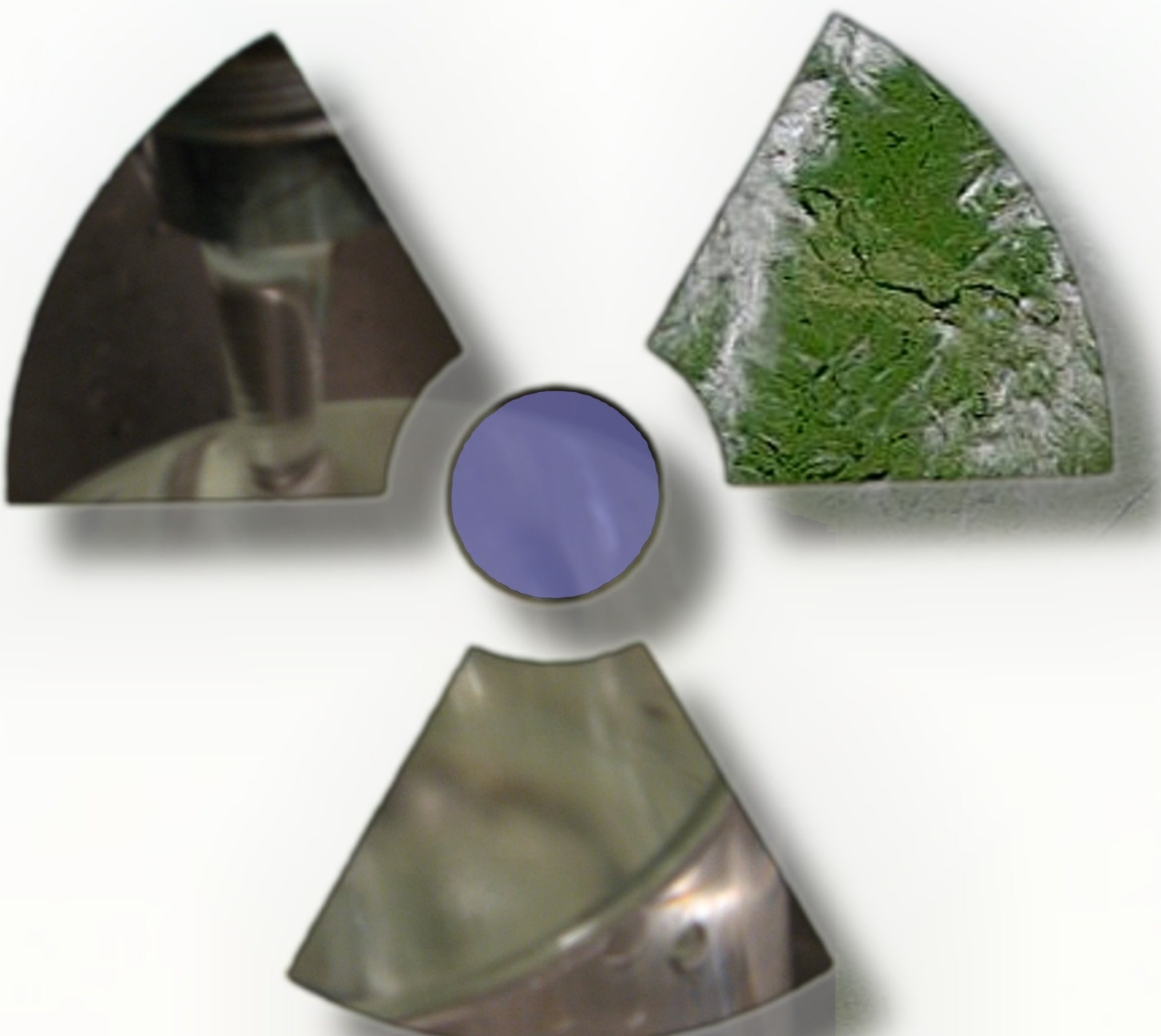
Sierra Club Canada

Tritium on Tap



KEEP RADIOACTIVE TRITIUM OUT OF OUR DRINKING WATER

Tritium on Tap:

Keep radioactive tritium out of our drinking water

By Mike Buckthought

Sierra Club Canada

Acknowledgements

We would like to thank Barbara Winter for her generous support of this project. Without her support, this publication would not have been possible.

Special thanks to staff at the City of Ottawa for sharing data for levels of tritium in Ottawa's drinking water.

Design & writing by Mike Buckthought.

November 18, 2009 | Rev. 0.54

Sierra Club Canada

National Office
412-1 Nicholas Street
Ottawa, ON K1N 7B7
Tel: (613) 241-4611
Fax: (613) 241-2292
www.sierraclub.ca

SIERRA CLUB CANADA

Contents

List of tables

Executive summary

Canada's nuclear reactors release massive quantities of radioactive pollution on a daily basis. Tritium gets into our air, lakes and rivers in the form of radioactive water. It contaminates our food and drinking water, and it is easily absorbed into our body. Tritium is a carcinogen and it causes birth defects.

Tritium pollution causes cancer and birth defects

Tritium replaces ordinary non-radioactive hydrogen and travels throughout the body, going wherever water goes. It becomes part of our DNA, fat, proteins and carbohydrates – and that's where it does its damage, from close range.

Tritium decays within our body, ejecting high-velocity beta particles that can break the chemical bonds of our DNA. The result can be cancer or birth defects. A developing fetus is particularly susceptible to damage from exposure to radiation.

There are higher rates of childhood leukemia near nuclear plants in Canada, Germany and the United States – the result of chronic exposure to radioactive pollution from reactors.

No safe level of exposure to radiation

New research has shown that the nuclear industry has greatly underestimated the risks of exposure to tritium and other radioactive pollutants from nuclear reactors. There is no safe level of exposure to radiation – even background levels of radiation cause cancer. Our drinking water standards need to be revised to take into account this new information, and protect people from chronic exposure to radioactive tritium.

Tritium in our drinking water

Sierra Club Canada tested Ottawa's drinking water following an incident at the NRU reactor operated by Atomic Energy of Canada Limited (AECL). We found elevated levels of tritium in the drinking water, with implications for our health.

There have been frequent leaks of radioactive water from the NRU reactor at Chalk River. AECL collects the radioactive water and dumps it into the Ottawa River. From December 2008 to February 2009, AECL deliberately released 30 trillion becquerels of tritium into the river.

During the spring and summer of 2009, AECL collected large quantities of radioactive water from the leaking reactor. We believe AECL is about to release the radioactive water into the Ottawa River. The practice of deliberately releasing tritium must be stopped immediately.

Radioactive waste flows into the Ottawa River

Chalk River Laboratories is Canada's leading nuclear research facility, but it has a long history of nuclear accidents. This report details some of the problems of radioactive waste that is now contaminating the groundwater and the Ottawa River.

Radioactive plumes of tritium and strontium-90 contaminate the groundwater below the NRU reactor.

The tritium flows into the Ottawa River, contaminating the drinking water of people living in Ottawa and other communities downstream from Chalk River.

Growing problems from glow-in-the-dark exit signs

Two of the largest sources of tritium pollution are SRB Technologies and Shield Source, manufacturers of radioactive glow-in-the-dark signs. Massive quantities of tritium pollute the communities of Pembroke and Peterborough, Ontario. The signs are made with tritium waste removed from Ontario's nuclear plants.

Tritium from SRB Technologies and Shield Source contaminates vegetables grown in local gardens. Tritium also contaminates wells and groundwater, threatening drinking water supplies.

The manufacturers dump radioactive tritium into the sewer systems of Pembroke and Peterborough, contaminating the municipal infrastructure with radioactive waste. The SRB Technologies plant is another active source of contamination of the Ottawa River.

Ending radioactive pollution

The nuclear industry would like us to believe that nuclear power is a clean alternative to fossil fuels – but that is simply not true. Radioactive pollution from Canada's nuclear reactors contaminates rivers, lakes and groundwater. Radioactive water also contaminates fruits and vegetables grown near nuclear plants.

Canada's nuclear power plants released 6.6 quadrillion becquerels of tritium oxide in 2008, and emissions have been rising steadily.

With widespread radioactive pollution of our water and the atmosphere, we need more stringent standards for emissions of tritium and other pollutants. We need to keep radioactive water out of the environment and our drinking water.

Nuclear power is not a pollution-free source of energy. There are safer, more economical alternatives.

Over the long term, we need to phase out nuclear power and ban the use of radioactive glow-in-the-dark signs. We can make the transition to renewable energy, and create tens of thousands of green jobs.

We need to take a precautionary approach. Stopping radioactive pollution at its source will help prevent childhood leukemia and lower cancer rates.

1. The trouble with tritium

Downstream from the NRU nuclear reactor at Chalk River, millions of people depend on the Ottawa River and the St. Lawrence River for their drinking water.

And yet, the reactor operated by Atomic Energy of Canada Limited (AECL) leaks radioactive water into the Ottawa River, upstream from the nation's capital. It has recently been shut down for repairs, but it could be started up again, leading to additional contamination of the river.

In the Ottawa Valley community of Pembroke, Ontario, a radioactive sign manufacturer releases radioactive tritium up a smoke stack, in a residential neighbourhood. SRB Technologies continues to manufacture radioactive signs, subjecting its neighbours to unacceptable risks.

High levels of radioactive tritium have been found in vegetable gardens in Pembroke, as well as nearby wells. Ice in a community hockey rink has been contaminated with tritium.

These examples point to the need for better standards to keep radioactive tritium out of our food and water. Radioactive tritium is getting into our drinking water, exposing many Canadians to a known carcinogen. Tritium can cause cancer and birth defects.

The Canadian Nuclear and Safety Commission (CNSC) assures us that our water is safe, but Canada has lax drinking water standards.

The guideline for Canada is 7,000 becquerels per litre for tritium in our drinking water. By contrast, the European Union guideline is 100 becquerels per litre. California's Public Health Goal calls for a limit of 14.8 becquerels per litre.

TRITIUM ON TAP. Water from this tap in downtown Ottawa has been found to contain elevated levels of tritium. Photo Mike Buckthought.

Radioactive water pollutes the Great Lakes, Ottawa River, St. Lawrence River and the Bay of Fundy. Millions of people are drinking water with elevated levels of tritium, thanks to our continued reliance on nuclear reactors. Below these reactors, the groundwater is contaminated with radioactive tritium, threatening our health and the environment.

Radioactive water pollutes our lakes and rivers

THE GREAT LAKES AND THE OTTAWA RIVER. Satellite image of the Great Lakes. From the SeaWiFS Project, NASA/Goddard Space Flight Center. Graphic by Mike Buckthought.

Some of the highest levels of radioactive tritium pollution have been found in Ontario, the province with most of Canada's nuclear reactors. Coincidentally, the reactors are located in some of the most densely populated areas in the country. The Pickering nuclear station is only 35 kilometres from downtown Toronto.

Millions of people living near the Pickering, Bruce and Darlington stations are exposed to routine airborne emissions of radioactive water vapour, and there are elevated levels of tritium in the Great Lakes.

As well as the chronic exposure to tritium, there are large increases following accidents. An accidental release of tritium from the Pickering nuclear plant in August 1992 sent 2,020 trillion becquerels of tritium into Lake Ontario. After this incident, high levels of tritium were measured at water treatment plants in the Toronto area.

Tritium levels reached 624 becquerels per litre at the R.C. Harris water treatment plant in Toronto, and 605 becquerels per litre at the F.J. Horgan treatment plant in Scarborough.[1]

Because of the routine and accidental releases of radioactive water from nuclear plants, Lake Ontario and Lake Huron have elevated levels of tritium – around 5-7 becquerels per litre. This is two to five times greater than levels in Lake Superior, which has no reactors on its shores. Tritium levels are rising over time. To deal with the buildup of tritium in Ontario's nuclear plants, the Darlington tritium removal facility was constructed. It processes heavy water from Candu reactors, to remove the tritium. Some of the excess tritium is used by manufacturers of glow-in-the-dark radioactive signs. These manufacturers include SRB Technologies, based in Pembroke, Ontario, and Shield Source in Peterborough.

What is a becquerel?

A becquerel is a unit of radioactivity, equivalent to one disintegration a second. An example: some water has a tritium concentration of 600 becquerels per litre. That means for each litre of water, 600 tritium atoms decay every second.

After a 1992 accident at the Pickering nuclear station, Toronto's drinking water contained 624 becquerels of tritium per litre.

By comparison, if you are far from a nuclear plant, drinking water can have tritium levels of one or two becquerels per litre. Before the nuclear age, levels would have been lower.

1 Kim Perrotta, Environmental Health Issues in the City of Toronto, Health Promotion and Environmental Protection, Toronto Public Health, September 1999. http://www.toronto.ca/health/hphe/pdf/boh_environmental_health_issues_technical_word.pdf.

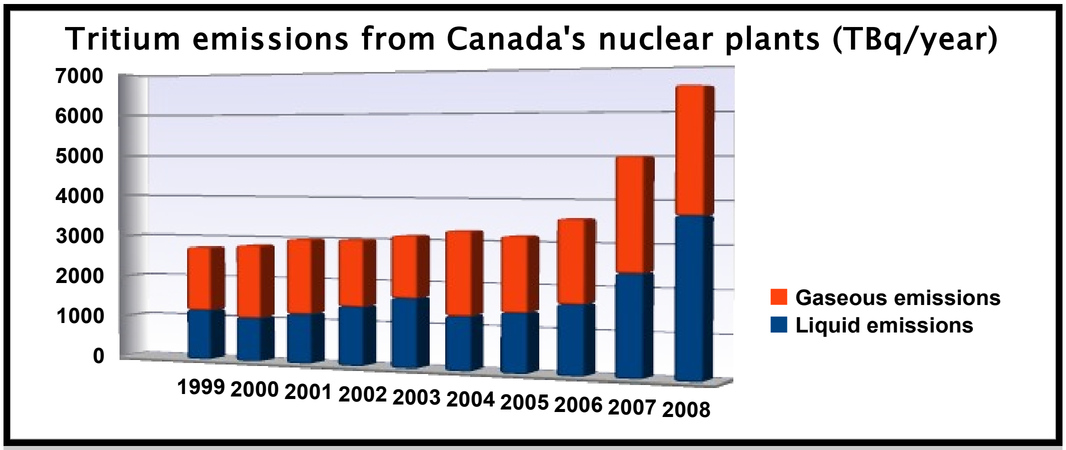


Figure 1. EMISSIONS OF TRITIUM OXIDE FROM CANADA'S NUCLEAR GENERATING STATIONS. Liquid and gaseous emissions of tritium from Canada's nuclear plants, in trillions of becquerels. Data compiled from CNSC release data.

