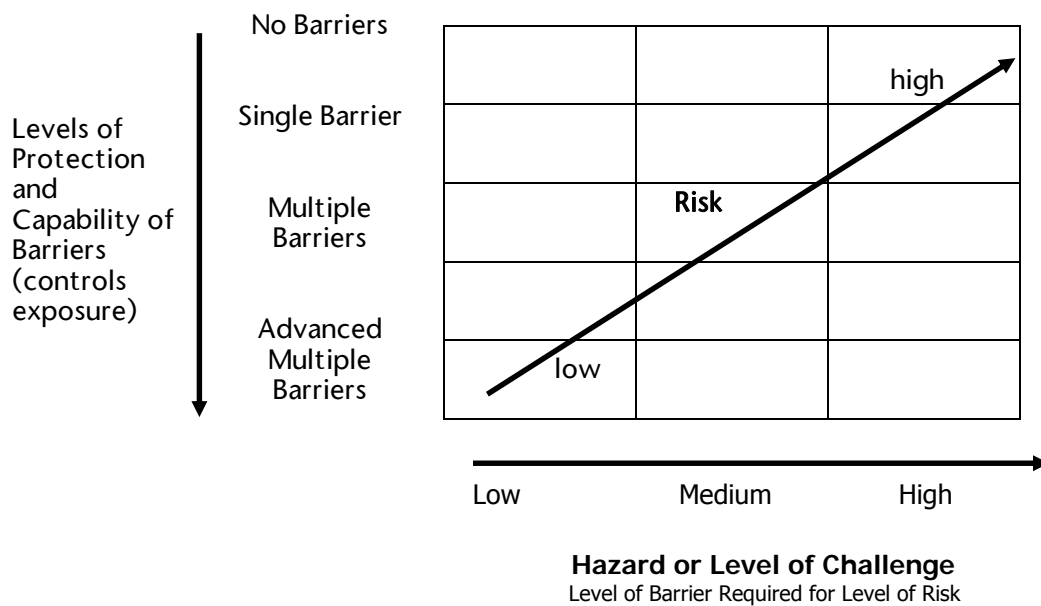
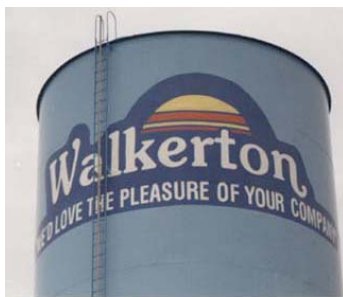


COST-BENEFIT ANALYSIS: TREAT THE ILLNESS OR TREAT THE WATER?

It isn't cheap to treat water so that it is safe to drink. But it also isn't cheap to treat everyone who becomes ill during a waterborne illness outbreak. This diagram shows the relationship between the risk of contamination and level of water protection. As the level of protection becomes more effective, the cost of water treatment generally rises, as well. Unfortunately, government agencies generally attempt to minimize costs while the health effects have not been properly assessed.



However, this approach results in some serious problems. In developing countries, waterborne disease epidemics are common. Many people like to think that developed countries are safe from contaminated water. But, in 1993, the United States Environmental Protection Agency estimated that about 403,000 people became ill, and more than 100 people died, when *Cryptosporidium* contaminated the water supply in Milwaukee, Wisconsin. And, in 2000, *E. coli* contaminated the water supply in Walkerton, Ontario, causing seven deaths, and over 2000 illnesses. In North Battleford, Saskatchewan, in 2001, *Cryptosporidium* contaminated the water and was responsible for between 5800 and 7100 illnesses.



The Walkerton water tower, inviting business to locate in the town

Walkerton, Ontario Water Tower;

<http://www.wsws.org/articles/2000/jun2000/walk-j10.shtml>

When a community experiences a waterborne illness outbreak, we hear about it. But there are a significant number of illnesses that we do not hear about. Health Canada only tracks a select few diseases that are commonly waterborne. Furthermore, the actual number of cases of waterborne illnesses is usually about ten times higher than the reported number.

