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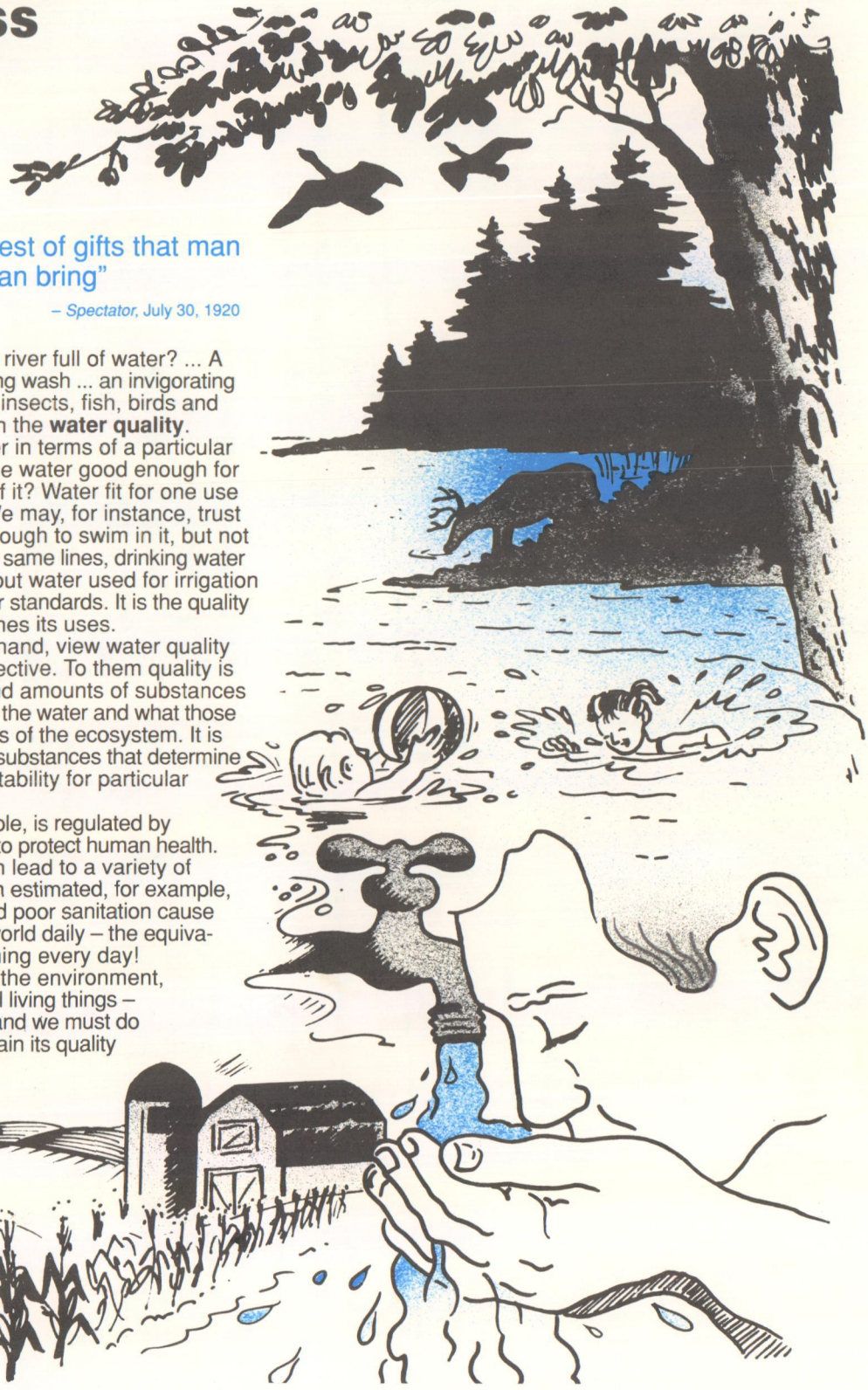
3
Water

Fact Sheet

Clean water – a priceless asset



"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 one 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, view water quality from a more precise perspective. 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.

Canada

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.

The Great Lakes: chemical hot spot

Over 360 chemical compounds have been identified in the Great Lakes. Many are persistent toxic chemicals — alkylated lead, benzo(a)pyrene, DDT, mercury and mirex — potentially dangerous to humans and already destructive to the aquatic ecosystems.

For example, various species of fish now suffer from tumours and lesions, and their reproductive capacities are decreasing. Populations of fish-consuming birds and mammals also seem to be on the decline. Of the ten most highly valued species of fish in Lake Ontario, seven have now almost totally vanished.

What determines water quality?

The water of even the healthiest rivers and lakes is not absolutely pure. All water (except if it is distilled) contains many naturally occurring substances — mainly bicarbonates, sulphates, sodium, chlorides, calcium, magnesium, and potassium (**total dissolved solids**). They reach the surface and ground waters from

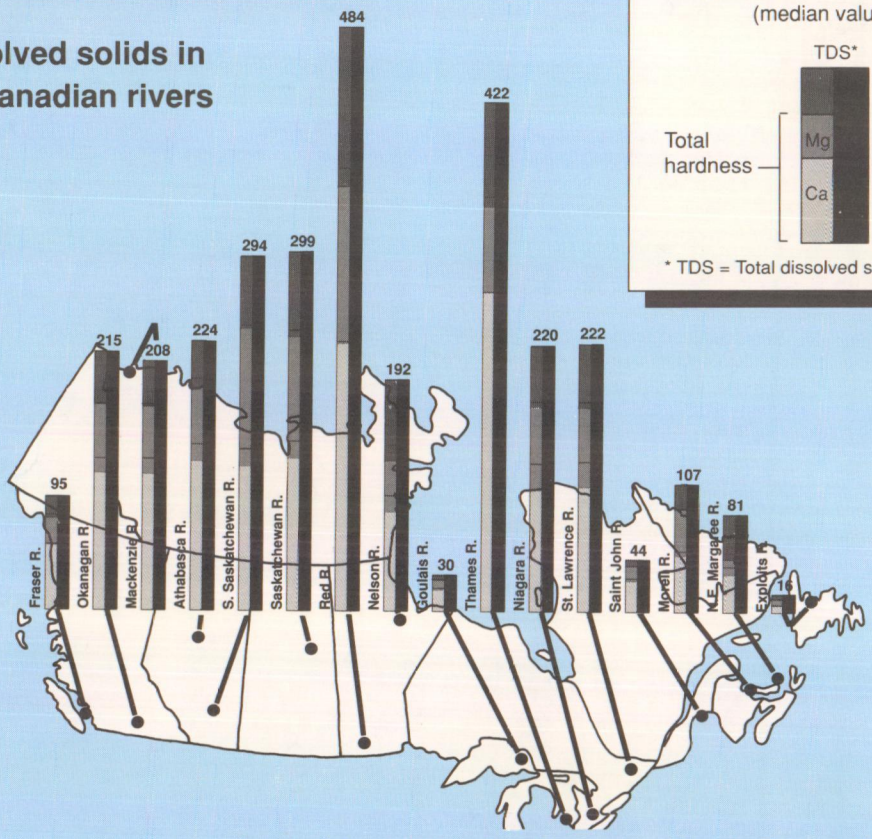
- soil, geologic formations and terrain in the catchment area (river basin)
- surrounding vegetation and wildlife
- precipitation and runoff from adjacent land
- biological, physical and chemical processes in the water
- human activities in the region.

