Health Canada Santé Canada

Interdepartmental Working Group on Drinking Water

Guidance for providing safe drinking water in areas of federal jurisdiction

Version 1

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Canada

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Preface

The purpose of this document is to give clear guidance 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
- Residents of First Nations communities

All such facilities should meet the minimum guidelines 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.

It should be noted that the Canada Labour Code and its occupational health and safety regulations cover federal government employees in their location of work, and this document does not supercede it. Additionally, this document does not supercede unique medical and health protection responsibilities for the Canadian Forces 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. In such cases, these departments are encouraged to strive to meet the guidance to the best of their ability.

[1]Examples of unique facilities/situations include Canadian embassies overseas with water systems that have difficulty meeting Canadian standards of sampling, testing, operator certification, availability of regular training for operators, etc. Other examples are seasonal facilities or water systems used for one-time large group events, special dedicated-use bottling plants (eg: Canadian Forces overseas), large scale domestic humanitarian deployments, emergencies, etc.

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Collaboration between departments is key to developing consistent approaches across the federal government and in First Nations communities. This document has been developed by a working group representing federal government departments that have certain responsibilities for providing clean, safe and reliable drinking water to consumers.

The publication and distribution of this document is only possible thanks to the commitment and hard work of the following individuals.

Interdepartmental Working Group on Drinking Water - Current members

- Pushkar Godbole (co-chair) - Correctional Service Canada
- Patricia Lemay (co-chair) - Health Canada - Healthy Environments and Consumer Safety Branch
- Bill Schutzman - Agriculture and Agri-Food Canada
- Rob May - Agriculture and Agri-Food Canada
- Lily Hang - Canada Border Services Agency
- Michel Maillet - Correctional Service Canada
- Doug Spry - Environment Canada
- Richard Bourassa - Foreign Affairs Canada
- Eric Domingue - Foreign Affairs Canada
- Tim Beattie - Health Canada - Healthy Environments and Consumer Safety Branch
- Jennifer Mercer - Health Canada - First Nations and Inuit Health Branch
- Kristina Taracha - Health Canada - First Nations and Inuit Health Branch
- Veronique Morisset - Health Canada - Healthy Environments and Consumer Safety Branch
- Michael Roy - Indian and Northern Affairs Canada
- Jim Steeves - Indian and Northern Affairs Canada (PWGSC for INAC)
- Bob Hardy - National Defence
- Jean Héroux - National Defence
- Tag Shattuck - Parks Canada Agency
- Monique St. Amour - Public Works and Government Services Canada
- Carla Pino - Public Works and Government Services Canada
- Chris MacInnis - Public Works and Government Services Canada
- Ryan Gallant - RCMP
- Jessica Baird - Transport Canada

Interdepartmental Working Group on Drinking Water - Past members

- David Bennitz - Health Canada
- Dylan Hardy - Canada Border Services Agency
- Bertrand Haubert - Canada Border Services Agency
- Trevor Whitehouse - Canadian Coast Guard, Department of Fisheries and Oceans
- Barry Duchene - City of Ottawa Drinking Water Services
- Colin Park - Fisheries and Oceans Canada
- Christina Yagminas - Correctional Service Canada
- Pierre-Yves Caux - Environment Canada
- Stephanie McFadyen - Health Canada
- Ruth Plant - Health Canada
- Susan Clay - Health Canada - Workplace Health and Public Safety Programme
- Ian Corbin - Indian and Northern Affairs Canada
- Pierre Lamontagne - Indian and Northern Affairs Canada
- Geoff Kendell - Indian and Northern Affairs Canada (PWGSC for INAC)
- Stephen McCanny - Parks Canada Agency
- Brian Milne - Public Works and Government Services Canada
- Craig Legare - Public Works and Government Services Canada
- Shirley Shea - Public Works and Government Services Canada
- Andrea Cherry - Public Works and Government Services Canada
- Anne Seguin - RCMP

Health Canada's Water Quality and Health Bureau - Secretariat to the Working Group

- Joyce Mortimer
- Will Robertson
- France Lemieux

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Glossary

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

Aesthetic Objective (AO)
Aesthetic objectives address 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.(15)

Aquifer
A geological formation of permeable rock, sand, or gravel that conducts groundwater and yields significant quantities of water to springs and wells.(21)

Baseline Chemical Analysis
Analysis of all *Guidelines for Canadian Drinking Water Quality* for chemical parameters (including initial screening for radiological parameters) with Maximum Acceptable Concentrations (MACs). As part of this analysis, departments may choose to look at aesthetic parameters and operational guidance values as well. (See also Sanitary Survey, Vulnerabilities Assessment, and Monitoring Program).

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

Boil Water Advisory
For the purpose of this document, the use of the term 'boil water advisory' is taken to mean advice given to the public by the responsible authority to boil their water, regardless of whether this advice is precautionary or in response to an outbreak. (See Appendix 7 for guidance regarding boil water advisories). Depending on the jurisdiction, the use of this term may vary. As well, the term 'boil water order' may be used in place of, or in conjunction with "boil water advisory."

Cistern
A small, covered tank, usually placed underground, in which potable water is stored for household purposes.(3)

Distribution system
A network of pipes leading from a well or treatment system to consumers' plumbing systems.

Drinking Water
See "potable water."

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

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

- *Large system:* serves more than 5000 people
- *Small system:* serves between 500 and 5000 people
- *Very small system:* serves fewer than 500 people

Drinking water systems serving less than 50 people are also included in the "very small system" category if they are owned or leased by the federal government such as those serving:
a) federal employees in federal facilities;
b) federal employees (and their family / visitors) living in residences provided by the federal government as a condition of employment;
c) members of the Canadian Forces;
d) inmates of federal correctional facilities; and,
e) visitors to federal facilities.

Due diligence
Due diligence is the measure of prudence, activity or assiduity that is properly to be expected from, and ordinarily exercised by, a reasonable and prudent person under the particular circumstances. (53)

Employer
An employer is a person who employs one or more persons (and includes an employers' organization and any person who acts on behalf of an employer). In the context of the drinking water program, the term "employer" covers each department and all levels of management.

Federal facility
Any federal infrastructure that provides access to a drinking water supply. This includes, but is not limited to, federal buildings, and hand pumps designed to provide drinking water, whether freestanding or not.

Federal Jurisdiction
A government's general power to exercise authority over all persons and things within its territory (25). For the purposes of this document, unless the context indicates otherwise, "federal jurisdiction" refers only to those elements of federal jurisdiction mentioned in the Preface.

Good Manufacturing Practices
Good Manufacturing Practices (GMP) relate to quality assurance programs that a manufacturer would establish to ensure that its products are consistently produced to the safety and quality standards appropriate to their intended use. They are conditions specific to the product being manufactured. In the case of bottled water, the Canadian Food Inspection System Implementation Group has developed a code of hygienic practice (Code of Hygienic Practice for Commercial Prepackaged and Non-Prepackaged Water) which provides guidance on what could be considered GMP for bottlers of water. The document is available at: http://www.cfis.agr.ca/english/regcode/bw/bwcode_e.shtml

Groundwater
The water found in underground aquifers which supplies wells and springs.(21) For the purpose of this document, groundwater refers to groundwater sources that are NOT under the direct influence of surface water.

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

Guideline
For the purpose of this document and unless specified otherwise, the term guideline refers to the most recent version of the *Guidelines for Canadian Drinking Water Quality*. These guidelines 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 established by the Federal-Provincial-Territorial Committee on Drinking Water (see Section 2.1 of this document for more details).

Large drinking water system
See "drinking water system."

Maximum Acceptable Concentration (MAC)
Maximum acceptable concentrations are the health-based limits for drinking water contaminants established in the *Guidelines for Canadian Drinking Water Quality*. They are designed to protect human health, incorporating safety factors and assuming exposure over a lifetime.

Monitoring program
A list of substances that should be routinely monitored. A sanitary survey, in combination with a vulnerabilities assessment and baseline chemical analysis, will provide the information required to develop an appropriate monitoring program and treatment regime. (See also Sanitary survey, Vulnerabilities Assessment and Baseline chemical analysis).

Operator training classification
Definitions of Class I to IV and including certification for "very small systems," based on the ABC certification structure and guidelines (See Section 7.2).

Plumbing
A building's distributing pipes for bringing in the water supply and removing liquid and waterborne wastes. It includes pipes, fixtures and other apparatuses, soil, waste and vent pipes, along with connections within and adjacent to the building.

