

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

© Ontario Power Generation Inc., 2007. This document has been produced and distributed for internal Ontario Power Generation Inc. purposes only. No part of this document may be reproduced, published, converted, or stored in any data retrieval system, or transmitted in any form or by any means (electronic, mechanical, photocopying, recording, or otherwise) without the prior written permission of Ontario Power Generation Inc.

**2006 Results of Radiological Environmental
Monitoring Programs**

N-REP-03481-10005-R001

2007-12-17

Order Number: N/A
Other Reference Number: N/A**Public Information**

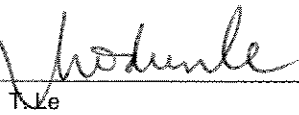
Prepared by:


DateJ. Borromeo
Senior Technical Engineer
Environment Programs
Department
Ontario Power Generation

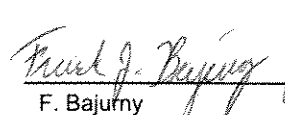
Reviewed by:


DateI. Benovich
Senior Technical Expert
Environment Programs
Department
Ontario Power Generation

Reviewed by:


DateT. Le
Section Manager
Environment Programs
Department
Ontario Power Generation

Reviewed by:


DateF. Bajumy
Manager
Environment Programs
Department
Ontario Power Generation

Approved by:


DateJ.J. Shaw
Director
Nuclear Protection
Programs and Training
Division
Ontario Power Generation

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 2 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table of Contents

	Page
Table of Contents.....	2
List of Figures	4
List of Tables	6
Acknowledgement.....	8
Revision Summary.....	9
Executive Summary	10
1.0 INTRODUCTION.....	12
2.0 OPG 2006 NUCLEAR GENERATION AND EMISSIONS DATA.....	13
2.1 Nuclear Generation Capacity.....	13
2.2 Radioactive Emissions and ¹⁴ C Inventory Data.....	13
3.0 ENVIRONMENTAL MONITORING DATA	16
3.1 External Gamma Dose Rate Measurements.....	17
3.2 Airborne Tritium and Carbon-14	19
3.3 Precipitation.....	21
3.4 Milk.....	22
3.5 Drinking Water.....	24
3.6 Aquatic Sampling	29
3.6.1 Sediment	30
3.6.2 Beach Sand/Silt Samples	30
3.6.3 Fish	30
3.7 Terrestrial Sampling	33
3.7.1 Fruits, Vegetables and Silage.....	34
3.7.2 Garden and Inland Soils	36
3.8 Sewage	36
3.9 Calculated Atmospheric Dispersion Factors	37
4.0 ASSESSMENT OF DOSES TO THE PUBLIC	40
4.1 Critical Group Dose Calculations	40
4.1.1 Darlington Nuclear Potential Critical Groups.....	43
4.1.2 Pickering Nuclear Potential Critical Groups	45
4.2 Change from Default Calculation Parameters.....	47
4.3 Critical Group Radionuclide Concentrations, Calculations and Results.....	47
4.3.1 Tritium	48
4.3.2 Carbon-14	49

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 3 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

4.3.3	Noble Gases and Skyshine	49
4.3.4	Radioiodines.....	50
4.3.5	Particulates	50
4.4	Critical Group Dose Calculation Procedure and Results	51
4.5	Discussion of Critical Group Dose Calculations	55
4.6	Background Dose Data	58
5.0	QUALITY ASSURANCE PROGRAM	59
5.1	Sample Availability	59
5.2	Laboratory Analysis	60
5.3	Laboratory Quality Assurance and Quality Control	64
5.3.1	Laboratory Quality Control.....	64
5.3.2	Laboratory Performance Testing	64
5.4	Independent and Self Assessments	66
5.4.1	Self Assessments	66
6.0	REFERENCES	67
Appendix A:	Radiological Units and Conversions.....	70
Appendix B:	Glossary of Acronyms and Symbols.....	71
Appendix C:	Maps of Environmental Monitoring and Critical Group Locations	73
Appendix D:	Environmental Monitoring Data	79
Appendix E:	Tables of Public Doses by Radionuclide, Pathway and Age Group for Darlington Nuclear and Pickering Nuclear Critical Groups	115
Distribution		131

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 4 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

List of Figures

Page

Figure 2.2.1	Darlington Nuclear Tritium Oxide Air Emissions Trend	14
Figure 2.2.2	Pickering Nuclear Tritium Oxide Air Emissions Trend.....	14
Figure 2.2.3	Darlington Nuclear Elemental Tritium Air Emissions Trend.....	15
Figure 2.2.4	Darlington Nuclear ¹⁴ C Air Emissions Trend	15
Figure 2.2.5	Pickering Nuclear ¹⁴ C Air Emissions Trend.....	15
Figure 2.2.6	Darlington Nuclear Tritium Oxide Water Emissions Trend	15
Figure 2.2.7	Pickering Nuclear Tritium Oxide Water Emissions Trend	15
Figure 3.1.1	Darlington Nuclear Site - Boundary Average TLD Gamma Dose Rate Trend	18
Figure 3.1.2	Pickering Nuclear Site - Boundary Average TLD Gamma Dose Rate Trend.....	18
Figure 3.1.3	Provincial Average TLD Gamma Dose Rate Trend	18
Figure 3.1.4	Pickering Nuclear Site – Boundary Average ⁴¹ Ar Dose In Air Trend	19
Figure 3.2.1	Darlington Nuclear Site Tritium-In-Air Trend	20
Figure 3.2.2	Pickering Nuclear Site Tritium-In-Air Trend	20
Figure 3.2.3	Darlington Nuclear Site ¹⁴ C-In-Air Trend.....	21
Figure 3.2.4	Pickering Nuclear Site ¹⁴ C-In-Air Trend	21
Figure 3.3.1	Darlington Nuclear Site Tritium-In-Precipitation Trend - Boundary Average	22
Figure 3.3.2	Pickering Nuclear Site Tritium-In-Precipitation Trend - Boundary Average	22
Figure 3.4.1	Darlington Nuclear Site Tritium-In-Milk Trend	23
Figure 3.4.2	Pickering Nuclear Site Tritium-In-Milk Trend	23
Figure 3.4.3	Darlington Nuclear Site ¹⁴ C-In-Milk Trend.....	24
Figure 3.4.4	Pickering Nuclear Site ¹⁴ C-In-Milk Trend	24
Figure 3.5.1	Darlington Nuclear Area WSP - Tritium In Water Concentrations	26
Figure 3.5.2	Pickering Nuclear Area WSP - Tritium In Water Concentrations.....	27
Figure 3.5.3a	Bowmanville WSP - Tritium In Water Trend.....	27
Figure 3.5.3b	Newcastle WSP – Tritium In Water Trend	27
Figure 3.5.3c	Ajax WSP - Tritium In Water Trend.....	28
Figure 3.5.3d	Oshawa WSP - Tritium In Water Trend	28
Figure 3.5.3e	Scarborough Horgan WSP – Tritium In Water Trend	28
Figure 3.5.3f	Toronto Harris WSP - Tritium In Water Trend.....	28
Figure 3.5.3g	Whitby WSP – Tritium In Water Trend.....	28
Figure 3.5.3h	Provincial Background Drinking Water Sources – Tritium In Water Trend	28
Figure 3.6.1	Darlington Nuclear Site - Tritium-In-Fish Trend	31
Figure 3.6.2	Pickering Nuclear Site - Tritium-In-Fish Trend.....	31
Figure 3.6.3	Darlington Nuclear Site - ¹⁴ C-In-Fish Trend.....	32
Figure 3.6.4	Pickering Nuclear Site - ¹⁴ C-In-Fish Trend	32
Figure 3.6.5	Darlington Nuclear Site - ¹³⁷ Cs-In-Fish Trend	32
Figure 3.6.6	Pickering Nuclear Site - ¹³⁷ Cs-In-Fish Trend	32
Figure 3.6.7	Lake Water Potassium Trend	33
Figure 3.6.8	Lake Water Total Suspended Solids Trend	33
Figure 3.7.1	Darlington Nuclear Tritium In Vegetation Trend.....	34
Figure 3.7.2	Pickering Nuclear Tritium In Vegetation Trend	34

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

5 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

List of Figures (Continued)

	Page
Figure 3.7.3 Darlington Nuclear ¹⁴ C In Vegetation Trend.....	36
Figure 3.7.4 Pickering Nuclear ¹⁴ C In Vegetation Trend	36
Figure 3.9.1 Darlington Nuclear Site Calculated Boundary Average Ka Values.....	38
Figure 3.9.2 Pickering Nuclear Site Calculated Boundary Average Ka Values	39
Figure 4.5.1 Darlington Nuclear Site Public Dose Trend	56
Figure 4.5.2 Pickering Nuclear Site Public Dose Trend.....	56
Figure 4.5.3 Graphical Presentation Of 2006 OPG Critical Group Doses In Relation To Canadian Background Doses	57

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

6 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

List of Tables

Page

Table 1.1	OPG Public Dose Estimates - 2006	11
Table 2.2	OPG Annual Nuclear Site Emissions - 2006	14
Table 3.7.5	¹⁴ C in Maple Leaves from Ottawa Compared to Vegetation from Provincial Background Locations	35
Table 3.9.1	Darlington Nuclear Site Annual Average Dispersion Factors - 2006	38
Table 3.9.2	Pickering Nuclear Site Annual Average Dispersion Factors - 2006	39
Table 3.9.3	Darlington and Pickering Nuclear Sites – 2006 Annual Average Wind Frequency by Direction (at 10 m height)	40
Table 4.1.1	Method (by Radionuclide and Pathway) for Determination of Critical Group Dose	42
Table 4.4.1	Total Critical Group Doses at Darlington Nuclear – 2006	54
Table 4.4.2	Total Critical Group Doses at Pickering Nuclear – 2006	54
Table 4.5.1	Examples of Typical Doses from Exposure to Natural and Anthropogenic Sources in the Range of Calculated Critical Group Doses at OPG Sites	58
Table 4.6.1	Naturally Occurring Annual Public Effective Doses	58
Table 5.1	Detailed Breakdown of REMP Sample Availability by Sample Types	61
Table 5.2	Detailed Breakdown of Laboratory Analyses for REMP in 2006	60
Table 5.3	Summary of Analytics Performance Test Results for 2006	65
Table D1.1	Darlington Nuclear Site TLD External Gamma Measurements - 2006	79
Table D1.2	Pickering Nuclear Site TLD External Gamma Measurements - 2006	80
Table D1.3	Provincial Background Sites TLD Gamma Measurements - 2006	81
Table D1.4	Darlington Nuclear Site - Noble Gas, Skyshine and ¹³¹ I Dose in Air - 2006	82
Table D1.5	Pickering Nuclear Site - Noble Gas, Skyshine and ¹³¹ I Dose in Air - 2006	83
Table D2.1	Darlington Nuclear Site Tritium-in-Air Concentrations – 2006	84
Table D2.2	Darlington Nuclear Site ¹⁴ C-in-Air Concentrations – 2006	85
Table D2.3	Pickering Nuclear Site Tritium-in-Air Concentrations – 2006	86
Table D2.4	Pickering Nuclear Site ¹⁴ C-in-Air Concentrations – 2006	87
Table D2.5	Provincial Background Sites Tritium-in-Air Concentrations – 2006	88
Table D2.6	Provincial Background Sites ¹⁴ C-in-Air Concentrations – 2006	89
Table D3.1	Darlington Nuclear Site Tritium in Precipitation and Gross Beta in Wet/Dry Fallout - 2006	90
Table D3.2	Pickering Nuclear Site Tritium in Precipitation and Gross Beta in Wet/Dry Fallout - 2006	91
Table D3.3	Background Tritium in Precipitation - 2006	92
Table D4.1	Darlington Nuclear Site: Milk - Tritium, ¹³¹ I, and ¹⁴ C Annual Average Concentrations - 2006	92
Table D4.2	Pickering Nuclear Site: Milk - Tritium, ¹³¹ I, ¹⁴ C and OBT Annual Average Concentrations - 2006	93
Table D4.3	Provincial Background Sites: Milk - Tritium, ¹³¹ I, and ¹⁴ C Annual Average Concentrations - 2006	93
Table D5.1	Darlington Nuclear Site - Drinking and Lake Water Tritium and Gross Beta Activity Concentrations- 2006	94

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 7 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

List of Tables (Continued)

Page

Table D5.2	Pickering Nuclear Site - Drinking and Lake Water Tritium and Gross Beta Activity Concentrations - 2006	95
Table D5.3	Provincial Background Sites - Drinking Water Tritium and Gross Beta Activity Concentrations - 2006.....	96
Table D6.1	Darlington Nuclear Site - Area Lake Ontario Sediment - 2006	97
Table D6.2	Pickering Nuclear Site - Area Lake Ontario Sediment - 2006.....	98
Table D6.3	Provincial Background - Lake Sediment - 2006.....	99
Table D6.4	Beach Sand/Silt - 2006	100
Table D6.5	Darlington Nuclear Site - Area Lake Ontario Fish - 2006.....	101
Table D6.6	Pickering Nuclear Site - Area Lake Ontario Fish - 2006	102
Table D6.7	Provincial Background - Fish - 2006	103
Table D7.1	Darlington Nuclear Site - Area Terrestrial Biota - 2006.....	105
Table D7.2	Pickering Nuclear Site - Area Terrestrial Biota - 2006	108
Table D7.3	Provincial Background - Terrestrial Biota - 2006	111
Table D7.4	Inland Soils and Garden Soils - 2006	112
Table D8.1	Pickering Nuclear Site-Sewage Effluent Gamma Scan Results-2006	113
Table D8.2	Pickering Nuclear Site Sewage Effluent Tritium and ¹⁴ C Concentration Results - 2006	114
Table D8.3	York Durham Water Pollution Control Plant, Ash Gamma Scan Results - 2006 ..	114
Table E1 -	Darlington Farm Critical Group Doses for 2006	116
Table E2 -	Darlington Dairy Farm Critical Group Doses for 2006	117
Table E3 -	Darlington Bowmanville Critical Group Doses for 2006	118
Table E4 -	Darlington St. Mary's Cement Critical Group Doses for 2006	119
Table E5 -	Darlington West/East Beach Critical Group Doses for 2006.....	120
Table E6 -	Darlington Rural Resident Critical Group Doses for 2006.....	121
Table E7 -	Darlington Provincial Park Camper Critical Group Doses for 2006	122
Table E8 -	Darlington Oshawa Critical Group Doses for 2006	123
Table E9 -	Darlington Sport Fisher Critical Group Doses for 2006.....	124
Table E10 -	Pickering Farm Critical Group Doses for 2006	125
Table E11 -	Pickering Dairy Farm Critical Group Doses for 2006	126
Table E12 -	Pickering Industrial Park Resident Critical Group Doses for 2006	127
Table E13 -	Pickering Correctional Institute (C2) Critical Group Doses for 2006	127
Table E14 -	Pickering Sport Fisher Critical Group Doses for 2006	128
Table E15 -	Pickering Urban Resident Critical Group Doses for 2006	129
Table E16 -	Pickering Squires Beach Resident Critical Group Doses for 2006.....	130

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 8 of 136
Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS		

Acknowledgement

The Environment Programs Department gratefully acknowledges the local residents and farmers living in the vicinity of Pickering and Darlington stations, and throughout the Province of Ontario who have voluntarily participated in our environmental monitoring programs. The samples that they provided throughout the year are essential to ensure that the annual public dose estimates are as realistic as possible.

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

9 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Revision Summary

Revision Number	Date	Comments
R000	2007-04-18	Initial Issue.
R001	2007-12-17	Updates to tables 4.4.2 and E15 to correct the Urban Resident critical group dose. This update was prompted by the discovery of an incorrect location used for the estimate of the Urban Resident dose. The result of this correction is a decrease in the estimated dose to all age classes of the Urban Resident critical group.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 10 of 136
Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS		

Executive Summary

Every year, Ontario Power Generation (OPG) conducts Radiological Environmental Monitoring Programs (REMPs) in the vicinity of the Darlington Nuclear (DN) and Pickering Nuclear (PN) sites to assess the radiological impact on the public resulting from the operation of these sites. OPG also conducts a similar monitoring program at various locations within the province of Ontario far from the influence of the nuclear station emissions in order to determine background radiation levels. The background radiation consists of naturally occurring radiation and anthropogenic sources such as nuclear weapons test fallout, exposures from technological processes, and consumer products and services.

In 2006, OPG operated ten nuclear reactors that produced 46.7 TWh of electricity. This represented an increase of 1.9 TWh over production levels in 2005. The net electrical outputs for DN, PN Units 1 and 4, and PN Units 5-8 were 26.9, 6.4 and 13.4 TWh, respectively. Emissions from DN and PN in 2006 continue to be significantly below the station Derived Release Limits (DRLs). These limits represent radionuclide release rates that correspond to critical group exposures at the public dose limit.

The DN site specific survey and the PN program were reviewed in 2006. With the exception of the removal of two potential critical groups at PN, there were no significant changes made to the REMPs. The 2006 assessments of the DN and PN REMP results demonstrate that the critical group doses resulting from the operation of the OPG nuclear generating stations continue to be well below the annual legal limit of 1,000 μSv and the annual average Canadian background radiation dose of 1,840 μSv . The official public doses for the DN and PN sites are summarized in Table 1.1 and described as follows:

- At the DN site, the highest dose calculated for the nine potential critical groups was 1.1 μSv for a nursing infant of the farm critical group. This limiting value is taken as the DN site critical group dose for 2006. This dose was virtually unchanged from the 2005 dose of 0.9 μSv .
- At the PN site, the highest dose calculated for the six potential critical groups was 2.8 μSv for both a 15 year old at the correctional institution (C2) and an adult worker at the industrial/commercial critical groups. This value is taken as the PN site critical group dose for 2006. The significant decrease from the 2005 critical group dose of 6.7 μSv is due to the closure of the correctional institution (C1) and the expropriation of the Squires Beach community for expansion of the municipal water pollution control plant. These two former potential critical groups often had the highest doses of all potential critical groups around the PN site.

The radiological impact of the OPG Western Waste Management Facility (WWMF) is assessed and reported in Bruce Power's annual REMP summary of the Bruce site.

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

11 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Executive Summary (Continued)

Table 1.1 OPG Public Dose Estimates - 2006

Facility	Critical Group (Receptor)	Effective Dose (μSv)	Percentage of Legal Limit (%)	Percentage of Canadian Background Radiation (%)
Darlington Nuclear Site	Farm (nursing infant)	1.1	0.1	0.06
Pickering Nuclear Site	C2 correctional institution (15 year old) and Industrial/Commercial (Adult)	2.8	0.3	0.15

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 12 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

1.0 INTRODUCTION

OPG's priority is to safely operate their facilities in a manner that minimizes the impact on the environment. OPG's nuclear power plants are registered to the internationally recognized ISO 14001 standard for Environmental Management Systems. As part of this commitment, OPG assesses the impact of the station operations by monitoring radioactivity in the environment surrounding Darlington Nuclear (DN) and Pickering Nuclear (PN). Where practical, mitigating actions will be initiated to reduce the identified impacts.

The operating licenses for Ontario Power Generation (OPG) Darlington and Pickering stations issued by the Canadian Nuclear Safety Commission (CNSC) require each site to maintain a Radiological Environmental Monitoring Program (REMP) and to report the results annually. This report provides the 2006 emissions and environmental data, their interpretations, and the estimates of radiation doses to the public resulting from operation of these stations. The REMP results for OPG's Western Waste Management Facility (WWMF) are reported by Bruce Power in their annual summary REMP report.

The site REMP is designed to satisfy the following primary objectives:

- (a) To demonstrate that nuclear site emissions of radioactive materials are properly controlled.
- (b) To independently estimate annual doses to the public based on environmental data measured in the public domain.
- (c) To provide data for evaluation of assumptions and transport models used to calculate station derived release limits and public doses.

Members of the public living near the nuclear generating stations are represented using the "Critical Group" concept. A critical group is determined according to the CSA Standard N288.1 **[R-1]** 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". Critical groups are characterized based on detailed site specific surveys that were made for each site and its surrounding areas. The radiological dose to these potential critical groups are estimated using a dose model and measured concentrations of radioactivity in environmental media or concentrations calculated from reported emissions.

Six potential critical groups at the PN site and nine potential critical groups at the DN site were identified to estimate doses in the 2006 assessment. The highest estimated critical group dose of each site establishes the official public dose for that site.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 13 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

The environmental and emissions data collected from January 1st to December 31st, 2006 for each site are summarized in Sections 2 and 3. The assessment of doses to the public is described in Section 4.

2.0 OPG 2006 NUCLEAR GENERATION AND EMISSIONS DATA

2.1 Nuclear Generation Capacity

In 2006, Ontario Power Generation (OPG) operated ten nuclear reactors that produced 46.7 TWh of electricity representing an increase in production of 1.9 TWh over the previous year. The sites are described as follows:

Darlington Nuclear (DN) - This site has four nuclear reactors with a total electrical power rating of 3,524 Megawatts electrical (MWe) and a Tritium Removal Facility (TRF) where tritium is extracted from tritiated heavy water and stored on site. DN's net electricity output for 2006 was 26.9 TWh, a decrease of 0.6 TWh over the previous year.

Pickering Nuclear (PN) - This site has two nuclear generating stations, PN1-4 and PN5-8, and a Pickering Waste Management Facility. PN1-4 reactor Units 1 and 4 are in operation with a total electrical power rating of 1,030 MWe. Units 2 and 3 are permanently shutdown. PN Units 1 and 4 produced a total of 6.4 TWh of electricity, an increase of 2.8 TWh compared to 2005. PN5-8 has four reactors with a total electrical power rating of 2,064 MWe. PN5-8 total net electrical output in 2006 was 13.4 TWh, a decrease of 0.3 TWh over the previous year. The Pickering Waste Management Facility consists of the Used Fuel Dry Storage Area and the Re-Tube Components Storage Area.

Western Waste Management Facility (WWMF) - This facility located on the Bruce Power site, consists of the Western Low and Intermediate Level Waste Storage Area which includes the Waste Volume Reduction Building and the Western Used Fuel Dry Storage Area. Radiological emissions from the WWMF for 2006 are reported by Bruce Power, covering the entire Bruce Power site.

2.2 Radioactive Emissions and ¹⁴C Inventory Data

The radioactive emissions from DN and PN in 2006 remain well below the station Derived Release Limits (DRLs). These limits represent radionuclide release rates that correspond to critical group exposure at the public dose limit.

The total airborne and waterborne emissions in 2006 from the DN and PN sites are summarized in Table 2.2.

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

14 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table 2.2 OPG Annual Nuclear Site Emissions - 2006

Site Emissions	Becquerels (Bq)	
	DN	PN
AIR		
Tritium Oxide	1.3E+14	5.7E+14
Elemental Tritium ^a	9.5E+13	NA
Noble Gas ^b	1.4E+13	1.9E+14
¹³¹ I	1.2E+08	1.4E+08
Particulates	6.3E+07	7.1E+07
¹⁴ C	1.2E+12	8.0E+12
WATER		
Tritium Oxide	1.9E+14	3.3E+14
Gross Beta/Gamma	4.8E+09	2.7E+10
¹⁴ C	5.9E+08	6.2E+09

NA = Not Applicable

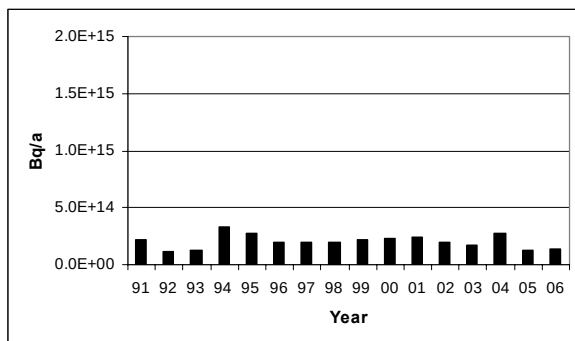


Figure 2.2.1 Darlington Nuclear Tritium Oxide Air Emissions Trend

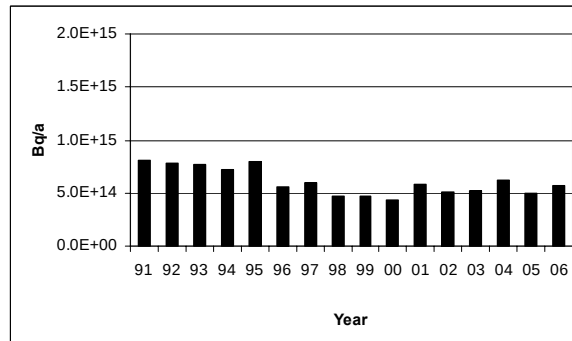


Figure 2.2.2 Pickering Nuclear Tritium Oxide Air Emissions Trend

^a Emissions from Darlington Tritium Removal Facility

^b units for noble gas emissions are γBq-MeV

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 15 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

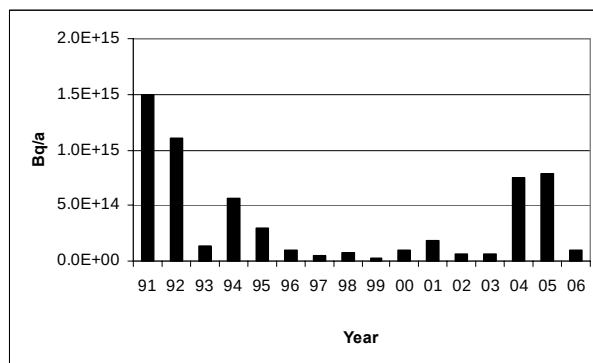


Figure 2.2.3 Darlington Nuclear Elemental Tritium Air Emissions Trend

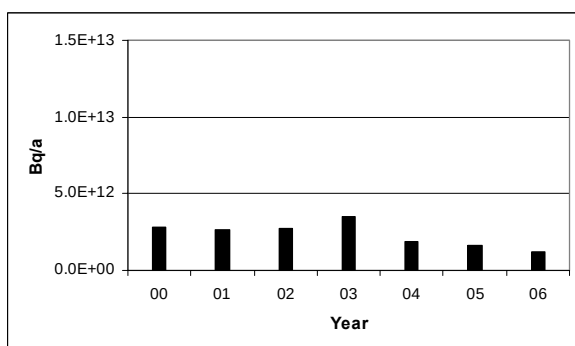


Figure 2.2.4 Darlington Nuclear ¹⁴C Air Emissions Trend

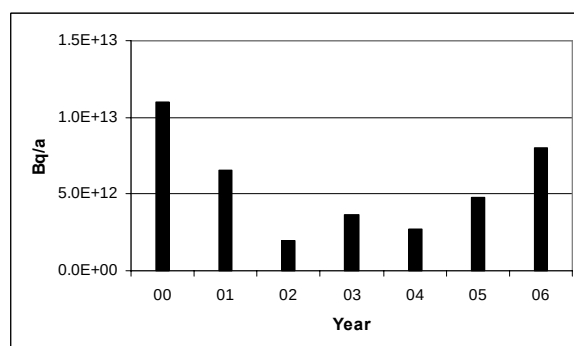


Figure 2.2.5 Pickering Nuclear ¹⁴C Air Emissions Trend

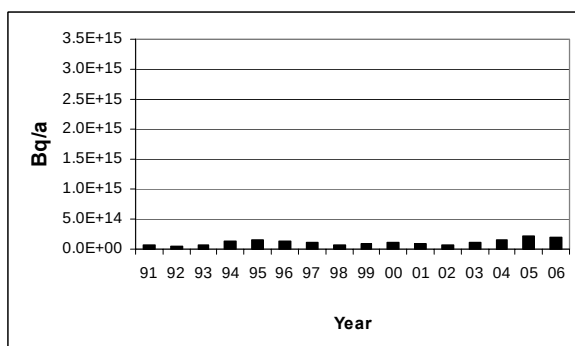


Figure 2.2.6 Darlington Nuclear Tritium Oxide Water Emissions Trend

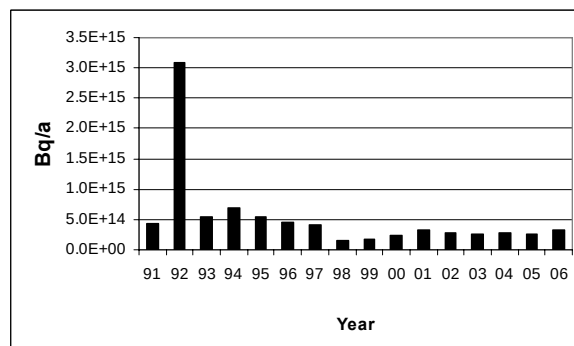


Figure 2.2.7 Pickering Nuclear Tritium Oxide Water Emissions Trend

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 16 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

The long term trends of tritium and ^{14}C emissions to air and tritium emissions to water from Darlington and Pickering are provided in Figures 2.2.1 to 2.2.7. Long term trends of noble gas emissions are better described using the Exploranium environmental monitors (refer to section 3.1). All other radionuclide emissions are not shown because their contributions to public dose are minimal.

Elemental tritium (HT) emissions at DN decreased significantly in 2006 compared to the previous two years. The elevated HT emissions were due to events at the Tritium Removal Facility in 2004 and 2005. However, the impact of these events was minimal on the dose to the public reported for those years. With the exception of HT, the emissions from DN have not changed significantly over the past several years.

Airborne ^{14}C emissions in 2006 from PN had increased 69 percent compared to 2005. An ingress of carbon dioxide gas into Unit 7 moderator system caused higher emissions in 2006. However, its contribution to the highest public dose for the site was small and is discussed in section 4.5.

The ^{14}C inventories at the Pickering and Darlington Nuclear sites are included to fulfill a regulatory commitment to the CNSC. The 2006 estimates of ^{14}C inventory in the PN and DN station spent resin storage tanks are $7.4\text{E}+14$ Bq and $5.5\text{E}+14$ Bq, respectively **[R-2]**.

3.0 ENVIRONMENTAL MONITORING DATA

This section contains the results of the environmental monitoring programs for the DN and PN sites, as well as those of the provincial background locations.

The environmental monitoring locations are classified as “indicator”, “area”, and “control” monitoring locations and defined as follows:

- (a) Indicator locations are used to assess the potential dose to the public. These locations are outside the facility perimeter, at points where the most significant public exposure (direct or indirect) occurs or is “predicted to occur”.
- (b) Area locations are used to provide additional information at sites farther away from the site boundary.
- (c) Control or background locations provide radiological information on the presence of naturally occurring radiation and radioactivity from nuclear atmospheric weapons testing, at locations well away from nuclear sources.

All sampling locations are shown in Appendix C, Figures C1 to C3. The results of the environmental monitoring programs are summarized in Appendix D and consist of:

- (a) External gamma dose rates in air.
- (b) Tritium oxide and ^{14}C concentrations in air.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 17 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

- (c) Tritium oxide concentrations in precipitation and gross beta activity deposition rates via dry/wet fallout.
- (d) Tritium oxide, Organically Bound Tritium (OBT), ^{14}C and ^{131}I concentrations in milk.
- (e) Tritium oxide and gross beta activity concentrations in drinking water.
- (f) Tritium oxide, OBT, ^{14}C and gamma emitting radionuclide concentrations in aquatic samples (e.g., fish, lake sediment, lake water and beach sand).
- (g) Tritium oxide, OBT, and ^{14}C concentrations in terrestrial samples (e.g., fruit, vegetables and honey).

Gamma radiation in the public domain is measured directly and is used to assess noble gas dose.

The protocol used to report the environment measurement values is as follows:

- If the sample analysis resulted in a value lower than the limit of detection of the analytical method (Ld) but exceeded the critical level (Lc), the actual measurement is reported but is in bold type in this report.
- If the measurement is less than the Lc then "< Lc" is reported.
- When averages are calculated, they are based on actual results obtained even if they are below the critical levels.
- The only exception to these rules is the gamma spectrometer results where values below the Ld are reported as "< Ld".

3.1 External Gamma Dose Rate Measurements

Environmental external gamma dose rates were measured using Panasonic Type UD-814 AR1 Thermoluminescent Dosimeters (TLDs). The dosimeters are placed at indicator locations near the facility boundary, at area locations in local communities, and at background locations around the Province of Ontario as shown in Appendix C. The dosimeters are analyzed quarterly with annual averages reported in Appendix D, Tables D1.1 to D1.3.

The TLDs measure total gamma dose from background as well as any gamma emitting radionuclides in the air or radiography skyshine. The TLD measurements are not sufficiently sensitive to detect the very low gamma doses associated with station emissions as the analytical error is about 15 percent. Any normal station contribution could not be distinguished from the high and variable contribution from natural background. The 2006 boundary average external dose rates in air for the DN and PN sites as measured with TLDs are 49.4 nGy/hr and 45.8 nGy/hr respectively, while the annual average of the provincial background sites is 49.4 nGy/hr.

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

18 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

The external gamma dose rate trend (Figures 3.1.1 to 3.1.3) show that external dose rates have fluctuated over the past ten years within a comparatively narrow range and have not changed significantly at DN, PN and Provincial background locations.

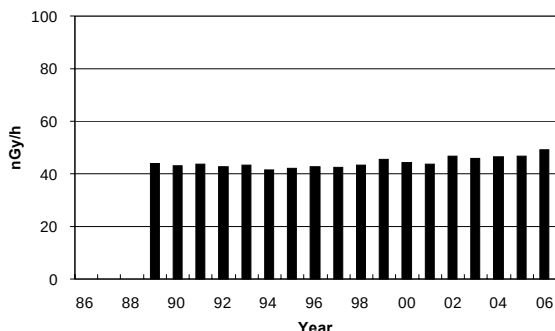


Figure 3.1.1 Darlington Nuclear Site - Boundary Average TLD Gamma Dose Rate Trend

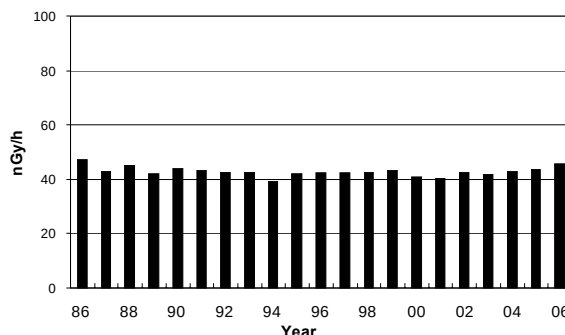


Figure 3.1.2 Pickering Nuclear Site - Boundary Average TLD Gamma Dose Rate Trend

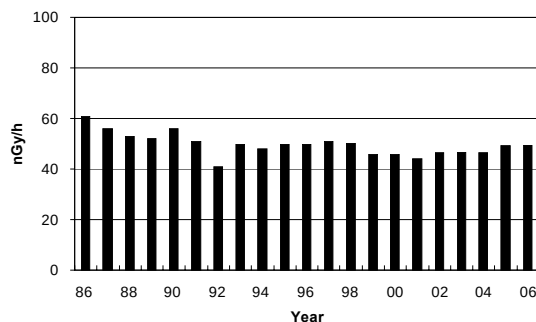


Figure 3.1.3 Provincial Average TLD Gamma Dose Rate Trend

Air kerma rates resulting from the presence of noble gases, Ir-192 radiography skyshine and ^{131}I in the environment are measured using Exploranium GR-150 Sodium Iodide (NaI) spectrometers. These monitors are set up around the DN and PN sites and are known as the OPG Gamma Ray Monitoring Network.

Results obtained in 2006 from the GR-150 monitors installed at air monitoring locations near the DN and PN site boundaries are summarized in Appendix D, Tables D1.4 and D1.5. It should be noted that annual values are calculated from monthly measurements and compared with the Lc or Ld to determine how they will be reported.

Argon-41 is the predominant noble gas radionuclide measured by the detectors at PN. The annual boundary average dose in air from ^{41}Ar increased to 1288 nGy in 2006 from 506 nGy in 2005. A historical trend of ^{41}Ar dose in air for PN is provided in Figure 3.1.4. The increase of ^{41}Ar emissions starting in 2003 was the result of PN Unit 4 returning to service, and an additional contribution from PN Unit 1 starting in November 2005. In 2006, the number of operating days of PN Units 1 and 4 increased compared to 2005 resulting in an increase in ^{41}Ar emissions from these units. Efforts

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

19 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

continue at PN to minimize emissions by increasing the station residency time of ^{41}Ar to allow for more decay. The increase in ^{41}Ar emission contributed proportionally to a rise in noble gas dose to the critical groups which are located close to the PN station.

^{133}Xe and ^{135}Xe were also measured above detection limits (Ld) at PN. At DN the GR-150 monitors did not measure any radionuclides above detection limits (Ld) although a few measurements were above Lc. Hence, a trend graph for DN ^{41}Ar dose in air is not provided.

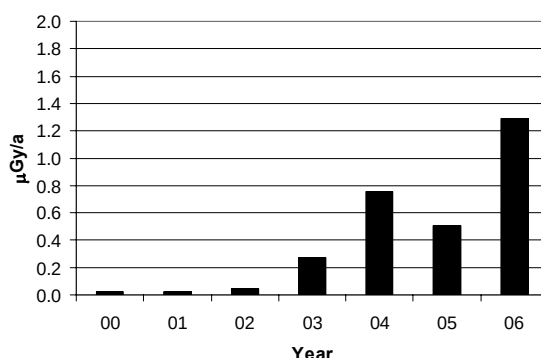


**Figure 3.1.4 Pickering Nuclear Site –
Boundary Average ^{41}Ar Dose in Air Trend**

3.2 Airborne Tritium and Carbon-14

Airborne tritium is sampled by passing air at a continuous steady rate through two molecular sieve canisters to collect water vapour for monthly tritium analysis. In some locations, an additional molecular sieve canister is installed after the tritium collection canisters to remove CO_2 from the air stream for ^{14}C analysis.

Passive sampling technology has been used to sample ^{14}C and tritium in air on a trial basis to confirm their performance to replace the molecular sieve technology. The passive samplers offer the advantages of easy installation, low maintenance and no power requirement. The passive tritium samplers have a diffusion head fitted on top of a liquid scintillation counting vial that contains tritium free water and ethylene glycol. The passive ^{14}C sampler is of a similar construction but contains soda lime pellets to absorb CO_2 from air.

The passive samplers are placed at critical group locations and at several locations where the molecular sieve samplers already exist to allow a comparison of the two technologies. They have also been located at a number of Provincial background locations. The passive samplers are replaced and analyzed quarterly.

The results collected to date show that the performance of both technologies is comparable for sampling ^{14}C . However, poor agreement between the two technologies for tritium in air sampling has been observed. OPG uses the higher

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

20 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

tritium in air value at locations where both technologies are available to ensure the dose estimates remain conservative.

The 2006 annual average results of airborne tritium and ^{14}C measured by molecular sieve monitors and the passive tritium samplers at the DN and PN sites are summarized in Appendix D, Tables D2.1 to D2.4. Provincial background results are in Appendix D, Tables D2.5 and D2.6.

At the DN site, the 2006 average boundary tritium-in-air concentration measured by molecular sieve samplers remained unchanged from the previous year at 0.7 Bq/m^3 . This is consistent with a 5 percent increase in tritium to air emissions which was off-set by more atmospheric dilution in 2006 compared to 2005 (see Section 3.9). At the PN site, the average boundary airborne tritium concentration decreased slightly to 6.2 Bq/m^3 in 2006 from 7.1 Bq/m^3 in 2005. This was due to more atmospheric dilution in 2006 compared to 2005 which was partially off-set by a 13 percent increase in site tritium emissions (see Section 3.9).

Figures 3.2.1 and 3.2.2 show the long-term trend plot of boundary average tritium-in-air concentrations measured by molecular sieve samplers at PN and DN. There is no discernable trend of tritium-in-air concentrations at either DN or PN in the past 10 years.

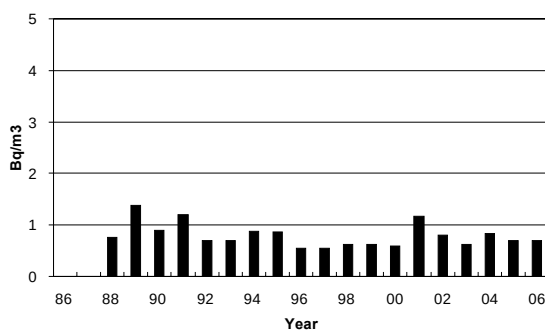


**Figure 3.2.1 Darlington Nuclear Site
Tritium-in-Air Trend**

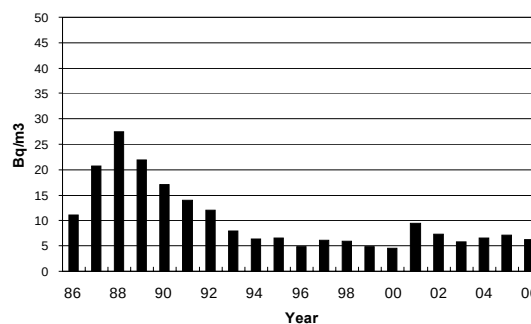


**Figure 3.2.2 Pickering Nuclear Site
Tritium-in-Air Trend**

In 2006, ^{14}C emissions reported at DN had decreased by 26 percent from the previous year. The level of change in emissions is not significant enough to cause a detectable corresponding change in the environmental sample concentrations above the background level. This is a result of the uncertainty of the analytical method. The average ^{14}C in air concentration from three DN boundary locations was reported to be 266 Bq/kg-C (net of 42 Bq/kg-C after background is subtracted) compared to 293 Bq/kg-C (net of 57 Bq/kg-C) in 2005.

