EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT

LIST OF FACTSHEETS

Available free from:

The EAGLE Project

Assembly of First Nations

55 Murray Street, 5th Floor

Ottawa, Ontario

K1N 5M3

Tel: (613) 236-0673

Fax: (613) 238-5780

EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT
A CO-OPERATIVE PROGRAM ON HOW ENVIRONMENTAL CONTAMINANTS IN THE GREAT LAKES BASIN AFFECT NATIVE HEALTH

Contamination of the Great Lakes Basin

The Great Lakes are contaminated and toxic chemicals, such as PCBs, dioxins, toxaphene, DDT and mercury have been found throughout the region. Not only are the air and water contaminated, contaminants have also been found in fish, wildlife and people living in the Great Lakes Basin. Indeed, human fat and mother's milk have been shown to contain residues of several organic chemicals, while metals, such as mercury, have been found in blood and hair.

Human Health and Contaminants in the Great Lakes Basin

Many of the toxic chemicals in the Great Lakes Basin cause health effects in laboratory animals and in fish and wildlife. These effects include population declines, altered behaviour, birth and developmental defects, biochemical and metabolic effects and cancer. Only a little work has been done on the health effects of contaminants in humans. Much of this has focused on people who are at a higher risk of experiencing health problems than the general population. This includes people who eat large amounts of contaminated fish and wildlife. The most important study showed that women who ate contaminated Lake Michigan fish gave birth to babies who had a shorter average gestation, smaller average head size and delayed reflexes. Further work is needed to confirm these findings and to explore other types of health effects that could be associated with toxic chemicals. As well, the effects of contaminants on the quality of life need to be studied.

The EAGLE Project

The Effects on Aboriginals from the Great Lakes Environment (EAGLE) Project community-based initiative to examine the effects of contaminants in the Great

Lakes Basin on native health, well-being and quality of life. It uses a broad definition of health and will look at the effects of contaminants on all aspects of individual and community health.

The program is being developed by native people for native people. While it will be based on 'scientific' principles, one of its main objectives is to help communities to understand how they are being affected by toxic chemicals and to enable them to do something about it. The program is being funded by Health and Welfare Canada and it is being managed on a day-to-day basis by the Assembly of First Nations (AFN). The partnership between Health and Welfare Canada, AFN and native communities is central to the program. This approach is entirely new and very different from other scientific studies.

There is a Steering Committee composed of AFN, Health and Welfare Canada and community representatives that is responsible for the program's overall direction. There is also a Scientific Advisory Group consisting of AFN, Health and Welfare Canada and scientists familiar with contamination and human health in the Great Lakes Basin. AFN has several staff who manage and run the program.

The EAGLE Project is still in the design phase and all ideas are welcome. We hope to build agreement on what the program should do within native communities very soon. So far, AFN staff have held meetings in many communities around the Great Lakes. These give people a chance to share information about their local environment and health, as well as learning about the EAGLE program. The next stages will be to design and implement the program itself. All of those involved are committed to full community participation and making available all information collected (confidential medical information will not be released, except to the individual concerned and possibly her/his doctor).

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FACTSHEET

SOME WORDS ON WORDS

Bioaccumulation

The process by which concentrations of chemicals get progressively higher at successive levels of the food web.

Bioconcentration

The process by which chemicals concentrate in certain tissues, such as fat and mothers' milk.

Carcinogen

A substance (e.g., a chemical) or an agent (e.g., ionising radiation) that causes cancer.

Congener

A different configuration or mixture of a single chemical where some of the molecules occupy different positions.

Contaminant

A substance foreign to a natural system or present at unnatural concentrations.

DDT

An insecticide, also called dichlorodiphenyl trichloroethane. DDT can break down to DDE (dichlorodiphenyl dichloroethylene), which is very persistent in the environment (see separate information sheet on DDT and its metabolites).

Detection Limit

The lowest concentration of a substance that can be detected with certainty by an analytical process.

Dioxin

A group of about 75 chemicals, also called polychlorinated dibenzodioxins (PCDDs). The most toxic is 2,3,4,5-TCDD (tetrachlorinated dibenzodioxin) is the most toxic (see separate information sheet).

Epidemiology

The study of diseases and other health effects in human populations.

Food Web

A food web consists of different species of plants and animals that are dependent on each other for food. It usually contains photosynthesising green plants (primary producers), herbivores that eat the plants and one or more level of carnivorous or predatory species. Humans are at the top of many food webs.

Guideline

A recommended limit for a substance or an agent intended to protect human health or the environment. It is not legally enforceable.

Hepatic

To do with the liver.

Mutagen

A substance or agent which can alter the genetic material (DNA).

Objective

A preferred or desired level of a substance or an agent in the environment, often zero or the detection limit.

PCBs

A group of 209 chemicals, also called polychlorinated biphenyls (see separate information sheet on PCBs).

Renal

To do with the kidney.

Standard

A legally enforceable limit for a substance or an agent intended to protect human health or the environment. Exceeding the standard could result in unacceptable harm to whatever it is intended to protect.

Teratogen

A substance or agent which can cause effects in the offspring of exposed adults.

Toxaphene

An insecticide that does not easily break down in the environment. It was also used to kill fish. Most uses have now been banned (see separate information sheet on toxaphene).

Toxicology

The study of how poisons, including toxic chemicals, affect living things.

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FACTSHEET ON ENVIRONMENTAL UNITS OF MEASUREMENT

To measure the amounts of chemicals in the environment, it is usually necessary to take a sample of the water, air, soil or living organism and to analyse it to determine the precise levels or concentrations. Levels or concentrations of contaminants in the environment are usually expressed in the following units:

State	Unit	Symbol
Solid	gram	g
Liquid	litre	l

Chemicals are often present in fractions of a gram per kilogram (a thousand grams) or per litre. The fractions of a gram that are most commonly used are:

	Prefix	Symbol
a thousandth	milli	m
a millionth	micro	μ
a billionth	nano	n
a trillionth	pico	p

Thus, one milligram is shown as 1mg, one microgram is 1μ, one nanogram is shown and 1 ng and one picogram is shown as 1pg.

