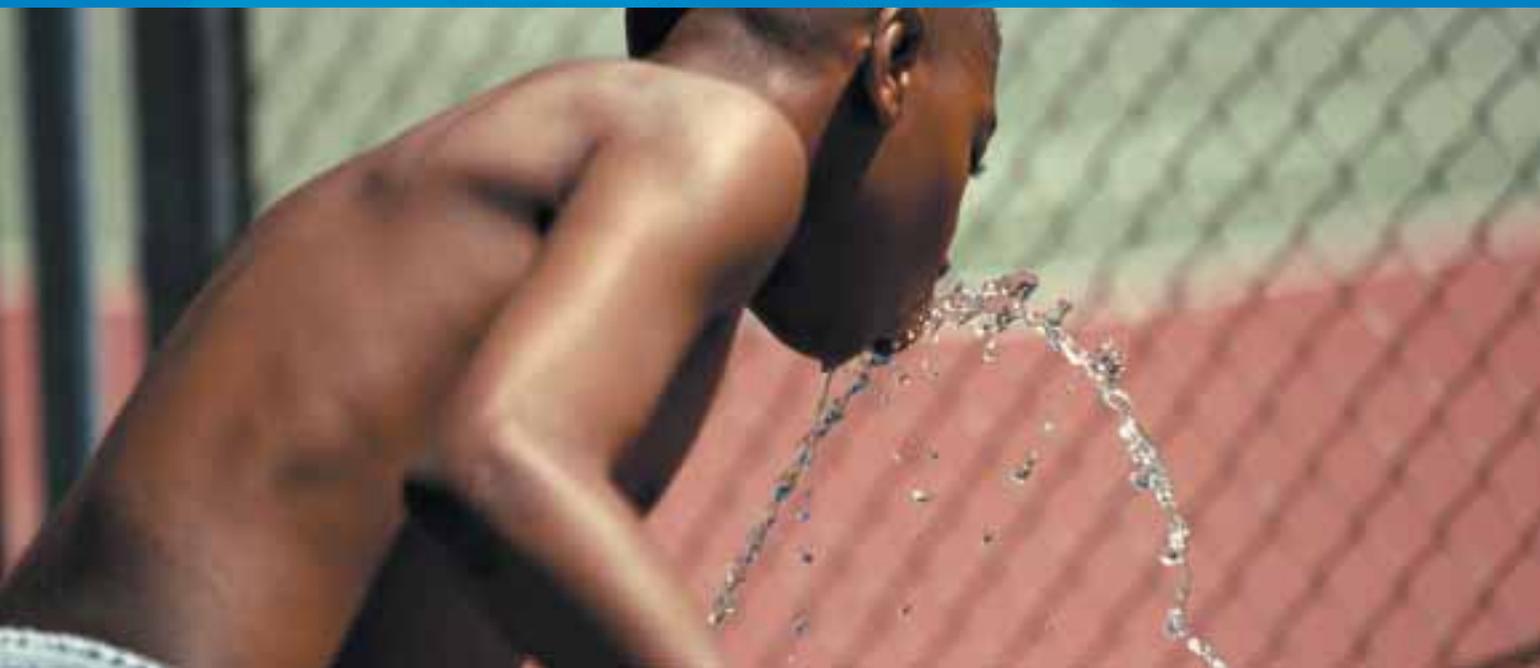


HEALTHY ENVIRONMENT

HEALTHY CANADIANS

the water we drink

AN INTERNATIONAL COMPARISON OF DRINKING
WATER QUALITY STANDARDS AND GUIDELINES



David
Suzuki
Foundation

SOLUTIONS ARE IN OUR NATURE

NOVEMBER 2006

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A REPORT PREPARED FOR THE DAVID SUZUKI FOUNDATION
HEALTHY ENVIRONMENT, HEALTHY CANADIANS SERIES

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SOLUTIONS ARE IN OUR NATURE

The Water We Drink: An International Comparison of Drinking Water Standards and Guidelines
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ISBN 1-897375-02-6

Canadian Cataloguing in Publication Data for this book
is available through the National Library of Canada

ACKNOWLEDGEMENTS

Many people provided valuable assistance in preparing this report. Among them are Dr. Ray Copes, Claire Garvey, Dr. David Suzuki, Rick Findlay and Matt Retallack. The author would also like to thank the David Suzuki Foundation staff, most particularly Ann Rowan, Lindsay Coulter, David Hocking, Dominic Ali, Jason Curran, and Jim Fulton.

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DESIGN AND PRODUCTION: Arifin Graham, Alaris Design

PHOTOGRAPHS: David Suzuki by Rich Frishman/Frish Photo; all others by Getty Images

CONTENTS

Foreword by Dr. David Suzuki | v

Introduction | 1

The Multiple Barrier Approach | 3

Jurisdictional Issues | 5

The Difference Between Standards and Guidelines | 7

International Comparison of Drinking Water Standards and Guidelines | 9

Microbiological Contaminants | 10

Health effects | 10

Regulatory comparison | 11

Chemical Contaminants | 13

Health effects | 13

Regulatory comparison | 14

Radiological Contaminants | 17

Health effects | 17

Regulatory comparison | 18

Comparative Analysis | 19

Other Concerns Regarding the Federal Role in Drinking Water Management | 21

Conclusion and Recommendations | 23

Glossary | 30

Notes | 32

The quality of water and the quality of life in all its infinite forms are critical parts of the overall, ongoing health of this planet of ours, not just here in the Amazon, but everywhere ... The hardest part of any big project is to begin. We have begun. We are underway. We have a passion. We want to make a difference.

– SIR PETER BLAKE (1948–2001),
LAST JOURNAL ENTRY BEFORE BEING MURDERED
BY PIRATES ON THE AMAZON RIVER



In Canada, hardly a day goes by without a news story about the debate over the future of health care. But while we fight to maintain and improve one of the world's best health-care systems, we have ignored new, important preventative actions that can save us from illness and death. We should pay attention to keeping healthy people healthy, instead of focusing on treating illness after it sets in.

Preventing pollutants and toxins from entering our air, water and food would have a profound effect on public health in Canada.

Health experts generally agree that microbiological pathogens – including bacteria, viruses, and protozoa – are the most important risk posed by drinking water. These pathogens can cause gastrointestinal disease outbreaks that result in acute health problems. Exposure to chemical and radiological contaminants in drinking water can also contribute to a range of adverse health effects including cancer, gastrointestinal illness, and reproductive problems.

Even very low-level contamination of food, drinking water and outdoor air with a wide array of pollutants of varying toxicities presents a chemical stress to which virtually every person is vulnerable.

In the third in a series of reports on environmental health in Canada, the David Suzuki Foundation looks at Canada's water quality guidelines and compares them with corresponding frameworks in the U.S., the European Union, and Australia, as well as guidelines recommended by the World Health Organization.

We possess the capacity to improve our health and our children's health; it's as simple as breathing clean air, drinking clean water and eating food that's free from harmful pollutants. To guarantee a clean natural environment and healthy citizens, we require adequate systems, laws, policies and commitments by government. Individuals can also play a role by taking the steps outlined in our Nature Challenge.

Our Foundation is committed to achieving sustainability within a generation in Canada. Living within the earth's limits is not easy, but it's essential. A healthy environment – including clean air, clean water, and healthy food – is a vital cornerstone of a sustainable, prosperous future.

A handwritten signature in black ink, appearing to read "David Suzuki". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

David Suzuki
CHAIR, DAVID SUZUKI FOUNDATION



Introduction

Drinking water is essential to life, yet it can be a source of exposure to pathogens and chemical, physical and radiological contaminants. For waterborne pathogens, including bacteria, viruses, and protozoa, drinking water is a major contributor to human exposures. Public health experts generally agree that microbiological pathogens are the most important risk posed by drinking water.¹ These pathogens can cause disease outbreaks that result in acute health problems for substantial proportions of an exposed population.

In contrast, health problems associated with chemical and radiological contaminants generally arise after prolonged periods of exposure. As well, for most chemical contaminants, exposure through food and air is generally more important than exposure through drinking water. However, arsenic and fluoride are two important examples of chemicals commonly present in drinking water that do pose a substantial risk to public health (although fluoride also provides benefits for dental health).²

The provision of safe drinking water to the majority of the world's population is one of the great public health achievements of recent centuries. For purposes of this report, safe drinking water means that the "level of risk is so small that a reasonable, well-informed individual need not be concerned about it, nor find any rational basis to change his/her behaviour to avoid a negligible but non-zero risk."³

In general, municipally treated drinking water in wealthy, industrialized nations including Canada, the U.S., Australia, and Western Europe is safe for consumption. In contrast, many people in developing countries face substantial health problems because they lack access to adequately treated water. It is estimated that nearly two million people die annually in poor countries because unsafe drinking water, poor hygiene, and inadequate sanitation facilities result in diarrhoeal diseases.⁴ Even in wealthy industrialized nations it would be a mistake to take drinking water for granted despite a plethora of laws, policies, programs,

and investments intended to protect public health from potential threats posed by drinking water. Affluent nations including Japan, Sweden, Canada, the U.S., the U.K., and Australia have experienced many outbreaks of waterborne disease in recent decades.⁵

In Canada, a number of high profile water contamination events have occurred in recent years:

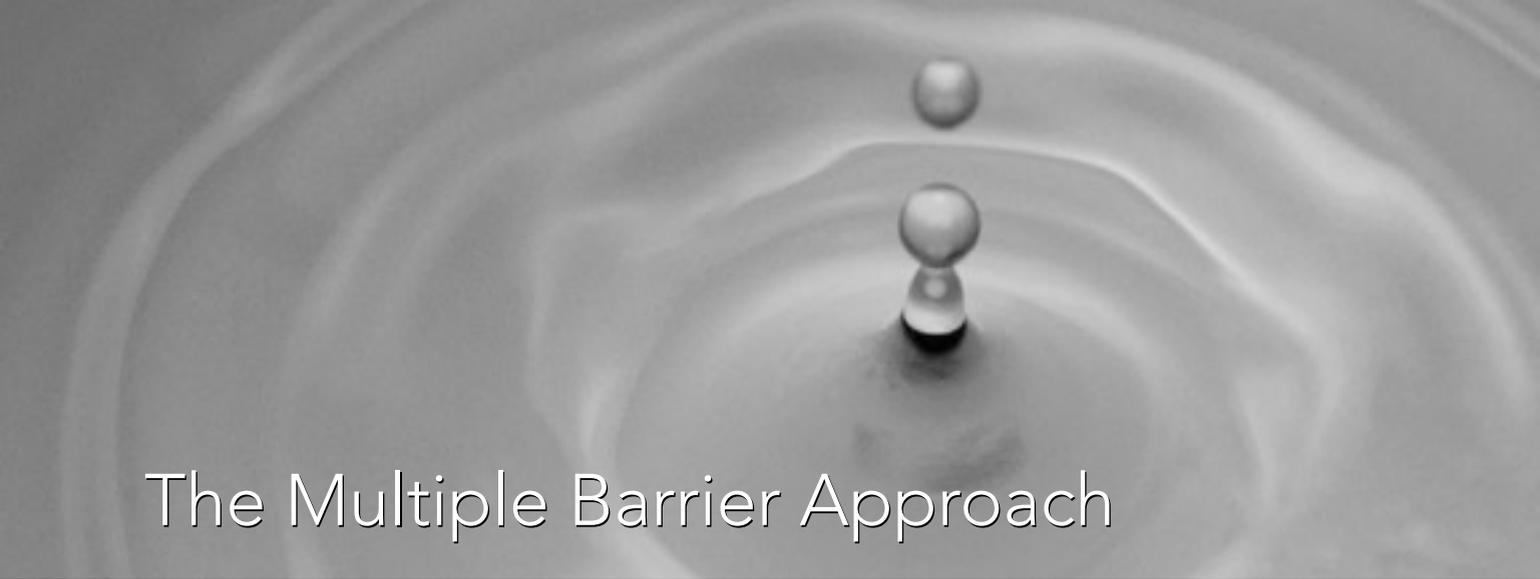
- Walkerton, Ontario, where seven people died, 65 people were hospitalized, and thousands more became ill;
- North Battleford, Saskatchewan, where thousands of people became ill; and,
- The Aboriginal community of Kashechewan in Ontario, where all residents were evacuated.

