Clean water – life depends on it!

"Pure water is the best of gifts that man to man can bring"

- *Spectator*, July 30, 1920

What's in a glass, a sink, a river full of water?... A refreshing drink... a cleansing wash... an invigorating swim... a home for plants, insects, fish, birds and mammals. It all depends on the water quality.

We tend to think of water in terms of a particular purpose: is the quality of the water good enough for the use we want to make of it? Water fit for own use may be unfit for another. We may, for instance, trust the quality of lake water enough to swim in it, but not enough to drink it. Along the same lines, drinking water can be used for irrigation, but water used for irrigation may not meet drinking water standards. It is the quality of the water which determines its uses.

Scientists, on the other hand, are interested in other aspects of water quality. To them quality is determined by the kinds and amounts of substances dissolved and suspended in the water and what those substances do to inhabitants of the ecosystem. It is the concentrations of these substances that determine the water quality and its suitability for particular purposes.

Drinking water, for example, is regulated by guidelines stringent enough to protect human health. Lack of such guidelines can lead to a variety of health problems. It has been estimated, for example, that contaminated water and poor sanitation cause 30 000 deaths around the world daily – the equivalent of 100 jumbo jets crashing every day!

Water is the lifeblood of the environment, essential to the survival of all living things – plant, animal and human – and we must do everything possible to maintain its quality for today and the future.

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Canada: a water paradise?

Here in Canada we are fortunate. We have extensive supplies of water. Our pristine rivers and lakes filled explorers and settlers with a sense of majesty and awe. Today, they continue to impress Canadians and visitors alike. Yet under the pressures of human development, many of these waters are losing their unspoiled quality.

It is no wonder. We dispose of human wastes, animal wastes and chemical substances into the environment at such a rate that even some of the largest lakes and river systems – the Great Lakes and the St. Lawrence River, for example – are having serious difficulty cleansing themselves and sustaining life.

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From "Source to Tap"... a multi-barrier approach to protecting drinking water

Do you ever think about how your drinking water gets from the lake, river, stream or underground aquifer all the way to the taps in your house? The place where the water originates is called the *source*. The most effective way to manage drinking water to make sure it is safe for consumption when it gets to your house is to protect it all the way from "source to tap".

Implementing drinking water protection from "source to tap" is called the *multi-barrier approach*. The multiple barriers are put in place to stop contamination along the drinking water delivery system.

The multi-barrier approach looks at all of the components of a drinking water system and identifies safeguards needed to provide safe drinking water. The components include source water protection, drinking water treatment, and distribution systems. The safeguards include management, monitoring, research, science and technology development, guidelines, standards and objectives, legislative and policy frameworks, and public involvement and awareness.

The multi-barrier approach is an integrated system that prevents or reduces the contamination of drinking water, from source to tap, in order to reduce risks to public health. Isolated, safeguards may not remove or prevent contamination, but together they offer greater assurance drinking water will be clean, safe and reliable.

Case studies

Source water protection is the first barrier in the approach and relies on measures which are generally preventive in nature. The Canadian Council of Ministers of the Environment (CCME) Source to Tap document contains an outline for developing a Source Water Protection Plan. In addition, many examples of source water protection plans can be found on provincial/territorial, municipal and non-government organization websites. Following are five existing case studies that illustrate how the components of source water protection were used in specific Canadian communities, how and why source water protection in the community is working, the lessons learned and improvements recommended, and the limitations of each particular case study.

- Amherst, Nova Scotia
- County of Oxford, Ontario
- Edmundston, New Brunswick
- North Saskatchewan Watershed in Alberta
- Powell River, British Columbia

See also: Source to Tap – Protecting our Water Quality (Canadian Council of Ministers of the Environment)

What determines water quality?

The water of even the healthiest rivers and lakes is not absolutely pure. All water (even if it is distilled) contains many naturally occurring substances – mainly bicarbonates, sulphates, sodium, chlorides, calcium, magnesium, and potassium.