To illustrate this:

1 part per million	=	1μg/g	or	1mg/kg	or	1mg/l
1 part per billion	=	1ng/g	or	1μg/kg	or	1μg/l
1 part per trillion	=	1pg/g	or	1ng/kg	or	1ng/l

For example, in 1983 the concentration of PCBs in Lake Ontario lake trout was about 6 parts per million (or 6μg/g or 6mg/kg). In another example, the average concentration of mercury in Lake Superior water was 10 parts per trillion or 10ng/litre in 1983.

Some people say that because many toxic chemicals are present in such small amounts, they are insignificant. After all, 1 part per billion is equivalent to 200 meters of the distance between the earth and the sun, or one drop of whisky in 20,000 litres of water. But these amounts can be biologically important and cause health effects. We all need a daily supply of tiny amounts of essential vitamins and minerals. Without them we would get sick. For example, an adult needs about half a milligram of vitamin C a day. This corresponds to about one hundredth of a part per million (compared to an average adult's body weight). Thus, even very small amounts of substances can have profound positive or negative effects of human health.

The dose of a contaminant is determined not just by the amount that one is exposed to, but also by its potential for toxicity.

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EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT
FACTSHEET ON ENVIRONMENTAL CONTAMINANTS AND HUMAN HEALTH

We are all exposed to environmental contaminants in food, air and drinking water, and they can affect human health. There are two factors that determine if and how human health will be affected: the dose or exposure received and the toxicity of the contaminant. Exposures to environmental contaminants are usually low, compared to occupational or accidental exposures. The toxicity of environmental contaminants varies enormously, as does the type of health effects that may be produced. Examples of health effects include chloracne (a skin disease), vomiting, sleeplessness, tremors, numbness in the arms or legs, behavioral effects, metabolic and biochemicals effects, developmental effects, and cancer. There are two scientific disciplines that provide information on the doses or exposures of environmental contaminants that cause different health effects. These are toxicology and epidemiology.

Toxicology

Toxicology is the study of how poisons, such as toxic chemicals, affect the body. Today, most environmental toxicology involves experimenting on laboratory animals, such as rats and mice. Animals are given different dosages of an environmental contaminant and then any health effects are recorded. The exposure can be acute (short term) or chronic (long term). Acute exposures often involve high doses and are used to find out how toxic a chemical is in the short term. The LD_{50} is the 'lethal dose' required to kill half (i.e., 50%) of a population of exposed laboratory animals over a certain amount of time. Chronic exposures involve lower doses and longer time periods. They are usually used to study cancer.

In toxicology, it is always necessary to extrapolate from observed effects in animals to possible effects in humans. It is also often necessary to extrapolate from effects observed at relatively high exposures to real-life exposure levels that are almost always lower than those used in the laboratory. Thus, toxicology can never be entirely accurate at predicting the human health effects of environmental contaminants.

Another problem is that although we have a relatively large amount of toxicological information on some contaminants (such as PCBs and dioxins), there is hardly any available on most.

Epidemiology

Epidemiology is the study of diseases in human populations. Most early epidemiological studies focused on the spread of communicable diseases. But environmental contaminants are associated with non-communicable health effects. In recent years, environmental epidemiology has begun to study the relationships between environmental contaminants and health in human populations.

There are four main types of environmental epidemiological studies: case-control, cohort cross-sectional and ecological. They all have advantages and disadvantages, but it is generally recognised that a case-control study (also the most difficult type of study usually) provides the best evidence that an environmental contaminant can cause a health effect. Environmental epidemiological studies can be retrospective (look back in time) or prospective (follow individuals or a group over time).

One of the main problems with environmental epidemiological studies is that it often takes a large sample size or population to detect a rare health effect. For example, if a cancer-producing chemical causes the incidence of cancer to increase by a rate of one in a million, then at least a million exposed people will be needed for the increased incidence to be seen. Such sample sizes are often impractical.

Another problem is that only about 45 environmental epidemiological studies have been done in Canada, so we really don't know very much about how environmental contaminants actually affect human health.

One thing that all environmental scientists must take account of is that in the environmental everything is 'connected to everything else'. Thus, it is virtually impossible to conclude that a single contaminant caused a single health effect. We are all exposed to mixtures of contaminants with different toxicities. Often they cause the same health effects as each other and these health effects can also be caused by many other things that are not environmental contaminants. Current scientific methods find it difficult to deal with this. One way of dealing with this is to look more at the 'weight of evidence' and to assess the probability that a particular level of exposure to a particular environmental contaminant will cause a specific health effect.

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EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT: FACTSHEET ON THE GREAT LAKES

Introduction

The Great Lakes are the largest body of freshwater on earth and they contain about one-fifth of the world's freshwater. Lake Superior is the second largest lake in the world, after Lake Baikal. Lake Huron is the fifth largest, Lake Michigan is the sixth largest, Lake Erie is the thirteenth largest and Lake Ontario is the seventeenth largest.

Lake Superior has a volume of 1,100 cubic kilometres, more than double the volume of the next largest lake, Lake Michigan (4,920 cubic kilometres). The volumes of the other lakes are: Huron 3,540 cubic kilometres, Erie 484 cubic kilometres and Ontario 1,640 cubic kilometres. The total volume of the Great Lakes is 22,684 cubic kilometres. Water stays in Lake Superior for an average of 191 years, in Lake Michigan for an average of 99 years, in Lake Huron for an average of 22 years, in Lake Erie for an average of only 2.6 years (because it is so shallow) and in Lake Ontario for an average of 6 years.

The Great Lakes system flows from Lakes Superior and Michigan, through Lakes Huron, Erie and Ontario and the St. Lawrence River to the Atlantic Ocean. The Lakes are one unit and are connected by short narrows at Mackinac and by the St. Clair, Detroit and Niagara Rivers. These rivers have very high flow rates.

Lake Superior

Lake Superior has the largest surface area of any lake in the world, although Lake Baikal contains more water because it is deeper. By volume, it contains half of the water stored in the Great Lakes. The main tributaries to Lake Superior are the Nipigon, St. Louis, Pigeon, Pic, Whit, Michipicoten and

Kaministiquia Rivers. It flows into the St Marys River. The lake is mainly surrounded by the forested, precambrian landscape of the Canadian Shield.

