Bruce Power

Environmental Protection Report 2021

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2021 ENVIRONMENTAL PROTECTION REPORT

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ABSTRACT OF PRESENT REVISION:

Initial Issue

EXECUTIVE SUMMARY

The purpose of this report is to fulfill regulatory requirements on environmental protection in accordance with Condition 3.3 of the Bruce A and Bruce B Power Reactor Operating Licence (PROL) for Bruce Nuclear Generating Stations A and B Licence number 18:02/2028 [R-1] and CNSC Regulatory Document REGDOC 3.1.1 Reporting Requirements for Nuclear Power Plants [R-2].

ISO 14001, Environmental Management Systems Standard provides organizations the framework to improve environmental performance and protect the environment. Bruce Power had a successful re-registration audit in 2020 to acquire re-certification to the ISO 14001 standard [R-3], and underwent a successful surveillance audit in 2021. More details are described in section 8.0.

The CSA N288 series of Standards and Guidelines provide overall direction on environmental management and protection for nuclear facilities and several are a requirement of the operating licence for the facility. Bruce Power has implemented the CSA N288 standards as per requirements of the Licence Condition Handbook (LCH) [R-4].

Site Location

The Site is located on the eastern shore of Lake Huron near Tiverton, Ontario within the traditional lands and treaty territory of the people of the Saugeen Ojibway Nation (SON), which includes the Chippewas of Nawash and Saugeen First Nations. Bruce Power is dedicated to honouring Indigenous history and culture and is committed to moving forward in the spirit of reconciliation and respect with the Saugeen Ojibway Nation (SON), Georgian Bay Métis Nation of Ontario (MNO) and the Historic Saugeen Métis, and to leading by example in this community and industry.

During the 2018 licence renewal process, Bruce Power presented their commitment to working with SON, MNO and HSM in a manner that best suits their communities, to enhance involvement in environmental monitoring. Recognizing that every community has a unique set of interests, in 2021 we worked with each community to further these commitments. Progress in environmental monitoring over the course of the year included:

- SON's Coastal Waters Monitoring Program continued for the third consecutive year. Results from this program are used in conjunction with environmental monitoring results in the Environmental Risk Assessment (ERA) to better understand the near shore environment of Lake Huron over a larger spatial scale.

- MNO Diet Survey was designed to better inform dose calculations as well as our environmental monitoring program. It was conducted in late 2020 and early 2021 with MNO Region 7 members via an online platform. The purpose of this survey was to collect information about lifestyle characteristics of MNO members in order to accurately represent them when considering Bruce Power's impact on nearby populations. The results of the diet survey were gathered from all three Indigenous Nations and Communities and used to refine the Hunter/Fisher scenario in the Environmental Risk Assessment to better inform dose calculations.

- HSM and Bruce Power submitted a fisheries offset plan in 2021 to remove invasive *Phragmites* from Fishing Islands wetland complex. This fish habitat restoration and enhancement project is a comprehensive blend, considering the values and interests of the HSM Community and the Fisheries & Oceans Canada (DFO) offsetting principles. This project embraces the important recent changes to the Fisheries Act that encourage a stronger role of Indigenous peoples in project reviews, monitoring and policy development as part of the early steps to advance reconciliation.

Bruce Power continues to build and develop our dialogue on environmental items of interest with indigenous Nations and Communities. Sharing and insights have strengthened our approach and have led to synergies for growth and partnership for continued environmental protections.

Dose to Public

Each year Bruce Power gathers information in order to calculate the radiological dose to representative persons living near the site. This includes meteorological data, analysis of local environmental media and site radiological emissions and effluents that include all utilities near or within the Bruce Power site boundary. Following the methodology outlined in CSA N288.1 and using an environmental transfer model (IMPACT 5.5.2), a dose is calculated for each representative person at three age classes – adult, child and infant. A representative person is determined using the lifestyle characteristics identified in the Site Specific Survey and is defined as an individual who receives a dose that is representative of the most highly exposed individuals in the population. The most limiting result, or highest calculated dose, is used as the annual dose to public and is published annually in this report.

For the 30th consecutive year, Bruce Power's contribution to the annual dose of a member of the public is less than the lower threshold for significance (<10 µSv/year) and is considered *de minimus*. The maximum dose associated with Bruce Power operations in 2021 was obtained for the BSF3 Adult who received 1.6 µSv/year. All other representative persons have a lower dose. This maximum dose is a small fraction of a percent of the legal limit of 1,000 µSv/year.

<u>2021 Maximum Representative Person's Dose</u>

Representative Person	Committed Effective Dose	Percentage of Legal Limit
BSF3 Adult	1.6 µSv/year	0.16%

Community Investment and Sustainability

Bruce Power is dedicated to promoting environmental stewardship and awareness, both throughout the local communities and in the greater Ontario region. Our Environment and Sustainability (E&S) Fund distributes $400,000 annually to environmental projects and partnerships mainly across Grey, Bruce and Huron counties. The funding is aimed at initiatives that focus on conservation, environmental education and environmental awareness and research. Some of our E&S Fund partnerships included:

- Supporting Saugeen Valley Conservation Authority's expansion of their seedling planting program. As of 2021 the planting of 181,005 seedlings were funded, with a commitment to continue to fund this program through 2025.

- Supporting the development of Zero Emission Vehicle infrastructure with Plug'n Drive, a non-profit organization committed to accelerating electric vehicle adoption in order to maximize their environmental and economic benefits.

In addition, Bruce Power remains committed to continue to seek ways to lower our environmental impact, all the while aligning support with broader provincial, national and global goals of sustainability. In 2021 Bruce Power formally announced its commitment to Net Zero (GHG Emissions) by 2027. This target will be met by identifying and implementing energy and emissions reduction opportunities in our operations, as well as investing in local carbon sequestration and offset projects through the Carbon Offset Coalition and Carbon Accelerator Fund.

Our sustainability program reporting continues to build on an Environmental, Social and Governance (ESG) approach, aligning with global standards, guidelines and best practices, as well as integrating a more quantitative and formalized approach with stronger governance.

Environmental Risk Assessment

As Environmental Risk Assessment (ERA) was prepared following the guidance of CSA N288.6-12 which defines an ERA as a systematic process used to identify, quantify, and characterize the risk posed by contaminants and physical stressors in the environment on biological receptors (human and non-human biota), including the magnitude and extent of the potential effects associated with a facility [R-5].

The 2017 ERA found that operation of the Site has not resulted in adverse effects on human health or nearby residents or visitors due to exposure to non-radiological substances. Risks to ecological receptors from exposure to non-radiological substances were limited to exposure to soil in three former industrial areas on site. A small number of non-human receptors were identified as potentially at risk. However, it should be noted that the conservative nature of the assessment likely overestimates the actual risks

Bruce Power is engaged in preparations for the submission of the next Environmental Risk Assessment in June of 2022. All items listed in the closure of the 2017 ERA will be addressed in the 2022 ERA. The 2022 ERA will also include integration of the results of the mitigation measures assessment and work completed in the area of climate change.

Environmental Monitoring

Bruce Power's Environmental Protection Program is built upon an integrated monitoring approach that strives to understand environmental impact, verify environmental protection, and continuously improve by driving strategic research and innovation through collaborations with industry and community. The environmental monitoring program is designed to meet the requirements of CSA N288.4-10 [R-6]. This consists of both radiological environmental monitoring program, which is used to characterize dose-to-public annually, and non-radiological (conventional) environmental monitoring. Together, environmental monitoring and assessment verifies that emissions and effluents as a result of site operations have a minimal impact on the surroundings. Environmental safety and responsibility are woven into all aspects of the company's nuclear safety culture, and Bruce Power commits to meet or exceed all relevant legal and voluntary environmental requirements. The company holds itself accountable to prevent pollution through strong management of emissions, effluents, and waste, and it implements robust spill mitigation measures in order to provide effective containment and control of contaminants.

Radiological Environmental Monitoring

The radiological environmental monitoring (REM) program establishes a database of radiological activity measured in the environment near Bruce Power and determines the contribution of overall radiation dose to members of the public as a consequence of the radiological releases from normal operations on Site. The REM data implicitly reflects the influence of releases from all Bruce Power licensed facilities as well as facilities within or adjacent to the Bruce Power site boundary that are owned by other parties. The program involves the annual collection and analysis of environmental media for radionuclides specific to nuclear power generation. The program design is based on risk and is informed by a radionuclide and exposure pathways analysis. Monitoring locations are conservatively selected to be representative of locations of exposure of representative persons and also based on practical considerations, including the availability of samples and participation of local residents and farmers. Sampling locations are grouped by proximity to site and these groups include indicator, area near and area far locations. Generally, radionuclide concentrations decrease with distance from site and all levels result in a *de minimus* dose. In 2021, as stated above, the maximum dose associated with Bruce Power operations was obtained for the BSF3 Adult who received 1.6 µSv/year which is less than the lower threshold for significance (<10 µSv/year).

Conventional Environmental Monitoring

The conventional environmental monitoring program monitors for conventional (non-radiological) contaminants, physical stressors, potential biological effects and pathways for both human and non-human biota and fish impingement. Bruce Power has a strong water quality monitoring program that continues to verify that effluent and emissions as well as physical stressors as a result of facility operations have little-to-no effect on the surrounding waterbody, and that Bruce Power has strong and effective containment and effluent control measures in place. Fish impingement and entrainment losses in 2021 were consistent with prior years and well below the maximum loss permitted in Bruce Power's *Fisheries Act* Authorization. Fish offsetting activities continued as planned in 2021, with monitoring in the Saugeen River in the vicinity of the former Truax Dam as per Bruce Power's Offsetting Plan. An initial assessment of the before-after changes in fish production demonstrated that a statistically significant offset in fish biomass and production has occurred in the main stem of the Saugeen River. Thermal monitoring also continued in 2021, with results used for ongoing verification for thermal risk assessment to address both the MECP ECA conditions and analysis for the ERA. Long term biological effects monitoring of local wildlife populations continues to demonstrate a diverse and abundant community including amphibians, reptiles, shorebirds, water fowl and fish.

Groundwater Protection

Recently, the groundwater monitoring program has evolved to ensure alignment with the new groundwater protection standard, CSA N288.7-15, Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills [R-4].

The groundwater protection program goal is to protect the overall quality and quantity of groundwater by minimizing the interactions with the environment from activities associated with Bruce Power thereby allowing the effective management of groundwater as a resource. Through development of sampling plans, monitoring, sampling and testing, evaluation of results against performance objectives and investigation of exceedances leading to revision of sampling plans, Bruce Power ensures that the overall groundwater protection goal is met. Groundwater within the Bruce A and Bruce B protected areas was sampled twice in 2021 (spring and fall). Results were evaluated using statistical based criteria which are derived from previous data for each monitoring location by calculating ‘mean plus three standard deviations’ (M3SD). Results which fall outside of M3SD will require further investigation. The 2021 groundwater tritium results at Bruce A and Bruce B wells within the protected areas are within normal trends.

Effluent Monitoring

Results of the Effluent Monitoring program demonstrate that all conventional and radiological effluents (waterborne and airborne) are, and continue to be, well below regulatory limits.

Radiological Emissions and Effluent Monitoring

In 2021, all releases remained well below the Derived Release Limits and Environmental Action Levels. Where possible, Bruce Power has several engineered barriers in place to minimize radionuclides released to the environment and keep airborne emissions and waterborne effluent as low as reasonably achievable (ALARA). These barriers, in conjunction with applying the ALARA principle, systematic monitoring, trending and investigation when emissions or effluent are above normal operating levels, assists Bruce Power in minimizing releases and ensuring they remain well below regulatory limits.

Conventional Effluent Monitoring

Bruce Power continues to comply with its Environmental Compliance Approvals, Permits and regulations under, but not limited to, the Environmental Protection Act [R-7] and the Ontario Water Resources Act [R-8].

In accordance with the ECA (Air) [R-9], noise complaints were received from Inverhuron residents between July 18, 2021 and July 20, 2021. In accordance with the conditions of Bruce Power’s ECA, the MECP District Office was notified of the complaints within two business days. Noise monitoring and assessments conducted between 2015 and 2020 demonstrate that Bruce Power’s noise level at concerned receptor locations remain in compliance with MECP limits. Even though all monitoring demonstrates we have been in compliance, in efforts to respond to neighbours concerns we mitigated our most significant noise source by installing silencers on our Bruce B Deaerator vents between 2018 and 2019.

Waste Management

Bruce Power complies with all waste regulations and requirements of the relevant Federal, Provincial, and Municipal authorities. Further, Bruce Power has taken an active role for many years to reduce all forms of waste: from an environmental and financial standpoint waste reduction is good for our company and the community in which we reside. Our philosophy employs a whole life-cycle approach in that we reduce waste at the consumer level, generate less waste at the company level, find opportunities to reuse products (on-site, off-site donations, or auction), and implement recycling programs that are available in the ever-changing recycling market. Wherever its fate, each waste stream generated at Bruce Power is processed and disposed of in a safe and environmentally-responsible manner.

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List of Acronyms and Abbreviations

°C	-	Degrees Celsius
µSv	-	Microsievert
^{131}I	-	Radioiodine
^{14}C	-	Carbon-14
^{3}H	-	Tritium
^{40}K	-	Potassium-40
^{60}Co	-	Cobalt-60
AECL	-	Atomic Energy Canada Limited
AL	-	Action Level
ALARA	-	As Low As Reasonably Achievable
ALc	-	Combined Dose Action Level
ALW	-	Active Liquid Waste
BA	-	Bruce A
BACI	-	Before-After-Control-Impact
BB	-	Bruce B
BDD	-	Baie du Doré
BEM	-	Biological Effects Monitoring
BNGS	-	Bruce Nuclear Generating Station
Bq	-	Becquerel
BSP	-	Bruce Steam Plant
CCME	-	Canadian Council of Ministries of the Environment
CCW	-	Condenser Cooling Water
CEPA	-	Canadian Environmental Protection Act
CFC	-	Chlorofluorocarbon
CMF	-	Central Maintenance Facility
CNL	-	Canadian Nuclear Laboratories
CNSC	-	Canadian Nuclear Safety Commission
CO_2e	-	Carbon Dioxide Equivalent
COPC	-	Chemicals of Potential Concern
COS	-	Centre of Site
COVID-19	-	Coronavirus Disease
CSA	-	Canadian Standards Association
CSF	-	Central Storage Facility
CSR	-	Corporate Social Responsibility
CWMP	-	Coastal Waters Monitoring Program
D_2O	-	Deuterium oxide (Heavy Water)
dBA	-	Decibel
DFO	-	Department of Fisheries and Oceans (Fisheries and Oceans Canada)
DPWF	-	Douglas Point Waste Facility
DRL	-	Derived Release Limit
DSC	-	Dry Storage Containers
E&S	-	Environment & Sustainability
EALs	-	Environmental Action Levels
ECA	-	Environment Compliance Approvals
ECI	-	Emergency Coolant Injection
ECCC	-	Environment and Climate Change Canada

EED	-	Emission Effective Dose
EMEL	-	Effluent Monitoring Effluent Limits
EMP	-	Environmental Management Plan
EMS	-	Environmental Management System
EPA	-	Environmental Protection Act
EPR	-	Environmental Protection Report
ERA	-	Environmental Risk Assessment
ESDM	-	Emission Summary Dispersion Modelling
ESG	-	Environmental Social Governance
EWST	-	Emergency Storage Water Tank
Fe	-	Iron
FFA	-	Film Forming Amines
FPS	-	Fixed Point Surveillance
Ft.	-	Feet
BG	-	Gross Beta
GHG	-	Greenhouse Gas
GS	-	Gross Scan
GWPP	-	Groundwater Protection Program
H_2O	-	Dihydrogen Monoxide (Water)
HCFC	-	Hydrochlorofluorocarbon
HECA	-	High Efficiency Carbon Air
HEPA	-	High Efficiency Particulate Air
HPI	-	Habitat Productivity Index
HSM	-	Historical Saugeen Métis
IEMP	-	Independent Environmental Monitoring Program
IESO	-	Independent Electricity System Operator
IIL	-	Internal Investigation Limit
KERMA	-	Kinectic Energy Released in Matter
KM	-	Kilometers
kW	-	Kilowatt
L	-	Litre
L&ILW	-	Low and Intermediate Level Waste
LCH	-	Licence Condition Handbook
L_d	-	Limit of Detection
LOF	-	Limited Operational Flexibility
m^3	-	Cubic Meter
MCR	-	Major Component Replacement
MDL	-	Method Detectable Limit
MECP	-	Ministry of Environment, Conservation and Parks
mg	-	Milligrams
MGLC	-	Maximum Ground Level Concentration
mGy	-	Milligray
MNO	-	Métis Nation of Ontario
MNRF	-	Ministry of Natural Resources and Forestry
mSv	-	Millisievert
NO_2	-	Nitrite
NO_3	-	Nitrate
NPRI	-	National Pollutant Release Inventory

OBT	-	Organically Bound Tritium
OPG	-	Ontario Power Generation
OWRA	-	Ontario Water Resources Act
PERA	-	Predictive Environmental Risk Assessment
PFIB	-	Primary Irradiated Fuel Bay
POI	-	Point of Impingement
PROL	-	Power Reactor Operating Licence
PTTW	-	Permit To Take Water
PWQO	-	Provincial Water Quality Objectives
QA	-	Quality Assurance
QC	-	Quality Control
REM	-	Radiological Environmental Monitoring
SAR	-	Species At Risk
SON	-	Saugeen Ojibway Nation
SPP	-	Sewage Processing Plant
TBWTF	-	Turbine Building Water Treatment Facility
TLD	-	Thermoluminescent Dosimeter
TP	-	Total Phosphorus
UNSCEAR	-	United Nations Scientific Committee of the Effects of Atomic Radiation
UV	-	Ultraviolet
VBO	-	Vacuum Building Outage
WNSL	-	Waste Nuclear Substance Licence
WSER	-	Wastewater System Effluent Regulation
WSP	-	Water Supply Plant
WWMF	-	Western Waste Management Facility
μg	-	Micrograms

1.0 INTRODUCTION

1.1 Purpose

The purpose of this report is to fulfill regulatory requirements on environmental protection in accordance with Licence Condition 3.3 of the Bruce A and Bruce B Power Reactor Operating Licence (PROL) Bruce Nuclear Generating Stations A and B 18:02/2028 [R-10] and the CNSC Regulatory Document REGDOC-3.1.1 Reporting Requirements for Nuclear Power Plants, Section 3.5 [R-2]. This report meets the content, timing and reporting requirements of REGDOC-3.1.1 [R-2].

1.2 Regulatory Requirements

1.2.1 Licence Requirements

Power Reactor Operating Licence (PROL) Bruce Nuclear Generating Stations A and B 18:02/2028 [R-10] and the associated Licence Condition Handbook[R-11], has Section 3.3 Reporting Requirements that require Bruce Power to notify and report in accordance with CNSC regulatory document REGDOC-3.1.1, version 2 [R-2]. Environmental Protection is one safety control area which covers programs that identify, control, and monitor all releases of radiological, non-radiological and hazardous substances, and monitors the effects on the environment from the operation of facilities or as the result of licensed activities.

The environmental protection report is submitted annually to the Canadian Nuclear Safety Commission (CNSC) and contains information as required by REGDOC-3.1.1, version 2 section 3.5 [R-2] posted publicly a, Publications – Bruce Power.

Federal and Provincial regulations require licencees to monitor and report on the characteristics of airborne and waterborne effluent. Licencees are required to comply with any statutes, regulations, licences, or permits that govern the operation of the nuclear facility or licenced activity. The release of hazardous substances is regulated by both the Ontario Ministry of the Environment Conservation and Parks (MECP) and Environment and Climate Change Canada (ECCC) through various acts and regulations, as well as by the CNSC.

If the licencee is required to submit annual reports to other government departments concerning their environmental protection program, that show the results of the effluent/emission and environmental monitoring programs, sending a copy of the report to the CNSC is acceptable. This satisfies the CNSC's requirement for oversight of the Bruce Power environmental monitoring program.

1.2.2 Environmental Protection Program

Bruce Power complies with Federal Regulations, programs, and standards which protect human health and the environment under the Nuclear Safety and Control Act [R-12]. The key elements are listed below:

- The General Nuclear Safety and Control Regulations [R-13] require every licensee to take all reasonable precautions to protect the environment and to control release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licenced activity.

- The Class 1 Nuclear Facilities Regulations [R-14] set out environmental protection requirements that must be met.

- The Radiation Protection Regulations [R-15] prescribe radiation dose limits for the general public of 1 mSv (1000 µSv) per calendar year.

- PROL 18.02/2028, Nuclear Reactor Operating Licence Bruce Nuclear Generating Stations A and B[R-10].

The CNSC, when considering relicensing, has an obligation through the Nuclear Safety and Control Act [R-12] to consider whether an applicant will make adequate provision for the protection of the environment and the health and safety of people as outlined in REGDOC 2.9.1 Environmental Protection Policies, Programs and Procedures [R-16]. As a result, the CSA N288 standards are implemented through requirements set out in the License Condition Handbook (LCH)[R-11].

REGDOC-2.9.1 [R-16] outlines the requirements needed for an environmental protection program consistent with the environmental management system standard, ISO 14001, Environmental Management System. Bruce Power's BP-PROG-00.02, Environmental Management [R-17] implements this environmental protection program.

1.2.2.1 Canadian Standards Association (CSA) N288 Series

The CSA N288 standards are part of a series of guidelines and standards on environmental management of nuclear facilities. Bruce Power will continue to strive to be industry best and implement newer versions of the CSA N288 series of environmental standards as they become available.

Bruce Power has implemented the following CSA standards that are relevant to the CNSC's regulatory framework for environmental compliance:

- CSA N288.1-14 (Update 3), Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities [R-18];
- CSA N288.4-10, Environmental Monitoring Program at Class I nuclear facilities and uranium mines and mills [R-6];
- CSA N288.5-11, Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills [R-19];
- CSA N288.6-12, Environmental Risk Assessments at Class I nuclear facilities and uranium mines and mills [R-20]; and
- CSA N288.7-15, Groundwater Protection Programs at Class I nuclear facilities and uranium mines and mills [R-21].
- CSA N288.8-17, Establishing and implementing action levels for releases to the environment from nuclear facilities [R-22].

Bruce Power is working towards implementing, N288.1-20, Guidelines for modelling radionuclide environmental transport, fate, and exposure associated with the normal operation of nuclear facilities [R-23].

Bruce Power is following the guidance provided in CSA N288.9-18, Guideline for design of fish impingement and entrainment programs at nuclear facilities [R-24] to enhance the fish impingement and entrainment programs and CSA N288.3.4-13, Performance testing of nuclear air-cleaning systems at nuclear facilities [R-25].

1.2.2.2 Environmental Management System (ISO 14001)

ISO 14001 [R-3] specifies the requirements for an environmental management system that an organization can use to enhance its environmental performance. The standard is used to manage its environmental responsibilities in a systematic manner that contributes to environmental sustainability and ensures environmental protection.

In 2021, Bruce Power had a successful surveillance audit to confirm that Bruce Power operates an Environmental Management System (EMS) compliant with the requirements of ISO 14001:2015 [R-3]. The current certification is valid for three years (2020-2023).

The Bruce Power EMS program oversees the planning, implementation, and operation of activities, with a focus on minimizing the potential adverse impact of Bruce Power operations on the environment. This includes ensuring the Bruce Power's Environmental Safety Program as defined by BP-PROG-00.02, Environmental Management [R-17], conforms to the ISO 14001 standard for Environmental Management System [R-3], environmental compliance obligations applicable to Bruce Power and the commitments made in the Environmental Policy.

<u>Environment & Sustainability Policy</u>

The Environmental Policy was updated in 2021 to the Environment & Sustainability Policy to enhance the description of sustainability principles, address work in strategic research and innovation, and to demonstrate our commitment of meeting or exceeding requirements. The Environment & Sustainability Policy establishes guiding principles and environmental expectations for employees and those working on behalf of Bruce Power. The Environmental Policy reflects the commitment of Bruce Power to protect the environment and states that you can count on Bruce Power to:

- Ingrain a healthy nuclear safety culture which promotes nuclear safety, radiological safety, industrial safety and environmental safety and sustainability;

- Commit to excellence by meeting or exceeding all relevant legal and voluntary requirements to which Bruce Power subscribes;

- Understand our environmental impact and verify environmental protection through monitoring the environment, collaborating with industry and the community, and driving related strategic research and innovation;

- Focus on continuous improvement by adopting applicable industry best practices and requirements of ISO 14001;

- Ensure our business decisions support the application and practice of sustainability principles by protecting, conserving, and restoring our resources through energy conservation, reducing water consumption, supporting waste diversion, and considering product life cycle in our Supply Chain;

- Hold ourselves accountable to prevent pollution through robust management of emissions, effluents and waste, as well as implementation of spill mitigation measures;

- Promote environmental stewardship and awareness at work, in the community, and across Ontario;

- Uphold the trust of the community through open and transparent communication with partners, Indigenous communities, and stakeholders on environmental interests;

- Play a leading role in keeping the air clean and fighting climate change; supporting emissions reductions strategies to achieve a Net Zero Canada by 2050; adopting ambitious net reduction strategies for Bruce Power to achieve Net Zero (GHG); and

- Support partners, communities and organizations to drive innovations and projects to offset and sequester carbon in a real and tangible way.

2.0 BACKGROUND

The Site is located in the Municipality of Kincardine on the eastern shore of Lake Huron within Bruce County. The Municipality of Kincardine is comprised of the town of Kincardine and several small villages and towns including Inverhuron and Tiverton. The area is a popular tourist destination with many cottages and holiday parks attracting visitors from across Ontario, Canada and the United States. The next closest municipality to the Site is the Town of Saugeen Shores, which is approximately 25 km from the Site. The Town of Saugeen Shores includes Southampton and Port Elgin.

Bruce County can be broadly split into three sections: (i) the Bruce Peninsula, part of the Niagara Escarpment, (ii) the Lakeshore that includes a number of sandy beaches and fresh water, and (iii) the Interior Region, also known as the “bread basket” which has a strong history of farming and agriculture. Bruce County has economic strengths in many sectors including tourism, agriculture and energy. The 2016 Census showed a population of 11,389 people in the Municipality of Kincardine (an increase of 1.9% from 2011) and a population of 13,715 in the Town of Saugeen Shores (an increase of 8.3% from 2011), which includes Southampton and Port Elgin. Both municipalities are in Bruce County, which has a total population of 68,147 (an increase of 3.1% from 2011).

2.1 Bruce Power Site

Bruce Power has been safely operating the Bruce Nuclear Facility (referred to as the “Site” herein) located near Tiverton, Ontario since May 2001. The Site is located on the east shore of Lake Huron about 18 kilometres (km) north of Kincardine. The Site includes Bruce Nuclear Generating Station A (Bruce A) and Bruce Nuclear Generating Station B (Bruce B), which each comprise four CANDU reactors, as well as ancillary facilities. The Site also encompasses lands currently occupied by Ontario Power Generation (OPG), Canadian Nuclear Laboratories (CNL) Douglas Point and Hydro One.

Currently, seven of the eight reactors are operational, and the facility also includes radioactive waste storage among other supporting facilities. Unit 6 at Bruce B is undergoing Major Component Replacement (MCR) which commenced in 2020.

2.1.1 Ontario Power Generation Land and Facilities

The Western Waste Management Facility (WWMF) is owned and operated by Ontario Power Generation (OPG). It is located centrally on the Bruce site and is designated for the management of radioactive waste and licenced for such use by the CNSC. This 19-hectare facility contains the Low and Intermediate Level Waste (L&ILW) storage area and the used fuel dry storage area [R-26].

The objectives of the WWMF are to provide safe material handling (receipt, transfers, and retrieval), treatment, and storage of radioactive materials produced at nuclear generating stations and other facilities currently or previously operated by Ontario Power Generation or its predecessor, Ontario Hydro. This facility also provides safe storage of Bruce Power’s used fuel in Dry Storage Containers (DSC) until it can be transported to an alternative long term used fuel storage or disposal facility. The used fuel dry storage area is a security protected area located northeast of the L&ILW storage area and consists of DSC processing and storage buildings [R-27].

The L&ILW portion of the facility consists of various structures such as the Amenities Building, Waste Volume Reduction Building, Transportation Package Maintenance Building, low level and intermediate level waste storage buildings, quadricells, in ground containers, trenches, and tile holes. These structures are primarily used for processing of low-level waste and storage of L&ILW from OPG's Pickering and Darlington Nuclear Generating Stations as well as Bruce Power operations.

2.1.2 Canadian Nuclear Laboratories Lands and Facilities

The Douglas Point Waste Facility (DPWF) is operated by Canadian Nuclear Laboratories (CNL) and is located on the Bruce Site. Douglas Point, which operated between 1966 and 1984, was the prototype commercial-scale CANDU nuclear power plant. With full operation commencing in 1968, the Douglas Point Generating Station supplied 220 MW to the Ontario grid over the next 16 years. Eventually a decision was made to shut down Douglas Point rather than undertake the refurbishment of the pressure tubes that was required for continued operation. While the Douglas Point facility structures remain in place today, the reactor has been permanently shut down since 1984. Used fuel from the reactor is stored in dry storage modules at the facility. Decommissioning of the Douglas Point Facility is progressing with a 2070 timeline for completion. The decommissioning plans for the coming years include the dismantling of non-nuclear buildings and nuclear support buildings. The reactor and its building are anticipated to be decommissioned after 2030.

In 2020, the facility was in Phase 2 of decommissioning, known as "Storage with Surveillance" [R-27] [R-28]. In 2021, the CNSC amended the decommissioning licence to allow CNL to begin Phase 3 of five-phase process of decommissioning activities.

2.1.3 Hydro One Lands and Facilities

Hydro One owns and operates a number of assets within Bruce Site. These include, but are not limited to, office and workshops for maintenance, switchyards at Bruce A and Bruce B, switching stations and transformer stations, and transmission corridors [R-28].

2.2 Kinectrics KI North Facility

Kinectrics' KI North Facility is located in Tiverton, Ontario, approximately 3 km from the Bruce Site. The site has an approximate footprint of 16.66 hectares and houses one building with an approximate footprint of 3440 m^2. The facility functions as a radioactive workspace to decontaminate and refurbish large nuclear reactor tools and equipment used during reactor maintenance outages [R-29].

Kinectrics carries out effluent monitoring activities on both airborne tritium releases through exhaust stacks and on liquid releases to sewer, following Kinectrics' effluent monitoring procedures. Specifically:

- Kinectrics' Waste Nuclear Substance Licence (WNSL) requires releases to air to be monitored for tritium only at KI North, since particulates are caught in pre-filters and HEPA filters prior to exhaust. Tritium releases through exhaust stacks are continuously sampled, and analysis of the samples is conducted weekly [R-29].

- Potentially active wastewater is temporarily stored in collection tanks and sampled and analyzed prior to release. If any radiological or chemical contaminant is found to be above administrative control levels, which are set below the WNSL limits, then the tank contents are filtered through two charcoal filters and then re-analyzed. All releases are maintained below the WNSL limits [R-29]. The processes at KI North produce very small volumes of liquid waste, hence discharge to the environment is not required often (less than once per year).

2.3 Canadian Nuclear Safety Commission (CNSC), IEMP

The CNSC has implemented its IEMP to verify that the public and the environment around licensed nuclear facilities are protected. It is separate from, but complementary to, the CNSC's ongoing compliance verification program. The IEMP involves taking samples from publicly accessible areas around the facilities and measuring and analyzing the amount of radioactive and hazardous substances in those samples. CNSC staff collect the samples and send them to the CNSC's state-of-the-art laboratory for testing and analysis. Since the implementation of the IEMP, the area outside of the BNGS perimeter was sampled in 2013, 2015, 2016 and 2019. [R-30]

The sampling plans focus on measuring concentrations of contaminants in the environment at publicly accessible locations such as parks, residential communities and beaches, and in areas of interest identified in environmental risk assessments (ERAs). Samples may be taken for air, water, soil, sediment, vegetation, and some food, such as meat and produce.

The CNSC has also conducted a large study to look at radiation exposure and the incidence of cancer around Ontario nuclear generating sites, including the Bruce Power site. This study concluded that doses to the public were well below levels of natural background radiation and that people who live near nuclear generating sites have no excess cancer risk and are as healthy as the rest of Canada's general population [R-31].

2.3.1 2019 IEMP Results

The 2019 IEMP sampling plan for the BNGS focused on nuclear and hazardous contaminants. This differs from IEMP sampling plans in 2013, 2015 and 2016 which focused only on nuclear contaminants. A site-specific sampling plan was developed based on Bruce Power's approved environmental monitoring program and the CNSC's regulatory experience with the site. The Métis Nation of Ontario (MNO), Saugeen Ojibway Nation (SON) and Historic Saugeen Métis (HSM) also collaborated with the CNSC by providing valuable information about locations and species of interest for sampling, and by participating in the collection of samples. It is a priority for the CNSC to ensure that IEMP sampling reflects traditional Indigenous land use, values and knowledge, where possible, so that IEMP results are meaningful to the communities [R-30].

In all years, samples were collected in publicly accessible areas outside the BNGS site perimeter and included samples of air, water, soil, sediment, vegetation and food, such as meat and produce from local farms.

In 2019, the radioactivity measured in air, water, sediment, soil and vegetation samples, as well as in samples of meat, fish, milk and produce was below guidelines and CNSC screening levels. These results are similar to those in 2013, 2015 and 2016. CNSC screening levels are based on conservative assumptions about the exposure that would result in a dose of 0.1 mSv/year. No health impacts are expected at this dose level.

The levels of hazardous (non-radiological) contaminants measured in water and sediment were below applicable guidelines. All samples were within the range of licensees' data based on their recent environmental risk assessments, and below the toxicity data available, indicating that potential effects to the environment are low.

2.3.2 IEMP Conclusions

IEMP results from 2013, 2015, 2016 and 2019 indicate that the public and the environment around the Bruce Nuclear Generating Station are protected, and there are no expected health impacts. These results are consistent with the results submitted by Bruce Power, demonstrating that the licensee's environmental protection program protects the health and safety of the people and the environment. [R-30]

2.4 Local Indigenous Communities

The Site lies within the traditional lands and treaty territory of the Saugeen Ojibway Nation. Bruce Power is dedicated to honouring Indigenous history and culture and is committed to moving forward in the spirit of reconciliation and respect with the Saugeen Ojibway Nation (SON), Georgian Bay Métis Nation of Ontario (MNO) and the Historic Saugeen Métis and to leading by example in this community and industry. Métis people living near the Site may be represented by either the HSM or the MNO.

2.4.1 Saugeen Ojibway Nation (SON)

The SON is comprised of the Chippewas of Nawash Unceded First Nation and the Chippewas of Saugeen First Nation. They are Aboriginal peoples of the Grey and Bruce region, which they know as Anishnaabekiing. Their traditional territory includes the lands and waters that surround the Site. The SON has two main on-reserve communities which are located approximately 30 km (Chippewas of Saugeen First Nation Reserve No. 29) and 80 km north of the Site (Cape Croker Reserve No. 27). The SON also has two hunting ground reserves that are located approximately 115 km north of the Site. The SON's traditional territory is identified in Figure 1.

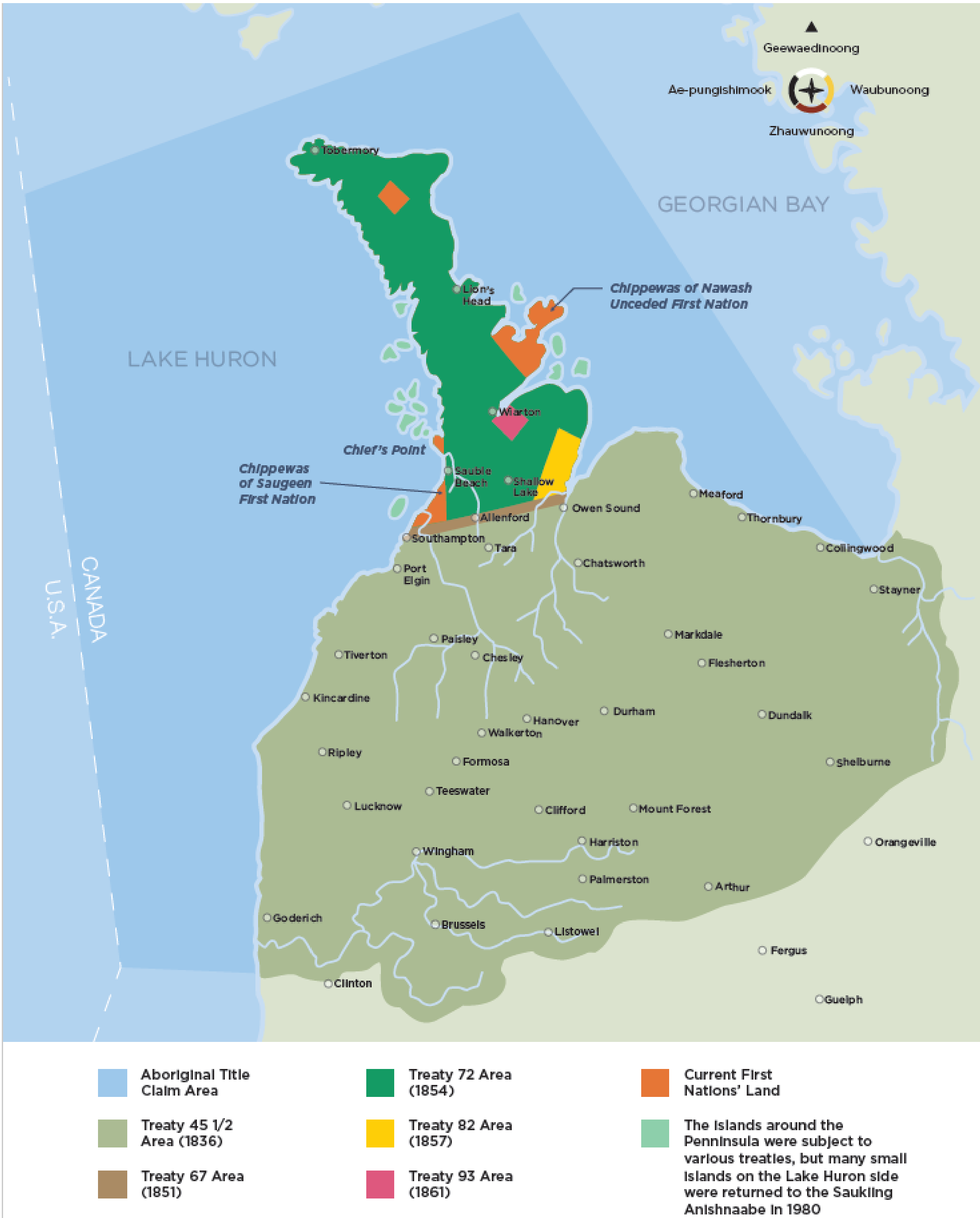


Figure 1 – Saugeen Ojibway Nation (SON)Traditional Territory [R-32]

The SON describes their asserted and established Aboriginal and treaty rights as follows:

“SON has asserted and proven Aboriginal and Treaty rights throughout its Traditional Territory and continues to rely on this Territory for its economic, cultural, and spiritual survival. The SON Territory, including its large reserves, is also the basis of significant and growing commercial fishing and tourism economies. SON asserts its Aboriginal and Treaty rights entitle its members to be sustained by the lands, waters and resources of their Traditional Territory. SON has the right to protect and preserve its Traditional Territory to ensure that it will be able to sustain its future generations. SON asserts that its rights include, but are not limited to:

- The right to continue to be a distinct people living within their Traditional Territory;
- The right to maintain their culture, language and way of life;
- The right to be sustained by the lands, waters and resources of their Traditional Territory;
- The right to the exclusive use and occupation of their communal lands;
- The right to continued use of all of their Traditional Territory;
- The right to harvest for sustenance, cultural and livelihood purposes;
- The right to be meaningfully involved in decisions that will affect their Traditional
- Territory so that they can protect their way of life for many generations to come; and
- The right to be the stewards of their Traditional Territory.

SON has a proven and exclusive Aboriginal and Treaty Right to a commercial fishery in the waters of Georgian Bay and Lake Huron, within SON Territory. Members of SON and their ancestors have been fishing these waters for sustenance and as the basis of trade and commerce for many hundreds of generations, and they continue to do so today. This fact has been recognized by the courts and by the Crown. While Lake Whitefish have significant cultural and economic significance to SON - and have consequently been discussed at length in past proceedings and in these submissions - SON's fishing rights are not species specific and include the right to harvest all species of fish" [R-33][R-34].

2.4.2 Historic Saugeen Métis (HSM)

The HSM is a self-governing Métis community at the mouth of the Saugeen River in Southampton, Ontario. The HSM are an independent, rights bearing community that began with the arrival of trader Pierre Piché in the Saugeen territory in 1818. Its members have historically hunted, fished, traded and lived in the traditional Saugeen territory since the early 1800s and assert harvesting rights based on the R. v. Powley decision of the Supreme Court of Canada. The HSM became independent and self-governing in 2008 and left the MNO in or around 2009. This Métis community is one of the formally organized Métis communities in Ontario that is not represented by the MNO. Its office is found in Southampton. According to the HSM website, the HSM [R-35]: "…are a distinctive Aboriginal community descended from unions between our European traders and Indian women. We are the Lake Huron watershed Métis with a unique Métis history and culture that lived, fished, hunted, trapped, and harvested the lands and waters of the Bruce Peninsula, the Lake Huron proper shoreline and its watersheds, their traditional Métis territory.

The HSM traded in a regional network since the early 1800s as far as the north shore of Lake Huron and have kinship with the Wikwemikong First Nations community and Killarney Métis community. The geographic scope of the contemporary community is described as covering over 275 kms of shoreline from Tobermory and south of Goderich, and includes the counties of Bruce, Grey and Huron. Upon the decline of the fur trade in the early 1820s, Métis families from the Northwest joined these early Métis at Goderich. The community traded in a cohesive regional trading network that extended from the Upper Detroit River system to the northern shoreline of Lake Huron, to the historic Métis community of Killarney, creating kinship along the network from Detroit to Killarney."

2.4.3 Métis Nation of Ontario (MNO)

The MNO was established in 1993 "as a representative organization with the objective to protect, assert, and support the distinct culture, traditions, economic wellbeing, and Métis constitutional rights embodied in the Constitution Act, 1982, Section 35, within the Métis Homelands of Ontario" [R-36]. The MNO has 29 community councils across Ontario, which represents regional rights bearing Métis communities. Three of these councils (Moon River Metis Council, Georgian Bay Metis Council, and the Great Lakes Metis Council) represent a regional right bearing community defined as the Georgian Bay Traditional Harvesting Territory, Figure 2, which includes the area surrounding the Site. These three councils (collectively known as "Georgian Bay Regional Consultation Committee") are distinct from the HSM which are no longer part of the MNO. The MNO and the Georgian Bay Regional Consultation Committee assert that their people exercise Aboriginal rights throughout the territory surrounding the Site. This includes hunting, fishing, trapping, gathering, sugaring, wood harvesting, use of sacred and communal sites, and use of water as described in the MNO's Oral Presentation to the CNSC in the public hearing for Bruce Power's application to renew its operating licence in 2015: "The MNO and their Regional Consultation Committee assert that their people exercise Aboriginal rights throughout the territory surrounding the Bruce site, including, among other things, hunting, fishing (food and commercial), trapping (food and commercial), gathering, sugaring, wood harvesting, use of sacred and communal sites (i.e., incidental cabins, family group assembly locations etc.) and use of water. These rights are protected under the Constitution Act, 1982, section 35, as existing Aboriginal rights that have not been extinguished by the Crown by way of treaty or other means. Métis peoples live in, harvest throughout and extensively rely on their traditional territories for their individual and community's wellbeing" [R-36].

Figure 2 – Métis Nation of Ontario Regions in Ontario

2.5 Bruce Power's Community Engagement

Bruce Power has a long history of engaging and supporting local communities surrounding the Site. Bruce Power's values guide its conduct, decision-making and relationships both on the Site and in the community. To Bruce Power, living its values means conducting business ethically, respectfully, safely and with professionalism. Bruce Power's Code of Conduct is based upon these corporate values and sets a high standard of personal and professional integrity and behavioural expectations for everyone. It provides detailed information, guidelines, and references to other policies and resources that will help the company's employees make the right choices on a daily basis. Bruce Power's engagement with local communities and Indigenous groups is supported by its Public Disclosure Protocol, its Indigenous Relations Policy, and its relationship/engagement agreements with the three Indigenous groups.

2.5.1 Community Investment and Sustainability

Corporate Social Responsibility (CSR) is a core value at Bruce Power. Since 2001, Bruce Power has been making an overall positive contribution to the region. Bruce Power's Community Investment fund has grown over the years and currently supports an annual giving of upwards of $2 million a year through five funding streams: Community Investment & Sponsorship, Environment & Sustainability, Indigenous Community Investment, Gifts in Kind and Tripartite. Since 2001, Bruce Power has contributed approximately $19 million to the local communities. The following sections detail some of the community-related initiatives that Bruce Power has supported in recent years. The Environment & Sustainability (E&S) Fund for 2021 saw the distribution of around $320,000 amongst sponsorship, long term partnerships and events. Established in 2015, the E&S fund focuses allocation of resources to initiatives in the areas of:

- Conservation & Preservation;
- Education, Awareness & Research and;
- Restoration, Remediation & Quality Improvement.

Priority is given to those initiatives within the Grey, Bruce and Huron counties given the Site location.

Bruce Power applies the As Low As Reasonably Achievable (ALARA) concept to minimize the impact of our Site operations on the environment. This means that even when we are well within our regulatory limits, we continue to seek ways to drive our impact even lower, all the while aligning support with broader provincial, national and global goals of sustainability. In 2021, Bruce Power committed to contribute to a Net Zero Canada by 2050 by announcing its commitment to achieve Net Zero greenhouse gas (GHG) emissions from its site operations by 2027. Bruce Power is working to achieve this by identifying and implementing energy and emission-reduction projects in its operations, identifying substitutions for high-emission energy sources and, where further reductions are not feasible, pursuing emission offsets. Through its Net Zero partnership with the Nuclear Innovation Institute (NII), Bruce Power is also funding the development of carbon-offset projects in our local communities through the Carbon Offset Coalition and the Carbon Offset Accelerator Fund. Carbon offsets generated by these projects will also support Bruce Power in meeting its Net Zero by 2027 commitments.

Over the course of 2021, our sustainability program continued to build on a more quantitative and formalized approach with stronger governance that included establishment and tracking of key performance indicators, and targets. Our program continues to be based off the Environmental, Social and Governance (ESG) approach, aligning with global standards, guidelines and best practices. The oversight and endorsement of initiatives to fulfil our aggressive sustainability targets, in both the Environmental and Social areas, sits with a top leadership ESG Committee that was established in 2020. More information on our sustainability program can be found in our 2021 Report, including our 2020 sustainability performance metrics. Our next report including our 2021 performance metrics will be published in June 2022.

2.6 Life Extension Program and Major Component Replacement Project

In December 2015, Bruce Power reached an agreement with the Independent Electricity System Operator (IESO) to advance a long-term investment program to refurbish its nuclear fleet and secure the site's operation until 2064.

The Life-Extension Program started planning activities on January 1, 2016 and involves the gradual replacement of older systems in the company's eight reactor units during routine maintenance outages.

As part of the Life-Extension Program, Bruce Power is carrying out an intensive Major Component Replacement (MCR) Project. The MCR Project activities began in January 2020 and focuses on the replacement of key primary side components in Units 3-8, including steam generators, pressure tubes, calandria tubes and feeder tubes.

Minor modifications were completed for existing Environmental Compliance Approvals as required. These were within the operational flexibility of the ECA and did not impact the environmental limits for effluent. As of February 2022, there were no environmental infractions related to the Life Extension Program or MCR. Environment personnel continue to perform as key stakeholders in Life Extension and MCR projects, providing document reviews and feedback throughout all stages of planning and execution. The Environment staff conduct routine field walk downs and observations; ensuring oversight on activities which have the potential to impact the environment and providing timely guidance on mitigation measures where appropriate.

Environmental Management Plans (EMP's) are created to manage potential environmental risks and mitigation strategies related to the larger project scopes of work. The EMPs are developed to provide project execution vendors with key information regarding the environmental aspects of the activities covered in their scope of work, including conventional and radiological emissions, waste, and spills. The EMPs also provide the execution owner with awareness on items such as regulatory requirements and event reporting expectation. For the remainder of smaller scope planned evolutions, an EMP may not be appropriate but Environmental Impact Workflows (EIWs) are utilized to perform an environmental impact assessment of the activity. EIWs prompt for a description of the activity being performed and contain a series of questions which allows for environment personnel to then assess the risk and provide relevant guidance to ensure any potential environmental risk the activity poses are appropriately managed and mitigated.

Over the course of 2021, many project related milestones were completed with minimal environmental impact as anticipated in the 2017 Predictive Environmental Risk Assessment. Following breaker open on January 17, 2020, Unit 6 was safely taken into a defueled guaranteed shutdown state and the lead in vault work completed. Crews then drained and dried the Moderator and Primary Heat Transport (PHT) systems. With these completed, the major component replacement could begin. The removal series of work started in 2020 and by the end of 2021, the upper and lower feeders had been removed as well as the pressure tubes and calandria tubes. The 8 steam generators were also removed, and new steam generators installed in 2021.

Construction and refurbishment of buildings has continued with preparations for MCR3 at Bruce A: a material handling vestibule has started construction to support transfer of materials from the un-zoned area into zone 3 of Unit 3, refurbishment of spaces at Bruce A for offices for additional personnel, construction trailers for the crane pad, and an Auxiliary Guardhouse for Bruce A.

Environment assessment and guidance is integrated throughout all the projects related to MCR; starting at the planning stage and continuing through to execution to ensure that EMP and EIW guidance and requirements are adhered to. As the execution of Unit 6 MCR progresses, planning and preparation is well underway with respect to Unit 3 MCR ensuring that previous experience and lessons learned are being incorporated.

3.0 DOSE TO PUBLIC

Canadians are regularly exposed to ionizing radiation as part of their everyday lives [R-37] [R-38] [R-39]. This is partly due to exposure to naturally occurring cosmic radiation from the sun and stars and from terrestrial radiation from radioactive materials (e.g. uranium, thorium and radium) that naturally exist in soil and rocks. Radon is a naturally occurring radioactive gas that is produced by the earth's crust and is present in the air. A variety of foods contain natural sources of radiation including potatoes, carrots, bananas, milk and red meats. The effective dose from natural radiation in Canada is estimated to be 1,800 µSv/year [R-38]. Other locations in the world have higher exposure rates, for example, the Kerala Coast in India has an annual effective dose of 12,500 µSv/year [R-38].

In addition to these sources, human activities also contribute to overall radiation exposure, such as air travel, smoking and medical or clinical services such as X ray machines and CT scanners. For example, a cross country flight (20 µSv), tobacco and smoke detectors (100 µSv), a dental (5 µSv) or chest (100 µSv) x-ray, or a CT scan (7,000 uSv) adds to a person's overall radiation dose [R-40].

Living near a nuclear power plant also contributes to annual dose as radionuclides associated with CANDU reactors are released to the environment as part of normal operation. These discharges to air and water are heavily regulated in Canada and limits are imposed to ensure levels are safe to workers, the public and the environment. The annual dose limit for a member of the public is 1,000 µSv per year [R-41]. As part of the regulatory requirements, Bruce Power must calculate and report its contribution to radiological exposure dose to members of the public on an annual basis.

The annual doses are calculated using the computer code IMPACT following the methodology described in CSA N288.1 [R-23]. The approach uses a radionuclide transport and exposure pathways model that incorporates concentrations of radionuclides measured in environmental media, human characteristics specific to local behaviors and lifestyles, site specific meteorological data, as well as facility characteristics and radiological release information. The details are described in the sections below, however the overall outcome for 2021 is provided here.

For the 30th consecutive year, Bruce Power's contribution to the annual dose of a member of the public is less than the lower threshold for significance (<10 µSv/year) and is considered *de minimus* [R-42]. The representative person's dose associated with Bruce Power operations in

2021, who is calculated to have the maximum, is the BSF3 Adult who received 1.6 µSv/year (Table 1). All other representative persons have a lower dose. This maximum dose is a fraction of a percent of the legal dose limit of 1,000 µSv/year.

Table 1 - 2021 Maximum Representative Person's Dose

Maximum Representative Person	Committed Effective Dose	Percentage of Legal Limit
BSF3 Adult	1.6 µSv/year	0.16%

The contribution of each radionuclide/radionuclide group to the 2021 radiological dose for the maximally exposed representative person is shown in Table 2 and Figure 3. Consistent with previous years, most of the radiological dose is from two radionuclides (carbon-14 ~ 60%, tritium oxide ~ 30%). Exposure pathways to these radionuclides are predominantly ingestion of local food sources as well as air inhalation and immersion.

Table 2 - 2021 Radiological Dose by Contaminant for Representative Persons Group BSF3 Adult

	C-14	Co-60	Cs-134	Cs-137	HTO*	I (mfp)	Noble Gases	Total
Dose (µSv/a)	8.8E-01	9.1E-03	3.4E-02	3.4E-02	5.2E-01	5.2E-08	8.6E-02	1.56E+00
Percentage	56%	1%	2%	2%	33%	0%	6%	100%

Notes:

BSF3 is Subsistence Farmer 3.

Radionuclides: Carbon-14, Cobalt-60, Cesium-134, Cesium-137, Tritium oxide, Iodine (mixed fission products), Noble Gases.

* Includes dose incurred via ingestion of Organically Bound Tritium (OBT) in fish, plant produce, and animal products. OBT - tritium is bound to organic matter, resulting from tritium being incorporated in various organic compounds during the synthesis process of living matter.

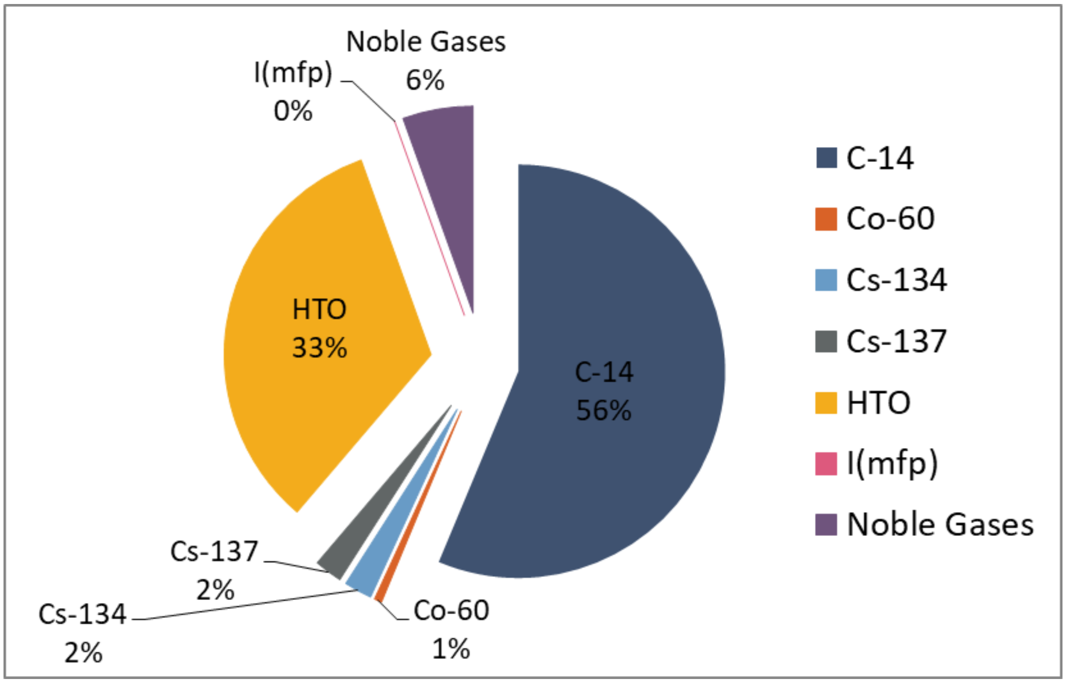


Figure 3 - 2021 Radiological Dose by Contaminant for Representative Persons Group BSF3 Adult

3.1 Historical Dose to Public

The additional contribution on the annual radiation dose to members of the public from Bruce Power Site activities has been below the level of significance (<10 µSv/year) for 30 consecutive years. The annual maximum dose for the last ten years is shown in Figure 4. Although the value fluctuates based on operational or maintenance activities that occur (e.g. preparations in advance of the vacuum building outage in 2015), the outcome is only a small fraction of a percent of the legal limit of 1,000 µSv/year. It is also a small contribution to the annual dose experienced from natural radiation in Canada (1,800 µSv/year) [R-38]. The calculation of public dose demonstrates that the radiological emissions from the Bruce Power Site have an extremely small impact on public dose.

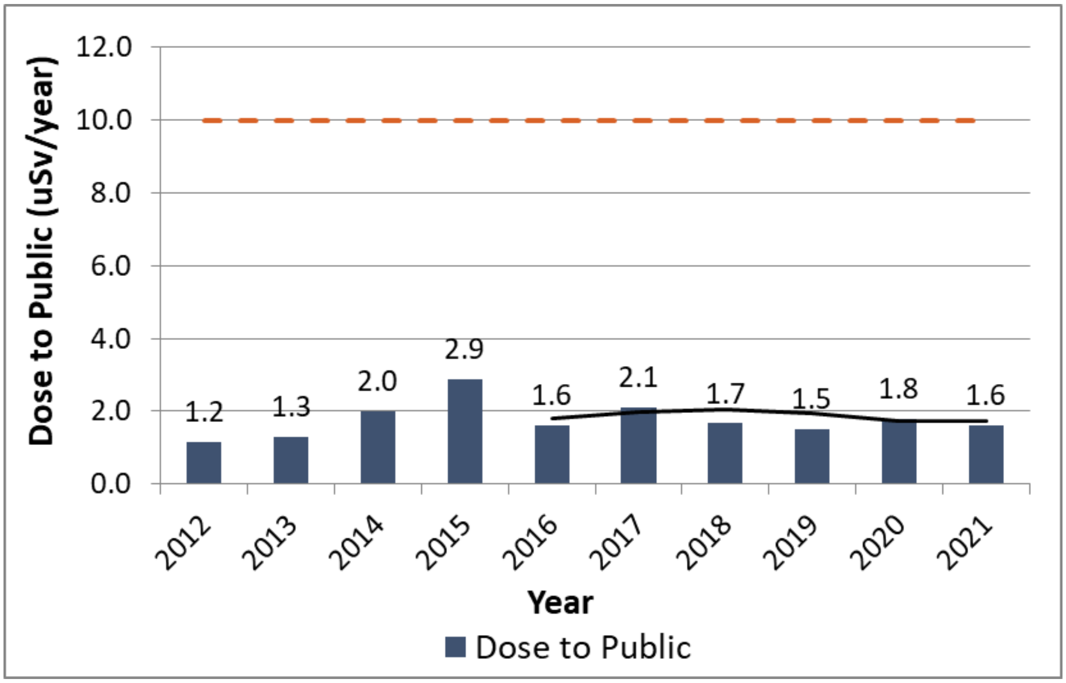


Figure 4 - Historical Dose to Public Over Time (Dose Limit 1000 µSv/year)

3.2 Methodology

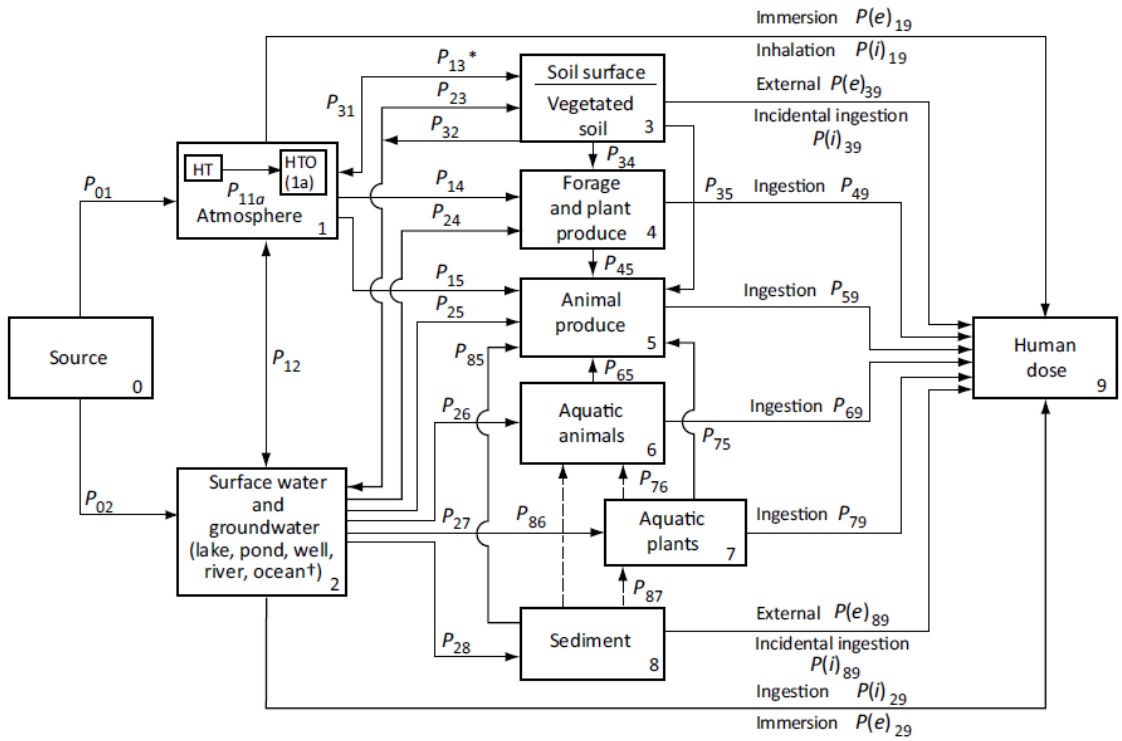
Living near the Bruce Power Site results in an additional radiation dose to members of the public due to radiological releases to the environment as part of normal operation. The additional contribution to a person's overall dose is calculated each year and provided in this report.

The following information is required for calculating the public dose:

- Annual radiological airborne emission and waterborne effluent data from all licensed facilities on or adjacent to the Bruce Power Site (Section 5.1)
- Annual radiological environmental monitoring data (Section 6.1)
- Annual meteorological data (Section 3.3)
- Characteristics of the Representative Persons (Section 3.5)

The methodology used to calculate annual public dose from normal operations at CANDU nuclear power stations is described in CSA N288.1- [R-23]. A radionuclide transport and exposure pathways model is used which relies on an array of mathematical equations that describe the transfer of radioactive materials through the environment, as depicted in Figure 5 [R-23]. This pathways model may be likened to a food web that is specific to the local area and population. For example, one pathway could be of a radiological contaminant (e.g. tritiated water) released to the air that is deposited on a field and taken up by the plants. Dairy cattle may eat these plants, which may impact the cow's milk that is ingested by a child.

These elaborate networks are set up in computer software called IMPACT (Integrated Model for the Probabilistic Assessment of Contaminant Transport). IMPACT is a customizable tool that allows the user to assess the transport and fate of a contaminant through a user-specified environment. All of these exposure pathways are summed together in order to quantify the overall human exposure (i.e. dose). CSA N288.1 provides the transport and exposure factors for each step, as well as default values for human and site characteristics, which are refined for the local area based on the Site Specific Survey and annual meteorological data [R-23].



* Includes transfer factors P_{13area}, P_{13mass}, and P_{13spw}.

† For ocean water, pathways P_{23}, P_{24}, P_{25}, and $P(i)_{29}$ are not used.

Notes:

1) *The broken lines represent pathways that are not explicitly considered in the model or are considered only in special circumstances.*
2) *Factors include multiple transfers where appropriate.*

Figure 5 - Environmental Transfer Model (Extracted from CSA N288.1)

Measured concentrations of radiological contaminants in environmental monitoring data are used in calculating dose. The data is verified and the background is subtracted before being entered into the IMPACT model by a third-party independent contractor. All data undergoes a QA/QC review prior to the dose calculation. For some radionuclide/media combinations, concentrations are below the limit of detection of the measuring equipment and thus may inhibit the ability to measure the desired radionuclide. In cases where monitoring data are not available for a particular exposure media, the available environmental monitoring data are used to calculate or define the missing radionuclide concentrations in the intermediate media as far along the exposure pathway (i.e. food chain) as possible. If no data is available for any media along a specified exposure pathway, transport modelling and emissions/effluent data (either atmospheric or aqueous) are used to define the radionuclide concentrations in the exposure media.

The exposure pathways used in the model for each of the radionuclides that contribute significantly to dose, based on sample medium, are shown in Table 3. The dose contributions from each of these exposure pathways are summed to give a total overall dose for each of the representative persons and age groups (i.e. infant, child and adult). These three age groups are used to refine exposure based on diet and lifestyle differences. The maximum result is taken as the "dose to public" for the year, with all others having a lower dose. As per the Radiation Protection Regulations SOR/2000 203, the public radiation dose limit for a year is 1000 µSv (100 mrem) [R-41].

Table 3 - Radionuclides Measured as Part of Radiological Environmental Monitoring

Radionuclide	Sample Medium	Exposure Pathway
Tritium oxide (HTO)	Air	Inhalation (includes skin absorption)
	Water (drinking water, surface water, well water)	Ingestion
	Water (precipitation, groundwater)	Ingestion
	Plants (fruits, vegetables, grains)	Ingestion
	Animals (meat, milk, honey)	Ingestion
	Fish	Ingestion
Carbon-14	Air	Inhalation, External
	Plants (fruits, vegetables, grains)	Ingestion
	Animals (meat, milk, honey, eggs)	Ingestion
	Fish	Ingestion
Gamma (e.g., Cs-137)	Air	Inhalation, External
	Water (surface water)	Ingestion
	Animals (meat, honey)	Ingestion
	Fish	Ingestion
	Sediment	External
	Soil	External
Gross Beta	Water (drinking water, surface water, well water, precipitation)	Ingestion
Iodine-131	Site emissions	Air inhalation, Air external Terrestrial animals (ingestion)
	Milk	Ingestion
Noble Gases ($t_{½}$~days)	Air	Air External
Organic Bound Tritium (OBT)	Fish	Ingestion

3.2.1 2021 Dose Calculations

For 2021, the basic set-up of the IMPACT model, in terms of transfer parameters and environmental variables, is identical to that used in 2020, as well as in the most recent ERA and DRL updates. The general physiological characteristics of the representative persons (e.g. inhalation rates, water ingestion rates, food intake rates) were the mean values taken from CSA N288.1 [R-23].

The fractions of ingested foodstuffs that originate from local sources (backyard gardens or local farm markets) are based in part on the results of the most recent Site-Specific Survey (Section 3.4). The net percentage contribution of each specific food type (e.g., fruits or beef) to each major category of consumption (i.e., total plant product or animal product) is based on both the local fraction and the generic intake rates. Local percentage of food intake from local sources and rates of intake used are provided in 10.0Appendix C:

The emissions/effluents that were directly considered in the dose calculation process include HTO, C-14, noble gases, and radio-iodines. For the purpose of public dose calculations, it is assumed that iodine emissions are in the form of mixed fission products (mfp), assumed to be present in a ratio associated with a state of secular equilibrium (i.e. other radionuclides from I-131 to I-135 are assumed to be present). The dose calculation process assumes that all iodine is I-131 for longer duration pathways (i.e., anything related to sediment or soil partitioning, or bio-uptake), but for shorter duration pathways (i.e., air inhalation or immersion, lake water immersion or ingestion) the full release is equivalent to I(mfp). In modeling the environmental transport and partitioning of radio-iodines, there is assumed to be no isotopic discrimination, and that I(mfp) behaves the same as I-131.

In 2018, it was decided *a priori* to assume that all reported beta/gamma emissions and effluents were Co-60, consistent with the approach applied in the ERA [R-43]. This assumption has been shown to be conservative, very likely over-stating the actual dose that could be associated with Bruce Power emissions and effluents. It should be noted that doses for Cs-134 and Cs-137 are still calculated where direct environmental measures of those radionuclides are available through the REM program. For alpha emitters, it has been determined in past analysis, including the ERA that alpha emitters are released at rates which lead to public doses that are negligible. For this reason, alpha emissions are not included in the dose calculation process.

In 2021, the approach taken when REM data included values that were less than the associated detection limit (Ld) or critical level (Lc), those values were taken as reported. For example, in the calculation of local or background averages where some measured values were reported as less than Lc or Ld, the uncensored analytical results were used in the calculation. In most cases, the resulting doses are slightly more conservative (i.e., higher) in using this approach.

For 2021 dose calculations [R-44], the following conservative measures were taken to address unavailable data or measured values being lower than background:

- In 2021, no milk sample was available for locations BDF13 and BDF14. The average results for the milk samples collected from the nearest dairy farm that is closer to the sources of emissions (i.e., BDF15) was applied for these locations.

- BR32 shallow well water data was not available for 2021 so the 2019 values were used instead.
- For deep residential wells, the activity level of HTO in all samples collected in 2021 was reported to be less than the critical level. In this specific case, the critical level itself was assigned, with adjustment for background, as the representative value for HTO in all deep residential wells. The public dose associated with HTO in deep residential wells is in the order of 0.01 µSv/year or less.
- The activity level of HTO or C-14 in some local samples of food products (e.g. honey, eggs, poultry, milk and fish) collected in 2021 was lower than the corresponding activity in background samples. To quantify the HTO or C-14 activity in these media, the environmental transport models in IMPACT were invoked.

3.3 Meteorological Data

Meteorological data are required in order to calculate doses to the public resulting from the operation of nuclear facilities on the Bruce Power site. Specifically, the processed meteorological data in the format of Triple Joint Frequency (TJF) are required as inputs to the computer code IMPACT for public dose calculations. The calculation of joint frequency data used by Bruce Power meets the requirements described in Clause 6.1.4 of CSA N288.1-20 [R-23].

There are two meteorological towers at the Bruce Power site; one 50m on-site tower and one 10m off-site tower. These towers were installed in 1990 at specific locations to ensure that the meteorological measurements are representative of local atmospheric conditions experienced, and to better account for how emissions are conveyed inland.

In order to be used for calculating the TJF, the annual data collection must be 90% complete as per Clause 4.3.2.6 of CSA N288.2-19 [R-45]. Over the past few years there have been significant data gaps due to multi-faceted recurring issues that included obsolete or unsupported instrumentation and/or equipment. As a consequence, the five-year average data set has been used in the past as a surrogate.

In 2020, both the on-site and off-site meteorological towers were upgraded. For the 10m off-site tower, the old tower and foundation were replaced. The obsolete data loggers were replaced with a new upgraded model with improved functionality from the same manufacturer (Campbell Scientific CR1000X). The data logger software was upgraded, and the associated modem and communication equipment was replaced. The anemometer was replaced with one that has hydrophobic coating properties to prevent freezing during winter months. New to this station is a temperature sensor and precipitation gauge capability. All data monitoring equipment (with exception of the precipitation gauge monitor) has been equipped with a battery back-up that is sufficient for approx. 20-25 consecutive days. The indoor equipment building has been removed, and all equipment is housed inside weather-proof enclosures designed to withstand and protect the equipment from inclement weather.

For the 50m on-site tower upgrade no changes were made to the tower or foundation; however, the same upgrades to equipment/instrument/software as those completed for the 10m off-site tower were made to the 50m tower.

The data availability analysis results for the two meteorological towers for 2021 is shown in Table 4.

Table 4 - Summary of Data Availability for 2021

Data Source	Available Records	Total Records Planned	Record Availability (%)
10m Tower	8760	8760	100
50m Tower	8744	8760	99.8

The data availability in the 2021 raw meteorological data met the 90% data availability requirement and were used to calculate the Double Joint Frequency (DJF) and TJF for the Site [R-46]. The methodology for obtaining the DJF and TJF, as well as the results for the 50m tower is provided in 10.0Appendix B:.

3.4 Site Survey

The Site Specific Survey Report includes a collection of information on the local population and the environment surrounding Bruce Power. The report is used to support a number of site programs, such as calculation of Derived Released Limits (DRL) of radiological environmental releases, Emergency Preparedness, the REM program, Safety Reports and license renewal. The Site Specific Survey is updated typically every five years to reflect recent changes to the area surrounding the Bruce Power site.

The survey report includes meteorology, land usage, population distribution, water usage, agriculture, recreational activities and food sources in the area. In addition, information on daycare centers, before and after school programs, long term care homes, school boards, and recreational parks located within 20 km of the Bruce Power site are documented. The diet and lifestyle data collected is used to identify groups of people with similar characteristics to develop or refine the “representative persons” (see 3.5). These unique groups are used for dose to public calculations as per CSA N288.1-20 [R-23].

The Site Specific Survey Report was updated in 2021 and focused on refining the characteristics of the Hunter/Fisher receptor (BHF) to better reflect the behaviours and practices of local First Nations and Métis groups. Diet surveys were co-developed and completed in 2019-2021 by members of SON, MNO and HSM. An independent third party reviewed and then consolidated the individual results to update the BHF receptor characteristics with the most conservative parameters. This ensures that the dose calculation is representative of the local population. The updated BHF receptor will be used for all dose calculations going forward, including the 2022 Environmental Risk Assessment.

3.5 Representative Persons

Doses received by individual members of the public as a result of a given radionuclide release vary depending on factors such as proximity to the release, dietary and behavioral habits, age and metabolism, and variations in the environment [R-23]. A homogenous group of individuals with the same exposure factors may be grouped together, where the individual that receives the highest dose within that group is considered the representative person of that group. Each representative person is broken down into three age classes (i.e. infant, child, adult) in order to account for different diets, breathing rates and dose coefficients.

The Site Specific Survey Report provides the information needed to refine the stock human characteristics provided in CSA N288.1 to include local environmental and lifestyle information. This includes details like where people live in relation to Bruce Power, where a person's drinking water comes from, how much local food a person consumes and how much time is spent outdoors.

The following categories of representative persons have been identified based on distinct lifestyle and proximity to the Site:

- **Non-farm resident** - The non-farm resident is considered the typical, full-time resident in the area surrounding the Site. They get a large portion of their food from grocery stores.
- **Farm resident** - The farm resident is more likely to consume their own crop or livestock, but still use grocery stores for a portion of their food intake.
- **Subsistence farm resident** - The subsistence farm resident gets a larger portion of their food, milk and water from local sources, over half of their diet is self-produced.
- **Dairy farm resident** - The dairy farm resident is assumed to consume some fresh milk from their own farm and a slightly higher fraction of locally grown produce and livestock.
- **Bruce Eco Industrial Park worker** - For consistency with previous studies, the Bruce Eco Industrial Park worker is referred to as a BEC worker, which corresponds to the former name of the facility, the Bruce Energy Centre. The assessment for a BEC worker represents occupational exposures at a location near the facility. It is assumed that the BEC worker does not also live at one of the other selected receptor locations, i.e., the BEC dose is independent of the other representative person doses.
- **Hunter/Fisher** - The hunter/fisher resident (BHF) represents individuals who may catch and consume wild game and fish in significantly greater quantities than other residents. Hunter/fisher dietary characteristics are based on the diet survey results completed by local First Nations and Métis groups. They are assumed to obtain all of their fish and wild game from local sources and consume greater quantities of these foods than the average Canadian diet. For other food categories, some is sourced locally while the remainder is from grocery stores.

A total of 19 representative persons were selected, each comprised of an adult (16 to 70 years old), child (6 to 15 years old), and infant (0 to 5 years old) [R-23], except for the Bruce Eco Industrial park worker, who is assumed to be an adult. All representative persons were chosen based on proximity to the Site (i.e., all locations are within 15 km from the Site), with the exception of the hunter/fisher, who is located approximately 20 km north of the site. A description of the representative persons by group name is provided in Table 5 and the locations are shown on Figure 6.