Aquatic ecosystems

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.

Whatever occurs on the land and in the air also affects the water. If a substance enters a river or lake, the water can purify itself biologically — but only to a degree. Whether it is in the smallest stream or lake — or even in the mighty oceans — the water can absorb only so much. It reaches a point where the natural cleaning processes can no longer cope.

Total dissolved solids in selected Canadian rivers



This map shows the large variations, mostly natural, in the water quality of rivers across Canada. The total dissolved solids (TDS) measure is very important in assessing the suitability of water for irrigation or for drinking.

The hardness is another important water quality measurement in assessing the suitability of water for domestic use and for supporting aquatic life. The toxicity of some metals to fish, for example, augments with increased hardness.

How does water clean itself?

At the origin of the water purification cycle is the energy from sunlight, which drives the oxygen-producing process of photosynthesis in aquatic plants. Bacteria use this 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, this process does not affect a large number of toxic chemicals – especially the persistent ones (see *Water Quality Pollutants*, p. 4). This is one of the reasons why these substances are of such great environmental concern.

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. They then analyze them 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 analyzing metals) and "gas chromatograph-mass spectrometer" (for analyzing pesticides, PCBs, dioxins, and other organic compounds) — bear little resemblance to the test-tube and gas burner laboratories used until 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 consequent lower detection limits. State-of-the-art analytical instruments can detect down to one part per trillion of a substance — comparable to tracing one thousandth of a teaspoon of salt dissolved in an olympic-size swimming pool.

Human health and water quality

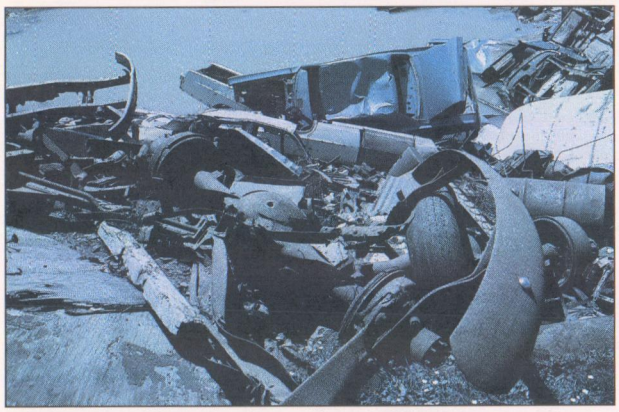
In Canada we are lucky to have plentiful supplies of good drinking water sources. Water-related illnesses — typhoid fever, cholera, dysentery — are almost unknown in this country today. Waste and wastewater treatment, the development and enforcement of drinking water guidelines, public health practices 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.

The price Canadians must pay to prevent water-borne disease is constant vigiliance 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 entering our waters from many different sources, including industry, agriculture and the home. Little is known about the effects of these substances on human health: often they do not become noticeable for long periods of time, and it is difficult to distinguish them from the effects of other factors impacting our day-to-day life (e.g., nutrition, stress, air quality). Much more remains to be done to control toxic chemical pollution. Meanwhile, all of us can contribute to its prevention by not abusing the water or the land (see *What can I do to improve water quality?* p. 10).

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.
- 26% of all Canadians rely on ground water 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.
- A strong green colour can be imparted to water from large amounts of algae. The phosphates in detergents and nitrates in fertilizers can build up in lakes and rivers and cause aquatic plants to grow very rapidly.
- 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 gram per thousand litres of water is, however, harmful.



The pollution problem

It is easy to dispose of waste by dumping it into a river or lake. In large or small amounts, dumped intentionally or accidentally, it may be carried away by the current, but will never disappear. It will reappear downstream, sometimes in changed form, or just diluted. Freshwater bodies have a great ability to break down some waste materials, but not in the quantities discarded by today's society. This resulting overload, called pollution, eventually puts the ecosystem out of balance.

Sometimes nature itself can produce these imbalances. In some cases, the natural composition of the water makes it unfit for certain uses: e.g., water flowing in the highly saline terrain of the prairies or gushing from highly mineralized springs in some parts of the country cannot sustain fish populations.

But most often our waterways are being polluted by municipal, agricultural and industrial wastes, including many toxic synthetic chemicals which cannot be broken down at all by natural processes. Even in tiny amounts, some of these substances can cause serious harm.

The Great Lakes, the Fraser River, and the St. Lawrence River are and continue to be seriously contaminated by such toxic chemicals.

We have polluted our way to wealth ... at the expense of the environment

The effects of pollution

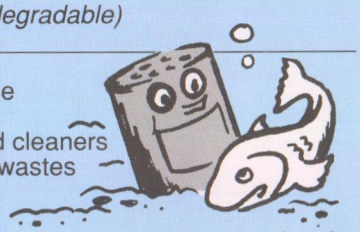
Pollution is not always visible. A river or lake may seem clean, but still be polluted. In ground water, on which over one quarter of all Canadians rely for their water supply, pollution is especially difficult to discern. Nor are the effects of pollution necessarily immediate; they may take years to appear.

When pollution makes water unsuitable for drinking, recreation, agriculture and industry, it eventually also diminishes the aesthetic quality of lakes and rivers. Even more seriously, when contaminated water destroys aquatic life and reduces its reproductive abilities, it eventually menaces human health. Nobody escapes the effects of water pollution.

