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Guidance for Providing Safe Drinking Water in Areas of Federal Jurisdiction

Version 2

Canada

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Prepared by the
Interdepartmental Working Group
on Drinking Water

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Other documents concerning Canadian drinking water quality can be found on the following website: www.healthcanada.gc.ca/waterquality

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Preface

The purpose of this document is to give clear, consistent guidance on how to implement the *Guidelines for Canadian Drinking Water Quality* (GCDWQ). This guidance is directed to federal civil servants or other responsible authorities whose jobs relate, either directly or indirectly, to ensuring the safety of drinking water on federal lands, in federal facilities and/or in First Nations communities. It is written for employees who make decisions at the policy and management levels, as well as for those who run drinking water systems on a day-to-day basis.

This guidance is applicable to all federal government departments, agencies and responsible authorities operating facilities in areas of federal jurisdiction that provide drinking water to consumers. Consumers in this context include:

- Federal government employees working in Canada, as well as Canadian Coast Guard, Canadian Forces personnel, and Canadian diplomatic mission staff working abroad;
- Inmates, staff, and visitors to federal correctional facilities;
- Visitors to federal lands and facilities; and
- Residents of First Nations communities.

All federal facilities should strive to meet the guidance set out in this document in order to protect the health of the people they serve. In some cases, a department or responsible authority may choose to meet more stringent objectives than those detailed in this document. This decision is left to the discretion of each department or authority. Departments may also choose to bring issues for discussion to the Interdepartmental Working Group on Drinking Water (IWGDW) to benefit from the expertise and experience of other members, as well as from any standard operating procedures developed by other departments. For issues or concerns specific to a given contaminant, the appropriate guideline technical document should be consulted.

It should be noted that the *Canada Labour Code* (CLC) and its occupational health and safety regulations cover federal government employees in their location of work, and this document provides additional information to help meet the requirements of the CLC. This document does not supersede the CLC and its regulations, or the unique medical and health protection responsibilities in place for some departments, such as Canadian Forces responsibilities established under the *National Defence Act*.

It is recognized that departments operating unique facilities,[1] such as those in remote locations or in locations beyond Canadian borders, may face challenges that prevent them from meeting all the guidance contained in this document in a timely manner. For example, very small systems[1] and micro-systems[1] face proportionally higher costs, and have less access to sophisticated technologies and adequately trained staff. While fully achieving the guidance in this document is a strong indicator of success, for very small systems and micro-systems, continuous incremental improvements over time should also be used as an indicator of success.

For all systems, a proactive, preventive approach is essential for providing safe drinking water. This approach means establishing priorities for managing risks and protecting public health based on site-specific considerations, using findings from the sanitary survey, the vulnerabilities assessment, and the baseline chemical analysis. An overall plan should be established to prioritize the order in which to address risks to best protect public health and to establish timelines for achieving these improvements. Following such a plan will ensure steady progress to achieving all of the health-based benchmarks in this document. It will also allow departments to maximize the use of limited resources and capacity to address the greatest risks to public health.

[1] Unique facilities, very small systems and micro-systems are defined in the glossary

Interdepartmental Working Group on Drinking Water (IWGDW)

The IWGDW was created in August 2002 to develop a federal drinking water program that would incorporate an intake-to-tap approach to drinking water quality in all areas of federal jurisdiction. In 2005, it published Version 1 of this document. The Mandate of the IWGDW is two-fold:

- To maintain this federal guidance document and update it as necessary, so it continues to provide up-to-date guidance on the general elements and activities that are necessary to safeguard drinking water quality in areas of federal jurisdiction; and
- To be the principal interdepartmental forum for discussing and providing input to issues related to drinking water quality and the GCDWQ.

The IWGDW consists of representatives of federal departments who have responsibilities for producing and/or providing clean, safe and reliable drinking water in areas of federal jurisdiction, as well as the Treasury Board of Canada Secretariat. *Current members are listed on Health Canada's water quality website at www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/multi-barrier/list-eng.php*

Interdepartmental Water Quality Training Board

The Interdepartmental Water Quality Training Board (Training Board) is a sub-group of the IWGDW. The Training Board is developing and disseminating a range of training tools for very small systems in the federal domain. Its focus is systems serving only up to 25 people, as virtually no tools are available to this vulnerable sub-set of drinking water systems.

The training materials from the Training Board are publically available through the Walkerton Clean Water Centre, at: www.waterqualitytraining.ca/docsAndInfo_e.php

Acknowledgements

Collaboration between departments is key to developing consistent approaches across the federal government and in First Nations communities. This document has been developed by the Interdepartmental Working Group on Drinking Water (IWGDW), which represents federal government departments that have certain responsibilities for providing clean, safe and reliable drinking water to consumers.

Health Canada provides the technical and scientific expertise to the IWGDW, through its role as technical secretariat. However, the development and update of this document is only possible thanks to the commitment and hard work of all of the following current or former members of the IWGDW:

- *Aboriginal Affairs and Northern Development Canada*:
  Pierre Lamontagne, Jim Steeves

- *Agriculture and Agri-Food Canada*:
  Rob May, Bill Schutzman

- *Canada Border Services Agency*:
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We would like to recognize the work and leadership of Pushkar E. Godbole from Correctional Service Canada. Pushkar had been the co-chair of the Interdepartmental Working Group on Drinking Water for 10 years at the time he passed away in 2013. His involvement and contributions to the working group and various projects, including this document, will continue to help ensure the safety of drinking water in areas of federal jurisdiction.

Introduction

In Canada, the responsibility for providing clean, safe and reliable drinking water to the public generally lies with the provincial and territorial governments. Health Canada plays a key role by leading the development of the *Guidelines for Canadian Drinking Water Quality* (GCDWQ) and by providing scientific and technical expertise to the provinces and territories through the Federal-Provincial-Territorial Committee on Drinking Water (CDW).

The federal government also has or shares responsibility for ensuring the safety of drinking water supplies on federal lands, in federal facilities, and in First Nations communities. While most supplies and facilities are located on Canadian soil, others such as military vessels and Canadian diplomatic missions may lie outside of Canada's physical borders. Specific requirements are established in federal acts and regulations. Some departments have responsibilities for drinking water right from the source through to the tap, whereas others are only responsible for the quality of drinking water after it enters a federal building or facility and until it reaches the consumer.

Departments demonstrate the safety and reliability of their supplies through their monitoring programs, developed through and complemented by periodic sanitary surveys, vulnerabilities assessments and baseline chemical analyses. Departments and other authorities responsible for treating their own water will have to develop more comprehensive quality management programs than those that receive treated water from a well-regulated outside agency (e.g., municipality). In locations where the quality of tap water is unreliable or consistently unsafe for consumption, a department or responsible authority may choose to provide additional localised treatment through the use of point-of-entry or point-of-use devices, or by providing an alternative to consumers, such as bottled water.

This document recognizes that federal government drinking water purveyors face a number of challenges in carrying out their duties, including:

- <u>The size and location of drinking water systems:</u> Most federal drinking water systems are very small, serving 500 or fewer people. In addition, many of these systems are located in remote areas, in countries where water supplies may be unreliable,[1] or on-board airplanes and ships, including Coast Guard and military vessels. In some of these locations, drinking water may need to be hauled by truck. In other cases, the only practical water supply may be bottled water.
- <u>Jurisdiction(s) responsible for water:</u> In most situations, the water source falls under the jurisdiction of a provincial government and/or the drinking water treatment plant is operated by a public or municipal utility. In some cases, the lines of responsibility may not be clear.
- <u>Cost of infrastructure:</u> Because the number of people served by the federal government in each location is often very small, the per capita cost of installing, operating and maintaining the necessary infrastructure is extremely high. This cost increases further with remote locations.
- <u>Cost of water quality monitoring:</u> The costs associated with water quality monitoring are based on the number of samples and the type and frequency of tests conducted, and not generally directly on the number of people served by a water system. Because of the number of federal systems and the relatively small number of people served by each one, the relative costs for water quality monitoring are high.

[1] A concern for Canadian diplomatic missions and Canadian Forces personnel.

- Funding: In order to ensure that federal drinking water systems are properly designed, constructed, operated and maintained, departments need to have adequate funds and program management controls in place. On-going funding is also required to cover employee training and infrastructure maintenance and upgrades. For the majority of departments for whom the provision of drinking water is not part of their mandate, funding may be considered as part of their department’s overhead and more difficult to obtain.

Purpose

The purpose of this document is to give clear, consistent guidance on how to implement the GCDWQ. Guidance is directed to federal civil servants and other responsible authorities whose jobs relate, either directly or indirectly, to ensuring the safety of drinking water on federal lands, in federal facilities and/or in First Nations communities. It is written for employees who make decisions at the policy and management levels, as well as for those who run drinking water systems on a day-to-day basis, such as treatment plant operators or drinking water monitors.

Detailed information is provided to assist federal departments and responsible authorities meet the GCDWQ and drinking water-related regulations. Meeting these requirements will ensure a more consistent approach to managing drinking water systems across areas of federal jurisdiction. For issues or concerns specific to a given contaminant, the appropriate guideline technical documents should be consulted. These are available at www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php#tech_doc

All affected departments and authorities are encouraged to strive to meet the guidance set out in this document in order to protect the health of the people who consume the water provided. In some cases, it may be preferable for a department to meet more stringent objectives than those detailed in this document. This decision is under the authority of each department or responsible authority.

It is recognized that departments operating unique facilities, such as those in remote locations or in locations beyond Canadian borders, may face challenges that prevent them from meeting all the guidance contained in this document. In such cases, these departments are encouraged to strive to meet the guidance to the best of their ability and to focus on a continuous improvement process.

Scope

This document relates to the management of drinking water supplies on federal lands and in federal government facilities. These supplies include those serving:

- Federal government employees working in Canada, as well as Canadian Coast Guard, Canadian Forces personnel, and federal government Canadian diplomatic mission staff working abroad;
- Inmates, staff, and visitors to federal correctional facilities;
- Visitors to federal lands and facilities; and
- Residents of First Nations communities.

The guidance in this document applies to facilities owned by or leased to the federal government. It outlines considerations regarding the design, operation and maintenance of treatment and distribution systems, and describes the requirements for conducting assessments and for setting up, running, and evaluating monitoring programs. Departments may have, or wish to develop, more detailed protocols for their staff which address their department's unique circumstances or requirements. This federal guidance document is meant to provide a framework to complement such efforts.

Given that the majority of federal water systems supply drinking water to 500 or fewer people, the guidance contained in this document relates primarily to very small drinking water systems and micro-systems. While this document recognizes the importance of managing drinking water from source to tap, source water issues are touched on only briefly. Wastewater issues are considered to be beyond the scope of this document. The focus is on drinking water quality from intake to tap.

Organization

Part 1: The Federal Framework

Chapter 1: Setting the stage provides details about the multi-barrier approach to safe drinking water and key jurisdictional issues related to drinking water in Canada. The multi-barrier approach is the overarching concept which ties together each of the individual commitments and tasks outlined in the subsequent chapters.

Chapter 2: Federal legislation and policies outlines the federal government's legislated and policy-based responsibilities as a purveyor of drinking water on federal lands and in First Nations communities, as well as in facilities owned or leased by the federal government.

Part 2: Application of the Federal Framework

Chapter 3: Developing a monitoring program outlines the steps involved in developing a monitoring program for microbiological and chemical contaminants, including choosing source water and conducting vulnerabilities assessments, sanitary surveys and baseline chemical analyses.

Chapter 4: Microbiological considerations and monitoring provides detailed guidance on microbiological indicators (*E. coli* and total coliforms) and related operational parameters (turbidity, chlorine residuals). It includes monitoring frequency, sampling locations and the interpretation of results.

Chapter 5: Treatment and distribution systems outlines various issues related to the treatment and distribution of drinking water, including system design and assessment, distribution of drinking water within buildings (i.e., plumbing systems), corrosion control, chlorine residual, drinking water materials and special circumstances (i.e., trucked water, alternative sources of drinking water).

Chapter 6: Operational requirements provides guidance on a range of issues, including operational planning, operator certification, monitoring requirements, record-keeping, incident and emergency response planning, and compliance verification and reporting.

Chapter 7: Information and resources provides readers with further resources.

Part 1. The Federal Framework

1.0 Setting the stage

1.1 The multi-barrier approach to safe drinking water

The drinking water system can be broken down into three main components: the water source, the treatment system and the distribution system. In each of these areas, steps can be taken to reduce the likelihood of contamination before it occurs. The multi-barrier approach to safe drinking water reflects this concept and is based on preventive action.

Variability in source water locations and composition, types of source waters (surface water, groundwater, groundwater under the direct influence of surface water), and range of water treatment processes available make it unlikely that a single solution can be applied to correct every exceedance or upset event. For this reason, health risks are more effectively reduced through planning, designing, and managing the entire drinking water system from source to tap, including implementing barriers at critical points throughout the system. This is done by implementing a multi-barrier approach, which is an integrated system of procedures, processes and tools that collectively prevent or reduce the contamination of drinking water, from source to tap.

In addition to the physical barriers which relate to the three main components, a number of procedures, processes and tools need to be in place which affect all aspects managing and operating the drinking water system. These include stakeholder commitments to develop legislative and/or policy frameworks; guidelines, standards and objectives; research, science and technology solutions; and consumer awareness and involvement.

The application of the multi-barrier approach at the federal level varies from department to department and from site to site. For instance, in cases where the drinking water for a particular facility is supplied by a municipality, a department will need to implement barriers within the building. In cases where a department collects water at the source and then treats and distributes it to consumers, many more barriers will need to be implemented. As a general rule, drinking water provided in areas of federal jurisdiction should meet the quality benchmarks set out in the GCDWQ *(see Section 2.1). For more information on the multi-barrier approach and its application to drinking water systems, see CDW and CCME (2004).*

1.2 Jurisdictional issues

In Canada, the responsibility for water quality is shared by various levels of government, and involves multi- jurisdictional and cross-disciplinary collaboration. Major stakeholders include federal, provincial, and territorial government departments, municipal and local governments, First Nations band councils, non-governmental organizations, and the public.

Although drinking water quality is generally an area of provincial jurisdiction, the federal government has some responsibilities for drinking water quality, including on federal lands and in First Nations communities located south of 60^{o} N latitude. North of 60° N, the territorial governments are responsible for ensuring safe drinking water in all communities in their territories, including First Nations and Inuit communities. In some instances (e.g., for federal employees), clear legislative obligations are in place to help ensure the safety of drinking water supplies. For example, federal departments have an obligation under the *Canada Labour Code* and its Occupational Health and Safety Regulations to provide potable water to their employees. In other cases (e.g., visitors to federal lands), ensuring the safety of drinking water supplies is more a matter of due diligence rather than a statutory obligation. *The issue of due diligence is discussed further in Section 2.6.*

1.2.1 Leased properties

In the case of facilities located on federal land but leased to a third party, the federal government's responsibilities and liabilities are determined on a case-by-case basis. In such cases, responsibilities for drinking water should be clearly laid out and understood before the lease or agreement is signed. Appropriate clauses should be written into the lease agreement.

When the federal government leases buildings or office space *from*, or is provided accommodation and/or a legislated installation *by* a third party, it is the government's responsibility as the employer to provide potable water (see section 9.1 or the *Canada Labour Code*, Part II, Occupational Health and Safety, Section 125).

The federal government's responsibilities regarding leased properties apply to existing leases as well as new ones. *For more information on the roles and responsibilities of specific departments, see Chapter 7: Information and Resources.*

1.3 Types of water supplies and systems

For the purpose of this document, the following definitions apply to drinking water systems owned or leased by the federal government or First Nations communities. They also apply to water supplies used through arrangements with municipalities (i.e., municipally-supplied federal facilities). Although the same basic principles apply for all drinking water systems, some guidance has been provided in this document that is specific to a given size and/or type of system.

- **Large systems** serve more than 5000 people.
- **Small systems** serve between 501 and 5000 people**.**
- **Very small systems** serve between 26 and 500 people.
- **Micro-systems** serve up to and including 25 people.

In addition to these categories, **unique facilities** exist, or situations may arise, that require special attention in order to protect public health (see the glossary for examples of unique facilities/situations). In these contexts, it is up to the affected department to determine the most appropriate means of supplying safe drinking water to consumers.

2.0 Federal legislation and policies

This chapter provides an overview of the legislation and policies guiding the provision of safe drinking water in areas of federal jurisdiction. It is not intended to be comprehensive, and therefore the original documents should be consulted for exact wording regarding federal obligations.

2.1 The *Guidelines for Canadian Drinking Water Quality*

Recognizing that safe drinking water is a core public health issue, Health Canada works in close collaboration with the provincial and territorial governments to develop the GCDWQ. Using the priorities established by the CDW, Health Canada leads the development of the health risk assessments for drinking water contaminants. The CDW then uses these assessments as the basis for establishing the GCDWQ.

The GCDWQ set out the basic parameters that every water system should strive to achieve in order to provide the cleanest, safest and most reliable drinking water possible. They are used by every jurisdiction in Canada as the basis for establishing their own requirements for drinking water quality, thereby ensuring national consistency.

The most important drinking water quality guidelines deal with microbiological quality, to ensure there is minimal risk of exposure to disease-causing organisms in drinking water. These include bacteriological parameters (e.g., *E. coli*, total coliforms), enteric viruses and protozoa. Turbidity, while not a microbiological parameter per se, is an important consideration for microbiological quality because spikes in turbidity may be associated with contamination and because turbidity may interfere with disinfection.

Health-based MACs have also been developed for a number of chemical and radiological substances found in drinking water supplies across Canada. While some contaminants are wide-spread (e.g., disinfection by-products), many of the substances may only be found at some locations (i.e., are site-specific), and are unlikely to be a concern for every drinking water supply.

Non health-based guidelines (e.g., aesthetic objectives, operational guidance values) have also been developed. These address parameters which may affect consumer acceptance of the water even though the substance in question is found at concentrations below those at which health effects can appear. These parameters affect general characteristics such as taste, odour, temperature and colour.

Although various editions of the GCDWQ have been referenced, it is recommended to use the most up-to-date version. General information on water quality can be found on Health Canada's water quality website at www.healthcanada.gc.ca/waterquality, and the current summary table, guideline technical documents and guidance documents are posted at www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php. To stay current, subscribe to Health Canada's listserv (www.hc-sc.gc.ca/ewh-semt/water-eau/water_list-liste_eau-eng.php), which notifies subscribers of changes to its website.

2.2 The *Canada Labour Code*

The federal government's legal obligations to its employees as a purveyor of drinking water are described in the *Canada Labour Code* and its related regulations (*Canada Occupational Health and Safety Regulations*, the *Aviation Occupational Safety and Health Regulations*, the *On Board Trains Occupational Safety and Health Regulations*, and the *Oil and Gas Occupational Safety and Health Regulations*).

