Water Quality

WATER QUALITY

Safe drinking water is essential to human health. Recently there has been growing public concern about the presence of a wide range of chemical and microbiological contaminants in drinking water as well as the limitations of common water treatment processes. Improved analytical methods developed in recent years have enabled research scientists to discover previously undetected chemicals at extremely low levels. However, in most cases, drinking water accounts for very little of peoples' total exposure to toxic or persistent contaminants in the environment.

PROCEDURES FOR TESTING DRINKING WATER HAVE BECOME VERY SOPHISTICATED. WE ARE NOW ABLE TO IDENTIFY CONCENTRATIONS OF SOME CHEMICALS IN WATER AS LOW AS ONE PART PER TRILLION (10^{-6} MG/L) OR ONE PART PER QUADRILLION (10^{-9} MG/L). ONE PART PER TRILLION EQUALS ONE SECOND IN THIRTY-TWO THOUSAND YEARS OR ONE CENT IN TEN BILLION DOLLARS. AT THESE LOW LEVELS, THEIR MERE PRESENCE IN DRINKING WATER DOES NOT NECESSARILY MEAN THAT THERE IS ANY RISK TO HEALTH.

6.1 PRIVATE DRINKING WATER SUPPLIES

Groundwater Contamination

Most of the world's potable water supply is not visible. Water underground is called groundwater and is found in large quantities in bodies of permeable rock called aquifers. Aquifers are of two main types, **confined**, those bordered on top and bottom by impermeable rock, and **unconfined**, where the upper limit is defined by the water table, which fluctuates freely. The water in confined aquifers is under pressure and when drilled can come to the surface with great force. Water in unconfined aquifers needs assistance from pumps to bring the water to the surface. Groundwater is not stationary, but moves according to the dynamics of rock formation and gravity.

Well Water Contamination

Chemically pure water does not exist in nature. Contaminants can reach groundwater (and therefore, well water) through the following:

- **Old or poorly dug wells:** Poor well design, faulty construction and lack of maintenance can result in bacterial and protozoa contamination from barnyards and manure storage and in pesticide or fertilizer contamination through improper use and storage of such chemicals.
- **Leaking sewers and septic systems:** Nitrogen in septic system effluent comes mostly from human waste. It exists originally as ammonium but is converted to nitrate (if the septic system is aerobic). Other contaminants of concern contained in septic system effluent include metal ions, organic chemicals, phosphate, bacteria and viruses.
- **Agricultural practices:** Pesticides and fertilizers can move down into aquifers with the normal water cycle. Manure applied on land can cause both nitrate and microbial contamination. Pesticide contamination of groundwater associated with farming practices, seems to be found in fewer wells than either microbial or nitrate contamination. Traces of pesticides or their by-products

in well water, including atrazine, 2,4-D, pentachlorophenol (PCP), and cyanazine, have been documented in several Ontario surveys.

- **Landfill leachate:** Older landfill sites, both municipal and industrial, may leak "leachate." Newer landfills are created with special liners to avoid leaching.
- **Surface water:** Polluted lakes and river systems connected with aquifers may pollute the aquifer.
- **Natural contaminants:** High concentrations of naturally occurring elements, both stable, (e.g., arsenic, calcium) and radioactive, (e.g., thorium and radium), in the surrounding rock and soil can contaminate groundwater.
- **Leaking underground fuel storage tanks:** The most common pollutants from storage tanks are the combination known as BTEX — benzene, toluene, ethyl-benzene and xylene. Ontario has an ongoing program of replacement for tanks over 17 years old.
- **Use of road salt:** Road salt (sodium chloride and calcium chloride) is used to de-ice roadways. Snow clearing from roads and city streets can introduce contaminants to the surface and groundwater in the springtime, during snow melt. In addition, aquifers near salt water can become salinated if so much groundwater is removed that salt water begins to move into the aquifer.

THE ONTARIO MINISTRY OF ENVIRONMENT AND ENERGY PROVIDES INFORMATION ON MAINTAINING WELLS AND PLUGGING ABANDONED WELLS.