Water quality pollutants

Non-persistent (degradable)

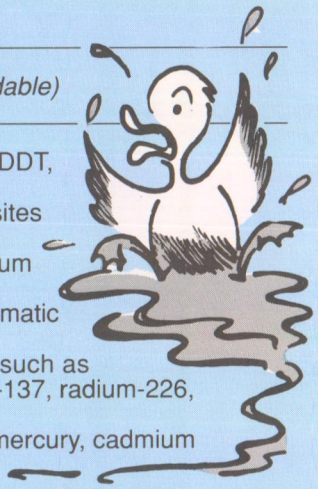
- domestic sewage
- fertilizers
- some household cleaners
- some industrial wastes



These compounds can be broken down by chemical reactions or by natural bacteria into simple, non-polluting substances such as carbon dioxide and nitrogen. The process can lead to low oxygen levels and eutrophication if the pollution load is high. But this damage is reversible.

Persistent (non-degradable)

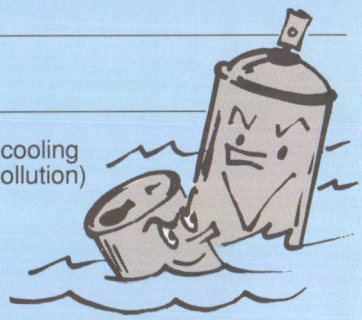
- some pesticides (e.g. DDT, dieldrin)
- leachate from landfill sites (municipal, industrial)
- petroleum and petroleum products
- PCBs, dioxins, polyaromatic hydrocarbons (PAHs)
- radioactive materials such as strontium-90, cesium-137, radium-226, and uranium
- metals such as lead, mercury, cadmium



This is the most rapidly growing type of pollution and includes substances that degrade very slowly or cannot be broken down at all; they may remain in the aquatic environment for years or longer periods of time. The damage they cause is either irreversible or reparable only over decades or centuries.

Other

- warm water from cooling towers (thermal pollution)
- floating debris
- garbage
- foam



These are examples not of chemical pollution, but of physical pollution which interferes mainly with the usability and/or aesthetic appeal of the water. In certain cases, thermal pollution can kill fish.

Toxic chemicals: the legacy of a chemical society

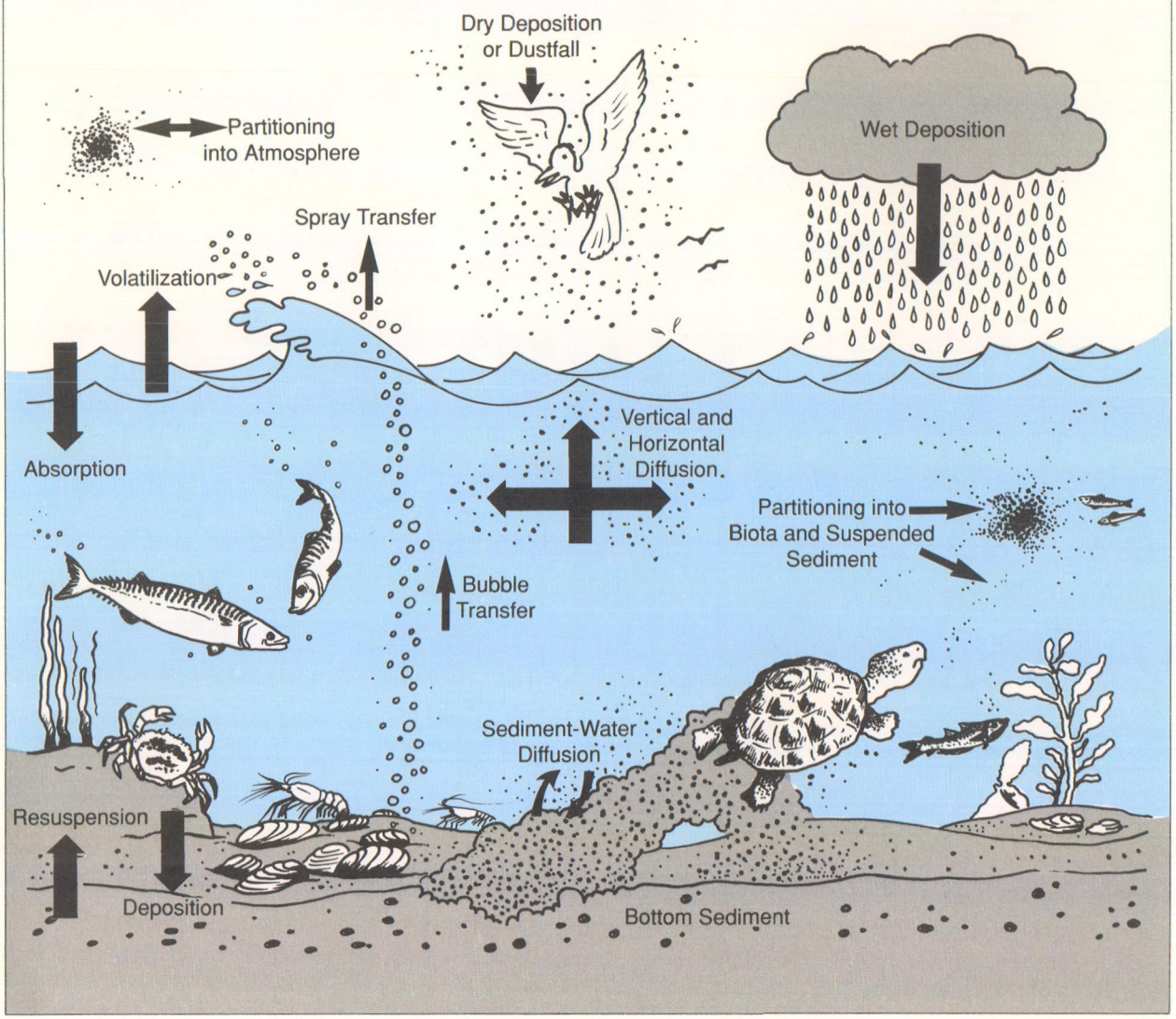
We are a "chemical" society, using hundreds of chemicals in our normal daily activities: washing, eating, house-cleaning, tending the lawn and garden, driving. Of the almost 10 million chemicals known today, approximately 100 000 chemicals are used commercially. Over 10 000 new chemicals are created each week.