Radioactive pollution from Canada's nuclear generating stations

Canada's nuclear reactors release massive quantities of radioactive tritium and carbon-14 into lakes, rivers and the atmosphere – and emissions have been rising.

Total emissions of tritium have been rising over the past decade. In 2008, Canada's nuclear generating stations released a total of 6.6 quadrillion becquerels of tritium oxide into Lake Ontario, Lake Huron, the Bay of Fundy, the St. Lawrence River and the atmosphere.[2]

The tritium gets into our drinking water, and it is carried with the wind to farms, where it can contaminate fruits and vegetables.

Year	Tritium oxide (gas) TBq	Tritium oxide (liquid) TBq	Total emissions of tritium oxide TBq
1999	1,550	1,196	2,746
2000	1,760	1,055	2,815
2001	1,800	1,187	2,987
2002	1,590	1,410	3,000
2003	1,480	1,649	3,129
2004	1,980	1,275	3,255
2005	1,770	1,392	3,162
2006	1,930	1,640	3,570
2007	2,630	2,371	5,001
2008	2,890	3,680	6,570

TABLE 1. TRITIUM OXIDE EMISSIONS FROM CANADA'S NUCLEAR GENERATING STATIONS, 1999-2008. Liquid and gaseous emissions of tritium oxide, measured in trillions of becquerels. Source: Data compiled from CNSC release data.

2 Total calculated from data in: CNSC, Radioactive Release Data from Canadian Nuclear Power Plants 1999-2008, INFO-0210, Revision 13, September 2009.

Tritium means trouble

Every day, Canada's nuclear reactors release massive quantities of tritium. It gets into our air, lakes and rivers in the form of radioactive water. When we breathe radioactive water vapour, or eat vegetables grown with radioactive water, the tritium is easily absorbed into our body.

Tritium is dangerous because it replaces ordinary non-radioactive hydrogen in water. A radioactive form of water is created, known as tritiated water. It can travel throughout the body, going wherever water goes.

Tritium also gets into our body in the form of organically bound tritium. Radioactive tritium atoms take the place of normal hydrogen in the organic compounds found in food, such as vegetables grown with contaminated water.

Once in our body, tritium enters our DNA, fat, proteins and carbohydrates – and that is where it does its damage, from close range.

When tritium decays, it becomes helium-3. Think of radioactive hydrogen atoms disintegrating inside your DNA, ejecting high-velocity beta particles that can break chemical bonds. The DNA code is disrupted. The result can be cancer, years down the road.

Women exposed to tritium can give birth to babies with birth defects. A developing fetus is particularly susceptible to damage from exposure to radiation.

The UK's Committee Examining Radiation Risks of Internal Emitters (CERRIE) calls attention to the dangers for pregnant women and fetuses. Ingestion, inhalation or absorption of tritium can lead to stillbirths and malformations.

Long-lived cells dividing at the time of exposure to tritium are at the greatest risk. These include nerve cells and oocytes. Genetic damage to reproductive cells can be passed on to future generations.

CERRIE concludes that the dose coefficient for tritium needs to be revised – the risks of exposure to tritiated water are underestimated by a factor of fifteen.

Tritium has special properties that make it hazardous: its ease of absorption, its concentration in DNA, its ability to bind with organic molecules, and its ability to exchange with non-radioactive hydrogen atoms.[3]

The trouble with tritium

- It is a carcinogen and causes birth defects. It is easily absorbed into our body.
- It makes water radioactive. Tritium atoms trade places with non-radioactive hydrogen atoms.
- Radioactive water gets into rain, rivers and lakes. It gets into our water and food.
- Tritium becomes part of our DNA, fat, proteins and carbohydrates. It gets inside our cells, and damages our DNA from close range.
- Tritium can disrupt the genetic code of oocytes, a woman's reproductive cells. Genetic defects can be carried on to future generations.
- Tritium easily binds with organic molecules to form organically bound tritium.
- Because it can get into food and water, there is chronic exposure to tritium.

3 "Tritium: Properties, Metabolism and Dosimetry," Committee Examining Radiation Risks of Internal Emitters (CERRIE), Paper 9-1, April 30, 2003. http://www.cerrie.org.

Radiation harms our children

Canada's CANDU reactors release far more tritium than other types of reactors, with potentially grave consequences. Studies have revealed increased rates of leukemia and birth defects near the Pickering and Bruce nuclear plants.

A study by the Atomic Energy Control Board (AECB) found an 80% increase in rates of Down's Syndrome for children living in the city of Pickering. A 46% increase in rates of Down's Syndrome was found in Ajax, a city further away from the Pickering nuclear plant.[4]

Other AECB studies found increased rates of childhood leukemia near the Bruce and Pickering nuclear plants. Death rates were 1.4 times higher than would be expected. The researchers also compared the death rates, before and after the Pickering reactors started operating. Deaths from childhood leukemia increased following the start of operations.[5] [6]

These early Canadian studies showed increased rates of leukemia for children. A number of international studies have come to the same conclusion: children living near nuclear reactors are hit by increased rates of leukemia. Dr. Ian Fairlie has surveyed some of these studies from Britain, Germany and other countries.[7]

A number of British studies found increased incidences of childhood leukemia near the Windscale (Sellafield), Burghfield and Dounreay nuclear plants in England and Scotland.

Similar results have been found in other countries. Research by Baker and Hoel at the Medical University of South Carolina analyzed results from 17 studies of 136 nuclear sites in the UK, Canada, France, United States, Germany, Japan and Spain. They found elevated death and incidence rates for childhood leukemia, and increased rates of leukemia continued into adulthood.

For babies and children up to the age nine, death rates went up by 5 to 24 per cent, depending on how close they lived to nuclear facilities. Incidence rates for leukemia increased by 14 to 21 per cent for babies and children up to 9 years old. For children and adults up to the age of 25 years old, the leukemia rates increased by 7 to 10 percent.[8]

Other recent studies in Germany have further bolstered the evidence pointing to increased risks of childhood leukemia near nuclear reactors.

The most comprehensive study looked at incidences of leukemia near 16 of 20 reactors in Germany, and was commissioned by the German Federal Office for Radiation Protection.

The study found an increase of 60 per cent for rates of solid cancers, and a 117 per cent increase for leukemia among children aged up to five years living near German nuclear plants.[9]

---

4 Tritium Releases from the Pickering Nuclear Generating Station and Birth Defects and Infant Mortality in Nearby Communities 1971-1988, Atomic Energy Control Board, Report INFO-0401, Ottawa, 1991.

5 Childhood Leukemia around Canadian Nuclear Facilities - Phase I, A Report prepared by the Ontario Cancer Treatment and Research Foundation, Atomic Energy Control Board, Ottawa, 1989.

6 Childhood Leukemia around Canadian Nuclear Facilities - Phase II-Final Report, A Report prepared by the Ontario Cancer Treatment and Research Foundation, Atomic Energy Control Board, AECB-INFO-0300-2, Ottawa, 1991.

7 For an excellent overview of recent studies showing increased rates of childhood leukemia, see: Ian Fairlie, "Childhood Leukemias Near Nuclear Power Stations," *MEDACT Communique.*

8 PJ Baker and D. Hoel, "Meta-analysis of standardized incidence and mortality rates of childhood leukaemia in proximity to nuclear facilities," *European Journal of Cancer Care* 16 (2007): 355-363.

9 P. Kaatsch et al, "Leukaemia in young children living in the vicinity of German nuclear power plants," International Journal of Cancer 122, no. 4 (February 15, 2008): 721-726.

Dr. Fairlie points to the higher emissions of tritium from boiling water reactors in Germany: "An interesting aspect is that many of the reactors in the KiKK study are boiling water reactors (BWRs) notable for their relatively high tritium emissions."

Another recent study looked at leukemia deaths for children living near reactors in the United States. The study analyzed leukemia death rates for children and teenagers aged 0-19 living in the 67 counties near 51 nuclear plants.[10] The authors looked for changes over time – comparing the earliest period of reactor operations with a more recent period of time (1985-2004). They found an increase in leukemia rates over time:

- an increase of 13.9% in death rates for children living near the oldest nuclear plants.
- an increase of 9.4% in death rates for children living near the newest nuclear plants.

People living near reactors are exposed to large quantities of radioactive pollution, and we are only beginning to understand some of the hazards – the increased rates of leukemia and other forms of cancer, and the genetic damage that can be passed on to future generations. These studies support the need for a precautionary approach. With evidence of rising rates of childhood leukemia near reactors, we can likely prevent many cancers by phasing out nuclear power.

10 Joseph Mangano and Janette Sherman, "Childhood Leukaemia Near Nuclear Installations," *European Journal of Cancer Care* 17 (2008): 416–418. http://www.radiation.org/reading/pubs/ecc_948.pdf.

Radiation risks: no safe level of exposure

The nuclear industry spin doctors downplay the risks. We are told that we all get exposed to natural sources of radiation, and we are given the impression that it is safe to be exposed to radiation from nuclear reactors, as long as the dose is below a certain level of exposure.

This is an outdated concept. It is now known that there is no safe threshold of exposure to radiation. New research points to the risks of developing cancer from exposure to low levels of radiation.

In 2006 the National Academies released a landmark study. The seventh Biological Effects of Ionizing Radiation (BEIR VII) report concluded that there is no safe level of exposure to radiation. According to the report:

> A comprehensive review of available biological and biophysical data supports a "linear-no-threshold" (LNT) risk model– that the risk of cancer proceeds in a linear fashion at lower doses without a threshold and that the smallest dose has the potential to cause a small increase in risk to humans.[11]

When a population is exposed to low levels of ionizing radiation, we can expect increased rates of cancer and death from cancer. We now know that exposure to background radiation causes cancers. Any additional exposure to radiation increases the risk of developing cancer. Even low levels of radiation can be dangerous to our health.

Using data from survivors exposed to the atomic bombings at Hiroshima and Nagasaki, and people exposed to radiation during medical tests and work in nuclear plants, the researchers modelled the increased incidence of cancer from exposure to low-level ionizing radiation. According to their

11 Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation, National Research Council, *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2* (Washington, DC: National Academies Press, 2006).

estimates, approximately one cancer in 100 people could result from a single exposure to 100 millisieverts of low-level ionizing radiation. Lower exposures are not risk-free; for example, "it is predicted that approximately one individual in 1000 would develop cancer from an exposure to 10 mSv." [12]

Another recent report found increased risks for cancer among nuclear workers.[13] The study coordinated by the International Agency for Research on Cancer (IARC) considered over 407,000 nuclear workers from fifteen countries, including Canada.

The excess relative risk for all cancers excluding leukemia was found to be 0.97 per sievert. In other words, for an exposure of one sievert of radiation, there was a 97% increase in a nuclear worker's risk of dying from cancer, excluding leukemia. On average, the nuclear workers were exposed to 19 millisieverts of radiation – increasing by 2% their risk of dying from all cancers, excluding leukemia.

The study found that the risks for Canadian nuclear workers were significantly higher than the risks for workers in other countries: "the risk estimate for Canada is the largest." This higher risk may be accounted for by the fact that Canadian reactors use a different design. Because Canadian nuclear reactors use heavy water as a moderator, nuclear workers are likely exposed to higher levels of tritium.

The recent comprehensive studies by the National Academies and IARC demonstrate clear links between exposures to low levels of radiation and increased risks of dying from cancer.

With this new evidence in mind, we need to take a precautionary approach. We need to keep levels of tritium as close to background as possible. What is the approach taken by governments in Canada, are they protecting everyone from exposure to radiation?

Unfortunately, Canada continues to rely on outdated models for estimating the risks of exposure to radiation. Canadian guidelines do not take into account the special properties of tritium. The limits for exposure to tritium are far too high, exposing millions of people to increased risks from radiation.

Drinking water standards: what's safe?

In Canada, we have dangerously high limits for tritium in our drinking water. The CNSC assures us that our standards are adequate. It ignores the fact that there is no safe level of exposure to radiation.

Canada has a guideline of 7,000 becquerels per litre for tritium in drinking water, and this is the standard in Ontario too. A becquerel is a unit of radioactivity corresponding to the decay of one radioactive atom each second.

Drinking water standards and guidelines for tritium	Bq/L
Canada	7,000
Ontario, Quebec, Manitoba, Alberta[14]	7,000
European Union	100
California[15]	14.8

TABLE 2. DRINKING WATER STANDARDS FOR TRITIUM. Measured in becquerels per litre (Bq/L).

12 Ibid.

13 E. Cardis et al, "Risk of cancer after low doses of ionising radiation: retrospective cohort study in 15 countries" *British Medical Journal* 331 (7508): 77-82.

14 These provinces have followed the federal guideline for their drinking water standards.

15 California's Public Health Goal (PHG) is 400 picocuries per litre for tritium in drinking water, equivalent to 14.8 Bq/L.

PICKERING NUCLEAR GENERATING STATION.

What would it mean if there were 7,000 becquerels per litre of tritium in our drinking water? Each second, 7,000 radioactive tritium atoms would decay, shooting off beta particles – high-velocity electrons that can do a lot of damage, breaking chemical bonds within our DNA.