All federal employers must comply with the requirements of the *Canada Labour Code* and its regulations. Section 125 (1)(j) in Part II requires federal employers to provide potable water to employees in accordance with prescribed standards. The Occupational Health and Safety Regulations prescribe a specific version of the GCDWQ as those standards. In addition to the requirement to provide potable water to employees, Section 125 (1) (z.11) of the *Canada Labour Code* states that the employer must provide a copy of any report on hazards in the work place, including an assessment of those hazards, to a policy committee, the work place health and safety committee, or to the health and safety representative.

For detailed information on Health and Safety Committees, see the Canada Labour Code, Part II, Occupational Health and Safety, Section 135. You can find the unofficial consolidation at http://laws.justice.gc.ca/eng/acts/L-2/index.html. Details about the Code and its regulations, and how they apply to drinking water, are given in section 9.1.

2.3 Other related federal legislation

Three other pieces of federal legislation deal directly or indirectly with drinking water issues relevant to purveyor departments:

- The *Food and Drugs Act*;
- The *National Defence Act*; and
- The *Corrections and Conditional Release Act*.

2.3.1 Food and Drugs Act
(includes regulations for pre-packaged water and ice and water used in food preparation)

Bottled water, which includes all pre-packaged water and ice, is considered to be a food under Canadian law. All bottled water sold in Canada is regulated under the *Food and Drugs Act*. The current regulations for bottled water are set out in Division 12 of Part B of the *Food and Drug Regulations*. *The website address for the unofficial consolidation of Division 12 of Part B of the Food and Drug Regulations is http://laws.justice.gc.ca/eng/C.R.C.-c.870/index.html*

As with all foods, bottled water must comply with Section 4 of the *Food and Drugs Act* which prohibits the sale of foods containing poisonous or harmful substances. It is proposed that when the safety of a particular bottled water is brought into question, the GCDWQ provide the basis for establishing the safety of substances for which no limits are specified in the regulations.

Information on bottled water can be accessed through the Health Canada and Canadian Food Inspection Agency websites:

- www.hc-sc.gc.ca/fn-an/securit/facts-faits/faqs_bottle_water-eau_embouteillee-eng.php
- www.inspection.gc.ca/english/fssa/labeti/inform/wateaue.shtml

2.3.2 National Defence Act

The *National Defence Act* gives the Chief of the Defence Staff certain powers of command, responsibilities and discretion regarding the health protection of members of the Canadian Forces with respect to operational imperatives. Some of these responsibilities are laid out in various directives, policies and standards applicable to drinking water. *The website address for the unofficial consolidation of the National Defence Act is http://laws-lois.justice.gc.ca/eng/acts/N-5/page-1.html*

2.3.3 Corrections and Conditional Release Act

Correctional Service Canada is mandated under the *Corrections and Conditional Release Act* and its supporting regulations to provide safe drinking water for inmates (*Corrections and Conditional Release Regulations*, 1992). *The website address for the unofficial consolidation of this section of the Corrections and Conditional Release Act is http://laws-lois.justice.gc.ca/eng/acts/C-44.6/*

2.4 Occupational Health and Safety Directive - Part IX (Sanitation)

The *National Joint Council Occupational Health and Safety Directive - Part IX (Sanitation)* (NJC, 2011) replaces the Treasury Board Sanitation Directive. It was co-developed by participating bargaining agents and public service employers, and is hosted by the National Joint Council. The Directive applies to federal employees in all government-owned buildings. Where employees occupy buildings not owned by the federal government, the Directive applies to the maximum extent that is reasonably practicable.

The Directive contains enhancements to the *Canada Labour Code* Part II, and should be read together with the appropriate sections of the Code and its applicable regulations. It states: "The employer will adhere, as a minimum, to the Guidelines for Canadian Drinking Water Quality, or to any other federally, provincially or territorially appropriate standards and any existing guidelines that provide the higher level of protection to workers."

It includes broad guidance for sanitary facilities, and ensuring sanitary conditions are met for drinking water storage containers and drinking water fountains. In addition, it requires contingency procedures to be developed to address issues such as an interrupted water supply. These procedures are to be developed with the advice of a qualified person and in consultation with the appropriate health and safety committee *(See Section 2.2 for more information on health* *and safety committees). For the sake of convenience, applicable sections of the National Joint Council Occupational Health and Safety Directive can be found in section 9.1. They can also be found at http://www.njc-cnm.gc.ca/directive/oshd-dsst/index-eng.php*

2.5 Roles and responsibilities in the federal jurisdiction

No single federal department has overall authority for drinking water quality on federal lands. Health Canada provides guidance upon request and leadership, but has no mandate to ensure safe drinking water in the federal house. Each department or responsible authority is in charge of implementing a drinking water program in areas within its mandate and should be accountable for carrying out its duties. However, given the differences in departmental structures, defining precisely who is responsible for drinking water management is beyond the scope of this document and should be determined by each department.

That said, each person involved with drinking water programs needs to know what is expected of them and their level of responsibility. Departments should make sure all required tasks have been assigned to specific, qualified staff. *As a reference, examples of the types of roles and responsibilities within some federal departments are given in Appendix C.*

Note: While the duties to be performed can be contracted to a third party, the accountability and responsibility for meeting drinking water program objectives remains with the department.

2.6 Due diligence

In addition to meeting regulatory requirements, federal departments, drinking water system operators, and other responsible authorities are expected to be able to demonstrate due diligence in carrying out their duties (whether these duties are regulated or not).

Demonstrating due diligence means taking every precaution reasonable in the given circumstances to avoid harm. It also means having mechanisms in place to deal with non-compliance and for holding employees accountable for their decisions and actions. The following programs are examples of what may constitute a proper exercise of due diligence:

- Employer leadership/employee input;
- Hazard identification/assessment (vulnerabilities assessment);
- Hazard elimination/control;
- Training;
- Monitoring;
- Enforcement;
- Documentation; and
- Communication.

Part 2 - Application of the Federal Framework

The multi-barrier approach incorporates the principle of sound quality management. Federal departments have the responsibility to ensure treatment programs, facilities and distribution systems are designed and maintained to perform consistently and reliably, and that they are operated by appropriately trained personnel.

A comprehensive review and approval process for new or upgraded water systems is essential to ensure all project proposals are reviewed and commented on at their various stages of development and to ensure that relevant standards and requirements are met. An effective and coordinated review and evaluation of project proposals will result in the overall reduction of potential health hazards in the new or upgraded water system.

3.0 Developing a monitoring program

The monitoring program for all federal drinking water systems should be developed based on a sanitary survey in combination with a vulnerabilities assessment and a baseline chemical analysis. Each of these steps should be conducted by a competent expert in the appropriate field.

At minimum, an initial sanitary survey, vulnerabilities assessment, and baseline chemical analysis should be conducted within five years for an existing system and before a new system is put into service. They should continue to be conducted every five years, or when there are significant changes to the treatment system, land use, or other conditions which may adversely affect water quality.

Although the survey/assessment/analysis may only be done every five years, departments should endeavour to be aware on an on-going basis of any changes at a site that could impact water quality. This will help to determine if changes are required to the monitoring program. *See Section 3.5 for specific guidance in cases where the frequency of the baseline chemical analysis may be reduced.*

These steps apply to all systems, new or existing. However, case-specific guidance for a number of scenarios, including groundwater supplies and municipally supplied systems, is provided in Section 3.7.

3.1 Selecting a source for drinking water

For new systems, the selection of a source water must take into consideration whether:

- The source water is of high enough quality that it can be rendered safe for human consumption.
- The quantity of water available is suitable for the number of people who will be using it over the long term, the types and duration of activities they will use it for, and water demands for other uses (e.g., industrial or recreational).

When selecting a source for drinking water, more than one water source should be evaluated, where feasible. Doing so will help determine whether a better source exists or if an alternative source is available that can be used as a back-up in cases where the chosen water supply becomes contaminated or otherwise unsuitable.

3.2 Vulnerabilities assessment

The first step in assessing the drinking water supply is to assess the quality and quantity of the source water. The vulnerabilities assessment is a comprehensive assessment of the vulnerability of the source water in the environment. The results of the vulnerabilities assessment help determine the extent of treatment or other management actions required. Drinking water supplies may originate from surface water or ground water sources. Microbiological risks differ depending on the type of source. Surface water is defined as water open to the atmosphere or subject to surface run-off. It is vulnerable to contamination, including microbiological, and must be treated.

Groundwater is defined as either *under the direct influence of surface water* (GUDI) or *less vulnerable to fecal contamination*. GUDI carries the same risks to health as surface water and is dealt with in the same way. It is defined as any water beneath the surface of the ground with (i) occurrence of insects or other microorganisms, algae, organic debris, or large-diameter pathogens such as *Giardia lamblia* or *Cryptosporidium*, or (ii) significant fluctuations in water characteristics such as turbidity, temperature, conductivity, or pH which may closely correlate to climatological or surface water conditions.

Groundwater (as opposed to GUDI) is from an aquifer where microbiological contamination is unlikely to occur because of the formation of the rock which protects it. It is typically determined by a hydrogeologist or other well specialist. That said, all groundwaters may be at some risk of contamination, particularly from enteric viruses.

As part of the overall assessment, an evaluation of demands on water quantity is also required.

3.2.1 Delineation of watersheds and aquifers

The land area that contributes water and potential contaminants to the water supply should be defined and mapped (delineated) in order for drinking water managers to focus their efforts within a defined area and respond appropriately to incidents or emergencies.

This component of the vulnerabilities assessment should include characterizing the water source, geology, and features of the surrounding area to determine what may be in the water and what could become a concern in the treated drinking water (e.g., bromide in humic acid in the source water could react with chlorine or other chlorinated disinfectants to form brominated disinfection by-products at the tap).

Many methods exist to delineate watersheds and aquifers, ranging from simplistic terrain mapping to complex mathematical models requiring significant amounts of field data. The decision about which method is required will depend on source water characteristics and the relative risk of contamination.

3.2.2 Identifying source water hazards

The next step is to identify the potential hazards to the water source within the delineated area. Hazards can be identified in a number of ways such as inventories of land uses and contaminant sources, evaluations of watershed and/or aquifer characteristics, and monitoring data related to source water quality and quantity.

The level of effort expended on identifying hazards will depend on available resources. However, the goal should be to collect as much data as feasible on contaminants (including their sources and concentrations), pressures on water quantity, and to fill knowledge gaps with new information from public consultations and/or field studies.

In the vulnerabilities assessment, it is essential to identify hazards since they influence the type of treatment required and any response required in the watershed or aquifer. For instance, a watershed where the primary hazards come from industrial effluent will be managed differently than one where the main threat to water quality is nutrient enrichment.

3.2.3 Susceptibility to contamination

Once the hazards have been identified within a delineated area, the vulnerability of the source to the hazards needs to be determined. The potential impact of the hazards on human health also needs to be determined. The results of these assessments influence the treatment required to ensure the water is safe and aesthetically-pleasing for human consumption. They also guide integrated watershed/aquifer protection efforts by identifying the quantity and quality of the water and its potential vulnerability to degradation. Assessment results may be extremely useful to other agencies and stakeholders who share common interests.

In assessing vulnerability or risk, the data from the identification of hazards needs to be complemented with monitoring data to get an idea of the concentration at which the contaminant is found in the source water and whether this concentration fluctuates over time. Fluctuations in physical parameters should also be noted. These types of data are gathered through long-term monitoring programs. While concentrations can be modelled, it is preferable to obtain real-time, site-specific monitoring data.

3.3 Sanitary survey

A sanitary survey is an on-site review, from intake to tap, of the specific raw water quality, facilities, equipment, operations, and maintenance records for the purpose of evaluating the system's ability to adequately treat source water in order to produce and deliver safe drinking water. The sanitary survey will vary depending upon the type and complexity of the system, but will include the elements outlined in figure 3.1:

Table 3.1 *Elements of a sanitary survey*
(refer to Chapters 5 and 6 for further information)

	Element	**Description**
1	System plans	To characterize the capability of the overall system and identify areas requiring improvement and/or corrective actions (intake, filters, pumps, etc.)
2	Monitoring, reporting, and data verification	Review paperwork and plans to verify and report compliance with applicable requirements
3	System management and operation	Review paperwork and plans to demonstrate that maintenance and operations can maintain compliance (e.g., cross connection control, emergency plan, operations and maintenance plan, personnel training)
4	Treatment system	Evaluate treatment processes (e.g., chemical addition, filtration), facilities, components, and techniques
5	Distribution system	Evaluate its adequacy, reliability and safety
6	Finished water storage	Evaluate its adequacy, reliability and safety

Variations in the quality of water supplies can help in detecting contamination problems, and in determining whether they have arisen at the source, during water treatment, or in the distribution system. However, it may often not be possible to take more than a few samples. Consequently, the results of any analysis may not be representative of the water-supply system as a whole.

Sanitary surveys, while they cannot replace water quality analyses, are an essential complement to such analyses as part of water quality control programmes. They allow for an overall appraisal of the many factors associated with a water supply system, including the waterworks and the distribution system.

Sanitary surveys are intended to provide a range of information and to locate potential problems. The data obtained may identify failures, anomalies, operator errors, and any deviations from normal conditions that may affect the production and distribution of safe drinking water.

3.4 Microbiological quality

Since the most significant health risk from drinking water supplies is the presence of disease-causing microorganisms, the most important goal of drinking water treatment is to reduce microbiological risk in the treated water to an acceptable level. The most appropriate type and level of treatment should take into account the potential fluctuations in the source water quality, including short-term water quality degradation, and variability in treatment performance.

For this reason, it is important that federal water quality management systems address any existing and potential microbiological quality concerns at the site (e.g., level of treatment, historical testing results, surface and groundwater vulnerabilities, potential water quality risks, user activities, and local trends), prior to establishing a routine monitoring regimen. *A full discussion of microbiological considerations is provided in Chapter 4.*

3.5 Baseline chemical analysis

The GCDWQ lists many chemical and physical parameters of concern in Canadian drinking water supplies. Many of these, though, are only a concern in certain parts of the country due to site-specific geology or industrial or agricultural activity. For this reason, it is recommended that a baseline chemical analysis of all drinking water supplies be conducted to determine which substances should be monitored as part of the monitoring program.

A baseline chemical analysis is an analysis of all chemical parameters with Maximum Acceptable Concentrations (MACs) in the GCDWQ. The analysis includes screening for radiological parameters where testing is feasible or warranted. Departments may also choose to look at parameters with aesthetic and/or operational values. Pesticides are generally tested in a suite. However, there may be no need to test for some pesticides (e.g., those not used in a particular watershed). A water quality professional should make this determination.

The department does not have to conduct the baseline chemical analysis if it can access the same data from a reliable third party source (e.g., an accredited laboratory or a municipality). Note: monitoring at the tap is still required for some contaminants originating in plumbing systems (e.g., lead).

As a safeguard, it is recommended that a baseline chemical analysis be conducted every five years, unless a sanitary survey or vulnerabilities assessment indicates that this type of analysis should be done more or less frequently. If particular substances are consistently absent from a water system, the frequency of sampling for those substances can be reduced. As well, where water supplies are obtained from sources that are not likely to be contaminated by industrial and agricultural wastes, a baseline chemical analysis may be needed only to help select new drinking water sources and then only occasionally thereafter.

For drinking water supplied by a municipality, the baseline chemical analysis would include an analysis of the water received to determine if there are any concerns with the supply that require further treatment or whether an alternative source should be used. Federal departments and First Nations communities should request water quality testing results from the municipality. This information will indicate which substances are being tested for and analysed.

3.6 Establishing a monitoring program

It is recommended that monitoring programs for identified chemical contaminants include, at minimum, annual monitoring for surface water sources, and monitoring every two years for groundwater sources, unless otherwise specified in the GCDWQ. *Microbiological monitoring should be implemented as per the guidance in Chapter 4 of this document.*

3.6.1 Disinfection by-products

For systems using chemical disinfection, monitoring of disinfection by-products (DBPs) should be conducted more frequently, in some cases every three months, to meet the requirements of the GCDWQ. For example, the MACs for trihalomethanes (THMs) and haloacetic acids (HAAs), which are DBPs linked to the use of chlorine as a disinfectant, are established as locational running annual average of quarterly samples.

3.7 Case-specific guidance

3.7.1 Groundwater supplies

The risks associated with groundwater contamination vary with the type of activities on the property, the surrounding land use, soil type, and the type and condition of the wellhead or wellfield. A vulnerabilities assessment report for all existing groundwater systems should include a description of the facility and surrounding land use, the direction and rate of groundwater flow, capacities of the selected water source, the radius of influence, hazards associated with the water source, and protection measures that are either in place or needed.

The sanitary survey for groundwater should also include a review of previous sampling results, identify whether further treatment is required, investigate the type of well in place (or proposed), and lay out requirements for wellhead protection. It should recommend improvements and upgrades where needed, and identify any compliance and enforcement issues. Federal staff and, in First Nations communities, managers and/or operators of facilities and the water treatment plant operator, will then be able to regularly update well records (CDW and CCME, 2004).

The amount of effort and resources expended on assessing the groundwater supply will depend on factors such as its size, use, and location. *A sample Well Assessment Form is provided in Appendix D.*

Suitable sealing, capping, filling or removal of wells to be abandoned is important to ensure the safety of the aquifer and the environment and to protect against future hazards. (Note: Listing relevant guidelines for abandoning wells is beyond the scope of this document.)

3.7.2 Municipally-supplied drinking water systems

Often the source of potable water for facilities owned and operated by the federal government is the local municipality. The quality of this water is the responsibility of the system owner.

In order to ensure the water received is of acceptable quality, water quality managers and/or technical support staff should be in regular contact with the municipality. Maintaining solid relationships with key contacts in the municipality's drinking water program is important in order to be kept informed of any water quality or quantity issues that could affect the health of consumers. Staff should periodically review the municipality's reports describing water sampling results in order to keep informed of the water's changing characteristics and to understand the quality of drinking water entering the facility's distribution system or building plumbing.

Sanitary surveys should be conducted every five years for all systems. Sanitary surveys are needed to verify a number of factors (fully described in other sections), which include the condition of the plumbing, the type of materials, and the state of the connections, including cross-connection control, within the building.

Where a federal department receives municipally-treated drinking water, a vulnerabilities assessment may not be practical or necessary. In its place, the information normally gathered through the vulnerabilities assessment should be obtained through a complete assessment of the water received from the municipality. This could be based on the municipality's reports describing water sampling results.