Table 5 - Description of Representative Persons

Group Name	General Characteristics and Location of Group
BR1	Non-farm resident, lakeshore at Scott Point (Located to the northeast of Bruce A at a distance of approximately 2 km and northeast of Bruce B at a distance of approximately 5 km)
BR17	Non-farm resident, inland (Located to the southeast of Bruce A at a distance of approximately 4 km and east of Bruce B at a distance of approximately 5 km)
BR25	Non-farm resident, inland (Located to the south of Bruce A at a distance of approximately 5 km and to the southeast of Bruce B at a distance of approximately 4 km)
BR27	Non-farm resident, inland, trailer park (Located to the south of Bruce A at a distance of approximately 5 km and to the southeast of Bruce B at a distance of approximately 3 km)
BR32	Non-farm resident, lakeshore (Located to the south of Bruce A in Inverhuron at a distance of approximately 6 km and to the south of Bruce B in Inverhuron at a distance of approximately 3 km)
BR48	Non-farm resident, inland (Located to the southeast of Bruce A near Baie du Doré at a distance of approximately 2 km and to the east of Bruce B near Baie du Doré at a distance of approximately 3 km)
BF8	Agricultural, farm resident (Located to the south of Bruce A at a distance of approximately 8 km and to the southeast of Bruce B at a distance of approximately 7 km)
BF14	Agricultural, farm resident (Located to the south of Bruce A at a distance of approximately 5 km and to the southeast of Bruce B at a distance of approximately 3 km)
BF16	Agricultural, farm resident (Located to the southeast of Bruce A at a distance of approximately 7 km and to the east of Bruce B at a distance of approximately 8 km)
BSF2	Agricultural, subsistence farm resident (Located to the southeast of Bruce A at a distance of approximately 9 km and to the southeast of Bruce B at a distance of approximately 9 km)
BSF3	Agricultural, subsistence farm resident (Located to the southeast of Bruce A at a distance of approximately 8 km and to the southeast of Bruce B at a distance of approximately 8 km)
BHF1	Generic hunter/fisher resident (Located approximately 20 km north of the Site in Southampton)
BDF1	Agricultural, dairy farm resident (Located to the northeast of Bruce A at a distance of approximately 11 km and to the northeast of Bruce B at a distance of approximately 14 km)
BDF9	Agricultural, dairy farm resident (Located to the southeast of Bruce A at a distance of approximately 13 km and to the southeast of Bruce B at a distance of approximately 12 km)

Group Name	General Characteristics and Location of Group
BDF12	Agricultural, dairy farm resident (Located to the east of Bruce A at a distance of approximately 13 km and to the northeast of Bruce B at a distance of approximately 15 km)
BDF13	Agricultural, dairy farm resident (Located to the southeast of Bruce A at a distance of approximately 13 km and to the southeast of Bruce B at a distance of approximately 12 km)
BDF14	Agricultural, dairy farm resident (Located to the southeast of Bruce A at a distance of approximately 14 km and to the southeast of Bruce B at a distance of approximately 13 km)
BDF15	Agricultural, dairy farm resident (Located to the southeast of Bruce A at a distance of approximately 13 km and to the southeast of Bruce B at a distance of approximately 12 km)
BEC	Worker in Bruce Energy Centre (Located to the southeast of Bruce A at a distance of approximately 4 km and to the east of Bruce B at a distance of approximately 4 km)

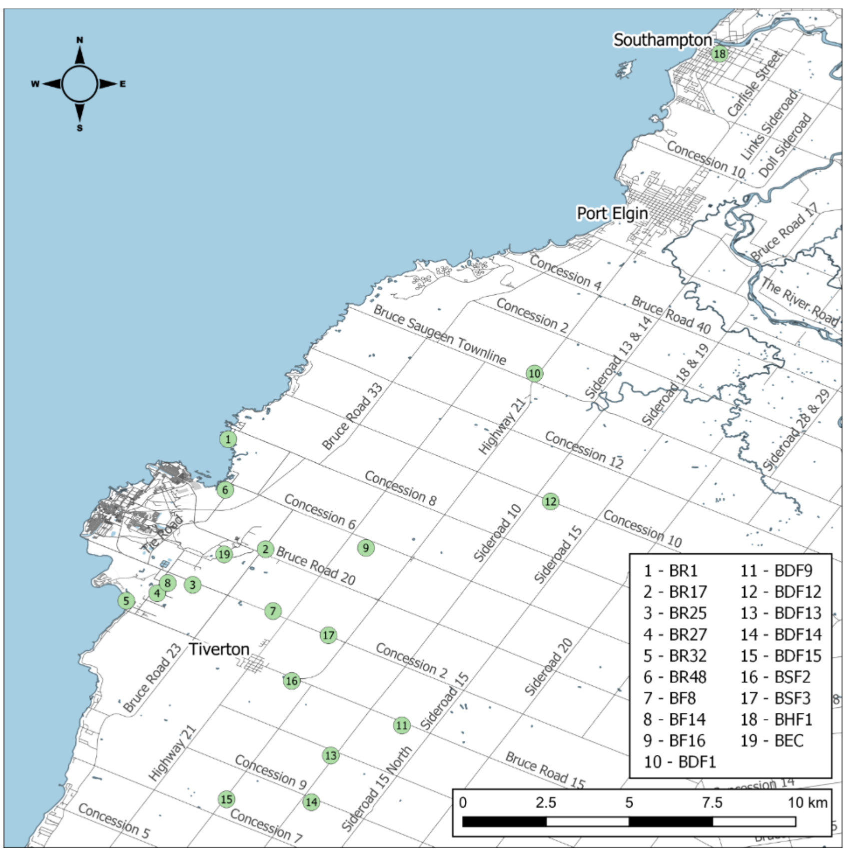


Figure 6 - Representative Person Locations

3.6 Dose Results and Interpretation

The maximum dose to a member of the public in 2021 was obtained for the Subsistence Farmer BSF3 Adult with a value of 1.56 µSv/year [R-44] and remains well below the public dose limit of 1000 µSv/year [R-41]. This is a decrease of about 11% compared to the maximum dose calculated in 2020 (1.76 µSv/year) for the same representative group and age class. The calculated dose for this BSF group has been the highest of all groups for all but one year (2019) since this group was added in 2012.

In 2021, the doses calculated for the Subsistence Farmer group at both locations (BSF2 and BSF3) were in the range of 1.29 to 1.56 µSv/year. No other group exhibits doses in this range except for the BR1 group, which has doses ranging from 1.19 to 1.55 µSv/a. Doses to the various representative locations and age classes of the Dairy Farm (BDF) group and also Farm (BF) groups range from 0.69 to 1.17 µSv/year. The doses calculated for the non-farming Resident (BR) group at various locations in close proximity to Bruce Power are mostly less than 1 µSv/year. Groups BR1 and BR48 are exceptions, with doses ranging up to 1.55 µSv/year, which is higher than doses determined for these and other non-farm Resident groups in recent years. The doses calculated for members of the Hunter-Fisher (BHF) group near Southampton were between 0.35 and 0.42 µSv/year, and about 30% lower than doses calculated for 2020. The BEC Adult had the lowest calculated dose with 0.08 µSv/year. Annual doses calculated for 2021 for all representative groups and age classes are provided in Section 10.0Appendix C:.

A substantial majority (60 to 85%) of the total dose to the BSF group and other farm-based groups has been associated with food ingestion, which simply reflects the relatively high rate of local food consumption by members of these groups. For most of the non-farm residential groups, the proportion of total dose associated with food ingestion is <50%, which is notably lower than that of farm-associated groups and consistent with previous years. For the non-farm residential group BR1 the relative proportion of food-related dose is slightly higher than other non-farm groups and also higher than in previous years. For the Adult receptor in the BR1 group, almost 60% of total dose is food-related. This is largely owing to a single sample of garden vegetables collected in 2021 that had levels of HTO several times higher than in previous years. This demonstrates the sensitivity and responsiveness of the dose calculation procedure to REM data.

Aside from food consumption, direct exposure to radionuclides in air via inhalation and immersion is the only other significant contributor to total dose, accounting for about 15% to 45% of dose for farm-based groups (BDF, BF, BSF) and 40% to 65% for the residential (BR) group. These general patterns are consistent with the patterns observed for the past decade.

The main contributing radionuclides to the limiting dose (BSF3 Adult) are carbon-14 (C-14) at ~55 % of total dose and tritium oxide (HTO) at ~35% of total dose. Overall, C-14 and HTO (including organically bound tritium, OBT) combined account for an average of about 82% of the total dose for all groups of representative persons that have been considered in 2021. This dominance of C-14 and HTO as contributors to total dose in 2021 is consistent with the findings of public dose calculations over the past decade. Noble gases were the only other radionuclide group to contribute consistently more than 1% of public dose.

The slight decline in public dose in 2021 relative to 2020 is in large part associated with a decrease in dose from C-14, with the proportion of C-14 to total dose decreasing by almost 40% on average in 2021. This change is associated with lower concentrations of C-14 measured in air and numerous food-related media in 2021. The decline in calculated dose is also partly due to the availability of certain food samples (e.g., beef and poultry) in 2021 that were not available in 2020. In absence of samples in 2020, the calculated dose was based on conservative model estimates of radionuclide activity in these media. This illustrates the general sensitivity of the dose calculation process to the availability and reliability of measures of C-14 in the environment, particularly in plant and animal food products and in air. For HTO, contributing >30% to public dose on average, the emission trends are roughly paralleled by measures in air and various other media, including fruits, vegetables and most animal products.

With the exceptions of residential locations BR1 and BR48, each of the locations of representative persons experienced a decrease in total dose from 2020 to 2021, with an overall average decrease of about 5%. The decrease in calculated doses is driven mainly by a decrease in measures of C-14 in air and food. In 2021, ingestion of C-14 in plant and animal products from local sources accounted for about 35% of the total public dose on average.

Overall, the calculation of public dose demonstrates that the emissions and effluents from Bruce Power facilities have an extremely small public dose impact. The maximum public dose associated with Bruce Power operations in 2021 (i.e., 1.56 µSv/year for the BSF3 Adult) is still only a fraction of a percent of the legal limit (i.e., 1,000 µSv/year) [R-41] and of the average Canadian background dose (i.e., 1,800 µSv/year) [R-47]. It is also well below the *de minimus* threshold of 10 µSv/year and is considered negligible [R-42].

4.0 ENVIRONMENTAL RISK ASSESSMENT (ERA)

4.1 Results of the 2017 ERA

A retrospective and predictive ERA was prepared following the guidance of CSA N288.6-12 in 2017. An updated version of the ERA was submitted in December 2018 and incorporated comments from the CNSC and Indigenous groups as applicable and applied a different approach to the thermal risk assessment (see [R-48][R-49]]).

CNSC and Environment and Climate Change Canada (ECCC) staff reviewed the December 2018 ERA and PERA submissions and updates. They concluded that the potential risk from physical stressors and from radiological and non-radiological releases to the environment are generally low to negligible and that the ERA was completed consistent with the overall methodology of N288.6-12 [R-50].

The ERA found that operation of the Site has not resulted in adverse effects on human health or nearby residents or visitors due to exposure to non-radiological substances. Risks to ecological receptors from exposure to non-radiological substances were limited to exposure to soil in a small number of former industrial areas on site. These included the former construction landfill, and the fire training facility. A small number of non-human receptors were identified as potentially at risk. However, it should be noted that the conservative nature of the assessment likely overestimates the actual risks. Risks to fish and wildlife populations due to physical stressors were generally considered to be negligible, with a low to moderate risk related to thermal effects for cold water species such as Round Whitefish. This low to moderate risk was expected to be limited to a small geographic area and thermal monitoring and modelling has continued in order to further refine the risk related to thermal effluent and cold water fish species.

The radiation doses to members of the public residing in the area surrounding the Site are less than 1% of the CNSC effective dose limit for a member of the public (1 mSv/y). There is no radiological risk to human health for members of the public resulting from normal operations on the Site. The radiation dose rates to non-human biota residing on or near the Site are less than 10% of the applicable United Nations Scientific Committee of the Effects of Atomic Radiation (UNSCEAR) benchmark values of 2.4 mGy/d for terrestrial biota and 9.6 mGy/d for aquatic biota. There is no radiological risk to non-human biota resulting from normal operations on the Site.

4.2 Preparation of the 2022 ERA

The ERA fulfills the environmental protection requirements under the Nuclear Safety and Control Act. The Canadian Impact Assessment Act does not apply. An important area of focus related to the ERA is public and Indigenous engagement. Bruce Power plans to proactively share the results of the draft 2022 ERA with indigenous Nations and Communities prior to the submission in 2022. The ERA process is meant to provide an on-going analysis of a company's interaction with the environment. Completion of the ERA on a 5-year cycle is supported by annual EPR reports and both documents are subject to in-depth regulatory review. The next ERA is nearing completion and will be submitted in June 2022. All items listed in the closure of the 2017 ERA will be addressed in the 2022 ERA, including:

- Comparisons for I & E loss estimates;
- Measurement of hazardous and radiological contaminants in the South Railway Ditch
- Improvements to the description of physical interactions between the thermal effluent discharge and the aquatic environment;
- Assessment of Deepwater Sculpin populations;
- Improved reptile and amphibian assessment;
- Updated comparisons between modelled and measured tritium concentrations in groundwater (including well BATR-1-14B);
- A description of the handling of radiological contaminants below detection limits;
- A full disposition of all Tier 1 screening exceedances with clear rationale for COPC inclusion;
- Consideration of all Tier 1 screening guidance recommended by CNSC and ECCC;

- Continued soil monitoring at sites with Hazard Quotients above 1.0 in the 2017 ERA;
- Continued sediment monitoring at Scott Point;
- Reassessment of thermal benchmarks for larval and embryonic Round Whitefish and larval Deepwater Sculpin, and;
- Improvements to the thermal risk assessment.

In 2020, Bruce Power engaged in a series of four meeting with CNSC and ECCC to clarify the thermal risk assessment plan for the 2022 ERA and provide an opportunity for regulatory feedback into the thermal risk assessment plan. Meetings and discussions continued in 2021 and the updated thermal risk assessment will be presented in the 2022 ERA.

Based on the review of the past concerns raised by Indigenous communities, all technical considerations within the construct of the CSA N288.6 framework have been dispositioned. Bruce Power has taken action in response to many of these concerns and continues to work actively with indigenous Nations and Communities. Bruce Power remains committed to having ongoing consultation and discussions with all three Indigenous Nations and Communities to ensure we enhance our monitoring programs to address areas of concern and interest. During the 2018 licence renewal process, Bruce Power presented their commitment to enhance the involvement of SON, MNO and HSM in environmental monitoring in a manner that best suits their communities. Recognizing that every community has a unique set of interests, we have, and will continue to work with each community.

The design and use of existing mitigation technologies has been implemented to minimize impingement and entrainment and thermal impacts to the greatest extent possible. The Bruce Power site location, situated on the Douglas Point headland, was strategically picked because of its high energy zone with access to cold, deep water. The headland juts into Lake Huron providing a natural feature for dispersion of thermal effluent and the shoreline location itself is naturally low in diversity of fish species due to high wave action and winter ice movement. In 2020, Bruce Power submitted an assessment of feasible mitigation measures for thermal effluent and impingement and entrainment effects at the Bruce Power site [R-51]. The results of this mitigation measures assessment are integrated into the ERA and any changes to mitigation technologies will be integrated into future ERAs. Given the overall current low impact of thermal effluent, impingement and entrainment on aquatic biota in Lake Huron, no additional mitigation measures will be actively implemented at the present time [R-52]. The update of the assessment of feasible mitigation measures within the ERA on a 5 year cycle provides a continual surveillance of potential mitigation measures in the event that continued monitoring of thermal effluent, impingement and entrainment show a significant increase in environmental impact to aquatic biota.

One of the benefits of using the ERA construct is the regular check in points with regulators and the public as an ERA reoccurs every 5 years on an ongoing basis. This gives all parties an opportunity to contribute, identify concerns and incorporate new studies or advances in science as per N288.6 guidance. This process allows for the identification of emerging trends and identifies any new risks that may arise, which is a further enhancement from past assessment processes. Indigenous groups and other members of the public will continue to participate in and provide feedback on the ERA. We are actively engaging and providing

Indigenous groups and the public opportunities to discuss topics of interest such as thermal effluent and impingement and entrainment of fish. However, this dialogue is not new and the company's future operations will not differ from what has been experienced and monitored since 2001; the company is confident in its conclusions and will continue to monitor and confirm the facility operates within these limits.

The ERA includes a Predictive Effects Risk Assessment (PERA) which considers future site works and activities that may interact with the environment. The PERA focuses on what is planned for the next 5 years which includes Lu-177 production, Life-Extension and MCR activities and routine operations. No interactions were identified in the PERA that may pose any unacceptable risk to humans or the environment during future Site activities, including MCR. Where activities were considered to be materially different than existing operations, a predicted bounding condition was developed and screened against accepted values for the protection of human health and the environment. In all cases, potential effects were predicted to be less than screening criteria for adverse effects.

The environmental effects and interactions that were discussed in this report will be continually evaluated throughout the MCR planning stages through involvement of the Environment Department as a stakeholder in the design process and planning of MCR activities. Environmental Management Plans continue to be implemented and executed with the appropriate Environmental oversight, as required for certain MCR activities.

In summary, activities at the Bruce Power site, including MCR activities, will continue to be executed in a manner that ensures continual protection of human health and the environment, in accordance with applicable operating licences, codes and standards.

Bruce Power continues to be engaged in understanding the impacts from climate change predictions and considering how they may affect future operations and the local environment. Bruce Power has prepared an assessment of the potential effects of climate change on water temperatures by 2054 to 2074 [R-53]. The impact of Bruce Power operations in terms of thermal effluent will remain unchanged under all climate change scenarios. This means that the temperature changes driven by thermal effluent from Bruce Power operations in the local study area will not change as Lake Huron temperatures increase. The absolute temperature in the local study area is predicted to increase proportionately to the temperature increase in other nearshore areas of Lake Huron by 1-2°C. As climate change prediction models become more advanced and/or the environment changes, the ERA will continue to be updated to determine if and how such change impacts the operation of Bruce Power's facilities and, if required, assess what changes are necessary to ensure continued environmental protection.

Finally, Bruce Power acknowledges the need to address the cumulative environmental effect of multiple stressors when and where it is warranted. The science behind the determination of cumulative effects is at its infancy: there is no consensus on a definition of "cumulative impact" and assessment methods are largely absent. Understanding cumulative impacts to a system first begins by evaluating its individual stressors. Bruce Power has done this and none of the individual stressors poses an unreasonable risk to the environment. Thus it is unlikely that the combination of single stressors with low to no risk will result in a cumulative impact or approach an unreasonable risk. Over, forty (40) years of operations of the Bruce site and continued monitoring and assessment has provided empirical evidence of little to no risk to the local environment.

5.0 EMISSIONS AND EFFLUENT MONITORING

Monitoring of emissions and effluent occurs at Bruce A and Bruce B Nuclear Generating Stations, the Central Maintenance Facility (CMF) and the Central Storage Facility (CSF). Bruce Power fully implemented CSA N288.5 Effluent Monitoring Programs at Class 1 nuclear facilities and uranium mines and mills [R-19] in 2018.

The purpose of Bruce Power's radiological emissions and effluent monitoring program is to establish the requirements for radiological emissions and effluent monitoring and equipment in order to comply with Nuclear Safety Control Act, regulations, and licences.

5.1 Radiological Emission and Effluent Monitoring Programs

Bruce A, Bruce B, CMF, CSF, CNL, and the OPG WWMF monitor for airborne (emission) and waterborne (effluent) radionuclides.

Bruce Power Facilities (Bruce A, Bruce B, CMF, CSF)

Radiological emissions and effluent monitoring occurs within the Bruce Power framework for control of radioactive emissions and effluent from Bruce A, Bruce B, the CMF and the CSF and includes the radionuclide emissions and effluent monitoring system operating and quality assurance (QA) requirements. Airborne radiological emissions are monitored at the Bruce A and Bruce B Nuclear Generating Stations' applicable stacks and on the applicable stacks at the Central Maintenance Facility (CMF) and Central Storage Facility (CSF). Waterborne radionuclides include tritium, carbon-14 (^{14}C), gross alpha/beta/gamma and are monitored through release pathways. All airborne and waterborne emissions are well below regulatory limits and reportable levels (DRLs, ALs) and on most occasions below Internal Investigation Levels (IILs).

As detailed in the Licence Condition Handbook, to ensure that members of the public and the environment are protected, Bruce Power operates well below Derived Release Limits (DRLs) that are developed (using CSA Standard N288.1) [R-54] based on a public dose limit of 1 mSv per year as mandated by the CNSC (Radiation Protection Regulations, SOR/2000-203) [R-15]. Furthermore, as an added layer of protection, Environmental Action Levels (EALs) are put in place, to provide early warning of any actual or potential losses of control of the Environmental Protection Program. EALs are derived based on CSA Standard N288.8 [R-55] and are precautionary levels that are set far below the actual DRLs to alert the operator before DRLs are reached. Bruce Power strives to control radiological emissions As Low As Reasonably Achievable (ALARA), by taking action to investigate causes and initiate mitigating actions when increased emissions and effluent are seen.

To demonstrate due diligence, radiological emissions and effluent monitoring feeds into the larger Environmental Protection framework to ensure the public and environment is protected at all times. Radiological emissions and effluent monitoring data is reported to the CNSC quarterly and compared to administrative levels, as well as regulatory levels and limits.

Data from radiological emissions and effluent monitoring is reviewed in relation to radiological environmental measurements to complete a comprehensive Environmental Risk Assessment in accordance with CSA N288.6 [R-20].

OPG Western Waste Management Facility

The OPG WWMF operates under a Waste Facility Operating Licence (WFOL-W4-314.00 2027) [R-56] and monitors emissions in accordance with OPG's N-STD-OP-0031 Monitoring of Nuclear and Hazardous Substances in Effluents [R-57]. N-STD-OP-0031 establishes the minimum standards for monitoring airborne and waterborne releases for OPG nuclear facilities in accordance with CSA N288.5 [R-19]. The effluent monitoring program ensures emissions are maintained well below the DRLs established in the Licence Condition Handbook (LCH-W4-314.00 2027) [R-58] and provides for early detection of potential adverse trends. The effluent monitoring results are reported quarterly to the CNSC by OPG. The effluent monitoring program is reviewed and updated as necessary to ensure it is inclusive of changing site conditions (e.g., expansions and aging management), historic performance, updated standards and industry best practices.

The efficacy of the effluent monitoring program is also assessed by the WWMF specific Environmental Risk Assessment process and the Environmental Monitoring Program. The Environmental Risk Assessment and Environmental Monitoring Program are completed in accordance with CSA N288.6 and N288.4 [R-20] [R-6]. The Environmental Risk Assessment [R-59] is updated at a minimum of once every five years and the Environmental Monitoring Program is reviewed annually.

The most recent Environmental Risk Assessment update was completed in 2021 [R-59]. The conclusions of the Environmental Risk Assessment and the Environmental Monitoring Program indicate that there are no adverse effects to human health or to the local community level ecology from the operation of the WWMF [R-60].

CNL Douglas Point Waste Facility

The Douglas Point Waste Facility (DPWF) is operated by Canadian Nuclear Laboratories (CNL) and is located on the Bruce Site. Douglas Point, which operated between 1966 and 1984, was the prototype commercial-scale CANDU nuclear power plant. With full operation commencing in 1968, the Douglas Point Generating Station supplied 220 MW to the Ontario grid over the next 16 years. Eventually a decision was made to shut down Douglas Point rather than undertake the refurbishment of the pressure tubes that was required for continued operation. While the Douglas Point facility structures remain in place today, the reactor has been permanently shut down since 1984. Used fuel from the reactor is stored in dry storage modules at the facility. Decommissioning of the Douglas Point Facility is progressing with a 2070 timeline for completion. The decommissioning plans for the coming years include the dismantling of non-nuclear buildings and nuclear support buildings. The reactor and its building are anticipated to be decommissioned after 2030.

In 2020, the facility was in Phase 2 of decommissioning, known as "Storage with Surveillance" [R-27] [R-28]. In 2021, the CNSC amended the decommissioning licence to allow CNL to begin Phase 3 of five-phase process of decommissioning activities.

KI North

Kinectrics carries out emissions and effluent monitoring activities on both airborne tritium releases through exhaust stacks and on liquid releases to sewer, following Kinectrics' effluent monitoring procedures. Specifically:

- Kinectrics' Waste Nuclear Substance Licence requires releases to air to be monitored for tritium only, since particulates are caught in HEPA filters and pre-filters prior to exhaust. Tritium releases through exhaust stacks are continuously sampled, and analysis of the samples is conducted weekly [R-29].

- Potentially active wastewater is temporarily stored in collection tanks and sampled and analyzed prior to release. If any radiological or chemical contaminant is found to be above administrative control levels, which are set below unconditional clearance levels, then the tank contents are filtered through two charcoal filters and then re-analyzed. All releases are maintained below prescribed unconditional clearance levels [R-29].

Bruce A, Bruce B, CMF, CSF, CNL, and the OPG WWMF monitor for airborne and waterborne radionuclides. Results for airborne radionuclides including tritium, noble gases, radioiodine (^{131}I), carbon-14 (^{14}C), alpha, beta, and gamma (emitters on particulate material) are presented in Table 6. Airborne radiological emissions are monitored at the Bruce A and Bruce B Nuclear Generating Stations' applicable stacks and on the applicable stacks at the Central Maintenance Facility (CMF) and Central Storage Facility (CSF). Waterborne radionuclides include tritium, carbon-14 (^{14}C), gross alpha/beta/gamma; these results are presented in Table 7**.** All airborne and waterborne emissions are well below regulatory limits and reportable levels (DRLs, EALs) and on most occasions below Internal Investigation Levels (IILs).

On December 31, 2021, Bruce Power implemented new DRLs and EALs, in accordance with CSA N288.1-14 Update 3 and CSA N288.8-17. Changes to the DRLs were minor in nature, but the revised EALs are much lower than previous EALs. In the past, EALs applied to the whole station and were equivalent to 10% of the DRL. Now, the EALs are pathway specific (e.g. each stack) and based on the upper bound of historical, normal releases. Figure 6 shows the framework for radioactive emissions and effluent controls and limits and compares them to the analogous nuclear power plant states.

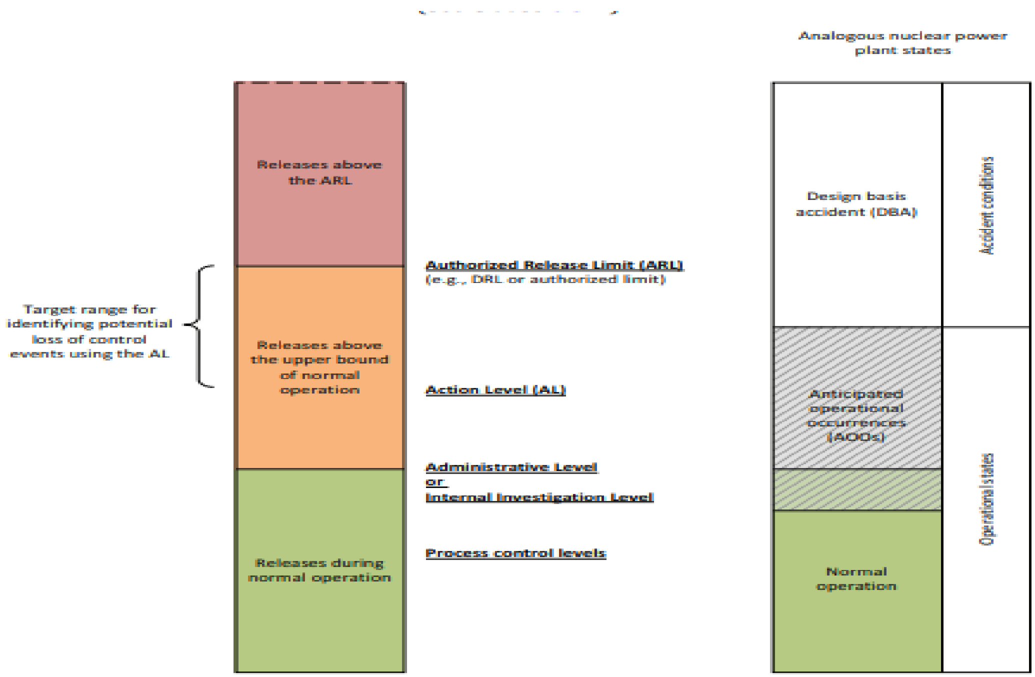


Figure 7 – Framework for Radioactive Emissions and Effluent Controls and Limits

5.1.1 Air

5.1.1.1 2021 Radiological Airborne Emissions Results

Through Bruce Power's normal operation and outage maintenance activities, airborne radiological emissions are released to the environment. These airborne emissions are primarily monitored through exhaust stacks and are well below regulatory levels. Radiological airborne emissions typically originate from reactor systems such as the main moderator and heat transport systems and their auxiliary systems (e.g. purification). Airborne emissions may fluctuate during some planned and unplanned activities. Examples of unplanned events that could cause emission increases include equipment deficiencies such as stack filter by-pass, resin exhaustion in ion-exchange purification systems, and boiler tube leaks causing increased emissions through feedwater venting. Planned activities that have the potential to result in temporary, elevated emissions include controlled removal of defect fuel bundles from the reactor core, purges from systems such as moderator cover gas to keep chemistry parameters within specifications, and increased outage days where maintenance work is performed on reactor systems to support equipment health and continued safe operation. In outages, reactor systems are opened and this can potentially result in increased airborne emissions.

Bruce Power has several engineered barriers in place to minimize the release of radionuclides to the environment and keep releases as low as reasonably achievable (ALARA). These barriers include high efficiency particulate air (HEPA) filters and high efficiency carbon air (HECA) filters to remove airborne particulates and radionuclides. Testing of Bruce Power's stack filters is conducted annually by a third party to assess and assure their removal efficiency. Additional barriers include moderator and heat transport purification systems designed to remove radionuclides and vault vapour recovery systems which reduce airborne tritium releases through the capture of water vapour within the vault before it reaches the exhaust stack. These barriers, in conjunction with applying the ALARA principle, systematic monitoring and investigation of emissions above normal operating levels, assists Bruce Power in minimizing emissions and ensuring they remain well below regulatory limits.

The 2021 radiological airborne emissions results for all licensed facilities onsite are shown in Table 6. In 2021, Bruce Power's radiological airborne effluent emissions were well below regulatory limits. Bruce Power routinely reports to the CNSC on the results of the radiological airborne emissions monitoring program in accordance with the Power Reactor Operating Licence.

Table 6 – Annual Radiological Airborne (Gaseous) Effluent Results for 2021

Pathway - Radionuclide	Emissions (Bq)/yr							
	Bruce A	Bruce B	CMF	CSF	WWMF (OPG)	CNL	Kinectrics KI**	Total
Air								
Tritium Oxide	8.1E+14	4.2E+14	1.6E+10	9.1E+10	2.16E+13	2.57E+11	1.24E+11	1.3E+15
Noble Gas	8.6E+13	3.4E+13	Not applicable	Not Applicable	Not Applicable	Not applicable	Not Applicable	1.2E+14
Iodine-131	3.1E+05	0.0E+00	0.0E+00	Not applicable	1.05E+03	Not applicable	Not Applicable	3.1E+05
Particulate Gamma	2.9E+06	5.7E+06	2.2E+04*	7.5E+2*	2.72E+03	Not applicable	Not Applicable	8.6E+06
Particulate Gross Beta	Not applicable	Not applicable	Not applicable	Not applicable	Not Applicable	7.58E+04	Not Applicable	7.6E+04
Particulate Gross Alpha	2.7E+04	3.5E+04	1.2E+03	Not applicable	Not Applicable	Not Applicable	Not Applicable	6.3E+04
Carbon-14	1.7E+12	9.5E+11	Not applicable	Not applicable	5.63E+09	Not applicable	Not Applicable	2.7E+12

Note: * Naturally occurring radionuclide material detected in gamma spectrum analysis is not reported.
** This is the net airborne emission from KI North Facility for the period of Dec 31, 2020, to Dec 29, 2021.

5.1.1.2 Historical Radiological Airborne Effluent Results

The figures below (Figure 7 through Figure 9) provide an overview of the annual releases of airborne radiological emissions at Bruce A and Bruce B. The long-term trend is illustrated by the 5-year moving average line.

Figure 8 provides the historical trend in airborne tritium emissions. Airborne tritium is a principal radiological emission associated with dose to the public. Radiological airborne emissions are managed in line with the concept of ALARA. In 2021, airborne tritium emissions increased at Bruce A and Bruce B compared to 2020. The increase at Bruce A was largely due to a Unit 1 moderator pump seal leak that occurred in December and was contained within containment prior to clean up. In order to maintain ALARA from a worker radiological dose perspective, it was crucial to minimize the airborne tritium in the room prior to clean up activities, and purges of the moderator room air were conducted and directed through the contaminated exhaust to allow personnel to enter the room. This resulted in elevated tritium airborne releases during this period; these remained well below any thresholds that would have a measurable public dose impact. Performance challenges with the Unit 3 moderator confinement vapour recovery dryer in August resulted in slightly higher than average tritium emissions for that month as well and was repaired prior to the end of the month.

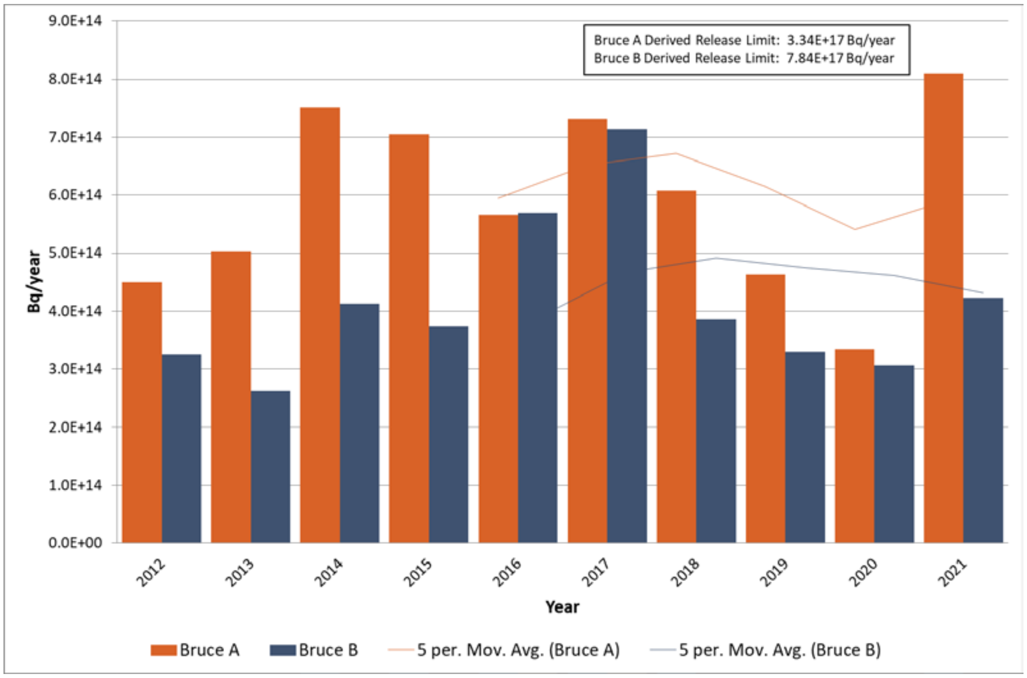


Figure 8 – Historical Airborne Tritium Emissions

Figure 9 details the historical trend in airborne ^{14}C emissions. Airborne ^{14}C is also a principal radiological emission contributing to dose to public. In 2021, ^{14}C emissions remained low at Bruce B, with a slight increase at Bruce A compared to the previous year. This increase was the result of saturated Moderator ion exchange columns, which were replaced throughout the year.

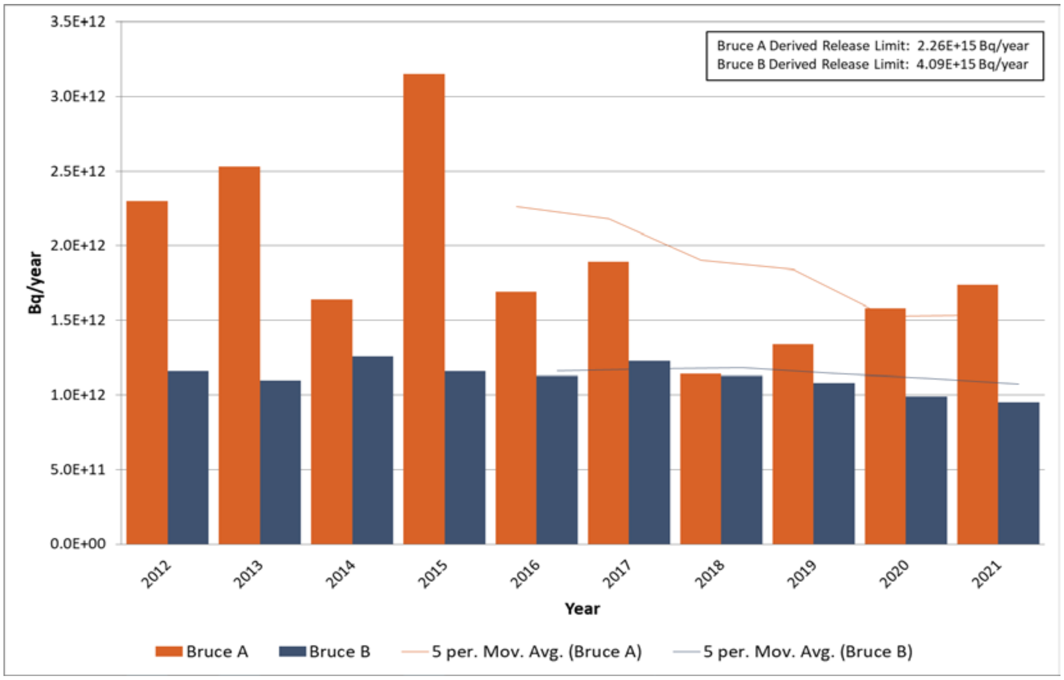


Figure 9 – Historical Airborne ^{14}C Emissions

The majority of airborne iodine emissions are captured by the high efficiency carbon air (HECA) filters, which are tested on an annual basis to determine efficiency and maintain equipment reliability. Most analytical results for iodine, as measured in the stacks are less than Limit of Detection (L_d). To prevent producing an over-conservative number, as of 2016 results that were below L_d were stated as such during routine reporting and results greater than L_d were included in the summation of iodine to provide a more representative value. The majority of iodine emissions at both Bruce A and B were below L_d.

Figure 10 details the historical trend in iodine airborne emissions over the last 10 years. Iodine in air is a radiological emission associated with dose to the public. The Bruce A 2014 iodine emissions were due to debris in the heat transport system after return to service of Units 1 and 2 which resulted in fuel defects and associated releases of iodine when these fuel defects were removed from the reactor. The 2012 iodine emissions are due to iodine not being captured by exhausted HECA filter beds. These HECA filter beds have since been replaced. Following the identification of this deficiency, an increased focus has been placed on filter maintenance and the filter testing program. Although the airborne iodine emissions in 2012 and 2014 were higher than other years, they were still well below regulatory limits.

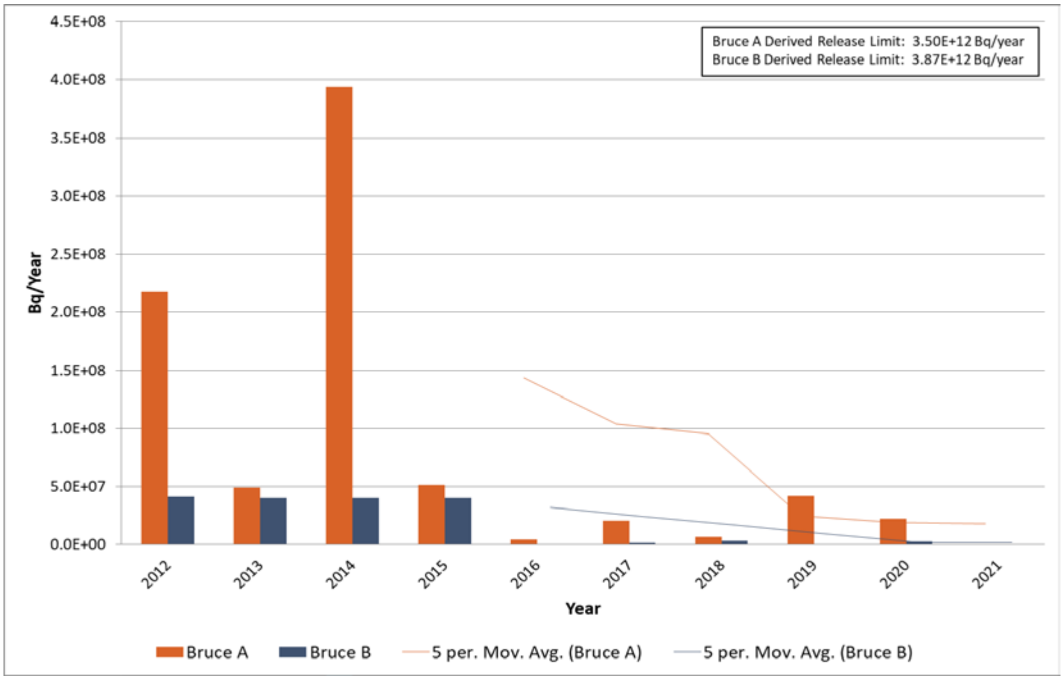


Figure 10 - Historical Iodine Emissions in Air

5.1.2 Water

5.1.2.1 2021 Radiological Waterborne Effluent Results

Through Bruce Power's normal operation and outage activities, waterborne radiological effluent is released to the environment. This waterborne effluent is well below regulatory limits and associated, reportable Environmental Action Levels. Waterborne effluent is monitored through release pathways that include Active Liquid Waste (ALW), feedwater discharges and foundation drainage. Ultimately, these effluent streams are discharged via the Condenser Cooling Water (CCW) duct. Radiological waterborne effluent typically originates within reactor systems such as the moderator and heat transport systems and their auxiliary systems (e.g. purification).

The largest contributor to waterborne radiological effluent is the Active Liquid Waste system. Water in this system is collected in tanks and re-circulated to allow time for short-lived radionuclides to decay. Reverse osmosis and conventional filtration systems are also used to remove radioactive particulate. Prior to release to the environment, tank contents are analyzed to ensure acceptance criteria are met. Waterborne effluents may fluctuate during particular planned and unplanned activities. Unplanned events that may result in higher radionuclide concentrations in effluent include equipment deficiencies such as the moderator or primary heat transport upgraders being out of service for maintenance, external challenges delaying D_2O de-tritiation processing off-site, purification resin exhaustion, boiler tube leaks, and controlled discharges from reactor systems routed to collection and recovery. Planned activities for which effluent fluctuations may occur include scheduled fuel bundle defect removals from the reactor, increased spent resin transfers, and increased outage days where maintenance work is performed on reactor systems to support equipment health and continued safe operation.

Bruce Power has several barriers in place to minimize waterborne radionuclides from being released to the environment. These barriers include moderator and heat transport purification to remove waterborne radionuclides from reactor systems, D_2O in H_2O leak detection to provide early indication of a heavy water leak or boiler tube leak and D_2O Supply and Inventory systems to maximize the capture of D_2O for re-use. These barriers, in conjunction with applying the ALARA principle, routine monitoring and initiating investigations when effluent levels are above normal operating levels, assists Bruce Power in minimizing effluent and ensuring it remains well below regulatory limits.

In 2021, Bruce Power's radiological waterborne effluents were well below regulatory limits and associated reportable Environmental Action Levels. Bruce Power routinely reports to the CNSC on the results of the radiological waterborne effluent monitoring program in accordance with the Power Reactor Operating Licence. The 2021 waterborne radiological effluent results are shown below in Table 7. Note: These totals include tritium releases from foundation drainage sump discharges.

There are no direct waterborne radiological effluent releases to the environment from the Central Maintenance Facility (CMF) or Central Storage Facility (CSF). All radiological waterborne releases from these buildings are directed to Bruce A's Active Liquid Waste management system for processing and are included in the waterborne total for that facility.

Starting January 2021, monitoring of discharge from the Western Waste Management Facility's Sample Stations system surface (stormwater) and subsurface (groundwater) streams was transitioned from the effluent monitoring program to CSA N288.6, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*, and CSA N288.7, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills*, respectively [R-61], [R-62]. This change was based on the absence of releases of effluent into the stormwater system—other than the deposition of airborne emissions via precipitation. The monitoring and reporting of these airborne emissions are already managed under the airborne effluent monitoring programs and not reported separately as waterborne effluent.

Table 7 - Annual Waterborne (Aqueous) Radioactive Effluent Results for 2021

Pathway Radionuclide	**Emissions (Bq)/yr**					
	Bruce A	**Bruce B**	**WWMF (OPG)**	**CNL**	**Kinectrics KI***	**Total**
Water						
Tritium Oxide	2.8E+14	9.1E+14	Not applicable	2.30E+10	Not applicable	1.2E+15
Carbon-14	6.9E+08	2.6E+09	Not applicable	Not applicable	Not applicable	3.3E+09
Gross Beta/Gamma	2.7E+09	2.1E+09	Not applicable	Not applicable	Not applicable	4.8E+09
Gross Beta	Not applicable	Not	Not applicable	2.97E+07	Not applicable	3.0E+07

		applicable				
Gross Alpha	<L_d	<L_d	Not applicable	Not applicable	Not applicable	0.0E+00
Note: <L_d = less than limit of detection *There were no waterborne emissions in 2021 for Kinectrics KI.						

5.1.2.2 Historical Radiological Waterborne Effluent Results

The figures below (Figure 11 through Figure 13) provide representations of the annual releases of waterborne radiological effluent at Bruce A and Bruce B. The figures include the long-term trend, illustrated by the 5-year moving average line.

Figure 11 details the historical trend in waterborne tritium. Tritium in water is a minor radiological effluent in terms of dose to the public. Bruce B experienced elevated tritium emissions (well within regulatory limits) in 2012 due to a boiler tube leak. Additionally, Unit 5 at Bruce B has been experiencing a minor ongoing boiler tube leak since 2017. The leak rate is monitored regularly and has remained controlled within acceptable values, allowing continued operation until it can be repaired, as scheduled in 2022.

Bruce B waterborne tritium emissions increased slightly in 2021 compared to 2020.This increase was driven by larger volumes of Moderator Confinement Vapour Recovery Dryer condensate being directed to the Active Liquid Waste System and a leaking motorized valve in the Unit 8 Emergency Coolant Injection (ECI) U loop.

All effluent is well below the regulatory limits and dose to public values remain *de minimus*.

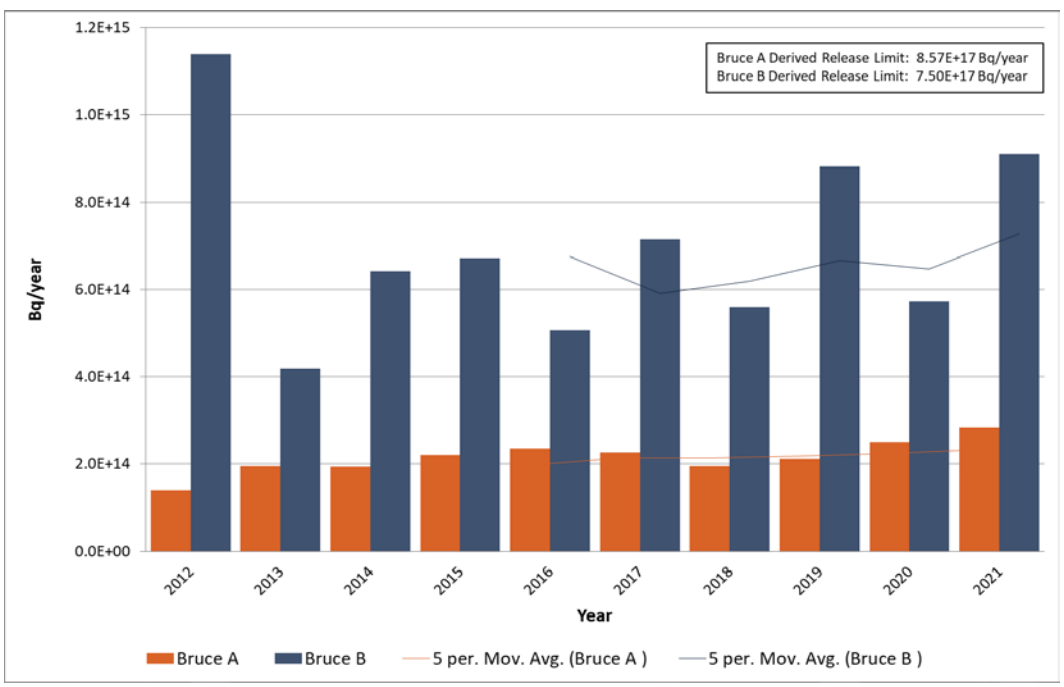


Figure 11 - Historical Tritium Waterborne Emissions

Figure 12 details the historical trend in ^{14}C waterborne emissions. ^{14}C in water is a radiological emission associated with dose to the public and oversight is provided through Bruce Power's Resin Management Program. The increase in ^{14}C emissions in 2014 and 2015 at Bruce B can be attributed to the draining of the Emergency Water Storage Tank (EWST) in preparation for the Vacuum Building Outage (VBO). These emissions remained well below the regulatory limit and dose to public remained *de minimus*. Since 2016, ^{14}C in waterborne effluent has fluctuated due to variations in the volume of Moderator ion exchange resins that have been processed each year.

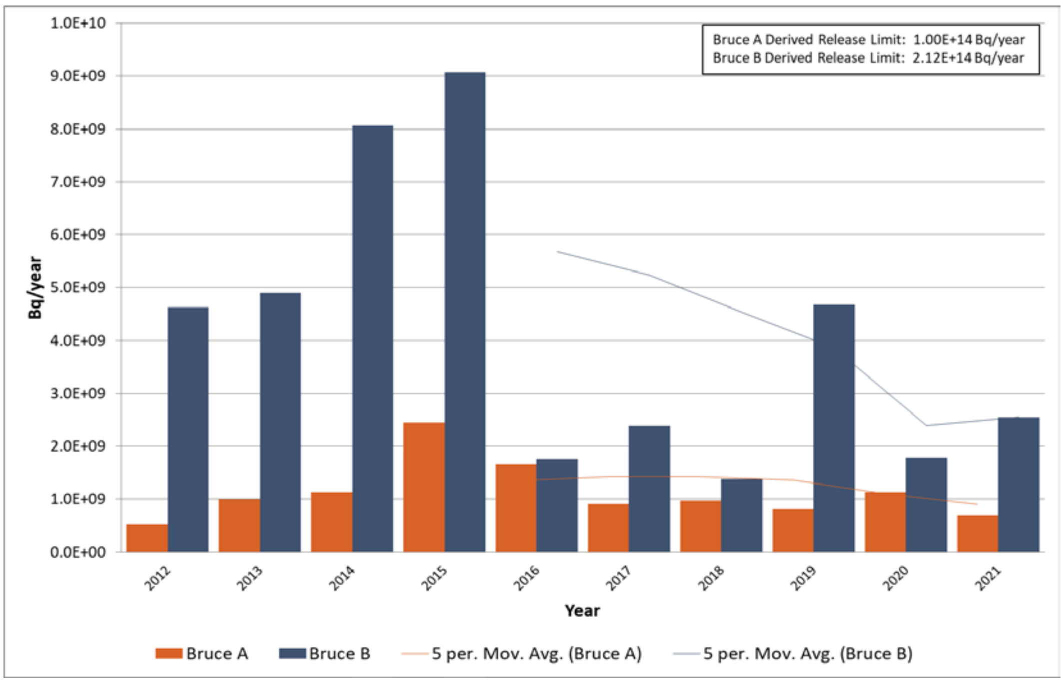


Figure 12 – Historical ^{14}C Waterborne Emissions

Historical waterborne gamma emissions are shown in Figure 13. Bruce A gamma emissions have been consistently low since 2011 however there was a small rise in 2019 due to an increase in loading of low level radiological water to the Active Liquid Waste System. For much of this loading, gamma results were less than background, but were reported at the background level, leading to conservative reporting. There were no events to contribute to this slight increase and emissions were well below the regulatory limits. Bruce B experienced elevated gamma emissions in 2012 associated with a boiler tube leak; these emissions remained well below the regulatory limit and dose to public values remained *de minimus*. Since 2017, Unit 5 at Bruce B has been experiencing a minor ongoing boiler tube leak (with a repair scheduled in 2022); these releases are included in the overall waterborne gamma emissions for 2021. Bruce A experienced elevated levels of gamma in effluent in late 2021 due to water ingress to the Primary Irradiated Fuel Bay (PIFB) and associated, controlled discharge of PIFB water to the Active Liquid Waste System.

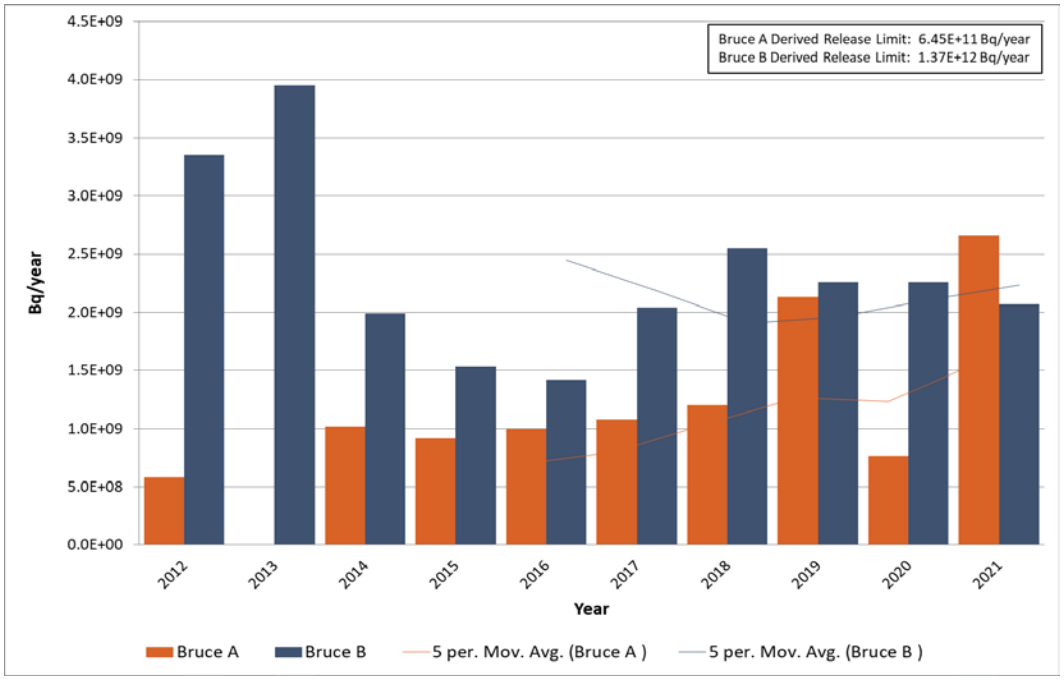


Figure 13 - Historical γ Emissions in Water

5.1.2.3 Foundation Drainage

Bruce A and Bruce B have a foundation drainage system that maintains a water level of 577 ft (176 m) or less, and therefore creates a local hydraulic sink around the powerhouses. The foundation drainage system is designed to collect groundwater seepage. This water is monitored and discharged to Lake Huron through the CCW duct.

Bruce Power monitors the foundation drainage system on a monthly basis and the tritium concentrations are used to estimate tritium loading. Foundation drainage effluent is included in the total station waterborne effluent that is reported quarterly to the CNSC. The effectiveness of this system is confirmed through the groundwater monitoring program described in Section 6.1.6.

5.1.2.4 Sewage

Domestic wastewater (sanitary sewage) is collected from all facilities at the Bruce Power site including Bruce A and Bruce B, CMF, CNL (Douglas Point), OPG (WWMF) and Centre of Site buildings, and is treated onsite at the Bruce Power Sewage Processing Plant (SPP). The sanitary sewage collection system is a network of 3 km of gravity sewers and 7 km of force mains.

The sewage processing plant has an average design flow capacity of 1,590 m^3/day and a maximum design flow capacity of 4,700 m^3/day. The plant consists of an inlet chamber, aerated equalization tank, screening and grinding equipment, liquid chemical injection, and two parallel biological treatment trains consisting of aeration tanks, settling tanks, and aerobic sludge digesters, followed by ultraviolet disinfection (UV), and two onsite lagoons for sludge storage. Final effluent from the plant is discharged to Lake Huron via a gravity pipe to the Lake Huron outfall located near Douglas Point.

Sewage processing plant effluent monitoring data was previously reported to the CNSC via quarterly technical reports, which included radiological analytical results from the treated liquid effluent routed to the lake and the sludge digester tanks routed to onsite lagoons. In 2017, Bruce Power requested to have the Waste Nuclear Substance Licence (WNSL) for the CMF revoked and consolidated into the Bruce A and Bruce B PROL since the activities were already described in the Bruce Power PROL. The consolidation occurred July 1, 2017 and requires the sewage effluent to be reported in this Environmental Protection report. Table 8 shows the radiological sewage analysis for 2021.

As shown in Table 8, quarterly averages for radiological parameters in sludge and sewage effluent in 2021 were well below internal acceptance criteria for the Sewage Processing Plant and the annual average is well below the Ontario Drinking Water Quality Objective for tritium (7.00×10^3 Bq/L).

Table 8 - 2021 Sewage Processing Plant Monitoring

Sample Source	Tritium[1] Bq/L	Beta[1] Bq/L	Gamma[1] Bq/L
Sewage Digester Sludge			
Q1	2.43E+02	Not Applicable*	None detected
Q2	2.64E+02	Not Applicable*	None detected
Q3	2.31E+02	Not Applicable*	None detected
Q4	3.11E+02	Not Applicable*	None detected
Average	2.62E+02	Not Applicable*	None detected
Effluent			
Q1	2.25E+02	4.62E-01	Not Applicable**
Q2	1.94E+02	5.64E-01	Not Applicable**
Q3	2.05E+02	6.49E-01	Not Applicable**
Q4	2.94E+02	5.90E-01	Not Applicable**
Average	2.29E+02	5.66E-01	Not Applicable**

Note: 1. Internal Acceptance Criteria: Tritium - 5.96×10^3, Gross Beta/Gamma - 9.00×10^0

* Analyses are not done on sludge samples due to sample β-self absorption.

**Gamma analyses are not done on effluent samples since β is the most sensitive analysis for liquids.

5.2 Conventional (Non-Radiological) Emission and Effluent Monitoring

Bruce Power monitors the emission and effluent streams for a variety of conventional parameters including hazardous substances. This monitoring is performed to meet the regulatory obligations of several Federal and Provincial regulatory agencies, including the CNSC. The results for these monitoring events are submitted to the lead environmental agencies at various times throughout the year. Table 9 provides a summary of the monitoring reports that Bruce Power submits throughout the year as well as identifies the time of submission and the lead regulatory agency. The reports provide details and information necessary to meet regulatory reporting requirements. The following sections describe some of the regulatory context for each report.

5.2.1 Conventional (Non-Radiological) Effluent Monitoring Program Methodologies

Effluent sampling and monitoring is conducted in compliance with limits set forth in the following:

- Ontario Regulation 215/95: Effluent Monitoring and Effluent Limits - Electrical Power Generation Sector [R-63] – this was revoked on July 1st, 2021 and now is enforced via ECA notices (outlined below).
- Ontario Regulation 419/05: Air Pollution - Local Air Quality) [R-64], the Environmental Protection Act (R.S.O. 1990, c. E. 19) [R-16]
- Ontario Water Resources Act (R.S.O. 1990, c.O.40) [R-8]
- ECAs issued by the Ministry of the Environment Conservation and Parks (MECP) [R-65] [R-65] [R-66][R-67] including Notice 1 for each [R-68] [R-69] [R-70]
- Permits to Take Water (PTTW) [R-71]–[R-73] issued by MECP and with Internal Administrative Levels - New Permits were acquired in May 2021 [R-74] [R-75] [R-76].
- Ontario Regulation 390/18: Greenhouse Gas Emissions: Quantification, Reporting and Verification [R-77]
- Federal Halocarbon Regulations, 2003, SOR 2003-289 [R-78]
- Notice to Report: Under the authority of Section 46 of the Canadian Environmental Protection Act (CEPA), operators of facilities that meet the criteria specified in the annual notice with respect to reporting of greenhouse gases (GHGs), published in the *Canada Gazette*, are required to report facility GHG emissions to Environment and Climate Change Canada by the annual June 1st reporting deadline [R-79].
- Notice to Report: Under the authority of the Canadian Environmental Protection Act, 1999 (CEPA 1999), owners or operators of facilities that meet published reporting requirements are required to report to the NPRI [R-80]
- Ontario Regulation 463/10: Ozone Depleting Substances and other Halocarbons [R-81]
- Ozone-Depleting Substances and Halocarbon Alternatives Regulations (SOR/2016-137) [R-82]

Table 9 - 2020 & 2021 Bruce Power Regulator Reporting for Conventional Parameters

Hazardous Substance (Section Reference)	Report Title (Document Control Number)	Regulatory Agency	Submission Date (Frequency)
Air - ECA	Written Summary for Reporting Year 2021 Environmental Compliance Approval - Air 7477-8PGMTZ (BP-CORR-00541-00124)	Ministry of Environment, Conservation and Parks	15JUN2022 (Annual)
Air - Halocarbon	Halocarbon Release Report Pursuant to the Federal Halocarbon Regulations (SOR 2003-289) Section 33 January to June 2021 (BP-CORR-00521-00023)	Environment Climate Change Canada	31July2021 (Semi-annual)
	Halocarbon Release Report Pursuant To The Federal Halocarbon Regulations (SOR/2003-289), Section 33, July to December 2021 (BP-CORR-00521-00024)	Environment Climate Change Canada	31Jan2022 (Semi-annual)
Air – Greenhouse Gas	Not required to report 2021 Federal and Provincial Greenhouse Gas Reporting	Internal Report	Quantify GHG emissions by 01JUN2022 (Annual) Not required to report
Air - NPRI	2021 National Pollutant Release Inventory for Bruce Power NPRI ID #7041 (BP-CORR-00521-00040)	Environment Climate Change Canada	01Jun2022 (Annual)
Water – Annual Effluent (formerly EMEL)	2021 Annual Effluent Discharge Report (BP-CORR-00541-00131)	Ministry of Environment, Conservation and Parks	01JUN2022 (Annual)
Water – Quarterly Effluent and ECA Report	Bruce Power EMEL and Environmental Compliance Approval Submission First Quarter 2021 (BP-CORR-00541-00076)	Ministry of Environment, Conservation and Parks	14MAY2021 (Quarterly)

Hazardous Substance (Section Reference)	**Report Title (Document Control Number)**	**Regulatory Agency**	**Submission Date (Frequency)**
(formerly EMEL/ECA)	Bruce Power EMEL and Environmental Compliance Approval Submission Second Quarter 2022 (BP-CORR-00541-00095)	Ministry of Environment, Conservation and Parks	14AUG2021 (Quarterly)
	Bruce Power Effluent Discharge Report Third Quarter 2021 (BP-CORR-00541-00106)	Ministry of Environment, Conservation and Parks	14NOV2021 (Quarterly)
	Bruce Power Effluent Discharge Report Fourth Quarter 2021 (BP-CORR-00541-00117)	Ministry of Environment, Conservation and Parks	14FEB2022 (Quarterly)
Water - ECA	2021 Environmental Compliance Approval (Water) Annual Compliance Report for Bruce A (BP-CORR-00541-00129)	Ministry of Environment, Conservation and Parks	01JUN2022 (Annual)
	2021 Environmental Compliance Approval (Water) Annual Compliance Report for Bruce B (BP-CORR-00541-00130)	Ministry of Environment, Conservation and Parks	01JUN2022 (Annual)
	2021 Environmental Compliance Approval (Water) Annual Compliance Report for Centre of Site (BP-CORR-00541-00121)	Ministry of Environment, Conservation and Parks	01MAR2022 (Annual)
Water - PTTW	2021 Water Taking Data - Permit To Take Water 1813-8MLLHG and P-300-2114648110 Bruce A (BP-CORR-00541-00125)	Ministry of Environment, Conservation and Parks	31MAR2022 (Annual)
	2021 Water Taking Data - Permit To Take Water 2233-8MLN8J and P-300-4114675736 Bruce B (BP-CORR-00541-00126)	Ministry of Environment, Conservation and Parks	31MAR2022 (Annual)
	2021 Water Taking Data - Permit To Take Water 1152-8MLPCR and P-300-7116089842 Centre of Site (BP-CORR-00541-00127)	Ministry of Environment, Conservation and Parks	31MAR2022 (Annual)

Hazardous Substance (Section Reference)	Report Title (Document Control Number)	Regulatory Agency	Submission Date (Frequency)
	2021 Construction Dewatering EASR R-009-1113257323 (BP-CORR-00541-00132)	Ministry of Environment, Conservation and Parks	31MAR2022 (One time report)
Water - WSER	2021 Q1 Wastewater System Effluent Regulation (WSER) Report (BP-CORR-00521-00028)	Environment Climate Change Canada	14MAY2021 (Quarterly)
	2021 Q2 Wastewater System Effluent Regulation Report (BP-CORR-00521-00030)	Environment Climate Change Canada	14AUG2021 (Quarterly)
	2021 Q3 Wastewater System Effluent Regulation Report (BP-CORR-00521-00031)	Environment Climate Change Canada	14NOV2021 (Quarterly)
	2021 Q4 Wastewater System Effluent Regulation Report (BP-CORR-00521-00036)	Environment Climate Change Canada	14FEB2022 (Quarterly)

5.2.2 Air Emissions

5.2.2.1 Environmental Compliance Approval

Conventional air emissions are held to performance standards stipulated in the Environmental Compliance Approval (ECA) (7477-8PGMTZ) [R-9] which incorporates all non-radiological air emission sources on site. The ECA allows operational flexibility to release contaminants up to a maximum Point of Impingement (POI) concentration limit at its property boundary. These limits are typically MECP limits (as per O. Reg 419/05) [R-64], and for cases where there is no pre-defined MECP POI limit, Bruce Power is bound by a Maximum Ground Level Concentration (MGLC) accepted by the MECP upon its ECA application submission.

Bruce Power's ECA Limited Operational Flexibility (LOF) expired 31DEC2021. An application to renew the LOF was submitted to the MECP on 01JAN2021. The application to review the LOF is currently under review by the MECP. The MECP Director issued a letter indicating that Condition 2.1 of the ECA allows the LOF to remain in effect until the ECA has been revoked with the issuance of the new LOF. All other Terms and Conditions of the ECA shall remain in effect. [R-83]

Air contaminants of concern are modelled for all non-negligible sources in worst-case scenarios. Estimated emission rates are then analyzed to ensure regulatory limits at the POI are met. While Bruce Power is bound by ECA performance limits, the company has operational flexibility to do things like modify the location of emissions sources or add new buildings and exhaust stacks, once it can be demonstrated that it will remain within these limits.

Specific contaminants emitted from every air emission source on site are identified in the Emission Summary and Dispersion Modelling (ESDM) Report that reflects the actual operation of the facility [R-64]:

- Bruce Power maintains up to date ESDM report that reflects current operations. Upon making any modifications (within the bounds of the operational flexibility prescribed in the ECA [R-9]), the modification log and ESDM report are updated to document that the facility is in compliance. The ESDM Report shows that:
  - The nature of the operations of the facility continues to be consistent with the description section of the ECA;
  - The production at the facility continues to be below the facility production limit specified in the ECA; and
  - The performance limits are met.

During 2021, two modifications were made for the use of film forming amines (FFA) during planned outages and the temporary use of two diesel generators to power heaters during the B44 natural gas connection project. The modifications demonstrated compliance with the POI limits (as per O. Reg 419/05) and the conditions of Bruce Power's ECA. As per the conditions of the ECA, the MECP District Office was notified of the modification.

Noise

The Environmental Compliance Approval (ECA) for air [R-9] requires that Bruce Power is within the noise limits of NPC-232 Sound Level Limits for Stationary Sources in Class 3 Areas (Rural).

Noise complaints and reports were received from various Inverhuron residents between July 18, 2021 and July 20, 2021. In accordance with the conditions of Bruce Power's ECA, the MECP District Office was notified of the complaints in writing following each complaint.

5.2.2.2 Halocarbons

In Canada, the Federal, Provincial, and Territorial governments have legislation in place for the protection of the ozone layer and management of ozone-depleting substances and their halocarbon alternatives. The use and handling of these substances are regulated by the provinces and territories in their respective jurisdictions, and through the Federal Halocarbon Regulations, 2003 [R-84] for refrigeration, air-conditioning, fire extinguishing, and solvent systems under Federal jurisdiction. Bruce Power is governed by both the Provincial and Federal regulations.

Figure 14 below provides a summary of all the halocarbon releases across site for the 2021 calendar year. These leaks (releases) are broken down by magnitude; releases between 10 kg and 100 kg are reportable in semi-annual reports and releases greater than 100 kg are immediately reportable to ECCC and MECP. In 2021, there were three releases greater than 100 kg from equipment installed and maintained by a Vendor and three releases between 10 and 100 kg. There were no reportable releases at Bruce A in 2021.

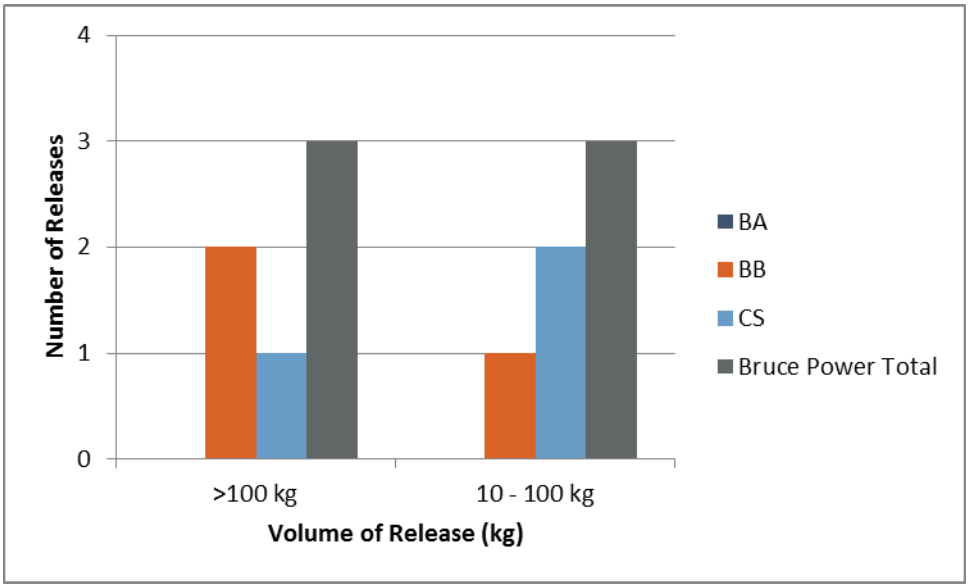


Figure 14 - 2021 Bruce Power Halocarbon Release Occurrences

Historical Conventional Halocarbons Air Monitoring

The environmental impact of these halocarbon discharges is reduced as a result of the older ozone depleting refrigerants (chlorofluorocarbon (CFCs) and HCFCs) being replaced by hydrofluorocarbons (HFCs) with negligible impact on the ozone layer (e.g., R134a and R410). HFCs however have high global warming potential and pose a threat as a greenhouse gas [R-84]. Figure 15 below provides the historical trend of the total number of halocarbon releases reported to ECCC since 2012. Between 2017 and 2020, no halocarbon releases >100 kg were reported to ECCC. However, three halocarbon releases > 100 kg (Bruce B – 317 kg and 209 kg and Centre of Site – 99 kg) were reported to ECCC in 2021. The 99 kg release at Centre of Site was conservatively reported given that the exact volume of halocarbon release cannot be determined.

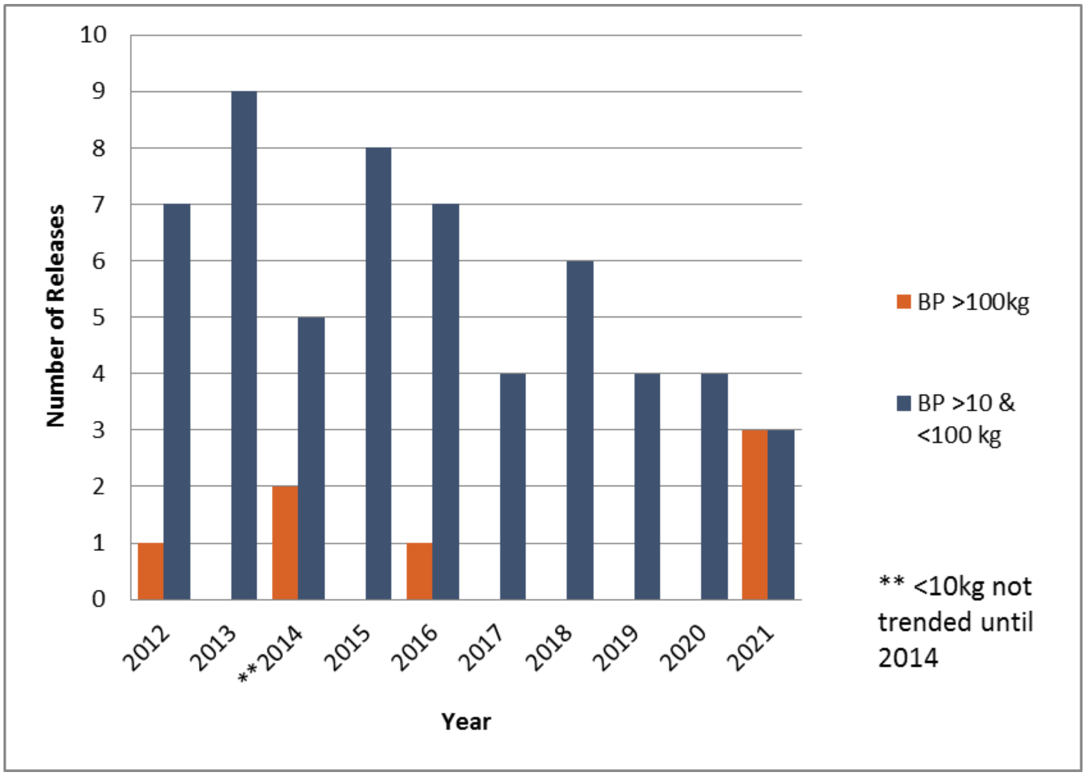


Figure 15 - Historical Bruce Power Halocarbon Releases (> 10 kg)

5.2.2.3 Greenhouse Gas

The Provincial threshold for reporting GHG emissions dropped from 25,000 tonnes CO_2e to 10,000 tonnes CO_2e in 2015. Bruce Power was below the 25,000 tonnes CO_2e threshold in 2013 and 2014 and below the 10,000 tonnes CO_2e threshold from 2015 to 2020. In order to cease reporting, there must be three consecutive years reported under the threshold. Therefore, 2015 was the last year of reporting GHG emissions.

GHG Emissions will continue to be calculated for 2021 and onwards to confirm they remain below threshold values; 2021 calculation to be completed by 01JUN2022.

<u>Historical Greenhouse Gas</u>

GHG releases on site have trended downwards due to the Bruce Steam Plant (BSP) shut down strategy. The Steam Plant last operated in 2015 to supplement the Vacuum Building Outage at Bruce B and was officially shut down in December of 2015 when the stack was removed. Since 2012, GHG emissions from Bruce Power included combustion of stove oil and diesel by boilers at the steam plant and combustion of stove oil and diesel from stationary equipment (i.e. standby generators, temporary generators, heaters).

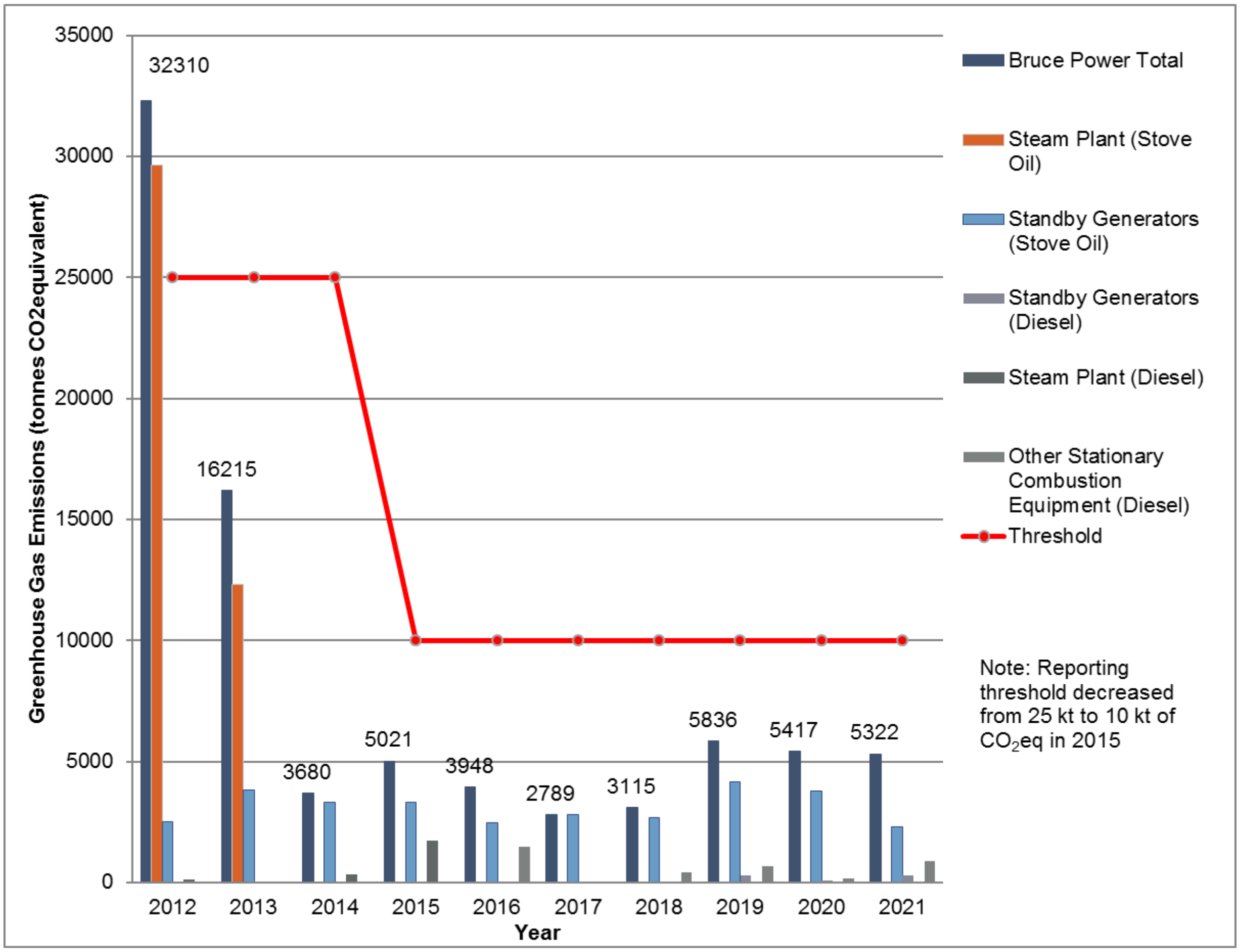


Figure 16 - Provincial Greenhouse Gas Reporting Tonnes CO_2 Equivalent - Conventional Air

5.2.2.4 National Pollutant Release Inventory (NPRI)

The National Pollutant Release Inventory (NPRI) is Canada's legislated, publicly accessible inventory of pollutant releases, disposals and recycling. NPRI information is a major starting point for identifying and monitoring sources of pollution in Canada, and in developing indicators for the quality of air, land, and water. The NPRI provides Canadians with annual information on industrial, institutional, commercial, and other releases and transfers in Canadian communities [R-85]. Bruce Power complies with reporting requirements and regulatory limits, as shown in Sections 5.2.2 and 5.2.3. Bruce Power's NPRI contaminants reported for the 2020 calendar year are presented in Table 10. Calculations and reporting for the 2021 calendar year will be completed by 01JUN2022. 2021 calculations are in progress for completion.

