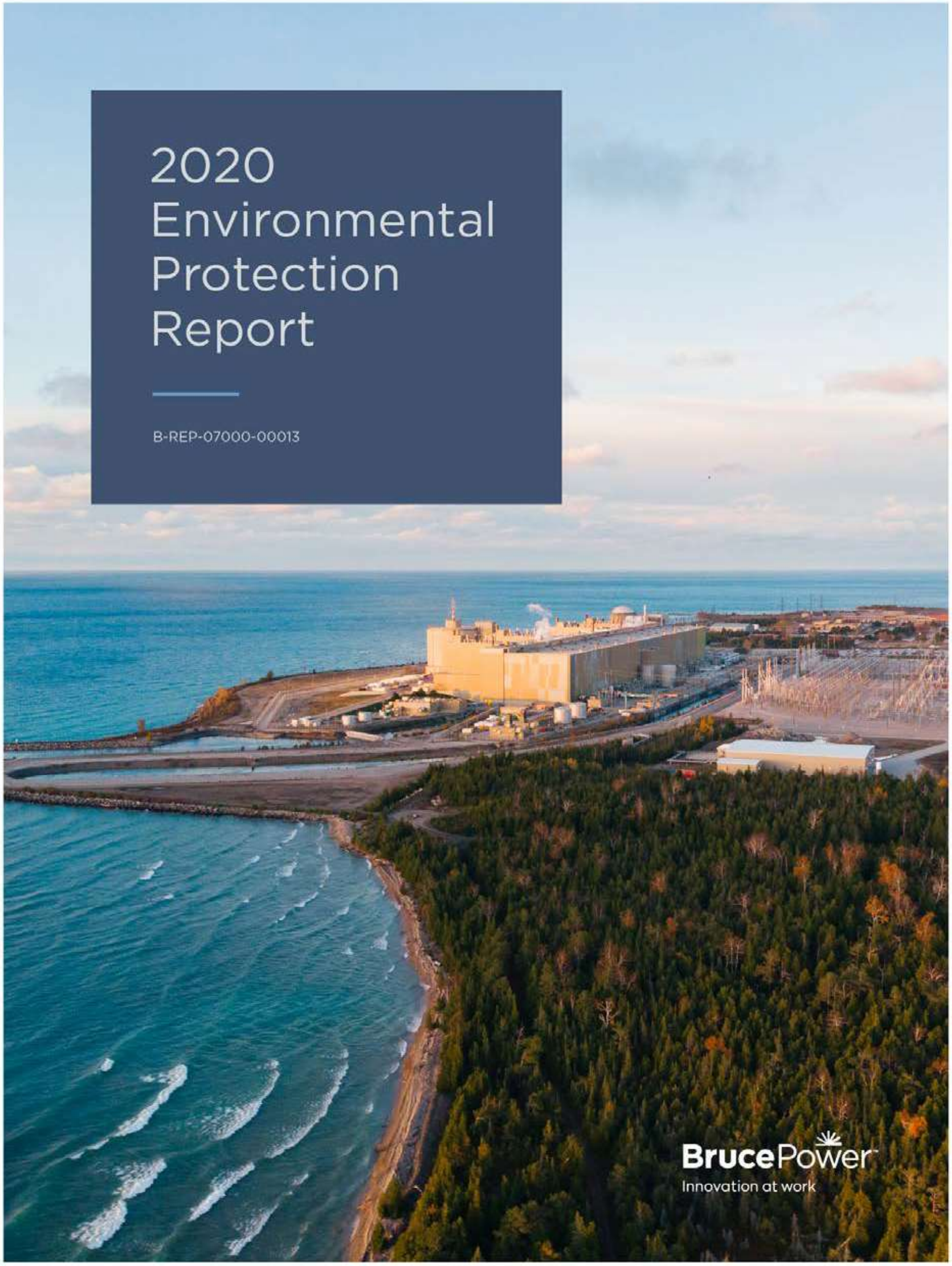
2020 Environmental Protection Report

B-REP-07000-00013



PUBLIC

2020 ENVIRONMENTAL PROTECTION REPORT

B-REP-07000-00013

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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 18:01/2028 [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], more details are described in section 8.0.

The CSA N288 series of Standards and Guidelines provide overall direction on environmental management for nuclear facilities and several are a requirement of the operating licence for the facility. Over the past several years, Bruce Power has been working towards implementation of these series and most recently, Bruce Power implemented CSA N288.7-15, Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills [R-4] and met the implementation date (DEC2020) in the Licence Condition Handbook (LCH-PR-18.01/2028-R002) [R-5].

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 2020 we worked with each community to further these commitments. Note that the Covid-19 pandemic did cause some need to revise plans, and in those instances, notes are included. Progress in environmental monitoring over the course of the year included:

- SON's Coastal Waters Monitoring Program execution of year two of a currently three-year monitoring program commitment. Bruce Power and SON met prior to the start of year two and jointly reviewed year 1 results and plans for year 2. Bruce Power received the year one results report at the end of December of 2020 and has committed to working with SON to understand how this information can be incorporated into our environmental monitoring and risk characterization program.

- MNO Diet Survey was initially planned to be distributed in April of 2020 at the annual general meeting between Bruce Power and the MNO. However, due to the pandemic the meeting was postponed until November of 2020, delaying the distribution of the diet survey which is designed to better inform dose calculations as well as our environmental monitoring program

- HSM is developing a fisheries offset project that is a comprehensive blend, considering the values and interests of the HSM Community and the Fisheries & Oceans Canada (DFO) offsetting principles. This fish habitat restoration and enhancement project embraces the important recent changes to the Fisheries Act which encourages strengthening the role of Indigenous peoples in project reviews, monitoring and policy development as part of the early steps to advance reconciliation.

- Diet survey results will be included within the updated version of the Environmental Risk Assessment in 2022 and will be included within the EPR that outlines 2021 performance.

Involvement in Environmental Monitoring remains a routine and active topic with all three communities moving into 2021.

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 results from local environmental media and site radiological emissions that include all utilities near or within the Bruce Power site boundary. Following the methodology outlined in CSA N288.1 DRL Guidance and using the 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 29th 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 2020 was obtained for the BSF3 Adult who received 1.8 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>2020 Maximum Representative Person's Dose</u>

Representative Person	Committed Effective Dose	Percentage of Legal Limit
BSF3 Adult	1.8 μSv/year	0.18%

Environmental Sustainability

Created in 2015, the Environment and Sustainability fund, has seen the distribution of about $2.4 million dollars since its inception into over 105 environmental projects, partnerships and initiatives mainly across Grey, Bruce and Huron counties. This fund focuses on the areas of conservation, restoration, and education. In 2020, recognizing challenges of the Covid-19 pandemic, fund recipients were given the option to redirect funding to local Covid-19 community initiatives, or maintain the funding to carry out their project at a later time. The projects that were able to proceed through 2020, following the necessary Covid-19 protocols, were:

- Continued protection of the Lake Huron and Georgian Bay Shoreline aquatic habitat via the removal and management of Phragmites in partnership with the Invasive Phragmites Control Centre, and the Oliphant Fishing Islands Phragmites Community Group project via the Grey Sauble Conservation Authority.
- Continued efforts towards clean air and biodiversity enhancements through the planting of 15,076 trees in 2020, bringing our total effort to approximately 165,000 trees since 2012 via organizations such as: Pine River Watershed Group, Penetangore Watershed Group, SauGREEN, Huron Stewardship Council and Saugeen Valley Conservation Authority.

Bruce Power remains dedicated to promoting environmental stewardship and awareness, both throughout the local communities and in the greater Ontario region. In 2020 this work was able to continue in a safe manner, as Bruce Power continued to collaborate across digital platforms and realized success through our partnerships with common environmental protection and sustainability goals.

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-6].

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 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. In 2020, this consisted of the submission of an assessment of feasible mitigation measures for thermal effluent and impingement and entrainment effects, engagement with CNSC and ECCC to clarify the thermal risk assessment plan and continued work in the areas of climate change through participation in a multi-year study with the Council of the Great Lakes Region (CGLR) and the Climate Risk Institute (CRI) and modelling of future lake water temperatures.

Environmental Monitoring

The environmental monitoring program is designed to meet the requirements of CSA N288.4-10 [R-7]. 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.

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. Involvement in Environmental Monitoring remains a routine and active topic with all three communities moving into 2021.

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 exposure pathways 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 2020, as stated above, the maximum dose associated with Bruce Power operations was obtained for the BSF3 Adult who received 1.8 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 2020 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 2020, with monitoring in the Saugeen River in the vicinity of the former Truax Dam as per Bruce Power's Offsetting Plan. Thermal monitoring also continued in 2020, with results used for ongoing verification for thermal risk assessment to address both 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. The 2020 groundwater results for tritium concentrations at Bruce A and Bruce B multi-level wells remain well below the Ministry of Environment, Conservation and Parks (MECP) Generic Guidelines for non-potable water and below the Ontario Drinking Water Standard (ODWS) of 7,000 Bq/L. Additional sampling for tritium in wells near the Transformer and Standby Generator areas at Bruce A and Bruce B also resulted in levels well below the ODWS which is protective of human health.

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 Effluent Monitoring

In 2020, all releases remained well below the derived release limits and action levels. Where possible, Bruce Power has several engineered barriers in place to assist in minimizing radionuclides released to the environment and keeping releases as low as reasonably achievable (ALARA). These barriers, in conjunction with applying the ALARA principle, systematic monitoring and trending of airborne emissions, and investigation when emissions fluctuate, assists Bruce Power in minimizing emissions 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-8] and the Ontario Water Resources Act [R-9]. For conventional waterborne emissions, there was one Effluent Monitoring Effluent Limits (EMEL) event of elevated nitrite levels as described in the report.

In accordance with the ECA (Air) [R-10], noise complaints were received from Inverhuron residents between May 21, 2020 and October 05, 2020. In accordance with the conditions of Bruce Power's ECA, the MECP District Office was notified of the complaints in writing following each complaint. 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
AL - Action Level
ALARA - As Low As Reasonably Achievable
ALc - Combined Dose Action Level
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
CGLR - Council of the Great Lakes Region
CLP - Chemistry Lab Procedure
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
CRI - Climate Risk Institute
CSA - Canadian Standards Association
CSF - Central Storage Facility
CSR - Corporate Social Responsibility
CWDD - Cooling Water Discharge Duct
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
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
Ft.	-	Feet
BG	-	Gross Beta
GHG	-	Greenhouse Gas
GS	-	Gross Scan
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
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
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
NOL	-	Normal Operating Level
NPRI	-	National Pollutant Release Inventory
OBT	-	Organically Bound Tritium
OPG	-	Ontario Power Generation

OWRA	-	Ontario Water Resources Act
PEA	-	Predictive Environmental Risk Assessment
POI	-	Point of Impingement
PROL	-	Power Reactor Operating Licence
PTTW	-	Permit To Take Water
PWQMN	-	Provincial Water Quality Monitoring Network
PWQO	-	Provincial Water Quality Objectives
QA	-	Quality Assurance
QC	-	Quality Control
REM	-	Radiological Environmental Monitoring
SAR	-	Species At Risk
SCR	-	Station Condition Record
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
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 18:00/2028 [R-1] 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 18:00/2028 [R-1] and the associated Licence Condition Handbook [R-5], 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 at https://www.brucepower.com/resources/publications/?_sf_s=environmental%20protection.

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-11]. The key elements are listed below:

- The General Nuclear Safety and Control Regulations [R-12] 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-13] set out environmental protection requirements that must be met.

- The Radiation Protection Regulations [R-14] prescribe radiation dose limits for the general public of 1 mSv (1000 µSv) per calendar year.

- PROL 18.01/2028, Nuclear Reactor Operating Licence Bruce Nuclear Generating Stations A and B [R-1].

The CNSC, when considering relicensing, has an obligation through the Nuclear Safety and Control Act [R-11] 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-15]. As a result, the CSA N288 standards are implemented through requirements set out in the License Condition Handbook (LCH) [R-5].

REGDOC-2.9.1 [R-15] 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-16] 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 N288.1-08, Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities [R-17];

- CSA N288.4-10, Environmental Monitoring Program at Class I nuclear facilities and uranium mines and mills [R-7];

- CSA N288.5-11, Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills [R-18];

- CSA N288.6-12, Environmental Risk Assessments at Class I nuclear facilities and uranium mines and mills [R-19]; and

- CSA N288.7-15, Groundwater Protection Programs at Class I nuclear facilities and uranium mines and mills [R-4].

Bruce Power is working towards implementing 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-20], by 31DEC2021 [R-21]. The timing aligns with the implementation of new environmental action levels (EALs) at Bruce Power.

Bruce Power is working towards a voluntary implementation of:

- CSA N288.3.4-13, Performance testing of nuclear air-cleaning systems at nuclear facilities [R-22]; and

- CSA N288.8-17, Establishing and implementing action levels for releases to the environment from nuclear facilities [R-23].

Bruce Power is following the guidance provided in CSA N288.9-19, Guideline for design of fish impingement and entrainment programs at nuclear facilities [R-24] to enhance the fish impingement and entrainment programs.

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 2020, Bruce Power had a successful re-registration audit and obtained a certificate of registration certifying that Bruce Power operates an Environmental Management System (EMS) compliant with the requirements of ISO 14001:2015 [R-3]. This certification is valid for three years.

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-16], 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.

Environmental Policy

The Environmental 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:

- Commit to comply with relevant legislation, regulations, and other requirements as a minimum standard;
- Ingrain a sense of environmental responsibility into our nuclear safety culture;
- Hold ourselves accountable to preventing pollution through emissions, spills, and waste, and reducing our impact on the environment;
- Protect, conserve, and restore our resources through energy conservation, reducing water consumption, and by reusing or recycling materials;
- Focus on continuous improvement by adopting applicable industry best practices and requirements of ISO 14001;
- Uphold the trust of the community through open and transparent communication with partners, Indigenous communities, and stakeholders on environmental interests;
- Promote environmental stewardship and awareness at work, in the community, and across Ontario; and
- Ensure our business decisions support the application and practice of sustainability principles.

Environment has proposed changes to the Environmental 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. These changes are expected to be reflected in a revised environmental policy in 2021.

2.0 BACKGROUND

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) starting 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-25].

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-26].

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. The facility consists of a permanently shut down, partially decommissioned prototype 200 megawatt CANDU® reactor and associated structures and ancillaries. This facility is presently in the long term "Storage with Surveillance" phase of a decommissioning program [R-26] [R-27].

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-27].

2.2 Kinetrics 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-28].

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-28].

- 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-28]. 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-29]

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-30].

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-29].

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 the findings 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-29]

2.4 Overview of Surrounding Area and Community

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).

2.5 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.

2.5.1 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: SON Traditional Territory [R-31]. Map created as part of SON community workshops held in October 2019.

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-32] [R-33].

2.5.2 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-34]:

"…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."

2.5.3 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-35]. 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 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-35].

2.6 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.

2.6.1 Bruce Power's Community Involvement and Investment

Corporate Social Responsibility (CSR) has been 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 2020 saw the distribution of around $400 thousand 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. Over the years, including 2020, we have had new environmental protection or sustainability opportunities arise which have motivated us to identify and allocate additional funds above and beyond the Environment & Sustainability fund. Over the course of 2020, our sustainability program pivoted to a more quantitative and formalized program with stronger governance that included establishment of key performance indicators, and targets. This has been built off the Environmental, Social and Governance (ESG) approach, to align with global standards and guidelines. 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 also established in 2020. More information on our Sustainability program will be provided via further sustainability reporting in 2021.

2.7 Life Extension Program and Major Component Replacement Project

In December 2015, Bruce Power reached an agreement with the Independent Electricity System Operator (IESO) [R-36] 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 [R-37]. 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 2021, there have been no reportable events or 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 Worksheets (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 is appropriately managed and mitigated. This guidance and key considerations are used in daily pre-job briefings for work execution.

Over the course of 2020, many project related milestones were completed with minimal environmental impact as anticipated in the 2017 Predictive Environmental Risk Assessment [R-38]. Following breaker open on January 17, 2020, Unit 6 was safely taken through over-poisoned guaranteed shutdown state to a defueled guaranteed shutdown state. Bulkheads were successfully installed, and a pressure test completed to remove the Unit 6 vault from the containment boundary. The Primary Heat Transport system was drained and dried to allow the vault to be turned over to project teams so that the fuel channel and feeder replacement work could commence. By the end of 2020, feeder removal was completed. In addition, construction and refurbishment of buildings and infrastructure on-site and off-site were completed including: the development a large training facility in Kincardine, a new warehouse to support receipt of MCR material including replacement steam generators, and a centralized storage facility on site to contain and repair potentially contaminated tooling and equipment for use in subsequent MCR projects. Bruce B has constructed an additional guard house as well as an auxiliary office annex within the protected area to support additional project staff. A material handling vestibule was constructed to support transfer of materials from the un-zoned area into zone 3 of Unit 6. This vestibule is in close proximity to an expanded crane pad which will support the large crane required to hoist the old steam generators out of the roof of Bruce B and subsequently lift the replacement steam generators into place.

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-39] [R-40] [R-41]. 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 at 1,800 µSv/year [R-40]. 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-40].

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-39].

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. 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 N288.1-14 [R-20]. 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 2020 is provided here.

For the 29th 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 2020, who is calculated to have the maximum, is the BSF3 Adult who received 1.8 µSv/year (Table 1). All other representative persons have a lower dose. This maximum dose is a fraction of a percent of the legal limit of 1,000 µSv/year.

Table 1: 2020 Maximum Representative Person's Dose

Maximum Representative Person	Committed Effective Dose	Percentage of Legal Limit
BSF3 Adult	1.8 µSv/year	0.18%

The contribution of each radionuclide/radionuclide group to the 2020 radiological dose for the maximally exposed representative person is shown in Table 2 and Figure 2. Consistent with previous years, most of the radiological dose is from two radionuclides (carbon-14 ~ 70%, tritium oxide ~ 20%). Exposure pathways to these radionuclides are predominantly via air inhalation and immersion as well as the ingestion of local food sources.

Table 2: 2020 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)	1.2E+00	1.1E-02	9.9E-03	1.7E-02	3.8E-01	1.5E-04	9.5E-02	**1.76E+00**
Percentage	70%	1%	1%	1%	22%	0%	6%	100%

Notes: 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.

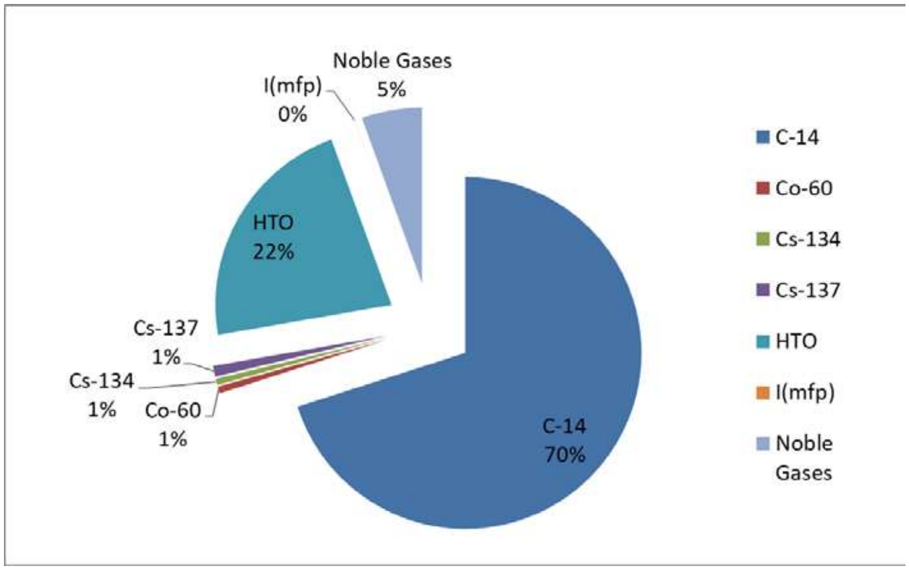

Figure 2: 2020 Radiological Dose by Contaminant for Representative Persons Group BSF3 Adult

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 29 consecutive years. The annual maximum dose for the last ten years is shown in Figure 3. 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-40]. The calculation of public dose demonstrates that the radiological emissions from the Bruce Power Site have an extremely small impact on public dose.

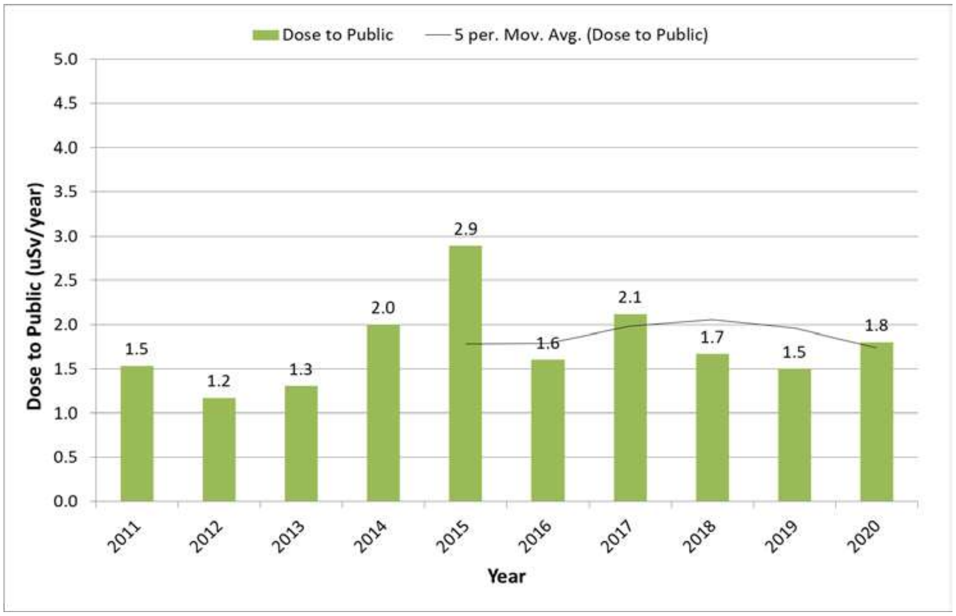

Figure 3: Historical Dose to Public Over Time (Dose Limit 1000 µSv/year)

3.1.1 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 3.1.2)
- Characteristics of the Representative Persons (Section 3.1.4)

The methodology used to calculate annual public dose from normal operations at CANDU nuclear power stations is described in CSA N288.1-14 Update 3 [R-20]. 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 4 [R-20]. 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 an airborne radiological contaminant (e.g. tritiated water) that is deposited on a field and taken up by the plants that are ingested by dairy cattle, which may impact the dairy milk that is ingested by a child. These elaborate networks are set up in a 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-20].

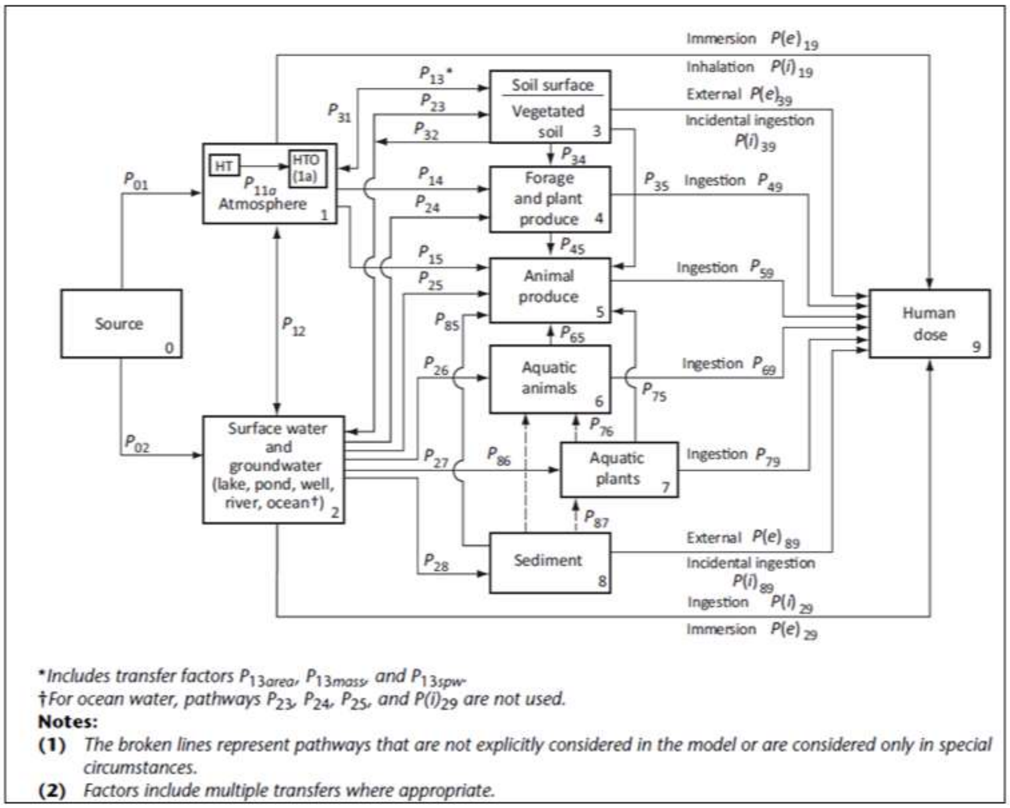

Figure 4: Environmental Transfer Model (Extracted from CSA N288.1-14)

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 as possible. If no data is available for any media along a specified exposure pathway, transport modelling and emissions 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 1,000 µSv (100 mrem).

Table 3: Radionuclides Measured as Part of Radiological Environmental Monitoring

Radionuclide	Sample Medium	Exposure Pathway
Tritium	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
C-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

Radionuclide	Sample Medium	Exposure Pathway
I-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

3.1.1.1 2020 Dose Calculations

For 2020, the basic set-up of the IMPACT model, in terms of transfer parameters and environmental variables, is identical to that used in 2019, 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 taken from the CSA N288.1-14 Update 3 [R-20]. For the Hunter-Fisherman group (BHF1), rates of intake of game animals were adjusted slightly from the DRL Guidance values to reflect conservative wild game intake rates of Indigenous communities from the First Nations Food, Nutrition, and Environmental Study (FNFES) [R-43]. For fish intake by the BHF1 group, central intake rates taken from the DRL Guidance were used. A recent study has indicated that the DRL central intakes are representative of fish ingestion rates of communities near Bruce Power [R-44].

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 3.1.3). 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 Appendix C:.

The emissions 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 were Co-60, consistent with the approach applied in the most recent ERA [R-38]. This assumption has been shown to be conservative, very likely over-stating the actual dose that could be associated with Bruce Power emissions. 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 most recent ERA that the dose associated with all alpha emitters is negligible. For this reason, alpha emissions are not included in the dose calculation process.

In 2020, 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 2020 dose calculations [R-45], the following conservative measures were taken to address unavailable data or measured values being lower than background:

- In 2020, no milk sample was available for location BDF14. The average results for the milk samples collected from the nearest dairy farm that is closer to the sources of emissions (i.e., BDF13) was applied for location BDF14.
- BR32 shallow well water data was not available for 2020 so the 2019 values were used instead.
- For deep residential wells, the activity level of HTO in all samples collected in 2020 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 C-14 in some local samples of vegetables and milk collected in 2020 was lower than the C-14 activity in corresponding background samples. To quantify the C-14 activity in these media, the environmental transport models in IMPACT were invoked.

For 2020, due to recurring technical issues with the meteorological tower and unavailability of a complete dataset for 2020, the five year average (2011 to 2016) triple joint frequency wind data was used (see Section 3.1.2) for the dose calculations.

3.1.2 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 Section 6.1.4 of CSA N288.1-20 [R-46].

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 Section 4.3.2.6 of CSA N288.2-19 [R-47]. 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. The construction started on Sept 30, 2020 and the tower returned to service on Dec 09, 2020. It is anticipated that these upgrades will result in improved meteorological data availability in 2021.

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 upgrades started on Dec 02, 2020 and the tower returned to service on Dec 23, 2020. In addition, the 50m tower had a planned outage in May with data unavailability from May 16-31, 2020.

The data availability analysis results for the two meteorological towers for 2020 is shown in Table 4.

Table 4: Summary of Missing Records for 2020

Data Source	Available Records	Total Records Planned	Records Missing (%)
10m Tower	3956	8784	55.0
50m Tower	7864	8784	10.5

The data gaps in the 2020 raw meteorological data did not meet the 90% data availability requirement [R-48]. Therefore, the five-year average dataset from the years 2011, 2012, 2013, 2015, and 2016 were utilized as a surrogate to calculate the Double Joint Frequency (DJF) and TJF for the dose to public calculation. The methodology for obtaining the DJF and TJF, as well as the results for the 50m tower used for the dose calculation is provided in Appendix B:.

3.1.3 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 Section 3.1.4). These unique groups are used for dose to public calculations as per CSA N288.1-14 Update 3 [R-20].

The most recent Site Specific Survey Report was completed in 2016 and included multiple surveys in order to determine the percentage of locally consumed food and water. The outcomes were used to update the representative person characteristics as well as inform the environmental monitoring program. The next Site Specific Survey Report is expected for 2021 and will focus on refining the characteristics of a representative group that may better reflect the behaviours and practices of local First Nations and Métis groups.

3.1.4 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-20]. 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/Fisherman** - The hunter/fisherman shares similar dietary characteristics as the subsistence farm resident. For both groups, the local food fractions for wild game, fish and most other foodstuff are assumed to be 100%.

The hunter/fisherman resident was added after the 2016 Site Survey and is defined as an individual who catches and consumes wild game and fish in significantly greater quantities than other residents. In this context, the hunter/fisherman is representative of Indigenous populations. Health Canada [R-43] recommends the incorporation of specific ingestion rates for fish and wild game for Indigenous populations; the ingestion rates for all other foodstuff may be assumed to be equivalent to those for the Canadian general population.

In 2019, Bruce Power began working closely with local First Nations and Metis communities to develop and carry out individualized diet surveys in order to further refine the hunter/fisherman receptor characteristics. The outcome of the diet surveys is not available for the 2020 dose to public calculation; however, it will be included in the next Environmental Risk Assessment.

Currently, the only difference between the subsistence farm resident and the hunter/fisherman resident is that the hunter/fisherman consumes a greater amount of wild game and fish each year. The wild game and fish intake rates for the hunter/fisherman were based on mean intake values of Indigenous peoples from the First Nations Food, Nutrition, and Environmental Study reported in 2014 [R-43]. This study provides a detailed report of the diet of First Nations people based on surveying of adults on reserve at 18 different communities throughout Ontario. Since only adults were surveyed, intake rates for infants and children were calculated by scaling the intake rates of adults by the average caloric intake of each age group, as identified in N288.1-14 Update 3 [R-20].

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), 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/fisherman, 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 5.

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)

Group Name	General Characteristics and Location of Group
BHF1	Generic hunter/fisherman 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)
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 5 : Representative Person Near-Field (Left) and Far-Field (Right) Locations

3.1.5 Dose Results and Interpretation

The maximum dose to a member of the public in 2020 was obtained for the Subsistence Farmer BSF3 Adult with a value of 1.76 µSv/year [R-45] and remains well below the public dose limit of 1000 µSv/year. This is a change from the previous year where the maximum dose went to the Farm Resident BF14 Adult; however, it is a return to the representative group that has had the maximum dose in previous years (2012-2018).

In 2020, the doses calculated for the Subsistence Farmer group at both locations (BSF2 and BSF3) were in the range of 1.58 to 1.76 µSv/year, which is moderately higher than doses calculated for group BF14 (1.11 to 1.32 µSv/year). Doses to the various representative locations and age classes of the Dairy Farm (BDF) group, and also farm groups other than BF14, range from 0.77 to 1.26 µSv/year. The dose to BF14 is typically higher than other farm groups due to its proximity to Site and location within a dominant wind location. The doses calculated for the non-farming Resident (BR) group at various locations in close proximity to Bruce Power were slightly lower, ranging from 0.73 to 1.16 µSv/year. The doses calculated for members of the Hunter-Fisherman (BHF) group near Southampton were between 0.52 and 0.55 µSv/year. The BEC Adult had the lowest calculated dose with 0.07 µSv/year. Annual doses calculated for 2020 for all representative groups and age classes are provided in Appendix C:.

For the Subsistence Farmer group (BSF), about 85% of the total dose was from food ingestion, which simply reflects the relatively high rate of local food consumption by members of this farm-based group. For the other farm-based groups (BDF, BF), food ingestion similarly accounts for the majority (~60 to 80%) of total dose. For the non-farm residential group (BR), the proportion of total dose associated with food ingestion is slightly less but still significant (~ 40% to 60%). Direct exposure to radionuclides in air via inhalation and immersion is the only other significant contributor to total dose, accounting for about 10% to 40% of dose for farm-based groups (BDF, BF, BSF) and 40% to 60% 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 ~70 % of total dose and tritium oxide (HTO) at ~20% 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 2020. This dominance of C-14 and HTO as contributors to total dose in 2020 is consistent with the findings of public dose calculations over the past decade. Noble gases were the only other radionuclide group to contribute substantially more than 1% of public dose, accounting for an average of about 16% of total dose for all groups considered.

The increase in public dose in 2020 is in large part associated with an increase in dose from C-14. Total atmospheric emissions of C-14 were slightly higher (~7%) in 2020 than they were in 2019Increases in C-14 emissions ultimately results in increases of C-14 in air and in local food sources, and in 2020, ingestion of C-14 in plant and animal products from local sources accounted for about 50% of the total public dose on average.

For the BSF and BDF groups there was a much larger increase in C-14 dose in 2020 compared to the previous year. This increase is attributed to the following items:

- Higher C-14 in air as measured at passive sampling station B11 (located in Tiverton and is closest to the location of the BSF group and most locations of the BDF group) relative to background, in comparison to 2019

- Where measured values were lower than background, including vegetable and milk samples at BDF and BSF locations, conservative models were used to quantify the concentration of C-14 based on C-14 measured in air

- Where there was an absence of various food types (i.e. pork, poultry, beef), conservative models were used to quantify the concentration of C-14 based on C-14 measured in air

Since the model was used to calculate certain parameters for the BSF and BDF groups, specifically for instances when (i) values were less than background and (ii) media was not sampled as part of REM, the resulting increase in dose from C-14 was higher than the other representative groups that simply mirrored the increases in C-14 emissions.

For HTO, which contributed about a third of 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. Overall, the 18% decline in emission of HTO to atmosphere from 2019 to 2020 corresponds with an overall average decline of 11% in the contribution of HTO to public dose.

4.0 ENVIRONMENTAL RISK ASSESSMENT (ERA)

A retrospective and predictive ERA (also known as a Predictive Environmental Assessment (PEA)) 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 an updated approach to the thermal risk assessment (see [R-38] [R-49]). The ERA fulfills the environmental protection requirements under the Nuclear Safety and Control Act. The Impact Assessment Act does not apply. An important area of focus related to the ERA is public and Indigenous engagement and consultation activities. The ERA process provides 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 will be submitted in June 2022.

CNSC and ECCC staff reviewed the December 2018 ERA and PEA 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-6].

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 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. 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 is limited to a small geographic area and thermal monitoring and modelling continues in order to further refine the risk related to thermal effluent and cold-water fish species. In 2020, Bruce Power engaged in a series of four meetings 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. The planned approach to the 2022 ERA thermal risk assessment was also shared with Indigenous communities.

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.

Based on the review of the past Bruce Power specific related concerns raised by Indigenous communities, all technical considerations within the construct of the CSA N288.6 framework have been dispositioned. Bruce Power has acted in response to many of these concerns and continues to work with Indigenous communities to address these issues. Bruce Power remains committed to having ongoing consultation and discussions with all three Indigenous 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, in 2021 we will continue to work with each community to determine where they see their connection to environmental protection in preparation for the 2022 ERA.

The design and use of mitigation technologies have been implemented to minimize 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-50]. Given the 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. The assessment of feasible mitigation measures provides a recent assessment 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.

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 both on site and in local communities.

Bruce Power is participating in a multi-year study with the Council of the Great Lakes Region (CGLR) and the Climate Risk Institute (CRI) to produce knowledge to help the communities surrounding Bruce Power understand the risks and opportunities associated with climate change. This includes understanding the potential effects on environmental, cultural and socioeconomic values and activities in the surrounding communities [R-51] (https://climateriskinstitute.ca/2020/11/17/bruce_grey_huron/).

Bruce Power has also completed an extensive modelling exercise examining the potential effect of climate change on the water temperature in Lake Huron under cold, median and warm climate change scenarios by the end of life in 2064. These scenarios considered conditions where Bruce Power is operating and where Bruce Power is not operating. The background temperature of Lake Huron water, without Bruce Power operating, is expected to increase under all scenarios, except the cold scenario, with cumulative average annual increases projected to be between 1.4°C and 2.4°C by 2054-2074. The change in water temperature that occurs as a result of the use of cooling water for the Bruce Power site is expected to remain unchanged under all climate change scenarios. With Bruce Power operating, the water temperatures are expected to increase under all scenarios, except the cold scenario, with cumulative average annual increases projected to be between 1.3°C and 2.3°C by 2054-2074. The impact of Bruce Power operations in terms of thermal effluent will remain unchanged under all climate change scenarios [R-52].

The ERA will continue to be updated as climate change prediction models are 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. 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 at the Bruce site combined with continued monitoring and assessment has provided empirical evidence of little to no risk to the local environment.

5.0 EFFLUENT MONITORING

5.1 Radiological Effluent Monitoring Programs – Bruce A, Bruce B, CMF, CSF, OPG, CNL, KI North Facility

Monitoring of emissions and effluents occurs at Bruce A and Bruce B Nuclear Generating Stations, the Central Maintenance Facility (CMF) and the Central Storage Facility (CSF) in accordance with BP-PROC-00080, Effluent Monitoring [R-53]. Bruce Power fully implemented CSA N288.5 Effluent Monitoring Programs at Class 1 nuclear facilities and uranium mines and mills [R-18] in 2018. BP-PROC-00080, Effluent Monitoring [R-53] encompasses radiological and conventional emissions and effluent monitoring, with BP-PROC-00171, Radiological Emissions [R-54] specifically focusing on radiological emissions and effluents.

The purpose of Bruce Power's Radiological Emissions and Effluent Monitoring 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. Radiological Emissions and Effluent Monitoring describes the Bruce Power framework for control of radioactive emissions and effluents from Bruce A, Bruce B, the CMF and the CSF and includes the radionuclide effluent monitoring system operating and quality assurance (QA) requirements.

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-17] based on a public dose limit of 1 mSv per year as mandated by the CNSC (Radiation Protection Regulations, SOR/2000-203) [R-14]. 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 precautionary levels that are set far below the actual DRLs to alert the operator well 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 the environment are protected at all times. Radiological emissions and effluent monitoring data are reported to the CNSC quarterly and are compared against internal investigative and regulatory levels and limits.

Data from Radiological Emissions and Effluent Monitoring is also compounded with other radiological and conventional environmental measurements to complete a comprehensive Environmental Risk Assessment in accordance with CSA N288.6 [R-19]. This confirms that Bruce Power has sound and robust Environmental Monitoring.

The OPG WWMF operates under a Waste Facility Operating Licence (WFOL-W4-314.00 2027) [R-55] and monitors emissions in accordance with OPG's N-STD-OP-0031, Monitoring of Nuclear and Hazardous Substances in Effluents [R-56]. N-STD-OP-0031 establishes the minimum standards for monitoring airborne and waterborne effluents for OPG nuclear facilities in accordance with CSA N288.5 [R-18]. The effluent monitoring program ensures emissions are maintained well below the DRLs established in the Licence Condition Handbook (LCH-W4-314.00 2027) [R-57] 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-19] [R-7]. The Environmental Risk Assessment [R-58] is updated at a minimum of once every five years and the Environmental Monitoring Program is reviewed annually.

The most recent Environmental Risk Assessment [R-58] was completed in 2016 and is scheduled to be updated in 2021. The first annual Environmental Monitoring Program report [R-59] for the WWMF was completed in 2020. 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 ecology from the operation of the WWMF [R-25].

The Douglas Point Waste Facility (DPWF) is operated by Canadian Nuclear Laboratories (CNL) and is located on the Bruce Site. The facility consists of a permanently shut down, partially decommissioned prototype 200 megawatt CANDU® reactor and associated structures and ancillaries. This facility is presently in the long-term “Storage with Surveillance” phase of a decommissioning program [R-27].

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-28].

- 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-28].

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 7. 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 8**.** All airborne and waterborne emissions are well below regulatory limits and reportable levels (DRLs, ALs) and on most occasions below Internal Investigation Levels (IILs).

Table 6 shows the framework for radioactive emissions and effluent controls and limits.

Table 6: Framework for Radioactive Effluent Controls and Limits

Basis	Levels/Limits	Unit of Measure	Description/Detail
1000 μSv/y	DRLs	Bq/wk (air) Bq/mo (water)	For each radionuclide release group per facility plus "sum of fractions of DRL" rule over all radionuclides per facility to ensure the total dose remains below the limit.
20 μSv/mo	ALc	EEDs (μSv/mo)	One combined dose Action Level for all radionuclide release groups from all Bruce Power facilities. EEDs = Bruce Power emission effective dose.
2 μSv/wk (air) 8 μSv/mo (water)	AL	Bq/wk (air) Bq/mo (water)	For each radionuclide release group per facility. 10% of DRL.
	IIL	Bq/wk (air) Bq/mo (water)	For each radionuclide release group per facility. IIL is at the high end of normal release rates, e.g., at 97.5th percentile. Single Pathway Thresholds are on each release point.
ALARA ↓	Normal Range of Releases ↓	Bq/wk (air) Bq/mo (water)	Normal releases may be characterized by 95% confidence interval and/or mean.
Legend			
DRL	=	Derived Release Limit for individual radionuclide groups, which triggers reporting to CNSC.	
AL	=	Action Level for individual radionuclide groups, which triggers reporting to CNSC.	
ALc	=	Combined Dose Action Level for all radionuclides, which triggers reporting to CNSC.	
IIL	=	Internal Investigation Level, which triggers the internal Bruce Power SCR process.	

NOL	=	Normal Operating Level, i.e., mean of historic releases. For longer term trend analysis.

Emissions and effluents can change depending on activities occurring in the nuclear facilities, such as planned/unplanned outages, maintenance and refurbishment activities. Outages are required to complete maintenance for continued safe and reliable operation. Maintenance activities may cause periodic elevated emissions during outage periods due to systems that are typically closed being opened for inspections and maintenance.

5.1.1 Air

5.1.1.1 2020 Radiological Airborne Effluent 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 or be elevated during particular planned and unplanned activities. Unplanned events that may cause emission increases can be a result of; equipment deficiencies such as stack filter by-pass, resin exhaustion in the ion-exchange purification processes, and boiler tube leaks causing increased emissions through feedwater venting. Planned activities where emission fluctuations may occur include: scheduled fuel bundle defect removals from the heat transport system, purges from systems including moderator cover gas required to keep key process 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.

Where possible, Bruce Power has several engineered barriers in place to assist in minimizing radionuclides released to the environment and keeping releases as low as reasonably achievable (ALARA). These barriers include high efficiency particulate air (HEPA) filters and high efficiency carbon air (HECA) filters to minimize the release of radionuclides through the exhaust stacks. Testing of Bruce Power's stack filters are 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 trending of airborne emissions, and investigation when emissions fluctuate, assists Bruce Power in minimizing emissions and ensuring they remain well below regulatory limits.

In 2020, 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 effluent monitoring program in accordance with the Power Reactor Operating Licence. The

2020 Radiological Airborne Effluent Results for all licensed facilities onsite are shown in Table 7. In addition to normal operations, maintenance work completed on the heat transport system, moderator, feeders and boilers also contributed to radiological emissions in 2020. The outage activities in 2020 were also focused on fuel channel inspections at both stations.

Table 7: Annual Radiological Airborne (Gaseous) Effluent Results for 2020

Pathway - Radionuclide	Emissions (Bq)/yr							
	Bruce A	Bruce B	CMF	CSF	WWMF (OPG)	CNL	Kinectrics KI**	Total
Air								
Tritium Oxide	3.4E+14	3.1E+14	2.4E+10	1.3E+09	1.73E+13	4.1E+11	1.18E+11	6.7E+14
Noble Gas	7.8E+13	2.6E+13	Not applicable	Not Applicable	Not Applicable	Not applicable	Not Applicable	1.0E+14
Iodine-131	2.2E+07	2.9E+06	0.00E+00	Not applicable	0.00E+00	Not applicable	Not Applicable	2.5E+07
Particulate Gamma	2.9E+06	6.4E+06	0.00E+00*	0.00E+00*	1.37E+04	Not applicable	Not Applicable	9.3E+06
Particulate Gross Beta	Not applicable	Not applicable	Not applicable	Not applicable	Not Applicable	1.4E+05	Not Applicable	1.4E+05
Particulate Gross Alpha	3.0E+04	4.3E+04	0.00E+00*	Not applicable	Not Applicable	8.4E+03	Not Applicable	8.1E+04
Carbon-14	1.6E+12	9.9E+11	Not applicable	Not applicable	2.63E+10	Not applicable	Not Applicable	2.6E+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 Jan 03, 2020 to Dec 30, 2020.

5.1.1.2 Historical Radiological Airborne Effluent Results

The figures below 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 6 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 2020, airborne tritium emissions decreased at Bruce A and Bruce B compared to prior years.

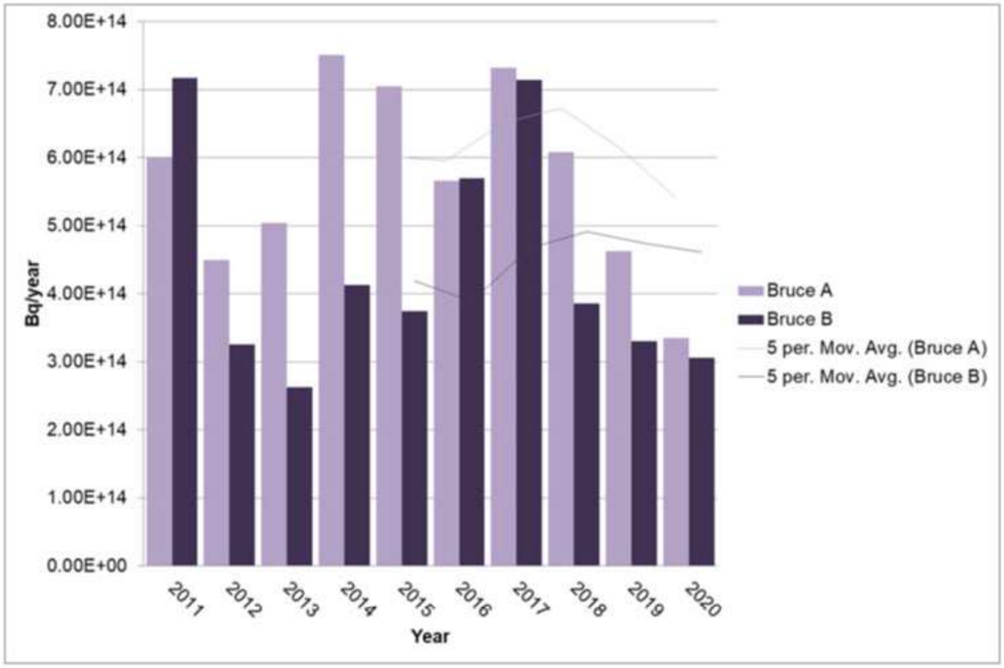

Figure 6: Historical Tritium Airborne Emissions

Figure 7 details the historical trend in airborne ^{14}C emissions. Airborne ^{14}C is also a principal radiological emission contributing to dose to public. In 2020, ^{14}C emissions remained low at Bruce B, with a slight increase at Bruce A compared to the previous year.

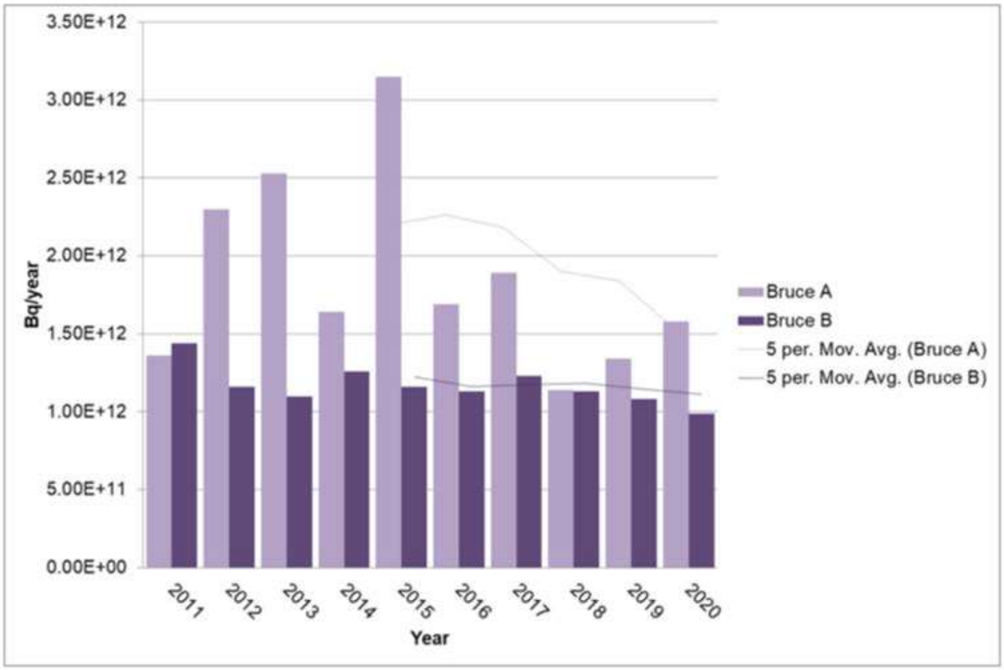

Figure 7: Historical Airborne ^{14}C Emissions

The majority of airborne iodine emissions are captured by the HECA filters, which are tested on an annual basis to probe filter exhaustion, overall efficiency, and in order to 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 8 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 noted iodine emissions at Bruce A in 2014 are greater than previous years but remained well below all regulatory limits and associated reportable action levels. 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 heat transport system. 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.

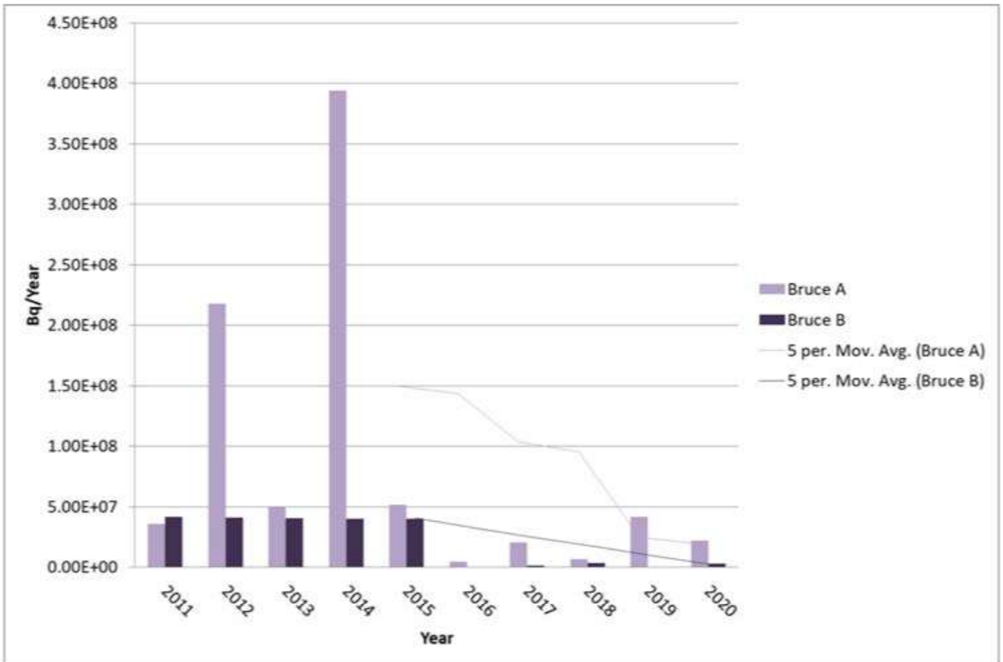

Figure 8: Historical Airborne Iodine Emissions

5.1.2 Water

5.1.2.1 2020 Radiological Waterborne Effluent Results

Through Bruce Power's normal operation and outage activities, waterborne radiological effluents are released to the environment. These waterborne effluents are well below regulatory limits and associated reportable action levels. Waterborne effluents are monitored through release pathways that include Active Liquid Waste, feedwater discharges and foundation drainage. Ultimately, these effluents are discharged via the Condenser Cooling Water (CCW) duct. Radiological waterborne effluents typically originate 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 (ALW) 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 is met. Waterborne effluents may fluctuate or be elevated during particular planned and unplanned activities. Unplanned events that may cause effluent increases can be a result of 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 heat transport system, increased spent resin transfers, and increased outage days where maintenance work is performed on reactor systems to support equipment health and continued safe operation.

Where possible, Bruce Power has several barriers in place to assist in minimizing 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, monitoring and trending waterborne effluents and initiating investigations when effluent levels are elevated, assists Bruce Power in minimizing effluents and ensuring they remain well below regulatory limits.

In 2020, Bruce Power's radiological waterborne effluents were well below regulatory limits and associated reportable 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 2020 waterborne radiological effluent results are shown below in Table 8. 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.

Table 8: Annual Waterborne (Aqueous) Radioactive Effluent Results for 2020

Pathway - Radionuclide	Emissions (Bq)/yr					
	Bruce A	**Bruce B**	**WWMF (OPG)**	**CNL**	**Kinectrics KI***	**Total**
Water						
Tritium Oxide	2.5E+14	5.7E+14	2.36E+11	1.74E+10	Not applicable	8.20E+14
Carbon-14	1.1E+09	1.79E+09	Not applicable	Not applicable	Not applicable	2.89E+09
Gross Beta/Gamma	7.7E+08	2.26E+09	Not applicable	Not applicable	Not applicable	3.03E+09
Gross Beta	Not applicable	Not applicable	9.54E+07	3.31E+07	Not applicable	1.29E+08
Gross Alpha	$<L_d$	$<L_d$	Not applicable	8.34E+06	Not applicable	8.34E+06

Note: $<L_d$ = less than limit of detection
*There were no waterborne emissions in 2020 for Kinectrics KI.

5.1.2.2 Historical Radiological Waterborne Effluent Results

The figures below (Figure 9 through Figure 11) provide representations of the annual releases of radionuclide waterborne effluents at Bruce A and Bruce B. The figures include the long-term trend, illustrated by the 5-year moving average line.

Figure 9 details the historical trend in tritium waterborne emissions. Tritium in water is a minor radiological emission 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. The leaking boiler tube was inspected during a planned outage in 2019 and the repair is scheduled to occur in 2022.

Bruce A waterborne tritium emissions increased slightly in 2020 compared to 2019, and this may be due to improved efficiency of vapour recovery systems in collecting airborne tritium, which is then condensed and processed through Active Liquid Waste.

All effluents are well below the Derived Release Limit (DRL) and dose to public values remain *de minimus*.

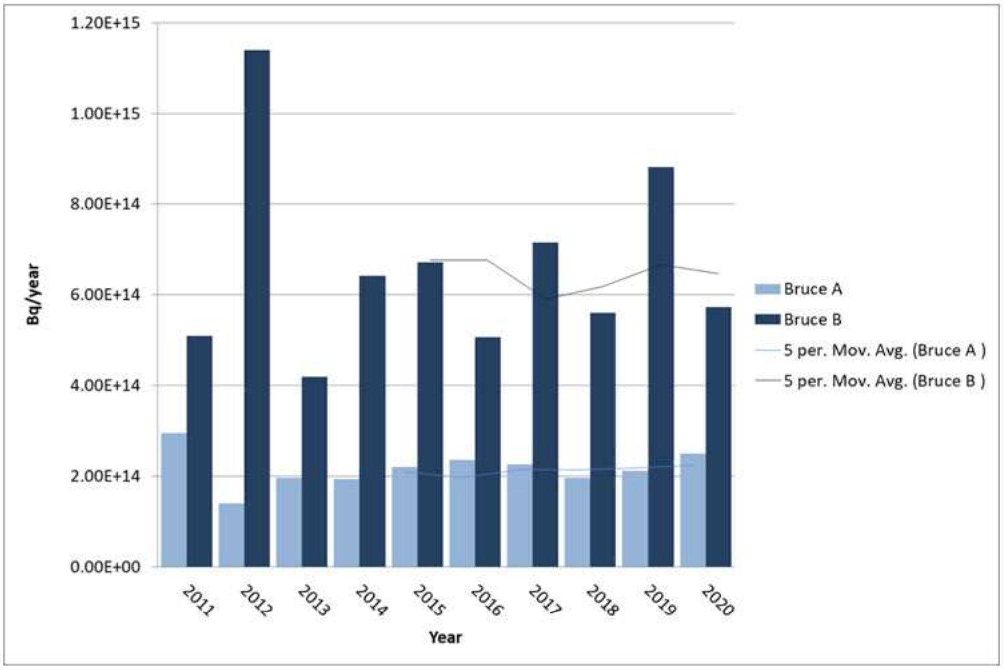

Figure 9: Historical Tritium Waterborne Emissions

Figure 10 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 remain well below the Derived Release Limit (DRL) and dose to public remains *de minimus*. Since 2016, Bruce A and Bruce B emissions have maintained consistently lower levels. This may be attributed to an increased focus on resin management and the return of routine outage activities (no draining activities from VBO). In 2019, waterborne ^{14}C emissions were higher at Bruce B than the previous year due to ion exchange resin dewatering and replacements in preparation of Major Component Replacement activities and returned to normal levels in 2020. In 2020, Bruce A saw a slight increase in ^{14}C in waterborne effluent.