These high profile events represent the tip of the iceberg. According to a recent study, there were 288 outbreaks of waterborne disease in Canada between 1974 and 2001.⁶

The Canadian government estimates that contaminated drinking water causes an estimated 90 deaths and 90,000 cases of illness annually.⁷ These estimates represent a rough extrapolation from U.S. figures (900 deaths and 900,000 cases of illness) published by the U.S. Centers for Disease Control and Prevention.⁸ Estimates by independent health experts suggest a much higher number of Canadians suffer from gastrointestinal illnesses because of contaminated drinking water.⁹ Because of widespread under-reporting, the actual number of cases is probably 10 to 1,000 times higher than the number of confirmed cases.¹⁰

In the U.S., the worst waterborne disease outbreak in recent history occurred in Milwaukee, Wisconsin, in 1993. Caused by the protozoa *Cryptosporidium*, this public health crisis resulted in more than 50 deaths, 4,400 hospitalizations, and more than 400,000 cases of illness. Experts have estimated that contaminated drinking water in the U.S. may cause 1200 deaths, 560,000 cases of moderate to severe illness, and 7.1 million cases of mild to moderate illness annually.¹¹

The most widely publicized incident of drinking water contamination in Australia occurred in 1998 in Sydney. High numbers of *Cryptosporidium* and *Giardia* were reported for treated water, and boil-water notices were issued for three million residents.¹² A subsequent public inquiry determined that the boil water advisories were justified although surveillance failed to identify any significant increase in gastrointestinal illness related to the contaminated water.¹³



The Multiple Barrier Approach

As the Australian government points out: “All waterborne disease outbreaks are avoidable. Pathogens can only cause death and disease in humans if water source protection, pathogen removal by disinfection or filtration, or integrity of distribution systems fail.”¹⁴ Additional factors that increase the risk of waterborne disease include: newly recognized pathogens that are resistant to disinfection; human changes to aquatic ecosystems including eutrophication, modified food webs, introduction of nuisance and alien species, and creation of breeding sites for disease vectors; increased density of agricultural production in proximity to human habitation; and deteriorating water infrastructure in urban areas.¹⁵

There is no silver bullet for ensuring water quality. Experts generally agree that a multiple barrier approach – comprehensively addressing threats to water quality all the way from water sources to taps – is necessary. The key elements of a comprehensive approach include protection of water sources (to keep raw water as clean as possible), adequate treatment (including disinfection and additional processes to remove or inactivate contaminants), a well maintained distribution system, strong water quality standards, regular inspection, testing, monitoring, operator training and certification, public notice, reporting, and involvement, contingency planning, research, adequate funding, and rigorous enforcement.¹⁶ The components of Australia’s comprehensive approach to managing drinking water quality are outlined in Table 1.

TABLE 1
Australia's Framework for Management of Drinking Water Quality

- 1. COMMITMENT TO DRINKING WATER QUALITY MANAGEMENT**
 - 1.1 Drinking water quality policy
 - 1.2 Regulatory and formal requirements
 - 1.3 Engaging stakeholders
- 2. WATER SUPPLY SYSTEM ANALYSIS**
 - 2.1 Assessment of water quality data
 - 2.2 Hazard identification and risk assessment
- 3. PREVENTATIVE MEASURES FOR DRINKING WATER QUALITY MANAGEMENT**
 - 3.1 Preventive measures and multiple barriers
 - 3.2 Critical control points
- 4. OPERATIONAL PROCEDURES AND PROCESS CONTROL**
 - 4.1 Operational procedures
 - 4.2 Operational monitoring
 - 4.3 Corrective action
 - 4.4 Equipment capability and maintenance
 - 4.5 Materials and chemicals
- 5. VERIFICATION OF DRINKING WATER QUALITY**
 - 5.1 Drinking water quality monitoring
 - 5.2 Consumer satisfaction
 - 5.3 Short-term evaluation of results
 - 5.4 Corrective action
- 6. MANAGEMENT OF INCIDENTS AND EMERGENCIES**
 - 6.1 Communication
 - 6.2 Incident and emergency response protocols
- 7. EMPLOYEE AWARENESS AND TRAINING**
 - 7.1 Employee awareness and involvement
 - 7.2 Employee training
- 8. COMMUNITY INVOLVEMENT AND AWARENESS**
 - 8.1 Community consultation
 - 8.2 Communication
- 9. RESEARCH AND DEVELOPMENT**
 - 9.1 Investigative studies and research monitoring
 - 9.2 Validation of processes
 - 9.3 Design of equipment
- 10. DOCUMENTATION AND REPORTING**
 - 10.1 Management of documentation and records
 - 10.2 Reporting
- 11. EVALUATION AND AUDIT**
 - 11.1 Long-term evaluation of results
 - 11.2 Audit of drinking water quality management
- 12. REVIEW AND CONTINUAL IMPROVEMENT**
 - 12.1 Review by senior executives
 - 12.2 Drinking water quality management improvement plan

SOURCE: Australian National Health and Medical Research Council. 2004. Australian Drinking Water Guidelines.



Jurisdictional Issues

In Canada, it is generally recognized that all levels of government share responsibility for the provision of safe drinking water. Most aspects of drinking water management however, fall under provincial jurisdiction. In the U.S., Australia, and many European nations, lower levels of governments also bear extensive responsibility for ensuring the provision of safe drinking water. Extensive reports outlining recommendations for improving drinking water policies and practices at the provincial, territorial, and municipal levels of government in Canada have recently been published.¹⁷

While each of the elements of a multiple barrier approach is important, the focus of this report is on the performance of Canada's federal government in comparison to governments in the U.S., Australia, and Europe. The federal government plays a vital role in the establishment of the Guidelines for Canadian Drinking Water Quality that provide recommendations for treatment techniques and the maximum allowable concentration (MAC) of various contaminants in drinking water after treatment has taken place. Although a federal-provincial-territorial committee develops these guidelines, it is the federal government's responsibility to ensure that the health of Canadians is protected, as is done through standards for food, drugs, and bottled water under the *Food and Drugs Act*. The Guidelines for Canadian Drinking Water Quality were originally called standards, but the name was deliberately changed in the 1970s to make it clear that the guidelines do not have a legislative basis and are not legally enforceable as national standards.¹⁸

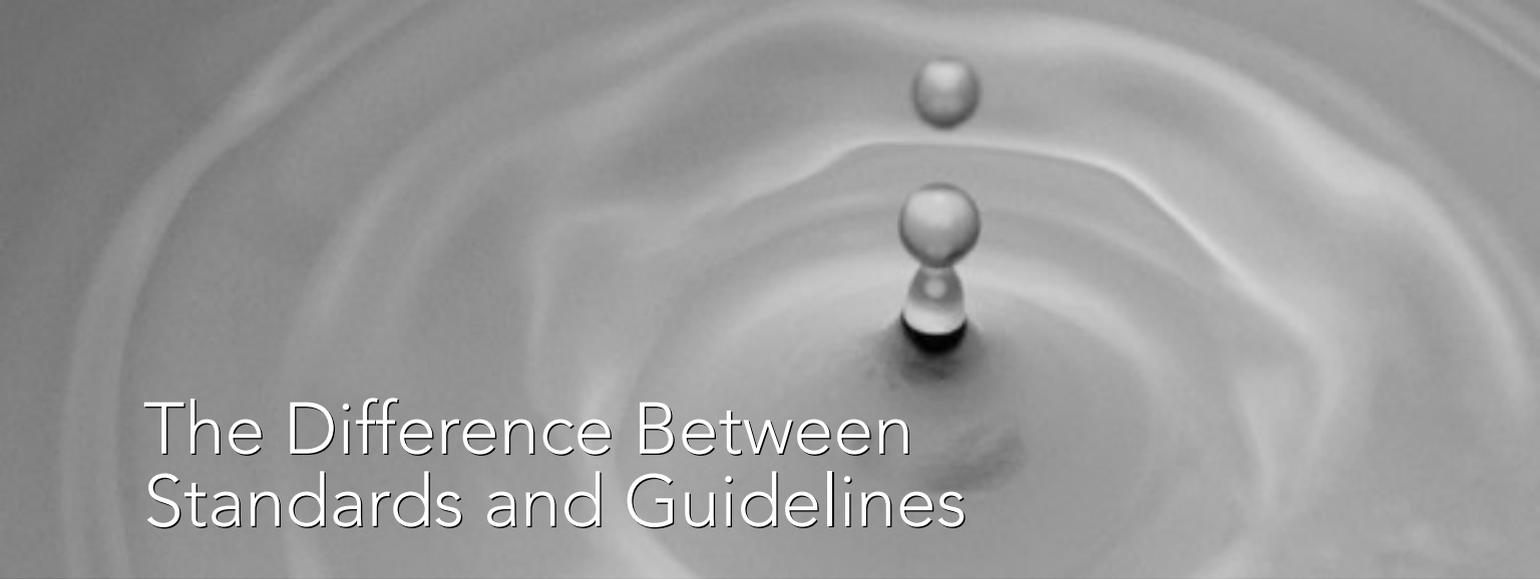
Because of the focus on the federal government, this report examines standards or guidelines that address various types of treatment techniques, and standards or guidelines that set the MAC of various contaminants in drinking water after treatment has taken place. It should be clear from the foregoing description of the multiple barrier approach that establishing standards for treatment techniques and MACs are important elements of comprehensive drinking water management but cannot alone ensure safe drinking water. In fact, these are not the only important standards and guidelines. Provincial laws, regulations,

and operator permits also prescribe legally binding requirements for operator certification and training, public reporting, and other aspects of drinking water management.

The federal government also has the responsibility to ensure safe drinking water is available on lands under federal jurisdiction (e.g. military bases, national parks, and Aboriginal reserves), on common carriers (e.g. planes, ships), and in federal facilities. The federal government is also responsible for ensuring the safety of materials and products that come into contact with drinking water, from distribution systems to home treatment devices. In 2005, the Commissioner for Environment and Sustainable Development pointed out a number of weaknesses in the federal government's efforts to fulfill these responsibilities, including:

- Extensive failures to provide safe drinking water to Aboriginal people on reserves;
- Uneven compliance with the Guidelines for Canadian Drinking Water Quality at federal facilities; and,
- A failure to inspect water on airplanes.¹⁹

The David Suzuki Foundation endorses the recommendations made by the Commissioner to remedy these problems in their entirety and adds several brief recommendations in this report.