Contamination of Wells

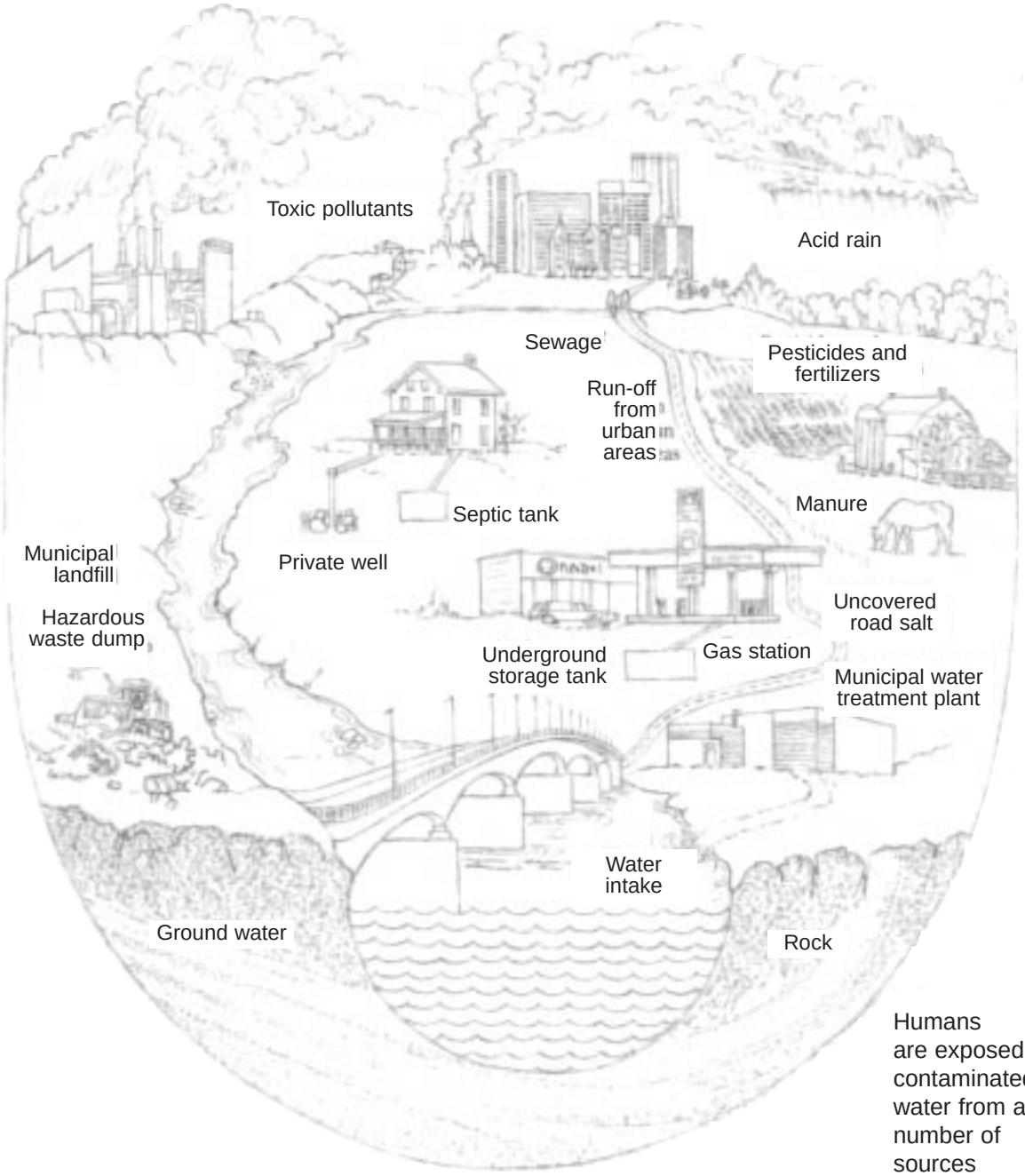
In a survey commissioned by Agriculture Canada in 1991-92, 1300 farm wells were tested across Ontario. Water was analysed for nitrate, several common herbicides, petroleum and total fecal coliform bacteria. The results showed that:

- 37% contained one or more of the target contaminants at concentrations above the provincial drinking water objectives;
- 13% exceeded the maximum acceptable level for nitrate;
- 31% exceeded the maximum acceptable for coliform bacteria.
- 20% contained fecal coliform bacteria indicating the likelihood for contamination from human and animal feces, which is a threat to human health; and
- only one well exceeded the Ontario interim, maximum acceptable concentration for pesticides although 8% had detectable levels of pesticides.

Source: *Agriculture Canada*, Ontario Farm Groundwater Quality Survey, 1992.

Figure 6.1

How Water Can Become Contaminated



Humans are exposed to contaminated water from a number of sources

Dealing with Contaminants

Bacteria

Private well water supplies can be tested by owners for bacterial contamination through the use of a sampling kit provided by the Ontario Ministry of Health. Sample bottles, instructions and testing are available from the local health unit. Sometimes there may be a nominal charge for the cost of the bottles and for postage. Samples are analysed for total coliform and fecal coliform bacteria which are indicators of sewage and the potential occurrence of disease causing organisms such as hepatitis a and salmonella. If the test results indicate either the presence of any fecal coliform bacteria or more than five colonies of total coliform bacteria per 100 mL, then the bacterial count exceeds the Ontario Drinking Water Objectives and the water is deemed unfit for human consumption without boiling or disinfection. Three samples are usually taken, about one week apart. Fecal coliform tend to die rapidly outside the body, therefore, their presence in water indicates a fairly recent contamination.

Communal well supplies are tested regularly as part of the water quality mandate of the regional jurisdiction.

Nitrates

The Ontario drinking water standard has been set at less than 10 mg/L. Samples can be tested for nitrates at many private labs usually at a cost of $15 to $30 per sample. Tap water should be run for five minutes before taking the sample which should then be kept out of direct sunlight in a cool place.

Pesticides

Contamination of a well with pesticides is most likely to occur if the well has been poorly built or if pesticides have been handled or applied improperly. Drinking water guidelines for selected pesticides are stated in the Ontario Drinking Water Objectives (ODWO). Some private labs offer pesticide testing services but usually at a cost of $100 or more per sample for each pesticide analysed.

Salt

The presence of sodium, calcium and chloride ions in drinking water is not a health concern for most people, but may be an issue for someone on a sodium restricted diet.