A graphical comparison of NPRI contaminant percentage change over time is shown in Figure 17. Refinements to construction dust calculations were made in 2020 resulting in changes to emissions of particulate matter and hence the step change in emissions. In addition, parking lot construction during 2020 resulted in an increase in particulate matter emissions. Nitrogen oxide emissions decreased in 2020 due to a decrease in fuel use for standby diesel generators.

Table 10 - NPRI Contaminants Reported for 2020

Contaminant	Total kgs
Ammonia (total)	12,682
Hydrazine	1,474
Lead[22, 23]	220
Oxides of nitrogen (NO_2)	26,772
PM10[26]	3,682
PM2.5[25]	975
Sulphuric acid	1.2
Volatile organic compounds[28]	16,153

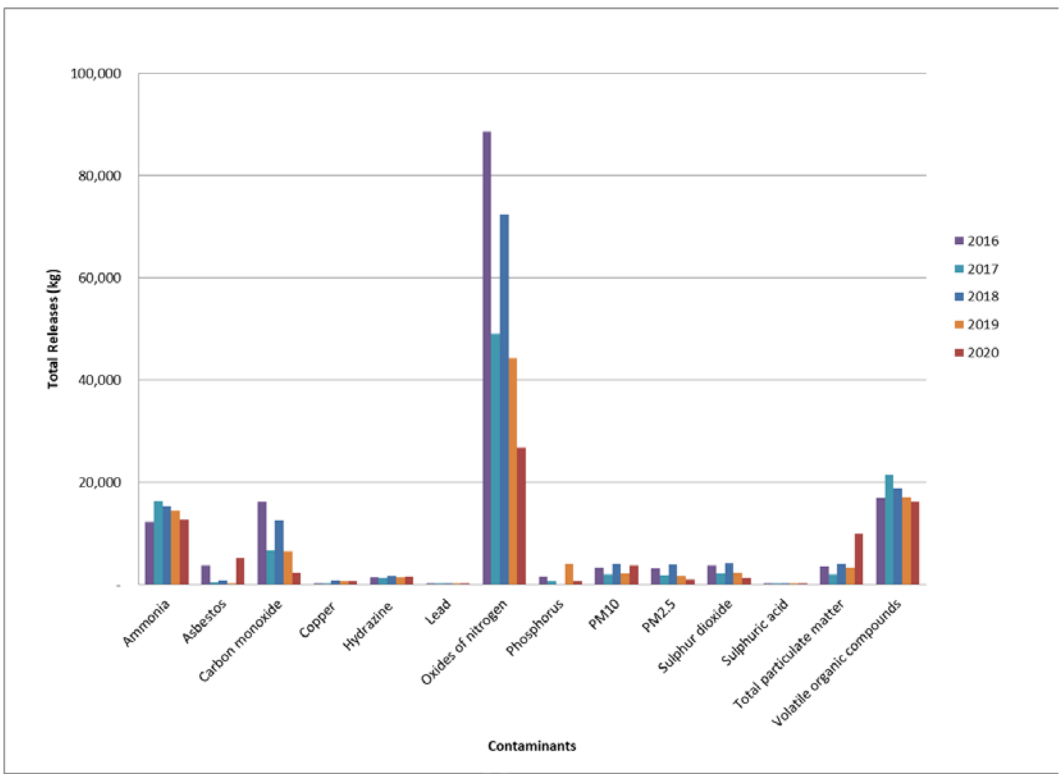


Figure 17 - 2016 to 2020 Contaminant Total Releases to Air, Water and Land

5.2.2.5 Quality Assurance/Quality Control (QA/QC)

Quality assurance activities for conventional air emissions are outlined in the Emission Summary and Dispersion Modelling (ESDM) Report [R-86]. The ESDM report includes the operating conditions, emission estimating, data quality and sample calculations. Modelling is conducted in accordance with the Air Dispersion Modelling Guideline for Ontario, Version 3.0 [R-87].

Data included in the National Pollutant Release Inventory reporting follows the guideline released by Environment and Climate Change Canada [R-88]. Hydrazine, Ammonia and Morpholine Calculation Methodology for National Pollutant Release Inventory Reporting [R-89], describes the process for obtaining CEM data, plant information, drain data for the calculation of air and water emissions for hydrazine, morpholine and ammonia.

Data included in the greenhouse gas calculations follows Canada's Greenhouse Gas Quantification Requirements [R-90] and are further described in the Greenhouse Gas Emissions Quantification Job Aid [R-91].

5.2.3 Water Effluent

Site conventional water emissions are controlled to meet regulatory requirements and to minimize environmental impacts to protect the environment. Conventional water emissions at Bruce Power are discharged according to specific licenses, permits, and regulations under (but not limited to) the Environmental Protection Act (EPA) [R-7] and the Ontario Water Resources Act (OWRA) [R-8].

5.2.3.1 Environmental Compliance Approvals (ECAs)

The OWRA states that no person shall use, operate, establish, alter, extend, or replace new or existing sewage works except under, and in accordance with, an Environmental Compliance Approval (ECA). Bruce Power operates according to three ECAs regulating conventional water emissions across site; Bruce A, Bruce B, and Centre of Site [R-65]–[R-67]. These ECAs impose site-specific effluent limits, monitoring and reporting requirements for the operation of the facility. Non-compliances to ECA limits are reportable to the MECP and are subject to Environmental Penalties under O. Reg. 223/07 [R-92]. Table 11 and Table 12 show a summary of the measured concentrations from 2017 to 2021 for the Bruce A CCW, Bruce B CCW and Centre of Site Sewage Processing Plant (SPP) compared to regulatory limits (including ECA).

Table 11 – Bruce A and Bruce B Condensing Cooling Water (CCW) Discharge Concentrations from Q1 2017 to Q4 2021

				Bruce A CCW Q1 2017 to Q4 2021		Bruce B CCW Q1 2017 to Q4 2021	
Parameter	**Units**	**Method Detection Limit (MDL)[a]**	**ECA Limit**	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Ammonia (unionized)	µg/L	varies[b]	<20	<MDL	2.2	<MDL	0.8
Boron, (total as B)[c]	µg/L	4	5,000	<MDL	180	N/A	N/A
Hydrazine	µg/L	3	100	<MDL	20	<MDL	73

Morpholine	µg/L	15	2,500	<MDL	770	<MDL	<MDL
Total Residual Chlorine (TRC)	µg/L	1	<10	<MDL	<MDL	<MDL	<MDL
pH	—	—	6.0 to 9.5	7.0	8.4	6.8	8.5
Phosphorus[d]	*µg/L*	*5*	*1,000* [d]	*<MDL*	*110*	*<MDL*	*54*

[a] Value shown is the current MDL (year 2022).

[b] Unionized ammonia (NH_3) is calculated from measurements of total ammonia (NH_3 + NH_4^+), temperature and pH. The MDL for total ammonia is 10 µg/L, and the MDL for unionized ammonia will vary as it is dependent on temperature and pH.

[c] Boron additions are only performed at Bruce A

[d] Bruce A and Bruce B do not have ECA limits for Total Phosphorous, rather there is a 1,000 µg/L objective established for each facility.

Table 12 – Centre of Site Sewage Processing Plant (SPP) Discharge Concentrations from Q1 2017 to Q4 2021

						Q1 2017 to Q4 2021	
Parameter	**Units**	**Method Detection Limit (MDL)**	**WSER Quarterly Avg. Limit**	**Daily ECA Limit**	**Monthly ECA Limit**	**Minimum**	**Maximum**
Biochemical Oxygen Demand (5-day) (BOD5)	mg/L	—	—	—	25.0	2.0	5.8
Nitrogen (Ammonia + Ammonium)	mg/L	0.006	—	—	7.000	0.011	5.420
Total Phosphorus	mg/L	0.014	—	—	1.000	0.120	0.499
Total Suspended Solids (TSS)	mg/L	0.4	—	44.0	18.0	5.4	12.5
Oil and Grease	mg/L	1.0	—	38.0	12.0	0.4	2.2
pH	—	—	—	6.0-9.5	—	6.1	8.2
E. coli	CFU/100 mL	—	—	—	200[b]	0	18.4
Carbonaceous Biochemical Oxygen Demand (CBOD)	mg/L	2.0	25.0	—	—	<MDL	62.4
Total Suspended Solids (WSER)	mg/L	2.0	25.0	—	—	<MDL	16.8
Acute Lethality	Pass/Fail[a]	—	—	—	—	Pass[c]	

[a] Pass = ≤ 50% mortality.

[b] Based on a rolling geometric mean of 5 samples.

[c] All quarterly toxicity tests for rainbow trout and *Daphnia magna* passed Q1 2017–Q4 2021.

In 2021, ECA amendment applications were submitted to the MECP for all three ECAs; in January for Centre of Site ECA 9809-9KXLEB and in December for Bruce A and Bruce B ECA's, 0732-B2MKYL and 5209-BLBSZY respectively [R-65]–[R-67]. The Bruce A and Bruce B amendment applications focused on the proposed use and discharge of Film Forming

Amines (FFA) used for protecting the feedwater system from corrosion product transfer, as well as other changes or updates to the ECA language and the supporting documents. The Centre of Site ECA amendment proposes a third treatment train for the Sewage Processing Plant (SPP) that will provide improved treatability without increasing the overall rated capacity. The third train will facilitate the plant to maintain compliance with objectives and limits while running at peak capacity while the site population increases for Major Component Replacement (MCR). In addition, the Bruce Steam plant (BSP) will be completely removed.

5.2.3.2 Effluent Monitoring Effluent Limits (EMEL)

The EPA formerly contained regulations which prescribed limits on discharge streams across nine different industrial sectors that discharge more than 50,000 litres of water a day. The electric power generating sector was regulated under O. Reg. 215/95 Effluent Monitoring Effluent Limits (EMEL) [R-93]. On July 1st, 2021, this regulation was revoked and the EMEL requirements captured in Notices to the three Bruce Power ECAs, took effect. The notices define a daily limit and a monthly average limit for each regulated parameter. It also requires that the discharge is not toxic to fish. Monitoring and reporting requirements to confirm compliance are also defined within the notices. Non compliances to ECA Notices are reportable to the MECP and are subject to Environmental Penalties under O. Reg. 222/07 [R-94]. In 2021, there were no reportable EMEL/ECA Notice 1 events and no reportable ECA events at Bruce A, Bruce B or Centre of Site.

5.2.3.3 Wastewater Systems Effluent Regulations (WSER)

The Wastewater Systems Effluent Regulations (WSER) is a Federal wastewater regulation under the Fisheries Act that came into effect in June 2012. The WSER applies to wastewater treatment systems, Bruce Power Sewage Processing Plant (SPP) that discharge wastewater effluent to water at a daily volume of 100 cubic meters or more. Table 12 shows a summary of the measured concentrations from 2017 to 2021. There were no exceedances reported in 2021.

5.2.3.4 Permit to Take Water (PTTW)

In Ontario, anyone who takes more than 50,000 litres of water per day from a lake, river, stream, or groundwater source must obtain a Permit to Take Water (PTTW) from the MECP [R-8] (with a few exceptions). These permits help to ensure the conservation, protection, management, and sustainable use of Ontario's water. Ontario's Water Taking Regulation (O. Reg. 387/04) [R-95] helps to ensure fair sharing of water resources and prevent interferences among water users. Permits are not issued to assign rights to water or to establish priorities on water use. O. Reg. 387/04 [R-95] sets out criteria that the Ministry must consider when assessing an application for a PTTW. A permit will not be issued if the Ministry determines that the proposed water taking will adversely impact existing users or the environment [R-95].

Bruce Power has a separate PTTW for each station Bruce A, Bruce B and Centre of Site. In 2021 new permits were applied for and received in May. The previous permits regulated water taking until the new permits were issued. For Bruce A the previous permit was 1813-8MLLHG [R-71] and the new permit is P-300-2114648110 [R-74], for Bruce B the previous permit is 2233-8MLN8J [R-72] and the new permit is P-300-4114675736 [R-75], and for Centre of Site the previous permit is 1152-8MLPCR [R-73] and the new permit is P-300-

7116089842 [R-76]. The new Bruce A and Bruce B permits introduced flexibility throughout the year to allow for future planned increases in unit output as well as changes to CCW pumps. In addition, in 2021 Bruce Power applied for an Environmental Activity and Sector Registry (EASR) permit to take water for a construction project where dewatering was expected. EASR permit R-009-1113257323 [R-96] was issued to Bruce Power and expired December 31st, 2021. Bruce Power remained in compliance with all PTTW requirements in 2021.

5.2.3.5 Quality Assurance/Quality Control (QA/QC)

Quality Assurance, quality control for the conventional water emissions program has been developed by applying the requirements of the Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater [R-97] for Environmental Compliance Approval (ECA) [R-65]–[R-67]and ECA Notice 1 [R-68] [R-69] [R-70] (formerly Effluent Monitoring and Effluent Limits (EMEL) regulation). The QA/QC program also includes requirements of the Environment and Climate Change Canada (ECCC) Wastewater Systems Effluent Regulation (WSER) [R-98].

The QA/QC requirements for conventional water include field quality control, lab quality control, tracking of QC data. The QA/QC program documentation further defines when lab accreditation is required for specific sampling parameters, and at times defines actions and how to report data depending on the QA/QC results.

5.3 Chemical Management Plans

Environment and Climate Change Canada (ECCC) routinely collects information from industry to assist in managing toxic and priority substances identified under the Canadian Environmental Protection Act, 1999 (CEPA) Part 5 [R-99] in order to protect the environment and human health. Bruce Power participates in the information collection. ECCC did not request any mandatory surveys of the Chemical Management Plans in 2021.

5.4 Pollution Prevention

Under Part 4 of CEPA [R-100], Environment and Climate Change Canada has the authority to require preparation and implementation of pollution prevention plans for toxic substances. Pollution prevention planning is a method of identifying and implementing pollution prevention options to minimize or avoid the creation of pollutants or waste. ECCC issued a pollution prevention planning notice for any person who operates a facility in the electricity sector that has a concentration of hydrazine that is higher than the specified target levels under normal operating conditions and at any final discharge point. Bruce Power reviewed the notice and determined that it does not apply and as such, submitted a Notification of Non-Engagement [R-101].

5.5 Environmental Emergency Regulations

The aim of the Federal Environmental Emergencies Regulations, 2019 [R-102] (under CEPA) is to help reduce the frequency and severity of accidental releases of hazardous substances into the environment. Two hundred and forty-nine hazardous substances are included in the regulations, identified for their emergency hazard characteristics (oxidizer that may explode, inhalation, aquatically toxic, explosion, combustible, pool fire). The Environmental

Emergencies Regulations identify minimum threshold quantities for these substances, above which there are requirements for submitting notices, developing Environmental Emergency Plans, and completing drills. These are based on both the total volume on site and the size of the largest container system for the substance(s). There are additional reporting requirements for Environmental Emergencies. To date, Bruce Power has not had a reportable Environmental Emergency under this regulation. Bruce Power currently meets the reporting threshold for two substances on site: diesel (CAS No. 68334-30-5) and propane (CAS No. 74-98-6). Diesel and propane volumes on site are above the total volume on site threshold; this requires submitting Schedule 2 notices to ECCC. Propane is also above the container system threshold, triggering the requirement to have an Environmental Emergency Plan and conduct drills. However, now that natural gas has been installed on site, the temporary propane tanks at the Central Storage Facility will be removed (anticipated to be in 2022). Once these tanks are removed from site, Bruce Power will no longer be above the threshold for propane, and ECCC will be notified of this change.

6.0 ENVIRONMENTAL MONITORING

Bruce Power's Environmental Protection Program is built upon an integrated monitoring approach that strives to understand environmental impact, verify environmental protection, and continuously improve by driving strategic research and innovation through collaborations with industry and community. Environmental safety and responsibility are woven into all aspects of the company's nuclear safety culture, and Bruce Power commits to meet or exceed all relevant legal and voluntary environmental requirements. The company holds itself accountable to prevent pollution through strong management of emissions, effluents, and waste, and it implements robust spill mitigation measures in order to provide effective containment and control of contaminants.

To demonstrate environmental protection Bruce Power performs extensive monitoring and modelling of radiological and conventional contaminants in the Earth's Critical Zone [R-103]. The Critical Zone is comprised of the permeable zones near the Earth's surface where living organisms, air, water, soil, sediment and groundwater interact (Figure 18).

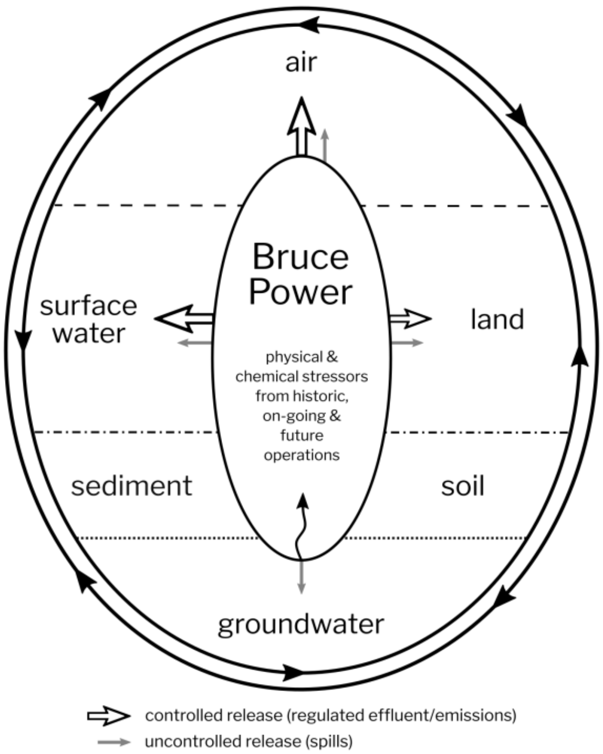


Figure 18 - Bruce Power has multiple layers of protection in place to minimize emissions and effluents released during facility operations. The Environmental Protection Program monitors and models physical and chemical stressors released to the environment and continuously assesses their risk and impact.

Air emissions and water/land effluents are controlled and regulated releases that occur in a manner that minimizes environmental impact. Bruce Power's radiological and conventional environmental monitoring programs are designed to continuously verify that environmental protection is being maintained and that these releases have a minimal impact on the surroundings. The programs are based on CSA N288.4-10 and N288.7-15 [R-6] [R-21] ,CNSC REGDOC-2.9.1 [R-16], reporting requirements in CNSC REGDOC-3.1.1 [R-2] and the framework laid out in internal procedures.

The key goal of the environmental protection program is to:

- Ensure that physical stressors and radiological and conventional contaminants released through controlled pathways or spills do not cause undue risk to living organisms.

This is achieved by fulfilling several program objectives:

- Assess the level of risk to human health and safety, and potential biological effects that may arise from operation of the facility.

- Demonstrate compliance with limits on the concentration/activity of radiological and conventional contaminants and intensity of physical stressors in the environment and/or their effect on the environment.

- Ensure that groundwater end-uses are protected by implementing a groundwater protection program, control releases that have the potential to impact groundwater and have a groundwater monitoring program in place

- Independently check the effectiveness of emission and effluent controls and provide public assurance of the efficacy of these measures.

- Obtain concentrations of radioactivity in environmental media, calculate radiation exposure doses to representative persons, and meet the applicable requirements of REGDOC 3.1.1: Reporting Requirements for Nuclear Power Plants [R-2].

- Provide data to verify predictions, refine models, and/or reduce uncertainty in predictions as required for the Environmental Risk Assessment (ERA) [R-43], and incorporate any recommendations into the program design; and,

- Demonstrate due diligence and meet stakeholder commitments.

Bruce Power has well-established environmental monitoring programs that focus on the local area around the facility, including neighboring communities and Lake Huron. Together, the results build an overall understanding of the risk to human health and impact on the environment. The company's strong commitment to excellence has yielded excellent environmental performance and Environmental Risk Assessments continually show the operation of the facility has little-to-no impact on human and ecological health. This conclusion is supported by evidence independently collected by the Federal and Provincial governments who monitor and measure concentrations of contaminants in the environment near Bruce Power, including the radiation dose to members of the public.

As of December 31, 2020, Bruce Power groundwater protection and monitoring program is designed and operated in general accordance with principles found CSA N288.7-15 [R-21]. The overall groundwater protection goal for the Bruce Power groundwater protection program (GWPP) is to protect the quality and quantity of groundwater by minimizing interactions with the environment from activities associated with the facility, allowing for effective management of groundwater resources. This includes ensuring that no further migration of contamination occurs at historic sites to identified discharge zones, thereby protecting end-use receptors; monitoring to provide data to evaluate risk to receptors and discharges to water bodies; ensure there are control measures, where appropriate, to minimize a release from the operation of Site systems, structures and components. Monitoring of water levels allows inference of groundwater flow direction. Groundwater monitoring characterizes the quality and quantity of groundwater which are compared against evaluation criteria, used to identify unforeseen conditions and assess risks to human health and the environment.

During the 2018 licence renewal process, Bruce Power presented their commitment to working with SON, MNO and HSM in a manner that best suits their communities, to enhance involvement in environmental monitoring. Recognizing that every community has a unique set of interests, in 2020 we worked with each community to further these commitments. Note that the COVID-19 pandemic did cause some need to revise plans, as noted below. Progress in environmental monitoring over the course of the year included:

- Results from this program are used in conjunction with environmental monitoring results in the Environmental Risk Assessment to better understand the near shore environment of Lake Huron over a larger spatial scale.

- MNO Diet Survey was designed to better inform dose calculations as well as our environmental monitoring program. It was conducted in late 2020 and early 2021 with MNO Region 7 members via an online platform. The purpose of this survey was to collect information about the lifestyle characteristics of MNO members in order to accurately represent them when considering Bruce Power's impact on nearby populations. The results of the diet survey were gathered from all three Indigenous Nations and Communities and used to refine the Hunter/Fisher scenario in the Environmental Risk Assessment to better inform dose calculations.

- HSM and Bruce Power submitted a fisheries offset plan in 2021 to remove invasive *Phragmites* from the Fishing Islands wetland complex. This fish habitat restoration and enhancement project is comprehensive blend, considering the values and interests of the HSM Community and the DFO offsetting principles. The project embraces the important recent changes to the *Fisheries Act* that encourage a stronger role of Indigenous peoples in project reviews, monitoring and policy development as part of the early steps to advance reconciliation.

Bruce Power continues to build and develop our dialogue on environmental items of interest with Indigenous Nations and Communities. Sharing and insights have strengthened our approach and have led to synergies for growth and partnership for continued environmental protection.

6.1 Radiological Environmental Monitoring

The radiological environmental monitoring (REM) program establishes a database of radiological activity measured in the environment near Bruce Power and determines the contribution of overall radiation dose to members of the public as a result of the radiological releases from normal operations on Site. The REM program is conducted in accordance with CSA N288.4-10 and N288.7-15 [R-6] [R-21] and is integrated into the Environmental Management System framework which requires a regular review, assessment and refinement of the program to ensure the environment and the public are adequately protected.

The REM data implicitly reflects the influence of releases from all licensed activities carried out at Bruce Power licensed facilities (i.e. Bruce A, Bruce B, CMLF and CSF) as well as from facilities within or adjacent to the Bruce Power site boundary that are owned by other parties. This includes the OPG WWMF (owned and operated by OPG), the Douglas Point Waste Facility (owned by CNL), and KI North (owned by Kinectrics).

The REM program involves the annual collection and analysis of environmental media for radionuclides specific to nuclear power generation. Background levels due to naturally occurring sources are subtracted from the totals in order to elucidate the impact specific to Bruce Power operations. The data gathered each year is used in the annual dose to public calculation, which is described in Section 3.0.

The design of the REM program is based on risk and is informed by a radionuclide and exposure pathways analysis. This analysis outlines which radionuclides and environmental media should be monitored due to their contribution to human or non-human radiological dose. For radionuclide-media pairs contributing >10% to the total dose of any human receptor, Bruce Power attempts to obtain samples at a minimum of one location per 22.5° wind sector over land to provide spatial resolution at the cardinal points of the compass and align with standard partitioning of meteorological data. The media contributing greater than 10% to receptor dose are air, milk, meat, and terrestrial plants such as grains, fruit and vegetables. For radionuclide-media contributing <10% to the total dose, a total of three locations over land within the REM boundary are required.

The following environmental media are collected and analyzed by the Bruce Power Health Physics Laboratory as part of the annual REM program:

- Air
- Precipitation
- Water
    - Drinking water (e.g. water supply plants, residential wells)
    - Lake and stream water
- Groundwater
- Terrestrial Samples
    - Animal products (e.g. milk, eggs, honey, animal meat)
    - Agricultural products (e.g. fruits, vegetables, farm crops, animal feed)
    - Soil
- Aquatic Samples
    - Fish
    - Sediment and beach sand

The radionuclides that are measured in the environmental media collected include tritiated water (tritium oxide), carbon-14 (C-14), iodine-131 (I-131), beta and gamma emitting radionuclides.

Bruce Power relies on the OPG Health Physics Laboratory in Whitby, Ontario for Provincial Background radiation levels measured in a variety of environmental media collected at locations outside the influence of Bruce Power. Background radiation comes from naturally occurring radioactive materials present in the environment (see Section 3.0), and these levels are subtracted from Bruce Power environmental monitoring results for dose calculations each year. The Provincial Background sampling locations are shown in Figure 19.

For the Bruce Power REM program, monitoring locations for aquatic media such as lake water, fish and sediment are downstream of the site, at locations where radionuclides are expected to accumulate. For air sampling, monitors are situated at varying distances from Bruce Power, at locations covering all landward wind directions. For terrestrial foodstuffs (e.g. milk, meat, fruit, vegetables, grains, eggs, honey), sampling is performed at nearby areas or at local farms and residences, as applicable. Monitoring locations are based on practical considerations, including the availability of samples and participation of local residents and farmers. Wild animals are sampled only when available (e.g. subject to on-site vehicle collisions or samples provided by local hunters). Milk is monitored from five local dairy farms through an agreement with the Dairy Farmers of Ontario.

Bruce Power groups the sampling locations by proximity to site and these groups include indicator, area near and area far locations. **Indicator** locations are used to assess the potential dose to the public. These locations are on or outside the facility perimeter and represent the highest risk of public exposure. Indicator locations are within 20 km of the facility and take into consideration the locations of representative persons and where they get their food/water for consumption, as well as prevailing wind directions. **Area Near** locations are used in conjunction with indicator locations to provide confirmation of the validity of the computing models used to assign dose to the public. Area Near location data is used to estimate atmospheric dispersion and doses to people in local population centers located further away from the site than the indicator locations, but less than 20 km from the facility. Data from the Area Near location may be used to calculate the average dilution available as a function of distance for a given monitoring period. **Area Far** locations are located further away but potentially still under the possible influence of Bruce Power. Area Far locations include the towns of Port Elgin, Paisley and Kincardine.

Bruce Power area near and area far sampling locations are provided in Figure 20 and Figure 21, Residential sampling locations where fruit, vegetable and milk samples are collected are included on Figure 22, alongside the locations of representative persons/groups.

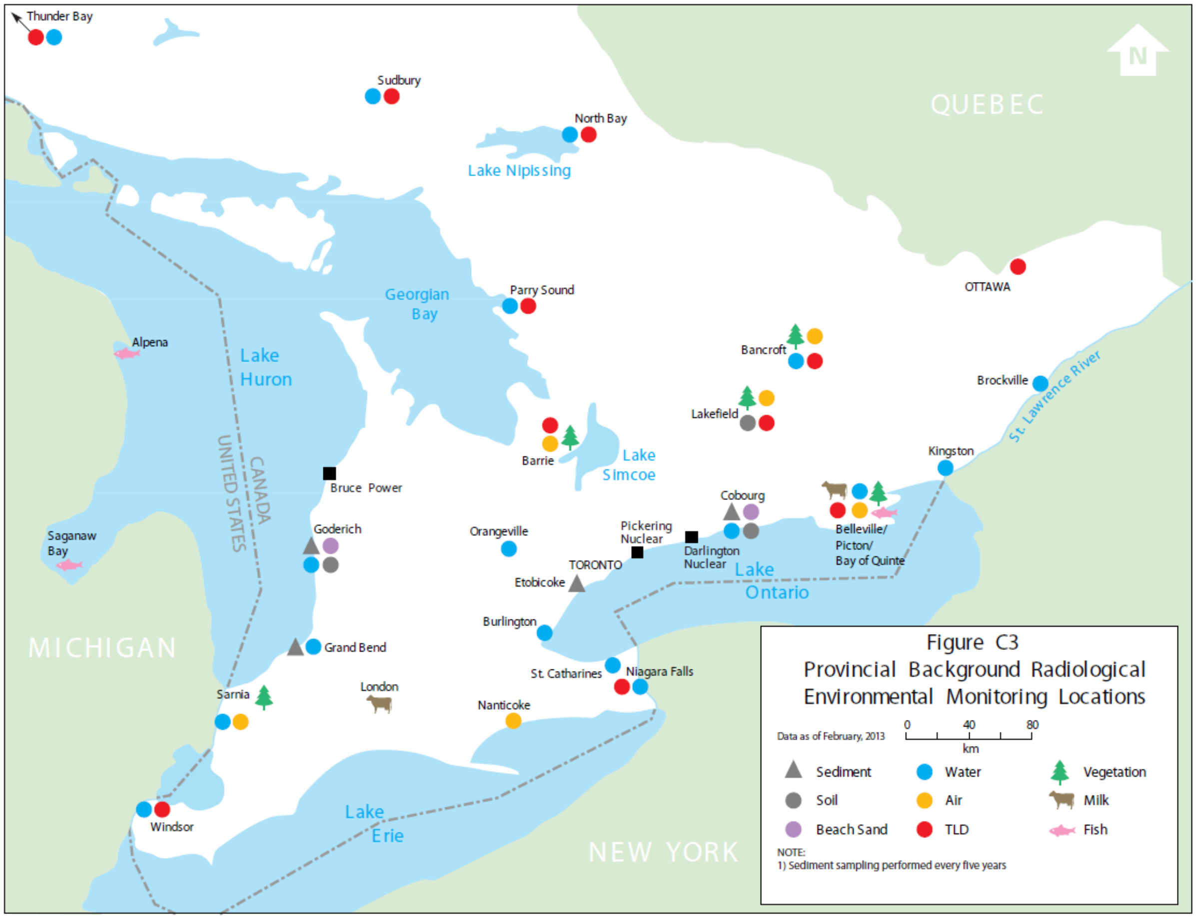


Figure 19 - Provincial Background Radiological Environmental Monitoring Locations

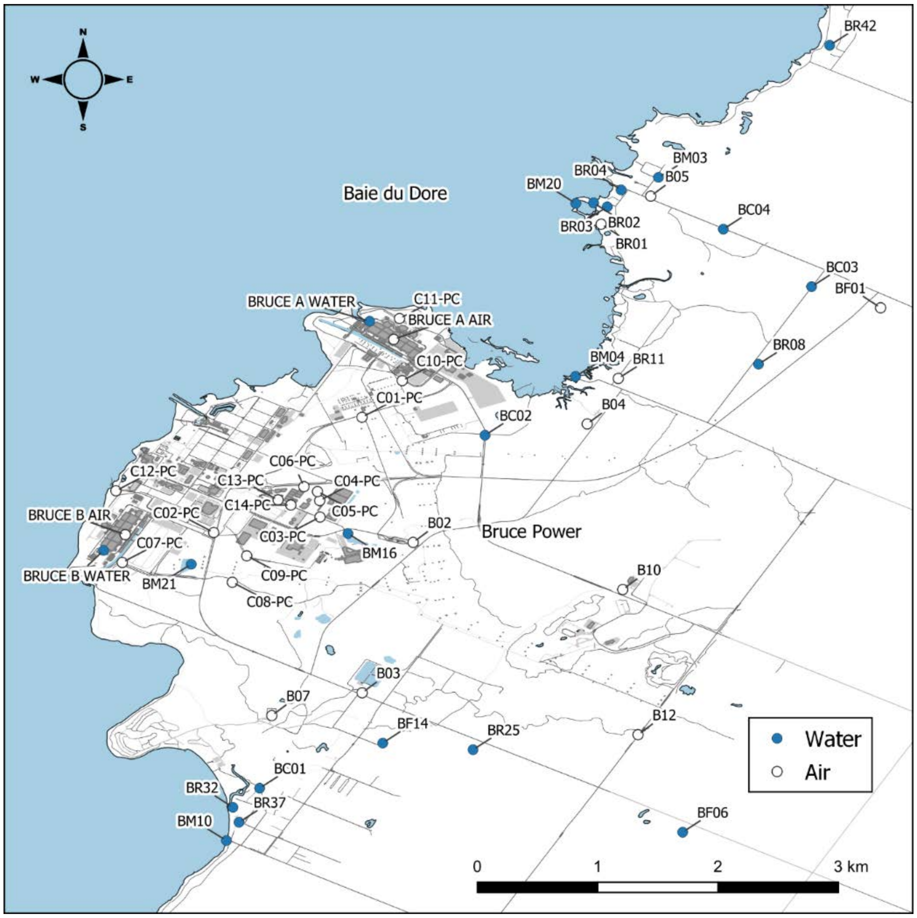


Figure 20 - Bruce Power On-Site and Area Near Radiological Environmental Monitoring Locations

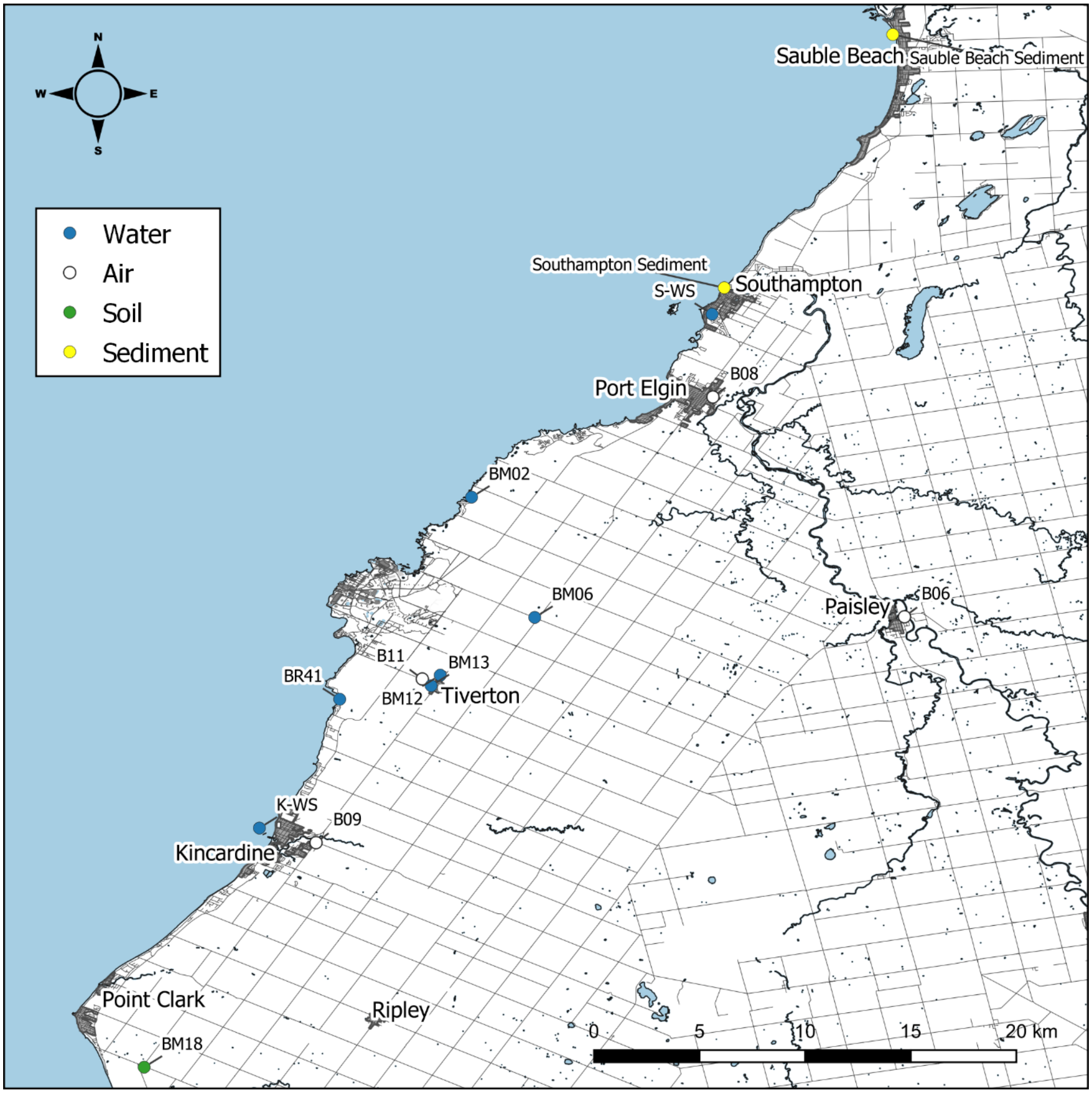


Figure 21 – Bruce Power Area Far Radiological Environmental Monitoring Locations

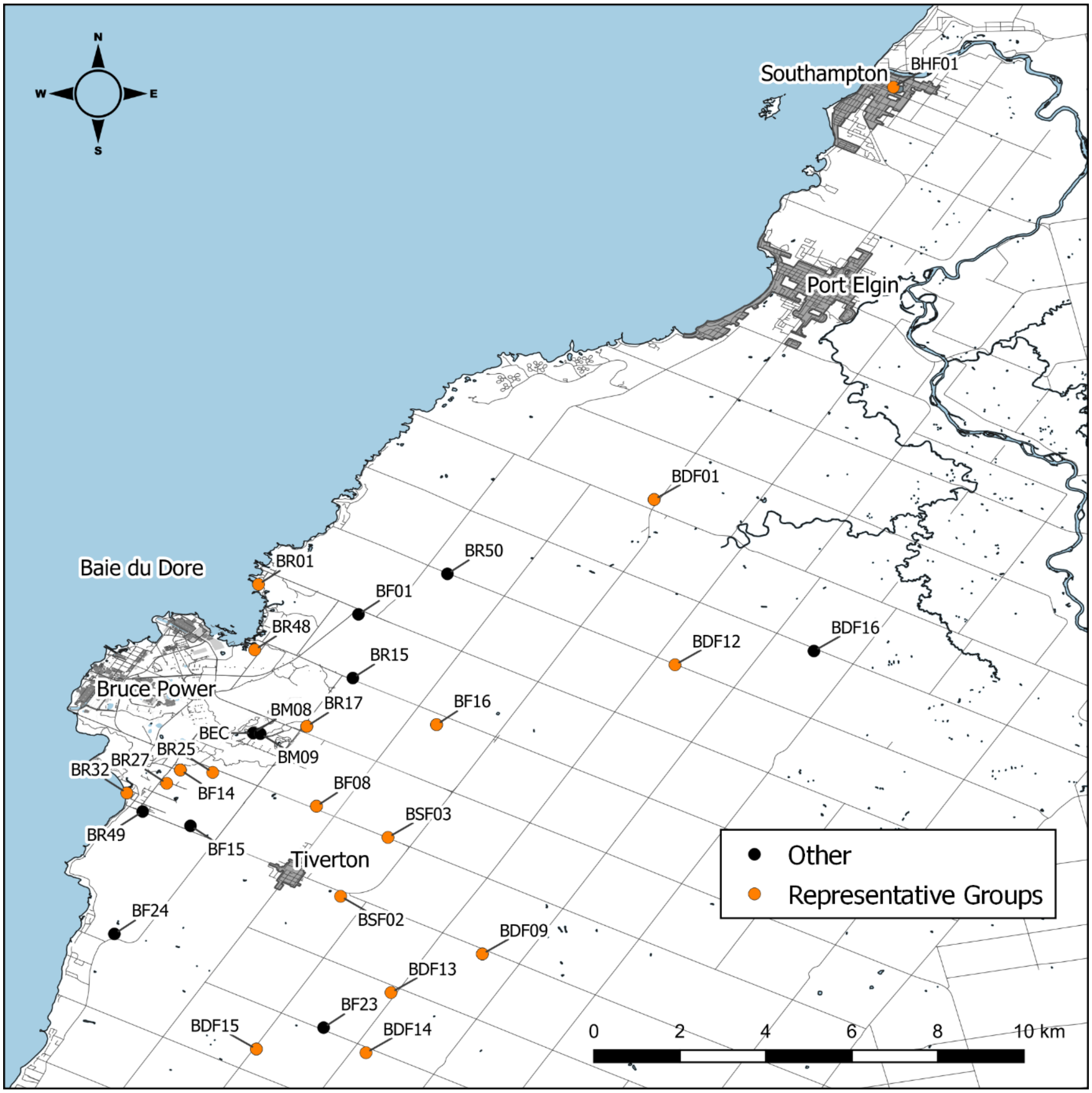


Figure 22 - Bruce Power Radiological Environmental Monitoring Residential Locations (Other) and Representative Groups

For REM data analysis the actual measured value, uncertainty, critical level and detection limit are recorded in a data management system. The critical level or decision threshold (Lc) is the calculated value based on background measurements, below which the net counts measured from the sample are indistinguishable from the background at the 95% probability level. The detection limit (Ld) is the calculated value based on the decision threshold and the measurement system parameters (e.g. count time) above which the net counts measured from the sample are expected to exceed the decision threshold at the 95% confidence level. These definitions of Lc and Ld are consistent with CSA N288.4-10 Annex D [R-6].

For Bruce Power REM data, when the actual measured value is less than the associated critical level (<Lc), those values were taken as reported (i.e. not censored). In the calculation of averages where some measured values were reported as less than Lc, the uncensored analytical results were used in the calculation. For instances where the annual *average* value is negative, the result is stated as "<Lc" for simplification. For Provincial Background data where the result was less than the detection limit (<Ld), the Ld value was used in the annual average. When all of the results for a particular radionuclide-media pair were <Ld, then "<Ld" was stated for the annual average.

The following sections provide the results of radiological environmental monitoring carried out by Bruce Power in 2021 and previous years. The Provincial Background results for 2021 are also provided where appropriate. The CNSC completed the IEMP in the Bruce County area in 2019 and these results are presented, as applicable, for additional demonstration that there is low radiological risk to the environment from Bruce Power operations.

6.1.1 Air Monitoring

Bruce Power monitors for external gamma radiation, tritium oxide and carbon-14 concentrations in air at a variety of locations near and far from site. The results are used in the annual dose to public calculation for each of the representative persons that live near Bruce Power. In addition, the results inform the environmental monitoring and environmental risk assessment programs to ensure that Bruce Power is appropriately monitoring and understanding its impact on the environment.

6.1.1.1 External Gamma in Air

Ambient external gamma radiation in air was measured using Harshaw EGM Thermoluminescent Dosimeters (TLDs) at 10 air monitoring stations near and far from Bruce Power (Figure 20 and Figure 21). The dosimeters were exposed for three-month periods, collected quarterly and measured by the OPG Whitby Health Physics Laboratory. The annual dose rates are calculated as the sum of the quarterly results.

Provincial Background dosimeters are located at various locations around Ontario (Figure 19) and are also collected quarterly and measured by the OPG Whitby Health Physics Laboratory. The dosimeter locations throughout the province show the range of background radiation levels experienced during the year. Bruce Power and Provincial Background results are detailed in Table 13.

The Bruce Power indicator sites B02, B03, and B04 are located closest to the Bruce Power site and the average external gamma dose in air was 53 ŋGy/h for 2021. For comparison, the average of the 8 Provincial Background sites was slightly higher at 59 ŋGy/h.

TLD measurements alone cannot resolve the very low gamma doses in air associated with radiological emissions from the Bruce Power site or those observed provincially. As a result, a conservative modelling method of estimating noble gas activity in the environment using emissions data and atmospheric dilution factors is used in the dose estimates. This demonstrates that the impact of Bruce Power on the surrounding environment, with regards to gamma radiation in air, is *de minimus* or negligible.

Table 13 - 2021 Annual External Gamma Dose Rate Measurements

Sample Location	Total Exposure Time (days)	Total Measured Dose in Air (μGy)	Annual Average Dose Rate in Air (ηGy/h)	Annualized Exposure (μGy)
Indicator				
B02-TLD	349	475	57	497
B03-TLD	349	458	55	479
B04-TLD	350	409	49	427
Average (Indicator)	**349**	**447**	**53**	**468**
Area Near				
B05-TLD	350	402	48	420
B07-TLD	349	405	48	424
B10-TLD	349	544	65	569
B11-TLD	349	509	61	533
Average (Area Near)	**349**	**465**	**55**	**486**
Area Far				
B06-TLD	350	409	49	427
B08-TLD	350	384	46	401
B09-TLD	350	403	48	421
Average (Area Far)	**350**	**399**	**47**	**416**
Provincial Background				
Bancroft	364	598	68	600
Barrie	363	532	61	535
Lakefield	364	564	65	566
Niagara Falls	364	407	47	408
North Bay	371	540	61	532
Ottawa	365	454	52	454
Thunder Bay	381	541	59	519
Windsor	350	506	60	528
Average (Provincial Background)	**365**	**518**	**59**	**518**

The annual average external gamma dose rates for Bruce Power indicator, area near and area far sites over time are shown in Figure 23, along with the annual average Provincial Background. External gamma values have remained relatively constant over the past ten years. Both Bruce Power and provincial measurements show similar trends, although Bruce Power is consistently below the Provincial Background. A general linear model (α=0.05) was performed and identified that there was no interaction between location and year for gamma in air ($p<0.05$). An analysis of variance ($\alpha=0.05$) shows a statistically significant difference by site when mean gamma in air results for Provincial Background, area far and area near sites were compared ($p<0.001$). The results showed that the Provincial sites had the highest mean gamma in air, that the indicator and area near sites had no significant difference from each other and that the area far sites had the lowest mean gamma in air.

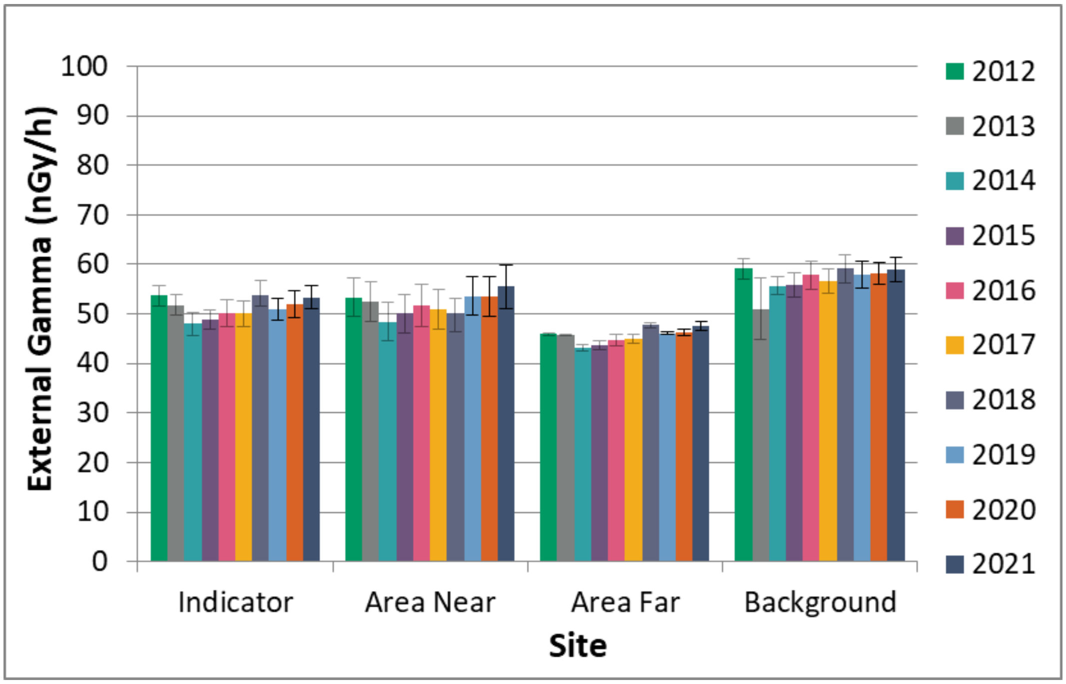


Figure 23 - Annual Average External Gamma Dose Rates (nGy/h) at Bruce Power Indicator, Near, Far and Provincial Background Locations Over Time (± Standard Error)

Health Canada also monitors total external gamma dose in the local area [R-104]. The Fixed Point Surveillance (FPS) network monitors radiation dose to the public in real-time due to radioactive materials (natural and manmade) in the terrestrial environment, whether they are airborne or on the ground. The radiation dose from all external gamma sources, which includes natural background from mineral deposits in the ground or radon gas in the air is provided as Total Air KERMA (Kinectic Energy Released in Matter). The contributions to external dose from 3 radioactive noble gases Argon-41, Xenon-133 and Xenon-135 are reported in nanoGray per month (1 nGy = $1x10^{-6}$ mSv). There are 8 FPS network monitors in the area near Bruce Power, including at the site boundary, the Visitor's Center (Infocentre), Scott Point, Kincardine, Inverhuron, Port Elgin, Tiverton, and Shore Road. In 2021, the results for Xe-133 and Xe-135 were less than the limit of detection for all months at all 8 locations. At most locations and months the results for Ar-41 were less than the limit of detection, although there were 2-3 months at Scott Point, Infocentre and Shore Rd that detected Ar-41 at or above the limit of detection of 6 nGy/month, but were very low (<15 nGy/month) [R-105]. These levels are considered negligible.

The CNSC IEMP does not monitor for external gamma using the same approach used by Bruce Power, the Province or Health Canada, but instead measures individual gamma emitting radionuclides in air. Therefore the results are not comparable; however they are presented to show all of the monitoring results in the Bruce area. The 2019 CNSC IEMP monitored for cesium-137 in air at Baie du Doré, Inverhuron and Tiverton locations. All results were <0.000068 Bq/m^3, which are well below the Guidance/Reference Level of 2.56 Bq/m^3. The CNSC also measured iodine-131 at these locations in 2019, in addition to Cape Croker and Southampton locations. The results at these five locations were <0.00082 Bq/m^3, much lower than the Guidance/Reference Level of 0.228 Bq/m^3 [R-30].

6.1.1.2 Tritium Oxide in Air

Tritium oxide in air is measured at 10 locations near Bruce Power (Figure 20 and Figure 21) using active air samplers that pass air at a continuous rate through molecular sieves, where water vapour from the atmosphere is absorbed. The molecular sieves are changed out on a monthly basis and the water is extracted and analyzed for tritium by liquid scintillation counting. The results are obtained by multiplying the specific activity of tritium in the extracted water by the average absolute humidity measured for the sampling period. The average absolute humidity is determined by dividing the mass of water collected on the molecular sieve by the volume of air sampled as measured by an integrated flow meter.

Monthly samples are averaged by location for the year and are shown in Table 14, along with the Provincial Background value measured in Nanticoke (Figure 19). The results are shown on a monthly basis in Figure 24.

The 2021 annual average for tritium oxide in air results were slightly higher at Bruce Power indicator, area near and area far locations compared to the previous year. At indicator sites closest to Bruce Power (B02, B03, B04), the annual average was 2.69 Bq/m^3 with sites further away (area near and area far) being progressively lower. The Provincial Background value is consistently lower than Bruce Power results.

In 2021 there were two months, May and December, with higher tritium levels at indicator and area near locations compared to other months. The December results may be attributed to elevated tritium releases at Bruce A due to a moderator pump seal leak, as described in Section 5.1.1.2, however the May results could not be attributed to any abnormal event at either Bruce A or Bruce B. Overall, these tritium concentrations are in line with historical results and are well below the CNSC Reference Level of 340 Bq/m^3.

Table 14 – 2021 Annual Average Tritium Oxide in Air

Sample Location	**Tritium Oxide**	
	Bq/m^3	**St. Dev**
Indicator		
B02-ST	2.96E+00	2.40E+00
B03-ST	2.31E+00	1.78E+00
B04-ST	2.79E+00	1.70E+00
Average (Indicator)	**2.69E+00**	
Area Near		

B05-ST	2.32E+00	2.08E+00
B07-ST	1.84E+00	8.48E-01
B10-ST	1.36E+00	7.17E-01
B11-ST	9.68E-01	7.06E-01
Average (Area Near)	**1.62E+00**	
Area Far		
B06-ST	1.51E-01	6.79E-02
B08-ST	3.56E-01	2.73E-01
B09-ST	2.93E-01	1.21E-01
Average (Area Far)	**2.61E-01**	
Provincial Background		
Nanticoke	1.84E-02	8.08E-02
Note: 1. St. Dev = standard deviation. E+00 represents scientific notation, E+03 = x10^3. 2. Sample count = 12 in all cases, except B09-ST sample count = 11. 3. For calculation of averages the uncensored analytical result was used.		

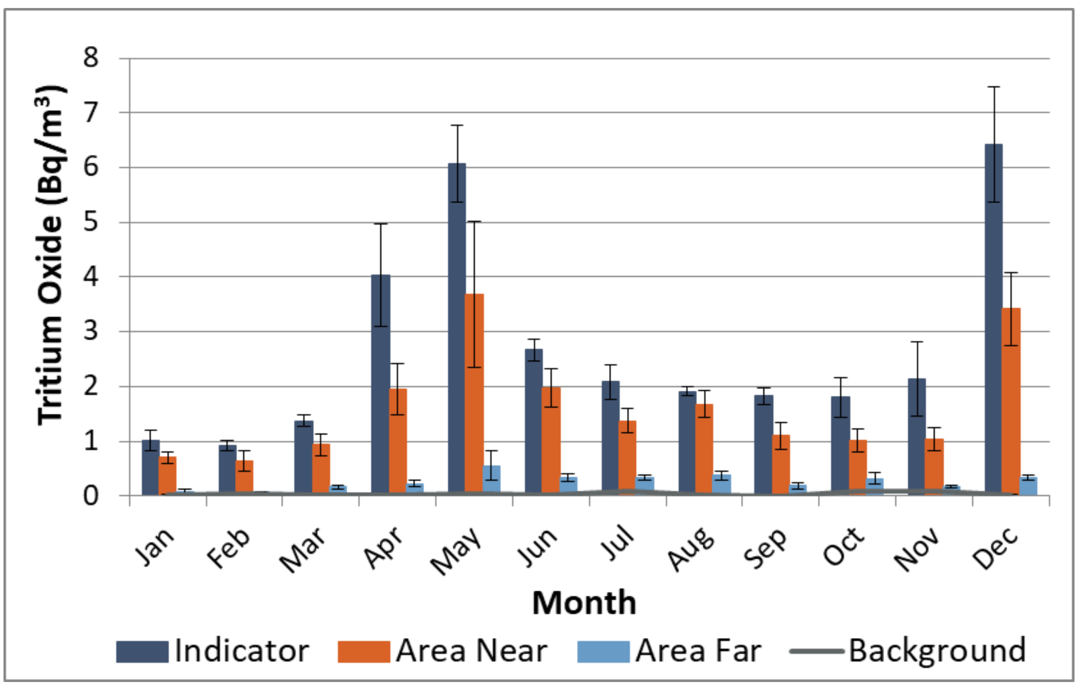


Figure 24 – 2021 Monthly Tritium Oxide in Air Concentrations (Bq/m^3) at Bruce Power Indicator, Near, Far and Provincial Background Locations (± Standard Error); CNSC Reference Level = 340 Bq/m^3

The historical trend of the annual average tritium oxide in air is shown in Figure 25 for indicator, area near, area far and Provincial Background locations. Concentrations of tritium oxide in air are typically higher closer to site and progressively decrease with distance. They also fluctuate with changes to airborne tritium emissions from the stations each year. For example, in 2014 airborne tritium emissions were impacted by outage work at Bruce A that involved moderator heat exchanger and end fitting work. At both stations in 2017, similar maintenance on reactor systems including heat transport and moderator systems occurred that resulted in higher annual tritium emissions in air. As mentioned previously, the average tritium in air results for 2021 were impacted by elevated emissions in May (unknown) and December (moderator pump seal leak at Bruce A).

Provincial Background tritium in air is typically lower than near Bruce Power. It is not known why the 2018 Provincial value is higher than other years. An analysis of variance (α=0.05) shows a statistically significant difference (p<0.001) by site. The indicator site showed the highest mean concentration, followed by area near. The area far and Provincial sites had the lowest mean concentrations and were not significantly different from each other.

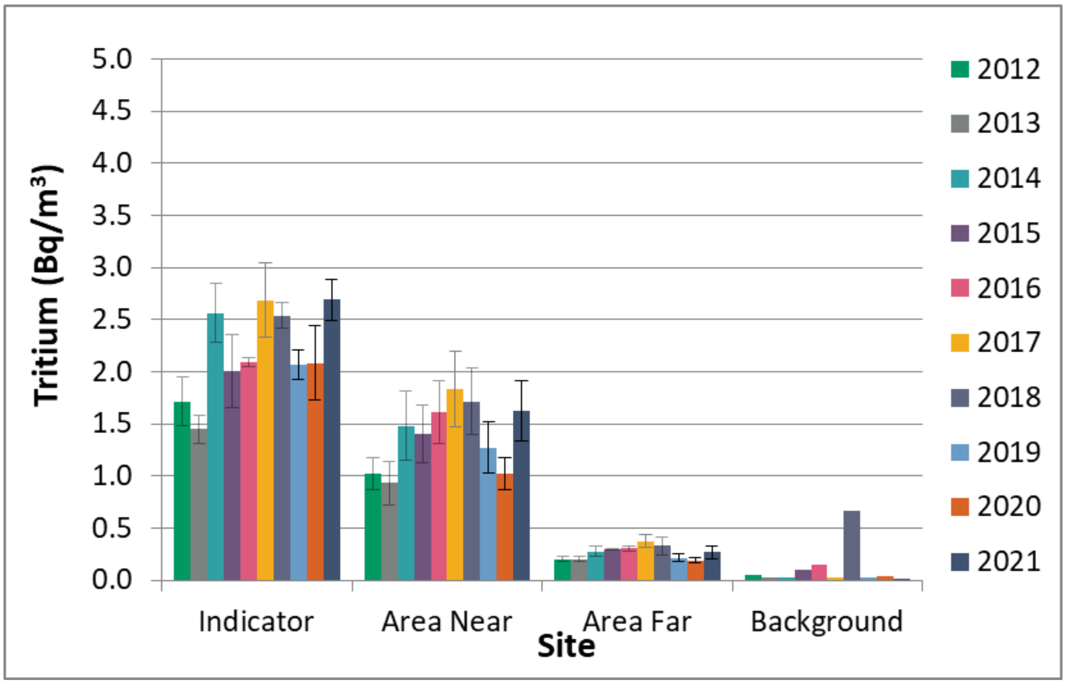


Figure 25 - 2021 Annual Average Tritium Oxide in Air Concentrations (Bq/m^3) at Bruce Power Indicator, Near, Far and Provincial Background Locations Over Time (± Standard Error); CNSC Reference Level = 340 Bq/m^3

The CNSC IEMP measured air samples for tritiated water and elemental tritium at five locations near Bruce Power in 2019 including Inverhuron, Baie du Doré, Tiverton, Southampton and Cape Croker [R-30]. All results were less than the limit of detection, with the exception of one which was obtained at the Inverhuron location with 4.8 Bq/m^3. During the 2016 IEMP, the result for this location was less than the detection limit (<2.5 Bq/m^3). All results were well below the guideline/reference level of 340 Bq/m^3 for tritiated water and 5,100,000 Bq/m^3 for elemental tritium and were not expected to cause a human health impact.

6.1.1.3 Carbon-14 in Air

Carbon-14 (C-14) in air is monitored using passive air samplers that contain mixed soda lime pellets that absorb carbon dioxide (CO_2) from the atmosphere at a controlled rate. The absorbent material is collected on a quarterly basis for analysis in the laboratory. The CO_2 is released from the pellets by titration with acid and then analyzed by liquid scintillation counting for carbon-14 content. There are eight sampling locations near Bruce Power (Figure 20), with a duplicate sampler at B05 at Scott Point. There are 14 passive samplers on-site situated around Bruce A, Bruce B and OPG WWMF. The Province has five carbon-14 samplers, shown in Figure 19, to measure background levels.

The 2021 annual average carbon-14 in air concentrations are provided in Table 15 and the quarterly results are shown in Figure 26. The off-site C-14 concentrations in air were similar to the previous year at all indicator and area near locations. The area near average was slightly higher than the average background concentration (235 Bq/kg vs 210 Bq/kg, respectively). The locations north (i.e. BR01, BR05) and northeast (i.e. BR11) of Bruce A had marginally higher results than other locations, as shown by the annual averages. Bruce A had higher C-14 emissions in 2021 compared to Bruce B, as described in Section 5.1.1.2.

The C-14 results from the on-site passive samplers circling the OPG WWMF (C03-PC, C04-PC, C05-PC, C06-PC, C13-PC and C14-PC) are typically higher than other areas on-site, including monitors near the Bruce A and Bruce B stations.

Table 15 - 2021 Annual Average Carbon-14 in Air from Passive Samplers

Sample Location	**Carbon-14**	
	Bq^{14}C/kgC	**St. Dev**
Indicator		
B03-PC	2.34E+02	1.42E+01
Area Near		
B05-PC (#1)	2.48E+02	1.28E+01
B05-PC (#2)	2.44E+02	2.00E+01
B11-PC	2.27E+02	1.29E+01
BF01-PC	2.34E+02	1.36E+01
BF14-PC	2.23E+02	1.04E+01
BF23-PC	2.08E+02	1.53E+01
BR01-PC	2.56E+02	7.80E+00
BR11-PC	2.43E+02	1.62E+01
Average (Area Near)	**2.35E+02**	

Sample Location	Carbon-14	
	Bq^{14}C/kgC	St. Dev
On-Site		
C01-PC	3.44E+02	4.92E+01
C02-PC	3.50E+02	3.64E+01
C03-PC	1.20E+04	6.13E+03
C04-PC	1.35E+03	3.70E+02
C05-PC	1.28E+03	3.79E+02
C06-PC	2.52E+03	1.73E+03
C07-PC	4.06E+02	8.79E+01
C08-PC	3.69E+02	4.33E+01
C09-PC	3.42E+02	8.13E+01
C10-PC	3.89E+02	5.19E+01
C11-PC	7.24E+02	7.81E+01
C12-PC	4.01E+02	2.67E+01
C13-PC	1.25E+03	2.77E+02
C14-PC	1.61E+03	3.84E+02
Provincial Background		
Bancroft	2.14E+02	2.02E+01
Barrie	2.04E+02	6.85E+00
Lakefield	2.08E+02	2.43E+01
Nanticoke	2.17E+02	1.13E+01
Picton	2.06E+02	2.22E+01
Average (Background)	**2.10E+02**	

Note:

1. St. Dev = standard deviation. E+00 represents scientific notation, E+03 = x10^3.
2. Sample count = 4 in all cases.
3. For calculation of averages the uncensored analytical result was used.

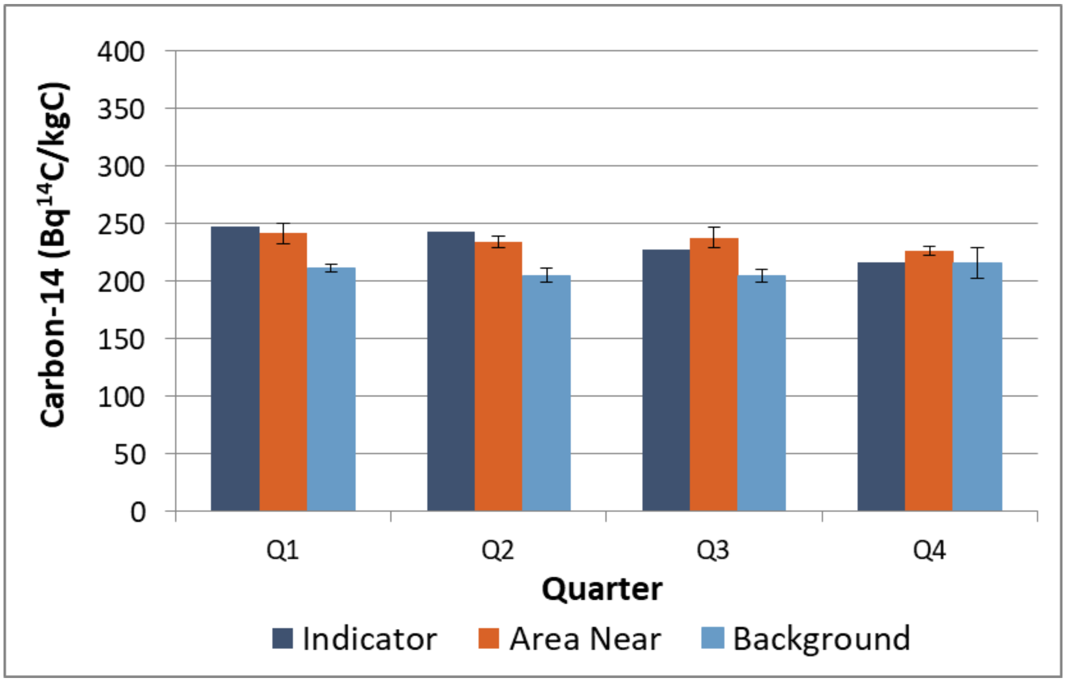


Figure 26 - 2021 Quarterly Average Carbon-14 in Air Concentrations at Bruce Power Indicator, Area Near and Provincial Background Locations (± Standard Error)

The annual average carbon-14 in air concentrations for the last ten years is shown in Figure 27. The Bruce Power annual average is consistently above the Provincial Annual Average, with trends in both being relatively stable. An analysis of variance (α=0.05) shows a statistically significant difference ($p<0.001$) by site, with the Provincial Mean Concentration being lower. The indicator and area near sites showed the highest mean concentrations and were not significantly different from each other.

The CNSC IEMP carried out near Bruce Power did not monitor for carbon-14 in air.

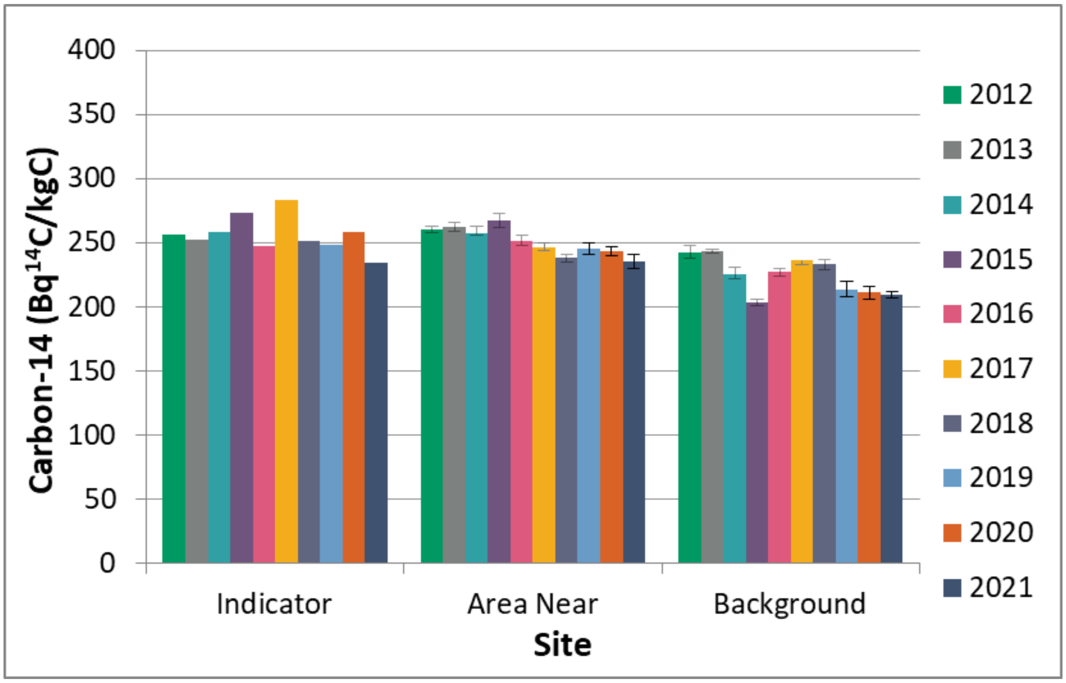


Figure 27 - Annual Average Carbon-14 in Air Concentrations at Bruce PowerIndicator, Area Near and Provincial Background Locations Over Time (± Standard Error)

6.1.1.4 Air Monitoring Summary

Bruce Power monitors external gamma radiation and tritium oxide and carbon-14 concentrations in air on a continuous basis at locations near Site. All results were within normal ranges and similar to historical levels. No human health impacts are expected.

A summary of each radionuclide group is provided here:

- External gamma results for 2021 were less than Provincial Background and have remained relatively constant over the last decade.
- Tritium levels in air increased compared to the previous year, however it was within the historical range and well below the CNSC Reference Level.
- Carbon-14 levels in air are lower than the previous year and are slightly higher than background levels.

6.1.2 Precipitation

Precipitation is collected in a bucket at 10 locations near and far from Bruce Power (Figure 20 and Figure 21). The province does not collect precipitation as part of their environmental monitoring program; however, the Bruce Power area far locations in Kincardine (B09), Port Elgin (B08) and Paisley (B06) may be used for reference. The water that has accumulated in the buckets is collected each month and analyzed for tritium oxide and gross beta radiation.

The volume of water collected is highly variable and depending on the year and season the pail may be empty or filled with snow or ice. The concentration of radioactivity in a sample is dependent on the time and amount of rainfall in relation to the collection date, due to dilution and/or evaporation. The results are not representative and are therefore not used in the dose calculations for members of the public. However, radioactivity measured in precipitation may give a rough estimate of airborne emissions, and precipitation will invariably become surface water and ground water, and potentially a source of drinking water via shallow wells or surface water.

In 2021 the months of May and August were drier than other months and most collection buckets were found to be nearly empty (< 0.5 L). This affected the analysis as there was not enough volume to perform one or both of the measurements (e.g. tritium or gross beta). In May 2021, 5 locations (50%) did not have enough volume for the tritium analysis, while one location did not have a beta analysis completed. In December, the pail at B07 was cracked and no sample was collected.

The annual average results for tritium oxide and gross beta in precipitation are presented in Table 16. As seen in previous years, the average tritium oxide results decrease with distance from Bruce Power (indicator > area near > area far locations), while gross beta remains consistent regardless of proximity to site. The annual average for tritium in precipitation at indicator locations was 205 Bq/L, while the annual average for area near locations was 154 Bq/L and area far locations was 19.1 Bq/L. By contrast the annual average gross beta deposition rate at indicator locations was 22.5 Bq/m^2/month, while area near and far locations had an annual average of 23.9 Bq/m^2/month and 20.8 Bq/m^2/month, respectively. This suggests that Bruce Power operations are not a significant contributor to beta radiation measured in precipitation.

Table 16 - 2021 Annual Average Precipitation Data

Sample Location	**Tritium Oxide**		**Gross Beta**	
	Bq/L	**St. Dev**	**Bq/m^2/ month**	**St. Dev**
Indicator				
B02-WP	2.03E+02	1.13E+02	2.37E+01	1.24E+01
B03-WP	2.16E+02	3.03E+02	2.22E+01	8.55E+00
B04-WP	1.71E+02	1.26E+02	2.15E+01	9.55E+00
Average Indicator	**2.05E+02**		**2.25E+01**	
Area Near				
B05-WP	2.35E+02	3.50E+02	2.34E+01	1.28E+01
B07-WP	1.27E+02	1.17E+02	2.28E+01	1.07E+01
B10-WP	7.57E+01	4.97E+01	2.82E+01	1.48E+01
B11-WP	4.45E+01	3.16E+01	2.14E+01	1.26E+01
Average Area Near	**1.54E+02**		**2.39E+01**	
Area Far				

B06-WP	1.35E+01	1.06E+01	2.14E+01	9.03E+00
B08-WP	2.11E+01	2.89E+01	2.07E+01	9.04E+00
B09-WP	1.93E+01	1.26E+01	2.12E+01	1.02E+01
Average Area Far	**1.92E+01**		**2.08E+01**	

Note:

1. St. Dev = standard deviation. E+00 represents scientific notation, E+03 = $x10^3$.
2. For tritium analysis, sample count = 12 in all cases, except at B07-WP, B10-WP, B11-WP, B08-WP, B09-WP with sample count = 11, and B02-WP with sample count = 10.
3. For beta analysis, sample count =12 in all cases, except B07-WP with sample count = 11.
4. For calculation of averages where result was less than critical level (Lc) the uncensored analytical result was used.

Tritium oxide in precipitation measured at Bruce Power monitoring locations are shown for the last ten years in Figure 28. Consistently the tritium concentration decreases with distance from Bruce Power. Averages vary from year to year mirroring the tritium emissions from Site. As observed in tritium oxide concentrations, precipitation was also impacted in May and December. The annual averages at the indicator and area near locations for 2021 were higher than in 2020, but lower than what was observed in previous years. An analysis of variance (α=0.05) shows a statistically significant difference ($p<0.001$) by site. The indicator site showed the highest mean concentration, followed by area near, and the lowest being area far. Precipitation is not included in the Provincial Monitoring Program.

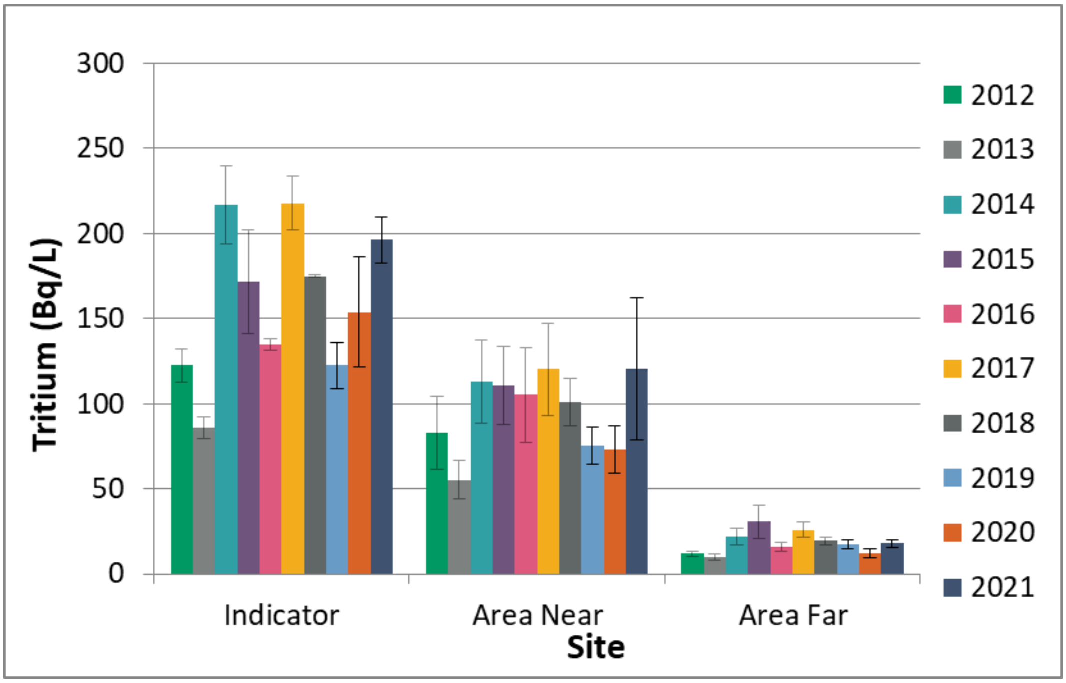


Figure 28 - Annual Average Tritium Concentrations in Precipitation at Bruce Power Indicator, Area Near, Area Far Locations over Time (± Standard Error)

6.1.3 Water Monitoring

Bruce Power regularly collects drinking water samples from the local municipal water supply plants and municipal and residential wells for use in calculating dose to members of the public each year. Surface water samples are also collected from Lake Huron, local streams and in-land ponds each year and used in the human dose calculation.

In 2021 additional sampling of surface water was completed at locations within the Bruce Power boundary for the 2022 Environmental Risk Assessment. The results were used to calculate the dose to ecological receptors that may live on Site.

Together, the routine monitoring of the on and off-site waterbodies informs the environmental monitoring and environmental risk assessment programs to ensure that Bruce Power is appropriately monitoring and understanding its impact on the environment.

6.1.3.1 Off-Site Water Monitoring

Background levels of tritium in lake water are a combination of natural cosmogenic sources (produced by the action of cosmic rays) and residual fallout from historical nuclear weapons testing. The Atomic Energy Canada Limited (AECL) developed a mathematical model for estimating background Lake Huron tritium activity from cosmogenic sources and fallout from nuclear weapons testing [R-106]. Natural Lake Huron tritium levels in the absence of CANDU tritium emissions are estimated to be 1.6 Bq/L.