Lake Superior is the least contaminated of the Great Lakes because it has fewer cities, less industry and less agriculture than the other lakes. The pulp and paper industry is an important source of contaminants. Another important source is the air. Chemicals such as PCBs, DDT, lead and toxaphene are atmospherically deposited into Lake Superior in relatively large amounts. This is mainly because of the lake's large surface area.

Lake Michigan

Lake Michigan is the only Great Lake completely in the U.S. It consists of two basins, a northern basin with depths up to 280 metres and a southern basin with depths up to 170 metres. One of its main tributaries is Fox River which empties into Green Bay, on the western side of the lake. Green Bay is one of the most contaminated areas in the Great Lakes. Downstream Lake Michigan is connected to Lake Huron by the Straits of Mackinac.

About 14 million Americans live around Lake Michigan and the largest urban area in the Great Lakes (Gary - Chicago - Milwaukee) is located at the southwest end of the Lake. There is a lot of industry around Lake Michigan, and much of the remaining rural land is farmed. Contaminants enter the Lake from sewage discharges, industries, agricultural practices and the air.

Lake Huron

The surface area of Lake Huron is 59,600 square kilometres and its maximum depth is 229 metres. Its main tributaries are the Straits of Mackinac, the St. Marys, Mississagi, Saginaw, French and Spanish Rivers. Manitoulin Island and the Bruce Peninsula divide the body of the Lake from the North Channel and Georgian Bay. Saginaw Bay is located on the west side of Lake Huron and extends 82 kilometres from the main body of the Lake. It is one of the most contaminated areas in the Great Lakes.

Most of the northern shoreline of Lake Huron is forested, but there is agriculture along the southern shoreline. Industrial contamination is most serious in harbours and bays, such as Saginaw Bay. The Lake is used extensively for recreational and commercial fishing.

Lake Erie

Lake Erie is the fourth largest of the Great Lakes by area. It is the smallest by volume and also the shallowest. It is divided into three basins. The eastern basin, into which the Detroit River flows, is very shallow but has the most important fish spawning and nursery grounds. It is also downstream from 'chemical valley' (i.e., the Canadian chemical companies on the St. Clair River) and Detroit and close to Toledo. As a result, this part of Lake Erie is extremely susceptible to chemical contamination.

Lake Erie has a higher biological productivity than the other Great Lakes partly because it is much shallower. In the 1970s, Lake Erie nearly 'died' because of the growth of plants and algae that prevented other normal ecological processes from occurring. Now that levels of nutrients, such as phosphorous, are somewhat lower, the lake has recovered. Lake Erie is also chemically contaminated, but contaminants are rapidly flushed out and into the Niagara River.

Lake Ontario

Lake Ontario is the smallest of the Great Lakes, by area, but with a maximum depth of 244 metres, it is the second deepest. The largest tributary is the Niagara River, but others include the Oswego, Trent, Black and Genessee Rivers. The lake flows to the Atlantic Ocean via the St. Lawrence River.

Lake Ontario has been chemically contaminated for many years by industrial, agricultural and municpal sources. Because of its relatively small surface area, atmospheric deposition is not a major problem. The highest contaminant levels are in industrialised bays and harbours. The main industrial centres are Toronto, Hamilton and Rochester. Other important cities include Kingston and

Oswego. There is quite a lot of recreational fishing in Lake Ontario and a few commercial fishermen are still active at the eastern end of the Lake.

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K1N 5M3

Tel: (613) 236-0673

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EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT: FACTSHEET ON THE HEALTH EFFECTS OF CONTAMINANTS IN THE GREAT LAKES BASIN

Exposure

People living in the Great Lakes Basin and elsewhere are exposed to many chemical contaminants and other agents that can cause adverse health effects. The majority (between 80 and 90%) of human exposure to persistent, chlorinated organic chemicals comes from food, and a smaller amount from air (between 5 and 10%) and a minute amount (less than 1%) from drinking water. It is important to remember that a large proportion of the food consumed by people living in the Great Lakes Basin is grown elsewhere. Of the food grown and consumed in the Basin, the largest sources of exposure are from the consumption of contaminated fish and wildlife.

People living in the Great Lakes Basin and elsewhere contain residues of several chemical contaminants in their tissues. Residents of the Basin contain similar residue levels as those in people living elsewhere. This indicates that people in the Great Lakes Basin are exposed to similar levels of toxic chemicals as those living elsewhere.

Residues of persistent, chlorinated organic chemicals, such as PCBs, DDT and dioxins, are often found in fat and mother's milk, while heavy metals, such as mercury, are found in blood and hair.

Effects

There have been only a few studies on the health effects of contaminants in human populations in the Great Lakes Basin. These studies have examined cancer incidence and mortality, birth and developmental effects and the effects of air pollution.

Birth Defects

Birth defects in Ontario do not have any obvious geographic patterns that could be a result of contaminants in the Great Lakes. One study of birth defects in babies born to women living in counties that use St. Clair River drinking water showed that defects were not associated with chemicals spills in the river.

Developmental Effects

An important ongoing study of the babies of women who consumed quite large amounts of contaminated fish from Lake Michigan has shown that exposure to toxic chemicals can cause developmental effects. Fish consumption was associated with significant decreases in average birth weight, length of gestation, head size and poorly developed reflexes. Further work has shown that these children have continued to have behavioral and learning difficulties as they grow up.

Air Pollution

Air pollution in southern Ontario has been linked to increased hospital admissions for respiratory conditions and effects on lung function in some children and adults.

Lead

The concentration of lead in the blood of children living in the Great Lakes Basin is similar to that in children living elsewhere. Current average blood lead levels may affect neurological development.

Native Studies

Studies on the effects of contaminants on native health in the Great Lakes Basin have not been able to relate contaminants with direct, physical health effects. Despite this, contaminants are undoubtedly affecting the well-being and quality of life of many native communities.

In conclusion, people who are highly exposed to contaminants, or who are sensitive to their effects, are at risk, but the precise nature and extent of these risks is not known. People at risk include those consuming large amounts of contaminated fish or wildlife, as well as the very young (the fetus and young babies) and the elderly.

