample collection; however, the audit noted that typically samples were labelled upon being collected in the field.
- Procedure EMP-010, *Residential Drinking Water – Field Sampling* stated that the tap from which a sample is obtained is to be allowed to flow for one minute prior to obtaining the sample; however, the audit noted that technicians in fact run the tap for about thirty seconds when conducting sampling.

None of these procedural deviations are viewed as significant with respect to the adequacy of the data gathered for the purposes of the EMP.

As a result of the audit findings, OFI-279 was raised to ensure that documented procedures were reflective of actual field sampling techniques, and the OFI was closed out on July 12, 2017.

4.3.1.11 Deviations from Analytical and Data Management Procedures

In 2017, there were no internally noted deviations from EMP analytical and data management procedures.

4.3.1.12 Field and Laboratory QA/QC Results and Non-conformances

Field and laboratory operations conducted by the independent third party laboratory include several quality assurance and quality control activities.

Field QA/QC activities include duplicate sampling of five passive air sampler stations, duplicate sampling of the Muskrat River, and the use of trip / method blanks for each type of sample obtained in the field.

Laboratory QA/QC activities include tritium spiking of certain collected samples and blanks, as well as laboratory reference standards for low and high activity concentrations. Sample QC is tested using spike recovery and relative percent difference (RPD) tests.

In 2017 there were no reported non-conformances relating to EMP field and laboratory QA/QC activities, and none were raised by SRBT after further assessment of raw data from the independent laboratory.

In addition, SRBT executes an internal data acceptance process as per procedure EMP-013, *Acceptance Criteria for EMP.*

In 2017, there were 211 QC checks and 661 benchmark value comparisons performed on EMP data, with 99.1% of all EMP QC checks meeting acceptance criteria, while 100% of all EMP measurements were below benchmark values.

There were two instances where an QC acceptance criterion was not met:

- In March 2017, the NE 250 and NE 250 Duplicate samples exhibited a a RPD of 55% (0.40 and 0.70 Bq/m^3), in excess of the acceptance criteria of 40%.
- In April 2017, the NE 250 and NE 250 Duplicate samples exhibited a RPD of 50% (0.50 and 0.30 Bq/m^3), in excess of the acceptance criteria of 40%.

In both cases, it was assessed that the RPD calculation is highly influenced by the magnitude of the measurement – in other words, at measurements very near the MDA, small differences in the two duplicates can easily fail the criteria.

This was the case in both of these instances; typically the lowest expected measurements where duplicate samplers are set up are on the order of at least 1-2 Bq/m^3. Based on this fact, and the fact that in both months these were the only failed QC check for the PAS set of data, the reported results were accepted for use.

4.3.1.13 Supplementary Studies – 2017

There were no supplementary studies initiated or completed relating to the SRBT EMP in 2017.

4.3.2 Effluent Monitoring

SRBT monitors two main effluent streams from the facility for tritium.

Tritium releases via the gaseous effluent pathway (active ventilation) are monitored in real time, with integrated measurements being conducted weekly to determine total emissions and verify compliance with licence limits and action levels.

Liquid effluent is retained in batches and analyzed for tritium concentration prior to being released to sewer.

4.3.2.1 Gaseous Effluent

In 2017, SRBT operated well within release limits to atmosphere that are prescribed as part of the operating licence of the facility. The operating licence (NSPFOL-13.00/2022)[1] references release limits defined in Appendix E of the Licence Conditions Handbook[2].

A summary of the releases of tritium oxide and total tritium in 2017 is tabulated below:

TABLE 15: GASEOUS EFFLUENT DATA (2017)

NUCLEAR SUBSTANCE AND FORM	ANNUAL LIMIT (GBq)	2017 RELEASED (GBq)	% LIMIT	WEEKLY AVERAGE (GBq)	MAXIMUM WEEKLY RELEASE (GBq)
TRITIUM AS TRITIUM OXIDE (HTO)	67,200	7,198	10.71%	138	349
TOTAL TRITIUM AS TRITIUM OXIDE (HTO) AND TRITIUM GAS (HT)	448,000	24,822	5.54%	477	1,275

Please refer to **Appendix O** for a complete data set on tritium releases to atmosphere in 2017.

For comparison, in 2016 HTO emissions were 9.36% of the licence limit, while total tritium emissions were 6.46% of the licence limit.

Total air emissions in 2017 decreased by approximately 14% of what they were in 2016, while tritium processed increased 17%. This is indicative of continued success in reducing process-based emissions as part of SRBT's emissions reduction initiatives.

Details on the past five years of gaseous effluent data are provided below for ease of trend analysis:

TABLE 16: GASEOUS EFFLUENT DATA (2013-2017)

NUCLEAR SUBSTANCE AND FORM	RELEASED 2013 (GBq)	RELEASED 2014 (GBq)	RELEASED 2015 (GBq)	RELEASED 2016 (GBq)	RELEASED 2017 (GBq)
TRITIUM AS TRITIUM OXIDE (HTO)	17,824	10,712	11,554	6,293	7,198
TOTAL TRITIUM AS TRITIUM OXIDE (HTO) AND TRITIUM GAS (HT)	78,875	66,161	56,237	28,945	24,822

When analyzing the operation's performance at reducing emissions it is important to assess the releases to atmosphere against the amount of tritium the facility processed. This provides an indication at how effective emission reduction initiatives have been successful in reducing emissions.

The following table defines the ratio of tritium released to atmosphere against tritium processed since 2008:

TABLE 17: TRITIUM RELEASED TO ATMOSPHERE vs PROCESSED (2008-2017)

YEAR	TRITIUM RELEASED TO ATMOSPHERE (GBq/YEAR)	TRITIUM PROCESSED (GBq/YEAR)	% RELEASED TO PROCESSED	% INCREASE (+) REDUCTION (-)
2008	40,100	2,356,979	1.70	N/A
2009	40,547	5,045,720	0.80	- 53%
2010	36,426	6,643,732	0.55	- 31%
2011	55,584	7,342,449	0.76	+ 38%
2012	29,905	10,224,590	0.29	- 62%
2013	78,875	30,544,759	0.26	- 10%
2014	66,161	28,714,119	0.23	-12%
2015	56,237	27,989,832	0.20	-13%
2016	28,945	28,122,678	0.10	-50%
2017	24,822	32,968,695	0.08	-20%

SRBT was once again able to achieve an overall reduction in the amount of tritium emitted from the facility for every unit of tritium processed. In 2017, this ratio was 21 times lower than the ratio achieved in 2008.

Expressed differently, in 2017 SRBT released an amount of tritium equivalent to 62% of that which was released in 2008, all while processing fourteen times the amount of tritium.

4.3.2.2 Air Emission Target

SRBT set an annualized total tritium emission target at the beginning of 2017 of ≤ 747 GBq / week (averaged over the year), and was successful in meeting this target (477 GBq / week). During the course of the calendar year, the weekly target was exceeded on five occasions (weeks 18, 26, 38, 39 and 41).

For calendar year 2018, SRBT has set a total tritium emission target of 650 GBq / week or less, on average, based upon projected production increases and the value achieved in 2017.

The 2017 targeted tritium released to processed ratio of ≤ 0.16% was achieved (0.08%). The 2018 target has been set at 0.13%.

4.3.2.3 Liquid Effluent

In 2017, SRBT operated well within release limits to sewer that are prescribed as part of the operating licence of the facility, as defined in Appendix E of the Licence Conditions Handbook[2].

TABLE 18: LIQUID EFFLUENT DATA (2017)

NUCLEAR SUBSTANCE AND FORM	LIMIT (GBq/YEAR)	RELEASED (GBq/YEAR)	% OF LIMIT
TRITIUM – WATER SOLUBLE	200	6.85	3.42%

Total liquid effluent releases in 2017 increased when compared to 2016 values (6.85 GBq in 2017 vs. 5.18 GBq in 2016). The increase is attributed to two key factors:

- The area experienced precipitation levels during the first nine months of the year (889.4 mm) that were well above normal levels (2010-16 average = 519 mm), leading to higher humidity and, by extension, increased amounts of dehumidification water collected in active areas of the facility.

- An increase in the manufacture of miniature light sources, a type of light source which, when assayed for integrity via water-submersion testing, can typically introduce elevated concentrations of tritium in collected effluent.

Details on the past five years of liquid effluent data are provided below for ease of trend analysis:

TABLE 19: LIQUID EFFLUENT DATA (2013-2017)

NUCLEAR SUBSTANCE AND FORM	RELEASED 2013 (GBq)	RELEASED 2014 (GBq)	RELEASED 2015 (GBq)	RELEASED 2016 (GBq)	RELEASED 2017 (GBq)
TRITIUM – WATER SOLUBLE	9.1	12.5	6.5	5.18	6.85

Please refer to **Appendix P** for a complete data set of liquid effluent releases to sewer in calendar year 2017.

4.3.2.4 Liquid Effluent Target

SRBT set a total tritium release target at the beginning of 2017 of ≤ 6 GBq for the year. The target was missed by 0.85 GBq.

Based upon an expected increase in miniature light source production in the 2018 calendar year, SRBT has set the total liquid effluent release target at 7 GBq for 2018, a value that is equivalent to the target set in 2016.

4.3.2.5 Action Level Exceedances

In 2017, there were no instances of an action level exceedance related to gaseous or liquid effluent monitoring at SRBT.

4.3.2.6 Summary of Field and Laboratory QA/QC

Effluent monitoring activities include several procedural steps that ensure acceptable quality assurance and control, including duplicate / triplicate sample acquisition and measurement, the use of process blanks, and the measurement of known reference standards as part of the assay of activity in collected sample media.

All QA/QC results obtained in 2017 were acceptable with no identified non-conformances.

4.3.2.7 Statement of Uncertainties Inherent in Monitoring Results

Uncertainties associated with effluent monitoring at SRBT may be present at several points in the process.

For gaseous effluent, such uncertainties include: sampling representativeness, total airflow collected, catalytic efficiency of HT to HTO conversion, capture efficiency of sample media, standard measurement errors associated with liquid scintillation counting, sample acquisition errors such as volume of drawn sample for analysis, and errors in stack flow rate and differential pressure measurement.

For liquid effluent, such uncertainties include: sample volume, liquid effluent volume, standard measurement errors associated with liquid scintillation counting, and sample acquisition errors such as volume of drawn sample for analysis.

In order to ensure that the uncertainties inherent in monitoring results are kept acceptably low, SRBT ensures that a third party laboratory conducts independent verification procedures on the gaseous effluent monitoring system on an annual basis. Allowable deviation between the assessed measurement of gaseous emissions is +/- 30%; in 2017, results were well within this acceptance criteria.

The QA/QC processes associated with gaseous effluent monitoring contribute to the confidence in the results. This includes independent verification of the assessment of gaseous releases at several levels. As well, the data gathered from the EMP is assessed against the data from the gaseous effluent monitoring process on a frequent basis to verify that results are relatively consistent with each other.

For liquid effluent, uncertainties inherent in monitoring results are addressed by QA/QC processes associated with liquid effluent monitoring, as well as independent verification of the assessment of releases.

The inherent uncertainties associated with effluent monitoring are well within acceptable bounds when contrasted against the measured releases, and the licenced limits for releases by each pathway.

4.3.2.8 Supplementary Studies

In 2017, no supplementary studies were conducted relating to effluent monitoring at SRBT.

4.3.2.9 Hazardous Substance Releases to Air

In 2017 SRBT continued to operate the facility under a Certificate of Approval (Air), number 5310-4NJQE2[42], issued by the Ontario Ministry of the Environment in accordance with section 9 of the Ontario Environmental Protection Act.

4.3.3 Groundwater Monitoring

SRBT implements and maintains a comprehensive Groundwater Monitoring Program (GMP) as part of our Groundwater Protection Program.

Groundwater data is reported to CNSC staff on a monthly basis, within 30 days of sampling, as required by Licence Conditions Handbook section 4.2, clause 2.

Dedicated, engineered sampling wells are used to establish tritium concentrations in the groundwater each month at various depths and in differing geologic strata. Variations are trended over time to measure the response of historical contamination of the local aquifer.

Since the program was established, groundwater measurements have been in very good agreement with established hydrogeological modelling predictions.

While most of the released tritium in the air is dispersed, some of it will reach the soil through dry and wet deposition. Infiltrated precipitation brings tritium into the groundwater below it. The deposition of tritium on and around the facility from air emissions and resulting soil moisture and standing water are the sole direct contributor to tritium found in groundwater.

Groundwater is affected by the percolation of soil moisture and standing water from the surface. Current concentrations in the wells are expected to gradually decrease once all historical emissions have flushed through the system and/or decayed with some influence of higher concentrations in nearby wells from lateral underground water flow.

This continues to be confirmed by routine monitoring of the existing network of wells. The rate at which this decrease will occur is dependent on the level and speed of recharge of the groundwater on and around the SRBT facility.

In 2017, 360 samples of groundwater were successfully obtained and analyzed, with all planned groundwater monitoring activities being accomplished, except for the following:

- MW06-3 was found to be dry during the January 2017 sample campaign.
- MW07-17 was found to be frozen during the January sample set campaign.
- CN-1D could not be sampled during the March sample campaign due to well inaccessibility.

4.3.3.1 Groundwater Tritium Concentration

Groundwater monitoring well results for 2017 can be found in **Appendix Q** of this report.

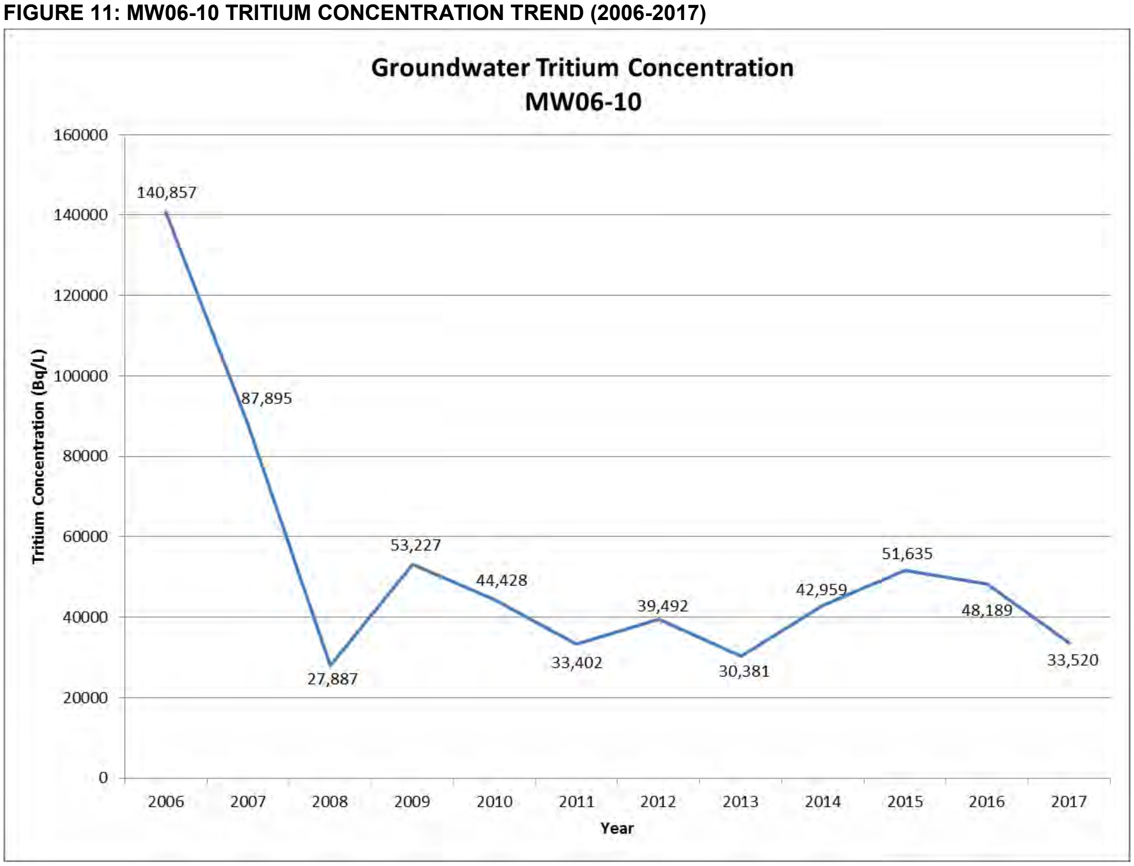
As of the end of 2017, the concentrations of two of the 34 groundwater monitoring wells surrounding the facility exceed the Ontario Drinking Water Guideline of 7,000 Bq/L.

These two wells (MW06-10 and MW07-13) are located on the SRBT site within 50 meters of the stacks. For comparison, in 2007, the concentration of eight wells exceeded 7,000 Bq/L.

The highest average tritium concentration in any well remains in monitoring well MW06-10 which is directly beneath the area where the active ventilation stacks are located.

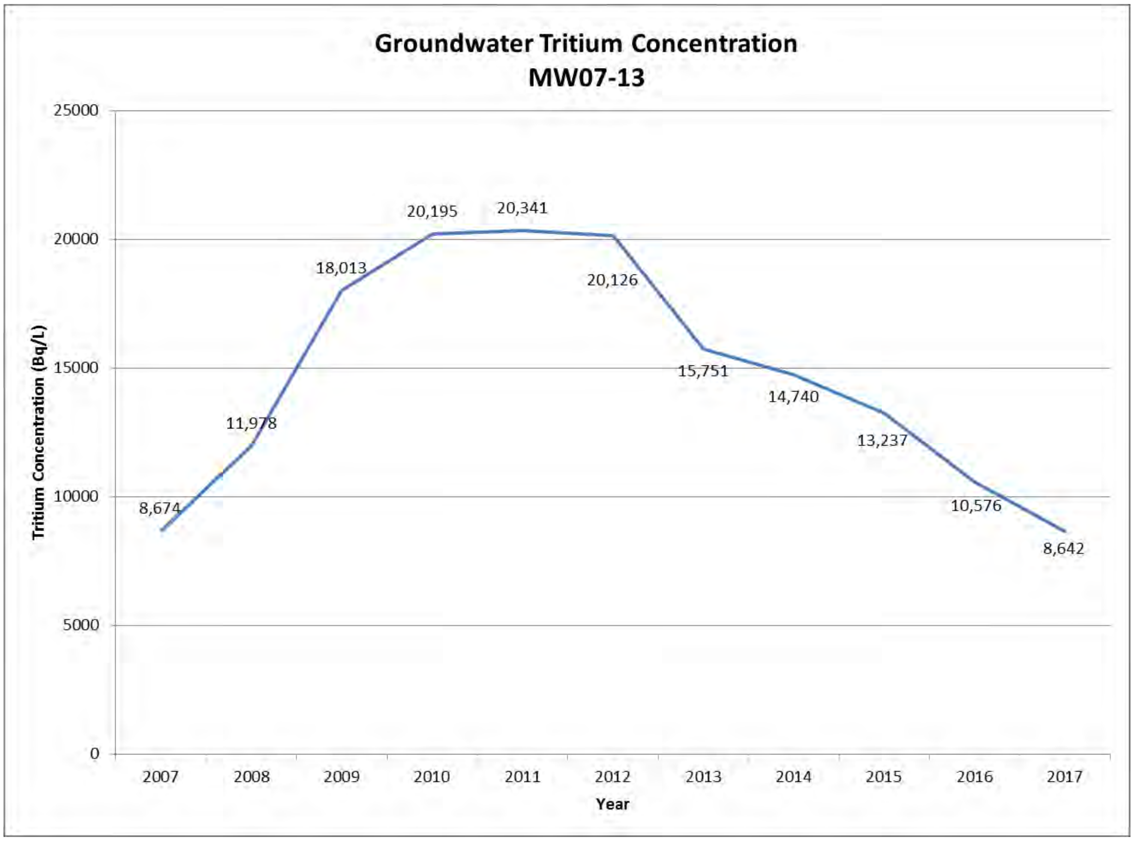
The average concentration of tritium measured in MW06-10 declined in 2017 to 33,520 Bq/L, compared to the 2016 value of 48,189 and the 2015 value of 51,635 Bq/L.

FIGURE 11: MW06-10 TRITIUM CONCENTRATION TREND (2006-2017)



The average concentration of MW07-13 in 2017 was 8,642 Bq/L, a decrease compared to the 2016 value of 10,576 Bq/L and the 2015 value of 13,237 Bq/L. At the end of 2017, the concentration of MW07-13 stands at 7,712 Bq/L.

FIGURE 12: MW07-13 TRITIUM CONCENTRATION TREND (2007-2017)



Of note is that the average of the 2017 measurements of well MW07-13 are, for the first time, below the initial average value when the well was first drilled and put into service in 2007.

Based upon the last three years, and if current trends continue as expected, MW07-13 is projected to fall below the guideline value before the end of 2019, and potentially before the end of 2018.

In 2017, all SRBT-installed groundwater monitoring wells exhibited an average tritium concentration that was lower than the previous year.

The following table compares the annualized average tritium concentration of the 29 dedicated, SRBT-installed groundwater monitoring wells between 2015 through 2017. Comparisons are made in the three columns on the right hand side of the table using a three-colour gradient, where green indicates decreasing concentrations, white indicating stable, and orange indicating a relative increase.

TABLE 20: 2015-17 AVERAGE TRITIUM CONCENTRATION IN ACTIVE MW

Well ID	2017	2016	2015	2017 / 2016	2017 / 2015	2016 / 2015
	(Bq/L)	(Bq/L)	(Bq/L)	(%)	(%)	(%)
MW06-1	1,946	2,753	4,338	70.7	44.9	63.5
MW06-2	1,166	1,467	1,965	79.5	59.3	74.7
MW06-3	683	1,029	1,218	66.4	56.1	84.5
MW06-8	780	848	906	92.0	86.1	93.6
MW06-9	2,224	2,476	2,731	89.8	81.4	90.7
MW06-10	33,520	48,189	51,635	69.6	64.9	93.3
MW07-11	1,099	1,344	1,521	81.8	72.3	88.4
MW07-12	467	469	463	99.5	100.8	101.2
MW07-13	8,642	10,576	13,237	81.7	65.3	79.9
MW07-15	1,617	1,810	1,680	89.3	96.3	107.8
MW07-16	1,649	1,879	2,188	87.7	75.4	85.9
MW07-17	335	602	780	55.6	42.9	77.2
MW07-18	2,739	3,690	5,491	74.2	49.9	67.2
MW07-19	1,926	2,500	3,222	77.0	59.8	77.6
MW07-20	571	670	775	85.3	73.7	86.4
MW07-21	879	1,009	1,121	87.1	78.4	90.0
MW07-22	1,023	1,131	1,171	90.5	87.4	96.6
MW07-23	1,743	1,929	2,206	90.4	79.0	87.4
MW07-24	2,022	2,206	2,314	91.6	87.4	95.3
MW07-26	1,190	1,491	1,941	79.8	61.3	76.8
MW07-27	3,589	4,292	4,869	83.6	73.7	88.1
MW07-28	1,063	1,311	1,446	81.1	73.5	90.7
MW07-29	2,472	3,395	3,950	72.8	62.6	86.0
MW07-31	186	440	756	42.2	24.6	58.2
MW07-32	76	155	128	49.1	59.5	121.2
MW07-34	2,291	2,822	3,312	81.2	69.2	85.2
MW07-35	3,015	3,448	3,945	87.4	76.4	87.4
MW07-36	2,109	2,618	2,892	80.5	72.9	90.5
MW07-37	871	989	1,009	88.1	86.4	98.0

4.3.3.2 Groundwater Level Measurements

The water levels are measured in monitoring wells on a monthly basis prior to purge and sampling. Analysis of this data shows consistent trends from year to year when comparing season to season.

A compilation of groundwater level measurements for 2017 can be found in **Appendix R** of this report.

4.3.3.3 Summary of Field and Laboratory QA/QC

In 2017, beginning in September SRBT commenced performing all groundwater monitoring activities with the implementation of the Groundwater Protection and Monitoring Programs, after consultation with CNSC staff and after conducting laboratory intercomparison work with the independent third party in the first quarter of the year.

These programs were submitted to CNSC staff and accepted as meeting the requirements of CSA standard N288.7-15, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills.*

Field and laboratory operations pertaining to groundwater monitoring conducted by both the independent third party laboratory (January – August) and SRBT (September – December) include several quality assurance and quality control activities.

Quality control activities include duplicate sampling of certain wells, duplicate laboratory subsampling, and the use of trip / method blanks during sampling campaigns. As well, several quality control checks are performed as part of the liquid scintillation counting procedures employed by both the third party and SRBT.

In 2017 there were no reported non-conformances relating to groundwater monitoring field and laboratory quality assurance and control activities.

4.3.3.4 Statement of Uncertainties Inherent in Monitoring Results

Uncertainties associated with SRBT groundwater monitoring may be present at certain points in the process.

The main uncertainties relate to standard measurement errors associated with liquid scintillation counting, and sample acquisition errors such as volume of drawn sample for analysis.

SRBT conducted an intercomparison sampling and analysis activity with our primary contracted third party in February and March, in anticipation of the development and implementation of the new GMP.

MW- and CN-wells were sampled and measured by SRBT concurrently with the third party, with SRBT results averaging 96% of those obtained by the contracted service provider, with a distribution profile where nearly half of the SRBT-measured samples exhibiting slightly higher concentrations.

In addition, the protocols implemented by SRBT to determine tritium concentration in groundwater samples typically achieve an MDA of between 35-38 Bq/L, while third party measurements were reported with a limit of detection around 80 Bq/L.

The inherent uncertainties associated with groundwater monitoring are well within acceptable bounds when contrasted against the tritium concentrations that may present an unacceptable risk to the public.

4.3.3.5 Supplementary Studies

In addition to the comparative work performed in advancing the transition of GMP activities to SRBT, we also provided collaborative support for a supplementary groundwater / subsurface soil study, championed by the University of Ottawa.

Soil core samples were obtained at depths of up to five metres from both the north side of the property along the line of sampling wells installed, and several dozen metres in the westerly direction of the site against the flow gradient of the aquifer.

The purpose of the sampling was to test the hypothesis that tritium oxide may exchange and activate non-living subsurface organic molecules, which may contribute to the understanding of OBT behaviour in the subsurface environment near sources of tritium.

Samples were acquired on May 16, 2017; the expectation is that sample analysis and data processing is likely to take up to a year by the collaborating parties.

4.3.3.6 Data Quality, Performance and Acceptance Criteria

Overall, the quality of data gathered as part of SRBT groundwater monitoring activities is successful in ensuring a high level of performance in monitoring, and in demonstrating that acceptance criteria (such as the limits on dose to the public) continue to be met.

All trip blanks, field duplicates, laboratory duplicates and quality control checks during liquid scintillation counting met performance criteria throughout 2017.

4.3.3.7 Program Objectives and Conceptual Site Model

The main objective of the GMP implemented by SRBT is to provide information to assess risks from site-affected groundwater to human health and the environment, ultimately to determine if the risk to the environment and the public from SRBT operations remains acceptably low.

Only two wells monitored on a regular basis exceed the Ontario Drinking Water Guideline value of 7,000 Bq/L. Both of these wells are dedicated, engineered groundwater monitoring wells very near to the facility, and are not available to be used as a source of water consumption.

The highest average concentration in a residential well continues to show a trend downward over time.

SRBT concludes that the comprehensive array of groundwater monitoring activities conducted continue to meet program objectives, and adheres to the conceptual site model developed as part of the Environmental Management System.

4.3.4 Other Monitoring

On occasion SRBT conducts monitoring of other environmental media in order to provide continued assurance of the safety of our operations.

4.3.4.1 Soil Monitoring

On August 3, 2017, samples of soil were obtained during construction activities in support of the upgraded electrical power supply to the facility.

Two samples were obtained from the west side of the site adjacent to the building: one sample of sandy fill and aggregate at a depth of 36”, and one sample of very compact clay at a depth of 60”.

These samples were analyzed by an independent laboratory, both for free-water tritium using conventional liquid scintillation counting techniques, and for organically-bound tritium through drying and subsequent measurement of Helium-3 ingrowth using noble gas mass spectrometry.

Free-water tritium measurements ranged from 111 – 832 Bq/L, while OBT was measured between 2.4 – 30.6 Bq/kg. These figures are well within historical values measured in other soils immediately surrounding the facility.

4.3.4.2 Sludge Monitoring

In March and September 2017, SRBT collected samples of sludge cake from the Pembroke Pollution Control Centre.

Sludge data does not enter into calculation of public dose; however, given previously expressed stakeholder interest, SRBT has integrated sludge cake monitoring as part of the routine EMP activities.

All samples were collected and analyzed by an independent laboratory. The results obtained are tabled below:

TABLE 21: SLUDGE MONITORING

SAMPLE TYPE	MARCH 2017	SEPTEMBER 2017
FREE-WATER TRITIUM (Bq/L)	37 (+/-7)	76 (+/-7)
OBT FRESH WEIGHT (Bq/kg)	378 (+/-7)	1,424 (+/-21)

4.3.5 Public Dose

The calculation method used to determine the dose to the representative persons as defined in the SRBT Environment Monitoring Program (EMP) is described in the EMP document. All data and tables relating to the calculation of the dose to the public can be found in **Appendix S**.

For 2017, the dose has been calculated using the effective dose coefficients found in CSA Guideline N288.1-14[43,44,45,46].

TABLE 22: CSA GUIDELINE N288.1-14 EFFECTIVE DOSE COEFFICIENTS FOR H-3

AGE GROUP	EFFECTIVE DOSE COEFFICIENT – INHALATION (HTO) (µSv/Bq)	EFFECTIVE DOSE COEFFICIENT – INGESTION (HTO) (µSv/Bq)	EFFECTIVE DOSE COEFFICIENT – INGESTION (OBT) (µSv/Bq)
INFANT	8.0E-5	5.3E-5	1.3E-4
CHILD	3.8E-5	2.5E-5	6.3E-5
ADULT	3.0E-5	2.0E-5	4.6E-5

NOTE: The dose coefficients listed for inhalation account for skin absorption, as per Table C.1 of N288.1-14.

The dose assessed for the Critical Group is a summation of:

- Tritium uptake from inhalation and absorption through skin at the place of residence and/or the place of work, ($P_{(i)19}$ and $P_{(e)19}$), and
- Tritium uptake due to consumption of well water (P_{29}), and
- Tritium uptake due to consumption of produce (P_{49}), and
- Tritium uptake due to consumption of dairy products (P_{59}).

Dose due to inhalation

The closest residence to SRBT is located by passive air sampler NW250 approximately 240 meters from the point of release. The 2017 average concentration of tritium oxide in air at passive air sampler NW250 has been determined to be **1.92 Bq/m^3**.

Three passive air samplers are located close to the SRBT facility and represent the tritium oxide in air ($P_{(i)19}$ and $P_{(e)19}$) concentrations for the critical group member (adult worker) at samplers 1, 2, and 13. The sampler indicating the highest tritium oxide in air concentration is used to calculate the P_{19} dose values while at work. The highest average result for 2017 for PAS # 1, PAS # 2, and PAS # 13 is **3.50 Bq/m^3** at PAS # 2.

Using the inhalation rates found in CSA Guideline N288.1-14[44], and assuming 2,080 hours (23.744%) of work per year with 6,680 hours (76.256%) at home (a total of 8,760 hours per year):

TABLE 23: CSA GUIDELINE N288.1-14 INHALATION RATES

AGE GROUP	INHALATION RATE (m^3/a)
INFANT	2,740
CHILD	7,850
ADULT	8,400

$P_{(i)19}$: Adult worker dose due to HTO inhaled at residence

The average value for tritium oxide in air for the sampler taken as representing the place of residence for the defined representative person equals 1.92 Bq/m^3.

$P_{(i)19r}$ = [H-3$_{air}$] (Bq/m^3) x Resp. Rate (m^3/a) x Occup. Factor x DCF$_{H3}$ (µSv/Bq)
= 1.92 Bq/m^3 x 8,400 m^3/a x 0.76256 x 3.0E-05 µSv/Bq
= 0.369 µSv/a

$P_{(i)19}$: Adult worker dose due to HTO inhaled at work

Taking the highest concentration between Passive Air Samplers #1, #2, and #13 is Passive Air Samplers #13 at 3.50 Bq/m^3.

$P_{(i)19w}$ = [H-3$_{air}$] (Bq/m^3) x Resp. Rate (m^3/a) x Occup. Factor x DCF$_{H3}$ (µSv/Bq)
= 3.50 Bq/m^3 x 8,400 m^3/a x 0.23744 x 3.0E-05 µSv/Bq
= 0.209 µSv/a.

$P_{(i)19}$: Adult resident dose due to HTO inhaled at residence

The average value for tritium oxide in air for the sampler representing the place of residence for the defined representative person equals 1.92 Bq/m^3:

$$P_{(i)19} = [H\text{-}3_{air}]\ (Bq/m^3) \times \text{Resp. Rate}\ (m^3/a) \times DCF_{H3}\ (\mu Sv/Bq)$$
$$= 1.92\ Bq/m^3 \times 8{,}400\ m^3/a \times 3.0E\text{-}05\ \mu Sv/Bq$$
$$= 0.484\ \mu Sv/a$$

$P_{(i)19}$: Infant resident dose due to HTO inhaled at residence

The average value for tritium oxide in air for the sampler representing the place of residence for the defined representative person equals 1.92 Bq/m^3:

$$P_{(i)19} = [H\text{-}3_{air}]\ (Bq/m^3) \times \text{Resp. Rate}\ (m^3/a) \times DCF_{H3}\ (\mu Sv/Bq)$$
$$= 1.92\ Bq/m^3 \times 2{,}740\ m^3/a \times 8.0E\text{-}05\ \mu Sv/Bq$$
$$= 0.421\ \mu Sv/a$$

$P_{(i)19}$: Child resident dose due to HTO inhaled at residence

The average value for tritium oxide in air for the sampler representing the place of residence for the defined representative person equals 1.92 Bq/m^3:

$$P_{(i)19} = [H\text{-}3_{air}]\ (Bq/m^3) \times \text{Resp. Rate}\ (m^3/a) \times DCF_{H3}\ (\mu Sv/Bq)$$
$$= 1.92\ Bq/m^3 \times 7{,}850\ m^3/a \times 3.8E\text{-}05\ \mu Sv/Bq$$
$$= 0.573\ \mu Sv/a$$

<u>Dose due to skin absorption</u>

Beginning in 2016, the dose due to skin absorption is wholly accounted for by the application of the inhalation dose conversion factors applied above.

Please see CSA N288.1-14, Table C.1 footnotes for details on dose conversion factors and how they account for skin absorption.

Dose due to consumption of well water

The tritium uptake due to consumption of well water is calculated by taking the average tritium concentration of the water sampled.

Using the following annual consumption rates (at the 95th percentile) found in CSA Guideline N288.1-14[45]:

TABLE 24: CSA GUIDELINE N288.1-14 WATER CONSUMPTION RATES

AGE GROUP	WELL WATER CONSUMPTION RATE (L/a)
INFANT	305.7
CHILD	482.1
ADULT	1,081.1

In 2017, the highest concentration in a residential well used as the sole source of the drinking water was found in RW-8 at 204 Boundary Road, equal to **113 Bq/L**. This value will therefore be used in the calculation of the public dose.

P_{29}: Adult dose due to consumption of well water

P_{29} = $[H\text{-}3]_{well}$ x M x 2.0E-05 μSv/Bq;
= [113 Bq/L] x 1,081.1 L/a x 2.0E-05 μSv/Bq
= 2.443 μSv/a

P_{29}: Infant dose due to consumption of well water

P_{29} = $[H\text{-}3]_{well}$ x M x 5.3E-05 μSv/Bq;
= [113 Bq/L] x 305.7 L/a x 5.3E-05 μSv/Bq
= 1.831 μSv/a

P_{29}: Child dose due to consumption of well water

P_{29} = $[H\text{-}3]_{well}$ x M x 2.5E-05 μSv/Bq;
= [113 Bq/L] x 482.1 L/a x 2.5E-05 μSv/Bq
= 1.362 μSv/a

Dose due to consumption of produce

The tritium uptake due to consumption of produce, both locally purchased and home grown is calculated by taking the average tritium concentration of produce purchased from the local market and assuming the consumption of 70% of the annual total of produce from this source, and by taking the average tritium concentration from local gardens and assuming the consumption of 30% of the annual total of produce from this source.

These fractions are based upon the site-specific survey conducted in 2005, which determined that the home-grown fraction of plant products consumed by residents in the surrounding area was approximately 30% - a slightly higher value than those recommended in the generic guidance of N288.1-14 (20-25%).

Using the following annual consumption rates for produce found in CSA Guideline N288.1-14[46]:

TABLE 25: CSA GUIDELINE N288.1-14 PRODUCE CONSUMPTION RATES

AGE GROUP	FRUIT CONSUMPTION RATE (Kg/a)	ABOVE-GROUND VEGETABLES CONSUMPTION RATE (Kg/a)	ROOT VEGETABLES CONSUMPTION RATE (Kg/a)	TOTAL CONSUMPTION RATE (Kg/a)
INFANT	76.6	36.1	12.1	124.8
CHILD	124.4	97.6	43.2	265.2
ADULT	149.2	192.3	71.8	413.3

The average tritium concentration in produce purchased from the sampled market in 2017 was **7.8 Bq/kg**, while the highest average concentration in produce from a local garden in 2017 was **83.5 Bq/kg** at 408 Boundary Road.

P_{49}: Adult dose due to consumption of produce (HTO)

P_{49HTO} = [[$H_{prod,market}$] + [$H_{prod,res}$]] x 2.0E-05 μSv/Bq
= [[H-3_{veg}] (Bq/kg) x (kg) x 0.7] + [H-3_{veg}] (Bq/kg) x (kg) x 0.3]] x 2.0E-5 μSv/Bq
= [[7.8 Bq/kg x 413.3 kg/a x 0.7] + [83.5 Bq/kg x 413.3 kg/a x 0.3]] x 2.0E-05 μSv/Bq
= [[2,257 Bq/a] + [10,353 Bq/a]] x 2.0E-05 μSv/Bq
= 0.252 μSv/a

P_{49}: Infant dose due to consumption of produce (HTO)

P_{49HTO} = [[$H_{prod,market}$] + [$H_{prod,res}$]] x 5.3E-05 μSv/Bq
= [[H-3_{veg}] (Bq/kg) x (kg) x 0.7] + [H-3_{veg}] (Bq/kg) x (kg) x 0.3]] x 5.3E-5 μSv/Bq
= [[7.8 Bq/kg x 124.8 kg/a x 0.7] + [83.5 Bq/kg x 124.8 kg/a x 0.3]] x 5.3E-05 μSv/Bq
= [[681 Bq/a] + [3,126 Bq/a]] x 5.3E-05 μSv/Bq
= 0.202 μSv/a

P_{49}: Child dose due to consumption of produce (HTO)

P_{49HTO} = [[$H_{prod,market}$] + [$H_{prod,res}$]] x 2.5E-05 μSv/Bq
= [[H-3_{veg}] (Bq/kg) x (kg) x 0.7] + [H-3_{veg}] (Bq/kg) x (kg) x 0.3]] x 2.5E-5 μSv/Bq
= [[7.8 Bq/kg x 265.2 kg/a x 0.7] + [83.5 Bq/kg x 265.2 kg/a x 0.3]] x 2.5E-05 μSv/Bq
= [[1,448 Bq/a] + [6,643 Bq/a]] x 2.5E-05 μSv/Bq
= 0.202 μSv/a

SRBT directly monitored organically bound tritium (OBT) concentrations in tomatoes in the garden at 408 Boundary Road, as well as tomatoes from the commercial market garden. The average OBT concentration from the residential produce was measured as 4.0 Bq/kg, while for the commercial produce a value of 3.0 Bq/kg was measured.