Bruce Power collects water samples from municipal water supply plants, residential wells, lakes and streams and monitors for tritium oxide, gross beta and gross gamma radiation. The province monitors for tritium oxide and gross beta in samples collected at water supply plants and lakes within Ontario that are outside the influence of nuclear power plants. These results are subtracted from the local results in the annual dose calculation of members of the public. Bruce Power water sampling locations are shown in Figure 20 and Figure 21 and Provincial Background sampling locations are provided in Figure 19.

Municipal Water Supply Plants

Municipal drinking water is sampled at two municipal water supply plants (WSP) on Lake Huron - the Southampton WSP (22 km NE of Bruce A) and the Kincardine WSP (15 km SSW of Bruce B). Water samples are collected twice per day during regular business hours and weekly composite samples are analyzed for tritium by liquid scintillation counting. Monthly composite samples are analyzed for gross beta radiation by proportional counting. The Ontario Drinking Water Standard for tritium is 7,000 Bq/L (annual average), however Bruce Power has a long standing commitment with the municipalities to maintain an annual and monthly average tritium concentration at the WSPs below 100 Bq/L [R-107].

The 2021 annual average tritium and gross beta results for drinking water samples collected by Bruce Power and the Province are listed in Table 17. The 2021 annual average for tritium at the Kincardine WSP was 5.45 Bq/L and at the Southampton WSP was 12.4 Bq/L. These values are well below the Ontario Drinking Water Standard and CNSC Reference level (7,000 Bq/L), as well as the committed administrative level of 100 Bq/L. The average annual tritium concentration at the Provincial locations ranged between 1.1 Bq/L and 3.2 Bq/L.

The gross beta results at the local water supply plants for 2021 were similar to historical and Provincial Background results and are well below the CNSC reference level of 1 Bq/L.

Table 17 - 2021 Annual Average Tritium and Gross Beta Concentrations in Drinking Water

Sample Location (Sample Count Tritium/Beta)	Tritium		Gross Beta	
	Bq/L	St. Dev	Bq/L	St. Dev
Municipal Water Supply				
Kincardine WSP (48/12)	5.45E+00	3.63E+00	7.20E-02	2.04E-02
Southampton WSP (48/12)	1.24E+01	7.14E+00	8.15E-02	2.77E-02
BM03-WW (Scott Point well) (2)	<Lc	-	N/A	-
BM06-WW (Underwood well) (2)	<Lc	-	N/A	-
BM12-WW (Tiverton well) (2)	<Lc	-	N/A	-
BM13-WW (Tiverton well) (2)	<Lc	-	N/A	-
Residential Deep Wells				
BR01-WW (1)	<Lc	-	N/A	-
BR08-WW (2)	<Lc	-	N/A	-

Sample Location (Sample Count Tritium/Beta)	Tritium		Gross Beta	
	Bq/L	St. Dev	Bq/L	St. Dev
BR25-WW (2)	<Lc	-	N/A	-
BF01-WW (2)	<Lc	-	N/A	-
BF14-WW (2)	<Lc	-	N/A	-
BF23-WW (2)	<Lc	-	N/A	-
BM02-WW (1)	<Lc	-	N/A	-
Residential Shallow Wells				
BR02-WW (6/2)	<Lc	-	1.32E-01	6.35E-02
BR03-WW (5)	8.47E+01	3.95E+00	N/A	-
BR04-WW (6)	<Lc	-	N/A	-
BR41-WW (4)	2.02E+01	4.16E+00	N/A	-
BR42-WW (6)	2.19E+01	3.94E+00	N/A	-
BF06-WW (6)	<Lc	-	N/A	-
BR32-WW (0)	No sample	-	No sample	-
Provincial Background				
Brockville (WSP) (4)	2.3E+00	8.2E-01	1.0E-01	2.3E-02
Burlington (WSP) (4)	3.2E+00	1.3E+00	1.2E-01	1.9E-02
Goderich (WSP) (4)	1.1E+00	1.3E+00	1.0E-01	4.9E-02
Kingston (WSP) (4)	2.8E+00	2.1E+00	9.8E-02	1.0E-02
Niagara Falls (WSP) (4)	1.1E+00	2.0E+00	9.3E-02	2.0E-02
Windsor (4)	2.0E+00	1.8E+00	8.7E-02	4.1E-02
St. Catherine's (4)	1.3E+00	9.2E-01	9.4E-02	1.9E-02
Thunder Bay (4)	<Ld	-	4.2E-02	1.1E-02
North Bay (4)	<Ld	-	7.0E-02	1.1E-02
Parry Sound (4)	<Ld	-	4.9E-02	1.3E-02

Notes:

1. St. Dev = standard deviation, N/A = not applicable, WSP = water supply plant. E+00 represents scientific notation, E+03 = $x10^3$.
2. Bruce Power: For calculation of averages where result was less than critical level (Lc), the uncensored analytical result was used. '<Lc' stated in table when all results were <Lc.
3. Provincial Background: For calculation of averages where the result was less than the minimum detection level (Ld), the uncensored analytical result was used. '<Ld' stated in table when all results were <Ld.

The impact of Bruce Power discharges to Lake Huron on the local water supply plants varies and is dependent on the distance from the stations, lake current direction and general dispersion conditions in the lake. The tritium concentrations at the WSPs over the last ten years are shown in Figure 29. The Southampton WSP has marginally higher annual average tritium concentrations each year compared to Kincardine due to the predominant lake currents outside Bruce Power travelling northward. These values are very low and no impacts to human health are expected.

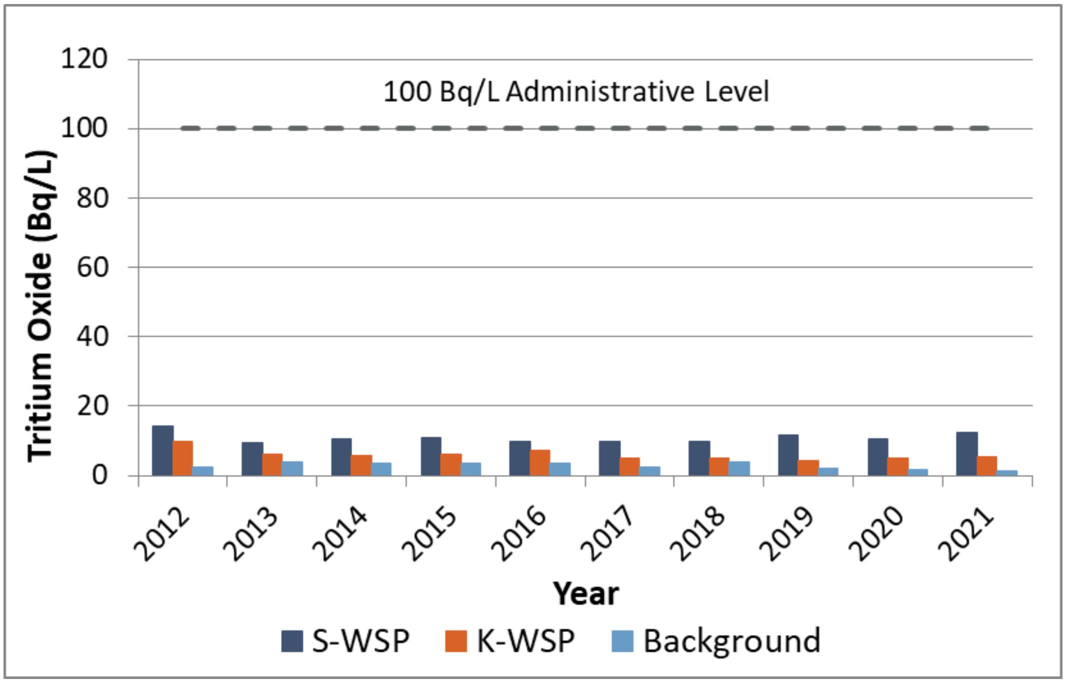


Figure 29 - Annual Average Tritium Concentrations (Bq/L) at the Municipal Water Supply Plants near Bruce Power and Provincial Background Locations Over Time. CNSC Reference Level = 7000 Bq/L

Municipal and Residential Wells

In addition to the WSPs in Southampton and Kincardine, drinking water is also collected at a number of municipal and local residential wells. Four municipal wells, located at Scott Point (BM03-WW), Underwood (BM06-WW) and Tiverton (BM12-WW, BM13-WW), are sampled semiannually. Seven deep residential wells are also sampled semiannually, while six shallow residential wells are sampled bimonthly, based on occupant availability. Water samples are analyzed for tritium by liquid scintillation counting. Two representative locations, one to the north of Bruce Power at Scott Point (BR02-WW) and one to the south at Inverhuron (BR32-WW), are also analyzed semiannually for gross beta and gross gamma radiation. Annual average tritium and gross beta results are shown in Table 17. Annual results for CANDU related radionuclides Co-60, Cs-134 and Cs-137 from the gamma scan are not shown as the results were less than the critical level and indistinguishable from background. Samples from BR32 were not available in 2020 or 2021 due to COVID-19 travel restrictions and no occupancy.

For shallow wells, the source of tritium may be attributed to deposition of airborne tritium emissions from Bruce Power or precipitation washout migrating into the shallow wells. The deep wells are less likely to be affected by airborne deposition. Tritium oxide concentrations for all municipal and deep residential wells were less than the critical level for detection (Lc) and indistinguishable from background. For the shallow wells the tritium oxide results were slightly higher, although 3 out of 6 available wells had results <Lc. The other four wells had annual averages < 100 Bq/L and well below the Ontario Drinking Water Standard of 7000 Bq/L. The average gross beta result for BR02 was slightly higher than the background locations but was well below the CNSC Reference Level of 1 Bq/L.

CNSC IEMP samples collected near Bruce Power in 2019 did not include drinking water from the municipal water supply plants or residential wells. However, samples of lake water, streams and ponds were collected, and these results are discussed in the appropriate sections below.

Lakes and Streams

Water samples are collected bimonthly from Lake Huron and ponds and streams in the vicinity of Bruce Power. Bruce Power sampling locations are shown on Figure 20. There are two sample locations for ponds located within the Bruce Power perimeter fence (B31 Pond - BM16 and Former Sewage Lagoon - BM21) and four stream locations off site near Bruce Power. These include Little Sauble (BC01), Stream C (BC02) and two locations on Underwood Creek (BC03-04). Lake water is sampled at Baie du Doré (BM04), Inverhuron (BM10) and Scott Point (BM20). Lake and stream water are sampled bimonthly when free of ice and analyzed for tritium by liquid scintillation counting. Gross beta is measured by proportional counting on lake water samples bi-monthly and on stream samples semiannually. Lake water samples are also analyzed for gross gamma twice per year. The 2021 annual average tritium and gross beta results are shown in Table 18. Gamma results for 2021 are not shown as all results for CANDU related radionuclides Co-60, Cs-134 and Cs-137 were less than the critical level (Lc) and indistinguishable from background.

Lake water is collected by the province on a quarterly basis at three locations (Bancroft, Belleville and Cobourg) as shown in Figure 19 and analyzed for tritium and gross beta radiation. Samples are not collected when the lake is frozen (typically Q1 and Q4). The 2021 annual average results are presented in Table 18.

Table 18 - 2021 Annual Average Tritium and Gross Beta Concentrations in Lakes and Streams

Sample Location (Sample Count Tritium/Beta)	Tritium		Gross Beta	
	Bq/L	St. Dev	Bq/L	St. Dev
On Site				
BM16-WL (B31 Pond) (5)	1.21E+02	4.88E+01	N/A	-
BM21-WL (Former Sewage Lagoon) (5)	5.23E+02	8.72E+01	N/A	-
Indicator (Off Site)				
BC02-WC (6/2)	7.42E+01	1.46E+01	1.34E-01	2.97E-02
BM04-WL (5/5)	9.45E+01	8.26E+01	9.83E-02	2.68E-02
BM04-WL duplicate (5/5)	9.80E+01	8.58E+01	1.01E-01	2.51E-02

Sample Location (Sample Count Tritium/Beta)	Tritium		Gross Beta	
	Bq/L	St. Dev	Bq/L	St. Dev
Area Near Streams				
BC01-WC (5/2)	2.23E+01	7.80E+00	1.36E-01	4.95E-02
BC03-WC (5/2)	3.36E+01	2.37E+01	1.84E-01	6.72E-02
BC04-WC (4/2)	8.22E+01	3.25E+01	7.10E-02	3.51E-02
Area Near Lake				
BM10-WL (6/6)	2.09E+01	1.15E+01	9.93E-02	6.49E-02
BM20-WL (5/5)	5.52E+01	1.45E+01	8.57E-02	3.42E-02
Provincial Background				
Bancroft (Clark Lake) (2/2)	<Ld	-	3.5E-02	2.8E-03
Belleville (Bay of Quinte) (2/2)	<Ld	-	6.7E-02	1.6E-02
Cobourg (Lake Ontario) (2/2)	<Ld	-	1.1E-01	3.5E-03

Notes:
1. St. Dev = standard deviation, N/A = not applicable, E+00 represents scientific notation, E+03 = $x10^3$.
2. Bruce Power: For calculation of averages where result was less than critical level (Lc) the uncensored analytical result was used. ‘<Lc’ stated in table when all results were <Lc.
3. Provincial Background: For calculation of averages where the result was less than the minimum detection level (Ld), the minimum detection level was used. ‘<Ld’ stated in table when all results were <Ld.
4. Bancroft, Belleville, and Cobourg are not sampled during winter months (Q1&Q4)

The 2021 Bruce Power results for lake and stream water show similar trends as those observed for shallow wells and air monitoring; tritium values decrease with increasing distance from Bruce Power. All values are well below the Ontario Drinking Water Standard and CNSC Reference Level for tritium in drinking water (7000 Bq/L). The gross beta results show little variation with proximity to Bruce Power and are similar to what is measured at Cobourg (Lake Ontario). The gross beta concentrations in surface water are well below the CNSC Reference Level of 1 Bq/L.

Average annual tritium concentrations in lake and stream water samples measured at Bruce Power indicator and area near locations over time are shown in Figure 30. The stream indicator location is Stream C (BC02) which is located on the north side of the Bruce Power boundary and feeds into Baie du Doré. The lake indicator location (BM04) is sampled from the eastern shore of Baie du Doré at the end of Concession Rd 6. In 2021, the annual average for the indicator stream was lower than in previous years; however, the annual average for the indicator lake was higher. Elevated levels of tritium were measured in November, which may be attributed to the higher tritium releases from Bruce B as a result of equipment deficiencies (see Section 5.1.2).

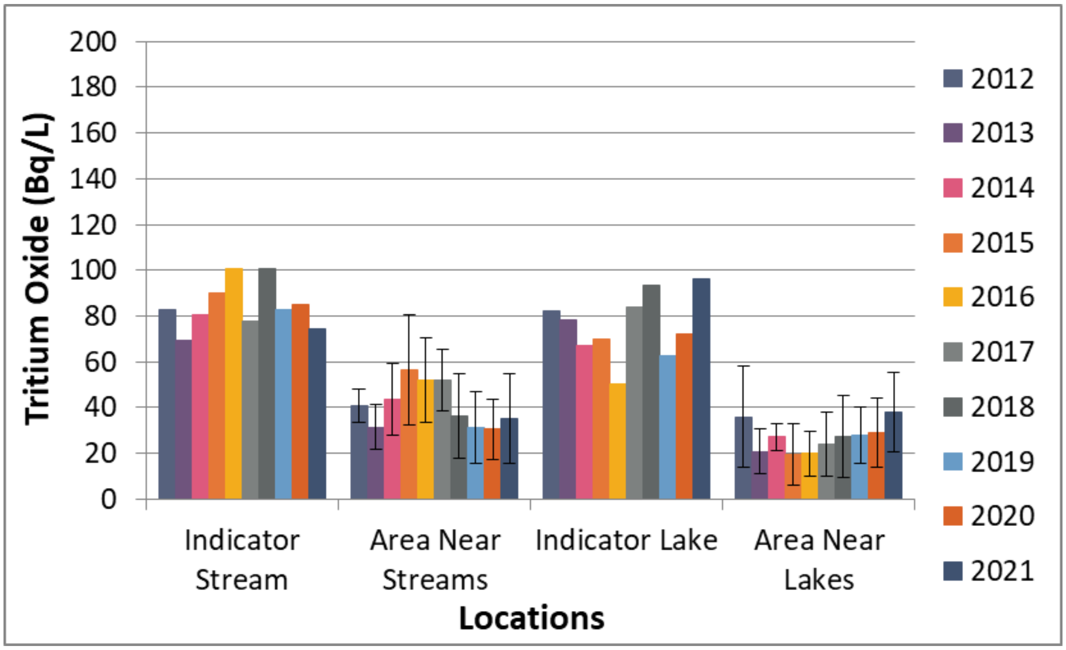


Figure 30 - Annual Average Tritium Concentrations (Bq/L) in Lake Huron and Streams Near Bruce Power Over Time (± Standard Error). CNSC reference level = 7000 Bq/L

The CNSC IEMP for 2019 included surface water sampling at ten locations near Bruce Power including two locations in the Saugeen River in Southampton, on the shores of Southampton, Port Elgin, Baie du Doré and Kincardine, offshore Lake Huron near Loscombe Bank and Baie du Doré, offshore Georgian Bay near Owen Sound, and at an inland location near Concession Rd. 2 close to the Bruce Power site. The following radionuclide / radionuclide groups were measured in the surface water samples: tritiated water, gross alpha, gross beta, cobalt-60 and cesium-137. The CNSC found that tritiated water concentrations were in the range of 2.0 Bq/L - 53.6 Bq/L and below the Guideline/Reference Level of 7000 Bq/L. All gross alpha, Co-60 and Cs-137 results were less than the limit of detection. Gross beta results at most locations were less than the detection limit (<0.15 Bq/L) except at the Concession Rd. 2 inland location with a value of 0.19 Bq/L. This value is much lower than the Guideline/Reference Level of 1 Bq/L. These results are consistent with what Bruce Power reports and indicate that no human health impacts are expected [R-30].

6.1.3.2 On-Site Water Monitoring

In preparation for the Environmental Risk Assessment, samples of surface water were collected in 2021 from the on-site waterbodies and analyzed for tritiated water and gamma emitting radionuclides. The locations included three locations that are regularly monitored as part of the REM Program, which include the B31 Pond (BM16), the Former Sewage Lagoon (BM21) and Stream C (BC02), but also the stormwater pond next to building B16 as shown in Figure 31. The tritium oxide results are provided in Table 19. The results of the CANDU related radionuclides Co-60, Cs-134 and Cs-137 from the gamma scan are not shown as the results were less than the critical level (<Lc) and indistinguishable from background. Sediment was also sampled at these locations and results are discussed in Section 6.1.5.

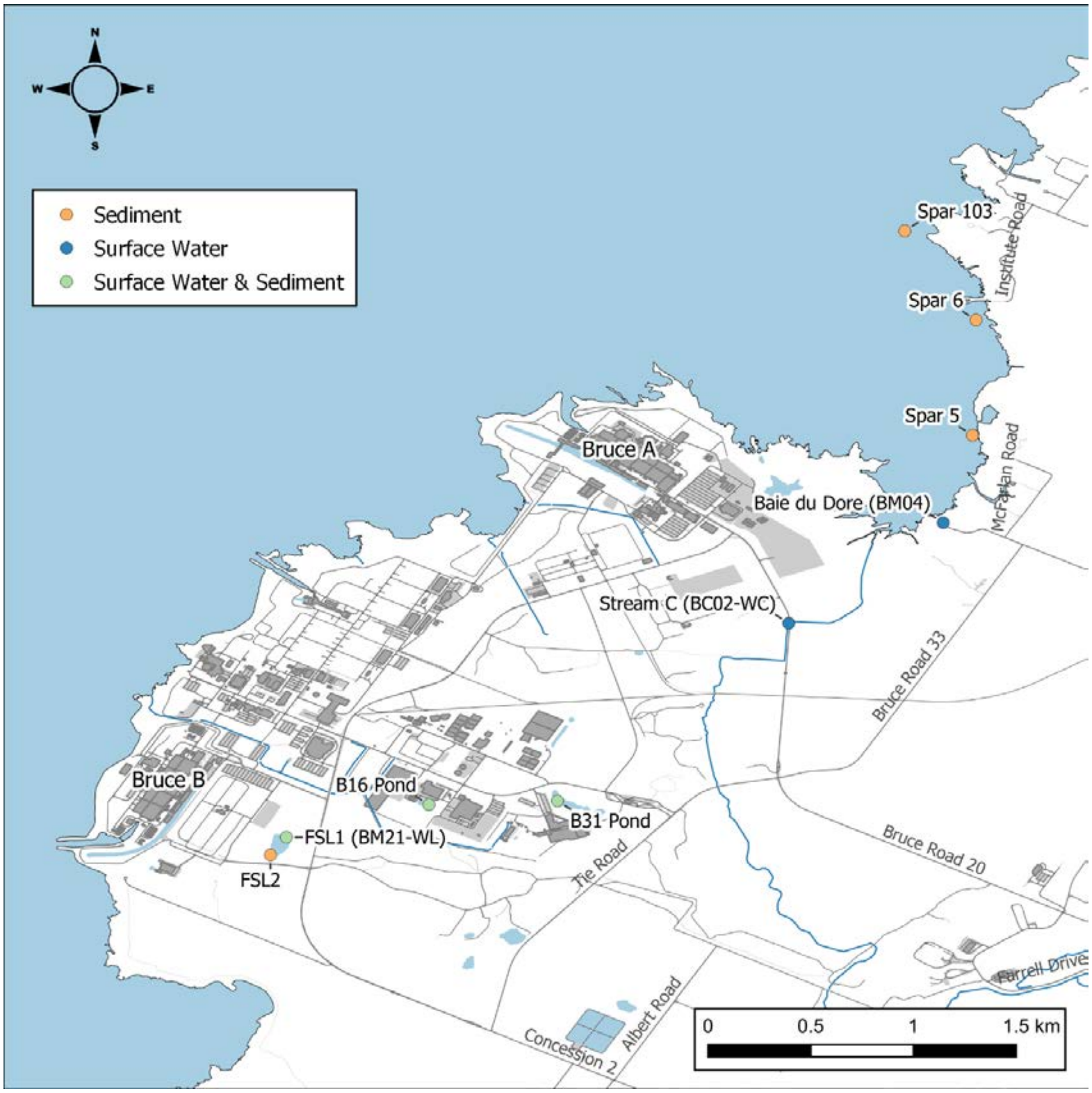


Figure 31 - On-Site Waterbody Monitoring Locations

Table 19 - 2021 Tritium Oxide Concentrations in On-Site Waterbodies

Location	Tritium Oxide		
	Bq/L	**±2σ**	**Lc**
B16 Stormwater Pond	1.71E+02	7.85E+00	3.11E+00
B31 Pond (BM16)	2.02E+02	8.46E+00	3.11E+00
Former Sewage Lagoon (BM21)	6.55E+02	1.47E+01	3.11E+00
Stream C (BC02)	8.21E+01	5.75E+00	3.11E+00
Notes: 1. E+00 represents scientific notation, E+03 = x10^3. Critical level = Lc.			

The surface water samples were collected in June/July 2021 and are consistent with tritium concentrations measured at these locations as part of REM. These values are higher than the annual averages at these locations, which takes into consideration bimonthly variation. The highest value is observed at the location closest to the source, which is the Former Sewage Lagoon located east of Bruce B. These results are used in the 2022 Environmental Risk Assessment for assessing radiological risk to ecological receptors that may live within the Site boundaries.

6.1.3.3 Water Monitoring Summary

Bruce Power regularly monitors tritium oxide, beta and/or gamma emitters in drinking water and surface water at a variety of locations on and off Site, including municipal water supply plants and residential wells, and in lakes, streams and ponds. In 2021 additional sampling was completed at on-site waterbodies for the Environmental Risk Assessment. All results were within historical levels and well below the CNSC Reference Levels, indicating that there is no risk to members of the public or the environment.

A summary is provided here:

- Concentrations of tritium oxide in drinking water at the municipal water supply plants in Kincardine and Southampton are similar to previous years and well below the Ontario Drinking Water Standard and the commitment with the municipalities.

- Radionuclide concentrations in drinking water from local residential wells and surface water collected in Lake Huron and nearby streams and ponds are well below the CNSC reference levels.

Additional sampling of on-site waterbodies was carried out in 2021 for the 2022 Environmental Risk Assessment to assess the radiological risk to ecological receptors that may live within the Site boundary.

6.1.4 Agricultural and Animal Products Monitoring

Bruce Power collects a variety of foodstuffs each year, including milk, fish, animal products and agricultural products and measures for radioactivity. The results are used in the annual dose to public calculation for each of the representative persons that live near Bruce Power. Additionally, the results inform the environmental monitoring and environmental risk assessment programs to ensure that Bruce Power is appropriately monitoring and understanding its impact on the environment.

6.1.4.1 Fish

Bruce Power monitors fish in Lake Huron for radionuclide concentrations as part of the REM Program. Samples of benthic forager (bottom feeders) and pelagic forager (open water) fish species are collected near Bruce Power and further afield at locations along the western shore of Lake Huron well away from Bruce Power for use as a control. The control area far sampling locations were updated in 2017 due to importation policies that came into effect that year. Starting in 2017, area far fish are collected on the Canadian side of Lake Huron north of Tobermory, by a contractor assisted by local Indigenous members.

The analysis of two types of fish species provides some insight into potential impacts from Bruce Power operations on the lakebed where benthic species inhabit, and through open water ecosystems where pelagic fish inhabit. The target fish species representing benthic and pelagic foragers are as follows:

- White Sucker (*Catostomus commersoni*) represents a benthic forager species. Brown Bullhead (*Ictalurus nebulosus*) is the alternate benthic species. Sample collection is conducted in the spring when adults are near shore to spawn.
- Lake Whitefish (*Coregonus clupeaformis*) represents a predominantly pelagic forager that feeds on a wide variety of organisms from invertebrates to small fish, to plankton. Round Whitefish (*Prosopium cylindraceum*) is the alternate pelagic species. Collection is conducted in the fall when adults are near shore to spawn. The secondary alternative is Lake Trout (*Salvelinus namaycush*).

Eight fish samples for each species and location are analyzed for tritiated water, carbon-14 and organically bound tritium (OBT) by liquid scintillation and for cobalt-60, cesium-134, cesium-137 by gamma spectrometry. The fish flesh ventral to the lateral line is included in the samples prepared for analysis. The sample preparation and analysis method for each radionuclide group is outlined in Table 20. The annual average results for 2021 are provided in Table 21 and Table 22 for Bruce Power area near and area far fish. Also shown are the Provincial Background annual average results for benthic and pelagic fish from Lake Huron and benthic fish from Lake Ontario for comparison.

Table 20 - Fish Preparation and Methods

Analyte	Sample	Preparation	Method
Co-60, Cs-134, Cs-137	Individual fish	Skinned, filleted, and flesh sliced	Gamma spectrometry
C-14	Two counts of a single sample per individual fish	Freeze-dried flesh combusted	Liquid scintillation counting
Tritium oxide	Average of two samples per individual fish	Water from freeze dried flesh	Liquid scintillation counting
Organically Bound Tritium (OBT)	Single composite by fish type	Solid residue (washed to remove free tritium oxide) combusted	Liquid scintillation counting

Table 21 - 2021 Annual Average Radionuclide Concentrations for Fish

Sample Type Location	Tritium Oxide		Carbon-14		OBT	
	Bq/L	St. Dev	Bq/kg	St. Dev	Bq/L	±2σ
Area Near						
Benthic, Lake Huron	4.18E+01	2.18E+01	2.38E+02	1.67E+01	7.8E+00	3.3E+00
Pelagic, Lake Huron	7.93E+00	4.58E+00	2.48E+02	1.17E+01	1.0E+01	3.6E+00
Bruce Power Control						
Benthic, Lake Huron	9.16E+00	4.38E+00	2.32E+02	1.11E+01	1.1E+01	3.6E+00
Pelagic, Lake Huron	5.91E+00	1.15E+00	2.47E+02	1.35E+01	9.4E+00	3.6E+00
Provincial Background						
Benthic, Lake Ontario	4.7E+00	1.4E+00	2.62E+02	4.44E+01	4.1E+01	3.5E+00
Benthic, Lake Huron	3.5E+00	1.4E+00	2.41E+02	8.60E+00	3.7E+01	3.4E+00
Pelagic, Lake Huron	1.7E+00	1.1E+00	2.31E+02	9.53E+00	2.8E+01	3.1E+00

Notes:

1. St. Dev = standard deviation. E+00 represents scientific notation, E+03 = x10^3.
2. Sample count = 8 in all cases, except for OBT, which includes one composite and raw data is provided.
3. OBT is organically bound tritium, ±2σ is the uncertainty associated with the analytical measurement, Lc = 3.9 Bq/L (Bruce Power), Ld = 3.9 Bq/L (Provincial)
4. Bruce Power: For calculation of averages where result was less than critical level (Lc) the uncensored analytical result was used.
5. Provincial Background: For calculation of averages where the result was less than the minimum detection level (Ld), the minimum detection level was used.

Table 22 - 2021 Annual Average Gamma Spectroscopy Results for Fish

Sample Type Location	Co-60		Cs-134		Cs-137	
	Bq/kg	St. Dev	Bq/kg	St. Dev	Bq/kg	St. Dev
Area Near						
Benthic, Lake Huron	7.33E-03	6.02E-02	<Lc	-	1.92E-01	6.96E-02
Pelagic, Lake Huron	<Lc	-	<Lc	-	2.96E-01	9.37E-02
Bruce Power Control						
Benthic, Lake Huron	7.48E-02	8.80E-02	<Lc	-	1.89E-01	5.15E-02
Pelagic, Lake Huron	<Lc	-	<Lc	-	2.57E-01	1.33E-01
Provincial Background						
Benthic, Lake Ontario	<Ld	-	<Ld	-	2.85E-01	7.45E-02
Benthic, Lake Huron	<Ld	-	<Ld	-	2.03E-01	3.50E-02
Pelagic, Lake Huron	<Ld	-	<Ld	-	4.71E-01	1.79E-01

Notes:

1. St. Dev = standard deviation. E+00 represents scientific notation, E+03 = x10^3.
2. Sample count = 8 in all cases.
3. Bruce Power: For calculation of averages where result was less than critical level (Lc) the uncensored analytical result was used. ‘<Lc’ stated in table when all results were <Lc.
4. Provincial Background: For calculation of averages where the result was less than the minimum detection level (Ld), the minimum detection level was used. . ‘<Ld’ stated in table when all results were <Ld.

Tritium Oxide in Fish

The 2021 annual average concentration of tritium oxide in pelagic fish was 7.9 Bq/L for area near, 5.91 Bq/L for the control group and 1.65 Bq/L for the Lake Huron Provincial Background group. For benthic fish in 2021, the area near annual average was 41.8 Bq/L, the control group average was 9.2 Bq/L and the Lake Huron Provincial Background group was 3.48 Bq/L. The differences between benthic and pelagic fish may be attributed to the timing of catch, habitat and correlation to operational activities.

The annual average tritium concentrations in fish for the past 10 years are shown in Figure 32 for pelagic fish and Figure 33 for benthic fish. There has been little variation in tritium oxide levels in pelagic fish over the years, except for the higher result for the control group in 2018 for reasons unknown. The benthic fish collected near Bruce Power annual average tritium oxide concentration increased compared to previous years; concentrations in the 8 fish samples ranged from 10.7 to 66.7 Bq/L.

Kruskal Wallis analysis of variance ($\alpha=0.05$) showed a statistically significant difference in both pelagic and benthic fish by site ($p<0.001$). The pelagic area near and control fish were not significantly different from each other, with both having higher concentrations compared to the Provincial pelagic fish. The benthic area near fish had a significantly higher concentration than the control and Provincial fish; these latter two were not significantly different from each other.

The CNSC IEMP collected fish at 3 locations in Lake Huron in 2019 that included Loscombe Bank, Baie du Doré and Georgian Bay near Owen Sound. Four fish species types were sampled, including Lake Trout, Bass, Suckers and Whitefish, for a total of 22 samples. The tritiated water results for all Lake Trout, Suckers and Whitefish ranged from 3.1 Bq/kg to less than detection, with 7 out of 20 results being <MDL. The results for the two Bass retrieved from Baie du Doré were higher at 26.0 Bq/kg and 17.0 Bq/kg. All sample results reported by the CNSC for tritiated water in fish tissue for all species and locations were well below the Guideline/Reference level of 488,000 Bq/kg. No human health impacts are expected from the measured values.

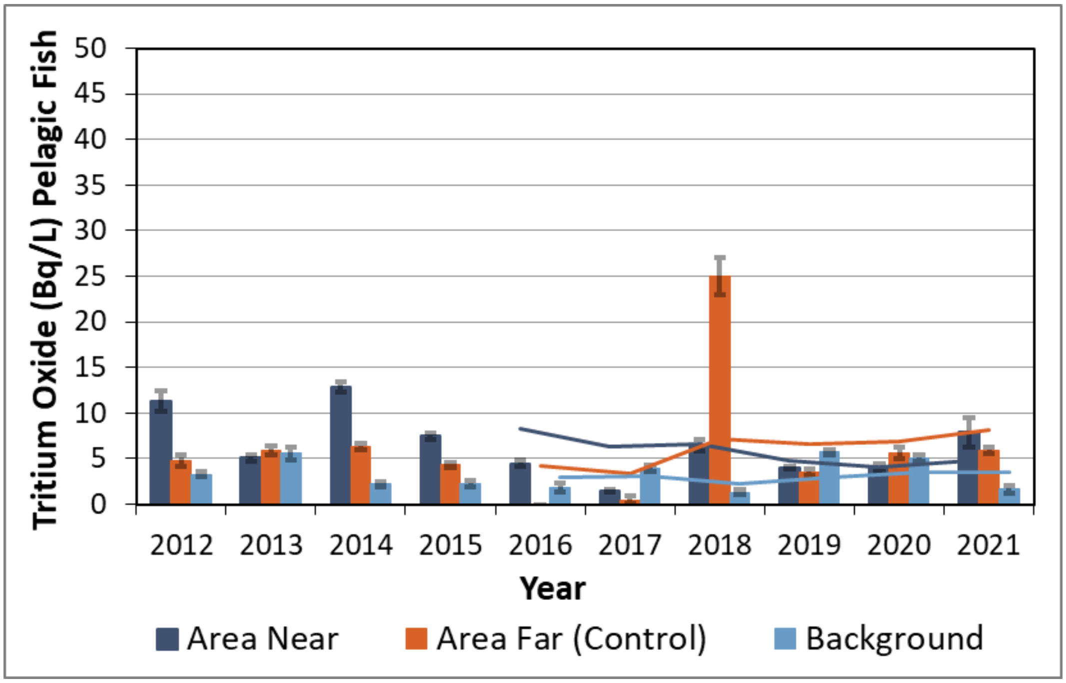


Figure 32 - Annual Average Tritium Oxide (Bq/L) in Pelagic Fish Tissue by Year Over Time (± Standard Error). Solid lines show 5-year rolling average

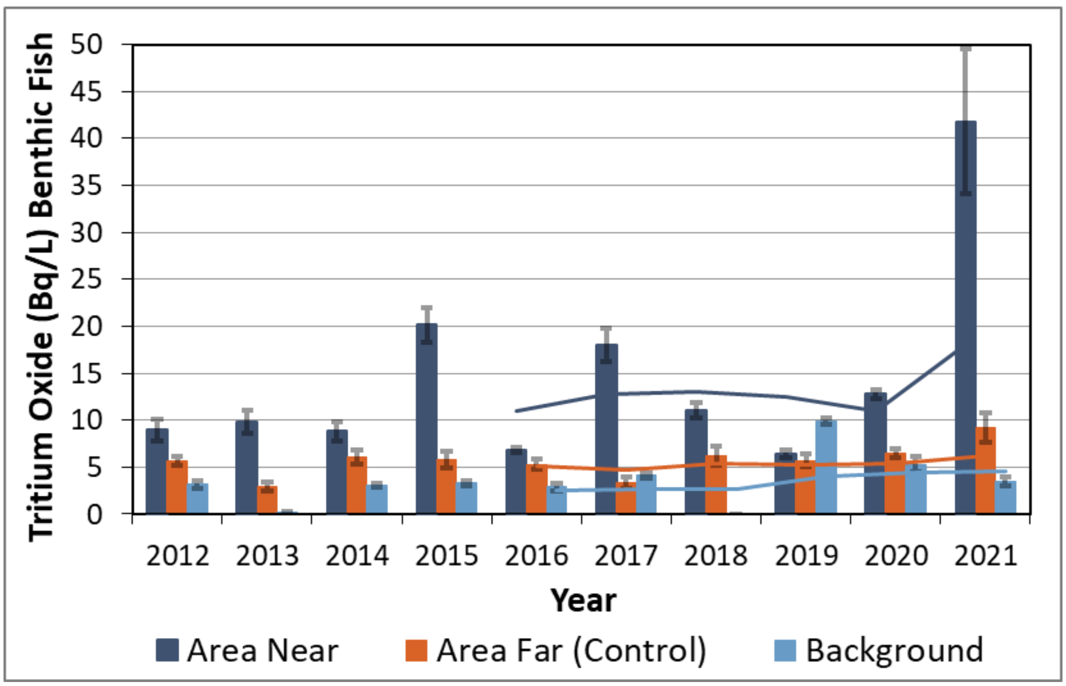


Figure 33 - Annual Average Tritium Oxide (Bq/L) in Benthic Fish Tissue by Year Over Time (± Standard Error). Solid lines show 5-year rolling average

Carbon-14 in Fish

The 2021 annual average concentration of C-14 in fish collected near Bruce Power was 248 Bq/kg for pelagic fish and 238 Bq/kg for benthic fish. Results for control fish were similar at 247 Bq/kg for pelagic and 232 Bq/L for benthic fish. The average Provincial results for Lake Huron fish collected in 2021 are consistent with these, at 231 Bq/kg for pelagic and 241 Bq/kg for benthic fish. The annual average C-14 concentrations over time are shown in Figure 34 for pelagic fish and Figure 35 for benthic fish. The C-14 levels measured in fish tissue of both species' types collected from Lake Huron have remained steady over time.

Kruskal Wallis analysis of variance (α= 0.05) showed a statistically significant difference for benthic fish by site (p=0.001); the median for the area near site was higher than the control site, though the Provincial site was not significantly different from either. Pelagic fish were not significantly different by site.

The CNSC IEMP near Bruce Power did not analyze for carbon-14 in fish.

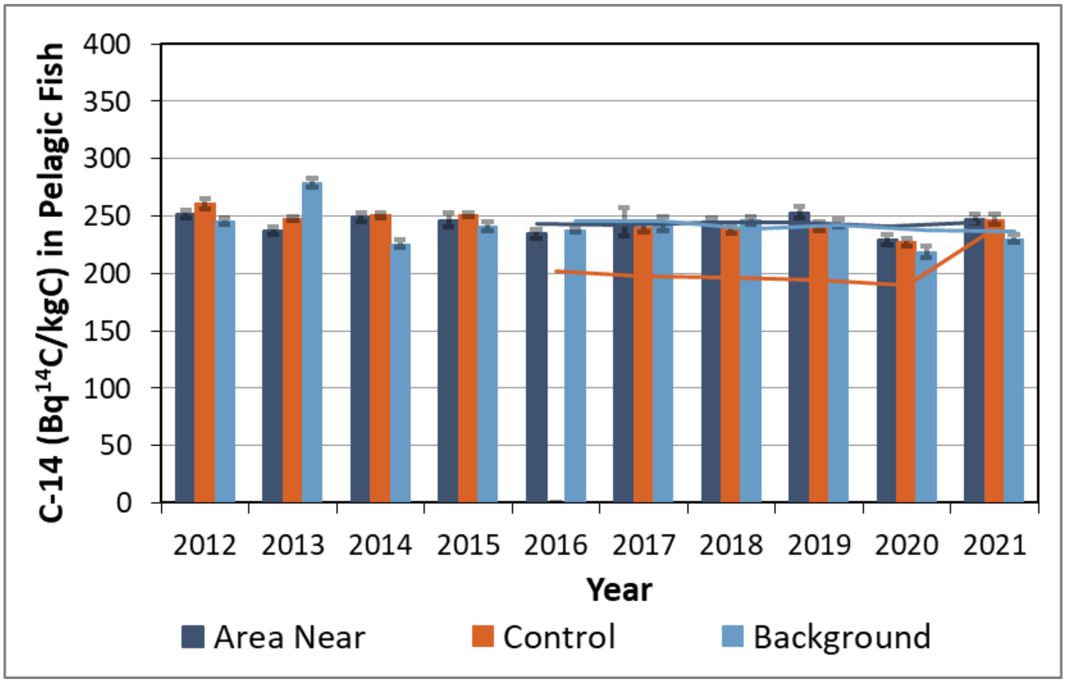


Figure 34 - Annual Average Carbon-14 (Bq/Kg) in Pelagic Fish Tissue by Year Over Time (± Standard Error). Solid lines show 5-year rolling average

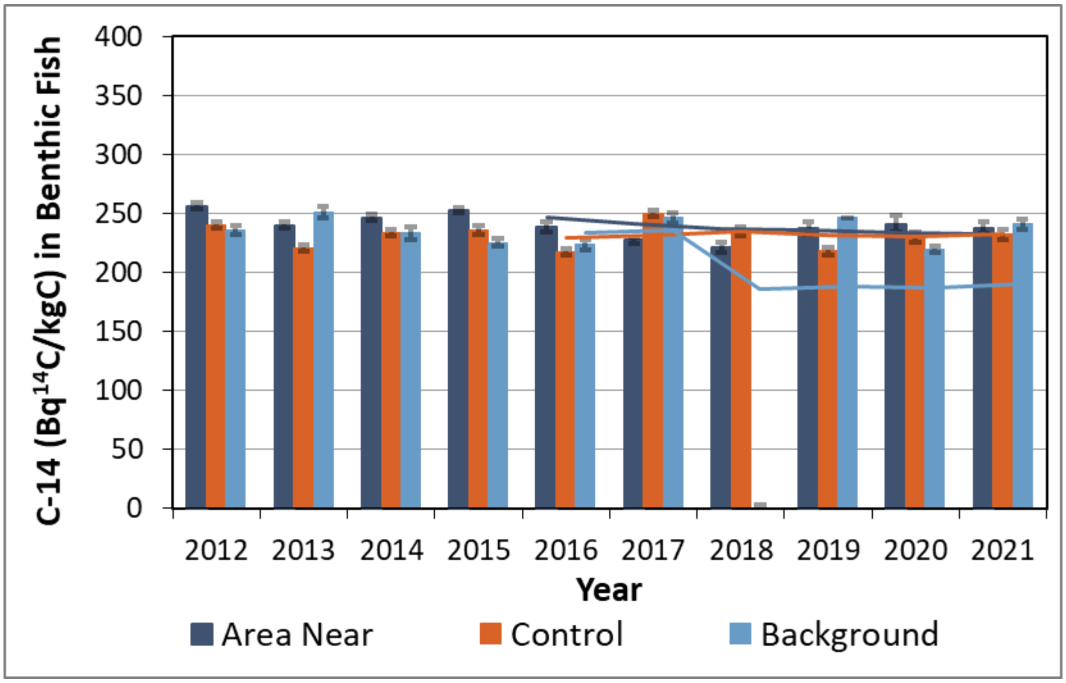


Figure 35- Annual Average Carbon-14 (Bq/Kg) in Benthic Fish Tissue by Year Over Time (± Standard Error). Solid lines show 5-year rolling average

Cobalt-60 and Cesium-134 in Fish

The Co-60 and Cs-134 concentrations in fish samples measured by Bruce Power in 2021 were all less than the critical level (<Lc) or slightly above, indicating that these concentrations are negligible. Where at least one fish result was >Lc the annual average, which includes uncensored data, was provided in Table 22. For groupings where all results were <Lc, the annual average was stated as <Lc. All fish measured by the province had Co-60 and Cs-134 concentrations less than the detection limit (<Ld) and annual averages were stated as <Ld.

Cesium-137 in Fish

The 2021 annual average concentration of Cs-137 in pelagic fish collected near Bruce Power was 0.30 Bq/kg and the Control was 0.26 Bq/kg. For benthic fish, the annual average for area near was 0.19 Bq/kg and control was 0.19 Bq/kg. The Provincial average Cs-137 results were similar to Bruce Power, with 0.47 Bq/kg and 0.20 Bq/kg for pelagic and benthic fish, respectively. These values are well below the CNSC Reference Level of 1040 Bq/kg.

The annual average Cs-137 results for the last ten years for Bruce Power area near, control and Provincial Background pelagic and benthic fish are shown in Figure 36 and Figure 37, respectively. For pelagic fish the Cs-137 levels measured in 2021 are slightly lower than previous years, and for benthic fish the results are similar to historical values. Generally, the Cs-137 concentrations in fish tissue of pelagic and benthic fish collected in Lake Huron are low and have remained steady over time. Kruskal Wallis analysis of variance (α= 0.05) showed no significant difference for either pelagic or benthic fish by site.

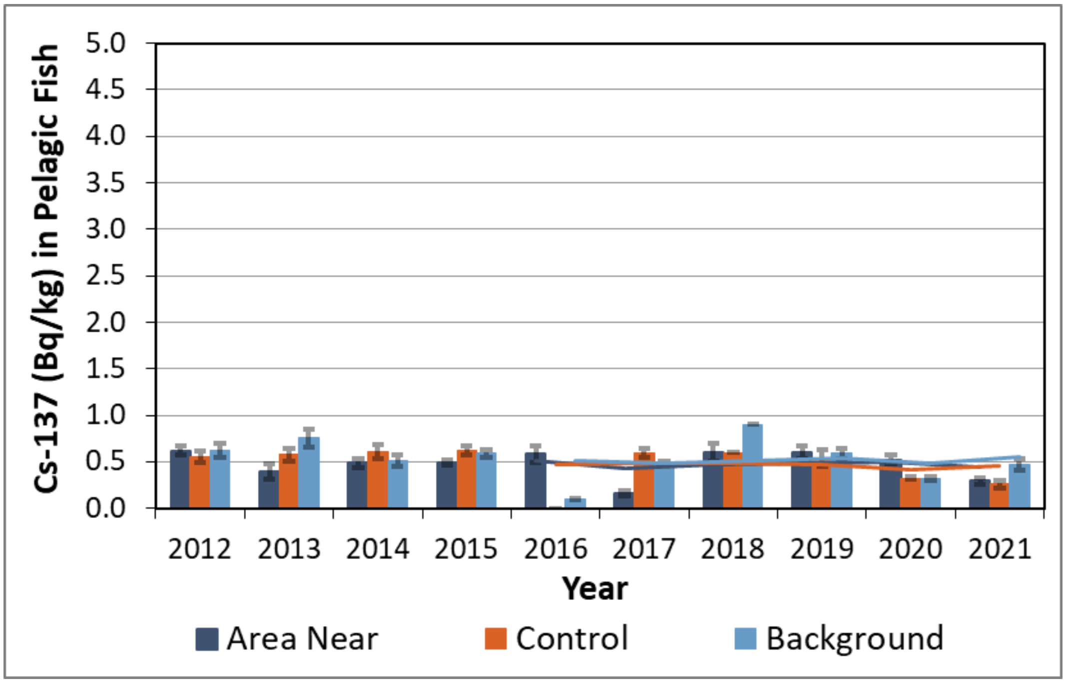


Figure 36 - Annual Average Cesium-137 (Bq/Kg) in Pelagic Fish Tissue by Year Over Time (± Standard Error). Solid lines show 5-year rolling average. CNSC Reference Level = 1040 Bq/kg

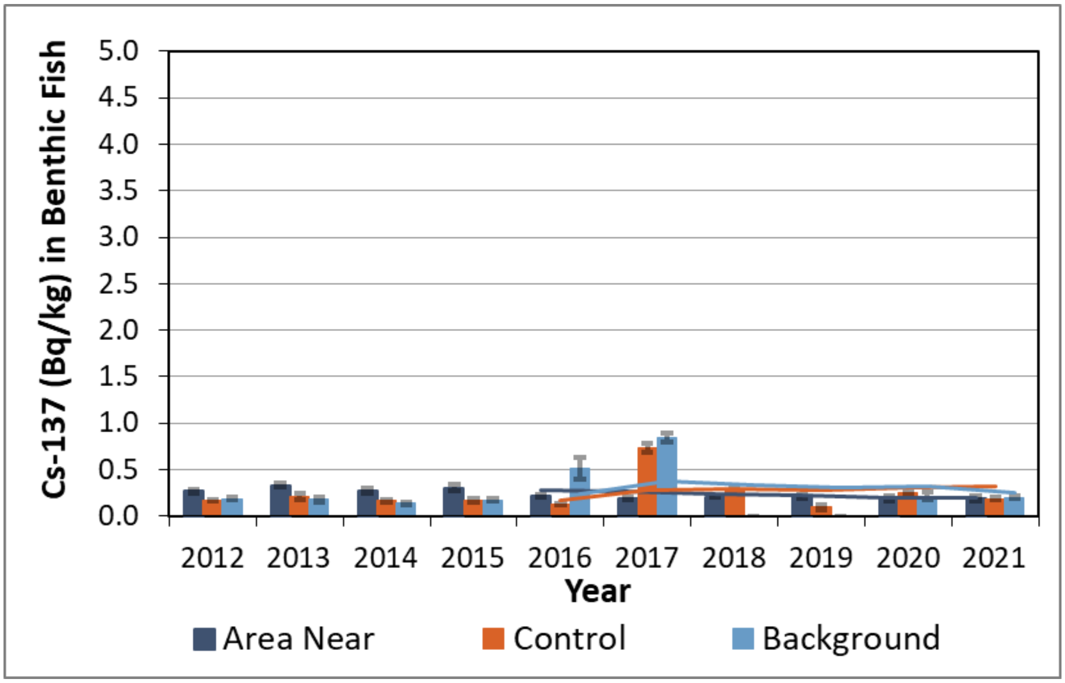


Figure 37 - Annual Average Cesium-137 (Bq/Kg) in Benthic Fish Tissue by Year Over Time (± Standard Error). Solid lines show 5-year rolling average. CNSC Reference Level = 1040 Bq/kg

The CNSC IEMP measured Cs-137 concentrations in fish collected at 3 locations in Lake Huron, including near Loscombe Bank, Baie du Doré and in Georgian Bay near Owen Sound.

Fish species included Lake Trout, Bass, Suckers and Whitefish. Out of the 22 fish samples taken, only 10 had results that were greater than the limit of detection (>MDL). The maximum Cs-137 value was for a Lake Trout (pelagic species) sample at 1.2 Bq/kg, which is much lower than the Guideline/Reference Level of 1040 Bq/kg. The IEMP results for the same species as used for the Bruce Power and Provincial monitoring programs (Suckers and Whitefish) had Cs-137 values less than the detection limit.

Organically Bound Tritium in Fish

Organically bound tritium (OBT) is measured on a composite sample of the eight fish samples collected for each type (pelagic and benthic) and location (area near and control) by Bruce Power. The final result is based on the arithmetic mean of the activity of the single composite sample counted twice. The 2021 results for pelagic fish collected at area near and control are 10.0 Bq/L and 9.4 Bq/L respectively. The area near and control benthic fish results are 7.8 Bq/L and 10.8 Bq/L respectively. In both cases the fish collected near Bruce Power had similar values of OBT than those collected at the control locations farther afield. The annual average Provincial OBT results for Lake Huron pelagic and benthic fish are higher than the Bruce Power results (27.9 Bq/L and 36.7 Bq/L, respectively).

The methodology used to prepare fish samples for measurement of OBT in fish is not standardized. Bruce Power uses a different methodology than the Province and therefore the results cannot be directly compared. For the past several years the Provincial OBT results for Lake Huron pelagic and benthic fish have consistently been higher than those of Bruce Power. The Bruce Power Health Physics Lab is working with the OPG Whitby Lab to understand the discrepancy; however, this has been delayed due to travel restrictions from the COVID-19 pandemic.

The OBT results for the past 10 years are presented in Figure 38 for pelagic fish and Figure 39 for benthic fish. The 2017 OBT results for Bruce Power (area near and control) pelagic and benthic fish were not available due to several factors including sample delivery, equipment reliability and QC failure. The ten-year trends show that, in general, the Bruce Power results for near and control fish for both types (pelagic and benthic) are similar to one another each year and are consistently ≤10 Bq/L. This demonstrates that fish residing closer to Bruce Power are not impacted by organically bound tritium more than fish collected further away.

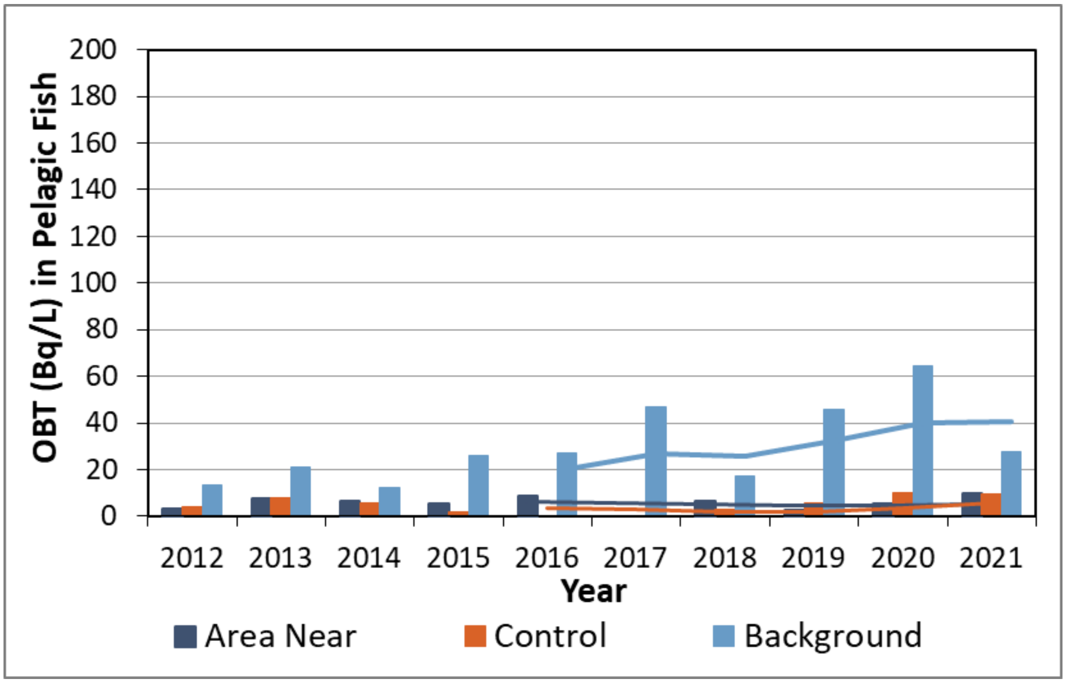


Figure 38 - Organically Bound Tritium (OBT) in Pelagic Fish Tissue. Solid lines show 5-year rolling average

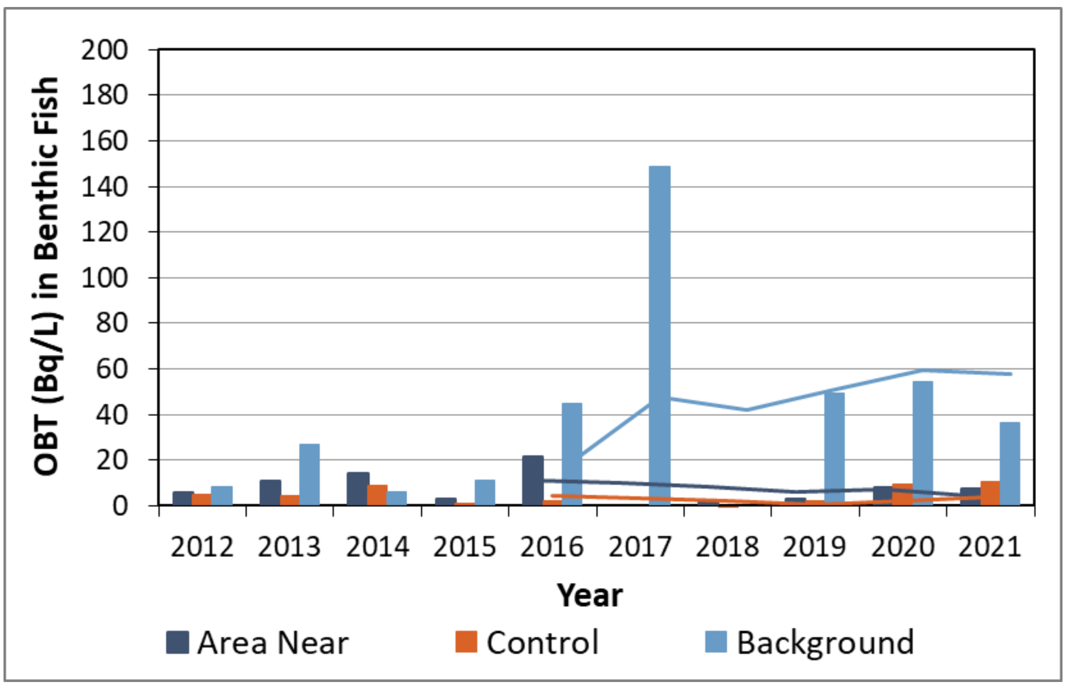


Figure 39 - Organically Bound Tritium (OBT) in Benthic Fish Tissue. Solid lines show 5-year rolling average

The CNSC IEMP collected 22 fish samples from 3 locations in Lake Huron, including Loscombe Bank, Baie due Doré and Georgian Bay near Owen Sound [R-30]. The fish types included Lake Trout, Bass, Suckers and Whitefish. Out of the 22 OBT results only 7 were greater than the limit of detection, with the maximum value of 4.1 Bq/kg fresh weight, which is well below the Guideline/Reference Level of 212,000 Bq/kg fresh weight.

6.1.4.2 Animal Products

Bruce Power samples animal products including honey, eggs, beef and poultry. Sampling locations are shown in Figure 22. Honey (harvested in area near and area far) is collected on an annual basis, while eggs are collected twice each year (spring and fall). Only one sample of eggs was available in 2021, as a new farm was established mid-year in time for fall sampling. Also new in 2021 were beef samples for cattle raised in area near and area far from Bruce Power, and a poultry sample for chicken raised near Bruce Power.

On occasion, Bruce Power collects samples from wild animal fatalities that occur onsite (i.e. vehicular collisions) or from donations made by local hunters. In 2021, two deer meat samples were obtained from a local hunter, taken near MacGregor Park.

Animal products are analyzed for tritium oxide and carbon-14 by liquid scintillation counting, and the 2021 results are listed in Table 23. Some samples are also analyzed by gamma spectroscopy and the 2021 results for Co-60, Cs-134 and Cs-137 are shown in Table 24. The HTO results are an average of two subsamples, the C-14 results are an average of two counts of a single sample, and the gamma results represent a single count of a single sample. As there is only one sample of each type, the analytical (uncensored) result is provided.

The province measures for background tritium oxide and carbon-14 in eggs (3 hens sampled quarterly for 12 samples in total) and poultry (8 samples). The sampling locations are shown in Figure 29, and the annual average values for 2021 are provided in Table 23.

Honey collected from a hive located near Bruce Power had a higher concentration of tritiated water compared to the honey sample collected farther afield (101 Bq/L vs 32.1 Bq/L, respectively). Both the area near and area far samples had higher tritium levels than in previous years, although the difference between near and far is similar to what was measured in 2019. The carbon-14 concentrations were similar, at 226 Bg/kg for area near and 196 Bq/kg for area far, lower than in previous years. Like other years, the CANDU radionuclides Co-60, Cs-134 and Cs-137 were less than the critical level (Lc) and indistinguishable from background.

The 2021 tritium oxide result measured in eggs obtained from a farm located near Bruce Power is similar to the Provincial Background average, although the carbon-14 result is slightly higher (252 Bq/kg vs 231 Bq/kg). As there has been a change to the farm where eggs are collected in 2021 there has been a step change in the results, with tritium oxide being lower and carbon-14 being higher than previous years. For poultry, the area near sample has lower tritium oxide, but similar carbon-14 concentration compared to the Provincial Background average. The gamma scan shows that concentrations of Co-60, Cs-134 and Cs-137 are less than the critical level (Lc) and negligible. This is the first time in many years that Bruce Power has sampled poultry; therefore there is no comparison of results to recent years.

For beef, the area near sample had marginally higher tritium oxide and carbon-14 concentrations compared to the area far sample. The gamma scan indicates that the Co-60, Cs-134 and Cs-137 levels are less than or very near the critical level, indicating that they are negligible. This is the first year that beef has been sampled for the REM program and therefore comparisons over time are not possible.

In 2021 a local hunter provided deer meat from two deer caught near MacGregor Park to be analyzed for radioactivity. The tritiated water and carbon-14 concentrations are very similar to one another and what has been measured in previous years (e.g. in 2020, tritium oxide 18.6 Bq/L, carbon-14 261 Bq/kg). The gamma scan results for Co-60, Cs-134 and Cs-137 are very close to or are below the critical level and considered negligible.

The CNSC IEMP included locally sourced beef and pork samples in 2019 that were analyzed for tritiated water and organically bound tritium (OBT) [R-30]. For the beef samples (stewing and ground) the tritiated water results were 3.9 Bq/kg fresh weight and 11.1 Bq/kg fresh weight, respectively, which are below the Guideline/Reference Level of 159,000 Bq/kg fresh weight. The maximum OBT result was 2.1 Bq/kg fresh weight with the other sample being less than the limit of detection (<1.5 Bq/kg fresh weight). These are much lower than the Guideline/Reference Level of 69,300 Bq/kg fresh weight. The results for the local pork sample were also below the Guideline/Reference Levels, with tritiated water measured at 3.7 Bq/kg fresh weight (Guideline value of 392,000 Bq/kg fresh weight) and OBT at 1.9 Bq/kg fresh weight (Guideline value 171,000 Bq/kg fresh weight).

Table 23 - 2021 Annual Tritium Oxide and Carbon-14 Concentrations in Animal Products

Sample	Sample Type	Tritium Oxide			C-14		
		(Bq/L)	± 2σ	Lc	(BqC^{14}/kg-C)	± 2σ	Lc
Bruce Power							
Near-Deer-AM	Deer	2.12E+01	3.74E+00	3.17E+00	2.34E+02	2.63E+01	1.40E+01
Near-Deer-AM	Deer	2.16E+01	3.75E+00	3.17E+00	2.46E+02	2.70E+01	1.42E+01
Far-Beef-AM	Beef	5.13E+00	2.85E+00	3.03E+00	2.29E+02	2.65E+01	1.43E+01
Near-Beef-AM	Beef	7.93E+00	3.01E+00	3.03E+00	2.51E+02	2.74E+01	1.44E+01
BF25-AM	Chicken	6.83E-01	2.14E+00	3.03E+00	2.25E+02	2.68E+01	1.47E+01
BF25 (spring)	Eggs	No sample			No sample		
BF25 (fall)	Eggs	2.98E+00	2.52E+00	3.56E+00	2.52E+02	2.74E+01	1.44E+01
Far-BR22-HO	Honey	3.21E+01	4.09E+00	3.03E+00	1.96E+02	2.54E+01	1.46E+01
Near-BR22-HO	Honey	1.01E+02	6.24E+00	3.03E+00	2.26E+02	2.62E+01	1.44E+01
Provincial Background – Annual Average							
Sample Location	**Sample Type**	**(Bq/L)**	**St. Dev**		**(Bq/L)**	**St. Dev**	
Picton	Eggs	3.0E+00	1.6E+00		2.31E+02	1.87E+01	
Picton	Poultry	2.2E+00	1.4E+00		2.23E+02	1.05E+01	

Notes:

1. St. Dev = standard deviation. E+00 represents scientific notation, E+03 = $x10^3$.
2. Provincial Background – sample count = 12 for eggs and 8 for poultry.
3. Provincial Background - For calculation of averages where the result was less than the minimum detection level (Ld), the minimum detection level was used.

Table 24 - 2021 Annual Gamma Radionuclide Concentrations in Animal Products Near Bruce Power

Sample	Sample Type	Co-60			Cs-134			Cs-137		
		Bq/kg	± 2σ	Lc	Bq/kg	± 2σ	Lc	Bq/kg	± 2σ	Lc
Near-Deer-AM	Deer	-3.41E-02	1.51E-01	1.10E-01	2.09E-01	1.52E-01	1.21E-01	3.08E-01	9.33E-02	6.64E-02
Near-Deer-AM	Deer	1.23E-01	1.32E-01	1.03E-01	-9.06E-02	1.40E-01	1.05E-01	3.80E-01	1.68E-01	1.03E-01
Far-Beef-AM	Beef	2.32E-02	1.38E-01	1.01E-01	-1.34E-01	1.41E-01	1.02E-01	4.87E-02	1.58E-01	8.79E-02
Near-Beef-AM	Beef	1.12E-01	1.47E-01	1.11E-01	-3.64E-01	1.42E-01	1.18E-01	-1.49E-01	1.97E-01	9.93E-02
BF25-AM	Chicken	-4.20E-02	1.30E-01	9.00E-02	-1.09E-01	9.83E-02	9.84E-02	-1.42E-01	1.59E-01	8.14E-02
Far-BR22-HO	Honey	1.13E-01	1.57E-01	1.26E-01	-6.96E-04	2.07E-01	1.56E-01	1.73E-01	2.46E-01	1.41E-01
Near-BR22-HO	Honey	3.64E-02	1.79E-01	1.37E-01	-7.67E-02	2.36E-01	1.72E-01	8.31E-02	2.80E-01	1.53E-01

Notes:

1. E+00 represents scientific notation, E+03 = $x10^3$.
2. For honey, gamma results in Bq/L.

6.1.4.3 Milk

Since 2016 Bruce Power has worked with the Dairy Farmers of Ontario to ensure that milk samples may be collected from local dairy farmers on a weekly basis. Each weekly sample is analyzed for iodine-131 by gamma spectrometry and monthly composite samples are analyzed for tritium oxide and carbon-14 by liquid scintillation counting. These radionuclides may be present in milk from the ingestion of feed and water and the inhalation of air by the dairy cattle. Samples are analyzed for I-131 more frequently than other radionuclides because of its shorter half-life. For 2021 there were five farms participating in the REM program.

The milk sampling locations are shown on Figure 22, and the 2021 annual results are provided in Table 25. Milk was sampled by the province at Belleville and London locations, as shown on Figure 19, and the results for tritium oxide, I-131 and C-14 are shown in Table 25. Gamma emitting radionuclides other than I-131 were also measured, but results for CANDU related radionuclides Co-60, Cs-134 and Cs-137 were less than the limit of detection and not shown.

Table 25 - 2021 Annual Average Concentration Tritium Oxide, Iodine-131, Carbon-14 in Milk Samples

Sample Location	**Tritium Oxide**		**Iodine-131**		**Carbon-14**	
	(Bq/L)	**St. Dev**	**(Bq/L)**	**St.Dev**	**(Bq/kg-C)**	**St.Dev**
Area Near						
BDF01-MK	7.94E+00	3.82E+00	<Lc	-	2.28E+02	1.89E+01
BDF09-MK	5.79E+00	2.72E+00			2.28E+02	2.40E+01
BDF12-MK	5.68E+00	2.05E+00			2.38E+02	2.19E+01
BDF15-MK	3.88E+00	2.88E+00			2.23E+02	1.09E+01
BDF16-MK	6.29E+00	2.22E+00			2.30E+02	1.62E+01
Average (Area Near)	**5.92E+00**				**2.29E+02**	
Provincial Background						
DF1 | Belleville- Sample D	<Ld	-	<Ld	-	2.35E+02	1.34E+01
DF1 | Belleville- Sample E	<Ld	-	<Ld	-	2.21E+02	4.57E+00
DF1 | Belleville- Sample F	<Ld	-	<Ld	-	2.30E+02	1.69E+01
DF2 | London	<Ld	-	<Ld	-	2.26E+02	1.75E+01

Note:
1. St.Dev = standard deviation. E+00 represents scientific notation, E+03 = $x10^3$.
2. Bruce Power: For calculation of averages where result was less than critical level (Lc) the uncensored analytical result was used. '<Lc' stated in table when average was a negative number.
3. Provincial Background: For calculation of averages where the result was less than the minimum detection level (Ld), the minimum detection level was used. '<Ld' stated in table when all values were <Ld.
4. Sample count for Bruce Power is 12, except for I-131 which is 52. For Provincial background sample count is 4.

For 2021, the average annual tritium concentration in milk at local dairy farms was 5.92 Bq/L. Although this is higher than the Provincial Background values(<Ld), this is well below the Ontario Drinking Water Standard for tritium (7000 Bq/L) [R-108]. Bruce Power and Provincial annual average tritium concentrations in milk for the last six years are shown in Figure 40. The recent Bruce Power averages are on a downward trend.

Analysis of variance (α=0.05) shows a statistically significant difference (p<0.001) between Bruce Power and Provincial background, with Bruce Power having the highest mean concentration.

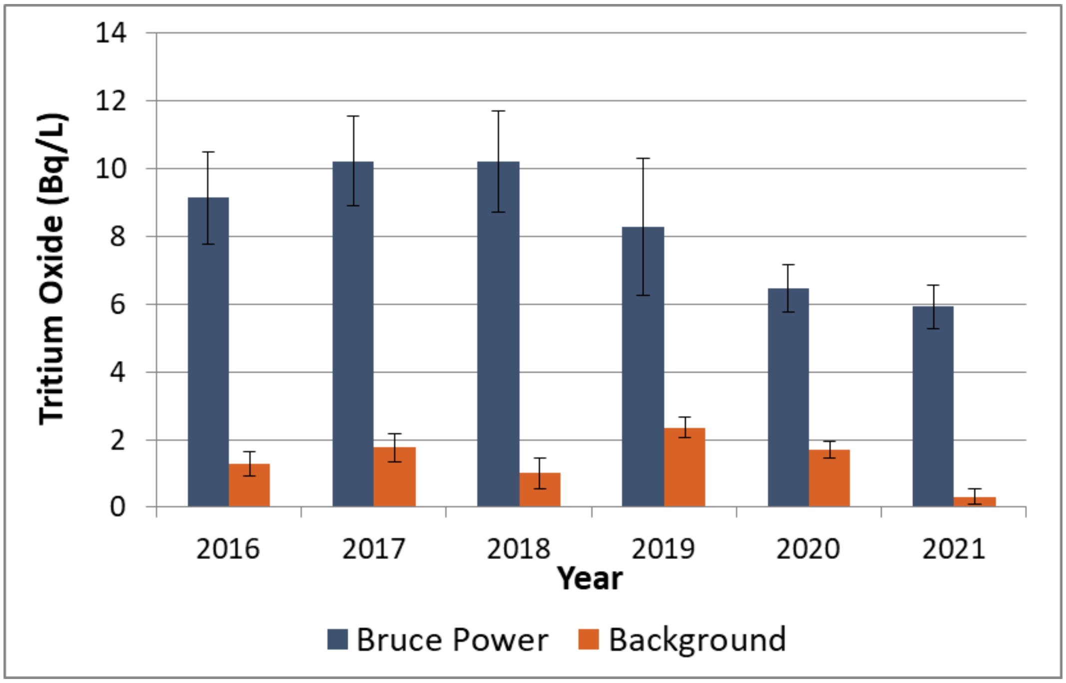


Figure 40 - Annual Average Tritium Oxide Concentration (Bq/L) in Milk Samples Collected Near the Bruce Power Site and Provincial Background Locations Over Time (± Standard Error)

The annual average C-14 result for area near milk samples was 229 Bq/Kg, which is very similar to the Provincial Background average of 228 Bq/kg. Annual I-131 concentrations in milk for both Bruce Power and Provincial samples were negligible.

For the 2019 CNSC IEMP milk was collected at a location near Tiverton and analyzed for tritiated water, I-131, Cs-137 and organically bound tritium [R-30]. The result for tritiated water was 19.6 Bq/kg fresh weight, which is well below the Guideline/Reference Value of 5,560 Bq/kg fresh weight. The results for I-131, Cs-137 and organically bound tritium were less than the limit of detection. These results are consistent with what Bruce Power reports and are not expected to have an impact on human health.

6.1.4.4 Agricultural Products

Local farms and residents supply Bruce Power with samples of various grains, fruits and vegetables grown on lands in the vicinity of Bruce Power. Sample locations are shown on Figure 22. These agricultural products are collected annually in specific wind sectors around the Bruce Power site and are analyzed for tritium oxide and carbon-14 by liquid scintillation counting. The commercial alcohol plant at the Bruce ECO-Industrial Park, formerly the Bruce Energy Centre (BEC), also provides Bruce Power with samples of corn mash (used for animal feed) for tritium analysis on a quarterly basis.

The annual average tritium oxide and carbon-14 results for agricultural products measured by Bruce Power are provided in Table 26. For 2021, the types of grains collected were corn and soybeans and fruit samples consisted of apples. Bruce Power collects a variety of vegetable types to include above ground, leafy and below ground vegetables. In 2021 the above ground variety included tomatoes, the leafy group included samples of rhubarb, swiss chard and kale, and the below ground vegetables were garlic, potato and beet. Where multiple samples within a group (i.e., above ground) were found at the same location, the samples were combined into a composite sample for analysis.

Provincial Background samples for fruits and vegetables typically include two sets of composite samples at four locations; however, in 2021 fruit composites were obtained from only two locations. For animal feed, sampling consists of semiannual collection at four locations. Sampling locations are provided in Figure 19 and the annual averages are provided in Table 26. The Provincial results for animal feed, fruit and vegetables are not equivalent to Bruce Power as the items are different and analysis is done on composites. However, the results may be broadly compared.

Table 26 - 2021 Annual Average Data for Agricultural Products

Sample Type (Sample Count)	Tritium Oxide		Carbon-14	
	Bq/L	St. Dev	BqC^{14}/kg-C	St. Dev
Area Near				
Grains (5)	8.51E+01	9.48E+01	2.32E+02	1.67E+01
Corn Mash (4)	2.28E+01	1.04E+01	N/A	N/A
Fruit (9)	4.74E+01	2.25E+01	2.57E+02	2.16E+01
Vegetables – All (14)	8.04E+01	1.62E+02	2.40E+02	1.77E+01
Vegetables - Above Ground (4)	4.63E+01	2.71E+01	2.23E+02	1.71E+01
Vegetables – Leafy (6)	1.31E+02	2.72E+02	2.47E+02	1.64E+01
Vegetables - Below Ground (4)	3.84E+01	2.45E+01	2.51E+02	7.89E+00
Provincial Background				
Animal Feed (8)	2.5E+00	1.2E+00	2.10E+02	1.85E+01
Fruit Composite (4)	6.0E-01	7.8E-01	2.19E+02	3.10E+00
Vegetable Composite (8)	2.3E+00	1.2E+00	2.12E+02	1.20E+01

Notes:

1. St. Dev = standard deviation. N/A = not applicable. E+00 represents scientific notation, E+03 = x10^{3}.
2. Bruce Power - For calculation of averages where result was less than critical level (Lc) the uncensored analytical result was used.
3. Provincial Background – For calculation of averages where the result was less than the minimum detection level (Ld), the minimum detection level was used.

Tritium oxide and carbon-14 content in agricultural products may vary each year based on the operational activities (i.e. radiological emissions) that occur during the growing season. The annual average trend of tritiated water in fruits and vegetables over time are shown in Figure 41 and Figure 42, respectively. Consistently fruit and vegetables near Bruce Power have higher tritium oxide concentrations than that at Provincial locations. The 2021 annual average for fruit harvested near Bruce Power was similar to what has been observed in previous years. There was an increase in the annual average tritium oxide concentration for vegetables in 2021. The annual average was impacted by higher levels to the north-east of Bruce A, which is consistent with elevated emissions from Bruce A in August during harvest time (See Section 5.1.1). Similar trends were observed in grains. The annual average trend of carbon-14 in fruit and vegetables over time is shown in Figure 43 and Figure 44. Carbon-14 average values in fruit and vegetables remain consistent with historic trends and are slightly higher than Provincial values in 2021.