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EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT: FACTSHEET ON ENVIRONMENTAL CONTAMINATION IN THE GREAT LAKES BASIN

History of Contamination

Chemical analyses of sediment cores from the bottom of the lakes have shown that the contamination of the Great Lakes started after World War II, at the same time as the rapid growth of many cities and industries. Some persistent, chlorinated organic chemicals, such as PCBs, were being produced before the War, but peak amounts were not manufactured until the 1950s, 1960s and early 1970s.

In the early 1960s, pesticides and industrial chemicals such as DDT and PCBs were first detected in the Great Lakes and in 1968, mercury was found in sediments, and in fish from Lake St. Clair. Subsequently, commercial fishing in the lake was banned. In 1971, the Michigan Public Health Department issued a consumption advisory because of PCBs in lake trout and salmon in Lake Michigan. Soon after, in 1974, mirex was discovered in fish from the Bay of Quinte and in late 1979, dioxins were found in herring gull eggs from Saginaw Bay on Lake Michigan. Toxaphene was first detected in fish from Lake Superior in 1982. Subsequent research has shown that these and other contaminants are present throughout the Great Lakes Basin. To date, 362 contaminants have been found in the waters of the Great Lakes.

Data from sediments show that the major loadings of persistent toxic chemicals took place between the 1950s and the early 1970s. Major influxes of several contaminants to the Great Lakes occurred several years before they were first detected in living organisms. Concentrations of many chemicals decreased in the mid and late 1970s, after bans or use restrictions were imposed. Since then, levels have stabilised, indicating that the Great Lakes Basin is still contaminated, but at lower levels than previously.

Levels of Contaminants

Lakes Ontario, Michigan and Erie are the most contaminated and Lake Superior is the least contaminated. The atmosphere is a more important source of contaminants to the Upper Great Lakes, than to the lower ones because of their larger surface areas. The lower Great Lakes receive more of their contaminants from their tributary rivers, industries, agriculture and sewage disposal.

Concentrations of contaminants in water are higher in the nearshore areas and bays than in the centres of the lakes. Higher levels of toxic chemicals are also found in the rivers that connect the Great Lakes, downstream from discharges. Leaking hazardous waste sites are a major problem in the Niagara River and chemical spills are still an important issue in the St. Clair River.

Contaminants in Fish

There are three programs that measure the levels of contaminants in fish:

- The open-lake fish contaminants program (run by the Canadian Department of Fisheries and Oceans, the U.S, Fish and Wildlife Service and the U.S. Environmental Protection Agency);
- The Ontario Ministry of the Environment's nearshore juvenile fish contaminants surveillance program; and
- The Ontario Ministry of the Environment's sport fish testing program.

Information from these programs has shown that levels of most contaminants in fish decreased in the mid and late 1970s, but have stabilised since then. This includes PCBs, hexachlorobenzene, DDT, toxaphene and mercury. Concentrations of dieldrin, a chlorinated organic pesticide, have not fallen as rapidly.

Several sets of guidelines have been developed that set maximum acceptable levels of contaminants in fish. These include the 'Guide on Sport Fish Consumption' issued by the Ontario Ministry of the Environment. The Guide is intended to protect human health. Contaminants have profoundly affected the once-thriving Great Lakes fishery. There is still a large sport fishing industry, but the commercial fishery has declined enormously. Although loss of habitat has been important, toxic chemicals have caused population declines, a loss in fertility, behavioral effects and tumours, as well as other health effects.

Wildlife

Levels of chlorinated organic chemicals have been measured in wildlife since 1968. The largest program has analysed herring gull eggs collected throughout the Great Lakes Basin. Concentrations of PCBs, DDT, mirex, hexachlorobenzene and other chlorinated organic chemicals decreased from the mid 1970s to the early 1980s. Since then, levels have stabilized. Dieldrin levels have not changed much. Information from other bird species is limited (terns, cormorants, night-herons), but indicate a general decrease.

There is some information on other species. Levels of contaminants in mink are higher in shoreline animals than inland, and high contaminant levels have been reported in snapping turtles and beluga whales (from the St. Lawrence River). Effects on wildlife include impaired metabolic and biochemical processes, birth defects (such as crossed-bill), behavioral effects, population declines and a loss of fertility and disruption of endocrine metabolism. To date, effects have been reported in at least 16 animal species.

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EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT: FACTSHEET ON THE GREAT LAKES WATER QUALITY AGREEMENT AND THE INTERNATIONAL JOINT COMMISSION

The Great Lakes Water Quality Agreement

In 1972, the Governments of Canada and the U.S. signed the first Great Lakes Water Quality Agreement, because of concerns about water quality. In the early 1970s, Lake Erie was apparently 'dying' because of the overgrowth of algae and other water plants caused by high levels of nutrients, including nitrogen and phosphorus. These nutrients were entering the Great Lakes in record amounts from agricultural fertilizers and sewage containing detergents.

The first Great Lakes Water Quality Agreement committed the two federal governments to reducing the large amounts of nutrients entering the Lakes. Since then, levels of phosphorus entering the Great Lakes in municipal sewage effluents have been reduced, although nitrogen in agricultural fertilizers is still a problem. The algae 'blooms' in Lake Erie have been very much reduced.

In 1978, the Governments of Canada and the U.S. signed the second Great Lakes Water Quality Agreement. Unlike the first Agreement, the second one focused on persistent toxic chemicals. By 1978, it was obvious that water quality was being affected not only by nutrients, but also by persistent toxic chemicals, such as PCBs and DDT. The second agreement was remarkable in several ways including:

- It committed the two federal governments to the 'virtual elimination' of persistent toxic chemicals;
- It emphasised that the federal governments should use an 'ecosystem approach' to resolving problems; and

- It contained common specific objectives for water quality.

All of these points are important because they were a new way of thinking about managing the environmental quality of the Great Lakes.

In 1987, the federal governments signed a Protocol amending the second Great Lakes Water Quality Agreement. This Protocol expanded the scope of the second Agreement considerably by, for example, including obligations to:

- prepare remedial action plans for the most seriously contaminated areas;
- study and reduce atmospheric contaminants;
- study and reduce groundwater contamination; and
- promote research on the environmental problems of the Great Lakes Basin.