The Ontario drinking water standard was recently reviewed by the Ontario Drinking Water Advisory Council (ODWAC). On May 21, 2009, the Council released a report recommending much more stringent drinking water standards for tritium.

ODWAC considered what level of tritium would result in a risk of one in a million – meaning one new excess cancer occurring over existing rates of cancer, for a population of one million exposed over a period of 70 years. The Council concluded that a risk of one in one million would be found with concentrations between 7 to 109 Bq/L. This would be much lower than the current dangerously high limit of 7,000 Bq/L.

According to one calculation of risk assessment shown in the report, the more stringent standard of 7 Bq/L is required if a relative biological effectiveness for tritium of 2 is applied – recognizing that radiation from tritium has a greater potential to do damage.[16]

The report recognizes that the current drinking water standards are far too dangerous. It backs the conclusions of many who have pushed for more stringent standards. Even so-called low levels of tritium will cause increased rates of cancer, when millions of people are exposed to radioactive water.

ODWAC's report builds on the work of the former Advisory Committee on Environmental Standards (ACES). In its 1994 report, ACES recommended "that the Ontario Drinking Water Objective for Tritium be set immediately at 100 Bq/L."

ACES also recommended that "due to the fact that tritium is a human carcinogen and because of the many uncertainties in the risk assessment, the tolerable level of tritium in drinking water be reduced to 20 Bq/L in 5 years with the goal of further reduction as human contributions to tritium background levels decline."

The committee recommended that "an alternative water supply should be made available" when tritium levels exceed the maximum.[17]

The ACES recommendation for Ontario's drinking water standard was to be an interim objective for tritium, with further reductions to be considered in the future. Years later, Ontario still has a dangerously high limit of 7,000 becquerels per litre for tritium in drinking water.

By contrast, the state of California is taking steps to protect people from exposure to tritium. California's San Onofre nuclear plant has leaked massive quantities of radioactive tritium into the groundwater. People in California have expressed concerns about exposure to tritium from nuclear plants.[18]

16 Report and Advice on the Ontario Drinking Water Quality Standard for Tritium, Ontario Drinking Water Advisory Council (ODWAC), May 21, 2009.

17 Advisory Committee on Environmental Standards (ACES), A Standard for Tritium: A recommendation to the Minister of the Environment and Energy, ACES Report 94-01, May 1994, ii.

18 Seema Mehta and Dave McKibben, "Groundwater Reveals Radiation Leak at San Onofre," *Los Angeles Times,* August 18, 2006.

The state has responded by developing a new Public Health Goal (PHG) of 400 picocuries per litre, equivalent to 14.8 Bq/L of tritium in drinking water.[19] The Public Health Goal was established based on a linear no-threshold model, estimating lifetime excess cancer risks of one in one million – the same level of risk used in the recent ODWAC study.

According to the calculation from California's Environmental Protection Agency, a cancer risk of one in one million would be found with tritium levels of 387 picocuries per litre.[20] That would be equivalent to 14.3 Bq/L – far lower than Canada's drinking water guideline of 7,000 Bq/L for tritium. However, even this level of tritium could be hazardous. Most risk calculations do not take into account the special properties of tritium.

Limiting our exposure to radioactive pollution

Canada's drinking water guideline of 7,000 Bq/L is based on a calculation that vastly underestimates the radiation hazards of tritium.

Calculations of radiation doses rely on a risk coefficient from the International Commission on Radiological Protection (ICRP) that does not take into account the dangerous properties of tritium.

Tritium has special properties: it exchanges readily with non-radioactive hydrogen; it binds with carbon atoms to form organically bound tritium; and it can spread easily, as tritiated water.

Tritium accumulates in our DNA, proteins and carbohydrates. It accumulates within our cells as organically bound tritium.

Because of the short range of a beta particle, the energy is concentrated where it can do the most damage – breaking chemical bonds, disrupting our DNA.

Calculations of radiation doses do not take into account these hazards. They vastly underestimate the increased risks of cancer resulting from chronic exposure to tritium in our food and water.[21]

We need to take a precautionary approach, to keep levels of tritium as close to background as possible.

Before the nuclear age, levels of tritium would be less than one becquerel per litre. In communities far from nuclear reactors, levels of tritium in drinking water are often 2 Bq/L or lower.

We need to have limits set as close to background levels as possible, with safer standards phased in over time. This approach recognizes that even background levels of radiation can cause cancer.

19 California Environmental Protection Agency, Public Health Goal for Tritium in Drinking Water, March 2006. http://oehha.ca.gov/water/phg/pdf/phgtritium030306.pdf.

20 This was rounded up to 400 picocuries per litre, for the Public Health Goal.

21 Ian Fairlie, Tritium Hazard Report: Pollution and Radiation Risk from Canadian Nuclear Facilities, Greenpeace Canada, June 2007, 33-34. http://www.greenpeace.org/raw/content/canada/en/documents-and-links/publications/tritium-hazard-report-pollu.pdf.

CHALK RIVER LABORATORIES. Photo by Padraic Ryan.

2. Chalk River: site of the world's first major nuclear accidents

The Chalk River Laboratories site was established in 1944, and now contains over 170 buildings administered by Atomic Energy of Canada Limited (AECL). Over the years, a number of research reactors would be constructed there.

After major nuclear accidents in 1952 and 1958, radioactive waste was buried in the sandy soil. Now several radioactive plumes are making their way into the Ottawa River. Radioactive tritium, strontium-90 and many other radioactive contaminants are trickling into the groundwater and the river, upstream from the nation's capital.

Radioactive tritium gets into drinking water, affecting the health of people living downstream. Levels increase when AECL collects radioactive water that leaks from the NRU reactor. AECL dumps contaminated water into the Ottawa River. The deliberate release of tritium into the river must stop – it threatens our health and the environment.

A short history of nuclear accidents at Chalk River

December 12, 1952 – Canada was the site of the world's first major nuclear disaster, with the partial meltdown of the Nuclear Research eXperimental (NRX) reactor at Chalk River. After the accident, hundreds of soldiers were called in to assist with "decontamination" efforts. The reactor core and liquid waste were buried in shallow trenches.

May 24, 1958 – An accident at the National Research Universal (NRU) reactor. Several uranium fuel rods overheated and ruptured within the reactor core. A fuel rod caught fire, and the reactor building and surrounding area needed to be decontaminated over a period of months. Over 600 men took part in decontamination operations, and were exposed to high levels of radiation. AECL has refused to conduct a follow-up medical study to monitor their health.

Years later, atomic veterans suffer from cancer. Three retired soldiers launched a class-action suit, hoping to get compensation from the federal government.

They allege that the government failed to inform soldiers about the hazards, and they were not given enough protection from radiation. They suffer from a wide range of health problems.[22]

May–June 1991 – 150 trillion becquerels of tritium were released from the heavy water upgrading plant in late May and early June 1991. This large leak was not detected for days, and was not considered to be a reportable incident under the operating license for Chalk River "because release of the full inventory of the unit would not have caused the DRL [derived release limit] to be exceeded." [23] Ottawa's drinking water was contaminated with high levels of tritium.

May 26, 1999 – Four workers inhaled particles of plutonium and other radionuclides while working in Building 220. AECL pleaded guilty to six charges by the former AECB and Human Resources Development Canada, on April 8, 2002. AECL was fined $4,000 per charge.[24]

November–December 2007 – Levels of tritium in Ottawa's drinking water reached 30 becquerels per litre on December 27, 2007, following the restart of AECL's NRU reactor. That is at least thirty times the natural background level, and twice the limit in California, where the Public Health Goal proscribes a maximum of 14.8 becquerels per litre for tritium.

The federal government ignored advice to shut down the reactor, and forced it to restart with special legislation. A report on the CNSC web site is censored, leading to questions – if AECL released radioactive water into the Ottawa River, why was the public not informed?

Tritium in treated water Britannia treatment plant Date	Bq/L	Tritium in treated water Lemieux Island treatment plant Date	Bq/L
November 13, 2007	< 10	November 13, 2007	< 10
November 19, 2007	6.1	November 19, 2007	< 10
November 26, 2007	13.7	November 26, 2007	< 10
December 4, 2007	12.2	December 4, 2007	11.6
December 10, 2007	10.5	December 10, 2007	8.3
December 18, 2007	12.5	December 17, 2007	6.9
December 27, 2007	21.3	December 27, 2007	29.9
		December 31, 2007	7.0
January 7, 2008	22.8	January 7, 2008	7.0
January 14, 2008	14.2	January 14, 2008	< 10
January 23, 2008	7.8	January 21, 2008	8.2
January 29, 2008	< 10	January 28, 2008	< 10

TABLE 3: LEVELS OF TRITIUM IN OTTAWA'S DRINKING WATER AFTER INCIDENTS AT CHALK RIVER, NOVEMBER 2007–JANUARY 2008. Tritium levels measured by Health Canada. Data provided by the City of Ottawa.

December 5, 2008 – AECL's NRU reactor released radioactive water. The public was not notified. Weeks later, the Ottawa Sun reported that 7,000 litres of radioactive water is leaking into the Ottawa River every day, because of a crack in a weld.[25]

Some of the heavy water that leaked from AECL's NRU reactor was collected in barrels and filtered at Chalk River's Waste Treatment Centre. Filtration can remove some contaminants, but not radioactive tritium – which is chemically indistinguishable from non-radioactive isotopes of hydrogen.

22 "Soldiers who cleaned up 1958 reactor accident sue government," *Canadian Press,* February 26, 2009.

23 AECB staff annual report on Chalk River Laboratories and Whiteshell Laboratories, BMD 92-117, Atomic Energy Control Board, Ottawa, 1992.

24 Minutes of the Canadian Nuclear Safety Commission meeting held Thursday, April 18, 2002, Ottawa, 191. http://www.cnsc-ccsn.gc.ca/eng/commission/pdf/17m-e.pdf.

25 "Radioactive Fallout," *Ottawa Sun,* January 28, 2009.

When questioned in the House of Commons, Natural Resources Minister Lisa Raitt denied that there had been any problems. Raitt repeated the CNSC's assurances, that "the leak had no impact on the safety or the operation of the reactor and posed no risk to the health and safety of the public, the workers or the environment." [26]

Following the December 5 incident, AECL deliberately released about 30 trillion becquerels of tritium into the Ottawa River from December 2008 to February 2009. Tritium levels rose as high as 17 becquerels per litre at the Britannia water treatment plant on January 5, 2009.

May 14, 2009 – AECL's NRU reactor was shut down following a power failure in eastern Ontario and western Quebec.

The following day, monitoring of the reactor revealed a leak of heavy water from the base of the reactor vessel. The heavy water was leaking at a rate of 5 kg/hour. It continued leaking at a steady rate, slowing to 4 kg/hour by June 10, and 3-4 kg/hour a week later.[27]

Over the summer and fall, the reactor was shut down for extensive repairs. Leaking heavy water was collected and stored in drums, but much of the tritium evaporated in the form of radioactive water vapour, and it was vented into the air via the NRU reactor's ventilation system.

On a number of occasions between May and September 2009, the release of tritium exceeded action levels for tritium for the NRU reactor and the Waste Treatment Centre. Large quantities of heavy water were released, and much of it evaporated into the atmosphere. Reporting limits for radioactive contamination were exceeded.

Once vented outside into the atmosphere, tritium is easily carried downwind in the form of radioactive water vapour – contaminating the Ottawa River and farms in the Ottawa Valley and western Quebec.

---

26 Hansard, February 24, 2009.
27 AECL status reports, May 18, June 10 and 17, 2009.

3. Caught in the act: radioactive water dumped into the Ottawa River

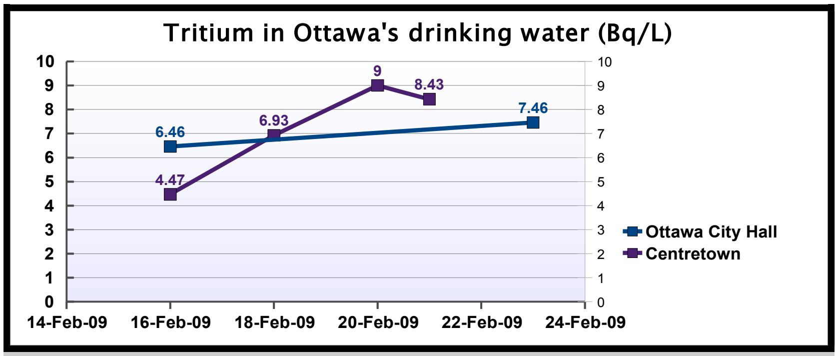


FIGURE 2: TRITIUM IN OTTAWA'S DRINKING WATER. Measurements of radioactive tritium in drinking water from Ottawa City Hall and another location in Centretown, February 16-23, 2009. Samples were collected by Sierra Club Canada and tested at the University of Waterloo. Measurements ± 0.95 Bq/L.

Following the December 5, 2008 incident at AECL's NRU Reactor, 30 trillion becquerels of tritium were dumped into the Ottawa River from December 2008 to February 2009.[28] [29]

AECL characterized this event as a "controlled release," but deliberately releasing radioactive tritium into the Ottawa River exposes millions of people living downstream from Chalk River to increased risks from radiation.

AECL reported that 47 kg of tritiated heavy water had leaked from the NRU reactor core. Heavy water was collected in a sump and transferred to the Waste Treatment Centre (WTC). The water was "purified" to remove some contaminants, but tritium cannot be filtered out using ordinary methods of filtration. After the water was treated, it was dumped into the Ottawa River.