Potable water
Water that is safe and satisfactory for drinking and food preparation (Synonym: drinking water)

Quality management
The consistent and effective management and operation of all the components of the drinking water system, from source to tap. In order to achieve quality management, verification tools and procedures must be in place, such as monitoring, record-keeping, and evaluation processes such as third-party auditing. In this document, quality management focusses on intake to tap.

Reservoir
An impounded body of water or controlled lake in which water can be collected and stored.(3)

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. The sanitary survey will vary depending upon the type and complexity of the system. A sanitary survey, in combination with a vulnerabilities assessment and baseline chemical analysis, will provide the information required to develop an appropriate monitoring program and treatment regime. (See also Vulnerabilities Assessment, Baseline Chemical Analysis, and Monitoring Program).

Shock Chlorination
The addition of a strong solution of liquid chlorine into a drinking water system to reduce the presence of microbiological contaminants.

Small drinking water system
See "drinking water system."

Surface water
Surface water is i) any water body on the land surface, including running water such as streams, rivers and brooks, or quiescent water such as lakes, reservoirs and ponds. ii) water open to the atmosphere and subject to surface run-off.

Treated Water Reservoir
An enclosed storage facility/structure intended to hold finished (post-treatment) water before it is distributed to consumers.

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

- Canadian embassies overseas with water systems that have difficulty meeting Canadian standards of sampling, testing, operator certification, availability of regular training for operators, *etc.*
- Remote locations within Canada
- Seasonal facilities
- Water systems used for one-time large group events
- Special dedicated-use bottling plants (*e.g.*, Canadian Forces overseas)
- Large scale domestic humanitarian deployments
- 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 Section 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.

Introduction

In Canada, the responsibility for providing clean, safe and reliable drinking water to the public generally lies with the provincial and territorial governments.

That said, the federal government 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.

In some cases, departments may have responsibilities for drinking water right from the source through to the tap. In others, departments may only be responsible for the quality of drinking water after it enters a federal building or facility and until it reaches the consumer.

The goal of the federal drinking water program is to protect the health of consumers by providing them with a clean, safe and reliable supply of drinking water. As a matter of policy, the onus for making sure these supplies are safe rests with each department.

Departments demonstrate the safety and reliability of their supplies through their monitoring programs, developed through and complemented by periodic sanitary surveys, vulnerabilities assessments and chemical baseline analyses.

Departments, and other responsible authorities, accountable 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 source 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:

- The size and location of drinking water systems: Most federal drinking water systems are very small, serving fewer than 500 people. In addition, many of these systems are located in remote areas, in countries where water supplies may be unreliable,[2] or on-board airplanes and ships, including Coast Guard and military vessels.

- Jurisdiction(s) responsible for the source water: In some cases, the federal government has jurisdiction

[2] A concern for Canadian diplomatic missions and Canadian Forces personnel

over the land which contains the source used for drinking water at a given facility and is also the operator of the facility. In many situations, though, the water source falls under the jurisdiction of a provincial government and the drinking water treatment plant is operated by a public or municipal utility. In remote locations, drinking water may need to be hauled into a community by truck. In other cases, the only practical water supply may be bottled water.

- Cost of infrastructure: 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.

- Cost of water quality monitoring: The costs associated with water quality monitoring are based on the number of samples and the type and frequency of tests conducted, not 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.

- Jurisdictional issues: Because of challenges related to the source water responsibilities or to cost issues, the federal government may enter into agreements with other governments or third parties to provide drinking water to its facilities. In some cases, the lines of responsibility may not be clear.

- 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. Some departments may not have adequate funding structures or agreements in place to cover these costs.

Purpose

The purpose of this document is to give clear, consistent guidance on how to implement the *Guidelines for Canadian Drinking Water Quality* and the Canada Occupational Health and Safety Regulations of the Canada Labour Code. 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. These employees could be at a management or policy-setting level, or could be directly responsible for drinking water supplies, such as treatment plant operators or drinking water monitors.

Technical standards, benchmarks and targets for water quality are provided to assist federal departments and responsible authorities to meet the *Guidelines for Canadian Drinking Water Quality* and drinking water-related regulations. Meeting these requirements will ensure a more consistent approach to managing drinking water systems across areas of federal jurisdiction.

All affected departments and authorities are encouraged to at least meet the minimum guidance set out in this document in order to protect the health of the people they serve. In some cases, it may be preferable for a department to meet more stringent objectives than those detailed in this document. This decision is left to the discretion 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 a timely manner. In such cases, these departments are encouraged to strive to meet the guidance to the best of their ability.

Scope of this document

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
- Residents of First Nations communities

The guidance in this document applies to facilities owned by and/or leased to and/or funded by the federal government.

The document describes the requirements for conducting assessments; for designing, operating, and maintaining drinking water treatment and distribution systems; 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 guidance document is meant to complement such efforts.

Given that the majority of federal water systems supply drinking water to fewer than 500 people, the guidance contained in this document relates primarily to very small drinking water systems.

While this document recognizes the importance of managing drinking water from source to tap, source water issues are touched on only briefly. Waste water issues are considered to be beyond the scope of this document.

How to use this document

The document is divided into two main parts: **Part 1: The Federal Framework** (Sections 1 and 2) and **Part 2: Application of the Federal Framework** (Sections 3 to 8).

Part 1: The Federal Framework

Section 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 sections.

Section 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

Section 3: Surveys, Assessments and Monitoring outlines the steps involved in developing a monitoring program, including the choice of the source water, and conducting vulnerabilities assessments, the sanitary survey and the baseline chemical analysis.

Section 4: Technical Standards, Benchmarks and Targets is a summary of the standards, benchmarks and targets that federal drinking water purveyors must strive to meet.

Section 5: Treatment System Design and Maintenance looks at various design and maintenance issues related to the treatment system.

Section 6: Distribution System Design and Maintenance looks at various design and maintenance issues related to the distribution system, including the distribution of drinking water within buildings and other federal facilities (*i.e.,* plumbing systems).

Section 7: Operational Requirements provides guidance on a range of issues, including operational planning, operator certification, monitoring requirements, record-keeping, incident and emergency response planning, and audits.

Section 8: 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

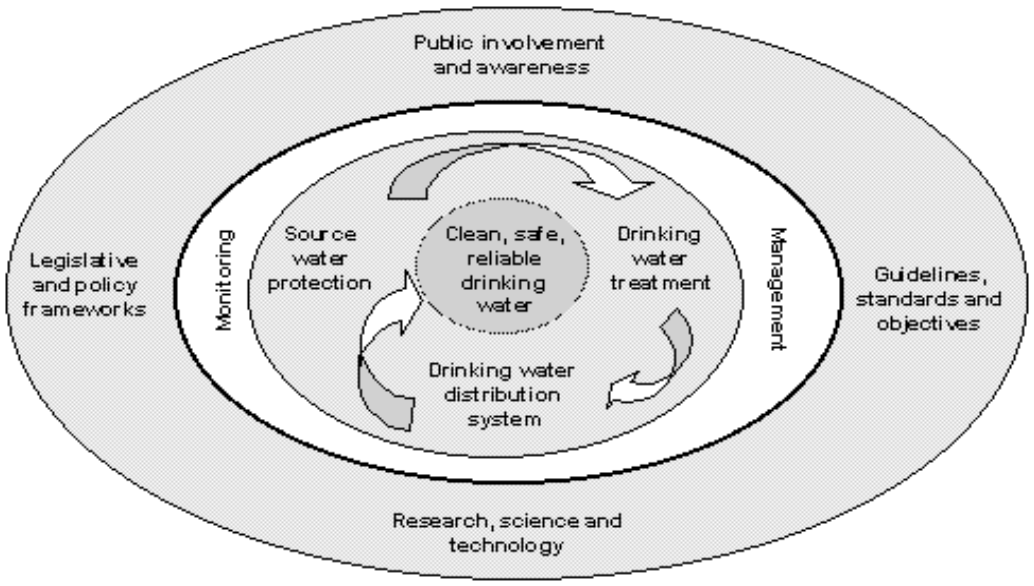
The drinking water system can be broken down into three main components: the water source, the treatment system and the distribution system. In each of these areas, steps can be taken to reduce the likelihood of contamination before it occurs. The multi-barrier approach to safe drinking water reflects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

Variability in source water locations, types of source waters (surface water, groundwater, groundwater under the influence of surface water), and range of water treatment processes available make it unlikely that a single solution can be applied to correct every abnormal water analysis result 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.

The multi-barrier approach is an integrated system of procedures, processes and tools that collectively prevent or reduce the contamination of drinking water.