In cases where water is received from a municipality, it may be possible to negotiate to have the federal building designated as a routine municipal water sampling location. If this is not possible, water samples may need to be collected for some water quality parameters (e.g., lead). Samples should be collected at the point closest to the intake of municipal water to the building in order to establish a baseline understanding of the water quality. Additional samples taken from points within the building will indicate whether water quality is deteriorating within the building. *Information specific to microbiological monitoring is found in Chapter 4.*

3.7.3 Staff quarters

The need to provide potable water to staff quarters is determined on a department-by-department basis.

4.0 Microbiological considerations and monitoring

Given the sheer number of federal drinking water systems and the wide variety in system size, location, and site-specific concerns, the guidance in this document is designed to be flexible. For the purpose of this document, drinking water systems have been categorized as large, small, very small, and micro-systems depending on the size of the population served *(see Section 1.3 and the glossary for definitions)*.

Microbiological monitoring programs should include the indicator organisms *E. coli* and total coliforms. Turbidity and chlorine residuals should also be monitored in order to ensure the microbiological integrity of the water, even though these are not microbiological parameters. System operators may also choose to test for heterotrophic plate count bacteria in order to better understand the general bacteriological quality of the drinking water and changes in water quality in distribution systems.

Generally, minimum treatment of supplies derived from surface water sources or groundwater under the influence of surface water should include adequate filtration (or the use of equivalent technologies) and disinfection (primary disinfection). Where there is a distribution system, a disinfectant residual (either chlorine or chloramine) should be maintained throughout the distribution system at all times (secondary disinfection). Very small systems or micro-systems where there is little or no distribution system do not require a disinfectant residual. Commonly used disinfectants include chlorine (primary and/or secondary disinfection), chloramine (primary and/or secondary disinfection), chlorine dioxide (primary disinfection), ultraviolet radiation (UV – primary disinfection) and ozone (primary disinfection).

It is important to note that all chemical disinfectants used in drinking water can be expected to form disinfection by-products, which may affect human health. Current scientific data show that the benefits of disinfecting drinking water (reduced rates of infectious illness) are much greater than any health risks from disinfection by-products. While every effort should be made to reduce concentrations of disinfection by-products, any method of control must not compromise the effectiveness of disinfection.

4.1 Monitoring frequency

Note: For facilities that receive municipally supplied drinking water, additional guidance is provided in Section 4.3.

For departments and other responsible authorities who produce/treat their own drinking water, the recommended monitoring frequency for microbiological parameters depends on a number of factors, including the size of the population served, the monitoring history, type and quality of the source water, and the presence and type of treatment used.

Some guidance on monitoring frequency is provided in the GCDWQ. Monitoring frequencies at the facility or system level should be established by the appropriate department or responsible authority, with proper guidance and due consideration of the above factors and any regulatory requirements.

Generally, for all systems serving up to and including 5,000 people, bacteriological samples should be collected at a minimum four times per month at regular intervals as shown in Table 4.1. Sampling could be scheduled to match provincial guidelines or regulations where these are more stringent. It is recommended that chlorine residuals be tested when bacteriological samples are taken. Ideally, each monitoring event for *E. coli* and total coliforms should include samples at both the treatment plant and in the distribution system.

Table 4.1 lists the default monitoring frequencies that should be followed (unless conditions are met for reduced monitoring as per Section 4.1.1, Box 4.1 and tables 4.2 through 4.5) by departments and other responsible authorities who produce/treat their own drinking water. (See Section 4.3 for guidance for facilities that receive municipal drinking water).

Table 4.1 *Default monitoring frequency and locations*

Systems serving up to and including 5,000 people		
E. coli / Total coliforms	Turbidity*	Chlorine residual*
4 times per month	Continuous or daily	Continuous or daily
Sampling locations *E. coli* / total coliforms and chlorine residual: • Water leaving the pumphouse or treatment plant • At representative locations in the distribution system (if applicable) Turbidity: • At source, prior to treatment • In treatment plant after each filter (if applicable)		

* assumes surface water and a distribution system. See tables 4.2 - 4.5 for additional guidance.

For routine sampling, an effort should be made to collect and analyse samples when the risk of contamination is highest and there is a potential public health risk (e.g., spring thaw, heavy rains, dry periods, and/or when there is a noticeable deterioration in water quality).

During high risk events (e.g., flooding, extreme or unusual weather events), there may be a need for additional monitoring. Additional monitoring should also be done when alterations are made to treatment, plumbing, or distribution systems). In addition, new or renovated wells should be sampled and analysed at start-up to confirm acceptable bacteriological quality (Health Canada, 2012a).

Where the finished water is expected to come into contact with a distribution system, a storage tank, or a trucked (hauled) water container, a chlorine residual should be maintained at all times (throughout the distribution system and/or in the storage tank or trucked (hauled) water container. If a very small system or micro-system has little or no distribution system, no chlorine residual is required.

Both surface water and GUDI systems require filtration in addition to disinfection, unless systems meet criteria for excluding filtration as outlined in the guideline technical document on turbidity (Health Canada, 2013).

4.1.1 Conditions for reducing monitoring frequency

There is no flexibility provided for small systems (i.e., serving 501 to 5000 people) to reduce monitoring frequencies. In some cases, for very small systems and micro-systems, it may be possible to reduce the number of samples taken and analysed.

Box 4.1 and tables 4.2 through 4.5 define the conditions for reduced monitoring frequency, once an acceptable history has been established. **Box 4.1 and the tables must be read together.** The department must default to four samples per month for systems serving 500 or fewer people if the conditions identified in Box 4.1 and tables 4.2 through 4.5 are not met.

Box 4.1: *Conditions for reduced monitoring frequencies in very small and micro systems*

Conditions for reduced monitoring frequencies

- For **very small systems**, the supply should have a vulnerabilities assessment with acceptable results and a history of acceptable bacteriological quality (i.e., monitoring history).

- For **micro-systems**, while having both a vulnerabilities assessment and a monitoring history is recommended, this is not always possible. Therefore, for these systems only, the department may choose to accept either a vulnerabilities assessment with acceptable results or a history of acceptable bacteriological quality, to implement a reduced monitoring frequency.

- For **very small systems and micro-systems in the "treated — surface water or GUDI" category**, departments may choose to reduce monitoring frequency for turbidity and chlorine residuals if they are satisfied that they have adequate strategies to ensure health protection in place.

Having a history of acceptable bacteriological quality is one of the conditions for reduced monitoring. New or renovated drinking water systems (and/or systems where a monitoring history has yet to be established) can establish a monitoring history by sampling four times per month for one year (for continuous operations), or four times per month for two years during the operating period (for seasonal operations).

That said, if an adverse sample result is obtained and confirmed at any time, the system is no longer considered to have a monitoring history of acceptable bacteriological quality and reverts back to Table 4.1's default frequencies. A history of acceptable bacteriological quality would need to be re-established per the above, in order to reduce the monitoring frequency.

Table 4.2 *Reduced monitoring for very small systems - continuous supply*
(This table must be read in conjunction with Box 4.1)

<table>
<tr><th colspan="6">Very small systems (26 to 500 people): Reduced monitoring frequency where conditions are met</th></tr>
<tr><td colspan="6">Conditions for Reduced Monitoring:
• A vulnerabilities assessment with acceptable results and a monitoring history of acceptable bacteriological quality
• Where water is treated, process in place to ensure treatment system operating effectively</td></tr>
<tr><th colspan="3">Reduced monitoring frequency</th><th colspan="3">Further reductions / conditions</th></tr>
<tr><th>E. coli / Total coliforms</th><th>Turbidity</th><th>Chlorine residual (if applicable)</th><th>E. coli / Total coliforms</th><th>Turbidity</th><th>Chlorine residual (if applicable)</th></tr>
<tr><td colspan="6">Groundwater* — Not disinfected</td></tr>
<tr><td>Once monthly, at regular intervals</td><td>Once weekly</td><td>N/A</td><td>No further reductions</td><td>No further reductions</td><td>N/A</td></tr>
<tr><td colspan="6">Groundwater* — Disinfected</td></tr>
<tr><td>Once monthly, at regular intervals</td><td>Once weekly</td><td>Once weekly</td><td>May be reduced to no less than once quarterly, at regular intervals, IF process is in place to ensure treatment system operating effectively and weekly monitoring demonstrates:
- Turbidity consistently less than 1 NTU.
- Where there is a distribution system, acceptable chlorine residual leaving treatment plant and in distribution system.</td><td>May be reduced to 4-12 times/year IF historical results consistently less than 1 NTU.</td><td>No further reductions</td></tr>
<tr><td colspan="6">Treated — Surface water or GUDI</td></tr>
<tr><td>Once monthly, at regular intervals if daily monitoring demonstrates:
- Turbidity of treated water consistently less than 1 NTU.
- Where there is a distribution system, acceptable chlorine residual leaving treatment plant and in distribution system.</td><td>Once daily</td><td>Once daily</td><td>No further reductions</td><td>No further reductions (Also see 3rd bullet in Box 4.1)</td><td>No further reductions (Also see 3rd bullet in Box 4.1)</td></tr>
<tr><td colspan="6"><u>Sampling locations</u>

E. coli / Total coliforms and chlorine residual:
• Water leaving the pumphouse or treatment plant
• At representative locations throughout the distribution system (if applicable)

Turbidity:
• At source, prior to treatment, to optimize treatment
• In treatment plant after each filter (if applicable)</td></tr>
</table>

* applies to groundwater that is considered less vulnerable to fecal contamination

Table 4.3 *Reduced monitoring for very small systems - seasonal supply*
(This table must be read in conjunction with Box 4.1)

Very small systems (26 to 500 people): Reduced monitoring frequency where conditions are met					
Conditions for Reduced Monitoring: • A vulnerabilities assessment with acceptable results and a monitoring history of acceptable bacteriological quality • Where water is treated, process in place to ensure treatment system operating effectively					
Reduced monitoring frequency			**Further reductions / conditions**		
E. coli / Total coliforms	Turbidity	Chlorine residual (if applicable)	*E. coli* / Total coliforms	Turbidity	Chlorine residual (if applicable)
Groundwater* — Not disinfected					
At start-up and once monthly, regular intervals, during operating period	Once weekly, during operating period	N/A	No further reductions	No further reductions	N/A
Groundwater* — Disinfected					
At start-up and once monthly, regular intervals, during operating period	Once weekly, during operating period	Once weekly, during operating period	May be reduced to once quarterly, at regular intervals during operating period, IF process is in place to ensure treatment system operating effectively, and weekly monitoring demonstrates: - Turbidity consistently less than 1 NTU. - Where there is a distribution system, acceptable chlorine residual leaving treatment plant and in distribution system.	May be reduced to 4-12 times/year during operating period IF historical results consistently less than 1 NTU.	N/A
Treated — Surface water or GUDI					
At start-up and once monthly, regular intervals, during operating period, if daily monitoring demonstrates: - Turbidity of treated water consistently less than 1 NTU. - Where there is a distribution system, acceptable chlorine residual leaving treatment plant and in distribution system.	Once daily, during operating period	Once daily, during operating period	No further reductions	No further reductions (Also see 3rd bullet in Box 4.1)	No further reductions (Also see 3rd bullet in Box 4.1)
<u>Sampling locations</u> *E. coli* / Total coliforms and chlorine residual: • Water leaving the pumphouse or treatment plant • At representative locations throughout the distribution system (if applicable) Turbidity: • At source, prior to treatment, to optimize treatment • In treatment plant after each filter (if applicable)					

* applies to groundwater that is considered less vulnerable to fecal contamination

Table 4.4 *Reduced monitoring for micro-systems - continuous supply*
(This table must be read in conjunction with Box 4.1)

Micro-systems (1 to 25 people): Reduced monitoring frequency where conditions are met					
Conditions for Reduced Monitoring: • A vulnerabilities assessment with acceptable results and a monitoring history of acceptable bacteriological quality • Where water is treated, process in place to ensure treatment system operating effectively					
Reduced monitoring frequency			**Further reductions / conditions**		
E. coli / Total coliforms	Turbidity	Chlorine residual (if applicable)	*E. coli* / Total coliforms	Turbidity	Chlorine residual (if applicable)
Groundwater* — Not disinfected					
4 samples per year (i.e., once quarterly at regular intervals	N/A	N/A	No further reductions	N/A	N/A
Groundwater* — Disinfected					
2 samples per year when risk of contamination highest (spring and fall)	N/A	Once monthly	No further reductions	N/A	No further reductions
Treated — Surface water or GUDI					
4 samples per year (i.e., once quarterly at regular intervals) IF daily monitoring demonstrates: - Turbidity of treated water consistently less than 1 NTU. - Where there is a distribution system, acceptable chlorine residual leaving treatment plant and in distribution system.	Once daily	Once daily	No further reductions	No further reductions (Also see 3rd bullet in Box 4.1)	No further reductions (Also see 3rd bullet in Box 4.1)
<u>Sampling locations</u> *E. coli* / Total coliforms and chlorine residual: • Water leaving the pumphouse or treatment plant • At representative locations throughout the distribution system (if applicable) Turbidity: • At source, prior to treatment, to optimize treatment • In treatment plant after each filter (if applicable)					

* applies to groundwater that is considered less vulnerable to fecal contamination

Table 4.5 *Reduced monitoring for micro-systems - seasonal supply*
(This table must be read in conjunction with Box 4.1)

Micro-systems (1 to 25 500 people): Reduced monitoring frequency where conditions are met					
Conditions for Reduced Monitoring: • A vulnerabilities assessment with acceptable results and a monitoring history of acceptable bacteriological quality • Where water is treated, process in place to ensure treatment system operating effectively					
Reduced monitoring frequency			**Further reductions / conditions**		
E. coli / Total coliforms	Turbidity	Chlorine residual (if applicable)	*E. coli* / Total coliforms	Turbidity	Chlorine residual (if applicable)
Groundwater* — Not disinfected					
Minimum of 3 samples per period of operation (at least one every three months at regular intervals), including at start-up and mid-season (if possible)	N/A	N/A	No further reductions	N/A	N/A
Groundwater* — Disinfected					
2 samples per period of operation, including at start-up	N/A	Once monthly during operating period	No further reductions	N/A	No further reductions
Treated — Surface water or GUDI					
2 to 4 samples per period of operation, including at start-up and mid-season, IF daily monitoring demonstrates: - Turbidity of treated water consistently less than 1 NTU. - Where there is a distribution system, acceptable chlorine residual leaving treatment plant and in distribution system.	Once daily	Once daily	No further reductions	No further reductions (Also see 3rd bullet in Box 4.1)	No further reductions (Also see 3rd bullet in Box 4.1)
Sampling locations *E. coli* / Total coliforms and chlorine residual: • Water leaving the pumphouse or treatment plant • At representative locations throughout the distribution system (if applicable) Turbidity: • At source, prior to treatment, to optimize treatment • In treatment plant after each filter (if applicable)					

* applies to groundwater that is considered less vulnerable to fecal contamination

4.2 Sampling locations

Samples should be taken at the point where the water enters the system (to eliminate the source water as the cause of the adverse water quality), in the treatment plant after each filter (if applicable) and from representative points throughout the network, although not necessarily the same points on each occasion. Samples should also be taken in any other locations identified in the sanitary survey as areas of concern. For **very small systems** where there is little or no distribution system, samples should be taken at the first point where water is taken for drinking.

If the water supply is obtained from more than one source, the location of sampling points in the distribution system should ensure that water from each source is periodically sampled. The majority of samples should be taken in potential problem areas: low-pressure zones, reservoirs, dead ends, areas at the periphery of the system farthest from the treatment plant and areas with a poor previous record.

4.3 Facilities that receive municipal drinking water

Facilities that receive municipal water (in Canada) should be receiving microbiologically safe water. However, it is the responsibility of the department to ensure they have the appropriate documentation (e.g., vulnerabilities assessment, third party reliable data) to verify that the incoming water is microbiologically safe. In this case, these facilities do not need to routinely collect bacteriological samples to verify the quality of the water entering the facility. Note that bacteriological sampling would still be needed in situations where the sanitary survey has identified potential risks (e.g., absence of a cross-connection control program). It may also be needed to respond to consumer complaints.

Where the quality of the municipally supplied water does not meet the microbiological parameters in the GCDWQ or is uncertain (e.g., no vulnerabilities assessment, absence of third party reliable data, inadequate chlorine residual levels), the system should be considered to be an untreated supply and steps taken to ensure public health is protected. The guidance in the whole of this document will help departments fulfill their responsibility to provide safe drinking water to their employees.

Facilities receiving municipal drinking water that requires bacteriological monitoring should collect samples at the main or at the point of entry to the building (where applicable), in the building's plumbing system (i.e., dead ends), and in other locations identified in the sanitary survey.

4.4 Interpreting results

4.4.1 Indicator organisms

As part of a "source to tap" approach, testing for *E. coli* and total coliforms should be used to verify the microbiological quality of the water. The GCDWQ have separate guideline technical documents for each of these parameters. *Information regarding sample analysis and laboratory accreditation can be found in Section 6.3.3.*

<u>*E. coli*</u>

E. coli is a member of the total coliform group and the only one found exclusively in the faeces of humans and other animals. The GCDWQ state that the MAC of *E. coli* in a drinking water system is none detectable per 100 mL. The presence of *E. coli* indicates recent faecal contamination and the possible presence of enteric pathogens that may adversely affect human health. If *E. coli* is detected, the appropriate agencies should be notified, and corrective actions taken, including re-sampling. A boil water advisory should be issued when the presence of *E. coli* is either detected or confirmed.

Total coliforms

Total coliforms, while not a reliable indicator of faecal contamination, are a good indicator of general microbiological water quality, and therefore are measured as well. For total coliform bacteria, the GCDWQ recommend:

- In water leaving a treatment plant, the MAC of total coliforms is none detectable per 100 mL.
- In distribution systems where fewer than 10 samples are collected in a given sampling period, no sample should contain total coliform bacteria. In distribution systems where greater than 10 samples are collected in a given sampling period, no consecutive samples from the same site or not more than 10% of samples should show the presence of total coliform bacteria.

While *E. coli* is the only member of the total coliform group that is found exclusively in faeces, other members of the group are found naturally in water, soil and vegetation, as well as in faeces. Total coliform bacteria are easily destroyed during disinfection. Therefore, their presence in water leaving a treatment plant indicates a serious treatment failure and should lead to the immediate issuance of a boil water advisory and to corrective actions being taken.

The presence of total coliforms in the distribution system (but not in water leaving the treatment plant) indicates that the distribution system may be vulnerable to contamination or may simply be experiencing bacterial regrowth. It does not necessarily mean a boil water advisory must immediately be issued; however, the source of the problem should be determined and corrective actions taken (Health Canada, 2012b).