The Difference Between Standards and Guidelines

From a legal perspective, standards generally are expected to provide a superior level of protection for human health compared to guidelines because standards are legally binding and enforceable. A failure to meet standards should result in a variety of different actions being taken to ensure compliance in the future. Guidelines, in contrast, represent voluntary targets that drinking water purveyors may strive toward but not achieve. Guidelines may not necessarily result in remedial action when violations occur. Because of this subtle but crucial distinction, the World Health Organization states that there should be legally binding national standards for drinking water quality in all countries.²⁰ As well, Justice Dennis O'Connor, in his extensive report on the causes of the Walkerton water disaster, concluded that drinking water quality standards “should have the force of law.”²¹ O'Connor added, “conservative and enforceable water quality standards are an important basis for a multi-barrier approach to water safety.”²² An extensive body of research has demonstrated that strictly voluntary approaches to environmental protection are generally ineffective.²³ However, standards can also be ineffective if they are poorly designed or not enforced.

The U.S. and Europe provide their citizens with national standards for drinking water quality, while Canada and Australia rely on weaker national guidelines that tend to be unevenly applied at the provincial or state level. Although there are differences in the approaches employed by European nations, all must meet the minimum standards prescribed by the E.U.'s Drinking Water Directive.²⁴

It should also be noted that the Guidelines for Canadian Drinking Water Quality are legally binding in some provinces by virtue of incorporation into provincial regulations. The Canadian guidelines are also legally binding in some municipalities because they have been incorporated into operating permits for water treatment facilities. These approaches mitigate some of the concerns about the relative weakness of relying on national guidelines

and provide additional flexibility and efficiency. However, these approaches raise concerns about consistency, transparency, and enforcement.

Finally, it should be noted that Canada's Commissioner of the Environment and Sustainable Development has been critical of the slow process for updating the Guidelines for Canadian Drinking Water Quality to reflect current science and protect the health of Canadians. In 2005, the Commissioner described the backlog of outdated guidelines for physical and chemical parameters as "unacceptable" and criticized reductions in the budget for updating the guidelines.²⁵



International Comparison of Drinking Water Standards and Guidelines

This study compares the Guidelines for Canadian Drinking Water Quality with corresponding frameworks in the U.S., the European Union (E.U.), and Australia. Guidelines for drinking water quality recommended by the World Health Organization (WHO) are also used in the comparative analysis. Both the U.S. and the E.U. provide mandatory, legally binding standards to ensure drinking water quality. Lower levels of government in the U.S. and Europe are bound to comply with the national, or in the E.U.'s case, supranational, standards. In contrast, it is imperative to understand that the Canadian drinking water guidelines are voluntary – not legally binding unless incorporated into provincial or territorial laws and regulations or operating permits for drinking water purveyors.

Although all provinces and territories have drinking water regulations, they appear to vary widely in terms of the level of legal protection they provide to water consumers.²⁶ For example, Canada has voluntary national drinking water guidelines for 83 contaminants (not including radiological contaminants). Binding regulations for these contaminants range by province and territory – from zero to 83.²⁷ Australia, like Canada, has established voluntary guidelines rather than standards. The World Health Organization does not have any law-making authority, so it establishes guidelines intended to assist nations in establishing consistent, adequate standards.

This study compares standards and guidelines for treatment methods and MACs for microbiological, physical, chemical, and radiological contaminants in drinking water. Microbiological, chemical (including disinfection byproducts), and radiological contaminants can cause a wide range of negative effects on human health. Most jurisdictions also establish drinking water guidelines for physical characteristics of water, including turbidity, colour, hardness, total dissolved solids, pH, temperature, taste, odour, and dissolved oxygen. Turbidity, discussed in more detail below, is important because it can have serious implications for public health and can serve as a surrogate for pathogens that are difficult

to monitor. Because they are not directly connected to public health, no comparison of the remaining physical water quality guidelines is undertaken in this study. These guidelines are primarily related to aesthetic considerations, although they can influence matters such as the corrosion of pipes (thus requiring corrosion control programs).

Microbiological Contaminants

A) HEALTH EFFECTS

As noted earlier, there is a general consensus among health, medical, and scientific experts that the greatest risks from consuming drinking water in industrialized nations are posed by waterborne pathogens.²⁸ Waterborne pathogens pose a greater threat than chemical contaminants because of the risk of immediate and severe health effects, the fact that infected persons can transmit the illness to others who may not have been exposed to the pathogen, and the fact that a single microorganism has the potential to cause harm, whereas exposure to many molecules of a chemical is needed to cause an adverse effect.²⁹

The three main categories of waterborne pathogens are bacteria, viruses, and protozoa. These waterborne pathogens are responsible for outbreaks of illness that can affect a high proportion of the population of a community, and can even cause death in some cases. The individuals at greatest risk of infection or most likely to suffer serious adverse health effects caused by waterborne illness are infants, young children, people with compromised immune systems, and the elderly. The adverse effects caused by waterborne pathogens range from mild gastroenteritis (upset stomach) to severe diarrhea and death. Waterborne diseases such as cholera and typhoid fever are extremely rare in industrialized nations.

Governments and agencies responsible for providing drinking water must cope with both current and emerging waterborne pathogens. Current bacterial waterborne pathogens have been linked to gastrointestinal illnesses in human populations. Bacteria (e.g. *E. coli* O157:H7, *Salmonella*, *Shigella*, and *Campylobacter jejuni*), enteric viruses (e.g. Hepatitis A), and protozoa (e.g. *Giardia*, *Cryptosporidium*, *Toxoplasmosis gondii*) have all caused waterborne disease outbreaks in Canada. Scientists have identified hundreds of emerging pathogens in recent years.³⁰ Emerging waterborne pathogens include, but are not limited to noroviruses, *Legionella*, *Mycobacterium avium complex*, *Aeromonas hydrophila*, and *Helicobacter pylori*.

Turbidity is not a direct threat to public health but rather an indirect threat. Turbidity in water is caused by the presence of fine suspended matter such as clay, silt, colloidal particles, plankton, and other microscopic organisms. Consumption of highly turbid waters may constitute a health risk if the suspended particles harbour microorganisms capable of causing disease in humans, or if the particles have adsorbed toxic organic or inorganic compounds. High turbidity can interfere with the detection of bacteria and viruses, by adsorbing them onto the particulate matter and thus shielding them. High turbidity may also protect microorganisms from the action of disinfectants. Conversely, low turbidity does not ensure that water is free from pathogens. A variety of management and treatment approaches can be used to reduce turbidity, including watershed management, storage, coagulation, and filtration.

A recent concern in drinking water management involves Cyanobacteria, a type of bacteria naturally found in bodies of fresh water. Cyanobacteria pose a risk to public health when found in excessive numbers, known as blooms, because they produce toxins that, when ingested through drinking water, can damage the liver, kidneys, nervous system, and gastro-intestinal system. Exposure to water contaminated by Cyanobacteria can also cause eye irritation and a skin rash when showering or bathing. Blooms result due to factors including high temperatures, direct sunshine, high levels of nutrients in water, and low flows. These risk factors are exacerbated by many of today's agricultural practices, urbanization, and climate change. As a result, Cyanobacteria are of increasing concern as a threat to drinking water.

B) REGULATORY COMPARISON

Effective drinking water treatment depends on a multitude of factors including:

- The treatment processes employed;
- The concentration of contaminants in the raw water;
- A variety of physical and chemical factors (temperature, turbidity, pH, etc.); and,
- The skill of the individuals operating the system.

The objective of treatment is to reduce concentrations of pathogens to levels too low to cause infection, while maintaining the aesthetic qualities of drinking water. The elements of water treatment most common in Canada and the U.S. include coagulation, flocculation, granular media filtration, and disinfection. The most common disinfectant is chlorine, although other disinfectants, such as ozone and ultraviolet radiation (UV), are increasingly popular. UV and ozonation are less widely used in Canada and the U.S. than in Europe, but are growing in popularity because of their superior effectiveness (relative to chlorine) in reducing the risk from protozoa and viruses.

In general, it is important to focus on outcomes rather than specific processes. For example, because of the small physical size of viruses, conventional water filtration has limited effectiveness. An advanced form of filtration (e.g. membrane filtration) or a different disinfection method such as UV or ozonation is also required in order to minimize the health risks posed by viruses and protozoa because many of these pathogens are resistant to chlorination. Similarly, *Cryptosporidium* is resistant to chlorination, and must be inactivated by UV or ozonation or removed by coagulation, flocculation, and filtration. It is also imperative to understand that treatment technologies are only effective when used by trained and experienced operators.³¹

It is widely believed that it is important to maintain a disinfection residual in the distribution system to prevent contamination from recurring, although this belief is not universal.³² Chlorine and chloramines can provide a disinfection residual; while a disadvantage of ozone and UV disinfection is that they do not.

For technical reasons, none of the nations studied have set MACs for most of the bacterial, viral, and protozoan waterborne pathogens. Although it may not be possible to establish MACs for protozoa and viruses, some jurisdictions have responded by establishing outcome-based standards for effective treatment. For example, standards enforced by the

CANADIAN GUIDELINES FOR TURBIDITY IN DRINKING WATER

- Turbidity levels from chemically assisted filtration shall be less than or equal to 0.3 NTU in at least 95 per cent of the measurements made, or at least 95 per cent of the time each calendar month, and shall not exceed one NTU at any time
- Turbidity levels from slow sand or diatomaceous earth filtration shall be less than or equal to one NTU in at least 95 per cent of the measurements made, or at least 95 per cent of the time each calendar month, and shall not exceed three NTU at any time
- Turbidity levels from membrane filtration shall be less than or equal to 0.1 NTU in at least 99 per cent of the measurements made, or at least 99 per cent of the time each calendar month, and shall not exceed 0.3 NTU at any time. If membrane filtration is the sole treatment technology employed, some form of virus inactivation should follow the filtration process.

U.S. Environmental Protection Agency require filtration (or an equally effective alternative form of treatment such as UV or ozonation) in all public water systems that rely on surface water or groundwater directly influenced by surface water. The filtration (or equally effective alternative) must remove or inactivate 99.9 per cent of *Giardia*, 99.99 per cent of viruses, and 99 per cent of *Cryptosporidium* (the latter due to a 1996 amendment to the *Safe Drinking Water Act*).³³

Although the Guidelines for Canadian Drinking Water Quality recognize that microbiological contaminants are the greatest threat to public health and recommend filtration, there are no outcome-based standards for effective treatment to address the problem. Only five provinces require the filtration of surface water – Nova Scotia, Quebec, Ontario, Saskatchewan, and Alberta. Some individual communities in provinces and territories without mandatory filtration provide filtration on a voluntary basis, but these communities are exceptions to the rule. Filtration is recommended, but not legally required, by the E.U. or Australia.

All nations in this study have set standards or guidelines for coliform bacteria and turbidity. All nations examined share the same MAC for *Escherichia coli* (*E. Coli*) and fecal coliform bacteria. In all of the nations compared in this study, the MAC for both *E. coli* and fecal coliforms in all drinking water systems is none detectable per 100 mL. The Canadian guideline for *total* coliforms is also zero if only one sample is taken monthly, but 10 per cent of multiple samples can contain total coliforms as long as there are fewer than 10 organisms per 100 mL. The U.S., Australia, and Europe have slightly more stringent limits for total coliforms than Canada, placing a maximum limit of five per cent of multiple samples testing positive for coliforms.³⁴

In the U.S., EPA standards state that turbidity may never exceed one nephelometric turbidity unit (NTU), and must not exceed 0.3 NTU in 95 per cent of daily samples in any month. The Australian and European guidelines also suggest that turbidity should never exceed one NTU. The Canadian guideline for turbidity was strengthened in 2004, but is conditional on the type of filtration. The general recommendation is that any water system that relies on surface water or groundwater under the direct influence of surface water should use filtration to reduce turbidity to the lowest levels possible, with a target of less than 0.1 NTU at all times. The accompanying sidebar details targets for water systems unable to meet the 0.1 NTU target.

