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Water

Fact Sheet

Water Works!

Water works for us in many ways, making our lives easier and more enjoyable. But we must take great care not to overuse and abuse this precious resource.

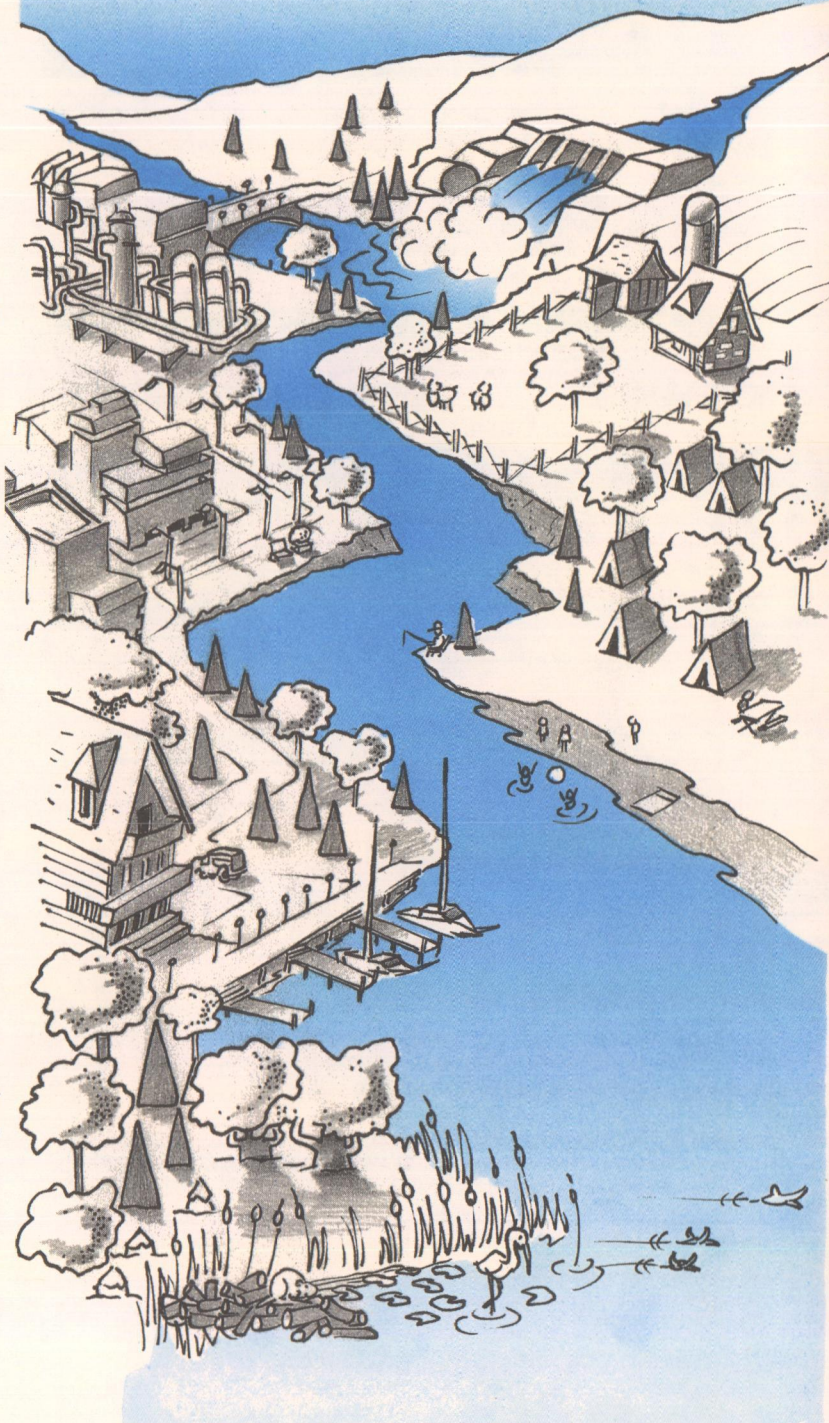
Water is a basic necessity of life, not only for people but for every type of plant and animal as well. Water accounts for about 65% of our body weight. If we lost as little as 12% of it, we would soon die.

Water is essential not only for survival but also contributes immeasurably to the quality of our lives. Since the dawn of time, human beings have harnessed water to improve their lives. In some ways, the history of civilization is the story of how we have made water work for us in ever more ingenious ways. As early as 5000 B.C., our predecessors used irrigation to increase crop production. Archaeologists have found masonry sewers dating back to 2750 B.C. and water-flushed toilets dating back almost as far.

Water played – and continues to play – a special role in the growth of our nation. The fur trade, which stimulated the exploration of Canada's vast interior, was totally dependent on water for transportation. Water powered the grist mills and sawmills along small and large rivers in the Maritimes and Upper Canada, making possible the production and export of grain and lumber, two early economic staples. As Canadian industry diversified, water was put to new uses: as a coolant, a solvent, a dispersant, and a source of hydroelectric energy.

Water transportation is still an efficient way to move bulk goods. Water is also the basis of cheap energy. It is a raw material in the manufacture of chemicals, drugs, beverages, and hundreds of other products. It is an essential part of manufacturing processes that produce everything from airplanes to zippers. In other words, we depend on water for most of our technology, comforts and conveniences and, of course, for personal hygiene and to flush away our waste products.