AECL assures us that the tritium "did not pose any risk to the public or the environment" because the releases were lower than the regulatory limits. An additional 4.5 kg of heavy water evaporated and was released into the air through the ventilation system.[30]

Airborne releases	**TBq**	**Destination**
November 24-December 1, 2008	4.4	From the NRU stack into the air
December 2-9, 2008	5	From the NRU stack into the air
December 10-17, 2008	2	From the NRU stack into the air
Waterborne releases	**TBq**	**Destination**
November 2008	4	Ottawa River
December 2008	6.4	Ottawa River
January 2009	11.5	Ottawa River
February 2009	11.9	Ottawa River

TABLE 4. TRITIUM RELEASED INTO THE AIR AND THE OTTAWA RIVER FOLLOWING DECEMBER 5, 2008 INCIDENT AT CHALK RIVER. Airborne releases from the reactor stack and waterborne releases from the Waste Treatment Centre (WTC).

28 CNSC, The NRU Leak Data, Presentation to the Standing Committee of the House of Commons on Natural Resources, February 24, 2009. http://www.cnsc-ccsn.gc.ca/pubs_catalogue/uploads/20090224_nrcommittee_nru_presentation_e.pdf.

29 CNSC, Update regarding media reports dealing with two separate leaks at the National Research Universal (NRU) research reactor, CMD 09-M7, February 19, 2009. http://www.cnsc-ccsn.gc.ca/eng/pdfs/PPT_Presentation_CMD_09-M7_CNSC_Staff_%20Update_Regarding_leaks_at_NRU_20080219_en.pdf.

30 CNSC, Minutes of the Canadian Nuclear Safety Commission Meeting held Thursday, February 19, 2009. http://nuclearsafety.gc.ca/eng/commission/pdf/2009-02-19-Minutes-final-e-EDOCS-3373570.pdf.

Radioactive tritium in Ottawa's drinking water

Levels of tritium in Ottawa's drinking water Date	Bq/L	Location
February 16, 2009	6.5	Ottawa City Hall
February 16, 2009	4.5	Centretown
February 18, 2009	6.9	Centretown
February 20, 2009	9	Centretown
February 21, 2009	8.4	Centretown
February 23, 2009	7.5	Ottawa City Hall

TABLE 5. TRITIUM IN OTTAWA'S DRINKING WATER, FEBRUARY 16-13, 2009. Sierra Club sampled water from Ottawa City Hall and another location in Centretown. The samples were tested at the University of Waterloo. Measurements ± 0.95 Bq/L.

The deliberate release of radioactive tritium into the Ottawa River had a measurable effect downstream in Ottawa's drinking water.

In February 2009, Sierra Club Canada collected samples of drinking water from Ottawa City Hall and another location in Centretown. The samples were sent to a research lab at the University of Waterloo for analysis.

The drinking water samples contained elevated levels of tritium, which increased somewhat during the week of February 16-23, 2009.

By mid-week, tritium concentrations went up to 9.0 Bq/L on February 20. Three days later, levels were still high with a reading of 7.5 Bq/L in water collected from a tap at Ottawa City Hall on February 23.[31] A reading of 9 becquerels per litre is around five times the background level of tritium. Cities that are located far from any nuclear reactors have tritium concentrations of 2 becquerels per litre or lower.

31 Tritium measurements ± 0.95 Bq/L.

These readings correspond with measurements taken during the same time period by Health Canada. Samples taken at the City of Ottawa's Britannia and Lemieux Island water purification plants had elevated levels of tritium following AECL's deliberate release of heavy water contaminated with tritium.

Levels of tritium in treated water at the Britannia treatment plant Date	Bq/L	Levels of tritium in treated water at Lemieux Island treatment plant Date	Bq/L
February 2, 2009	7.1	February 2, 2009	< 5
February 9, 2009	7	February 9, 2009	10
February 17, 2009	8	February 19, 2009	10
February 23, 2009	10	February 24, 2009	10
March 2, 2009	8	March 2, 2009	10
March 9, 2009	10	March 9, 2009	13
March 16, 2009	10	March 16, 2009	11

TABLE 6. TRITIUM IN OTTAWA'S DRINKING WATER, FEBRUARY 2-MARCH 16, 2009. Tritium levels measured by Health Canada. Data provided by the City of Ottawa.

We have seen how levels of tritium in drinking water are elevated, after AECL deliberately releases tritium into the Ottawa River. We are now faced with a similar situation, one that calls for urgent action.

Throughout the spring and summer of 2009, the NRU reactor leaked large quantities of heavy water contaminated with tritium – and AECL collected it in barrels. AECL must not release the radioactive water into the Ottawa River. Tritium pollution threatens the health of people living downstream from Chalk River.

4. Chalk River's radioactive legacy

Over the decades, a total of seven reactors have operated at Chalk River Laboratories. The reactors have produced massive quantities of radioactive waste, and much of it has not been stored in a secure manner. Much of the radioactive waste was dumped into shallow trenches, dug into the sandy soil.

Some of the trenches had asphalt liners, others had nothing between the waste and the surrounding sandy soil.

Because of the poor controls, radioactive waste has seeped into the groundwater, the Ottawa River and other neighbouring bodies of water. Radioactive plumes containing tritium, strontium-90 and other radioisotopes are now spreading. A total of ten distinct radioactive plumes have been identified in the groundwater at Chalk River.

Radioactive contamination has reached local streams, swamps and lakes. These include Perch Lake, near Waste Management Area A. The lake is located only 1.7 kilometres from the Ottawa River. From Perch Lake, water flows through Perch Creek, directly into the Ottawa River.

High levels of tritium have been measured in Ottawa River water at Pointe au Baptême, south of Perch Creek – with annual average concentrations ranging from 114 to 218 Bq/L over a five year period.[32]

Another serious source of radioactive contamination has been the spent fuel rods from the NRX reactor. The NRX reactor has a rod bay that was used to store spent fuel until 1995. From 1959 on, the fuel rods leaked tritium and strontium-90 into the groundwater.

There are high levels of radioactive contamination now, with concentrations of tritium reaching 3 million becquerels per litre in the groundwater below. A radioactive plume is flowing from the groundwater and the 04 Storm Sewer directly into the Ottawa River.[33]

Levels of tritium at Chalk River **Location**	**Mean Bq/L**	**Mean+2S Bq/L**
Riverfront Stream 1	173	308
Riverfront Stream 3	207	410
Riverfront Stream 5	541	1,115
Riverfront Stream 6	22,604	36,160
Pointe au Baptême	281	901
Maskinonge Lake	1,030	1,380
Lower Bass Lake	7,270	10,100
Duke Swamp	53,100	71,200
Main Stream	1,080	2,780
East Swamp	27,300	93,000
South Swamp	64,800	252,000
Perch Creek	11,100	18,100
Perch Lake, Inlet 1	1,970	2,930
Perch Lake, Inlet 2	12,900	28,000

TABLE 7. CONCENTRATIONS OF TRITIUM AT CHALK RIVER. Measured by AECL, 2000-2001. Mean concentrations of tritium during the time period studied. Mean+2S: The mean + 2 standard deviations.

32 For the years 2002-2006. CRL-509243-ASR-2007. These are mean concentrations; monthly readings can be higher.

33 Donald H. Hart, and Paul McKee, Ecological Effects Review of Chalk River Laboratories, Report prepared by EcoMetrix Incorporated and C. Wren and Associates, Ref. 04-1178, January 2005. http://www.aecl.ca/Assets/Publications/Reports/EER-Report-Jan05.pdf.

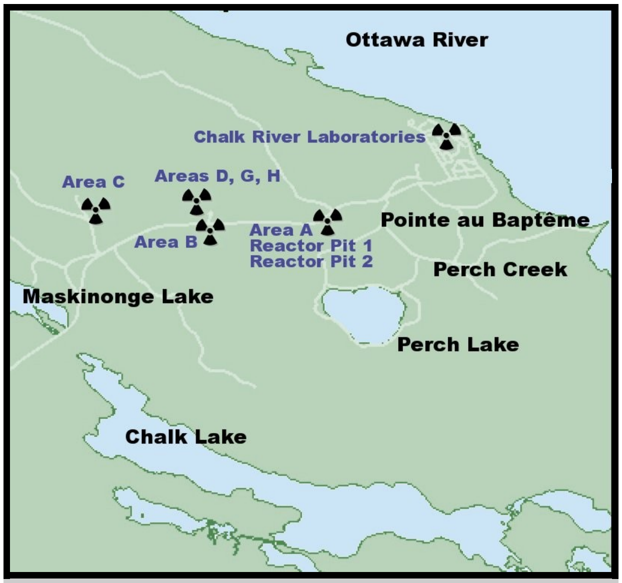


FIGURE 3. MAP OF CHALK RIVER LABORATORIES. Depicts some of the significant Waste Management Areas.

An overview of Chalk River's radioactive dumps

The Chalk River site has been used as a dumping ground for a deadly mixture of low-level and high-level radioactive waste. A wide range of Waste Management Areas are in use, ranging from unlined trenches dug into the sandy soil, to more secure areas with concrete canisters.

Because of the haphazard approach to storing the waste, most of the Waste Management Areas are active sources of contamination, with radioactive plumes of tritium and strontium-90 leaking into the groundwater below.

Radioactive wastes at Chalk River include tritium, strontium-90, cobalt-60, cesium-137, carbon-14, radium-226 and plutonium-239.[34]

Half-lives for these radioisotopes cover a wide range of time spans: 12.3 years for tritium, 1,600 years for radium-226 and 24,400 years for plutonium-239.

However, AECL's decommissioning plan only considers a period of 300 years. It reassures us, saying that the radioactivity of tritium and strontium-90 will be diminished after a hundred years because these isotopes have shorter half-lives. The decommissioning plan does not reveal what will happen to the longer-lived radioisotopes such as plutonium.

Liquid Dispersal Area

The Liquid Dispersal Area is in active use. Liquid waste from the NRU reactor is dumped here.

Reactor Pit #1: 230,000 m^3 of liquid waste. An estimated 100 TBq of radioactivity, including around 74 TBq of strontium-90 (1953-1998). Approximately 100 g of plutonium present (or other alpha emitters, equivalent to plutonium).

Laundry Pit: 680 m^3 of liquid waste, with 0.06 TBq of radioactivity (1956-1957). Recorded inventory includes 0.1 g of plutonium-239.

Chemical Pit: 330,000 m^3 of liquid waste released in a gravel-filled pit. Over 300 TBq of radioactivity, including 70 TBq of tritium (1956-present).

Reactor Pit #2: 1,500,000 m^3 of contaminated water, with 1,000 TBq of tritium, 500.5 TBq other sources (1956-present). Source of radioactive groundwater plume containing tritium and cobalt-60.

34 AECL, Renewal (2006) of the CRL Site Operating Licence – Information Presented for the Day One CNSC Public Hearing (2006 April 26), CRL-00521-LP-002, Revision 0, March 2006. http://www.aecl.ca/AssetFactory.aspx?did=233.

Waste Management Area A

After the nuclear accident in 1952, the NRX reactor was dismantled and buried in Area A, along with radioactive liquid waste.

Liquid wastes dumped into trenches (1953-1955):

- 4,500 m^3 of mixed fission products, 330 TBq (1953).
- 7.2 m^3 of mixed fission products, 6.3 TBq (1954).
- 50 m^3 of mixed fission products, 34 TBq (1955).

Solid wastes were dumped into unlined trenches and buried structures (1946-1955). There are few details.

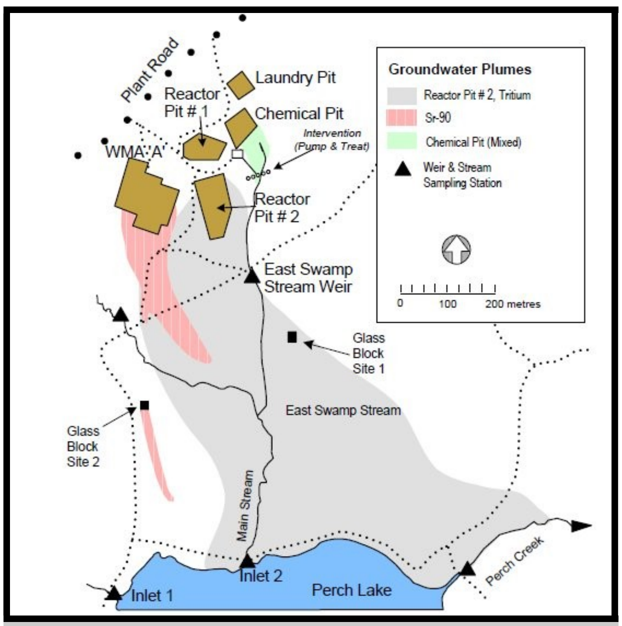


FIGURE 4: PLUMES OF TRITIUM AND STRONTIUM-90 IN THE GROUNDWATER NEAR PERCH LAKE. Depicts some of the radioactive plumes at Chalk River. Source: AECL report CRL-00521-LP-002.

Waste Management Area B

Waste Management B was created in 1953, as a site for solid waste disposal. It is located in sandy soil around 750 metres west of Waste Management A. Radioactive waste was dumped into unlined trenches capped with sandy fill in the northern part of the site.

Many reactor components were buried here, including the NRU reactor's first calandria and the NRX reactor's second calandria. These components were buried directly in the sand, or in concrete containers.

Sandy trenches were used for low-level radioactive waste until 1963. More recently, since 1977 a number of cylindrical concrete bunkers are used.

High-level radioactive waste is also stored in this area, in concrete and steel structures known as Tile Holes. The waste includes irradiated fuel and fuel bundles.

Radioactive waste from Waste Management Area B is responsible for some plumes of radioactive contamination in the groundwater.

The source of contamination is principally from the unlined sandy trenches used to hold radioactive waste, with additional contamination from asphalt-lined and capped trenches, and burials of reactor components.

According to AECL, the most important radioactive nuclides found in groundwater plumes include tritium, strontium-90 and cesium-137.

Some of the groundwater is being filtered to reduce levels of strontium-90. Levels of strontium-90 have been lowered over time. However, the tritium cannot be filtered out with any filtration methods used at Chalk River Laboratories.