The Centers for Disease Control and Prevention estimates that there are between four and 33 million cases of gastrointestinal illness associated with public drinking water systems in the United States each year. This number does not include the number of illnesses due to private water sources, recreational water sources, or illnesses other than diarrhea. When there are outbreaks of *E. coli*, *Cryptosporidium*, or other waterborne pathogens, the recovery and repair costs are substantial. This begs the question: is it better to treat the water to ensure that it is safe for human consumption, or is it alright to provide minimal water treatment and hope for the best?

Who is responsible for making sure our drinking water is safe?

The legislation and standards of drinking water vary from country to country. In Canada, the federal government sets guidelines for drinking water, and each provincial and territorial government is responsible for drinking water provisions within their province or territory. Due to funding, facilities and water that may be difficult to treat, each province and territory can decide which guidelines they will follow and which they will not.

The exception to provincial and territorial responsibility for water is in the case of national parks, military bases and First Nations communities, where the federal government is responsible for drinking water. For First Nations communities south of 60 degrees parallel, responsibility for drinking water is shared between the First Nations community and the federal government. Indian and Northern Affairs Canada (INAC) provides funding and Health Canada provides water quality monitoring assistance for the distribution system. The federal government needs to also monitor the raw water so that it can tell which water treatment plants work. In the territories (north of 60 degrees parallel), the territorial governments and INAC are responsible for safe drinking water provisions in both First Nations and non-First Nations communities.

How are water treatment facilities funded?

Water treatment and distribution systems are generally funded by local municipalities and cities, sometimes supplemented by meager amounts from the federal and provincial governments. According to the Federation of Canadian Municipalities, 92 cents of every tax dollar goes to the federal and provincial governments, which leaves cities with only 8 cents from each tax dollar to use to fund a number of services. And, it has been estimated that the public water infrastructure in Canada has a deficit of over \$50 billion.

First Nations communities receive funding from INAC and the local community. For example, according to INAC, in June 2007, a new water treatment plant opened in Mashteuiatsh, an Innu community in Quebec. For this project, INAC provided \$4.2 million and the community invested an additional \$1.2 million. But many First Nations communities have water facilities that are comparable to conditions in developing countries. Health Canada generally invests around \$5 million each year to protect and enhance drinking water quality on reserves. In the 2003 federal budget, the government committed themselves to investing \$600 million over five years to support the First Nations Water Management Strategy.

To put that into perspective, consider this: According to the city of Winnipeg, it will cost about \$214 million, plus \$12.75 million per year to design, engineer, construct, and maintain a UV disinfection system. The amount of money that the federal government allocates to protecting and enhancing drinking water on reserves is not nearly enough to repair the situation that many drinking water facilities are in.

Who is responsible for providing healthcare in Canada? How is healthcare funded?

Each province and territory is responsible for providing healthcare services in their province or territory. The Canadian healthcare system is funded by the federal and provincial governments.

Ultimately, healthcare is funded from personal and corporate income tax. Some provinces, such as Alberta, British Columbia, and Ontario, also charge supplemental health premiums. The federal government contributes a sum of money to the provinces for healthcare, investing over \$30 billion in some years.

Healthcare expenditures, however, total more than \$100 billion each year, which works out to more than \$3000 per capita. In 2003, of the countries that are members of the Organisation for Economic Cooperation and Development (OECD), the United States spent the most on healthcare (at \$5635 per capita), followed by Norway (at \$3807 per capita), Switzerland (at \$3781 per capita) and Canada (at \$3001 per capita). The lowest expenditures occurred in Mexico (at \$583 per capita) and Turkey (at \$513 per capita). Compare that with the healthcare expenditures in developing countries, which tend to be less than one-tenth the amount that most European countries, as well as Canada and the United States, pay per capita per year. For example, in 1994, Costa Rica spent the most on healthcare, out of any developing country, and that was only \$140 per capita per year!

By 2005, in Canada, average expenditures had risen to approximately \$4400 per capita. The lowest healthcare expenditures in Canada occur in Quebec, where the average is \$3900 per capita. The highest healthcare expenditures occur in the Yukon, the Northwest Territories, and Nunavut, where the averages range from \$6000 to \$10,700 per capita.