PN ^{14}C emissions have increased by 69 percent compared to 2005 (see Section 2.2). For PN, the boundary average ^{14}C concentrations increased to 838 Bq/kg-C from 780 Bq/kg-C reported in 2005. The net (background subtracted) ^{14}C average concentration

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

21 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

from three PN boundary locations increased by 13 percent. This represents adequate agreement with ^{14}C emissions given the level of measurement uncertainty and limited number of sample points at the boundary. Figures 3.2.3 and 3.2.4 show trend plots of average ^{14}C concentrations in air measured by molecular sieve samplers at PN and DN.

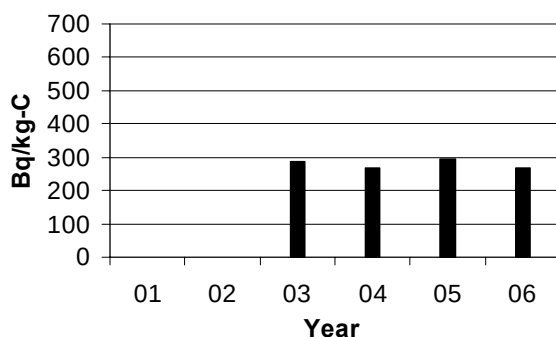


**Figure 3.2.3 Darlington Nuclear Site
 ^{14}C -in-Air Trend**

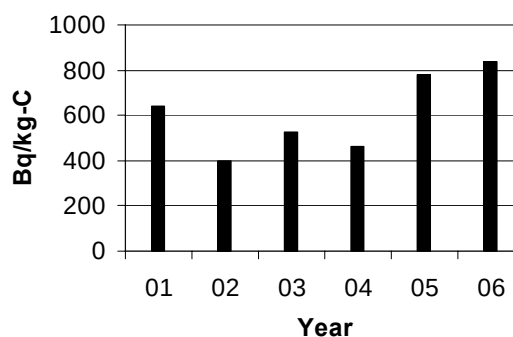


**Figure 3.2.4 Pickering Nuclear Site
 ^{14}C -in-Air Trend**

To resolve the disagreement in the results of the two sampling technologies for tritium in air, a study funded by the CANDU Owners Group (COG) was conducted at four Pickering sampling locations (P2, P7, P10, and P11) throughout 2006 to provide a comparison between the active and passive samplers. The field testing was complemented by laboratory work to explain some of the factors that influence monitor performance. The project objective was to provide a better understanding of variability and differences between the two technologies. All data collection was completed and the final report will be available in second quarter of 2007.

The ^{14}C values measured by passive samplers in 2006 continued to show good agreement with those measured by molecular sieve samplers. Typically, passive ^{14}C values are within ± 10 percent of the molecular sieve sampler values. Either sampling technology is acceptable for routine field ^{14}C -in-air measurement.

3.3 Precipitation

Precipitation, and dry/wet fallout samples that are collected monthly and analyzed for tritium and gross beta activity, respectively are presented in Appendix D, Tables D3.1 and D3.2. Background tritium in precipitation data for 2006 is presented in Appendix D, Table D3.3.

Precipitation data are not used in the calculation of public dose but are used as a gross indication of other direct measurements such as tritium in air and biota, and tritium in drinking water from wells.

Tritium in precipitation tends to follow roughly with tritium in air trends over the long term as shown in the annual trend plots of precipitation (Figures 3.3.1 and 3.3.2) and

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 22 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

tritium in air (Figures 3.2.1 and 3.2.2). The degree of correlation is limited by the infrequent nature of precipitation and changes in tritium concentrations in air between precipitation events. All values measured at the Darlington and Pickering nuclear sites were well above the average Canadian background value. Since precipitation can ultimately impact groundwater and possibly drinking water sources (e.g. wells), the value can be compared to the Ministry of Environment (MOE) drinking water standard of 7,000 Bq/L for tritium. All annual tritium concentrations were below this value. The highest average annual tritium concentration in precipitation was measured at the PN monitoring site 2 – Montgomery Park Road location, at 493 Bq/L.

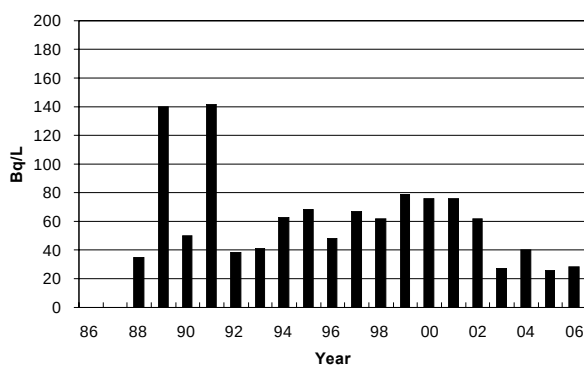


**Figure 3.3.1 Darlington Nuclear Site
Tritium-in-Precipitation Trend - Boundary
Average**

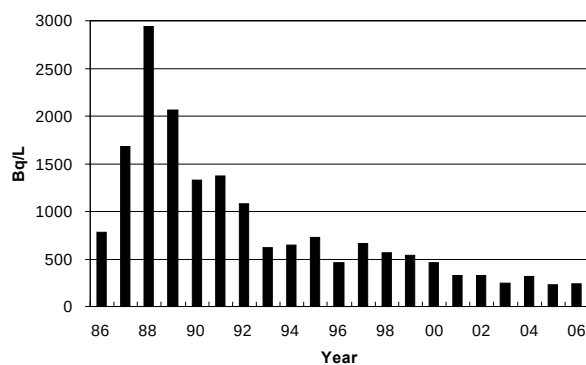


**Figure 3.3.2 Pickering Nuclear Site
Tritium-in-Precipitation Trend - Boundary
Average**

Measurements of gross beta activity in dry/wet fallout are reported in units of Bq/(m²·month). This measurement represents the total fallout as a result of deposition of airborne radionuclides both as dry deposition and that carried down in precipitation. Gross beta in fallout in Canada normally averages from 5 to 40 Bq/(m²·month) on an annual basis due to radioactive fallout from both natural sources (⁷Be, ⁴⁰K, U, and Th series radionuclides in dust from surface soil and other natural sources) and atmospheric nuclear weapon testing [R-3]. The 2006 averages for the DN and PN sites were within this range (see Tables D3.1 and D3.2).

3.4 Milk

Milk samples are collected weekly from dairy farms. For each of the site programs (DN and PN), samples from all dairy farms are combined to form a weekly composite sample and analyzed for ¹³¹I. The weekly samples from each of the farms are also combined to form a monthly composite for tritium and ¹⁴C analyses. Quarterly samples from background locations are collected and analyzed for tritium, ¹⁴C and ¹³¹I. Annual average values of measurement results are provided in Appendix D, Tables D4.1 to D4.3.

In 2006, ¹³¹I was not detected in any milk samples. The detection limit (Ld) for ¹³¹I averaged approximately 0.11 Bq/L for all samples.

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

23 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

The interpretation of annual average tritium and ^{14}C in milk measurements compared to the previous year is complicated given that cow milk is influenced by many factors such as air emissions, drinking water and food sources.

At the DN site, the average level of tritium-in-milk at all farms was 5.8 Bq/L in 2006 compared to 6.2 Bq/L in 2005. The average tritium in milk at the PN site was 24.4 Bq/L in 2006 from 26.2 Bq/L in 2005. Measurements of tritium in milk remain essentially unchanged and within the uncertainty of the analytical method.

The 2006 annual averages of ^{14}C concentrations in milk at DN and PN were 240 Bq/kg-C and 246 Bq/kg-C, respectively. The provincial background quarterly ^{14}C in milk samples ranged from 223 to 239 Bq/kg-C with an annual average of 232 Bq/kg-C. At the measured levels and with the uncertainties associated with these measurements, these values for both DN and PN are not different from background. Furthermore, ^{14}C levels in milk are also influenced by ^{14}C levels in silage which was grown in the previous year and averaged 241 Bq/kg-C over five samples at DN and 229 Bq/kg-C for a single sample at PN.

Annual average trend plots of tritium and ^{14}C concentrations in milk at both nuclear sites are presented in Figures 3.4.1 through 3.4.4. The values plotted represent the average of measurements made each year at each site. It should be noted that the number and location of dairy farms sampled at both sites have changed over the years.

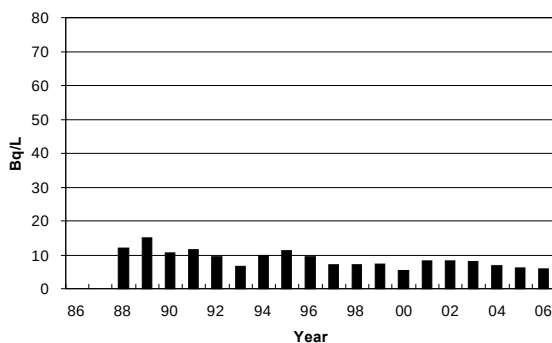


**Figure 3.4.1 Darlington Nuclear Site
Tritium-in-Milk Trend**

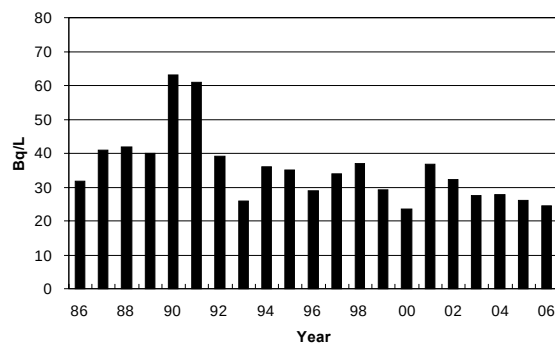


**Figure 3.4.2 Pickering Nuclear Site
Tritium-in-Milk Trend**

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

24 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

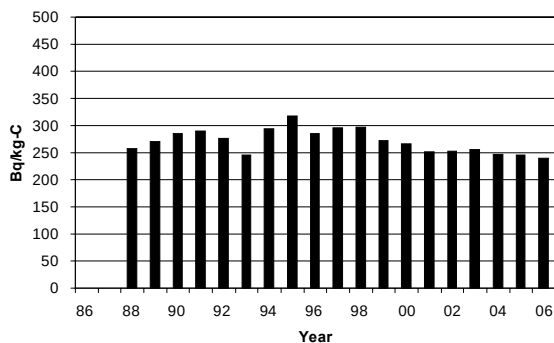


**Figure 3.4.3 Darlington Nuclear Site
¹⁴C-in-Milk Trend**

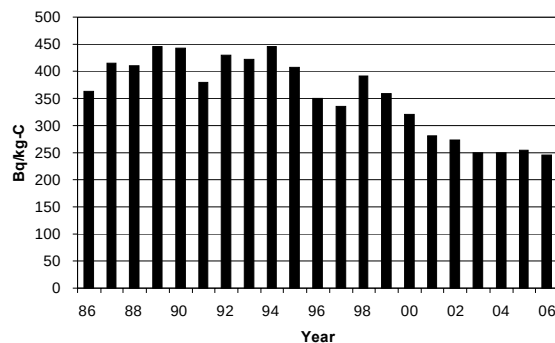


**Figure 3.4.4 Pickering Nuclear Site
¹⁴C-in-Milk Trend**

Organically Bound Tritium (OBT) was measured in all monthly composite milk samples from Pickering site DF8 and averaged 35 Bq/L (water equivalent or w.e.). The 2006 ratio of OBT/TFWT (Organically Bound Tritium/Tissue Free Water Tritium) is 1.3. This ratio compares well with those observed in previous years which ranged from 1.0 to 1.3 and is within the acceptable range of 1.25 ± 0.75 determined by Brown for a variety of foodstuffs [R-4].

3.5 Drinking Water

Drinking water samples are taken from three DN area Water Supply Plants (WSPs), four PN area WSPs and local wells near each site. The locations of these WSPs relative to the nearest nuclear station discharge are as follows:

	Distance from Site
DARLINGTON NUCLEAR SITE	
Bowmanville WSP	7 km ENE of DN
Newcastle WSP	13 km E of DN
Oshawa WSP	8 km W of DN
PICKERING NUCLEAR SITE	
R.C. Harris WSP	22km WSW of PN
Horgan WSP	11 km SW of PN
Ajax WSP	5 km ENE of PN
Whitby WSP	12 km ENE of PN

Samples of lake water are taken three times daily at the R.C. Harris WSP and Horgan WSP. All other water supply plants in the DN and PN areas are sampled twice daily. Weekly composite samples are used for tritium analysis, and monthly composite samples are used for gross beta analysis. Appendix D, Tables D5.1 and D5.2 provide the 2006 annual averages of the concentrations measured at the DN and PN sites area water supply plants respectively.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 25 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Quarterly "grab" samples are taken from drinking water supplies throughout the province and analyzed for tritium and gross beta activity. The annual averages of these analyses are shown in Appendix D, Table D5.3.

Monthly well water samples are collected from farms and residents near the DN and PN sites. Lake water samples (non-drinking water) are also collected monthly. The annual averages of the concentrations measured are reported in Appendix D, Tables D5.1 and D5.2.

Tritium

Tritium in the Great Lakes originates from several sources: natural cosmogenic tritium, residual tritium fallout from atmospheric weapons testing, current emissions from nuclear plants and residual tritium from past emissions from nuclear plants. For the purpose of calculating public dose resulting from OPG operations, OPG conservatively considers background tritium to include only natural cosmogenic tritium and residual weapons fallout tritium. The Lake Ontario background for 2006 was conservatively estimated to be 1.7 Bq/L, using the Klukas Tritium Lake Model **[R-5]**.

Impacts of tritium emissions from OPG stations on the nearby water supply plants vary depending upon distance from the station, lake current direction, location and depth of the WSP intake pipe and general dispersion conditions. Annual average tritium levels at all water supply plants were well below 7,000 Bq/L which is the MOE Drinking Water Standard for tritium. OPG also met its voluntary commitment to maintain annual average tritium levels at all water supply plants below 100 Bq/L. A discussion of each site follows.

(a) Darlington Nuclear

Average weekly tritium concentrations in drinking water taken from Lake Ontario at the Newcastle, Bowmanville and Oshawa Water Supply Plants (Table D5.1) ranged from < 1.9 (Lc) to 19.1 Bq/L in 2006. The highest annual average tritium concentration in 2006 municipal drinking water (7.1 Bq/L) was measured at the Oshawa WSP. The annual average tritium concentrations at the Oshawa, Bowmanville and Newcastle WSPs remained essentially unchanged in 2006 over 2005. Although there was an decrease in tritium to water emissions at DN of 13 percent compared to the previous year, at these low levels, the uncertainty of the measurement is high and therefore an observable variation in WSP tritium will only occur if the tritium to water emissions increase more significantly. A trend plot of the monthly average tritium concentrations for 2006 at the Darlington area WSP's is given in Figure 3.5.1.

Tritium concentrations in well water samples are variable depending on the depth of the well. Well water concentrations are related to the level of past atmospheric tritium releases and the amount of time it takes for the precipitation to reach the aquifer from where the well draws its water. Radioactive decay of the tritium during its transit time to the aquifer determines the residual activity level in the well water. Deeper wells tend to have lower tritium concentrations. The

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

26 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

maximum annual average tritium concentration in well water was found at R2 where it was reported at 21.6 Bq/L.

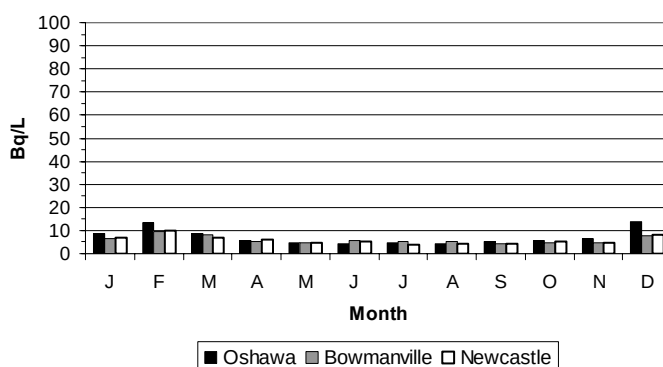


Figure 3.5.1 Darlington Nuclear Area WSP - Tritium in Water Concentrations

(b) Pickering Nuclear

Average weekly tritium concentrations in drinking water taken from Lake Ontario at the Ajax, Whitby, Horgan and Harris water supply plants (Table D5.2) ranged from < 1.9 to 12.6 Bq/L in 2006. Whitby WSP reported the highest municipal drinking water annual average tritium concentration of 6.4 Bq/L. Changes in the annual average tritium concentrations from the previous year were essentially nil. Even though tritium emissions to water increased by 25 percent in 2006 over 2005, no consistent impact on the WSP's was observed. A trend plot of 2006 monthly average tritium concentrations of Pickering area WSP's is provided in Figure 3.5.2.

The maximum average tritium concentration in well water was found at R125 where it was reported at 115 Bq/L (based on seven months of sampling) which is well below 7000 Bq/L (MOE drinking water standard for tritium).

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 27 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

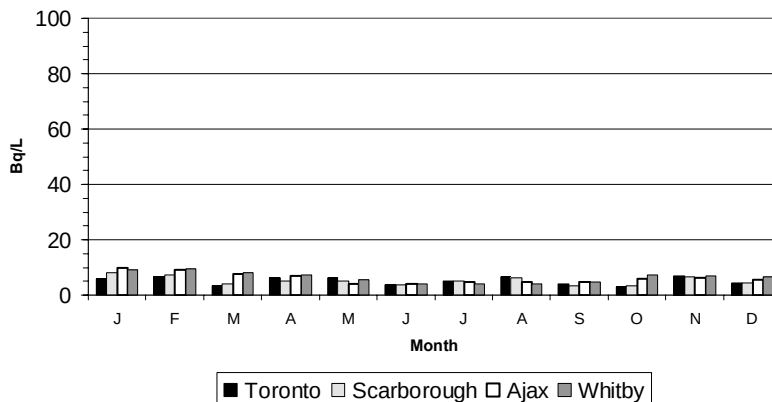


Figure 3.5.2 Pickering Nuclear Area WSP - Tritium in Water Concentrations

The historic trend plots of all water supply plants annual tritium in drinking water concentrations are shown in Figures 3.5.3a through 3.5.3h.

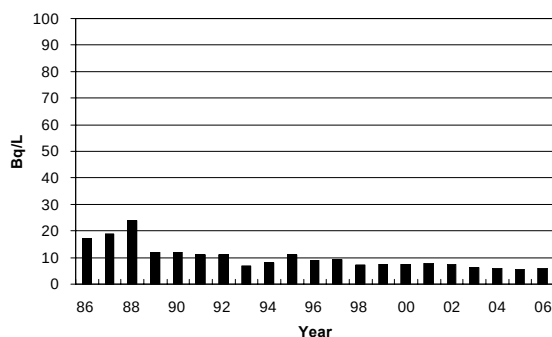


Figure 3.5.3a Bowmanville WSP - Tritium in Water Trend

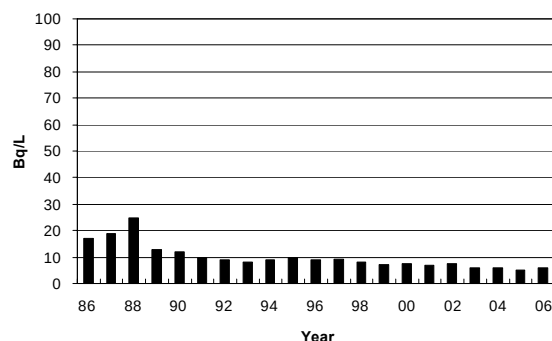


Figure 3.5.3b Newcastle WSP – Tritium in Water Trend

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 28 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

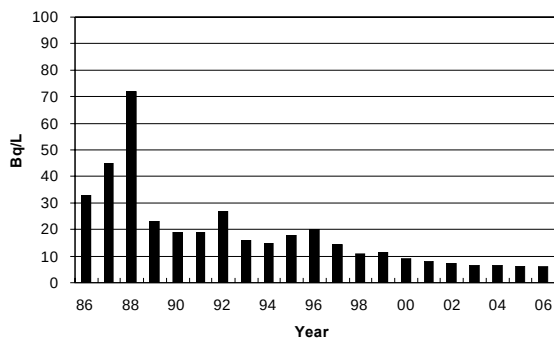


Figure 3.5.3c Ajax WSP - Tritium in Water Trend

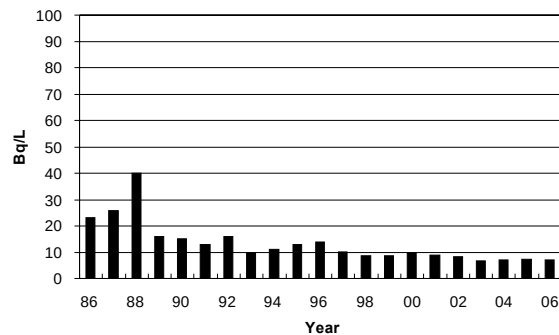


Figure 3.5.3d Oshawa WSP - Tritium in Water Trend

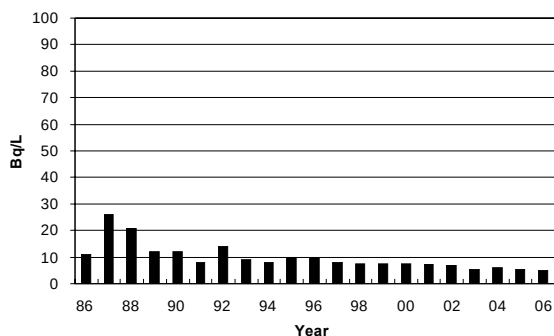


Figure 3.5.3e Scarborough Horgan WSP – Tritium in Water Trend

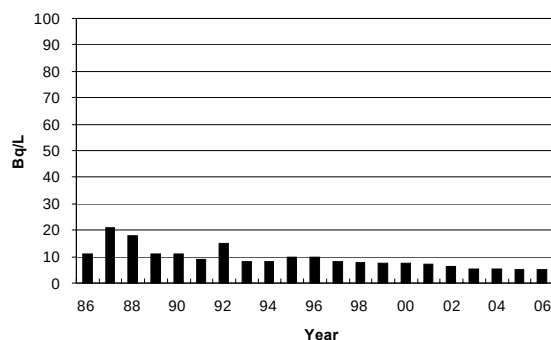


Figure 3.5.3f Toronto Harris WSP - Tritium in Water Trend

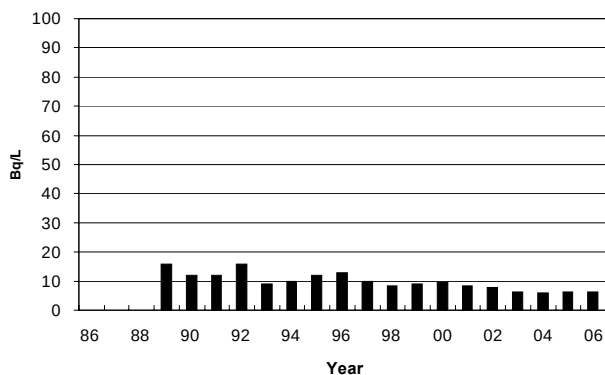


Figure 3.5.3g Whitby WSP – Tritium in Water Trend

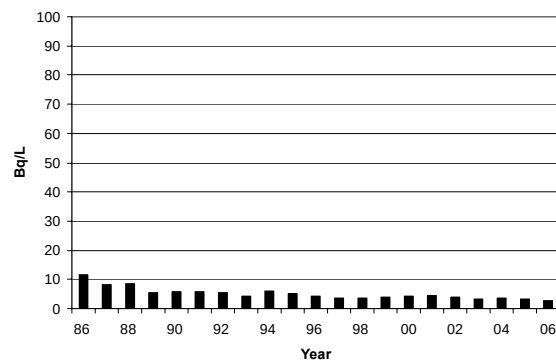


Figure 3.5.3h Provincial Background Drinking Water Sources – Tritium in Water Trend

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

29 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Gross Beta

Annual average gross beta activity levels in samples from the water supply plants near the DN and PN facilities ranged from 0.09 to 0.11 Bq/L. These results are not significantly different than the average of the 4 provincial background Lake Ontario measurements of 0.10 to 0.11 Bq/L (see Table D5.3).

In samples from two residential wells, gross beta activities were found higher than OPG's internal screening level of 1 Bq/L. The annual gross beta activity was reported as 1.46 and 2.66 Bq/L. Follow-up investigations confirmed the high gross beta activities were due to the presence of naturally occurring ^{40}K .

3.6 Aquatic Sampling

Samples of sediments, beach sand and fish are taken annually from the aquatic receiving environment adjacent to the DN site, the PN site and in background locations. The results of this sampling program are given in Appendix D, Tables D6.1 to D6.8.

The fish sampling program consists of the following:

- At the DN site, fish sampling takes place over the cooling water discharge diffuser. At the PN site, the sampling location is in the PN5-8 outfall. Background locations in Lake Ontario and Lake Huron were chosen based on sufficient distance away from the influences of the stations (see Appendix C, Figure C3).
- Target fish species to be collected at each site and at background locations are Lake Whitefish and White Sucker, with Round Whitefish and Brown Bullhead as their respective backup species.
- Eight replicate fish samples are collected and analyzed at each location.
- Four replicate samples are obtained from McLaughlin Bay in Darlington Provincial Park, as campers are known to fish in this area. Assorted pan fish (i.e., crappie, sunfish, etc) are to be collected.
- Tissue free water tritium (TFWT), ^{14}C , ^{60}Co , ^{134}Cs , ^{137}Cs , and ^{40}K measurements are performed on each replicate fish species sample. A composite sample of each fish species at each location is analyzed for organically bound tritium (OBT).

Lake bottom sediment can be an indicator of potential radionuclide build-up in the environment. Four replicate samples of sediment are obtained from each of three locations around the DN site, four locations around the PN site and four background locations.

Sand/silt from beaches around DN and PN sites are collected and gamma analysis performed as it represents a potential pathway for external dose exposure.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 30 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

3.6.1 Sediment

A major portion of the activity in sediment, in the vicinity of the stations, comes from the naturally occurring radionuclide, ^{40}K . Cesium-137 is a product of both nuclear weapon tests and reactor operations and was detected in sediment samples at the DN and PN sites. Cesium-134 and ^{60}Co (which are solely reactor produced) were not detected in any of the sediment samples at both the DN and PN sites in 2006. See Appendix D, Tables D6.1 and 6.2.

Carbon-14 is a product of both nuclear weapon tests and reactor operations, and is produced naturally in the upper atmosphere. All measurement of ^{14}C in lake bottom sediments with the exception of the PN-A discharge were below the terrestrial ^{14}C background level of 224 Bq/kg-C in 2006 (see Section 3.7). Most of the results, including background locations, were significantly below 224 Bq/kg-C indicating the presence of low activity inorganic carbon diluting the sample. Annual ^{14}C measurements at Cobourg (Lake Ontario background location) from 2002 to 2006 averaged about 127 ± 43 Bq/kg-C in sediment. Given the uncertainty in the background level of ^{14}C in sediment, it is not possible to observe any accumulation from reactor operations.

3.6.2 Beach Sand/Silt Samples

Beach sand samples were collected at Cobourg and Goderich to determine the ^{137}Cs concentration in provincial background sand due to atmospheric weapon test fallout. ^{137}Cs concentrations measured in beach sand at Cobourg ranged from 0.4 ± 0.1 Bq/kg to 0.8 ± 0.2 Bq/kg in the past four years. See Table D6.4.

The ^{137}Cs concentrations measured at the DN site beach and PN site beaches ranged from <0.3 Bq/kg to 0.9 ± 0.2 Bq/kg. Wave action continuously moves the cesium around disturbing the original deposition patterns. This range of values makes it difficult to determine if ^{137}Cs measured along the shoreline is from OPG operations unless the values measured are significantly higher than background values, or other radionuclides more closely related to reactor operation, such as ^{60}Co or ^{134}Cs , are present. As reported in previous years, there was no ^{60}Co or ^{134}Cs detected in any of the DN and PN beach sand samples in 2006.

3.6.3 Fish

Tritium

The tritium levels in fish change quickly in response to changes in water tritium levels. Thus, tritium concentrations measured in fish tissue reflect the tritium concentration in the water on the day when they were sampled each year. Tritium levels in DN outfall fish samples ranged from 4 Bq/L to 19 Bq/L and averaged 8.1 Bq/L, and PN fish samples ranged from <1.8 Bq/L to 26 Bq/L, and averaged 10.2 Bq/L. Tritium in Lake Ontario background fish samples ranged from 2.7 Bq/L to 7.4 Bq/L and averaged 5.0 Bq/L. Long term trend graphs of fish tritium levels for PN and DN are provided in

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

31 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Figures 3.6.1 and 3.6.2. Tritium levels in DN and PN fish have remained relatively low and stable over the last few years with some year to year fluctuations.

OBT measurements were performed on composite samples of each DN and PN site target species. The OBT/TFWT ratios obtained were 7.8 and 2.1 for the White Sucker and White Fish composite sample respectively at the DN site. OBT/TFWT ratio for White Sucker and White Fish caught at the PN site were 10.2 and 2, respectively. For McLaughlin Bay fish, the OBT/TFWT ratio was found to be 1.1. The OBT/TFWT ratio is not meaningful for outfall fish samples, due to the quickly changing TFWT levels in fish from day to day with changing water tritium levels in lake water near the nuclear sites compared to the much slower response of OBT.

However, a ratio closer to unity is expected at background locations where the concentration of TFWT is expected to be fairly uniform. Both OBT/TFWT ratios seen in the provincial background fish in Lake Ontario and Lake Huron were 3.7 in 2006. Refer to section 3.7 for further discussion of the investigation into OBT/TFWT ratios.

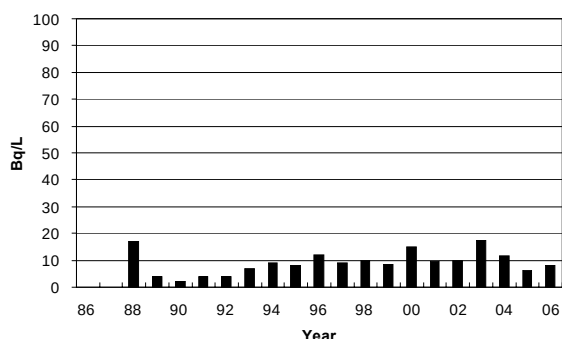


Figure 3.6.1 Darlington Nuclear Site - Tritium-in-Fish Trend

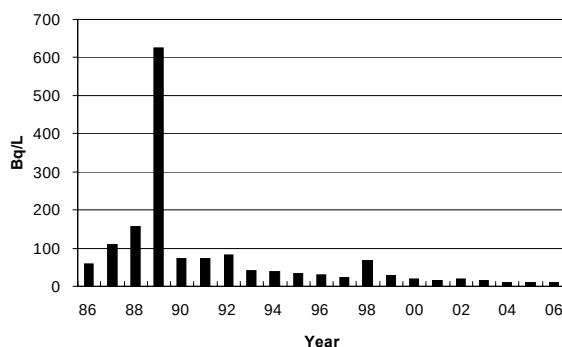


Figure 3.6.2 Pickering Nuclear Site - Tritium-in-Fish Trend

Carbon-14

The 2006 annual average ^{14}C levels in DN and PN fish are 241 Bq/kg-C and 238 Bq/kg-C, respectively. These values are comparable to background fish ^{14}C levels of 241 Bq/kg-C from Lake Ontario and 230 Bq/kg-C from Lake Huron. The trends of ^{14}C in fish at DN and PN for the past ten years show no appreciable change with time as shown in Figures 3.6.3 and 3.6.4.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 32 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

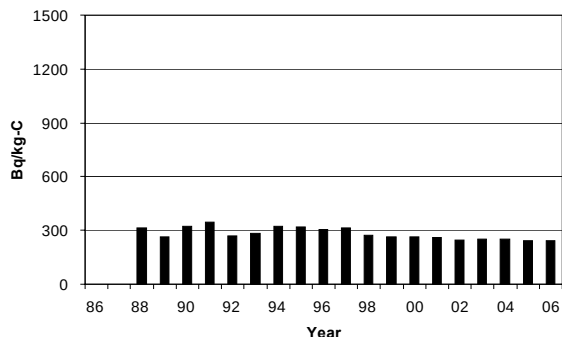


Figure 3.6.3 Darlington Nuclear Site - ¹⁴C-in-Fish Trend

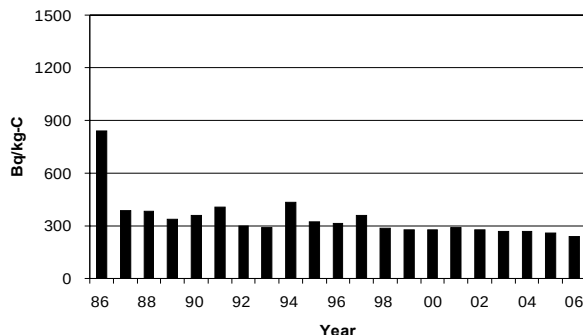


Figure 3.6.4 Pickering Nuclear Site - ¹⁴C-in-Fish Trend

Gamma Spectrometry

The major portion of the activity in fish is naturally occurring ⁴⁰K and ¹⁴C. A small amount of ¹³⁷Cs is usually present due primarily to nuclear weapon testing and to a lesser extent from reactor operation. ¹³⁴Cs and ⁶⁰Co, which are indicative of reactor operation, were not detected in any fish samples at the DN and PN sites in 2006.

The maximum reported values for ¹³⁷Cs in fish at far field locations of Lake Ontario and Lake Huron were 0.5 ± 0.1 Bq/kg and 0.9 ± 0.1 Bq/kg, respectively. The maximum ¹³⁷Cs concentration at DN and PN were reported to be 0.3 ± 0.2 Bq/kg and 0.4 ± 0.2 Bq/kg. The average ¹³⁷Cs values for DN, PN and background Lake Ontario fish were 0.2, 0.3 and 0.3 Bq/kg, respectively. The differences among these values are not statistically significant when considering the uncertainties of the measurement. Figure 3.6.5 and 3.6.6 illustrate that the ¹³⁷Cs levels in fish around DN and PN in the past five years are fairly stable.

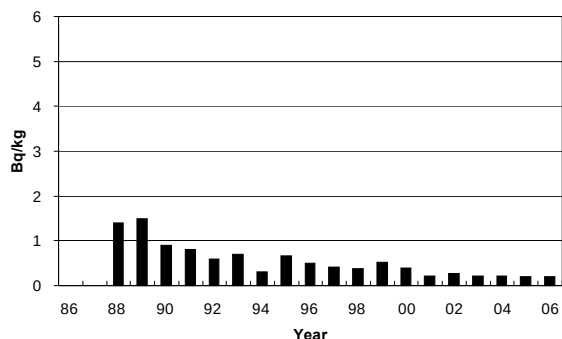


Figure 3.6.5 Darlington Nuclear Site - ¹³⁷Cs-in-Fish Trend

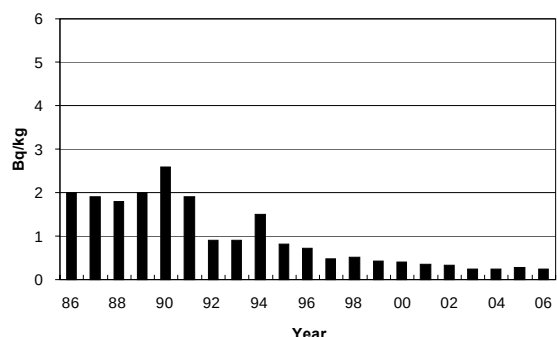


Figure 3.6.6 Pickering Nuclear Site - ¹³⁷Cs-in-Fish Trend

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

33 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Cesium Bioaccumulation Factor (BAF) for Fish In Lake Ontario

OPG continues to assess and confirm that the Cesium BAF for fish used for modeling remains valid. Cesium BAF can be calculated by using an equation recommended by IAEA [R-6] which takes into account the relationship of lake water concentrations of potassium and total suspended solids (TSS). To date, the measured environmental data support the continued use of a value of 3000 for the Cesium BAF for fish as a conservative number. The 2006 average Cesium BAF as determined from measurements at three locations (PN outfall, DN outfall and Cobourg) was 2418. The trend graphs of potassium and TSS concentrations for the past five years are provided in Figures 3.6.7 and 3.6.8. Potassium trends are relatively stable while total suspended solids concentrations vary depending on the lake conditions when samples are taken. Additional samples will be taken to demonstrate that the trend of potassium and TSS does not vary significantly over time.

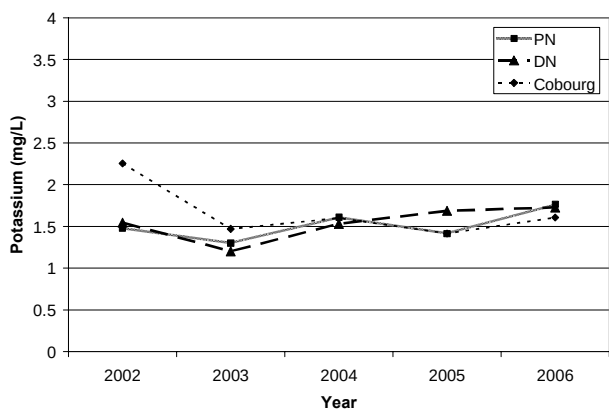


Figure 3.6.7 Lake Water Potassium Trend ^a

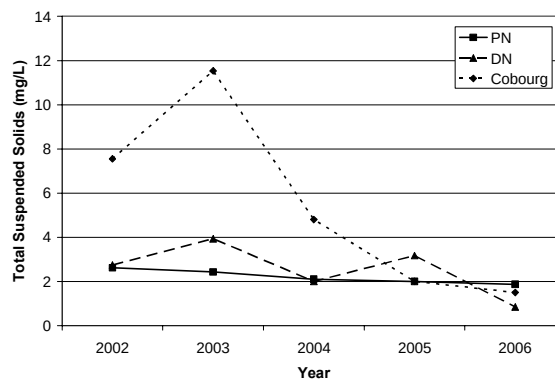


Figure 3.6.8 Lake Water Total Suspended Solids Trend ^b

3.7 Terrestrial Sampling

Samples of terrestrial biota representative of the 2006 growing season were taken from the vicinity of the DN and PN sites. Actual sample locations and the wind sectors in which they were taken at each nuclear site are shown in Appendix C (Figures C1 and C2). Analyses were carried out for tissue-free water tritium, ¹⁴C and OBT and presented in Appendix D, Tables D7.1 to D7.3. Where multiple sample types are found (e.g., carrot and corn at a given location) the samples were combined into composites for analysis.

A number of commercial apiaries are located in the DN and PN area where honey samples were obtained for tritium, ¹⁴C and gamma emitters.

^a Potassium method detection limit is 0.01 mg/L

^b Starting in 2006, the Total Suspended Solids method detection limit was reduced to 0.5 mg/L.

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

34 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Soil sample results are presented in Appendix D, Table D7.4. The soil is monitored to verify transfer model calculations as well as to monitor radionuclide build-up.

3.7.1 Fruits, Vegetables and Silage

Tritium

The average tissue free water tritium concentration measured in the vegetation in provincial background locations was 2.7 Bq/L. Local fruit and vegetation around the DN site were above the provincial background average for tritium. The 2006 average concentration of tritium in DN vegetation is unchanged at 23 Bq/L compared to 2005. Concentrations of tritium in PN vegetation marginally decreased to 91 Bq/L from 134 Bq/L in 2005. Figures 3.7.1 and 3.7.2 indicate the long-term trend of tritium in vegetation surrounding the DN and PN sites. It should be noted that the number of samples and their locations have changed throughout the trend period.

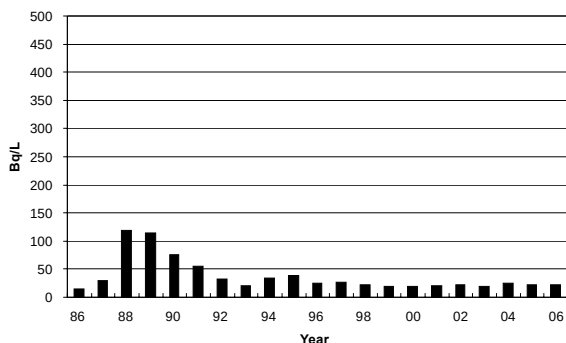


Figure 3.7.1 Darlington Nuclear Tritium in Vegetation Trend

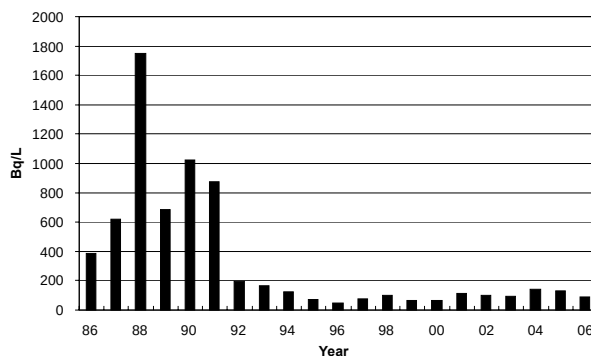


Figure 3.7.2 Pickering Nuclear Tritium in Vegetation Trend

OBT measurements were performed on selected vegetation as shown in Tables D7.2 and D7.3 and are summarized as follows:

- The average OBT/TFWT ratio obtained for the 2006 terrestrial samples collected at background locations was 11.2.
- The average OBT/TFWT ratio obtained for the 2006 terrestrial samples collected at PN site locations was 1.9.

OBT/TFWT ratio around the nuclear sites tends to be more variable as the TFWT values reflect the conditions (i.e., prevailing winds, tritium emissions, humidity etc.) at the time of sampling. OBT values represent an integrated value over the growing period [R-7]. The OBT/TFWT ratio at background locations is expected to be less variable and closer to unity. A literature review was conducted under a COG project to

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

35 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

understand tritium behaviour in the environment in relation to the expected and measured values of the OBT/TFWT ratios in environmental samples. In general, the background values of plant OBT/TFWT ratios found in literature are greater than one, with the majority of values lying between one and two. Further study will be required to understand the reasons that OPG ratios remain higher than values measured by others. An industry funded COG project was proposed for 2007/2008 which includes experimental work to take measurements of tritium in all parts of the environment affecting plants.