The Canadian guidelines explicitly recognize that some drinking water purveyors will be unable to meet these targets and urge supplementary forms of treatment as an alternative means of providing safe water. However, these turbidity guidelines are inferior to the more direct approach of establishing outcome-based standards for bacteria, viruses, and protozoa.

For cyanobacterial toxins, Australia and Canada are alone in having established MAC guidelines. Australia's guideline for cyanobacterial toxins (0.0013 mg/L) is slightly more stringent than the Canadian guideline (0.0015 mg/L), but the difference appears to be negligible. The U.S. Environmental Protection Agency has placed cyanobacterial toxins on its contaminant candidate list, a step that often leads to a drinking water standard.

Overall, the U.S. has the most rigorous standards for protecting public health from microbiological contaminants because of outcome-based treatment standards that require a

high level of effectiveness in addressing bacteria, viruses, and protozoa. Canada has weaker guidelines, with no legal requirement for effective treatment.

Chemical Contaminants

A) HEALTH EFFECTS

Health effects associated with exposure to chemicals include not only cancer but also neurological disorders, damage to internal organs, gastrointestinal illness, reproductive problems, developmental disorders, and disruption of the endocrine or hormone systems. Some chemicals are naturally occurring but the majority are found in drinking water because of human activities ranging from agriculture to industry. The two main sources of chemical contamination of drinking water are industrial agriculture (pesticides and fertilizers), and the widespread use of hydrocarbons and solvents. The good news is that for many chemicals, drinking water provides a small proportion of overall exposure (meaning food and air are more important sources of exposure).

There are also health concerns related to disinfection byproducts. The most common disinfection byproducts – trihalomethanes and chlorinated acetic acids – are created by reactions between chlorine and organic materials found in water supplies. Other types of disinfectants produce different byproducts. For example, ozone disinfection can produce formaldehyde and other aldehydes.

Although disinfection byproducts such as trihalomethanes and formaldehyde are linked to various types of cancer, most experts agree that these cancer risks are smaller than the risks posed by pathogenic microorganisms in water that is not disinfected. In other words, despite the health risks posed by disinfection, the benefits outweigh the risks. Disinfection is a critical part of the comprehensive source-to-tap approach. However it is vital to note there are approaches to disinfection (e.g. ultraviolet disinfection and the limiting of organic materials in the source water) that reduce or eliminate the risk posed by disinfection byproducts. New standards and guidelines for treatment methods and disinfection byproducts should reflect the availability of these alternative approaches.

In theory, concentrations of a chemical at levels below the MAC do not pose a significant risk to health. Unfortunately, this theory does not always hold water. In fact, for some substances, such as carcinogens and endocrine disrupting chemicals, exposure to even tiny concentrations can produce adverse health effects. There is no threshold below which adverse effects are absent.

The pesticide atrazine, widely found in Canadian drinking water supplies, causes sexual deformities and reproductive problems in frogs at concentrations measured in just a few parts per billion – concentrations that have been found in drinking water.³⁵ Scientists do not yet know whether atrazine affects the health of humans exposed to the pesticide at similar concentrations. However, the E.U. now prohibits all uses of atrazine because of concerns about health and environmental effects, whereas atrazine continues to be one of the most heavily used pesticides in Canada. A recent report noted “hundreds of studies in the peer-reviewed literature show that adverse health effects from low dose exposures are occurring

in the population, caused by unavoidable contamination with PCBs, DDT, dioxin, mercury, lead, toxic air pollutants and other chemicals.”³⁶ The old saying that “the dose makes the poison” continues to be relevant, but must now be modified by recognition that other factors, including the timing of the exposure, the genetic vulnerability of some individuals, bioaccumulation, and interactive effects with other chemicals, also determine toxicity.

One of the challenges with respect to the thousands of potential chemical contaminants of drinking water is identifying priority substances for assessment and risk reduction. Unfortunately there are major gaps in our knowledge of human exposure to many of these substances and the potential effects on human health. In particular, there is a widespread lack of data for health endpoints other than cancer (e.g. neurotoxicity, reproductive impairments, developmental toxicity). In reference to pesticides, herbicides, petroleum products, and solvents, one leading expert concluded: “very little is known about the real health effects of pollution of drinking water from this group of compounds.”³⁷ These knowledge gaps make risk assessment difficult and reinforce the importance of a precautionary and preventive approach. These knowledge gaps also need to be addressed by research programs and bio-monitoring of the Canadian population.

B) REGULATORY COMPARISON

In this study, the chemical contaminants for which Canada has established a MAC were compared to other jurisdictions and World Health Organization recommendations. Of those 67 contaminants (see Table 2), Canada has established a weaker MAC than at least one of the other jurisdictions or the World Health Organization for 53 contaminants. In other words, more than three-quarters of the Guidelines for Canadian Drinking Water Quality relating to chemical contaminants appear to provide less protection for public health than the standards or guidelines in other industrialized nations. In some cases, the difference may seem relatively minor, as in the case of 1,2-dichloroethane, where Canada’s guideline of 0.005 mg/L is only slightly weaker than the European standard of 0.003 mg/L. Yet even in this case, it is important to recognize that 1,2-dichloroethane is recognized by the International Agency for Cancer Research as a possible human carcinogen, indicating that there is elevated risk at any level of exposure.

In other cases, however, there is a wide gap between Canada’s guideline for acceptable drinking water quality and the standard or guideline applied in another jurisdiction. European standards range from 50 to 1,000 times stronger than Canadian guidelines. The European Union does not establish specific guidelines for individual pesticides but uses a generic guideline of 0.0001 mg/L, well below almost all of the Canadian guidelines for acceptable concentrations of pesticides in drinking water. The E.U. also sets an overall limit of 0.0005 mg/L for the total amount of all pesticides that can be in drinking water. This approach recognizes that cumulative exposure to a number of different pesticides, each of which is below the individual level of concern, may cause negative health effects. Canada does not have any comparable limit, meaning that Canadians can be exposed to combinations of various pesticides in drinking water at levels that would be unlawful in Europe. In the past, Canada established a guideline for the maximum acceptable level of total pesticides in drinking water, but it was discontinued.³⁸

In theory, both Canada and the European Union endorse the precautionary principle, which means “where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.”³⁹ Most current Canadian environmental legislation incorporates the precautionary principle, and the Supreme Court of Canada has endorsed it.⁴⁰ There is evidence connecting pesticides in drinking water to adverse health effects, although this evidence is not conclusive. By applying the precautionary principle, we should strive to minimize human exposure to the pesticides that are believed to cause harm to health. As Justice O’Connor recommended in his report on the Walkerton disaster: “Standards setting should be based on a precautionary approach, particularly with respect to contaminants whose effects on human health are unknown.”⁴¹ In practice, when it comes to protecting human health from the adverse effects of pesticides in drinking water, the E.U.’s more conservative standards indicate that it is applying the precautionary principle with more vigour than Canada.

It is not only Europe that is ahead of Canada in establishing more conservative MACs for chemical contaminants. For example, for the pesticide 2,4-D Canada’s guideline is 1,000 times higher than Australia’s guideline. In other words, Canadians may be exposed to up to 1,000 times the concentration of 2,4-D in their drinking water without raising alarm bells with the relevant authorities. For glyphosate, the most heavily applied pesticide in Ontario, Australia’s guideline is 28 times as strict as the corresponding Canadian guideline.⁴²

Radiological contaminants

A) HEALTH EFFECTS

Radioactive contaminants in drinking water include naturally occurring substances such as uranium and radon, as well as a wide range of radionuclides produced by humans through activities including mining, the operation of nuclear reactors, and disposal of nuclear waste. The good news is that a very low proportion of human exposure to radiation, generally less than 10 per cent, comes from drinking water.⁴⁹ Exposure to radiation at low doses over long periods of time is linked to an increased risk of both cancer and genetic disorders. The acute health effects of radiation – skin burns, vomiting, reduced blood cell counts and death – occur at much higher exposures and are not relevant in the context of drinking water. Different forms of radiation are emitted by radioactive species (alpha particles, beta particles

TABLE 2
International Comparison of Drinking Water Quality Standards and Guidelines for Chemicals (Maximum Allowable Concentration). All standards and guidelines in mg/L.⁴³

CHEMICAL	WHO	E.U.	AUSTRALIA	U.S.	CANADA
2,4-D	0.03	0.0001	0.0001	0.07	0.1
Aldicarb	0.01	0.0001	0.001	-	0.009
Aldrin/Dieldrin	0.00003	0.00003	0.00001	-	0.0007
Antimony	0.02	0.005	0.003	0.006	0.006
Arsenic	0.01	0.01	0.007	0.01	0.01
Atrazine	0.002	0.0001	0.0001	0.003	0.005
Azinphos-methyl	-	0.0001	0.002	-	0.02
Barium	0.7	-	0.7	2	1
Bendiocarb	-	0.0001	-	-	0.04
Benzene	0.01	0.001	0.001	0.005	0.005
Benzo[a]pyrene	0.0007	0.00001	0.00001	0.0002	0.00001
Boron	0.5	1	4	-	5
Bromate	0.01	0.01	0.02	0.01	0.01
Bromoxynil	-	0.0001	0.03	-	0.005
Cadmium	0.003	0.005	0.002	0.005	0.005
Carbaryl	-	0.0001	0.005	-	0.09
Carbofuran	0.007	0.0001	0.005	0.04	0.09
Carbon tetrachloride	0.004	0.0001	0.003	0.005	0.005
Chloramines-total	-	-	3	4	3
Chlorpyrifos	0.03	0.0001	0.01	-	0.09
Chromium	0.05	0.05	0.05	0.1	0.05
Cyanazine	0.0006	0.0001	-	-	0.01
Cyanide	0.07	0.05	0.08	0.2	0.2
Cyanobacterial toxins	-	-	0.0013	-	0.0015
Diazinon	-	0.0001	0.001	-	0.02
Dicamba	-	0.0001	0.1	-	0.12
1,2-Dichlorobenzene	1	0.0001	1.5	0.6	0.2
1,4-Dichlorobenzene	0.3	0.0001	0.04	0.075	0.005
1,2-Dichloroethane	0.03	0.003	0.003	0.005	0.005
1,1-Dichloroethylene	0.03	-	0.03	0.007	0.014
Dichloromethane	0.02	-	0.004	0.005	0.05
2,4-Dichlorophenol	-	0.0001	0.2	-	0.9
Diclofop-methyl	-	0.0001	0.005	-	0.009
Dimethoate	0.006	0.0001	0.05	-	0.02
Dinoseb	-	0.0001	-	0.007	0.01
Diquat	-	0.0001	0.0005	0.02	0.07
Diuron	-	0.0001	0.03	-	0.15
Ethylbenzene	0.3	-	0.3	0.7	-

CHEMICAL	WHO	E.U.	AUSTRALIA	U.S.	CANADA
Fluoride	1.5	1.5	1.5	4.0	1.5
Glyphosate	-	0.0001	0.01	0.7	0.28
Lead	0.01	0.01	0.01	0.015	0.01
Malathion	-	0.0001	-	-	0.19
Mercury	0.001	0.001	0.001	0.002	0.001
Methoxychlor	0.02	0.0001	0.0002	0.04	0.9
Metolachlor	0.01	0.0001	0.002	-	0.05
Metribuzin	-	0.0001	0.001	-	0.08
Monochlorobenzene	-	-	-	-	0.08
Nitrate	11	11	11	10	10
Nitrilotriacetic acid	0.2	-	0.2	-	0.4
Paraquat	-	0.0001	0.001	-	0.01
Parathion	-	0.0001	0.01	-	0.05
Pentachlorophenol	0.009	0.0001	-	0.001	0.06
Phorate	-	0.0001	-	-	0.002
Picloram	-	0.0001	0.3	0.5	0.19
Selenium	0.01	-	0.01	0.05	0.01
Simazine	0.002	0.0001	0.0005	0.004	0.01
Terbufos	-	0.0001	0.0005	-	0.001
Tetrachloroethylene	0.04	0.01	0.05	0.005	0.03
2,4,6-trichlorophenol	0.2	0.0001	-	-	0.005
2,3,4,6-tetrachlorophenol	-	0.0001	-	-	0.1
Toluene	0.7	-	0.8	1.0	-
Trichloroethylene	0.07	0.01	-	0.005	0.005
Trifluralin	0.02	0.0001	0.0001	-	0.045
Trihalomethanes	-	0.1	0.25	0.08	0.1
Uranium	0.015	-	0.02	0.03	0.02
Vinyl chloride	0.0003	0.0005	0.0003	0.002	0.002
Xylenes-total	0.5	-	0.6	10	-

NOTE: A dash (-) indicates that no standard or guideline has been established for a given parameter.