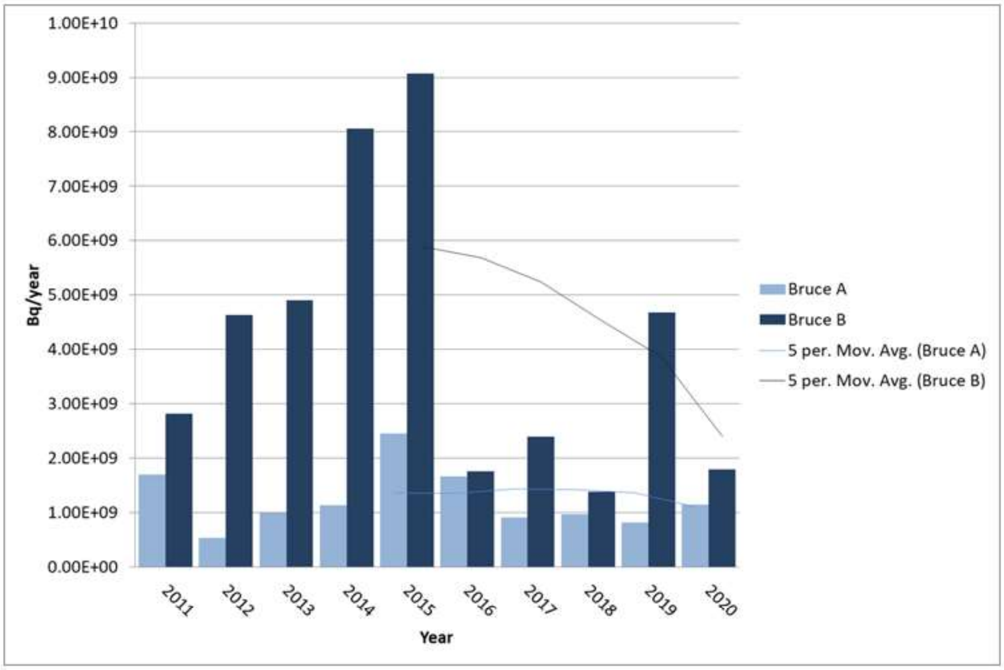

Figure 10: Historical ^{14}C Waterborne Emissions

Historical waterborne gamma emissions are shown in Figure 11. 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 ALW 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 and associated reportable action levels. Bruce B experienced elevated gamma emissions in 2012 associated with a boiler tube leak; these emissions remained well below the Derived Release Limit (DRL) and dose to public values remained *de minimus*. Since 2017, Unit 5 at Bruce B has been experiencing a minor ongoing boiler tube leak; these releases are included in the overall waterborne gamma emissions for 2020.

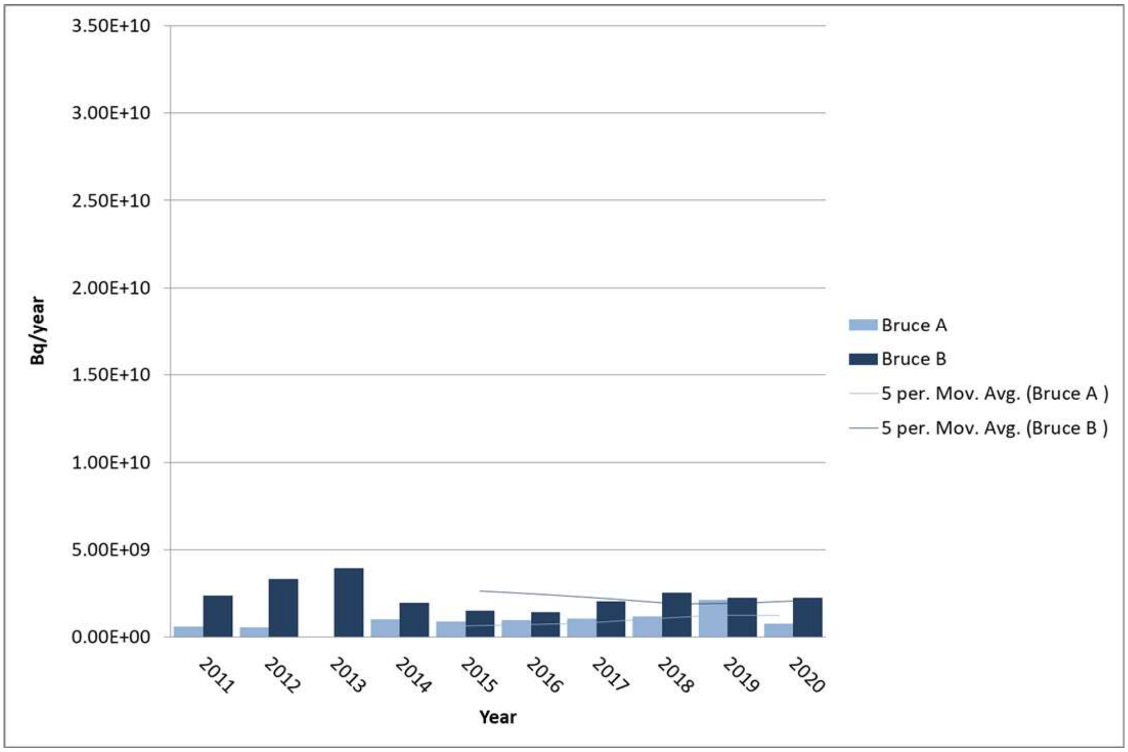

Figure 11: Historical γ Emissions in Water

5.1.2.3 Foundation Drainage Waterborne Effluent Results

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 (concentrations x volume). Foundation drainage effluent constitutes a very small fraction of the annual total waterborne tritium loading (Bruce A - 3.7%, Bruce B - 0.05%) and is included in the total station waterborne effluent totals that are reported quarterly to the CNSC. All waterborne tritium results in 2020 were well below regulatory limits and associated reportable action levels.

Tritium trends in the foundation sumps are monitored and actions taken to identify any significant increases in effluent. Variability may be attributed to atmospheric tritium in the powerhouse which accumulates in low lying areas and concentrates in collection sumps over time (this effect is particularly elevated during outage maintenance activities when systems are opened and there are periods of higher tritium concentrations in the station). It is evident from the trends that the potential implications and impacts on the environment are low, as indicated by monitoring on two fronts: (1) CCW tritium measurements remain very low, and

(2) multi-level groundwater wells situated near the perimeter of the powerhouse continue to show tritium concentrations that are well below the Provincial Drinking Water Objective of 7,000 Bq/L (Note: There is no regulatory criterion for tritium in non-potable water).

Foundation Drainage Bruce A

The Bruce A 2020 foundation drainage waterborne tritium effluent results are included in the water effluent results in Table 8 and presented with further detail in Table 9. Routine monitoring on a monthly basis continues. There are periods when tritium levels are elevated; however, there are no adverse effects on the environment or impact on groundwater quality as confirmed by the concentrations of tritium measured in the multi-level groundwater wells. Tritium concentrations measured in 2020 were similar to those seen in 2019.

Historical Bruce A foundation drainage waterborne effluent results for the past 10 years are presented in Figure 12.

Table 9: 2020 Bruce A Foundation Drainage

Month	Concentration of Tritium (Bq/L)			
	Unit 1	Unit 2	Unit 3	Unit 4
January	1,739	7,289	12,173	48,100
February	2,775	30,192	14,948	39,960
March	2,331	8,954	13,579	52,170
April	2,516	8,621	11,803	33,263
May	1,517	5,846	4,514	41,810
June	1,443	13,246	63,640	172,050
July	3,441	15,873	14,689	222,740
August	1,073	5,032	17,279	83,620
September	2,701	13,542	18,500	119,880
October	1,184	6,179	48,359	52,170
November	1,776	40,848	222	73,260
December	1,776	15,466	222	109,890
Average	2,023	14,257	18,327	87,409

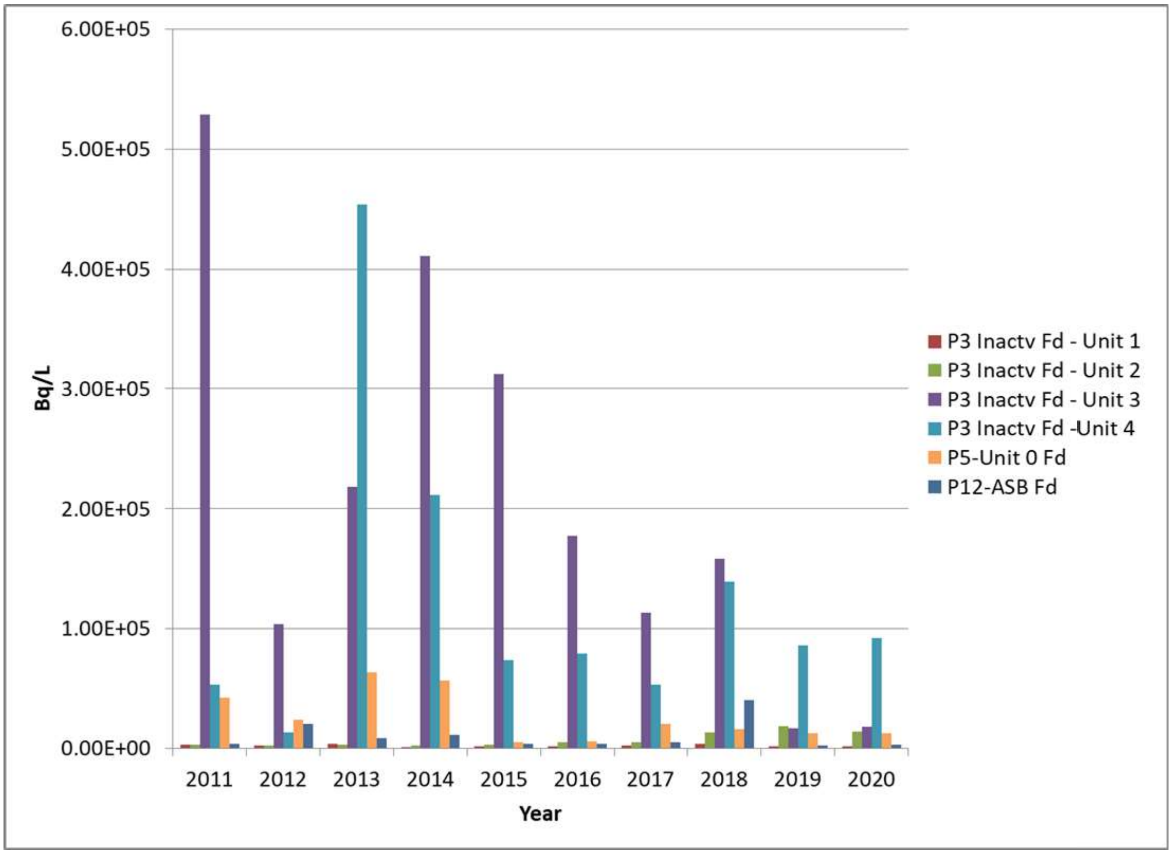

Figure 12: Annual Average Tritium Concentrations in Foundation Drainage at Bruce A

<u>Foundation Drainage Bruce B</u>

The Bruce B 2020 foundation drainage waterborne tritium results are included in the overall station waterborne effluent results in Table 8 and presented with further detail in Table 10. As stated previously, in 2020, Bruce Power's radiological waterborne effluent emissions (including foundation drainage discharges) were well below regulatory limits and associated reportable action levels.

Historical Bruce B foundation drainage waterborne effluent results for the past 10 years are presented in Figure 13.

Table 10: 2020 Bruce B Foundation Drainage

Month	Concentration of Tritium (Bq/L)			
	Unit 5	Unit 6	Unit 7	Unit 8
January	9,095	5,328	63,492	46,942
February	8,880	2,590	21,830	75,480
March	10,057	3,545	29,559	37,629
April	10,778	2,893	13,553	23,595
May	31,565	13,919	6,875	14,652
June	32,083	8,954	15,244	18,104
July	62,689	3,830	92,670	21,482
August	79,728	1,262	48,107	25,759
September	80,161	7,367	26,211	5,269
October	8,451	1,565	10,760	2,331
November	22,903	20,912	26,388	50,690
December	9,657	17,579	37,237	64,360
Average	30,504	7,479	32,661	32,191

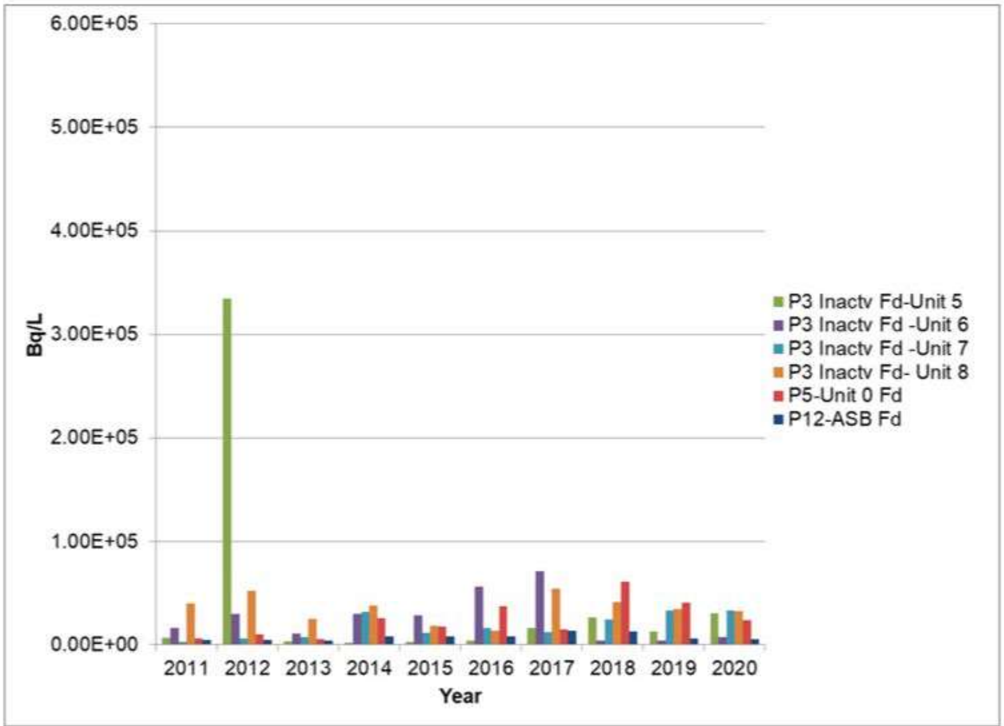

Figure 13: Annual Average Tritium Concentrations in Foundation Drainage at Bruce B

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). There are 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.

In 2017, the Waste Nuclear Substance Licence (WNSL) for the CMF was revoked at the request of Bruce Power and consolidated into the Bruce A and Bruce B PROL [R-1]. This consolidation requires radiological analytical results from the treated liquid sewage effluent routed to the lake and the sludge digester tanks routed to onsite lagoons be reported in this Environmental Protection Report. Table 11 shows the radiological sewage analysis for 2020.

Quarterly averages for radiological parameters in sludge and sewage effluent in 2020 were well below internal acceptance criteria limits for the Sewage Processing Plant and the annual average is well below the Provincial Water Quality Objective for tritium (7,000 Bq/L).

Table 11: 2020 Sewage Processing Plant Monitoring

Sample Source	Tritium Bq/L	Beta Bq/L	Gamma Bq/L
Sewage Digester Sludge			
Q1	3.57E+02	Not Applicable*	None detected
Q2	4.95E+02	Not Applicable*	None detected
Q3	2.60E+02	Not Applicable*	None detected
Q4	2.56E+02	Not Applicable*	None detected
Average	**3.42E+02**	Not Applicable*	**None detected**
Effluent			
Q1	5.62E+02	6.31E-01	**
Q2	3.04E+02	3.71E-01	**
Q3	1.78E+02	3.58E-01	**
Q4	2.37E+02	6.12E-01	**
Average	**3.20E+02**	**4.93E-01**	**

Note: * 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) Effluent Monitoring Program

Bruce Power monitors the effluent emission 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 12 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 report requirements. The following sections describe some of the regulatory context for each report.

5.2.1 Conventional (Non-Radiological) Effluent Monitoring Program Methodologies

The conventional monitoring program operated by Bruce Power is described in:

- BP-PROC-00080, Effluent Monitoring Program [R-53]
- BP-PROC-00099, Conventional Emissions-Water [R-60]
- BP-PROC-00928, Conventional Emissions-Air [R-61]

The aforementioned procedures provide requirements for effluent sampling, monitoring and compliance with limits set forth in the following:

- Ontario Regulation 215/95: Effluent Monitoring and Effluent Limits - Electrical Power Generation Sector [R-62]
- Ontario Regulation 419/05: Air Pollution - Local Air Quality [R-63]
- Ontario Water Resources Act (R.S.O. 1990, c.O.40) [R-9]
- ECAs issued by the Ministry of the Environment Conservation and Parks (MECP) [R-10] [R-64] [R-65] [R-66]
- Permits to Take Water (PTTW) [R-67] [R-68] [R-69] issued by MECP and with Internal Administrative Levels
- Ontario Regulation 389/18: Quantification, Reporting and Verification of Greenhouse Gas Emissions [R-70]
- Federal Halocarbon Regulations, 2003, SOR 2003-289 [R-71]
- Wastewater Systems Effluent Regulations, 2003, SOR 2003-289 [R-72]
- 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-73]
- 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-74]
- Ontario Regulation 463/10: Ozone Depleting Substances and other Halocarbons [R-75]
- Ozone-Depleting Substances Regulations, 1998, SOR/99-7 [R-76]

Table 12: 2020 Bruce Power Regulatory 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 2020 Environmental Compliance Approval - Air 7477-8PGMTZ (BP-CORR-00541-00057)	Ministry of Environment, Conservation and Parks	15Jun2021 (Annual)
Air - Halocarbon	Halocarbon Release Report Pursuant to the Federal Halocarbon Regulations (SOR 2003-289) Section 33 January to June 2020 (BP-CORR-00521-00012)	Environment Climate Change Canada	31July2020 (Semi-annual)
	Halocarbon Release Report Pursuant To The Federal Halocarbon Regulations (SOR/2003-289), Section 33, July to December 2020 (BP-CORR-00521-00013)	Environment Climate Change Canada	31Jan2021 (Semi-annual)
Air - Greenhouse Gas	Not required to report 2020 Federal Greenhouse Gas Reporting	Internal Report	Quantify GHG emissions by 01JUN2021 (Annual) Not required to report
	Not required to report 2020 Provincial Greenhouse Gas	Internal Report	Quantify GHG emissions by 01JUN2021 (Annual) Not required to report
Air - NPRI	2020 National Pollutant Release Inventory for Bruce Power NPRI ID #7041 (BP-CORR-00521-00025)	Environment Climate Change Canada	01Jun2021 (Annual)
Water - EMEL	2020 Annual Effluent Monitoring Effluent Limit (EMEL) Report (BP-CORR-00541-00060)	Ministry of Environment, Conservation and Parks	01JUN2021 (Annual)

Hazardous Substance (Section Reference)	Report Title (Document Control Number)	Regulatory Agency	Submission Date (Frequency)
Water - EMEL/ECA	Bruce Power EMEL and Environmental Compliance Approval Submission First Quarter 2020 (BP-CORR-00541-00026)	Ministry of Environment, Conservation and Parks	14MAY2020 (Quarterly)
	Bruce Power EMEL and Environmental Compliance Approval Submission Second Quarter 2020 (BP-CORR-00541-00032)	Ministry of Environment, Conservation and Parks	14AUG2020 (Quarterly)
	Bruce Power EMEL and Environmental Compliance Approval Submission Third Quarter 2020 (BP-CORR-00541-00037)	Ministry of Environment, Conservation and Parks	14NOV2020 (Quarterly)
	Bruce Power EMEL and Environmental Compliance Approval Submission Fourth Quarter 2020 (BP-CORR-00541-00054)	Ministry of Environment, Conservation and Parks	14FEB2021 (Quarterly)
Water - ECA	2020 Environmental Compliance Approval (Water) Annual Compliance Report for Bruce A (BP-CORR-00541-00061)	Ministry of Environment, Conservation and Parks	01JUN2021 (Annual)
	2020 Environmental Compliance Approval (Water) Annual Compliance Report for Bruce B (BP-CORR-00541-00062)	Ministry of Environment, Conservation and Parks	01JUN2021 (Annual)
	2020 Environmental Compliance Approval (Water) Annual Compliance Report for Centre of Site (BP-CORR-00541-00058)	Ministry of Environment, Conservation and Parks	01MAR2021 (Annual)
Water - PTTW	2020 Water Taking Data - Permit To Take Water 1813-8MLLHG Bruce A (BP-CORR-00541-00063)	Ministry of Environment, Conservation and Parks	31MAR2021 (Annual)
	2020 Water Taking Data - Permit To Take Water 2233-8MLN8J Bruce B (BP-CORR-00541-00064)	Ministry of Environment, Conservation and Parks	31MAR2021 (Annual)

Hazardous Substance (Section Reference)	Report Title (Document Control Number)	Regulatory Agency	Submission Date (Frequency)
	2020 Water Taking Data - Permit To Take Water 1152-8MLPCR Centre of Site (BP-CORR-00541-00065)	Ministry of Environment, Conservation and Parks	31MAR2021 (Annual)
Water - WSER	2020 Q1 Wastewater System Effluent Regulation (WSER) Report (BP-CORR-00521-00011)	Environment Climate Change Canada	14MAY2020 (Quarterly)
	2020 Q2 Wastewater System Effluent Regulation Report (BP-CORR-00521-00014)	Environment Climate Change Canada	14AUG2020 (Quarterly)
	2020 Q3 Wastewater System Effluent Regulation Report (BP-CORR-00521-00016)	Environment Climate Change Canada	14NOV2020 (Quarterly)
	2020 Q4 Wastewater System Effluent Regulation Report (BP-CORR-00521-00021)	Environment Climate Change Canada	14FEB2021 (Quarterly)

5.2.2 Air – Effluent

5.2.2.1 Environmental Compliance Approval

Site conventional air emissions are controlled to meet regulatory requirements and to minimize environmental impacts to protect the environment.

Conventional air emissions are held to performance standards stipulated in the Environmental Compliance Approval (ECA) (7477-8PGMTZ) [R-10] 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-63], 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) expires 31DEC2021. An application to renew the LOF was submitted to MECP on 01JAN2021.

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-63]:

- Bruce Power maintains an 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-10]), 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;
    - Production at the facility continues to be below the facility production limit specified in the ECA; and
    - Performance limits are met.

During 2020, one modification was made for the temporary addition of a 1000 kW diesel generator in the Bruce B Switchyard. 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) [R-10] for air 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 May 21, 2020 and October 05, 2020. In accordance with the conditions of Bruce Power's ECA, the MECP District Office was notified of the complaints in writing following each complaint.

2015-2020 Noise Monitoring and Noise Control Investigations

A Noise Investigation was conducted for a one-week period in July 2020. During the investigation, natural sounds were typically dominant. Bruce Power was faintly audible when background sound was lower. During periods where the contribution of background sound was at a minimum, the sound levels at Lake Street and within Inverhuron Provincial Park were as low as 22 to 24 dBA, which is well within the applicable MECP criterion of 40 dBA.

Noise investigations conducted annually between 2015 and 2020 demonstrated that the sound levels at the concerned receptors (Lake Street) complied with the quantitative limits stipulated by the MECP. There was no direct correlation between the noise logs provided by the residents at Lake Street and operational events at Bruce Power. The study revealed that changing meteorological conditions influence the propagation of sound from the stations (i.e., Bruce Power is slightly audible during periods of low background noise).

A Noise Control Investigation for the four rooftop deaerator vents at Bruce B was conducted using sound level measurements and source measurements collected during the 2015 and 2016 Noise Monitoring Programs. The sound power emission measurements collected from each of the four deaerator vents at Bruce B in 2015 were input to an acoustical model of the Bruce Power site and surrounding area to determine predicted sound levels at locations within the surrounding community. With a worst-case predicted sound level of 33 dBA at Lake Street, the facility is well below the applicable criteria.

In order to mitigate the sound level exceedances, a project was initiated in 2018 to install silencers on the four deaerator vents at Bruce B affording a minimum of 30 dBA of attenuation. A silencer was installed on the Unit 8 deaerator vent in October 2018. A sound level measurement was collected from the Unit 8 deaerator vent following the installation of the vent silencer and compared to measurements collected in 2015. The sound level measurement confirmed that an overall reduction of 31dBA was achieved relative to the unsilenced vent (4 by-pass valves open). In addition, the sound from the Unit 8 deaerator vent is no longer tonal (high frequency hum/whistle). The design and installation of this silencer was successful in exceeding its reduction target of 30dBA (greater reductions were achieved) as recommended by the Noise Control Investigation.

Remaining silencers were installed throughout 2019, on the Unit 7 deaerator vent in March; the Unit 6 deaerator vent in May; and the Unit 5 deaerator vent in October. A two-week noise monitoring campaign was completed in August 2019 to assess the change in sound levels following the installation of Unit 6, Unit 7 and Unit 8 deaerator vent silencers. Unit 5 was in outage at the time of the campaign. Results indicated that the sounds of nature and resident activities were dominant at Lake Street and within Inverhuron Provincial Park. The distinct tone that was audible from all four deaerator vents prior to installation of the silencers was completely inaudible with Unit 5 shutdown, which is an indication of the effectiveness of the silencers.

5.2.2.2 Halocarbons

In Canada, the federal, provincial and territorial governments have legislation in place for the protection of the ozone layer, 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-71] 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 2020 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. There were no releases greater than 100 kg in 2020, and 4 releases on Site that were between 10-100 kg.

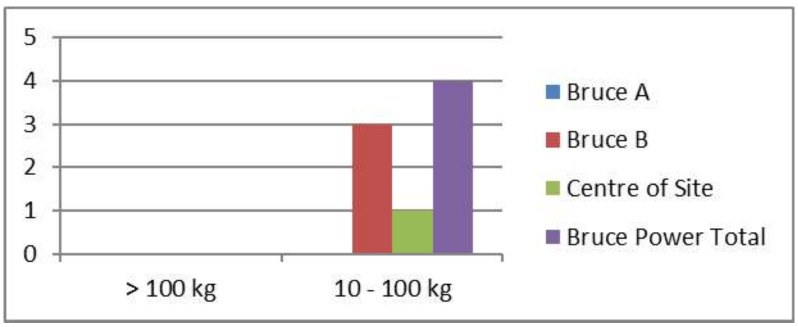

Figure 14: 2020 Bruce Power Halocarbon Release Occurrences

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). HFCs have a negligible impact on the ozone layer (e.g., R134a and R410) compared to CFCs and HCFCs. However, HFCs have high global warming potential and pose a threat as a greenhouse gas [R-71]. Figure 15 below provides the historical trend of the total number of halocarbon releases reported to ECCC since 2011. The number of events has decreased since 2016 and has remained stable.

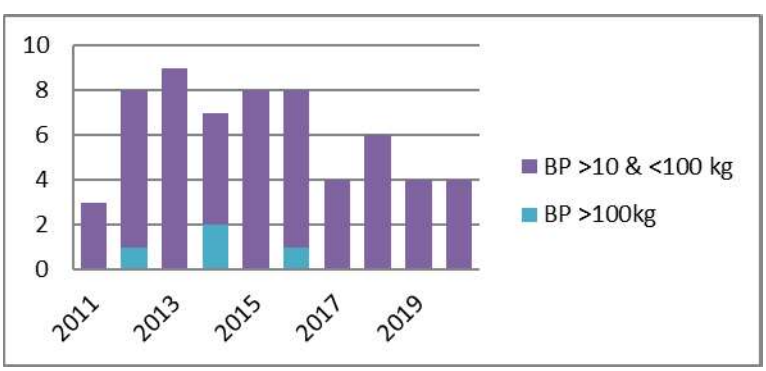

Figure 15: Historical Bruce Power Halocarbon Releases (>10 kg)

There have been no immediately reportable releases >100 kg since 2016.

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 2019. 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 2020 and onwards to confirm they remain below threshold values.

<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. Calculations for the 2020 year will be completed by 01JUN2021 and are not included in this report.

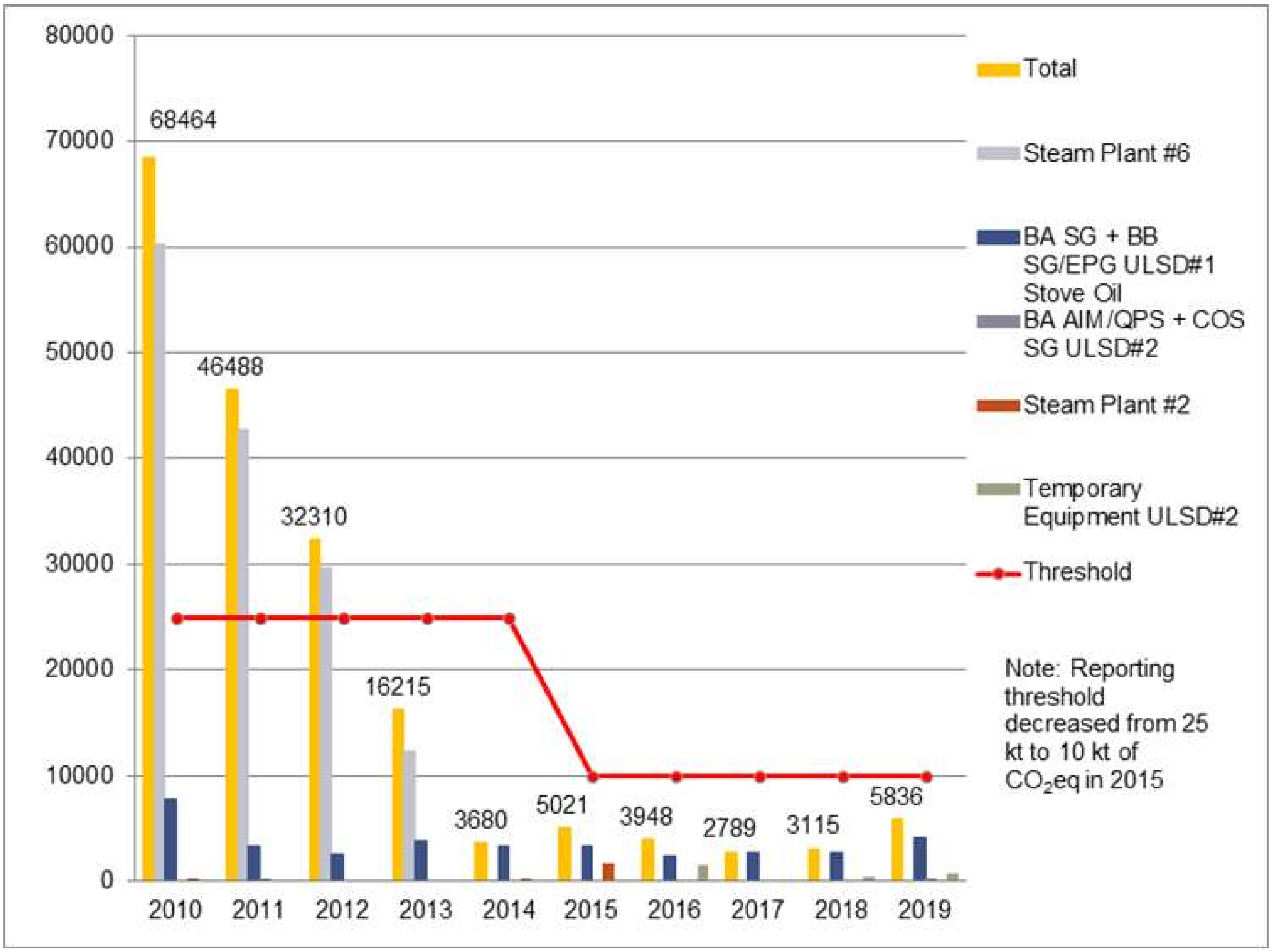

Figure 16: Provincial Greenhouse gas Reporting Tonnes CO2 Equivalent - Conventional Air

5.2.2.4 National Pollutant Release Inventory

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-74]. Bruce Power complies with reporting requirements and regulatory limits, as shown in Sections 5.2.2.2 and 5.2.2.3. Bruce Power's NPRI contaminants reported for the 2019 calendar year are presented in Table 13. A graphical comparison of NPRI contaminant percentage change over time is shown in Figure 17. Releases of nitrogen oxides, carbon monoxide and particulate matter decreased in 2019 due to a decrease in Bruce B standby generator test runs. Calculations and reporting for the 2020 year will be completed by 01JUN2021 and are not included in this report.

Table 13: NPRI Contaminants Reported for 2019

Contaminant	Total kgs
Ammonia (total)	14,346
Hydrazine	1,310
Lead	129
Oxides of nitrogen (NO_2)	44,347
PM10	2,145
PM2.5	1,707
Sulphuric acid	22
Volatile organic compounds	17,010

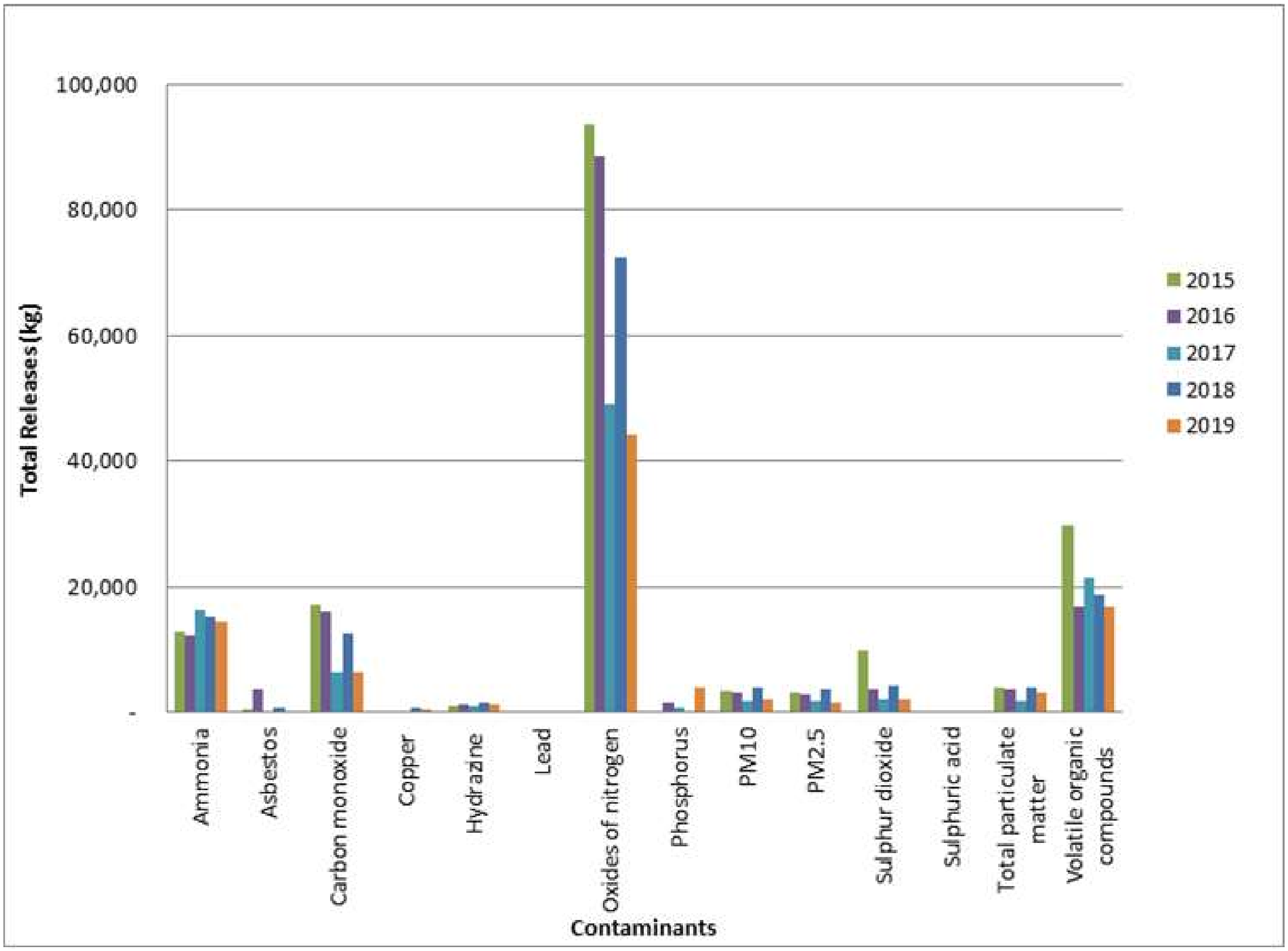

Figure 17: 2015 to 2019 Contaminant Total Releases to Air, Water and Land

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-8], the Ontario Water Resources Act (OWRA) [R-9], and the Fisheries Act [R-77].

The EPA contains regulations which prescribe 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 is regulated under O. Reg. 215/95 - Effluent Monitoring Effluent Limits (EMEL) [R-62]**.** This regulation defines 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 regulation. Non-compliances to O. Reg. 215/95 [R-62] are reportable to the MECP and are subject to Environmental Penalties under O. Reg. 222/07 [R-78].

In addition to EMEL, and as per OWRA, 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. The ECAs impose site-specific effluent limits, monitoring and reporting requirements for the operation of the facility. As mentioned, these site-specific limits are in addition to limits imposed by EMEL. Non-compliances to ECA limits are reportable to the MECP and are subject to Environmental Penalties under O. Reg. 223/07 [R-79].

In 2020, the MECP initiated a process to eliminate O. Reg. 215/95 (among other sector based EMEL regulations) and initiated efforts to transpose those requirements into the existing facility ECAs. Three ECA notices have been provided to Bruce Power, incorporating the EMEL requirements, however, they do not come into effect until such time that O. Reg. 215/95 is revoked. On 20JUL2018, Bruce A received a revised Environmental Compliance Approval, 0732-B2MKLY, which granted Bruce A thermal flexibility for five years (6 summer seasons), expiring following the summer season of 2023. This flexibility required the development of a thermal monitoring plan in collaboration with local Indigenous communities. This plan was developed, building on existing monitoring activities, and incorporating input from the Indigenous communities, and successfully implemented in 2019.

On 25JUN2020, Bruce B received a revised ECA, 5209-BLBSZY; a non-intent update to better describe the discharges to the forebay resulting from the Bruce B domestic water treatment works that has been part of the Bruce B from the early days of its operations The descriptions of these works and associated discharges had previously been described in the Drinking Water Certificate of Approval (CofA) prior to its revocation following the implementation of the Safe Drinking Water Act as a result of the Walkerton *E.coli* tragedy.

Federally, under the Fisheries Act via the Wastewater Systems Effluent Regulation (SOR/2012-139) [R-72], water emissions from the Sewage Processing Plant are monitored to ensure wastewater contaminants are minimized and meet specific effluent characteristics. Monthly sampling and quarterly reporting are required.

5.2.3.1 Permit to Take Water

In Ontario, anyone who takes more than 50,000 liters of water per day from a lake, river, stream, or groundwater source must obtain a Permit to Take Water (PTTW) from the MECP [R-9] (with a few exceptions). These permits help to ensure the conservation, protection, management, and sustainable use of Ontario's water. Ontario's Water Taking and Transfer Regulation (O. Reg. 387/04) [R-80] 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-80] 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-80].

Bruce Power has a separate PTTW for each Bruce A (1813-8MLLHG) [R-67], Bruce B (2233-8MLN8J) [R-68], and Centre of Site (COS) (1152-8MLPCR) [R-69]. Bruce Power remained in compliance with all PTTW requirements in 2020.

5.2.3.2 Effluent Monitoring Effluent Limits

Table 14 summarizes the EMEL events reported in 2020 as per reporting requirements as noted in section 5.2.3 the MECP has initiated a process to eliminate the EMEL section regulations.

Table 14: 2020 Bruce Power EMEL Events

Facility	Event Description
Bruce A	TBWTF BA Control Point 2800 acute lethality failure
Bruce B	None
Centre of Site	None

Bruce A Turbine Building Water Treatment Facility (TBWTF) Acute Lethality Failure (EMEL CP 2800).

On February 20, 2020, quarterly EMEL samples were collected from the TBWTF discharge point and shipped for analysis; pre-discharge analyses performed on a suite of routine parameters showed no indication of adverse chemistry. Final results were received on February 28, 2020 indicating rainbow trout at 100% mortality and daphnia magna at 0% mortality and 0% immobility. Bruce Power promptly suspended all discharges from the TBWTF to the Cooling Water Discharge Duct (CWDD) and initiated an investigation to determine probable cause for the acute lethality failure. Further forensic analysis was performed on the remaining sample, which indicated that elevated levels of nitrite (NO_2^-) was the likely cause of the failure. As part of this investigation, it was determined that when small volumes of feedwater get into the sumps, bacterial nitrifiers consume the ammonia compounds and generate nitrite (NO_2^-); an intermediate compound, which eventually oxidizes to less toxic nitrate (NO_3^-). When this natural process is not at steady-state, nitrite can temporarily accumulate if populations of *Nitrobacter* are not in sufficient abundance to seamlessly metabolize the nitrite. These elevated levels of nitrite, not previously monitored as part of the pre discharge criteria, was believed to be the cause of mortality to the rainbow trout.

Corrective actions have been taken to prevent recurrence, including enhanced monitoring of nitrite levels through pre-discharge analysis. This ensures nitrite levels are acceptable prior to each batch discharge preventing the discharge of toxic effluent.

5.2.3.3 Environmental Compliance Approvals (ECA)

Table 15 summarizes the ECA events reported in 2020 as per reporting requirements. There were no reportable ECA events in 2020.

Table 15: 2020 Bruce Power ECA Events

Facility	Event Description
Bruce A	None
Bruce B	None
Centre of Site	None

5.2.3.4 Wastewater Systems Effluent Regulations (WSER) – SPP only

Table 16 summarizes the WSER events reported in 2020 as per reporting requirements. There were no reportable WSER events in 2020.

Table 16: 2020 Bruce Power WSER Events

Facility	Event Description
Sewage Processing Plant	None

5.3 Quality Assurance/Quality Control (QA/QC)

A revised Quality Assurance/ Quality Control (QA/QC) manual for on-site chemistry laboratories (Bruce A, Bruce B and Centre of Site) was issued in 2016. The manual was developed to ensure that Bruce Power chemistry lab practices are aligned with CSA N286-12, Management System Requirements for Nuclear Facilities [R-81]. ISO/IEC 17025, General Requirements for the Competence of Calibrating and Testing Laboratories [R-82], was used as a guideline in developing the revised QA/QC Manual.

The QA/QC requirements of the Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater have been incorporated into BP-PROC-00099, Conventional Emissions – Water [R-60] which influence the station Chemistry Laboratory Procedures (CLPs) and ensures appropriate QA/QC is performed on EMEL and ECA required samples and related equipment. An annual report for EMEL/ECA QA/QC is prepared and filed outlining the QA/QC from the reporting year.

5.4 Chemical Management Plans

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-83] 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 2020.

5.5 Pollution Prevention

Under Part 4 of CEPA [R-83], 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.

5.6 Environmental Emergency Regulations

The aim of the Environmental Emergency Regulations, 2019 (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 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, when natural gas is installed on site and the temporary propane tanks at the Central Storage Facility are removed (anticipated to be removed in the second half of 2021), 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-84]. 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).

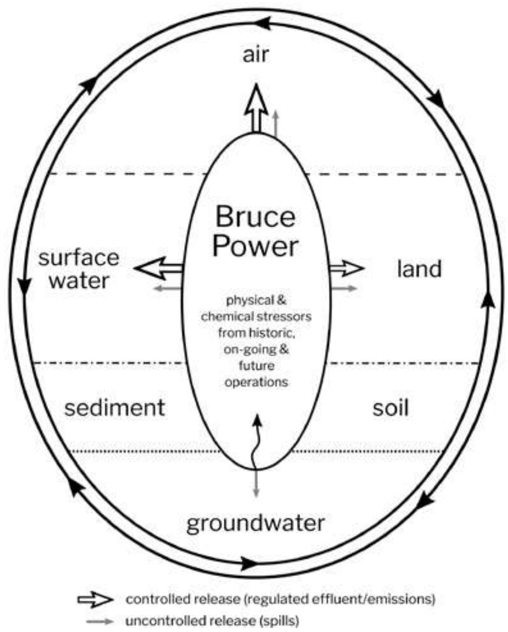

Figure 18: Bruce Power has multiple layers of protection in place to minimize emissions and effluents released during facility operations. The Environmental Protection Program monitors and models physical and chemical stressors released to the environment and continuously assesses their risk and impact.

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-7] [R-4] ,CNSC REGDOC-2.9.1 [R-15], 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-38], 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 that members of the public are exposed to.

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-4]. 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:

- SON's Coastal Waters Monitoring Program execution of year two of a currently three-year monitoring program commitment. Bruce Power and SON met prior to the start of year two and jointly reviewed year 1 results and plans for year 2. Bruce Power received the year one results report at the end of December of 2020 and has committed to working with SON to understand how this information can be incorporated into our environmental monitoring and risk characterization program.

- MNO Diet Survey was initially planned to be distributed in April of 2020 at the annual general meeting between Bruce Power and the MNO. However, due to the pandemic the meeting was postponed until November of 2020, delaying the distribution of the diet survey which is designed to better inform dose calculations as well as our environmental monitoring program.

- HSM is developing a fisheries offset project that is a comprehensive blend, considering the values and interests of the HSM Community and the DFO offsetting principles. This fish habitat restoration and enhancement project embraces the important recent changes to the Fisheries Act which encourages strengthening the role of Indigenous peoples in project reviews, monitoring and policy development as part of the early steps to advance reconciliation.

- Diet survey results will be included within the updated version of the Environmental Risk Assessment in 2022 and will be included within the EPR that outlines 2021 performance.

Involvement in Environmental Monitoring remains a routine and active topic with all three communities moving into 2021.

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 consequence 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-7] [R-4] 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 Bruce Power licensed facilities (i.e. Bruce A, Bruce B, CMLF and CSF) as well as 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. For other media, a total of three locations over land within the REM boundary are required. The media contributing greater than 10% to receptor dose are air, milk, meat, and terrestrial plants such as grains, fruit and vegetables.

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 and sand

- Aquatic Samples
  - Fish
  - Sediment

The radionuclides that are measured in the environmental media collected include tritiated water (tritium), 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 near and far field 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.

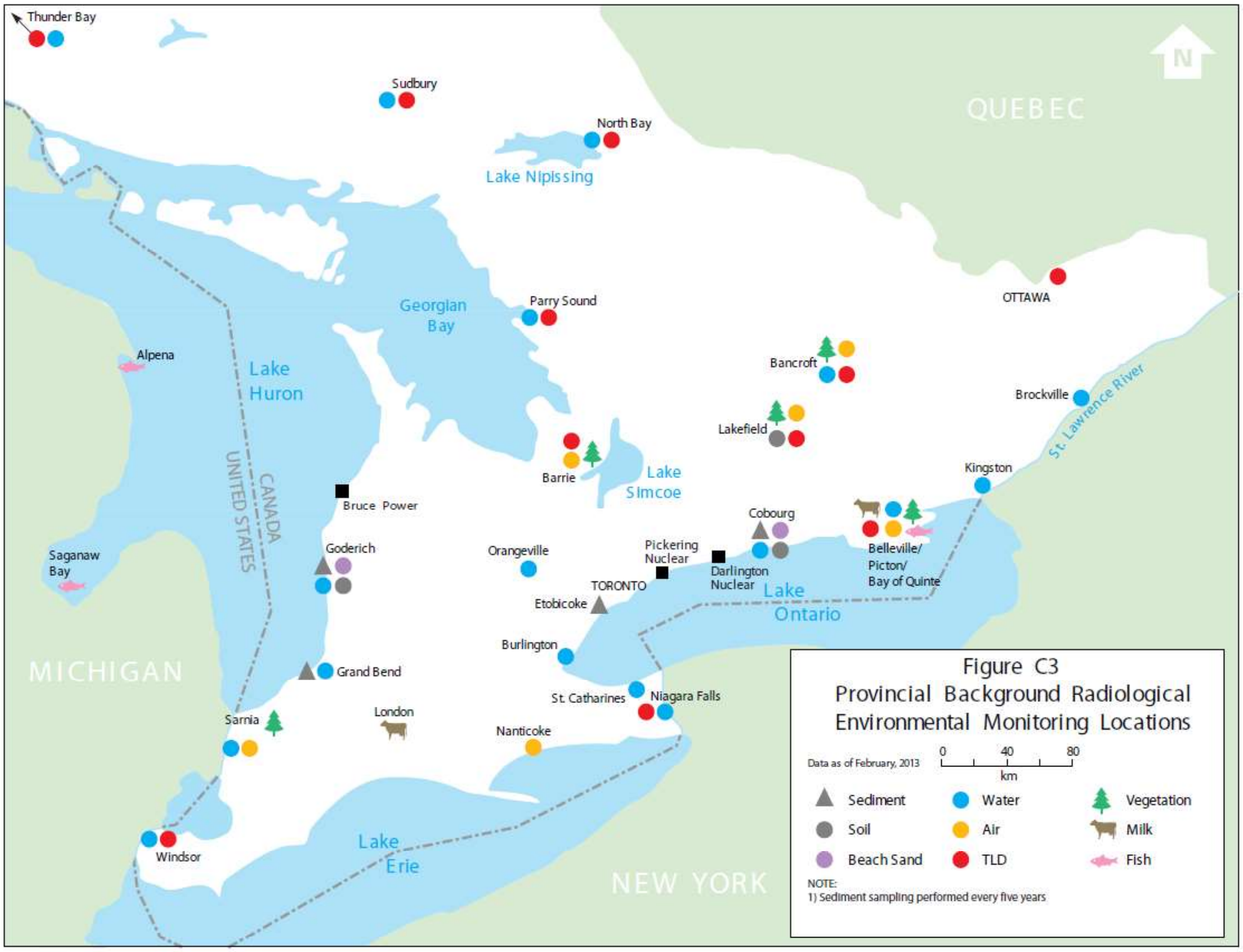

Figure 19: Provincial Background Radiological Environmental Monitoring Locations

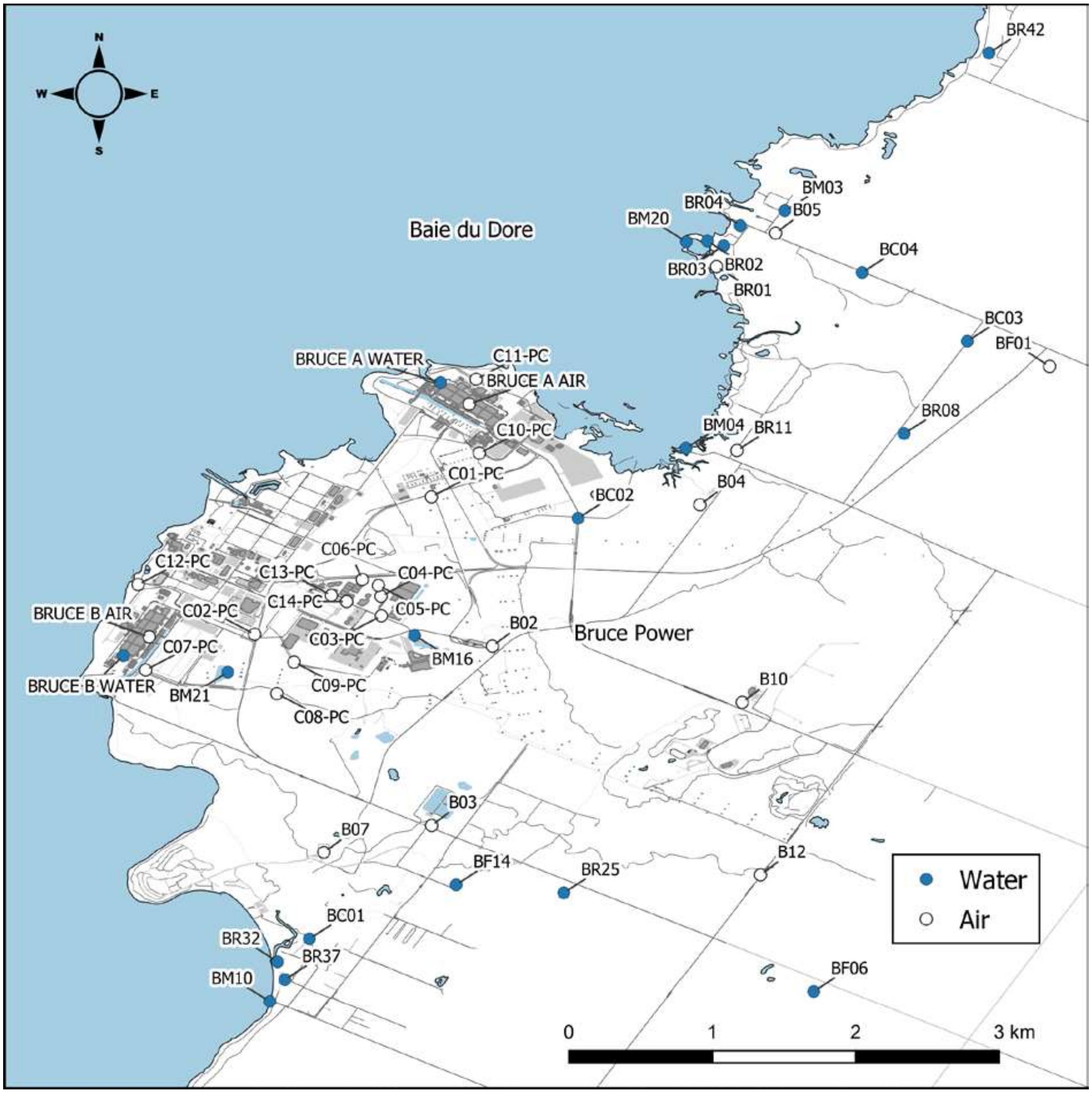

Figure 20: Bruce Power On-site and Near Field Radiological Environmental Monitoring Locations

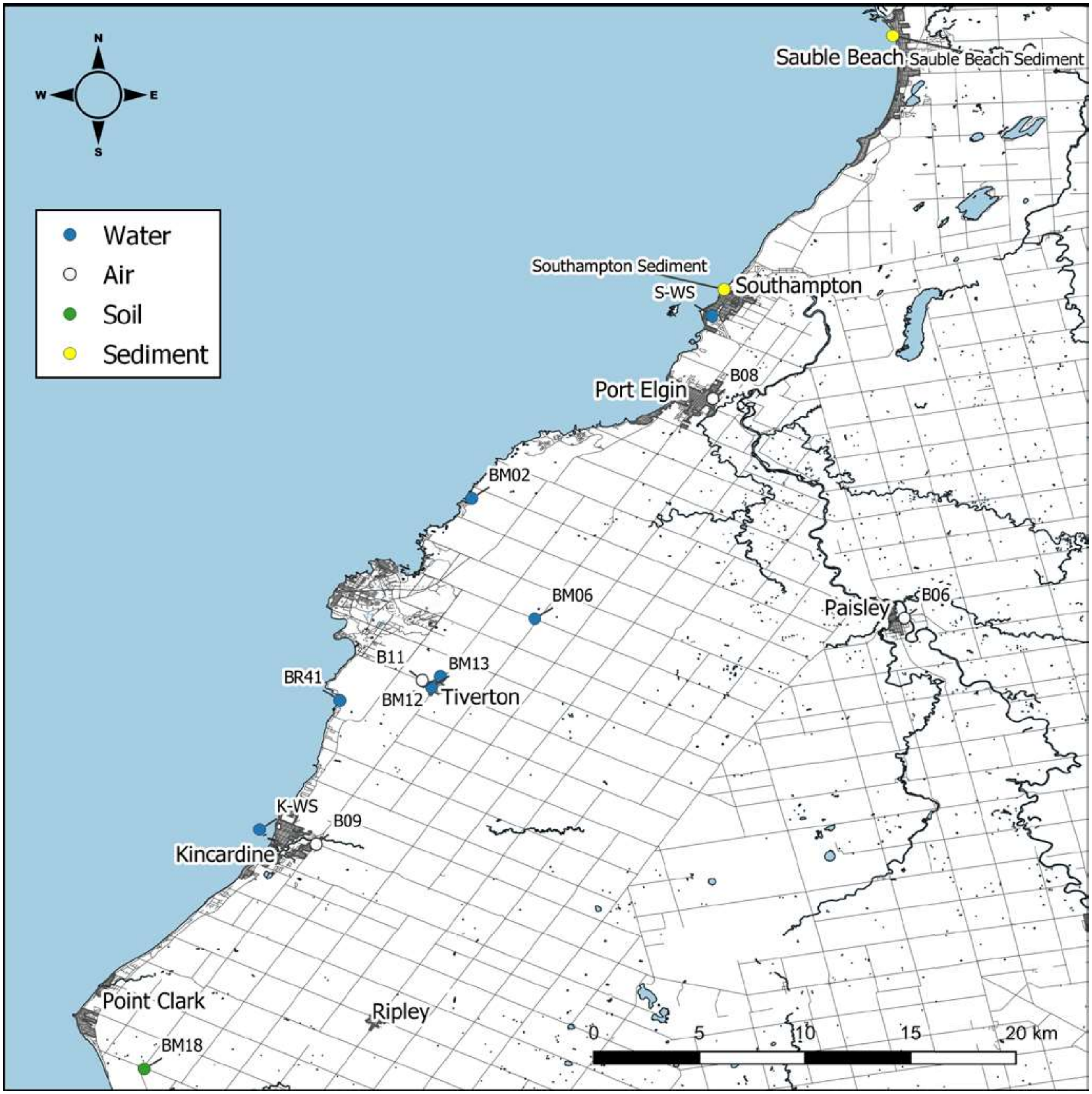

Figure 21: Bruce Power Far Field Radiological Environmental Monitoring Locations

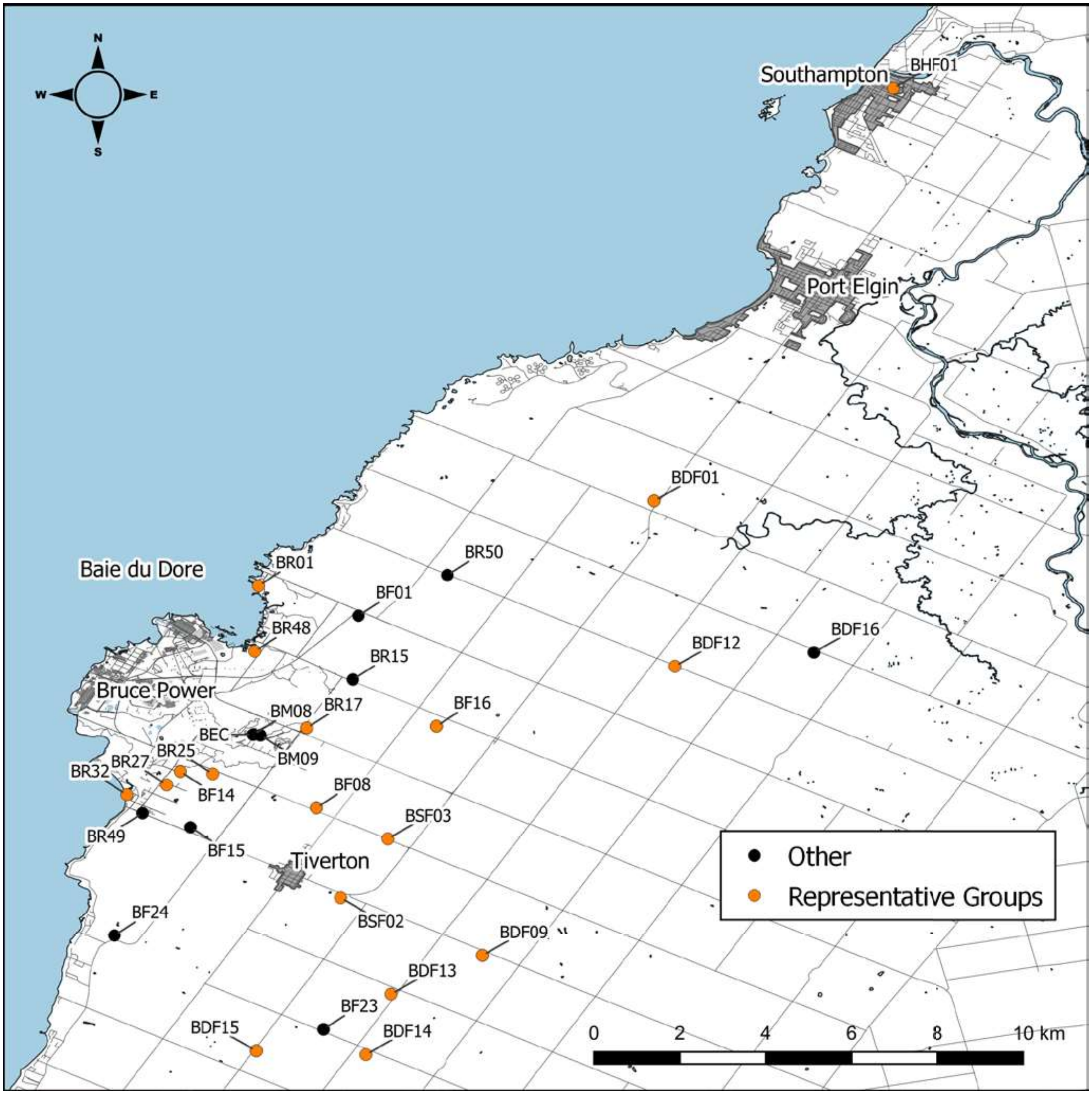

Figure 22: Bruce Power Radiological Environmental Monitoring Residential Locations (other) and Representative Groups

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-7].