Carbon-14

Carbon-14 background concentrations are currently falling around the world as weapon test ^{14}C is being removed naturally from the environment. Pre-atmospheric weapon test levels were measured at 226 Bq/kg-C [R-8].

Historically, maple leaf data were used to determine the background value in calculating public doses from ^{14}C pathways. Ottawa maple leaves were sampled and analyzed by the Geological Survey of Canada (GSC) Radiocarbon Dating Laboratory until 2005 when the GSC no longer provided this service. OPG HPL analyzed the collected maple leaves in 2005 and reported an average ^{14}C concentration of 236 ± 35 Bq/kg-C. A historical comparison of ^{14}C in background vegetation analyzed by HPL shows a fairly good agreement as shown in Table 3.7.5 within uncertainty compared to the Ottawa maple leaves analyzed by GSC which is measured by a higher precision method. In 2006, the maple leaves from Ottawa were not available for analysis and therefore the average ^{14}C in background vegetation will be used for dose calculation. The measured value of 224 ± 42 Bq/kg-C was found to have a steeper decline than expected for background ^{14}C levels but still follows the established trend within the level of uncertainty associated with its analysis method.

Table 3.7.5 ^{14}C in Maple Leaves from Ottawa Compared to Vegetation from Provincial Background Locations

Year	^{14}C in Ottawa Maple Leaves (Bq/kg-C)	^{14}C in Vegetation From Provincial Background Locations (Bq/kg-C)
2001	247	241
2002	246	238
2003	246	235
2004	243	238
2005	236 ^a	234
2006	NA	224

NA = Not Available

^a Ottawa maple leaf samples were obtained by the Geological Survey of Canada but analyzed by OPG HPL in 2005.

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

36 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

The average concentration of ^{14}C in DN local fruit, vegetables and silage is 239 Bq/kg-C (net of 15 Bq/kg-C after background is subtracted) which is unchanged compared to 247 Bq/kg-C in 2005 (net of 11 Bq/kg-C). Figure 3.7.3 indicates that over the long-term, ^{14}C levels in vegetation around DN are fairly stable and are nearing background levels. The average concentration of ^{14}C in PN local fruit, vegetables and silage is 482 Bq/kg-C (net of 258 Bq/kg-C) in 2006 compared to 281 Bq/kg-C (net of 45 Bq/kg-C) in 2005. The 473 percent increase in average ^{14}C levels (background subtracted) in vegetation is poorly related to a 69 percent increase in ^{14}C emissions in 2006 compared to the previous year. This rise compared well when considering only the emissions during the growing season. The ^{14}C emissions from May to August increased by 542 percent compared to 2005. Figure 3.7.4 indicates the long-term trend in ^{14}C concentrations in fruits and vegetables around PN peaked in 1988 to 1990 and have been on a downward trend with the exception of 2006.

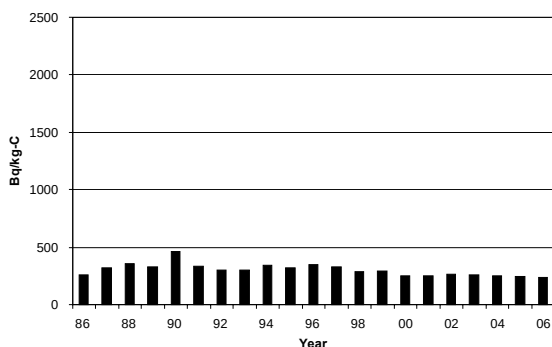


Figure 3.7.3 Darlington Nuclear ^{14}C in Vegetation Trend

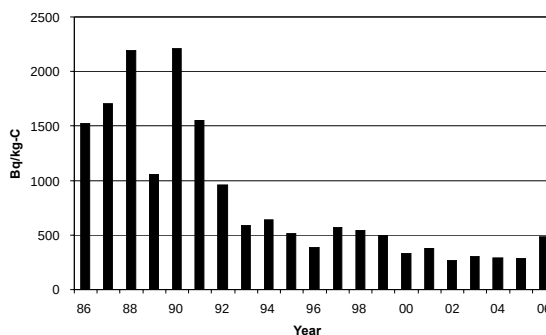


Figure 3.7.4 Pickering Nuclear ^{14}C in Vegetation Trend

3.7.2 Garden and Inland Soils

One open field (undisturbed soil) sample was obtained from the Squires Beach area east of the PN site. Four samples of garden soils and two open field samples were obtained at local farms and residences close to the DN site. Cesium-137 concentrations in soil samples was measured as 10.5 Bq/kg at the PN location, ranged from 5.6 to 9.9 Bq/kg at the DN locations, and from 0.5 to 8.6 Bq/kg in Provincial background samples. The range of values around the sites appears to be higher in 2006 but still within the range of values seen (from 0.4 to 12.5 Bq/kg) at the background locations over the last 5 years. Neither ^{134}Cs nor ^{60}Co were detected in either site's soil samples in 2006. It is therefore suspected the ^{137}Cs measured in these garden samples is weapon based and not from OPG operations.

3.8 Sewage

The York - Durham Water Pollution Control Plant (WPCP) is located about 2 km east of the PN site. The WPCP receives a sewage stream from the PN site. There are,

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 37 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

however, other sources of radioactivity from other sewage paths, mainly from the use of radionuclides in medical diagnosis and treatment. The PN site sewage stream is mixed with other sewage streams from the York and Durham municipalities, processed at the WPCP and the resulting sludge is normally incinerated. Sewage sludge from the Darlington Nuclear site sewage treatment plant may also be shipped to the York-Durham WPCP for treatment and disposal. This sludge is sampled and analyzed at DN before shipment to check for radioactivity.

High resolution gamma scans were carried out on weekly samples of collected PN sewage. ^{131}I was not detected in any of the samples with the exception of one weekly sample taken on August 8, 2006 where the ^{131}I was reported to be 1.6 ± 0.2 Bq/kg. The monthly average values of the weekly gamma scan results are provided in Appendix D, Table D8.1. ^{134}Cs was not detected in any of the PN sewage effluent samples. Measurable levels of ^{60}Co were reported in two weekly samples as 3.4 ± 0.3 Bq/kg (March 21st) and 0.6 ± 0.2 Bq/kg (June 20th). Quarterly composite samples made up from the weekly samples were also analyzed for tritium and ^{14}C . ^{14}C was not detected in these quarterly composite samples and tritium was measured well above background levels. See Appendix D, Table D8.2 for results.

WPCP incinerator ash is also collected as it is the form of sewage that has the highest concentration of radionuclides (other than ^{14}C and tritium) and has the potential to cause the highest dose in WPCP workers. Monthly samples of ash were analyzed by high resolution gamma spectrometry. The concentrations of ^{131}I in ash were well above the detection level and ranged from 1.9 Bq/kg to 26.4 Bq/kg with an average value of 10.6 Bq/kg as shown in Appendix D, Table D8.3. The results strongly suggest the ^{131}I detected in the WPCP ash samples is not from OPG operations. The gamma scans also identified other radionuclides of medical or industrial origin, but these are not quantified here.

3.9 Calculated Atmospheric Dispersion Factors

Atmospheric dispersion factors provide a measure of the dilution of station radiological stack emissions in the atmosphere. Factors influencing atmospheric dispersion at a specific location include wind speed and direction as well as the level of turbulence of the atmosphere.

Atmospheric dispersion factors (Ka) are calculated from the measured tritium oxide in air concentrations and station tritium oxide emissions using the relationship:

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

Where C is the annual average tritium oxide in air concentration (Bq/m³) measured outside the station boundary and Q is the average tritium oxide release rate (Bq/s) for 2006 measured with stack monitors at the point of release. The release rate is determined by dividing the station total annual emission of tritium oxide as given in Table 2.2 by 3.16×10^7 seconds per year. Ka values for DN and PN Indicator sites are given in Tables 3.9.1 and 3.9.2 respectively.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 38 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Figures 3.9.1 and 3.9.2 graphically show how these measured Ka values have varied historically at the DN and PN sites. For purpose of historical comparison, Ka values have been calculated using tritium in air concentration from the active samplers at the boundary location. For the purpose of dose calculation, the Ka values are calculated using the higher tritium concentration from either the active (molecular sieve) or passive samplers where available.

The boundary average Ka values at DN and PN decreased by 6 percent and 23 percent respectively in 2006 compared to 2005. A decrease in Ka values means there is more dilution of emissions released to air.

Wind speed and direction are measured continuously at meteorological towers at each nuclear site. The average annual wind frequency and direction for DN and PN sites for 2006 are presented in Table 3.9.3.

Table 3.9.1 Darlington Nuclear Site Annual Average Dispersion Factors - 2006

Site Description	Measured Average Airborne Tritium Concentration (Bq/m ³)	Calculated Ka (s/m ³) ^a
INDICATOR SITES		
D1 - South East Fence	1.3	3.1E-07
D2 - East Fence	1.1	2.6E-07
D3 - Maple Grove	0.6	1.4E-07
D4 - Park Road	0.4	1.1E-07
D5 - Knight Road	0.4	9.0E-08
D6 - Provincial Park	0.3	7.9E-08
Boundary Average	-	1.6E-07

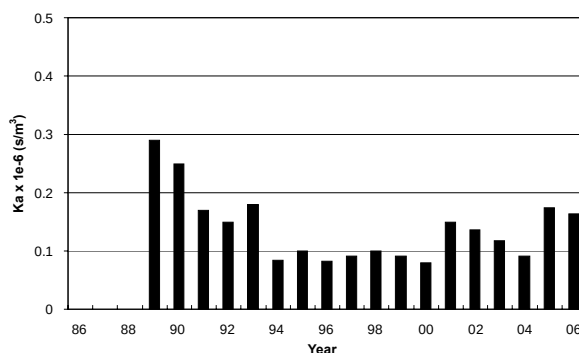


Figure 3.9.1 Darlington Nuclear Site Calculated Boundary Average Ka Values

^a For the measured annual tritium to air emissions of 1.3E+14 Bq.

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

39 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table 3.9.2 Pickering Nuclear Site Annual Average Dispersion Factors - 2006

Site Description	Measured Average Airborne Tritium Concentration (Bq/m ³)	Calculated Ka (s/m ³) ^a
INDICATOR SITES		
P2 - Montgomery Park Road	16.7	9.3E-07
P3 - Sandy Beach Road	3.2	1.8E-07
P4 - Liverpool Road	1.3	7.4E-08
P6 - East Boundary	5.5	3.1E-07
P7 - Central Maintenance-West	7.4	4.1E-07
P8 - Frenchman's Bay	2.0	1.1E-07
P9 - Petticoat Creek Conservation Area	1.9	1.0E-07
P10 - Central Maintenance-East	14.5	8.0E-07
P11 - Alex Robertson Park	3.2	1.8E-07
Boundary Average	-	3.4E-07

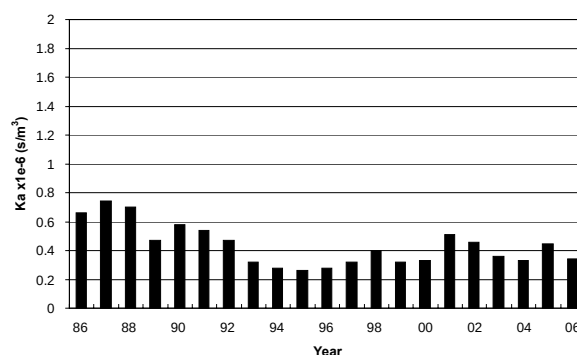


Figure 3.9.2 Pickering Nuclear Site Calculated Boundary Average Ka Values

^a For the measured annual tritium to air emissions of 5.7E+14 Bq

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

40 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

**Table 3.9.3 Darlington and Pickering Nuclear Sites –
2006 Annual Average Wind Frequency by Direction (at 10 m height)**

Direction From	Darlington Nuclear Wind Frequency (%)	Pickering Nuclear Wind Frequency (%)
N	7.39	6.77
NNE	7.72	2.95
NE	5.88	4.22
ENE	5.35	7.06
E	3.01	4.95
ESE	4.60	3.40
SE	5.51	1.45
SSE	2.07	2.00
S	4.14	8.74
SSW	9.86	10.27
SW	6.12	5.41
WSW	7.62	6.44
W	6.84	7.41
WNW	9.82	9.47
NW	8.24	9.59
NNW	5.84	9.83
Total	100.01	99.96

4.0 ASSESSMENT OF DOSES TO THE PUBLIC

This section contains an assessment of doses to the public resulting from the operation of OPG's nuclear generating stations. These doses are based on measured concentrations of radionuclides in environmental media as much as possible. Where environmental concentrations are not statistically measurable above background, doses are based on measured station emission data and environmental pathway modeling.

In this report, dose to members of the public is calculated only for members of potential critical groups that reside in the vicinity of DN and PN. The methodology used in this report for calculating public dose follows that described in OPG's Methodology for Data Analysis and Public Dose Determination for the Radiological Environmental Monitoring Program [R-9].

4.1 Critical Group Dose Calculations

The calculation of public dose in this report is intended to be as realistic as possible using the information collected in the DN and PN Site Specific Surveys [R-10] [R-11] and [R-12] [R-13] in regard to potential critical group lifestyles and attributes.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 41 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

In environmental assessments, “critical groups” are used to estimate the maximum realistic impacts of emissions. Critical groups are actual groups of members of the public generally residing close to the nuclear site. The CSA N288.1 Standard **[R-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 this report, a single critical group with the highest total dose estimate is identified for each nuclear site, DN and PN. Since it is not apparent beforehand which group this will be, a number of potential critical groups are identified, and dose estimates are calculated for each one. Doses are calculated for all age classes within each potential critical group.

The 6 age classes for which doses are calculated are: an adult, a 15 year old child, a 10 year old child, a 5 year old child, a 1 year old infant, and a nursing infant. The one year old infant is assumed to drink formula for all potential critical groups, except the dairy farm infant who drinks fresh cow’s milk. The nursing infant encompasses the age span from birth to 12 months, and is also assumed to consume solid foods in addition to mother’s milk during some part of this period.

The potential critical group dose calculations use realistic receptor characteristics, based as much as possible on data collected in the DN and PN site-specific surveys, and thus give rise to more realistic doses. For example, critical group calculations make use of known contaminated ingestion fractions.

These dose calculations include all pathways of radionuclide uptake or external exposure. The pathways included are listed below and are described in the OPG DRL Guidance document **[R-14]**.

- (a) Air inhalation (including tritium skin absorption)
- (b) Air Immersion (external exposure)
- (c) Water Ingestion
- (d) Water immersion (external exposure – swimming and bathing)
- (e) Soil external exposure or soil groundshine
- (f) Terrestrial plant ingestion – fruits and vegetables
- (g) Terrestrial animal product ingestion – milk, meat, eggs
- (h) Aquatic animal ingestion – fish
- (i) Sediment external exposure – beach groundshine
- (j) Incidental soil and sediment ingestion.

The IMPACT version 4.0.3 program was run using environmental monitoring data and radiological emissions data for 2006 (Table 2.2). Where measured environmental data are not available, IMPACT calculates the doses from emissions. Table 4.1.1 indicates for each radionuclide and pathway how the dose was calculated with respect to input data.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 42 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table 4.1.1 Method (by Radionuclide and Pathway) for Determination of Critical Group Dose

Pathway	Radionuclide	Modeled ⁽¹⁾	Measured
Air	HTO		✓
	HT	✓ ⁽²⁾	
	C-14		✓
	I(mfp)	✓ ⁽²⁾	
	Noble Gas		✓ ⁽³⁾
	Cs-137	✓ ⁽²⁾	
Soil	HTO	✓	
	C-14	✓	
	I(mfp)	✓	
	Cs-137	✓	
Terrestrial Animals	HTO		✓ ⁽⁴⁾
	C-14		✓ ⁽⁴⁾
	I(mfp)	✓	
	Cs-137	✓	
	OBT ⁽⁵⁾	✓	
Terrestrial Plants	HTO		✓
	C-14		✓
	I(mfp)	✓	
	Cs-137	✓	
	OBT ⁽⁵⁾	✓	
Aquatic Animals	HTO		✓
	C-14		✓
	I(mfp)	✓	
	Cs-137		✓
	OBT ⁽⁵⁾	✓	
Sand	HTO	✓	
	C-14	✓	
	I(mfp)	✓	
	Cs-137		✓
Water	HTO		✓
	C-14	✓	
	I(mfp)	✓	
	Cs-137	✓	

- Note:**
- (1) Modeling is based on emissions or from local air measurements where they are available.
 - (2) Concentrations are modeled from emissions and adjusted using empirical atmospheric dilution factors (Ka) determined at each critical group location.
 - (3) Doses are measured directly at the site boundary and adjusted to critical group locations using the ratio of modeled air dispersion factors for the boundary monitor and critical group.
 - (4) Most radionuclide concentrations in animal products are modeled from measured concentrations in air, water and forage. Concentrations of tritium and ¹⁴C in milk are measured.
 - (5) The OBT dose is modeled from emissions and adjusted using the ratio of measured HTO to modeled HTO in terrestrial plants and aquatic animals. The adjustment removes some of the conservatism in the model.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 43 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

The IMPACT version 4.0.3 software calculates Organically Bound Tritium (OBT) concentrations in plants and animal products from airborne tritium emissions data. Similarly, the software incorporates conversion of elemental tritium to tritiated water by soil bacteria.

Concentrations of iodine and particulates in air were calculated at each potential critical group location using emissions data and an empirical atmospheric dilution factor (Ka) as determined from the ratio of measured airborne tritium emissions to measured tritium in air at the critical group location.

Noble gas doses were measured directly using Exploranium gamma radiation monitors. The doses measured at the site boundary were adjusted to the potential critical group locations using modeled atmospheric dilution factors from IMPACT.

Location specific measures of each radionuclide were used in the potential critical group calculations where the group occupied a relatively small geographic location. Some groups such as the Farm, Dairy Farm or Urban Resident are spread over much wider geographic areas, and for these the maximum group value was used in order to keep the calculated doses on the conservative side.

4.1.1 Darlington Nuclear Potential Critical Groups

A review of the DN site specific survey was conducted in 2006 **[R-11]** to determine if any significant changes occurred over the past several years that may impact the design of the DN REMP or public dose calculations. The review included updating population data, fruit and vegetable production and meteorological data. Changes to municipal water supply plants, critical groups and new construction were also considered. A summary of the conclusions of the review is as follows:

- No new potential critical groups were identified as a result of the review.
- The updated characteristics for the rural residents, farm, dairy farm and West-East Beach residents potential critical groups were gathered in 2006 and will be utilized for 2007 public dose calculations.
- Several new residential subdivisions have been built in Bowmanville and Oshawa since 2001 closer to the DN site. The new residential developments should be considered for sampling and modeling purposes.
- In the IMPACT model, the current representative location of the rural residents critical group will need to be revised since this location was converted into a construction office for the new water pollution control plant being built west of the DN site.
- The current representative location of the dairy farm potential group may have to be updated as one new dairy farmer lives approximately 2.2 km north of the DN site. This should be confirmed by modeling.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 44 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

- Several industrial companies are located as close or closer to the DN site than St. Mary's Cement. These companies should be considered candidates for the representative location of the industrial/commercial worker potential critical group.
- There were no changes in water supply plant intake locations and distances from DN.

Changes to the design of the DN REMP or public dose calculation resulting from this review will be implemented in 2007.

The nine potential critical groups at Darlington Nuclear for which doses are calculated in this report are shown in Figure C4 (see Appendix C) and described below. They are the same potential critical groups identified in the Darlington Nuclear DRL report [R-15]. All of the potential critical groups except the farm group consume some locally caught fish, and all but the Fisher groups are assumed to be exposed to local beach sand.

- (a) The **Oshawa/Courtice** potential critical group consists of urban residents located to the W and WNW of the site starting at about 7 km from the site. These residents obtain almost all their drinking water from the local water supply plant, and grow a small percentage of their annual fruit and vegetable consumption in gardens.
- (b) The **Bowmanville** potential critical group consists of urban residents located to the NE and NNE of the site at distances from 4 to 7 km. These residents obtain almost all their drinking water from the local water supply plant, and grow a small percentage of their annual fruit and vegetable consumption in gardens. They also purchase a small percentage of their annual meat, poultry and egg consumption from local farms.
- (c) The **West/East Beach** potential critical group consists of urban residents located to the ENE of the site at distances from 3.5 km to 7 km. These residents obtain their drinking water from both wells and the local water supply plant, and grow a small percentage of their annual fruit and vegetable consumption in gardens. They also purchase a small percentage of their annual poultry and egg consumption from local farms.
- (d) The **Non-Dairy Farm** potential critical group consists of farms located in all landward wind sectors around the DN site at distances from 1.5 km. to over 10 km. The closest is in the WNW wind sector. Members of this group obtain their water supply mostly from wells and use it for drinking, bathing, irrigation and watering livestock. They also obtain a large fraction of their annual fruit, vegetable and animal product consumption from locally grown products.
- (e) The **Dairy Farm** potential critical group consists of dairy farms located in all landward wind sectors around the DN site at distances from 3 km. to over 10 km. The closest is in the N wind sector. Members of this group obtain their water supply mostly from wells and use it for drinking, bathing, irrigation, and livestock

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 45 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

watering. They also obtain a large fraction of their annual fruit, vegetable and animal product consumption, including fresh cow's milk, from locally grown products.

- (f) The **Rural Residents** potential critical group consists of residents in rural areas in all wind sectors around the site at distances of about 2 km to 5 km. Members of this group obtain about half of their water supply from wells and half from local water supply plants, and use it for drinking, bathing, and irrigation. They do not raise livestock. They obtain a moderate fraction of their annual fruits, vegetables and eggs from locally grown products.
- (g) The **Industrial/Commercial** potential critical group consists of adult workers whose work location is close to the nuclear site. The closest location for this group is the St. Mary's cement plant about 1.8 km NE of the site. Members of this group are typically at this location about 23 percent of the time. They consume water from the local water supply plant.
- (h) The **Sport Fisher** potential critical group is comprised of non-commercial individuals fishing near the DN Site discharge, about 0.5 km S of the DN Site. Members of this group were conservatively assumed to obtain their entire amount of fish for consumption from the vicinity of the DN Site and spend 1 percent of their time at the discharge location where atmospheric exposure occurs.
- (i) The **Camper** potential critical group consists of campers at the Darlington Provincial Park, located from 4 to 6 km W of the site at the lakeshore, and includes McLaughlin Bay, a shallow water body where some fishing takes place. The campers are assumed to be in the park no more than 6 months of the year. They consume drinking water from local water supply plants, and purchase a small fraction of their annual fruits, vegetables, meat, poultry, and eggs from locally grown sources.

4.1.2 Pickering Nuclear Potential Critical Groups

A review of the PN site specific survey was conducted in 2005 following the same methodology as for DN's review as described in section 4.1.1 [R-11]. The review resulted in minor revisions to the sampling program and several changes identified by this review were incorporated into 2006 dose calculation. The conclusions of the PN review and modifications to the program are described as follows:

- No new potential critical groups were identified as a result of the site specific review.
- At the end of 2005, the building that used to be the C1 Correctional Institution was converted to a construction office for the expansion of the municipal water pollution control plant. This group is now considered to be part of the Industrial/Commercial potential critical group.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 46 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

- A new industrial building was built closer to Pickering station in north-north-east wind sector since the last site specific survey. For modeling purposes, this location will represent the Industrial/Commercial potential critical group.
- The Squires Beach potential critical group no longer exists as Squires Beach residents moved out by July 2006 to allow for the expansion of the municipal water pollution control plant.
- Updated characteristics were obtained for farm and dairy farm residents and have been utilized in public dose calculation.
- New residential dwellings were built in the west-north-west wind sector approximately 1.2 km from the PN site. For modeling purposes, this location in the west-north-west wind sector will represent the Urban Resident potential critical group.

Based on these changes, the doses are calculated in this report for six potential critical groups at Pickering Nuclear as shown in Figure C5 (see Appendix C) and as described below. Squires Beach critical group dose was calculated but based on very limited environmental data for the first six months of 2006.

- (a) The **C2** potential critical group consisting of inhabitants at a second correctional institute, located approximately 3 km NNE of the PN Site. The C2 group also obtains drinking water from municipal supplies and does not consume locally produced fruits or vegetables. The C2 resident is conservatively assumed to be at this location 100 percent of the time over at least 1 year.
- (b) The **Industrial/Commercial** potential critical group consists of adult workers whose work location is close to the nuclear site. Members of this group are typically at this location about 23 percent of the time. They consume water from the local water supply plant. The closest location for this group is about 1 km NNE of the site.
- (c) **The Urban Residents** potential critical group consists of Pickering and Ajax area residents which surround the PN Site (e.g., Fairport, Fairport Beach, Rose Bank, Liverpool, Pickering Village, etc.). The members of this group consume water from municipal supplies and also consume a diet composed in part of locally grown produce and some locally caught fish. Members of this potential critical group are also externally exposed to beach sand at local beaches.
- (d) The **Local Farms** potential critical group consists of residents of agricultural, non-dairy farms within a 10 km radius of the PN Site. Members of this group obtain a portion of their water supply from wells and consume locally grown produce and animal products, as well as locally caught fish. They are also externally exposed to beach sand at local beaches.
- (e) The **Local Dairy Farms** potential critical group consists of residents of dairy farms within a 20 km radius of the PN Site. This group obtains a portion of their

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 47 of 136
Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS		

water supply from local wells. They also consume locally grown fruit and vegetables and locally produced animal products, particularly fresh cow's milk. Members of this potential critical group are also externally exposed to beach sand at local beaches.

- (f) The **Sport Fisher** potential critical group is comprised of non-commercial individuals fishing near the PN Site outfalls, 0.5 km S of the PN Site. Members of this group were conservatively assumed to obtain their entire amount of fish for consumption from the vicinity of the PN Site and spend 1 percent of their time at the outfall location where atmospheric exposure occurs.

4.2 Change from Default Calculation Parameters

The assumptions and modeling parameters used in the IMPACT 4.0.3 program for potential critical group calculations at DN and PN are generally the same as those documented in the DN and PN DRL reports [R-15] [R-16] except for the following:

- (a) Default Food Consumption

The default total food consumption rates given in the OPG DRL Guidance document represent the 90th percentile of the population. These rates are much higher than the average intake rates for the population, and were used to ensure a degree of conservatism in calculating doses used to determine DRLs. For this report, the intent is to provide a realistic estimate of dose, and so the default food intake rates used here are the "reference" values. These are based on the same data as those used in the DRL Guidance document, but are adjusted to reference caloric intake requirements for each age group, as given in ICRP 23 [R-17] and shown in Table G20a of the OPG DRL Guidance report [R-14]. Similarly, mean drinking water intake rates are used in this report instead of the conservative rates recommended in the DRL Guidance report. The food and water intake rates used are documented in [R-9].

- (b) Nursing Infant Milk Intake

The milk intake rate for the nursing infant used in this report is the mean value as given by the United States Environment Protection Agency (US EPA) [R-18]. The DRL Guidance gives the 95th percentile intake rate.

- (c) Meteorological Data

Calculations of atmospheric dispersion in the IMPACT software use site-specific meteorological data. The DN and PN DRL reports used 5 year average data. In this report, only the current year's site-specific data are used [R-19].

4.3 Critical Group Radionuclide Concentrations, Calculations and Results

The following section details how the radionuclide concentrations are determined, whether they are measured or modeled and any calculations made to obtain results.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 48 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

4.3.1 Tritium

For the purpose of estimating the critical group dose the concentrations used in the corresponding pathways were determined as follows:

- (a) Tritium in air was measured at each critical group location with background subtracted. At some locations there were two different types of tritium collectors, the standard active molecular sieve collector, and the passive collector which is part of a trial program. In order to remain conservative in making dose estimates, the higher concentration was used. In 2006, the second quarter passive samplers were not available due to a laboratory problem. As a result, the second quarter airborne tritium concentrations at the critical group locations were modeled from the site boundary active molecular sieve collector. In order to ensure these modeled values remain conservative, the result was further doubled to account for the known difference in active and passive results (see Section 3.2).
- (b) Drinking water is sampled and measured at the local water supply plants as well as at wells where local residents obtain their water. For the water supply plants, the annual average concentration less background is used, and for wells the maximum annual average concentration found at each critical group is used. Tritium concentration in wells used for purposes other than drinking water is modeled.
- (c) Milk from local dairy farms is sampled on a monthly basis and the highest annual average of all the dairy farms is used for the dose calculation with background subtracted. Only dairy farm residents drink local milk since it is illegal to sell unprocessed milk.
- (d) Fruit and vegetable tritium concentrations are measured at each critical group location and the background value is subtracted. The maximum concentration measured at each critical group is used in the dose calculation.
- (e) In Pickering one silage sample is obtained from a Dairy Farm around the site. Since the Farms and the Dairy Farms are located at a fair distance away from the nuclear station (>5 km) it is assumed that there is not a large variance in radionuclide concentrations in silage obtained at these locations. Therefore, a silage sample taken at one location can be applied to both the Farm and Dairy Farm critical groups. At Darlington silage samples are obtained only from Dairy Farms. The maximum value is used for the Dairy Farm critical group. However this value cannot be used for the Farm critical group because it is located much closer to the station. Instead, the maximum concentrations obtained in the vegetables sampled at the farm locations are used to represent concentrations in silage. Background values are subtracted.
- (f) The concentration used in locally caught fish is the maximum measured in the fish samples with the background value subtracted.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 49 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Pathways not covered by the REMP program are modeled from emissions data using the IMPACT program. See Table 4.1.1.

Organically Bound Tritium (OBT)

Due to some limitations of the IMPACT program, OBT dose can only be calculated from site Tritium Oxide (HTO) and elemental tritium (HT) emissions. OBT dose calculated for ingestion of fruit, vegetables and fish is adjusted using a ratio of measured HTO to modeled HTO concentrations. At critical group locations where there are no locally grown fruits and vegetables, the OBT dose is adjusted using the ratio obtained for the Farm critical group.

Elemental Tritium

For elemental tritium, the inhalation pathway is the only direct pathway to humans resulting in dose. Concentrations in air are modeled from emissions data and the atmospheric dispersion factor measured from tritium oxide data, as described in Section 4.1. This is the same approach as utilized for iodine and particulate dose calculations. Elemental tritium converts into tritium oxide through interaction with microbes in the soil. The resultant tritium oxide is routinely measured in air and local biota around nuclear sites.

4.3.2 Carbon-14

The concentrations of terrestrial ^{14}C used for the calculations of critical group doses are based on the maximum of the measurements for each sample type obtained at each location minus a background concentration of 224 Bq/kg-C.

For fish, the maximum ^{14}C concentration of all samples per site is used, minus a background concentration of 241 Bq/kg-C (mean value for Lake Ontario background fish samples).

Concentrations of ^{14}C in well water are modeled from measured local air concentrations at each critical group location and concentrations in the water supply plants are modeled from site waterborne emissions.

Currently there are no ^{14}C monitors set up at the PN Urban Residents, DN Oshawa Residents and DN Bowmanville Residents critical groups. At these locations the ^{14}C in air is modeled from emissions using the empirical atmospheric dilution factors (K_a) as described in Section 4.1.

4.3.3 Noble Gases and Skyshine

Environmental TLDs are present at the boundary air monitoring stations at all sites and are replaced and read out quarterly (see Section 3.1). Using TLDs to measure environmental gamma dose rates does not allow for detection of contributions from noble gas emissions with statistical certainty at the normal levels of emissions.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 50 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Exploranium G.S. Ltd. sodium iodide gamma spectrometers are installed at the boundary around the DN and PN sites. These systems allow continuous monitoring of all natural and anthropogenic gamma dose rates (i.e., noble gases and ^{192}Ir skyshine) in the public domain.

The monitors measure the air kerma rate, which is converted to effective dose using appropriate age-specific conversion factors (effective dose/air kerma rate) **[R-20]** and standard occupancy and shielding factors for air immersion dose as described in the OPG DRL Guidance document.

The air kerma rate at the PN site due to the Used Fuel Dry Storage Area and Re-Tube Components Storage Area was measured in September 2000 over water on Lake Ontario **[R-21]**. The results showed a rapid drop in the measured air kerma rate with distance, such that it is below the detection limit (0.13 nGy/h) at a distance of 500 m from these storage areas which were identified as the major source. At 1 km distance, the air kerma rate is estimated to be negligible assuming an inverse square relation with distance as well as a further reduction of 1,000 due to scattering in air (effective half distance of 56 metres for skyshine radiation at 300 keV **[R-22]**). The skyshine dose from this source is therefore not significant and will not be calculated for any PN site critical group outside the 1 km boundary. The skyshine dose is added to the Fisher Critical Group as it is assumed to be located 500 metres south of the site in Lake Ontario.

4.3.4 Radioiodines

The concentrations used to calculate doses to the critical group individuals from radioiodines are calculated from emissions using the empirical atmospheric dilution factors (K_a) based on HTO in air at each critical group location as described in Section 4.1. They are directly modeled from emissions where no local HTO measurements are available. This approach is utilized since the concentrations of radioiodines are too low to be easily detected by measurement in the environment.

The dose from radioiodines is based on mixed fission product radioiodines $[I(mfp)]$. This is to account for other shorter lived radioiodines, which may be emitted with ^{131}I . Iodine (mixed fission product) refers to ^{131}I in equilibrium with a mixture of fission product radioiodines with radioactivity in the ratio $^{131}\text{I} : ^{132}\text{I} : ^{133}\text{I} : ^{134}\text{I} : ^{135}\text{I} = 1.00 : 1.48 : 2.05 : 2.29 : 1.95$.

4.3.5 Particulates

The term "particulates" refers to the remaining group of nuclides not otherwise identified in the initial four groups of nuclides that make up the activity released in airborne effluents. These radionuclides are assumed to be in the form of particles. Typically, the measurement of the small concentrations of particulates in the effluent, is based on the gross beta-gamma radioactivity in the effluent monitor filter sample, and there is no further analysis to determine the specific radionuclides present. There was no analysis for alpha radioactivity because alpha radionuclide emissions from the stations are extremely low. To assess a dose on the basis of a particulate

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 51 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

measurement, a conservative approach requires the assumption that the radionuclides present are the most limiting, that is, the radionuclides which result in the highest assignment of dose.

Analysis of DRLs and percent composition of different radionuclides in airborne and waterborne effluents indicates that ^{137}Cs has the highest impact on dose at both DN and PN. Therefore, all gross radioactivity measured in the air or water emissions is counted as ^{137}Cs .

As with the procedure for radioiodines, the concentrations used to calculate doses to critical group individuals are modeled using the empirical atmospheric dilution factors (Ka) at each critical group location as described in Section 4.1. The only pathways in which gross beta-gamma activity is detected in environmental samples are fish and beach sand. The gross beta gamma activity is assigned by default to be ^{137}Cs and a background value is always subtracted.

Cs-137 in fish may originate from historic atmospheric weapons testing or from reactor operation, but for purposes of the dose calculation it is conservatively assumed to be entirely from reactor operation.

4.4 Critical Group Dose Calculation Procedure and Results

Critical Group doses are calculated according to the methodology described in OPG's Methodology for Data Analysis and Public Dose Determination for the Radiological Environmental Monitoring Program [R-9]. The following assumptions were made:

- Residents live at the location 100 percent of the time.
- The fraction of contaminated food eaten is as determined by the site specific survey.
- Drinking water is consumed from local sources as determined by the site specific survey.
- Only Dairy Farm residents ingest local cow milk.
- No local grain products are consumed by humans.

The doses are calculated using the criteria listed below:

Dose from Air: Based on measured HTO and ^{14}C concentrations and modeled I(mfp) and particulate concentrations as described in Sections 4.3.4 and 4.3.5 respectively. Noble Gas dose is measured directly in every wind sector at the site boundary and adjusted to the critical group location using air dispersion ratios from the critical group locations to the boundary monitor locations. For critical groups that span over several wind sectors, the wind sector with the highest air concentration is used to determine the corresponding ratio.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 52 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Dose from Drinking Water: Based on measured HTO from the critical group's drinking water source (WSP or well). All other radionuclide concentrations of ^{14}C , I(mfp) and gross beta-gamma in well water are modeled from the local air concentrations, and the water supply plant (WSP) concentrations are modeled from site waterborne effluent values.

Dose from Water Immersion: Based on measured HTO from the critical group's water source (WSP, local beach or well) and modeled concentrations of ^{14}C , I(mfp) and gross beta gamma in well water, WSP and beach water. The radionuclide concentrations are modeled from local air concentrations for the wells and are modeled from site waterborne effluent for the WSP and the beach water.

Dose from Terrestrial Plants: Calculated from measured HTO and ^{14}C in local fruits and vegetables. I(mfp) and particulate are modeled from emissions using empirical atmospheric dilution factors. OBT is modeled from emissions of HTO and HT (for DN) and adjusted using the ratio of measured to modeled HTO in local produce. See Section 4.3.1 OBT for details.

Dose from Terrestrial Animals: Calculated directly from measured concentrations of HTO and ^{14}C in milk. Dose resulting from the ingestion of terrestrial animal products other than milk are calculated from measured concentrations of HTO and ^{14}C in forage, air and water. The model is used to predict the transfer of HTO and ^{14}C to animals from forage, air and water. The dose resulting from I(mfp) and particulate is modeled from emissions and empirical atmospheric dilution factors. OBT is modeled from HTO and HT (for DN) emissions and adjusted to reflect the ratio of the measured to modeled values of HTO in local produce. See Section 4.3.1 OBT for details.

Dose from Aquatic Animals: Based on measured concentrations of HTO, ^{14}C and ^{137}Cs in local fish. OBT is modeled from emissions of HTO and adjusted to reflect the ratio of measured to modeled HTO in fish.

Dose from Groundshine: Concentrations of radionuclides in soil are measured by gamma scan. Doses are then calculated by standard methods. See Sections 4.3.4 and 4.3.5.

Dose from Beachshine: Concentrations of radionuclides in beach sand are measured by gamma scan. Doses are then calculated by standard methods.

Exceptions

Fisher Critical Group: This critical group only resides at the location for 1 percent of the time. Since this critical group is located offshore it is impractical to measure radionuclide concentrations in the air, therefore all concentrations except those for fish are modeled emissions for this critical group location.

St. Mary's Cement and Pickering Industrial Area Critical Groups: They are considered to be at the location for only 23 percent of the time since they do not reside at the location.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 53 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Farm Critical Group (Darlington): This farm maintains one cow on their property and the residents consume its milk. However no milk samples were taken at this location. Therefore, the dose obtained from local cow milk is modeled from the local radionuclide concentrations in air, water and forage.

Appendix E provides doses by radionuclide, pathway and age group for each critical group. Tables 4.4.1 and 4.4.2 provide a summary of the total doses for each critical group for the DN and PN sites.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 54 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table 4.4.1 Total Critical Group Doses at Darlington Nuclear – 2006

Age Class	Potential Critical Group Doses (μSv)								
	Rural Residents	Bowmanville Residents	Oshawa Residents	St. Mary's Cement Workers	Campers	Farm Residents	Dairy Farm Residents	West/East Beach Residents	Sport Fishers
Adult	0.7	0.3	0.2	0.25	0.2	0.8	0.6	0.4	0.06
15yr. Old	0.6	0.3	0.2	NA	0.2	0.7	0.6	0.4	0.05
10yr. Old	0.6	0.3	0.2	NA	0.2	0.7	0.6	0.3	0.05
5yr. Old	0.6	0.2	0.2	NA	0.2	0.6	0.6	0.3	0.04
1yr. Old	0.6	0.3	0.2	NA	0.2	0.7	0.9	0.4	0.03
Nursing Infant	1.0	0.5	0.4	NA	0.3	1.1	0.7	0.6	0.06

Limiting Critical Group: Farm - Nursing Infant
 Limiting Critical Group Dose (μSv/a): 1.1
 Percent of Legal Limit (%): 0.1
 Percent of Canadian Background Radiation (%): 0.06

Table 4.4.2 Total Critical Group Doses at Pickering Nuclear – 2006

Age Class	Potential Critical Group Doses (μSv)						
	Urban Residents	Industrial/Commercial	C2 Correctional Institution	Dairy Farm Residents	Farm Residents	Sport Fishers	Squires Beach Residents ^a
Adult	1.4	2.8	NA	1.3	1.1	0.6	1.0
15yr. Old	1.3	NA	2.8	1.2	1.0	0.6	0.9
10yr. Old	1.3	NA	NA	1.1	0.9	0.5	0.9
5yr. Old	1.1	NA	NA	1.1	0.9	0.4	0.9
1yr. Old	1.2	NA	NA	1.1	0.9	0.4	1.0
Nursing Infant	1.7	NA	NA	1.5	1.4	0.8	1.3

Limiting Critical Group: C2 – 15 yr old and Industrial/Commercial - Adult
 Limiting Critical Group Dose (μSv/a): 2.8
 Percent of Legal Limit (%): 0.3
 Percent of Canadian Background Radiation (%): 0.15

^a Squires Beach is no longer a potential critical group for PN. Dose to Squires Beach residents was calculated based on limited data available the first six months of 2006.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 55 of 136
Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS		

4.5 Discussion of Critical Group Dose Calculations

The critical group dose is the best estimate of the mean realistic dose received by the most affected group of members of the public. This is a result of using the monitoring data collected under OPG's REMPs.