When the World Health Organization (WHO) conducted a cost benefit analysis of improving water and sanitation services at an international level, they estimated the healthcare cost associated with a diarrheal illness to be between \$10 and \$23, depending on the geographic region. Healthcare costs are higher in remote areas, which means that, in providing safe drinking water in isolated regions, healthcare costs can be reduced by a significant amount.

Using the low estimate of \$10 per diarrheal illness, the United States could avoid between four and 33 million dollars in healthcare costs for diarrheal illnesses each year if drinking water was effectively treated! Though there are fewer people in Canada, it is likely that Canada could also save millions of dollars in healthcare costs as well. And these cost savings only include healthcare costs associated with diarrheal illnesses; when productive days that are lost to illness are considered, the saved expenses could be many times higher.

What kinds of costs are associated with waterborne disease outbreaks?

There are many direct and indirect costs associated with waterborne illnesses. A great number of illnesses, and associated costs, can be avoided with effective water treatment. The WHO divides the benefits (or avoided or minimized costs) into the following three categories:

1. Direct economic benefits of avoiding waterborne illnesses. This simply refers to the amount of money that is saved from healthcare expenses.
2. Indirect economic benefits, which includes a decrease in work days lost to illness and a longer lifespan, because these benefits enable people to work more.

3. Non-health benefits include a decrease in time spent collecting water (especially for people who have long distances to walk to get water), an increase in property prices around water sources, and increased time spent in leisure activities.

The Safe Drinking Water Act, in the United States, categorizes water benefits into the following seven categories:

1. Avoided illnesses; which are then classified into decreased mortality (or less premature deaths) and decreased morbidity (or less people who experience a reduction in their physical or mental well-being from a disease).
2. Enhanced aesthetic qualities, where aesthetic qualities refer to the taste, odour and colour of the water. People often base their confidence in the safety of the water on aesthetic factors, so when the taste, odour and colour of the water improves, consumer satisfaction also improves.
3. Avoided cost of averting behaviour, where averting behaviour refers to the use of water treatments, such as filters and reverse osmosis units, on tap water. Effective treatment removes the need for water treatment in the home, and also reduces human exposure to the contaminants that may be in their water.
4. Avoided material damage, such as corrosion and breakage of pipes. Minimizing the damage of materials also reduces the amount of water lost due to leakage.
5. Avoided cost of market production, which means that when restaurants, food processors and manufacturing industries do not have to treat water before using it, they pass on these savings to the consumers.
6. Nonuse benefits, such as personal satisfaction from the knowledge that others have access to safe drinking water or that natural resources are being protected.
7. Information benefits, meaning that when people have access to public information about their water, they can make informed decisions and avoid threats to their health.

What kinds of costs are associated with effective water treatment facilities?

The costs of treating water vary, depending on the quality of the raw water, the type of treatment, and the quality of existing facilities. In 1998, the Canadian Water and Wastewater Association estimated that \$27.5 billion would have to be invested in water treatment and distribution systems over the following 15 years.

The study that was published by the WHO in 2004 uses the following five intervention levels to determine the costs and benefits of implementing safe drinking water and sanitation services:

1. Halve the proportion of people who do not have access to improved water sources by 2015.
2. Halve the proportion of people who do not have access to improved water sources and improved sanitation.
3. Provide access to improved water and improved sanitation for all.

4. In addition to improving water and sanitation for all, provide a minimum of water disinfection at the point of use.
5. Provide access to a regulated piped water supply and sewage connection into houses for all.

The following table shows the initial costs for several regions, by type of water and sanitation improvement.