Most toxic chemicals are discharged directly into our waterways as waste, but many also enter the water after everyday use in the home, agriculture and industry. They constantly change the chemical composition of our waters. One way is seepage: the chemicals soak through the earth into the ground water from waste disposal sites and agricultural lands, for example. Another way is runoff: the chemicals are washed into bodies of water from the land where they were used or spilled, or from the air into which they were emitted.

The chemicals can cause problems with the taste, odour and colour in water. Fish and wildlife can experience reduced fertility, genetic deformities, immune system damage, increased incidences of tumours, and death.

Many of the chemicals that enter the water are, even in minute amounts, toxic to human, plant and animal life. Pesticides, PCBs and PCPs (polychlorinated phenols) are typical examples. Pesticides are used in agriculture, forestry and homes. PCBs, although no longer used in new installations, are still found as insulators in older electrical transformers, and PCPs can be found in wood preservatives. The very qualities which make them desirable for use — toxicity and persistence, for instance — make them so harmful to the environment.

Toxic substances in the aquatic environment



The long-range transport of airborne pollutants: what goes up must come down

On a daily basis, human activities — industrial, agricultural and residential — cause vast quantities of natural and synthetic chemicals to be emitted into the atmosphere. Once released, the substances are dispersed throughout the globe by air currents that know no boundaries — provincial or international. This phenomenon is known as the **long-range transport of airborne pollutants (LRTAP)**.

Over time, these emissions expose human beings, wildlife and resources to diverse quantities and mixtures of air pollutants. The resulting harm is difficult to evaluate, since it occurs over varying time frames and over vast areas with differing degrees of sensitivity. The reversibility of the damage is not yet well understood.

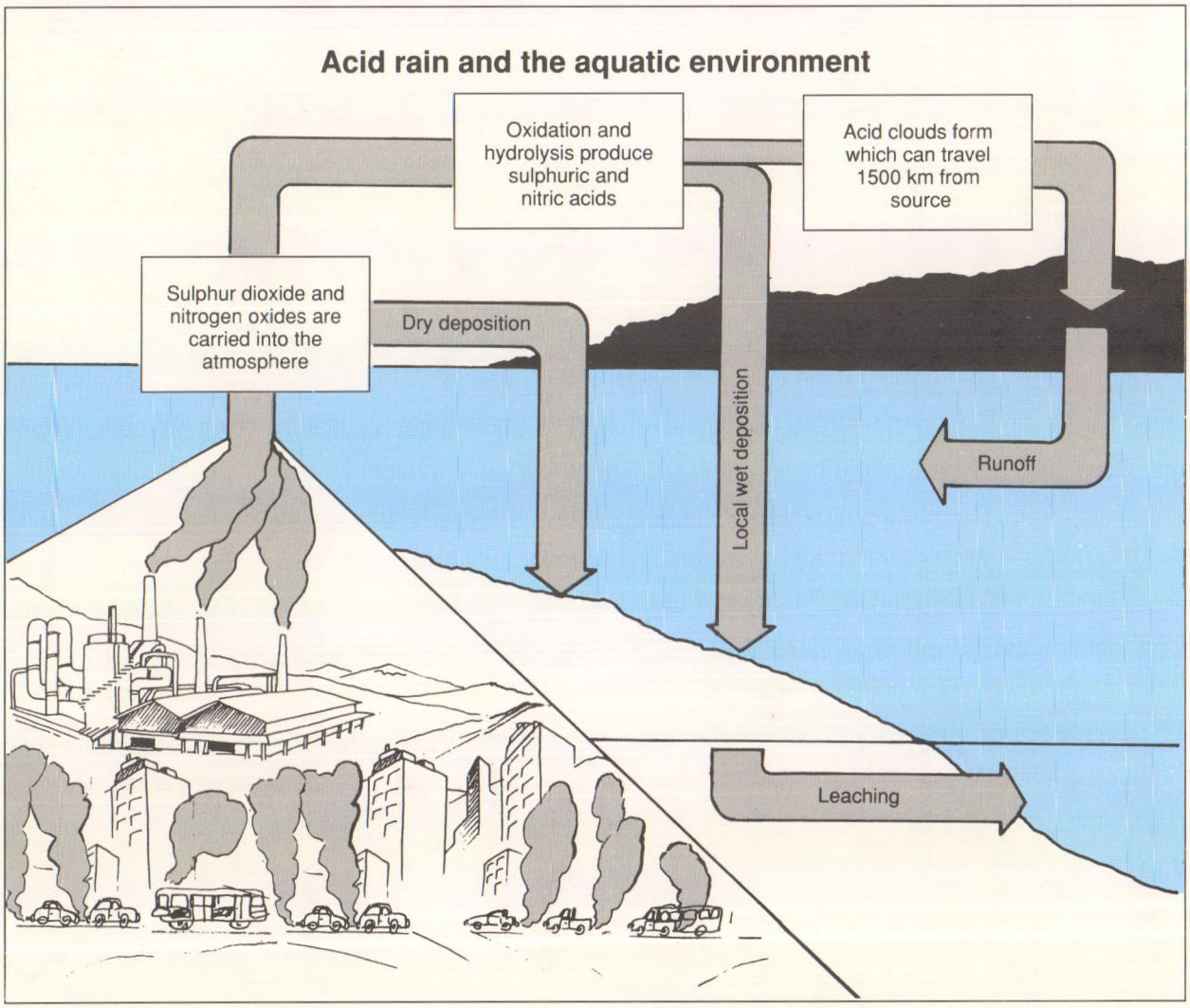
Some of the chemicals in the atmosphere are rendered harmless through exposure to sunlight, but others are extremely persistent, surviving and circulating around the earth for as long as months or years. They reach our water systems through dry or wet deposition.

Acid rain, one of the most publicized LRTAP phenomena, originates with emissions from coal-fired generators, non-ferrous metal smelters, petroleum refineries, iron and steel mills, pulp and paper mills, and from motor vehicle exhaust. The released sulphur dioxide and nitrogen oxides are converted to sulphuric and nitric acids in the atmosphere. These acids return to earth through wet sulphate and/or nitrate deposition (including rain, snow and fog).