Many people think it makes no difference how much water we use or what we use it for. Actually, the way we use water is very important. Some uses are incompatible with others. Some uses remove water from the natural cycle for longer periods than others. Worst of all, most uses actually lower the quality of the water.



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(Courtesy of Joachim Moenig)

Great Blue Heron fishing.

Water quality is everybody's business because ultimately we all draw from the same supply of water. Most people live downstream from somebody else, not to mention the fact that the same basic supply of water, replenished over and over again through the hydrologic cycle, has been used millions of times over in the long history of the earth. We are now aware of limits to the reuse of water, when and where it is returned to nature diminished in quantity and quality. Therefore, we must learn to understand water use much better: where we use it, what to measure, what the main uses are, how they compete and interfere with each other, and how to manage the growing competition.

Withdrawal uses

Only withdrawal use is directly measurable as quantities of intake, discharge, and consumption. *Water intake* is the amount withdrawn from the source for a particular activity over a specific period of time. This measure is important because it represents the demand imposed by that particular use on the water source at a given location. Usually, however, most of the water taken out is returned at or near the source. This is called *water discharge*.

Water consumption is the difference between water intake and water discharge. Consumption removes water from a river system and makes it unavailable for further use downstream. The irrigation of crops is by far the largest consumptive use, followed by evaporation in large open water reservoirs and cooling ponds. However, because evaporation is difficult to measure, it is seldom recognized as water use.

In the global hydrologic cycle, water is never actually lost. For example, the water evaporated from industrial cooling towers or an irrigated field simply returns to the atmosphere, later to fall again as precipitation somewhere else on earth.

Where we use water

The most obvious and immediate uses of water occur in its natural setting. They are called *instream* uses. Fish live in it, as do some birds and animals, at least part of the time. Hydroelectric power generation, shipping, and water-based recreation are examples of human instream uses.

These instream uses are not always harmless. For example, oil leaking from outboard motors and freighters causes pollution. Large reservoirs needed for hydroelectric power generation remove water by evaporation and completely change the river regime for downstream users.

The greatest number and variety of water uses occur on the land. These are called *withdrawal* uses. This term is appropriate because the water is withdrawn from its source (a river, lake or groundwater supply), piped or channelled to many different locations and users, and then is collected again for return to a lake, river or into the ground. Household and industrial uses, thermal and nuclear power generation, irrigation and livestock watering all fall into this category.

Most withdrawal uses "consume" some of the water, meaning less is returned to the source than was taken out. Furthermore, the water which is put back into its natural setting is often contaminated. For example, water leaving our houses contains human and household wastes. The same is true of water used in many industrial processes. Often this liquid waste is only partially treated, if at all, before it is returned to nature.

We determine how efficiently we use water in a particular process or economic sector with the help of two additional measurements: *gross water use* and the amount of water that is recirculated. Gross water use represents the total amount of water used during a process. This would normally be equal to the water intake, except that more and more users (especially industries) reuse the same water one or more times. In such cases, the gross water use could be equal to several times the water intake. The difference between gross water use and water intake is the amount recirculated, which can be expressed as a *use rate*. This is the number of times that the water is recirculated and indicates how efficient a particular water use is.



(Courtesy of TransAlta Utilities Corporation)

Sundance Thermal Plant, located approximately 75 kilometres west of Edmonton, Alberta. The cooling pond in the foreground provides a reservoir for water used in various cooling operations within the plant, particularly for returning the steam, which drives the turbine, to a liquid for reheating.

In 1986, five main withdrawal uses accounted for a gross water use in Canada of 56 541 million cubic metres (MCM), made up of intake (42 210 MCM) and recirculation (14 331 MCM). About 10% of the intake was consumed and the rest was discharged back to receiving waters (Figure 1).

The following is a closer look at these withdrawal uses, starting with the largest.