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 of the management and operation of the drinking water system. These include stakeholder commitments to develop legislative and/or policy frameworks;

Figure 1.1: Elements of the multi-barrier approach to safe drinking water



guidelines, standards and objectives; research, science and technology solutions, and consumer awareness and involvement.

Figure 1.1 shows how these elements work together to ensure the safety of the drinking water supply.

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 by federal departments or in First Nations communities should meet the quality benchmarks set out in the *Guidelines for Canadian Drinking Water Quality* (discussed in Section 2.1).

For more information on the multi-barrier approach and its application to drinking water systems, see "From Source to Tap: Guidance on the Multi-Barrier Approach to Safe Drinking Water" published jointly by the Federal-Provincial-Territorial Committee on Drinking Water and the Canadian Council of Ministers of the Environment (CCME). This document can be downloaded from Health Canada's website at http://www.hc-sc.gc.ca/waterquality or CCME's website at http://www.ccme.ca/sourcetotap/mba.html

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 responsibilities for drinking water quality, including on federal lands and in First Nations communities.

North of 60, the Territorial governments are responsible for ensuring safe drinking water in all communities in their territories, including First Nations and Inuit communities. Responsibility for drinking water quality monitoring and boil water advisories reside with the Territorial governments and Indian and Northern Affairs Canada.

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, the federal government has a legislated duty as an employer to provide potable water to its employees.

In other cases (*e.g.*, visitors to federal lands), ensuring the safety of drinking water supplies is more a matter of due diligence. The issue of due diligence is discussed further in Section 2.6.

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 *by* a third party, it is the government's responsibility as the employer to provide potable water (see the Canada Labour Code, Section 125 (part II)).

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 Section 8: 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).

Large systems serve more than 5000 people.

Small systems serve 500 or more people but fewer than 5000.

Very small systems serve fewer than 500 people.

Drinking water systems serving less than 50 people are also included in this category if they are owned or leased by the federal government such as those serving:
a) federal employees in federal facilities;
b) federal employees (and their family / visitors) living in residences provided by the federal government as a condition of employment;
c) members of the Canadian Forces
d) inmates of federal correctional facilities; and
e) visitors to federal facilities.

In addition to these categories, **unique facilities** exist, or situations may arise, that require special attention in order to protect public health. Examples of unique facilities/situations include:

- Canadian embassies overseas with water systems that have difficulty meeting Canadian standards of sampling, testing, operator certification, availability of regular training for operators, *etc.*
- Remote locations within Canada
- Seasonal facilities
- 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
- Emergencies

In these contexts, it is up to the department in question to determine the most appropriate means of supplying safe drinking water to consumers.

2.0 Federal Legislation and Policies

2.1 The *Guidelines for Canadian Drinking Water Quality*

Recognizing that safe drinking water is a core public health issue, the federal government works in close collaboration with the provincial and territorial governments to develop the *Guidelines for Canadian Drinking Water Quality.*

These guidelines 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 support drinking water requirements in all Canadian jurisdictions.

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 guidelines include bacteriological parameters (*E.coli*, total coliforms, HPC, and emerging pathogens), protozoa, and viruses.

Turbidity, while not a microbiological parameter *per se*, is considered an important surrogate measure of microbiological quality because increased turbidity may be associated with a contamination episode and because turbidity may interfere with disinfection.

Health-based guidelines have also been developed for a number of chemical and radiological substances that are found in drinking water supplies across Canada. Some of these substances may only be found at some locations (*i.e.,* are site-specific), meaning they may not be a concern for every drinking water supply.

Aesthetic and operational guidelines have also been developed. These guidelines address 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.(15)

Because guidelines are re-assessed on an as-needed basis and new guidelines are continually being developed, Health Canada's website (see below) should be checked on at least an annual basis.

Although various editions of the *Guidelines for Canadian Drinking Water Quality* have been referenced, it is recommended to use the most up-to-date version, the 6th edition, as modified by the *Summary of Guidelines for Canadian Drinking Water Quality*, which can be downloaded from Health Canada’s water quality website at http://www.hc-sc.gc.ca/waterquality. All guideline values and supporting documentation are posted on this website. Appendix 2 provides the complete address for this summary table.

To help stakeholders stay current, Health Canada's Water Quality and Health Bureau also moderates a listserv that automatically notifies subscribers of changes to its website, including updates to the guidelines.

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 Safety and Health Regulations*, the *Aviation Occupational Safety and Health Regulations*, the *Marine 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 *Canada Labour Code*. Section 125 (1)(j) in Part II requires federal employers to provide potable water to employees in accordance with prescribed standards which are set out in the *Guidelines for Canadian Drinking Water Quality*.

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. *An unofficial consolidation may be found on the Internet at http://laws.justice.gc.ca/en/L-2/17394.html*

Details about the Code and its regulations, and how they apply to drinking water, are given in Appendix 1.

2.3 Other related federal legislation

Three other pieces of federal legislation have sections that deal directly or indirectly with drinking water issues:

- The *Department of Health Act* (Potable Water Regulations for Common Carriers)
- The *Food and Drugs Act* (regulations for pre-packaged water and ice and water used in food preparation)
- The *National Defence Act*

2.3.1 Department of Health Act (13)

The *Department of Health Act* sets out the powers, duties and functions of the Minister of Health. These powers, duties and functions extend to all matters related to the promotion or preservation of the health of Canadians over which the federal government has jurisdiction.

The web site address for the Department of Health Act and its regulations is: http://laws.justice.gc.ca/en/H-3.2/48548.html

2.3.2 Food and Drugs Act

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.

As with all foods, bottled water must comply with Section 4 of the *Food and*

Drugs Act which prohibits the sale of foods which contain poisonous or harmful substances. It is proposed that when the safety of a particular bottled water is brought into question, the *Guidelines for Canadian Drinking Water Quality* provide the basis for establishing the safety of substances for which no limits are specified in the regulations.[3]

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

- http://www.hc-sc.gc.ca/fn-an/securit/facts-faits/faqs_bottle_water-eau_embouteillee_e.html
- http://www.inspection.gc.ca/english/corpaffr/foodfacts/bottwate.shtml

2.3.3 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. Part of these responsibilities includes various directives, policies and standards applicable to drinking water.

The web site address for the unofficial consolidation of the National Defence Act is http://laws.justice.gc.ca/en/N-5/text.html

2.4 Treasury Board Sanitation Directive

The Treasury Board Sanitation Directive (54) applies to all government-owned buildings occupied by federal public service employees. It only applies to federal employees. The Directive states that potable water must "meet the standards set out in the *Guidelines for Canadian Drinking Water Quality 1987* published by authority of the Minister of Health and Welfare."

The Directive also states that every plumbing system that supplies potable water and removes water-borne waste must:

- Meet the standards set out in the Canadian Plumbing Code (now the National Plumbing Code of Canada).
- Be connected to a municipal sanitation sewer or water main.

The Directive specifies that drinking water fountains must meet the standards found in the ARI Standard 1010-82, *Standard for Drinking-Fountains and Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers*.

The Directive includes specific guidance for ensuring sanitary conditions are met when transporting and storing drinking water, drinking cups, and ice.

[3] Health Canada and the Canadian Food Inspection Agency (CFIA) are working on revisions to the regulations and labelling requirements for bottled water stipulated in Division 12 of the Food and Drug Regulations. A consultation document released in November 2002 outlined the government's proposal and requested stakeholder input on proposed approaches and options. Comments supported the proposed approach to explicitly reference the *Guidelines for Canadian Drinking Water Quality* in the Regulations. If this occurs, the Guidelines will, in effect, become law for bottled water and prepackaged ice. Comments and analysis from the consultation will guide the development of the proposed regulatory amendments, expected to be prepublished in Canada Gazette, Part I during 2005.

In addition, contingency procedures must be developed to deal with issues such as an interrupted or contaminated water supply. These procedures are to be developed in consultation with Health Canada and health and safety committees (*See Section 2.2 for more information on health and safety committees)*.

Applicable sections of the Treasury Board Sanitation Directive can be found in Appendix 1.

2.5 Roles and responsibilities in the federal jurisdiction

Each department or responsible authority is in charge of implementing the federal drinking water program in areas within its mandate and should be accountable for carrying out its duties. 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 in the drinking water program 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 9.*

Note: While the duties to be performed can be contracted to a third party, the responsibility for meeting the 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 must 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 or loss. 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
- Communication

As a due diligence measure, managers and operators of federal facilities are advised to ensure water provided by their systems meets the *Guidelines for Canadian Drinking Water Quality*. At some sites, departments may choose to follow provincial or municipal requirements where these are more stringent. Regardless, facility managers should be familiar with current water quality guidelines and initiatives in their geographical area.