Improvement	Initial Investment Cost Per Capita (US dollars)		
	Africa	Asia	Latin America and Caribbean
Water improvement			
House connection	102	92	144
Standpost	31	64	41
Borehole	23	17	55
Dug well	21	22	48
Rainwater	49	34	36
Disinfection at point of use	0.13	0.094	0.273
Sanitation improvement			
Sewer connection	120	154	160
Small bore sewer	52	60	112
Septic tank	115	104	160
Pour flush	91	50	60
VIP (Ventilated Improved Pit) latrine	57	50	52
Simple pit latrine	39	26	60

Initial Investment Cost Per Capita For Water and Sanitation Improvement;

http://www.who.int/water_sanitation_health/wsh0404.pdf

This next table shows the annual cost per capita, for operating and management expenses.

Intervention	Annual cost per person reached (US dollars)		
	Africa	Asia	Latin America and Caribbean
Improved water supply			
Standpost	2.40	4.96	3.17
Borehole	1.70	1.26	4.07
Dug well	1.55	1.63	3.55
Rain water	3.62	2.51	2.66
Disinfected	0.33	0.26	0.58
Regulated piped water in-house (hardware and software)	12.75	9.95	15.29
Regulated piped water in-house (software only)	8.34	5.97	9.06
Improved sanitation			
Septic tank	9.75	9.10	12.39
VIP (Ventilated Improved Pit) latrine	6.21	5.70	5.84
Small pit latrine	4.88	3.92	6.44
Household sewer connection plus partial treatment of sewage (hardware and software)	10.03	11.95	13.38
Household sewer connection plus partial treatment of sewage (software only)	4.84	5.28	6.46

Annual Cost Per Person For Improved Water and Sanitation;

http://www.who.int/water_sanitation_health/wsh0404.pdf

You can see that the costs of installing safe drinking water measures are relatively small, especially when compared with the long list of benefits of safe drinking water.

So which is more cost-effective: treating the illnesses as they occur or treating the water so that it is safe?

The most noticeable and measurable benefit of effectively treated water for drinking is the reduction of waterborne illnesses. The following chart shows the estimated number of diarrheal illnesses that could be avoided each year by the improvement of water and sanitation services.

Region/Country	Population (millions)	Cases of diarrhea (millions)	Number of cases avoided per year (thousands) by intervention (descriptions of levels on page 4-5)				
			1	2	3	4	5
Africa Region with very high adult and high child mortality	481	619	28,548	87,405	127,049	345,132	439,980
Region of the Americas with high adult and child mortality	93	93	3,250	9,307	13,208	48,679	64,106
European Region with high adult and child mortality	223	43	112	568	1,056	19,816	27,983
South East Asian Region with high adult and child mortality	1689	1491	26,895	146,829	272,361	807,596	1,043,922
Western Pacific Region with low adult and child mortality	1488	1193	39,454	131,171	239,104	659,687	844,381
World	7183	5388	154,854	545,950	903,004	2,860,951	3,717,971

Number of Cases of Diarrhea Avoided per Year, Based on Water and Sanitation Improvements;

http://www.who.int/water_sanitation_health/wsh0404.pdf

You can see that, if everyone in the world had access to the water and sanitation services that most of us in Canada enjoy, the number of cases of diarrhea would be reduced by about 75 percent! Through the decrease in diarrheal illnesses, total health costs in many areas of the world can also be significantly reduced. The following chart shows the estimated healthcare costs that would be saved due to the reduction in diarrhea caused by unsafe drinking water.

Region/Country	Population (millions)	Annual health sector treatment costs saved per capita (US dollars; millions) by intervention (descriptions of levels on page 4-5)				
		1	2	3	4	5
Africa Region with very high adult and high child mortality	481	288	883	1,284	3,487	4,445
Region of the Americas with high adult and child mortality	93	45	128	181	668	879
European Region with high adult and child mortality	223	2	12	22	419	591
South East Asian Region with high adult and child mortality	1689	262	1,431	2,654	7,869	10,172
Western Pacific Region with low adult and child mortality	1488	636	2,115	3,855	10,636	13,614
World	7183	2,020	6,975	11,624	38,337	50,022

Health Care Costs Saved per Year, Based on Water and Sanitation Improvements;
http://www.who.int/water_sanitation_health/wsh0404.pdf

Around the world, between two and five billion dollars could be saved in healthcare costs each year, just for diarrheal illnesses! This next chart illustrates the estimated number of productive days that could be gained due to the decrease in diarrheal illnesses. This estimate is based on an assumption that, for each case of adult diarrhea, two work days are lost.

