ANNUAL SUMMARY AND ASSESSMENT OF ENVIRONMENTAL RADIOLOGICAL DATA FOR 2006

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ABSTRACT OF PRESENT REVISION:

Initial Issue.

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PREFACE

This document has been prepared by the Environment Management Section in the Safety, Environment and Assessment Division of Bruce Power. The information presented is based on measurements and analyses performed by the Bruce Power Health Physics Laboratory (HPL) and the Ontario Power Generation (OPG) Whitby Health Physics Laboratory, with the exception of information in Section 2.2 which is included as reported by the Environment Management Section of Bruce Power.

The following individuals are acknowledged for the contributions to this report:

- The sample collection and technical analyses performed by Wayne Melvin, Jeff Tuck, Diane Wylds-Molnar, Scott Andrews, Ken Campbell and Randy McLeod. Under the supervision of Joanne McFarlan and Frank Vanderzwet.
- The quality assurance work of Margaret Tout, Nestor Contartese and Adelene Gaw.
- Kat McCulloch for development of the figures displaying the potential critical group locations and the sampling locations.
- Jared Ellenor, University Development Student, Environment Management Section, for data validation and proof reading.
- Technical Critiques provided by Maury Burton, Al Scott, Francis Chua, Margaret Tout, Frank Vanderzwet and Catharine Davidson.

EXECUTIVE SUMMARY

During 2006, an ongoing radiological environmental monitoring program (REMP) was conducted by Bruce Power in the vicinity of the Bruce Power site to assess the effect of all operations at the site including those of Ontario Power Generation (OPG) and Atomic Energy Canada Limited (AECL). The program included specific sampling conducted within a 20 km radius of the Bruce Power site. In addition, a provincial monitoring program, administered by OPG, provided data on background radionuclide levels.

Based on the results of the Bruce Power radiological environmental monitoring program and the OPG provincial radiological monitoring program, the committed effective dose to each of the potential critical groups located in the vicinity of the Bruce Power Site was calculated. The highest calculated group dose is shown in Table E1.

Table E1

Critical Group	Committed Effective Dose (µSv)	Percentage of Legal Limit
BR1 Infant	2.45	0.25%

The 2006 assessment demonstrates that the maximum dose received by a member of the public due to Bruce Power site operations continues to be a very small percentage of the annual legal limit of 1000 µSv. Furthermore, for the fifteenth year the calculated dose to a member of the public is less than the 10 µSv/yr value that is regarded as the lower threshold for significance (the de minimus) [R-1].

Figure E1 graphically shows the calculated committed effective dose as a percentage of the annual legal limit.

Figure E1
Percent of Dose Received By the Critical Group versus the Annual Legal Limit

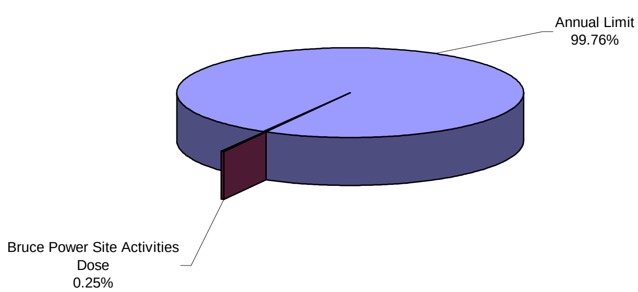
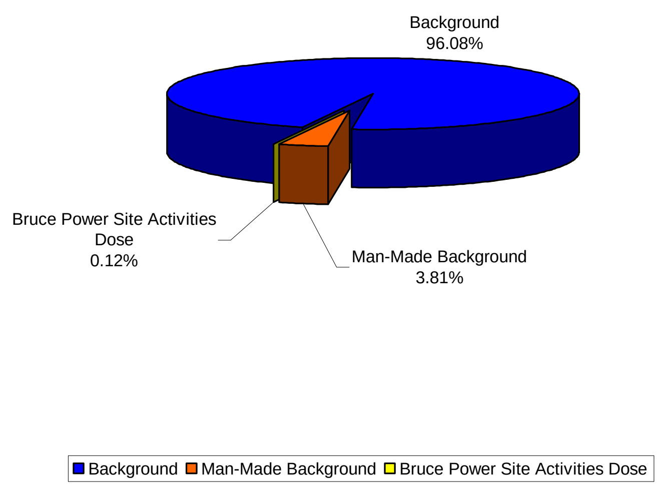


Figure E2 graphically shows the percentage of dose from Bruce Power site operations versus man-made background and Natural Background levels.

Figure E2
Dose to Public from Bruce Power Site Activities in Relation to Dose to Public in Ontario



1.0 INTRODUCTION

This report is produced to meet reporting requirements of the Canadian Nuclear Safety Commission (CNSC) [R-2]. CNSC Regulatory Standard S-99 requires that this report contain the following information regarding the environmental monitoring activities for the previous calendar year:

- a summary of the results of the environmental monitoring program;
- an analysis of the significance, with respect to the health and safety of persons, and the protection of the environment, of the results of the environmental monitoring program;
- calculations of the radiation doses to the critical group, via environmental pathways associated with the operation of the nuclear power plant;
- a description of the dosimetric models used to calculate the radiation doses reported in the report;
- a description of the results of the quality assurance program that was implemented to assure the quality of the environmental monitoring; and
- a description of any significant events or findings with respect to the conduct of, or results of, the environmental monitoring program.

Ontario Power Generation (OPG) operates a provincial background radiological monitoring program [R-3] and provides this data to Bruce Power.

The data gathered from the monitoring programs are summarized in this report on a calendar year basis along with the site emissions data. The locations of the Bruce Power potential critical groups is detailed in Appendix A. The locations of the Bruce Power sampling sites are detailed in Appendix B. Based on this data, assessments are made of the public dose impact resulting from radiological emissions.

Background Tritium and Carbon-14 concentrations due to atmospheric weapons testing, natural occurrence, or other non-Bruce Power site sources have been subtracted, where appropriate, to determine the net environmental concentrations due to the emissions from the facilities on the Bruce Power site.

The contribution of noble gases, radioiodines and radioactive particulate emissions to public dose cannot be reliably distinguished from natural background by the radiological environmental monitoring program at the typical emission rates measured at the Bruce Power site. Estimates are therefore made of these contributors to dose based on site radiological emissions data. Environmental monitoring is carried out to ensure that this practice is not in error by any discernible amount.

The assessment of radiological dose to members of the public living in the vicinity of the Bruce Power site (Section 3.0) is based upon dose calculations using measured concentrations of radioactivity in environmental media supplemented by concentrations calculated from reported emissions or contaminant transport modeling. Dose calculations are used because it is impossible to measure directly the radiation dose to a member of the public.

Doses are calculated for the eight potential critical groups identified for the Bruce Power site. A critical group as defined by CSA Standard N288.1 [R-4] is “a fairly homogenous group of people whose location, habits, diet etc. cause them to receive doses higher than the average received by typical people in all other groups in the exposed population.” The locations of the potential critical groups are detailed in Appendix A Table A.2 and Figure A.2.

2.0 SUMMARY OF RESULTS OF THE ENVIRONMENTAL MONITORING PROGRAM

2.1 Introduction

The facilities operated by Bruce Power on the Bruce Power site include the Bruce A and Bruce B nuclear generating stations and the Central Maintenance and Laundry Facility (CMLF). The nuclear generating stations each consist of four nuclear reactors. The Bruce A nuclear generating station currently has two operating reactors and two reactors undergoing refurbishment. The Bruce B nuclear generating station currently has four operating reactors. The CMLF provides services such as non-radioactive and radioactive laundry for the site as well as for OPG's Pickering and Darlington sites.

The facilities operated by OPG on the Bruce Power site include the Radioactive Waste Operations Site (RWOS-1) and the Western Waste Management Facility (WWMF). The RWOS-1 storage facility has been in caretaking mode since the mid-1970's. The WWMF processes and stores waste received from nuclear facilities at the Bruce Power site as well as from OPG's Pickering and Darlington sites.

Atomic Energy Canada Limited maintains the decommissioned Douglas Point reactor on the Bruce Power site.

2.2 Radiological Emissions

Airborne radiological emissions monitoring occurs at Bruce A and Bruce B nuclear generating stations on the contaminated and non-contaminated stacks and on the contaminated stack of the CMLF. The WWMF also monitors for airborne radioactive emissions. The airborne radionuclides that are monitored are Tritium, Noble Gases, Radioiodines (^{131}I), Particulates and Carbon-14 and the results are presented in Table 2.2.1.

Waterborne radiological emissions monitoring occurs at Bruce A and Bruce B nuclear generating stations on the Active Liquid Waste discharges. The WWMF also monitors for waterborne radioactive emissions. The waterborne radionuclides that are monitored are Tritium, Gross Beta/Gamma and Carbon-14 and are presented in Table 2.2.1.

Table 2.2.1

Pathway - Radionuclide	Emissions (Bq)				
	Bruce A	**Bruce B**	**CMLF**	**WWMF**	**Total**
Air					
Tritium Oxide	4.53E+14	4.43E+14	1.30E+10	5.49E+13	9.51E+14
Noble Gas	1.22E+14	5.09E+13	N/A	N/A	1.73E+14
^{131}I	3.41E+07	1.00E+08	1.94E+05	1.13E+04	1.35E+08
Particulates	6.73E+06	1.10E+08	7.28E+04	5.03E+05	1.17E+08
^{14}C	1.88E+12	9.96E+12	N/A	1.12E+09	1.18E+13
Water					
Tritium Oxide	3.04E+14	4.30E+14	N/A	4.38E+10	7.34E+14
Gross Beta/Gamma	0.00E+00	0.00E+00	N/A	1.35E+07	1.35E+07
^{14}C	1.29E+09	6.25E+09	N/A	N/A	7.55E+09

2.3 Radiological Environmental Monitoring Data

The following sections detail the results of the radiological environmental monitoring programs for both the Bruce Power site and the provincial monitoring program.

The Bruce Power radiological environmental monitoring program carries out sampling and analysis of the following environmental media:

- External gamma radiation
- Air
- Precipitation
- Water
- Aquatic samples (including fish, sediment and sand)
- Terrestrial samples (including animal products, vegetation and soils)

The external gamma dose rates and the provincial monitoring program samples are measured by the OPG Whitby Health Physics Laboratory. All other samples from the Bruce Power radiological environmental monitoring program were analyzed by the Bruce Power Health Physics Laboratory.

2.3.1 External Gamma Dose Rate Measurements

Environmental external gamma dose rates were measured using Panasonic Type UD-814 AR1 thermo luminescent dosimeters (TLDs). The dosimeters are exposed for three month periods and the annual doses are the sum of the quarterly results. The accuracy of the dosimeters is estimated to be ±15 percent. The accuracy is verified by the quality control program described in the Ontario Power Generation 2006 Results of Radiological Environment Monitoring Programs [R-5].

The dosimeters are located within 20 km of the Bruce Power site at air sampling stations. The data is expressed as the quantity air kerma rate, measured in units of nanogray to air per hour (nGy/hr) in accordance with international practice. The results are detailed in Table 2.3.1.

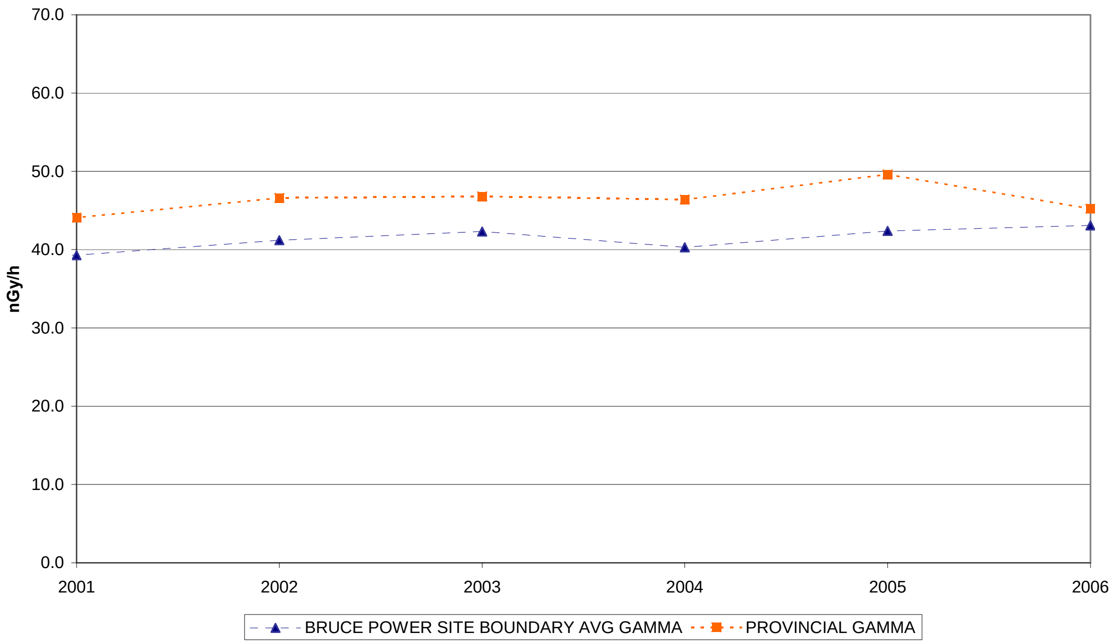
Background dosimeters are also located at various locations around Ontario and are collected quarterly. The dosimeters located throughout the province show the range of background levels experienced during the year. The results are detailed in Table 2.3.1.

Table 2.3.1

Location	Total Exposure Time (Days)	Total Measured Dose in Air (µGy)	Annual Average Dose Rate in Air (nGy/h)
Bruce Power Sites:			
B2	363	418	48.0
B3	363	355	40.7
B4	363	353	40.5
B5	363	333	38.2
B6	363	325	37.3
B7	363	339	38.9
B8	363	350	40.2
B9	363	338	38.8
B10	363	440	50.5
B11	363	395	45.3
Provincial Sites:			
Bancroft	364	499	57.12
Barrie	367	479	54.38
Belleville	364	492	56.32
Kapuskasing	268	338	52.55
Windsor	364	392	44.87
Niagara Falls	357	335	39.10
North Bay	353	453	53.47
Ottawa	370	394	44.37
Parry Sound	188	176	39.01
Sudbury	370	456	51.35
Thunder Bay	394	613	64.83
Lakefield	358	531	61.80

The external gamma rate trend plot, Figure 2.3.1a shows that the external gamma values have stabilized and remained relatively constant over the last five years. This is primarily due to the decline in atmospheric weapons testing fallout.

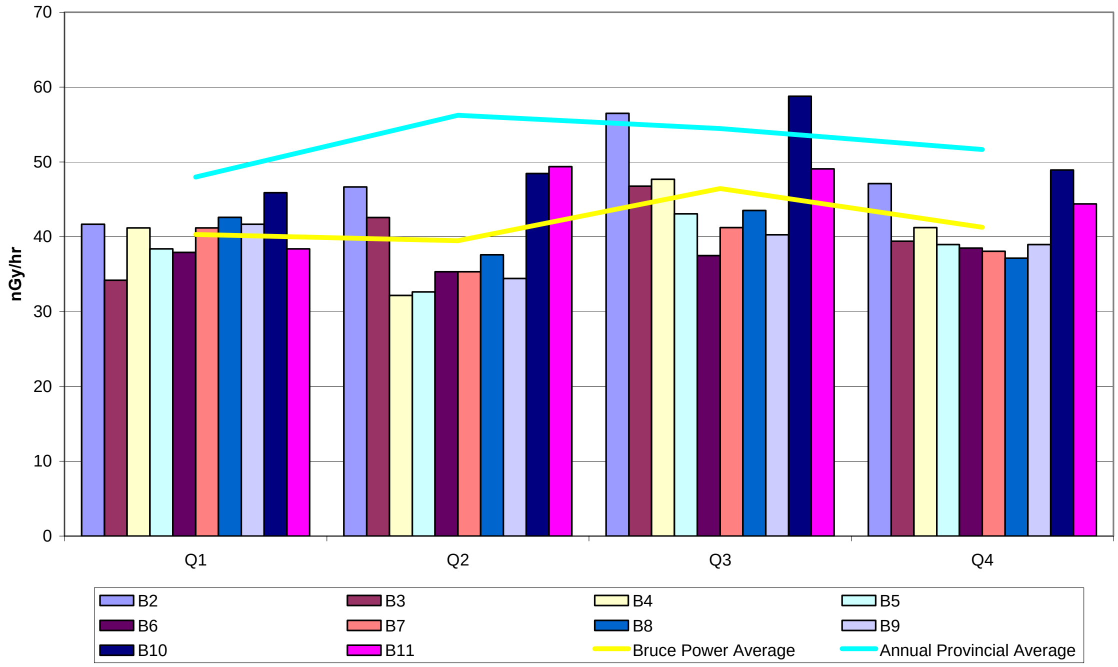
Figure 2.3.1a
Gamma Dose Trends
Bruce Power Indicator Site Average vs Provincial Average



The Bruce Power indicator sites are sites B2, B3 and B4 and are located closest to the Bruce Power site. The average of the results of TLD measurements at the Bruce Power indicator sites for external gamma dose is less than the average for the provincial background sites. TLD measurements alone cannot resolve the very low gamma doses associated with station emissions. As a result, a conservative method of estimating noble gas activity in the environment using emission data and atmospheric dilution factors is used in the dose calculations.

The average external gamma dose in air at the Bruce Power indicator sites was 377.6 µGy, prorated over 365 days and the average of the provincial background sites was 452.3 µGy. The results of the Bruce Power gamma dose rates and the provincial gamma dose rates are presented in Figure 2.3.1b. The Bruce Power average of the quarterly gamma dose rates is consistently below the provincial average indicating no incremental effect on gamma dose rates from Bruce Power site activities.

Figure 2.3.1b
Bruce Power Gamma Dose Rates



2.3.2 Air Sampling

2.3.2.1 Tritium in Air Sampling

Water vapour is collected by passing air at a continuous steady rate through an adsorbent material (molecular sieve). This is known as "active sampling." The water is extracted and analyzed monthly for tritium. 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. Airborne tritium monitoring may be unavailable due to failure of the sampling pump, loss of power to the monitoring site, or other causes. Samples from the active samplers are collected and analyzed monthly.

Passive sampling of tritium in air is also conducted at various locations. The passive tritium samplers have a diffusion head fitted on top of a liquid scintillation counting vial that contains a 50/50 mixture of "dead water" (very low tritium) and ethylene glycol. Scintillation cocktail is added in the laboratory at the conclusion of the sampling and the sample is analyzed by liquid scintillation counting. The passive samplers are replaced and analyzed quarterly.

The results of the Active and Passive Tritium in Air sampling is detailed in Table 2.3.2.1 and graphically in Figure 2.3.2.1a, Figure 2.3.2.1b and Figure 2.3.2.1c.

Table 2.3.2.1

Site	Active Sampling (Bq/m^3)	Passive Sampling (Bq/m^3)
Bruce Power Sites:		
B2	2.29	N/A
B3	2.11	1.63
B4	2.17	1.69
B5	1.51	1.56
B5	N/A	1.43
B6	0.14	N/A
B7	1.08	N/A
B8	0.29	N/A
B9	0.38	N/A
B10	1.44	N/A
B11	0.62	N/A
BR1	N/A	1.82
BR11	N/A	2.66
BR25	N/A	1.18
BR27	N/A	1.74
BR39	N/A	1.07
BF1	N/A	0.76
BF14	N/A	1.31
BDF11	N/A	0.33
BM6	N/A	0.49
BM6	N/A	0.39
Provincial Sites:		
Lambton	0.05	<0.32
Nanticoke	0.10	N/A
Lakefield	N/A	<0.32
Bancroft	N/A	<0.32
Barrie	N/A	<0.32
Belleville	N/A	<0.32
Picton	N/A	<0.32
Provincial Average	0.08	<0.32

Figure 2.3.2.1a
Bruce Power Tritium in Air
(Active Sampling)

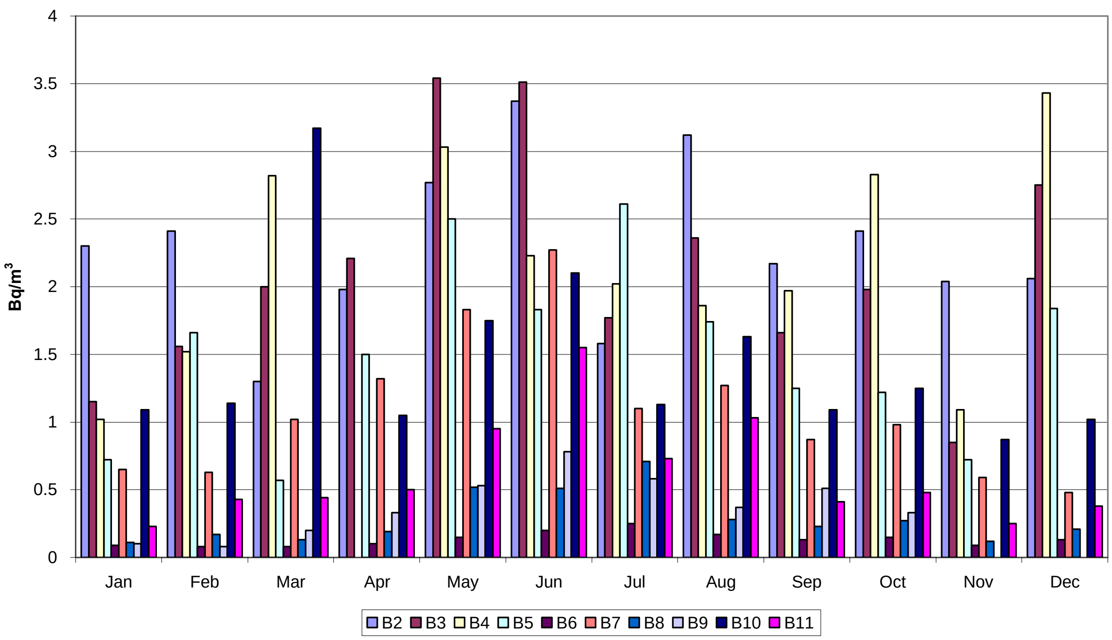
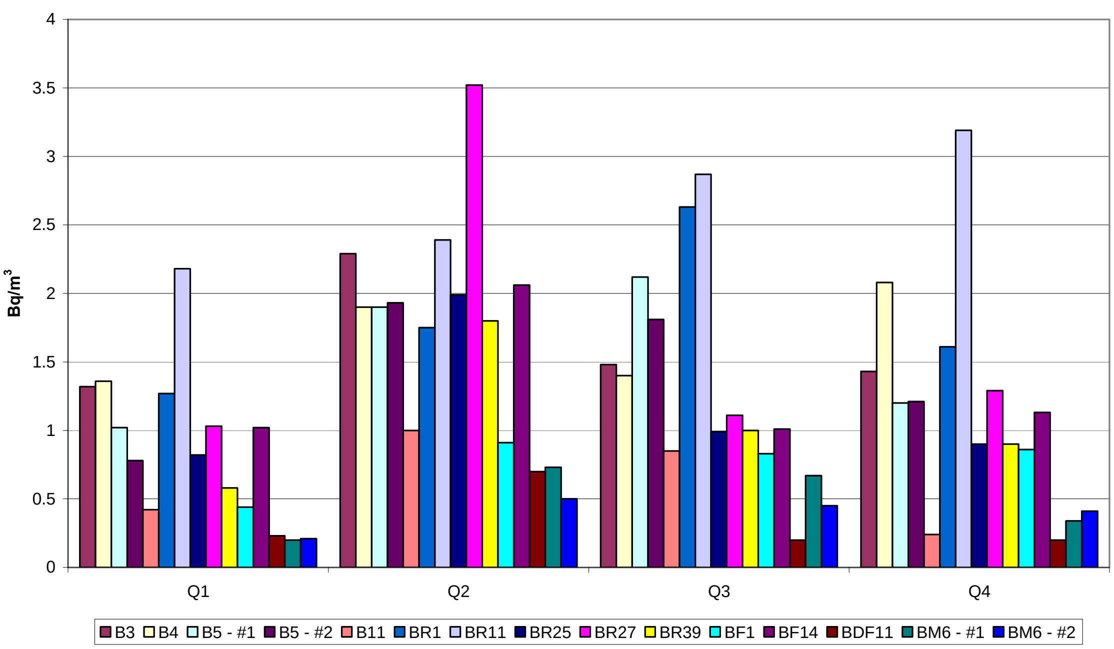