The Protocol is important because it recognizes that the Great Lakes is an ecosystem and that water quality in the Lakes is related to air quality and groundwater quality.

The International Joint Commission

The International Joint Commission (IJC) was established in 1909 under the Boundary Waters Treaty between Canada and the U.S. Its primary purpose is to mediate and resolve transboundary issues between Canada and the U.S. It consists of equal numbers of Canadian and U.S. Commissioners, appointed by the Prime Minister and the President, respectively. It has offices in Ottawa and Washington D.C., as well as a regional office Windsor. When the first Great Lakes Water Quality Agreement was signed, the IJC was made responsible for monitoring its implementation. This responsibility continues today.

Every two years the IJC prepares a report on the Agreement that is submitted to the two federal governments. The next biennial report will be prepared in 1993. To assist the commissioners, there are two boards, the Water Quality Board and the Science Advisory Board. Both are composed of Canadians and Americans. The Boards have a series of committees to help them. The Boards also prepare reports every two years. They are submitted to the Commissioners. The next Science Advisory and Water Quality Board reports will be prepared in 1993. Copies of the IJC and its Board's reports are available free of charge. Other free reports and information are also available from the IJC.

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EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT: FACTSHEET ON PCBs

What are PCBs?

PCBs (polychlorinated biphenyls) are a group of organic chemicals containing chlorine. There are 209 possible types of PCBs that vary from being very toxic to being relatively harmless. PCBs had a wide variety of uses including in capacitors, transformers, hydraulic fluids, cutting oils, flame retardants, adhesives, plasticizers and heat transfer fluids. PCBs are unreactive and chemically stable.

In the mid 1970s, concern about the environmental effects of PCBs led to a ban on their manufacture and importation into Canada. But although most non-electrical uses of PCBs have now been phased out in Canada and the U.S., a large amount is still being used in electrical equipment (capacitors and transformers).

Trace levels of PCBs have been found throughout the world in air, water, soil and living organisms. This is because of careless disposal and accidents. As well, PCBs can be transported many thousands of miles by air, water and migrating birds and animals. PCBs are very persistent and do not readily breakdown in the environment. They bioconcentrate up food webs. Levels are higher in tissues containing a lot of fat, such as fat and mothers' milk, than in low-fat tissues, such as muscle.

How Are We Exposed to PCBs?

The most important source of exposure to PCBs is food, and in particular contaminated fish and wildlife. PCBs have also been detected in air and very occasionally in drinking water. However, most exposure comes from food.

The levels of PCBs in fish and wildlife in the Great Lakes Basin vary from lake to lake and from species to species. Age is also an important factor. In some cases, levels in fish exceed fish consumption advisories. Fish from Lakes Michigan and Ontario have the highest concentrations of PCBs. Concentrations in fish from the other Great Lakes are all about the same and are about half those in Lake Ontario fish. There is much less information on PCBs in wildlife, but there is probably the same general pattern is likely. Levels of PCBs have decreased over the last twenty years.

PCBs have been found in human fat and milk from Canadians, although there is not enough information to tell whether levels are going up or going down, or if they are different in different parts of the country. However, levels in people living in the Great Lakes Basin are about the same as those in people living elsewhere.

What Are The Health Effects of PCBs?

Different types of PCBs have different toxicities. In laboratory animals, short-term, high exposures, can shorten the lifespan, be toxic to the liver, prevent normal growth and development and cause reproductive problems and cancer, although much depends on the dose and the type of PCB. However, it is unlikely that PCBs can 'start' cancer. It is more likely that they act as 'promoters' once a cancer has already been initiated.

Up until about five years ago, people thought that all PCBs were similar and had roughly similar toxicities, so levels in the environment were reported as 'total PCBs'. We now know that different PCBs have different toxicities. Therefore, it is difficult to interpret the significance of early data on 'total PCBs'. These days, a lot of the work on PCBs is focusing on measuring levels of individual PCBs and understanding their effects.

What Are The Standards And Guidelines For PCBs?

Human exposure	lμg/kg body weight/day	National Health and Welfare
Drinking water	0.003 parts per million	Ontario Ministry of the Environment

Fish	2 parts per million in the 'edible portion' for commercial fish	National Health and Welfare

If you would like any further information on this subject, or have any comments or questions on this factsheet, please contact:

The EAGLE Project
Assembly of First Nations
55 Murray Street, 5th Floor
Ottawa, Ontario
K1N 5M3
Tel: (613) 236-0673
Fax: (613) 238-5780

EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT: FACTSHEET ON DDT AND ITS METABOLITES

What Is DDT?

DDT was developed in the late 1930s and it was used as an insecticide. Its use peaked in the early 1960s, and in 1963, 176 million pounds were produced in the U.S. In the early 1970s, most uses of DDT were banned in Canada and the U.S., largely because of environmental concerns. The last use of DDT in Canada (bat control) was banned in 1989.

DDT and its metabolites are broadly distributed in the environment. Although DDT is quite stable, it breaks down to DDE and other compounds. DDE is less toxic to humans, but is more stable, than DDT. DDE also has a stronger attraction to fat than DDT, therefore, DDE, rather than DDT is the major residue stored in human tissues.

How Are We Exposed to DDT And Its Metabolites?

Food is the major exposure pathway to DDT and its metabolites. Fish, such as lake trout, contain DDT, although the levels vary from lake to lake and from species to species. Levels of DDT and its metabolites decreased in the 1970s, but have now stabilised. This is because DDT and its metabolites are quite persistent and because they are transported to the Great Lakes in the air from places, such as Central America, that still use it for mosquito control.

DDT and its metabolites have been found in air, but it is rarely found in drinking water.

DDT and its metabolites have also been found in human fat and milk. Concentrations in people living in the Great Lakes Basin are similar to those in people living elsewhere.

What Are The Health Effects Of DDT And Its Metabolites?

DDT causes several effects in laboratory animals including liver enlargement and necrosis, nervous system, immune system and reproductive system, as well as cancer.