Radiological Quality

Natural radionuclides found in groundwater from surrounding rock include radioactive uranium, thorium, radium, and their decay products. Concentrations of natural radionuclides in surface water are less than in groundwater, but may be enhanced in the vicinity of certain industrial practices, such as uranium

and phosphate mining. Artificial radionuclides released during nuclear power production may also appear in local water supplies. These levels are typically very low, although spills from nuclear power plants have resulted in short-term increases.

Radon is a chemically inert gas formed from the decay of radium. It is the major source of naturally occurring radiation exposure, and occurs via the inhalation of airborne radon, and the ingestion of radon dissolved in water. Radon gas and its decay products can be inhaled when released from water used in the home. Groundwater generally contains higher levels than surface waters. However, the major route of exposure to radon comes from outdoor and indoor air; the contribution from drinking water by ingestion or inhalation is significantly less.

The primary radionuclides of concern in water are uranium, radium and tritium. (See also Chapter 3. "Contaminants" and *Contaminant Profiles*.)

Aesthetic Qualities of Groundwater

Groundwater often takes on the chemical characteristics of the rock formations in which it is stored. Therefore, well water may contain dissolved minerals such as calcium, magnesium, sulphur or iron, affecting colour, hardness, taste and smell. These minerals do not normally present a health risk. High levels of iron may cause discolouration of fixtures. High levels of sulphate may have a laxative effect. Calcium and magnesium occur naturally in deep aquifers and are associated with the "hardness" of water related to the amount of dissolved calcium or magnesium ions. Some types of hardness can cause build-up of calcium/magnesium carbonate on the inside of pipes and fixtures causing reduction in water flow and pressure.

Contaminants in Springs

Local springs, where cottagers and others fill their water containers, are sometimes but not always monitored by the municipality. The quality of the water will vary, particularly if the springs are located in areas susceptible to run off contamination after heavy rainfalls.

Testing of Private Drinking Water Supplies

Many provinces have recommended sampling programs for private waters and these should be followed. It is an individual's responsibility to test his or her private water supply. As a general rule, a private water supply should be tested for coliform bacteria and nitrates:

- one to two times per year in spring or fall. The Ontario Ministry of Health recommends that new mothers whose drinking water is from a private well use an alternative source of water for preparing infant formula if there is any history of nitrate contamination of wells in the area or if any nitrate is detected with testing of the well water, even if below guideline levels. This is because nitrate levels can change over time and such testing can give a false assurance of safety;

- more frequently than twice a year if the well is shallow or if the well is close to contamination sources such as barnyards, septic tanks etc.;
- if an adult or child becomes inexplicably ill with a gastro-intestinal disorder;
- following periods when the well has not been in use;
- after repairs have been made to the well;
- when there has been a change in the condition of the supply, such as flooding after heavy rains or an extended drought; and
- if there is a sudden change in the appearance, odour or taste in the water.

Consider testing the water supply:

- for organic chemicals if the water source is near a landfill, chemical manufacturer, an industrial development, underground tanks storing petroleum products or other hazardous materials; if pesticides are being used nearby or if neighbours have experienced chemical contamination of their wells; and
- for lead if the plumbing pipes are joined with lead solder.

6.2 Drinking Water Guidelines

Responsibilities

In Canada, drinking water guidelines are revised and updated on a continuing basis by the federal government in collaboration with the provinces and territories. This work is carried out by the Federal-Provincial Subcommittee on Drinking Water which was established by the Federal-Provincial Committee on Environmental and Occupational Health in 1983. The Guidelines for Canadian Drinking Water Quality (GCDWQ) outline maximum acceptable concentrations (MAC) and/or aesthetic objectives for the physical, microbiological, chemical and radiological parameters of drinking water supplies, both public and private. The guidelines are recognized throughout Canada as the standard of water quality. They provide a convenient, reliable yardstick against which water quality can be measured, so that problems can be quickly identified and corrected.

Since provision of drinking water is a provincial responsibility, the guidelines are not applied nationally except in those areas that fall under federal jurisdiction. Virtually all provincial and territorial governments have established their own measures of water quality based on the guidelines.

The GCDWQ and ODWO should always be referred to when dealing with drinking water issues. The GCDWQ are under regular review. As new information becomes available, the pertinent values are reassessed and changed. New guidelines are published periodically to reflect these changes. The current *Guidelines for Canadian Drinking Water Quality* is the sixth edition, and was published in 1996.

In Ontario, the Ontario Ministry of the Environment and Energy (OMOEE) conducts two testing programs. The Drinking Water Surveillance Program tests raw and treated water at treatment plants for bacteria, over 180 chemicals, and radiological parameters. The Trace Organics Testing Program tests raw and treated water from each water treatment plant for up to 140 organic compounds, including pesticides and herbicides, approximately three times a year.

Maximum Acceptable Concentration

MACs have been established for substances that are known or suspected to cause adverse effects on health. Each MAC has been created to safeguard health assuming lifelong consumption of drinking water containing the substance at that concentration. The methods used to develop the guidelines for non-carcinogenic contaminants ensure that MACs are sufficiently below (i.e., 10 to 10 000 times) the exposure levels at which any adverse health effects have been observed. For carcinogenic contaminants, the MAC takes into consideration the best available treatment technologies, the practical limits in the laboratory methods used to measure the contaminants, and the estimated lifetime cancer risk. The use of drinking water for usual domestic purposes, including personal hygiene, has been considered in the derivation of the guidelines wherever possible. Water of higher quality may be required for some special purposes such as renal dialysis.