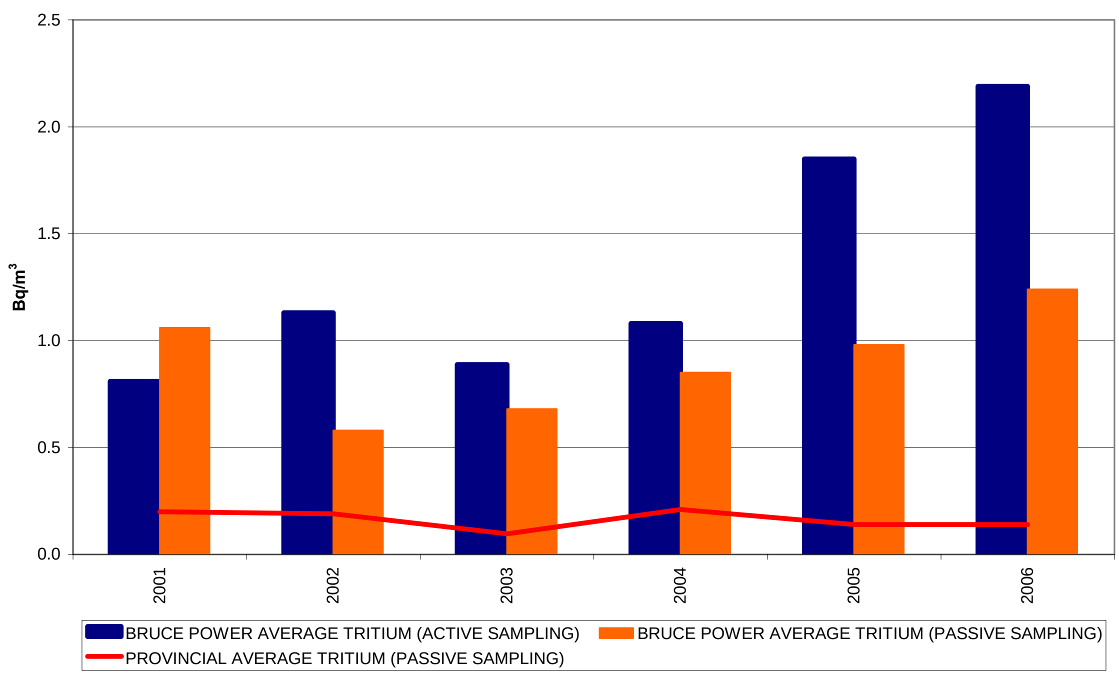
Figure 2.3.2.1b
Bruce Power Tritium in Air
(Passive Sampling)



Results of measurements throughout 2006 showed higher than average airborne tritium oxide concentrations in the vicinity of the Bruce Power site relative to provincial background measurements. Peak values typically occur in the summer which is consistent with the seasonal variation in humidity. The increased levels of humidity contain increased levels of evapo-transpired tritiated moisture from the ground during the warm months and do not necessarily reflect variations in Bruce Power site tritium emissions.

The average tritium in air concentration for the Bruce Power indicator sites was 2.75 Bq/m^3 for active sampling and 1.66 Bq/m^3 for passive sampling versus a provincial tritium in air concentration of 0.08 Bq/m^3. In general, passive tritium samples are lower than those obtained via active sampling at the same locations. The CANDU Owner's Group (COG) is continuing to study both the Active and Passive sampling processes to determine which method most accurately captures the tritium in air concentrations. The increased levels of tritium in air in the vicinity of the Bruce Power site versus the provincial background levels are attributed to emissions from Bruce Power site operations.

Figure 2.3.2.1c
Tritium in Air



2.3.2.2 Carbon-14 in Air Sampling

CO_2 is collected by passing air at a continuous steady rate through a molecular sieve canister to remove the CO_2 from the air stream. The CO_2 is then analyzed by liquid scintillation counting for ^{14}C content. This is known as “active sampling”. The active sampler samples are collected and analyzed monthly.

Passive sampling of air for ^{14}C is also conducted. The ^{14}C passive samplers contain mixed hydroxide pellets to absorb CO_2 from air at a controlled rate. The CO_2 is released from the pellets, in the laboratory, collected and analyzed by liquid scintillation counting for ^{14}C content. The passive sampler samples are collected and analyzed quarterly.

The results of the Active and Passive ^{14}C in Air sampling is detailed in Table 2.3.2.2 and graphically in Figure 2.3.2.2a and Figure 2.3.2.2b.

Table 2.3.2.2

Site	Active Sampling (Bq/kg-C)	Passive Sampling (Bq/kg-C)
Bruce Power Sites:		
B3	303	331
B5	295	296
B5	N/A	307
B11	240	265
BR1	N/A	301
BR11	N/A	392
BF1	N/A	307
BF14	N/A	306
BDF11	N/A	261
B1	N/A	549
B2	N/A	566
B3	N/A	676
B4	N/A	1114
B5	N/A	988
B6	N/A	1866
B7	N/A	1954
B8	N/A	604
B9	N/A	604
B10	N/A	612
B11	N/A	1438
B12	N/A	2557
B13	N/A	976
B14	N/A	1108
Provincial Sites:		
Lambton	248	230
Nanticoke	252	N/A
Lakefield	N/A	231
Bancroft	N/A	231
Barrie	N/A	235
Belleville	N/A	233
Picton	N/A	227

Figure 2.3.2.2a
Bruce Power Carbon-14 in Air
(Active Sampling)

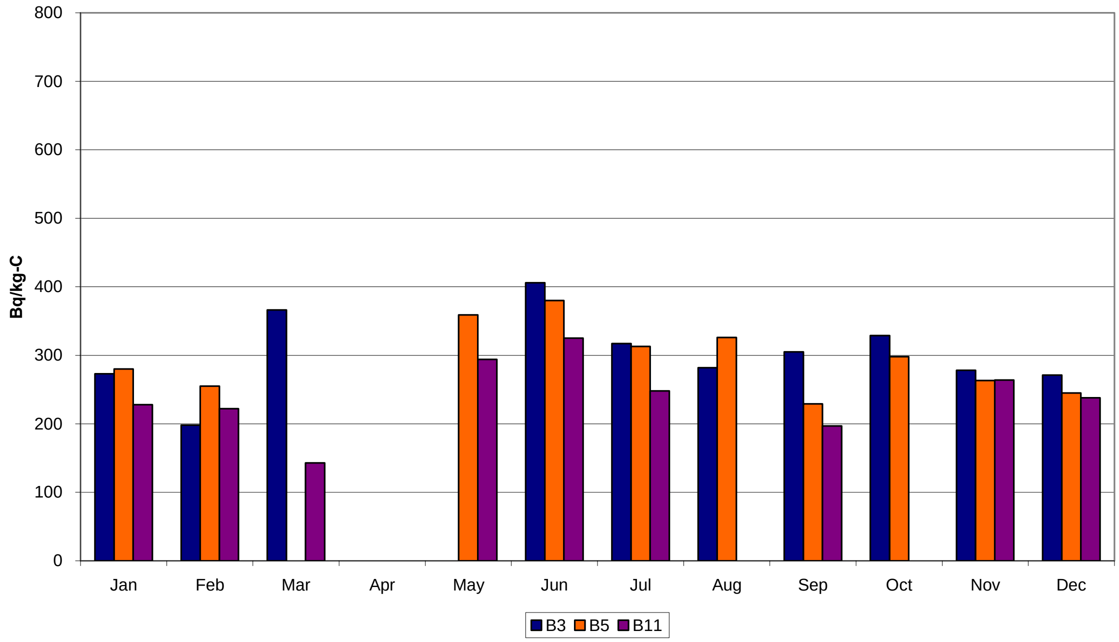
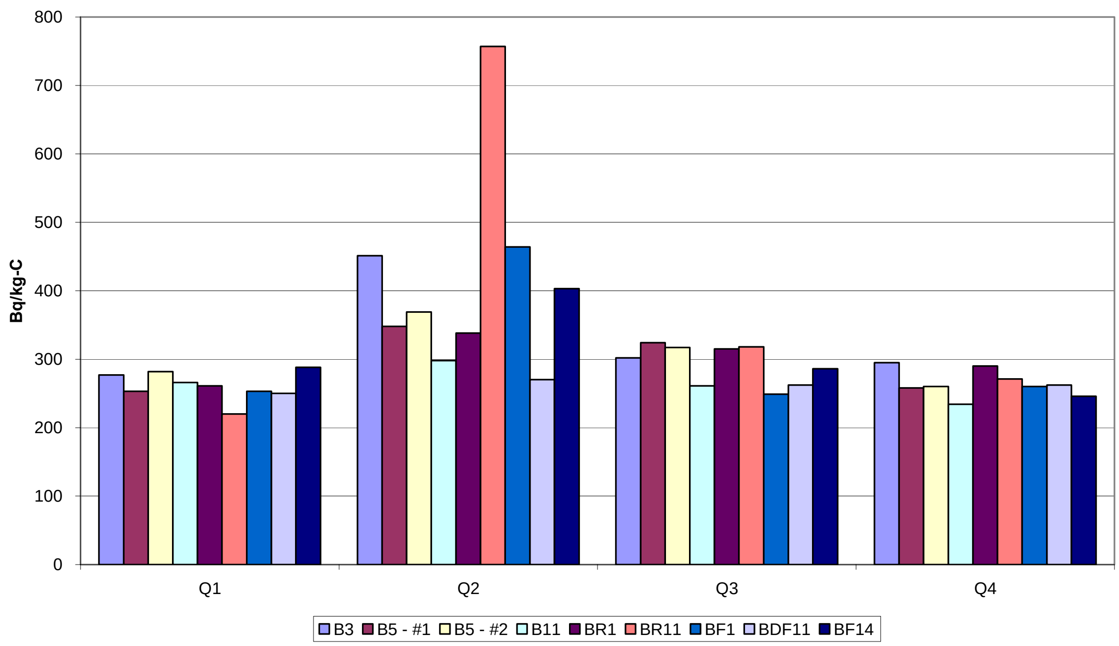


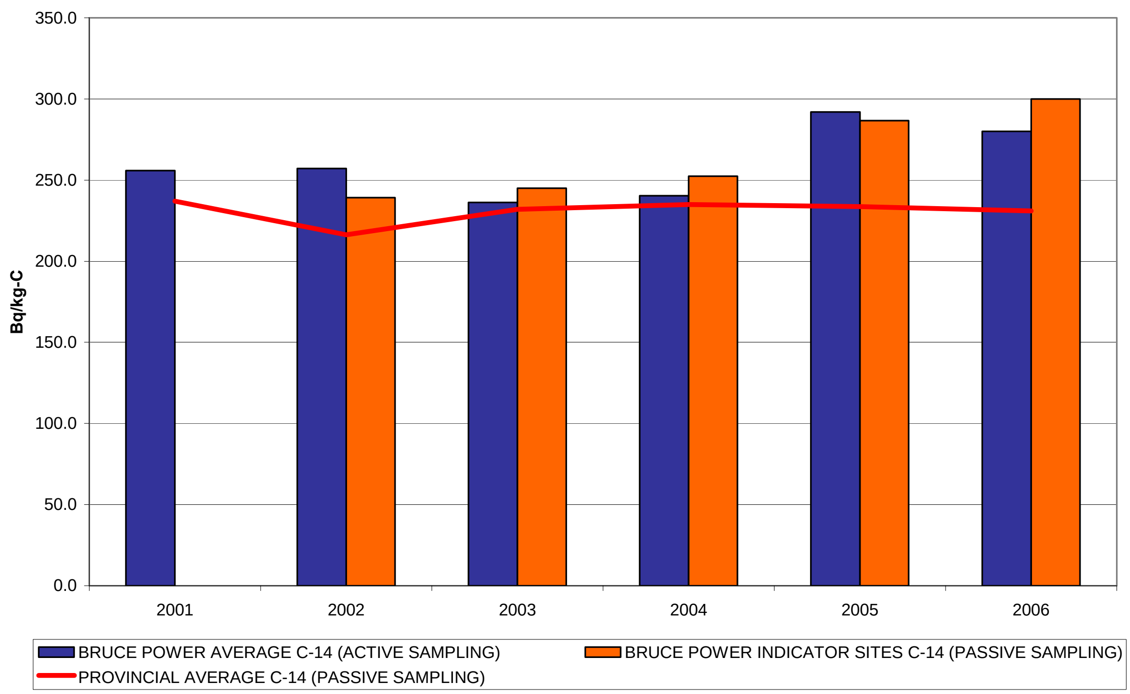
Figure 2.3.2.2b
Bruce Power Carbon-14 in Air
(Passive Sampling)



Results of measurements throughout 2006 showed slightly higher average airborne C^{14} concentrations in the vicinity of the Bruce Power site relative to provincial background measurements.

The average ^{14}C in air concentration for the Bruce Power sites B3, BR5 and BR11 was 280 Bq/m^3 for active samples and 300 Bq/m^3 for passive samples versus a provincial average ^{14}C in air concentration of 231 Bq/m^3. The increased levels of ^{14}C in air in the vicinity of the Bruce Power site versus the provincial background levels are attributed to emissions from Bruce Power site operations. Figure 2.3.2.2c shows the average ^{14}C in air concentration levels since 2001. The graph shows an increasing trend in ^{14}C in air concentration. This increasing trend parallels an increase in emissions from Bruce B from increased moderator cover gas purging and the return to service of the Bruce A Units 3 and 4. The planned return to service of the oxygen addition system to the moderator cover gas system at Bruce B in 2007 is anticipated to result in a decrease in moderator cover gas purging and therefore a reduction in ^{14}C emissions.

Figure 2.3.2.2c
Carbon-14 in Air



2.3.3 Precipitation Sampling

Dry and wet fallout monitoring data is not used in dose calculations however the data does give a gross indication of levels of tritium and gross beta activity in other environmental media.

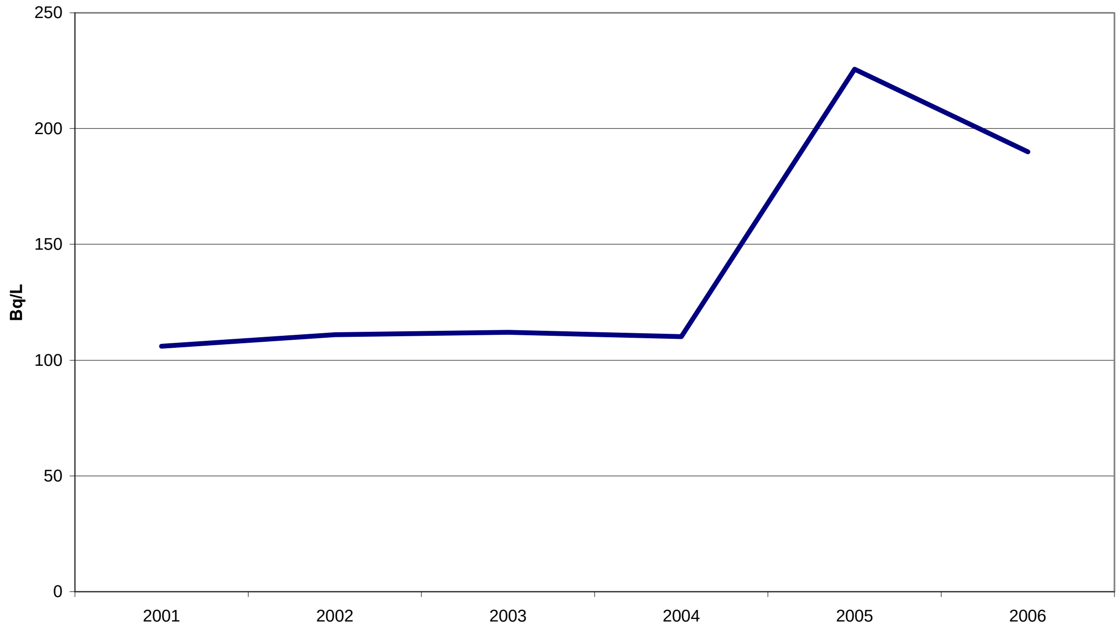
In the 1950's and early 1960's, atmospheric nuclear weapons testing significantly increased the tritium concentration in rainwater the world over. Monitoring of precipitation in the Ottawa Valley for tritium was initiated in the late 1950's. The tritium concentration in precipitation peaked in 1963 at approximately 350 Bq/l and has declined in an exponential fashion to less than 3 Bq/l.

Dry and wet fallout, which includes precipitation, is collected monthly and analyzed for tritium and gross beta activity. Samples are analyzed for tritium by liquid scintillation counting and for gross beta by proportional counting. Liquid is not always present in the samples during dry months, thus monthly tritium results and annual tritium averages are generally only representative of wetter months. The results are detailed in Table 2.3.3 and graphically in Figure 2.3.3.

Table 2.3.3

Site	Average Tritium Activity in Precipitation (Bq/l)	Average Gross Beta Deposition Rate (Bq/m^2)/month)
Bruce Power Sites:		
B2	258.0	21.2
B2	159.5	19.3
B4	150.0	20.5
B5	125.9	22.1
B6	10.0	17.8
B7	73.7	22.7
B8	25.0	18.6
B9	26.1	18.8
B10	72.8	22.7
B11	95.2	17.9
Background Sites:		
Calgary	< 3.7	N/A
Saskatoon	< 3.7	N/A
Fredericton	6.80	N/A

Figure 2.3.3
Bruce Power Sites
AverageTritium in Precipitation



All samples collected in the vicinity of the Bruce Power site indicated tritium in precipitation concentrations greater than the background value of 6.8 Bq/l. Precipitation will invariably become groundwater and potentially a source of drinking water, via shallow wells.
The highest average tritium concentration in precipitation was 258 Bq/l. If a shallow well contained water with a concentration of 258 Bq/l of tritium it would be well below the Provincial Drinking Water Act (2000) and the Guidelines for Canadian Drinking Water Quality limit of an annual average tritium concentration of 7,000 Bq/l.

2.3.4 Milk Sampling

Milk samples are collected weekly from dairy farms in the vicinity of the Bruce Power site. The samples are analyzed for tritium, ^{14}C and gamma emitters. The milk is analyzed as received by gamma spectrometry. The sample is then freeze dried, the water fraction being analyzed for tritium by liquid scintillation and the solid residue used to measure ^{14}C by combustion, collection of the CO_2 and liquid scintillation counting.

BDF11 samples were only collected for the first 6 months of 2006 as the dairy farm sold its herd in June 2006. The annual averages of the results of the analysis are detailed in Table 2.3.4.

Table 2.3.4

Farm	Tritium (Bq/l)	^{131}I (Bq/l)	^{14}C (Bq/l)
Bruce Power Sites:			
BDF1	8.70	<0.16	260
BDF9	8.37		245
BDF11	8.23		239
Provincial Sites:			
Belleville	<3.7	<0.10	234
London	<3.7	<0.15	231

The average tritium concentration in milk has increased slightly over the last 2 years as indicated in Figure 2.3.4a. The average ^{14}C concentrations in milk has remained stable and continues to correlate to provincial background levels as indicated in Figure 2.3.4b. ^{131}I was less than the detection limit in milk samples collected in the vicinity of the Bruce Power site and at provincial sites.