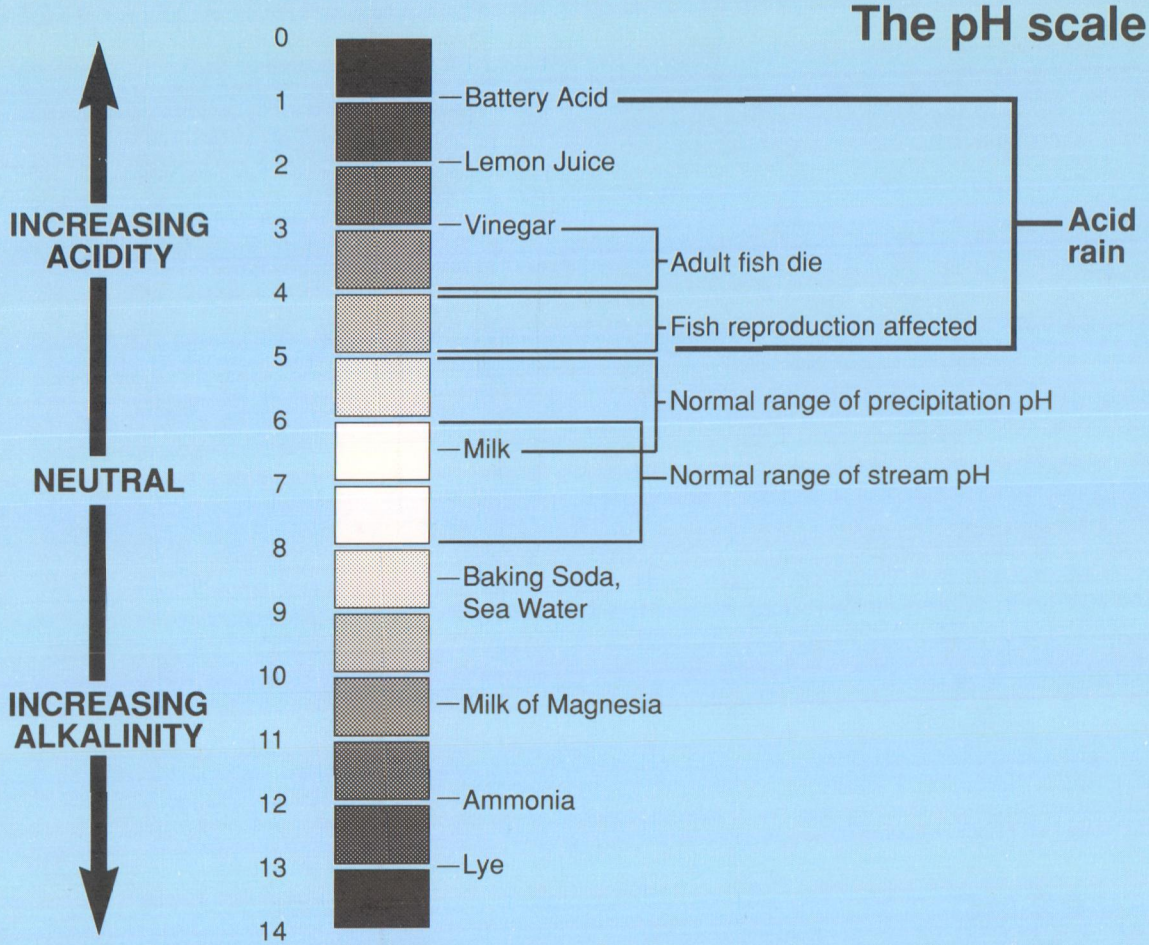
In Canada, the major sources of sulphur dioxide emissions are non-ferrous metal smelters, followed by coal-fired generators. Motor vehicles and, to a lesser extent, coal-fired generators, are the major sources of nitrogen oxides. About half the wet sulphate deposition in eastern Canada is estimated to come from the United States, while about ten percent of the deposition in the northeastern United States comes from Canada.

The damage caused by acid rain deposition occurs in environments which cannot tolerate acidification — to the extent that many species of fish, insects, aquatic plants and bacteria develop reproduction difficulties. Many even die. The resulting decline in the population of any of these aquatic organisms affects the food chain. Dwindling populations of insects and small aquatic plants and animals are especially serious because the entire food chain is affected.

Acid rain and the aquatic environment



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.

Accelerated aquatic plant growth: too much too fast

The growth and reproduction of aquatic plants is stimulated by eutrophication, a natural process which, over geological time, turns a lake into a bog and eventually into land. But today, in many places, this process is tremendously accelerated by high concentrations of phosphorus and nitrogen (from fertilizer, for example) which enrich the water with nutrients, causing the aquatic plants to bloom. As the plant growth explodes, it chokes off the oxygen supply normally shared with other organisms living in the water. When the plants die, their decomposition uses up even more oxygen. As a result, fish suffocate and die, and bacterial activity decreases.

Yet if phosphorus and nitrogen inputs are reduced or stopped, the system can recover by itself. In the late 1960s, Lake Erie experienced such an extreme case of eutrophication that fish were dying and the decomposing algae, washed up on bathing beaches, had to be removed with bulldozers.

The phosphorus (phosphate) in laundry detergents washed into the lake was the main culprit. A law was passed to reduce the substance, and in 1972 laundry detergent phosphate contents were cut by approximately 90%. Lake Erie has since made a remarkable recovery.

Controlling water pollution

Since water plays such a vital role in life on earth, good quality water is a precious resource. Often water quality is more important than water quantity. The quality of the water affects the use we make of it, but the reverse is also true. Once we have used the water, we affect its quality.

This circular situation sends us the message that the traditional habit of discharging untreated sewage and chemical wastes directly into rivers, lakes, estuaries or oceans for eventual "assimilation" into the environment is no longer acceptable — either technically or morally.

The explosion in human population and industrial activities, and the rate at which new chemicals and products are being developed and used — these factors pose a global environmental threat. The natural decay processes in water bodies can no longer cope with these loads.

The approach to controlling pollution depends on

- **the type of pollutant**
  is it degradable? persistent?
  is it a metal? pesticide? dioxin? PCB?
- **the source**
  does it come from an industrial pipe?
  a farmer's field? the atmosphere?
- **the effects**
  is it harming fish? birds? plants? humans?