This document is intended to help system operators fulfill proper duty of care and due diligence requirements.

Part 2 - Application of The Federal Framework

The multi-barrier approach incorporates the principle of sound quality management. A significant part of the federal government's commitment to ensuring the safety and reliability of drinking water supplies lies in its commitment to properly design treatment programs, facilities, and distribution systems that are run by appropriately trained staff to perform consistently and reliably.

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 Surveys, Assessments and Monitoring

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.

Thereafter, a sanitary survey, vulnerabilities assessment and baseline chemical analysis should be conducted every 5 years, or when there are significant changes to the treatment system, land use, or other conditions which may adversely affect water quality. This will help to determine if changes are required to the monitoring program.

It is recognized that, in the case of unique facilities or situations such as systems in remote locations that serve very few individuals, it may not be physically or economically feasible to conduct each of the survey/assessment/analysis components every 5 years once the initial ones have been done. In these cases, every effort should be made to, at a minimum, do the sanitary survey and vulnerabilities assessment every 5 years, to determine if any changes have occurred that might require changes to the ongoing monitoring program.

Although the survey/assessment/analysis may only be done every five years, departments should endeavour to be aware on an ongoing basis of any changes at a site that could impact on water quality.

These steps apply for all systems, new or existing. However, case-specific guidance for a number of scenarios, including groundwater supplies and municipally-owned systems, is provided in Section 3.5. New systems will also need to undergo the steps outlined in Section 3.1.

3.1 Choosing a source for drinking water

The first step in assessing the drinking water supply is to assess the quality and quantity of the source water. This would include sampling and analysis of the raw water quality at the intake, as well as assessment of seasonal variations as applicable.

The goal of this step is to determine 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).

In addition, the results of the source water assessment help determine the extent of treatment or other management actions required.

When selecting a source for drinking water, where feasible, more than one water source should be evaluated. 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.

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

Once the source water has been identified, a vulnerabilities assessment needs to be completed.

3.2 Vulnerabilities assessment

The vulnerabilities assessment is 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.

3.2.1 Delineation of watersheds and aquifers

The land area that contributes water and potential contaminants to the water supply must 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, as they

influence the type of treatment required as well as any response required in the watershed/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 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. The sanitary survey will vary depending upon the type and complexity of the system.

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, and consequently the results of any analysis may not be representative of the water-supply system as a whole. (56)

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. (56)

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 that may affect the production and distribution of safe drinking-water. (56)

3.4 Baseline chemical analysis

A baseline chemical analysis is an analysis of all *Guidelines for Canadian Drinking Water Quality* for chemical parameters (including initial screening for radiological parameters) with Maximum Acceptable Concentrations (MACs). As part of this analysis, departments may choose to look at aesthetic parameters and operational guidance values as well.

The baseline chemical analysis, in combination with the sanitary survey and vulnerabilities assessment, should result in the monitoring program, i.e. a list of substances that should be routinely monitored. Based on the list, departments should be able to develop an appropriate treatment regime.

It is recommended that monitoring programs for identified chemical contaminants include, at a minimum, annual monitoring for surface water sources, and monitoring every 2 years for groundwater sources, unless otherwise specified in the *Guidelines for Canadian Drinking Water Quality*.

As a safeguard, it is also recommended that a baseline chemical analysis be re-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 of 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. (15)

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.

See Appendix 2: Summary of Guidelines for Canadian Drinking Water Quality *for the detailed listing of chemical contaminants for which drinking water quality guidelines have been developed.*

3.5 Case-specific guidance

3.5.1 Groundwater supplies

The risks associated with groundwater contamination vary with the type of activities on the property and the surrounding land use, the soil type, as well as 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, 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 well head 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.(5, 21)

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 3.

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. (Inclusion of relevant guidelines for abandoning wells is beyond the scope of this document.)

3.5.2 Municipally-owned 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, federal water quality managers and, in the case of First Nations communities, water treatment plant operators and 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.

3.5.2.1 Federal buildings with municipally supplied drinking water

The sanitary survey and vulnerabilities assessment for federal buildings needs to verify the condition of the plumbing, the type of materials, and the state of the connections, including cross-connections, within the building. The sanitary survey should be done every five years. However, federal departments could use the vulnerabilities assessment to support their decision to do sanitary surveys on a less frequent basis. Alternatively, depending on the results of the assessment, some parameters may be subject to annual, or more frequent, testing.

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 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.

If the water quality meets the guidelines, it is suggested that annual sampling at fewer locations (sampling points) in the building be conducted. A later iteration of this document is likely to include the number and location of sampling points to be included in each monitoring program, and what a sanitary survey and vulnerabilities assessment would entail.

3.5.3 Staff quarters

For unique facilities and situations (such as where departments provide staff housing in remote locations), each department must establish their own monitoring programs based on the sanitary survey, vulnerabilities assessment and baseline chemical analysis.

For these unique facilities/situations, departments may choose to stagger the monitoring programs over a five year period for each individual staff quarters, but at least 5% should be completed in any given year. All staff quarters must be covered in the 5 year period, unless the sanitary survey and vulnerabilities assessment indicates a different frequency would be appropriate.

4.0 Technical Standards, Benchmarks and Targets

The following technical standards, benchmarks and targets for water quality are provided to assist federal departments, water managers, designers and operators (including those in First Nations communities) to meet the *Guidelines for Canadian Drinking Water Quality* and drinking water-related regulations.

Guidance on how to meet these targets is provided throughout Part 2 of this document. The benchmarks noted below are current as of July 2005 and may be updated as new information becomes available.

Given the sheer number of federal drinking water supplies and the wide variety in system size, location, and site-specific concerns, the guidance in this document is designed to be flexible. In broad terms, for the purpose of this document, drinking water systems are defined as large, small, and very small, depending on the size of the population served *(see Section 1.3 or the Glossary for definitions).*

Drinking water sources may be surface water or ground water supplies. Surface water is defined as water open to the atmosphere and subject to surface run-off. Groundwater under the direct influence of surface water (GUDI) is defined as any water beneath the surface of the ground with (i) significant occurrence of insects or other microorganisms, algae, organic debris, or large-diameter pathogens such as *Giardia lamblia* or *Cryptosporidium,* or (ii) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions. Groundwater sources not under the direct influence of surface water (hereafter referred to as groundwater), by default, are neither of these two cases.

4.1 Microbiological quality

The most significant parameters to be monitored relate to the microbiological quality of drinking water. The presence of pathogens can result in serious health hazards. Indeed, ensuring the micro-biological quality of drinking water is the highest priority for protecting public health.

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.

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

Table 4.1 provides a summary of the recommended sampling frequencies and locations for the microbiological parameters.

4.1.1 Sampling frequencies

The recommended sampling frequency for microbiological parameters depends upon the quality of the source water, the number of water sources, the past frequency of unsatisfactory samples, the adequacy of treatment and capacity of the treatment plant, the size and complexity of the distribution system, the practice of disinfection, the size of the population served, and sampling history (15).

For federal departments and First Nations communities that collect and treat their own drinking water, the variables listed above make it difficult to apply a universal sampling frequency formula.

Table 4.1: Recommended sampling frequencies and locations for microbiological parameters (See text in Section 4 for detailed guidance based on system size and unique facilities/situations)

Parameter	Type of system	Recommended sampling frequency	Sampling location
E.coli Total Coliforms	All systems (For guidance on very small systems see 4.1.1)	In general, 4 samples / month at regular intervals . For very small systems, case-specific guidance is provided (see 4.1.1)	Water entering the distribution system and at representative points in the network
	Existing wells and supplies serving very few individuals, where the supply has a history of producing water of high bacteriological quality	When risk of contamination is highest (See Section 4.1.1)	After disinfection (where practiced), as water leaves the pumphouse
	New or renovated wells	One sample at start-up and then as above	As water leaves the pumphouse
	Federal buildings receiving municipal water	1 sample / month (or more/less based on sanitary survey / vulnerabilities assessment)	In the building's plumbing
HPC Bacteria (optional)	All	See above guidance	See above guidance
Turbidity (See 4.2)	Surface water & GUDI systems (filtered)	Continuous or 1 / day to 1 / week	In the treatment plant at each filter, post filtration
	Surface water & GUDI systems (unfiltered)	1/day (grab sample or daily average)	At the source, prior to treatment
	Groundwater systems	1 / day; or can reduce to 4-12 / year + during high-risk periods if historical turbidity results consistently less than 1 NTU	At the source, prior to treatment
Chlorine residual (See 4.3)	Disinfected surface water systems	Continuous or 1 / day (grab sample or daily average) to 1/week	In the distribution system, after disinfection
	Groundwater systems (if chlorination is used)	1 / day (See Section 6.3)	In the distribution system, after disinfection

Sampling frequency should be established by the appropriate department or responsible authority, at the facility or system level, with proper guidance and after due consideration of local conditions and sampling history. The following sampling frequencies are offered as a guide and do not necessarily apply to very small systems.

