SRB Technologies (Canada) Inc.

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2019 Annual Compliance and Performance Report

Reporting Period:	January 1 – December 31, 2019
Licence Number:	NSPFOL-13.00/2022
Licence Condition:	4.2

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SRB Technologies (Canada) Inc.

2019 Annual Compliance and Performance Report

Submission date: March 31, 2020

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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 improvements achieved during 2019.

The ratio of the amount of tritium released to atmosphere versus the amount of tritium that we processed in 2019 decreased when compared to the previous year. For every 1,000 units of tritium that went into our products this year, 1.0 unit of tritium was eventually released as gaseous effluent. This ratio (0.10%) met our annual target of 0.13%.

In 2019, SRBT processed 30,327,048 GBq of tritium into self-luminous light sources and safety devices; in comparison, in 2018, a total of 31,251,329 GBq of tritium was processed.

The total amount of tritium released to the environment through the gaseous effluent pathway decreased (31,769 GBq) compared with the previous year (33,180 GBq). The annualized gaseous tritium releases met our target for 2019; on the average, 599 GBq of tritium was released weekly, versus our target of 650 GBq per week.

The collective dose to workers at SRBT totalled 2.95 person·mSv, and no staff member exceeded 1 mSv for the year – a value that represents the dose limit to the public. As well, no action levels were exceeded with respect to radiation doses. 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.

In 2019, CNSC staff performed two inspections at the facility; all identified compliance and improvement 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 Maintenance Program, our Licence Limits, Action Levels and Administrative Limits document, the Health and Safety Policy, Fire Protection Program, Fire Safety Plan, and Preliminary Decommissioning Plan.

Our financial guarantee was maintained fully-funded throughout 2019, and does not rely on insurance, letters of credit or third party resources in order to ensure funding availability for future decommissioning of the facility. In late 2019, the SRBT Preliminary Decommissioning Plan was revised and submitted to CNSC staff in accordance with our Licence Conditions Handbook. This plan includes an updated financial guarantee valuation which, if accepted, will result in our financial guarantee being topped up and fully funded in early 2020.

In summary, 2019 represents a highly successful and safe year of operation for SRBT. Continual improvements in compliance and safety is an ongoing mission, and we will always strive to reduce our operational impact on the environment, and to optimize safety and the effective doses to our workers and the public.

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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
CSM	Conceptual Site Model
CVC	Compliance Verification Criteria
dp	Differential Pressure
DS	Downspout
DSL	Dosimetry Service Licence
DU	Depleted Uranium
ECR	Engineering Change Request
EffMP	Effluent Monitoring Program
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
FSEP	Fire Safety and Emergency Preparedness
GMP	Groundwater Monitoring Program
GNSCR	General Nuclear Safety and Control Regulations
GTLS	Gaseous Tritium Light Source

Acronyms and Abbreviations

GWMP	Groundwater Monitoring Program
HT	Elemental Tritium
HTO	Tritium Oxide
HVAC	Heating, Ventilation, Air Conditioning
IAEA	International Atomic Energy Agency
IATA	International Air Transportation Agency
IEMP	Independent Environmental Monitoring Program
ISO	International Organization For Standardization
IT	Information Technology
JHSC	Joint Health and Safety Committee
LCH	Licence Conditions Handbook
LLW	Low-Level Waste
LMI	Laser Machining Incorporated
LSC	Liquid Scintillation Counters / Counting
LTI	Lost Time Incident
MDA	Minimum Detectable Activity
MW	Monitoring Well
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

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
WHSC	Workplace Health and Safety Committee
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, 2019, 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. Two events occurred during the year which were deemed to meet criteria for reporting to CNSC staff, neither of which impacted nuclear safety.

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 safely and compliantly throughout 2019.

1.2.1 Tritium Processing

In 2019, SRBT conducted 4,521 tritium processing operations (light source filling), with a total of 30,327,048 GBq of tritium being processed into gaseous tritium light sources (GTLS). Both of these figures represent slight decreases over 2018 processing statistics (4,919 operations, 31,251,329 GBq).

Please refer to section 1.4, 'Production or Utilization' for additional details on tritium processing in 2019.

1.2.2 Production and Distribution of Self-luminous Safety Products

In 2019, 949 shipments of our self-luminous safety products were made to customers in 20 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 2019.

1.2.3 Acceptance of Expired Products

In 2019, a total of 28,073 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 5,144.93 TBq of tritium. In 2018, 21,232 signs were processed representing 3,530.29 TBq of tritium.

These signs were disassembled safely and the light sources removed. A very small number of these signs were evaluated as having light sources that could be reused in other self-luminous devices. Lights that could not be repurposed were packaged and shipped to a licenced radioactive waste management service provider.

As well, an additional 184.62 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 2019.

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 on two occasions in 2019.

In February, CNSC staff conducted a general compliance inspection (SRBT-2019-01), with a broad scope that included six Safety and Control Areas (SCAs), while in August, CNSC staff conducted a compliance inspection (SRBT-2019-02) focused on the Environmental Protection SCA.

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

BSI Management Systems, on behalf of the International Organization for Standardization (ISO), conducted a major audit of SRBT operations in September 2019. The audit verified our implementation of a quality management system aligned with the 2015 version of the ISO 9001 standard. The audit resulted in one opportunity for improvement being identified.

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 confirmed our certification to the 2015 version of ISO 9001.

Two major customers of SRBT products conducted independent audits of our operations in 2019. Underwriters' Laboratories (UL) completed four quarterly audits as planned.

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 August, while Professional Loss Control (PLC) Fire Safety Solutions conducted a N393-13 compliant facility condition inspection in October. Details on these inspections can be found in section 4.4, 'SCA – Emergency Management and Fire Protection'.

1.2.5 Internal Oversight

Internally, twelve internal compliance audits were conducted through the year, focused on all aspects of our operations and our organization. A total of 20 non-conformance reports (NCR) and 49 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 two events to CNSC staff in 2019, neither of which had any impact on nuclear safety.

Details on these reported events can be found in section 2.3, 'SCA – Operating Performance', and in section 4.8, 'SCA – Packaging and Transport'.

1.2.7 Operational Challenges

SRBT did not experience any significant operational challenges in 2019.

1.2.8 Summary of Significant Modifications

No significant modifications were implemented in the facility which pertain to our licensed activities in 2019, and there were no changes to the production capacity of the facility.

SRBT undertook and completed three major projects in the Rig Room area of our facility in 2019 – a laser cutting system was dismantled, the Rig Room fume hoods were replaced, and the Reclaim Rig was decontaminated and dismantled.

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

Please refer to section 3.2, 'SCA – Physical Design', for more information regarding notable facility modifications carried out in 2019.

1.2.9 Summary of Organizational Structure and Key Personnel

SRBT underwent an organizational change in the fall of 2019, primarily related to the way the organization supporting Health Physics-related programs is comprised. This change was fully controlled and assessed in accordance with our change control processes.

At the conclusion of 2019, SRBT employs 42 employees and managers.

Please refer to section 2.1, ‘SCA – Management System’ for details regarding SRBT’s organizational structure in 2019.

1.3 Summary of Compliance with Licence and OLCs

Throughout 2019, 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 regulatory requirements.

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.
- 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 2019.

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 2019.

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 2019. 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 where measureable precipitation was not occurring during 2019.

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 2019 was equal to 1.19E+13 Bq (11,858 GBq), representing 17.6% 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 2019 was equal to 3.18E+13 Bq (31,769 GBq), representing 7.1% 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 2019 when the noted differential pressures (dp) were not being achieved, as measured daily prior to operations commencing.

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 2019 was equal to 1.367E+10 Bq, representing 6.84% 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 2019 was conducted using PUTTs that had been cycled 30 times or less on the bulk splitter.

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 2019, 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.

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 compliance with this limit throughout 2019.

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 2019.

Please refer to section 2.3, ‘SCA – Operating Performance’ for more details on inventory controls of DU in 2019.

1.3.12 Exceedances of Facility Action Levels

There were no exceedances of radiation protection or environmental protection action levels in 2019.

Facility action levels were reviewed, and revised or revalidated in 2019. Please refer to section 2.1.7 for details on this initiative.

1.4 Production or Utilization

1.4.1 Tritium Processing

In 2019, at total of 30,327,048 GBq of tritium was processed. This represents a decrease of about 3% from the 2018 value of 31,251,329 GBq.

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

TABLE 1: TRITIUM PROCESSED – FIVE YEAR TREND

Calendar Year	2015	2016	2017	2018	2019
Tritium Processed (GBq)	27,989,832	28,122,678	32,968,695	31,251,329	30,327,048

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 2019 this possession limit was not exceeded. The maximum tritium activity possessed at any time during 2019 was 4,607 TBq, in December. The monthly average inventory of tritium in the facility was 3,551 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 2019 can be found in **Appendix A** of this report.

1.5 Changes in Management System Documentation

In 2019, SRBT revised several key program-level management system documents associated with our licensing basis, following the change control provisions of our Licence Conditions Handbook.

These include:

- Maintenance Program,
- Licence Limits, Action Levels and Administrative Limits document,
- Health and Safety Policy,
- Fire Protection Program,
- Fire Safety Plan, and
- Preliminary Decommissioning Plan.

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, 105 Engineering Change Requests (ECRs) were generated to control the revision and review of programs, procedures or forms in 2019.

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 2019, 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 82 non-conformances (NCR) and 113 opportunities for improvement (OFI) were raised in different areas of the company operations.

As of the end of 2019, 61 out of the 82 NCRs raised in 2019 had been addressed, reviewed for effectiveness and closed, with all having been evaluated as being effective in correcting the issue identified.

The remaining 21 NCRs are still in progress due to the fact that they were raised in the later part of the year, or due to relative longer timeframes for the actions that are to be taken to resolve the issues identified.

For opportunities for improvement (OFIs), 66 out of the 113 raised in 2019 have been addressed, reviewed for effectiveness and closed, with all having been evaluated as being effective in achieving the improvement identified.

The remaining 47 OFIs were either raised later in the year, and/or 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 2019.

Organizational Management Reviews were conducted in early 2019 by all program owners and responsible managers, including benchmarking and self-assessment activities. These reviews were focused on the 2018 calendar year. Reports were submitted to the Compliance Manager and Executive Assistant in preparation for the annual Management Review.

This review was conducted by way of three daily meetings of the Executive Committee, held between March 26-28, 2019, where the results of the benchmarking and self-assessment activities performed for the previous calendar year were reported and discussed, and areas where improvements could be made in the various company safety programs were highlighted.

The management system was found to be effective at meeting the current requirements of the NSCA, associated regulations and the conditions of the operating licence, as well as ISO 9001:2015, and customer requirements.

The 2019 Organizational Management Reviews are scheduled to take place in early 2020, followed by a meeting of the Executive Committee to discuss the outputs of the reviews, and identify any opportunities for improvements, actions required to mitigate risks, and compliance or performance issues.

2.1.1 Staffing and Organization

At the beginning of 2019, SRBT total staff complement stood at 42 employees.

Four of these employees are no longer employed by the company, while four new employees were hired during the year. As of the end of 2019, the total staff complement stands at 42 employees.

A number of changes in our organizational structure were implemented in November 2019, in full compliance with the Change Control process.

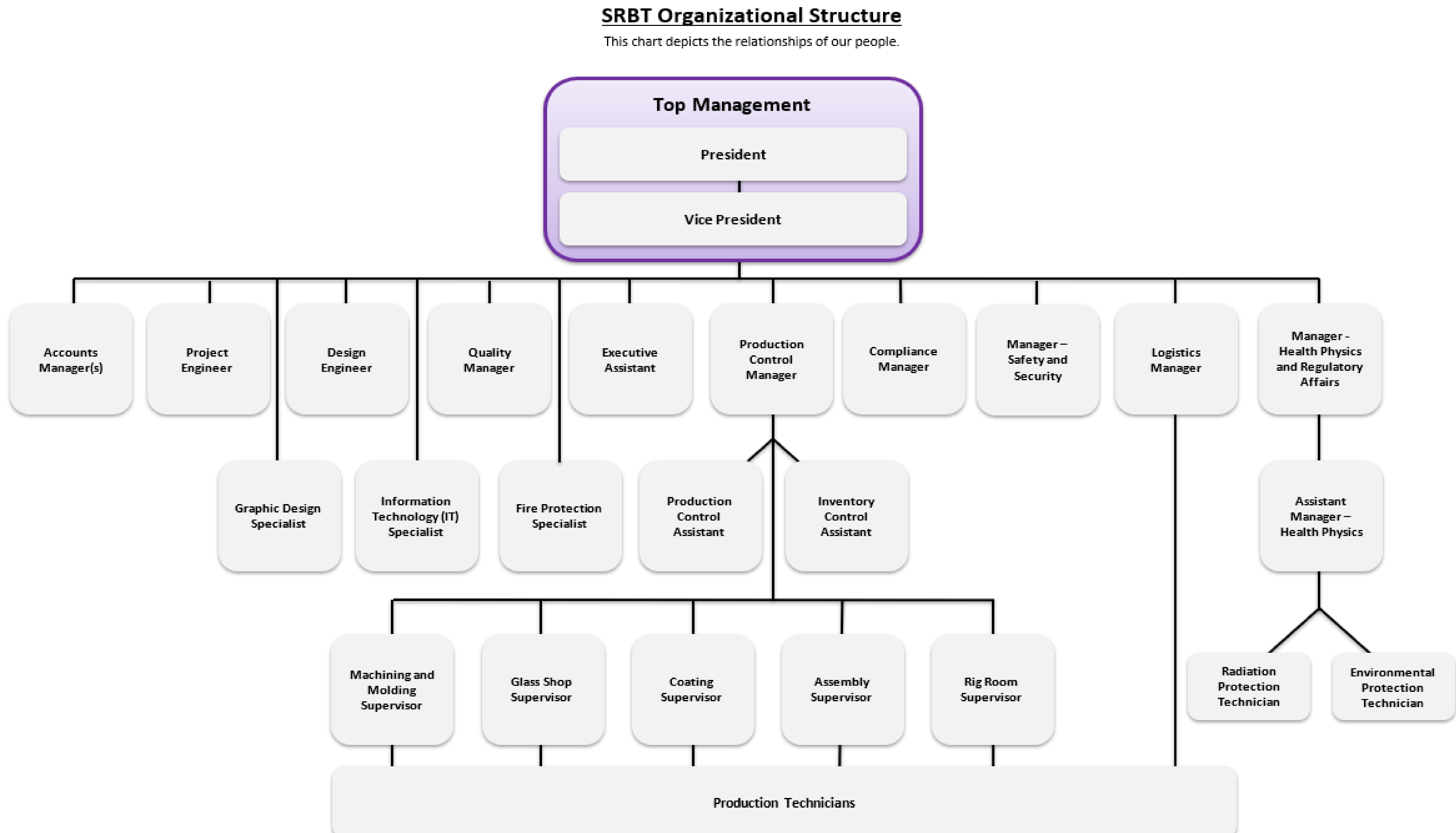
A new position of Logistics Manager was created as a replacement to the position of Import / Export Manager, with the title change intended to better capture the nature and breadth of the responsibilities of this manager in our organization.

As well, the Health Physics Team underwent a change in structure, with the creation of three new positions, including the Assistant Manager – Health Physics, the Radiation Protection Technician and the Environmental Protection Technician. A complete description of this change can be found in Section 4.1.12 of this report.

Finally, new positions of Graphic Design Specialist and Inventory Control Assistant were created to better align internal resource allocations and clarify responsibilities.

The organizational chart on Figure 1 represents the structure of the company, as of the end of 2019, 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 2019, a total of 42 employees work at the company, including 18 administrative employees and 24 production / technician-level 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.

Administrative employees also include 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 also provide input ensuring that our management system meets the requirements of the ISO 9001 standard.
- Logistics Manager is mainly responsible for the shipment, receipt and inventory control of radioactive materials, as well as 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 developing and maintaining product specifications and manufacturing procedures, and managing facility maintenance activities.
- Design Engineer is mainly responsible for product research and development, plastics molding and printing, and oversight of the change control process.
- 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 Canada Occupational Health and Safety Regulations, and support for the Security Program.

- 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 on regulatory matters.

Six employees provide program oversight and/or directly assist individuals at the management support level,

- Graphic Design Specialist is responsible for coordinating changes to the company website, and for the design and development of public information products and sales literature.
- IT Specialist manages and maintains the facility computer network and provides a wide range of technical and engineering support.
- Fire Protection Specialist ensures that facility fire safety procedures are implemented, and for coordinating with the Pembroke Fire Department for drills, inspection and training.
- Production Control Assistant is responsible for processing sales orders, maintaining the order book and distributing work packages (vacant as of end of 2019 – all responsibilities being executed or managed by the Production Control Manager).
- Inventory Control Assistant oversees the receipt of all materials, including quality evaluation where applicable, and for general stores and materials.
- Assistant Manager – Health Physics is responsible for the day-to-day implementation of company Health Physics-related programs and processes, including coordinating the activities of technician-level resources assigned to the department.

At the technician level, within the Health Physics department, two individuals are assigned:

- Radiation Protection Technician performs duties relating primarily to radiation protection.
- Environmental Protection Technician has been retained since May, and is primarily responsible for performing duties relating to environmental protection.

Twenty-two production-focused 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 seventeen Production Technicians,

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

2.1.2 Committees

In 2019, 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 2019, a total of 82 committee meetings took place at the company compared to 77 in 2018.

TABLE 2: COMMITTEE MEETINGS

COMMITTEE	NUMBER OF MEETINGS
PRODUCTION COMMITTEE	31
WORKPLACE HEALTH AND SAFETY COMMITTEE	16
HEALTH PHYSICS COMMITTEE	8
MAINTENANCE COMMITTEE	5
MITIGATION COMMITTEE	5
EXECUTIVE COMMITTEE	4
FIRE PROTECTION COMMITTEE	3
TRAINING COMMITTEE	3
WASTE MANAGEMENT COMMITTEE	3
PUBLIC INFORMATION COMMITTEE	2
OTHER COMMITTEE / STAFF MEETINGS	1
SAFETY CULTURE COMMITTEE	1
TOTAL	**82**

Committee meetings 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 reviews, 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:

- Zero lost-time injuries or incidents occurring in 2019,
- All workplace injuries were relatively minor in nature,
- Highest worker dose for 2019 is 1.14% of the regulatory limit,
- Maximum calculated public dose remains less than 1% of the regulatory limit for persons who are not nuclear energy workers,
- Continued low ratio of tritium released vs. processed,
- Gaseous tritium oxide releases were less than 20% of authorized limits, while combined oxide and elemental tritium releases were less than 10% of authorized limits,
- Tritium releases via liquid effluent were less than 10% of authorized limits,
- All conditions of our facility operating licence met throughout the year,
- No open CNSC compliance actions as of the end of 2019,
- Continued improvement of several key programs and processes, and
- Continuous registered 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 2019 that touched on several aspects of our operations.

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

- Quality Department
- Management System
- Maintenance
- Dosimetry Service
- Radiation Protection
- Environmental Protection
- Production Departments
- Public Information Program and Financial Guarantee
- Shipping and Inventory Control
- Material and Production Control
- Health and Safety
- Emergency Management and Fire Protection

Internal audits resulted in 20 non-conformances (NCR) and 49 opportunities for improvement (OFI) being identified in 2019. Actions have been established and tracked 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 in 2019.

In February, CNSC staff conducted a general compliance inspection (SRBT-2019-01), with a broad scope that included six Safety and Control Areas (SCAs).

As a result of the inspection, six compliance actions and two recommendations were issued[4], which were satisfactorily addressed by SRBT[5].

In August, CNSC staff conducted a compliance inspection (SRBT-2019-02) focused on the Environmental Protection SCA. This included numerous compliance assessments of processes related to the Environmental, Effluent and Groundwater Monitoring Programs.

No compliance actions were issued as a result of this inspection, and only a single recommendation[6] was put forth pertaining to the future content of the SRBT ACR, to which SRBT responded accordingly[7].

At the conclusion of 2019, there are no outstanding compliance actions associated with the SRBT operating licence.

2.1.5.2 ISO Certification Audits (1)

On behalf of the International Organization for Standardization (ISO), BSI Management Systems conducted an audit of SRBT operations related to the quality management system on September 23-24, as part of the maintenance of SRBT's ISO 9001 certification.

The audit resulted in one opportunity for improvement being identified that is in the process of being addressed and completed in early 2020.

2.1.5.3 Customer-Led Audits (2)

In 2019 there were two external audits executed by customers. Both were product-focused quality audits of our facility.

A customer of aerospace safety signs conducted an audit between April 16-17, resulting in four findings. The non-conformances identified have since been fully addressed.

The second audit was conducted by a major customer of commercial safety signs, between October 8-9. The audit resulted in no findings being identified.

2.1.5.4 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 2019, UL performed inspections on February 12, April 10, July 31 and November 13, with no variation notices being raised through the year.

2.1.5.5 Fire Protection Inspections (2)

Two focused facility inspections were conducted relating to fire protection.

The Pembroke Fire Department inspected the facility in August, with no violations being identified.

Professional Loss Control (PLC) Fire Safety Solutions conducted a N393-13 compliant site condition inspection in October. One finding and two Opportunity for Improvements (OFI) were found as a result of the site condition inspection, all of which were minor in nature.

The site condition inspection finding, as well as the two OFI's, were remedied immediately following the inspection. Extra precautions were taken at the annual radiation safety training by talking to all staff regarding the finding and OFI's of the inspection.

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

2.1.5.6 SRBT Audits of Suppliers, Manufacturers or Service Providers

In 2019, SRBT performed one audit of a supplier, manufacturer or service provider.

The University of Ottawa was audited as a service provider supporting SRBT's Environmental Monitoring Program in August, resulting in two OFIs which have been addressed by the appropriate program manager.

2.1.6 Benchmarking and Self-assessments

In 2019, 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 is encouraged. Documents describing the performance of similar CNSC licensees are made available for review, including:

- 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 over the course of three days between March 25-27, 2019.

The scope of this meeting was to fully and critically review our operations for calendar year 2018, to develop actions to address identified issues and risks, and to take advantage of opportunities for improvement.

The 2019 Management Review is scheduled to be completed by March 31, 2020.

2.1.7 Programs and Procedures

2.1.7.1 Programs and Major Licensing Documents

In 2019, several key management system programs and plans were revised in line with SRBT's mission of continuous improvement.

On March 26, 2019, SRBT submitted an **LCH Change Request**, focused on removing the requirement to routinely sample the CN wells across the road from the SRBT facility[8]. The CN wells are not owned by SRBT, nor are they on land that SRBT owns or controls. Over the years, these wells have physically degraded and became increasingly difficult to sample reliably. More than ten years of data had been obtained using these wells, with a clear downward trend in tritium concentration over time.

CNSC staff acknowledged the request, and granted permission to discontinue this sampling in advance of the next LCH revision[9].

On May 2, 2019, SRBT submitted Revision 7 of the **Maintenance Program** to CNSC staff[10]. The program was reviewed and accepted by CNSC staff, and three recommendations put forth for a future revision on June 5, 2019[11].

On May 23, 2019, SRBT submitted a revised version of our **Licence Limits, Action Levels and Administrative Limits** document to CNSC staff for review and acceptance[12]. This document is required to be reviewed and revised, if necessary, every five years, as per the LCH. The revision to the document focused exclusively on action levels and administrative limits (as Licence Limits are set by the CNSC).

The revision of this document was executed in line with the processes described in CSA standard N288.8-17, *Establishing and implementing action levels for releases to the environment from nuclear facilities.*

Comments were received on the document on June 27, 2019[13], and a teleconference between SRBT and CNSC staff was arranged for July 15, 2019 to discuss the comments and provide both parties with additional clarification and details on the changes. A modified version of the document was then submitted on July 19, 2019[14], and the revised version was ultimately accepted by CNSC staff on August 21, 2019[15].

SRBT submitted a revised **Health and Safety Policy** document to CNSC staff on May 30, 2019[16]. This was accepted by CNSC staff on July 18[17].

With the publication of REGDOC 2.1.2, *Safety Culture,* SRBT submitted a **gap analysis** to CNSC staff on May 31, 2019[18].

This gap analysis demonstrated that SRBT documents our commitment to fostering safety culture in our management system documentation, and that there are no gaps in compliance with the applicable requirements in the regulatory document.

SRBT submitted four LCH-listed procedures that had undergone revision on July 4, 2019[19], including **RSO-009, *Tritium Inventory Management,* RSO-029, *Nuclear Substances Inventory Management,* SHP-001, *Packing and Shipping – General Requirements*,** and **SHP-005, *Document – Dangerous Goods Document*.** CNSC staff accepted these revised procedures on November 15[20], with additional clarification being provided by SRBT on SHP-005 on November 21[21].

CNSC staff provided SRBT with a draft of Revision 3 of the **Licence Conditions Handbook** on October 28, 2019[22], and comments were provided by SRBT on November 12[23].

SRBT submitted a revised **Fire Protection Program** and **Fire Safety Plan** to CNSC staff on November 27, 2019[24]. These revisions were made to incorporate a new procedure, to describe new training requirements, to change the location of the Pembroke Fire Hall (which had moved into a new building much nearer to the facility), and changes in the frequency of meetings of the Fire Protection Committee.

On November 29, 2019, SRBT submitted a revised **Preliminary Decommissioning Program** (PDP) to CNSC staff[25].

The PDP was revised in accordance with requirements in the LCH, which requires the plan to be revised at a minimum of every five years. The last revision of the PDP was completed in 2014.

Several important changes were made to the PDP, including but not limited to:

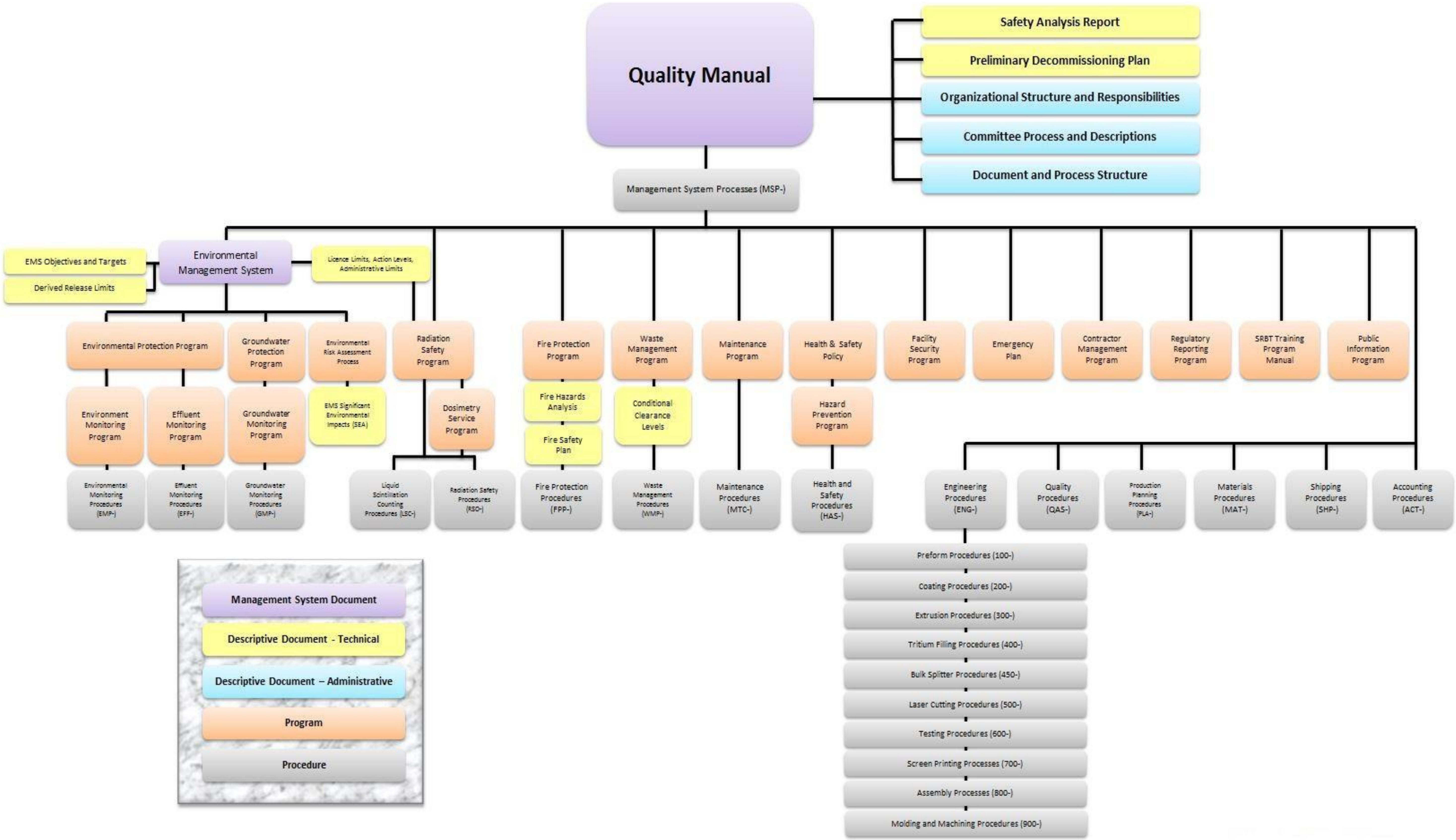
- updating the facility footprint to account for the recent expansion,
- adjusting labour rates to account for inflation,
- incorporating clearance-level waste limits,
- alignment with the modernized SRBT management system,

- updated waste cost projections,
- incorporating recycling as a potential strategy during decommissioning work,
- removed references to Laser Machining Incorporated (LMI) laser and Reclaim Rig, and updated the description of Rig Room fume hoods which were replaced by stainless steel models in 2019,
- updated aerial photos of the facility and the surrounding area,
- updated all cost estimates, including the total required financial guarantee to fund the work 100% with contingencies, and
- other improvements and corrections where needed.

2.1.7.2 SRBT Management System Document Hierarchy

Figure 2 illustrates the Management System document hierarchy in place as of the end of 2019.

FIGURE 2: MANAGEMENT SYSTEM DOCUMENTS



2.1.7.3 Management System Changes

In 2019, a total of 105 Engineering Change requests (ECR) were filed relating to procedural changes in the SRBT management system (compared to 60 in 2018, and 76 in 2017). The breakdown of ECRs filed was as follows:

TABLE 3: PROCEDURAL ECR SUMMARY

PROGRAM / AREA	NUMBER OF ECRs
ENGINEERING	21
MAINTENANCE	14
RADIATION SAFETY	14
WORK PLANNING	10
PRODUCTION	9
ENVIRONMENTAL MONITORING AND PROTECTION	8
MANAGEMENT SYSTEM	7
FIRE PROTECTION	4
QUALITY	3
CONVENTIONAL HEALTH AND SAFETY	3
EFFLUENT MONITORING	3
WASTE MANAGEMENT	3
SHIPPING AND RECEIVING	2
LIQUID SCINTILLATION COUNTING LAB	2
OTHER	2
TOTAL	**105**

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 2019, 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 2019 our staff complement remained stable; at the end of the year, SRBT employed a total of 42 staff members, compared to 42 staff members at the conclusion of 2018.

The average experience of our workforce stands just under 11 years, with an average age of just under 43 years old. The Health Physics Team possesses a combined 115 years of work experience with the company, while production supervisors average just over 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	**16.34**	✓	-	-
RIG ROOM	**9.69**	-	✓	✓
GLASS SHOP	**13.25**	-	-	-
ASSEMBLY	**12.56**	-	-	✓
MACHINING AND MOLDING	**9.33**	-	-	-
COATING	**4.79**	-	-	-
SHIPPING	**4.85**	-	-	-
CLEANING	**0.23**	-	-	-

The Assembly department is where handling of light sources takes place, and has the second highest average work experience with the company of any production department. The average work experience of the staff within this department is just under 13 years.

In 2019, an employee with over 28 years of experience was moved from the Rig Room to the Assembly department, in order to provide more experience with handling of tritium light sources, and to reduce the frequency of light breakages.

Consequently, the average experience in the Rig Room has reduced; however, the level of experienced oversight has not been affected, as the Rig Room Supervisor possesses just over 28 years of work experience.

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 2, 2019, 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). As well, a safety culture survey was administered to all staff.

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 30, 2019. 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 Protection Specialist Training

The Fire Protection Specialist attended a one-day seminar in Ottawa on October 3, 2019 at the 3rd International Canadian Nuclear Society Conference on Fire Safety and Emergency Preparedness for the Nuclear Industry (FSEP 2019).

2.2.1.4 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.

In line with the schedule of this training, a session was conducted on February 25, 2019. Seven employees successfully underwent this training and were TDG-certified.

2.2.1.5 Health and Safety Training

The Manager - Safety and Security and an employee representative of the Health and Safety Committee attended a Health & Safety Training Conference in Ottawa on October 16, 2019, and took part in training seminars that included:

- You Have a Sexual Harassment Complaint, Now What?
- The New World of Cannabis
- Implementation of Bill C-65
- JHSC - Stories from the Trenches
- Incident Investigations Through The Eyes of the Ministry of Labour
- Workplace Depression and Prevention

In December 2019, all SRBT staff were provided refresher training in WHMIS at the annual SRBT training day.

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 2019, with the annual program evaluation being held in May, and the annual review of the qualification of SAT-based trainers being conducted in November.

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

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 nine 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. One individual was allowed to have their qualification lapse in 2019, as they are no longer responsible for conducting stack monitoring activities.

The following table compiles information on the number of qualified workers assigned tasks that are trained in accordance with a SAT-based method at the end of 2019.

TABLE 5: WORKER QUALIFICATION IN SAT-BASED ACTIVITIES

SAT Work Activity	Fully Qualified Workers	Workers Progressing Toward Full Qualification
SAT-HP-01: ADVANCED HEALTH PHYSICS INSTRUMENTATION	3	0
SAT-HP-02: LIQUID EFFLUENT MANAGEMENT AND CONTROL	4	1
SAT-HP-03: WEEKLY STACK MONITORING	3	1
SAT-HP-04: BIOASSAY AND DOSIMETRY	4	0
SAT-OP-01: TRITIUM PROCESSING – FILLING AND SEALING LIGHT SOURCES	5	0
SAT-OP-02: BULK SPLITTER OPERATIONS	4	0
SAT-OP-03: HANDLING PUTTS	4	0

2.3 SCA – Operating Performance

SRBT has continued to operate the facility safely and in compliance with our operating license throughout 2019.

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, while 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 2019 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 reduction initiatives.

The following table illustrates how this ratio has trended over the past five years.

TABLE 6: TRITIUM RELEASED TO PROCESSED RATIO FIVE YEAR TREND (2015-2019)

DESCRIPTION	2015	2016	2017	2018	2019
TOTAL TRITIUM RELEASED TO ATMOSPHERE (GBq/YEAR)	56,237	28,945	24,822	33,180	31,769
TRITIUM PROCESSED (GBq/YEAR)	27,989,832	28,122,678	32,968,695	31,251,329	30,327,048
RELEASED / PROCESSED (%)	**0.20**	**0.10**	**0.08**	**0.11**	**0.10**
CHANGE IN RATIO INCREASE (+) / REDUCTION (-)	-13%	-50%	-20%	+38%	-9%

A slight decrease in the ratio of tritium released to processed was observed in 2019.

2.3.2 Objectives and Targets

SRBT performance against key objectives and targets for 2019 is tabled below.

TABLE 7: 2019 PERFORMANCE TARGETS

DESCRIPTION	2019 TARGET	PERFORMANCE
MAXIMUM DOSE TO NUCLEAR ENERGY WORKER	≤ 0.70 mSv	0.57 mSv
AVERAGE DOSE TO NUCLEAR ENERGY WORKER	≤ 0.055 mSv	0.065 mSv
CALCULATED DOSE TO MEMBER OF THE PUBLIC	≤ 0.0060 mSv	0.0022 mSv
WEEKLY AVERAGE TRITIUM RELEASES TO ATMOSPHERE	≤ 650 GBq / week	599 GBq
RATIO OF TRITIUM EMISSIONS VS. PROCESSED	≤ 0.13	0.10%
TOTAL TRITIUM EMISSIONS LIQUID EFFLUENT PATHWAY	≤ 10 GBq	13.67 GBq
ACTION LEVEL EXCEEDANCES ENVIRONMENTAL	≤ 1	0
ACTION LEVEL EXCEEDANCES RADIATION PROTECTION	≤ 1	0
CONTAMINATION CONTROL FACILITY-WIDE PASS RATE	≥ 95%	93.6%
LOST TIME INJURIES	0	0
MINOR INJURIES REPORTABLE TO ESDC	≤ 15	22

Targets values are set at the outset of each calendar year by committee. Data is tracked and trended throughout the year in order to ensure that appropriate measures can be taken where appropriate, in an effort to ensure a high level of safety performance.

Where targets are missed, specific actions are documented and tracked to improve performance where feasible; however, in some cases production considerations can result in effects that were not anticipated when the annual targets were set.

Two key production-related factors influenced our performance in three specific areas - namely, the average dose to nuclear energy workers, tritium in liquid effluent, and the pass rate for routine contamination control checks:

- A major customer renewed an order for additional miniature light sources that are known as having a significant impact on our liquid effluent.
- An increase took place in the rate of expired sign returns beginning in September 2019. This resulted in an increase to the average worker dose, and also had an impact on the pass rate for routine contamination assessments as well as low-level chronic airborne contamination levels in the facility.

All three of these missed targets have been researched and investigated, and actions taken aimed at increasing our performance in these areas in 2020.

The fourth missed target pertains to the number of minor injuries reported to Employment and Social Development Canada (ESDC). For 2019, the Workplace Health and Safety Committee (WHSC) had set an ambitious target of 15 such injuries or less for 2019, after achieving the previous year's target (15 instances vs. 2018 target of 20).

Beginning in 2017, the criteria for an injury that requires reporting to the ESDC was modified so as to include ALL injuries that required first aid to be administered, including minor cuts, scrapes and burns that would not have been reported before.

These minor injuries were reported to ESDC annually by March 1, and this data point is what has been tracked and targeted in the SRBT ACR since the 2017 report.

In January 2020, additional guidance was obtained from ESDC clarifying the nature of the injuries that should be included in this statistic in the annual report. SRBT determined that the vast majority of the injuries reported did not meet this definition, and that we had been over-reporting this data.

By applying the correct interpretation of a reportable injury, in fact only a single injury was reported to ESDC for calendar year 2019. Data submitted for 2017 and 2018 was also corrected.

Notwithstanding, the target as set at the start of 2019 was missed for the previous definition of reportable injury, and the WHSC has researched and investigated ways to continually reduce such injuries in the workplace.

The 2020 target has been set to account for the corrected interpretation of what constitutes a minor, reportable injury. This target is detailed in section 6.2 of this report.

2.3.3 Reported Events

In line with our Regulatory Reporting Program, SRBT reported two events to CNSC staff in 2019.

Lumber Yard Fire

On January 2, 2019, a significant fire at a nearby industrial lumber facility occurred. The fire destroyed key municipal electrical infrastructure, including a main power supply line into the City of Pembroke, resulting in the loss of power for much of the city and surrounding communities, including the SRBT facility.

The event was assessed as being sufficiently major and within a close enough proximity to the facility as to warrant a report to the CNSC Duty Officer, in line with the guidance provided in REGDOC 3.1.2 on the interpretation of the reportable situations described in GNSCR 29 (1) (d).

At no time was there any effect on the environment, the health and safety of persons, or the maintenance of security due to the nearby fire or the loss of power. For the duration of the loss of power, an SRBT employee was present in the facility as per the requirements of our Security Program. Power returned to the facility the next morning at approximately 0630h.

Package Received Without Import Licence

On January 16, 2019, SRBT erroneously accepted three (3) aircraft signs containing a total of 279.72 GBq of tritium gas from a customer in the European Union.

The three signs had recently been sold and exported by SRBT in accordance with an export licence issue by the CNSC. The signs were received by the customer, but after inspection the signs were rejected as they were found to not meet the design requirements for their purpose.

The customer sent the three signs back, and the shipment was mistakenly accepted upon arrival, prior to being authorized by SRBT.

SRBT reinforced with the customer that the returns process had not been followed, and that SRBT expects that this process shall be followed in the future in all cases where products may need to be returned to Canada.

The event and the lessons learned were discussed with our staff in the shipping department, and the importance of adherence to the returned goods authorization process was emphasized.

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 2019 was 4,607 TBq, or approximately 77% of our possession limit. The average monthly inventory on site was 3,551 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 2019.

2.3.4.2 Depleted Uranium

SRBT possessed a reported 9.678 kg of depleted uranium in metallic form at the beginning of 2019. This material is used for tritium traps as part of the production of gaseous tritium light sources.

The inventory of material changed twice in 2019:

- A reweighing of container 1 on May 22 determined that the container mass was 12 grams lower than that recorded, due primarily to the removal of non-uranium foreign matter from the container when selecting pellets for traps since the last weighing.
- As a result of a detailed mass assessment, the total inventory was adjusted downward by 143 grams on July 29. The discrepancy between the mass of material on record and the actual total mass measured is attributed to the removal of excess plastic packing material from container 2 (the small rods delivered to SRBT in 2018), the deduction of the weight of the jar as well as the removal of small amounts of foreign materials from container 1 during the inventory taking process.

At the conclusion of 2019, the total mass of depleted uranium on site stands at 9.523 kg. 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 8: DEPLETED URANIUM INVENTORY BREAKDOWN AT THE END OF 2019

QTY	DESCRIPTION	DEPLETED URANIUM IN EACH (GRAMS)	TOTAL DEPLETED URANIUM (GRAMS)
1	LOOSE FORM – CONTAINER 1	N/A	2,079
1	LOOSE FORM – CONTAINER 2	N/A	4,926
9	ACTIVE P.U.T.T.	30 +/- 5	268
3	NON-ACTIVE P.U.T.T.	30 +/- 5	330
6	AMERSHAM CONTAINERS	320	1,920
		TOTAL	**9,523**

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 2019 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. An instrument must meet acceptability criteria on a weekly basis, or the unit is removed from service pending corrective maintenance or actions.

2.3.5.3 Assay Quality Control Tests

NIST-traceable reference standards are prepared in-house, and are analyzed and checked against quality control acceptance criteria with every batch of liquid scintillation counting samples being analyzed.

All tests were performed as required with every assay throughout 2019, in order to ensure quality control of LSC laboratory processes.

3. Facility and Equipment SCAs

3.1 SCA – Safety Analysis

Our operating practices and processes in 2019 have continued to be conducted in full alignment with the latest version of SRBT's Safety Analysis Report (SAR).

There were no changes to the facility or our operations that had any direct bearing on the safety analysis in 2019.

Please refer to section 1.3 of the report for a complete assessment of SRBT compliance against the Operating Limits and Conditions in the SAR.

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 facility, our licensed activities or our processes will change significantly over the coming years; however, SRBT will continue to manage and improve the SAR in line with our management system processes.

As per the Licence Conditions Handbook (LCH), condition 5.1, compliance verification criterion 2, the SAR is next due for scheduled periodic review in 2022.

3.2 SCA – Physical Design

As a manufacturing company, SRBT owns and operates several pieces of equipment, many of which constitute structures, systems and components (SSC) 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 and overall management system.

Three changes in physical design of production-related facility systems or components took place in 2019, 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 did not have any impact on our licensing basis.

3.2.1 Dismantlement of the LMI Laser Cutting Station

The LMI laser was commissioned and installed in the early 2000s for the purposes of manufacturing miniature light sources at SRBT. The laser operated in a limited fashion for a period of a few years before a decision was made to discontinue its use for production. It had not been used in any productive capacity since 2006.

A decision was made to dismantle the equipment in accordance with SRBT’s change control process (ECR-928), and to dispose of all associated materials in accordance with SRBT’s Waste Management Program (WMP).

A work plan was developed and approved for use on May 28, 2019, with the work being executed in accordance with the plan over several weeks, culminating in the completion of the plan on August 12, 2019.

No safety-related issues or events took place during the project, and the space previously occupied by this equipment is now available for other uses. A total of 463 kg of metal was cleared for recycling, while approximately 23 kg of metal was disposed of as low-level waste in accordance with our WMP.

3.2.2 Replacement of Rig Room Fume Hoods

A project was executed in order to replace the fume hoods in the Rig Room. The units that were in place were original equipment, and were primarily comprised of wood which was structurally deteriorating, thus necessitating replacement.

The project was executed in four phases, in accordance with SRBT's change control processes:

- ECR-932 covered the Design Requirements and Selection phase
- ECR-962 covered the Fume Hood Dismantlement phase
- ECR-981 covered the Installation and Commissioning phase
- ECR-982 covered the Turnover phase

The project began in April, and was deemed fully completed on September 20, 2019. No safety-related issues or events took place during the project, and the new stainless-steel units have performed in accordance with all design specifications. A total of approximately 400 kg of materials was sent for disposal as clearance-level waste in accordance with our WMP.

3.2.3 Dismantlement of the Reclaim Rig

The Reclaim Rig was commissioned and installed in the 1990s for the purposes of reclaiming tritium from expired and non-conforming light sources at SRBT.

The rig was operated until January 2007 before a decision was made to discontinue its use. It had not been used in any productive capacity since then; the last reclaim operation was conducted on January 29, 2007.

The ventilated cabinetry had been left in-state since that time. Some dismantlement had been performed on certain components within the rig several years ago; however, the main crushing chamber, gearbox, collection can and some associated tritium gas lines remained in place.

A decision was made to dismantle the equipment in accordance with SRBT's change control process (ECR-1002), and to dispose of all associated materials in accordance with SRBT's Waste Management Program (WMP).

Once the planning phase was complete and approved, work began to dismantle the equipment and cabinetry on November 11, 2019. Work proceeded over the course of the following weeks, culminating in the completion of the project on November 29, 2019.

No safety-related issues or events took place during the project, and the space previously occupied by this equipment is now available for other uses.

A total of approximately 120 kg of metal was recycled, and 58 kg of non-recyclable material was sent to landfill as clearance-level waste. Approximately 430 kg of material classified as low-level waste was generated and stored in four drums, which will be disposed of in accordance with our WMP early in 2020.

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.

Note that, although the Maintenance Program incorporates several program elements associated with nuclear power plants as best practice (such as critical spares, master equipment lists, etc.), aging management is not an element that is formally included as a strategy.

In 2019 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 2019. As part of management review processes, an annual review of 2019 activities will be conducted in the first quarter of 2020, 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 2019 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 2019. 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.

A listing of the ventilation equipment maintained in 2019 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.

The annual stack flow performance verification was performed on September 27, 2019 by a third party. The inspection confirmed that the stacks continue to perform to design requirements. 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 October 7, 2019. No significant concerns or issues were identified during the maintenance activity.

Two instances of corrective maintenance on a counter took place; a rack-jamming issue was corrected over the course of two visits by a technician in February, and an elevated background problem was addressed in December. 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.

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 2019, with all records of the maintenance kept on file.

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 deployed for continuous airborne tritium monitoring at the facility, with two spare units available if needed.

The in-service monitors operate 24 hours a day to ensure that any upset conditions are identified and addressed quickly.

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 light sources are 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 2019. All facility monitors functioned effectively and continuously throughout the year, with all records of maintenance retained on file.

Two of the five monitors that are of an older vintage (circa 2005 manufacture) have been sent back to the manufacturer for refurbishment in the last 18 months; the remaining three units are to be sent for this process in 2020. The refurbishment includes pump replacement, main circuit board and power supply modernization, and installation of advance filter housing components.

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 as required in 2019.

The chart recorders (analog and digital), tritium monitors 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 devices is only valid for one year, each device is rotated with a newly calibrated unit on a slightly less than annual basis. Newly calibrated units were placed into service rotation on January 22, with the four units with expiring calibration validity being removed from service, and sent out for third party calibration. The calibration was performed in September, and then these units were put back into service on October 22.

3.3.7 Stack Monitoring Verification Activities

The annual verification activity for the bubbler systems was performed in February 2019, where independent third party measurements provided validation that SRBT bubblers continue to effectively measure weekly gaseous tritium emissions (both HTO and HT).

The acceptance criterion for deviation between the assessed measurements of gaseous emissions is +/- 30%; in 2019, results were within this acceptance criteria, save for one instance where SRBT’s gaseous measurements were determined to be approximately 38.9% higher than the measurements obtained using third-party services for tritium oxide from the ‘Rig’ stack.

The source of this deviation was investigated, and actions were taken to rectify these measurements. The most likely cause of this deviation is flow perturbations in the sampling lines due to volumetric air flow rate differences between the two parallel sampling systems.

As the SRBT data represented the conservative set of measurements, the continued use of the on-line equipment to measure gaseous effluent was permitted. The next annual intercomparison test is scheduled for February 2020, where the effectiveness of the actions taken to address this deviation will be determined.

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 not performed in 2019. It was last performed on June 29, 2018, and is next scheduled to be performed in 2020.

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 2019.

4. Core Control Processes SCAs

4.1 SCA – Radiation Protection

4.1.1 Dosimetry Services

During 2019, SRBT maintained a Dosimetry Service Licence (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. SRBT implements a dedicated Dosimetry Service Program in support of compliance with the requirements of this licence.

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 2019.

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 2019[26].

SRBT also submitted an Annual Compliance Report to CNSC Dosimetry Services Specialists for the Dosimetry Service Licence[27].

4.1.2 Staff Radiation Exposures and Trends

In compliance with Dosimetry Service Licences 11341-3-28.0 (replaced by 11341-3-28.1 on December 23, 2019), 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.

Those 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. Those 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 2019.

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 2019 was 0.57 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 0.065 mSv, while the collective dose for all workers was measured as 2.95 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 2019, as well as a comparison of dosimetry results for the past five years (2015-2019).

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[28].

Radiation-protection related action levels were reviewed and revised in 2019, in line with the requirements of the LCH. The new action levels were accepted by CNSC staff on August 21, and are as follows:

TABLE 9: ACTION LEVELS FOR RADIATION PROTECTION

PERSON	PERIOD	ACTION LEVEL
NUCLEAR ENERGY WORKER	CALENDAR QUARTER	1.0 mSv
	1 YEAR	3.0 mSv
	5 YEAR	10.0 mSv
PREGNANT NUCLEAR ENERGY WORKER	BALANCE OF THE PREGNANCY	0.5 mSv

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

In 2019 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 also defined in SRBT's *Licence Limits, Action Levels and Administrative Limits document*[28].

Radiation-protection related administrative limits were reviewed and revised in 2019, in line with the requirements of the LCH. The new administrative limits were accepted by CNSC staff on August 21, and are as follows:

TABLE 10: ADMINISTRATIVE LIMITS FOR RADIATION PROTECTION

PERSON	PERIOD	ADMINISTRATIVE LIMIT
NUCLEAR ENERGY WORKER	CALENDAR QUARTER	0.67 mSv
	1 YEAR	2.00 mSv
	5 YEAR	8.50 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 2019, one exceedance of an administrative limit occurred relating to the bioassay tritium concentration measured in a worker.

A measurement of 133.31 Bq/ml was obtained from a sample submitted on September 19 by a worker who had been performing assembly activities in Zone 2; this value exceeded the administrative limit of 100 Bq/ml for such work.

An investigation was conducted which determined that the exceedance was likely a result of the mishandling of light sources, and resultant breakage of some of these lights which led to the intake event.

Non-conformance report NCR-757 was raised, and appropriate actions were taken to correct the issue and prevent recurrence.

4.1.5 Contractor Dose

In 2019, SRBT did not employ contract staff to perform work that presented a significant radiological hazard.

Nineteen 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 2019.

4.1.6 Discussion of Significance of Dose Control Data

A tabular summary of effective dose metrics for 2019 is provided in **Appendix D.**

4.1.6.1 Maximum Dose

The maximum effective dose to any staff member in 2019 was 0.57 mSv. This individual works in Zone 3 and performs tritium processing operations in Zone 3 as their primary duty.

In 2018, the maximum dose to a staff member was 0.48 mSv; the 2019 value represents a 19% increase in the maximum dose to a worker from 2018.

The increase in maximum dose is small, and within expected operational variance given the activities conducted during the year.

A maximum dose of 0.57 mSv represents the achievement of our internal target for 2019 of less than 0.70 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 fifth consecutive year where no SRBT worker received an effective dose in excess of 1 mSv, despite a consistently high rate of production throughput.

The maximum individual dose for the current five-year dosimetry period (January 1, 2016 – December 31, 2020) is 1.85 mSv.

SRBT continuously strives to lower the maximum dose to workers by using several strategies, including training, 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 2019, the maximum dose to an employee working primarily in Zone 2 was 0.27 mSv, while for Zone 1 staff the maximum dose was 0.09 mSv.

Both of these values are higher than in previous years, a phenomenon attributed to four instances of abnormal exposure for a particular worker over the course of the year in Zone 2 (including the aforementioned administrative exceedance), and the execution of three special projects in Zone 3 that involved direct oversight and involvement of Zone 1 staff.

The maximum worker dose over the past nine years is trended below for comparison, as well as a distribution chart for worker doses in 2019:

FIGURE 3: MAXIMUM ANNUAL WORKER DOSE TREND

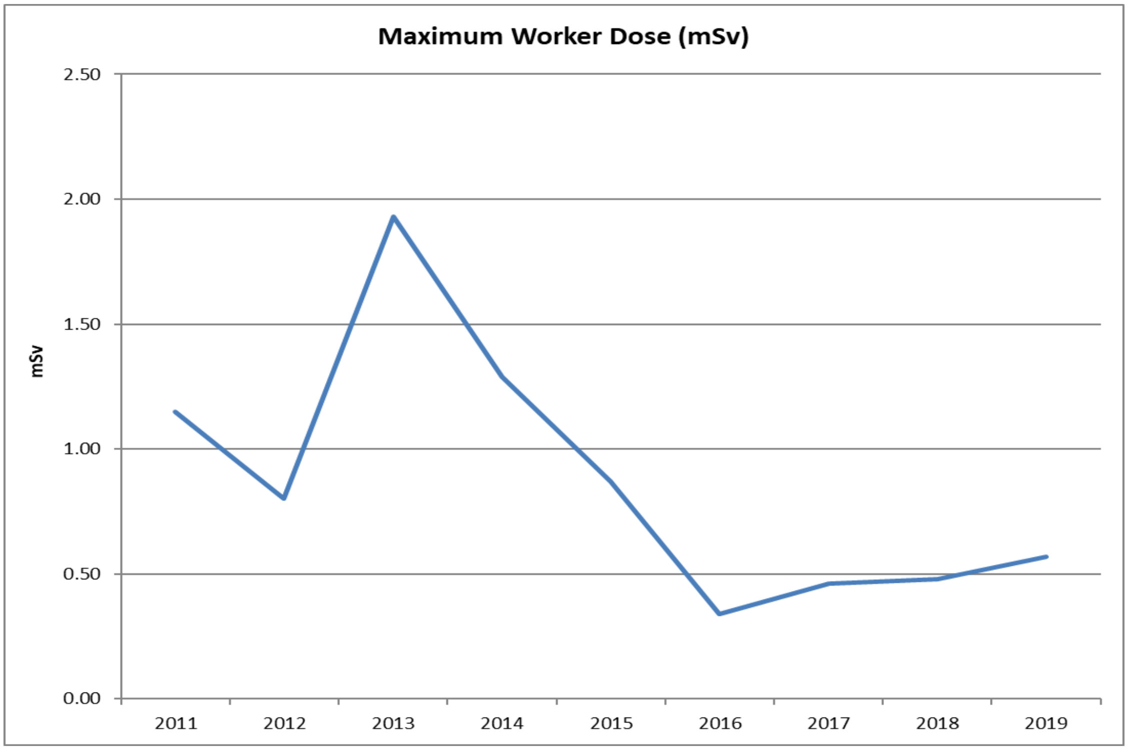
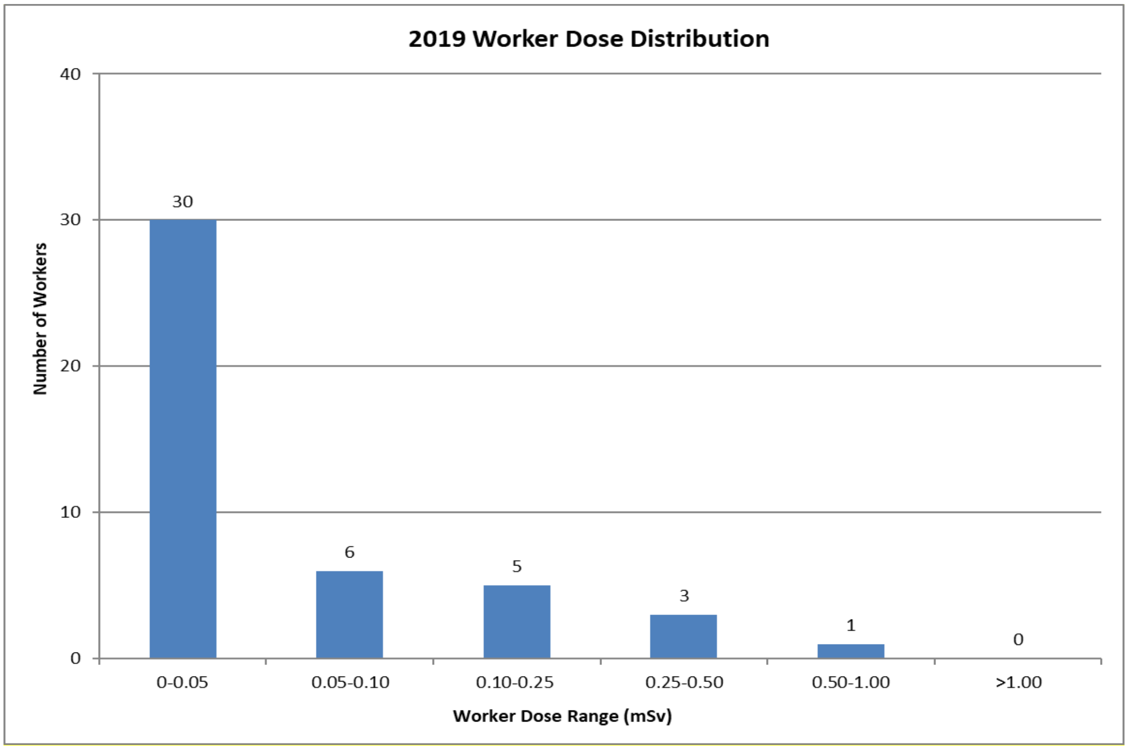


FIGURE 4: WORKER DOSE DISTRIBUTION



4.1.6.2 Average Dose

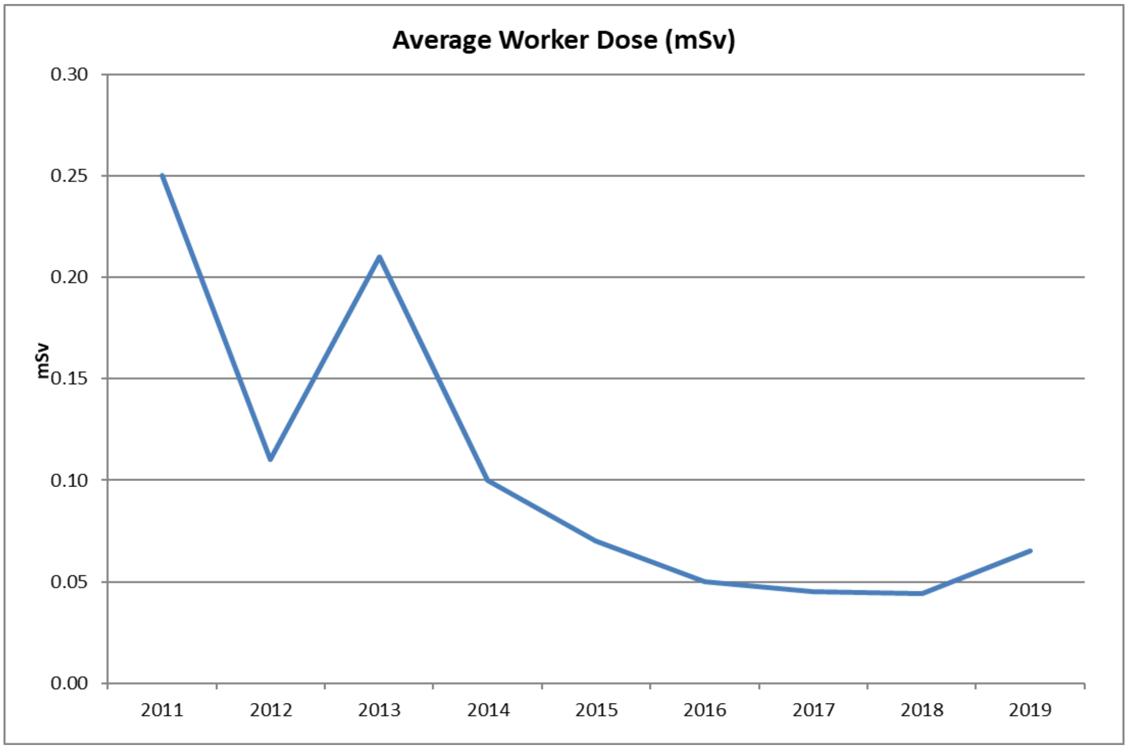
The average dose to workers at SRBT in 2019, including those workers whose dose value was zero, was 0.065 mSv.