Figure 2.3.4a
Tritium in Milk Trend

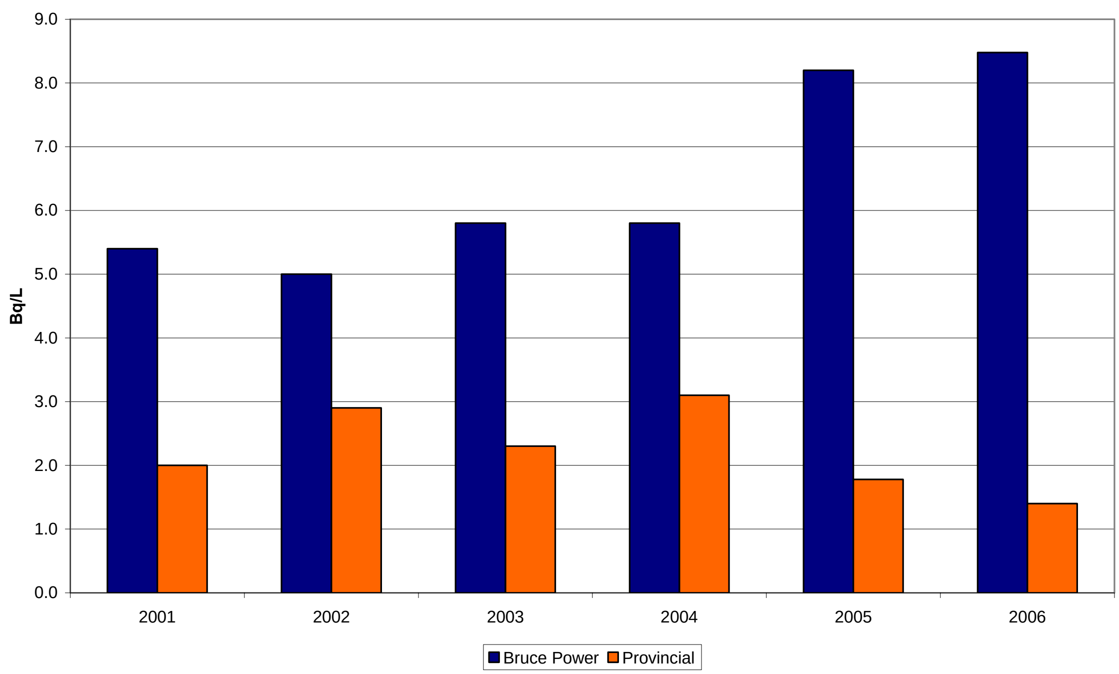
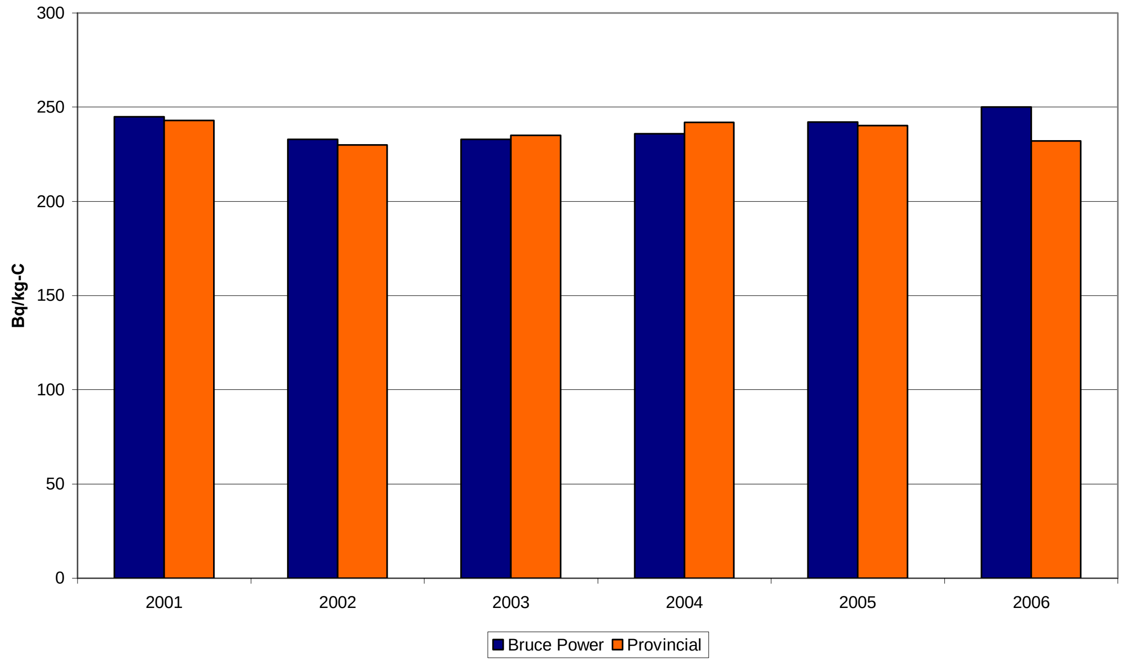


Figure 2.3.4b
Carbon-14 in Milk Trend



2.3.5 Drinking Water Sampling

Drinking water samples are collected from three water supply plants in the vicinity of the Bruce Power Site. The locations of these water supply plants relative to the nearest nuclear station discharge are:

Water Supply Plant	Distance From Bruce Power Site
Port Elgin Water Supply Plant	17 km NE of Bruce A
Southampton Water Supply Plant	22 km NE of Bruce A
Kincardine Water Supply Plant	15 km SSW of Bruce B

The water supply plants are sampled twice per day. Weekly composite samples are analyzed for tritium by liquid scintillation counting and monthly composite samples are analyzed for gross beta by proportional counting. Drinking water samples are also collected from local wells within the vicinity of the Bruce Power site. The provincial background samples are collected from locations throughout the province on a quarterly basis. Table 2.3.5 details the annual average tritium and gross beta results.

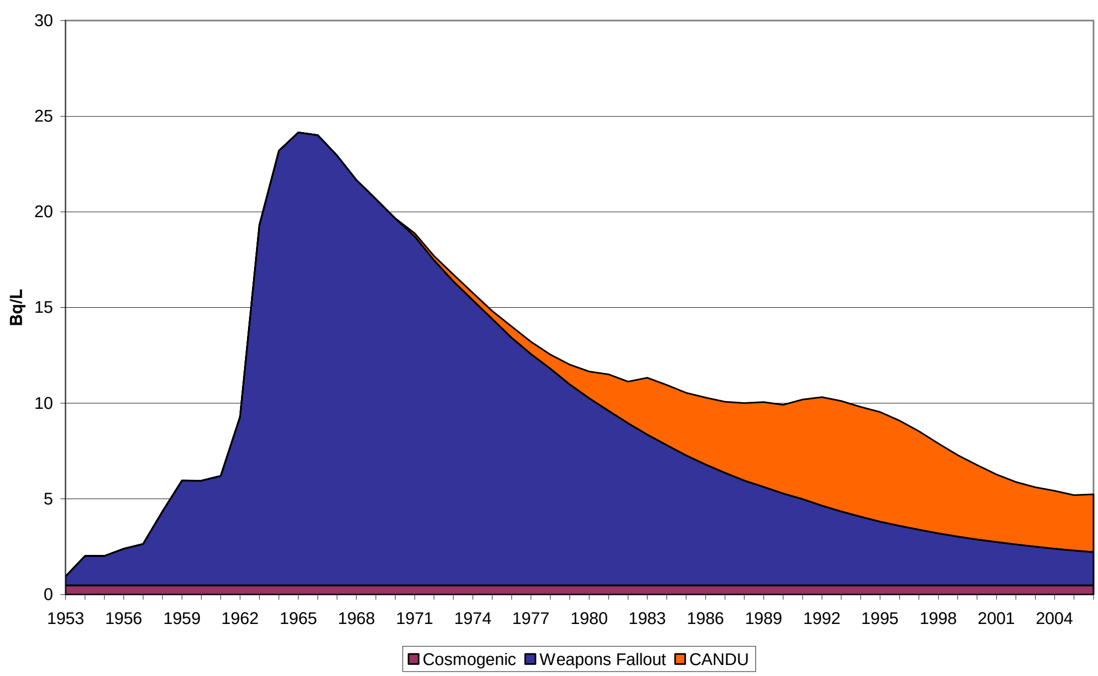
Table 2.3.5

Water Source	Tritium (Bq/l)	Gross Beta (Bq/l)
Water Supply Plants:		
Kincardine	6.4	0.08
Port Elgin	17.4	0.08
Southampton	12.0	0.08
Deep Wells:		
BM12	<5.9	N/A
BM13	<5.9	N/A
BM6	<5.9	N/A
BR27	<5.9	N/A
BM2	<5.9	N/A
BM9	<5.9	N/A
BR1	<5.9	N/A
BR8	<5.9	N/A
BR25	<5.9	N/A
BR39	19.1	N/A
BF1	<5.9	N/A
BF14	<5.9	N/A
BDF11	<5.9	N/A
Shallow Wells:		
BR32	12.3	N/A
BR41	23.7	N/A
BR2	58.2	0.03
BR32	55.4	N/A
BR41	52.8	N/A
BR42	25.5	N/A
BF6	26.1	N/A
Lakes & Streams:		
BR2	89.1	0.08
BR39	6.7	0.13
BM4	142.9	0.09
BM14	20.7	0.01
BC1	24.7	0.19
BC2	101.0	0.13
BC3	28.3	0.20
BC4	46.4	0.13
Provincial Sites:		
Bancroft	<3.7	0.05
Belleville	4.2	0.07
Brockville	4.6	0.11
Burlington	6.0	0.11
Coburg	5.3	0.11
Goderich	5.2	0.19
Kingston	4.6	0.10

Water Source	Tritium (Bq/l)	Gross Beta (Bq/l)
London	3.7	0.07
Niagara Falls	4.1	0.11
North Bay	<3.7	0.07
Orangeville	<3.7	0.08
Parry Sound	<3.7	0.07
Sarnia	4.0	0.08
St. Catharines	3.7	0.09
Sudbury	5.8	0.05
Thunder Bay	<3.7	0.05
Windsor	5.2	0.09

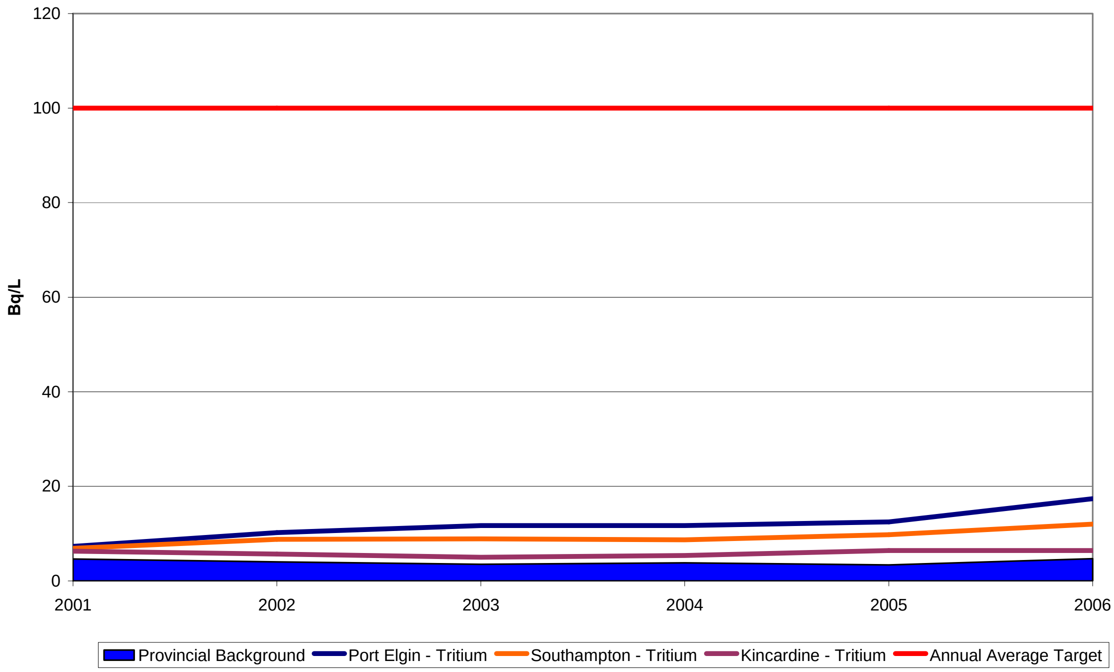
Tritium activity in drinking water above background levels can be attributed emissions from the Bruce Power site. Background levels of tritium are a combination of natural cosmogenic sources and fallout from atmospheric nuclear weapons testing. Atomic Energy Canada Limited (AECL) developed a mathematical model for estimating background lake Huron tritium activity from cosmogenic sources and fallout from atmospheric nuclear weapons testing sources [R-7]. A graphical representation of this is shown in Figure 2.3.5a. The model estimates a background tritium concentration of 2.21 Bq/L in Lake Huron for 2006.

Figure 2.3.5a
Historic Lake Huron Tritium Activity



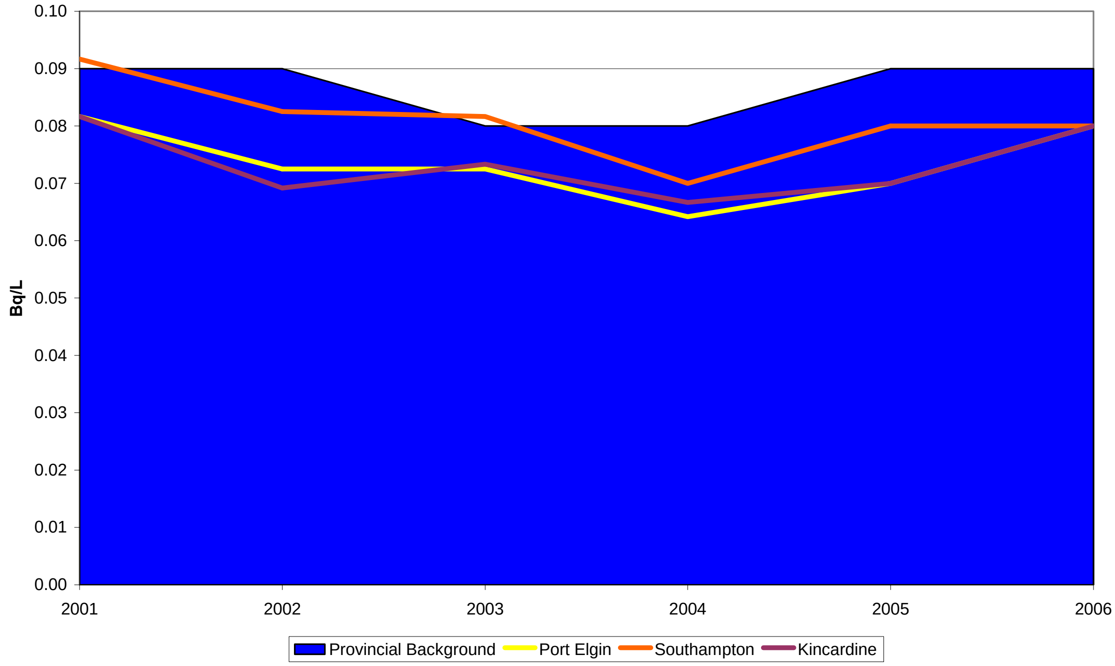
The impact of site emission on the local water supply plants varies and is dependant on the distance from the stations, lake current direction and general dispersion conditions. In order to minimize the impact of emissions Bruce Power has a long-standing stakeholder commitment to keep water treatment plant annual average tritium levels below 100 Bq/l. As shown in Figure 2.3.5b the annual average tritium concentrations at all local water supply plants has remained relatively stable for the past five years and well below 100 Bq/l.

Figure 2.3.5b
Tritium in Drinking Water Trend



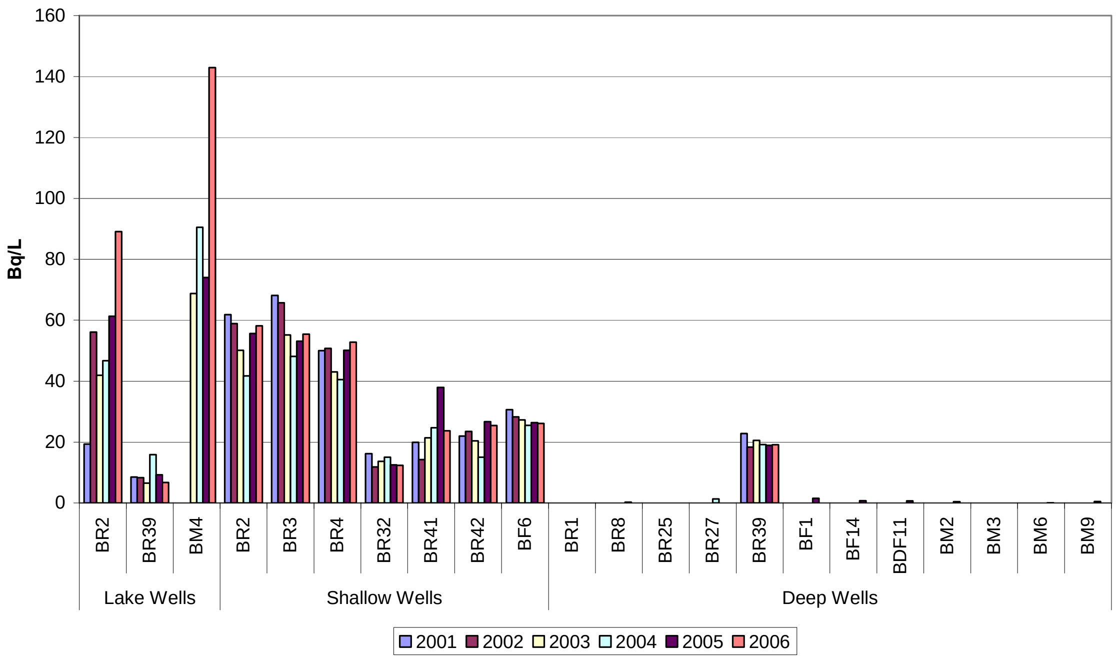
The annual average gross beta levels at the local water treatment plants and the provincial background levels are comparable as shown in Figure 2.3.5c. Over the last 5 years the gross beta levels have remained relatively constant and are essentially at the same level as the provincial background level. Gross beta activities in the range of 0.005 – 0.2 Bq/l in drinking water are normal and result from naturally occurring radionuclides and fallout from atmospheric weapons testing.

Figure 3.5.1c
Gross Beta in Drinking Water Trend



Drinking water from local wells is also sampled and analyzed for tritium, Figure 2.3.5d. The shallow wells continue to have tritium concentrations that are elevated relative to provincial background levels and the source of the tritium can be attributed to tritium emissions from the Bruce Power site. Tritium concentrations in the deep wells continue to be negligible with the exception of the deep well located at R39. The concentrations of tritium seen at deep well R39 are comparable to those seen in local shallow wells and may indicate that the deep well is also fed by surface water and is influenced by tritium in precipitation in the same manner that the shallow wells are.

Figure 2.3.5d
Average Tritium Concentration in Well Water



2.3.6 Bruce Power Site Groundwater Sampling

Monitoring of ground water around the Bruce A and Bruce B generating stations was initiated as a result of the Reconnaissance Level Groundwater Quality Monitoring Program Study Bruce Nuclear Power Development Generating Stations Bruce 1-4 and Bruce 5 – 8 [R-6]. The purpose of the study was to assess the influence of the operation of the stations on groundwater tritium activities within sub-surface pathways that may discharge to off-site receptors. The study concluded that the groundwater flow systems in the vicinity of Bruce A and Bruce B are hydraulically isolated from properties east of the Bruce Power site boundary. Evidence presented in the report strongly suggests that the tritium found in the groundwater around the station is the consequence of the station airborne emissions and tritiated precipitation infiltrating into the carbonate aquifer.

Groundwater samples from ten multi-level wells installed into the bedrock around the Bruce A and Bruce B stations are collected semi-annually and analyzed for tritium by liquid scintillation counting. These wells are located between the stations and the lake. The results of the semi-annual sampling are detailed in Table 2.3.6.

Table 2.3.6

Station	Well Number - Level	Elevation to Top of Zone ft (above sea level)	Tritium Activity (Bq/l) Sampling Date June	December
Bruce A	1-1	547.70	214.9 ± 7.5	201.1 ± 7.2
	1-2	559.20	430 ± 10	375.5 ± 9.4
	2-1	536.08	<5.1	<5.0
	2-2	550.58	12.5 ± 2.8	89.1 ± 5.0
	2-3	566.08	840 ± 14	1499 ± 19
	3-1	536.30	<5.1	<5.0
	3-2	550.80	<5.1	<5.0
	3-3	560.30	778 ± 14	585 ± 12
	4-1	552.90	14.8 ± 2.9	<5.0
	4-2	567.40	188.9 ± 7.1	176.2 ± 6.8
	5-1	536.21	<5.1	5.7 ± 2.4
	5-2	548.71	<5.1	<5.0
Bruce B	1-1	538.82	19.7 ± 3.1	19.5 ± 3.0
	1-2	553.32	191.0 ± 7.1	213.2 ± 7.4
	1-3	569.82	373.4 ± 9.7	286.6 ± 8.5
	2-1	552.04	221.2 ± 7.6	167.9 ± 6.6
	2-2	571.54	390.8 ± 9.9	407.0 ±10.0
	3-1	536.00	<5.1	<5.0
	3-2	552.50	52.3 ± 4.1	33.9 ± 3.5
	3-3	573.00	547 ± 12	397.7 ± 9.9
	4-1	539.00	52.0 ± 4.1	48.8 ± 4.0
	4-2	558.40	513 ± 11	583 ± 12
	4-3	572.90	1895 ± 21	2042 ± 22
	5-1	535.95	253.1 ± 8.1	233.0 ± 7.7
	5-2	553.45	467 ± 11	462 ± 11
	5-3	972.95	656 ± 13	613 ±12

Based on a review of the data collected to date from the groundwater monitoring programs:

- Groundwater tritium activities decrease with depth and the lowest levels at both Bruce A and Bruce B indicate negligible groundwater quality impact.
- The tritium activities in groundwater collected from the wells at Bruce A and Bruce B are orders of magnitude lower than the generic screening criterion (3,000,000 Bq/l) for non-potable groundwater [R-8].

2.3.7 Aquatic Sampling

2.3.7.1 Sediment Sampling

Samples of sediment are collected from various locations in the vicinity of the Bruce Power site and further a field along the shore of Lake Huron. The samples are dried, sieved, packaged and undergo gamma spectrometry. The results of the analysis are detailed in Table 2.3.7.1.

Table 2.3.7.1

Location	**Gamma Analysis Bq/kg ± 2σ (dry weight)**			
	^{40}K	**^{60}Co**	**^{134}Cs**	**^{137}Cs**
Bruce Power:				
Bruce A Discharge #1	267.6 ± 7.1	1.69 ± 0.11	<0.26	6.18 ± 0.17
Bruce A Discharge #2	255.0 ± 7.1	1.46 ± 0.11	<0.29	5.94 ± 0.20
Bruce A Discharge #3	255.2 ± 7.1	1.85 ± 0.12	<0.31	6.89 ± 0.22
Bruce A Discharge #4	257.3 ± 7.1	1.47 ± 0.12	<0.29	6.59 ± 0.20
Bruce B Discharge #1	322.5 ± 8.8	1.72 ± 0.13	<0.32	1.55 ± 0.11
Bruce B Discharge #2	341.4 ± 9.0	2.38 ± 0.14	<0.31	1.79 ± 0.10
Bruce B Discharge #3	327.0 ± 9.9	1.33 ± 0.11	<0.33	1.28 ± 0.15
Bruce B Discharge #4	339.1 ± 9.2	1.69 ± 0.14	<0.32	1.58 ± 0.14
Baie du Doré Spar #5 - #1	358.2 ± 9.2	0.28 ± 0.08	<0.25	5.85 ± 0.20
Baie du Doré Spar #5 - #2	387 ± 11	0.43 ± 0.10	<0.30	8.04 ± 0.25
Baie du Doré Spar #5 - #3	364.5 ± 9.3	0.29 ± 0.08	<0.26	6.72 ± 0.21
Baie du Doré Spar #5 - #4	372.6 ± 9.9	0.41 ± 0.09	<0.30	7.83 ± 0.25
Baie du Doré Spar #6 - #1	418 ± 11	0.52 ± 0.10	<0.28	7.53 ± 0.40
Baie du Doré Spar #6 - #2	418 ± 11	0.54 ± 0.11	<0.32	8.28 ± 0.26
Baie du Doré Spar #6 - #3	423 ± 11	0.46 ± 0.92	<0.28	7.42 ± 0.35
Baie du Doré Spar #6 - #4	407 ± 11	0.55 ± 0.11	<0.31	7.46 ± 0.25
Baie du Doré Spar #103 - #1	354.3 ± 9.0	0.15 ± 0.07	<0.23	2.24 ± 0.10
Baie du Doré Spar #103 - #2	350.4 ± 8.9	<0.23	<0.23	1.88 ± 0.24
Baie du Doré Spar #103 - #3	330.5 ± 8.4	0.17 ± 0.07	<0.25	2.11 ± 0.10
Baie du Doré Spar #103 - #4	346.3 ± 9.1	0.21 ± 0.09	<0.26	1.88 ± 0.13
Scott Point #1	431 ± 12	<0.17	<0.32	1.24 ± 0.31
Scott Point #2	436 ± 12	0.33 ± 0.10	<0.35	5.90 ± 0.22
Scott Point #3	426 ± 12	<0.30	<0.32	5.47 ± 0.37
Scott Point #4	445 ± 12	0.31 ± 0.10	<0.37	6.48 ± 0.22
BR32	379.2 ± 9.5	<0.23	<0.22	0.94 ± 0.11
BR32	380.6 ± 9.9	<0.25	<0.25	1.03 ± 0.11
BR32	372.4 ± 9.7	<0.24	<0.25	0.97 ± 0.11
BR32	372.8 ± 9.4	<0.22	<0.22	0.94 ± 0.09
Southampton #1	271.5 ± 7.1	<0.21	<0.22	0.22 ± 0.07
Southampton #2	274 ± 10	<0.59	<0.67	<0.54
Southampton #3	284.9 ± 9.8	<0.53	<0.61	<0.33
Southampton #4	284.4 ± 9.7	<0.51	<0.58	0.37 ± 0.17

Location	Gamma Analysis Bq/kg ± 2σ (dry weight)			
	^{40}K	^{60}Co	^{134}Cs	^{137}Cs
Provincial:				
Goderich #1A	258 ± 5	<0.3	<0.2	0.4 ± 0.2
Goderich #1B	153 ± 5	<0.3	<0.3	<0.4
Goderich #2A	232 ± 12	<0.4	<0.3	<0.4
Goderich #2B	171 ± 10	<0.4	<0.3	<0.4
Goderich C	215 ± 5	<0.2	<0.2	0.4 ± 0.1
Goderich D	198 ± 11	<0.4	<0.3	<0.4
Grand Bend A	231 ± 12	<0.4	<0.3	0.6 ± 0.2
Grand Bend B	205 ± 30	<0.3	<0.3	0.5 ± 0.2
Grand Bend C	251 ± 13	<0.4	<0.3	<0.4
Grand Bend D	254 ± 5	<0.3	<0.2	0.5 ± 0.2

Analysis of the samples indicates that the primary radionuclides present in the sediment samples are ^{40}K and ^{137}Cs. Potassium-40 (^{40}K) is a naturally occurring radioisotope and Cesium-137 (^{137}Cs) is resultant from atmospheric nuclear weapons testing and from activities at the Bruce Power site. Cesium-137 (^{137}Cs), Cesium-134 (^{134}Cs) and Cobalt-60 (^{60}Co) are not naturally occurring and result from Bruce Power site emissions.