THE LEVELS OF CHEMICALS EXPRESSED AS MAXIMUM ACCEPTABLE CONCENTRATIONS, (MACs) INDICATE THE HIGHEST CONCENTRATION OF A SUBSTANCE IN DRINKING WATER THAT IS CONSIDERED SAFE FOR HUMAN USE BASED ON LIFELONG CONSUMPTION. EXPOSURES TO CONTAMINANTS AT THE MAC ARE DEEMED TO HAVE AN ACCEPTABLE LEVEL OF IMPACT ON HEALTH.

Maximum acceptable concentrations for radionuclides are derived differently than those for chemical carcinogens in drinking water and are based on international radiation protection methodologies. Unlike chemical contaminants, which are treated individually in the setting and application of guidelines, maximum acceptable concentrations for radionuclides are based on a guideline dose that applies to the total radioactivity in a water sample, whether the radionuclides appear singly or in combination. If more than one radionuclide is present, the total dose should not exceed the guideline dose. The guideline dose limit is based solely on health considerations, and has not been adjusted to incorporate any limitations in the sampling treatment capability of water supplies.

Drinking water that continually contains a substance at a substantially greater level than its maximum acceptable concentration will significantly raise overall exposure levels to the substance and may, in some instances, have negative effects on health. However, using drinking water that exceeds the MAC for short periods of time, does not necessarily mean that the water constitutes an undue risk to health. The amount by which, and the period for which, the MAC can be exceeded without posing an unacceptable health risk must be assessed on a case by case basis. When the MAC for a substance is exceeded, however, the minimum action required is immediate resampling. If the MAC continues to be exceeded, the local authority responsible for drinking water supplies should be consulted concerning appropriate corrective action. (Health Canada, *Guidelines for Canadian Drinking Water Quality*, Sixth Edition, 1996). (See also Chapter 5. "Dose and Response for Chemicals.")

Interim Maximum Acceptable Concentration

When not enough is known about the toxicity of a substance to establish a MAC, interim guidelines are recommended. The interim maximum acceptable concentration (IMAC) takes into account the available health-related data, but uses a larger safety factor to compensate for additional uncertainty. In some cases, the lowest achievable concentration of a substance in drinking water using available technology poses a lifetime cancer risk that is greater than what is considered negligible. In these cases the IMAC is set at the lowest practically achievable level. IMACs are reviewed periodically as new toxicological data and new methods of measurement and treatment become available.

Aesthetic Objective (AO)

Aesthetic objectives apply to certain substances or characteristics of drinking water that may affect its acceptance by consumers or interfere with practices for supplying good water. If a concentration is well above an AO, there is also a possibility of a health hazard.

EXAMPLES OF AESTHETIC OBJECTIVES

AESTHETIC OBJECTIVES HAVE BEEN DEVELOPED FOR A WIDE RANGE OF SUBSTANCES. FOR INSTANCE IRON SHOULD BE LESS THAN 0.3 MG/L, TASTE AND ODOUR SHOULD BE INOFFENSIVE, TOTAL DISSOLVED SOLIDS SHOULD NOT EXCEED 500 MG/L AND SODIUM SHOULD BE LESS THAN 200 MG/L. A FULL LISTING OF THE OBJECTIVES IS FOUND IN *GUIDELINES FOR CANADIAN DRINKING WATER QUALITY*, 6TH EDITION, HEALTH CANADA, 1996.

6.3 Treated Drinking Water

The quality of drinking water varies with location, however, water produced by treatment plants usually conforms to both chemical and bacteriological guidelines set out by individual provinces. Municipally supplied water is carefully treated and systematically monitored. In rare cases, municipally treated water can become contaminated by spills, industrial accidents or breaks in the drinking water supply lines.

Bacterial Contamination

Bacterial contamination is generally no longer a problem in municipal water supplies due to chlorination at treatment plants. In Canada, as recently as 1912, people died of typhoid fever after communal water was contaminated by the bacterium *Salmonella typhi*. However, some protozoan parasites (*Giardia, Cryptosporidium*), form cysts which are resistant to chlorination. Where this occurs, other treatment methods have to be instituted.

Giardia and *Cryptosporidium* in Drinking Water

Among the protozoan parasites to cause illness from drinking water are *Giardia* and *Cryptosporidium*. Both parasites produce cysts that are very resistant to harsh environmental conditions. When ingested, the cysts germinate, reproduce, and cause intestinal illness. After growth and multiplication in the intestine, the parasites form new cysts which are then passed in the feces.

Giardia has been spread in drinking water, lake water, swimming pools, through food and person-to-person contact. Day-care centres can be prime sites for outbreaks when the cysts are spread among children and staff. Infected children can spread the parasites to their parents and siblings. Sources of transmission of *Cryptosporidium* include water treatment systems, recreational waters, animal contact (e.g., feces of cattle, sheep, dogs, cats), and sexual practices.

Due to their resistance to disinfection, the only practical way for municipalities to remove *Giardia* and *Cryptosporidium* from water is filtration. When water supplies are suspect (e.g., when in the outdoors or travelling in foreign countries) water should be boiled for at least one minute before it is used for drinking, food preparation or dental hygiene. This will destroy *Giardia* and *Cryptosporidium* as well as many other disease-causing micro-organisms that might be present.