In 2018, this average was 0.044 mSv, thus the 2019 data represents an increase in the average dose to staff. This increase is somewhat significant, and is correlated both to radiation doses of individuals, as well as the number of individuals working at SRBT.

A general trend can be taken over the past five 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 nine 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 (n=13), was 0.09 mSv in 2019.

4.1.6.3 Collective Dose

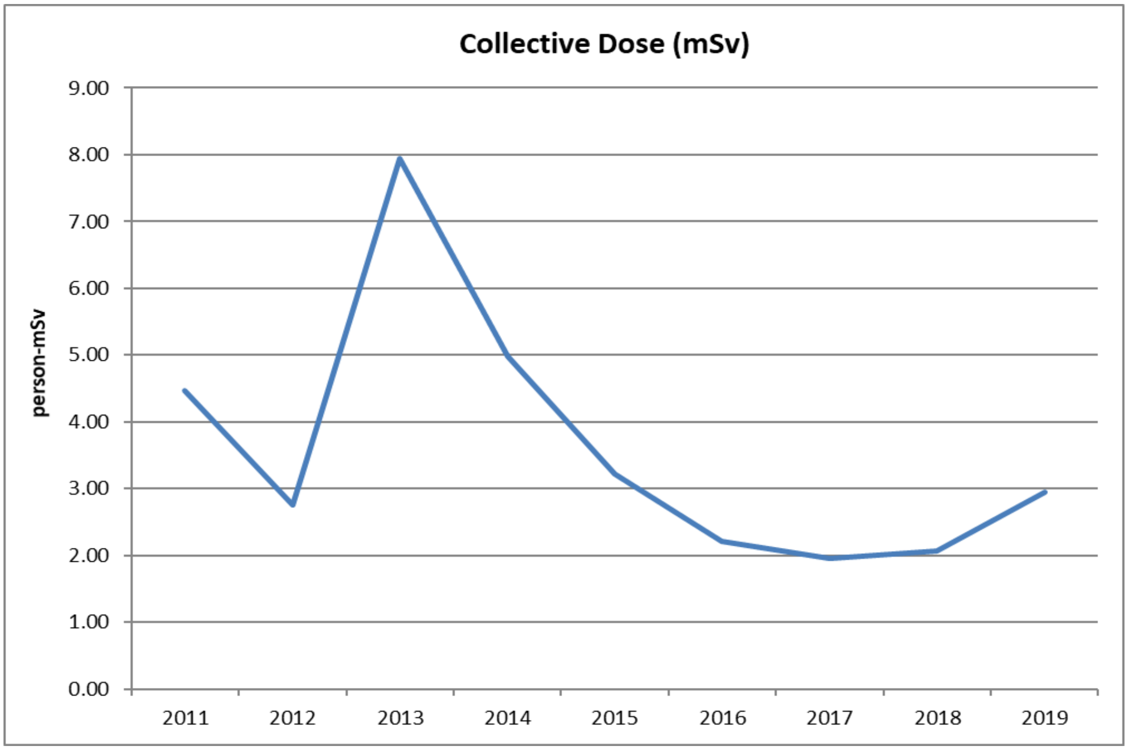
The collective dose to workers at SRBT in 2019 was 2.95 person·mSv. In 2018, the collective dose was 2.06 person·mSv. The annual collective dose for SRBT workers increased by 43%.

Three key factors influenced the collective dose increase in 2019:

- the occurrence of a higher than usual number of light source breakage events in Zone 2,
- an increase in the rate of expired sign processing beginning in September 2019, and
- the completion of three major projects in Zone 3 – and in particular, the dismantlement and removal of the Reclaim Rig.

The collective dose to workers at SRBT over the past nine 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 11: 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 2019 has been tabulated and is included in **Appendix E** of this report. A total of 8,090 assessments were performed in various work areas in 2019.

A total of 509 swipes were taken in Zone 1 resulting in a pass rate of 96.5% below the administrative level of 4 Bq/cm^2.

A total of 1,731 swipes were taken in Zone 2 resulting in a pass rate of 93.1% below the administrative level of 4 Bq/cm^2.

A total of 5,850 swipes were taken in Zone 3 resulting in a pass rate of 93.5% 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 12: PASS RATE FOR CONTAMINATION ASSESSMENTS

ZONE	2015 PASS RATE	2016 PASS RATE	2017 PASS RATE	2018 PASS RATE	2019 PASS RATE
1	96.9%	98.4%	98.7%	97.0%	96.5%
2	96.6%	94.7%	97.1%	93.2%	93.1%
3	93.4%	91.3%	95.2%	94.9%	93.5%

Overall, routine contamination measurements conducted throughout the facility in 2019 fell below the administrative limits 93.6% of the time, missing the internal target of ≥ 95% by a margin of 1.4%.

Notable variances in 2019 routine contamination control data include:

- Elevated surface contamination in the Zone 3 Laser Room area in the first and third quarter, influenced by high rates of miniature laser light manufacturing.
- Elevated shoe cover contamination in Zone 2 in the fourth quarter, coincident with an increase in light source breakage events during routine production work.
- An improved pass rate for the disassembly table in Zone 1 starting in the second quarter of the year, commensurate with a change in process designed to reduce administrative level exceedances.
- A decrease in the pass rate in Zone 3 in the fourth quarter of the year, commensurate with the dismantlement of the Reclaim Rig that is likely to have resulted in slightly elevated room contamination levels in the late November timeframe.

The Health Physics Team continues to track and trend all facility contamination control data throughout the year, with a focused quarterly review to identify areas for improvement.

With respect to the monitoring of airborne tritium contamination throughout the facility, SRBT's Radiation Safety Program includes several processes that measure and control airborne tritium hazards in our facility:

- Stationary tritium-in-air monitors are strategically located throughout the facility, with audible alarms triggered at conservative tritium concentrations.
- All staff are trained in the use of portable tritium-in-air monitors for self-protection purposes; these are also strategically located in the facility for quick use when needed.
- A series of passive air samplers are distributed throughout the facility, allowing for weekly averaging of tritium concentrations in key areas.
- The Health Physics Team logs all stationary tritium-in-air monitor alarm events, in order to track and trend frequency of occurrence, to facilitate radiological assessments and/or investigations, and to drive improvements in process safety.

Zone alarm cause / frequency and passive air sampling data is routinely assessed by the Health Physics Team in order to identify any areas of concerns or trends.

The frequency of zone alarms and the average level of chronic, low-level airborne tritium in the facility increased in the second half of 2019, a phenomenon which correlates with the increase in the average and collective dose of workers at SRBT during the year.

The handling of certain light sources which present manufacturing challenges, coupled with a higher volume of expired sign returns beginning in September 2019 resulted in a measured impact on the magnitude of low-level, chronic airborne contamination levels in the facility.

Actions have been taken to drive improvements in these areas, with the ultimate aim of ensuring exposures and dose remains ALARA, and improvements are being seen in the early part of 2020 in these areas.

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; however, certain trends are evident that are being monitored and addressed by the Health Physics Team going into 2020.

Key points:

- Highest worker dose for 2019 of 0.57 mSv, or 1.14% of regulatory limit, and was for the fifth year in a row less than 1 mSv (representing the regulatory limit for a person who is not a nuclear energy worker). This data point has trended upward over the last few years.
- Collective dose and average dose remain low in relation to production levels, although both of these data points were elevated in 2019.
- Contamination control data demonstrates a high level of control and a low rate of contamination in excess of administrative limits; however, internal targets for pass rate were missed for the second consecutive year.
- Although the target pass rate for contamination control was narrowly missed by 1.4%, a 93.6% pass rate for routine facility contamination checks is in line with the last several years of data. There were no personnel contamination events.
- Radiation protection equipment issues are minimal, with a 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 2018 annual compliance report, the occupational dose targets for 2019 were set as 0.70 mSv (maximum dose to staff member) and 0.055 mSv (average dose to all staff).

The maximum dose to any worker was 0.57 mSv (target met), while the average dose to all workers was 0.065 mSv (target missed).

The causes of the trends observed in 2019 have been investigated and are understood, and actions are being taken to improve performance in this area; however, it is important to acknowledge that the radiation protection-related dose metrics for the SRBT facility remain exceedingly low for a facility of our class.

SRBT projects that in 2020 both the maximum and average dose to workers should remain stable or decrease slightly with the implementation of effective improvement actions.

With these considerations, the targets for calendar year 2020 have been set as follows:

- Maximum dose: ≤ 0.70 mSv, and
- Average dose: ≤ 0.060 mSv
- Action level exceedances: No more than 1 instance

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 2019, four 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 2, 2019, 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 2019, all participants successfully challenged the test. Test results averaged 96.9%, and any incorrect answer on the test was also discussed in detail with all employees individually to ensure full understanding following the completion of the training.

4.1.11 Summary of Radiation Protection Equipment Performance

In 2019, all equipment associated with radiation protection at SRBT performed acceptably, and all key maintenance activities, such as instrument calibration, were performed as required.

Radiation protection equipment includes liquid scintillation counters, portable tritium in air monitors, stationary tritium in air monitors and portable radiation detectors (‘RadEye’ type alpha/beta/gamma detectors).

Two unscheduled corrective maintenance visits were conducted in 2019 by the manufacturer of the LSC units in order to resolve minor issues related to the consistent function of the internal vial elevator, and slightly elevated background count rates.

4.1.12 Summary of Radiation Protection Improvements

In 2019, the following improvements were implemented with respect to the Radiation Safety Program at SRBT:

- An organizational change was implemented to the Health Physics Team in the fourth quarter of 2019, in order to better align our resources and improve performance:
  - The position of Assistant Manager – Health Physics was created. Reporting directly to the Manager – Health Physics and Regulatory Affairs, this individual is responsible for the direct day-to-day oversight of radiation protection-related processes throughout the facility. The previous Health Physics Technician was promoted into this organizational position.
  - The position of Health Physics Technician was divided into two new technician-level positions, both of which are directly overseen by the Assistant Manager – Health Physics:
    - The Radiation Protection Technician is responsible for the execution of shop floor-level radiation protection processes and routines, including daily contamination control assessments, Betalight leak testing, and others.
    - The Environmental Protection Technician is responsible for the execution of routine processes under the programs that form part of the Environmental Management System. This includes applicable components of the Environmental, Effluent and Groundwater Monitoring Programs.
  - The position of Human Protection Coordinator was eliminated, and the individual previously occupying this role is now fully focused on production demands as the deputy supervisor in the Assembly Room.
  - All changes were made in accordance with SRBT change control processes, and all previous responsibilities of both the Health Physics Technician and Human Protection Coordinator have been reallocated to the three newly created organizational positions.
- Twelve of the sixteen procedures in the RSO- procedure set were reviewed and revised in 2019, in order to incorporate several improvement opportunities.

- RSO-001, *Facility Contamination Monitoring* was revised to incorporate enhancements to routine contamination assessment processes.
- RSO-004, *Bioassay Procedure* was revised to ensure better clarity on requirements and to reduce the administrative resources required to generate weekly dose reports. This procedure was submitted to CNSC staff for review and acceptance in November 2019, as this document is listed in the appendices to our Dosimetry Service Licence. CNSC staff accepted this revision, and subsequently amended the DSL on December 23, 2019.
- RSO-009, *Tritium Inventory Management,* and RSO-029, *Nuclear Substances Inventory Management* were both revised to address minor inaccuracies. These were both submitted to CNSC staff for review and acceptance on July 4, 2019, as these documents are listed in the SRBT LCH as requiring written notification when changes are made. CNSC staff accepted both procedures on November 15, 2019.
- RSO-011, *Instrument Calibration* was revised to better capture the in-house acceptance criteria for the calibration of certain health physics-related instruments.
- RSO-020, *Betalight Leak Testing* was revised to formally incorporate independent verification of process outputs, as well as other minor improvements.
- RSO-024, *Zone Alarm Record Keeping* was revised to improve the form used to track tritium-in-air monitor alarm events, as well as to capture changes to the Health Physics Team.
- RSO-027, *Contractors* was revised to improve the form used to track contractor bioassay results, as well as to capture changes to the Health Physics Team.
- RSO-030, *Inventory Control of Time Expired Product* was revised to ensure accuracy and to incorporate title changes to responsible managers.
- RSO-035, *Routine Performance Testing* and RSO-036, *Independent Testing for In-Vitro Measurements* were both revised to ensure clarity on the process to be followed if equipment or measurement method changes may have an adverse impact on the

precision or accuracy of bioassay measurements. Independent verification steps were also clarified.

  - RSO-040, *Facility Passive Air Sampling* was revised to improve the forms used to track this in-house air monitoring, as well as to capture changes to the Health Physics Team.

- Two stationary tritium-in-air monitors (model 357RM) were refurbished by the original manufacturer in 2019. This included the installation of new main circuit boards, transformers, pumps, filter assemblies and cables. The remaining models owned by SRBT of similar vintage (2006-07) are planned to undergo similar refurbishment operations in 2020. The refurbishment work will significantly extend the life and reliability of each unit, and improve monitoring throughout the facility.

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 Conventional Health and Safety Program

Being under federal jurisdiction in 2019, the Health and Safety Policy for the SRBT facility was compliant with the requirements of the CLC Part II, and the 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 13 times in 2019, with all meeting minutes kept on file.

An election was held on December 20, 2019 for the employee representatives on the committee. Elections are conducted every 2 years as required. One member was re-elected, and a new member was added.

4.2.4 Minor Incidents

There were 22 minor incidents reported in 2019 where an employee required first aid treatment; of these, one 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 2019 is provided:

- Minor Cuts – 14 (predominantly due to glass blowing / handling)
- Burns (flame) – 1
- Object in eye - 2
- Ankle injury – 1
- Hit by object – 1
- Glass in finger - 3

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

4.2.5 Lost Time Incidents

In 2019, no lost time incidents (LTI) occurred. The following table summarizes the frequency of occurrence of LTIs over the past five years:

TABLE 13: LOST TIME INCIDENTS FIVE YEAR TREND (2015-2019)

DESCRIPTION	2015	2016	2017	2018	2019
LOST TIME INCIDENTS	0	0	3	0	0

SRBT's continuing goal is to have zero LTIs each year; the fact that this goal was achieved in 2019 speaks to the effectiveness of our conventional safety program.

4.2.6 Health and Safety Goals

SRBT sets programmatic goals that are tracked by responsible safety committees throughout the year. Actions are taken that are intended to help the organization reach safety goals / objectives / targets, as well as when they may be missed.

In 2019, SRBT set the following goals for the area of Conventional Health and Safety:

- Zero lost time incidents (experienced zero – goal achieved)
- No more than twenty minor incidents (experienced 22)

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 Employment and Social Development Canada (ESDC) prior to March 1, 2019, as required.

In accordance with Section 9 of the Policy Committees, Work Place Committees and Health and Safety Representatives Regulations, the Work Place Committee Report was submitted to the Regional Safety Officer at Canada Labour prior to March 1, 2019, as required.

4.2.8 Health and Safety Training

The Manager - Safety and Security and an employee representative of the Health and Safety Committee attended a Health & Safety Training Conference in Ottawa on October 16, 2019, and took part in training seminars that included:

- You Have a Sexual Harassment Complaint, Now What?
- The New World of Cannabis
- Implementation of Bill C-65
- JHSC - Stories from the Trenches
- Incident Investigations Through The Eyes of the Ministry of Labour
- Workplace Depression and Prevention

In December 2019, all SRBT staff were provided refresher training in WHMIS at the annual SRBT training day.

4.2.9 Health and Safety Initiatives and Improvements

In 2019, several health and safety initiatives were implemented, and numerous improvements were put in place. Significant initiatives and improvements include:

- An extensive air sample testing campaign was performed by an independent third party in the injection molding area between April 24 & 25, 2019. The cumulative level of all 77 airborne contaminants tested represented less than 0.5% of time-weighted average limits.
- Due to the 2019 legalization of Cannabis, a new drug and alcohol policy was created, and is awaiting approval from company legal counsel.
- Nine new health and safety procedures were created.
- Canada Labour Code Part II refresher training was provided to department supervisors on November 1, 2019.
- Health and Safety Policy was amended in June 2019. Policy amendments were approved by CNSC staff.
- All department supervisors were provided notebooks to document any health and safety related concerns or issues.

4.3 SCA – Environmental Protection

This section of the report will provide environmental protection compliance information, 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 SRBT's overall Environmental Protection Program, and as an input into the design of the environmental, effluent and groundwater monitoring programs, a conceptual site model (CSM) can provide a valuable representation of the factors and elements that are considered for monitoring within the boundaries of the program.

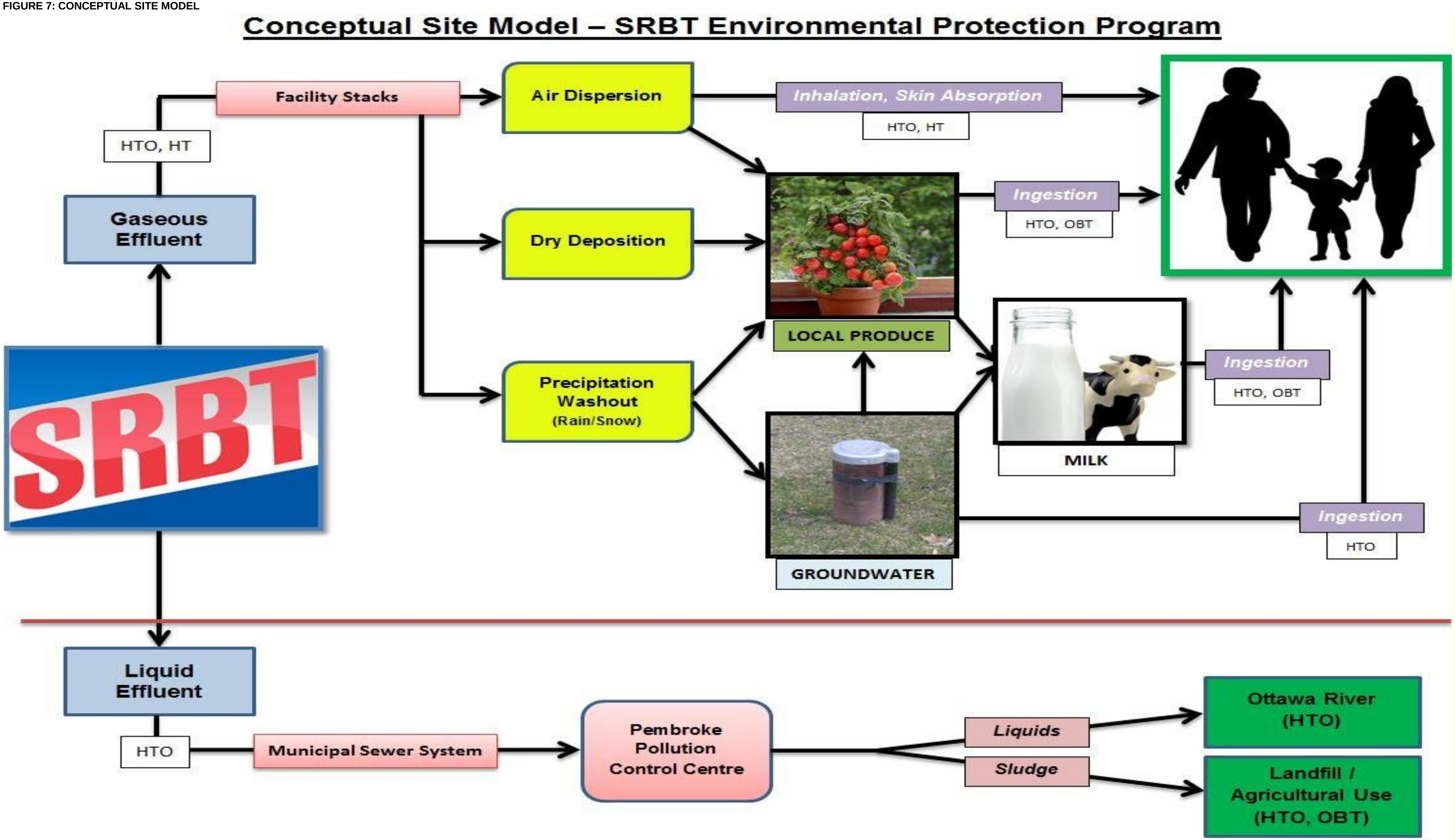
SRBT has been in operation since 1990, and has performed extensive monitoring of effluent, the environment and groundwater over the course of operations since then. In 2007, a comprehensive analysis was performed of the operations of the facility (including historical practices) in order to identify the sources of tritium that could affect the environment and the groundwater.

As well, in 2008 the significant environmental aspects of facility operation were initially established, and have been reviewed periodically since then in order to identify if there are other processes or operations that have been introduced that could lead to an impact on the environment.

These analyses, coupled with decades of operational experience, leads to the establishment of a simplified CSM that shows the significant pathways and environmental interactions pertaining to the release of the sole radiological contaminant of potential concern – tritium.

A pictographic representation of these source – receptor pathways is provided below, and should be consulted when considering the information provided in the next three subsections of this report.

FIGURE 7: CONCEPTUAL SITE MODEL



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 14: 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**
	Radiation doses calculated as doses to receptors where this is required.	4.3.5 **Appendix S**
	An assessment of the EMP results compared with the previous performance indicator targets.	4.3 Reference is made to previous years for performance indication.
	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 15: 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 P and Q**
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 16: 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 O**
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)[29] that provides data for site-specific determination of tritium concentrations along the various pathways of exposure to the public due to the activities of the operations.

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 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 2019 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 2019 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 2019.

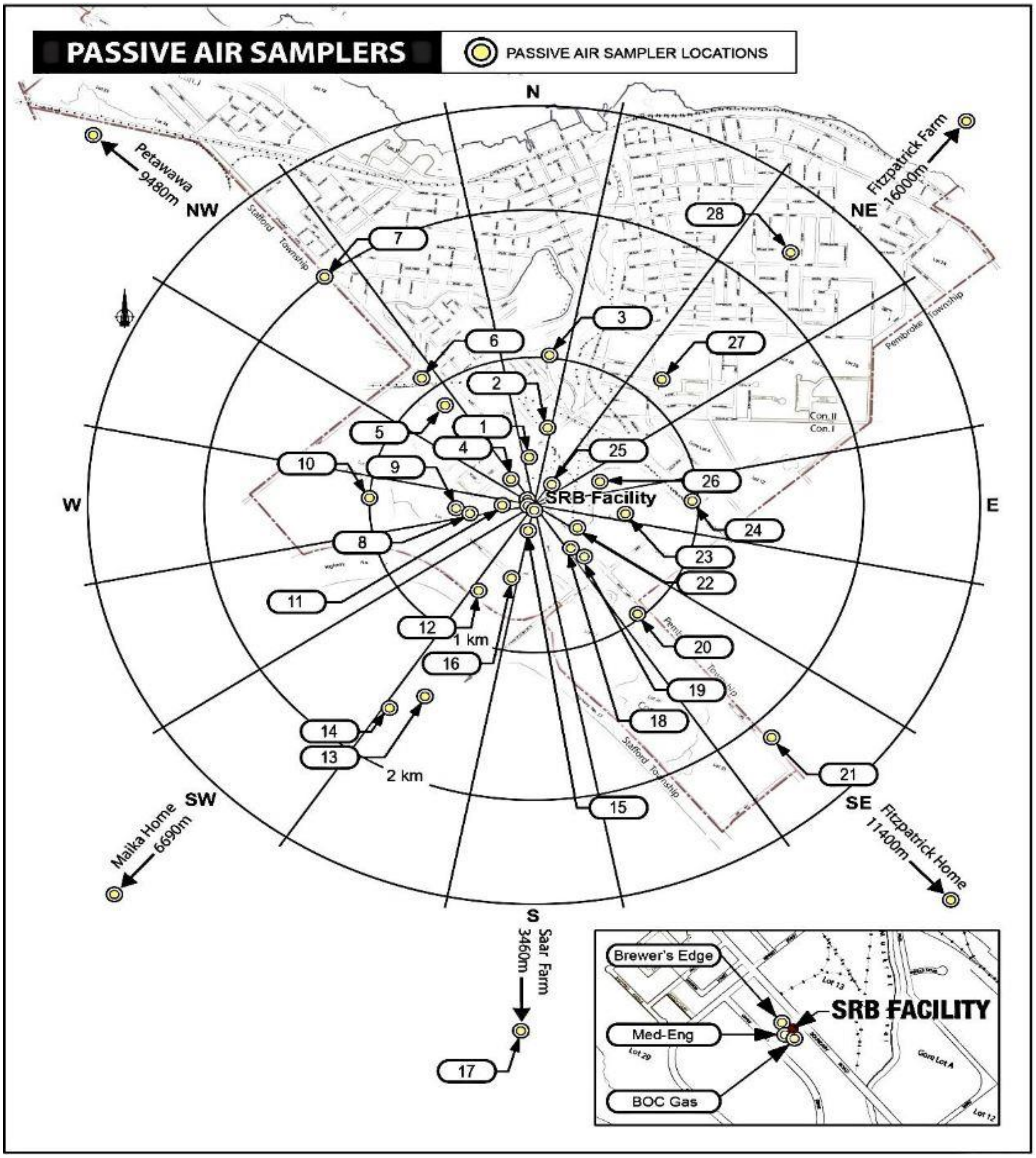
The sum of the average concentration for the passive air samplers in 2019 was 48.42 Bq/m^3, a value that is slightly elevated when compared with the value observed in 2018 (44.43 Bq/m^3).

Total tritium emissions in 2019 were 31,769 GBq, a decrease of approximately 4% compared to emissions in 2018 (33,180 GBq); however, the oxide component of tritium emissions increased by just over 10%, with 11,858 GBq of HTO released in 2019, versus 10,741 GBq in 2018.

The data relating to PAS in 2019 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 8: 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 9: LOCATION OF PRECIPITATION MONITORS

The samples were collected on a monthly basis by a third party laboratory for tritium concentration assessment. Averaged results in 2019 ranged between 16 Bq/L (sampler 15P) and 54 Bq/L (sampler 22P), with a reported MDA range of 5 - 7 Bq/L.

The average tritium concentration for all eight precipitation monitors in 2019 was 33 Bq/L, a slight decrease when compared to the 2018 average of 34 Bq/L.

This represents a very slight decrease that cannot be attributed to a single cause, as the geographic distribution of the sample collectors, coupled with any given meteorological conditions during processing, is expected to yield some variations in the data year-to-year.

Precipitation monitoring results for 2019 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.

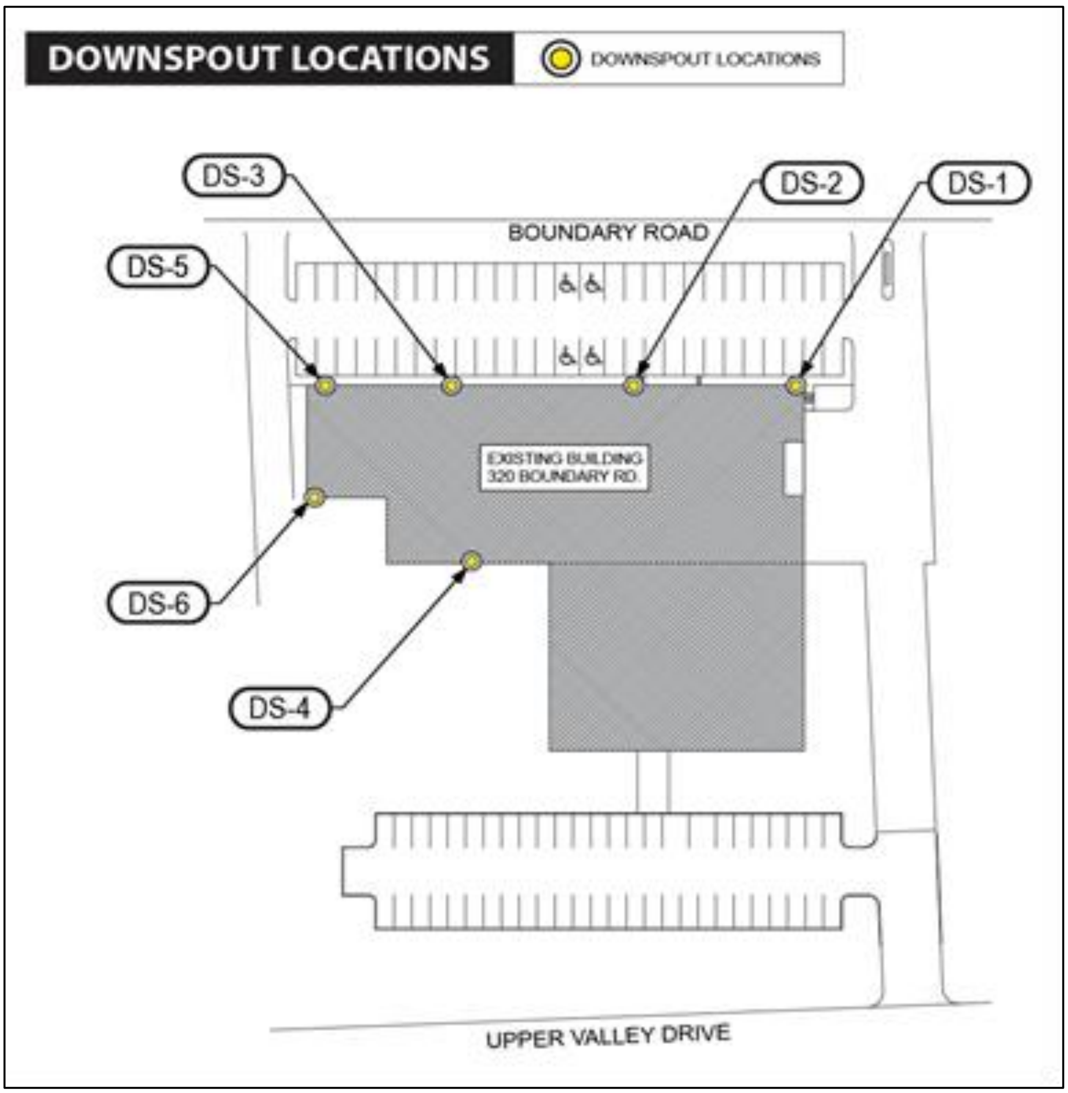
All obtained samples of receiving waters in 2019 fell below the MDA for tritium concentration (between 5 - 6 Bq/L), as they were in 2018.

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 (DS). The samples were collected periodically by SRBT for tritium concentration assessment.

FIGURE 10: LOCATION OF FACILITY DOWNSPOUTS



Runoff from downspouts was collected during four precipitation events throughout 2019, with a total of 20 samples being assessed.

The average tritium concentration for all downspouts / facility runoff in 2019 was 432 Bq/L; in 2018, this value was 179 Bq/L. The highest value measured was from DS-6 on September 26 (1,857 Bq/L), while the lowest values measured were seven individual measurements that were less than the MDA of between 40-46 Bq/L.

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

Please note that the downspout collection point for DS-1, on the roof of the southeast corner of the building in which the SRBT facility is housed, is of a higher elevation that the other five points. As such, water does not typically flow down through DS-1 during most periods of rain as it does not reach the drain on the roof, unless the rate of precipitation is heavy for prolonged periods.

4.3.1.5 Produce Monitoring

Produce from a local produce stand and from five local residential gardens were sampled in 2019.

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 minimum detectable activity = approximately 3 Bq/kg).

The official results were compiled and reported to the participating members of the public, and are also posted on our website. This data is used in the calculations for annual estimated dose to the public for 2019.

The average free water tritium concentration in produce offered by local residents in 2019 was 30.9 Bq/kg, a value that is lower than the 2018 figure of 97.3 Bq/kg.

The maximum measured value in 2019 was 75 Bq/kg measured in a sample of apples; this measurement represents less than 0.1% of the SRBT benchmark value and CNSC Independent Environmental Monitoring Program (IEMP) screening value for free water tritium in fresh produce.

The average free water tritium concentration in produce offered by the local farm gate was 8.2 Bq/kg, a measurement that is very comparable with the 2017 value of 8 Bq/kg from the same farm (which was not sampled in 2018 due to the business having closed for the season during the SRBT sampling campaign).

For OBT, samples of tomatoes from a nearby residential garden showed a concentration of 3 Bq/kg, while tomatoes from the commercial garden were measured at 1 Bq/kg. Both values are at or below the MDA for these measurements.

Produce monitoring results and locations for calendar year 2019 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 2019.

Milk monitoring results and locations for 2019 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 - 4 Bq/L, while no sample exceeded 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 2019 remain low at 9 Bq/L, a slight decrease compared to 2018 (15 Bq/L).

Annual data can be found in **Appendix M** of this report with a graph trending these results from 2006 to 2019.

4.3.1.8 Weather Data

A weather station near the facility collects data on a continuous basis. See weather data for 2019 in **Appendix N**.

4.3.1.9 Residential Drinking Water

Several nearby local residences permit SRBT to acquire samples of drinking water 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 2019, the highest residential well tritium concentration value was measured at 58 Bq/L (in March at RW-2 and also in November at RW-3), a value that is well below the Ontario Drinking Water Quality Standard of 7,000 Bq/L. In 2018, the highest measured value was 120 Bq/L from RW-8, which has since been taken out of service.

FIGURE 11: RESIDENTIAL WELL TRITIUM CONCENTRATION TREND (2006-2019)

Derived public dose values attributed to residential well water consumption have decreased since the inception of the monitoring program as a direct result of our efforts to minimize our environmental impact.

Residential well monitoring results for 2019 can be found in **Appendix O** of this report.

4.3.1.10 Deviations from Field Sampling Procedures

In 2019, there were no noted occurrences of deviations from field sampling procedures.

4.3.1.11 Deviations from Analytical and Data Management Procedures

In 2019, there were no noted occurrences of deviations from 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 samples 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 2019, there were 229 QC checks and 659 benchmark value comparisons performed on EMP data.

There were four instances where a QC acceptance criterion was not met, all of which related to the duplicated PAS relative percent difference (RPD):

- The June and July sample data for the SE 250 and SE 250 duplicate samples exhibited a relative percent difference in excess of the acceptance criteria of 40%. For June the difference was evaluated as 152% (2.90 and 0.40 Bq/m^3), while for July the difference was -52% (2.40 and 4.10 Bq/m^3). Two NCRs were raised, once for the June exceedance, and the second after it was determined by CNL that the actual cause of the issue was likely an error of failing to swap out one of the two samplers during June's campaign. Actions were taken to address this issue in closing out both NCRs.

- The RPD for the SW 250 samplers in July exceeded the acceptance criteria; however, this was an insignificant issue as the result was due to a small variation between samplers at very low tritium concentrations (0.50 vs. 0.80 Bq/m^3).

- The October sample data for SE 250 RPD showed a variation in excess of the acceptance criteria. The RPD was measured to be 77% (1.40 vs. 0.62 Bq/m^3). The absolute concentrations measured is again very low, leading to an artificially high RPD; however, OFI-443 was raised to action CNL to clean the orifices from both samplers.

In 2019, 98.3% of all EMP QC checks met acceptance criteria, while 100% of all EMP measurements were below benchmark values.

With respect to the four instances where the RPD acceptance criteria was exceeded, two of these instances were clearly related to an error in sample changing, while the other two instances were due to small absolute variations between samplers that are mathematically high when compared by relative percentage.

The overall trend in these occurrences is relatively stable year-to-year and are not indicative of systemic quality control issues within the PAS sampling processes of the EMP.

The following table illustrates the year-to-year variances in acceptance criteria data for the EMP:

TABLE 17: EMP QUALITY CONTROL DATA (2016-2019)

Calendar Year	2016	2017	2018	2019
Benchmark Value Exceedances	0	0	0	0
Duplicate RPD Exceedances	0	2	1	4
Reference Standard Accuracy Exceedances	0	0	0	0
Blanks <MDA	0	0	0	0
Sample Acquisition Success Rate	97.6%	98.8%	98.8%	98.5%
QC Check Pass Rate	100%	99.1%	99.6%	98.3%

4.3.1.13 Supplementary Studies

There were no supplementary studies initiated or completed relating to the SRBT EMP in 2019.

The CNSC last conducted IEMP sampling near the facility in 2018.

4.3.2 Effluent Monitoring

SRBT monitors two main effluent streams from the facility for tritium as part of our Effluent Monitoring Program (EffMP).

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 2019, 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 2019 is tabulated below:

TABLE 18: GASEOUS EFFLUENT DATA (2019)

NUCLEAR SUBSTANCE AND FORM	ANNUAL LIMIT (GBq)	2019 RELEASED (GBq)	% LIMIT	WEEKLY AVERAGE (GBq)	MAXIMUM WEEKLY RELEASE (GBq)
TRITIUM AS TRITIUM OXIDE (HTO)	67,200	11,858	17.65%	224	488
TOTAL TRITIUM AS TRITIUM OXIDE (HTO) AND TRITIUM GAS (HT)	448,000	31,769	7.09%	599	1,351

Please refer to **Appendix P** for a complete data set on tritium releases to atmosphere in 2019.

For comparison, in 2018 HTO emissions were 15.98% of the licence limit, while total tritium emissions were 7.41% of the licence limit.

Total air emissions in 2019 decreased by approximately 4% of what they were in 2018, while annual tritium processed decreased by about 3%.

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

TABLE 19: GASEOUS EFFLUENT FIVE YEAR TREND (2015-2019)

NUCLEAR SUBSTANCE AND FORM	RELEASED 2015 (GBq)	RELEASED 2016 (GBq)	RELEASED 2017 (GBq)	RELEASED 2018 (GBq)	RELEASED 2019 (GBq)
TRITIUM AS TRITIUM OXIDE (HTO)	11,554	6,293	7,198	10,741	11,858
TOTAL TRITIUM AS TRITIUM OXIDE (HTO) AND TRITIUM GAS (HT)	56,237	28,945	24,822	33,180	31,769

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 20: TRITIUM RELEASED TO ATMOSPHERE vs PROCESSED (2008-2019)

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%
2018	33,180	31,251,329	0.11	+38%
2019	31,769	30,327,048	0.10	-10%

In 2019, the ratio of tritium released versus processed decreased slightly; SRBT was able to achieve our internal target of 0.13% for the year.

4.3.2.2 Air Emission Target

SRBT set an annualized total tritium emission target at the beginning of 2019 of ≤ 650 GBq / week (averaged over the year), and was successful in meeting this target (599 GBq / week).

For calendar year 2020, SRBT has retained a tritium emission target of 650 GBq / week or less, on average, based upon projected production rates and the value achieved in 2019.

The 2019 targeted tritium released to processed ratio of ≤ 0.13% was achieved (0.10%). The 2020 target has been lowered to 0.12%.

4.3.2.3 Liquid Effluent

In 2019, 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 21: LIQUID EFFLUENT DATA (2019)

NUCLEAR SUBSTANCE AND FORM	LIMIT (GBq/YEAR)	RELEASED (GBq/YEAR)	% OF LIMIT
TRITIUM – WATER SOLUBLE	200	13.67	6.83%

Total liquid effluent releases in 2019 increased when compared to 2018 values (13.67 GBq in 2019 vs. 10.02 GBq in 2018).

The increase is attributed mainly to a persistently higher rate 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 22: LIQUID EFFLUENT FIVE YEAR TREND (2015-2019)

NUCLEAR SUBSTANCE AND FORM	RELEASED 2015 (GBq)	RELEASED 2016 (GBq)	RELEASED 2017 (GBq)	RELEASED 2018 (GBq)	RELEASED 2019 (GBq)
TRITIUM – WATER SOLUBLE	6.5	5.18	6.85	10.02	13.67

Please refer to **Appendix Q** for a complete data set of liquid effluent releases to sewer in calendar year 2019.

4.3.2.4 Liquid Effluent Target

SRBT set a total tritium release target at the beginning of 2019 of ≤ 9 GBq for the year, a target that was missed by 4.67 GBq.

Based upon continuing production of miniature light source into the 2020 calendar year, and based upon the past years of data, SRBT has set the total liquid effluent release target at 12 GBq for 2020.

A non-conformance report has been raised to document corrective actions taken in response to missing in-house targets for annual liquid effluent releases for the last three years.

4.3.2.5 Action Level Exceedances

In 2019, 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 EffMP QA/QC results obtained in 2019 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.

The acceptance criterion for deviation between the assessed measurements of gaseous emissions is +/- 30%; in 2019, results were within this acceptance criteria, save for one instance where gaseous measurements by the online equipment were determined to be approximately 38.9% higher than the measurements obtained using third-party services for tritium oxide from the ‘Rig’ stack.

The source of this deviation was investigated, and actions were taken to rectify these measurements. The most likely cause of this deviation is flow perturbations in the sampling lines due to volumetric air flow rate differences between the two parallel sampling systems.

As the SRBT data represented the conservative set of measurements, the continued use of the on-line equipment to measure gaseous effluent was permitted. The next annual intercomparison test is scheduled for February 2020, where the effectiveness of the actions taken to address this deviation will be determined.

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 2019, no supplementary studies were conducted relating to effluent monitoring at SRBT.

4.3.2.9 Hazardous Substance Releases

In 2019, SRBT continued to operate the facility under a Certificate of Approval (Air), number 5310-4NJQE2[30], issued by the Ontario Ministry of the Environment in accordance with section 9 of the Ontario Environmental Protection Act.

No hazardous non-radiological substances are released from the facility through either gaseous or liquid effluent pathways in any significant quantity.

4.3.3 Groundwater Monitoring

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

Groundwater data continued to be 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 2019, 342 samples of groundwater were successfully obtained and analyzed, with all planned groundwater monitoring activities being accomplished, except for the following sixteen instances:

- A total of ten samples were attempted of CN-coded wells on the adjacent property, with only two successful samples obtained. All five wells were dry during the March sample attempt, and only CN-1S and -1D could provide water the following month.
- MW06-3 was found to be dry five times (February, March, August, September and October sampling campaigns).

- MW06-8, MW07-20 and MW07-21 were found to be dry during the February sampling campaign.

SRBT submitted a request to CNSC staff on March 26, 2019, aimed at removing the requirement to sample the CN wells routinely. The CN wells are not owned by SRBT, nor are they on land that SRBT owns or controls. Over the years, these wells have physically degraded, and have become increasingly difficult to sample reliably.

More than ten years of data had been obtained using these wells, and a clear downward trend in tritium concentration over time has been observed, attributable to changes in processing and emission-reduction initiatives.

The data from these wells does not contribute to the calculation of public dose, or otherwise form an input into any of our Environmental Protection programs. The data is used for trending purposes only.

Considering the data routinely generated by the SRBT-owned array of twenty-nine groundwater monitoring wells which are nearer the source term, the CN wells are not critical for identifying the development of an adverse trend should one begin to take place. A negative trend in groundwater conditions would be recognized through data from wells nearer the facility, well in advance of the CN wells.

CNSC staff confirmed their acceptance of this proposal by email message on May 21, 2019.

4.3.3.1 Groundwater Tritium Concentration

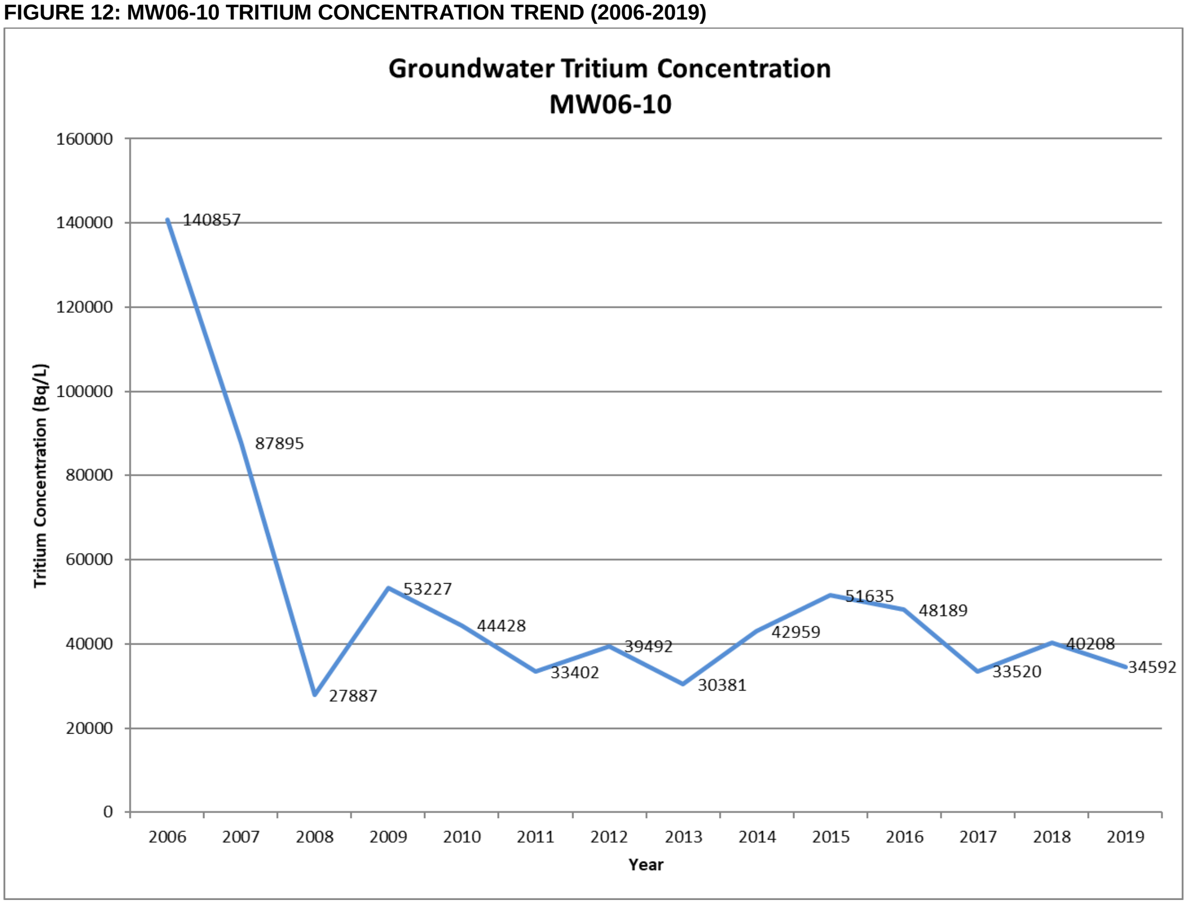
Groundwater monitoring well results for 2019 can be found in **Appendix O** of this report.

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. As of the end of 2019, this represents the only well where tritium concentration exceeds the Ontario Drinking Water Guideline value of 7,000 Bq/L.

The average concentration of tritium measured in MW06-10 decreased by approximately 14%, falling from 40,208 Bq/L in 2018, down to 34,592 Bq/L in 2019.

The average concentration measured this year is very near the 2017 average value of 33,520 Bq/L, and is lower than the 2016 value of 48,189, the 2015 value of 51,635 Bq/L, and the 2014 value of 42,959 Bq/L.

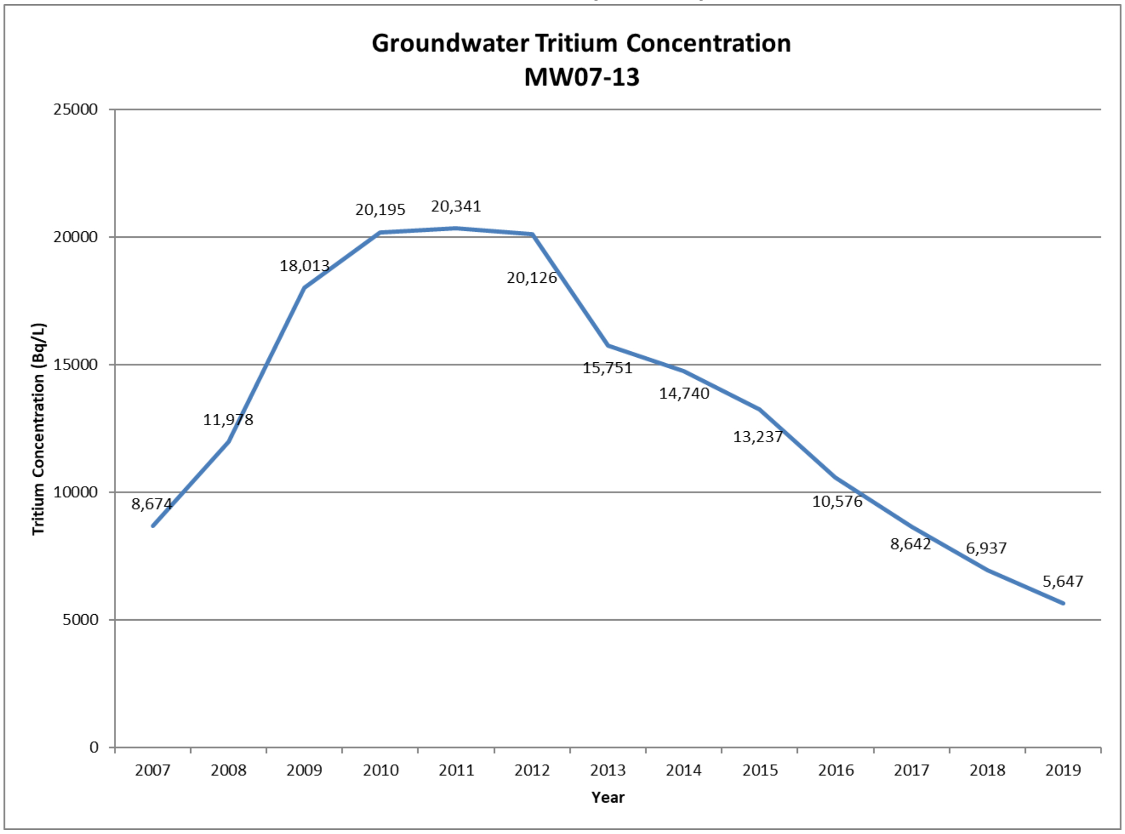
FIGURE 12: MW06-10 TRITIUM CONCENTRATION TREND (2006-2019)



The average concentration of MW07-13 continues to fall; in 2019 the average measurement was 5,647 Bq/L.

This well averaged 6,937 Bq/L in 2018, 8,642 Bq/L in 2017, 10,576 Bq/L in 2016 and 13,237 Bq/L in 2015.

FIGURE 13: MW07-13 TRITIUM CONCENTRATION TREND (2007-2019)



In 2019, 28 of 29 SRBT-installed groundwater monitoring wells exhibited an average tritium concentration that was lower than the previous year, with the sole well exhibiting an average increase (MW07-32) rising only 5 Bq/L.

The following table compares the annualized average tritium concentration of the 29 dedicated, SRBT-installed groundwater monitoring wells between 2015 through 2019.

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 23: 2015-19 AVERAGE TRITIUM CONCENTRATION IN SRBT MONITORING WELLS

Well ID	2019	2018	2017	2016	2015	2019 / 2018	2019 / 2017	2019 / 2016	2019 / 2015
	(Bq/L)					(%)			
MW06-1	1,045	1,334	1,946	2,753	4,338	78.3	53.7	38.0	24.1
MW06-2	1,031	1,160	1,166	1,467	1,965	88.9	88.4	70.3	52.5
MW06-3	367	469	683	1,029	1,218	78.2	53.7	35.6	30.1
MW06-8	679	724	780	848	906	93.8	87.0	80.1	74.9
MW06-9	1,774	1,952	2,224	2,476	2,731	90.9	79.8	71.7	65.0
MW06-10	34,592	40,208	33,520	48,189	51,635	86.0	103.2	71.8	67.0
MW07-11	1,053	1,122	1,099	1,344	1,521	93.9	95.8	78.4	69.3
MW07-12	425	468	467	469	463	90.8	90.9	90.5	91.6
MW07-13	5,647	6,937	8,642	10,576	13,237	81.4	65.3	53.4	42.7
MW07-15	1,399	1,505	1,617	1,810	1,680	92.9	86.5	77.3	83.3
MW07-16	1,240	1,433	1,649	1,879	2,188	86.6	75.2	66.0	56.7
MW07-17	338	359	335	602	780	94.2	101.0	56.1	43.3
MW07-18	2,000	2,192	2,739	3,690	5,491	91.2	73.0	54.2	36.4
MW07-19	1,468	1,889	1,926	2,500	3,222	77.7	76.2	58.7	45.6
MW07-20	438	498	571	670	775	87.9	76.6	65.3	56.5
MW07-21	545	778	879	1,009	1,121	70.1	62.0	54.0	48.6
MW07-22	921	974	1,023	1,131	1,171	94.6	90.0	81.4	78.6
MW07-23	1,443	1,572	1,743	1,929	2,206	91.8	82.8	74.8	65.4
MW07-24	1,839	1,928	2,022	2,206	2,314	95.4	91.0	83.4	79.5
MW07-26	697	904	1,190	1,491	1,941	77.1	58.6	46.7	35.9
MW07-27	2,683	3,136	3,589	4,292	4,869	85.6	74.8	62.5	55.1
MW07-28	843	1,017	1,063	1,311	1,446	82.9	79.3	64.3	58.3
MW07-29	2,058	2,415	2,472	3,395	3,950	85.2	83.2	60.6	52.1
MW07-31	352	407	186	440	756	86.3	189.1	79.9	46.5
MW07-32	75	70	76	155	128	107.8	98.7	48.4	58.7
MW07-34	1,526	1,889	2,291	2,822	3,312	80.8	66.6	54.1	46.1
MW07-35	2,256	2,637	3,015	3,448	3,945	85.5	74.8	65.4	57.2
MW07-36	1,716	2,008	2,109	2,618	2,892	85.5	81.4	65.6	59.3
MW07-37	821	830	871	989	1,009	98.9	94.2	83.1	81.4

Several factors can influence the concentration of tritium in any given well, including the rate of precipitation accumulation, contaminant dispersion patterns, and the lateral and vertical migration of historical contaminant plumes.

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 2019 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 2019, one opportunity for improvement was raised relating to groundwater monitoring to ensure that a record of the purging of a well before sampling is completely documented. OFI-429 was raised to drive the improvement and was closed with the revision of form GMP-002-F-01.

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.

In order to provide assurance of accuracy and precision, SRBT conducted an intercomparison sampling and analysis activity with our primary contracted third party in May, as required by the GMP.

Five wells were sampled and measured by SRBT concurrently with the third party, with SRBT results averaging 98.4% of those obtained by the contracted service provider.

In addition, the protocols implemented by SRBT to determine tritium concentration in groundwater samples typically achieve an MDA of between 40-50 Bq/L, while third party measurements were reported with a limit of detection around 93 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 2019, no supplementary studies were conducted relating to groundwater monitoring at SRBT.

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 2019.

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 one well monitored on a regular basis exceeds the Ontario Drinking Water Guideline value of 7,000 Bq/L. This well is a dedicated, engineered groundwater monitoring well very near to the facility within a secured area, and is not available to be used as a source of water consumption.

With respect to the conceptual site model, the highest average concentration of potable groundwater obtained from a residential well continues to show a generally stable or decreasing trend over time (see discussion in section 4.3.1.9 earlier in this report).

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, as illustrated earlier in this report in Figure 7.

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

No soil monitoring was conducted in 2019.

4.3.4.2 Sludge Monitoring

In March and September 2019, 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 sludge samples are collected and analyzed by an independent laboratory.

The averaged annual results obtained for the past five years are tabled below:

TABLE 24: SLUDGE MONITORING (2015-2019)

SAMPLE TYPE	2019	2018	2017	2016	2015
FREE-WATER TRITIUM (Bq/L)	41	40	57	27	20
OBT FRESH WEIGHT (Bq/kg)	206	420	901	567	166

4.3.5 Public Dose

The calculation methods used to determine the dose to the representative persons as defined in the SRBT Environment Monitoring Program (EMP) are described in the program and in EMP-014, *Interpretation and Reporting Requirements for EMP Data.*

All data and tables relating to the calculation of the dose to the public can be found in **Appendix S**.

For 2019, the dose has been calculated using the effective dose coefficients found in Canadian Standards Association (CSA) Guideline N288.1-14[31].

TABLE 25: 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 group of representative persons 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 2019 average concentration of tritium oxide in air at passive air sampler NW250 has been determined to be **2.49 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 representative person (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 2019 between these samplers is **6.10 Bq/m^3** at PAS # 1.

Using the inhalation rates found in CSA Guideline N288.1-14[32], 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 26: 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 2.49 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)
= 2.49 Bq/m^3 x 8,400 m^3/a x 0.76256 x 3.0E-05 μSv/Bq
= 0.478 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 #1 at 6.10 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)
= 6.10 Bq/m^3 x 8,400 m^3/a x 0.23744 x 3.0E-05 μSv/Bq
= 0.365 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 2.49 Bq/m^3:

$P_{(i)19}$ = [$H\text{-}3_{air}$] (Bq/m^3) x Resp. Rate (m^3/a) x DCF_{H3} (μSv/Bq)
= 2.49 Bq/m^3 x 8,400 m^3/a x 3.0E-05 μSv/Bq
= 0.627 μSv/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 2.49 Bq/m^3:

$P_{(i)19}$ = [$H\text{-}3_{air}$] (Bq/m^3) x Resp. Rate (m^3/a) x DCF_{H3} (μSv/Bq)
= 2.49 Bq/m^3 x 2,740 m^3/a x 8.0E-05 μSv/Bq
= 0.546 μSv/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 2.49 Bq/m^3:

$P_{(i)19}$ = [$H\text{-}3_{air}$] (Bq/m^3) x Resp. Rate (m^3/a) x DCF_{H3} (μSv/Bq)
= 2.49 Bq/m^3 x 7,850 m^3/a x 3.8E-05 μSv/Bq
= 0.743 μSv/a

Dose due to skin absorption

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) derived from information found in CSA Guideline N288.1-14[33]:

TABLE 27: 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 2019, the highest average concentration in a residential well used as the sole source of the drinking water was found in RW-3 at 183 Mud Lake Road, equal to **48 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;
= [48 Bq/L] x 1,081.1 L/a x 2.0E-05 μSv/Bq
= 1.031 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;
= [48 Bq/L] x 305.7 L/a x 5.3E-05 μSv/Bq
= 0.772 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;
= [48 Bq/L] x 482.1 L/a x 2.5E-05 μSv/Bq
= 0.575 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 previously conducted by SRBT, 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 that recommended in the generic guidance of N288.1-14 (20-25%).

Using the following annual consumption rates for produce derived using information found in CSA Guideline N288.1-14[34]:

TABLE 28: 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 2019 was **8.2 Bq/kg**, while the highest average concentration in produce from a local garden in 2019 was **75.0 Bq/kg** at 413 Sweezy Court.