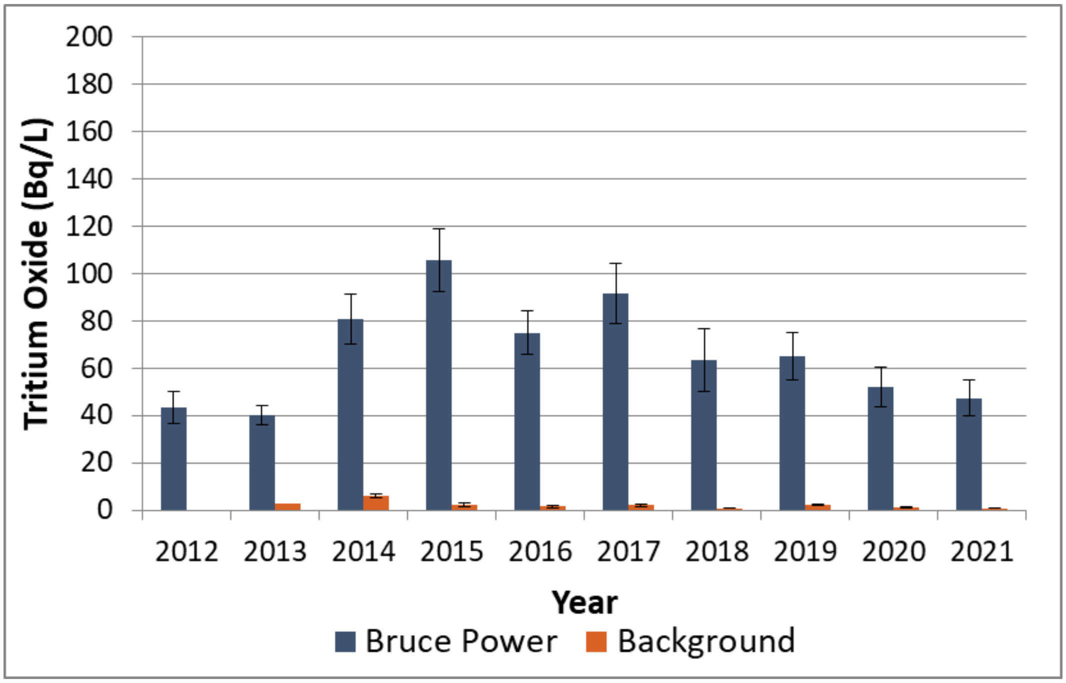


Figure 41 - Annual Average Tritium Oxide in Fruit at Bruce Power and Provincial Background Locations Over Time (± Standard Error)

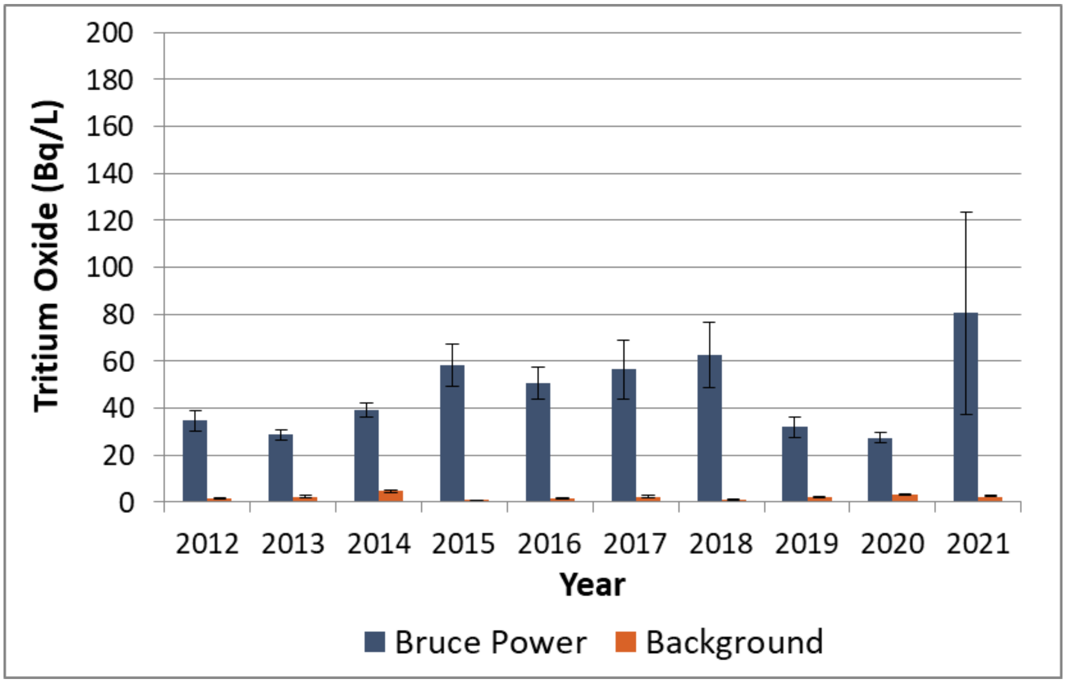


Figure 42 - Annual Average Tritium Oxide in Vegetables at Bruce Power and Provincial Background Locations Over Time (± Standard Error).

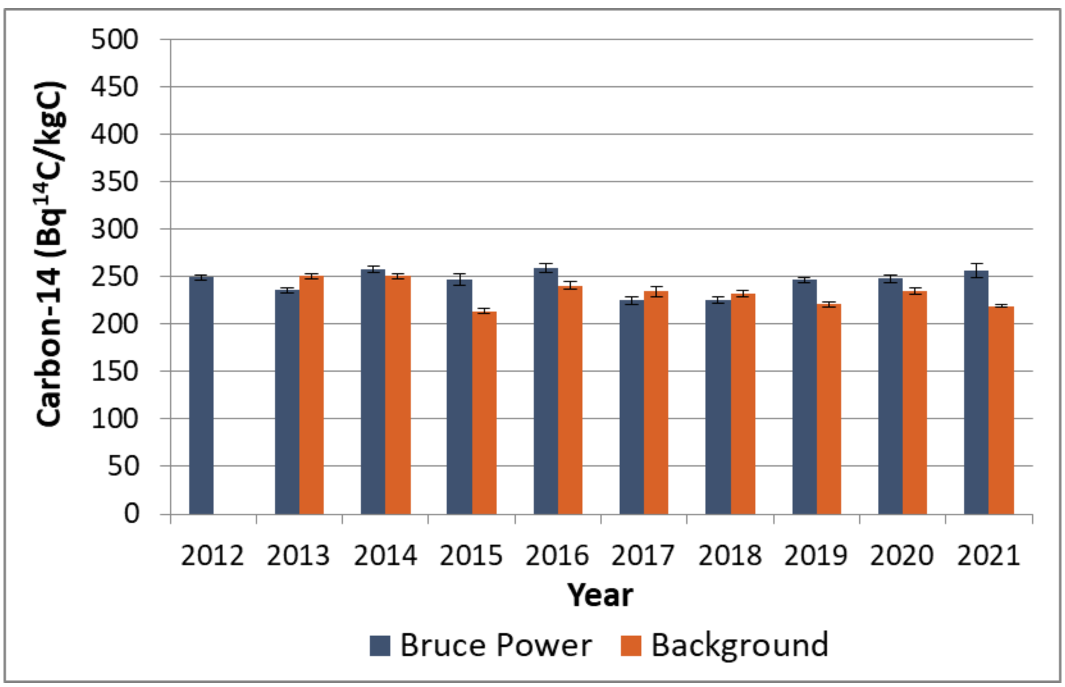


Figure 43 - Annual Average Carbon-14 in Fruit at Bruce Power and Provincial Background Locations Over Time (± Standard Error).

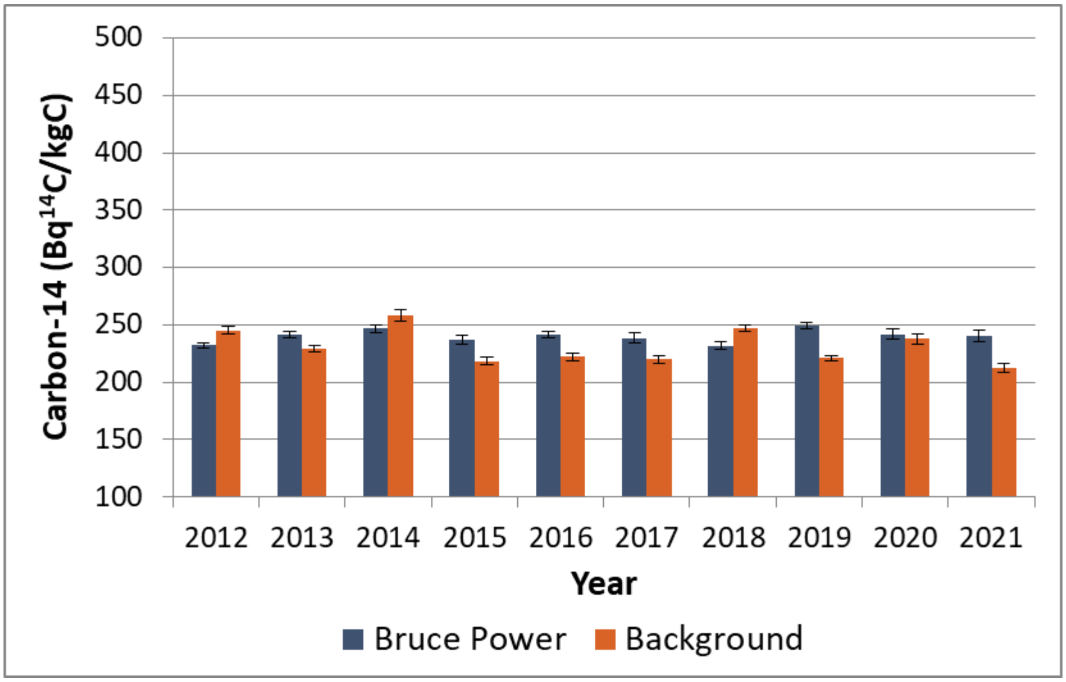


Figure 44 - Annual Average Carbon-14 in Vegetables at Bruce Power and Provincial Background Locations Over Time (± Standard Error).

As part of the 2019 CNSC IEMP a variety of agricultural products were sampled including fruits, vegetables and vegetation [R-30]. Fruit samples were collected at Inverhuron (apples), Saugeen Shores (strawberries) and Concession 2 near Bruce Power (pears) and were analyzed for tritiated water and organically bound tritium (OBT). The results for tritiated water ranged from 4.2 Bq/kg to 57.4 Bq/kg fresh weight and were well below the Guideline/Reference Level of 123,000 Bq/kg fresh weight. The OBT results ranged from 4.7 Bq/kg to less than detection and were also below the Guideline Level (50,300 Bq/kg).

Vegetables were sampled from Saugeen Shores (tomato, carrot, kale) and Concession 2 near Bruce Power (asparagus, rhubarb root) and analyzed for tritiated water and OBT. The results for tritiated water ranged from 8.6 Bq/kg to 13.3 Bq/kg fresh weight and were well below the Guideline/Reference Level of 104,000 Bq/kg fresh weight. The OBT results ranged from 9.4 Bq/kg to less than detection and were also below the Guideline Level (45,200 Bq/kg). These results suggest that the tritium levels in fruits and vegetables sampled near Bruce Power are very low.

Locations where vegetation was collected included Baie du Doré, Inverhuron, Kincardine, Southampton and Cape Croker. Samples included plantain, Eastern white cedar, cat tails (roots and leaves) and Balsam fir and were analyzed for Cs-137. All results, for all sample types and locations, had Cs-137 values that were less than the limit of detection (<3.2 Bq/kg).

6.1.4.5 Agricultural and Animal Products Summary

Bruce Power regularly monitors tritium oxide, carbon-14 and gamma emitters in fish, animal meat, honey, eggs, milk, fruit and vegetables, grains and animal feed at a variety of locations near Bruce Power. All results in 2021 were within historical levels and where applicable were well below the CNSC Reference Levels, indicating that there is no impact to members of the public from ingesting foods grown locally to Bruce Power.

A summary is provided here:

- Radioactivity measured in representative pelagic (those that feed within the water column) and benthic (those that feed on the lakebed) fish that were collected at Baie du Doré in 2021 are within historical trends, though the benthic fish have slightly higher tritium oxide concentrations in comparison to previous years. No human health impacts are expected from these low levels.

- Poultry and beef were added to the program in 2021 and levels of radioactivity are similar to samples obtained from Provincial Background locations where applicable.

- Radionuclide concentrations measured in milk are indistinguishable from background, except for low levels of tritiated water, which have been decreasing over the past 5 years.

- As in previous years, concentrations of tritiated water are higher in fruits and vegetables grown near Bruce Power, varying by wind sector and operational activities that occur during harvest time.

6.1.5 Beach Sand, Soil and Sediment Monitoring

Samples of garden soil and sediment are collected once every five years, while beach sand is collected annually. This is aligned with the sampling frequency carried out by the province. Samples are dried, sieved and analyzed for gamma-emitting radionuclides using gamma spectrometry. The results are used in the annual dose to public calculation and inform the environmental monitoring and environmental risk assessment programs to ensure that Bruce Power is appropriately monitoring and understanding its impact on the environment.

Sampling locations in the vicinity of Bruce Power and further afield along the shore of Lake Huron are shown in Figure 20, Figure 21 and Figure 22. Off-site samples of sediment and garden soil were last collected in 2019, as were the on-site soil samples for the Environmental Risk Assessment [R-109]. In 2021, samples of Lake Huron beach sand were collected for the dose calculation, and sediment samples were collected from on-site waterbodies for use in the 2022 Ecological Risk Assessment.

6.1.5.1 Offsite Beach Sand Monitoring

Beach sand was collected in 2021 at Baie du Doré, Inverhuron (duplicate samples) and Scott Point. The annual average results for CANDU related radionuclides Co-60, Cs-134 and Cs-137 are shown in Table 27, along with the Provincial Background results. The Provincial REM program collects 8 beach sand samples from Cobourg and 2 samples from Goderich.

Table 27 - 2021 Annual Average Beach Sand Data

Sample Location (Sample Count)	Co-60		Cs-134		Cs-137	
	Bq/kg	St. Dev	Bq/kg	St. Dev	Bq/kg	St. Dev
Bruce Power						
Area Near (4)	<Lc	-	<Lc	-	7.50E-01	2.62E-01
Provincial Background						
Cobourg (8)	<Ld	-	<Ld	-	3.53E-01	5.66E-02
Goderich (2)	<Ld	-	<Ld	-	<Ld	-

Notes:
1. St. Dev = Standard deviation. E+00 represents scientific notation, E+03 = $x10^3$.
2. Bruce Power - For calculation of averages where result was less than critical level (Lc) the uncensored analytical result was used. '<Lc' stated in table when average was a negative number.
3. Provincial Background – For calculation of averages where the result was less than the minimum detection level (Ld), the minimum detection level was used. '<Ld' stated in table when all values were <Ld

In 2021, all Bruce Power and Provincial beach sand samples had results for Co-60 and Cs-134 that were less than the limit of detection, indicating that levels of these radionuclides in sand are negligible. The area near average for Cs-137 was marginally higher than the Provincial Background averages for Cobourg and Goderich, but well below the CNSC Reference Level for soil (58.6 Bq/kg dry weight) or sediment (37,300 Bq/kg dry weight). As observed in previous years, Cs-137 levels are slightly higher at Scott Point, which is consistent with the predominant lake current direction moving in the northerly direction and the position of the point in relation to the sill at the mouth of Baie du Doré.

The CNSC IEMP included both soil and sediment samples in 2019. Soil was sampled at 4 locations, including Cape Croker, Southampton, Tiverton, and a Concession Rd. 2 location near Bruce Power, and analyzed for Cs-137. The results were in the range of 3.0 Bq/kg to 13.0 Bq/kg and were well below the Guideline/Reference Level of 58.6 Bq/kg dry weight. One sediment sample was included in the 2019 IEMP and was collected in Baie du Doré. The result for Cs-137 was 1.6 Bq/kg, a value much lower than the Guideline/Reference Level of 37,300 Bq/kg dry weight sited by the CNSC.

6.1.5.2 On-site Sediment Sampling

In preparation of the 2022 Environmental Risk Assessment, samples of sediment were collected in 2021 from the on-site waterbodies and analyzed for gamma emitting radionuclides. The locations include the B31 Pond (BM16), the Former Sewage Lagoon (BM21) and the stormwater pond next to building B16 as shown Figure 31. The results of the CANDU related radionuclides Co-60, Cs-134 and Cs-137 are shown in Table 28. Results that are less than the critical level (<Lc) are indistinguishable from background, and this is the case for all Co-60 and Cs-134 concentrations, except at FSL-1 on the northern side of the Former Sewage Lagoon, located east of Bruce B. All of the Cs-137 results are above Lc, with the highest value at FSL-1. These results are used to assess the risk to ecological receptors in the 2022 Environmental Risk Assessment.

Table 28 - 2021 Sediment Data for On-Site Waterbodies

Sample Location	Co-60			Cs-134			Cs-137		
	Bq/kg	± 2σ	Lc	Bq/kg	± 2σ	Lc	Bq/kg	± 2σ	Lc
B16 Stormwater Pond	1.33E-01	2.06E-01	1.47E-01	3.01E-02	1.48E-01	1.78E-01	2.83E-01	7.15E-02	7.85E-02
B31 Pond (BM16)	4.52E-02	3.47E-01	2.40E-01	-4.92E-01	1.82E-01	2.96E-01	7.65E+00	8.17E-01	1.41E-01
Former Sewage Lagoon (BM21) FSL-1	1.34E+00	1.82E-01	1.38E-01	-4.28E-01	1.86E-01	2.90E-01	1.34E+02	1.06E+01	2.41E-01
Former Sewage Lagoon (BM21) FSL-2	-6.77E-02	2.08E-01	1.46E-01	2.52E-02	1.46E-01	1.73E-01	1.10E+00	1.29E-01	8.35E-02

Notes:
1. E+00 represents scientific notation, E+03 = x10^3. Critical level = Lc.

6.1.6 Groundwater Monitoring

6.1.6.1 2021 Non-Potable Groundwater Monitoring

Monitoring for tritium in groundwater occurred within the protected zone at Bruce A and Bruce B in 2021 at the 5 multi-level wells located between the powerhouse and Lake Huron, and also at wells located on the opposite side of the powerhouse, within the transformer areas. A map of sampled well location is shown in Figure 45 for Bruce A and Figure 49 for Bruce B. The monitoring wells are sampled on a semi-annual basis.

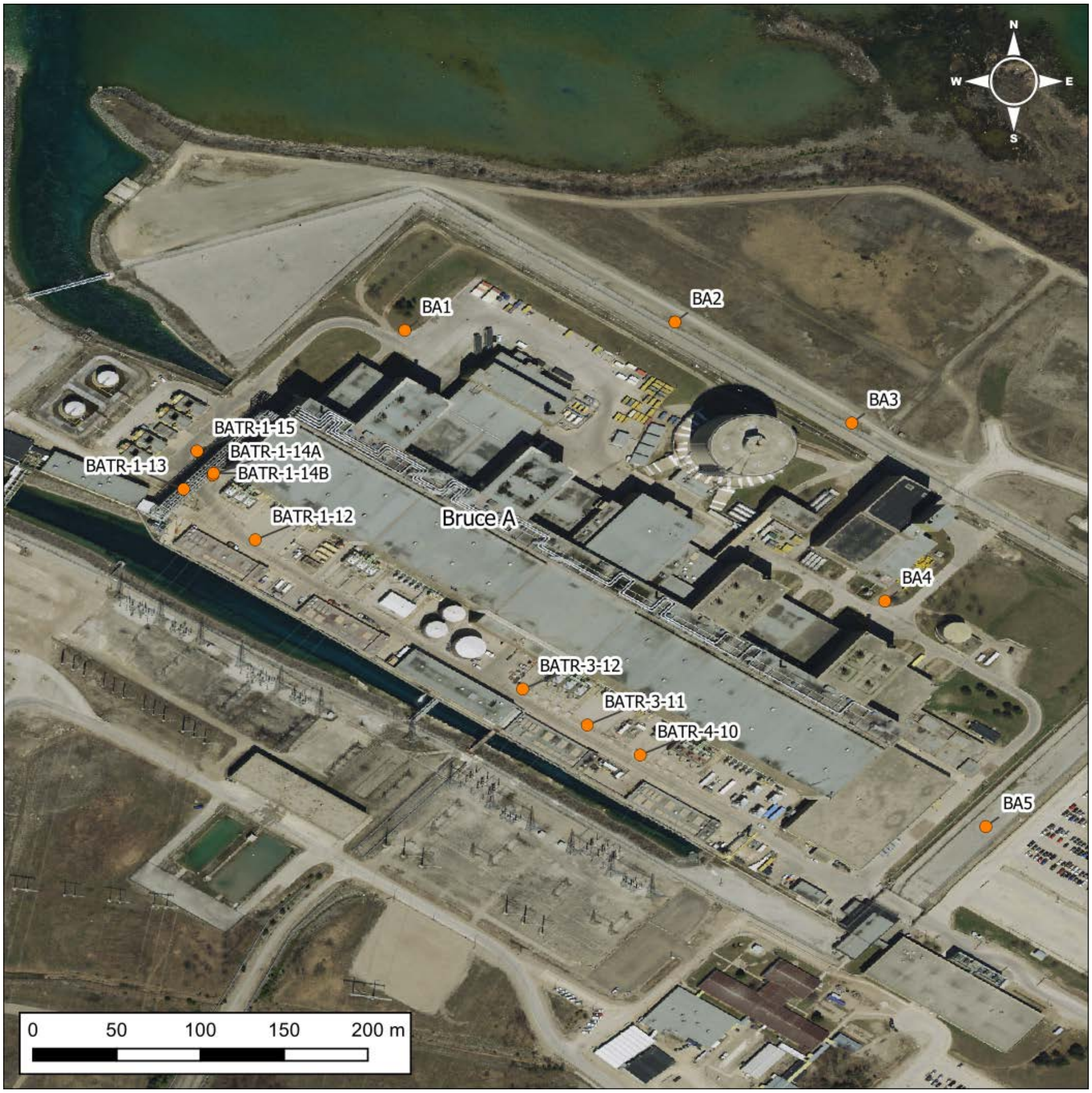


Figure 45 – Groundwater Monitoring Locations at Bruce A

Bruce Power groundwater protection program uses a statistical approach to understand any deviation from normal. The statistical based evaluation criteria are derived for each indicator parameter using the 'mean plus three standard deviations' approach (M3SD). When deviations from normal are observed, further investigation or other actions are undertaken as needed. The 2021 groundwater tritium results at Bruce A wells are within normal trends. The groundwater tritium results from 2021 are shown below (Table 29) along with a graphical representation of the results for the last number of years (Figure 46). Note that BA1 – BA5 and BB1 –BB-5 are named such that the deepest interval is numbered the lowest (i.e. BA 1-1 is deeper than BA 1-2). Sampling of BA 1- BA 5 took place in the spring on May 13 and in the fall on October 19.

Table 29 - 2021 Tritium in Groundwater for BA Multi-level Wells at Bruce A

Sample Location	**Spring**		**Fall**	
	Bq/L	**±2σ**	**Bq/L**	**±2σ**
BA 1-1	12.9	3.03E+00	6.5	2.88E+00
BA 1-2	27.9	3.74E+00	28.5	3.91E+00
BA 2-1	1.2	1.88E+00	0.3	2.10E+00
BA 2-2	4.3	2.53E+00	6.6	2.88E+00
BA 2-3	350.0	1.08E+01	357.0	1.09E+01
BA 3-1	2.3	2.18E+00	-0.7	2.10E+00
BA 3-2	2.9	2.19E+00	0.1	2.10E+00
BA 3-3	234.0	8.94E+00	236.0	9.00E+00
BA 4-1	1.9	1.88E+00	1.9	2.10E+00
BA 4-2	1440.0	2.16E+01	1410.0	2.13E+00
BA 5-1	3.9	2.24E+00	0.7	2.10E+00
BA 5-2	0.8	1.88E+00	-0.7	2.10E+00

Notes:
1. Lc for 2021S data is 2.67E+00 Bq/L and for 2021F data is 2.96E+00 Bq/L
2. ±2σ is the uncertainty associated with the analytical measurement

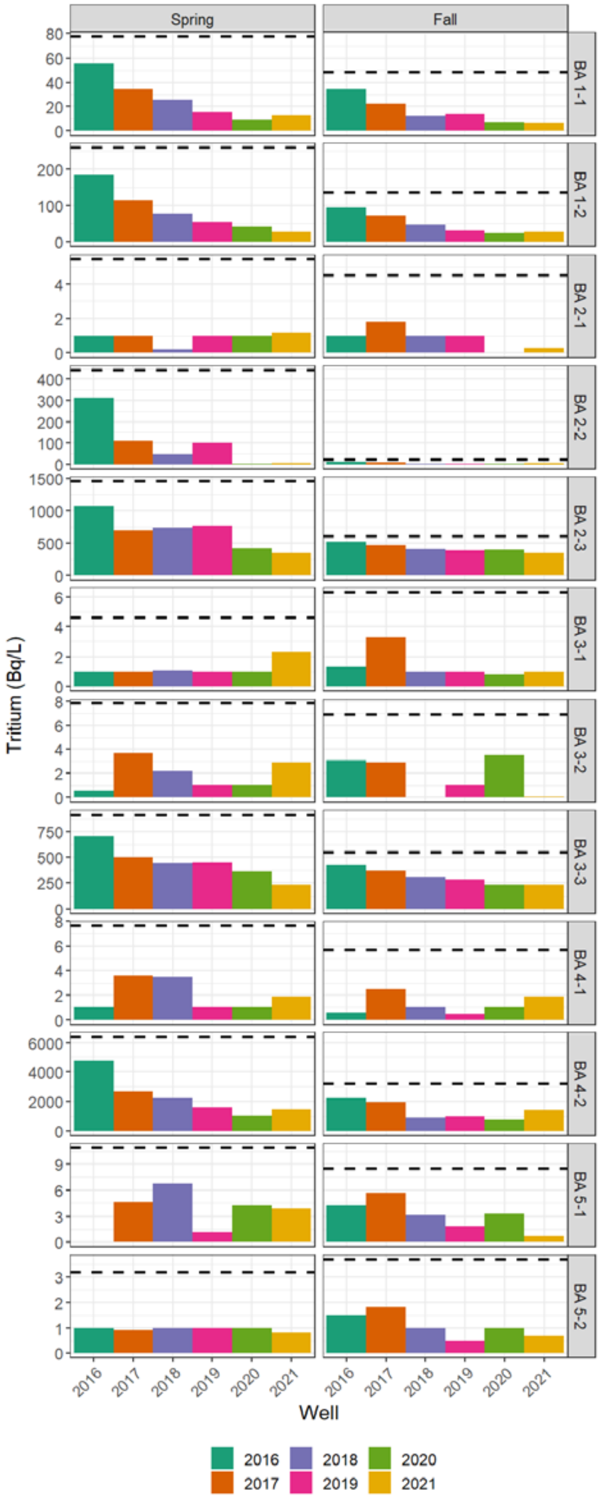


Figure 46 – Tritium in Groundwater – Multi-level Wells at Bruce A (dashed lines show statistically based evaluation criteria as mean +3 standard deviations)

Results from the groundwater sampling events indicate that tritium appears to be a result of atmospheric downwash due to tritium levels being higher in the shallower well intervals. The multi-year trend shown in Figure 46 above also demonstrates a level of seasonal variation which is occurring noting higher levels of tritium in the springtime when there would naturally be a greater amount of precipitation.

Tritium was measured in groundwater wells in the Bruce A Transformer Area, with 2021 results shown below in Table 30. These wells are located across the construction south side of the powerhouse in the vicinity of the unit transformers. This area is named the Bruce A Transformer Area (BATR). The first sampling event took place on July 20 followed by the second sampling event on October 6. Only fall results have been shown on the historical trend graph (Figure 47) since the spring sampling has not historically been completed at these monitoring locations. The 2021 spring/fall data are shown in the Table 30 below and represented on a separate graph (Figure 48) and demonstrate the observation of seasonal variation at these locations consistent with other semi-annual events.

Table 30 - 2021 Tritium in Groundwater for Transformer Area wells at Bruce A

Sample Location	Spring		Fall	
	Bq/L	±2σ	Bq/L	±2σ
BATR-1-12	917.0	1.72E+01	909	1.71E+01
BATR-1-13	878.0	1.70E+01	684	1.49E+01
BATR-1-14A	28.5	3.93E+00	18.7	3.58E+00
BATR-1-14B	6680.0	4.61E+01	4230	3.65E+01
BATR-1-15	634	1.44E+01	416	1.71E+01
BATR-3-11	223	8.78E+00	399	1.15E+01
BATR-3-12	1430	2.14E+01	1600	2.26E+01
BATR-4-10	880	1.69E+01	1500	2.19E+01

Notes:
1. Lc for 2021S data is 3.01E+00 Bq/L and for 2021F data is 3.13E+00 Bq/L
2. ±2σ is the uncertainty associated with the analytical measurement

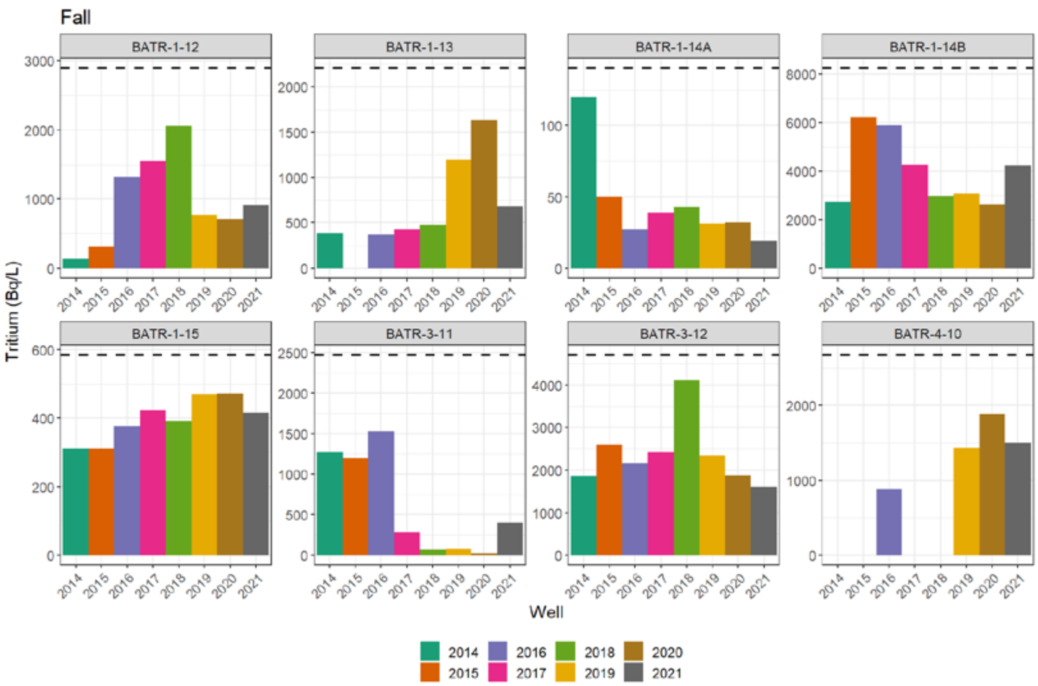


Figure 47 - Fall Tritium in Groundwater – Transformer Area wells at Bruce A (dashed lines show statistically based evaluation criteria as mean +3 standard deviation)

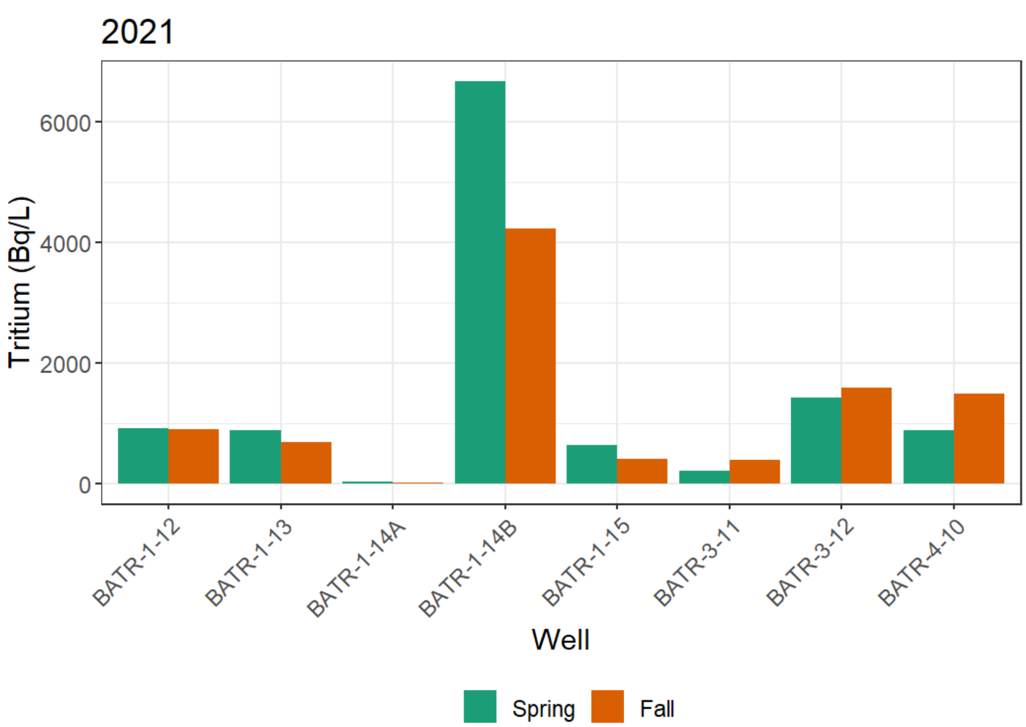


Figure 48 - Spring/Fall 2021 Tritium in Groundwater Results – Transformer Area wells at Bruce A

Tritium levels in the Bruce A Transformer Area wells are within normal trends. An elevated level of tritium in BATR-1-14B in 2015 (as shown in Figure 47) prompted action to continue to monitor the following year to confirm an increasing trend. The level dropped the following year and has continued to drop in subsequent years. The level observed in the first sampling event of 2021 (as shown in Figure 48) may be attributed to atmospheric downwash since the second sampling event shows a decreased level, likely due to seasonal variation. Semi-annual trends will continue to be monitored in upcoming years. Sampling in 2021 at these wells was the first instance of semi-annual sampling.

Bruce B spring sampling event occurred on May 15 with the fall sampling event taking place on October 20. Sampling locations are included in the map shown below however not all locations on the map were sampled (Figure 49). Note that fall sampling at BB 1 did not occur (as shown on Table 31) as the well was damaged. Repairs are being scheduled to be completed as per the requirements of the Bruce Power groundwater protection program.

Figure 49 - Groundwater Monitoring Locations at Bruce B

Table 31 - 2021 Tritium in Groundwater for Multi-level Wells at Bruce B

Sample Locations	Spring		Fall	
	Bq/L	±2σ	Bq/L	±2σ
BB 1-1	6.9	3.07E+00	-	-
BB 1-2	32.8	4.22E+00	-	-
BB 1-3	606.0	1.43E+01	-	-
BB 2-1	25.3	3.92E+00	23.6	3.08E+00
BB 2-2	1020.0	1.84E+01	998.0	1.80E+01
BB 3-1	5.0	2.97E+00	3.2	2.55E+00
BB 3-2	110.0	6.55E+00	111.0	6.48E+00
BB 3-3	265.0	9.66E+00	275.0	9.70E+00
BB 4-1	28.6	4.05E+00	22.9	3.77E+00
BB 4-2	417.0	1.19E+01	303.0	1.01E+01
BB 4-3	1730.0	2.38E+01	1510.0	2.20E+01
BB 5-1	327.0	1.07E+01	243.0	9.16E+00
BB 5-2	390.0	1.16E+01	369.0	1.11E+01
BB 5-3	488.0	1.29E+01	402.0	1.16E+01

Notes:

1. Lc for 2021S data is 3.19E+00 Bq/L and for 2021F data is 3.15E+00 Bq/L
2. ±2σ is the uncertainty associated with the analytical measurement

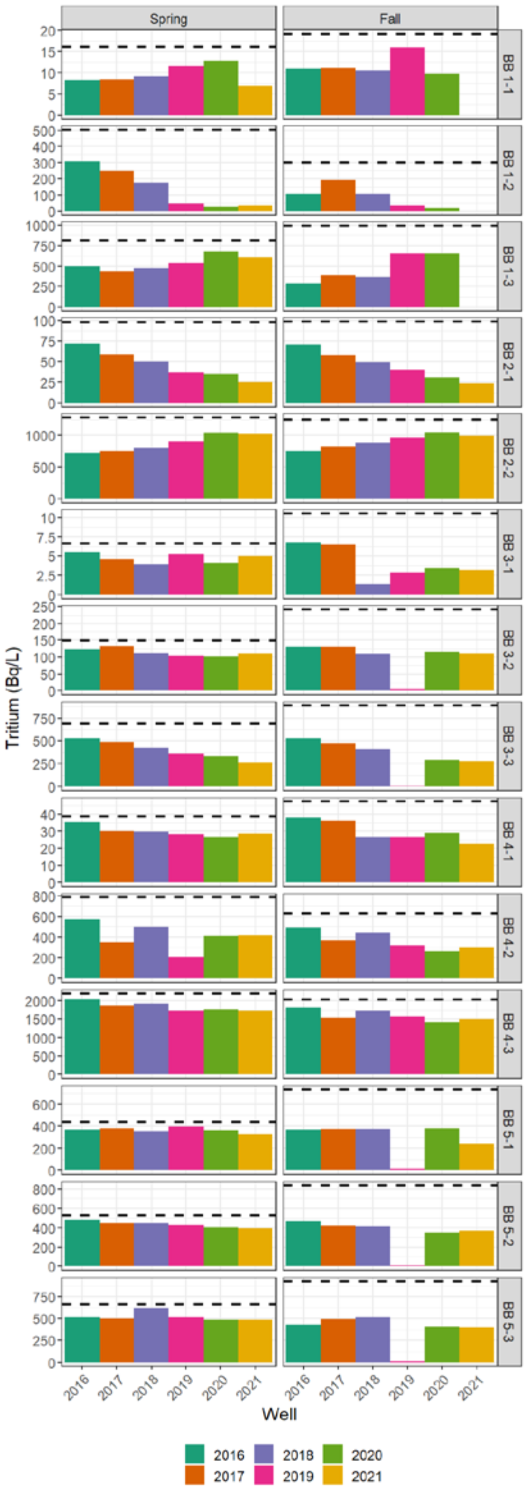


Figure 50 - Tritium in Groundwater - Multi-level Wells at Bruce B (dashed lines show statistically based evaluation criteria as mean +3 standard deviations)

Similar to Bruce A, tritium levels at Bruce B multi-level wells are within normal trends with some evidence of seasonal variation. Tritium levels are slightly more elevated in the spring sampling event compared to the fall, however seasonal variation is less evident at Bruce B compared to Bruce A (see Figure 50). This may be due to a combination of the low levels of tritium measure and the impact of uncertainty on the representation of seasonal variation. Trends shown in Figure 51 have very consistent levels over the course of 5 years.

Tritium was measured in groundwater wells in the Bruce B Transformer Area (BBTR), with 2021 results shown in Table 32. These wells are located across the construction south side of the powerhouse in the vicinity of the unit transformers. The first sampling event took place on May 15 followed by the second sampling event on October 20. Only fall results have been shown on the historical trend graph (Figure 51) since the spring sampling has not historically been completed at these monitoring locations. The 2021 spring/fall results are shown on a separate graph (Figure 52) to illustrate the observation of seasonal variation at these locations consistent with other semi-annual events.

Table 32 - 2021 Tritium in Groundwater at Transformer Area wells at Bruce B

Sample Location	**Spring**		**Fall**	
	Bq/L	**±2σ**	**Bq/L**	**±2σ**
BBTR-5-11	559	1.36E+01	546	1.34E+01
BBTR-6-28	1030	1.83E+01	727	1.53E+01
BBTR-6-30	900	1.71E+01	1140	1.91E+01
BBTR-6-40	1370	2.10E+01	1280	2.02E+01
BBTR-7-12	4250	3.68E+01	2620	2.88E+01
BBTR-8-12	827	1.64E+01	644	1.45E+01

Notes:

1. Lc for 2021S data is 3.01E+00 Bq/L and for 2021F data is 3.13E+00 Bq/L
2. ±2σ is the uncertainty associated with the analytical measurement

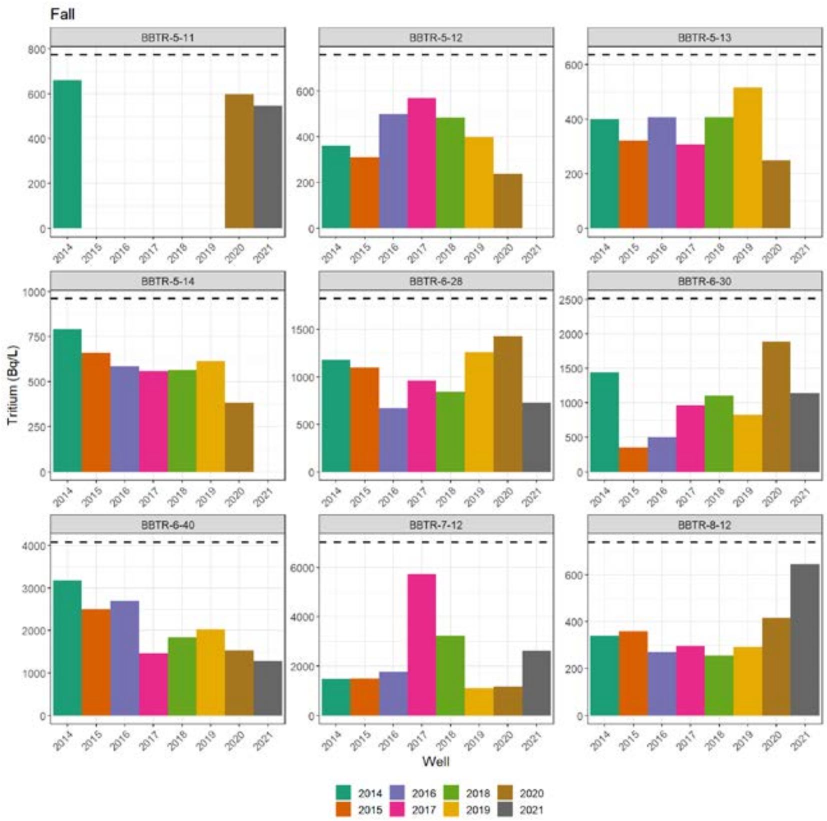


Figure 51 - Fall Tritium in Groundwater – Transformer Area wells at Bruce B (dashed lines show statistically based evaluation criteria as mean +3 standard deviations)

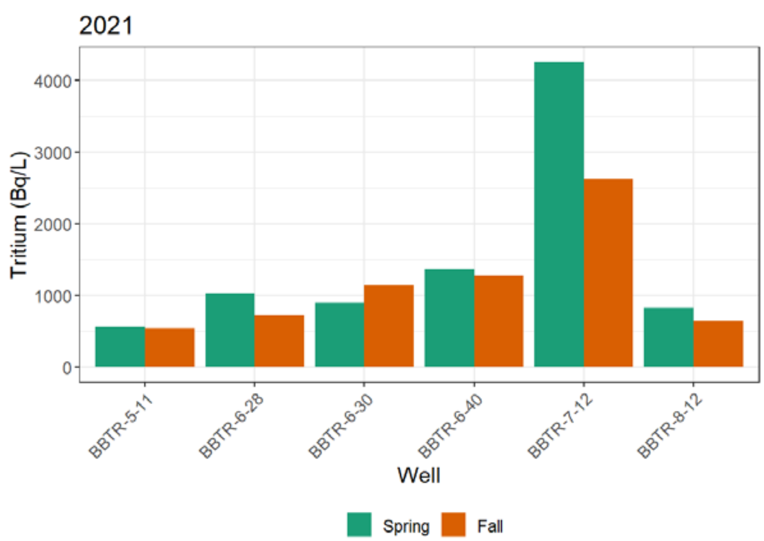


Figure 52 - Spring/Fall 2021 Tritium in Groundwater Results – Transformer Area wells at Bruce B

Historical tritium results at the Bruce B Transformer Area show levels to be within normal trends. Increased tritium level noted in 2017 at BBTR 7-12 (as shown on Figure 51) prompted action to continue sampling the following year to confirm the increasing trend. Levels decreased in 2018 and continued to drop in subsequent years.

Overall, in 2021, spring and fall sampling was conducted at the historically sampled wells at locations behind each station as well as at additional monitoring well locations around Bruce A and Bruce B. The results from 2021 continue to verify that:

- Tritium levels are within expected levels;
- There were no adverse trends observed which required immediate follow up action;
- Seasonal variation is evident based on spring versus fall sampling events. Tritium results in the spring are greater than the fall which is in line with increased springtime precipitation; and
- Tritium in groundwater appears to be a result of atmospheric deposition based on the observation of increased tritium levels in the shallower intervals of the multi-level wells.

6.1.7 Quality Assurance/Quality Control

6.1.7.1 Radiological Environmental Monitoring

6.1.7.2 Meteorological Data Analysis

The meteorological data analysis documented in this report was conducted in accordance with the Kinectrics Quality Assurance program [R-110]. The Kinectrics Quality Assurance program is ISO 9001 registered and the scope of the ISO 9001:2015 registration covers "consulting, scientific and engineering services to nuclear and other industries to support siting, safety, licensing, design and operations by providing specialized: asset management, project management, procurement, software, environmental, integrated analytical and engineering solutions and services". The Kinectrics Quality Assurance program is regularly audited by organizations such as CANPAC and has consistently been assessed as compliant with requirements of CSA Z299.1-85 [R-111] CSA N286-12 [R-112].

6.1.7.3 Public Dose Calculations

The Public Dose calculations for 2021 were conducted in accordance with the Calian ETS Quality Assurance Program. Calian has implemented and maintains a Quality Management System (QMS) that is certified to the ISO 9001:2015 Standard [R-113].

The 2021 public dose calculations were conducted using the IMPACT 5.5.2 software. All inputs to the IMPACT model were verified based on Bruce Power environmental and emissions and effluents data. A verification tool was utilized to ensure that all numerical entries to the IMPACT model were inputted correctly, and the results of this IMPACT model verification were recorded. The results of the IMPACT calculation were independently verified.

The development of IMPACT 5.5.2 has been guided by, and subject to, an overall Tool Qualification Program (TQP), which follows the CSA N286.7-99 (Canadian Standards

Association, 1999) guidelines for quality assurance in software development for nuclear power plants [R-114].

6.1.7.4 Provincial Background – OPG Whitby Laboratory

The OPG Whitby Laboratory performed the TLD gamma analyses and most of the Provincial sample analyses. Details regarding the OPG QA program are described in the OPG report *2021 Results of Environmental Monitoring Programs* [R-115].

6.1.7.5 Bruce Power Health Physics Lab

The Bruce Power Health Physics Lab operates a comprehensive QA program, which includes quality control samples, blank/background samples, process control samples, and externally generated proficiency testing samples.

6.1.7.6 Sample Availability

The Bruce Power Health Physics Lab collected and analyzed 956 analyte samples against a target of 994 for an overall sample availability of 96%. This meets the sampling criteria of >90% for the REM program. Sample unavailability is due to several factors, notably seasonal conditions (such as variations in agricultural yields) or due to the nature of seasonal residences closed for certain months of the year, making the wells unavailable for sampling. In 2021, no occupancy as a result of COVID-19 travel restrictions impacted sample collection. Details of the sample availability for 2021 are presented in Table 33 below.

Table 33 - 2021 Sample Availability Data

Sample Types	Collection Frequency	Bruce Power		
		Planned	**Actual**	**% Complete**
Atmospheric				
Air Effluents	Monthly (^{3}H)	120	120	100%
	Quarterly (^{3}H,^{14}C)	172	172	100%
Environmental Gamma	Quarterly (GS)	64	64	100%
Precipitation*	Monthly (^{3}H, GB)	120	116	97%
Water				
Water Supply Plants	Weekly Composite (^{3}H)	96	96	100%
	Monthly Composite (GB)	24	24	100%
Resident Well & Lake Water*	Bi-Monthly (^{3}H, GB)	72	61	85%
	Semi-Annually (^{3}H, GB, GS)	64	50	78%
Local Streams*	Bi-Monthly (^{3}H)	24	21	88%
	Semi-Annually (GB)	8	8	100%
Site Ground Water	Semi-Annually (^{3}H)	52	49	94%
Aquatic				
Fish	Annually (^{3}H,^{14}C, GS, OBT)	32	32	100%
Terrestrial				
Milk	Weekly Composite (GS)	53	53	100%
	Monthly Composite (^{3}H,^{14}C)	60	60	100%
Fruits & Vegetables	Annually (^{3}H,^{14}C)	13	12	92%
Honey	Annually	2	2	100%

Sample Types	Collection Frequency	Bruce Power		
		Planned	Actual	% Complete
Eggs	Annually	2	1	50%
Grains	Annually (^{3}H, ^{14}C)	6	5	83%
	Quarterly (^{3}H)	4	4	100%
Animal Meat & Feed	Annually (^{3}H, ^{14}C, GS)	2	2	100%
Soil & Sand	Annually (GS)	4	4	100%
Overall Site Sample Availability		**994**	**956**	**96%**

Note:
1. GB = Gross Beta. GS= Gross Scan
2. * = Samples may have been unavailable because of seasonal conditions (e.g., freezing of water samples and seasonal residences that are closed for certain months of the year).

6.1.7.7 Laboratory Analysis Summary

A total of 1,259 laboratory analyses were conducted in support of the Bruce Power REM program this year (2021). The analyses included tritium, gross beta, ^{14}C, ^{131}I, TLD gamma (under contract to OPG), gamma spectrometry and organically bound tritium (OBT). Table 34 provides a summary of the number of samples analyzed for each analysis method.

Table 34 - 2021 Laboratory Analysis Summary

Laboratory Analysis	Number of Analyses
^{3}H	623
Gross Beta	181
^{14}C	286
^{131}I	53
TLD Gamma*	64
Gamma Spectrometry - ^{134}Cs, ^{137}Cs, ^{40}K, ^{60}Co	112
Organically Bound Tritium (OBT)	4
Total	1259

Note:
*64 TLD Gamma Analysis Completed by OPG Whitby

6.1.7.8 Laboratory Quality Assurance and Quality Control

The purpose of inter-laboratory proficiency testing is to provide independent assurance to Bruce Power, the CNSC, and external stakeholders that the laboratory's analytical performance is adequate, and the accuracy of the measurements meets required standards. Table 35 presents a summary of the Bruce Power REM QA/QC program.

Table 35 - Summary of the QA/QC Program

Analyses		**Tritium**			**Gross Beta**	**^{14}C**	**Gamma Spec**		
Medium		**OBT**	**Water**	**Air**	**Water**	**Produce**	**Water**	**Sediment**	**Soil**
Reality Check	Historical	X	X	X	X	X		X	X
Reality Check	Relative	X	X	X		X		X	X
External Benchmarks	Inter-lab Comparison		Eckert & Ziegler Analytics		Eckert & Ziegler Analytics		Eckert & Ziegler Analytics	Eckert & Ziegler Analytics	Eckert & Ziegler Analytics
Internal Quality Control	Bias	QC Sample			QC Sample (^{137}Cs)	QC Sample (Sawdust)	Mixed Gamma QC Sample		
Internal Quality Control	Precision	QC Sample			QC Sample (^{137}Cs)	QC Sample (Sawdust)	Mixed Gamma QC Sample		
Internal Quality Control	Background	Low Tritium Water			Blank	Blank	Blank		
Internal Quality Control	Process Controls	Contamination			Contamination (de-min water)	Contamination (Coal)			

6.1.7.9 Laboratory Quality Control

Various quality control samples are utilized to estimate the precision and accuracy of analytical results and to indicate errors introduced by laboratory practices. There are two types of quality control samples used to accompany the analyses of the environmental samples collected for the REM program: process control samples and quality control samples.

6.1.7.10 Process Control Samples

Process Control samples are low analyte samples that are treated as actual samples and go through the same handling process. These are intended to detect contamination and specific sources of error. The following main process control samples are used for REM samples:

- Low tritium reference water samples kept open to the air during sample handling to detect if tritium contamination is picked up
- Coal (low ^{14}C) samples to detect anomalies with ^{14}C analyses
- Demineralized water samples run as low gross beta samples to detect contamination
- Blank TLDs to detect radiation exposure during shipping to and from the OPG Whitby laboratory

6.1.7.11 Quality Control Samples

Quality control samples are samples which contain known values of the analyte (usually derived from traceable standards), which are included for analysis. Statistically based quality control charts are used to evaluate validity of environmental sample results; results are considered valid when the values for the accompanying quality control samples are within ± 3 standard deviations of the known or expected value for the respective control chart.

6.1.7.12 External Laboratory Comparisons

The main purpose of inter-laboratory comparison programs is to provide independent assurance to Bruce Power, the CNSC, and external stakeholders that the laboratory's analytical proficiency is adequate, and the accuracy of the measurements meets required standards. The comparison program forms a crucial part of the overall laboratory QA program and demonstrates that the laboratory is performing within acceptable limits as measured against external unbiased standards.

Proficiency testing service is operated by Eckert & Ziegler Analytics Inc. of Atlanta, Georgia. On a quarterly basis Eckert & Ziegler Analytics provides samples containing known quantities of radionuclides to the Bruce Power Health Physics Laboratory. The samples are environmental matrices which are analogous to the samples collected for the REM program.

These samples include:

- Tritium in water
- Beta emitters in water
- Iodine in milk
- Gamma emitters in water
- Gamma emitters in soil
- Iodine-131 in iodine cartridge (annually)
- Gamma emitters on particulate filter (annually)

Upon completion of analysis, the Bruce Power analytical values are submitted to Eckert & Ziegler Analytics, which subsequently provides a final report for Bruce Power, detailing the expected values and the ratio of the laboratory value to the expected value.

6.1.7.13 Acceptance Criteria

All results obtained from Eckert & Ziegler Analytics shall meet the following self-imposed pass/fail investigation criteria:

$$\frac{(V_L + 1\sigma_L)}{V_A} \geq 0.75 \text{ AND } \frac{(V_L - 1\sigma_L)}{V_A} \leq 1.2$$

Where:

V_L = Bruce Power HPL value
σ_L = Bruce Power HPL one sigma uncertainty value
V_A = Analytics Supplier value

The results for the proficiency testing are presented in 10.0Appendix B:. All results meet the acceptance criteria in SEC-DOS-00028, Radiological Analysis Proficiency Testing [R-116]**.** All results are acceptable.

6.1.8 Updates to Radiological Environmental Monitoring

The following changes were made in 2021:

- A dairy farm (BDF16) was added to the program in the fall of 2020, with weekly sampling starting in January 2021.
- Addition of annual samples of beef (near and far) to the program through participation from Beefway in Kincardine. Sample collection started in 2021.
- Loss of semi-annual egg sample from farm BF24 in 2021. A replacement farm (BF25) was added to the program and eggs were obtained for the latter half of the year.
- Addition of annual samples of poultry to the program through participation from farm BF25.

6.2 Conventional Environmental Monitoring

This program monitors for conventional contaminants, physical stressors, potential biological effects, and pathways for both human and non-human biota. Non-radiological chemical stressors from historic and current operations are monitored (with future effects predicted using models as needed) in local surface waters, sediments, soil, and/or air using an activity-centered, risk-based approach. Effects on wildlife from physical stressors are documented using numerous Biological Effects Monitoring (BEM) approaches.

Chemical stressors that have the *potential* for environmental impact are referred as Chemicals of Potential Concern (COPCs). COPCs are routinely monitored at Bruce Power, and they are chosen based on known controlled releases from the facility. Controlled emissions/effluents are regulated and are described in Bruce Power's Conventional Effluent Monitoring Program (see section 5.0). A second pathway to the environment is through an uncontrolled release (i.e., spill). If a spill was to occur and a contaminant reached the environment, the location and frequency of COPC monitoring may change on a case-by-case basis, as dictated by remediation activities and/or follow-up monitoring.

Routine monitoring for conventional COPCs occurs in surface waters (annually) and sediments (every 5 years) because they have the highest probability of impact from facility operations such as station effluents, storm water discharges, and Centre of Site operations (e.g., sewage treatment and discharges). Soil has a low probability of being impacted by chemical stressors at Bruce Power, primarily because COPCs are not discharged directly to soil under normal operations. This has been repeatedly demonstrated in past Environmental Risk Assessments [R-43]. Sediments, soils, and surface waters were sampled in 2021 to inform an updated environmental risk assessment that is to be presented in 2022. These 2021 results are shared and discussed here at a high-level and a detailed assessment of risk to potential receptors will be presented in the 2022 ERA.

The impact of air emissions on the surrounding environment is assessed annually in the Conventional Environmental Monitoring Program and in recurring ERAs which have demonstrated that these impacts are very low [R-43]. The transport of COPCs through the air to surface water (and potentially sediment, soil or groundwater) occurs via deposition, runoff and percolation processes. Transport through air is short-lived and thus there is minimal interaction between COPCs and potential receptors.

6.2.1 Routine Lake Water Quality and Stream Water Quality Assessment – 2021

6.2.1.1 Lake Water Quality

Lake Huron surface water quality samples were taken from 1 m below the lake surface at five long-term monitoring locations near Bruce Power on June 9, 2021 (Figure 53). These locations are representative of near field, wildlife habitat and reference areas. Bruce A and Bruce B discharges (LWQ1 and LWQ2, respectively) were sampled to sufficiently characterize the effluent from facility operations. Baie du Doré (LWQ5) was sampled as it is a wildlife habitat area. Sampling locations at the southern (LWQ8) and northern (LWQ7) limits are reference locations. The results of these water quality analyses are presented in Table 36 alongside the historical trend observed between 2017-2021. These data continue to show that Bruce Power has effective containment and effluent control measures in place, and that facility operations have little-to-no effect on the water quality in Lake Huron [R-43] [R-117] .

The 'hold time' for analysis of the June 9th hydrazine samples exceeded the recommended time limit so samples were re-collected on July 11, 2021 and promptly analyzed within 24 hrs. The hydrazine results were below the 3.14 µg/L method detection limit on both dates at all locations. Additional un-ionized ammonia (NH_3) samples were collected on August 15th in order to obtain an additional sampling point in the summer to assess whether or not elevated NH_3 concentrations existed as had been observed in August of 2017. The NH3 concentrations on both sampling dates were below the CCME screening criteria at all sample locations (Table 36).

Additional lake water quality data collected between 2017-2020 are presented in the 2022 ERA. These data were collected from the locations shown in Figure 53, historical monitoring locations, and from the CWMP stations in Baie du Dore and Inverhuron Bay. The 2017-2020 data and those collected in 2021 (Table 36) are comprehensively assessed in the 2022 ERA (on track for submission by end of June 2022), including a discussion of any exceedances of the screening criteria and characterization of the risk to potential receptors.

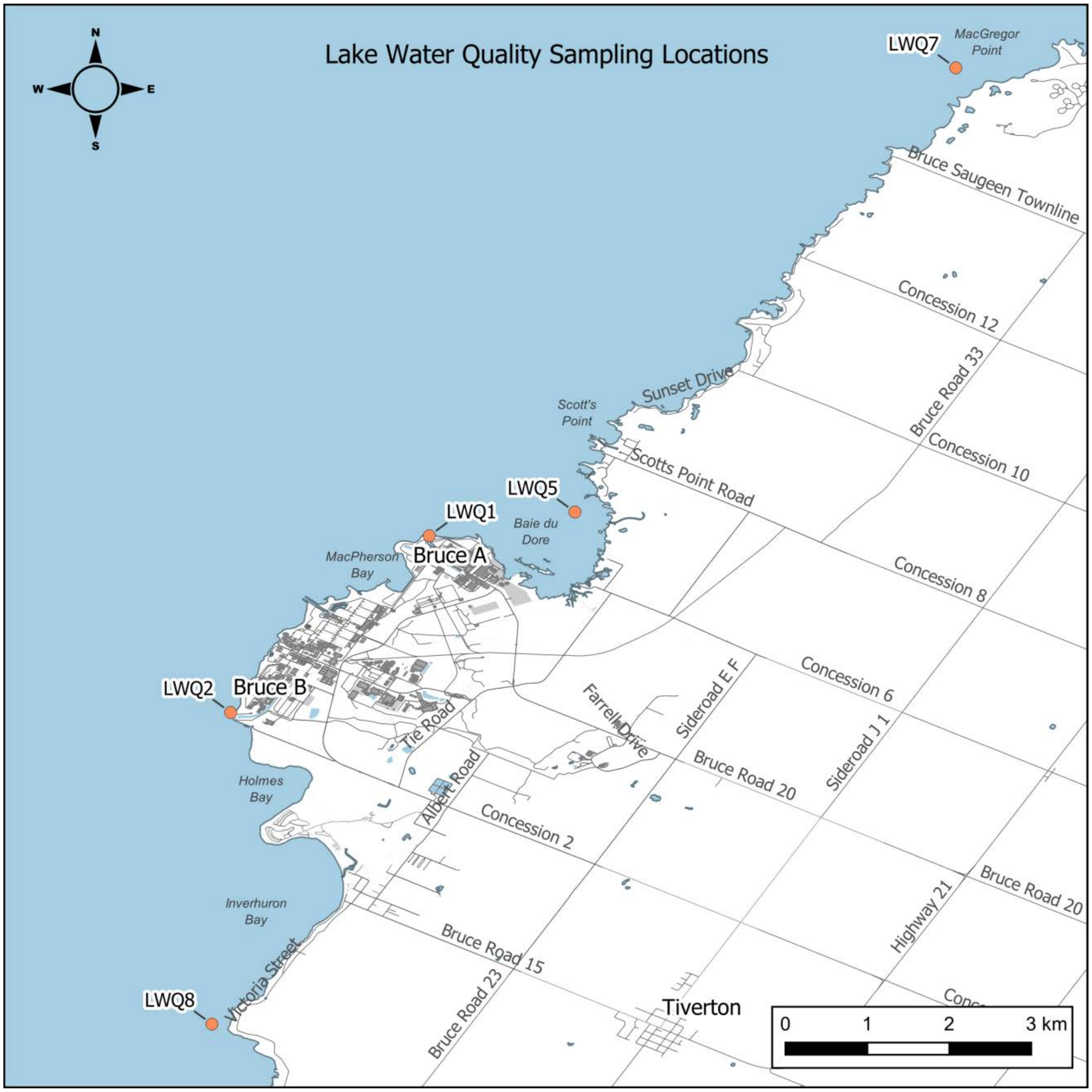


Figure 53 - Long-term Water Quality Monitoring Locations Sampled in Lake Huron (LWQ) in 2021

Table 36 - The results of water quality samples taken from 1 m below the lake surface in 2021 from 5 long-term monitoring locations in Lake Huron. The range and number of measurements taken between 2017 and 2021 are shown for context. Screening criteria chosen are the most conservative available.

			Location	**Bruce A Discharge**	**Bruce B Discharge**	**Bruce B Discharge**	**Baie du Doré**	**North Reference Location**	**South Reference Location**	**Historical Trend (2017-2021)**		
			Site ID	**LWQ1**	**LWQ2**	**LWQ2 (duplicate)**	**LWQ5**	**LWQ7**	**LWQ8**	**Range (min-max)**	**# of observations (*n*)**	**# of exceedances, if applicable**
Parameter	**Unit**	**Screening Criteria (source)**	**Date (2021)**									
Field Observations												
Specific Conductivity	µS/cm	NV	09-Jun	-	-	-	-	-	-	175-615	29	n/a
pH	-	6.5-8.5 (a)	09-Jun	***8.58***	8.42	8.42	***8.59***	***8.69***	***8.63***	7.48-8.84	46	6
Temperature	°C	NV	09-Jun	21.9	21.1	21.1	21.0	15.2	15.5	1.8-31.0	46	n/a
Dissolved Oxygen (DO)	mg/L	6 (a,e)	09-Jun	9.2	8.6	8.6	10.0	10.8	11.0	6.7-19.0	41	0
General Chemistry												
Total Ammonia-N	µg/L	NV	09-Jun	<50	<50	<50	<50	56	<50	<10-910	65	n/a
			15-Aug	16	12	-	12	<10	18			
Un-ionized ammonia (NH_3-N)	µg/L	15.6 (b,f)	09-Jun	<7.4	<5.1	<5.1	<7.1	6.7	<5.4	<0.9-305.0	65	8
			15-Aug	3.0	2.1	-	1.7	<0.9	1.8			
Total Phosphorous (TP)	µg/L	20 (a)	09-Jun	<20	<20	<20	<20	<20	<20	3.3-28.0	60	3
Total Dissolved Solids (TDS)	mg/L	NV	09-Jun	90	85	80	95	70	75	30-216	57	n/a
Hardness ($CaCO_3$)	mg/L	NV	09-Jun	94	94	94	96	94	96	90-99	47	n/a
Total Suspended Solids (TSS)	mg/L	NV	09-Jun	<10	<10	<10	<10	<10	<10	<1-<10	60	n/a
Alkalinity (Total as $CaCO_3$)	mg/L	NV	09-Jun	81	78	80	79	80	82	78-87	57	n/a
Nitrite (NO_2^--N)	µg/L	60 (b)	09-Jun	<10	<10	<10	<10	<10	<10	<10-<50	60	0
Chloride (Cl)	mg/L	120 (b)	09-Jun	7.6	7.7	7.8	7.9	7.7	7.6	6.5-9.0	57	0
Nitrate (NO_3^--N)	mg/L	2.93 (b)	09-Jun	0.24	0.24	0.24	0.21	0.20	0.21	0.19-0.81	57	0
Sulphate (SO_4^{2-})	mg/L	NV	09-Jun	16	20	17	19	16	16	13-20	57	n/a
Fluoride (F^-)	µg/L	120 (b)	09-Jun	<100	<100	<100	<100	110	<100	<100-150	57	2
Metals												
Total Aluminum (Al)	µg/L	*Varies*	09-Jun	16	18	17	17	18	15	<5-62	60	0
Aluminum PWQO	µg/L	*Calculated on a per sample basis using pH measured at time of sampling event.*		*75*	*75*	*75*	*75*	*75*	*75*			
Aluminum CWQG	µg/L			*100*	*100*	*100*	*100*	*100*	*100*			
Minimum Al guideline	µg/L			*75*	*75*	*75*	*75*	*75*	*75*			
Total Arsenic (As)	µg/L	5 (a,b)	09-Jun	<1	<1	<1	<1	<1	<1	0.53-<1	60	0
Total Boron (B)	µg/L	200 (a)	09-Jun	21	16	12	16	11	11	11-21	60	0
Total Cadmium (Cd)	µg/L	*Varies*	09-Jun	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.005-<0.10	60	0
Cadmium PWQO	µg/L	*Calculated on a per sample basis using hardness measured at time of sampling event.*		*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*			
Cadmium CWQG	µg/L			*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*			
Minimum Cd guideline	µg/L			*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*			
Total Chromium (Cr)	µg/L	50 (c,d)	09-Jun	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<0.5-<5.0	60	0
Chromium III (Cr^{3+})	µg/L	8.9 (a,b)	09-Jun	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5-<5	6	0

			Location	Bruce A Discharge	Bruce B Discharge	Bruce B Discharge	Baie du Doré	North Reference Location	South Reference Location	Historical Trend (2017-2021)		
			Site ID	LWQ1	LWQ2	LWQ2 (duplicate)	LWQ5	LWQ7	LWQ8	Range (min-max)	# of observations (*n*)	# of exceedances, if applicable
Parameter	**Unit**	**Screening Criteria (source)**	**Date (2021)**									
Chromium VI (Cr^{6+})	µg/L	1 (a,b)	09-Jun	<0.99	<0.99	<0.99	<0.99	<0.99	<0.99	<0.5-<0.99	57	0
Total Copper (Cu)	µg/L	*Varies*	09-Jun	1.5	2.1	1.3	1.3	<0.9	<0.9	<0.9-2.1	60	0
Copper PWQO	µg/L	*Calculated on a per sample*		*5*	*5*	*5*	*5*	*5*	*5*			
Copper CWQG	µg/L	*basis using hardness*		*2.24*	*2.24*	*2.24*	*2.28*	*2.24*	*2.28*			
Minimum Cu guideline	µg/L	*measured at time of sampling event.*		*2.24*	*2.24*	*2.24*	*2.28*	*2.24*	*2.28*			
Total Iron (Fe)	µg/L	300 (c,d)	09-Jun	<100	<100	<100	<100	<100	<100	<10-<100	60	0
Total Lead (Pb)	µg/L	*Varies*	09-Jun	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.05-0.71	60	0
Lead PWQO	µg/L	*Calculated on a per sample*		*5*	*5*	*5*	*5*	*5*	*5*			
Lead CWQG	µg/L	*basis using hardness*		*2.94*	*2.94*	*2.94*	*3.02*	*2.94*	*3.02*			
Minimum Pb guideline	µg/L	*measured at time of sampling event.*		*2.94*	*2.94*	*2.94*	*3.02*	*2.94*	*3.02*			
Total Mercury (Hg)	µg/L	0.026 (b)	09-Jun	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.005-<0.1	60	0
Total Nickel (Ni)	µg/L	*Varies*	09-Jun	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.5-6.8	60	0
Nickel PWQO	µg/L	*Calculated on a per sample*		*25*	*25*	*25*	*25*	*25*	*25*			
Nickel CWQG	µg/L	*basis using hardness*		*91.19*	*91.19*	*91.19*	*92.66*	*91.19*	*92.66*			
Minimum Ni guideline	µg/L	*measured at time of sampling event.*		*25*	*25*	*25*	*25*	*25*	*25*			
Total Zinc (Zn)	µg/L	*Varies*	09-Jun	***27.0***	***16.0***	**130.0**	***9.3***	6.4	***21.0***	<0.2-130.0	60	6
Zinc PWQO	µg/L	*Calculated on a per sample*		*30*	*30*	*30*	*30*	*30*	*30*			
Zinc CWQG	µg/L	*basis using hardness, pH*		*8.94*	*10.18*	*10.18*	*9.04*	*8.17*	*8.75*			
Minimum Zn guideline	µg/L	*and DOC measured at time of sampling event.*		*8.94*	*10.18*	*10.18*	*9.04*	*8.17*	*8.75*			
Petroleum Hydrocarbons												
F1 (C6-C10)	µg/L	NV	09-Jun	<25	<25	<25	<25	<25	<25	<25-<25	57	n/a
F1 (C6-C10) - BTEX	µg/L	NV	09-Jun	<25	<25	<25	<25	<25	<25	<25-<25	57	n/a
F2 (C10-C16 Hydrocarbons)	µg/L	NV	09-Jun	<100	<100	<100	<100	<100	<100	<100-<100	57	n/a
F3 (C16-C34 Hydrocarbons)	µg/L	NV	09-Jun	<200	<200	<200	<200	<200	<200	<200-<200	57	n/a
F4 (C34-C50 Hydrocarbons)	µg/L	NV	09-Jun	<200	<200	<200	<200	<200	<200	<200-<200	57	n/a
Reached Baseline at C50	-	NV	09-Jun	Yes	Yes	Yes	Yes	Yes	Yes	Yes-Yes	57	n/a
BTEX												
Benzene	µg/L	1 (c)	09-Jun	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20-<0.20	57	0
Ethylbenzene	µg/L	8 (a)	09-Jun	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20-<0.20	57	0
o-Xylene	µg/L	NV	09-Jun	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20-<0.20	57	0
p+m-Xylene	µg/L	NV	09-Jun	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40-<0.40	57	0
Toluene	µg/L	0.8 (a)	09-Jun	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20-<0.20	57	0
Xylene (Total)	µg/L	2 (a)	09-Jun	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40-<0.40	57	0

			Location	Bruce A Discharge	Bruce B Discharge	Bruce B Discharge	Baie du Doré	North Reference Location	South Reference Location	Historical Trend (2017-2021)		
			Site ID	LWQ1	LWQ2	LWQ2 (duplicate)	LWQ5	LWQ7	LWQ8	Range (min-max)	# of observations (*n*)	# of exceedances, if applicable
Parameter	**Unit**	**Screening Criteria (source)**	**Date (2021)**									
Other												
Morpholine	µg/L	4 (a)	09-Jun	<4	<4	<4	<4	<4	<4	<4-<4	52	0
Hydrazine	µg/L	26 (g)	09-Jun	<3.14	<3.14	<3.14	<3.14	<3.14	<3.14	<0.2-<0.5	50	0
			11-Jul	<3.14	<3.14	<3.14	<3.14	<3.14	<3.14			
Phenol	µg/L	1 (a)	09-Jun	<1	<1	<1	<1	<1	<1	<1-<1	6	0

NV – no value. No screening criteria are available to assess risk to receptors; often because the parameter is not associated with acute or chronic toxicity.

(a) Provincial Water Quality Objective (PWQO) established by the Ontario MECP.

(b) Canadian Council of Ministers of the Environment (CCME), freshwater, long-term water quality guideline for the protection of aquatic life.

(c) Ontario Drinking Water Standards (ODWS), O.Reg. 169/03.

(d) Health Canada Guidelines for Canadian Drinking Water Quality (GCDWQ).

(e) dissolved oxygen is temperature dependent. A temperature of 15°C was considered to derive the PWQO guideline of 6 mg/L.

(f) un-ionized ammonia (NH_3) is calculated from measurements of total ammonia (NH_3 + NH_4^+), temperature and pH according to [R-118]. Ammonia concentrations reported in mg/L NH_3 units were converted to mg/L NH_3-N units by multiplying by 0.82247.

(g) Notice requiring the preparation and implementation of pollution prevention plans in respect of hydrazine related to the electricity sector, https://canadagazette.gc.ca/rp-pr/p1/2018/2018-11-10/html/sup1-eng.html.

Bold & Italics – result exceeded the most stringent screening criteria established but did not exceed an alternate published threshold that is also considered protective of aquatic life. E.g., some pH values were greater than 8.5 – the upper range of pH documented in the PWQOs. However, these results did not exceed pH 9.0 – the upper range of the long-term water quality guideline published by the CCME, which was developed to protect aquatic organisms from chronic effects.

Bold – result exceeded the most stringent screening criteria available. When multiple published screening criteria exist, the result exceeded two or more of the thresholds.

6.2.1.2 Water Quality in Stream C and On-site Drainage Features

Surface water quality samples were taken at several locations across the Bruce Power site in 2021, including the long-term monitoring locations in ‘Stream C’ (Figure 54). Stream C is a small stream that originates off-site (headwaters on the Nipissing Bluff just east of site), flows through site including Hydro One and OPG lands, and discharges to Baie du Doré. Two long-term monitoring locations exist in Stream C; one at the upstream boundary of the facility (SW1), and one at a downstream location near the discharge to Lake Huron (SW2). Additional on-site surface water monitoring locations (SW3-SW6) were sampled throughout the year in the spring, summer, and fall of 2021. Sampling at SW4-SW6 was contingent upon sufficient flow, which is restrictive during summer months when base-flow conditions are low. Additional samples were taken from the pond adjacent building B31 and the former OPG Construction Landfill #4 (historically referred to as ‘Ornamental Pond’). Samples were also taken from the pond beside B16 and from the pond at the ‘Former Sewage Lagoon’. One sample taken by OPG in 2020 for their WWMF ERA (‘Stream C Confluence’) is shown for reference only and was not sampled by Bruce Power in 2021 (Figure 54).

The results of these water quality analyses are presented in Table 37 - The results of surface water quality samples taken in 2021 from Stream C and on-site drainage features. The range and number of measurements taken between 2017 and 2021 are shown for context. Screening criteria chosen are the most conservative available alongside the historical trend observed between 2017 - 2021. Additional results collected from these locations between 2017 - 2020 are presented in the 2022 ERA. The 2017-2020 data and those collected in 2021 (Table 37) are comprehensively assessed in the 2022 ERA, including a discussion of any exceedances of the screening criteria and characterization of the risk to potential receptors.

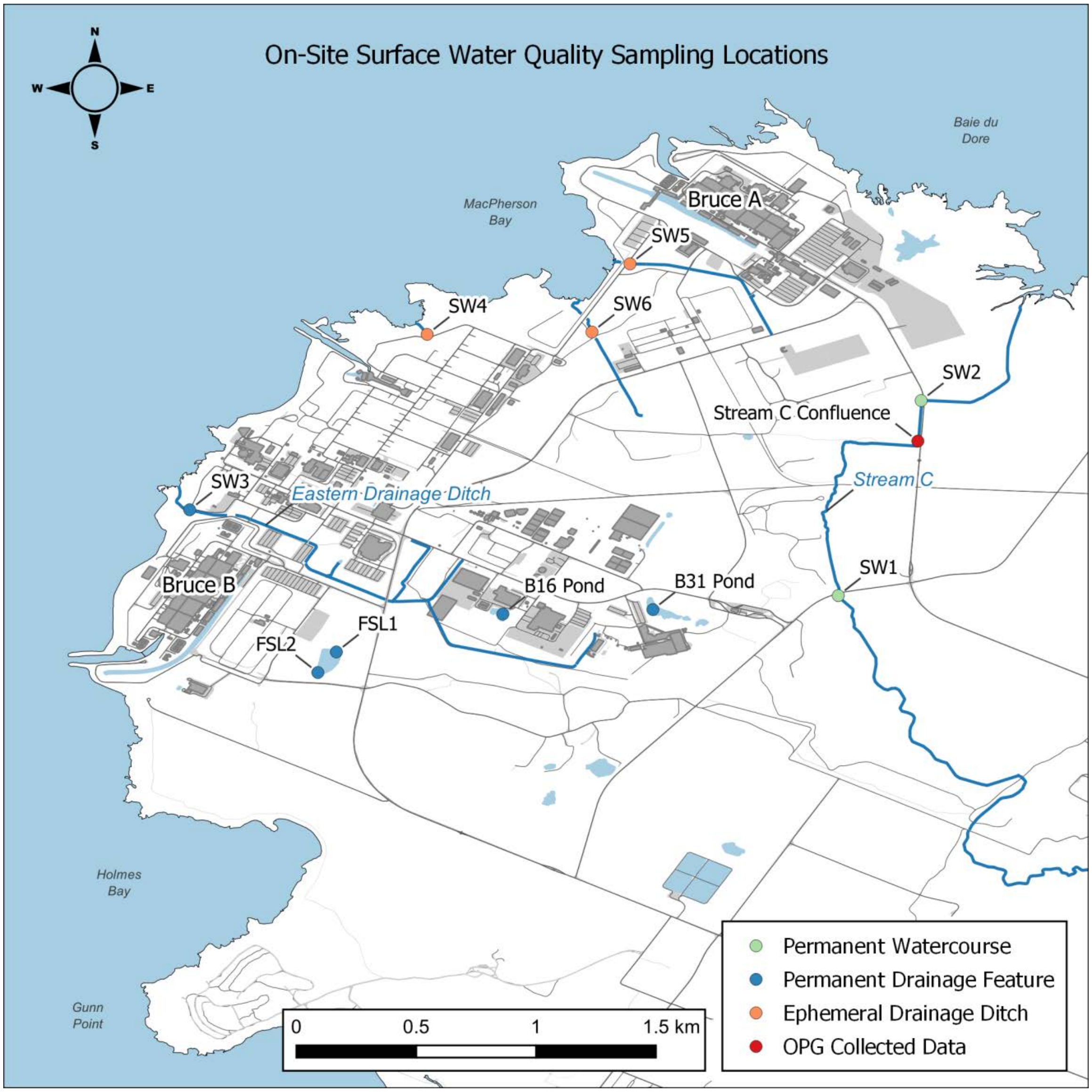


Figure 54 - Water quality monitoring locations sampled in 2021 from Stream C and on-site drainage features. The OPG sampling station 'Stream C Confluence' is shown here for reference only and was not sampled in 2021 by Bruce Power.