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, which is a conservative approach. 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 2020 and previous years. The provincial background results for 2020 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 a low radiological risk to the environment from Bruce Power operations.

6.1.1 Air Monitoring

Bruce Power monitors for external gamma radiation, tritium and carbon-14 concentrations in air at a variety of locations near and far field 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 17.

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 52 ηGy/h for 2020. For comparison, the average of the 8 Provincial background sites was slightly higher at 58 ηGy/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 emission 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*.

Table 17: 2020 Annual External Gamma Dose Rate Measurements at Bruce Power and Provincial Monitoring Locations

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	368	488	55	484
B03-TLD	369	477	54	472
B04-TLD	368	413	47	410
Average (Indicator)	**368**	**459**	**52**	**455**
Area Near				
B05-TLD	368	409	46	406
B07-TLD	368	415	47	412
B10-TLD	369	555	63	549
B11-TLD	369	515	58	510
Average (Area Near)	**369**	**474**	**54**	**469**
Area Far				
B06-TLD	368	404	46	401
B08-TLD	368	402	46	399
B09-TLD	368	420	48	417
Average (Area Far)	**368**	**409**	**46**	**406**
Provincial Background				
Bancroft	355	575	67	592
Barrie	364	508	58	510
Lakefield	355	540	63	556
Niagara Falls	369	410	46	406
North Bay	379	529	58	510

Sample Location	Total Exposure Time (days)	Total Measured Dose in Air (μGy)	Annual Average Dose Rate in Air (ηGy/h)	Annualized Exposure (μGy)
Ottawa	349	454	54	475
Thunder Bay	366	532	61	531
Windsor	382	519	57	496
Average (Provincial Background)	**365**	**508**	**58**	**509**

The annual average external gamma dose rates for Bruce Power indicator, near and 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 ($\alpha=0.05$) 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, 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.

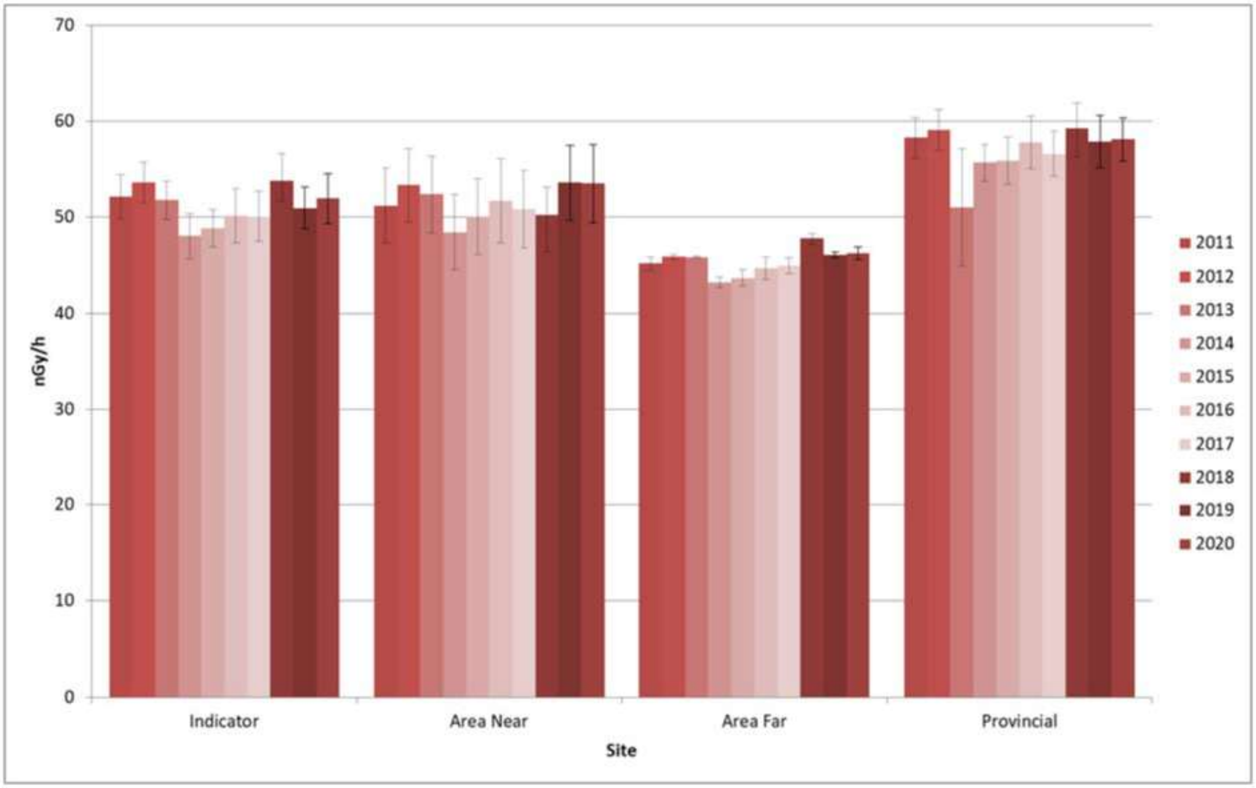

Figure 23: Annual Average External Gamma Dose Rates (nGy/h) at Bruce Power Indicator, Near, Far and Provincial Background Locations Over Time (± Standard Error)

The 2019 CNSC IEMP monitored for Cs-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 I-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-29]

Health Canada also monitors total external gamma dose in the local area [R-85]. 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 contributions to external dose from 3 radioactive noble gases Argon-41, Xenon-133 and Xenon-135 are reported as Air KERMA (Kinetic Energy Released in unit MAss of Material). 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 2020, the monthly results for Ar-41, Xe-133 and Xe-135 were less than the limit of detection at all 8 locations.

6.1.1.2 Tritium in Air

Tritium 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. 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 integrating flow meter.

Monthly samples are averaged by location for the year and are shown in Table 18, along with the provincial background value measured in Nanticoke (Figure 19). The results are shown on a monthly basis in Figure 24.

The 2020 annual average for tritium in air results mirror what was reported in 2019, with very similar values and trends at indicator, area near, area far and provincial background locations. At indicator sites closest to Bruce Power (B02, B03, B04), the annual average was 2.08 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.

The higher monthly average tritium result for the indicator sites in July (7.13 Bq/m^3) was skewed, as shown by the larger standard error bar for July in Figure 24, by an elevated result measured at B02. B02 is located outside the main guardhouse and is closest to Bruce Power. Tritium in air results at the other indicator sites B03 and B04 for July were lower. There were no known operational activities or elevated tritium releases in July to account for the larger result measured at this one location.

Table 18: 2020 Annual Average Tritium in Air

Sample Location	**Tritium**	
	Bq/m^3	**St. Dev**
Indicator		
B02-ST	2.75E+00	3.60E+00
B03-ST	1.55E+00	1.49E+00
B04-ST	1.95E+00	6.45E-01
Average (Indicator)	**2.08E+00**	
Area Near		
B05-ST	1.12E+00	4.86E-01
B07-ST	1.39E+00	1.13E+00
B10-ST	9.33E-01	3.99E-01

B11-ST	6.43E-01	5.15E-01
Average (Area Near)	**1.01E+00**	
Area Far		
B06-ST	1.39E-01	9.23E-02
B08-ST	2.14E-01	1.36E-01
B09-ST	2.15E-01	1.85E-01
Average (Area Far)	**1.89E-01**	
Provincial Background		
Nanticoke	3.63E-02	4.71E-02
Note: 1.St. Dev = standard deviation. 2.Sample count = 12 in all cases, except B07-ST sample count = 11. 3.For calculation of averages the uncensored analytical result was used.		

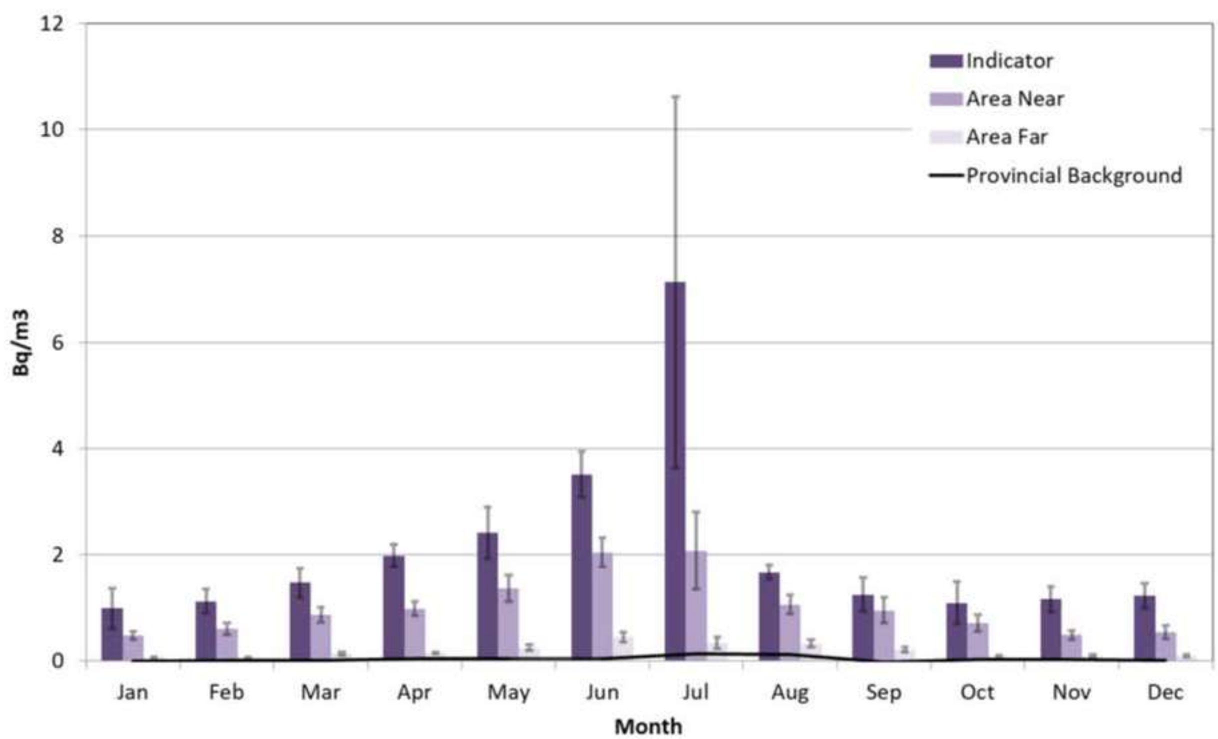

Figure 24: 2020 Monthly Tritium in Air Concentrations (Bq/m3) at Bruce Power Indicator, Near, Far and Provincial Background Locations (± Standard Error)

The historical trend of the annual average tritium in air is shown in Figure 25 for indicator, area near, area far and provincial background locations. Concentrations of tritium 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, tritium in air emissions was higher in 2011 due to activities associated with the restart of Units 1 and 2 at Bruce A (restart occurred in 2012). 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, 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.

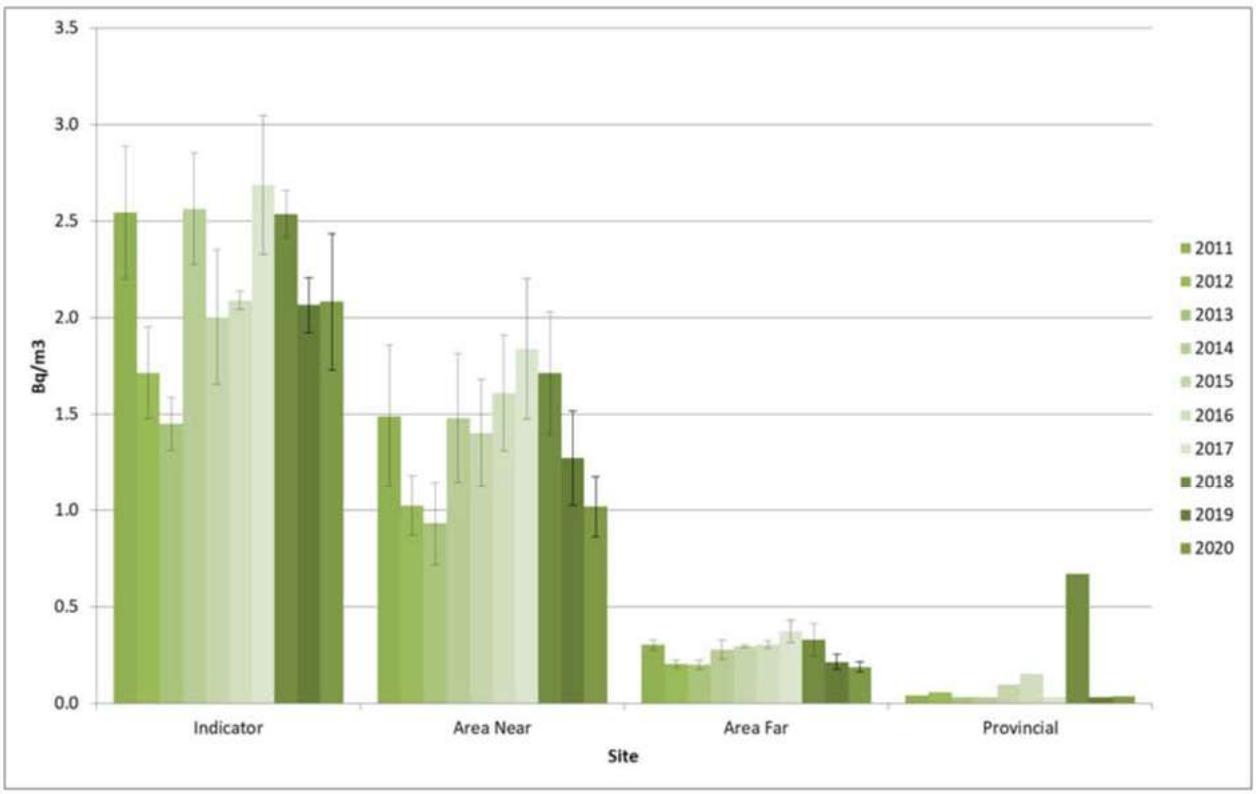

Figure 25: 2020 Annual Average Tritium in Air Concentrations (Bq/m^3) at Bruce Power Indicator, Near, Far and Provincial Background Locations Over Time (± Standard Error)

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-29]. 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 health impact.

6.1.1.3 Carbon-14 in Air

Carbon-14 (^{14}C) 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 scintillations 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 2020 annual average carbon-14 in air concentrations are provided in Table 19 and the quarterly results are shown in Figure 26. The off-site C-14 concentrations in air were similar each quarter with values decreasing with increasing distance from site, except in the fourth quarter where the area near location average was higher than that at the indicator site. This quarter's average was influenced by slightly elevated values at locations northwest of Bruce Power, specifically B05-PC and BR11-PC. Higher values were also observed at the on-site monitor near Bruce A (C11-PC) during this period. Moderator ion exchange resin change outs that occurred at Bruce A (Units 2, 3 and 4) during this quarter may have impacted these environmental monitoring locations.

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 19: 2020 Annual Average Carbon-14 in Air from Passive Samplers

Sample Location	Carbon-14	
	Bq^{14}C/kgC	St. Dev
Indicator		
B03-PC	2.58E+02	1.68E+01
Area Near		
B05-PC (#1)	2.44E+02	1.96E+01
B05-PC (#2)	2.59E+02	2.95E+01
B11-PC	2.40E+02	1.89E+01
BF01-PC	2.40E+02	9.95E+00
BF14-PC	2.43E+02	2.09E+01

Sample Location	Carbon-14	
	Bq ^{14}C/kgC	St. Dev
BF23-PC	2.26E+02	2.38E+01
BR01-PC	2.49E+02	1.10E+01
BR11-PC	2.47E+02	2.92E+01
On-Site		
C01-PC	3.53E+02	3.01E+01
C02-PC	3.88E+02	2.06E+01
C03-PC	1.43E+04	4.61E+03
C04-PC	1.61E+03	9.58E+02
C05-PC	1.26E+03	3.14E+02
C06-PC	1.90E+03	1.05E+03
C07-PC	3.73E+02	5.11E+01
C08-PC	5.22E+02	2.90E+02
C09-PC	3.12E+02	2.35E+01
C10-PC	4.25E+02	8.11E+01
C11-PC	9.90E+02	5.85E+02
C12-PC	4.35E+02	4.06E+01
C13-PC	1.18E+03	1.84E+02
C14-PC	1.80E+03	3.65E+02
Provincial Background		
Bancroft	2.27E+02	2.74E+01
Barrie	2.08E+02	3.12E+01
Lakefield	2.16E+02	2.43E+01
Nanticoke	1.98E+02	3.02E+01
Picton	2.06E+02	2.27E+01

Note:

1. St. Dev = standard deviation.
2. Sample count = 4 in all cases, except BR05-PC (#2) sample count = 3.
3. For calculation of averages the uncensored analytical result was used.

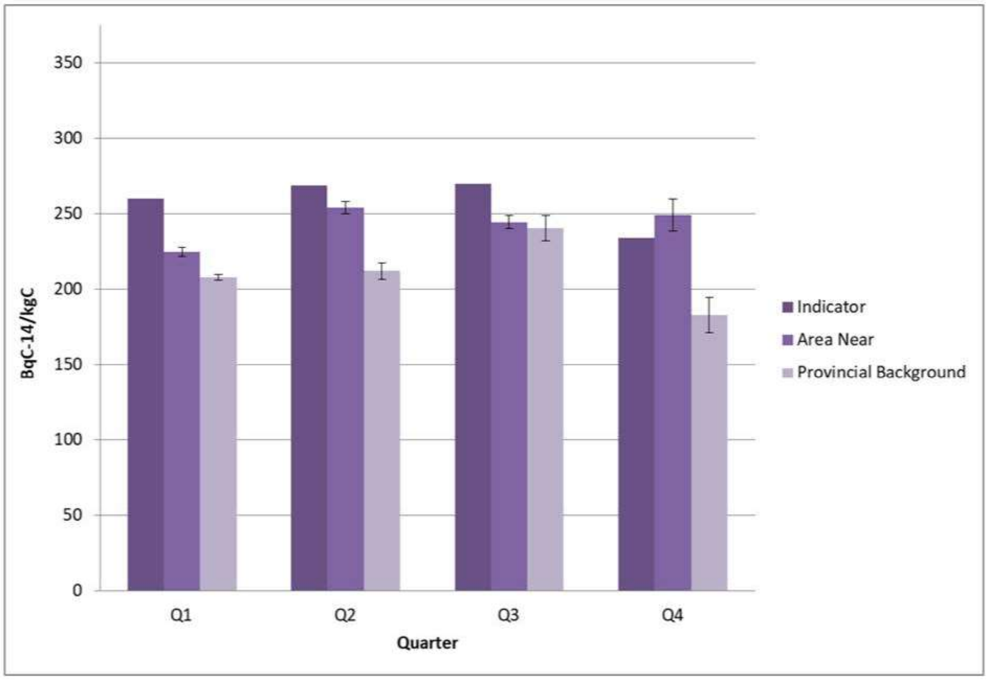

Figure 26: 2020 Quarterly Average Carbon-14 in Air Concentrations at Bruce Power Indicator, Area Near and Provincial Background Locations (± Standard Error)

The annual average C-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 ($\alpha=0.05$) shows a statistically significant difference ($p<0.001$) by site, with the provincial mean concentration being lower. The indicator and area far 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 C-14 in air.

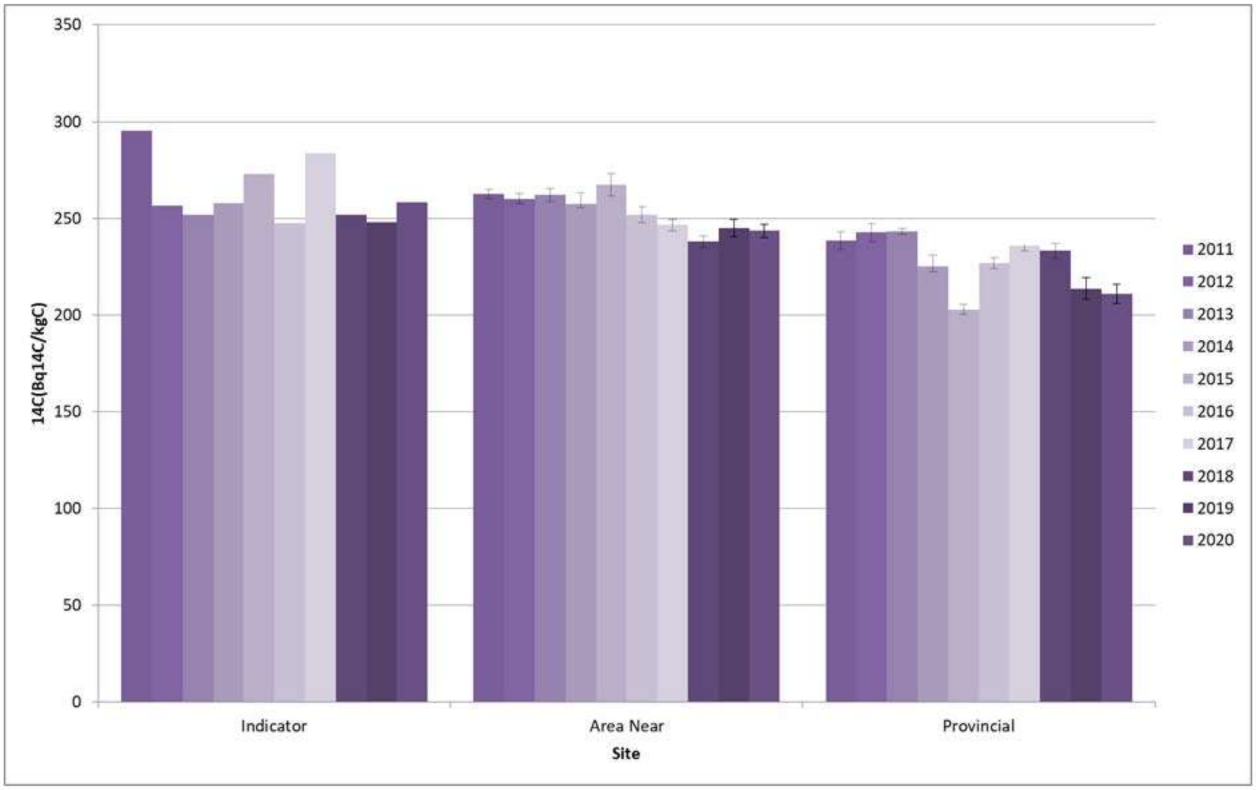

Figure 27: Annual Average Carbon-14 in Air Concentrations at Bruce Power Indicator, Area and Provincial Background Locations Over Time (± Standard Error)

6.1.2 Precipitation

Precipitation is collected in a bucket at 10 locations near and far field 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 far field 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 and gross beta radiation (e.g. carbon-14).

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. Radioactivity measured in precipitation may give a rough estimate of airborne emissions; however, they are not representative and are therefore not used in the dose calculations for members of the public. Nevertheless, precipitation will invariably become surface water and ground water, and potentially a source of drinking water via shallow wells or surface water.

In 2020 the months of February, May and June were drier than other months and some collection buckets were found to be nearly empty (< 0.5 L). This was particularly evident in June where 50% of the locations had volumes < 0.5 L. This may have impacted the results for this month as well as the annual average.

The annual average results for tritium and gross beta in precipitation are presented in Table 20. As seen in previous years, the average tritium results decrease with distance from Bruce Power (indicator > near field > far field locations), while gross beta remains consistent regardless of proximity to site. The annual average for tritium in precipitation at indicator locations was 154 Bq/L, while the annual average for area near locations (within approximately 10 km from the facility boundary) was 76.3 Bq/L. By contrast the annual average gross beta deposition rate at indicator locations was 20.1 Bq/m^2/month, while area near locations had an annual average of 21.3 Bq/m^2/month. This suggests that there are no substantial impacts from beta radiation in precipitation.

Table 20: 2020 Annual Average Precipitation Data

Sample Location	Tritium		Gross Beta	
	Bq/L	St. Dev	Bq/m^2/ month	St. Dev
Indicator				
B02-WP	2.18E+02	1.83E+02	2.03E+01	9.80E+00
B03-WP	1.13E+02	1.02E+02	1.90E+01	9.91E+00
B04-WP	1.31E+02	6.43E+01	2.10E+01	1.03E+01
Average Indicator	**1.54E+02**		**2.01E+01**	
Area Near				
B05-WP	1.04E+02	8.50E+01	2.29E+01	1.35E+01
B07-WP	8.48E+01	8.04E+01	2.06E+01	1.14E+01
B10-WP	6.64E+01	4.52E+01	2.51E+01	1.30E+01
B11-WP	3.70E+01	2.65E+01	1.65E+01	7.46E+00
Average Area Near	**7.63E+01**		**2.13E+01**	
Area Far				
B06-WP	7.10E+00	5.09E+00	1.79E+01	7.70E+00
B08-WP	1.57E+01	1.41E+01	1.89E+01	9.18E+00
B09-WP	1.37E+01	1.25E+01	1.85E+01	8.39E+00
Average Area Far	**1.19E+01**		**1.84E+01**	

Note:
1.St. Dev = standard deviation.
2.Sample count = 12 in all cases, except tritium analysis at B11-WP, B08-WP, B09-WP with sample count = 11.
3.For calculation of averages where result was less than critical level (Lc) the uncensored analytical result was used.

Tritium 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 and sampling locations in the near and far areas are relatively stable from year to year. An analysis of variance ($\alpha=0.05$) 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.

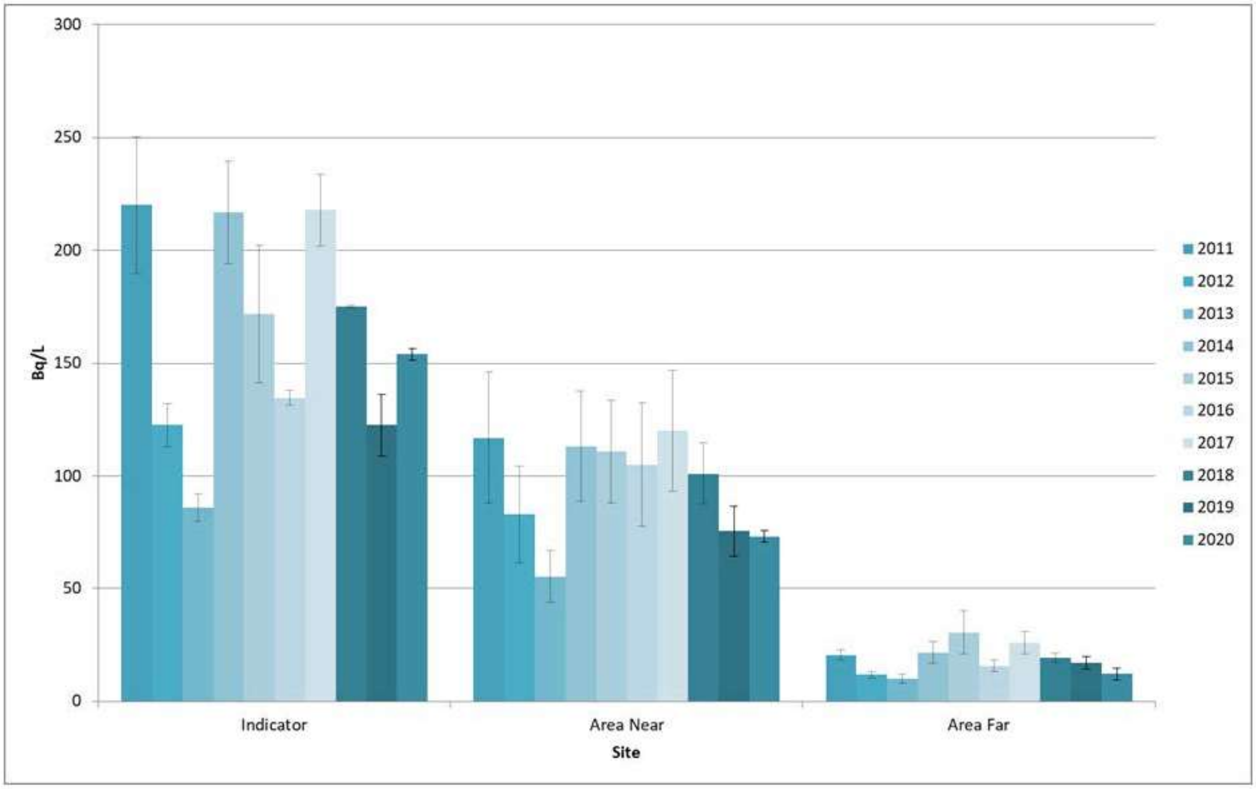

Figure 28: Annual Average Tritium Concentrations in Precipitation at Bruce Power Indicator, Area Near, Area Far Locations over Time (± Standard Error)

6.1.3 Water Monitoring

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-86]. 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, gross beta and gross gamma radiation. The results are used in the annual dose to public calculation for each of the representative persons that live near Bruce Power. Furthermore, 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.

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-87].

The 2020 annual average tritium and gross beta results for drinking water samples collected by Bruce Power and the Province are listed in Table 21. The 2020 annual average for tritium at the Kincardine WSP was 4.95 Bq/L and at the Southampton WSP was 10.4 Bq/L. These values are well below Ontario Drinking Water Standard (7,000 Bq/L) and the committed objective of 100 Bq/L. The average annual tritium concentration at the provincial locations ranges between 1.7 Bq/L and 3.4 Bq/L.

Table 21: 2020 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)	4.95E+00	4.21E+00	5.63E-02	2.52E-02
Southampton WSP (48/12)	1.04E+01	4.10E+00	6.02E-02	2.16E-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	-
BR25-WW (2)	<Lc	-	N/A	-

Sample Location (Sample Count Tritium/Beta)	Tritium		Gross Beta	
	Bq/L	St. Dev	Bq/L	St. Dev
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)	2.78E+01	2.22E+01	<Lc	-
BR03-WW (6)	9.77E+01	5.89E+00	N/A	-
BR04-WW (6)	<Lc	-	N/A	-
BR41-WW (5)	1.83E+01	2.93E+00	N/A	-
BR42-WW (6)	2.57E+01	2.28E+00	N/A	-
BF06-WW (6)	<Lc	-	N/A	-
BR32-WW (0)	No sample	-	No sample	-
Provincial Background				
Brockville (WSP) (4)	2.7E+00	1.2E+00	1.1E-01	4.2E-03
Burlington (WSP) (4)	3.4E+00	6.4E-01	1.2E-01	9.9E-03
Goderich (WSP) (4)	3.2E+00	6.4E-01	8.8E-02	1.3E-02
Kingston (WSP) (4)	2.4E+00	1.1E+00	1.1E-01	4.9E-03
Niagara Falls (WSP) (4)	1.7E+00	4.2E-01	9.8E-02	9.9E-03
Windsor (4)	<Ld	-	7.8E-02	2.1E-03
St. Catherine's (4)	<Ld	-	9.9E-02	6.4E-03
Thunder Bay (4)	<Ld	-	4.3E-02	7.1E-03
North Bay (4)	<Ld	-	6.5E-02	4.9E-03
Parry Sound (4)	<Ld	-	5.2E-02	4.2E-03

Notes:

1.St. Dev = standard deviation, N/A = not applicable, WSP = water supply plant

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 uncensored analytical result was used.

The impact of site emissions 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 consistently has marginally higher annual average tritium concentrations each year compared to Kincardine, due to the predominant lake currents outside Bruce Power travelling northward.

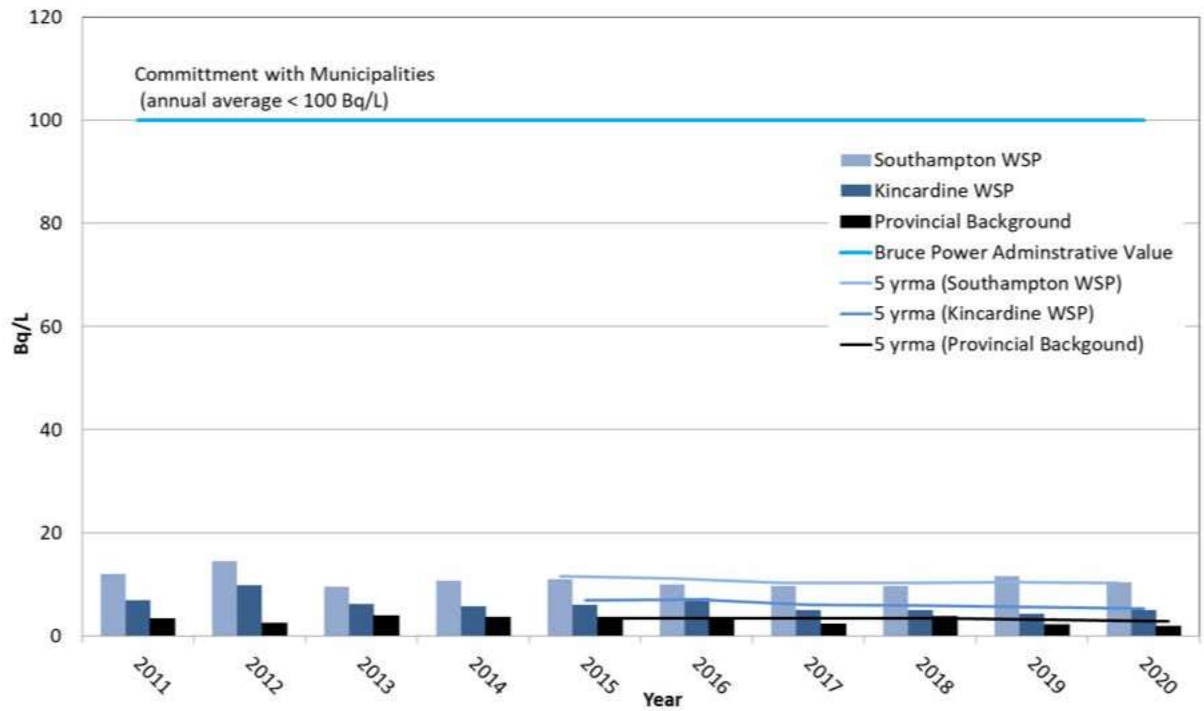

Figure 29: Annual Average Tritium Concentrations (Bq/L) at the Municipal Water Supply Plants near Bruce Power and Provincial Background Locations Over Time

<u>Municipal and Residential Wells</u>

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 beta results are shown in Table 21 above. 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 due to COVID-19 travel restrictions and no occupancy.

For shallow wells, the source of tritium may be attributed to airborne tritium emissions from the Bruce Power site related to precipitation washout migrating into the shallow wells. The deep wells are less likely to be affected by airborne deposition. Tritium 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 results were slightly higher, although 2 out of 6 available wells had results <Lc. The other four wells had annual averages < 100 Bq/L and well below the Provincial Water Quality Objective of 7000 Bq/L. The gross beta results for BR02 were < Lc and negligible.

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.

<u>Lakes and Streams</u>

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 (BM16 and BM21) and four stream locations off site near Bruce Power (BC01-04). 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 2020 annual average tritium and gross beta results are shown in Table 22. Gamma results for 2020 are not shown as all results for CANDU related radionuclides Co-60, Cs-134 and Cs-137 were either less than or slightly above the critical level (Lc).

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 2020 annual average results are presented in Table 22.

Table 22: 2020 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 (ornamental pond) (6)	1.15E+02	2.49E+01	N/A	-
BM21-WL (former sewage lagoon) (6)	5.26E+02	3.88E+01	N/A	-
Indicator (Off Site)				
BC02-WC (6/2)	8.53E+01	2.07E+01	7.61E-02	7.42E-03
BM04-WL (6/6)	7.26E+01	3.60E+01	8.63E-02	3.41E-02

Sample Location (Sample Count Tritium/Beta)	Tritium		Gross Beta	
	Bq/L	St. Dev	Bq/L	St. Dev
BM04-WL duplicate (6/6)	7.13E+01	3.82E+01	8.33E-02	9.63E-03
Area Near Streams				
BC01-WC (6/2)	2.14E+01	6.55E+00	8.45E-02	1.20E-02
BC03-WC (6/2)	4.73E+01	3.31E+01	9.34E-02	1.36E-02
BC04-WC (6/2)	5.05E+01	2.14E+01	6.01E-02	3.37E-02
Area Near Lake				
BM10-WL (6/6)	1.41E+01	7.09E+00	8.85E-02	2.79E-02
BM20-WL (6/6)	4.44E+01	2.89E+01	8.32E-02	2.47E-02
Provincial Background				
Bancroft (Clark Lake) (2/2)	1.3E+00	2.1E-01	4.8E-02	1.6E-02
Belleville (Bay of Quinte) (2/2)	1.8E+00	2.1E-01	9.1E-02	4.7E-02
Cobourg (Lake Ontario) (2/2)	3.1E+00	7.1E-01	1.1E-01	1.6E-02

Notes:

1. St. Dev = standard deviation, N/A = not applicable
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. N/A is not applicable.
4. Bancroft, Belleville, and Cobourg are not sampled during winter months (Q1&Q4)

The 2020 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. Additionally, locations on-site and to the north of Bruce Power have slightly higher values than those to the south. All values are well below the Provincial Water Quality Objective for tritium in drinking water (7000 Bq/L). The gross beta results show little variation with proximity or orientation relative to Bruce Power. The average provincial lake water tritium results range between 1.3 Bq/L to 3.1 Bq/L and for gross beta 0.011 Bq/L to 0.091 Bq/L. These results are slightly lower or similar to lake and stream water measured at the Bruce Power indicator and area near locations.

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 (BC02) 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 Baie du Doré. In 2020, there were minor changes to the annual average tritium concentration at the indicator and area near locations for both stream and lake sites compared to the previous year.

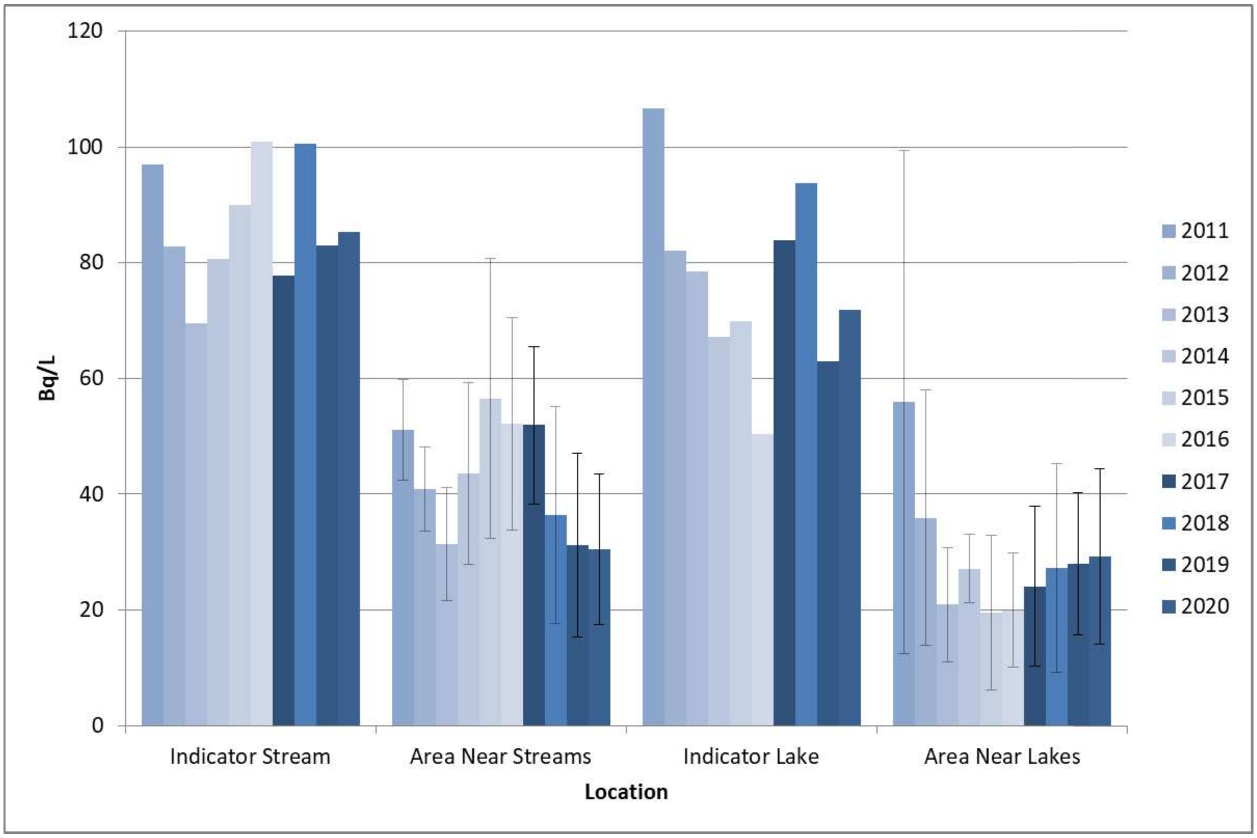

Figure 30: Annual Average Tritium Concentrations (Bq/L) in Lake Huron and Streams Near Bruce Power Over Time (± Standard Error)

The CNSC IEMP for 2019 included lake 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, off shore Georgian Bay near Owen Sound, and at an inland location near Concession 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 2 inland location with a value of 0.19 Bq/L. This value is lower than the Guideline/Reference Level of 1 Bq/L. These results are consistent with what Bruce Power reports and indicate that no health risks are expected. [R-29]

6.1.4 Agricultural and Animal Products Monitoring

Bruce Power collects a variety of foodstuffs each year, including milk, fish, animal 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 (see Figure 31). The far field sampling locations were updated in 2017 due to importation policies that came into effect that year. Starting in 2017, far field fish are collected on the Canadian side of Lake Huron with the aid of a contractor assisted by local Indigenous members.

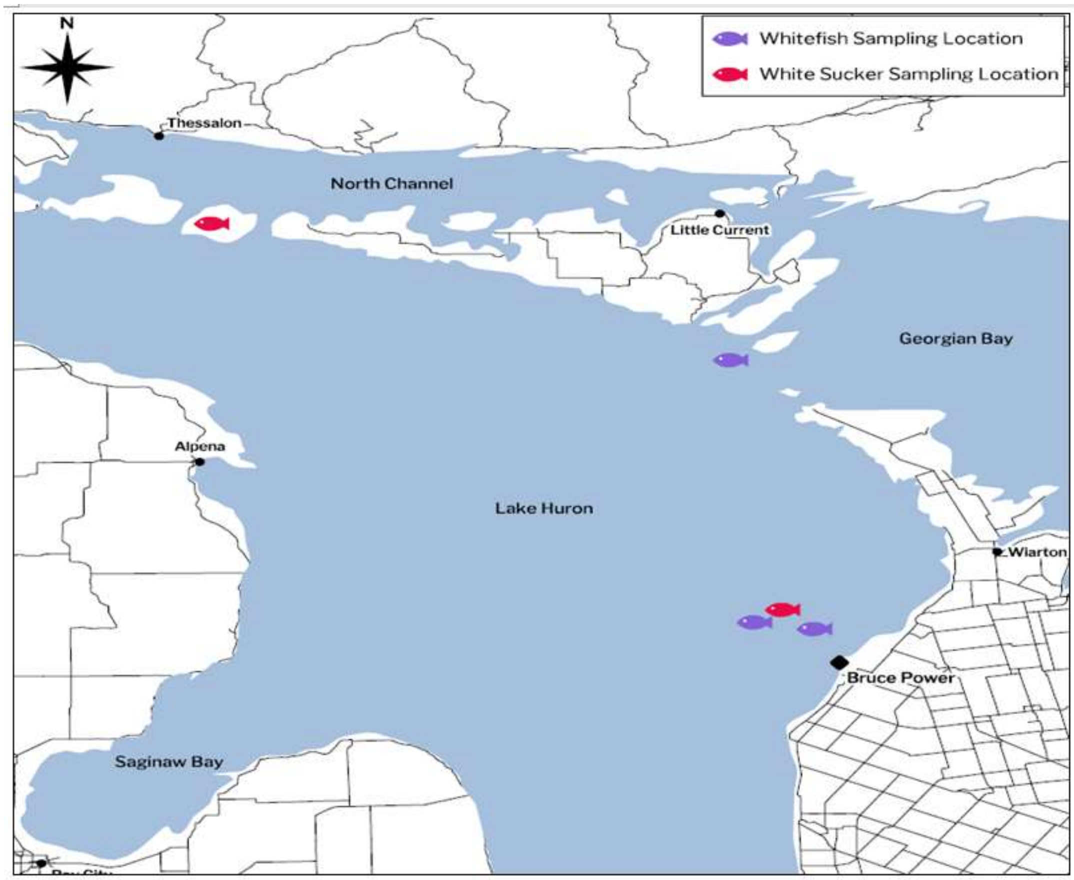

Figure 31: 2020 Fish Sampling Locations

The analysis of two types of fish species provides some insight into potential impacts for Bruce Power operations on the lakebed where benthic species inhabit, through open water ecosystems where pelagic fish inhabit. The target fish species representing both 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*).

The fish flesh ventral to the lateral line is included in the samples prepared for analysis. Sample preparation and analysis method is outlined in Table 23. 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 potassium-40, cobalt-60, cesium-134, cesium-137 by gamma spectrometry. Potassium-40 is a naturally occurring gamma-emitting radionuclide and is used as a reference for the analysis. The annual average results for 2020 are provided in

Table 24 and

Table 25 for Bruce Power near and far field fish. Also shown are the Province annual average results for benthic and pelagic fish from Lake Huron and benthic fish from Lake Ontario.

Table 23: Fish Preparation and Methods

Analyte	Sample	Preparation	Method
K-40, 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	Single composite	Solid residue (washed to remove free tritium	Liquid scintillation

Tritium (OBT)	by fish type	oxide) combusted	counting

Table 24: 2020 Annual Average Radionuclide Concentrations for Bruce Power Near and Far Field and Provincial Background Fish

Sample Type Location	Tritium		Carbon-14		OBT	
	Bq/L	St. Dev	Bq/kg	St. Dev	Bq/L	±2σ
Near Field						
Benthic, Lake Huron	1.28E+01	1.38E+00	2.41E+02	1.50E+01	8.1E+00	3.7E+00
Pelagic, Lake Huron	4.00E+00	1.23E+00	2.29E+02	1.33E+01	5.6E+00	3.6E+00
Far Field						
Benthic, Lake Huron	6.44E+00	1.37E+00	2.30E+02	1.33E+01	9.8E+00	3.8E+00
Pelagic, Lake Huron	5.65E+00	1.66E+00	2.27E+02	1.08E+01	9.9E+00	3.8E+00
Provincial Background						
Far Field Benthic, Lake Ontario	5.0E-02	7.3E-01	2.26E+02	1.4E+01	1.10E+02	4.7E+00
Far Field Benthic, Lake Huron	5.3E+00	2.2E+00	2.20E+02	1.2E+01	5.46E+01	3.7E+00
Far Field Pelagic, Lake Huron	5.1E+00	1.0E+00	2.19E+02	1.3E+01	6.43E+01	3.9E+00

Notes:

1. St. Dev = standard deviation. Sample count = 8 in all cases, except for OBT, which includes one composite and raw data is provided.
2. OBT is organically bound tritium, ±2σ is the uncertainty associated with the analytical measurement, Lc = 4.1 Bq/L (Bruce Power), Ld = 3.8 Bq/L (Provincial)
3. Bruce Power - For calculation of averages where result was less than critical level the uncensored analytical result was used.
4. Provincial Background – For calculation of averages where the result was less than the minimum detection level, the minimum detection level was used.

Table 25: 2020 Annual Average Gamma Spectroscopy Results for Bruce Power Near and Far Field and Provincial Background Fish

Sample Type Location	K-40		Co-60		Cs-134		Cs-137	
	Bq/kg	St. Dev	Bq/kg	St. Dev	Bq/kg	St. Dev	Bq/kg	St. Dev
Near Field								
Benthic, Lake Huron	1.15E+02	1.39E+00	5.92E-03	7.07E-02	<Lc	-	1.87E-01	7.71E-02
Pelagic, Lake Huron	1.09E+02	6.82E+00	4.11E-02	5.98E-02	<Lc	-	5.24E-01	1.39E-01
Far Field								
Benthic, Lake Huron	1.08E+02	2.87E+00	1.04E-02	6.36E-02	<Lc	-	2.59E-01	9.06E-02
Pelagic, Lake Huron	1.11E+02	5.88E+00	3.08E-02	1.00E-01	1.02E-02	9.91E-02	3.25E-01	5.70E-02
Provincial Background								
Benthic, Lake Ontario	1.37E+02	1.7E+00	<Ld	-	<Ld	-	1.10E-01	4.8E-02
Benthic, Lake Huron	1.23E+02	7.9E+00	<Ld	-	<Ld	-	2.16E-01	1.1E-01
Pelagic, Lake Huron	1.15E+02	6.4E+00	<Ld	-	<Ld	-	3.18E-01	4.9E-02

Notes:
1. St. Dev = standard deviation. Sample count = 8 in all cases.
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 in Fish

The 2020 annual average concentration of tritium oxide in pelagic fish was 4.0 Bq/L for near field and 5.7 Bq/L for the far field control group. For benthic fish in 2020, the near field annual average was 12.8 Bq/L and the far field average was 6.4 Bq/L. These values are similar to what has been reported for previous years. 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 in Figure 33 for benthic fish. The 2020 annual averages for the pelagic and benthic fish caught in Lake Huron reported by the Province were very similar to Bruce Power, at 5.1 Bq/L and 5.3 Bq/L respectively.

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 near field and far-field fish were not significantly different from each other, with both having higher concentrations compared to the provincial control. The benthic near-field fish had a significantly higher concentration than the far-field 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 health impacts are expected from the measured values.

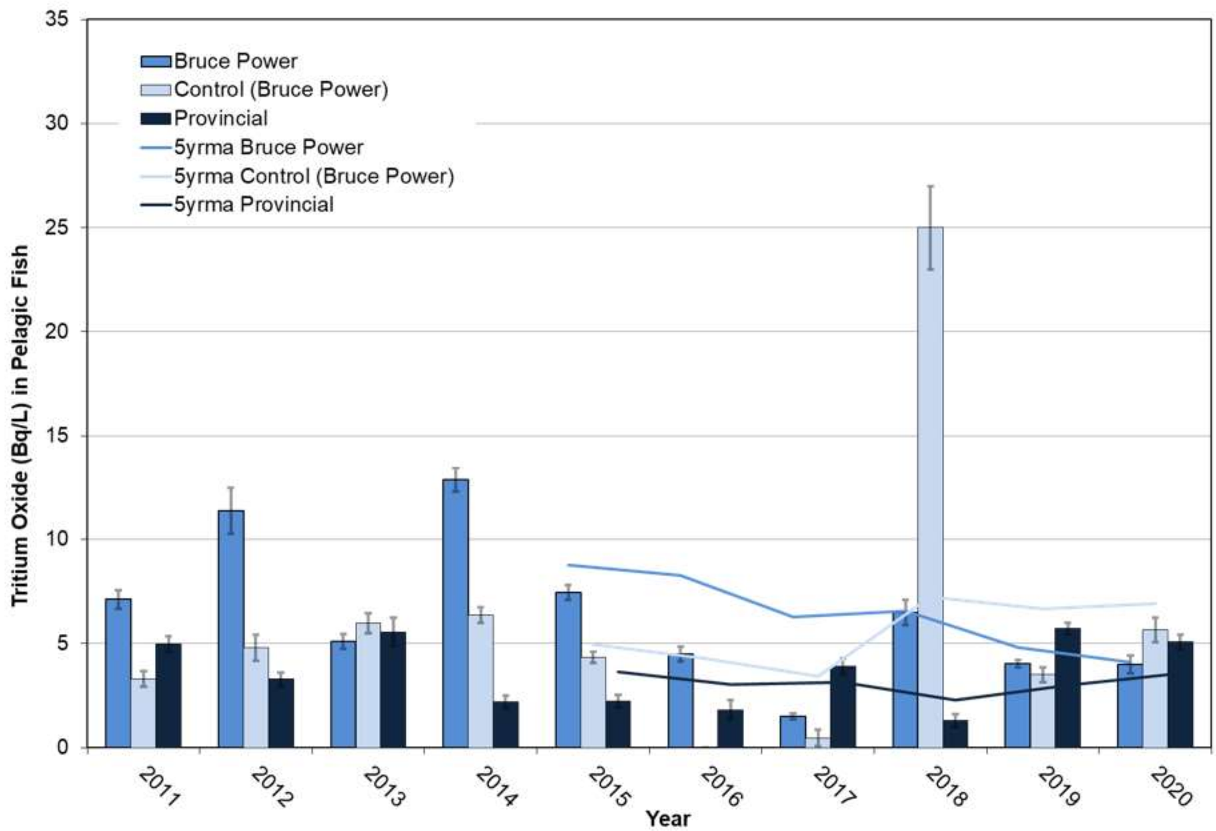

Figure 32: Annual Average Tritium Oxide (Bq/L) in Pelagic Fish Tissueby Year Over Time (± Standard Error)

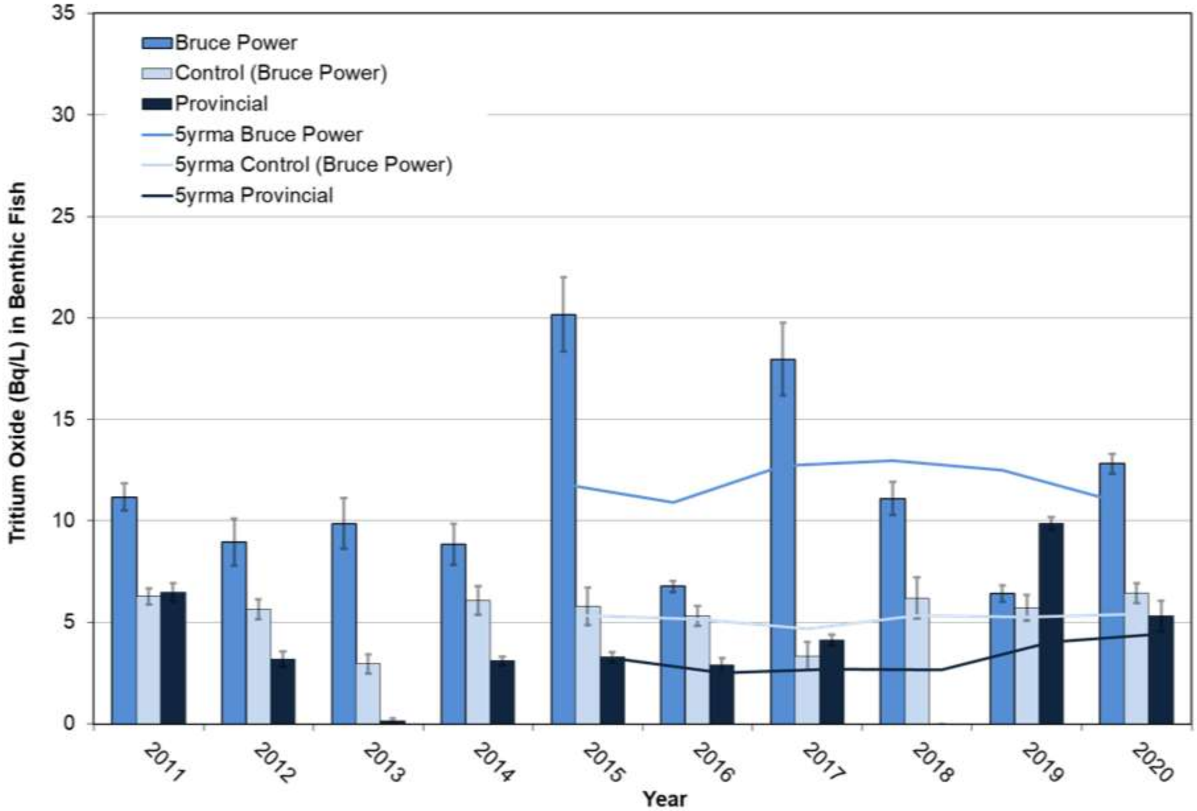

Figure 33: Annual Average Tritium Oxide (Bq/L) in Benthic Fish Tissue by Year Over Time (± Standard Error)

Carbon-14 in Fish

The 2020 annual average concentration of C-14 in fish collected near Bruce Power was 229 Bq/kg for pelagic fish and 241 Bq/kg in benthic fish. Results for fish collected far field (Bruce Power Control) were similar at 227 Bq/kg for pelagic and 230 Bq/L for benthic fish. The average Provincial results for Lake Huron fish collected in 2020 are consistent with these, at 219 Bq/kg for pelagic and 220 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 near-field site was higher than the far field and provincial site medians (which were not significantly different from each other). Pelagic fish were not significantly different by site.