2.3.7.2 Fish Sampling

Samples of fish are collected from various locations in Baie du Doré of the Bruce Power site and farther a field along the western shore of Lake Huron.

The target fish species are:

- White Sucker – *Castostomus commersoni*, representing a benthic forager species that is a bottom feeder. Brown Bullhead – *Ictaluras nebulosus* is the backup species.

- Lake Whitefish – *Corregonus clupeaformis* representing a predominantly benthic forager species which also feeds on minnows. Round Whitefish – *Prosopium cylindraceum* is the backup species.

The fish flesh ventral to the lateral line is included in the samples prepared for analysis. Individual fish are analyzed using gamma spectrometry for ^{40}K, ^{60}Co, ^{134}Cs and ^{137}Cs. Four composite samples are prepared for Whitefish and Suckers from the individual Baie du Doré fish and from the individual Lake Huron fish. These composite samples are analyzed for tritium oxide (HTO), ^{14}C and organically bound tritium (OBT). The fish sample flesh is freeze dried and the water collected analyzed by liquid scintillation counting for tritium oxide. The solid residue is washed to remove all HTO and small molecule tritium, then combusted. The water is collected an analyzed for tritium by liquid scintillation counting and the CO_2 is collected and analyzed for ^{14}C by liquid scintillation counting.

The results of the analysis are detailed in Table 2.3.7.2.

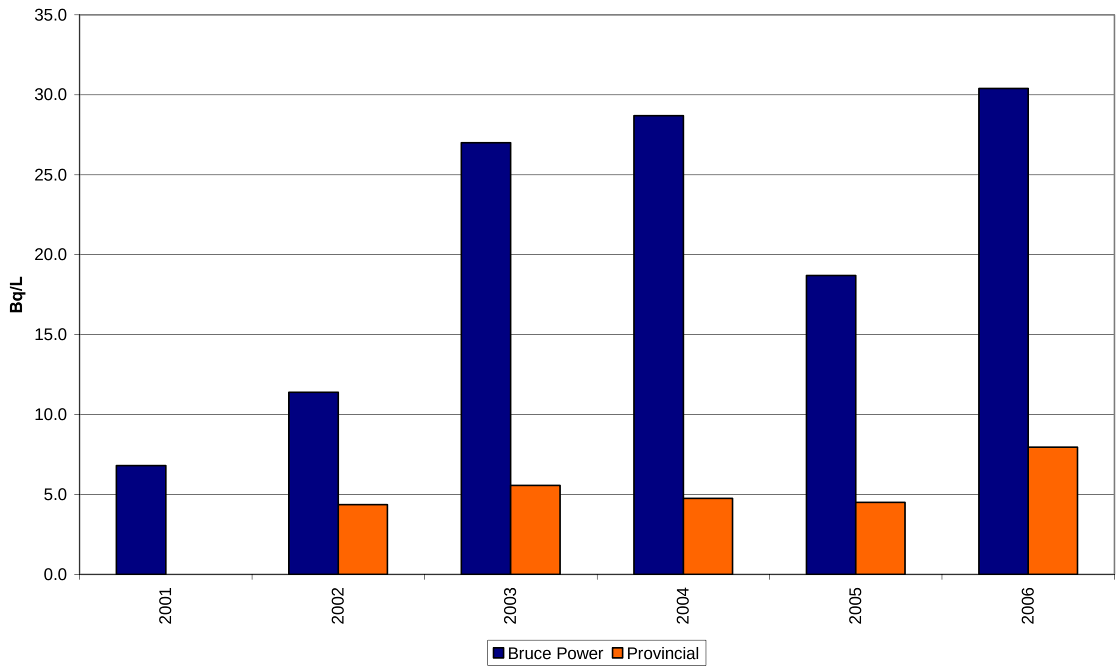
Table 2.3.7.2

Location	Species (Composites)	HTO Bq/l ± 2σ	^{14}C Bq/kg-C ± 2σ	OBT Bq^{3}H/L ± 2σ	Gamma Bq/kg ± 2σ (wet weight) ^{40}K	^{60}Co	^{134}Cs	^{137}Cs
Bruce Power								
Baie du Doré	White Sucker #1	44.6 ± 4.1	327 ± 31	16.76 ± 4.0	122.0 ± 4.2	<0.18	<0.14	0.48 ± 0.08
	White Sucker #2				122.8 ± 3.9	<0.16	<0.11	0.35 ± 0.07
	White Sucker #3				132.8 ± 4.3	<0.18	<0.14	0.30 ± 0.07
	White Sucker #4				122.2 ± 3.9	<0.17	<0.12	0.53 ± 0.07
	White Sucker #5				122.3 ± 4.0	<0.17	<0.13	0.45 ± 0.07
	White Sucker #6				120.9 ± 3.8	<0.15	<0.12	0.60 ± 0.08
	White Sucker #7				130.8 ± 4.6	<0.21	<0.15	0.44 ± 0.09
	White Sucker #8				117.8 ± 3.8	<0.16	<0.12	0.30 ± 0.07
	Whitefish #1	16.1 ± 3.1	303 ± 31	10.72 ± 3.8	138.5 ± 4.5	<0.18	<0.14	0.60 ± 0.09
	Whitefish #2				135.1 ± 4.6	<0.17	<0.13	0.55 ± 0.08
	Whitefish #3				137.4 ± 4.2	<0.15	<0.12	0.47 ± 0.07
	Whitefish #4				135.6 ± 4.4	<0.19	<0.13	0.40 ± 0.08
	Whitefish #5				146.8 ± 4.9	<0.19	<0.14	0.51 ± 0.09
	Whitefish #6				139.1 ± 4.5	<0.19	<0.14	0.58 ± 0.09
	Whitefish #7				133.6 ± 4.2	<0.16	<0.12	0.47 ± 0.08
	Whitefish #8				129.2 ± 4.1	<0.17	<0.12	0.35 ± 0.07
Background								
Lake Huron	Whitefish #A	8.2 ± 2.7	252 ± 30	12.88 ± 3.9	117.0 ± 3.8	<0.16	<0.13	0.60 ± 0.08
	Whitefish #B				122.4 ± 4.3	<0.18	<0.15	0.70 ± 0.09
	Whitefish #C				109.7 ± 3.5	<0.14	<0.11	0.55 ± 0.07
	Whitefish #D				117.5 ± 3.8	<0.15	<0.13	0.65 ± 0.08
	Whitefish #E				102.8 ± 3.3	<0.13	<0.11	0.36 ± 0.06
	Whitefish #F				109.6 ± 3.5	<0.14	<0.12	0.50 ± 0.07
	Whitefish #G				116.4 ± 3.9	<0.15	<0.14	0.67 ± 0.08
	Whitefish #H				115.9 ± 3.8	<0.16	<0.13	1.32 ± 0.10
	White Sucker #A	7.7 ± 2.7	237 ± 28	7.27 ± 3.8	116.4 ± 4.3	<0.21	<0.16	0.25 ± 0.08
	White Sucker #B				115.3 ± 4.1	<0.17	<0.15	0.25 ± 0.08
	White Sucker #C				118.5 ± 4.2	<0.20	<0.15	0.22 ± 0.07
	White Sucker #D				85.1 ± 3.4	<0.17	<0.14	0.19 ± 0.07
	White Sucker #E				108.1 ± 4.1	<0.20	<0.17	0.39 ± 0.08
	White Sucker #F				117.5 ± 4.2	<0.18	<0.14	0.24 ± 0.07
	White Sucker #G				120.9 ± 4.4	<0.20	<0.16	0.16 ± 0.06
	White Sucker #H				121.8 ± 4.3	<0.17	<0.13	0.15 ± 0.06

The sampling program is broken into two parts based on the respective spawning periods of the target species. Sampling for White Suckers is conducted in the spring and sampling for Lake Whitefish is conducted in the fall.

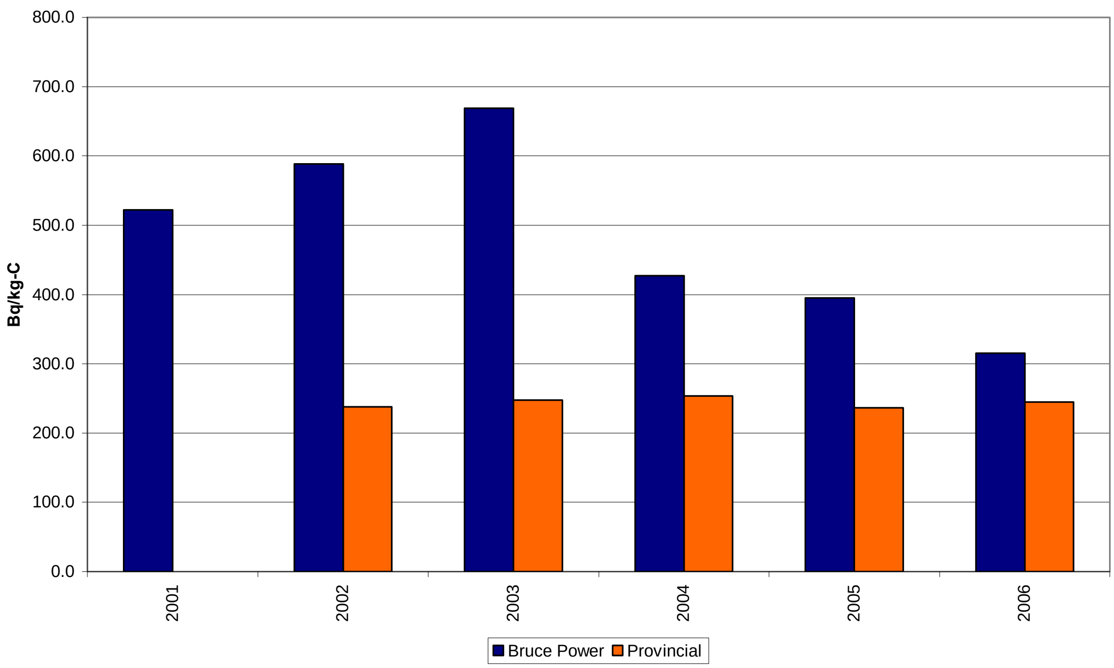
The average tritium oxide concentration in fish shows an increasing trend over the past five years, Figure 2.3.7.2a paralleling the increasing trend in waterborne tritium emissions over the last 5 years.

Figure 2.3.7.2a
Annual Average Tritium Oxide in Fish



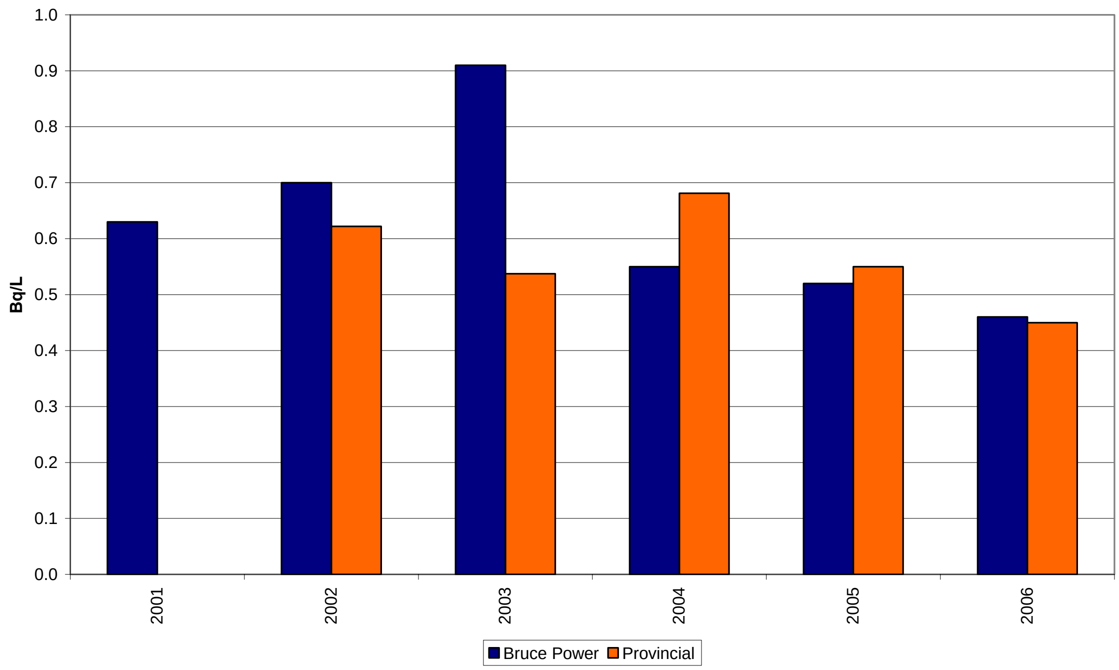
Carbon-14 (^{14}C) was found at levels above the provincial background in all samples collected from Baie du Doré. As indicated in Figure 2.3.7.2b, the past three years indicate a decreasing trend in ^{14}C concentrations.

Figure 2.3.7.2b
Annual Average Carbon-14 in Fish



Cesium-137 (^{137}Cs) was detected in all fish collected in Baie du Doré and continues to be at levels comparable to the provincial background levels, Figure 2.3.7c, and is likely the result of atmospheric weapons testing.

Figure 2.3.7.2c
Annual Average Cs-137 in Fish



2.3.8 Terrestrial Sampling

Bruce Power routinely collects samples from a variety of sources. The samples are typically analyzed for tritium by liquid scintillation counting, ^{14}C and some samples undergo gamma spectrometry for ^{40}K, ^{60}Co, ^{134}Cs and ^{137}Cs.

Table 2.3.8a contains the results of the animal and animal feed sampling.

Table 2.3.8a

Sample Location	Sample Type	^{14}C (Bq/kg-C ± 2σ)	^{40}K (Bq/kg ± 2σ)	^{60}Co (Bq/kg-C ± 2σ)	^{134}Cs (Bq/kg-C ± 2σ)	^{137}Cs (Bq/kg-C ± 2σ)
BF14	Chicken Meat	261 ± 30	N/A	N/A	N/A	N/A
BF14	Lamb Meat	275 ± 34	N/A	N/A	N/A	N/A
BF14	Hay	581 ± 40	N/A	N/A	N/A	N/A
Bruce Power	Deer Meat	750 ± 44	810 ± 14	110.6 ± 3.8	<0.15	<0.12
BF14	Chicken Eggs (Spring)	258 ± 28	N/A	N/A	N/A	N/A
BF14	Chicken Eggs (Fall)	207 ± 29	N/A	N/A	N/A	N/A

Table 2.3.8b contains the results of the grain sampling.

Table 2.3.8b

Sample Location	Sample Type	HTO (Bq/l ± 2σ)	^{14}C (Bq/kg-C ± 2σ)
BF21	Soybeans	43.2 ± 4.1	261 ± 31
BF20	White Beans	149.9 ± 6.8	321 ± 31
BF8	Corn	67.8 ± 4.9	306 ± 31
BF20	Soybeans	65.4 ± 4.8	258 ± 29
BF15	Soybeans	128.0 ± 6.3	252 ± 28
BF6	Soybeans	41.7 ± 4.1	255 ± 29

Table 2.3.8c contains the results of the honey sampling. Naturally occurring ^{40}K was the only gamma emitter present above detection limits.

Table 2.3.8c

Sample Location	Sample Type	HTO (Bq/l ± 2σ)	^{14}C (Bq/kg-C ± 2σ)	^{40}K (Bq/l ± 2σ)
BR29	Honey	43.7 ± 4.0	259 ± 28	5.73 ± 0.98

Table 2.3.8d contains the results of the alcohol and corn mash sampling at the Bruce Energy Centre.

Table 2.3.8d

Sample Date	Sample Type (Composites)	Tritium (Bq/l ± 2σ)
BEC Alcohol		
Q1	Alcohol	9.5 ± 4.6
Q2	Alcohol	8.1 ± 4.6
Q3	Alcohol	10.6 ± 4.8
Q4	Alcohol	14.1 ± 4.8
BEC Corn Mash		
Q1	Corn Mash	21.7± 3.4
Q2	Corn Mash	14.4 ± 3.0
Q3	Corn Mash	9.6 ± 2.8
Q4	Corn Mash	21.4 ± 3.1

The results presented above typical of the results for the last 5 years and indicate no increase in impact on these products as a result of the current activities at the Bruce Power site.

2.3.8.1 Agricultural Produce Sampling

Samples of fruit and vegetables are collected in the vicinity of the Bruce Power site and at provincial background locations. These samples are analyzed for tritium and carbon-14 and the results are shown in Table 2.3.8.1. Where multiple sample types are found at the same location the samples were combined into composite samples for analysis.

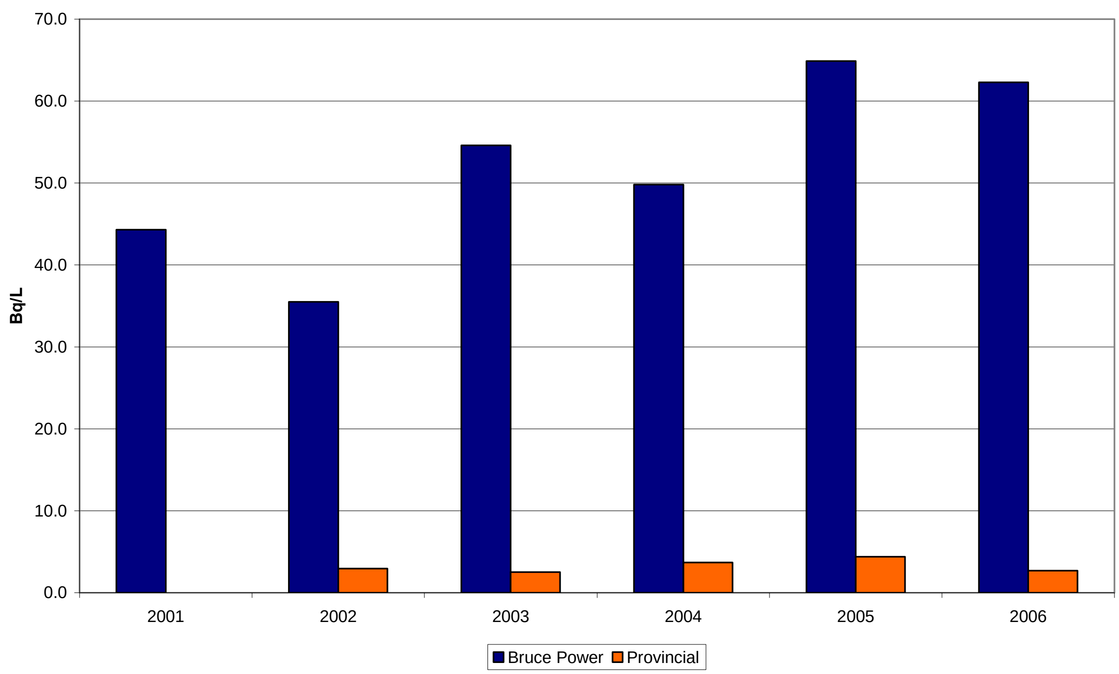
Table 2.3.8.1

Sample Location	Sample Type	HTO (Bq/l ± 2)	^{14}C (Bq/kg-C ± 2σ)
Bruce Power Sites:			
BG1	Apples	84.4 ± 5.0	351 ± 33
BG2	Apples	44.8 ± 4.2	306 ± 36
BG3	Apples	63.2 ± 4.4	299 ± 30
BG4	Apples	39.6 ± 3.8	281 ± 30
BG5	Apples	25.5 ± 3.3	280 ± 30
BG7	Apples	34.1 ± 3.6	287 ± 32
BG8	Apples	47.7 ± 4.0	290 ± 32
BG10	Apples	122.7 ± 5.8	355 ± 33
BG11	Apples	69.9 ± 4.6	358 ± 33
BG13	Apples	60.1 ± 4.4	294 ± 31
BG14	Apples	155.7 ± 6.4	375 ± 33
BG15	Apples	142.2 ± 6.2	389 ± 34
BG16	Apples	47.3 ± 4.0	332 ± 32
BG17	Apples	52.2 ± 4.1	313 ± 32
BG18	Apples	77.1 ± 4.8	323 ± 32
BG19	Pears	100.4 ± 5.3	333 ± 33
BG20	Apples	114.8 ± 5.6	437 ± 36
BG21	Apples	116.4 ± 5.7	403 ± 35
B6	Apples	11.3 ± 2.7	250 ± 33
BR15	Above Ground	77.3 ± 5.2	358 ± 33
BR17	Leafy	42.5 ± 4.2	313 ± 31
BR17	Below Ground	37.7 ± 4.1	339 ± 32
BR44	Leafy	50.2 ± 4.4	291 ± 31
BR44	Below Ground	34.6 ± 4.0	288 ± 31
BF8	Above Ground	35.1 ± 4.0	305 ± 34
BF8	Leafy	37.2 ± 4.0	255 ± 30
BF8	Below Ground	23.2 ± 3.5	252 ± 30
BF14	Apples	70.1 ± 4.6	331 ± 32
BF14	Above Ground	60.8 ± 4.8	271 ± 30
BF14	Leafy	70.9 ± 5.0	282 ± 31
BF14	Below Ground	46.7 ± 4.3	370 ± 34
BF15	Above Ground	61.3 ± 4.8	263 ± 30
BF15	Leafy	29.6 ± 3.8	271 ± 31
BF15	Below Ground	30.4 ± 3.8	263 ± 31

Sample Location	Sample Type	HTO (Bq/l ± 2)	^{14}C (Bq/kg-C ± 2σ)
Provincial Sites:			
Lakefield	Vegetable Composite	3.8 ± 2.6	224 ± 19
Bancroft	Vegetable Composite	2.4 ± 2.5	222 ± 19
Barrie	Vegetable Composite	2.6 ± 2.5	229 ± 19
Picton	Vegetable Composite	2.7 ± 2.5	230 ± 19
Sarnia	Vegetable Composite	1.9 ± 2.5	217 ± 19

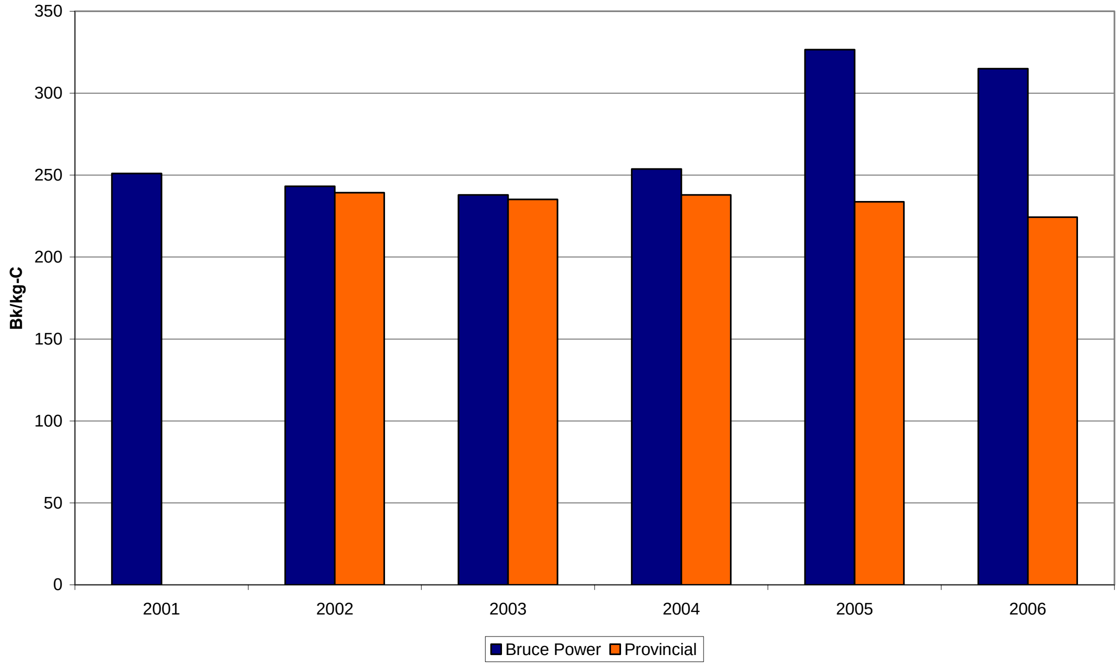
The HTO activity in vegetation has shown an increasing trend, Figure 2.3.8.1a. This increase can be attributed to increased tritium emissions from the Bruce Power site following the restart of units 3 & 4.