For more information on these two parasites refer to *It's Your Health — Giardia and Cryptosporidium in Drinking Water*. Health Canada. January 22, 1996. See also *Contaminant Profiles*.

Contaminant Concerns Related to Water Treatment

The procedure used by treatment facilities to make water fit for human consumption varies. Depending on the quality of the raw water source, the volume of water treated and the distance over which the water is distributed to consumers, some facilities will use more treatment steps than others.

Alum

Most surface water treatment plants in Canada use aluminum (in the form of alum) to help remove pathogenic micro-organisms and organic particulate matter from the raw water. Most of the aluminum is removed in the treatment process. As a result, for most Canadians treated water does not appear to be a major source of aluminum. Estimates indicate that on average drinking water contributes less than 5 percent of daily aluminum intake. Healthy individuals have effective barriers to aluminum intoxication because very little of the aluminum ingested by humans is retained in the body. There are however, special health risks for kidney disease patients undergoing dialysis. (See also *Contaminant Profiles*.)

Q. Does aluminum cause Alzheimer's disease?

A. While the exact cause of the degenerative brain disease known as Alzheimer's disease is unknown, several theories are currently under investigation, including exposure to aluminum. Autopsies have revealed that the brain cells of Alzheimer's patients have 10 to 30 times the normal concentrations of aluminum. However, it is not clear whether aluminum accumulation is a cause or a result of the disease.

Several ecological studies provide a weak association between aluminum concentration in drinking water and dementia, especially for the most elderly. However, a review of the etiology of Alzheimer's disease indicates that aluminum in drinking water is very unlikely to be responsible for a major burden of illness from dementia.

A number of Health Canada initiatives are currently under way to further investigate this issue. (See also *Contaminant Profiles*.)

Fluoride

Floride is added to drinking water to reduce cavities in teeth. (See also *Contaminant Profiles*.)

Chlorination By-products

Most municipalities use chlorine for water disinfection because it is the most effective and cost-efficient means of reducing harmful bacteria and viruses capable of causing severe and life-threatening diseases. While chlorine is effective

in inactivating disease-causing micro-organisms, its addition to water can lead to the formation of a number of chlorination by-products, such as trihalomethanes (THMs).

Chlorination by-products are chemical compounds that form when water containing organic matter (the decay products of living things such as plant material, human and animal wastes, etc.) is chlorinated. Of the chlorination by-products, the THMs are normally present in the highest quantities. Other chlorination by-products have been identified (e.g., halogenated acids and halogenated acetonitriles) and are beginning to be evaluated for potential health risks. THMs are currently used as indicators of the presence of these other by-products.

Exposure to chlorination by-products in municipal water supplies can occur through consumption of the water, breathing the vapours through showering or absorbing these materials when bathing.

The weight of evidence from toxicologic (animal) and epidemiologic (human) studies suggests a link between chlorination by-products and increased risk of some cancers. (See Box: Great Lakes Basin Cancer Risk Assessment page 105.) It is not possible to determine whether excess bladder and colon cancer risk detected in recent studies was due to THMs, or whether it was due to other by-products of chlorination that co-exist with THMs, or to other factors in water that were not measured or considered.

Most of the drinking water supplied in Ontario meets the proposed objective for THMs or the current Canadian Drinking Water Quality Guideline of 0.01 mg/L. Concerned consumers can contact their local water supplier or municipality for information on levels of THMs in their local water supply. The following measures can be used to reduce the levels of THMs and some other chlorination by-products in treated water used for drinking:

- aerate tap water in a blender;
- store water in the refrigerator for 24 hours;
- use water treatment devices containing activated carbon.

Note: For home water treatment devices containing activated carbon filters it is important to follow all filter flushing and replacement instructions to avoid risks of bacterial contamination.

(For more information on THMs, see *Contaminant Profiles*.)

Great Lakes Basin Cancer Risk Assessment: A Case-control Study of Cancers of the Bladder, Colon and Rectum

Results of a Health Canada/Ontario Cancer Treatment and Research Foundation epidemiological study entitled "Great Lakes Basin Cancer Risk Assessment: A Case-control Study of Cancers of the Bladder, Colon and Rectum" support the overall weight of evidence from other published scientific research that there is an association between the use of chlorinated water and bladder cancer risk, and a somewhat weaker association with colon cancer risk. Unlike some other studies, this study did not find an association between use of chlorinated water and rectal cancer. The study is one of the largest and most convincing to date, involving nearly 5000 residents (cases and controls) of Ontario.

Risks are highest for those with the longest duration of exposure (35 years or more) and the highest concentrations. People using treated water from sources with low chlorination by-products (i.e., groundwater), or those who have used water with high levels of chlorination by-products for shorter periods of time (less than 35 years), do not appear to be at increased risk.

The lifetime probability, however, that an individual living in Ontario will develop bladder or colon cancer due to the use of chlorinated water is quite low. For example, about 1.34 percent of men who are exposed to chlorinated surface water for 35 years or more will develop bladder cancer before the age of 70, while about 1 percent not exposed to chlorinated surface water will develop it. For women, approximately 0.37 percent of those exposed to chlorinated surface water will develop bladder cancer before the age of 70, compared with 0.27 percent of women who are not exposed. The risk of developing bladder or colon cancer is influenced by other factors, not just those related to drinking water. For example, smoking for bladder cancer and aspects of diet for colon cancer will also influence risk.