SOURCES: Guidelines for Canadian Drinking Water Quality (2006).⁴⁴

U.S. EPA National Primary Drinking Water Standards.⁴⁵

E.U. Council Directive on the quality of water intended for human consumption⁴⁶

Australian Drinking Water Guidelines, 2004.⁴⁷

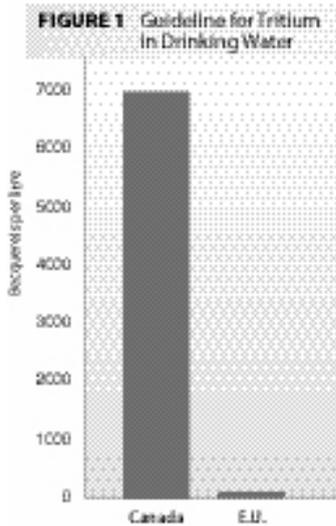
World Health Organization Drinking Water Quality Guidelines.⁴⁸

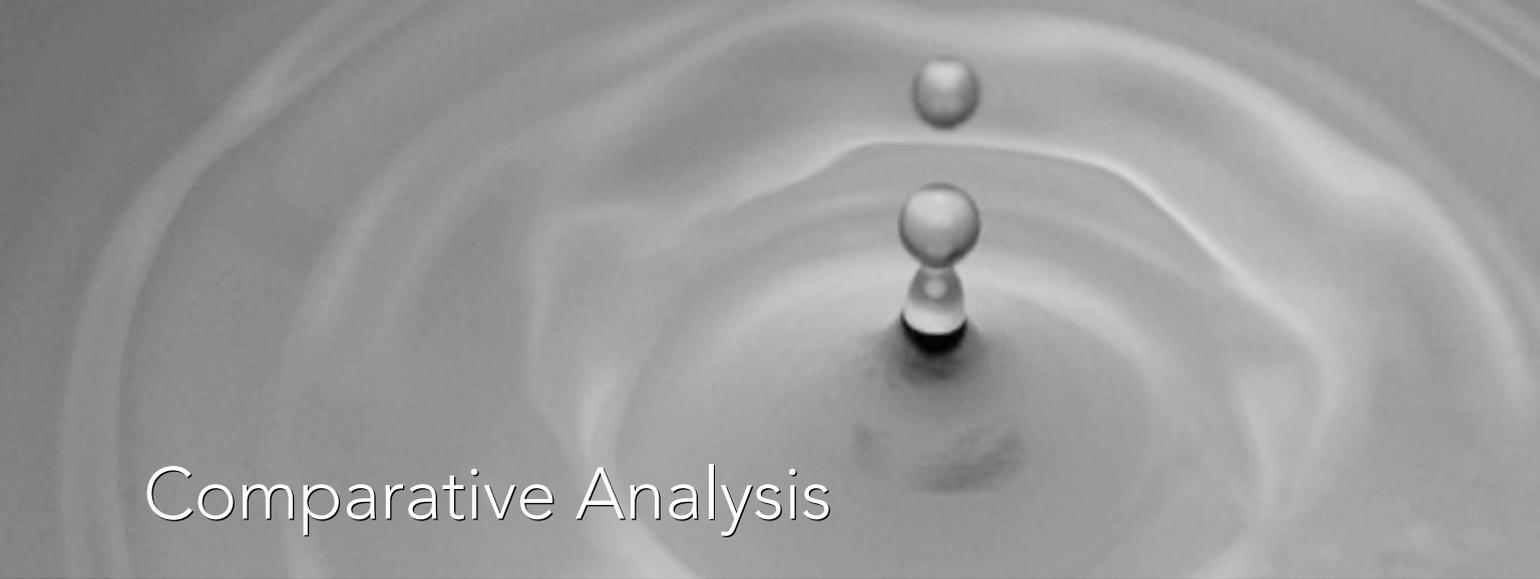
and positrons, gamma rays and x-rays). Drinking water contaminated with radionuclides causes internal radiation that can last for months or even years. The radiation dose resulting from ingestion depends on a number of biological and chemical factors. Health effects depend on the type of radiation and the tissues or organs that are exposed.

B) REGULATORY COMPARISON

Standards and guidelines for radiological contaminants are difficult to compare across nations, as each jurisdiction takes a different approach to measurement and standard setting. Canada and Europe both set 0.1 millisieverts per year (mSv/year) as the maximum level of acceptable exposure to radioactivity in water. Europe's value is a legally binding standard whereas Canada's guideline is voluntary. However, the European standard specifically excludes tritium, potassium-40, and radon and radon decay products, which are subject to separate individual standards. Canada also has gross alpha and gross beta guidelines (0.1 Becquerels per litre (Bq/L) and 1 Bq/L, respectively), plus a series of radioisotope specific guidelines that are to be applied if gross alpha or beta guidelines are exceeded. Australia sets the guideline for annual exposure to radioactivity in water at 1.0 mSv/year. The U.S. takes an entirely different approach, setting standards for alpha particles (15 picocuries per litre) and measuring beta particles and photon emitters (four millirems per year).

Although comparing rules for radiological contaminants is difficult, it is worth noting that the Canadian guideline for tritium in drinking water is 70 times higher (i.e. weaker) than the corresponding European standard. Tritium is a radioactive isotope that occurs naturally but is also produced in nuclear reactors. The Canadian guideline is 7000 Bq/L, whereas the European standard for tritium is 100 Bq/L. The Canadian guidelines for radiological contaminants, including tritium, are currently under review.





Comparative Analysis

In terms of requiring effective treatment for waterborne pathogens and setting MACs for chemical and radiological contaminants, this study indicates the Guidelines for Canadian Drinking Water Quality are weaker than the standards set by the U.S. and the E.U., the guidelines relied upon by Australia, and the recommendations provided by the World Health Organization. In this comparative analysis, there are 55 contaminants for which Canada has weaker guidelines for the protection of drinking water quality than at least one other jurisdiction or the World Health Organization recommendation. These contaminants include bacteria, pesticides, carcinogenic industrial chemicals, disinfection byproducts, naturally occurring toxic substances, and a radioactive substance released by nuclear reactors.

The difference between the Canadian MAC guidelines and the European standards is striking. Canada's MAC guidelines are weaker than the E.U. standards for 44 chemical drinking water contaminants and one radiological contaminant; stronger than the E.U. standards for only two contaminants; and the same as the E.U. standards for nine contaminants. There are 12 contaminants included in this study for which either Canada or the E.U. has not established a maximum allowable concentration.

The gap between Australia's MAC guidelines and the Canadian guidelines is also large. Canada's MAC guidelines are weaker than the Australian guidelines for 36 drinking water contaminants, stronger than the Australian guidelines for only 10 contaminants, and the same as the Australian guidelines for eight contaminants. There are 13 contaminants included in this study for which either Canada or Australia has not established a maximum allowable concentration.

Canada's MAC guidelines are weaker than the World Health Organization recommendations for 21 drinking water contaminants, stronger than WHO recommendations for 12 contaminants, and the same as WHO recommendations for seven contaminants. There are 27 contaminants included in this study for which either Canada or the WHO has not established a maximum allowable concentration.

CONTAMINANTS FOR WHICH CANADA HAS WEAKER DRINKING WATER GUIDELINES THAN AT LEAST ONE OTHER JURISDICTION OR WORLD HEALTH ORGANIZATION RECOMMENDATION

2,4-D	dimethoate
aldicarb	dinoseb
aldrin and dieldrin	diquat
antimony	diuron
arsenic	glyphosate
atrazine	malathion
azinphos-methyl	methoxychlor
barium	metolachlor
bendiocarb	metribuzin
benzene	nitrilotriacetic acid
boron	paraquat
bromoxynil	parathion
cadmium	pentachlorophenol
carbaryl	phorate
carbofuran	picloram
carbon tetrachloride	simazine
chlorpyrifos	terbufos
cyanazine	tetrachloroethylene
cyanide	total coliforms
cyanobacterial toxins	trifluralin
diazinon	trihalomethanes
dicamba	tritium
1,2-dichlorobenzene	2,4,6-trichlorophenol
1,4-dichlorobenzene	2,3,4,6-tetra-chloro-phenol
1,2-dichloroethane	uranium
1,1-dichloroethylene	vinyl chloride
dichloromethane	
2,4-dichlorophenol	
diclofop-methyl	

Only in comparison to the U.S. does Canada fare better, as Canada's MAC guidelines are more conservative than the American standards for 13 drinking water contaminants, weaker than the American standards for 12 contaminants, and the same as the American standards for 11 contaminants. There are 31 contaminants included in this study for which either Canada or the U.S. has not established a maximum allowable concentration.

In contrast to the 55 substances for which the Guidelines for Canadian Drinking Water Quality are weaker than the standards or guidelines applied in other industrialized nations or the recommendations of the World Health Organization, there are only three substances for which Canada has set the most conservative MAC. Again, however, even this modest piece of seemingly good news must be tempered by the fact that Canada has voluntary MAC guidelines, not legally enforceable national standards, for drinking water quality.

Finally, other jurisdictions have set guidelines or standards for contaminants that Canada has not yet addressed. For example, Australia, the U.S., and the World Health Organization all have a standard or a guideline for di(2-ethylhexyl) phthalate (DEHP), an industrial substance used to soften plastic. There is evidence suggesting that DEHP is carcinogenic and capable of disrupting the human hormone system, leading to a potentially broad array of adverse health effects.⁵⁰ Canada has no guideline for DEHP in drinking water. The WHO sets limits for some plastics, solvents, and water disinfection byproducts for which Canada has no guidelines.⁵¹ Asbestos, beryllium, and thallium have legal limits under the American *Safe Drinking Water Act*, but these substances are not included in the Guidelines for Canadian Drinking Water Quality.⁵² Australia has drinking water quality guidelines for dozens of pesticides that Canada has not addressed.⁵³

The goal is not to establish the most standards or guidelines. Of paramount importance is the identification of substances that pose the greatest risk to water consumers. Canada lacks critical knowledge that is required to inform priorities, particularly regarding chemical contaminants. Key knowledge gaps include exposure data, the health effects of long-term exposure at low concentrations, and possible gene-environment interactions.