They reach the surface and groundwater from:

- soil, geologic formations and terrain in the catchment area (river basin);
- surrounding vegetation and wildlife;
- precipitation and runoff from adjacent land;
- biological, physical and chemical processes in the water;
- human activities in the region.

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How does water clean itself?

Water is purified in large part by the routine actions of living organisms. Energy from sunlight drives the process of photosynthesis in aquatic plants, which produces oxygen to break down some of the organic material such as plant and animal waste. This decomposition produces the carbon dioxide, nutrients and other substances needed by plants and animals living in the water. The purification cycle continues when these plants and animals die and the bacteria decompose them, providing new generations of organisms with nourishment.

Unfortunately, there are many toxic substances which are affected only slowly, or not at all, by this and other processes. These are called *persistent* and are of great environmental concern.

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How do we measure water quality?

To identify the substances present in a stream or lake, scientists collect samples of the water, of living organisms, and of suspended and bottom sediments. Technicians then analyze these samples in a laboratory with specialized instruments and procedures. Certain measurements such as temperature, dissolved oxygen, turbidity and conductivity can be taken in the field with portable equipment.

Today's analytical laboratory instruments – with such high-tech names as "plasma emission spectrometer" (for analysing metals) and "gas chromatograph-mass spectrometer" (for analysing pesticides, PCBs dioxins, and other organic compounds) – bear little resemblance to the test-tube and gas burner laboratories of the 1950s.

Nowadays the analysis of water and sediment samples detects more substances than a decade ago, partly because there are more substances present in water, but also because of improved analytical instruments and consequently lower detection limits. State-of-the-art analytical instruments can detect down to one part per trillion of some substances – comparable to tracing one thousandth of a teaspoon of salt dissolved in an olympic-size swimming pool.

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Human health and water quality

In Canada we are lucky to have plentiful supplies of good drinking water sources. Water-related illnesses – typhoid fever, cholera, dysentery – are almost unknown in this country today. Waste and wastewater treatment, the development and enforcement of drinking water guidelines, public health practices and education – all have resulted in a decrease in water related illnesses in Canada. Developing nations are less fortunate: 80% of their diseases are water-related.

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The price Canadians must pay to prevent water-borne disease is constant vigilance against bacterial contamination. Periodic beach closures and local epidemics are evidence that the battle is never won. These problems underscore the need for maintaining strict control over water quality and for improving water and wastewater treatment.

Of serious concern today are the toxic chemicals that enter our waters from many different sources, including industry, agriculture and the home. Little is known about the effects of these toxic substances on human health; often the effects do not become noticeable for long periods of time, and it is difficult to distinguish them from the effects of other factors that impact on our day-to-day life (e.g., nutrition, stress, air quality). Much more remains to be done to control toxic chemical pollution. Meanwhile, we can all contribute to the prevention of water pollution by not abusing the water or the land.

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A sampling of water quality facts

- Approximately 57% of Canadians are served by wastewater treatment plants, compared with 74% of Americans, 86.5% of Germans, and 99% of Swedes.
- In developing nations, 80% of diseases are water-related.
- Of all Canadians, 26% rely on groundwater for domestic use.
- One drop of oil can render up to 25 litres of water unfit for drinking.
- One gram of 2,4-D (a common household herbicide) can contaminate ten million litres of drinking water.
- One gram of PCBs can make up to one billion litres of water unsuitable for freshwater aquatic life.
- One gram of lead in 20 000 litres of water makes it unfit for drinking. Older homes often contain plumbing made of lead or soldered in lead, which can then leach into water.
- The nitrates in fertilizers promote excessive growth of algae and larger aquatic plants, causing offensive algal blooms and driving out sport fish.
- Methane gas can often be seen bubbling up from the bottom of ponds; it is produced by the decomposition of dead plants and animals in the mud.
- Calcium and magnesium – both essential elements for man – account for most water hardness. Death rates for certain types of cardiovascular disease have been found to be higher in soft water areas than in hard water areas in many parts of the world.
- Copper is another essential element – for optimal absorption and metabolism of iron and for bone formation – and fairly common in natural water. More than one milligram per litre may make water unpalatable.