P_{49}: Adult dose due to consumption of produce (OBT)

P_{49OBT} = [[$H_{prod,market}$] + [$H_{prod,res}$]] x 4.6E-05 μSv/Bq
= [[H-3_{veg}] (Bq/kg) x (kg) x 0.7] + [H-3_{veg}] (Bq/kg) x (kg) x 0.3]] x 4.6E-5 μSv/Bq
= [[3 Bq/kg x 413.3 kg/a x 0.7] + [4 Bq/kg x 413.3 kg/a x 0.3]] x 4.6E-05 μSv/Bq
= [[868 Bq/a] + [496 Bq/a]] x 4.6E-05 μSv/Bq
= 0.063 μSv/a

P_{49}: Infant dose due to consumption of produce (OBT)

P_{49OBT} = [[$H_{prod,market}$] + [$H_{prod,res}$]] x 1.3E-4 μSv/Bq
= [[H-3_{veg}] (Bq/kg) x (kg) x 0.7] + [H-3_{veg}] (Bq/kg) x (kg) x 0.3]] x 1.3E-4 μSv/Bq
= [[3 Bq/kg x 124.8 kg/a x 0.7] + [4 Bq/kg x 124.8 kg/a x 0.3]] x 1.3E-4 μSv/Bq
= [[262 Bq/a] + [150 Bq/a]] x 1.3E-4 μSv/Bq
= 0.054 μSv/a

P_{49}: Child dose due to consumption of produce (OBT)

P_{49OBT} = [[$H_{prod,market}$] + [$H_{prod,res}$]] x 6.3E-5 µSv/Bq
= [[H-3_{veg}] (Bq/kg) x (kg) x 0.7] + [H-3_{veg}] (Bq/kg) x (kg) x 0.3]] x 6.3E-5 µSv/Bq
= [[3 Bq/kg x 265.2 kg/a x 0.7] + [4 Bq/kg x 265.2 kg/a x 0.3]] x 6.3E-5 µSv/Bq
= [[557 Bq/a] + [318 Bq/a]] x 6.3E-5 µSv/Bq
= 0.055 µSv/a

Total dose due to consumption of produce:

P_{49}: Adult dose due to consumption of produce (HTO + OBT)

P_{49} = P_{49HTO} + P_{49OBT}
= 0.252 µSv/a + 0.063 µSv/a
= 0.315 µSv/a

P_{49}: Infant dose due to consumption of produce (HTO + OBT)

P_{49} = P_{49HTO} + P_{49OBT}
= 0.202 µSv/a + 0.054 µSv/a
= 0.256 µSv/a

P_{49}: Child dose due to consumption of produce (HTO + OBT)

P_{49} = P_{49HTO} + P_{49OBT}
= 0.202 µSv/a + 0.055 µSv/a
= 0.257 µSv/a

Dose due to consumption of local milk

The tritium uptake due to consumption of milk, from a local producer and distributor is calculated by taking the average tritium concentration of the milk sampled.

Using the following annual milk consumption rates found in CSA Guideline N288.1-14[46]:

TABLE 26: CSA GUIDELINE N288.1-14 MILK CONSUMPTION RATES

AGE GROUP	MILK CONSUMPTION RATE (kg/a)
INFANT	339.9
CHILD	319.6
ADULT	188.5

The average concentration in milk being 3.67 Bq/L but adjusting for the density of milk 3.67 Bq/L x 0.97 L/kg = **3.56 Bq/kg**.

P_{59}: Adult dose due to consumption of milk

P_{59} = $[H\text{-}3]_{dairy}$ x M x 2.0E-05 μSv/Bq;
= [3.56 Bq/kg] x 188.5 kg/a x 2.0E-05 μSv/Bq
= 0.013 μSv/a

P_{59}: Infant dose due to consumption of milk

P_{59} = $[H\text{-}3]_{dairy}$ x M x 5.3E-05 μSv/Bq;
= [3.56 Bq/kg] x 339.9 kg/a x 5.3E-05 μSv/Bq
= 0.064 μSv/a

P_{59}: Child dose due to consumption of milk

P_{59} = $[H\text{-}3]_{dairy}$ x M x 5.3E-05 μSv/Bq;
= [3.56 Bq/kg] x 319.6 kg/a x 2.5E-05 μSv/Bq
= 0.028 μSv/a

Critical group annual dose due to tritium uptake based on EMP

Based on the EMP results and the coefficients and parameters taken from N288.1-14[43,44,45,46], the annual dose (P_{total}) due to tritium uptake from inhalation and skin absorption, consumption of local produce, local milk and well water equates to a conservatively calculated maximum of **3.349 µSv** for an adult worker representative person in 2017, compared to 4.579 µSv in 2016, 6.840 µSv in 2015, and 6.738 µSv in 2014.

TABLE 27: 2017 CRITICAL GROUP ANNUAL DOSE BASED ON EMP

DOSE CONTRIBUTOR		ADULT WORKER ANNUAL DOSE (µSv/A)	ADULT RESIDENT ANNUAL DOSE (µSv/A)	INFANT RESIDENT ANNUAL DOSE (µSv/A)	CHILD RESIDENT ANNUAL DOSE (µSv/A)
DOSE DUE TO INHALATION and ABSORPTION AT WORK	$P_{(I)19}$	0.209			
DOSE DUE TO INHALATION and ABSORPTION AT RESIDENCE	$P_{(I)19}$	0.369	0.484	0.421	0.573
DOSE DUE TO CONSUMPTION OF WELL WATER	P_{29}	2.443	2.443	1.831	1.362
DOSE DUE TO CONSUMPTION OF PRODUCE	P_{49}	0.315	0.315	0.256	0.257
DOSE DUE TO CONSUMPTION OF MILK	P_{59}	0.013	0.013	0.064	0.028
2017 PUBLIC DOSE	P_{TOTAL}	**3.349**	3.255	2.572	2.220

Statement of Uncertainties in Calculation of Public Dose:

All parameters taken from N288.1-14 are at the 95th percentile where available. Actual ingestion and inhalation rates are likely to be lower for most of the population. Calculated doses are likely to be significantly higher than actual doses to persons as a result.

4.3.6 Program Effectiveness

The suite of SRBT environmental protection programs have continued to be effective in measuring tritium in the environment and at ensuring the prevention of unreasonable risk to the environment.

The Environmental Monitoring Program continues to be implemented effectively. The past year represents the first full year of operation since the program revision to comply with the requirements of CSA standard N288.4-10. Considering this factor, and the measurements that have been obtained through sampling, it is viewed that the program functioned in a highly effective way.

Our passive air sampling array is effective and provides a picture of the full extent of tritium concentrations in air resulting from the emissions from the facility, and in turn providing real data to accurately estimate the dose to representative persons resulting from the emissions from the facility.

Total air emissions in 2017 decreased when compared to 2016, despite an increase in production. This is indicative of continued success in reducing process-based emissions as part of SRBT’s emissions reduction initiatives. The percentage increase of HTO emissions (approximately +14.4%) trends well with the observed increase in cumulative average of all PAS data (+16.2%), suggesting excellent correlation between these two parameters.

Tritium concentrations in residential wells, and in milk and produce that are consumed by residents living near the facility are measured. This data is effective at providing the full extent of tritium concentrations in human food and potable water sources resulting from the emissions from the facility, and in turn providing data to reliably estimate the dose to representative persons resulting from the emissions from the facility.

The Effluent Monitoring Program was also implemented very effectively in 2017, and succeeded in achieving the defined objectives of the program, including confirming the adequacy of controls on releases from the source, providing high-quality data, and demonstrating adherence to licence limits.

The Groundwater Monitoring Program was highly effective at providing data on the full extent of tritium concentrations in groundwater resulting from the emissions from the facility, and demonstrating the effectiveness of operational changes that have taken place over the last several years. There have been no issues with the transition of the program sampling and analysis activities from the third party service provider to SRBT.

4.3.7 Program Review and Audit Summary

All major elements of the EMS are scheduled to be audited at least once every three years. In 2017, the EMP was subjected to an internal audit in July, including the observation of field sampling procedures.

The audit resulted in two opportunities for improvement being identified. The audit also identified that each of the identified issues in the 2016 audit had been addressed and closed.

The issues raised are described below, along with corrective actions taken to address each item:

TABLE 28: ENVIRONMENTAL PROTECTION AUDIT ACTIONS

IDENTIFIER	FINDING	ACTION TAKEN
OFI-279	While observing CNL workers carrying out the collection of EMP samples, some minor discrepancies were noted. An opportunity for improvement is to consider if the EMP procedures should be revised to reflect the actual practices of the third party service provider or if the workers should adhere to SRBT's written procedures. ▪ Milk collection. EMP-007 describes the use of a cooler to transport the milk samples, however observed that the samples were placed in a cardboard box. The third party workers stated that the samples will be placed into a fridge once transferred to their laboratory. Additionally, 2 units of samples were obtained however the procedure only indicates a single sample of each. ▪ Noted that almost all samples are collected and then labelled after. While SRBT procedures stated that they are to be labelled prior to collection. ▪ EMP-004. Noted that the third party pre-wets or rinses the sample vials a total of three times before taking the actual sample. SRBT procedure only calls for one pre-rinse. ▪ EMP-010. Procedure requires that water is to be run for at least one minute however the CNL worker stated that the water is typically ran for approximately 30 seconds.	The deviations were assessed by the responsible program manager as having no significance on the quality or accuracy of the data generated; as a result, all procedures were updated to eliminate the discrepancies between field techniques and the described processes.

IDENTIFIER	FINDING	ACTION TAKEN
OFI-280	The MDA limit for downspout water is listed as 100 Bq/L in EMP-013, while the procedure EMP-001 states that the detection limit is 200 Bq/L. An opportunity for improvement is to clarify the MDA value (detection limit) for downspout water and ensure that both procedures are consistent.	EMP-001 was revised to reflect that the limit for the MDA in downspout water shall be 100 Bq/L.

In December 2017, the responsible program manager completed a comprehensive design review of the EMP, as part of the N288-series action plan.

The design review concluded that the EMP design is adequate to support the effective achievement of the program objectives. Three areas where a design modification may be considered as improvement initiatives were highlighted:

- Consider creating and implementing a new EMP-procedure to formally define the trending and data analysis techniques used to support the objectives, including perhaps derived investigation levels where an EMP measurement triggers an investigation into the source.
- Explore if reference areas for other EMP media (such as produce, milk, river water and residential wells) can be obtained and integrated into the program.
- Explore if residential and commercial produce grab samples could be feasible over the course of the growing season, in order to provide a more accurate representation of potential exposure to the public.

These potential improvements are planned to be discussed and considered during the 2017 Management Review in early 2018.

4.3.8 CSA N288-series Gap Analysis

In 2015, SRBT undertook a gap analysis of the entire set of management system documentation associated with Environmental Protection against the available suite of CSA standards related to the subject. These standards included:

- CSA N288.4-10 – *Environmental monitoring at Class I nuclear facilities and uranium mines and mills*
- CSA N288.5-11 – *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*
- CSA N288.6-12 – *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*
- CSA N288.7-15 – *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills*

The final gap analysis document was submitted to CNSC staff on January 15, 2016[47], with an associated action plan designed as a multi-year project of improvement and assessment of all aspects of environmental protection associated with our operations.

Comments from CNSC staff were received on March 31, 2016[48], which were subsequently dispositioned through a new revision of the gap analysis / action plan document. This was provided to CNSC staff on May 26, 2016[49], and the plan has continued to be executed since then.

Several major plan milestones were achieved in 2017, including:

- CNSC acceptance of the Environmental Management System (EMS) document, which meets the requirements of REGDOC 2.9.1.
- CNSC acceptance of the Effluent Monitoring Program document, which meets the requirements of CSA N288.5-11.
- The development, submission and CNSC acceptance of new Groundwater Monitoring Program and Groundwater Protection Program documents, along with the implementation of a comprehensive set of GMP-procedures, followed by SRBT commencing full in-house implementation of all GMP-related activities in September.

In 2018, SRBT expects to develop and finalize the process for the conduct of Environmental Risk Assessments (ERA), in line with the continued execution of our N288-series action plan. Otherwise, there are no planned or proposed modifications to the EMS and associated programs foreseen.

4.3.9 Emission Reduction Initiatives

SRBT has committed to investing a significant percentage of annualized profits into researching, developing and implementing initiatives aimed at reducing the emission of tritium to the environment associated with our licenced activities.

In 2017, SRBT continued to allocate resources into several areas in order to adhere to this commitment and further reduce emissions. A description of these initiatives is provided here.

4.3.9.1 PUTT Design Improvements

In 2017, a prototype tritium trap base was manufactured for SRBT which incorporates several potentially improved characteristics into the component. A research and development plan was created as part of change control package ECR-790-CCP-01, and the prototype was put into service in November.

The new base design should result in a lower probability of thermally-induced base integrity failure over the course of the life cycle of the component, an event which can result in unplanned releases of tritium as gaseous effluent. The in-use design does not fail at an unacceptable rate; however, the potential improvement was deemed to be worth investigating.

The research is expected to be completed in 2018, with a decision on the acceptability of the new design shortly thereafter.

4.3.9.2 Preventative Maintenance on Tritium Processing Equipment

An assessment was completed by the Maintenance Committee, where it was decided that increasing the frequency of preventative maintenance on tritium processing equipment may contribute to reducing tritium releases.

Wearable process components such as valve stems were placed on a revised schedule of replacement, moving away from ‘run-to-failure’ maintenance strategies.

Data on the effectiveness of this change continues to be collected and assessed by the committee. In some cases, ‘run-to-failure’ may be the preferred strategy due to the potential of damaging or disturbing key process components when performing the replacement of the parts.

4.3.9.3 Band Heaters for Tritium Processing

A research and development plan was developed in 2016 to explore if band heaters may be an appropriate alternative trap heating source when processing tritium. From the perspective of emission reduction, the hypothesis is that a reduction in tritium oxide may be achieved by using band heaters during routine processing.

The final version of the plan was accepted in November 2016, with the intent to implement the active testing soon thereafter; however, due to competing research initiatives (specifically, the increase in the number of cycles traps can be used for during processing), this initiative was placed on hold until a later time. It is expected that in 2018, this research will resume after completion of other projects, including the design change to the bases of the traps.

4.4 SCA – Emergency Management and Fire Protection

As most potential hazards associated with the facility would result from fire, Emergency Management and Response for the facility are addressed by an extensive Fire Protection Program supported by an Emergency Plan.

4.4.1 Fire Protection

Various measures were taken at the facility in 2017 to improve fire safety. These activities included but were not limited to the following:

- Fire Protection Program (FPP) was revised and accepted by CNSC staff,
- Third party contractor completed a Site Condition Inspection at the facility (a detailed report was completed),
- The Pembroke Fire Department (PFD) completed an inspection of the SRBT facility,
- Provided employee fire safety training session,
- Annual fire safety and extinguisher training for all employees, provided by the PFD,
- Continued enhanced training for two Fire Protection committee members, and
- Emergency responders received training at the SRBT facility.

4.4.1.1 Fire Protection Committee

In 2017, four formal Fire Protection Committee meetings were held which resulted in the implementation of several improvements for fire protection and life safety at the facility. All Fire Protection Committee meeting minutes are kept on file.

4.4.1.2 Fire Protection Program, Fire Safety Plan and Procedures

On September 7, 2017[28], SRBT submitted a revised Fire Protection Program and Fire Safety Plan to CNSC staff. Changes to both of these documents reflected findings and recommendations of internal audits. CNSC staff accepted both revised documents on December 7, 2017[29].

One new Fire Protection procedure was created, and numerous upgrades and minor revisions were made to internal existing procedures to enhance fire protection and life safety at the facility, in line with our policy of continuous improvement.

4.4.1.3 Sprinkler System Design Modification

On November 3, 2017[50], SRBT notified CNSC staff of a proposed change to the fire suppression system servicing the facility, where the installation of tamper switches and dual monitoring modules would replace the 'lock and chain' control mechanism on the main water supply valve to the building.

The change proposal was acknowledged by CNSC staff on December 20, 2017[51]. The detailed proposal was in process of change control review as of the end of 2017, and is expected to be implemented in the first half of 2018.

4.4.1.4 Maintenance of the Sprinkler System

In 2017 quarterly and annual maintenance was performed on the sprinkler system by a third party. In addition, a weekly check of various valves and line pressures were performed by trained SRBT staff. All records are kept on file.

4.4.1.5 Fire Protection Equipment Inspections

In 2017, in-house routine inspection, testing and maintenance was performed on all fire protection and life safety equipment at the SRBT facility on a daily, weekly, monthly and annual basis by trained staff.

Qualified third party contractors also performed routine inspection, testing and maintenance of fire protection and life safety equipment at the SRBT facility. Annual inspection, testing and maintenance include fire extinguishers, emergency lighting, the fire panel and sprinkler system.

4.4.1.6 Fire Extinguisher Training

Annual fire extinguisher training was conducted with the support of the Pembroke Fire Department on October 4, 2017.

As in past years, the training was conducted using an electronic simulator, eliminating the risks associated with the controlled, repeated burning and extinguishing of liquid hydrocarbons as an environmentally-friendly measure.

The training also included a classroom-based session discussing personal safety when detecting a fire, the types of extinguishers available in the facility, and the proper and safe use of extinguishers when fighting fires.

4.4.1.7 Fire Protection Committee Member Training

The Fire Protection Committee continues to include a member who volunteers as a firefighter for a local fire department, and receives fire protection training from this department.

Throughout 2017, two SRBT employees (including the Fire Protection Specialist) continued a program of learning offered through Algonquin College in Ottawa, titled ‘Occupational Safety and Health: Fire Code Administration’.

This program of study began in 2016, and culminated in both employees successfully challenging the certification examination in December 2017.

4.4.1.8 Fire Responder Training

Responders with the Pembroke Fire Department (PFD) were provided training during two separate sessions, held on October 3 and 10, 2017.

A total of sixteen volunteer and full time fire responders participated in the training. SRBT provided the Pembroke Fire Department with radiation protection training and information about the possible risks associated with a fire emergency at the SRBT facility. Each fire responder was provided with an “Emergency Responder Radiation Safety Training” handout to keep.

4.4.1.9 Fire Alarm Drills

A total of seven in-house fire alarm drills were conducted in 2017.

Following each fire drill, supervisory staff and other personnel complete a Fire Alarm Drill Report. Each report is reviewed by the Fire Protection Committee and actions are taken as required to enhance fire and life safety at the facility.

4.4.1.10 Fire Protection Consultant Inspection

In October 2017 a qualified third party (PLC Fire Safety Solutions) was contracted to complete a Site Condition Inspection, in order to meet the operating licence requirements, including the requirements of CSA standard N393-13, *Fire protection for facilities that process, handle, or store nuclear substances*.

The scope of the inspection was to evaluate the SRBT facility for compliance with the applicable inspection, testing and maintenance requirements of our operating licence.

The following codes and standards were reviewed for applicability to the specific systems at SRBT:

- NFCC-2010, *National Fire Code of Canada*
- NBCC-2010, *National Building Code of Canada*
- CSA standard N393-13, *Fire protection for facilities that process, handle, or store nuclear substances*.

Following the inspection, PLC prepared a "Site Condition Inspection Report", from which one minor finding was observed pertaining to the temporary storage of combustible trash in Zone 3. The finding was rectified immediately following the handover of the report, and process changes are being implemented in early 2018 to minimize the amount of trash located in Zones 2 and 3 at any time.

4.4.1.11 Pembroke Fire Department Inspection

The Pembroke Fire Department conducted a facility inspection to confirm compliance with the Ontario Fire Code in June 2017. A minor item of non-compliance was identified where a ceiling tile was observed to be in disrepair. The tile was replaced immediately.

4.4.2 Emergency Preparedness

Various measures were taken at the facility in 2017 to further improve emergency preparedness and emergency response measures.

4.4.2.1 Emergency Plan

The Emergency Plan was revised in 2017 after a draft revision was submitted to CNSC staff for acceptance on January 26, 2017[10]. CNSC staff accepted the revised plan on September 22, 2017[11].

The changes made were mostly administrative in nature, with no significant technical alterations to the planned response to an emergency situation, other than changes to address the last of the recommendations resulting from the emergency exercise conducted in February 2015.

4.4.2.2 Emergency Exercises

In 2017 SRBT did not conduct an emergency exercise. The last full scale emergency exercise was conducted in 2015.

As per the Emergency Plan, SRBT conducts such exercises at least once every five years. The next exercise is projected to be conducted in 2020.

4.5 SCA – Waste Management

SRBT implements a Waste Management Program (WMP) that is aligned with the applicable requirements and guidelines in the following CSA Standards:

- CSA N292.0-14, *General principles for the management of radioactive waste and irradiated fuel*
- CSA N292.3-14, *Management of low- and intermediate-level radioactive waste*
- CSA N292.5-11, *Guideline for the exemption or clearance from regulatory control of materials that contain, or potentially contain, nuclear substances*

4.5.1 Radioactive Consignments – Waste

Eight shipments of "Low Level Waste" (LLW) were made in 2017.

Of the eight shipments, four included expired gaseous tritium light sources (January 31, May 30, September 12 and November 28). A total of 212 Type A packages of expired gaseous tritium light sources were generated in 2017.

Four of the eight shipments included waste materials generated by other processes, including used protective clothing, used equipment components, crushed glass, filters, broken lights and cleaning material.

The following table is provided as a summary of the low-level waste material that was generated and routed to a licenced waste management facility in 2017.

TABLE 29: RADIOACTIVE WASTE CONSIGNMENTS (2017)

DATE	CONSIGNOR	WASTE DESCRIPTION	QTY AND PACKAGE DESCRIPTION	TOTAL WEIGHT (Kg)	TOTAL ACTIVITY (TBq)
Jan. 31, 2017	CNL	LLW	48 x Type A Pkgs	192	1,057.43
April 4, 2017	CNL	LLW	19 x UN2910 Pkgs	399	0.076
May 2, 2017	CNL	LLW	4 x UN2910 Drums	280	0.040
May 30, 2017	CNL	LLW	58 x Type A Pkgs	231	1,057.45
July 18, 2017	CNL	LLW	5 x UN2910 Pkgs	105	0.020
			1 x UN2910 Drum	70	0.010
Sept. 12, 2017	CNL	LLW	51 x Type A Pkgs	204	1,210.64
Oct. 10, 2017	CNL	LLW	8 x UN2910 Pkgs	168	0.032
			1 x UN2910 Drum	70	0.010
Nov. 28, 2017	CNL	LLW	55 x Type A Pkgs	220	1,181.15

4.5.2 Storage of Radioactive Waste

Radioactive waste was stored on-site and inventory records of the waste were maintained. All packaged wastes were inspected monthly for potential off-gassing and container integrity.

4.5.2.1 Low-level Waste Interim Storage

Low-level waste (LLW) is any waste assessed as possessing activity levels that exceeds conditional clearance limits (for tritium), or in excess of the exemption quantities established in the Nuclear Substances and Radiation Devices Regulations (for all other radionuclides). Typical examples of such wastes are tritium-contaminated equipment or components, crushed glass, filters, broken lights, clean-up material, etc.

LLW was collected in various sealed receptacles, assessed, and ultimately placed into approved containers in the Waste Storage Room within Zone 3. Once sufficient material was collected, it was prepared for transfer to a licensed waste handling facility, using approved processes.

TABLE 30: INTERIM STORAGE OF LOW-LEVEL WASTE

AMOUNT IN STORAGE AT YEAR END 2016	AMOUNT GENERATED THROUGHOUT 2017	TRANSFERRED OFF SITE 2017	AMOUNT IN STORAGE AT YEAR END 2017
3 x 200 L drums	4 x 200 L drums	6 x 200 L drums	1 x 200 L drums
0.03 TBq	0.04 TBq	0.06 TBq	0.01 TBq

4.5.2.2 Clearance-level Waste Interim Storage

Waste that is only minimally contaminated and is likely to meet accepted clearance criteria is classified as “Very Low-Level Waste” (VLLW). This classification is temporary, as ultimately VLLW is assessed and routed through one of two accepted disposal pathways – either as LLW or as clearance-level waste (CLW).

Examples of such materials are typically paper towels, gloves, disposable lab coats, shoe covers, etc. and was collected in various receptacles in the active areas of the facility, assessed, and ultimately placed into storage awaiting transfer or disposal.

Throughout 2017, the WMP clearance criteria applied to VLLW was 0.25 MBq/g, up to a maximum of 3 tonnes of cleared material per pathway.

Any VLLW that was assessed as being less than this criteria was routed through accepted CLW pathways, such as landfill or recycling.

The amount of CLW generated and stored in 2017 is tabulated below.

TABLE 31: INTERIM STORAGE OF CLEARANCE-LEVEL WASTE (LANDFILL)

AMOUNT IN STORAGE AT YEAR END 2016	AMOUNT GENERATED THROUGHOUT 2017	TRANSFERRED OFF SITE 2017	AMOUNT IN STORAGE AT YEAR END 2017
0 Kg	+1,293.80 Kg	-1,293.80 Kg	0 Kg
0 GBq	+33.53 GBq	-33.53 GBq	0 GBq

TABLE 32: INTERIM STORAGE OF CLEARANCE-LEVEL WASTE (PLASTIC RECYCLE)

AMOUNT IN STORAGE AT YEAR END 2016	AMOUNT GENERATED THROUGHOUT 2017	TRANSFERRED OFF SITE 2017	AMOUNT IN STORAGE AT YEAR END 2017
379.60 kg	1,415.80 Kg	1,254.30 Kg	541.10 Kg
6.94 GBq	47.66 GBq	36.13 GBq	18.47 GBq

4.5.2.3 Hazardous Waste

SRBT ships waste phosphorescent (ZnS) powder (classified as mild environmental contaminant) to a licenced hazardous waste management contractor. This waste is picked up quarterly, and disposed of in accordance with the requirements of the Ontario Ministry of Environment and Climate Change. In 2017, 340 kg of this material was processed and safely disposed of through this program.

4.5.2.4 Waste Minimization

SRBT continues to minimize the generation of radioactive waste materials as part of our overall approach to waste management.

The Waste Management committee met twice in 2017 to review and discuss initiatives that could ultimately minimize the amount of radioactive waste routed to licenced waste management facilities.

Continued segregation of material prior to bringing items into active zones remains effective at reducing waste materials that require management.

The implementation of Conditional Clearance Levels for waste materials has continued to be successful in reducing the amount of waste material that is needlessly disposed of as radioactive waste.

4.5.2.5 Expired Product Management

SRBT continues to offer return and disposal services to customers who possess expired tritium-illuminated devices, such as 'EXIT' signs.

In 2017, a total of 18,977 expired (or otherwise removed from service) self-luminous safety 'EXIT' type signs were accepted by SRBT from Canadian and American sources, representing a total activity of 3,599.10 TBq of tritium. For comparison, in 2016 a total of 31,667 expired signs were accepted by SRBT.

As well, an additional 1,412.73 TBq of tritium was accepted from international origins (i.e. other than Canada and the United States) in the form of expired tritium illuminated devices, such as aircraft signs, dials, gauges and other smaller equipment.

Expired signs are disassembled safely and the light sources removed, in order to ensure that the volume of low-level radioactive waste that is generated is minimized. The expired lights are then packaged and shipped to a licenced radioactive waste management service provider.

A small number of these signs were evaluated as being fit for service in other applications, or having light sources that could be reused in other self-luminous devices. This practice is the only re-use of the lights and the tritium associated with these lights, and would represent a very small fraction of the total light sources managed. SRBT no longer 'reclaims' tritium gas from expired or non-conforming light sources, and has not done so since 2007.

4.6 SCA – Security

SRB Technologies (Canada) Inc. implements an accepted Facility Security Program for the facility, in accordance with CNSC regulatory requirements and expectations.

SRBT did not experience any security-related events in 2017.

New staff members are required to qualify for a Facility Access Security Clearance (FASC), even if they are not expected to handle nuclear substances as part of their responsibilities. Individuals and contractors that visit the facility are required to also have an FASC or be escorted at all times by a staff member with a valid FASC.

Maintenance of the physical facility security system is performed by an independent third party at least every 6 months.

In April, SRBT Information Technology Technicians attended a symposium focused on Cyber Security on April 12, 2017, in Vaughan, Ontario, as a learning opportunity in support of the Security Program.

4.7 SCA – Safeguards and Non-Proliferation

SRBT possesses, uses, stores and manages an extremely small quantity of depleted uranium, which is a controlled nuclear substance.

This material is used as storage media for tritium gas on our processing equipment, a well-understood and widely-used strategy for manipulating and storing tritium in its gaseous, elemental state. By using depleted uranium in this fashion, we can ensure that the quantity of gaseous tritium being used during any given processing operation is restricted. This helps to ensure that the consequences of any unplanned event are minimized with respect to radiation and environmental protection, by ensuring that any release of tritium is limited.

Our inventory of depleted uranium inventory did not increase in 2017, and was in fact adjusted downward to reflect a physical inventory being performed which identified an error in the amount of depleted uranium on four of the tritium storage containers owned and stored by SRBT.

During 2017, the IAEA did not conduct verification activities of our inventory of this material, nor requested any information on this matter. As a licensee, and pursuant to the General Nuclear Safety and Control Regulations, SRBT is fully committed to ensure that we meet all applicable regulatory requirements relating to Canada’s obligations relating to nuclear non-proliferation and safeguards.

Should a safeguards verification activity be requested or conducted, or a request for information made by the IAEA, SRBT will provide all accommodation to the agency and CNSC staff in order to satisfy our responsibilities in this safety and control area.

4.8 SCA – Packaging and Transport of Nuclear Substances

SRBT prepared, packaged and shipped all manufactured products containing nuclear substances in accordance with the *Packaging and Transport of Nuclear Substances Regulations.*

For the purpose of packaging and offering for transport, shipments of product designated as dangerous goods, SRBT must comply with the requirements of:

- CNSC
- IAEA
- International Air Transport Association (IATA)
- Transport Canada

The procedures used at SRBT are based on regulations and practices found in the following publications:

- Packaging and Transport of Nuclear Substances Regulations (PTNSR)
- IAEA Safety Standards Series - No. SSR-6
- Dangerous Goods Regulations (IATA)
- The TDG Compliance Manual: Clear Language Edition (Carswell)

Staff members involved with the packaging, offering for transport and receipt of dangerous goods are given Transportation of Dangerous Goods (TDG) training in accordance with the applicable regulations and are issued certificates by the employer.

In 2017, two “dangerous occurrences” (as per section 35 of the PTNSR) occurred associated with packaging and transport of SRBT products to or from the facility. See section 4.8.3 below for a description of these events.

4.8.1 Outgoing Shipments

In total, 970 consignments were safely shipped to various customers located in 23 countries around the world, including Canada.

A table is provided comparing the amount of outgoing shipments of our products over the past five years.

TABLE 33: OUTGOING SHIPMENTS OF PRODUCT (2013-2017)

Year	2013	2014	2015	2016	2017
Number of Shipments*	744	1,122	1,150	1,001	970
Number of Countries	13	19	16	18	23

*Note – SRBT often ships single palletized shipments of safety signs to the US which subsequently get broken down into multiple sub-consignments. These types of shipments are counted as a single consignment for the purposes of this table.

All outgoing shipments were conducted in compliance with all regulatory requirements pertaining to the transport of dangerous goods and / or nuclear substances. All packages were assessed for surface contamination prior to being offered for transport as required by SRBT procedures.

Information pertaining to the number of monthly outgoing shipments containing radioactive material for 2017 can be found in **Appendix T** of this report.

4.8.2 Incoming Shipments

In total, 539 consignments of radioactive shipments were received from various customers located in 6 countries around the world, including Canada. These returns held a total activity of 5,049 TBq of tritium.

The vast majority of the returned, expired devices were in the form of expired 'EXIT' signs that were destined to have the expired light sources removed and sent for storage at a licenced waste management facility.

A table is provided comparing the amount of incoming shipments of radioactive products have been made over the past five years.

TABLE 34: INCOMING SHIPMENTS OF RADIOACTIVE PRODUCT (2013-2017)

Year	2013	2014	2015	2016	2017
Number of Shipments	204	467	598	562	539
Number of Countries	6	10	9	9	6

All incoming shipments were received safely and in acceptable condition. Incoming packages containing nuclear substances are assessed for tritium leakage upon receipt.

Information pertaining to the number of monthly received shipments containing radioactive material for 2017 can be found in **Appendix U** of this report.

4.8.3 Dangerous Occurrences

SRBT made two reports to CNSC staff on events classified as 'dangerous occurrences' under the *Packaging and Transport of Nuclear Substances Regulations.*

The first occurrence took place in June, where an excepted package containing self-luminous aircraft safety signs destined for Bulgaria was returned to SRBT after being damaged in transit prior to reaching the consignee. The package appeared to have been punctured at some point after being picked up at SRBT for delivery.

The package was received at SRBT and a radiological assessment was immediately conducted. No airborne or surface contamination was detected in the assessment, and the products were visually inspected and confirmed as undamaged. The items were repackaged and the order was shipped out anew without incident.

SRBT provided a combined preliminary/full report on June 6, 2017[33], and CNSC staff notified SRBT of the acceptance of the report on June 20, 2017[34].

The second occurrence took place in November; SRBT was notified by a freight forwarder that they were unable to locate a package of SRBT self-luminous aircraft safety signs that was in transit from our facility to a customer in Germany. The package was classified as UN2911, Excepted Package, Instruments / Articles.

Once the freight forwarder declared the package to be lost, SRBT concluded that the event met the definition of a dangerous occurrence in the Packaging and Transport of Nuclear Substances Regulations, paragraph 35 (b). SRBT made a verbal report by telephone to the CNSC Duty Officer shortly thereafter, and then immediately provided a written preliminary report to the CNSC Project Officer[35].

Through the next several weeks, SRBT made every effort to investigate the event with the freight forwarding and transportation agents involved. On December 6, 2017, it was noted that the package had been discovered in a warehouse in Munich, Germany in good condition. The package was finally delivered to the customer on December 14, 2017.

The full report of this event[36] was provided to CNSC staff on December 12, 2017.

5. Other Matters of Regulatory Interest

5.1 Public Information and Disclosure

This section of the report will provide public information initiatives taken in 2017.

5.1.1 Direct Interaction with the Public

Historically almost all public inquiries occur during re-licensing. In 2017, there was one public inquiry made requesting documentation (licence application, waste management program ad preliminary decommissioning plan) and a contact person with whom they could speak to regarding waste inventory and waste management. A response was sent within five days of the request.

In 2017 we have sampled water from a number of wells belonging to the public every four months for tritium concentration. On a yearly basis we also sample produce from gardens belonging to members of the public for tritium concentration. We promptly provide each member of the public with a report of the sample results along with the anticipated radioactive exposure due to tritium from consuming either the water or produce. We provide members of the public a comparison of this exposure against the CNSC limit and against radioactive exposure from other known sources, such as cosmic radiation, x-rays, etc.

Plant tours have proven to be a useful tool for SRBT to reach the public. In 2017 we have provided plant tours to 25 members of the general public (compared with 27 in 2016) who had expressed interest in our facility.

In 2017 we provided plant tours to local representatives of:

- Labour Canada
- Renfrew County Community Futures Development Corporation
- The City of Pembroke,
- the Pembroke Fire Department,
- Industrial Research Assistance Program (IRAP)
- UL
- Ontario Power Generation, and
- Ottawa River Power

In 2017 as part of conducting our business in Pembroke we have also provided plant tours to local employee representatives of our existing and prospective suppliers of goods and/or services, including:

- Canadian Nuclear Laboratories,
- Veolia
- University of Ottawa.
- Linde
- En-Plas
- JP2G
- EIP
- Manitoulin, and
- FedEx

In 2017 we also provided plant tours to existing and prospective customers including:

- Isolite,
- Seiler
- MB Microtec, and
- Javelin.

TABLE 35: PLANT TOURS (2017)

	2017
GENERAL PUBLIC	25
LOCAL INSTITUTIONS	8
LOCAL SUPPLIERS	9
CUSTOMERS	4
TOTAL	**46**

In 2017, there was one public inquiry made requesting documentation (2015 licence renewal application, Waste Management Program, and Preliminary Decommissioning Plan) and a contact person with whom they could speak to regarding waste inventory and waste management. A response was sent within five days of the request.

During the public meeting held by the CNSC on December 13, 2017 regarding the annual regulatory oversight report, there were three intervenors who discussed SRBT in their written submissions. During the meeting the President of SRBT addressed some of these comments by stating SRBT would incorporate "some of the comments that they have said and some of the requests in our future compliance reports and activities".

In 2017, the Public Information Committee discussed and agreed to not have a presentation to Pembroke City Council in 2017, nor to initiate a public opinion survey in 2017 (though the survey is available on our website). Considering the inquiry and the comments from the intervenors which came at the end of 2017, the Public Information Committee will be revisiting these decisions for 2018.

The President of SRBT made several presentations to members of the public this year:

- In May at the Chamber of Commerce Awards gala in Petawawa Ontario, SRBT accepted the Professional Services Award – Technical and Engineering award, the President gave a speech to attendees.
- In November the President discussed SRBT through a video campaign presented by The City of Pembroke and the Pembroke Economic Development Advisory Committee (PEDAC). The video can be seen on YouTube and social media.
- In November at the 2017 Ontario Export Awards in Toronto Ontario, SRBT accepted the Ontario Export Award – Consumer Products & Technology Category, the President gave a speech to attendees.
- The President of SRBT is a member of the Pembroke Economic Development Advisory Committee (PEDAC), attending monthly meetings where SRBT was discussed on occasion.
- The President of SRBT is also a member and chair of the Community Improvement Plan (CIP), attending meetings and discussing SRBT on occasion.

5.1.2 Program Revision

Revision 9 of the Public Information Program (PIP) continues to demonstrate SRBT's commitment to openness and transparency. A review is planned in 2018 to determine if changes or improvements to the PIP can be made; for example, the inclusion of non-local stakeholders may be considered considering the interest from this sector during the 2015 licence renewal process.

5.1.3 Program Audit

There were no internal audits conducted on the Public Information Program in 2017. The next internal audit is scheduled for August 2019.'

5.1.4 Public Information Committee

The Public Information Committee held four formal meetings in 2017, mostly consisting of discussions pertaining to our groundwater brochure, the general information brochure and pamphlet, all of which were updated on March 31, 2017 to reflect the data in the 2016 Annual Compliance Report and subsequently posted on our website.

The committee also discussed press releases, letters sent to residences and businesses, funding the Muskrat Watershed Council, the CNSC public meeting, Emergency Response Personnel Training, Public Notifications, presentations, and public perception. The committee also discussed posting on social media.

5.1.5 Website and Social Media

SRBT continues to operate a website at www.srbt.com, which continues to provide current environmental monitoring data, information about tritium, content on emergency preparedness, the safe transport of tritium to the facility and products from the facility, how to safely dispose of products, and the Licence and Licence Condition Handbook.

The main page provides a number of possible information sources for the public on tritium and radiation exposure. Several "Public Notifications" were posted on the website in 2017, including details on two reportable events, as well as the annual regulatory oversight report for our facility as presented by CNSC on December 13, 2017 in Ottawa. Three senior members of SRBT management attended the meeting in person, and were available to answer all questions directly.

SRBT continues to post information of public interest on a frequent basis to our Facebook page. SRBT now also has an Instagram account as well as a Twitter account which are updated on a frequent basis.

5.1.6 Community Support

SRBT has supported the local community by providing support to various organizations and causes.

SRBT again in 2017 is a gold level corporate and club member of the Muskrat Watershed Council (MWC) in support of the water quality monitoring data report and ongoing work for 2017-18.

SRBT is a member of the Algonquin College Radiation Safety Program Advisory Committee and during the summer of 2017, SRBT employed a summer student from this program. In turn that student was hired full time at the conclusion of their student term.

SRBT has supported the Main Street Community Services who provides research-based programs for children with special needs.

SRBT has supported causes such as Community Living Upper Ottawa Valley and Bernadette McCann House for Women, CareFor, the Coldest Night of the Year and the Ontario SPCA.

SRBT also supports Festival Hall the local community theater, a Rotary Ride for Kids charity event, the" 2017 Horse Classic" and the second annual Mardi Gras in support of Family Children's Services. SRBT also sponsors sports teams and groups, including a local hockey team and fishing team, and a basketball development program for local youth.