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

P_{49HTO} = [[$H_{prod,market}$] + [$H_{prod,res}$]] x 2.0E-05 μSv/Bq
= [[$H\text{-}3_{veg}$] (Bq/kg) x (kg) x 0.7] + [$H\text{-}3_{veg}$] (Bq/kg) x (kg) x 0.3]] x 2.0E-5 μSv/Bq
= [[8.2 Bq/kg x 413.3 kg/a x 0.7] + [75.0 Bq/kg x 413.3 kg/a x 0.3]] x 2.0E-05 μSv/Bq
= [[2,372.34 Bq/a] + [9,299.25 Bq/a]] x 2.0E-05 μSv/Bq
= 0.233 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
= [[8.2 Bq/kg x 124.8 kg/a x 0.7] + [75.0 Bq/kg x 124.8 kg/a x 0.3]] x 5.3E-05 μSv/Bq
= [[716.35 Bq/a] + [2,808 Bq/a]] x 5.3E-05 μSv/Bq
= 0.187 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
= [[8.2 Bq/kg x 265.2 kg/a x 0.7] + [75.0 Bq/kg x 265.2 kg/a x 0.3]] x 2.5E-05 μSv/Bq
= [[1,522.25 Bq/a] + [5,967 Bq/a]] x 2.5E-05 μSv/Bq
= 0.187 μSv/a

SRBT directly monitored organically bound tritium (OBT) concentrations in tomatoes in the garden at 408 Boundary Road, as well as from tomatoes from the commercial market garden. The average OBT concentration from the residential produce was measured as 3.0 Bq/kg, while for the commercial produce a value of 1.0 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
= [[1 Bq/kg x 413.3 kg/a x 0.7] + [3 Bq/kg x 413.3 kg/a x 0.3]] x 4.6E-05 μSv/Bq
= [[289.31 Bq/a] + [371.97 Bq/a]] x 4.6E-05 μSv/Bq
= 0.030 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
= [[1 Bq/kg x 124.8 kg/a x 0.7] + [3 Bq/kg x 124.8 kg/a x 0.3]] x 1.3E-4 μSv/Bq
= [[87.36 Bq/a] + [112.32 Bq/a]] x 1.3E-4 μSv/Bq
= 0.026 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
= [[1 Bq/kg x 265.2 kg/a x 0.7] + [3 Bq/kg x 265.2 kg/a x 0.3]] x 6.3E-5 μSv/Bq
= [[185.64 Bq/a] + [238.68 Bq/a]] x 6.3E-5 μSv/Bq
= 0.027 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}
= 0.233 μSv/a + 0.030 μSv/a
= 0.263 μSv/a

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

P_{49} = P_{49HTO} + P_{49OBT}
= 0.187 μSv/a + 0.026 μSv/a
= 0.213 μSv/a

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

P_{49} = P_{49HTO} + P_{49OBT}
= 0.187 μSv/a + 0.027 μSv/a
= 0.214 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 derived using information found in CSA Guideline N288.1-14[35]:

TABLE 29: 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 in 2019 was measured as 3.77 Bq/L; adjusting for the density of milk, a specific activity of 3.77 Bq/L x 0.97 L/kg = **3.654 Bq/kg** is calculated.

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

P_{59} = $[H\text{-}3]_{dairy}$ x M x 2.0E-05 µSv/Bq;
= [3.654 Bq/kg] x 188.5 kg/a x 2.0E-05 µSv/Bq
= 0.014 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;
= [3.654 Bq/kg] x 339.9 kg/a x 5.3E-05 µSv/Bq
= 0.066 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;
= [3.654 Bq/kg] x 319.6 kg/a x 2.5E-05 µSv/Bq
= 0.029 µSv/a

Representative persons annual dose due to tritium uptake based on EMP

Based on the EMP results and the coefficients and parameters taken or derived from N288.1-14[32,33,34,35], 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 **2.151 µSv** for an adult worker representative person in 2019, compared to 3.792 µSv in 2018, 3.349 µSv in 2017, and 4.579 µSv in 2016.

TABLE 30: 2019 REPRESENTATIVE PERSONS 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	$P_{(I)19}$	0.365			
DOSE DUE TO INHALATION and ABSORPTION AT RESIDENCE	$P_{(I)19}$	0.478	0.627	0.546	0.743
DOSE DUE TO CONSUMPTION OF WELL WATER	P_{29}	1.031	1.031	0.772	0.575
DOSE DUE TO CONSUMPTION OF PRODUCE	P_{49}	0.263	0.263	0.213	0.214
DOSE DUE TO CONSUMPTION OF MILK	P_{59}	0.014	0.014	0.066	0.029
2019 PUBLIC DOSE	P_{TOTAL}	**2.151**	1.935	1.597	1.561

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 third full year of operation since the program revision to comply with the requirements of CSA standard N288.4-10, and the program continues to be improved over time.

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 2019 decreased slightly when compared to 2018, as did several indicators pertaining to the EMP. A slight increase in tritium oxide emissions trends well alongside an observed increase in cumulative average of all PAS data.

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 2019, 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.

4.3.7 Program Review and Audit Summary

All major elements of the Environmental Management System (EMS) are scheduled to be audited at least once every three years.

An internal audit was performed in 2019 which encompassed several major elements of the EMS, including the Effluent and Groundwater Monitoring Programs.

Five opportunities for improvement were raised as a result of the audit, all of which pertained to administrative improvements for management review reports, procedures and forms. All improvements have been integrated into the EMS, and subsequently closed.

4.3.8 Proposed Modifications to EMS Programs

As of the end of 2019, there are no significant anticipated changes to the monitoring programs that comprise SRBT’s EMS, including the EMP, EffMP and GMP. These programs continue to effectively measure the impact of facility operations on the environment, and provide data to help optimize our processes and reduce our emissions.

In 2018, SRBT developed the process for the conduct of Environmental Risk Assessments (ERA), in line with the continued execution of our N288-series action plan. The final major deliverable relating to the gap analysis is the conduct and issuance of a formal ERA, expected in late 2020.

4.3.9 Emission Reduction Initiatives

SRBT is committed to researching, developing and implementing initiatives aimed at reducing the emission of tritium to the environment associated with our licenced activities.

A description of the some of these initiatives in 2019 is provided here.

4.3.9.1 Miniature Light Source Leak Test Improvements

In order to reduce the amount of tritium being released via the liquid effluent pathway, actions have been taken to optimize and improve the process for conducting leak testing of certain types of miniature light sources that have historically been problematic.

All light sources manufactured by SRBT undergo a test where they are submerged for a period of time (either four or twenty-four hours, depending on the application), and then the water is sampled and tested for tritium concentration.

When the amount of tritium in the water exceeds certain criteria, the light source(s) are not moved to the next stage of production until it can be determined if a source is leaking.

For most lights, leak test failure is very infrequent; however, for miniature light sources cut with lasers, the frequency of light source leaks is typically much higher than usual. This can be especially pronounced with small-diameter sources.

SRBT has initiated several improvements aimed at lowering the amount of tritium that is transferred into water during these tests, which ultimately must be processed as liquid effluent. These improvements include:

- Increasing the amount of time between cutting and washing miniature light sources and conducting the leak testing procedure – this allows for more time for leaking lights to dim and be visually rejected from the batch.
- Removing the light sources from the water immediately after obtaining the sample – previously the lights would often remain submerged until the results of the leak test were finalized, a process which could take several hours, or even extend into the next day depending on the number of samples being processed.

- In early 2020, procedures will be revised to permit an early screening test to be conducted for batches of miniature light sources, in order to quickly identify light sources that will not pass the leak test if left for the full submersion time. Samples will be permitted to be taken within 15 minutes of submersion, and quickly assessed via liquid scintillation counting, the theory being that it will be clear if a set of sources is bound to fail. These can then be removed from the water, and the remaining batches sampled as normal after the required submersion time has elapsed.

It is hoped that with these improvements, SRBT will be able to meet our in-house target of less than 12 GBq of tritium released via liquid effluent in 2020.

4.3.9.2 Pulsed Purging of Filling Rigs

A change to the purging method applied after a light source filling run is complete was implemented in 2019, in order to reduce the amount of tritium being released to the gaseous effluent pathway.

Previously, a number of purging ‘pulses’ would be introduced into the rig after having pumped down the rig. Argon gas is introduced into the filling rig lines to a target pressure and then it is pumped out immediately, carrying with it any tritium gas or oxide that could not be recaptured on the tritium trap. This first purge after each processing run represents the source of the majority of routine gaseous emissions from the facility.

The pulsed purge would be repeated a second time, followed by the application of a ‘flow-through’ purge where argon was continuously run through the system at a constant pressure while being simultaneously removed via the vacuum pump. The flow-through purge would be terminated once a target tritium concentration in the gaseous effluent stream was approached (as measured by the real-time stack monitoring systems).

In the summer of 2019, the purging method was changed by eliminating the flow-through purge, and instead only performing pulsed purges at the conclusion of the processing operation.

Data suggests that this has helped to lower the amount of tritium released per production run. During the first half of 2019, SRBT released 18,217 GBq of tritium, with a released-to-processed ratio of 0.11%, while in the second half of the year after the change, these figures dropped to 13,552 GBq and 0.10%.

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, tritium trap base design), this initiative was placed on hold, with an eye to return to this project at some point in the future.

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 2019 to improve and maintain fire safety. These activities included but were not limited to the following:

- Fire Protection Program (FPP) was revised and accepted by CNSC staff and the Pembroke Fire Department (PFD),
- Third party contractor completed a Site Condition Inspection at the facility (a detailed report was completed),
- The 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, and
- Enhanced training for one Fire Protection committee member.

4.4.1.1 Fire Protection Committee

In 2019, three 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 November 27, 2019[24], 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 third party audits.

One new Fire Protection procedure was created to enhance fire protection and life safety at the facility, in line with our policy of continuous improvement.

4.4.1.3 Maintenance of the Sprinkler System

In 2019, 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.

4.4.1.4 Fire Protection Equipment Inspections

In 2019, 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.

4.4.1.5 Fire Extinguisher Training

Annual fire extinguisher training was conducted with the support of the Pembroke Fire Department on October 30, 2019.

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.

4.4.1.6 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.

4.4.1.7 Fire Alarm Drills

A total of four in-house fire alarm drills were conducted in 2019.

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.

4.4.1.8 Fire Protection Consultant Inspection

In October, 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 finding and two opportunity for improvements (OFI) were observed pertaining to access to fire protection equipment and storage of waste. Both the finding and OFI’s were acted upon immediately following the handover of the report.

4.4.1.9 Pembroke Fire Department Inspection

The Pembroke Fire Department conducted a facility inspection to confirm compliance with the Ontario Fire Code in May, with no violations being identified.

4.4.2 Emergency Preparedness

SRBT ensures that we are prepared for an emergency at our facility. Staff, equipment and infrastructure are in place and ready to respond to an emergency in accordance with documented procedures.

4.4.2.1 Emergency Plan

The SRBT Emergency Plan has been developed based on the probability and potential severity of emergency scenarios associated with the operation of the facility.

The plan includes preparing for, responding to, and recovering from the effects of accidental radiological and/or hazardous substance releases from the SRBT facility.

The plan was last revised in 2017, and remains up-to-date for the facility's current state.

4.4.2.2 Emergency Exercises

In 2019 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

Twelve shipments of low level waste (LLW) were made to Canadian Nuclear Laboratories in 2019.

All twelve shipments included expired gaseous tritium light sources, as SRBT changed the frequency of these shipments in 2019 to once per month. A total of 251 Type A packages of expired gaseous tritium light sources were generated in 2019.

All twelve shipments also included tritium-contaminated waste materials generated by other processes, including material such as used protective clothing, used equipment components, crushed glass, filters, broken lights and cleaning material.

Four drums of waste liquid scintillation counting vials were also generated and disposed of through EnergySolutions in 2019.

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 2019.

TABLE 31: RADIOACTIVE WASTE CONSIGNMENTS (2019)

	Date of Shipment	Waste Description	Number of Packages	Waste Description	Total Weight (Kgs)	Total Activity H-3 (TBq)
CNL	Jan. 17, 2019	LLW	15	Expired light sources	60	226.602
			2	Crushed stub glass	42	0.018
			1	Drum of LLW (#119)	70	0.010
	Feb. 27, 2019	LLW	19	Expired light sources	76	402.672
			2	Crushed stub glass	42	0.018
			1	Drum of LLW (#121)	70	0.010
	Mar. 13, 2019	LLW	20	Expired light sources	80	258.999
			2	Crushed stub glass	42	0.018
			1	Drum of LLW (#122)	70	0.253
	Apr. 17, 2019	LLW	13	Expired light sources	52	305.163
			3	Crushed stub glass	63	0.027
	May 22, 2019	LLW	10	Expired light sources	40	186.952
			2	Crushed stub glass	42	0.018
			1	Drum of LLW (#123)	70	0.010
	June 26, 2019	LLW	27	Expired light sources	108	585.582
			2	Crushed stub glass	42	0.018
	July 17, 2019	LLW	14	Expired light sources	56	245.393
			3	Crushed stub glass	63	0.027
			1	Drum of LLW (#125)	70	0.010
	Aug. 21, 2019	LLW	26	Expired light sources	104	517.953
			3	Crushed stub glass	63	0.027
			1	Drum of LLW (#127)	70	0.010
	Sep. 18, 2019	LLW	29	Expired light sources	116	719.787
			2	Crushed stub glass	42	0.018
			1	Drum of LLW (#128)	70	0.565
	Oct. 30, 2019	LLW	19	Expired light sources	76	353.192
			2	Crushed stub glass	42	0.018
			2	Drums of LLW (#130&131)	140	0.020
	Nov. 20, 2019	LLW	34	Expired light sources	136	493.701
			1	Crushed stub glass	21	0.009
			1	Drum of LLW (#132)	70	0.010
	Dec. 11, 2019	LLW	25	Expired light sources	100	512.753
			3	Crushed stub glass	63	0.027
			2	Drums of LLW (#133&136)	140	0.020
ENERGY SOLNS	April 1, 2019	LLW Scint Vials	2	Drums	182	0.010
	August 8, 2019	LLW Scint Vials	2	Drums	182	0.010

4.5.2 Storage of Radioactive Waste

Radioactive waste was stored on-site and inventory records of the waste were maintained throughout the year, as per the WMP.

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 dedicated 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 (CNL), using approved processes.

TABLE 32: INTERIM STORAGE OF LOW-LEVEL WASTE (ZONE 3)

AMOUNT IN STORAGE AT YEAR END 2018	AMOUNT GENERATED THROUGHOUT 2019	TRANSFERRED OFF SITE 2019	AMOUNT IN STORAGE AT YEAR END 2019
0 x 200 L drums	17 x 200 L drums	12 x 200 L drums	5 x 200 L drums
0.00 TBq	1.24 TBq	0.12 TBq	1.12 TBq

As well, six drums of liquid scintillation counting vials were generated in 2019, four of which were sent for disposal (via EnergySolutions), and two remaining in storage for disposal in early 2020.

4.5.2.2 Clearance-level Waste Generation

Waste materials in Zone 2 and 3 that may be 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 radiologically, 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, and other such materials that are collected in various receptacles in the active areas of the facility. These materials are assessed, and should they meet the clearance criteria, disposed of via conventional pathways.

The approved WMP clearance criteria is set at 0.15 MBq/g, up to a maximum of 5,000 kg of cleared material per pathway. The mass of CLW generated in 2019 is tabulated below.

TABLE 33: CLEARANCE-LEVEL WASTE (2019)

TYPE OF MATERIAL	PATHWAY	AMOUNT GENERATED (kg)
General waste, plastic	Landfill	3,256
Metal	Recycler	764

4.5.2.3 Phosphorescent Powder Waste

SRBT ships waste phosphorescent (zinc sulfide) 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 2019, 526 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 three times in 2019 to review and discuss initiatives that could ultimately minimize the amount of radioactive waste routed to licenced waste management facilities.

The scope of oversight of the committee was also expanded in 2019, to focus beyond radiological waste considerations, and to begin to look at ways to minimize non-radiological waste and other environmental impacts of facility operations.

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 2019, a total of 28,073 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 5,144.93 TBq of tritium. For comparison, in 2018, a total of 21,232 signs were processed representing 3,530.29 TBq of tritium.

As well, an additional 184.62 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.

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. In 2019, the processing equipment that was historically used to reclaim tritium gas from light sources was dismantled and disposed of through the WMP.

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 2019.

There were no CNSC inspections focused on the Security SCA in 2019.

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.

On May 8, 2019, the Manager – Safety and Security attended an International Security Conference and Exposition in Ottawa, Ontario, hosted by the Canadian Security Association.

4.7 SCA – Safeguards and Non-Proliferation

SRBT possesses, uses, stores and manages a 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.

SRBT possessed a reported 9.678 kg of depleted uranium in metallic form at the beginning of 2019. The inventory of material changed twice in 2019:

- A reweighing of container 1 on May 22 determined that the container mass was 12 grams lower than that recorded, due primarily to the removal of non-uranium foreign matter from the container when selecting pellets for traps since the last weighing.

- As a result of a detailed mass assessment, the total inventory was adjusted downward by 143 grams on July 29. The discrepancy between the mass of material on record and the actual total mass measured is attributed to the removal of excess plastic packing material from container 2 (the small rods delivered to SRBT in 2018), the deduction of the weight of the jar as well as the removal of small amounts of foreign materials from container 1 during the inventory taking process.

At the conclusion of 2019, the total mass of depleted uranium on site stands at 9.523 kg. A limit of 10 kg of this material in inventory is applied as part of the operating limits and conditions in the SAR.

During 2019, the IAEA did not conduct verification activities of our inventory of this material, nor did the agency request 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.

4.8.1 Outgoing Shipments

In total, 949 consignments were safely shipped to various customers located in 20 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 34: OUTGOING SHIPMENTS OF PRODUCT FIVE YEAR TREND (2015-2019)

Year	2015	2016	2017	2018	2019
Number of Shipments*	1,150	1,001	970	948	949
Number of Countries	16	18	23	22	20

*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. 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 2019 can be found in **Appendix T** of this report.

4.8.2 Incoming Shipments

In total, 484 consignments of radioactive shipments were received from various customers located in 8 countries around the world, including Canada. These returns held a total activity of 5,330.02 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 35: INCOMING SHIPMENTS OF PRODUCT FIVE YEAR TREND (2015-2019)

Year	2015	2016	2017	2018	2019
Number of Shipments	598	562	539	518	484
Number of Countries	9	9	6	7	8

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 2019 can be found in **Appendix U** of this report.

4.8.3 Reportable Events

No packaging and transport-related reportable events took place in 2019; however, in line with our Regulatory Reporting Program SRBT reported one event relating to import controls that involved the shipping and receiving area.

On January 16, 2019, SRBT erroneously accepted three (3) aircraft signs containing a total of 279.72 GBq of tritium gas from a customer in the European Union.

The three signs had recently been sold and exported by SRBT in accordance with an export licence issue by the CNSC. The signs were received by the customer, but after inspection the signs were rejected as they were found to not meet the design requirements for their purpose.

The customer sent the three signs back, and the shipment was mistakenly accepted upon arrival, prior to being authorized by SRBT.

SRBT reinforced with the customer that the returns process had not been followed, and that SRBT expects that this process shall be followed in the future in all cases where products may need to be returned to Canada.

The event and the lessons learned were discussed with our staff in the shipping department, and the importance of adherence to the returned goods authorization process was emphasized.

5. Other Matters of Regulatory Interest

5.1 Public Information and Disclosure

This section of the report will provide public information initiatives taken in 2019.

5.1.1 Direct Interaction with the Public

Historically almost all public inquiries occur during re-licensing. In 2019, there were no public local or non-local inquiries made.

In 2019, 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. No questions or comments were received in 2019.

Plant tours have proven to be a useful tool for SRBT to reach the public. In 2019, we have provided plant tours to 17 members of the general public (compared to 26 in 2018, 25 in 2017 and 27 in 2016) who had expressed interest in our facility.

In 2019 we provided plant tours to local representatives of:

- Renfrew County Community Futures Development Corporation,
- The City of Pembroke,
- Pembroke Fire Department,
- UL,
- Environmental Health and Safety Consulting, and
- Algonquin College

In 2019 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:

- Black and MacDonald,
- Irvcon,
- Laird Plastics, and
- Layman Fire

In 2019 we also provided plant tours to existing and prospective customers including:

- Isolite,
- Bell Helicopter, and
- Gumsung Trading

TABLE 36: FACILITY TOURS (2019)

	2019
GENERAL PUBLIC	17
LOCAL INSTITUTIONS	6
LOCAL SUPPLIERS	4
CUSTOMERS	3
TOTAL	**30**

A public meeting was held by the CNSC on December 11, 2019 regarding the annual regulatory oversight report. During the meeting, SRBT addressed questions regarding point of contact for recipients of the participant funding, Monitoring Well 06-10, how SRBT safely stores tritium at the facility, and reportable event regarding a Type 'A' shipment containing a Type 'B' quantity. All questions were answered to the satisfaction of both the Commission and the CNSC staff.

Once again, the Public Information Committee discussed and agreed to not have a presentation to Pembroke City Council in 2019, nor to initiate a public opinion survey in 2019 (though the survey is available on our website) due to no concerns being voiced. Both decisions will be revisited in 2020.

In 2018, SRBT sent letters to five aboriginal groups as part of our public outreach. To date, SRBT has received two responses to these letters. One response stated that they would be willing to meet with SRBT, contingent on all costs being paid by SRBT.

The second response expressed positive interest in a meeting and a tour, and SRBT has continued to communicate with this group on arranging a time and date for a meeting and facility tour to take place; however, due to other competing commitments and several last-minute schedule changes, this group was not been able to make their way to our facility in calendar year 2019.

SRBT continues to engage interested public stakeholders and aboriginal groups.

During 2019, SRBT made presentations to members of the public:

- The President of SRBT is a member of the Pembroke Economic Development Tourism Advisory Committee (PEDTAC), attending monthly meetings where updates on SRBT are often discussed.
- The President of SRBT is also a member and chair of the Community Improvement Plan (CIP), attending meetings and discussing SRBT on occasion. The Mayor of Pembroke is also on the Committee.
- The President of SRBT is also a member of the Ontario River Energy Solutions (ORES), attending meetings and discussing SRBT on occasion.
- The Manager – Health Physics and Regulatory Affairs made a presentation to Kiwanis Club of Pembroke to discuss SRBT's products, markets, being licensed by the Canadian Nuclear Safety Commission (CNSC), the local economic impact, recent recognitions in industry, facility operations and SRBT in our community.
- The Manager – Health Physics and Regulatory Affairs made a presentation to Algonquin College to discuss Liquid Scintillation Counting theory, instrument description, limitations and considerations and provided a demonstration.

5.1.2 Program Revision

Revision 9 of the Public Information program (PIP) continues to demonstrate SRBT's commitment to openness and transparency. In 2020, there will be a review of the PIP to determine if changes or improvements can be made to better include non-local stakeholders etc. and also to review REGDOC 3.2.1, Public and Aboriginal Engagement Public Information and Disclosure, which supersedes RD-99.3 and verify compliance.

5.1.3 Program Audit

There was one internal audit conducted on the Public Information Program on November 14, 2019. The audit resulted in one NCR and one OFI. NCR-781, adding the current disclosure protocol to the website is closed and OFI-454, transition to current website "SRBT.com", target completion date is December 2020.

5.1.4 Public Information Committee

The Public Information Committee held two formal meetings in 2019, mostly consisting of our groundwater brochure, the general information brochure and pamphlet all updated on March 29, 2019 which all reflect the data in the 2018 Annual Compliance Report and subsequently posted on our website. The committee also discussed the outreach to the First Nations and the response received. The frequency of meetings was changed from quarterly to twice yearly.

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.

The CNSC Inspection report, 2018 Annual Compliance Report and addendum, the CNSC 2018 annual regulatory oversight report, the press release and environmental results were posted on the website during 2019.

We also maintain a Facebook, Instagram and Twitter account which are all updated periodically. In 2019, SRBT created new social media accounts on LinkedIn and Reddit.

Since being initiated on February 3, 2015 our Facebook account has gained a total of 291 followers (44 in 2019), we made a total of 48 posts (12 in 2019) and received 18 reviews to date (0 in 2019) all of which are positive with a total of 282 page “likes’ (40 in 2019).

Since its inception on December 11, 2016, our Instagram account has gained a total of 167 followers (28 in 2019), we made a total of 27 posts (9 in 2019) and received an average of 29 likes per post in 2019.

Our Twitter account was started on April 6, 2017 and has since gained 55 followers (12 in 2019), we made a total of 17 posts (6 in 2019) and received 74 “likes” (26 in 2019).

5.1.6 Community Support

SRBT has supported the local community by providing support to various organizations and causes.

SRBT 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.

The Manager – Health Physics and Regulatory Affairs is a member of the Algonquin College Radiation Safety Program Advisory Committee. During the summer of 2019, SRBT employed a summer student from this program, and in turn that student continues working part time while still attending school.

SRBT is a member of the Upper Ottawa Valley Chamber of Commerce.

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, Bernadette McCann House for Women and The Robbie Dean Family Counseling Center.

SRBT also supports Festival Hall the local community theater, the Alice and Fraser Horse Association and the Renfrew County Regional Science and Technology Fair.

SRBT supported the OSPCA, several public skating events and several trivia nights

SRBT sponsored and put in a team for the Upper Ottawa River Race & Paddle Festival in support of CHEO

SRBT sponsored the Renfrew CFDC Winner Announcement night for the RC100 pitch finals.

SRBT also sponsors many sports teams and groups, including hockey teams, 2 fishing teams, baseball teams, a volleyball team, a soccer team and a basketball team. SRBT also sponsored two fishing tournaments and a golf tournament.

5.2 Preliminary Decommissioning Plan and Financial Guarantee

The SRBT Preliminary Decommissioning Plan (PDP) underwent a significant revision in 2019, in compliance with compliance verification criteria 3 for Licence Condition 12.2, as described in the SRBT LCH.

The revised and updated plan was submitted to CNSC staff on November 29, 2019. Major changes in the submitted version of the PDP included:

- Updated floor space and floor plan figure to include molding / machining area,
- Synchronized information on site location with SAR for consistency,
- Adjusted labour rates to account for five years of inflation,
- Updated action levels,
- Updates throughout Section 8 to align with current management system,
- Updated LLW rate per unit volume to $28,000 per m^3,
- Added concept of clearance-level waste and associated mass expected throughout work packages,
- Introduced recycling as a potential management strategy during decommissioning phase,
- Removed references to LMI laser and Reclaim Rig, and
- Updated total cost estimate ($727,327.00).

CNSC staff accepted the revised PDP on February 3, 2020.

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.

At the conclusion of 2019, the financial guarantee held in escrow maintained a balance of $701,691.33, and continues to accrue interest over time.

On February 4, 2020, SRBT submitted a proposal in February 2020 to fully fund the guarantee to the new PDP cost estimate level of $727,327.00, to be completed no later than April 30, 2020.

6 Improvement Plans and Forecast

6.1 Emission Reduction Initiatives

SRBT continues to explore ways toward reducing tritium emissions from the facility in all forms, as per our continuing commitment to environmental protection and the ‘as low as reasonably achievable (ALARA) philosophy.

We expect that the changes that are being introduced to leak testing of miniature light sources should lower the rate of generation of tritium-contaminated liquid effluent in 2020.

We continue to track the effectiveness of altering our purging strategy for tritium processing runs, and to optimize our procedures and equipment to lower routine emissions.

The removal of the reclaim rig is also expected to have a small effect on the amount of tritium oxide released chronically.

6.2 Safety Performance Targets for 2020

For the coming year, our safety committees, in consultation with SRBT Senior Management, have approved a set of performance targets which will be tracked and reported on as part of the 2020 ACR.

The following table documents the safety performance targets for SRBT in 2020:

TABLE 37: SRBT SAFETY AND PERFORMANCE TARGETS FOR 2020

PARAMETER	2020 TARGET
Maximum Worker Dose	≤ 0.70 mSv
Average Worker Dose	≤ 0.060 mSv
Calculated Dose to Member of the Public	≤ 0.0040 mSv
Total Tritium Emissions to Atmosphere (per week average)	≤ 650 GBq / week
Ratio – Tritium Emissions vs. Processed	≤ 0.12
Total Tritium Emissions – Liquid Effluent Pathway	≤ 12 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	≤ 5

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, and production levels are expected to remain stable.

We have seen a number of modifications and changes to our operations and our management system since licence renewal. We project that the coming year will be relatively static in terms of our operations and management.

That being said, the following key management system programs or documents are expected to be revised and submitted in 2020, and subsequently reviewed and accepted by CNSC staff:

- Fire Protection Program,
- Public Information Program, and
- Environmental Risk Assessment (ERA)

We have implemented our process for the conduct of an environmental risk assessment (ERA), as part of the N288-series action plan[36]; this process is ongoing, and is expected to culminate in the submission of an ERA report at the end of 2020 that will support licence renewal in the 2021-22 timeframe.

SRBT will be continuing to explore increasing the amount of sampling and analysis done in-house in support of the EMP. We will also continue to pursue and explore opportunities to reduce emissions in all forms, as part of our ongoing commitment to ensure that our environmental impacts are as low as reasonably achievable.

7 Concluding Remarks

Throughout the year, the management and staff of SRBT complied with all regulatory requirements and the conditions of our operating licence.

The year 2019 represented the third full year of operation under our N286-compliant management system, which remains effective at achieving our operational and safety-related goals. We continue to adjust and improve our processes in support of the safe and effective operation of our facility, and we continue to use operating experience to continuously improve the 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 2019 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.

No lost time injuries occurred in 2019, and our conventional health and safety program continues to ensure our workers are safe.

Security of the facility and all nuclear substances was maintained at all times.

SRBT remains well protected from fire hazards, and have maintained an accepted plan should an emergency condition arise. We are looking forward to conducting a full-scale emergency exercise in 2020, in order to practice our response as described in our Emergency Plan, should an emergency arise at our facility.

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 will be fully funded no later than April 30, 2020.

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 important consideration with respect to our regulatory standing, as well as 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 2019 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. Rashapov (CNSC) to S. Levesque (SRBT), *Inspection Report No. SRBT-2019-01 February 26, 2019 – February 28, 2019,* dated May 9, 2019 (e-Doc 5896684).

[5] Letter from S. Levesque (SRBT) to R. Rashapov (CNSC), *SRBT Response to Inspection Report SRBT-2019-01,* dated June 11, 2019.

[6] Letter from L. Posada (CNSC) to S. Levesque (SRBT), *CNSC Compliance Inspection Report No. SRBT-2019-02,* dated November 1, 2019 (e-Doc 6018987).

[7] Letter from S. Levesque (SRBT) to L. Posada (CNSC), *SRBT Response to CNSC Compliance Inspection Report SRBT-2019-02,* dated November 21, 2019.

[8] Email from J. MacDonald (SRBT) to R. Rashapov (CNSC), *Change Request – SRBT LCH*, dated March 26, 2019.

[9] Email from R. Rashapov (CNSC) to J. MacDonald (SRBT), *RE: For next revision of LCH…*, dated May 21, 2019.

[10] Letter from S. Levesque (SRBT) to R. Rashapov (CNSC), *Submission of Revised Maintenance Program,* dated May 2, 2019.

[11] Letter from R. Rashapov (CNSC) to S. Levesque (SRBT), *CNSC Staff Review of SRB Technologies (Canada) Inc.'s Revised Maintenance Program (Revision 7),* dated June 5, 2019 (e-Doc 5914020).

[12] Letter from S. Levesque (SRBT) to R. van Hoof (CNSC), *SRBT Licence Limits, Action Levels and Administrative Limits,* dated May 23, 2019.

[13] Letter from L. Posada (CNSC) to S. Levesque (SRBT), *CNSC Staff Review of SRB Technologies (Canada) Inc.'s Revised Licence Limits, Action Levels and Administrative Limits (Revision F),* dated June 27, 2019 (e-Doc 5934615).

[14] Letter from S. Levesque (SRBT) to L. Posada (CNSC), *SRBT Response to CNSC Staff Review of Revised Licence Limits, Action Levels and Administrative Limits,* dated July 19, 2019.

[15] Letter from R. Rashapov (CNSC) to S. Levesque (SRBT), *CNSC Staff's Review of SRB Technologies (Canada) Inc.'s Revised Licence Limits, Action Levels and Administrative Limits*, dated August 21, 2019 (e-Doc 5972701*).*

[16] Email from J. MacDonald (SRBT) to R. van Hoof (CNSC), *Submission of Revised Health and Safety Policy Document,* dated May 30, 2019.

[17] Letter from L. Posada (CNSC) to J. MacDonald (SRBT), *CNSC Staff Review of SRB Technologies (Canada) Inc.'s Revised Health and Safety Policy, Revision B,* dated July 18, 2019 (e-Doc 5951597).

[18] Letter from S. Levesque (SRBT) to H. Tadros (CNSC), *SRBT Implementation of REGDOC 2.1.2,* dated May 31, 2019.

[19] Email from J. MacDonald (SRBT) to L. Posada (CNSC), *SRBT Submission of Four Revised Procedures (LCH Appendix C),* dated July 4, 2019.

[20] Letter from L. Posada (CNSC) to J. MacDonald (SRBT), *CNSC Staff Review of SRB Technologies (Canada) Inc.'s Revised Four Procedures,* dated November 15, 2019 (e-Doc 5976574).

[21] Letter from S. Levesque (SRBT) to L. Posada (CNSC), *SRBT Clarification: SHP-005 Revision C, section 5.2,* dated November 21, 2019.

[22] Email from L. Posada (CNSC) to J. MacDonald (SRBT), *SRBT Licence Conditions Handbook Revision 3 Draft,* dated October 28, 2019.

[23] Letter from S. Levesque (SRBT) to L. Posada (CNSC), *SRBT Comments on Revision 3 Draft of Licence Conditions Handbook,* dated November 12, 2019.

[24] Letter from R. Fitzpatrick (SRBT) to L. Posada (CNSC), *Submission of Revised SRBT Fire Protection Program and Fire Safety Plan,* dated November 27, 2019.

[25] Letter from S. Levesque (SRBT) to L. Posada (CNSC), *SRBT Submission of Revised Preliminary Decommissioning Plan - 2019,* dated November 29, 2019.

[26] Letter from M. Tremblay (Health Canada) to J. MacDonald (SRBT), *Certificate of Achievement,* dated June 24, 2019.

[27] Email from J. MacDonald (SRBT) to T. Barr (CNSC), *2018 Annual Compliance Report – 11341-3-28.0,* dated February 7, 2019.

[28] SRBT *Licence Limits, Action Levels and Administrative Limits*, Revision F, August 19, 2019.

[29] SRBT *Environmental Monitoring Program*, Revision B, August 12, 2016.

[30] Ontario Ministry of the Environment, *Certificate of Approval Air,* number 5310-4NJQE2, August 31, 2000.

[31] 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*

[32] 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.

[33] 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.

[34] 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.

[35] 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.

[36] Letter from S. Levesque (SRBT) to R. Buhr (CNSC), *Disposition of Comments – SRBT Environmental Protection Gap Analysis and Action Plan,* dated May 26, 2016.

9 Appendices

DESCRIPTION **LETTER**

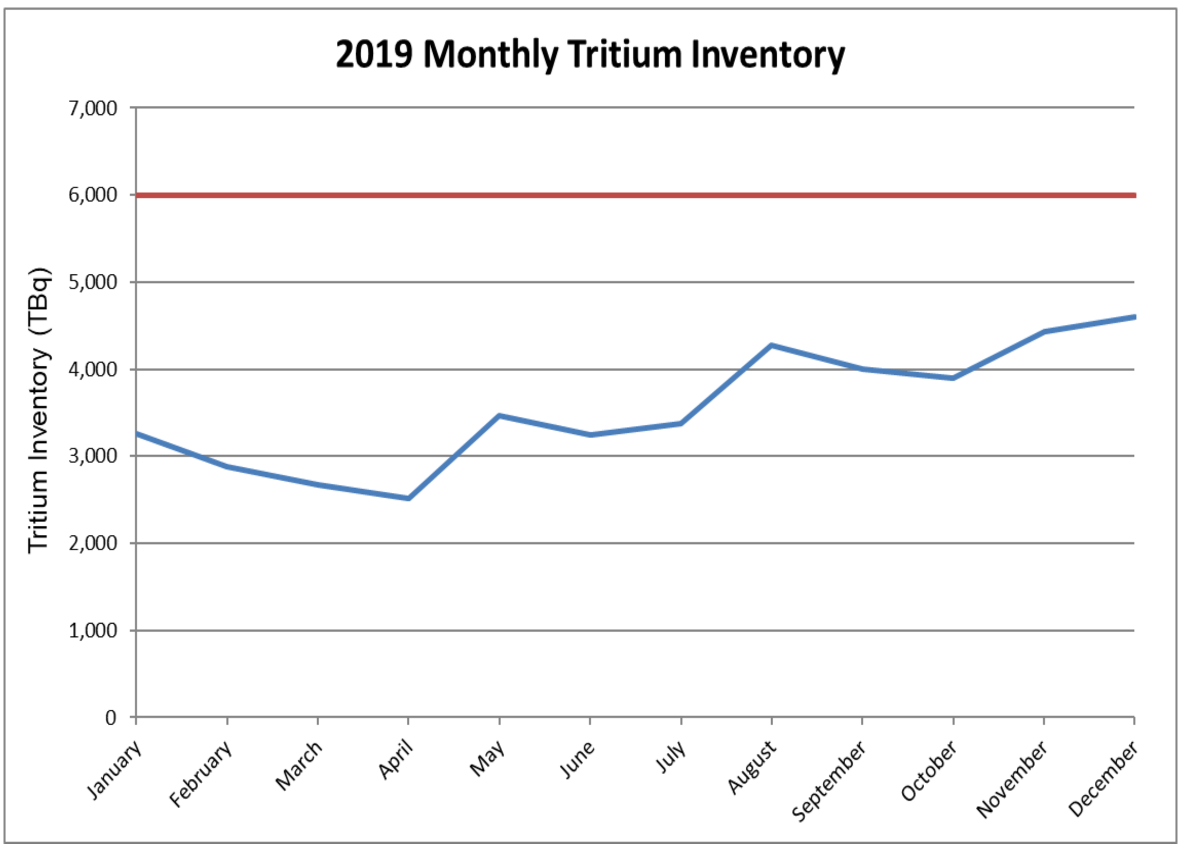
APPENDIX A

Tritium Activity on Site During 2019

TRITIUM ACTIVITY ON SITE DURING 2019

Month	Month-end H-3 Activity On-Site (TBq)	Percent of Licence Limit (%)
January	3,252	54.2
February	2,874	47.9
March	2,670	44.5
April	2,518	42.0
May	3,464	57.7
June	3,244	54.1
July	3,378	56.3
August	4,269	71.2
September	3,998	66.6
October	3,901	65.0
November	4,431	73.9
December	4,607	76.8
2019 Monthly Average	**3,551**	**59.2**

Note: Tritium possession limit = 6,000 TBq.



APPENDIX B

Equipment Maintenance Information for 2019

2019 Scheduled Maintenance Activities Performed

Semi-Annual maintenance on HVAC equipment: **Contract:** Ainsworth	April 17, 2019 Sept 20, 2019
Quarterly maintenance on Rig & Bulk stack units: **Contract:** Ainsworth	March 26, 2019 June 13, 2019 Sept 20, 2019 Dec 17, 2019
Annual stack verification by a third party on Rig & Bulk stack units: **Contract:** Tab Inspection	Sept 27, 2019
Sprinkler System quarterly maintenance by a third party: **Contract:** Drapeau Automatic Sprinkler Corp	March 15, 2019 June 12, 2019 Sept 26, 2019 Dec 19, 2019
Emergency Lighting & Fire Extinguisher annual inspection by a third party: **Contract:** Layman Fire and Safety	March 13, 2019
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 3, 2019 Feb 25, 2019 Apr 10, 2019 July 5, 2019 Oct 4, 2019
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 26, 2019
Liquid Scintillation Counters third party annual maintenance: **Contract:** PerkinElmer	Oct 7, 2019
Real-time Stack Monitoring system verification by SRBT:	March 11, 2019 June 5, 2019 Sept 27, 2019 Dec 4, 2019

2019 Scheduled Maintenance Activities Performed

Monitoring well inspection by SRBT:	Feb 4, 2019 June 26, 2019 Oct 1, 2019
Annual IT maintenance inspection by SRBT:	September 25, 2019
Non-active air filter inspection by SRBT:	Monthly
Annual Zone Differential Pressure Test by SRBT:	December 17, 2019
UV printer maintenance by SRBT:	Monthly
Molding machine maintenance by SRBT:	June 28, 2019 Sept 24, 2019 Dec 17, 2019
3D printer maintenance by SRBT:	Mar 21, 2019 June 28, 2019 Sept 4, 2019 Dec 17, 2019
Forkcrane maintenenance by SRBT:	May 28, 2019
Forklift maintenance by a third party: Contract: Hyster	April 15, 2019
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 2019

Ventilation Equipment Maintained In 2019

#	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 / molding

APPENDIX D

Radiological Occupational Annual Dose Data for 2019

SRBT ROLLING FIVE-YEAR EFFECTIVE DOSE DATA (2015 - 2019)

ANNUAL DOSE (mSv)	2015	2016	2017	2018	2019	AVERAGE
Maximum Dose	0.87	0.34	0.46	0.48	0.57	**0.69**
Average Dose	0.07	0.049	0.045	0.044	0.065	**0.062**
Collective Dose	3.22	2.21	1.96	2.06	2.95	**2.89**

EFFECTIVE DOSE RANGE (mSv)	2015	2016	2017	2018	2019	AVERAGE
0 – 0.05	33	32	36	39	30	**34**
0.05 – 0.10	5	7	4	1	6	**5**
0.10 – 0.25	5	3	2	5	5	**4**
0.25 – 0.50	3	3	3	2	3	**2**
0.50 – 1.00	1	0	0	0	1	**1**
>1.00	0	0	0	0	0	**0**
Number of Workers Monitored	47	45	45	47	45	**46**

APPENDIX D

APPENDIX E

Swipe Monitoring Results for 2019

Q1 2019 Routine Contamination Assessment Summary - Zone 3

Zone 3 Swipe Areas	No. of swipes	Amount pass	Average Pass
Rig 7 Floor	61	58	95.08%
Rig 7	61	60	98.36%
Rig 1 Floor	61	58	95.08%
Rig 1	61	59	96.72%
Rig 6 Floor	61	58	95.08%
Rig 6	61	60	98.36%
Rig 8 Floor	61	60	98.36%
Rig 8	61	61	100.00%
Rig 5 Floor	61	54	88.52%
Rig 5	61	61	100.00%
Waste Room Floor	57	53	92.98%
Wash-Station Fume Hood	57	56	98.25%
Liquid Nitrogen Tank	61	61	100.00%
Oven	61	61	100.00%
Floor @ Barrier	61	54	88.52%
Laser Room Floor	61	52	85.25%
EIP Area	61	51	83.61%
Laser Rm F/H	61	43	70.49%
Shoe Covers	61	52	85.25%
Tritium Lab Floor	61	57	93.44%
Bulk Fume Hood	61	59	96.72%
Disassembly Lower Cabinets	57	51	89.47%
Toolbox	57	54	94.74%
Reclaim Fume Hood	57	57	100.00%
Muffle Fume Hood	4	4	100.00%
Waste Room Shelving	4	3	75.00%
Disassembly Fume Hood	4	2	50.00%
Variac	4	4	100.00%
Reclaim Sash	4	4	100.00%
	1464	1367	93.37%

Q1 2019 Routine Contamination Assessment Summary - Zone 2

Zone 2 Swipe Areas	No. of swipes	Amount pass	Average Pass
Floor at Barrier	36	34	94.44%
Work Area Floors	36	32	88.89%
Work Counters	36	36	100.00%
WIP Cabinet	36	35	97.22%
Shoe Covers	36	30	83.33%
Completed Order Cabinet	33	32	96.97%
Floor Beside Disassembly	36	33	91.67%
Disassembly Bins	36	31	86.11%
Silk Screening Room Floor	33	33	100.00%
Photometer Room Shelving	33	32	96.97%
Inspection Prep Floor	36	33	91.67%
Insp. Prep. Counter	36	34	94.44%
Paint Booth	3	3	100.00%
Laser Light Trays	3	3	100.00%
Photometer Room Floor	3	2	66.67%
	432	403	93.29%

Q1 2019 Routine Contamination Assessment Summary - Zone 1

Zone 1 Swipe Areas	No. of swipes	Amount pass	Average Pass
Lunch Room	13	13	100.00%
LSC Room	13	13	100.00%
RR Ante Rm	13	13	100.00%
RR Barrier	13	13	100.00%
Assy Barrier	13	13	100.00%
Disassembly Table	13	10	76.92%
Disassembly Cabinet	11	11	100.00%
Shipping Area	13	13	100.00%
RMA Storage Bins	11	11	100.00%
RMA Storage Area	13	13	100.00%
Disassembly Wire Racks	2	2	100.00%
Mold Storage	2	2	100.00%
	130	127	97.69%

Q2 2019 Routine Contamination Assessment Summary - Zone 3

Zone 3 Swipe Areas	No. of swipes	Amount pass	Average Pass
Rig 7 Floor	62	58	93.55%
Rig 7	62	61	98.39%
Rig 1 Floor	62	58	93.55%
Rig 1	62	59	95.16%
Rig 6 Floor	62	61	98.39%
Rig 6	62	62	100.00%
Rig 8 Floor	62	60	96.77%
Rig 8	62	62	100.00%
Rig 5 Floor	62	56	90.32%
Rig 5	62	61	98.39%
Waste Room Floor	62	60	96.77%
Table at Barrier	59	54	91.53%
Portable Monitors	59	59	100.00%
LR Microscope	59	58	98.31%
Floor @ Barrier	62	56	90.32%
Laser Room Floor	62	59	95.16%
EIP Area	62	60	96.77%
Laser Rm Fume Hood	62	59	95.16%
Shoe Covers	62	56	90.32%
Tritium Lab Floor random	62	57	91.94%
Bulk Fume Hood	62	58	93.55%
Disassembly Lower Cabinets	62	62	100.00%
Muffle Fume Hood	59	45	76.27%
Reclaim Sash	59	59	100.00%
Wash-Station Fume Hood	3	3	100.00%
Liquid Nitrogen Tank	3	3	100.00%
Oven	3	3	100.00%
Toolbox	3	3	100.00%
Reclaim Fume Hood	3	3	100.00%
	1488	1415	95.09%

Q2 2019 Routine Contamination Assessment Summary - Zone 2

Zone 2 Swipe Areas	No. of swipes	Amount pass	Average Pass
Floor at Barrier	36	35	97.22%
Work Area Floors	36	33	91.67%
Work Counters	36	35	97.22%
WIP Cabinet	36	35	97.22%
Shoe Covers	36	29	80.56%
Foot rest	34	31	91.18%
Floor Beside Disassembly	36	31	86.11%
Disassembly Bins	36	33	91.67%
Microscope Area	34	31	91.18%
UV Printer Cabinet	34	34	100.00%
Inspection Prep Floor	36	34	94.44%
Insp. Prep. Counter	36	33	91.67%
Completed Order Cabinet	2	1	50.00%
Silk Screening Room Floor	2	1	50.00%
Photometer Room Shelving	2	2	100.00%
	432	398	92.13%

Q2 2019 Routine Contamination Assessment Summary - Zone 1

Zone 1 Swipe Areas	No. of swipes	Amount pass	Average Pass
Lunch Room	13	13	100.00%
LSC Room	13	13	100.00%
RR Ante Rm	13	13	100.00%
RR Barrier	13	12	92.31%
Assy Barrier	13	13	100.00%
Disassembly Table	13	12	92.31%
Disassembly Cart	12	11	91.67%
Shipping Area	13	12	92.31%
Hallway at Z2	12	12	100.00%
RMA Storage Area	13	13	100.00%
Disassembly Cabinet	1	1	100.00%
RMA Storage Bins	1	1	100.00%
	130	126	96.92%

Q3 2019 Routine Contamination Assessment Summary - Zone 3

Zone 3 Swipe Areas	No. of swipes	Amount pass	Average Pass
Rig 7 Floor	63	60	95.24%
Rig 7	63	63	100.00%
Rig 1 Floor	63	61	96.83%
Rig 1	63	62	98.41%
Rig 6 Floor	63	61	96.83%
Rig 6	63	63	100.00%
Rig 8 Floor	63	63	100.00%
Rig 8	63	63	100.00%
Rig 5 Floor	63	60	95.24%
Rig 5	63	63	100.00%
Waste Room Shelf	61	55	90.16%
Table at Barrier	63	58	92.06%
LMI Floor	61	50	81.97%
Wash Station Fume Hood	59	58	98.31%
Floor @ Barrier	63	60	95.24%
Laser Room Floor	63	54	85.71%
EIP Area	63	61	96.83%
Laser Room Fume Hood	63	49	77.78%
Shoe Covers	63	56	88.89%
Tritium Lab Floor	63	60	95.24%
Bulk Fume Hood	63	57	90.48%
Disassembly Fume Hood	61	56	91.80%
Muffle Fume Hood	61	48	78.69%
Reclaim Cabinets	61	58	95.08%
Waste Room Floor	2	2	100.00%
Portable Monitors	2	2	100.00%
LR Microscope	2	2	100.00%
Disassembly Lower Cabinets	2	2	100.00%
Reclaim Sash	2	2	100.00%
	1508	1409	93.44%

Q3 2019 Routine Contamination Assessment Summary - Zone 2

Zone 2 Swipe Areas	No. of swipes	Amount pass	Average Pass
Floor at Barrier	38	37	97.37%
Work Area Floors	38	36	94.74%
Work Counters	38	38	100.00%
Silk Screen Room Floor	38	38	100.00%
Shoe Covers	38	36	94.74%
Foot rest	38	35	92.11%
Floor Beside Disassembly	38	33	86.84%
Disassembly Bins	38	36	94.74%
Microscope Area	38	36	94.74%
Photometer Room	38	37	97.37%
Shoe Storage	38	37	97.37%
Insp. Prep. Counter	38	36	94.74%
	456	435	95.39%

Q3 2019 Routine Contamination Assessment Summary - Zone 1

Zone 1 Swipe Areas	No. of swipes	Amount pass	Average Pass
Lunch Room	13	13	100.00%
LSC Room	13	13	100.00%
RR Ante Room	13	13	100.00%
RR Barrier	13	13	100.00%
Assy Barrier	13	13	100.00%
Disassembly Table	13	11	84.62%
Disassembly Cart	13	12	92.31%
Shipping Area	13	13	100.00%
Hallway at Z2	13	12	92.31%
RMA Storage Area	13	12	92.31%
	130	125	96.15%

Q4 2019 Routine Contamination Assessment Summary - Zone 3

Zone 3 Swipe Areas	No. of swipes	Amount pass	Average Pass
Rig 7 Floor	58	53	91.38%
Rig 7	58	58	100.00%
Rig 1 Floor	58	54	93.10%
Rig 1	58	58	100.00%
Rig 6 Floor	58	53	91.38%
Rig 6	58	57	98.28%
Rig 8 Floor	58	53	91.38%
Rig 8	58	56	96.55%
Rig 5 Floor	58	52	89.66%
Rig 5	58	57	98.28%
Waste Room Shelf	58	56	96.55%
Table at Barrier	58	54	93.10%
Laser Room Floor West	53	48	90.57%
Photometer Room	53	51	96.23%
Floor @ Barrier	58	48	82.76%
Laser Room Floor East	58	51	87.93%
EIP Area	58	57	98.28%
Laser Room Fume Hood	58	51	87.93%
Shoe Covers	58	42	72.41%
Tritium Lab Floor	58	44	75.86%
Bulk Fume Hood	58	53	91.38%
Disassembly Fume Hood	58	55	94.83%
Muffle Fume Hood	58	57	98.28%
LLW Drums	13	12	92.31%
LMI Floor	5	5	100.00%
Wash-Station Fume Hood	5	5	100.00%
Reclaim Cabinets	5	5	100.00%
Reclaim Fume Hood	37	35	94.59%
Reclaim Area Floor	1	0	0.00%
	1390	1280	92.09%

APPENDIX E

Q4 2019 Routine Contamination Assessment Summary - Zone 2

Zone 2 Swipe Areas	No. of swipes	Amount pass	Average Pass
Floor at Barrier	35	35	100.00%
Work Area Floors	35	33	94.29%
Work Counters	35	34	97.14%
Cart at Barrier	32	30	93.75%
Shoe Covers	35	23	65.71%
Foot rest	35	33	94.29%
Floor Beside Disassembly	35	30	85.71%
Disassembly Bins	35	31	88.57%
Microscope Area	35	31	88.57%
Storage Cabinets	32	30	93.75%
Paint Booth	32	32	100.00%
Insp. Prep. Counter	35	33	94.29%
	411	375	91.24%

Q4 2019 Routine Contamination Assessment Summary - Zone 1

Zone 1 Swipe Areas	No. of swipes	Amount pass	Average Pass
Lunch Room	12	12	100.00%
LSC Room	12	12	100.00%
RR Ante Room	12	11	91.67%
RR Barrier	12	10	83.33%
Assy Barrier	12	12	100.00%
Disassembly Table	12	10	83.33%
Disassembly Cart	12	11	91.67%
Shipping Floor	11	11	100.00%
Hallway at Z2	12	12	100.00%
RMA Storage Area	12	12	100.00%
	119	113	94.96%

Overall Facility Summary

Facility Zone	Assessments	Pass	Pass Rate
ZONE 3	5,850	5,471	93.5%
ZONE 2	1,731	1,611	93.1%
ZONE 1	509	491	96.5%
2019	8,090	7,573	93.6%

APPENDIX F

Passive Air Sampler Results for 2019

2019 Environment Monitoring Program
Passive Air Sampling System

Sampler No.	Sampler ID	Location	Dist. to SRBT	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average (Bq/m3)
				(Bq/m3)												
				Jan 3-Feb 5	Feb 5-Mar 1	Mar 1-Apr 2	Apr 2-May 1	May 1-May 31	May 31-Jun 28	Jun 28-Aug 1	Aug 1-Aug 29	Aug 29-Sep 30	Sep 30-Nov 1	Nov 1-Dec 2	Dec 2-Jan 7	
1	N250	N 45º 48.486' W 077º 07.092' Elev. 137m	322m	1.13	0.44	2.00	2.10	1.10	1.40	1.00	1.30	2.00	2.40	0.66	0.28	1.32
2	N500	N 45º 48.572' W 077º 07.008' Elev. 134m	493m	0.34	0.43	0.93	0.54	0.36	0.39	0.70	0.45	0.67	1.20	0.65	0.28	0.58
3	N1000	N 45º 48.869' W 077º 06.997' Elev. 135m	1040m	0.32	0.43	0.33	0.37	0.36	0.39	0.33	0.39	0.36	0.34	0.31	0.29	0.35
4 (PAS #4)	NW250	N 45º 48.412' W 077º 07.189' Elev. 137m	222m	1.00	0.50	2.40	4.20	5.40	3.40	1.30	3.20	3.20	1.90	2.00	1.40	2.49
5	NW500	N 45º 48.577' W 077º 07.382' Elev. 134m	615m	0.73	0.44	0.93	0.91	1.20	0.70	0.41	0.81	0.81	0.55	0.55	0.50	0.71
6 (PAS # 8)	NW1000	N 45º 48.754' W 077º 07.599' Elev. 130m	1050m	0.45	0.43	0.56	0.36	0.37	0.38	0.31	0.38	0.37	0.31	0.31	0.28	0.38
7	NW2000	N 45º 49.141' W 077º 08.090' Elev. 139m	2000m	0.32	0.43	0.33	0.37	0.36	0.40	0.33	0.39	0.36	0.32	0.31	0.28	0.35
8	W250	N 45º 48.300' W 077º 07.323' Elev. 138m	297m	0.60	1.10	1.70	2.10	2.40	1.90	0.36	0.91	0.66	2.70	0.59	0.28	1.28
9	W500	N 45º 48.288' W 077º 07.393' Elev. 137m	389m	0.59	0.73	0.89	0.99	1.60	1.20	0.30	0.61	0.35	1.40	0.31	0.28	0.77
10	W1000	N 45º 48.306' W 077º 07.630' Elev. 134m	691m	0.45	1.11	1.70	0.50	0.67	0.39	0.32	0.38	0.35	0.76	0.31	0.28	0.60
11	SW250	N 45º 48.247' W 077º 07.206' Elev. 140m	183m	0.50	0.43	0.49	0.90	2.60	0.70	0.37	1.10	0.74	1.20	0.31	0.28	0.80
12	SW500	N 45º 47.896' W 077º 07.307' Elev. 148m	839m	0.32	0.43	0.45	0.37	0.42	0.39	0.32	0.39	0.36	0.32	0.31	0.29	0.36
13	SW1000	N 45º 47.599' W 077º 07.543' Elev. 149m	1470m	0.31	0.43	0.32	0.37	0.36	0.39	0.32	0.39	0.35	0.32	0.30	0.28	0.35
14	SW2000	N 45º 47.408' W 077º 07.866' Elev. 155m	2110m	0.31	0.43	0.32	0.36	0.36	0.39	0.32	0.39	0.35	0.32	0.32	0.28	0.35
15	S250	N 45º 48.129' W 077º 07.014' Elev. 131m	356m	0.51	0.43	1.30	1.70	2.30	1.50	0.74	0.61	0.77	0.66	1.20	0.34	1.01
16	S500	N 45º 48.029' W 077º 07.110' Elev. 143m	532m	0.40	0.43	0.70	0.37	0.95	0.46	0.32	0.39	0.35	0.80	0.31	0.29	0.48
17 (PAS # 12)	S1000	N 45º 46.466' W 077º 07.441' Elev. 158m	1450m	0.31	0.43	0.32	0.36	0.35	0.38	0.32	0.37	0.35	0.32	0.32	0.29	0.34
18	SE250	N 45º 48.189' W 077º 06.874' Elev. 132m	365m	3.70	2.10	5.20	5.10	2.90	4.10	1.40	1.70	1.40	1.50	2.50	1.10	2.73
19	SE500	N 45º 48.108' W 077º 06.783' Elev. 123m	554m	2.30	1.30	3.00	2.50	1.70	1.40	0.60	1.00	0.78	1.09	1.60	0.73	1.50
20	SE1000	N 45º 47.894' W 077º 06.501' Elev. 120m	1090m	0.63	0.45	1.00	0.70	0.48	0.43	0.37	0.42	0.37	0.47	0.36	0.28	0.50
21	SE2000	N 45º 47.505' W 077º 05.978' Elev. 137m	2080m	0.35	0.43	0.36	0.37	0.36	0.39	0.32	0.38	0.35	0.32	0.31	0.28	0.35
22	E250	N 45º 80.564' W 077º 11.556' Elev. 131m	220m	*	6.80	3.70	3.00	2.00	4.20	1.90	2.80	2.50	3.00	2.50	0.59	3.00
23	E500	N 45º 48.333' W 077º 06.693' Elev. 132m	520m	0.31	0.67	0.68	0.36	0.36	0.66	0.32	0.56	0.53	0.81	0.59	0.29	0.51
24	E1000	N 45º 48.303' W 077º 06.260' Elev. 143m	1080m	0.31	0.43	0.32	0.36	0.36	0.39	0.32	0.39	0.35	0.32	0.31	0.29	0.35
25	NE250	N 45º 48.371' W 077º 06.964' Elev. 124m	198m	0.80	1.30	3.20	1.50	2.30	5.00	3.80	4.70	2.30	3.50	2.70	0.44	2.63
26	NE500	N 45º 48.421' W 077º 06.732' Elev. 131m	508m	0.31	0.43	0.58	0.54	0.42	1.16	0.72	0.91	0.54	0.78	0.71	0.29	0.62
27	NE1000	N 45º 48.683' W 077º 06.441' Elev. 148m	1100m	0.32	0.44	0.32	0.37	0.36	0.39	0.32	0.38	0.35	0.32	0.34	0.28	0.35
28	NE2000	N 45º 49.116' W 077º 05.843' Elev. 156m	2200m	0.31	0.42	0.32	0.36	0.35	0.38	0.32	0.38	0.34	0.31	0.31	0.28	0.34
Pre-Sample Points																
(PAS #1)		N 45º 48.287' W 077º 07.123' Elev. 129m	94.1m	1.80	1.40	5.90	6.50	14.40	10.90	8.10	3.30	8.30	6.60	4.90	1.10	6.10
(PAS #2)		N 45º 48.325' W 077º 07.132' Elev. 132m	52.8m	1.70	2.00	2.40	9.50	7.70	7.00	3.00	6.80	1.30	6.10	0.88	2.20	4.22
(PAS #13)		N 45º 48.262' W 077º 07.093' Elev. 132m	61.5m	0.80	1.00	1.50	4.70	6.40	8.20	4.40	2.50	4.60	4.80	2.80	0.39	3.51
Duplicates																
4-2	NW250	N 45º 48.412' W 077º 07.189' Elev. 137m	222m	1.00	0.40	2.10	4.10	4.80	3.30	1.20	3.00	3.20	1.80	1.80	1.30	2.33
11-2	SW250	N 45º 48.247' W 077º 07.206' Elev. 140m	183m	0.41	0.43	0.48	0.83	2.60	0.50	0.32	1.00	0.65	1.10	0.31	0.28	0.74
18-2	SE250	N 45º 48.189' W 077º 06.874' Elev. 132m	365m	2.90	1.50	4.00	4.00	0.40	2.40	1.20	1.50	0.62	1.30	2.50	1.00	1.94
25-2	NE250	N 45º 48.371' W 077º 06.964' Elev. 124m	198m	0.60	1.10	3.10	1.30	2.10	4.70	3.60	4.50	2.20	3.40	2.40	0.35	2.45
Background Samples																
Maika (PAS # 10)	SW	N 45º 46.367' W 077º 11.447' Elev. 149m	6690m	0.31	0.44	0.33	0.37	0.36	0.39	0.33	0.39	0.36	0.32	0.31	0.29	0.35
Maika	Duplicate	Same as above	6690m	0.31	0.43	0.32	0.37	0.36	0.38	0.31	0.38	0.34	0.31	0.31	0.29	0.34
Fitzpatrick	SE	N 45º 44.818' W 076º 59.822' Elev. 159m	11400m	0.31	0.43	0.33	0.37	0.36	0.39	0.58	0.48	0.35	0.32	0.31	0.28	0.38
Petawawa	NW	N 45º 51.497' W 077º 12.828' Elev. 149m	9480m	0.31	0.43	0.33	0.36	0.36	0.38	0.32	0.39	0.35	0.32	0.32	0.28	0.35
Farm	NE	N 45º 53.071' W 076º 56.768' Elev. 142m	16000m	0.32	0.43	0.32	0.36	0.36	0.38	0.32	0.38	0.36	0.33	0.31	0.28	0.35
Results shaded in blue are below minimum detectable activity			Sum	28.70	33.81	55.46	64.79	72.95	72.18	42.15	50.70	44.84	54.94	38.45	19.09	48.42