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

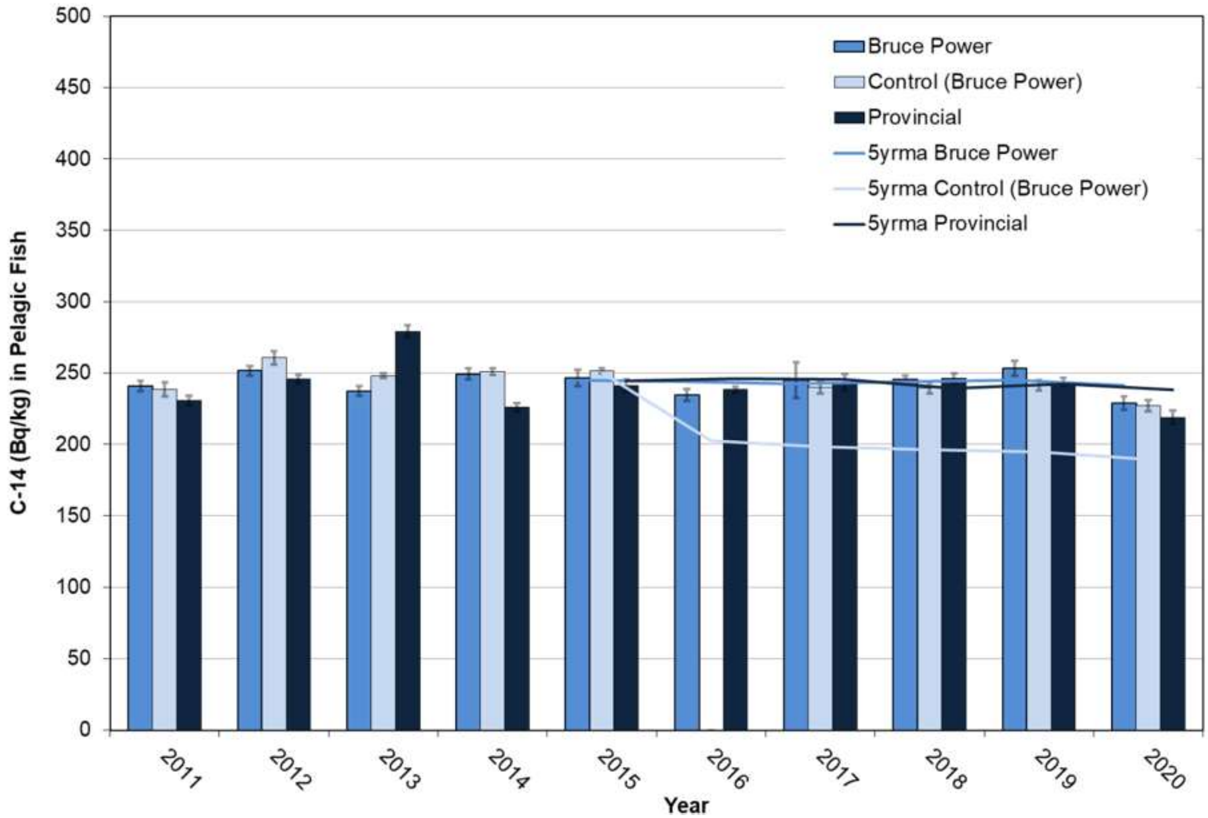

Figure 34: Annual Average Carbon-14 (Bq/Kg) in Pelagic Fish Tissue by Year Over Time (± Standard Error)

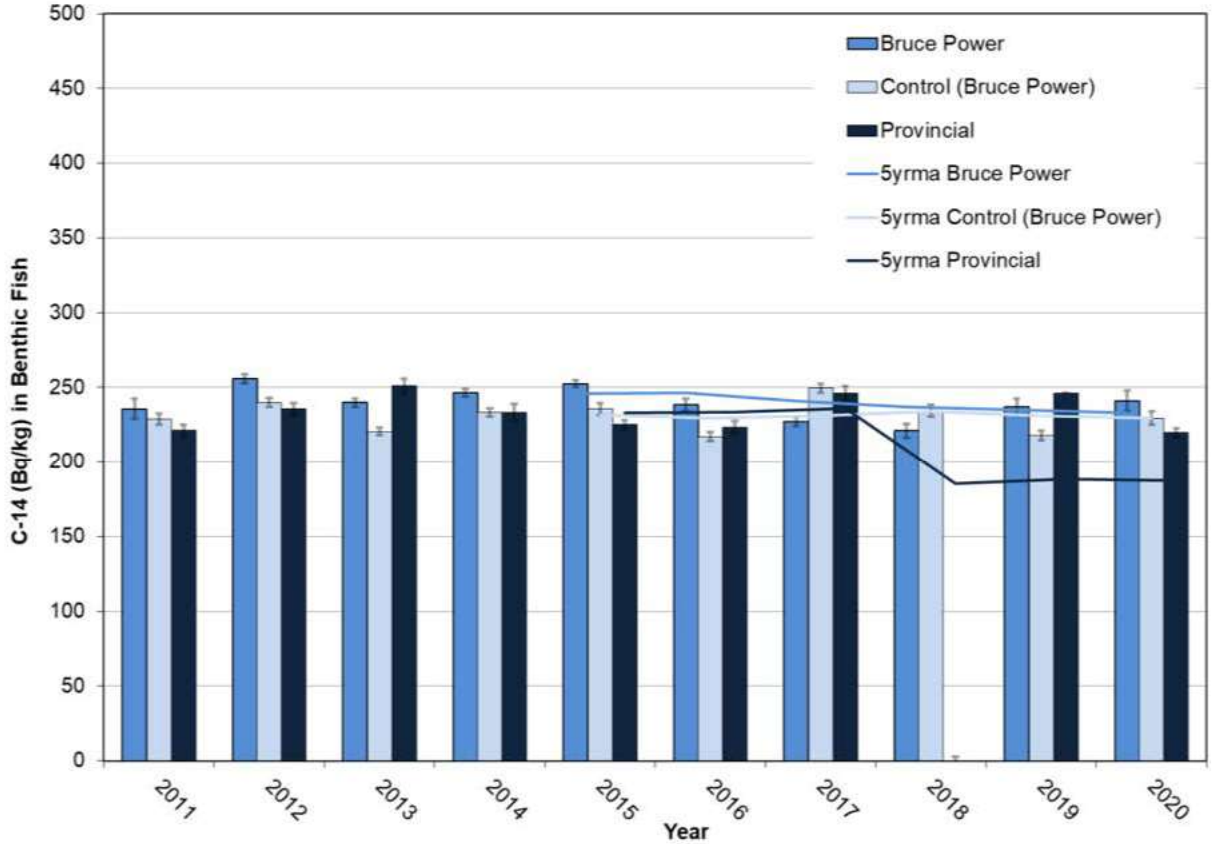

Figure 35: Annual Average Carbon-14 (Bq/Kg) in Benthic Fish Tissue by Year Over Time (± Standard Error)

Cobalt-60 and Cesium-134 in Fish

The Co-60 and Cs-134 concentrations in fish samples measured by Bruce Power in 2020 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 25. 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 2020 annual average concentration of Cs-137 in pelagic fish collected near Bruce Power was 0.52 Bq/kg and farther afield (Control) was 0.33 Bq/kg. For benthic fish, the annual average for near field was 0.19 Bq/kg and far field was 0.26 Bq/kg. The provincial average Cs-137 results were similar to Bruce Power, with 0.32 Bq/kg and 0.22 Bq/kg for pelagic and benthic fish respectively.

The annual average Cs-137 results for Bruce Power near field, Bruce Power far field and provincial background pelagic and benthic fish are shown in Figure 36 and Figure 37, respectively, for the last ten years. For pelagic fish the Cs-137 levels measured in 2020 are lower than previous years, and for benthic fish the results, other than 2017, are similar to historical values. Generally, the Cs-137 concentrations in fish tissue of pelagic and benthic fish collected in Lake Huron have remained steady over the years.

Kruskal Wallis analysis of variance (α= 0.05) showed a statistically significant difference for benthic fish by site ($p<0.001$); there was no significant difference for pelagic fish by site. The benthic provincial fish had a higher concentration than the near-field and far-field fish; these latter two were not significantly different from each other.

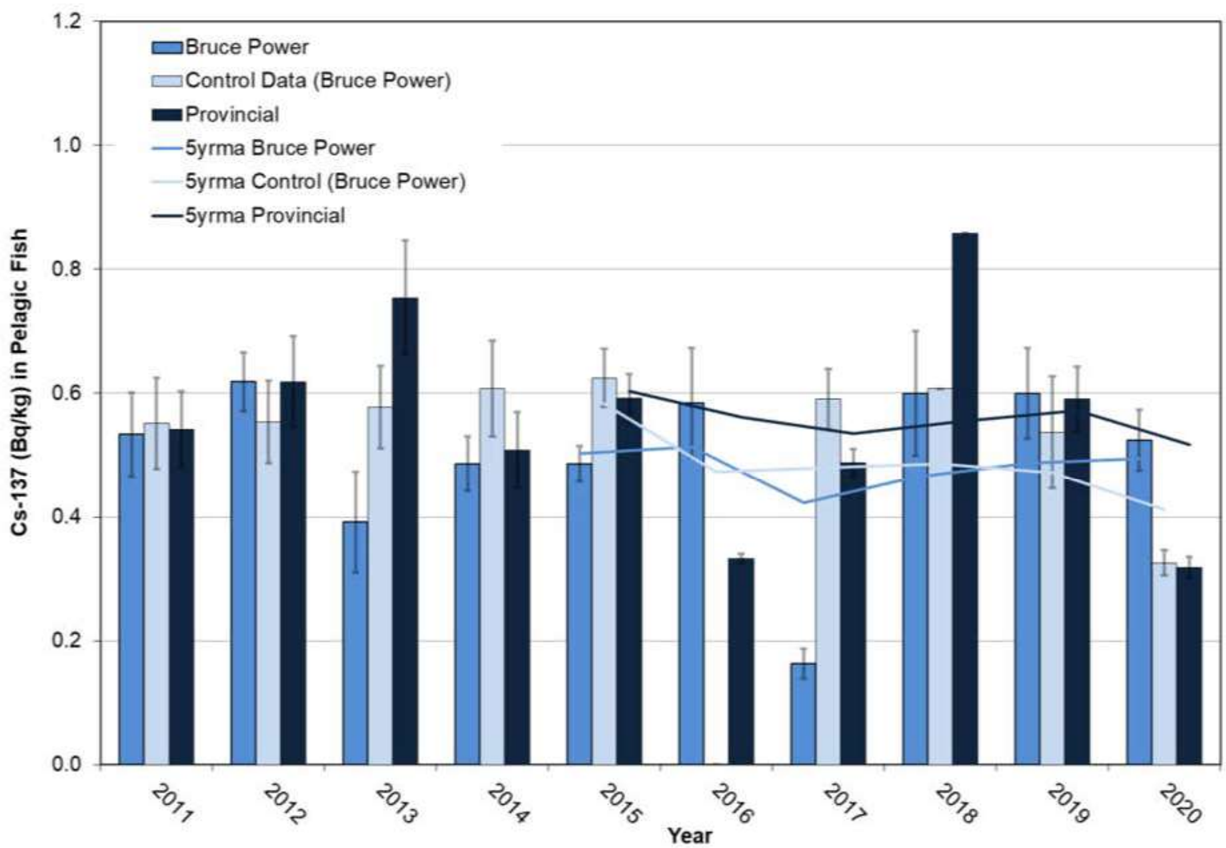

Figure 36: Annual Average Cesium-137 (Bq/Kg) in Pelagic Fish Tissue by Year Over Time (Standard Error)

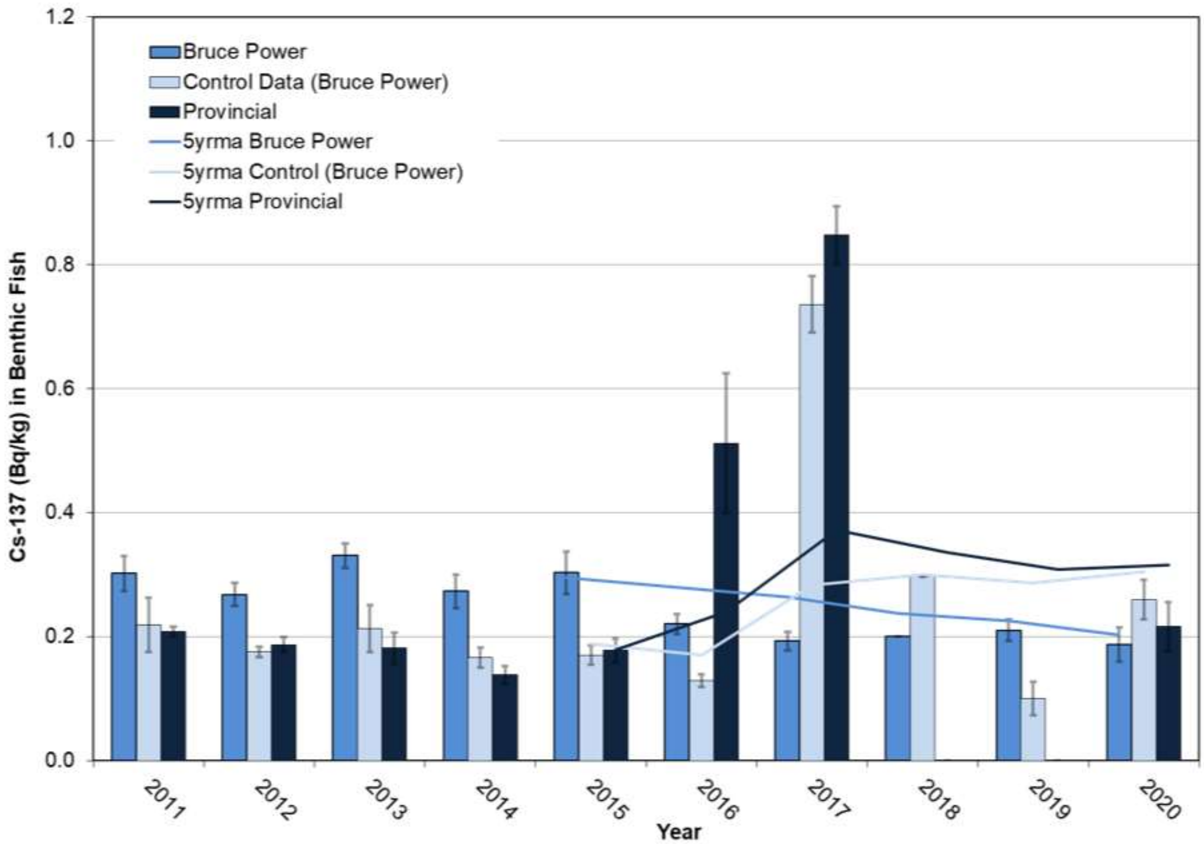

Figure 37: Annual Average Cesium-137 (Bq/Kg) in Benthic Fish Tissue by Year Over Time (□ Standard Error)

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 fish monitoring program (Suckers and Whitefish) had Cs-137 values less than the critical level or detection limit.

Organically Bound Tritium in Fish

Organically bound tritium is measured on a composite sample of the eight fish samples collected for each type and location (near field and far field) by Bruce Power. The final result is based on the arithmetic mean of the activity of the single composite sample counted twice. The 2020 results for pelagic fish collected near and far field are 5.6 Bq/L and 9.9 Bq/L respectively. The near and far field benthic fish results are 8.1 Bq/L and 9.8 Bq/L respectively. In both cases the fish collected near Bruce Power had lower 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 (64.3 Bq/L and 54.6 Bq/L, respectively).

The methodology used to measure 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 an order of magnitude higher than those of Bruce Power. The Bruce Power Health Physics Lab is working with the Provincial Whitby Lab to understand the discrepancy through a benchmarking workshop; 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 (near field 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.

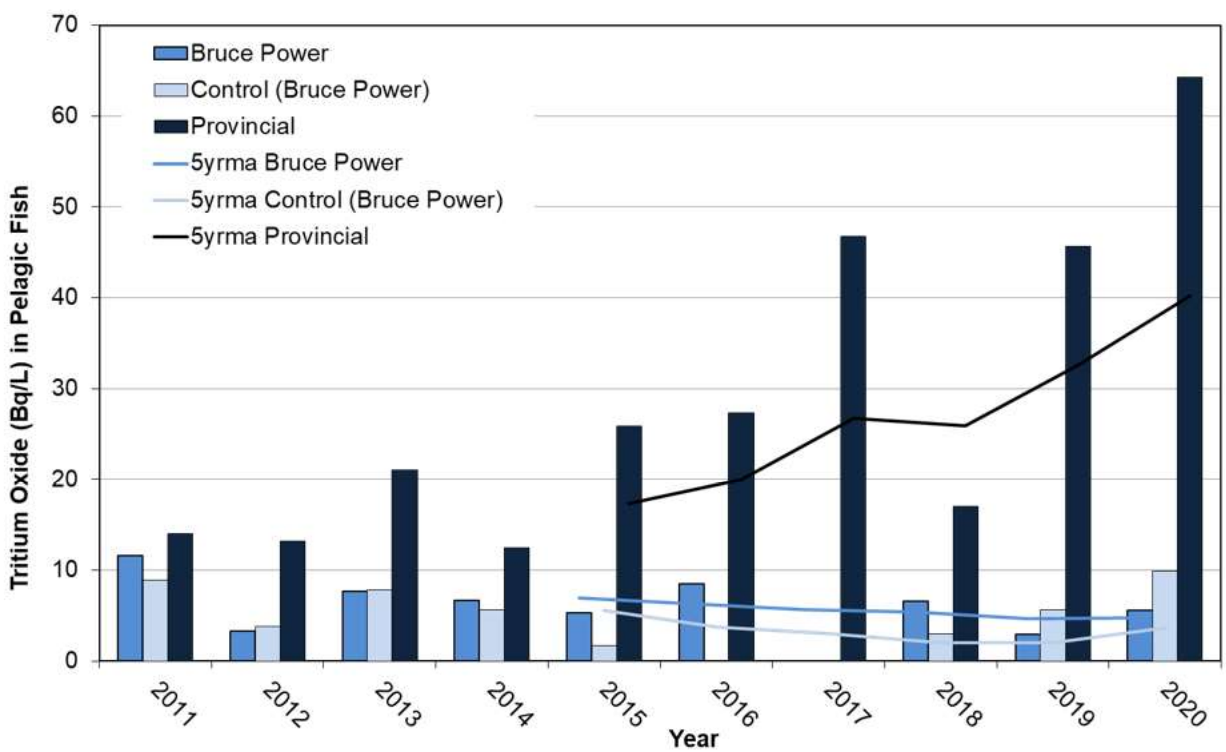

Figure 38: OBT in Pelagic Fish Tissue

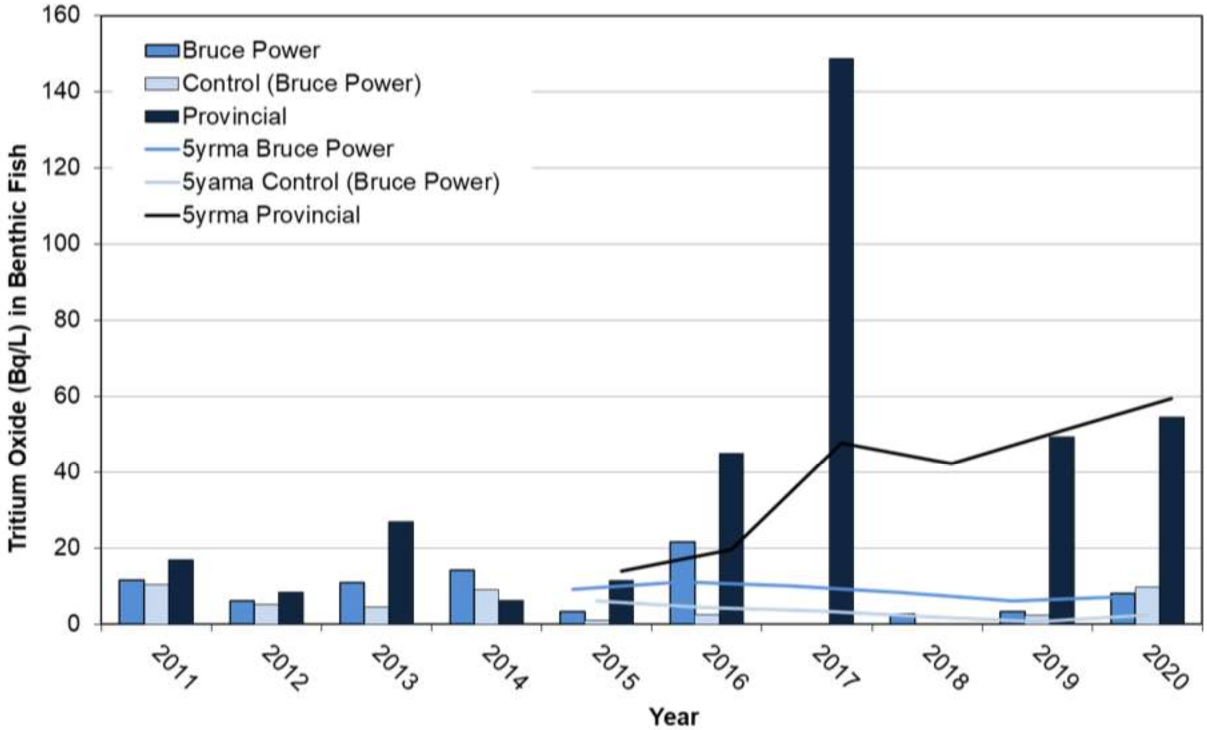

Figure 39: OBT in Benthic Fish Tissue

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-29]. 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 and eggs, as well as livestock when available. Sampling locations are shown in Figure 22. Honey (harvested near and far field) is collected on an annual basis, while eggs are collected twice each year (spring and fall). Only one collection of eggs was available in 2020. No livestock samples were available in 2020.

On occasion, Bruce Power will also collect samples from wild animal fatalities that occur onsite (i.e. vehicular collisions) or from donations made by local hunters. In 2020, beaver and deer meat were obtained for use in the REM program and the results will be used in the dose to public calculation (deer) and ecological environmental risk assessment (beaver and deer).

Animal products are analyzed for tritium and carbon-14 by liquid scintillation counting, and the 2020 results are listed in Table 26. Some samples are also analyzed by gamma spectroscopy and the 2020 results for potassium-40, cobalt-60, cesium-134 and cesium-137 are shown in Table 27. The tritium 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 time, the analytical (uncensored) result was provided.

The province measures for background tritium and carbon-14 in eggs (quarterly results for 3 samples) and poultry (8 samples). The sampling locations are shown in Figure 19, and the annual average values for 2020 are provided in Table 26.

The 2020 tritium result measured in eggs located near Bruce Power is lower than the provincial background average, and the C-14 result is very similar (228 Bq/kg vs 224 Bq/kg), suggesting that there is little difference between eggs sourced near Bruce Power and those elsewhere. Animal meat results are not comparable.

The CNSC IEMP included locally sourced beef and pork samples in 2019 that were analyzed for tritiated water and organically bound tritium (OBT) [R-29]. 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 26: 2020 Annual Tritium and Carbon-14 Concentrations in Animal Products from Bruce Power and Provincial Locations

Sample Location	Sample Type	Tritium			C-14		
		(Bq/L)	± 2σ	Lc	(BqC^{14}/kg-C)	± 2σ	Lc
Near Field							
On-site Bruce Power	Beaver Meat	2.75E+02	9.68E+00	3.02E+00	3.19E+02	3.45E+01	1.85E+01
On-site Bruce Power	Deer Meat	1.86E+01	3.51E+00	3.02E+00	2.61E+02	3.05E+01	1.69E+01
BR22-HO Near	Honey	3.51E+01	4.06E+00	2.85E+00	2.46E+02	2.76E+01	1.50E+01
BR22-HO Far	Honey	6.95E+00	2.81E+00	2.85E+00	2.38E+02	2.83E+01	1.57E+01
B24	Chicken Eggs (Spring)	2.80E+01	3.88E+00	2.99E+00	2.28E+02	2.70E+01	1.49E+01
B24	Chicken Eggs (Fall)	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample
Provincial Background							
Sample Location	**Sample Type**	**(Bq/L)**	**St. Dev**		**(Bq/L)**	**St. Dev**	
Average – Picton	Eggs	4.1E+00	2.1E+00		2.24E+02	1.2E+01	
Average – Picton	Poultry	2.2E+00	1.1E+00		2.23E+02	1.4E+01	

Notes:
1.St. Dev = standard deviation.
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 27: 2020 Annual Gamma Radionuclide Concentrations in Animal Products Near Bruce Power

Sample Location	Sample Type	K-40			Co-60			Cs-134			Cs-137		
		Bq/kg	± 2σ	Lc	Bq/kg	± 2σ	Lc	Bq/kg	± 2σ	Lc	Bq/kg	± 2σ	Lc
On-site Bruce Power	Beaver Meat	9.24E+01	7.96E+00	7.47E-01	-6.13E-02	1.27E-01	8.88E-02	-1.61E-01	1.24E-01	8.77E-02	4.22E-01	1.01E-01	6.91E-02
Off-site Bruce Power	Deer Meat	9.70E+01	8.41E+00	9.06E-01	-1.10E-02	1.37E-01	9.77E-02	-7.29E-02	1.40E-01	1.06E-01	6.47E-01	1.19E-01	7.37E-02
BR22-HO Near	Honey*	1.11E+01	2.42E+00	1.51E+00	1.27E-01	1.89E-01	1.50E-01	-2.35E-01	2.49E-01	1.87E-01	-6.49E-02	3.08E-01	1.65E-01
BR22-HO Far	Honey*	8.76E+00	2.40E+00	1.68E+00	6.25E-02	2.09E-01	1.64E-01	-4.81E-02	2.41E-01	2.09E-01	1.62E-01	3.35E-01	1.84E-01

Note: *For honey samples, gamma results are 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 and carbon-14 by liquid scintillation counting. These radionuclides may be present in milk from the ingestion of feed, water and the inhalation of air of dairy cattle. Samples are analyzed for I-131 more frequently than other radionuclides because of its shorter half-life. For the first half of 2020 there were five farms participating in the REM program, however one farm stopped milk production in July (BDF13) reducing the number of sample locations to four.

The milk sampling locations are shown on Figure 22, and the 2020 annual results are provided in Table 28. Milk was sampled by the Province in Belleville and London, as shown on Figure 19, and the results for tritium, I-131 and C-14 are shown in Table 28. Gamma emitting radionuclides other than I-131 were also measured, but results for CANDU related radionuclides such as Co-60, Cs-134 and Cs-137 were less than the limit of detection.

Table 28: 2020 Annual Average Concentration Tritium, Iodine-131, Carbon-14 in Milk Samples

Sample Location (Sample Count)	Tritium		Iodine-131		Carbon-14	
	(Bq/L)	St. Dev	(Bq/L)	St.Dev	(Bq/kg-C)	St.Dev
Area Near						
BDF01-MK (12)	4.86E+00	1.67E+00	<Lc	-	2.39E+02	7.66E+00
BDF09-MK (12)	8.62E+00	1.78E+00			2.42E+02	1.02E+01
BDF12-MK (12)	6.99E+00	1.96E+00			2.48E+02	1.66E+01
BDF13-MK (7)	6.87E+00	2.93E+00			2.26E+02	1.21E+01
BDF15-MK (12)	4.92E+00	2.20E+00			2.40E+02	1.91E+01
Average (Area Near) (55)	**6.45E+00**	**2.48E+00**			**2.39E+02**	**1.40E+01**
Provincial Background						
DF1 | Belleville (12)	1.9E+00	1.4E+00	<Ld	-	2.28E+02	1.74E+01
DF2 | London (4)	1.0E+00	2.0E+00	<Ld	-	2.30E+02	1.94E+01

Note:
1. St.Dev = standard deviation
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.
4. I-131 sample count is 53 for Bruce Power (weekly), 12 for Belleville and 4 for London (quarterly).

For 2020, the average annual tritium concentration in milk at local dairy farms was 6.45 Bq/L. Although this is higher than the provincial background annual average of 1.7 Bq/L, this is well below the Provincial Water Quality Objective for tritium in drinking water (7000 Bq/L) [R-88]. Bruce Power and Provincial annual average tritium concentrations in milk for the last five 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 sites. The Bruce Power site showed the highest mean concentration.

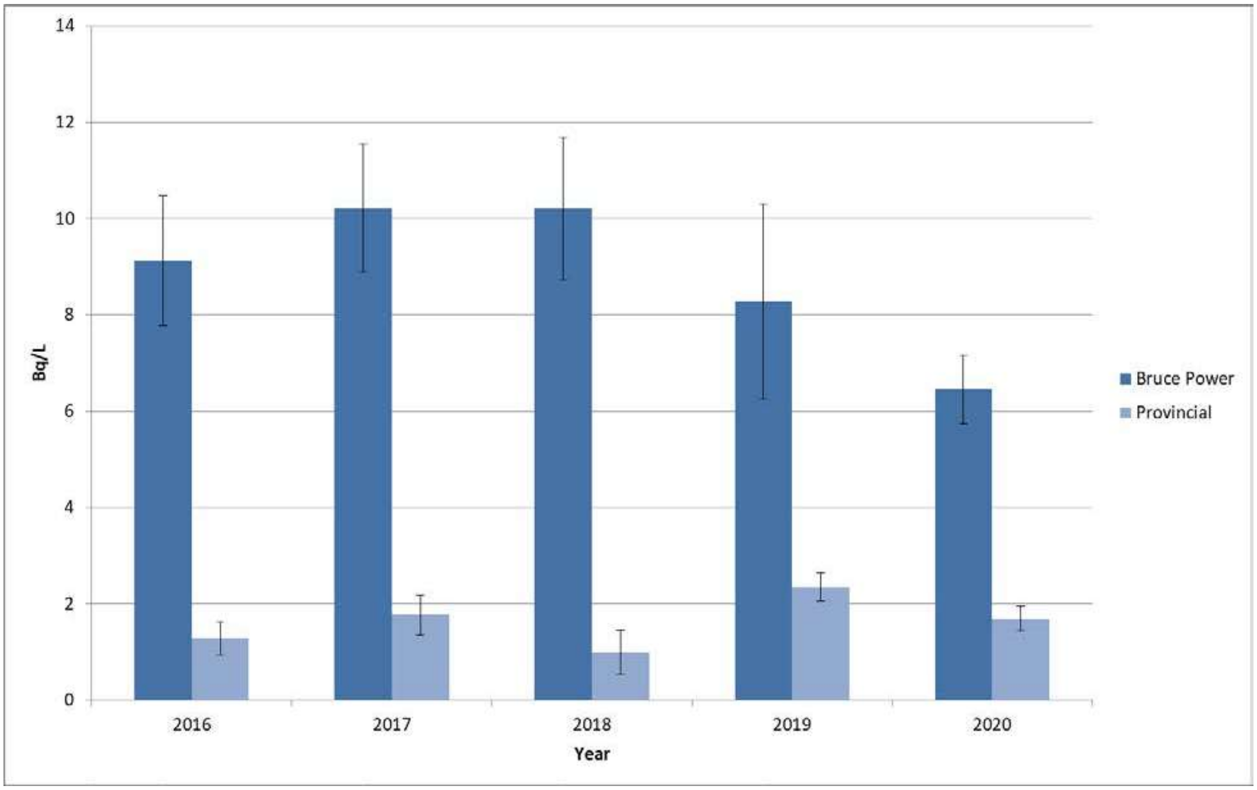

Figure 40: Annual Average Tritium Concentration (Bq/L) in Milk Samples Collected Near the Bruce Power Site and Provincial Locations Over Time (± Standard Error)

The annual average C-14 result for near field milk samples was 239 Bq/Kg, which is very similar to the provincial background average of 229 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-29]. 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 impact 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 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 for tritium analysis on a quarterly basis.

The annual average tritium and C-14 results for agricultural products measured by Bruce Power are provided in Table 29. For 2020, 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 2020 the above ground variety included tomatoes, peppers and eggplant, the leafy group included samples of rhubarb, swiss chard, spinach and lettuce, and the below ground vegetables were radish, garlic, onion, potato, carrot 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 include two sets of composite samples at four locations, while animal feed samples consist of semiannual collection at four locations. Sampling locations are provided on Figure 19 and the annual averages are provided in Table 29. 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 29: 2020 Annual Average Data for Agricultural Products from Near Bruce Power and Provincial Locations

Sample Type (Sample Count)	Tritium		Carbon-14	
	Bq/L	St. Dev	BqC^{14}/kg-C	St. Dev
Near Field				
Grains (6)	2.73E+01	9.06E+00	2.38E+02	1.78E+01
Corn Mash (4)	1.69E+01	2.27E+00	N/A	N/A
Fruit (9)	5.21E+01	2.48E+01	2.48E+02	1.29E+01
Vegetables – All (20)	2.73E+01	1.00E+01	2.42E+02	2.08E+01
Vegetables - Above Ground (6)	2.62E+01	6.68E+00	2.33E+02	1.42E+01
Vegetables – Leafy (7)	2.64E+01	1.04E+01	2.51E+02	2.98E+01
Vegetables - Below Ground (7)	2.91E+01	1.29E+01	2.40E+02	1.21E+01
Provincial Background				
Animal Feed (8)	2.8E+00	1.1E+00	2.12E+02	1.02E+01
Fruit Composite (8)	1.1E+00	1.1E+00	2.35E+02	1.02E+01

Sample Type (Sample Count)	Tritium		Carbon-14	
	Bq/L	St. Dev	BqC^{14}/kg-C	St. Dev
Vegetable Composite (8)	3.1E+00	5.4E-01	2.38E+02	1.15E+01

Notes:
1. St. Dev = standard deviation. N/A = not applicable.
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 and C-14 content in agricultural products may vary each year based on the operational activities, and therefore radiological emissions, that occur during the growing season. The annual average trend of tritium in fruits and vegetables over time are shown in Figure 41 and Figure 42, respectively. Fruit and vegetables near Bruce Power are consistently higher than that of provincial levels. The 2020 annual average for Bruce Power fruit is lower than what has been observed in previous years. There was little difference in tritium or C-14 content by vegetable type. The annual average tritium in vegetables was also lower than in previous years. The annual average trend of carbon-14 in fruit and vegetables over time is shown in Figure 43 and Figure 44. C-14 average values in fruit and vegetables remain consistent with historic trends and similar to provincial values.

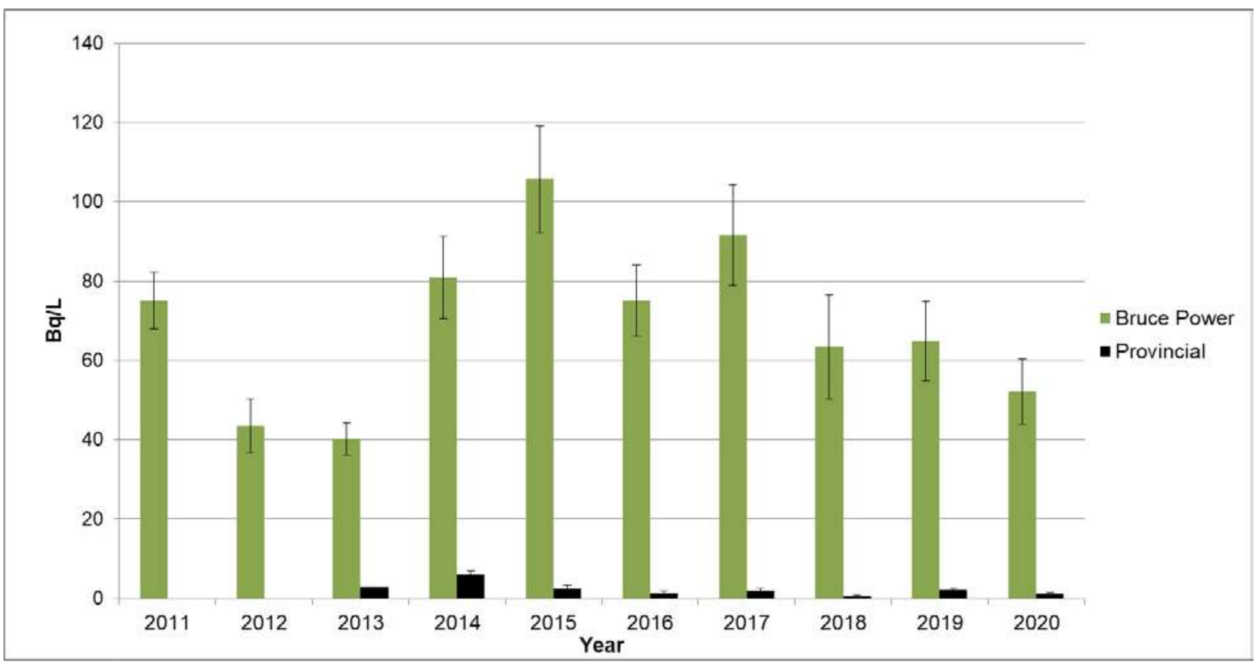

Figure 41: Annual Average Tritium in Fruit at Bruce Power and Provincial Locations Over Time (± Standard Error)

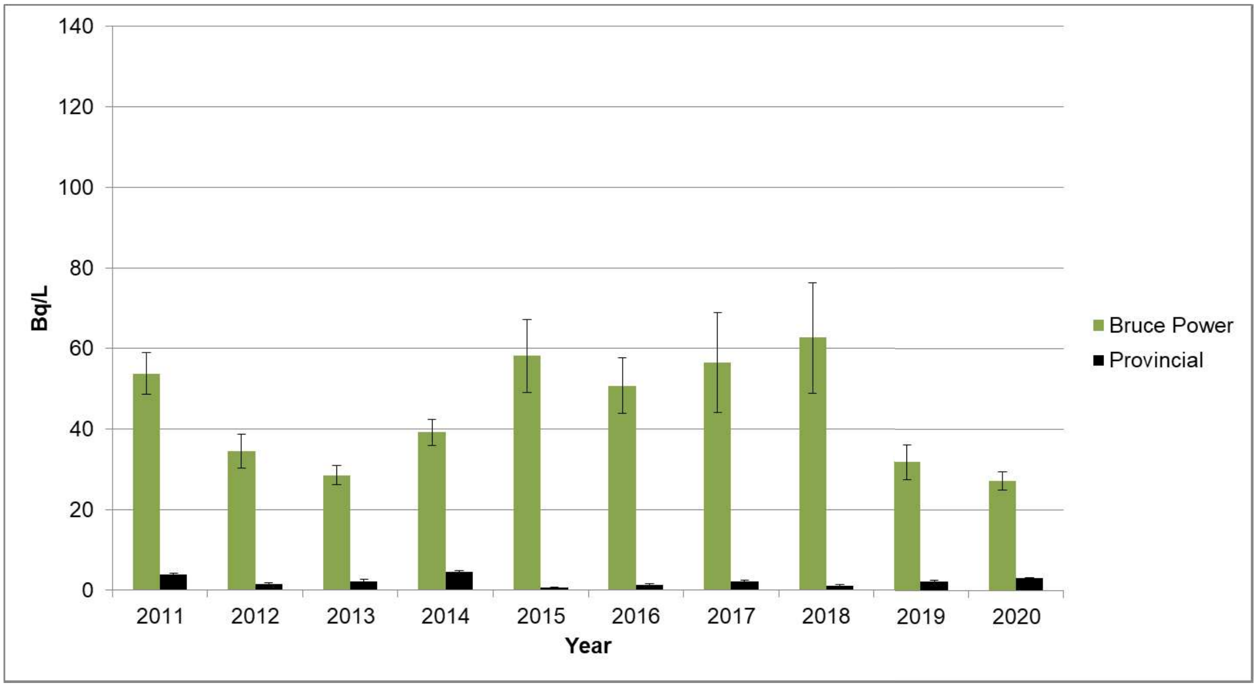

Figure 42: Annual Average Tritium in Vegetables at Bruce Power and Provincial Locations Over Time (± Standard Error)

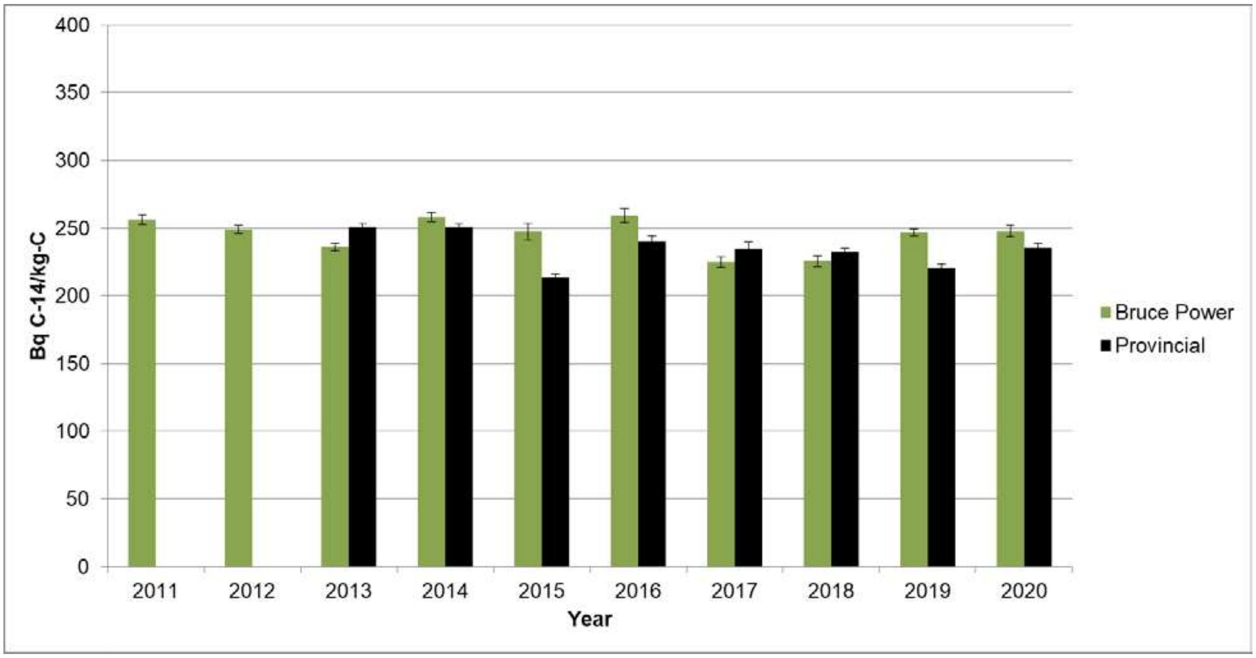

Figure 43: Annual Average Carbon-14 in Fruit at Bruce Power and Provincial Locations Over Time (± Standard Error)

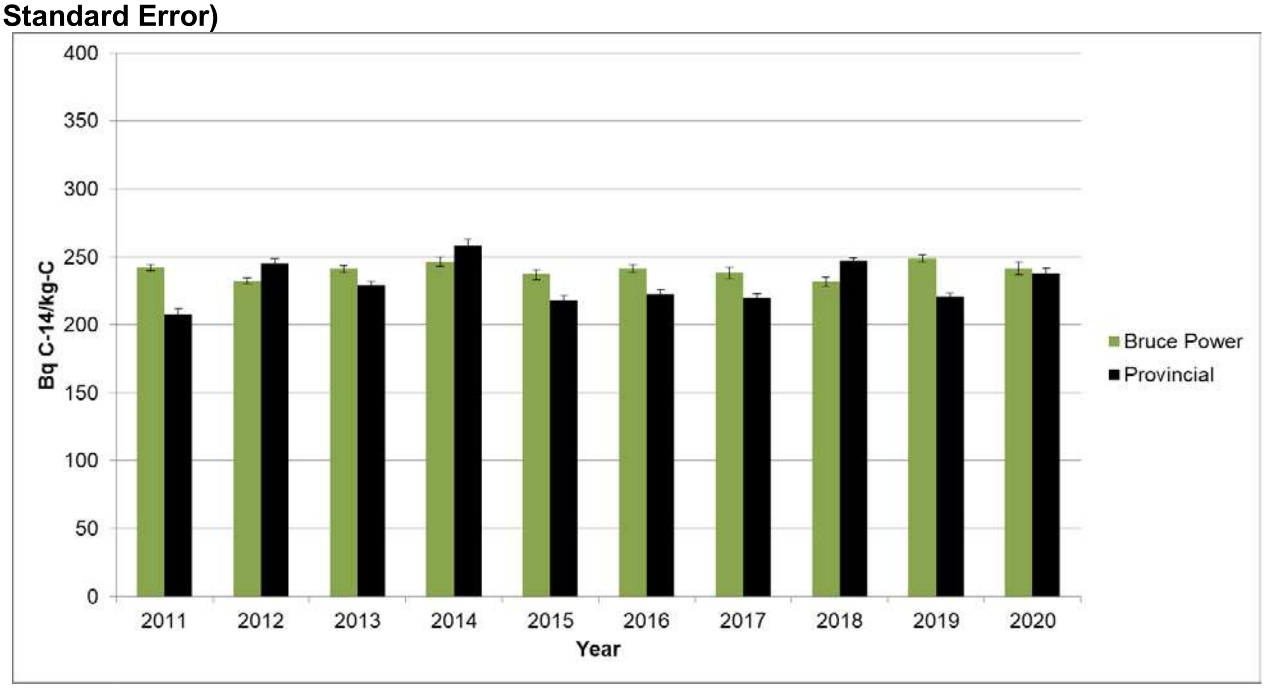

Figure 44: Annual Average Carbon-14 in Vegetables at Bruce Power and Provincial Locations Over Time (± Standard Error)

As part of the 2019 CNSC IEMP a variety of agricultural products were sampled including fruits, vegetables and vegetation [R-29]. 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 negligible.

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).

6.1.5 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. Sampling locations in the vicinity of Bruce Power and further afield along the shore of Lake Huron are shown in Figure 20 and Figure 21. Sediment and onsite soil sampling was last analyzed in 2019 [R-89].

Beach sand was collected in 2020 at Baie du Doré, Inverhuron (duplicate samples) and Brucedale, along with a background soil sample from Amberley (BM18). Samples are dried, sieved and analyzed for gamma-emitting radionuclides using gamma spectrometry. The annual average results for potassium-40 (naturally occurring), cobalt-60, cesium-134 and cesium-137 are shown in Table 30, along with the results taken by the Province. The Province analyses 8 beach sand samples from Cobourg and 2 from Goderich.

Table 30: 2020 Annual Average Beach Sand Data

Sample Location (Sample Count)	K-40		Co-60		Cs-134		Cs-137	
	Bq/kg	St. Dev	Bq/kg	St. Dev	Bq/kg	St. Dev	Bq/kg	St. Dev
Bruce Power*								
Near Field (4)	2.74E+02	5.96E+01	<Lc	-	<Lc	-	1.04E+00	5.59E-01
Far Field (1) Background (BM18)	4.93E+02	4.04E+01	<Lc	-	<Lc	-	4.59E+00	5.95E-01
Provincial Background**								
Cobourg (8)	4.28E+02	2.91E+01	<Ld	-	<Ld	-	4.00E-01	1.23E-01
Goderich (2)	3.10E+02	1.06E+00	<Ld	-	<Ld	-	<Ld	-

Notes:
1. St. Dev = standard deviation.
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.

In 2020, all Bruce Power and provincial beach sand samples had results for Co-60 and Cs-134 that were less than the critical level (Bruce Power) or minimum level of detection (Provincial), indicating that levels of these radionuclides sand are negligible. The near field average for Cs-137 (1.04 Bq/kg) was lower than the far field background result (4.50 Bq/kg) but was higher than the Provincial background averages for Cobourg and Goderich.

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 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.

6.1.6 Groundwater Monitoring

Monitoring for tritium in groundwater occurred within the protected zone at Bruce A and Bruce B in 2020, at the 5 multi-level wells located between the powerhouse and Lake Huron, and also at additional wells located in the transformer and standby generator areas to gain a better understanding of groundwater tritium concentrations. A map of sampled well location is shown in Figure 45 for Bruce A and Figure 49 for Bruce B. The 5 multi-level wells are sampled on a semiannual basis and the transformer and standby generator areas were sampled in the fall of 2020. These results, in combination with the results from the radiological monitoring wells historically reported allow for a more comprehensive picture of tritium values in groundwater in the vicinity of the station.

Bruce Power compares groundwater monitoring results to the Generic Guidelines for non-potable water and below the Ontario Drinking Water Standard (ODWS) of 7,000 Bq/L [R-90] and uses a statistical approach is used to understand any deviation from normal. When deviations from normal are observed, further investigation or other actions are undertaken as needed. The 2020 groundwater tritium results at Bruce A and Bruce B wells remain well below the ODWS. The groundwater tritium results from 2020 are shown below along with a graphical representation of the results for the last 5 years compared to the ODWS (shown as a dashed blue line on each figure). Note that multi-level wells are named such that the deepest interval is numbered the lowest (i.e. BA 1-1 is deeper than BA 1-2).

6.1.6.1 Bruce A

Three groups of wells were sampled in 2020 in the protected area of Bruce A. This included the multi-level wells (labeled BA), the Standby Generator Area wells (labeled BASG) and the Transformer Area wells (labeled BATR) as shown in Figure 45.

Figure 45: Sampling Locations of Bruce A Groundwater Wells

The Bruce A Multi-Level groundwater wells were sampled in the spring on April 27, 2020 and in the fall sampling on October 22, 2020. These wells are located between the north east side of the powerhouse and Lake Huron (labeled BA1 to BA5 in Figure 45). Tritium levels and historical trends are shown in Table 31 and Figure 46 respectively.

Table 31: Semi-annual Multi-level Groundwater Well Tritium Results for Bruce A

	Spring 2020			Fall 2020		
	Result	±2δ	Lc	Result	±2δ	Lc
BA 1-1	8.9	3.29E+00	3.37E+00	7.1	2.83E+00	2.86E+00
BA 1-2	43.7	4.65E+00	3.37E+00	24.8	3.67E+00	2.86E+00
BA 2-1	-4.7	2.39E+00	3.37E+00	0.0	2.02E+00	2.86E+00
BA 2-2	-0.1	2.39E+00	3.37E+00	2.0	2.02E+00	2.86E+00
BA 2-3	420.0	1.18E+01	3.37E+00	393.0	1.13E+01	2.86E+00
BA 3-1	-2.0	2.39E+00	3.37E+00	0.8	2.02E+00	2.86E+00
BA 3-2	-1.5	2.39E+00	3.37E+00	3.5	2.62E+00	2.86E+00
BA 3-3	366.0	1.10E+01	3.37E+00	231.0	8.79E+00	2.86E+00
BA 4-1	-0.7	2.39E+00	3.37E+00	-0.6	2.02E+00	2.86E+00
BA 4-2	1,030.0	1.81E+01	3.37E+00	769.0	1.56E+01	2.86E+00
BA 5-1	4.3	3.06E+00	3.37E+00	3.3	2.34E+00	2.86E+00
BA 5-2	-2.3	2.39E+00	3.37E+00	-0.5	2.02E+00	2.86E+00

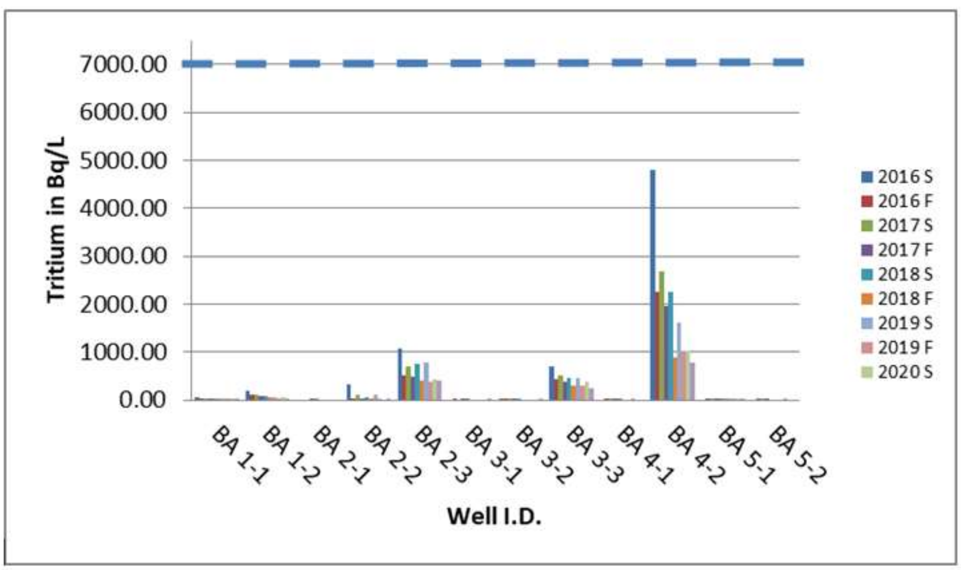

Figure 46: Multi-Level Groundwater Well Tritium Levels at Bruce A compared to the Ontario Drinking Water Standard (dashed line)

Results from the groundwater sampling events suggest that tritium appears to be a result of atmospheric downwash due to tritium levels being higher in the shallower well intervals. The tritium levels in the multi-level wells are well within the ODWS limit of 7000 Bq/L (shown as a dashed line). The five-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.

Bruce A Transformer Area wells were sampled October 1 and October 2. These wells are located on the south side of the powerhouse in the vicinity of the unit transformers (labeled BATR in Figure 45). Tritium levels and historical trends are shown in Table 32 and Figure 47 respectively.

Table 32: Bruce A Transformer Area Tritium Levels in Groundwater Wells

	Fall 2020		
	Result	**±2δ**	**Lc**
BATR-1-12	706	3.83E+01	9.35E+00
BATR-1-13	1,630	5.69E+01	9.35E+00
BATR-1-14A	32	1.35E+01	9.30E+00
BATR-1-14B	2,600	7.12E+01	9.34E+00
BATR-1-15	471	3.19E+01	9.32E+00
BATR-3-11	25	1.31E+01	9.36E+00
BATR-3-12	1,880	6.09E+01	9.73E+00
BATR-4-10	1,890	6.25E+01	9.80E+00

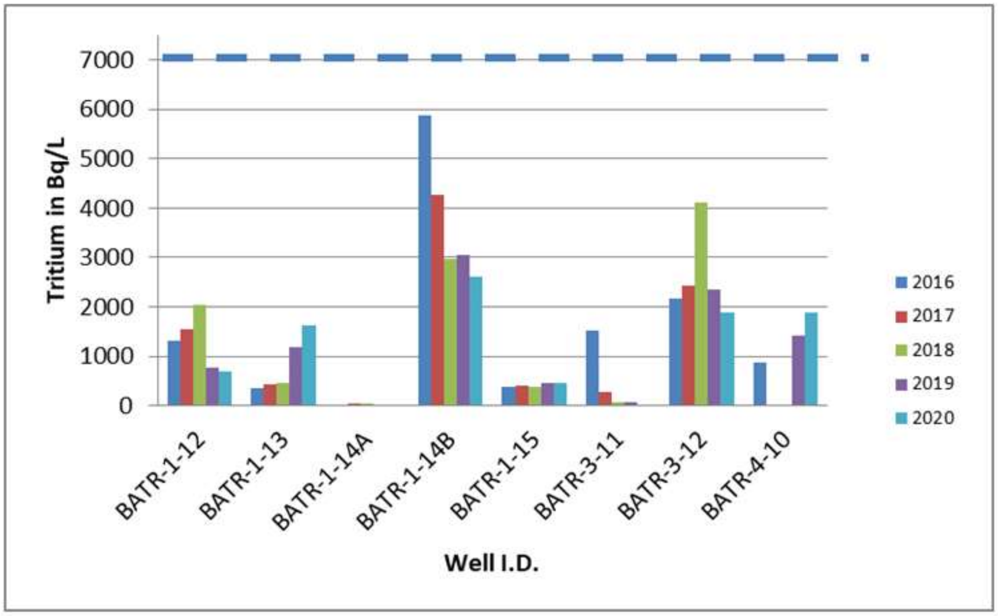

Figure 47: Bruce A Transformer Area Tritium Levels in Groundwater Wells compared to the Ontario Drinking Water Standard (dashed line)

The tritium levels shown above are below the ODWS [R-90] threshold of 7,000 Bq/L (shown as a dashed line). The elevated level in BATR-1-14B in 2016 prompted action to continue to monitor the following year to confirm the increasing trend. The level dropped the following year and continues to drop in subsequent years.

Bruce A Standby Generator Area wells were sampled on October 2nd. These wells are located on the west side of the powerhouse (labeled BASG in Figure 45). Tritium values for wells and historical trends are shown in Table 33 and Figure 48 respectively.

Table 33: Bruce A Standby Generator Area Tritium Levels in Groundwater Wells

	Fall 2020		
	Result	±2δ	Lc
BASG-13	352	2.91E+01	9.59E+00
BASG-14	-	-	-
BASG-15	186	2.24E+01	9.51E+00
BASG-16	1,130	4.89E+01	9.49E+00
BASG-17	76	1.67E+01	9.48E+00
BASG-21	110	1.81E+01	9.52E+00
BASG-22	475	3.31E+01	9.59E+00
BASG-25	561	3.54E+01	9.47E+00
BASG-26	-	-	-

Blank cells – sampling not requested in 2020

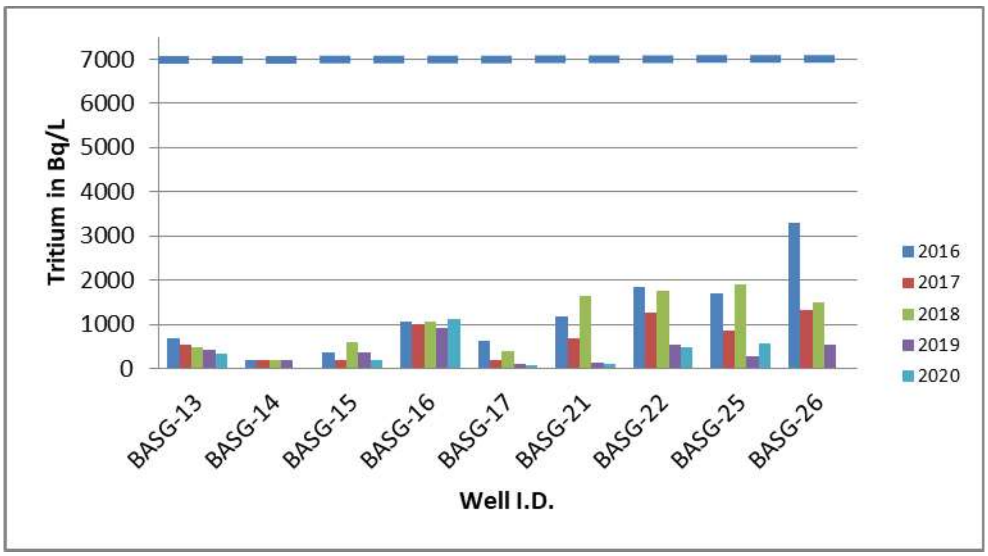

Figure 48: Bruce A Standby Generator Area Tritium Levels in Groundwater Wells compared to the Ontario Drinking Water Standard (dashed line)

Tritium levels shown above are below the ODWS [R-90] threshold of 7,000 Bq/L (shown as a dashed line).

All Bruce A results are well below the ODWS limit of 7000 Bq/L which is protective of human health. As shown by the spring and fall sampling of the multi-level wells, there is a seasonal variation and therefore in 2021 spring and fall sampling will occur at selected wells within the protected area, and continue at the Multi-Level locations, of both stations.

6.1.6.2 Bruce B

Three groups of wells were sampled in 2020 in the protected area of Bruce B. This included the multi-level wells (labeled BB), the Standby Generator Area wells (labeled BBSG) and the Transformer Area wells (labeled BBTR) as shown in Figure 49.