Region/Country	Population (millions)	Productive days gained due to less diarrheal illness (million days), by intervention (descriptions of levels on page 4-5)				
		1	2	3	4	5
Africa Region with very high adult and high child mortality	481	75	229	333	905	1,153
Region of the Americas with high adult and child mortality	93	12	35	49	182	239
European Region with high adult and child mortality	1689	1	4	8	148	210
Western Pacific Region with low adult and child mortality	1488	516	1,714	3,125	8,622	11,036
World	7183	919	3,225	5,600	17,043	22,059

Productive Days Gained As Diarrheal Illnesses are Reduced, Based on Water and Sanitation Improvements;
http://www.who.int/water_sanitation_health/wsh0404.pdf

There is also a substantial gain in the number of school attendance days, as the number of diarrheal illnesses is reduced. Using an average of three days away from school for each case of diarrhea, between 78.7 million and 1.9 billion school days could be gained, depending on the level of intervention. Using the minimum wage as the basis, the value of the productive days

that could be gained as illnesses are reduced, is worth between \$210 million and \$5.5 billion, again depending on the level of intervention.

Many people, especially women, are required to walk for hours each day to fill buckets with water. When these services are improved, the WHO estimates that, around the world, between 29.5 billion and 992.6 billion hours can be saved each year. Again using the minimum wage, that translates to a monetary value between \$12 billion and \$405.5 billion each year! There seems to be a significant economic value to providing safe drinking water. This next chart provides a summary of all savings, illustrating the sum of all economic benefits for the various intervention levels.

Region/Country	Population (millions)	Total economic benefits of interventions (US dollars; millions), by intervention (descriptions of levels on page 4-5)				
		1	2	3	4	5
Africa Region with very high adult and high child mortality	481	3,084	13,475	25,153	34,631	58,993
Region of the Americas with high adult and child mortality	93	382	1,607	3,334	5,074	9,007
European Region with high adult and child mortality	223	46	242	934	1,551	5,337
South East Asian Region with high adult and child mortality	1689	2,201	11,457	57,155	72,478	101,643
Western Pacific Region with low adult and child mortality	1488	2,436	11,013	43,487	54,885	54,426
World	7183	18,142	84,400	262,879	344,106	555,901

Total Economic Benefits of Improved Water and Sanitation;

http://www.who.int/water_sanitation_health/wsh0404.pdf

So, the cost benefit analysis that the World Health Organization undertook tells us that, globally, between \$18.142 billion and \$555.901 billion could be saved if drinking water and sanitation services were improved. This total doesn't even take into consideration the human right to water, and the immeasurable cost of losing a friend or family member to a waterborne illness! Finally, this last chart shows the cost benefit ratio for each region and intervention. A cost benefit ratio less than one would indicate that the costs outweigh the benefits. A number greater than one indicates that the benefits outweigh the costs, and the greater the number, the greater the difference between economic benefits and costs. For example, in Africa, intervention level one would produce economic benefits that are 11.50 times higher than the costs of constructing drinking water and sanitation facilities.

Region/Country	Population (millions)	Cost-benefit ratio, by intervention (descriptions of levels on page 4-5)				
		1	2	3	4	5
Africa Region with very high adult and high child mortality	481	11.50	12.54	11.71	15.02	4.84
Region of the Americas with high adult and child mortality	93	10.01	10.21	10.59	13.77	3.88
European Region with high adult and child mortality	223	6.03	3.40	6.55	5.82	1.27
South East Asian Region with high adult and child mortality	1689	7.81	3.16	7.88	9.41	2.90
Western Pacific Region with low adult and child mortality	1488	5.24	3.36	6.63	7.89	1.93

Cost-Benefit Ratio of Water and Sanitation Improvements;
http://www.who.int/water_sanitation_health/wsh0404.pdf

What about here in Canada?