Figure 2.3.8.1a
Annual Average Tritium in Vegetation



The Carbon-14 activity in vegetation has shown an increasing trend in the last 3 years, Figure 2.3.8.1b. Any concentrations of ^{14}C above the average provincial background level can be attributed to increased ^{14}C emissions from the Bruce Power site. The return to service of Oxygen Addition to the Moderator Cover Gas system at Bruce B is anticipated to reduce ^{14}C emissions in 2007.

Figure 2.3.8.1b
Annual Average Carbon-14 in Vegetation



2.3.8.2 Soil Sampling

Samples of soil and sand are collected in the vicinity of the Bruce Power site and at provincial background locations. These samples are analyzed for gamma emitters (^{137}Cs, ^{134}Cs, ^{60}Co and ^{40}K) and the results are shown in Table 2.3.8.2.

Table 2.3.8.2

Location	Sample Type	Gamma Analysis Bq/kg ± 2σ (dry weight)			
		^{137}Cs	^{134}Cs	^{60}Co	^{40}K
Bruce Power Sites:					
BR2	Garden Soil	7.88 ± 0.25	<0.39	<0.34	473 ± 13
BR5	Garden Soil	6.40 ± 0.21	<0.36	<0.33	604 ± 16
BF14	Garden Soil	5.71 ± 0.21	<0.42	<0.38	685 ± 18
BR4	Lakeshore Soil	5.01 ± 0.35	<0.27	<0.26	312.9 ± 8.9
Amberley #1 (0-6")	Inland Soil	6.78 ± 0.23	<0.43	<0.37	589 ± 16
Amberley #2 (6-12")	Inland Soil	0.69 ± 0.08	<0.32	<0.31	509 ± 14
BM4	Lakeshore Soil	4.17 ± 0.16	<0.28	<0.28	463 ± 12
BM10 - #1	Lakeshore Soil	0.95 ± 0.10	<0.22	<0.20	316.7 ± 8.2
BM10 - #2	Lakeshore Soil	0.91 ± 0.09	<0.22	<0.21	309.6 ± 8.0
Provincial Sites:					
Goderich #1A	Sand	0.4 ± 0.2	<0.2	<0.3	258 ± 5
Goderich #1B	Sand	<0.3	<0.3	<0.3	153 ± 5
Goderich #2A	Sand	<0.4	<0.3	<0.4	232 ± 12
Goderich #2B	Sand	<0.4	<0.3	<0.4	171 ± 10
Goderich C	Sand	0.4 ± 0.1	<0.2	<0.2	215 ± 5
Goderich D	Sand	<0.4	<0.3	<0.4	198 ± 11
Grand Bend #1	Soil	0.6 ± 0.2	<0.3	<0.4	231 ± 12
Grand Bend #2	Soil	0.5 ± 0.2	<0.3	<0.3	205 ± 30
Grand Bend #3	Soil	<0.4	<0.3	<0.4	251 ± 13
Grand Bend #4	Soil	0.5 ± 0.2	<0.2	<0.3	254 ± 5

Background inland soils and beach sand soil samples were collected, at Goderich and Amberley, to determine the ^{137}Cs concentrations in Ontario soils due to atmospheric nuclear weapons testing fallout. The concentrations measured in inland soils at Amberley ranged from 0.69 Bq/kg to 6.78 Bq/kg and those in sand at Goderich ranged from 0.30 Bq/kg to 0.60 Bq/kg. The difference between these two background readings is due to soil type (clay soils retain more ^{137}Cs than sandy soils) as well as wave action which is continually moving Cesium and not allowing it to sit undisturbed as originally deposited from the atmosphere.

Samples of garden soil at location BR2 and BR5 were obtained from the Scott Point area north of the Bruce Power site. Cesium-137 levels were measured at 7.88 Bq/kg and 6.40 Bq/kg which are slightly above the provincial background levels and can be attributed to activities at the Bruce Power site. As described in the Annual Summary and Assessment of Environmental Radiological Data for 2000 [R-9] the BR2 garden was constructed with soil/manure imported from 10-20 km away. Samples of garden soil at location BF14 and lakeshore soil at location BR4 had ^{137}Cs levels of 5.71 Bq/kg and 5.01 Bq/kg which are also above the provincial background levels and can be attributed to activities at the Bruce Power site.

Cobalt-60 and Cesium-134 were not found above detection limits in any soil samples indicating activities at the Bruce Power site are not significant contributors to these radionuclides in the environment. ^{40}K was detected at levels slightly above provincial background levels but is a naturally occurring radionuclide and not a result of Bruce Power site activities.

2.3.9 Meteorological Data

Wind speed and direction are measured continuously at two locations. A 50 m tower located on the Bruce Power site measures wind speed and direction at both the 10 m and 50 m levels. A 10 m tower located on the 4th Concession to the east of the Bruce Power information centre also records wind speed and direction.

Data on wind origin (in percent of total) by speed and direction as measured at the 10 m level of the 50 m meteorological tower on the Bruce Power site is presented in Table 2.3.9.

Table 2.3.9

Direction From	Wind Speed Ranges in km/h								
	0 - 10	**10 - 20**	**20 - 30**	**30 - 40**	**40 - 50**	**50 - 60**	**60 - 70**	**>70**	**Total**
N	1.75	3.87	1.71	0.36	0.00	0.00	0.00	0.00	**7.69**
NNE	1.73	2.66	0.72	0.01	0.00	0.00	0.00	0.00	**5.12**
NE	1.76	1.76	0.36	0.02	0.00	0.00	0.00	0.00	**3.90**
ENE	1.63	2.11	0.32	0.00	0.00	0.00	0.00	0.00	**4.06**
E	1.62	1.66	0.41	0.06	0.00	0.00	0.00	0.00	**3.75**
ESE	1.90	1.40	0.56	0.05	0.00	0.00	0.00	0.00	**3.91**
SE	2.71	1.88	0.95	0.50	0.00	0.00	0.00	0.00	**6.04**
SSE	1.90	2.29	1.17	0.17	0.00	0.00	0.00	0.00	**5.53**
S	2.10	3.61	1.54	0.19	0.00	0.00	0.00	0.00	**7.44**
SSW	2.07	4.25	2.00	0.58	0.00	0.00	0.00	0.00	**8.90**
SW	1.58	3.38	3.28	0.95	0.08	0.00	0.00	0.00	**9.27**
WSW	1.26	2.85	1.42	1.47	0.24	0.00	0.00	0.00	**7.24**
W	1.49	2.40	1.36	0.84	0.31	0.06	0.00	0.00	**6.46**
WNW	0.94	2.50	1.68	0.66	0.49	0.07	0.00	0.00	**6.34**
NW	0.92	2.17	1.74	0.72	0.41	0.11	0.00	0.00	**6.07**
NNW	1.31	3.28	2.78	0.81	0.09	0.00	0.00	0.00	**8.27**
Total	**26.67**	**42.07**	**22.00**	**7.39**	**1.62**	**0.24**	**0.00**	**0.00**	**99.99**

2.4 Atmospheric Dilution Factors

Atmospheric dilution factors (K_a) are calculated for a given location from the measured tritium oxide (THO) in air activities and annual average site tritium oxide emissions using the following relationship:

$K_a = C/Q\ (s/m^3)$

Where

C = the annual average tritium oxide in air concentration (Bq/m3) measured at a given monitoring location.

And

Q = the site average tritium oxide release rate (Bq/s) for the year.

Using the calculated Ka, the average annual airborne specific activity of other radionuclides can be estimated by rearranging the formula:

$C_r = K_a \times Q_r$

Where

C_r = the calculated specific activity of radionuclide r in air

And

Q_r = the site average annual release rate for that radionuclide.

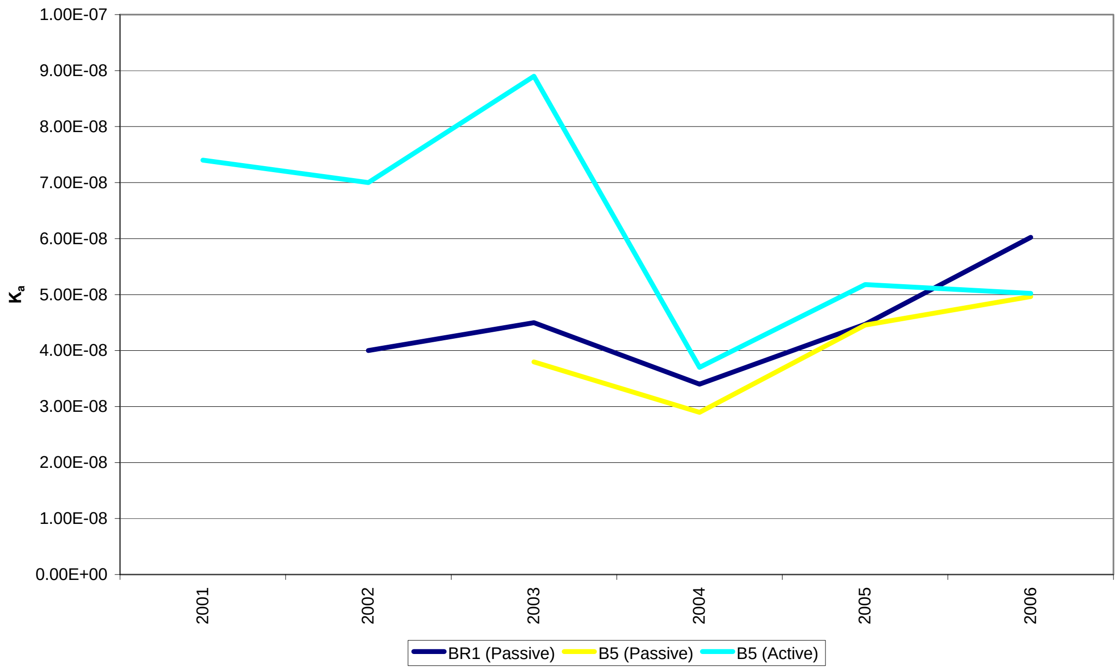
The atmospheric dilutions factors (K_a) at the air monitoring locations for the current year are detailed in Table 2.4.

Table 2.4

Site	**Measured Average Airborne Tritium Concentration (Bq/m^3)**	**K_a (s/m^3)**
Active Sampling Sites:		
B2	2.29	7.61E-08
B3	2.11	7.01E-08
B4	2.17	7.19E-08
B5	1.51	5.02E-08
B6	0.14	4.48E-09
B7	1.08	3.60E-08
B8	0.29	9.54E-09
B9	0.38	1.26E-08
B10	1.44	4.78E-08
Passive Sampling Locations:		
B3	1.63	5.41E-08
B4	1.69	5.59E-08
B5 - #1	1.56	5.18E-08
B5 - #2	1.43	4.75E-08
B11	0.63	2.08E-08
BR1	1.82	6.02E-08
BR11	2.66	8.82E-08
BR25	1.18	3.90E-08
BR27	1.74	5.77E-08
BR39	1.07	3.55E-08
BF1	0.76	2.52E-08
BF14	1.31	4.33E-08
BDF11	0.33	1.10E-08
BM6 - #1	0.49	1.61E-08
BM6 - #2	0.39	1.30E-08

Figure 2.4 shows the trend in the average annual K_a (s/m^3) as calculated for site BR1 and BR5. BR1 is the critical group location and BR5 is also located in Scott Point.

Figure 2.4
Annual Average Dilution Factors at the Bruce Power Site



3.0 RADIOLOGICAL DOSE TO THE PUBLIC

3.1 Introduction

In simple terms, the radiological dose to a human for a radionuclide is determined by the degree of exposure to that radionuclide in the exposure medium, and the radionuclide-specific and pathway specific dose conversion factor (DCF). The degree of exposure is dependant on the specific activity of the radionuclide in the exposure medium and the attributes that define the degree of contact with the medium.

For example:

The radiological dose received by a human due to the ingestion of tritiated water (HTO) in drinking water over a calendar year is calculated via the following equation.

E = A x Q

Where:

E = Exposure (E), the amount of tritiated water ingested,

A = the specific activity of HTO in the drinking water source (Bq/l)

And

Q = the quantity of drinking water consumed in a year (l/year).

E = A x Q

The radiological dose (D) is then equal to the exposure (E) multiplied by the dose conversion factor (DCF).

D = E x DCF

= A x Q x DCF

This assumes the drinking water source containing HTO was the only source of drinking water for the entire year.

The doses for the different nuclides and pathways are similarly calculated and summed.

3.2 Potential Critical Groups

CSA N288.1 defines a critical group as a fairly homogenous group of people whose location, habits, diet, etc cause them to receive doses higher than the average received by typical people in all other groups in the exposed population. In environmental assessments, “Critical Groups” are used to estimate the maximum realistic impacts of emissions. These should be actual groups of members of the public residing in the vicinity of the site being assessed.

A survey of the area surrounding the Bruce Power site [R-10] gathered information regarding land usage, population distribution, meteorology, hydrology, water sources, water usage, and food sources. As a result of the information accumulated during the survey, eight potential critical groups were defined for the purpose of estimating radiation doses to determine which group is the most highly exposed.

The eight potential critical groups are:

1. BR1 (Scott Point), located north of the Bruce Power site. The characteristics of residents BR1 through BR5 define this group and the dose calculations performed with the calculated dose assigned to the resident closest to Bruce A.

2. BR11, located to the northeast of the Bruce Power site near Baie du Doré.
The characteristics of residents BR7 through BR13 define this group and the dose calculations performed with the calculated dose assigned to the resident closest to Bruce A.

3. BR22, located to the south of the Bruce Power site. The characteristics of residents BR22 through BR28 define this group and the dose calculations performed with the calculated dose assigned to the resident closest to the Bruce Power site.

4. BR27, located to the south of the Bruce Power site. The characteristics of residents of the trailer park define this group and the dose calculations performed with the calculated dose assigned to the resident closest to Bruce B.

5. BR32 is located to the south of Bruce Power site in Inverhuron. The characteristics of residents BR32 through BR40 define this group and the dose calculations performed with the calculated dose assigned to the resident closest to the Bruce Power site.

6. BF1 is located to the northeast of the Bruce Power site. The characteristics of farms BF1 through BF17 define this group and the dose calculations performed with the calculated dose assigned to the resident at the farm closest to Bruce A.

7. BF14 is located to the southeast of the Bruce Power site. The characteristics of farms BF1 through BF17 define this group and the dose calculations performed with the calculated dose assigned to the resident at the farm closest to Bruce B.

8. BDF11 is located southeast of the Bruce Power site near Tiverton. The characteristics of dairy farms BDF1 through BDF12 define this group and the dose calculations performed with the calculated dose assigned to the resident at the dairy farm closest to the Bruce Power site.

Dose calculations are performed for adults and one year old infants at each of the eight potential critical groups. The group which is assigned the highest calculated dose for the year is termed the critical group.

Dose calculations are also performed for a worker employed at the Bruce Energy Centre.

3.3 Radionuclides and Exposure Pathways

Doses are calculated for each of the potential critical groups due to the exposures to each of the following radionuclides via the pathways in Table 3.3. The results are summed to produce the total dose.

Table 3.3

Radionuclides	Pathways
Tritiated Water (HTO)	Air Inhalation/Skin Absorption
Noble Gases	Air Immersion (external exposure)
Iodine (mfp)*	Water Ingestion
Particulates	Water Immersion (swimming/bathing)
Carbon-14	Soil External Exposure (soil ground shine)
Organically Bound Tritium	Terrestrial Plant Ingestion
	Terrestrial Animal Ingestion
	Aquatic Plant Ingestion
	Aquatic Animal Ingestion (fish)
	Sediment External Exposure (beach ground shine)

*Note:

Where Iodine (mfp), or mixed fission product iodine, is defined as:

1 Bq I (mfp) = 1 Bq ^{131}I + 1.48 Bq ^{132}I + 2.05 Bq ^{133}I + 2.29 Bq ^{134}I + 1.95 Bq ^{135}I

and reflects the amount of each of the radionuclides ^{132}I, ^{133}I, ^{134}I and ^{135}I which accompany one Bq of ^{131}I at the time of release.

The term “particulates” refers to samples of particulate matter which are analyzed to determine the gross gamma activity in the particulate sample. The activity is then attributed entirely to one radionuclide. In order to perform dose calculations it is necessary to assign all the particulate activity to a specific radionuclide. A conservative approach is to choose the radionuclide which would result in the highest dose taking into account the expected composition of different radionuclides in the airborne and waterborne emissions from the Bruce Power site. That radionuclide has been determined to be ^{137}Cs. Therefore all gross radioactivity measured in airborne or waterborne emissions from the Bruce Power site is considered, for dose calculation purposes, to be ^{137}Cs.

3.4 Human Attributes

The human attributes which determine the degree of exposure to, or intake of, radionuclides present in environmental media were drawn from the default values in the Derived Release Limit (DRL) Guidance document [R-11]. The default rates in the DRL Guidance document represent the 90^{th} percentile values for the population. These rates were purposely chosen for the DRL Guidance document to introduce conservatism in release calculations. The intent of this report is to provide a more realistic assessment of doses and therefore the default food consumption rates used were adjusted to reference the caloric intake requirements of each age group, as outlined in International Commission on Radiation Protection (ICRP) 23 [R-12] and shown in the DRL Guidance document. Values for some of the more prominent parameters from the perspective of performing dose calculations are outlined in Table 3.4.

Table 3.4

Parameter	Units	Adult	1 yr Infant	Dairy Farm 1 yr Infant
Inhalation Rate	**m^3/yr**	**8103**	**1883**	**1883**
Water Ingestion Rate	**L/yr**	**840**	**402**	**186**
Grain Intake	kg/yr	155	54	54
Fruit & Berry Intake	kg/yr	117	61	61
Vegetable Intake	kg/yr	157	40	40
Mushrooms Intake	kg/yr	1	0.1	0.1
Potato Intake	kg/yr	70	21	21
Total Plant Ingestion Rate	**kg/yr**	**500**	**176**	**176**
Beef Intake	kg/yr	45	9.8	9.8
Pork Intake	kg/yr	19	3	3
Lamb Intake	kg/yr	0.5	0.009	0.009
Poultry Intake	kg/yr	13	4.1	4.1
Egg Intake	kg/yr	20	7.8	7.8
Deer Intake	kg/yr	0.08	0.02	0.02
Rabbit Intake	kg/yr	0.2	0.05	0.05
Milk Intake	kg/yr	178	0	216
Total Animal Ingestion Rate	**kg/yr**	**276**	**25**	**241**
Fish Ingestion Rate	**kg/yr**	**5**	**0.8**	**0.8**

The difference in consumption rates between the one year old infant and the dairy farm one year old infant is due to whether the infant drinks formula or fresh cow's milk. The amount of milk ingested by the dairy farm infant (216 kg/yr) is subtracted from the default water ingestion rate and added to the terrestrial animal ingestion rate.

It is important to note that these are global attributes, i.e., consumption rates for each parameter are from all sources. When performing the dose calculations for the potential critical groups, the consumption rates are modified to take into account the local attributes of the potential critical groups obtained during the course of conducting the site specific survey [R-10]. Plant and animal ingestion rates are modified by taking into account information regarding the fraction of plant and animal products obtained from sources affected by emission from the Bruce Power site. For example, an adult living in the vicinity of the Bruce Power site might consume 500 kg of fruit and vegetables per year but only 10 percent of these were from a local source. Fish ingestion rates are estimated directly from the site specific survey.

3.5 IMPACT Software

Dose calculations were performed using version 4.1.3 of the IMPACT (Integrated Model for the Probalistic Assessment of Contaminant Transport) software. IMPACT is a customized tool that allows the user to assess the transport and fate of radionuclides through a user-defined environment. It also enables the quantification of human exposure to those radionuclides and the calculation of associated dose.

IMPACT models the movement of contaminants through the environment from the point furthest along each exposure pathway for which there is available data from monitoring locations. If no monitoring information is available, the IMPACT software would calculate the activity based on emissions from the Bruce Power site and atmospheric dispersion models contained in the software.

For contaminant transport and exposure modeling completed as part of the dose calculations, each of the potential critical groups is considered to reside at the location of the member household that is nearest to a source of emissions from the Bruce Power site.