In 2006, the critical group dose for the DN site was 1.1 μSv for the Farm Nursing Infant, which was virtually unchanged from 0.9 μSv for the same receptor in 2005. The small increase in tritium to air emissions and an increase in the wind frequency to the northwest wind sector where the most exposed farm resides may have caused the fluctuation in the estimated dose. The wind frequency from the southeast to the northwest (Table 3.9.3) was 5.5 percent in 2006 compared to 2.9 percent in 2005.

At the PN site, the critical group dose was 2.8 μSv for the C2 Correctional Institution 15 year old and the Industrial/Commercial adult. This substantial decrease from the 6.7 μSv dose reported for 2005 is attributed to the elimination of two potential critical groups that have typically been the highest (C1 Correctional Institution) and the second highest (Squires Beach) groups. Both C1 occupants and Squires Beach residents were relocated elsewhere due to the expansion of the municipal water pollution control plant. The increase of 69 percent in ^{14}C emissions had a small impact on the Industrial/Commercial and C2 critical groups as these groups do not consume locally grown fruits and vegetables. The dose contribution from ^{14}C via the inhalation pathway is very low.

The public dose trends for DN and PN are presented in Figures 4.5.1 and 4.5.2, respectively. Two step changes are observed in the PN trend and one in the DN trend:

- A decrease in dose in 1992 due to the change in dose assessment procedures applied to both DN and PN.
- The second step change in the PN dose trend starting in 2000 which reflects the introduction of the OPG Gamma Ray Monitoring Network. The improved sensitivity of this technology resulted in a significant reduction in the reported noble gas dose.

Hypothetical Individual dose was reported as the site official dose up to 2002 and thereafter, the official dose was based on the site Critical Group. A description of Hypothetical Individual dose calculation methodology can be found in previously published annual reports.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 56 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

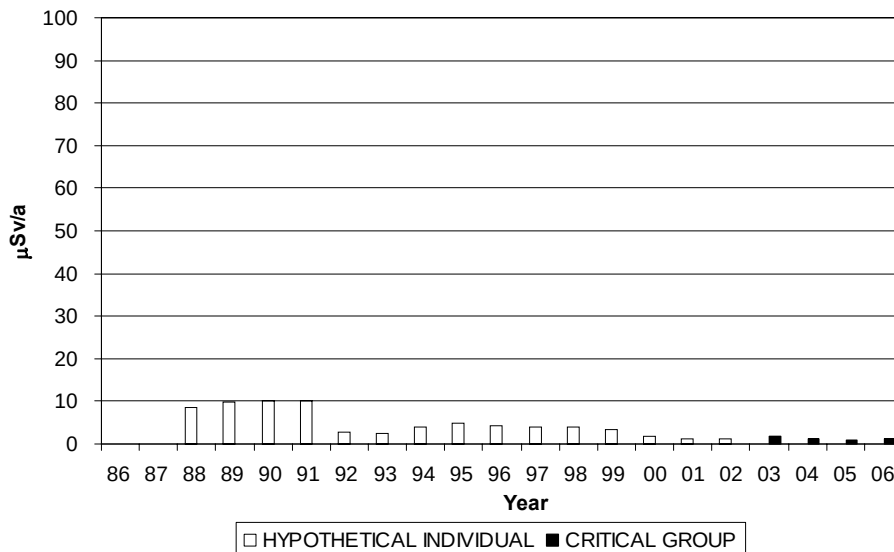


Figure 4.5.1 Darlington Nuclear Site Public Dose Trend

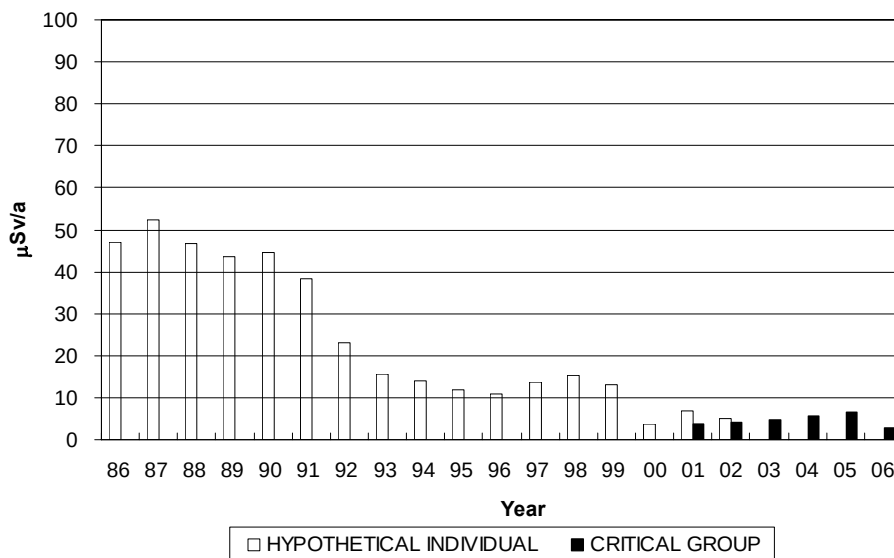


Figure 4.5.2 Pickering Nuclear Site Public Dose Trend

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

57 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

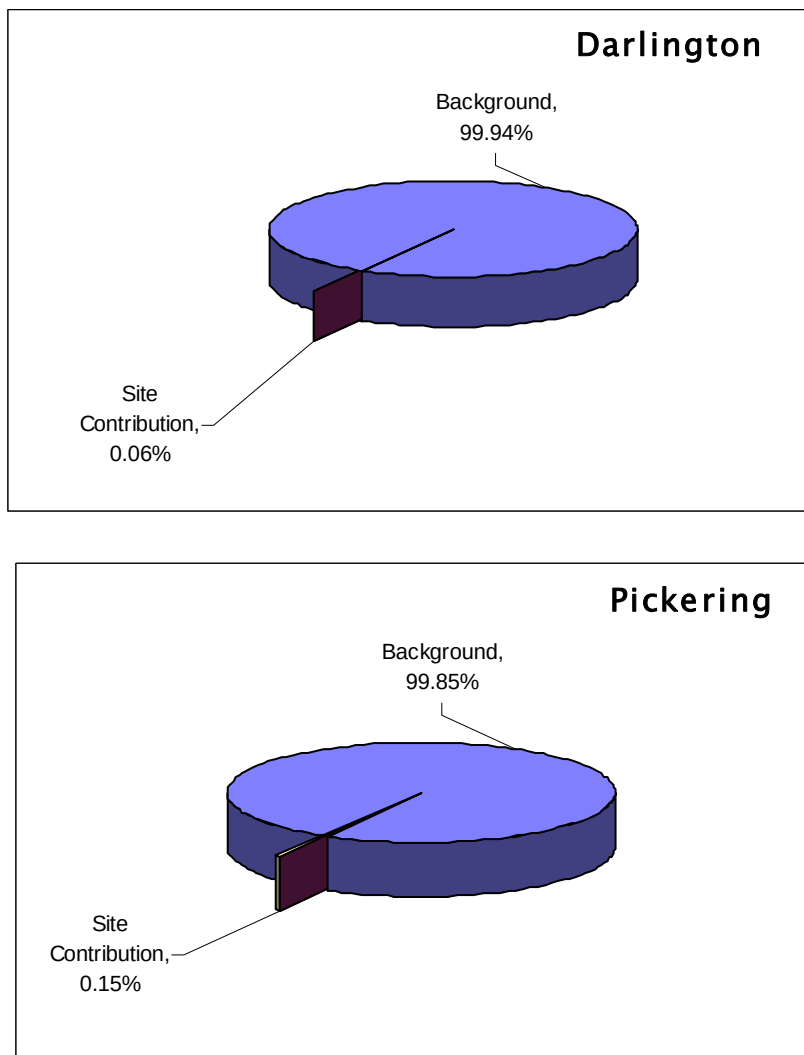


Figure 4.5.3 Graphical Presentation of 2006 OPG Critical Group Doses in Relation to Canadian Background Doses

The critical group dose at each site is compared with the legal limit for a member of the public of 1,000 $\mu\text{Sv/a}$ and the estimated background public doses from naturally occurring and anthropogenic (man-made) radiation of about 1,840 $\mu\text{Sv/year}$ (Refer to Section 4.6). See Figure 4.5.3 for a graphical representation of critical group dose compared to Canadian background sources. Table 4.5.1 provides examples of typical doses from exposure to natural and anthropogenic sources.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 58 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table 4.5.1 Examples of Typical Doses from Exposure to Natural and Anthropogenic Sources in the Range of Calculated Critical Group Doses at OPG Sites

Source of Exposure	Effective Dose (μSv)
Ingestion of one 250 ml glass of milk (⁴⁰ K)	0.06
Ingestion of one Banana (⁴⁰ K)	0.1
Annual External Exposure during Precipitation Events (Gamma Radiation from Naturally Occurring Radon Gas Decay Products)	4
Airplane Travel (2 hours flight)	12
Chest X-ray	70

4.6 Background Dose Data

Information on Canadian public doses from naturally occurring sources was updated in 2002, including new data from ground gamma surveys in 4 major Canadian cities [R-23] [R-24]. Results are summarized in Table 4.6.1, where it can be seen that most of the variation is due to the inhalation dose from ²²²Rn ("Radon").

Table 4.6.1 Naturally Occurring Annual Public Effective Doses^{a b}

Radiation Source	Worldwide Average (μSv)	Canada (μSv)	Toronto (μSv)	Montreal (μSv)	Winnipeg (μSv)	Pickering Nuclear Site (μSv)	Darlington Nuclear Site (μSv)
Cosmic	380	318	313	313	315	313	313
Internal	306	306	306	306	306	306	306
Inhalation	1,256	926	757	667	3,225	565	565
External	480	219	178	278	176	154	154
Total	2,422	1,769	1,554	1,564	4,022	1,338	1,338

As described in Section 3 and 4, OPG monitors various radionuclides in the environment at locations away from the influences of the nuclear stations to establish the background levels for the DN and PN REMPs. The objectives of the provincial REMP is to obtain sufficient background radiation information to allow subtraction from the public dose estimate such that the reported radiological impact is exclusively the result of the operations of OPG nuclear facilities and to gather information for direct comparison to measurements made in the vicinity of the nuclear stations.

^a In addition to naturally occurring radiation, the public also receives about 70 μSv/a effective dose from anthropogenic sources such as nuclear weapon test fallout, and exposures from technological processes and consumer products and services, excluding medical sources. Thus, the total background dose in Canada from naturally occurring and anthropogenic sources is 1,840 μSv/a. In addition, the average Canadian also receives 1,100 μSv/a from medical sources.

^b The legal limit of 1,000 μSv per year from licensed industrial practices is over and above the dose the public already receives from the natural environment and from medical procedures [R-25].

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 59 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

The provincial program was reviewed in 2006 with the intent to determine whether the existing program continues to be adequate and to confirm that the practices are in line with program expectations or objectives [R-26]. Overall, the current provincial program exceeds the REMP requirements. Several areas have been identified for elimination or reduced sampling frequency based on the review of historical data and how the data have been used. Highlights of the recommended changes are summarized below:

- Background tritium in air concentrations are largely below the detection limit (see Appendix D, Table D2.5). The impact of conservatively assuming a background value of zero or the natural cosmogenic tritium level on the calculation of facility-related tritium dose will be assessed. If the results of such a change are deemed insignificant, consideration will be given to eliminate background tritium in air monitoring.
- The background measures of tritium in precipitation are very low and below the method detection limit. For these reasons, the sampling of precipitation was removed from the program starting in January 2007.
- The ^{14}C specific activity model assumes that all the plant carbon comes from the air and thus, ^{14}C in plants will have the same specific activity as in the air during the growing season. The number of ^{14}C sampling locations and media (air or vegetation) will be reviewed to optimize the number of samples to be taken.
- The sampling program for provincial drinking water demonstrates the variation of tritium concentrations in the Great Lakes and inland lakes or wells. The measurements are not used in the dose calculation as prediction from the Klukas Lake Tritium Model (see Section 3.5) is used. A comprehensive survey of tritium in the Great Lakes will be considered to verify the Klukas Lake Tritium Model projections are still reasonable. Periodic confirmation of lake tritium levels can replace routine quarterly sampling.

5.0 QUALITY ASSURANCE PROGRAM

The Quality Assurance (QA) program for the REMP embraces all activities in field sample collection, sample availability, laboratory analysis, laboratory quality control, and external laboratory comparison. The objective is to provide best estimates of radiation doses to the public resulting from the operations of OPG nuclear generating sites. This section provides an overview of quality assurance activities that are critical to ensure the quality of the REMP data.

5.1 Sample Availability

This indicator tracks the performance of sample collection and analysis for the REMP. The field sampling campaign of the REMP is designed to collect representative field samples from selected pathways near each nuclear site and from background locations.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 60 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

The sample availability percentage is determined by dividing the number of valid sample analyses by the number of planned sample analyses for each REMP site. The overall sample availability for year 2006 was 98.0 percent for PN, 98.0 percent for the DN and 98 percent for the Provincial Background REMPs. These are all above the minimum performance target of 90 percent.

As indicated in Table 5.1, the availability of sample types varies from 74 percent to 100 percent. Despite several sample types having availability under 90 percent, the overall sample availability values for Darlington Nuclear REMP, Pickering Nuclear REMP, and Provincial Background REMP are all greater than the target of 90 percent, which indicates that the quality of the program is not compromised.

5.2 Laboratory Analysis

A total of 3,302 laboratory analyses were reported for the year 2006. The analyses covered tritium, gross beta, ^{14}C , ^{131}I , TLD gamma, OBT, gamma scan, and organic carbon. The DN site accounted for 44 percent of the total number of sample analyses, while PN and Provincial programs accounted for 42 percent and 14 percent, respectively. The detailed breakdown for the radiological analyses is presented in Table 5.2.

Table 5.2 Detailed Breakdown of Laboratory Analyses for REMP in 2006

Laboratory Analysis	Number of Sample Analyses for each REMP Site			
	DN	PN	Provincial	Total Analyses
Tritium	805	733	188	1727
Gross Beta	201	171	68	440
^{14}C	212	161	93	466
^{131}I	52	52	8	112
TLD Gamma / Ext Gamma	111	147	45	303
Gamma Scan - ^{95}Nb , ^{152}Eu , ^{134}Cs , ^{137}Cs , ^{40}K , ^{60}Co , ^{95}Zr	58	103	58	219
OBT	3	18	9	30
Organic Carbon	1	2	2	5
Site Totals	1443	1387	471	3302

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 61 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table 5.1 Detailed Breakdown of REMP Sample Availability by Sample Types

Sample Types	Collection Frequency	Pickering Nuclear				Darlington Nuclear				Provincial Controls			
		Locations	Plan	Actual	Availability	Locations	Plan	Actual	Availability	Locations	Plan	Actual	Availability
Tritium													
Tritium-in-Air (Molecular Sieves)	Monthly (H3)	11	132	126	95%	8	96	93	97%	2	24	23	96%
Tritium-in-Air (Passive Samplers)	Quarterly (H3)	10	39	29	74%	13	52	39	75%	6	24	18	75%
Precipitation	Monthly (H3)	15	154	154	100%	20	204	203	100%	3	34	34	100%
Lake Water (Supply Plants)	Weekly Composite (H3)	5	204	202	99%	3	132	132	100%				
Residents Wells/Cisterns	Monthly (H3)	11	103	103	100%	15	180	179	99%				
Drinking Water	Quarterly (H3)									17	68	68	100%
Fish	Annual (H3) & Annual Composite (OBT)	1	18	18	100%	2	23	23	100%	2	36	36	100%
Lake Water	Monthly (H3)	3	36	36	100%	3	36	36	100%				
Milk	Monthly Composite (H3, OBT) ^(a)	3	48	48	100%	5	60	59	98%				
Milk	Quarterly (H3)									2	8	8	100%
Fruits	Annual & Annual Composite (H3, OBT) ^(a)	9	11	11	100%	19	19	19	100%				
Vegetables	Annual & Annual Composite (H3, OBT) ^(c)	15	17	14	82%	16	16	14	88%	5	10	10	100%
Animal Silage	Annual (H3)	1	1	1	100%	5	5	5	100%				
Honey	Annual (H3, OBT) ^(a)	4	5	5	100%	6	6	6	100%				
Sewage and Ash	Quarterly Composite (H3)	1	4	4	100%								
Overall tritium sample availability			772	751	97%		829	808	97%		204	197	97%

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 62 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table 5.1 Detailed Breakdown of REMP Sample Availability by Sample Types-(Continued)

Sample Types	Collection Frequency	Pickering Nuclear				Darlington Nuclear				Provincial Controls			
		Locations	Plan	Actual	Availability	Locations	Plan	Actual	Availability	Locations	Plan	Actual	Availability
Carbon-14													
Carbon-14 in Air (Molecular Sieves)	Monthly (C-14)	3	36	35	97%	3	36	34	94%	2	24	22	92%
Carbon-14 in Air (Passive Samplers)	Quarterly (C-14)	10	39	39	100%	13	52	52	100%	6	24	24	100%
Fish	Annual (C-14)	1	16	16	100%	2	20	20	100%	2	32	32	100%
Sediments	Annual Composite (C-14, Organic Carbon)	6	6	6	100%	3	4	4	100%	2	4	4	100%
Milk	Monthly Composite (C14)	3	36	36	100%	5	60	59	98%				
Milk	Quarterly (C-14)									2	8	8	100%
Fruits	Annual & Annual Composite (C-14)	9	9	9	100%	19	19	19	100%				
Vegetables	Annual & Annual Composite (C-14)	15	15	13	87%	16	16	14	88%	5	5	5	100%
Animal Silage	Annual (C-14)	1	1	1	100%	5	5	5	100%				
Honey	Annual (C-14)	4	4	4	100%	6	6	6	100%				
Sewage and Ash	Quarterly Composite (C-14)	1	4	4	100%								
Overall carbon-14 sample availability			166	163	98%		218	213	98%		97	95	98%

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 63 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table 5.1 Detailed Breakdown of REMP Sample Availability by Sample Types-(Continued)

Sample Types	Collection Frequency	Pickering Nuclear				Darlington Nuclear				Provincial Controls			
		Locations	Plan	Actual	Availability	Locations	Plan	Actual	Availability	Locations	Plan	Actual	Availability
Gamma													
External Gammas (TLD's)	Quarterly (Gamma)	11	43	43	100%	10	40	40	100%	12	48	45	94%
External Gammas (Exploranium Monitor)	Monthly (Gamma)	9	108	104	96%	6	72	71	97%				
Fish	Annual (Gamma Scan)	1	16	16	100%	2	20	20	100%	2	32	32	100%
Sediments	Annual (Gamma Scan)	4	16	16	100%	3	12	12	100%	4	16	16	100%
Milk	Weekly Composite (Gamma Scan)	3	52	52	100%	5	52	52	100%				
Milk	Quarterly (Gamma Scan)									2	8	8	100%
Honey	Annual (Gamma Scan)	4	4	4	100%	6	6	6	100%				
Sewage and Ash	Weekly (Gamma Scan)	1	51	51	100%								
Sewage and Ash	Monthly (Gamma Scan)	1	12	12	100%								
Sewage Sludge	Bi-Monthly (Gamma Scan)					2	12	12	100%				
Soil and Beach Sand/Silt	Annual (Gamma Scan)	4	4	4	100%	5	8	8	100%	5	10	10	100%
Overall gamma scan sample availability			306	302	99%		222	221	100%		114	111	97%
Gross Beta													
Wet/Dry Fallout	Monthly (Gross Beta)	9	108	107	99%	8	96	96	100%				
Lake Water (Supply Plants)	Monthly Composite (Gross Beta)	5	51	50	98%	3	33	33	100%				
Residents Wells/Cisterns	Quarterly Composite (Gross Beta)	6	14	14	100%	15	60	60	100%				
Drinking Water	Quarterly (Gross Beta)									17	68	68	100%
Lake Water	Quarterly (Gross Beta) ^(b)					3	12	12	100%				
Overall gross beta sample availability			173	171	99%		201	201	100%		68	68	100%
OVERALL SITE SAMPLE AVAILABILITY			1417	1387	98%		1470	1443	98%		483	471	98%

Note (a) OBT is performed on selected Pickering samples only.

(b) Quarterly (Gross Beta) for Darlington only.

(c) OBT is performed on selected Pickering and Provincial Background samples.

(d) Exploranium availability is based on an average of actual run time of all monitors for PN and DN.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 64 of 136
Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS		

5.3 Laboratory Quality Assurance and Quality Control

The OPG Health Physics Laboratory (HPL) is accredited for radioanalysis of drinking water and soil by the Canadian Association of Environmental Analytical Laboratories (CAEAL). The accreditation is based on demonstrated compliance with ISO 17025. HPL is also licensed for radioanalysis of drinking water by the Province of Ontario's Ministry of Environment (MOE). HPL performs laboratory activities according to a documented quality assurance program [R-27].

5.3.1 Laboratory Quality Control

Quality control samples are used to estimate the precision and accuracy of analytical results and to examine sources of error 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, process control samples and quality control standards. The process control samples are 'dead water' (radiation free water/blank) samples to be treated as real samples and go through the same handling process as the real samples. The quality control standards are samples with predetermined values (usually traceable standards) to be included for final analysis. The analysis of the environmental sample is considered valid when the results of the accompanying quality control samples are within ± 10 -20 percent of the known/expected values, depending on the analysis type. For 2006, the results for the quality control samples were all within the required range. The results provide added confidence in terms of the quality of the data for the program and the consistency of the laboratory measurements.

5.3.2 Laboratory Performance Testing

The main purpose of the laboratory performance testing programs is to provide assurance to OPG Nuclear and the CNSC of the laboratory's analytical proficiency (i.e., the accuracy of the measurements). The testing programs provide a quality check to a laboratory operation including equipment calibration, analytical procedures, data review and internal quality control. These testing programs are a crucial part of the laboratory QA program and demonstrate that the laboratory is performing within the acceptable limits as measured against external unbiased standards.

OPG Nuclear participated in two independent laboratory performance testing programs in 2006 [R-28]. The suppliers of the test samples and irradiations were:

- (a) Eckert and Ziegler Analytics Inc. and;
- (b) National Research Council of Canada (NRCC).

These programs involved the measurement of tritium, gross beta, and gamma in water/drinking water; gamma emitters in milk and soil; and environmental gamma measurements using thermoluminescent dosimeters (TLDs).

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

65 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

(a) Analytics Inc.

The QA test samples are supplied on a quarterly basis by Analytics Inc. Results of analyses are reported back to Analytics, who then provide performance reports for each of the analytical types. The performance test limits used are as follows:

$$\begin{aligned} -25 \text{ percent} &\leq \text{Mean Relative Difference} \leq +50 \text{ percent} \\ \text{Relative Precision} &\leq 40 \text{ percent} \end{aligned}$$

These test limits correspond to the *in vitro* accuracy specifications of the CNSC's Regulatory Standard S-106 Technical and Quality Assurance Standards for Dosimetry Services in Canada which are used in the absence of any prescribed or generally accepted limits for environmental QA tests.

All QA performance test results in 2006 met the limits except for second quarter where ^{134}Cs and ^{65}Zn in soil were reported high due to failure to compensate for interference from ^{214}Bi in the sample. In this incident, the HPL technicians were coached to manually review and interpret gamma spectra for samples with identified nuclide activity over the Ld. The maximum and minimum Mean Relative Difference and Relative Precision are summarized for each sample type and presented in Table 5.3.

Table 5.3 Summary of Analytics Performance Test Results for 2006

Sample Types	Mean Relative Difference (%)		Relative Precision (%)	
	High	Low	High	Low
Tritium in Water	0	-13	2	1
Gross Beta in Water	+26	1	4	3
Gamma in Milk	+9	-13	20	0
Gamma in Water	+11	-17	11	1
Gamma in Soil	+57	-4	51	1

(b) NRCC Environmental Gamma QA Program

The laboratory performance testing program for environmental Gamma measurements is performed on a quarterly basis through independent exposure of TLDs at an irradiation facility at the NRCC. The Mean Relative Biases of the quarterly measurements were found to be between -19 percent to -14 percent. It should be noted that the NRCC uses a different source of radiation (^{60}Co , compared to ^{137}Cs used by OPG Nuclear for instrument calibration) and this resulted in different responses for the measurements (a bias of -18 percent). If the known bias is taken into account (i.e., the mean relative responses are increased by 18 percent), then the results are very good, and well within the performance criteria ANSI-N545-1975 [R-29] (bias less than ± 30 percent).

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 66 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

5.4 Independent and Self Assessments

In 2006 two self-assessments were performed by HPL and one performed by Environment Program Department (EPD). A summary of the assessments are described in the following sections.

5.4.1 Self Assessments

- (a) Self-assessment of application of Quality Assurance program to TLD card processing (HPL)

The main finding of this assessment found that the control over the approval and deployment of spreadsheets is not consistent with the expectations of the quality assurance program. This observation was similar to the event resulting in the revision of the 2005 annual report [R-30]. In this incident, the tritium results were underestimated due to an erroneous date entry in a laboratory spreadsheet used to establish tritium decay values.

The procedural requirement to use specific named spreadsheets in the performance of laboratory functions demands that these spreadsheets be subject to the same degree of review, approval and control over modification as is given to either other documents or software that is deployed in the lab. A process of managing the use of spreadsheets within HPL processes that ensures demonstrable conformance with quality principles will be developed.

- (b) Assessment of Quality Assurance Program for environmental measurement with respect to new requirements in ISO/IEC 17025:2005 (HPL)

In September 2006, CAEAL notified HPL that the standard for certification was being updated from ISO/IEC 17025/1999 to ISO/IEC 17025/2005. This assessment consists of a review of each of the changed requirements to determine the extent to which HPL met the new requirements.

Overall the Health Physics Laboratory operation already meets the changes to the requirements included in ISO/IEC 17025:2005, however some revisions to the QA Manual are required to accurately describe existing practices so that conformance to the requirements can be demonstrated. The one weakness identified was in being able to demonstrate evidence of top managements' "commitment to the development and implementation of the management system and continually improving its effectiveness." It was not a finding that there is no commitment from top management, only that it is hard to demonstrate. The corrective actions to be taken include rewriting the policy statement in the QA manual and to establish an annual meeting where the HPD manager will present the policy to HPL staff.

- (c) Field Sampling (Monitoring Stations) Verification (EPD)

A self assessment was carried out by the EPD in October 2006 to evaluate compliance of HPL technicians with sampling procedures and to evaluate monitoring site

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 67 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

conditions. The focus of the assessment was on the provincial background locations. Specifically, the assessment included the sample handling of airborne tritium and ^{14}C , lake water, TLD and milk at several eastern Ontario locations. In general, HPL technicians complied with the sampling procedures. However, a few opportunities for improvement were noted. The HPL procedure for lake water sampling requires updating to reflect the sampling method performed in the field. Re-evaluation of the requirement for safety equipment worn by the technician to better suit the risk involved is needed. Several of the passive sample holders in provincial locations need replacement as the samplers are in disrepair.

6.0 REFERENCES

- [R-1] Guidelines for Calculating Derived Release Limits for Radioactive Material in Airborne and Liquid Effluents for Normal Operation of Nuclear Facilities, Canadian Standards Association, CAN/CSA-N288.1-M87, August 1987.
- [R-2] Polack, A. to file, Carbon-14 Inventory 2006, March 19, 2007, N-03467.
- [R-3] Health Canada, Environmental Radioactivity in Canada 1989-1996, Radiological Monitoring Report.
- [R-4] Brown, R.M., The Measurement of Tritium in Canadian Food Items, March 1995, AECB INFO-0499, AECB Project No. 3.135.1.
- [R-5] Klukas, M.H., Tritium in the Great Lakes: Concentration – Time Model, AECL Report: RC-2338, December 1999.
- [R-6] Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments, Technical Report Series No. 364, IAEA, Vienna, 1994.
- [R-7] Kotzer, T.G., Workman, W.J., Measurements of Tritium (HTO, TFWT, OBT) in Environmental Samples at Varying Distances from a CANDU Nuclear Generating Station, AECL-CRL, AECL-12029, December, 1999.
- [R-8] Beninson, D., Gonzalez, A.J., Application of the Dose Limitation System to the Control of ^{14}C Releases from Heavy-Water-Moderated Reactors, IAEA-SM-258/53.
- [R-9] Benovich I., Methodology for Data Analysis and Public Dose Determination for the Radiological Environmental Monitoring Program, N-INS-03481.21-10000, March 21, 2006.
- [R-10] Schweinsberg, S., Site-Specific Survey for the Darlington Nuclear Site, NK38-REP-03443-10001-R00, December 14, 2001.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 68 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

- [R-11] Schweinsberg, S., Review of the Darlington Nuclear Site Specific Survey, December 20, 2006, NK38-REP-03481-10002-R000.
- [R-12] Schweinsberg, S., Site-Specific Survey for the Pickering Nuclear Site, P-REP-03443-10001-R00, December 16, 1999.
- [R-13] Schweinsberg, S., Review of Pickering Nuclear Site Specific Survey, November 21, 2006, P-REP-03481-00001-R001.
- [R-14] BEAK International Inc., Guidance for Calculation of Derived Release Limits for Radionuclides in Airborne and Liquid Effluents from Ontario Power Generation Nuclear Facilities, N-REP-03482-10000, October 31, 2002 OPG Report.
- [R-15] Benovich, I., Derived Release Limits for the Darlington Nuclear Generating Station, OPG Report NK38-REP-03482-10001-R00, July 10, 2003.
- [R-16] Benovich, I., Derived Release Limits for Pickering Nuclear Generating Station B, OPG Report, NK30-REP-03482-00001-R00, June 2003.
- [R-17] Report of the Task Group on Reference Man, International Commission on Radiological Protection, ICRP-23, October 1974.
- [R-18] US Environmental Protection Agency, Child Specific Exposure Factors Handbook, EPA-600-P-00-002B, September 2002, Interim Report.
- [R-19] Oliverio, M., OPG Meteorological Data Processing for Dose Calculations of Fourth Quarter and All of 2006, March 7, 2007, P0687/RP/005.
- [R-20] ICRP Publication 74, Conversion Coefficients for use in Radiological Protection Against External Radiation, September 1995.
- [R-21] Grasty, R.L., The Air Kerma Rates from the Pickering Nuclear Generating Station, Gamma – Bob Report 00-2, October 2002.
- [R-22] Grasty, R.L., Gamma Ray Spectrometric Methods in Uranium Exploranium – Theory and Operational Procedures, in Geophysics and Geochemistry in the Search for Metallic Ores; Peter J. Hood, Editor, Geological Survey of Canada, Economic Geology Report 31, P. 147-161.
- [R-23] Grasty, R.L., The Annual Effective Dose from Natural Sources of Ionizing Radiation in Canada, Gamma-Bob Report 02-6, December 2002.
- [R-24] Grasty, R.L., LaMarre, J.R., The Annual Effective Dose from Natural Sources of Ionizing Radiation in Canada, Radiation Protection Dosimetry, Volume 108 No. 3, pages 215 to 226 (2004), Oxford University Press.
- [R-25] ACRP-9, Radiation Doses From Medical Diagnostic Procedures in Canada, Aldrich, J.E. et al, March 1997, CNSC-INFO-0670.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 69 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

- [R-26] Borromeo, J., Review of the Provincial Radiological Environmental Monitoring Program – 2006, January 8, 2007, N-REP-03481.21-10003-R000.
- [R-27] OPG, Dosimetry and Radiological Environmental Quality Assurance Program Manual, N-MAN-03416.3-0020.
- [R-28] Christiani, W., Annual Summary 2006 – Health Physics Laboratory Environmental Measurements Quality Assurance Program, April 12, 2007, N-REP-03443.8-10001
- [R-29] American National Standards Institute, Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry Environmental Applications, ANSI N-545-1975.
- [R-30] Borromeo, J., Annual Summary and Assessment of Environmental Radiological Data for 2005, November 30, 2006, N-REP-03481-10004-R01.
- [R-31] King, K.J. et al., The Provincial Radiological Environmental Monitoring Program, N-REP-03481-10000-R00, December 14, 2000.

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

70 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Appendix A: Radiological Units and Conversions

Absorbed Dose

1 gray (Gy) = 1 joule/kg absorbed dose

1 gray (Gy) = 100 rad

1 milligray (mGy) = 100 millirad (mrad)

Effective Dose

1 sievert = 100 rem

1 millisievert (mSv) = 100 millirem (mrem)

1 microsievert (μ Sv) = 0.1 millirem (mrem)

Quantity of Radionuclide

1 becquerel (Bq) = 1 disintegration per second

1 curie (Ci) = 3.7×10^{10} Bq

1 mCi/($\text{km}^2 \cdot \text{month}$) = 37 Bq/($\text{m}^2 \cdot \text{month}$)

Dose per Unit Intake

1 mrem per pCi intake = 0.00027 Sv/Bq

Appendix B: Glossary of Acronyms and Symbols

⁴¹ Ar	- Argon-41
⁷ Be	- Beryllium-7
²¹⁴ Bi	- Bismuth-214
¹⁴ C	- Carbon-14
¹³⁴ Cs	- Cesium-134
¹³⁷ Cs	- Cesium-137
¹³⁷ Cs+	- Cesium-137 including progenies
⁶⁰ Co	- Cobalt-60
CO ₂	- Carbon Dioxide
³ H	- Tritium (Hydrogen-3)
¹³¹ I	- Iodine-131
¹⁹² Ir	- Iridium-192
⁹⁵ Nb	- Niobium-95
⁴⁰ K	- Potassium-40
²²⁰ Rn	- Radon-220
²²² Rn	- Radon-222
¹³³ Xe	- Xenon-133
¹³⁵ Xe	- Xenon-135
⁶⁵ Zn	- Zinc-65
AECL-CRL	- Atomic Energy of Canada Limited – Chalk River Laboratories
Bq	- Becquerel
BP	- Bruce Power
CAEAL	- Canadian Association for Environmental Analytical Laboratories
CANDU	- Canadian Deuterium Uranium
CNSC	- Canadian Nuclear Safety Commission, previously known as the Atomic Energy Control Board
COG	- CANDU Owners Group
CSA	- Canadian Standards Association
DN	- Darlington Nuclear
DN1-4	- Reactors 1 through 4 at the Darlington Nuclear Site
EPD	- Environment Programs Department
GSC	- Geological Survey of Canada
Gy	- Gray
HPL	- OPG Health Physics Laboratory (Whitby, Ontario)
HT	- Elemental Tritium
HTO	- Tritium Oxide
I(mfp)	- Mixed Fission Products Radioiodines
ICRP	- International Commission on Radiological Protection
IMPACT	- Integrated Model for Probabilistic Assessment of Contaminated Transport
Ka	- Atmospheric Dilution (or Dispersion) Factor (s/m ³)
Lc	- Critical Level
Ld	- Detection Limit
MOE	- Ministry of the Environment (Ontario)
Nal	- Sodium Iodide

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

72 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

NGS	- Nuclear Generating Station
NRCC	- National Research Council of Canada
OBT	- Organically Bound Tritium
OPG	- Ontario Power Generation
PN	- Pickering Nuclear
PN1-4	- Reactors 1 through 4 at the Pickering Nuclear Site
PN5-8	- Reactors 5 through 8 at the Pickering Nuclear Site
QA	- Quality Assurance
QC	- Quality Control
REMP	- Radiological Environmental Monitoring Program
Sv	- Sievert
TFWT	- Tissue Free Water Tritium
TLD	- Thermoluminescent Dosimeter
TRF	- Tritium Removal Facility (DN)
TS	- Transformer Station
US	- United States
w.e.	- Water Equivalent
WPCP	- Water Pollution Control Plant
WSP	- Water Supply Plant
WWMF	- Western Waste Management Facility

Report

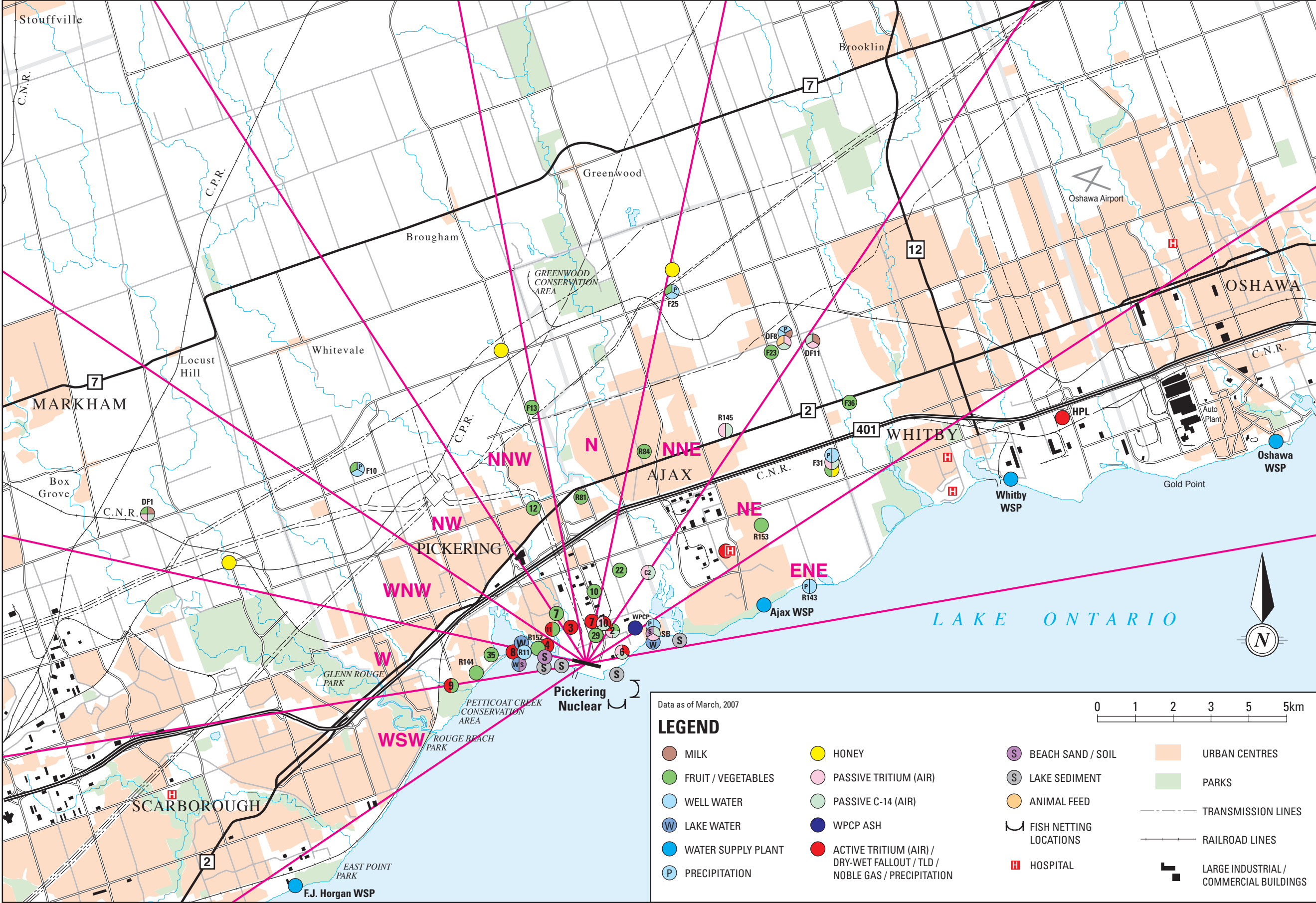
Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 73 of 136
Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS		

Appendix C: Maps of Environmental Monitoring and Critical Group Locations

FIGURE C1
DARLINGTON ENVIRONMENTAL MONITORING LOCATIONS



FIGURE C2
PICKERING ENVIRONMENTAL MONITORING LOCATIONS



● R.C. Harris WSP (21 km WSW of PN site)

NOTE: 1) Active Tritium (air) only at Ajax Hospital and HPL.
2) Noble Gas monitors at Air Monitoring Stations 2, 3, 4, 6, 7, 8, 9, 10, and 11.

3) TLD's at location SB and C2.
4) Active Carbon-14 (air) at Air Monitoring Stations 2, 6, and 10.

5) Squires Beach (SB) Sample at R115, R116, R122, R124, R125, and R127.