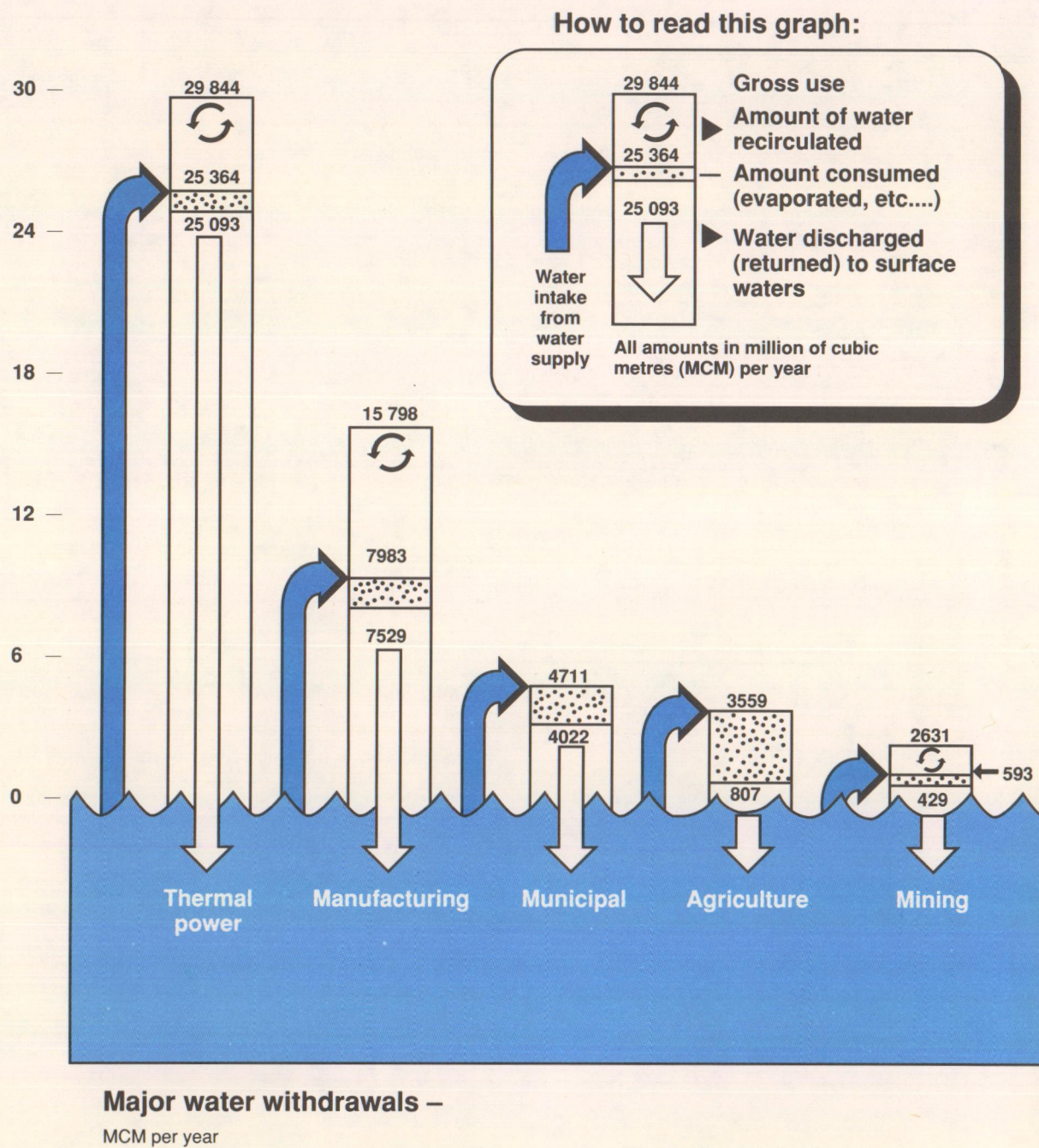
- **Thermal power generation:** This industrial sector, which includes both conventional and nuclear power generating plants, withdrew slightly more than 60% of the total water intake in 1986. Next to fuels, water is the most important resource used in large-scale thermal power production. Production of one kilowatt-hour of electricity requires 140 litres of water for fossil fuel plants and 205 litres for nuclear power plants. Some of the water is converted to steam which drives the generator producing the electricity. Most of the water, however, is used for condenser cooling.

Why is so much cooling necessary? Because today's processes can only convert 40% of the fuel's energy into usable electricity. The rest is wasted. This shows the double cost of inefficient energy use: first, in the wasted energy, and then in the water required to cool the wasted heat to the temperature where it can be released safely into the environment. This requires a continuous flow of cooling water circulating through the condenser. All the cooling water is therefore returned to the environment much warmer.

- **Manufacturing:** Water is the lifeblood of industry. It is used as a raw material, a coolant, a solvent, a transport agent, and as a source of energy. An automobile coming off the assembly line, for example, will have used at least 120 000 litres of water – 80 000 to produce its tonne of steel and 40 000 more for the actual fabrication process. Many thousands more litres of water are involved in the manufacture

Figure 1

Water use in Canada, 1986



This figure illustrates the importance of the main water uses in Canada. It shows how:

- We use water in many different ways and quantities.
- Some uses require much more water than others. For example, electrical power generation (excluding hydroelectric power, which is an instream use) withdraws three times as much water as all manufacturing uses, and 50% more than the other four uses combined.
- Some uses are more efficient than others. The manufacturing sector, for example, has a gross use almost twice its water intake, thanks to recirculation. The mining industry reuses its water four times.
- Some uses consume more water than others. Agricultural uses, for example, return very little of the intake water to its source. Unfortunately, in southern Alberta and Saskatchewan, agricultural withdrawals are highest for irrigation where water supplies are lowest.

Regional water intake in Canada, 1986

(MCM per year)

Region	Thermal power	Manufacturing	Municipal	Agriculture	Mining	Regional total
Atlantic	2 490	958	338	13	212	4 011
Quebec	986	1521	1483	89	52	4 131
Ontario	19 967	3763	1600	166	100	25 596
Prairies	1 867	357	674	2688	132	5 718
British Columbia*	54	1384	616	603	97	2 754
National total	25 364	7983	4711	3559	593	42 210
Percent of total	60.2	18.9	11.2	8.4	1.4	100.0

* Sectoral data for the territories are included with British Columbia region. Data for some sectors have been extrapolated and rounded.