There is much less information available on effects in people. Few incidents of DDT poisoning have been reported, however, exposure to quite high levels of DDE in mothers' milk may cause babies to have slower reflexes than normal.

What Are The Standards And Guidelines For DDT And Its Metabolites?

Drinking water	0.003 parts per million	National Health and Welfare
Fish	5 parts per million	National Health and Welfare

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EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT: FACTSHEET ON TOXAPHENE

What is Toxaphene?

Toxaphene is an insecticide consisting of several chemicals, most notably different forms of chlorine-containing camphenes. It has been used in North America since 1949 and in 1975 it was the most heavily used insecticide in the U.S. Its major uses were on cotton, cereal crops, grains, fruits, nuts, oil seed and vegetables. It has also been used to kill fish in fish eradication programs. The permitted uses of toxaphene have now been severely restricted and it is no longer manufactured in North America. Toxaphene is very persistent in the environment and can be transported long distances in the air.

How Are We Exposed To Toxaphene?

The major source of toxaphene in the Great Lakes is deposition from the air. Therefore, the lakes with the largest surface areas, Superior, Huron and Michigan, are more susceptible to toxaphene contamination. Data from the 1970s show that lake trout from these lakes contained quite high concentrations, although levels have now fallen. Consumption of contaminated fish is still the most important route of exposure. Toxaphene has also been found in air, but only very rarely in drinking water.

There is no information available on toxaphene residues in people.

What Are The Health Effects Of Toxaphene?

There is very little information available on the health effects of toxaphene in humans. It is known to be moderately toxic in laboratory animals, causing effects in the liver, kidney and thyroid. It can also cause cancer in mice and rats.

What Are The Standards And Guidelines For Toxaphene?

Tolerable Daily Intake	0.2μg/kg body weight/day	National Health and Welfare
Drinking water	5 parts per billion	National Health and Welfare

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55 Murray Street, 5th Floor
Ottawa, Ontario
K1N 5M3
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Fax: (613) 238-5780

EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT
FACTSHEET ON DIOXINS AND FURANS

What are dioxins and furans?

Dioxins[1] and furans[2] are organic chemicals containing chlorine. There are 75 different types of dioxin and (to add) different types of furans. The most toxic is thought to be 2,3,7,8-TCDD[3]. They are stable, persistent contaminants that bioconcentrate up the food web.

Dioxins and furans have never been intentionally produced, but are by-products of some industrial processes, such as the manufacture of some herbicides (several chlorophenols and phenoxy herbicides) and Kraft pulp and paper processing. Dioxins and furans are also produced in combustion processes. They have been found in emissions from cars using leaded gasoline.

How are we exposed to dioxins and furans?

Dioxins and furans are found throughout the Great Lakes. Levels in fish and wildlife have fallen since the early 1970s, but they have now stabilised. About 90% of human exposure to dioxins and furans is from food and of that 99% comes from animal products, including fish, meat and milk. Levels of dioxins are highest in lake trout from Lake Ontario, although fish from parts of Lakes Michigan and Huron also have high levels. There is less information available on wildlife.

About 10% of human exposure to dioxins and furans comes from air and only a very small proportion comes from drinking water and other sources.

2,3,7,8-TCDD has been found in human fat and mother's milk. While there are not enough data available to say whether levels are going up or going down,

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1 Also known as polychlorinated dibenzodioxins or PCDDs

2 Also known as polychlorinated dibenzofurans or PCDFs

3 2,3,7,8-tetrachlorodibenzodioxin

or where they are the highest, the concentrations in Canadians are similar to those in people from countries such as Sweden and the U.S.

People are normally exposed to mixtures of different dioxins and furans with different toxicities. Since 2,3,7,8-TCDD is the most toxic form, the toxicity of all types of
dioxins and furans are assessed by comparing with 2,3,7,8-TCDD, using an internationally accepted method. Thus, the toxicity of dioxins and furans is usually stated in terms of the toxic equivalents of 2,3,7,8-TCDD. These vary from about 0.001 (a thousand times less toxic) to 1.0 (equal toxicity).

What are the health effects of dioxins and furans?

2,3,7,8-TCDD is extremely toxic, but its potency is different in different species. Guinea pigs are the most sensitive species found so far and hamsters the least sensitive. Acute exposures in laboratory animals cause a skin disease called chloracne, weight loss, effects on the thymus gland (the thymus is important in keeping the immune system working properly) and death. Longer term exposures cause liver damage, weight loss, effects on reproduction, the immune system and normal development. Lifetime exposure in laboratory rats and mice has caused cancer in the liver and other organs. However, PCBs, dioxins and furans probably do not start cancer, but 'promote' it after it has already been initiated.

Accidental exposures of humans to dioxins and furans, such as at Seveso in Italy and in Vietnam, have definitively caused chloracne, but reports of other, more serious health effects, such as cancer and developmental effects have been disputed.

What are the standards and guidelines for dioxins and furans?

Exposure Guidelines	10pg 2,3,7,8-TCDD toxic equivalents/kg body weight/day	National Health and Welfare
Fish	20 parts per trillion	National Health and Welfare
Drinking Water	15 parts per quadrillion	Ontario Ministry of the Environment

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Assembly of First Nations
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Ottawa, Ontario
K1N 5M3
Tel: (613) 236-0673
Fax: (613) 238-5780

EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT
FACTSHEET ON MERCURY

What is mercury?

Mercury is a toxic heavy metal. It occurs naturally in the environment and can be found in some types of rocks, volcanic ash and soils. It is also released by rotting plants and animals. In addition, many human activities use mercury, and until recently chlor-alkali plants, associated with the pulp and paper industry, were major sources of mercury to the Great Lakes. There are about 3,000 uses of mercury. In Canada, the greatest single use has been in the production of chlorine, sodium hydroxide and hydrogen for the electrolysis of brine in a mercury cell. Mercury and its compounds have also been used in dental fillings, thermometers, pharmaceuticals, as fungicides in paints and in gold extraction.

Mercury can exist in three forms: as pure metallic mercury; in inorganic compounds, such as mercuric chloride; and in organic compounds, like alkyl mercury. Mercury in rocks and soil and most industrial discharges is inorganic. Inorganic mercury can be converted to the organic form by bacteria and other living organisms especially in aquatic ecosystems. The organic form can concentrate in fish and render them unacceptable for human consumption.