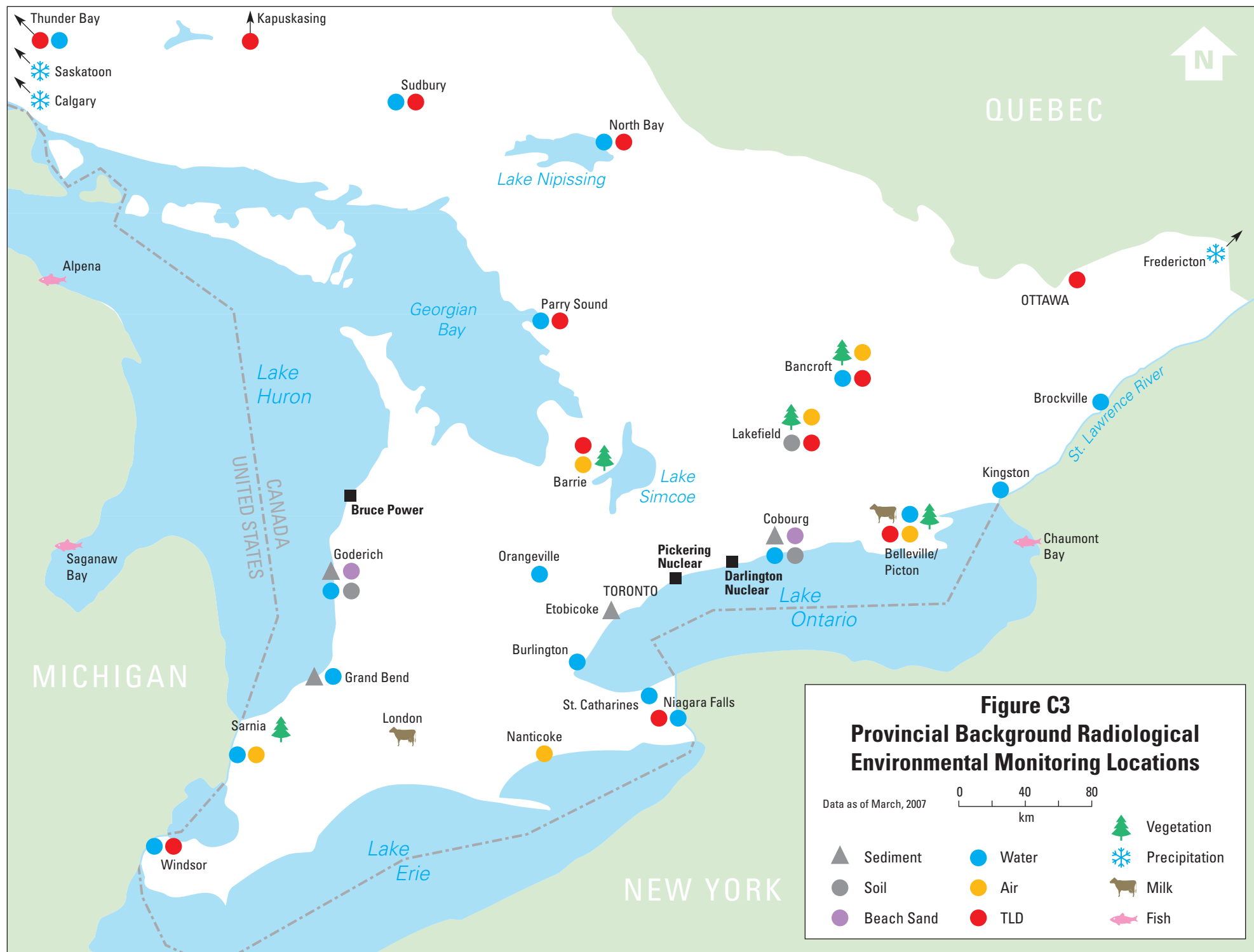
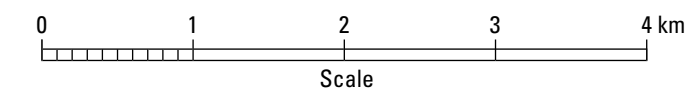
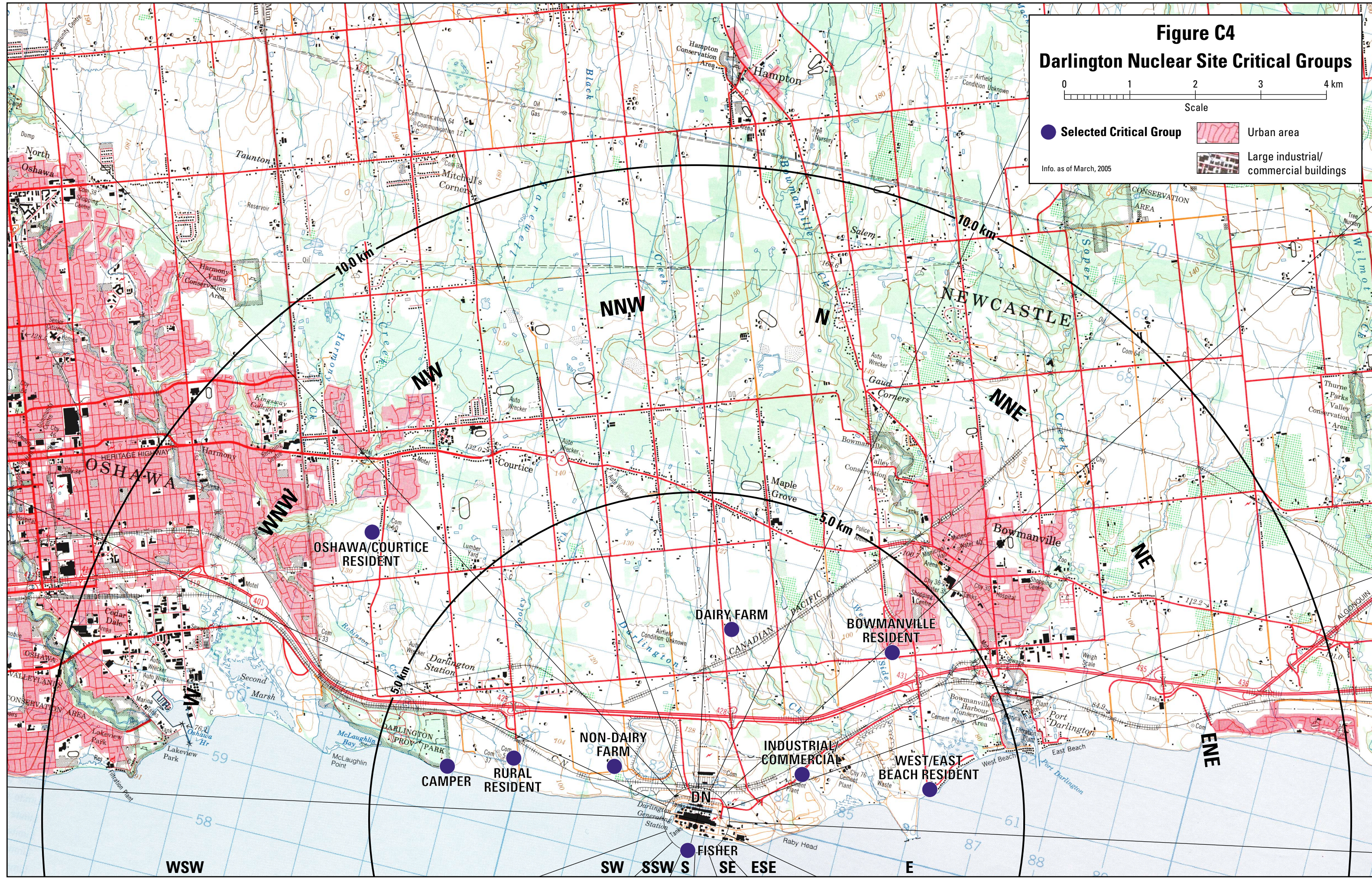
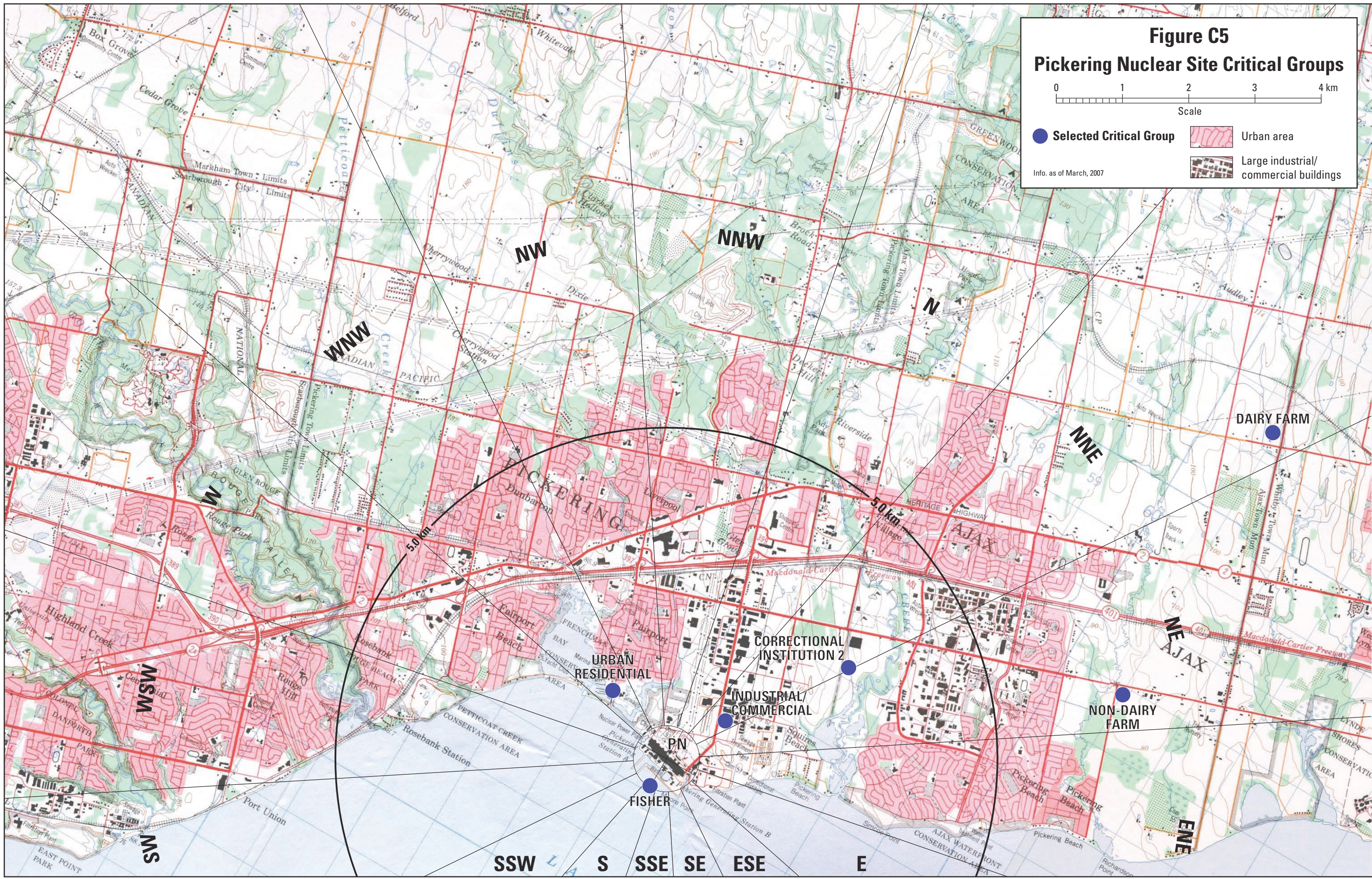
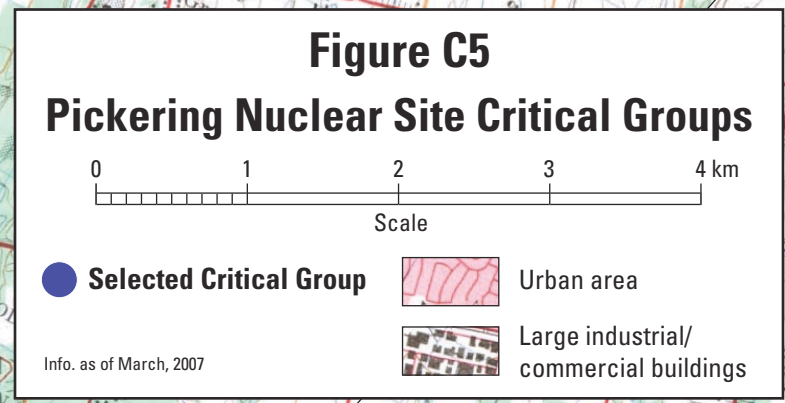


Figure C4
Darlington Nuclear Site Critical Groups



- Selected Critical Group
 - Urban area
 - Large industrial/commercial buildings
- Info. as of March, 2005





Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 79 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Appendix D: Environmental Monitoring Data

Table D1.1 Darlington Nuclear Site TLD External Gamma Measurements - 2006

Site Description	Annual Average Dose Rate in Air (nGy/h)	Annual Dose in Air (μGy/a)
INDICATOR SITES:		
D1 - Southeast Fence	49.5	434
D2 - East Fence	49.4	433
D3 - Maple Grove Road.	51.5	451
D4 - Park Road	47.0	412
D5 - Knight Road	46.7	409
D6 - Provincial Park	52.2	457
Average	49.4	433
AREA SITES:		
D7 - Oshawa Wilson TS	51.0	447
D8 - Bowmanville TS	51.0	447

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 80 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D1.2 Pickering Nuclear Site TLD External Gamma Measurements - 2006

Site Description	Annual Average Dose Rate in Air (nGy/h)	Annual Dose in Air (μGy/a)
INDICATOR SITES:		
P2 - Montgomery Park Road	46.3	406
P3 - Sandy Beach Road	45.3	397
P4 - Liverpool Road	47.2	414
P6 - East Boundary	48.0	421
P7 - Central Maintenance West	42.8	375
P8 - Frenchman's Bay	41.8	366
P9 – Petticoat Creek	49.0	430
P10 – Central Maintenance – East	38.8	340
P11 - Alex Robertson Park	52.5	459
Average	45.8	401
CRITICAL GROUP LOCATIONS:		
R125 ^a	57.6	505
C2	55.2	483

^a Property vacated due to expansion of the water pollution control plant. Average based on three quarters.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 81 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D1.3 Provincial Background Sites TLD Gamma Measurements - 2006

Site Description	Annual Average Dose Rate in Air (nGy/h)	Annual Dose in Air (μGy/a)
Bancroft	57.1	500
Belleville	56.3	493
Kapuskasing	52.5 ^a	460
Windsor	44.9	393
Niagara Falls	39.1	343
North Bay	53.5	468
Barrie	54.4	476
Ottawa	44.4	389
Parry Sound	39.0 ^b	342
Sudbury	51.4	450
Thunder Bay	64.8	568
Lakefield	61.8	541
Average ^c	49.4	433

^a Annual average based on three quarters because the dosimeter was not returned in the fourth quarter.

^b Annual average based on two quarters because the dosimeter was not returned in the second and third quarters.

^c Bancroft, Thunder Bay and Kapuskasing are excluded from the average due to historically higher than normal levels of natural radioactivity that are inappropriate to be used in comparison with nuclear facility results [R-31].

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 82 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

**Table D1.4 Darlington Nuclear Site -
Noble Gas, Skyshine and ¹³¹I Dose in Air - 2006**

Site Description	Total Measured Dose in Air (nGy) ^{a b}				
	¹³³ Xe	¹³⁵ Xe	⁴¹ Ar	Ir-192 Skyshine	¹³¹ I ^c
INDICATOR SITES:					
D1 - Southeast Fence	< 4	< 8	< 31	< 28	< 17
D2 - East Fence	< 4	12	40	< 27	22
D3 - Maple Grove Road	< 5	< 10	< 37	< 29	21
D4 - Park Road	< 4	< 9	< 36	< 29	< 18
D5 - Knight Road	< 4	< 9	< 35	< 31	< 18
D6 - Provincial Park	< 5	< 10	< 39	< 32	< 19
Average	<4	<9	<36	<29	<18

^a “<” indicates less than the critical level, Lc.

^b Bolded values are greater than Lc but less than Ld.

^c In this context, dose means the air immersion effective dose from gamma radiation.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 83 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

**Table D1.5 Pickering Nuclear Site -
Noble Gas, Skyshine and ¹³¹I Dose in Air - 2006**

Site Description	Total Measured Dose in Air (nGy) ^{a b}				
	¹³³ Xe	¹³⁵ Xe	⁴¹ Ar	Ir-192 Skyshine	¹³¹ I ^c
INDICATOR SITES:					
P2 - Montgomery Park Road	81	49	2547	< 30	< 19
P3 - Sandy Beach Road	27	13	964	< 28	< 18
P4 - Liverpool Road	13	12	550	< 29	< 17
P6 - East Boundary	26	26	1055	< 26	28
P7 - Central Maintenance - West	44	22	1732	< 27	< 16
P8 - Frenchman's Bay	11	< 7	482	< 24	< 12
P9 - Petticoat Creek	13	< 10	325	< 31	< 20
P10 - Central Maintenance -East	96	31	3149	< 24	< 15
P11 - Alex Robertson Park	20	13	791	< 30	< 19
Average	37	18	1288	<28	<17

^a “<” indicates less than the critical level, Lc.

^b Bolded values are greater than Lc but less than Ld.

^c In this context, dose means the air immersion effective dose from gamma radiation.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 84 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D2.1 Darlington Nuclear Site Tritium-in-Air Concentrations – 2006

Site Description	Molecular Sieve Tritium-in-Air (Bq/m ³)	Passive Sampler Tritium-in-Air (Bq/m ³) ^a
INDICATOR SITES:		
D1 - Southeast Fence	1.3	3.3
D2 - East Fence	1.1 ^b	2.7
D3 - Maple Grove Road	0.6	NR
D4 - Park Road	0.4	NR
D5 - Knight Road	0.4 ^c	NR
D6 - Provincial Park	0.3	0.5
Average	0.7	-
AREA SITES:		
D7 - Oshawa	0.2	NR
D8 - Bowmanville	0.5	NR
CRITICAL GROUP LOCATIONS:		
R2	NR	0.4
R27	NR	0.5
R275	NR	0.7
F1	NR	0.8
R329	NR	0.9
DF3/DF10	NR	0.4
DF5	NR	0.3
DF7	NR	0.3
DF8	NR	0.5
DF9	NR	0.6

NR = Not Required by the program.

^a All annual averages based on three quarters due to a problem in the laboratory resulting in the loss of second quarter results.

^b Annual average based on ten monthly samples due to a pump failure in January and a flowmeter malfunction in May.

^c Annual average based on eleven monthly samples due to a pump malfunction in September.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 85 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D2.2 Darlington Nuclear Site ¹⁴C-in-Air Concentrations – 2006

Site Description	Molecular Sieve ¹⁴ C-in-Air (Bq/kg-C) ^a	Passive Sampler ¹⁴ C-in-Air (Bq/kg-C)
INDICATOR SITES		
D1 - Southeast Fence	272	275
D2 - East Fence	273	255
D6 - Provincial Park	252	235
Average	266	-
CRITICAL GROUP LOCATIONS		
R2	NR	235
R27	NR	245
R275	NR	250
F1	NR	242
R329	NR	239
DF3/DF10	NR	245
DF5	NR	223
DF7	NR	240
DF8	NR	244
DF9	NR	229

NR = Not Required by the program.

^a Bq/Kg-C (Bq per Kg of carbon).

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 86 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D2.3 Pickering Nuclear Site Tritium-in-Air Concentrations – 2006

Site Description	Molecular Sieve Tritium-in-Air (Bq/m ³)	Passive Sampler Tritium-in-Air (Bq/m ³) ^a
INDICATOR SITES		
P2 - Montgomery Park Road	16.7	31.2
P3 - Sandy Beach Road	3.2	NR
P4 - Liverpool Road	1.3	NR
P6 - East Boundary	5.5 ^b	11.7
P7 - Central Maintenance – West	7.4	NR
P8 - Frenchman's Bay	2.0	NR
P9 - Petticoat Creek	1.9 ^c	NR
P10 - Central Maintenance – East	14.5	30.0
P11 - Alex Robertson Park	3.2 ^d	NR
Average	6.2	-
AREA SITES		
Ajax Hospital	1.1	NR
Heath Physics Lab (HPL)	1.4	NR
CRITICAL GROUP LOCATIONS		
R125	NR	3.0 ^e
DF1	NR	0.4
DF8	NR	1.4
DF11	NR	2.1
C2	NR	7.8
F31	NR	0.9
R145	NR	1.9

NR = Not Required by the program.

^a All annual averages based on three quarters due to a problem in the laboratory resulting in the loss of second quarter results.

^b Annual average based on ten monthly samples due to insufficient sample collection necessary for analysis in February and a pump failure in November.

^c Annual average based on ten monthly samples due to a power failure in October and November.

^d Annual average based on ten monthly samples due to a suspected leak in the monitoring system.

^e Property vacated after the third quarter. Annual average based on first and third quarters. Second quarter not available as indicated in note a above.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 87 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D2.4 Pickering Nuclear Site ¹⁴C-in-Air Concentrations – 2006

Air Monitoring Sites	Molecular Sieve ¹⁴ C-in-Air (Bq/kg-C)	Passive Sampler ¹⁴ C-in-Air (Bq/kg-C)
INDICATOR SITES		
P2 - Montgomery Park Road	1125	1189
P6 - East Boundary	570 ^a	500
P10 - Central Maintenance – East	819	828
Average	838	-
CRITICAL GROUP LOCATIONS		
R125	NR	341 ^b
DF1	NR	240
DF8	NR	264
DF11	NR	269
C2	NR	446
F31	NR	250
R145	NR	300

NR = Not Required by the program.

^a Annual average based on eleven monthly samples due to insufficient sample collection necessary for analysis.

^b Property vacated after the third quarter. No result is available for fourth quarter.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 88 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D2.5 Provincial Background Sites Tritium-in-Air Concentrations – 2006

Site Description	Molecular Sieve Tritium-in-Air (Bq/m ³) ^a	Passive Sampler Tritium-in-Air (Bq/m ³) ^{bc}
Lambton	< 0.2 ^d	< 0.2
Nanticoke	< 0.1	NR
Lakefield	NR	< 0.2
Bancroft	NR	< 0.2
Barrie	NR	< 0.2
Belleville	NR	< 0.2
Picton	NR	< 0.2
Average	< 0.2	< 0.2

NR = Not Required by the program.

^a Lc in Bq/m³ determined from tritium activity in water (Lc of 0.02 Bq/g-water) and the average humidity for the site.

^b Ld for passive airborne tritium is 0.3 Bq/m³ and Lc is 0.2 Bq/m³.

^c All annual averages based on three quarters due to a problem in the laboratory resulting in the loss of second quarter results.

^d Annual average based on eleven monthly samples due to column saturation resulting in unrepresentative result for August.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 89 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D2.6 Provincial Background Sites ¹⁴C-in-Air Concentrations – 2006

Site Description	Molecular Sieve ¹⁴ C-in-Air (Bq/kg-C)	Passive Sampler ¹⁴ C-in-Air (Bq/kg-C)
Lambton	254 ^a	230
Nanticoke	252 ^b	NR
Lakefield	NR	231
Bancroft	NR	231
Barrie	NR	235
Belleville	NR	233
Picton	NR	227
Average	253	231

NR = Not Required by the program.

^a Annual average based on eleven monthly samples due to a rotameter failure.

^b Annual average based on eleven monthly samples because the wrong molecular sieve was sent back for analysis.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 90 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D3.1 Darlington Nuclear Site Tritium in Precipitation and Gross Beta in Wet/Dry Fallout - 2006

Site Description	Average Tritium Concentration in Precipitation (Bq/L)	Average Gross Beta Deposition Rate (Bq/(m ² ·month))
INDICATOR SITES:		
D1 – Southeast Fence	42	15.8
D2 – East Fence	45	24.1
D3 - Maple Grove Road	19	28.4
D4 - Park Road	18	29.0
D5 - Knight Road	31	16.9
D6 - Provincial Park	14	23.9
Average	28	23.0
AREA SITES:		
D7 - Oshawa-Bond St. TS	9	20.8
D8 - Bowmanville TS	12	24.2
CRITICAL GROUP LOCATIONS:		
R2	24	NR
R29	17	NR
R47	15	NR
R65	27 ^a	NR
R275	24	NR
F1	52	NR
R329	14	NR
F15	13	NR
DF3/DF10	7	NR
DF5	10	NR
DF7	6 ^b	NR
DF8	7	NR
DF9	5	NR

NR= Not Required by the program.

^a Samples from January to March since R65 is no longer a participant.

^b Sample was not available in April due to damage to the rain gauge.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 91 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D3.2 Pickering Nuclear Site Tritium in Precipitation and Gross Beta in Wet/Dry Fallout - 2006

Sites	Average Tritium Concentration in Precipitation (Bq/L)	Average Gross Beta Deposition Rate (Bq/(m ² ·month))
INDICATOR SITES:		
P2 - Montgomery Park Road	493	22.1
P3 - Sandy Beach Road	154	16.9
P4 - Liverpool Road	141	18.0
P6 - East Boundary	194	17.8
P7 - Central Maintenance - West	245	17.3
P8 - Frenchman's Bay	178	20.2
P9 - Petticoat Creek	179	20.5
P10 - Central Maintenance	457	16.6
P11 - Alex Robertson Park	121	15.7
Average	240	18.3
CRITICAL GROUP LOCATIONS::		
R122	98 ^a	NR
R143	22	NR
DF8	27	NR
F10	20	NR
F25	18	NR
F31	22	NR

NR= Not Required by the program.

^a Property vacated in May. Average is based on January to April results.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 92 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D3.3 Background Tritium in Precipitation - 2006

Background Sites	Average Tritium Concentration in Precipitation (Bq/L) ^a
Calgary, Alberta	< 1.9 ^b
Saskatoon, Saskatchewan	< 1.9 ^b
Fredericton, New Brunswick	2.0
Average	< 1.9

Table D4.1 Darlington Nuclear Site: Milk - Tritium, ¹³¹I, and ¹⁴C Annual Average Concentrations - 2006

Site Description	Distance and Direction from Station (km)	Tritium ^c (Bq/L)	¹³¹ I ^d (Bq/L)	¹⁴ C (Bq/kg-C)
DF3/DF10	11 km NW	6.0 ^e	-	235 ^e
DF5	3 km N	6.7	-	249
DF7	9 km NNE	4.0	-	240
DF8	10 km NW	7.4	-	238
DF9	13 km ENE	5.0	-	239
Average		5.8	< 0.11 ^f	240

^a Ld for tritium = 3.7 Bq/L and Lc = 1.9 Bq/L

^b Annual average based on eleven months due to insufficient rainfall.

^c Weekly samples are used to form monthly composite samples at each farm for tritium oxide and C-14 analyses.

^d For I-131 "<" indicates less than the detection limit, Ld.

^e Annual average is based on one month (January) from DF3 and ten months from DF10.

^f Weekly samples from all farms are combined to form a weekly composite for I-131 analysis. The annual average I-131 concentration is presented in the table.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 93 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

**Table D4.2 Pickering Nuclear Site: Milk - Tritium ¹³¹I, ¹⁴C and OBT
Annual Average Concentrations - 2006**

Site Description	Distance and Direction from Station (km)	Tritium ^a (Bq/L)	¹³¹ I ^b (Bq/L)	¹⁴ C ^a (Bq/kg-C)	OBT (w.e. Bq/L)
DF1	12 km WNW	18.0	-	245	NR
DF8	10 km NNE	28.0	-	250	35
DF11	10 km NE	27.3	-	242	NR
Average		24.4	< 0.10 ^c	246	-

**Table D4.3 Provincial Background Sites: Milk - Tritium, ¹³¹I, and ¹⁴C
Annual Average Concentrations - 2006**

Site Description	Tritium (Bq/L)	¹³¹ I (Bq/L) ^b	¹⁴ C (Bq/kg-C)
Belleville	< 1.9	-	234
London	< 1.9	-	231
Average	< 1.9	< 0.11	232

^a Weekly samples are used to form monthly composite samples at each farm for tritium and carbon-14 analyses.

^b For I-131 “<” indicates less than the detection limit, Ld.

^c Weekly samples from all farms are combined to form a weekly composite for I-131 analysis. The annual average I-131 concentration is presented in the table.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 94 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D5.1 Darlington Nuclear Site - Drinking and Lake Water Tritium and Gross Beta Activity Concentrations- 2006

Drinking Water Supply Plants	Annual Average Tritium Concentration (Bq/L)	Annual Average Gross Beta Activity Concentration (Bq/L) ^a
Bowmanville WSP	6.0	0.11
Newcastle WSP	5.8	0.10
Oshawa WSP	7.1	0.11
Drinking Water Well Locations (Critical Group Locations)	Annual Average Tritium Concentration (Bq/L)	Annual Average Gross Beta Activity Concentration (Bq/L)
DF3	< 1.9	0.57
DF5	< 1.9	0.10
DF7	< 1.9	0.20
DF8	3.7	0.32
DF9	< 1.9	0.07
F1	< 1.9	0.05
R329	11.5	1.46 ^c
F15	5.9 ^b	0.17
R2	21.6	2.66 ^c
R29	< 1.9	0.07
R47	10.5	0.09
R279	< 1.9	0.09
R294	12.7	0.07
R316	9.4	0.10
R320	11.6	0.06
Lake Water Locations	Annual Average Tritium Concentration (Bq/L)	Annual Average Gross Beta Activity Concentration (Bq/L)
Darlington Provincial Park	9.0	0.13
McLaughlin Bay	24.2	0.22
St. Mary's Cement	5.9	0.12

^a Ld for gross beta = 0.05 Bq/L and Lc = 0.03 Bq/L

^b Annual average based on eleven monthly samples due to a missing sample in December.

^c High gross beta activity due to presence of naturally occurring K-40 (confirmed through gamma spectroscopy).

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 95 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D5.2 Pickering Nuclear Site - Drinking and Lake Water Tritium and Gross Beta Activity Concentrations - 2006

Drinking Water Supply Plants	Annual Average Tritium Concentration (Bq/L)	Annual Average Gross Beta Activity Concentration (Bq/L)
Ajax	6.1	0.09
Scarborough Horgan	5.1	0.11
Toronto Harris ^a	5.1	0.11
Whitby	6.4	0.11
Drinking Water Well Locations (Critical Group Locations)	Annual Average Tritium Concentration (Bq/L)	Annual Average Gross Beta Activity Concentration (Bq/L)
R124 ^b	16.1	0.05
R122 ^c	11.3	0.69
R125 ^b	114.7	0.10
R115 ^b	39.8	0.09
R11a (March – November)	78.0	0.19
R11b (March – November)	71.6	0.15
F10	13.4	NR
DF8	15.3	NR
F25	< 1.9	NR
R143	19.5	NR
F31	17.4	NR
Lake Water Locations	Annual Average Tritium Concentration (Bq/L)	Annual Average Gross Beta Activity Concentration (Bq/L)
Frenchman's Bay	29.8	NR
Beachpoint Promenade	19.6	NR
Squire's Beach	31.1	NR

NR = Not Required by the program.

^a No samples were available at Harris WSP for two weeks in December due to a maintenance outage.

^b Property vacated in July. Average based on samples taken from January to July.

^c Property vacated in April. Average based on samples taken from January to April.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 96 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

**Table D5.3 Provincial Background Sites - Drinking Water
Tritium and Gross Beta Activity Concentrations – 2006**

Locations	Water Source	Annual Average Tritium Concentration (Bq/L) ^a	Annual Average Gross Beta Activity Concentration (Bq/L) ^b
Bancroft	Clarke Lake	< 1.9	0.04
Belleville	Bay of Quinte	2.6	0.07
Brockville	Lake Ontario	3.9	0.11
Burlington	Lake Ontario	3.3	0.11
Cobourg	Lake Ontario	4.8	0.11
Goderich	Lake Huron	4.5	0.19
Kingston	Lake Ontario	3.6	0.10
London	Lake Huron	2.5	0.07
Niagara Falls	Niagara River	2.7	0.11
North Bay	Trout Lake	< 1.9	0.07
Orangeville	Well Water	< 1.9	0.07
Parry Sound	Georgian Bay	2.0	0.07
Sarnia	Lake Huron	4.0	0.08
St. Catharines	Lake Moodie/Gibson	2.9	0.09
Sudbury	Ramsay Lake	2.9	0.04
Thunder Bay	Lake Superior	< 1.9	0.05
Windsor	Lake St. Clair	4.6	0.09

^a Ld for tritium = 3.7 Bq/L and Lc = 1.9 Bq/L

^b Ld for gross beta = 0.05 Bq/L and Lc = 0.03 Bq/L

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 97 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D6.1 Darlington Nuclear Site - Area Lake Ontario Sediment - 2006

Site Description	Sample Type	¹⁴ C Composites (Bq/kg-C ± 2σ)	Gamma Analysis Bq/kg ± 2σ (dry weight)			
			¹³⁷ Cs	¹³⁴ Cs	⁶⁰ Co	⁴⁰ K
Darlington Provincial Park	-A	61 ± 24	< 0.7	< 0.6	< 0.7	294 ± 14
	-B		< 0.4	< 0.4	< 0.4	284 ± 6
	-C		0.4 ± 0.1	< 0.4	< 0.3	286 ± 16
	-D		< 0.5	< 0.6	< 0.7	275 ± 9
Port Darlington	-A	130 ± 27	< 0.4	< 0.4	< 0.5	341 ± 15
	-B		< 0.4	< 0.4	< 0.5	344 ± 15
	-C		< 0.3	< 0.3	< 0.3	351 ± 7
	-D		< 0.3	< 0.3	< 0.3	343 ± 6
Diffuser	-A	107 ± 26 ^a	< 0.3	< 0.3	< 0.3	289 ± 6
	-B		< 0.2	< 0.3	< 0.3	308 ± 6
	-C		< 0.5	< 0.4	< 0.5	287 ± 17
	-D		< 0.2	< 0.3	< 0.3	294 ± 6

^a The total organic carbon content of the DN diffuser composite sediment sample was determined to be 5,400 ppm.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 98 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D6.2 Pickering Nuclear Site - Area Lake Ontario Sediment - 2006

Site Description		Sample Type	¹⁴ C Composites (Bq/kg-C ± 2σ)	Gamma Analysis (dry weight) (Bq/kg ± 2σ)			
				¹³⁷ Cs	¹³⁴ Cs	⁶⁰ Co	⁴⁰ K
"A" Discharge	-A	Sediment	269 ± 31 ^a	2.8 ± 0.2	< 0.2	< 0.3	350 ± 6
	-B	Sediment		2.7 ± 0.3	< 0.3	< 0.3	339 ± 7
	-C	Sediment		2.9 ± 0.3	< 0.3	< 0.3	355 ± 6
	-D	Sediment		2.9 ± 0.3	< 0.3	< 0.3	339 ± 7
"B" Discharge	-A	Sediment	148 ± 28 ^b	2.3 ± 0.3	< 0.3	< 0.3	407 ± 7
	-B	Sediment		2.2 ± 0.2	< 0.3	< 0.3	423 ± 7
	-C	Sediment		1.9 ± 0.4	< 0.4	< 0.5	393 ± 16
	-D	Sediment		2.3 ± 0.3	< 0.3	< 0.3	410 ± 7
Liverpool Road Beach	-A	Sediment	120 ± 26	0.9 ± 0.1	< 0.3	< 0.3	346 ± 6
	-B	Sediment		0.7 ± 0.2	< 0.3	< 0.3	312 ± 6
	-C	Sediment		0.7 ± 0.3	< 0.4	< 0.5	293 ± 14
	-D	Sediment		0.8 ± 0.2	< 0.3	< 0.3	321 ± 7
Duffin's Creek	-A	Sediment	155 ± 28	1.0 ± 0.4	< 0.4	< 0.5	355 ± 15
	-B	Sediment		0.8 ± 0.1	< 0.3	< 0.3	363 ± 6
	-C	Sediment		0.9 ± 0.2	< 0.3	< 0.3	353 ± 11
	-D	Sediment		0.9 ± 0.2	< 0.3	< 0.3	344 ± 7

^a The total organic carbon content of the Pickering A composite sediment samples was 5,100 ppm.

^b The total organic carbon content of Pickering B composite sediment samples was 6,500 ppm.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 99 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D6.3 Provincial Background - Lake Sediment – 2006

Site Description		Sample Type	¹⁴ C Composites (Bq/kg-C±2σ)	Gamma Analysis (dry weight) (Bq/kg ± 2σ)			
				¹³⁷ Cs	¹³⁴ Cs	⁶⁰ Co	⁴⁰ K
Cobourg	-A	Sediment	141 ± 28 ^a	0.7 ± 0.2	< 0.3	< 0.3	360 ± 6
	-B	Sediment		0.8 ± 0.2	< 0.3	< 0.3	342 ± 7
	-C	Sediment		0.8 ± 0.2	< 0.3	< 0.3	349 ± 7
	-D	Sediment		0.6 ± 0.1	< 0.3	< 0.3	356 ± 6
Goderich	-A	Sediment	31 ± 24 ^b	< 0.3	< 0.3	< 0.3	153 ± 5
	-B	Sediment		< 0.4	< 0.3	< 0.4	171 ± 10
	-C	Sediment		0.4 ± 0.1	< 0.2	< 0.2	215 ± 5
	-D	Sediment		< 0.4	< 0.3	< 0.4	198 ± 11
Grand Bend	-A	Sediment	NR	0.6 ± 0.2	< 0.3	< 0.4	231 ± 12
	-B	Sediment		0.5 ± 0.2	< 0.3	< 0.3	205 ± 30
	-C	Sediment		< 0.4	< 0.3	< 0.4	251 ± 13
	-D	Sediment		0.5 ± 0.2	< 0.2	< 0.3	254 ± 5
Marie Curtis Park	-A	Sediment	NR	< 0.3	< 0.3	< 0.3	392 ± 7
	-B	Sediment		< 0.2	< 0.3	< 0.3	386 ± 7
	-C	Sediment		0.3 ± 0.1	< 0.3	< 0.3	382 ± 7
	-D	Sediment		< 0.5	< 0.4	< 0.5	388 ± 16

NR - Not required by the program.

^a The total organic carbon content of the Cobourg composite sediment samples was 2,800 ppm.