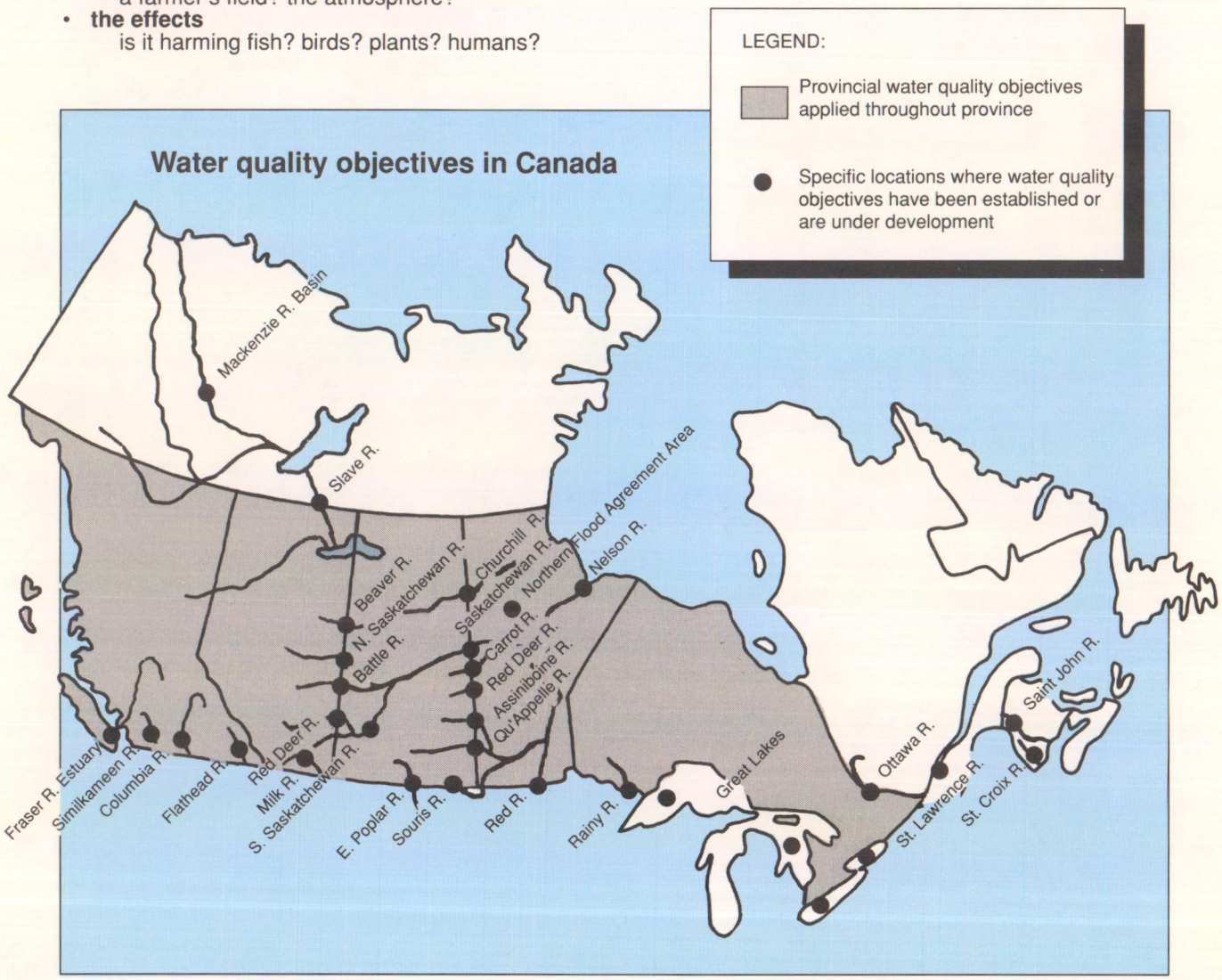
Water quality objectives and guidelines

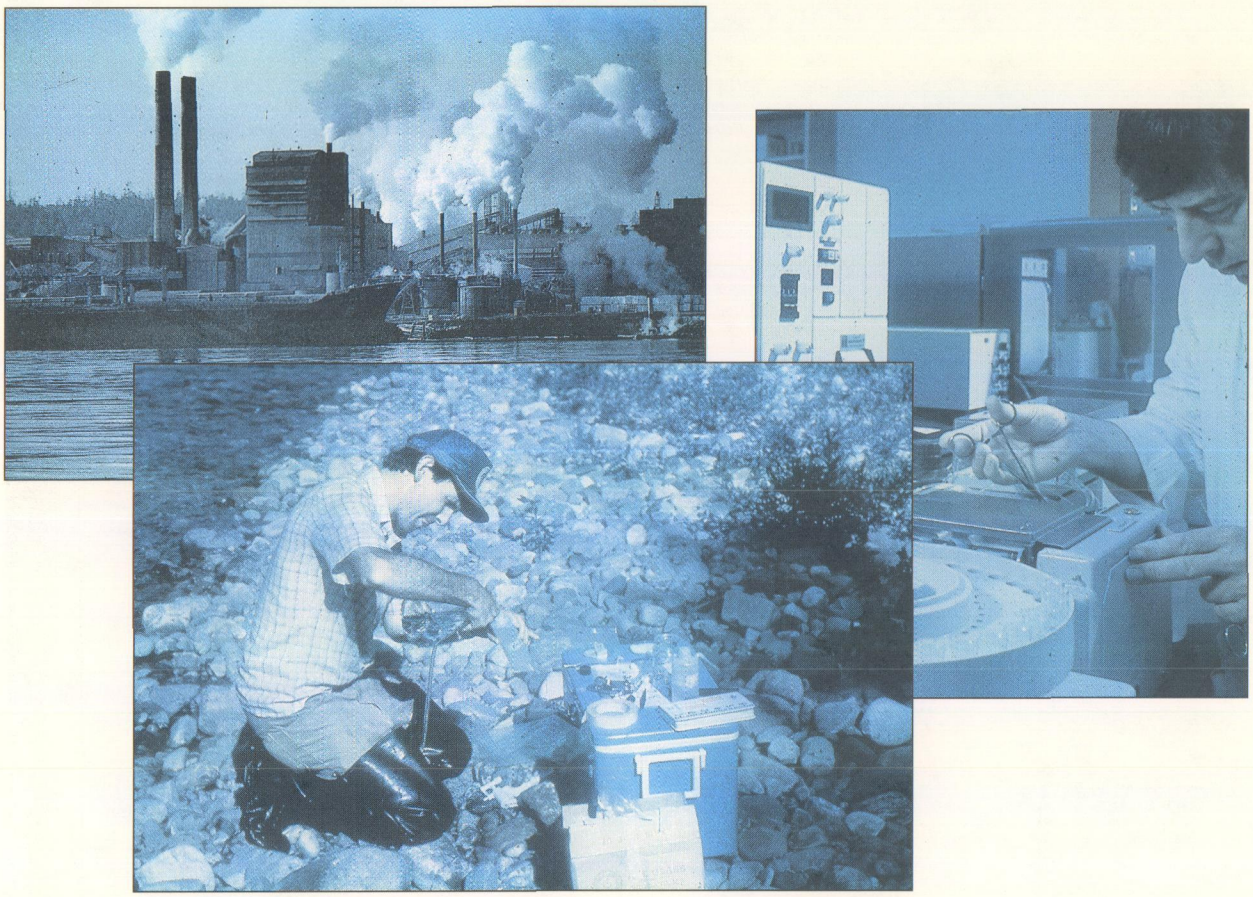
In Canada, governments use various measures to protect water quality, among them **guidelines** and **objectives**. The two measures are similar in that both describe how much of a substance we, as a society, will tolerate in water. But guidelines and objectives are arrived at and applied differently.