How are we exposed to mercury?

Food is the largest route of exposure to mercury, especially if contaminated fish or wildlife are consumed. In recent years, concentrations of mercury in fish from the Great Lakes have decreased, particularly in Lake St. Clair, where the commercial walleye fishery (closed because of mercury contamination) has now been re-opened.

Mercury has been found in samples of Ontario drinking water quite often, although the levels have not exceeded the provincial drinking water guideline.

What are the health effects of mercury?

Organic mercury is more toxic than either metallic or inorganic mercury. Two major epidemics of methyl (i.e., organic) mercury poisoning have occurred in Japan, in Minimata Bay and in Niigata. Both were caused by a release of mercury compounds and the subsequent accumulation of mercury by fish which were then eaten. The largest recorded incident of methyl mercury poisoning was in Iraq in 1971-72 when imported seed grain dressed with methyl mercury fungicide was made into bread that was, in turn, eaten. Over 6,000 people were hospitalised and of these, there were over 500 deaths. The early symptoms included a prickling or tingling feeling in the hands or feet, tunnel vision and slurred speech. In Canada, the health effects of mercury have been investigated in Indian and Inuit communities, where contaminated fish and wildlife were consumed. Although severe organic mercury poisoning was not found, many of the reported symptoms suggested mild mercury poisoning. Inorganic mercury can also affect the nervous system in humans. In laboratory animals, inorganic mercury can cause kidney damage and affect normal development.

What are the standards and guidelines for mercury?

Weekly intake	0.3mg total mercury (5μg/kg body weight) including up to 0.2mg organic mercury, as mercury (3.3μg/kg body weight)	World Health Organization
Fish	0.2 parts per million for native people 0.5 parts per million for fish caught commercially	National Health and Welfare
Drinking Water	1 part per billion	National Health and Welfare

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Ottawa, Ontario
K1N 5M3
Tel: (613) 236-0673
Fax: (613) 238-5780

EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT: FACTSHEET ON MORE INFORMATION

Books and Reports

Copies of these books and reports can be obtained from the EAGLE Project at the Assembly of First Nations (see below for address).

1. Government of Canada 1991. *Toxic Chemicals in the Great Lakes and Associated Effects.* Volumes I, II and Executive Summary. Government of Canada. Ottawa, Ontario. (Volumes I and II are very detailed, the Executive Summary provides a good overview).

2. Institute for Research on Public Policy and the U.S. Conservation Foundation. 1991. *Great Lakes, Great Legacy?* Institute for Research on Public Policy and the U.S. Conservation Foundation. Ottawa, Ontario. (A very readable book on environmental contaminants and the Great Lakes).

3. The 1991 Biennial Reports:

   - From the International Joint Commission to the federal governments of Canada and the U.S.;

   - From the Water Quality Board to the International Joint Commission;

   - From the Science Advisory Board to the International Joint Commission.

   (Good, thorough reports that update earlier reports)

People

Kate Davies
1363 Norview Crescent
Orleans, Ontario
K4A 1Y6

Tel: (613) 837-0044
Fax: (613) 837-7547

John Cooley
Great Lakes Laboratory for Fisheries and Aquatic Sciences
Canadian Centre for Inland Waters
P.O. Box 5050
867 Lakeshore Road
Burlington, Ontario
L7R 4A6

Tel: (416) 336-4568
Fax: (416) 336-6437

Glen Fox
National Wildlife Research Center
Canadian Wildlife Service
100 Gamelin Boulevard, Building 9
Hull, Quebec
K1A 0H3

Tel: (819) 997-6076
Fax: (819) 953-6612

Norm Fraser
Medical Services Branch, Ontario Region
Health and Welfare Canada
1500 Merivale Road, 5th Floor
Nepean, Ontario

Tel: (613) 941-2154
Fax: (613) 941-2156

Henry Lickers
St. Regis Environmental Division
P.O. Box 579
Cornwall, Ontario
K6H 5T3

Tel: (613) 575-2377
Fax: (613) 575-2181

Maxine Caldwell
Assembly of First Nations
55 Murray Street, 5th Floor
Ottawa, Ontario
K1N 5M3

Tel: (613) 236-0673
Fax: (613) 236-5780

Brian Wheatley
Medical Services Branch
Health and Welfare Canada
Jeanne Mance Building, 11th Floor
Tunney's Pasture
Ottawa, Ontario
K1A 0L3

Tel: (613) 954-5113
Fax: (613) 954-5822

Birgit Braune
National Wildlife Research Center
Canadian Wildlife Service
100 Gamelin Boulevard, Building 9
Hull, Quebec
K1A 0H3

Tel: (819) 953-5959
Fax: (819) 953-6612

EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT: FACTSHEET ON BACTERIA, CHEMICALS AND VIRUSES

What are bacteria, chemicals and viruses?

When people say that their water is polluted, they could mean that it contains bacteria, chemicals or viruses at unacceptable levels. It is important to distinguish between these different types of contaminants because they can cause quite different health effects and because they are dealt with quite differently.

Bacteria are small, single-cell organisms, some of which can cause disease. They are living creatures that require nutrients, produce waste products and reproduce by cell division. They proliferate when there is an abundance of nutrients and at suitably warm (often) temperatures. In contrast, chemicals are non-living. They are composed of basic elements, such as carbon, hydrogen and oxygen. They cannot generally reproduce themselves (DNA, the genetic material is an important exception to this), but they can combine to form an infinite variety of compounds and undergo many different types of reactions. Organic chemicals are chemicals that contain hydrogen and carbon, and sometimes other elements. Inorganic chemicals are those that do not contain hydrogen and carbon. Viruses are small organisms that consist of genetic material wrapped in a protein coat. Unlike bacteria, they can only reproduce inside a living host cell. Many viruses cause diseases including the common cold and viral hepatitis.

How are we exposed to bacteria, chemicals and viruses?