Source: Environment Canada surveys and studies.

of its plastic, glass, and fabric components. Manufacturing accounted for 19% of water withdrawals in 1986. Paper and allied products, chemicals, and primary metals were the three main industrial users.

- **Municipal use:** Can you imagine a city without water? We use it for drinking, cooking, and for other household needs. Water is also needed to clean our streets, fight fires, fill swimming pools, and water lawns and gardens. Where would this water go without a sewerage system? These residential, commercial, and public uses, and the water lost from reservoirs and pipes amounted to about 11% of all withdrawals in Canada in 1986. This figure does not include rural areas where water use is not measured. If rural domestic uses were included, this figure would rise to about 13%.
- **Agriculture:** Farmers depend on water for livestock and crop production. Although 99% of the farms in Canada depend on natural precipitation, agriculture was still the fourth largest use in 1986, accounting for 8.4% of total withdrawals. Water is used for irrigation (85%) and livestock watering (15%). Irrigation is needed mainly in the drier parts of Canada, such as the southern regions of Alberta, British Columbia, Saskatchewan, and Manitoba. Irrigation is also used in Ontario and the Maritimes for frost control. Since so much of the water intake evaporates, only a small fraction is returned to its source. This is a highly consumptive use.
- **Mining:** This category includes metal mining, non-metal mining, and the extraction of fossil fuels. Water is used by the mining industry to separate ore from the rock, to cool drills, to wash the ore during production, and to carry away unwanted material.

Water is also used to extract and process oil that cannot be recovered by conventional drilling methods. Deep well injection, for example, involves pumping water into wells under pressure to force the oil to the surface.

Although the mining industry had a gross use almost as great as agriculture, mining accounted for only 1.4% of all water withdrawals in 1986. This was the smallest withdrawal use, but mining recirculates its water intake to a greater extent than any other sector.

Instream use

Unlike withdrawal uses, instream uses cannot be measured quantitatively because the water is not removed from its natural environment. Instead, instream uses are described by certain characteristics of the water or by the benefits they provide to us and the ecosystem.

Flow rates and water levels are very important factors for instream uses. When these conditions are changed by a dam, for example, it is easy for conflicts to arise. The most common conflict is between hydroelectric development and other uses with respect to aquatic life, wildlife, water supply and water transportation. Storage of the spring freshet (a high river flow caused by rapidly melting snow) removes the natural variability of streamflows on which all life processes depend, in particular, the highly productive ecosystems of deltas, estuaries and wetlands. To make the best use of our water, all needs must be carefully assessed and taken into account.

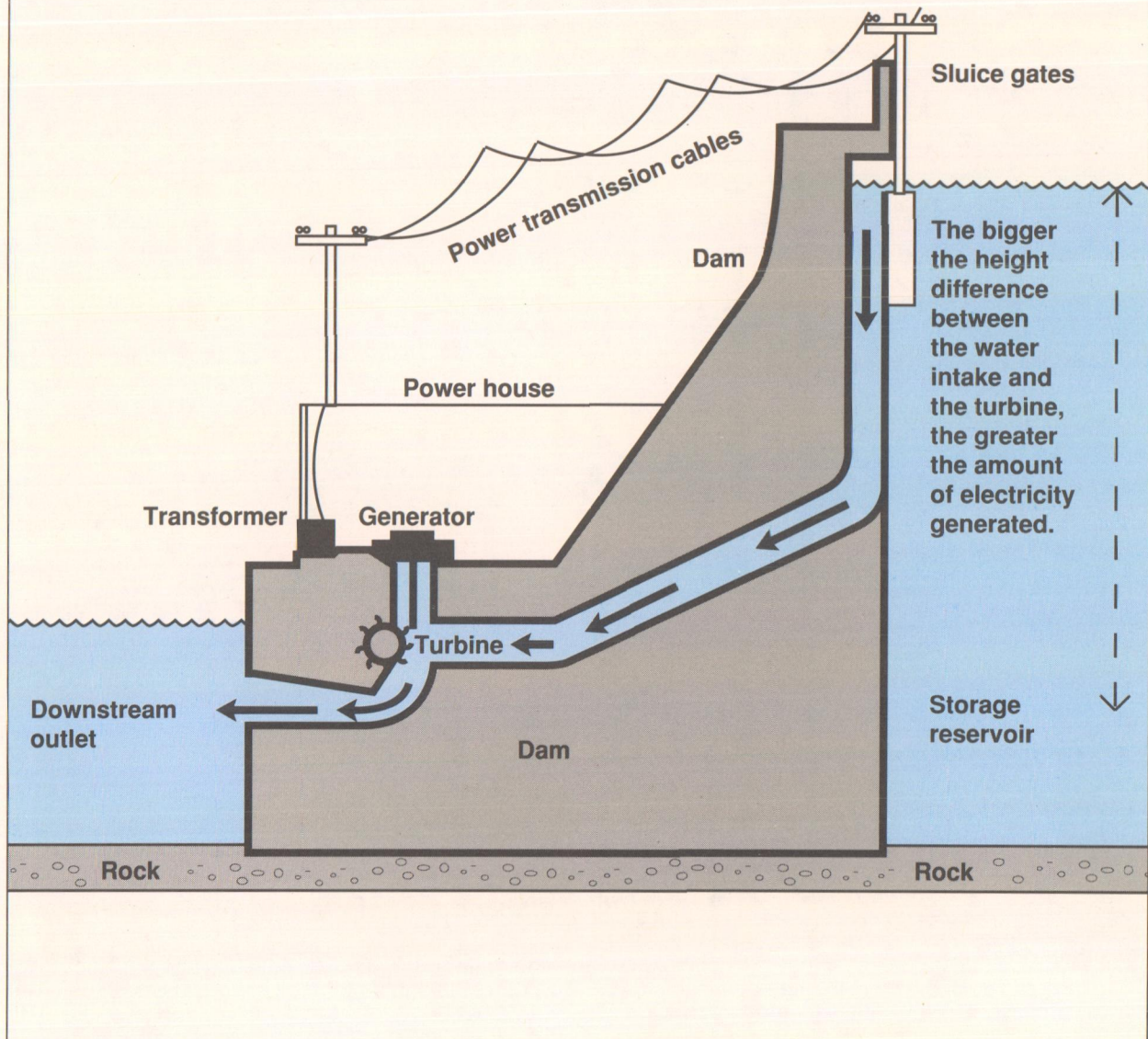
The main instream uses are:

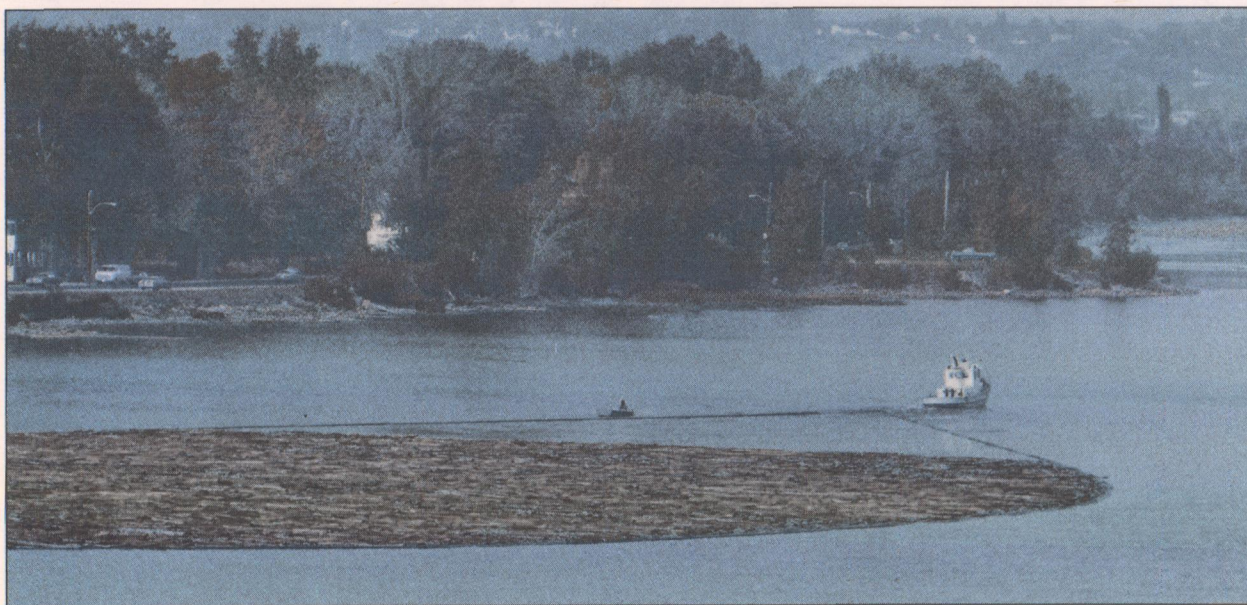
- **Hydroelectric power generation:** This water use is the principal source of electricity in Canada today (Figure 2). Billions of dollars are invested in its development every year. With large undeveloped hydroelectric sites still available in Quebec, Newfoundland, Manitoba, British Columbia, and the territories, this form of energy development will retain its prominent position for years to come. However, the environmental and human effects to be avoided or mitigated in such large projects make them increasingly difficult and costly to plan and build.
- **Water transport:** Inland waterways in Canada have historically played a major role in getting Canadian goods and raw materials to market. Some traditional uses, such as log driving, are now disappearing. However, water transport is still the most economical means of moving the bulky raw materials which are our main exports: wheat, pulp, lumber, and minerals. The main transportation waterways are the St. Lawrence River, which allows passage of ocean-going ships from the Atlantic Ocean deep into the heart of North America, nearly as far as the prairie wheat fields; the Mackenzie River, which is a vital northern transportation link; and the lower Fraser River on the Pacific Coast. Cargo in the hundreds of millions of tonnes is transported along these routes each year. Reliable and predictable lake and river levels are very important for this use.
- **Freshwater fisheries:** Blessed with hundreds of thousands of freshwater lakes and rivers, Canada provides some of the most spectacular sport fishing in the world. According to a 1985 survey, 6.5 million people make use of this fisherman's paradise every year. They spent about \$4.4 billion dollars that year on goods and services directly related to sport fishing. In addition, inland commercial fisheries employ some 10 000 Canadians, mostly in Ontario and the Prairie provinces. The fish they catch has a market value of about \$140 million. Moreover, coastal rivers provide spawning grounds for salmon and other fish populations which support major saltwater fisheries.