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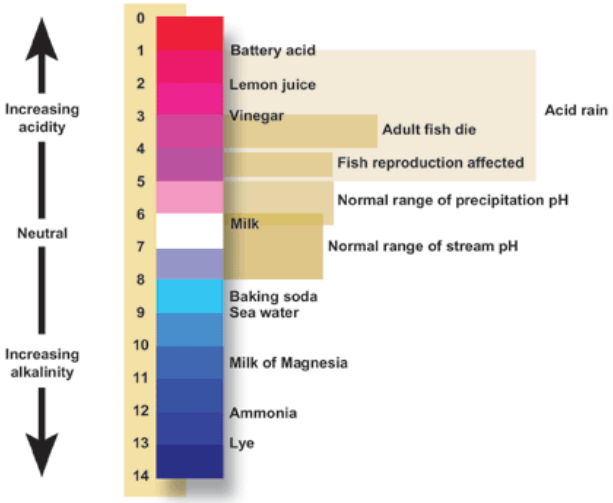
The pH scale



The acidity of a water sample is measured on a pH scale. This scale ranges from 0 (maximum acidity) to 14 (maximum alkalinity). The middle of the scale, 7, represents the neutral point. The acidity increases from neutral toward 0.

Because the scale is logarithmic, a difference of one pH unit represents a tenfold change. For example, the acidity of a sample with a pH of 5 is ten times greater than that of a sample with a pH of 6. A difference of 2 units, from 6 to 4, would mean that the acidity is one hundred times greater, and so on.

Normal rain has a pH of 5.6 – slightly acidic because of the carbon dioxide picked up in the earth's atmosphere by the rain.

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Water quality objectives and guidelines

In Canada, governments use various measures to protect water quality, among them *guidelines* and *objectives*. The two measures are similar in that both describe how much of a substance we, as a society, will tolerate in water. But guidelines and objectives are arrived at and applied differently.

Water quality guidelines are scientifically determined and indicate the

maximum allowable concentration of substances for a *particular water use* such as livestock watering or swimming. These national guidelines serve as the targets for environmental protection.

Water quality objectives, on the other hand, specify the concentrations of substances permissible for all intended water uses at a *specific location* on a lake, river, or estuary. The objectives are based on the water quality guidelines for the uses at that location, as well as on public input and socio-economic considerations.

Water quality guidelines and objectives not only protect water users and the environment, they also promote sustainable water management strategies.

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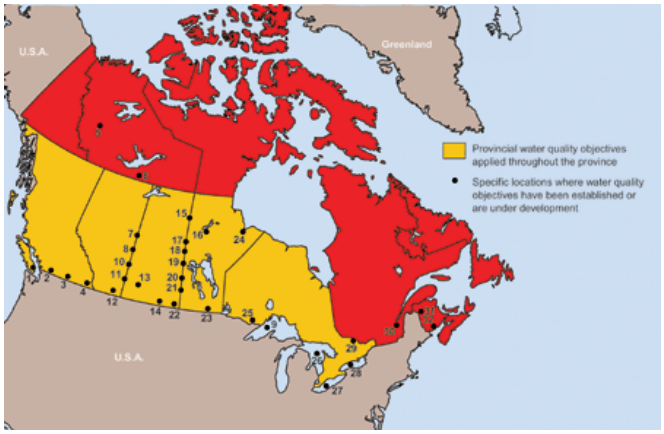
Water quality objectives in Canada



The map of Canada shows that provincial water quality objectives are applied throughout the provinces of British Columbia, Alberta, Saskatchewan, Manitoba, and Ontario. Water quality objectives have been established or are under development at the following specific locations:

1. Fraser River estuary, British Columbia
2. Similkameen River, British Columbia
3. Columbia River, British Columbia
4. Flathead River, British Columbia
5. Mackenzie River basin, Northwest Territories
6. Slave River, Alberta and Northwest Territories
7. Beaver River, Alberta and Saskatchewan
8. North Saskatchewan River, Alberta and Saskatchewan
9. Lake Superior
10. Battle River, Alberta and Saskatchewan
11. Red Deer River, Alberta and Saskatchewan
12. Milk River, Alberta
13. South Saskatchewan River, Saskatchewan
14. East Poplar River, Saskatchewan
15. Churchill River, Saskatchewan and Manitoba
16. Northern Flood Agreement Area, Manitoba
17. Saskatchewan River, Saskatchewan and Manitoba
18. Carrot Rive, Saskatchewan and Manitoba
19. Red Deer River, Saskatchewan and Manitoba

20. Assiniboine River, Saskatchewan and Manitoba
21. Qu'Appelle River, Saskatchewan and Manitoba
22. Souris River, Saskatchewan and Manitoba
23. Red River, Manitoba
24. Nelson River, Manitoba
25. Rainy River, Ontario
26. Lake Huron
27. Lake Erie
28. Lake Ontario
29. Ottawa River, Ontario and Quebec
30. St. Lawrence River, Quebec
31. Saint John River, New Brunswick
32. St. Croix River, New Brunswick

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Groundwater quality

We often think of water quality as a matter of taste, clarity and odour, and in terms of other properties which determine whether water is fit for drinking. For other uses different properties may be important. Most of these properties depend on the kinds of substances that are dissolved or suspended in the water. Water for most industrial uses, for instance, must not be corrosive and must not contain dissolved solids that might precipitate on the surfaces of machinery and equipment.

Pure water is tasteless and odourless. A molecule of water contains only hydrogen and oxygen atoms. Water is never found in a pure state in nature. Both groundwater and surface water may contain many constituents, including microorganisms, gases, inorganic and organic materials.

The chemical nature of water continually evolves as it moves through the hydrologic cycle. The kinds of chemical constituents found in groundwater depend, in part, on the chemistry of the precipitation and recharge water. Near coastlines, precipitation contains higher concentrations of sodium chloride, and downwind of industrial areas, airborne sulphur and nitrogen compounds make precipitation acidic.

One of the most important natural changes in groundwater chemistry occurs in the soil. Soils contain high concentrations of carbon dioxide which dissolves in the groundwater, creating a weak acid capable of dissolving many silicate minerals. In its passage from recharge to discharge area, groundwater may dissolve substances it encounters or it may deposit some of its constituents along the way. The eventual quality of the groundwater depends on temperature and pressure conditions, on the kinds of rock and soil formations through which the groundwater flows, and possibly on the residence time. In general, faster flowing water dissolves less material. Groundwater, of course, carries with it any soluble contaminants which it encounters.

Scientists assess *water quality* by measuring the amounts of the various constituents contained in the water. These amounts are often expressed as milligrams per litre (mg/L), which is equivalent to the number of grams of a substance per million grams of water.

The suitability of water for a given use depends on many factors such as hardness, salinity and pH. Acceptable values for each of these parameters for any given use depend on the use, not on the source of the water, so that the considerations important for surface water (as mentioned in Freshwater Series No. A-3, entitled "Clean Water – Life Depends on It!") are equally applicable to groundwater.

The natural quality of groundwater differs from surface water in that:

- for any given source, its quality, temperature and other parameters are less variable over the course of time and
- in nature, the range of groundwater parameters encountered is much larger than for surface water, e.g., total dissolved solids can range from 25 mg/L in some places in the Canadian Shield to 300 000 mg/L in some deep saline waters in the Interior Plains.

At any given location, groundwater tends to be harder and more saline than surface water, but this is by no means a universal rule. It is also generally the case that groundwater becomes more saline with increasing depth, but again, there are many exceptions.