Because of the limitations of current treatment methods, the study authors do not recommend eliminating the use of chlorine at this time since chlorination inactivates disease-causing viruses, bacteria and some parasites. Although there is considerable uncertainty in the risk estimates derived from this study, the authors suggest that some of these cancers could be prevented through further reduction of levels of chlorination by-products. Disinfection practices that reduce the formation of chlorination by-products should be investigated further, with the objective of reducing these by-products.

Q. Is there a drinking water guideline for THMs?

A. In May of 1993, the Canadian drinking water guideline for total THMs was reduced from a MAC of 350 parts per billion (or 0.35 mg/L) to an IMAC of 100 parts per billion (or 0.1 mg/L). This IMAC is based on the risk associated with chloroform, the THM most often present and generally found in the greatest concentration in drinking water. The IMAC is based on assessments of health considerations, available treatment and analytical technology, as well as economic feasibility. The guideline will remain an IMAC until the risks from other

disinfection by-products are determined. It is not expected that all water systems will be able to meet the revised guideline for THMs immediately. When water systems are expanded or upgraded, every effort should be made not only to meet the revised guideline, but to reduce concentrations of THMs to as low a level as possible without compromising the effectiveness of water disinfection. Many water treatment facilities have been implementing methods for several years to reduce levels of THMs and other chlorination by-products in treated water.

Q. What changes are being made to current water treatment and what alternatives can be used?

A. Various changes to current treatment methods through which the levels of chlorination by-products in treated water can be reduced are being investigated. Local treatment plants are making efforts to optimize the use of chlorine in water treatment. For example, reducing the extent of pre-treatment of water with chlorine reduces chlorination by-products. Other water treatment options include removing the organic matter from the raw water so that it cannot react with the chlorine to form by-products, and taking steps to remove the by-products by using activated carbon beds to absorb these chemicals.

Chlorine dioxide can also be used as an alternative to chlorine for primary disinfection. In the final, or secondary, stages of disinfection, chlorine is used to keep water disinfected while it travels from the treatment plants to consumers.

A few municipalities are now using ozonation as a primary disinfectant for drinking water treatment, since ozonation does not form chlorination by-products. Modifying water treatment facilities to use ozone is expensive, and ozone treatment creates other by-products that can be harmful to health if they are not controlled (e.g., formaldehyde and bromate).

The most appropriate treatment method depends on the water sources and must be assessed on a case-by-case basis. Changes made to the process of water disinfection must not compromise disinfection effectiveness.

Lead and Copper

Lead and copper can be introduced, not in the treatment process, but during its distribution to the consumer through the use of lead and copper water supply lines and solder from plumbing or in fixtures.

Municipally treated drinking water entering the home generally meets federal and provincial guidelines. However, lead problems are possible after the treated water enters the home. Tap water may contain high levels of lead that has leached from plumbing fixtures. Houses over 30 years old are more likely to have lead pipes or pipes joined with lead solder. Reducing lead levels will usually be up to the homeowner. Here are some suggestions:

- Allow tap water to run for at least one minute, or until it is as cold as possible, before drinking or cooking with water that has been standing more than five hours.

- Use cold water for cooking and drinking because hot water dissolves lead from pipes more quickly. Especially use cold water for making baby formula.
- Water softeners can contribute to the corrosiveness of water and cause a more rapid release of lead if it is present in the plumbing system.
- A water treatment device may be necessary to remove lead from the tap water. Boiling the water will NOT reduce lead levels

For more information on lead, see *Contaminant Profiles*.

Bottled Water and Home Water Treatment Devices

A 1996 poll of Canadians found that over 80 percent rate the overall quality of the available tap water as "high" or "acceptable." Less than two in 10 consider their local tap water as being of poor quality. Nonetheless, over 36 percent of respondents reported using water filtering devices or drinking bottled water (The Environmental Monitor 1995). The trend of drinking bottled water, which has been increasing in recent years, may be due to the belief that drinking tap water is unsafe. However, there is little evidence to support this. A study done by the Toronto Department of Public Health in 1990 found municipal tap water to be better than bottled water and water from point-of-use filtration devices from a health standpoint (City of Toronto 1990). At the time the study was undertaken, bottled water was not required to meet the same quality guidelines as tap water. It is possible that the preference for bottled water may reflect taste and other aesthetic considerations rather than health concerns.

Q. Does bottled water have to meet the same standards as other Canadian drinking water?

A. It is estimated that Canadians currently spend over $100 million on bottled water annually. Bottled water in Canada is generally of good quality, although it may not be safer than municipal tap water. Ozone, carbon dioxide and fluoride are sometimes added to bottled water during processing. Concentrations of minerals and other chemicals are listed on labels and most brands comply with Canadian Drinking Water Guidelines. Some brands have excessive fluoride, chloride, nitrate or sodium contents.

Bottled water is not yet subject to the same set of guidelines as other drinking water. Bottled water is treated as a food product, regulated under the *Food and Drugs Act* and Regulations under the jurisdiction of the Health Protection Branch of Health Canada. It is subject to government inspection for bacteriological quality but there is no legal requirement for water bottlers to test for trace toxic contaminants. The *Food and Drugs Act* and Regulations specifies that water represented as mineral or spring water cannot be obtained from a public community water supply. New regulations have been proposed for bottled water to parallel the proposed new Drinking Water Materials Safety Act. Ontario has no regulations applying directly to bottled water quality. Bottled water is not licensed.