Figure 2

Water: A powerful source of energy

Hydroelectric energy is produced by the force of falling water. The capacity to produce this energy is dependent on both the available flow and the height from which it falls. Building up behind a high dam, water accumulates potential energy. This is transformed into mechanical energy when the water rushes down the sluice and strikes the rotary blades of a turbine. The turbine's rotation spins electromagnets which generate current in stationary coils of wire. Finally, the current is put through a transformer where the voltage is increased for long-distance transmission over power lines. In Canada, hydroelectric plants satisfy 62% of electricity demands.





(Courtesy of The Ottawa Citizen, Canada)

The end of an era

After more than 180 years, the annual summer log drive down the Ottawa River is coming to an end. Since 1806, the river has been an economical way to float timber from where it is cut to market. Changing economic conditions and the fact that most cutting areas are now farther away from the river spell the end of this tradition after 1990.

Although some people view this as the end of an era, local representatives of the tourism industry think the decision to end the log drive will improve recreational use of the river. Partly submerged logs left behind during the drives have been a problem for boaters and water skiers for years. Decaying bark and logs sinking to the bottom have altered the water quality and disturbed fish spawning beds. Similar considerations apply to other waterways being used for log drives.

- **Wildlife:** Many wildlife species live in, on, or near water and require access to it throughout their lives. Other species may not use water as their primary habitat, but it is nonetheless essential to their well-being. Watching, photographing, studying and feeding wildlife are all popular forms of recreation for Canadians. About 70% of Canadians participated in these activities, according to a 1987 survey, and spent about \$2.2 billion that year on them. Hunting attracts nearly one in ten Canadians and accounts for \$1.1 billion of wildlife-related spending each year. And these activities are all on the rise. A comparison between the 1987 survey and a similar study in 1981 shows that a growing number of Canadians participate in wildlife-related activities.
- **Waste disposal:** It has long been convenient to use lakes, rivers, and oceans as receiving bodies for human and industrial wastes. While water is capable of diluting and "digesting" society's wastes to some degree, there are limits to what even the largest body of water can absorb. The extent to which instream processes can accept contaminants depends on factors such as the nature of the contaminant, how much of it there is compared with the volume of water, how long the contaminant stays in the water, the temperature of the water, and the rate of flow. Many of our waterways are now overloaded with wastes and require costly cleanup before the water can be used again, or what is more important, before it can once again renew itself.
- **Recreation:** Canadians have traditionally valued opportunities for outdoor recreation and in recent years have sought the outdoors as never before. Activities such as swimming, boating, canoeing, fishing, and camping allow us to experience the beauty of our lakes and rivers. While not all outdoor recreation requires water, the presence of water tends to enhance the experience. Expenditures on water-related recreational activities and tourism also contribute billions of dollars per year to the national economy.

Water quality is everybody's problem

How water recovers from pollution and the limits to what nature can do by itself are discussed in detail in Fact Sheet No. 3, "Clean Water – Life Depends on It!" An understanding of how water is used helps us to predict and anticipate shortages of clean water even where there seem to be sufficient quantities. Using water entails the responsibility to clean it up after its use, and before it passes on to the next user downstream. We must do unto others what we would have them do unto us.

We take water for granted

Because we undervalue this precious resource, we tend to overuse it and, in fact, abuse it. The apparent abundance of water is deceptive, and the capacity of our lakes and rivers – and even of the oceans – to purify the wastes we dump into them is much more limited than we once thought it was. There is a price for it: billions and billions of dollars to clean up pollution. It is becoming abundantly clear that water is not a free good. Sooner or later it presents us with a bill: the price of neglect. In many cases we pay less than the actual cost of processing and delivery. For example, irrigation water charges only recover about 10% of the actual costs of the service. The same is true for water costs to householders.

Our overuse of water begins at home. Compared to some countries, we pay very little to have water delivered to our kitchen and bathroom faucets (Figure 3). Nevertheless, we use more water per person than most other countries (Figure 4).

What is a fair price?