Other Concerns Regarding the Federal Role in Drinking Water Management

In Canada, the most systemic failure to provide safe drinking water is occurring on Aboriginal reserves – areas that fall under federal jurisdiction. As many as 75 per cent of water systems on reserves face significant threats to the quality and safety of drinking water.⁵⁴ In part this problem is caused by a lack of enforceable standards for drinking water quality. Even in provinces with good drinking water laws and regulations, such as Ontario, provincial standards do not apply on reserves because of complex jurisdictional issues. In 2003, the federal government allocated \$600 million over five years for implementation of a First Nations Water Management Strategy. In 2005, an audit by the Commissioner for the Environment and Sustainable Development identified several key weaknesses in the federal government’s approach, including the lack of a regulatory regime to ensure the provision of safe drinking water on reserves. The Commissioner recommended the development of regulations that set forth roles and responsibilities, water quality requirements, technical requirements, operator training and certification, compliance and enforcement, and public reporting requirements. Such regulations have not yet been introduced.

A decade ago, the federal government introduced legislation intended to provide national standards to protect Canadians from the potentially harmful effects of materials that come into contact with drinking water – additives used in treatment systems, components of distribution systems, and household treatment products. Studies conducted for Health Canada concluded that:

- 70 per cent of drinking water treatment devices are not certified to the level Health Canada believes they should be;
- 70 per cent of components used in distribution systems do not meet proposed standards; and,
- More than 30 per cent of treatment additive products sold in Canada do not meet proposed standards.⁵⁵

The *Drinking Water Materials Safety Act* was introduced in 1996 but never passed.⁵⁶

Although it is beyond the parameters of the present study, it appears that regulations for bottled water in Canada also fare poorly in international comparisons. To provide just one example, the Canadian regulation for arsenic in bottled water allows 10 times more arsenic than the corresponding American standard.⁵⁷ Another related problem is that Canada allows lead in juices at a level 20 times higher than suggested under the Guidelines for Canadian Drinking Water Quality.⁵⁸ Since some children consume significant volumes of juice and are particularly vulnerable to long-term health effects caused by lead exposure, this regulatory anomaly demands urgent corrective action.



Conclusion and Recommendations

Although Canada is envied around the world for its natural wealth of fresh water, there is a gap between the quality of our water and the quality of our drinking water guidelines. Compared to other nations, Canada's lack of outcome-based standards for effective treatment is a weakness in protecting the health of Canadians. Canada has weaker MAC guidelines than at least one other nation or the World Health Organization recommendations for 55 of the contaminants examined in this study, including microbiological contaminants, chemical contaminants, radiological contaminants, and disinfection byproducts. In many cases, the Canadian guideline is 50, 100, or even 1,000 times weaker than the corresponding European standard or Australian guideline. As well, Canada's continued reliance on voluntary national guidelines puts us behind the U.S. and the E.U. and at odds with the recommendations of both the World Health Organization and the Walkerton Inquiry. As Justice Dennis O'Connor wrote in his compelling analysis of the Walkerton water disaster, matters as important as safe drinking water and public health "should have been covered by regulations which, unlike guidelines, are legally binding."⁵⁹ These results indicate that the federal government could improve its efforts to contribute to the provision of safe drinking water in Canada.

The David Suzuki Foundation believes that Canadians should enjoy a level of protection from environmental threats to their health that is equal to or better than the highest standard enjoyed by the citizens of other industrialized nations. Most Canadians would be upset to learn that the voluntary national drinking water guidelines in Canada are weaker than the drinking water quality standards and guidelines in other industrialized nations, including legally enforceable standards in the U.S. and Europe. By increasing the level of protection for drinking water, the federal government has the ability to prevent unnecessary deaths and illnesses, reduce health care expenses and productivity losses, and improve Canadians' quality of life.

In order to close the gap between the Guidelines for Canadian Drinking Water Quality and the standards and guidelines in the U.S., the E.U., and Australia, the David Suzuki Foundation offers the following recommendations.

Recommendation 1

THE CANADIAN GUIDELINES FOR DRINKING WATER QUALITY SHOULD BE REPLACED BY A SET OF HEALTH-BASED LONG-TERM OBJECTIVES FOR DRINKING WATER QUALITY, AND LEGALLY BINDING NATIONAL STANDARDS FOR DRINKING WATER QUALITY THAT ARE EQUAL TO OR BETTER THAN THE HIGHEST STANDARDS PROVIDED IN ANY OTHER INDUSTRIALIZED NATION.

This recommendation is intended to improve the protection of public health, increase the transparency of the process involved in setting the Guidelines for Canadian Drinking Water Quality, and enhance public confidence.

a) Health-based long-term objectives

The new Canadian Drinking Water Objectives and Standards should incorporate health-based long-term objectives for drinking water quality similar to the Maximum Contaminant Level Goals (MCLGs) established by the U.S. Environmental Protection Agency. MCLGs are non-enforceable public health goals that set the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on human health would occur, including an adequate margin of safety. These long-term objectives would provide a vision for the future and clarify the distinction between purely health-based objectives and standards that are based on economic costs and technological constraints.

b) National standards for effective water treatment

The new Canadian Drinking Water Objectives and Standards should establish outcome-based treatment standards to ensure effective protection from microbiological organisms through advanced filtration, or an equally effective treatment process, such as UV, for all communities whose drinking water supply is provided by surface water sources or groundwater that is directly influenced by surface water. This step is needed to address the threat to public health posed by microbiological contaminants, particularly protozoa and viruses. The U.S. has already taken this important step. Canada should consider adopting the U.S. requirements for effective treatment, including: 99 per cent inactivation or removal of *Cryptosporidium*, 99.9 per cent removal of *Giardia*, and 99.99 per cent removal of viruses.

c) National standards for Maximum Allowable Concentrations (MACs) for microbiological, physical, chemical and radiological contaminants

The U.S. and the European Union both have legally binding standards for MACs in drinking water. Canadians should enjoy the same level of protection. One approach would be to create a federal safety net so that the national standards would only apply on federal lands and in provinces and territories that did not provide the same level of health protection as the national standards.

To ensure that this approach is effective and efficient, a flexibility mechanism should be created, enabling jurisdictions to avoid unnecessary testing and monitoring costs for contaminants that can reasonably be expected to be absent in drinking water. Such an approach would also take regional differences into account. This flexibility mechanism would apply to chemical and radiological contaminants, but not waterborne pathogens. The U.S. EPA, pursuant to the *Safe Drinking Water Act*, allows small communities to seek variances and exemptions from national MACs for chemical contaminants, but not microbial contaminants.

In upgrading current MAC guidelines, Canada should adopt the most stringent level established by the U.S., Australia, the European Union, or the World Health Organization (see Table 3).

TABLE 3
Recommendations for new Canadian MAC guidelines

POLLUTANT	RECOMMENDED CANADIAN STANDARD (mg/L)	CURRENT CANADIAN GUIDELINES (mg/L)
2,4-D	0.0001 (E.U., AUS.)	0.1
Aldicarb	0.0001 (E.U.)	0.009
Aldrin and dieldrin	0.00001 (AUS.)	0.0007
Antimony	0.003 (AUS.)	0.006
Arsenic	0.007 (AUS.)	0.01
Atrazine	0.0001 (E.U., AUS.)	0.005
Azinphos-methyl	0.0001 (E.U.)	0.02
Barium	0.7 (AUS., WHO)	1.0
Bendiocarb	0.0001 (E.U.)	0.04
Benzene	0.001 (E.U., AUS.)	0.005
Boron	0.5 (WHO)	5.0
Bromoxynil	0.0001 (E.U.)	0.005
Cadmium	0.002 (AUS.)	0.005
Carbaryl	0.0001 (E.U.)	0.09
Carbofuran	0.0001 (E.U.)	0.09
Carbon tetrachloride	0.0001 (E.U.)	0.005
Chlorpyrifos	0.0001 (E.U.)	0.09
Cyanazine	0.0001 (E.U.)	0.01
Cyanide	0.05 (E.U.)	0.2
Cyanobacterial toxins	0.0013 (AUS.)	0.0015
Diazinon	0.0001 (E.U.)	0.02
Dicamba	0.0001 (E.U.)	0.12
1,2-Dichlorobenzene	0.0001 (E.U.)	0.2
1,4-Dichlorobenzene	0.0001 (E.U.)	0.005
1,2-Dichloroethane	0.003 (AUS., E.U.)	0.005
1,1-Dichloroethylene	0.007 (U.S.)	0.014
Dichloromethane	0.004 (AUS.)	0.05
2,4-Dichlorophenol	0.0001 (E.U.)	0.9

TABLE 4 CONTINUED

POLLUTANT	RECOMMENDED CANADIAN STANDARD (mg/L)	CURRENT CANADIAN GUIDELINES (mg/L)
Diclofop-methyl	0.0001 (E.U.)	0.009
Dimethoate	0.0001 (E.U.)	0.02
Dinoseb	0.0001 (E.U.)	0.01
Diquat	0.0001 (E.U.)	0.07
Diuron	0.0001 (E.U.)	0.15
Glyphosate	0.0001 (E.U.)	0.28
Malathion	0.0001 (E.U.)	0.19
Methoxychlor	0.0001 (E.U.)	0.9
Metolachlor	0.0001 (E.U.)	0.05
Metribuzin	0.0001 (E.U.)	0.08
Nitrilotriacetic acid	0.2 (AUS.)	0.4
Paraquat	0.0001 (E.U.)	0.01
Parathion	0.0001 (E.U.)	0.05
Pentachlorophenol	0.0001 (E.U.)	0.06
Phorate	0.0001 (E.U.)	0.002
Picloram	0.0001 (E.U.)	0.19
Simazine	0.0001 (E.U.)	0.01
Terbufos	0.0001 (E.U.)	0.001
Tetrachloroethylene	0.005 (U.S.)	0.03
Trifluralin	0.0001 (E.U.)	0.045
Trihalomethanes	0.08 (U.S.)	0.1
2,4,6-trichlorophenol	0.0001 (E.U.)	0.005
2,3,4,6-tetrachlorophenol	0.0001 (E.U.)	0.1
Uranium	0.015 (WHO)	0.02
Vinyl chloride	0.0003 (AUS.)	0.002

Note: AUS., E.U., U.S., and WHO refer to the jurisdiction setting the highest standard for the protection of health and the environment for a specific contaminant.

Because guidelines for radiological contaminants use different measurement units, tritium was not included in the above table. However, the current Canadian guideline for tritium of 7000 Bequerels per litre should be replaced by the European standard for tritium of 100 Bequerels per litre.

Recommendation 2

TAKE URGENT STEPS TO ENSURE THE PROVISION OF CLEAN DRINKING WATER ON THE RESERVES OF ABORIGINAL AND INUIT PEOPLE.