Generally, for all systems, a minimum of four samples per month should be taken at regular intervals throughout the month. 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.

For very small systems which serve very few individuals, and where the supply has a history of producing water of high bacteriological quality, it may be possible to reduce the number of samples analysed (15). In such cases, samples should be collected and analysed when the risk of contamination is highest (i.e. there is potential public health risk) (*e.g.,* spring thaw, heavy rains or dry periods, and/or when a noticeable deterioration in water quality occurs). In addition to this, **new or renovated wells** should be sampled and analysed at start-up to confirm acceptable bacteriological quality.(18)

Facilities that receive municipal water should already be receiving microbiologically safe water. Nonetheless, technical support staff and drinking water monitors should adopt internal water monitoring procedures and schedules to suit local conditions.

As a general rule, these facilities should take one bacteriological sample per month. Actual sampling frequency, number of samples and range of analyses completed should be based on the sanitary survey and vulnerabilities assessment. If they demonstrate that no problems exist and the municipality is sampling at the recommended frequency (or more), fewer samples could be deemed appropriate. Conversely, if a greater degree of risk or unknowns exists, the planned sampling should be adjusted accordingly in order to gather sufficient data upon which to base corrective actions. If corrective actions are successful, sampling could ultimately be scaled back to the recommended frequency according to this document.

If the review of the municipal water quality against federal benchmarks reveals non-compliance, measures should be taken to protect public health. Measures could include maintenance (*e.g.,* disinfection and flushing), additional treatment, or providing an alternative safe supply of drinking water.

4.1.2 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) and from representative points throughout the network, although not necessarily the same points on each occasion. For very small systems where there is little or no distribution system, samples should be taken as the water leaves the pumphouse.

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. (18, 51)

Facilities that receive municipal water should collect samples at the main or point of entry to the building, in the building's plumbing system, and in other locations identified in the sanitary survey and vulnerabilities assessment.

Sampling locations within the building's plumbing system could be randomly selected at first, to find "hot spots." Over time, these "hot spots" could become regular sampling locations. Samples should occasionally be collected from other locations in the building.

4.1.3 Interpreting sampling results

4.1.3.1 Total Coliforms and *E. coli* bacteria

General:
Microbiological quality is measured by testing samples for total coliforms and *E.coli*. Samples should be analysed by an accredited laboratory or by trained personnel using an accepted portable laboratory test kit. (*See Section 7.3.2.1)*

The *Guidelines for Canadian Drinking Water Quality* state that the maximum acceptable concentration (MAC) for bacteriological quality of drinking water systems is no coliforms detectable per 100 mL. Drinking water that fulfills all the following conditions is considered to conform to this MAC:

1. No sample should contain *Escherichia coli* (*E. coli*). 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, a boil water advisory should be issued, and corrective actions taken.

2. No consecutive samples from the same sampling location within a distribution system, or not more than 10% of samples from the distribution system in a given calendar month, should show the presence of total coliform bacteria. In systems collecting fewer than 10 samples per month, no samples should contain total coliforms.

The ability of total coliforms to indicate the presence of faecal pollution is less reliable than *E. coli*. However, this group of bacteria is a good indicator for quality control purposes.

While the presence of total coliforms does not necessarily mean a boil water advisory must immediately be issued, re-sampling and corrective actions may need to be taken.

Very small systems with little or no distribution system*:*
For very small systems with little or no distribution system, the following guidance could apply:

1. No sample should contain *E. coli*. As stated above, the presence of *E. coli* indicates faecal contamination

and the possible presence of enteric pathogens; therefore the water is unsafe to drink. If *E. coli* is detected, a boil water advisory should be issued and corrective actions taken.

2. No sample should contain total coliform bacteria.

The presence of total coliforms does not necessarily mean a boil water advisory must immediately be issued; however, corrective actions should be taken.

In non-disinfected 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. In disinfected water systems, the presence of total coliform bacteria indicates a potential failure in the disinfection process. In both disinfected and non-disinfected systems, total coliform detection may also indicate the presence of biofilm in the well or plumbing system.(18) A biofilm is a community of micro-organisms attached to a solid surface, for example the inside wall of a pipe, in an aquatic environment.

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 deterioration of aesthetic water quality and ultimately taste and odour problems.

Boil water advisories

For very small systems, boil water advisories should be issued—or an alternative safe source of drinking water used—in the following cases:

- If the water supply is not disinfected and is contaminated with either total coliforms or *E.coli*.
- If the water supply is disinfected and water leaving the pumphouse has no chlorine residual or is contaminated with either total coliforms or *E.coli*.

It is recommended that a boil water advisory be used only as a temporary measure while problems are being identified and remediated. If total coliforms are present with no *E. coli* present, it is likely due to the presence of biofilm. If this is the case, re-sampling and corrective action should be taken. These 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.

If there is no evidence to suggest faecal contamination, a boil water advisory may not be necessary.

A recommended approach to shock chlorination of wells can be found in Health Canada's "Water Talk: What's In Your Well? - A Guide To Well Water Treatment And Maintenance", at http://www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/well_water-eau_de_puits_e.html

For more information on issuing and rescinding boil water advisories, see Section 7.6 and Appendix 7.

4.1.3.2 Heterotrophic Plate Count

Heterotrophic plate count (HPC) bacteria and background colonies, although not a suitable indicator of the microbiological safety of water, are a useful indicator of the overall quality of the water. Testing for HPC bacteria or background colonies is optional.

Effective treatment can reduce concentrations of HPC bacteria to less than 10 colony forming units per 100mL 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 disinfectant residual verified. 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. (18)

4.2 Turbidity

Federal facilities and facilities in First Nations communities that treat and supply their own drinking water must 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.(16) Turbidity can be measured by on-line turbidity meters, a laboratory, or by using a test kit.

Turbidity in water is caused by suspended and colloidal matter such as clay, silt, fine organic and inorganic matter, and plankton and other microscopic organisms.(16) Control of turbidity in water supplies is important for both health and aesthetic reasons. Water that has high levels of turbidity is not only unappealing to the consumer, but the substances and particles that cause turbidity can interfere with disinfection and can be a source of disease-causing organisms.

Turbidity samples must be tested immediately by a trained person using a turbidity meter that measures in Nephelometric Turbidity Units (NTU). (48)

The most recent Canadian guideline for turbidity (October 2003) states that waterworks systems that use a surface water or groundwater source under the direct influence of surface water (GUDI) should filter the water to reduce the level of turbidity to as low as reasonably achievable, with a treated water turbidity target of less than 0.1 NTU at all times. However, actual levels of turbidity achieved will vary from technology to technology, so for this reason, the turbidity guideline is broken down by type of technology.

For guidance regarding situations where the target of 0.1.NTU is not achievable, and for criteria that describe the circumstances when filtration is not required, see the supporting document for the turbidity guideline in the *Guidelines for Canadian Drinking Water Quality*.

4.2.1 Guidance for surface water or GUDI sources that use filtration

For systems that use a surface water or GUDI source and use filtration, the water that passes through each filter should be

continuously monitored to make sure the filters are operating properly and to determine when backwashing is necessary. Micro-organisms concentrate on filters and a breakthrough could result in contaminated water reaching consumers.

Where continuous monitoring is not feasible, a sample of water that has not been disinfected should be taken at least once per day (for large and small systems) or once weekly (for very small systems) from a point in the system where all filtration has been completed. Frequency may be increased or decreased depending upon historical data. A turbidity sample should also be taken at each filter outlet following filter cleaning or backwashing.

4.2.2 Guidance for unfiltered systems that use a surface water or GUDI source

For unfiltered systems that use a surface water or GUDI source, turbidity should be measured at least once per calendar day at the point in the system directly before the first treatment chemical is applied. 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.(2) Frequency may be increased or decreased depending upon historical data.

4.2.3 Guidance for secure groundwater sources

The health-based turbidity guideline does not apply to secure groundwater sources, i.e., those not under the direct influence of surface water. Turbidity in these cases is non-organic, should pose no health threat and should not hinder disinfection (in cases where disinfection is being done). However, for effective operation of the distribution system , it is good practice to ensure that water entering the distribution system has low turbidity levels of around 1.0 NTU.