SRBT supported the Black and White Gala 150 which helps improvements made to the Pembroke Regional Hospital.

SRBT supported the Zombie Thrill run in support of the newly acquired Algonquin Trail as well as the Renfrew County Regional Science and Technology Fair.

SRBT sponsored and entered a team for the Upper Ottawa River Race & Paddle Festival in support of CHEO. SRBT took home the trophy for the Celebrity Relay Race, and also raised the most donations.

5.2 Preliminary Decommissioning Plan and Financial Guarantee

The SRBT Preliminary Decommissioning Plan (PDP) and Financial Guarantee last underwent a significant revision in 2014-15 prior to licence renewal, and was accepted by the Commission on June 29, 2015 with the renewal of the SRBT operating licence for a period of seven years. The next revision of the PDP is scheduled for 2019.

The SRBT Financial Guarantee is a cash fund held in escrow, and does not rely on any letters of credit, bonds, insurance or other expressed commitments.

In 2015, third party consultants directly involved with the decommissioning of similar facilities determined that the projected decommissioning cost for the SRBT facility was $652,488. In order to ensure the financial guarantee was fully funded, a series of six equal installments were scheduled to be made over a three year period, beginning in October 2015, as part of the renewal of our operating licence.

Historical annual inflationary indexes are typically below the annual accrued interest rate of the Escrow Account; as such, SRBT proposed that all accrued interest in the existing Escrow Account remain in that account and be used to address inflationary indexing.

In 2017, SRBT deposited both of the required installments[52,53]; as of October 31, 2017, $655,477.14 is held in escrow, and continues to build interest - as such, the financial guarantee has been fully funded. Despite this fact, SRBT fully intends on completing the final planned installment to the account in April 2018.

6. Improvement Plans and Forecast

6.1 Emission Reduction Initiatives

SRBT continues to explore multiple avenues toward reducing tritium emissions from the facility, as per our stated commitment to ensuring investment in this area[54]. SRBT has made the commitment to invest no less than 5% of the company annualized net profit back into emission reduction initiatives (based upon fiscal year profit figures, October 1 through September 30 each year).

We continue to research improvements into the design and handling of our tritium traps, through which we have achieved significant reductions in tritium releases in the past two years.

In 2018, we expect to have sufficient information and data on hand in order to make decisions on potentially changing the design of the trap bases, and on the prospect of introducing the use of band heaters as the heat source when processing tritium.

The benefits and detriments to more frequent preventive maintenance activities on processing equipment also continues to be explored.

As well, SRBT plans to explore a minor modification to the equipment where tritium traps are stored when not in use, in order to add an additional layer of isolation that will help in preventing unnecessary tritium releases.

6.2 Safety Performance Targets for 2018

For the coming year, SRBT Senior Management has approved a set of performance targets, which will be tracked and reported on as part of the 2018 ACR.

The following table documents the safety performance targets for SRBT in 2018:

TABLE 36: SRBT SAFETY AND PERFORMANCE TARGETS FOR 2018

PARAMETER	2018 TARGET
Maximum Worker Dose	≤ 0.75 mSv
Average Worker Dose	≤ 0.060 mSv
Calculated Dose to Member of the Public	≤ 0.0060 mSv
Total Tritium Emissions to Atmosphere (per week average)	≤ 650 GBq / week
Ratio – Tritium Emissions vs. Processed	≤ 0.13
Total Tritium Emissions – Liquid Effluent Pathway	≤ 7 GBq
Action Level Exceedances – Environmental	≤ 1
Action Level Exceedances – Radiation Protection	≤ 1
Contamination Control – Facility-wide Pass / Fail Rate	≥ 95%
Lost Time Injuries	0
Minor Injuries Reportable To Employment and Social Development Canada (ESDC)	≤ 20

6.3 Planned Modifications and Foreseen Changes

The upcoming year of operation is not expected to involve significant modifications to the facility or our licensed activities. Production levels are expected to remain stable, with increases in miniature light source production anticipated.

The past several years have seen a number of modifications and changes to our operations and our management system, resulting in improved operating performance and reduced impact to persons and the environment. We project that the coming year will be, in comparison, relatively static in terms of operations and management.

That being said, the following key management system programs or documents are expected to be revised and submitted in 2018, and subsequently reviewed and accepted by CNSC staff:

- Quality Manual,
- SRBT Training Program,
- Maintenance Program,
- Fire Protection Program,
- Security Program,
- Regulatory Reporting Program (to align with REGDOC 3.1.2),
- Public Information Program, and
- Conventional Health and Safety Manual

As part of the N288-series action plan[19], the process for how SRBT conducts environmental risk assessments (ERA) will also be developed and documented before the conclusion of 2018, leading into the conduct of an ERA in support of future licence renewal activities.

From the perspective of Environmental Protection, as was done with groundwater monitoring in 2017, SRBT will be continuing to explore increasing the amount of sampling and analysis done in-house in support of the EMP. This year we plan on conducting intercomparison work towards commencing passive air sampling and precipitation monitoring.

We also plan on completing the installation of tamper switches and dual monitoring modules as a replacement to the lock-and-chain control mechanism on the main water supply valve to the building, as was previously noted to CNSC staff[50].

SRBT will continue to pursue and explore opportunities to reduce emissions in all forms, as part of our 2015 commitment to allocate 5% of our annualized net profit towards this end.

7. Concluding Remarks

Throughout 2017, the management and staff of SRBT complied with all regulatory and licensing requirements of our operating licence.

This first full year of operation under the new, N286-compliant management system has been a success, and we continue to adjust and improve our processes in support of the safe and effective operation of our facility, as we gain experience in the new system.

Our facility remains within its designed safety basis, and continues to be fit for service. Key structures, systems and components have continued to be maintained diligently and effectively throughout 2017 through the implementation of our Maintenance Program.

Exposures to ionizing radiation to both workers and members of the public continue to remain low, and are far less than the regulatory limits prescribed. The local environment has remained protected, and the already low level of impact of our operations continues to be reduced over time, as we continue to implement best practices each and every day. Licence limits for our nuclear substance effluent streams continue to be respected with significant margin.

Three lost time injuries occurred in 2017 – the first such injuries in several years. Although the severity of these injuries was quite minor, our management team strives to ensure such events are minimized in both frequency and consequence.

The inspection of our conventional health and safety program by safety officers with ESDC found that although these injuries occurred, SRBT's program remains highly compliant and effective at keeping our workforce safe. Despite these positive findings, we continue to work towards improving our program.

Security of the facility and all nuclear substances was maintained at all times. Two instances of safety-related events with respect to the packaging and transport of our packages occurred that were beyond our direct control, and both events were ultimately resolved with no safety issues or concerns.

SRBT remains well protected from fire hazards, and have maintained an accepted plan should an emergency condition arise. Our Public Information Program fully satisfies the requirements of the CNSC, and we continue to look for new ways to reach out into our local community in a positive and constructive fashion.

We continue to effectively manage all forms of waste generated by our operations, and continue to look to minimize the amount of waste that must be managed and controlled.

Our decommissioning responsibilities are documented and accepted, and our financial guarantee is fully funded. Although we plan on operating the facility for at least the next two decades, if not longer, having a complete, self-funded financial guarantee is an additional testament to our commitment of being a good community partner.

Safety and excellence in operations shall always remain as the number one overall priority in everything we do, and 2017 was a direct reflection of the success at achieving these goals. We will continue to improve our operations and minimize our impact on people and the environment as our company continues to sustainably grow over the coming years.

8. References

[1] Nuclear Substance Processing Facility Operating Licence NSPFOL-13.00/2022, valid from July 1, 2015 to June 30, 2022.

[2] Licence Condition Handbook – SRB Technologies (Canada) Inc. Nuclear Substance Processing Facility Operating Licence NSPFOL-13.00/2022 (e-Doc 4624621 (Rev. 0), 4899130 (Rev.1), 5127037 (Rev. 2)).

[3] Annual Compliance Monitoring and Operational Performance Reporting Requirements for Class 1B Nuclear Facilities (CNSC e-Doc 3471152); provided via email to J. MacDonald (SRBT) by J. Campbell (CNSC), February 17, 2016.

[4] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *SRB Technologies (Canada) Inc. Inspection Report No. SRBT-2017-01 February 16, 2017,* dated April 13, 2017 (e-Doc 5228891).

[5] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *SRBT Response to Inspection Report SRBT-2017-01,* dated May 8, 2017.

[6] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Staff Review of SRBT Response to Inspection Report SRBT-2017-01,* dated June 20, 2017 (e-Doc 5278877).

[7] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *SRB Technologies (Canada) Inc. Inspection Report No. SRBT-2017-02 conducted on March 20, 2017 to March 21, 2017,* dated May 12, 2017 (e-Doc 5245853).

[8] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *SRBT Response to Inspection Report SRBT-2017-02,* dated June 30, 2017.

[9] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Staff Review of SRBT Response to Inspection Report SRBT-2017-02,* dated August 11, 2017 (e-Doc 5315180).

[10] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Submission of Revision 6 of SRBT Emergency Plan,* dated January 26, 2017.

[11] Letter from R. Rashapov (CNSC) to S. Levesque (SRBT), *CNSC Staff Review of SRB Technologies (Canada) Inc.'s Emergency Program Revision 6,* dated September 22, 2017 (e-Doc 5341760).

[12] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Submission of Revised Waste Management Program,* dated February 24, 2017.

[13] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Staff Assessment of SRB Technologies (Canada) Inc.'s Waste Management Program Revision F,* dated June 7, 2017 (e-Doc 5263396).

[14] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Staff Review of SRBT's Environmental Management System and Effluent Monitoring Program,* dated March 31, 2017 (e-Doc 5219267).

[15] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Submission of Revised Environmental Management System and Effluent Monitoring Program,* dated December 30, 2016.

References continued…

[16] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Disposition of Comments on SRBT Effluent Monitoring Program,* dated May 29, 2017.

[17] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Review of SRB Technologies' Disposition of Comments on SRBT's Effluent Monitoring Program,* dated July 11, 2017 (e-Doc 5293534).

[18] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Submission of Groundwater Protection and Groundwater Monitoring Programs,* dated June 30, 2017.

[19] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Disposition of Comments – SRBT Environmental Protection Gap Analysis and Action Plan,* dated May 26, 2016.

[20] Letter from R. Rashapov (CNSC) to S. Levesque (SRBT), *CNSC Staff Review of SRB Technologies (Canada) Inc.'s Groundwater Protection Program and Groundwater Monitoring Program,* dated September 22, 2017 (e-Doc 5319912).

[21] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Submission of SRBT Quality Manual, Revision J,* dated June 30, 2017.

[22] Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *CNSC Staff Assessment of SRB Technologies (Canada) Inc.'s Quality Manual Revision J,* dated August 17, 2017 (e-Doc 5317231).

[23] Letter from S. Levesque (SRBT) to R. Rashapov (CNSC), *Submission of Hazard Prevention Program, Revision D,* dated August 23, 2017.

[24] Letter from R. Rashapov (CNSC) to S. Levesque (SRBT), *CNSC Staff Review of SRB Technologies (Canada) Inc.'s Hazard Prevention Program Revision D,* dated September 22, 2017 (e-Doc 5342906).

[25] Letter from S. Levesque (SRBT) to R. Rashapov (CNSC), *Submission of SRBT Safety Analysis Report, Revision 4,* dated August 25, 2017.

[26] Letter from R. Rashapov (CNSC) to S. Levesque (SRBT), *CNSC Staff Comments on the Safety Analysis Report for SRB Technologies (Canada) Inc., Revision 4,* dated October 31, 2017 (e-Doc 5375172).

[27] Letter from S. Levesque (SRBT) to R. Rashapov (CNSC), *Disposition of Comments on Safety Analysis Report, Rev. 4,* dated November 10, 2017.

[28] Letter from R. Fitzpatrick (SRBT) to R. Rashapov (CNSC), *Submission of Revised SRBT Fire Protection Program and Fire Safety Plan,* dated September 7, 2017.

[29] Letter from R. Rashapov (CNSC) to S. Levesque (SRBT), *CNSC Staff Review of SRB Technologies (Canada) Inc.'s Revised Fire Protection Program and Fire Safety Plan,* dated December 7, 2017 (e-Doc 5409199).

[30] Letter from S. Levesque (SRBT) to R. Rashapov (CNSC), *Submission of Radiation Safety Program, Revision L,* dated October 31, 2017.

References continued…

[31] Letter from S. Levesque (SRBT) to T. Barr (CNSC), *SRBT Application for Renewal of Dosimetry Service Licence,* dated October 31, 2017.

[32] Email from J. MacDonald (SRBT) to R. Buhr (CNSC), *Combined Preliminary/Full Report – GNSCR 29(1)(h) – Worker Injury,* dated January 26, 2017.

[33] Email from J. MacDonald (SRBT) to R. Buhr (CNSC), *Preliminary Report: 'Dangerous Occurrence' – UN2910 Excepted Package Damaged in Transit,* dated June 6, 2017.

[34] Email from R. Buhr (CNSC) to J. MacDonald (SRBT), *RE: Preliminary Report: 'Dangerous Occurrence' – UN2910 Excepted Package Damaged in Transit,* dated June 20, 2017.

[35] Email from J. MacDonald (SRBT) to R. Rashapov (CNSC), *Preliminary Report – Section 35 (c) of PTNSR – Lost Package of Aircraft Tritium Safety Signs,* dated November 21, 2017.

[36] Letter from S. Levesque (SRBT) to R. Rashapov (CNSC), *Full Report – Event Defined as a Dangerous Occurrence, as per Section 35 (c) of the PTNSR,* dated December 12, 2017.

[37] Email from J. MacDonald (SRBT) to R. Buhr (CNSC), *Implementation of SRBT Research and Development Plan – Extension of Tritium Trap Base Use Beyond 13 Cycles,* dated February 9, 2017.

[38] Letter from B. Hauck (Health Canada) to J. MacDonald (SRBT), *Certificate of Achievement,* dated June 16, 2017.

[39] Email from J. MacDonald (SRBT) to T. Barr (CNSC), *2016 Annual Compliance Report – 11341-3-18.1,* dated February 27, 2017.

[40] SRBT *Licence Limits, Action Levels and Administrative Limits*, Revision E, November 14, 2014.

[41] SRBT *Environmental Monitoring Program*, Revision B, August 12, 2016.

[42] Ontario Ministry of the Environment, *Certificate of Approval Air,* number 5310-4NJQE2, August 31, 2000.

[43] 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,* Tables C.1, C.2.

[44] 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,* Table 19.

[45] 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,* Table 21.

[46] 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,* Table G.9c.

[47] Letter from S. Levesque (SRBT) to M. Rinker (CNSC), *Environmental Protection Gap Analysis and Action Plan,* dated January 15, 2016.

References continued…

[48] Letter from J. Campbell (CNSC) to S. Levesque (SRBT), *SRB Technologies (Canada) Inc's Gap Analysis – Regulatory Requirements and Standards for Environmental Management and Protection,* dated March 31, 2016 (e-Doc 4967340).

[49] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Disposition of Comments – SRBT Environmental Protection Gap Analysis and Action Plan,* dated May 26, 2016.

[50] Letter from R. Fitzpatrick (SRBT) to R. Rashapov (CNSC), *Notification of Change to Fire Suppression System,* dated November 3, 2017.

[51] Letter from R. Rashapov (CNSC) to S. Levesque (SRBT), *CNSC Staff Review of SRB Technologies (Canada) Inc.'s Notification of Planned Change to the Fire Suppression,* dated December 20, 2017.

[52] Email from J. MacDonald (SRBT) to R. Buhr (CNSC), *Decommissioning Escrow Account Deposit – April 2017,* dated April 20, 2017.

[53] Email from J. MacDonald (SRBT) to R. Rashapov (CNSC), *Decommissioning Escrow Account Deposit – October 2017,* dated October 26, 2017.

[54] SRB Technologies (Canada) Inc. *Written Submission for Hearing in Support of Application to Renew Nuclear Substance Processing Facility Operating Licence for a Period of Ten Years,* dated March 13, 2015.

9. Appendices

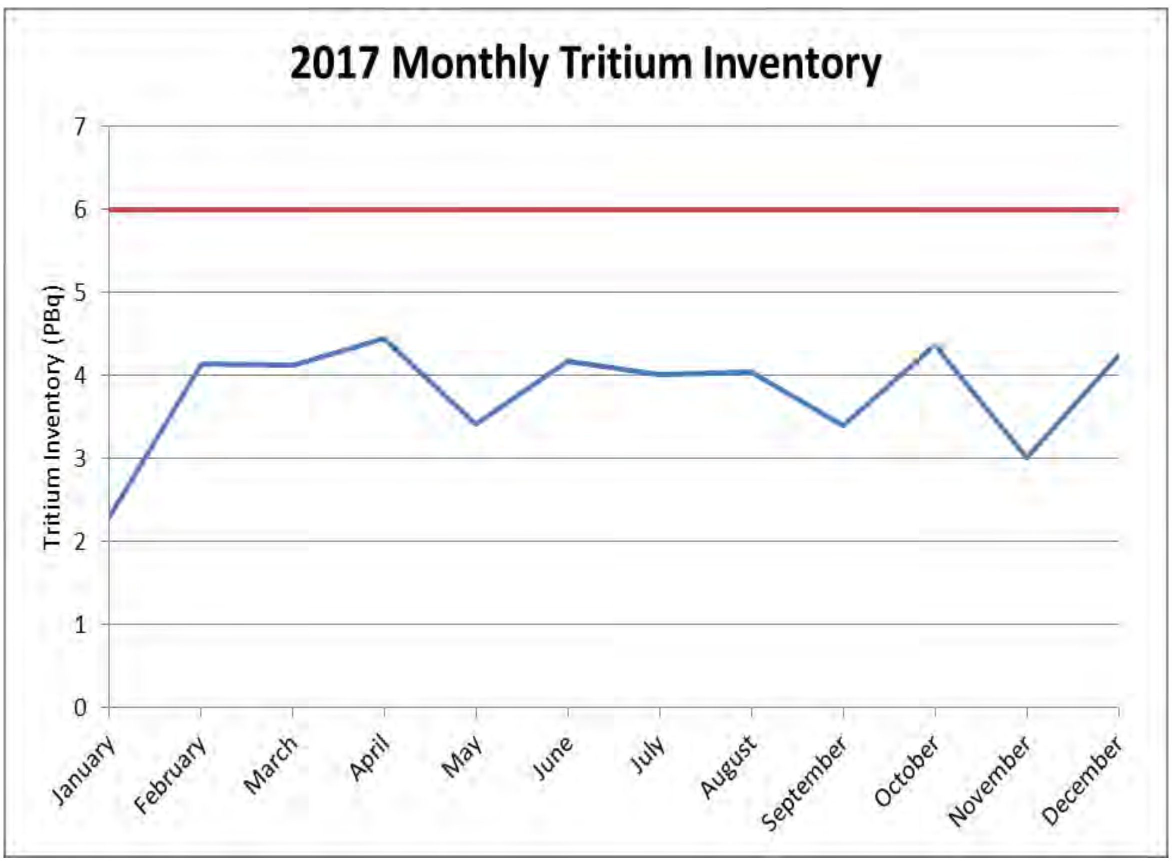
APPENDIX A

Tritium Activity on Site During 2017

TRITIUM ACTIVITY ON SITE DURING 2017

Month	Month-end H-3 Activity On-Site (PBq)	Percent of Licence Limit (%)
January	2.30	38.33
February	4.14	69.00
March	4.13	68.83
April	4.45	74.17
May	3.41	56.83
June	4.17	69.50
July	4.01	66.83
August	4.04	67.33
September	3.40	56.67
October	4.37	72.83
November	3.02	50.33
December	4.24	70.67
2017 Monthly Average	***3.81***	***63.44***

Note: Tritium possession limit = 6.00 PBq.



APPENDIX B

Equipment Maintenance Information for 2017

2017 Scheduled Maintenance Activities Performed

Semi-Annual maintenance on HVAC equipment: **Contract:** Ainsworth	April 13, 2017 Sept 26, 2017
Quarterly maintenance on Rig & Bulk stack units: **Contract:** Ainsworth	March 3, 2017 June 22, 2017 Sept 19, 2017 Dec 20, 2017
Annual stack verification by a third party on Rig & Bulk stack units: **Contract:** Tab Inspection	Sept 26, 2017
Sprinkler System quarterly maintenance by a third party: **Contract:** Drapeau Automatic Sprinkler Corp	March 17, 2017 June 8, 2017 Sept 7, 2017 Dec 12, 2017
Emergency Lighting & Fire Extinguisher annual inspection by a third party: **Contract:** Layman Fire and Safety	March 16, 2017
Sprinkler System inspection by SRBT:	Weekly
Fire Alarm Components inspection by SRBT:	Weekly
Fire Separation doors inspection by SRBT:	Weekly
Fire Extinguisher inspection by SRBT:	Monthly
Emergency Lights inspection by SRBT:	Monthly
Quarterly maintenance carried out on the compressor: **Contract:** Valley Compressor	Jan 6, 2017 April 7, 2017 July 6, 2017 Oct 16, 2017
Fumehood Inspections by SRBT:	Monthly
Tritium-in-Air Sample Collector Bubblers maintenance:	Bi-monthly
Tritium-in-Air Sample Collector Bubblers third party annual verification: **Contract:** Canadian Nuclear Laboratories	Feb 21, 2017
Liquid Scintillation Counters third party annual maintenance: **Contract:** PerkinElmer	Nov 1, 2017
Real-time Stack Monitoring system verification by SRBT:	March 9, 2017 June 5, 2017 Sept 6, 2017 Dec 5, 2017
Monitoring well inspection by SRBT:	Jan 31, 2017 June 1, 2017 Oct 31, 2017
Report of any weakening or possible major failure of any components:	None

All ventilation systems were maintained at a high fitness for service. Corrective maintenance was performed as required. Ventilation equipment maintenance was performed under contract with a fully licensed maintenance and TSSA certified local HVAC contract provider.

All process equipment is serviced and maintained by qualified staff and through contract with companies that specialize in process control systems. All process equipment has been maintained in fully operational condition. Corrective maintenance was performed on equipment as required as a result of as found conditions during inspections and is recorded.

APPENDIX C

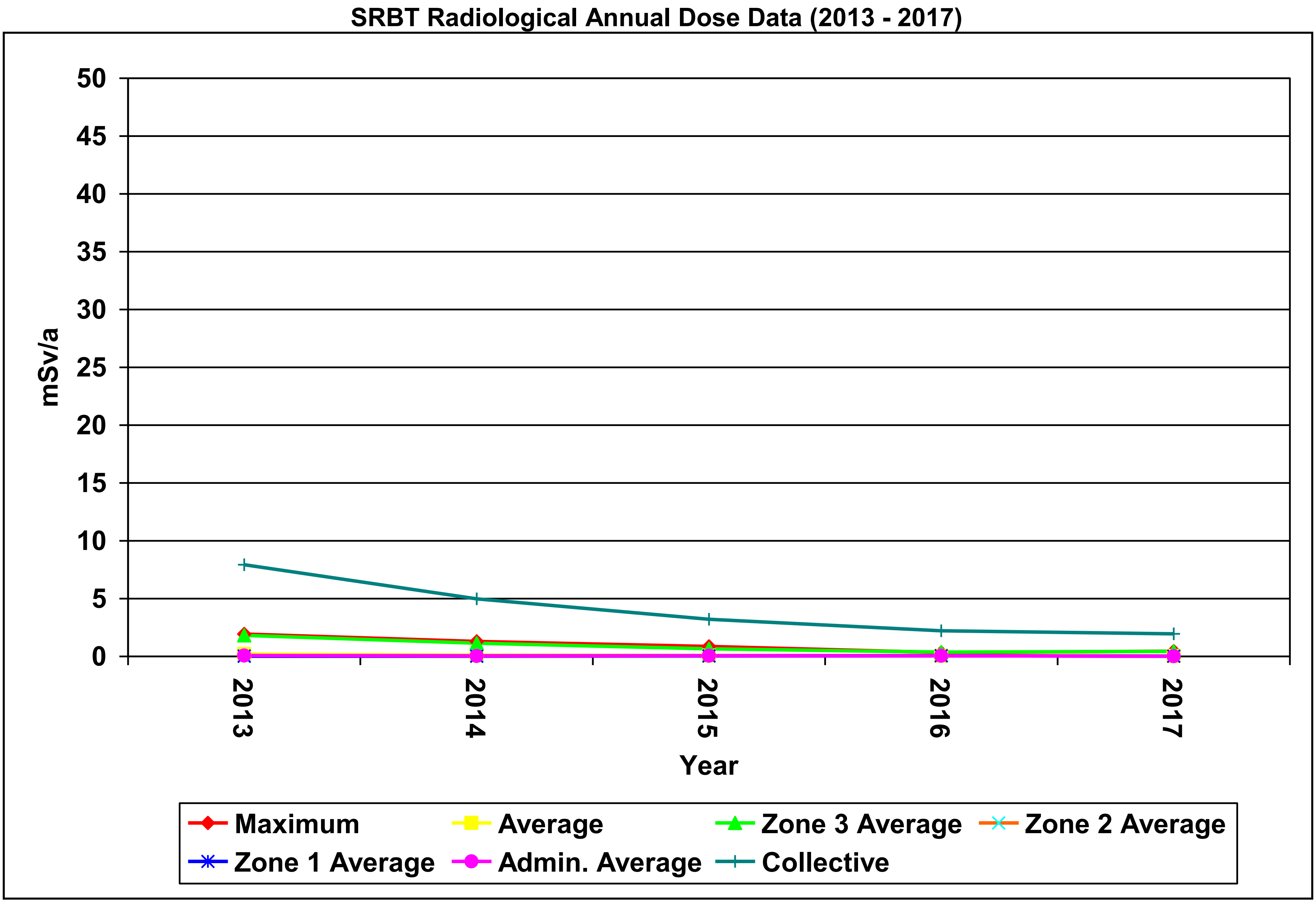
Ventilation Equipment Maintained in 2017

VENTILATION EQUIPMENT MAINTAINED IN 2017

	TYPE	ZONE SERVICED	LOCATION OF UNIT
1	Gas Furnace	1	Front office / server hallway
1	Mid efficient gas furnace	1	Receiving area
1	Mid efficient gas furnace & central air	1	Stores
1	Mid efficient gas furnace	1	Back bay
1	Heat Recovery unit	1	Receiving area
1	HRV with reheat	2	Coating
2	Makeup air units	1 & 2	Coating room
3	Unit heaters	1 & 3	Rig room, Glass shop, Receiving area
1	A/C wall unit	1	Glass shop
4	Exhaust fans	1 & 2	Coating, Assembly, Glass room, Paint Booth
1	Electric furnace with central air	1	Front office
1	Bulk stack air handling unit	3	Compound
1	Rig stack air handling unit	3	Compound
2	Rig and Bulk stack air handling units pitot tubes	3	Compound
1	Gas furnace with central air	1	Milling / moulding

APPENDIX D

Radiological Occupational Annual Dose Data for 2017



(Note: Zone and Admin Averages are of the quarterly collective dose of those groups)

APPENDIX D

SRBT ROLLING FIVE-YEAR EFFECTIVE DOSE DATA (2013 - 2017)

ANNUAL DOSE (mSv)	2013	2014	2015	2016	2017	AVERAGE
Maximum Dose	1.93 mSv	1.29	0.87	0.34	0.46	0.98
Average Dose	0.21	0.10	0.07	0.049	0.045	0.095
Collective Dose	7.94	4.98	3.22	2.21	1.96	4.06

EFFECTIVE DOSE RANGE (mSv)	2013	2014	2015	2016	2017	AVERAGE
0 – 0.05	23 workers	32	33	32	36	31
0.05 – 0.10	2	7	5	7	4	5
0.10 – 0.25	5	5	5	3	2	4
0.25 – 0.50	4	0	3	3	3	3
0.50 – 1.00	0	3	1	0	0	1
>1.00	4	1	0	0	0	1
Staff Members	38	48	47	45	45	45

APPENDIX E

Swipe Monitoring Results for 2017

2017 Routine Contamination Assessment Summary - Zone 3

Zone 3 Swipe Area	No. of Assessments	Amount > Admin. Level	Pass Rate
Rig 7	246	1	99.6
Rig 1 Floor	246	8	96.7
Rig 1	246	2	99.2
Flr @ Rig 6	246	18	92.7
Rig 6	246	5	98.0
Floor @ Rig 8	246	20	91.9
Rig 5	246	5	98.0
Flr @ Barrier	246	19	92.3
Muffle F/H	246	14	94.3
Laser rm flr random	246	22	91.1
EIP Area	246	9	96.3
Laser Rm F/H	246	33	86.6
Trit Lab Flr random	246	11	95.5
Bulk Splitter Fume Hood	246	15	93.9
Shoe Covers	246	36	85.4
Rig 7 Floor	244	29	88.1
Rig 8	244	2	99.2
Floor @ Rig 5	244	19	92.2
Computer Desk Floor	129	3	97.7
Trit. Lab Storage Room	127	2	98.4
Cleaning Cabinet	117	1	99.1
Lower Reclaim Cabinets	115	5	95.7
Waste Room Floors	67	0	100.0
Reclaim Sash	67	0	100.0
Trit Lab Cabinets	65	2	96.9
Photometer Room	65	0	100.0
Oven Bins	65	0	100.0
Waste Room Door	64	1	98.4
Laser Room Chair	64	0	100.0
EIP Pressure Knob	64	0	100.0
Reclaim Fume Hood	64	0	100.0
Waste Room Shelving	63	0	100.0
Laser Room Desk	63	0	100.0
Trit Lab Desk	63	3	95.2
Waste Room Walls	52	0	100.0
Port-Hole	52	0	100.0
Operations Logbook	52	0	100.0
Torch Handles	52	1	98.1
Pen Drawers	2	0	100.0
Laser Stick Cabinet	2	0	100.0
Shoe Cover Bins	2	0	100.0
TOTAL ZONE 3	**5,898**	**286**	**95.2**

2017 Routine Contamination Assessment Summary - Zone 2

Zone 2 Swipe Area	No. of Assessments	Amount > Admin. Level	Pass Rate
Floor at Barrier I	146	6	95.9
WIP Cabinets	146	1	99.3
Shoe Covers	146	4	97.3
Work Area Floors	146	9	93.8
Work Counters	146	2	98.6
Sign Light Stock Cabinet	146	3	97.9
Insp. Prep. Counter	146	11	92.5
Reflector Bin Handles	115	4	96.5
Wire Rack at Barrier	75	1	98.7
UV Printing Room	70	1	98.6
Silk Screening Room	70	3	95.7
Dark Room	39	0	100.0
UV Printer	39	0	100.0
Counter at Barrier	38	2	94.7
Computer and Peripherals	38	0	100.0
Paint Booth	38	0	100.0
Floor at Barrier II	37	0	100.0
Floor at Barrier III	37	1	97.3
Microscope Inspection Area	36	1	97.2
Welding Area Counter	32	0	100.0
Racks in Spray Room	31	1	96.8
Exposing Unit	31	0	100.0
Paint Booth Floor	1	0	100.0
Bubbler Fume Hood	1	0	100.0
TOTAL ZONE 2	**1,750**	**50**	**97.1**

2017 Routine Contamination Assessment Summary - Zone 1

Zone 1 Swipe Area	No. of Assessments	Amount > Admin. Level	Pass Rate
Lunch Room	52	0	100.0
LSC Room	52	0	100.0
RR Ante Rm	52	4	92.3
RR Barrier	52	2	96.2
Assy Barrier	52	0	100.0
Shipping Area	52	0	100.0
Disassembly Wire Racks	38	0	100.0
Mezzanine	28	1	96.4
RMA Storage Floors	27	0	100.0
Cleaning Cart	24	0	100.0
Zone 3 Door	14	0	100.0
Portable Staircase	14	0	100.0
Glass Shop	14	0	100.0
QA Hold	14	0	100.0
Palette Truck	13	0	100.0
3D Printer	10	0	100.0
Cardboard/Garbage Bins	10	0	100.0
Rear Facility Door	1	0	100.0
Zone 2 Door	1	0	100.0
TOTAL ZONE 1	**520**	**7**	**98.7**

Overall Facility Summary

Facility Zone	No. of Assessments	Amount > Admin. Level	Pass Rate
ZONE 3	5,898	286	95.2
ZONE 2	1,750	50	97.1
ZONE 1	520	7	98.7
TOTAL ZONE 1	**8,168**	**343**	**95.8**

APPENDIX F

Passive Air Sampler Results for 2017

SRBT Passive Air Sampler Results 2017				(Bq/m3)												Average
Sampler No.	Sampler ID	Location	Dist. to SRBT	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(Bq/m3)
				Jan 4 - Feb 1	Feb. 1 - Mar. 1	Mar. 1 - Apr. 4	Apr. 4 - May 2	May 2 - June 2	Jun. 2 - Jul. 5	Jul. 5 - Aug. 2	Aug. 2 - Sept. 1	Sept. 1 - Oct. 3	Oct. 3 - Nov. 1	Nov. 1 - Nov. 30	Nov. 30 - Jan. 3	
1	N250	N 45º 48.486' W 077º 07.092' Elev. 137m	322m	0.60	0.33	0.44	0.43	1.20	1.10	1.30	1.20	2.10	3.20	3.10	1.50	1.38
2	N500	N 45º 48.572' W 077º 07.008' Elev. 134m	493m	0.35	0.33	0.28	0.34	0.43	0.56	0.85	0.59	1.30	1.80	1.10	0.60	0.71
3	N1000	N 45º 48.869' W 077º 06.997' Elev. 135m	1040m	0.35	0.33	0.26	0.34	0.30	0.29	0.34	0.33	0.54	0.32	0.38	0.26	0.34
4 (PAS #4)	NW250	N 45º 48.412' W 077º 07.189' Elev. 137m	222m	1.50	1.10	0.72	1.50	1.40	1.00	1.00	2.60	3.70	3.50	4.30	0.69	1.92
5	NW500	N 45º 48.577' W 077º 07.382' Elev. 134m	615m	0.78	0.33	0.26	0.46	0.39	0.43	0.44	0.69	1.20	1.00	1.20	0.26	0.62
6 (PAS # 8)	NW1000	N 45º 48.754' W 077º 07.599' Elev. 130m	1050m	0.35	0.32	0.26	0.34	0.29	0.29	0.33	0.33	0.60	0.46	0.57	0.26	0.37
7	NW2000	N 45º 49.141' W 077º 08.090' Elev. 139m	2000m	0.35	0.33	0.26	0.34	0.30	0.47	0.80	0.34	0.67	0.38	0.35	0.26	0.40
8	W250	N 45º 48.300' W 077º 07.323' Elev. 138m	297m	1.50	0.60	0.74	2.20	1.40	0.80	0.72	0.70	1.10	0.80	0.51	0.48	0.96
9	W500	N 45º 48.288' W 077º 07.393' Elev. 137m	389m	0.55	0.32	0.40	1.10	0.80	0.60	0.72	0.41	0.70	0.67	0.31	0.39	0.58
10	W1000	N 45º 48.306' W 077º 07.630' Elev. 134m	691m	0.98	*	0.24	0.70	0.35	0.29	0.33	0.32	0.31	0.34	0.31	0.26	0.40
11	SW250	N 45º 48.247' W 077º 07.206' Elev. 140m	183m	0.35	0.40	0.30	0.89	1.10	1.00	1.40	0.30	1.20	1.00	0.31	0.26	0.71
12	SW500	N 45º 47.896' W 077º 07.307' Elev. 148m	839m	0.35	0.33	0.26	0.34	0.30	0.28	0.33	0.33	0.32	0.33	0.31	0.26	0.31
13	SW1000	N 45º 47.599' W 077º 07.543' Elev. 149m	1470m	0.34	0.33	0.26	0.34	0.29	0.29	0.34	0.32	0.32	0.33	0.31	0.26	0.31
14	SW2000	N 45º 47.408' W 077º 07.866' Elev. 155m	2110m	0.35	0.33	0.26	0.34	0.29	0.29	0.34	0.33	0.32	0.32	0.30	0.26	0.31
15	S250	N 45º 48.129' W 077º 07.014' Elev. 131m	356m	0.48	0.55	0.73	0.70	0.83	0.67	0.92	0.72	1.10	0.32	0.47	0.28	0.65
16	S500	N 45º 48.029' W 077º 07.110' Elev. 143m	532m	0.35	0.33	0.26	0.34	0.34	0.32	0.38	0.33	0.49	0.32	0.31	0.26	0.34
17 (PAS # 12)	S1000	N 45º 46.466' W 077º 07.441' Elev. 158m	1450m	0.35	0.33	0.26	0.34	0.29	0.28	0.34	0.33	0.31	0.32	0.31	0.26	0.31
18	SE250	N 45º 48.189' W 077º 06.874' Elev. 132m	365m	2.90	2.90	2.90	1.30	1.50	1.60	1.30	1.50	2.90	1.60	3.40	1.40	2.10
19	SE500	N 45º 48.108' W 077º 06.783' Elev. 123m	554m	1.10	1.20	1.40	0.50	0.80	0.70	0.68	0.62	1.80	0.70	1.30	0.55	0.95
20	SE1000	N 45º 47.894' W 077º 06.501' Elev. 120m	1090m	0.35	0.33	0.35	0.34	0.29	0.29	0.34	0.32	0.76	0.32	0.31	0.26	0.36
21	SE2000	N 45º 47.505' W 077º 05.978' Elev. 137m	2080m	0.35	0.33	0.26	0.34	0.30	0.29	0.33	0.32	0.31	0.32	0.31	0.26	0.31
22	E250	N 45º 48.234' W 077º 06.807' Elev. 131m	401m	2.00	1.70	1.20	0.90	1.00	1.40	1.30	1.20	2.00	2.00	0.31	3.40	1.53
23	E500	N 45º 48.333' W 077º 06.693' Elev. 132m	520m	0.76	0.33	0.26	0.33	0.48	1.40	0.67	0.44	1.60	0.87	0.43	0.27	0.65
24	E1000	N 45º 48.303' W 077º 06.260' Elev. 143m	1080m	0.35	0.33	0.26	0.34	0.30	0.37	0.33	0.33	0.62	0.33	0.31	0.26	0.34
25	NE250	N 45º 48.371' W 077º 06.964' Elev. 124m	198m	1.70	0.70	0.46	0.82	4.00	7.60	4.10	5.00	5.40	5.00	1.10	0.62	3.04
26	NE500	N 45º 48.421' W 077º 06.732' Elev. 131m	508m	0.65	0.33	0.26	0.34	0.69	1.30	0.65	1.03	1.50	1.00	0.31	0.26	0.69
27	NE1000	N 45º 48.683' W 077º 06.441' Elev. 148m	1100m	0.35	0.33	0.26	0.34	0.30	0.33	0.39	0.32	0.66	0.32	0.31	0.26	0.35
28	NE2000	N 45º 49.116' W 077º 05.843' Elev. 156m	2200m	0.35	0.33	0.26	0.34	0.30	0.29	0.33	0.32	0.31	0.32	0.31	0.26	0.31
Pre-Sample Points																
(PAS #1)		N 45º 48.287' W 077º 07.123' Elev. 129m	94.1m	1.10	1.80	3.40	2.00	4.30	4.50	3.40	4.50	5.20	3.60	0.36	1.30	2.96
(PAS #2)		N 45º 48.325' W 077º 07.132' Elev. 132m	52.8m	1.20	1.20	1.80	5.60	4.30	4.00	8.50	2.50	7.40	2.50	2.30	0.75	3.50
(PAS #13)		N 45º 48.262' W 077º 07.093' Elev. 132m	61.5m	0.51	1.10	1.00	2.60	3.00	6.30	6.20	1.50	3.40	3.40	0.31	0.26	2.47
Replicates																
4-2	NW250	N 45º 48.412' W 077º 07.189' Elev. 137m	222m	1.40	0.90	0.71	1.40	1.20	0.90	1.00	2.60	3.50	3.20	4.10	0.58	1.79
11-2	SW250	N 45º 48.247' W 077º 07.206' Elev. 140m	183m	0.35	0.34	0.29	0.82	1.10	0.90	1.20	0.30	1.00	1.00	0.31	0.26	0.66
18-2	SE250	N 45º 48.189' W 077º 06.874' Elev. 132m	365m	2.30	2.50	2.20	1.20	1.50	1.60	1.20	1.50	2.70	1.50	2.70	1.10	1.83
25-2	NE250	N 45º 48.371' W 077º 06.964' Elev. 124m	198m	1.70	0.40	0.27	0.65	3.50	7.20	3.90	4.70	4.80	4.00	1.00	0.59	2.73
Background Samples																
Maika (PAS # 10)	SW	N 45º 46.367' W 077º 11.447' Elev. 149m	6690m	0.35	0.33	0.26	0.34	0.31	0.30	0.35	0.34	0.33	0.32	0.31	0.26	0.32
Maika	Duplicate	Same as above	6690m	0.35	0.33	0.26	0.34	0.30	0.29	0.33	0.32	0.32	0.32	0.31	0.26	0.31
Fitzpatrick	SE	N 45° 44.818' W 076° 59.822' Elev. 159m	11400m	0.35	0.47	0.26	0.34	0.32	0.50	0.70	0.67	0.66	0.33	0.31	0.26	0.43
Petawawa	NW	N 45° 51.497' W 077° 12.828' Elev. 149m	9480m	0.35	0.33	0.26	0.34	0.30	0.29	0.33	0.32	0.31	0.32	0.31	0.26	0.31
Farm	NE	N 45° 53.071' W 076° 56.768' Elev. 142m	16000m	*	*	0.26	0.33	0.30	0.29	0.33	0.33	0.32	0.32	0.31	0.26	0.31
Results shaded in blue are <minimum detectable activity (MDA)			Sum	30.70	25.10	25.03	32.89	40.69	51.60	48.74	41.15	64.08	49.00	35.48	20.74	38.85