* No Sample Available

APPENDIX G

Wind Direction Graphs for 2019

2019 Directional Data

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	1.13	0.34	0.32		0.44	0.43	0.43		2.00	0.93	0.33	
North West	1.00	0.73	0.45	0.32	0.50	0.44	0.43	0.43	2.40	0.93	0.56	0.33
West	0.60	0.59	0.45		1.10	0.73	1.11		1.70	0.89	1.70	
Southwest	0.50	0.32	0.31	0.31	0.43	0.43	0.43	0.43	0.49	0.45	0.32	0.32
South	0.51	0.40	0.31		0.43	0.43	0.43		1.30	0.70	0.32	
South East	3.70	2.30	0.63	0.35	2.10	1.30	0.45	0.43	5.20	3.00	1.00	0.36
East	*	0.31	0.31		6.80	0.67	0.43		3.70	0.68	0.32	
North East	0.80	0.31	0.31	0.31	1.30	0.43	0.44	0.42	3.20	0.58	0.32	0.32

2nd Quarter

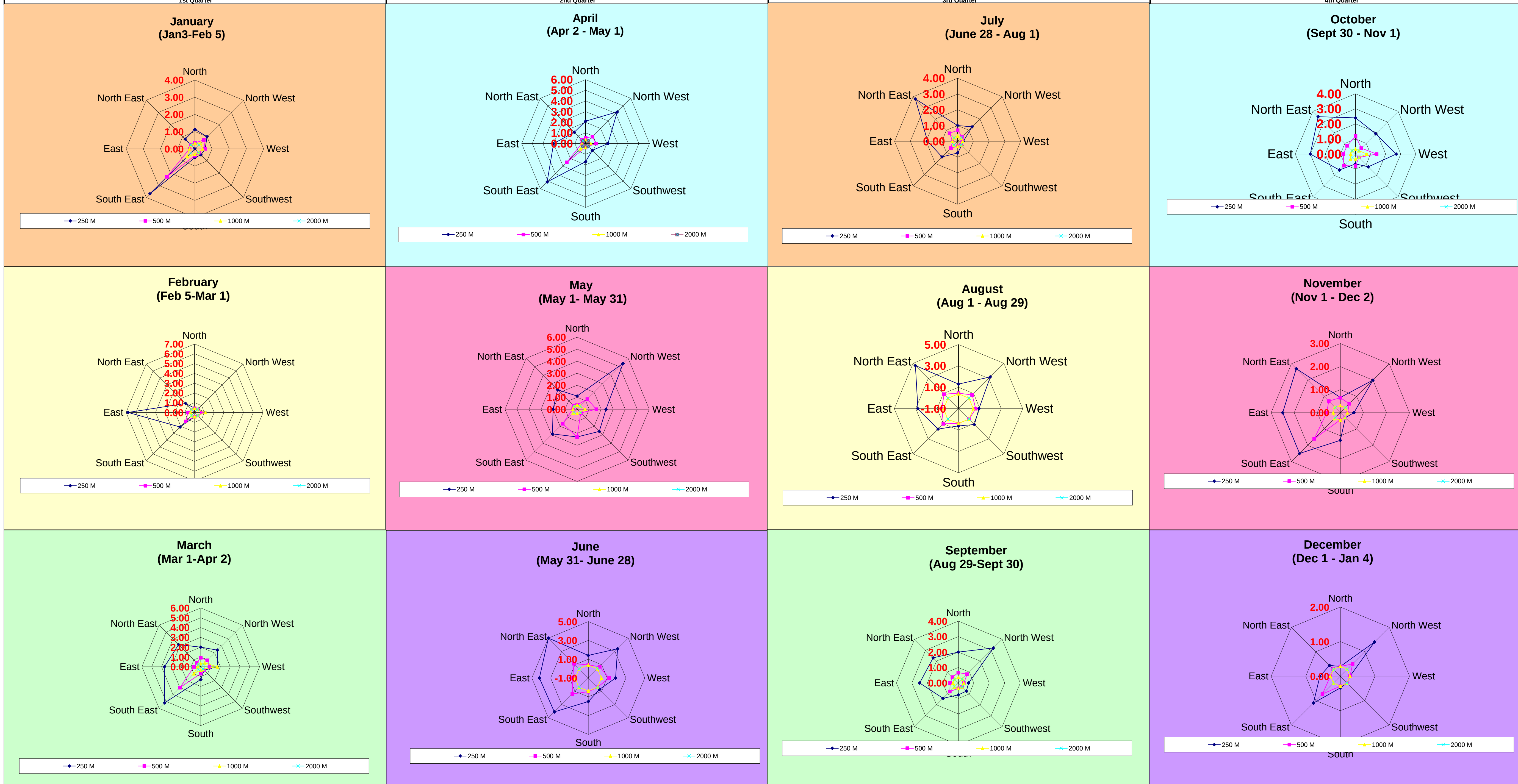
Direction	April 250 M	April 500 M	April 1000 M	April 2000 M	May 250 M	May 500 M	May 1000 M	May 2000 M	June 250 M	June 500 M	June 1000 M	June 2000 M
North	2.10	0.54	0.37		1.10	0.36	0.36		1.40	0.39	0.39	
North West	4.20	0.91	0.36	0.37	5.40	1.20	0.37	0.36	3.40	0.70	0.38	0.40
West	2.10	0.99	0.50		2.40	1.60	0.67		1.90	1.20	0.39	
Southwest	0.90	0.37	0.37	0.36	2.60	0.42	0.36	0.36	0.70	0.39	0.39	0.39
South	1.70	0.37	0.36		2.30	2.30	0.35		1.50	0.46	0.38	
South East	5.10	2.50	0.70	0.37	2.90	1.70	0.48	0.36	4.10	1.40	0.43	0.39
East	3.00	0.36	0.36		2.00	0.36	0.36		4.20	0.66	0.39	
North East	1.50	0.54	0.37	0.36	2.30	0.42	0.36	0.35	5.00	1.16	0.39	0.38

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	1.00	0.70	0.33		1.30	0.45	0.39		2.00	0.67	0.36	
North West	1.30	0.41	0.31	0.33	3.20	0.81	0.38	0.39	3.20	0.81	0.37	0.36
West	0.36	0.30	0.32		0.91	0.61	0.38		0.66	0.35	0.35	
Southwest	0.37	0.32	0.32	0.32	1.10	0.39	0.39	0.39	0.74	0.36	0.35	0.35
South	0.74	0.32	0.32		0.61	0.39	0.37		0.77	0.35	0.35	
South East	1.40	0.60	0.37	0.32	1.70	1.00	0.42	0.38	1.40	0.78	0.37	0.35
East	1.90	0.32	0.32		2.80	0.56	0.39		2.50	0.53	0.35	
North East	3.80	0.72	0.32	0.32	4.70	0.91	0.38	0.38	2.30	0.54	0.35	0.34

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	2.40	1.20	0.34		0.66	0.65	0.31		0.28	0.28	0.29	
North West	1.90	0.55	0.31	0.32	2.00	0.55	0.31	0.31	1.40	0.50	0.28	0.28
West	2.70	1.40	0.76		0.59	0.31	0.31		0.28	0.28	0.28	
Southwest	1.20	0.32	0.32	0.32	0.31	0.31	0.30	0.32	0.28	0.29	0.28	0.28
South	0.66	0.80	0.32		1.20	0.31	0.32		0.34	0.29	0.29	
South East	1.50	1.09	0.47	0.32	2.50	1.60	0.36	0.31	1.10	0.73	0.28	0.28
East	3.00	0.81	0.32		2.50	0.59	0.31		0.59	0.29	0.29	
North East	3.50	0.78	0.32	0.31	2.70	0.71	0.34	0.31	0.44	0.29	0.28	0.28



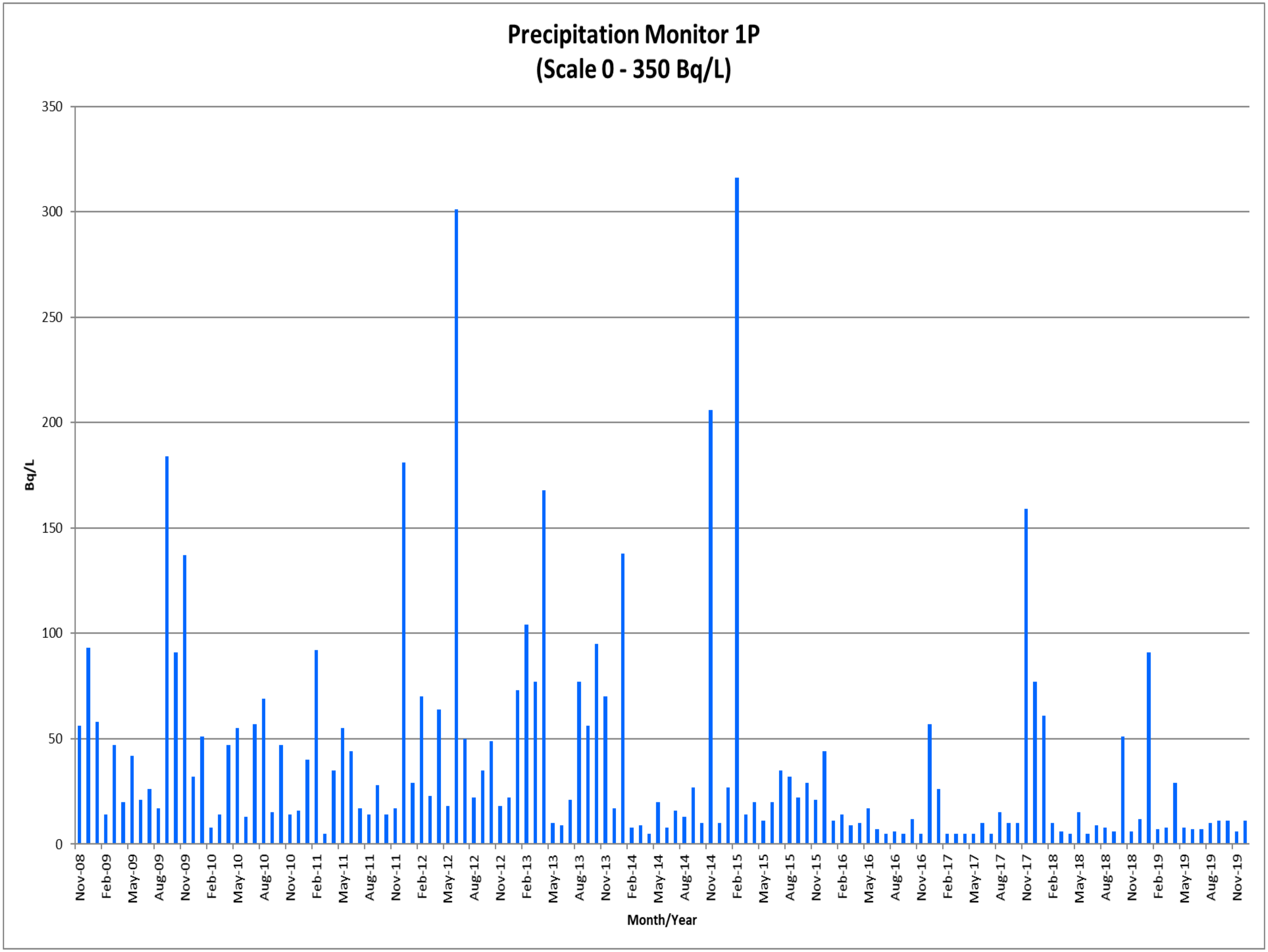
APPENDIX H

Precipitation Monitoring Results for 2019

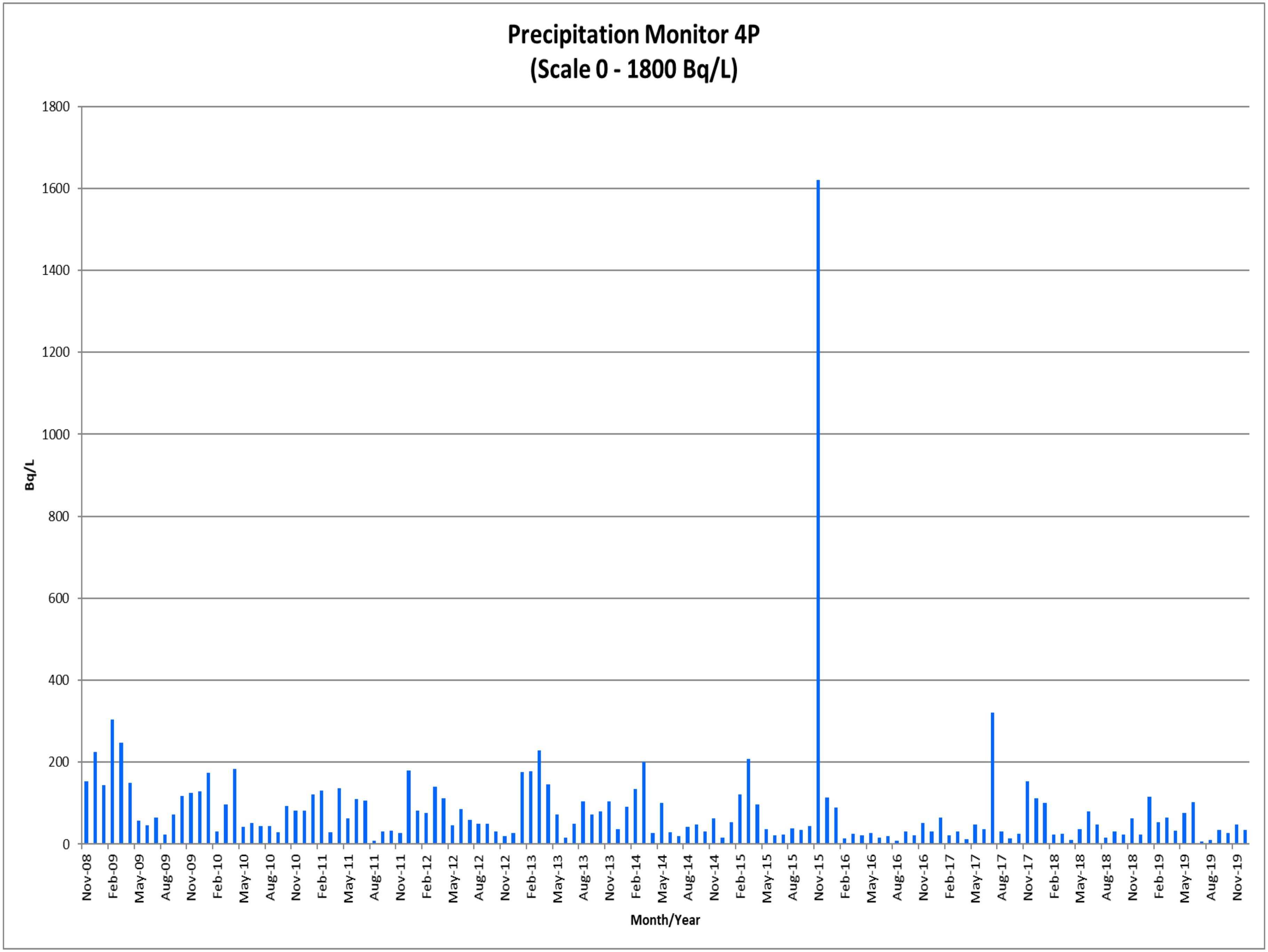
PRECIPITATION SAMPLERS									
	1P	4P	8P	11P	15P	18P	22P	25P	AVG
Date Range	Bq/L								
January 4 - February 5, 2019	91	115	67	78	35	No sample	No sample	64	75
February 5 - March 1, 2019	7	53	49	19	14	92	131	35	50
March 1 - April 2, 2019	8	65	14	18	20	106	27	24	35
April 2 - May 1, 2019	29	32	20	13	17	45	17	5	22
May 1 - May 31, 2019	8	76	58	97	9	14	9	7	35
May 31 - June 28, 2019	7	103	5	7	5	19	200	11	45
June 28 - August 1, 2019	7	6	6	5	6	7	9	21	8
August 1 - August 29, 2019	10	10	5	11	5	10	19	28	12
August 29 - September 30, 2019	11	35	11	13	35	32	22	29	24
September 30 - November 1, 2019	11	27	6	23	19	12	13	10	15
November 1 - December 2, 2019	6	47	81	34	15	36	112	34	46
December 2, 2019 - January 7, 2020	11	35	10	5	11	137	31	15	32
AVERAGE	17	50	28	27	16	46	54	24	33

Results shaded in blue are <minimum detectable activity (MDA)

MAP OF AIR AND PRECIPITATION MONITORING STATIONS

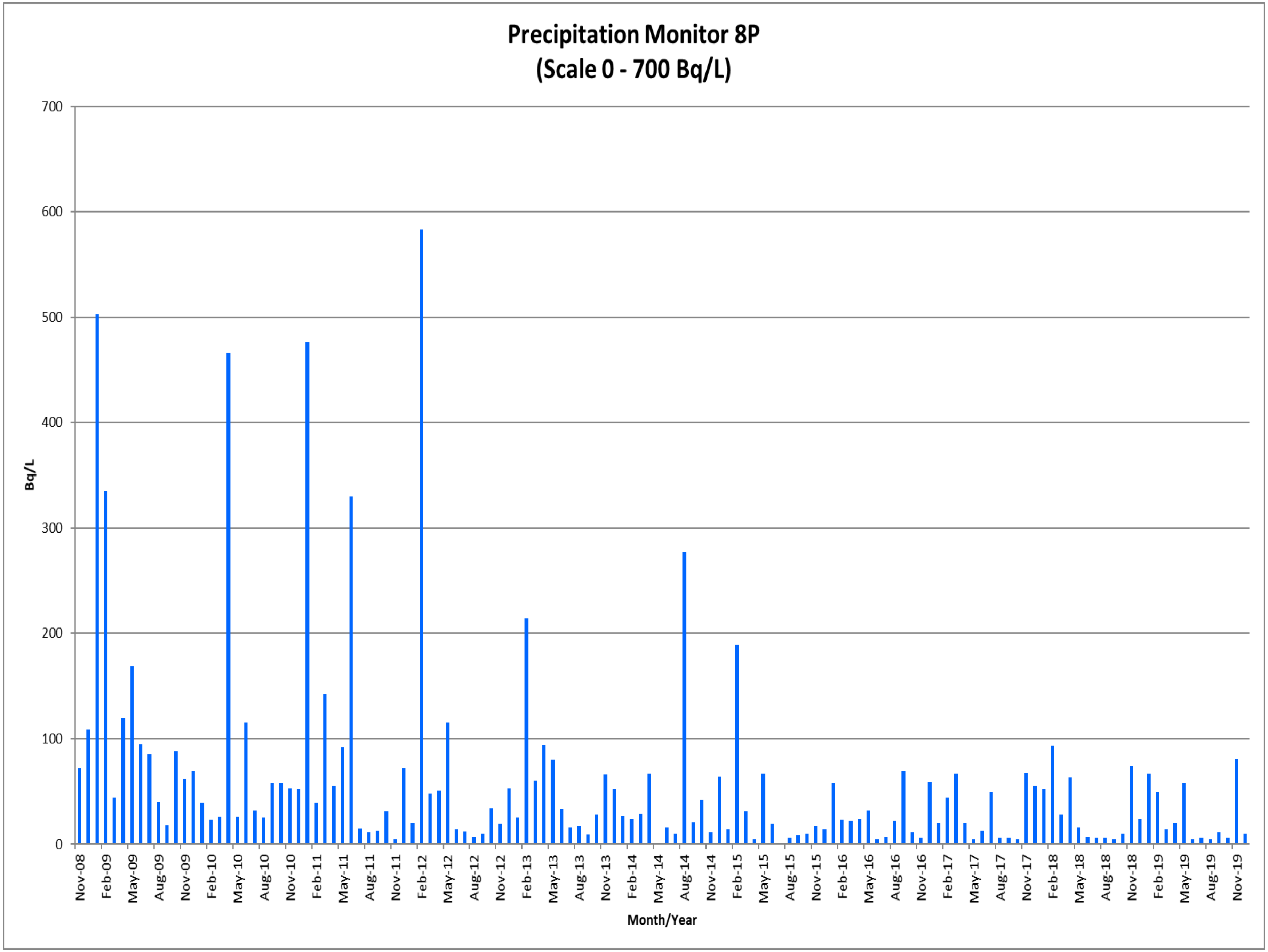

Precipitation Monitor 1P
(Scale 0 - 350 Bq/L)
Bq/L
Month/Year
0
50
100
150
200
250
300
350
Nov-08
Feb-09
May-09
Aug-09
Nov-09
Feb-10
May-10
Aug-10
Nov-10
Feb-11
May-11
Aug-11
Nov-11
Feb-12
May-12
Aug-12
Nov-12
Feb-13
May-13
Aug-13
Nov-13
Feb-14
May-14
Aug-14
Nov-14
Feb-15
May-15
Aug-15
Nov-15
Feb-16
May-16
Aug-16
Nov-16
Feb-17
May-17
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19

APPENDIX H

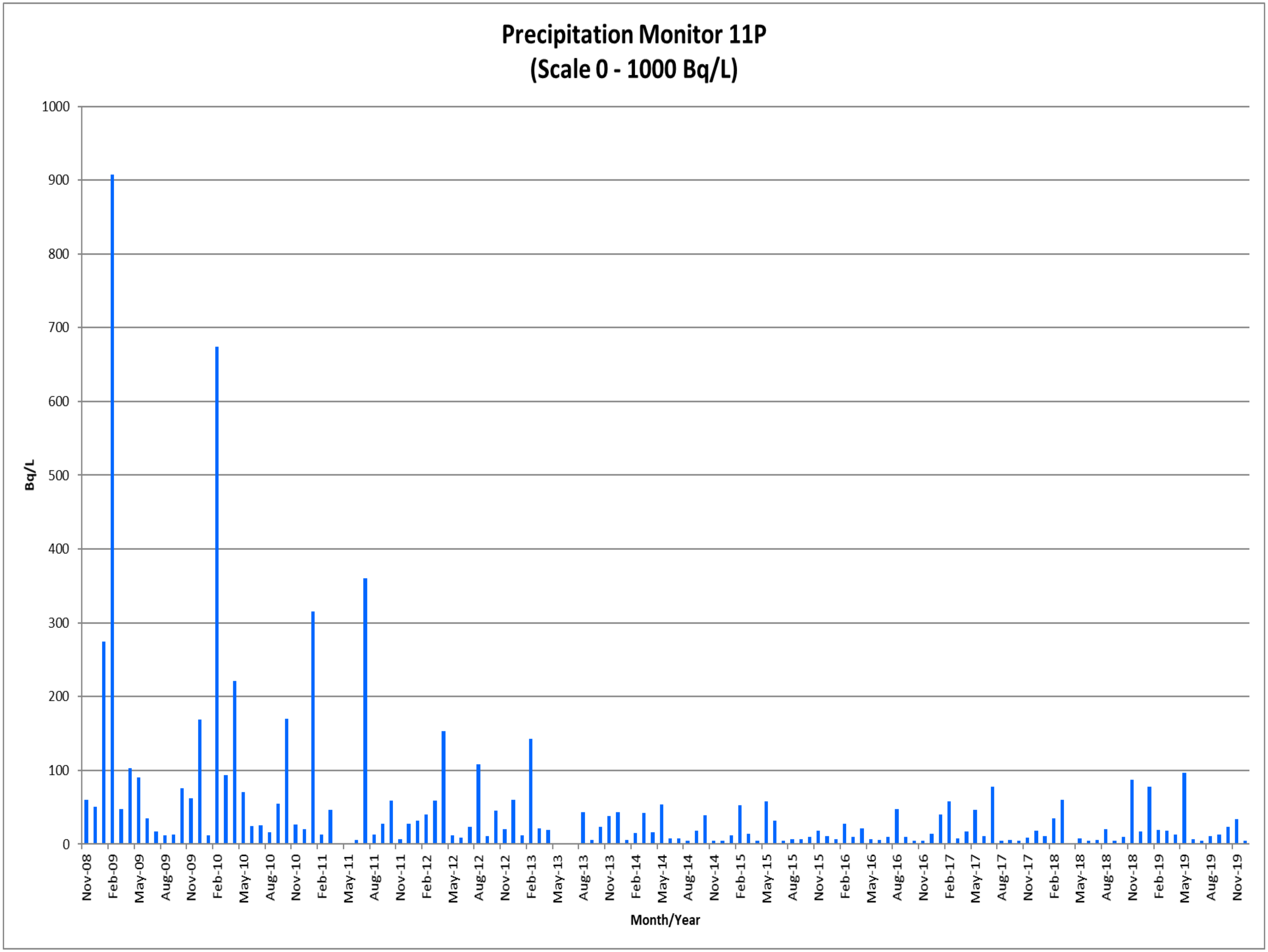


Precipitation Monitor 4P
(Scale 0 - 1800 Bq/L)
Bq/L
Month/Year
0
200
400
600
800
1000
1200
1400
1600
1800
Nov-08
Feb-09
May-09
Aug-09
Nov-09
Feb-10
May-10
Aug-10
Nov-10
Feb-11
May-11
Aug-11
Nov-11
Feb-12
May-12
Aug-12
Nov-12
Feb-13
May-13
Aug-13
Nov-13
Feb-14
May-14
Aug-14
Nov-14
Feb-15
May-15
Aug-15
Nov-15
Feb-16
May-16
Aug-16
Nov-16
Feb-17
May-17
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19

APPENDIX H



Precipitation Monitor 8P
(Scale 0 - 700 Bq/L)
Bq/L
700
600
500
400
300
200
100
0
Nov-08
Feb-09
May-09
Aug-09
Nov-09
Feb-10
May-10
Aug-10
Nov-10
Feb-11
May-11
Aug-11
Nov-11
Feb-12
May-12
Aug-12
Nov-12
Feb-13
May-13
Aug-13
Nov-13
Feb-14
May-14
Aug-14
Nov-14
Feb-15
May-15
Aug-15
Nov-15
Feb-16
May-16
Aug-16
Nov-16
Feb-17
May-17
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Month/Year


Precipitation Monitor 11P
(Scale 0 - 1000 Bq/L)
Bq/L
0
100
200
300
400
500
600
700
800
900
1000
Nov-08
Feb-09
May-09
Aug-09
Nov-09
Feb-10
May-10
Aug-10
Nov-10
Feb-11
May-11
Aug-11
Nov-11
Feb-12
May-12
Aug-12
Nov-12
Feb-13
May-13
Aug-13
Nov-13
Feb-14
May-14
Aug-14
Nov-14
Feb-15
May-15
Aug-15
Nov-15
Feb-16
May-16
Aug-16
Nov-16
Feb-17
May-17
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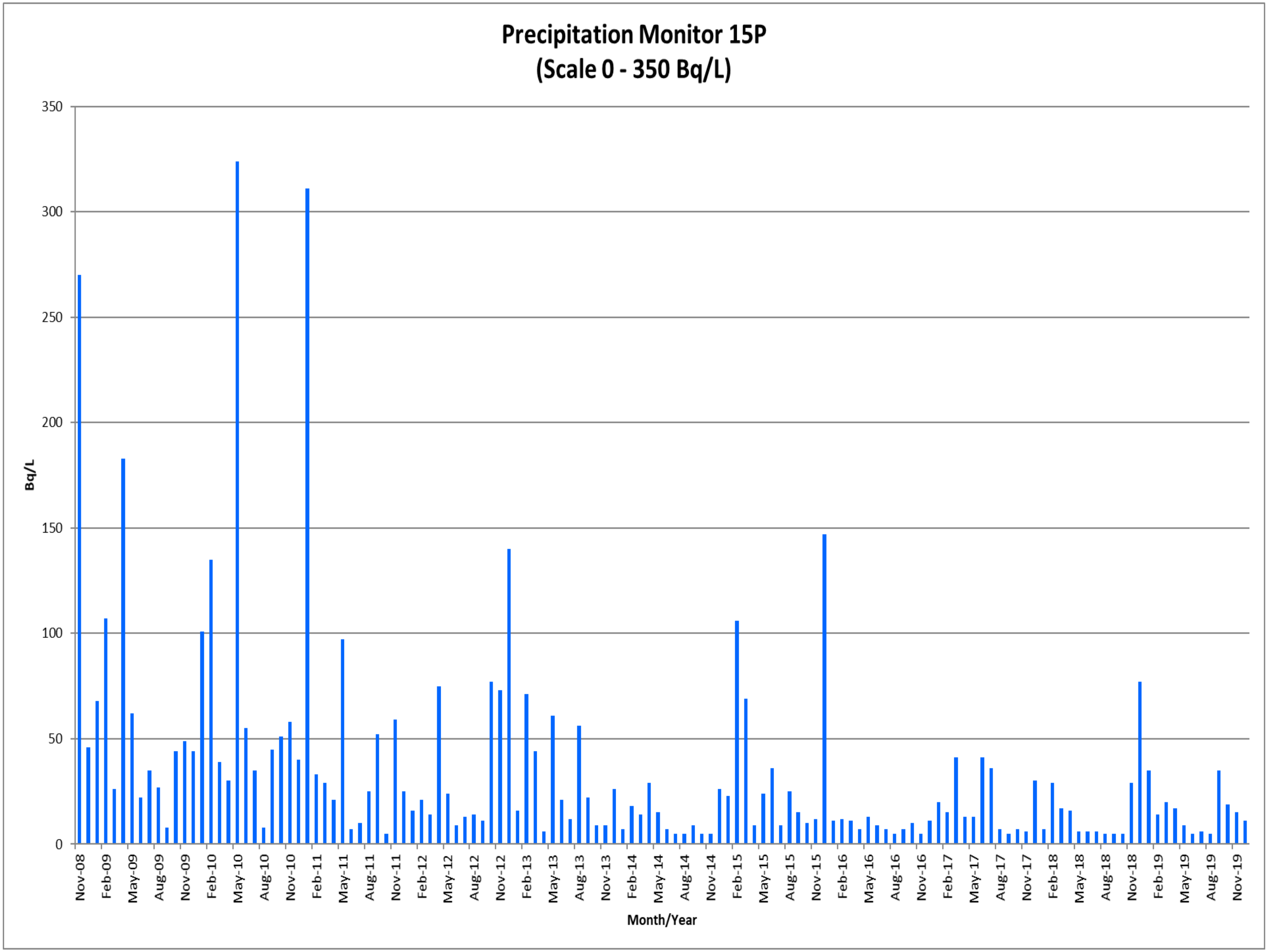
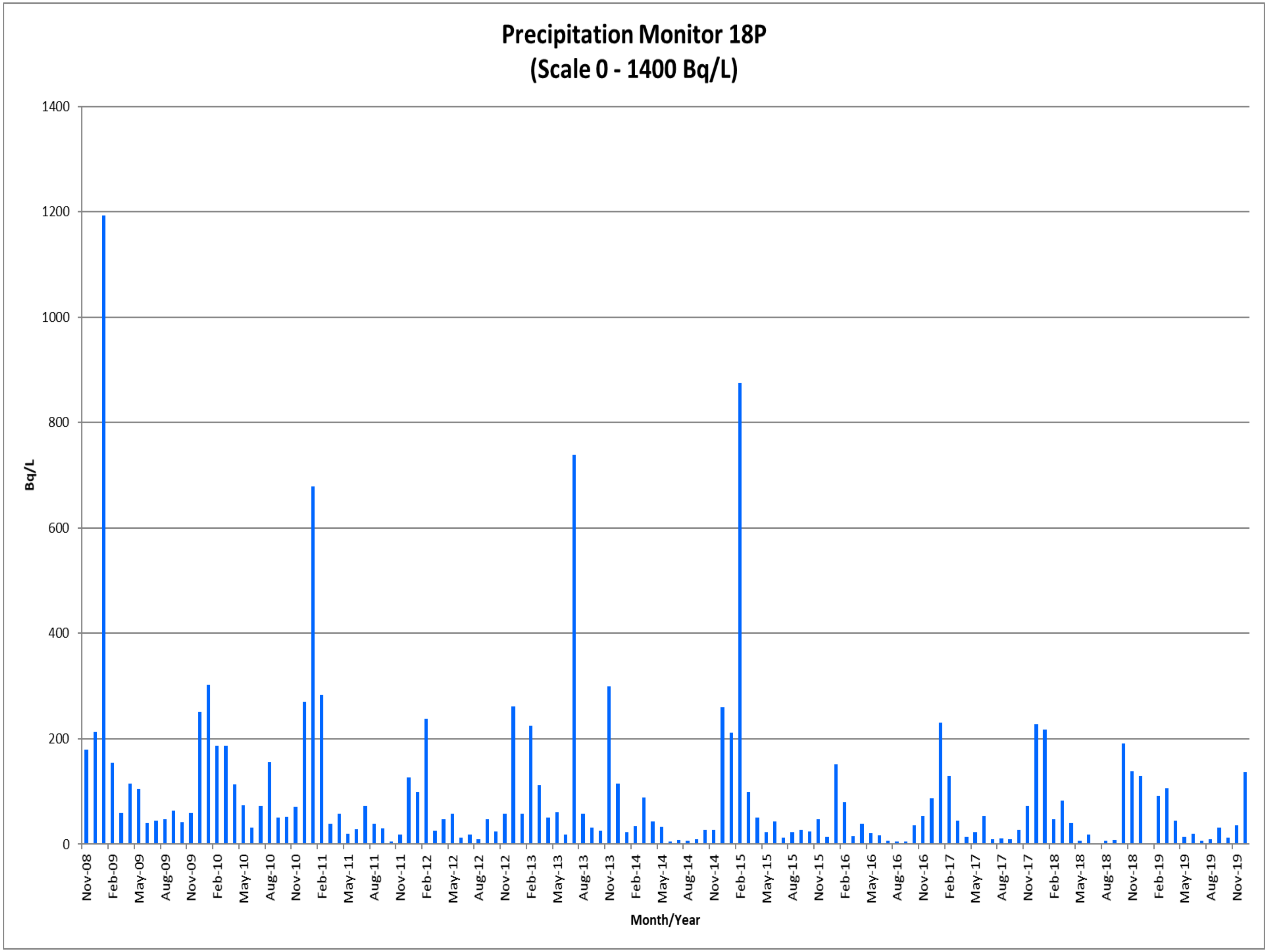
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Month/Year


Precipitation Monitor 15P
(Scale 0 - 350 Bq/L)
Bq/L
0
50
100
150
200
250
300
350
Nov-08
Feb-09
May-09
Aug-09
Nov-09
Feb-10
May-10
Aug-10
Nov-10
Feb-11
May-11
Aug-11
Nov-11
Feb-12
May-12
Aug-12
Nov-12
Feb-13
May-13
Aug-13
Nov-13
Feb-14
May-14
Aug-14
Nov-14
Feb-15
May-15
Aug-15
Nov-15
Feb-16
May-16
Aug-16
Nov-16
Feb-17
May-17
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Month/Year

APPENDIX H



Precipitation Monitor 18P
(Scale 0 - 1400 Bq/L)
Bq/L
1400
1200
1000
800
600
400
200
0
Nov-08
Feb-09
May-09
Aug-09
Nov-09
Feb-10
May-10
Aug-10
Nov-10
Feb-11
May-11
Aug-11
Nov-11
Feb-12
May-12
Aug-12
Nov-12
Feb-13
May-13
Aug-13
Nov-13
Feb-14
May-14
Aug-14
Nov-14
Feb-15
May-15
Aug-15
Nov-15
Feb-16
May-16
Aug-16
Nov-16
Feb-17
May-17
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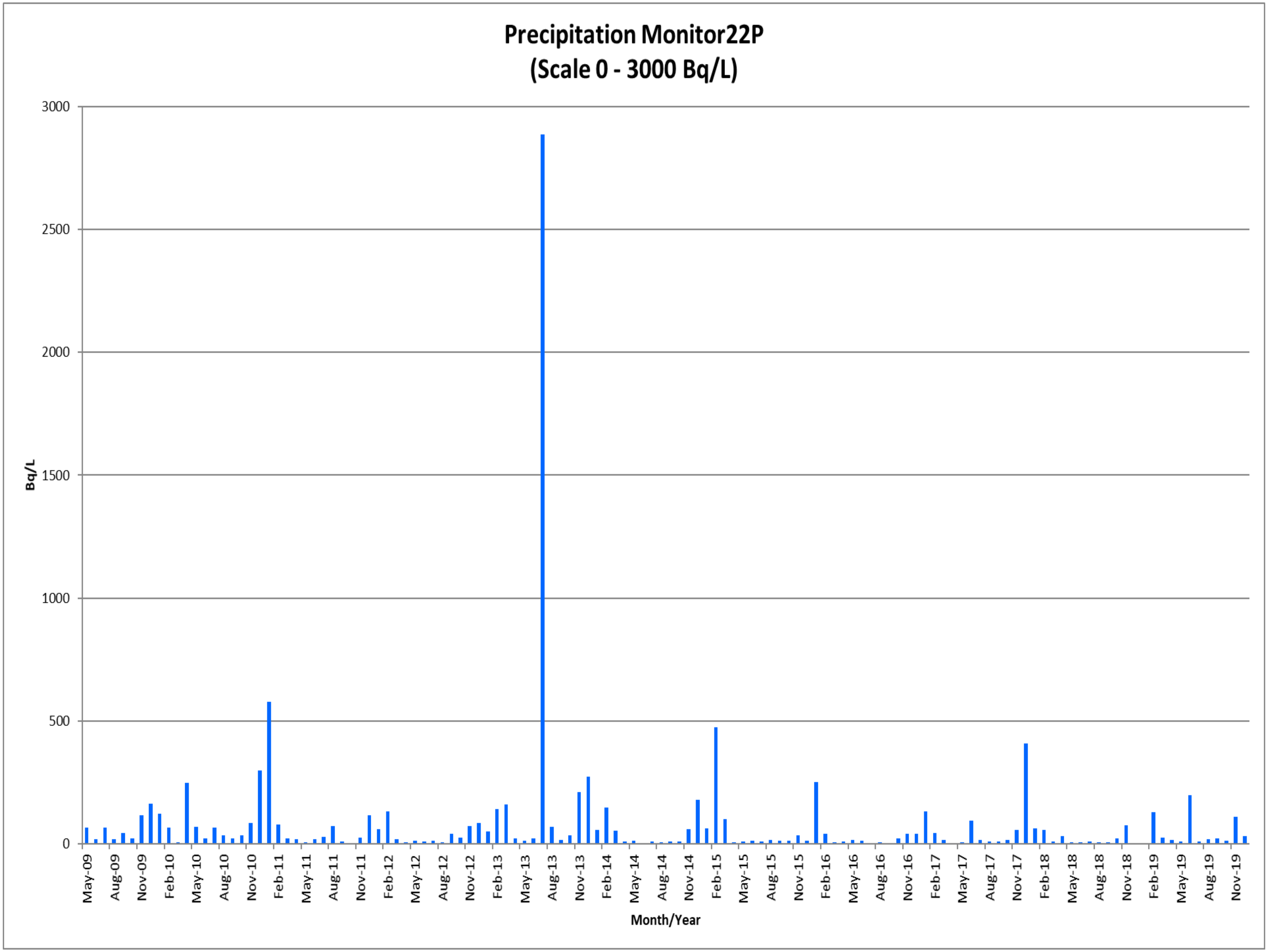
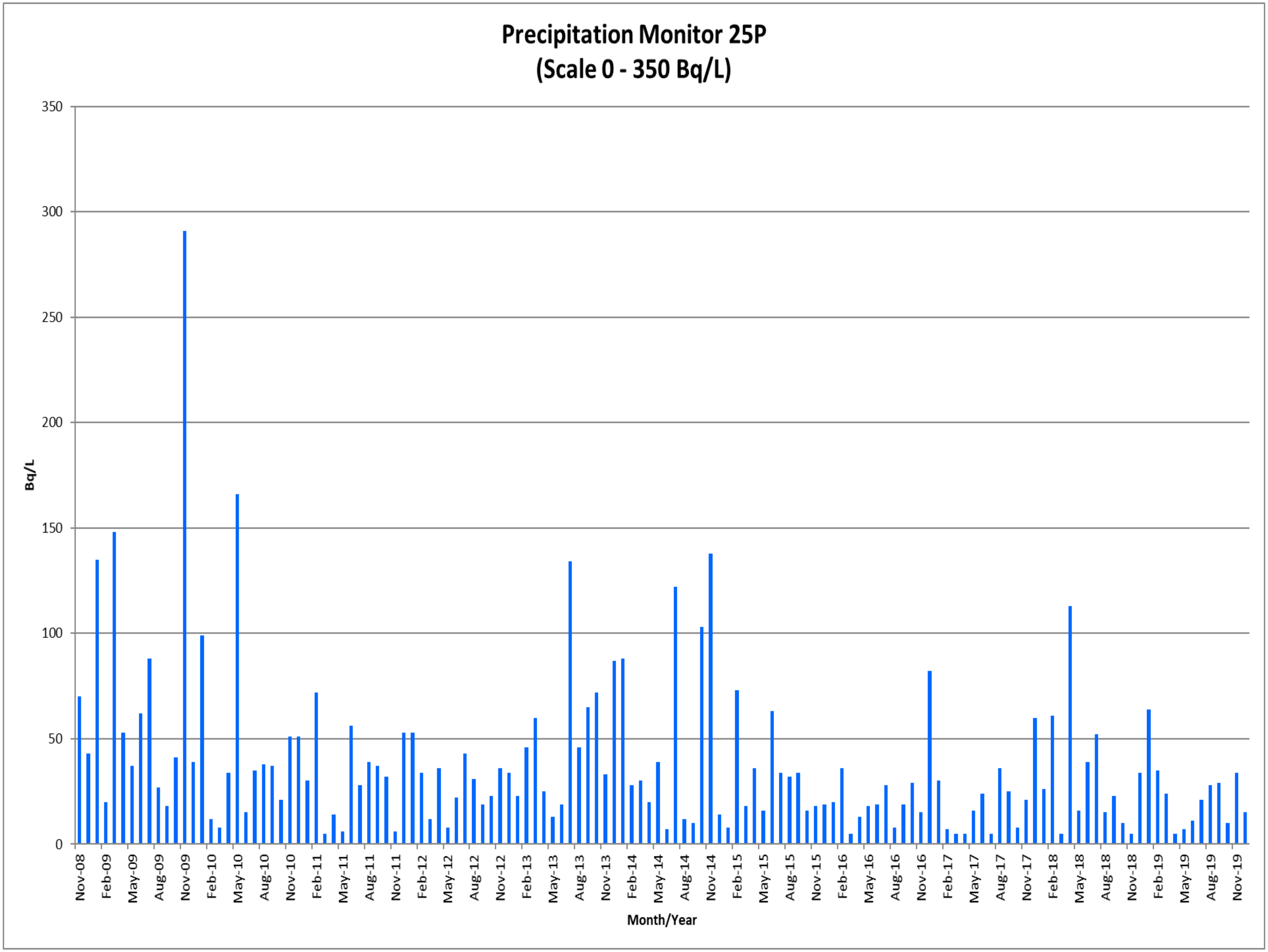
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Month/Year



Precipitation Monitor22P
(Scale 0 - 3000 Bq/L)
Bq/L
3000
2500
2000
1500
1000
500
0
May-09
Aug-09
Nov-09
Feb-10
May-10
Aug-10
Nov-10
Feb-11
May-11
Aug-11
Nov-11
Feb-12
May-12
Aug-12
Nov-12
Feb-13
May-13
Aug-13
Nov-13
Feb-14
May-14
Aug-14
Nov-14
Feb-15
May-15
Aug-15
Nov-15
Feb-16
May-16
Aug-16
Nov-16
Feb-17
May-17
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Month/Year

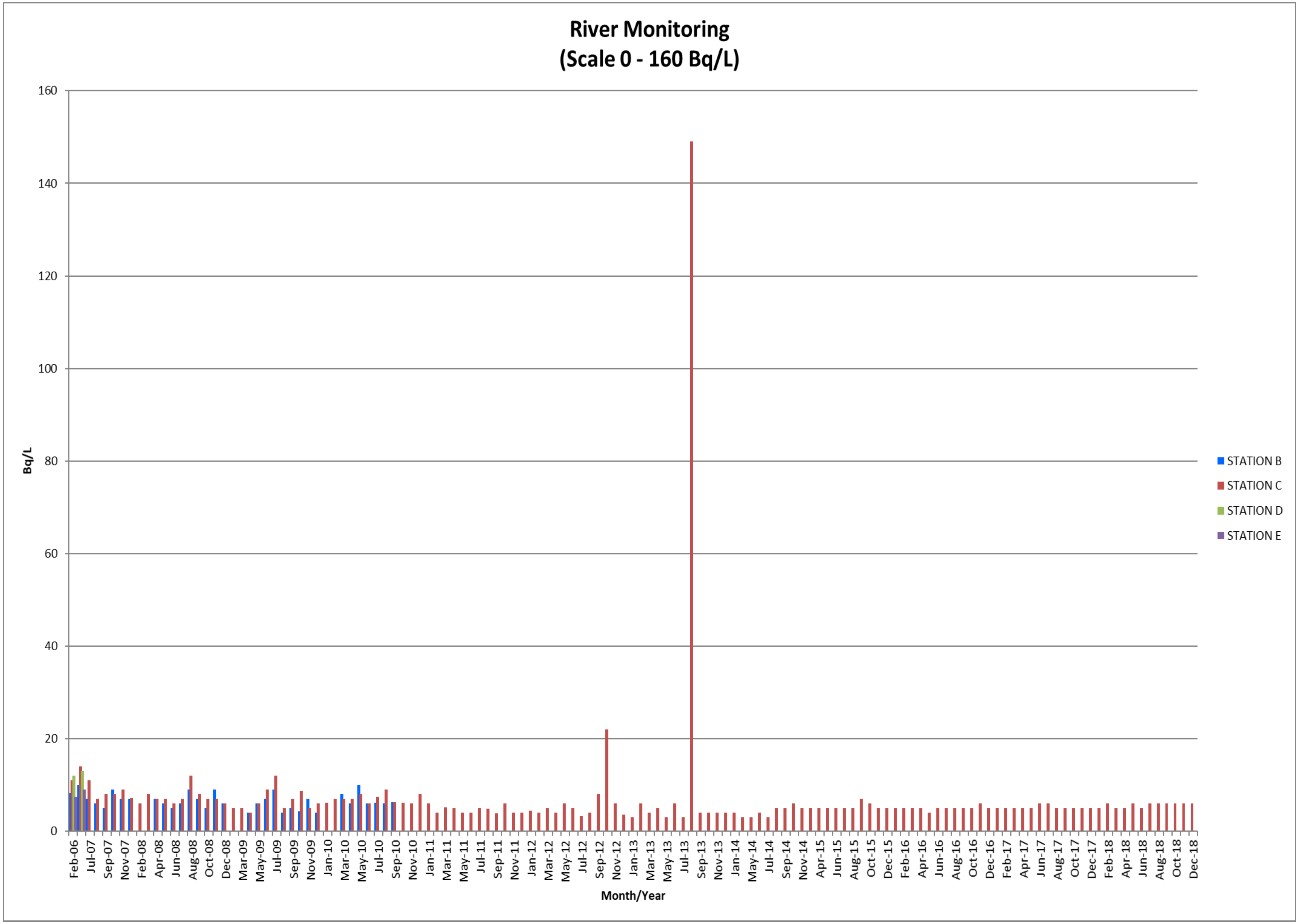


Precipitation Monitor 25P
(Scale 0 - 350 Bq/L)
350
300
250
200
150
100
50
0
Bq/L
Nov-08
Feb-09
May-09
Aug-09
Nov-09
Feb-10
May-10
Aug-10
Nov-10
Feb-11
May-11
Aug-11
Nov-11
Feb-12
May-12
Aug-12
Nov-12
Feb-13
May-13
Aug-13
Nov-13
Feb-14
May-14
Aug-14
Nov-14
Feb-15
May-15
Aug-15
Nov-15
Feb-16
May-16
Aug-16
Nov-16
Feb-17
May-17
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Month/Year

APPENDIX H

APPENDIX I

Receiving Waters Monitoring Results for 2019



River Monitoring
(Scale 0 - 160 Bq/L)
Bq/L
160
140
120
100
80
60
40
20
0
Month/Year
STATION B
STATION C
STATION D
STATION E

APPENDIX I

RECEIVING WATERS MONITORING LOCATIONS

Basemap Source: City of Pembroke (www.pembrokeontario.com)

APPENDIX J

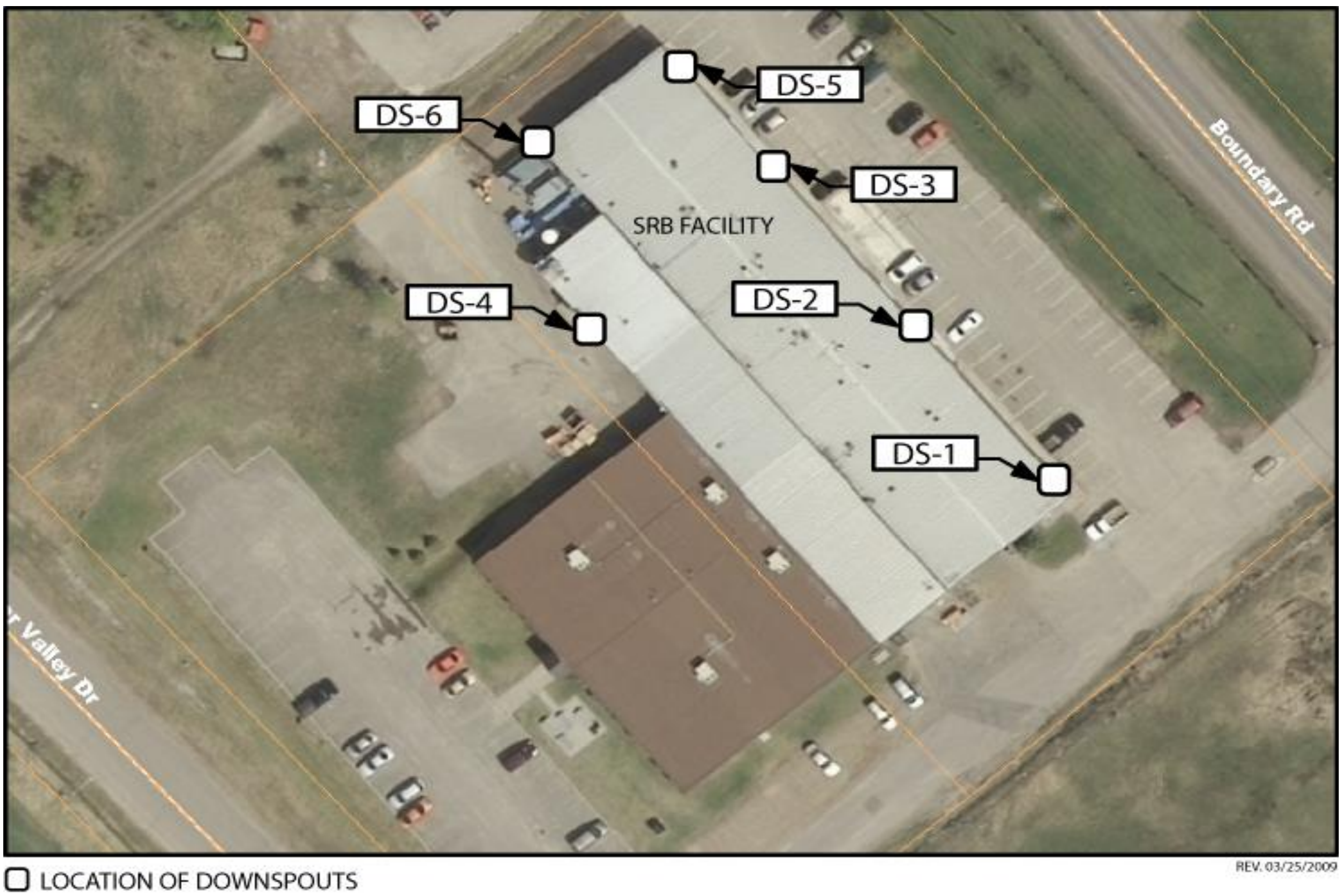
Runoff Monitoring Results for 2019

Facility Runoff Monitoring Results for 2019

DOWNSPOUTS (Bq/L)								
Date	**Time**	**DS-1**	**DS-2**	**DS-3**	**DS-4**	**DS-5**	**DS-6**	**MDA**
23-May-19	2:30 PM	No sample	152	179	211	232	322	44
14-Jun-19	8:30 AM	No sample	36	1,193	693	638	42	46
26-Sep-19	10:30 AM	No sample	983	415	669	933	1,857	46
16-Oct-19	11:10 AM	No sample	7	3	14	18	35	40
Average (Bq/L)		**-**	**295**	**448**	**397**	**455**	**564**	**44**

Average (w/o <MDA)	652 Bq/L
Average all results	**432 Bq/L**

*MDA = Minimum Detectable Activity (measurements shaded in are <MDA)



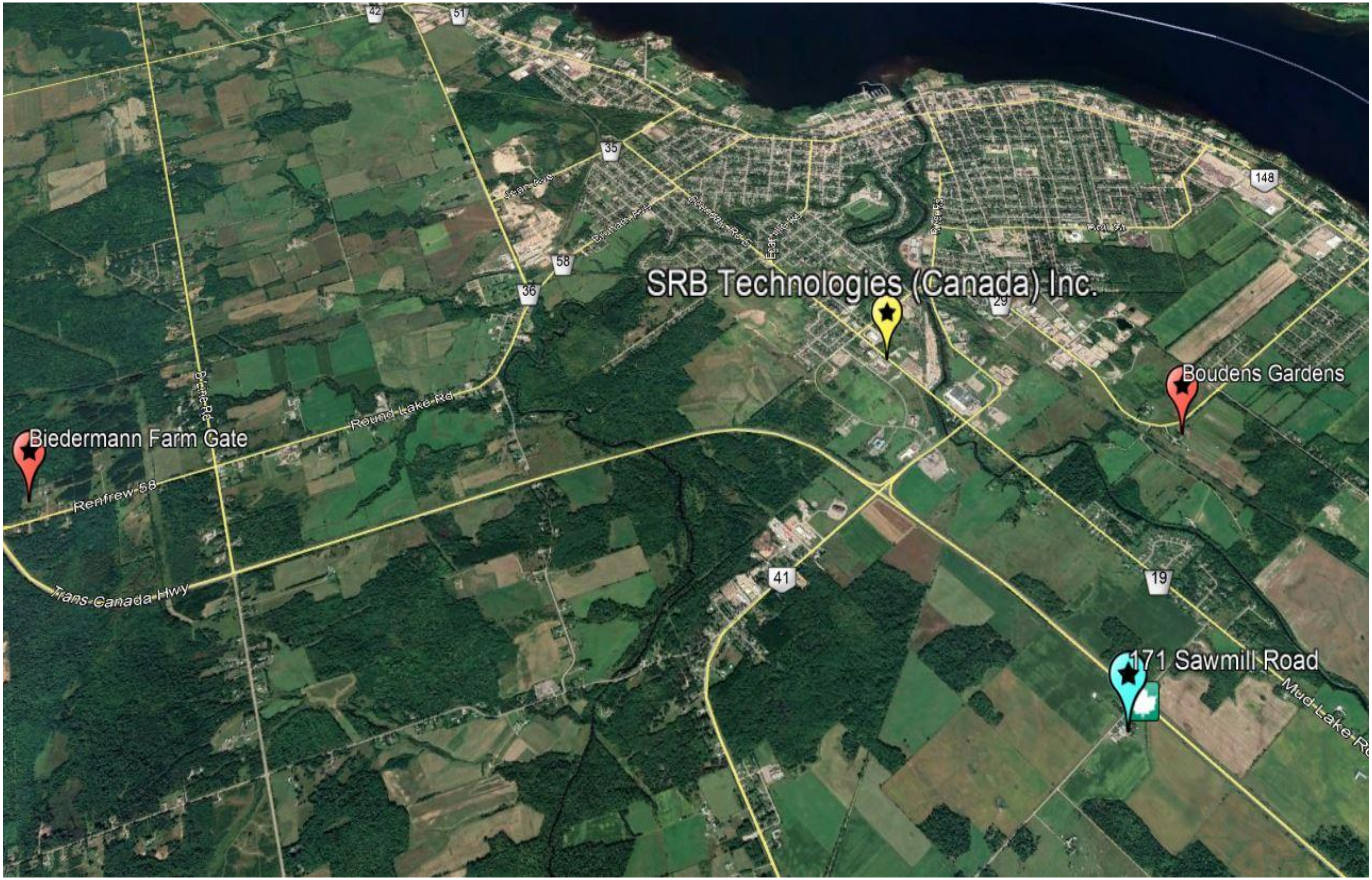
APPENDIX K

Produce Monitoring Results for 2019

Map –Produce Sampling 2019

APPENDIX K

Map – Produce Sampling 2019



APPENDIX K

2019 Residential Produce Sampling – Free-water Tritium Concentration

Sample	Units	Result
Apples 406 Boundary Road	Bq/kg Fresh weight	53
Tomatoes 408 Boundary Road	Bq/kg Fresh weight	55
Onions 408 Boundary Road	Bq/kg Fresh weight	48
Beans 408 Boundary Road	Bq/kg Fresh weight	32
Apples 413 Sweezey Court	Bq/kg Fresh weight	75
Tomatoes 611 Moss Drive	Bq/kg Fresh weight	46
Cucumber 611 Moss Drive	Bq/kg Fresh weight	44
Zucchini 611 Moss Drive	Bq/kg Fresh weight	30
Zucchini 171 Sawmill Road	Bq/kg Fresh weight	4
Carrots 171 Sawmill Road	Bq/kg Fresh weight	3
Onion 171 Sawmill Road	Bq/kg Fresh weight	3
Corn 171 Sawmill Road	Bq/kg Fresh weight	4
Beets 171 Sawmill Road	Bq/kg Fresh weight	4
AVERAGE	**Bq/kg Fresh weight**	**30.9**