Waste Management Area C

Waste Management Area C was created in 1963 for low-level radioactive waste with half lives of less than 150 years, as well as suspect wastes that could not be confirmed to be free of contamination. It covers an area of 4.5 hectares, around 3 km west of the main site.

In the early days, waste was dumped directly into parallel trenches dug into the sand. None of the trenches were lined – which meant that radioactive materials could flow unimpeded into groundwater.

The radioactive plume originating from Waste Management Area C contains tritium as its primary constituent. Some cobalt-60 and carbon-14 has also been found.

Part of this waste management area was covered with an impermeable cover in 1983 to reduce the flow of rainwater into this area, and subsequent releases of tritium into neighbouring bodies of water.

The Ottawa River's radioactive sediments

Over a period of decades, the facilities at Chalk River Laboratories have discharged radioactive waste through the site's Process Sewer. Radioactive wastes have been dumped directly into the Ottawa River. According to AECL's monitoring, this has led to "concentrations of radionuclides and non-radiological substances in the river sediment that are elevated above background levels." The total level of radioactive contamination is estimated to be around 40 Gbq.[35]

The area of contaminated radioactive river sediments measures approximately 200 metres by 400 metres, and contamination is concentrated in the upper 15 cm of sediment. Researchers have measured lower levels of contamination near the sediment's surface, and this is said to be indicative of "cleaner" operations since the NRX reactor ceased operating in 1991.

On September 12, 2005, researchers sampled the river bottom sediments at seven locations near Chalk River Laboratories – two locations upstream, one near the site, and four downstream. The samples were tested for the presence of radioisotopes.[36]

Cobalt-60 was found in the sediments, with levels of activity at 20 Bq/kg near Chalk River, decreasing to 1-5 Bq/kg downstream.

Cesium-137 was also found, with an activity level of 52.3 Bq/kg in the sediments close to Chalk River Laboratories. Downstream from Chalk River, levels ranged from 12.1 Bq/kg to 60.9 Bq/kg. These levels are higher than the readings found in the past – by comparison, fourteen sediment samples taken from 1999 to 2000 showed a range of 1.1 to 22.4 Bq/kg.

35 AECL, Comprehensive Preliminary Decommissioning Plan for AECL's Chalk River Laboratories, CPDP-01600-PDP-002 Revision R1, February 2006. http://www.aecl.ca/Assets/Publications/Reports/CPDP-01600-PDP-002.pdf.

36 See Table 7 in Claude Barbeau and Serge Groleau, Radiological Environmental Survey outside the Chalk River Laboratories Site, Laboratoire de Radioécologie, February 2006. http://www.aecl.ca/AssetFactory.aspx?did=545.

Radioactivity in fish

The radioactive waste deposited in the Ottawa River is not contained. The top layer of sediment is in direct contact with water flowing in the Ottawa River – and this could mean that radioactive waste gets into the water and fish in the river.

Not surprisingly, samples of fish caught in the Ottawa River have been shown to contain the radioisotope cesium-137.

Samples of catfish, pickerel and other fish species were caught on September 10-12, 2005. The researchers Claude Barbeau and Serge Groleau were able to find contamination of cesium-137, ranging from 7.1 Bq/kg to 14.3 Bq/kg at three locations.[37]

What is striking is that relatively high levels of cesium-137 were found in fish as far away as 35 km upstream from the site. People eating fish from the Ottawa River could be exposed to radioactive cesium-137, leading to increased risks for cancer.

Radioactivity in fish from the Ottawa River **Date**	**Bq/kg**	**Location**
September 12, 2005	8.7	Rapides-des-Joachims, about 35 km upstream from Chalk River
September 12, 2005	7.1	Ottawa River, below Chalk River Labs
September 10, 2005	14.3	Meehan Bay, downstream from Chalk River. Between Chalk River and Petawawa.

TABLE 8. LEVELS OF CESIUM-137 IN FISH FROM THE OTTAWA RIVER. Samples of fish caught near Chalk River Laboratories.

37 See Table 5 in Claude Barbeau and Serge Groleau, Radiological Environmental Survey outside the Chalk River Laboratories Site, Laboratoire de Radioécologie, February 2006. http://www.aecl.ca/AssetFactory.aspx?did=545.

5. Radioactive signs: marketing nuclear waste

One of Canada's largest sources of tritium pollution can be found in the Ottawa Valley community of Pembroke, Ontario.

Since 1990, SRB Technologies has been using tritium waste collected from Candu reactors to make radioactive glow-in-the-dark exit signs. The exit signs glow in the dark, as radiation hits a phosphorescent coating in the tubes.

Large quantities of tritium are released from the stack at the SRB Technologies plant, located in a strip mall in the middle of a residential area in Pembroke.

Once dispersed into the air, the tritium is carried with the wind and rain, spreading radioactive contamination throughout the community. Extremely high levels of tritium have been found in area wells, vegetables and the groundwater.

SRB Technologies has also been releasing large quantities of radioactive water into Pembroke's sewer system. The tritium gets into the community's waste treatment plant, leading to radioactive contamination of sludge and water.

Once it is flushed into the sewer, radioactive tritium gets into the Ottawa River – flowing downstream to communities such as Ottawa and Montreal.

Another manufacturer of radioactive signs is based in Peterborough, Ontario. Shield Source Incorporated manufactures exit signs, using tubes filled with radioactive tritium to make them glow in the dark. The Shield Source plant outputs massive quantities of radioactive tritium oxide vapour into the atmosphere.

Apples grown 220 metres from the plant have been found to be contaminated with high levels of tritium, with levels of 4,879 becquerels per litre measured in July 2007.[38]

Shield Source also discharges large quantities of radioactive wastewater into Peterborough's sewer system. In 2007, a total of 2.41 billion becquerels of tritium was dumped into the community's sewers. This is done with the permission of the CNSC. It has set a very high limit of 100 billion becquerels per year for discharges into Peterborough's sewer system.

Tritium pollution from SRB Technologies

Tritium pollution from the SRB Technologies plant contaminates vegetables grown in gardens in Pembroke. High levels of tritium contamination have been found in a nearby hockey arena, snow and area wells.

Radioactive water has also contaminated Pembroke's groundwater. It is not surprising. SRB Technologies has output massive quantities of tritium from its stack – ranging from 18 quadrillion becquerels of tritium in 2000, to 40 trillion becquerels in 2008.[39]

38 Shield Source 2007 Annual Compliance Report.

39 The following table includes data compiled from the SRB Technologies Annual Compliance Reports, 2001-2008. http://www.betalight.com/pip/relations.htm. Note: in August 2005, SRB Technologies discovered an error in its calculations for emissions. As noted on page 13 of its 2005 Annual Compliance Report, the company underestimated its emissions before 2005 by a factor of 10. The data have been corrected here, for reports issued before 2005. Data for the year 2000 is from Appendix H in the report for 2004.

Year	Tritium oxide (HTO) TBq	Tritium gas (HT) TBq	Total airborne emissions (HTO and HT) TBq
2000	1,390	16,600	17,990
2001	1,006	12,854	13,860
2002	777	7,402	8,179
2003	420	6,338	6,758
2004	338	3,922	4,260
2005	247	977	1,224
2006	71.6	213	285
2007	5.75	36.1	41.8
2008	6.43	33.7	40.1

TABLE 9. RADIOACTIVE TRITIUM POLLUTION RELEASED FROM THE SRB TECHNOLOGIES STACK, 2000-2008. Emissions of tritium from the stack of the SRB Technologies plant. Includes gaseous and liquid tritiated water (HTO) and gaseous tritium (HT). Source: Data compiled from the SRB Technologies Annual Compliance Reports, 2001-2008.

Pembroke's radioactive rhubarb

Community members have expressed grave concerns about the contamination of vegetables grown in Pembroke. With high levels of tritium in their food, residents are concerned about the impacts on their health.

According to the CNSC, tritium levels in vegetables collected from gardens near SRB Technologies were found to range from 500 to 949 Bq/L in 2006, compared to typical background readings for Ontario of 1.9 to 3.8 Bq/L.

In September 2007, tritium concentrations in vegetables dropped off to 13 to 326 Bq/L.[40] The lower levels were observed following a temporary suspension of the plant's operations that year.

Much higher readings of tritium have been found. In 1999, area resident Ole Hendrickson collected some vegetables and sent them for testing at the University of Waterloo. A radioactive rhubarb was found to have tritium levels of 2,000 Bq/L.[41]

SRB Technologies has also tested some vegetables grown in Pembroke. In 2004 it tested some potatoes from a local garden, and they were found to be contaminated with tritium concentrations of 12,737.5 Bq/L (± 60 Bq/L).[42]

Although levels of tritium have been found to be hundreds or thousands of times higher than background, the CNSC insists that the vegetables are safe to eat. According to CNSC staff, "the radiotoxicity of tritium is extremely low and that to be exposed to 1 mSv (the public dose limit), a person would have to take in about 50 million becquerels of tritium." [43]

The CNSC allows SRB Technologies to dump massive quantities of tritium pollution. In 2008, the limit was 448 trillion becquerels of tritium oxide and tritium gas.[44]

40 CNSC, Record of Proceedings, Including Reasons for Decision in the Matter of SRB Technologies Application to Resume the Processing and Use of Tritium at the Gaseous Tritium Light Source Facility in Pembroke, Ontario, April 3 and June 12, 2008. http://www.cnsc-ccsn.gc.ca/eng/commission/pdf/2008-06-12-Decision-SRBT-e-Final-Edocs3261694.pdf.

41 Martin Mittelstaedt, "Tritium-laced plants found near town's glow-in-the-dark sign factory," Globe and Mail, September 28, 1999.

42 SRB Technologies 2004 Annual Compliance Report, February 14, 2006.

43 CNSC Record of Proceedings, June 12, 2008.

44 SRB Technologies 2008 Annual Compliance Report, March 31, 2009, 9.

Tritium down the sewer

SRB Technologies regularly sends large quantities of radioactive tritium into Pembroke's sewer system. The CSNC has not imposed stringent limits. It has given SRB Technologies permission to dispose of as much as 200 billion becquerels of tritium per year into Pembroke's sewers. In 2008, SRB Technologies discharged a total of 29.5 billion becquerels of tritium into the community's sewer system.

Elevated levels of tritium have been found in sludge water at Pembroke's Waste Water Treatment Plant – with levels ranging from 36 Bq/L to 172 Bq/L in 2008. Once the tritium is dumped into the sewers, it makes its way into the Ottawa River – flowing downstream to communities such as Ottawa and Montreal.

Year	Tritium released into the sewer system Annual release (HTO) GBq	Maximum weekly release (HTO) GBq	Tritium in the waste water treatment plant – water and sludge Minimum and maximum levels Bq/L
2006	43.2	Not reported	109 – 258
2007	8.09	1.35	38 – 162
2008	29.50	2.18	35 – 172

TABLE 10. RADIOACTIVE TRITIUM POLLUTION RELEASED INTO PEMBROKE'S SEWER SYSTEM, 2006-2008. Tritium released by SRB Technologies into Pembroke's sewer system, measured in billions of becquerels. Minimum and maximum levels of tritium found in sludge and water at Pembroke's Waste Water Treatment Plant. Source: SRB Technologies Annual Compliance Reports, 2006-2008.

With the routine disposal of tritium into Pembroke's sewer system, we have another active source of radioactive pollution threatening the Ottawa River.

Radioactive groundwater

Radioactive water vapour released from the stack at SRB Technologies gets into rain and snow – and then the tritium trickles into the groundwater of Pembroke.

Some of the readings have been extremely high. Tritium levels have reached 156,643 Bq/L at a well located near the stack of the SRB Technologies plant.[45] When this well was bored on September 21, 2006, samples of soil were taken and sent to AECL for analysis. High levels of contamination were found in the soil, with concentrations of tritium between 10,281 Bq/L and 248,455 Bq/L.[46]

According to EcoMetrix's 2008 study, tritium in the groundwater will slowly move east towards the Muskrat River at a rate of about four metres a year. The concentrations will be reduced over time as the tritium decays.

EcoMetrix concludes that concentrations of tritium between the bedrock and the surface "clearly show that the source of tritium in soil and groundwater is from atmospheric emissions and air dispersion."

Because of concerns about contamination of the groundwater, the CNSC placed some temporary restrictions on the operations of SRB Technologies on January 31, 2007.[47]

45 Well MW06-10, measured on November 15, 2006. SRB Technologies 2008 Annual Compliance Report, March 31, 2009.

46 EcoMetrix Incorporated, Comprehensive Report - Groundwater Studies at the SRB Technologies Facility, Pembroke, ON, January 2008, Appendix I.

47 CNSC News Release, January 31, 2007.

CNSC issued a special 18-month "Nuclear Substance Processing Facility Possession Licence," which did not allow SRB Technologies "to process or use tritium for the purpose of manufacturing gaseous tritium light sources."

However, since then the CNSC has allowed SRB Technologies to continue manufacturing radioactive signs.

During public hearings in 2006, the CNSC expressed its concerns about the company's environmental monitoring program: "there is not enough information to determine exactly what is going on on the site and at what rate any contaminated groundwater could leave the site."

Its first groundwater study "did not adequately define the magnitude of tritium contamination underlying the SRBT facility or consider the potential impact that the contaminated groundwater may have on the future land use of the site." [48]

High levels of tritium have been found on the stack of the manufacturing plant, and surface soils are contaminated. Tritium levels as high as 560,000 Bq/L have been measured in soil near the SRB Technologies plant.

Water dripping from the stack was found to contain dangerously high levels of tritium, ranging from 2 million to 59 million Bq/L. The CNSC has identified the stack as a source of contamination of area groundwater: "It results in high levels of tritium in the soil moisture that are available to move down to groundwater." [49]

48 CNSC, Record of Proceedings, November 27, 2006.
49 CNSC, 06-H144.1, Oral presentation by SRB Technologies, August 28, 2006.