Therefore, turbidity sampling once per day is suggested for secure groundwater supplies. However, if historical data indicates that turbidity is consistently less than 1 NTU, the frequency of routine monitoring can be reduced to 4-12 times per year depending on the number of people served.

That said, turbidity should also be monitored during events such as spring run-off, heavy rains, and seasonal start-ups.

4.3 Disinfection targets

Barring system-specific exemptions (as described below), all drinking water supplies should be disinfected [4] to ensure the safety of the drinking water supply in the treatment plant. In addition, where disinfection is practised, a residual of an appropriate disinfectant, typically chlorine or chloramine, should be present at all times in the distribution system. *(See Section 6.3 for further information on chlorine/chloramine residuals.)*

The effectiveness of disinfection can be predicted based on a knowledge of the residual concentration of disinfectant,

[4] Includes bottled water

temperature, pH (for chlorine and chloramine), 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 (18)

C-T tables can be found within each supporting document for microbiological guidelines for Canadian drinking water quality, at http://www.hc-sc.gc.ca/waterquality

Chlorine/chloramine 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 (*See Section 7.3.2.1*).

Additional testing of chlorine residuals could also be done to routinely monitor the integrity of the distribution system. Note that residuals are not necessary for in-home plumbing (*e.g.*, where point-of-use treatment devices are used).

For more information on chlorine residuals, see Section 6.3.

In the case of a groundwater source not under the direct influence of surface water, disinfection may not be necessary provided an annual sanitary survey and vulnerabilities assessment (determined on a case-by-case basis), is conducted to ensure that the source is not subject to contamination and that conditions have not changed.

If a comprehensive sanitary survey is conducted following the methods outlined in Appendix K of the *Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems using Surface Water Sources* (35) then the survey frequency may be reduced to once every three to five years, as appropriate. However, sufficient microbiological testing must still be done to ensure the water is potable.

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, disinfection equipment and supplies, or an equivalent incident response mechanism (such as an alternative source or boil water advisory), must be available to deal with potential occurrences.

4.4 Contaminant targets

The *Guidelines for Canadian Drinking Water Quality* 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 federal departments and, in First Nations communities, water managers and technical

support staff, conduct a baseline chemical analysis of their water supplies to determine which substances should be monitored as part of the monitoring program. The baseline chemical analysis should be done for all drinking water supplies (including municipal and hauled water).

4.5 Drinking water materials

Drinking water materials are materials that come into contact with drinking water, 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 their manufacturer's claim of efficiency for removal of specific contaminants.

During the construction, maintenance or replacement of any component of a drinking water treatment or distribution system, only materials that meet applicable performance and health-based standards should be used.

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) standard. 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 or service 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 (http://www.scc.ca).

NSF standards are widely accepted in North America. They reference and incorporate other relevant standards and protocols as appropriate.

The NSF International web site (http://www.nsf.org) has information about both health-based and performance standards related to drinking water treatment devices including a listing of certified systems. 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 and NSF/ANSI Standard 61: Drinking water system components-health effects. NSF/ANSI Standard 61 is often referenced in many of the standards for drinking water treatment devices to ensure the devices meet minimum health effects requirements.

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. This may not be possible in situations such

as foreign embassies in other countries. In these situations, minimum sanitary engineering practices should be met.

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. Any chemicals and additives used in drinking water treatment processes and/or the distribution system must meet the applicable health-based standards established by NSF International.(14)

5.0 Treatment System Design and Maintenance

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. The characteristics of the treated water will be further affected by the treatment processes used, the treatment components, equipment design, chemicals used, treatment efficiency, and monitoring procedures, etc.

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 must be performed by qualified authorities (*e.g.,* registered professional engineers).

5.2 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.(38) In addition, the use of Supervisory Control And Data Acquisition (SCADA) technology or similar products 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 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 equipment suggested.

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. As a general rule, only technology that is realistic should be installed.

5.3 Surface water intakes

A surface water source will have an intake structure for drawing water into a 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.(14) 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.

Proper design, maintenance and operation are essential to prevent partial or complete shut-down of the entire drinking water system. Screens should be cleaned regularly to prevent 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.[5] (39)

5.4 Treatment options

The treatment process selected should address all potential hazards and the level of risk associated with those hazards identified in the source assessment.(17) Only expert qualified professionals should be hired to design drinking water treatment systems.

Minimum treatment of all supplies derived from surface water sources and groundwater under the influence of surface waters should include sedimentation, flocculation, coagulation, filtration, and disinfection, or equivalent technologies.(18)

Technical standards, benchmarks and targets for drinking water quality are given in Section 4. Monitoring requirements are discussed in Section 7.3.

Operator training and certification are discussed in Section 7.2. For detailed information on water treatment technologies, see references 33 and 38.

[5]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.(14)

6.0 Distribution System Design and Maintenance

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.(39)

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 the proper maintenance of 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 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 (51). The plumbing systems in federal facilities must meet the National Plumbing Code of Canada and Standard B64.10.01.

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: inspection of the building's plumbing for cross-connections, pressure testing, flushing of water lines (when warranted) and hydrants, regular disinfection of bottled water coolers and drinking fountains, and monitoring of water quality (*see Section 7.3 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.

6.1 Distribution systems, including treated water reservoirs

Distribution systems, including treated water reservoirs, should be designed to take the following into account: access by wildlife, public access, system capacity, emergency water storage (including fire flow capacity), contact time required for disinfection, the minimization or elimination of dead ends, and cross-connection controls. They should also be designed and constructed in compliance 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. Table 1 in Appendix 8 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. 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 8.

For more information on the disinfection of water storage facilities, see the American Water Works Association (AWWA) C650 series of manuals (found at the AWWA website under "AWWA Bookstore / AWWA Standards / Disinfection of Facilities" at url http://www.awwa.org/bookstore

6.2 Maintenance issues

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:

Internal corrosion:

- 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).

External corrosion:

- High leakage rate due to external corrosion of the infrastructure, through holes in pipe barrels and/or deteriorating joints.
- Frequent breaks due to external corrosion, material degradation, poor installation practices, manufacturing defects and operating conditions.(42)

A lead and copper corrosion control document is under consideration by the Federal-Provincial-Territorial Committee on Drinking Water, which would address issues related to internal corrosion.

Cross-connections can also lead to poor water quality. 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.

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.

6.2.1 Water mains

The condition of critical water mains 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. (42)

Mains may need to be replaced, or a structural liner may need to be used, if water mains 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.

6.2.2 Cross-connection controls

Cross-connections are physical links in the distribution system through which contaminants can enter the drinking water supply. Contaminants (eg. wastewater, detergent from a carwash) may enter the drinking water system when the pressure in a plumbed-in contaminated component is higher than that of the potable water, an event commonly called backsiphonage or backflow.

Cross-connection control programs should be in place in order to prevent contamination. Such programs include:

- Surveying established installations to rank them based on the degree of hazard that they present to the water system.
- Preparing a list of all testable backflow devices in the water system.
- Assessing new construction plans for cross-connection hazards.
- Installing proper backflow preventers (backflow preventers must be testable).

- Inspecting and maintaining cross-connection control devices on an annual basis, following manufacturers' instructions.
- Training and educating staff.
- Establishing protocols for notifying the building owner or responsible party to have a particular device tested.
- Setting out the qualifications required for a person to be allowed to perform a building's cross-connection control survey.
- Instituting a tamper policy.

(32, 33, 39)

6.2.3 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.(51) 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, which serves as a means of anti-freeze protection.

6.2.4 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 5 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.(42)

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 National Plumbing Code of Canada.(9)

Low-pressure complaints must be recorded. If the number of complaints increases over time, it may suggest that 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 tuberculation and encrustation.

The inferior condition can also be determined by visually inspecting the water when a water main is flushed.(42)

A complete cross-connection control program includes training and education for staff. Employees who will administer the program will need competencies in the use of backflow testers, surveys and device repair.(32) Each department's training plan must address these needs.

6.2.5 Routine flushing of the plumbing system

Routine maintenance must include flushing of 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.(26) The sanitary survey and vulnerabilities assessment may identify site-specific problems that require more, or less, frequent attention.

6.2.6 Drinking water fountains

Drinking water fountains must be disinfected to ensure contamination does not occur at the spigot. Fountains should be disinfected a minimum of once every two months and at an increased frequency if heavily used.(51) They should also be maintained according to the manufacturer's recommendations.