In well water, the presence of total coliform bacteria in the absence of E. coli indicates the well may be prone to surface water infiltration and is therefore at risk of faecal contamination, or may indicate the presence of biofilm in the well or plumbing system (Health Canada, 2012b). A biofilm is a community of micro-organisms attached to a solid surface in an aquatic environment, for example the inside wall of a pipe. Even though the biofilm itself is not a health concern, it could interfere with analytical testing. Also, it could eventually impede water flow, potentially leading to the deterioration of aesthetic water quality and ultimately to taste and odour problems.

If total coliforms are found in the absence of *E. coli*, in a non-disinfected groundwater system, necessary action will vary depending on the source of the total coliforms and the size and history of the system. A boil water advisory may not need to be issued immediately. However, for very small systems and micro-systems, it is recommended that boil water advisories be issued—or an alternative safe source of drinking water used—if the presence of total coliforms has been confirmed in the groundwater system. Regardless of whether a boil water advisory was issued, corrective actions should be implemented.

Corrective actions could include shock chlorination (the addition of a strong solution of liquid chlorine into a drinking water system to reduce the presence of microbiological contaminants) and flushing of the well and/or distribution system.

A recommended approach to shock chlorinating wells can be found in Health Canada's "Water Talk: What's In Your Well? - A Guide To Well Water Treatment And Maintenance" at www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/well-puits-eng.php

It is recommended that a boil water advisory be used only as a temporary measure while problems are being identified and remediated. In certain circumstances, boil water advisories may be in place for a longer period of time. *More information on issuing and rescinding boil water advisories is provided in section 6.6 and on the website at www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/boil_water-eau_ebullition/index-eng.php*

4.4.2 Heterotrophic plate count

Heterotrophic plate count (HPC) bacteria are not a suitable indicator of the microbiological safety of water, but can provide an indication of the general bacteriological quality. For example, increases in HPC bacteria above normal baseline levels can indicate changes in raw water quality, problems such as bacterial regrowth in the distribution system or plumbing, or problems with drinking water treatment.

Effective treatment can reduce concentrations of HPC bacteria to fewer than ten colony forming units per 100 mL of water. These counts can be used for quality control in water treatment plants and as a measure of quality deterioration in wells, distribution lines, and reservoirs.

A sudden rise of HPC or background colonies in drinking water collected from a site that has traditionally had low counts should give rise to concern. If a sample contains greater than usual levels of HPC or background colonies, the site should be re-sampled and the chlorine residual verified (if applicable). If the repeat sample still indicates an elevated HPC, the system should be inspected to determine the cause, and if necessary, remedial action should be taken (Health Canada, 2012c).

4.4.3 Turbidity

Federal facilities and facilities in First Nations communities that treat and supply their own drinking water should monitor their water for turbidity as it is a strong indicator of water quality. It is also an important indicator of treatment efficiency and filter performance in particular (Health Canada, 2013).

Generally, minimum treatment of supplies derived from surface water and GUDI sources should include adequate filtration (or technologies providing an equivalent log reduction credit) and disinfection. Filtration is an important barrier for removing particles that cause turbidity. Microorganisms, in addition to being particles themselves, can become attached to soil and waste particles in the environment and can aggregate or attach to inorganic or other particles during treatment. Effective removal of microbial pathogens is best achieved when water of low turbidity is produced and effective inactivation of microbial pathogens is best achieved when low-turbidity water is disinfected.

The most important consideration when dealing with turbidity is the need to reduce it to a level as low as reasonably achievable and to minimize fluctuation. Optimizing treatment performance for turbidity reduction and particle removal also generally optimizes pathogen removal and subsequent disinfection while reducing the potential formation of undesirable disinfection by-products.

Health-based treatment limits (HBTL) for turbidity have been established for the different filtration technologies to help ensure that systems are meeting the minimum levels of pathogen removal (log removal credits) provided in the enteric protozoa guideline technical document. The HBTL are achievable by most filtration systems. However, filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.

Where filtration is not required to meet pathogen removal goals, it is best practice to keep turbidity levels below 1.0 NTU to minimize the potential for interference with disinfection. In addition, to mimimize particulate loading and effectively operate the distribution system, it is also good practice to ensure that water entering the distribution system has turbidity levels below 1.0 NTU. Turbidity should be measured at each individual filter, and can be measured by on-line turbidity meters, a laboratory, or by using a test kit.

Turbidity monitoring is also recommended for systems using groundwater that is less vulnerable to fecal contamination (with the exception of serving 25 people or less, i.e., micro-systems). Turbidity levels in groundwater should be relatively constant. Changes in turbidity outside the normal range for a groundwater system indicate changes in groundwater quality or changes in the integrity of the well that need to be investigated. For systems that use groundwater that is not under the direct influence of surface water, which are considered less vulnerable to faecal contamination, turbidity should generally be below 1.0 NTU.

Turbidity sampling should take place in accordance with tables 4.1 through 4.5. The daily source water turbidity level can be based on either a single grab sample measurement or the arithmetic average of all the source water turbidity measurements taken in one calendar day (ADI Ltd., 2002b). In systems where turbidity monitoring is not continuous, turbidity samples should be taken during times of poorest source water quality, such as after heavy rains, and during spring run-off (when possible).

4.5 Disinfection targets

Barring system-specific exemptions (as described below), all drinking water supplies should be disinfected to ensure the safety of the drinking water leaving the treatment plant. The effectiveness of disinfection can be predicted based on a knowledge of the residual concentration of disinfectant, temperature, pH (for chlorine), and the time between the moment the disinfectant is added to the water and the moment the water arrives to the first customer. This relationship is commonly referred to as the “contact time” or “CT” concept. CT is the product of C (the residual concentration of disinfectant, measured in mg/L) and T (the disinfectant contact time, measured in minutes). This calculation is used by large drinking water systems as a tool for ensuring adequate inactivation of organisms during disinfection (Health Canada, 2012a,b).

In the case of a groundwater source that is less vulnerable to fecal contamination, primary disinfection may not be necessary for very small systems and micro-systems provided an annual sanitary survey / vulnerabilities assessment are conducted to ensure that the source is not subject to contamination, that conditions have not changed, and that routine monitoring and appropriate system maintenance is in place. A vulnerabilities assessment may not be required for micro-systems if conditions described in box 4.1 are met. In addition, if a comprehensive sanitary survey is conducted following the elements described it table 3.1, its frequency may be reduced to once every three to five years, as appropriate.

Where disinfection is practised, a residual of an acceptable disinfectant, typically chlorine, should be present at all times in the distribution system (*see section 5.3 for further information on chlorine residuals*). Free and/or total chlorine residuals should be tested when bacteriological samples are taken, as identified above, as well as independently. Chlorine residuals can be verified by a laboratory or by using an acceptable test kit (*addressed in section 6.3.3*). Additional testing of chlorine residuals could also be done to routinely monitor the integrity of the distribution system.

Note: Even in cases where a sanitary survey or vulnerabilities assessment suggests that disinfection is not required, periodic disinfection may become necessary in situations where the microbiological quality of the water deteriorates. For this reason, it is recommended that disinfection equipment and supplies, or an equivalent incident response mechanism (such as an alternative source or boil water advisory), be available to deal with potential occurrences.

5.0 Treatment and distribution systems

The properties of the treated water will be affected by the quality of the source water, treatment components and design, treatment processes and chemicals used, treatment efficiency, and distribution system characteristics.

5.1 Design of drinking water treatment systems

Treatment systems should be designed based on the site-specific raw water quality and quantity and should take into account seasonal variations. Because of the complexity of assessing the level of risk associated with drinking water hazards, as well as the need to properly design a water treatment system, the evaluation of the source water and the design and construction of the treatment facility should be performed by appropriately qualified specialists (e.g., registered professional engineers).

5.1.1 Continuous monitoring and automated systems

When considering the construction of a new treatment plant or upgrading an existing plant, it is recommended that the design include an automated, continuous monitoring system that allows an operator to control and monitor processes from a central location. When a plant does not have an operator present 24 hours per day, 7 days per week, such systems are capable of calling a designated location if there is a process failure during silent hours (DND, 2007). In addition, the use of some remote monitoring technologies, such as Supervisory Control And Data Acquisition (SCADA) or similar, allows the operator to make operational adjustments from a remote location. These products should be secure from accidental or deliberate interference.

Automation is advantageous in situations where an operator's duties are shared between different systems or different roles (i.e., not just drinking water) and when it is not possible for the operator to physically check equipment every day (including weekends). It can be used for any size of system; however, the utility of automation in a very small system would have to be assessed in terms of the costs and benefits related to the level of risk the water system represents to the users. The costs associated with the operator's time need to be assessed against the cost of the suggested equipment.

For very small systems, less sophisticated automated notification systems can be used to communicate alarms to an offsite location, such as a pager or phone, when a water quality parameter is out of compliance.

5.1.2 Surface water intakes

A surface water source requires an intake structure for drawing water into the water treatment plant. The main purpose of the intake structure is to draw in water while preventing leaves and other debris from clogging or damaging pumps, pipes, and other pieces of equipment in the treatment plant. The location of the water intake structure can greatly affect the quality of the water withdrawn. Ideally, the intake would be located upstream of any potential source of contamination or, if that is not possible, sufficiently downstream to minimize impact (Earth Tech, 2002). It should also be located deep enough under water to ensure that the water around it does not freeze in the winter, thereby ensuring water can be drawn year round, but far enough from the bottom of the water body to avoid sediments and mud.

Proper design, maintenance, and operation are essential to prevent partial or complete shut-down of the entire drinking water system.[2] Screens should be cleaned regularly to prevent

[2] Guidelines on screen designs to prevent fish entrainment are available from Fisheries and Oceans Canada. Intake construction should also be reviewed under the Navigable Water Act in consultation with the Coast Guard (Earth Tech, 2002).

blockage. Each spring, the lake or river intake pipe and screen should be inspected by divers to ensure no damage has occurred over the winter (DND, 2007).

5.1.3 Treatment options

The treatment process selected should address all potential hazards identified in the source assessment (Health Canada, 2001). Minimum treatment of all supplies derived from surface water sources and groundwater under the influence of surface waters should include disinfection and filtration (Health Canada, 2012a). For detailed information on water treatment technologies, see Holden (2001) and DND (2007).

5.2 Distribution systems

Drinking water distribution systems are made up of components that connect the water treatment plant to buildings, such as treated water reservoirs, water mains (distribution system pipes), service lines to individual buildings, backflow preventers, valves, hydrants, and, if required, pipe insulation and heating cables.

In general, the distribution system does not include in-home plumbing, point-of-entry or point-of-use treatment devices. However, in some situations, such as non-residential buildings and staff quarters, the plumbing may be considered part of the distribution system.

When a water source is provided by a municipality, the municipality's responsibility for the quality of the water generally ends at the curb or the point where the water enters the building's plumbing system. When a federal facility or First Nations community uses municipal drinking water as its supply, the beginning of the facility or community’s supply system marks the end of municipal responsibility. For instance, facilities in First Nations communities that receive water from the local municipality are responsible for properly maintaining a community water supply pipe and for monitoring the quality of water in that pipe. Should this pipe deteriorate, the water quality would suffer.

Regardless of the jurisdiction over the water source, all federal purveyors of drinking water, or, in the case of First Nations communities, Chief and Council, are responsible for ensuring the water in drinking water supply systems is tested to ensure contamination events are detected as soon as possible and can be appropriately addressed. The department or facility's responsibilities include routine maintenance of the facility’s plumbing system and analysis to determine if a change in water quality is occurring within the building. The plumbing systems in federal facilities must meet the National Plumbing Code of Canada and CSA Standard B64.10.01.

Federal facilities or First Nations communities that supply their own drinking water have to consider the distribution system from the water supply to the building or to the curb stop before the house (this may include water delivered by trucks) and then within the building to consumers. Other facilities may receive their water from municipal sources, but must still concern themselves with the distribution through the plumbing system within the building. First Nations communities are responsible for the routine maintenance of the plumbing in their homes.

A routine maintenance schedule for plumbing systems should include the following elements: inspecting the building's plumbing for cross-connections, pressure testing, flushing water lines (when warranted) and hydrants, regular disinfection of bottled water coolers and drinking fountains, and monitoring water quality. *See section 6.3 for further information on monitoring.*

In order to keep track of the infrastructure as it was built and changes made over time, it is important to keep up-to-date drawings on hand. These drawings should include notes describing all work and observations over time.

5.2.1 Design and assessment

Distribution systems, including treated water reservoirs, should be designed to take the following into account: public access, access by wildlife, system capacity, emergency water storage (including fire flow capacity), contact time required for disinfection, the minimization or elimination of dead ends, and cross-connection control. They should also be designed and constructed to comply with all local or provincial by-laws and regulations and take into account best management practices.

Portions of the infrastructure that are accessible to the public and/or animals should be secured, where applicable. Treated water reservoirs should be covered, watertight, and secured to prevent contamination.

When assessing the condition of water distribution systems, a two-phase approach is suggested. The first phase involves a preliminary assessment of the structural condition, hydraulic capacity, leakage and water quality on a system-wide basis using existing data. The second phase involves a more detailed investigation of specific problems based on findings of the preliminary assessment.

The most effective way to investigate the condition of a water distribution system is through regular analysis of readily available data. A preliminary assessment of this data should be conducted every three to five years to identify trends and to determine the need for more detailed investigations. If the preliminary assessment indicates that a more detailed investigation is needed, experts in distribution system analysis should do the work.

Descriptions of the components of the distribution system and guidance for investigating water distribution systems are found in Appendix E. Table E.1 summarizes the type of data that should be used to complete a preliminary assessment of each of the four common types of problems that can occur in water distribution systems.

For more information on the disinfection of water storage facilities, see AWWA's C650 series of manuals at www.awwa.org/store.aspx

5.2.2 Corrosion control

If not properly maintained, many water distribution system components (including plumbing) could lead to contamination of the water supply. Corrosion is a key issue, and can cause deterioration of water distribution systems in the following ways:

<u>Internal corrosion:</u>

- Impaired/poor water quality due to internal corrosion of unlined metallic components, biofilm build-up and/or poor maintenance practices.
- Reduced hydraulic capacity due to internal corrosion of unlined metallic components or calcium carbonate precipitation (e.g., scaling).

<u>External corrosion:</u>

- High leakage rate due to external corrosion of the infrastructure, through holes in pipe walls and/or deteriorating joints.
- Frequent breaks due to external corrosion, material degradation, poor installation practices, manufacturing defects and operating conditions (InfraGuide, 2002).

Health Canada and the CDW have developed guidance on corrosion control in drinking water systems. Further information can be found on Health Canada's website at www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php

5.2.3 Watermains

The condition of critical watermains should be monitored to minimize failures. Critical mains are typically those which serve as a trunk line to the smaller water lines. It is also important to monitor the condition of non-critical water mains. Failures should be "managed" to minimize operational and maintenance costs (InfraGuide, 2002).

Watermains may need to be replaced, or a structural liner may need to be used, if they fail because of high rates of breakage or excessive leakage. If hydraulic capacity or water quality are a concern, rehabilitation might be more cost-effective than replacement.

5.2.4 Cross-connection control

Cross-connections are physical links in the distribution system through which contaminants can enter the drinking water supply. This can happen when the pressure in a plumbing component connected to the distribution system is higher than that of the distribution system, an event commonly called back siphonage or backflow. When conducting a sanitary survey of a water system, it is important to include cross-connection control to ensure risks of contaminants entering the water system through backflow are identified.

The National Plumbing Code (NPC) is the over-riding code for cross-connection control and backflow prevention requirements. It stipulates the need to comply with the most recent version of the CSA B64 standard. Most jurisdictions have adopted the NPC. Purveyors may also have to meet additional requirements for their jurisdiction. The NPC applies from the property line into the facility. When a municipality is responsible for meters, valves, or other fittings within the property line, municipal codes or other by-laws may also apply.

Cross-connection control programs should be in place in order to prevent contamination. Such programs include (Holden, 2001; U.S. EPA, 2003; DND, 2007):

- Surveying existing buildings to rank the connections based on the degree of hazard that they present to the water supply. (Note: where a cross-connection can be classified at different degrees of hazard, purveyors should classify at the highest degree of hazard);
- Preparing a list of all testable backflow devices in the building's water system;
- Assessing new construction plans for cross-connection hazards;
- Installing proper backflow preventers;
- Instituting a tamper policy;
- Testing, inspecting, and maintaining devices;
- Setting out the qualifications required for a person to be allowed to perform a building's cross-connection control survey;
- Training and educating staff; and
- Establishing protocols for notifying the building owner or responsible party to test devices.

A cross-connection control survey, as well as testing backflow prevention or cross-connection control devices, should be conducted by a certified cross-connection control specialist or other qualified professional who has expertise in this area.

Devices used in the prevention of cross-connections and backflow may also deteriorate over time without regular maintenance and inspection, potentially allowing contaminants to enter the water system. Consequently, testing, inspecting, and maintaining cross-connection control devices must be done following manufacturers' instructions with guidance from CSA B64. For more detailed information on cross-connection control, the AWWA Standard (M14, listed below) can provide additional guidance. You may also wish to consult your local Canadian section of AWWA (*see www.awwa.org/awwa/membership/sections-your-local-awwa.aspx*) for additional information relevant to the Canadian situation. The InfraGuide document, "Methodology for Setting a Cross-Connection Control Program," outlines the differences between the CSA B64 and AWWA documents, which could be helpful in selecting the most appropriate approach. The CSA B64 Standard can be purchased online through CSA at http://shop.csa.ca/en/canada/invt/27013342007

Additional guidance is provided in other documents such as:

- AWWA Manual "Recommended Practice for Backflow Prevention and Cross-Connection Control (M14), Third Edition". (Available at: www.awwa.org/store/productdetail.aspx?ProductId=6706)
- AWWA Standard "C510-07: Double Check Valve Backflow-Prevention Assembly". (Available at: www.awwa.org/store/productdetail.aspx?ProductId=6859)
- AWWA Standard "C511-07: Reduced-Pressure Principle Backflow Prevention Assembly". (Available at: http://www.awwa.org/store/productdetail.aspx?ProductId=6860)
- AWWA's "Distribution Valves: Selection, Installation, Field Testing, and Maintenance (M44), Second Edition". (Available at: www.awwa.org/store/productdetail.aspx?productid=6732)
- InfraGuide. "Methodology for Setting a Cross-Connection Control Program". (Available at: www.fcm.ca/Documents/reports/Infraguide/Methodology_for_Setting_a_Cross_Connection_Control_Program_EN.pdf)
- U.S. EPA. "Cross-Connection Control Manual". (Available at: http://water.epa.gov/infrastructure/drinkingwater/pws/crossconnectioncontrol/crossconnectioncontrol_manual.cfm

Individual jurisdictions may have their own guidance manuals as well.