APPENDIX G

Wind Direction Graphs for 2017

Passive Air Sampling Data (Results in Bq/m3)

1st Quarter

Direction	January 250 M	January 500 M	January 1000 M	January 2000 M	February 250 M	February 500 M	February 1000 M	February 2000 M	March 250 M	March 500 M	March 1000 M	March 2000 M
North	0.60	0.35	0.35		0.33	0.33	0.33		0.44	0.28	0.26	
North West	1.50	0.78	0.35	0.35	1.10	0.33	0.32	0.33	0.72	0.26	0.26	0.26
West	1.50	0.55	0.98		0.60	0.32 *			0.74	0.40	0.24	
Southwest	0.35	0.35	0.34	0.35	0.40	0.33	0.33	0.33	0.30	0.26	0.26	0.26
South	0.48	0.35	0.35		0.55	0.33	0.33		0.73	0.26	0.26	
South East	2.90	1.10	0.35	0.35	2.90	1.20	0.33	0.33	2.90	1.40	0.35	0.26
East	2.00	0.76	0.35		1.70	0.33	0.33		1.20	0.26	0.26	
North East	1.70	0.65	0.35	0.35	0.70	0.33	0.33	0.33	0.46	0.26	0.26	0.26

2nd Quarter

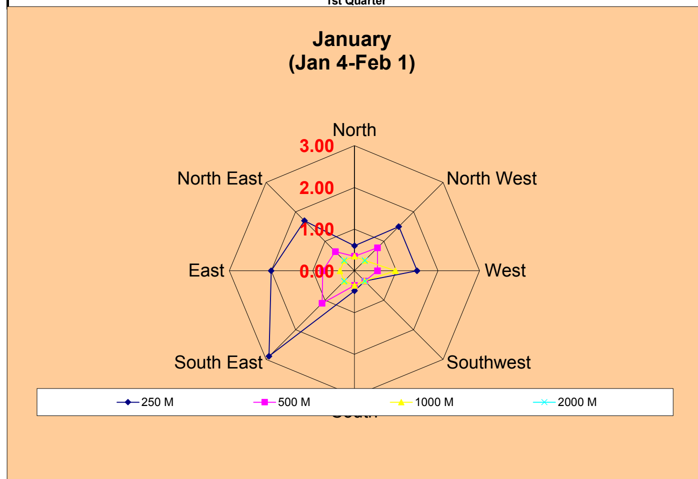
Direction	April 250 M	April 500 M	April 1000 M	April 2000 M	May 250 M	May 500 M	May 1000 M	May 2000 M	June 250 M	June 500 M	June 1000 M	June 2000 M
North	0.43	0.34	0.34		1.20	0.43	0.30		1.10	0.56	0.29	
North West	1.50	0.46	0.34	0.34	1.40	0.39	0.29	0.30	1.00	0.43	0.29	0.47
West	2.20	1.10	0.70		1.40	0.80	0.35		0.80	0.60	0.29	
Southwest	0.89	0.34	0.34	0.34	1.10	0.30	0.29	0.29	1.00	0.28	0.29	0.29
South	0.70	0.34	0.34		0.83	0.83	0.29		0.67	0.32	0.28	
South East	1.30	0.50	0.34	0.34	1.50	0.80	0.29	0.30	1.60	0.70	0.29	0.29
East	0.90	0.33	0.34		1.00	0.48	0.30		1.40	1.40	0.37	
North East	0.82	0.34	0.34	0.34	4.00	0.69	0.30	0.30	7.60	1.30	0.33	0.29

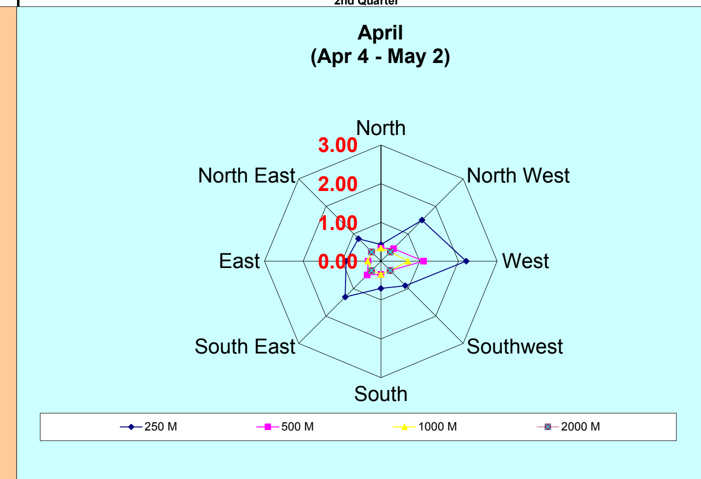
3rd Quarter

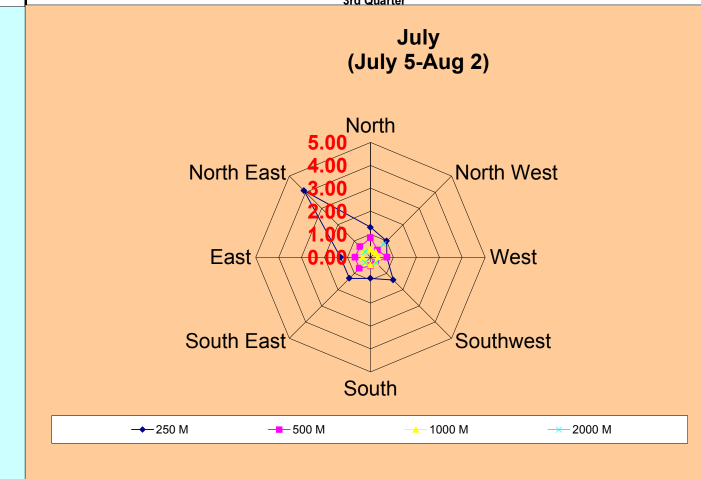
Direction	July 250 M	July 500 M	July 1000 M	July 2000 M	August 250 M	August 500 M	August 1000 M	August 2000 M	September 250 M	September 500 M	September 1000 M	September 2000 M
North	1.30	0.85	0.34		1.20	0.59	0.33		2.10	1.30	0.54	
North West	1.00	0.44	0.33	0.80	2.60	0.69	0.33	0.34	3.70	1.20	0.60	0.67
West	0.72	0.72	0.33		0.70	0.41	0.32		1.10	0.70	0.31	
Southwest	1.40	0.33	0.34	0.34	0.30	0.33	0.32	0.33	1.20	0.32	0.32	0.32
South	0.92	0.38	0.34		0.72	0.33	0.33		1.10	0.49	0.31	
South East	1.30	0.68	0.34	0.33	1.50	0.62	0.32	0.32	2.90	1.80	0.76	0.31
East	1.30	0.67	0.33		1.20	0.44	0.33		2.00	1.60	0.62	
North East	4.10	0.65	0.39	0.33	5.00	1.03	0.32	0.32	5.40	1.50	0.66	0.31

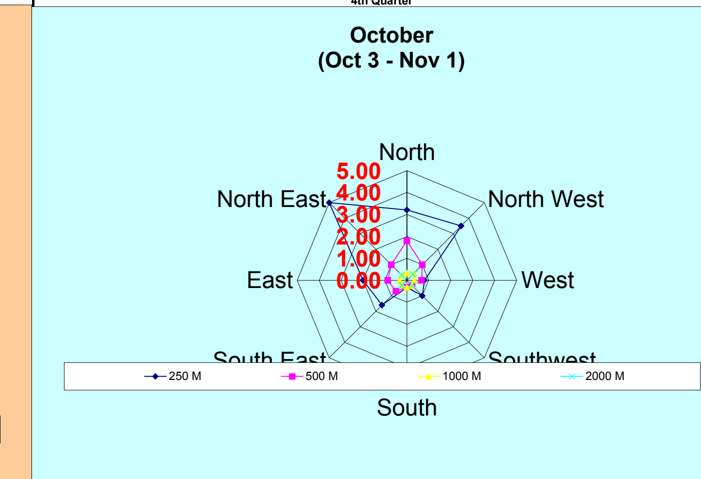
4th Quarter

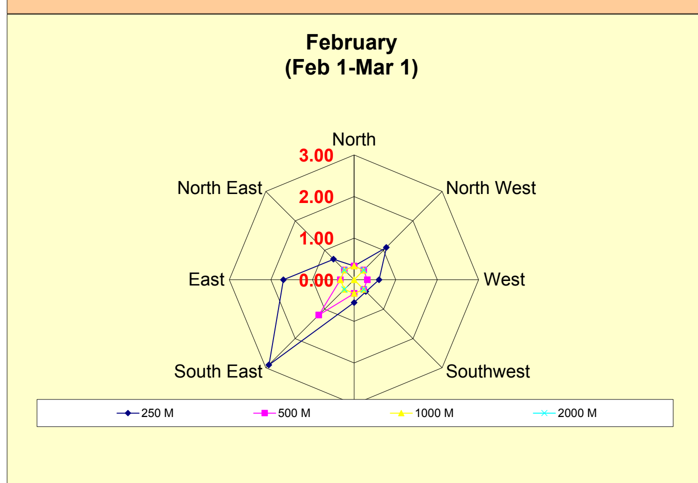
Direction	October 250 M	October 500 M	October 1000 M	October 2000 M	November 250 M	November 500 M	November 1000 M	November 2000 M	December 250 M	December 500 M	December 1000 M	December 2000 M
North	3.20	1.80	0.32		3.10	1.10	0.38		1.50	0.60	0.26	
North West	3.50	1.00	0.46	0.38	4.30	1.20	0.57	0.35	0.69	0.26	0.26	0.26
West	0.80	0.67	0.34		0.51	0.31	0.31		0.48	0.39	0.26	
Southwest	1.00	0.33	0.33	0.32	0.31	0.31	0.31	0.30	0.26	0.26	0.26	0.26
South	0.32	0.32	0.32		0.47	0.31	0.31		0.28	0.26	0.26	
South East	1.60	0.70	0.32	0.32	3.40	1.30	0.31	0.31	1.40	0.55	0.26	0.26
East	2.00	0.87	0.33		0.31	0.43	0.31		3.40	0.27	0.26	
North East	5.00	1.00	0.32	0.32	1.10	0.31	0.31	0.31	0.62	0.26	0.26	0.26

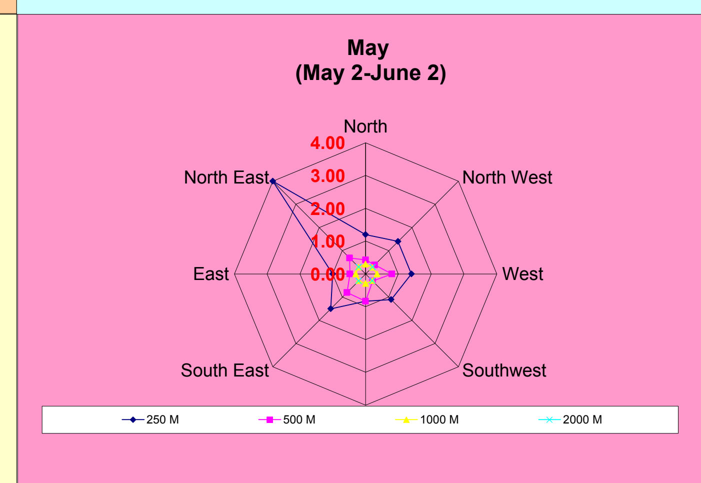


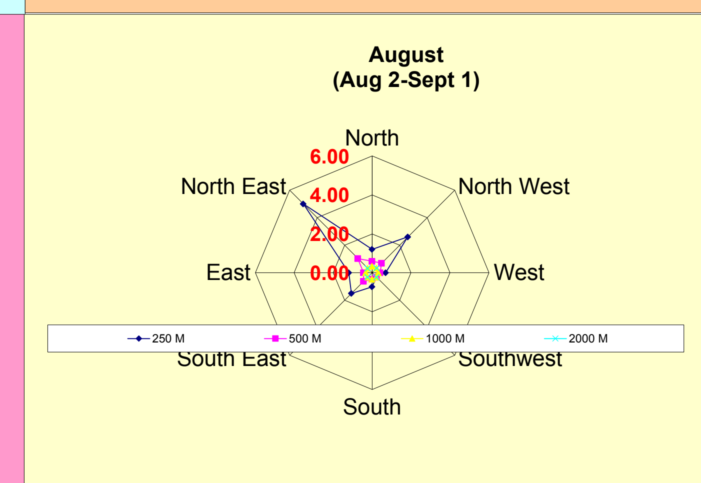


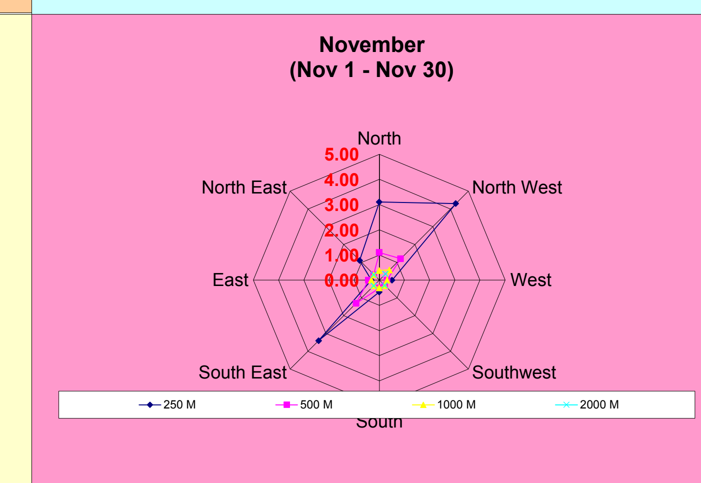


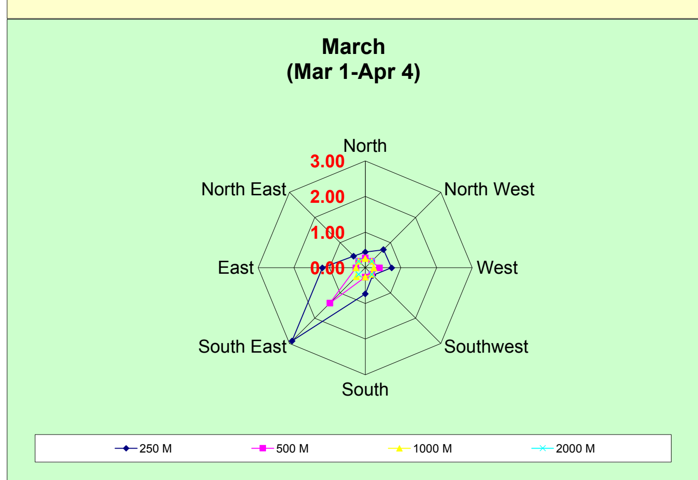


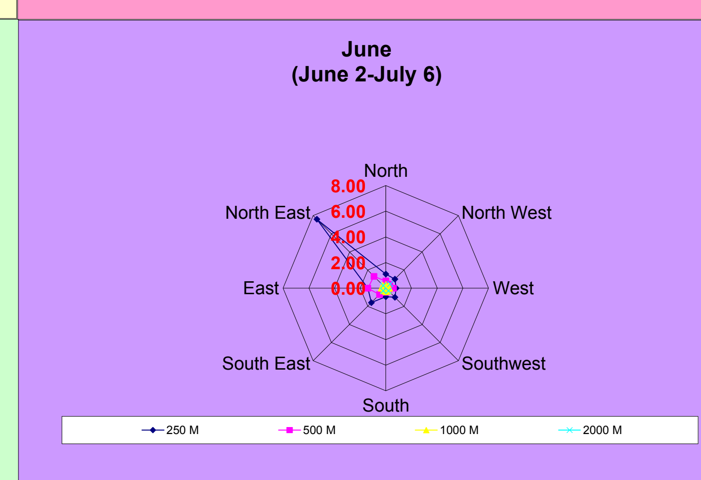


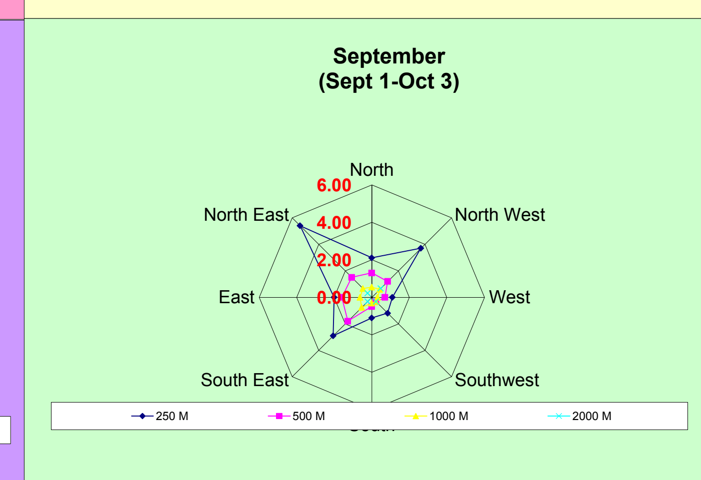


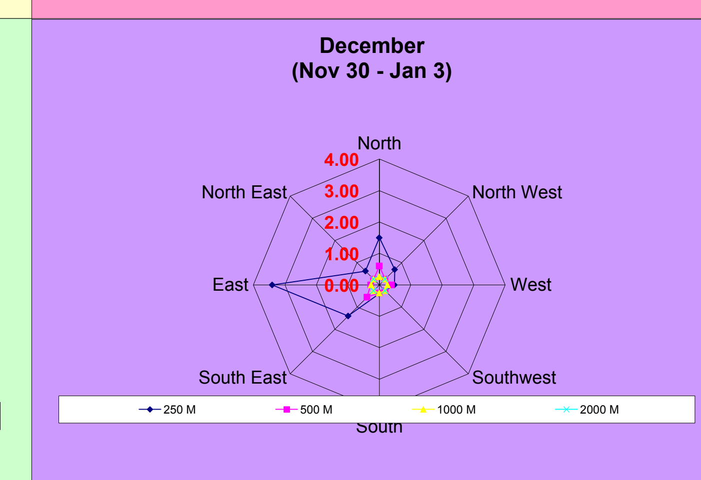












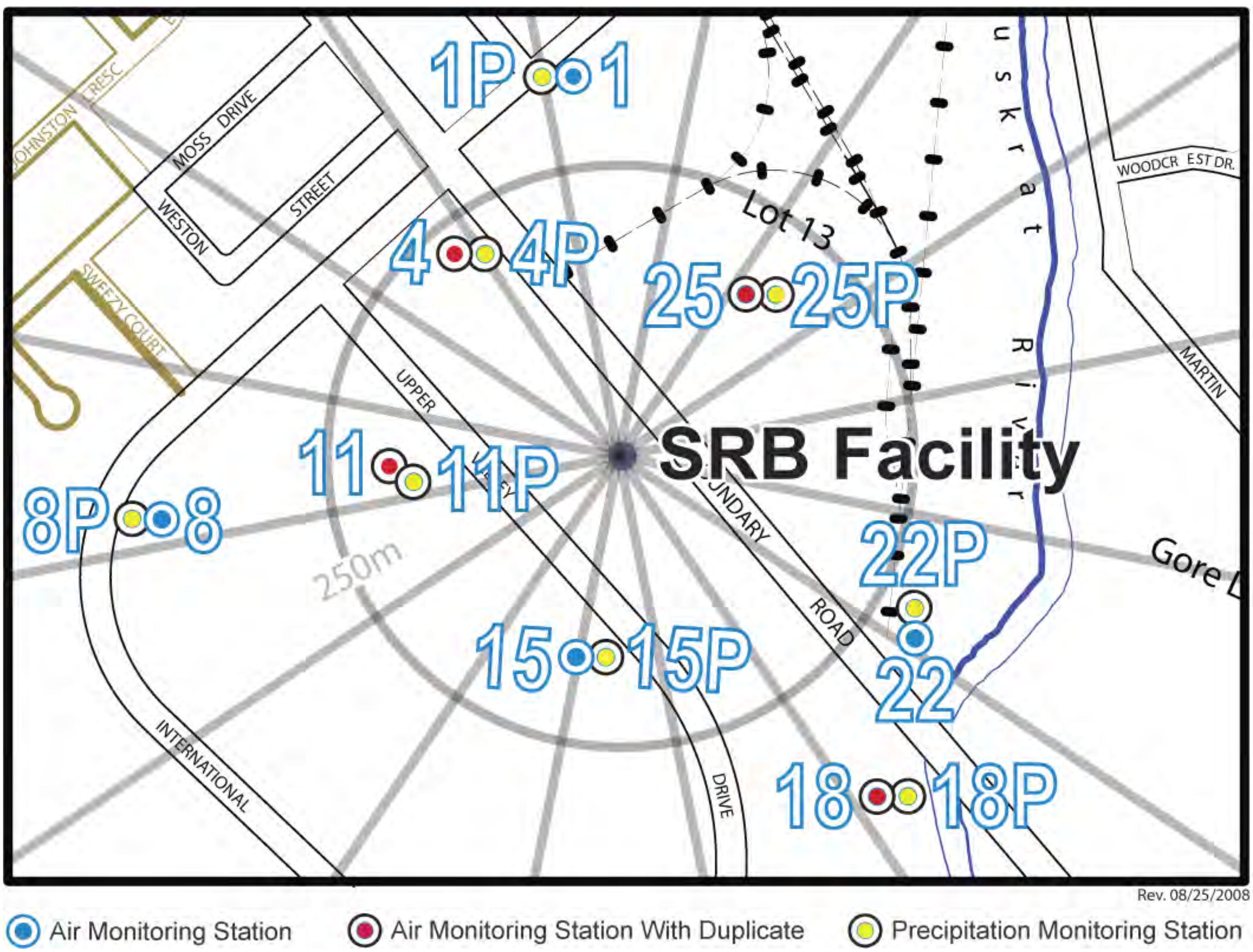
APPENDIX H

Precipitation Monitoring Results for 2017

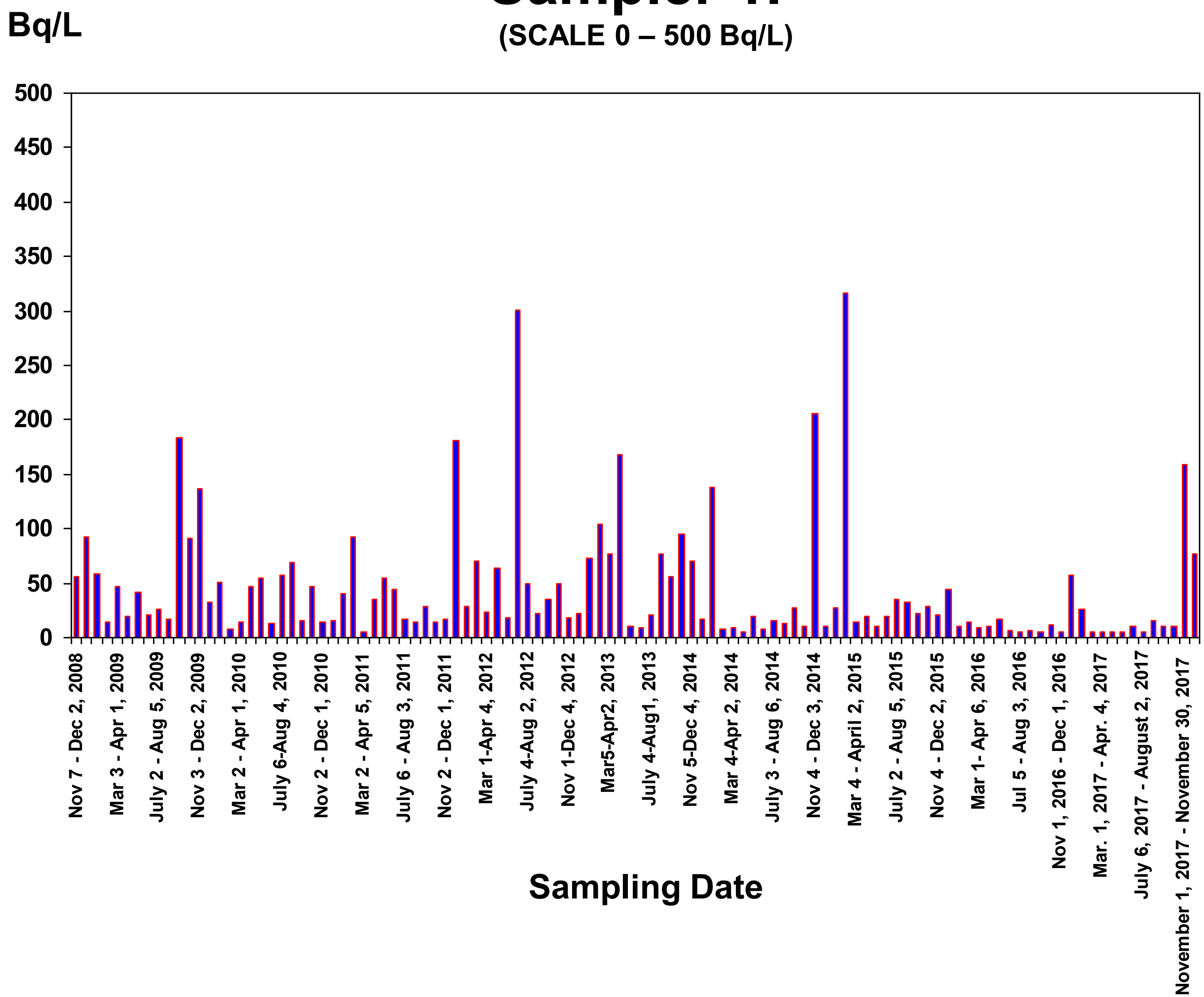
PRECIPITATION SAMPLERS									
	1P	4P	8P	11P	15P	18P	22P	25P	AVG
Date Range	Bq/L								
Jan. 4, 2017 - Feb. 1, 2017	26	65	20	40	20	230	133	30	71
Feb. 1, 2017 - Mar. 1, 2017	5	21	44	58	15	129	46	7	41
Mar. 1, 2017 - Apr. 4, 2017	5	31	67	8	41	44	16	5	27
Apr. 4, 2017 - May 2, 2017	5	12	20	17	13	14	5	5	11
May 2, 2017 - June 2, 2017	5	47	5	46	13	22	8	16	20
June 2, 2017 - July 6, 2017	10	36	13	13	41	53	95	24	36
July 6, 2017 - August 2, 2017	5	320	49	78	36	10	18	5	65
August 2, 2017 - September 1, 2017	15	31	6	5	7	11	10	36	15
September 1, 2017 - October 3, 2017	10	14	6	6	5	10	9	25	11
October 3, 2017 - November 1, 2017	10	26	5	5	7	27	17	8	13
Nov. 1, 2017 - Nov. 30, 2017	159	153	68	9	6	73	56	21	68
Nov. 30, 2017 - January 3, 2018	77	111	55	18	30	228	409	60	124
AVERAGE	28	72	30	25	20	71	69	20	42

Results shaded in blue are <minimum detectable activity (MDA)

MAP OF AIR AND PRECIPITATION MONITORING STATIONS

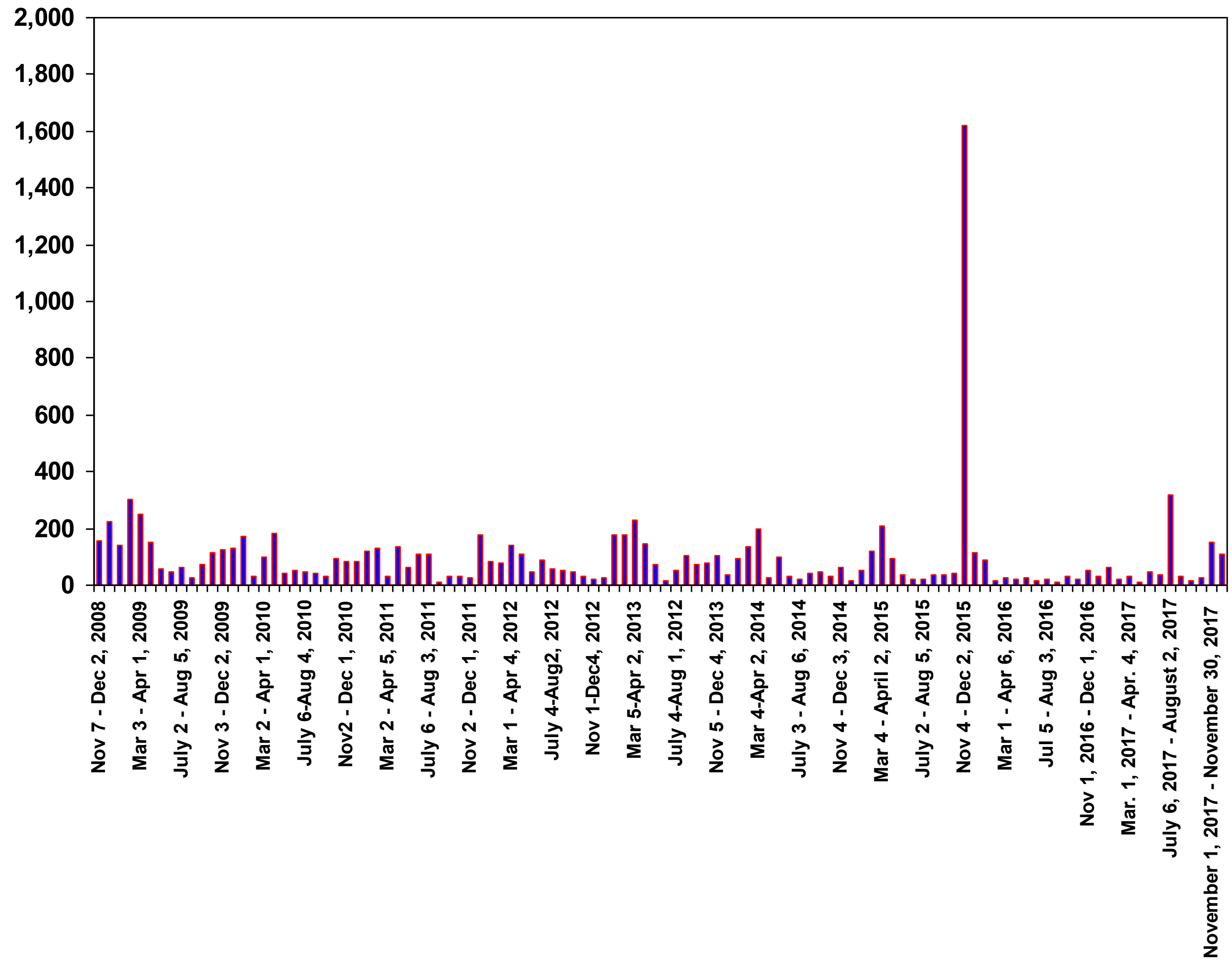


PRECIPITATION RESULTS
Sampler 1P
(SCALE 0 – 500 Bq/L)



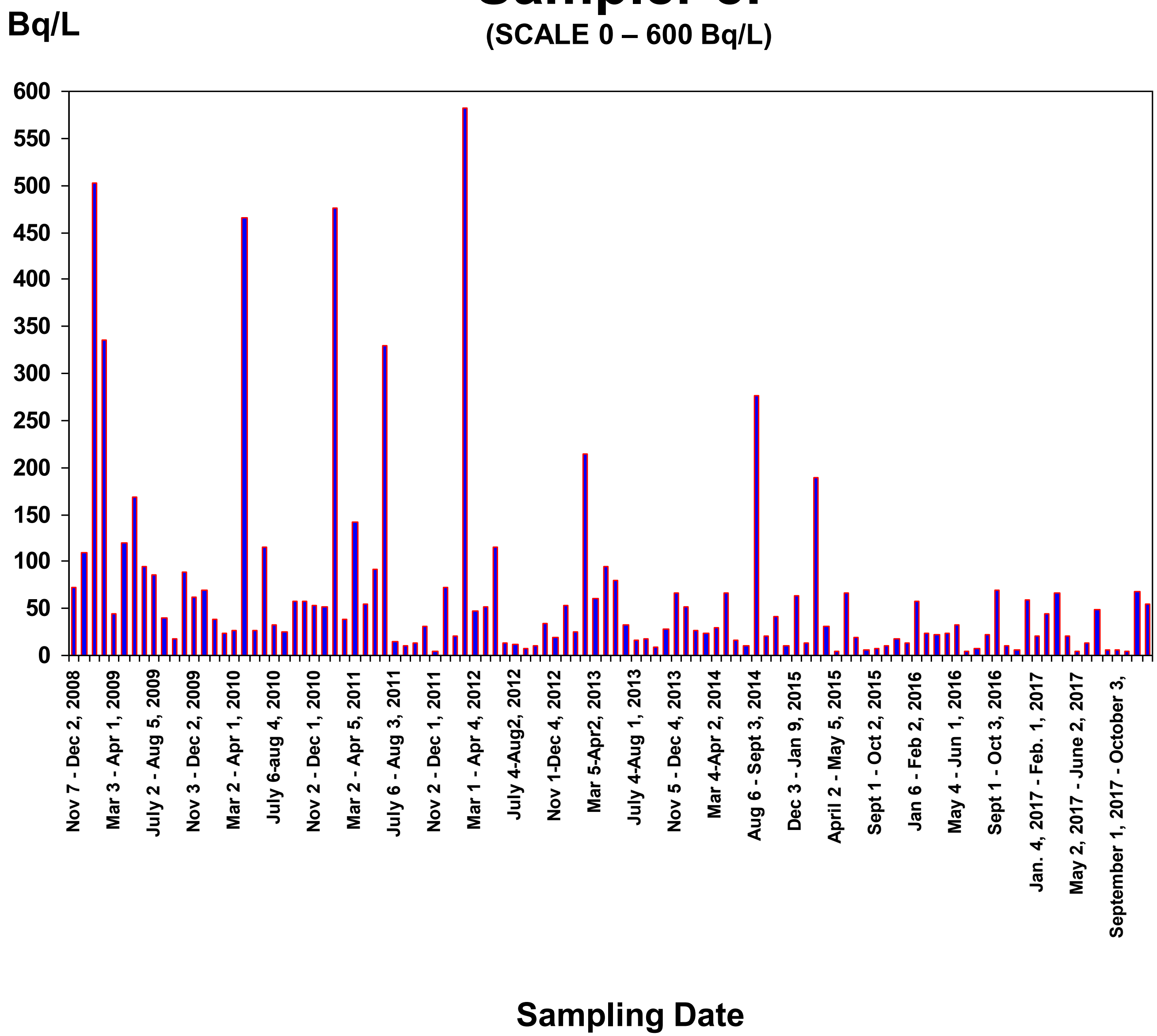
APPENDIX H

PRECIPITATION RESULTS
Sampler 4P
(SCALE 0 – 2,000 Bq/L)



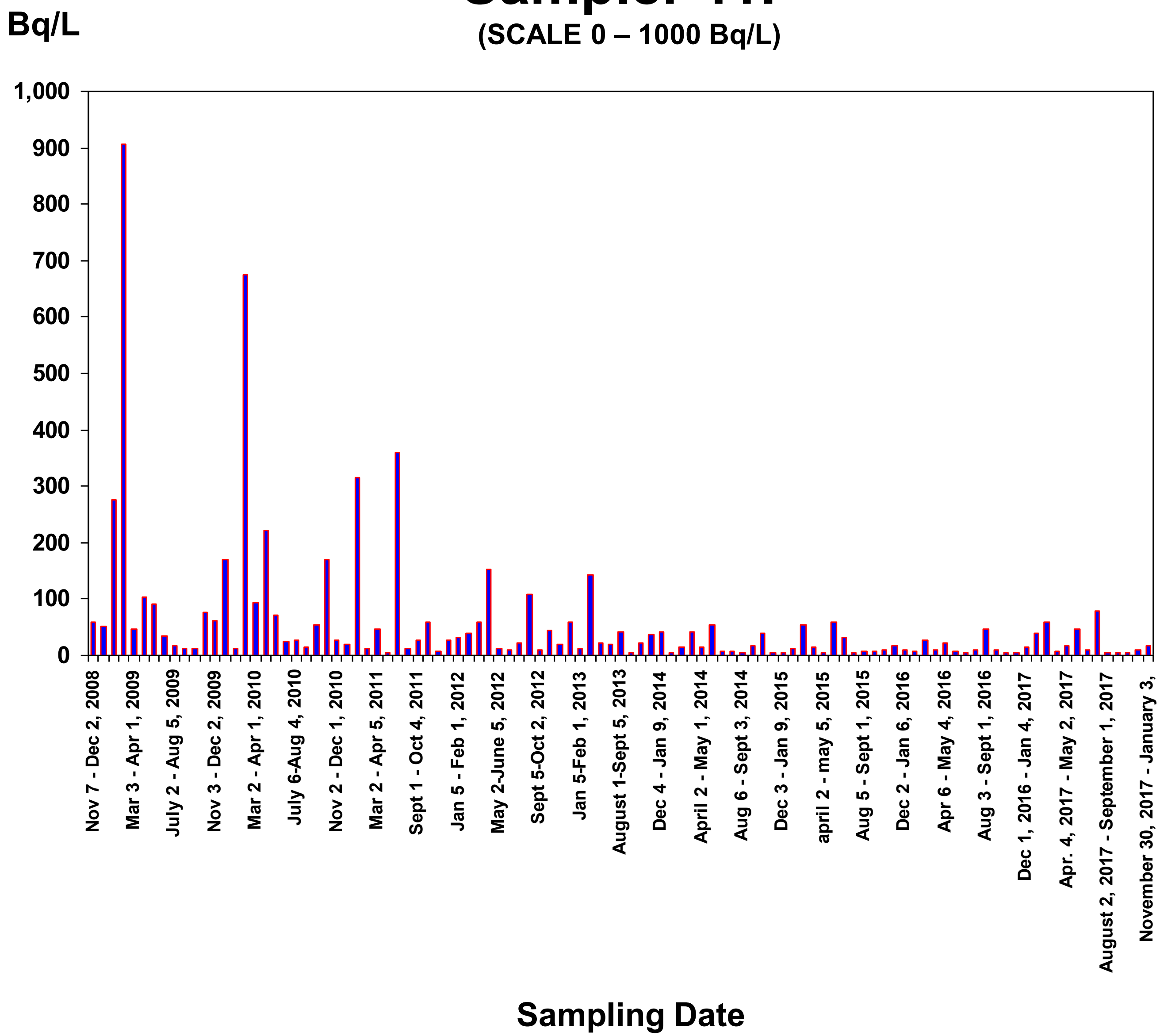
Sampling Date

PRECIPITATION RESULTS
Sampler 8P
(SCALE 0 – 600 Bq/L)