It is well known that the worst drinking water quality in Canada is found on Aboriginal reserves. Investments in infrastructure, training, distribution systems, testing, and monitoring are urgently required. As the Commissioner for the Environment and Sustainable

Development pointed out in her 2005 audit, a regulatory regime is required to ensure that people living on reserves enjoy the same level of protection for drinking water quality as people living off reserves. The Commissioner recommended the development of regulations that set forth roles and responsibilities, water quality requirements, technical requirements, operator training and certification, compliance and enforcement, and public reporting requirements. The appointment of a respected special envoy for drinking water on reserves, comparable to Stephen Lewis's role as a special envoy for HIV/AIDS with the United Nations, could ensure that this issue gets the attention and resources that are urgently needed.

Recommendation 3

ESTABLISH LONG-TERM TARGETS AND TIMELINES FOR THE REDUCTION OF WATER POLLUTION.

A report published by the David Suzuki Foundation in 2004, *Sustainability Within A Generation: A New Vision for Canada*, proposed a long-term goal of reducing the release of toxic substances into the environment by 60 per cent from current levels by 2020.⁶⁰ This goal was based on a review of long-term objectives established by leading nations in the field of environmental sustainability as well as projections of technological improvements in the decades ahead. Environment Canada is in the process of developing a series of National Environmental Objectives, based on a similar evaluation of scientific evidence and international benchmarks. Canada should adopt ambitious and measurable long-term objectives for eliminating some water pollutants while reducing others. Interim targets and timelines are also necessary to ensure that progress is being made and governments are held accountable.

Recommendation 4

IMPLEMENT A NATIONAL TAX ON POLLUTERS

Canada should implement a national tax on polluters.⁶¹ Pollution taxes are widely endorsed by both economists and environmentalists as the most effective, efficient, and equitable way to implement the polluter pays principle. European nations have used pollution taxes with great success in reducing the release of toxic chemicals into air and water, reducing pesticide use, and reducing emissions of carbon dioxide, sulphur dioxide, and nitrogen oxides.⁶² For example, the Netherlands used pollution taxes to achieve a 72 to 99 per cent reduction in various water pollutants.⁶³ Data on water pollution gathered by Canada's National Pollutant Release Inventory could serve as the basis for such a policy, with the initial fees being relatively modest but projected to grow over time.

The revenue from a Canadian pollution tax could be used to finance a just transition strategy for workers who lose jobs due to the elimination of toxic substances. The Ontario Task Force on the Primary Prevention of Cancer recommended this kind of pollution tax and transition strategy in 1995.⁶⁴ Alternatively, revenues from taxes on water pollution could be targeted toward repairing and upgrading water infrastructure, rehabilitating damaged aquatic ecosystems, or financing improved protection for drinking water sources.

Recommendation 5

PROVIDE FUNDING FOR SOURCE WATER PROTECTION AND INCREASE FUNDING FOR INFRASTRUCTURE UPGRADES

Federal programs that provide funding for drinking water infrastructure (e.g. treatment and distribution systems) should allow funds to be used for protecting drinking water sources. Experiences in cities from Vancouver to New York to Melbourne indicate that protecting sources of drinking water is not only a key element of the multiple barrier approach but also a good investment.

There is a significant backlog of needed improvements to drinking water infrastructure across Canada, particularly with respect to aging distribution systems that both waste valuable water and pose a threat of contamination. Federal funding for sustainable infrastructure upgrades should be increased.

Recommendation 6

THE *DRINKING WATER MATERIALS SAFETY ACT* – PROMISED IN THE 1990S – SHOULD BE REINTRODUCED AND ENACTED.

This legislation was intended to reduce the risks caused by inadequate or inappropriate materials in drinking water treatment, distribution, and residential systems. Studies commissioned by Health Canada found that 70 per cent of drinking water treatment devices are not certified to the level Health Canada believes they should be; 70 per cent of products used in distribution systems do not meet proposed standards; and over 30 per cent of treatment additive products sold in Canada do not meet proposed standards.⁶⁵

Recommendation 7

PURSUE REAL-TIME CONTINUOUS MONITORING

Federal funding should be provided to develop cost-effective, real-time continuous monitoring of water treatment processes to provide early warning of possible treatment failure. The Walkerton Inquiry recommended real-time continuous monitoring.⁶⁶ The U.S. EPA is already investing significant resources in this area, and Canadian research could be designed to be complementary.⁶⁷

Recommendation 8

KNOWLEDGE GAPS NEED TO BE ADDRESSED BY RESEARCH PROGRAMS AND BIO-MONITORING OF THE CANADIAN POPULATION

Canada should begin to conduct national bio-monitoring studies to regularly identify and track the exposure of Canadians to chemicals and other toxic substances by testing blood, urine, etc.⁶⁸ The U.S. Centres for Disease Control and Prevention conduct national bio-monitoring studies and publish the results bi-annually.⁶⁹

The federal government, in partnership with the provinces, should establish a national environmental health tracking system.⁷⁰ The system would monitor environmental hazards, environmental exposures, and health impacts (e.g. waterborne illnesses, pesticide poisonings, hospital admissions caused by cardiovascular and respiratory illness related to air quality, learning and behavioural disabilities, childhood cancers, reproductive health outcomes, etc). This information should be made publicly available to help inform and shape public health policies and actions. The United States recently began building a national environmental health tracking system, which could serve as a model.⁷¹

Environmental health indicators would ensure accountability by enabling the public to monitor progress, and would also play a role in public education. As a result, Canada should develop a robust set of indicators, building on work that has been done in the U.S., Europe, and Australia.⁷²

In addition, Canada should increase funding for research on health and environment issues through the Canadian Institutes of Health Research, the Social Sciences and Humanities Research Council, and the Natural Science and Engineering Research Council. Research should be focused on informing regulatory actions by: identifying pathways from hazards to exposures; understanding the effects of these exposures on health; identifying vulnerable sub-populations; and exploring the health effects of new substances, substances in combination, and gene-environment interactions.

Finally, Canada should significantly increase support for the National Collaborating Centre for Environmental Health (established in B.C. by the federal government in 2004).

Recommendation 9

RECOGNIZE THE RIGHT TO LIVE IN A HEALTHY ENVIRONMENT

Canada should recognize that all Canadians enjoy a basic human right to breathe clean air, drink clean water, and live in a healthy environment. The Supreme Court of Canada has endorsed recognition of the right to live in a healthy environment.⁷³ In recent years more than 70 nations, including more than 20 in Europe, have explicitly acknowledged, in their constitutions, that all citizens have the right to a healthy environment.

GLOSSARY

Cyanobacteria: type of bacteria that obtains its energy through photosynthesis. Cyanobacteria are one of the largest and most important groups of bacteria on earth.

Dissolved oxygen: measure of the amount of oxygen dissolved or carried in water. In terms of drinking water, a small amount of dissolved oxygen is desirable because it adds to the taste of water. However, high levels of dissolved oxygen can contribute to corrosion problems in pipes.

Disinfection byproducts: chemicals generated when the substances used for disinfecting drinking water interact with substances naturally occurring in the water supply. These secondary products may pose health risks.

Eutrophication: refers to the enrichment of an ecosystem with chemical nutrients, typically compounds containing nitrogen or phosphorus. In aquatic environments, enhanced growth of vegetation or algae blooms can disrupt normal ecological functioning causing a variety of problems for fish and other aquatic life. In terms of affecting human health, eutrophication can interfere with drinking water treatment.

Hardness: characteristic of water that refers to its mineral content. Hard water has a high mineral content.

MAC: acronym for maximum allowable concentration. MACs for chemicals are set by an authority responsible for regulating the quality of drinking water.

Multi-barrier approach: used by a water supply authority to comprehensively address threats to water quality from its source to the tap.

pH: characteristic of water that refers to its acidity.

Pathogen: biological agent that causes disease or illness to its host.

Protozoa: single-celled organisms that commonly show characteristics associated with animals (including the consumption of other organisms - as opposed to photosynthesis - for growth and development). *Giardia* and *Cryptosporidium* are two examples of protozoa that affect drinking water quality.

Radiological: refers to radioactive materials.

Total dissolved solids: characteristic of water that refers to the combined content of all substances present in water in a suspended form. TDS is used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of presence of a broad array of chemical contaminants.

Turbidity: characteristic of water referring to its cloudiness or haziness. Measurement of turbidity is a key test of water quality.

Water treatment: describes the processes used to make water more acceptable for the desired end use, in this case drinking water. The elements of water treatment most common in North America are:

- **Coagulation and flocculation:** water purification methods that work by using chemicals that effectively “glue” small suspended particles together, so that they settle out of the water, or stick to sand or other granules in a filter. Coagulation works

by eliminating the repulsive electrical charge of the suspended particles so they attract and stick to each other. Flocculation refers to the formation of aggregate or compound masses of particles.

- **Filtration:** after particles coagulate and form aggregates, water is filtered as the final step to remove remaining suspended particles. The most common type of filter is a “rapid sand filter.” Water moves vertically through sand, which often has a layer of activated carbon or anthracite coal above the sand. The top layer removes organic compounds including taste and odour. “Slow sand filtration” is the oldest method of filtration, but still widely used in municipal water treatment plants.
- **Disinfection:** normally the last step in purifying drinking water. Water is disinfected to destroy any pathogens that passed through the filters. Possible pathogens include viruses, bacteria and protozoans. In most developed countries public water supplies are required to maintain a residual disinfecting agent throughout the distribution system.

NOTES

- 1 S.E. Hrudey and E.J. Hrudey. 2004. *Safe Drinking Water: Lessons from Recent Outbreaks in Affluent Nations*. London, UK: IWA Publishing.
- 2 S.E. Hrudey and E.J. Hrudey. 2004, p. 395.
- 3 S.E. Hrudey and E.J. Hrudey. 2004., p. 4.
- 4 World Health Organization. 2002. *The World Health Report 2002: Reducing Risks, Promoting Healthy-Life*. Geneva: WHO.
- 5 S. E. Hrudey and E. J. Hrudey. 2004.
- 6 CG Schuster, AG Ellis, WJ Robertson et al. 2005. "Infectious Disease Outbreaks Related to Drinking Water in Canada 1974-2001" *Canadian Journal of Public Health* 96(4):254-58.
- 7 T. Edge, J.M. Byrne, R. Johnson, et al. 2001. "Waterborne Pathogens," in Environment Canada, ed. *Threats to Sources of Drinking Water and Aquatic Ecosystem Health in Canada*. Burlington, ON: National Water Research Institute.
- 8 J. Rose, R. Atlas, C. Gerba, et al. 1999. *Microbial Pollutants in Our Nation's Water: Environmental and Public Health Issues*. Washington, D.C.: National Water Research Institute.
- 9 P. Payment, J. Siemiatycki, L. Richardson, et al. 1997. "A prospective epidemiological study of gastrointestinal health effects due to the consumption of drinking water," *International Journal of Environmental Health Research*. 7: 5-31., P. Payment et al. 1991. "Epidemiology of endemic gastrointestinal and respiratory diseases: Incidence, fraction attributable to tap water and costs to society," *American Journal of Public Health*. 81: 703-708.
- 10 T. Edge, et al. 2001.
- 11 R.D. Morris and R. Levin. 1995. "Estimating the incidence of waterborne infectious disease relating to drinking water in the United States," in *Assessing and Managing Health Risks from Drinking Water Contamination: Approaches and Applications*. Proceedings of the Rome Symposium, September 1994. IAHS Publ. no. 233.
- 12 Australian National Health and Medical Research Council. 2004. Australian Drinking Water Guidelines. <http://www.nhmrc.gov.au/publications/synopses/eh19syn.htm>
- 13 P. McClellan. 1998. *Sydney Water Inquiry – Fifth Report*. Sydney: New South Wales Premier's Department.
- 14 Australian National Health and Medical Research Council. 2004. Australian Drinking Water Guidelines, p. 1-1. <http://www.nhmrc.gov.au/publications/synopses/eh19syn.htm>
- 15 S.E. Hrudey and E.J. Hrudey. 2004., p. 393-394.
- 16 Federal-Provincial-Territorial Committee on Drinking Water. 2004. *From Source to Tap: Guidance on the Multi-barrier Approach to Safe Drinking Water*. Winnipeg: Canadian Council of Ministers of the Environment. www.ccme.ca
- 17 D.R. O'Connor. 2002. *Report of the Walkerton Inquiry*. Toronto: Queen's Printer; D. Krewski, J. Balbus, D. Butler-Jones, et al. 2002. "Managing Health Risks from Drinking Water: A Report to the Walkerton Inquiry". *Journal of Toxicology and Environmental Health Part A*, 65: 1635-1823, R.D. Laing. 2002. *Report of the Commission of Inquiry into matters relating to the public safety of the drinking water of the City of North Battleford*, BC Provincial Health Officer. 2001. *Annual Report 2000 – Drinking Water Quality in B.C.: The Public Health Perspective*. Victoria: Ministry of Health.
- 18 D. Krewski, et al.. 2002, p. 1717.
- 19 Commissioner of the Environment and Sustainable Development. 2005. "Chapter 4 – Safety of Drinking Water: Federal Responsibilities" and "Chapter 5 – Drinking Water in First Nations Communities", in *2005 Annual Report of the Commissioner of the Environment and Sustainable Development to the House of Commons*.
- 20 World Health Organization. 2004. *Guidelines for Drinking-water Quality, 3rd ed.* Geneva: WHO, p. 31.
- 21 D.R. O'Connor. 2002.
- 22 *ibid.* Part 2, p. 149.
- 23 D.R. Boyd. 2003. *Unnatural Law: Rethinking Canadian Environmental Law and Policy*. Vancouver: UBC Press. pp. 243-245.