Let's turn from an international focus to a national focus. In May and June of 2000, the water supply in Walkerton, Ontario, became contaminated with the *E. coli* bacteria. In the end, there were seven deaths and more than 2000 people became ill. Households and businesses could not use their water for eight months, as every component of the water supply system, right up to the kitchen taps, had to be disinfected. The following table summarizes the calculated economic cost estimates of the water crisis.

Category	Cost Estimate (dollars)
Households (Walkerton)	6,876,452
Households (non-Walkerton)	40,497
Household property values	1,106,136
Walkerton business costs	1,460,139
Lost productivity	1,234,296
Drinking water	4,167,179
Hospital stays	437,872
Opportunity cost of time spent in hospital	50,824
Physician's visits	99,239
Long-term health costs	2,497,932
Epidemiology costs	212,160
Helicopter ambulance cost	159,546
Local public health unit	2,775,000
Assistance to BGOSHU	375,000
Chief Coroner	509,000
Walkerton health study	5,000,000
Water testing, laboratory, and auditing costs	645,000
OCWA costs of remediation and repair	9,222,215
Other Brockton costs	6,548,523
Walkerton Inquiry	9,000,000
Private legal expenses	1,000,000
Other agency costs	11,110,184
Total	64,527,194

Estimated Costs Associated with *E. coli* Outbreak in Walkerton, Ontario;
<http://www.uoguelph.ca/~live/WICP-14-Livernois1.pdf>

The average cost per household was reported to be \$3764. Within the household costs were costs for treatment, water pickup, food replacement and travel costs. The total costs for

healthcare were in the range of \$6.6 million. The cost to repair the water treatment plant was almost \$10 million.

After the Walkerton crisis, a study was done to find an alternative long-term water source. There were two options, one costing approximately two million dollars and the other costing about six million dollars. To account for leasing the present water filtration system while the new one is constructed, it is estimated that the two million dollar option would cost a minimum of three million dollars, and could well exceed ten million dollars. But, compare the ten million dollars for the water treatment system with the \$64.5 million that the Walkerton crisis ended up costing! And, that doesn't even take into consideration the value of lives lost and illnesses suffered. The author of the study, attempting to put a statistical value on a human life, estimated these costs at \$90.8 million, bringing the total cost of Walkerton to \$155 million!

In the *Cryptosporidium* outbreak in North Battleford, the costs were slightly lower, as no one died as a result. However, a group of 700 people who become ill received \$3.2 million for compensation. The estimated costs for legal fees and the public inquiry were approximately \$400,000. After the outbreak, the city committed itself to building a new sewage treatment plant for \$15 million. Even with minimal data, it is easy to see the costs that the city of North Battleford could have saved by ensuring that the water treatment facility could produce safe drinking water. For more information about waterborne disease outbreaks (in particular, those that occurred in Walkerton, Ontario; North Battleford, Saskatchewan; New Orleans, Louisiana and Milwaukee, Wisconsin), see the lesson plan in Operation Water Health called "[Cases of Contamination.](#)"

Though these outbreaks may be caused by different contaminants, in different areas of the world and in various levels of severity, they all have one thing in common: waterborne disease outbreaks are avoidable, and the benefits to providing safe drinking water always outweigh the costs of building the infrastructure to ensure effective water treatment.

The Safe Drinking Water Foundation has educational programs that can supplement the information found in this fact sheet. Operation Water Drop looks at the chemical contaminants that are found in water; it is designed for a science class. Operation Water Flow looks at how water is used, where it comes from and how much it costs; it has lessons that are designed for Social Studies, Math, Biology, Chemistry and Science classes. Operation Water Spirit presents a First Nations perspective of water and the surrounding issues; it is designed for Native Studies or Social Studies classes. Operation Water Health looks at common health issues surrounding drinking water in Canada and around the world and is designed for a Health, Science and Social Studies collaboration. Operation Water Pollution focuses on how water pollution occurs and how it is cleaned up and has been designed for a Science and Social Studies collaboration. To access more information on these and other educational activities, as well as additional fact sheets, visit the Safe Drinking Water Foundation website at www.safewater.org.

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