^b The total organic carbon content of the Goderich composite sediment samples was 59,500 ppm.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 100 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D6.4 Beach Sand/Silt – 2006

Site	Site Description	Sample Type	Gamma Analysis (dry weight) (Bq/kg $\pm 2\sigma$)			
			¹³⁷ Cs	¹³⁴ Cs	⁶⁰ Co	⁴⁰ K
Darlington	Darlington Provincial Park	Beach Sand	< 0.5	< 0.5	< 0.5	365 $\pm$ 16
	Darlington Provincial Park	Beach Sand	< 0.3	< 0.3	< 0.3	356 $\pm$ 17
Pickering	Beach Point Promenade	Beach Sand	0.9 $\pm$ 0.2	< 0.3	< 0.3	322 $\pm$ 6
	Squires Beach	Beach Sand	0.5 $\pm$ 0.2	< 0.3	< 0.3	320 $\pm$ 6
	Liverpool Road Beach	Beach Sand	0.5 $\pm$ 0.2	< 0.3	< 0.4	285 $\pm$ 17
Provincial	Cobourg - A	Beach Sand	0.5 $\pm$ 0.1	< 0.3	< 0.3	246 $\pm$ 5
	- B	Beach Sand	0.4 $\pm$ 0.1	< 0.3	< 0.3	235 $\pm$ 6
	Goderich - A	Beach Sand	0.4 $\pm$ 0.2	< 0.2	< 0.3	258 $\pm$ 5
	- B	Beach Sand	< 0.4	< 0.3	< 0.4	232 $\pm$ 12

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 101 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D6.5 Darlington Nuclear Site - Area Lake Ontario Fish – 2006

Site Description	Fish Type Composites		Tritium (TFWT) (Bq/L $\pm 2\sigma$)	^{14}C (Bq/kg-C $\pm 2\sigma$)	Gamma (wet weight) (Bq/kg $\pm 2\sigma$)				OBT Composites (Bq/L (w.e.) $\pm 2\sigma$)
					^{137}Cs	^{134}Cs	^{60}Co	^{40}K	
Darlington Diffuser	White Sucker	-A	5.8 $\pm$ 2.6	250 $\pm$ 20	< 0.1	< 0.1	< 0.1	141 $\pm$ 3	44 $\pm$ 4
		-B	6.5 $\pm$ 2.7	249 $\pm$ 20	0.2 $\pm$ 0.1	< 0.1	< 0.2	142 $\pm$ 4	
		-C	5.5 $\pm$ 2.6	231 $\pm$ 19	< 0.2	< 0.2	< 0.3	121 $\pm$ 4	
		-D	4.0 $\pm$ 2.5	232 $\pm$ 20	0.2 $\pm$ 0.1	< 0.2	< 0.3	123 $\pm$ 8	
		-E	5.3 $\pm$ 2.6	246 $\pm$ 20	0.2 $\pm$ 0.1	< 0.1	< 0.2	130 $\pm$ 4	
		-F	6.1 $\pm$ 2.6	225 $\pm$ 19	0.1 $\pm$ 0.1	< 0.1	< 0.1	134 $\pm$ 3	
		-G	5.2 $\pm$ 2.6	227 $\pm$ 19	0.1 $\pm$ 0.1	< 0.1	< 0.1	131 $\pm$ 3	
		-H	7.2 $\pm$ 2.7	228 $\pm$ 19	0.1 $\pm$ 0.1	< 0.1	< 0.1	129 $\pm$ 3	
Darlington Diffuser	Round Whitefish	-A	6.9 $\pm$ 2.7	251 $\pm$ 19	0.2 $\pm$ 0.1	< 0.1	< 0.1	151 $\pm$ 3	22 $\pm$ 4
		-B	7.4 $\pm$ 2.7	244 $\pm$ 19	0.3 $\pm$ 0.2	< 0.2	< 0.3	137 $\pm$ 6	
		-C	7.0 $\pm$ 2.7	257 $\pm$ 20	0.2 $\pm$ 0.1	< 0.1	< 0.2	155 $\pm$ 4	
		-D	7.2 $\pm$ 2.7	241 $\pm$ 20	< 0.3	< 0.2	< 0.3	144 $\pm$ 5	
		-E	5.6 $\pm$ 2.6	241 $\pm$ 19	0.2 $\pm$ 0.1	< 0.1	< 0.2	150 $\pm$ 4	
		-F	13 $\pm$ 3	251 $\pm$ 20	0.3 $\pm$ 0.2	< 0.2	< 0.3	144 $\pm$ 6	
		-G	18 $\pm$ 3	234 $\pm$ 19	0.2 $\pm$ 0.1	< 0.1	< 0.1	149 $\pm$ 3	
		-H	19 $\pm$ 3	241 $\pm$ 19	0.3 $\pm$ 0.1	< 0.2	< 0.3	136 $\pm$ 5	
Average			8.1	241	0.2	<0.1	<0.2	139	33
McLaughlin Bay	Assorted Pan Fish	-A	21 $\pm$ 3	237 $\pm$ 20	< 0.1	< 0.1	< 0.1	120 $\pm$ 3	26 $\pm$ 4
		-B	25 $\pm$ 4	238 $\pm$ 21	< 0.1	< 0.1	< 0.2	126 $\pm$ 3	
		-C	24 $\pm$ 4	244 $\pm$ 21	< 0.2	< 0.2	< 0.2	109 $\pm$ 4	
		-D	23 $\pm$ 4	245 $\pm$ 21	< 0.2	< 0.2	< 0.3	96 $\pm$ 11	
Average			23	241	<0.2	<0.2	<0.2	113	-

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 102 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D6.6 Pickering Nuclear Site - Area Lake Ontario Fish – 2006

Site Description	Fish Type Composites	Tritium (TFWT) (Bq/L $\pm 2\sigma$)	¹⁴ C (Bq/kg-C $\pm 2\sigma$)	Gamma (wet weight) (Bq/kg $\pm 2\sigma$)				OBT Composites (Bq/L (w.e.) $\pm 2\sigma$)	
				¹³⁷ Cs	¹³⁴ Cs	⁶⁰ Co	⁴⁰ K		
Pickering 5-8 Outfall	White Sucker	-A	4.0 $\pm$ 2.9	230 $\pm$ 19	0.1 $\pm$ 0.1	< 0.1	< 0.1	150 $\pm$ 3	25 $\pm$ 4
		-B	1.9 + 2.8	231 $\pm$ 19	0.2 $\pm$ 0.1	< 0.1	< 0.1	133 $\pm$ 3	
		-C	< 1.9	243 $\pm$ 20	0.1 $\pm$ 0.1	< 0.1	< 0.1	114 $\pm$ 3	
		-D	< 1.9	214 $\pm$ 19	< 0.2	< 0.2	< 0.3	123 $\pm$ 8	
		-E	2.3 + 2.9	235 $\pm$ 19	< 0.2	< 0.2	< 0.2	112 $\pm$ 7	
		-F	4.6 $\pm$ 3.0	249 $\pm$ 20	0.2 $\pm$ 0.1	< 0.1	< 0.1	137 $\pm$ 3	
		-G	< 1.9	212 $\pm$ 19	0.2 $\pm$ 0.1	< 0.1	< 0.1	123 $\pm$ 3	
		-H	3.6 $\pm$ 2.9	229 $\pm$ 19	0.3 $\pm$ 0.1	< 0.1	< 0.1	116 $\pm$ 2	
Pickering 5-8 Outfall	Round Whitefish	-A	26 $\pm$ 4	249 $\pm$ 19	0.3 $\pm$ 0.1	< 0.1	< 0.1	157 $\pm$ 3	36 $\pm$ 4
		-B	26 $\pm$ 9	247 $\pm$ 19	0.3 $\pm$ 0.1	< 0.1	< 0.2	152 $\pm$ 4	
		-C	20 $\pm$ 9	237 $\pm$ 19	0.4 $\pm$ 0.2	< 0.2	< 0.3	132 $\pm$ 5	
		-D	14 $\pm$ 8	246 $\pm$ 19	0.4 $\pm$ 0.1	< 0.1	< 0.1	135 $\pm$ 2	
		-E	20 $\pm$ 9	255 $\pm$ 20	0.3 $\pm$ 0.1	< 0.1	< 0.1	157 $\pm$ 3	
		-F	13 $\pm$ 8	259 $\pm$ 20	0.2 $\pm$ 0.1	< 0.1	< 0.2	150 $\pm$ 4	
		-G	15 $\pm$ 8	239 $\pm$ 20	0.3 $\pm$ 0.1	< 0.2	< 0.3	144 $\pm$ 6	
		-H	8.7 $\pm$ 7.1	235 $\pm$ 20	0.3 $\pm$ 0.1	< 0.1	< 0.1	127 $\pm$ 2	
Average		10.2	238	0.3	<0.1	<0.2	135	31	

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 103 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D6.7 Provincial Background - Fish - 2006

Site Description	Fish Type Composites	Tritium (TFWT) (Bq/L ± 2σ)	¹⁴ C (Bq/kg-C ± 2σ)	Gamma (wet weight) (Bq/kg ± 2σ)				OBT Composites (Bq/L (w.e) ± 2σ)	
				¹³⁷ Cs	¹³⁴ Cs	⁶⁰ Co	⁴⁰ K		
Lake Ontario-Far Field	White Sucker	-A	5.2 ± 2.6	227 ± 20	0.2 ± 0.1	< 0.2	< 0.2	126 ± 4	20 ± 4
		-B	5.7 ± 2.7	217 ± 19	0.2 ± 0.1	< 0.1	< 0.1	133 ± 3	
		-C	2.7 ± 2.5	236 ± 20	0.1 ± 0.1	< 0.1	< 0.1	122 ± 3	
		-D	3.3 ± 2.5	250 ± 20	0.4 ± 0.2	< 0.3	< 0.3	112 ± 6	
		-E	5.2 ± 2.6	245 ± 20	0.5 ± 0.1	< 0.1	< 0.1	128 ± 3	
		-F	6.4 ± 2.7	252 ± 20	0.3 ± 0.1	< 0.2	< 0.2	142 ± 4	
		-G	6.2 ± 2.7	242 ± 20	0.2 ± 0.1	< 0.2	< 0.2	140 ± 4	
		-H	4.8 ± 2.6	234 ± 20	0.3 ± 0.1	< 0.1	< 0.1	134 ± 3	
	White Fish	-A	3.9 ± 2.6	235 ± 20	0.3 ± 0.1	< 0.1	< 0.1	112 ± 2	16 ± 4
		-B	5.5 ± 2.7	292 ± 21	0.2 ± 0.1	< 0.1	< 0.1	126 ± 3	
		-C	3.7 ± 2.6	243 ± 19	0.3 ± 0.1	< 0.1	< 0.1	116 ± 3	
		-D	4.9 ± 2.7	234 ± 19	0.3 ± 0.1	< 0.1	< 0.1	108 ± 3	
		-E	3.7 ± 2.6	234 ± 19	0.3 ± 0.1	< 0.1	< 0.1	115 ± 3	
		-F	4.9 ± 2.7	231 ± 20	0.4 ± 0.1	< 0.1	< 0.1	117 ± 3	
		-G	6.5 ± 2.8	240 ± 20	0.2 ± 0.1	< 0.1	< 0.1	115 ± 2	
		-H	7.4 ± 2.8	241 ± 21	0.3 ± 0.1	< 0.1	< 0.1	120 ± 3	
Average		5.0	241	0.3	<0.1	<0.1	123	18	

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 104 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D6.7 Provincial Background - Fish – 2006-Continued

Site Description	Fish Type Composites	Tritium (TFWT) (Bq/L ± 2σ)	¹⁴ C (Bq/kg-C ± 2σ)	Gamma (wet weight) (Bq/kg ± 2σ)				OBT Composites (Bq/L (w.e) ± 2σ)	
				¹³⁷ Cs	¹³⁴ Cs	⁶⁰ Co	⁴⁰ K		
Lake Huron- Far Field	White Sucker	-A	3.1 ± 2.5	235 ± 20	< 0.3	< 0.2	< 0.3	109 ± 6	14 ± 3
		-B	3.8 ± 2.6	207 ± 19	0.3 ± 0.1	< 0.2	< 0.3	116 ± 6	
		-C	1.8 ± 2.4	210 ± 20	0.2 ± 0.1	< 0.2	< 0.2	124 ± 4	
		-D	4.8 ± 2.6	210 ± 19	0.2 ± 0.1	< 0.1	< 0.2	138 ± 3	
		-E	2.6 ± 2.5	225 ± 20	0.6 ± 0.1	< 0.2	< 0.2	142 ± 4	
		-F	6.0 ± 2.7	208 ± 19	0.5 ± 0.1	< 0.2	< 0.2	132 ± 4	
		-G	4.4 ± 2.6	230 ± 20	0.2 ± 0.1	< 0.1	< 0.1	132 ± 3	
		-H	4.4 ± 2.6	225 ± 20	0.2 ± 0.1	< 0.1	< 0.1	126 ± 3	
	Lake Whitefish	-A	3.5 ± 3.1	236 ± 20	0.3 ± 0.1	< 0.1	< 0.1	120 ± 3	17 ± 4
		-B	3.5 ± 3.1	221 ± 20	0.6 ± 0.1	< 0.1	< 0.1	120 ± 2	
		-C	5.8 ± 3.2	232 ± 20	0.5 ± 0.1	< 0.1	< 0.1	122 ± 3	
		-D	3.5 ± 3.1	255 ± 21	0.7 ± 0.1	< 0.1	< 0.2	132 ± 4	
		-E	3.4 ± 3.1	244 ± 20	0.8 ± 0.1	< 0.1	< 0.1	136 ± 3	
		-F	7.8 ± 3.3	231 ± 20	0.4 ± 0.1	< 0.1	< 0.1	129 ± 2	
		-G	3.9 ± 3.1	278 ± 23	0.9 ± 0.1	< 0.1	< 0.1	129 ± 3	
		-H	5.4 ± 3.2	234 ± 20	0.7 ± 0.1	< 0.1	< 0.1	136 ± 3	
Average		4.2	230	0.5	<0.1	<0.2	128	16	

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 105 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D7.1 Darlington Nuclear Site - Area Terrestrial Biota – 2006

Site Description	Sample Type Composite ^a	Tritium (TFWT) (Bq/L $\pm 2\sigma$)	¹⁴ C (Bq/kg-C $\pm 2\sigma$)
R2	Fruit	27 $\pm$ 4	228 $\pm$ 20
R85	Fruit	28 $\pm$ 9	249 $\pm$ 20
F1	Fruit	58 $\pm$ 12	249 $\pm$ 20
R122	Fruit	18 $\pm$ 8	233 $\pm$ 19
R17	Fruit	15 $\pm$ 8	234 $\pm$ 19
R24	Fruit	13 $\pm$ 7	229 $\pm$ 19
DF10	Fruit	15 $\pm$ 8	241 $\pm$ 20
R27	Fruit	26 $\pm$ 9	243 $\pm$ 20
R35	Fruit	12 $\pm$ 7	233 $\pm$ 19
R39	Fruit	19 $\pm$ 8	270 $\pm$ 21
F18	Fruit	11 $\pm$ 3	248 $\pm$ 20
R47	Fruit	23 $\pm$ 4	251 $\pm$ 20
R63	Fruit	12 $\pm$ 3	233 $\pm$ 19
DF7	Fruit	9.7 $\pm$ 2.9	219 $\pm$ 20
R65	Fruit	61 $\pm$ 5	282 $\pm$ 21
R228	Fruit	37 $\pm$ 4	238 $\pm$ 20
F26	Fruit	32 $\pm$ 4	229 $\pm$ 19
R275	Fruit	44 $\pm$ 4	252 $\pm$ 20
DF9	Fruit	12 $\pm$ 3	240 $\pm$ 20
R2	Vegetable	30 $\pm$ 4	223 $\pm$ 19
R77	Vegetable	11 $\pm$ 3	220 $\pm$ 19

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 106 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D7.1 Darlington Nuclear Site - Area Terrestrial Biota – 2006 (Continued)

Site Description	Sample Type Composite ^a	Tritium (TFWT) (Bq/L $\pm 2\sigma$)	¹⁴ C (Bq/kg-C $\pm 2\sigma$)
F1	Vegetable ^b	43 $\pm$ 4	239 $\pm$ 19
R130	Vegetable	11 $\pm$ 3	242 $\pm$ 20
R329	Vegetable	17 $\pm$ 3	232 $\pm$ 19
R165	Vegetable	13 $\pm$ 3	232 $\pm$ 20
DF2	Vegetable	7.8 $\pm$ 2.7	228 $\pm$ 20
F13	Vegetable ^c	12 $\pm$ 3	236 $\pm$ 20
F16	Vegetable	32 $\pm$ 4	221 $\pm$ 19
DF6	Vegetable	4.6 $\pm$ 2.7	227 $\pm$ 20
R47	Vegetable	26 $\pm$ 4	237 $\pm$ 19
R66	Vegetable	27 $\pm$ 4	246 $\pm$ 19
R228	Vegetable	22 $\pm$ 4	235 $\pm$ 19
F25	Vegetable	37 $\pm$ 4	239 $\pm$ 19
R275	Vegetable ^c	55 $\pm$ 5	227 $\pm$ 19
DF10	Silage	11 $\pm$ 3	255 $\pm$ 21
DF5	Corn	34 $\pm$ 4	245 $\pm$ 20
DF7	Silage	9.0 $\pm$ 3.2	234 $\pm$ 20
DF8	Silage	12 $\pm$ 3	255 $\pm$ 21
DF9	Corn	10.0 $\pm$ 3.2	239 $\pm$ 20
Average (Fruits, Vegetables, and Silage)		22.5	239

^a Composite vegetables are from the following categories: Above ground (e.g., cucumber, zucchini, tomato, beans and peppers); Below ground (e.g., onions, potato, beet and carrots); Leafy (e.g., chard, cabbage, parsley, sorrel, rhubarb and beet leaves). Two of the three types (i.e. above ground, below ground or leafy) are required to form a valid composite.

^b Leafy and below ground sample not available. Invalid composite sample and therefore the value is not included in the vegetation average.

^c Below ground sample not available.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 107 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D7.1 Darlington Nuclear Site - Area Terrestrial Biota – 2006 (Continued)

Site Description	Sample Type	Tritium (TFWT) (Bq/L $\pm$ 2 σ)	¹⁴ C (Bq/kg-C $\pm$ 2 σ)	Gamma (Bq/L $\pm$ 2 σ)
F27	Honey	27 $\pm$ 4	249 $\pm$ 21	¹³⁷ Cs: < 0.1 ¹³⁴ Cs: < 0.1 ⁴⁰ K: 22 $\pm$ 1
R326	Honey	52 $\pm$ 5	242 $\pm$ 20	¹³⁷ Cs: < 0.1 ¹³⁴ Cs: < 0.1 ⁴⁰ K: 12 $\pm$ 1
F24	Honey	55 $\pm$ 5	241 $\pm$ 20	¹³⁷ Cs: < 0.1 ¹³⁴ Cs: < 0.1 ⁴⁰ K: 9.9 $\pm$ 0.7
R328	Honey	81 $\pm$ 6	260 $\pm$ 21	¹³⁷ Cs: < 0.1 ¹³⁴ Cs: < 0.1 ⁴⁰ K: 10.0 $\pm$ 0.7
R327	Honey	28 $\pm$ 4	250 $\pm$ 21	¹³⁷ Cs: < 0.1 ¹³⁴ Cs: < 0.1 ⁴⁰ K: 16 $\pm$ 1
R32	Honey	43 $\pm$ 5	256 $\pm$ 21	¹³⁷ Cs: < 0.1 ¹³⁴ Cs: < 0.1 ⁴⁰ K: 13 $\pm$ 1

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 108 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D7.2 Pickering Nuclear Site - Area Terrestrial Biota - 2006

Site Description	Sample Type Composite ^a	Tritium (TFWT) (Bq/L $\pm 2\sigma$)	¹⁴ C (Bq/kg-C $\pm 2\sigma$)	OBT (Bq/L (w.e.) $\pm 2\sigma$)
L35	Fruit	124 $\pm$ 6	467 $\pm$ 25	NR
R152	Fruit	68 $\pm$ 5	319 $\pm$ 21	NR
F10	Fruit	22 $\pm$ 3	266 $\pm$ 20	NR
L7	Fruit	70 $\pm$ 5	457 $\pm$ 25	43 $\pm$ 4
L12	Fruit	45 $\pm$ 4	305 $\pm$ 21	NR
L10	Fruit	139 $\pm$ 7	468 $\pm$ 24	NR
L22 ^b	Fruit	95 $\pm$ 6	434 $\pm$ 23	144 $\pm$ 7
L29	Fruit	1194 $\pm$ 19	1671 $\pm$ 42	NR
F31	Fruit	36 $\pm$ 4	280 $\pm$ 20	NR

NR = Not Required by the program

^a Composite of fruits found at the target location. Typical fruits collected are: apples, pears, berries, chestnuts and grapes.

^b Site 29 value (previously Site 6 in 1992 assessment) is excluded from the calculation of the average, as it is considered on-site.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 109 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D7.2 Pickering Nuclear Site - Area Terrestrial Biota – 2006 (Continued)

Site Description	Sample Type Composite ^a	Tritium (TFWT) (Bq/L $\pm 2\sigma$)	¹⁴ C (Bq/kg-C $\pm 2\sigma$)	OBT (Bq/L (w.e.) $\pm 2\sigma$)
P9 – Petticoat Creek	Vegetable	82 $\pm$ 6	341 $\pm$ 24	NR
R144	Vegetable	83 $\pm$ 6	454 $\pm$ 25	NR
L16	Vegetable ^b	13 $\pm$ 3	242 $\pm$ 21	37 $\pm$ 4
DF1	Vegetable	18 $\pm$ 3	276 $\pm$ 22	NR
P11 – Alex Robertson Park	Vegetable	165 $\pm$ 7	753 $\pm$ 30	NR
F13	Vegetable ^c	16 $\pm$ 3	261 $\pm$ 20	NR
F40	Vegetable ^b	20 $\pm$ 3	243 $\pm$ 20	NR
R81	Vegetable ^c	52 $\pm$ 5	258 $\pm$ 20	NR
R84	Vegetable	55 $\pm$ 5	349 $\pm$ 22	NR
DF8 ^d	Vegetable	40 $\pm$ 4	342 $\pm$ 22	NR
F25	Vegetable	19 $\pm$ 3	270 $\pm$ 20	43 $\pm$ 5
P2 – Montgomery Park Rd.	Vegetable	695 $\pm$ 14	3229 $\pm$ 56	NR
F31	Vegetable	28 $\pm$ 4	255 $\pm$ 20	NR
F36	Vegetable	22 $\pm$ 4	233 $\pm$ 20	NR
R153	Vegetable	68 $\pm$ 5	349 $\pm$ 22	NR
DF8	Silage	56 $\pm$ 5	243 $\pm$ 21	NR
Average (Fruits, Vegetables and Silage)		91	482	77

NR = Not Required by the program.

^a Composite vegetables are from the following categories: Above ground (e.g., cucumber, zucchini, tomato, beans and peppers); Below ground (e.g., onions, potato, beet and carrots); Leafy (e.g., chard, cabbage, parsley, sorrel, rhubarb and beet leaves). Two of the three types (i.e. above ground, below ground or leafy) are required to form a valid composite.

^b Leafy and below ground sample are not available. Invalid composite sample and therefore the value is not included in vegetation average.

^c Below ground sample is not available.

^d Alternate site sampled.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 110 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D7.2 Pickering Nuclear Site - Area Terrestrial Biota – 2006 (Continued)

Location Number	Sample Type	Tritium (TFWT) (Bq/L $\pm 2\sigma$)	¹⁴ C (Bq/kg-C $\pm 2\sigma$)	OBT (Bq/L (w.e.) $\pm 2\sigma$)	Gamma (Bq/L $\pm 2\sigma$)
R148	Honey	31 $\pm$ 4	278 $\pm$ 22	NR	¹³⁷ Cs: < 0.1 ¹³⁴ Cs: < 0.1 ⁴⁰ K: 15 $\pm$ 1
R150	Honey	86 $\pm$ 6	268 $\pm$ 21	45 $\pm$ 4	¹³⁷ Cs: < 0.1 ¹³⁴ Cs: < 0.1 ⁴⁰ K: 12 $\pm$ 1
R154	Honey	70 $\pm$ 5	304 $\pm$ 22	NR	¹³⁷ Cs: < 0.1 ¹³⁴ Cs: < 0.1 ⁴⁰ K: 11 $\pm$ 1
F31	Honey	85 $\pm$ 6	271 $\pm$ 21	NR	¹³⁷ Cs: < 0.1 ¹³⁴ Cs: < 0.1 ⁴⁰ K: 13 $\pm$ 1

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 111 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D7.3 Provincial Background - Terrestrial Biota – 2006

Site Description	Sample Type Composite ^a	Tritium (TFWT) (Bq/L $\pm 2\sigma$)	¹⁴ C (Bq/kg-C $\pm 2\sigma$)	OBT (Bq/L (w.e.) $\pm 2\sigma$)
Lakefield	Vegetable	3.8 $\pm$ 2.6	224 $\pm$ 19	28 $\pm$ 4
Bancroft	Vegetable	2.4 $\pm$ 2.5	222 $\pm$ 19	27 $\pm$ 4
Barrie	Vegetable	2.6 $\pm$ 2.5	229 $\pm$ 19	36 $\pm$ 4
Picton	Vegetable ^b	2.7 $\pm$ 2.5	230 $\pm$ 19	28 $\pm$ 4
Sarnia	Vegetable ^c	1.9 $\pm$ 2.5	217 $\pm$ 19	25 $\pm$ 4
Average (Vegetables)		2.7	224	29

^a Composite vegetables are from the following categories: Above ground (e.g., cucumber, zucchini, tomato, beans and peppers); Below ground (e.g., onions, potato, beet and carrots); Leafy (e.g., chard, cabbage, parsley, sorrel, rhubarb and beet leaves). Two of the three types (i.e. above ground, below ground or leafy) are required to form a valid composite.

^b Leafy sample not available.

^c Below ground sample not available.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 112 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D7.4 Inland Soils and Garden Soils – 2006

Site	Site Description	Sample Type	Gamma Analysis (dry weight) (Bq/kg $\pm 2\sigma$)			
			¹³⁷ Cs	¹³⁴ Cs	⁶⁰ Co	⁴⁰ K
Darlington	F1	Soil (open area – not irrigated)	9.9 $\pm$ 1.0	< 0.7	< 0.8	596 $\pm$ 26
	F1	Garden Soil (irrigated – shallow well water)	5.6 $\pm$ 0.5	< 0.4	< 0.5	718 $\pm$ 11
	F16	Soil (open area – not irrigated)	5.9 $\pm$ 0.7	< 0.6	< 0.8	644 $\pm$ 24
	F16	Garden soil (irrigated – shallow well water)	8.2 $\pm$ 0.3	< 0.4	< 0.5	733 $\pm$ 11
	R2	Garden Soil (irrigated – deep well water)	6.2 $\pm$ 0.3	< 0.5	< 0.5	774 $\pm$ 11
	R316	Garden Soil (irrigated – deep well water)	7.8 $\pm$ 0.5	< 0.5	< 0.5	704 $\pm$ 12
Pickering	Squires Beach – Field	Soil (open area – not irrigated)	10.5 $\pm$ 0.5	< 0.4	< 0.5	802 $\pm$ 11
Provincial Background	Cobourg -A	Inland Soil	0.5 $\pm$ 0.3	< 0.4	< 0.4	491 $\pm$ 9
	-B	Inland Soil	< 0.6	< 0.5	< 0.6	449 $\pm$ 29
	Goderich-A	Inland Soil	1.4 $\pm$ 0.4	< 0.5	< 0.6	375 $\pm$ 18
	-B	Inland Soil	1.5 $\pm$ 0.3	< 0.4	< 0.4	373 $\pm$ 8
	Lakefield-A	Inland Soil	8.6 $\pm$ 0.6	< 0.5	< 0.5	769 $\pm$ 12
	-B	Inland Soil	8.5 $\pm$ 0.9	< 0.7	< 0.9	764 $\pm$ 35

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 113 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

**Table D8.1 Pickering Nuclear Site-Sewage Effluent
Gamma Scan Results-2006^{a b}**

Date	¹³¹ I (Bq/kg)	¹³⁷ Cs (Bq/kg)	¹³⁴ Cs (Bq/kg)	⁶⁰ Co (Bq/kg)	⁴⁰ K (Bq/kg)
January	< 0.3	< 0.3	< 0.3	< 0.2	7.3
February	< 0.3	0.5	< 0.3	< 0.3	7.7
March	< 0.3	< 0.3	< 0.3	1.0	13.3
April	< 0.3	0.7	< 0.3	< 0.2	6.7
May	< 0.3	< 0.3	< 0.3	< 0.3	3.8
June	< 0.3	0.4	< 0.3	0.3	5.4
July	< 0.3	< 0.3	< 0.3	< 0.3	8.2
August	0.5	< 0.3	< 0.3	< 0.3	5.3
September	< 0.3	0.4	< 0.3	< 0.3	4.7
October	< 0.3	< 0.3	< 0.3	< 0.3	4.2
November	< 0.3	< 0.3	< 0.3	< 0.3	5.6
December	< 0.3	< 0.3	< 0.3	< 0.3	5.6

^a < Indicates limit of Detection (Ld).

^b Monthly average of PN Site Sewage Effluent weekly sample results. The sewage stream is treated at the York Durham Water Pollution Control Plant.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 114 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table D8.2 Pickering Nuclear Site Sewage Effluent Tritium and ^{14}C Concentration Results - 2006

Sewage Effluent Sample ^a	^3H (Bq/L)	^{14}C (Bq/L) ^b
Quarter 1	820 ± 15	< 1
Quarter 2	559 ± 13	< 1
Quarter 3	636 ± 14	< 1
Quarter 4	526 ± 13	< 1

Table D8.3 York Durham Water Pollution Control Plant, Ash Gamma Scan Results - 2006 ^c

Month	^{131}I (Bq.Kg ⁻¹ ±2σ)	^{137}Cs ^d (Bq.Kg ⁻¹ ±2σ)	^{40}K (Bq.Kg ⁻¹ ±2σ)	^{60}Co (Bq.Kg ⁻¹ ±2σ)	^{134}Cs (Bq.Kg ⁻¹ ±2σ)
January	4.6 ± 0.3	< 0.4	189 ± 6	< 0.4	< 0.4
February	12.4 ± 0.6	< 0.4	269 ± 7	< 0.4	< 0.4
March	26.4 ± 1.2	< 0.4	343 ± 8	< 0.4	< 0.4
April	10.0 ± 0.4	< 0.3	230 ± 6	< 0.2	< 0.3
May	19.4 ± 0.4	< 0.3	231 ± 6	< 0.3	< 0.3
June	10.6 ± 0.5	< 0.4	212 ± 7	< 0.4	< 0.4
July	8.5 ± 0.5	0.6 ± 0.3	199 ± 7	< 0.4	< 0.4
August	7.2 ± 0.4	0.4 ± 0.2	257 ± 6	< 0.3	< 0.3
September	1.9 ± 0.3	< 0.4	190 ± 6	< 0.3	< 0.4
October	8.1 ± 0.4	< 0.4	203 ± 6	< 0.3	< 0.4
November	6.7 ± 0.3	< 0.5	226 ± 6	< 0.3	< 0.4
December	11.8 ± 0.6	0.6 ± 0.3	240 ± 7	< 0.4	< 0.4

^a Quarterly composite samples are prepared from weekly samples.

^b Ld for C-14 is 2 Bq/L and Lc for C-14 is 1 Bq/L.

^c The ash samples contain elevated concentrations of natural background and medical source radionuclides.

^d The low Cs-137 levels detected are believed to be from atmospheric testing of nuclear weapons from the 1960's.

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 115 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Appendix E: Tables of Public Doses by Radionuclide, Pathway and Age Group for Darlington Nuclear and Pickering Nuclear Critical Groups

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 116 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E1 – Darlington Farm Critical Group Doses for 2006

DN - FARM		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animals	Terrestrial plants	Aquatic animals	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
Adult	C-14	2.58E-13	3.33E-10	1.57E-14	3.24E-15	2.95E-08	6.67E-08	0.00E+00	3.15E-18	4.93E-16	7.88E-17	4.48E-12	9.65E-08
	Cs-137+	3.87E-13	1.95E-11	8.50E-09	9.06E-13	6.88E-10	1.79E-09	0.00E+00	0.00E+00	0.00E+00	1.52E-12	8.40E-12	1.10E-08
	HT	0.00E+00	1.28E-11	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	1.28E-11
	HTO	0.00E+00	3.60E-07	0.00E+00	2.10E-12	1.70E-08	6.94E-08	0.00E+00	0.00E+00	0.00E+00	1.02E-08	1.31E-07	5.87E-07
	Noble Gas	6.10E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.10E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.35E-08	1.30E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.65E-08
	I(mfp)	1.92E-11	2.52E-10	7.38E-11	1.15E-14	1.10E-09	6.48E-10	0.00E+00	0.00E+00	0.00E+00	1.29E-13	2.19E-12	2.10E-09
Total		6.10E-08	3.60E-07	8.58E-09	3.02E-12	7.18E-08	1.52E-07	0.00E+00	3.15E-18	4.93E-16	1.02E-08	1.31E-07	7.94E-07
15yr. Old	C-14	2.58E-13	3.26E-10	1.57E-14	3.18E-15	3.05E-08	4.78E-08	0.00E+00	3.15E-18	4.84E-16	7.88E-17	3.82E-12	7.86E-08
	Cs-137+	3.87E-13	1.69E-11	8.50E-09	9.06E-13	5.19E-10	1.34E-09	0.00E+00	0.00E+00	0.00E+00	1.52E-12	7.28E-12	1.04E-08
	HT	0.00E+00	1.16E-11	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	1.16E-11
	HTO	0.00E+00	3.26E-07	0.00E+00	2.10E-12	1.37E-08	5.08E-08	0.00E+00	0.00E+00	0.00E+00	8.94E-09	1.13E-07	5.12E-07
	Noble Gas	6.10E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.10E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.75E-08	1.00E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.75E-08
	I(mfp)	1.92E-11	3.53E-10	7.38E-11	1.79E-14	1.48E-09	7.47E-10	0.00E+00	0.00E+00	0.00E+00	1.29E-13	2.94E-12	2.68E-09
Total		6.10E-08	3.27E-07	8.58E-09	3.02E-12	6.36E-08	1.11E-07	0.00E+00	3.15E-18	4.84E-16	8.94E-09	1.13E-07	6.93E-07
10yr. Old	C-14	2.58E-13	3.44E-10	1.57E-14	8.93E-15	3.21E-08	5.02E-08	0.00E+00	3.15E-18	1.36E-15	7.88E-17	4.54E-12	8.27E-08
	Cs-137+	3.87E-13	1.08E-11	8.50E-09	1.39E-12	2.67E-10	7.30E-10	0.00E+00	0.00E+00	0.00E+00	1.52E-12	4.74E-12	9.52E-09
	HT	0.00E+00	1.10E-11	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	1.10E-11
	HTO	0.00E+00	3.10E-07	0.00E+00	5.24E-12	1.19E-08	4.73E-08	0.00E+00	0.00E+00	0.00E+00	8.45E-09	1.20E-07	4.98E-07
	Noble Gas	6.10E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.10E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.59E-08	1.00E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.59E-08
	I(mfp)	1.92E-11	4.14E-10	7.38E-11	5.45E-14	1.68E-09	8.08E-10	0.00E+00	0.00E+00	0.00E+00	1.29E-13	3.80E-12	3.00E-09
Total		6.10E-08	3.11E-07	8.58E-09	6.70E-12	6.19E-08	1.09E-07	0.00E+00	3.15E-18	1.36E-15	8.46E-09	1.20E-07	6.80E-07
5yr. Old	C-14	2.58E-13	2.40E-10	1.57E-14	1.11E-14	3.38E-08	5.43E-08	0.00E+00	3.15E-18	1.68E-15	7.88E-17	4.59E-12	8.84E-08
	Cs-137+	3.87E-13	5.98E-12	8.50E-09	1.34E-12	1.85E-10	5.81E-10	0.00E+00	0.00E+00	0.00E+00	1.52E-12	3.73E-12	9.28E-09
	HT	0.00E+00	8.54E-12	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	8.54E-12
	HTO	0.00E+00	2.40E-07	0.00E+00	7.13E-12	1.29E-08	5.60E-08	0.00E+00	0.00E+00	0.00E+00	7.40E-09	1.33E-07	4.50E-07
	Noble Gas	6.10E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.10E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.46E-08	1.08E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.54E-08
	I(mfp)	1.92E-11	4.78E-10	7.38E-11	1.06E-13	2.74E-09	1.30E-09	0.00E+00	0.00E+00	0.00E+00	1.29E-13	6.03E-12	4.62E-09
Total		6.10E-08	2.41E-07	8.58E-09	8.58E-12	6.42E-08	1.23E-07	0.00E+00	3.15E-18	1.68E-15	7.40E-09	1.33E-07	6.39E-07
Infant	C-14	3.36E-13	2.45E-10	2.04E-14	2.23E-14	5.53E-08	6.70E-08	0.00E+00	4.09E-18	3.40E-15	2.24E-17	6.59E-12	1.23E-07
	Cs-137+	5.03E-13	5.31E-12	1.11E-08	2.09E-12	1.90E-10	4.97E-10	0.00E+00	0.00E+00	0.00E+00	4.14E-15	4.13E-12	1.18E-08
	HT	0.00E+00	7.87E-12	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	7.87E-12
	HTO	0.00E+00	2.22E-07	0.00E+00	1.39E-11	1.93E-08	6.63E-08	0.00E+00	0.00E+00	0.00E+00	1.44E-09	1.85E-07	4.93E-07
	Noble Gas	7.48E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.48E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.99E-08	1.29E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.28E-08
	I(mfp)	2.49E-11	5.05E-10	9.59E-11	2.39E-13	4.41E-09	1.61E-09	0.00E+00	0.00E+00	0.00E+00	8.85E-15	9.67E-12	6.65E-09
Total		7.49E-08	2.22E-07	1.12E-08	1.62E-11	9.91E-08	1.48E-07	0.00E+00	4.09E-18	3.40E-15	1.44E-09	1.85E-07	7.42E-07
Nursing Infant	C-14	3.36E-13	1.36E-10	2.04E-14	1.95E-14	5.33E-08	4.79E-08	0.00E+00	4.09E-18	2.97E-15	2.24E-17	4.74E-13	1.01E-07
	Cs-137+	5.03E-13	4.80E-12	1.11E-08	3.66E-12	1.21E-09	5.88E-10	0.00E+00	0.00E+00	0.00E+00	4.14E-15	5.94E-13	1.29E-08
	HT	0.00E+00	5.77E-12	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	5.77E-12
	HTO	0.00E+00	1.62E-07	0.00E+00	1.83E-11	5.31E-07	7.06E-08	0.00E+00	0.00E+00	0.00E+00	1.16E-09	2.00E-08	7.85E-07
	Noble Gas	7.48E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.48E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.28E-07	9.21E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-07
	I(mfp)	2.49E-11	2.84E-10	9.59E-11	2.40E-13	1.11E-08	1.09E-09	0.00E+00	0.00E+00	0.00E+00	8.85E-15	8.00E-13	1.26E-08
Total		7.49E-08	1.63E-07	1.12E-08	2.23E-11	7.25E-07	1.29E-07	0.00E+00	4.09E-18	2.97E-15	1.16E-09	2.00E-08	1.12E-06

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 117 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E2 – Darlington Dairy Farm Critical Group Doses for 2006

DN - DAIRY FARM		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animals	Terrestrial plants	Aquatic animals	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
Adult	C-14	3.11E-13	4.01E-10	1.89E-14	3.90E-15	1.75E-07	5.06E-08	7.55E-11	3.15E-18	4.93E-16	8.82E-17	7.30E-12	2.26E-07
	Cs-137+	1.65E-13	8.28E-12	2.95E-09	3.15E-13	8.83E-10	9.22E-10	1.69E-11	0.00E+00	0.00E+00	7.74E-13	4.85E-13	4.78E-09
	HT	0.00E+00	5.43E-12	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	5.43E-12
	HTO	0.00E+00	1.52E-07	0.00E+00	8.87E-13	3.01E-08	4.54E-08	2.03E-11	0.00E+00	0.00E+00	4.63E-09	7.26E-08	3.05E-07
	Noble Gas	1.13E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.05E-08	6.73E-09	1.40E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.72E-08
	I(mfp)	8.16E-12	1.07E-10	2.93E-11	4.58E-15	2.78E-09	3.42E-10	0.00E+00	0.00E+00	0.00E+00	5.13E-14	1.71E-12	3.26E-09
Total		1.13E-08	1.53E-07	2.98E-09	1.21E-12	2.29E-07	1.04E-07	1.27E-10	3.15E-18	4.93E-16	4.63E-09	7.26E-08	5.78E-07
15yr. Old	C-14	3.11E-13	3.93E-10	1.89E-14	3.83E-15	2.21E-07	3.36E-08	4.15E-11	3.15E-18	4.84E-16	8.82E-17	6.22E-12	2.54E-07
	Cs-137+	1.65E-13	7.17E-12	2.95E-09	3.15E-13	9.54E-10	6.60E-10	9.47E-12	0.00E+00	0.00E+00	7.74E-13	4.20E-13	4.58E-09
	HT	0.00E+00	4.92E-12	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	4.92E-12
	HTO	0.00E+00	1.38E-07	0.00E+00	8.87E-13	3.43E-08	3.08E-08	1.14E-11	0.00E+00	0.00E+00	4.08E-09	6.29E-08	2.70E-07
	Noble Gas	1.13E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.17E-08	4.76E-09	7.84E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.65E-08
	I(mfp)	8.16E-12	1.50E-10	2.93E-11	7.08E-15	5.50E-09	3.80E-10	0.00E+00	0.00E+00	0.00E+00	5.13E-14	2.29E-12	6.07E-09
Total		1.13E-08	1.38E-07	2.98E-09	1.21E-12	2.83E-07	7.01E-08	7.02E-11	3.15E-18	4.84E-16	4.08E-09	6.29E-08	5.73E-07
10yr. Old	C-14	3.11E-13	4.14E-10	1.89E-14	1.08E-14	2.43E-07	3.83E-08	4.44E-11	3.15E-18	1.36E-15	8.82E-17	7.39E-12	2.82E-07
	Cs-137+	1.65E-13	4.59E-12	2.95E-09	4.84E-13	5.53E-10	3.79E-10	5.55E-12	0.00E+00	0.00E+00	7.74E-13	2.74E-13	3.90E-09
	HT	0.00E+00	4.68E-12	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	4.68E-12
	HTO	0.00E+00	1.31E-07	0.00E+00	2.22E-12	3.28E-08	3.11E-08	1.08E-11	0.00E+00	0.00E+00	3.86E-09	6.66E-08	2.66E-07
	Noble Gas	1.13E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.23E-08	5.14E-09	8.20E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.74E-08
	I(mfp)	8.16E-12	1.76E-10	2.93E-11	2.16E-14	6.68E-09	4.31E-10	0.00E+00	0.00E+00	0.00E+00	5.13E-14	2.96E-12	7.32E-09
Total		1.13E-08	1.32E-07	2.98E-09	2.74E-12	3.05E-07	7.54E-08	6.90E-11	3.15E-18	1.36E-15	3.86E-09	6.66E-08	5.97E-07
5yr. Old	C-14	3.11E-13	2.89E-10	1.89E-14	1.33E-14	2.69E-07	4.49E-08	4.90E-11	3.15E-18	1.68E-15	8.82E-17	7.49E-12	3.14E-07
	Cs-137+	1.65E-13	2.54E-12	2.95E-09	4.65E-13	4.53E-10	3.19E-10	4.75E-12	0.00E+00	0.00E+00	7.74E-13	2.15E-13	3.73E-09
	HT	0.00E+00	3.63E-12	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	3.63E-12
	HTO	0.00E+00	1.02E-07	0.00E+00	3.02E-12	3.90E-08	3.99E-08	1.31E-11	0.00E+00	0.00E+00	3.38E-09	7.41E-08	2.58E-07
	Noble Gas	1.13E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.40E-08	5.99E-09	9.28E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-08
	I(mfp)	8.16E-12	2.03E-10	2.93E-11	4.19E-14	1.17E-08	7.33E-10	0.00E+00	0.00E+00	0.00E+00	5.13E-14	4.70E-12	1.27E-08
Total		1.13E-08	1.02E-07	2.98E-09	3.54E-12	3.44E-07	9.19E-08	7.62E-11	3.15E-18	1.68E-15	3.38E-09	7.41E-08	6.30E-07
Infant	C-14	4.05E-13	2.95E-10	2.46E-14	2.69E-14	4.65E-07	6.25E-08	3.53E-11	4.09E-18	3.40E-15	2.66E-17	2.79E-12	5.28E-07
	Cs-137+	2.14E-13	2.26E-12	3.84E-09	7.26E-13	5.78E-10	3.02E-10	2.65E-12	0.00E+00	0.00E+00	1.51E-15	6.20E-14	4.72E-09
	HT	0.00E+00	3.34E-12	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	3.34E-12
	HTO	0.00E+00	9.38E-08	0.00E+00	5.88E-12	6.37E-08	5.33E-08	9.13E-12	0.00E+00	0.00E+00	3.72E-10	2.67E-08	2.38E-07
	Noble Gas	1.38E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.98E-08	8.09E-09	6.73E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.78E-08
	I(mfp)	1.06E-11	2.14E-10	3.80E-11	9.46E-14	2.22E-08	9.98E-10	0.00E+00	0.00E+00	0.00E+00	3.68E-15	1.96E-12	2.35E-08
Total		1.38E-08	9.43E-08	3.88E-09	6.73E-12	5.91E-07	1.25E-07	5.38E-11	4.09E-18	3.40E-15	3.72E-10	2.67E-08	8.56E-07
Nursing Infant	C-14	4.05E-13	1.63E-10	2.46E-14	2.35E-14	1.39E-07	5.46E-08	0.00E+00	4.09E-18	2.97E-15	2.66E-17	7.72E-13	1.94E-07
	Cs-137+	2.14E-13	2.04E-12	3.84E-09	1.27E-12	9.81E-10	4.41E-10	0.00E+00	0.00E+00	0.00E+00	1.51E-15	3.43E-14	5.26E-09
	HT	0.00E+00	2.45E-12	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	2.45E-12
	HTO	0.00E+00	6.87E-08	0.00E+00	7.77E-12	2.90E-07	6.97E-08	0.00E+00	0.00E+00	0.00E+00	3.00E-10	1.11E-08	4.40E-07
	Noble Gas	1.38E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.81E-08	7.49E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.56E-08
	I(mfp)	1.06E-11	1.21E-10	3.80E-11	9.52E-14	1.54E-08	8.32E-10	0.00E+00	0.00E+00	0.00E+00	3.68E-15	6.23E-13	1.64E-08
Total		1.38E-08	6.90E-08	3.88E-09	9.15E-12	5.03E-07	1.33E-07	0.00E+00	4.09E-18	2.97E-15	3.00E-10	1.11E-08	7.34E-07