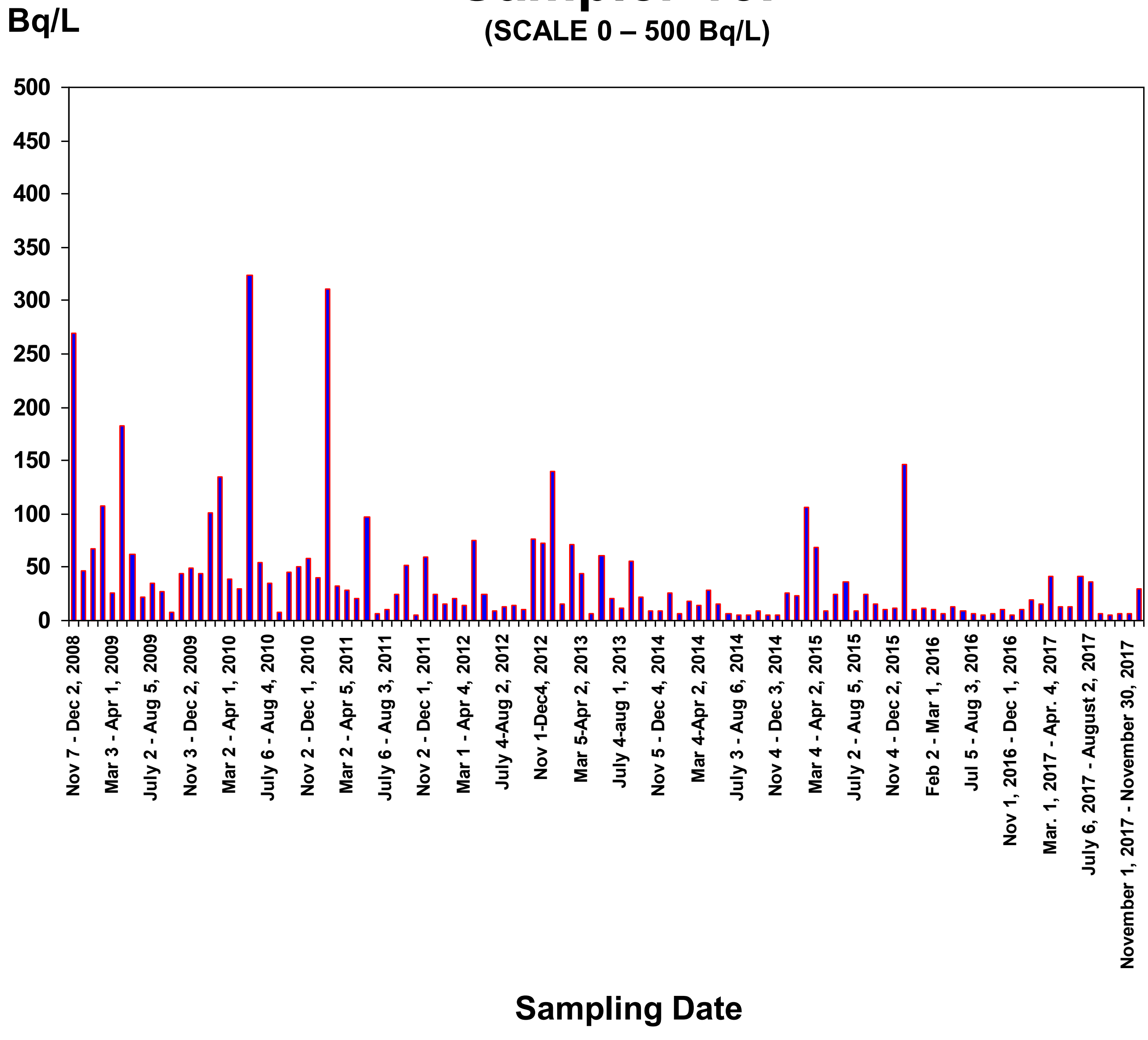
APPENDIX H

PRECIPITATION RESULTS
Sampler 11P
(SCALE 0 – 1000 Bq/L)



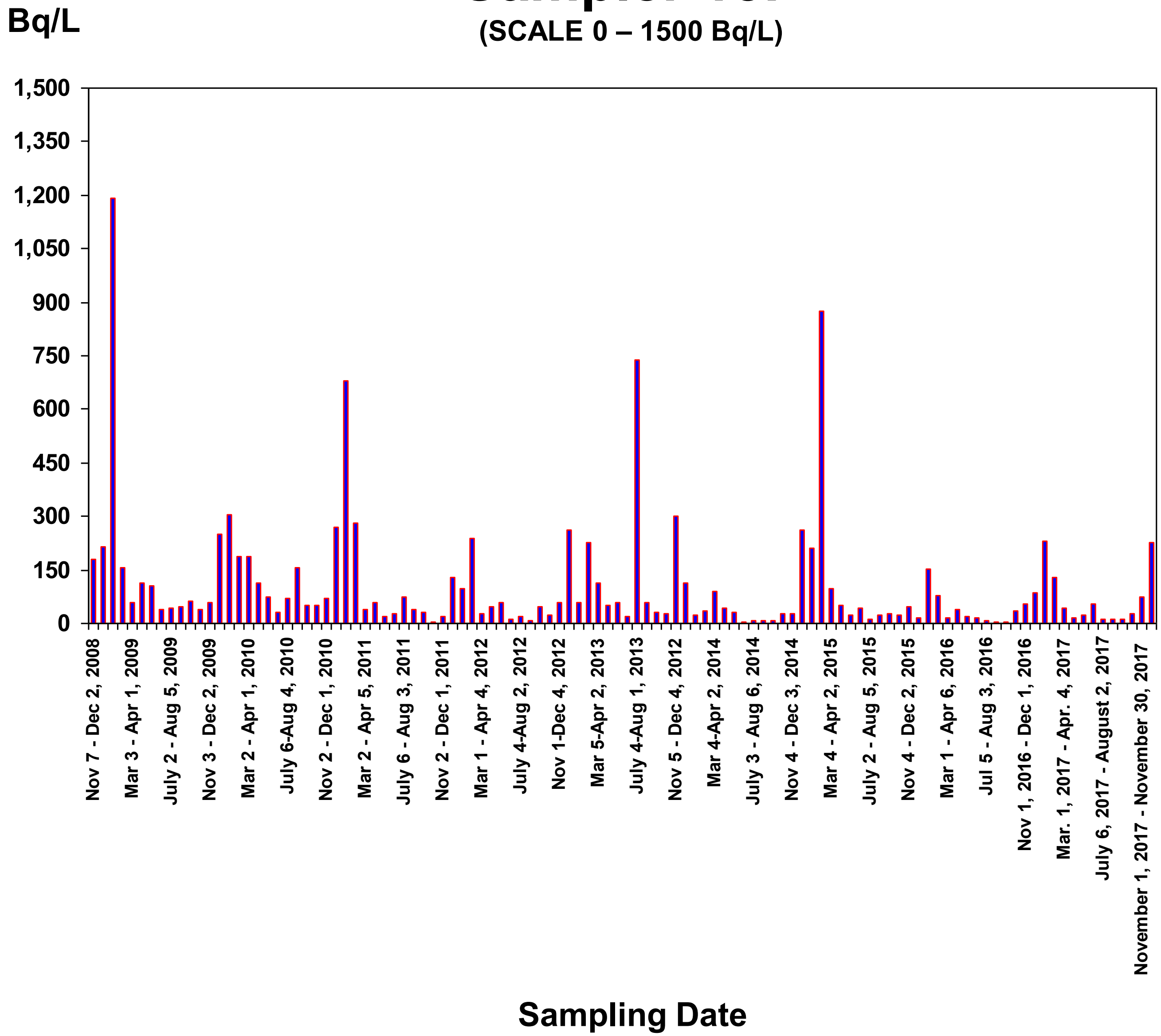
APPENDIX H

PRECIPITATION RESULTS
Sampler 15P

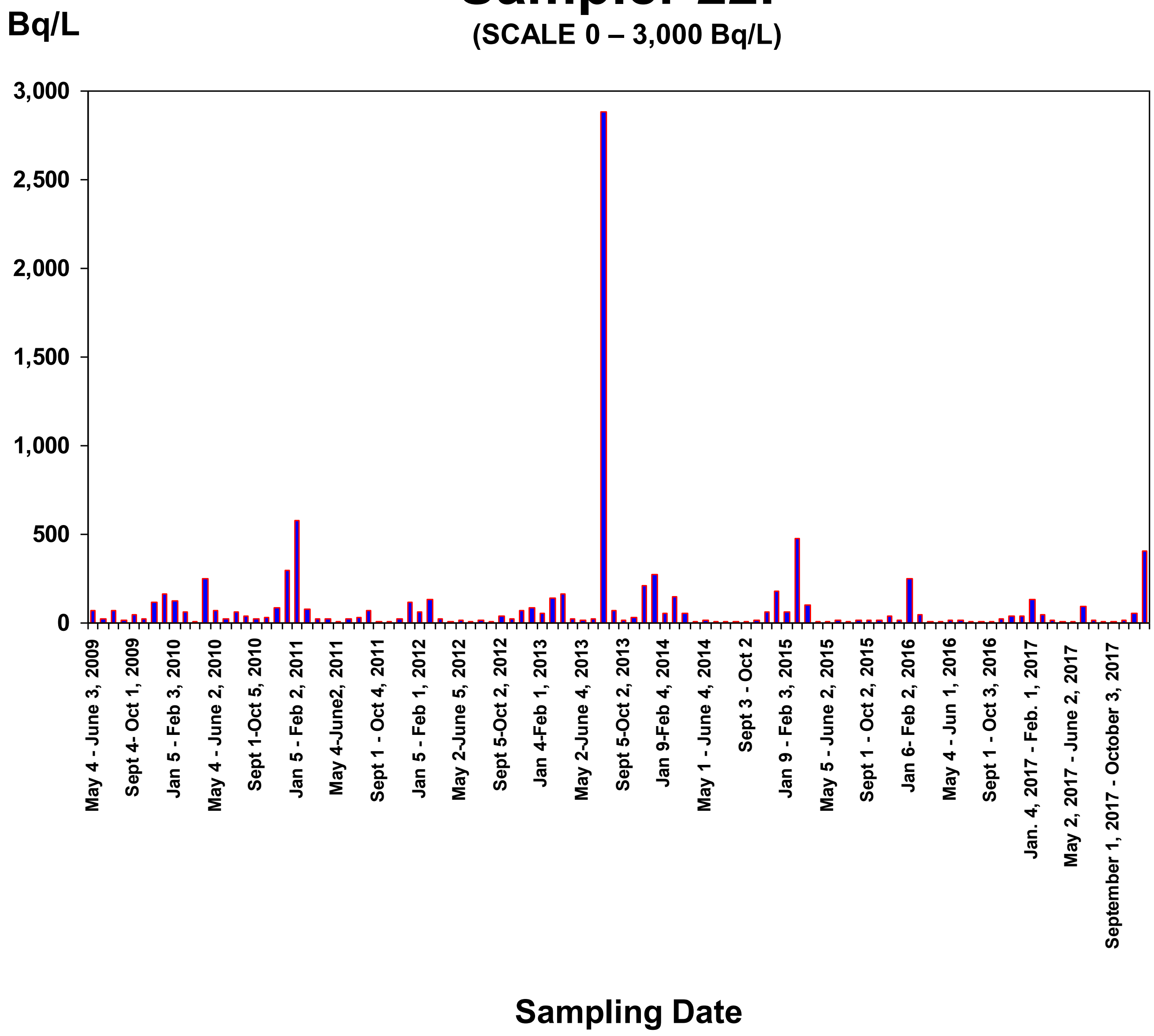


APPENDIX H

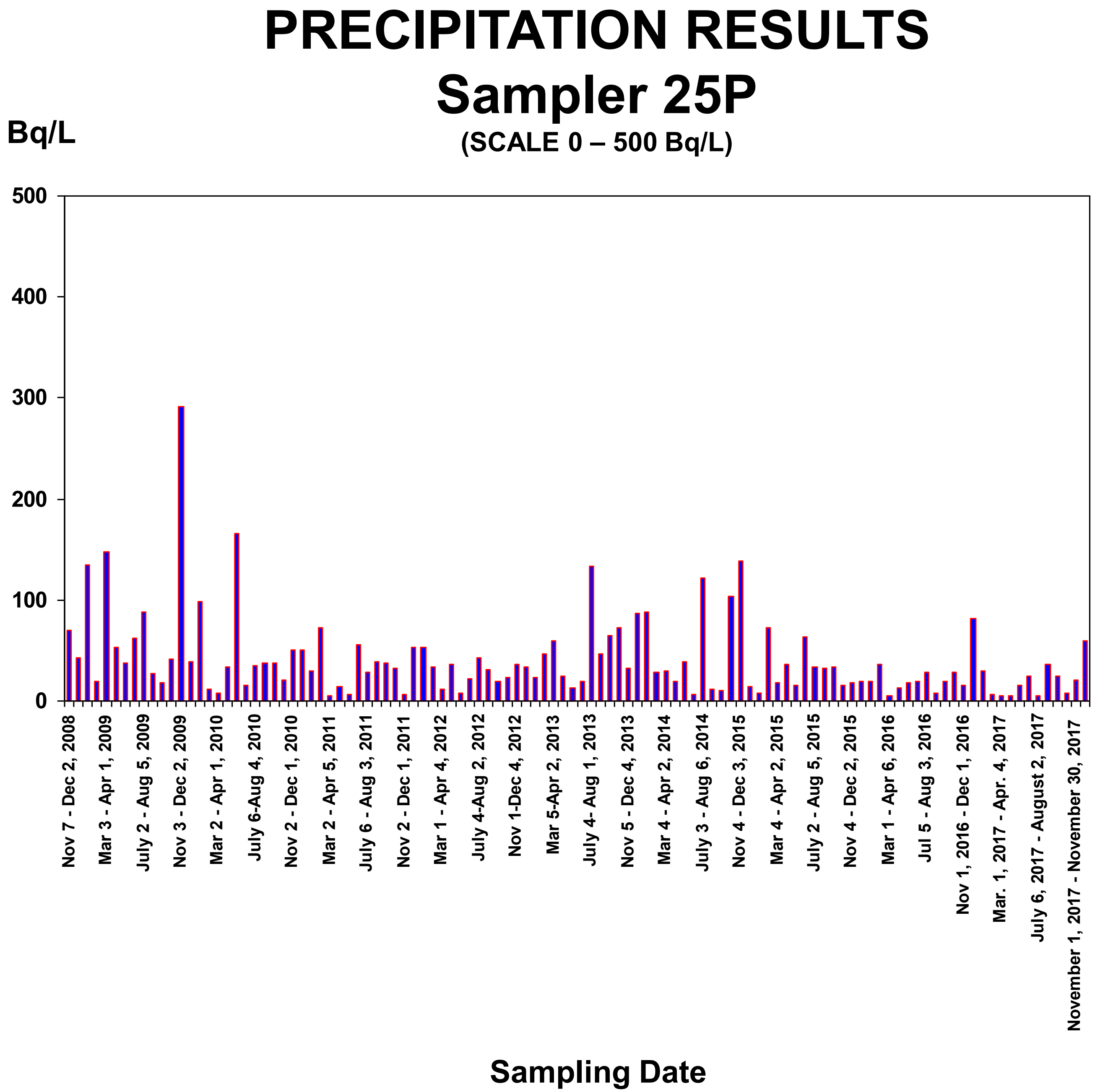
PRECIPITATION RESULTS
Sampler 18P



PRECIPITATION RESULTS
Sampler 22P



APPENDIX H



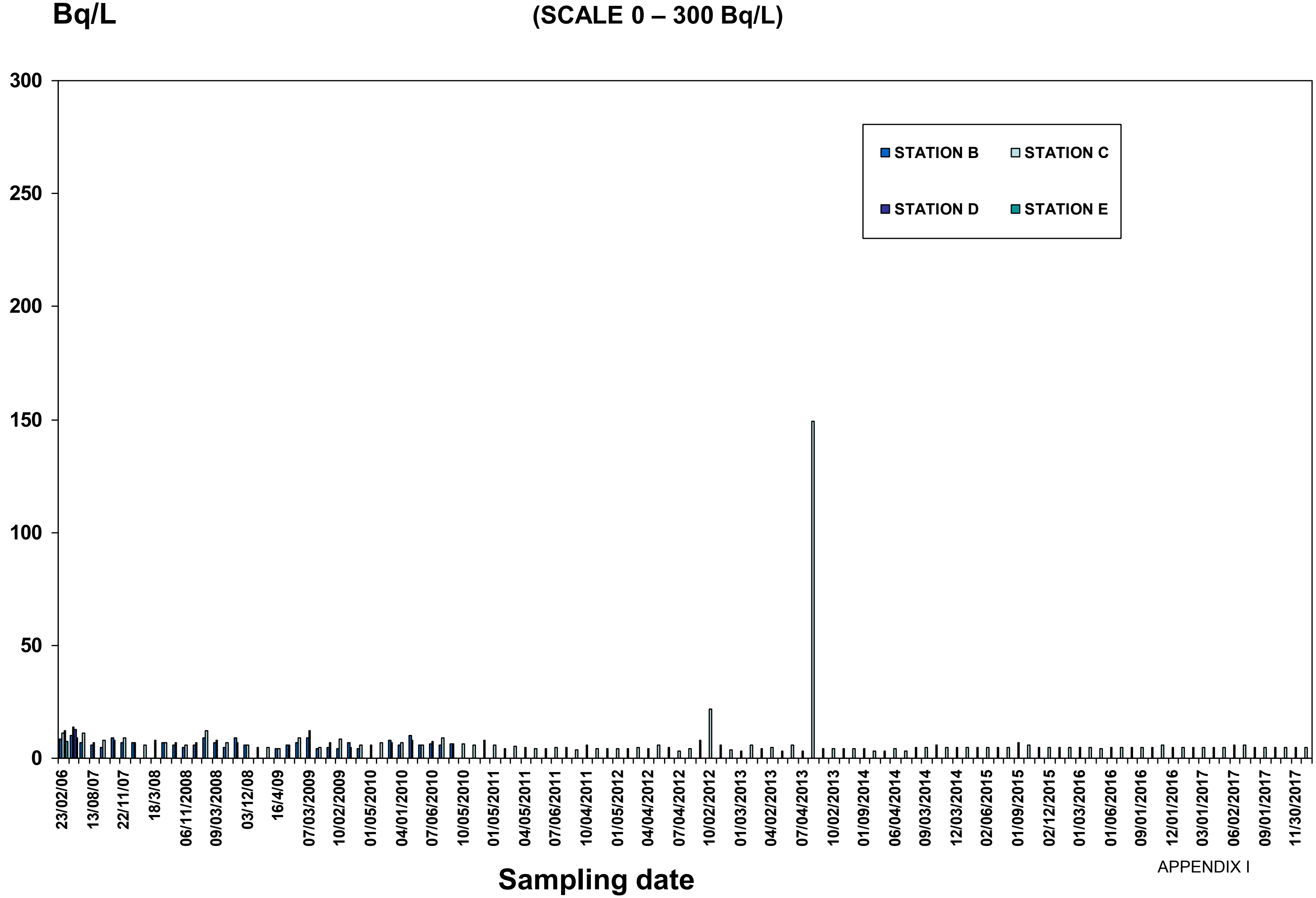
PRECIPITATION RESULTS
Sampler 25P
(SCALE 0 – 500 Bq/L)
Bq/L
500
400
300
200
100
0
Nov 7 - Dec 2, 2008
Mar 3 - Apr 1, 2009
July 2 - Aug 5, 2009
Nov 3 - Dec 2, 2009
Mar 2 - Apr 1, 2010
July 6-Aug 4, 2010
Nov 2 - Dec 1, 2010
Mar 2 - Apr 5, 2011
July 6 - Aug 3, 2011
Nov 2 - Dec 1, 2011
Mar 1 - Apr 4, 2012
July 4-Aug 2, 2012
Nov 1-Dec 4, 2012
Mar 5-Apr 2, 2013
July 4- Aug 1, 2013
Nov 5 - Dec 4, 2013
Mar 4 - Apr 2, 2014
July 3 - Aug 6, 2014
Nov 4 - Dec 3, 2015
Mar 4 - Apr 2, 2015
July 2 - Aug 5, 2015
Nov 4 - Dec 2, 2015
Mar 1 - Apr 6, 2016
Jul 5 - Aug 3, 2016
Nov 1, 2016 - Dec 1, 2016
Mar. 1, 2017 - Apr. 4, 2017
July 6, 2017 - August 2, 2017
November 1, 2017 - November 30, 2017
Sampling Date

APPENDIX H

APPENDIX I

Receiving Waters Monitoring Results for 2017

MONITORING RESULTS
RECEIVING WATERS



APPENDIX I

RECEIVING WATERS MONITORING LOCATIONS

Basemap Source: City of Pembroke (www.pembrokeontario.com)

APPENDIX J

Runoff Monitoring Results for 2017

Facility Runoff Monitoring Results for 2017

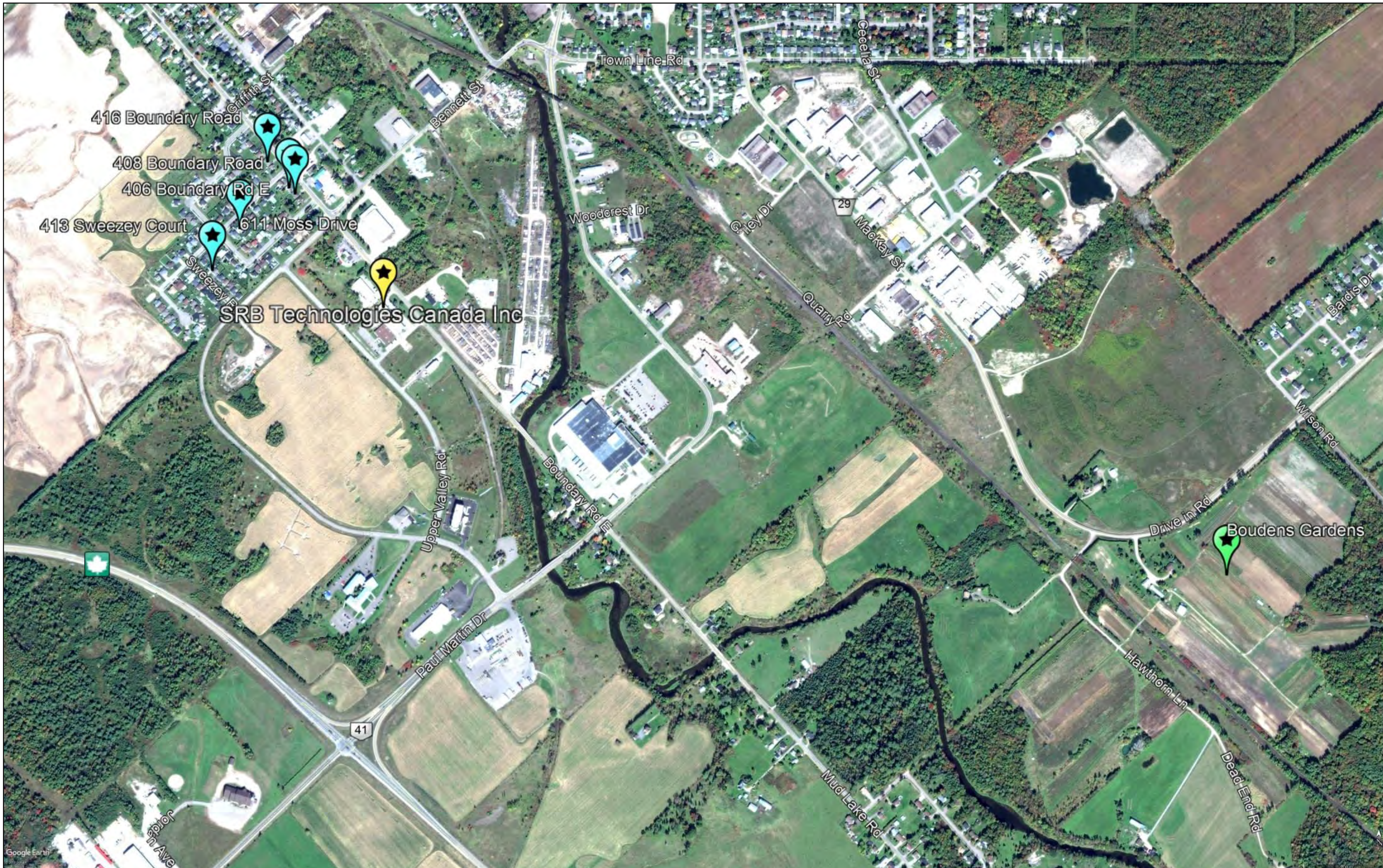
DOWNSPOUTS (Bq/L)								
Date	**Time**	**DS-1**	**DS-2**	**DS-3**	**DS-4**	**DS-5**	**DS-6**	**MDA**
4-Apr-17	5:00 PM	No sample	*49*	*49*	*49*	*49*	50	49
29-May-17	11:00 AM	No sample	*46*	*46*	*46*	*46*	60	46
22-Aug-17	2.15 PM	50	40	380	60	300	1,230	36
30-Oct-17	9:45 AM	No sample	150	290	370	*41*	220	41
Average (Bq/L)		**50**	**71**	**191**	**131**	**109**	**390**	**43**
Average all results		**172 Bq/L**						

*MDA = Minimum Detectable Activity (measurements shaded in are <MDA)

APPENDIX K

Produce Monitoring Results for 2017

Map –Produce Sampling 2017



APPENDIX K

2017 Residential Produce Sampling – Free-water Tritium Concentration

Sample	Units	Result
Tomatoes 408 Boundary Road	Bq/kg Fresh weight	58
Onions 408 Boundary Road	Bq/kg Fresh weight	109
Apples 416 Boundary Road	Bq/kg Fresh weight	12
Apples 413 Sweezey Ct.	Bq/kg Fresh weight	71
Beet Tuber 413 Sweezey Ct.	Bq/kg Fresh weight	28
Onion 413 Sweezey Ct.	Bq/kg Fresh weight	26
Carrots 413 Sweezey Ct.	Bq/kg Fresh weight	24
Tomatoes 611 Moss Dr.	Bq/kg Fresh weight	52
Cucumber 611 Moss Dr.	Bq/kg Fresh weight	32

2017 Residential Produce Sampling – Organically-bound Tritium (OBT) Concentration

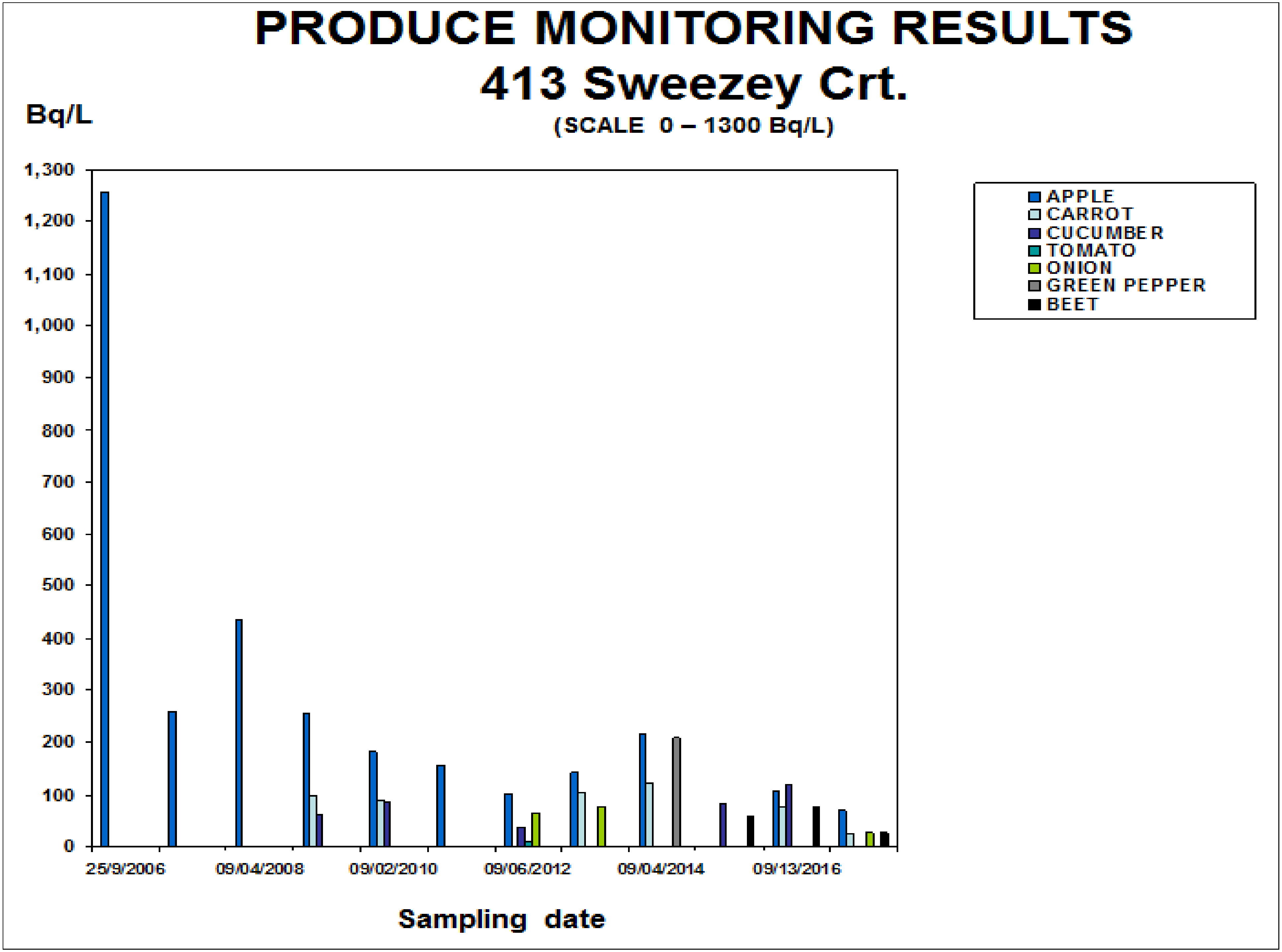
Sample	Units	Result
Tomatoes 408 Boundary Road	Bq/kg Fresh weight	4

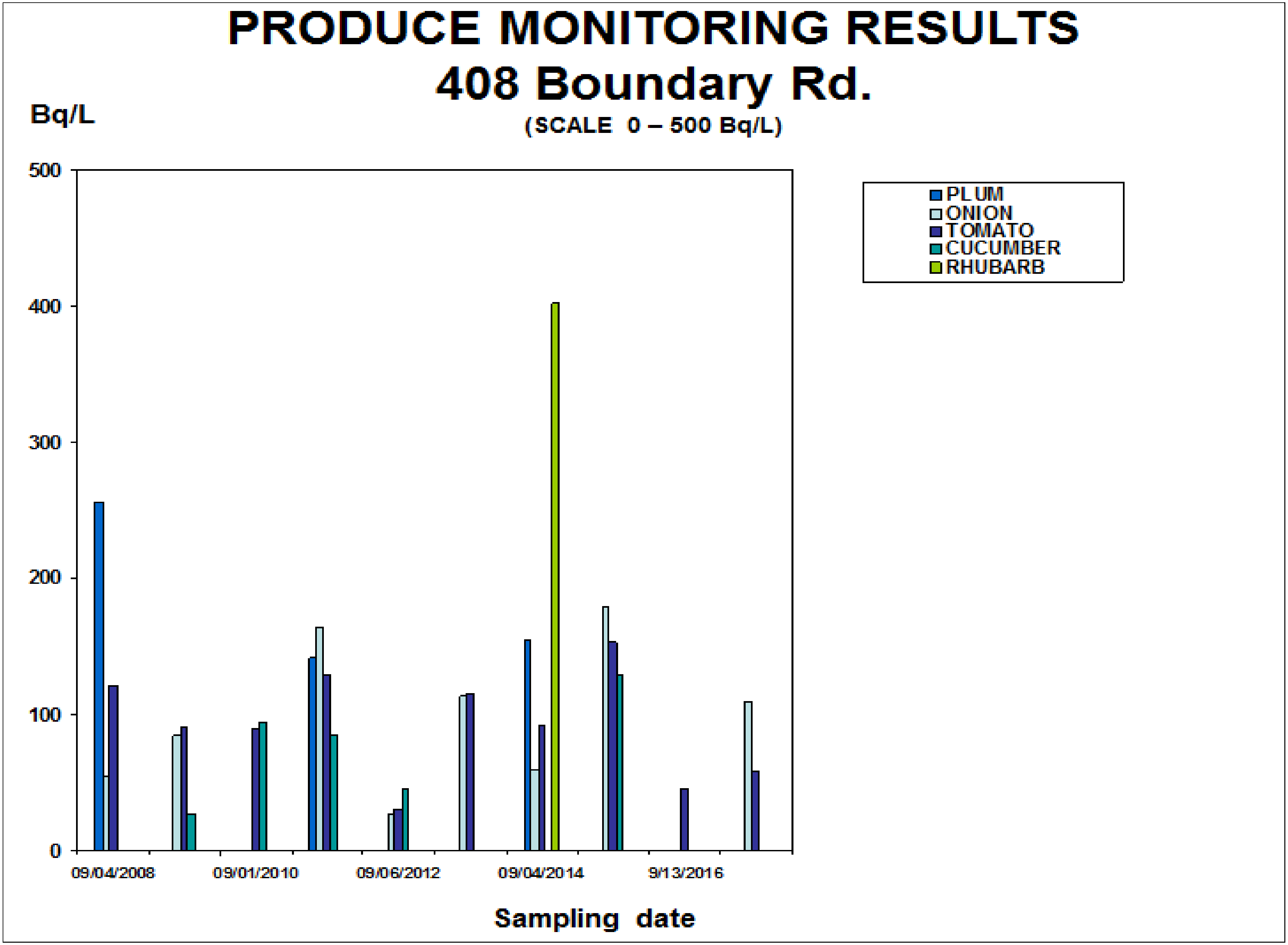
2017 Commercial Produce Sampling – Free-water Tritium Concentration

Sample	Units	Result
Cabbage – Boudens	Bq/kg Fresh weight	8
Eggplant - Boudens	Bq/kg Fresh weight	9
Pepper - Boudens	Bq/kg Fresh weight	9
Onion - Boudens	Bq/kg Fresh weight	5
Tomatoes - Boudens	Bq/kg Fresh weight	8

2017 Commercial Produce Sampling – Organically-bound Tritium (OBT) Concentration

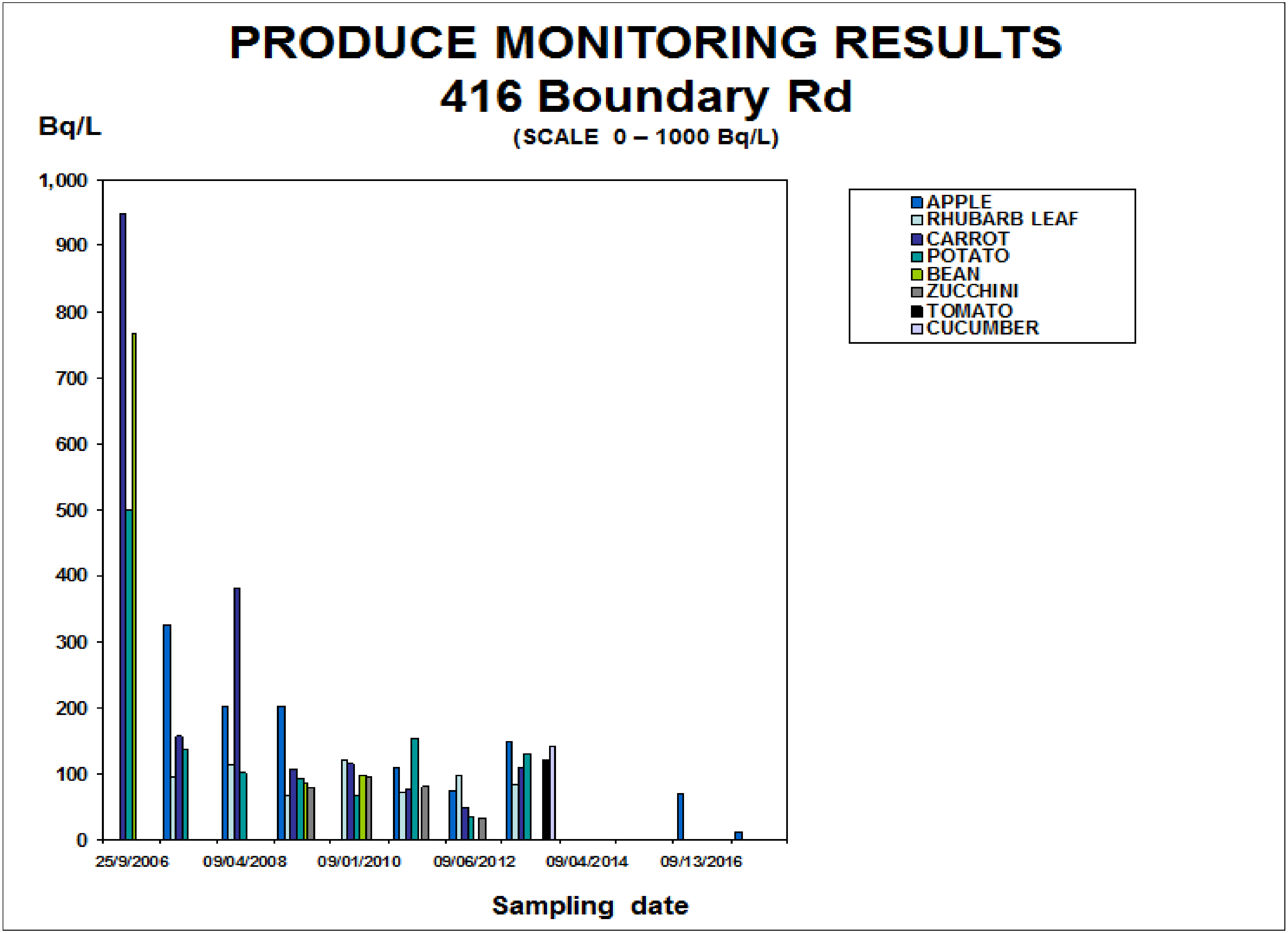
Sample	Units	Result
Tomatoes – Boudens	Bq/kg Fresh weight	3


PRODUCE MONITORING RESULTS
413 Sweezey Crt.
(SCALE 0 – 1300 Bq/L)
Bq/L
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
25/9/2006
09/04/2008
09/02/2010
09/06/2012
09/04/2014
09/13/2016
Sampling date
APPLE
CARROT
CUCUMBER
TOMATO
ONION
GREEN PEPPER
BEET