.

Figure 49: Sampling Locations of Bruce B Groundwater Wells

The Bruce B Multi-Level groundwater wells were sampled in the spring on April 24, 2020 and in the fall sampling on October 23, 2020. These wells are located between the northwest side of the powerhouse and Lake Huron (labeled BB1 to BB5 in Figure 49). Tritium values for wells and historical trends are shown in Table 34 and Figure 50 respectively.

Table 34: Semi-annual Multi-level Groundwater Well Tritium Results for Bruce B

	Spring 2020			Fall 2020		
	Result	±2δ	Lc	Result	±2δ	Lc
BB 1-1	12.7	3.20E+00	2.98E+00	9.7	2.96E+00	2.85E+00
BB 1-2	25.2	3.75E+00	2.98E+00	19.2	3.43E+00	2.85E+00
BB 1-3	679.0	1.47E+01	2.98E+00	657.0	1.45E+01	2.85E+00
BB 2-1	34.8	4.13E+00	2.98E+00	30.7	3.92E+00	2.85E+00
BB 2-2	1,040.0	1.81E+01	2.98E+00	1,050.0	1.83E+01	2.85E+00
BB 3-1	4.1	2.47E+00	2.98E+00	3.4	2.36E+00	2.85E+00
BB 3-2	101.0	6.11E+00	2.98E+00	116.0	6.49E+00	2.85E+00
BB 3-3	333.0	1.04E+01	2.98E+00	294.0	9.88E+00	2.85E+00
BB 4-1	26.7	3.81E+00	2.98E+00	28.9	3.84E+00	2.85E+00
BB 4-2	413.0	1.16E+01	2.98E+00	264.0	9.38E+00	2.85E+00
BB 4-3	1,760.0	2.34E+01	2.98E+00	1,410.0	2.12E+01	2.85E+00
BB 5-1	365.0	1.09E+01	2.98E+00	378.0	1.12E+01	2.85E+00
BB 5-2	404.0	1.14E+01	2.98E+00	349.0	1.07E+01	2.85E+00
BB 5-3	486.0	1.25E+01	2.98E+00	407.0	1.15E+01	2.85E+00

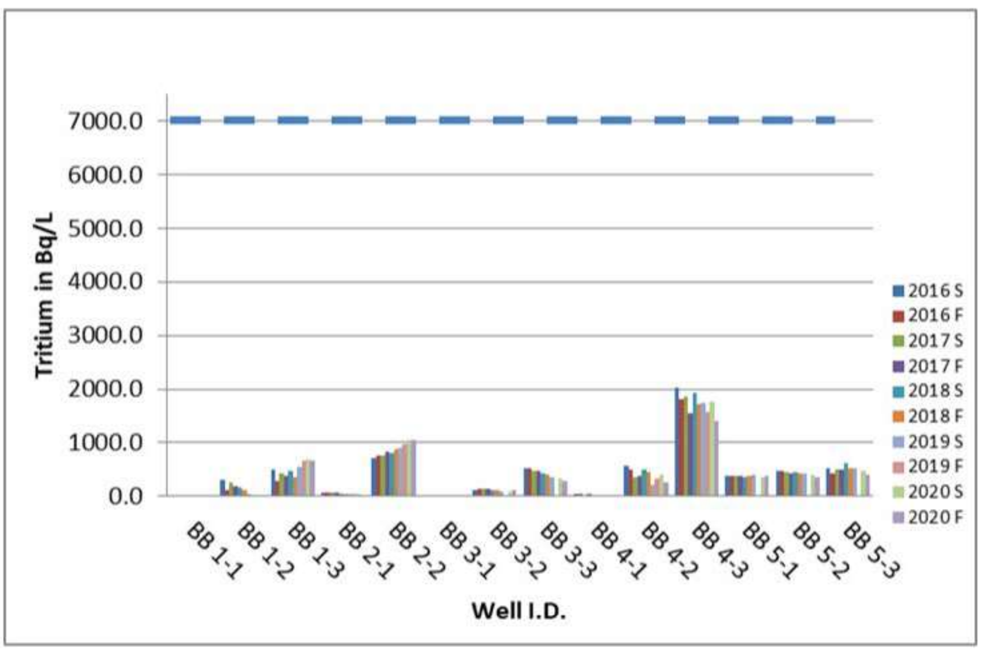

Figure 50: Multi-Level Groundwater Well Tritium Levels at Bruce B compared to the Ontario Drinking Water Standard (dashed line)

Similar to Bruce A, tritium levels in the multi-levels wells are well below ODWS thresholds (shown as a dashed line) with some evidence of seasonal variation. Tritium levels are slightly more elevated in the spring sampling event compared to the fall; however, this seasonal difference is less than that observed at Bruce A. The tritium level trends are very consistent over 5 years.

Bruce B Transformer Area wells were sampled on September 29, 2020. These wells are located across the construction south side of the powerhouse in the vicinity of the unit transformers (labeled BBTR in Figure 49). Tritium levels and historical trends are shown in Table 35 and Figure 51.

Table 35: Tritium Levels at Bruce B Transformer Area Groundwater Wells

	Fall 2020		
	Result	**±2δ**	**Lc**
BBTR-5-11	598	3.65E+01	9.50E+00
BBTR-5-12	238	2.45E+01	9.44E+00
BBTR-5-13	249	2.51E+01	9.50E+00
BBTR-5-14	384	3.00E+01	9.49E+00
BBTR-6-14	-	-	-
BBTR-6-15	-	-	-
BBTR-6-28	1,430	5.46E+01	9.46E+00
BBTR-6-30	1,890	6.26E+01	9.50E+00
BBTR-6-40	1,530	5.66E+01	9.51E+00
BBTR-6-44	-	-	-
BBTR-6-45	-	-	-
BBTR-6-46	-	-	-
BBTR-7-12	1,160	4.94E+01	9.44E+00
BBTR-8-12	416	3.09E+01	9.45E+00

Blank cells – not sampled due to insufficient water in well

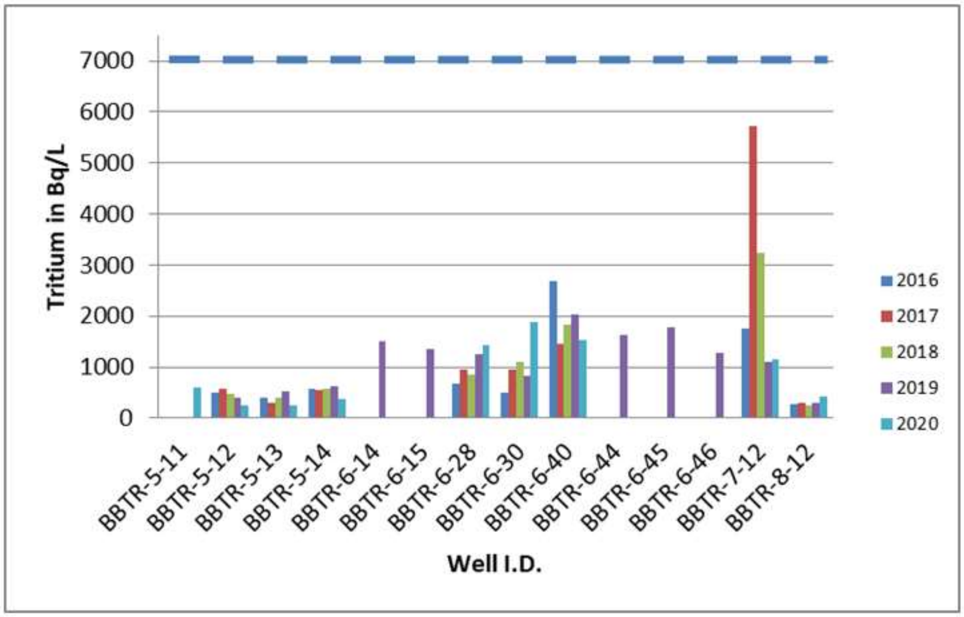

Figure 51: Tritium Levels at the Bruce B Transformer Area Compared against the Ontario Drinking Water Standard (dashed line)

Historical tritium results at the Bruce B Transformer Area show levels to be well below ODWS thresholds (shown as a dashed line). Increased tritium level noted in 2017 at BBTR 7-12 prompted action to continue sampling the following year. Levels decreased in 2018 and continued to drop in subsequent years.

Bruce B Standby Generator Area wells were sampled on September 30, 2020. These wells are located on the west side of the powerhouse (labeled BBSG in Figure 49).Tritium values for wells and historical trends are shown in Table 35 and Figure 52 respectively.

Table 36: Bruce B Standby Generator Area Tritium Levels in Groundwater Wells

	Fall 2020		
	Result	**±2δ**	**Lc**
BBSG-16	216	2.38E+01	1.00E+01
BBSG-18	150	2.10E+01	1.01E+01
BBSG-19	145	2.09E+01	1.02E+01
BBSG-20	-	-	-
BBSG-42	186	2.26E+01	1.01E+01
BBSG-43	192	2.31E+01	1.02E+01
BBSG-44	167	2.20E+01	1.02E+01
BBSG-45	200	2.34E+01	1.02E+01
BBSG-46	162	2.15E+01	1.01E+01

Blank cells – not sampled due to insufficient water in well

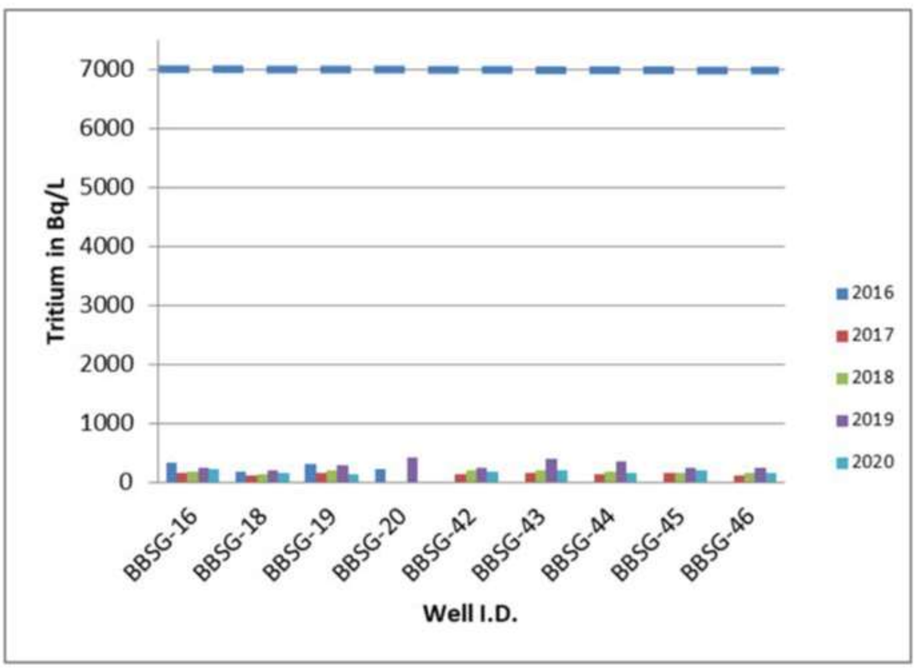

Figure 52: Tritium Levels at the Bruce B Standby Generator Area Compared against the Ontario Drinking Water Standard (dashed line)

As can be seen from the 5-year trend shown in Figure 52, the tritium levels in groundwater wells in the standby generator area is well below the ODWS level of 7000 Bq/L (shown as a dashed line).

6.1.6.3 Conclusion

Overall, spring and fall sampling was conducted in 2020 at the historically sampled wells at five locations behind each station. Fall sampling also occurred at an additional 15 locations around Bruce A and 17 locations around Bruce B. The results from 2020 confirm the following:

- There were no exceedances of the ODWS limit of 7000 Bq/L which is protective of human health;
- 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.

Future sampling will occur in the spring and fall at up to 20 locations around Bruce A and up to 22 locations around Bruce B.

6.1.7 Quality Assurance/Quality Control (QA/QC)

Note that groundwater QA/QC is in Section 6.2.2.5.

6.1.7.1 Meteorological Data Analysis

The meteorological data analysis documented in this report was conducted in accordance with the Kinectrics Quality Assurance program [R-91]. 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-92] CSA N286-12 [R-81].

6.1.7.2 Public Dose Calculations

The Public Dose calculations for 2020 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.

The 2020 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 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-93].

6.1.7.3 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 *2019 Results of Environmental Monitoring Programs* [R-94].

6.1.7.4 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.

6.1.7.5 Sample Availability

The Bruce Power Health Physics Lab collected and analyzed 964 analyte samples against a target of 1,002 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 2020, no occupancy as a result of COVID-19 travel restrictions impacted sample collection. Details of the sample availability for 2020 are presented in Table 37 below.

Table 37: 2020 Sample Availability Data

Sample Types	Collection Frequency	Bruce Power		
		Planned	Actual	% Complete
Atmospheric				
Air Effluents	Monthly (^3H)	120	119	99%
	Quarterly (^3H, ^{14}C)	156	156	100%
Environmental Gamma	Quarterly (GS)	64	64	100%
Precipitation*	Monthly (^3H, GB)	120	117	98%
Water				
Water Supply Plants	Weekly Composite (^3H)	96	96	100%
	Monthly Composite (GB)	24	24	100%
Resident Well & Lake Water*	Bi-Monthly (^3H, GB)	72	59	82%
	Semi-Annually (^3H, GB, GS)	74	60	81%

Sample Types	Collection Frequency	Bruce Power		
		Planned	Actual	% Complete
Local Streams*	Bi-Monthly (^{3}H)	36	35	97%
	Semi-Annually (GB)	8	8	100%
Site Ground Water	Semi-Annually (^{3}H)	52	52	100%
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	55	92%
Fruits & Vegetables	Annually (^{3}H, ^{14}C)	13	13	100%
Honey	Annually	2	2	100%
Eggs	Annually	2	1	50%
Grains	Annually (^{3}H, ^{14}C)	6	6	100%
	Quarterly (^{3}H)	4	4	100%
Animal Meat & Feed	Annually (^{3}H, ^{14}C, GS)	2	2	100%
Soil & Sand	Annually (GS)	6	6	100%
Overall Site Sample Availability		**1002**	**964**	**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).

6.1.7.6 Laboratory Analysis Summary

A total of 1,240 laboratory analyses were conducted in support of the Bruce Power REM program this year (2020). The analyses included tritium, gross beta, ^{14}C, ^{131}I, TLD gamma (under contract to OPG), gamma spectrometry and organically bound tritium (OBT). Table 38 provides a summary of the number of samples analyzed for each analysis method.

Table 38: 2020 Laboratory Analysis Summary

Laboratory Analysis	Number of Analyses
^{3}H	594
Gross Beta	185
^{14}C	215
^{131}I	52
TLD Gamma*	64
Gamma Spectrometry - ^{134}Cs, ^{137}Cs, ^{40}K, ^{60}Co	126
Organically Bound Tritium (OBT)	4
Total	**1240**

Note:*64 TLD Gamma Analysis Completed by OPG Whitby Laboratory

6.1.7.7 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 39 presents a summary of the Bruce Power REM QA/QC program.

Table 39: 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)			

6.1.7.8 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.

6.1.7.9 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

6.1.7.10 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.

6.1.7.11 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.

6.1.7.12 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 Appendix B: All results meet the acceptance criteria in SEC-DOS-00028, Radiological Analysis Proficiency Testing [R-95]. All results are acceptable.

6.1.8 Updates to Radiological Environmental Monitoring

The following changes were made in 2020:

- Improvements to both the off-site 10M and on-site 50M meteorological towers were made in order to improve data availability and enhance monitoring capabilities of local meteorological information.
- Loss of weekly milk samples from dairy farmer BDF13 in July. A replacement dairy farm (BDF16) was added to the program in the fall to start weekly sampling in January 2021.
- Addition of annual samples of beef (near and far) to the program through participation from Beefway in Kincardine. Sample results are not expected until 2021.

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 activitycentered, 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).

Bruce Power has been performing annual groundwater monitoring on the site since 2005 to evaluate the impact of operations on the environment. Groundwater monitoring was designed to include 14 subject locations around the site. These locations were determined to be of significant concern and in need of long-term monitoring based on earlier environmental site assessment (ESA) work that was undertaken by Ontario Hydro [R-96]. Many of these sites have had historical events or operations which caused or had the potential to cause groundwater contamination. Annual groundwater monitoring is in place to ensure that any existing contamination or on-going activities do not negatively impact the environment.

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-38]. 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.

Soil has a very 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-38]. Recent and historical randomized sampling of local soils to evaluate baseline COPC levels has demonstrated that no elevated risk exists that would justify the continuation of confirmatory baseline sampling [R-38] [R-49]. Moving forward, soil sampling will only occur in response to spills on a case-by-case basis to inform targeted clean-up strategies, remediation activities, and/or follow-up monitoring. There were no accidental releases in 2020 on Bruce Power managed lands that necessitated any soil monitoring or contamination assessment. Soil sampling in 2021 will focus on select areas previously identified as requiring monitoring as identified in the ERA.

6.2.1 Routine Lake Water Quality and Stream Water Quality Assessment – 2020

6.2.1.1 Selections of Locations

Lake Huron surface water quality samples were taken at five long-term monitoring locations near Bruce Power on October 25, 2020 (Figure 53). These locations were chosen because samples obtained from the Bruce A and Bruce B discharges (LWQ1 and LWQ2, respectively) sufficiently characterize the effluent from facility operations and the monitoring location within Baie du Doré (LWQ5) represents the water quality in this 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 40.

Additional lake water quality monitoring locations (LWQ1-LWQ11) were sampled in the spring, summer and fall of 2016 and 2017 (Figure 53). The data collected in this monitoring campaign were assessed in the last Environmental Risk Assessment, which verified 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-38] [R-49] . These data, along with the results of samples collected in 2018 and 2020 at LWQ1, LWQ2, LWQ5, LWQ7 and LWQ8 are presented in Table 40. This historical range of values is provided to give context to the 2020 results and will be discussed more fully in the next Environmental Risk Assessment in 2022.

Stream water quality samples were obtained from ‘Stream C’ on August 26, 2020 and November 11, 2020 and the results are presented in Table 41. 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) (Figure 53). Additional on-site surface water monitoring locations (SW3-SW6) will be sampled in the spring, summer, and fall of 2021 and these results will be presented in the 2021 EPR. Measurements at these locations will be contingent upon sufficient flow, which can be restrictive during some months when base-flow conditions are low.

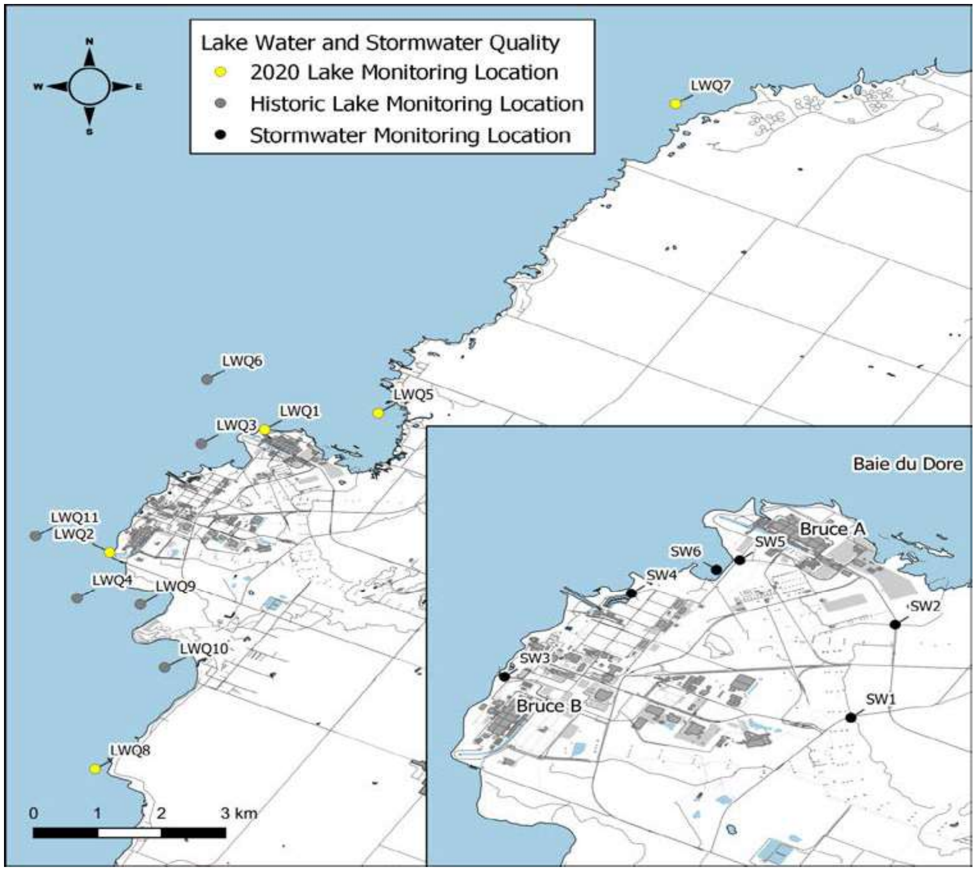

Figure 53: Long-term water quality monitoring locations sampled in Lake Huron (LWQ) in 2020 (yellow) and prior years (grey) and at on-site streams and storm water ditches (SW).

Table 40: The results of water quality samples taken Oct 25, 2020from 5 long-term monitoring locations in Lake Huron. The range and number of measurements taken between 2016 and 2020 are shown for context. Screening criteria chosen are the most conservative levels available and results that exceed the screening criteria are bolded and shaded yellow.

			Site ID	LWQ1	LWQ2	LWQ5	LWQ7	LWQ8	Historical Trend (2016-2020)	
			Location	Bruce A Discharge	Bruce B Discharge	Baie du Doré	North Reference Location	South Reference Location	Range (min-max)	Number of observations (and exceedances, if applicable)
Parameter	Unit of Measure	Screening Criteria	Detection Limit of 2020 samples							
Temperature	°C	n/a	n/a	20.2	19.5	12.8	10.7	10.7	1.8-28.6	75
pH	n/a	6.5-8.5 (i)	0.01	8.0	7.9	7.9	7.7	7.9	**6.5-8.8**	75 (6)
Total Alkalinity	mg/L of $CaCO_3$	n/a	1	82	81	84	83	82	78-100	93

			Site ID	LWQ1	LWQ2	LWQ5	LWQ7	LWQ8	Historical Trend (2016-2020)	
			Location	Bruce A Discharge	Bruce B Discharge	Baie du Doré	North Reference Location	South Reference Location	Range (min-max)	Number of observations (and exceedances, if applicable)
Parameter	**Unit of Measure**	**Screening Criteria**	**Detection Limit of 2020 samples**							
Inorganics										
Total Ammonia (NH_3-N)	µg/L	n/a	50	120	180	120	<50	<50	<50-910	93
Unionized ammonia (calculated, NH_3-N)	µg/L	15.6 (ii, iii)	n/a	4.2	5.2	2.3	n/a (ii)	n/a (ii)	**<0.3-304.6**	93 (13)
Nitrite (NO_2^--N)	µg/L	60 (iii)	10	<10	<10	<10	<10	<10	all non-detect	93
Nitrate (NO_3^--N)	mg/L	2.90 (iii)	0.10	0.25	0.25	0.26	0.25	0.25	0.20-0.80	93
Total Phosphorus	µg/L	10 (i)	20	**21**	<20	<20	<20	<20	**<4-28**	93 (3)
Sulphate (SO_4^{2-})	mg/L	n/a	1	16	16	16	16	16	13.0-16.0	93
Chloride	mg/L	n/a	1.0	8.7	8.3	8.8	8.8	8.9	6.0-8.9	93
Fluoride	µg/L	120 (iii)	100	<100	<100	<100	<100	<100	**<100-150**	93 (2)
Hydrazine	µg/L	2.6 (iv)	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2-17.3	80 (1)
Organics & Petroleum Hydrocarbons										
Morpholine	µg/L	4.0 (i)	n/a	n/a	n/a	n/a	n/a	n/a	**<4.0-5.0**	88 (2)
Benzene	µg/L	100.0 (i)	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2-6.0	93
Toluene	µg/L	0.8 (i)	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	**<0.2-12.0**	93 (4)
Ethylbenzene	µg/L	80.0 (i)	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2-2.5	93
o-Xylene	µg/L	40.0 (i)	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2-4.5	93
p+m-Xylene	µg/L	2.0 (i)	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	**<0.4-9.2**	93 (1)
Total Xylenes	µg/L	90.0 (v)	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4-14.0	93
F1 (C6-C10)	µg/L	n/a	25	<25	<25	<25	<25	<25	<25-40	93
F1 (C6-C10) - BTEX	µg/L	n/a	25	<25	<25	<25	<25	<25	all non-detect (vi)	93
F2 (C10-C16)	µg/L	n/a	100	<100	<100	<100	<100	<100		93
F3 (C16-C34)	µg/L	n/a	200	<200	<200	<200	<200	<200		93
F4 (C34-C50)	µg/L	n/a	200	<200	<200	<200	<200	<200		93
Metals										
Aluminium (total)	µg/L	75 (i)	5	12	13	30	14	15	<5-62	93
Arsenic (total)	µg/L	5.0 (i)	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	all non-detect	93
Boron (total)	µg/L	200 (i)	10	16	16	15	15	14	12-22	93

			Site ID	LWQ1	LWQ2	LWQ5	LWQ7	LWQ8	Historical Trend (2016-2020)	
			Location	Bruce A Discharge	Bruce B Discharge	Baie du Doré	North Reference Location	South Reference Location	Range (min-max)	Number of observations (and exceedances, if applicable)
Parameter	**Unit of Measure**	**Screening Criteria**	**Detection Limit of 2020 samples**							
Cadmium (total)	µg/L	0.10 (i)	0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09-0.10	93
Chromium (VI)	µg/L	1.00 (i)	0.50	0.55	0.58	<0.50	0.54	<0.50	<0.05-0.60	93
Chromium (total)	µg/L	n/a	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	all non-detect	93
Copper (total)	µg/L	5.00 (i)	0.90	<0.90	<0.90	<0.90	1.80	0.96	<0.9-2.8	93
Iron (total)	µg/L	300 (i)	100	<100	<100	<100	<100	<100	all non-detect	93
Lead (total)	µg/L	5.0 (i)	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5-0.7	93
Mercury (total)	µg/L	0.026 (i)	0.100	<0.100	<0.100	<0.100	<0.100	<0.100	all non-detect	93
Nickel (total)	µg/L	25.0 (i)	1.0	<1.0	1.5	<1.0	1.0	<1.0	<1.0-6.8	93
Zinc (total)	µg/L	20.0 (i)	5.0	<5.0	<5.0	<5.0	5.9	<5.0	**<5.0-27.0**	93 (1)

(i) Ontario Ministry of Environment, Conservation and Parks Provincial Water Quality Objectives (PWQO)

(ii) Unionized Ammonia is calculated from Total Ammonia measurements using field temperature and pH measurements, where the fraction (*ƒ*) of ammonia is equal to 1/(10^(pKa – pH) + 1), and the pKa of ammonia/ammonium is equal to 0.09018 + 2729.92/(temp. + 273.16). When the Total Ammonia value is less than the reportable detection limit, the unionized ammonia value is listed as not applicable (n/a) because it is not possible to exceed the 15.6 µg/L screening level for ammonia under the observed ranges of pH and temperature.

(iii) Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the long-term protection of freshwater aquatic life

(iv) Federal Environmental Quality Guideline (FEQG)

(v) Health Canada guidelines for Canadian Drinking Water Quality (CDWQ)

(vi) All samples reached baseline at C50

Table 41: The results of stream water quality samples taken Aug 26, 2020 and Nov 11, 2020 from 2 long-term monitoring locations on Stream C, a small stream that traverses through Bruce Power lands and discharging to Baie du Doré, Lake Huron. The range and number of measurements taken between 2016 and 2020 are shown for context. Screening criteria chosen are the most conservative levels available and results that exceed the screening criteria are bolded and shaded yellow.

			Date	Aug 26, 2020		Nov 11, 200		Historical Trend (2016-2020)	
			Site ID	SW1	SW2	SW1	SW2		
			Location	Stream C Upstream	Stream C Downstream	Stream C Upstream	Stream C Downstream	Range (min-max)	Number of observations (and exceedances, if applicable)
Parameter	Unit of Measure	Screening Criteria	Detection Limit of 2020 samples						
Temperature	°C	n/a	n/a	18.3	20.3	12.1	11.5	-0.2 to +21.7	19
pH	n/a	6.5-8.5 (i)	0.01	7.9	8.1	7.9	7.9	6.7-8.1	19
Dissolved Oxygen	mg/L	n/a	n/a	6.1	8.2	6.4	9.0	4.4-15.5	19
Specific Conductivity	µS/cm	n/a	n/a	583	579	554	552	383-610	16
Total Alkalinity	mg/L of $CaCO_3$	n/a	1	284	231	254	257	231-300	22
Inorganics									
Total Ammonia (NH_3-N)	µg/L	n/a	100	<100	<100	<100	<100	<50-590	22
Unionized ammonia, (calculated, NH_3-N)	µg/L	15.6 (ii, iii)	n/a	n/a	n/a	n/a	n/a	**<0.8-21.2**	22 (1)
Nitrite (NO_2^--N)	µg/L	60 (iii)	30	<30	<30	<30	<30	all non-detect	22
Nitrate (NO_3^--N)	mg/L	2.90 (iii)	0.10	<0.10	<0.10	0.14	<0.10	<0.03-0.60	22
Total Phosphorus	µg/L	10 (i)	30	<30	<30	<30	<30	**<2-26**	22 (17)
Fluoride	µg/L	120 (iii)	100	**370**	**460**	**340**	**320**	**280-490**	22 (22)
Petroleum Hydrocarbons									
Benzene	µg/L	100.0 (i)	0.5	<0.5	<0.5	<0.5	<0.5	<0.2-<0.5	22
Toluene	µg/L	0.8 (i)	0.5	<0.5	<0.5	<0.5	<0.5	<0.2-<0.5	22
Ethylbenzene	µg/L	80.0 (i)	0.5	<0.5	<0.5	<0.5	<0.5	<0.2-<0.5	22
o-Xylene	µg/L	40.0 (i)	0.5	<0.5	<0.5	<0.5	<0.5	<0.2-<0.5	22
p+m-Xylene	µg/L	2.0 (i)	0.5	<0.5	<0.5	<0.5	<0.5	<0.4-<0.5	22
Total Xylenes	µg/L	90.0 (iv)	0.5	<0.5	<0.5	<0.5	<0.5	<0.4-<0.5	22
F1 (C6-C10)	µg/L	n/a	25	<25	<25	<25	<25	all non-detect (v)	22
F2 (C10-C16)	µg/L	n/a	100	<100	<100	<100	<100		22
F3 (C16-C34)	µg/L	n/a	200	<200	<200	<200	<200		22
F4 (C34-C50)	µg/L	n/a	200	<200	<200	<200	<200		22

			Date	Aug 26, 2020		Nov 11, 200		Historical Trend (2016-2020)	
			Site ID	SW1	SW2	SW1	SW2		
			Location	Stream C Upstream	Stream C Downstream	Stream C Upstream	Stream C Downstream	Range (min-max)	Number of observations (and exceedances, if applicable)
Parameter	**Unit of Measure**	**Screening Criteria**	**Detection Limit of 2020 samples**						
Metals									
Aluminium (total)	µg/L	75.0 (i)	1.0	26.0	16.0	65.0	40.0	0.6-96.0	
Antimony (total)	µg/L	6.0 (iv)	n/a	n/a	n/a	n/a	n/a	all less than <0.5	18
Arsenic (total)	µg/L	5.0 (i)	n/a	n/a	n/a	n/a	n/a	<1.0-1.4	18
Barium (total)	µg/L	2,000 (iv)	0.02	19.1	19.8	19.0	17.1	11.0-24.0	22
Boron (total)	µg/L	200 (i)	n/a	n/a	n/a	n/a	n/a	<10-24	18
Cadmium (total)	µg/L	0.100 (i)	0.003	0.003	<0.003	0.008	0.012	**<0.003-0.400**	22 (1)
Chromium (VI)	µg/L	1.0 (i)	0.2	0.3	0.3	0.4	0.5	0.3-0.5	22
Chromium (total)	µg/L	n/a	0.08	11.50	0.23	0.16	0.13	0.10-11.50	22
Copper (total)	µg/L	5.0 (i)	0.2	0.4	0.7	0.8	1.1	**0.4-8.9**	22 (1)
Iron (total)	µg/L	300 (i)	7	**904**	170	**419**	187	**110-904**	22 (10)
Lead (total)	µg/L	5.00 (i)	0.01	<0.01	<0.01	0.06	0.06	<0.01-0.10	22
Mercury (total)	µg/L	0.026 (i)	0.01	<0.01	< 0.01	<0.01	< 0.01	all non-detect	22
Molybdenum (total)	µg/L	40.00 (i)	0.04	0.15	0.27	0.26	0.33	0.20-0.30	22
Nickel (total)	µg/L	25.0 (i)	0.1	0.3	0.5	0.3	0.4	0.3-2.1	22
Selenium (total)	µg/L	1.0	n/a	n/a	n/a	n/a	n/a	all less than <2.0	18
Uranium (total)	µg/L	5.000 (i)	0.002	0.210	0.216	0.462	0.560	0.100-0.800	22
Vanadium (total)	µg/L	6.00 (i)	0.01	0.28	0.23	0.33	0.22	0.20-0.30	22
Zinc (total)	µg/L	20 (i)	2	2	<2	6	4	<2-10	22

(i) Ontario Ministry of Environment, Conservation and Parks Provincial Water Quality Objectives (PWQO)

(ii) Unionized Ammonia is calculated from Total Ammonia measurements using field temperature and pH measurements, where the fraction (f) of ammonia is equal to 1/(10^(pKa – pH) + 1), and the pKa of ammonia/ammonium is equal to 0.09018 + 2729.92/(temp. + 273.16). When the Total Ammonia value is less than the reportable detection limit, the unionized ammonia value is listed as not applicable (n/a) because it is not possible to exceed the 15.6 µg/L screening level for ammonia under the observed ranges of pH and temperature.

(iii) Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the long-term protection of freshwater aquatic life

(iv) Health Canada guidelines for Canadian Drinking Water Quality (CDWQ)

(v) All samples reached baseline at C50

6.2.1.2 Overview of Results

Lake and stream water quality results obtained in 2020 continue to demonstrate that effluent and emissions from 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. As per the N288.4 and N288.6 framework, an effective environmental monitoring program is in place and water quality results are screened against established criteria (Table 40 and Table 41), which set limits for environmental protection. Where multiple criteria exist, the most conservative values were chosen in order to flag potential issues that require follow-up assessment and/or sampling.

Results of Lake Huron water samples collected in 2020 that exceeded the screening criteria are bolded and shaded yellow in Table 40. Of all the parameters measured in the lake in 2020, 23 have screening criteria. There was 1 exceedance at 1 lake location in 2020 (total phosphorus – LWQ1), and 114 measurements were below the screening criteria (many were below the limit of analytical detection). This demonstrates that there continues to be excellent lake water quality in and around the Bruce Power site as 99.1% of the measurements were below the most conservative water quality screening thresholds available.

Results of stream water samples collected in 2020 that exceeded the screening criteria are bolded and shaded yellow in Table 41. Of all the parameters measured in Stream C in 2020, 23 have screening criteria. Six of the 92 stream measurements that have screening criteria were above the threshold, and the remaining 86 measurements were below the criteria (many were below the limit of analytical detection). This demonstrates that there continues to be excellent water quality in Stream C as 93.5% of the measurements in 2020 were below the most stringent water quality screening thresholds available.

Where an exceedance of the screening criteria occurred in one or more of the historical samples collected from 2016 onward, these were also bolded and shaded yellow in Table 40 and Table 41, and the number of exceedances was noted. These historical trends and exceedances will not be discussed here; rather they will be evaluated using approaches identified in N288.6 and presented in the 2022 Environmental Risk Assessment [R-38] [R-49].

6.2.1.3 Total Phosphorus

Phosphorus loading from Great Lakes watersheds to their receiving water bodies is a very active topic of research as researchers, policy makers, and agricultural stakeholders across Canada and USA work to better understand phosphorus loading from the landscape, its effects on the environment and its control on nuisance algae blooms and degraded water quality [R-97]. Phosphorus levels measured since 2016 in Lake Huron near Bruce Power have not exceeded 28 µg/L (Table 40), and levels observed in Stream C have not exceeded 30 µg/L (Table 41). The range of TP values measured on and near the Bruce Power site is not concerning and is typical of local stream chemistry measured by the MECP. The MECP's Provincial Stream Water Quality Monitoring Network (PWQMN) has monitored TP concentrations across Ontario for decades, and local streams such as Mill Creek and Pine

River commonly have TP concentrations >100 µg/L. Much higher concentrations are observed in streams across the Province where agriculture activity is more intense.

Phosphorus use/addition is not part of Bruce Power's operations at this time. There is an on-site sewage treatment plant and its effluent contributes nutrient loading to Lake Huron in accordance with the environmental compliance approval that permits its operation (see Section 5.2.3).

6.2.1.4 Fluoride and Iron in Stream C

The concentration of fluoride in SW1 and SW2 exceeded the screening criteria level of 120 µg/L on both sampling dates at Stream C (range of values: 320-460 µg/L). This threshold is set by the Canadian Council of Ministers of the Environment (CCME) and is a guideline for the long-term protection of aquatic life in freshwater. While it may be true that this low level of fluoride is protective of aquatic life, many streams in this region of Ontario will exceed this threshold because fluoride is naturally occurring (of geologic origin) and it is elevated in local groundwater near Bruce Power. Nearby in Tiverton, ON the municipal drinking water sources are local wells that routinely exceed the Guidelines for Canadian Drinking Water Quality level of 1,500 µg/L [R-98]. Values in local wells are frequently >2,000 µg/L [R-99] and the levels observed in Stream C reflect this groundwater contribution to the surface water.

The concentration of iron in SW1 (Stream C, upstream boundary) exceeded the screening criteria of 300 µg/L on both sampling dates. Similar to fluoride, iron (Fe) is often found in groundwater discharging to streams, especially when the groundwater is low in oxygen (suboxic or anoxic) [R-100]. These low-oxygen conditions allow for the reduction of ferrous iron minerals (Fe^{3+}) to more soluble ferric iron (Fe^{2+}), and consequently dissolved iron concentrations will be elevated in downstream locations. SW1 represents the upstream boundary, prior to any potential influence from site activities, so this exceedance is attributed to natural sources.

6.2.1.5 Morpholine Samples

Morpholine results from Lake Huron were not available in 2020 due to laboratory error. Samples bottles were collected from all 5 locations on Oct 25, 2020 and shipped to the commercial laboratory, but they were either not received or processed by the lab (reason is undetermined). Morpholine effluent from Bruce Power poses little-to-no environmental risk because discharges are strictly regulated under compliance approvals and the appropriate operational controls are in place (see section 5.2.3). Further, all but 2 of the 88 samples collected between 2016 and 2018 were below the reportable detection limit and the Provincial Water Quality Objective screening criteria (4.0 µg/L).

6.2.1.6 Analytical Limits of Detection

The analytical limits of detection for total mercury (2020 lake samples only) and total phosphorus (2020 lake and stream samples) were greater than the screening threshold. In the future, additional consideration and oversight will be taken to ensure that all analyses requested from the commercial laboratory are of sufficient sensitivity to ensure the limit of detection is below the lowest screening criteria available.

All lake samples taken in 2020 were below the analytical limit of detection of 100 parts per trillion for mercury. This detection limit was only slightly higher than the screening threshold of 26 parts per trillion. This indicates that mercury is either absent in the lake water or present at ultra-low, trace concentrations.

The most conservative screening level for total phosphorus (TP) in an oligotrophic lake such as Lake Huron is 10 µg/L. This objective sets a high level of protection against aesthetic deterioration due to excessive algal growth. This Provincial Water Quality Objective is a general guideline, but “current scientific evidence is insufficient to develop a firm objective at this time” (Ontario PWQO, Appendix A, [R-101]). Analytical methods to determine TP levels below ~20-30 µg/L with sufficient sensitivity are not commonly available in commercial laboratories. Thus, detection of TP at the most conservative threshold of 10 µg/L is only available at specialized academic and government research labs which can usually measure nutrient concentrations at very low levels.

6.2.1.7 Summary of Next Steps

Bruce Power has a strong water quality monitoring program that continues to verify that effluent and emissions from 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. This conclusion is supported by independent monitoring conducted by the CNSC, who measured concentrations of cobalt, copper, selenium, strontium, and zinc in 10 Lake Huron water samples in 2019 [R-29]. None of the measurements exceeded the guideline/reference level, including the three locations closest to Bruce Power in the vicinity of Baie du Dore and Loscombe Bank.

Very few of the water quality measurements taken by Bruce Power in 2020 exceeded the conservative criteria used to screen the results. None of the exceedances are attributed to Bruce Power operations because the main sources of these COPCs are natural (geologic origin) or from upstream sources in the watershed.

Sampling for COPCs in 2021 will continue in the lake at the same locations as 2020 and at on-site surface water monitoring locations. Additional COPCs (antimony, arsenic, boron, and selenium) will be measured in Stream C in 2021. These parameters were sampled historically and none of the results were above the screening level (Table 41) and this finding will be verified again in 2021.

6.2.2 Groundwater

Groundwater monitoring and sampling at Bruce Power was completed between September 29 and October 2, 2020. 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 2020, groundwater level monitoring occurred across 16 sites at 113 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 2020 were:

- Bruce A Storage Compound
- Bunker C Oil Aboveground Storage Tanks
- Bunker C Oil Acid Wash Pond
- Former Sewage Lagoon
- Fire Training Facility
- Former Construction Landfill
- 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 Maintenance Facility

Table 42 (shown below) 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 2020 results, all groundwater monitoring sites sampled are within normal, as expected trends. Based on the groundwater monitoring program's management system for exceedances of evaluation criteria, these results prompt continued monitoring in 2021.

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 2020 can be attributed to known historical events or activities and are grouped into a small number of parameter groups. Site locations (in Section 6.1.6) are shown in for Bruce A in Figure 45 , for Bruce B in Figure 49 and in Figure below for the Former Bruce Heavy Water Plant.

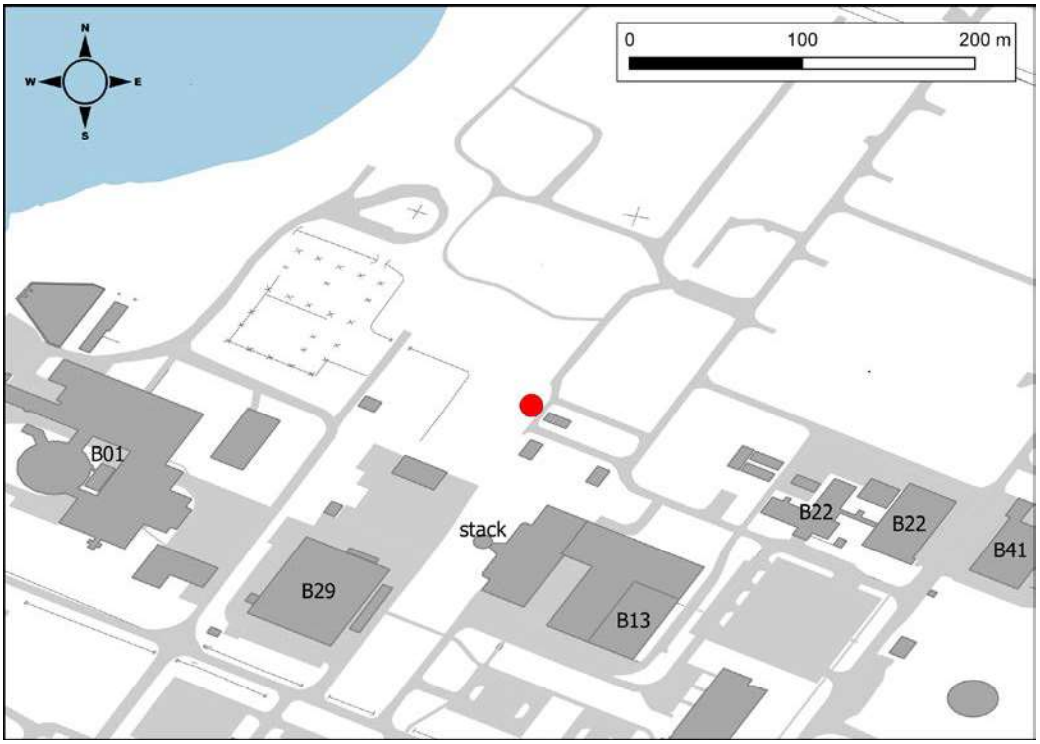

Figure 54: Sampling Location on the Former Bruce Heavy Water Plant

Table 42: Summary of Conventional Groundwater Exceedances for 2020 and 5 Year Trend

Site	Well ID	Parameter	Unit of Measure	Criteria	Detection Limit	Result	Historical Trend (2016 – 2020)	
							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	230	<100-1,820	5 (3)
	BASG-22	Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (ii)	100	600	<100 - 600	4 (2)
Bruce B Standby Generators (south)	BBSG-46	Polycyclic aromatic hydrocarbons - Benzo(a)pyrene	ug/L	0.01 (ii)	0.01	0.019	<0.01 – 0.019	3 (1)
Bruce A Transformer Area	BATR-1-13	Metals – Sodium	ug/L	490,000 (ii)	500	506,000	148,000 – 506,000	4 (1)
	BATR-1-14A	Metals – Uranium	ug/L	20 (ii)	0.10	20.7	18.2 – 21	4 (3)
	BATR-4-10	Metals - Chromium	ug/L	50 (ii)	0.5	67.4	1.2 – 67.4	2 (1)
		Polycyclic aromatic hydrocarbons - Benzo(a)pyrene	ug/L	0.01 (ii), (iii)	0.01	0.056	0.011 – 0.056	4 (4)
Bruce B Transformer Area	BBTR-5-11	Petroleum hydrocarbons F2 (C10-C16 less Naphthalene)	ug/L	150 (ii)	100	600	600 – 1,710	2 (2)
		Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (ii)	100	600	600 – 1,710	2 (2)
		Petroleum hydrocarbons F3 (C16-C34 less PAHs)	ug/L	500 (ii)	250	11,900	11,900 – 25,600	2 (2)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (ii)	250	11,900	11,900 – 25,600	2 (2)
	BBTR-5-14	Metals – Uranium	ug/L	20 (ii)	0.10	22.3	22.3 – 31.6	4 (4)
	BBTR-6-30	Polycyclic aromatic hydrocarbons - Benzo(a)pyrene	ug/L	0.01 (ii)	0.01	0.016	<0.01 – 0.048	4 (3)
	BBTR-6-40	Nutrients – Chloride	mg/L	790 (ii)	5.0	959	549 - 959	3 (2)
		Metals – Selenium	ug/L	10 (ii)	0.50	33.0	<0.50 - 33	3 (1)
		Metals - Sodium	ug/L	490,000 (ii)	500	630,000	396,000 – 630,000	3 (2)
Former Bruce Heavy Water Plant	MW-1-07	Petroleum hydrocarbons F2 (C10-C16 less Naphthalene)	ug/L	150 (ii)	100	2,530	1,550 – 2,530 (iii)	3 (3)
		Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (ii)	100	2,530	1,550 – 2,530 (iii)	3 (3)
		Petroleum hydrocarbons F3 (C16-C34 less PAHs)	ug/L	500 (ii)	250	266,000	238,000 – 266,000 (iii)	3 (3)
		Petroleum	ug/L	500 (ii)	250	266,000	238,000 –	3 (3)

Site	Well ID	Parameter	Unit of Measure	Criteria	Detection Limit	Result	Historical Trend (2016 – 2020)	
							Range (min-max)	Number of observations (and exceedances if applicable)
		hydrocarbons F3 (C16-C34)					266,000 (iii)	
		Petroleum hydrocarbons F4 (C34-C50)	ug/L	500 (ii)	250	17,900	17,900 – 35,400 (iii)	3 (3)
		Polycyclic aromatic hydrocarbons - Benzo(a)pyrene	ug/L	0.01 (ii)	0.30	***<0.24***	***<1.1 - <0.24***	***2 (2)***
		Polycyclic aromatic hydrocarbons - Benzo(b)fluoranthene	ug/L	0.1 (ii)	0.16	***<0.22***	***<0.22 - <0.33***	***2 (2)***
		Polycyclic aromatic hydrocarbons - Benzo(k)fluoranthene	ug/L	0.1 (ii)	0.19	***<0.19***	***<0.19 - <0.31***	***2 (2)***
		Chrysene	ug/L	0.1 (ii)	0.12	***<0.11***	<0.065 - ***<0.11***	***2 (1)***
	MW-2-07	Petroleum hydrocarbons F2 (C10-C16 less Naphthalene)	ug/L	150 (ii)	100	1,760	790 – 1,760 (iii)	3 (3)
		Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (ii)	100	1,760	790 – 1,760 (iii)	3 (3)
		Petroleum hydrocarbons F3 (C16-C34 less PAHs)	ug/L	500 (ii)	250	175,000	82,000 – 175,000 (iii)	3 (3)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (ii)	250	175,000	82,000 – 175,000 (iii)	3 (3)
		Petroleum hydrocarbons F4 (C34-C50)	ug/L	500 (ii)	250	12,200	11,300 – 12,200 (iii)	3 (3)
		Polycyclic aromatic hydrocarbons - Benzo(a)pyrene	ug/L	0.01 (ii)	0.27	***<0.27***	***<0.27 - <0.33***	***2 (2)***
		Polycyclic aromatic hydrocarbons - Benzo(b)fluoranthene	ug/L	0.1 (ii)	0.085	***<0.25***	<0.085 - ***<0.25***	***2 (1)***
		Polycyclic aromatic hydrocarbons - Benzo(k)fluoranthene	ug/L	0.1 (ii)	0.24	***<0.24***	<0.06 - ***<0.24***	***2 (1)***
	MW-4-07	Metals - Cobalt	ug/L	3.8	0.10	43.6	8.74 – 43.6	3 (3)
		Petroleum hydrocarbons F3 (C16-C34 less PAHs)	ug/L	500 (ii)	250	1,560	340 – 1,560	3 (1)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (ii)	250	1,560	340 – 1,560	3 (1)
	MW-4-B	Petroleum hydrocarbons F2	ug/L	150 (ii)	100	35,700	10,800 – 35,700	3 (3)

Site	Well ID	Parameter	Unit of Measure	Criteria	Detection Limit	Result	Historical Trend (2016 – 2020)	
							Range (min-max)	Number of observations (and exceedances if applicable)
		(C10-C16 less Naphthalene)						
		Petroleum hydrocarbons F2 (C10-C16)	ug/L	150 (ii)	100	35,700	10,800 – 35,700	2 (2)
		Petroleum hydrocarbons F3 (C16-C34 less PAHs)	ug/L	500 (ii)	250	153,000	47,700 – 153,000	3 (3)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (ii)	250	153,000	47,700 – 153,000	2 (2)
		Petroleum hydrocarbons F4 (C34-C50)	ug/L	500 (ii)	250	11,900	4,930 – 11,900	3 (3)
		Polycyclic aromatic hydrocarbons - Benzo(a)pyrene	ug/L	0.01 (ii)	0.08	0.573	0.177 – 0.573	2 (2)
		Polycyclic aromatic hydrocarbons - Benzo(b)fluoranthene	ug/L	0.1 (ii)	0.08	0.716	***<0.35*** – 0.716	***2 (2)***
		Polycyclic aromatic hydrocarbons - Benzo(g,h,i)perylene	ug/L	0.2 (ii)	0.08	0.413	0.166 – 0.413	2 (1)
		Polycyclic aromatic hydrocarbons - Benzo(k)fluoranthene	ug/L	0.1 (ii)	0.08	0.320	***<0.18*** – 0.320	***2 (2)***
		Chrysene	ug/L	0.1 (ii)	0.08	0.345	0.12 – 0.345	2 (2)
		Fluoranthene	ug/L	0.41 (ii)	0.08	0.884	0.368 – 0.884	2 (1)
		Indeno(1,2,3-Cd)pyrene	ug/L	0.2 (ii)	0.08	0.480	0.221 – 0.480	2 (2)
	MW-5-07	Petroleum hydrocarbons F3 (C16-C34 less PAHs)	ug/L	500 (ii)	250	740	330 – 1,050	3 (2)
		Petroleum hydrocarbons F3 (C16-C34)	ug/L	500 (ii)	250	740	330 – 740	2 (1)

(i)Table 2 – Full Depth Generic Site Condition Standards in a Potable Groundwater Condition
(ii)Table 8 – Generic Site Condition Standards for Use Within 30m of a Water Body in a Potable Groundwater Condition
(iii)Free product identified in 2018 – product removed and no sample taken
Bold/Italic - Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.

6.2.2.1 Petroleum Hydrocarbons (PHC) and Polycyclic Aromatic Hydrocarbons (PAH)

PHC and PAH exceedances are observed at areas where there have historically been fueling activities, combustion operations and large inventories of fuel oils maintained. Events have occurred which has caused PHC and PAH 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. 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 2020. Free product represents a source of contamination to groundwater. The free product was removed and disposed of as hazardous waste.

PAH contamination can also be related to fuel inventories and activities related to fuel oil. Minor exceedances have been observed at the Bruce B Standby Generator Area, the Transformer Areas at Bruce A and Bruce B as well as the Former Oil Storage Area located within the Former Bruce Heavy Water Plant.

6.2.2.2 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 selenium and uranium exceedances observed in 2020. These exceedances are minor in nature and are isolated to individual wells (not observed in multiple wells at a specific site). Chromium in groundwater may be naturally occurring or as a result of chemical processes depending on the valence state of chromium detected. Chromium detected in 2020 is total chromium which may represent both trivalent and hexavalent chromium, and therefore it is difficult to understand the mechanism for its presence. Chromium was observed in one well in the Bruce A Transformer Area where it was detected slightly above the Table 8 Site Condition Standard and is not widespread. Cobalt observations have been made in the last three sampling campaigns (2018-2020) at the former oil storage area within the Former Bruce Heavy Water Plant. Cobalt was not detected in a 2016 investigation of this area. This exceedance has been isolated to one well and is not widespread or migrating. The mechanism for its presence is not fully understood. Monitoring will continue to determine if further investigation is required. Sodium was observed at both the Bruce A and Bruce B Transformer Areas. These areas are adjacent to the main roadway running in front of the Bruce A and Bruce B Powerhouses respectively. Winter road maintenance and road salt application explains the sodium exceedances in these areas.

Metals exceedances noted in 2020 are minor in nature and are not widespread. These exceedances may be due to be either due to natural processes or due to previous site activities (historical) with the exception of sodium which is due to active winter maintenance. Based on levels seen in 2020, these exceedances are not a cause for concern and will continue to be monitored.

6.2.2.3 Nutrients

A chloride exceedance was observed in the Bruce B Transformer Area. This is attributed to winter road maintenance activities with the application of road salt. This exceedance was minor in nature, was isolated to one monitoring well and is not a cause for concern. Monitoring will continue in 2021.

6.2.2.4 Summary of Next Steps

In 2021, Bruce Power will continue to monitor groundwater at select locations based on on-going 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.

6.2.2.5 Quality Control

The 2020 groundwater sampling campaign consisted of 43 samples, five field duplicate samples, five trip blank samples, and five field blank 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.

6.2.3 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-102]. 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.

6.2.3.1 Impingement and Entrainment – 2020

The total loss of fish due to impingement and entrainment at Bruce A and Bruce B Generating Stations in 2020 was 2,472.5 kg (Table 43) expressed as a Habitat Productivity Index (HPI) metric [R-103] [R-104]). This was consistent with prior year losses (Figure 55), and well below the maximum loss permitted in Bruce Power’s *Fisheries Act* Authorization (6,600 kg/yr). None of the fish impinged in 2020 were listed as Threatened or Endangered on Schedule 1 of the *Species At Risk Act.*

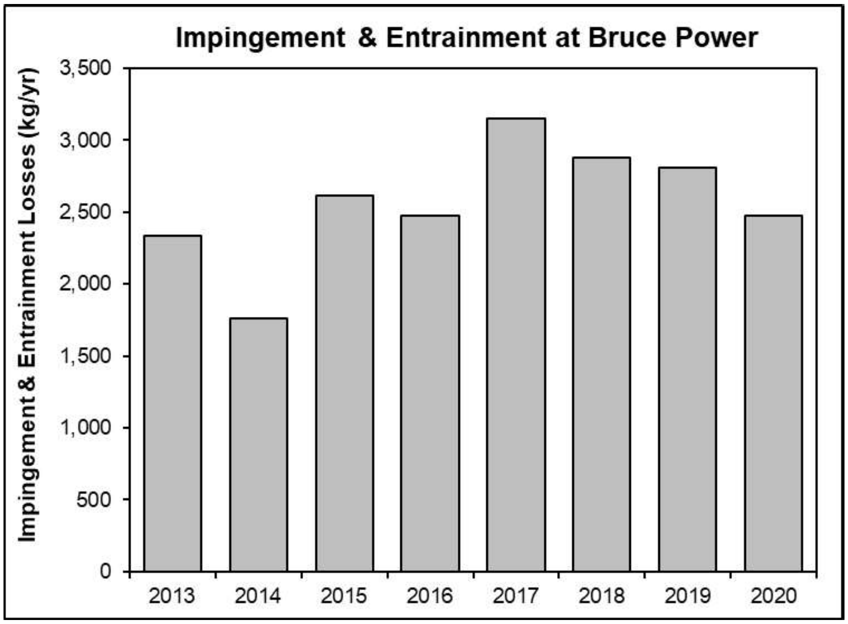

Figure 55: Total impingement and entrainment losses at Bruce Power (2013-2020) ,calculated using the HPI metric [R-103] [R-104]. Impingement was measured in all years. Entrainment was measured in 2013-2014 and estimated in 2015-2020 using a conservative approach.

Table 43: Impingement and entrainment fish losses at Bruce A and Bruce B in 2020.