3.6 Environmental Monitoring Data used in Dose Calculations

The environmental monitoring data used in the dose calculations for each of the potential critical groups and the Bruce Energy Centre Worker is detailed in Tables 3.6.1 through 3.6.9. The data included in Tables 3.6.1 and 3.6.9 has been background corrected so that dose calculations are performed using only the incremental radionuclide concentrations attributable to activities on the Bruce Power site.

All other necessary specific activities of radionuclides in environmental media are modeled by the IMPACT software.

Table 3.6.1 – Potential Critical Group BR1

Exposure Medium	Radionuclide	Value	Units	Note
Air	Tritium	1.49	Bq/m^3	1
	I(mfp)	2.57E-07	Bq/m^3	2
	^{137}Cs	2.23E-07	Bq/m^3	2
	Noble Gases	3.30E-01	$Bq\text{-}MeV/m^3$	2
	^{14}C	57.26	Bq/kg-C	1
Fruit	Tritium	153.02	Bq/l	3
	^{14}C	165	Bq/kg-C	3
Vegetables	Tritium	153.02	Bq/l	3
	^{14}C	165	Bq/kg-C	3
Well Water - Deep	Tritium	0.00	Bq/l	4
Well Water - Shallow	Tritium	53.5	Bq/l	5
Lake (Baie du Doré)	Tritium	140.7	Bq/l	6
Fish	Tritium	22.4	Bq/l	6
	^{14}C	71	Bq/kg-C	6
	^{137}Cs	0.01	Bq/kg (wet)	6
Beach Sand	^{137}Cs	3.74	Bq/kg (dry)	7

Notes:

1 The higher of the annual average from either active or passive sampling at BR1
2 Calculated based on the atmospheric dilution factor (K_a) derived from Tritium emissions and the measured Tritium activity at BR5
3 The highest of the annual average of the results of samples collected at BG14 and BG15
4 The highest of the annual average of samples for deep wells at BR1 and BM3
5 The highest of the annual average of samples for shallow wells at BR2, BR3 and BR4
6 The annual average of the results of samples collected at Baie du Doré
7 The result from the beach sand sample collected at Baie du Doré

Table 3.6.2 – Potential Critical Group BR11

Exposure Medium	Radionuclide	Value	Units	Note
Air	Tritium	2.58	Bq/m^3	1
	I(mfp)	3.76E-07	Bq/m^3	2
	^{137}Cs	3.27E-07	Bq/m^3	2
	Noble Gases	4.83E-01	$Bq\text{-}MeV/m^3$	2
	^{14}C	142	Bq/kg-C	1
Fruit	Tritium	67.2	Bq/l	3
	^{14}C	134	Bq/kg-C	3
Vegetables	Tritium	153.02	Bq/l	4
	^{14}C	165	Bq/kg-C	4
Well Water - Deep	Tritium	0.00	Bq/l	5
Lake (Baie du Doré)	Tritium	140.7	Bq/l	6
Fish	Tritium	22.4	Bq/l	7
	^{14}C	71	Bq/kg-C	7
	^{137}Cs	0.01	Bq/kg (wet)	7
Beach Sand	^{137}Cs	3.74	Bq/kg (dry)	8

Notes:

1 The annual average of the results from the passive sampler at BR11

2 Calculated based on the atmospheric dilution factor (K_a) derived from Tritium emissions and the measured Tritium activity at BR11

3 The annual average of the results of samples collected at BG11

4 The highest of the annual average of the results of samples collected at BG14 and BG15

5 The annual average of the results of samples collected at BR8

6 The annual average of the results of samples collected at Baie du Doré

7 The average of the results of samples collected at Baie du Doré

8 The result from the beach sand sample collected at Baie du Doré

Table 3.6.3 – Potential Critical Group BR27

Exposure Medium	Radionuclide	Value	Units	Note
Air	Tritium	1.66	Bq/m^3	1
	I(mfp)	2.46E-07	Bq/m^3	2
	^{137}Cs	2.14E-07	Bq/m^3	2
	Noble Gases	3.15E-01	$Bq\text{-}MeV/m^3$	2
Well Water - Deep	Tritium	0.00	Bq/l	3
Fish	Tritium	22.4	Bq/l	4
	^{14}C	71	Bq/kg-C	4
	^{137}Cs	0.01	Bq/kg (wet)	4
Beach Sand	^{137}Cs	0.50	Bq/kg (dry)	5

Notes:

1 The annual average of the results from the passive sampler at BR27

2 Calculated based on the atmospheric dilution factor (K_a) derived from Tritium emissions and the measured Tritium activity at BR27

3 The annual average of the results of samples collected at BR27

4 The average of the results of samples collected at Baie du Doré

5 The average result from the beach sand samples collected at Inverhuron

Table 3.6.4 - Potential Critical Group BR22

Exposure Medium	Radionuclide	Value	Units	Note
Air	Tritium	1.00	Bq/m^3	1
	I(mfp)	1.51E-07	Bq/m^3	2
	^{137}Cs	1.32E-07	Bq/m^3	2
	Noble Gases	1.94E-01	Bq-MeV/m^3	2
Fruit	Tritium	67.4	Bq/l	3
	^{14}C	107	Bq/kg-C	3
Vegetables	Tritium	56.8	Bq/l	4
	^{14}C	83	Bq/kg-C	4
Well Water - Deep	Tritium	19.1	Bq/l	5
Well Water - Shallow	Tritium	19.0	Bq/l	6
Fish	Tritium	22.4	Bq/l	7
	^{14}C	71	Bq/kg-C	7
	^{137}Cs	0.01	Bq/kg (wet)	7
Beach Sand	^{137}Cs	0.50	Bq/kg (dry)	8

Notes:

1 The annual average from the passive samples at BR39

2 Calculated based on the atmospheric dilution factor (K_a) derived from Tritium emissions and the measured Tritium activity at BR39

3 The highest of the annual average of the results of samples collected at BG2 and BF14

4 The highest of the annual average of the results of samples collected at BR44 and BF14

5 The annual average of the results of samples collected at BR39

6 The highest of the annual average of the results of samples collected at BR32 and BR41

7 The annual average of the results of samples collected at Baie du Doré

8 The result from the beach sand sample collected at Inverhuron

Table 3.6.5 - Potential Critical Group BR32

Exposure Medium	Radionuclide	Value	Units	Note
Air	Tritium	1.01	Bq/m^3	1
	I(mfp)	1.53E-07	Bq/m^3	2
	^{137}Cs	1.33E-07	Bq/m^3	2
	Noble Gases	1.97E-01	Bq-MeV/m^3	2
Well Water - Deep	Tritium	19.1	Bq/l	3
Well Water - Shallow	Tritium	7.6	Bq/l	4
Fish	Tritium	22.4	Bq/l	5
	^{14}C	71	Bq/kg-C	5
	^{137}Cs	0.01	Bq/kg (wet)	5
Beach Sand	^{137}Cs	0.50	Bq/kg (dry)	6

Notes:

1 The annual average from the active sampler at B7

2 Calculated based on the atmospheric dilution factor (K_a) derived from Tritium emissions and the measured Tritium activity at B7

3 The annual average of the results of samples collected at BR39

4 The annual average of the results of samples collected at BR32

5 The annual average of the results of samples collected at Baie du Doré

6 The result from the beach sand sample collected at Inverhuron

Table 3.6.6 - Potential Critical Group BDF11

Exposure Medium	Radionuclide	Value	Units	Note
Air	Tritium	0.26	Bq/m^3	1
	I(mfp)	4.71E-08	Bq/m^3	2
	^{137}Cs	4.09E-08	Bq/m^3	2
	Noble Gases	6.04E-02	Bq-MeV/m^3	2
	^{14}C	11	Bq/kg-C	1
Fruit	Tritium	36.9	Bq/l	3
	^{14}C	57	Bq/kg-C	3
Vegetables	Tritium	47.0	Bq/l	4
	^{14}C	64	Bq/kg-C	4
Well Water - Deep	Tritium	0.00	Bq/l	5
Milk	Tritium	4.5	Bq/l	6
	^{14}C	7	Bq/kg-C	6
Fish	Tritium	22.4	Bq/l	7
	^{14}C	71	Bq/kg-C	7
	^{137}Cs	0.01	Bq/kg (wet)	7
Beach Sand	^{137}Cs	0.50	Bq/kg (dry)	8

Notes:

1 The annual average from the passive sampler at BDF11
2 Calculated based on the atmospheric dilution factor (K_a) derived from Tritium emissions and the measured Tritium activity at BDF11
3 The annual average of the results of samples collected at BG4
4 The annual average of the results of samples collected at BF15
5 The annual average of the results of samples collected at BDF11
6 The annual average of the results of samples collected at BDF11
7 The annual average of the results of samples collected at Baie du Doré
8 The result from the beach sand sample collected at Inverhuron

Table 3.6.7 - Potential Critical Group BF1

Exposure Medium	Radionuclide	Value	Units	Note
Air	Tritium	0.69	Bq/m^3	1
	I(mfp)	1.08E-07	Bq/m^3	2
	^{137}Cs	9.34E-08	Bq/m^3	2
	Noble Gases	1.38E-01	Bq-MeV/m^3	2
	^{14}C	57	Bq/kg-C	1
Fruit	Tritium	67.2	Bq/l	3
	^{14}C	134	Bq/kg-C	3
Vegetables	Tritium	67.2	Bq/l	3
	^{14}C	134	Bq/kg-C	3
Well Water - Deep	Tritium	0.0	Bq/l	4
Fish	Tritium	22.4	Bq/l	5
	^{14}C	71	Bq/kg-C	5
	^{137}Cs	0.01	Bq/kg (wet)	5
Beach Sand	^{137}Cs	3.74	Bq/kg (dry)	6

Notes:

1 The annual average from the passive sampler at BF1

2 Calculated based on the atmospheric dilution factor (K_a) derived from Tritium emissions and the measured Tritium activity at BF1

3 The highest of the annual average of the results of samples collected at BG13 and BG11

4 The annual average of the results of samples collected at BF1

5 The annual average of the results of samples collected at Baie du Doré

6 The result from the beach sand sample collected at Baie du Doré

Table 3.6.8 - Potential Critical Group BF14

Exposure Medium	Radionuclide	Value	Units	Note
Air	Tritium	1.23	Bq/m^3	1
	I(mfp)	1.85E-07	Bq/m^3	2
	^{137}Cs	1.60E-07	Bq/m^3	2
	Noble Gases	2.37E-01	Bq-MeV/m^3	2
	^{14}C	56	Bq/kg-C	1
Fruit	Tritium	67.4	Bq/l	3
	^{14}C	107	Bq/kg-C	3
Vegetables	Tritium	56.8	Bq/l	3
	^{14}C	83	Bq/kg-C	3
Well Water - Deep	Tritium	0.0	Bq/l	4
Fish	Tritium	22.4	Bq/l	5
	C^{14}	71	Bq/kg-C	5
	^{137}Cs	0.01	Bq/kg (wet)	5
Beach Sand	^{137}Cs	0.50	Bq/kg (dry)	6

Notes:

1 The annual average from the passive sampler at BF14

2 Calculated based on the atmospheric dilution factor (K_a) derived from Tritium emissions and the measured Tritium activity at BF14

3 The average of the results of samples collected at BF14

4 The annual average of the results of samples collected at BF14

5 The annual average of the results of samples collected at Baie du Doré

6 The result from the beach sand sample collected at Inverhuron

Table 3.6.9 – Bruce Energy Centre Worker

Exposure Medium	Radionuclide	Value	Units	Note
Air	Tritium	1.37	Bq/m^3	1
	I(mfp)	2.04E-07	Bq/m^3	2
	^{137}Cs	1.77E-07	Bq/m^3	2
	Noble Gases	2.62E-01	$Bq\text{-}MeV/m^3$	2
	^{14}C	362	Bq/m^3	3
Well Water - Deep	Tritium	0.00	Bq/l	4

Notes:

1 The annual average from the active sampler at B10

2 Calculated based on the atmospheric dilution factor (K_a) derived from Tritium emissions and the measured Tritium activity at B10

3 The annual average from the passive sampler at B10

4 The results of samples collected at BM9

Table 3.6.10 – Provincial Background

Exposure Medium	Radionuclide	Value	Units	Note
Air	Tritium	0.07	Bq/m^3	1
	I(mfp)	N/A	Bq/m^3	
	^{137}Cs	N/A	Bq/m^3	
	Noble Gases	N/A	Bq-MeV/m^3	
	^{14}C	250	Bq/kg-C	2
Fruit	Tritium	2.68	Bq/l	3
	^{14}C	224	Bq/kg-C	3
Vegetables	Tritium	3	Bq/l	3
	^{14}C	224	Bq/kg-C	3
Well Water - Deep	Tritium	0.00	Bq/l	4
Well Water - Shallow	Tritium	4.70	Bq/l	4
Lake (Baie du Doré)	Tritium	2.21	Bq/l	5
Milk	Tritium	<3.7	Bq/l	3
	^{14}C	232	Bq/kg-C	3
Fish	Tritium	8	Bq/l	6
	^{14}C	245	Bq/kg-C	6
	^{137}Cs	0.45	Bq/kg (wet)	6
Beach Sand	^{137}Cs	0.43	Bq/kg (dry)	7

Notes:

1 The annual average of the active sample results for the provincial locations
2 The annual average of the passive sample results for the provincial locations
3 The annual average of the results of samples collected a provincial locations
4 The annual average of the results of samples collected at background locations
5 The sum of the atmospheric weapons testing and naturally occurring contributions based on the Klukas' model.
6 The average of results of samples collected at control locations on Lake Huron
7 The average of results of samples collected at Goderich and Grand Bend

3.7 Summary of Dose Calculation Results

The calculated dose to the eight potential critical groups plus the Bruce Energy Centre Worker is summarized in Table 3.7a.

Table 3.7a

Group		Radionuclide	Air External µSv	Air Inhalation µSv	Aquatic Animals µSv	Sediment External µSv	Soil External µSv	Terrestrial Animals µSv	Terrestrial Plants µSv	Water External µSv	Water Ingestion µSv	Total µSv
BR1	Adult	Tritium	0.00E+00	4.83E-01	2.29E-03	0.00E+00	0.00E+00	3.03E-03	1.09E-01	3.06E-02	8.99E-01	1.53
		Noble Gas	4.74E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.47
		I(mfp)	4.89E-06	6.46E-05	0.00E+00	0.00E+00	7.23E-03	8.83E-06	5.03E-05	1.84E-05	1.16E-03	0.01
		Cs-137	1.65E-07	8.31E-06	8.15E-04	1.10E-02	1.31E-03	0.00E+00	6.77E-05	1.65E-05	1.97E-06	0.01
		C-14	8.61E-07	1.11E-03	2.91E-02	0.00E+00	5.21E-08	8.52E-03	2.65E-01	1.72E-09	3.33E-05	0.30
		OBT	0.00E+00	0.00E+00	1.11E-02	0.00E+00	0.00E+00	0.00E+00	8.24E-03	0.00E+00	0.00E+00	0.02
		Total	**4.74E-01**	**4.84E-01**	**4.33E-02**	**1.10E-02**	**8.54E-03**	**1.16E-02**	**3.82E-01**	**3.07E-02**	**9.00E-01**	**2.34**
	Infant	Tritium	0.00E+00	2.97E-01	2.13E-03	0.00E+00	0.00E+00	3.06E-03	8.86E-02	3.00E-03	1.14E+00	1.53
		Noble Gas	6.07E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.61
		I(mfp)	6.36E-06	1.31E-04	0.00E+00	0.00E+00	1.08E-02	2.97E-05	1.51E-04	2.39E-05	4.89E-03	0.02
		Cs-137	2.15E-07	2.27E-06	2.64E-04	1.43E-02	1.70E-03	0.00E+00	2.12E-05	4.01E-09	8.72E-07	0.02
		C-14	1.12E-06	8.16E-04	2.82E-02	0.00E+00	6.65E-08	8.97E-03	2.24E-01	7.91E-11	4.40E-05	0.26
		OBT	0.00E+00	0.00E+00	1.10E-02	0.00E+00	0.00E+00	0.00E+00	7.59E-03	0.00E+00	0.00E+00	0.02
		Total	**6.07E-01**	**2.98E-01**	**4.15E-02**	**1.43E-02**	**1.25E-02**	**1.21E-02**	**3.21E-01**	**3.02E-03**	**1.14E+00**	**2.45**
BR11	Adult	Tritium	0.00E+00	8.39E-01	6.99E-04	0.00E+00	0.00E+00	0.00E+00	1.07E-01	2.72E-02	0.00E+00	0.97
		Noble Gas	6.93E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.69
		I(mfp)	7.16E-06	9.44E-05	0.00E+00	0.00E+00	1.06E-02	0.00E+00	6.14E-05	2.69E-05	1.70E-03	0.01
		Cs-137	2.42E-07	1.22E-05	2.49E-04	1.10E-02	1.92E-03	0.00E+00	8.27E-05	1.65E-05	2.89E-06	0.01
		C-14	2.14E-06	2.75E-03	8.88E-03	0.00E+00	0.00E+00	0.00E+00	2.61E-01	1.66E-09	0.00E+00	0.27
		OBT	0.00E+00	0.00E+00	3.38E-03	0.00E+00	0.00E+00	0.00E+00	1.29E-02	0.00E+00	0.00E+00	0.02
		Total	6.93E-01	8.42E-01	1.32E-02	1.10E-02	1.25E-02	0.00E+00	3.82E-01	2.72E-02	1.70E-03	**1.98**
	Infant	Tritium	0.00E+00	5.17E-01	6.50E-04	0.00E+00	0.00E+00	0.00E+00	7.58E-02	0.00E+00	0.00E+00	0.59
		Noble Gas	8.89E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.89
		I(mfp)	9.31E-06	1.91E-04	0.00E+00	0.00E+00	1.59E-02	0.00E+00	1.44E-04	3.49E-05	7.15E-03	0.02
		Cs-137	3.16E-07	3.33E-06	8.05E-05	1.43E-02	2.49E-03	0.00E+00	2.03E-05	5.86E-09	1.28E-06	0.02
		C-14	2.79E-06	2.02E-03	8.59E-03	0.00E+00	0.00E+00	0.00E+00	1.92E-01	0.00E+00	0.00E+00	0.20
		OBT	0.00E+00	0.00E+00	3.35E-03	0.00E+00	0.00E+00	0.00E+00	9.68E-03	0.00E+00	0.00E+00	0.01
		Total	**8.89E-01**	**5.19E-01**	**1.27E-02**	**1.43E-02**	**1.84E-02**	**0.00E+00**	**2.78E-01**	**3.49E-05**	**7.15E-03**	**1.74**
BR27	Adult	Tritium	0.00E+00	5.41E-01	0.00E+00	0.00E+00	0.00E+00	1.68E-02	0.00E+00	1.35E-02	0.00E+00	0.57
		Noble Gas	4.52E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.45
		I(mfp)	4.68E-06	6.18E-05	0.00E+00	0.00E+00	6.92E-03	4.89E-05	0.00E+00	1.76E-05	1.11E-03	0.01
		Cs-137	1.59E-07	7.98E-06	0.00E+00	1.48E-03	1.25E-03	0.00E+00	0.00E+00	2.55E-05	1.89E-06	0.00
		C-14	2.48E-04	3.20E-01	0.00E+00	0.00E+00	0.00E+00	4.72E-02	0.00E+00	2.61E-09	0.00E+00	0.37
		OBT	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	0.00
		Total	**4.52E-01**	**8.61E-01**	**0.00E+00**	**1.48E-03**	**8.17E-03**	**6.40E-02**	**0.00E+00**	**1.36E-02**	**1.11E-03**	**1.40**
	Infant	Tritium	0.00E+00	3.33E-01	0.00E+00	0.00E+00	0.00E+00	1.69E-02	0.00E+00	0.00E+00	0.00E+00	0.35
		Noble Gas	5.80E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.58
		I(mfp)	6.09E-06	1.25E-04	0.00E+00	0.00E+00	1.04E-02	1.64E-04	0.00E+00	2.29E-05	4.68E-03	0.02
		Cs-137	2.07E-07	2.18E-06	0.00E+00	1.92E-03	1.63E-03	0.00E+00	0.00E+00	3.83E-09	8.35E-07	0.00
		C-14	3.24E-04	2.35E-01	0.00E+00	0.00E+00	0.00E+00	4.96E-02	0.00E+00	0.00E+00	0.00E+00	0.29
		OBT	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	0.00
		Total	**5.80E-01**	**5.69E-01**	**0.00E+00**	**1.92E-03**	**1.20E-02**	**6.66E-02**	**0.00E+00**	**2.29E-05**	**4.68E-03**	**1.23**
BR22	Adult	Tritium	0.00E+00	3.60E-01	3.06E-03	0.00E+00	0.00E+00	3.26E-03	4.41E-02	1.47E-02	3.19E-01	0.74
		Noble Gas	3.06E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.31
		I(mfp)	3.16E-06	4.17E-05	0.00E+00	0.00E+00	4.67E-03	9.51E-06	3.40E-05	1.19E-05	7.48E-04	0.01
		Cs-137	1.07E-07	5.37E-06	1.09E-03	1.48E-03	8.44E-04	0.00E+00	4.54E-05	2.55E-05	0.00E+00	0.00
		C-14	2.53E-04	3.26E-01	3.88E-02	0.00E+00	1.53E-05	9.18E-03	1.49E-01	1.63E-08	7.49E-03	0.53
		OBT	0.00E+00	0.00E+00	1.48E-02	0.00E+00	0.00E+00	0.00E+00	8.25E-03	0.00E+00	0.00E+00	0.02
		Total	**3.06E-01**	**6.86E-01**	**5.78E-02**	**1.48E-03**	**5.53E-03**	**1.25E-02**	**2.02E-01**	**1.48E-02**	**3.27E-01**	**1.61**
	Infant	Tritium	0.00E+00	2.22E-01	2.83E-03	0.00E+00	0.00E+00	3.38E-03	3.58E-02	1.07E-03	4.05E-01	0.67
		Noble Gas	3.92E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.39
		I(mfp)	4.11E-06	8.44E-05	0.00E+00	0.00E+00	7.00E-03	3.28E-05	9.87E-05	1.54E-05	3.16E-03	0.01
		Cs-137	1.39E-07	1.46E-06	3.51E-04	1.92E-03	1.10E-03	0.00E+00	1.38E-05	0.00E+00	0.00E+00	0.00
		C-14	3.30E-04	2.40E-01	3.75E-02	0.00E+00	1.96E-05	9.91E-03	1.27E-01	1.78E-08	9.89E-03	0.42
		OBT	0.00E+00	0.00E+00	1.46E-02	0.00E+00	0.00E+00	0.00E+00	7.40E-03	0.00E+00	0.00E+00	0.02
		Total	**3.92E-01**	**4.62E-01**	**5.52E-02**	**1.92E-03**	**8.12E-03**	**1.33E-02**	**1.71E-01**	**1.08E-03**	**4.18E-01**	**1.52**
BR32	Adult	Tritium	0.00E+00	3.27E-01	1.31E-03	0.00E+00	0.00E+00	3.03E-03	0.00E+00	1.42E-02	1.68E-01	0.51
		Noble Gas	2.83E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.28
		I(mfp)	2.91E-06	3.84E-05	0.00E+00	0.00E+00	4.30E-03	8.83E-06	0.00E+00	1.09E-05	6.90E-04	0.01
		Cs-137	9.86E-08	4.96E-06	4.65E-04	1.48E-03	7.80E-04	0.00E+00	0.00E+00	2.55E-05	9.27E-07	0.00
		C-14	3.32E-04	4.28E-01	1.66E-02	0.00E+00	2.01E-05	8.52E-03	0.00E+00	2.60E-08	1.28E-02	0.47
		OBT	0.00E+00	0.00E+00	6.31E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.01
		Total	**2.83E-01**	**7.55E-01**	**2.47E-02**	**1.48E-03**	**5.10E-03**	**1.16E-02**	**0.00E+00**	**1.42E-02**	**1.82E-01**	1.28
	Infant	Tritium	0.00E+00	2.02E-01	1.21E-03	0.00E+00	0.00E+00	2.95E-03	0.00E+00	5.62E-04	2.14E-01	0.42
		Noble Gas	3.62E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.36
		I(mfp)	3.79E-06	7.78E-05	0.00E+00	0.00E+00	6.46E-03	2.86E-05	0.00E+00	1.42E-05	2.91E-03	0.01
		Cs-137	1.28E-07	1.35E-06	1.50E-04	1.92E-03	1.01E-03	0.00E+00	0.00E+00	1.88E-09	4.10E-07	0.00
		C-14	4.33E-04	3.15E-01	1.61E-02	0.00E+00	2.57E-05	8.65E-03	0.00E+00	3.04E-08	1.69E-02	0.36
		OBT	0.00E+00	0.00E+00	6.26E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.01