Tritium pollution from Shield Source Incorporated

Another manufacturer of radioactive glow-in-the-dark exit signs is based in Peterborough, Ontario. The Shield Source plant is located near Peterborough's airport. Shield Source releases massive quantities of tritium from the facility's stack.

In 2007, a total of 111 trillion becquerels of tritium oxide (HTO) and tritium gas (HT) was released from the stack into the air.[50] Once in the atmosphere, the tritium can be carried by the wind as radioactive water vapour around the city of Peterborough, contaminating vegetables grown in local gardens. It can also return to earth as radioactive rain, contaminating the groundwater.

Year	Tritium oxide (HTO) TBq	Tritium gas (HT) TBq	Total airborne emissions (HTO and HT) TBq
2000	31.9	91.8	123.7
2001	27.0	105	132
2002	27.0	105	132
2003	21.8	69.7	91.5
2004	17.3	90.7	108
2005	17.2	104	121.2
2006	13.3	96.4	109.7
2007	23.3	87.7	111

TABLE 11. RADIOACTIVE TRITIUM POLLUTION RELEASED FROM SHIELD SOURCE'S STACK, 2000-2007. Emissions of tritium from the stack of the Shield Source plant in Peterborough, Ontario. Includes tritiated water vapour (HTO) and tritium gas (HT). Source: Data compiled from the Annual Compliance Reports for Shield Source Incorporated, 2000-2007.

50 Data for the following table compiled from the Annual Compliance Reports for Shield Source Incorporated, 2000-2007, http://www.shieldsource.com/Public%20Information/publicinformation_files/annual_reports.htm.

Radioactive tritium in Peterborough's sewers

Another serious pollution problem is the disposal of radioactive tritium into Peterborough's sewer system. Shield Source Incorporated is permitted to dispose of massive quantities of tritium. The CNSC has set a limit of 100 GBq of tritium per year for Shield Source's releases of tritium into Peterborough's sewer system.

Since December 2002, the Shield Source plant has dumped radioactive wastewater containing tritium into the sewers. This is done with the full support and knowledge of the CNSC. Shield Source reports: "CNSC staff conducted a screening environmental assessment and prepared a screening report on the disposal of tritiated aqueous waste to the City of Peterborough sewer system. CNSC concluded that the project was not likely to cause significant adverse environmental effects, when taking into account the appropriate mitigation measures." [51]

Before December 2002, the Shield Source facility collected radioactive wastewater in two holding tanks, and transferred the wastewater into a septic tank. The septic tank was pumped out on a weekly basis, and the radioactive water was spread out on land.[52]

In 2001, Shield Source disposed of 28,691 litres of tritiated water in this manner. The radioactive wastewater was analyzed before it was dumped, and the level of tritium was duly noted in its annual report.

In 2001, the wastewater had an average level of 10,100 becquerels per litre, higher than Ontario's outrageously high limit of 7,000 becquerels per litre for drinking water.[53] One wonders where this radioactive water was spread – and how much of it washed off into farmers' fields, or entered the groundwater.

Year	Tritium released into the sewer system Annual release (HTO) GBq	Radioactive wastewater spread on land Annual release (HTO) GBq	Average level of tritium in the radioactive wastewater Bq/L
2000	---	0.567	18,300
2001	---	0.291	10,100
2002	---	0.452	---
2003	0.756	---	---
2004	2.48	---	---
2005	3.86	---	---
2006	2.37	---	---
2007	2.41	---	---

TABLE 12. RELEASES OF TRITIUM INTO PETERBOROUGH'S SEWER SYSTEM, AND RADIOACTIVE WASTEWATER SPREAD ON LAND, 2000-2007. Tritium has been released by Shield Source into Peterborough's sewer system since December 2002. Before then, radioactive wastewater was spread on land. Waterborne releases measured in billions of becquerels. Source: Data compiled from Shield Source Annual Compliance Reports, 2000-2007.

51 Shield Source Incorporated, 2002 Annual Compliance Report, 5.
52 Ibid.

53 Shield Source Incorporated, 2001 Annual Compliance Report, 3.

Wal-Mart goes shopping for radioactive waste

SRB Technologies and Shield Source sell thousands of radioactive glow-in-the-dark exit signs to customers in Canada, the United States, Britain and other countries.

Wal-Mart bought tens of thousands of the radioactive exit signs. After an audit in 2007, the retailer discovered that 15,800 of its exit signs had gone missing from its stores in the United States. That represented approximately one fifth of the signs that it had in its US stores.[54]

The US Nuclear Regulatory Commission (NRC) keeps close tabs over the use of tritium signs. Lost, stolen and broken signs must be reported. Following the loss of thousands of signs from Wal-Mart stores, the US Nuclear Regulatory Commission cited Wal-Mart for four violations "concerning improper disposal and transfer of tritium exit signs at its stores throughout the United States and Puerto Rico."

The NRC has followed up by requesting detailed information from more than sixty organizations and corporations, asking them to report the procedures they use to keep track of their inventories of tritium exit signs.[55]

Tritium is one of the key substances used in nuclear weapons. The relative ease of gaining access to tritium adds to the risks of nuclear proliferation. There are also the health risks from breaking radioactive signs, releasing tritium into the air.

The NRC downplays the risk in its press release, saying the tritium poses "little threat to public health and safety." But in the next sentence, the NRC says it "requires proper recordkeeping and disposal of the signs because a damaged or broken sign could cause minor radioactive contamination of the immediate vicinity, requiring environmental clean up."

54 Tyler Hamilton, "Wal-Mart's glow-in-the-dark mystery." Toronto Star, February 15, 2009.

55 US Nuclear Regulatory Commission, NRC Cites Wal-Mart for Violations in Handling Tritium Exit Signs, October 30, 2009. http://www.nrc.gov/reading-rm/doc-collections/news/2009/09-180.html.

6. Radioactive Prairies?

PRAIRIE FARMS COULD BE THREATENED BY RADIOACTIVE POLLUTION. Photo by elliottzone. This work is licensed under the Creative Commons Attribution-Noncommercial-Share Alike 2.0 Generic License.

Bruce Power has announced plans to construct nuclear plants at two locations in the Prairies, near Peace River, Alberta, and at an unspecified location in Saskatchewan.

The company fails to provide estimates for the potential economic losses for tourism and local farmers, if nuclear reactors are constructed in the Prairies.

There are likely health impacts if the projects go ahead. An aquifer near Peace River, Alberta could be contaminated by routine releases of tritium.

Saskatchewan farmers could find that their crops will be contaminated by tritium and other radioisotopes. Children living near nuclear plants could suffer from leukemia and other diseases.

Alberta

In 2007, Calgary-based Energy Alberta Corporation filed an application with the CNSC to build a 2,200 megawatt nuclear plant at Lac Cardinal, 30 km from Peace River, Alberta.[56] Energy Alberta Corp. was then bought by Bruce Power.

On March 13, 2008, Bruce Power filed an application with the CNSC for a licence to prepare a site for a nuclear plant. The initial application mentioned the same Lac Cardinal site proposed by Energy Alberta.

Faced with mounting public opposition, Bruce Power withdrew its application for the Lac Cardinal site. Opponents expressed their concerns about the health and environmental impacts. Lac Cardinal is an important area for birds, and it is a picturesque lake with many recreational uses.

Few local residents would want a nuclear plant there. A nuclear plant would threaten the Grimshaw Gravels aquifer which supplies water for 30,000 people, including local farmers and ranchers.[57]

A January 6, 2009 letter to the CNSC indicates that Bruce Power is now considering an alternate site at Whitemud, located on the west bank of the Peace River, 30 km north of the town of Peace River.[58] However, a nuclear plant there could still contaminate the Peace River and the Grimshaw Gravels Aquifer.[59] It is a shallow water table aquifer, so it is vulnerable to pollution from surface contaminants.[60]

56 "Company begins process to build Alberta's 1st nuclear plant," *CBC News,* August 28, 2007. http://www.cbc.ca/money/story/2007/08/28/alberta-nuclear.html.

57 Water Matters, February 4, 2009. http://www.water-matters.org/node/264.

58 Letter to the CNSC, January 6, 2009. http://www.cnsc-ccsn.gc.ca/eng/pdfs/Bruce_Alberta_letter_Jan2009.pdf.

59 Kelly Cryderman, "New site for nuclear plant considered: Residents' concerns heard," *Calgary Herald,* January 9, 2009.

60 Grimshaw Aquifer Management Advisory Committee. http://www.telusplanet.net/public/grimshaw/aquifers/aquifers.htm.

Tritium could enter the aquifer, contaminating the region's drinking water. We have seen examples of tritium pollution in the Great Lakes and the Ottawa River. A reactor near Peace River would threaten water supplies, lead to unacceptable health risks for many Albertans and contaminate crops grown near the nuclear plant.

Saskatchewan

The province's pro-nuclear Saskatchewan Party has backed Bruce Power's bid to construct a nuclear plant. The provincial government created a new advisory panel, the Saskatchewan Uranium Development Partnership (UDP).

On March 31, 2009, it released a report with recommendations to ramp up Saskatchewan's nuclear industry. The panel was stacked with representatives from the nuclear industry, including Cameco, Bruce Power, and AREVA.[61]

During public consultations across Saskatchewan, there was strong opposition to nuclear power. Out of 2,263 responses from the public, 1401 expressed opposition to nuclear power in the province.

Many people expressed concerns about health and environmental implications, and there was strong opposition to storing radioactive waste. The report acknowledged the frustration expressed by Saskatchewan's citizens:

> With some exceptions, those consulted express significant opposition to nuclear power generation primarily due to concerns about the environmental impacts, health and safety of the public, potential cost and management of waste. Furthermore, there is considerable interest in alternative energies, in particular, wind and solar. Renewable energy sources are seen as more financially feasible, with few health and safety risks, and of potential benefit to the economy in terms of job creation.[62]

Faced with such strong opposition, the panel recommended further study of nuclear power as well as other options, including an "expanded use of renewables, with particular emphasis on wind and solar."

Meanwhile, Bruce Power has tried to sell people on the idea that nuclear power is needed in Saskatchewan.

On June 17, 2008, Bruce Power announced its Saskatchewan 2020 study to look for a site for a nuclear plant in Saskatchewan.[63]

The glossy brochure shows iconic pictures of Saskatchewan, and glosses over the dangers of generating tens of thousands of tonnes of high-level nuclear waste.

---

61 For an overview of recent developments in Saskatchewan, see: Jim Harding, "Living behind the uranium curtain: The dubious legacy and dangerous future of Saskatchewan's uranium industry," *Briarpatch,* December 2008.

62 Dan Perrins, The Future of Uranium in Saskatchewan, Public Consultation Process – Final Report. http://www.saskuranium.ca/Default.aspx?DN=4bffe9d7-3a6b-44b2-aa1d-58fd8a9562ea&l=English.

63 Bruce Power, Bruce Power Launches Saskatchewan 2020 Initiative, June 17, 2008. http://www.brucepower.com/pagecontent.aspx?navuid=1211&dtuid=83768.

The Bruce Power study does not mention the dangers associated with building a nuclear plant on Lake Diefenbaker, one of the locations proposed by a SaskPower study. Around 40% of Saskatchewan's citizens depend on Lake Diefenbaker for their water. There would be routine releases of tritium into the air and water, contaminating drinking water and crops.

However, public opposition has been mounting with hundreds of people attending public meetings in Paradise Hill and other communities. Grassroots groups such as Save Our Saskatchewan (SOS) have been raising awareness about the dangers of nuclear power.

7. Take action: a guide for radioactivists

Canada's nuclear industry is trying to sell nuclear power as a clean solution to deal with climate change. They talk about a so-called "nuclear renaissance," when we are still dealing with the legacy of radioactive pollution. The "re-birth" of the nuclear industry would rob us of funds for green energy solutions – investing in wind turbines, solar power and energy efficiency.

Write to the Ontario government

Together we can change Ontario's lax drinking water standard for tritium. You can express your concerns by writing to Premier Dalton McGuinty and MPPs.

Ask them to consider new evidence from the BEIR VII report demonstrating that there is no safe level of exposure to radiation. Therefore, a precautionary approach would keep levels of tritium as close as possible to background. Please write to:

► Premier Dalton McGuinty
Legislative Building
Queen's Park
Toronto, Ontario
M7A 1A1

► Your Member of Provincial Parliament (MPP).

For a list of Members of Ontario's Legislative Assembly, visit: http://www.ontla.on.ca/.

Support municipal motions to keep tritium out of our drinking water

You can also take action at the municipal level by encouraging your mayor and city councillors to introduce municipal motions to encourage the province and federal government to support safer drinking water standards.

Taking action at City Hall is often easier than getting things done at the federal or provincial level. Municipal councillors are easy to approach. Start by identifying some potential allies on council, and set up meetings with them.

Municipal motions can express support for safer drinking water standards, to ensure that levels of radioactive tritium are as close to background levels as possible.

The current drinking water standard of 7,000 becquerels per litre is far too dangerous. According to the 1994 ACES report, exposure to this level of tritium would increase cancer rates – leading to 340 deaths from cancer per million people. We need to follow a precautionary approach to prevent cancers and protect our children from danger.

For an example of what is possible, consider the motion passed by Toronto City Council in June 2006.

The Toronto Board of Health asked City Council to help protect people from exposure to tritium by backing more stringent standards. They asked the Ontario government to reduce levels of tritium allowed in drinking water:

Ionizing Radiation and Public Health in the City of Toronto (GTA) in Relation to the Refurbishment and Expansion of Nuclear Power Reactors and Facilities on Lake Ontario

The Board of Health recommends that City Council adopt the recommendations in the communication (May 10, 2004) from Ruth Grier, Co-Chair, Toronto Cancer Prevention Coalition, Occupational and Environmental Carcinogens Working Group, as follows:

(1) that the City of Toronto test and report information on tritium and other radionuclides both in the raw water of Lake Ontario and in Toronto's drinking water and include these results in the annual report on drinking water required by the Ontario Drinking Water Standards; and

(2) that the City of Toronto request the current Ontario Government to revisit the recommendations of the Ontario Advisory Committee on Environmental Standards Committee and consider the more health protective standard be required.