5.2.5 Dead ends and loops

Dead ends and loops within plumbing and distribution systems result in water remaining in pipes for an extended period of time. As the water stagnates, metal concentrations may increase as a result of the pipes leaching metals into the water. Bacteriological growth in stagnant areas is also a concern.

Problems may also arise as the result of low water use or water sitting in pipes overnight (or on weekends) when no one is at the facility. As it is not possible to eliminate these times of low use, it is advisable to allow for several minutes, or other appropriate length of time, of flushing when using water the morning following weekends or other periods of low usage. Automatic flushing hydrants are available to improve water quality at the end of lines.
The appropriate flushing frequency may be determined through a sanitary survey/vulnerabilities assessment process.

As part of a sanitary survey/vulnerabilities assessment process, facility managers should work to identify any dead ends or loops in the system and measure chlorine residual. They should give special attention to dead ends and loops in flushing and monitoring schedules. Generally speaking, it is a good idea to practice uni-directional flushing, create a written plan including valve-opening and closing sequences, and record turbidity levels and flow volumes and rates. In northern areas, it is necessary to have looped water networks designed to ensure the continuous flow of water. This serves as a means of anti-freeze protection.

5.2.6 Routine flushing of the plumbing system

Routine maintenance should include flushing water lines within a building. A minimum flushing regimen should be put into place, with flushing frequency based on the sanitary survey and vulnerabilities assessment. At minimum, it is suggested that water be flushed through the lines every 6 to 8 weeks in all inactive areas of the plumbing system (e.g., water fountains that are used infrequently, areas with dead ends or loops). The entire system should be flushed once a year. The sanitary survey and vulnerabilities assessment may identify site-specific problems that require more, or less, frequent attention.

5.2.7 Drinking water fountains

Drinking water fountains should be disinfected to ensure contamination does not occur at the spigot. Current industry standards recommend that fountains be disinfected a minimum of once every two months and at an increased frequency if heavily used. They should also be maintained according to the manufacturer's recommendations.

5.2.8 Recording and tracking maintenance issues

Main Breaks

Federal facilities and facilities in First Nations communities should record the location and details of water main breaks. Appendix F includes a form that summarizes the data that should be recorded for each break occurrence. The total number of breaks in a year should be compiled and reviewed to identify any trends (InfraGuide, 2002).

Low Pressure

The distribution system should be pressure-tested on a regular basis to ensure that flow pressure conforms to section 6.3 of the most recent version of the NPC (NRC, 2010). Low-pressure complaints should be recorded. If the number of complaints increases over time, it may suggest the hydraulic capacity of the system is deteriorating. A visual or camera inspection of the interior of water mains can help indicate the degree of flow restriction from corrosion. The inferior condition can also be determined by visually inspecting the water when a water main is flushed (InfraGuide, 2002).

A complete cross-connection control program includes training and education for staff. Employees who will administer the program need to be competent in the use of backflow testers, surveys, and device repair (U.S. EPA, 2003). Each department's training plan should address these needs.

5.2.9 Water quality complaints

A preliminary assessment of the water quality in a distribution system can be completed using routine water quality monitoring data, complemented by water quality complaint records. The water quality complaint records should be recorded and tracked in a manner similar to that for low-pressure complaints or breaks. Water quality complaints related to construction and maintenance activities (e.g., flushing, repairs, new construction) should be excluded from the analysis to properly reflect the condition of the system but should be reviewed to determine if operational changes are necessary.

On-going analysis of water quality data will indicate if the water quality is changing through the distribution system, both spatially and over time. Low chlorine residuals in some parts of a system, in combination with increased colour, high turbidity, increased iron, increased HPC, or drops in pressure or flow may demonstrate that the mains in these areas are deteriorating. Low chlorine residuals could also indicate deteriorating water quality. Similarly, the concentration of iron in the water may denote the degree of internal corrosion of unlined mains (InfraGuide, 2002).

5.3 Chlorine residuals

Disinfection is critical to ensuring the safety of the drinking water supply in the treatment plant. In addition to this primary disinfection, free and/or total chlorine is used in residual amounts to ensure continued disinfection throughout the distribution system (secondary disinfection) and to protect the water from re-contamination. Where there is a distribution system, a disinfectant residual (either chlorine or chloramine) should be maintained throughout the system at all times. The chlorine residual is the concentration of chlorine species present in water after the oxidant demand has been satisfied.

Tests of chlorine residuals at the drinking water treatment plant and in the distribution system are needed to determine chlorine dosage levels and to monitor water quality. A disinfectant residual should be detectable at all points in a distribution system. Maintenance of an adequate free chlorine residual will minimize bacterial regrowth in the distribution system and provide a measurable level of chlorine; therefore, a rapid drop in free chlorine concentrations suggesting unexpected changes in water quality can be more quickly detected.

A free chlorine residual of 0.2 mg/L is considered a desirable minimum level throughout the distribution system for control of bacterial regrowth. In the provinces and territories, specific requirements for chlorine residual concentrations are set by the regulatory authority and may vary between jurisdictions. Further information on chlorine residual can be found in the guideline technical document for chlorine (Health Canada, 2009c).

In the case of a very small system or micro-system that obtains its water from a groundwater source, and has little or no distribution system, no chlorine residual is needed.

More information on disinfection, including for groundwater issues, is found in Section 4.5.

5.4 Drinking water materials

Drinking water materials are materials that come into contact with drinking water for its treatment or distribution, from its intake at the source through the treatment plant and the distribution system and all the way to the consumer's tap (and beyond). These materials fall into three general categories: treatment devices (such as filters and reverse osmosis systems and their components), treatment additives (such as alum and chlorine) and system components (such as pipes and faucets). Drinking water quality concerns from these materials are generally related to:

- Leaching of contaminants from the material into the drinking water;
- Treatment devices not meeting manufacturers’ claims of efficiency for removing specific contaminants.

Health Canada does not recommend specific brands of drinking water treatment devices, but it strongly recommends that consumers look for a mark or label indicating that the device has been certified by an accredited certification body as meeting the appropriate NSF International (NSF)/American National Standards Institute (ANSI) health-based performance standards. These standards have been designed to safeguard drinking water by helping to ensure the material safety and performance of products that come into contact with drinking water. Certification organizations provide assurance that a product conforms to applicable standards and must be accredited by the Standards Council of Canada (SCC). An up-to-date list of accredited certification organizations can be obtained from the SCC (www.scc.ca).

NSF standards are widely accepted in North America. They reference and incorporate other relevant standards and protocols as appropriate. The NSF website (www.nsf.org) has information about both health-based and performance standards related to drinking water treatment devices. Standards exist for most drinking water treatment devices. The two key standards with respect to health effects are NSF/ANSI Standard 60: Drinking water treatment chemicals-health effects (which addresses treatment chemicals/additives; NSF, 2012a) and NSF/ANSI Standard 61: Drinking water system components-health effects (which addresses leaching from products that come into contact with drinking water, including pipes, fittings and coatings such as water storage tank liners; NSF, 2012b).

Plumbing systems (internal building distribution systems) within federal buildings and in First Nations communities must be designed and constructed to meet the National Plumbing Code of Canada (NPC). The NPC requires that plumbing products, at the time of installation, comply with a number of standards but in particular, Canadian Standards Association (CSA) standards for plumbing fittings, fixtures and backflow prevention. Many of the CSA standards are currently being harmonized with equivalent US standards. NSF/ANSI Standard 61 is incorporated in these standards, where applicable, to ensure that the plumbing components also meet minimum health effects requirements. Meeting the NPC may not be possible in places such as Canadian diplomatic missions in other countries. In these situations, minimum sanitary engineering practices should be met.

Any chemicals (additives) used in drinking water treatment processes and/or the distribution system must meet the applicable health-based standards established by NSF, namely NSF/ANSI Standard 60 (NSF, 2012). The NSF/ANSI standard ensures that treatment chemicals meet purity and performance requirements for drinking water applications but does not include product performance requirements. These are currently addressed in standards established by the American Water Works Association (AWWA). Because these AWWA standards complement NSF/ANSI 60, regulators generally recommend that products also meet the appropriate requirements specified in the AWWA standards.

Other international standards do exist (e.g., British Standards International) but do not currently address the health-based issues related to materials that come into contact with drinking water and therefore should not be considered equivalent.

5.5 Special circumstances

5.5.1 Alternative sources of drinking water

Departments may need to provide an alternative source of drinking water under certain circumstances, such as:

- If the water supply has become contaminated or is otherwise considered unacceptable;
- If there are problems in the distribution system or plumbing; or
- Simply for convenience.

One option departments may consider is to provide bottled water, including water from water coolers and/or dispensers. Although bottled water may be safe when it is delivered, precautions should be taken to ensure it does not become contaminated at the dispenser. *See Appendix H for details on how to maintain water coolers and dispensers.*

Outside of Canada, for example in Canadian diplomatic missions in foreign countries, the bottled water available is not necessarily safe. In foreign jurisdictions where no water quality results are available from the manufacturer, departments should ensure the safety of bottled water by conducting tests as per their own policies. For example, the Department of Foreign Affairs and International Trade requires that, for each bottled water provider, at least five samples from five different water bottles be collected and analysed (DFAIT, 2007).

5.5.2 Trucked (hauled) water

Remote locations, or those that do not have easy access to a reliable drinking water source, may have to rely on drinking water hauled to the site. No federal regulations relate to hauling potable water. Some provinces/territories have specific requirements for trucked water, and the guidance in this document is based mainly on these guidelines/standards. Hauled water to be used as a drinking water supply must meet the GCDWQ. The original source of the hauled water should be a water system whose treatment provides a disinfectant residual before being delivered to the truck (ADI Ltd., 2002a).

The sanitary condition of the transportation equipment is very important. The tank or container used to carry potable water and pumps, hoses, and other equipment used in the supply or delivery of the potable water should be maintained and operated in a clean and sanitary condition (Province of Alberta, 2003), and must be free of contaminants. The tank/container must not be used to transport other materials likely to contaminate that water (e.g., milk) (ADI Ltd., 2002a; Ministère du Développement durable, de l'Environnement et des Parcs du Québec, 2005), and must not have been used previously to transport a noxious, hazardous or toxic substance. The container should be constructed of materials that meet NSF/ANSI Standard 61 NSF, 2012b), and should allow easy access for cleaning. The tank/container used to transport the water should be disinfected on at least a weekly basis. When the container is filled or emptied, precautions must be in place to prevent backflow or back siphonage (e.g., through an air gap or double check valve assembly).

For information on disinfection of water storage containers, see the AWWA C650 series of manuals (found at www.awwa.org/store.aspx).

The outlet connections at filling points must be constructed and protected so contaminants cannot enter the water supply and so their nozzles are kept free of ice build-up during the winter. These inlets should be closed except when filling or cleaning the tank. Receiving tanks or cisterns should also be maintained in a clean and sanitary condition and should not be used for any other purpose (ADI Ltd., 2002a; Quebec Ministry of Environment, 2005). Receiving tanks or cisterns must be cleaned and disinfected before they are put into use and when the system or any of its parts are dismantled for repair, maintenance or replacement. Cisterns should be monitored for bacteriological parameters at least four times per year (Health Canada, 2007).

A disinfectant residual of at least 1.0 mg/L of total chlorine or 0.2 mg/L free chlorine should be present in the water at the time of delivery. The quantity of free chlorine residual should be measured once per day, in a water sample collected at the outlet of the tank truck. All data should be recorded in a register containing the data and results of the measurements and the name of the person who took them (ADI Ltd., 2002a; Quebec Ministry of Environment, 2005).

For an example of guidelines for ensuring the safety of trucked water, see the Quebec government's regulations in this area, at www.mddep.gouv.qc.ca/eau/potable/brochure-en/index.htm

6.0 Operational requirements

Federal departments and First Nations may benefit from the use of a quality management framework to manage their drinking water systems. A framework can help in coordinating existing or new operational activities, setting priorities and making decisions. It can provide a mechanism to identify and manage risks, apply and introduce measures for prevention, and achieve continuous improvement.

6.1 Operational plans

The purpose of an operational plan is to characterize the capability of the system to provide safe drinking water, identify areas requiring improvement, and to allow the implementation of corrective actions where necessary. The detailed operational plan forms the foundation for the quality management of the drinking water system.

Operational plans should be specific to each individual drinking water system, and prepared for each drinking water system or facility. Generic plans could be developed at a departmental level for office buildings serviced by municipal water. For leased buildings and/or office space, the department would need to negotiate with the other party to determine who is responsible for developing the plan. This responsibility should be clearly laid out in the lease. The operational plan for each facility should include detailed guidance or instructions related to monitoring, as well as for reporting and record-keeping. It should be developed in consultation with the system designer. In addition, operational plans should include:

- A system assessment noting where barriers are or should be in place;
- The identification of all activities and processes essential to the control of water quality (critical control points), including a list of preventive maintenance activities; and
- The identification of operational controls for each critical control point. This includes the monitoring methods for these controls to ensure proper performance and to trigger corrective actions in a timely fashion when required.

The operational planning process should include management and operational staff in order to develop specific and realistic written operational procedures. The operational plan should be revisited through audit, inspection, or self assessment cycles in order to continuously improve the system over time. The operational plan is intended to be revised as technologies, methods, and/or risks change.

6.2 Training and certification

All staff or personnel involved in drinking water quality management must be adequately trained for their role and function(s). This includes personnel whose duties relate only to distribution systems, including plumbing. Training should be planned, executed, and documented on a continuous basis and must be directly applicable and appropriate to the person's specific job and the type of facility being operated or managed (e.g., its classification, the size of the population served, the complexity of operation, and the source of raw water). Specific mechanisms should be developed for evaluating the appropriateness and effectiveness of the training. Regardless of whether an operator is certified, training is essential. Operators of federal drinking water treatment facilities must be trained to the appropriate level for their facility.

Management should support initial and on-going training and provide a training budget. Federal departments and First Nations communities should provide opportunities for their operators to participate in approved training. Many well-recognized training programs are available for drinking water treatment operators. Training sessions can range in rigour from educational seminars to certification courses with written examinations.

It is recommended that federal departments follow the Association of Boards of Certification (ABC) system for classification of facilities and certification of operators, used by most other Canadian jurisdictions. ABC has developed a designation for very small systems (defined by ABC as serving a maximum population of 100) which may be applicable to many federal or First Nations facilities. *More information on the ABC system can be found at www.abccert.org*

All operators are encouraged to participate in on-going training in an organized, continuing education setting by qualified instructors. This training may include formal classroom training, conferences, online and interactive presentations, seminars or hands-on workshops or training sessions. It can include training on new or revised operating procedures, reviews of existing operating processes, safety training, computer training and/or training in related environmental or technical areas (DND, 2007).

In the case of less complex treatment systems (i.e., a liquid chlorinator with no further treatment), operators may participate in system-specific training which would provide a site-specific equivalent to a certification for this role only. Such a certificate would not be recognized as valid at other facilities. It is especially important for operators of very small systems to meet one another and develop network contacts amongst their peers. These relationships can facilitate the use of best practices and encourage continuous improvement (ADI Ltd., 2002b).

Initially, operator certification should be encouraged on a voluntary basis. Over time, certification should become a mandatory requirement, though this may not be possible in some situations such as in Canadian diplomatic missions overseas. For departments with an "equivalent to certified" program, mandatory certification may not be required, but operators should aim to have an equivalent amount of training as their certified counterparts.

6.3 Monitoring

Monitoring the treated water helps assess the effectiveness of the treatment and determine the presence and concentration of disinfection by-products. Operational monitoring will help ensure the plant is operated effectively, while compliance monitoring ensures the water leaving the plant and distribution system meets the established requirements, typically the GCDWQ. Sampling at various points in the distribution system indicates the quality of water reaching consumers at the tap and identifies problems which may arise due to faults with the distribution system (Health Canada, 2001; CDW and CCME, 2002). *Specific guidance regarding monitoring frequencies, locations, and the interpretation of results is found throughout Chapter 4.*

Parameters and frequency of monitoring are dependent on many contributing factors including water source, historical results, population served, building factors, and local conditions. Routine monitoring should be performed to yield an overall understanding of drinking water quality, protect consumers, and increase acceptance and confidence in the water supply. Routine monitoring results can also serve as background data and can be used to compare water quality from one year to the next.

6.3.1 Operational monitoring

Operational monitoring practices focus on critical control points in the drinking water system to ensure the system is being operated as required. This type of monitoring allows the operator to detect changes in water quality and adjust the treatment process accordingly. In addition, increased monitoring during extreme conditions yields important information on the ability of the system to cope, and helps identify required improvements. Where feasible, continuous monitoring at plants is recommended for some parameters (e.g., chlorine residual, turbidity). Tests for operational monitoring do not need to go to an accredited lab.
Operational monitoring strategies should:

- be system-specific;
- be developed in the operational plan;
- facilitate more comprehensive documentation of the system; and
- foster due diligence.

6.3.2 Compliance monitoring

Compliance monitoring ensures drinking water reaching consumers meets established requirements. Every facility will need to develop its monitoring program based on the results of the vulnerabilities assessment, sanitary survey and baseline chemical analysis as discussed in Chapter 3. In addition, many federal departments and First Nations communities have their own documents and/or directives that provide guidance on monitoring frequency and related monitoring issues. The guidance in this document is meant to complement existing protocols.

Federal facilities that receive water from a municipal source will usually have to monitor only a few parameters that may be affected by the facility's plumbing (e.g., lead levels). Regardless, it is important to be aware of issues related to the municipal water source and obtain water quality reports from the municipal purveyor. Federal facilities and facilities in First Nations communities that supply and treat their own drinking water will have to implement a more comprehensive monitoring program.

In addition to making sure water entering federal facilities is of acceptable quality, federal staff are responsible for ensuring water does not become contaminated once it enters the facility (e.g., through leaching of metals from pipes). Results of water testing within the building should be compared with the results of testing at the treatment plant or in the distribution system (municipal or federal), conducted during the same time period, in order to identify any discrepancies. All discrepancies should be investigated and remedial actions taken as appropriate.

Collection and preservation of any other samples should follow procedures (collection, preservation, storage and shipment) recommended by the accredited laboratory analysing the samples.

6.3.3 Laboratory accreditation

Accreditation is the best mechanism to provide assurance to customers on the quality and competence of the laboratory. When testing and analysing water samples (with the possible exception of *E. coli* and total coliforms under the conditions outlined below), federal departments or, in the case of First Nations communities, managers and operators of facilities and technical support personnel, should use a laboratory accredited by one of the following: Canadian Association for Laboratory Accreditation (CALA), the Standards Council of Canada (SCC) or, in Quebec, the Bureau de normalisation du Québec (BNQ). Accreditation is awarded to a laboratory for each individual test (e.g., the analysis of pesticides in drinking water).