Group		Radionuclide	Air External µSv	Air Inhalation µSv	Aquatic Animals µSv	Sediment External µSv	Soil External µSv	Terrestrial Animals µSv	Terrestrial Plants µSv	Water External µSv	Water Ingestion µSv	Total µSv
		Total	**3.63E-01**	**5.17E-01**	**2.37E-02**	**1.92E-03**	**7.49E-03**	**1.16E-02**	**0.00E+00**	**5.77E-04**	**2.33E-01**	1.16

Group		Radionuclide	Air External µSv	Air Inhalation µSv	Aquatic Animals µSv	Sediment External µSv	Soil External µSv	Terrestrial Animals µSv	Terrestrial Plants µSv	Water External µSv	Water Ingestion µSv	Total µSv
BDF11	Adult	Tritium	0.00E+00	8.43E-02	2.97E-04	0.00E+00	0.00E+00	1.67E-02	6.41E-02	1.43E-02	1.99E-01	**0.38**
		Noble Gas	8.67E-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	**0.09**
		I(mfp)	8.97E-07	1.18E-05	0.00E+00	0.00E+00	0.00E+00	8.31E-05	2.02E-05	3.37E-06	2.12E-04	**0.00**
		Cs-137	3.03E-08	1.52E-06	1.06E-04	1.48E-03	0.00E+00	0.00E+00	2.69E-05	2.55E-05	3.61E-07	**0.00**
		C-14	1.66E-07	2.14E-04	3.78E-03	0.00E+00	0.00E+00	5.98E-02	2.03E-01	2.62E-09	6.43E-06	**0.27**
		OBT	0.00E+00	0.00E+00	1.44E-03	0.00E+00	0.00E+00	2.12E-02	4.11E-03	0.00E+00	0.00E+00	**0.03**
		Total	**8.67E-02**	**8.45E-02**	**5.62E-03**	**1.48E-03**	**0.00E+00**	**9.78E-02**	**2.71E-01**	**1.43E-02**	**1.99E-01**	**0.76**
	Infant	Tritium	0.00E+00	5.19E-02	2.77E-04	0.00E+00	0.00E+00	4.01E-02	5.43E-02	6.63E-04	1.17E-01	**0.26**
		Noble Gas	1.11E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.11**
		I(mfp)	1.17E-06	2.39E-05	0.00E+00	0.00E+00	0.00E+00	7.75E-04	6.62E-05	4.38E-06	4.15E-04	**0.00**
		Cs-137	3.95E-08	4.16E-07	3.43E-05	1.92E-03	0.00E+00	0.00E+00	9.23E-06	7.33E-10	7.39E-08	**0.00**
		C-14	2.17E-07	1.57E-04	3.66E-03	0.00E+00	0.00E+00	1.26E-01	1.82E-01	1.53E-11	3.93E-06	**0.31**
		OBT	0.00E+00	0.00E+00	1.43E-03	0.00E+00	0.00E+00	1.31E-02	4.12E-03	0.00E+00	0.00E+00	**0.02**
		Total	**1.11E-01**	**5.21E-02**	**5.40E-03**	**1.92E-03**	**0.00E+00**	**1.79E-01**	**2.40E-01**	**6.67E-04**	**1.17E-01**	**0.71**
BF1	Adult	Tritium	0.00E+00	2.24E-01	7.88E-04	0.00E+00	0.00E+00	5.29E-03	1.08E-01	2.92E-02	5.27E-01	**0.89**
		Noble Gas	1.98E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.20**
		I(mfp)	2.06E-06	2.71E-05	0.00E+00	0.00E+00	3.04E-03	1.66E-05	4.24E-05	7.72E-06	4.87E-04	**0.00**
		Cs-137	6.93E-08	3.48E-06	2.80E-04	1.10E-02	5.48E-04	0.00E+00	5.66E-05	1.65E-05	8.25E-07	**0.01**
		C-14	8.54E-07	1.10E-03	1.00E-02	0.00E+00	5.17E-08	5.87E-02	4.84E-01	1.72E-09	3.30E-05	**0.55**
		OBT	0.00E+00	0.00E+00	3.81E-03	0.00E+00	0.00E+00	2.06E-02	1.39E-02	0.00E+00	0.00E+00	**0.04**
		Total	**1.98E-01**	**2.25E-01**	**1.49E-02**	**1.10E-02**	**3.59E-03**	**8.47E-02**	**6.06E-01**	**2.92E-02**	**5.27E-01**	**1.70**
	Infant	Tritium	0.00E+00	1.38E-01	7.35E-04	0.00E+00	0.00E+00	3.43E-03	7.96E-02	1.76E-03	6.68E-01	**0.89**
		Noble Gas	2.54E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.25**
		I(mfp)	2.67E-06	5.49E-05	0.00E+00	0.00E+00	4.56E-03	3.92E-05	1.09E-04	1.00E-05	2.05E-03	**0.01**
		Cs-137	9.02E-08	9.50E-07	9.11E-05	1.43E-02	7.11E-04	0.00E+00	1.52E-05	1.67E-09	3.65E-07	**0.02**
		C-14	1.11E-06	8.09E-04	9.72E-03	0.00E+00	6.60E-08	3.86E-02	3.72E-01	7.84E-11	4.36E-05	**0.42**
		OBT	0.00E+00	0.00E+00	3.79E-03	0.00E+00	0.00E+00	1.24E-02	1.12E-02	0.00E+00	0.00E+00	**0.03**
		Total	**2.54E-01**	**1.39E-01**	**1.43E-02**	**1.43E-02**	**5.27E-03**	**5.45E-02**	**4.63E-01**	**1.77E-03**	**6.70E-01**	**1.62**
BF14	Adult	Tritium	0.00E+00	4.02E-01	7.88E-04	0.00E+00	0.00E+00	2.51E-02	9.17E-02	1.39E-02	1.14E-01	**0.65**
		Noble Gas	3.40E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.34**
		I(mfp)	3.52E-06	4.65E-05	0.00E+00	0.00E+00	5.20E-03	5.05E-05	7.26E-05	1.32E-05	8.34E-04	**0.01**
		Cs-137	1.19E-07	5.96E-06	2.80E-04	1.48E-03	9.38E-04	0.00E+00	9.69E-05	2.55E-05	1.41E-06	**0.00**
		C-14	8.46E-07	1.09E-03	1.00E-02	0.00E+00	5.12E-08	1.04E-01	3.08E-01	2.67E-09	3.27E-05	**0.42**
		OBT	0.00E+00	0.00E+00	3.81E-03	0.00E+00	0.00E+00	6.95E-02	2.51E-02	0.00E+00	0.00E+00	**0.10**
		Total	**3.40E-01**	**4.03E-01**	**1.49E-02**	**1.48E-03**	**6.14E-03**	**1.98E-01**	**4.25E-01**	**1.40E-02**	**1.14E-01**	**1.52**
	Infant	Tritium	0.00E+00	2.48E-01	7.35E-04	0.00E+00	0.00E+00	1.67E-02	6.83E-02	3.79E-04	1.44E-01	**0.48**
		Noble Gas	4.36E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.44**
		I(mfp)	4.58E-06	9.41E-05	0.00E+00	0.00E+00	7.81E-03	1.19E-04	1.87E-04	1.72E-05	3.52E-03	**0.01**
		Cs-137	1.55E-07	1.63E-06	9.11E-05	1.92E-03	1.22E-03	0.00E+00	2.60E-05	2.87E-09	6.24E-07	**0.00**
		C-14	1.10E-06	8.01E-04	9.72E-03	0.00E+00	6.54E-08	6.82E-02	2.40E-01	7.77E-11	4.32E-05	**0.32**
		OBT	0.00E+00	0.00E+00	3.79E-03	0.00E+00	0.00E+00	4.17E-02	2.02E-02	0.00E+00	0.00E+00	**0.07**
		Total	**4.36E-01**	**2.48E-01**	**1.43E-02**	**1.92E-03**	**9.02E-03**	**1.27E-01**	**3.28E-01**	**3.97E-04**	**1.48E-01**	**1.31**
BEC	Adult	Tritium	0.00E+00	1.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.12**
		Noble Gas	1.02E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**0.10**
		I(mfp)	1.05E-06	1.38E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.94E-06	2.48E-04	**0.00**
		Cs-137	3.54E-08	1.78E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.59E-10	4.22E-07	**0.00**
		C-14	1.48E-06	1.90E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E-10	5.71E-05	**0.00**
		OBT	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	**0.00**
		Total	**1.02E-01**	**1.22E-01**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**3.94E-06**	**3.06E-04**	**0.22**

The calculated doses represent the average dose for each potential critical group. Individual members of a potential critical group may receive more or less dose than the average calculated for the potential critical group depending on the individual's deviation from average values used in the calculations.

A one year old infant living at BR1 (Scott Point) historically receives the highest dose as a result of the emissions from the Bruce Power site. Two main factors contribute to the higher calculated dose to the critical group BR1:

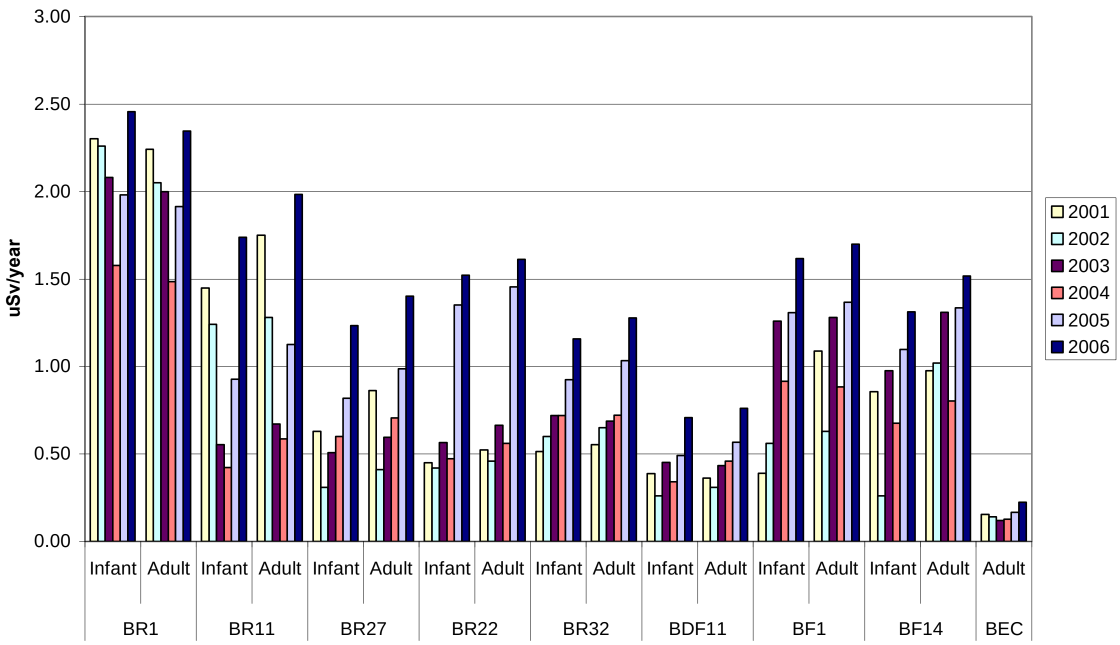
1. Wind and lake currents normally move more frequently in a northerly direction

2. The close proximity of Scott Point to Bruce A.

Scott Point has a number of shallow wells that historically are impacted by tritium in precipitation. The highest average tritium concentration of the Scott Point shallow wells was used as the drinking water source to calculate the dose for the BR1 critical group. This is conservative as the majority of Scott Point residents receive their drinking water from a deep community well with tritium concentrations below detection limits.

The historical trend of dose to the critical group from Bruce Power site activities is shown in Figure 3.7. The calculated dose to public has remained relatively constant over the past five years at less than 2.5 µSv/year.

Figure 3.7
Potential Critical Group Dose Trend



The legal dose limit for a member of the public from Bruce Power Site operations is 1,000 µSv/year. An estimate of the background radiation dose to the public in Ontario is 2,100 µSv/year. A breakdown of background doses are given in Table 3.7b. The incremental dose to the critical group as a result of Bruce Power site activities is significantly less than the background dose the critical group receives from exposure to natural background and manmade background sources.

Table 3.7b

Source of Exposure	Effective Dose μSv/year
NATURAL BACKGROUND	
Cosmic Rays	300
^{14}C	10
^{40}K	300
Radon and Thoron Daughters (Lung Irradiation)	1,000
^{238}U and ^{232}Th Series (Internal Irradiation)	170
External	230
Other Natural	10
Total Natural Background	2,020
MANMADE BACKGROUND	
Atmospheric Nuclear Weapons Testing Fallout	20
Exposures from Technological Processes	40
Consumer Products and Services	20
Total Manmade Background	80
TOTAL BACKGROUND	2,100
MEDICAL EXPOSURES	1,100
TOTAL ANNUAL EXPOSURE from all SOURCES	3,200

4.0 QUALITY ASSURANCE PROGRAMS

4.1 Introduction

Bruce Power is committed to an effective Quality Assurance (QA) Program to ensure the Radiological Environmental Monitoring Program is carried out at the highest quality to fulfill the following objectives:

- Provide data to calculate estimated potential doses to critical groups and populations from the presence of radiation fields or radioactive materials in the environment as a result of operations on the Bruce site.

- Provide data to confirm compliance of the facility or source with release guidelines and regulations and to provide public assurance of compliance.

- Provide a check, independent of effluent monitoring, and the effectiveness of containment and effluent control.

The QA program applies to all analytical and sampling activities that affect the quality of the results obtained. This section provides an overview of the quality assurance activities in place to provide quality REMP data.

4.2 Field Sampling

The field sampling program of the Bruce Power REMP is designed to collect representative samples from the selected pathways in the near vicinity of the Bruce Power site as well as from background locations. The following is a list of sample types collected in support of the Bruce Power REMP:

- Air, gaseous and particulate samples;
- Precipitation and dust fallout;
- Ambient gamma fields;
- Water from local water supply plants, shallow wells and deep wells;
- Aquatic samples: fish and lake sediment;
- Terrestrial samples: milk, honey, fruits and vegetables.

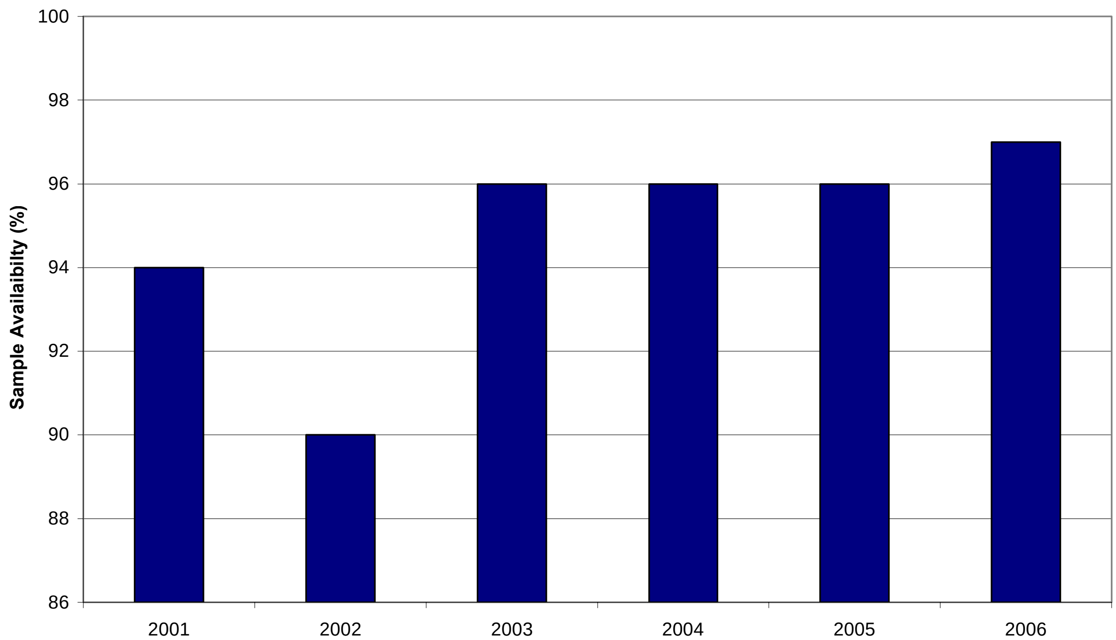
Sample availability, the number of valid sample analysis divided by the number of planned samples, is the performance measure used to evaluate the sampling program. Table 4.2 details the sample availability for this year. Figure 4.2 details the historical sample availability for the Bruce Power REMP sampling program.

Table 4.2

Sample Types	Collection Frequency	Bruce Power		
		Planned	Actual	Availability
Atmospheric				
Air Effluents	Monthly (^{3}H,^{14}C)	156	147	94%
	Quarterly (^{3}H,^{14}C)	152	152	100%
Environmental Gamma	Quarterly (GS[1])	44	44	100%
Precipitation/Particulate	Monthly (^{3}H, GB[2])	240	239	100%
Water				
Water Supply Plants	Weekly Composite (^{3}H)	144	141	98%
	Monthly Composite (GB)	36	36	100%
Resident Well & Lake Water	Bi-Monthly (^{3}H, GB) Semi-Annually (^{3}H, GB, GS)	121	115	95%
Local Streams	Bi-Monthly (^{3}H) Semi-Annually (GB)	40	40	100%
Site Ground Water	Semi-Annually (^{3}H)	52	52	100%
Bruce Energy Centre Well	Bi-Monthly (^{3}H)	6	6	100%
Aquatic				
Fish	Annually (^{3}H,^{14}C, GS, OBT)	140	140	100%
Sediment	Annually (GS)	160	144	90%
Terrestrial				
Milk	Weekly Composite (GS)	52	52	100%
	Monthly Composite (^{3}H,^{14}C)	60	60	100%
Fruits & Vegetables	Annually (^{3}H,^{14}C)	80	68	85%
Honey	Annually	3	3	100%
Eggs	Semi- Annually	2	2	100%
Grains	Annually (^{3}H,^{14}C) Quarterly (^{3}H)	12	12	100%
Animal Meat & Feed	Annually (^{3}H,^{14}C, GS)	9	9	100%
Soil & Sand	Annually (GS)	28	24	86%
Bruce Energy Center	Quarterly ($_3$H)	8	8	100%
Overall Site Sample Availability		1545	1494	97%

[1] Gamma Scan
[2] Gross Beta

Figure 4.2
Sample Availability



4.3 Laboratory Analysis

A total of 1354 laboratory analyses were conducted in support of the Bruce Power REMP this year. The analyses included tritium, gross beta, carbon-14, Iodine-131, TLD Gamma (under contract to OPG), gamma spectroscopy and organically bound tritium. Table 4.3 details the number of individual analyses performed by radionuclide category.

Table 4.3

Laboratory Analysis	Number of Analyses
^{3}H	796
Gross Beta	173
^{14}C	201
^{131}I	52
TLD Gamma	40
Gamma Spectrometry - ^{134}Cs, ^{137}Cs, ^{40}K, ^{60}Co	88
Organically Bound Tritium (OBT)	4
Total	**1354**

4.4 Laboratory Quality Assurance and Quality Control

The laboratory QA program described here applies only to the REMP analyses performed by the Bruce Power Health Physics Laboratory. The OPG Whitby Laboratory performed the TLD Gamma analyses and most of the provincial sample analyses. Details regarding the OPG QA program can be found in the OPG report “2006 Results of Environment Radiological Monitoring Programs” [R-5].

The Bruce Power Health Physics Laboratory operates a quality assurance program in accordance with the CNSC regulatory standard S-106(E) [R-13] and ISO 17025 [R-14].
The Health Physics Laboratory operates a technical Quality Assessment and Quality Control program to demonstrate the accuracy and precision of results. Table 4.4 presents a summary of the QA/QC program as applicable to the Bruce Power REMP.

Table 4.4

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
	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		
	Precision	QC Sample			QC Sample (^{137}Cs)	QC Sample (Sawdust)	Mixed Gamma QC Sample		
	Background	Low Tritium Water			Blank	Blank	Blank		
	Process Controls	Contamination			Contamination (de-min water)	Contamination (Coal)			

4.4.1 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 REMP. They are process control samples and quality control samples.

The process control samples are low analyte samples that are treated as real 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 REMP samples:

- Low tritium “dead” 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 problems with ^{14}C analyses;
- Demineralized water samples run as low gross beta samples to detect contamination, and;
- Blank TLDs to detect radiation exposure during shipping to and from the OPG Whitby laboratory.

The quality control samples are samples which contain known values of the analyte (usually derived from traceable standards), which are included for analysis. For general environmental samples, results are considered valid when the values for the accompanying quality control samples are within ±10 percent of the known or expected values. Analyses of tritium in air and ^{14}C in air collected by molecular sieve are considered valid if the observed values of the corresponding quality control samples are within ±19 percent of the expected value. Analyses of ^{14}C in air collected by passive samplers are considered valid if the observed values of the corresponding quality control samples are within ±15 percent of the expected value.

Table 4.4.1 summarizes the results of the quality control samples for tritium and ^{14}C analyses performed by the Bruce Power Health Physics Laboratory. These results are considered acceptable and provide confidence in the quality of data for the REMP program and the consistency of the laboratory measurements.

Table 4.4.1

Sample Type	Tritium		^{14}C	
	Low	High	Low	High
Air	84	112	92	107
Drinking Water	92	103	N/A	N/A
Precipitation	90	105	N/A	N/A
Milk	92	102	92	103

4.4.2 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.