Species	2020 Impingement		2013/2014 Entrainment[1]		Total
	Count (#)	Nominal Weight (g)	Count (# age-1 equivalents)	Age-1 Weight (g)	2020 Productivity Loss (HPI, kg yr^{-1})
Alewife	611	6,643	6	24	7.7
Bloater	-	-	14,124	790,944	510.4
Brown Trout	12	6,652	-	-	1.9
Bullhead	1	334	-	-	0.1
Burbot	234	172,662	9,089	78,165	209.2
Carp	13	10,475	-	-	2.7
Channel Catfish	24	28,729	-	-	6.3
Chinook Salmon	22	28,844	2,208	266,285	140.9
Cisco	-	-	17,545	538,632	428.9
Coho Salmon	28	49,654	-	-	9.6
Cyprinid	-	-	431	259	0.8
Deepwater Sculpin	-	-	2,610	3,654	8.6
Freshwater Drum	4	7,261	-	-	1.4
Gizzard Shad	1,264	342,272	-	-	127.2
Lake Trout	133	154,093	-	-	34.4
Lake Whitefish	42	57,766	8,547	639,316	395
Pike	3	11,641	-	-	1.7
Rainbow Smelt	210	2,754	16,898	152,082	189.1
Rainbow Trout	58	44,038	-	-	11.4
Rock Bass	1	305	-	-	0.1
Round Goby	3,632	26,890	2,529	2,529	44.9
Round Whitefish	1	1,698	-	-	0
Salmonid	-	-	427	8,028	7.6
Smallmouth Bass	6	4,448	-	-	1.2
Spottail Shiner	142	16,251	-	-	8.2
Suckers	1,252	349,516	5,089	26,972	238
Walleye	50	46,016	75	8,730	17.2
White Bass	101	4,633	-	-	3.2
White Perch	22	460	10,512	81,994	105.9
Yellow Perch	69	7,308	-	-	3.8
Total					**2,517.4 kg yr^{-1}**
Total (less Round Goby)					**2,472.5 kg yr^{-1}**

[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 2020, and the 2,472 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.

6.2.3.2 Fish Impingement QA/QC

Impingement losses were measured consistently throughout 2020 by Bruce Power Operators who identified and quantified fish impinged in all 8 of the unit pump houses each day. In 2020, 1,431 routines were completed by Bruce A Operations (98.0%) and 1,460 routines were completed by Bruce B Operations (100.0% routine completion).

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 our field biologists who oversee the program. Lake Whitefish have cultural and commercial importance and are very similar in appearance to Round Whitefish, thus accurate identification is needed. Deepwater Sculpin is a species of Special Concern and are also identified as a species to freeze to verify their identification. This species is similar in appearance to Round Goby, a common invasive species, and thus it is important to keep them to verify identification. There have been no confirmed identifications of Deepwater Sculpin since Operators have been freezing these specimens.

Frozen fish are bagged, labelled, and placed in freezers stored in each pump house until they are inspected by Bruce Power's field biologists. Bruce Power Operators will also freeze specimens that they would like the field biologists to perform a confirmatory identification. When Operators perform their routines and a specimen(s) is added to the freezer this is noted on the fish impingement form. Each fish impingement form is given a unique number that is generated during the entry into the database, and if a fish is placed in the freezer it is noted during the data entry of the form. All fish frozen during 2017-2020 are shown in Appendix E:.

Almost 350 individual fish were placed into the pump house freezers by Operations staff during 2017-2020. Of those, 22 fish could not initially be identified by the Operators but were later identified by the field biologists. For Lake Whitefish, 117 fish were labelled as Lake Whitefish and a correct identification was confirmed by the field biologists. An additional 34 fish were placed in the freezer and labelled as possible Lake Whitefish but were later confirmed by the field biologists to be a different species. Finally, an additional 13 fish were incorrectly identified as Round Whitefish, but later confirmed by field biologists to be Lake Whitefish. For Round Whitefish, 3 fish were labelled as Round Whitefish and a correct identification was confirmed by the field biologists. An additional 19 fish were placed in the freezer and labelled as possible Round Whitefish but were later confirmed by the field biologists to be a different species. Finally, 1 additional fish was originally labelled as a Lake Whitefish but was confirmed by the field biologists to be a Round Whitefish.

6.2.3.3 Offsetting Activities – 2020

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 56). 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.

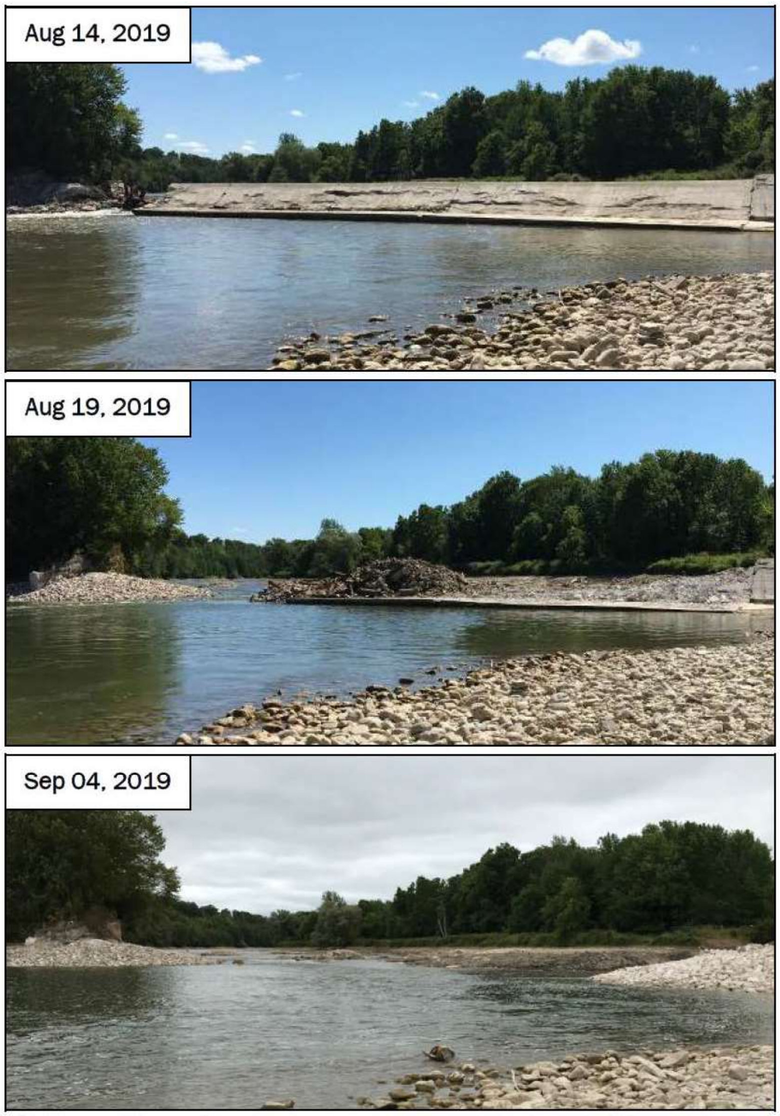

Figure 56: Truax Dam, Walkerton, ON. The original wooden dam was built in 1852 and later replaced by the concrete structure shown above in 1919. The dam posed a significant barrier to fish passage for more than a century before it was removed in the summer of 2019 over the course of 3 weeks.

The dam was removed in order to eliminate a major fish passage barrier to all fish species in this section of the Saugeen River, and thereby allow all community fish unrestricted passage to high-quality fish habitat upstream of the former dam site (Figure 57). For trout and salmon species that migrate up the Saugeen each fall and spring, they are no longer delayed or blocked by the dam and they no longer suffer physical stress and injury from repeatedly trying to jump over the tall concrete barrier. Trout and Salmon species are able to continue their migration upstream of the Maple Hill Dam where an operational fish passage structure is in place (Figure 57).

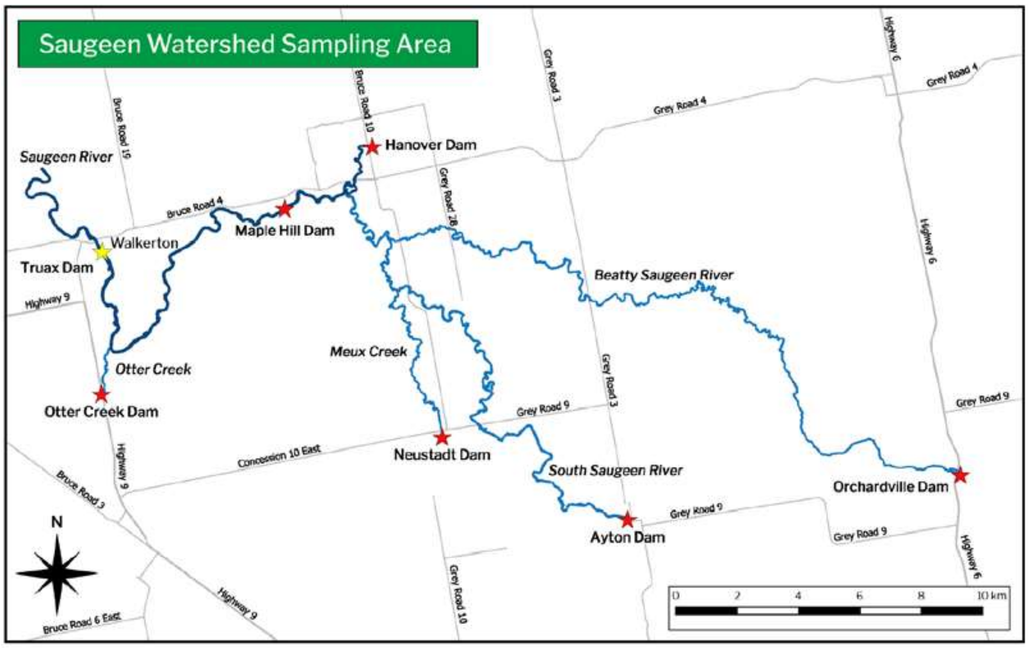

Figure 57: Twenty-two long-term monitoring sites are located in the Saugeen (upstream & downstream of the former Truax Dam) and within the South Saugeen & Beatty Saugeen Rivers and Otter and Meux Creeks. Dams (red stars) are natural endpoints of the study area as fish cannot pass upstream of these structures. 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. 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 (Figure 57) 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 (Figure 55). The first assessment of before-after changes in fish production to calculate the offset will occur after the 2022 monitoring year is complete. It is expected that it will take some time for a new equilibrium to be established in the study area.

In the meantime, Bruce Power provided funding to the Ontario Ministry of Natural Resources and Forestry (MNRF) to support their Lake Trout Rehabilitation Program in Lake Huron. Lake Trout stocking was initially proposed as a 5-year temporary offsetting measure that would allow Bruce Power to immediately meet its interim offsetting needs, while work continued on the Truax Dam Removal project. Ultimately, this temporary offsetting measure was not supported by local Indigenous Nations and Communities and so it was removed from the Authorization just prior to its issuance on December 17, 2019. However, Bruce Power had already initiated its partnership with the MNRF to support Lake Trout stocking activities in 2019 and 2020 and so two years of offsetting occurred, accounting for an addition of 3,077 kg of fish biomass to Lake Huron per year. Offsetting by fish stocking will not continue in 2021.

Finally, 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-105].

6.2.4 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-38]. Temperature and current monitoring in Lake Huron continued in 2020 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 2020 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.

6.2.5 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.

6.2.5.1 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-106]. 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 2020 and one observation of a Spotted Salamander (*Ambystoma maculatum*), which is not listed as a Species At Risk (SAR).

Targeted nocturnal amphibian vocalization surveys were conducted in the spring and summer of 2020, following the methodology described by Bird Studies Canada/ Environment Canada Marsh Monitoring Protocol [R-106]. 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 44: Amphibian call level codes using in survey protocol [R-106]

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

A total of 13 survey locations were established for 2020 based on previous monitoring locations and proximity to wetlands, ponds, and ephemeral pools (Figure 58). Two new locations were added in 2020 based on joint environmental monitoring between Bruce Power and OPG. Five different frog species were identified in 2020 over the three survey dates in April, May and July.

The most common and abundant species documented was the Spring Peeper (*Pseudacris crucifer*). This early breeding frog species was heard calling at every monitoring station in 2020. The call levels for Spring Peeper were relatively high with majority of recorded levels at level 2. Although this species was heard calling at high levels during the first two visits, no calls were heard at any of the stations during the third and final survey (July 4, 2020). This commonly occurs with later-season sampling as the Spring Peeper is an early breeding amphibian species.

The Northern Leopard Frog (*Lithobates pipiens*) was observed at 7 of the monitoring stations. This early-mid season breeder was only heard during the first survey (April 27, 2020) except for station A5016.1 where it was also recorded during the second survey (May 20, 2020). Call levels of the Northern Leopard Frog were a level 2 in Baie du Dore (BDD, Figure 58) and a level 1 at an additional 6 locations. Habitat at BDD consists of a large, contiguous wetland and moist forest/swamp communities.

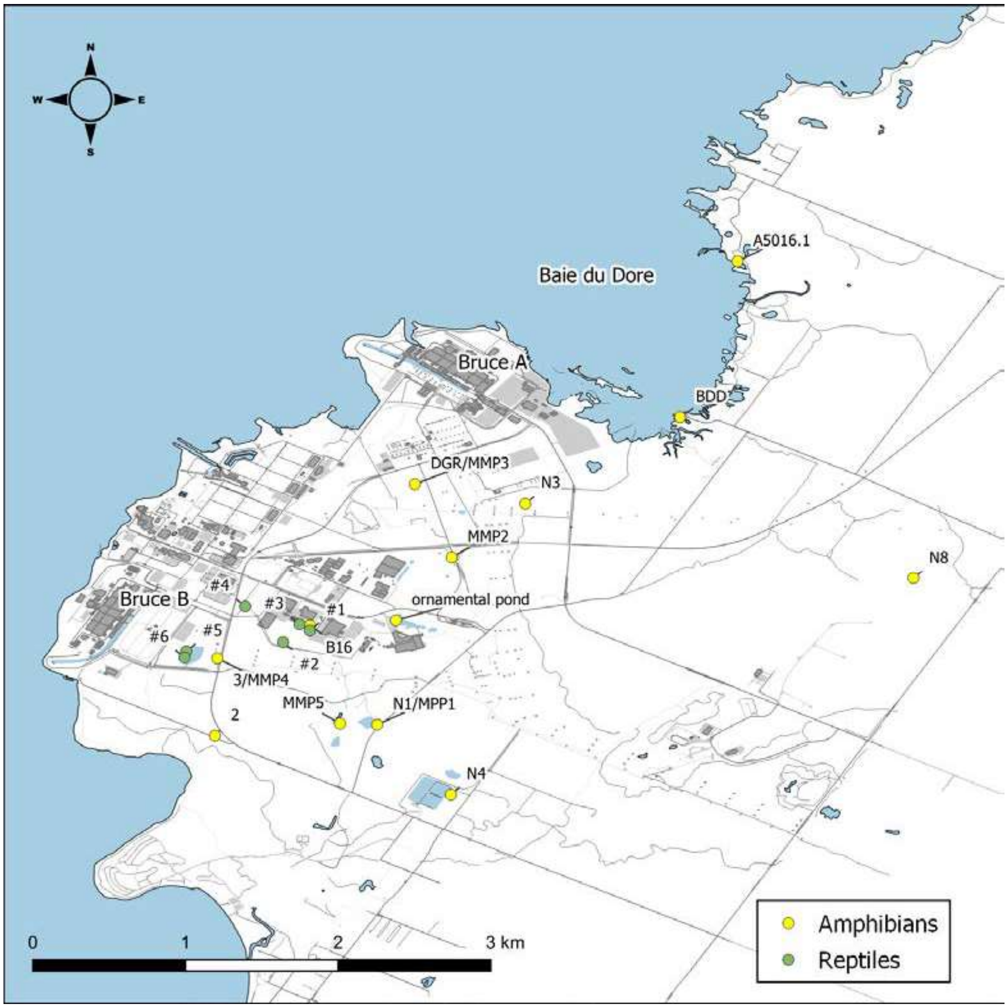

Figure 58: Amphibian and reptile survey monitoring locations at Bruce Power.

Mid-season breeders typically include the American Toad (*Anaxyrus americanus*) and the Grey Treefrog (*Hyla versicolor*). The American Toad was heard at 7 of the monitoring stations, predominantly at a call level 1, but it was present at a call level 2 at site BDD. American toads have very diverse breeding habitat requirements and they are often found in shallow ponds and streams, river margins, and even large puddles and roadside ditches [R-107]. The Grey Treefrog was observed at 3 locations at a call level 1, indicating they are established but in slightly lower abundance compared to other species. Late breeding frog species include the Green Frog (*Lithobates clamitans*) and the American Bullfrog (*Lithobates catesbeianus*). No Bullfrogs have been observed during any of the surveys from 2017 to 2020, however Green Frogs were heard at 3 stations at all monitoring events in 2020. 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.

6.2.5.2 Reptiles

Due to the decline of certain snake populations in Ontario it is important for Bruce Power to collect data on their presence, diversity, and well-being so that sound land-use planning decisions can be made that are protective of these sensitive species. Snake monitoring has been ongoing since 2017 and has focused on locating and characterizing the species assemblage and identifying potential critical habitat within the facility lands. Incidental reptile observations are recorded year-round during vehicle-wildlife interaction surveys, pedestrian surveys and with employee sightings.

Focused snake board studies were initiated in 2020 in collaboration with OPG following guidelines for snake monitoring outlined in the Ontario Ministry of Natural Resources and Forestry (MNRF) survey protocol [R-108]. Bruce Power placed 6 snake boards in key habitat locations on-site (Figure 58) and surveyed them on 5 occasions between July 3, 2020 and August 14, 2020. OPG placed an additional 33 snake boards around the site and observed them on 5 occasions between May 6, 2020 and June 24, 2020. In total, 38 snakes were observed at all locations in 2020.

Five different snake species were observed in 2020: The Eastern Garter Snake (*Thamnophis sirtalis*), Dekay's Brown Snake (*Storeria dekayi*), Red-bellied Snake (*Storeira ociptiomarulat*), Smooth Green Snake (*Opheodys vernalis*), and the Eastern Ribbonsnake (*Thamnophis sauritus*). The Eastern Ribbonsnake is a listed SAR in Ontario and Canada with a conservation status of *Special Concern* [R-109]. These observations are generally consistent with snakes species recorded on-site in prior years (Table 45), with the Smooth Green Snake being first observed in 2020.

Focused turtle monitoring campaigns were not completed in 2020, however incidental observations were made of Snapping Turtle (*Chelydra serpentina*), Midland Painted Turtle (*Chrysemys picta marginata*), and an additional turtle species. This is consistent with turtle species observed from 2017-2019 (Table 45).

Table 45: Reptile species presence recorded in the local area 2017-2020

Species	2017	2018	2019	2020
Dekay's Brown Snake	Yes	Yes	Yes	Yes
Eastern Garter Snake	Yes	Yes	Yes	Yes
Eastern Ribbonsnake	Yes	No	Yes	Yes
Red-bellied Snake	Yes	Yes	No	Yes
Smooth Green Snake	No	No	No	Yes
Midland Painted Turtle	Yes	Yes	Yes	Yes
Snapping Turtle	Yes	Yes	Yes	Yes

6.2.5.3 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 59).

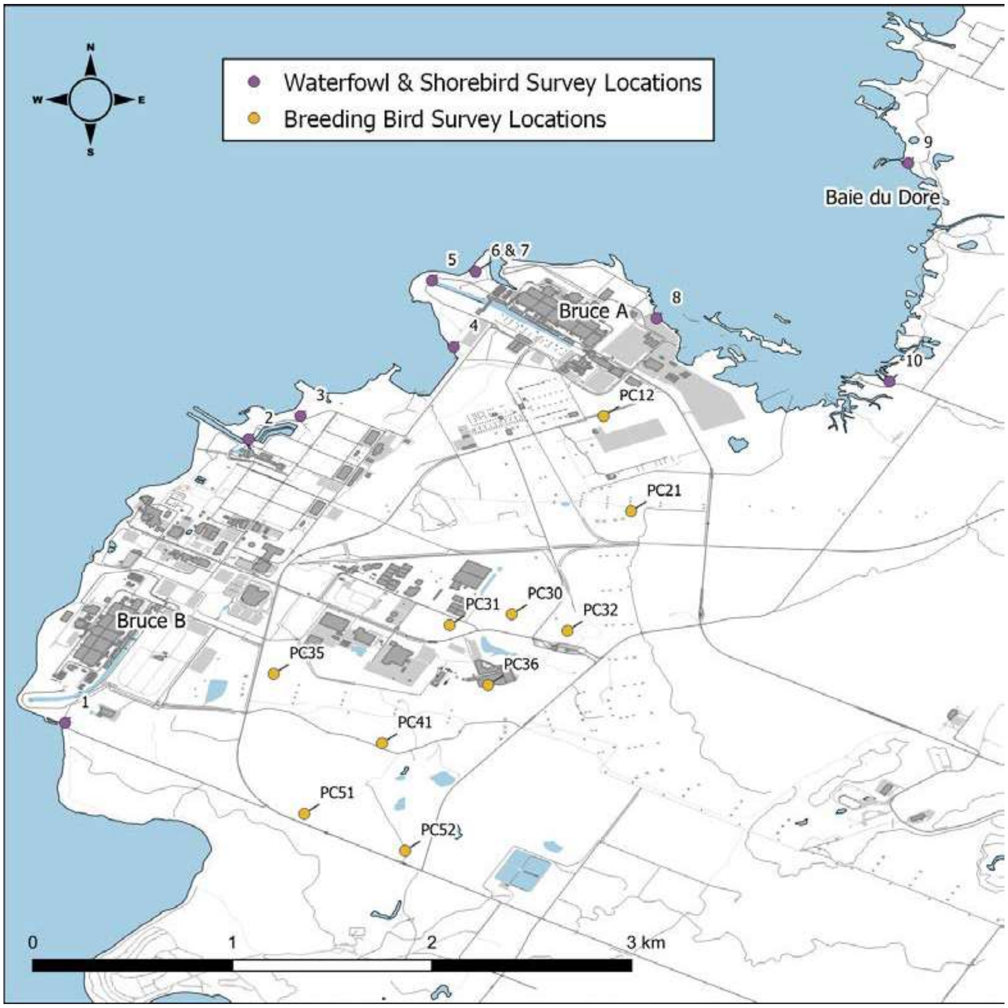

Figure 59: Waterfowl & shorebird and breeding bird monitoring locations at Bruce Power

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 and 2020 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 60).

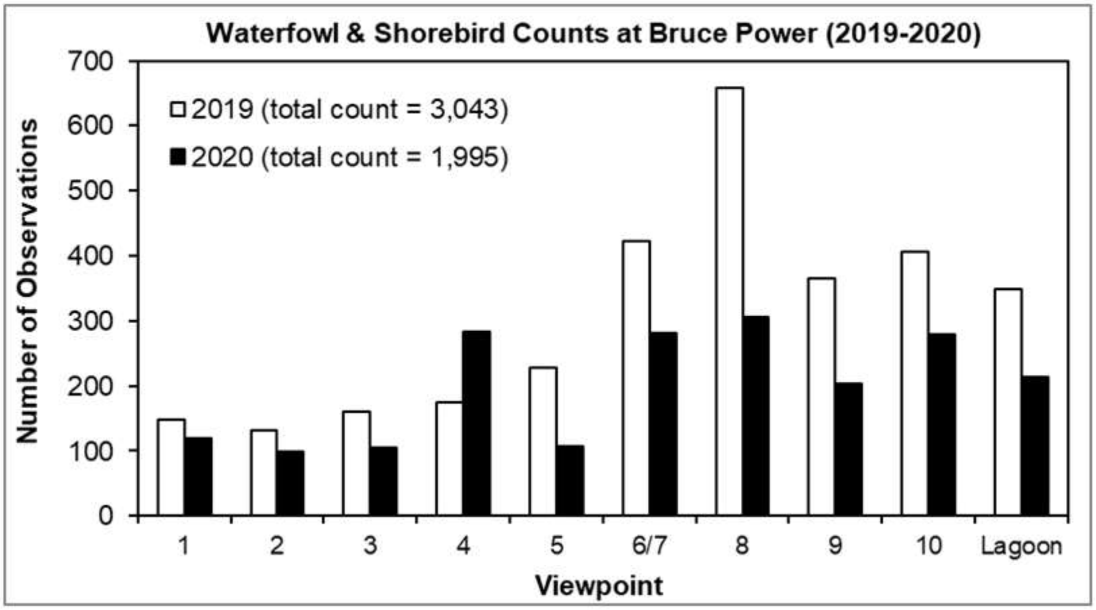

Figure 60: Counts of local waterfowl and shorebirds observed in 2019 and 2020

Canada Geese (*Branta Canadensis*) and Double-Crested Cormorant (*Phalacrocorax auritus*) were the most abundant birds observed in 2020 with a total of 425 Canada Geese and 237 Double-Crested Cormorants observed. The next most common bird species was the Herring Gull (*Larus argentatus*) with 203 observations. Ducks were relatively abundant in 2020 with 18 different species observed. Mallard (*Anas platyhynchos*) was the most abundant waterfowl species encountered with 136 observations. The Common Merganser (*Mergus merganser*) was observed 125 times, and the third-most common duck observed in 2020 was the Ring-Necked Duck (*Aythya collaris*) with 97 observations.

The Greater Yellowlegs (*Tringa melanoleuca*) was observed on 2 occasions; the only shore/wading bird species recorded in 2020. Both the Caspian Tern (*Hydroprogne capia*) and the Common Tern (*Sterna hirundo*) were recorded, along with 2 marsh bird species: The Pied-Billed Grebe (*Podilymbus podiceps*) and the Sora (*Porzana carolina*). The White-Winged Scoter (*Melanitta deglandi*) and the Surf Scoter (*Melanitta perspicillata*) were observed in 2020; two uncommon Scoter species in this area that have been consistently recorded in very low numbers since waterfowl surveys were initiated at Bruce Power. Sandhill Cranes (*Grus canadensis*) are commonly observed flying over the area in the spring; three individuals were recorded on April 7, 2020. Birds of prey are abundant in the waterfowl survey areas. A total of 97 Bald Eagles (*Haliaeetus leucocephalus*), a single Merlin (*Falco columbarius*), and a single Broad-Winged Hawk (*Buteo platypterus*) were observed in 2020.

6.2.5.4 Breeding Bird Monitoring Surveys

Breeding bird monitoring surveys were completed by Bruce Power and OPG biologists at 10 locations in the morning of June 4, 2020 (Figure 59). Monitoring protocols followed the standards prescribed by Birds Canada (formerly Bird Studies Canada) for the Ontario Breeding Bird Atlas [R-110]. A total of 43 bird species were documented during the 5-minute surveys at each location.

The most commonly observed species were the Red-Eyed Vireo (*Vireo olivaceus*) and American Goldfinch (*Spinus tristis*), which were each found at 8 of the survey locations. The Red-Winged Blackbird (*Agelaius phoeniceus*) and American Redstart (*Setophaga ruticilla*) were each found at 7 of the survey locations. Interesting observations included 4 SAR bird species (3 showed evidence of breeding): Eastern Wood Pewee (*Contopus virens*), Wood Thrush (*Hylocichla mustelina*), Eastern Meadowlark (*Sturnella magna*), and Bobolink (*Dolichonyx oryzivorus*). Two Sedge Wren (*Cistothorus stellaris*) were observed and this bird is not locally common.

6.2.5.5 Bald Eagle and Winter Raptor 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 2020-2021 at 6 of the 7 original monitoring stations (Stn), labelled Stn. 1 and Stn. 3-7 on Figure 61. Stn. 2 (not labelled on Figure 61) 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 (Figure 62). Overall across the whole site, counts have increased in the last four years indicating an increase in the abundance of the local overwintering Bald Eagle population (Figure 62).

Although other raptor species are frequently observed in the spring, summer and fall, few raptors are found on or near Bruce Power in the winter months. None were observed during winter raptor surveys conducted in 2017-2018 and 2020-2021. One Red-tailed Hawk was observed in 2018-2019, and one Snowy Owl and one Northern Harrier were recorded in 2019-2020. Winter raptor habitat availability in the local area is poor because a considerable snowpack often accumulates. This makes foraging for food difficult compared to areas inland and south of Bruce Power that have a smaller snowpack. Raptors can more easily find food in open agricultural fields where windswept areas expose rodents and other creatures to predation. Formal surveys for winter raptor species will not continue in 2021 but recording of incidental observations made by employees and Bruce Power field biologists will continue.

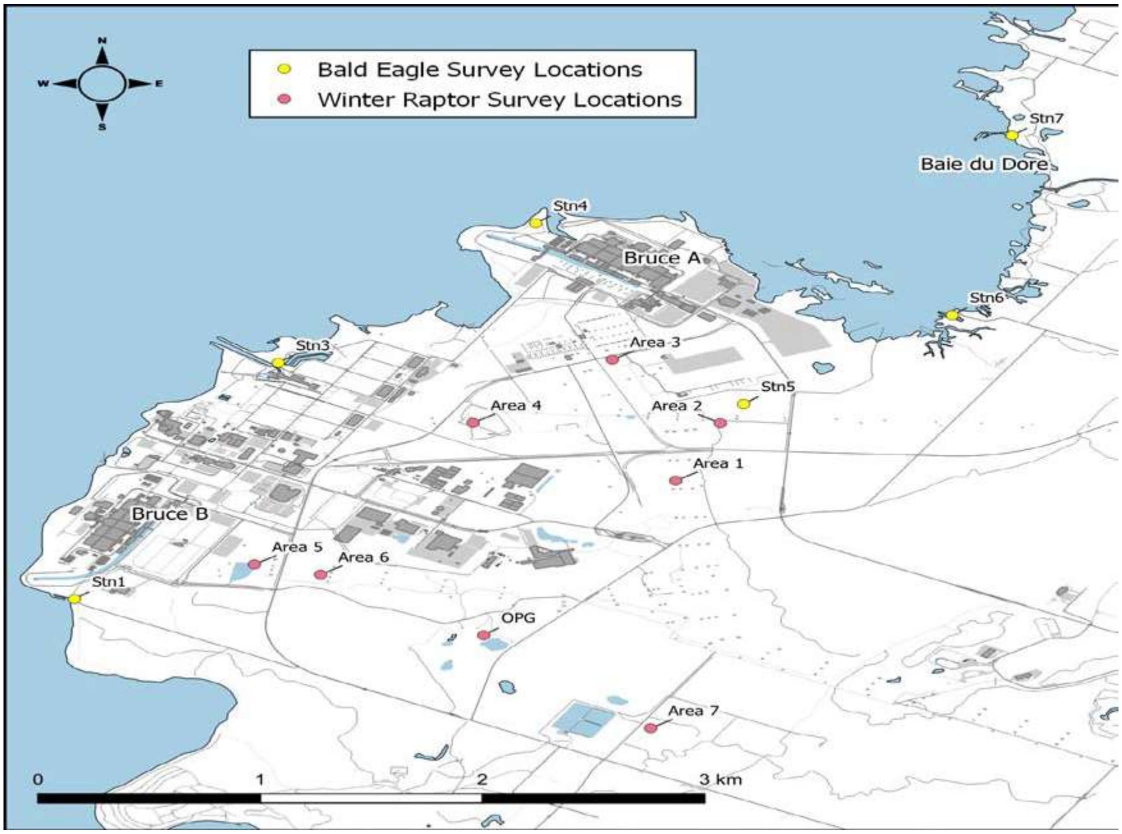

Figure 61: Bald eagle and winter raptor monitoring locations at Bruce Power

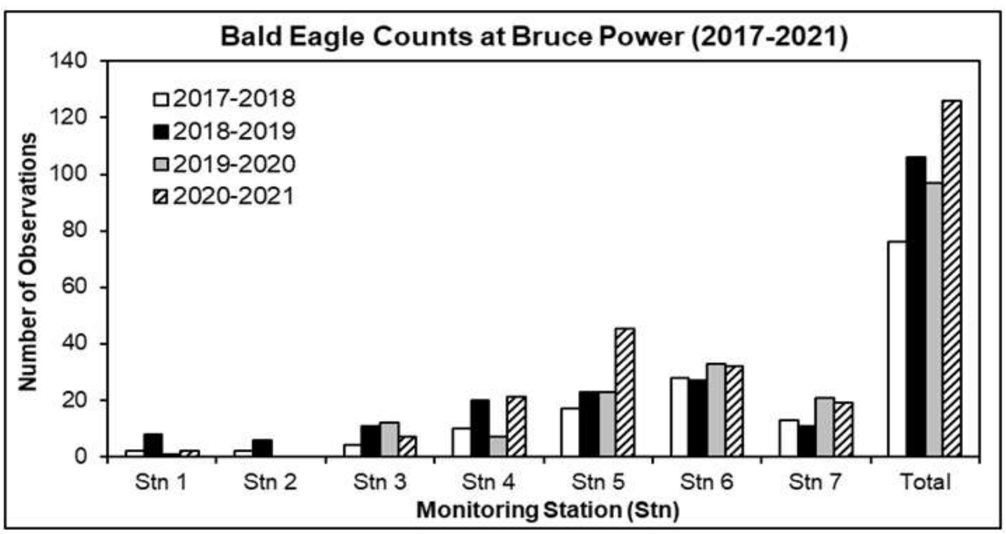

Figure 62: Counts of Bald Eagles observed near Bruce Power between 2017 and 2021

6.2.5.6 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 may include both Chinook (*Oncorhynchus tshawytscha*) and Coho (*Oncorhynchus kisutch)* salmon, and historically Brown Trout (*Salmo trutta*) and Brook Trout (*Salvelinus fontinalis*).

Six surveys were completed in 2020 (4 in the spring, 2 in the fall). Forty-five Rainbow Trout redds were observed in 2020, which was 3 more than the number recorded in 2019 (Figure 63). Of these, 21 had one fish on or near the nest and 11 had a pair of fish on or near the nest. No Chinook Salmon redds were observed in Stream C in 2019 or 2020. Twenty Coho Salmon redds were recorded in the 2020 fall surveys, which was a slight decline from the previous year (Figure 63), however fewer formal surveys were made in 2020. Three redds had one Coho Salmon on or near the nest and 1 redd had a pair of fish on or near the nest. 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 2020 to assess activity, but fewer formal redd surveys were required because of the low stream flows. The consistent and high number of redds observed in Stream C since 2017 demonstrates there is high water quality and fish habitat in this stream.

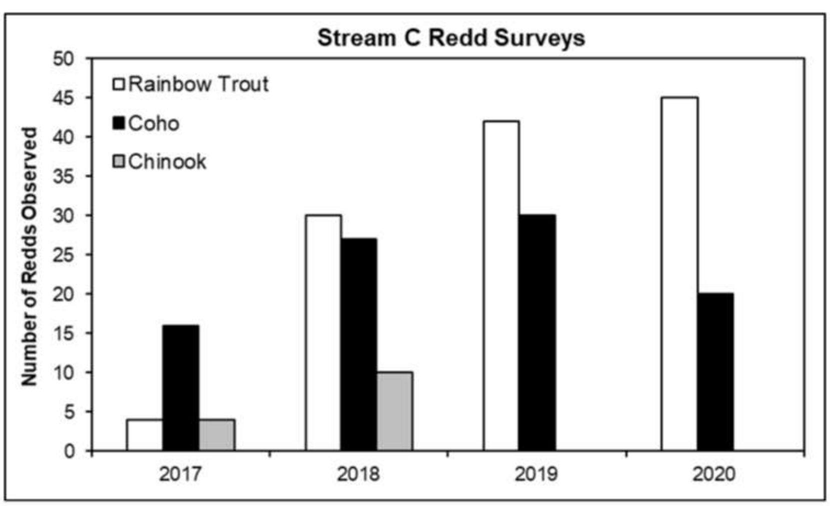

Figure 63: Counts of Redds Observed on Stream C between 2017 and 2020

6.2.5.7 Smallmouth Bass Nesting

Smallmouth Bass nesting surveys to monitor local bass populations have occurred annually since 2009 (Bruce A and Bruce B discharge channels) and 2010 (Baie du Doré). These areas provide excellent Smallmouth Bass nesting habitat as there is abundant spawning conditions present (adequate depth, gravel/sand substrate and shelter from prevailing winds/wave action). Nesting surveys occurred in 2020 from May 22nd to July 14th, which is the latest start date since the onset of the sampling in 2009. Sampling was delayed by ~1 month due to high winds/poor boating conditions and uncertainty in permissible work activities during the COVID-19 pandemic that was unfolding at the time.

Nests were observed throughout the season to monitor development and success criteria. Transects of the sampling areas were performed in a small boat (16 ft.), stopping to observe nesting sites with a custom viewing box (aquarium) that minimized glare and allowed for a clear view of the nest. Nests were assigned a unique identification number and GPS coordinates were recorded along with field notes on the stage of development. A standardized protocol was used classify nest development and outcome (Table 46). A nest was considered 'successful' if it had reached development stage 6-8 (risen fry to green fry), 'unsuccessful' if it was abandoned and 'remained active' if it had reached development stage 1-5 during the extent of the survey. Nests were re-visited during each subsequent survey to reassess their development over time.

Table 46: Smallmouth Bass nesting survey development stage codes

Code	Code Description	Field Indicators
0	Pairing	A pair of adult Smallmouth Bass with no nest observed.
1	Cleared nest	A cleared nest with no observed guarding male.
2	Cleared nest; bass guarding	A cleared nest with a guarding bass, but no observed eggs or fry.
3	Eggs	A cleared nest was present and eggs were observed in the nest.
4	Yolk-sac larvae	Transparent yolk-sac fry that had not risen off the bottom observed in the nest
5	Fry risen; tight to bottom	Fry, observed at or very near the bottom.
6	Fry <2 cm risen; suspended	Fry <2 cm total length, observed swimming suspended in the water column.
7	Fry >2 cm risen; dispersed	Fry >2 cm total length, observed swimming suspended in the water column and starting to disperse.
8	Green fry	Fry with a green colouration, which occurs at approximately 1.5 cm total length, observed in proximity of nest.

Code	Code Description	Field Indicators
A	Abandoned	Nest was observed to be abandoned by male adult Smallmouth Bass or an abrupt absence of eggs, fry, or adults was observed. This code includes nests that are abandoned as the result of natural physical destruction (e.g., nest silted up).

Nests are consistently located in similar geographic areas from one year to the next, which is likely due to site fidelity. Males are known to return to the same location year after year, with the majority returning to within 140 m of prior nesting sites [R-111]. Nests in Bruce A in 2020 were found near the sheltered dock area, along the bedrock shelves and also in between the crevices within the large boulders that line the north and south areas of the discharge channel (Appendix F:). This is consistent between all monitoring years. Nesting locations in the Bruce B discharge included the north side of the channel that is sheltered by the Bruce B dock, and the shallow areas along the discharge groyne (Appendix F:). The sheltered shoreline areas of Baie du Doré and areas around the submerged island which separates the bay into east and west sections under high water conditions continued to be highly utilized for bass nesting in 2020 (Appendix F:).

A total of 25 nests were observed in the Bruce A discharge channel in 2020, which was consistent with the number observed over time (Figure 64), but likely a little lower due to the later sampling start in 2020. Of those, 15 nests (60%) were observed to have successful spawning outcomes and 9 nests (36%) were abandoned (Figure 65). One nest at Bruce A remained active on the last survey of the year.

Thirty-eight nests were observed in the Bruce B discharge channel in 2020, which was consistent with the number observed over time (Figure 66), but likely a little lower due to the later sampling start in 2020. Of these, 24 nests (63%) were classified as successful (Figure 67), 5 nests (13%) were still active at the last survey, and 9 nests (24%) were abandoned.

A total of 98 nests were observed in Baie du Doré in 2020 (Figure 68), mostly in the southern portion of bay. This was consistent with prior years. Of these, 54 nests (55%) were classified as successful and 40 nests (41%) were unsuccessful (Figure 69). Four nests (4%) remained active at the time of the final survey.

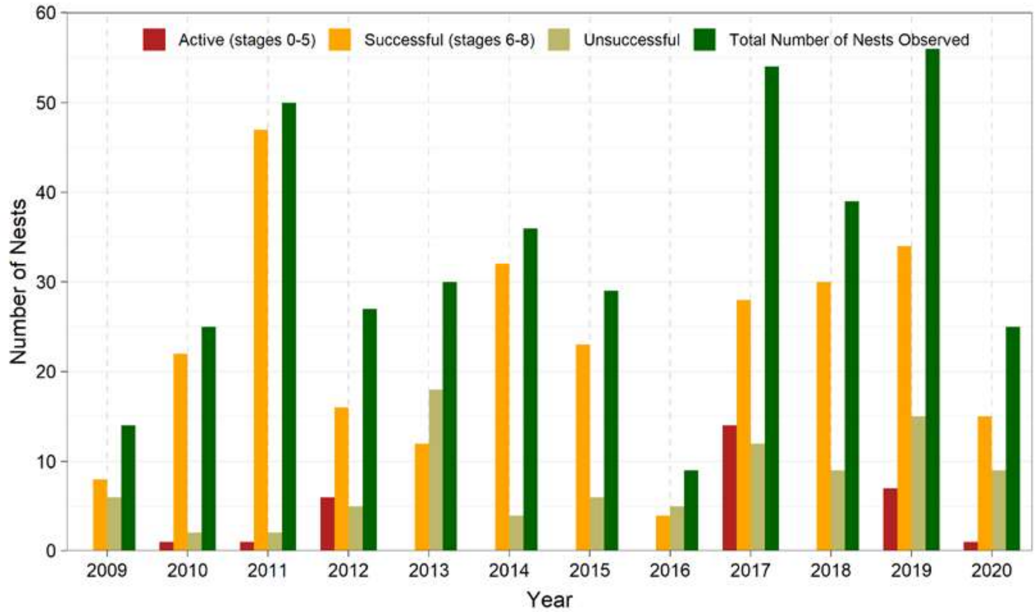

Figure 64: Bruce A discharge – Smallmouth Bass nesting results at the final survey (2009-2020)

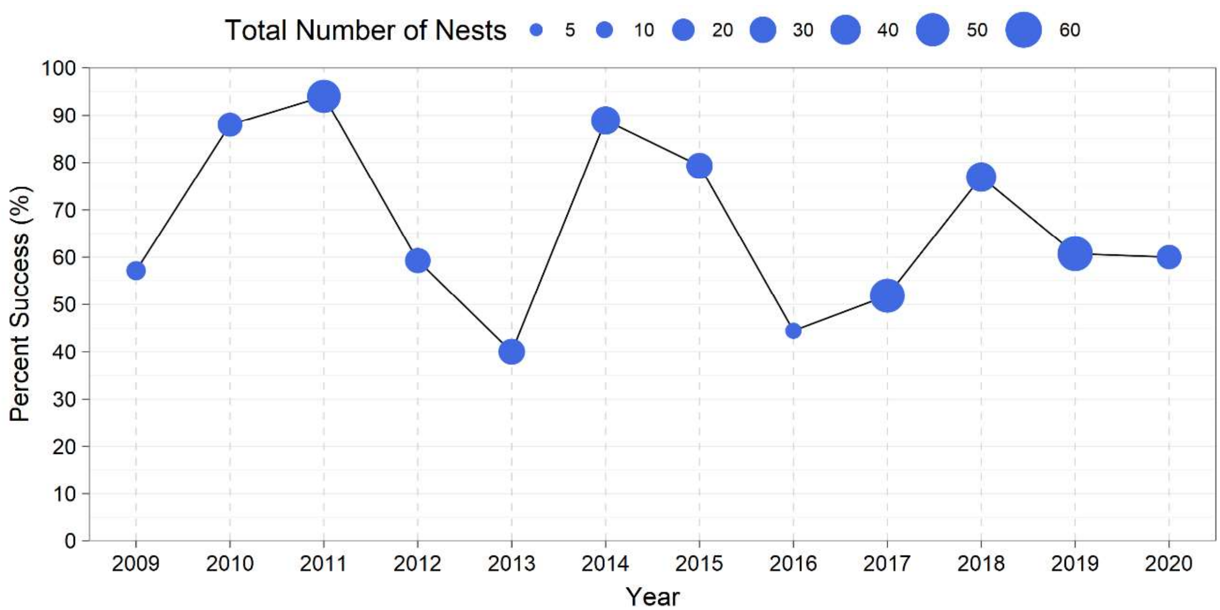

Figure 65: Bruce A discharge – Smallmouth Bass nest success at the final survey (2009-2020)

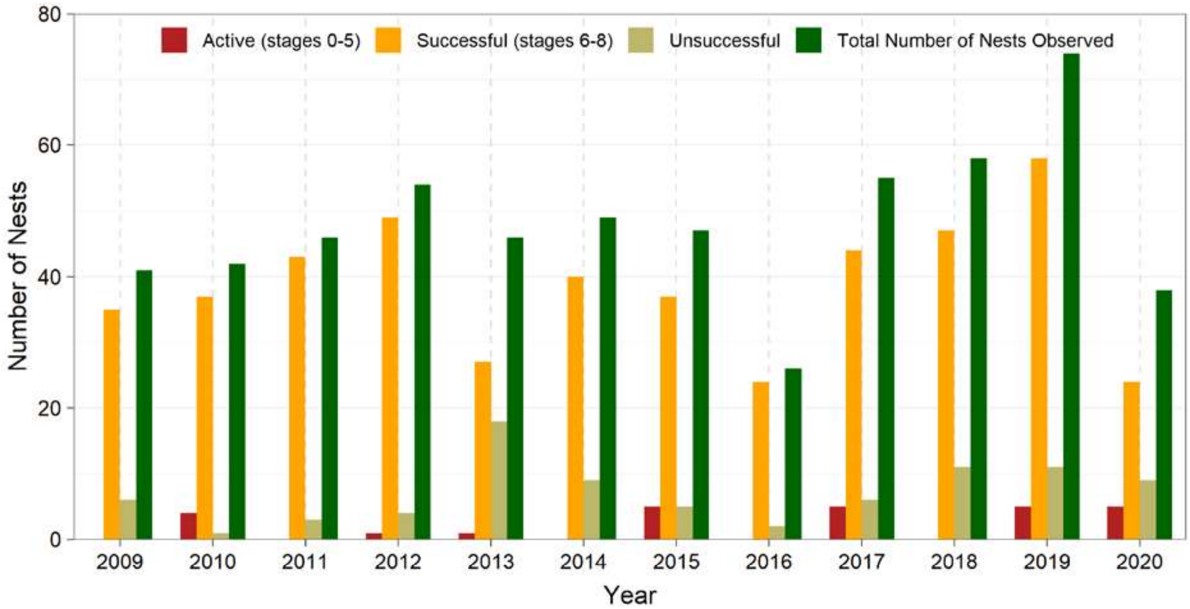

Figure 66: Bruce B discharge – Smallmouth Bass nesting results at the final survey (2009-2020)

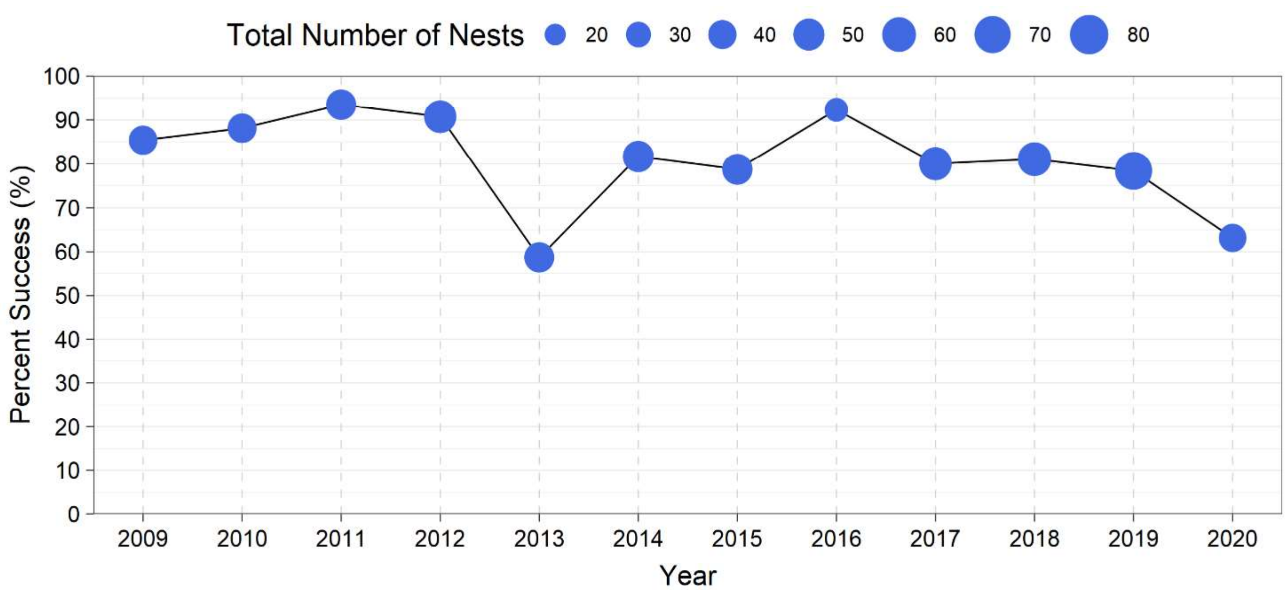

Figure 67: Bruce B discharge – Smallmouth Bass nest success at the final survey (2009-2020)

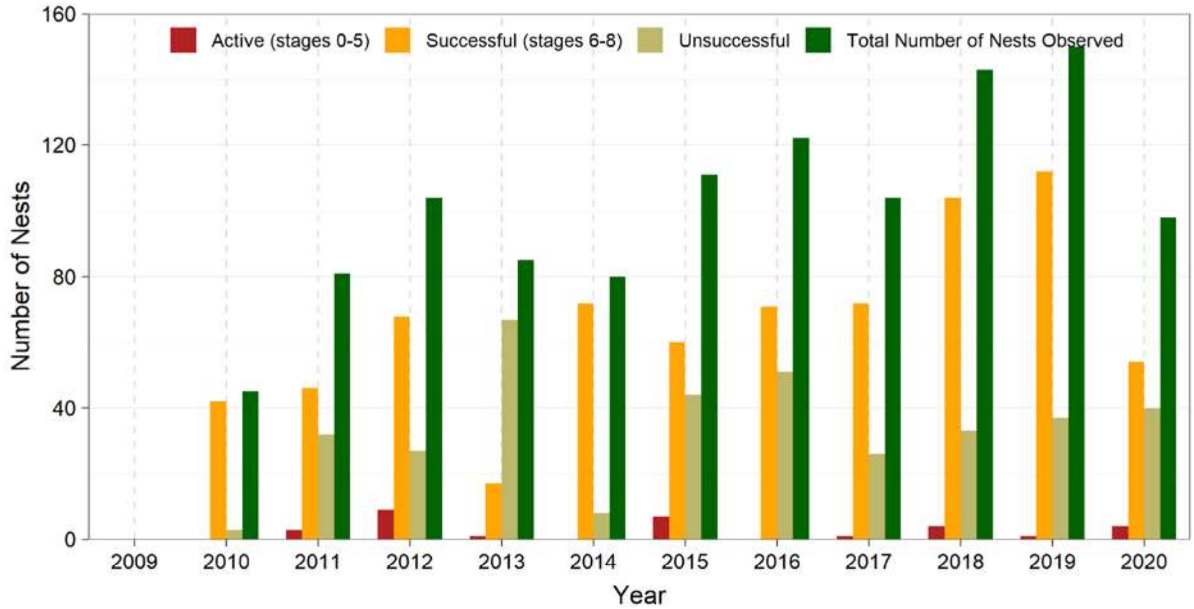

Figure 68: Baie du Doré – Smallmouth Bass nesting results at the final survey (2010-2020)

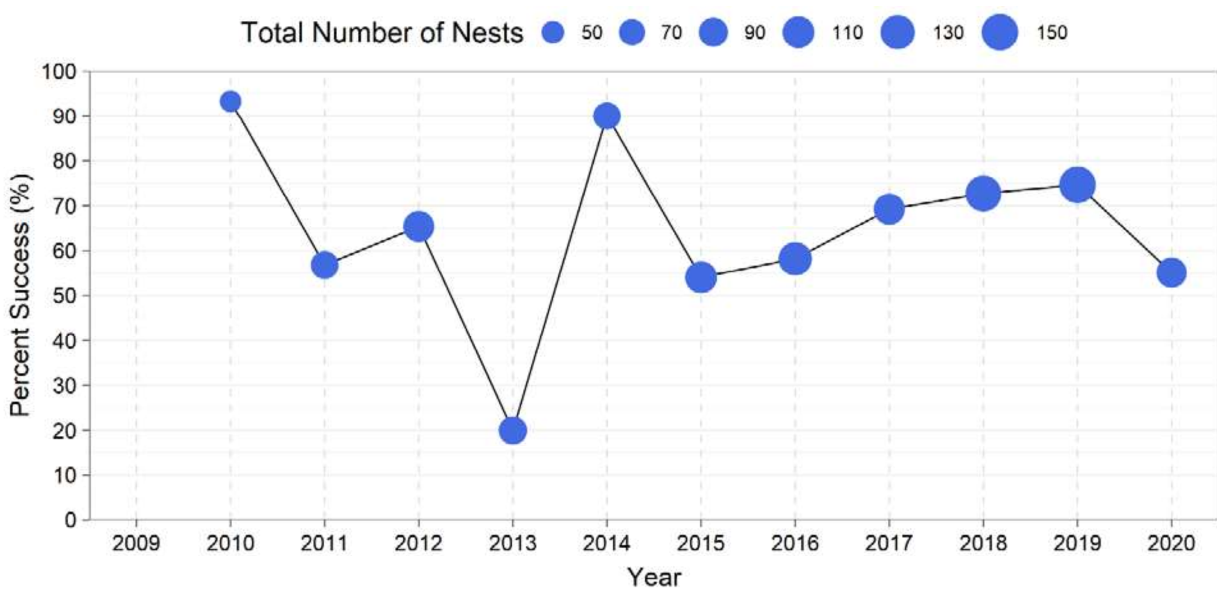

Figure 69: Baie du Doré – Smallmouth Bass nest success at the final survey (2010-2020)

6.2.5.8 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 2020 with 37 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 70). 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.

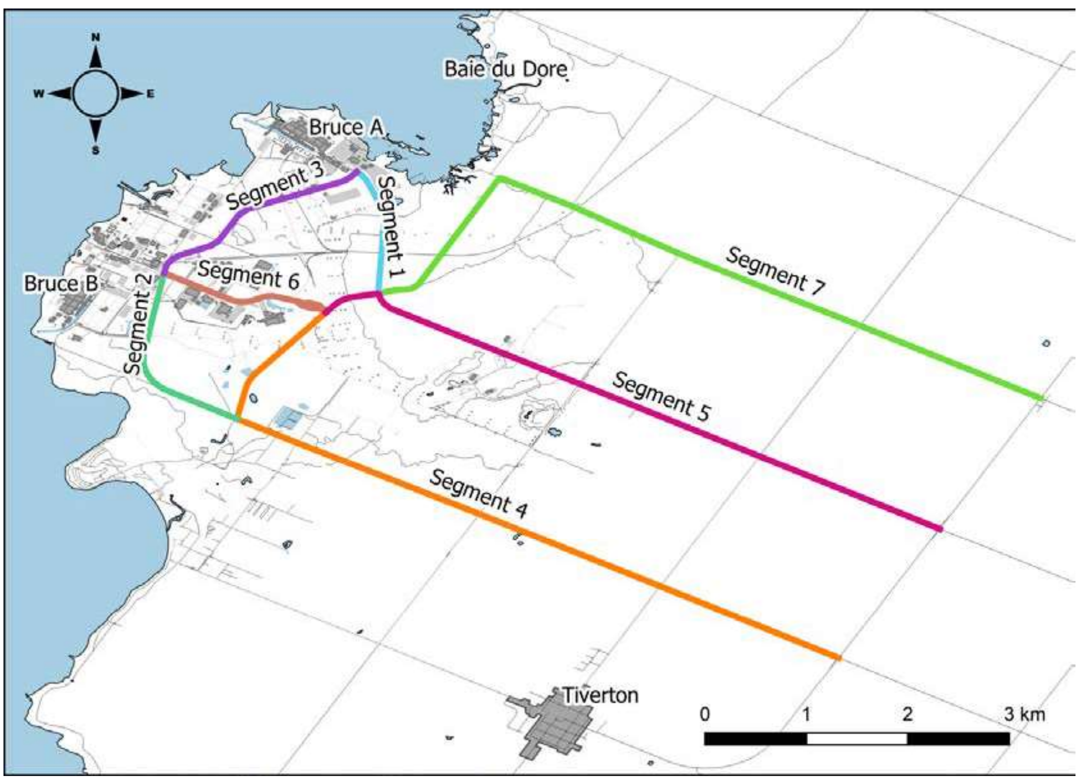

Figure 70: Vehicle-wildlife collision survey areas

Fifty deceased animals were recorded over the 37 formal surveys conducted in 2020 (1.3 animals per survey day). An additional 10 carcasses were observed incidentally throughout the year. This represents a slight decline in mortality from that observed in 2019 and 2017, but similar to that observed in 2018 (Table 47).

Table 47: The results of vehicle-wildlife collision surveys conducted in the local area (2017-2020)

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

The majority (55%) of the animals involved in collisions in 2020 were mammals 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 2020, there were no on-site vehicle collisions and no individuals were recorded off-site during the vehicle-collision surveys. Amphibians and reptiles represented 32% of the mortalities and included: Northern Leopard Frog, Green Frog, Spotted Salamander, Eastern Gartersnake, Midland Painted Turtle, and Snapping Turtle. The remaining animal mortalities (13%) were made up of birds and insects and included: Wild Turkey, Ring-billed Gull, Monarch Butterfly, and Dragonfly.

Table 48: Mortality by survey segment as a proportion of the annual total , ranked from highest to lowest (2017-2020)

Segment	4	5	2	1	7	3	6
2017	42	33	14	7	n/a	5	0
2018	37	28	12	13	n/a	8	2
2019	29	13	19	10	n/a	18	10
2020	34	16	8	18	16	8	0

The highest frequencies of collisions occur along Segment 4 (Concession 2) where 29-42% of the total mortality happens each year. Segment 5 (Bruce Road 20) also has a high proportion of collisions with 13-33% 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 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.

6.2.5.9 Bird Interactions with Structures

Bird migrations in the spring and fall pose a potential increased risk for collision with building structures at Bruce Power. Bird strike monitoring was completed on 36 occasions in 2020 at three on-site buildings identified as B10, B16, and B31. Monitoring in 2017-2019 occurred at B10 and B31, only. All surveys took place on foot at the perimeter of each building, slowly walking and scanning for bird carcasses. Two passes were made at each building (in opposite directions) on or before 2:00 pm as most bird collisions with buildings occur in the morning and early afternoon [R-112]. Birds were identified to the species level, photographed, georeferenced and recorded.

A total of 36 monitoring surveys were completed in 2020 and no dead birds were found at the base of the building structures. Since 2017, 8 observed bird mortalities have been recorded in 132 surveys completed over 4 years near the perimeter of the three monitored buildings. All recorded species were associated with forests, reflecting the presence of nearby woodlots. Moving forward, bird-building collision surveys will not be completed in 2021 as intensive monitoring in the last 4 years has demonstrated very low bird mortality due to collisions with on-site buildings. Incidental reports from employees and observations from Bruce Power field biologists will continue to be recorded.

Table 49: Bird-building collisions observed at Bruce Power (2017-2020)

Year	Surveys completed (#)	Deceased birds observed during surveys (#)	Species
2017	5	5	Northern Flicker, Ovenbird, Song Sparrow
2018	46	1	Tree Sparrow
2019	45	2	Northern Flicker, Song Sparrow
2020	36	0	n/a

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)
- Organic waste (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, organic 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 a number of 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 50 summarizes the waste management and pollution prevention reports submitted to regulatory agencies.