Table 37 - The results of surface water quality samples taken in 2021 from Stream C and on-site drainage features. The range and number of measurements taken between 2017 and 2021 are shown for context. Screening criteria chosen are the most conservative available

		Location	**Stream C – Upstream (Background)**			**Stream C – Downstream**			**Eastern Drainage Ditch**		**B31 Pond**	**B16 Pond**	**Former Sewage Lagoon**		**Heavy Water Lands Drainage Ditch**			**Drainage Ditch S. of BA**	**Drainage Ditch S. of BA Switchyard**	**Historical Trend (2017-2021)**		
		Site ID	**SW1**			**SW2**			**SW3**		**B31-Pond**	**B16-Pond**	**FSL-1**	**FSL-2**	**SW4**			**SW5**	**SW6**			
		Sample Date (2021)																				
Parameter	**Unit**	**Screening Criteria (source)**	**12-Mar**	**22-Jul**	**17-Nov**	**12-Mar**	**22-Jul**	**17-Nov**	**22-Jul**	**17-Nov**	**22-Jul**	**22-Jul**	**22-Jul**	**22-Jul**	**12-Mar**	**22-Jul**	**17-Nov**	**17-Nov**	**17-Nov**	**Range (min-max)**	**# of observations (*n*)**	**# of exceedances, if applicable**
Field Observations																						
Specific Conductivity	µS/cm	NV	-	573	635	-	641	800	1675	1563	492	1040	111	111	-	1243	1278	883	774	111-1675	24	n/a
pH	-	6.5-8.5 (a)	8.11	8.33	8.16	8.10	7.80	7.61	8.30	8.10	7.73	7.64	**9.54**	9.54	8.35	8.40	8.01	7.84	7.84	6.65-9.54	40	2
Temperature	°C	NV	-	19.0	4.1	-	20.1	4.7	21.1	6.6	23.3	22.9	23.0	23.0	-	21.4	5.5	5.3	6.3	-0.2-23.3	24	n/a
Dissolved Oxygen (DO)	mg/L	6 (a,e)	-	7.8	11.5	-	8.1	10.4	6.1	8.2	**5.6**	**4.3**	7.9	7.9	-	8.9	8.8	11.2	11.1	4.3-15.5	27	4
General Chemistry																						
Total Ammonia-N	µg/L	n/a	<100	22000	108	<100	12000	119	300	224	99	<61	<61	62	<100	30000	95	375	476	<50-30000	30	n/a
Un-ionized ammonia (NH_3-N)	µg/L	15.6 (b,f)	<1.1	**1608**	1.8	<1.0	**296**	0.6	**23.7**	3.9	0.8	<1.3	**<38.5**	0.5	<1.8	**2971**	1.3	3.3	4.5	<1.0-2971	30	5
Total Phosphorous (TP)	µg/L	20 (a)	**80**	**26**	**53.1**	**60**	**27**	19.7	<20	6.7	**74**	**28**	**230**	**220**	**<30**	<20	8.9	7.7	<3	<3-230	40	14
Total Dissolved Solids (TDS)	mg/L	NV	206	285	238	169	285	264	790	514	200	485	70	70	691	525	429	308	311	70-790	33	n/a
Hardness ($CaCO_3$)	mg/L	NV	160	280	202	149	270	224	230	230	80	160	58	53	312	200	207	200	265	53-322	30	n/a
Dissolved Organic Carbon (DOC)	mg/L	NV	-	-	7.33	-	-	6.93	-	6.49	-	-	-	-	-	-	2.77	5.04	4.34	2.8-7.3	6	n/a
Total Suspended Solids (TSS)	mg/L	NV	25	<10	4.5	11	<10	4.2	<10	<3.0	10	<10	35	43	2	<10	4.1	<3.0	3.7	1.0-43.0	43	n/a
Alkalinity (Total as $CaCO_3$)	mg/L	NV	124	290	198	122	280	219	230	237	63	140	59	57	173	200	196	178	246	57-290	33	n/a

		Location	Stream C – Upstream (Background)			Stream C – Downstream			Eastern Drainage Ditch		B31 Pond	B16 Pond	Former Sewage Lagoon		Heavy Water Lands Drainage Ditch			Drainage Ditch S. of BA	Drainage Ditch S. of BA Switchyard	Historical Trend (2017-2021)		
		Site ID	SW1			SW2			SW3		B31-Pond	B16-Pond	FSL-1	FSL-2	SW4			SW5	SW6			
		Sample Date (2021)																				
Parameter	Unit	Screening Criteria (source)	12-Mar	22-Jul	17-Nov	12-Mar	22-Jul	17-Nov	22-Jul	17-Nov	22-Jul	22-Jul	22-Jul	22-Jul	12-Mar	22-Jul	17-Nov	17-Nov	17-Nov	Range (min-max)	# of observations (*n*)	# of exceedances, if applicable
Nitrite (NO_2^--N)	µg/L	60 (b)	<30	<10	<10	<30	<10	<10	<10	<10	<10	<10	<10	<10	<30	<10	<10	<10	<10	<10-<30	30	0
Chloride (Cl)	mg/L	120 (b)	-	16	12.5	-	38	19.4	**360**	**164**	96	**210**	2.6	1.8		**220**	**125**	62.8	25.1	1.8-360	23	5
Nitrate (NO_3^--N)	mg/L	2.93 (b)	0.61	<0.1	0.32	0.46	0.16	0.19	<0.1	0.18	<0.1	<0.1	<0.1	<0.1	0.33	0.21	0.225	0.156	0.091	<0.03-0.63	30	0
Sulphate (SO_4^{2-})	mg/L	NV	-	<1.0	4.96	-	<1.0	5.68	19.00	9.48	8.40	17.00	<1.0	<1.0		30	21.7	18.3	15.3	<1-30	23	n/a
Fluoride (F^-)	µg/L	120 (b)	**210**	**350**	**170**	**150**	**370**	**220**	**660**	**480**	**370**	**380**	**430**	**410**	**990**	**1300**	**1080**	**539**	**824**	150-1300	30	30
Metals																						
Total Aluminum (Al)	µg/L	*Varies Calculated on a per sample basis using pH measured at time of sampling event.*	**1630**	18	**1010**	**1540**	8	**502**	13	***90.1***	**210**	7.3	86	98	66	44	**194**	**175**	23	7.3-1630	43	17
Aluminum PWQO	µg/L		75	75	75	75	75	75	75	75	75	75	-	-	75	75	75	75	75			
Aluminum CWQG	µg/L		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100			
Minimum Al guideline	µg/L		75	75	75	75	75	75	75	75	75	75	100	100	75	75	75	75	75			
Total Antimony (Sb)	µg/L	6 (c,d)	-	<0.50	<0.1	-	<0.50	<0.1	<0.50	0.14	<0.50	<0.50	<0.50	<0.50		<0.50	0.28	0.13	0.13	<0.1-<0.5	36	0
Total Arsenic (As)	µg/L	5 (a,b)	-	<1.0	0.43	-	<1.0	0.37	<1.0	0.30	<1.0	<1.0	<1.0	<1.0		<1.0	0.3	0.27	0.24	0.17-0.80	36	0
Total Barium (Ba)	µg/L	1000 (c)	19.6	17.0	16.2	18.4	16.0	14.9	51.0	32.1	12.0	19.0	21.0	22.0	57.4	52	40.1	35.2	27.7	1.6-80.0	43	0
Total Boron (B)	µg/L	200 (a)	-	15	13	-	21	14	45	22	63	19	12	10		110	135	12	12	<10-135	36	0
Total Cadmium (Cd)	µg/L	*Varies Calculated on a per sample basis using hardness measured at time of sampling*	0.02	<0.09	0.01	0.02	<0.09	0.01	<0.09	0.01	<0.09	<0.09	<0.09	<0.09	0.01	<0.09	0.01	0.01	<0.005	<0.003-0.019	43	0
Cadmium PWQO	µg/L		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.10	0.50	0.10	0.10	0.50	0.50	0.50	0.50	0.50			
Cadmium CWQG	µg/L		0.23	0.37	0.28	0.22	0.36	0.31	0.32	0.32	0.13	0.23	0.10	0.09	0.37	0.28	0.29	0.28	0.36			
Minimum Cd	µg/L		0.23	0.37	0.28	0.22	0.36	0.31	0.32	0.32	0.10	0.23	0.10	0.09	0.37	0.28	0.29	0.28	0.36			

		Location	**Stream C – Upstream (Background)**			**Stream C – Downstream**			**Eastern Drainage Ditch**		**B31 Pond**	**B16 Pond**	**Former Sewage Lagoon**		**Heavy Water Lands Drainage Ditch**			**Drainage Ditch S. of BA**	**Drainage Ditch S. of BA Switchyard**	**Historical Trend (2017-2021)**		
		Site ID	**SW1**			**SW2**			**SW3**		**B31-Pond**	**B16-Pond**	**FSL-1**	**FSL-2**	**SW4**			**SW5**	**SW6**			
		Sample Date (2021)																				
Parameter	**Unit**	**Screening Criteria (source)**	**12-Mar**	**22-Jul**	**17-Nov**	**12-Mar**	**22-Jul**	**17-Nov**	**22-Jul**	**17-Nov**	**22-Jul**	**22-Jul**	**22-Jul**	**22-Jul**	**12-Mar**	**22-Jul**	**17-Nov**	**17-Nov**	**17-Nov**	**Range (min-max)**	**# of observations (*n*)**	**# of exceedances, if applicable**
guideline		*event.*																				
Total Chromium (Cr)	µg/L	50 (c,d)	2.4	<5.0	1.60	2.2	<5.0	0.80	<5.0	<0.50	<5.0	<5.0	<5.0	<5.0	0.8	<5.0	0.89	0.53	<0.50	<0.5-25.0	43	0
Chromium III (Cr^{3+})	µg/L	8.9 (a,b)	2.4	<5.0	1.60	2.2	<5.0	<1.00	<5.0	<1.00	<5.0	<5.0	<5.0	<5.0	0.4	<5.0	<1.00	<1.00	<1.00	<1-11.2	33	1
Chromium VI (Cr^{6+})	µg/L	1 (a,b)	<0.2	<0.5	<0.5	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.4	0.52	<0.5	<0.5	<0.5	0.3-0.5	33	0
Total Copper (Cu)	µg/L	*Varies Calculated on a per sample basis using hardness measured at time of sampling event.*	2.4	<0.9	1.4	1.8	1.1	<0.001	2.4	1.2	***4.8***	<0.9	***2.8***	1.4	1.2	1.6	1.2	1.5	<0.001	<0.001-8.9	43	3
Copper PWQO	µg/L		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5			
Copper CWQG	µg/L		3.53	4.00	4.00	3.32	4.00	4.00	4.00	4.00	2.00	3.53	2.00	2.00	4.00	4.00	4.00	4.00	4.00			
Minimum Cu guideline	µg/L		3.53	4.00	4.00	3.32	4.00	4.00	4.00	4.00	2.00	3.53	2.00	2.00	4.00	4.00	4.00	4.00	4.00			
Total Iron (Fe)	µg/L	300 (c,d)	**1300**	**870**	**1150**	**1360**	<100	**479**	<100	129	**310**	**370**	150	150	64	120	205	184	30	30-1360	43	15
Total Lead (Pb)	µg/L	*Varies Calculated on a per sample basis using hardness measured at time of sampling event.*	0.68	<0.50	0.40	0.59	<0.50	0.21	<0.50	0.09	<0.50	<0.50	<0.50	<0.50	0.10	<0.50	0.25	0.16	<0.005	<0.005-1.00	43	0
Lead PWQO	µg/L		5	5	5	5	5	5	5	5	3	5	3	3	5	5	5	5	5			
Lead CWQG	µg/L		5.79	7.00	7.00	5.29	7.00	7.00	7.00	7.00	2.39	5.79	1.00	1.00	7.00	7.00	7.00	7.00	7.00			
Minimum Pb guideline	µg/L		5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	2.39	5.00	1.00	1.00	5.00	5.00	5.00	5.00	5.00			
Total Mercury (Hg)	µg/L	0.026 (b)	<0.01	<0.10	<0.005	<0.01	<0.10	<0.005	<0.10	<0.005	<0.10	<0.10	<0.10	<0.10	<0.01	<0.10	<0.005	<0.005	<0.005	<0.005-<0.01	43	0
Total Molybdenum (Mo)	µg/L	40 (a)	0.28	<0.50	0.229	0.21	<0.50	0.322	1.20	0.877	0.62	<0.50	<0.50	0.55	4.06	4.1	3.680	0.972	1.150	0.20-6.00	43	0
Total Nickel (Ni)	µg/L	*Varies*	1.9	<1.0	1.45	1.8	<1.0	0.85	1.3	1.06	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	0.94	0.85	0.55	0.3-4.0	43	0

		Location	Stream C – Upstream (Background)			Stream C – Downstream			Eastern Drainage Ditch		B31 Pond	B16 Pond	Former Sewage Lagoon		Heavy Water Lands Drainage Ditch			Drainage Ditch S. of BA	Drainage Ditch S. of BA Switchyard	Historical Trend (2017-2021)		
		Site ID	**SW1**			**SW2**			**SW3**		**B31-Pond**	**B16-Pond**	**FSL-1**	**FSL-2**	**SW4**			**SW5**	**SW6**			
		Sample Date (2021)																				
Parameter	**Unit**	**Screening Criteria (source)**	**12-Mar**	**22-Jul**	**17-Nov**	**12-Mar**	**22-Jul**	**17-Nov**	**22-Jul**	**17-Nov**	**22-Jul**	**22-Jul**	**22-Jul**	**22-Jul**	**12-Mar**	**22-Jul**	**17-Nov**	**17-Nov**	**17-Nov**	**Range (min-max)**	**# of observations (*n*)**	**# of exceedances, if applicable**
Nickel PWQO	µg/L	*Calculated on a per sample basis using hardness measured at time of sampling event.*	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25			
Nickel CWQG	µg/L		136.61	150.00	150.00	129.41	150.00	150.00	150.00	150.00	80.67	136.61	25.00	25.00	150.00	150.00	150.00	150.00	150.00			
Minimum Ni guideline	µg/L		25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00			
Total Selenium (Se)	µg/L	1 (b)	-	<2.0	0.104	-	<2.0	0.109	<2.0	0.140	<2.0	<2.0	<2.0	<2.0		<2.0	0.630	0.125	0.170	0.104-3.0	36	2
Total Uranium (U)	µg/L	5 (a)	0.35	0.21	0.425	0.25	0.47	0.596	1.20	1.080	0.31	0.14	0.15	0.14	4.00	3.50	4.010	0.912	1.420	0.140-4.010	43	0
Total Vanadium (V)	µg/L	6 (a)	2.72	<0.50	1.75	2.47	<0.50	1.01	**7.30**	**20.50**	1.30	<0.50	0.50	0.53	0.53	0.83	0.80	0.63	<0.5	0.20-20.50	43	3
Total Zinc (Zn)	µg/L	*Varies*	6.0	<5.0	4.3	7.0	14.0	<3.0	16.0	14.0	12.0	<5.0	***8.7***	<5.0	10.0	7.1	11.5	24.4	11.4	<2-45.0	43	5
Zinc PWQO	µg/L	*Calculated on a per sample basis using hardness, pH and DOC measured at time of sampling event.*	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30			
Zinc CWQG	µg/L		21.69	30.80	25.97	20.44	45.84	44.84	26.20	30.84	15.34	31.82	2.59	2.38	33.58	21.16	30.04	33.39	43.59			
Minimum Zn guideline	µg/L		21.69	30.00	25.97	20.44	30.00	30.00	26.20	30.00	15.34	30.00	2.59	2.38	30.00	21.16	30.00	30.00	30.00			
Petroleum Hydrocarbons																						
F1 (C6-C10)	µg/L	NV	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<20-<25	40	n/a
F1 (C6-C10) - BTEX	µg/L	NV	-	<25	<25	-	<25	<25	<25	<25	<25	<25	<25	<25	-	<25	<25	<25	<25	<25-<25	23	n/a
F2 (C10-C16 Hydrocarbons)	µg/L	NV	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100-<100	40	n/a
F3 (C16-C34	µg/L	NV	<200	<200	<250	<200	<200	<250	<200	<250	<200	<200	200	<200	<200	<20	<25	<250	<250	<100-	40	n/a

		Location	Stream C – Upstream (Background)			Stream C – Downstream			Eastern Drainage Ditch		B31 Pond	B16 Pond	Former Sewage Lagoon		Heavy Water Lands Drainage Ditch			Drainage Ditch S. of BA	Drainage Ditch S. of BA Switchyard	Historical Trend (2017-2021)		
		Site ID	SW1			SW2			SW3		B31-Pond	B16-Pond	FSL-1	FSL-2	SW4			SW5	SW6			
		Sample Date (2021)																				
Parameter	**Unit**	**Screening Criteria (source)**	**12-Mar**	**22-Jul**	**17-Nov**	**12-Mar**	**22-Jul**	**17-Nov**	**22-Jul**	**17-Nov**	**22-Jul**	**22-Jul**	**22-Jul**	**22-Jul**	**12-Mar**	**22-Jul**	**17-Nov**	**17-Nov**	**17-Nov**	**Range (min-max)**	**# of observations (*n*)**	**# of exceedances, if applicable**
Hydrocarbons)																0	0			<250		
F4 (C34-C50 Hydrocarbons)	µg/L	NV	<200	<200	<250	<200	<200	<250	<200	<250	<200	<200	<200	<200	<200	<200	<250	<250	<250	<100-<250	40	n/a
Reached Baseline at C50	-	NV	-	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes-Yes	23	n/a
BTEX																						
Benzene	µg/L	1 (c)	<0.5	<0.20	<0.50	<0.5	<0.20	<0.50	<0.20	<0.50	<0.20	<0.20	<0.20	<0.20	<0.5	<0.20	<0.50	<0.50	<0.50	<0.2-<0.5	30	0
Ethylbenzene	µg/L	8 (a)	<0.5	<0.20	<0.50	<0.5	<0.20	<0.50	<0.20	<0.50	<0.20	<0.20	<0.20	<0.20	<0.5	<0.20	<0.50	<0.50	<0.50	<0.2-<0.5	30	0
o-Xylene	µg/L	NV	<0.5	<0.20	<0.30	<0.5	<0.20	<0.30	<0.20	<0.30	<0.20	<0.20	<0.20	<0.20	<0.5	<0.20	<0.30	<0.30	<0.30	<0.2-<0.5	30	n/a
p+m-Xylene	µg/L	NV	<0.5	<0.40	<0.40	<0.5	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.5	<0.40	<0.40	<0.40	<0.40	<0.4-<0.5	30	n/a
Toluene	µg/L	0.8 (a)	<0.5	<0.20	<0.50	<0.5	<0.20	<0.50	<0.20	<0.50	<0.20	<0.20	0.32	0.35	<0.5	<0.20	<0.50	<0.50	<0.50	<0.4-<0.5	30	0
Xylene (Total)	µg/L	2 (a)	<0.5	<0.40	<0.50	<0.5	<0.40	<0.50	<0.40	<0.50	<0.40	<0.40	<0.40	<0.40	<0.5	<0.40	<0.50	<0.50	<0.50	<0.4-<0.5	30	0
Other																						
Phenol	µg/L	1 (a)	-	-	<1	-	-	<1	-	<1	-	-	-	-	-	-	<1	<1	<1	<1-<1	6	0

NV – no value. No screening criteria are available to assess risk to receptors; often because the parameter is not associated with acute or chronic toxicity.

(a) Provincial Water Quality Objective (PWQO) established by the Ontario MECP.

(b) Canadian Council of Ministers of the Environment (CCME), freshwater, long-term water quality guideline for the protection of aquatic life.

(c) Ontario Drinking Water Standards (ODWS), O.Reg. 169/03.

(d) Health Canada Guidelines for Canadian Drinking Water Quality (GCDWQ).

Location			Stream C – Upstream (Background)			Stream C – Downstream			Eastern Drainage Ditch		B31 Pond	B16 Pond	Former Sewage Lagoon		Heavy Water Lands Drainage Ditch			Drainage Ditch S. of BA	Drainage Ditch S. of BA Switchyard	Historical Trend (2017-2021)		
Site ID			SW1			SW2			SW3		B31-Pond	B16-Pond	FSL-1	FSL-2	SW4			SW5	SW6			
Sample Date (2021)																						
Parameter	**Unit**	**Screening Criteria (source)**	**12-Mar**	**22-Jul**	**17-Nov**	**12-Mar**	**22-Jul**	**17-Nov**	**22-Jul**	**17-Nov**	**22-Jul**	**22-Jul**	**22-Jul**	**22-Jul**	**12-Mar**	**22-Jul**	**17-Nov**	**17-Nov**	**17-Nov**	**Range (min-max)**	**# of observations (*n*)**	**# of exceedances, if applicable**

(e) dissolved oxygen is temperature dependent. A temperature of 15°C was considered to derive the PWQO guideline of 6 mg/L.

(f) un-ionized ammonia (NH_3) is calculated from measurements of total ammonia ($NH_3 + NH_4^+$), temperature and pH according to [R-118]. Ammonia concentrations reported in mg/L NH_3 units were converted to mg/L NH_3-N units by multiplying by 0.82247.

(g) Notice requiring the preparation and implementation of pollution prevention plans in respect of hydrazine related to the electricity sector, https://canadagazette.gc.ca/rp-pr/p1/2018/2018-11-10/html/sup1-eng.html.

Bold & Italics – result exceeded the most stringent screening criteria established but did not exceed an alternate published threshold that is also considered protective of aquatic life. E.g., one aluminum value exceeded the PWQO (75 µg/L) but did not exceed the CCME CWQG (100 µg/L), which was developed to protect aquatic organisms from chronic effects.

Bold – result exceeded the most stringent screening criteria available. When multiple published screening criteria exist, the result exceeded two or more of the thresholds.

6.2.1.3 Sediment Sampling in Lake Huron, Stream C and On-site Drainage Features

Several sediment samples were taken in June and July 2021 from near-shore locations in Lake Huron (Figure 55) and on-site (Figure 56). All samples were collected from the upper sediment layers near the sediment-water interface. These data collected from lake, stream, drainage ditch and pond sediments are helpful to characterize the health of the aquatic features because sediments provide a long-term historical record of activity and impacts if they are present. Lake sediment samples were collected using a Ponar grab sampler. Samples of sediment from Stream C and the other drainage features were collected manually. A long-reach excavator was used to assist sampling of the Former Sewage Lagoon.

The results of these water quality analyses are presented in Figure 40**.** Additional results for Stream C sediments collected in 2017 and 2020 are presented in the 2022 ERA where the complete dataset is assessed, including a comprehensive discussion of any exceedances of the screening criteria and characterization of risk to receptors.

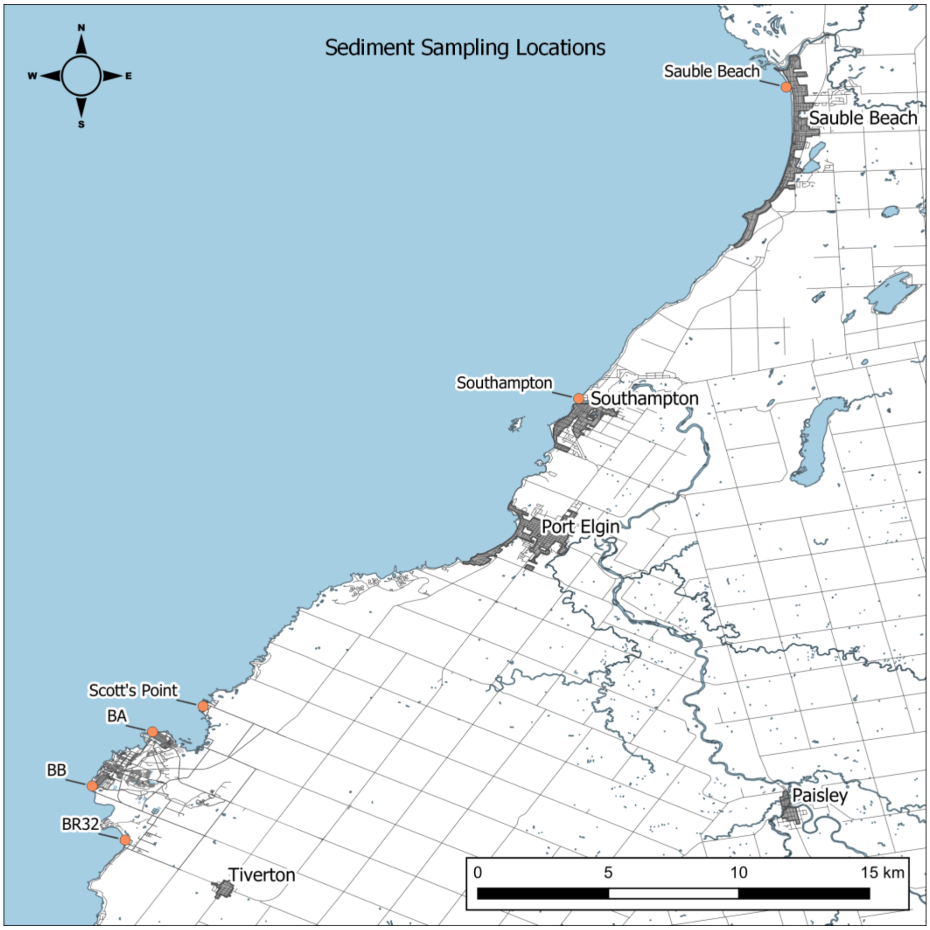


Figure 55 - The Locations of Sediment Samples Collected from the Lake Huron Nearshore in 2021

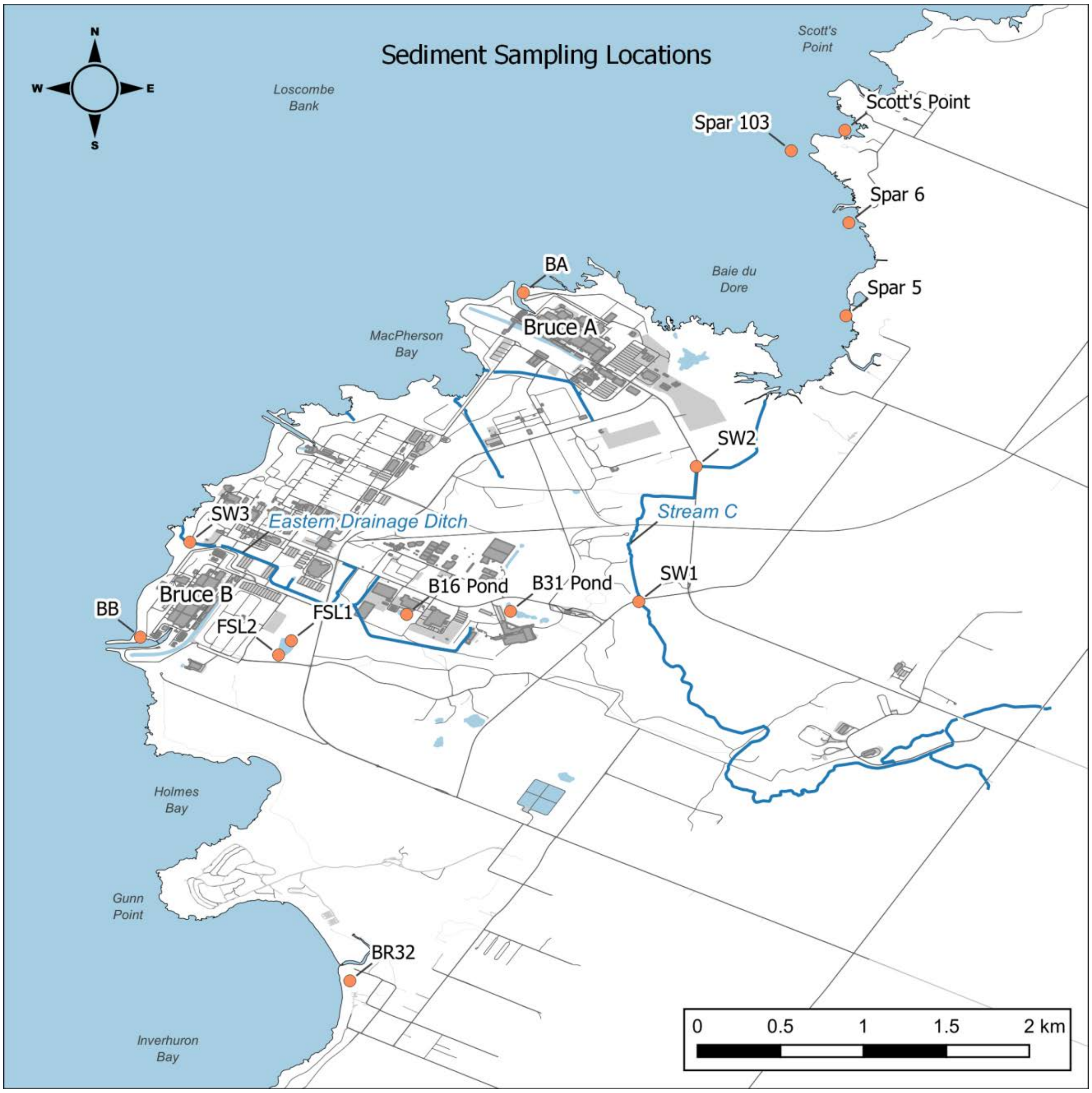


Figure 56 - The Locations of Sediment Samples Collected On-site and Off-site (nearby Bruce Power) in 2021

Table 38 - The results of sediment samples taken in 2021 from on-site and off-site locations. Screening criteria chosen are the most conservative available.

		Location	Sauble Beach	Southampton	Baie du Doré				Bruce A Discharge	Bruce B Discharge		Inverhuron	Stream C – Upstream (Background)	Stream C – Downstream	Eastern Drainage Ditch		Former Sewage Lagoon		B16 Pond	B31 Pond
		Site ID			Scott's Point	SPAR 103	SPAR 6	SPAR5	BA	BB	BB (duplicate)	BR32	SW1	SW2	SW3	SW3 (duplicate)	FSL1	FSL2		
		Sample Date (2021)																		
Parameter	Unit	Screening Criteria (source)	17-Jun	17-Jun	11-Jul	11-Jul	11-Jul	11-Jul	11-Jul	11-Jul	11-Jul	05-Jul	24-Jun	24-Jun	24-Jun	24-Jun	30-Jun	30-Jun	06-Jul	06-Jul
Metals																				
Aluminum (Al)	µg/g	26000 (e)	1200	1700	1500	1800	1600	1600	1600	1700	1800	1300	4000	2400	5500	-	22000	5800	2600	14000
Antimony (Sb)	µg/g	1.3 (d)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.29	-	**11**	<0.20	<0.20	0.59
Arsenic (As)	µg/g	5.9 (b)	1	1.5	<1.0	<1.0	1.1	<1.0	<1.0	<1.0	1.1	<1.0	1.9	1.8	3	-	3.3	1.7	1.2	2.5
Barium (Ba)	µg/g	220 (d)	3	6.5	7.7	7.4	4.2	5.7	5.6	6	7.6	3.7	35	12	60	-	57	23	9.7	62
Boron (B)	µg/g	36 (d)	<5.0	7.1	7.5	<5.0	<5.0	<5.0	<5.0	5.6	<5.0	<5.0	7.2	7	13	-	7.3	9.6	5.3	12
Cadmium (Cd)	µg/g	0.6 (a,b)	<0.10	<0.10	<0.10	0.15	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.16	<0.10	***0.74***	-	**2**	<0.10	<0.10	0.47
Chromium III (Cr^{3+})	µg/g	26 (a)	4	5	11	7	9	5	6	7	6	4	7	6	14	-	**37**	11	7	25
Chromium VI (Cr^{6+})	µg/g	0.7 (d)	<0.18	<0.18	<0.36	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	-	<0.18	<0.18	<0.18	<0.18
Total Chromium (Cr)	µg/g	26 (a)	3.7	5	11	6.7	8.7	5.1	6.2	7.1	6.4	3.9	7.4	5.7	14	-	**37**	11	6.6	25
Copper (Cu)	µg/g	12 (c)	0.63	2.6	2.7	3.4	1.7	1.8	4.1	3.2	4.3	1	7.2	8.2	**37**	-	**210**	***13***	5.2	**150**
Iron (Fe)	µg/g	34000 (e)	3000	5200	6000	5100	8100	4300	5400	5000	4600	2900	8400	8100	9200	-	9300	10000	6500	18000
Lead (Pb)	µg/g	27.7 (c)	1.1	1.9	2	2.2	1.6	1.1	2.4	1.6	1.8	<1.0	3.8	2.6	16	-	**50**	3.9	2.9	16
Mercury (Hg)	µg/g	0.17 (b)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.075	-	**0.61**	<0.050	<0.050	0.11
Molybdenum (Mo)	µg/g	8.3 (c)	<0.50	<0.50	1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	1.1	-	3	<0.50	<0.50	1.1
Nickel (Ni)	µg/g	16 (a)	2	3	7.8	4.9	4	3.6	4.3	4.9	4.8	2.8	5.6	5.2	***17***	-	***17***	8.4	5.1	**22**
Selenium (Se)	µg/g	0.9 (c)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	**1.1**	-	0.68	<0.50	<0.50	**1.0**
Silver (Si)	µg/g	0.5 (a)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	**4.4**	-	**54**	**0.86**	<0.20	<0.20
Uranium (U)	µg/g	32 (c)	0.23	0.34	0.31	0.33	0.36	0.27	0.49	0.39	0.36	0.19	0.45	0.49	1.4	-	1.8	0.49	0.38	1.6
Vanadium (V)	µg/g	27.3 (c)	<5.0	6	12	9.2	19	8.4	8.7	9.6	8	<5.0	12	9.6	**100**	-	17	14	9.8	27
Zinc (Zn)	µg/g	120 (a)	5.9	16	12	27	8	8.2	11	14	14	6.2	25	35	**390**	-	**310**	23	19	**360**
Petroleum Hydrocarbons																				
Benzene	µg/g	0.02 (d)	<0.020	<0.020	<0.040	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.040	<0.020	<0.20	<0.20	<0.060	<0.020	<0.040	<0.060
Toluene	µg/g	0.2 (d)	<0.020	<0.020	0.053	<0.020	<0.020	<0.020	<0.020	**0.59**	0.15	<0.020	<0.040	<0.020	**0.28**	**0.26**	0.13	<0.020	0.041	<0.060
Ethylbenzene	µg/g	0.05 (d)	<0.020	<0.020	<0.040	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.040	<0.020	<0.20	<0.20	<0.060	<0.020	<0.040	<0.060
Xylene (Total)	µg/g	0.05 (d)	<0.040	<0.040	<0.080	<0.040	<0.040	<0.040	<0.040	0.043	<0.040	<0.040	<0.080	<0.040	<0.40	<0.40	<0.12	<0.040	<0.080	<0.12
F1 (C6-C10)	µg/g	25 (d)	<10	<10	<20	<10	<10	<10	<10	<10	<10	<10	<20	<10	<100	<100	<30	<10	<20	<30
F1 (C6-C10) - BTEX	µg/g	25 (d)	<10	<10	<20	<10	<10	<10	<10	<10	<10	<10	<20	<10	<100	<100	<30	<10	<20	<30
F2 (C10-C16 Hydrocarbons)	µg/g	10 (d)	<10	<10	<20	<10	<10	<10	<10	<10	<20	<10	<20	<10	<70	-	<20	<10	<20	<30
F3 (C16-C34 Hydrocarbons)	µg/g	240 (d)	<50	<50	<100	74	<50	85	74	120	200	<50	<100	62	**500**	-	**1100**	<50	<100	<150
F4 (C34-C50 Hydrocarbons)	µg/g	120 (d)	<50	<50	<100	<50	<50	<50	<50	<50	<100	<50	<100	<50	<350	-	**230**	<50	<100	<150
Other																				
1-Methylnaphthalene	µg/g	NV	-	-	<0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2-	µg/g	0.0202	-	-	<0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Location			Sauble Beach	Southampton	Baie du Doré				Bruce A Discharge	Bruce B Discharge		Inverhuron	Stream C – Upstream (Background)	Stream C – Downstream	Eastern Drainage Ditch		Former Sewage Lagoon		B16 Pond	B31 Pond
Site ID					Scott's Point	SPAR 103	SPAR 6	SPAR5	BA	BB	BB (duplicate)	BR32	SW1	SW2	SW3	SW3 (duplicate)	FSL1	FSL2		
Sample Date (2021)			17-Jun	17-Jun	11-Jul	11-Jul	11-Jul	11-Jul	11-Jul	11-Jul	11-Jul	05-Jul	24-Jun	24-Jun	24-Jun	24-Jun	30-Jun	30-Jun	06-Jul	06-Jul
Parameter	Unit	Screening Criteria (source)																		
Methylnaphthalene		(b)																		

NV – no value. No screening criteria are available to assess risk to receptors; often because the parameter is not associated with acute or chronic toxicity.

(a) Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA. Table 1 Full Depth Background Site Condition Standards (SCS) for Sediment - All types of property use.

(b) Canadian Council of Ministers of the Environment (CCME), 2002. Interim Sediment Quality Guidelines (ISGQ) for the Protection of Aquatic Life, Freshwater.

(c) Thompson, P. A., Kurias, J., and Mihok, S., 2005. Derivation and Use of Sediment Quality Guidelines for Ecological Risk Assessment of Metals and Radionuclides Released to the Environment from Uranium Mining and Milling Activities in Canada. Environmental Monitoring and Assessment. 110: 71-85.

(d) Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA (MOE, 2011). Table 1 Full Depth Background Site Condition Standards: Soil: Industrial Property Use.

(e) Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, Ontario Ministry of environment and Energy, December 1993.

Bold & Italics – result exceeded the most stringent screening criteria established but did not exceed an alternate published threshold that is also considered protective of aquatic life.

Bold – result exceeded the most stringent screening criteria available. When multiple published screening criteria exist, the result exceeded two or more of the thresholds.

6.2.1.4 On-site Soil Sampling in 2021

Shallow soil samples (0-20 cm) were taken in 2021 at several on-site locations in order to re-assess potential impacts to receptor organisms. Six samples were taken from the Bruce A Storage Compound (BASC) on June 10, 2021 and samples were taken from 14 additional locations on Aug 31, 2021 (Figure 57). Five samples were taken on Bruce Power-managed lands between the former OPG landfill, 'Construction Landfill 4' (CL4) and the nearby pond (B31 Pond). Samples were also taken from 4 locations surrounding the Fire Training Facility (FTF) and from 1 location at the Former Sewage Lagoon (FSL) (Figure 58).

The results of these soil samples are presented in Table 39 and Table 40. Additional soil results collected since 2000 from these locations and several others are presented in the 2022 ERA where a comprehensive discussion and analysis of the complete dataset occurs, including disposition of any exceedances of the screening criteria and characterization of potential risk to receptors.

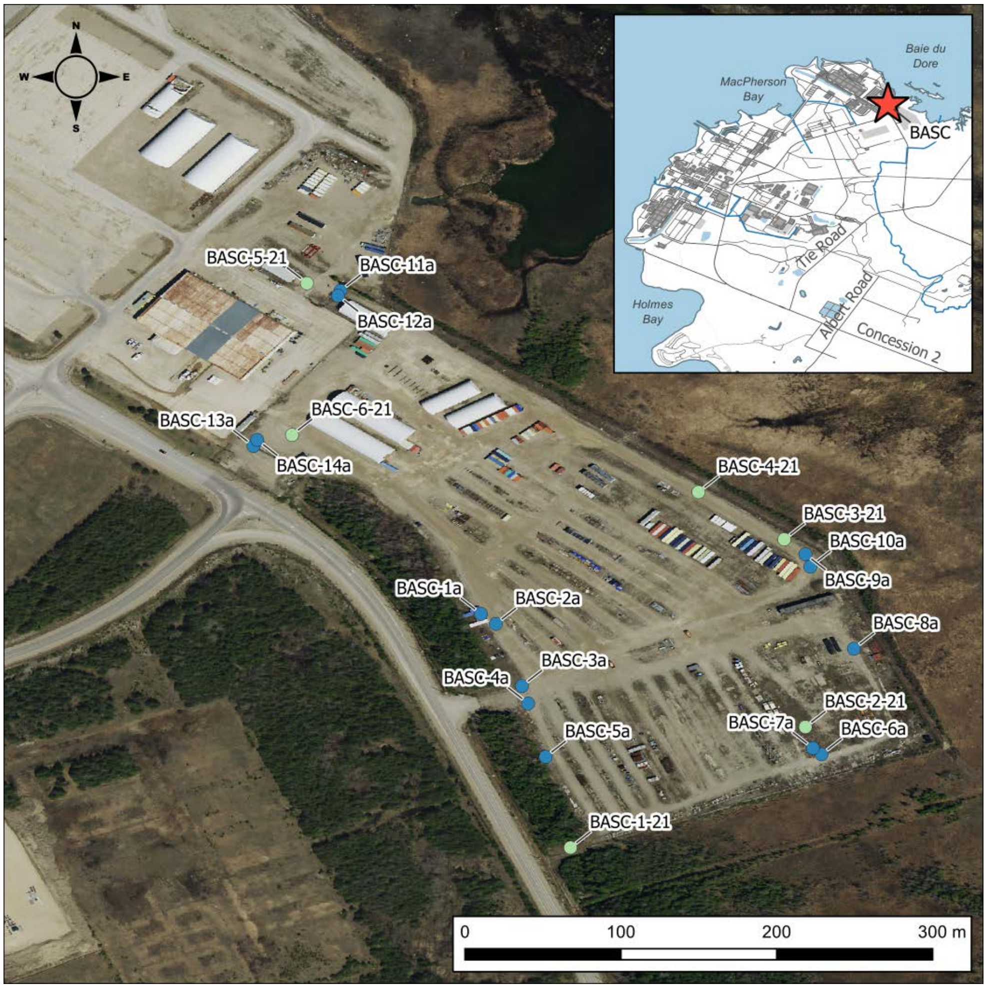


Figure 57 - The locations of Sediment Samples Collected from the Lake Huron Nearshore in 2021

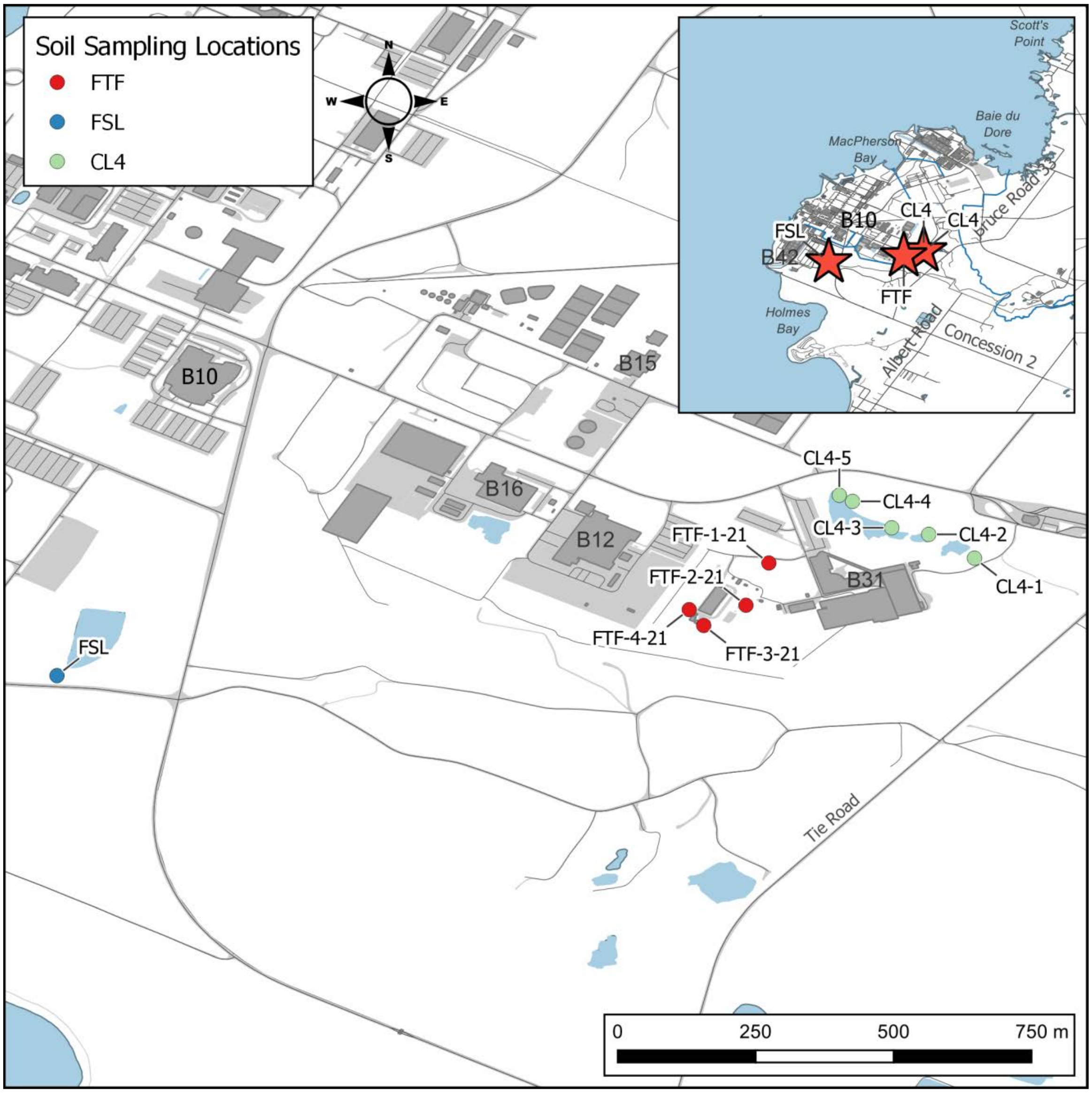


Figure 58 - The locations of sediment samples collected on-site and offsite (nearby Bruce Power) in 2021.

Table 39 – The Results of Shallow Soil Samples (0-20 cm) taken in 2021 from the Bruce A Storage Compound (BASC). Screening Criteria Chosen are the Most Conservative Available

		Sample Date (2021)	10-Jun						31-Aug														
		Site ID																					
Parameter	**Unit**	**Screening Criteria (source)**	**BASC-1**	**BASC-2**	**BASC-3**	**BASC-4**	**BASC-5**	**BASC-6**	**BASC 1a**	**BASC 2a**	**BASC 3a**	**BASC 4a**	**BASC 5a**	**BASC 6a**	**BASC 7a**	**BASC 8a**	**BASC 9a**	**BASC 10a**	**BASC 11a**	**BASC 12a**	**BASC 13a**	**BASC 14a**	**BASC 14a (dup)**
Metals																							
Aluminum (Al)	µg/g	26000 (c)	6400	3200	3000	2700	3100	2700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antimony (Sb)	µg/g	1.3 (a)	0.23	0.43	0.40	0.91	0.81	**4.0**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic (As)	µg/g	12 (b)	1.9	2.5	3.9	6.0	2.7	1.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barium (Ba)	µg/g	220 (a)	31	120	28	22	13	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron (B)	µg/g	36 (a)	13	11	8.2	8.0	7.2	5.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium (Cd)	µg/g	1.2 (a)	0.17	0.53	0.19	0.19	0.41	0.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium III (Cr^{3+})	µg/g	70 (a)	15	12	12	19	16	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium VI (Cr^{6+})	µg/g	0.66 (d)	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Chromium (Cr)	µg/g	70 (a)	15	12	12	19	16	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper (Cu)	µg/g	91 (b)	12	15	18	27	40	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron (Fe)	µg/g	34000 (c)	11000	10000	16000	27000	15000	9300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead (Pb)	µg/g	120 (a)	12	17	12	19	21	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mercury (Hg)	µg/g	0.27 (a)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum (Mo)	µg/g	2 (a)	<0.50	1.5	1.3	**2.2**	1.4	0.59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel (Ni)	µg/g	82 (a)	12	11	12	24	13	8.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium (Se)	µg/g	1.5 (a)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver (Si)	µg/g	0.5 (a)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium (U)	µg/g	2.5 (a)	0.49	1.9	0.82	0.78	0.53	0.37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium (V)	µg/g	86 (a)	20	12	13	16	13	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc (Zn)	µg/g	290 (a)	42	280	97	260	**490**	**520**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons																							
Benzene	µg/g	0.02 (a)	<0.040	<0.040	<0.020	<0.020	<0.020	<0.020	<0.0068	<0.0068	0.0069	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	***0.025***
Toluene	µg/g	0.2 (a)	<0.040	<0.040	<0.020	<0.020	<0.020	<0.020	<0.080	<0.080	0.09	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080
Ethylbenzene	µg/g	0.05 (a)	<0.040	<0.040	<0.020	<0.020	<0.020	<0.020	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	0.031
Xylene (Total)	µg/g	0.05 (a)	<0.080	<0.080	<0.040	<0.040	<0.040	<0.040	<0.050	<0.050	***0.094***	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
F1 (C6-C10)	µg/g	25 (a)	<20	<20	<10	<10	<10	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
F1 (C6-C10) - BTEX	µg/g	25 (a)	<20	<20	<10	<10	<10	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
F2 (C10-C16 Hydrocarbons)	µg/g	10 (a)	<10	***18***	<10	***13***	***12***	***30***	<10	<10	<10	<10	***26***	<10	<10	<10	<10	<10	<10	<10	***10***	<10	***11***
F3 (C16-C34 Hydrocarbons)	µg/g	240 (a)	82	***340***	74	71	59	120	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
F4 (C34-C50 Hydrocarbons)	µg/g	120 (a)	<50	83	<50	<50	<50	***130***	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50

Sample Date (2021)			10-Jun						31-Aug														
Site ID			BASC-1	BASC-2	BASC-3	BASC-4	BASC-5	BASC-6	BASC 1a	BASC 2a	BASC 3a	BASC 4a	BASC 5a	BASC 6a	BASC 7a	BASC 8a	BASC 9a	BASC 10a	BASC 11a	BASC 12a	BASC 13a	BASC 14a	BASC 14a (dup)
Parameter	Unit	Screening Criteria (source)																					

NV – no value. No screening criteria are available to assess risk to receptors; often because the parameter is not associated with acute or chronic toxicity.

(a) Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA. Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use.

(b) Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial.

(c) Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR98 for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Bold & Italics – result exceeded the most stringent screening criteria established but did not exceed an alternate published threshold that is also considered protective of aquatic life.

Bold – result exceeded the most stringent screening criteria available. When multiple published screening criteria exist, the result exceeded two or more of the thresholds.

Table 40 - The results of shallow soil samples (0-20 cm) taken June 10, 2021 from the Construction Landfill 4 (CL4), the Fire Training Facility (FTF), and the Former Sewage Lagoon (FSL). Screening criteria chosen are the most conservative available.

		Site ID	**CL4-1**	**CL4-2**	**CL4-3**	**CL4-4**	**CL4-5**	**FTF-1**	**FTF-2**	**FTF-3**	**FTF-4**	**FSL**
Parameter	**Unit**	**Screening Criteria (source)**										
Metals												
Aluminum (Al)	µg/g	26000 (c)	5000	6100	12000	13000	7900	6400	7300	5700	12000	6000
Antimony (Sb)	µg/g	1.3 (a)	<0.20	<0.20	0.63	0.29	0.34	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic (As)	µg/g	12 (b)	1.2	1.9	2.0	1.8	1.1	2.5	3.2	2.9	3.1	1.8
Barium (Ba)	µg/g	220 (a)	21	23	61	62	31	25	29	25	52	24
Boron (B)	µg/g	36 (a)	9.9	5.4	12	13	8.4	8.9	11	10	12	8.4
Cadmium (Cd)	µg/g	1.2 (a)	0.20	0.17	0.34	0.32	0.19	0.21	0.13	0.14	0.24	0.10
Chromium III (Cr^{3+})	µg/g	70 (a)	12	13	25	22	15	11	14	13	21	11
Chromium VI (Cr^{6+})	µg/g	0.66 (d)	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18
Total Chromium (Cr)	µg/g	70 (a)	12	13	25	22	15	11	14	13	21	11
Copper (Cu)	µg/g	91 (b)	10	12	86	39	48	11	15	14	14	11
Iron (Fe)	µg/g	34000 (c)	9200	12000	15000	15000	10000	11000	12000	11000	16000	10000
Lead (Pb)	µg/g	120 (a)	7.7	7.4	15	11	9.7	7.1	7.0	5.6	10	5.9
Mercury (Hg)	µg/g	0.27 (a)	<0.050	<0.050	0.057	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Molybdenum (Mo)	µg/g	2 (a)	<0.50	<0.50	0.83	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Nickel (Ni)	µg/g	82 (a)	9.9	7.9	20	17	12	8.1	12	12	16	8.7
Selenium (Se)	µg/g	1.5 (a)	<0.50	<0.50	0.56	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver (Si)	µg/g	0.5 (a)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Uranium (U)	µg/g	2.5 (a)	0.64	0.44	0.90	1.2	0.78	0.52	0.74	0.61	0.54	0.47
Vanadium (V)	µg/g	86 (a)	15	23	25	27	19	19	20	18	28	17
Zinc (Zn)	µg/g	290 (a)	33	45	180	95	120	35	50	92	66	32
Petroleum Hydrocarbons												
Benzene	µg/g	0.02 (a)	<0.040	<0.040	<0.040	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Toluene	µg/g	0.2 (a)	<0.040	<0.040	<0.040	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Ethylbenzene	µg/g	0.05 (a)	<0.040	<0.040	<0.040	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Xylene (Total)	µg/g	0.05 (a)	<0.080	<0.080	<0.080	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
F1 (C6-C10)	µg/g	25 (a)	<20	<20	<20	<10	<10	<10	<10	<10	<10	<10
F1 (C6-C10) – BTEX	µg/g	25 (a)	<20	<20	<20	<10	<10	<10	<10	<10	<10	<10
F2 (C10-C16 Hydrocarbons)	µg/g	10 (a)	<10	<10	<10	<10	<10	<10	<10	<10	<10	***24***
F3 (C16-C34 Hydrocarbons)	µg/g	240 (a)	<50	<50	92	68	160	64	90	58	60	60
F4 (C34-C50 Hydrocarbons)	µg/g	120 (a)	<50	<50	53	<50	80	<50	<50	<50	<50	<50

NV – no value. No screening criteria are available to assess risk to receptors; often because the parameter is not associated with acute or chronic toxicity.

(a) Ontario Ministry of the Environment, Conservation and Parks (MECP), 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA. Table 1 Full Depth Background Site Condition Standards (SCS) - Soil (µg/g) Industrial/Commercial/Community Property Use.

(b) Canadian Council of Ministers of the Environment (CCME), 2021. Canadian Soil Quality Guidelines (CSQGs) for the Protection of Environmental and Human Health, Industrial.

		Site ID	CL4-1	CL4-2	CL4-3	CL4-4	CL4-5	FTF-1	FTF-2	FTF-3	FTF-4	FSL
Parameter	**Unit**	**Screening Criteria (source)**										

(c) Ontario Ministry of Environment and Energy, "Ontario Typical Range" OTR98 for Soil - Urban Parks. Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Mossbags and Snow, December 1993.

Bold & Italics – result exceeded the most stringent screening criteria established but did not exceed an alternate published threshold that is also considered protective of aquatic life.

Bold – result exceeded the most stringent screening criteria available. When multiple published screening criteria exist, the result exceeded two or more of the thresholds.

6.2.1.5 2022 Environmental Monitoring Activities

Bruce Power has a strong environmental monitoring program that continues to verify that effluent and emissions from facility operations have little-to-no effect on the surrounding terrestrial and aquatic environment, and that Bruce Power has strong and effective containment and effluent control measures in place.

The environmental monitoring program has a strong focus on locations with historical activity (e.g., BASC, CL4/B31 Pond, FSL) in order to monitor for impacts and ensure risk to receptors is sufficiently characterized. Although data collected from some areas in 2021 demonstrated elevated COPCs indicative of industrial activity, very few of the monitoring data exceeded the conservative criteria used to screen the results. The data collected in 2021 are presented in the 2022 ERA alongside a multi-year dataset. A comprehensive discussion and analysis of these data occurs in the ERA and exceedances of the screening criteria and potential risk to receptors are discussed.

Environmental monitoring in 2022 and subsequent years will be guided by the conclusions and recommendations outlined in the 2022 ERA. Water quality monitoring of Lake Huron, Stream C and on-site drainage features will continue in 2022 and the monitoring effort will be equal to, or greater than, the effort expended in 2021. Sediment and soil sampling at areas of interest will occur within the next 5-year period in preparation for the next ERA.

6.2.2 Fish Impingement, Entrainment and Offsetting Activities

Bruce Power uses cold, deep Lake Huron water in a once-through-cooling system to condense steam and supply operational needs. This cooling requirement can cause adult fish and larger juveniles to become trapped against water intake screens (impingement). Smaller aquatic organisms, like fish eggs and larvae, can fit through the intake screens and then be carried through the cooling water system before returning to the lake (entrainment).

Bruce Power received a *Fisheries Act* Authorization from Fisheries and Oceans Canada (DFO) in December 2019 [R-119]. The Authorization requires Bruce Power to quantify fish losses through continued monitoring of fish impingement and entrainment and to measure fish gains obtained from approved offsetting measures. These monitoring results are reported annually to the DFO. Bruce Power works closely with the CNSC, DFO and local Indigenous communities to ensure the requirements of the Authorization are met and that all are well-informed of relevant fish impingement, entrainment, and fish offsetting activities.

6.2.2.1 Impingement and Entrainment – 2021

The total loss of fish due to impingement and entrainment at Bruce A and Bruce B Generating Stations in 2021 was 2,739 kg (Table 41) expressed as a Habitat Productivity Index (HPI) metric [R-120] [R-121]). This was consistent with prior year losses (Figure 59), below the administrative threshold of 4,500 kg/yr, and well below the maximum loss permitted in Bruce Power's *Fisheries Act* Authorization (6,600 kg/yr). None of the fish impinged in 2021 were listed as Threatened or Endangered on Schedule 1 of the *Species At Risk Act.*

Impingement losses were measured consistently throughout 2021 by Bruce Power Operations who identified and quantified fish impinged in all unit pump houses each day. The impingement monitoring program has several levels of QA/QC checks to ensure data integrity. Operators undergo training in fish identification and quantification prior to performing these tasks. The QA/QC program for fish impingement requires Operators to freeze Lake Whitefish and Round Whitefish so that identification can be confirmed by field biologists who oversee the program. Frozen fish are bagged, labelled, and placed in freezers stored in each pump house until they are inspected by Bruce Power's field biologists. Pump house Operations staff will also freeze specimens that they would like the field biologists to perform a confirmatory identification.

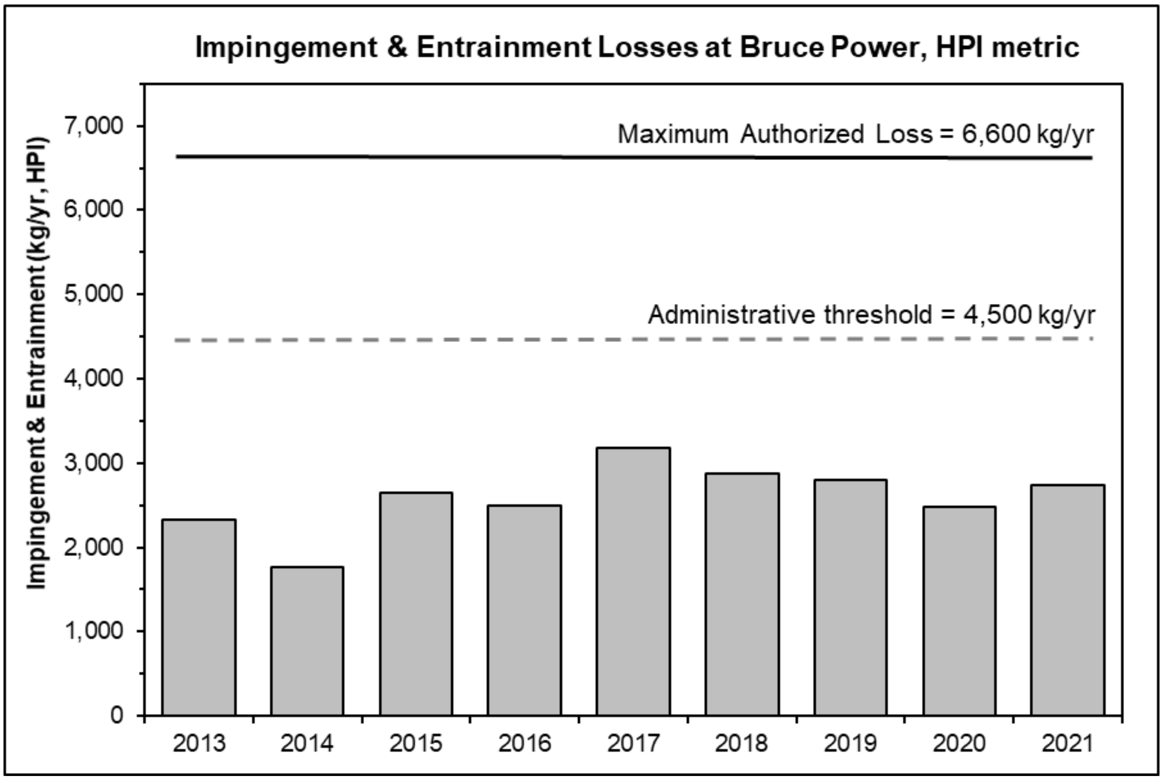


Figure 59 - Total impingement and entrainment losses at Bruce Power (2013-2021), calculated using the HPI metric [R-120] [R-121]. Impingement was measured in all years. Entrainment was measured in 2013-2014 and estimated in 2015-2021 using a conservative approach.

Table 41 - Impingement and Entrainment Fish Loses at Bruce A and Bruce B in 2021

Species	2021 Impingement		2013/2014 Entrainment[1]		Total
	Count (#)	Nominal Weight (g)	Count (# age-1 equivalents)	Age-1 Weight (g)	2021 Productivity Loss (HPI, kg yr^{-1})
Alewife	27	1,116	6	24	0.9
Bloater	-	-	14,124	790,944	510.4
Brown Trout	13	20,166	-	-	4.1
Bullhead	10	4,156	-	-	1.3
Burbot	411	367,460	9,089	78,165	305.9
Carp	105	34,973	-	-	12.1
Channel Catfish	110	80,723	-	-	21.2
Chinook Salmon	35	78,378	2,208	266,285	156.2

Cisco	-	-	17,545	538,632	428.9
Coho Salmon	37	51,524	-	-	10.8
Cyprinid	-	-	431	259	0.8
Deepwater Sculpin	-	-	2,610	3,654	8.6
Freshwater Drum	12	17,336	-	-	3.6
Gizzard Shad	1,202	408,228	-	-	140.2
Lake Trout	109	153,735	-	-	32.1
Lake Whitefish	27	32,537	8,547	639,316	385.4
Rainbow Smelt	120	2,871	16,898	152,082	188.8
Rainbow Trout	41	46,147	-	-	10.4
Rock Bass	10	1,511	-	-	0.7
Round Goby	221	2,998	2,529	2,529	11.4
Round Whitefish	5	5,875	-	-	1.3
Salmonid	-	-	427	8,028	7.6
Smallmouth Bass	22	6,217	-	-	2.3
Spottail Shiner	1,488	119,724	-	-	68.1
Suckers	1,398	394,425	5,089	26,972	258.1
Walleye	111	143,899	75	8,730	38.5
White Perch	16	1,265	-	-	0.7
Yellow Perch	426	42,228	10,512	81,994	140.1
Total					**2,750.5**
Total (less Round Goby)					**2,739.0**

[1] Entrainment is estimated from data collected in 2013 and 2014 at Bruce A. Shown here is the count and age-1 weight for the higher of the two years, yielding the most conservative estimate based on the 2013/2014 data.

Entrainment losses were not measured in 2020; power generation facilities do not routinely measure entrainment because it is a very resource-intensive effort. Instead, entrainment was estimated in 2021, and the 2,739 kg total loss value includes a conservative estimate based on the highest value observed (by species) in either the 2013 or 2014 monitoring years that were completed in preparation of the Authorization application.

6.2.2.2 Truax Dam Removal Project Offsetting Activities – 2021

In August 2019, the Truax Dam (Saugeen River, Walkerton, ON) was successfully removed as part of Bruce Power's *Fisheries Act* Authorization Offsetting Plan. This project was completed in partnership between Bruce Power, the Lake Huron Fishing Club and the Municipality of Brockton, and represents the largest known dam removal to occur in the Province of Ontario in recent times (Figure 60). The successful dam removal in 2019 was a key step forward in Bruce Power's efforts to fully offset its fish losses from impingement and entrainment.

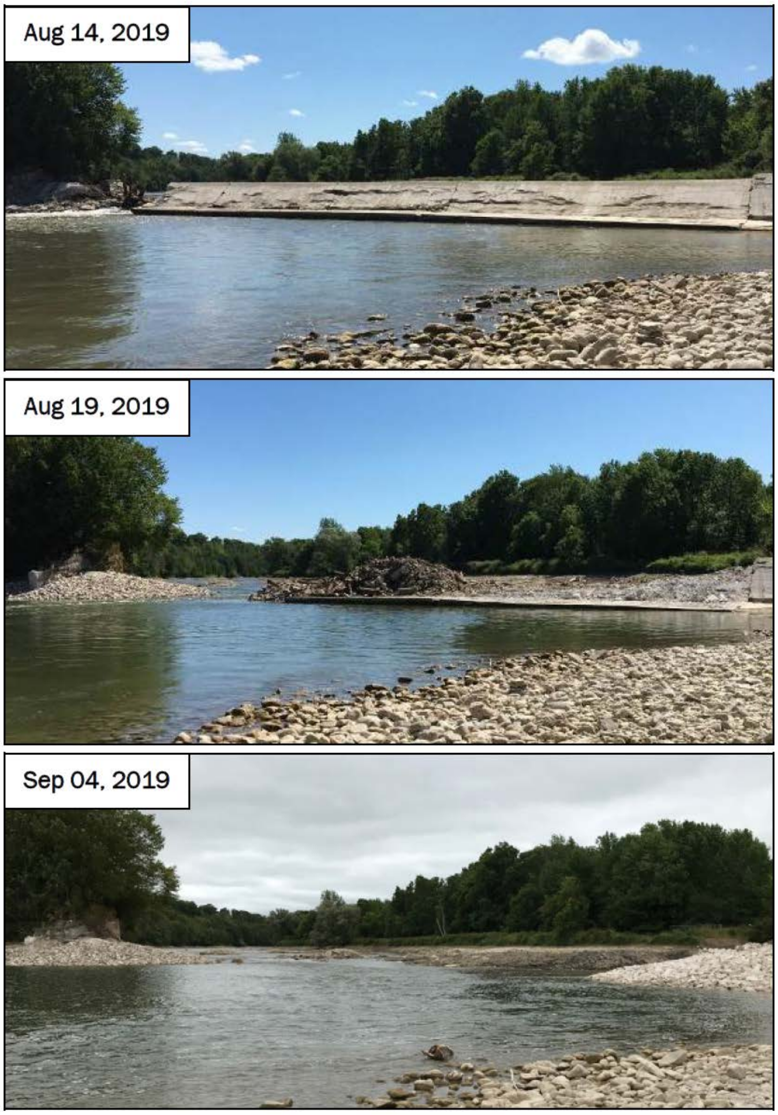


Figure 60 - Truax Dam, Walkerton, ON. The original wooden dam was built in 1852 and later replaced by the concrete structure shown above in 1919. The dam posed a significant barrier to fish passage for more than a century before it was removed in the summer of 2019 over the course of 3 weeks

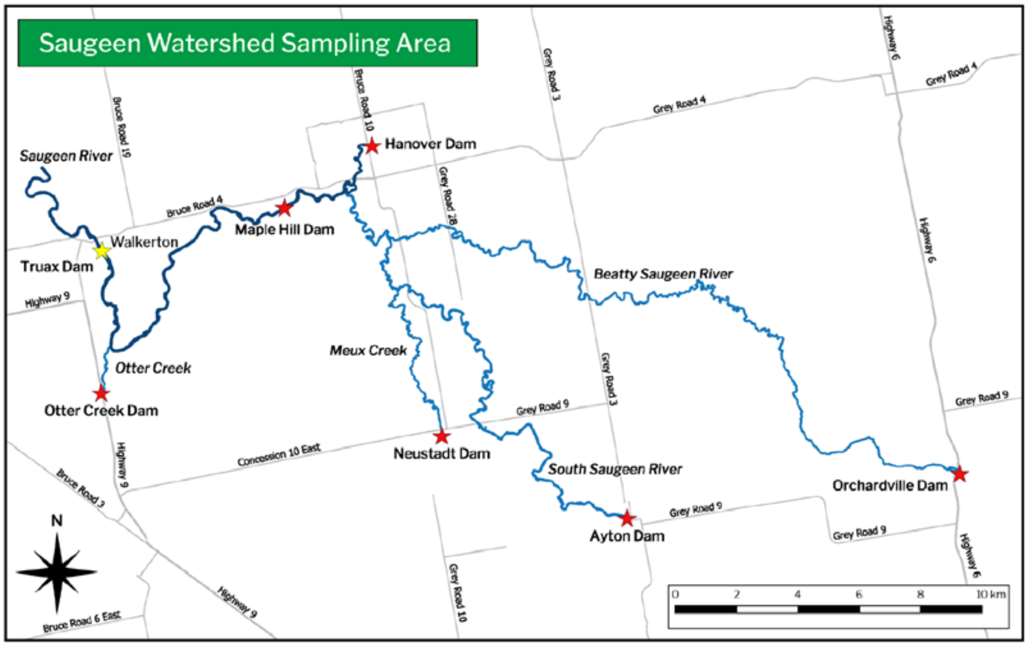


Figure 61 - Twenty-two long-term monitoring sites are located in the Saugeen (upstream & downstream of the former Truax Dam) and within the South Saugeen & Beatty Saugeen Rivers and Otter and Meux Creeks. Dams (red stars) are natural endpoints of the study area as fish cannot pass upstream of these structures. Control sites with independent fish communities are located outside of the study area, upstream of the Hanover and Otter Creek dams

Fish and fish habitat monitoring upstream and downstream of the former Truax Dam began in 2018 and will continue over several more years in order to quantify the change in fish biomass that occurs as a result of the dam removal. Twenty-two long-term monitoring locations were established in the study area where biologists carry out electrofishing surveys to measure changes in fish biomass and production (Figure 61). Additionally, habitat assessments and redd surveys are used to monitor changes in fish spawning, and underwater video and radio-telemetry studies are being done to track fish passage throughout the watershed.

Fish biomass is expected to increase in the study area as a result of the dam removal, and the net increase in biomass is anticipated to fully offset fish impingement and entrainment losses that occur at Bruce Power. An initial assessment of the before-after changes in fish production to calculate the offset took place after the 2021 biomass monitoring was completed. This BACI (before-after-control-impact) analysis demonstrated that a statistically significant increase in fish biomass and production has occurred in the main stem of the Saugeen River upstream of the former Truax Dam in Walkerton, ON. This was firmly demonstrated in the data collected at the monitoring station located immediately upstream of the former Truax Dam. At this time, a demonstrable offset of 1,523.1 kg/yr has occurred in 2020 and 2021 due to increases in fish production in the main stem of the Saugeen River immediately upstream of the former Truax Dam. This is a conservative estimate and will be refined as additional monitoring data is collected in future years.

The BACI analysis did not demonstrate a statistically significant increase in fish biomass or production at any of the tributary locations. This outcome is not concerning at this stage in the project given only two years have passed since the Truax Dam was removed and changes in the upstream tributaries, when/if they occur, are not likely to be realized as quickly as those effects that were observed almost immediately upstream of the former dam.

Fish production within the Saugeen River main stem is expected to continue to increase in future years as the warm-water fish community continues to re-distribute across the newly reconnected river system and as additional successful Salmonid spawning occurs within the newly formed habitat upstream of the dam footprint. Indeed, additional observations gathered through radiotelemetry studies of Rainbow Trout, Salmonid redd surveys and videography monitoring have demonstrated an almost instantaneous increase in Salmonid presence in the Saugeen River upstream of the Truax Dam to Carrick Dam and within Otter Creek. Increased fish production of Salmonids in the tributaries is also anticipated in future years.

A photographic collection of the Saugeen River watershed field work is found at [R-122]–[R-124]:

The radiotelemetry studies have shown that movement and dam passage upstream of the former Truax Dam has increased as a function of the dam removal. The telemetry work has shown that when compared to Rainbow Trout who migrate up the Saugeen River in the fall, spring-run fish migrate much quicker making the ~77 km journey from Southampton to Walkerton in just over 6 days. Fall-run fish tend to overwinter in the watershed, often downstream of Walkerton and then migrate upstream to spawn in the early spring, likely reaching areas earlier than the spring-run fish who are just entering the watershed. Additional information is available at Biotactic's website (www.biotactic.com, [R-125]) or by following these links:

2022 Summary - Saugeen River Telemetry [R-126]

Migratory Patterns of Rainbow Trout [R-127]

Videographic surveys are performed at the confluence of the Saugeen River and Otter Creek and at the Maple Hill Dam fishway. This work has shown that movement of fish into Otter Creek has increased by >200% in the spring and ~150% in the fall since the dam was removed. Passage at the Maple Hill Dam fishway increased in the spring by ~180% and by >900% in the fall.

Videographic Surveys [R-128]

Redd counts of Rainbow Trout and Chinook Salmon spawning are showing exciting results. The number of redds in Otter Creek have increased by an average of 177% in the spring and 156% in the fall since the dam was removed. The area immediately upstream of the former Truax Dam (the former headpond) is now a riffle-run habitat and multiple redds have been observed in this area in the spring and fall (maximum count = 31 in Spring 2020), indicating Rainbow Trout and Chinook Salmon are using this newly remediated fish habitat.

Redd Count Surveys [R-129]

6.2.2.3 Indigenous Nation and Community Offsetting Projects – 2021

In addition to the Truax Dam Removal Project, Bruce Power continues to collaborate with local Indigenous Nations and Communities to develop additional offsetting projects. These projects provide an opportunity to work together in meaningful ways to improve fish and fish habitat in areas of the Lake Huron watershed that are of special importance to local Indigenous Nations and Communities. These projects are in addition to Bruce Power's support of the Saugeen Ojibway Nation (SON) Coastal Waters Monitoring Program (CWMP), which is a nearshore/coastal monitoring program with the goal of building a comprehensive baseline inventory of aquatic habitat and wildlife in the SON Territory [R-130].

Bruce Power and the Historic Saugeen Métis (HSM) have developed an offsetting project to remove invasive *Phragmites australis* from the Fishing Islands. This project plan was approved by DFO in 2021 and an amended Fisheries Act Authorization was issued to Bruce Power. Field work was conducted in 2021 and the first progress report was jointly submitted to the DFO in March 2022.

No projects have been formally proposed to Bruce Power by the Saugeen Ojibway Nation (SON). This remains an open agenda item for discussion at our regular meetings. Bruce Power looks forward to continuing engagement with the SON to develop an offsetting project that is important to their community when one is identified.

Although a project with the Métis Nation of Ontario (MNO) has not yet been formalized, discussions and an in-person meeting occurred in 2021 in order to define an offsetting project to take place on Bothwell's Creek in Leith, ON. The MNO have identified this as important fishing ground and have expressed desire to maintain/improve its fishery. At this time, Bruce Power and the MNO are working with Trout Unlimited Canada to define a project scope.

6.2.3 Thermal Monitoring of Lake Temperatures

High-pressure steam is produced at Bruce A and Bruce B by heating demineralized light water in a closed-loop system. This steam is used to produce the electricity in the turbine-generator systems and is then condensed to liquid water in the Condenser Cooling Water (CCW) system before travelling back to boilers to be reheated to high-pressure steam again. Steam condensation occurs in the CCW system using a separate open loop of cool lake water that is drawn from offshore deep-water intakes, and warmer water is discharged back to the lake.

The temperature of water leaving the Bruce A and Bruce B discharge channels is monitored continuously to ensure it meets the specifications outlined in MECP environmental compliance approvals (ECA), which are established to be protective of the environment and minimize negative impact(s) to aquatic organisms and their habitat. Because this warmer discharge water has the potential to be a physical stressor to aquatic organisms, Bruce Power has carried out extensive thermal and current monitoring over several years in order to characterize any potential risk from thermal effluent [R-43]. Temperature and current monitoring in Lake Huron continued in 2021 in order to collect ongoing verification data for its thermal risk assessment, and these data will be presented in the next ERA.