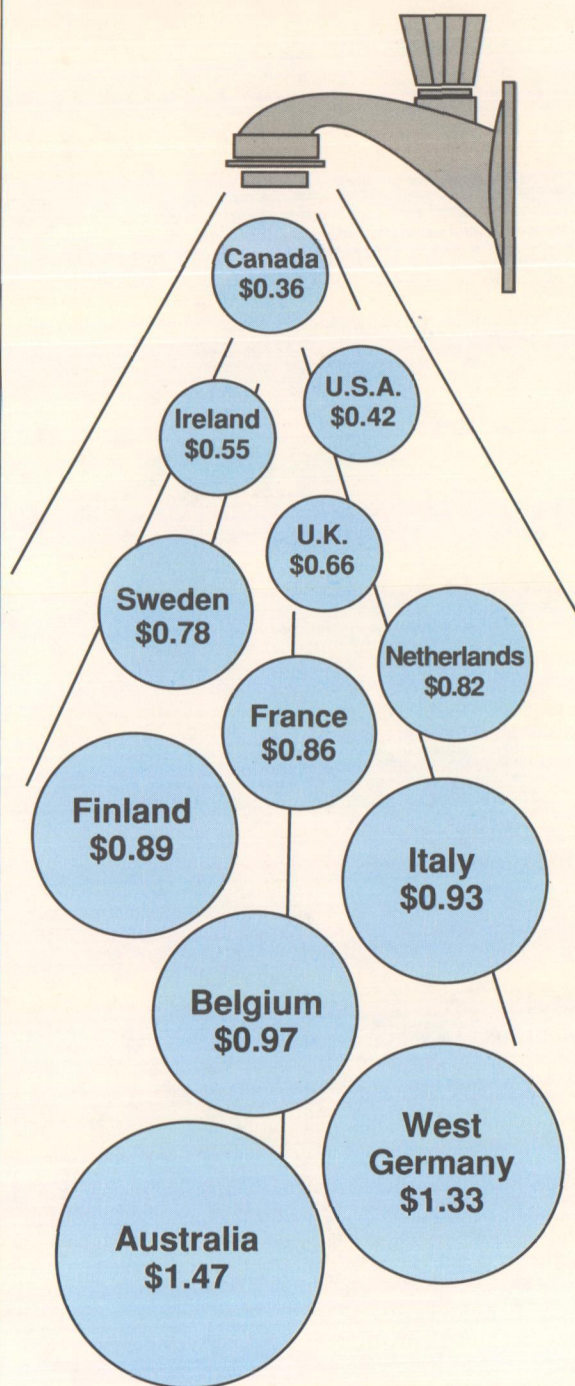
Consider for a moment the great contribution water makes to our quality of life – indeed to life itself. Most of us rely on municipal water service, and our health depends on the quality of the water supplied. Most Canadians have been putting this service inadvertently at serious risk by not paying a sufficient price for its provision. As a result, the repair and upgrading of neglected and crumbling municipal water supply and sewerage systems may cost well above the \$8 to \$10 billion estimated in 1985.

There is one clear way to deal with this problem. We need to pay realistic rates for water services which are sufficient to cover their true cost. In other words, we should pay a fair price that will recover the full cost of water delivered to the tap, one that is based on the actual quality used. Those who use more water should pay more and those who use less should pay less. Experience has shown that one important result will be that users recognize the real value of this resource, and will use it more efficiently and wisely.

The price Canadians pay for water varies significantly across the country. However, studies have determined that on the average we pay 47 cents for 1000 litres (which includes the cost of waste treatment). Correcting the problem of the undervalued water resource would involve minimal change. For instance, doubling the low price of 47 cents for 1000 litres of drinking water would cover the estimated \$8 to \$10 billion in upgrading costs within five years. Moreover, the installation of water meters would reduce demand enough to postpone the demand for new water and sewage treatment facilities for years, with significant interest and operational savings for each year of postponement. In Alberta, for example, Edmonton meters all residential water users, while Calgary is only partially metered. Metered users in both cities use about the same amounts. However, the unmetered households in Calgary use about 50% more water.

Figure 3

Typical municipal water prices (\$/1000 litres*)



* All amounts are 1989 Canadian dollars. In most countries, these prices are increasing from year to year. These figures do not include the cost of waste treatment.

Even at twice the price, water would still be the best bargain going, compared with the cost of other liquids we consume – and which, unlike water, are not delivered at our taps year-round. Bottled water, for example, is in great demand at \$500 for 1000 litres, or 1000 times the price for the same volume of high-quality tap water! Typical prices of popular beverages are listed in Figure 5.

The average Canadian household uses over 500 000 litres of water per year. At least half of this amount is unnecessary and wasteful. Common causes of waste at home are leaking faucets, faulty plumbing, and over-use of water for watering the lawn and washing the car. Much of this waste would be reduced if we had to pay a fair price for water. As our usage becomes more efficient, we would not only produce less sewage, we could also afford better treatment for it. The result would be multiple savings and a better environment.

The same principle applies to industrial, agricultural, and commercial users. If major industries with their own water supplies were also charged for the amount they withdraw from their source of water, reuse would increase and a more efficient use of water would result. In fact, recycling has been called an automatic solution to the water quality problem. The cleaner the discharge required by regulations, the easier and more economical it is to reuse that same water instead of pumping in fresh supplies. Realistic pricing of water for large-volume agricultural uses such as irrigation would tend to lead to greater efficiency in its use, and therefore to conservation.