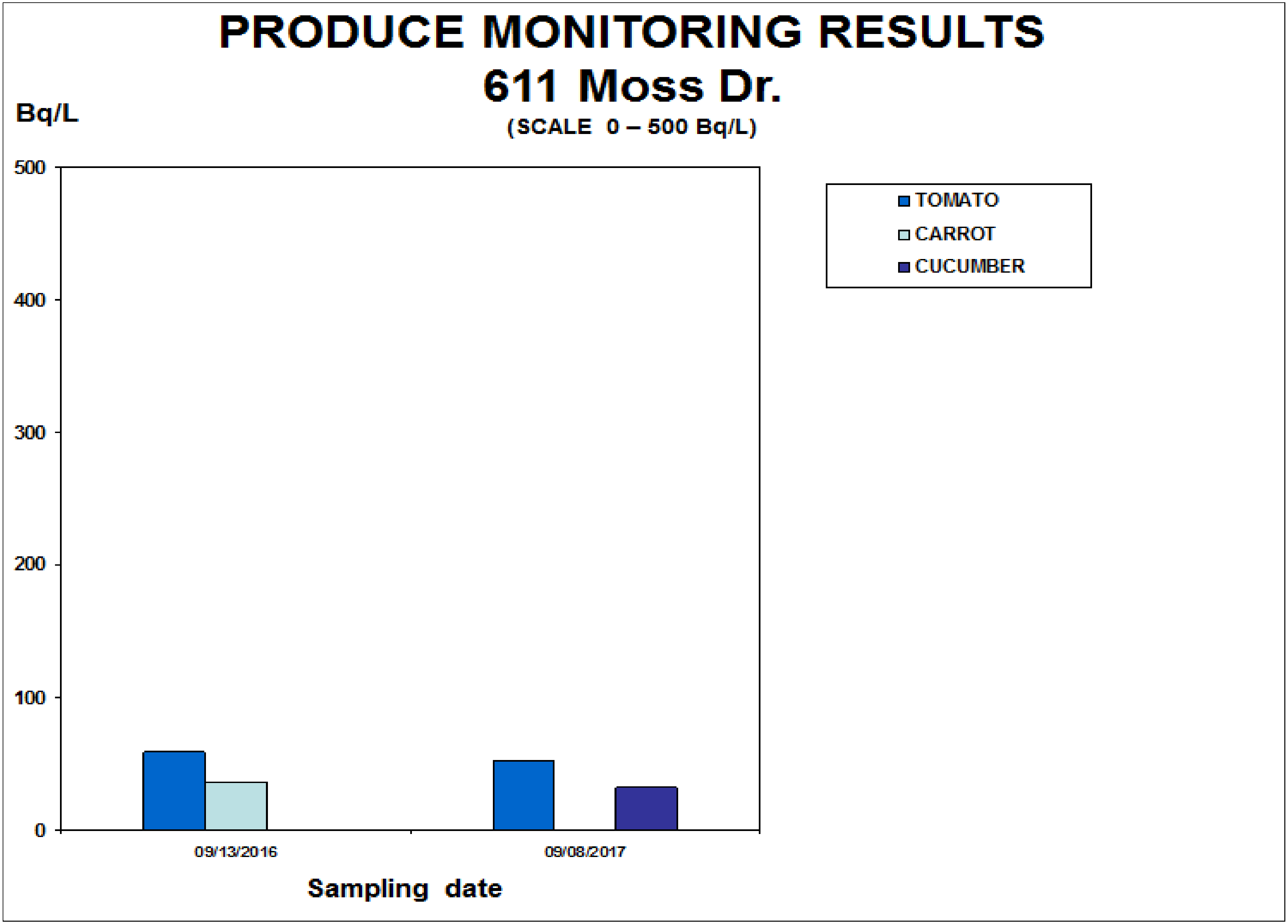
PRODUCE MONITORING RESULTS
408 Boundary Rd.
(SCALE 0 – 500 Bq/L)
Bq/L
500
400
300
200
100
0
09/04/2008
09/01/2010
09/06/2012
09/04/2014
9/13/2016
Sampling date
PLUM
ONION
TOMATO
CUCUMBER
RHUBARB

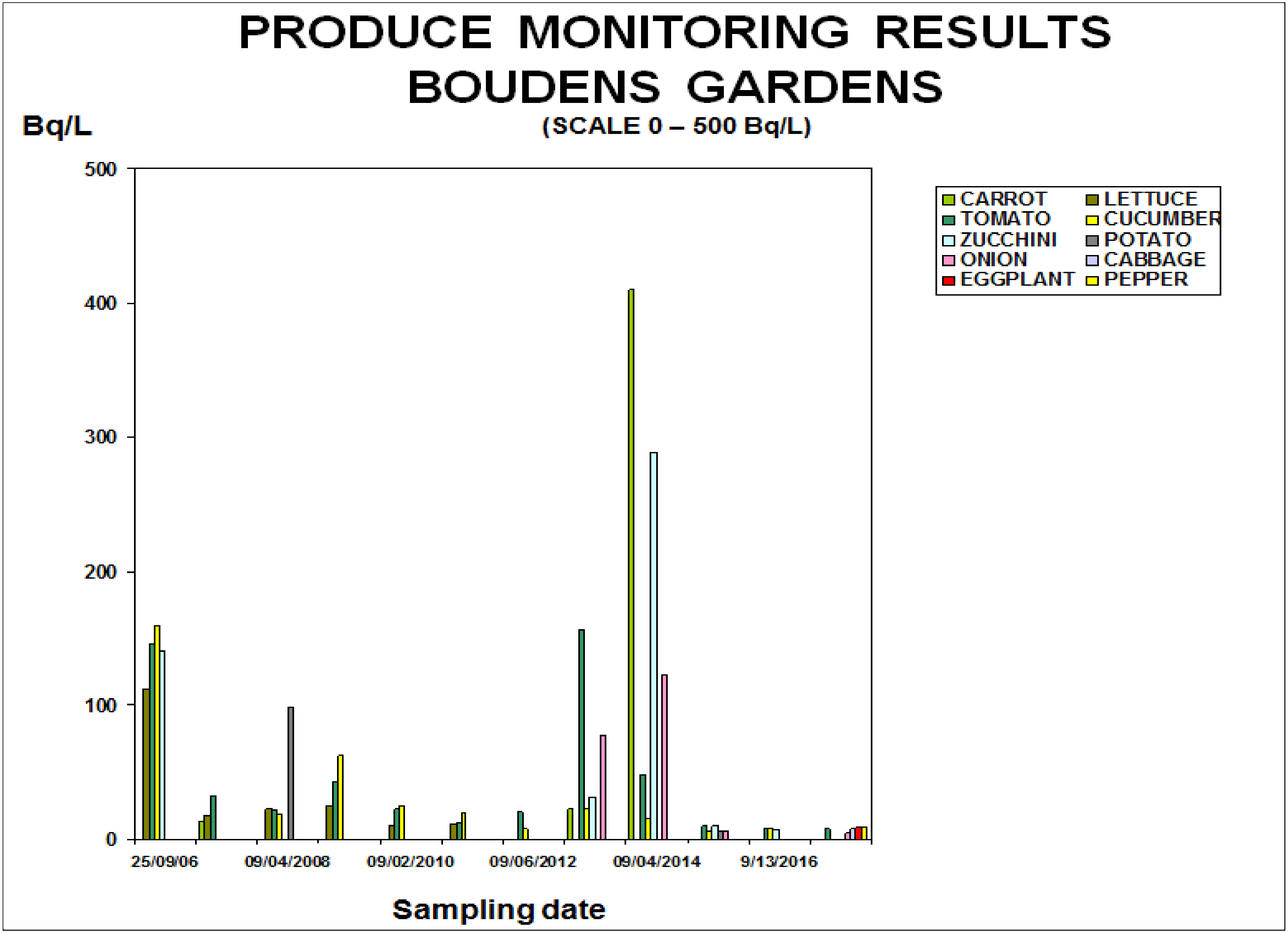
APPENDIX K



PRODUCE MONITORING RESULTS
416 Boundary Rd
Bq/L
(SCALE 0 – 1000 Bq/L)
1,000
900
800
700
600
500
400
300
200
100
0
25/9/2006
09/04/2008
09/01/2010
09/06/2012
09/04/2014
09/13/2016
Sampling date
APPLE
RHUBARB LEAF
CARROT
POTATO
BEAN
ZUCCHINI
TOMATO
CUCUMBER

APPENDIX K


PRODUCE MONITORING RESULTS
611 Moss Dr.
(SCALE 0 – 500 Bq/L)
Bq/L
500
400
300
200
100
0
TOMATO
CARROT
CUCUMBER
09/13/2016
09/08/2017
Sampling date



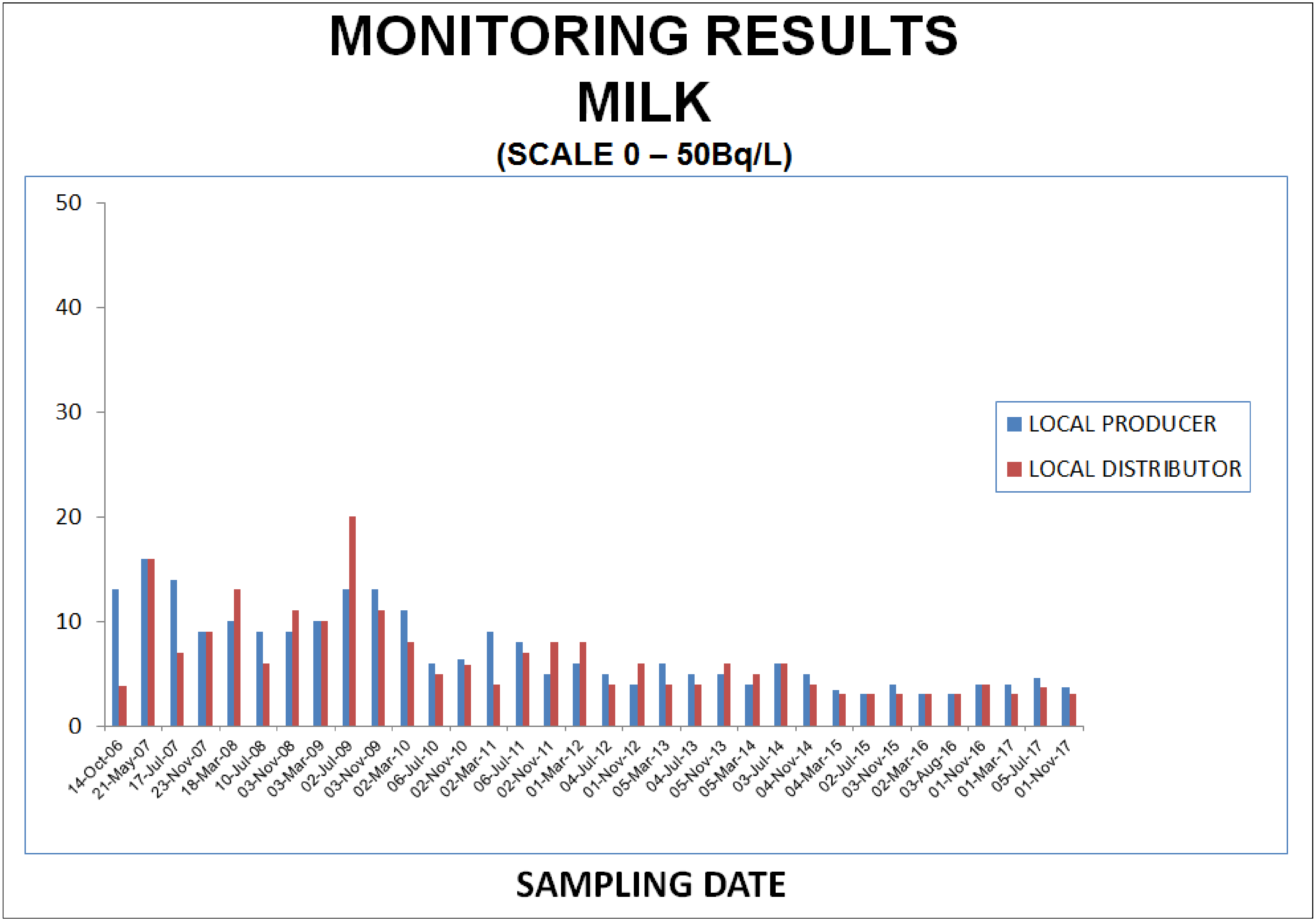
PRODUCE MONITORING RESULTS
BOUDENS GARDENS
(SCALE 0 – 500 Bq/L)
Bq/L
500
400
300
200
100
0
25/09/06
09/04/2008
09/02/2010
09/06/2012
09/04/2014
9/13/2016
Sampling date
CARROT
LETTUCE
TOMATO
CUCUMBER
ZUCCHINI
POTATO
ONION
CABBAGE
EGGPLANT
PEPPER

APPENDIX L

Milk Monitoring Results for 2017

MILK

Results shaded in blue are <MDA (minimum detectable activity)		
	LOCAL MILK PRODUCER	**LOCAL MILK DISTRIBUTOR**
	Bq/L	**Bq/L**
14-Oct-06	13	3.8
21-Mar-07	16	16
17-Jul-07	14	7
23-Nov-07	9	9
18-Mar-08	10	13
10-Jul-08	9	6
03-Nov-08	9	11
03-Mar-09	10	10
02-Jul-09	13	20
03-Nov-09	13	11
02-Mar-10	11	8
06-Jul-10	6	5
02-Nov-10	6.3	5.8
02-Mar-11	9	4
06-Jul-11	8	7
02-Nov-11	5	8
01-Mar-12	6	8
04-Jul-12	5	4
01-Nov-12	4	6
05-Mar-13	6	4
04-Jul-13	5	4
05-Nov-13	5	6
05-Mar-14	4	5
03-Jul-14	6	6
04-Nov-14	5	4
04-Mar-15	3.4	3
02-Jul-15	3	3
03-Nov-15	4	3
02-Mar-16	3	3
03-Aug-16	3	3
01-Nov-16	4	4
01-Mar-17	4	3
05-Jul-17	4.6	3.7
01-Nov-17	3.7	3



MONITORING RESULTS
MILK
(SCALE 0 – 50Bq/L)
50
40
30
20
10
0
LOCAL PRODUCER
LOCAL DISTRIBUTOR
14-Oct-06
21-May-07
17-Jul-07
23-Nov-07
18-Mar-08
10-Jul-08
03-Nov-08
03-Mar-09
02-Jul-09
03-Nov-09
02-Mar-10
06-Jul-10
02-Nov-10
02-Mar-11
06-Jul-11
02-Nov-11
01-Mar-12
04-Jul-12
01-Nov-12
05-Mar-13
04-Jul-13
05-Nov-13
05-Mar-14
03-Jul-14
04-Nov-14
04-Mar-15
02-Jul-15
03-Nov-15
02-Mar-16
03-Aug-16
01-Nov-16
01-Mar-17
05-Jul-17
01-Nov-17
SAMPLING DATE

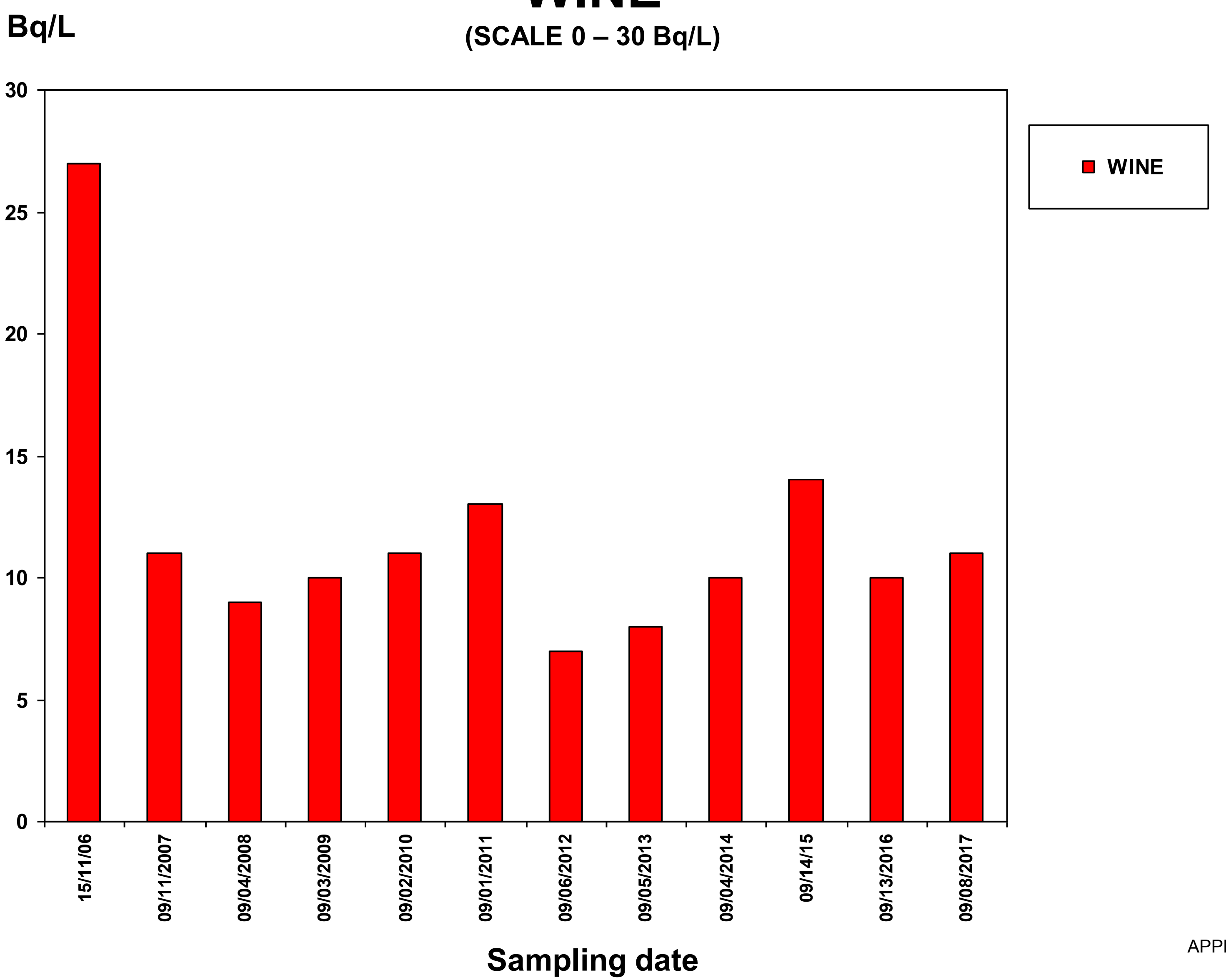
APPENDIX L

APPENDIX M

Wine Monitoring Results for 2017

MONITORING RESULTS
WINE

(SCALE 0 – 30 Bq/L)



APPENDIX M

APPENDIX N

Weather Data for 2017

WEATHER DATA SUMMARY

Month	Precip Counts, # (TOTAL)	Wind Speed, m/s (AVG)	Gust Speed, m/s (AVG)	Wind Direction, ø (AVG)	Temp, °C (AVG)	RH, % (AVG)	DewPt, °C (AVG)	Wind sector (nesw)	Total rain (mm)
June-2009	434	2.1	3.1	193.5	17.8	72.3	12.1	SSW	86.8
July-2009	429	2.4	3.6	187.9	18.4	77.6	14.1	SSW	85.8
August-2009	351	2.3	3.4	216.5	18.7	76.8	14.2	SW	70.2
September-2009	274	2.4	3.6	204.3	13.2	79.5	9.4	SSW	54.8
October-2009	311	2.7	3.9	184.4	5.9	80.4	2.6	SSW	62.2
November-2009	223	2.4	3.4	181.2	3.1	84.1	0.5	SSW	44.6
December-2009	205	3.1	4.3	212.7	-8.0	84.2	-10.2	SW	41
January-2010	130	2.9	4.1	207.5	-8.0	82.8	-10.5	SSW	26
February-2010	98	3.8	5.4	263.3	-4.8	78.7	-8.0	WSW	19.6
March-2010	66	2.6	3.8	207.5	3.2	55.3	-5.7	SSW	13.20
April-2010	241	3.3	4.9	225.2	9.8	59.6	1.1	SW	48.20
May-2010	143	2.8	4.1	209.7	15.2	62.1	7.0	SSW	28.6
June-2010	541	2.5	3.8	223.2	18.1	71.9	12.4	SW	108.2
July-2010	456	2.2	3.4	205.3	21.6	74.6	16.4	SSW	91.20
August-2010	212	2.3	3.5	182.9	19.8	74.6	14.6	SSW	42.4
September-2010	582	2.7	4.0	215.3	12.9	83.0	9.9	SW	116.4
October-2010	336	3.1	4.6	229.6	6.5	76.6	2.3	SW	67.2
November-2010	488	2.8	4.0	181.9	1.4	80.3	-1.8	SSW	97.6
December-2010	42	2.8	4.3	236.2	-6.1	83.6	-8.5	SW	8.4
January-2011	36	2.3	3.4	219.0	-13.6	80.6	-16.2	SW	7.2
February-2011	64	3.0	4.4	210.5	-7.9	72.0	-12.3	SSW	12.8
March-2011	243	2.9	4.3	221.8	-2.2	68.6	-7.8	SW	48.6
April-2011	625	3.1	4.7	198.5	6.0	66.9	-0.6	SSW	125
May-2011	313	2.8	4.3	172.7	14.5	70.0	8.3	SSE	62.6
June-2011	499	2.2	3.5	209.2	19.2	71.6	13.2	SSW	99.8
July-2011	508	2.2	3.3	214.0	21.3	73.5	15.8	SW	101.6
August-2011	297	2.2	3.3	205.7	19.4	75.6	14.7	SSW	59.4
September-2011	345	2.3	3.5	207.6	14.9	79.6	11.1	SSW	69
October-2011	263	2.5	3.8	195.4	8.9	76.2	4.6	SSW	52.6
November-2011	334	2.7	4.0	191.1	3.8	76.2	-0.3	SSW	66.8
December-2011	135	2.9	4.1	194.4	-3.9	84.1	-6.3	SSW	27
January-2012	79	3.1	4.4	174.9	-8.8	82.7	-11.3	SSE	15.8
February-2012	42	2.6	3.8	237.0	-5.2	76.1	-8.9	SW	8.4
March-2012	143	3.0	4.5	184.5	3.0	73.1	-1.9	SSW	28.6
April-2012	253	3.8	5.7	231.2	6.1	64.1	-1.1	SW	50.6
May-2012	283	2.8	4.1	193.1	15.4	65.6	8.0	SSW	56.6
June-2012	151	2.7	4.2	202.5	20.5	68.0	13.7	SSW	30.2
July-2012	83	2.2	3.4	203.1	22.0	61.0	13.2	SSW	16.6
August-2012	376	2.3	3.6	184.4	19.8	75.1	14.8	SSW	75.2
September-2012	288	2.6	3.8	172.0	13.1	77.7	8.9	SSE	57.6
October-2012	698	3.0	4.5	154.9	8.2	82.7	5.2	SSE	139.6
November-2012	107	2.6	3.8	149.0	-0.3	79.5	-3.5	SE	21.4
December-2012	227	2.6	3.8	175.9	-7.4	86.7	-9.3	SSE	45.4
January-2013	238	2.9	4.1	158.5	-9.4	81.0	-12.1	SSE	47.6
February-2013	120	3.1	4.4	172.1	-7.9	80.6	-10.7	SSE	24
March-2013	56	3.1	4.4	184.9	-0.8	68.3	-6.3	SSW	11.2
April-2013	393	3.4	5.0	180.6	5.5	67.4	-0.7	S	78.6
May-2013	444	2.9	4.4	157.7	13.7	65.6	6.3	SSE	88.8
June-2013	575	2.0	3.1	143.9	17.0	76.4	12.4	SE	115
July-2013	616	2.0	3.2	204.9	20.8	75.0	15.8	SSW	123.2
August-2013	189	2.0	3.2	194.8	18.6	75.7	13.8	SSW	37.8
September-2013	329	2.2	3.4	179.3	13.5	79.1	9.6	SSE	65.8
October-2013	485	2.5	3.8	185.7	7.6	78.9	3.9	SSW	97
November-2013	181	3.5	5.2	165.6	-1.7	81.0	-4.6	SSE	36.2
December-2013	54	2.6	3.8	157.6	-12.6	80.8	-15.3	SSE	10.8
January-2014	126	3.1	4.4	179.9	-10.2	77.5	-13.5	SSE	25.2
February-2014	36	3.0	4.4	163.4	-10.6	70.1	-15.2	SSE	7.2
March-2014	63	3.3	4.8	146.1	-5.4	66.6	-10.9	SE	12.6
April-2014	469	3.3	4.9	145.9	4.9	68.9	-1.1	SE	93.8
May-2014	327	2.6	4.0	193.1	14.3	67.1	7.5	SSW	65.4
June-2014	675	2.3	3.6	209.9	19.1	71.3	13.1	SSW	135
July-2014	609	2.1	3.3	251.3	18.8	75.4	14.0	WSW	121.8
August-2014	417	2.3	3.4	232.0	18.3	81.2	14.6	SW	83.4
September-2014	371	2.2	3.4	185.8	13.8	82.6	10.6	SSW	74.2
October-2014	477	2.8	4.3	164.5	8.4	82.8	5.5	SSE	95.4
November-2014	123	3.0	4.7	212.7	-1.2	79.6	-4.3	SW	24.6
December-2014	178	2.7	4.2	209.5	-7.4	82.0	-10.0	SSW	35.6
January-2015	19	2.6	3.8	228.1	-14.2	75.4	-17.7	SW	3.8
February-2015	20	2.8	4.1	220.5	-15.2	70.9	-19.6	SW	4.0
March-2015	88	2.7	4.2	204.2	-3.7	64.7	-9.9	SSW	17.6
April-2015	179	3.2	5.0	227.1	7.3	61.4	-0.7	SW	35.8
May-2015	453	2.8	4.4	199.4	15.1	66.4	7.9	SSW	90.6
June-2015	549	2.4	3.7	212.6	17.4	73.7	12.1	SW	109.8
July-2015	313	2.1	3.3	163.9	20.6	74.6	15.4	SSE	62.6
August-2015	357	1.9	3.0	146.0	19.3	80.6	15.6	SE	71.4
September-2015	163	2.1	3.3	203.5	16.8	77.5	12.5	SSW	32.6
October-2015	372	2.8	4.3	188.5	7.0	78.2	3.2	SSW	74.4
November-2015	197	2.6	3.9	160.6	3.0	82.7	0.2	SSE	39.4
December-2015	240	2.8	4.2	177.4	-0.8	84.3	-3.2	SSE	48
January-2016	151	3.1	4.4	166.1	-7.5	83.6	-9.9	SSE	30.2
February-2016	122	2.7	4.1	171.8	-9.7	77.7	-13.0	SSE	24.4
July-2016	401	1.9	3.2	254.8	21.3	72.5	15.7	WSW	80.2
August-2016	576	2.1	3.4	268.3	21.2	74.9	16.1	WSW	115.2
September-2016	331	1.8	2.9	230.0	15.8	79.7	12.0	SW	66.2
October-2016	140	2.9	4.4	214.9	7.9	80.1	4.4	SW	28
November-2016	330	2.7	4.1	192.2	3.0	84.5	0.4	SSW	66
December-2016	165	2.9	4.2	184.2	-5.8	83.1	-8.2	SSW	33
January-2017	113	3.0	4.4	187.5	-5.8	82.0	-8.4	SSW	22.6
February-2017	246	2.8	4.1	160.3	-5.2	79.4	-8.4	SSE	49.2
March-2017	209	2.9	4.4	227.5	-4.7	67.0	-10.3	SW	41.8
April-2017	857	2.6	4.1	179.4	6.8	75.1	2.1	SSE	171.4
May-2017	552	2.6	4.2	202.9	11.9	74.4	6.9	SSW	110.4
June-2017	1041	2.2	3.5	249.5	18.2	75.0	13.1	WSW	208.2
July-2017	712	1.7	2.8	221.6	20.0	76.0	15.2	SW	142.4
August-2017	433	2.0	3.3	241.1	17.5	79.3	13.6	WSW	86.6
September-2017	284	1.4	2.3	227.9	16.2	81.5	12.7	SW	56.8
October-2017	534	2.5	4.0	210.1	11.0	79.4	7.3	SSW	106.8
November-2017	286	3.2	4.6	162.8	-0.4	79.4	-3.7	SSE	57.2
December-2017	79	2.8	4.1	135.1	-10.9	79.2	-13.8	SE	15.8

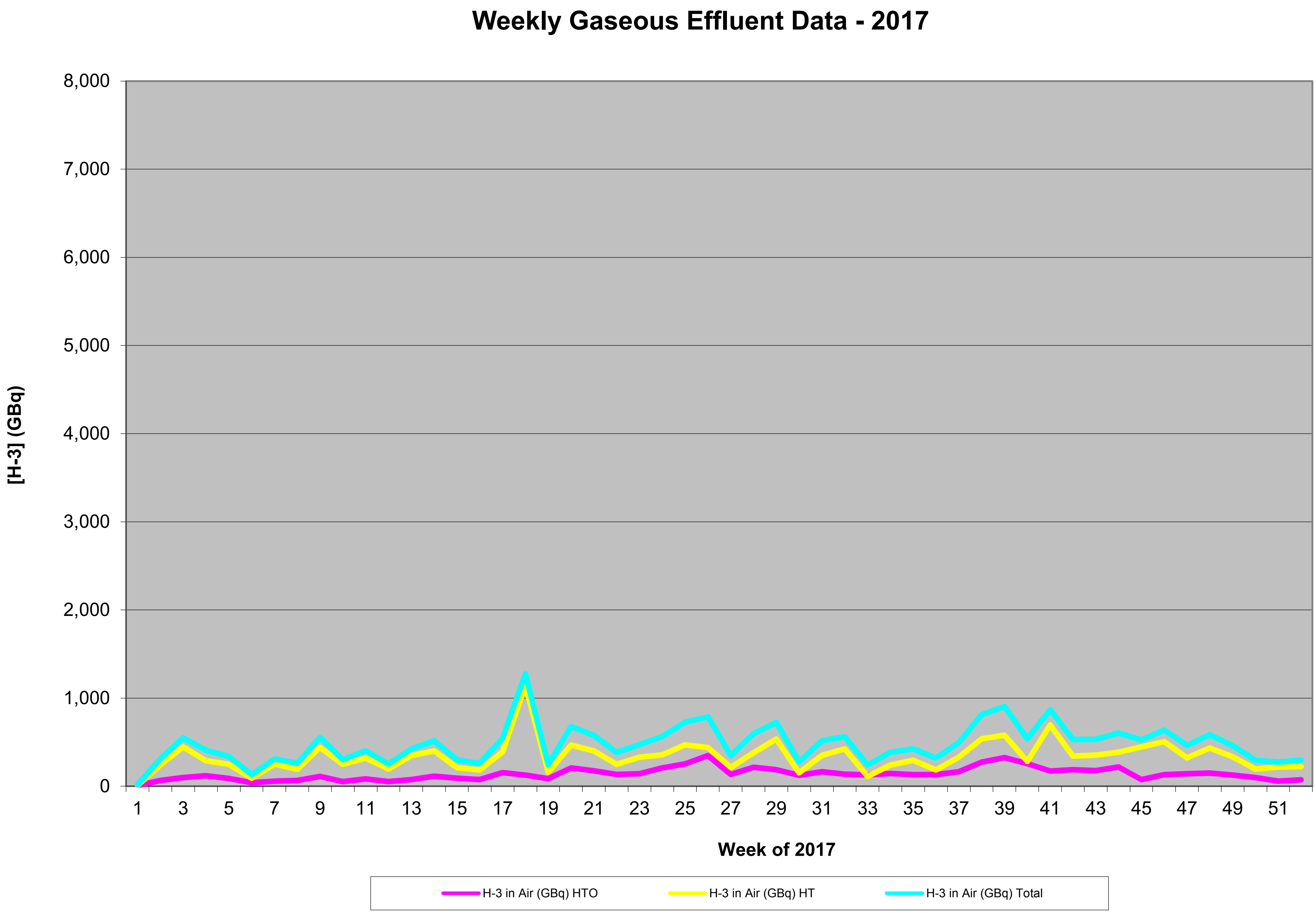
APPENDIX O

Gaseous Effluent Data for 2017

2017 Gaseous Effluent Data

Week	Date		H-3 in Air (GBq)			(GBq)		% 2016 SRBT DRL (12 hr. TJF Data)				Weekly Action Levels	
	Initial	Final	HTO	HT	Total	∑(HTO)	∑(HTO + HT)	1 year old	10 year old	Adult Resident	Adult Worker	HTO (840 GBq)	HTO+HT (7,753 GBq)
1	27/12/2016	03/01/2017	10.09	9.64	19.73	10.09	19.73	0.00	0.01	0.01	0.01	1%	0%
2	03/01/2017	10/01/2017	67.07	244.54	311.61	77.16	331.34	0.03	0.04	0.04	0.05	8%	4%
3	10/01/2017	17/01/2017	99.40	447.99	547.39	176.56	878.73	0.05	0.06	0.06	0.07	12%	7%
4	17/01/2017	24/01/2017	119.83	289.52	409.35	296.39	1288.08	0.06	0.07	0.06	0.08	14%	5%
5	24/01/2017	31/01/2017	88.41	248.29	336.70	384.80	1624.78	0.04	0.05	0.05	0.06	11%	4%
6	31/01/2017	07/02/2017	39.51	91.96	131.47	424.31	1756.25	0.02	0.02	0.02	0.03	5%	2%
7	07/02/2017	14/02/2017	57.92	252.60	310.52	482.23	2066.77	0.03	0.04	0.03	0.04	7%	4%
8	14/02/2017	21/02/2017	67.14	194.00	261.14	549.37	2327.91	0.03	0.04	0.04	0.04	8%	3%
9	21/02/2017	28/02/2017	111.18	442.69	553.87	660.55	2881.78	0.06	0.07	0.06	0.08	13%	7%
10	28/02/2017	07/03/2017	53.97	248.94	302.91	714.52	3184.69	0.03	0.03	0.03	0.04	6%	4%
11	07/03/2017	14/03/2017	84.02	320.71	404.73	798.54	3589.42	0.04	0.05	0.05	0.06	10%	5%
12	14/03/2017	21/03/2017	54.16	196.52	250.68	852.70	3840.10	0.03	0.03	0.03	0.04	6%	3%
13	21/03/2017	28/03/2017	75.19	348.74	423.93	927.89	4264.03	0.04	0.05	0.04	0.05	9%	5%
14	28/03/2017	04/04/2017	115.14	400.58	515.72	1043.03	4779.75	0.06	0.07	0.06	0.08	14%	7%
15	04/04/2017	04/11/2017	90.09	210.18	300.27	1133.12	5080.02	0.04	0.05	0.05	0.06	11%	4%
16	04/11/2017	04/18/2017	75.78	184.33	260.11	1208.90	5340.13	0.04	0.04	0.04	0.05	9%	3%
17	04/18/2017	04/25/2017	155.54	389.07	544.61	1364.44	5884.74	0.08	0.09	0.08	0.10	19%	7%
18	04/25/2017	05/02/2017	127.63	1147.84	1275.47	1492.07	7160.21	0.08	0.09	0.08	0.10	15%	16%
19	05/02/2017	05/09/2017	85.23	158.88	244.11	1577.30	7404.32	0.04	0.05	0.04	0.06	10%	3%
20	05/09/2017	05/16/2017	208.96	468.47	677.43	1786.26	8081.75	0.10	0.12	0.11	0.14	25%	9%
21	05/16/2017	05/23/2017	175.01	402.26	577.27	1961.27	8659.02	0.08	0.10	0.09	0.11	21%	7%
22	05/23/2017	05/30/2017	135.67	249.04	384.71	2096.94	9043.73	0.06	0.08	0.07	0.09	16%	5%
23	05/30/2017	06/06/2017	143.21	329.23	472.44	2240.15	9516.17	0.07	0.08	0.07	0.09	17%	6%
24	06/06/2017	06/13/2017	207.62	356.80	564.42	2447.77	10080.59	0.10	0.12	0.11	0.13	25%	7%
25	06/13/2017	06/20/2017	254.70	471.01	725.71	2702.47	10806.30	0.12	0.14	0.13	0.16	30%	9%
26	06/20/2017	06/27/2017	349.02	438.91	787.93	3051.49	11594.23	0.16	0.19	0.18	0.22	42%	10%
27	06/27/2017	07/04/2017	134.45	213.82	348.27	3185.94	11942.50	0.06	0.08	0.07	0.09	16%	4%
28	07/04/2017	07/11/2017	215.71	382.20	597.91	3401.65	12540.41	0.10	0.12	0.11	0.14	26%	8%
29	07/11/2017	07/18/2017	188.86	535.18	724.04	3590.51	13264.45	0.09	0.11	0.10	0.13	22%	9%
30	07/18/2017	07/25/2017	125.08	152.95	278.03	3715.59	13542.48	0.06	0.07	0.06	0.08	15%	4%
31	07/25/2017	08/01/2017	166.22	350.41	516.63	3881.81	14059.11	0.08	0.09	0.09	0.11	20%	7%
32	08/01/2017	08/08/2017	136.62	424.91	561.53	4018.43	14620.64	0.07	0.08	0.07	0.09	16%	7%
33	08/08/2017	08/15/2017	130.28	112.04	242.32	4148.71	14862.96	0.06	0.07	0.06	0.08	16%	3%
34	08/15/2017	22/08/2017	145.69	241.39	387.08	4294.40	15250.04	0.07	0.08	0.07	0.09	17%	5%
35	22/08/2017	29/08/2017	131.53	293.64	425.17	4425.93	15675.21	0.06	0.08	0.07	0.09	16%	5%
36	29/08/2017	05/09/2017	132.84	186.60	319.44	4558.77	15994.65	0.06	0.07	0.07	0.08	16%	4%
37	05/09/2017	12/09/2017	165.15	330.55	495.70	4723.92	16490.35	0.08	0.09	0.09	0.11	20%	6%
38	12/09/2017	19/09/2017	273.67	538.62	812.29	4997.59	17302.64	0.13	0.16	0.14	0.18	33%	10%
39	19/09/2017	26/09/2017	324.97	580.37	905.34	5322.56	18207.98	0.15	0.18	0.17	0.21	39%	12%
40	26/09/2017	03/10/2017	256.28	281.25	537.53	5578.84	18745.51	0.12	0.14	0.13	0.16	31%	7%
41	03/10/2017	10/10/2017	172.43	696.50	868.93	5751.27	19614.44	0.09	0.10	0.10	0.12	21%	11%
42	10/10/2017	17/10/2017	188.40	342.21	530.61	5939.67	20145.05	0.09	0.11	0.10	0.12	22%	7%
43	17/10/2017	24/10/2017	178.80	352.81	531.61	6118.47	20676.66	0.09	0.10	0.09	0.12	21%	7%
44	24/10/2017	31/10/2017	218.51	386.00	604.51	6336.98	21281.17	0.10	0.12	0.11	0.14	26%	8%
45	31/10/2017	07/11/2017	77.11	448.00	525.11	6414.09	21806.28	0.04	0.05	0.05	0.06	9%	7%
46	07/11/2017	14/11/2017	132.27	504.58	636.85	6546.36	22443.13	0.07	0.08	0.07	0.09	16%	8%
47	14/11/2017	21/11/2017	141.94	321.64	463.58	6688.30	22906.71	0.07	0.08	0.07	0.09	17%	6%
48	21/11/2017	28/11/2017	150.75	434.49	585.24	6839.05	23491.95	0.07	0.09	0.08	0.10	18%	8%
49	28/11/2017	05/12/2017	127.97	334.91	462.88	6967.02	23954.83	0.06	0.07	0.07	0.08	15%	6%
50	05/12/2017	12/12/2017	99.21	195.44	294.65	7066.23	24249.48	0.05	0.06	0.05	0.06	12%	4%
51	12/12/2017	19/12/2017	57.15	217.22	274.37	7123.38	24523.85	0.03	0.03	0.03	0.04	7%	4%
52	19/12/2017	26/12/2017	74.64	223.64	298.28	7198.02	24822.13	0.04	0.04	0.04	0.05	9%	4%
	Annual Total		7198.02	17624.11	24822.13			Average % DRL					
	Weekly Average		138.42	338.93	477.35			0.07	0.08	0.07	0.09		
				(Bq/a)	% Limit			Projected Dose (uSv/a)					
% Annual Release Limit:			HTO	6.72E+13	10.71			0.67	0.80	0.73	0.91		
			HTO + HT	4.48E+14	5.54			1 year old	10 year old	Adult Resident	Adult Worker		
Derived Weekly HTO Release/Emission Limit (GBq/week)								2.24E+05	1.88E+05	2.08E+05	1.63E+05		
Derived Weekly HT Release/ Emission Limit (GBq/week)								6.32E+06	5.61E+06	5.54E+06	5.69E+06		