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.





Regulations
Ideally, polluting substances should be prevented from entering the water. At the most, in some circumstances, they can be allowed only in low concentrations. All provinces and territories in Canada have pollution control regulations. Deciding on the substances for control, their concentrations and how they may enter the environment means answering a number of questions, including:

- what are the sources, amounts and effects of various substances?
- what happens to them and what do they do after they have entered the water? do they change? to what?
- where do the substances end up?
- can they be prevented from reaching the water body or removed by treatment?

An example of a substance successfully regulated to reduce pollution is the phosphate found in laundry detergents (see *Accelerated aquatic plant growth*, p. 7). The new Canadian Environmental Protection Act (CEPA) will regulate many more toxic substances.

Technology
Technology can be used in many cases to reduce or eliminate substances which may be harmful to the environment. Sewage treatment plants, properly operated and maintained, are a means of removing many toxic substances from wastewater and returning the treated water to a river or lake without causing harm downstream. Water treatment plants can take river or lake water and make it fit for drinking.

But what happens when contaminants are not removed, even by the most modern water treatment methods? They may be present only in minuscule quantities, but because they are persistent, they can build up to very harmful levels. In such cases, we can protect future generations and the ecosystem as a whole in only one way: preventing the chemicals from entering the water system.

Substitution and recycling — 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 and use non-polluting alternatives. Common substances such as salt, baking soda and vinegar can be used effectively instead of the usual oven, window and drain cleaners which contain pollutants. In many cases, washing houseplant leaves with soapy water can work as well as an insecticide.

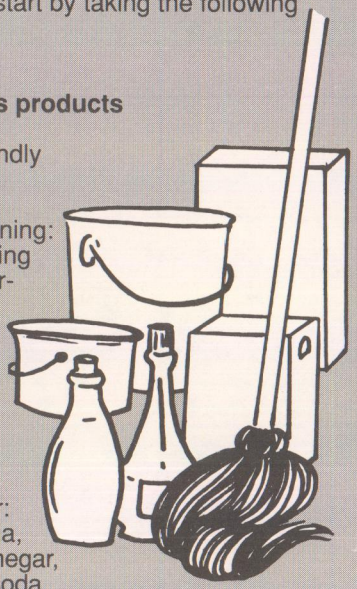
Non-degradable products such as glass, cans and motor oil can be recycled. Many municipalities in Canada have recycling programs.

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:

Don't use hazardous products

Use environment-friendly options instead.



- for household cleaning: vinegar, soap, baking soda (sodium bicarbonate), washing soda (sodium carbonate), borax (sodium borate, a natural mould inhibitor), household ammonia
  - an excellent all-purpose cleaner: 1/2 cup ammonia, 1/2 cup white vinegar, 1/4 cup baking soda, 1.9 litres (1/2 gallon) water
  - an effective furniture polish: mix 1/2 teaspoon lemon oil with 1 litre mineral or vegetable oil
- clean household drains by pouring boiling water into them or hot water mixed with 1/2 cup washing soda (sodium carbonate)
- buy products marked as environment-friendly now available in stores
- buy only those environmentally hazardous products you really need, and buy them in quantities you will be able to completely use up. That way you won't have to worry about disposing of leftovers later
- for more information, send a self-addressed, stamped envelope to environmental groups such as:
  - **Friends of the Earth**, 251 Laurier Ave. W., Suite 701, Ottawa, Ont., K1P 5J6
  - **Greenpeace**, 578 Bloor St. W., Toronto, Ont., M6G 1K1
  - **Pollution Probe**, 12 Madison Ave., Toronto, Ont., M5R 2S1