Toronto City Council passed this motion supporting the 1994 ACES recommendation that a safer standard of 20 Bq/L be phased in after five years. If Ontario adopted this as a drinking water standard, tritium would be limited to around twenty times background levels found before the nuclear age.

A safer, more precautionary approach would be to ask that tritium be brought down to background levels over time, to limit increases in the rates of cancer and birth defects from exposure to tritium. Background levels of tritium are around 1 to 2 Bq/L, in lakes located far away from nuclear reactors.

Write to the federal government

You can write to the federal government to express your concerns about dangerously high limits for tritium in Canada. Express your concerns about recent incidents at Chalk River, and the continued releases of radioactive water from Canada's nuclear reactors. The CNSC has a duty to inform and protect the public.

AECL must not be allowed to dump radioactive water into the Ottawa River. Following the May 2009 shutdown of the NRU reactor at Chalk River, large quantities of radioactive water were collected in barrels.

AECL may be about to dump large quantities of radioactive water into the river once again, and this practice must be stopped immediately.

There also needs to be timely information about accidental releases of tritium and other contaminants. The public has the right to know about releases of radioactive water into our rivers, lakes and drinking water supplies.

Over the long run, we need to phase out costly and dangerous nuclear power and invest in sustainable alternatives to create thousands of green jobs. Please write to:

► Hon. Lisa Raitt
Natural Resources Minister
House of Commons
Ottawa, Ontario
K1A 0A6
Raitt.L@parl.gc.ca

► Members of Parliament (MP). To find contact information for your MP, visit: http://www.parl.gc.ca/. Postage is free for letters sent to the House of Commons.

8. Conclusion

Around the world, people are recognizing that nuclear power is a dangerous, prohibitively expensive way to generate electricity – one that relies on declining reserves of uranium. There are much more effective ways to tackle the climate crisis.

Nuclear power is presented as a “clean” source of power, a way to tackle the climate crisis. In reality, nuclear plants are daily sources of radioactive water pollution, threatening our health and the environment.

Rising levels of tritium in the Great Lakes, Ottawa River and the St. Lawrence River will likely lead to increased rates of cancer and birth defects.

In addition to the routine massive releases of radioactive tritium and carbon-14, we have the unsolved problem of high-level nuclear waste. We are told that we can bury tens of thousands of tonnes of highly radioactive waste, but we are placing an unfair burden on future generations.

There are viable alternatives to nuclear energy. Over the long run, we need to phase out both nuclear energy and fossil fuels.

Our manufacturing sector can reinvent itself as a centre for renewable energy – creating tens of thousands of jobs for Canadians. We can transform our economy, shifting support to renewable energy and energy efficiency – to create thousands of green jobs, and take action on climate change.

With increased investments in renewable energy, we can phase out nuclear energy. We can protect our health and environment, and avoid the contamination of drinking water, groundwater and farmland by radioactive water released from nuclear plants.

POLLUTION-FREE: WIND TURBINE ON WOLFE ISLAND. Photo by Mike Buckthought.

Safety first: keep radioactive tritium out of our food and drinking water

► We need to phase out nuclear reactors, and switch to safer, reliable and sustainable alternatives such as wind and solar power. Ontario's recent announcement of the Green Energy Act represents an important step in the right direction – with support for renewable energy, we can turn away from the dangerous path of nuclear power.

► We need safe drinking water standards, to keep radioactive tritium out of our drinking water. Over time, limits should approach background levels of tritium – recognizing that there is no safe level of exposure to radiation. Even background levels of radiation lead to increased risks for cancer.

► Atomic Energy of Canada Limited (AECL) should not be permitted to continue the practice of dumping radioactive water into the Ottawa River. Following recent incidents at the NRU reactor at Chalk River, radioactive water was collected in barrels and dumped into the river, resulting in elevated levels of tritium. Radioactive tritium should not be deliberately dumped into the Ottawa River, contaminating the drinking water of people living downstream.

► There should be a public investigation of recent nuclear accidents at Chalk River Laboratories, upstream from the nation's capital.

► The Canadian Nuclear Safety Commission (CNSC) should uphold its responsibilities to inform the public about the health hazards posed by tritium and other radioisotopes released from reactors.

► The CNSC should shut down unsafe reactors, and take action to stop massive emissions of tritium from manufacturers of radioactive glow-in-the-dark signs.

► The CNSC should take immediate action to lower dangerously high release limits for emissions of radioactive pollutants such as tritium and carbon-14.

► We need to research alternative means of production to create radioisotopes used for medical tests. Some scientists have proposed the use of linear accelerators as a safer alternative to depending on the unreliable NRU reactor at Chalk River.

Glossary: from alpha particles to zirconium

alpha particle – consists of two protons and two neutrons. Alpha particles are emitted by radioactive substances such as uranium as they decay.

becquerel (Bq) – a unit of radioactivity corresponding to one disintegration each second.

- 1 TBq is a terabecquerel = a trillion becquerels.
- 1 GBq is a gigabecquerel = a billion becquerels.
- 1 Bq = 2.7 x 10^{-11} Ci.

beta particle – a high-speed particle emitted when a tritium atom decays.

carbon-14 – a radioactive isotope of carbon routinely released by nuclear reactors. Carbon-14 has a half-life of around 5,730 years.

cesium-137 – a radioactive isotope produced in nuclear reactors. It has been found in the Ottawa River's sediments and fish caught from the river near Chalk River Laboratories.

curie (Ci) – a unit of dose equivalent to 3.7 x 10^{10} disintegrations per second. 1 Ci = 3.7 x 10^{10} Bq.

deuterium – a stable form of hydrogen found in heavy water. A deuterium atom is heavier than an ordinary hydrogen atom, and that is because it has a neutron added. The word "deuterium" comes from the Greek word for "second" – so named because it is the second isotope of hydrogen. Deuterium is not radioactive.

heavy water – massive quantities of heavy water are used in Candu reactors to moderate nuclear reactions – in other words, to keep them under control. The heavy water slows down neutrons, the sub-atomic particles that are released during the routine operation of a nuclear plant. Unfortunately, heavy water molecules often absorb an extra neutron – and that's why we get the problem of tritium being produced in nuclear plants. Add a neutron to a non-radioactive deuterium atom, and you get a radioactive tritium atom. There's lots of tritium being produced as we speak.

iodine-131 – a radioactive isotope of iodine produced during the routine operation of a nuclear plant. It is also present in radioactive fallout from nuclear tests, and fallout from Chernobyl. Iodine-131 concentrates in the thyroid gland, where it can cause thyroid cancer. Children are particularly susceptible. Exposure to iodine-131 can also stunt the development of young children. Iodine-131 emits gamma rays and beta particles as it decays.

neutron – a sub-atomic particle that is released during nuclear chain reactions.

noble gases – gases with an extremely low chemical reactivity: argon, helium, krypton, neon and xenon. Nuclear reactors create radioactive isotopes of these noble gases. These radioactive gases are routinely released into the air surrounding nuclear plants. They are strong emitters of gamma rays, and can dissolve in body fluids.

organically bound tritium (OBT) – tritiated water can be converted into organically bound tritium. Radioactive hydrogen atoms take the place of ordinary non-radioactive hydrogen atoms in organic compounds. The radioactive tritium atoms become bound in the basic building blocks of life – the molecules found in proteins, fats and carbohydrates all contain hydrogen atoms. From the point of view of chemical reactions, radioactive and non-radioactive forms of hydrogen are the same. Because tritium is so readily incorporated into our cells, it can do a lot of damage within our bodies.

plutonium – a highly radioactive metal produced in nuclear reactors. Plutonium-239 has a half-life of 24,100 years.

sievert (Sv) – dose unit, equivalent to 100 rem.

strontium-90 – a radioisotope produced by nuclear reactors. It is also present in radioactive fallout from atmospheric testing of nuclear weapons, and the fallout from the Chernobyl disaster. Strontium-90 concentrates in bones and teeth. Researchers have found a correlation between levels of strontium-90 in baby teeth and rates of childhood cancer.[64] Strontium-90 has a half-life of 29 years.

tritiated water (HTO) – radioactive water that contains tritium atoms, in place of ordinary non-radioactive hydrogen atoms.

tritium (hydrogen-3, or ^{3}H) – a radioactive form of hydrogen. The nucleus of a tritium atom consists of one proton and two neutrons. Most hydrogen found around us is not radioactive. A non-radioactive hydrogen atom contains one proton, and no neutrons in its nucleus. Tritium has a half-life of 12.3 years. When a tritium atom decays, it emits a beta particle. This can cause a lot of damage, if it happens within the human body. The beta radiation can break chemical bonds within our cells. There is an added problem: a tritium atom decays into helium-3 – disrupting chemical bonds within a molecule. DNA containing tritium can be damaged if a tritium atom decays.

zirconium – metal used in Candu reactors. The fuel bundles consist of zirconium alloy tubes containing uranium. Each bundle will contain a number of tubes, about 10 cm in diameter and 50 cm long.

64 Jay M. Gould et al, "Strontium-90 in Deciduous Teeth as a Factor in Early Childhood Cancer," *International Journal of Health Services* 30, no. 3 (2000): 515-539.

Further reading

Fairlie, Ian. *Tritium Hazard Report: Pollution and Radiation Risk from Canadian Nuclear Facilities.* Greenpeace Canada, June 2007.
http://www.greenpeace.org/raw/content/canada/en/documents-and-links/publications/tritium-hazard-report-pollu.pdf

A report on tritium releases from nuclear plants in Canada. Includes technical information about the health hazards from exposure to tritium. The report concludes that concerns about tritium's hazards are not adequately addressed by Canada's nuclear regulators. A precautionary approach should be used to prevent exposure to tritium.

Harding, Jim. *Canada's Deadly Secret: Saskatchewan Uranium and the Global Nuclear System.* Black Point, NS: Fernwood Publishing, 2007.

Explores the environmental and human rights impacts of uranium mining in Saskatchewan. The book challenges the expansion of nuclear power and exposes Saskatchewan's deadly role in the proliferation of nuclear weapons.

Caldicott, Helen. *Nuclear Power is Not the Answer: To Global Warming or Anything Else.* New York: New Press, 2006.

Anti-nuclear activist Helen Caldicott exposes the true costs of nuclear energy, and counters the myth that nuclear power is a "clean and green" option to deal with climate change. Nuclear power is prohibitively expensive, and there is a limited supply of uranium.

McKay, Paul. *Atomic Accomplice: How Canada Deals in Deadly Deceit.* 2009.
http://www.paulmckay.com/

This new book exposes Canada's role in exporting uranium and reactors, contributing to the proliferation of nuclear weapons around the world. CANDU reactors produce hundreds of kilograms of plutonium. Plutonium can be used to make nuclear weapons.

Makhijani, Arjun. *Carbon-Free and Nuclear-Free: A Roadmap for U.S. Energy Policy.* Takoma Park, Maryland and Muskegon, Michigan: Institute for Energy and Environmental Research Press and RDR Books, 2007.
http://www.carbonfreenuclearfree.org/files/images/CarbonFreeNuclearFree.pdf

The nuclear industry claims that we must embrace nuclear power to tackle the climate crisis. This study demonstrates that the United States can move to a zero-carbon economy within the next 30-50 years without the use of nuclear power. Renewable energy and energy efficiency are much more economical, safe and efficient options.

***Health Risks from Exposure to Low Levels of Ionizing Radiation.* BEIR VII Phase 2. Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation, Board on Radiation Effects, Research Division on Earth and Life Studies, National Research Council of the National Academies. Washington: National Academy of Sciences, 2006. http://www.nap.edu/openbook.php?isbn=030909156X**

New assessment of the health risks from exposure to low levels of radiation. It is now recognized that exposure to even low levels of radiation can result in increased rates of cancer.

Appendix: Emissions of tritium and carbon-14 from Canada's nuclear reactors

The nuclear industry claims that nuclear power is a pollution-free source of energy. This is not true. Nuclear power plants routinely pollute the air, lakes, rivers and the ocean with massive quantities of radioactive tritium and carbon-14.

Tritium is a radioactive form of hydrogen. Carbon-14 is a radioactive form of carbon. Because hydrogen and carbon are the "building blocks" of life, these radioactive pollutants are easily incorporated into our bodies. Radioactive hydrogen bonds with oxygen to form water. Because humans are mostly made out of water, the tritium becomes part of us.

The Canadian Nuclear Safety Commission (CNSC) publishes reports detailing the quantities of radioactive pollution from Canada's nuclear power plants.

Massive quantities of tritium and carbon-14 are released by the Point Lepreau, Bruce, Darlington, Pickering and Gentilly-2 nuclear plants on a routine basis.

There are also releases of many other forms of radioactive pollution. There are routine releases of iodine-131, noble gases, and radioactive particulates into the air and nearby bodies of water.

The following tables include the CNSC's latest data for the eighteen year period from 1990 to 2008.[65 66 67]

The annual releases of tritium and carbon-14 are expressed in units of terabecquerels (Tbq) and gigabecquerels (GBq).

- One terabecquerel (TBq) is equivalent to a trillion becquerels – it represents a trillion disintegrations per second.
- One gigabecquerel (Gbq) is equivalent to a billion becquerels – it represents a billion disintegrations per second.
- One quadrillion becquerels is equivalent to 1,000 trillion becquerels, representing 1,000,000,000,000,000 disintegrations every second. It represents a very large quantity of radioactive water.

---

65 CNSC, Radioactive Release Data from Canadian Nuclear Power Plants 1999-2008, INFO-0210, Revision 13, September 2009. http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/INFO0210_R13_e.pdf.