We are exposed to bacteria, chemicals and viruses mainly through the food we eat and the water we drink or have contact with. Exposure through air can also be important, especially for viruses. There is some evidence that food is the major exposure pathway for many persistent toxic chemicals. There are two possible routes of exposure through water. The first is consumption i.e., through drinking water or washing food with water before it is eaten. The second is through contact with water from washing, bathing, swimming, windsurfing etc. Not only can contact with water be an important route of exposure for bacteria and viruses, but research has shown that some chemicals can be absorbed through the skin.

What are the health effects of bacteria, chemicals and viruses?

Bacteria, chemicals and viruses can cause a very wide variety of health effects ranging from the virtually insignificant (e.g., a runny nose) to the fatal. In general, bacteria and viruses cause infections, whereas the health effects of chemicals are much more subtle. Bacterial and viral infections can occur anywhere in the body. The most common is probable the common cold. Chemicals can cause several different types of health effects although at current levels in the environment, chemicals rarely cause health effects. However, at higher exposure levels, some chemicals can cause effects including cancer, developmental, reproductive and behavioural effects.

What are the standards and guidelines for bacteria, chemicals and viruses?

For drinking water, the Ontario Ministry of the Environment objective is no more than 5 total coliform bacteria per 100 ml (coliform is a type of bacteria). Fecal coliforms should not be detected at all. The Department of National Health and Welfare is currently drafting guidelines for the bacteriological quality of drinking water. There are also guidelines for recreational water quality (to add). Because bacterial numbers increase a lot after it rains, many health authorities now recommend against swimming and water contact activities for 48 hours after a heavy rainfall.

As well, there are guidelines for the presence of bacteria in food. These are in the regulations of the Foods and Drugs Act (to add details).

Guidelines are set for individual chemicals for air, water and food. Some of these are shown in the other factsheets. Guidelines have not been set for viruses because it is often difficult to identify and count them accurately.

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The EAGLE Project
Assembly of First Nations
55 Murray Street, 5th Floor
Ottawa, Ontario
K1N 5M3
Tel: (613) 236-0673
Fax: (613) 238-5780

EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT: FACTSHEET ON RADIATION

What is radiation?

Radiation is a type of energy. Some very heavy elements, such as uranium, are inherently unstable and decay to produce other lighter elements. As they decay, the atoms release energy in the form of ionising radiation. Ionising radiation includes gamma rays and X-rays. It is called ionising because it has sufficient energy to ionise or 'charge' any material through which it passes. Non-ionising radiation includes ultraviolet light, microwaves and radiowaves.

How are we exposed to radiation?

Radiation is part of the normal environment. We are all exposed to radiation from space, as well as from the earth itself. The major sources of exposure to radiation are natural. The largest source of radiation from human activities is X-rays, but radiation from the nuclear fuel cycle is becoming increasingly important, because of the problems of disposing of nuclear waste products and accidents. We are also exposed to non-ionising radiation from many sources that use microwaves, such as leaky microwave ovens, ultraviolet radiation, such as tanning parlours, and other forms of non-ionising radiation.

What are the health effects of radiation?

Ionising radiation causes cancer and developmental effects, as well as cataracts, sterility or impaired fertility and perhaps premature aging. Radiation-induced cancers can follow exposure after a latent period of as little as two to five years for leukemia, and from five to twenty-five years in the case of other cancers. There is no threshold dose below which there is no risk of developing cancer and the risk of developing cancer is proportional to the dose received. Ultraviolet radiation can current skin cancer and cataracts. There is some evidence that the thinning of the ozone layer and consequent increase in ultraviolet radiation reaching the Earth, is resulting in increased rates of skin cancer and cataracts. Microwave radiation can current deep tissue burns and has been associated with impaired fertility.

What are the standards and guidelines for radiation?

The standards and guidelines for whole body exposure to radiation are those established by the International Commission of Radiological Protection. The limit for public exposure is currently 5 sieverts a year. (check)

From a health perspective, the radioactive elements of greatest concern are tritium, strontium-90, iodine-131, cesium-137 and radium-226. The Ontario Ministry of Environment has established the following maximum acceptable levels in drinking water:

	Maximum Acceptable Concentration (Becquerels/litre)
Tritium	40,000
Strontium	10
Iodine-131	10
Cesium-137	50
Radium-226	1

The Department of National Health and Welfare is currently drafting federal guidelines for maximum acceptable levels in drinking water.

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Assembly of First Nations

55 Murray Street, 5th Floor

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Tel: (613) 236-0673

Fax: (613) 238-5780

EFFECTS ON ABORIGINALS FROM THE GREAT LAKES ENVIRONMENT: FACTSHEET ON CADMIUM

What is cadmium?

Cadmium is a toxic heavy metal. It was not used very much until about 50 years ago. Now, it is very important and it is used in many industrial processes. Its main industrial use is in electroplating but it is also used as a colour pigment in paints and plastics. It is produced as a by-product of zinc and lead mining and smelting.

Cadmium has been found in water, air, soil and food. Levels in the environment are though to be increasing because of its widespread use.

How are we exposed to cadmium?

We are exposed to cadmium through the air we breathe, the water we drink and the food we eat. Another important source of cadmium is smoking cigarettes. Smoking one pack of cigarettes a day can double a person's exposure to cadmium. For non-smokers, the majority of exposure is usually through food. Most cadmium in the body is stored in the liver and kidneys. Since it is extremely persistent and is not easily excreted, levels of cadmium increase with age.

What are the health effects of cadmium?

The main long term effects of low level exposure to cadmium are reduced lung function, emphysema and kidney disease. There may also be effects on the circulatory system and skeleton. A disease called "itai-itai", first described in Japan, has been associated with the chronic ingestion of cadmium. Itai-itai is characterised by a softening of the bones, pain in the back and spontaneous bone fractures. There are also indications that cadmium is carcinogenic. Specifically, a study of battery workers in England found a relationship between cadmium exposure and prostate cancer. In addition, cadmium has been shown to be carcinogenic in several species of experimental animals, including rats.

What are the standards and guidelines for cadmium?

Weekly intake	0.4 to 0.5mg	World Health Organisation
Daily intake	0.057 to 0.071mg	World Health Organisation
Drinking water	0.005mg/L	National Health and Welfare

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Fax: (613) 238-5780