6.2.7 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 reflect the condition of the system properly 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, 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.(42)

6.3 Chlorine/chloramine residuals

Disinfection is critical to ensuring the safety of the drinking water supply in the treatment plant. In addition to disinfection, chlorine

(or chloramine) is used in residual amounts to ensure continued disinfection throughout the distribution system and to protect the water from re-contamination.

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

In a drinking water distribution system, a disinfection residual of at least 1.0 mg/L of total chlorine or 0.2 mg/L free chlorine must be present in the water at all times. Other disinfection processes can be used in the treatment plant (*e.g.* ultraviolet disinfection), but in these cases a chlorine residual must still be maintained in the drinking water distribution system.

In the case of a groundwater source that serves very few individuals and has little or no distribution system, no chlorination is needed.

More information on disinfection, including groundwater issues, is found in Section 4.3.

6.4 Special circumstances

6.4.1 Alternative sources of drinking water

On a temporary basis, departments may need to provide an alternative source of drinking water to consumers:

- 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.

This water could be boiled and filtered or departments could choose to provide bottled water. Bottled water also includes 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.

Canadian missions in foreign countries may also use bottled water. However, water bottled in other countries is not necessarily safe. In foreign jurisdictions, initial bacteriological testing of bottled water should be conducted to ensure a safe supply. A total of five samples from each brand of bottled water is recommended to test for *E.coli* and total coliforms. *Pseudomonas aeruginosa* could be measured as well, as an indicator of whether the product has been manufactured under Good Manufacturing Practices. Once a bottled water supplier is selected, periodic sampling should be conducted to ensure the continued safety of the supply.(24)

See Appendix 4 for details on how to maintain water coolers and dispensers.

6.4.2 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. Hauled water to be used as

a drinking water supply must meet the *Guidelines for Canadian Drinking Water Quality*. [6] The original source of the hauled water should be a water system whose treatment provides a disinfection residual before being delivered to the truck. (1,52)

Contamination issues with trucked water may arise as a result of the increased handling of the water and storage within a reservoir tank at the point where the water is dropped off. Testing the quality of trucked water should include sampling at the filling point. Water in the truck should be sampled once per day.(43)

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 (50), 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) (1,52), 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 for Drinking Water Additives (Unintentional Additives - Drinking Water System Components - Health Effects), 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 backsiphonage (*e.g.,* through an air gap or double-check valve assembly).

For information on disinfection of water storage containers, see the American Water Works Association (AWWA) C650 series of manuals (found at the AWWA website under "AWWA Bookstore / AWWA Standards / Disinfection of Facilities" at url http://www.awwa.org/bookstore

The outlet connections at filling points must be constructed and protected so that 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.(1,52) 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. (43,55) Cisterns should be monitored for bacteriological parameters at least 4 times per year.(28)

A disinfection residual of at least 1.0 mg/L of total chlorine or 0.2 mg/L free chlorine must 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

[6] 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, as well as on additional information from Indian and Northern Affairs Canada and the Department of National Defence.

register containing the data and results of the measurements and the name of the person who took them. (1,52)

For an example of guidelines for ensuring the safety of trucked water, see the Quebec government's regulations in this area.

7.0 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 assist 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. Such frameworks could include approaches such as HACCP (Hazard Analysis and Critical Control Points).(21)

7.1 Operational plans

An operational plan, specific to each individual drinking water system, must be 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 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 operational plan for each facility should include detailed guidance/instructions related to monitoring, as well as for reporting and record-keeping and 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 preventative maintenance activities;
- 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 so specific, realistic, written operational procedures can be developed. 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.

The detailed content of the operational plan forms the foundation for the quality management of the drinking water system.

7.2 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 to 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.

Management must 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.

All operators are encouraged to participate in on-going training in an organized, continuing education setting under responsible sponsorship, capable direction, and qualified instruction.[7] (39) 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.

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.(2)

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.[8]

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.

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.

[7] Based on the definition of continuing education unit (CEU)" registered to the Council on the Continuing Educational Unit in Washington DC.

[8] For more information on the ABC system, see http://www.abccert.org

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.

7.3 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 *Guidelines for Canadian Drinking Water Quality*.

Sampling at various points in the distribution system will indicate the quality of water reaching consumers at the tap and identify problems which may arise due to faults with the distribution system. (17, 20)

Specific guidance regarding sampling frequencies, locations, and the interpretation of results is found throughout Section 4.

Parameters and frequency of sampling 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 the 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.(51)

7.3.1 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 assists in identifying 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:

- Are system specific.
- Are developed in the operational plan.
- Facilitate more comprehensive documentation of the system.
- Foster due diligence.

7.3.2 Compliance monitoring

Compliance monitoring ensures drinking water reaching consumers meets established requirements. Every facility will need to develop their monitoring program based on

the results of the vulnerabilities assessment, sanitary survey and baseline chemical analysis. In addition, many federal departments and First Nations communities have their own documents and/or directives that provide guidance on sampling 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.

Sampling procedures for bacteriological parameters, lead and copper are described in "National Drinking Water Sampling Procedures"(26) prepared by the Occupational Health and Safety Agency (now called Workplace Health and Public Safety Programme). Collection and preservation of any other samples should use procedures (collection, preservation, storage and shipment) recommended by the accredited laboratory analysing the samples.

7.3.2.1 Laboratory accreditation for compliance monitoring

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, must use a laboratory accredited by one of the following: Canadian Association for Environmental Analytical Laboratories (CAEAL), the Standards Council of Canada (SCC), or, in Quebec, the Programme d'accréditation de laboratoires d'analyse environnementale (PALAE).(26) SCC/CAEAL defines accreditation as "the formal recognition of the competence of a laboratory to carry out specific tests."(14) Accreditation is awarded to a laboratory for each individual test, *e.g.*, the analysis of pesticides in drinking water.(51)

A list of CAEAL accredited labs is available on-line at http://www.scc.ca/certific/labs

Canadian 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 http://www.ilac.org under the heading "Directory."(24)

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 must 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.

7.4 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.(39)

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 well head and routinely reading it. Static and operating water levels should be measured and plotted to determine if a trend exists over time.

7.5 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 5 years and all other "routine" records must be maintained for 2 years.(37) Where feasible, at a minimum, the following records must be kept for every federal facility:

- 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 (*a sample table is included in Appendix 6*)
- Reports of in-house operational procedures tests
- Correspondence
- Communications protocols
- Maintenance reports
- Assessment reports (27)
- 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 (39)
- 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
- Training records, including test results, relevance of training, and validation of the source of training

7.6 Incident and emergency response plans

Federal purveyors of drinking water and, in First Nations communities, Chief and Council, must 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.(2)

Events that a water system purveyor should plan for include weather events, natural disasters, unplanned human activities, line breaks, valve replacements, or extended electrical power outages. Any work on wells, standpipes, and distribution systems must follow proper disinfection procedures as described in the latest edition of American Water Works Association C650 series standards (C651-92, C652-92, C653-97, C654-87).

To address cases of a suspected/confirmed (see Section 4) event of microbiological contamination, the plan should include the possibility that a boil water advisory may need to be issued. Details about issuing and rescinding advisories are given in the box below.

It is important to remember that boil water advisories are not effective against chemical and radiological concerns. In cases of chemical contamination, water will need to be treated or an alternative source of drinking water will need to be found until the situation can be remedied. Incident

Incident Response: Boil Water Advisories

Issuing a boil water advisory
In most cases, boil water advisories are issued on evidence of conditions such as:

- significant deterioration in source water quality;
- equipment malfunction during treatment or distribution;
- inadequate disinfection or disinfectant residuals;
- unacceptable microbiological quality;
- unacceptable turbidities or particle counts;
- situations where operation of the system would compromise public health; or
- where epidemiological evidence indicates that the drinking water is or may be responsible for an outbreak of illness.

Boil water advisories are most frequently based on unacceptable bacteriological quality. If *E. coli* is found in drinking water, a boil water advisory should be issued immediately. Federal departments should prepare and make available site specific protocols for boil water advisories (trigger incident definition, names, notifications, contacts, etc) for larger federal sites or compounds.

The confirmed presence of total coliforms or thermotolerant coliforms in the absence of *E. coli* in the distribution system, but not in water leaving the treatment plant, usually indicates that the distribution system is experiencing bacterial regrowth problems. As total coliform bacteria are ubiquitous in nature, their presence in the distribution system does not necessarily indicate a health risk. Nevertheless, if remedial measures, such as flushing water mains and increasing chlorine residuals, do not correct this problem, then the water manager for the affected facility may wish to issue an advisory after consultation with the appropriate authorities. There is no evidence that HPC bacteria are pathogenic or indicative of other waterborne pathogens. Therefore, boil water advisories should not be issued based solely on the presence of HPC bacteria.(19)

Appendix 7 provides instructions for boiling and disinfecting tap water.