66 CNSC, Radioactive Release Data from Canadian Nuclear Generating Stations 1994 to 2003, INFO-0210, Revision 12, January 2006. http://nuclearsafety.gc.ca/pubs_catalogue/uploads/I0210r12_e.pdf.

67 CNSC, Radioactive Release Data from Canadian Nuclear Generating Stations 1990 to 1991, INFO-0210, Revision 10, October 2000. http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/I21010_e.pdf.

Point Lepreau

The Point Lepreau Nuclear Generating Station is the only nuclear plant in Atlantic Canada. It is located on the shore of the Bay of Fundy, near the city of Saint John, New Brunswick. The Point Lepreau station has one 680 MW CANDU-6 reactor.

Large quantities of radioactive water containing tritium are routinely released into the air and the Bay of Fundy, with unknown impacts on people and marine ecosystems. In 2008, 2,140 trillion becquerels of tritium were released into the Bay of Fundy and the atmosphere.

Year	Tritium oxide (gas) TBq	Tritium oxide (liquid) TBq	Carbon-14 (gas) TBq	Carbon-14 (liquid) GBq
1990	250	160	1.20	---
1991	170	110	0.88	---
1992	400	320	1.80	---
1993	640	470	0.58	---
1994	520	260	0.20	---
1995	310	170	0.14	---
1996	240	480	0.12	---
1997	200	500	0.15	11
1998	130	140	0.32	5.5
1999	110	53	0.28	2.6
2000	130	96	0.23	1.8
2001	140	150	0.22	2.8
2002	130	140	0.29	3.4
2003	100	81	0.21	1.8
2004	130	96	0.91	13
2005	170	210	0.28	1.7
2006	170	160	0.28	2.3
2007	200	300	0.36	40
2008	140	2,000	0.14	27

TABLE 13. RADIOACTIVE POLLUTION FROM POINT LEPREAU NUCLEAR GENERATING STATION, 1990-2008. Gaseous and liquid emissions of tritium oxide and carbon-14. Carbon-14 aqueous were emissions not reported before 1997. Source: Data compiled from CNSC reports.

Gentilly-2

The Gentilly-2 Nuclear Generating Station is located on the St. Lawrence River near the city of Trois-Rivières, Québec, about half-way between the cities of Montréal and Québec. It consists of one nuclear reactor which started operating in 1982.

There is a plan to refurbish the reactor, but it is strongly opposed by the citizens of Québec who are concerned about the health and environmental impacts of the nuclear plant.

Large quantities of radioactive water containing tritium are routinely released into the air and water around Gentilly-2, contaminating nearby agricultural land and the St. Lawrence River.

Year	Tritium oxide (gas) TBq	Tritium oxide (liquid) TBq	Carbon-14 (gas) TBq	Carbon-14 (liquid) GBq
1990	230	160	---	---
1991	270	250	---	---
1992	320	260	0.0074	15
1993	200	240	0.48	7
1994	260	130	2.9	3.7
1995	310	200	1.2	9.7
1996	220	120	1.6	6.4
1997	160	140	0.50	9.7
1998	140	250	0.27	25
1999	130	360	0.25	15
2000	250	340	0.23	32
2001	190	450	0.40	34
2002	180	500	0.37	26
2003	150	350	0.39	30
2004	120	140	0.22	16
2005	160	270	0.22	23
2006	180	230	0.28	19
2007	150	200	0.16	8
2008	170	370	0.21	11

TABLE 14. RADIOACTIVE POLLUTION FROM GENTILLY-2 NUCLEAR GENERATING STATION, 1990-2008. Gaseous and liquid emissions of tritium oxide and carbon-14. Source: Data compiled from CNSC reports.

Darlington

The Darlington Nuclear Generating Station is located in the municipality of Clarington, Ontario, near the cities of Oshawa and Toronto. It is situated on the north shore of Lake Ontario. There are four reactors, as well as the Tritium Removal Facility. This facility removes tritium building up in the heavy water moderator used in Candu reactors – however, it releases tritium into the atmosphere.

The Darlington nuclear plant routinely releases large quantities of tritium into the air and Lake Ontario. A total of 560 trillion becquerels of tritium was released in 2008. Elevated levels of tritium have been found in fruit and vegetables grown near the nuclear plant.

The Darlington Nuclear Generating Station is also notorious for its cost overruns. When it was approved in 1978, the nuclear plant was expected to cost $2.5 billion to build. The project was delayed by over a decade, and plagued by cost overruns – bringing the total cost of construction to $14.4 billion. The project was finally completed in 1993.

Ontario Power Generation has proposed building up to four new reactors at the Darlington site. The Ontario government initiated a bidding process. AECL's bid came in at around $26 billion. France's Areva also submitted a bid, with an anticipated cost of $23.6 billion for two new reactors. On June 29, 2009, the province decided to halt the bidding process, due to the high costs of the bids.[68]

However, on October 30, 2009, the CNSC established a three-member joint review panel to conduct an environmental assessment and hold public hearings for the construction of up to four new reactors at the Darlington site.[69]

Year	Tritium oxide (gas) TBq	Tritium oxide (liquid) TBq	Carbon-14 (gas) TBq	Carbon-14 (liquid) GBq
1990	120	13	---	---
1991	230	71	---	---
1992	110	46	---	---
1993	130	58	---	---
1994	330	130	---	---
1995	270	140	---	---
1996	200	120	---	---
1997	190	110	---	---
1998	190	75	---	---
1999	220	89	3.5	0.57
2000	230	110	2.8	2.8
2001	240	94	2.6	3
2002	190	69	2.8	1.7
2003	170	100	3.5	1.2
2004	280	160	1.9	0.43
2005	130	220	1.6	0.28
2006	130	190	1.2	0.59
2007	160	350	1.3	0.76
2008	170	390	1.7	9.5

TABLE 15. RADIOACTIVE POLLUTION FROM DARLINGTON NUCLEAR GENERATING STATION, 1990-2008. Gaseous and liquid emissions of tritium oxide and carbon-14. For 1990-1998, includes gaseous emissions from the tritium removal facility. Emissions of carbon-14 were not reported before 1999. Source: Data compiled from CNSC reports.

68 Tyler Hamilton, "$26B cost killed nuclear bid," *Toronto Star,* July 14, 2009. http://www.thestar.com/comment/columnists/article/665644.

69 CNSC News Release, October 30, 2009. http://www.ceaa-acee.gc.ca/050/document-eng.cfm?document=39279.

Pickering A

The Pickering A Nuclear Generating Station is located on the north shore of Lake Ontario near the cities of Pickering and Toronto. There are four reactors at Pickering A (Units 1-4).

Ontario Hydro shut down all four reactors in 1997. Unit 4 was restarted in September 2003, and Unit 1 was started again in November 2005. Units 2 and 3 remain shut down.

Large quantities of radioactive water containing tritium are routinely released into the air and Lake Ontario, and there have been some serious accidents. In August 1992, the Pickering A station accidentally released around 2,020 trillion becquerels of tritium during one incident – leading to increased levels of tritium throughout Lake Ontario.[70]

Year	Tritium oxide (gas) TBq	Tritium oxide (liquid) TBq	Carbon-14 (gas) TBq	Carbon-14 (liquid) * GBq
1990	630	410	2.9	---
1991	640	400	3.5	---
1992	590	3,000	2.1	---
1993	520	520	1.6	---
1994	480	560	1.2	---
1995	590	440	4.1	---
1996	370	430	0.23	---
1997	440	350	1.1	---
1998	250	85	0.33	---
1999	200	320	0.32	---
2000	180	120	0.19	---
2001	310	130	0.16	---
2002	230	77	0.19	---
2003	170	68	1.1	---
2004	210	120	1.2	---
2005	240	82	2.1	---
2006	270	130	1.4	---
2007	280	71	0.94	---
2008	520	250	1.3	---

TABLE 16. RADIOACTIVE POLLUTION FROM PICKERING A NUCLEAR GENERATING STATION, 1990-2008. Gaseous and liquid emissions of tritium oxide and carbon-14. Source: Data compiled from CNSC reports.

*** Carbon-14 aqueous effluent from Pickering A is not recorded separately; quantities are included in the data for Pickering B.**

70 L.A. Chant et al, Tritium Concentrations in Lake Ontario, AECL Report RC-1149, COG 93-484, 1994.

Pickering B

The Pickering B Nuclear Generating Station is located next to Pickering A on the north shore of Lake Ontario, near the cities of Pickering and Toronto. There are four reactors at Pickering B (Units 5-8).

Large quantities of radioactive water containing tritium are routinely released into the air and Lake Ontario.

Year	Tritium oxide (gas) TBq	Tritium oxide (liquid) TBq	Carbon-14 (gas) TBq	Carbon-14 (liquid) * GBq
1990	280	30	---	---
1991	180	32	---	---
1992	190	44	---	---
1993	240	13	---	---
1994	230	120	---	---
1995	190	110	---	---
1996	190	16	---	---
1997	170	50	---	---
1998	220	71	---	---
1999	270	130	---	11
2000	270	110	11	7.3
2001	270	200	6.3	3.3
2002	280	210	1.8	15
2003	330	190	2.6	11
2004	380	170	1.6	4.4
2005	330	180	3.9	5.5
2006	290	200	6.7	6.2
2007	280	180	11	2
2008	240	200	5.4	0.99

TABLE 17. RADIOACTIVE POLLUTION FROM PICKERING B NUCLEAR GENERATING STATION, 1990-2008. Gaseous and liquid emissions of tritium oxide and carbon-14. Carbon-14 gaseous emissions were not reported before the year 2000. Carbon-14 liquid releases were not reported before 1999. Source: Data compiled from CNSC reports.

* Carbon-14 aqueous effluent includes data for Pickering A.

Bruce A

The Bruce A Nuclear Generating Station is located near the town of Kincardine, Ontario, on the shore of Lake Huron. There are four reactors (Units 1-4) operated by Bruce Power.

In 1997 Ontario Hydro shut down all four reactors at Bruce A.

Unit 4 was restarted in October 2003, and Unit 3 was restarted in January 2004.

Bruce A Units 1 and 2 are being refurbished, and are now expected to be back online in 2011. The much-delayed refurbishment project will cost as much as $3.74 billion – about $1 billion over budget.[71]

Total emissions of tritium from Bruce A reached 4.4 quadrillion becquerels in 1991. Emissions declined substantially after all four reactors were shut down in 1997.

There has been a sharp rise in total emissions of tritium from Bruce A, after Units 3 and 4 were brought back online. Emissions increased from 308 trillion becquerels in 1998 to over 1.4 quadrillion becquerels in 2008.

Large quantities of radioactive water containing tritium are routinely released into the air and Lake Huron. Water from wells in the Bruce Peninsula has been found to contain elevated levels of tritium.

Year	Tritium oxide (gas) TBq	Tritium oxide (liquid) TBq	Carbon-14 (gas) TBq	Carbon-14 (liquid) GBq
1990	1,600	1,200	---	---
1991	1,200	3,200	---	---
1992	1,100	1,700	---	---
1993	1,700	1,500	---	---
1994	1,000	1,400	---	---
1995	610	1,900	---	---
1996	700	1,200	---	---
1997	350	310	---	---
1998	230	78	---	---
1999	310	24	0.20	860
2000	210	9	0.35	24
2001	230	13	0.39	6.4
2002	150	64	0.39	1.4
2003	190	60	0.51	1.7
2004	670	99	1.2	5.7
2005	360	170	1.7	8.2
2006	450	300	1.9	1.3
2007	930	170	1.5	1.8
2008	1,200	240	0.87	0.92

TABLE 18. RADIOACTIVE POLLUTION FROM BRUCE A NUCLEAR GENERATING STATION, 1990-2008. Gaseous and liquid emissions of tritium oxide and carbon-14. Carbon-14 releases were not reported before 1999. Source: Data compiled from CNSC reports.

71 Tyler Hamilton, "Setbacks slow Bruce Power reactor restarts," *Toronto Star,* November 5, 2009. http://www.thestar.com/business/article/721335--setbacks-slow-bruce-power-reactor-restarts.

Bruce B

The Bruce B Nuclear Generating Station is located near the town of Kincardine, Ontario, on the shore of Lake Huron. There are four reactors (Units 5-8) operated by Bruce Power.

Total emissions of tritium have increased in recent years, reaching about 1,700 trillion becquerels in 2007.

Large quantities of radioactive water containing tritium are routinely released into the air and Lake Huron. Water from wells in the Bruce Peninsula has been found to contain elevated levels of tritium.

Year	Tritium oxide (gas) TBq	Tritium oxide (liquid) TBq	Carbon-14 (gas) TBq	Carbon-14 (liquid) GBq
1990	780	480	---	---
1991	390	490	---	---
1992	340	410	---	---
1993	390	660	---	---
1994	370	560	---	---
1995	230	380	---	---
1996	310	230	---	---
1997	270	680	---	---
1998	260	380	---	---
1999	310	220	---	36
2000	490	270	4.1	5.2
2001	420	150	2.7	3.1
2002	430	350	2.1	7.1
2003	370	800	4.3	6.5
2004	190	490	2.6	8.5
2005	380	260	8.8	6
2006	440	430	10	6.3
2007	630	1,100	5.7	5.1
2008	450	230	4.5	3.6

TABLE 19: RADIOACTIVE POLLUTION FROM BRUCE B NUCLEAR GENERATING STATION, 1990-2008. Gaseous and liquid emissions of tritium oxide and carbon-14. Gaseous emissions of Carbon-14 were not reported before the year 2000. Liquid releases of carbon-14 into Lake Huron were not reported before 1999. Source: Data compiled from CNSC reports.

Sierra Club Canada

National Office
412-1 Nicholas Street
Ottawa, ON K1N 7B7
Tel: (613) 241-4611
Fax: (613) 241-2292
www.sierraclub.ca

Sierra Club Canada