Water Treatment Systems

People on private water supplies who have water quality problems, whether from chemical contaminants or from non-health threatening aesthetic problems such as sulphur or iron, may benefit from a point-of-use or point-of-entry water treatment device. A homeowner should have the water tested for specific contaminants in order to know which treatment system will correct the problem.

Point of use (POU) devices

These devices are usually small appliances that fit onto a kitchen faucet or attach to the cold water line under the sink. They can be installed on single or multiple taps but cannot treat water for an entire house. They can also be plastic pitcher-type units that store drinking water in the refrigerator.

A microbiological water purifier is a treatment system that kills disease-causing micro-organisms. Not all POU systems purify water.

Although activated carbon filters are the most common, POU devices may also treat water using reverse osmosis filtration, ultraviolet irradiation, distillation, and ozonation. Devices differ in their effectiveness in removing contaminants. Activated carbon is used to remove organic contaminants, chlorine, oils, mercury and THMs. Reverse osmosis and distillation can remove inorganics such as chloride, sulphate, nitrate, barium, lead and arsenic. Ultraviolet disinfection will destroy bacteria and viruses, but usually does not affect parasites or chemical contaminant levels. *To ensure proper filtration and to prevent build up of bacteria, consumers must follow all instructions for servicing and replacement of filters.*

Point of entry (POE) systems

POE systems are installed on the main water line and treat the entire water supply entering the building. Most commonly, they are used to reduce iron or to soften the water.

Individuals on a low-sodium diet or those suffering from high blood pressure or heart disease should be made aware that water softeners increase the sodium content of water.

At the federal level the claims made by manufacturers and retailers are governed by provisions under the *Competition Act* for misleading or false advertising. The devices are also governed by the *Consumer Packaging and Labelling Act*, which prohibits false or misleading representation. Ontario does not currently regulate POU devices.

Q. What are some of the concerns with home water treatment devices ?

A. The use of home water treatment devices to remove contaminants from water can sometimes lead to problems with water quality. If the devices are not properly maintained, organic materials can build up in the filter and stimulate bacterial growth. Thus, drinking water passing through a poorly maintained filter can become contaminated. ***It has been shown that the bacteriological quality of tap water in Ontario almost always met Ontario Drinking Water Objectives, but this was not the case with device-treated water or bottled water*** (City of Toronto 1990).

6.4 Recreational Water Quality

Surface waters are being used increasingly for recreational purposes such as swimming, boating, fishing, waterskiing and windsurfing. The large number of industrial, agricultural and municipal waste water sources entering these waters is cause for concern regarding human health.

Contamination of recreational water may have natural or human origins.

- Urban storm water run off contains micro-organisms from pet and wildlife feces, and sewage from cross-connections with sanitary sewers and faulty plumbing.
- Malfunctioning septic systems contribute a variety of contaminants.
- Agricultural run off and waste from animals can contribute micro-organisms, nitrates and pesticide residues. Micro-organisms may enter the water from agricultural activities like livestock operations whose potential problems include manure and feedlot run off, livestock access to streams, and disposal of milkhouse wash water to nearby drainage ditches and streams.
- Combined sewer overflows contain sanitary sewage and storm water. Heavy rainfall can result in poor recreational water quality. Many communities are served by older sewer systems that still combine storm water and sanitary sewage. Treatment facilities may be unable to handle excess volumes after a large storm and sewage discharge may go directly into rivers and lakes without treatment. Combined sewer overflows and waste water by-passing the sewage treatment plant consist of a mixture of untreated or partially treated domestic, municipal and industrial waste water and storm water.
- Storm water also brings run off that may be polluted with a variety of compounds such as fuel, oil and salts. Oils are of greatest concern and may come from urban storm water run off, industrial wastes, residuals from boat engines, or leaking marine fuel tanks. While these materials tend to make the water look unattractive, the toxicity from oily substances is considered relatively low.
- Large waterfowl or gull populations colonizing a beach or surrounding area contribute feces that raise fecal coliform levels and disease-causing micro-organisms in the water.

- Winds and currents in a lake or river will affect the turbidity and hence the appearance, microbiological and chemical quality of recreational water. Contaminated sediments may be resuspended if water becomes turbulent.

Exposure to Contaminants Through Skin

The absorption of contaminants from water through the skin occurs during bathing, showering or swimming. How quickly a chemical travels through the skin is affected by the physical and chemical properties of the substance including:

- the weight, size and shape of the molecules of the chemical;
- its electrostatic charge; and
- whether or not it is more soluble in water, or in oils, fats, and other organic material.

In general, chemicals that travel quickly through the skin have low molecular weights, no electrostatic charge, and easily dissolve in fat. How fast a chemical travels can be measured and expressed as a value, called the permeability constant. This constant is different for every chemical. (See also Chapter 4. "Exposure.")