Water use in the future

As time goes on, more and more water users will compete for what remains of the same finite supply. This implies increases in water efficiency and conservation

Figure 4

Average daily household water use (per capita)

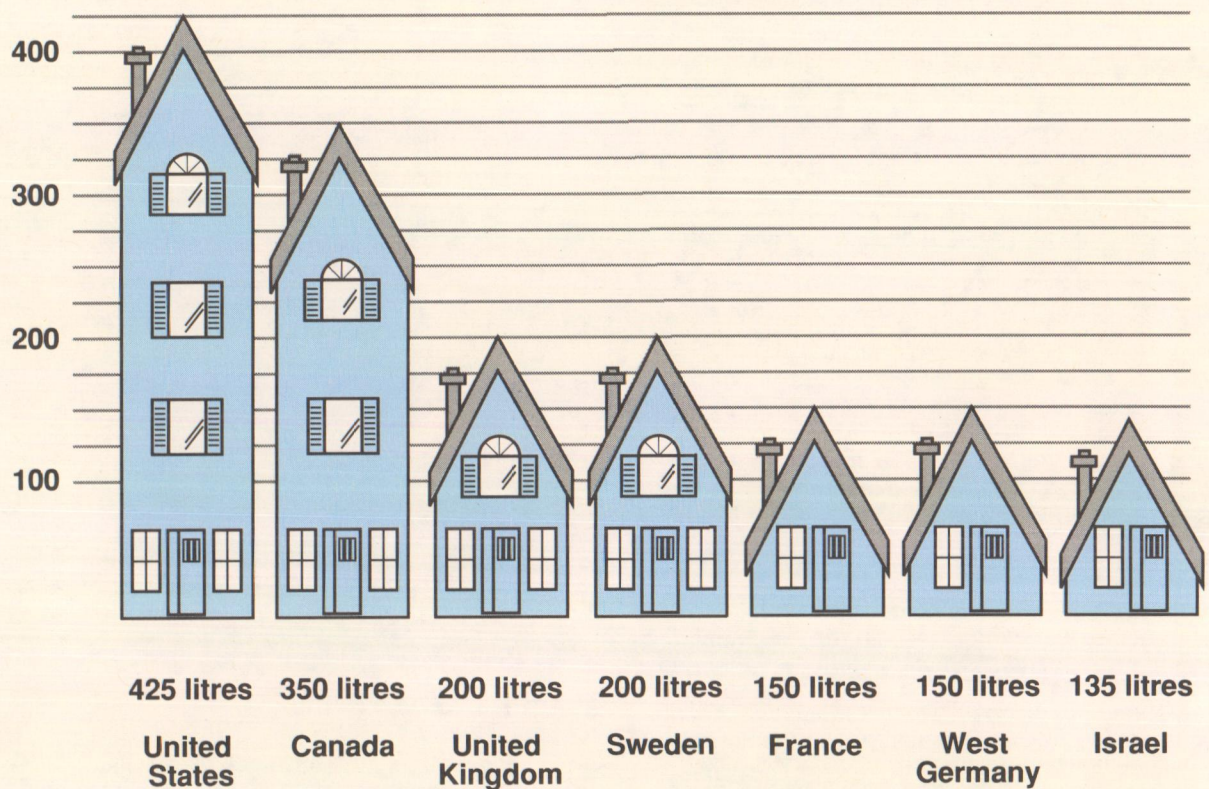


Figure 5

Typical prices for popular beverages

(\$/1000 litres)

Beverage	Cost*
Tap water †	0.47
Bottled water	500.00
Cola	790.00
Milk	950.00
Beer	3 000.00
Wine	8 000.00
Whiskey, gin...	24 300.00

* All amounts are in 1989 Canadian dollars.

† Only tap water includes automatic delivery to the user.
This figure includes the cost of waste treatment.



and doing even more to restore its quality after use. Nor is conservation restricted to only the uses of water: energy conservation, a desirable goal in itself, also contributes to water conservation. The reason is that reduced energy consumption lessens the need for electric power generation, which outranks all other water uses many times.

**We must learn to use only what we need,
and need what we use. In the words of
one conservation slogan:
"Let's keep it on tap for the future."**

Paying for the accumulated deterioration of water supply and sewerage systems, and making up for the years of indifference and neglect our water resources have suffered is very much a part of the challenge to conserve water for our own use and for that of future generations. But if we do not learn from our past mistakes now, we will add to an already large environmental mortgage.

Did you know?

- Canadians use an average of 350 litres of water each day for household and gardening purposes (somewhat less during the fall to spring seasons and much more during the summer months).
- A mere 5% of our home water supply is used for drinking and cooking.
- About 75% of indoor home water use occurs in our bathrooms. Toilets are the single greatest indoor water user.
- Indoor water use peaks twice a day year-round, in the mornings and evenings.
- The biggest peaks during the year occur in the summer, when about half to three quarters of all municipally treated water is sprayed onto lawns.
- As a community grows, the water use grows even faster because the diversity of water uses increases with size.
- 1000 litres = 1 cubic metre (m³)

Water use data

Environment Canada is developing a water use database which will include information on all major water users obtained from national surveys on:

Municipal water use: The first set of data is from a federal and provincial inventory of municipal water works and water treatment facilities published in 1975. It was updated by Environment Canada by the 1983, 1986 and 1989 surveys of municipalities with a population of over 1000.

Industrial water use: Four industrial water use surveys have been done (1972, 1976, 1981, 1986). They were undertaken with the cooperation of Statistics Canada and cover over 5000 industrial companies in four major water-using industries (manufacturing, mineral extraction, thermal power, and hydro power).

Periodic reports on these data may be obtained by writing to the address listed at the end of this fact sheet.

Diving beneath the surface

For more information about water, its nature, what it can do and how it is used and managed, please write or call for other fact sheets in this series:

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