As groundwater flows through an aquifer it is naturally filtered. This filtering, combined with the long residence time underground, means that groundwater is usually free from disease-causing microorganisms. A source of contamination close to a well, however, can defeat these natural safeguards. Natural filtering also means that groundwater usually contains less suspended material and undissolved solids than surface water.

See also: Groundwater section
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Water and Ecosystem Initiatives

In nature nothing exists alone. Living things relate to each other as well as to their non-living, but supporting, environments. These complex relationships are called *ecosystems*. Each body of water is a delicately balanced ecosystem in continuous interaction with the surrounding air and land.

Ecosystems are comprised of four basic components: water, land (rock and soils), air and living things (plants and animals including humans). Everything in an ecosystem is related to everything else. Consequently, anything that occurs in one of these basic components will have an effect on the other three. Thinking in terms of ecosystems is key to achieving sustainability because an ecosystem approach places equal emphasis on concerns related to the environment, the economy and the community.

An ecosystem approach is one of five guiding principles underlying Ecosystem Initiatives.

See also: Ecosystem Initiatives Website
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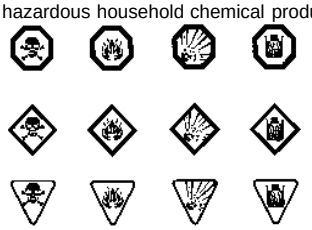
What can I do to improve water quality?

In the face of this planet's overwhelming environmental problems, each individual effort to protect water quality is vital. Together, individual actions can and do make a difference to water quality and the environment as a whole. You can start by taking the following actions:

Avoid hazardous household products

Most proprietary household chemicals are safe to use and are environmentally friendly, when used according to the directions on the package. However, some have a harmful cumulative effect on the environment when they are over-used or incorrectly disposed of.

- Check the label for hazard warnings. The symbols used on hazardous household chemical products are shown below:



The warning symbols are based on shape: the more corners a symbol has, the greater the risk. Read the label to find out how to use the product safely and what precautions to take.

- Buy only those environmentally hazardous products you really need, and buy them in quantities you will be able to completely use up, so that you will not have to worry about disposing of the leftovers later.

- Use "environmentally friendly" products now available in your supermarket and drugstore.

- The federal government endorses products that are environmentally friendly. Look for the Environmental Choice EcoLogo. Products bearing this label have been tested and certified by the Canadian Standards Association. Each dove represents a sector of society – consumers, industry, and government – linked together to improve and protect the environment. The logo identifies the products that maximize energy efficiency and the use of recycled or recyclable materials and minimize the use of environmentally hazardous substances. Consumers can make informed choices.

  For more information, contact:

  Environmental Choice Program
  Terra-Choice Environmental Services Inc.
  1280 Old Innes, Suite 801
  Ottawa, Ontario K1B 5M7
  Tel.: 613-247-1900
  Toll free: 1-800-478-0399
  Fax: 613-247-2228
  E-mail: ecoinfo@terrachoice.ca

  Additional information on environmentally friendly household products and their uses can be obtained from the following and similar organizations:

  Canadian Manufacturers of Chemical Specialties Association
  56 Sparks Street, Suite 500
  Ottawa, Ontario K1P 5A9
  Tel.: 613-232-6616
  Fax: 613-233-6350
  E-mail: morinm@cmcs.org

  Consumers Association of Canada
  267 O'Connor Street, Suite 307
  Ottawa, Ontario K2P 1V3
  Tel.: 613-238-2533
  Fax: 613-563-2254
  E-mail: info@consumer.ca

Don't misuse the sewage system

Don't throw waste down the drain just because it's convenient. Toxic household products can damage the environment and return to us through water and food.