APPENDIX O


Weekly Gaseous Effluent Data - 2017
[H-3] (GBq)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
49
51
Week of 2017
H-3 in Air (GBq) HTO
H-3 in Air (GBq) HT
H-3 in Air (GBq) Total

APPENDIX P

Liquid Effluent Data for 2017

ANNUAL LIQUID EFFLUENT TRACKING TABLE			
Year = 2017			
WEEK ENDING	WEEKLY RELEASE (Bq)	WEEK	ANNUAL LICENCE LIMIT
			200,000,000,000
8-Jan-17	451,667	1	199,999,548,333
15-Jan-17	2,497,193	2	199,997,051,140
22-Jan-17	0	3	199,997,051,140
29-Jan-17	0	4	199,997,051,140
5-Feb-17	2,531,500	5	199,994,519,640
12-Feb-17	354,667	6	199,994,164,973
19-Feb-17	192,090,480	7	199,802,074,493
26-Feb-17	91,439,933	8	199,710,634,560
5-Mar-17	0	9	199,710,634,560
12-Mar-17	0	10	199,710,634,560
19-Mar-17	3,368,193	11	199,707,266,367
26-Mar-17	0	12	199,707,266,367
2-Apr-17	0	13	199,707,266,367
9-Apr-17	453,536,360	14	199,253,730,007
16-Apr-17	252,829,757	15	199,000,900,250
23-Apr-17	364,170,967	16	198,636,729,283
30-Apr-17	309,456,750	17	198,327,272,533
7-May-17	281,695,010	18	198,045,577,523
14-May-17	281,403,050	19	197,764,174,473
21-May-17	122,173,193	20	197,642,001,280
28-May-17	304,214,736	21	197,337,786,544
4-Jun-17	252,041,496	22	197,085,745,048
11-Jun-17	171,965,097	23	196,913,779,951
18-Jun-17	281,885,168	24	196,631,894,783
25-Jun-17	254,145,639	25	196,377,749,144
2-Jul-17	323,228,892	26	196,054,520,252
9-Jul-17	77,375,597	27	195,977,144,655
16-Jul-17	301,992,095	28	195,675,152,560
23-Jul-17	178,215,843	29	195,496,936,717
30-Jul-17	86,844,667	30	195,410,092,050
6-Aug-17	24,684,050	31	195,385,408,000
13-Aug-17	36,051,720	32	195,349,356,280
20-Aug-17	80,359,860	33	195,268,996,420
27-Aug-17	28,867,667	34	195,240,128,753
3-Sep-17	229,785,050	35	195,010,343,703
10-Sep-17	143,674,013	36	194,866,669,690
17-Sep-17	35,057,000	37	194,831,612,690
24-Sep-17	237,743,400	38	194,593,869,290
1-Oct-17	325,519,246	39	194,268,350,044
8-Oct-17	153,613,460	40	194,114,736,584
15-Oct-17	133,988,240	41	193,980,748,344
22-Oct-17	85,585,680	42	193,895,162,664
29-Oct-17	3,872,227	43	193,891,290,437
5-Nov-17	68,654,867	44	193,822,635,570
12-Nov-17	70,541,267	45	193,752,094,303
19-Nov-17	0	46	193,752,094,303
26-Nov-17	7,049,067	47	193,745,045,236
3-Dec-17	122,535,042	48	193,622,510,194
10-Dec-17	305,456,805	49	193,317,053,389
17-Dec-17	165,119,296	50	193,151,934,093
24-Dec-17	0	51	193,151,934,093
31-Dec-17	0	52	193,151,934,093
		53	193,151,934,093
Annual Total (Bq)	6,848,065,907		
Annual Total (GBq)	6.85		
Limit (GBq)	200		EFF-002-F-04
% of limit	**3.42**		Rev. A - 2016-Dec-30

APPENDIX Q

Well Monitoring Results for 2017

WELL I.D.	DESCRIPTION		DISTANCE FROM STACKS (m)	Jan. 4, 2017	Feb. 1, 2017	Mar. 1, 2017	Apr. 4, 2017	May 2, 2017	Jun. 2, 2017	Jul. 5, 2017	Aug. 2, 2017	Sep. 1, 2017	Oct. 3, 2017	Nov. 1, 2017	Dec. 1, 2017	WELL I.D.
MW06-1	SRB SITE	IN SOIL	50	2,253	2,429	2,682	2,312	2,226	1,895	1,736	1,688	1,546	1,617	1,511	1,460	MW06-1
MW06-2	SRB SITE	IN SOIL	75	1,525	1,552	1,053	1,352	947	973	1,026	959	1,156	1,172	1,181	1,090	MW06-2
MW06-3	SRB SITE	IN SOIL	50	Dry	934	866	786	722	666	627	606	569	637	598	500	MW06-3
MW06-8	SRB SITE	IN SOIL	55	744	774	809	773	809	836	765	800	732	769	798	746	MW06-8
MW06-9	SRB SITE	IN SOIL	25	2,329	2,360	2,400	2,323	2,364	2,137	2,165	2,217	2,085	2,213	2,039	2,055	MW06-9
MW06-10	SRB SITE	SURFACE OF BEDROCK	0	49,457	49,332	21,220	28,151	13,330	20,019	31,360	27,566	42,714	45,608	40,059	33,427	MW06-10
MW07-11	SRB SITE	SURFACE OF BEDROCK	75	1,421	1,333	1,406	1,083	896	816	949	967	1,021	1,130	1,181	986	MW07-11
MW07-12	SRB SITE	SURFACE OF BEDROCK	55	390	462	482	502	489	451	479	502	452	481	467	445	MW07-12
MW07-13	SRB SITE	SURFACE OF BEDROCK	50	9,594	9,539	9,535	9,052	9,117	8,216	8,494	7,809	8,095	8,409	8,131	7,712	MW07-13
MW07-15	SRB SITE	SURFACE OF BEDROCK	25	1,589	1,617	1,685	1,695	1,713	1,677	1,590	1,614	1,563	1,599	1,570	1,490	MW07-15
MW07-16	SRB SITE	SURFACE OF BEDROCK	15	1,723	1,648	1,677	1,694	1,770	1,650	1,662	1,656	1,623	1,618	1,582	1,481	MW07-16
MW07-17	SRB SITE	DEEPER BEDROCK	15	Frozen	548	566	420	301	303	255	255	187	250	302	293	MW07-17
MW07-18	SRB SITE	SURFACE OF BEDROCK	10	3,280	3,121	3,339	2,451	2,557	2,393	2,458	2,343	2,629	2,880	2,846	2,567	MW07-18
MW07-19	SRB SITE	SURFACE OF BEDROCK	20	2,108	2,372	2,139	1,930	1,700	1,569	1,687	1,678	1,897	2,172	2,024	1,831	MW07-19
MW07-20	SUPERIOR PROPANE PROPERTY	SURFACE OF BEDROCK	90	575	552	631	560	634	576	593	576	548	571	524	513	MW07-20
MW07-21	SUPERIOR PROPANE PROPERTY	SURFACE OF BEDROCK	110	994	918	810	852	1,034	863	949	871	760	918	835	738	MW07-21
MW07-22	SRB SITE	SURFACE OF BEDROCK	70	1,096	1,151	1,081	904	1,040	1,003	956	1,082	925	1,037	1,072	926	MW07-22
MW07-23	SRB SITE	SURFACE OF BEDROCK	90	1,751	1,820	1,875	1,836	1,808	1,745	1,746	1,688	1,662	1,690	1,670	1,630	MW07-23
MW07-24	HARRINGTON PROPERTY	SURFACE OF BEDROCK	115	2,035	2,110	2,284	2,104	2,193	1,992	1,953	1,897	1,852	1,998	1,925	1,915	MW07-24
MW07-26	SRB SITE	SURFACE OF BEDROCK	50	1,408	1,390	1,180	951	1,357	1,003	1,196	1,182	1,194	1,228	1,087	1,099	MW07-26
MW07-27	CITY PROPERTY	SURFACE OF BEDROCK	55	4040	4,166	4,161	3,409	3,422	3,125	3,393	3,011	3,271	3,630	3,809	3,629	MW07-27
MW07-28	CITY PROPERTY	DEEPER BEDROCK	55	1,001	1,154	887	1,340	1,175	951	1,080	1,013	1,030	1,103	953	1,069	MW07-28
MW07-29	SRB SITE	DEEPER BEDROCK	10	3,462	3,334	2,707	1,925	2,315	1,983	1,897	2,184	2,531	2,691	2,736	1,904	MW07-29
MW07-31	SRB SITE	DEEPER BEDROCK	70	239	155	190	143	110	<89	125	115	296	310	231	131	MW07-31
MW07-32	HARRINGTON PROPERTY	DEEPER BEDROCK	115	<87	<77	103	<88	<96	<89	<84	<81	<37	51	106	44	MW07-32
MW07-34	SRB SITE	SHALLOW BEDROCK	10	2,245	2,122	2,024	2,401	2,640	2,504	2,469	2,418	2,281	2,315	2,075	1,992	MW07-34
MW07-35	CITY PROPERTY	SHALLOW BEDROCK	55	3,183	3,302	3,228	3,059	3,136	2,990	3,032	2,972	2,853	2,897	2,825	2,699	MW07-35
MW07-36	CITY PROPERTY	SHALLOW BEDROCK	80	2,727	2,737	2,485	1,857	1,702	1,731	1,798	1,777	1,929	2,287	2,265	2,007	MW07-36
MW07-37	SRB SITE	SHALLOW BEDROCK	60	1,057	1,010	995	880	879	807	782	822	740	809	853	823	MW07-37
CN-1S	CN PROPERTY		125			490				231				352		CN-1S
CN-1D	CN PROPERTY		130			No Sample				445				427		CN-1D
CN-2	CN PROPERTY		150			284				286				362		CN-2
CN-3S	CN PROPERTY		165			129				111				176		CN-3S
CN-3D	CN PROPERTY		160			<87				186				365		CN-3D
RW-2	185 MUD LAKE ROAD		1,100			63				57				38		RW-2
RW-3	183 MUD LAKE ROAD		1,100			63				64				56		RW-3
RW-5	171 SAWMILL ROAD		2,300			9				8				9		RW-5
RW-6	40987 HWY 41		1,400			7				5				6		RW-6
RW-7	40925 HWY 41		1,600			<3				<4				<3		RW-7
RW-8	204 BOUNDARY ROAD		700			132				98				108		RW-8
RW-9	206 BOUNDARY ROAD		650			38				38				NOTE 2		RW-9
RW-10	208 BOUNDARY ROAD		625			<4				NOTE 1				NOTE 1		RW-10
RW-12	202 MUD LAKE ROAD		753			6				33				<3		RW-12
B-1	VALLEY POOL SERVICE OFFICE		160			876				927				965		B-1
B-2	SUPERIOR PROPANE TRUCK WASH		250			910				653				871		B-2
B-3	HEIDEMAN & SONS LUMBER		385			<4				<4				<3		B-3

NOTE 1 *(July) RW-10 reported by resident that home is now on municipal water supply; sampling to be discontinued as well water is now inaccessible. RW-8, 9 and 12 expected to be on municipal water supply soon once water meter issues addressed with municipality. (JMac)*

NOTE 2 *(November) RW-9 reported by resident that home is now on municipal water supply; sampling to be discontinued as well water is now inaccessible. RW-8 and 12 expected to be on municipal water supply soon once water meter issues addressed with municipality. (JMac)*

APPENDIX R

Compilation of Water Level Measurements for 2017

GMP-001-F-02: Well Level Tracking Sheet - Revision A - May 17, 2017

	MW06-1	MW06-2	MW06-3	MW06-8	MW06-9	MW06-10	MW07-11	MW07-12	MW07-13	MW07-15	MW07-16	MW07-17	MW07-18	MW07-19
Easting	335449	335478	335363	335464	335401	335408	335478	335465	335448	335403	335393	335392	335387	335378
Northing	5074615	5074578	5074535	5074590	5074605	5074506	5074576	5074588	5074616	5074605	5074599	5074599	5074595	5074587
TOP Elevation (m)	130.99	130.03	133.09	130.30	131.15	131.32	130.06	130.41	130.92	130.84	130.98	131.08	131.23	131.61
GS Elevation (m)	130.17	129.24	132.32	129.58	129.86	130.24	129.15	129.58	130.03	129.93	130.16	130.16	130.37	130.79
Well Diameter (m)	0.051	0.051	0.051	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.051	0.032	0.032
Well Depth (m)	5.165	5.330	6.130	6.700	5.930	7.770	7.215	7.450	6.615	7.230	7.050	14.610	7.250	7.400
Stick-up (m)	0.820	0.788	0.767	0.720	1.290	1.077	0.905	0.835	0.893	0.910	0.822	0.915	0.868	0.815
dd/mm/yyyy														
03-Jan-17	127.71	127.23	127.57	126.34	127.42	126.94	126.43	126.32	126.08	126.85	126.80	121.85	126.82	126.91
31-Jan-17	127.99	127.33	128.04	126.54	127.19	127.19	126.61	126.50	126.25	127.08	127.03	121.99	127.07	127.17
28-Feb-17	128.86	128.06	130.47	127.55	128.44	128.86	127.54	127.54	127.48	128.65	128.70	123.31	128.88	129.07
03-Apr-17	129.21	127.93	130.61	128.15	129.56	129.70	128.16	128.21	128.27	129.54	129.59	125.07	129.80	129.94
01-May-17	129.31	128.74	130.62	128.32	129.73	129.72	128.33	128.36	128.38	129.64	129.66	125.33	129.83	129.97
01-Jun-17	128.22	127.49	127.36	126.43	127.75	127.08	126.47	126.38	126.28	127.12	127.04	121.86	126.98	127.04
04-Jul-17	129.04	128.38	130.44	128.20	129.51	129.49	128.20	128.23	128.16	129.37	129.39	125.15	129.56	129.69
01-Aug-17	128.77	127.93	129.20	127.62	129.21	128.67	127.96	127.65	127.54	128.66	128.63	124.02	128.68	128.74
31-Aug-17	128.60	127.73	128.16	127.04	128.63	127.92	127.10	127.03	126.93	127.94	127.88	122.66	127.97	127.97
02-Oct-17	127.75	127.46	127.22	126.34	127.64	127.02	126.39	126.29	126.05	126.95	126.89	121.93	126.91	126.99
31-Oct-17	128.71	128.30	129.57	126.81	127.70	127.98	126.89	126.79	126.70	127.90	127.86	121.73	127.88	128.04
30-Nov-17	128.72	128.17	129.22	127.45	128.82	128.40	127.49	127.45	127.26	128.35	128.30	123.37	128.37	128.50

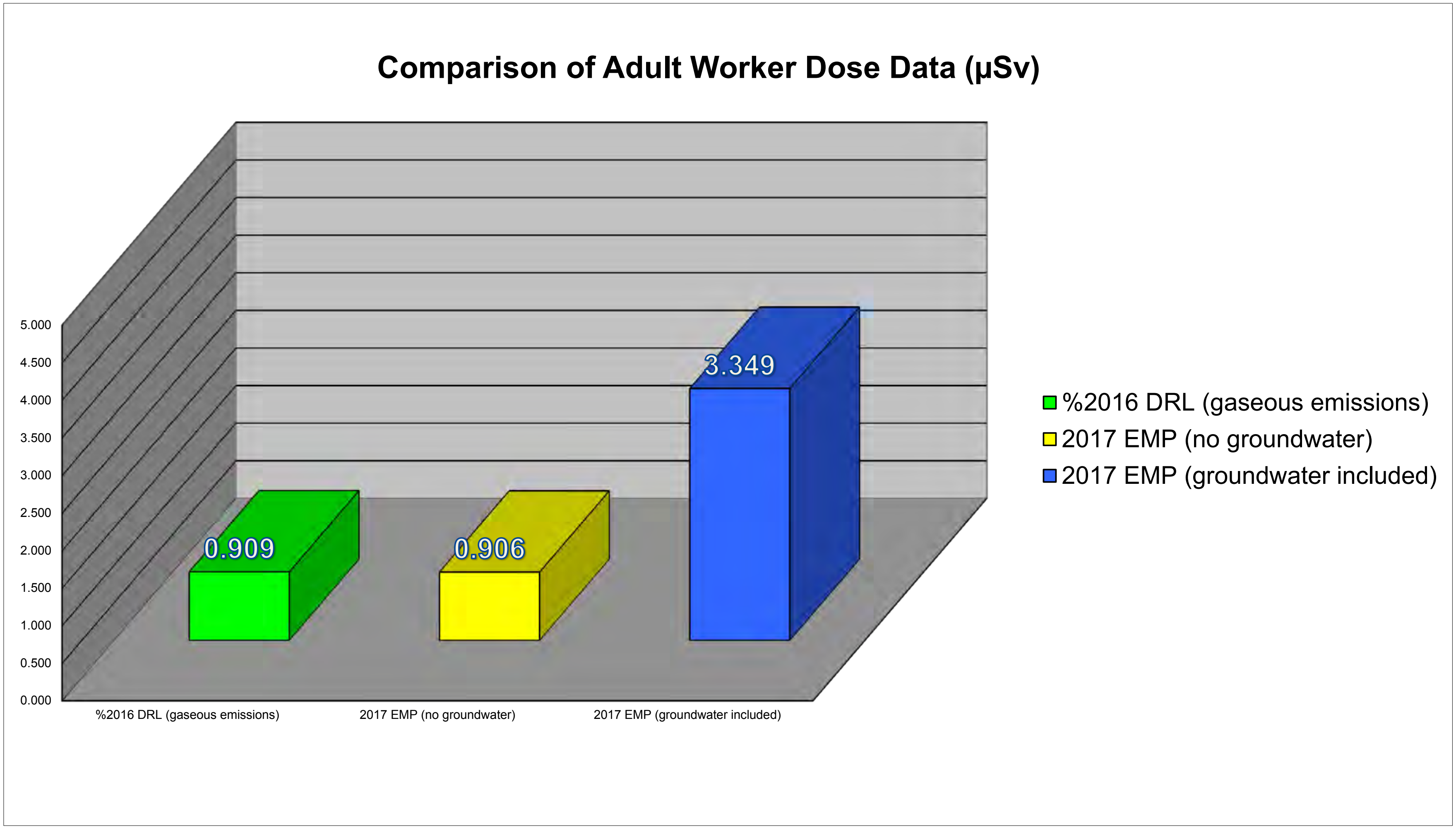
	MW07-20	MW07-21	MW07-22	MW07-23	MW07-24	MW07-26	MW07-27	MW07-28	MW07-29	MW07-31	MW07-32	MW07-34	MW07-35	MW07-36	MW07-37
Easting	335296	335522	335472	335492	335519	335357	335354	335352	335384	335471	335517	335393	335354	335338	335468
Northing	5074616	5074584	5074584	5074560	5074530	5074567	5074611	5074612	5074592	5074583	5074530	5074591	5074613	5074629	5074589
TOP Elevation (m)	130.70	129.51	130.25	130.04	129.03	132.42	132.89	132.71	131.09	130.16	128.86	131.12	132.89	133.10	130.06
GS Elevation (m)	129.85	128.78	129.05	129.29	128.22	131.85	132.02	132.04	130.57	129.38	128.23	130.71	132.16	132.31	129.47
Well Diameter (m)	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032
Well Depth (m)	7.820	7.580	7.465	5.905	6.525	7.310	8.330	14.400	13.000	13.240	13.090	9.110	9.390	9.330	8.590
Stick-up (m)	0.850	0.730	1.200	0.750	0.810	0.570	0.870	0.670	0.520	0.780	0.630	0.410	0.730	0.790	0.590
dd/mm/yyyy															
03-Jan-17	125.37	124.89	126.22	127.13	126.43	126.84	126.16	121.87	121.88	121.49	121.49	125.94	125.85	125.12	126.41
31-Jan-17	125.55	125.42	126.41	127.43	126.63	127.46	126.31	121.88	121.89	122.17	122.20	126.09	125.92	125.11	126.60
28-Feb-17	127.14	126.92	127.43	127.96	127.18	130.15	128.47	123.00	122.99	124.30	124.28	127.83	127.92	126.65	127.62
03-Apr-17	127.82	127.37	128.09	128.35	127.53	130.70	130.00	129.82	124.80	125.51	125.50	128.96	129.52	128.52	128.29
01-May-17	127.91	127.28	128.24	128.52	127.59	130.64	130.25	125.18	125.14	125.77	125.76	129.08	129.50	128.54	128.46
01-Jun-17	125.49	124.43	126.27	127.10	126.15	126.77	126.36	121.95	121.96	120.71	120.71	126.11	125.93	125.05	126.46
04-Jul-17	127.84	127.26	128.11	128.41	127.48	130.32	129.68	124.81	124.79	125.70	125.68	128.81	129.24	128.18	128.33
01-Aug-17	127.12	126.68	127.53	128.00	127.08	129.04	128.54	123.76	123.76	124.11	124.09	127.91	128.13	127.14	127.74
31-Aug-17	126.28	125.83	126.93	127.62	126.71	128.02	127.47	122.60	122.61	121.82	121.83	126.97	126.99	125.79	127.13
02-Oct-17	125.32	124.31	126.19	127.01	126.19	126.85	126.34	121.87	121.89	121.21	121.17	126.07	125.93	124.98	126.41
31-Oct-17	125.87	125.53	126.69	127.53	126.60	128.71	127.05	121.67	121.70	121.06	121.05	126.88	126.54	125.37	126.91
30-Nov-17	126.88	126.50	127.34	128.00	126.07	128.92	128.08	123.29	123.29	123.31	123.30	127.63	127.63	126.52	127.55

APPENDIX S

Data and Calculations for Public Dose in 2017

ADULT WORKER

Dose Calculation	2017 µSv
%2016 DRL (gaseous emissions)	0.909
2017 EMP (no groundwater)	0.906
2017 EMP (groundwater included)	3.349



ADULT WORKER

Stack Emissions

	2017 Emissions as %2016 SRBT DRL	
	ADULT WORKER	
Sample End	% weekly DRL	(uSv)
03/01/2017	0.01	0.0012
10/01/2017	0.05	0.0087
17/01/2017	0.07	0.0132
24/01/2017	0.08	0.0151
31/01/2017	0.06	0.0113
07/02/2017	0.03	0.0050
14/02/2017	0.04	0.0077
21/02/2017	0.04	0.0086
28/02/2017	0.08	0.0146
07/03/2017	0.04	0.0072
14/03/2017	0.06	0.0110
21/03/2017	0.04	0.0071
28/03/2017	0.05	0.0100
04/04/2017	0.08	0.0149
04/11/2017	0.06	0.0113
04/18/2017	0.05	0.0096
04/25/2017	0.10	0.0197
05/02/2017	0.10	0.0189
05/09/2017	0.06	0.0106
05/16/2017	0.14	0.0262
05/23/2017	0.11	0.0220
05/30/2017	0.09	0.0168
06/06/2017	0.09	0.0180
06/13/2017	0.13	0.0257
06/20/2017	0.16	0.0316
06/27/2017	0.22	0.0427
07/04/2017	0.09	0.0166
07/11/2017	0.14	0.0267
07/18/2017	0.13	0.0241
07/25/2017	0.08	0.0153
08/01/2017	0.11	0.0208
08/08/2017	0.09	0.0176
08/15/2017	0.08	0.0157
22/08/2017	0.09	0.0180
29/08/2017	0.09	0.0165
05/09/2017	0.08	0.0163
12/09/2017	0.11	0.0206
19/09/2017	0.18	0.0341
26/09/2017	0.21	0.0403
03/10/2017	0.16	0.0312
10/10/2017	0.12	0.0227
17/10/2017	0.12	0.0234
24/10/2017	0.12	0.0223
31/10/2017	0.14	0.0271
07/11/2017	0.06	0.0106
14/11/2017	0.09	0.0173
21/11/2017	0.09	0.0178
28/11/2017	0.10	0.0193
05/12/2017	0.08	0.0162
12/12/2017	0.06	0.0124
19/12/2017	0.04	0.0075
26/12/2017	0.05	0.0096
Sum (uSv)		**0.909**
Ave. (%DRL)	**0.09**	
Annual Dose Est.	**0.909 uSv/a**	

ADULT WORKER

ADULT WORKER
EMP Factors for Dose

Pathways Analysis of Dose to the Public		
		per annum
Atmospheric HTO inhalation, immersion	P(i)19, P(e)19	0.578
Surface HTO ingestion	P(i)29	2.443
Surface HTO immersion	P(e)29	0.000
External soil exposure	P39	0.000
Forage & crop ingestion	P49	0.315
Animal produce ingestion	P59	0.013
Aquatic animal ingestion	P69	0.000
Aquatic plant ingestion	P79	0.000
External sediment exposure	P89	0.000
Total (uSv)		**3.349 uSv/a**
Total without P_{29} (uSv)		**0.906 uSv/a**

ADULT WORKER
EMP Factors for Dose P19

P19 is the transfer pathway of exposure to HTO from compartment 1 (Atmosphere) to 9 (dose)
P(i)19 is the pathway of exposure due to inhalation of HTO, and also implicitly captures skin absorption dose P(e)19 as per CSA N288.1-14 Table C.1.

Formula:
P(i)19 (uSv) = [HTO]air (Bq/m3) x Inhalation (m3) x DCF (uSv/Bq)

Calculation:

PAS # (#)	P(i)19 (uSv)	[HTO]air (Bq/m^3)	Volume (m^3)	(uSv/Bq)	(uSv/a)	(uSv/a)	(uSv/a)	Maximum (uSv/a)	
1	0.177	2.960	1994.496	3.000E-05	0.177				
2	0.209	3.500	1994.496	3.000E-05		0.209			
3	0.000			3.000E-05					
4	0.369	1.920	6405.504	3.000E-05	0.369	0.369	0.369		
5	0.000			3.000E-05					
6	0.000			3.000E-05					
7	0.000			3.000E-05					
8	0.000			3.000E-05					
9	0.000			3.000E-05					
10	0.000			3.000E-05					
11	0.000			3.000E-05					
12	0.000			3.000E-05					
13	0.148	2.470	1994.496	3.000E-05			0.148		
			P(i)19	**Sum**	**0.546**	**0.578**	**0.517**	**0.578**	**uSv/a**

ADULT WORKER
EMP Factors for Dose P29

P29 is the transfer pathway of exposure to HTO from compartment 2 (Surface Water) to 9 (Dose)
P(i)29 is the pathway of exposure due to ingestion of HTO
P(e)29 is the pathway of exposure due to immersion in HTO

Formula:
P(i)29 = [HTO] (Bq/L) x Ingestion (L) x DCF (uSv/Bq)

Well	P(i)29 (uSv/a)	[HTO]well (Bq/L)	Ingestion (L/a)	DCF (uSv/Bq)
1	0.000	0	1081.1	2.00E-05
2	1.139	53	1081.1	2.00E-05
3	1.319	61	1081.1	2.00E-05
4	0.000	0	1081.1	2.00E-05
5	0.187	9	1081.1	2.00E-05
6	0.130	6	1081.1	2.00E-05
7	0.072	3	1081.1	2.00E-05
8	2.443	113	1081.1	2.00E-05
9	0.822	38	1081.1	2.00E-05
10	0.086	4	1081.1	2.00E-05
11	0.000	0	1081.1	2.00E-05
12	0.303	14	1081.1	2.00E-05
Avg P(i)29	**0.542**	**uSv/annum**		

Date	Well 1 (Bq/L)	Well 2 (Bq/L)	Well 3 (Bq/L)	Well 4 (Bq/L)	Well 5 (Bq/L)	Well 6 (Bq/L)	Well 7 (Bq/L)	Well 8 (Bq/L)	Well 9 (Bq/L)	Well 10 (Bq/L)	Well 11 (Bq/L)	Well 12 (Bq/L)
Jan. 4, 2017												
Feb. 1, 2017												
Mar. 1, 2017		63	63		9	7	3	132	38	4		6
Apr. 4, 2017												
May 2, 2017												
Jun. 2, 2017												
Jul. 5, 2017		57	64		8	5	4	98	38			33
Aug. 2, 2017												
Sep. 1, 2017												
Oct. 3, 2017												
Nov. 1, 2017		38	56		9	6	3	108				3
Dec. 1, 2017												
Average		**53**	**61**		**9**	**6**	**3**	**113**	**38**	**4**		**14**

Well 1	*No longer sampled*
Well 2	185 Mud Lake Road
Well 3	183 Mud Lake Road
Well 4	*No longer sampled*
Well 5	171 Sawmill Road
Well 6	40987 Highway 41
Well 7	40925 Highway 41
Well 8	204 Boundary Road
Well 9	206 Boundary Road
Well 10	208 Boundary Road
Well 11	*No longer sampled*
Well 12	202 Mud Lake Road

P(e)29 is the pathway of exposure to HTO due to immersion in surface water.
P(e)29 is considered negligible as surface waters throughout 2017 were measured as <detectable.

P(e)29 = 0.000 uSv/mo

RW-8	**P(i)29**	**2.443**	**uSv/mo**
	P(e)29	**0.000**	**uSv/mo**
	P29	**2.443**	**uSv/mo**

ADULT WORKER
EMP Factors for Dose P49

P49 is the pathway for exposure to HTO due to ingestion of forage and crops.

Produce Sample Results (Bq free water tritium / kg fresh weight)

Source	Market						Home												
Type	Cabbage	Eggplant	Pepper	Onion	Tomato	Average	LOCATION	Beet	Green Pepper	Rhubarb Leaf	Carrot	Apple	Tomato	Potato	Cucumber	Swiss Chard	Onion	Zucchini	Average
	8.00	9.00	9.00	5.00	8.00	7.8	413 SWEEZEY COURT	28.00			24.00	71.00					26.00		37.3
							408 BOUNDARY ROAD						58.00				109.00		83.5
							611 MOSS DRIVE						52.00		32.00				42.0
							416 BOUNDARY ROAD					12.00							12.0
Average	**8.00**	**9.00**	**9.00**	**5.00**	**8.00**	**7.8**		**28.00**			**24.00**	**41.50**	**55.00**		**32.00**		**67.50**		43.7

Produce Sample Results (Bq organically bound tritium / kg fresh weight)

Comm.					3.00	**3.0**	408 BOUNDARY ROAD						4.00						**4.0**

Produce Consumption

100%=	413.300	kg/a	[HTO] (Bq/kg)	(Bq/a)	[OBT] (Bq/kg)	(Bq/a)
70%	289.310	**kg/a**	7.8	2256.62	3.0	867.93
30%	123.990	**kg/a**	83.5	10353.17	4.0	495.96

P49 = [HTO or OBT]produce (Bq/kg) x Produce Ingested (kg/mo) x DCF (uSv/Bq)

P49 (uSv/a)	[HTO] pro (Bq/a)	DCF (uSv/Bq)	[OBT] pro (Bq/a)	DCF (uSv/Bq)
0.315	**12609.78**	2.00E-05	**1363.89**	4.60E-05

P49	**0.315**	**uSv/mo**

ADULT WORKER
EMP Factors for Dose P59

P59 is the exposure to HTO due to ingestion of animal produce.

2017 Sample Results

Local Producer	
	(Bq/L)
1	4.00
2	4.60
3	3.70
Average	**4.10**

Local Distributor	
	(Bq/L)
1	3.00
2	3.70
3	3.00
Average	**3.23**

TOTAL AVERAGE	3.67	Bq/L

Milk Density Adjustment		
Milk Average (Bq/L) x Milk density (L/kg)		
Bq/L	**L/kg**	**Bq/kg**
3.67	0.97	**3.557**

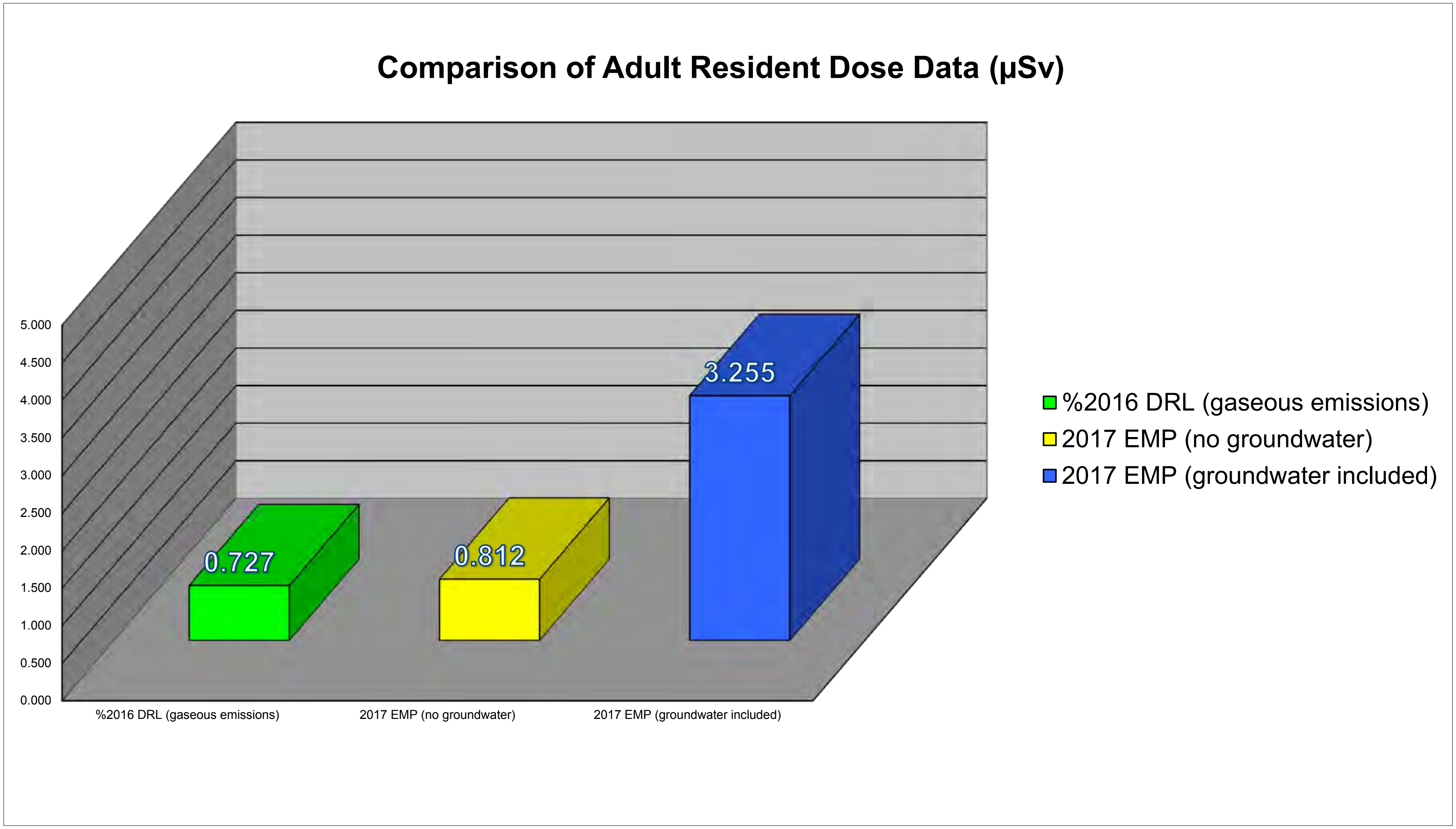
Consumption kg/da x da/a = kg/a		
(kg/da)	**(da/a)**	**(kg/a)**
0.516	365.25	**188.5**

P59 = [HTO]animal produce (Bq/kg) x Ingestion (kg) x DCF				
P59	**[HTO]**	**Ingested**	**DCF**	
(uSv/a)	**(Bq/kg)**	**(kg/a)**	**(uSv/Bq)**	
0.013	**3.56**	**188.5**	2.00E-05	

P59	0.013	uSv/a

ADULT RESIDENT

Dose Calculation	2017 µSv
%2016 DRL (gaseous emissions)	0.727
2017 EMP (no groundwater)	0.812
2017 EMP (groundwater included)	3.255



ADULT RESIDENT

Stack Emissions

	2017 Emissions as %2016 SRBT DRL	
	ADULT RESIDENT	
Sample End	% weekly DRL	(uSv)
03/01/2017	0.01	0.0010
10/01/2017	0.04	0.0070
17/01/2017	0.06	0.0107
24/01/2017	0.06	0.0121
31/01/2017	0.05	0.0090
07/02/2017	0.02	0.0040
14/02/2017	0.03	0.0062
21/02/2017	0.04	0.0069
28/02/2017	0.06	0.0118
07/03/2017	0.03	0.0059
14/03/2017	0.05	0.0089
21/03/2017	0.03	0.0057
28/03/2017	0.04	0.0082
04/04/2017	0.06	0.0120
04/11/2017	0.05	0.0091
04/18/2017	0.04	0.0076
04/25/2017	0.08	0.0157
05/02/2017	0.08	0.0158
05/09/2017	0.04	0.0084
05/16/2017	0.11	0.0209
05/23/2017	0.09	0.0176
05/30/2017	0.07	0.0134
06/06/2017	0.07	0.0144
06/13/2017	0.11	0.0204
06/20/2017	0.13	0.0252
06/27/2017	0.18	0.0338
07/04/2017	0.07	0.0132
07/11/2017	0.11	0.0213
07/18/2017	0.10	0.0193
07/25/2017	0.06	0.0121
08/01/2017	0.09	0.0166
08/08/2017	0.07	0.0141
08/15/2017	0.06	0.0124
22/08/2017	0.07	0.0143
29/08/2017	0.07	0.0132
05/09/2017	0.07	0.0129
12/09/2017	0.09	0.0164
19/09/2017	0.14	0.0272
26/09/2017	0.17	0.0321
03/10/2017	0.13	0.0247
10/10/2017	0.10	0.0184
17/10/2017	0.10	0.0186
24/10/2017	0.09	0.0178
31/10/2017	0.11	0.0215
07/11/2017	0.05	0.0087
14/11/2017	0.07	0.0140
21/11/2017	0.07	0.0142
28/11/2017	0.08	0.0154
05/12/2017	0.07	0.0130
12/12/2017	0.05	0.0099
19/12/2017	0.03	0.0060
26/12/2017	0.04	0.0077
Sum (uSv)		0.727
Ave. (%DRL)	0.07	
Annual Dose Est.	0.727 uSv/a	

Adult Resident

ADULT RESIDENT
EMP Factors for Dose

Pathways Analysis of Dose to the Public		
		per annum
Atmospheric HTO inhalation, immersion	P(i)19, P(e)19	0.484
Surface HTO ingestion	P(i)29	2.443
Surface HTO immersion	P(e)29	0.000
External soil exposure	P39	0.000
Forage & crop ingestion	P49	0.315
Animal produce ingestion	P59	0.013
Aquatic animal ingestion	P69	0.000
Aquatic plant ingestion	P79	0.000
External sediment exposure	P89	0.000
Total (uSv)		**3.255 uSv/a**
Total without P_{29} (uSv)		**0.812 uSv/a**

ADULT RESIDENT
EMP Factors for Dose P19

P19 is the transfer pathway of exposure to HTO from compartment 1 (Atmosphere) to 9 (dose)
P(i)19 is the pathway of exposure due to inhalation of HTO, and also implicitly captures skin absorption dose P(e)19 as per CSA N288.1-14 Table C.1.