2019 Residential Produce Sampling – Organically-bound Tritium (OBT) Concentration

Sample	Units	Result
Tomatoes 408 Boundary Road	Bq/kg Fresh weight	3

2019 Commercial Produce Sampling – Free-water Tritium Concentration

Sample	Units	Result
Beans Boudens Gardens	Bq/kg Fresh weight	10
Onion Boudens Gardens	Bq/kg Fresh weight	6
Zucchini Boudens Gardens	Bq/kg Fresh weight	7
Cucumber Boudens Gardens	Bq/kg Fresh weight	12
Tomato Boudens Gardens	Bq/kg Fresh weight	6
AVERAGE	**Bq/kg Fresh weight**	**8.2**

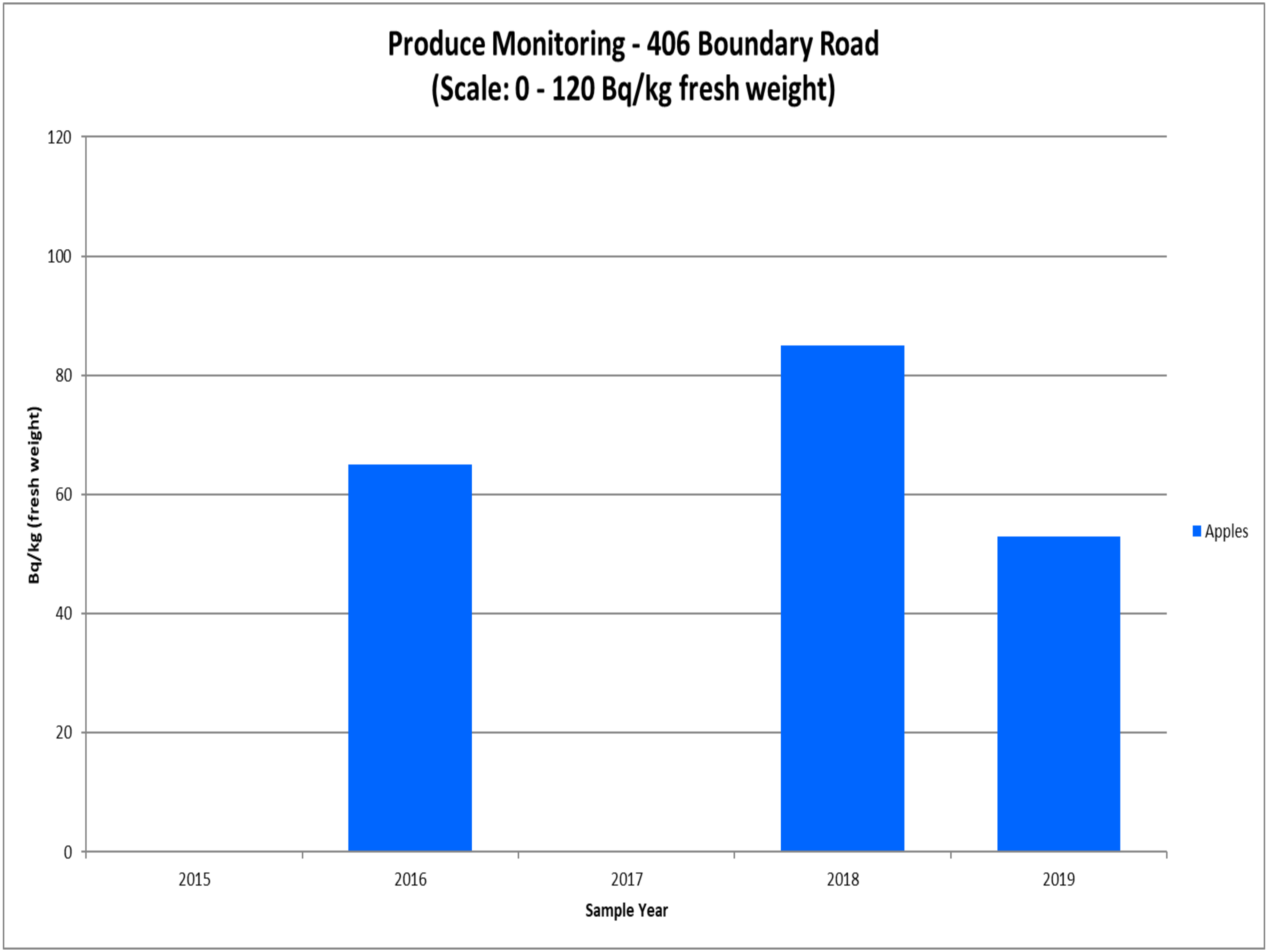
2019 Commercial Produce Sampling – Organically-bound Tritium (OBT) Concentration

Sample	Units	Result
Tomato Boudens Gardens	Bq/kg Fresh weight	1

Produce Sampling Data Trends

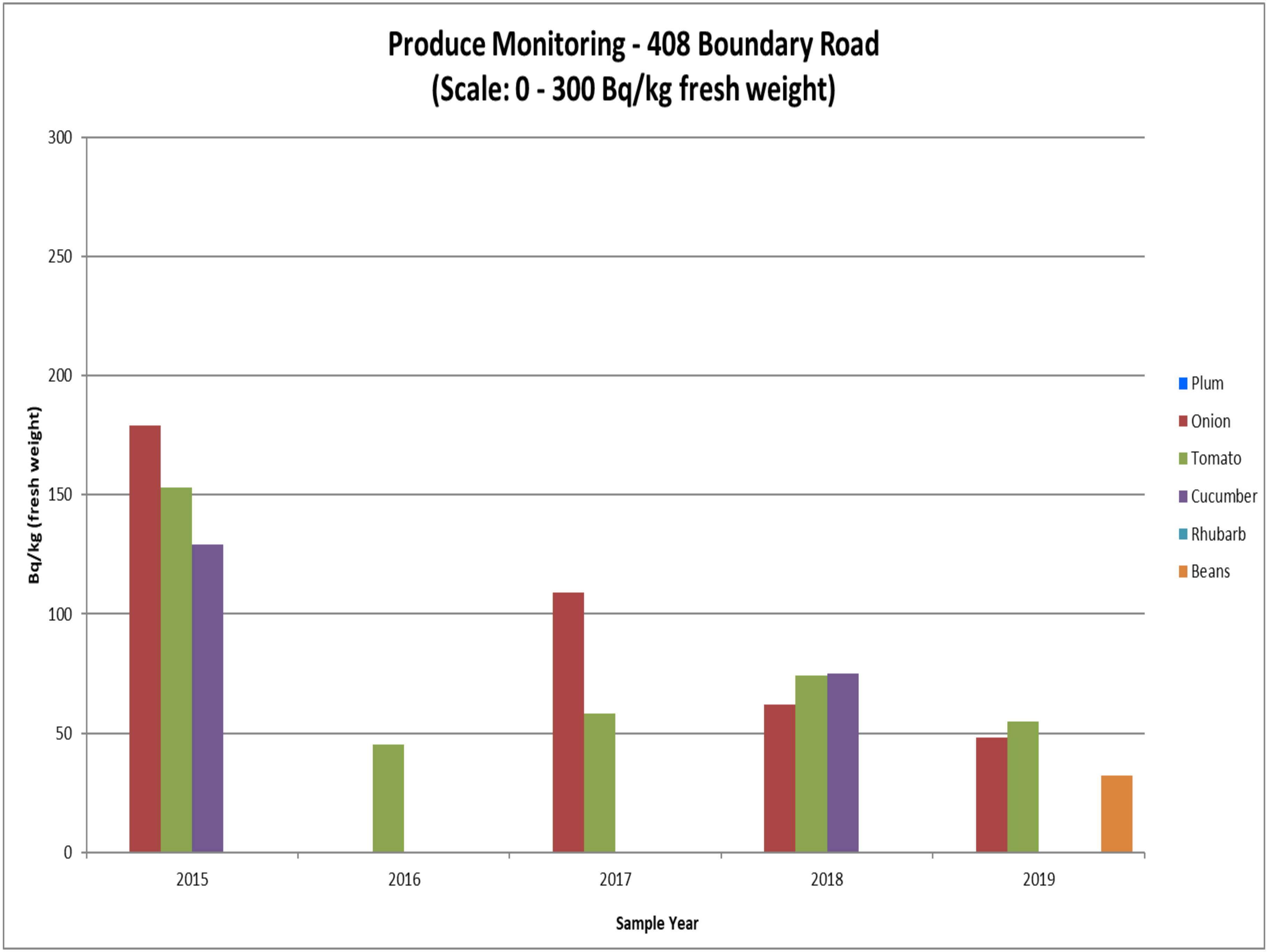
2015-2019

APPENDIX K

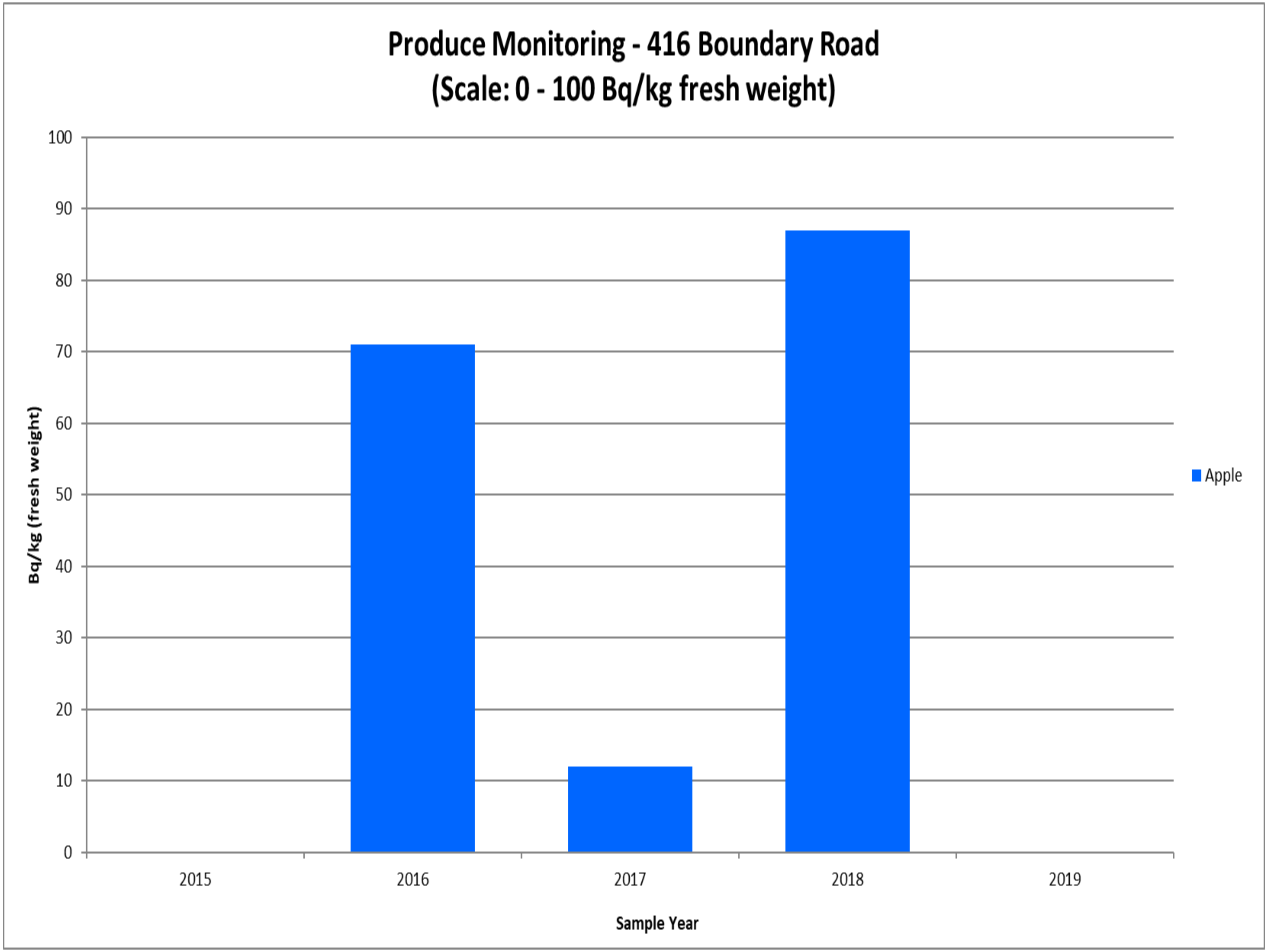


Produce Monitoring - 406 Boundary Road
(Scale: 0 - 120 Bq/kg fresh weight)
120
100
80
60
40
20
0
Bq/kg (fresh weight)
Apples
2015
2016
2017
2018
2019
Sample Year

APPENDIX K

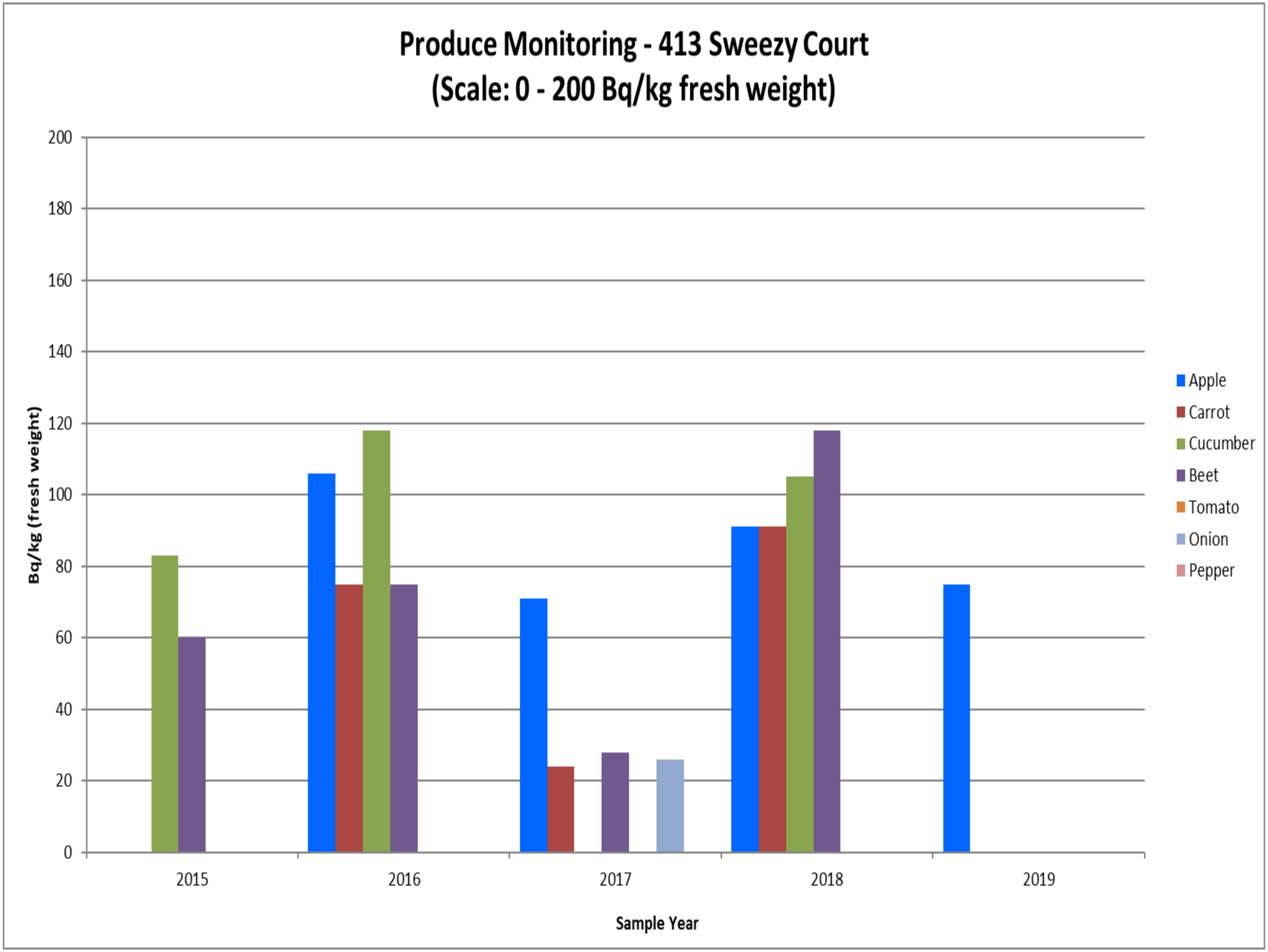

Produce Monitoring - 408 Boundary Road
(Scale: 0 - 300 Bq/kg fresh weight)
300
250
200
150
100
50
0
Bq/kg (fresh weight)
2015
2016
2017
2018
2019
Sample Year
Plum
Onion
Tomato
Cucumber
Rhubarb
Beans

APPENDIX K



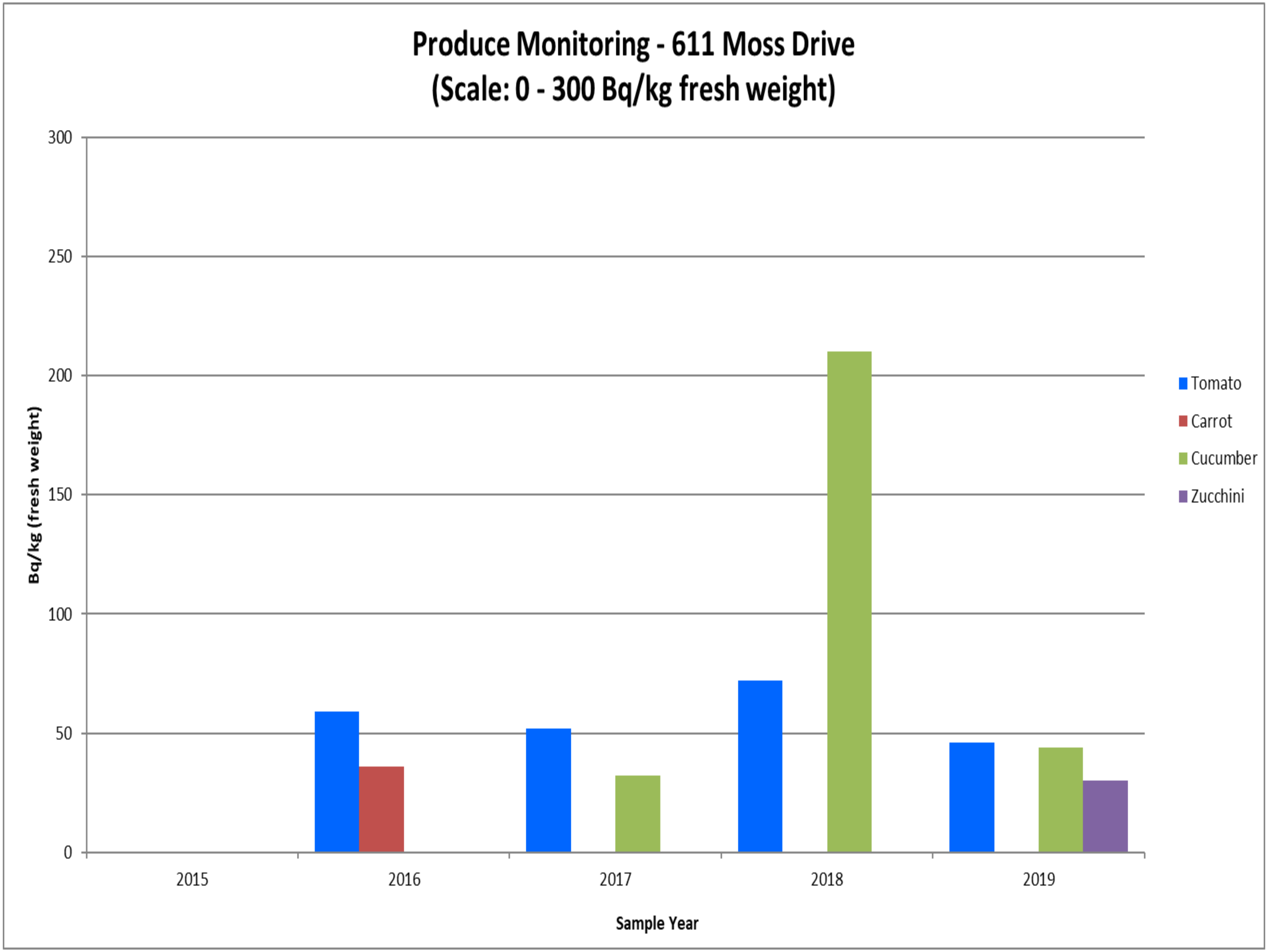
Produce Monitoring - 416 Boundary Road
(Scale: 0 - 100 Bq/kg fresh weight)
100
90
80
70
60
50
40
30
20
10
0
Bq/kg (fresh weight)
2015
2016
2017
2018
2019
Sample Year
Apple

APPENDIX K



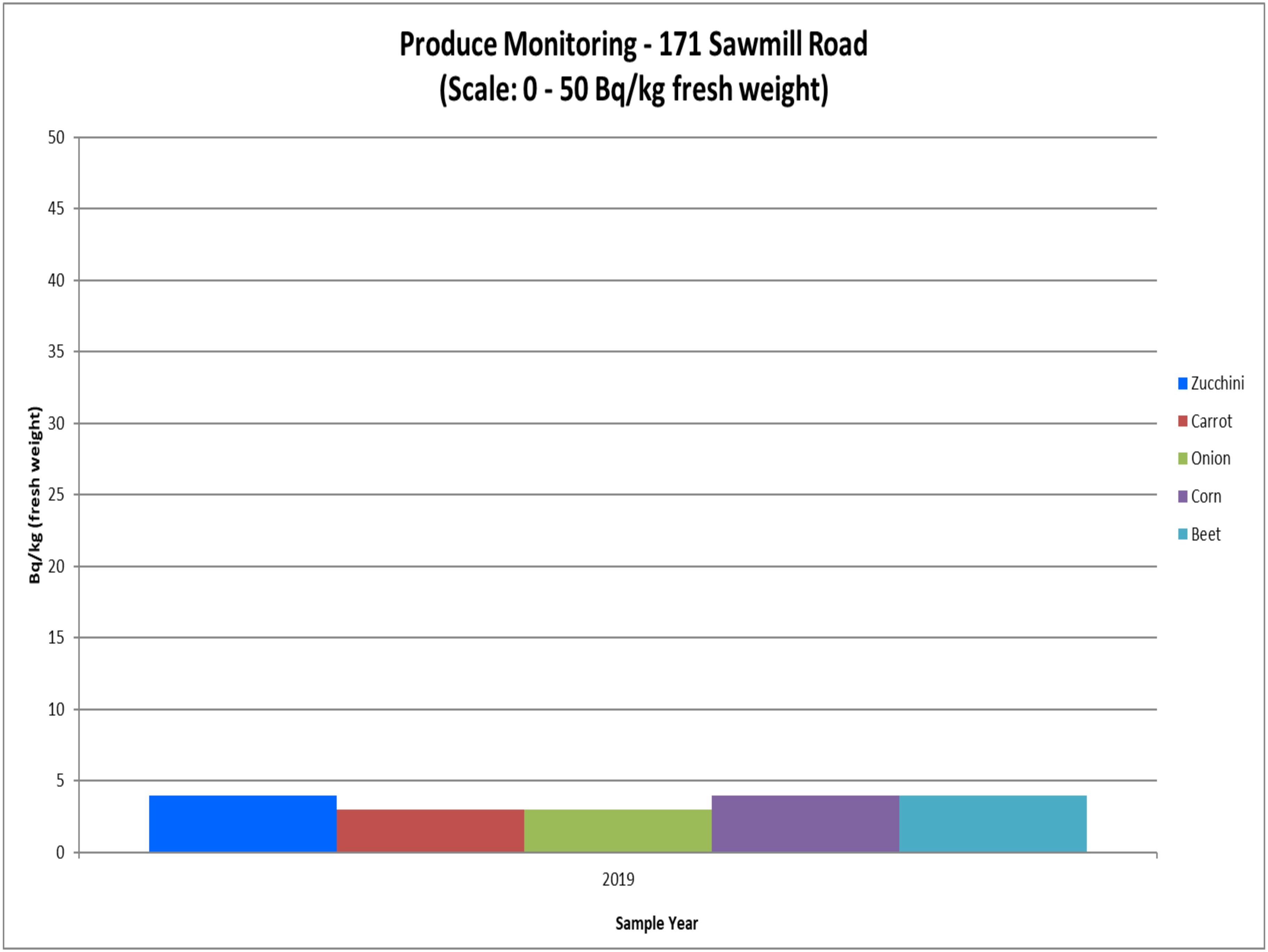
Produce Monitoring - 413 Sweezy Court
(Scale: 0 - 200 Bq/kg fresh weight)
Bq/kg (fresh weight)
200
180
160
140
120
100
80
60
40
20
0
2015
2016
2017
2018
2019
Sample Year
Apple
Carrot
Cucumber
Beet
Tomato
Onion
Pepper

APPENDIX K



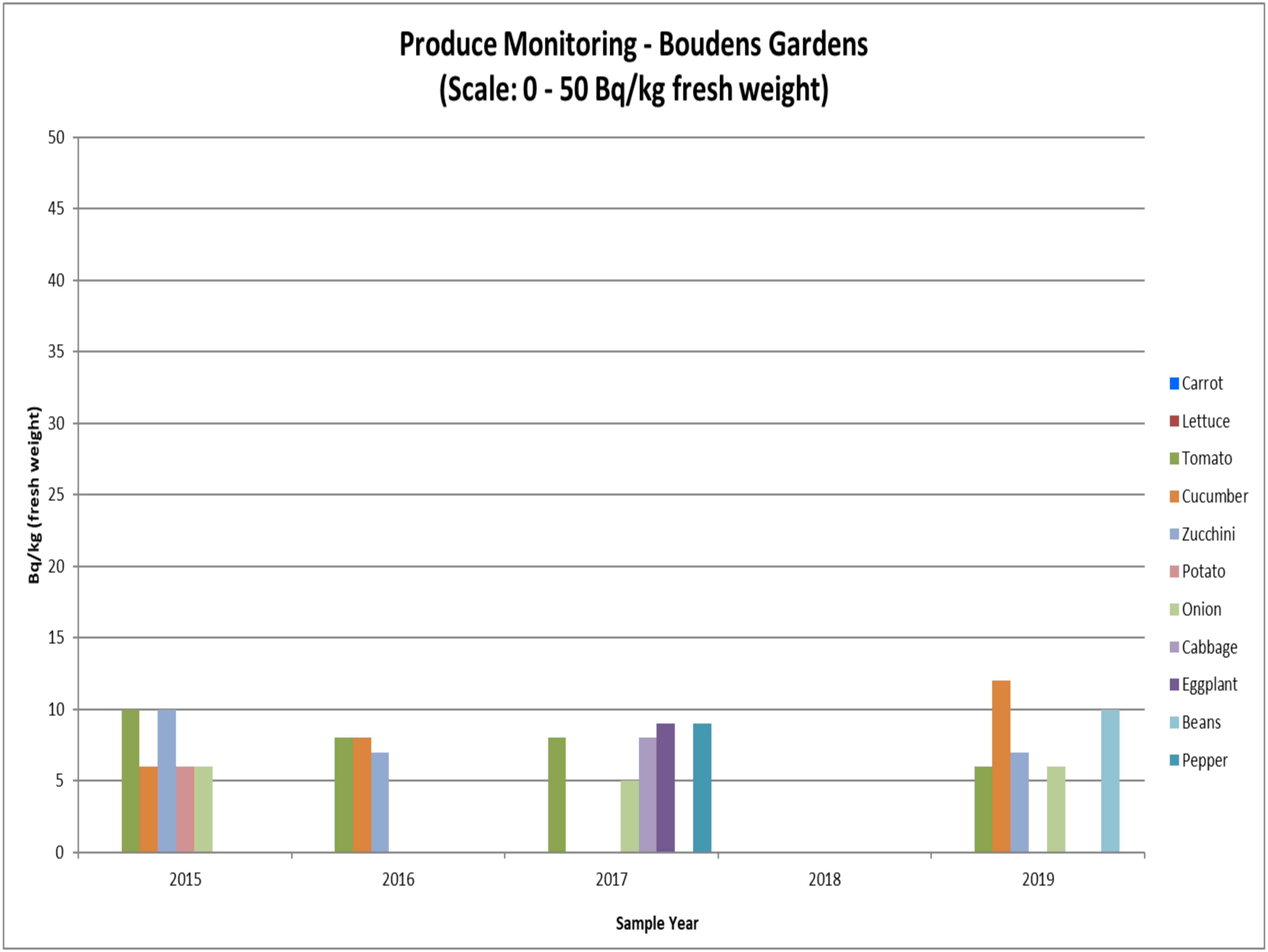
Produce Monitoring - 611 Moss Drive
(Scale: 0 - 300 Bq/kg fresh weight)
300
250
200
150
100
50
0
Bq/kg (fresh weight)
2015
2016
2017
2018
2019
Sample Year
Tomato
Carrot
Cucumber
Zucchini

APPENDIX K

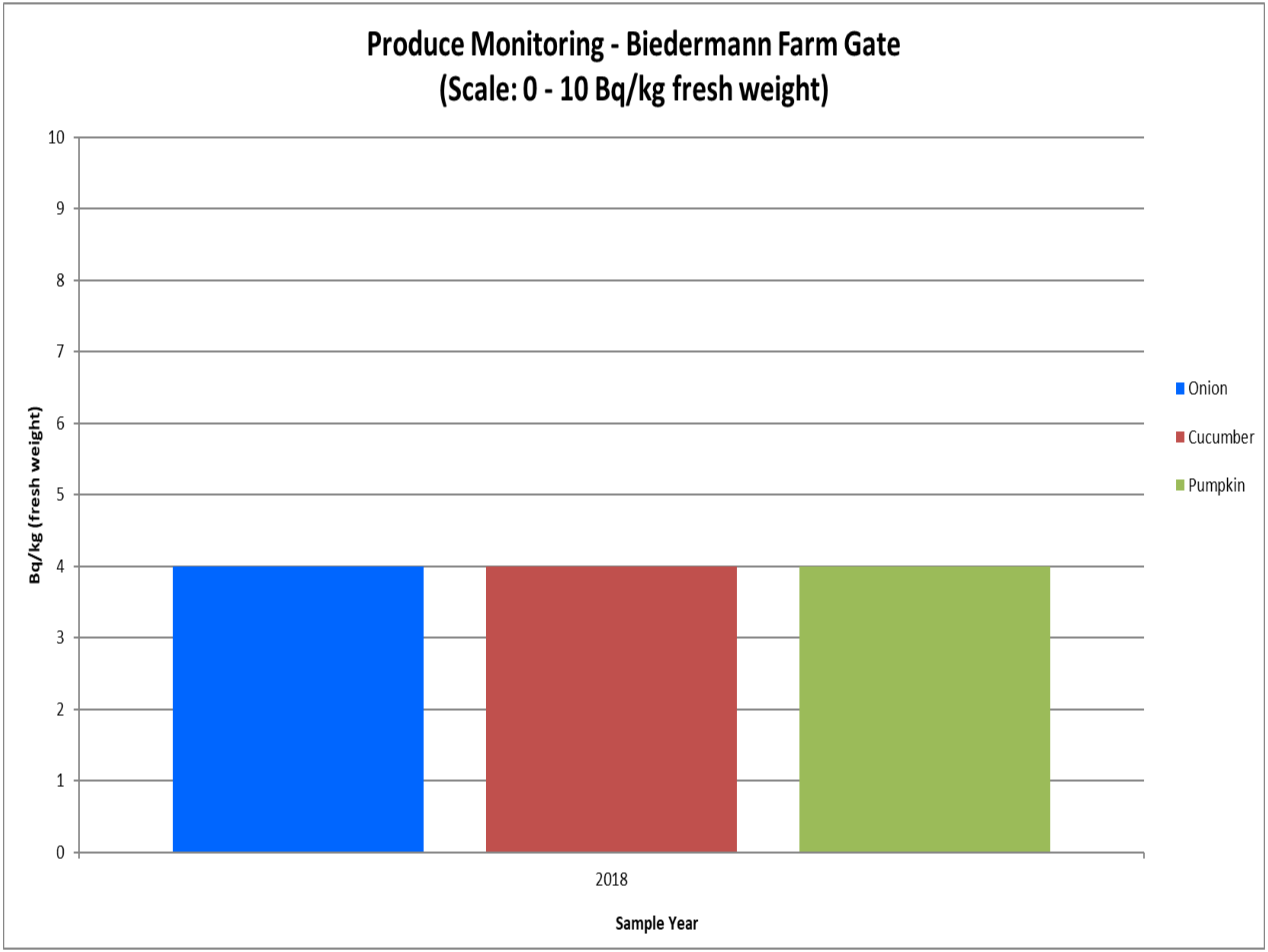


Produce Monitoring - 171 Sawmill Road
(Scale: 0 - 50 Bq/kg fresh weight)
Bq/kg (fresh weight)
50
45
40
35
30
25
20
15
10
5
0
2019
Sample Year
Zucchini
Carrot
Onion
Corn
Beet

APPENDIX K


Produce Monitoring - Boudens Gardens
(Scale: 0 - 50 Bq/kg fresh weight)
Bq/kg (fresh weight)
0
5
10
15
20
25
30
35
40
45
50
2015
2016
2017
2018
2019
Sample Year
Carrot
Lettuce
Tomato
Cucumber
Zucchini
Potato
Onion
Cabbage
Eggplant
Beans
Pepper

APPENDIX K



Produce Monitoring - Biedermann Farm Gate
(Scale: 0 - 10 Bq/kg fresh weight)
10
9
8
7
6
5
4
3
2
1
0
Bq/kg (fresh weight)
2018
Sample Year
Onion
Cucumber
Pumpkin

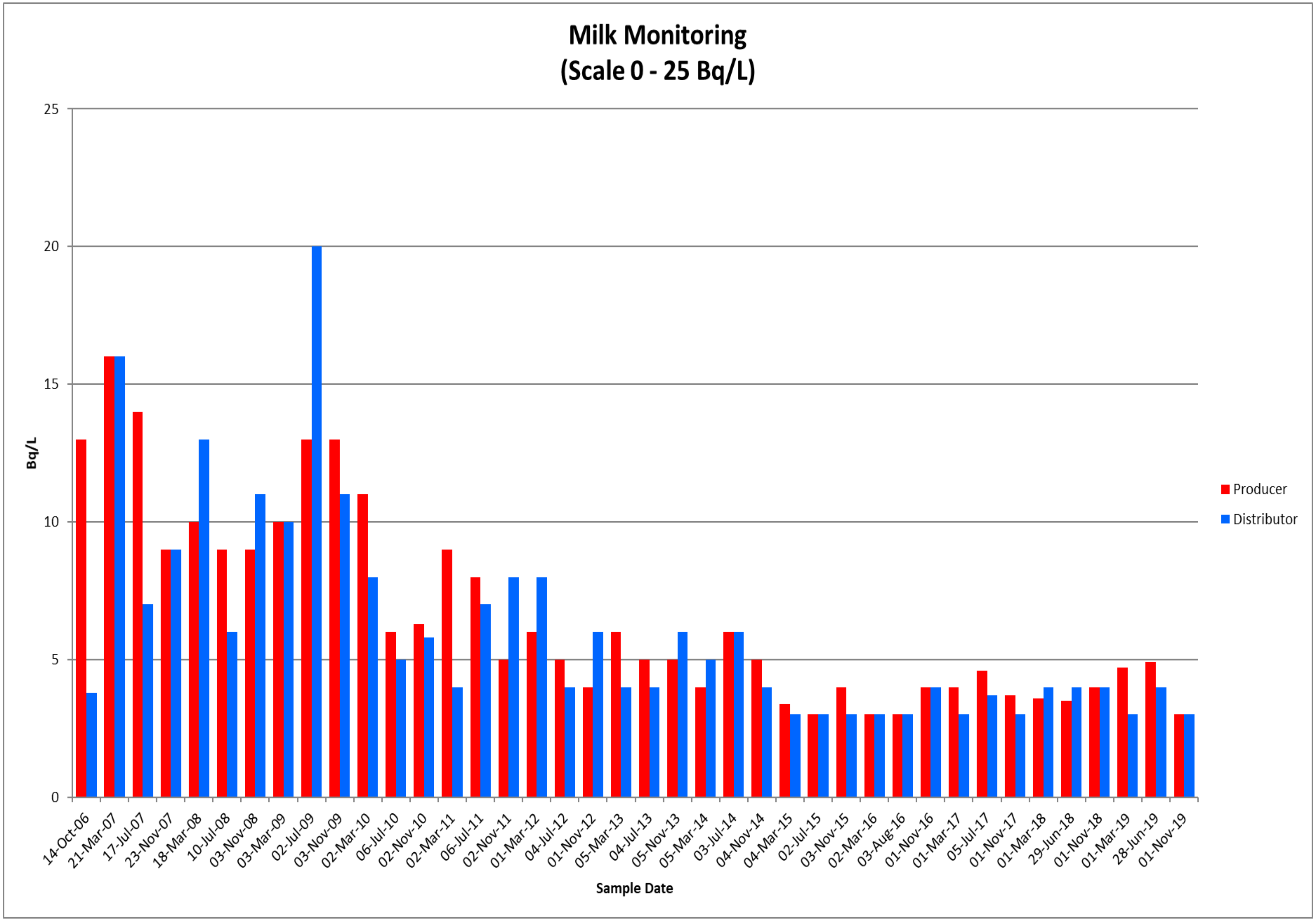
APPENDIX K

APPENDIX L

Milk Monitoring Results for 2019

MILK MONITORING

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
01-Mar-18	3.6	4
29-Jun-18	3.5	4
01-Nov-18	4	4
01-Mar-19	4.7	3
28-Jun-19	4.9	4
01-Nov-19	3	3



Milk Monitoring
(Scale 0 - 25 Bq/L)
Bq/L
Sample Date
Producer
Distributor
25
20
15
10
5
0
14-Oct-06
21-Mar-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
01-Mar-18
29-Jun-18
01-Nov-18
01-Mar-19
28-Jun-19
01-Nov-19

APPENDIX L

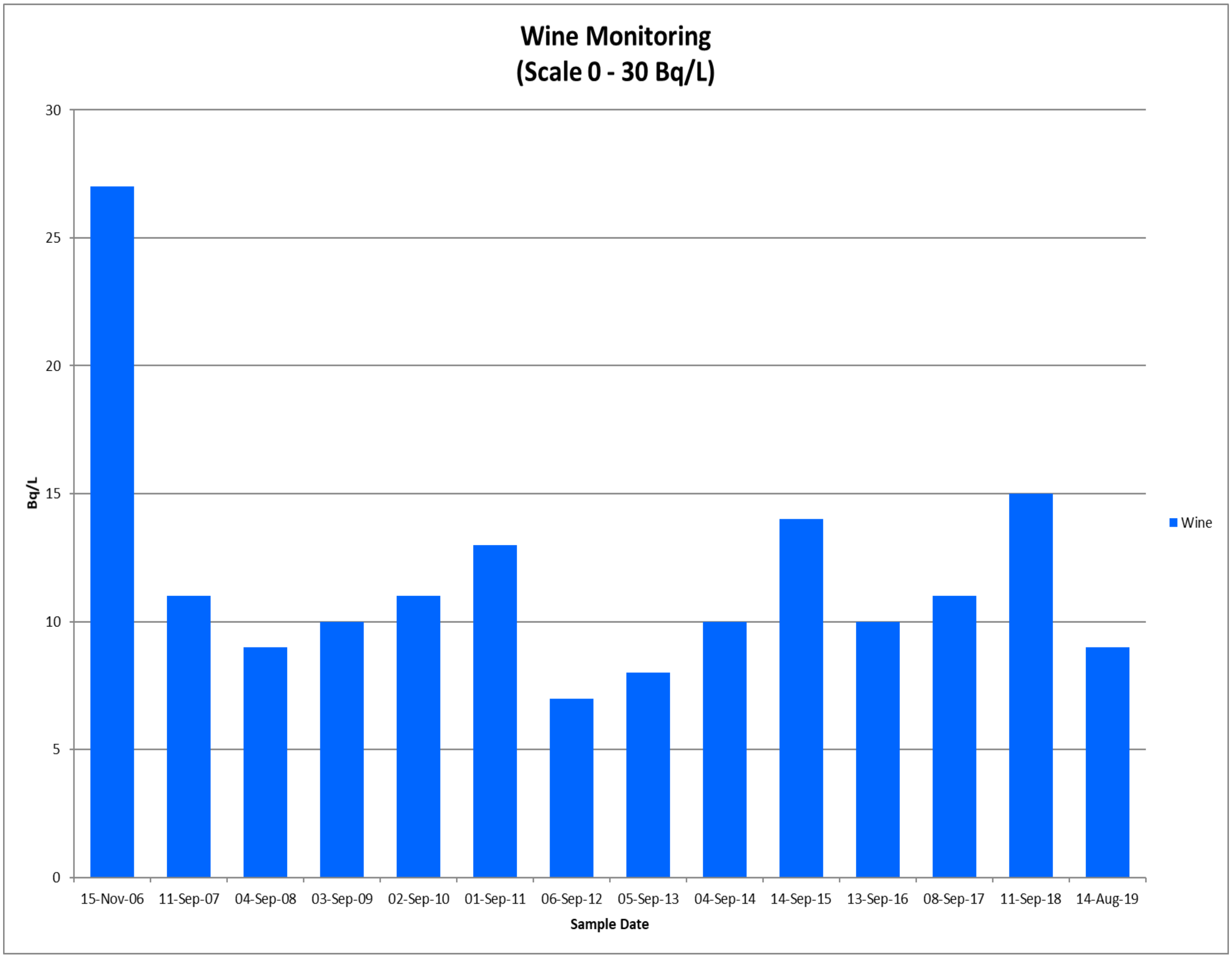
APPENDIX M

Wine Monitoring Results for 2019

WINE MONITORING

Results shaded in blue are <MDA (minimum detectable activity)

	Bq/L
15-Nov-06	27
11-Sep-07	11
04-Sep-08	9
03-Sep-09	10
02-Sep-10	11
01-Sep-11	13
06-Sep-12	7
05-Sep-13	8
04-Sep-14	10
14-Sep-15	14
13-Sep-16	10
08-Sep-17	11
11-Sep-18	15
14-Aug-19	9



APPENDIX N

Weather Data for 2019

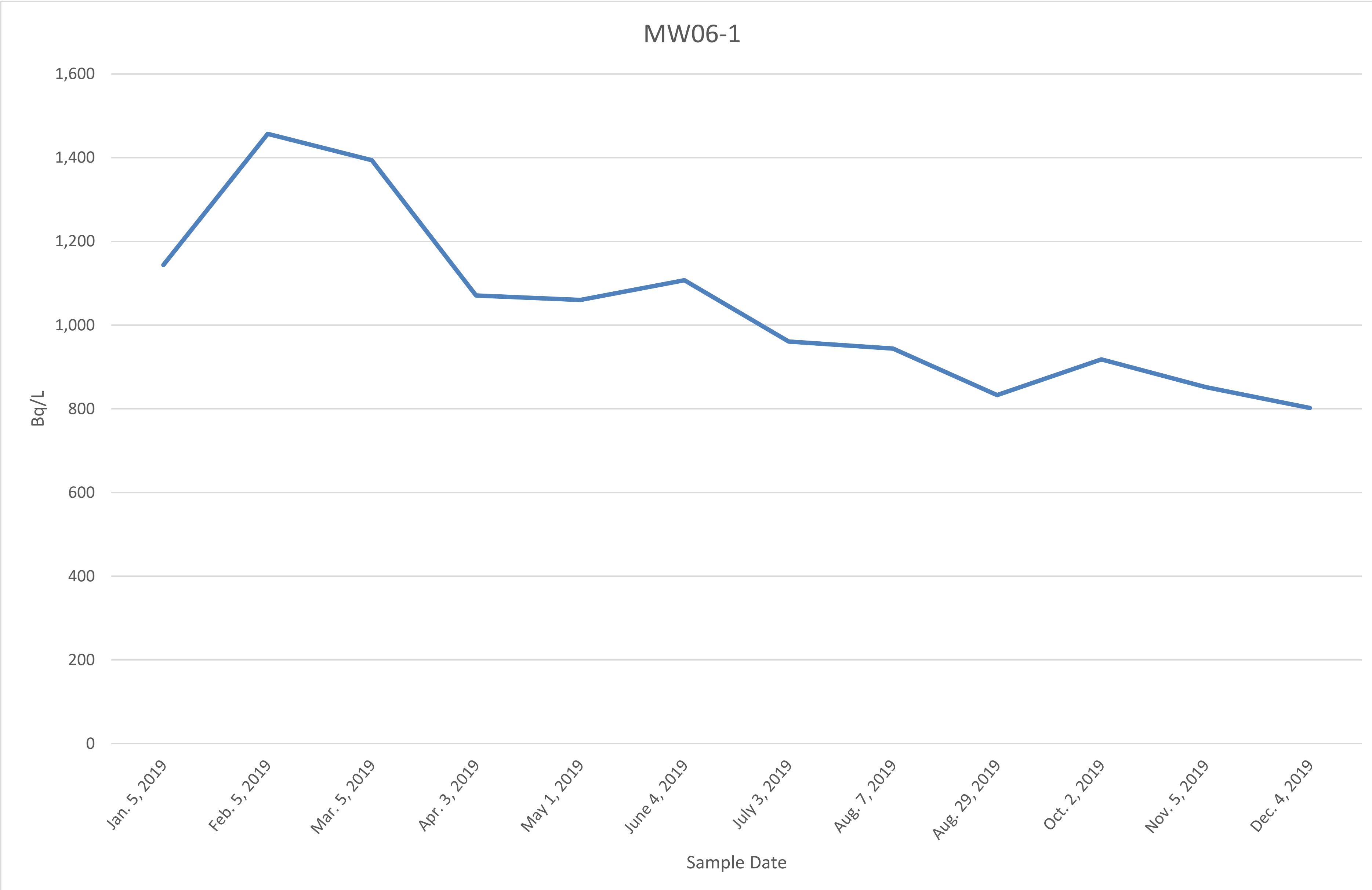
WEATHER DATA SUMMARY (2015-2019)									
Month	Precip Counts, # (TOTAL)	Wind Speed, m/s (AVG)	Gust Speed, m/s (AVG)	Wind Direction, ø (AVG)	Temp, °C (AVG)	RH, % (AVG)	DewPt, °C (AVG)	Wind sector (nesw)	Total rain (mm)
January-2015	19	2.6	3.8	228.1	-14.2	75.4	-17.7	SW	3.8
February-2015	20	2.8	4.1	220.5	-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
January-2018	167	3.3	4.9	146.0	-9.7	80.2	-12.6	SE	33.4
February-2018	169	3.3	3.7	154.8	-5.6	77.9	-9.1	SSE	33.8
March-2018	158	3.9	5.1	94.1	-2.3	68.6	-7.7	ESE	31.6
April-2018	348	2.8	4.2	146.6	3.5	66.5	-3.1	SE	69.6
May-2018	276	2.4	3.9	202.6	15.1	60.7	6.4	SSW	55.2
June-2018	273	2.1	3.4	221.4	17.2	70.1	11.0	SW	54.6
July-2018	340	2.1	3.3	250.8	22.4	69.7	15.9	WSW	68
August-2018	336	1.8	2.9	213.2	21.0	78.7	16.8	SW	67.2
September-2018	352	2.1	3.3	205.2	14.5	81.1	11.1	SSW	70.4
October-2018	234	2.8	4.3	213.7	6.0	79.0	2.4	SW	46.8
November-2018	352	2.9	4.3	204.3	-2.3	85.6	-4.4	SSW	70.4
December-2018	170	2.3	3.4	195.0	-8.0	85.6	-10.0	SSW	34
January-2019	767	2.7	4.0	215.7	-13.0	79.2	-15.9	SW	153.4
February-2019	116	2.6	3.9	196.8	-9.7	74.9	-13.5	SSW	23.2
March-2019	178	3.0	4.5	231.7	-3.6	68.1	-9.2	SW	35.6
April-2019	778	3.0	4.5	204.9	4.1	73.3	-0.8	SSW	155.6
May-2019	369	2.6	4.0	212.2	10.8	72.9	5.6	SW	73.8
June-2019	493	2.3	3.7	248.4	16.8	70.5	10.7	WSW	98.6
July-2019	321	1.9	3.1	264.1	21.9	71.2	15.9	WSW	64.2
August-2019	285	2.0	3.2	239.8	19.4	71.7	13.6	SW	57
September-2019	228	2.1	3.3	246.7	14.6	78.8	10.6	WSW	45.6
October-2019	690	2.4	3.7	246.2	7.8	80.9	4.5	WSW	138
November-2019	219	2.1	3.3	249.3	14.8	78.9	10.8	WSW	43.8
December-2019	190	1.7	2.8	237.0	-5.0	84.7	-7.2	SW	38

APPENDIX O

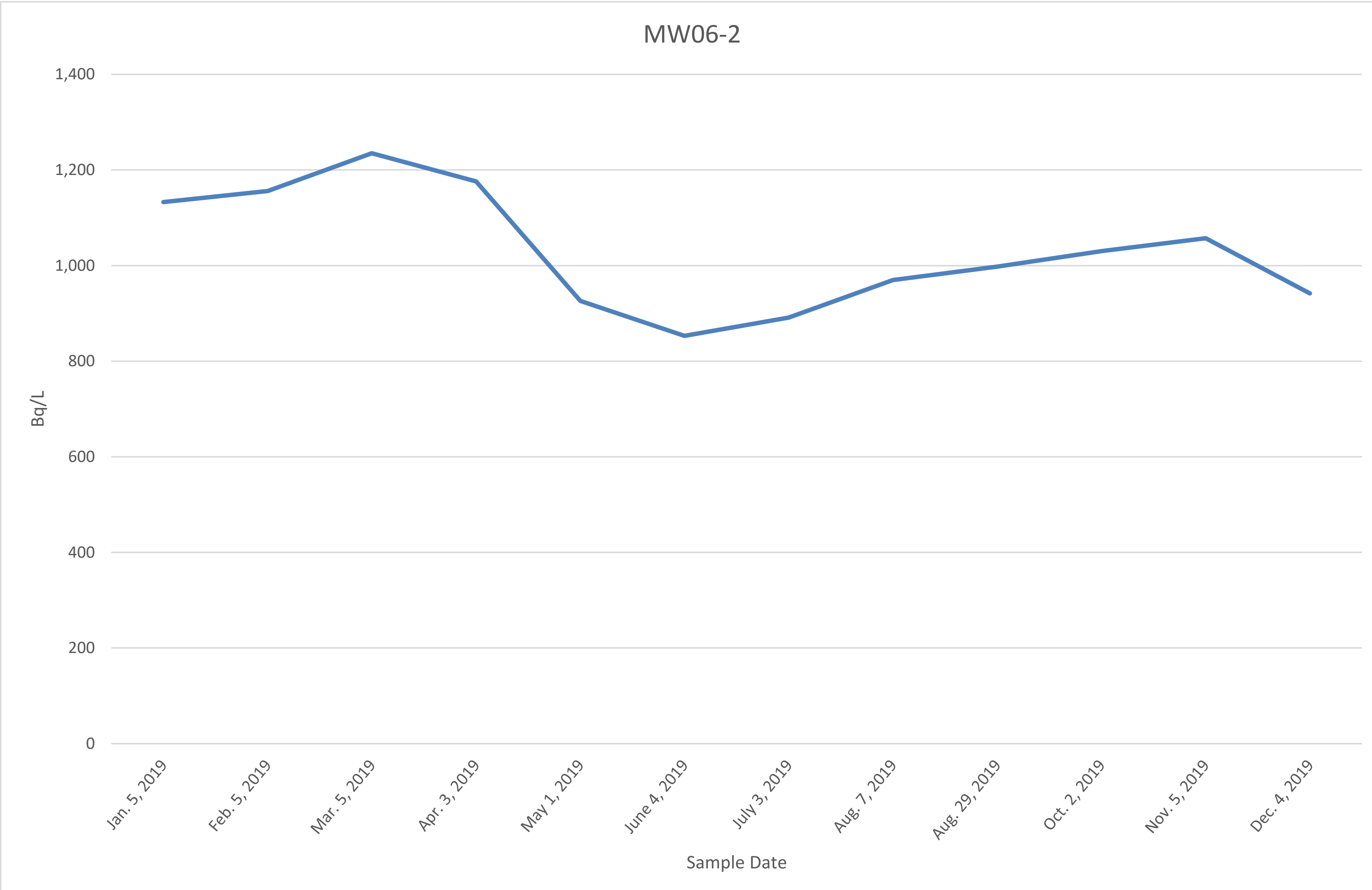
Well Monitoring Results for 2019

Groundwater Tritium Concentration Summary 2019

WELL I.D.	DESCRIPTION		DISTANCE FROM STACKS (m)	Jan. 5, 2019	Feb. 5, 2019	Mar. 5, 2019	Apr. 3, 2019	May 1, 2019	June 4, 2019	July 3, 2019	Aug. 7, 2019	Aug. 29, 2019	Oct. 2, 2019	Nov. 5, 2019	Dec. 4, 2019	WELL I.D.
MW06-1	SRB SITE	IN SOIL	50	1,144	1,457	1,394	1,071	1,060	1,107	961	944	833	918	852	802	MW06-1
MW06-2	SRB SITE	IN SOIL	75	1,133	1,156	1,235	1,176	926	853	891	970	998	1,030	1,057	942	MW06-2
MW06-3	SRB SITE	IN SOIL	50	461			352	356	392	341				341	323	MW06-3
MW06-8	SRB SITE	IN SOIL	55	708		709	664	642	711	759	700	646	619	665	641	MW06-8
MW06-9	SRB SITE	IN SOIL	25	1,831	2,158	1,975	1,772	1,737	1,836	1,762	1,716	1,668	1,607	1,622	1,606	MW06-9
MW06-10	SRB SITE	SURFACE OF BEDROCK	0	38,017	52,321	49,531	37,741	17,069	23,900	27,085	26,908	39,766	48,332	29,012	25,421	MW06-10
MW07-11	SRB SITE	SURFACE OF BEDROCK	75	1,155	1,234	1,222	1,139	821	917	1,094	1,071	1,076	1,053	864	995	MW07-11
MW07-12	SRB SITE	SURFACE OF BEDROCK	55	432	427	337	402	417	472	465	441	434	405	471	391	MW07-12
MW07-13	SRB SITE	SURFACE OF BEDROCK	50	6,152	6,436	6,129	5,968	5,739	5,686	5,530	5,582	5,313	5,253	5,083	4,891	MW07-13
MW07-15	SRB SITE	SURFACE OF BEDROCK	25	1,387	1,532	1,486	1,410	1,366	1,427	1,438	1,427	1,320	1,359	1,321	1,310	MW07-15
MW07-16	SRB SITE	SURFACE OF BEDROCK	15	1,259	1,348	1,535	1,239	1,203	1,288	1,269	1,236	1,165	1,196	1,109	1,032	MW07-16
MW07-17	SRB SITE	DEEPER BEDROCK	15	445	452	434	408	323	308	256	219	239	293	351	326	MW07-17
MW07-18	SRB SITE	SURFACE OF BEDROCK	10	1,850	2,197	2,917	3,530	1,492	1,502	1,572	1,798	1,868	1,921	1,677	1,679	MW07-18
MW07-19	SRB SITE	SURFACE OF BEDROCK	20	1,766	2,009	1,583	1,656	993	1,097	1,252	1,464	1,744	1,651	1,258	1,142	MW07-19
MW07-20	SUPERIOR PROPANE PROPERTY	SURFACE OF BEDROCK	90	436		530	405	406	473	439	448	373	437	488	378	MW07-20
MW07-21	SUPERIOR PROPANE PROPERTY	SURFACE OF BEDROCK	110	671		716	407	267	374	500	593	614	727	617	508	MW07-21
MW07-22	SRB SITE	SURFACE OF BEDROCK	70	1,061	1,026	1,017	780	803	926	996	991	885	913	775	873	MW07-22
MW07-23	SRB SITE	SURFACE OF BEDROCK	90	1,459	1,531	1,511	1,469	1,423	1,519	1,463	1,466	1,390	1,373	1,352	1,365	MW07-23
MW07-24	HARRINGTON PROPERTY	SURFACE OF BEDROCK	115	1,846	1,934	1,927	1,888	1,812	1,902	1,988	1,865	1,746	1,748	1,742	1,672	MW07-24
MW07-26	SRB SITE	SURFACE OF BEDROCK	50	883	798	723	717	427	661	783	805	700	550	649	663	MW07-26
MW07-27	CITY PROPERTY	SURFACE OF BEDROCK	55	3,211	3,365	Dry	3,139	1,611	1,745	2,154	2,730	2,825	3,052	2,910	2,772	MW07-27
MW07-28	CITY PROPERTY	DEEPER BEDROCK	55	884	797	775	788	777	807	997	909	864	854	741	926	MW07-28
MW07-29	SRB SITE	DEEPER BEDROCK	10	1,894	2,423	2,305	2,317	1,159	1,368	2,002	2,075	2,283	2,941	2,296	1,631	MW07-29
MW07-31	SRB SITE	DEEPER BEDROCK	70	452	470	434	289	<MDA (46)	147	148	386	336	376	415	414	MW07-31
MW07-32	HARRINGTON PROPERTY	DEEPER BEDROCK	115	<MDA (37)	<MDA (40)	44	<MDA (40)	<MDA (46)	92	60	104	<MDA (39)	<MDA (41)	<MDA (40)	<MDA (44)	MW07-32
MW07-34	SRB SITE	SHALLOW BEDROCK	10	1,691	1,421	1,351	1,328	1,639	1,751	1,705	1,576	1,479	1,554	1,471	1,343	MW07-34
MW07-35	CITY PROPERTY	SHALLOW BEDROCK	55	2,567	2,588	2,555	2,421	2,025	2,159	2,133	1,991	2,027	2,182	2,275	2,146	MW07-35
MW07-36	CITY PROPERTY	SHALLOW BEDROCK	80	2,054	2,123	1,944	1,950	1,266	1,314	1,425	1,563	1,671	1,815	1,680	1,788	MW07-36
MW07-37	SRB SITE	SHALLOW BEDROCK	60	903	952	943	841	719	800	796	748	731	805	806	809	MW07-37
CN-1S	CN PROPERTY		125			Dry	328		*No longer sampled as part of routine GMP*							CN-1S
CN-1D	CN PROPERTY		130			Dry	287		*No longer sampled as part of routine GMP*							CN-1D
CN-2	CN PROPERTY		150			Dry			*No longer sampled as part of routine GMP*							CN-2
CN-3S	CN PROPERTY		165			Dry			*No longer sampled as part of routine GMP*							CN-3S
CN-3D	CN PROPERTY		160			Dry			*No longer sampled as part of routine GMP*							CN-3D
RW-2	185 MUD LAKE ROAD		1,100			58				32				33		RW-2
RW-3	183 MUD LAKE ROAD		1,100			39				46				58		RW-3
RW-5	171 SAWMILL ROAD		2,300			8				6				7		RW-5
RW-6	40987 HWY 41		1,400			8				6				5		RW-6
RW-7	40925 HWY 41		1,600			<4				<4				<4		RW-7
RW-8	204 BOUNDARY ROAD		700	[redacted]												RW-8
RW-9	206 BOUNDARY ROAD		650	[redacted]												RW-9
RW-10	208 BOUNDARY ROAD		625	[redacted]												RW-10
RW-12	202 MUD LAKE ROAD		753	[redacted]												RW-12
B-1	VALLEY POOL SERVICE OFFICE		160			916				812				893		B-1
B-2	SUPERIOR PROPANE TRUCK WASH		250			826				No sample	563			800		B-2
B-3	HEIDEMAN & SONS LUMBER		385			<4				No sample	<4			<4		B-3