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 118 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E3 – Darlington Bowmanville Critical Group Doses for 2006

DN - BOWMANVILLE		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animals	Terrestrial plants	Aquatic animals	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
Adult	C-14	3.50E-13	4.50E-10	2.13E-14	4.38E-15	1.83E-09	3.02E-08	2.02E-11	3.15E-18	4.93E-16	1.09E-17	4.44E-13	3.25E-08
	Cs-137+	1.81E-13	9.10E-12	4.64E-09	4.95E-13	2.11E-11	7.39E-10	4.52E-12	0.00E+00	0.00E+00	1.71E-12	8.16E-11	5.50E-09
	HT	0.00E+00	5.98E-12	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	5.98E-12
	HTO	0.00E+00	1.72E-07	0.00E+00	1.00E-12	1.13E-09	3.08E-08	5.43E-12	0.00E+00	0.00E+00	2.28E-09	3.68E-08	2.43E-07
	Noble Gas	1.18E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.04E-10	8.70E-09	3.75E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.51E-09
	I(mfp)	9.47E-12	1.18E-10	3.48E-11	5.40E-15	5.01E-11	2.67E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.79E-10
Total		1.18E-08	1.72E-07	4.68E-09	1.51E-12	3.83E-09	7.08E-08	3.39E-11	3.15E-18	4.93E-16	2.28E-09	3.68E-08	3.03E-07
15yr. Old	C-14	3.50E-13	4.42E-10	2.13E-14	4.31E-15	1.25E-09	2.14E-08	1.11E-11	3.15E-18	4.84E-16	1.09E-17	3.79E-13	2.31E-08
	Cs-137+	1.81E-13	7.88E-12	4.64E-09	4.95E-13	1.44E-11	5.49E-10	2.53E-12	0.00E+00	0.00E+00	1.71E-12	7.07E-11	5.29E-09
	HT	0.00E+00	5.42E-12	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	5.42E-12
	HTO	0.00E+00	1.56E-07	0.00E+00	1.00E-12	7.34E-10	2.23E-08	3.04E-12	0.00E+00	0.00E+00	2.01E-09	3.19E-08	2.12E-07
	Noble Gas	1.18E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.35E-10	6.57E-09	2.10E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.10E-09
	I(mfp)	9.47E-12	1.66E-10	3.48E-11	8.35E-15	5.02E-11	3.06E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.66E-10
Total		1.18E-08	1.56E-07	4.68E-09	1.51E-12	2.58E-09	5.11E-08	1.88E-11	3.15E-18	4.84E-16	2.01E-09	3.19E-08	2.60E-07
10yr. Old	C-14	3.50E-13	4.66E-10	2.13E-14	1.21E-14	1.12E-09	2.28E-08	1.19E-11	3.15E-18	1.36E-15	1.09E-17	4.50E-13	2.44E-08
	Cs-137+	1.81E-13	5.04E-12	4.64E-09	7.61E-13	7.18E-12	3.02E-10	1.48E-12	0.00E+00	0.00E+00	1.71E-12	4.60E-11	5.00E-09
	HT	0.00E+00	5.15E-12	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	5.15E-12
	HTO	0.00E+00	1.48E-07	0.00E+00	2.50E-12	6.01E-10	2.11E-08	2.89E-12	0.00E+00	0.00E+00	1.90E-09	3.37E-08	2.05E-07
	Noble Gas	1.18E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.74E-10	6.67E-09	2.19E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.15E-09
	I(mfp)	9.47E-12	1.94E-10	3.48E-11	2.55E-14	5.35E-11	3.33E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.25E-10
Total		1.18E-08	1.49E-07	4.68E-09	3.30E-12	2.26E-09	5.12E-08	1.84E-11	3.15E-18	1.36E-15	1.90E-09	3.37E-08	2.54E-07
5yr. Old	C-14	3.50E-13	3.24E-10	2.13E-14	1.50E-14	9.55E-10	2.49E-08	1.31E-11	3.15E-18	1.68E-15	1.09E-17	4.55E-13	2.62E-08
	Cs-137+	1.81E-13	2.80E-12	4.64E-09	7.30E-13	4.81E-12	2.42E-10	1.27E-12	0.00E+00	0.00E+00	1.71E-12	3.62E-11	4.93E-09
	HT	0.00E+00	3.99E-12	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	3.99E-12
	HTO	0.00E+00	1.15E-07	0.00E+00	3.40E-12	6.37E-10	2.53E-08	3.51E-12	0.00E+00	0.00E+00	1.66E-09	3.75E-08	1.80E-07
	Noble Gas	1.18E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.45E-10	7.30E-09	2.48E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.75E-09
	I(mfp)	9.47E-12	2.24E-10	3.48E-11	4.94E-14	8.39E-11	5.42E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.94E-10
Total		1.18E-08	1.15E-07	4.68E-09	4.20E-12	2.13E-09	5.83E-08	2.04E-11	3.15E-18	1.68E-15	1.66E-09	3.75E-08	2.31E-07
Infant	C-14	4.55E-13	3.31E-10	2.76E-14	3.02E-14	1.16E-09	3.14E-08	9.44E-12	4.09E-18	3.40E-15	2.06E-18	6.53E-13	3.29E-08
	Cs-137+	2.35E-13	2.48E-12	6.03E-09	1.14E-12	4.64E-12	2.11E-10	7.08E-13	0.00E+00	0.00E+00	3.23E-13	4.01E-11	6.29E-09
	HT	0.00E+00	3.68E-12	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	3.68E-12
	HTO	0.00E+00	1.06E-07	0.00E+00	6.63E-12	9.51E-10	3.06E-08	2.44E-12	0.00E+00	0.00E+00	2.40E-10	5.19E-08	1.89E-07
	Noble Gas	1.45E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.39E-10	8.97E-09	1.80E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.61E-09
	I(mfp)	1.23E-11	2.37E-10	4.52E-11	1.12E-13	1.15E-10	6.81E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-09
Total		1.45E-08	1.06E-07	6.08E-09	7.91E-12	2.87E-09	7.19E-08	1.44E-11	4.09E-18	3.40E-15	2.40E-10	5.19E-08	2.54E-07
Nursing Infant	C-14	4.55E-13	1.84E-10	2.76E-14	2.65E-14	1.45E-08	2.33E-08	0.00E+00	4.09E-18	2.97E-15	2.06E-18	4.70E-14	3.79E-08
	Cs-137+	2.35E-13	2.24E-12	6.03E-09	2.00E-12	3.19E-10	2.59E-10	0.00E+00	0.00E+00	0.00E+00	3.23E-13	5.77E-12	6.62E-09
	HT	0.00E+00	2.70E-12	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	2.70E-12
	HTO	0.00E+00	7.75E-08	0.00E+00	8.76E-12	2.11E-07	3.41E-08	0.00E+00	0.00E+00	0.00E+00	1.93E-10	5.63E-09	3.29E-07
	Noble Gas	1.45E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.11E-08	6.80E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.79E-08
	I(mfp)	1.23E-11	1.33E-10	4.52E-11	1.12E-13	1.89E-09	4.82E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.56E-09
Total		1.45E-08	7.78E-08	6.08E-09	1.09E-11	2.89E-07	6.49E-08	0.00E+00	4.09E-18	2.97E-15	1.94E-10	5.64E-09	4.58E-07

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 119 of 136

Title: 2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E4 – Darlington St. Mary's Cement Critical Group Doses for 2006

DN - ST.MARY'S CEMENT		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animals	Terrestrial plants	Aquatic animals	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
Adult	C-14	1.77E-13	2.28E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E-13	2.28E-10
	Cs-137+	2.42E-13	1.22E-11	5.32E-09	5.67E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.39E-11	5.36E-09
	HT	0.00E+00	7.98E-12	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	7.98E-12
	HTO	0.00E+00	2.24E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-08	2.34E-07
	Noble Gas	7.09E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.09E-09
	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	0.00E+00	0.00E+00	0.00E+00
	I(mfp)	1.20E-11	1.57E-10	4.59E-11	7.18E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.15E-10
Total		7.10E-09	2.24E-07	5.37E-09	5.74E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-08	2.47E-07

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 120 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E5 – Darlington West/East Beach Critical Group Doses for 2006

DN - WEST/EAST BEACH		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animals	Terrestrial plants	Aquatic animals	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
Adult	C-14	3.83E-13	4.93E-10	2.33E-14	4.80E-15	1.91E-10	3.37E-08	2.44E-10	3.15E-18	4.93E-16	1.06E-16	3.08E-12	3.46E-08
	Cs-137+	2.31E-13	1.16E-11	5.19E-09	5.53E-13	5.40E-12	8.69E-10	5.48E-11	0.00E+00	0.00E+00	1.58E-12	2.99E-11	6.16E-09
	HT	0.00E+00	7.62E-12	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	7.62E-12
	HTO	0.00E+00	2.14E-07	0.00E+00	1.25E-12	5.41E-10	3.85E-08	6.58E-11	0.00E+00	0.00E+00	7.05E-09	8.44E-08	3.45E-07
	Noble Gas	9.02E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.02E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.54E-10	1.60E-08	4.54E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.63E-08
	I(mfp)	1.14E-11	1.50E-10	4.32E-11	6.77E-15	2.55E-11	3.14E-10	0.00E+00	0.00E+00	0.00E+00	8.24E-14	2.19E-12	5.47E-10
Total		9.03E-09	2.15E-07	5.23E-09	1.81E-12	1.02E-09	8.94E-08	4.10E-10	3.15E-18	4.93E-16	7.05E-09	8.44E-08	4.11E-07
15yr. Old	C-14	3.83E-13	4.84E-10	2.33E-14	4.72E-15	1.19E-10	2.37E-08	1.34E-10	3.15E-18	4.84E-16	1.06E-16	2.62E-12	2.45E-08
	Cs-137+	2.31E-13	1.01E-11	5.19E-09	5.53E-13	3.62E-12	6.44E-10	3.07E-11	0.00E+00	0.00E+00	1.58E-12	2.60E-11	5.91E-09
	HT	0.00E+00	6.90E-12	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	6.90E-12
	HTO	0.00E+00	1.94E-07	0.00E+00	1.25E-12	3.48E-10	2.80E-08	3.68E-11	0.00E+00	0.00E+00	6.22E-09	7.32E-08	3.01E-07
	Noble Gas	9.02E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.02E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.63E-10	1.21E-08	2.54E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-08
	I(mfp)	1.14E-11	2.10E-10	4.32E-11	1.05E-14	2.48E-11	3.60E-10	0.00E+00	0.00E+00	0.00E+00	8.24E-14	2.94E-12	6.53E-10
Total		9.03E-09	1.94E-07	5.23E-09	1.81E-12	6.59E-10	6.48E-08	2.27E-10	3.15E-18	4.84E-16	6.22E-09	7.32E-08	3.54E-07
10yr. Old	C-14	3.83E-13	5.10E-10	2.33E-14	1.32E-14	1.27E-10	2.54E-08	1.44E-10	3.15E-18	1.36E-15	1.06E-16	3.12E-12	2.62E-08
	Cs-137+	2.31E-13	6.45E-12	5.19E-09	8.51E-13	2.04E-12	3.54E-10	1.80E-11	0.00E+00	0.00E+00	1.58E-12	1.69E-11	5.59E-09
	HT	0.00E+00	6.56E-12	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	6.56E-12
	HTO	0.00E+00	1.84E-07	0.00E+00	3.12E-12	3.01E-10	2.63E-08	3.51E-11	0.00E+00	0.00E+00	5.88E-09	7.74E-08	2.94E-07
	Noble Gas	9.02E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.02E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.55E-10	1.22E-08	2.65E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-08
	I(mfp)	1.14E-11	2.47E-10	4.32E-11	3.20E-14	2.85E-11	3.92E-10	0.00E+00	0.00E+00	0.00E+00	8.24E-14	3.80E-12	7.26E-10
Total		9.03E-09	1.85E-07	5.23E-09	4.01E-12	6.14E-10	6.46E-08	2.23E-10	3.15E-18	1.36E-15	5.88E-09	7.74E-08	3.48E-07
5yr. Old	C-14	3.83E-13	3.55E-10	2.33E-14	1.64E-14	1.36E-10	2.80E-08	1.59E-10	3.15E-18	1.68E-15	1.06E-16	3.16E-12	2.87E-08
	Cs-137+	2.31E-13	3.58E-12	5.19E-09	8.17E-13	1.58E-12	2.85E-10	1.54E-11	0.00E+00	0.00E+00	1.58E-12	1.33E-11	5.51E-09
	HT	0.00E+00	5.09E-12	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	5.09E-12
	HTO	0.00E+00	1.43E-07	0.00E+00	4.24E-12	3.40E-10	3.14E-08	4.25E-11	0.00E+00	0.00E+00	5.15E-09	8.61E-08	2.66E-07
	Noble Gas	9.02E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.02E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.63E-10	1.34E-08	3.00E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.36E-08
	I(mfp)	1.14E-11	2.84E-10	4.32E-11	6.20E-14	4.83E-11	6.38E-10	0.00E+00	0.00E+00	0.00E+00	8.24E-14	6.03E-12	1.03E-09
Total		9.03E-09	1.44E-07	5.23E-09	5.13E-12	6.89E-10	7.38E-08	2.47E-10	3.15E-18	1.68E-15	5.15E-09	8.62E-08	3.24E-07
Infant	C-14	4.98E-13	3.63E-10	3.03E-14	3.31E-14	1.47E-10	3.57E-08	1.14E-10	4.09E-18	3.40E-15	2.53E-17	4.53E-12	3.63E-08
	Cs-137+	3.01E-13	3.17E-12	6.75E-09	1.28E-12	1.62E-12	2.48E-10	8.58E-12	0.00E+00	0.00E+00	9.90E-14	1.47E-11	7.03E-09
	HT	0.00E+00	4.69E-12	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	4.69E-12
	HTO	0.00E+00	1.32E-07	0.00E+00	8.26E-12	5.08E-10	3.76E-08	2.96E-11	0.00E+00	0.00E+00	1.04E-09	1.19E-07	2.90E-07
	Noble Gas	1.11E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.54E-10	1.65E-08	2.18E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.68E-08
	I(mfp)	1.49E-11	3.01E-10	5.62E-11	1.40E-13	5.92E-11	8.02E-10	0.00E+00	0.00E+00	0.00E+00	1.40E-14	9.67E-12	1.24E-09
Total		1.11E-08	1.32E-07	6.80E-09	9.71E-12	9.70E-10	9.08E-08	1.74E-10	4.09E-18	3.40E-15	1.04E-09	1.19E-07	3.63E-07
Nursing Infant	C-14	4.98E-13	2.01E-10	3.03E-14	2.90E-14	1.34E-08	2.70E-08	0.00E+00	4.09E-18	2.97E-15	2.53E-17	3.26E-13	4.05E-08
	Cs-137+	3.01E-13	2.87E-12	6.75E-09	2.23E-12	5.37E-10	3.04E-10	0.00E+00	0.00E+00	0.00E+00	9.90E-14	2.12E-12	7.60E-09
	HT	0.00E+00	3.44E-12	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	3.44E-12
	HTO	0.00E+00	9.65E-08	0.00E+00	1.09E-11	3.04E-07	4.11E-08	0.00E+00	0.00E+00	0.00E+00	8.37E-10	1.29E-08	4.55E-07
	Noble Gas	1.11E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E-07	1.25E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-07
	I(mfp)	1.49E-11	1.69E-10	5.62E-11	1.41E-13	2.03E-09	5.67E-10	0.00E+00	0.00E+00	0.00E+00	1.40E-14	8.00E-13	2.84E-09
Total		1.11E-08	9.68E-08	6.80E-09	1.33E-11	4.36E-07	8.14E-08	0.00E+00	4.09E-18	2.97E-15	8.37E-10	1.29E-08	6.46E-07

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 121 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E6 – Darlington Rural Resident Critical Group Doses for 2006

DN - RURAL RESIDENTS		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animals	Terrestrial plants	Aquatic animals	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
Adult	C-14	3.07E-13	3.96E-10	1.87E-14	3.85E-15	1.63E-09	4.49E-08	1.70E-10	3.15E-18	4.93E-16	8.97E-17	3.45E-12	4.71E-08
	Cs-137+	3.87E-13	1.95E-11	8.57E-09	9.13E-13	1.90E-11	9.57E-10	3.81E-11	0.00E+00	0.00E+00	1.55E-12	2.21E-11	9.62E-09
	HT	0.00E+00	1.28E-11	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	1.28E-11
	HTO	0.00E+00	3.60E-07	0.00E+00	2.10E-12	1.81E-09	3.32E-08	4.57E-11	0.00E+00	0.00E+00	9.94E-09	1.44E-07	5.49E-07
	Noble Gas	9.08E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.08E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-09	1.41E-08	3.16E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E-08
	I(mfp)	1.92E-11	2.52E-10	7.38E-11	1.15E-14	1.33E-10	3.46E-10	0.00E+00	0.00E+00	0.00E+00	1.32E-13	1.62E-12	8.25E-10
Total		9.08E-08	3.60E-07	8.64E-09	3.02E-12	4.61E-09	9.34E-08	2.86E-10	3.15E-18	4.93E-16	9.94E-09	1.44E-07	7.12E-07
15yr. Old	C-14	3.07E-13	3.88E-10	1.87E-14	3.79E-15	1.07E-09	3.23E-08	9.35E-11	3.15E-18	4.84E-16	8.97E-17	2.94E-12	3.39E-08
	Cs-137+	3.87E-13	1.69E-11	8.57E-09	9.13E-13	1.27E-11	7.14E-10	2.13E-11	0.00E+00	0.00E+00	1.55E-12	1.91E-11	9.35E-09
	HT	0.00E+00	1.16E-11	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	1.16E-11
	HTO	0.00E+00	3.26E-07	0.00E+00	2.10E-12	1.14E-09	2.43E-08	2.56E-11	0.00E+00	0.00E+00	8.76E-09	1.25E-07	4.85E-07
	Noble Gas	9.08E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.08E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.54E-10	1.06E-08	1.77E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-08
	I(mfp)	1.92E-11	3.53E-10	7.38E-11	1.79E-14	1.29E-10	3.99E-10	0.00E+00	0.00E+00	0.00E+00	1.32E-13	2.17E-12	9.77E-10
Total		9.08E-08	3.27E-07	8.64E-09	3.03E-12	3.00E-09	6.83E-08	1.58E-10	3.15E-18	4.84E-16	8.76E-09	1.25E-07	6.31E-07
10yr. Old	C-14	3.07E-13	4.09E-10	1.87E-14	1.06E-14	1.04E-09	3.37E-08	1.00E-10	3.15E-18	1.36E-15	8.97E-17	3.50E-12	3.53E-08
	Cs-137+	3.87E-13	1.08E-11	8.57E-09	1.40E-12	6.32E-12	3.89E-10	1.25E-11	0.00E+00	0.00E+00	1.55E-12	1.25E-11	9.00E-09
	HT	0.00E+00	1.10E-11	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	1.10E-11
	HTO	0.00E+00	3.10E-07	0.00E+00	5.24E-12	9.26E-10	2.26E-08	2.44E-11	0.00E+00	0.00E+00	8.28E-09	1.32E-07	4.74E-07
	Noble Gas	9.08E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.08E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.83E-10	1.08E-08	1.85E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E-08
	I(mfp)	1.92E-11	4.14E-10	7.38E-11	5.45E-14	1.48E-10	4.31E-10	0.00E+00	0.00E+00	0.00E+00	1.32E-13	2.80E-12	1.09E-09
Total		9.08E-08	3.11E-07	8.64E-09	6.71E-12	2.70E-09	6.79E-08	1.55E-10	3.15E-18	1.36E-15	8.28E-09	1.32E-07	6.21E-07
5yr. Old	C-14	3.07E-13	2.85E-10	1.87E-14	1.32E-14	9.96E-10	3.62E-08	1.10E-10	3.15E-18	1.68E-15	8.97E-17	3.54E-12	3.76E-08
	Cs-137+	3.87E-13	5.98E-12	8.57E-09	1.35E-12	4.46E-12	3.08E-10	1.07E-11	0.00E+00	0.00E+00	1.55E-12	9.79E-12	8.91E-09
	HT	0.00E+00	8.54E-12	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	8.54E-12
	HTO	0.00E+00	2.40E-07	0.00E+00	7.13E-12	1.04E-09	2.68E-08	2.96E-11	0.00E+00	0.00E+00	7.25E-09	1.47E-07	4.22E-07
	Noble Gas	9.08E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.08E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E-10	1.17E-08	2.09E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-08
	I(mfp)	1.92E-11	4.78E-10	7.38E-11	1.06E-13	2.49E-10	6.92E-10	0.00E+00	0.00E+00	0.00E+00	1.32E-13	4.44E-12	1.52E-09
Total		9.08E-08	2.41E-07	8.64E-09	8.59E-12	2.88E-09	7.57E-08	1.72E-10	3.15E-18	1.68E-15	7.25E-09	1.47E-07	5.73E-07
Infant	C-14	4.00E-13	2.91E-10	2.43E-14	2.66E-14	1.08E-09	4.41E-08	7.96E-11	4.09E-18	3.40E-15	2.36E-17	5.08E-12	4.56E-08
	Cs-137+	5.03E-13	5.31E-12	1.11E-08	2.11E-12	4.60E-12	2.61E-10	5.97E-12	0.00E+00	0.00E+00	4.25E-14	1.09E-11	1.14E-08
	HT	0.00E+00	7.87E-12	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	7.87E-12
	HTO	0.00E+00	2.22E-07	0.00E+00	1.39E-11	1.70E-09	3.17E-08	2.06E-11	0.00E+00	0.00E+00	1.26E-09	2.03E-07	4.59E-07
	Noble Gas	1.11E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.57E-10	1.43E-08	1.51E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.53E-08
	I(mfp)	2.49E-11	5.05E-10	9.59E-11	2.39E-13	2.89E-10	8.47E-10	0.00E+00	0.00E+00	0.00E+00	1.32E-14	7.12E-12	1.77E-09
Total		1.11E-07	2.22E-07	1.12E-08	1.63E-11	4.03E-09	9.12E-08	1.21E-10	4.09E-18	3.40E-15	1.26E-09	2.03E-07	6.45E-07
Nursing Infant	C-14	4.00E-13	1.62E-10	2.43E-14	2.33E-14	1.95E-08	3.07E-08	0.00E+00	4.09E-18	2.97E-15	2.36E-17	3.65E-13	5.03E-08
	Cs-137+	5.03E-13	4.80E-12	1.11E-08	3.69E-12	5.13E-10	3.02E-10	0.00E+00	0.00E+00	0.00E+00	4.25E-14	1.56E-12	1.20E-08
	HT	0.00E+00	5.77E-12	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	5.77E-12
	HTO	0.00E+00	1.62E-07	0.00E+00	1.83E-11	4.90E-07	3.36E-08	0.00E+00	0.00E+00	0.00E+00	1.01E-09	2.20E-08	7.08E-07
	Noble Gas	1.11E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E-07	1.07E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.15E-07
	I(mfp)	2.49E-11	2.84E-10	9.59E-11	2.40E-13	3.36E-09	5.63E-10	0.00E+00	0.00E+00	0.00E+00	1.32E-14	5.89E-13	4.33E-09
Total		1.11E-07	1.63E-07	1.12E-08	2.23E-11	6.17E-07	7.58E-08	0.00E+00	4.09E-18	2.97E-15	1.01E-09	2.20E-08	1.00E-06

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 122 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E7 – Darlington Provincial Park Camper Critical Group Doses for 2006

DN - CAMPER		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animals	Terrestrial plants	Aquatic animals	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
Adult	C-14	7.93E-14	1.02E-10	0.00E+00	0.00E+00	6.83E-10	1.72E-08	1.80E-09	3.15E-18	4.93E-16	7.92E-18	2.89E-13	1.98E-08
	Cs-137+	1.07E-13	5.37E-12	4.69E-09	5.00E-13	7.02E-12	4.78E-10	3.23E-10	0.00E+00	0.00E+00	1.24E-12	5.30E-11	5.56E-09
	HT	0.00E+00	3.53E-12	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	3.53E-12
	HTO	0.00E+00	9.89E-08	0.00E+00	0.00E+00	8.49E-10	1.79E-08	9.10E-10	0.00E+00	0.00E+00	1.98E-09	2.98E-08	1.50E-07
	Noble Gas	6.29E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.29E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.65E-10	3.40E-09	3.17E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.04E-09
	I(mfp)	5.28E-12	6.94E-11	4.06E-11	6.36E-15	6.42E-11	1.73E-10	2.77E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.52E-10
Total		6.29E-08	9.90E-08	4.73E-09	5.06E-13	2.07E-09	3.92E-08	6.21E-09	3.15E-18	4.93E-16	1.98E-09	2.99E-08	2.46E-07
15yr. Old	C-14	7.93E-14	1.00E-10	0.00E+00	0.00E+00	4.41E-10	1.24E-08	9.90E-10	3.15E-18	4.84E-16	7.92E-18	2.46E-13	1.40E-08
	Cs-137+	1.07E-13	4.65E-12	4.69E-09	5.00E-13	4.59E-12	3.58E-10	1.81E-10	0.00E+00	0.00E+00	1.24E-12	4.59E-11	5.29E-09
	HT	0.00E+00	3.19E-12	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	3.19E-12
	HTO	0.00E+00	8.95E-08	0.00E+00	0.00E+00	5.29E-10	1.32E-08	5.09E-10	0.00E+00	0.00E+00	1.74E-09	2.59E-08	1.31E-07
	Noble Gas	6.29E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.29E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.93E-10	2.63E-09	1.77E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.70E-09
	I(mfp)	5.28E-12	9.72E-11	4.06E-11	9.83E-15	6.22E-11	2.00E-10	2.40E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.05E-10
Total		6.29E-08	8.97E-08	4.73E-09	5.10E-13	1.33E-09	2.88E-08	3.45E-09	3.15E-18	4.84E-16	1.74E-09	2.59E-08	2.19E-07
10yr. Old	C-14	7.93E-14	1.06E-10	0.00E+00	0.00E+00	4.37E-10	1.29E-08	1.06E-09	3.15E-18	1.36E-15	7.92E-18	2.92E-13	1.45E-08
	Cs-137+	1.07E-13	2.98E-12	4.69E-09	7.69E-13	2.32E-12	1.94E-10	1.06E-10	0.00E+00	0.00E+00	1.24E-12	2.99E-11	5.03E-09
	HT	0.00E+00	3.04E-12	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	3.04E-12
	HTO	0.00E+00	8.52E-08	0.00E+00	0.00E+00	4.33E-10	1.22E-08	4.85E-10	0.00E+00	0.00E+00	1.65E-09	2.74E-08	1.27E-07
	Noble Gas	6.29E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.29E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.63E-10	2.61E-09	1.85E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.73E-09
	I(mfp)	5.28E-12	1.14E-10	4.06E-11	3.00E-14	7.19E-11	2.15E-10	2.79E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.47E-10
Total		6.29E-08	8.54E-08	4.73E-09	7.99E-13	1.21E-09	2.81E-08	3.50E-09	3.15E-18	1.36E-15	1.65E-09	2.74E-08	2.15E-07
5yr. Old	C-14	7.93E-14	7.35E-11	0.00E+00	0.00E+00	4.30E-10	1.39E-08	1.17E-09	3.15E-18	1.68E-15	7.92E-18	2.96E-13	1.56E-08
	Cs-137+	1.07E-13	1.65E-12	4.69E-09	7.39E-13	1.67E-12	1.54E-10	9.07E-11	0.00E+00	0.00E+00	1.24E-12	2.35E-11	4.97E-09
	HT	0.00E+00	2.35E-12	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	2.35E-12
	HTO	0.00E+00	6.60E-08	0.00E+00	0.00E+00	4.93E-10	1.44E-08	5.88E-10	0.00E+00	0.00E+00	1.44E-09	3.05E-08	1.13E-07
	Noble Gas	6.29E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.29E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.72E-10	2.80E-09	2.10E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.17E-09
	I(mfp)	5.28E-12	1.32E-10	4.06E-11	5.82E-14	1.22E-10	3.46E-10	4.83E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.46E-10
Total		6.29E-08	6.62E-08	4.73E-09	7.97E-13	1.32E-09	3.16E-08	3.95E-09	3.15E-18	1.68E-15	1.44E-09	3.05E-08	2.03E-07
Infant	C-14	1.03E-13	7.51E-11	0.00E+00	0.00E+00	4.59E-10	1.69E-08	8.43E-10	4.09E-18	3.40E-15	1.05E-18	4.24E-13	1.83E-08
	Cs-137+	1.39E-13	1.46E-12	6.10E-09	1.15E-12	1.79E-12	1.31E-10	5.06E-11	0.00E+00	0.00E+00	1.65E-13	2.61E-11	6.31E-09
	HT	0.00E+00	2.17E-12	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	2.17E-12
	HTO	0.00E+00	6.09E-08	0.00E+00	0.00E+00	8.21E-10	1.68E-08	4.09E-10	0.00E+00	0.00E+00	1.53E-10	4.21E-08	1.21E-07
	Noble Gas	7.72E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.72E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.50E-10	3.31E-09	1.52E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.28E-09
	I(mfp)	6.86E-12	1.39E-10	5.28E-11	1.31E-13	1.41E-10	4.23E-10	3.89E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.63E-10
Total		7.72E-08	6.11E-08	6.15E-09	1.29E-12	1.87E-09	3.75E-08	2.82E-09	4.09E-18	3.40E-15	1.53E-10	4.22E-08	2.29E-07
Nursing Infant	C-14	1.03E-13	4.17E-11	0.00E+00	0.00E+00	8.35E-09	1.17E-08	0.00E+00	4.09E-18	2.97E-15	1.05E-18	3.05E-14	2.01E-08
	Cs-137+	1.39E-13	1.32E-12	6.10E-09	2.02E-12	7.92E-10	1.51E-10	0.00E+00	0.00E+00	0.00E+00	1.65E-13	3.75E-12	7.05E-09
	HT	0.00E+00	1.59E-12	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	1.59E-12
	HTO	0.00E+00	4.46E-08	0.00E+00	0.00E+00	1.32E-07	1.73E-08	0.00E+00	0.00E+00	0.00E+00	1.23E-10	4.57E-09	1.99E-07
	Noble Gas	7.72E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.72E-08
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-08	2.27E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.70E-08
	I(mfp)	6.86E-12	7.82E-11	5.28E-11	1.32E-13	1.46E-09	2.81E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.88E-09
Total		7.72E-08	4.47E-08	6.15E-09	2.15E-12	1.68E-07	3.18E-08	0.00E+00	4.09E-18	2.97E-15	1.23E-10	4.58E-09	3.32E-07

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 123 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E8 – Darlington Oshawa Critical Group Doses for 2006

DN - OSHAWA		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animals	Terrestrial plants	Aquatic animals	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
Adult	C-14	2.33E-13	3.01E-10	1.42E-14	2.93E-15	1.96E-11	1.65E-08	3.75E-10	3.15E-18	4.93E-16	1.10E-17	4.81E-13	1.72E-08
	Cs-137+	1.21E-13	6.08E-12	3.33E-09	3.55E-13	4.02E-13	3.49E-10	8.40E-11	0.00E+00	0.00E+00	1.73E-12	8.84E-11	3.86E-09
	HT	0.00E+00	3.99E-12	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	3.99E-12
	HTO	0.00E+00	1.36E-07	0.00E+00	7.93E-13	1.11E-10	1.39E-08	1.01E-10	0.00E+00	0.00E+00	2.50E-09	4.98E-08	2.02E-07
	Noble Gas	7.48E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.48E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.23E-11	9.99E-09	6.96E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.01E-08
	I(mfp)	9.97E-12	8.17E-11	2.54E-11	3.62E-15	3.38E-12	1.26E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.46E-10
Total		7.49E-09	1.36E-07	3.36E-09	1.15E-12	1.86E-10	4.08E-08	6.29E-10	3.15E-18	4.93E-16	2.50E-09	4.99E-08	2.41E-07
15yr. Old	C-14	2.33E-13	2.95E-10	1.42E-14	2.88E-15	1.18E-11	1.19E-08	2.06E-10	3.15E-18	4.84E-16	1.10E-17	4.10E-13	1.24E-08
	Cs-137+	1.21E-13	5.26E-12	3.33E-09	3.55E-13	2.46E-13	2.59E-10	4.70E-11	0.00E+00	0.00E+00	1.73E-12	7.66E-11	3.72E-09
	HT	0.00E+00	3.61E-12	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	3.61E-12
	HTO	0.00E+00	1.23E-07	0.00E+00	7.93E-13	6.76E-11	1.01E-08	5.64E-11	0.00E+00	0.00E+00	2.21E-09	4.31E-08	1.79E-07
	Noble Gas	7.48E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.48E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.19E-11	7.55E-09	3.89E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.63E-09
	I(mfp)	9.97E-12	1.14E-10	2.54E-11	5.60E-15	3.19E-12	1.45E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.97E-10
Total		7.49E-09	1.24E-07	3.36E-09	1.16E-12	1.15E-10	2.99E-08	3.48E-10	3.15E-18	4.84E-16	2.21E-09	4.32E-08	2.10E-07
10yr. Old	C-14	2.33E-13	3.11E-10	1.42E-14	8.07E-15	1.07E-11	1.24E-08	2.21E-10	3.15E-18	1.36E-15	1.10E-17	4.87E-13	1.30E-08
	Cs-137+	1.21E-13	3.37E-12	3.33E-09	5.47E-13	1.23E-13	1.42E-10	2.76E-11	0.00E+00	0.00E+00	1.73E-12	4.99E-11	3.56E-09
	HT	0.00E+00	3.44E-12	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	3.44E-12
	HTO	0.00E+00	1.17E-07	0.00E+00	1.98E-12	5.48E-11	9.50E-09	5.37E-11	0.00E+00	0.00E+00	2.09E-09	4.56E-08	1.75E-07
	Noble Gas	7.48E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.48E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.83E-11	7.67E-09	4.07E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.74E-09
	I(mfp)	9.97E-12	1.33E-10	2.54E-11	1.71E-14	3.16E-12	1.58E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.30E-10
Total		7.49E-09	1.18E-07	3.36E-09	2.55E-12	9.71E-11	2.99E-08	3.42E-10	3.15E-18	1.36E-15	2.09E-09	4.57E-08	2.07E-07
5yr. Old	C-14	2.33E-13	2.16E-10	1.42E-14	9.99E-15	1.14E-11	1.34E-08	2.43E-10	3.15E-18	1.68E-15	1.10E-17	4.93E-13	1.38E-08
	Cs-137+	1.21E-13	1.87E-12	3.33E-09	5.25E-13	1.01E-13	1.14E-10	2.36E-11	0.00E+00	0.00E+00	1.73E-12	3.92E-11	3.51E-09
	HT	0.00E+00	2.66E-12	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	2.66E-12
	HTO	0.00E+00	9.09E-08	0.00E+00	2.70E-12	6.39E-11	1.14E-08	6.52E-11	0.00E+00	0.00E+00	1.83E-09	5.08E-08	1.55E-07
	Noble Gas	7.48E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.48E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.09E-11	8.38E-09	4.60E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.46E-09
	I(mfp)	9.97E-12	1.54E-10	2.54E-11	3.32E-14	5.24E-12	2.56E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.50E-10
Total		7.49E-09	9.13E-08	3.36E-09	3.26E-12	1.11E-10	3.35E-08	3.78E-10	3.15E-18	1.68E-15	1.83E-09	5.08E-08	1.89E-07
Infant	C-14	3.03E-13	2.21E-10	1.84E-14	2.02E-14	2.09E-11	1.64E-08	1.75E-10	4.09E-18	3.40E-15	2.10E-18	7.08E-13	1.68E-08
	Cs-137+	1.57E-13	1.66E-12	4.33E-09	8.20E-13	1.43E-13	9.86E-11	1.32E-11	0.00E+00	0.00E+00	3.30E-13	4.35E-11	4.49E-09
	HT	0.00E+00	2.46E-12	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	2.46E-12
	HTO	0.00E+00	8.38E-08	0.00E+00	5.25E-12	1.13E-10	1.37E-08	4.53E-11	0.00E+00	0.00E+00	3.05E-10	7.03E-08	1.68E-07
	Noble Gas	9.18E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.18E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.69E-11	1.03E-08	3.34E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E-08
	I(mfp)	1.30E-11	1.63E-10	3.30E-11	7.49E-14	1.08E-11	3.19E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.39E-10
Total		9.19E-09	8.42E-08	4.37E-09	6.17E-12	2.02E-10	4.08E-08	2.67E-10	4.09E-18	3.40E-15	3.06E-10	7.03E-08	2.10E-07
Nursing Infant	C-14	3.03E-13	1.23E-10	1.84E-14	1.77E-14	6.55E-09	1.16E-08	0.00E+00	4.09E-18	2.97E-15	2.10E-18	5.09E-14	1.82E-08
	Cs-137+	1.57E-13	1.50E-12	4.33E-09	1.44E-12	4.86E-10	1.19E-10	0.00E+00	0.00E+00	0.00E+00	3.30E-13	6.25E-12	4.95E-09
	HT	0.00E+00	1.80E-12	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	1.80E-12
	HTO	0.00E+00	6.14E-08	0.00E+00	6.94E-12	1.80E-07	1.52E-08	0.00E+00	0.00E+00	0.00E+00	2.47E-10	7.63E-09	2.65E-07
	Noble Gas	9.18E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.18E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.95E-08	7.75E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.72E-08
	I(mfp)	1.30E-11	9.13E-11	3.30E-11	7.54E-14	8.46E-10	2.22E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.21E-09
Total		9.19E-09	6.16E-08	4.37E-09	8.47E-12	2.58E-07	3.48E-08	0.00E+00	4.09E-18	2.97E-15	2.47E-10	7.64E-09	3.76E-07

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 124 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E9 – Darlington Sport Fisher Critical Group Doses for 2006

DN - FISHER		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animals	Terrestrial plants	Aquatic animals	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
Adult	C-14	9.24E-14	1.19E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.77E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.88E-09
	Cs-137+	4.79E-14	2.41E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-09
	HT	0.00E+00	1.58E-12	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	1.58E-12
	HTO	0.00E+00	4.51E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.55E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.67E-08
	Noble Gas	1.34E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.34E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-09
	I(mfp)	2.29E-12	3.10E-11	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	3.33E-11
	Total	1.34E-09	4.53E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.68E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.63E-08
15yr. Old	C-14	9.24E-14	1.17E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.17E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-09
	Cs-137+	4.79E-14	2.08E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.23E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.25E-10
	HT	0.00E+00	1.43E-12	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	1.43E-12
	HTO	0.00E+00	4.09E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.67E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.17E-08
	Noble Gas	1.34E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.34E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.99E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.99E-10
	I(mfp)	2.29E-12	4.34E-11	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	4.57E-11
	Total	1.34E-09	4.10E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.36E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.77E-08
10yr. Old	C-14	9.24E-14	1.23E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.39E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E-09
	Cs-137+	4.79E-14	1.33E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.24E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.25E-10
	HT	0.00E+00	1.36E-12	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	1.36E-12
	HTO	0.00E+00	3.89E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.27E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.97E-08
	Noble Gas	1.34E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.34E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.26E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.26E-10
	I(mfp)	2.29E-12	5.10E-11	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	5.33E-11
	Total	1.34E-09	3.90E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.27E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.57E-08
5yr. Old	C-14	9.24E-14	8.56E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.74E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.83E-09
	Cs-137+	4.79E-14	7.40E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.63E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.64E-10
	HT	0.00E+00	1.05E-12	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	1.05E-12
	HTO	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.11E-08
	Noble Gas	1.34E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.34E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.08E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.08E-10
	I(mfp)	2.29E-12	5.88E-11	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	6.11E-11
	Total	1.34E-09	3.03E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.82E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.74E-08
Infant	C-14	1.20E-13	8.75E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.70E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.79E-09
	Cs-137+	6.22E-14	6.56E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.02E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.03E-10
	HT	0.00E+00	9.71E-13	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	9.71E-13
	HTO	0.00E+00	2.78E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.97E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.85E-08
	Noble Gas	1.64E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.64E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.13E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.13E-10
	I(mfp)	2.97E-12	6.21E-11	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	6.51E-11
	Total	1.65E-09	2.79E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.11E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.37E-08
Nursing Infant	C-14	1.20E-13	4.85E-11	0.00E+00	0.00E+00	2.25E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.29E-09
	Cs-137+	6.22E-14	5.93E-13	0.00E+00	0.00E+00	4.48E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.48E-10
	HT	0.00E+00	7.11E-13	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	7.11E-13
	HTO	0.00E+00	2.04E-08	0.00E+00	0.00E+00	3.94E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.97E-08
	Noble Gas	1.64E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.64E-09
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.32E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.32E-11
	I(mfp)	2.97E-12	3.49E-11	0.00E+00	0.00E+00	1.31E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.69E-10
	Total	1.65E-09	2.04E-08	0.00E+00	0.00E+00	4.22E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.43E-08

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 125 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E10 – Pickering Farm Critical Group Doses for 2006