Formula:
P(i)19 (uSv) = [HTO]air (Bq/m3) x Inhalation (m3) x DCF (uSv/Bq)

Calculation:

PAS # (#)	P(i)19 (uSv)	[HTO]air (Bq/m^3)	Volume (m^3)	DCF (uSv/Bq)	Sum1,4 (uSv/a)	Sum 2,4 (uSv/a)	Sum 13,4 (uSv/a)	Maximum (uSv/a)
1	0.000			3.000E-05				
2	0.000			3.000E-05				
3	0.000			3.000E-05				
4	0.484	1.920	8400.000	3.000E-05	0.484	0.484	0.484	
5	0.000			3.000E-05				
6	0.000			3.000E-05				
7	0.000			3.000E-05				
8	0.000			3.000E-05				
9	0.000			3.000E-05				
10	0.000			3.000E-05				
11	0.000			3.000E-05				
12	0.000			3.000E-05				
13	0.000			3.000E-05				
			P(i)19	**Sum**	**0.484**	**0.484**	**0.484**	**0.484** uSv/a

ADULT RESIDENT
EMP Factors for Dose P29

P29 is the transfer pathway of exposure to HTO from compartment 2 (Surface Water) to 9 (Dose)
P(i)29 is the pathway of exposure due to ingestion of HTO
P(e)29 is the pathway of exposure due to immersion in HTO

Formula:
P(i)29 = [HTO] (Bq/L) x Ingestion (L) x DCF (uSv/Bq)

Well	P(i)29 (uSv/a)	[HTO]well (Bq/L)	Ingestion (L/a)	DCF (uSv/Bq)
1	0.000	0	1081.1	2.00E-05
2	1.139	53	1081.1	2.00E-05
3	1.319	61	1081.1	2.00E-05
4	0.000	0	1081.1	2.00E-05
5	0.187	9	1081.1	2.00E-05
6	0.130	6	1081.1	2.00E-05
7	0.072	3	1081.1	2.00E-05
8	2.443	113	1081.1	2.00E-05
9	0.822	38	1081.1	2.00E-05
10	0.086	4	1081.1	2.00E-05
11	0.000	0	1081.1	2.00E-05
12	0.303	14	1081.1	2.00E-05
Avg P(i)29	**0.542**	**uSv/annum**		

Date	Well 1 (Bq/L)	Well 2 (Bq/L)	Well 3 (Bq/L)	Well 4 (Bq/L)	Well 5 (Bq/L)	Well 6 (Bq/L)	Well 7 (Bq/L)	Well 8 (Bq/L)	Well 9 (Bq/L)	Well 10 (Bq/L)	Well 11 (Bq/L)	Well 12 (Bq/L)
Jan. 4, 2017												
Feb. 1, 2017												
Mar. 1, 2017		63	63		9	7	3	132	38	4		6
Apr. 4, 2017												
May 2, 2017												
Jun. 2, 2017												
Jul. 5, 2017		57	64		8	5	4	98	38			33
Aug. 2, 2017												
Sep. 1, 2017												
Oct. 3, 2017												
Nov. 1, 2017		38	56		9	6	3	108				3
Dec. 1, 2017												
Average		**53**	**61**		**9**	**6**	**3**	**113**	**38**	**4**		**14**

Well 1	*No longer sampled*
Well 2	185 Mud Lake Road
Well 3	183 Mud Lake Road
Well 4	*No longer sampled*
Well 5	171 Sawmill Road
Well 6	40987 Highway 41
Well 7	40925 Highway 41
Well 8	204 Boundary Road
Well 9	206 Boundary Road
Well 10	208 Boundary Road
Well 11	*No longer sampled*
Well 12	202 Mud Lake Road

P(e)29 is the pathway of exposure to HTO due to immersion in surface water.
P(e)29 is considered negligible as surface waters throughout 2017 were measured as <detectable.

P(e)29 =	**0.000**	**uSv/mo**

RW-8	**P(i)29**	**2.443**	**uSv/mo**
	P(e)29	**0.000**	**uSv/mo**
	P29	**2.443**	**uSv/mo**

ADULT RESIDENT
EMP Factors for Dose P49

P49 is the pathway for exposure to HTO due to ingestion of forage and crops.

Produce Sample Results (Bq free water tritium / kg fresh weight)																			
Source	**Market**						**Home**												
Type	**Cabbage**	**Eggplant**	**Pepper**	**Onion**	**Tomato**	**Average**	**LOCATION**	**Beet**	**Green Pepper**	**Rhubarb Leaf**	**Carrot**	**Apple**	**Tomato**	**Potato**	**Cucumber**	**Swiss Chard**	**Onion**	**Zucchini**	**Average**
	8.00	9.00	9.00	5.00	8.00	7.8	413 SWEEZEY COURT	28.00			24.00	71.00					26.00		37.3
							408 BOUNDARY ROAD						58.00				109.00		83.5
							611 MOSS DRIVE						52.00		32.00				42.0
							416 BOUNDARY ROAD					12.00							12.0
Average	**8.00**	**9.00**	**9.00**	**5.00**	**8.00**	**7.8**		**28.00**			**24.00**	**41.50**	**55.00**		**32.00**		**67.50**		43.7
Produce Sample Results (Bq organically bound tritium / kg fresh weight)																			
Comm.					3.00	**3.0**	408 BOUNDARY ROAD						4.00						**4.0**

Produce Consumption						
100%=	**413.300**	**kg/a**	**[HTO] (Bq/kg)**	**(Bq/a)**	**[OBT] (Bq/kg)**	**(Bq/a)**
70%	289.310	**kg/a**	7.8	2256.62	3.0	867.93
30%	123.990	**kg/a**	83.5	10353.17	4.0	495.96

P49 = [HTO or OBT]produce (Bq/kg) x Produce Ingested (kg/mo) x DCF (uSv/Bq)

P49 (uSv/a)	[HTO] pro (Bq/a)	DCF (uSv/Bq)	[OBT] pro (Bq/a)	DCF (uSv/Bq)
0.315	**12609.78**	2.00E-05	**1363.89**	4.60E-05

P49	**0.315**	**uSv/mo**

ADULT RESIDENT
EMP Factors for Dose P59

P59 is the exposure to HTO due to ingestion of animal produce.

2017 Sample Results

Local Producer	
	(Bq/L)
1	4.00
2	4.60
3	3.70
Average	**4.10**

Local Distributor	
	(Bq/L)
1	3.00
2	3.70
3	3.00
Average	**3.23**

TOTAL AVERAGE	**3.67**	Bq/L

Milk Density Adjustment		
Milk Average (Bq/L) x Milk density (L/kg)		
Bq/L	**L/kg**	**Bq/kg**
3.67	0.97	**3.557**

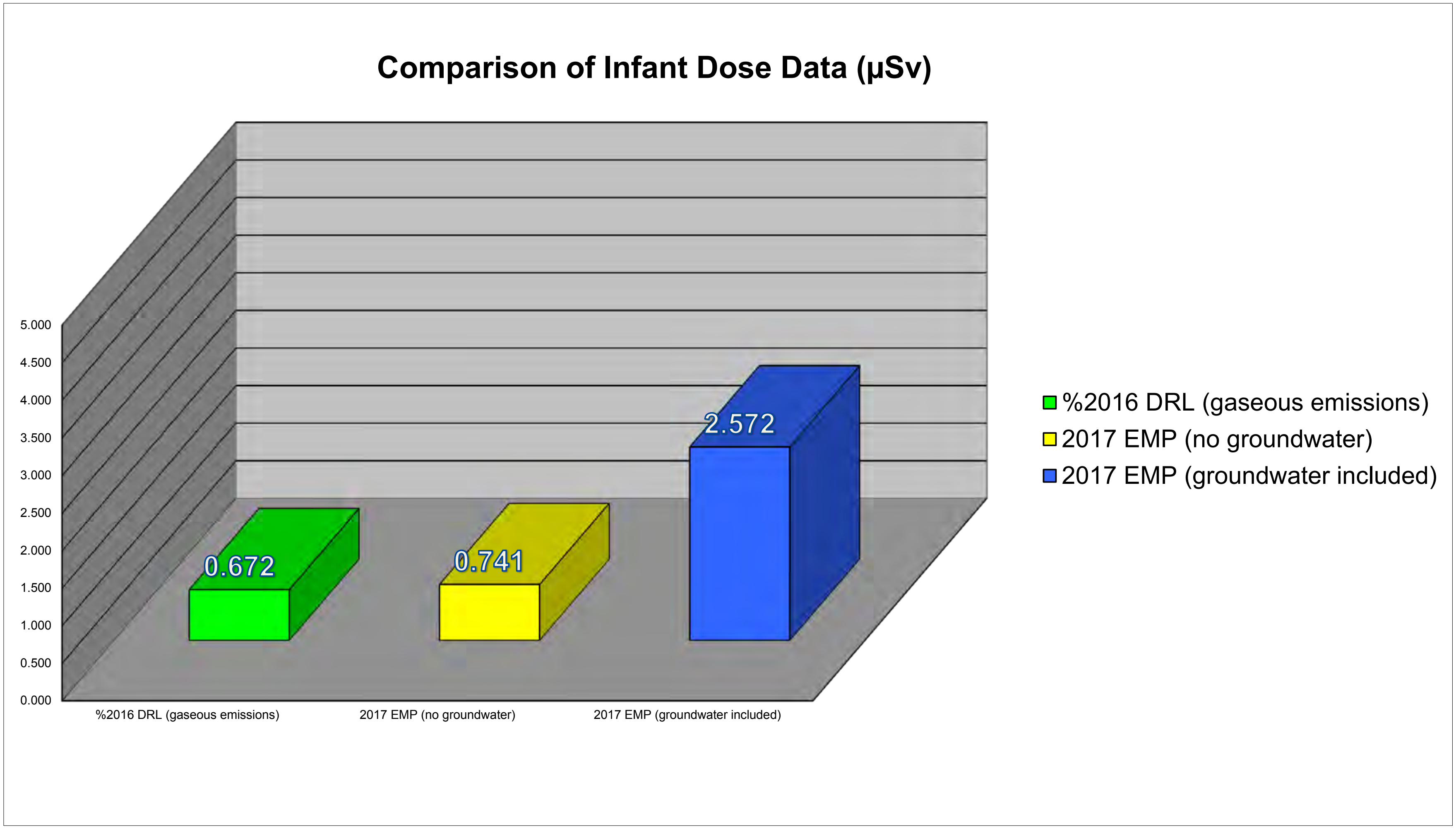
Consumption kg/da x da/a = kg/a		
(kg/da)	**(da/a)**	**(kg/a)**
0.516	365.25	**188.5**

P59 = [HTO]animal produce (Bq/kg) x Ingestion (kg) x DCF				
P59	**[HTO]**	**Ingested**	**DCF**	
(uSv/a)	**(Bq/kg)**	**(kg/a)**	**(uSv/Bq)**	
0.013	**3.56**	**188.5**	2.00E-05	

P59	**0.013**	**uSv/a**

INFANT (1 year old child)

Dose Calculation	2017 µSv
%2016 DRL (gaseous emissions)	0.672
2017 EMP (no groundwater)	0.741
2017 EMP (groundwater included)	2.572



INFANT (1 year old child)

Stack Emissions

	2017 Emissions as %2016 SRBT DRL	
	INFANT	
Sample End	% weekly DRL	(uSv)
03/01/2017	0.00	0.0009
10/01/2017	0.03	0.0065
17/01/2017	0.05	0.0099
24/01/2017	0.06	0.0112
31/01/2017	0.04	0.0083
07/02/2017	0.02	0.0037
14/02/2017	0.03	0.0057
21/02/2017	0.03	0.0064
28/02/2017	0.06	0.0109
07/03/2017	0.03	0.0054
14/03/2017	0.04	0.0082
21/03/2017	0.03	0.0052
28/03/2017	0.04	0.0075
04/04/2017	0.06	0.0111
04/11/2017	0.04	0.0084
04/18/2017	0.04	0.0071
04/25/2017	0.08	0.0145
05/02/2017	0.08	0.0144
05/09/2017	0.04	0.0078
05/16/2017	0.10	0.0194
05/23/2017	0.08	0.0162
05/30/2017	0.06	0.0124
06/06/2017	0.07	0.0133
06/13/2017	0.10	0.0189
06/20/2017	0.12	0.0233
06/27/2017	0.16	0.0313
07/04/2017	0.06	0.0122
07/11/2017	0.10	0.0197
07/18/2017	0.09	0.0178
07/25/2017	0.06	0.0112
08/01/2017	0.08	0.0153
08/08/2017	0.07	0.0130
08/15/2017	0.06	0.0115
22/08/2017	0.07	0.0132
29/08/2017	0.06	0.0122
05/09/2017	0.06	0.0120
12/09/2017	0.08	0.0152
19/09/2017	0.13	0.0251
26/09/2017	0.15	0.0297
03/10/2017	0.12	0.0229
10/10/2017	0.09	0.0169
17/10/2017	0.09	0.0172
24/10/2017	0.09	0.0164
31/10/2017	0.10	0.0199
07/11/2017	0.04	0.0080
14/11/2017	0.07	0.0129
21/11/2017	0.07	0.0132
28/11/2017	0.07	0.0143
05/12/2017	0.06	0.0120
12/12/2017	0.05	0.0091
19/12/2017	0.03	0.0056
26/12/2017	0.04	0.0071
Sum (uSv)		0.672
Ave. (%DRL)	0.07	
Annual Dose Est.	0.672 uSv/a	

INFANT

INFANT (1 year old child)
EMP Factors for Dose

Pathways Analysis of Dose to the Public			
		per annum	
Atmospheric HTO inhalation, immersion	P(i)19, P(e)19	0.421	
Surface HTO ingestion	P(i)29	1.831	
Surface HTO immersion	P(e)29	0.000	
External soil exposure	P39	0.000	
Forage & crop ingestion	P49	0.256	
Animal produce ingestion	P59	0.064	
Aquatic animal ingestion	P69	0.000	
Aquatic plant ingestion	P79	0.000	
External sediment exposure	P89	0.000	
Total (uSv)		**2.572 uSv/a**	
Total without P_{29} (uSv)		**0.741 uSv/a**	

INFANT (1 year old child)
EMP Factors for Dose P19

P19 is the transfer pathway of exposure to HTO from compartment 1 (Atmosphere) to 9 (dose)
P(i)19 is the pathway of exposure due to inhalation of HTO, and also implicitly captures skin absorption dose P(e)19 as per CSA N288.1-14 Table C.1.

Formula:
P(i)19 (uSv) = [HTO]air (Bq/m3) x Inhalation (m3) x DCF (uSv/Bq)

Calculation:

PAS # (#)	P(i)19 (uSv)	[HTO]air (Bq/m^3)	Volume (m^3)	DCF (uSv/Bq)	Sum1,4 (uSv/a)	Sum 2,4 (uSv/a)	Sum 13,4 (uSv/a)	Maximum (uSv/a)
1	0.000			8.000E-05				
2	0.000			8.000E-05				
3	0.000			8.000E-05				
4	0.421	1.920	2740.000	8.000E-05	0.421	0.421	0.421	
5	0.000			8.000E-05				
6	0.000			8.000E-05				
7	0.000			8.000E-05				
8	0.000			8.000E-05				
9	0.000			8.000E-05				
10	0.000			8.000E-05				
11	0.000			8.000E-05				
12	0.000			8.000E-05				
13	0.000			8.000E-05				
			P(i)19	**Sum**	**0.421**	**0.421**	**0.421**	**0.421** uSv/a

INFANT (1 year old child)
EMP Factors for Dose P29

P29 is the transfer pathway of exposure to HTO from compartment 2 (Surface Water) to 9 (Dose)
P(i)29 is the pathway of exposure due to ingestion of HTO
P(e)29 is the pathway of exposure due to immersion in HTO

Formula:
P(i)29 = [HTO] (Bq/L) x Ingestion (L) x DCF (uSv/Bq)

Well	P(i)29 (uSv/a)	[HTO]well (Bq/L)	Ingestion (L/a)	DCF (uSv/Bq)
1	0.000	0	305.7	5.30E-05
2	0.853	53	305.7	5.30E-05
3	0.988	61	305.7	5.30E-05
4	0.000	0	305.7	5.30E-05
5	0.140	9	305.7	5.30E-05
6	0.097	6	305.7	5.30E-05
7	0.054	3	305.7	5.30E-05
8	1.831	113	305.7	5.30E-05
9	0.616	38	305.7	5.30E-05
10	0.065	4	305.7	5.30E-05
11	0.000	0	305.7	5.30E-05
12	0.227	14	305.7	5.30E-05
Avg P(i)29	**0.406**	**uSv/annum**		

Date	Well 1 (Bq/L)	Well 2 (Bq/L)	Well 3 (Bq/L)	Well 4 (Bq/L)	Well 5 (Bq/L)	Well 6 (Bq/L)	Well 7 (Bq/L)	Well 8 (Bq/L)	Well 9 (Bq/L)	Well 10 (Bq/L)	Well 11 (Bq/L)	Well 12 (Bq/L)
Jan. 4, 2017												
Feb. 1, 2017												
Mar. 1, 2017		63	63		9	7	3	132	38	4		6
Apr. 4, 2017												
May 2, 2017												
Jun. 2, 2017												
Jul. 5, 2017		57	64		8	5	4	98	38			33
Aug. 2, 2017												
Sep. 1, 2017												
Oct. 3, 2017												
Nov. 1, 2017		38	56		9	6	3	108				3
Dec. 1, 2017												
Average		**53**	**61**		**9**	**6**	**3**	**113**	**38**	**4**		**14**

Well 1	*No longer sampled*
Well 2	185 Mud Lake Road
Well 3	183 Mud Lake Road
Well 4	*No longer sampled*
Well 5	171 Sawmill Road
Well 6	40987 Highway 41
Well 7	40925 Highway 41
Well 8	204 Boundary Road
Well 9	206 Boundary Road
Well 10	208 Boundary Road
Well 11	*No longer sampled*
Well 12	202 Mud Lake Road

P(e)29 is the pathway of exposure to HTO due to immersion in surface water.
P(e)29 is considered negligible as surface waters throughout 2017 were measured as <detectable.

P(e)29 = 0.000 uSv/mo

RW-8	**P(i)29**	**1.831**	**uSv/mo**
	P(e)29	**0.000**	**uSv/mo**
	P29	**1.831**	**uSv/mo**

INFANT (1 year old child)
EMP Factors for Dose P49

P49 is the pathway for exposure to HTO due to ingestion of forage and crops.

Produce Sample Results (Bq free water tritium / kg fresh weight)																			
Source	Market						Home												
Type	Cabbage	Eggplant	Pepper	Onion	Tomato	Average	LOCATION	Beet	Green Pepper	Rhubarb Leaf	Carrot	Apple	Tomato	Potato	Cucumber	Swiss Chard	Onion	Zucchini	Average
	8.00	9.00	9.00	5.00	8.00	7.8	413 SWEEZEY COURT	28.00			24.00	71.00					26.00		37.3
							408 BOUNDARY ROAD						58.00				109.00		83.5
							611 MOSS DRIVE						52.00		32.00				42.0
							416 BOUNDARY ROAD					12.00							12.0
Average	**8.00**	**9.00**	**9.00**	**5.00**	**8.00**	**7.8**		**28.00**			**24.00**	**41.50**	**55.00**		**32.00**		**67.50**		43.7
Produce Sample Results (Bq organically bound tritium / kg fresh weight)																			
Comm.					3.00	**3.0**	408 BOUNDARY ROAD						4.00						**4.0**

Produce Consumption							
100%=	**124.800**	**kg/a**	**[HTO] (Bq/kg)**	**(Bq/a)**	**[OBT] (Bq/kg)**	**(Bq/a)**
70%	87.360	**kg/a**	7.8	681.41	3.0	262.08
30%	37.440	**kg/a**	83.5	3126.24	4.0	149.76

P49 = [HTO or OBT]produce (Bq/kg) x Produce Ingested (kg/mo) x DCF (uSv/Bq)

P49 (uSv/a)	[HTO] pro (Bq/a)	DCF (uSv/Bq)	[OBT] pro (Bq/a)	DCF (uSv/Bq)
0.256	**3807.65**	5.30E-05	**411.84**	1.30E-04

P49	**0.256**	**uSv/mo**

APPENDIX S

INFANT (1 year old child)
EMP Factors for Dose P59

P59 is the exposure to HTO due to ingestion of animal produce.

2017 Sample Results

Local Producer	
	(Bq/L)
1	4.00
2	4.60
3	3.70
Average	4.10

Local Distributor	
	(Bq/L)
1	3.00
2	3.70
3	3.00
Average	3.23

TOTAL AVERAGE	3.67	Bq/L

Milk Density Adjustment Milk Average (Bq/L) x Milk density (L/kg)		
Bq/L	**L/kg**	**Bq/kg**
3.67	0.97	3.557

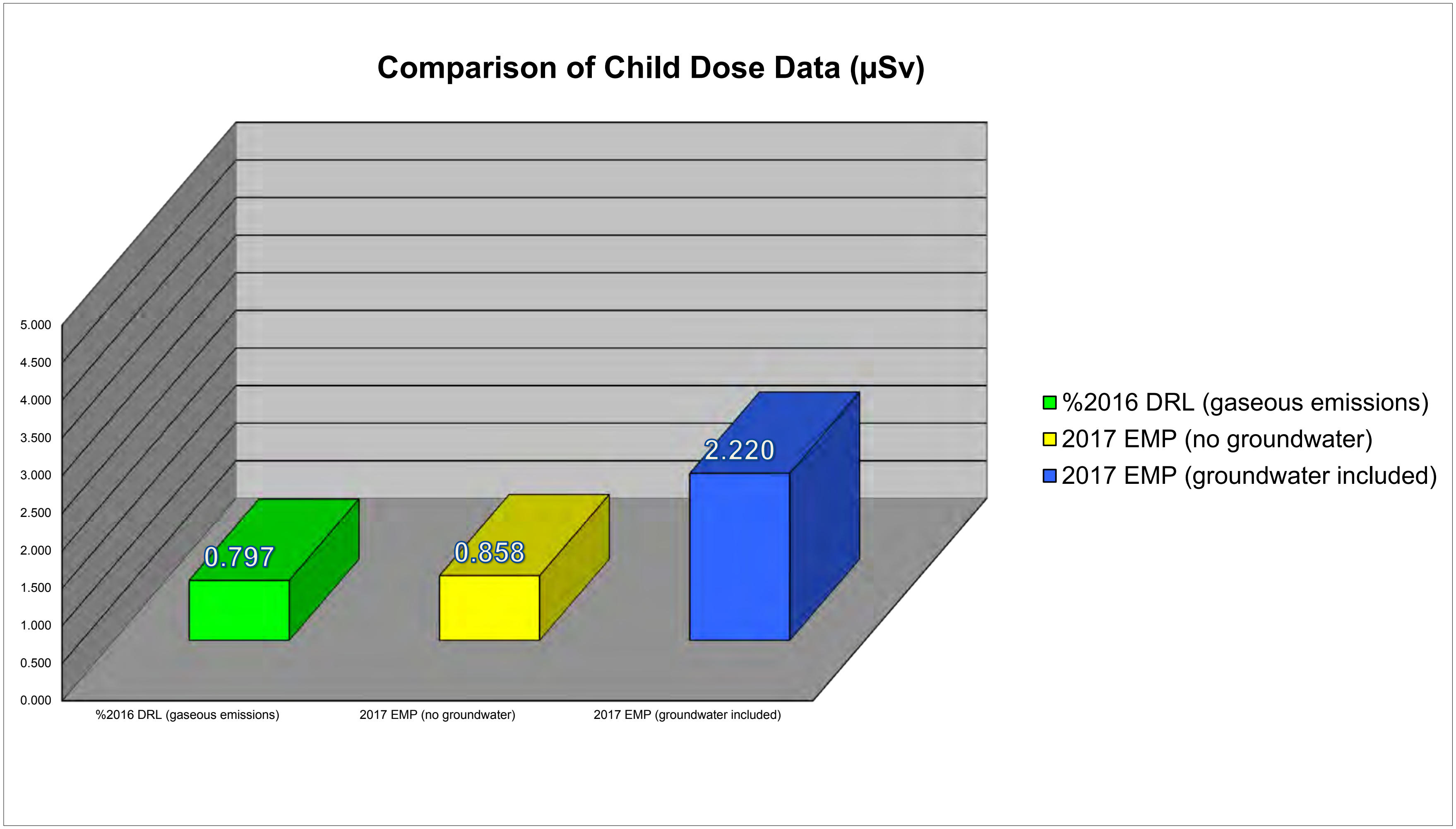
Consumption kg/da x da/a = kg/a		
(kg/da)	**(da/a)**	**(kg/a)**
0.931	365.25	340.0

P59 = [HTO]animal produce (Bq/kg) x Ingestion (kg) x DCF				
P59	**[HTO]**	**Ingested**	**DCF**	
(uSv/a)	**(Bq/kg)**	**(kg/a)**	**(uSv/Bq)**	
0.064	3.56	340.0	5.30E-05	

P59	0.064	uSv/a

CHILD (10 year old child)

Dose Calculation	2017 µSv
%2016 DRL (gaseous emissions)	0.797
2017 EMP (no groundwater)	0.858
2017 EMP (groundwater included)	2.220



CHILD (10 year old child)

Stack Emissions		
	2017 Emissions as %2016 SRBT DRL	
	CHILD	
Sample End	% weekly DRL	(uSv)
03/01/2017	0.01	0.0011
10/01/2017	0.04	0.0077
17/01/2017	0.06	0.0117
24/01/2017	0.07	0.0133
31/01/2017	0.05	0.0099
07/02/2017	0.02	0.0044
14/02/2017	0.04	0.0068
21/02/2017	0.04	0.0075
28/02/2017	0.07	0.0129
07/03/2017	0.03	0.0064
14/03/2017	0.05	0.0097
21/03/2017	0.03	0.0062
28/03/2017	0.05	0.0089
04/04/2017	0.07	0.0132
04/11/2017	0.05	0.0099
04/18/2017	0.04	0.0084
04/25/2017	0.09	0.0172
05/02/2017	0.09	0.0170
05/09/2017	0.05	0.0093
05/16/2017	0.12	0.0230
05/23/2017	0.10	0.0193
05/30/2017	0.08	0.0147
06/06/2017	0.08	0.0158
06/13/2017	0.12	0.0225
06/20/2017	0.14	0.0277
06/27/2017	0.19	0.0372
07/04/2017	0.08	0.0145
07/11/2017	0.12	0.0234
07/18/2017	0.11	0.0212
07/25/2017	0.07	0.0133
08/01/2017	0.09	0.0182
08/08/2017	0.08	0.0154
08/15/2017	0.07	0.0137
22/08/2017	0.08	0.0157
29/08/2017	0.08	0.0145
05/09/2017	0.07	0.0142
12/09/2017	0.09	0.0180
19/09/2017	0.16	0.0298
26/09/2017	0.18	0.0352
03/10/2017	0.14	0.0272
10/10/2017	0.10	0.0200
17/10/2017	0.11	0.0204
24/10/2017	0.10	0.0195
31/10/2017	0.12	0.0237
07/11/2017	0.05	0.0094
14/11/2017	0.08	0.0153
21/11/2017	0.08	0.0156
28/11/2017	0.09	0.0169
05/12/2017	0.07	0.0142
12/12/2017	0.06	0.0108
19/12/2017	0.03	0.0066
26/12/2017	0.04	0.0084
Sum (uSv)		0.797
Ave. (%DRL)	0.08	
Annual Dose Est.	0.797 uSv/a	
	CHILD	

CHILD (10 year old child)
EMP Factors for Dose

Pathways Analysis of Dose to the Public			
		per annum	
Atmospheric HTO inhalation, immersion	P(i)19, P(e)19	0.573	
Surface HTO ingestion	P(i)29	1.362	
Surface HTO immersion	P(e)29	0.000	
External soil exposure	P39	0.000	
Forage & crop ingestion	P49	0.257	
Animal produce ingestion	P59	0.028	
Aquatic animal ingestion	P69	0.000	
Aquatic plant ingestion	P79	0.000	
External sediment exposure	P89	0.000	
Total (uSv)		**2.220 uSv/a**	
Total without P_{29} (uSv)		**0.858 uSv/a**	

CHILD (10 year old child)
EMP Factors for Dose P19

P19 is the transfer pathway of exposure to HTO from compartment 1 (Atmosphere) to 9 (dose)
P(i)19 is the pathway of exposure due to inhalation of HTO, and also implicitly captures skin absorption dose P(e)19 as per CSA N288.1-14 Table C.1.

Formula:
P(i)19 (uSv) = [HTO]air (Bq/m3) x Inhalation (m3) x DCF (uSv/Bq)

Calculation:

PAS # (#)	P(i)19 (uSv)	[HTO]air (Bq/m^3)	Volume (m^3)	DCF (uSv/Bq)	Sum1,4 (uSv/a)	Sum 2,4 (uSv/a)	Sum 13,4 (uSv/a)	Maximum (uSv/a)
1	0.000			3.800E-05				
2	0.000			3.800E-05				
3	0.000			3.800E-05				
4	0.573	1.920	7850.000	3.800E-05	0.573	0.573	0.573	
5	0.000			3.800E-05				
6	0.000			3.800E-05				
7	0.000			3.800E-05				
8	0.000			3.800E-05				
9	0.000			3.800E-05				
10	0.000			3.800E-05				
11	0.000			3.800E-05				
12	0.000			3.800E-05				
13	0.000			3.800E-05				
			P(i)19	**Sum**	**0.573**	**0.573**	**0.573**	**0.573** uSv/a

CHILD (10 year old child)
EMP Factors for Dose P29

P29 is the transfer pathway of exposure to HTO from compartment 2 (Surface Water) to 9 (Dose)
P(i)29 is the pathway of exposure due to ingestion of HTO
P(e)29 is the pathway of exposure due to immersion in HTO

Formula:
P(i)29 = [HTO] (Bq/L) x Ingestion (L) x DCF (uSv/Bq)

Well	P(i)29 (uSv/a)	[HTO]well (Bq/L)	Ingestion (L/a)	DCF (uSv/Bq)	Date	Well 1 (Bq/L)	Well 2 (Bq/L)	Well 3 (Bq/L)	Well 4 (Bq/L)	Well 5 (Bq/L)	Well 6 (Bq/L)	Well 7 (Bq/L)	Well 8 (Bq/L)	Well 9 (Bq/L)	Well 10 (Bq/L)	Well 11 (Bq/L)	Well 12 (Bq/L)
1	0.000	0	482.1	2.50E-05	Jan. 4, 2017												
2	0.635	53	482.1	2.50E-05	Feb. 1, 2017												
3	0.735	61	482.1	2.50E-05	Mar. 1, 2017		63	63		9	7	3	132	38	4		6
4	0.000	0	482.1	2.50E-05	Apr. 4, 2017												
5	0.104	9	482.1	2.50E-05	May 2, 2017												
6	0.072	6	482.1	2.50E-05	Jun. 2, 2017												
7	0.040	3	482.1	2.50E-05	Jul. 5, 2017		57	64		8	5	4	98	38			33
8	1.362	113	482.1	2.50E-05	Aug. 2, 2017												
9	0.458	38	482.1	2.50E-05	Sep. 1, 2017												
10	0.048	4	482.1	2.50E-05	Oct. 3, 2017												
11	0.000	0	482.1	2.50E-05	Nov. 1, 2017		38	56		9	6	3	108				3
12	0.169	14	482.1	2.50E-05	Dec. 1, 2017												
Avg P(i)29	**0.302**	**uSv/annum**															
					Average		**53**	**61**		**9**	**6**	**3**	**113**	**38**	**4**		**14**

Well 1	*No longer sampled*
Well 2	185 Mud Lake Road
Well 3	183 Mud Lake Road
Well 4	*No longer sampled*
Well 5	171 Sawmill Road
Well 6	40987 Highway 41
Well 7	40925 Highway 41
Well 8	204 Boundary Road
Well 9	206 Boundary Road
Well 10	208 Boundary Road
Well 11	*No longer sampled*
Well 12	202 Mud Lake Road

P(e)29 is the pathway of exposure to HTO due to immersion in surface water.
P(e)29 is considered negligible as surface waters throughout 2017 were measured as <detectable.

P(e)29 =	**0.000**	**uSv/mo**

RW-8	**P(i)29**	**1.362**	**uSv/mo**
	P(e)29	**0.000**	**uSv/mo**
	P29	**1.362**	**uSv/mo**

CHILD (10 year old child)
EMP Factors for Dose P49

P49 is the pathway for exposure to HTO due to ingestion of forage and crops.

Produce Sample Results (Bq free water tritium / kg fresh weight)																			
Source	**Market**						**Home**												
Type	**Cabbage**	**Eggplant**	**Pepper**	**Onion**	**Tomato**	**Average**	**LOCATION**	**Beet**	**Green Pepper**	**Rhubarb Leaf**	**Carrot**	**Apple**	**Tomato**	**Potato**	**Cucumber**	**Swiss Chard**	**Onion**	**Zucchini**	**Average**
	8.00	9.00	9.00	5.00	8.00	8	413 SWEEZEY COURT	28.00			24.00	71.00					26.00		37.3
							408 BOUNDARY ROAD						58.00				109.00		83.5
							611 MOSS DRIVE						52.00		32.00				42.0
							416 BOUNDARY ROAD					12.00							12.0
Average	**8.00**	**9.00**	**9.00**	**5.00**	**8.00**	**7.8**		**28.00**			**24.00**	**41.50**	**55.00**		**32.00**		**67.50**		43.7
Produce Sample Results (Bq organically bound tritium / kg fresh weight)																			
Comm.					3.00	**3.0**	408 BOUNDARY ROAD						4.00						**4.0**

Produce Consumption							
100%=	**265.200**	**kg/a**	**[HTO] (Bq/kg)**	**(Bq/a)**	**[OBT] (Bq/kg)**	**(Bq/a)**
70%	185.640	**kg/a**	7.8	1447.99	3.0	556.92
30%	79.560	**kg/a**	83.5	6643.26	4.0	318.24

P49 = [HTO or OBT]produce (Bq/kg) x Produce Ingested (kg/mo) x DCF (uSv/Bq)

P49 (uSv/a)	**[HTO] pro (Bq/a)**	**DCF (uSv/Bq)**	**[OBT] pro (Bq/a)**	**DCF (uSv/Bq)**
0.257	**8091.25**	2.50E-05	**875.16**	6.30E-05

P49	**0.257**	**uSv/mo**

CHILD (10 year old child)
EMP Factors for Dose P59

P59 is the exposure to HTO due to ingestion of animal produce.

2017 Sample Results

Local Producer	
	(Bq/L)
1	4.00
2	4.60
3	3.70
Average	4.10

Local Distributor	
	(Bq/L)
1	3.00
2	3.70
3	3.00
Average	3.23

TOTAL AVERAGE	3.67	Bq/L

Milk Density Adjustment		
Milk Average (Bq/L) x Milk density (L/kg)		
Bq/L	L/kg	Bq/kg
3.67	0.97	3.557

Consumption kg/da x da/a = kg/a		
(kg/da)	(da/a)	(kg/a)
0.875	365.25	319.6

P59 = [HTO]animal produce (Bq/kg) x Ingestion (kg) x DCF				
P59	[HTO]	Ingested	DCF	
(uSv/a)	(Bq/kg)	(kg/a)	(uSv/Bq)	
0.028	3.56	319.6	2.50E-05	

P59	0.028	uSv/a

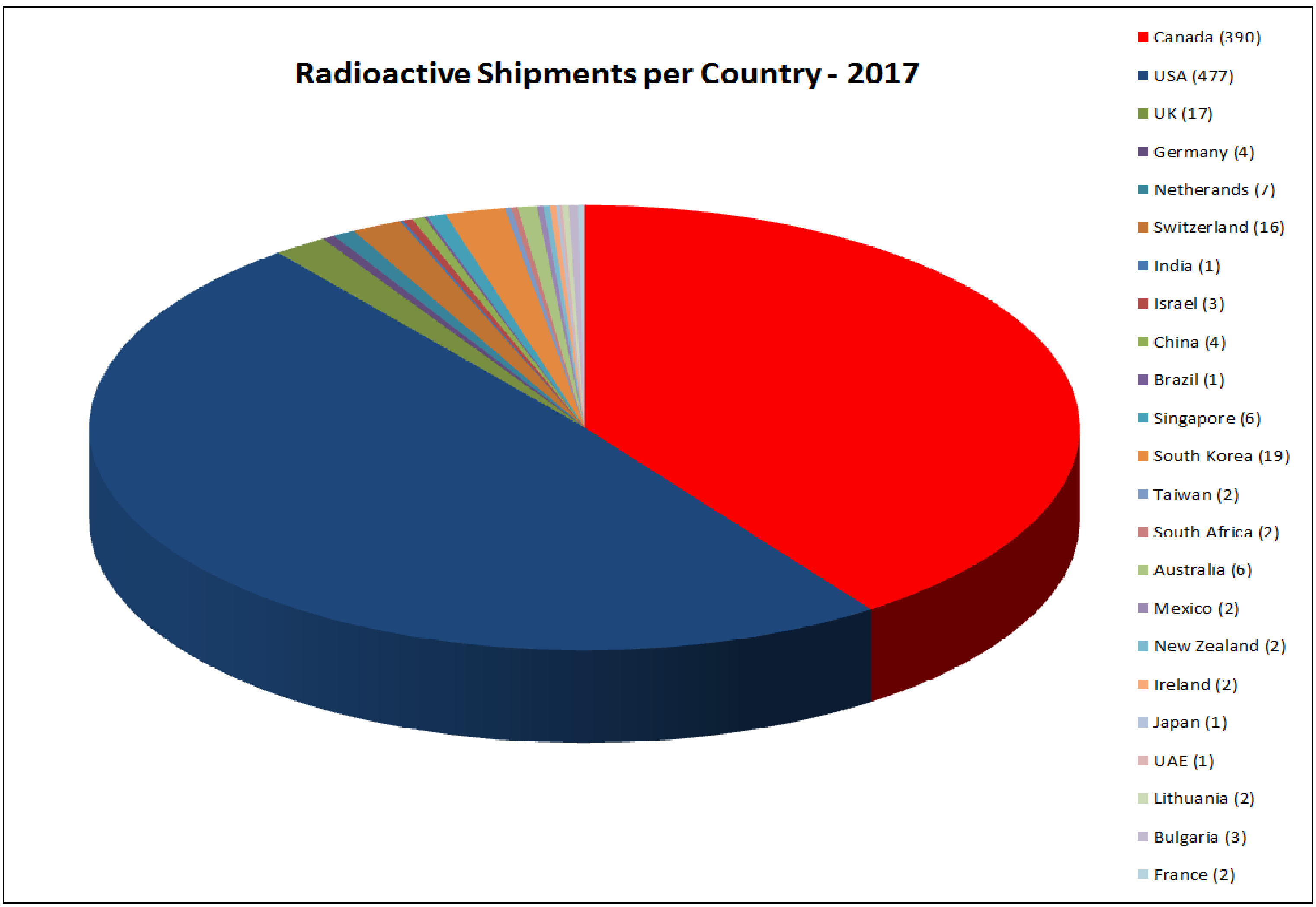
APPENDIX T

Outgoing Shipments Containing Radioactive Material for 2017

SHIPMENTS CONTAINING RADIOACTIVE MATERIAL FOR 2017

Month	Number of Shipments
January	83
February	63
March	105
April	84
May	100
June	82
July	71
August	83
September	72
October	76
November	86
December	65
Total Shipments	**970**
2017 Monthly Average:	81

DISTRIBUTION OF SHIPMENTS CONTAINING RADIOACTIVE MATERIAL FOR 2017



APPENDIX U

Incoming Shipments Containing Radioactive Material for 2017

INCOMING SHIPMENTS CONTAINING RADIOACTIVE MATERIAL FOR 2017

Month	Number of Shipments
January	52
February	17
March	35
April	60
May	54
June	54
July	43
August	33
September	33
October	63
November	60
December	35
Total Shipments	**539**
2017 Monthly Average:	45

ORIGIN OF INCOMING SHIPMENTS FOR 2017