A list of SCC accredited labs is available on-line at http://palcan.scc.ca/SpecsSearch/SpecsSearchAction.do

Canadian diplomatic missions in other countries should use laboratory services accredited as meeting the International Organization for Standardization (ISO) standard IEC17025-1999, General Requirements for Competence of Calibration and Testing Laboratories. *A list of accredited laboratories worldwide can be found at www.ilac.org/index.php*

In the case of compliance monitoring for some microbiological parameters (i.e., *E. coli* and total coliforms), managers and/or operators of facilities may allow trained personnel to use portable test kits rather than an accredited laboratory. However, in order to ensure quality control, a minimum of 10% of all samples should be sent to an accredited lab for analysis or, if this is not physically possible, additional samples should be analysed using the kit for quality control purposes. Also, if using field-type kits, each new batch should be tested for accuracy.

Test kits should meet minimum requirements for accuracy and detection (sensitivity) for the contaminant of interest. When using test kits for monitoring purposes, the operator must ensure instruments are calibrated and reagents are not past their due date.

6.4 Operation of groundwater systems

Operating a groundwater system consists mainly of taking necessary measurements, maintaining yield, and preventing contamination. In general, wells should be pumped within specific pumping rates. When there is more than one well, they should be operated in rotation, if possible, to equalize wear on pumping equipment. If specified pumping rates are exceeded, sand and silt may pack in and around the well screen and clog it or may fill the voids in gravel-wall wells, reducing yield. Frequent starting and stopping of a well pump causes agitation in the aquifer around the well and may wash out sand or gravel, causing clogging or cave-ins that will reduce the yield. Any requirement for altering pump operation methods can be determined from well performance records and the quality of water produced (DND, 2007).

It is good practice to monitor the quantity of water produced from a well over time to verify that the pump is working properly and the well yield is not dropping. Some of these activities can be completed by installing a water meter at the wellhead and routinely reading it. Static and operating water levels should be measured and plotted to determine if a trend exists over time.

6.5 Records and record-keeping

Maintaining a system of documentation is essential to quality management. Monitoring all operational and compliance aspects of a drinking water system establishes on-going verification that the water is safe to drink and the operational plan is being followed.

Documentation is equally important as a tool for verifying that training activities are taking place and that corrective actions have been taken as required. It also helps track the continuous improvement of operations or policies. Comprehensive documentation is a fundamental requirement in the event that any operator or manager should be required to make a case for due diligence.

Finally, well-maintained documentation facilitates a more effective and meaningful audit process which in turn leads to continuous improvement of the managerial and operational strategy to provide safe drinking water.

All records, including “as built” construction records, should be maintained. Records related to policy and procedures must be retained for a minimum of five years and all other “routine” records must be maintained for two years (Library and Archives Canada, 2007). Records to be kept include:

- Reports from the municipality on the quality of drinking water from the municipal system (if municipally supplied water);
- Results of all bacterial and chemical analyses;
- All recorded chlorine residual and turbidity levels;
- A summary of analytical results obtained during the year, in table format;
- Reports of in-house operational procedures tests;
- Correspondence;
- Communications protocols;
- Maintenance reports;
- Assessment reports;
- Operational and maintenance manuals and “as-built” design drawings, including “life history cards” (these files contain data about each piece of equipment in the water system, including the date and conditions of installation, types of material, record of service problems/performance, and costs of operation and maintenance);
- Manufacturer’s information for each piece of equipment;

- Reports of any incidents, including remedial and emergency measures, boil advisories, shock chlorination, etc.;
- Auditor's reports;
- A record of corrective actions taken as part of operational controls, or in the event of non-compliant finished water; and
- Training records, including test results, relevance of training, and validation of the source of training.

6.6 Incident and emergency response plans

Federal purveyors of drinking water and, in First Nations communities, Chief and Council, should prepare and maintain written emergency and incident response plans to deal with events which occur outside of normal operating conditions. Such plans should also identify potential events. The water purveyor's response and remediation strategy will depend on the type of event affecting the water system (ADI Ltd., 2002b). Events that should be considered include extreme or unusual weather events, natural disasters, unplanned human activities, line breaks, valve replacements, or extended electrical power outages.

To address cases of a suspected/confirmed event of microbiological contamination (see Chapter 4), the plan should include the possibility that a boil water advisory may need to be issued. For extreme events where a significant chemical/radiological contamination has or is expected to occur, drinking water avoidance advisories may be issued. *Details about boil water advisories and drinking water avoidance advisories are given in Box 6.1.*

Incident response protocols should be established with the understanding that notification and reporting should be compatible with existing provincial / territorial approaches. These reporting relationships should be established well in advance and are fundamental to public health protection and due diligence. This type of integrated information sharing is typically the trigger for implementing appropriate response and keeps all agencies properly informed whether the incident originates at a federal facility or municipal supply.

One of the tools available to drinking water purveyors is a real time, Web-based alert and reporting system for drinking water advisories. It was developed collaboratively between Health Canada and the Public Health Agency of Canada (PHAC), and is a component of the Canadian Network of Public Health Intelligence (CNPHI), an interactive, web-based platform created by PHAC. The drinking water advisories module provides a means of real-time notification and information sharing regarding drinking water advisories. It is now available for use by agencies across Canada at no cost. *See appendix G for further information.*

***Box 6.1:** Incident response: Drinking water advisories*

Drinking water advisories

Drinking water advisories are public announcements to advise the public of an identified or expected risk to their water supply.

- Boil water advisories are related to possible or confirmed microbiological contamination of drinking water (including possible failures in the treatment or distribution system).
- Drinking water avoidance advisories are related to the chemical or radiological quality of the water, when the contaminant of concern may not be removed or inactivated by boiling.

Decisions concerning drinking water advisories are generally made at the provincial/territorial or local level, using a risk management/risk assessment approach based upon site-specific knowledge and conditions. Boil water advisories are used much more commonly than drinking water avoidance advisories.

Boil water advisories

Boil water advisories are generally issued as a result of a possible or confirmed microbiological contamination. They can be issued either as a precaution against or in response to a waterborne disease outbreak.

A number of factors may prompt further investigation or form the basis for issuing a boil water advisory. These include operational conditions such as local maintenance or emergency repairs in the distribution system; equipment malfunction during treatment or distribution; inadequate disinfection or disinfectant residuals; or situations where operation of the system would compromise public health. They also include water quality conditions such as significant deterioration in the microbiological quality or turbidity of the source water; sudden unexpected changes in water quality; unacceptable microbiological quality of treated water; unacceptable turbidity or particle counts of treated water; or where epidemiological evidence indicates that the drinking water is or may be responsible for an outbreak of illness (Health Canada, 2009a).

Drinking water avoidance advisories

Drinking water avoidance advisories are typically issued in emergency situations (e.g., chemical spill) to advise the public that they should avoid using their tap water, either completely or for specified uses.

Drinking water avoidance advisories would typically be issued following a catastrophic event such as a natural disaster or as a result of accidental or deliberate action, where the drinking water or its source may or has become heavily contaminated (usually by chemicals) and its use could pose a significant public health risk. These advisories are not intended to address short-term minor exceedances over existing MACs. Drinking water avoidance advisories rarely, if ever, require a cessation of supply, as the water will most likely be suitable for domestic purposes, such as flushing toilets and washing clothes, and necessary for essential services such as firefighting.

There are two types of drinking water avoidance advisories:

1. Where the contaminant is only of concern through ingestion, a "do not consume" advisory tells the public to avoid using the water for drinking; preparing food, beverages, or ice cubes; washing fruits and vegetables; dish-washing; and personal hygiene (such as brushing teeth);
2. Where dermal or inhalation exposure to the contaminant could affect the skin, eyes, and/or nose, a "do not use" advisory tells the public to avoid the water for any domestic purpose, including all uses identified for a "do not consume" advisory and activities such as showering and bathing (Health Canada, 2009b).

6.7 Compliance verification and reporting

Compliance verification and reporting activities are an essential part of any quality management approach. They provide an opportunity to evaluate performance related to each component of the federal framework identified in this document. They can also serve to identify issues and determine appropriate corrective measures in a timely fashion.

Such a process should be undertaken on a regular basis, to ensure the safety of drinking water is maintained through the risk management activities described in this document, and to be able to report on any progress or concerns.

In addition to routine compliance verification and reporting activities, internal or external audits should be undertaken at regular intervals (e.g., every five years) to ensure that:

- Policies and procedures are current and are being implemented as intended;
- A process for continuous improvement supports drinking water activities; and
- Responsible authorities can demonstrate at the headquarters, regional or site level how they meet the requirements and expectations outlined in this document.

An audit or verification is normally completed in three phases:

1. Planning: The objective of the pre-audit planning is to define the scope of the audit and identify specific activities to be conducted as part of the audit. The pre-audit file review should generate a list of items to be verified, and a list of questions or lines of inquiry. Activities may include a combination of interviews with managers or operational personnel and a review of documents such as engineering studies, monitoring records, policies or procedures.
2. Conducting the audit/verification: This process should be collaborative, transparent and non-adversarial, explain the scope and goals, provide an opportunity to raise questions and concerns, and allow reasonable flexibility in terms of timelines. It should follow the established scope and lines of inquiry to verify that observed operational activities and procedures are consistent with written policies and procedures, and identify inconsistencies as a deficiency. These should be brought to the attention of the appropriate personnel, together with a discussion of suggested corrective measures, prior to writing the final report.
3. Final reporting: The final report should include the timelines of the process, the scope, verification goals and lines of inquiry, the names and titles of participants, the findings of the process, as well as recommended corrective measures and timelines to address identified deficiencies.

6.7.1 Site level compliance verification

This level of audit activity is aimed to verify that operations and procedures at a given site are implemented as intended by the responsible authority. Site level verification goals will generally seek to confirm that the drinking water system is operated and managed in a manner consistent with the site operational plan and that issues have been documented and resolved with appropriate and timely corrective measures. This verification should confirm that aspects of drinking water management described throughout this document are being maintained in a manner appropriate to site characteristics.

Section 6.5 on records and record-keeping provides an overview of the types of documentation that should be maintained at the site. Auditors will want to confirm that site records are present and accurately reflect operations. This can be facilitated by making observations on-site, or by interviewing site personnel, for example.

As a general guide, lines of inquiry for the site level compliance verification may seek to confirm that:

- The operational plan is maintained and accessible;
- An appropriate vulnerabilities assessment has been carried out and is sufficiently current;
- The drinking water system design remains relevant and offers acceptable performance;
- Sanitary surveys have been completed with appropriate frequency and related preventive maintenance has been carried out;
- Monitoring activities and related corrective measures are carried out as required;
- An incident or emergency response plan is in place and properly maintained;
- Site personnel have received training appropriate to their roles; and
- Recommendations from previous compliance verifications have been addressed.

6.7.2 Corporate roll up

Findings and recommendations developed at the site levels should be rolled up at the corporate level. This allows departments to maintain a global understanding of the state of their drinking water systems and related priorities and to help inform responsible authorities to focus improvements in areas of greatest benefits, either to a specific site or to address departmental-wide gaps or issues (e.g., training, equipment upgrades).

Verification goals at the corporate level may seek to confirm that organizational drinking water policies and procedures are being implemented consistently across their sites and that progress on addressing broader organizational priorities can be demonstrated and evaluated.

6.7.3 Core federal reporting on drinking water management

Core reporting is important to ensure transparency at the federal level, and to allow departments to respond consistently to requests for compliance information from central agencies, the Commissioner of the Environment and Sustainable Development (CESD, Office of the Auditor General of Canada), senior management or the Canadian public. Core reporting should reflect the main activities that comprise drinking water risk management.

Core reporting will allow the federal government to demonstrate due diligence at the jurisdictional level, characterize priority areas and contribute to federal, provincial, territorial drinking water protection initiatives. The most important outcome of federal core reporting to agencies such as CESD will be an improved understanding of key risks and vulnerabilities across all areas of federal responsibility, which in turn will help central agencies to make informed decisions around funding and other resource priorities.

Based on Chapter 4 of the 2005 CESD Report, Safety of Drinking Water: Federal Responsibilities, core federal reporting should reflect how drinking water related risks are assessed and managed. Reporting should incorporate the following information:

- Water source (municipally supplied, surface or groundwater);
- Size and location of water treatment systems (accessible or remote);
- Water treatment system design and performance (disinfection, filtration);
- Distribution system design and status (age, condition, complexity); and
- Operational requirements (monitoring, testing, maintenance and training).

7.0 Information and resources

A number of federal programs and documents exist to support departments in carrying out their duties related to drinking water issues.

7.1 Health Canada

CDW and GCDWQ

Health Canada's Water and Air Quality Bureau plays a key role in the safety of drinking water by working with the provinces and territories, through the CDW, to establish the GCDWQ. The GCDWQ are used by every jurisdiction in Canada as the basis for their own enforceable drinking water quality requirements.

The role of the Water and Air Quality Bureau is one of scientific expertise and leadership. Following the priorities established by the CDW, it leads the development of health risk assessments for drinking water contaminants. These assessments can be presented either as guideline technical documents or as guidance documents. All these documents undergo public consultations.

All current documents, including the guideline Summary Table, guideline technical documents and guidance documents are available at the following address: www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php

Guideline technical documents

Guideline technical documents present the scientific and technical information that forms the basis for the establishment of a numerical guideline. They are developed for contaminants that meet all of the following criteria:

- Exposure to the contaminant could lead to adverse health effects;
- The contaminant is frequently detected or could be expected to be found in a large number of drinking water supplies throughout Canada; and
- The contaminant is detected, or could be expected to be detected, at a level that is of possible health significance.

The process remains flexible. Guideline technical documents may be developed for some parameters which do not meet all criteria (e.g., chlorine, ammonia), at the request of the CDW.

Guidance documents

The role of the CDW has evolved over the years, and new methodologies and approaches have led the CDW to develop a new type of document—guidance documents—to provide advice and guidance on issues related to drinking water quality for parameters that do not require a formal drinking water guideline.

If a contaminant of interest does not meet all the criteria for developing a guideline technical document, the CDW may choose to develop a guidance document. The CDW may choose to develop guidance documents in two instances. The first would be to provide operational or management guidance related to specific drinking water related issues (such as boil water advisories), in which case the documents would provide only limited scientific information or health risk assessment. The second instance would be to make risk assessment information available when a guideline is not deemed necessary.

Guidance documents undergo a similar development process to guideline technical documents, including public consultations through the Health Canada website. They are offered as information for drinking water authorities and, in some cases, to help provide guidance in spill or other emergency situations.

Federal role

The Bureau also plays a coordinating role at the federal level, to help ensure a consistent federal approach to drinking water quality. It provides the secretariat function and scientific expertise to the IWGDW, coordinating the update and publication of this federal guidance document.

Other activities

In order to help ensure the quality of drinking water nationally, and thereby protecting public health, the Bureau:

- Shares expertise and scientific advice with other government departments and organizations interested in drinking water issues, and with the public;
- Conducts scientific health assessments related to the GCDWQ;
- Participates in the development of standards for materials that come into contact with drinking water; and
- Provides advice and assists in emergencies such as chemical spills, on request.

Drinking water guidance values

Health Canada can develop a drinking water guidance value (DWGV) at the request of a federal department, a province, or territory, usually as a result of a spill or unexpected contamination. It is not based on thorough research of all existing studies; rather, it is developed for use within the department or government that has made the request. A DWGV is based on the scientific information available at the time of the request.

DWGVs are not subject to a review as detailed as the GCDWQ, which undergo internal peer review and public consultation before approval by the CDW and subsequent approval by the Federal-Provincial-Territorial Committee on Health and the Environment.

7.2 Interdepartmental Water Quality Training Board

The Training Board has focused its efforts in developing and disseminating training tools aimed at very small and micro-systems, filing a documented gap in resources and tools. This has been possible through the amalgamation of resources and expertise from all members. In recognition of this amazing collaboration between federal departments, the Training Board received in 2013 the Public Service Award of Excellence in the area of innovation.

The Training Board has developed the following documents and videos, which are all available in English, French and Spanish:

- Safe Drinking Water – Your Responsibility
- Water Sampling in Federal Facilities
- Ultraviolet & Reverse Osmosis for Micro-Systems
- Drinking Water Storage Tanks
- Bottled Water: Selection & Application in Federal Facilities
- Water Wells for Micro-Systems
- Water Filtration and Ion Exchange for Micro-Systems
- Disinfection for Micro-Systems
- Advice for the Operation of Potable Water Field Test Equipment
- Water Quality 101: Potable Water Micro-System Fundamentals (a course consisting of 10 modules and a supporting workbook, which may count as a half-credit in some certification programs).

The training materials from the Training Board are publically available through the Walkerton Clean Water Centre, at: www.waterqualitytraining.ca/docsAndInfo_e.php

7.3 InfraGuide

InfraGuide operated from 2001 to 2007 as a partnership between the Federation of Canadian Municipalities, the National Research Council and Infrastructure Canada. The program developed a series of how-to manuals, which address innovations and best practices related to drinking water quality, including treatment and distribution systems. *Further information can be found at www.fcm.ca/home/programs/past-programs/infraguide/program-resources.htm*

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9.0 Relevant legislation and policies

9.1 Titles

Canada Labour Code. R.S. 1985, c. L-2. Part II: Occupational Health and Safety, ss. 125(1)(j) and 125(1)(z.11). Available at: http://laws-lois.justice.gc.ca/eng/acts/L-2/index.html

- *Canada Occupational Health and Safety Regulations*. SOR/86-304, Part IX - Sanitation. s. 9.24 - 9.29. Available at: http://laws.justice.gc.ca/en/L-2/SOR-86-304/index.html
- *Aviation Occupational Safety and Health Regulations*. SOR/2011-87, Part IV - Sanitation. s.4.9 - 4.12. Available at: http://laws-lois.justice.gc.ca/eng/regulations/SOR-2011-87/index.html
- *Maritime Occupational Health and Safety Regulations*. SOR/2010-120, Part 4 – Sanitation. s.73-79. Available at: http://laws-lois.justice.gc.ca/eng/regulations/SOR-2010-120/index.html
- *On-Board Trains Occupational Safety and Health Regulations*. SOR/95-105, Part VI - Sanitation. ss. 6.9 - 6.24. Available at: http://laws.justice.gc.ca/en/L-2/SOR-87-184/index.html
- *Oil and Gas Occupational Safety and Health Regulations*. SOR/87-612. Part X - Sanitation. s. 10.19. Available at: http://laws.justice.gc.ca/en/L-2/SOR-87-612/index.html

Corrections and Conditional Release Act

- *Corrections and Conditional Release Regulations* (SOR/92-620) Section 83 (1) - Living Conditions. Available at: http://laws-lois.justice.gc.ca/eng/regulations/SOR-92-620/index.html

Food and Drugs Act (R.S.C., 1985, c. F-27)

- *Food and Drug Regulations* (C.R.C., c. 870), Division 12, Prepackaged Water and Ice,. Available at: http://laws.justice.gc.ca/en/F-27/C.R.C.-c.870/index.html

National Joint Council Occupational Health and Safety Directive

- Available at: www.njc-cnm.gc.ca/directive/oshd-dsst/index-eng.php

9.2 Excerpts

Excerpts of relevant texts are provided below, for information. It is important to note that these excerpts are included for information only and that the reader should refer to the official version.