As climate change gradually affects lake-wide temperature, a temporary amendment of the Bruce A ECA is in place to allow a maximum effluent temperature of 34.5°C (an increase of

2.3°C) between June 15th and September 30th each year. This provides operational flexibility for a maximum of 30 aggregate days within this period, and for no more than a maximum of 15 consecutive days at a time. This operational flexibility was not invoked in 2021 because the maximum daily average effluent temperature at Bruce A did not exceed 32.2°C. Bruce Power continues to provide monthly (Jul-Sep) and quarterly updates on its thermal effluent to local Indigenous communities as part of its ongoing commitment to Indigenous engagement and information sharing.

6.2.4 Biological Effects Monitoring

Bruce Power has conducted long-term monitoring of local wildlife populations for many years to trend baseline wildlife populations on our site. By doing so, we can understand local population dynamics, detect changes if they occur, and ensure that facility operations have minimal impact on the environment. Each of the following biological effects monitoring programs provides an additional layer of assurance that Bruce Power continues to operate its facility safely in a manner that is protective of the environment.

6.2.4.1 Amphibians

Amphibians are monitored as an indicator for ecosystem health as they have a dual life cycle (water and land) and are sensitive to pollutants during all life stages [R-131]. Incidental amphibian observations are recorded year-round during vehicle-wildlife interaction surveys, pedestrian surveys and with employee sightings. There were several incidental observations of frogs across the site in 2021.

Targeted nocturnal amphibian vocalization surveys were conducted in the spring and summer of 2021, following the methodology described by Bird Studies Canada/ Environment Canada Marsh Monitoring Protocol [R-131]. The protocol requires sampling on three separate calm, mild evenings at least 15 days apart to determine species presence and relative abundance. In addition to the targeted vocalization surveys, incidental observations were made throughout the year during other field studies (pedestrian surveys, vehicle/wildlife interaction surveys) in order to document evidence of amphibian breeding activity (e.g., egg masses, larvae, spermatophores, daytime calling).

Table 42 - Amphibian Call Level Codes used in Survey Protocol [R-131]

Level 1	Calls did not overlap and calling individuals could be discretely counted
Level 2	Calls of individuals occasionally overlap, but numbers of individuals could still reasonably be estimated
Level 3	Numerous individuals were calling and an overlap of calls seemed continuous, making an estimate of individuals impossible

In 2021, 13 survey locations continued to be monitored, which were established in 2020 based on previous monitoring locations and proximity to wetlands, ponds, and ephemeral pools (Figure 62). Five different frog species were identified in 2021 over the three survey dates in April, May and July.

The most common and abundant species continues to be the Spring Peeper (*Pseudacris crucifer*). This early breeding frog species was heard calling at every monitoring station in 2021. The call levels for Spring Peeper were relatively high with majority of recorded levels at level 2.

The Northern Leopard Frog (*Lithobates pipiens*), an early-mid season breeder, was observed at 7 of the monitoring stations and was only heard during the first visit with the exception of Station A5016.1 where it was recorded during the first two visits. Call levels for this species were only recorded at call level 2 at station BDD and at level 1 for all the other locations. Station BDD consists of large contiguous wetland and moist forest/swamp communities.

Mid-season breeders typically include the American Toad (*Anaxyrus americanus*) and the Grey Treefrog (*Hyla versicolor*). The American Toad was heard at seven of the monitoring stations, calling at levels 1 predominantly and level 2 at Station BDD. American toads have probably the most diverse breeding habitat requirements and may be found in shallow ponds, shallow streams, river margins and even large puddles and roadside ditches. Only three locations had recordings of the Grey Treefrog. Call levels were recorded as level 1 indicating that they are present but in slightly lower abundance as compared to a species like the Spring Peeper, which was heard calling at very high levels at similar locations. Late breeding frog species include the Green Frog (*Lithobates clamitans*) and the American Bullfrog (*Lithobates catesbeianus*). No Bullfrog species have been documented during any of the surveys from 2017 to 2021. Green Frogs were heard at three of the stations and were recorded during each of three surveys.

Overall, taking into consideration the expected natural variation in amphibian abundance and diversity, the diversity of species and trends through time of frog populations in the local area is very good and has remained consistent across monitoring sites and years.

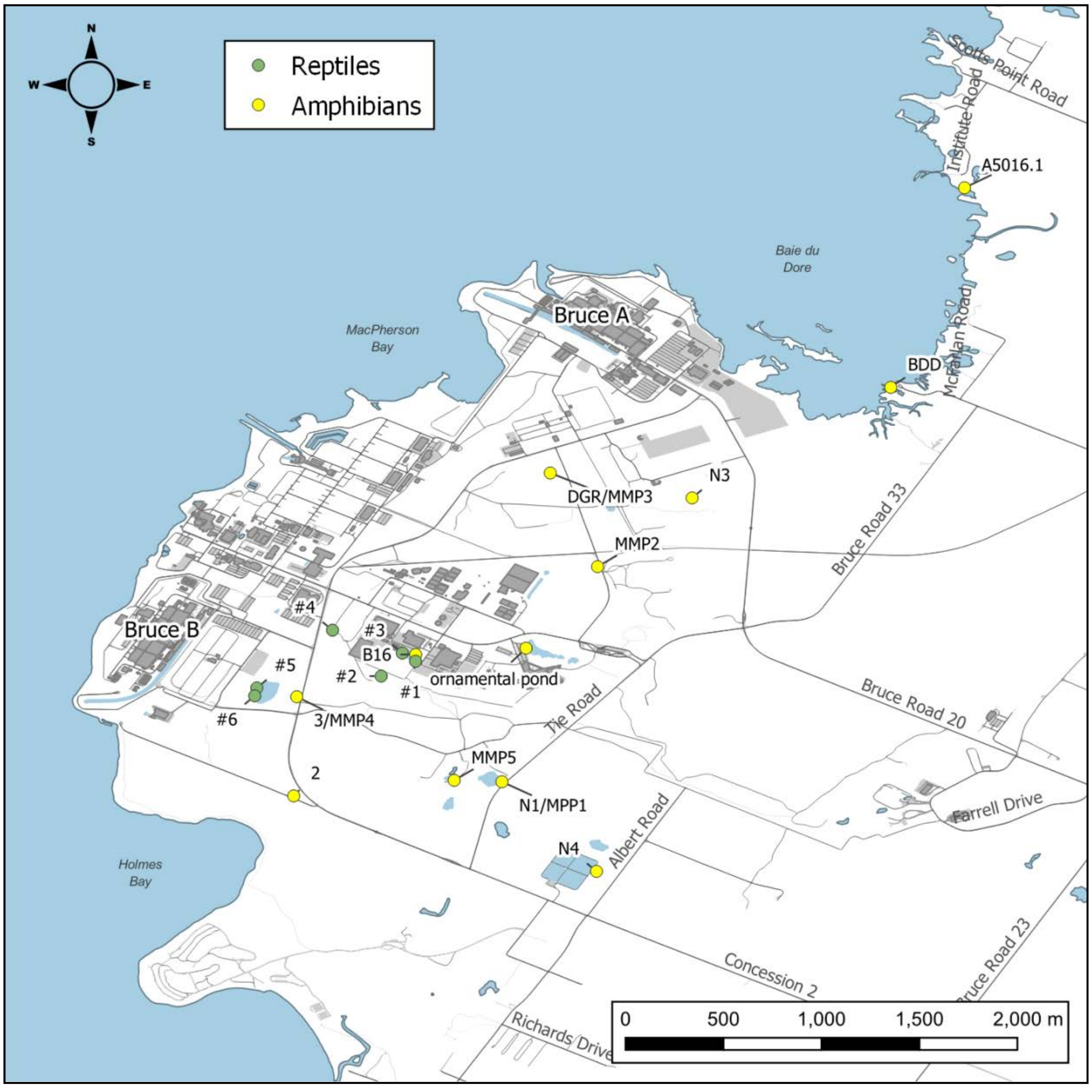


Figure 62 - Amphibian and Reptile Survey Monitoring Locations at Bruce Power

6.2.4.2 Reptiles

Several snake species inhabit the Bruce Power site. They are an important component to any natural ecosystem for many reasons, some of which include their need for diverse habitats to complete their life cycles, for example they need hibernacula areas, grasslands, wetlands and other surface water features. Due to the decline and sensitivity of certain populations in Ontario it's important to collect data on presence and abundance; this data provides the necessary tools to make planning decisions and manage property holdings from an ecological perspective. Due to the increasing number of SAR species in Ontario it is vital to monitor vulnerable snake populations in our local area. Investigations specific to snakes have been conducted in the form of pedestrian surveys from 2017 to present; to locate and characterize the species assemblage and to identify potential critical habitat within the Bruce Power leased lands. Along with pedestrian surveys, bioinventories of the 2016-2017 seasons focused on identifying and recording any Species at Risk snakes. Data is also collected during Vehicle-

Wildlife Collision Surveys and incidental observations by Bruce Power employees. Vehicle wildlife surveys began in June 2017; they are completed on a weekly basis to the extent possible.

Beginning in 2020, environment staff from Ontario Power Generation and Bruce Power have collaborated on several programs, including snake board studies, turtle nesting, breeding birds and amphibians. The snake specific work followed the guidelines for monitoring snakes outlined in the Ontario Ministry of Natural Resources and Forestry (MNRF) survey protocol [R-132]. OPG placed 33 snake monitoring boards at various locations throughout the site and Bruce Power added snake boards to 11 additional locations.

Five different snake species were recorded in 2021 by Bruce Power in the thirteen monitoring events. Eastern Garter snake was the most common snake observed, followed by Dekay's Brown snake and then Red-bellied snake. A total of 15 snakes were found during the snake board monitoring with the most observations made on June 24th and July 5th with three snakes recorded on each of those two days.

The most commonly found snake under coverboards in 2021 by OPG biologists were Eastern Garter snake, with eight observations (compared to 9 in 2020). Red-bellied snake was the most frequently encountered snake in 2020 but only six individuals of this species were found in 2021. The lower number may be because in 2021 coverboard checks did not commence until May 14. A significant number (7 of 17) Red-bellied snake observations in 2020 were made during the first day of monitoring, May 6, 2020. Although the sample size is small, this may be an indication that Red-bellied snakes are more likely to use the coverboards earlier in the spring.

Perhaps the most significant discovery during 2021 coverboard monitoring was the two young Northern Ring-necked snakes found under separate boards on September 7. This is one of the least frequently encountered snakes in Bruce County. Its relatively small size and secretive, nocturnal habits may be a factor in the low rates of detection and it may actually be more common than records suggest.

There were single observations of the two other new species for the OPG WWMF surveys: Eastern Milk snake and Northern Water snake. Dekay's Brown snake and Smooth Green snake were also found on only one occasion in 2021.

Table 43 - Reptile Species Presence Recorded in the Local Area 2017-2020

Species	**2017**	**2018**	**2019**	**2020**	**2021**
Dekay's Brown Snake	Yes	Yes	Yes	Yes	Yes
Eastern Garter Snake	Yes	Yes	Yes	Yes	Yes
Eastern Milk Snake	No	No	No	No	Yes
Eastern Ribbon Snake	Yes	No	Yes	Yes	Yes
Red-bellied Snake	Yes	Yes	No	Yes	Yes
Ring-neck Snake	Yes	No	No	No	Yes
Smooth Green Snake	No	No	No	Yes	Yes

Midland Painted Turtle	Yes	Yes	Yes	Yes	Yes
Snapping Turtle	Yes	Yes	Yes	Yes	Yes

6.2.4.3 Waterfowl & Shorebird Surveys

The purpose of waterfowl and shorebird surveys is to monitor overwintering and stopover migration areas to trend species abundance and distribution over time. The shoreline of Bruce Power is surveyed for waterfowl and shorebirds with both binoculars and a spotting scope from a set of 10 viewpoints which were selected to cover most of the shoreline from Gunn Point to Scott Point with very little overlap (Figure 63).

In total there were 3 spring and 3 fall survey days in 2021 completed between March and December. The total number of birds observed during the 2021 monitoring season was 3,138. A total of 35 waterfowl/shorebird and gull species were identified during the waterfowl/shorebird monitoring.

In comparison six spring/fall surveys were completed between April 7, 2020 and November 25, 2020, recording a total of 1,995 birds across 32 species of waterfowl/shorebirds. A similar monitoring effort was completed in 2019 (6 surveys) when 3,043 birds were observed across 44 species. Overall, surveys in 2019, 2020 and 2021 have demonstrated that there are diverse populations of local and migrant waterfowl and shorebirds inhabiting the lands nearby Bruce Power, with the highest density in Baie du Doré (Figure 64).

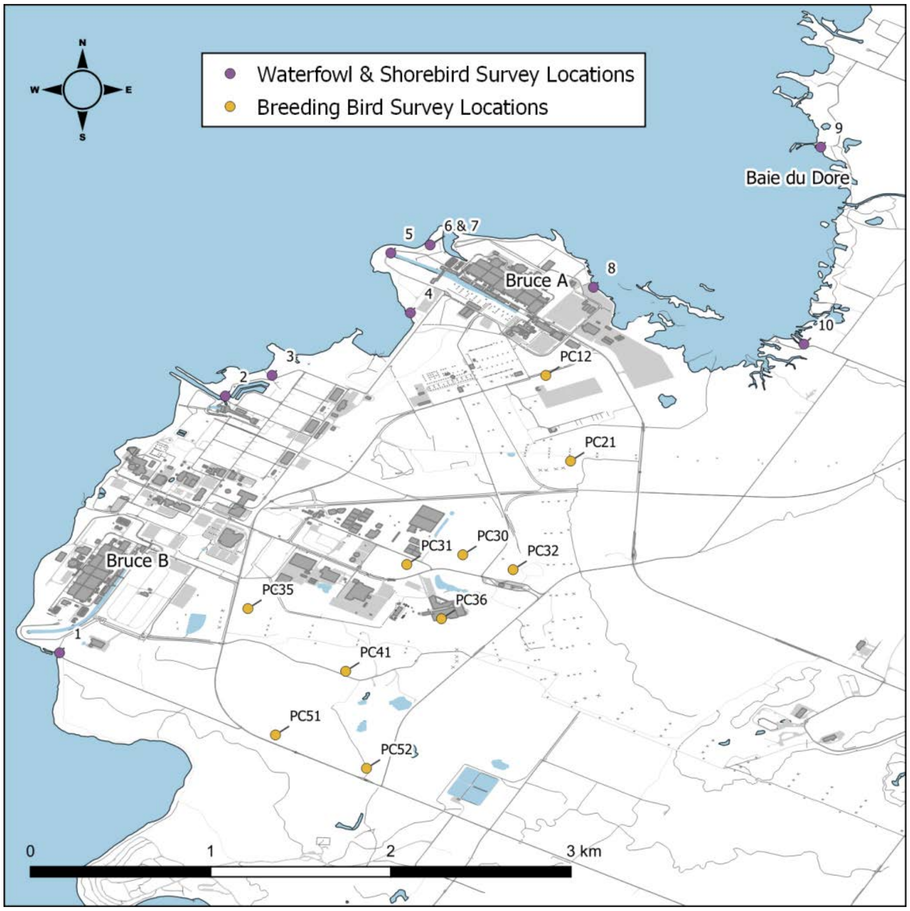


Figure 63 - Waterfowl & Shorebird and Breeding Bird Monitoring Locations at Bruce Power

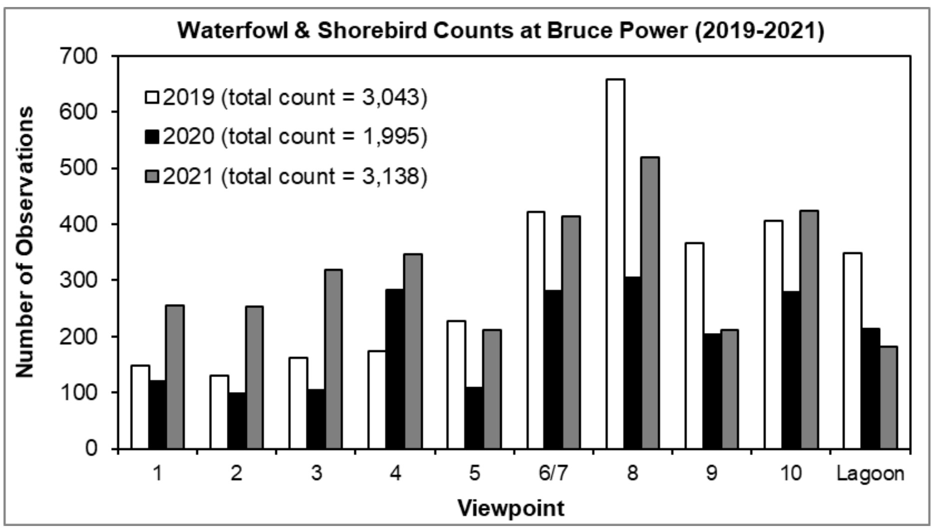


Figure 64 - Counts of Local Waterfowl and Shorebirds Observed 2019-2021

Canada Geese were the most abundant bird species recorded during the 2021 surveys; this is reflective of the locally high populations. The second most abundant was Herring Gull, this is normally a spot reserved for the Double-crested Cormorant, which was the 4th highest in total observations, this may be a result of the Ontario wide hunting season initiated in 2020. A total of 18 duck species were observed with Mallard and Common Merganser being the most common. They are very common local species for Lake Huron.

The Herring Gull was the second most recorded of all the observed bird species on Site. It is the most common of all the gulls in Canada and it, along with the Ring-Billed Gull, thrives in a large lake environment like Lake Huron. The areas around the Bruce Power site offer abundant food and breeding opportunities. Great Black-Backed Gull and Bonaparte's Gull were also observed but at less frequency. Two grebe species, the Pied-Billed Grebe and the Horned Grebe, were encountered during the 2021 monitoring. As consistent with other sightings in previous years, these grebes were spotted in the Baie du Dore wetland. The Horned Grebe is currently listed as Special concern in Ontario and is considered a rare breeder.

The White-Winged Scoter was documented during the fall 2021 monitoring season along with a few other Scoter sp. that were unidentifiable to species due to the distance observed offshore. They are late season migrants and are usually observed during the winter migration period.

Birds of prey are relatively common in the areas surrounding Bruce Power. The Bald Eagle (*Haliaeetus leucocephalus*) which is becoming more of a regular visitor and even has been seen nesting in the area along the Saugeen River, Lake Huron shoreline and even on the Bruce Power site. With the existing open water environments and abundant food supply the local populations seem to be flourishing (see Section 6.2.4.5).

The majority of the survey locations are not the best habitat for shoreline/wading birds. No true wading birds were observed this year during any of the spring or fall monitoring events.

Mute swans (*Cygnus olor*) are fairly regular inhabitants of Baie du Doré and are found all year round till freeze up. These natives of Eurasia have adapted very well to conditions in Canada and are common in city parks and sheltered bays. The once abundant Trumpeter swan (*Cygnu buccinator*) was observed during the 2021 monitoring season at the Baie du Doré survey locations but wasn't recorded in 2020. This native bird is making a comeback in Ontario due to several restoration efforts. The Tundra swan was also observed in Baie du Doré during the 2021 surveys and this bird is not commonly observed.

Overall, the surveys in 2021 have resulted in a fairly diverse abundance and overall diversity of birds in the surrounding area of Bruce Power. The habitat diversity and area of available open lake environment is conducive to healthy local and migrant populations.

6.2.4.4 Breeding Bird Monitoring Surveys

Nineteen 5-minute breeding bird surveys occurred across the site (Figure 63) on June 19 and 22, 2021. Monitoring protocols followed the standards prescribed by Birds Canada (formerly Bird Studies Canada) for the Ontario Breeding Bird Atlas [R-133]. A total of 59 breeding bird species were documented. Of these, 50 species were detected on June 19, 2021 and 44 species were observed on June 22, 2021. The most commonly observed species in 2021 was the Red-Eyed Vireo, detected at 9 stations, while American Robin, American Goldfinch and American Redstart were each found at 8 stations. Interesting observations included five Species at Risk (Eastern Wood-Pewee, Wood Thrush, Eastern Meadowlark, Bobolink and Canada Warbler), all of them showing evidence of breeding at the site.

Table 44 - Breeding Bird Species Detected at Bruce Power During Formal Surveys Conducted June 19 and 22, 2021

Species		
Canada Goose	Wood Duck	Mallard
Wild Turkey	Rock Pigeon	Mourning Dove
Killdeer	Spotted Sandpiper	Ring-Billed Gull
Herring Gull	Downy Woodpecker	Hairy Woodpecker
Pileated Woodpecker	Northern Flicker	Eastern Wood-Pewee
Alder Flycatcher	Least Flycatcher	Great Crested Flycatcher
Eastern Kingbird	Red-Eyed Vireo	Blue Jay
American Crow	Common Raven	Black-Capped Chickadee
Red-breasted Nuthatch	White-Breasted Nuthatch	House Wren
Winter Wren	European Starling	Gray Catbird
Brown Thrasher	Veery	Wood Thrush
American Robin	Cedar Waxwing	Purple Finch
American Goldfinch	Chipping Sparrow	Field Sparrow
White-Throated Sparrow	Song Sparrow	Swamp Sparrow
Eastern Towhee	Bobolink	Eastern Meadowlark
Red-Winged Blackbird	Brown-Headed Cowbird	Common Grackle
Ovenbird	Black-and-White Warbler	Common Yellowthroat
American Redstart	Yellow Warbler	Chestnut-sided Warbler
Black-Throated Green Warbler	Canada Warbler	Scarlet Tanager
Rose-breasted Grosbeak	Indigo Bunting	

6.2.4.5 Bald Eagle Surveys

Bald Eagles (*Haliaeetus leucocephalus*) are currently listed as a species of *Special Concern* in Ontario. Since 2016, Bruce Power has monitored habitat use by Bald Eagles and other raptors in the vicinity of the Bruce Power Site during the overwintering period (Nov-Mar). Four Bald Eagle monitoring surveys were completed in each of the last 4 winter monitoring periods. Observations of Bald Eagles continued in 2021-2022 at 6 of the 7 original monitoring stations (Stn), labelled Stn. 1 and Stn. 3-7 on Figure 65. Stn. 2 (not labelled on Figure 65) was abandoned in 2019 due to lack of visibility because of woody shoreline vegetation.

Bald Eagles are frequently observed at Stn. 4-7 and lower numbers are recorded at Stn. 1-3 where there are less foraging and perching opportunities than within Baie du Doré. Overall, counts have increased across the whole site in the last five years indicating an increase in the abundance of the local overwintering Bald Eagle population (Figure 66).

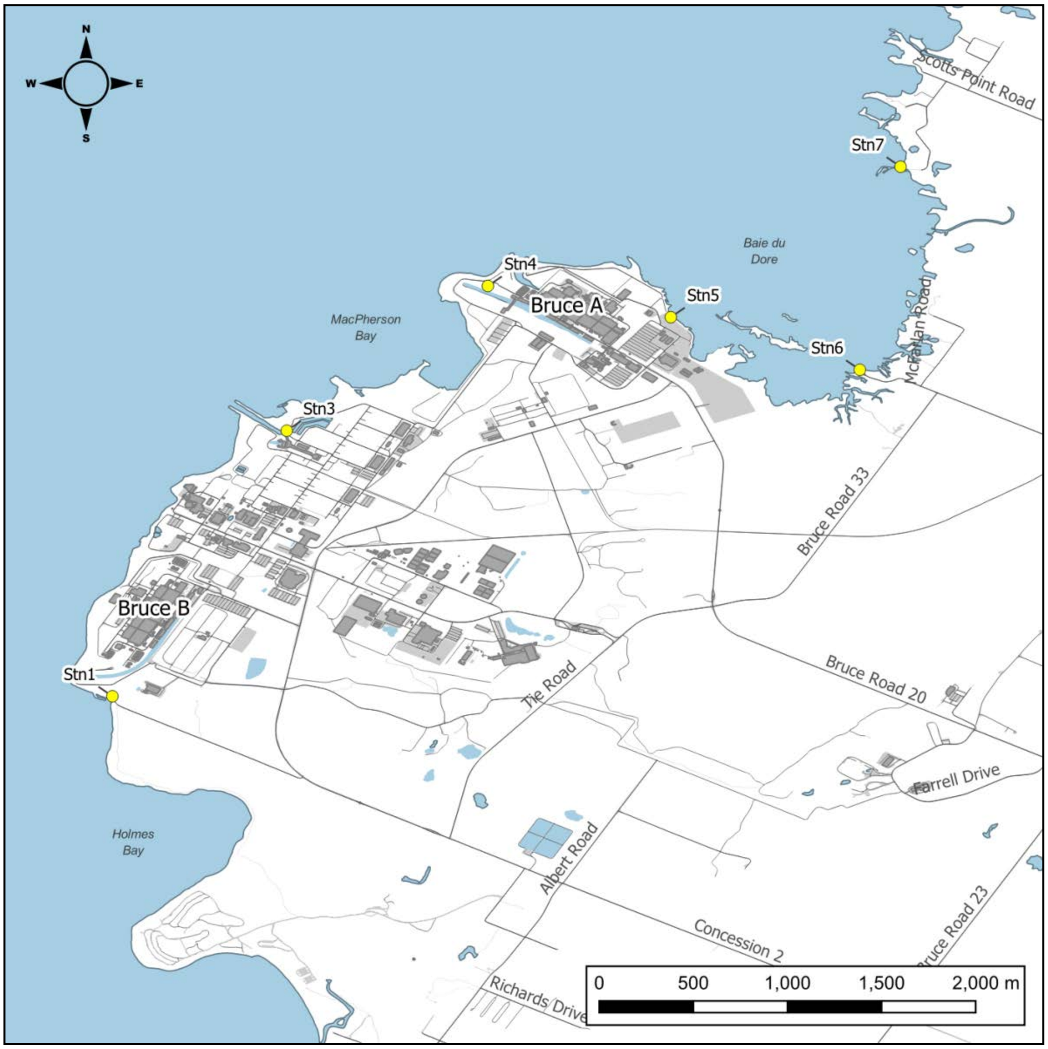


Figure 65 - Bald Eagle Monitoring Locations at Bruce Power

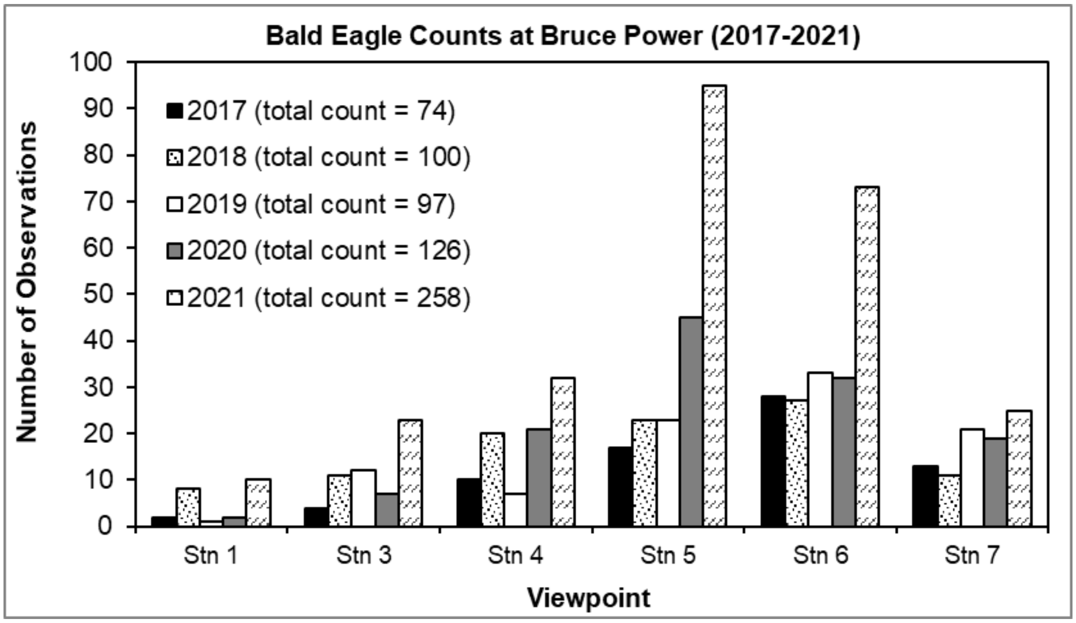


Figure 66 - Counts of Bald Eagles Observed near Bruce Power Between 2017 and 2021

Formal surveys for winter raptor species did not continue in 2021 as none were observed during winter raptor surveys conducted in 2017-2018 and 2019-2020.; however incidental observations made by employees and Bruce Power field biologists were recorded. One Red-tailed Hawk was observed in 2018-2019, and one Snowy Owl and one Northern Harrier were recorded in 2019-2020. In 2021 a Coopers Hawk, Northern Harrier and a Snowy Owl were observed on site.

6.2.4.6 Redd Surveys on Stream C

In the early spring and late fall, salmonids migrate upstream to reach suitable cool-cold water spawning grounds. The female selects a nest site and begins excavating a pit, referred to as a redd. This redd is where eggs will be deposited for fertilization by one or more males. Redd surveys are a tool for assessing the productivity and health of a watercourse, as presence and success of spawning salmonids indicates the watercourse has the necessary environmental conditions to promote healthy spawning/hatching and rearing (i.e., substrate, temperature, and flow regimes). Timing of the start for the survey varies depending on conditions like water temperature, rainfall, and stream water levels. Stream C surveys are conducted in the spring to capture the migration of Rainbow Trout (*Onchorynkus mykiss*) and in the fall to observe various salmon species, which include both Chinook (*Oncorhynchus tshawytscha*) and Coho (*Oncorhynchus kisutch)* salmon.

Nine surveys were completed in 2021 (4 in the spring, 5 in the fall). Twenty-seven Rainbow Trout redds were observed in 2021, which was 18 less than the number recorded in 2020 (Figure 67). Of these, 17 had one fish on or near the nest. Seven Chinook Salmon redds were observed in Stream C in 2021 and a total of 29 Coho Salmon redds were recorded in the 2021 season. Of these fall redds, 21 of them had fish on or near the redd (Figure 63). Increased beaver activity in Stream C over the last few years has caused lower stream flow downstream of the dam structures. Several informal observations of Stream C occurred throughout the fall of 2021 to assess activity. The consistent and high number of redds observed in Stream C since 2017 demonstrates there is high water quality and suitable fish habitat in this stream.

Figure 67 - Counts of Redds Observed in Stream C between 2017 and 2021

6.2.4.7 Vehicle-Wildlife Collisions

Monitoring of vehicle-wildlife collisions on local roadways began in July 2017 to improve our understanding of wildlife mortality caused by vehicle collisions. This monitoring continued in 2021 with 48 formal surveys completed, targeting weekly sampling in the spring and fall. Standardized two pass surveys occurred on the main access roads that run between Highway 21 and Bruce Power (Bruce Road 20 – Segment 5; Concession 2 – Segment 4) and on the major on-site roadways that have the most traffic (Segments 1-3, 6). Concession 6 (Segment 7) was added in 2019 because of increased traffic around the Farrell Drive industrial complex (Figure 68). Surveys were completed after 9:00 a.m. on weekdays after the peak morning traffic had subsided. All animals were identified to the species-level (wherever possible), photographed and georeferenced. Incidental observations of wildlife carcasses (outside of the formal surveys) were also recorded throughout the year.

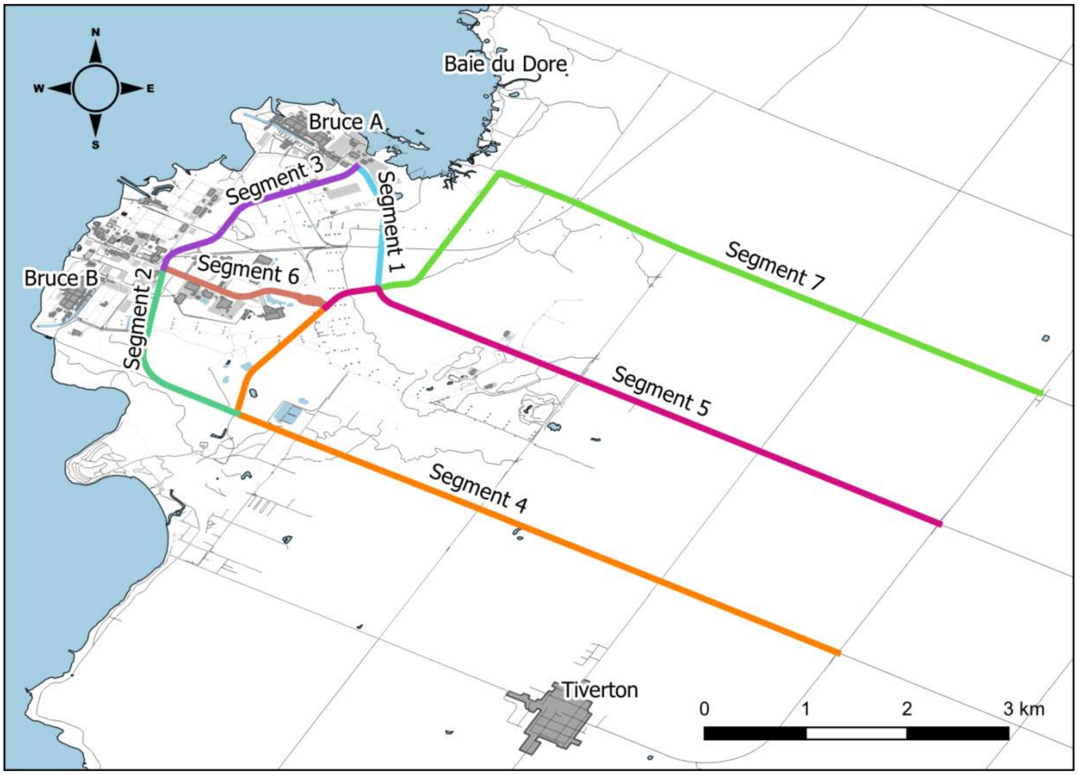


Figure 68 - Vehicle-Wildlife Collision Survey Areas

Eighty deceased animals were recorded over the 48 formal surveys conducted in 2021 (1.7 animals per survey day in 2021). An additional 13 carcasses were observed incidentally throughout the year. This represents a slight increase in mortality from that observed in 2020, but similar to that observed in 2019 (Table 45).

Table 45 - The Results of Vehicle-Wildlife Collision Surveys Conducted in the Local Area (2017-2021)

Year	Surveys Completed (#)	Deceased Animals Observed During Formal Surveys (#)	Mortality Rate (# Animals / # Surveys)	Incidental Observations of Animal Mortality (#)
2017	19	43	2.3	9
2018	46	60	1.3	31
2019	46	78	1.7	15
2020	37	50	1.3	10
2021	48	83	1.7	13

The majority (55%) of the animals involved in collisions in 2021 were amphibians and reptiles and included: Northern Leopard Frog, Green Frog, Spotted Salamander, Eastern Gartersnake, Midland Painted Turtle, and Snapping Turtle. Mammals represented 31% of the collisions and included: American Mink, Eastern Cottontail, Eastern Gray Squirrel, Muskrat, American Woodchuck, North American Porcupine, Raccoon, Striped Skunk, Coyote, and Opossum. For White-tailed Deer in 2021, there were no on-site vehicle collisions, and no individuals were recorded off-site during the vehicle-collision surveys. The remaining animal mortalities (14%) were made up of birds and insects and included: Wild Turkey, American Robin and Monarch Butterfly.

Table 46 - Mortality by Survey Segment as a Proportion (%) of the Annual Total (2017-2021)

Segment	1	2	3	4	5	6	7
2017	7	14	5	42	33	0	n/a
2018	13	12	8	37	28	2	n/a
2019	10	19	18	29	13	10	n/a
2020	18	8	8	34	16	0	16
2021	13	19	6	24	12	2	23
Average Proportion (%)	*12*	*14*	*9*	*33*	*20*	*3*	*20*

The highest frequencies of collisions occur along Segment 4 (Concession 2) where 24-42% of the total mortality happens each year. The main entrance for Inverhuron Provincial Park is located on the west end of Concession 2; (segment 4) this adds considerable traffic to the concession road between the months of June and September. The park sees approximately 120,000 visitors over the course of the season. Segment 5 (Bruce Road 20) and Segment 7 (Concession 6) also have a high proportion of collisions with 12-33% of the annual mortality. The remaining segments have fewer collisions, which may be in part due to lower speed limits in these on-site areas. Bruce Power has installed road signs on Bruce Rd 20 (segment 5) and on Concession 2 (segment 4), warning traffic of turtle and snake crossings and is also working in conjunction with the Provincial Parks on possible speed reductions on those impacted sections.

Bruce Power is committed to reducing its environmental footprint and this includes working with its employees to minimize vehicle-wildlife collisions to the greatest possible extent. Year-round focused communications are used to reinforce safety on- and off-site. These communications include sharing vehicle-wildlife collision data with our employees, so they understand where (and when) there is the greatest risk of collision with wildlife.

6.2.5 Groundwater – 2021 Non-Potable Groundwater Monitoring

Groundwater monitoring and sampling at Bruce Power was completed between September 29 and October 7, 2021. Currently there are 16 conventional groundwater monitoring sites at Bruce Power. Note that the radiological groundwater monitoring results are in Section 6.1.6. In 2021, groundwater level monitoring occurred between September 28th and September 30th across 16 sites at 118 locations within the Site. Sampling occurred at a refined set of groundwater monitoring locations based on the previous year's results (exceedance follow-up) or due to site operational activities and potential risks to groundwater (i.e. existence of SSC's containing COPC's). Locations that did not require sampling in 2021 were:

- Bunker C Oil Aboveground Storage Tanks
- Fire Training Facility
- Bruce Nuclear Standby Generators
- Bruce B Standby Generators –North (MNA Program in progress)
- Bruce B Emergency Power Generators (MNA Program in progress)
- Distribution Station #1
- Central Storage Facility
- Central Maintenance Facility

Table 47 summarizes exceedances of Ministry of Environment, Conservation and Parks Site Condition Standards (either Table 2 –Full Depth Generic Site Condition Standards in a Potable Groundwater Condition or Table 8 –Generic Site Condition Standards for Use Within 30m of a Water Body in a Potable Groundwater Condition based on groundwater monitoring site location). These criteria are considered protective of the environment but do not represent reportable limits.

The Bruce Power groundwater monitoring program ensures that any sources of contamination are removed and that residual contamination as a result of past activities is confirmed to be decreasing and not migrating. Based on 2021 results, all groundwater monitoring sites sampled are within normal, showing as expected trends. Based on the groundwater monitoring program's management system for exceedances of evaluation criteria, these results prompt continued monitoring in 2022.

Long term monitoring is in place in order to confirm that groundwater related impacts have not migrated and pose no risk to receptors. Many sites which were originally ranked as being of potential concern to groundwater have shown no exceedances for a number of years. These areas have experienced operational change, de-commissioning activities or removal of systems structures and/or components containing contaminants of concern.

The exceedances observed in 2021 can be attributed to known historical events or activities and are grouped into a small number of parameter groups. These results were observed at groundwater depths greater than that which would potentially impact any receptors. Site locations (in Section 6.1.6) are shown for Bruce A in Figure 45 and for Bruce B in Figure 49, with a summary in Table 47 which also includes Centre of Site locations (Fire Training Field, Former Bruce Heavy Water Plant, Former Bunker C).

Table 47 - Summary of Conventional Groundwater Exceedances for 2021 and 5-year Trend

Site	Well ID	Parameter	Unit of Measure	Criteria	Detection Limit	Result	Historical Trend (2017–2021)	
							Range (min-max)	Number of observations (and exceedances if applicable)
Bruce A Standby Generators	BASG-13	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (ii)	100	1,960	<100-1,960	5 (3)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (ii)	250	860	<250 - 940	5 (3)
	BASG-22	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (ii)	100	440	<100 - 600	5 (3)
Former Bunker C Oil Ignition and Day Tank	BCO-27	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (i)	100	520	<100 - 520	4 (1)
	BCO-28B	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (i)	100	210	210 – 5,330	4 (4)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (i)	250	640	640 – 5,680	4 (4)
	BCO-34B	Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (i)	250	730	650 – 1,370	4 (4)
	BCO-28A	Metals - Vanadium	ug/L	6.2 (i)	0.5	43.8	10.4 - 45	4 (4)
	BCO-28B	Metals - Vanadium	ug/L	6.2 (i)	0.5	38	10.1 – 38	4 (4)
	BCO-30	Metals - Vanadium	ug/L	6.2 (i)	0.5	397	397	1 (1)
	BCO-34A	Metals - Vanadium	ug/L	6.2 (i)	0.5	10.9	1.05 – 10.9	4 (1)
	BCO-34B	Metals - Vanadium	ug/L	6.2 (i)	0.5	60.6	6.1 – 60.6	4 (3)
Fire Training Facility	FTF-38	Ethylbenzene	ug/L	2.4 (i)	0.5	2.65	0.77 – 2.65	4 (1)
	FTF-23	Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (i)	250	990	<250 - 990	3 (1)
	FTF-30 (iv)	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (i)	100	1,450	1,250 – 15,300	4 (4)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (i)	250	740	740 – 16,800	4 (4)
	FTF-38 (iii)	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (i)	100	200,000	1,260 – 200,000	4 (4)

Site	Well ID	Parameter	Unit of Measure	Criteria	Detection Limit	Result	Historical Trend (2017–2021)	
							Range (min-max)	Number of observations (and exceedances if applicable)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (i)	250	209,000	1,170 – 209,000	4 (4)
		Petroleum hydrocarbons F4 (C34-C50)	ug/L	500 (i)	250	1,600	<250 – 1,600	4 (1)
	FTF-42 (iv)	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (i)	100	2,140	2,140 – 8,670	4 (4)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (i)	250	1,880	1,880 – 7,680	4 (4)
	FTF-48 (iv)	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (i)	100	900	900 – 48,200	4 (4)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (i)	250	570	570 – 36,500	4 (4)
	FTF-50	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (i)	100	380	380 – 1,460	4 (4)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (i)	250	680	680 – 1,970	4 (4)
	FTF-52 (iv)	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (i)	100	21,600	180 – 21,600	4 (4)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (i)	250	21,500	<250 – 21,500	4 (3)
Bruce B Standby Generators (south)	BBSG-46	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (ii)	100	210	150 - 220	5 (4)
Bruce A Transformer Area	BATR-3-11	Volatile Organic Compounds - Chloroform	ug/L	2.4 (ii)	1	7.8	7.8 - 30	4 (4)
Bruce B Transformer Area	BBTR-5-11 (iv)	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (ii)	100	660	600 – 1,710	3 (3)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (ii)	250	12,300	11,900 – 25,600	3 (3)
	BBTR-5-14	Metals – Uranium	ug/L	20 (ii)	0.10	23.3	22.3 – 31.6	5 (5)
Former Bruce Heavy	MW-1-07 (iii)	Petroleum hydrocarbons F2	ug/L	150 (ii)	100	15,900	1,550 – 15,900	3 (3)

Site	Well ID	Parameter	Unit of Measure	Criteria	Detection Limit	Result	Historical Trend (2017–2021)	
							Range (min-max)	Number of observations (and exceedances if applicable)
Water Plant		(C10-C16)						
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (ii)	250	1,170,000	229,000 – 1,170,000	3 (3)
		Petroleum hydrocarbons F4 (C34-C50)	ug/L	500 (ii)	250	40,100	16,900 – 40,100	3 (3)
	MW-2-07 (iv)	Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (ii)	250	4,850	4,850 – 175,000	3 (3)
	MW-3-07	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (ii)	100	230	<100 - 230	4 (1)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (ii)	250	2,160	<250 – 2,160	4 (1)
		Petroleum hydrocarbons F4 (C34-C50)	ug/L	500 (ii)	250	540	<250 - 540	4 (1)
	MW-4-07	Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (ii)	250	1,090	340 – 1,560	4 (2)
	MW-4B	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (ii)	100	11,400	10,800 – 35,700	4 (4)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (ii)	250	60,200	60,200 – 153,000	4 (4)
		Petroleum hydrocarbons F4 (C34-C50)	ug/L	500 (ii)	250	3,950	3,950 – 11,900	4 (4)
		Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (ii)	100	580	<100 - 580	4 (2)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (ii)	250	3,950	330 – 3,950	4 (3)

Table 2 – Full Depth Generic Site Condition Standards in a Potable Groundwater Condition

Table 8 – Generic Site Condition Standards for Use Within 30m of a Water Body in a Potable Groundwater Condition

Free product identified during sampling event

Sheen observed during sampling event

Bold/Italic - Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.

6.2.5.1 Petroleum Hydrocarbons (PHC) and Benzene, Toluene, Ethylbenzene and Xylene (BTEX)

PHC and BTEX exceedances are observed at areas where there has historically been firefighting training, fueling activities, combustion operations and large inventories of fuel oils and mineral oils maintained. Events have occurred which have caused PHC and BTEX contamination in these areas.

- The Bruce A Standby Generator area experienced a cracked valve in the supply pipeline in 1996 leading to a 22,000L fuel oil spill. Residual contamination remains in this area as a result.
- A main output transformer explosion occurred in 2005 in front of Bruce B Unit 6 causing a large mineral oil release which migrated to the subsurface. PHC exceedances are still observed in this area due to this event.
- A leak of an underground fuel supply line used in training activities occurred at the Fire Training Facility. A follow-up remediation program occurred following the identification of this failure. Free product was identified in one of the monitoring wells in 2021. Free product represents a source of contamination to groundwater. The free product was removed and disposed of as hazardous waste.
- Firefighting training continuously occurs at the Fire Training Facility. This site operates under an approved Environmental Compliance Approval.
- Historical activities at the former oil storage area within the Former Bruce Heavy Water Plant resulted in residual hydrocarbon contamination. Free product was identified in one of the monitoring wells in 2021. Free product represents a source of contamination to groundwater. The free product was removed and disposed of as hazardous waste.

Residual contamination from petroleum hydrocarbons exists at a number of areas across the Bruce Power site, typically related to historical events. Long-term monitoring is in place at these locations in order to verify that this contamination is not migrating and is either stable or degrading with time such that it does not impact identified receptors.

6.2.5.2 Metals

Metals exceedances may be due to operational activities causing groundwater contamination or be due to natural sources from metal/mineral deposits. It is not possible to discern actual sources of minor metals exceedances in all cases. This is true for uranium and exceedances observed in 2020 which were not observed again in 2021 except for a minor exceedance at the Bruce B Transformer area. Chromium in groundwater may be naturally occurring, or may be present as a result of chemical processes depending on the valence state of chromium detected. Chromium that was observed 2020 in one well in the Bruce A Transformer Area slightly above the Table 8 Site Condition Standard which was not observed in 2021. Vanadium exceedances have been observed in multiple wells at the former Bunker C Oil Ignition and Day Tank and former Acid Wash Pond monitoring locations. These exceedances are likely due to former boiler cleaning activities related to these sites. Metal exceedances noted in 2021 are minor in nature and are not widespread. These exceedances may be due to natural processes or previous site activities (historical). Based on levels seen in 2021, these exceedances are not a cause for concern and will continue to be monitored.

6.2.5.3 Volatile Organic Compounds (VOC)

A chloroform exceedance was observed at the Bruce A Transformer Area in a single well in the vicinity of Unit 3. Chloroform was not included in the sampling plan for 2020, however exceedances have been observed over the last number of years. Detections of bromo-dichloromethane were also observed however were not found to exceed the applicable site condition standard. These two compounds are trihalomethanes and may be related to drinking water ingress into the groundwater monitoring well. A failed drinking water distribution pipe was identified in 2020 and has been subsequently repaired. The chloroform result in 2021 is at the lowest level observed since 2016.

6.2.5.4 Summary of Next Steps

In 2022, Bruce Power will continue to monitor groundwater at select locations based on ongoing site operations and related risk to groundwater (i.e. storage of fuel oil or transformer operation) in order to provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring. Residual impacts from previous site activities will continue to be monitored to verify that levels are decreasing and confirm that subsurface contamination is not migrating. Water levels will be taken at all site monitoring locations in order to confirm the inferred groundwater flow direction. Groundwater results will be evaluated against the applicable MECP Site Condition Standard in order to assess risks from site-affected groundwater to human health and the environment.

6.2.5.5 Quality Control

The 2021 groundwater sampling campaign consisted of 67 normal groundwater samples, eight groundwater field duplicate samples, eight groundwater field blank samples and eight trip blank water samples. The samples were collected and delivered to a third party, ISO 17025 certified laboratory and analyzed with an applicable EPA or CCME laboratory method. Through data quality evaluation, the certificates of analysis were reviewed for chain of custody documentation, holding time compliance, method blanks, laboratory control samples, matrix spikes, surrogate recoveries, laboratory duplicates and field quality control samples. The goal of the data quality evaluation is to demonstrate that a sufficient number of representative samples were collected, and that the resulting analytical data can be used to support the decision making process. This is done through an evaluation of the following: Precision – through the review of laboratory data quality indicators that include laboratory and field duplicate relative percent differences. The overall precision was acceptable. Accuracy – through the review of laboratory control samples, matrix spikes and surrogate recoveries, as well as the evaluation of method/field blank data. Accuracy was acceptable. Representativeness –verified through the sample’s collection, storage and preservation procedures and verification of holding time compliance. The overall representativeness of the data was acceptable. Comparability –verified through the use of standard USEPA analytical procedures and standard units for reporting. Results obtained are comparable to industry standards, in that the collection and analytical techniques followed approved, documented procedures. Completeness –is a measure of the number of valid measurements obtained in relation to the total number of measurements planned. Completeness is expressed as a percentage of the valid or usable measurements compared to the planned measurements. Valid data are defined as all data that are not rejected for project use. All data were considered valid. The completeness goal of 95 percent was met for all methods and analytes. The data obtained can be used for project decision making.

7.0 WASTE MANAGEMENT

Bruce Power manages many different forms of waste to ensure they are disposed of safely without polluting the environment:

- Hazardous waste (oils, chemicals, lighting lamps and ballasts – some of these are recycled)
- Recyclable waste (glass, plastic, metal, cardboard, paper, wood, batteries, and electronics)
- Organics and food wastes (compost)
- Radiological waste (low-, intermediate-, and high-level radiological waste is taken to the on-site Western Waste Management Facility, which is operated by Ontario Power Generation)
- Landfill waste (for those items that are neither hazardous, recyclable, compostable, nor radiological)

Bruce Power complies with all waste regulations and requirements of the relevant Federal, Provincial, and Municipal authorities. Further, Bruce Power has taken an active role for many years to reduce all forms of waste: from an environmental and financial standpoint waste reduction is good for our company and the community in which we reside. Our philosophy employs a whole life-cycle approach in that we reduce waste at the consumer level, generate less waste at the company level, find opportunities to reuse products (on-site, off-site donations, or sell them at auction), and implement recycling programs that are available in the ever-changing recycling market. To minimize the amount of waste sent to landfill each day, Bruce Power has implemented several initiatives that apply the principles of reduce, reuse, recycle, and recover. Wherever its fate, each waste stream generated at Bruce Power is processed and disposed of in a safe and environmentally responsible manner.

Table 48 summarizes the waste management and pollution prevention reports submitted to regulatory agencies.

Table 48 - Bruce Power Waste Regulatory Reporting

Waste	Report Title (Document Control Number)	Regulatory Agency	Submission Date (Frequency)
Conventional Waste (See s7.1)	Report of a Waste Reduction Work Plan, O Reg 102/94	Internal Report	Q1 2022 (Annual)
Conventional Waste (See s7.1)	Report of a Waste Audit, O Reg 102/94	Internal Report	Q1 2022 (Annual)
Hazardous (See s7.2)	Generator Reregistration Report, O Reg 347	Ministry of Environment, Conservation and Parks	15FEB2022 (Annual)
Waste & Pollution Prevention - PCB (See s7.5)	Federal PCB Regulations Bruce Power 2021 Annual Report Declaration	Environment and Climate Change Canada	31MAR2022 (Annual)
Waste & Pollution Prevention - PCB (See 7.5)	2021 Annual Bruce A Polychlorinated Biphenyl (PCB) Waste Storage Report for Bruce A Storage Facility # 10400A003 (BP-CORR-00541-00114)	Ministry of Environment, Conservation and Parks	31JAN2022 (Annual)
	2021 Annual WCTF Polychlorinated Biphenyl (PCB) Waste Storage Report for Storage Facility # 10402A001 (BP-CORR-00541-00115)	Ministry of Environment, Conservation and Parks	31JAN2022 (Annual)

7.1 Conventional Waste

The primary objective of the Conventional Waste Program is to process wastes in a safe and environmentally responsible manner while achieving waste minimization through the application of reduce, reuse, recover, and recycle principles.

Conventional waste at Bruce Power is managed and disposed of in accordance with regulatory requirements including:

- The Ontario Environmental Protection Act [R-134]
- Ontario Regulation 347, General Waste Management [R-135]
- Ontario Regulation 103/94, Industrial, Commercial and Institutional Source Separation Programs [R-136]
- Ontario Regulation 102/94, Waste Audits and Waste Reduction Work Plans [R-137]

- Transport Canada's Transportation of Dangerous Goods (TDG) Act [R-138]

Management of conventional waste includes all non-hazardous and non-radiological items: recyclables, compost, and waste destined for landfill. As defined in Ontario Reg. 103/94 [R-136], Bruce Power is a large manufacturing establishment and is mandated to have recycling programs in place for the following materials:

- Aluminum
- Cardboard (corrugated)
- Fine paper
- Glass
- Newsprint
- Polyethylene (high density) jugs, pails, crates, totes, and drums
- Polyethylene (linear low density and low density) film*
- Polystyrene (expanded) foam*
- Polystyrene trays, reels and spools*
- Steel
- Wood (not including painted, treated, or laminated wood)

*Limitations apply depending on the availability of service providers able to recycle these materials.

In addition to these recycling programs, Bruce Power has an established composting program for organic waste including food, paper towels, and biodegradable coffee cups, lids and food containers.

Bruce Power utilizes approved waste disposal contractors to collect conventional wastes on site. Waste disposal vendors are bound by Environmental Compliance Approvals (ECA) that stipulate approved wastes that can be accepted by the landfill or facility.

As shown in Table 49, the total amount of conventional waste produced at Bruce Power in 2021 was 1,980 metric tons. In 2021, 597 metric tons of waste was sent to an off-site landfill, while a total 1,333 metric tons of waste was diverted to a recycling or compost program. While the total waste generated on site increased by 650 metric tons compared to the previous year, Bruce Power's diversion rate increased from 64% in 2020 to 67% in 2021, indicating an increased amount of waste diverted from landfill. The increase of waste across all the conventional waste programs is likely due to a significant increase in the number of on-site workers at Bruce Power during 2021. In 2021, the average number of employees working at the Bruce Power site increased to 12,386, as compared to 2020, where there was an average of 2,267 workers on-site. As COVID-19 restrictions lessened, more staff were able to safely return to on-site working. There was also more staff working on-site in 2021 to support U6-MCR activities and outage-related work.

Table 49 - Conventional Waste Generated at Bruce Power from 2016 to 2021 [1 metric ton (mt) = 1,000 kg]

Year	Landfill (mt)	Compost (mt)	Recycling (mt)	Total (mt)	Number of Workers*	Diversion Rate
2016	555	103	1,145	1,965	8,201	64%
2017	462	97	1,042	1,795	8,584	63%
2018	572	111	1,226	1,967	9,654	68%
2019	609	61	1,288	2,016	10,010	67%
2020	511	62	847	1,420	2,267	64%
2021	597	98	1,235	1,980	12,386	67%
Note: * Includes all categories of active workers working at the Bruce Power Site (does not include remote workers): Regular, Temporary, Casual, Augmented Staff, Student, and External Non-Time Reporting workers.						

In 2021, 30% of Bruce Power's conventional waste was sent to landfill, 5% was composted, and the remainder was recycled via several different recycling streams (65%). The distribution among different waste streams has changed significantly over time, depending on the types of activities occurring at the company (commissioning/decommissioning) and the different recycling processes available in the global waste management market.

As per Ontario Reg. 102/94 [R-137], Bruce Power must also perform an annual conventional waste audit. The waste audit must be completed by a third-party vendor, and a waste audit report that includes a waste reduction work plan must be prepared for Bruce Power. Independent assessments of Bruce Power's performance in conventional waste management have occurred annually for many years. The auditor's assessments consistently show that Bruce Power is performing well in comparison to other large industrial facilities.

7.2 Hazardous Waste

Bruce Power's Hazardous Waste Program ensures the safe handling, storage and disposal of hazardous wastes in accordance with regulatory requirements outlined in the Environmental Protection Act, O Reg 347, General Waste Management [R-139].

Hazardous wastes, such as chemicals, oils, batteries, and fluorescent tubes, are generated at numerous locations on-site. They are carefully tracked to ensure all hazardous waste is safely disposed of in accordance with all applicable regulatory requirements. Bruce Power has an excellent network of external waste vendors (certified to carry and/or receive hazardous wastes) who frequently work with us to dispose of all our hazardous waste streams in an industrially and environmentally safe manner. Hazardous wastes are routinely diverted from landfill by recycling batteries, lamps, oil, and electronic waste.

7.2.1 Hazardous Waste Inspections

In October 2021, the CNSC completed inspections of the Bruce A, Bruce B and COS Hazardous Waste Storage Facilities. There were no significant findings out of the CNSC inspections. Monthly inspections of Bruce Power's two PCB Storage Facilities continue to occur.

7.2.2 Polychlorinated Biphenyls (PCB)

According to the PCB Regulation SOR/208-273 [R-140], equipment containing PCBs in a concentration of at least 50 parts per million but less than 500 parts per million, must have the equipment removed from site by December 31, 2025. This includes electrical transformers and their auxiliary electrical equipment, lighting ballasts, and capacitors. Electrical cables in any concentration must also be removed so that they are not "abandoned in place" which is a violation of the Environmental Protection Act [R-99]. Currently there is no regulatory removal date for PCB cables. In 2018, a plan was created for PCB removal, focusing on the above equipment, to meet the regulatory deadline of December 31, 2025. This plan is reviewed and updated on a regular basis to ensure that Bruce Power will complete the regulatory deadline.

8.0 AUDITS

The N288.4, N288.5 and N288.7 environmental standards [R-19][R-141][R-142] require an audit to be performed once every five years to help ensure that environmental, effluent and groundwater monitoring programs operate in compliance with their procedures and elements. The initial Independent Oversight Audit against N288.4 and N288.5, AU-2018-00001[R-143], was performed in the spring of 2018. Bruce Power addressed all audit findings and is in conformance with these standards. N288.7-15 was audited in Q4 2020, AU-2020-00013[R-144]. Bruce Power has action plans in place to address gaps and opportunities for improvement identified in the report and is in conformance with the N288.7-15 standard[R-144].

8.1.1 EMS Audit Internal/External

Internal Independent Oversight Audits are performed once annually against the ISO 14001 standard [R-3]. These audits are performed to ensure Bruce Power's environmental management system (EMS) continually conforms to the standard. These audits are generally more in depth than the external audits and are used to focus on certain environmental program areas each year. All environmental program areas (e.g. Effluent and Environmental Monitoring, Spills and Waste Management) are required to be audited once in a three-year period. This three-year period aligns with the external re-registration timeframe set out by the accreditation body. The 2021 Environmental Management System Audit, AU-2021-00005 [R-145], concluded that Bruce power has a mature EMS that is effectively implemented and maintained in accordance with the requirements of both the organization and the ISO 14001 Standard [R-3].

9.0 CONCLUSION

The purpose of this report is to fulfill regulatory requirements on environmental protection in accordance with Licence Condition 3.3 of the Bruce A and Bruce B Power Reactor Operating

Licence (PROL) Bruce Nuclear Generating Stations A and B 18:02/2028 [R-1] and the CNSC Regulatory Document REGDOC-3.1.1 Reporting Requirements for Nuclear Power Plants, Section 3.5 [R-2]. Within this report, Bruce Power has provided information on effluent and emission results, environmental monitoring findings and demonstrated our continued commitment to environmental protection and sustainability.

Bruce Power continued to have strong community relations and demonstrated commitment to continued engagement with the local Indigenous communities of the SON, MNO and HSM throughout 2021 and will continue to build on these strengths and commitments. The sustainability program pivoted to support a more quantitative and formalized program with stronger governance, built off the Environmental Social and Governance (ESG) approach, to align with global standards and guidelines in this space. Specific sustainability reporting utilizing this quantitative approach will began in 2021.

For the 30th consecutive year, Bruce Power's contribution to the annual dose of a member of the public is less than the lower threshold for significance (<10 µSv/year) and is considered *de minimus* [R-42]. The representative person's dose associated with Bruce Power operations in 2021, who is calculated to have the maximum, is the BSF3 Adult who received 1.6 µSv/year. All other representative persons have a lower dose. This maximum dose is a fraction of a percent of the legal dose limit of 1,000 µSv/year.

Bruce Power is engaged in preparations for the submission of the 2022 ERA. All items listed in the closure of the 2017 ERA will be addressed in the 2022 ERA. The 2022 ERA will also include integration of the results of the mitigation measures assessment and work completed in the area of climate change.

Through Bruce Power's normal operation and outage maintenance activities, airborne emissions and waterborne effluents are released to the environment and monitored following robust monitoring standards (CSA N288.5) to confirm releases remain within compliance limits and ensure environmental protection. All radiological releases remained well below regulatory limits and Environmental Action Levels, and all conventional effluent parameter limits were met.

Bruce Power's radiological and conventional environmental monitoring programs are designed to continuously verify that environmental protection is being maintained and that any releases have a minimal impact on the surroundings. The radiological environmental monitoring program monitors radionuclides in the air, precipitation, water, agricultural and animal products, soil, sediment and groundwater. The conventional environmental monitoring program monitors for conventional contaminants, physical stressors and wildlife species presence. In 2021, conventional contaminant monitoring included water quality in the lake, on-site waterbodies and groundwater, and soil (on-site) and sediment (on- and off-site locations). Results of the radiological and conventional environmental monitoring programs in 2021 demonstrated that there were no significant or adverse changes to contaminant levels or wildlife species presence in the environment. This provides verification of the continued effectiveness of environmental protection policies and programs at Bruce Power.

Bruce Power continues to comply with all waste regulations and requirements of the relevant Federal, Provincial, and Municipal authorities. Further, Bruce Power plans to continue taking an active role to reduce all forms of waste: from an environmental and financial standpoint waste reduction is good for our company and the community in which we reside.

Finally, Bruce Power's compliance with ISO14001 and the CSA N288.4, N288.5 and N288.7 standards has been verified through internal independent oversight audits. Opportunities for improvement and any identified gaps are being addressed and do not impact overall conformance to ISO14001 or the N288 series standards.

The 2021 Environmental Protection Report provides evidence to support the conclusion that Bruce Power is complying with all relevant Provincial, Federal and regulatory requirements and legislations. Beyond compliance, Bruce Power is striving to measure and minimize its impact on the environmental through excellence in effluent and emissions management, continuous environmental monitoring, spill prevention and waste management. Bruce Power plans to continue to strive for excellence in all aspects of environmental monitoring and protection throughout 2021.

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APPENDIX A: REPRESENTATIVE PERSON PARAMETERS FOR DOSE CALCULATION

Table 50 - Local Percentage of Food Intake Obtained by Local Sources

Food Type	Infant (1-yr old)	Child (10-yr old)	Adult
Non-Farm Residential			
Milk and dairy	23.1%	19.9%	12.1%
Beef	0.72%	1.95%	6.95%
Pork	0.39%	1.07%	2.23%
Poultry	0.85%	2.07%	4.06%
Egg	0.29%	1.00%	2.62%
Deer	0.10%	0.29%	1.11%
Honey	0.08%	0.20%	0.27%
Total Animal Products	***25.5%***	***26.5%***	***29.3%***
Grain	3.44%	3.84%	3.35%
Fruit and Berries	10.4%	7.40%	6.23%
Vegetables (above-ground)	4.26%	5.02%	6.95%
Root Vegetables	1.57%	2.44%	2.85%
Total plant Products	**19.7%**	**18.7%**	**19.4%**
Fish	23.0%	23.0%	23.0%
Non-Dairy Farms			
Milk and dairy	12.5%	10.7%	6.51%
Beef	1.04%	2.80%	9.97%
Pork	0.58%	1.59%	3.33%
Poultry	1.41%	3.42%	6.70%
Egg	0.56%	1.94%	5.10%
Deer	0.20%	0.57%	2.22%
Honey	0.10%	0.26%	0.34%
Total Animal Products	***16.4%***	***21.3%***	***34.2%***
Grain	4.25%	4.73%	4.13%
Fruit and Berries	21.1%	15.0%	12.6%
Vegetables (above-ground)	10.1%	12.0%	16.5%
Root Vegetables	3.60%	5.62%	6.56%

Food Type	**Infant (1-yr old)**	**Child (10-yr old)**	**Adult**
Total Plant Products	**39.1%**	**37.3%**	**39.8%**
Fish	22.3%	22.3%	22.3%
Dairy Farms			
Milk and dairy	62.0%	53.4%	32.4%
Beef	1.04%	2.82%	10.1%
Pork	0.67%	1.82%	3.81%
Poultry	1.88%	4.57%	8.96%
Egg	0.66%	2.31%	6.07%
Deer	0.20%	0.57%	2.22%
Honey	0.12%	0.30%	0.40%
Total Animal Products	***66.6%***	***65.8%***	***63.9%***
Grain	7.92%	8.82%	7.71%
Fruit and Berries	13.8%	9.79%	8.25%
Vegetables (above-ground)	10.3%	12.1%	16.8%
Root Vegetables	3.51%	5.48%	6.39%
Total Plant Products	**35.5%**	**36.3%**	**39.1%**
Fish	25.0%	25.0%	25.0%
Subsistence Farms			
Milk and dairy	73.9%	63.6%	38.6%
Beef	1.97%	5.33%	19.0%
Pork	1.33%	3.64%	7.61%
Poultry	3.14%	7.62%	14.9%
Egg	0.81%	2.81%	7.39%
Deer	0.20%	0.57%	2.22%
Honey	0.18%	0.47%	0.62%
Total Animal Products	***81.5%***	***84.1%***	***90.4%***
Grain	18.7%	20.8%	18.2%
Fruit and Berries	28.4%	20.2%	17.0%
Vegetables (above-ground)	17.1%	20.1%	27.9%
Root Vegetables	5.80%	9.04%	10.5%
Total Plant Products	**69.9%**	**70.2%**	**73.6%**

Food Type	Infant (1-yr old)	Child (10-yr old)	Adult
Fish	100%	100%	100%
Hunter-Fisher			
Milk and dairy	23.1%	19.9%	12.0%
Beef	0.64%	1.72%	6.11%
Pork	0.39%	1.06%	2.21%
Poultry	0.86%	2.09%	4.07%
Egg	0.31%	1.08%	2.82%
Deer	0.27%	0.77%	2.97%
Honey	0.13%	0.33%	0.43%
Total Animal Products	25.7%	26.9%	30.6%
Grain	7.57%	8.44%	7.38%
Fruit and Berries	20.5%	14.5%	12.2%
Vegetables (above-ground)	8.60%	10.2%	14.0%
Root Vegetables	2.72%	4.24%	4.94%
Total Plant Products	39.3%	37.4%	38.6%
Fish	100%	100%	100%

Notes:

1. Values are percentage of total annual intake of combined food groups (e.g. fish, plants, animals).

Table 51 - Generic Rates of Intake of Air, Water and Various Foods

Parameter	Units	Infant (1-yr old)[1]	Child (10-yr old)	Adult (male)
Inhalation Rate	m^3/yr	1830	5660	5950
Water Ingestion Rate	L/yr	0	151.1	379.6
Grain Intake	kg/yr	55.2	140.7	163.5
Fruit & Berry Intake	kg/yr	54.6	88.8	99.4
Vegetable Intake	kg/yr	25.8	69.7	128.1
Mushrooms Intake	kg/yr	0.3	1.0	1.2
Potato Intake	kg/yr	8.7	30.9	47.9
Total Plant Product Ingestion Rate	***kg/yr***	***144.5***	***331.1***	***440.0***

Parameter	Units	Infant (1-yr old)[1]	Child (10-yr old)	Adult (male)
Beef Intake	kg/yr	4.4	13.1	45.8
Pork Intake	kg/yr	3.5	10.4	19.8
Lamb Intake	kg/yr	0.0	1.0	0.6
Poultry Intake	kg/yr	8.2	21.9	38.9
Egg Intake	kg/yr	2.1	8.1	19.2
Game (Deer, Rabbit) Intake	kg/yr	0.5/0.7	1.6/2.2	5.8/7.8
Milk Intake	kg/yr	242.7	228.1	125.6
Total Animal Product Ingestion Rate	***kg/yr***	***262.8/263.0***	***286.8/287.4***	***260.4/262.4***
Total Fish Ingestion Rate	***kg/yr***	***1.8/2.5***	***5.4/7.2***	***8.2/11.1***

1. The 1-year old infant is assumed to ingest cow's milk, which accounts for all fluid needs. Water (or formula made from water) is not ingested, as per CSA N288.1 [R-23].
2. All values are mean or central values from CSA N288.1 [R-23], with the exception of the Hunter/Fisher fish intake and game (e.g. deer, rabbit) intake for all age classes, which is based on the 2021 Site Specific Survey [R-146].

APPENDIX B: 2021 METEOROLOGICAL DATA ANALYSIS

The 2021 Double Joint Frequencies (DJF) and Triple Joint Frequencies (TJF) for the Bruce Power site were calculated following the usual approach [R-46]. The DJF was calculated for the 10m off-site tower and for the 10m and 50m elevations for the 50m on-site tower. The TJF was calculated for the 50m on-site tower at the 10m elevation only. It is this TJF data that is used in the dose to public calculation.

The hourly data was screened and grouped into wind speed bins, which are defined as per Table 10 of CSA N288.1-20 [R-23] and reproduced in Table 52. The wind direction was then divided into 16 wind direction sectors with each sector being 22.5 degrees, as shown in Table 53.

Table 52 - Wind Speed Bins Used for the Generation of DJF and TJF Tables

Wind Speed Class	Wind Speed, u (m/s)
1	u ≤ 2
2	2 < u ≤3
3	3 < u ≤ 4
4	4 < u ≤ 5
5	5 < u ≤ 6
6	u > 6

Table 53 - Wind Direction Sectors

Wind Sector (direction from which wind is blowing)	Wind Direction (θ) in degrees
N	θ > 348.75 or θ ≤ 11.25
NNE	11.25 < θ ≤ 33.75
NE	33.75 < θ ≤ 56.25
ENE	56.25 < θ ≤ 78.75
E	78.75 < θ ≤ 101.25
ESE	101.25 < θ ≤ 123.75
SE	123.75 < θ ≤ 146.25
SSE	146.25 < θ ≤ 168.75
S	168.75 25 < θ ≤ 191.25
SSW	191.25 < θ ≤ 213.75
SW	213.75 < θ ≤ 236.25
WSW	236.25 < θ ≤ 258.75
W	258.75 < θ ≤ 281.25
WNW	281.25 < θ ≤ 303.75

NW	303.75 < θ ≤ 326.25
NNW	326.25 < θ ≤ 348.75

The Pasquill-Gifford stability classes A to F were used. Stability class was estimated from the standard deviation of wind direction measured, taking into account night-time conditions and wind speeds [R-147]. A surface roughness of 0.4 m was assumed for all sectors. This value represents rural areas with mixed farming, tall bushes and small villages, consistent with CSA N288.2-19 [R-45]. Inclusion of surface roughness in the methodology for determining Pasquill-Gifford stability category is a refinement in the classification scheme, which results in shifting more cases towards the neutral D-stability class conditions with increased roughness [R-148].

The calculated DJF and TJF data at the 50m on-site meteorological tower are presented in Table 54, Table 55 and Table 56.