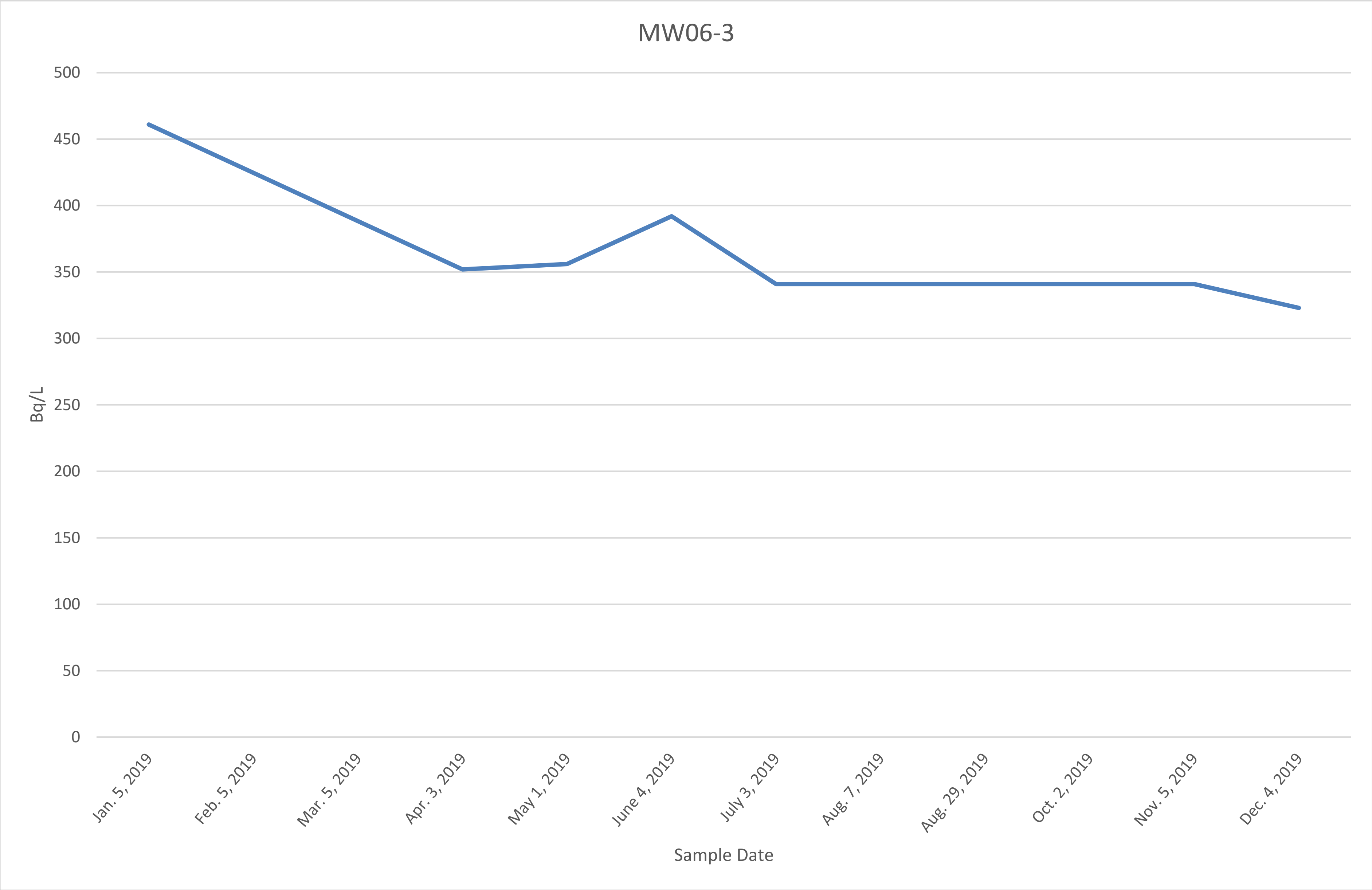


MW06-1
1,600
1,400
1,200
1,000
800
600
400
200
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date



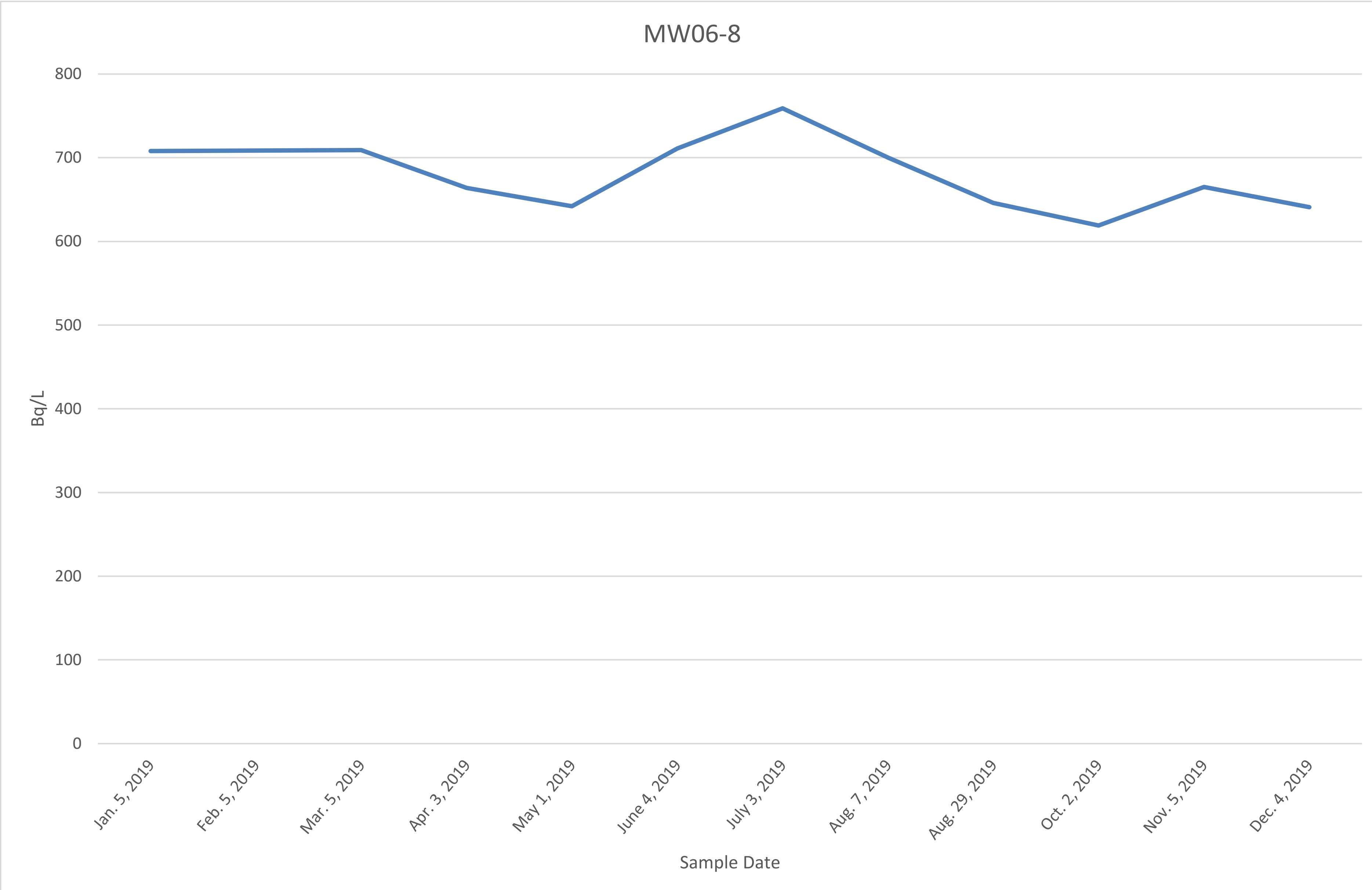
MW06-2
1,400
1,200
1,000
800
600
400
200
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O

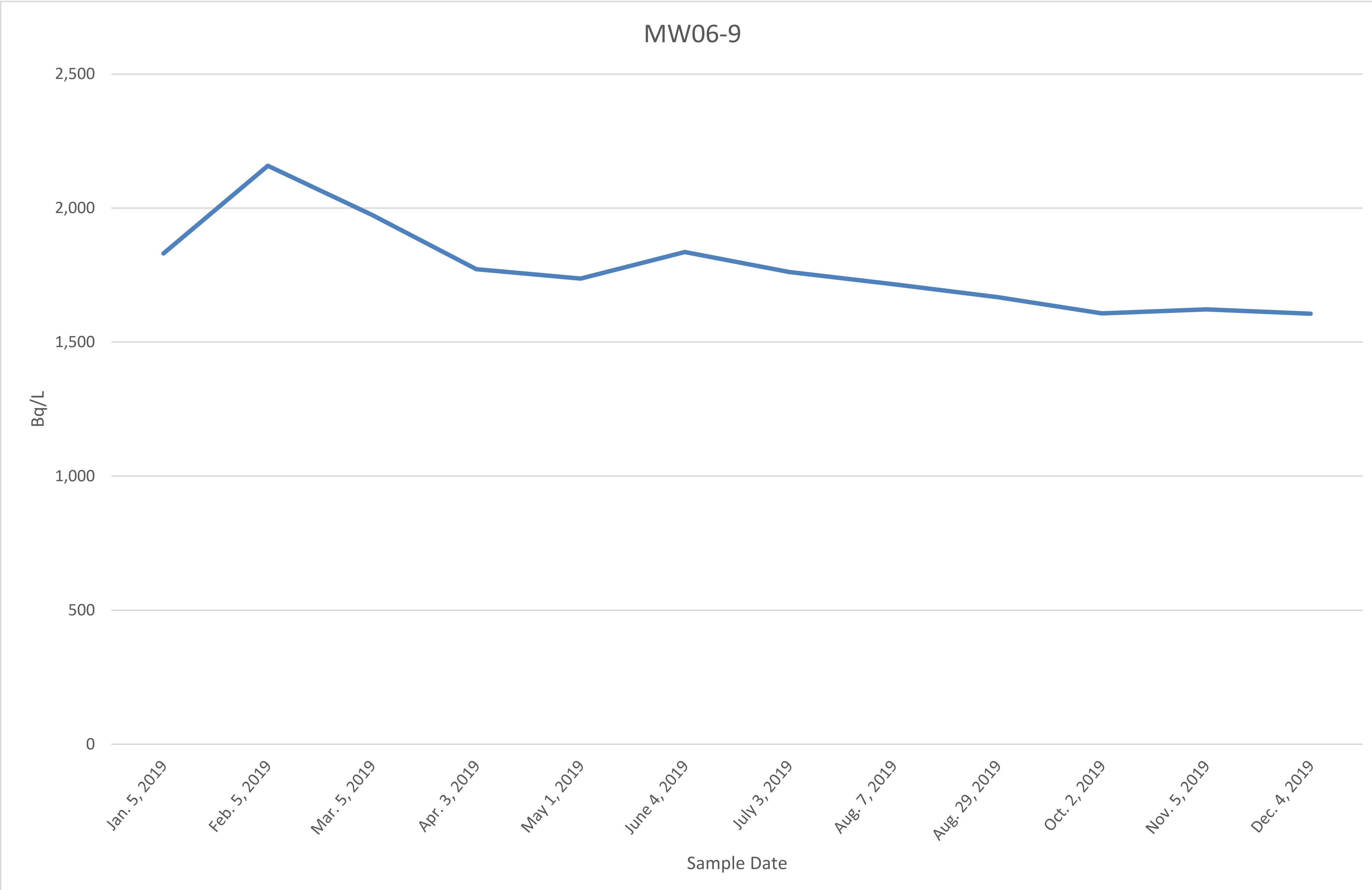


MW06-3
500
450
400
350
300
250
200
150
100
50
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

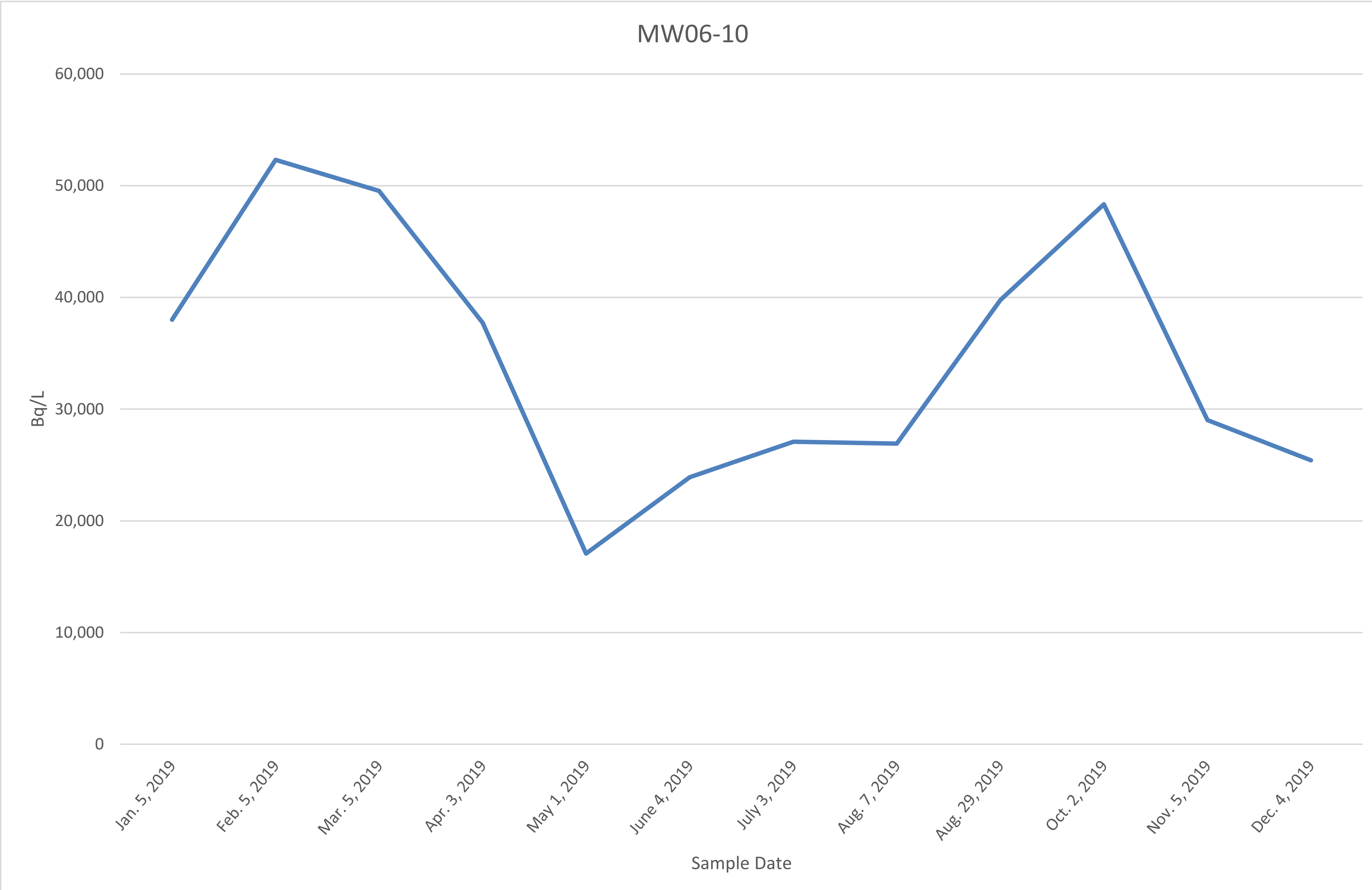
APPENDIX O


MW06-8
800
700
600
500
400
300
200
100
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O

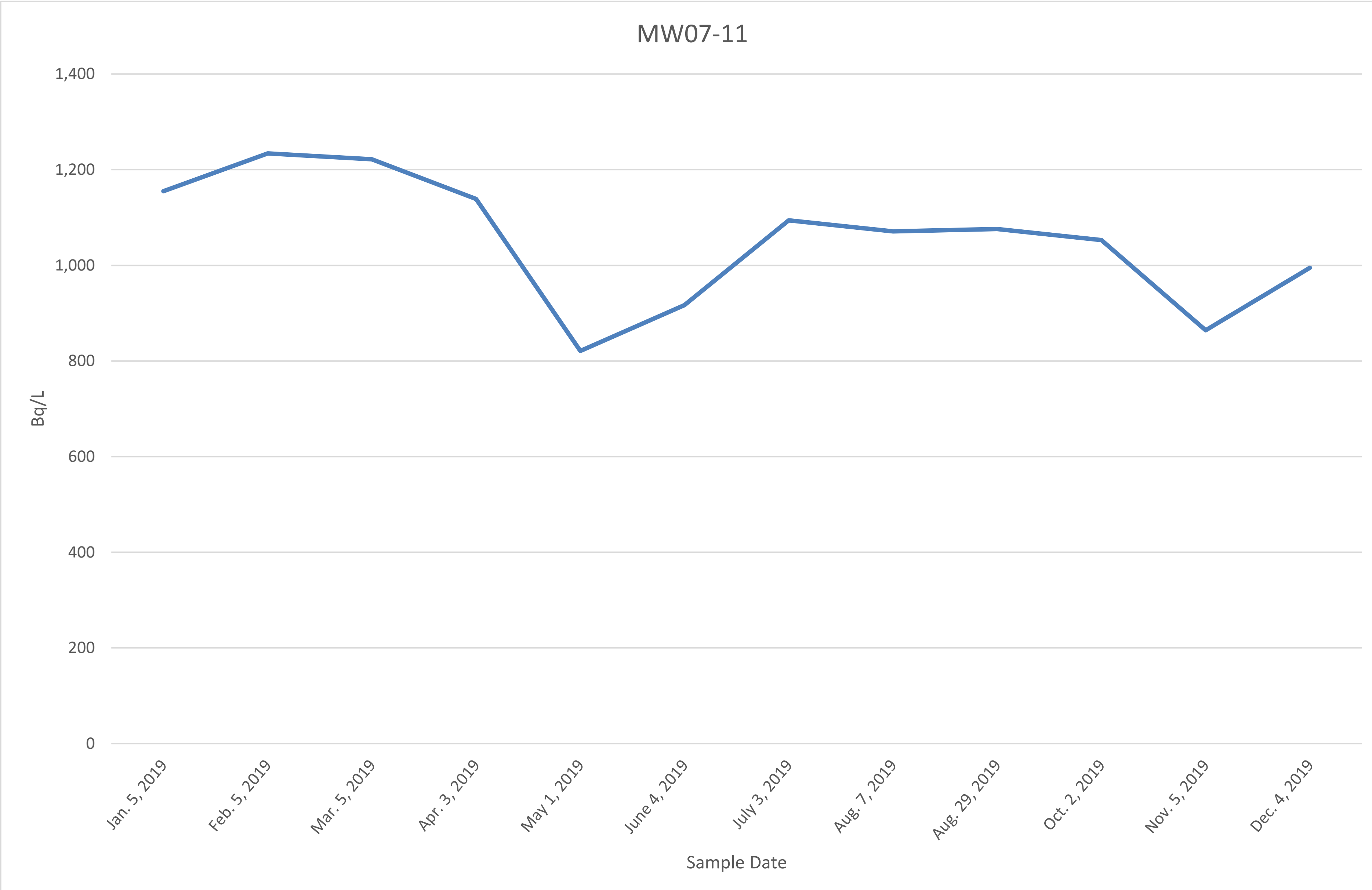

MW06-9
2,500
2,000
1,500
1,000
500
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O



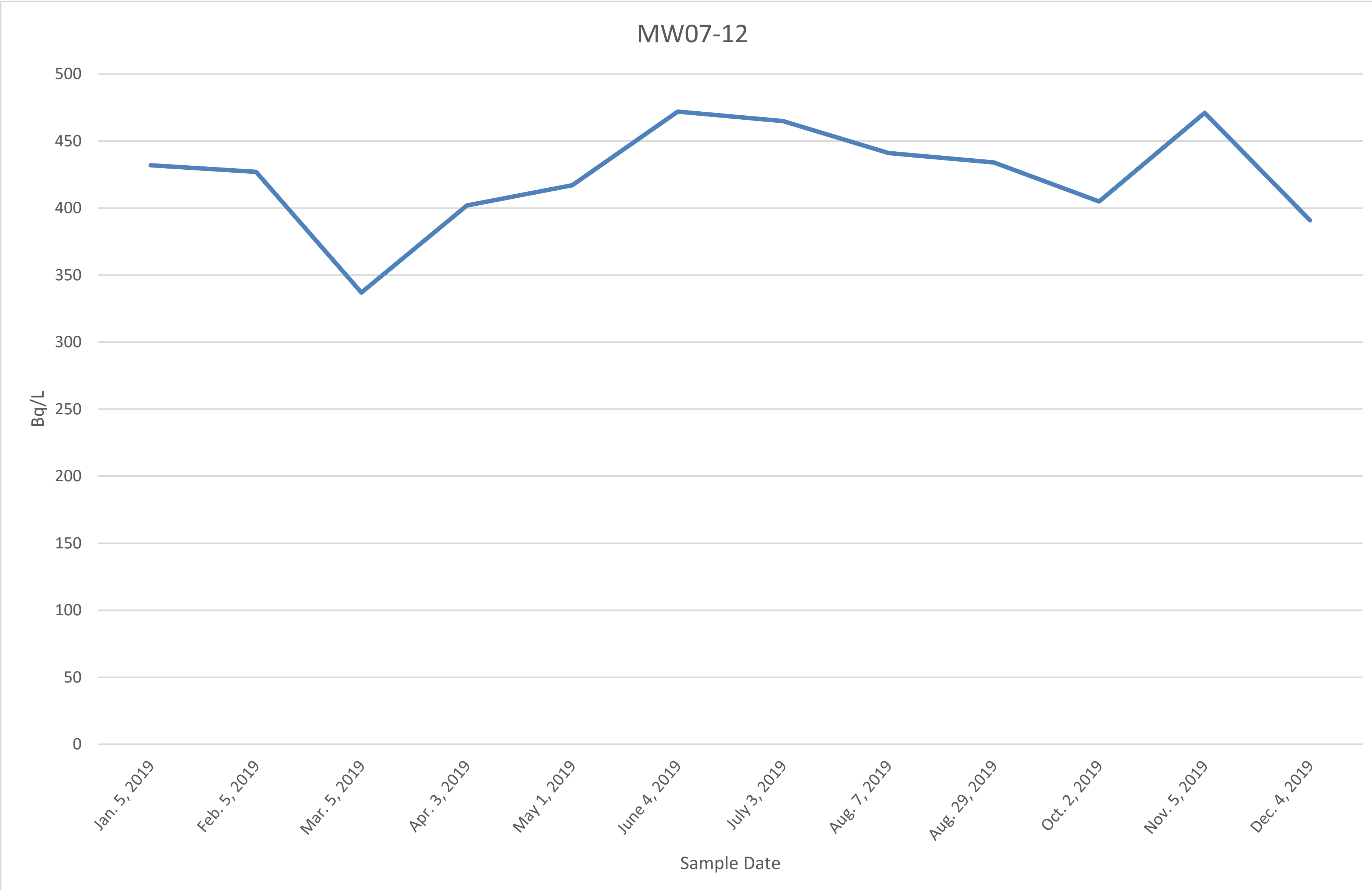
MW06-10
60,000
50,000
40,000
30,000
20,000
10,000
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O



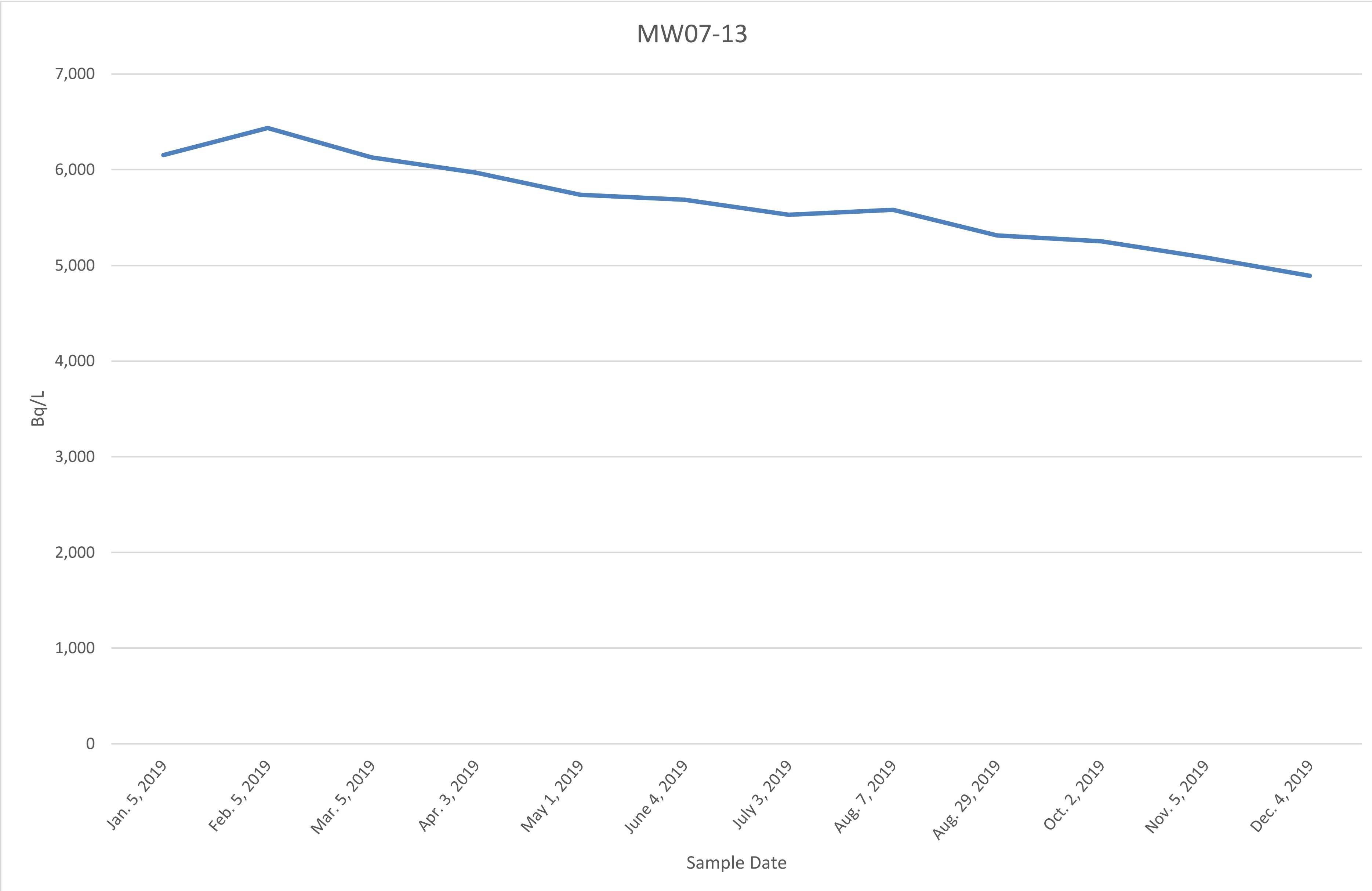
MW07-11
1,400
1,200
1,000
800
600
400
200
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O



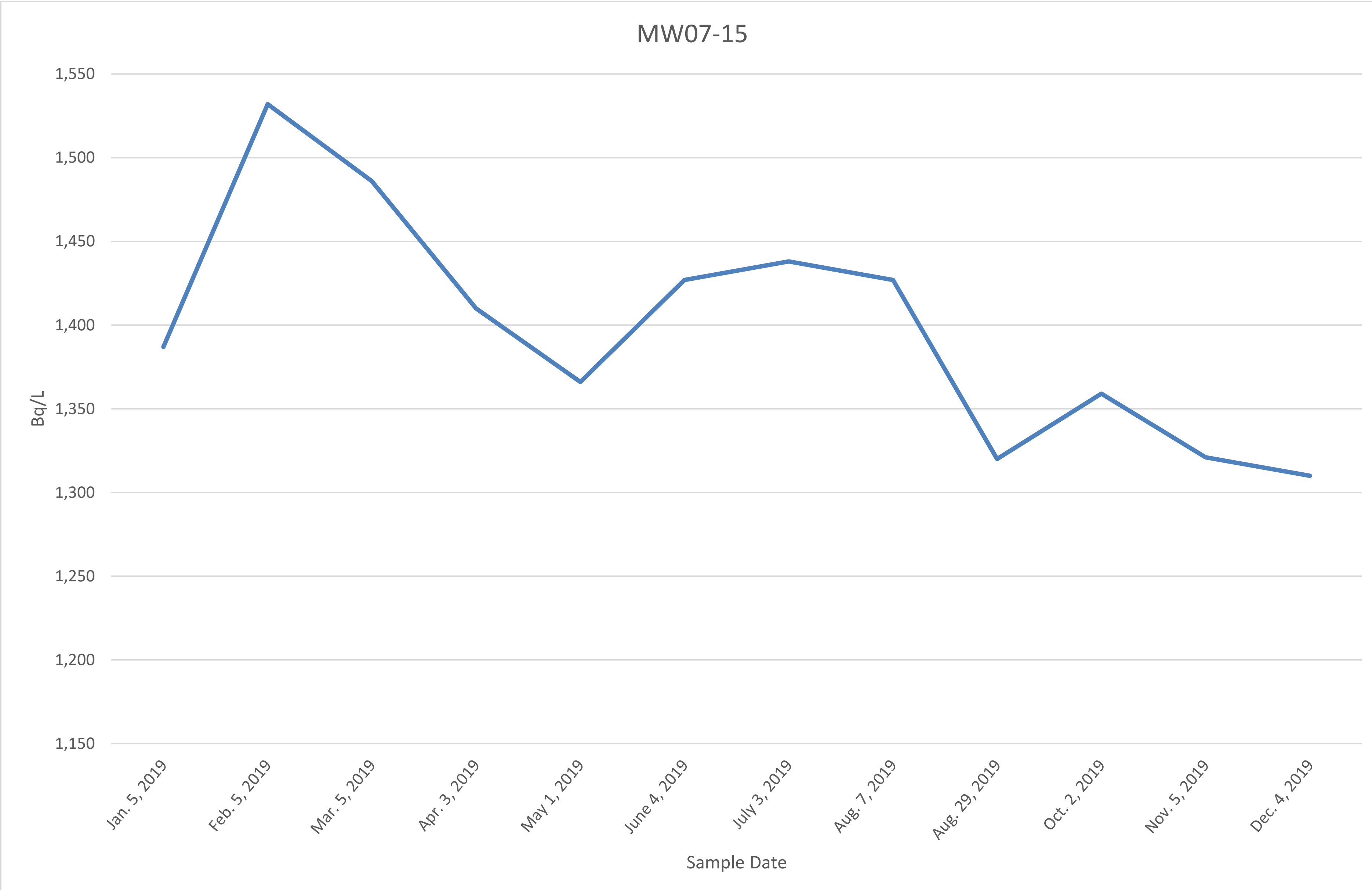
MW07-12
500
450
400
350
300
250
200
150
100
50
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O



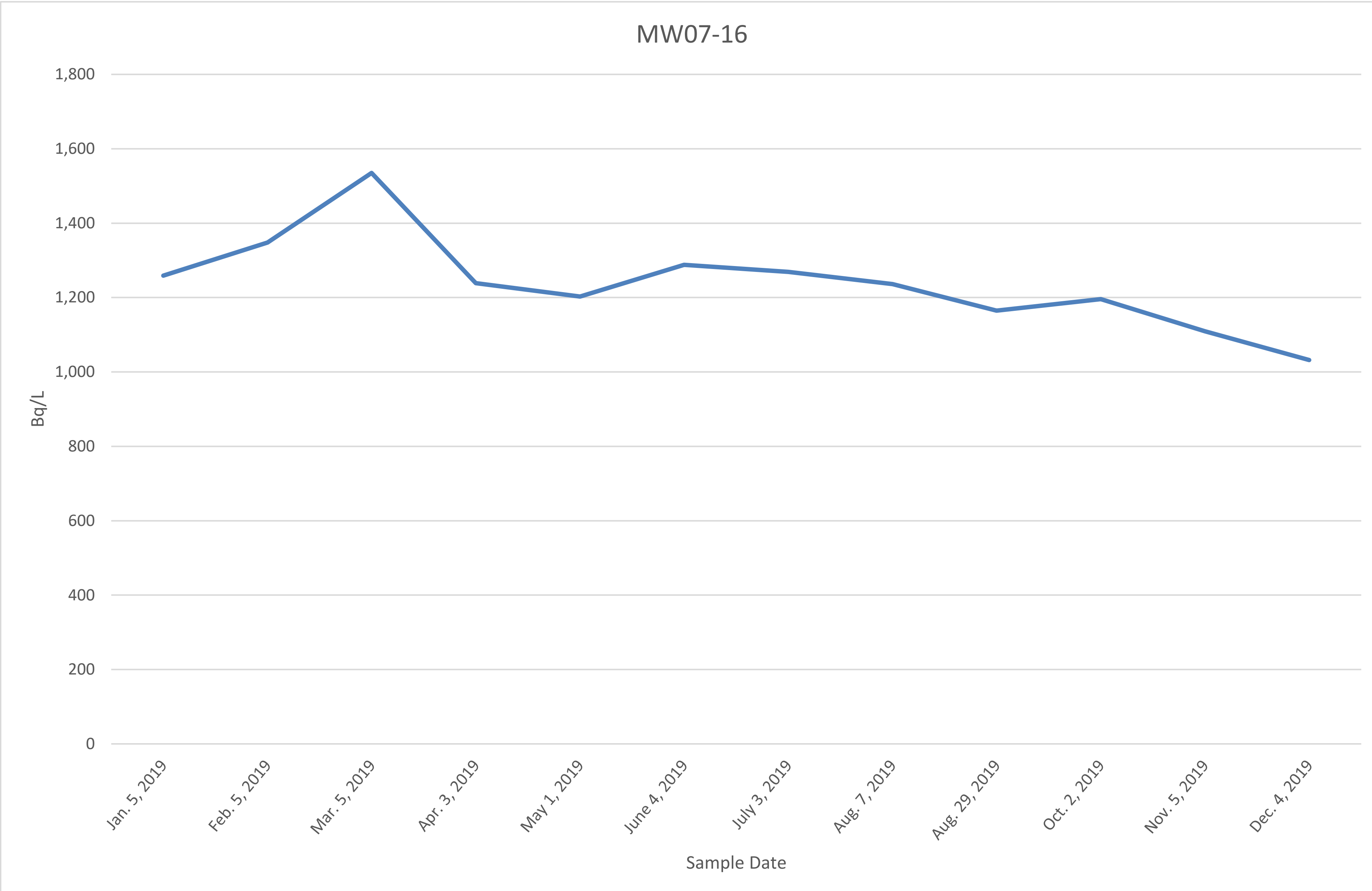
MW07-13
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O

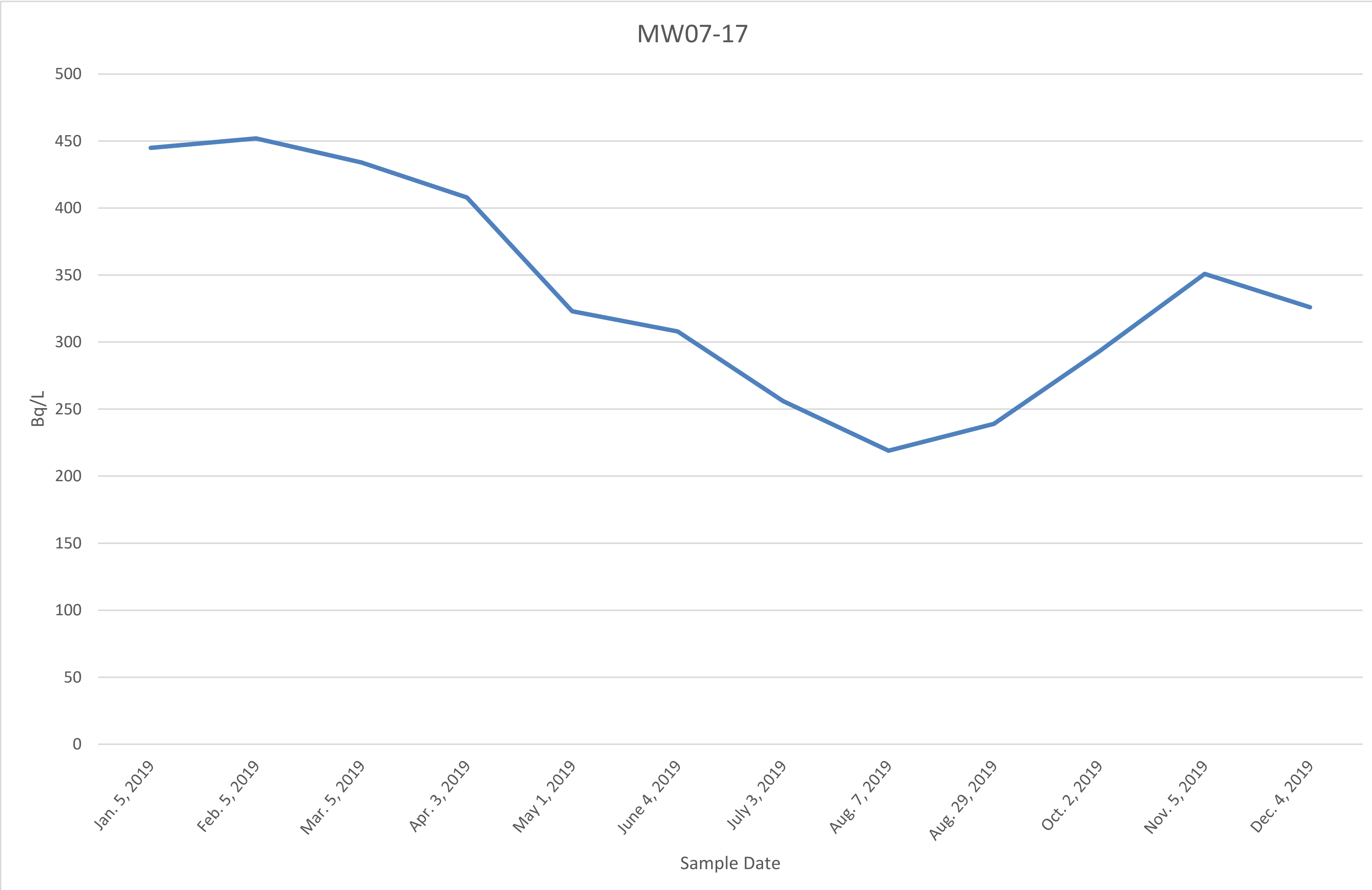


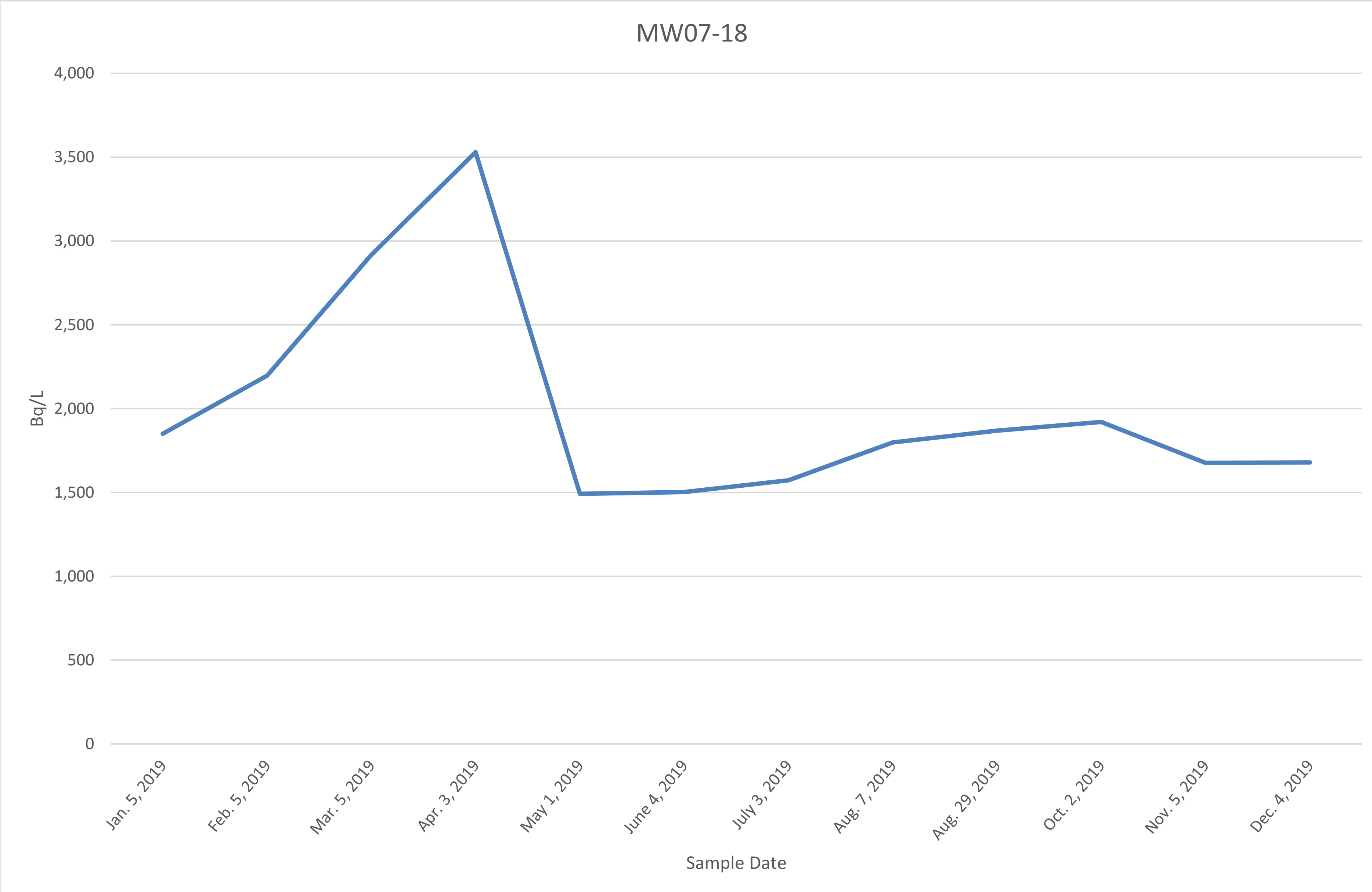
MW07-15
1,550
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

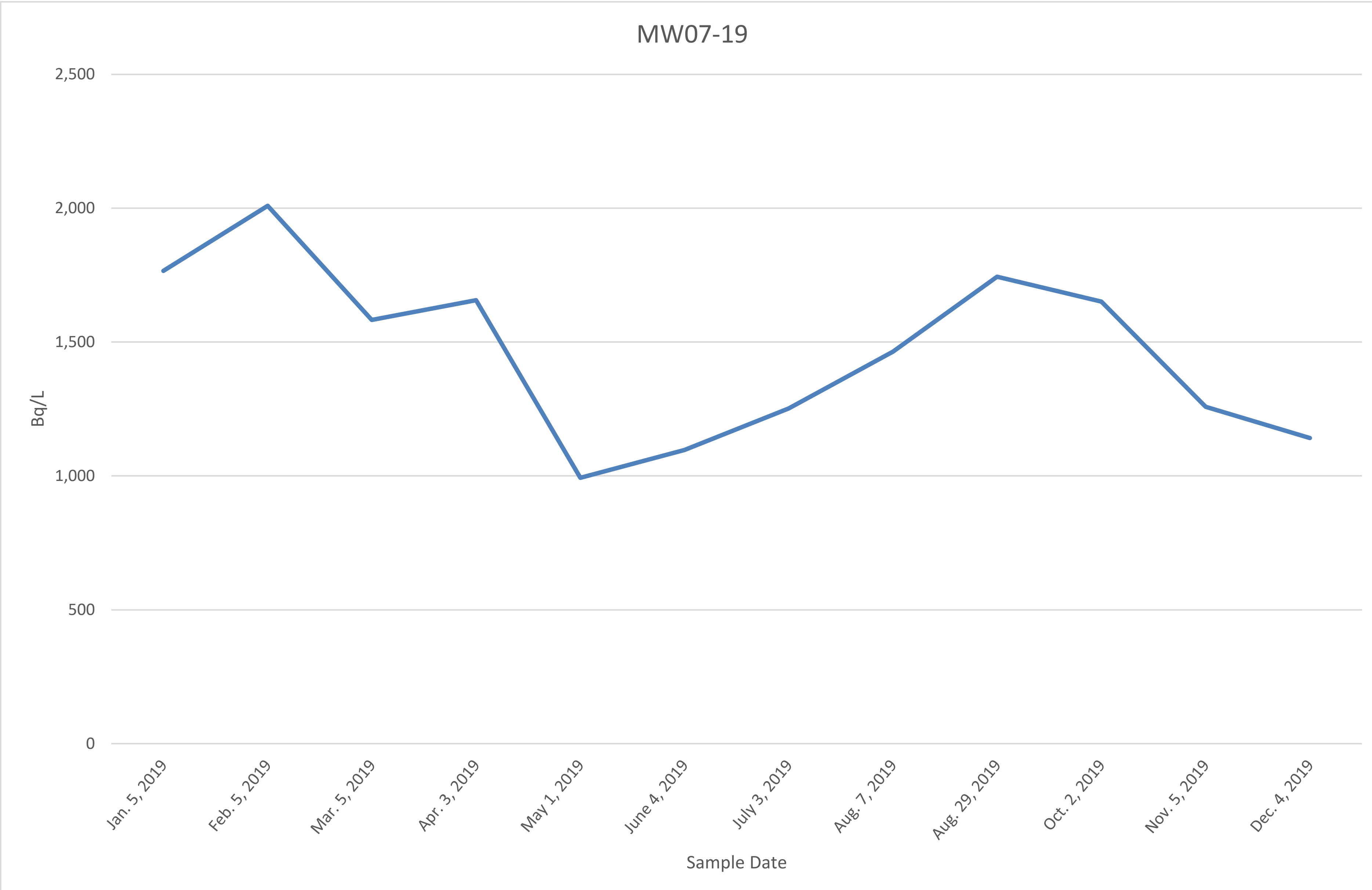
APPENDIX O


MW07-16
Bq/L
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O

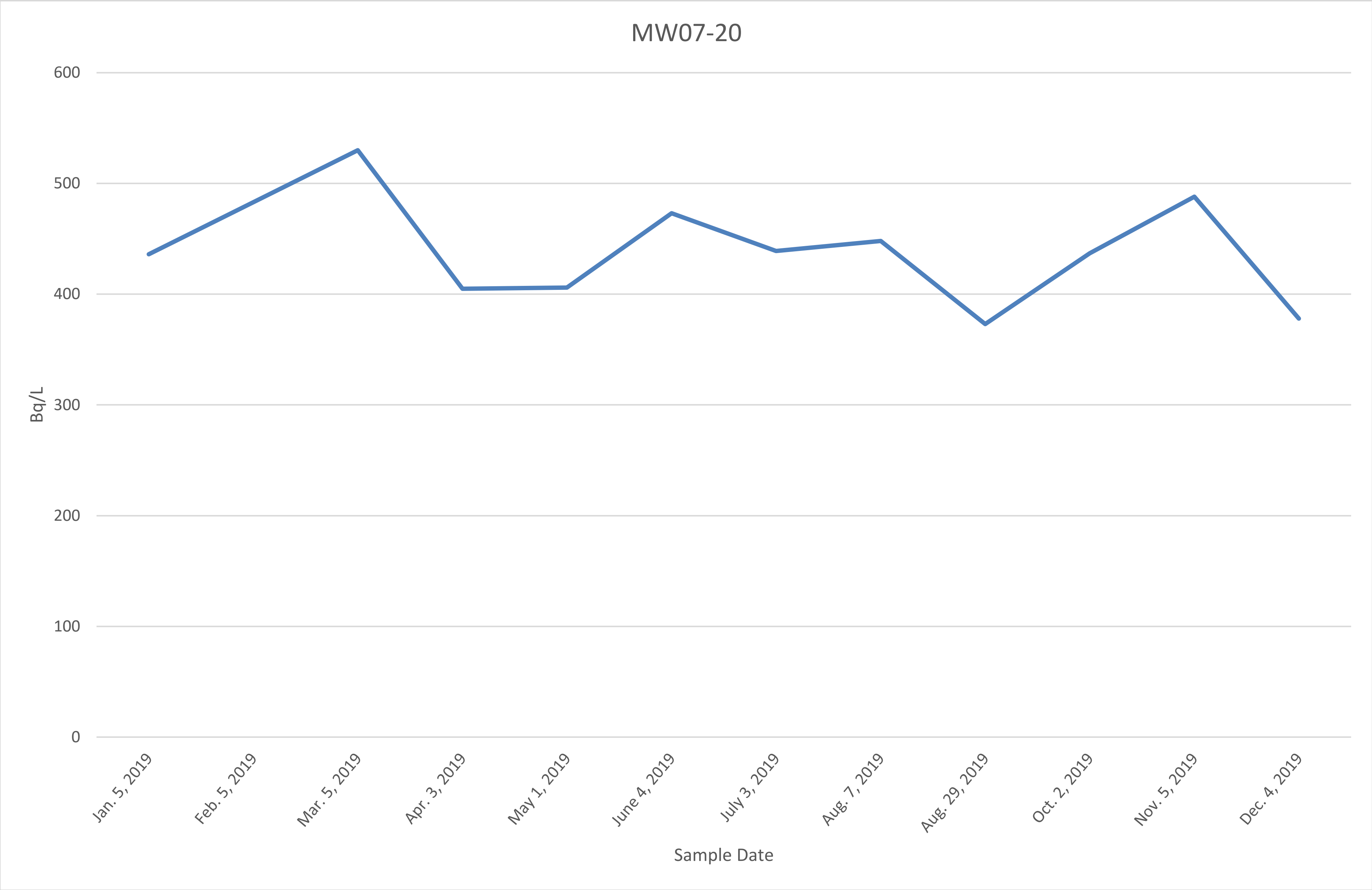

MW07-17
500
450
400
350
300
250
200
150
100
50
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date


MW07-18
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date



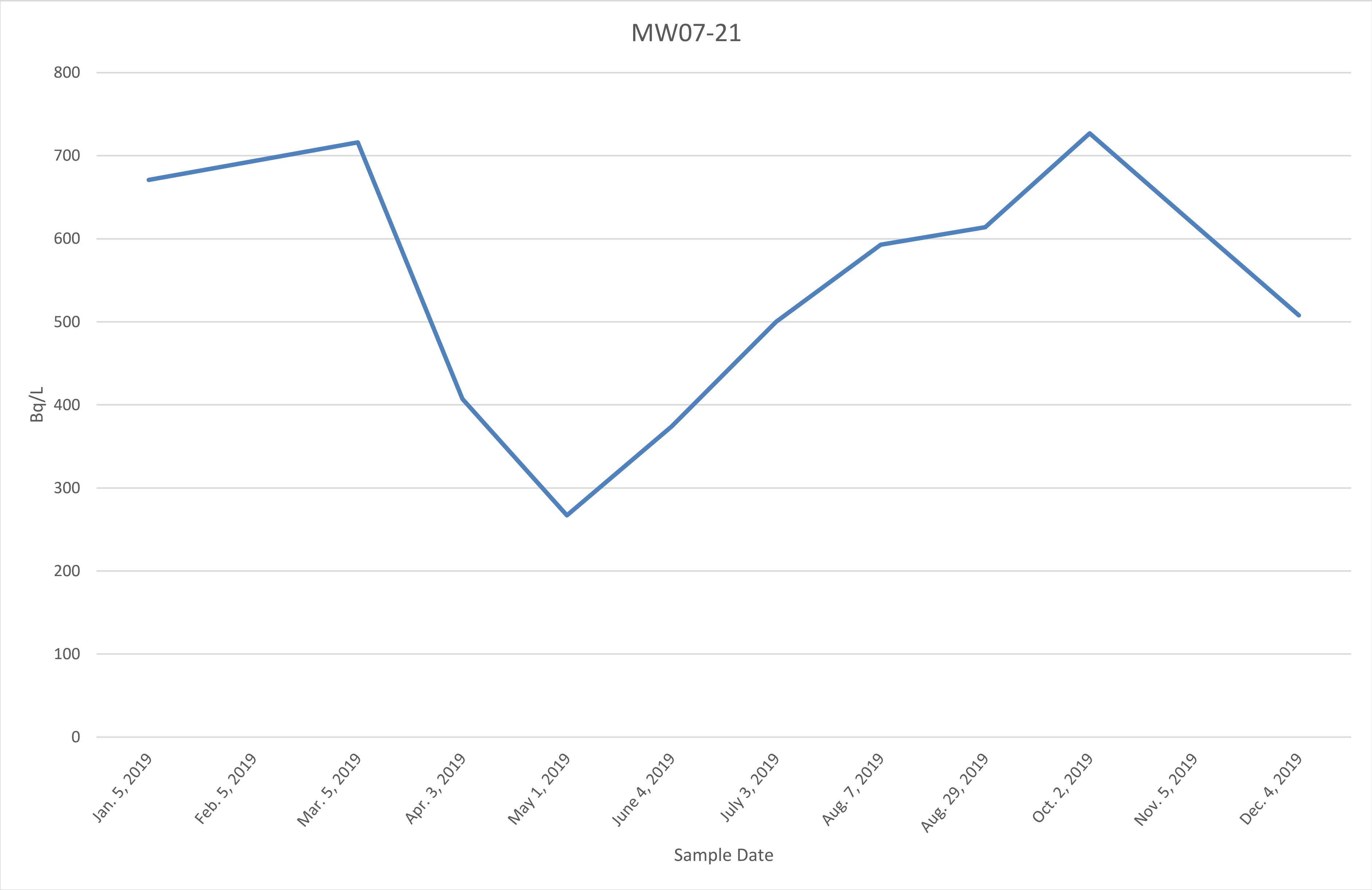
MW07-19
2,500
2,000
1,500
1,000
500
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O

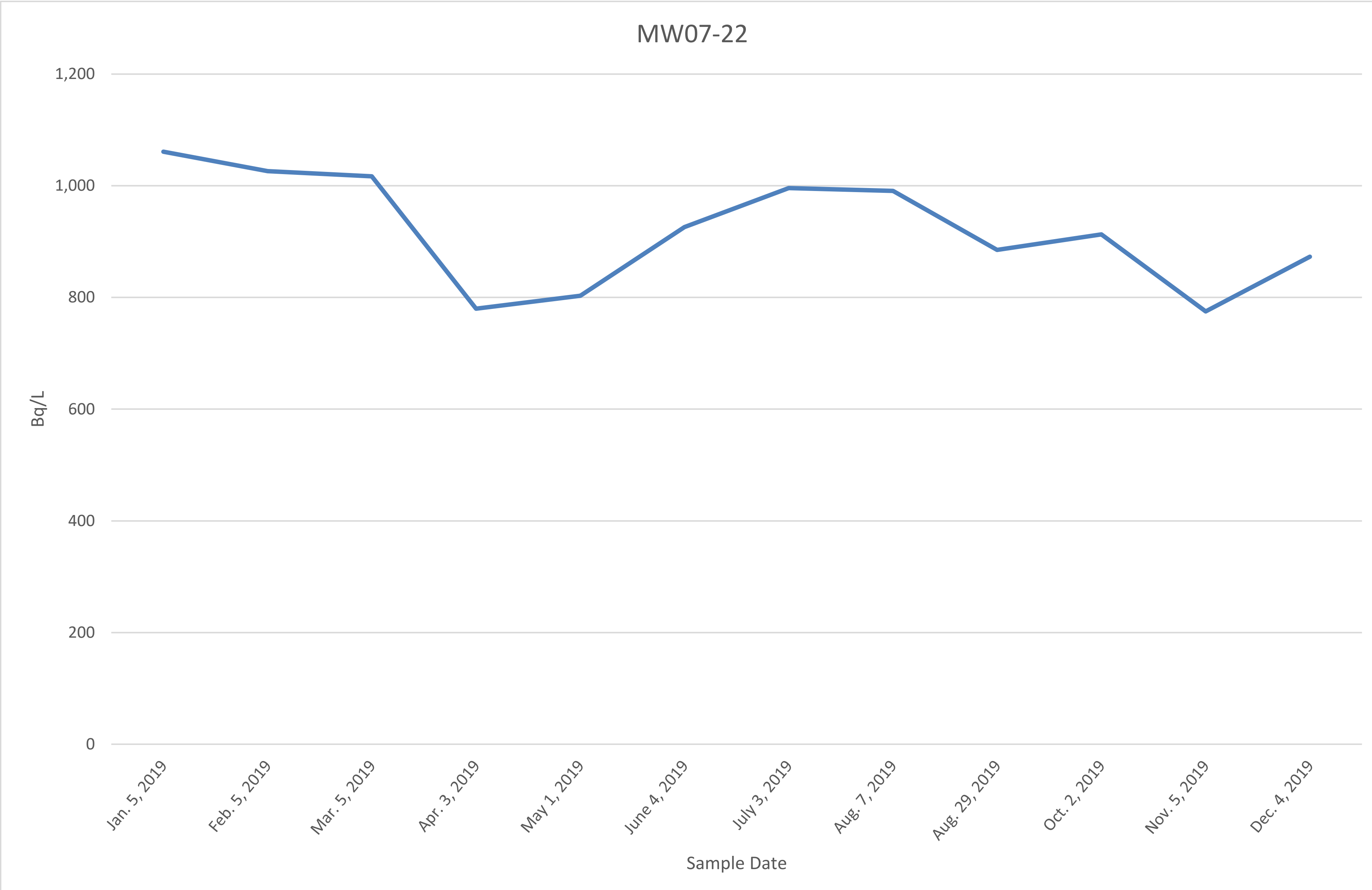


MW07-20
600
500
400
300
200
100
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