PN - FARM		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animal: Terrestrial plants	Aquatic animals	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)	
Adult	C-14	1.15E-12	1.48E-09	6.98E-14	1.44E-14	5.97E-09	1.50E-07	3.13E-10	4.39E-16	6.86E-14	1.32E-15	2.10E-11	1.57E-07
	Cs-137+	1.71E-13	8.61E-12	3.76E-09	4.01E-13	9.36E-11	6.51E-10	3.65E-10	1.48E-09	2.93E-11	8.37E-11	7.67E-10	7.24E-09
	HTO	0.00E+00	6.03E-07	0.00E+00	3.51E-12	8.13E-09	3.75E-08	1.03E-10	0.00E+00	0.00E+00	1.51E-08	1.52E-07	8.16E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.10E-09	6.71E-09	7.07E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-08
	Noble Gases	1.09E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-07
	I(mfp)	8.71E-12	1.14E-10	3.34E-11	5.22E-15	2.26E-10	2.40E-10	0.00E+00	0.00E+00	0.00E+00	5.88E-14	7.83E-13	6.23E-10
Total		1.09E-07	6.05E-07	3.80E-09	3.93E-12	2.05E-08	1.95E-07	8.51E-10	1.48E-09	2.93E-11	1.52E-08	1.53E-07	1.10E-06
15yr. Old	C-14	1.15E-12	1.45E-09	6.98E-14	1.41E-14	4.12E-09	1.10E-07	1.72E-10	4.39E-16	6.74E-14	1.32E-15	1.79E-11	1.16E-07
	Cs-137+	1.71E-13	7.46E-12	3.76E-09	4.01E-13	6.61E-11	4.88E-10	2.04E-10	1.48E-09	2.93E-11	8.37E-11	6.65E-10	6.78E-09
	HTO	0.00E+00	5.46E-07	0.00E+00	3.51E-12	5.56E-09	2.80E-08	5.74E-11	0.00E+00	0.00E+00	1.33E-08	1.32E-07	7.25E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.28E-09	5.21E-09	3.95E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.52E-09
	Noble Gases	1.09E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-07
	I(mfp)	8.71E-12	1.60E-10	3.34E-11	8.08E-15	2.32E-10	2.78E-10	0.00E+00	0.00E+00	0.00E+00	5.88E-14	1.05E-12	7.13E-10
Total		1.09E-07	5.48E-07	3.80E-09	3.94E-12	1.43E-08	1.44E-07	4.73E-10	1.48E-09	2.93E-11	1.34E-08	1.33E-07	9.67E-07
10yr. Old	C-14	1.15E-12	1.53E-09	6.98E-14	3.97E-14	3.78E-09	1.12E-07	1.84E-10	4.39E-16	1.89E-13	1.32E-15	2.12E-11	1.18E-07
	Cs-137+	1.71E-13	4.77E-12	3.76E-09	6.17E-13	3.25E-11	2.65E-10	1.20E-10	1.48E-09	4.50E-11	8.37E-11	4.33E-10	6.22E-09
	HTO	0.00E+00	5.19E-07	0.00E+00	8.78E-12	4.49E-09	2.55E-08	5.47E-11	0.00E+00	0.00E+00	1.26E-08	1.40E-07	7.02E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.77E-09	5.15E-09	4.13E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.96E-09
	Noble Gases	1.09E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-07
	I(mfp)	8.71E-12	1.87E-10	3.34E-11	2.47E-14	2.56E-10	2.99E-10	0.00E+00	0.00E+00	0.00E+00	5.88E-14	1.36E-12	7.86E-10
Total		1.09E-07	5.21E-07	3.80E-09	9.46E-12	1.23E-08	1.43E-07	3.99E-10	1.48E-09	4.52E-11	1.27E-08	1.40E-07	9.44E-07
5yr. Old	C-14	1.15E-12	1.06E-09	6.98E-14	4.91E-14	3.28E-09	1.18E-07	2.03E-10	4.39E-16	2.34E-13	1.32E-15	2.15E-11	1.22E-07
	Cs-137+	1.71E-13	2.65E-12	3.76E-09	5.92E-13	2.10E-11	2.09E-10	1.03E-10	1.48E-09	4.32E-11	8.37E-11	3.40E-10	6.04E-09
	HTO	0.00E+00	4.03E-07	0.00E+00	1.19E-11	4.40E-09	2.95E-08	6.63E-11	0.00E+00	0.00E+00	1.10E-08	1.55E-07	6.03E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E-09	5.49E-09	4.67E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.82E-09
	Noble Gases	1.09E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-07
	I(mfp)	8.71E-12	2.16E-10	3.34E-11	4.79E-14	3.98E-10	4.79E-10	0.00E+00	0.00E+00	0.00E+00	5.88E-14	2.15E-12	1.14E-09
Total		1.09E-07	4.04E-07	3.80E-09	1.26E-11	1.14E-08	1.53E-07	4.18E-10	1.48E-09	4.34E-11	1.11E-08	1.56E-07	8.50E-07
Infant	C-14	1.49E-12	1.09E-09	9.07E-14	9.93E-14	4.00E-09	1.37E-07	1.46E-10	5.70E-16	4.73E-13	1.07E-16	3.08E-11	1.42E-07
	Cs-137+	2.23E-13	2.35E-12	4.89E-09	9.26E-13	2.02E-11	1.76E-10	5.72E-11	1.92E-09	6.75E-11	2.39E-12	3.77E-10	7.52E-09
	HTO	0.00E+00	3.71E-07	0.00E+00	2.33E-11	5.92E-09	3.33E-08	4.61E-11	0.00E+00	0.00E+00	1.55E-09	2.15E-07	6.27E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.20E-09	6.41E-09	3.39E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.06E-08
	Noble Gases	1.33E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.33E-07
	I(mfp)	1.13E-11	2.29E-10	4.34E-11	1.08E-13	4.17E-10	5.81E-10	0.00E+00	0.00E+00	0.00E+00	4.43E-15	3.45E-12	1.29E-09
Total		1.33E-07	3.73E-07	4.94E-09	2.44E-11	1.46E-08	1.77E-07	2.83E-10	1.92E-09	6.80E-11	1.55E-09	2.16E-07	9.22E-07
Nursing Infant	C-14	1.49E-12	6.03E-10	9.07E-14	8.69E-14	6.68E-08	8.64E-08	0.00E+00	5.70E-16	4.14E-13	1.07E-16	2.22E-12	1.54E-07
	Cs-137+	2.23E-13	2.12E-12	4.89E-09	1.62E-12	2.08E-08	2.00E-10	0.00E+00	1.92E-09	1.18E-10	2.39E-12	5.43E-11	2.80E-08
	HTO	0.00E+00	2.72E-07	0.00E+00	3.07E-11	7.23E-07	3.23E-08	0.00E+00	0.00E+00	0.00E+00	1.25E-09	2.34E-08	1.05E-06
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.09E-08	4.28E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.52E-08
	Noble Gases	1.33E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.33E-07
	I(mfp)	1.13E-11	1.28E-10	4.34E-11	1.09E-13	3.29E-09	3.81E-10	0.00E+00	0.00E+00	0.00E+00	4.43E-15	2.85E-13	3.85E-09
Total		1.33E-07	2.73E-07	4.94E-09	3.25E-11	8.74E-07	1.24E-07	0.00E+00	1.92E-09	1.19E-10	1.25E-09	2.34E-08	1.43E-06

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 126 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E11 – Pickering Dairy Farm Critical Group Doses for 2006

PN - DAIRY FARM		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animal	Terrestrial plant	Aquatic animal	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
Adult	C-14	6.65E-13	8.56E-10	4.04E-14	8.33E-15	7.70E-08	3.06E-07	0.00E+00	4.39E-16	6.86E-14	1.18E-15	1.07E-11	3.84E-07
	Cs-137+	1.58E-13	7.94E-12	2.99E-09	3.19E-13	5.84E-10	4.82E-10	0.00E+00	1.48E-09	2.93E-11	8.19E-11	9.54E-11	5.75E-09
	HTO	0.00E+00	5.54E-07	0.00E+00	3.23E-12	4.90E-08	4.31E-08	0.00E+00	0.00E+00	0.00E+00	1.40E-08	1.10E-07	7.70E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.20E-08	6.84E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.88E-08
	Noble Gases	6.35E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.35E-08
	I(mfp)	8.00E-12	1.05E-10	2.92E-11	4.56E-15	1.26E-09	1.96E-10	0.00E+00	0.00E+00	0.00E+00	4.92E-14	0.00E+00	1.60E-09
Total		6.35E-08	5.55E-07	3.02E-09	3.56E-12	2.00E-07	3.57E-07	0.00E+00	1.48E-09	2.93E-11	1.41E-08	1.10E-07	1.30E-06
15yr. Old	C-14	6.65E-13	8.39E-10	4.04E-14	8.19E-15	8.90E-08	2.37E-07	0.00E+00	4.39E-16	6.74E-14	1.18E-15	9.08E-12	3.27E-07
	Cs-137+	1.58E-13	6.88E-12	2.99E-09	3.19E-13	5.36E-10	3.68E-10	0.00E+00	1.48E-09	2.93E-11	8.19E-11	8.27E-11	5.57E-09
	HTO	0.00E+00	5.02E-07	0.00E+00	3.23E-12	5.38E-08	3.40E-08	0.00E+00	0.00E+00	0.00E+00	1.23E-08	9.54E-08	6.97E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.42E-08	5.62E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.98E-08
	Noble Gases	6.35E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.35E-08
	I(mfp)	8.00E-12	1.47E-10	2.92E-11	7.06E-15	2.29E-09	2.32E-10	0.00E+00	0.00E+00	0.00E+00	4.92E-14	0.00E+00	2.71E-09
Total		6.35E-08	5.03E-07	3.02E-09	3.56E-12	2.10E-07	2.77E-07	0.00E+00	1.48E-09	2.93E-11	1.24E-08	9.55E-08	1.17E-06
10yr. Old	C-14	6.65E-13	8.85E-10	4.04E-14	2.30E-14	9.57E-08	2.29E-07	0.00E+00	4.39E-16	1.89E-13	1.18E-15	1.08E-11	3.25E-07
	Cs-137+	1.58E-13	4.40E-12	2.99E-09	4.91E-13	2.93E-10	1.95E-10	0.00E+00	1.48E-09	4.50E-11	8.19E-11	5.38E-11	5.14E-09
	HTO	0.00E+00	4.78E-07	0.00E+00	8.07E-12	5.08E-08	2.92E-08	0.00E+00	0.00E+00	0.00E+00	1.17E-08	1.01E-07	6.70E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-08	5.28E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.70E-08
	Noble Gases	6.35E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.35E-08
	I(mfp)	8.00E-12	1.72E-10	2.92E-11	2.15E-14	2.68E-09	2.44E-10	0.00E+00	0.00E+00	0.00E+00	4.92E-14	0.00E+00	3.14E-09
Total		6.35E-08	4.79E-07	3.02E-09	8.61E-12	2.11E-07	2.64E-07	0.00E+00	1.48E-09	4.52E-11	1.17E-08	1.01E-07	1.13E-06
5yr. Old	C-14	6.65E-13	6.16E-10	4.04E-14	2.84E-14	1.04E-07	2.25E-07	0.00E+00	4.39E-16	2.34E-13	1.18E-15	1.09E-11	3.29E-07
	Cs-137+	1.58E-13	2.44E-12	2.99E-09	4.71E-13	2.24E-10	1.50E-10	0.00E+00	1.48E-09	4.32E-11	8.19E-11	4.23E-11	5.01E-09
	HTO	0.00E+00	3.70E-07	0.00E+00	1.10E-11	5.98E-08	3.15E-08	0.00E+00	0.00E+00	0.00E+00	1.02E-08	1.12E-07	5.84E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.15E-08	5.27E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.68E-08
	Noble Gases	6.35E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.35E-08
	I(mfp)	8.00E-12	1.99E-10	2.92E-11	4.18E-14	4.55E-09	3.79E-10	0.00E+00	0.00E+00	0.00E+00	4.92E-14	0.00E+00	5.17E-09
Total		6.35E-08	3.71E-07	3.02E-09	1.15E-11	2.30E-07	2.62E-07	0.00E+00	1.48E-09	4.34E-11	1.03E-08	1.12E-07	1.05E-06
Infant	C-14	8.64E-13	6.30E-10	5.25E-14	5.75E-14	1.75E-07	2.31E-07	0.00E+00	5.70E-16	4.73E-13	5.51E-17	4.08E-12	4.07E-07
	Cs-137+	2.05E-13	2.17E-12	3.89E-09	7.36E-13	2.68E-10	1.18E-10	0.00E+00	1.92E-09	6.75E-11	4.49E-16	1.22E-11	6.28E-09
	HTO	0.00E+00	3.41E-07	0.00E+00	2.14E-11	9.70E-08	3.12E-08	0.00E+00	0.00E+00	0.00E+00	1.32E-09	4.05E-08	5.11E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.47E-08	5.46E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-07
	Noble Gases	7.72E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.72E-08
	I(mfp)	1.04E-11	2.10E-10	3.79E-11	9.43E-14	8.62E-09	4.33E-10	0.00E+00	0.00E+00	0.00E+00	1.08E-15	0.00E+00	9.31E-09
Total		7.72E-08	3.42E-07	3.89E-09	2.22E-11	3.67E-07	2.67E-07	0.00E+00	1.92E-09	6.80E-11	1.32E-09	4.05E-08	1.10E-06
Nursing Infant	C-14	8.64E-13	3.49E-10	5.25E-14	5.03E-14	1.82E-07	9.90E-08	0.00E+00	5.70E-16	4.14E-13	5.51E-17	1.13E-12	2.82E-07
	Cs-137+	2.05E-13	1.96E-12	3.89E-09	1.29E-12	7.32E-10	1.12E-10	0.00E+00	1.92E-09	1.18E-10	4.49E-16	6.75E-12	6.78E-09
	HTO	0.00E+00	2.50E-07	0.00E+00	2.83E-11	7.01E-07	2.02E-08	0.00E+00	0.00E+00	0.00E+00	1.06E-09	1.69E-08	9.89E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.40E-07	2.28E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.42E-07
	Noble Gases	7.72E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.72E-08
	I(mfp)	1.04E-11	1.18E-10	3.79E-11	9.49E-14	7.91E-09	2.38E-10	0.00E+00	0.00E+00	0.00E+00	1.08E-15	0.00E+00	8.31E-09
Total		7.72E-08	2.50E-07	3.93E-09	2.97E-11	1.03E-06	1.22E-07	0.00E+00	1.92E-09	1.19E-10	1.06E-09	1.69E-08	1.51E-06

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 127 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E12 – Pickering Industrial Park Resident Critical Group Doses for 2006

PN - Industrial		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animal:	Terrestrial plants	Aquatic animals	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
Adult	C-14	2.10E-12	2.70E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.56E-12	2.71E-09
	Cs-137+	6.36E-13	3.20E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.14E-10	9.47E-10
	HTO	0.00E+00	2.24E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-08	2.25E-06
	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	0.00E+00	0.00E+00	0.00E+00
	Noble Gases	5.13E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.13E-07
	I(mfp)	3.23E-11	4.23E-10	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	4.55E-10
Total		5.13E-07	2.24E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-08	2.76E-06

Table E13 – Pickering Correctional Institute (C2) Critical Group Doses for 2006

PN - C2		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animal:	Terrestrial plants	Aquatic animals	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
15yr. Old	C-14	3.35E-12	4.23E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E-16	3.54E-11	4.26E-09
	Cs-137+	7.26E-13	3.16E-11	1.38E-08	1.47E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.51E-12	3.45E-09	1.72E-08
	HTO	0.00E+00	2.31E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E-10	4.18E-08	2.36E-06
	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	0.00E+00	0.00E+00	0.00E+00
	Noble Gases	4.69E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.69E-07
	I(mfp)	3.68E-11	6.75E-10	1.34E-10	3.24E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.46E-10
Total		4.69E-07	2.32E-06	1.39E-08	1.50E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.59E-10	4.53E-08	2.85E-06

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 128 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E14 – Pickering Sport Fisher Critical Group Doses for 2006

PN - FISHER		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animal: Terrestrial plants	Aquatic animals	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
Adult	C-14	1.53E-12	1.97E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.63E-09	0.00E+00	0.00E+00	0.00E+00	8.61E-09
	Cs-137+	1.32E-13	6.64E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.76E-09	0.00E+00	0.00E+00	0.00E+00	7.76E-09
	HTO	0.00E+00	4.64E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.18E-09	0.00E+00	0.00E+00	0.00E+00	4.66E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.50E-09	0.00E+00	0.00E+00	0.00E+00	1.50E-09
	Noble Gases	1.19E-07	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	1.19E-07
	I(mfp)	6.38E-12	8.76E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.40E-11
	Total	1.19E-07	4.66E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.81E-08	0.00E+00	0.00E+00	0.00E+00	6.03E-07
15yr. Old	C-14	1.53E-12	1.93E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.65E-09	0.00E+00	0.00E+00	0.00E+00	5.58E-09
	Cs-137+	1.32E-13	5.75E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.34E-09	0.00E+00	0.00E+00	0.00E+00	4.34E-09
	HTO	0.00E+00	4.20E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-09	0.00E+00	0.00E+00	0.00E+00	4.21E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.39E-10	0.00E+00	0.00E+00	0.00E+00	8.39E-10
	Noble Gases	1.19E-07	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	1.19E-07
	I(mfp)	6.38E-12	1.23E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-10
	Total	1.19E-07	4.22E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-08	0.00E+00	0.00E+00	0.00E+00	5.51E-07
10yr. Old	C-14	1.53E-12	2.04E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.90E-09	0.00E+00	0.00E+00	0.00E+00	5.94E-09
	Cs-137+	1.32E-13	3.68E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.54E-09	0.00E+00	0.00E+00	0.00E+00	2.55E-09
	HTO	0.00E+00	4.00E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E-09	0.00E+00	0.00E+00	0.00E+00	4.01E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.76E-10	0.00E+00	0.00E+00	0.00E+00	8.76E-10
	Noble Gases	1.19E-07	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	1.19E-07
	I(mfp)	6.38E-12	1.44E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.50E-10
	Total	1.19E-07	4.02E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.48E-09	0.00E+00	0.00E+00	0.00E+00	5.29E-07
5yr. Old	C-14	1.53E-12	1.42E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.30E-09	0.00E+00	0.00E+00	0.00E+00	5.73E-09
	Cs-137+	1.32E-13	2.04E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.18E-09	0.00E+00	0.00E+00	0.00E+00	2.18E-09
	HTO	0.00E+00	3.10E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.41E-09	0.00E+00	0.00E+00	0.00E+00	3.11E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.92E-10	0.00E+00	0.00E+00	0.00E+00	9.92E-10
	Noble Gases	1.19E-07	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	1.19E-07
	I(mfp)	6.38E-12	1.66E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.73E-10
	Total	1.19E-07	3.11E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.88E-09	0.00E+00	0.00E+00	0.00E+00	4.39E-07
Infant	C-14	1.99E-12	1.45E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.10E-09	0.00E+00	0.00E+00	0.00E+00	4.55E-09
	Cs-137+	1.72E-13	1.81E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.21E-09	0.00E+00	0.00E+00	0.00E+00	1.22E-09
	HTO	0.00E+00	2.86E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.79E-10	0.00E+00	0.00E+00	0.00E+00	2.87E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.19E-10	0.00E+00	0.00E+00	0.00E+00	7.19E-10
	Noble Gases	1.45E-07	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	1.45E-07
	I(mfp)	8.30E-12	1.76E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.84E-10
	Total	1.45E-07	2.87E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.01E-09	0.00E+00	0.00E+00	0.00E+00	4.38E-07
Nursing Infant	C-14	1.99E-12	8.05E-10	0.00E+00	0.00E+00	3.23E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.03E-09
	Cs-137+	1.72E-13	1.64E-12	0.00E+00	0.00E+00	2.68E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.68E-09
	HTO	0.00E+00	2.09E-07	0.00E+00	0.00E+00	3.92E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.01E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.48E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.48E-10
	Noble Gases	1.45E-07	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	1.45E-07
	I(mfp)	8.30E-12	9.88E-11	0.00E+00	0.00E+00	3.69E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.76E-10
	Total	1.45E-07	2.10E-07	0.00E+00	0.00E+00	3.99E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.54E-07

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 129 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E15 – Pickering Urban Resident Critical Group Doses for 2006

PN -URBAN RESIDENT		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animals	Terrestrial plants	Aquatic animals	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
Adult	C-14	2.31E-12	2.98E-09	1.40E-13	2.90E-14	3.37E-12	1.24E-07	4.38E-12	4.39E-16	6.86E-14	1.12E-15	3.49E-11	1.27E-07
	Cs-137+	1.99E-13	9.99E-12	2.98E-08	3.18E-12	1.01E-14	9.61E-11	5.12E-12	1.48E-09	2.93E-11	9.12E-11	3.30E-09	3.48E-08
	HTO	0.00E+00	7.10E-07	0.00E+00	4.14E-12	5.18E-12	1.80E-08	1.44E-12	0.00E+00	0.00E+00	2.83E-09	4.17E-08	7.72E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.78E-12	2.77E-09	9.90E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.77E-09
	Noble Gases	4.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.63E-07
	I(mfp)	9.89E-12	1.32E-10	3.87E-11	6.07E-15	7.11E-13	3.09E-11	0.00E+00	0.00E+00	0.00E+00	1.12E-16	0.00E+00	2.13E-10
Total		4.63E-07	7.13E-07	2.99E-08	7.35E-12	1.11E-11	1.45E-07	1.19E-11	1.48E-09	2.93E-11	2.92E-09	4.50E-08	1.40E-06
15yr. Old	C-14	2.31E-12	2.92E-09	1.40E-13	2.85E-14	1.99E-12	9.49E-08	2.41E-12	4.39E-16	6.74E-14	1.12E-15	2.98E-11	9.79E-08
	Cs-137+	1.99E-13	8.65E-12	2.98E-08	3.18E-12	6.14E-15	7.29E-11	2.86E-12	1.48E-09	2.93E-11	9.12E-11	2.86E-09	3.44E-08
	HTO	0.00E+00	6.43E-07	0.00E+00	4.14E-12	3.23E-12	1.40E-08	8.04E-13	0.00E+00	0.00E+00	2.49E-09	3.62E-08	6.95E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-12	2.21E-09	5.54E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.22E-09
	Noble Gases	4.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.63E-07
	I(mfp)	9.89E-12	1.86E-10	3.87E-11	9.39E-15	6.55E-13	3.60E-11	0.00E+00	0.00E+00	0.00E+00	1.12E-16	0.00E+00	2.71E-10
Total		4.63E-07	6.46E-07	2.99E-08	7.35E-12	6.98E-12	1.11E-07	6.62E-12	1.48E-09	2.93E-11	2.58E-09	3.90E-08	1.29E-06
10yr. Old	C-14	2.31E-12	3.08E-09	1.40E-13	7.99E-14	2.21E-12	9.25E-08	2.58E-12	4.39E-16	1.89E-13	1.12E-15	3.53E-11	9.56E-08
	Cs-137+	1.99E-13	5.54E-12	2.98E-08	4.89E-12	3.50E-15	3.93E-11	1.68E-12	1.48E-09	4.50E-11	9.12E-11	1.86E-09	3.33E-08
	HTO	0.00E+00	6.12E-07	0.00E+00	1.03E-11	2.56E-12	1.22E-08	7.66E-13	0.00E+00	0.00E+00	2.36E-09	3.82E-08	6.64E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.06E-12	2.13E-09	5.78E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E-09
	Noble Gases	4.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.63E-07
	I(mfp)	9.89E-12	2.18E-10	3.87E-11	2.87E-14	8.28E-13	3.85E-11	0.00E+00	0.00E+00	0.00E+00	1.12E-16	0.00E+00	3.06E-10
Total		4.63E-07	6.15E-07	2.99E-08	1.53E-11	6.66E-12	1.07E-07	5.60E-12	1.48E-09	4.52E-11	2.45E-09	4.01E-08	1.26E-06
5yr. Old	C-14	2.31E-12	2.14E-09	1.40E-13	9.89E-14	2.43E-12	9.23E-08	2.84E-12	4.39E-16	2.34E-13	1.12E-15	3.58E-11	9.45E-08
	Cs-137+	1.99E-13	3.07E-12	2.98E-08	4.69E-12	2.99E-15	3.09E-11	1.44E-12	1.48E-09	4.32E-11	9.12E-11	1.46E-09	3.29E-08
	HTO	0.00E+00	4.74E-07	0.00E+00	1.41E-11	3.10E-12	1.36E-08	9.29E-13	0.00E+00	0.00E+00	2.06E-09	4.26E-08	5.32E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-12	2.20E-09	6.55E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.20E-09
	Noble Gases	4.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.63E-07
	I(mfp)	9.89E-12	2.51E-10	3.87E-11	5.56E-14	1.43E-12	6.13E-11	0.00E+00	0.00E+00	0.00E+00	1.12E-16	0.00E+00	3.63E-10
Total		4.63E-07	4.76E-07	2.99E-08	1.89E-11	8.16E-12	1.08E-07	5.86E-12	1.48E-09	4.34E-11	2.16E-09	4.41E-08	1.13E-06
Infant	C-14	3.01E-12	2.19E-09	1.83E-13	2.00E-13	2.14E-12	9.75E-08	2.05E-12	5.70E-16	4.73E-13	1.53E-16	5.13E-11	9.98E-08
	Cs-137+	2.58E-13	2.73E-12	3.88E-08	7.34E-12	2.56E-15	2.56E-11	8.01E-13	1.92E-09	6.75E-11	1.21E-11	1.62E-09	4.24E-08
	HTO	0.00E+00	4.37E-07	0.00E+00	2.74E-11	5.22E-12	1.42E-08	6.46E-13	0.00E+00	0.00E+00	3.24E-10	5.89E-08	5.11E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.54E-12	2.43E-09	4.75E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.44E-09
	Noble Gases	5.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.63E-07
	I(mfp)	1.29E-11	2.66E-10	5.03E-11	1.26E-13	1.14E-12	7.36E-11	0.00E+00	0.00E+00	0.00E+00	1.46E-16	0.00E+00	4.04E-10
Total		5.63E-07	4.40E-07	3.88E-08	3.51E-11	1.00E-11	1.14E-07	3.97E-12	1.92E-09	6.80E-11	3.36E-10	6.06E-08	1.22E-06
Nursing Infant	C-14	3.01E-12	1.21E-09	1.83E-13	1.75E-13	4.82E-08	4.66E-08	0.00E+00	5.70E-16	4.14E-13	1.53E-16	3.69E-12	9.60E-08
	Cs-137+	2.58E-13	2.46E-12	3.88E-08	1.23E-11	1.23E-09	2.78E-11	0.00E+00	1.92E-09	1.18E-10	1.21E-11	2.33E-10	4.23E-08
	HTO	0.00E+00	3.20E-07	0.00E+00	3.62E-11	6.57E-07	1.11E-08	0.00E+00	0.00E+00	0.00E+00	2.62E-10	6.39E-09	9.95E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.39E-08	1.35E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.52E-08
	Noble Gases	5.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.63E-07
	I(mfp)	1.29E-11	1.49E-10	5.03E-11	1.26E-13	6.83E-10	4.67E-11	0.00E+00	0.00E+00	0.00E+00	1.46E-16	0.00E+00	9.43E-10
Total		5.63E-07	3.21E-07	3.88E-08	4.93E-11	7.31E-07	5.91E-08	0.00E+00	1.92E-09	1.19E-10	2.74E-10	6.63E-09	1.72E-06

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 130 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Table E16 – Pickering Squires Beach Resident Critical Group Doses for 2006*

PN-SQUIRES BEACH		Air external	Air inhalation	Soil external	Soil ingestion	Terrestrial animal	Terrestrial plant	Aquatic animal	Sediment ext.	Sediment ingest	Water external	Water ingestion	Total (Sv/a)
Adult	C-14	7.70E-13	9.92E-10	4.68E-14	9.66E-15	0.00E+00	5.76E-09	3.76E-12	1.45E-16	2.26E-14	5.56E-16	1.32E-11	6.76E-09
	Cs-137+	1.26E-13	6.35E-12	2.77E-09	2.96E-13	0.00E+00	7.75E-11	1.88E-12	2.95E-10	5.85E-12	4.30E-11	6.10E-10	3.81E-09
	HTO	0.00E+00	4.58E-07	0.00E+00	2.67E-12	0.00E+00	4.99E-09	5.80E-13	0.00E+00	0.00E+00	1.12E-08	2.65E-07	7.39E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.58E-10	4.47E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.58E-10
	Noble Gases	2.73E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.73E-07
	I(mfp)	3.81E-12	5.13E-11	1.50E-11	2.35E-15	0.00E+00	1.76E-11	0.00E+00	0.00E+00	0.00E+00	2.90E-14	1.42E-12	8.91E-11
Total		2.73E-07	4.59E-07	2.79E-09	2.97E-12	0.00E+00	1.17E-08	6.67E-12	2.95E-10	5.87E-12	1.12E-08	2.66E-07	1.02E-06
15yr. Old	C-14	7.70E-13	9.73E-10	4.68E-14	9.49E-15	0.00E+00	4.41E-09	2.07E-12	1.45E-16	2.22E-14	5.56E-16	1.12E-11	5.40E-09
	Cs-137+	1.26E-13	5.50E-12	2.77E-09	2.96E-13	0.00E+00	5.89E-11	1.05E-12	2.95E-10	5.85E-12	4.30E-11	5.29E-10	3.71E-09
	HTO	0.00E+00	4.15E-07	0.00E+00	2.67E-12	0.00E+00	3.81E-09	3.24E-13	0.00E+00	0.00E+00	9.83E-09	2.30E-07	6.58E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.93E-10	2.50E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.93E-10
	Noble Gases	2.73E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.73E-07
	I(mfp)	3.81E-12	7.19E-11	1.50E-11	3.64E-15	0.00E+00	2.06E-11	0.00E+00	0.00E+00	0.00E+00	2.90E-14	1.90E-12	1.13E-10
Total		2.73E-07	4.16E-07	2.79E-09	2.98E-12	0.00E+00	8.99E-09	3.69E-12	2.95E-10	5.87E-12	9.87E-09	2.30E-07	9.41E-07
10yr. Old	C-14	7.70E-13	1.03E-09	4.68E-14	2.66E-14	0.00E+00	4.29E-09	2.21E-12	1.45E-16	6.24E-14	5.56E-16	1.33E-11	5.33E-09
	Cs-137+	1.26E-13	3.52E-12	2.77E-09	4.55E-13	0.00E+00	3.12E-11	6.15E-13	2.95E-10	9.00E-12	4.30E-11	3.44E-10	3.50E-09
	HTO	0.00E+00	3.94E-07	0.00E+00	6.67E-12	0.00E+00	3.38E-09	3.09E-13	0.00E+00	0.00E+00	9.30E-09	2.43E-07	6.50E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.59E-10	2.61E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.59E-10
	Noble Gases	2.73E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.73E-07
	I(mfp)	3.81E-12	8.43E-11	1.50E-11	1.11E-14	0.00E+00	2.17E-11	0.00E+00	0.00E+00	0.00E+00	2.90E-14	2.45E-12	1.27E-10
Total		2.73E-07	3.96E-07	2.79E-09	7.16E-12	0.00E+00	8.38E-09	3.40E-12	2.95E-10	9.06E-12	9.34E-09	2.43E-07	9.33E-07
5yr. Old	C-14	7.70E-13	7.14E-10	4.68E-14	3.30E-14	0.00E+00	4.28E-09	2.44E-12	1.45E-16	7.72E-14	5.56E-16	1.35E-11	5.01E-09
	Cs-137+	1.26E-13	1.95E-12	2.77E-09	4.37E-13	0.00E+00	2.42E-11	5.26E-13	2.95E-10	8.64E-12	4.30E-11	2.70E-10	3.42E-09
	HTO	0.00E+00	3.06E-07	0.00E+00	9.07E-12	0.00E+00	3.81E-09	3.75E-13	0.00E+00	0.00E+00	8.14E-09	2.71E-07	5.88E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.72E-10	2.96E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.72E-10
	Noble Gases	2.73E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.73E-07
	I(mfp)	3.81E-12	9.73E-11	1.50E-11	2.16E-14	0.00E+00	3.41E-11	0.00E+00	0.00E+00	0.00E+00	2.90E-14	3.89E-12	1.54E-10
Total		2.73E-07	3.07E-07	2.79E-09	9.56E-12	0.00E+00	8.83E-09	3.64E-12	2.95E-10	8.72E-12	8.18E-09	2.71E-07	8.70E-07
Infant	C-14	1.00E-12	7.30E-10	6.09E-14	6.66E-14	0.00E+00	4.52E-09	1.76E-12	1.88E-16	1.56E-13	6.70E-17	1.94E-11	5.27E-09
	Cs-137+	1.64E-13	1.73E-12	3.61E-09	6.82E-13	0.00E+00	1.94E-11	2.93E-13	3.84E-10	1.35E-11	1.22E-12	3.00E-10	4.33E-09
	HTO	0.00E+00	2.82E-07	0.00E+00	1.77E-11	0.00E+00	4.11E-09	2.60E-13	0.00E+00	0.00E+00	2.14E-09	3.74E-07	6.62E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.23E-10	2.14E-13	7.24E-10	0.00E+00	0.00E+00	0.00E+00	1.45E-09
	Noble Gases	3.32E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.32E-07
	I(mfp)	4.95E-12	1.03E-10	1.95E-11	4.87E-14	0.00E+00	3.96E-11	0.00E+00	0.00E+00	0.00E+00	5.43E-15	6.24E-12	1.73E-10
Total		3.32E-07	2.83E-07	3.63E-09	1.85E-11	0.00E+00	9.41E-09	2.53E-12	1.11E-09	1.37E-11	2.15E-09	3.75E-07	1.01E-06
Nursing Infant	C-14	1.00E-12	4.05E-10	6.09E-14	5.83E-14	2.54E-09	2.15E-09	0.00E+00	1.88E-16	1.37E-13	6.70E-17	1.39E-12	5.10E-09
	Cs-137+	1.64E-13	1.56E-12	3.61E-09	1.19E-12	3.40E-10	1.93E-11	0.00E+00	3.84E-10	2.36E-11	1.22E-12	4.31E-11	4.42E-09
	HTO	0.00E+00	2.06E-07	0.00E+00	2.33E-11	6.80E-07	3.53E-09	0.00E+00	0.00E+00	0.00E+00	1.73E-09	4.06E-08	9.33E-07
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-08	3.62E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.40E-08
	Noble Gases	3.32E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.32E-07
	I(mfp)	4.95E-12	5.78E-11	1.95E-11	4.90E-14	2.88E-10	2.28E-11	0.00E+00	0.00E+00	0.00E+00	5.43E-15	5.16E-13	3.94E-10
Total		3.32E-07	2.07E-07	3.63E-09	2.46E-11	6.97E-07	6.07E-09	0.00E+00	3.84E-10	2.38E-11	1.73E-09	4.07E-08	1.29E-06

* NOTE: Dose calculated based on limited data available in the first six months of 2006. Squires Beach is no longer a critical group for PN

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 131 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Distribution

Paper Copy

CANADIAN NUCLEAR SAFETY COMMISSION

Director of Pickering Compliance and Licensing Division	- Ottawa
Director of Darlington Compliance and Licensing Division	- Ottawa
Director, Environmental Protection and Audit Division	- Ottawa
Librarian	- Ottawa

ONTARIO POWER GENERATION

Nuclear Protection Programs and Training Division

Director, Nuclear Protection Programs and Training	- P82
Manager, Environment Programs Department	- P82
Section Manager, Environment Support and Services	- P82
Records	- P82
Section Manager, Dosimetry	- P58
Health and Safety Technical Information Centre (Records)	- P58

Pickering Nuclear

Section Manager, Environmental Compliance	- P41-E2
Manager, Site Public Affairs	- P02A0
Record Centre	- P41-E2

Darlington Nuclear

Section Manager, Environmental Compliance	- D08 ES1
Manager, Site Public Affairs	- D01I
Record Centre	- D08 ES1

Nuclear Waste Management Division

Manager, Environment Health and Safety	- B23
--	-------

BRUCE POWER

REMP Program Coordinator	- B21
--------------------------	-------

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

132 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Distribution (Continued)

ATOMIC ENERGY OF CANADA LIMITED

Manager, Radiation Biology and Health Physics Branch
Manager, Environmental Protection

- AECL Chalk River
- AECL Chalk River

NEW BRUNSWICK POWER

Manager, Health Physics Division

- Pt Lepreau NGS

HYDRO QUEBEC

Chief, Radioprotection

- Gentilly NGS

CANDU OWNERS GROUP

Chairman, COG Operations

- Toronto

NUCLEAR WASTE MANAGEMENT ORGANIZATION

Technical Advisor, Nuclear Waste Management Organization

- Toronto

REGIONAL MUNICIPALITY OF DURHAM

Medical Officer of Health (3 copies)

- Whitby, Ontario

Executive Summary Only by Email Notification

ONTARIO POWER GENERATION

President and Chief Executive Officer
Chief Nuclear Officer
Senior Vice-President - Pickering A Nuclear
Senior Vice-President - Pickering B Nuclear
Senior Vice-President - Darlington Nuclear
Senior Vice-President – Plant Life Extension Projects
Vice-President - Engineering and Modifications and CNE
Vice-President - Performance Improvement and Nuclear Oversight
Vice-President - Sustainable Development
Vice-President - Nuclear Waste Management
Director – Licensing, Plant Life Extension Projects
Director - Regulatory Affairs

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 133 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Distribution (Continued)

Nuclear Protection and Training

Manager, Health Physics Department
Radiation Protection Manager, Pickering A
Radiation Protection Manager, Pickering B
Radiation Protection Manager, Darlington

Nuclear Waste Management

Director, Nuclear Waste Projects
Director, Nuclear Waste Engineering and Technology
Director, Nuclear Waste Operations
Manager, Pickering Waste Management Facility

Pickering Nuclear

Director, Operations and Maintenance – Pickering A
Director, Operations and Maintenance – Pickering B
Director, Station Engineering – Pickering A
Director, Station Engineering – Pickering B
Manager, Chemistry and Environment
Manager, Regulatory Affairs
Manager, Pickering Public Affairs

Darlington Nuclear

Director, Operations & Maintenance
Director, Station Engineering
Manager, Chemistry and Environment
Manager, Regulatory Affairs
Manager, Darlington Public Affairs

Corporate Public Affairs

Director, Nuclear Public Affairs

Report

Public Information

Document Number:

N-REP-03481-10005

Sheet Number:

N/A

Revision:

R001

Page:

134 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Distribution (Continued)

Letter Notification Announcing Report Posting on OPG Website

CANADIAN NUCLEAR SAFETY COMMISSION

Director General, Directorate of Assessment & Analysis	- Ottawa
Director General, Directorate of Operational Strategies	- Ottawa
Director General, Directorate of Nuclear Substance Regulation	- Ottawa
Director General, Directorate of Power Reactor Regulation	- Ottawa
Director General, Directorate of Nuclear Cycle and Facilities Regulation	- Ottawa
Director, Radiation Protection Division	- Ottawa

BRUCE POWER

Vice-President Safety and Environment	- B06
Section Manager Dosimetry – Health Physics Laboratory	- B13

NEW BRUNSWICK POWER

Director, Health & Safety Division	- Fredericton, NB
------------------------------------	-------------------

ATOMIC ENERGY OF CANADA LIMITED

Manager, Environmental Technologies Branch	- AECL Chalk River
Manager, Environment and Radiological Science Division	- AECL Sheridan Park

MINISTRY OF ENVIRONMENT

Director	- Environmental Monitoring and Reporting Branch
Director	- Standards Development Branch
Senior Manager, Integration and Planning	- Integrated Environmental Planning Division
Director	- Central Region
District Manager	- Ottawa District
District Manager	- York Durham District
Group Leader, Sport Fish and Bio-monitoring Unit	- Environmental Monitoring and Reporting Branch

MINISTRY OF ENERGY

Assistant Deputy Minister, Energy Supply and Conservation	- Toronto, Ontario
---	--------------------

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 135 of 136

Title:

2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Distribution (Continued)

MINISTRY OF COMMUNITY SAFETY AND CORRECTIONAL SERVICES

Chief, Emergency Management Ontario - Toronto, Ontario

MINISTRY OF NATURAL RESOURCES

Planning Biologist – Southern Region Planning Unit - Peterborough, Ontario
Manager – Lake Huron - Owen Sound, Ontario

MINISTRY OF AGRICULTURE AND FOOD

Manager, Risk Management Unit - Guelph, Ontario

CANADIAN FOOD INSPECTION AGENCY

Inspection Manager, Fish Inspection - Mississauga, Ontario

ENVIRONMENT CANADA

Head, Nuclear Programs and Contaminants - Downsview, Ontario

HEALTH CANADA

Director, Radiation Protection Bureau - Ottawa, Ontario
Chief, Environmental Radiation Hazards Division - Ottawa, Ontario

ONTARIO MINISTRY OF LABOUR

Manager, Radiation Protection Service - Weston, Ontario

REGIONAL MUNICIPALITY OF DURHAM

Technical Support Manager - Whitby, Ontario
Director of Emergency Management - Whitby, Ontario
Plant Superintendent - Duffin Creek Water
Pollution Control Plant

TORONTO PUBLIC HEALTH

Medical Officer of Health - Toronto, Ontario

Report

Public Information		
Document Number: N-REP-03481-10005		
Sheet Number: N/A	Revision: R001	Page: 136 of 136

Title:
2006 RESULTS OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Distribution (Continued)

REGIONAL MUNICIPALITY OF HALTON

Laboratory Supervisor

- Oakville, Ontario

TECHNICAL SERVICES DIVISION, CITY OF TORONTO

Manager, Toronto Office of Emergency Management

- Toronto, Ontario