The absorption of contaminants through the skin depends on a number of factors including:

- the total surface area of the exposed skin;
- what part of the body was in contact with the contaminant;
- duration of contact;
- concentration of the contaminant on the skin;
- the ability of the specific contaminant to move through the skin into the body. This is called the "chemical-specific permeability";
- the type of substance through which the contaminant comes into contact with the skin. For example, is the contaminant dissolved in water, or in oil, when it comes into contact with the person; and
- whether the skin is damaged in any way before coming into contact with the contaminant. Absorption through the skin can be more rapid where skin cuts and abrasions, or skin conditions such as psoriasis or eczema, are present.

The area of the skin that is exposed will be influenced by the activity being performed and the season of the year. Total skin surface area also varies with age.

Guidelines For Recreational Water Quality

Health Canada, in collaboration with the provinces, sets guidelines for recreational water quality that address contaminants which cause health problems. These are published by Health Canada in ***Guidelines for Recreational Water Quality***, the latest edition was released 1992. The guidelines deal with health hazards associated with recreational water use, as well as aesthetic and nuisance conditions. The guidelines discuss the indicator organisms — enterococci, *Escherichia coli*, other fecal coliforms, and coliphages — as well as health risks related to exposure to waterborne pathogenic bacteria, viruses, protozoa, and

toxic blue-green algae. Sampling of recreational waters is also addressed. Other sections deal with physical, chemical, and aesthetic characteristics, nuisance organisms, microbiological methods of sampling and analysis, and posting of beaches and other recreational waters.

In Ontario, it is generally up to the medical officer of health for the local health unit to judge when a beach should be posted. *Escherichia coli (E. coli)* are bacteria present in the feces of virtually all warm-blooded animals and are the indicator organism for fecal contamination of surface waters. The recreational water quality guideline of 100 *E. coli* per 100 mL of water is set jointly by the ministries of Environment and Energy, and Health. Once a beach has been posted for high *E. coli* levels, more frequent testing is done. Beaches are usually reopened after levels have returned to acceptable limits for two or three days. Tests for specific pathogens are indicated when there are reports of specific illness (e.g., shigella).

OMOEE guidelines state that swimming is not recommended when the total coliform geometric mean count exceeds 1000 per 100 mL of water, and/or when the fecal coliform geometric mean count exceeds 100 per 100 mL. Federal guidelines for recreational water quality state that the geometric mean count of at least five samples should not exceed 2000 *E.coli*/L.

There are no established standards for human exposure to chemical contamination in recreational waters because of insufficient scientific information and the costliness of chemical testing. (See also Chapter 3. "Contaminants.")

Beach Postings

When the appropriate authority (usually the medical officer health at the local public health unit) has determined that a beach or body of water is not suitable for recreational use, the public is notified by the posting of one or more signs along the beach or shoreline. These signs should be clear as to the health risk and recommend a course of action. They should be written in simple text and symbols. The authority making the decision should be indicated on the signs. The signs are left in place as long as necessary and are promptly removed when the health hazard has passed. Usually beaches are posted due to the levels of one or more of the indicator organisms. Occasionally, a beach may be posted due to floating debris, oils, scum, excessive weed (algae) growth, bad odours and turbidity.

Because of combined sewer overflows and waste run off from animal fecal material, beaches are often closed after a heavy rain. In Toronto, some beaches are posted with permanent signs warning swimmers of the dangers of water contamination within 48 hours of a heavy rain storm.

Reducing Exposure: Considerations For Recreational Water

People should be encouraged to pay attention to beach postings.

Illness can result from direct contact with water that is contaminated including infections caused by micro-organisms. The most common health problems thought to be due to direct skin contact with polluted water include skin rashes,

ear and throat infections, eye irritation and gastro-intestinal illness if the water is accidentally swallowed.

Current information is not sufficient to allow exact calculation of the risk of illness from swimming in contaminated water but most research indicates that illness is more likely to occur when immersion occurs as compared to non-bathing activities such as wading along the beach. (See also Chapter 3. "Contaminants" and *Salmonella*, *Campylobacter*, *E. coli*, *Staphylococcus aureus*, *Clostridium botulinum*, *Clostridium perfringens*, and PAHs in *Contaminant Profiles*.)

Q. Is there a risk to bathers from the presence of chemicals in recreational waters?

A. Very few studies have been found in the literature that equate a hazard to the health of swimmers and others to skin absorption of contaminants present in river or lake water (Seyfried et al. 1985). National surveys of the water quality of lakes and rivers used for recreational activities indicate that health hazards to recreational users from inorganic or organic chemicals are very unlikely.

Q. Why are recreational waters not tested for chemicals?

A. It is recommended that no measurable limits be established for chemicals in recreational water for human exposure risk because of lack of sufficient scientific information (i.e., type of chemical, effective concentration, effects, etc.). Decisions for use should be based on microbiologic quality, aesthetic quality (e.g., presence of odour or visible oil and grease) and other factors considered in the environmental health assessment of the beach, (e.g., proximity to industrial discharge).

Q. Can I be exposed to chlorination by-products in swimming pools?

A. Swimming in pools, particularly indoor pools, can be a significant source of exposure to volatile chlorination by-products since large amounts of chlorine are added to ensure bacteriologically safe water. Exposure to chlorination by-products from swimming would be mainly through inhalation and dermal routes. It should be noted, however, that only individuals regularly using swimming pools may be at increased risk from this source. A Health Canada study is currently under way to further investigate the effects of waterborne chemicals on competitive swimmers.