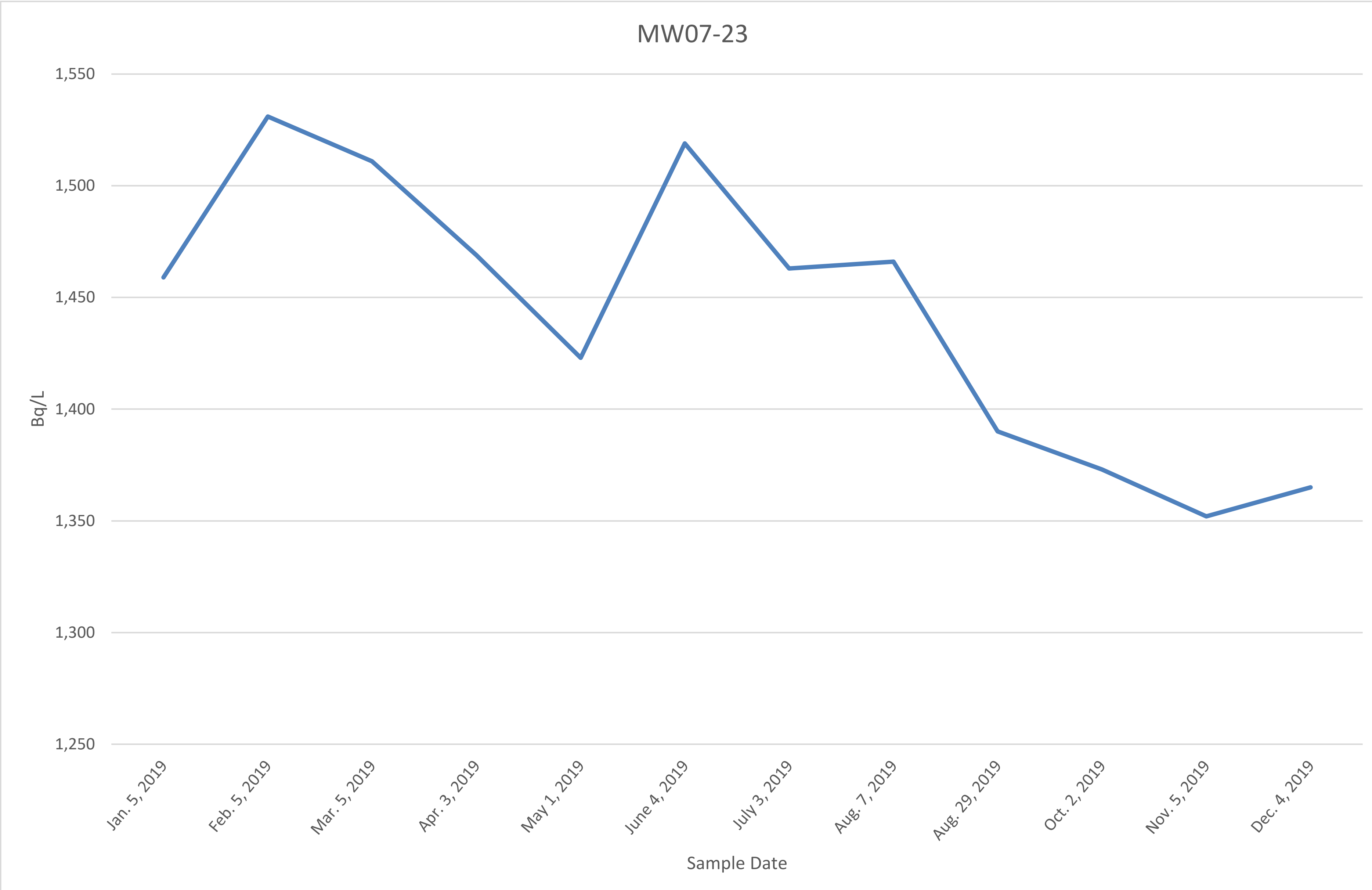
APPENDIX O


MW07-21
800
700
600
500
400
300
200
100
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

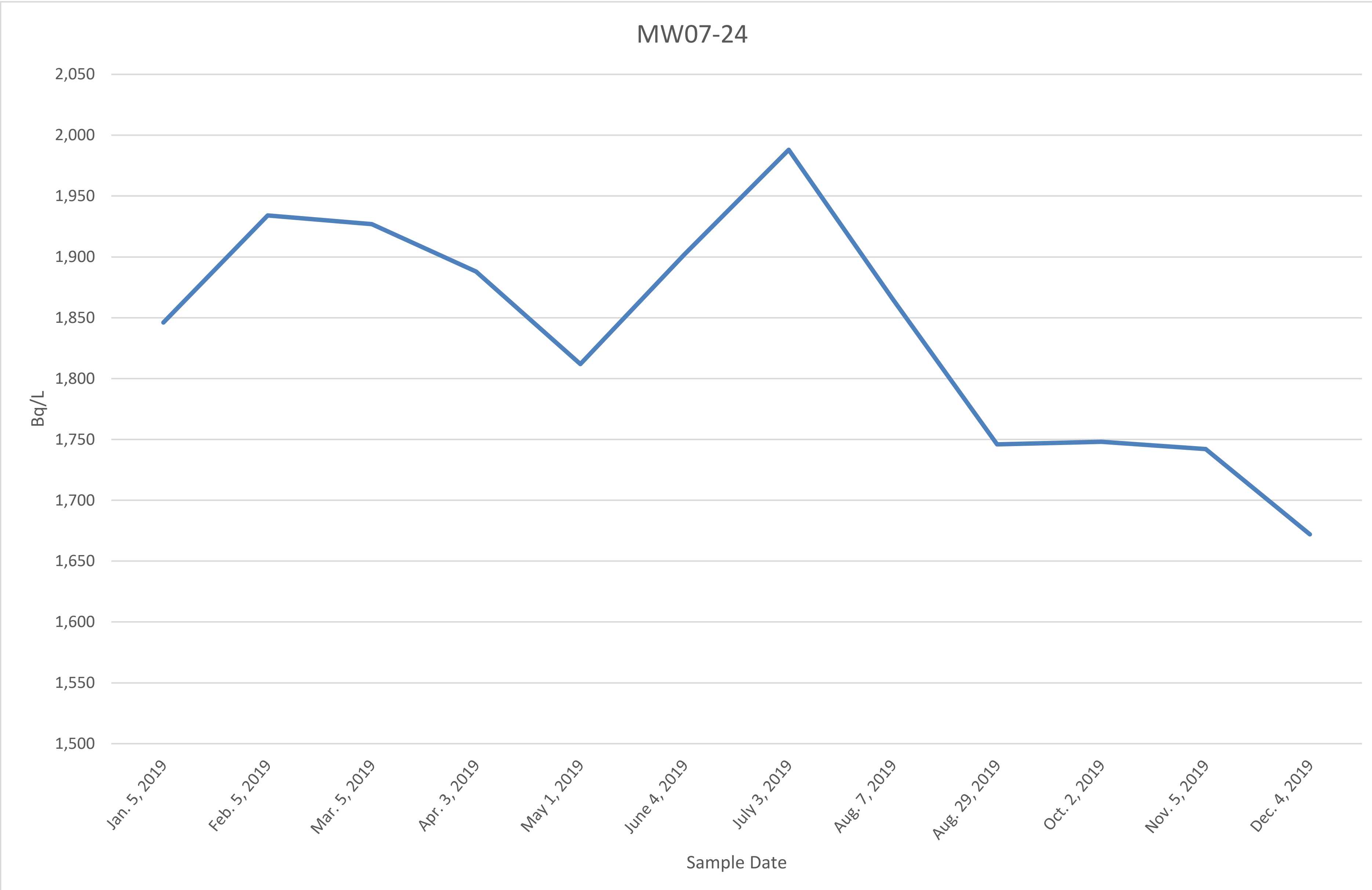
APPENDIX O

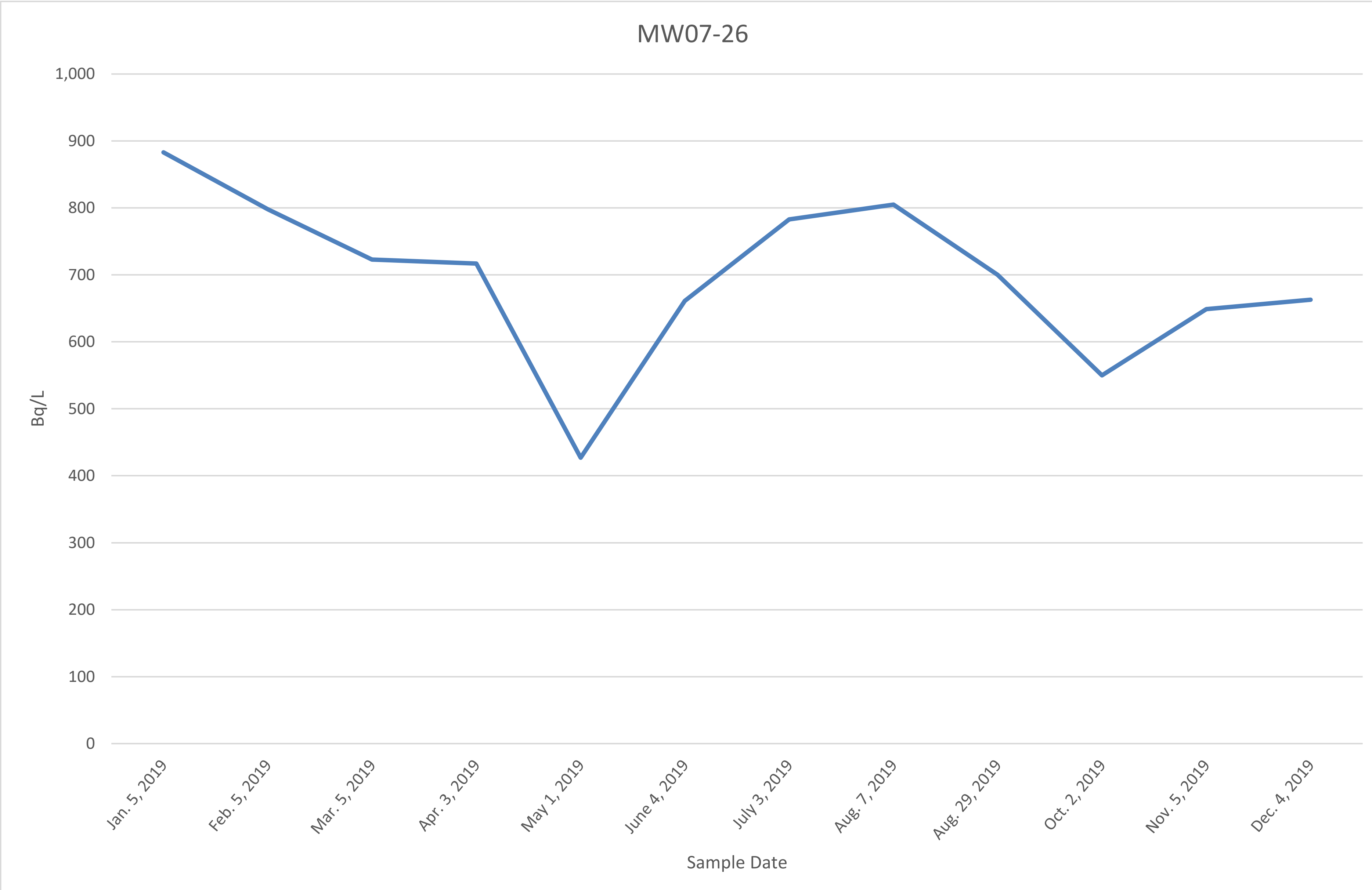

MW07-22
1,200
1,000
800
600
400
200
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O


MW07-23
1,550
1,500
1,450
1,400
1,350
1,300
1,250
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

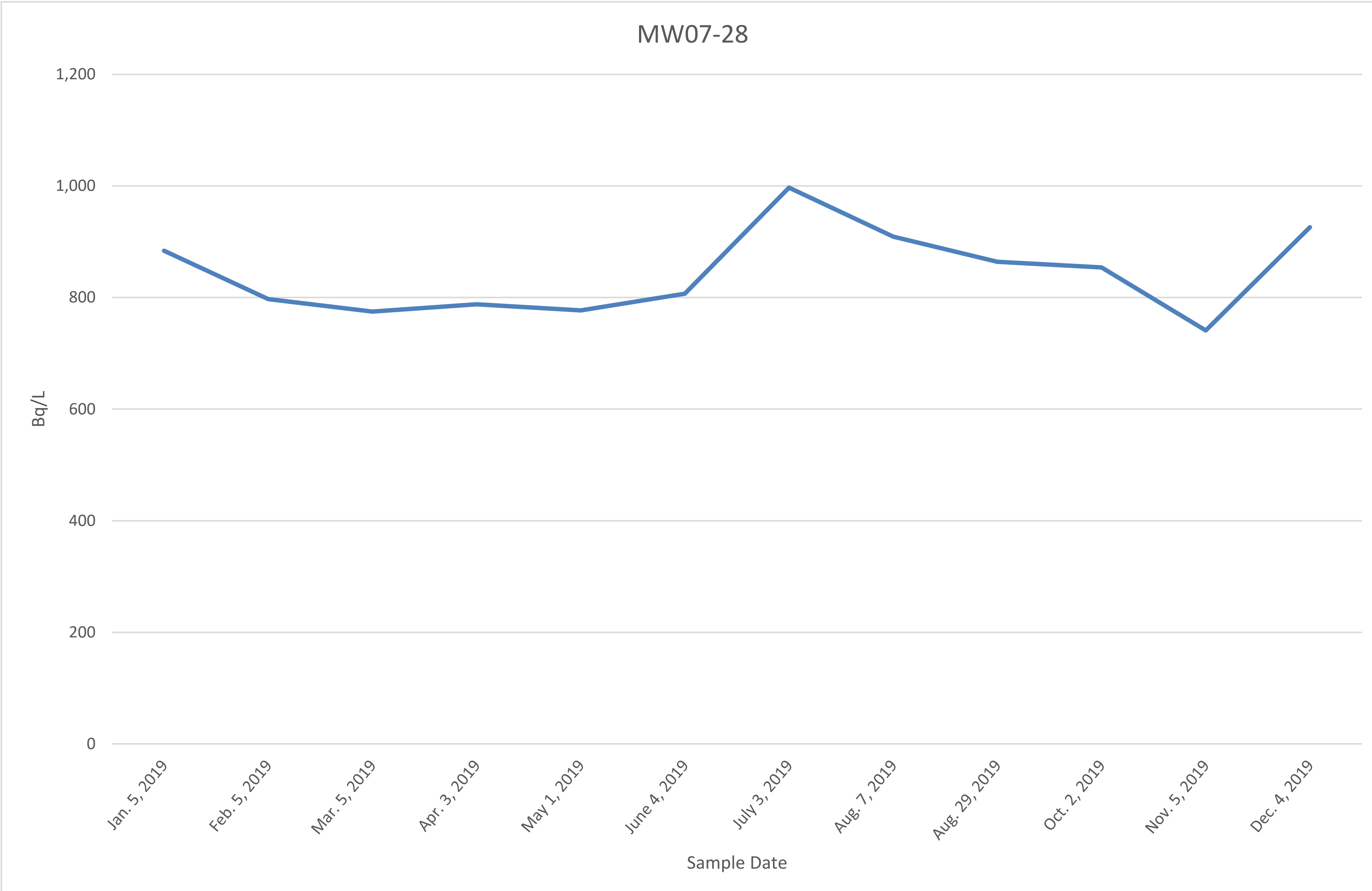
APPENDIX O


MW07-24
2,050
2,000
1,950
1,900
1,850
1,800
1,750
1,700
1,650
1,600
1,550
1,500
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date



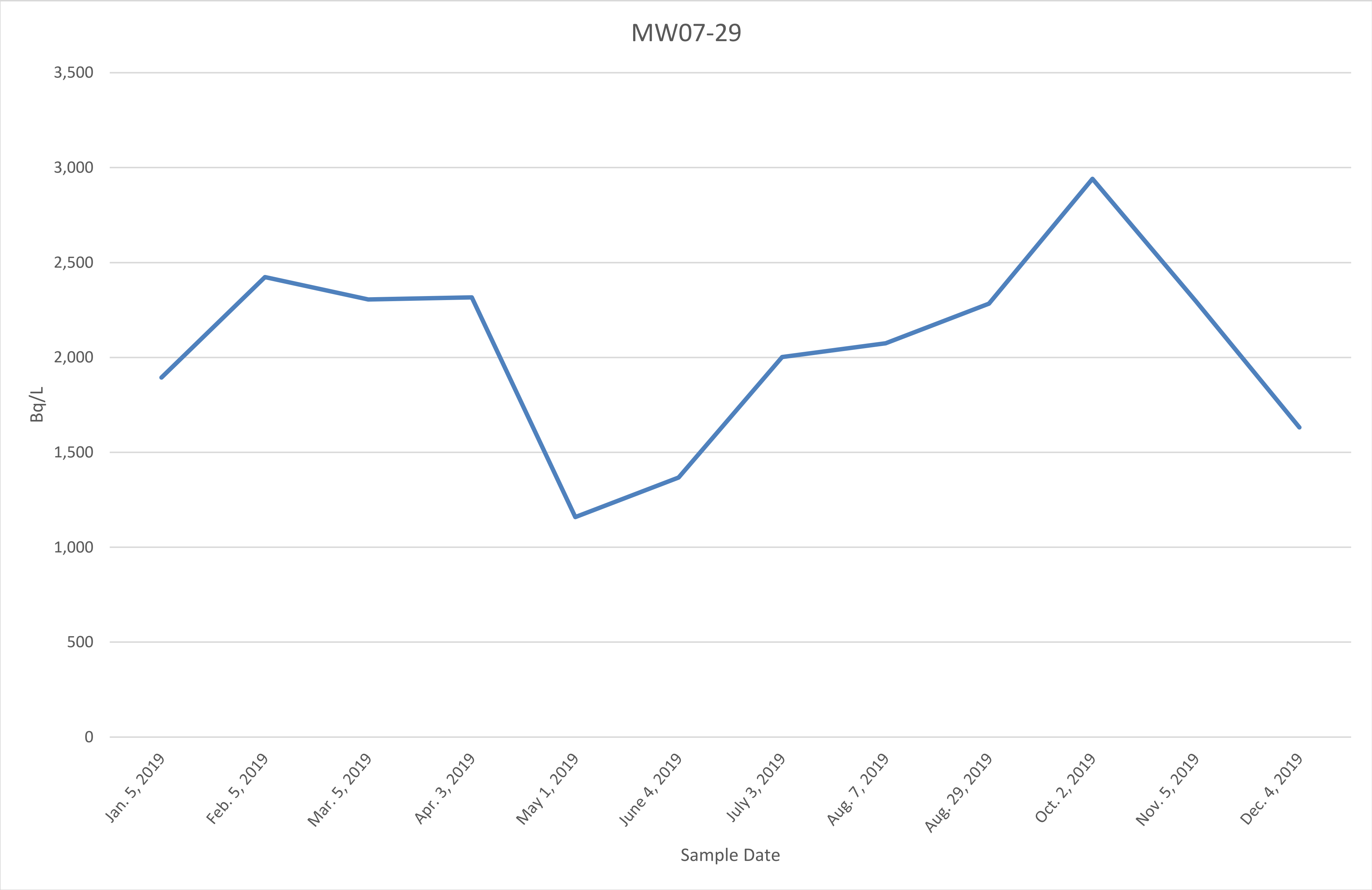
MW07-26
Bq/L
1,000
900
800
700
600
500
400
300
200
100
0
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O

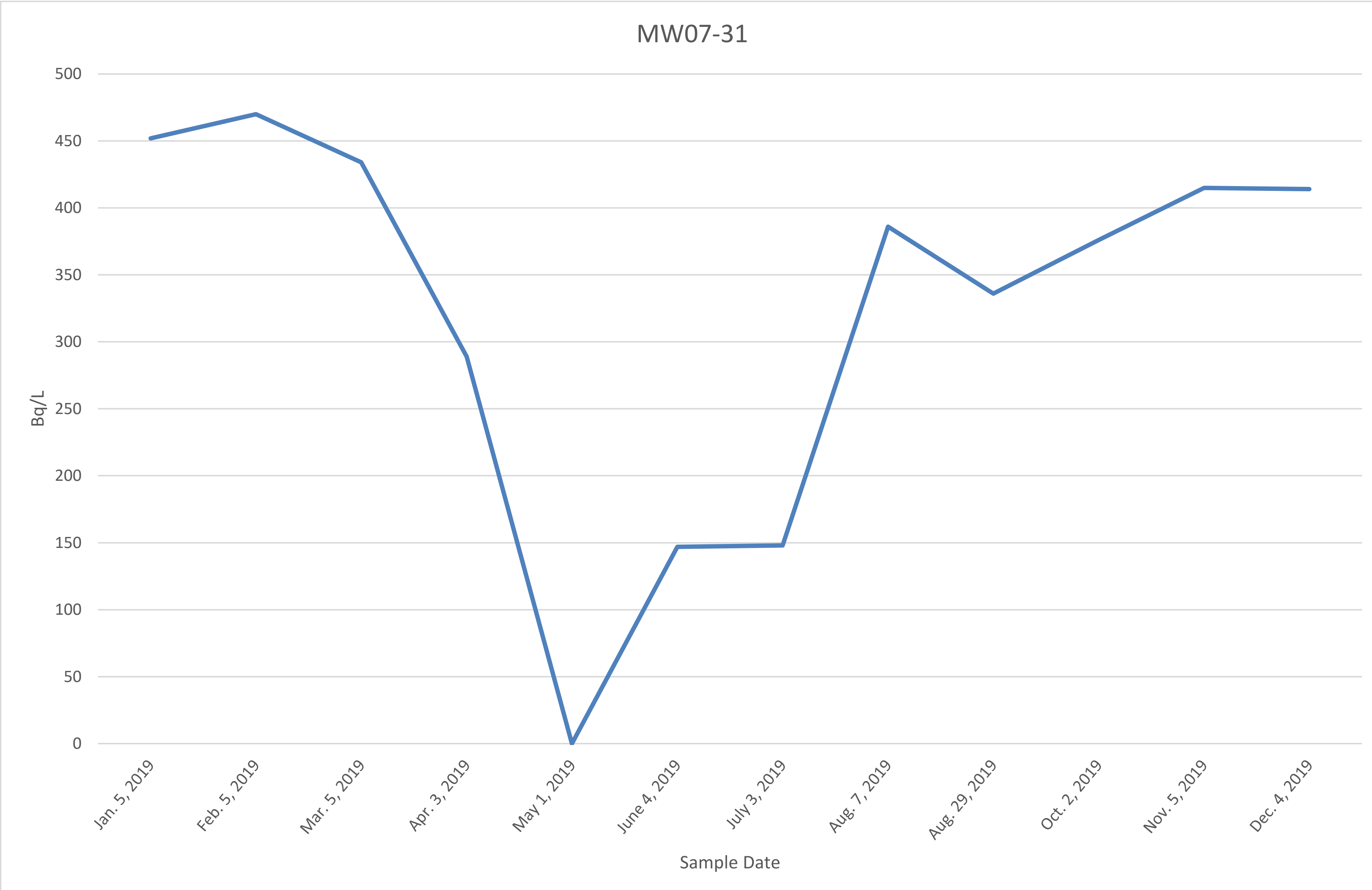


MW07-28
1,200
1,000
800
600
400
200
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O

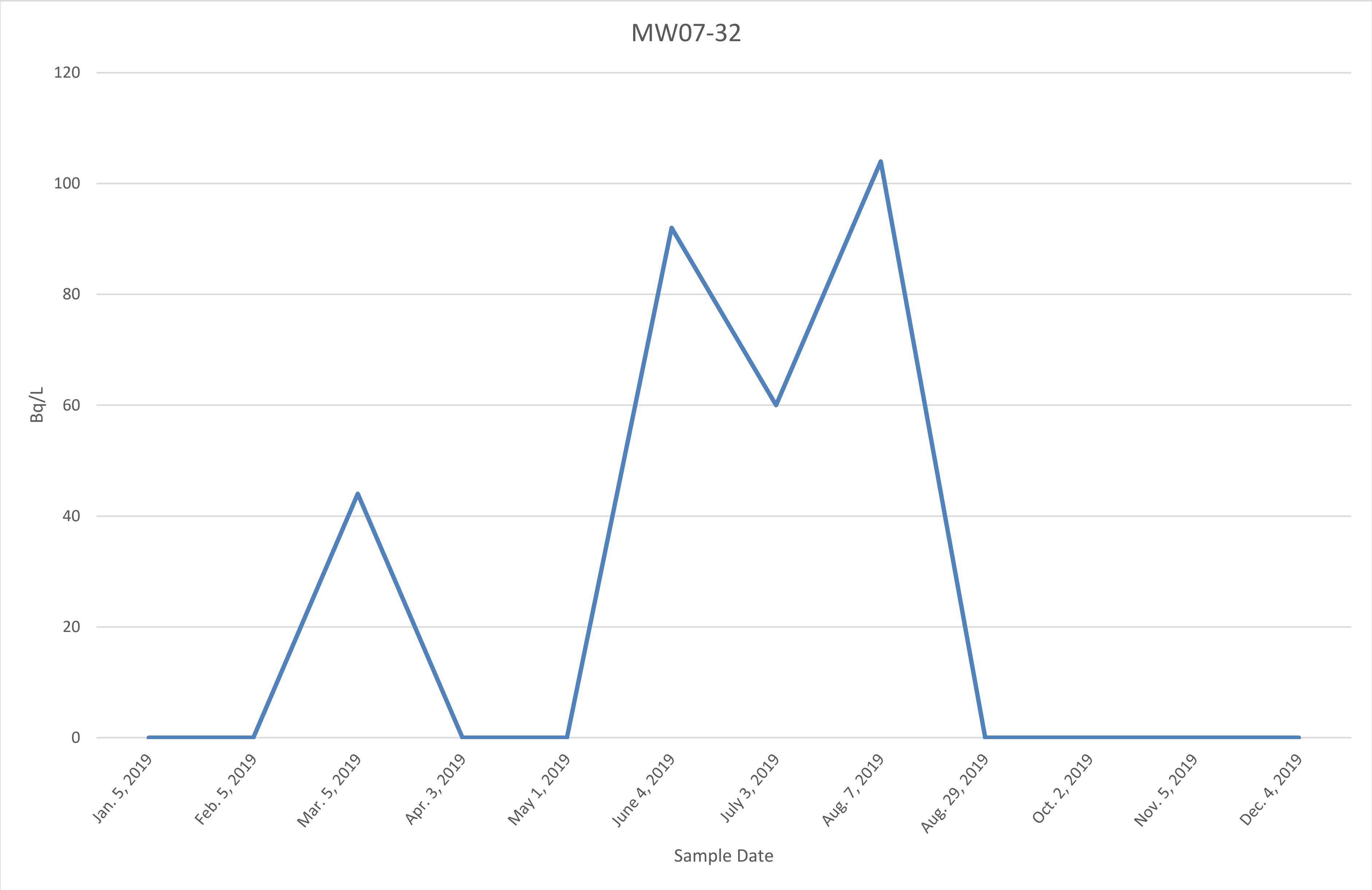

MW07-29
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O



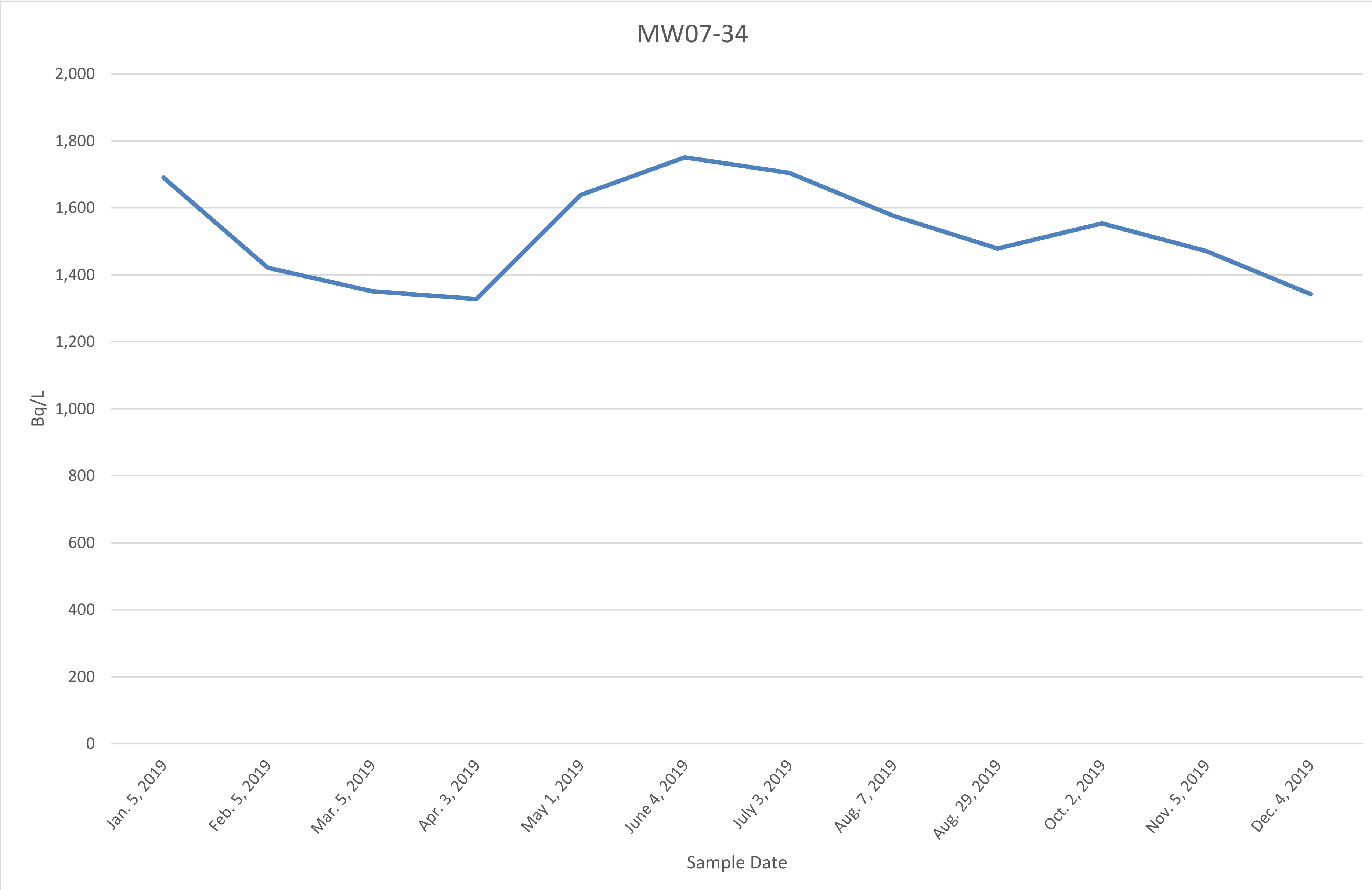
MW07-31
Bq/L
500
450
400
350
300
250
200
150
100
50
0
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O

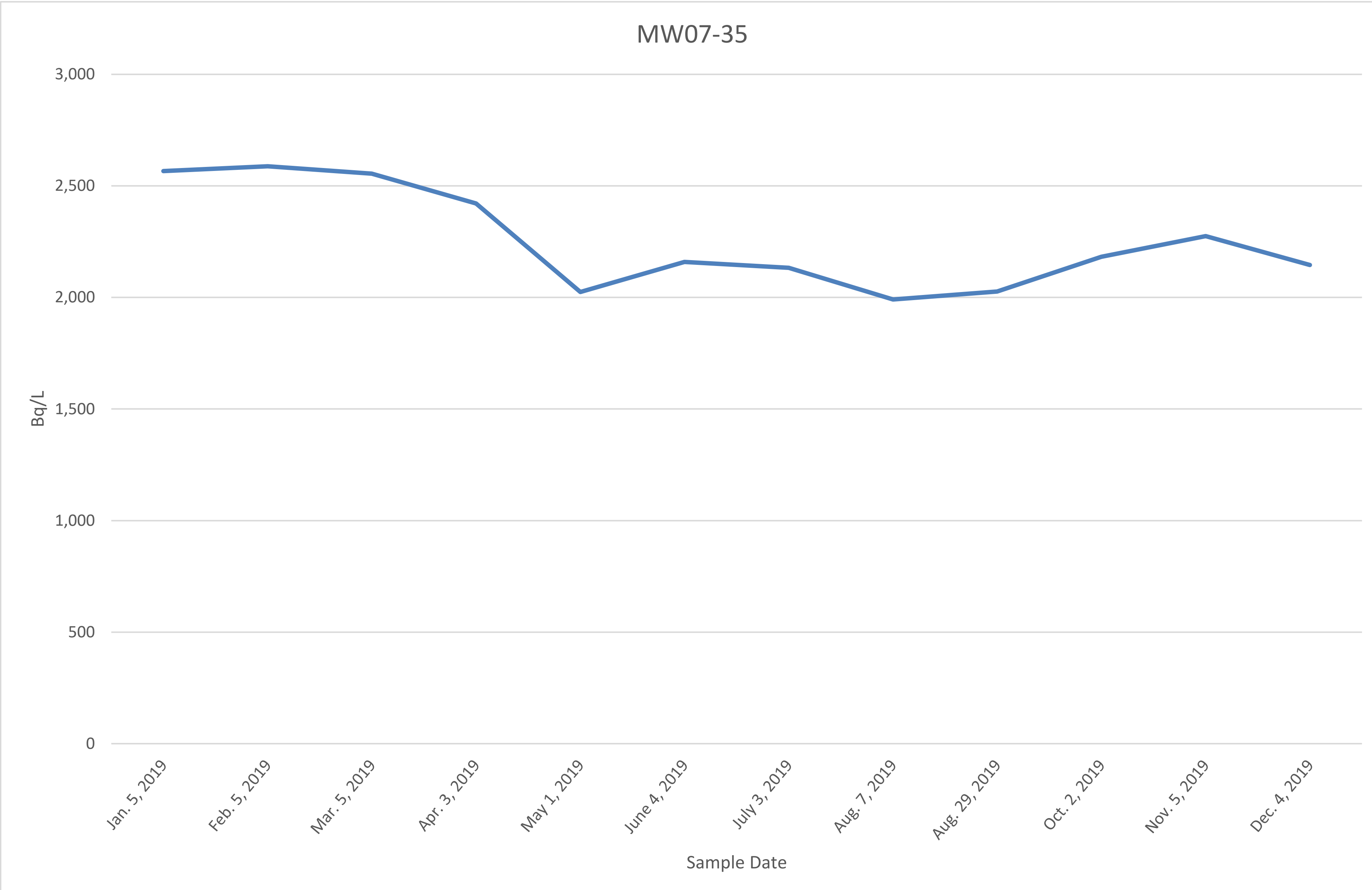


MW07-32
120
100
80
60
40
20
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O

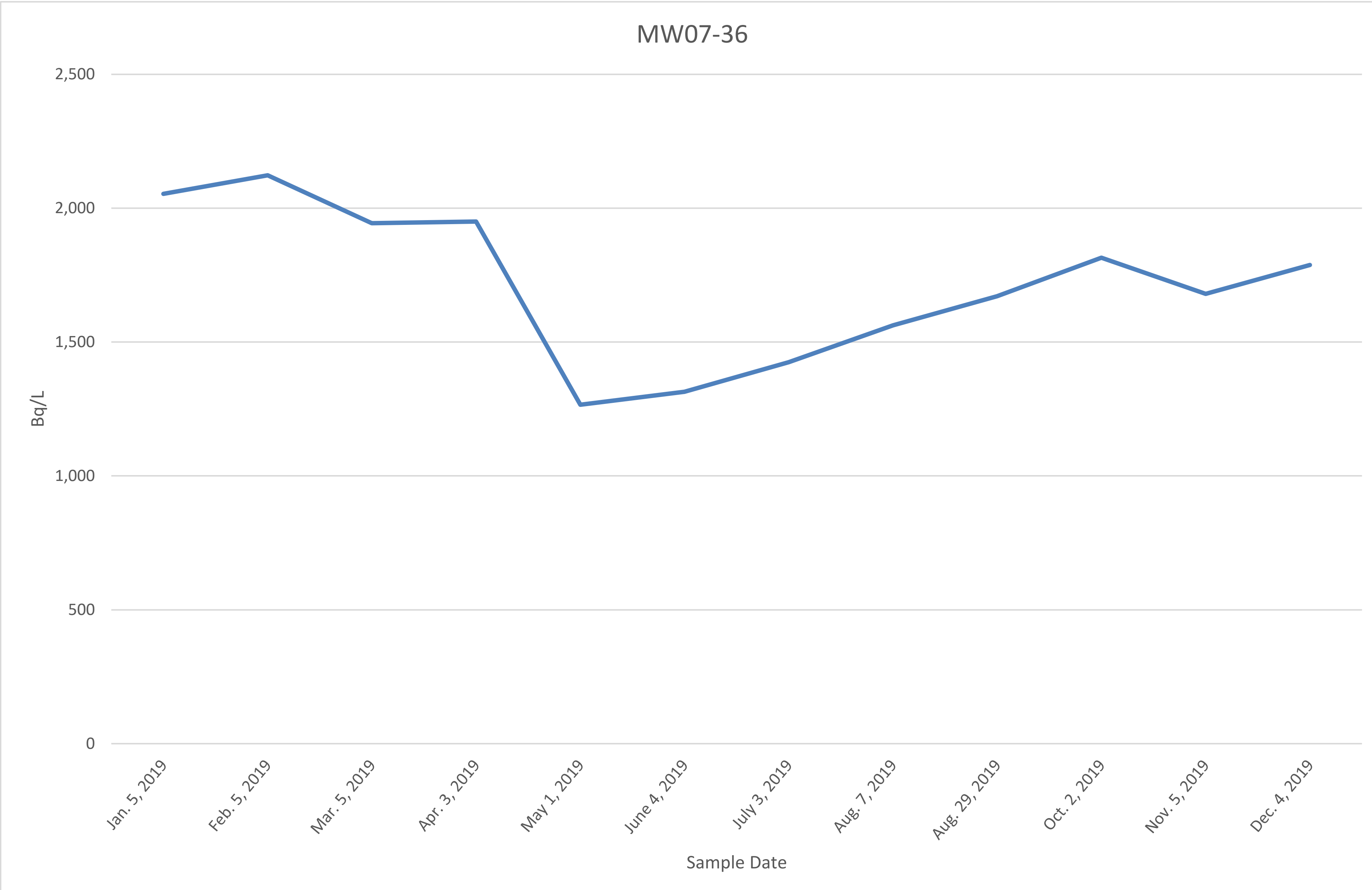

MW07-34
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O



MW07-35
3,000
2,500
2,000
1,500
1,000
500
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

APPENDIX O


MW07-36
2,500
2,000
1,500
1,000
500
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

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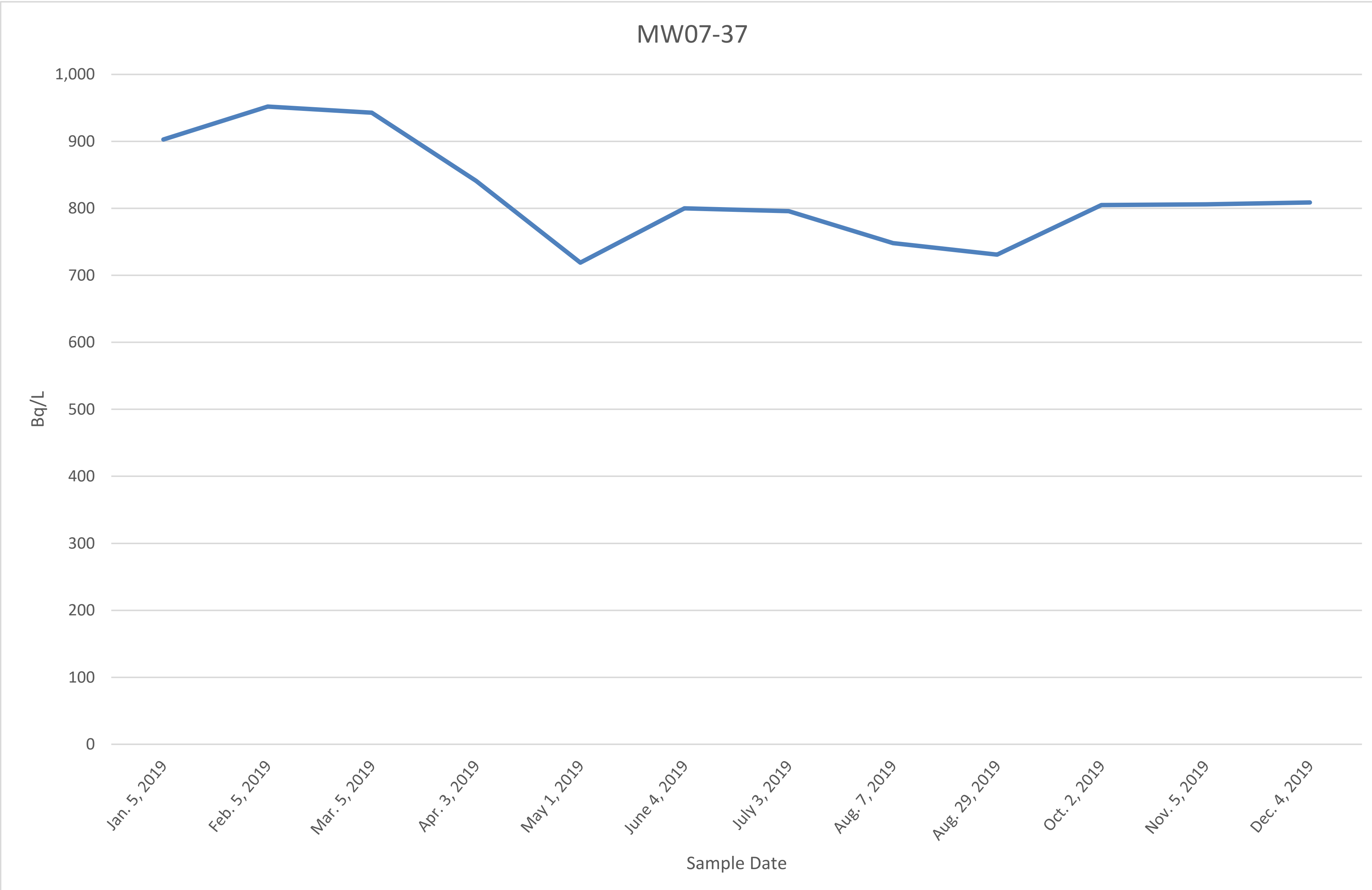


MW07-37
1,000
900
800
700
600
500
400
300
200
100
0
Bq/L
Jan. 5, 2019
Feb. 5, 2019
Mar. 5, 2019
Apr. 3, 2019
May 1, 2019
June 4, 2019
July 3, 2019
Aug. 7, 2019
Aug. 29, 2019
Oct. 2, 2019
Nov. 5, 2019
Dec. 4, 2019
Sample Date

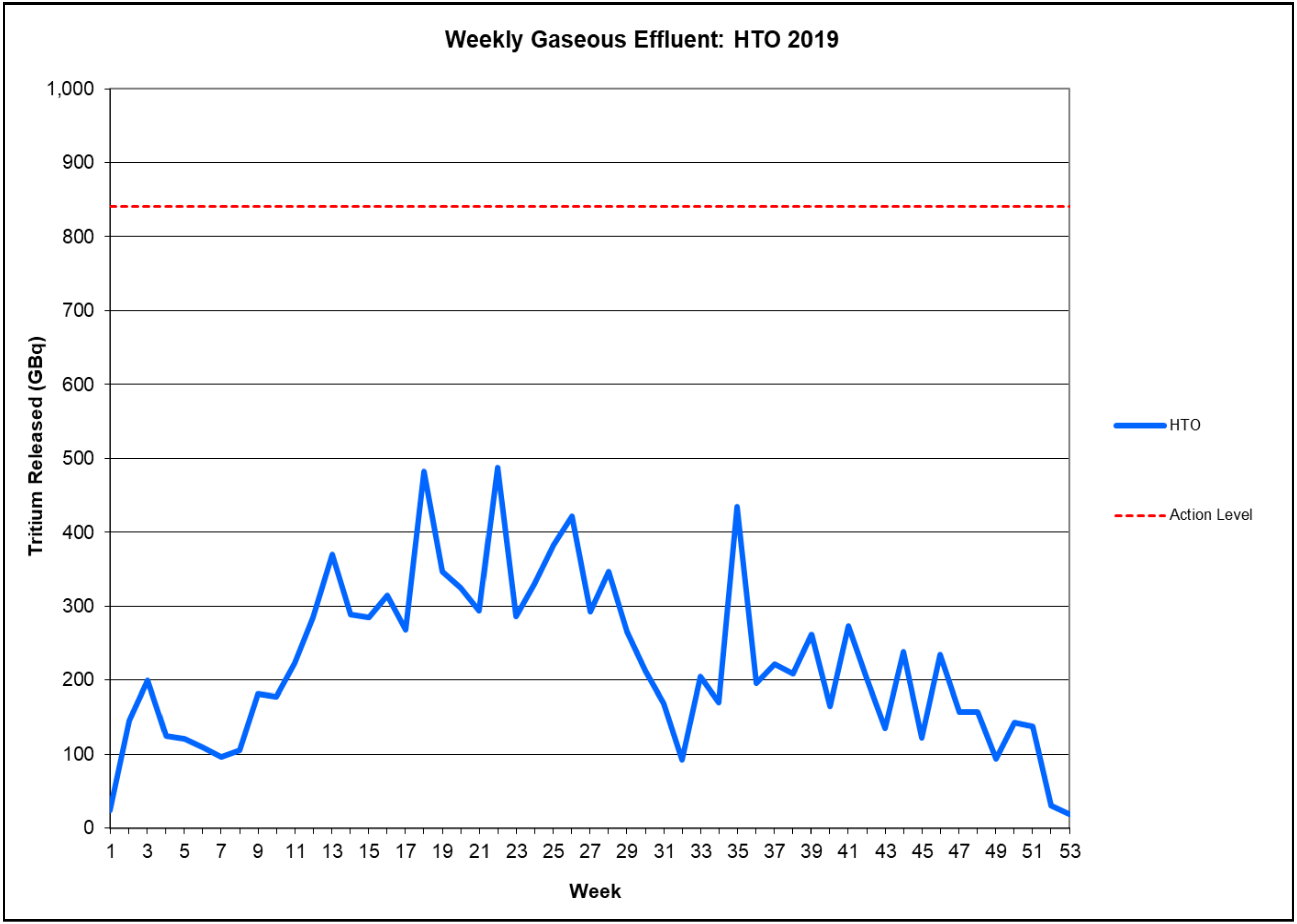
APPENDIX O

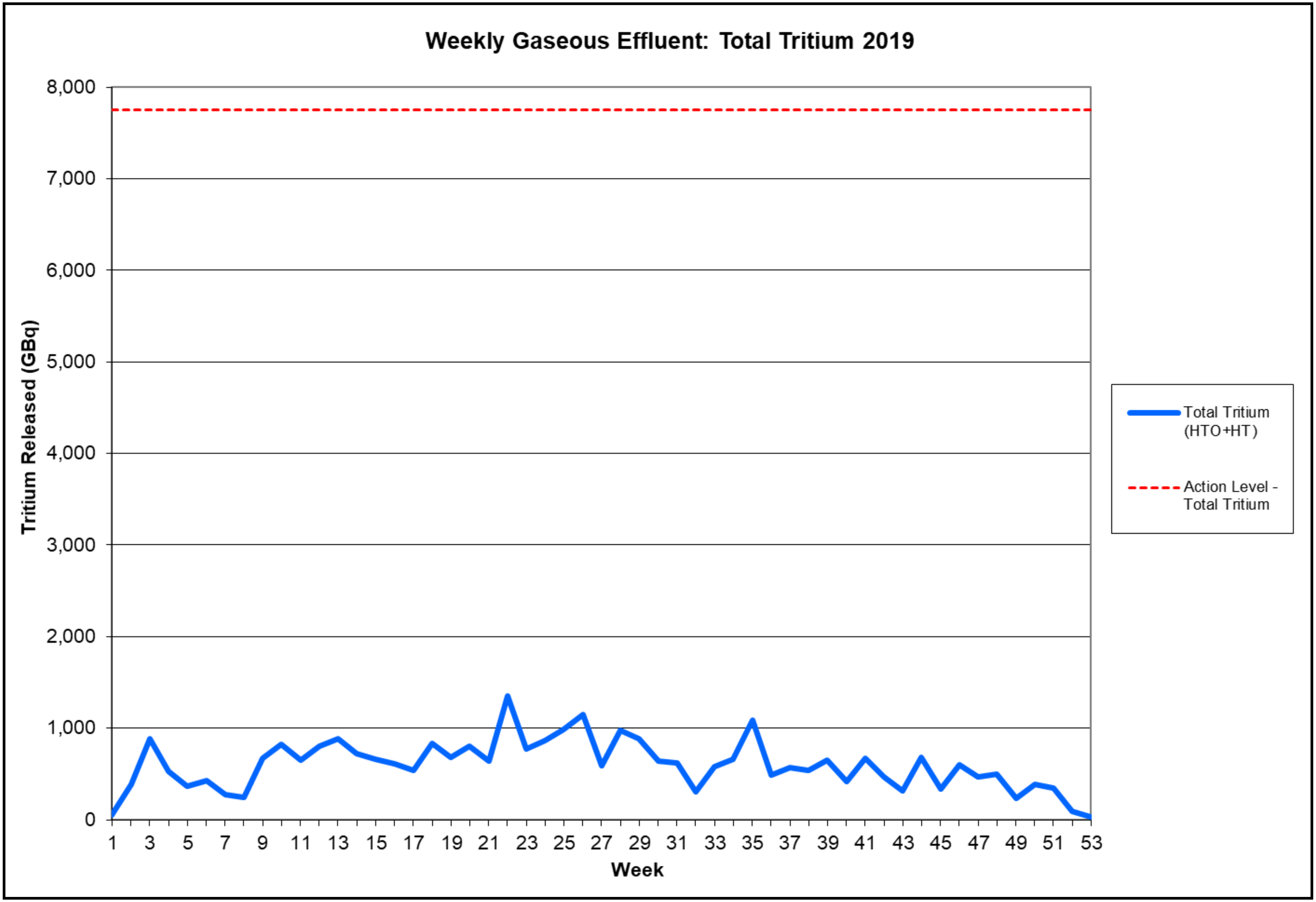
APPENDIX P

Gaseous Effluent Data for 2019

2019 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	2018-12-25	2019-01-01	23.90	27.93	51.83	23.90	51.83	0.01	0.01	0.01	0.02	3%	1%
2	2019-01-01	2019-01-08	145.49	236.14	381.63	169.39	433.46	0.07	0.08	0.07	0.09	17%	5%
3	2019-01-08	2019-01-15	199.12	686.97	886.09	368.51	1319.55	0.10	0.12	0.11	0.13	24%	11%
4	2019-01-15	2019-01-22	124.54	408.73	533.27	493.05	1852.82	0.06	0.07	0.07	0.08	15%	7%
5	2019-01-22	2019-01-29	121.37	245.29	366.66	614.42	2219.48	0.06	0.07	0.06	0.08	14%	5%
6	2019-01-29	2019-02-05	108.97	315.40	424.37	723.39	2643.85	0.05	0.06	0.06	0.07	13%	5%
7	2019-02-05	2019-02-12	96.54	176.20	272.74	819.93	2916.59	0.05	0.05	0.05	0.06	11%	4%
8	2019-02-12	2019-02-19	105.30	141.35	246.65	925.23	3163.24	0.05	0.06	0.05	0.07	13%	3%
9	2019-02-19	2019-02-26	180.99	489.18	670.17	1106.22	3833.41	0.09	0.10	0.10	0.12	22%	9%
10	2019-02-26	2019-03-05	178.02	647.31	825.33	1284.24	4658.74	0.09	0.11	0.10	0.12	21%	11%
11	2019-03-05	2019-03-12	222.88	427.93	650.81	1507.12	5309.55	0.11	0.13	0.11	0.14	27%	8%
12	2019-03-12	2019-03-19	284.19	518.82	803.01	1791.31	6112.56	0.14	0.16	0.15	0.18	34%	10%
13	2019-03-19	2019-03-26	369.91	518.89	888.80	2161.22	7001.36	0.17	0.21	0.19	0.24	44%	11%
14	2019-03-26	2019-04-02	288.87	436.72	725.59	2450.09	7726.95	0.14	0.16	0.15	0.18	34%	9%
15	2019-04-02	2019-04-09	285.19	376.50	661.69	2735.28	8388.64	0.13	0.16	0.14	0.18	34%	9%
16	2019-04-09	2019-04-16	314.42	297.60	612.02	3049.70	9000.66	0.15	0.17	0.16	0.20	37%	8%
17	2019-04-16	2019-04-23	267.85	269.24	537.09	3317.55	9537.75	0.12	0.15	0.13	0.17	32%	7%
18	2019-04-23	2019-04-30	482.06	354.19	836.25	3799.61	10374.00	0.22	0.26	0.24	0.30	57%	11%
19	2019-04-30	2019-05-07	346.10	333.60	679.70	4145.71	11053.70	0.16	0.19	0.17	0.22	41%	9%
20	2019-05-07	2019-05-14	325.34	479.54	804.88	4471.05	11858.58	0.15	0.18	0.17	0.21	39%	10%
21	2019-05-14	2019-05-21	294.40	348.96	643.36	4765.45	12501.94	0.14	0.16	0.15	0.19	35%	8%
22	2019-05-21	2019-05-28	487.71	863.09	1350.80	5253.16	13852.74	0.23	0.27	0.25	0.31	58%	17%
23	2019-05-28	2019-06-04	286.54	484.40	770.94	5539.70	14623.68	0.14	0.16	0.15	0.18	34%	10%
24	2019-06-04	2019-06-11	330.17	535.85	866.02	5869.87	15489.70	0.16	0.19	0.17	0.21	39%	11%
25	2019-06-11	2019-06-18	382.54	604.98	987.52	6252.41	16477.22	0.18	0.21	0.19	0.25	46%	13%
26	2019-06-18	2019-06-25	421.13	725.03	1146.16	6673.54	17623.38	0.20	0.24	0.22	0.27	50%	15%
27	2019-06-25	2019-07-02	293.11	300.67	593.78	6966.65	18217.16	0.14	0.16	0.15	0.19	35%	8%
28	2019-07-02	2019-07-09	347.15	633.37	980.52	7313.80	19197.68	0.16	0.20	0.18	0.22	41%	13%
29	2019-07-09	2019-07-16	265.22	615.59	880.81	7579.02	20078.49	0.13	0.15	0.14	0.17	32%	11%
30	2019-07-16	2019-07-23	212.76	425.79	638.55	7791.78	20717.04	0.10	0.12	0.11	0.14	25%	8%
31	2019-07-23	2019-07-30	168.63	449.34	617.97	7960.41	21335.01	0.08	0.10	0.09	0.11	20%	8%
32	2019-07-30	2019-08-06	92.98	211.45	304.43	8053.39	21639.44	0.04	0.05	0.05	0.06	11%	4%
33	2019-08-06	2019-08-13	205.16	377.94	583.10	8258.55	22222.54	0.10	0.12	0.11	0.13	24%	8%
34	2019-08-13	2019-08-20	170.43	488.34	658.77	8428.98	22881.31	0.08	0.10	0.09	0.11	20%	8%
35	2019-08-20	2019-08-27	434.09	650.24	1084.33	8863.07	23965.64	0.20	0.24	0.22	0.28	52%	14%
36	2019-08-27	2019-09-03	195.52	295.64	491.16	9058.59	24456.80	0.09	0.11	0.10	0.13	23%	6%
37	2019-09-03	2019-09-10	222.09	342.52	564.61	9280.68	25021.41	0.10	0.12	0.11	0.14	26%	7%
38	2019-09-10	2019-09-17	208.65	330.35	539.00	9489.33	25560.41	0.10	0.12	0.11	0.13	25%	7%
39	2019-09-17	2019-09-24	261.06	394.26	655.32	9750.39	26215.73	0.12	0.15	0.13	0.17	31%	8%
40	2019-09-24	2019-10-01	164.28	254.09	418.37	9914.67	26634.10	0.08	0.09	0.08	0.11	20%	5%
41	2019-10-01	2019-10-08	273.60	400.58	674.18	10188.27	27308.28	0.13	0.15	0.14	0.17	33%	9%
42	2019-10-08	2019-10-15	201.72	265.89	467.61	10389.99	27775.89	0.09	0.11	0.10	0.13	24%	6%
43	2019-10-15	2019-10-22	134.39	184.33	318.72	10524.38	28094.61	0.06	0.07	0.07	0.09	16%	4%
44	2019-10-22	2019-10-29	238.33	444.47	682.80	10762.71	28777.41	0.11	0.13	0.12	0.15	28%	9%
45	2019-10-29	2019-11-05	122.59	212.77	335.36	10885.30	29112.77	0.06	0.07	0.06	0.08	15%	4%
46	2019-11-05	2019-11-12	234.42	369.74	604.16	11119.72	29716.93	0.11	0.13	0.12	0.15	28%	8%
47	2019-11-12	2019-11-19	157.23	307.84	465.07	11276.95	30182.00	0.08	0.09	0.08	0.10	19%	6%
48	2019-11-19	2019-11-26	157.19	341.72	498.91	11434.14	30680.91	0.08	0.09	0.08	0.10	19%	6%
49	2019-11-26	2019-12-03	93.43	143.70	237.13	11527.57	30918.04	0.04	0.05	0.05	0.06	11%	3%
50	2019-12-03	2019-12-10	143.15	241.16	384.31	11670.72	31302.35	0.07	0.08	0.07	0.09	17%	5%
51	2019-12-10	2019-12-17	137.53	205.68	343.21	11808.25	31645.56	0.06	0.08	0.07	0.09	16%	4%
52	2019-12-17	2019-12-24	30.22	61.37	91.59	11838.47	31737.15	0.01	0.02	0.02	0.02	4%	1%
53	2019-12-24	2019-12-31	19.24	13.01	32.25	11857.71	31769.40	0.01	0.01	0.01	0.01	2%	0%
	Annual Total		11857.71	19911.69	31769.40			Average % DRL					
	Weekly Average		223.73	375.69	599.42			0.11	0.13	0.11	0.14		
				(Bq/a)	Release Limit			Projected Dose (uSv/a)					
% Annual Release Limit:			HTO	6.72E+13	17.65			1.06	1.26	1.14	1.44		
			HTO + HT	4.48E+14	7.09			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 P


Weekly Gaseous Effluent: HTO 2019
Tritium Released (GBq)
1,000
900
800
700
600
500
400
300
200
100
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
53
Week
HTO
Action Level



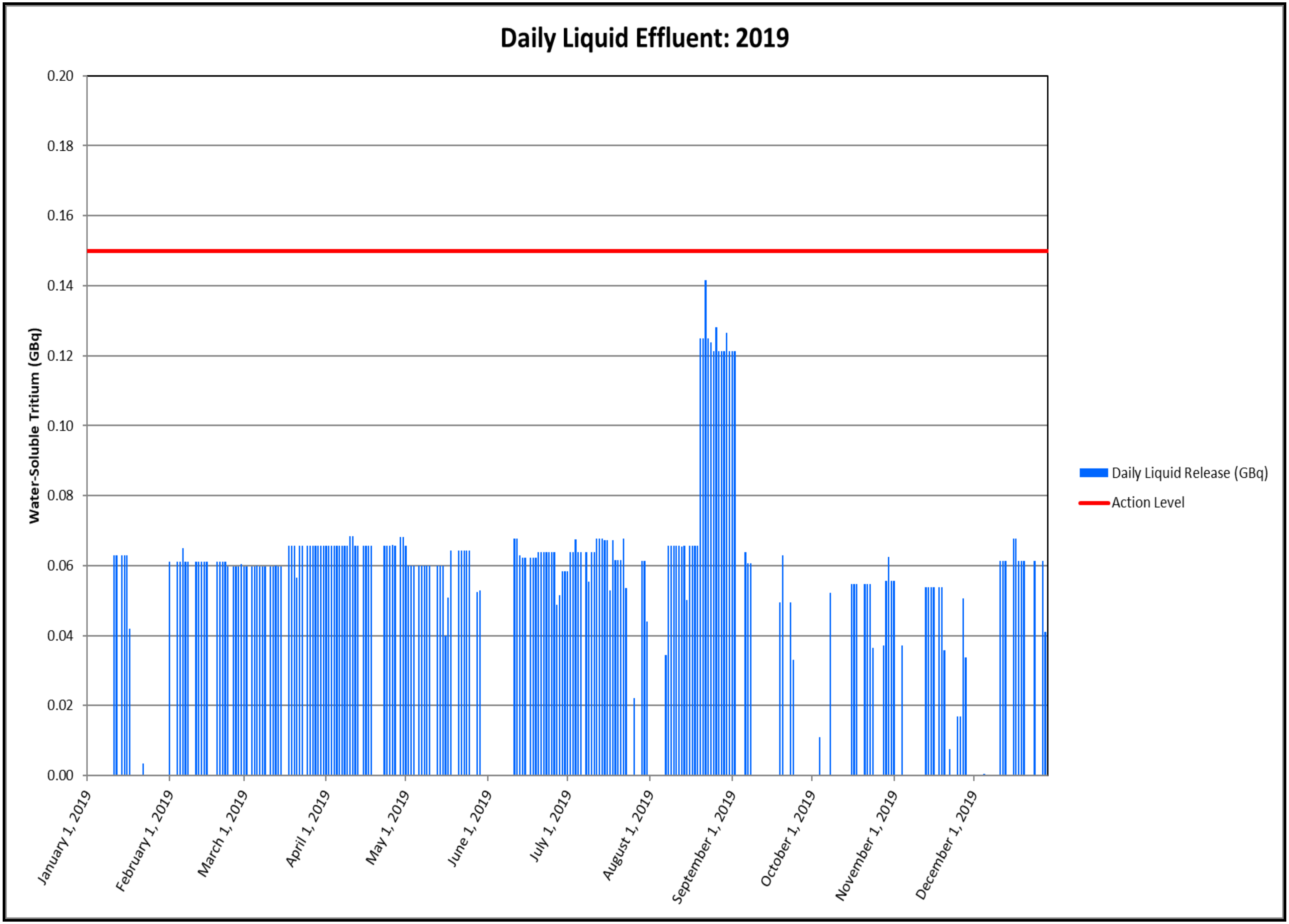
Weekly Gaseous Effluent: Total Tritium 2019
Tritium Released (GBq)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
49
51
53
Week
Total Tritium (HTO+HT)
Action Level - Total Tritium