Table 50: 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 2021 (Annual)
Conventional Waste (See s7.1)	Report of a Waste Audit O Reg 102/94	Internal Report	Q1 2021 (Annual)
Hazardous (See s7.2)	Generator Registration Report (O Reg 347) Records	Ministry of Environment, Conservation and Parks	10FEB2021 (Annual)
Waste & Pollution Prevention - PCB (See s7.5)	Federal PCB Regulations Bruce Power 2020 Annual Report Declaration (BP-CORR-00521-00019)	Environment and Climate Change Canada	12FEB2021 (Annual)
Waste & Pollution Prevention - PCB (See 7.5)	2020 Annual Bruce A Polychlorinated Biphenyl (PCB) Waste Storage Report for Bruce A Storage Facility # 10400A003 (BP-CORR-00541-00049)	Ministry of Environment, Conservation and Parks	21JAN2021 (Annual)
	2020 Annual WCTF Polychlorinated Biphenyl (PCB) Waste Storage Report for Storage Facility # 10402A001 (BP-CORR-00541-00050)	Ministry of Environment, Conservation and Parks	31JAN2021 (Annual)

7.1 Conventional Waste

The primary objectives of the Conventional Waste Program are 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-8]
- Ontario Regulation 347, General Waste Management [R-113]
- Ontario Regulation 103/94, Industrial, Commercial and Institutional Source Separation Programs [R-114]
- Ontario Regulation 102/94, Waste Audits and Waste Reduction Work Plans [R-115]
- Transport Canada’s Transportation of Dangerous Goods (TDG) Act [R-116]

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, Bruce Power is considered to be 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, coffee cups and lids, and biodegradable 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 51, the total amount of conventional waste produced at Bruce Power in 2020 was at its lowest point in 5 years. In 2020, 1,420 metric tons of conventional waste was generated (30% decrease from the previous year). This is likely correlated with the marked decrease in average number of workers on-site at Bruce Power during 2020 as a result of the COVID-19 pandemic. The average number of employees working at the Bruce Power site in 2020 was 2,267, a 77% decrease from 2019.

Table 51: Conventional Waste Generated at Bruce Power from 2016 to 2020[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%
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 2020, 36% of Bruce Power's conventional waste was sent to landfill (a 64% diversion rate), 4.4% was composted, and the remainder was recycled via several different recycling streams (60%). 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, 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

Waste programs are in place across Bruce Power to safely handle and dispose of hazardous wastes in accordance with regulatory requirements outlined in the Environmental Protection Act, O Reg 347, General Waste Management [R-113].

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, and electronic waste.

7.2.1 Hazardous Waste Inspections

In March and December of 2020, the CNSC completed field inspections of the Bruce A and B elevation 591’ – Chemical Waste Handling Areas. There were no significant findings as a result of the inspections.

Routine inspections of both Bruce A and Center of Site PCB Storage Facilities continue to occur monthly to verify that all regulatory requirements continue to be met.

7.2.2 Polychlorinated biphenyl (PCB)

According to the PCB regulations (SOR/2008-273) [R-117], 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 electronic control equipment including capacitors and, lighting ballasts. In 2018, a plan was created for PCB removal, focusing on the above equipment, in order to meet the regulatory deadline of December 31, 2025. This plan is reviewed and updated on a regular basis to ensure that Bruce Power continues to make adequate progress to meetthe regulatory deadline.

8.0 AUDITS

The N288.4, N288.5 and N288.7 environmental standards [R-7] [R-18] [R-4] require an audit to be performed once every five years to help ensure that the 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-62], 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-118]. 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-4].

8.1 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 2020 Environmental Management System Audit, AU-2020-00006 [R-119], 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].

8.2 N288.7 Groundwater Audit

The 2020 Groundwater Protection Program audit was conducted in October/November 2020 to determine effective implementation of the requirements of CSA N288.7-15, Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills. Bruce Power made a commitment to being in general conformance with the standard by December 31, 2020. The audit evaluated all elements of the Standard excluding those elements related to audit function itself. The Bruce Power Program was found to be in general conformance with the Standard, with some areas not effectively implemented and/or maintained. Corrective actions have been created to address these non-conformances.

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 18:00/2028 [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 2020 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 begin in 2021.

For the 29th 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 maximum representative person's dose associated with Bruce Power operations in 2020 is the BSF3 Adult who received 1.8 µSv/year. All other representative persons have a lower dose. This maximum dose is a fraction of a percent of the legal limit of 1,000 µSv/year.

Bruce Power is engaged in preparations for the submission of the 2022 ERA In 2020, this consisted of the submission of an assessment of feasible mitigation measures for thermal effluent and impingement and entrainment effects, engagement with CNSC and ECCC to clarify the thermal risk assessment plan and continued work in the areas of climate change through participation in a multi-year study with the Council of the Great Lakes Region (CGLR) and the Climate Risk Institute (CRI) and modelling of future lake water temperatures.

Through Bruce Power's normal operation and outage maintenance activities, airborne and waterborne emissions and effluent are released to the environment and these are monitored following robust monitoring standards (CSA N288.5) to confirm these releases remain within compliance limits to ensure environmental protection. All radiological effluent remained well below regulatory limits and action levels, and all conventional effluent parameter limits were met, with the exception of a one-time occurrence toxicity failure resulting from elevated nitrite levels in a building effluent discharge. An investigation and corrective actions were promptly implemented in response to this event, and enhanced effluent monitoring has been instituted (pre-release) to prevent reoccurrence.

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 2020, conventional contaminant monitoring included water quality in the lake, on-site waterbodies and groundwater. Results of the radiological and conventional environmental monitoring programs in 2020 did not demonstrate any significant 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 2020 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 Environment monitoring and protection throughout 2021.

10.0 REFERENCES

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APPENDIX A: REPRESENTATIVE PERSON PARAMETERS FOR DOSE CALCULATION

Table 52: 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	23.09%	19.89%	12.06%
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	10.41%	7.40%	6.23%
Vegetables (above-ground)	4.26%	5.02%	6.95%
Root Vegetables	1.57%	2.44%	2.85%
Total plant Products	**19.68%**	**18.70%**	**19.38%**
Fish	23.00%	23.00%	23.00%
Non-Dairy Farms			
Milk and dairy	12.47%	10.74%	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%

Food Type	**Infant (1-yr old)**	**Child (10-yr old)**	**Adult**
Fruit and Berries	21.09%	14.99%	12.62%
Vegetables (above-ground)	10.12%	11.95%	16.52%
Root Vegetables	3.60%	5.62%	6.56%
Total Plant Products	**39.07%**	**37.29%**	**39.83%**
Fish	22.30%	22.30%	22.30%
Dairy Farms			
Milk and dairy	61.98%	53.38%	32.37%
Beef	1.04%	2.82%	10.05%
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	***66.60%***	***65.80%***	***63.90%***
Grain	7.92%	8.82%	7.71%
Fruit and Berries	13.78%	9.79%	8.25%
Vegetables (above-ground)	10.28%	12.14%	16.79%
Root Vegetables	3.51%	5.48%	6.39%
Total Plant Products	**35.50%**	**36.24%**	**39.13%**
Fish	25.00%	25.00%	25.00%
Subsistence Farms			
Milk and dairy	73.90%	63.64%	38.59%
Beef	1.97%	5.33%	19.00%
Pork	1.33%	3.64%	7.61%
Poultry	3.14%	7.62%	14.93%
Egg	0.81%	2.81%	7.39%
Deer	0.20%	0.57%	2.22%
Honey	0.18%	0.47%	0.62%
Total Animal Products	***81.50%***	***84.10%***	***90.40%***

Food Type	Infant (1-yr old)	Child (10-yr old)	Adult
Grain	18.67%	20.80%	18.18%
Fruit and Berries	28.40%	20.18%	16.99%
Vegetables (above-ground)	17.06%	20.14%	27.85%
Root Vegetables	5.80%	9.04%	10.54%
Total Plant Products	**69.93%**	**70.16%**	**73.56%**
Fish	100.00%	100.00%	100.00%
Hunter-Fisherman			
Milk and dairy	72.87%	62.10%	37.82%
Beef	1.95%	5.20%	18.62%
Pork	1.32%	3.55%	7.46%
Poultry	3.10%	7.44%	14.63%
Egg	0.79%	2.74%	7.24%
Deer	1.58%	2.98%	4.17%
Honey	0.18%	0.46%	0.60%
Total Animal Products	***81.80%***	***84.50%***	***90.50%***
Grain	18.67%	20.80%	18.18%
Fruit and Berries	28.40%	20.18%	16.99%
Vegetables (above-ground)	17.06%	20.14%	27.85%
Root Vegetables	5.80%	9.04%	10.54%
Total Plant Products	**100.00%**	**100.00%**	**100.00%**
Fish	100.00%	100.00%	100.00%

Table 53: 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***
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
Deer Intake	kg/yr	0.0/4.21	0.0/8.75	0.1/11.08
Milk Intake	kg/yr	242.7	228.1	125.6
Total Animal Product Ingestion Rate	***kg/yr***	***261.0/264.2***	***282.6/291.4***	***250.0/261.0***
Total Fish Ingestion Rate	***kg/yr***	***1.8***	***5.4***	***8.2***

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.
2. All values are mean or central values from CSA N288.1-14 [R-20], with the exception of Hunter/Fisherman Group Deer intake, which is based on the FNFES [R-43].

APPENDIX B: 2020 METEOROLOGICAL DATA ANALYSIS

The 2020 surrogate Double Joint Frequencies (DJF) and Triple Joint Frequencies (TJF) for the Bruce Power site were calculated following the usual approach. The raw hourly data was used for each year from 2011 to 2016 (excluding 2014) due to data availability issues described in Section 0. 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 wind speed bins, wind direction sectors and stability class were determined. Wind speed groupings are defined as per Table 10 of CSA N288.1-20 [R-46] which is reproduced in Table 54. The wind direction was then divided into 16 wind direction sectors with each sector being 22.5 degrees, as shown in Table 55.

Table 54: 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 55: 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-120] 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 N288.2-14 [R-47] 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-121]
The calculated surrogate DJF and TJF data at the 50m on-site meteorological tower are presented in Table 56, Table 57 and Table 58.

Table 56: Annual Average DJF (Surrogate) for Bruce Power Site for Year 2020 – 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	1.71	0.88	1.00	0.80	0.42	0.50	**5.30**
NNE	1.77	1.02	1.10	0.72	0.31	0.34	**5.27**
NE	1.57	0.80	0.57	0.40	0.20	0.09	**3.62**
ENE	2.69	0.86	0.68	0.40	0.17	0.11	**4.90**
E	2.15	0.72	0.49	0.15	0.09	0.12	**3.72**
ESE	1.75	0.52	0.32	0.20	0.15	0.16	**3.09**
SE	2.66	0.92	0.56	0.35	0.22	0.19	**4.91**
SSE	4.00	1.70	1.08	0.54	0.31	0.37	**8.00**
S	4.31	1.60	1.42	1.05	0.61	0.64	**9.63**
SSW	3.30	1.62	1.44	1.17	1.20	1.54	**10.27**
SW	2.73	1.21	1.74	1.69	1.07	1.33	**9.77**
WSW	1.57	0.99	0.95	0.82	0.72	1.77	**6.81**
W	1.08	0.85	0.82	0.57	0.54	1.44	**5.30**
WNW	1.36	0.89	0.77	0.67	0.72	1.50	**5.89**
NW	1.56	0.92	0.77	0.80	0.63	1.16	**5.85**
NNW	2.24	1.37	1.24	1.00	0.71	1.10	**7.67**
Total	**36.44**	**16.85**	**14.95**	**11.32**	**8.07**	**12.37**	**100.00**

Table 57: Annual Average DJF (Surrogate) for Bruce Power Site for Year 2020 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	0.47	0.57	0.72	0.79	0.80	1.96	**5.30**
NNE	0.44	0.65	0.84	0.89	0.88	2.35	**6.05**
NE	0.46	0.60	0.79	0.74	0.59	1.21	**4.39**
ENE	0.40	0.68	0.96	0.96	0.74	0.74	**4.49**
E	0.43	0.80	1.04	0.71	0.33	0.40	**3.70**
ESE	0.38	0.71	0.93	0.45	0.25	0.41	**3.13**
SE	0.30	0.52	0.85	0.90	0.72	1.01	**4.31**
SSE	0.32	0.44	0.77	1.12	1.49	1.94	**6.08**
S	0.28	0.50	0.83	1.58	2.31	2.62	**8.12**
SSW	0.36	0.52	0.94	1.68	2.60	5.59	**11.69**
SW	0.56	0.76	1.16	1.56	1.78	4.49	**10.31**
WSW	0.40	0.63	0.91	0.85	0.70	3.52	**7.00**
W	0.39	0.65	0.68	0.56	0.55	2.76	**5.59**
WNW	0.43	0.60	0.61	0.56	0.62	3.03	**5.85**
NW	0.52	0.73	0.65	0.61	0.62	3.37	**6.50**
NNW	0.60	0.82	0.87	0.78	0.79	3.64	**7.49**
Total	**6.74**	**10.18**	**13.53**	**14.75**	**15.77**	**39.02**	**100.00**

Table 58: Annual Average TJF (Surrogate) for Bruce Power Site for Year 2020 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	0.53	0.30	0.25	0.05	0.03	0.03	**1.19**
	NNE	0.52	0.36	0.34	0.11	0.03	0.01	**1.37**
	NE	0.29	0.17	0.09	0.02	0.01	0.01	**0.58**
	ENE	0.33	0.15	0.10	0.01	0.00	0.00	**0.59**
	E	0.46	0.20	0.07	0.01	0.01	0.00	**0.76**
	ESE	0.43	0.12	0.05	0.02	0.01	0.00	**0.63**
	SE	0.36	0.18	0.05	0.02	0.00	0.00	**0.60**
	SSE	0.35	0.13	0.11	0.03	0.00	0.00	**0.62**
	S	0.34	0.16	0.13	0.03	0.01	0.00	**0.68**
	SSW	0.37	0.14	0.13	0.07	0.03	0.00	**0.74**
	SW	0.37	0.27	0.19	0.08	0.01	0.01	**0.93**
	WSW	0.36	0.28	0.20	0.03	0.01	0.02	**0.89**
	W	0.29	0.37	0.16	0.02	0.02	0.02	**0.88**
	WNW	0.35	0.39	0.16	0.02	0.01	0.00	**0.94**
	NW	0.49	0.43	0.14	0.05	0.03	0.00	**1.14**
	NNW	0.90	0.54	0.19	0.07	0.03	0.00	**1.72**
	Total	**6.72**	**4.19**	**2.37**	**0.64**	**0.23**	**0.11**	**14.26**
B	N	0.21	0.10	0.32	0.32	0.12	0.05	**1.12**
	NNE	0.35	0.37	0.55	0.42	0.15	0.05	**1.89**
	NE	0.13	0.09	0.14	0.12	0.03	0.02	**0.54**
	ENE	0.26	0.10	0.14	0.11	0.03	0.00	**0.65**
	E	0.11	0.11	0.08	0.03	0.00	0.00	**0.32**
	ESE	0.07	0.05	0.07	0.05	0.03	0.02	**0.29**
	SE	0.24	0.16	0.12	0.05	0.03	0.02	**0.63**
	SSE	0.37	0.28	0.26	0.15	0.08	0.06	**1.20**
	S	0.40	0.21	0.27	0.26	0.12	0.10	**1.36**
	SSW	0.38	0.27	0.37	0.41	0.36	0.40	**2.19**
	SW	0.77	0.38	0.94	0.90	0.42	0.15	**3.56**
	WSW	0.26	0.18	0.28	0.12	0.08	0.06	**0.98**
	W	0.15	0.14	0.25	0.11	0.08	0.09	**0.81**
	WNW	0.22	0.15	0.22	0.21	0.13	0.10	**1.03**
	NW	0.23	0.14	0.22	0.27	0.12	0.10	**1.09**
	NNW	0.34	0.35	0.47	0.39	0.20	0.14	**1.89**
	Total	**4.49**	**3.09**	**4.71**	**3.90**	**1.98**	**1.36**	**19.54**

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	0.01	0.03	0.03	0.02	0.01	**0.10**
	NNE	0.03	0.03	0.02	0.01	0.00	0.00	**0.08**
	NE	0.01	0.01	0.01	0.01	0.00	0.00	**0.05**
	ENE	0.09	0.05	0.03	0.02	0.00	0.00	**0.20**
	E	0.02	0.02	0.00	0.00	0.00	0.00	**0.03**
	ESE	0.01	0.00	0.00	0.00	0.00	0.00	**0.03**
	SE	0.08	0.01	0.00	0.00	0.00	0.00	**0.10**
	SSE	0.14	0.12	0.10	0.04	0.01	0.01	**0.42**
	S	0.19	0.16	0.14	0.08	0.05	0.01	**0.64**
	SSW	0.17	0.11	0.13	0.06	0.08	0.07	**0.62**
	SW	0.18	0.14	0.39	0.47	0.19	0.24	**1.60**
	WSW	0.21	0.13	0.19	0.18	0.19	0.54	**1.43**
	W	0.07	0.11	0.09	0.11	0.11	0.23	**0.73**
	WNW	0.06	0.04	0.06	0.09	0.07	0.13	**0.45**
	NW	0.01	0.01	0.04	0.06	0.07	0.11	**0.30**
	NNW	0.04	0.05	0.12	0.16	0.08	0.16	**0.61**
	Total	**1.33**	**1.00**	**1.34**	**1.33**	**0.88**	**1.51**	**7.39**
D	N	0.00	0.03	0.43	0.33	0.22	0.24	**1.26**
	NNE	0.00	0.00	0.24	0.27	0.14	0.11	**0.76**
	NE	0.07	0.03	0.26	0.21	0.10	0.05	**0.73**
	ENE	0.22	0.17	0.29	0.11	0.04	0.04	**0.87**
	E	0.11	0.02	0.11	0.04	0.01	0.00	**0.29**
	ESE	0.05	0.02	0.12	0.07	0.04	0.03	**0.33**
	SE	0.15	0.09	0.27	0.17	0.08	0.04	**0.80**
	SSE	0.57	0.69	0.76	0.25	0.12	0.04	**2.43**
	S	0.52	0.38	0.92	0.63	0.25	0.11	**2.81**
	SSW	0.25	0.45	0.86	0.72	0.64	0.68	**3.60**
	SW	0.02	0.19	0.50	0.51	0.42	0.51	**2.15**
	WSW	0.01	0.12	0.31	0.51	0.42	0.91	**2.28**
	W	0.00	0.07	0.30	0.35	0.34	0.72	**1.80**
	WNW	0.00	0.08	0.37	0.44	0.51	0.66	**2.06**
	NW	0.00	0.06	0.37	0.48	0.45	0.43	**1.79**
	NNW	0.00	0.07	0.54	0.54	0.44	0.45	**2.05**
	Total	**1.99**	**2.48**	**6.63**	**5.63**	**4.24**	**5.03**	**26.00**

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	0.03	0.23	0.06	0.00	0.00	0.00	**0.32**
	NNE	0.06	0.15	0.10	0.00	0.00	0.00	**0.32**
	NE	0.22	0.18	0.05	0.00	0.00	0.00	**0.45**
	ENE	0.68	0.22	0.02	0.00	0.00	0.00	**0.91**
	E	0.38	0.10	0.02	0.00	0.00	0.00	**0.51**
	ESE	0.20	0.08	0.00	0.00	0.00	0.00	**0.29**
	SE	0.60	0.30	0.01	0.00	0.00	0.00	**0.92**
	SSE	1.17	0.60	0.02	0.00	0.00	0.00	**1.78**
	S	1.20	0.55	0.03	0.00	0.00	0.00	**1.78**
	SSW	0.93	0.48	0.04	0.00	0.00	0.00	**1.44**
	SW	0.40	0.24	0.05	0.00	0.00	0.00	**0.69**
	WSW	0.34	0.17	0.03	0.00	0.00	0.00	**0.54**
	W	0.17	0.11	0.03	0.00	0.00	0.00	**0.30**
	WNW	0.21	0.13	0.05	0.00	0.00	0.00	**0.39**
	NW	0.06	0.18	0.05	0.00	0.00	0.00	**0.29**
	NNW	0.06	0.27	0.07	0.00	0.00	0.00	**0.41**
	Total	**6.72**	**4.00**	**0.63**	**0.00**	**0.00**	**0.00**	**11.35**
F	N	0.94	0.27	0.00	0.00	0.00	0.00	**1.21**
	NNE	0.97	0.30	0.00	0.00	0.00	0.00	**1.27**
	NE	1.05	0.25	0.00	0.00	0.00	0.00	**1.31**
	ENE	1.37	0.22	0.00	0.00	0.00	0.00	**1.59**
	E	1.42	0.17	0.00	0.00	0.00	0.00	**1.59**
	ESE	1.08	0.12	0.00	0.00	0.00	0.00	**1.20**
	SE	1.43	0.17	0.00	0.00	0.00	0.00	**1.60**
	SSE	1.95	0.22	0.00	0.00	0.00	0.00	**2.17**
	S	2.14	0.34	0.00	0.00	0.00	0.00	**2.49**
	SSW	1.47	0.25	0.00	0.00	0.00	0.00	**1.72**
	SW	1.01	0.18	0.00	0.00	0.00	0.00	**1.20**
	WSW	0.37	0.12	0.00	0.00	0.00	0.00	**0.49**
	W	0.42	0.14	0.00	0.00	0.00	0.00	**0.55**
	WNW	0.57	0.15	0.00	0.00	0.00	0.00	**0.73**
	NW	0.86	0.19	0.00	0.00	0.00	0.00	**1.05**
	NNW	1.03	0.27	0.00	0.00	0.00	0.00	**1.31**
	Total	**18.09**	**3.38**	**0.00**	**0.00**	**0.00**	**0.00**	**21.46**
Grand Total		**39.33**	**18.15**	**15.69**	**11.49**	**7.33**	**8.01**	**100.00**

APPENDIX C: 2020 DETAILED DOSE CALCULATION RESULTS

Table 59: 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	5.49E-04	6.31E-07	6.49E-06	8.32E-10	6.60E-11	1.58E-08	1.87E-03	1.30E-01	1.93E-01	3.26E-01
	Co-60	9.40E-07	3.56E-08	1.38E-04	6.12E-03	3.05E-03	5.19E-04	4.52E-04	1.66E-05	1.52E-06	1.03E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.16E-03	0.00E+00	0.00E+00	2.65E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.45E-03	0.00E+00	0.00E+00	5.92E-03
	HTO[2]	1.93E-01	0.00E+00	9.00E-03	4.81E-03	0.00E+00	0.00E+00	2.01E-04	6.64E-02	1.92E-02	2.92E-01
	I(mfp)	7.86E-06	5.29E-07	0.00E+00	0.00E+00	1.06E-06	0.00E+00	0.00E+00	2.94E-05	3.21E-05	7.09E-05
	Noble Gases	0.00E+00	1.67E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.67E-01
Total		1.93E-01	1.67E-01	9.15E-03	1.09E-02	3.05E-03	3.48E-03	8.14E-03	1.96E-01	2.12E-01	**8.03E-01**
Child (6-15 yrs)	C-14	7.83E-04	6.31E-07	3.56E-06	8.32E-10	1.43E-10	1.95E-07	1.68E-03	1.45E-01	1.74E-01	3.21E-01
	Co-60	1.34E-06	3.56E-08	1.78E-04	6.12E-03	3.05E-03	5.22E-04	9.51E-04	4.07E-05	2.67E-06	1.09E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.04E-03	0.00E+00	0.00E+00	1.53E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.73E-03	0.00E+00	0.00E+00	4.26E-03
	HTO[2]	2.29E-01	0.00E+00	4.48E-03	4.01E-03	0.00E+00	0.00E+00	1.68E-04	6.30E-02	1.47E-02	3.16E-01
	I(mfp)	1.76E-05	5.29E-07	0.00E+00	0.00E+00	1.06E-06	0.00E+00	0.00E+00	5.32E-05	7.38E-05	1.46E-04
	Noble Gases	0.00E+00	1.67E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.67E-01
Total		2.30E-01	1.67E-01	4.66E-03	1.01E-02	3.05E-03	3.55E-03	5.57E-03	2.08E-01	1.89E-01	**8.20E-01**
Infant (0-5 yrs)	C-14	5.35E-04	6.31E-07	0.00E+00	3.95E-11	2.44E-10	4.30E-07	1.14E-03	1.17E-01	2.40E-01	3.59E-01
	Co-60	9.83E-07	4.63E-08	0.00E+00	7.17E-05	3.96E-03	6.84E-04	7.96E-04	4.52E-05	2.75E-06	5.56E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.04E-04	0.00E+00	0.00E+00	1.05E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	7.07E-04	0.00E+00	0.00E+00	4.00E-03
	HTO[2]	1.58E-01	0.00E+00	0.00E+00	1.28E-04	0.00E+00	0.00E+00	1.20E-04	6.52E-02	2.17E-02	2.45E-01
	I(mfp)	2.10E-05	6.88E-07	0.00E+00	0.00E+00	1.38E-06	0.00E+00	0.00E+00	8.24E-05	2.12E-04	3.18E-04
	Noble Gases	0.00E+00	2.16E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.16E-01
Total		1.59E-01	2.16E-01	0.00E+00	2.00E-04	3.97E-03	4.62E-03	3.17E-03	1.82E-01	2.62E-01	**8.31E-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 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	2.63E-04	3.02E-07	3.12E-06	7.90E-10	8.75E-12	1.58E-08	1.87E-03	1.68E-01	1.53E-01	3.23E-01
	Co-60	7.85E-07	2.98E-08	1.38E-04	6.12E-03	3.98E-03	5.19E-04	4.52E-04	1.83E-05	1.73E-06	1.12E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.16E-03	0.00E+00	0.00E+00	2.65E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.45E-03	0.00E+00	0.00E+00	5.92E-03
	HTO[2]	1.61E-01	0.00E+00	9.01E-03	4.81E-03	0.00E+00	0.00E+00	2.01E-04	5.89E-02	1.73E-02	2.51E-01
	I(mfp)	6.55E-06	4.41E-07	0.00E+00	0.00E+00	9.62E-07	0.00E+00	0.00E+00	2.71E-05	3.05E-05	6.56E-05
	Noble Gases	0.00E+00	1.39E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-01
Total		1.61E-01	1.39E-01	9.15E-03	1.09E-02	3.98E-03	3.48E-03	8.14E-03	2.27E-01	1.70E-01	**7.32E-01**
Child (6-15 yrs)	C-14	3.75E-04	3.02E-07	1.71E-06	7.90E-10	1.90E-11	1.95E-07	1.68E-03	1.82E-01	1.57E-01	3.41E-01
	Co-60	1.12E-06	2.98E-08	1.78E-04	6.12E-03	3.98E-03	5.22E-04	9.51E-04	4.47E-05	3.04E-06	1.18E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.04E-03	0.00E+00	0.00E+00	1.53E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.73E-03	0.00E+00	0.00E+00	4.26E-03
	HTO[2]	1.91E-01	0.00E+00	4.48E-03	4.01E-03	0.00E+00	0.00E+00	1.68E-04	5.37E-02	1.39E-02	2.67E-01
	I(mfp)	1.47E-05	4.41E-07	0.00E+00	0.00E+00	9.64E-07	0.00E+00	0.00E+00	4.91E-05	7.19E-05	1.37E-04
	Noble Gases	0.00E+00	1.39E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-01
Total		1.91E-01	1.39E-01	4.66E-03	1.01E-02	3.98E-03	3.55E-03	5.57E-03	2.36E-01	1.71E-01	**7.65E-01**
Infant (0-5 yrs)	C-14	2.56E-04	3.02E-07	0.00E+00	2.20E-11	3.24E-11	4.30E-07	1.14E-03	1.54E-01	2.29E-01	3.85E-01
	Co-60	8.21E-07	3.87E-08	0.00E+00	7.17E-05	5.18E-03	6.84E-04	7.96E-04	4.95E-05	3.07E-06	6.78E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.04E-04	0.00E+00	0.00E+00	1.05E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	7.07E-04	0.00E+00	0.00E+00	4.00E-03
	HTO[2]	1.32E-01	0.00E+00	0.00E+00	1.28E-04	0.00E+00	0.00E+00	1.20E-04	5.23E-02	2.11E-02	2.05E-01
	I(mfp)	1.75E-05	5.73E-07	0.00E+00	0.00E+00	1.26E-06	0.00E+00	0.00E+00	7.61E-05	2.10E-04	3.06E-04
	Noble Gases	0.00E+00	1.79E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.79E-01
Total		1.32E-01	1.79E-01	0.00E+00	2.00E-04	5.18E-03	4.62E-03	3.17E-03	2.07E-01	2.50E-01	**7.81E-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 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	6.78E-04	7.79E-07	7.60E-06	8.49E-10	1.47E-11	1.58E-08	1.87E-03	2.05E-01	2.11E-01	4.19E-01
	Co-60	1.30E-06	4.94E-08	1.38E-04	6.12E-03	4.84E-03	5.19E-04	4.52E-04	2.03E-05	1.98E-06	1.21E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.16E-03	0.00E+00	0.00E+00	2.65E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.45E-03	0.00E+00	0.00E+00	5.92E-03
	HTO[2]	2.70E-01	0.00E+00	9.01E-03	4.81E-03	0.00E+00	0.00E+00	2.01E-04	9.03E-02	2.32E-02	3.97E-01
	I(mfp)	1.09E-05	7.32E-07	0.00E+00	0.00E+00	1.50E-06	0.00E+00	0.00E+00	4.18E-05	4.07E-05	9.55E-05
	Noble Gases	0.00E+00	2.30E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.30E-01
Total		2.70E-01	2.30E-01	9.16E-03	1.09E-02	4.84E-03	3.48E-03	8.14E-03	2.95E-01	2.35E-01	**1.07E+00**
Child (6-15 yrs)	C-14	9.67E-04	7.79E-07	4.17E-06	8.49E-10	3.19E-11	1.95E-07	1.68E-03	2.04E-01	1.82E-01	3.89E-01
	Co-60	1.86E-06	4.94E-08	1.78E-04	6.12E-03	4.84E-03	5.22E-04	9.51E-04	4.98E-05	3.46E-06	1.27E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.04E-03	0.00E+00	0.00E+00	1.53E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.73E-03	0.00E+00	0.00E+00	4.26E-03
	HTO[2]	3.20E-01	0.00E+00	4.48E-03	4.01E-03	0.00E+00	0.00E+00	1.68E-04	8.44E-02	1.63E-02	4.30E-01
	I(mfp)	2.43E-05	7.32E-07	0.00E+00	0.00E+00	1.50E-06	0.00E+00	0.00E+00	7.56E-05	8.38E-05	1.86E-04
	Noble Gases	0.00E+00	2.30E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.30E-01
Total		3.21E-01	2.30E-01	4.67E-03	1.01E-02	4.84E-03	3.55E-03	5.57E-03	2.89E-01	1.98E-01	**1.07E+00**
Infant (0-5 yrs)	C-14	6.60E-04	7.79E-07	0.00E+00	4.58E-11	5.44E-11	4.30E-07	1.14E-03	1.59E-01	2.46E-01	4.07E-01
	Co-60	1.36E-06	6.42E-08	0.00E+00	7.17E-05	6.29E-03	6.84E-04	7.96E-04	5.49E-05	3.45E-06	7.90E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.04E-04	0.00E+00	0.00E+00	1.05E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	7.07E-04	0.00E+00	0.00E+00	4.00E-03
	HTO[2]	2.21E-01	0.00E+00	0.00E+00	1.28E-04	0.00E+00	0.00E+00	1.20E-04	8.71E-02	2.29E-02	3.31E-01
	I(mfp)	2.91E-05	9.51E-07	0.00E+00	0.00E+00	1.96E-06	0.00E+00	0.00E+00	1.17E-04	2.24E-04	3.74E-04
	Noble Gases	0.00E+00	2.98E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.98E-01
Total		2.22E-01	2.98E-01	0.00E+00	2.00E-04	6.29E-03	4.62E-03	3.17E-03	2.46E-01	2.69E-01	**1.05E+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 62: 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	6.78E-04	7.79E-07	9.48E-06	8.58E-10	1.47E-11	1.58E-08	1.87E-03	2.05E-01	2.11E-01	4.19E-01
	Co-60	1.30E-06	4.94E-08	1.74E-04	6.12E-03	3.52E-03	5.19E-04	4.52E-04	1.97E-05	2.01E-06	1.08E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.16E-03	0.00E+00	0.00E+00	2.65E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.45E-03	0.00E+00	0.00E+00	5.92E-03
	HTO[2]	2.70E-01	0.00E+00	1.51E-02	4.87E-03	0.00E+00	0.00E+00	2.01E-04	8.35E-02	2.35E-02	3.97E-01
	I(mfp)	1.09E-05	7.32E-07	0.00E+00	0.00E+00	1.43E-06	0.00E+00	0.00E+00	3.94E-05	3.90E-05	9.14E-05
	Noble Gases	0.00E+00	2.30E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.30E-01
Total		2.70E-01	2.30E-01	1.53E-02	1.10E-02	3.52E-03	3.48E-03	8.14E-03	2.89E-01	2.35E-01	**1.07E+00**
Child (6-15 yrs)	C-14	9.67E-04	7.79E-07	5.21E-06	8.58E-10	3.19E-11	1.95E-07	1.68E-03	2.04E-01	1.82E-01	3.89E-01
	Co-60	1.86E-06	4.94E-08	2.25E-04	6.12E-03	3.52E-03	5.22E-04	9.51E-04	4.81E-05	3.51E-06	1.14E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.04E-03	0.00E+00	0.00E+00	1.53E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.73E-03	0.00E+00	0.00E+00	4.26E-03
	HTO[2]	3.20E-01	0.00E+00	7.51E-03	4.06E-03	0.00E+00	0.00E+00	1.68E-04	7.68E-02	1.64E-02	4.26E-01
	I(mfp)	2.43E-05	7.32E-07	0.00E+00	0.00E+00	1.43E-06	0.00E+00	0.00E+00	7.13E-05	8.19E-05	1.80E-04
	Noble Gases	0.00E+00	2.30E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.30E-01
Total		3.21E-01	2.30E-01	7.74E-03	1.02E-02	3.52E-03	3.55E-03	5.57E-03	2.81E-01	1.99E-01	**1.06E+00**
Infant (0-5 yrs)	C-14	6.60E-04	7.79E-07	0.00E+00	5.47E-11	5.44E-11	4.30E-07	1.14E-03	1.59E-01	2.46E-01	4.07E-01
	Co-60	1.36E-06	6.42E-08	0.00E+00	7.51E-05	4.58E-03	6.84E-04	7.96E-04	5.34E-05	3.49E-06	6.19E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.04E-04	0.00E+00	0.00E+00	1.05E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	7.07E-04	0.00E+00	0.00E+00	4.00E-03
	HTO[2]	2.21E-01	0.00E+00	0.00E+00	1.80E-04	0.00E+00	0.00E+00	1.20E-04	7.72E-02	2.30E-02	3.22E-01
	I(mfp)	2.91E-05	9.51E-07	0.00E+00	0.00E+00	1.86E-06	0.00E+00	0.00E+00	1.10E-04	2.22E-04	3.64E-04
	Noble Gases	0.00E+00	2.98E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.98E-01
Total		2.22E-01	2.98E-01	0.00E+00	2.56E-04	4.58E-03	4.62E-03	3.17E-03	2.36E-01	2.69E-01	**1.04E+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 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	6.78E-04	7.79E-07	1.48E-05	9.75E-10	9.39E-11	1.58E-08	1.87E-03	2.05E-01	2.11E-01	4.19E-01
	Co-60	1.17E-06	4.42E-08	8.99E-05	6.09E-03	5.82E-03	5.19E-04	4.52E-04	1.31E-05	2.72E-06	1.30E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.16E-03	0.00E+00	0.00E+00	2.65E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.45E-03	0.00E+00	0.00E+00	5.92E-03
	HTO[2]	2.41E-01	0.00E+00	2.56E-02	5.22E-03	0.00E+00	0.00E+00	2.01E-04	8.35E-02	2.22E-02	3.78E-01
	I(mfp)	9.74E-06	6.56E-07	0.00E+00	0.00E+00	1.27E-06	0.00E+00	0.00E+00	3.51E-05	3.60E-05	8.28E-05
	Noble Gases	0.00E+00	2.06E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.06E-01
Total		2.42E-01	2.06E-01	2.57E-02	1.13E-02	5.82E-03	3.48E-03	8.14E-03	2.89E-01	2.34E-01	**1.02E+00**
Child (6-15 yrs)	C-14	9.67E-04	7.79E-07	8.11E-06	9.75E-10	2.04E-10	1.95E-07	1.68E-03	2.04E-01	1.82E-01	3.89E-01
	Co-60	1.66E-06	4.42E-08	1.16E-04	6.09E-03	5.82E-03	5.22E-04	9.51E-04	3.25E-05	4.81E-06	1.35E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.04E-03	0.00E+00	0.00E+00	1.53E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.73E-03	0.00E+00	0.00E+00	4.26E-03
	HTO[2]	2.87E-01	0.00E+00	1.27E-02	4.35E-03	0.00E+00	0.00E+00	1.68E-04	7.68E-02	1.60E-02	3.97E-01
	I(mfp)	2.18E-05	6.56E-07	0.00E+00	0.00E+00	1.27E-06	0.00E+00	0.00E+00	6.35E-05	7.84E-05	1.66E-04
	Noble Gases	0.00E+00	2.06E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.06E-01
Total		2.88E-01	2.06E-01	1.29E-02	1.04E-02	5.82E-03	3.55E-03	5.57E-03	2.81E-01	1.98E-01	**1.01E+00**
Infant (0-5 yrs)	C-14	6.60E-04	7.79E-07	0.00E+00	5.97E-11	3.47E-10	4.30E-07	1.14E-03	1.59E-01	2.46E-01	4.07E-01
	Co-60	1.22E-06	5.75E-08	0.00E+00	7.20E-06	7.57E-03	6.84E-04	7.96E-04	3.52E-05	4.67E-06	9.10E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.04E-04	0.00E+00	0.00E+00	1.05E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	7.07E-04	0.00E+00	0.00E+00	4.00E-03
	HTO[2]	1.98E-01	0.00E+00	0.00E+00	1.89E-04	0.00E+00	0.00E+00	1.20E-04	7.72E-02	2.27E-02	2.98E-01
	I(mfp)	2.61E-05	8.53E-07	0.00E+00	0.00E+00	1.66E-06	0.00E+00	0.00E+00	9.84E-05	2.18E-04	3.45E-04
	Noble Gases	0.00E+00	2.67E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.67E-01
Total		1.98E-01	2.67E-01	0.00E+00	1.96E-04	7.57E-03	4.62E-03	3.17E-03	2.36E-01	2.69E-01	**9.86E-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 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	5.50E-04	6.32E-07	6.50E-06	8.32E-10	6.60E-11	1.58E-08	1.87E-03	1.44E-01	1.93E-01	3.39E-01
	Co-60	1.64E-06	6.23E-08	1.38E-04	6.12E-03	7.94E-03	5.19E-04	4.52E-04	2.64E-05	2.77E-06	1.52E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.16E-03	0.00E+00	0.00E+00	2.65E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.45E-03	0.00E+00	0.00E+00	5.92E-03
	HTO[2]	3.43E-01	0.00E+00	9.00E-03	4.81E-03	0.00E+00	0.00E+00	2.01E-04	7.39E-02	2.72E-02	4.58E-01
	I(mfp)	1.37E-05	9.23E-07	0.00E+00	0.00E+00	1.99E-06	0.00E+00	0.00E+00	5.61E-05	5.06E-05	1.23E-04
	Noble Gases	0.00E+00	2.90E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.90E-01
Total		3.43E-01	2.90E-01	9.15E-03	1.09E-02	7.95E-03	3.48E-03	8.14E-03	2.18E-01	2.21E-01	**1.11E+00**
Child (6-15 yrs)	C-14	7.84E-04	6.32E-07	3.57E-06	8.32E-10	1.43E-10	1.95E-07	1.68E-03	1.63E-01	1.74E-01	3.40E-01
	Co-60	2.34E-06	6.23E-08	1.78E-04	6.12E-03	7.94E-03	5.22E-04	9.51E-04	6.52E-05	4.78E-06	1.58E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.04E-03	0.00E+00	0.00E+00	1.53E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.73E-03	0.00E+00	0.00E+00	4.26E-03
	HTO[2]	4.08E-01	0.00E+00	4.48E-03	4.01E-03	0.00E+00	0.00E+00	1.68E-04	7.38E-02	1.80E-02	5.08E-01
	I(mfp)	3.07E-05	9.23E-07	0.00E+00	0.00E+00	2.00E-06	0.00E+00	0.00E+00	1.02E-04	9.55E-05	2.31E-04
	Noble Gases	0.00E+00	2.90E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.90E-01
Total		4.08E-01	2.90E-01	4.66E-03	1.01E-02	7.95E-03	3.55E-03	5.57E-03	2.37E-01	1.92E-01	**1.16E+00**
Infant (0-5 yrs)	C-14	5.35E-04	6.32E-07	0.00E+00	3.95E-11	2.44E-10	4.30E-07	1.14E-03	1.41E-01	2.40E-01	3.83E-01
	Co-60	1.72E-06	8.09E-08	0.00E+00	7.17E-05	1.03E-02	6.84E-04	7.96E-04	7.13E-05	4.64E-06	1.20E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.04E-04	0.00E+00	0.00E+00	1.05E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	7.07E-04	0.00E+00	0.00E+00	4.00E-03
	HTO[2]	2.81E-01	0.00E+00	0.00E+00	1.28E-04	0.00E+00	0.00E+00	1.20E-04	8.15E-02	2.41E-02	3.87E-01
	I(mfp)	3.67E-05	1.20E-06	0.00E+00	0.00E+00	2.60E-06	0.00E+00	0.00E+00	1.57E-04	2.39E-04	4.36E-04
	Noble Gases	0.00E+00	3.76E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.76E-01
Total		2.82E-01	3.76E-01	0.00E+00	2.00E-04	1.03E-02	4.62E-03	3.17E-03	2.23E-01	2.65E-01	**1.16E+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 65: 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	4.17E-04	4.79E-07	7.61E-06	8.02E-10	1.47E-11	1.58E-08	1.81E-03	2.49E-01	2.39E-01	4.91E-01
	Co-60	5.40E-07	2.05E-08	1.65E-03	6.07E-03	2.29E-03	5.19E-04	4.38E-04	1.87E-04	1.03E-05	1.12E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.10E-03	0.00E+00	0.00E+00	2.59E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.35E-03	0.00E+00	0.00E+00	5.82E-03
	HTO[2]	1.09E-01	0.00E+00	2.12E-02	4.75E-03	0.00E+00	0.00E+00	1.95E-04	1.13E-01	2.04E-02	2.68E-01
	I(mfp)	4.50E-06	3.03E-07	0.00E+00	0.00E+00	6.37E-07	0.00E+00	0.00E+00	3.22E-05	2.43E-05	6.19E-05
	Noble Gases	0.00E+00	9.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.55E-02
Total		1.09E-01	9.55E-02	2.29E-02	1.08E-02	2.29E-03	3.48E-03	7.89E-03	3.63E-01	2.60E-01	**8.74E-01**
Child (6-15 yrs)	C-14	5.95E-04	4.79E-07	4.18E-06	8.02E-10	3.19E-11	1.95E-07	1.63E-03	2.57E-01	1.74E-01	4.34E-01
	Co-60	7.70E-07	2.05E-08	2.13E-03	6.07E-03	2.29E-03	5.22E-04	9.22E-04	4.36E-04	1.65E-05	1.24E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.01E-03	0.00E+00	0.00E+00	1.50E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.68E-03	0.00E+00	0.00E+00	4.21E-03
	HTO[2]	1.29E-01	0.00E+00	1.06E-02	3.96E-03	0.00E+00	0.00E+00	1.63E-04	1.18E-01	1.28E-02	2.75E-01
	I(mfp)	1.01E-05	3.03E-07	0.00E+00	0.00E+00	6.38E-07	0.00E+00	0.00E+00	5.62E-05	4.73E-05	1.15E-04
	Noble Gases	0.00E+00	9.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.55E-02
Total		1.30E-01	9.55E-02	1.27E-02	1.00E-02	2.29E-03	3.55E-03	5.40E-03	3.76E-01	1.87E-01	**8.22E-01**
Infant (0-5 yrs)	C-14	4.06E-04	4.79E-07	0.00E+00	2.31E-11	5.44E-11	4.30E-07	1.11E-03	2.04E-01	1.87E-01	3.92E-01
	Co-60	5.64E-07	2.66E-08	0.00E+00	0.00E+00	2.98E-03	6.84E-04	7.71E-04	4.99E-04	1.46E-05	4.95E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	3.92E-04	0.00E+00	0.00E+00	1.04E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	6.86E-04	0.00E+00	0.00E+00	3.98E-03
	HTO[2]	8.93E-02	0.00E+00	0.00E+00	7.81E-05	0.00E+00	0.00E+00	1.17E-04	1.38E-01	1.51E-02	2.43E-01
	I(mfp)	1.21E-05	3.94E-07	0.00E+00	0.00E+00	8.32E-07	0.00E+00	0.00E+00	8.87E-05	1.23E-04	2.25E-04
	Noble Gases	0.00E+00	1.24E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-01
Total		8.97E-02	1.24E-01	0.00E+00	7.81E-05	2.98E-03	4.62E-03	3.08E-03	3.43E-01	2.02E-01	**7.69E-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 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	4.63E-04	5.33E-07	8.11E-06	8.08E-10	1.47E-11	1.58E-08	1.81E-03	3.69E-01	2.49E-01	6.20E-01
	Co-60	1.17E-06	4.42E-08	1.65E-03	6.07E-03	3.69E-03	5.19E-04	4.38E-04	1.92E-04	1.09E-05	1.26E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.10E-03	0.00E+00	0.00E+00	2.59E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.35E-03	0.00E+00	0.00E+00	5.82E-03
	HTO[2]	2.41E-01	0.00E+00	2.12E-02	4.75E-03	0.00E+00	0.00E+00	1.95E-04	1.77E-01	3.08E-02	4.75E-01
	I(mfp)	9.74E-06	6.56E-07	0.00E+00	0.00E+00	1.31E-06	0.00E+00	0.00E+00	6.54E-05	4.29E-05	1.20E-04
	Noble Gases	0.00E+00	2.06E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.06E-01
Total		2.41E-01	2.06E-01	2.29E-02	1.08E-02	3.69E-03	3.48E-03	7.89E-03	5.46E-01	2.79E-01	**1.32E+00**
Child (6-15 yrs)	C-14	6.61E-04	5.33E-07	4.45E-06	8.08E-10	3.19E-11	1.95E-07	1.63E-03	3.50E-01	1.78E-01	5.30E-01
	Co-60	1.66E-06	4.42E-08	2.13E-03	6.07E-03	3.69E-03	5.22E-04	9.22E-04	4.49E-04	1.75E-05	1.38E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.01E-03	0.00E+00	0.00E+00	1.50E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.68E-03	0.00E+00	0.00E+00	4.21E-03
	HTO[2]	2.87E-01	0.00E+00	1.06E-02	3.96E-03	0.00E+00	0.00E+00	1.63E-04	1.59E-01	1.71E-02	4.77E-01
	I(mfp)	2.18E-05	6.56E-07	0.00E+00	0.00E+00	1.31E-06	0.00E+00	0.00E+00	1.14E-04	6.85E-05	2.07E-04
	Noble Gases	0.00E+00	2.06E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.06E-01
Total		2.87E-01	2.06E-01	1.27E-02	1.00E-02	3.69E-03	3.55E-03	5.40E-03	5.09E-01	1.95E-01	**1.23E+00**
Infant (0-5 yrs)	C-14	4.51E-04	5.33E-07	0.00E+00	2.56E-11	5.44E-11	4.30E-07	1.11E-03	2.70E-01	1.89E-01	4.61E-01
	Co-60	1.22E-06	5.75E-08	0.00E+00	0.00E+00	4.80E-03	6.84E-04	7.71E-04	5.13E-04	1.55E-05	6.78E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	3.92E-04	0.00E+00	0.00E+00	1.04E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	6.86E-04	0.00E+00	0.00E+00	3.98E-03
	HTO[2]	1.98E-01	0.00E+00	0.00E+00	7.81E-05	0.00E+00	0.00E+00	1.17E-04	1.58E-01	1.82E-02	3.74E-01
	I(mfp)	2.61E-05	8.53E-07	0.00E+00	0.00E+00	1.71E-06	0.00E+00	0.00E+00	1.80E-04	1.48E-04	3.58E-04
	Noble Gases	0.00E+00	2.67E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.67E-01
Total		1.98E-01	2.67E-01	0.00E+00	7.81E-05	4.80E-03	4.62E-03	3.08E-03	4.29E-01	2.08E-01	**1.11E+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 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	2.63E-04	3.02E-07	5.94E-06	7.81E-10	8.75E-12	1.58E-08	1.81E-03	2.69E-01	2.08E-01	4.80E-01
	Co-60	7.85E-07	2.98E-08	1.65E-03	6.07E-03	3.70E-03	5.19E-04	4.38E-04	1.92E-04	1.08E-05	1.26E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.10E-03	0.00E+00	0.00E+00	2.59E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.35E-03	0.00E+00	0.00E+00	5.82E-03
	HTO[2]	1.61E-01	0.00E+00	2.12E-02	4.75E-03	0.00E+00	0.00E+00	1.95E-04	1.20E-01	2.45E-02	3.32E-01
	I(mfp)	6.55E-06	4.41E-07	0.00E+00	0.00E+00	9.46E-07	0.00E+00	0.00E+00	4.80E-05	3.31E-05	8.91E-05
	Noble Gases	0.00E+00	1.39E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-01
Total		1.61E-01	1.39E-01	2.29E-02	1.08E-02	3.70E-03	3.48E-03	7.89E-03	3.90E-01	2.33E-01	**9.71E-01**
Child (6-15 yrs)	C-14	3.75E-04	3.02E-07	3.26E-06	7.81E-10	1.90E-11	1.95E-07	1.63E-03	2.85E-01	1.61E-01	4.48E-01
	Co-60	1.12E-06	2.98E-08	2.13E-03	6.07E-03	3.70E-03	5.22E-04	9.22E-04	4.48E-04	1.74E-05	1.38E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.01E-03	0.00E+00	0.00E+00	1.50E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.68E-03	0.00E+00	0.00E+00	4.21E-03
	HTO[2]	1.91E-01	0.00E+00	1.06E-02	3.96E-03	0.00E+00	0.00E+00	1.63E-04	1.07E-01	1.45E-02	3.28E-01
	I(mfp)	1.47E-05	4.41E-07	0.00E+00	0.00E+00	9.48E-07	0.00E+00	0.00E+00	8.39E-05	5.74E-05	1.57E-04
	Noble Gases	0.00E+00	1.39E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-01
Total		1.91E-01	1.39E-01	1.27E-02	1.00E-02	3.70E-03	3.55E-03	5.40E-03	3.93E-01	1.75E-01	**9.34E-01**
Infant (0-5 yrs)	C-14	2.56E-04	3.02E-07	0.00E+00	1.45E-11	3.24E-11	4.30E-07	1.11E-03	2.47E-01	1.77E-01	4.26E-01
	Co-60	8.21E-07	3.87E-08	0.00E+00	0.00E+00	4.81E-03	6.84E-04	7.71E-04	5.12E-04	1.54E-05	6.79E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	3.92E-04	0.00E+00	0.00E+00	1.04E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	6.86E-04	0.00E+00	0.00E+00	3.98E-03
	HTO[2]	1.32E-01	0.00E+00	0.00E+00	7.81E-05	0.00E+00	0.00E+00	1.17E-04	1.04E-01	1.63E-02	2.53E-01
	I(mfp)	1.75E-05	5.73E-07	0.00E+00	0.00E+00	1.24E-06	0.00E+00	0.00E+00	1.32E-04	1.35E-04	2.87E-04
	Noble Gases	0.00E+00	1.79E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.79E-01
Total		1.32E-01	1.79E-01	0.00E+00	7.81E-05	4.81E-03	4.62E-03	3.08E-03	3.52E-01	1.94E-01	**8.70E-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 68: 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	4.17E-04	4.79E-07	5.20E-06	8.01E-10	1.47E-11	1.58E-08	8.13E-03	7.35E-01	4.79E-01	1.22E+00
	Co-60	5.40E-07	2.05E-08	0.00E+00	6.07E-03	1.73E-03	5.19E-04	1.96E-03	1.63E-05	1.64E-06	1.03E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	9.41E-03	0.00E+00	0.00E+00	9.90E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	1.50E-02	0.00E+00	0.00E+00	1.75E-02
	HTO[2]	1.09E-01	0.00E+00	9.58E-03	4.75E-03	0.00E+00	0.00E+00	8.73E-04	1.87E-01	4.06E-02	3.52E-01
	I(mfp)	4.50E-06	3.03E-07	0.00E+00	0.00E+00	6.06E-07	0.00E+00	0.00E+00	7.18E-05	6.79E-05	1.45E-04
	Noble Gases	0.00E+00	9.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.55E-02
Total		1.09E-01	9.55E-02	9.59E-03	1.08E-02	1.73E-03	3.48E-03	3.54E-02	9.22E-01	5.20E-01	**1.71E+00**
Child (6-15 yrs)	C-14	5.95E-04	4.79E-07	2.85E-06	8.01E-10	3.19E-11	1.95E-07	7.30E-03	8.07E-01	3.81E-01	1.20E+00
	Co-60	7.70E-07	2.05E-08	0.00E+00	6.07E-03	1.73E-03	5.22E-04	4.13E-03	4.13E-05	3.30E-06	1.25E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	4.51E-03	0.00E+00	0.00E+00	5.01E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	7.52E-03	0.00E+00	0.00E+00	1.00E-02
	HTO[2]	1.29E-01	0.00E+00	4.77E-03	3.96E-03	0.00E+00	0.00E+00	7.30E-04	1.95E-01	3.64E-02	3.71E-01
	I(mfp)	1.01E-05	3.03E-07	0.00E+00	0.00E+00	6.07E-07	0.00E+00	0.00E+00	1.31E-04	1.97E-04	3.39E-04
	Noble Gases	0.00E+00	9.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.55E-02
Total		1.30E-01	9.55E-02	4.77E-03	4.03E-03	1.73E-03	3.55E-03	2.42E-02	1.00E+00	4.18E-01	**1.69E+00**
Infant (0-5 yrs)	C-14	4.06E-04	4.79E-07	0.00E+00	2.32E-11	5.44E-11	4.30E-07	4.98E-03	6.33E-01	4.37E-01	1.07E+00
	Co-60	5.64E-07	2.66E-08	0.00E+00	0.00E+00	2.24E-03	6.84E-04	3.46E-03	4.21E-05	4.21E-06	6.43E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	1.76E-03	0.00E+00	0.00E+00	2.40E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	3.07E-03	0.00E+00	0.00E+00	6.36E-03
	HTO[2]	8.93E-02	0.00E+00	0.00E+00	7.80E-05	0.00E+00	0.00E+00	5.23E-04	2.15E-01	5.81E-02	3.63E-01
	I(mfp)	1.21E-05	3.94E-07	0.00E+00	0.00E+00	7.91E-07	0.00E+00	0.00E+00	1.93E-04	6.41E-04	8.47E-04
	Noble Gases	0.00E+00	1.24E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-01
Total		8.97E-02	1.24E-01	0.00E+00	7.80E-05	2.25E-03	4.62E-03	1.38E-02	8.48E-01	4.96E-01	**1.58E+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 69: 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	4.17E-04	4.79E-07	5.20E-06	8.01E-10	1.47E-11	1.58E-08	8.13E-03	7.60E-01	4.79E-01	1.25E+00
	Co-60	5.40E-07	2.05E-08	0.00E+00	6.07E-03	2.30E-03	5.19E-04	1.96E-03	2.10E-05	2.13E-06	1.09E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	9.41E-03	0.00E+00	0.00E+00	9.90E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	1.50E-02	0.00E+00	0.00E+00	1.75E-02
	HTO[2]	1.09E-01	0.00E+00	9.58E-03	4.75E-03	0.00E+00	0.00E+00	8.73E-04	2.12E-01	4.06E-02	3.77E-01
	I(mfp)	4.50E-06	3.03E-07	0.00E+00	0.00E+00	6.37E-07	0.00E+00	0.00E+00	7.63E-05	7.22E-05	1.54E-04
	Noble Gases	0.00E+00	9.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.55E-02
Total		1.09E-01	9.55E-02	9.59E-03	1.08E-02	2.30E-03	3.48E-03	3.54E-02	9.72E-01	5.20E-01	**1.76E+00**
Child (6-15 yrs)	C-14	5.95E-04	4.79E-07	2.85E-06	8.01E-10	3.19E-11	1.95E-07	7.30E-03	8.41E-01	3.81E-01	1.23E+00
	Co-60	7.70E-07	2.05E-08	0.00E+00	6.07E-03	2.30E-03	5.22E-04	4.13E-03	5.33E-05	4.28E-06	1.31E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	4.51E-03	0.00E+00	0.00E+00	5.01E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	7.52E-03	0.00E+00	0.00E+00	1.00E-02
	HTO[2]	1.29E-01	0.00E+00	4.77E-03	3.96E-03	0.00E+00	0.00E+00	7.30E-04	1.92E-01	3.64E-02	3.67E-01
	I(mfp)	1.01E-05	3.03E-07	0.00E+00	0.00E+00	6.38E-07	0.00E+00	0.00E+00	1.39E-04	2.10E-04	3.60E-04
	Noble Gases	0.00E+00	9.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.55E-02
Total		1.30E-01	9.55E-02	4.77E-03	1.00E-02	2.30E-03	3.55E-03	2.42E-02	1.03E+00	4.18E-01	**1.72E+00**
Infant (0-5 yrs)	C-14	4.06E-04	4.79E-07	0.00E+00	2.32E-11	5.44E-11	4.30E-07	4.98E-03	6.90E-01	4.37E-01	1.13E+00
	Co-60	5.64E-07	2.66E-08	0.00E+00	0.00E+00	2.99E-03	6.84E-04	3.46E-03	5.45E-05	5.45E-06	7.19E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	1.76E-03	0.00E+00	0.00E+00	2.40E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	3.07E-03	0.00E+00	0.00E+00	6.36E-03
	HTO[2]	8.93E-02	0.00E+00	0.00E+00	7.80E-05	0.00E+00	0.00E+00	5.23E-04	1.78E-01	5.81E-02	3.26E-01
	I(mfp)	1.21E-05	3.94E-07	0.00E+00	0.00E+00	8.32E-07	0.00E+00	0.00E+00	2.05E-04	6.81E-04	8.99E-04
	Noble Gases	0.00E+00	1.24E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-01
Total		8.97E-02	1.24E-01	0.00E+00	7.80E-05	2.99E-03	4.62E-03	1.38E-02	8.68E-01	4.96E-01	**1.60E+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 70: 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	2.63E-04	3.02E-07	2.56E-06	7.80E-10	8.75E-12	1.58E-08	2.03E-03	3.55E-01	2.54E-01	6.11E-01
	Co-60	7.85E-07	2.98E-08	0.00E+00	6.07E-03	3.49E-03	5.19E-04	4.91E-04	1.53E-05	1.97E-06	1.06E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.35E-03	0.00E+00	0.00E+00	2.84E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.75E-03	0.00E+00	0.00E+00	6.22E-03
	HTO[2]	1.61E-01	0.00E+00	7.48E-03	4.75E-03	0.00E+00	0.00E+00	2.18E-04	1.14E-01	2.93E-02	3.17E-01
	I(mfp)	6.55E-06	4.41E-07	0.00E+00	0.00E+00	9.35E-07	0.00E+00	0.00E+00	5.48E-05	7.84E-05	1.41E-04
	Noble Gases	0.00E+00	1.39E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-01
Total		1.61E-01	1.39E-01	7.48E-03	1.08E-02	3.49E-03	3.48E-03	8.85E-03	4.69E-01	2.83E-01	**1.09E+00**
Child (6-15 yrs)	C-14	3.75E-04	3.02E-07	1.40E-06	7.80E-10	1.90E-11	1.95E-07	1.83E-03	3.84E-01	2.23E-01	6.09E-01
	Co-60	1.12E-06	2.98E-08	0.00E+00	6.07E-03	3.49E-03	5.22E-04	1.03E-03	3.77E-05	4.18E-06	1.12E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.13E-03	0.00E+00	0.00E+00	1.62E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.88E-03	0.00E+00	0.00E+00	4.41E-03
	HTO[2]	1.91E-01	0.00E+00	3.72E-03	3.96E-03	0.00E+00	0.00E+00	1.83E-04	1.01E-01	2.35E-02	3.23E-01
	I(mfp)	1.47E-05	4.41E-07	0.00E+00	0.00E+00	9.36E-07	0.00E+00	0.00E+00	9.71E-05	2.47E-04	3.60E-04
	Noble Gases	0.00E+00	1.39E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-01
Total		1.91E-01	1.39E-01	3.72E-03	1.00E-02	3.49E-03	3.55E-03	6.05E-03	4.85E-01	2.47E-01	**1.09E+00**
Infant (0-5 yrs)	C-14	2.56E-04	3.02E-07	0.00E+00	1.46E-11	3.24E-11	4.30E-07	1.24E-03	3.14E-01	2.80E-01	5.95E-01
	Co-60	8.21E-07	3.87E-08	0.00E+00	0.00E+00	4.53E-03	6.84E-04	8.65E-04	3.84E-05	5.89E-06	6.13E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.39E-04	0.00E+00	0.00E+00	1.08E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	7.69E-04	0.00E+00	0.00E+00	4.06E-03
	HTO[2]	1.32E-01	0.00E+00	0.00E+00	7.80E-05	0.00E+00	0.00E+00	1.31E-04	9.13E-02	3.51E-02	2.58E-01
	I(mfp)	1.75E-05	5.73E-07	0.00E+00	0.00E+00	1.22E-06	0.00E+00	0.00E+00	1.43E-04	8.27E-04	9.89E-04
	Noble Gases	0.00E+00	1.79E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.79E-01
Total		1.32E-01	1.79E-01	0.00E+00	7.80E-05	4.53E-03	4.62E-03	3.45E-03	4.06E-01	3.16E-01	**1.05E+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 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	4.17E-04	4.79E-07	4.06E-06	8.01E-10	0.00E+00	1.58E-08	2.03E-03	3.45E-01	2.94E-01	6.42E-01
	Co-60	5.40E-07	2.05E-08	0.00E+00	6.07E-03	1.94E-03	5.19E-04	4.91E-04	8.69E-06	1.12E-06	9.03E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.35E-03	0.00E+00	0.00E+00	2.84E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.75E-03	0.00E+00	0.00E+00	6.22E-03
	HTO[2]	1.09E-01	0.00E+00	7.48E-03	4.75E-03	0.00E+00	0.00E+00	2.18E-04	9.31E-02	3.15E-02	2.46E-01
	I(mfp)	4.50E-06	3.03E-07	0.00E+00	0.00E+00	6.17E-07	0.00E+00	0.00E+00	3.59E-05	5.14E-05	9.27E-05
	Noble Gases	0.00E+00	9.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.55E-02
Total		1.09E-01	9.55E-02	7.49E-03	1.08E-02	1.94E-03	3.48E-03	8.85E-03	4.38E-01	3.26E-01	**1.00E+00**
Child (6-15 yrs)	C-14	5.95E-04	4.79E-07	2.23E-06	8.01E-10	0.00E+00	1.95E-07	1.83E-03	3.70E-01	2.58E-01	6.31E-01
	Co-60	7.70E-07	2.05E-08	0.00E+00	6.07E-03	1.94E-03	5.22E-04	1.03E-03	2.14E-05	2.37E-06	9.59E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.13E-03	0.00E+00	0.00E+00	1.62E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.88E-03	0.00E+00	0.00E+00	4.41E-03
	HTO[2]	1.29E-01	0.00E+00	3.72E-03	3.96E-03	0.00E+00	0.00E+00	1.83E-04	9.55E-02	3.62E-02	2.69E-01
	I(mfp)	1.01E-05	3.03E-07	0.00E+00	0.00E+00	6.18E-07	0.00E+00	0.00E+00	6.36E-05	1.62E-04	2.36E-04
	Noble Gases	0.00E+00	9.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.55E-02
Total		1.30E-01	9.55E-02	3.72E-03	1.00E-02	1.94E-03	3.55E-03	6.05E-03	4.65E-01	2.95E-01	**1.01E+00**
Infant (0-5 yrs)	C-14	4.06E-04	4.79E-07	0.00E+00	2.32E-11	0.00E+00	4.30E-07	1.24E-03	2.87E-01	3.36E-01	6.25E-01
	Co-60	5.64E-07	2.66E-08	0.00E+00	0.00E+00	2.52E-03	6.84E-04	8.65E-04	2.18E-05	3.34E-06	4.10E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.39E-04	0.00E+00	0.00E+00	1.08E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	7.69E-04	0.00E+00	0.00E+00	4.06E-03
	HTO[2]	8.93E-02	0.00E+00	0.00E+00	7.80E-05	0.00E+00	0.00E+00	1.31E-04	1.05E-01	6.62E-02	2.60E-01
	I(mfp)	1.21E-05	3.94E-07	0.00E+00	0.00E+00	8.07E-07	0.00E+00	0.00E+00	9.34E-05	5.42E-04	6.49E-04
	Noble Gases	0.00E+00	1.24E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-01
Total		8.97E-02	1.24E-01	0.00E+00	7.80E-05	2.52E-03	4.62E-03	3.45E-03	3.92E-01	4.02E-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 72: 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	2.63E-04	3.02E-07	2.56E-06	7.80E-10	8.75E-12	1.58E-08	2.03E-03	3.55E-01	2.81E-01	6.38E-01
	Co-60	7.85E-07	2.98E-08	0.00E+00	6.07E-03	3.51E-03	5.19E-04	4.91E-04	1.54E-05	1.99E-06	1.06E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.35E-03	0.00E+00	0.00E+00	2.84E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.75E-03	0.00E+00	0.00E+00	6.22E-03
	HTO[2]	1.59E-01	0.00E+00	7.48E-03	4.75E-03	0.00E+00	0.00E+00	2.18E-04	1.15E-01	3.27E-02	3.19E-01
	I(mfp)	6.55E-06	4.41E-07	0.00E+00	0.00E+00	9.36E-07	0.00E+00	0.00E+00	5.49E-05	7.86E-05	1.41E-04
	Noble Gases	0.00E+00	1.39E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-01
Total		1.59E-01	1.39E-01	7.48E-03	1.08E-02	3.51E-03	3.48E-03	8.85E-03	4.69E-01	3.14E-01	**1.12E+00**
Child (6-15 yrs)	C-14	3.75E-04	3.02E-07	1.40E-06	7.80E-10	1.90E-11	1.95E-07	1.83E-03	3.84E-01	2.92E-01	6.78E-01
	Co-60	1.12E-06	2.98E-08	0.00E+00	6.07E-03	3.51E-03	5.22E-04	1.03E-03	3.80E-05	4.21E-06	1.12E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.13E-03	0.00E+00	0.00E+00	1.62E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.88E-03	0.00E+00	0.00E+00	4.41E-03
	HTO[2]	1.89E-01	0.00E+00	3.72E-03	3.96E-03	0.00E+00	0.00E+00	1.83E-04	1.01E-01	3.17E-02	3.29E-01
	I(mfp)	1.47E-05	4.41E-07	0.00E+00	0.00E+00	9.38E-07	0.00E+00	0.00E+00	9.73E-05	2.47E-04	3.61E-04
	Noble Gases	0.00E+00	1.39E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-01
Total		1.89E-01	1.39E-01	3.72E-03	1.00E-02	3.51E-03	3.55E-03	6.05E-03	4.85E-01	3.24E-01	**1.16E+00**
Infant (0-5 yrs)	C-14	2.56E-04	3.02E-07	0.00E+00	1.46E-11	3.24E-11	4.30E-07	1.24E-03	3.14E-01	4.26E-01	7.41E-01
	Co-60	8.21E-07	3.87E-08	0.00E+00	0.00E+00	4.57E-03	6.84E-04	8.65E-04	3.86E-05	5.93E-06	6.16E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.39E-04	0.00E+00	0.00E+00	1.08E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	7.69E-04	0.00E+00	0.00E+00	4.06E-03
	HTO[2]	1.30E-01	0.00E+00	0.00E+00	7.80E-05	0.00E+00	0.00E+00	1.31E-04	9.13E-02	5.35E-02	2.75E-01
	I(mfp)	1.75E-05	5.73E-07	0.00E+00	0.00E+00	1.22E-06	0.00E+00	0.00E+00	1.43E-04	8.28E-04	9.90E-04
	Noble Gases	0.00E+00	1.79E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.79E-01
Total		1.31E-01	1.79E-01	0.00E+00	7.80E-05	4.57E-03	4.62E-03	3.45E-03	4.06E-01	4.80E-01	**1.21E+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 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	4.17E-04	4.79E-07	4.06E-06	8.01E-10	0.00E+00	1.58E-08	2.03E-03	3.55E-01	3.40E-01	6.97E-01
	Co-60	5.40E-07	2.05E-08	0.00E+00	6.07E-03	1.51E-03	5.19E-04	4.91E-04	6.97E-06	8.92E-07	8.59E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.35E-03	0.00E+00	0.00E+00	2.84E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.75E-03	0.00E+00	0.00E+00	6.22E-03
	HTO[2]	1.09E-01	0.00E+00	7.48E-03	4.75E-03	0.00E+00	0.00E+00	2.18E-04	1.14E-01	2.86E-02	2.64E-01
	I(mfp)	4.50E-06	3.03E-07	0.00E+00	0.00E+00	5.94E-07	0.00E+00	0.00E+00	3.42E-05	4.90E-05	8.87E-05
	Noble Gases	0.00E+00	9.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.55E-02
Total		1.09E-01	9.55E-02	7.49E-03	1.08E-02	1.51E-03	3.48E-03	8.85E-03	4.69E-01	3.69E-01	**1.07E+00**
Child (6-15 yrs)	C-14	5.95E-04	4.79E-07	2.23E-06	8.01E-10	0.00E+00	1.95E-07	1.83E-03	3.84E-01	3.73E-01	7.60E-01
	Co-60	7.70E-07	2.05E-08	0.00E+00	6.07E-03	1.51E-03	5.22E-04	1.03E-03	1.72E-05	1.89E-06	9.15E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.13E-03	0.00E+00	0.00E+00	1.62E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.88E-03	0.00E+00	0.00E+00	4.41E-03
	HTO[2]	1.29E-01	0.00E+00	3.72E-03	3.96E-03	0.00E+00	0.00E+00	1.83E-04	1.01E-01	2.95E-02	2.67E-01
	I(mfp)	1.01E-05	3.03E-07	0.00E+00	0.00E+00	5.95E-07	0.00E+00	0.00E+00	6.07E-05	1.54E-04	2.26E-04
	Noble Gases	0.00E+00	9.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.55E-02
Total		1.30E-01	9.55E-02	3.72E-03	1.00E-02	1.51E-03	3.55E-03	6.05E-03	4.85E-01	4.03E-01	**1.14E+00**
Infant (0-5 yrs)	C-14	4.06E-04	4.79E-07	0.00E+00	2.32E-11	0.00E+00	4.30E-07	1.24E-03	3.14E-01	5.80E-01	8.96E-01
	Co-60	5.64E-07	2.66E-08	0.00E+00	0.00E+00	1.96E-03	6.84E-04	8.65E-04	1.75E-05	2.68E-06	3.53E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.39E-04	0.00E+00	0.00E+00	1.08E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	7.69E-04	0.00E+00	0.00E+00	4.06E-03
	HTO[2]	8.93E-02	0.00E+00	0.00E+00	7.80E-05	0.00E+00	0.00E+00	1.31E-04	9.12E-02	5.11E-02	2.32E-01
	I(mfp)	1.21E-05	3.94E-07	0.00E+00	0.00E+00	7.76E-07	0.00E+00	0.00E+00	8.91E-05	5.17E-04	6.19E-04
	Noble Gases	0.00E+00	1.24E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-01
Total		8.97E-02	1.24E-01	0.00E+00	7.80E-05	1.96E-03	4.62E-03	3.45E-03	4.05E-01	6.32E-01	**1.26E+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 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	4.17E-04	4.79E-07	4.06E-06	8.01E-10	0.00E+00	1.58E-08	2.03E-03	3.45E-01	3.40E-01	6.87E-01
	Co-60	5.40E-07	2.05E-08	0.00E+00	6.07E-03	1.25E-03	5.19E-04	4.91E-04	5.94E-06	7.56E-07	8.33E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.35E-03	0.00E+00	0.00E+00	2.84E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.75E-03	0.00E+00	0.00E+00	6.22E-03
	HTO[2]	1.09E-01	0.00E+00	7.48E-03	4.75E-03	0.00E+00	0.00E+00	2.18E-04	9.31E-02	2.86E-02	2.43E-01
	I(mfp)	4.50E-06	3.03E-07	0.00E+00	0.00E+00	5.79E-07	0.00E+00	0.00E+00	3.33E-05	4.76E-05	8.62E-05
	Noble Gases	0.00E+00	9.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.55E-02
Total		1.09E-01	9.55E-02	7.49E-03	1.08E-02	1.25E-03	3.48E-03	8.85E-03	4.38E-01	3.69E-01	**1.04E+00**
Child (6-15 yrs)	C-14	5.95E-04	4.79E-07	2.23E-06	8.01E-10	0.00E+00	1.95E-07	1.83E-03	3.70E-01	3.73E-01	7.45E-01
	Co-60	7.70E-07	2.05E-08	0.00E+00	6.07E-03	1.25E-03	5.22E-04	1.03E-03	1.46E-05	1.61E-06	8.89E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.13E-03	0.00E+00	0.00E+00	1.62E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.88E-03	0.00E+00	0.00E+00	4.41E-03
	HTO[2]	1.29E-01	0.00E+00	3.72E-03	3.96E-03	0.00E+00	0.00E+00	1.83E-04	9.55E-02	2.95E-02	2.62E-01
	I(mfp)	1.01E-05	3.03E-07	0.00E+00	0.00E+00	5.80E-07	0.00E+00	0.00E+00	5.89E-05	1.50E-04	2.20E-04
	Noble Gases	0.00E+00	9.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.55E-02
Total		1.30E-01	9.55E-02	3.72E-03	1.00E-02	1.25E-03	3.55E-03	6.05E-03	4.65E-01	4.03E-01	**1.12E+00**
Infant (0-5 yrs)	C-14	4.06E-04	4.79E-07	0.00E+00	2.32E-11	0.00E+00	4.30E-07	1.24E-03	2.87E-01	5.80E-01	8.69E-01
	Co-60	5.64E-07	2.66E-08	0.00E+00	0.00E+00	1.63E-03	6.84E-04	8.65E-04	1.49E-05	2.27E-06	3.19E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.39E-04	0.00E+00	0.00E+00	1.08E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	7.69E-04	0.00E+00	0.00E+00	4.06E-03
	HTO[2]	8.93E-02	0.00E+00	0.00E+00	7.80E-05	0.00E+00	0.00E+00	1.31E-04	1.05E-01	5.11E-02	2.45E-01
	I(mfp)	1.21E-05	3.94E-07	0.00E+00	0.00E+00	7.57E-07	0.00E+00	0.00E+00	8.65E-05	5.02E-04	6.02E-04
	Noble Gases	0.00E+00	1.24E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-01
Total		8.97E-02	1.24E-01	0.00E+00	7.80E-05	1.63E-03	4.62E-03	3.45E-03	3.92E-01	6.32E-01	**1.25E+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 75: 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	4.17E-04	4.79E-07	4.06E-06	8.01E-10	0.00E+00	1.58E-08	2.03E-03	3.45E-01	2.89E-01	6.36E-01
	Co-60	5.40E-07	2.05E-08	0.00E+00	6.07E-03	1.49E-03	5.19E-04	4.91E-04	6.89E-06	8.82E-07	8.58E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	2.35E-03	0.00E+00	0.00E+00	2.84E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	3.75E-03	0.00E+00	0.00E+00	6.22E-03
	HTO[2]	1.09E-01	0.00E+00	7.48E-03	4.75E-03	0.00E+00	0.00E+00	2.18E-04	9.31E-02	2.53E-02	2.40E-01
	I(mfp)	4.50E-06	3.03E-07	0.00E+00	0.00E+00	5.93E-07	0.00E+00	0.00E+00	3.42E-05	4.89E-05	8.85E-05
	Noble Gases	0.00E+00	9.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.55E-02
Total		1.09E-01	9.55E-02	7.49E-03	1.08E-02	1.49E-03	3.48E-03	8.85E-03	4.38E-01	3.14E-01	**9.89E-01**
Child (6-15 yrs)	C-14	5.95E-04	4.79E-07	2.23E-06	8.01E-10	0.00E+00	1.95E-07	1.83E-03	3.70E-01	2.45E-01	6.17E-01
	Co-60	7.70E-07	2.05E-08	0.00E+00	6.07E-03	1.49E-03	5.22E-04	1.03E-03	1.70E-05	1.87E-06	9.13E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	1.13E-03	0.00E+00	0.00E+00	1.62E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	1.88E-03	0.00E+00	0.00E+00	4.41E-03
	HTO[2]	1.29E-01	0.00E+00	3.72E-03	3.96E-03	0.00E+00	0.00E+00	1.83E-04	9.55E-02	2.20E-02	2.55E-01
	I(mfp)	1.01E-05	3.03E-07	0.00E+00	0.00E+00	5.94E-07	0.00E+00	0.00E+00	6.06E-05	1.54E-04	2.26E-04
	Noble Gases	0.00E+00	9.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.55E-02
Total		1.30E-01	9.55E-02	3.72E-03	1.00E-02	1.49E-03	3.55E-03	6.05E-03	4.65E-01	2.67E-01	**9.83E-01**
Infant (0-5 yrs)	C-14	4.06E-04	4.79E-07	0.00E+00	2.32E-11	0.00E+00	4.30E-07	1.24E-03	2.87E-01	3.07E-01	5.96E-01
	Co-60	5.64E-07	2.66E-08	0.00E+00	0.00E+00	1.94E-03	6.84E-04	8.65E-04	1.73E-05	2.65E-06	3.51E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	4.39E-04	0.00E+00	0.00E+00	1.08E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	7.69E-04	0.00E+00	0.00E+00	4.06E-03
	HTO[2]	8.93E-02	0.00E+00	0.00E+00	7.80E-05	0.00E+00	0.00E+00	1.31E-04	1.05E-01	3.44E-02	2.28E-01
	I(mfp)	1.21E-05	3.94E-07	0.00E+00	0.00E+00	7.74E-07	0.00E+00	0.00E+00	8.89E-05	5.16E-04	6.18E-04
	Noble Gases	0.00E+00	1.24E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-01
Total		8.97E-02	1.24E-01	0.00E+00	7.80E-05	1.94E-03	4.62E-03	3.45E-03	3.92E-01	3.42E-01	**9.57E-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 76: 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	6.02E-05	6.92E-08	2.27E-05	4.85E-10	1.44E-10	2.77E-09	8.13E-03	1.15E-01	8.85E-02	2.12E-01
	Co-60	1.80E-07	6.81E-09	1.46E-04	4.74E-05	4.93E-03	5.19E-04	1.96E-03	4.79E-05	1.11E-05	7.66E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-04	9.41E-03	0.00E+00	0.00E+00	9.90E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-03	1.50E-02	0.00E+00	0.00E+00	1.75E-02
	HTO[2]	3.21E-02	0.00E+00	6.67E-02	2.26E-03	0.00E+00	0.00E+00	8.73E-04	1.25E-01	4.74E-02	2.74E-01
	I(mfp)	1.50E-06	1.01E-07	0.00E+00	0.00E+00	1.94E-07	0.00E+00	0.00E+00	2.28E-05	2.20E-05	4.66E-05
	Noble Gases	0.00E+00	3.17E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.17E-02
Total		3.22E-02	3.17E-02	6.69E-02	2.31E-03	4.93E-03	3.48E-03	3.54E-02	2.40E-01	1.36E-01	**5.53E-01**
Child (6-15 yrs)	C-14	8.59E-05	6.92E-08	1.24E-05	4.85E-10	3.13E-10	3.44E-08	7.30E-03	1.27E-01	8.72E-02	2.22E-01
	Co-60	2.56E-07	6.81E-09	1.87E-04	4.74E-05	4.93E-03	5.22E-04	4.13E-03	1.18E-04	2.07E-05	9.96E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	4.51E-03	0.00E+00	0.00E+00	5.01E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-03	7.52E-03	0.00E+00	0.00E+00	1.00E-02
	HTO[2]	3.82E-02	0.00E+00	3.32E-02	1.89E-03	0.00E+00	0.00E+00	7.30E-04	1.15E-01	5.98E-02	2.49E-01
	I(mfp)	3.36E-06	1.01E-07	0.00E+00	0.00E+00	1.94E-07	0.00E+00	0.00E+00	4.16E-05	6.42E-05	1.09E-04
	Noble Gases	0.00E+00	3.17E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.17E-02
Total		3.83E-02	3.17E-02	3.34E-02	1.93E-03	4.93E-03	3.55E-03	2.42E-02	2.42E-01	1.47E-01	**5.27E-01**
Infant (0-5 yrs)	C-14	5.86E-05	6.92E-08	0.00E+00	9.17E-11	5.33E-10	7.57E-08	4.98E-03	1.02E-01	1.17E-01	2.24E-01
	Co-60	1.88E-07	8.86E-09	0.00E+00	1.16E-05	6.40E-03	6.84E-04	3.46E-03	1.23E-04	2.16E-05	1.07E-02
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.45E-04	1.76E-03	0.00E+00	0.00E+00	2.40E-03
	Cs-137[1]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-03	3.07E-03	0.00E+00	0.00E+00	6.36E-03
	HTO[2]	2.64E-02	0.00E+00	0.00E+00	4.93E-04	0.00E+00	0.00E+00	5.23E-04	1.05E-01	1.07E-01	2.40E-01
	I(mfp)	4.02E-06	1.31E-07	0.00E+00	0.00E+00	2.53E-07	0.00E+00	0.00E+00	6.13E-05	2.06E-04	2.72E-04
	Noble Gases	0.00E+00	4.11E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.11E-02
Total		2.64E-02	4.11E-02	0.00E+00	5.05E-04	6.40E-03	4.62E-03	1.38E-02	2.08E-01	2.24E-01	**5.24E-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 77: 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	6.04E-05	6.95E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.05E-05
	Co-60	1.81E-07	6.85E-09	0.00E+00	0.00E+00	8.88E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.89E-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]	3.69E-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	3.69E-02
	I(mfp)	1.51E-06	1.01E-07	0.00E+00	0.00E+00	2.20E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-06
	Noble Gases	0.00E+00	3.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.19E-02
Total		3.70E-02	3.19E-02	0.00E+00	0.00E+00	8.89E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**6.98E-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 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 78: 2020 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	3.47E+02	4.72E+00	3.65E+02	96%	94%
Q2	4.56E+02	5.74E+00	4.64E+02	100%	97%
Q3	4.42E+02	1.86E+01	4.46E+02	103%	95%
Q4	1.60E+01	1.59E+00	1.79E+01	98%	80%