- 24 EU Council Directive 1998/93/EC of 3 November 1998 on the quality of water intended for human consumption.
- 25 Commissioner of the Environment and Sustainable Development. 2005. "Chapter 4 – Safety of Drinking Water: Federal Responsibilities".
- 26 R. Christensen. 2001. *Waterproof: Canada's Drinking Water Report Card*. Vancouver: Sierra Legal Defence Fund.
- 27 The number of national drinking water quality guidelines incorporated into provincial and territorial regulations is as follows: Newfoundland and Labrador – 28; Nova Scotia – 83; New Brunswick – under revision; Prince Edward Island – 50; Quebec – 77; Ontario – 73; Manitoba – at the medical health officer's discretion; Saskatchewan – 65; Alberta – 83; British Columbia – 3; Northwest Territories and Nunavut – 24; Yukon – discretionary. Source: K. Bakker, ed. 2006. *Eau Canada: The Future of Canada's Water*. Vancouver: UBC Press, Appendix 1.
- 28 T. Edge, et al. 2001, J.B. Rose, et al. 1999.
- 29 D. Krewski, et al. 2002, p. 1749.
- 30 World Health Organization. 2003. *Emerging Issues in Water and Infectious Disease*. Geneva: WHO.
- 31 S.E. Hrudey and E.J. Hrudey. 2004, Chapter 3.
- 32 J.A.M. Clement. 1999. "The disinfectant residual dilemma". *Journal of the American Waterworks Association*, C.N. Haas. 1999. "Benefits of using a disinfectant residual". *Journal of the American Waterworks Association*.
- 33 U.S. Surface Water Treatment Rule (1989) and Interim Enhanced Surface Water Treatment Rule (1998), 40 C.F.R. SS. 141.170-141.173.
- 34 In both the U.S. and Australia, 95% of samples must be zero for total coliforms (compared to 90% for Canada).
- 35 T.B. Hayes, et al. 2002. "Hermaphroditic, Demasculinized Frogs after Exposure to the Herbicide, Atrazine, at Low Ecologically Relevant Doses". *Proceedings of the National Academy of Sciences (U.S.)* 99: 5476-5480.
- 36 J. Houlihan, R. Wiles, K. Thayer, et al. 2003. *Body Burden: The Pollution in People*. Washington: Environmental Working Group. www.ewg.org
- 37 P.R. Hunter. 1997. *Waterborne Disease – Epidemiology and Ecology*. Chichester, UK: John Wiley and Sons, p. 268.
- 38 Federal-Provincial-Territorial Committee on Drinking Water. 2006. Guidelines for Canadian Drinking Water Quality: Summary Table. Ottawa: Health Canada. http://www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/guide/index_e.html
- 39 Bergen Ministerial Declaration on Sustainable Development. 1990. 1 Yearbook on International Environmental Law 429: 4312.
- 40 For example, see the *Species at Risk Act*, S.C. 2002, c. 29, the *Oceans Act*, S.C. 1996, c. 31, and the *Canadian Environmental Protection Act*, 1999, S.C. 1999, c. 33. *114957 Canada Ltee (Spraytech, Societe d'arrosage) v. Town of Hudson* (2001), 40 C.E.L.R. (N.S.) 1 (S.C.C.).
- 41 D.R. O'Connor. 2002, Part 2, p. 150, Recommendation 19.
- 42 Ontario Ministry of Agriculture and Food. 2004. Survey of Pesticide Use in Ontario, 2003.
- 43 Australian National Health and Medical Research Council. 2004. Australian Drinking Water Guidelines. <http://www.nhmrc.gov.au/publications/synopses/eh19syn.htm>
- 44 Federal-Provincial-Territorial Committee on Drinking Water. 2006. Guidelines for Canadian Drinking Water Quality: Summary Table. Ottawa: Health Canada. http://www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/guide/index_e.html
- 45 EU Council Directive 1998/93/EC of 3 November 1998 on the quality of water intended for human consumption.
- 46 U.S. EPA National Primary Drinking Water Standards. <http://www.epa.gov/safewater/mcl.html>
- 47 World Health Organization. 2004. Guidelines for Drinking-water Quality, 3rd ed. Geneva: WHO. http://www.who.int/water_sanitation_health/dwq/gdwq3/en/index.html
- 48 Federal-Provincial-Territorial Committee on Drinking Water. 2006.
- 49 U.S. Environmental Protection Agency. Primary Drinking Water Standards, enacted pursuant to the *Safe Drinking Water Act*. <http://www.epa.gov/safewater/mcl.html#mcls>

- 46 EU Council Directive 1998/93/EC of 3 November 1998 on the quality of water intended for human consumption.
- 47 Australian National Health and Medical Research Council. 2004.
- 48 World Health Organization. 2004. Guidelines for Drinking-water Quality, 3rd ed. Geneva: WHO. http://www.who.int/water_sanitation_health/dwq/gdwq3/en/index.html
- 49 *ibid.*
- 50 U.S. Agency for Toxic Substances and Disease Registry. 2002. Toxicological Profile for Di(2-ethylhexyl)phthalate (DEHP). www.atsdr.cdc.gov
- 51 World Health Organization. 2004.
- 52 U.S. Environmental Protection Agency. Primary Drinking Water Standards, enacted pursuant to the *Safe Drinking Water Act*. <http://www.epa.gov/safewater/mcl.html#mcls>
- 53 Australian National Health and Medical Research Council. 2004.
- 54 Commissioner of Environment and Sustainable Development. 2005. "Chapter 5 – Drinking Water in First Nations Communities," in Report to the House of Commons. Ottawa: CESD.
- 55 The reports published by NSF International are summarized on the Health Canada website. http://www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/mater/index_e.html
- 56 Pollution Probe. 2002. *The Drinking Water Primer*. www.pollutionprobe.org
- 57 Canada – Food and Drug Regulations, C.R.C. 870, as amended. United States – Food and Drug Administration. Beverages: Bottled Water. Final Rule. Federal Register, Vol. 70, no. 110, p. 33694. June 9, 2005.
- 58 *Food and Drug Regulations*, C.R.C. c. 870, Division 15: Adulteration of Food.
- 59 D.R. O'Connor. 2002.
- 60 D.R. Boyd. 2004. *Sustainability Within a Generation: A New Vision for Canada*. Vancouver: David Suzuki Foundation. www.davidsuzuki.org
- 61 A national pollution tax has been recommended repeatedly by the Green Budget Coalition, representing 21 environmental groups from across Canada. Green Budget Coalition. 2005. Recommendations for Budget 2005. www.greenbudget.ca/2005.html
- 62 For extensive examples of ecological tax shifting, see David R. Boyd. 2003. pp. 321-325.
- 63 Organization for Economic Cooperation and Development. 1998. *Eco-efficiency*. Paris: OECD.
- 64 Ontario Task Force on the Primary Prevention of Cancer. 1995. *Recommendations for the Primary Prevention of Cancer*. Toronto: Queen's Printer.
- 65 The reports published by NSF International are summarized on the Health Canada website. http://www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/mater/index_e.html
- 66 D.R. O'Connor. 2002, Part 2, p. 336.
- 67 U.S. Environmental Protection Agency. 2005. Water Distribution System Analysis: Field Studies, Modeling, and Management: A Reference Guide for Utilities.
- 68 Commission for Environmental Cooperation. 2006. Children's Health and the Environment in North America: A First Report on Available Indicators and Measures. Montreal: CEC.
- 69 U.S. Centers for Disease Control and Prevention. 2005. Third National Report on Human Exposure to Environmental Chemicals.
- 70 Commission for Environmental Cooperation. 2006, Government of Canada. 2005. *Children's Health and the Environment in North America: A First Report on Available Indicators and Measures. Country Report: Canada*. Gatineau, QC: Environment Canada.
- 71 See Pew Environmental Health Commission. 2000. America's Environmental Health Gap: Why the country needs a nation-wide health tracking network. <http://healthyamericans.org/reports/files/healthgap.pdf>. Centers for Disease Control. 2005. *CDC's Strategy for the National Environmental Public Health Tracking Program*. Atlanta, GA: CDC.
- 72 Centers for Disease Control. 2005, World Health Organization (Europe). 2004. *Environmental Health Indicators*. P. Gosselin and C.M. Furgal. 2002. "Challenges and directions for environmental public health indicators and surveillance," *Canadian Journal of Public Health* 93(5): S5.
- 73 Ontario v. Canadian Pacific [1995] 2 S.C.R. 1031 at 1076.

Drinking water is essential to life, yet it can also be a source of exposure to pathogens and chemical, physical, and radiological contaminants. Exposure to these pathogens and contaminants can contribute to a range of adverse health effects including cancer, neurological disorders, gastrointestinal illness, reproductive problems, and disruption of the endocrine system. In Canada, the federal government estimates that contaminated drinking water causes 90 deaths and 90,000 cases of illness annually.

The Water We Drink: An International Comparison of Drinking Water Quality Standards and Guidelines is the third in a series of reports on how contaminants in the environment affect human health in Canada.

In an effort to propose real, workable solutions, this report compares Canada's water quality guidelines with corresponding frameworks in the U.S., the European Union, and Australia, as well as guidelines recommended by the World Health Organization.

The David Suzuki Foundation is committed to achieving sustainability within a generation in Canada. A healthy environment – including clean air, clean water, and healthy food – is a vital cornerstone of a sustainable, prosperous future.



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