APPENDIX Q

Liquid Effluent Data for 2019

ANNUAL LIQUID EFFLUENT TRACKING TABLE			
Year = 2019			
WEEK ENDING	WEEKLY RELEASE (Bq)	WEEK	ANNUAL LICENCE LIMIT
			200,000,000,000
6-Jan-19	0	1	200,000,000,000
13-Jan-19	125,906,583	2	199,874,093,417
20-Jan-19	230,432,400	3	199,643,661,017
27-Jan-19	3,357,867	4	199,640,303,150
3-Feb-19	61,185,123	5	199,579,118,027
10-Feb-19	309,729,074	6	199,269,388,953
17-Feb-19	305,925,615	7	198,963,463,338
24-Feb-19	304,507,416	8	198,658,955,922
3-Mar-19	359,360,886	9	198,299,595,036
10-Mar-19	358,795,211	10	197,940,799,825
17-Mar-19	299,028,287	11	197,641,771,538
24-Mar-19	385,028,914	12	197,256,742,624
31-Mar-19	459,798,353	13	196,796,944,271
7-Apr-19	459,798,353	14	196,337,145,918
14-Apr-19	399,616,874	15	195,937,529,044
21-Apr-19	262,741,916	16	195,674,787,128
28-Apr-19	328,732,595	17	195,346,054,533
5-May-19	382,162,593	18	194,963,891,940
12-May-19	299,933,370	19	194,663,958,570
19-May-19	335,061,695	20	194,328,896,875
26-May-19	321,314,070	21	194,007,582,805
2-Jun-19	105,293,333	22	193,902,289,472
9-Jun-19	196,250	23	193,902,093,222
16-Jun-19	322,676,881	24	193,579,416,341
23-Jun-19	442,091,262	25	193,137,325,079
30-Jun-19	408,643,181	26	192,728,681,898
7-Jul-19	381,325,324	27	192,347,356,574
14-Jul-19	449,826,064	28	191,897,530,510
21-Jul-19	438,945,054	29	191,458,585,456
28-Jul-19	143,413,896	30	191,315,171,560
4-Aug-19	166,651,587	31	191,148,519,973
11-Aug-19	297,275,246	32	190,851,244,727
18-Aug-19	444,205,075	33	190,407,039,652
25-Aug-19	827,380,338	34	189,579,659,314
1-Sep-19	861,342,030	35	188,718,317,284
8-Sep-19	306,671,440	36	188,411,645,844
15-Sep-19	0	37	188,411,645,844
22-Sep-19	112,499,480	38	188,299,146,364
29-Sep-19	82,529,840	39	188,216,616,524
6-Oct-19	11,026,133	40	188,205,590,391
13-Oct-19	52,555,787	41	188,153,034,604
20-Oct-19	164,207,016	42	187,988,827,588
27-Oct-19	200,697,464	43	187,788,130,124
3-Nov-19	266,720,113	44	187,521,410,011
10-Nov-19	37,117,940	45	187,484,292,071
17-Nov-19	215,392,212	46	187,268,899,859
24-Nov-19	151,156,108	47	187,117,743,751
1-Dec-19	117,911,178	48	186,999,832,573
8-Dec-19	498,507	49	186,999,334,066
15-Dec-19	184,246,515	50	186,815,087,551
22-Dec-19	319,674,713	51	186,495,412,838
29-Dec-19	163,744,680	52	186,331,668,158
		53	186,331,668,158
Annual Total (Bq)	13,668,331,842		
Annual Total (GBq)	13.67		
Limit (GBq)	200		
% of limit	**6.83**		

APPENDIX Q


Daily Liquid Effluent: 2019
Water-Soluble Tritium (GBq)
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
January 1, 2019
February 1, 2019
March 1, 2019
April 1, 2019
May 1, 2019
June 1, 2019
July 1, 2019
August 1, 2019
September 1, 2019
October 1, 2019
November 1, 2019
December 1, 2019
Daily Liquid Release (GBq)
Action Level

APPENDIX R

Compilation of Water Level Measurements for 2019

Groundwater Well Level Measurement Summary 2019

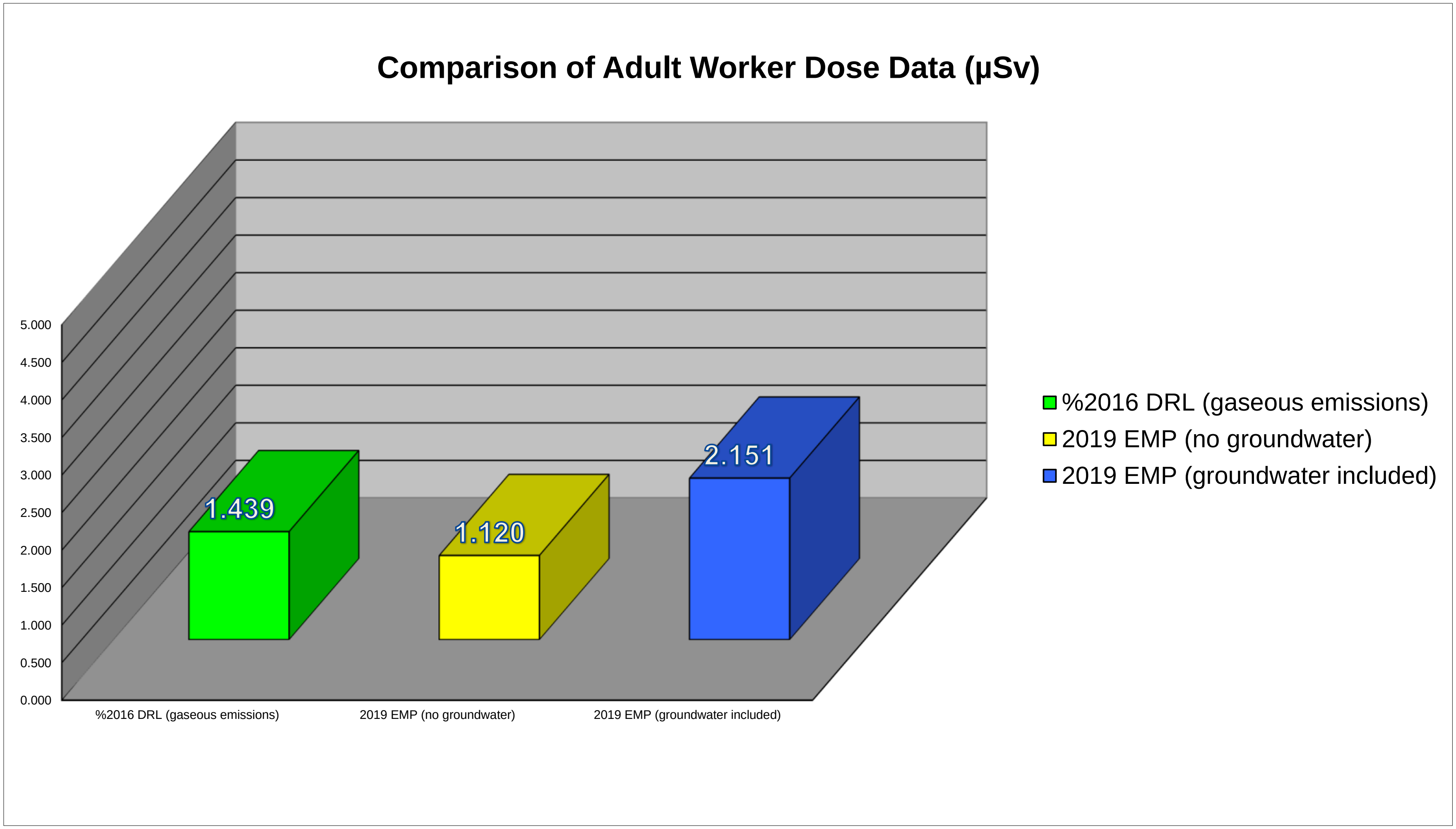
	MW06-1	MW06-2	MW06-3	MW06-8	MW06-9	MW06-10	MW07-11	MW07-12	MW07-13	MW07-15	MW07-16	MW07-17	MW07-18	MW07-19	MW07-20	MW07-21	MW07-22	MW07-23	MW07-24	MW07-26	MW07-27	MW07-28	MW07-29	MW07-31	MW07-32	MW07-34	MW07-35	MW07-36	MW07-37
Easting	335449	335478	335363	335464	335401	335408	335478	335465	335448	335403	335393	335392	335387	335378	335296	335522	335472	335492	335519	335357	335354	335352	335384	335471	335517	335393	335354	335338	335468
Northing	5074615	5074578	5074535	5074590	5074605	5074506	5074576	5074588	5074616	5074605	5074599	5074599	5074595	5074587	5074616	5074584	5074584	5074560	5074530	5074567	5074611	5074612	5074592	5074583	5074530	5074591	5074613	5074629	5074589
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	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)	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	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)	0.051	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	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)	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	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)	0.820	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	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/yy																													
04-Jan-19	127.90	127.18	127.49	126.41	127.60	127.06	126.49	126.39	126.18	127.01	126.95	121.81	126.98	127.04	125.45	124.84	126.28	127.09	126.38	126.91	126.23	121.83	121.86	120.89	120.89	126.07	125.95	125.17	126.53
04-Feb-19	126.27	126.39	127.02	124.92	125.89	125.49	125.10	124.93	124.34	125.13	125.18	121.02	125.31	125.41	123.61	124.84	124.84	125.88	125.15	125.62	124.89	122.01	121.03	120.14	120.12	124.65	124.71	124.35	125.08
04-Mar-19	125.96	125.53	127.02	124.67	125.45	125.30	124.91	124.73	124.58	125.11	125.04	120.55	125.11	125.22	123.44	124.84	124.65	125.58	125.15	125.46	124.74	120.54	120.57	116.98	119.87	124.49	124.56	124.27	124.87
02-Apr-19	128.67	127.28	130.13	127.20	128.54	128.57	127.22	127.15	127.18	128.41	128.28	122.34	128.45	128.78	126.84	124.84	127.08	127.66	126.81	129.78	127.91	122.30	122.33	121.47	121.46	127.26	127.45	126.18	127.32
30-Apr-19	129.11	128.25	130.40	128.25	129.85	129.44	128.26	128.30	128.31	129.59	129.08	125.28	129.77	129.89	127.76	124.84	128.17	128.38	127.52	130.39	129.87	124.91	124.90	125.86	125.83	129.00	129.53	128.70	128.39
03-Jun-19	128.90	128.03	129.65	127.90	130.99	129.06	127.86	127.92	127.85	129.40	129.03	124.39	129.11	129.22	127.14	124.84	127.84	128.13	127.23	129.46	129.01	124.15	124.14	124.24	124.22	128.30	128.66	127.67	128.05
02-Jul-19	128.77	127.73	128.70	127.51	128.10	128.47	127.55	127.53	127.40	128.52	128.45	123.45	128.51	128.57	126.96	126.38	127.42	127.83	126.93	128.62	128.19	123.38	123.38	122.72	122.72	127.64	127.89	126.75	127.65
06-Aug-19	127.69	127.00	127.15	126.21	127.51	126.96	126.29	126.20	125.92	126.85	126.76	121.61	126.74	126.82	125.11	123.99	126.09	126.73	125.83	126.32	126.08	121.64	121.67	120.59	120.59	125.79	125.79	124.94	126.32
28-Aug-19	127.11	126.76	127.05	125.94	127.14	126.52	126.03	125.92	125.62	126.50	126.39	121.20	126.40	126.45	124.73	123.82	125.83	126.53	125.69	126.16	125.67	121.29	121.30	120.08	120.06	125.49	125.44	124.79	126.06
01-Oct-19	126.91	126.39	127.02	125.57	126.65	126.09	125.74	125.57	124.95	125.97	125.89	120.46	125.93	125.96	124.07	123.38	125.49	126.34	125.53	125.68	125.14	120.51	120.55	119.61	119.61	124.99	124.93	124.52	125.71
04-Nov-19	128.69	127.55	129.32	127.16	128.75	128.25	127.23	127.17	127.09	128.25	128.21	121.45	128.19	128.28	126.47	125.95	127.07	127.73	126.84	128.32	127.29	121.51	121.54	120.19	120.17	126.90	126.88	125.80	127.28
03-Dec-19	128.47	127.78	128.25	126.90	128.33	127.75	126.96	126.89	126.77	127.76	127.66	121.82	127.63	127.76	126.30	125.49	126.77	127.51	126.64	127.78	126.87	121.94	121.98	120.66	120.67	126.53	126.53	125.55	127.00

APPENDIX S

Data and Calculations for Public Dose in 2019

ADULT WORKER

Dose Calculation	2019 µSv
%2016 DRL (gaseous emissions)	1.439
2019 EMP (no groundwater)	1.120
2019 EMP (groundwater included)	2.151



ADULT WORKER

Stack Emissions

	2019 Emissions as %2016 SRBT DRL	
	ADULT WORKER	
Sample End	% weekly DRL	(uSv)
2019-01-01	0.02	0.0029
2019-01-08	0.09	0.0180
2019-01-15	0.13	0.0258
2019-01-22	0.08	0.0161
2019-01-29	0.08	0.0151
2019-02-05	0.07	0.0139
2019-02-12	0.06	0.0120
2019-02-19	0.07	0.0129
2019-02-26	0.12	0.0230
2019-03-05	0.12	0.0232
2019-03-12	0.14	0.0277
2019-03-19	0.18	0.0353
2019-03-26	0.24	0.0454
2019-04-02	0.18	0.0356
2019-04-09	0.18	0.0349
2019-04-16	0.20	0.0381
2019-04-23	0.17	0.0325
2019-04-30	0.30	0.0581
2019-05-07	0.22	0.0420
2019-05-14	0.21	0.0400
2019-05-21	0.19	0.0359
2019-05-28	0.31	0.0605
2019-06-04	0.18	0.0354
2019-06-11	0.21	0.0408
2019-06-18	0.25	0.0472
2019-06-25	0.27	0.0521
2019-07-02	0.19	0.0356
2019-07-09	0.22	0.0431
2019-07-16	0.17	0.0334
2019-07-23	0.14	0.0265
2019-07-30	0.11	0.0214
2019-08-06	0.06	0.0117
2019-08-13	0.13	0.0255
2019-08-20	0.11	0.0218
2019-08-27	0.28	0.0534
2019-09-03	0.13	0.0241
2019-09-10	0.14	0.0274
2019-09-17	0.13	0.0257
2019-09-24	0.17	0.0321
2019-10-01	0.11	0.0202
2019-10-08	0.17	0.0336
2019-10-15	0.13	0.0247
2019-10-22	0.09	0.0165
2019-10-29	0.15	0.0296
2019-11-05	0.08	0.0152
2019-11-12	0.15	0.0289
2019-11-19	0.10	0.0196
2019-11-26	0.10	0.0197
2019-12-03	0.06	0.0115
2019-12-10	0.09	0.0177
2019-12-17	0.09	0.0169
2019-12-24	0.02	0.0038
2019-12-31	0.01	0.0023
Sum (uSv)		**1.466**
Ave. (%DRL)	**0.14**	
Annual Dose Est.	**1.439 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	0.843	
Surface HTO ingestion	P(i)29	1.031	
Surface HTO immersion	P(e)29	0.000	
External soil exposure	P39	0.000	
Forage & crop ingestion	P49	0.263	
Animal produce ingestion	P59	0.014	
Aquatic animal ingestion	P69	0.000	
Aquatic plant ingestion	P79	0.000	
External sediment exposure	P89	0.000	
Total	**(uSv)**	**2.151**	**uSv/a**
Total without P_{29}	**(uSv)**	**1.120**	**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	0.365	6.100	1994.496	3.000E-05	0.365			
2	0.253	4.220	1994.496	3.000E-05		0.253		
3	0.000			3.000E-05				
4	0.478	2.490	6405.504	3.000E-05	0.478	0.478	0.478	
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	0.210	3.510	1994.496	3.000E-05			0.210	
			P(i)19	**Sum**	**0.843**	**0.731**	**0.688**	**0.843** 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	0.887	41	1081.1	2.00E-05
3	1.031	48	1081.1	2.00E-05
4	0.000	0	1081.1	2.00E-05
5	0.151	7	1081.1	2.00E-05
6	0.137	6	1081.1	2.00E-05
7	0.086	4	1081.1	2.00E-05
8	0.000	0	1081.1	2.00E-05
9	0.000	0	1081.1	2.00E-05
10	0.000	0	1081.1	2.00E-05
11	0.000	0	1081.1	2.00E-05
12	0.000	0	1081.1	2.00E-05
Avg P(i)29	**0.191**	**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. 5, 2019												
Feb. 5, 2019												
Mar. 5, 2019		58	39		8	8	4					
Apr. 3, 2019												
May 1, 2019												
Jun. 4, 2019												
Jul. 3, 2019		32	46		6	6	4					
Aug. 7, 2019												
Aug. 29, 2019												
Oct. 2, 2019												
Nov. 5, 2019		33	58		7	5	4					
Dec. 4, 2019												
Average		**41**	**48**		**7**	**6**	**4**					

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	*No longer sampled*
Well 9	*No longer sampled*
Well 10	*No longer sampled*
Well 11	*No longer sampled*
Well 12	*No longer sampled*

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 2019 were measured as <detectable.

P(e)29 = 0.000 uSv/a

RW-3	**P(i)29**	**1.031**	**uSv/a**
	P(e)29	**0.000**	**uSv/a**
	P29	**1.031**	**uSv/a**

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	**Beans**	**Onion**	**Zucchini**	**Cucumber**	**Tomato**	**Average**	**LOCATION**	**Beet**	**Corn**	**Beans**	**Carrot**	**Apple**	**Tomato**	**Cucumber**	**Onion**	**Zucchini**	**Average**
	10.00	6.00	7.00	12.00	6.00	8.2	413 SWEEZEY COURT					75.00					75.0
							406 BOUNDARY ROAD					53.00					53.0
							408 BOUNDARY ROAD			32.00			55.00		48.00		45.0
							611 MOSS DRIVE						46.00	44.00		30.00	40.0
							171 SAWMILL ROAD	4.00	4.00		3.00				3.00	4.00	3.6
Average	10.00	6.00	7.00			8.2		4.00			3.00	64.00	50.50	44.00	25.50		43.3
Produce Sample Results (Bq organically bound tritium / kg fresh weight)																	
Comm.			1.00			1.0	408 BOUNDARY ROAD						3.00				3.0

Produce Consumption						
100%=	**413.300**	**kg/a**	**[HTO] (Bq/kg)**	**(Bq/a)**	**[OBT] (Bq/kg)**	**(Bq/a)**
70%	289.310	**kg/a**	8.2	2372.34	1.0	289.31
30%	123.990	**kg/a**	75.0	9299.25	3.0	371.97

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)
0.263	**11671.59**	2.00E-05	**661.28**	4.60E-05

P49	**0.263**	**uSv/a**

ADULT WORKER
EMP Factors for Dose P59

P59 is the exposure to HTO due to ingestion of animal produce.

2019 Sample Results

Local Producer	
	(Bq/L)
1	4.70
2	4.90
3	3.00
Average	**4.20**

Local Distributor	
	(Bq/L)
1	3.00
2	4.00
3	3.00
Average	**3.33**

TOTAL AVERAGE	**3.77**	Bq/L

Milk Density Adjustment		
Milk Average (Bq/L) x Milk density (L/kg)		
Bq/L	**L/kg**	**Bq/kg**
3.77	0.97	**3.654**

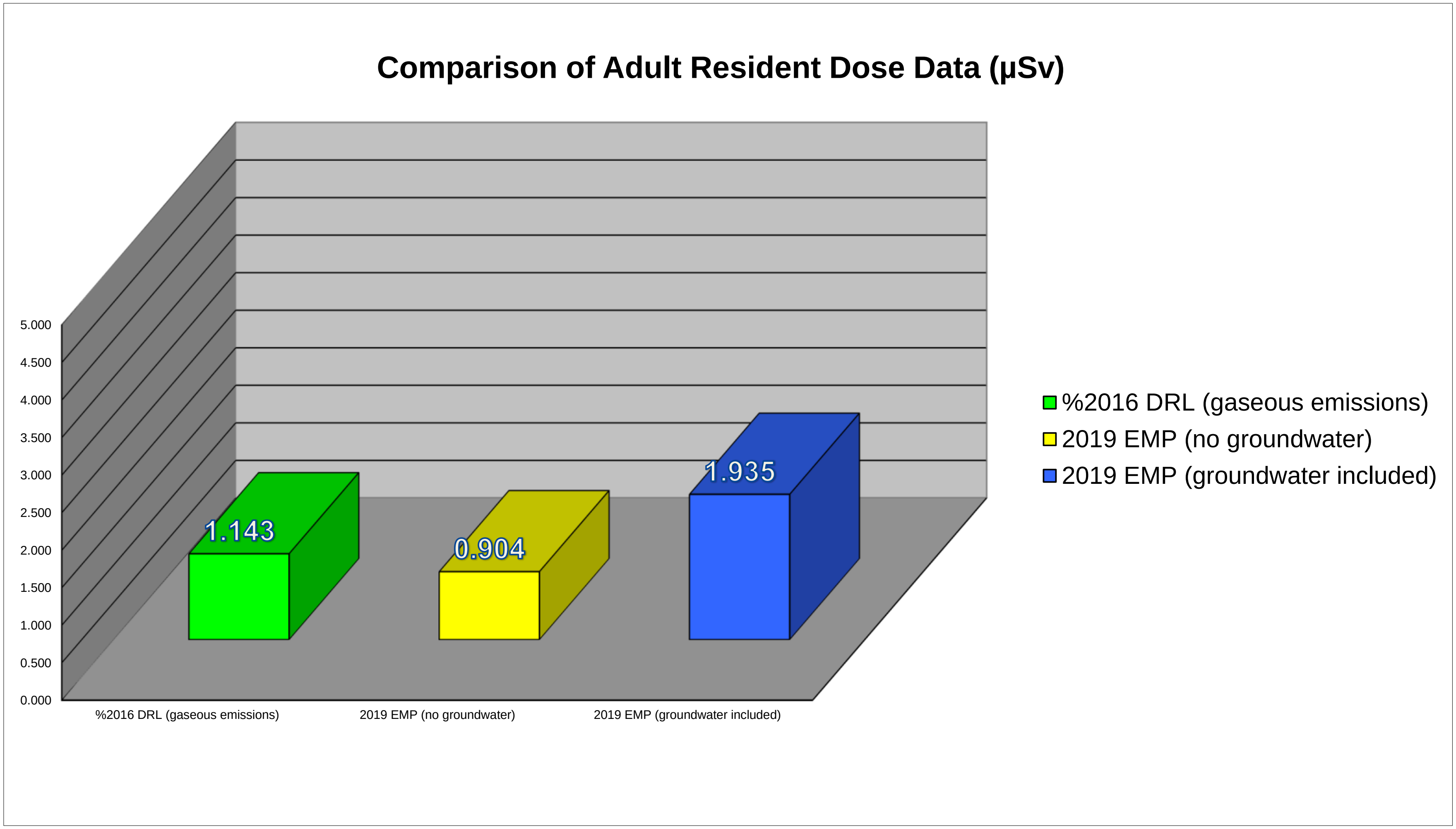
Consumption		
kg/da x da/a = kg/a		
(kg/da)	**(da/a)**	**(kg/a)**
0.516	365.25	**188.5**

P59 = [HTO]animal produce (Bq/kg) x Ingestion (kg) x DCF				
P59	**[HTO]**	**Ingested**	**DCF**	
(uSv/a)	**(Bq/kg)**	**(kg/a)**	**(uSv/Bq)**	
0.014	**3.65**	**188.5**	2.00E-05	

P59	**0.014**	**uSv/a**

ADULT RESIDENT

Dose Calculation	2019 µSv
%2016 DRL (gaseous emissions)	1.143
2019 EMP (no groundwater)	0.904
2019 EMP (groundwater included)	1.935



ADULT RESIDENT

Stack Emissions

	2019 Emissions as %2016 SRBT DRL	
	ADULT RESIDENT	
Sample End	% weekly DRL	(uSv)
2019-01-01	0.01	0.0023
2019-01-08	0.07	0.0143
2019-01-15	0.11	0.0208
2019-01-22	0.07	0.0129
2019-01-29	0.06	0.0121
2019-02-05	0.06	0.0112
2019-02-12	0.05	0.0095
2019-02-19	0.05	0.0102
2019-02-26	0.10	0.0184
2019-03-05	0.10	0.0187
2019-03-12	0.11	0.0221
2019-03-19	0.15	0.0281
2019-03-26	0.19	0.0360
2019-04-02	0.15	0.0282
2019-04-09	0.14	0.0277
2019-04-16	0.16	0.0301
2019-04-23	0.13	0.0257
2019-04-30	0.24	0.0458
2019-05-07	0.17	0.0332
2019-05-14	0.17	0.0317
2019-05-21	0.15	0.0284
2019-05-28	0.25	0.0481
2019-06-04	0.15	0.0282
2019-06-11	0.17	0.0324
2019-06-18	0.19	0.0375
2019-06-25	0.22	0.0415
2019-07-02	0.15	0.0281
2019-07-09	0.18	0.0343
2019-07-16	0.14	0.0267
2019-07-23	0.11	0.0211
2019-07-30	0.09	0.0172
2019-08-06	0.05	0.0093
2019-08-13	0.11	0.0203
2019-08-20	0.09	0.0175
2019-08-27	0.22	0.0424
2019-09-03	0.10	0.0191
2019-09-10	0.11	0.0217
2019-09-17	0.11	0.0204
2019-09-24	0.13	0.0255
2019-10-01	0.08	0.0161
2019-10-08	0.14	0.0267
2019-10-15	0.10	0.0196
2019-10-22	0.07	0.0131
2019-10-29	0.12	0.0236
2019-11-05	0.06	0.0121
2019-11-12	0.12	0.0230
2019-11-19	0.08	0.0156
2019-11-26	0.08	0.0157
2019-12-03	0.05	0.0091
2019-12-10	0.07	0.0141
2019-12-17	0.07	0.0134
2019-12-24	0.02	0.0030
2019-12-31	0.01	0.0018
Sum (uSv)		1.165
Ave. (%DRL)	0.11	
Annual Dose Est.	1.143 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	0.627	
Surface HTO ingestion	P(i)29	1.031	
Surface HTO immersion	P(e)29	0.000	
External soil exposure	P39	0.000	
Forage & crop ingestion	P49	0.263	
Animal produce ingestion	P59	0.014	
Aquatic animal ingestion	P69	0.000	
Aquatic plant ingestion	P79	0.000	
External sediment exposure	P89	0.000	
Total	**(uSv)**	**1.935**	**uSv/a**
Total without P_{29}	**(uSv)**	**0.904**	**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)	(uSv/Bq)	(uSv/a)	(uSv/a)	(uSv/a)	Maximum (uSv/a)
1	0.000			3.000E-05				
2	0.000			3.000E-05				
3	0.000			3.000E-05				
4	0.627	2.490	8400.000	3.000E-05	0.627	0.627	0.627	
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**	**0.627**	**0.627**	**0.627**	**0.627** 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	0.887	41	1081.1	2.00E-05
3	1.031	48	1081.1	2.00E-05
4	0.000	0	1081.1	2.00E-05
5	0.151	7	1081.1	2.00E-05
6	0.137	6	1081.1	2.00E-05
7	0.086	4	1081.1	2.00E-05
8	0.000	0	1081.1	2.00E-05
9	0.000	0	1081.1	2.00E-05
10	0.000	0	1081.1	2.00E-05
11	0.000	0	1081.1	2.00E-05
12	0.000	0	1081.1	2.00E-05
Avg P(i)29	**0.191**	**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. 5, 2019												
Feb. 5, 2019												
Mar. 5, 2019		58	39		8	8	4					
Apr. 3, 2019												
May 1, 2019												
Jun. 4, 2019												
Jul. 3, 2019		32	46		6	6	4					
Aug. 7, 2019												
Aug. 29, 2019												
Oct. 2, 2019												
Nov. 5, 2019		33	58		7	5	4					
Dec. 4, 2019												
Average		**41**	**48**		**7**	**6**	**4**					

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	*No longer sampled*
Well 9	*No longer sampled*
Well 10	*No longer sampled*
Well 11	*No longer sampled*
Well 12	*No longer sampled*

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 2019 were measured as <detectable.

P(e)29 = 0.000 uSv/a

RW-3			
	P(i)29	**1.031**	**uSv/a**
	P(e)29	**0.000**	**uSv/a**
	P29	**1.031**	**uSv/a**

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	Beans	Onion	Zucchini	Cucumber	Tomato	Average	LOCATION	Beet	Corn	Beans	Carrot	Apple	Tomato	Cucumber	Onion	Zucchini	Average
	10.00	6.00	7.00	12.00	6.00	8.2	413 SWEEZEY COURT					75.00					75.0
							406 BOUNDARY ROAD					53.00					53.0
							408 BOUNDARY ROAD			32.00			55.00		48.00		45.0
							611 MOSS DRIVE						46.00	44.00		30.00	40.0
							171 SAWMILL ROAD	4.00	4.00		3.00				3.00	4.00	3.6
Average	10.00	6.00	7.00			**8.2**		4.00			3.00	64.00	50.50	44.00	25.50		43.3
Produce Sample Results (Bq organically bound tritium / kg fresh weight)																	
Comm.			1.00			**1.0**	408 BOUNDARY ROAD						3.00				**3.0**

Produce Consumption						
100%=	**413.300**	**kg/a**	**[HTO] (Bq/kg)**	**(Bq/a)**	**[OBT] (Bq/kg)**	**(Bq/a)**
70%	289.310	**kg/a**	8.2	2372.34	1.0	289.31
30%	123.990	**kg/a**	75.0	9299.25	3.0	371.97

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)
0.263	**11671.59**	2.00E-05	**661.28**	4.60E-05

P49	**0.263**	**uSv/a**

ADULT RESIDENT
EMP Factors for Dose P59

P59 is the exposure to HTO due to ingestion of animal produce.

2019 Sample Results

Local Producer	
	(Bq/L)
1	4.70
2	4.90
3	3.00
Average	**4.20**

Local Distributor	
	(Bq/L)
1	3.00
2	4.00
3	3.00
Average	**3.33**

TOTAL AVERAGE	**3.77**	Bq/L

Milk Density Adjustment		
Milk Average (Bq/L) x Milk density (L/kg)		
Bq/L	**L/kg**	**Bq/kg**
3.77	0.97	**3.654**

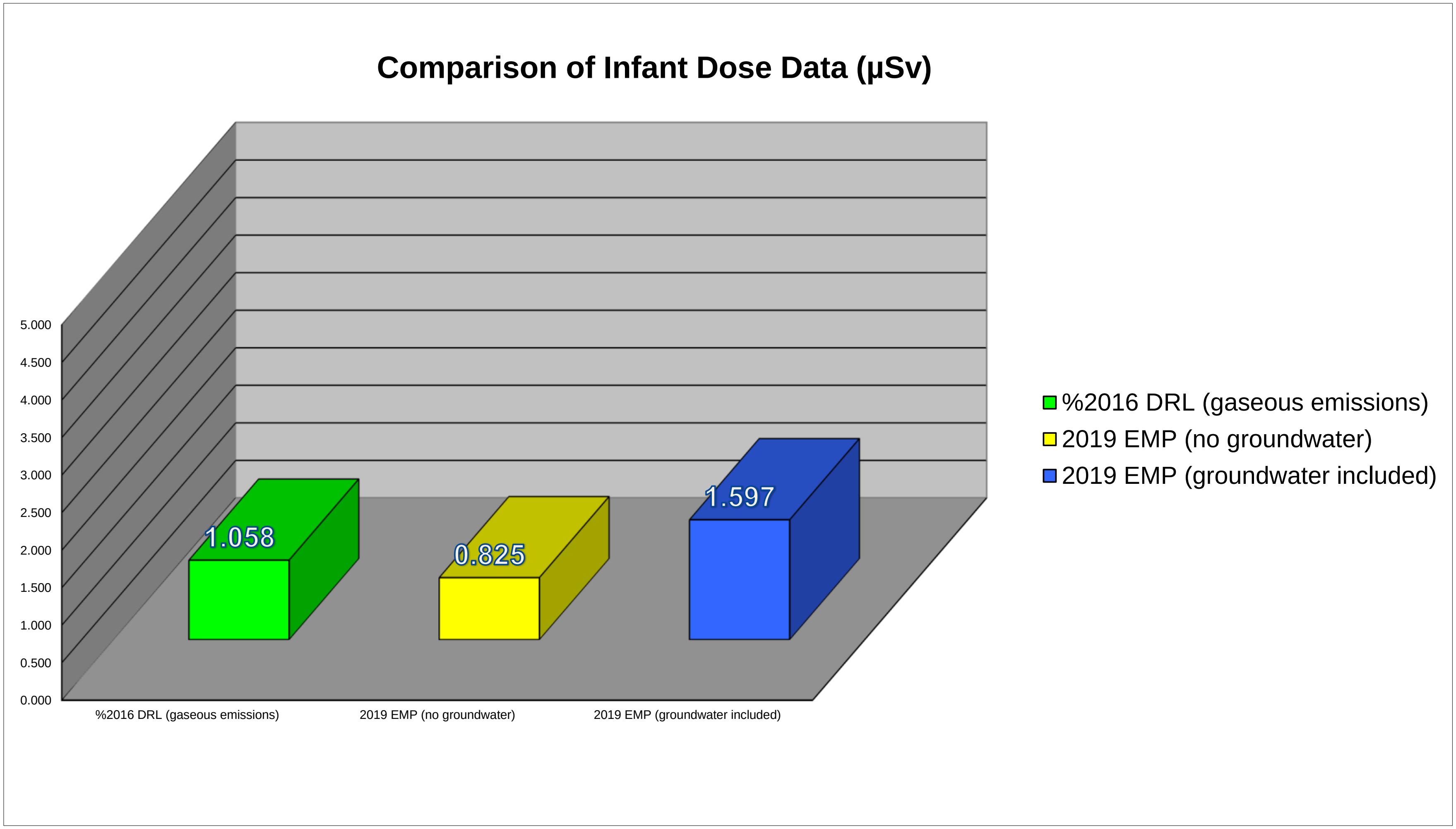
Consumption kg/da x da/a = kg/a		
(kg/da)	**(da/a)**	**(kg/a)**
0.516	365.25	**188.5**

P59 = [HTO]animal produce (Bq/kg) x Ingestion (kg) x DCF				
P59	**[HTO]**	**Ingested**	**DCF**	
(uSv/a)	**(Bq/kg)**	**(kg/a)**	**(uSv/Bq)**	
0.014	**3.65**	**188.5**	2.00E-05	

P59	**0.014**	**uSv/a**

INFANT (1 year old)

Dose Calculation	2019 µSv
%2016 DRL (gaseous emissions)	1.058
2019 EMP (no groundwater)	0.825
2019 EMP (groundwater included)	1.597



INFANT (1 year old)

Stack Emissions

	2019 Emissions as %2016 SRBT DRL	
	INFANT	
Sample End	**% weekly DRL**	**(uSv)**
2019-01-01	0.01	0.0021
2019-01-08	0.07	0.0132
2019-01-15	0.10	0.0192
2019-01-22	0.06	0.0119
2019-01-29	0.06	0.0112
2019-02-05	0.05	0.0103
2019-02-12	0.05	0.0088
2019-02-19	0.05	0.0095
2019-02-26	0.09	0.0170
2019-03-05	0.09	0.0173
2019-03-12	0.11	0.0204
2019-03-19	0.14	0.0260
2019-03-26	0.17	0.0333
2019-04-02	0.14	0.0261
2019-04-09	0.13	0.0256
2019-04-16	0.15	0.0279
2019-04-23	0.12	0.0238
2019-04-30	0.22	0.0425
2019-05-07	0.16	0.0307
2019-05-14	0.15	0.0294
2019-05-21	0.14	0.0263
2019-05-28	0.23	0.0445
2019-06-04	0.14	0.0261
2019-06-11	0.16	0.0300
2019-06-18	0.18	0.0347
2019-06-25	0.20	0.0384
2019-07-02	0.14	0.0261
2019-07-09	0.16	0.0317
2019-07-16	0.13	0.0246
2019-07-23	0.10	0.0196
2019-07-30	0.08	0.0158
2019-08-06	0.04	0.0086
2019-08-13	0.10	0.0188
2019-08-20	0.08	0.0161
2019-08-27	0.20	0.0392
2019-09-03	0.09	0.0177
2019-09-10	0.10	0.0201
2019-09-17	0.10	0.0189
2019-09-24	0.12	0.0236
2019-10-01	0.08	0.0149
2019-10-08	0.13	0.0247
2019-10-15	0.09	0.0181
2019-10-22	0.06	0.0121
2019-10-29	0.11	0.0218
2019-11-05	0.06	0.0112
2019-11-12	0.11	0.0213
2019-11-19	0.08	0.0144
2019-11-26	0.08	0.0145
2019-12-03	0.04	0.0085
2019-12-10	0.07	0.0130
2019-12-17	0.06	0.0124
2019-12-24	0.01	0.0028
2019-12-31	0.01	0.0017
Sum (uSv)		**1.079**
Ave. (%DRL)	**0.11**	
Annual Dose Est.	**1.058 uSv/a**	

INFANT

INFANT (1 year old)
EMP Factors for Dose

Pathways Analysis of Dose to the Public		
		per annum
Atmospheric HTO inhalation, immersion	P(i)19, P(e)19	0.546
Surface HTO ingestion	P(i)29	0.772
Surface HTO immersion	P(e)29	0.000
External soil exposure	P39	0.000
Forage & crop ingestion	P49	0.213
Animal produce ingestion	P59	0.066
Aquatic animal ingestion	P69	0.000
Aquatic plant ingestion	P79	0.000
External sediment exposure	P89	0.000
Total	**(uSv)**	**1.597 uSv/a**
Total without P_{29}	**(uSv)**	**0.825 uSv/a**

INFANT (1 year old)
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	0.000			8.000E-05					
2	0.000			8.000E-05					
3	0.000			8.000E-05					
4	0.546	2.490	2740.000	8.000E-05	0.546	0.546	0.546		
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**	**0.546**	**0.546**	**0.546**	**0.546**	**uSv/a**

INFANT (1 year old)
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	0.664	41	305.7	5.30E-05
3	0.772	48	305.7	5.30E-05
4	0.000	0	305.7	5.30E-05
5	0.113	7	305.7	5.30E-05
6	0.103	6	305.7	5.30E-05
7	0.065	4	305.7	5.30E-05
8	0.000	0	305.7	5.30E-05
9	0.000	0	305.7	5.30E-05
10	0.000	0	305.7	5.30E-05
11	0.000	0	305.7	5.30E-05
12	0.000	0	305.7	5.30E-05
Avg P(i)29	**0.143**	**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. 5, 2019												
Feb. 5, 2019												
Mar. 5, 2019		58	39		8	8	4					
Apr. 3, 2019												
May 1, 2019												
Jun. 4, 2019												
Jul. 3, 2019		32	46		6	6	4					
Aug. 7, 2019												
Aug. 29, 2019												
Oct. 2, 2019												
Nov. 5, 2019		33	58		7	5	4					
Dec. 4, 2019												
Average		**41**	**48**		**7**	**6**	**4**					

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	*No longer sampled*
Well 9	*No longer sampled*
Well 10	*No longer sampled*
Well 11	*No longer sampled*
Well 12	*No longer sampled*

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 2019 were measured as <detectable.

P(e)29 = 0.000 uSv/a

RW-3	**P(i)29**	**0.772**	**uSv/a**
	P(e)29	**0.000**	**uSv/a**
	P29	**0.772**	**uSv/a**

INFANT (1 year old)
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 Type	Market Beans	Market Onion	Market Zucchini	Market Cucumber	Market Tomato	Market Average	LOCATION	Home Beet	Home Corn	Home Beans	Home Carrot	Home Apple	Home Tomato	Home Cucumber	Home Onion	Home Zucchini	Average
	10.00	6.00	7.00	12.00	6.00	8.2	413 SWEEZEY COURT					75.00					75.0
							406 BOUNDARY ROAD					53.00					53.0
							408 BOUNDARY ROAD			32.00			55.00		48.00		45.0
							611 MOSS DRIVE						46.00	44.00		30.00	40.0
							171 SAWMILL ROAD	4.00	4.00		3.00				3.00	4.00	3.6
Average	10.00	6.00	7.00			8.2		4.00			3.00	64.00	50.50	44.00	25.50		43.3

Produce Sample Results (Bq organically bound tritium / kg fresh weight)

Source Type	Market Beans	Market Onion	Market Zucchini	Market Cucumber	Market Tomato	Market Average	LOCATION	Home Beet	Home Corn	Home Beans	Home Carrot	Home Apple	Home Tomato	Home Cucumber	Home Onion	Home Zucchini	Average
Comm.			1.00			1.0	408 BOUNDARY ROAD						3.00				3.0

Produce Consumption

100%=	124.800 kg/a	[HTO] (Bq/kg)	(Bq/a)	[OBT] (Bq/kg)	(Bq/a)
70%	87.360 **kg/a**	8.2	716.35	1.0	87.36
30%	37.440 **kg/a**	75.0	2808.00	3.0	112.32

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)
0.213	**3524.35**	5.30E-05	**199.68**	1.30E-04

P49	**0.213**	**uSv/a**

INFANT (1 year old)
EMP Factors for Dose P59

P59 is the exposure to HTO due to ingestion of animal produce.

2019 Sample Results

Local Producer	
	(Bq/L)
1	4.70
2	4.90
3	3.00
Average	**4.20**

Local Distributor	
	(Bq/L)
1	3.00
2	4.00
3	3.00
Average	**3.33**

TOTAL AVERAGE	**3.77**	Bq/L

Milk Density Adjustment		
Milk Average (Bq/L) x Milk density (L/kg)		
Bq/L	**L/kg**	**Bq/kg**
3.77	0.97	**3.654**

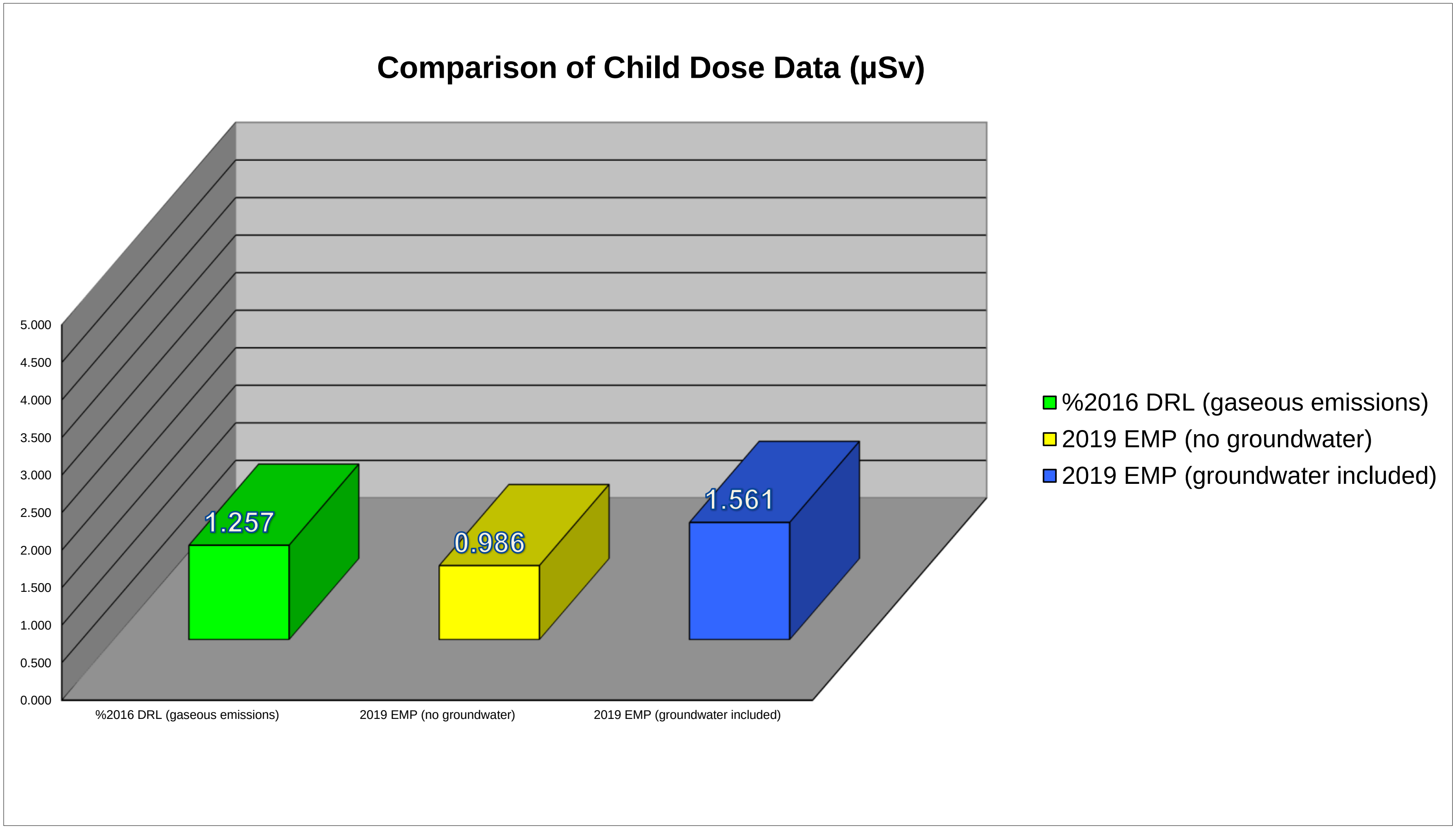
Consumption kg/da x da/a = kg/a		
(kg/da)	**(da/a)**	**(kg/a)**
0.931	365.25	**340.0**

P59 = [HTO]animal produce (Bq/kg) x Ingestion (kg) x DCF				
P59	**[HTO]**	**Ingested**	**DCF**	
(uSv/a)	**(Bq/kg)**	**(kg/a)**	**(uSv/Bq)**	
0.066	**3.654**	**340.0**	5.30E-05	

P59	**0.066**	**uSv/a**

CHILD (10 years old)

Dose Calculation	2019 µSv
%2016 DRL (gaseous emissions)	1.257
2019 EMP (no groundwater)	0.986
2019 EMP (groundwater included)	1.561



CHILD (10 years old)

Stack Emissions

	2019 Emissions as %2016 SRBT DRL	
	CHILD	
Sample End	**% weekly DRL**	**(uSv)**
2019-01-01	0.01	0.0025
2019-01-08	0.08	0.0157
2019-01-15	0.12	0.0227
2019-01-22	0.07	0.0141
2019-01-29	0.07	0.0133
2019-02-05	0.06	0.0122
2019-02-12	0.05	0.0105
2019-02-19	0.06	0.0113
2019-02-26	0.10	0.0202
2019-03-05	0.11	0.0204
2019-03-12	0.13	0.0243
2019-03-19	0.16	0.0308
2019-03-26	0.21	0.0396
2019-04-02	0.16	0.0310
2019-04-09	0.16	0.0305
2019-04-16	0.17	0.0332
2019-04-23	0.15	0.0283
2019-04-30	0.26	0.0505
2019-05-07	0.19	0.0365
2019-05-14	0.18	0.0349
2019-05-21	0.16	0.0313
2019-05-28	0.27	0.0528
2019-06-04	0.16	0.0310
2019-06-11	0.19	0.0356
2019-06-18	0.21	0.0412
2019-06-25	0.24	0.0456
2019-07-02	0.16	0.0310
2019-07-09	0.20	0.0377
2019-07-16	0.15	0.0292
2019-07-23	0.12	0.0232
2019-07-30	0.10	0.0188
2019-08-06	0.05	0.0102
2019-08-13	0.12	0.0223
2019-08-20	0.10	0.0191
2019-08-27	0.24	0.0466
2019-09-03	0.11	0.0210
2019-09-10	0.12	0.0239
2019-09-17	0.12	0.0225
2019-09-24	0.15	0.0281
2019-10-01	0.09	0.0177
2019-10-08	0.15	0.0294
2019-10-15	0.11	0.0215
2019-10-22	0.07	0.0144
2019-10-29	0.13	0.0259
2019-11-05	0.07	0.0133
2019-11-12	0.13	0.0252
2019-11-19	0.09	0.0171
2019-11-26	0.09	0.0173
2019-12-03	0.05	0.0100
2019-12-10	0.08	0.0155
2019-12-17	0.08	0.0148
2019-12-24	0.02	0.0033
2019-12-31	0.01	0.0020
Sum (uSv)		**1.281**
Ave. (%DRL)	**0.13**	
Annual Dose Est.	**1.257 uSv/a**	

CHILD

CHILD (10 years old)
EMP Factors for Dose

Pathways Analysis of Dose to the Public			
		per annum	
Atmospheric HTO inhalation, immersion	P(i)19, P(e)19	0.743	
Surface HTO ingestion	P(i)29	0.575	
Surface HTO immersion	P(e)29	0.000	
External soil exposure	P39	0.000	
Forage & crop ingestion	P49	0.214	
Animal produce ingestion	P59	0.029	
Aquatic animal ingestion	P69	0.000	
Aquatic plant ingestion	P79	0.000	
External sediment exposure	P89	0.000	
Total	**(uSv)**	**1.561**	**uSv/a**
Total without P_{29}	**(uSv)**	**0.986**	**uSv/a**

CHILD (10 years old)
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	0.000			3.800E-05					
2	0.000			3.800E-05					
3	0.000			3.800E-05					
4	0.743	2.490	7850.000	3.800E-05	0.743	0.743	0.743		
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**	**0.743**	**0.743**	**0.743**	**0.743**	**uSv/a**

CHILD (10 years old)
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. 5, 2019												
2	0.494	41	482.1	2.50E-05	Feb. 5, 2019												
3	0.575	48	482.1	2.50E-05	Mar. 5, 2019		58	39		8	8	4					
4	0.000	0	482.1	2.50E-05	Apr. 3, 2019												
5	0.084	7	482.1	2.50E-05	May 1, 2019												
6	0.076	6	482.1	2.50E-05	Jun. 4, 2019												
7	0.048	4	482.1	2.50E-05	Jul. 3, 2019		32	46		6	6	4					
8	0.000	0	482.1	2.50E-05	Aug. 7, 2019												
9	0.000	0	482.1	2.50E-05	Aug. 29, 2019												
10	0.000	0	482.1	2.50E-05	Oct. 2, 2019												
11	0.000	0	482.1	2.50E-05	Nov. 5, 2019		33	58		7	5	4					
12	0.000	0	482.1	2.50E-05	Dec. 4, 2019												
Avg P(i)29	**0.106**	**uSv/annum**															
					Average		**41**	**48**		**7**	**6**	**4**					

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	*No longer sampled*
Well 9	*No longer sampled*
Well 10	*No longer sampled*
Well 11	*No longer sampled*
Well 12	*No longer sampled*

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 2019 were measured as <detectable.

P(e)29 = 0.000 uSv/a

RW-3	**P(i)29**	**0.575**	**uSv/a**
	P(e)29	**0.000**	**uSv/a**
	P29	**0.575**	**uSv/a**

CHILD (10 years old)
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	**Beans**	**Onion**	**Zucchini**	**Cucumber**	**Tomato**	**Average**	**LOCATION**	**Beet**	**Corn**	**Beans**	**Carrot**	**Apple**	**Tomato**	**Cucumber**	**Onion**	**Zucchini**	**Average**
	10.00	6.00	7.00	12.00	6.00	8.2	413 SWEEZEY COURT					75.00					**75.0**
							406 BOUNDARY ROAD					53.00					53.0
							408 BOUNDARY ROAD			32.00			55.00		48.00		45.0
							611 MOSS DRIVE						46.00	44.00		30.00	40.0
							171 SAWMILL ROAD	4.00	4.00		3.00				3.00	4.00	3.6
Average	10.00	6.00	7.00			**8.2**		4.00			3.00	64.00	50.50	44.00	25.50		43.3
Produce Sample Results (Bq organically bound tritium / kg fresh weight)																	
Comm.			1.00			**1.0**	408 BOUNDARY ROAD						3.00				**3.0**

Produce Consumption						
100%=	**265.200**	**kg/a**	**[HTO] (Bq/kg)**	**(Bq/a)**	**[OBT] (Bq/kg)**	**(Bq/a)**
70%	185.640	**kg/a**	8.2	1522.25	1.0	185.64
30%	79.560	**kg/a**	75.0	5967.00	3.0	238.68

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)**
0.214	**7489.25**	2.50E-05	**424.32**	6.30E-05

P49	**0.214**	**uSv/a**

CHILD (10 years old)
EMP Factors for Dose P59

P59 is the exposure to HTO due to ingestion of animal produce.

2019 Sample Results

Local Producer	
	(Bq/L)
1	4.70
2	4.90
3	3.00
Average	**4.20**

Local Distributor	
	(Bq/L)
1	3.00
2	4.00
3	3.00
Average	**3.33**

TOTAL AVERAGE	**3.77**	Bq/L

Milk Density Adjustment		
Milk Average (Bq/L) x Milk density (L/kg)		
Bq/L	**L/kg**	**Bq/kg**
3.77	0.97	**3.654**

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)**	
0.029	**3.654**	**319.6**	2.50E-05	

P59	**0.029**	**uSv/a**

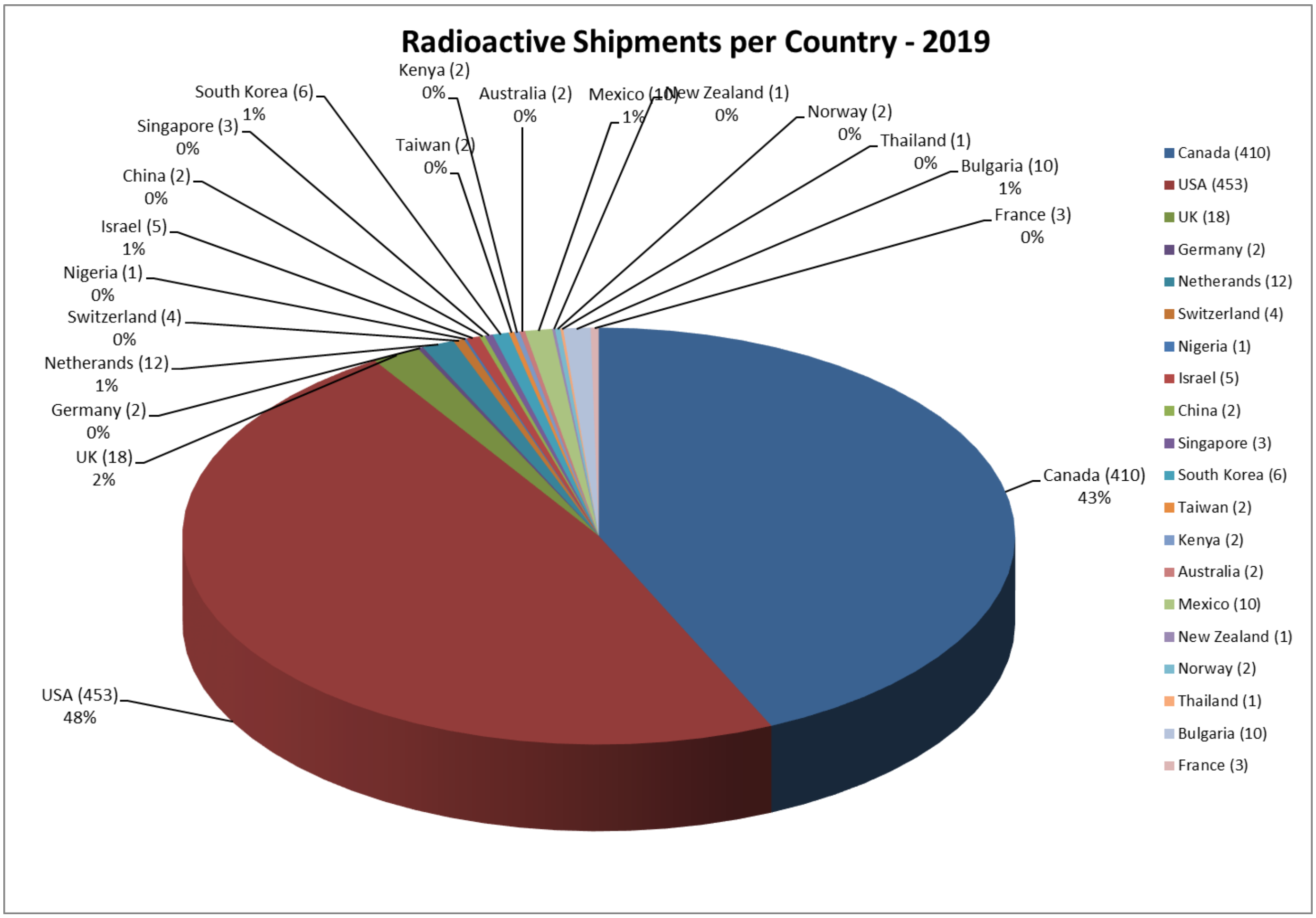
APPENDIX T

Outgoing Shipments Containing Radioactive Material for 2019

SHIPMENTS CONTAINING RADIOACTIVE MATERIAL FOR 2019

Month / 2019	Number of Shipments
January	70
February	68
March	92
April	85
May	94
June	77
July	83
August	69
September	90
October	90
November	78
December	53
Total Shipments	**949**
2019 Monthly Average:	***79.08***

DISTRIBUTION OF SHIPMENTS CONTAINING RADIOACTIVE MATERIAL



APPENDIX U

Incoming Shipments Containing Radioactive Material for 2019

INCOMING SHIPMENTS CONTAINING RADIOACTIVE MATERIAL FOR 2019

Month / 2019	Number of Shipments
January	37
February	18
March	36
April	48
May	40
June	47
July	39
August	32
September	47
October	56
November	30
December	54
Total Shipments	***484***
2019 Monthly Average:	***40.33***

ORIGIN OF INCOMING SHIPMENTS FOR 2019