The inter-comparison program relevant to REMP is one for radionuclides in environmental matrices operated by Eckert & Ziegler Analytics Inc. of Atlanta, Georgia. On a quarterly basis Eckert & Ziegler Analytics provides a number of samples containing known quantities of radionuclides to the Bruce Power health physics laboratory. These samples include:

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

Upon completion of analysis of the supplied samples the results are provided to Eckert & Ziegler Analytics. Eckert & Ziegler Analytics subsequently provides a report for Bruce Power detailing the expected values and the ratio of the laboratory value to the expected value.

The internally imposed test limits are as follows:

$0.8 \leq V_L/V_A \leq 1.2$

Where V is the value, and A and L refer to Eckert & Ziegler Analytics and Bruce Power health physics laboratory respectively.

The results for the four sets of quarterly tests completed this year are presented in Tables 4.4.2a - 4.4.2g

Table 4.4.2a – Eckert & Ziegler Analytics Test Results for Tritium in Water

Quarter	Eckert & Ziegler Analytics Value V_A (pCi/L)	Bruce Power Value V_L (pCi/L)	Ratio V_L/V_A (%)	Relative Standard Deviation (%)
Q1	4.21E+03	4.42E+03	105	3.4
Q2	6.00E+03	6.16E+03	103	1.2
Q3	1.10E+04	1.11E+04	101	1.4
Q4	5.40E+02	5.67E+02	105	5.8

Table 4.4.2b – Eckert & Ziegler Analytics Test Results for Gross Beta in Water

Quarter	Eckert & Ziegler Analytics Value V_A (pCi/L)	Bruce Power Value V_L (pCi/L)	Ratio V_L/V_A (%)	Relative Standard Deviation (%)
Q1	1.53E+02	1.73E+02	113	7.5
Q2	1.99E+02	2.18E+02	110	6.8
Q3	2.50E+02	2.27E+02	91	7.0
Q4	2.49E+02	2.69E+02	108	3.1

Table 4.4.2c – Eckert & Ziegler Analytics Test Results for Iodine in Milk

Quarter	Eckert & Ziegler Analytics Value V_A (pCi/L)	Bruce Power Value V_L (pCi/L)	Ratio V_L/V_A (%)	Relative Standard Deviation (%)
Q1	7.80E+01	7.50E+01	96	5.3
Q2	6.32E+01	6.10E+01	97	4.9
Q3	7.38E+01	7.60E+01	103	6.6
Q4	7.08E+01	6.70E+01	95	4.5

Table 4.4.2d – Eckert & Ziegler Analytics Test Results for Gamma in a Filter

Annual	Eckert & Ziegler Analytics Value V_A (pCi/L)	Bruce Power Value V_L (pCi/L)	Ratio V_L/V_A (%)	Relative Standard Deviation (%)
^{141}Ce	2.26E+02	2.22E+02	98	3.6
^{51}Cr	3.32E+02	3.02E+02	91	9.9
^{134}Cs	1.13E+02	1.20E+02	106	2.3
^{137}Cs	1.82E+02	1.56E+02	86	4.2
^{58}Co	6.42E+01	5.55E+01	86	11.3
^{54}Mn	8.49E+01	8.35E+01	98	5.1
^{59}Fe	6.10E+01	5.60E+1	92	5.7
^{65}Zn	1.26E+02	1.16E+02	92	5.2
^{60}Co	2.15E+02	2.04E+02	95	2.8

Table 4.4.2e – Eckert & Ziegler Analytics Test Results for I^{131} in a Cartridge

Annual	Eckert & Ziegler Analytics Value V_A (pCi/L)	Bruce Power Value V_L (pCi/L)	Ratio V_L/V_A (%)	Relative Standard Deviation (%)
^{131}I	8.67E+01	7.80E+01	90	11.5

Table 4.4.2f –Eckert & Ziegler Analytics Test Results for Gamma in Water

Quarter	Analyte	Eckert & Ziegler Analytics Value V_A (pCi/L)	Bruce Power Value V_L (pCi/L)	Ratio V_L/V_A (%)	Relative Standard Deviation (%)
Q1	^{141}Ce	8.68E+01	9.20E+01	106	8.7
	^{51}Cr	2.34E+02	2.05E+02	88	7.8
	^{134}Cs	1.01E+02	1.01E+02	100	5.9
	^{137}Cs	7.43E+01	7.80E+01	105	5.1
	^{58}Co	8.75E+01	9.20E+01	105	3.3
	^{54}Mn	7.81E+01	8.40E+01	108	3.6
	^{59}Fe	7.24E+01	8.00E+01	110	6.3
	^{65}Zn	1.48E+02	1.48E+02	100	2.7
	^{60}Co	1.07E+02	1.12E+02	105	1.8

Quarter	Analyte	Eckert & Ziegler Analytics Value V_A (pCi/L)	Bruce Power Value V_L (pCi/L)	Ratio V_L/V_A (%)	Relative Standard Deviation (%)
Q2	^{141}Ce	1.49E+02	1.60E+02	108	3.8
	^{51}Cr	2.10E+02	2.28E+02	109	7.5
	^{134}Cs	1.03E+02	1.07E+02	104	1.9
	^{137}Cs	9.51E+01	9.80E+01	103	2.0
	^{58}Co	8.12E+01	8.00E+01	99	3.8
	^{54}Mn	1.19E+02	1.23E+02	104	4.1
	^{59}Fe	7.58E+01	8.40E+01	111	3.6
	^{65}Zn	1.50E+02	1.57E+02	105	3.2
	^{60}Co	1.04E+02	1.08E+02	104	4.6
Q3	^{141}Ce	8.80E+01	9.30E+01	106	5.4
	^{51}Cr	2.88E+02	2.96E+02	103	8.1
	^{134}Cs	8.70E+01	8.80E+01	101	6.8
	^{137}Cs	1.79E+02	1.84E+02	103	1.6
	^{58}Co	1.12E+02	1.14E+02	102	2.6
	^{54}Mn	1.15E+02	1.19E+02	103	2.5
	^{59}Fe	4.47E+01	4.70E+01	105	6.4
	^{65}Zn	1.48E+02	1.51E+02	102	4.6
	^{60}Co	1.37E+02	1.40E+02	102	2.9
Q4	^{141}Ce	2.86E+02	2.83E+02	99	2.1
	^{51}Cr	4.21E+02	4.38E+02	104	5.0
	^{134}Cs	1.43E+02	1.48E+02	104	3.4
	^{137}Cs	2.30E+02	2.39E+02	104	1.7
	^{58}Co	8.14E+01	8.40E+01	103	7.1
	^{54}Mn	1.08E+02	1.14E+02	106	2.6
	^{59}Fe	7.74E+01	7.80E+01	101	6.4
	^{65}Zn	1.59E+02	1.59E+02	100	5.0
	^{60}Co	2.73E+02	2.85E+02	105	1.1

Table 4.4.2g – Eckert & Ziegler Analytics Test Results for Gamma in Soil

Quarter	Analyte	Eckert & Ziegler Analytics Value V_A (pCi/L)	Bruce Power Value V_L (pCi/L)	Ratio V_L/V_A (%)	Relative Standard Deviation (%)
Q1[1]	^{141}Ce	1.49E-01	1.39E-01	93	17.3
	^{51}Cr	4.02E-01	4.45E+00	1107	5.2
	^{134}Cs	1.73E-01	2.05E-01	118	12.7
	^{137}Cs	2.27E-01	1.93E-01	85	8.3
	^{58}Co	1.50E-01	2.72E-01	181	9.2
	^{54}Mn	1.34E-01	2.02E-01	151	10.9
	^{59}Fe	1.24E-01	4.26E-01	344	2.3
	^{65}Zn	2.53E-01	1.49E+03	586957	2.6
	^{60}Co	1.83E-01	5.07E-01	277	0.6
Q2	^{141}Ce	2.14E-01	2.18E-01	102	2.3
	^{51}Cr	3.02E-01	2.82E-01	93	4.6
	^{134}Cs	1.47E-01	1.48E-01	101	2.0
	^{137}Cs	2.37E-01	2.60E-01	110	1.5
	^{58}Co	1.17E-01	1.19E-01	102	1.7
	^{54}Mn	1.70E-01	1.79E-01	105	4.5
	^{59}Fe	1.09E-01	1.15E-01	106	3.5
	^{65}Zn	2.16E-01	2.26E-01	105	1.3
	^{60}Co	1.50E-01	1.50E-01	100	2.0
Q3	^{141}Ce	1.29E-01	1.41E-01	109	2.1
	^{51}Cr	4.23E-01	4.13E-01	98	3.1
	^{134}Cs	1.28E-01	1.33E-01	104	3.0
	^{137}Cs	3.62E-01	4.05E-01	112	1.2
	^{58}Co	1.64E-01	1.70E-01	104	1.7
	^{54}Mn	1.69E-01	1.81E-01	107	1.1
	^{59}Fe	6.60E-02	6.90E-02	105	4.3
	^{65}Zn	2.18E-01	2.45E-01	112	4.4
	^{60}Co	2.01E-01	2.06E-01	102	1.5
Q4	^{141}Ce	5.03E-01	4.79E-01	95	3.3
	^{51}Cr	7.41E-01	6.63E-01	89	4.1
	^{134}Cs	2.52E-01	2.45E-01	97	0.9

Quarter	Analyte	Eckert & Ziegler Analytics Value V_A (pCi/L)	Bruce Power Value V_L (pCi/L)	Ratio V_L/V_A (%)	Relative Standard Deviation (%)
	^{137}Cs	5.04E-01	5.06E-01	100	0.8
	^{58}Co	1.43E-01	1.36E-01	95	1.5
	^{54}Mn	1.90E-01	1.95E-01	103	3.1
	^{59}Fe	1.36E-01	1.37E-01	101	2.9
	^{65}Zn	2.80E-01	2.90E-01	104	1.7
	^{60}Co	4.80E-01	4.49E-01	94	1.3

Note:

1. Eckert & Ziegler Analytics sample appeared to be contaminated. SCR B-2006-04683 was raised to document the contamination.

4.4.3 Independent and Self Assessments

4.4.3.1 Independent Assessments

An external audit of the Bruce Power Health Physics laboratory was completed by The Canadian Association for Environmental Analytical Laboratories (CAEAL) from August 3 to August 4, 2006. The CAEAL audit [R-15] identified several findings requiring attention.

The findings identified the need for some procedural revisions for clarification and the need to maintain a list of external references, ensuring these are up to date and that methods selected from these documents are also up to date. There were also 2 findings on the use of calibration and quality control standards. The first regarding calibration standards made from the same stock and the second on the age of one calibration standard.

A Station Condition Record (SCR) was raised to deal with these findings and all corrective actions have been addressed. Thus the Dosimetry Section has maintained its accreditation with CAEAL.

4.4.3.2 Self Assessments

An internal audit of the Bruce Power Health Physics laboratory was completed by the Bruce Power Audit Section from November 27 to December 8, 2006. Weaknesses were found in the areas of management oversight, corrective action processes, work management, Health Physics Technologist training, housekeeping and safety practices, software control, records control and use of operating experience. Some of the findings were identified in a previous audit in 2005 with some of the corrective actions from that audit still remain open.

The audit team has prepared a report [R-16] and created appropriate Station Condition Records (SCRs) to document the findings and to ensure corrective action plans were generated to address them. The self-assessment concludes that the Bruce Power Health Physics Laboratory does a reasonable job at meeting the minimum requirements of the ISO/IEC 17025 and S-206 standards.

5.0 REFERENCES

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[R-2] Canadian Nuclear Safety Commission, March 2003, “Reporting Requirements for Operating Nuclear Power Plants, Regulatory Standard S-99”.

[R-3] Ontario Power Generation, N-REP-03481-10000, “The Provincial Radiological Environmental Program”.

[R-4] Canadian Standards Association, CAN/CSA-N288.1-M87, June 23, 1988, “Guidelines for Calculating Derived Release Limits for Radioactive Material in Airborne and Liquid Effluents for Normal Operation of Nuclear Facilities”.

[R-5] Benovich, I., Boromeo, J., N-REP-03481-10005, April, 2007, “2006 Results Of Radiological Environment Monitoring Programs”.

[R-6] Vorauer, A., Johnson, H.M., and Jensen, M.R., OHT Report 6292-001-1997-RA-0001-R00, “Reconnaissance Level Groundwater Quality Monitoring Program Bruce Nuclear Power Development Generating Stations Bruce 1-4 and Bruce 5-8”.

[R-7] Klukas, M.H., RC-2338, December 1999, “Tritium in the Great Lakes; Concentration – Time Model”.

[R-8] Jacques Whitford Environment Limits, Project No. 33288, October 19, 2001, “Development of a Generic Screening Criteria for Tritium in Groundwater Not Used As Drinking Water”.

[R-9] J. LaMarre, April, 2001, N-REP-03419-10001, “Annual Summary and Assessment of Environmental Radiological Data for 2000”.

[R-10] Schweinsberg, S, January 22, 1998, NK37(BS)-03443-97065(ED), “Site-Specific Survey for the BNPD Site – Summary Report”.

[R-11] Beak, October 31, 2002, N-REP-03482-10000, “Guidance for Calculation of Derived Release Limits in Airborne and Liquid Effluents from Ontario Power Generation Facilities”.

[R-12] International Commission on Radiological Protection, April 18, 1975, ICRP 23, “Report on the Reference Man”.

[R-13] Canadian Nuclear Safety Commission, Regulatory Standard S-106(E) “Technical and Quality Assurance Standards for Dosimetry Services in Canada”.

[R-14] International Organization for Standardization, ISO 17025:2005, “General requirements for the competence of testing and calibration laboratories”.

[R-15] 2006, CAEAL Audit Report

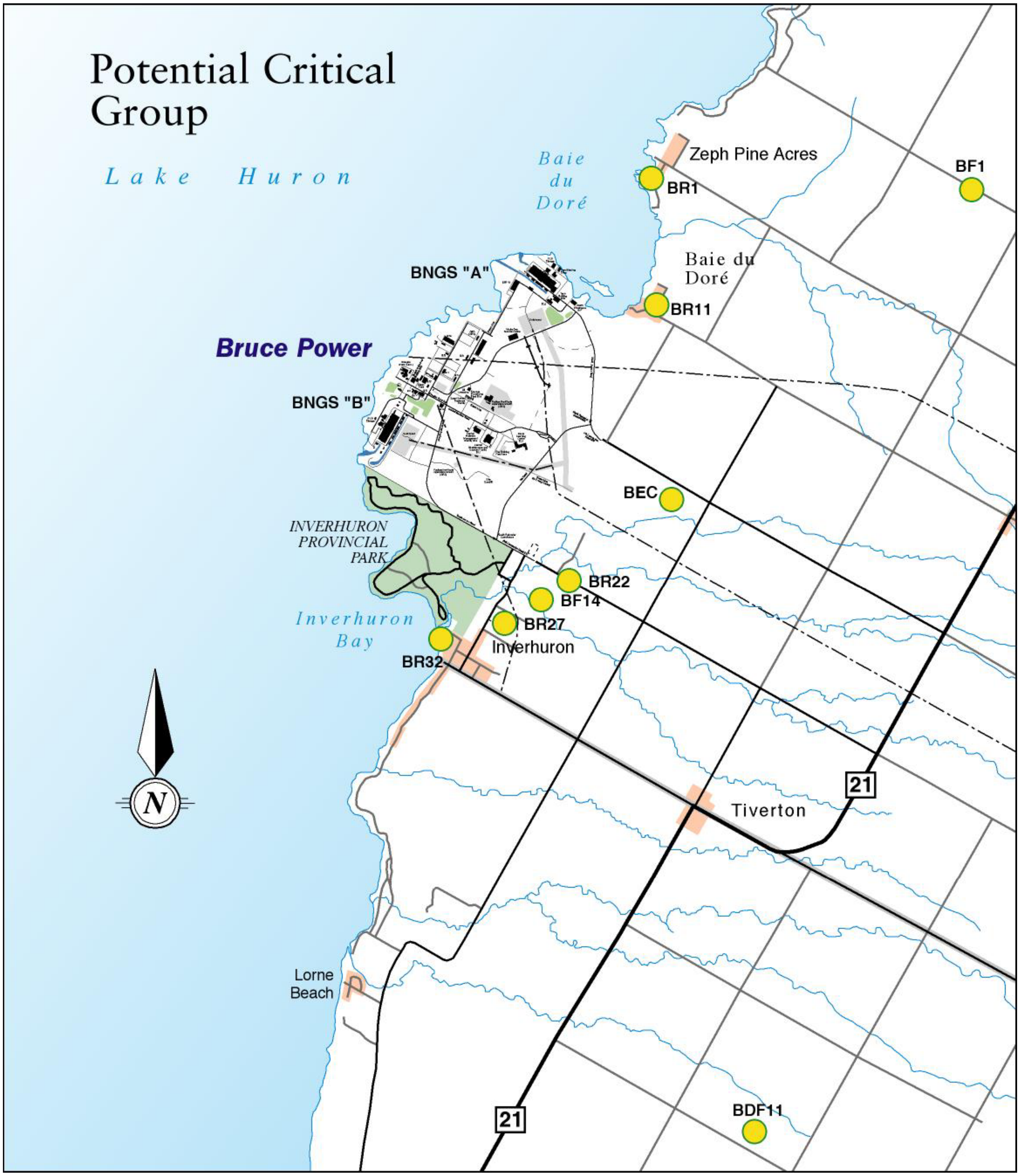
[R-16] H. Marsh, March 14, 2007, AU-2006-00030, “Health Physics Lab”.

APPENDIX A: MAP OF POTENTIAL CRITICAL GROUPS

Potential Critical Groups Legend

Key	Location
BR1	Located north of the Bruce Power site. The characteristics of residents BR1 through BR5 define this group and the dose calculations are performed with the calculated dose assigned to the resident closest to Bruce A.
BR11	Located northeast of the Bruce Power site near Baie du Doré. The characteristics of residents BR7 through BR13 define this group and the dose calculations are performed with the calculated dose assigned to the resident closest to Bruce A.
BR22	Located south of the Bruce Power site. The characteristics of residents BR22 through BR28 define this group and the dose calculations are performed with the calculated dose assigned to the resident closest to the Bruce Power site.
BR27	Located south of the Bruce Power site. The characteristics of residents at the trailer park define this group and the dose calculations are performed with the calculated dose assigned to the resident closest to Bruce B.
BR32	Located south of the Bruce Power site in Inverhuron. The characteristics of residents BR32 through BR40 define this group and the dose calculations are performed with the calculated dose assigned to the resident closest to the Bruce Power Site.
BF1	Located northeast of the Bruce Power site. The characteristics of farms BF1 through BR17 define this group and the dose calculations are performed with the calculated dose assigned to the resident at the farm closest to Bruce A.
BF14	Located southeast of the Bruce Power site. The characteristics of farms BF1 through BR17 define this group and the dose calculations are performed with the calculated dose assigned to the resident at the farm closest to Bruce B.
BDF11	Located southeast of the Bruce Power site near Tiverton. The characteristics of dairy farms BDF1 through BDF12 define this group and the dose calculations are performed with the calculated dose assigned to the resident at the farm closest to the Bruce Power site.
BEC	Located to the east of the Bruce Power Site. The characteristics of a worker at the Bruce Energy Centre define this group and the dose calculations are performed with the calculated dose assigned to a worker closest to the Bruce Power site.

Appendix A (Continued)



APPENDIX B: MAP OF SAMPLING SITES

Code Location

AIR MONITORING STATIONS

B2 Bruce Power Main Gate Exit
B3 Across from Park Rd, 2nd of Bruce
B4 Shore Rd, Between 4th and 6th Concession of Bruce
B5 Pine Acres, West of 6th Concession
B6 Goldie St, Paisley
B7 Daniel St, Inverhuron
B8 Arlington St, Port Elgin
B9 SE corner of Hwy.21 and Hwy.9, Kincardine
B10 Bruce Power Visitors' Centre, 4th Concession of Bruce
B11 Bruce County Rd #15, Tiverton

FARMS

BF1 RR#3, Tiverton, 8th Concession of Bruce Township
BF6 RR#3, Tiverton, 2nd Concession Bruce Township
BF8 RR#3, Tiverton, 2nd Concession Bruce Township
BF14 Albert St. Inverhuron
BF15 Conc. 1, Lot D and Eeast, Bruce Township
BF20 6th Concession of Bruce Township

DAIRY FARMS

BDF1 1st Concession of Saugeen Township
BDF9 RR#1 Tiverton
BDF11 9th Concession of Bruce Township

CREEKS

BC-1 Inverhuron Park
BC-2 North Access Rd. (On-site)
BC-3 Lake Range Road, between 6th and 8th
BC-4 8th C oncession between Lake Range Rd & Scott Point

MISCELLANEOUS

BM2 Brucedale Conservation Area, 12th Concession of Saugeen Township
BM3 Zepf Pine Acres 8th Concession of Saugeen Township
BM4 Baie du Dore, West end of 6th Concession of Bruce Township
BM6 Underwood Community Well, Underwood
BM9 D'Angelo Brand, Bruce Energy Centre
BM10 Inverhuron Park, 2nd Concession of Bruce Township
BM12 Briar Hill Well, Tiverton
BM13 Tiverton Dent Well, Tiverton
BM14 Condensate Line (On Site, East of CMLF)

RESIDENCES

BR1 Red Pine St, Scott Point
BR2 12 Cedar Lane, Scott Point
BR3 7 Cedar Lane, Scott Point
BR4 Red Pine St, Scott Point
BR5 Pine Cres., Scott Point
BR8 Lakeshore Rd, between 6th and 8th Concession of Bruce Township
BR11 6th Concession of Bruce Township
BR15 6th Concession, of Bruce Township
BR17 5th Concession of Bruce Township, Lot 5
BR25 2nd Concession of Bruce Township
BR27 Woodland Court Trailer Park, Inverhuron,
BR29 1st Concession of Bruce Township, Lot 8
BR32 55 Lake St, Inverhuron
BR39 7 Lake St, Inverhuron
BR41 Upper Lorne Beach Rd, RR#2 Tiverton
BR42 Brucedale, 10th Concession of Bruce Township
BR44 75 Whispering Woods, Inverhuron

FRUIT

BG1 South of 2nd Concession of Bruce Township, Inverhuron Park
BG2 Bruce County Rd 1, 0.2 km East of Albert St., Inverhuron.
BG3 Bruce County Rd 15, South Side of Road, Inverhuron
BG4 Bruce County Rd 15, 3.7 km from Albert St., Inverhuron
BG5 South Bruce Orchard, Tiverton
BG7 0.6 km North of 2nd Concession, Bruce Township
BG8 6th Concession, Bruce Township
BG10 0.1 km North of 6th Concession of Bruce Township
BG11 8th Concession of Bruce Township
BG13 Eastside Lake Range Rd., Bruce Township
BG14 North of 6th Concession of Bruce Township
BG15 Baie du Doré - End of 6th Concession of Bruce Township
BG16 1.2 km South of 4th Concession, Bruce Township
BG17 600 m South of 2nd Concession, Bruce Township
BG18 1.2 km South of 2nd Concession, Bruce Township
BG19 1.2 km South of 2nd Concession, Bruce Township
BG20 Between 2nd Concession of Bruce Township and Bruce Power Main Guard House
BG21 0.5 km North of Main Guard House

WATER TREATMENT PLANTS

WTP Kincardine, Port Elgin and Southampton

Appendix B (Continued)