- toss items such as dental floss, hair, disposable diapers and plastic tampon holders into the wastebasket, not the toilet – these items create many problems at the sewage treatment plant
- always use up completely (or pass on for other people to use) the unused contents of oven, toilet bowl and sink drain cleaners; carpet and furniture cleaners and polishes; bleaches, rust removers and solvents; paints and glue; and most other acid and alkali products
- save food scraps (except dairy and meat) and compost them; don't dump them down the drain
- choose latex (water-based) paint instead of oil-based and use it up instead of storing or dumping it

Don't use pesticides or other hazardous materials in your garden

Adopt alternative pest control methods, such as:

- hand pulling weeds
- snipping and discarding infested leaves
- dislodging insects with insecticidal soap or a water hose
- practising companion planting – for more information, contact:

  Ecological Agriculture Projects
  McGill University (Macdonald Campus)
  Ste-Anne-de-Bellevue, Quebec H9X 3V9
  Tel.: (514) 398-7771
  Fax: (514) 398-7621
  E-mail: eapinfo@macdonald.mcgill.ca

- setting ant and roach traps instead of using chemical sprays
- applying a natural insecticide such as diatomaceous earth, available in garden centres
- fertilize with natural materials such as bone meal or peat

Don't dump hazardous products into storm drains

Storm drains empty directly into nearby streams in many areas. The contents of storm sewers are generally not processed at sewage treatment facilities and can therefore do immediate harm to fish and wildlife. Beach closures are a typical example of storm water pollution in many communities.

- DON'T pour oils, paint compounds, solvents and other products into storm sewers, onto the street, or into your driveway
- DO take them to local recycling or disposal facilities. Some communities even organize hazardous waste disposal days; contact local health and environment officers or waste disposal companies for details. If nothing comparable exists in your community, introduce and promote the idea
- DO contact your local Fire Department, which will normally accept unwanted remainders of barbecue starter fluids, lighter fluids, gasoline and furnace oils.

Don't forget about water quality – even when you're having fun

- power boats can pollute the water through gasoline leaks and spills. Consider using a sailboat, rowboat, canoe or kayak. If you use a powerboat, keep the engine in good repair to avoid leaking oil, gasoline and solvents
- if you are a cottage owner, make sure you have a proper sewage disposal system
- while camping, always bury biodegradable waste at least 60 meters (200 feet) from any water source. Use only biodegradable soaps, and take your non-biodegradable garbage with you for proper disposal

Take further action

There is more you can do!

- read up on environmental issues
- be willing to change your attitudes, behaviour and expectations

write away for more information on environmentally-friendly products and methods
- urge and support federal, provincial and municipal action on environmental issues
- join and support local and national environmental groups that work to solve environmental problems; they are always in need of more volunteers and different talents
- boycott environmentally harmful products and let the stores know why
- attend public hearings, participate in advisory boards, address review committees, request information – as a citizen, you have these rights and should seize these opportunities
- inform your friends and educate your children

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Be a responsible consumer – it makes sense

Something all of us, as individuals, can do to protect water quality and the environment is to recycle products that are not degradable such as glass, cans and motor oil. Many municipalities in Canada have recycling programs.

Choose non-hazardous products. Most household chemical products and pesticides sold in Canada have warning labels. These labels tell whether the product is flammable, poisonous, corrosive or explosive. Proper disposal of these products is important to ensure water quality is not affected.

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Sustainable development

As we enter the 21st century, we find ourselves at a critical point and with very little time – years, not generations – in which to undo environmental damage and bring water resources to the point at which they can maintain themselves naturally. We must now think in terms of *sustainable development*: using and managing resources and the environment in such a way that they both maintain a strong economy and preserve a healthy environment today and in the years to come.

All of us must do our part – government, industry, public interest groups, individuals – at home, at school, at the workplace, while working, while playing, while travelling. It is time to re-examine our values, make thoughtful choices, and adjust our lifestyles to give more consideration to the environment. This includes changing our water use habits in ways that will help the resource sustain itself and maintain its quality.

It is important for each one of us to act – not only for ourselves and our children, but for future generations and for the other living things sharing the earth with us.

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