Canada Labour Code

Part II -- Occupational Health and Safety

125. (1) Without restricting the generality of section 124, every employer shall, in respect of every work place controlled by the employer and, in respect of every work activity carried out by an employee in a work place that is not controlled by the employer, to the extent that the employer controls the activity,

(j) provide, in accordance with prescribed standards, potable water;

(z.11) provide to the policy committee, if any, and to the work place committee or the health and safety representative, a copy of any report on hazards in the work place, including an assessment of those hazards;

***Canada Occupational Health and Safety Regulations* (SOR/86-304)**
9.24 Every employer shall provide potable water for drinking, personal washing and food preparation that meets the standards set out in the *Guidelines for Canadian Drinking Water Quality 1978*, published by authority of the Minister of National Health and Welfare.

9.25 Where it is necessary to transport water for drinking, personal washing or food preparation, only sanitary portable water containers shall be used.

9.26 Where a portable storage container for drinking water is used,
- (a) the container shall be securely covered and closed;
- (b) the container shall be used only for the purpose of storing potable water;
- (c) the container shall not be stored in a toilet room; and
- (d) the water shall be drawn from the container by
  - (i) a tap,
  - (ii) a ladle used only for the purpose of drawing water from the container, or
  - (iii) any other means that precludes the contamination of the water.

9.27 Except where drinking water is supplied by a drinking fountain, sanitary single-use drinking cups shall be provided.

9.28 Any ice that is added to drinking water or used for the contact refrigeration of foodstuffs shall
- (a) be made from potable water; and
- (b) be so stored and handled as to prevent contamination.

9.29 Where drinking water is supplied by a drinking fountain, the fountain shall meet the standards set out in ARI Standard 1010-82, *Standard for Drinking-Fountains and Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers*, dated 1982.

***Aviation Occupational Safety and Health Regulations* (SOR/2011-87)**
4.10 (1) Every employer shall ensure that employees are provided with potable water in sufficient quantity for drinking, personal washing and food preparation.
(2) The potable water shall meet the microbiological quality guidelines set out in the *Guidelines for Canadian Drinking Water Quality*, prepared by the Federal-Provincial-Territorial Committee on Drinking Water and published by the Department of Health.

4.11 If a portable storage container for potable water is used,
- (a) the container shall be equipped with an airtight cover that can be securely closed;
- (b) the container shall be used only for the purpose of storing potable water;
- (c) the container shall not be stored in a washroom; and
- (d) the water shall be drawn from the container by a tap, a ladle used only for the purpose of drawing water from the container or any other means that precludes the contamination of the water.

4.12 If potable water is not supplied by a drinking fountain the employer shall provide sanitary single-use drinking cups or bottled water.

4.13 Any ice that is added to potable water or used for the contact refrigeration of foodstuffs shall be

(a) made from potable water; and
(b) stored and handled in a manner that prevents contamination.

***Maritime Occupational Health and Safety Regulations* (SOR/2010-120)**

73. (1) Every employer must ensure that employees are provided with potable water for drinking, personal washing and food preparation.
(2) The potable water must
(a) be in sufficient quantity to meet the purposes set out in subsection (1); and
(b) meet the quality guidelines set out in the most recent edition of Guidelines for Canadian Drinking Water Quality, prepared by the Federal-Provincial-Territorial Committee on Drinking Water and published by the Department of Health.
(3) Potable water for drinking must be available at all times for the use of every employee working on the vessel.

74. (1) Every employer must develop a potable water management program that sets out the testing procedures and frequency and the measures to be taken to prevent contamination.
(2) The potable water management program must be made readily available for inspection.

75. (1) Every vessel of 300 gross tonnage or more that is not a day vessel must have on board a supply of water that is available for all wash basins, tubs and showers and is sufficient to provide at least 68 l of water for each employee on the vessel for each day that the employee spends on that vessel.
(2) A day vessel must have on board at least 22.7 l of water for each employee on the vessel for each day that the employee spends on that vessel.

76. If it is necessary to transport water for drinking, personal washing or food preparation, only sanitary portable water containers must be used.

77. If a portable storage container for drinking water is used,
(a) the container must be securely closed;
(b) the container must be used only for storing potable water;
(c) the container must not be stored in a sanitary facility; and
(d) the water must be drawn from the container by
(i) a tap,
(ii) a ladle used only for the purpose of drawing water from the container, or
(iii) any other means that precludes the contamination of the water.

78. Any ice that is added to drinking water or used for the contact refrigeration of foodstuffs must be made from potable water, and stored and handled so as to prevent contamination.

79. If drinking water is supplied by a drinking fountain,
(a) the fountain must meet the standards set out in the Air-Conditioning and Refrigeration Institute (ARI) of the United States ARI 1010-2002, Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers; and
(b) the fountain must not be installed in a sanitary facility.

***On Board Trains Occupational Safety and Health Regulations* (SOR/87-184)**

6.19 (1) Subject to subsection (2), every employer shall provide employees with potable water for drinking, personal washing and food preparation that meets the standards set out in the publication entitled *Guidelines for Canadian Drinking Water Quality, 1978,* as amended in March 1990, published under the authority of the Minister of National Health and Welfare.
(2) An employer is not required to provide potable water for personal washing if waterless hand cleaning supplies are provided.

6.20 Where it is necessary to transport water for drinking, personal washing or food preparation, only sanitary portable water containers shall be used.

6.21 Where a portable storage container for drinking water is used,
(a) the container shall be securely covered and closed;
(b) the container shall be used only for the purpose of storing potable water;
(c) the container shall not be stored in a toilet room; and
(d) where the container is not a single-use storage container, water shall be drawn from it by
(i) a tap,
(ii) a ladle used only for the purpose of drawing water from the container, or
(iii) any other means that precludes the contamination of the water.

6.22 Except where drinking water is supplied by a drinking fountain or a single-use portable storage container, sanitary single-use drinking cups shall be provided.

6.23 Any ice that is added to drinking water or used for the contact refrigeration of foodstuffs shall be
(a) made from potable water; and
(b) stored and handled in a manner that prevents contamination.

6.24 Where drinking water is supplied by a drinking fountain, the fountain shall meet the standards set out in ARI Standard 1010-82, *Standard for Drinking-Fountains and Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers*, dated 1982.

***Oil and Gas Occupational Safety and Health Regulations* (SOR/87-612)**

10.19 Every employer shall provide potable water for drinking, personal washing and food preparation that meets the standards set out in the *Guidelines for Canadian Drinking Water Quality, 1978,* published by authority of the Minister of National Health and Welfare.

10.20 Where water is transported for drinking, personal washing or food preparation, only sanitary water containers shall be used.

10.21 Where a storage container for drinking water is used,
(a) the container shall be securely covered and labelled that it contains potable water;
(b) the container shall be used only for the purpose of storing potable water; and
(c) the water shall be drawn from the container by
(i) a tap,

(ii) a ladle used only for the purpose of drawing water from the container, or
(iii) any other means that precludes the contamination of the water.

10.22 Except where drinking water is supplied by a drinking fountain, sanitary single-use drinking cups shall be provided.

10.23 Any ice that is added to drinking water or used for the contact refrigeration of foodstuffs shall

(a) be made from potable water; and
(b) be so stored and handled as to prevent contamination.

10.24 Where drinking water is supplied by a drinking fountain, the fountain shall meet the standards set out in ARI Standard 1010-82, *Standard for Drinking-Fountains and Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers,* dated 1982.

Occupational Health and Safety Directive

This directive, hosted by the National Joint Council, was co-developed by participating bargaining agents and public service employers.

Part IX – Sanitation of the Directive enhances and supplements Part IX (Sanitation) of the *Canada Occupational Health and Safety Regulations* (SOR/86-304) and should be read in that context.

Scope: This part applies in all government-owned buildings. However, where employees occupy buildings not owned by the federal government, this part shall apply to the maximum extent that is reasonably practicable.

9.2 Care of Premises

9.2.3 With the advice of a qualified person and in consultation with the appropriate health and safety committee, departments shall establish contingency procedures for cases in which there is a temporary interruption in the supply of drinking water or to the water used to remove water-borne waste.

9.4 Water Quality

9.4.1 The employer will adhere, as a minimum, to the *Guidelines for Canadian Drinking Water Quality*, or to any other federally, provincially or territorially appropriate standards and any existing guidelines that provide the higher level of protection to workers.

9.4.2 Any storage container for drinking water shall be disinfected in a manner approved by a qualified person at least once a week while in use, and before the container is used following storage.

9.4.3 A fountain supplying drinking water shall not be installed in a personal service room containing a toilet.

Appendix A: Acronyms

ABC	Association of Boards of Certification
ANSI	American National Standards Institute
AO	aesthetic objective
AWWA	American Water Works Association
BNQ	Bureau de normalisation du Québec
CALA	Canadian Association for Laboratory Accreditation
CCME	Canadian Council of Ministers of the Environment
CDW	Federal-Provincial-Territorial Committee on Drinking Water
CESD	Commissioner of the Environment and Sustainable Development
CLC	*Canada Labour Code*
CNPHI	Canadian Network for Public Health Intelligence
CSA	Canadian Standards Association
CWWA	Canadian Water and Wastewater Association
DFAIT	Foreign Affairs and International Trade Canada
DND	Department of National Defence
DWGV	drinking water guidance value
GCDWQ	Guidelines for Canadian Drinking Water Quality
GOC	Government of Canada
GUDI	groundwater under the direct influence of surface water
HPC	heterotrophic plate count
ISO	International Organization for Standardization
IWGDW	Interdepartmental Working Group on Drinking Water
MAC	maximum acceptable concentration
NJC	National Joint Council
NPC	National Plumbing Code
NSF	NSF International
RA	responsible authority
SCADA	supervisory control and data acquisition
SCC	Standards Council of Canada

Appendix B: Glossary

For the sake of clarity, key terms have been defined in the glossary specifically for the purpose of this document. They may differ slightly from standard dictionary definitions.

Aesthetic Objective (AO)
Aesthetic objectives are established under the GCDWQ for parameters which may affect consumer acceptance of the water even though the substance in question is found at concentrations below which health effects appear. These parameters generally affect characteristics such as taste, odour and colour.

Aquifer
A geological formation of permeable rock, sand or gravel that conducts groundwater and yields significant quantities of water to springs and wells (CDW and CCME, 2004).

Baseline chemical analysis
An analysis of all chemical parameters with maximum acceptable concentrations (MACs) in the GCDWQ. The analysis should include screening for radiological parameters where feasible or warranted. Departments may also choose to include specific parameters with aesthetic and/or operational values. *See also "Sanitary survey", "Vulnerabilities assessment" and "Monitoring program".*

Biofilm
A community of microorganisms attached to a solid surface, such as the inside wall of a pipe, in an aquatic environment.

Boil water advisory
Advice given to the public by the responsible authority to boil their water to address microbiological concerns, regardless of whether this advice is precautionary or in response to an outbreak. Jurisdictions may use variances of this term, such as boil water order. *See Sections 4.4 and 6.6 (Box 6.1).*

Cistern
A small, covered tank, usually placed underground, in which potable water is stored for household purposes (AWWA, 2000).

Chlorine residual
Where chlorine or chloramine is used as a secondary disinfectant, chlorine residual is the concentration of chlorine species present in water after the oxidant demand has been satisfied.

Drinking water system
All aspects from the point of collection of water to the consumer (can include intakes, treatment systems, service reservoirs, distribution and plumbing systems, storage reservoirs and supply systems).

For the purpose of this document, federal drinking water systems have been broken down into the following categories:

- Large systems: serve more than 5000 people.
- Small systems: serve between 501 and 5000 people.
- Very small systems: serve between 26 and 500 people.
- Micro-systems: serve up to and including 25 people.

See also "Unique facility/situation".

Due diligence
Taking every precaution reasonable, in the circumstances, to avoid harm or loss. In the context of drinking water, taking every reasonable precaution means implementing the multi-barrier approach to safe drinking water (GOC, 2009).

Federal facility
Any federal government infrastructure that provides access to a drinking water supply, including, but not limited to, federal buildings and hand pumps designed to

provide drinking water, whether freestanding or not.

GCDWQ
Refers to the most recent version of the Guidelines for Canadian Drinking Water Quality. The GCDWQ are established by the CDW and establish limits for contaminants and parameters. These limits may be health-based (i.e., MAC) or not (i.e. AO, operational guidance value). *See Section 2.1 for more details.*

Guidance document
Document developed as part of the GCDWQ to: (1) provide operational or management guidance related to a specific drinking water-related issues (such as boil water advisories); or (2) make risk assessment information available when a guideline is not deemed necessary.

Guideline technical document
Document, developed as part of the GCDWQ, that provides the scientific and technical basis for the establishment of the guideline for a specific parameter, including any risk management decision.

Groundwater
The water found in underground aquifers which supplies wells and springs (CDW and CCME, 2004). For the purpose of this document, refers to groundwater from an aquifer where microbiological contamination is unlikely to occur due to the formation of the rock which protects the aquifer. It is typically determined by a hydrogeologist or other well specialist. In the contexte of this document, refers to a groundwater that is considered less vulnerable to fecal contamination. Note: all groundwaters may be at some risk of contamination, particularly from enteric viruses.

Groundwater under the direct influence of surface water (GUDI)
Any water beneath the surface of the ground with (i) the presence of insects or other microorganisms, algae, organic debris, or large-diameter pathogens such as *Giardia lamblia* or *Cryptosporidium*, or (ii) significant fluctuations in water characteristics such as turbidity, temperature, conductivity or pH which may closely correlate to climatological or surface water conditions (Adapted from AWWA, 2000).

Large drinking water system
See "Drinking water system".

Legislated installation
Term applied to "port of entry" installations (i.e., the land itself, physical infrastructure, operations, and all supporting services) provided at no cost to Her Majesty by third party owners and/or operators, as required by law (e.g., *Customs Act*).

Maximum acceptable concentration
MACs are the health-based limits for drinking water contaminants established in the GCDWQ. They are designed to protect human health, while being measurable and achievable at a reasonable cost.

Micro-system
See "Drinking water system".

Monitoring program
A plan that identifies the parameters that should be routinely monitored, and related details (e.g., frequency). A monitoring program is developed using information provided by the vulnerabilities assessment, sanitary survey and baseline chemical analysis. *See also "Sanitary survey", "Vulnerabilities assessment" and "Baseline chemical analysis".*

Plumbing system
A plumbing system (plumbing) is a building's internal piping system, starting at the curb stop. It includes water supply pipes,

fixtures and other devices; drainage and vent systems and connections within and adjacent to the building.

Quality management
The consistent and effective management and operation of all the components of the drinking water system, from source to tap. Verification tools and procedures, including monitoring, record-keeping, and evaluation processes such as third-party auditing, are required to achieve quality management.

Reservoir
An impounded body of water or controlled lake in which water can be collected and stored (AWWA, 2000).

Sanitary survey
An on-site review, from intake to tap, of a water utility's raw water quality, facilities, equipment, operations, and maintenance records for the purpose of evaluating the utility's ability to adequately treat source water in order to produce and deliver safe drinking water. Sanitary surveys vary depending on the type and complexity of the system. A sanitary survey, in combination with a vulnerabilities assessment and baseline chemical analysis, provides the information required to develop an appropriate monitoring program and treatment regime. *See also "vulnerabilities assessment", "baseline chemical analysis" and "monitoring program".*

Small drinking water system
See "Drinking water system".

Surface water
1) Any water body on the land surface, including running water (e.g., streams, rivers) as well as lakes, reservoirs and ponds. 2) Any water open to the atmosphere and subject to surface run-off.

Treated water reservoir
An enclosed storage facility or structure intended to hold finished (treated) water before it is distributed to consumers.

Unique facility/situation
Facilities or situations that require special attention in order to protect public health. Examples of unique facilities/situations include:

- Canadian diplomatic missions overseas;
- Remote locations within Canada;
- Seasonal facilities;
- Legislated installations;
- Water systems used for one-time large group events;
- Coast Guard and military vessels;
- Special dedicated-use bottling plants (e.g., Canadian Forces overseas);
- Large scale domestic humanitarian deployments; and
- Emergencies.

Very small system
See "Drinking water system".

Vulnerabilities assessment
A comprehensive assessment of the vulnerability of the source water in the environment. It includes three elements:

- Delineation of watersheds, aquifers and their protection areas;
- Identification of hazards, including contaminants of concern and their sources (where possible to determine);
- Assessment of susceptibility to contamination and ranking of the hazards.

See Chapter 3 for details. See also "Sanitary survey", "Baseline chemical analysis" and "Monitoring program".

Watershed
The area draining naturally from a system of watercourses and leading to one body of water.

Appendix C: Examples of types of drinking water-related roles and responsibilities within some federal departments

Responsible authority (RA)

The RA employs one or more persons and includes the RA's organization and any person who acts on behalf of the RA. In the context of drinking water programs, the term "RA" includes each department and all levels of management and, in the case of First Nations communities, Chief and Council.

As discussed, federal legislation and regulations require federal employers to provide employees with potable water meeting the GCDWQ. Although the employer may hire or designate a manager or operator-in-charge of drinking water systems, a duty remains with the employer to ensure all requirements of drinking water programs are met. This duty is met through a commitment to implement, validate and verify program elements, as well as through responding appropriately to complaints or deficiencies. The general and specific duties of the employer are found in the *Canada Labour Code*, Part II - Occupational Health and Safety, sections 124 and 125, respectively.

Manager or water treatment plant operator

The manager or water treatment plant operator is ideally an individual who is on-site at a facility on a daily basis. In situations where one person cares for many facilities, s/he would be expected to visit each one on a regular schedule.

The manager or operator-in-charge is responsible for ensuring the water treatment plant is operated in accordance with appropriate protocols and guidelines, as well as for ensuring water consumers have access to safe drinking water. S/he should assess the facility to identify any risks to drinking water quality. S/he should also develop a protocol specific to his or her facilities that references any applicable regulations (including the federal ones identified in Section 2.2 - 2.4) and that follows best management practices as detailed in Section 6.0. Other management duties include:

- Assessing the facility to identify risks to occupational and environmental health, specific to purveying drinking water;
- Developing a mitigation or remediation plan, including time frames, costs and risk statements, to correct deficiencies;
- Developing a training and information plan for the employees who operate and maintain facilities (see Section 6.2);
- Securing services from qualified, accredited laboratories and consultants, as required (see Section 6.3.3);
- Developing a records system for potable water management (see Section 6.5);
- Developing incident and emergency response plans, including a communications plan (see Section 6.6);
- Preparing an annual report on all aspects of the drinking water system, including incidents and remedial actions;
- Developing public information packages (Holden, 2001);
- Encouraging the use of best management practices for system operations; and
- Ensuring that an evaluation/audit procedure is in place (see Section 6.7).