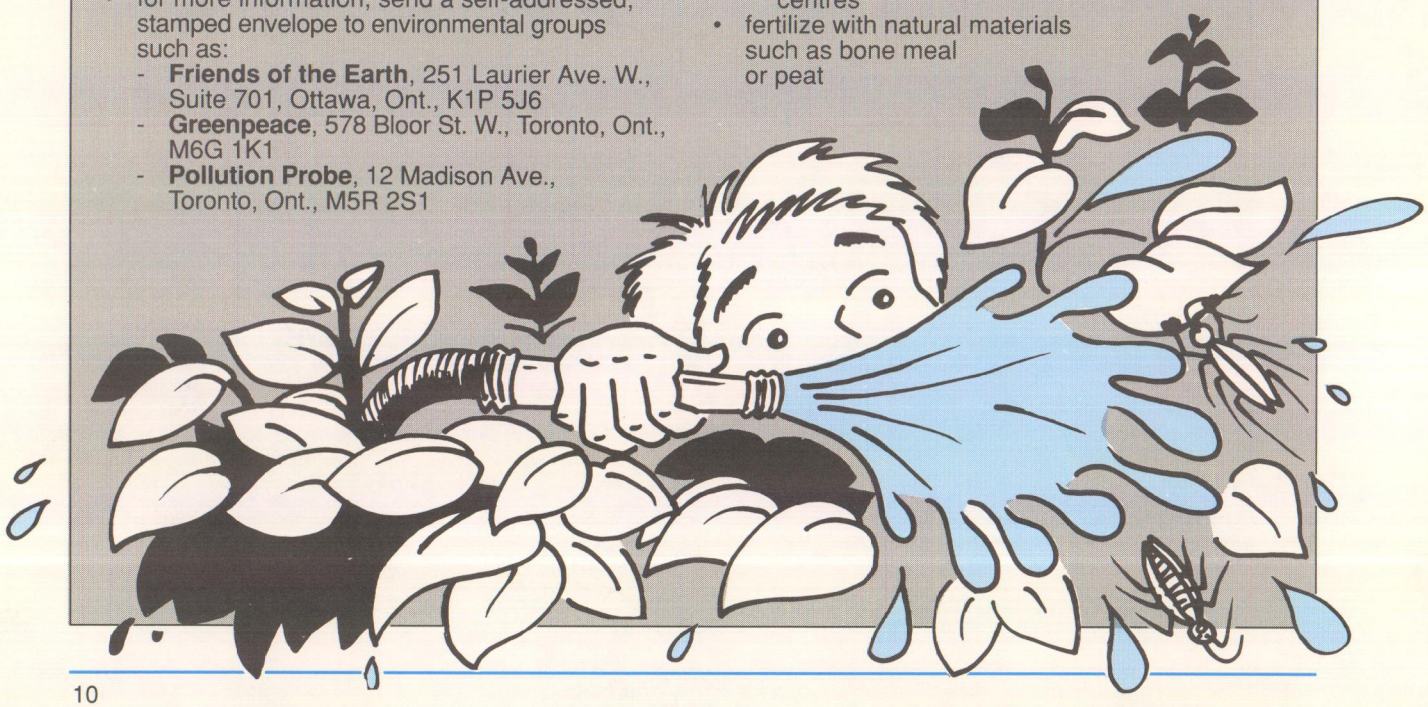
Don't misuse the sewage system

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) all the contents of oven, toilet bowl and sink drain cleaners; carpet and furniture cleaners and polishes; bleaches, rust removers and solvents; paints and glue; plus 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, send a self-addressed, stamped envelope to:
    - **Ecological Agriculture Project**, Box 191, Macdonald College, Ste-Anne de Bellevue, Que., H9C 1C0
  - 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, detergents, 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

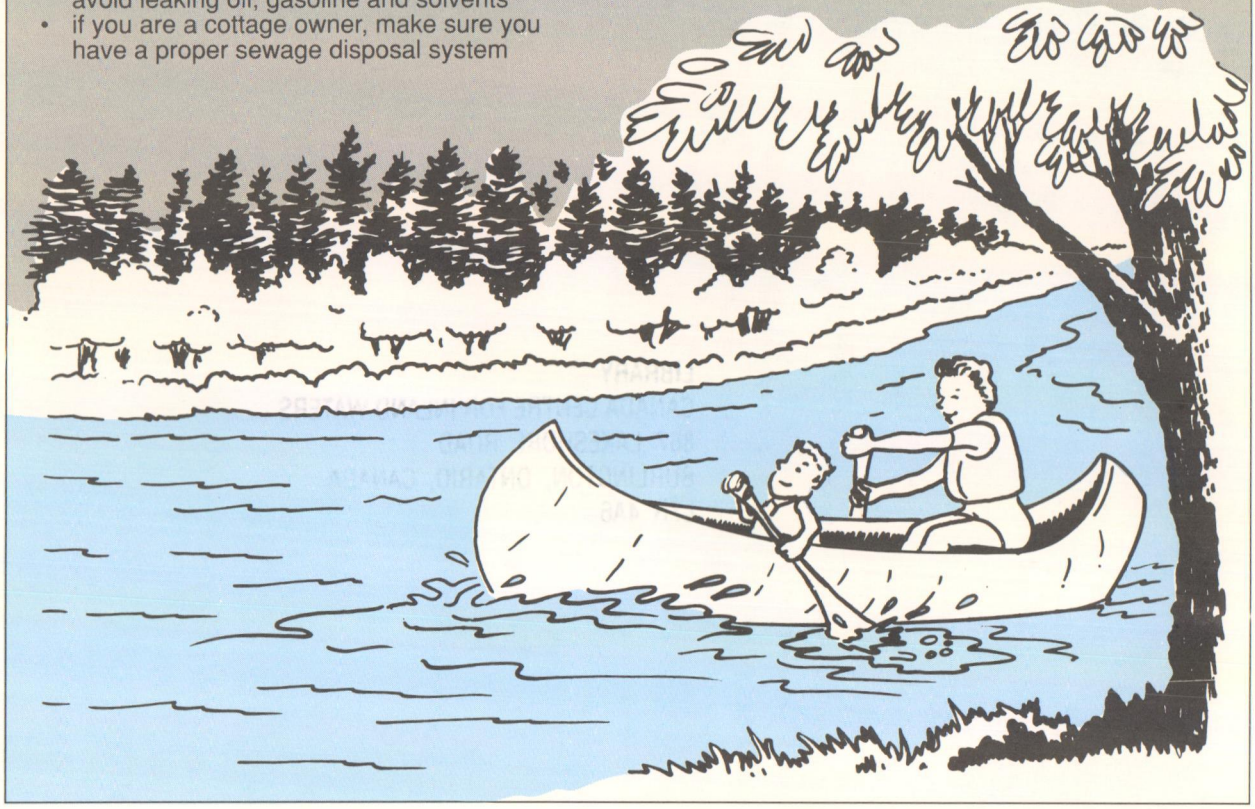
Don't forget about water quality — even when you're having fun

- 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 metres (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 environment-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

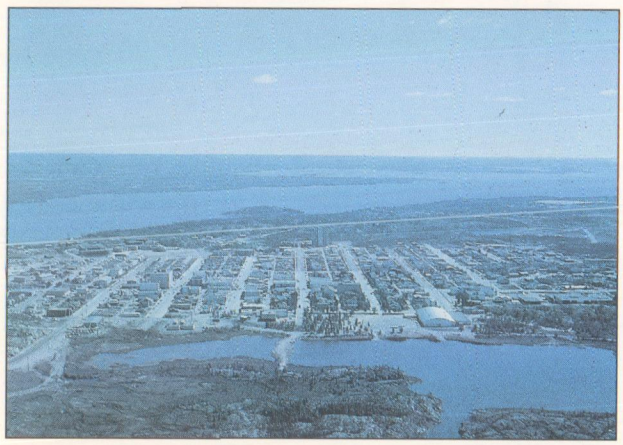


The choice we make now

Sustainable development
In the last decade of the 20th 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.



Diving beneath the surface

This is one in a series of fact sheets prepared by Environment Canada. For more information about water, its nature, what it can do and how it is used and managed, please write or call:

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