Table 79: 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	1.21E+01	8.14E-01	1.07E+01	121%	106%
Q2	1.21E+01	8.13E-01	1.01E+01	128%	112%
Q3	1.02E+01	6.90E-01	9.23E+00	118%	103%
Q4	1.17E+01	7.85E-01	9.99E+00	125%	109%

Table 80: 2020 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	2.43E+00	1.32E-01	2.42E+00	106%	95%
Q2	3.05E+00	1.55E-01	3.02E+00	106%	96%
Q3	3.32E+00	2.23E-01	3.52E+00	101%	88%
Q4	3.12E+00	1.80E-01	3.40E+00	97%	86%

Table 81: 2020 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	2.52E+00	1.11E-01	2.75E+00	96%	88%
Cobalt-58	2.12E+00	6.42E-02	2.32E+00	94%	88%
Cobalt-60	3.98E+00	8.44E-02	4.18E+00	97%	93%
Chromium-51	6.40E+00	3.18E-01	6.97E+00	96%	87%
Cesium-134	2.65E+00	5.07E-02	2.96E+00	91%	88%
Cesium-137	3.27E+00	9.65E-02	3.50E+00	96%	91%
Iron-59	2.84E+00	6.91E-02	3.09E+00	94%	90%
Manganese-54	3.78E+00	1.11E-01	3.94E+00	99%	93%
Zinc-65	4.83E+00	1.46E-01	5.23E+00	95%	90%

Table 82: 2020 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	2.09E+00	8.26E-02	2.82E+00	77%	71%

Table 83: 2020 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	6.92E+00	3.78E-01	6.37E+00	115%	103%
	Cobalt-58	6.88E+00	2.30E-01	6.92E+00	103%	96%
	Cobalt-60	9.28E+00	2.15E-01	8.72E+00	109%	104%
	Chromium-51	1.27E+01	9.96E-01	1.28E+01	107%	91%
	Cesium-134	5.90E+00	1.45E-01	5.69E+00	106%	101%
	Cesium-137	7.01E+00	2.53E-01	6.86E+00	106%	99%
	Iron-59	5.58E+00	2.49E-01	5.80E+00	100%	92%
	Iodine-131	2.44E+00	1.76E-01	2.43E+00	108%	93%
	Manganese-54	8.21E+00	2.71E-01	7.93E+00	107%	100%
	Zinc-65	9.81E+00	5.72E-01	9.52E+00	109%	97%
Q2	Cerium-141	4.99E+00	3.15E-01	4.35E+00	122%	108%
	Cobalt-58	3.47E+00	1.84E-01	3.76E+00	97%	87%
	Cobalt-60	7.32E+00	1.76E-01	7.31E+00	102%	98%
	Chromium-51	9.24E+00	1.07E+00	9.59E+00	107%	85%
	Cesium-134	5.60E+00	1.41E-01	5.48E+00	105%	100%
	Cesium-137	3.96E+00	1.60E-01	3.88E+00	106%	98%
	Iron-59	3.78E+00	1.57E-01	3.78E+00	104%	96%
	Iodine-131	3.29E+00	2.44E-01	2.98E+00	119%	102%
	Manganese-54	5.19E+00	1.87E-01	5.01E+00	107%	100%
	Zinc-65	8.50E+00	3.31E-01	8.41E+00	105%	97%
Q3	Cerium-141	5.30E+00	3.37E-01	5.57E+00	101%	89%
	Cobalt-58	6.89E+00	2.64E-01	6.67E+00	107%	99%
	Cobalt-60	1.46E+01	3.21E-01	1.41E+01	106%	101%
	Chromium-51	1.43E+01	1.41E+00	1.38E+01	114%	94%
	Cesium-134	7.54E+00	1.69E-01	7.43E+00	104%	99%

Quarter	Analyte	Bruce Power Value V_L (Bq/L)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/L)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
	Cesium-137	9.59E+00	3.15E-01	9.28E+00	107%	100%
	Iron-59	7.42E+00	2.49E-01	7.44E+00	103%	96%
	Iodine-131	3.51E+00	4.35E-01	3.63E+00	109%	85%
	Manganese-54	7.06E+00	3.97E-01	6.69E+00	112%	100%
	Zinc-65	1.04E+01	3.91E-01	1.00E+01	108%	100%
Q4	Cerium-141	4.35E+00	2.70E-01	3.92E+00	118%	104%
	Cobalt-58	3.24E+00	2.04E-01	3.30E+00	104%	92%
	Cobalt-60	6.23E+00	1.55E-01	5.94E+00	108%	102%
	Chromium-51	1.08E+01	1.38E+00	9.91E+00	123%	95%
	Cesium-134	4.32E+00	1.31E-01	4.22E+00	105%	99%
	Cesium-137	4.97E+00	1.88E-01	4.99E+00	103%	96%
	Iron-59	4.18E+00	1.72E-01	4.39E+00	99%	91%
	Iodine-131	3.92E+00	3.32E-01	3.54E+00	120%	101%
	Manganese-54	5.88E+00	2.06E-01	5.60E+00	109%	101%
	Zinc-65	7.58E+00	3.11E-01	7.44E+00	106%	98%

Table 84: 2020 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	1.09E+01	4.91E-01	1.09E+01	105%	96%
	Cobalt-58	1.05E+01	3.30E-01	1.19E+01	91%	85%
	Cobalt-60	1.39E+01	2.92E-01	1.49E+01	95%	91%
	Chromium-51	2.14E+01	1.06E+00	2.20E+01	102%	92%
	Cesium-134	8.48E+00	1.54E-01	9.75E+00	89%	85%
	Cesium-137	1.31E+01	4.01E-01	1.44E+01	94%	88%
	Iron-59	8.92E+00	2.31E-01	9.95E+00	92%	87%
	Manganese-54	1.22E+01	3.82E-01	1.36E+01	92%	87%
	Zinc-65	1.47E+01	4.71E-01	1.63E+01	93%	87%
Q2	Cerium-141	7.87E+00	5.24E-01	7.63E+00	110%	96%
	Cobalt-58	5.84E+00	1.94E-01	6.60E+00	91%	86%
	Cobalt-60	1.15E+01	2.41E-01	1.28E+01	92%	88%
	Chromium-51	1.51E+01	7.80E-01	1.68E+01	95%	86%
	Cesium-134	8.48E+00	1.52E-01	9.61E+00	90%	87%
	Cesium-137	8.69E+00	2.72E-01	9.49E+00	94%	89%
	Iron-59	6.14E+00	1.90E-01	6.64E+00	95%	90%
	Manganese-54	8.02E+00	2.66E-01	8.79E+00	94%	88%
	Zinc-65	1.35E+01	4.05E-01	1.48E+01	94%	88%
Q3	Cerium-141	7.56E+00	3.70E-01	7.05E+00	112%	102%
	Cobalt-58	7.88E+00	2.59E-01	8.43E+00	97%	90%
	Cobalt-60	1.68E+01	3.58E-01	1.78E+01	96%	92%
	Chromium-51	1.64E+01	8.90E-01	1.75E+01	99%	88%
	Cesium-134	8.66E+00	1.69E-01	9.40E+00	94%	90%
	Cesium-137	1.37E+01	4.17E-01	1.44E+01	98%	92%
	Iron-59	8.55E+00	2.74E-01	9.42E+00	94%	88%

Quarter	Analyte	Bruce Power Value V_L (Bq/kg)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/kg)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
	Manganese-54	7.96E+00	2.71E-01	8.46E+00	97%	91%
	Zinc-65	1.21E+01	3.99E-01	1.27E+01	98%	92%
Q4	Cerium-141	6.69E+00	3.44E-01	6.28E+00	112%	101%
	Cobalt-58	4.84E+00	1.57E-01	5.29E+00	94%	88%
	Cobalt-60	9.21E+00	2.02E-01	9.52E+00	99%	95%
	Chromium-51	1.60E+01	8.63E-01	1.59E+01	106%	95%
	Cesium-134	6.03E+00	2.79E-01	6.76E+00	93%	85%
	Cesium-137	9.91E+00	3.04E-01	1.06E+01	96%	91%
	Iron-59	6.49E+00	2.21E-01	7.04E+00	95%	89%
	Manganese-54	8.56E+00	2.85E-01	8.98E+00	99%	92%
	Zinc-65	1.11E+01	3.66E-01	1.19E+01	97%	90%

APPENDIX E: FISH IMPINGEMENT QA/QC VERIFICATION OF FROZEN FISH

Table 85: Listing of impinged fish placed in Bruce A and Bruce B pump house freezers by Operations staff and the results of the QA/QC verification performed by Bruce Power field biologists (2017-2020)

ID #	Date	Unit	Reported Species	Correct ID?	Corrected Species ID / Comment
14106	9-Jan-17	4	Longnose Sucker	Yes	
14110	11-Jan-17	4	Lake Whitefish	Yes	
14110	11-Jan-17	4	Lake Whitefish	Yes	
14110	11-Jan-17	4	Lake Whitefish	Yes	
14114	8-Jan-17	4	Lake Whitefish	Yes	
14138	1-Jan-17	8	Round Whitefish	No	Lake Whitefish
14399	28-Jan-17	8	Lake Whitefish	Yes	
14405	29-Jan-17	8	Lake Whitefish	No	Round Whitefish
14479	2-Feb-17	8	Round Whitefish	No	Lake Whitefish
14706	18-Feb-17	8	Lake Whitefish	Yes	
14706	18-Feb-17	8	Lake Whitefish	Yes	
14787	25-Feb-17	8	Unknown	No	Walleye
14787	27-Feb-17	8	Lake Whitefish	Yes	
14914	6-Mar-17	6	Sculpin	No	Round Goby
14914	6-Mar-17	6	Spottail Shiner	No	Trout Perch
14963	9-Mar-17	8	Gizzard Shad	Yes	
14963	9-Mar-17	8	Gizzard Shad	Yes	
15027	16-Mar-17	8	Lake Whitefish	Yes	
15055	8-Mar-17	3	Lake Whitefish	Yes	
15055	8-Mar-17	3	Lake Whitefish	Yes	
15058	9-Mar-17	4	Gizzard Shad	Yes	
15065	11-Mar-17	4	Lake Whitefish	No	Gizzard Shad
15097	18-Mar-17	8	Lake Whitefish	Yes	
15097	18-Mar-17	8	Lake Whitefish	Yes	
15097	18-Mar-17	8	Lake Whitefish	No	Gizzard Shad
15109	19-Mar-17	6	Lake Whitefish	No	Gizzard Shad

ID #	Date	Unit	Reported Species	Correct ID?	Corrected Species ID / Comment
15196	29-Mar-17	8	Lake Whitefish	Yes	
15265	21-Mar-17	8	Lake Whitefish	No	Gizzard Shad
15265	21-Mar-17	8	Lake Whitefish	No	Gizzard Shad
15265	21-Mar-17	8	Lake Whitefish	No	Gizzard Shad
15265	21-Mar-17	8	Lake Whitefish	No	Gizzard Shad
15265	21-Mar-17	8	Lake Whitefish	No	Gizzard Shad
15265	21-Mar-17	8	Lake Whitefish	No	Gizzard Shad
15265	21-Mar-17	8	Lake Whitefish	Yes	
15589	24-Apr-17	4	Lake Whitefish	Yes	
15599	22-Apr-17	8	Round Whitefish	Yes	
15684	26-Apr-17	4	Chinook Salmon	No	Brown Trout
15788	5-May-17	4	Gizzard Shad	Yes	
15788	5-May-17	4	Lake Whitefish	Yes	
15788	5-May-17	4	Lake Whitefish	Yes	
15899	12-May-17	8	Lake Whitefish	Yes	
16023	24-May-17	8	Longnose Sucker	Yes	
16023	24-May-17	8	Longnose Sucker	Yes	
16023	24-May-17	8	Round Goby	Yes	
16023	24-May-17	8	White Sucker	Yes	
16023	24-May-17	8	White Sucker	Yes	
16023	24-May-17	8	White Sucker	Yes	
16023	24-May-17	8	Yellow Perch	Yes	
16034	27-May-17	8	Channel Catfish	Yes	
16034	27-May-17	8	Lake Trout	Yes	
16066	22-May-17	4	Lake Whitefish	Yes	
16137	30-May-17	4	Lake Whitefish	Yes	
16169	3-Jun-17	8	Lake Whitefish	Yes	
16181	5-Jun-17	8	Lake Whitefish	Yes	
16225	11-Jun-17	3	Chinook Salmon	No	Walleye
16279	11-Jun-17	5	Unknown	No	Longnose Sucker

ID #	Date	Unit	Reported Species	Correct ID?	Corrected Species ID / Comment
16290	14-Jun-17	6	Lake Whitefish	No	Walleye
16311	17-Jun-17	8	Lake Whitefish	Yes	
16311	17-Jun-17	8	Lake Whitefish	Yes	
16375	22-Jun-17	8	Lake Whitefish	Yes	
16375	22-Jun-17	8	Lake Whitefish	Yes	
16399	25-Jun-17	8	Lake Whitefish	Yes	
16460	29-Jun-17	8	Lake Whitefish	Yes	
16462	27-Jun-17	6	Lake Whitefish	No	White Sucker
16587	8-Jul-17	8	Longnose Sucker	Yes	old Lamprey wound
16599	10-Jul-17	8	Round Whitefish	Yes	
16734	24-Jul-17	8	Lake Whitefish	Yes	
16734	24-Jul-17	8	Lake Whitefish	Yes	
16855	30-Jul-17	6	Round Whitefish	No	Longnose Sucker
16945	7-Aug-17	8	Coho Salmon	No	Rainbow Trout
16945	7-Aug-17	8	Round Whitefish	No	Walleye
16960	8-Aug-17	6	Coho Salmon	No	Lake Trout
17011	12-Aug-17	8	Lake Trout	Yes	
17011	12-Aug-17	8	Lake Trout	Yes	
17031	16-Aug-17	1	Coho Salmon	No	Rainbow Trout
17049	18-Aug-17	4	Carp	Yes	
17049	18-Aug-17	4	Lake Trout	Yes	
17053	21-Aug-17	4	Lake Whitefish	Yes	
17055	21-Aug-17	2	Burbot	Yes	
17055	21-Aug-17	2	Burbot	Yes	
17055	21-Aug-17	2	Burbot	Yes	
17055	21-Aug-17	2	Burbot	Yes	
17055	21-Aug-17	2	Burbot	Yes	
17085	18-Aug-17	8	Lake Whitefish	Yes	
17189	29-Aug-17	7	Lake Whitefish	Yes	
17241	1-Sep-17	4	Burbot	Yes	

ID #	Date	Unit	Reported Species	Correct ID?	Corrected Species ID / Comment
17264	1-Sep-17	8	Lake Whitefish	Yes	
17338	10-Sep-17	8	Lake Whitefish	Yes	
17391	13-Sep-17	4	Lake Trout	Yes	
17500	26-Sep-17	8	Lake Whitefish	Yes	
17558	30-Sep-17	8	Unknown	No	Lake Whitefish
17765	21-Oct-17	8	Lake Whitefish	Yes	
18064	14-Nov-17	8	Lake Whitefish	Yes	
18111	20-Nov-17	7	Unknown	No	Walleye
18189	25-Nov-17	6	Deep Water Sculpin	No	Yellow Perch
18189	25-Nov-17	6	Deep Water Sculpin	No	Yellow Perch
18189	25-Nov-17	6	Deep Water Sculpin	No	Yellow Perch
18223	27-Nov-17	8	White Bass	Yes	
18223	27-Nov-17	8	White Bass	Yes	
18267	4-Dec-17	8	Yellow Perch	Yes	
18290	5-Dec-17	8	Lake Whitefish	Yes	
18301	7-Dec-17	8	Lake Whitefish	Yes	
18380	13-Dec-17	8	Lake Whitefish	No	Longnose Sucker
18494	25-Dec-17	8	Lake Whitefish	Yes	
18494	25-Dec-17	8	Lake Whitefish	Yes	
18534	27-Dec-17	4	Lake Whitefish	Yes	
18534	27-Dec-17	4	Lake Whitefish	Yes	
18585	3-Jan-18	8	Lake Whitefish	Yes	
18585	3-Jan-18	8	Round Whitefish	No	Lake Whitefish
18594	5-Jan-18	8	Round Whitefish	No	Lake Whitefish
18640	10-Jan-18	8	Unknown	No	Gizzard Shad
18854	29-Jan-18	8	Brown Trout	No	Lake Trout
19147	25-Feb-18	6	Round Whitefish	No	Decomposed Lake Whitefish
19148	25-Feb-18	5	Lake Whitefish	No	Gizzard Shad
19170	26-Feb-18	8	Unknown	No	Rainbow Smelt
19170	26-Feb-18	8	Unknown	No	Rainbow Smelt

ID #	Date	Unit	Reported Species	Correct ID?	Corrected Species ID / Comment
19174	27-Feb-18	8	Lake Whitefish	Yes	
19209	1-Mar-18	8	Lake Whitefish Juvenile	Yes	
19220	2-Mar-18	6	Lake Whitefish	Yes	
19223	3-Mar-18	8	Lake Whitefish	Yes	
19223	3-Mar-18	8	Lake Whitefish	Yes	
19304	10-Mar-18	8	Unknown	No	Gizzard Shad
19308	11-Mar-18	8	Lake Whitefish	Yes	
19413	20-Mar-18	8	Lake Whitefish	Yes	
19417	20-Mar-18	8	Lake Whitefish (31 Individuals)	No	Gizzard Shad (31 Individuals)
19626	8-Apr-18	6	Lake Whitefish	No	Gizard Shad
19789	24-Apr-18	5	Unknown	No	Gizzard Shad
19925	6-May-18	5	Lake Whitefish	No	Gizzard Shad
20178	29-May-18	8	Unknown	No	Round Goby
20357	14-Jun-18	4	Lake Whitefish	Yes	
20361	15-Jun-18	8	Lake Whitefish	Yes	
20397	19-Jun-18	8	Lake Whitefish	Yes	
20397	19-Jun-18	8	Unknown	No	Burbot
20450	25-Jun-18	8	Brown Bullhead	No	Channel Catfish
20450	25-Jun-18	8	Brown Bullhead	No	Channel Catfish
20454	26-Jun-18	8	Round Whitefish	No	Lake Whitefish
20480	27-Jun-18	2	Longnose Sucker	No	White Sucker
20480	27-Jun-18	2	Unknown	No	Smallmouth Bass
20480	27-Jun-18	2	White Sucker	No	Longnose Sucker
20483	28-Jun-18	3	Lake Whitefish	Yes	
20537	3-Jul-18	1	Round Whitefish	No	Lake Trout
20557	6-Jul-18	4	Lake Whitefish	Yes	
20617	10-Jul-18	8	Lake Whitefish	Yes	
20680	16-Jul-18	8	Lake Whitefish	Yes	
20683	16-Jul-18	5	Lake Whitefish	Yes	

ID #	Date	Unit	Reported Species	Correct ID?	Corrected Species ID / Comment
20727	21-Jul-18	7	Lake Whitefish	Yes	
20742	23-Jul-18	8	Unknown	No	Walleye
20742	23-Jul-18	8	Unknown	No	Walleye
20762	24-Jul-18	8	Lake Whitefish	Yes	
20762	24-Jul-18	8	Lake Whitefish	Yes	
20785	25-Jul-18	8	Lake Whitefish	No	Walleye
20785	25-Jul-18	8	Lake Whitefish	No	Redhorse Sucker
20785	25-Jul-18	8	Lake Whitefish	No	Walleye
20785	25-Jul-18	8	Lake Whitefish	No	Walleye
20805	28-Jul-18	8	Lake Whitefish	Yes	
20875	1-Aug-18	2	Burbot	Yes	
20894	4-Aug-18	7	Burbot	Yes	
21029	16-Aug-18	5	Lake Whitefish	Yes	
21073	20-Aug-18	8	Lake Whitefish	Yes	
21077	21-Aug-18	8	Lake Whitefish	Yes	
21081	22-Aug-18	4	Lake Whitefish	Yes	
21130	26-Aug-18	8	Lake Whitefish	Yes	
21130	26-Aug-18	8	Round Whitefish	Yes	
21167	27-Aug-18	8	Lake Whitefish	Yes	
21182	29-Aug-18	4	Lake Whitefish	Yes	
21230	3-Sep-18	8	Lake Whitefish	Yes	
21250	4-Sep-18	7	Lake Whitefish	Yes	
21261	5-Sep-18	4	Lake Whitefish	No	Lake Trout
21261	5-Sep-18	4	Unknown	No	Burbot
21262	5-Sep-18	3	Unknown (decomposed)	No	Burbot
21263	5-Sep-18	2	Longnose Sucker	Yes	
21269	6-Sep-18	7	Lake Whitefish	Yes	
21282	8-Sep-18	7	Lake Chub	No	Rainbow Smelt
21580	4-Oct-18	7	Lake Whitefish	Yes	
21604	6-Oct-18	7	Round Whitefish	No	Lake Trout

ID #	Date	Unit	Reported Species	Correct ID?	Corrected Species ID / Comment
21630	10-Oct-18	5	Brown Bullhead	No	Burbot
21710	16-Oct-18	5	Lamprey Eel	Yes	
21794	23-Oct-18	7	Unknown	No	Burbot
22265	6-Dec-18	8	Unknown	No	White Sucker
22563	9-Jan-19	5	Gizzard Shad	Yes	
22741	27-Jan-19	8	Lake Whitefish	No	Lake Trout
22821	2-Feb-19	7	Round Whitefish	No	Gizzard Shad
22934	14-Feb-19	8	Lake Trout	Yes	
22953	14-Feb-19	4	Rainbow Trout	No	Longnose Sucker
22966	15-Feb-19	8	Lake Whitefish	No	Gizzard Shad
23106	2-Mar-19	4	Gizzard Shad	Yes	
23313	20-Mar-19	8	Lake Whitefish	No	Gizzard Shad
23313	20-Mar-19	8	Lake Whitefish	No	Gizzard Shad
23313	27-Mar-19	6	Lake Whitefish	Yes	
23345	24-Mar-19	8	Lake Whitefish	Yes	
23461	3-Apr-19	8	Round Whitefish	No	Lake Whitefish- Juvenile
23492	6-Apr-19	8	Round Whitefish	No	Lake Whitefish
23492	6-Apr-19	8	Round Whitefish	No	Lake Whitefish
23492	6-Apr-19	8	Round Whitefish	No	Lake Whitefish
23521	29-Mar-19	2	Gizzard Shad	Yes	
23521	29-Mar-19	2	Salmon	No	Walleye
23584	14-Apr-19	8	Lake Whitefish	No	Gizzard Shad
23584	14-Apr-19	8	Lake Whitefish	No	Gizzard Shad
23584	14-Apr-19	8	Lake Whitefish	No	Gizzard Shad
23618	15-Apr-19	3	Walleye	Yes	
23618	15-Apr-19	3	Walleye	Yes	
23618	15-Apr-19	3	Walleye	Yes	
23696	23-Apr-19	2	Gizzard Shad (35 individuals)	Yes	
23728	26-Apr-19	8	Lake Whitefish	Yes	
23870	9-May-19	8	Lake Whitefish	Yes	

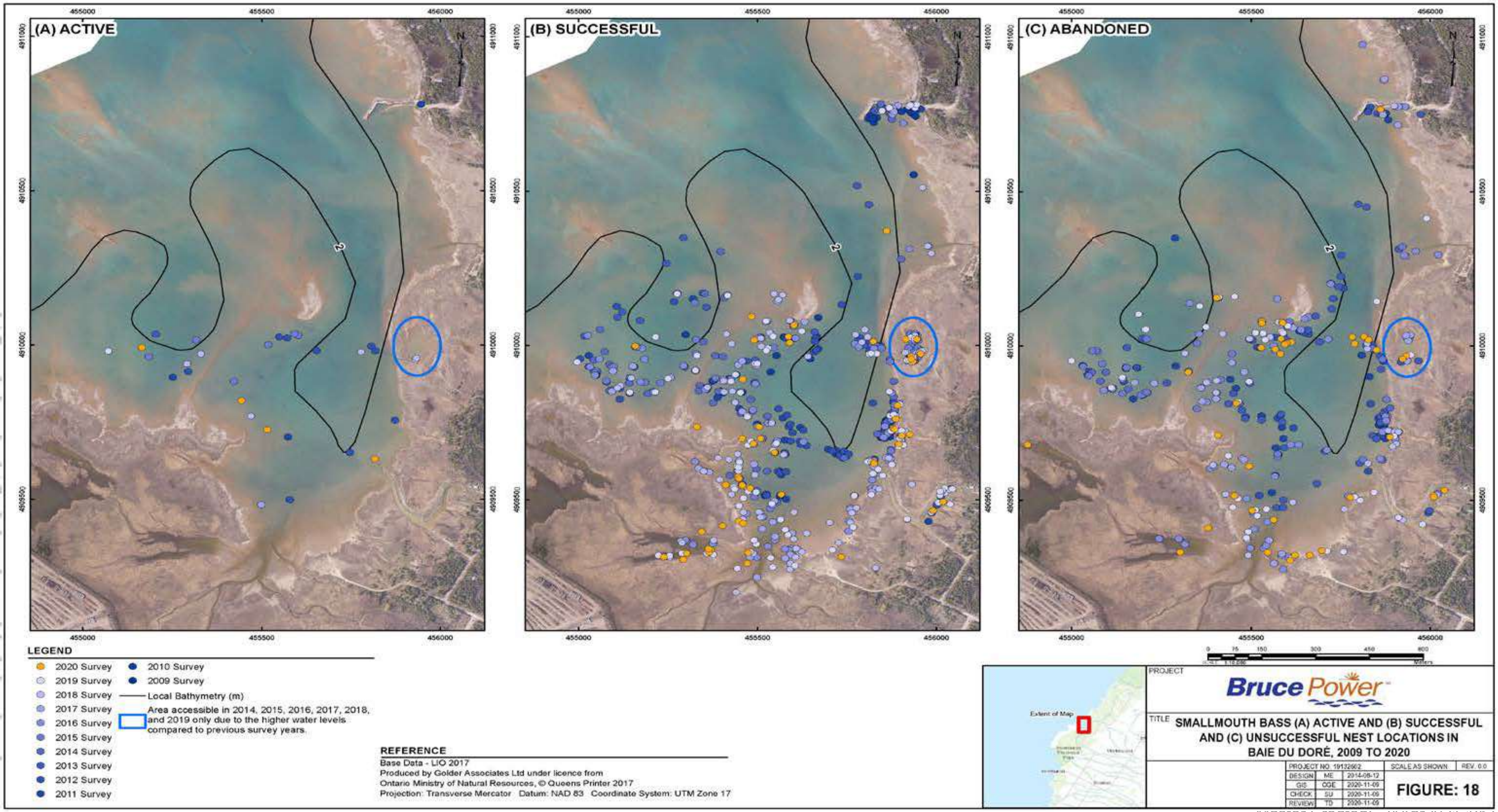
ID #	Date	Unit	Reported Species	Correct ID?	Corrected Species ID / Comment
24078	28-May-19	7	Unknown	No	Round Goby
24164	7-Jun-19	8	Lake Whitefish	No	Lake Trout
24168	8-Jun-19	8	Lake Whitefish	Yes	
24313	22-Jun-19	8	Walleye	Yes	
24317	23-Jun-19	8	Lake Whitefish	Yes	
24317	23-Jun-19	8	Lake Whitefish	Yes	
24428	2-Jul-19	5	Burbot	Yes	
24441	8-Jul-19	8	Walleye	Yes	
24622	20-Jul-19	8	Lake Whitefish	Yes	
24654	22-Jul-19	8	Lake Whitefish	Yes	
24654	22-Jul-19	8	Lake Whitefish	Yes	
24662	23-Jul-19	8	Lake Whitefish	Yes	
24694	27-Jul-19	8	Carp	Yes	
24694	27-Jul-19	8	Round Whitefish	No	Lake Whitefish
24726	30-Jul-19	8	Lake Trout	Yes	
24726	30-Jul-19	8	Longnose Sucker	Yes	
24770	4-Aug-19	8	Lake Whitefish	No	Freshwater Drum
24783	1-Aug-19	2	Unknown	No	Burbot
24921	15-Aug-19	8	Brown Trout	No	Walleye
24921	15-Aug-19	8	Redhorse Sucker	No	Longnose Sucker
25365	28-Sep-19	8	Lake Whitefish	Yes	
25560	20-Oct-19	8	Lake Whitefish	Yes	
25954	21-Nov-19	5	Unknown	No	Burbot
26196	13-Dec-19	8	Lake Whitefish	Yes	
26196	13-Dec-19	8	Lake Whitefish	Yes	
26196	13-Dec-19	8	Lake Whitefish	Yes	
26207	16-Dec-19	8	Round Whitefish	No	Lake Whitefish
26211	16-Dec-19	8	Lake Whitefish	Yes	
26211	16-Dec-19	8	Lake Whitefish	Yes	
26382	20-Dec-19	8	Lake Whitefish	Yes	

ID #	Date	Unit	Reported Species	Correct ID?	Corrected Species ID / Comment
26391	6-Jan-20	6	Unknown	No	Burbot
26394	7-Jan-20	8	Walleye	Yes	
26394	7-Jan-20	8	Walleye	No	Lake Trout
26395	7-Jan-20	6	White Bass	Yes	
26403	8-Jan-20	6	White Bass	Yes	
26423	9-Jan-20	8	Lake Whitefish	Yes	
26423	9-Jan-20	8	Lake Whitefish	Yes	
26423	9-Jan-20	8	Lake Whitefish	Yes	
26423	9-Jan-20	8	Lake Whitefish	Yes	
26423	9-Jan-20	8	Walleye	Yes	
26423	9-Jan-20	8	Walleye	Yes	
26423	9-Jan-20	8	Walleye	Yes	
26423	9-Jan-20	8	Walleye	Yes	
26442	12-Jan-20	8	Lake Chub	No	Juvenile Longnose Sucker
26442	12-Jan-20	8	Lake Whitefish	Yes	
26455	10-Jan-20	8	Lake Whitefish	Yes	
26455	10-Jan-20	8	Lake Whitefish	Yes	
26496	15-Jan-20	8	Round Whitefish	No	Lake Whitefish
26800	11-Feb-20	2	Lake Whitefish	Yes	
27011	1-Mar-20	5	Rock Bass	Yes	
27022	2-Mar-20	8	Lake Trout	Yes	
27038	2-Mar-20	5	Gizzard Shad	Yes	
27038	2-Mar-20	5	White Sucker	No	Longnose Sucker
27067	5-Mar-20	8	Channel Catfish	Yes	
27074	6-Mar-20	8	Lake Whitefish	Yes	
27098	9-Mar-20	8	Lake Whitefish	Yes	
27199	16-Mar-20	6	Lake Whitefish	Yes	
27202	17-Mar-20	6	Round Whitefish	No	Longnose Sucker
27290	1-Apr-20	3	Gizzard Shad	Yes	
27324	3-Apr-20	6	Burbot	No	Channel Catfish

ID #	Date	Unit	Reported Species	Correct ID?	Corrected Species ID / Comment
27406	18-Apr-20	1	Lake Whitefish	No	White Sucker
27478	21-Apr-20	8	Lake Whitefish	Yes	
27482	22-Apr-20	8	Lake Whitefish	Yes	
27566	7-May-20	1	Lake Whitefish	No	White Sucker
27757	28-May-20	8	Carp	Yes	
27757	28-May-20	8	Lake Whitefish	Yes	
27904	14-Jun-20	4	Lake Whitefish	No	Gizzard Shad
27998	27-Jun-20	7	Longnose Sucker	Yes	
28079	7-Jul-20	8	Lake Whitefish	Yes	
28087	9-Jul-20	5	White Sucker	No	Longnose Sucker
28366	12-Aug-20	8	Lake Whitefish	Yes	
28468	27-Aug-20	2	Burbot	Yes	
28468	27-Aug-20	2	Burbot	Yes	
28474	27-Aug-20	8	Lake Whitefish	Yes	
28507	30-Aug-20	8	Lake Whitefish	Yes	
28554	5-Sep-20	8	Lake Whitefish	Yes	
28565	6-Sep-20	7	Lake Whitefish	Yes	
28964	26-Oct-20	5	Burbot	Yes	
28968	27-Oct-20	4	Lake Whitefish	Yes	
29280	5-Dec-20	7	Lake Whitefish	Yes	

APPENDIX F: SMALLMOUTH BASS NESTING LOCATIONS IN THE BRUCE A AND BRUCE B DISCHARGES AND IN BAIE DU DORĖ (2009-2020)


(A) ACTIVE
(B) SUCCESSFUL
(C) ABANDONED
N
451400
451500
451600
451700
4907300
4907200
4907100
4907000
LEGEND
2020 Survey
2019 Survey
2018 Survey
2017 Survey
2016 Survey
2015 Survey
2014 Survey
2013 Survey
2012 Survey
2011 Survey
2010 Survey
2009 Survey
Direction of Flow
REFERENCE
Base Data - LIO 2017
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2017
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17
0 25 50 100 150
SCALE 1:2,500
Meters
Extent of Map
PROJECT
Bruce Power
TITLE SMALLMOUTH BASS (A) ACTIVE, (B) SUCCESSFUL, AND (C) UNSUCCESSFUL NEST LOCATIONS IN THE BRUCE B DISCHARGE CHANNEL, 2009 TO 2020
PROJECT NO. 19132602
SCALE AS SHOWN
REV. 0.0
DESIGN ME 2016-09-21
GIS CGE 2020-11-09
CHECK SU 2020-11-09
REVIEW TD 2020-11-09
FIGURE: 15


(A) ACTIVE
(B) SUCCESSFUL
(C) ABANDONED
455000
455500
456000
4911000
4910500
4910000
4909500
2
LEGEND
2020 Survey
2019 Survey
2018 Survey
2017 Survey
2016 Survey
2015 Survey
2014 Survey
2013 Survey
2012 Survey
2011 Survey
2010 Survey
2009 Survey
Local Bathymetry (m)
Area accessible in 2014, 2015, 2016, 2017, 2018, and 2019 only due to the higher water levels compared to previous survey years.
REFERENCE
Base Data - LIO 2017
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2017
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17
0 75 150 300 450 600
Meters
Extent of Map
PROJECT
Bruce Power
TITLE SMALLMOUTH BASS (A) ACTIVE AND (B) SUCCESSFUL AND (C) UNSUCCESSFUL NEST LOCATIONS IN BAIE DU DORÉ, 2009 TO 2020
PROJECT NO. 19132602
SCALE AS SHOWN
REV. 0.0
DESIGN ME 2014-08-12
GIS CGE 2020-11-09
CHECK SU 2020-11-09
REVIEW TD 2020-11-09
FIGURE: 18