The manager or operator-in-charge should also ensure that anyone affected by problems with the drinking water supply is notified and kept well informed of developments. Potential contacts include occupants, management, health and safety representatives at the facility, and the local Medical Officer of Health. Provincial regulatory branches could also be consulted. A process for notification is outlined in Section 6.6.

If the quality of the water at the facility is deemed unsafe, the manager is responsible for providing an alternate and safe supply of potable water for drinking, dental hygiene, and food preparation. Section 6.6 describes the requirements of a contingency plan.

Technical support staff for monitoring drinking water quality results

These staff members are responsible for ensuring that the quality of drinking water is being monitored and results interpreted and communicated with the RAs. In First Nations communities, these staff are known as Environmental Health Officers.

In some situations, technical support staff may sample and test drinking water quality. They are then responsible for following the sampling procedures outlined in Section 6.3 in order to ensure consistent and accurate test results. If a portable lab has been used, staff should ensure that the QA/QC procedures are followed. If a laboratory service is used, staff should verify that the laboratory service is accredited to perform testing of specific parameters. *See Section 6.3.3 for details.*

Drinking water monitor

In remote and isolated locations, including in under-developed countries, it may be most cost-effective to have portable laboratories available on-site for water quality testing. In such cases, a Drinking Water Monitor should be assigned responsibility for the on-going operation of the water laboratory. The responsibilities of the drinking water monitor include:

- Sampling and testing drinking water quality;
- Recording all results on water quality data sheets weekly and sending reports monthly to the appropriate health authority;
- Performing quality assurance tests on testing media according to the quality assurance plan developed in collaboration with the appropriate health authority;
- Immediately notifying the appropriate health authority if *E. coli* and/or total coliforms exceed the GCDWQ or when there are unusual changes in disinfectant residual (the health authority is notified so it can interpret the results and recommend further action); and
- Meeting regularly with the appropriate health authority throughout the year, as required, and reporting orally on program activities.

If a drinking water monitor is not available, then the technical support staff will fill the roles and responsibilities of the drinking water monitor (Health Canada, 2007)

Health and safety representatives

Health and safety representatives at the facility should be involved and informed throughout the testing procedure and involved with the communication process. They can reinforce communications made by the manager or operator in charge and may facilitate lines of communication by acting as liaisons between employees and management.

Appendix D: Sample Well Assessment Form

PART I: WELL SYSTEM INFORMATION / PARTIE I: INFORMATIONS GÉNÉRALES

SITE LOCATION IDENTIFICATION / Adresse du site étudié	DESCRIPTION OF WELL LOCATION / Décrire emplacement du puits	
HOW MANY WELLS ON SITE?/ Combien de puits sur le site?	POPOULATION BEING SERVED / Nbr. d'utilisateurs	WATER METER / Compteur ☐ YES/Oui ☐ NO/Non
WELL OPERATOR NAME / Nom du technicien, responsable du puits		WELL OPERATOR TELEPHONE / # de tél du technicien, responsible du puits
WELL OPERATOR ADDRESS / Adresse du technicien, responsable du puits		

PART II: WELL CONSTRUCTION INFORMATION PARTIE II: PARAMÈTRES STRUCTURELS DU PUITS

WELL DRILLER'S NAME, COMPANY, ADDRESS / Nom de l'entreprise de forage et adresse	POSTAL CODE / code postal	DATE WELL ORIGINALLY CONTRUCTED / Date de construction du puits
	WELL DRILLER'S TELEPHONE NUMBER / # de tél	DATE OF LAST RECONSTRUCTION / Date de dernière modification du puits
TYPE OF WELL / Type de puits ☐ DRILLED Foré ☐ DUG Creusé ☐ OTHER (SPECIFY) Autre (spécifier) ____________		WELL LOG AVAILABLE? / Dossier disponible sur le puits? ☐YES/Oui ☐NO/Non ATTACH COPY IF YES Si oui, annexer une copie
DEPTH OF WELL / Profondeur du puits m	DIAMETER OF WELL / Diamètre du puits m	WELL CAPACITY / Capacité du puits L/s
WELLHEAD ENCLOSURE / Enceinte de la tête de puits ☐ PUMP HOSE Station de pompage ☐ MANHOLE Trou d'homme ☐ OTHER (SPECIFY) Spécifiez ____________		

PUMP AGE / Age de la pompe	AVERAGE PUMPING RATE / Taux de pompage moyen L/s	ANNUAL VOLUME OF WATER PUMPED / Volume annuel pompé L/s	PUMPING CAPACITY / Capacité de pompage L/s
TYPE OF STORAGE / MOYEN DE RÉTENTION ☐ TANK Cuve ☐ RESEVOIR Citerne ☐ OTHER (SPECIFY) Autre (spécifier) ____________			STORAGE CAPACITY / Capacité de rétention L

PART III: HYDROGEOLOGIC INFORMATION PARTIE III: PROFIL HYDROGEOLOGIQUE

DEPTH TO PUMPING WATER / Profondeur de captage m or feet/pi	WELL ASSOCIATED WITH KNOWN AQUIFIER (IF YES, GIVE NAME) / Puits associé à un aquifère connu (si oui, nommer)	TYPE OF AQUIFER / Type d'aquifère
OTHER HIGH CAPACITY WELLS (30L/S) LOCATED WITHIN 300m RADIUS / Autre puits à haut débit (30L/s) dans un rayon de 300m)		ANNUAL RAINFALL / Précipitations annuelles m

PART IV: ASSESSMENT OF WATER QUALITY PARTIE IV: EVALUATION DE LA QUALITÉ DE L'EAU

HOW LONG HAS THE WATER SYSTEM BEEN IN EXISTENCE? / Depuis quand le système dàpprovisionnement est-il en opération?	HAS THE WELL EVER BEEN DEEPENED, CLEANED, RECONSTRUCTED? / Le puits a-t-il été recreusé, nettoyé, reconsturit? ☐ YES/Oui –WHY/Pourquoi ____________ ☐NO/Non
HAVE THERE EVER BEEN ANY WATER QUALITY PROBLEMS? / Y a-t-il déjà eu des problèmes de qualité de l'eau? ☐ YES — WHEN AND WHAT WAS THE CAUSE? ____________ ☐NO/Non Oui — Quand et quelle en était la cause?	

INDICATE RESULTS AND IDENTIFIED PROBLEMS FOR EACH OF THE FOLLOWING PARAMETERS (10 YEARS). Indiquez les résultats et problèmes identifiés pour chacun des paramètres suivants (10 dernières années).	
BACTERIOLOGICAL/Bactériologique COLIFORMS (coliformes)	
DISINFECTION BY-PRODUCTS/Désinfection BROMODI AND DIBROMOCHLOROMETHANE, CHLOROFORM (bromodi et dibromochlorométhane, chloroforme)	
PHYSICAL PARAMETERS/Paramètres physiques pH, COLOUR, ALKALINITY, CONDUCTANCE, HARDNESS, TURBIDITY, OTHERS (pH couleur, alcalinité, conductivité, dureté, turbidité, autres)	
INORGANIC PARAMETERS/Paramètres inorganiques NITRATES, FLUORIDE, SULFATES, AMMONIA, CHLORIDE, NITROGEN, OTHERS (nitrates, fluorures, sulfates, ammoniac, chlorures, azote, autres)	
METALS/Métaux CALCIUM, IRON, MAGNESIUM, MANGANESE, SODIUM Calcium, fer, magnésium, manganèse, sodium	

PART V: WATER TREATMENT INFORMATION
PARTIE V: INFORMATIONS SUR LE TRAITEMENT DE L'EAU

IS THE SOURCE TREATED? / L'eau est-elle traitée? ☐ YES – TYPE OF TREATMENT ____________________ ☐NO Oui – Type de traitement Non	PURPOSE OF TREATMENT / Raison du traitement
IS WATER CHLORINATED AT ANY POINT IN THE DISTRIBUTION SYSTEM? / L'eau a-t-elle été chlorée avant son arrivée au robinet? ☐ YES ☐ NO Oui Non	WHAT TYPE OF CHEMICALS ARE USED IN THE TREATMENT PROCESS? / Quels sont les produits chimiques utilisés dans le traitment?

COMPLETED BY / Complétée par	TITLE / Titre
SIGNATURE / Signature	DATE / Date
ORGANIZATION / Organisation	

(Canada Customs and Revenue Agency, 2002)

Appendix E: Distribution System

Table E.1 Investigation of water distribution systems (InfraGuide, 2002)

Problem	Preliminary assessment	Detailed investigation*
Structural condition	• Spatial and temporal analysis of water main breaks • Compilation of soil map • Routine inspection of valves and hydrants • Routine inspection of insulation and heat tracing in northern areas	• Detailed analysis of break patterns, rates and trends • Statistical and physical models • Pipe sampling • Soil corrosivity measurements • Pit depth measurements • Non-destructive testing • Failure analysis • Visual inspection • Thermal analysis (far north)
Hydraulic capacity	• Low-pressure complaints • Hydrant flow tests • Unusual rusty/coloured water occurrences • Visual inspection of pipe interior • Monitoring of pressure and pumping costs	• Hazen-Williams C factor tests (pipe roughness) • Computer modelling
Leakage	• Water use audit • Per capita water demand • Routine leak detection survey	• Leak detection survey • Detailed limited area leakage/demand assessment
Water quality	• Water quality complaints • Routine sampling data • Results of flushing program	• Detailed water quality investigation • Computer modelling

*** Reasons for more detailed investigation:**

Level of service

- Preliminary investigations indicate an excessive break rate, excessive leakage, inadequate hydraulic capacity and/or impairment of water quality.

Cost effectiveness, to facilitate capital planning and asset management programs:

- Pilot testing of new technologies to facilitate long-range planning support
- Opportunistic work, such as when a water main is temporarily out of service

Risk management

- Risk analysis identifies critical water mains that have a high potential for significant property damage, environmental impact or loss of service
- Due diligence (e.g., failure analysis of a failed critical water main)

Some distribution system-specific definitions

Vacuum breakers

Vacuum breakers are used to prevent backflow of water into the distribution system. These include atmospheric, hose bibb, and pressure vacuum breakers. These devices can provide protection against back-siphonage (the flow of water into the potable water system pipes caused by the sudden reduction of pressure in the potable water supply system) but should not be used to protect against back-pressure (when a facility's system pressure is greater than the supplier's system pressure) conditions (U.S. EPA, 2003; NRC, 2010). The selection, installation, maintenance and repair of these devices is to be done in accordance with Standard B64.10.01.

Valves

Valves are important devices in the distribution system. Their purposes include turning on, shutting off and regulating flow; providing air or vacuum release; and reducing pressure.

Isolation valves are the most common type used in distribution systems. Buried gate valves with valve boxes are typically used to isolate small-diameter water mains and water services, whereas butterfly valves are direct buried or installed in chambers and are typically used for large diameter mains. Isolation valves require regular exercise to ensure they are accessible, are in their proper position (open or closed), are operable and not leaking. Isolation valves are prone to deterioration and failures such as stripped, broken or bent stems; leaking O-rings or packing; corrosion of the valve body and connecting bolts; and wear on the valve disk and seat (InfraGuide, 2002).

Water storage

Ground storage reservoirs are large tanks made of concrete or metal located at ground level. Concrete tanks are usually buried to prevent freezing of their contents. Metal storage tanks, when used, are insulated and may have a steam line running from the boilers to keep them ice-free. Recirculation of water from top to bottom of the tank will minimize the heat required.

Elevated storage is provided by means of standpipes or tanks. As elevated storage is more difficult to keep from freezing, especially the water in the riser to the tank; steam or hot water lines can be installed in the riser and the riser can be insulated.

All reservoirs are to be covered to prevent contamination and pollution. The covers also safeguard against drowning. Covered reservoirs or tanks must have air vents to allow air in and out as the water level is changed and these vents must be screened to keep out insects and small animals. Access manhole covers are to be provided for cleaning and inspection purposes.

The security of water storage reservoirs is an increasingly important issue. Federal water reservoir access covers are to be locked and secured at all times (DND, 2007).

Appendix F: Watermain Break Report (Sample)

General

Date and time break reported:	____________
Time when water was shut off:	____________
Time when water was turned on:	____________
Properties affected:	____________
Air temperature:	____________
Repair by:	____________
Property damage:	____________

Location

Nearest property address:	____________
Distance from nearest property line:	____________
Distance from nearest intersection:	____________
Northing and easting:	____________
Isolation valves operated:	____________

Physical Data

Pipe diameter:	____________
Pipe material:	____________
Year of installation:	____________
Pipe wall thickness or pipe class:	____________
Type of lining:	____________
Type of joint:	____________
Type of water service:	____________
Normal operating pressure:	____________
Under boulevard or road:	____________
Depth of cover:	____________
Depth of frost:	____________
Type of native soil:	____________
Type of backfill:	____________
Soil resistivity:	____________
Soil sample collected (Yes / No):	____________
Pipe sample collected (Yes / No):	____________

Type of Failure

Circumferential break	□
Longitudinal break	□
Split bell	□
Corrosion pit hole	□
Leaking joint	□
Leaking valve	□
Leaking service connection	□

Probable Cause of Failure

Corrosion	□
Ground frost	□
Joint failure	□
Disturbance (third party)	□
High pressure	□
Frozen pipe	□

Type of Repair

Repair clamp	□
Replace pipe section	□
Replace valve	□
Replace service connection	□
Anode installed	□
Repair joint	□

Appendix G: CNPHI – Drinking Water Advisories Module

Drinking Water Advisories Application

The Drinking Water Advisories Application is a secure, web-based, pan-Canadian application within the Canadian Network for Public Health Intelligence (CNPHI). The application is available for use by agencies across Canada at no cost.

Drinking water advisories – measures to protect human health

- Boil water orders/advisories and drinking water avoidance orders/advisories are issued to protect the health of consumers when there is a potential or real situation in which the safety of drinking water may be compromised or threatened

Benefits of a nationally consistent real-time alert and response system

- Once a drinking water advisory has been issued, communication is key to ensure appropriate action is taken quickly. The CNPHI Drinking Water Advisories application provides a means of real-time notification and information sharing to address communication gaps and enhance the coordination of response efforts

- Regional health authorities and municipal, provincial, territorial or federal government departments can now be linked by a common information sharing platform

- All partner agencies can be immediately notified when advisories are issued, updated or rescinded, and kept informed on the status of all advisories

Analysis and reporting on a local, regional or national scale

- Users can employ custom query tools as needed for analysis and reporting on a local, regional, provincial/territorial or national basis on the causes of advisories and trends that can help define priority needs

- National analysis of advisories can help all jurisdictions work together to identify common root causes and promote actions that can help reduce the need for advisories, such as; infrastructure renewal, support for small community systems, and enhanced preparedness for events that challenge drinking water systems

Added to the CNPHI platform as a live application in 2008

- CNPHI is a suite of secure, web-based applications and resources designed to fill critical gaps in Canada's national public health infostructure. CNPHI Public Health Alert systems are organized into five areas: Respiratory, Enteric, Zoonotic, General and Adverse Events Following Immunizations alert systems

- There are currently over 5000 CNPHI users in health protection agencies across Canada; existing Public Health Alerts users can register to the Drinking Water Advisories application with no change to their existing username or password

- Registration of new users to the Drinking Water Advisories application is also quick and easy. Training and orientation materials are available within the application, and training web-casts are available from the CNPHI team upon request at any time

- Various information links and publications are accessible to users as an added value

- The Drinking Water Advisories application continues to evolve to meet the needs of a growing number of agencies in various jurisdictions, with the goal of achieving national coverage

Adaptable and evergreen

- Jurisdictions remain in control of how to best use the platform according to their needs, registering readers and writers according to roles and desired inter-agency communication linkages

- The application is an evergreen platform intended to improve and adapt over time in order to meet the needs of users working to protect the safety of drinking water and the health of consumers

- The CNPHI Drinking Water Advisories application is not intended to duplicate work or replace existing tools, and can be linked electronically with complementary systems already in place

Collaborating Centres

- Users of the CNPHI Drinking Water Advisories application can join or create collaborating centres and work towards solutions with partners coast to coast who are facing similar issues or challenges in their daily work

For more information please contact:
Tim Beattie, Health Canada; Phone: (613) 954-2461 Email: tim.beattie@hc-sc.gc.ca

Appendix H: Bottled Water Dispenser Maintenance

Note: This information can be found on Health Canada's website at:
www.hc-sc.gc.ca/fn-an/securit/facts-faits/faqs_bottle_water-eau_embouteillee-eng.php#A27

Cleaning your water cooler:

Reservoir

- Note: Clean your bottled water cooler before every bottle change.
- Unplug cord from electrical outlet of cooler.
- Remove empty bottle (carboy).
- Drain water from stainless steel reservoir(s) through faucet(s).
- Prepare a disinfecting solution by adding one tablespoon (15 mL) household bleach to one Imperial gallon (4.5 L) of water solution.

OR

- Some companies suggest using one part vinegar to three parts water solution to clean the reservoir of scale before cleaning with bleach. Check your manual.
- Note: Other disinfecting solutions may be suitable. Please check with your water cooler supplier/manual.
- Pour the bleach/other disinfection solution into the reservoir.
- Wash reservoir thoroughly with bleach solution and let stand for not less than two minutes (to be effective) and not more than five minutes (to prevent corrosion).
- Drain bleach/disinfection solution from reservoir through faucet(s).
- Rinse reservoir thoroughly with clean tap water, draining water through faucets, to remove traces of the bleach/disinfection solution.

Drip Tray (located under faucets)

- Lift off drip tray.
- Remove the screen and wash both tray and screen in mild detergent.
- Rinse well in clean tap water and replace on cooler.

Replacing Bottle

- Wash hands with soap and warm water before handling. If you choose to use clean protective gloves (ex. latex), discard or disinfect after each use and prior to reuse.
- Note: Protective gloves should never replace proper hand washing and hygiene.
- Wipe the top and neck of the new bottle with a paper towel dipped in household bleach solution (1 tablespoon (15 mL) of bleach, 1 gallon (4.5 L) of water). Rubbing alcohol may also be used, but must be completely evaporated before placing the bottle in the cooler.
- Remove cap from new bottle without touching the surface of the opening to avoid any contamination. Place new bottle on cooler.