Table 54 - Annual Average DJF for Bruce Power Site for Year 2021 – 50 m Meteorological Tower at 10 m Height

Wind Direction (wind blowing from)	**Wind Speed, u (m/s)**						
	u ≤ 2	**2 < u ≤ 3**	**3 < u ≤ 4**	**4 < u ≤ 5**	**5 < u ≤ 6**	**u > 6**	**Total**
	Frequency (%) at 10 m Height						
N	0.89	1.51	1.53	0.68	0.48	0.14	**5.23**
NNE	1.45	0.68	0.65	0.32	0.31	0.13	**3.54**
NE	2.24	1.23	0.55	0.24	0.05	0.00	**4.30**
ENE	3.16	1.15	0.37	0.06	0.00	0.00	**4.74**
E	1.84	0.49	0.34	0.17	0.01	0.00	**2.85**
ESE	2.23	0.88	0.58	0.39	0.23	0.06	**4.36**
SE	4.16	2.43	1.51	0.87	0.26	0.03	**9.26**
SSE	4.28	2.37	1.34	1.00	0.19	0.01	**9.20**
S	3.39	2.15	1.35	0.99	0.86	0.74	**9.47**
SSW	1.52	2.01	2.83	2.13	1.12	0.51	**10.13**
SW	0.88	1.72	2.19	1.03	0.73	0.71	**7.26**
WSW	0.58	1.24	0.92	0.67	0.49	1.07	**4.99**
W	0.56	1.16	0.79	0.68	0.56	1.00	**4.76**
WNW	0.75	1.23	0.94	0.67	0.81	0.79	**5.19**
NW	1.40	1.85	1.22	1.15	0.83	1.37	**7.83**
NNW	0.87	1.76	1.52	1.34	0.99	0.41	**6.88**
Total	**30.19**	**23.88**	**18.62**	**12.41**	**7.92**	**6.97**	**100.00**

Table 55 - Annual Average DJF for Bruce Power Site for Year 2021 – 50 m Meteorological Tower at 50 m Height

Wind Direction (wind blowing from)	**Wind Speed, u (m/s)**						
	u ≤ 2	**2 < u ≤ 3**	**3 < u ≤ 4**	**4 < u ≤ 5**	**5 < u ≤ 6**	**u > 6**	**Total**
	Frequency (%) at 50 m Height						
N	0.41	0.39	0.64	0.73	0.63	2.01	**4.81**
NNE	0.49	0.48	0.64	0.58	0.48	1.67	**4.34**
NE	0.43	0.56	0.98	0.89	0.64	0.94	**4.44**
ENE	0.43	1.04	1.28	1.18	0.56	0.37	**4.85**
E	0.39	0.81	0.83	0.67	0.30	0.18	**3.18**
ESE	0.32	0.74	0.98	0.54	0.41	1.05	**4.04**
SE	0.38	0.72	1.32	1.21	1.06	1.85	**6.54**
SSE	0.37	0.65	1.15	1.38	1.59	2.04	**7.18**
S	0.32	0.33	0.98	1.63	2.21	3.18	**8.66**
SSW	0.32	0.74	1.23	1.77	2.07	5.78	**11.91**
SW	0.49	0.84	1.15	1.61	1.28	2.72	**8.09**
WSW	0.38	0.91	0.89	0.82	0.73	2.17	**5.90**
W	0.32	0.84	0.75	0.46	0.53	2.40	**5.30**
WNW	0.54	0.80	0.53	0.67	0.49	2.95	**5.97**
NW	0.54	0.84	0.79	0.89	0.59	3.74	**7.40**
NNW	0.50	0.81	1.03	1.00	0.89	3.15	**7.39**
Total	**6.62**	**11.52**	**15.18**	**16.04**	**14.45**	**36.19**	**100.00**

Table 56 - Annual Average TJF for Bruce Power Site for Year 2021 – 50 m Meteorological Tower at 10m Height

Stability Class	**Wind Direction** (wind blowing from)	**Wind Speed, u (m/s)**						
		u ≤ 2	**2 < u ≤ 3**	**3 < u ≤ 4**	**4 < u ≤ 5**	**5 < u ≤ 6**	**u > 6**	**Total**
		Frequency (%) at 10 m Height						
A	N	0.27	0.95	0.87	0.37	0.27	0.09	**2.82**
	NNE	0.48	0.31	0.25	0.11	0.14	0.07	**1.36**
	NE	0.35	0.19	0.06	0.05	0.00	0.00	**0.65**
	ENE	0.50	0.47	0.19	0.00	0.00	0.00	**1.16**
	E	0.50	0.21	0.09	0.00	0.00	0.00	**0.80**
	ESE	0.25	0.17	0.06	0.02	0.00	0.00	**0.50**
	SE	0.29	0.18	0.11	0.06	0.02	0.00	**0.66**
	SSE	0.29	0.31	0.33	0.25	0.02	0.00	**1.20**
	S	0.27	0.29	0.16	0.21	0.09	0.10	**1.12**
	SSW	0.30	0.49	0.84	0.49	0.19	0.03	**2.35**
	SW	0.27	0.62	0.49	0.07	0.02	0.00	**1.47**
	WSW	0.24	0.64	0.21	0.06	0.01	0.01	**1.16**
	W	0.22	0.58	0.10	0.05	0.01	0.03	**0.99**
	WNW	0.35	0.68	0.21	0.03	0.01	0.01	**1.30**
	NW	0.50	0.81	0.18	0.05	0.01	0.00	**1.55**
	NNW	0.30	0.65	0.51	0.41	0.16	0.05	**2.08**
	Total	**5.39**	**7.55**	**4.67**	**2.21**	**0.97**	**0.40**	**21.19**
B	N	0.01	0.02	0.02	0.00	0.00	0.00	**0.06**
	NNE	0.08	0.02	0.02	0.00	0.01	0.00	**0.14**
	NE	0.21	0.21	0.08	0.07	0.00	0.00	**0.56**
	ENE	0.16	0.14	0.09	0.03	0.00	0.00	**0.42**
	E	0.06	0.01	0.03	0.01	0.00	0.00	**0.11**
	ESE	0.15	0.16	0.09	0.11	0.09	0.05	**0.65**
	SE	0.22	0.24	0.32	0.18	0.03	0.00	**0.99**
	SSE	0.18	0.31	0.38	0.37	0.06	0.00	**1.29**
	S	0.14	0.25	0.29	0.30	0.31	0.31	**1.59**
	SSW	0.08	0.40	1.00	1.11	0.54	0.15	**3.28**
	SW	0.09	0.39	0.87	0.45	0.18	0.16	**2.13**
	WSW	0.02	0.21	0.33	0.23	0.10	0.21	**1.10**
	W	0.00	0.24	0.37	0.18	0.22	0.16	**1.16**
	WNW	0.02	0.11	0.17	0.33	0.22	0.23	**1.08**
	NW	0.08	0.26	0.48	0.32	0.18	0.24	**1.56**
	NNW	0.08	0.23	0.37	0.18	0.19	0.06	**1.11**
	Total	**1.58**	**3.20**	**4.91**	**3.87**	**2.13**	**1.55**	**17.24**

Stability Class	Wind Direction (wind blowing from)	Wind Speed, u (m/s)						
		u ≤ 2	2 < u ≤ 3	3 < u ≤ 4	4 < u ≤ 5	5 < u ≤ 6	u > 6	Total
		Frequency (%) at 10 m Height						
C	N	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
	NNE	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
	NE	0.02	0.01	0.00	0.00	0.00	0.00	**0.03**
	ENE	0.01	0.00	0.00	0.00	0.00	0.00	**0.01**
	E	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
	ESE	0.05	0.00	0.01	0.00	0.00	0.00	**0.06**
	SE	0.07	0.14	0.05	0.00	0.00	0.00	**0.25**
	SSE	0.15	0.03	0.00	0.00	0.00	0.00	**0.18**
	S	0.08	0.16	0.02	0.00	0.01	0.00	**0.27**
	SSW	0.03	0.02	0.03	0.00	0.00	0.01	**0.10**
	SW	0.00	0.03	0.10	0.11	0.06	0.10	**0.41**
	WSW	0.00	0.06	0.06	0.11	0.05	0.23	**0.50**
	W	0.00	0.01	0.01	0.05	0.05	0.01	**0.13**
	WNW	0.01	0.01	0.01	0.00	0.00	0.02	**0.06**
	NW	0.03	0.08	0.07	0.13	0.08	0.34	**0.73**
	NNW	0.02	0.00	0.00	0.02	0.02	0.00	**0.07**
	Total	**0.48**	**0.56**	**0.37**	**0.42**	**0.26**	**0.72**	**2.81**
D	N	0.00	0.00	0.29	0.32	0.21	0.05	**0.86**
	NNE	0.05	0.00	0.21	0.21	0.16	0.06	**0.67**
	NE	0.08	0.14	0.39	0.13	0.05	0.00	**0.78**
	ENE	0.35	0.03	0.08	0.02	0.00	0.00	**0.49**
	E	0.06	0.00	0.15	0.16	0.01	0.00	**0.38**
	ESE	0.16	0.05	0.41	0.25	0.14	0.01	**1.02**
	SE	0.56	0.55	1.00	0.63	0.21	0.03	**2.98**
	SSE	0.57	0.25	0.55	0.39	0.11	0.01	**1.88**
	S	0.65	0.34	0.82	0.49	0.45	0.33	**3.08**
	SSW	0.05	0.18	0.76	0.54	0.39	0.32	**2.24**
	SW	0.00	0.10	0.59	0.40	0.47	0.45	**2.01**
	WSW	0.00	0.07	0.29	0.27	0.33	0.63	**1.59**
	W	0.00	0.03	0.26	0.41	0.29	0.80	**1.79**
	WNW	0.01	0.03	0.43	0.31	0.58	0.53	**1.89**
	NW	0.00	0.08	0.45	0.66	0.56	0.79	**2.53**
	NNW	0.02	0.00	0.45	0.72	0.62	0.31	**2.11**
	Total	**2.56**	**1.86**	**7.12**	**5.90**	**4.55**	**4.30**	**26.30**

Stability Class	Wind Direction (wind blowing from)	Wind Speed, u (m/s)						
		u ≤ 2	**2 < u ≤ 3**	**3 < u ≤ 4**	**4 < u ≤ 5**	**5 < u ≤ 6**	**u > 6**	**Total**
		Frequency (%) at 10 m Height						
E	N	0.02	0.07	0.35	0.00	0.00	0.00	**0.45**
	NNE	0.10	0.10	0.17	0.00	0.00	0.00	**0.38**
	NE	0.38	0.32	0.02	0.00	0.00	0.00	**0.72**
	ENE	0.80	0.17	0.00	0.00	0.00	0.00	**0.97**
	E	0.22	0.06	0.07	0.00	0.00	0.00	**0.34**
	ESE	0.43	0.27	0.01	0.00	0.00	0.00	**0.72**
	SE	1.40	0.96	0.02	0.00	0.00	0.00	**2.39**
	SSE	1.35	0.72	0.08	0.00	0.00	0.00	**2.15**
	S	1.00	0.59	0.06	0.00	0.00	0.00	**1.66**
	SSW	0.23	0.48	0.18	0.00	0.00	0.00	**0.89**
	SW	0.08	0.19	0.14	0.00	0.00	0.00	**0.41**
	WSW	0.02	0.14	0.05	0.00	0.00	0.00	**0.21**
	W	0.05	0.13	0.05	0.00	0.00	0.00	**0.22**
	WNW	0.07	0.16	0.11	0.00	0.00	0.00	**0.34**
	NW	0.14	0.35	0.05	0.00	0.00	0.00	**0.54**
	NNW	0.05	0.33	0.19	0.00	0.00	0.00	**0.57**
	Total	**6.34**	**5.05**	**1.55**	**0.00**	**0.00**	**0.00**	**12.93**
F	N	0.58	0.47	0.00	0.00	0.00	0.00	**1.05**
	NNE	0.74	0.25	0.00	0.00	0.00	0.00	**0.99**
	NE	1.20	0.37	0.00	0.00	0.00	0.00	**1.56**
	ENE	1.34	0.34	0.00	0.00	0.00	0.00	**1.68**
	E	1.00	0.22	0.00	0.00	0.00	0.00	**1.22**
	ESE	1.19	0.23	0.00	0.00	0.00	0.00	**1.42**
	SE	1.62	0.37	0.00	0.00	0.00	0.00	**1.99**
	SSE	1.75	0.75	0.00	0.00	0.00	0.00	**2.50**
	S	1.24	0.51	0.00	0.00	0.00	0.00	**1.76**
	SSW	0.83	0.43	0.00	0.00	0.00	0.00	**1.27**
	SW	0.43	0.39	0.00	0.00	0.00	0.00	**0.82**
	WSW	0.30	0.14	0.00	0.00	0.00	0.00	**0.43**
	W	0.30	0.17	0.00	0.00	0.00	0.00	**0.47**
	WNW	0.29	0.23	0.00	0.00	0.00	0.00	**0.51**
	NW	0.65	0.26	0.00	0.00	0.00	0.00	**0.91**
	NNW	0.40	0.55	0.00	0.00	0.00	0.00	**0.95**
	Total	**13.86**	**5.67**	**0.00**	**0.00**	**0.00**	**0.00**	**19.53**
Grand Total		**30.19**	**23.88**	**18.62**	**12.41**	**7.92**	**6.97**	**100.00**

APPENDIX C: 2021 DETAILED DOSE CALCULATION RESULTS

Table 57 - Dose to Representative Persons Located at BR1

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	6.60E-04	7.59E-07	7.52E-06	7.90E-10	3.86E-11	1.56E-08	5.07E-03	1.55E-01	7.78E-02	2.39E-01
	Co-60	9.46E-07	3.59E-08	3.61E-05	1.60E-03	3.12E-03	5.19E-04	6.75E-04	9.33E-06	1.18E-03	7.15E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	3.77E-03	0.00E+00	8.79E-03	1.31E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	1.28E-02	2.10E-02
	HTO[2]	4.11E-01	0.00E+00	1.22E-02	6.53E-03	0.00E+00	0.00E+00	1.31E-03	6.22E-01	1.45E-02	1.07E+00
	I(mfp)	1.07E-07	7.18E-09	0.00E+00	0.00E+00	1.11E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E-07
	Noble Gases	0.00E+00	2.08E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.08E-01
Total		**4.11E-01**	**2.08E-01**	**1.22E-02**	**8.13E-03**	**3.12E-03**	**9.22E-03**	**1.08E-02**	**7.77E-01**	**1.15E-01**	**1.55E+00**
Child (6-15 yrs)	C-14	9.41E-04	7.59E-07	4.13E-06	7.90E-10	8.37E-11	1.82E-07	3.05E-03	1.61E-01	5.24E-02	2.17E-01
	Co-60	1.35E-06	3.59E-08	4.65E-05	1.60E-03	3.12E-03	5.22E-04	9.51E-04	2.32E-05	1.10E-03	7.38E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.21E-03	0.00E+00	1.86E-03	3.57E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	2.83E-03	1.11E-02
	HTO[2]	4.88E-01	0.00E+00	6.06E-03	5.44E-03	0.00E+00	0.00E+00	7.36E-04	4.78E-01	1.42E-02	9.92E-01
	I(mfp)	2.39E-07	7.18E-09	0.00E+00	0.00E+00	1.11E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-07
	Noble Gases	0.00E+00	2.08E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.08E-01
Total		**4.89E-01**	**2.08E-01**	**6.11E-03**	**7.04E-03**	**3.12E-03**	**9.29E-03**	**5.94E-03**	**6.39E-01**	**7.24E-02**	**1.44E+00**
Infant (0-5 yrs)	C-14	6.43E-04	7.59E-07	0.00E+00	4.48E-11	1.43E-10	3.99E-07	2.08E-03	1.29E-01	4.08E-02	1.72E-01
	Co-60	9.89E-07	4.66E-08	0.00E+00	1.88E-05	4.06E-03	6.84E-04	7.96E-04	2.52E-05	8.58E-04	6.44E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.71E-04	0.00E+00	6.73E-04	1.79E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	1.07E-03	1.18E-02
	HTO[2]	3.37E-01	0.00E+00	0.00E+00	1.73E-04	0.00E+00	0.00E+00	5.27E-04	3.68E-01	2.20E-02	7.27E-01
	I(mfp)	2.86E-07	9.33E-09	0.00E+00	0.00E+00	1.45E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.09E-07
	Noble Gases	0.00E+00	2.69E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.69E-01
Total		**3.37E-01**	**2.69E-01**	**0.00E+00**	**1.92E-04**	**4.06E-03**	**1.21E-02**	**3.87E-03**	**4.96E-01**	**6.54E-02**	**1.19E+00**

Note: All doses reported in units of µSv/year.
[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment
[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 58 - Dose to Representative Persons Located at BR17

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	2.08E-04	2.40E-07	2.51E-06	7.24E-10	6.59E-12	1.56E-08	5.07E-03	1.32E-01	7.17E-02	2.09E-01
	Co-60	5.53E-07	2.10E-08	3.61E-05	1.60E-03	2.86E-03	5.19E-04	6.75E-04	8.50E-06	1.18E-03	6.88E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	3.77E-03	0.00E+00	8.79E-03	1.31E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	1.28E-02	2.10E-02
	HTO[2]	2.39E-01	0.00E+00	1.22E-02	6.53E-03	0.00E+00	0.00E+00	1.31E-03	7.01E-02	1.35E-02	3.43E-01
	I(mfp)	6.25E-08	4.21E-09	0.00E+00	0.00E+00	7.11E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.38E-08
	Noble Gases	0.00E+00	1.22E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-01
Total		**2.39E-01**	**1.22E-01**	**1.22E-02**	**8.13E-03**	**2.86E-03**	**9.22E-03**	**1.08E-02**	**2.02E-01**	**1.08E-01**	**7.14E-01**
Child (6-15 yrs)	C-14	2.97E-04	2.40E-07	1.38E-06	7.24E-10	1.43E-11	1.82E-07	3.05E-03	1.45E-01	4.55E-02	1.94E-01
	Co-60	7.90E-07	2.10E-08	4.65E-05	1.60E-03	2.86E-03	5.22E-04	9.51E-04	2.11E-05	1.10E-03	7.11E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.21E-03	0.00E+00	1.86E-03	3.57E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	2.83E-03	1.11E-02
	HTO[2]	2.84E-01	0.00E+00	6.06E-03	5.44E-03	0.00E+00	0.00E+00	7.36E-04	6.86E-02	1.36E-02	3.79E-01
	I(mfp)	1.40E-07	4.21E-09	0.00E+00	0.00E+00	7.12E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E-07
	Noble Gases	0.00E+00	1.22E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-01
Total		**2.85E-01**	**1.22E-01**	**6.11E-03**	**7.04E-03**	**2.86E-03**	**9.29E-03**	**5.94E-03**	**2.14E-01**	**6.49E-02**	**7.16E-01**
Infant (0-5 yrs)	C-14	2.03E-04	2.40E-07	0.00E+00	1.83E-11	2.44E-11	3.99E-07	2.08E-03	1.22E-01	3.57E-02	1.60E-01
	Co-60	5.79E-07	2.73E-08	0.00E+00	1.88E-05	3.71E-03	6.84E-04	7.96E-04	2.30E-05	8.58E-04	6.09E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.71E-04	0.00E+00	6.73E-04	1.79E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	1.07E-03	1.18E-02
	HTO[2]	1.96E-01	0.00E+00	0.00E+00	1.73E-04	0.00E+00	0.00E+00	5.27E-04	6.32E-02	2.16E-02	2.82E-01
	I(mfp)	1.67E-07	5.47E-09	0.00E+00	0.00E+00	9.29E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.82E-07
	Noble Gases	0.00E+00	1.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.58E-01
Total		**1.96E-01**	**1.58E-01**	**0.00E+00**	**1.92E-04**	**3.71E-03**	**1.21E-02**	**3.87E-03**	**1.85E-01**	**5.99E-02**	**6.19E-01**

Note: All doses reported in units of µSv/year.
[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment
[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 59 - Dose to Representative Persons Located at BR25

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	3.49E-04	4.01E-07	4.04E-06	7.45E-10	1.15E-11	1.56E-08	5.07E-03	1.64E-01	7.36E-02	2.43E-01
	Co-60	9.40E-07	3.56E-08	3.61E-05	1.60E-03	3.55E-03	5.19E-04	6.75E-04	1.01E-05	1.18E-03	7.58E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	3.77E-03	0.00E+00	8.79E-03	1.31E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	1.28E-02	2.10E-02
	HTO[2]	4.09E-01	0.00E+00	1.22E-02	6.53E-03	0.00E+00	0.00E+00	1.31E-03	8.64E-02	1.44E-02	5.30E-01
	I(mfp)	1.06E-07	7.14E-09	0.00E+00	0.00E+00	1.13E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E-07
	Noble Gases	0.00E+00	2.07E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.07E-01
Total		**4.09E-01**	**2.07E-01**	**1.22E-02**	**8.13E-03**	**3.55E-03**	**9.22E-03**	**1.08E-02**	**2.50E-01**	**1.11E-01**	**1.02E+00**
Child (6-15 yrs)	C-14	4.98E-04	4.01E-07	2.22E-06	7.45E-10	2.50E-11	1.82E-07	3.05E-03	1.79E-01	4.76E-02	2.30E-01
	Co-60	1.34E-06	3.56E-08	4.65E-05	1.60E-03	3.55E-03	5.22E-04	9.51E-04	2.53E-05	1.10E-03	7.81E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.21E-03	0.00E+00	1.86E-03	3.57E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	2.83E-03	1.11E-02
	HTO[2]	4.86E-01	0.00E+00	6.06E-03	5.44E-03	0.00E+00	0.00E+00	7.36E-04	8.78E-02	1.42E-02	6.00E-01
	I(mfp)	2.38E-07	7.14E-09	0.00E+00	0.00E+00	1.13E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.56E-07
	Noble Gases	0.00E+00	2.07E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.07E-01
Total		**4.87E-01**	**2.07E-01**	**6.11E-03**	**7.04E-03**	**3.55E-03**	**9.29E-03**	**5.94E-03**	**2.67E-01**	**6.76E-02**	**1.06E+00**
Infant (0-5 yrs)	C-14	3.40E-04	4.01E-07	0.00E+00	2.65E-11	4.26E-11	3.99E-07	2.08E-03	1.59E-01	3.73E-02	1.99E-01
	Co-60	9.83E-07	4.63E-08	0.00E+00	1.88E-05	4.62E-03	6.84E-04	7.96E-04	2.73E-05	8.58E-04	7.01E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.71E-04	0.00E+00	6.73E-04	1.79E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	1.07E-03	1.18E-02
	HTO[2]	3.35E-01	0.00E+00	0.00E+00	1.73E-04	0.00E+00	0.00E+00	5.27E-04	8.89E-02	2.20E-02	4.47E-01
	I(mfp)	2.84E-07	9.28E-09	0.00E+00	0.00E+00	1.48E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.08E-07
	Noble Gases	0.00E+00	2.68E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.68E-01
Total		**3.36E-01**	**2.68E-01**	**0.00E+00**	**1.92E-04**	**4.62E-03**	**1.21E-02**	**3.87E-03**	**2.48E-01**	**6.19E-02**	**9.34E-01**

Note: All doses reported in units of µSv/year.
[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment
[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 60 - Dose to Representative Persons Located at BR27

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	3.49E-04	4.01E-07	9.39E-06	7.70E-10	1.15E-11	1.56E-08	5.07E-03	1.64E-01	7.36E-02	2.43E-01
	Co-60	9.40E-07	3.56E-08	1.04E-04	1.61E-03	2.58E-03	5.19E-04	6.75E-04	1.18E-05	1.18E-03	6.69E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	3.77E-03	0.00E+00	8.79E-03	1.31E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	1.28E-02	2.10E-02
	HTO[2]	4.09E-01	0.00E+00	1.84E-02	6.59E-03	0.00E+00	0.00E+00	1.31E-03	8.20E-02	1.46E-02	5.32E-01
	I(mfp)	1.06E-07	7.14E-09	0.00E+00	0.00E+00	1.08E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-07
	Noble Gases	0.00E+00	2.07E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.07E-01
Total		**4.09E-01**	**2.07E-01**	**1.85E-02**	**8.20E-03**	**2.58E-03**	**9.22E-03**	**1.08E-02**	**2.46E-01**	**1.11E-01**	**1.02E+00**
Child (6-15 yrs)	C-14	4.98E-04	4.01E-07	5.16E-06	7.70E-10	2.50E-11	1.82E-07	3.05E-03	1.79E-01	4.76E-02	2.30E-01
	Co-60	1.34E-06	3.56E-08	1.34E-04	1.61E-03	2.58E-03	5.22E-04	9.51E-04	2.90E-05	1.10E-03	6.94E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.21E-03	0.00E+00	1.86E-03	3.57E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	2.83E-03	1.11E-02
	HTO[2]	4.86E-01	0.00E+00	9.14E-03	5.49E-03	0.00E+00	0.00E+00	7.36E-04	8.28E-02	1.43E-02	5.99E-01
	I(mfp)	2.38E-07	7.14E-09	0.00E+00	0.00E+00	1.08E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.55E-07
	Noble Gases	0.00E+00	2.07E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.07E-01
Total		**4.87E-01**	**2.07E-01**	**9.28E-03**	**7.10E-03**	**2.58E-03**	**9.29E-03**	**5.94E-03**	**2.62E-01**	**6.77E-02**	**1.06E+00**
Infant (0-5 yrs)	C-14	3.40E-04	4.01E-07	0.00E+00	5.17E-11	4.26E-11	3.99E-07	2.08E-03	1.59E-01	3.73E-02	1.99E-01
	Co-60	9.83E-07	4.63E-08	0.00E+00	2.51E-05	3.36E-03	6.84E-04	7.96E-04	3.19E-05	8.59E-04	5.76E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.71E-04	0.00E+00	6.73E-04	1.79E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	1.07E-03	1.18E-02
	HTO[2]	3.35E-01	0.00E+00	0.00E+00	2.27E-04	0.00E+00	0.00E+00	5.27E-04	8.25E-02	2.20E-02	4.41E-01
	I(mfp)	2.84E-07	9.28E-09	0.00E+00	0.00E+00	1.41E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.07E-07
	Noble Gases	0.00E+00	2.68E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.68E-01
Total		**3.36E-01**	**2.68E-01**	**0.00E+00**	**2.52E-04**	**3.36E-03**	**1.21E-02**	**3.87E-03**	**2.42E-01**	**6.19E-02**	**9.27E-01**

Note: All doses reported in units of µSv/year.
[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment
[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 61 - Dose to Representative Persons Located at BR32

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	3.49E-04	4.01E-07	1.84E-05	9.76E-10	1.17E-10	1.56E-08	5.07E-03	1.64E-01	7.36E-02	2.43E-01
	Co-60	7.50E-07	2.84E-08	1.68E-04	1.63E-03	7.18E-03	5.19E-04	6.75E-04	1.64E-05	1.19E-03	1.14E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	3.77E-03	0.00E+00	8.79E-03	1.31E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	1.28E-02	2.10E-02
	HTO[2]	3.27E-01	0.00E+00	2.95E-02	6.96E-03	0.00E+00	0.00E+00	1.31E-03	8.20E-02	1.46E-02	4.61E-01
	I(mfp)	8.47E-08	5.70E-09	0.00E+00	0.00E+00	8.55E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.89E-08
	Noble Gases	0.00E+00	1.65E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.65E-01
Total		**3.27E-01**	**1.65E-01**	**2.97E-02**	**8.59E-03**	**7.18E-03**	**9.22E-03**	**1.08E-02**	**2.46E-01**	**1.11E-01**	**9.14E-01**
Child (6-15 yrs)	C-14	4.98E-04	4.01E-07	1.01E-05	9.76E-10	2.54E-10	1.82E-07	3.05E-03	1.79E-01	4.76E-02	2.30E-01
	Co-60	1.07E-06	2.84E-08	2.16E-04	1.63E-03	7.18E-03	5.22E-04	9.51E-04	4.07E-05	1.11E-03	1.17E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.21E-03	0.00E+00	1.86E-03	3.57E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	2.83E-03	1.11E-02
	HTO[2]	3.88E-01	0.00E+00	1.47E-02	5.80E-03	0.00E+00	0.00E+00	7.36E-04	8.28E-02	1.43E-02	5.07E-01
	I(mfp)	1.90E-07	5.70E-09	0.00E+00	0.00E+00	8.56E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.04E-07
	Noble Gases	0.00E+00	1.65E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.65E-01
Total		**3.89E-01**	**1.65E-01**	**1.49E-02**	**7.43E-03**	**7.18E-03**	**9.29E-03**	**5.94E-03**	**2.62E-01**	**6.77E-02**	**9.28E-01**
Infant (0-5 yrs)	C-14	3.40E-04	4.01E-07	0.00E+00	7.45E-11	4.33E-10	3.99E-07	2.08E-03	1.59E-01	3.73E-02	1.99E-01
	Co-60	7.84E-07	3.70E-08	0.00E+00	1.35E-05	9.34E-03	6.84E-04	7.96E-04	4.42E-05	8.63E-04	1.17E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.71E-04	0.00E+00	6.73E-04	1.79E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	1.07E-03	1.18E-02
	HTO[2]	2.68E-01	0.00E+00	0.00E+00	2.18E-04	0.00E+00	0.00E+00	5.27E-04	8.25E-02	2.21E-02	3.73E-01
	I(mfp)	2.27E-07	7.41E-09	0.00E+00	0.00E+00	1.12E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.45E-07
	Noble Gases	0.00E+00	2.13E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E-01
Total		**2.68E-01**	**2.13E-01**	**0.00E+00**	**2.32E-04**	**9.34E-03**	**1.21E-02**	**3.87E-03**	**2.42E-01**	**6.19E-02**	**8.11E-01**

Note: All doses reported in units of µSv/year.

[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment

[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 62 - Dose to Representative Persons Located at BR48

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	4.28E-04	4.92E-07	5.03E-06	7.56E-10	3.86E-11	1.56E-08	5.07E-03	2.04E-01	7.46E-02	2.84E-01
	Co-60	1.14E-06	4.31E-08	3.61E-05	1.60E-03	5.60E-03	5.19E-04	6.75E-04	1.41E-05	1.18E-03	9.63E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	3.77E-03	0.00E+00	8.79E-03	1.31E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	1.28E-02	2.10E-02
	HTO[2]	4.94E-01	0.00E+00	1.22E-02	6.53E-03	0.00E+00	0.00E+00	1.31E-03	1.20E-01	1.49E-02	6.49E-01
	I(mfp)	1.28E-07	8.62E-09	0.00E+00	0.00E+00	1.44E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E-07
	Noble Gases	0.00E+00	2.50E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E-01
Total		**4.95E-01**	**2.50E-01**	**1.22E-02**	**8.13E-03**	**5.60E-03**	**9.22E-03**	**1.08E-02**	**3.24E-01**	**1.12E-01**	**1.23E+00**
Child (6-15 yrs)	C-14	6.10E-04	4.92E-07	2.76E-06	7.56E-10	8.37E-11	1.82E-07	3.05E-03	2.19E-01	4.88E-02	2.71E-01
	Co-60	1.62E-06	4.31E-08	4.65E-05	1.60E-03	5.60E-03	5.22E-04	9.51E-04	3.54E-05	1.11E-03	9.86E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.21E-03	0.00E+00	1.86E-03	3.57E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	2.83E-03	1.11E-02
	HTO[2]	5.88E-01	0.00E+00	6.06E-03	5.44E-03	0.00E+00	0.00E+00	7.36E-04	1.15E-01	1.45E-02	7.30E-01
	I(mfp)	2.87E-07	8.62E-09	0.00E+00	0.00E+00	1.44E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.10E-07
	Noble Gases	0.00E+00	2.50E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E-01
Total		**5.89E-01**	**2.50E-01**	**6.11E-03**	**7.04E-03**	**5.60E-03**	**9.29E-03**	**5.94E-03**	**3.34E-01**	**6.91E-02**	**1.28E+00**
Infant (0-5 yrs)	C-14	4.17E-04	4.92E-07	0.00E+00	3.15E-11	1.43E-10	3.99E-07	2.08E-03	1.97E-01	3.82E-02	2.38E-01
	Co-60	1.19E-06	5.60E-08	0.00E+00	1.88E-05	7.28E-03	6.84E-04	7.96E-04	3.81E-05	8.60E-04	9.67E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.71E-04	0.00E+00	6.73E-04	1.79E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	1.07E-03	1.18E-02
	HTO[2]	4.06E-01	0.00E+00	0.00E+00	1.73E-04	0.00E+00	0.00E+00	5.27E-04	1.14E-01	2.22E-02	5.42E-01
	I(mfp)	3.43E-07	1.12E-08	0.00E+00	0.00E+00	1.88E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.73E-07
	Noble Gases	0.00E+00	3.24E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.24E-01
Total		**4.06E-01**	**3.24E-01**	**0.00E+00**	**1.92E-04**	**7.28E-03**	**1.21E-02**	**3.87E-03**	**3.11E-01**	**6.30E-02**	**1.13E+00**

Note: All doses reported in units of µSv/year.

[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment

[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 63 - Dose to Representative Persons Located at BF8

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	2.42E-04	2.78E-07	5.49E-06	7.21E-10	1.15E-11	1.56E-08	4.92E-03	1.97E-01	1.12E-01	3.15E-01
	Co-60	3.93E-07	1.49E-08	4.34E-04	1.59E-03	1.70E-03	5.19E-04	6.55E-04	5.30E-05	2.37E-03	7.32E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	3.66E-03	0.00E+00	1.76E-02	2.17E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	2.55E-02	3.38E-02
	HTO[2]	1.70E-01	0.00E+00	2.88E-02	6.45E-03	0.00E+00	0.00E+00	1.27E-03	1.49E-01	1.82E-02	3.73E-01
	I(mfp)	4.45E-08	2.99E-09	0.00E+00	0.00E+00	4.86E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.23E-08
	Noble Gases	0.00E+00	8.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-02
Total		**1.70E-01**	**8.65E-02**	**2.92E-02**	**8.04E-03**	**1.70E-03**	**9.22E-03**	**1.05E-02**	**3.46E-01**	**1.76E-01**	**8.37E-01**
Child (6-15 yrs)	C-14	3.45E-04	2.78E-07	3.01E-06	7.21E-10	2.50E-11	1.82E-07	2.95E-03	2.15E-01	6.79E-02	2.86E-01
	Co-60	5.61E-07	1.49E-08	5.58E-04	1.59E-03	1.70E-03	5.22E-04	9.22E-04	1.24E-04	2.17E-03	7.59E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.17E-03	0.00E+00	3.66E-03	5.33E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	5.56E-03	1.38E-02
	HTO[2]	2.02E-01	0.00E+00	1.43E-02	5.38E-03	0.00E+00	0.00E+00	7.13E-04	1.51E-01	1.35E-02	3.86E-01
	I(mfp)	9.96E-08	2.99E-09	0.00E+00	0.00E+00	4.87E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-07
	Noble Gases	0.00E+00	8.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-02
Total		**2.02E-01**	**8.65E-02**	**1.49E-02**	**6.96E-03**	**1.70E-03**	**9.29E-03**	**5.76E-03**	**3.65E-01**	**9.28E-02**	**7.85E-01**
Infant (0-5 yrs)	C-14	2.36E-04	2.78E-07	0.00E+00	1.35E-11	4.26E-11	3.99E-07	2.01E-03	1.88E-01	4.71E-02	2.38E-01
	Co-60	4.11E-07	1.94E-08	0.00E+00	0.00E+00	2.21E-03	6.84E-04	7.71E-04	1.41E-04	1.72E-03	5.52E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.57E-04	0.00E+00	1.35E-03	2.45E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	2.14E-03	1.29E-02
	HTO[2]	1.39E-01	0.00E+00	0.00E+00	1.06E-04	0.00E+00	0.00E+00	5.11E-04	1.59E-01	1.60E-02	3.14E-01
	I(mfp)	1.19E-07	3.89E-09	0.00E+00	0.00E+00	6.36E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-07
	Noble Gases	0.00E+00	1.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-01
Total		**1.39E-01**	**1.12E-01**	**0.00E+00**	**1.06E-04**	**2.21E-03**	**1.21E-02**	**3.75E-03**	**3.47E-01**	**6.83E-02**	**6.85E-01**

Note: All doses reported in units of µSv/year.
[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment
[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 64 - Dose to Representative Persons Located at BF14

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	1.85E-04	2.13E-07	4.88E-06	7.13E-10	1.15E-11	1.56E-08	4.92E-03	2.83E-01	1.11E-01	3.99E-01
	Co-60	7.50E-07	2.84E-08	4.34E-04	1.59E-03	2.41E-03	5.19E-04	6.55E-04	5.59E-05	2.37E-03	8.04E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	3.66E-03	0.00E+00	1.76E-02	2.17E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	2.55E-02	3.38E-02
	HTO[2]	3.27E-01	0.00E+00	2.88E-02	6.45E-03	0.00E+00	0.00E+00	1.27E-03	1.56E-01	1.97E-02	5.39E-01
	I(mfp)	8.47E-08	5.70E-09	0.00E+00	0.00E+00	8.79E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.92E-08
	Noble Gases	0.00E+00	1.65E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.65E-01
Total		**3.27E-01**	**1.65E-01**	**2.92E-02**	**8.04E-03**	**2.41E-03**	**9.22E-03**	**1.05E-02**	**4.39E-01**	**1.77E-01**	**1.17E+00**
Child (6-15 yrs)	C-14	2.64E-04	2.13E-07	2.68E-06	7.13E-10	2.50E-11	1.82E-07	2.95E-03	3.00E-01	6.67E-02	3.69E-01
	Co-60	1.07E-06	2.84E-08	5.58E-04	1.59E-03	2.41E-03	5.22E-04	9.22E-04	1.31E-04	2.17E-03	8.31E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.17E-03	0.00E+00	3.66E-03	5.33E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	5.56E-03	1.38E-02
	HTO[2]	3.88E-01	0.00E+00	1.43E-02	5.38E-03	0.00E+00	0.00E+00	7.13E-04	1.52E-01	1.45E-02	5.75E-01
	I(mfp)	1.90E-07	5.70E-09	0.00E+00	0.00E+00	8.81E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.04E-07
	Noble Gases	0.00E+00	1.65E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.65E-01
Total		**3.89E-01**	**1.65E-01**	**1.49E-02**	**6.96E-03**	**2.41E-03**	**9.29E-03**	**5.76E-03**	**4.52E-01**	**9.26E-02**	**1.14E+00**
Infant (0-5 yrs)	C-14	1.80E-04	2.13E-07	0.00E+00	1.04E-11	4.26E-11	3.99E-07	2.01E-03	2.72E-01	4.63E-02	3.21E-01
	Co-60	7.84E-07	3.70E-08	0.00E+00	0.00E+00	3.14E-03	6.84E-04	7.71E-04	1.49E-04	1.72E-03	6.46E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.57E-04	0.00E+00	1.35E-03	2.45E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	2.14E-03	1.29E-02
	HTO[2]	2.68E-01	0.00E+00	0.00E+00	1.06E-04	0.00E+00	0.00E+00	5.11E-04	1.54E-01	1.67E-02	4.39E-01
	I(mfp)	2.27E-07	7.41E-09	0.00E+00	0.00E+00	1.15E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.46E-07
	Noble Gases	0.00E+00	2.13E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E-01
Total		**2.68E-01**	**2.13E-01**	**0.00E+00**	**1.06E-04**	**3.14E-03**	**1.21E-02**	**3.75E-03**	**4.26E-01**	**6.82E-02**	**9.95E-01**

Note: All doses reported in units of µSv/year.
[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment
2 includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 65 - Dose to Representative Persons Located at BF16

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	2.08E-04	2.40E-07	5.11E-06	7.17E-10	6.59E-12	1.56E-08	4.92E-03	2.35E-01	1.12E-01	3.52E-01
	Co-60	5.53E-07	2.10E-08	4.34E-04	1.59E-03	2.65E-03	5.19E-04	6.55E-04	5.64E-05	2.37E-03	8.27E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	3.66E-03	0.00E+00	1.76E-02	2.17E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	2.55E-02	3.38E-02
	HTO[2]	2.39E-01	0.00E+00	2.88E-02	6.45E-03	0.00E+00	0.00E+00	1.27E-03	1.29E-01	1.89E-02	4.23E-01
	I(mfp)	6.25E-08	4.21E-09	0.00E+00	0.00E+00	6.99E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.37E-08
	Noble Gases	0.00E+00	1.22E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-01
Total		**2.39E-01**	**1.22E-01**	**2.92E-02**	**8.04E-03**	**2.65E-03**	**9.22E-03**	**1.05E-02**	**3.64E-01**	**1.76E-01**	**9.61E-01**
Child (6-15 yrs)	C-14	2.97E-04	2.40E-07	2.81E-06	7.17E-10	1.43E-11	1.82E-07	2.95E-03	2.43E-01	6.72E-02	3.14E-01
	Co-60	7.90E-07	2.10E-08	5.58E-04	1.59E-03	2.65E-03	5.22E-04	9.22E-04	1.32E-04	2.17E-03	8.55E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.17E-03	0.00E+00	3.66E-03	5.33E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	5.56E-03	1.38E-02
	HTO[2]	2.84E-01	0.00E+00	1.43E-02	5.38E-03	0.00E+00	0.00E+00	7.13E-04	1.21E-01	1.40E-02	4.40E-01
	I(mfp)	1.40E-07	4.21E-09	0.00E+00	0.00E+00	7.00E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E-07
	Noble Gases	0.00E+00	1.22E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-01
Total		**2.85E-01**	**1.22E-01**	**1.49E-02**	**6.96E-03**	**2.65E-03**	**9.29E-03**	**5.76E-03**	**3.64E-01**	**9.25E-02**	**9.03E-01**
Infant (0-5 yrs)	C-14	2.03E-04	2.40E-07	0.00E+00	1.15E-11	2.44E-11	3.99E-07	2.01E-03	2.06E-01	4.66E-02	2.55E-01
	Co-60	5.79E-07	2.73E-08	0.00E+00	0.00E+00	3.45E-03	6.84E-04	7.71E-04	1.50E-04	1.72E-03	6.77E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.57E-04	0.00E+00	1.35E-03	2.45E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	2.14E-03	1.29E-02
	HTO[2]	1.96E-01	0.00E+00	0.00E+00	1.06E-04	0.00E+00	0.00E+00	5.11E-04	1.13E-01	1.63E-02	3.26E-01
	I(mfp)	1.67E-07	5.47E-09	0.00E+00	0.00E+00	9.14E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.82E-07
	Noble Gases	0.00E+00	1.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.58E-01
Total		**1.96E-01**	**1.58E-01**	**0.00E+00**	**1.06E-04**	**3.45E-03**	**1.21E-02**	**3.75E-03**	**3.19E-01**	**6.82E-02**	**7.61E-01**

Note: All doses reported in units of µSv/year.

[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment

[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 66 - Dose to Representative Persons Located at BSF2

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	2.42E-04	2.78E-07	3.02E-06	7.21E-10	1.15E-11	1.56E-08	2.21E-02	5.81E-01	2.12E-01	8.16E-01
	Co-60	3.93E-07	1.49E-08	0.00E+00	1.59E-03	1.28E-03	5.19E-04	2.94E-03	1.20E-05	2.36E-03	8.70E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	1.64E-02	0.00E+00	1.76E-02	3.45E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	2.55E-02	3.38E-02
	HTO[2]	1.70E-01	0.00E+00	1.30E-02	6.45E-03	0.00E+00	0.00E+00	5.71E-03	3.06E-01	4.08E-02	5.41E-01
	I(mfp)	4.45E-08	2.99E-09	0.00E+00	0.00E+00	4.62E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.21E-08
	Noble Gases	0.00E+00	8.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-02
Total		**1.70E-01**	**8.65E-02**	**1.30E-02**	**8.04E-03**	**1.28E-03**	**9.22E-03**	**4.71E-02**	**8.87E-01**	**2.99E-01**	**1.52E+00**
Child (6-15 yrs)	C-14	3.45E-04	2.78E-07	1.66E-06	7.21E-10	2.50E-11	1.82E-07	1.32E-02	6.58E-01	1.38E-01	8.10E-01
	Co-60	5.61E-07	4.66E-08	0.00E+00	1.88E-05	1.28E-03	5.22E-04	4.13E-03	3.06E-05	2.17E-03	8.15E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	5.26E-03	0.00E+00	3.66E-03	9.42E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	5.56E-03	1.38E-02
	HTO[2]	2.02E-01	0.00E+00	6.45E-03	5.38E-03	0.00E+00	0.00E+00	3.20E-03	3.18E-01	4.26E-02	5.78E-01
	I(mfp)	9.96E-08	2.99E-09	0.00E+00	0.00E+00	4.63E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-07
	Noble Gases	0.00E+00	8.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-02
Total		**2.02E-01**	**8.65E-02**	**6.45E-03**	**5.39E-03**	**1.28E-03**	**9.29E-03**	**2.58E-02**	**9.76E-01**	**1.92E-01**	**1.51E+00**
Infant (0-5 yrs)	C-14	2.36E-04	2.78E-07	0.00E+00	1.34E-11	4.26E-11	3.99E-07	9.02E-03	5.41E-01	1.10E-01	6.60E-01
	Co-60	4.11E-07	1.94E-08	0.00E+00	0.00E+00	1.67E-03	6.84E-04	3.46E-03	3.12E-05	1.72E-03	7.56E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	2.05E-03	0.00E+00	1.35E-03	4.04E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	2.14E-03	1.29E-02
	HTO[2]	1.39E-01	0.00E+00	0.00E+00	1.05E-04	0.00E+00	0.00E+00	2.29E-03	3.07E-01	6.84E-02	5.16E-01
	I(mfp)	1.19E-07	3.89E-09	0.00E+00	0.00E+00	6.04E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-07
	Noble Gases	0.00E+00	1.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-01
Total		**1.39E-01**	**1.12E-01**	**0.00E+00**	**1.05E-04**	**1.67E-03**	**1.21E-02**	**1.68E-02**	**8.48E-01**	**1.84E-01**	**1.31E+00**

Note: All doses reported in units of µSv/year.
[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment
[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 67 - Dose to Representative Persons Located at BSF3

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	2.42E-04	2.78E-07	3.02E-06	7.21E-10	1.15E-11	1.56E-08	2.21E-02	6.45E-01	2.13E-01	8.81E-01
	Co-60	3.93E-07	1.49E-08	0.00E+00	1.59E-03	1.70E-03	5.19E-04	2.94E-03	1.56E-05	2.36E-03	9.13E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	1.64E-02	0.00E+00	1.76E-02	3.45E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	2.55E-02	3.38E-02
	HTO[2]	1.70E-01	0.00E+00	1.30E-02	6.45E-03	0.00E+00	0.00E+00	5.71E-03	2.84E-01	4.08E-02	5.19E-01
	I(mfp)	4.45E-08	2.99E-09	0.00E+00	0.00E+00	4.87E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.23E-08
	Noble Gases	0.00E+00	8.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-02
Total		**1.70E-01**	**8.65E-02**	**1.30E-02**	**8.04E-03**	**1.70E-03**	**9.22E-03**	**4.71E-02**	**9.29E-01**	**2.99E-01**	**1.56E+00**
Child (6-15 yrs)	C-14	3.45E-04	2.78E-07	1.66E-06	7.21E-10	2.50E-11	1.82E-07	1.32E-02	7.06E-01	1.39E-01	8.59E-01
	Co-60	5.61E-07	1.49E-08	0.00E+00	1.59E-03	1.70E-03	5.22E-04	4.13E-03	3.96E-05	2.17E-03	1.02E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	5.26E-03	0.00E+00	3.66E-03	9.42E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	5.56E-03	1.38E-02
	HTO[2]	2.02E-01	0.00E+00	6.45E-03	5.38E-03	0.00E+00	0.00E+00	3.20E-03	2.83E-01	4.26E-02	5.42E-01
	I(mfp)	9.96E-08	2.99E-09	0.00E+00	0.00E+00	4.88E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-07
	Noble Gases	0.00E+00	8.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-02
Total		**2.02E-01**	**8.65E-02**	**6.45E-03**	**6.96E-03**	**1.70E-03**	**9.29E-03**	**2.58E-02**	**9.89E-01**	**1.93E-01**	**1.52E+00**
Infant (0-5 yrs)	C-14	2.36E-04	2.78E-07	0.00E+00	1.34E-11	4.26E-11	3.99E-07	9.02E-03	5.71E-01	1.10E-01	6.91E-01
	Co-60	4.11E-07	1.94E-08	0.00E+00	0.00E+00	2.22E-03	6.84E-04	3.46E-03	4.03E-05	1.72E-03	8.12E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	2.05E-03	0.00E+00	1.35E-03	4.04E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	2.14E-03	1.29E-02
	HTO[2]	1.39E-01	0.00E+00	0.00E+00	1.05E-04	0.00E+00	0.00E+00	2.29E-03	2.48E-01	6.84E-02	4.58E-01
	I(mfp)	1.19E-07	3.89E-09	0.00E+00	0.00E+00	6.36E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-07
	Noble Gases	0.00E+00	1.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-01
Total		**1.39E-01**	**1.12E-01**	**0.00E+00**	**1.05E-04**	**2.22E-03**	**1.21E-02**	**1.68E-02**	**8.20E-01**	**1.84E-01**	**1.29E+00**

Note: All doses reported in units of µSv/year.
[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment
[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 68 - Dose to Representative Persons Located at BDF1

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	2.08E-04	2.40E-07	2.03E-06	7.16E-10	6.59E-12	1.56E-08	5.51E-03	3.06E-01	1.25E-01	4.36E-01
	Co-60	5.53E-07	2.10E-08	0.00E+00	1.59E-03	2.50E-03	5.19E-04	7.34E-04	1.10E-05	2.36E-03	7.72E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	4.10E-03	0.00E+00	1.76E-02	2.22E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	2.55E-02	3.38E-02
	HTO[2]	2.39E-01	0.00E+00	1.01E-02	6.45E-03	0.00E+00	0.00E+00	1.43E-03	1.42E-01	3.27E-02	4.32E-01
	I(mfp)	6.25E-08	4.21E-09	0.00E+00	0.00E+00	6.90E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.36E-08
	Noble Gases	0.00E+00	1.22E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-01
Total		**2.39E-01**	**1.22E-01**	**1.01E-02**	**8.04E-03**	**2.50E-03**	**9.22E-03**	**1.18E-02**	**4.48E-01**	**2.03E-01**	**1.05E+00**
Child (6-15 yrs)	C-14	2.97E-04	2.40E-07	1.11E-06	7.16E-10	1.43E-11	1.82E-07	3.31E-03	3.26E-01	7.69E-02	4.07E-01
	Co-60	7.90E-07	2.10E-08	0.00E+00	1.59E-03	2.50E-03	5.22E-04	1.03E-03	2.71E-05	2.17E-03	7.84E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.32E-03	0.00E+00	3.66E-03	5.47E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	5.56E-03	1.38E-02
	HTO[2]	2.84E-01	0.00E+00	5.04E-03	5.38E-03	0.00E+00	0.00E+00	7.99E-04	1.37E-01	4.08E-02	4.73E-01
	I(mfp)	1.40E-07	4.21E-09	0.00E+00	0.00E+00	6.92E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E-07
	Noble Gases	0.00E+00	1.22E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-01
Total		**2.85E-01**	**1.22E-01**	**5.04E-03**	**6.96E-03**	**2.50E-03**	**9.29E-03**	**6.46E-03**	**4.63E-01**	**1.29E-01**	**1.03E+00**
Infant (0-5 yrs)	C-14	2.03E-04	2.40E-07	0.00E+00	1.16E-11	2.44E-11	3.99E-07	2.26E-03	2.63E-01	5.52E-02	3.21E-01
	Co-60	5.79E-07	2.73E-08	0.00E+00	0.00E+00	3.25E-03	6.84E-04	8.65E-04	2.75E-05	1.72E-03	6.55E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	5.12E-04	0.00E+00	1.35E-03	2.50E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	2.14E-03	1.29E-02
	HTO[2]	1.96E-01	0.00E+00	0.00E+00	1.05E-04	0.00E+00	0.00E+00	5.73E-04	1.19E-01	7.37E-02	3.90E-01
	I(mfp)	1.67E-07	5.47E-09	0.00E+00	0.00E+00	9.02E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.82E-07
	Noble Gases	0.00E+00	1.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.58E-01
Total		**1.96E-01**	**1.58E-01**	**0.00E+00**	**1.05E-04**	**3.25E-03**	**1.21E-02**	**4.21E-03**	**3.82E-01**	**1.34E-01**	**8.90E-01**

Note: All doses reported in units of µSv/year.

[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment

[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 69 - Dose to Representative Persons Located at BDF9

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	2.42E-04	2.78E-07	2.36E-06	7.21E-10	0.00E+00	1.56E-08	5.51E-03	2.67E-01	1.24E-01	3.97E-01
	Co-60	3.93E-07	1.49E-08	0.00E+00	1.59E-03	1.44E-03	5.19E-04	7.34E-04	6.44E-06	2.36E-03	6.65E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	4.10E-03	0.00E+00	1.76E-02	2.22E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	2.55E-02	3.38E-02
	HTO[2]	1.70E-01	0.00E+00	1.01E-02	6.45E-03	0.00E+00	0.00E+00	1.43E-03	1.50E-01	2.83E-02	3.66E-01
	I(mfp)	4.45E-08	2.99E-09	0.00E+00	0.00E+00	4.71E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.22E-08
	Noble Gases	0.00E+00	8.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-02
Total		**1.70E-01**	**8.65E-02**	**1.01E-02**	**8.04E-03**	**1.44E-03**	**9.22E-03**	**1.18E-02**	**4.16E-01**	**1.98E-01**	**9.11E-01**
Child (6-15 yrs)	C-14	3.45E-04	2.78E-07	1.29E-06	7.21E-10	0.00E+00	1.82E-07	3.31E-03	2.96E-01	7.53E-02	3.75E-01
	Co-60	5.61E-07	1.49E-08	0.00E+00	1.59E-03	1.44E-03	5.22E-04	1.03E-03	1.59E-05	2.16E-03	6.77E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.32E-03	0.00E+00	3.66E-03	5.47E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	5.56E-03	1.38E-02
	HTO[2]	2.02E-01	0.00E+00	5.04E-03	5.38E-03	0.00E+00	0.00E+00	7.99E-04	1.52E-01	3.21E-02	3.97E-01
	I(mfp)	9.96E-08	2.99E-09	0.00E+00	0.00E+00	4.72E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-07
	Noble Gases	0.00E+00	8.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-02
Total		**2.02E-01**	**8.65E-02**	**5.04E-03**	**6.96E-03**	**1.44E-03**	**9.29E-03**	**6.46E-03**	**4.48E-01**	**1.19E-01**	**8.85E-01**
Infant (0-5 yrs)	C-14	2.36E-04	2.78E-07	0.00E+00	1.34E-11	0.00E+00	3.99E-07	2.26E-03	2.44E-01	5.06E-02	2.97E-01
	Co-60	4.11E-07	1.94E-08	0.00E+00	0.00E+00	1.87E-03	6.84E-04	8.65E-04	1.62E-05	1.71E-03	5.15E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	5.12E-04	0.00E+00	1.35E-03	2.50E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	2.14E-03	1.29E-02
	HTO[2]	1.39E-01	0.00E+00	0.00E+00	1.05E-04	0.00E+00	0.00E+00	5.73E-04	1.46E-01	5.49E-02	3.41E-01
	I(mfp)	1.19E-07	3.89E-09	0.00E+00	0.00E+00	6.16E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-07
	Noble Gases	0.00E+00	1.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-01
Total		**1.39E-01**	**1.12E-01**	**0.00E+00**	**1.05E-04**	**1.87E-03**	**1.21E-02**	**4.21E-03**	**3.90E-01**	**1.11E-01**	**7.70E-01**

Note: All doses reported in units of µSv/year.
[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment
[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 70 - Dose to Representative Persons Located at BDF12

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	2.08E-04	2.40E-07	2.03E-06	7.16E-10	6.59E-12	1.56E-08	5.51E-03	3.06E-01	1.54E-01	4.65E-01
	Co-60	5.53E-07	2.10E-08	0.00E+00	1.59E-03	2.52E-03	5.19E-04	7.34E-04	1.10E-05	2.36E-03	7.74E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	4.10E-03	0.00E+00	1.76E-02	2.22E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	2.55E-02	3.38E-02
	HTO[2]	2.39E-01	0.00E+00	1.01E-02	6.45E-03	0.00E+00	0.00E+00	1.43E-03	1.42E-01	2.90E-02	4.28E-01
	I(mfp)	6.25E-08	4.21E-09	0.00E+00	0.00E+00	6.92E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.37E-08
	Noble Gases	0.00E+00	1.22E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-01
Total		**2.39E-01**	**1.22E-01**	**1.01E-02**	**8.04E-03**	**2.52E-03**	**9.22E-03**	**1.18E-02**	**4.48E-01**	**2.28E-01**	**1.08E+00**
Child (6-15 yrs)	C-14	2.97E-04	2.40E-07	1.11E-06	7.16E-10	1.43E-11	1.82E-07	3.31E-03	3.26E-01	1.50E-01	4.80E-01
	Co-60	7.90E-07	2.10E-08	0.00E+00	1.59E-03	2.52E-03	5.22E-04	1.03E-03	2.73E-05	2.17E-03	7.86E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.32E-03	0.00E+00	3.66E-03	5.47E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	5.56E-03	1.38E-02
	HTO[2]	2.84E-01	0.00E+00	5.04E-03	5.38E-03	0.00E+00	0.00E+00	7.99E-04	1.37E-01	3.22E-02	4.65E-01
	I(mfp)	1.40E-07	4.21E-09	0.00E+00	0.00E+00	6.93E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E-07
	Noble Gases	0.00E+00	1.22E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-01
Total		**2.85E-01**	**1.22E-01**	**5.04E-03**	**6.96E-03**	**2.52E-03**	**9.29E-03**	**6.46E-03**	**4.63E-01**	**1.94E-01**	**1.09E+00**
Infant (0-5 yrs)	C-14	2.03E-04	2.40E-07	0.00E+00	1.16E-11	2.44E-11	3.99E-07	2.26E-03	2.63E-01	2.12E-01	4.77E-01
	Co-60	5.79E-07	2.73E-08	0.00E+00	0.00E+00	3.28E-03	6.84E-04	8.65E-04	2.77E-05	1.72E-03	6.58E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	5.12E-04	0.00E+00	1.35E-03	2.50E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	2.14E-03	1.29E-02
	HTO[2]	1.96E-01	0.00E+00	0.00E+00	1.05E-04	0.00E+00	0.00E+00	5.73E-04	1.19E-01	5.43E-02	3.71E-01
	I(mfp)	1.67E-07	5.47E-09	0.00E+00	0.00E+00	9.04E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.82E-07
	Noble Gases	0.00E+00	1.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.58E-01
Total		**1.96E-01**	**1.58E-01**	**0.00E+00**	**1.05E-04**	**3.28E-03**	**1.21E-02**	**4.21E-03**	**3.82E-01**	**2.71E-01**	**1.03E+00**

Note: All doses reported in units of µSv/year.
[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment
[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 71 - Dose to Representative Persons Located at BDF13

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	2.42E-04	2.78E-07	2.36E-06	7.21E-10	0.00E+00	1.56E-08	5.51E-03	3.06E-01	1.24E-01	4.35E-01
	Co-60	3.93E-07	1.49E-08	0.00E+00	1.59E-03	1.12E-03	5.19E-04	7.34E-04	5.16E-06	2.36E-03	6.33E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	4.10E-03	0.00E+00	1.76E-02	2.22E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	2.55E-02	3.38E-02
	HTO[2]	1.70E-01	0.00E+00	1.01E-02	6.45E-03	0.00E+00	0.00E+00	1.43E-03	1.42E-01	2.51E-02	3.55E-01
	I(mfp)	4.45E-08	2.99E-09	0.00E+00	0.00E+00	4.53E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.20E-08
	Noble Gases	0.00E+00	8.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-02
Total		**1.70E-01**	**8.65E-02**	**1.01E-02**	**8.04E-03**	**1.12E-03**	**9.22E-03**	**1.18E-02**	**4.48E-01**	**1.94E-01**	**9.39E-01**
Child (6-15 yrs)	C-14	3.45E-04	2.78E-07	1.29E-06	7.21E-10	0.00E+00	1.82E-07	3.31E-03	3.26E-01	7.40E-02	4.04E-01
	Co-60	5.61E-07	1.49E-08	0.00E+00	1.59E-03	1.12E-03	5.22E-04	1.03E-03	1.28E-05	2.16E-03	6.44E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.32E-03	0.00E+00	3.66E-03	5.47E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	5.56E-03	1.38E-02
	HTO[2]	2.02E-01	0.00E+00	5.04E-03	5.38E-03	0.00E+00	0.00E+00	7.99E-04	1.37E-01	2.48E-02	3.75E-01
	I(mfp)	9.96E-08	2.99E-09	0.00E+00	0.00E+00	4.54E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-07
	Noble Gases	0.00E+00	8.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-02
Total		**2.02E-01**	**8.65E-02**	**5.04E-03**	**6.96E-03**	**1.12E-03**	**9.29E-03**	**6.46E-03**	**4.63E-01**	**1.10E-01**	**8.91E-01**
Infant (0-5 yrs)	C-14	2.36E-04	2.78E-07	0.00E+00	1.34E-11	0.00E+00	3.99E-07	2.26E-03	2.63E-01	4.79E-02	3.13E-01
	Co-60	4.11E-07	1.94E-08	0.00E+00	0.00E+00	1.46E-03	6.84E-04	8.65E-04	1.30E-05	1.70E-03	4.72E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	5.12E-04	0.00E+00	1.35E-03	2.50E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	2.14E-03	1.29E-02
	HTO[2]	1.39E-01	0.00E+00	0.00E+00	1.05E-04	0.00E+00	0.00E+00	5.73E-04	1.19E-01	3.85E-02	2.98E-01
	I(mfp)	1.19E-07	3.89E-09	0.00E+00	0.00E+00	5.92E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-07
	Noble Gases	0.00E+00	1.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-01
Total		**1.39E-01**	**1.12E-01**	**0.00E+00**	**1.05E-04**	**1.46E-03**	**1.21E-02**	**4.21E-03**	**3.82E-01**	**9.16E-02**	**7.43E-01**

Note: All doses reported in units of µSv/year.
[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment
[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 72 - Dose to Representative Persons Located at BDF14

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	2.42E-04	2.78E-07	2.36E-06	7.21E-10	0.00E+00	1.56E-08	5.51E-03	2.67E-01	1.75E-01	4.47E-01
	Co-60	3.93E-07	1.49E-08	0.00E+00	1.59E-03	9.28E-04	5.19E-04	7.34E-04	4.39E-06	2.36E-03	6.13E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	4.10E-03	0.00E+00	1.76E-02	2.22E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	2.55E-02	3.38E-02
	HTO[2]	1.70E-01	0.00E+00	1.01E-02	6.45E-03	0.00E+00	0.00E+00	1.43E-03	1.50E-01	2.51E-02	3.62E-01
	I(mfp)	4.45E-08	2.99E-09	0.00E+00	0.00E+00	4.42E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.19E-08
	Noble Gases	0.00E+00	8.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-02
Total		**1.70E-01**	**8.65E-02**	**1.01E-02**	**8.04E-03**	**1.11E-03**	**9.22E-03**	**1.18E-02**	**4.16E-01**	**2.46E-01**	**9.59E-01**
Child (6-15 yrs)	C-14	3.45E-04	2.78E-07	1.29E-06	7.21E-10	0.00E+00	1.82E-07	3.31E-03	2.96E-01	2.03E-01	5.03E-01
	Co-60	5.61E-07	1.49E-08	0.00E+00	1.59E-03	9.28E-04	5.22E-04	1.03E-03	1.09E-05	2.16E-03	6.25E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.32E-03	0.00E+00	3.66E-03	5.47E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	5.56E-03	1.38E-02
	HTO[2]	2.02E-01	0.00E+00	5.04E-03	5.38E-03	0.00E+00	0.00E+00	7.99E-04	1.52E-01	2.48E-02	3.90E-01
	I(mfp)	9.96E-08	2.99E-09	0.00E+00	0.00E+00	4.43E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-07
	Noble Gases	0.00E+00	8.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-02
Total		**2.02E-01**	**8.65E-02**	**5.04E-03**	**6.96E-03**	**1.11E-03**	**9.29E-03**	**6.46E-03**	**4.48E-01**	**2.39E-01**	**1.00E+00**
Infant (0-5 yrs)	C-14	2.36E-04	2.78E-07	0.00E+00	1.34E-11	0.00E+00	3.99E-07	2.26E-03	2.44E-01	3.21E-01	5.68E-01
	Co-60	4.11E-07	1.94E-08	0.00E+00	0.00E+00	1.21E-03	6.84E-04	8.65E-04	1.10E-05	1.71E-03	4.48E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	5.12E-04	0.00E+00	1.35E-03	2.50E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	2.14E-03	1.29E-02
	HTO[2]	1.39E-01	0.00E+00	0.00E+00	1.05E-04	0.00E+00	0.00E+00	5.73E-04	1.46E-01	3.85E-02	3.24E-01
	I(mfp)	1.19E-07	3.89E-09	0.00E+00	0.00E+00	5.78E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-07
	Noble Gases	0.00E+00	1.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-01
Total		**1.39E-01**	**1.12E-01**	**0.00E+00**	**1.05E-04**	**1.44E-03**	**1.21E-02**	**4.21E-03**	**3.90E-01**	**3.65E-01**	**1.02E+00**

Note: All doses reported in units of µSv/year.
[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment
[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 73 - Dose to Representative Persons Located at BDF15

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	2.42E-04	2.78E-07	2.36E-06	7.21E-10	0.00E+00	1.56E-08	5.51E-03	2.67E-01	1.75E-01	4.47E-01
	Co-60	3.93E-07	1.49E-08	0.00E+00	1.59E-03	1.11E-03	5.19E-04	7.34E-04	5.10E-06	2.36E-03	6.31E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	4.10E-03	0.00E+00	1.76E-02	2.22E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	2.55E-02	3.38E-02
	HTO[2]	1.70E-01	0.00E+00	1.01E-02	6.45E-03	0.00E+00	0.00E+00	1.43E-03	1.50E-01	2.51E-02	3.62E-01
	I(mfp)	4.45E-08	2.99E-09	0.00E+00	0.00E+00	4.52E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.20E-08
	Noble Gases	0.00E+00	8.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-02
Total		**1.70E-01**	**8.65E-02**	**1.01E-02**	**8.04E-03**	**1.11E-03**	**9.22E-03**	**1.18E-02**	**4.16E-01**	**2.46E-01**	**9.59E-01**
Child (6-15 yrs)	C-14	3.45E-04	2.78E-07	1.29E-06	7.21E-10	0.00E+00	1.82E-07	3.31E-03	2.96E-01	2.03E-01	5.03E-01
	Co-60	5.61E-07	1.49E-08	0.00E+00	1.59E-03	1.11E-03	5.22E-04	1.03E-03	1.26E-05	2.16E-03	6.43E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.32E-03	0.00E+00	3.66E-03	5.47E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	5.56E-03	1.38E-02
	HTO[2]	2.02E-01	0.00E+00	5.04E-03	5.38E-03	0.00E+00	0.00E+00	7.99E-04	1.52E-01	2.48E-02	3.90E-01
	I(mfp)	9.96E-08	2.99E-09	0.00E+00	0.00E+00	4.53E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-07
	Noble Gases	0.00E+00	8.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-02
Total		**2.02E-01**	**8.65E-02**	**5.04E-03**	**6.96E-03**	**1.11E-03**	**9.29E-03**	**6.46E-03**	**4.48E-01**	**2.39E-01**	**1.00E+00**
Infant (0-5 yrs)	C-14	2.36E-04	2.78E-07	0.00E+00	1.34E-11	0.00E+00	3.99E-07	2.26E-03	2.44E-01	3.21E-01	5.68E-01
	Co-60	4.11E-07	1.94E-08	0.00E+00	0.00E+00	1.44E-03	6.84E-04	8.65E-04	1.28E-05	1.71E-03	4.71E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	5.12E-04	0.00E+00	1.35E-03	2.50E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	2.14E-03	1.29E-02
	HTO[2]	1.39E-01	0.00E+00	0.00E+00	1.05E-04	0.00E+00	0.00E+00	5.73E-04	1.46E-01	3.85E-02	3.24E-01
	I(mfp)	1.19E-07	3.89E-09	0.00E+00	0.00E+00	5.91E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-07
	Noble Gases	0.00E+00	1.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-01
Total		**1.39E-01**	**1.12E-01**	**0.00E+00**	**1.05E-04**	**1.44E-03**	**1.21E-02**	**4.21E-03**	**3.90E-01**	**3.65E-01**	**1.02E+00**

Note: All doses reported in units of µSv/year.
[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment
[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 74 - Dose to Representative Persons Located at BHF1

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	5.46E-05	6.28E-08	2.48E-05	5.30E-10	1.58E-10	3.25E-09	3.07E-03	4.68E-02	2.76E-02	7.75E-02
	Co-60	1.45E-07	5.48E-09	2.07E-04	6.73E-05	6.74E-03	5.19E-04	1.96E-03	3.20E-05	9.93E-06	9.54E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	1.10E-02	0.00E+00	0.00E+00	1.15E-02
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-03	0.00E+00	0.00E+00	0.00E+00	8.21E-03
	HTO[2]	6.07E-02	0.00E+00	8.24E-02	2.79E-03	0.00E+00	0.00E+00	3.82E-03	1.05E-01	2.64E-02	2.81E-01
	I(mfp)	1.64E-08	1.10E-09	0.00E+00	0.00E+00	1.63E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.91E-08
	Noble Gases	0.00E+00	3.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.18E-02
Total		**6.07E-02**	**3.18E-02**	**8.26E-02**	**2.86E-03**	**6.74E-03**	**9.22E-03**	**1.98E-02**	**1.52E-01**	**5.41E-02**	**4.20E-01**
Child (6-15 yrs)	C-14	7.79E-05	6.28E-08	1.36E-05	5.30E-10	3.42E-10	3.78E-08	2.75E-03	5.16E-02	2.53E-02	7.97E-02
	Co-60	2.06E-07	5.48E-09	2.66E-04	6.73E-05	6.74E-03	5.22E-04	4.13E-03	7.93E-05	1.91E-05	1.18E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	5.26E-03	0.00E+00	0.00E+00	5.76E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-03	0.00E+00	0.00E+00	0.00E+00	8.27E-03
	HTO[2]	7.22E-02	0.00E+00	4.10E-02	2.33E-03	0.00E+00	0.00E+00	3.20E-03	9.81E-02	3.15E-02	2.48E-01
	I(mfp)	3.66E-08	1.10E-09	0.00E+00	0.00E+00	1.64E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.94E-08
	Noble Gases	0.00E+00	3.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.18E-02
Total		**7.22E-02**	**3.18E-02**	**4.13E-02**	**2.40E-03**	**6.74E-03**	**9.29E-03**	**1.54E-02**	**1.50E-01**	**5.68E-02**	**3.86E-01**
Infant (0-5 yrs)	C-14	5.32E-05	6.28E-08	0.00E+00	1.00E-10	5.83E-10	8.29E-08	1.88E-03	4.23E-02	3.30E-02	7.73E-02
	Co-60	1.51E-07	7.13E-09	0.00E+00	1.65E-05	8.76E-03	6.84E-04	3.46E-03	8.63E-05	2.48E-05	1.30E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	2.05E-03	0.00E+00	0.00E+00	2.69E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	0.00E+00	0.00E+00	0.00E+00	1.08E-02
	HTO[2]	4.98E-02	0.00E+00	0.00E+00	6.09E-04	0.00E+00	0.00E+00	2.29E-03	9.49E-02	5.42E-02	2.02E-01
	I(mfp)	4.38E-08	1.43E-09	0.00E+00	0.00E+00	2.13E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.74E-08
	Noble Gases	0.00E+00	4.12E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.12E-02
Total		**4.98E-02**	**4.12E-02**	**0.00E+00**	**6.25E-04**	**8.76E-03**	**1.21E-02**	**9.68E-03**	**1.37E-01**	**8.72E-02**	**3.47E-01**

Note: All doses reported in units of µSv/year.

[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment

[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

Table 75 - Dose to Representative Persons Located at BEC

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult (16-70 yrs)	C-14	4.80E-05	5.51E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-05
	Co-60	1.27E-07	4.83E-09	0.00E+00	0.00E+00	6.37E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.37E-04
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	HTO[2]	5.50E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.50E-02
	I(mfp)	1.44E-08	9.68E-10	0.00E+00	0.00E+00	1.62E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.70E-08
	Noble Gases	0.00E+00	2.80E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.80E-02
Total		**5.51E-02**	**2.80E-02**	**0.00E+00**	**0.00E+00**	**6.37E-04**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**8.37E-02**

Note: All doses reported in units of µSv/year.

[1] includes dose due to external exposure to progeny of Cs-137 in air, water, soil, and sediment

[2] includes dose incurred via ingestion of OBT (organically bound tritium) in fish, plant produce and animal products.

APPENDIX D: RADIOLOGICAL ENVIRONMENTAL MONITORING QUALITY ASSURANCE TESTING

As explained in Section 6.1.7.12 External Laboratory Comparisons, acceptance criteria are:

$$\frac{(V_L + 1\sigma_L)}{V_A} \geq 0.75 \text{ AND } \frac{(V_L - 1\sigma_L)}{V_A} \leq 1.2$$

Where:
V_L = Bruce Power Health Physics Laboratory value
σ_L = S_L, Bruce Power Health Physics Laboratory one sigma uncertainty value
V_A = Analytics Supplier value

Table 76 - 2021 Eckert & Ziegler Analytics Test Results for Tritium in Water

Quarter	Bruce Power Value V_L (Bq/L)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/L)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
Q1	5.36E+02	6.32E+00	5.47E+02	99%	97%
Q2	3.83E+02	6.60E+00	3.89E+02	100%	97%
Q3	4.15E+02	5.48E+00	4.33E+02	97%	95%
Q4	2.17E+01	1.74E+00	2.04E+01	115%	98%

Table 77 - 2021 Eckert & Ziegler Analytics Test Results for Gross Beta in Water

Quarter	Bruce Power Value V_L (Bq/L)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/L)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
Q1	1.09E+01	7.30E-01	1.05E+01	111%	97%
Q2	8.96E+00	6.05E-01	9.25E+00	103%	90%
Q3	1.16E+01	7.75E-01	1.03E+01	120%	105%
Q4	1.04E+01	7.00E-01	9.64E+00	115%	101%

Table 78 - 2021 Eckert & Ziegler Analytics Test Results for Iodine in Milk

Quarter	Bruce Power Value V_L (Bq/L)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/L)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
Q1	2.98E+00	3.93E-01	3.21E+00	105%	81%
Q2	2.96E+00	2.39E-01	3.10E+00	103%	88%
Q3	3.04E+00	1.37E-01	3.17E+00	100%	91%
Q4	3.27E+00	1.99E-01	3.34E+00	104%	92%

Table 79 - 2021 Eckert & Ziegler Analytics Test Results for Gamma in a Filter

Annual	Bruce Power Value V_L (Bq)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
Cerium-141	3.53E+00	1.43E-01	3.57E+00	103%	95%
Cobalt-58	2.99E+00	1.06E-01	3.11E+00	100%	93%
Cobalt-60	5.80E+00	1.06E-01	6.05E+00	98%	94%
Chromium-51	8.40E+00	5.86E-01	7.96E+00	113%	98%
Cesium-134	4.32E+00	7.74E-02	4.52E+00	97%	94%
Cesium-137	2.99E+00	8.54E-02	3.18E+00	97%	91%
Iron-59	2.97E+00	9.25E-02	3.06E+00	100%	94%
Manganese-54	3.95E+00	1.06E-01	4.12E+00	98%	93%
Zinc-65	6.35E+00	3.45E-01	6.99E+00	96%	86%

Table 80 - 2021 Eckert & Ziegler Analytics Test Results for I-131 in a Cartridge

Annual	Bruce Power Value V_L (Bq)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
Iodine-131	3.14E+00	3.33E-01	3.56E+00	98%	79%

Table 81 - 2021 Eckert & Ziegler Analytics Test Results for Gamma in Water

Quarter	Analyte	Bruce Power Value V_L (Bq/L)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/L)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
Q1	Cerium-141	5.29E+00	3.05E-01	4.58E+00	122%	109%
	Cobalt-58	4.63E+00	1.70E-01	4.68E+00	103%	95%
	Cobalt-60	5.66E+00	1.44E-01	5.63E+00	103%	98%
	Chromium-51	1.06E+01	1.05E+00	8.85E+00	132%	108%
	Cesium-134	5.57E+00	1.52E-01	5.54E+00	103%	98%
	Cesium-137	4.04E+00	1.31E-01	4.02E+00	104%	97%
	Iron-59	4.00E+00	2.83E-01	4.00E+00	107%	93%
	Iodine-131	3.15E+00	9.48E-01	3.25E+00	126%	68%
	Manganese-54	4.24E+00	1.30E-01	4.10E+00	107%	100%
	Zinc-65	7.43E+00	4.43E-01	7.71E+00	102%	91%
Q2	Cerium-141	7.22E+00	3.01E-01	6.66E+00	113%	104%
	Cobalt-58	6.60E+00	1.82E-01	6.61E+00	103%	97%
	Cobalt-60	8.08E+00	1.54E-01	7.96E+00	103%	100%
	Chromium-51	1.97E+01	1.07E+00	1.97E+01	105%	95%
	Cesium-134	8.07E+00	1.49E-01	7.88E+00	104%	101%
	Cesium-137	7.14E+00	1.99E-01	6.94E+00	106%	100%
	Iron-59	6.91E+00	1.82E-01	6.77E+00	105%	99%
	Iodine-131	3.48E+00	2.55E-01	3.40E+00	110%	95%
	Manganese-54	9.76E+00	2.54E-01	9.21E+00	109%	103%
	Zinc-65	1.13E+01	4.34E-01	1.11E+01	106%	98%
Q3	Cerium-141	5.96E+00	2.59E-01	5.59E+00	111%	102%
	Cobalt-58	6.23E+00	4.54E-01	5.76E+00	116%	100%
	Cobalt-60	7.14E+00	1.40E-01	7.08E+00	103%	99%
	Chromium-51	1.25E+01	8.35E-01	1.15E+01	116%	101%
	Cesium-134	4.91E+00	2.87E-01	4.55E+00	114%	102%
	Cesium-137	5.60E+00	1.64E-01	5.46E+00	106%	100%
	Iron-59	5.10E+00	1.48E-01	4.98E+00	105%	99%

Quarter	**Analyte**	**Bruce Power Value V_L (Bq/L)**	**1 Standard Deviation (S_L)**	**Eckert & Ziegler Analytics Value V_A (Bq/L)**	**$(V_L+S_L)/V_A$**	**$(V_L-S_L)/V_A$**
	Iodine-131	9.61E+00	3.76E-01	9.16E+00	109%	101%
	Manganese-54	6.48E+00	1.80E-01	6.28E+00	106%	100%
	Zinc-65	7.30E+00	4.62E-01	7.49E+00	104%	91%
Q4	Cerium-141	6.47E+00	2.89E-01	5.69E+00	119%	109%
	Cobalt-58	5.15E+00	1.54E-01	4.95E+00	107%	101%
	Cobalt-60	1.01E+01	1.87E-01	9.64E+00	107%	103%
	Chromium-51	1.20E+01	1.56E+00	1.27E+01	107%	82%
	Cesium-134	7.55E+00	1.32E-01	7.20E+00	107%	103%
	Cesium-137	5.04E+00	1.82E-01	5.07E+00	103%	96%
	Iron-59	5.13E+00	1.60E-01	4.87E+00	109%	102%
	Iodine-131	3.26E+00	3.18E-01	3.38E+00	106%	87%
	Manganese-54	6.79E+00	1.89E-01	6.56E+00	106%	101%
	Zinc-65	1.10E+01	3.23E-01	1.11E+01	102%	96%

Table 82 - 2021 Eckert & Ziegler Analytics Test Results for Gamma in Soil

Quarter	Analyte	Bruce Power Value V_L (Bq/kg)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/kg)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
Q1	Cerium-141	1.06E+01	4.21E-01	9.69E+00	114%	105%
	Cobalt-58	8.98E+00	2.27E-01	9.90E+00	93%	88%
	Cobalt-60	1.12E+01	1.96E-01	1.19E+01	96%	92%
	Chromium-51	1.82E+01	9.16E-01	1.87E+01	102%	92%
	Cesium-134	1.08E+01	1.83E-01	1.17E+01	94%	91%
	Cesium-137	1.06E+01	2.64E-01	1.11E+01	98%	93%
	Iron-59	7.81E+00	1.77E-01	8.46E+00	94%	90%
	Manganese-54	8.34E+00	2.22E-01	8.69E+00	99%	93%
	Zinc-65	1.51E+01	3.81E-01	1.63E+01	95%	90%
Q2	Cerium-141	6.50E+00	2.57E-01	6.03E+00	112%	104%
	Cobalt-58	5.68E+00	1.56E-01	5.99E+00	97%	92%
	Cobalt-60	6.95E+00	1.24E-01	7.21E+00	98%	95%
	Chromium-51	1.76E+01	8.61E-01	1.78E+01	104%	94%
	Cesium-134	6.73E+00	1.72E-01	7.14E+00	97%	92%
	Cesium-137	8.89E+00	2.30E-01	8.95E+00	102%	97%
	Iron-59	5.79E+00	1.33E-01	6.14E+00	96%	92%
	Manganese-54	8.05E+00	2.23E-01	8.35E+00	99%	94%
	Zinc-65	9.49E+00	2.53E-01	1.00E+01	97%	92%
Q3	Cerium-141	8.77E+00	3.28E-01	8.11E+00	112%	104%
	Cobalt-58	7.57E+00	1.95E-01	8.35E+00	93%	88%
	Cobalt-60	9.64E+00	1.71E-01	1.03E+01	95%	92%
	Chromium-51	1.55E+01	6.91E-01	1.67E+01	97%	88%
	Cesium-134	6.27E+00	1.41E-01	6.60E+00	97%	93%
	Cesium-137	9.94E+00	2.56E-01	1.05E+01	97%	92%
	Iron-59	6.82E+00	1.56E-01	7.23E+00	96%	92%
	Manganese-54	8.56E+00	2.17E-01	9.10E+00	96%	92%
	Zinc-65	1.02E+01	2.53E-01	1.09E+01	96%	91%
Q4	Cerium-141	8.73E+00	3.38E-01	8.28E+00	110%	101%
	Cobalt-58	6.58E+00	1.76E-01	7.20E+00	94%	89%
	Cobalt-60	1.32E+01	2.23E-01	1.40E+01	96%	93%
	Chromium-51	1.74E+01	9.71E-01	1.84E+01	100%	89%
	Cesium-134	9.47E+00	1.55E-01	1.05E+01	92%	89%

Quarter	Analyte	Bruce Power Value V_L (Bq/kg)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/kg)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
	Cesium-137	9.14E+00	2.27E-01	1.00E+01	94%	89%
	Iron-59	6.64E+00	1.78E-01	7.08E+00	96%	91%
	Manganese-54	8.88E+00	2.25E-01	9.54E+00	95%	91%
	Zinc-65	1.48E+01	3.60E-01	1.62E+01	94%	89%