Rescinding a boil water advisory
Boil water advisories may be rescinded as soon as the microbiological quality, turbidity, particle counts, or disinfection residual of the treated water in at least two consecutive sets of samples have returned to acceptable levels or when the treatment, distribution or operational malfunction has been corrected and sufficient water displacement has occurred in the distribution system to eliminate any remaining contaminated water. In the case of an outbreak, advisories may be rescinded after the above conditions have been met and when surveillance indicates that the incidence of the illness in the facility has returned to background levels.(19)

For an example of a Boil Water Advisory, see Appendix II, "Boil Water Advisory to Consumers" in the *Protocol for the Issuance of a Boil Water Advisory, Safe Water Program, In Accordance with the Mandatory Health Programs and Services Guidelines* published in August 1993 by the Ontario Ministry of Health and Long-term Care, Public Health Branch.

response protocols should be established with the understanding that notification and reporting must 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.

7.7 Audits

A third party (*i.e.,* an external evaluator) should evaluate and audit all federal drinking water facilities every three to five years to ensure that the quality of water and the service provided by the water facility is maintained. In some cases, such as in diplomatic missions overseas, this type of audit may not be feasible.

An audit can involve three phases, including planning, conducting the audit, and compiling the final report.

Prior to conducting an audit, there should be a detailed review of the water system. The review should pay particular attention to past audits and documentation describing previously identified problems and solutions. Other information to review includes: general documentation, water system plans, chemical and microbiological sampling results, operating reports, and engineering studies. This review will help auditors become familiar with the system's history and present conditions.

The pre-audit file review should generate a list of items to check in the field, and a list of questions about the system. It will also help to plan the format of the audit and to estimate how much time it may take. The next step is to make the initial contact with the system management to establish the survey date(s) and time. Any records, files, or people to be referenced during the audit should be mentioned at the outset.

The initial phase of the audit is a review of the purveyor's monitoring records to verify compliance with applicable microbiological, chemical, physical and operational parameters and radiological guidelines. The audit should provide an opportunity to review these records with the purveyor, and to discuss solutions to any parameter in non-compliance. The audit also provides an opportunity to review how and where samples are collected, and how field measurements (*e.g.,* turbidity, chlorine residual) are made.

The on-site portion of the audit is the most important and involves interviewing management as well as operators and other technical people. The audit should review all major system components from the treatment point to the end of the distribution system.

An auditor should evaluate all water treatment processes in use at the water system. This evaluation should consider the design, operation, maintenance, and management of the water treatment plant to identify existing or potential risks. The treatment and other processes should be

assessed against their ability to continually meet the requirements of the federal drinking water program.

Ideally, as the audit progresses any observed deficiencies would be brought to the attention of the water system personnel, together with a discussion of suggested corrective measures. At the very least, this should be done at the end of the audit, prior to writing the final report.

The final audit report should be completed as soon as possible to formally notify the purveyor and/or the regulator of the findings. The report may be used for future compliance actions and inspections.

Ideally, the final report provided by the auditor should include the following elements:

- The date of the survey
- Names and titles of the people who were present during the survey
- The findings of the survey
- Recommended improvements to identified problems
- Recommended dates for completion of any improvements.(2)

8.0 Information and Resources

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

8.1 Health Canada's Water Quality and Health Bureau

Health Canada's Water Quality and Health Bureau plays a key role in the safety of drinking water by publishing the Guidelines for Canadian Drinking Water Quality (Guidelines) and leading their development. The Bureau develops the health risk assessments for microbiological and chemical contaminants of drinking water. The Federal-Provincial-Territorial Committee on Drinking Water (Committee) then uses these assessments to establish the Guidelines. The Bureau coordinates the activities of this committee, and is the federal voting member.

The Bureau also plays a coordinating role at the federal level, to help ensure a consistent federal approach to drinking water quality.

8.2 Health Canada's Workplace Health and Public Safety Programme

Two Bureaus within WHPSP provide assistance to federal departments to provide safe drinking water for federal employees.

8.2.1 Public Health

i) The Public Health Bureau's Federal Drinking Water Compliance Program assists federal departments to demonstrate due diligence in protecting human health from risks related to drinking water. The program is responsible for:

- Disseminating information to assist departments to remain current with best practices, new technical developments, research, training, etc. for drinking water management systems
- Developing partnerships and alliances with and among federal departments, agencies and non government organizations to foster sharing of best practices in the management of drinking water systems.
- Developing tools for federal departments to facilitate the implementation of appropriate drinking water management practices.

ii) The Public Health Bureau, through its Environmental Health Officers located in the regions, provides routine services including advice, consultation and inspection services to federal departments on the day-to-day management of their drinking water systems. Services include water sampling, interpretation of sampling results, and recommendations on preventive measures related to drinking water systems. Services are provided on a cost recovery basis.

8.2.2 Operations Bureau

Regional staff provide emergency services related to drinking water systems to

departments upon request. They provide advice, consultation and worksite investigations for physical, chemical and biological hazards associated with drinking water systems. Services may include water sampling, analysis and interpretation of sample results, investigations of drinking water related incidents and recommendations on corrective actions.

8.3 Infraguide

A series of how-to manuals is being developed by the National Research Council, in collaboration with the Federation of Canadian Municipalities, called InfraGuide. These manuals address innovations and best practices related to drinking water quality, including treatment and distribution systems. *Further information can be found at http://www.infraguide.ca*

Appendix 1: Legislation and Policies

Because the Canada Labour Code, its regulations, and the Treasury Board Sanitation Directive all have similar text regarding potable water issues, the text included below is complete for the potable water sections of the Treasury Board Sanitation Directive, and then just the first paragraph is identified for the other regulations. The citation for the legislation and/or Treasury Board Directive is provided for each regulation, as well as the website address, should you want to access the full text. Note that the electronic version of statutes and regulations on Justice Canada's website are unofficial. For the official version, the reader is referred to the *Revised Statutes of Canada* and the *Canada Gazette*.

A: Canada Labour Code and Related Regulations: Sections 125(1)j and 125(1)z.11

A1. Canada Labour Code (R.S. 1985, c. L-2)

Note: The Canada Labour Code is posted on Justice Canada's web site at http://laws.justice.gc.ca/en/L-2/index.html

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;

A2. Related Regulations

a) The Canada Labour Code is the enabling statute for the following regulations:

Canada Occupational Safety and Health Regulations (7)

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 (GCDWQ) 1978, published by authority of the Minister of National Health and Welfare."

(SOR/86-304)
Note: full text is available at: http://laws.justice.gc.ca/en/L-2/SOR-86-304/index.html

Aviation Occupational Safety and Health Regulations (4)

4.9 Every employer shall provide employees with potable water for drinking, personal washing and food preparation that, where reasonably practicable, meets the standards set out in the publication entitled *Guidelines for Canadian Drinking Water Quality*, 1978, as amended in March 1990 and published under the authority of the Minister of National Health and Welfare.

(SOR/87-182)
Note: full text is available at: http://laws.justice.gc.ca/en/L-2/SOR-87-182/index.html

Marine Occupational Safety and Health Regulations (36)

7.24 (1) Every employer shall provide employees with potable water for drinking and food preparation that meets the standards set out in the *Guidelines for Canadian Drinking Water Quality*, 1978, as amended in March 1990, published under the authority of the Minister of National Health and Welfare.

(SOR/87-183)
Note full text is available at: http://laws.justice.gc.ca/en/L-2/SOR-87-183/index.html

On-Board Trains Occupational Safety and Health Regulations (45)

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.

(DORS/87-184)
Note full text is available at: http://laws.justice.gc.ca/en/L-2/SOR-87-184/index.html

Oil and Gas Occupational Safety and Health Regulations

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.

(SOR/87-612)
Note full text is available at http://laws.justice.gc.ca/en/L-2/SOR-87-612/index.html

B: Treasury Board Sanitation Directive

Chapter 2-18 - Sanitation Directive (paragraphs 44-50 - potable water)
Excerpted from: Treasury Board of Canada Secretariat. Occupational Safety and Health Directives and Standards. Chapter 2-18: Sanitation Directive.

Note: The Treasury Board Sanitation Directive is on the Treasury Board Secretariat's web site at: http://www.tbs-sct.gc.ca/pubs_pol/hrpubs/TBM_119/chap2_18_e.asp

Potable water

44. Water for drinking, personal washing and food preparation shall be potable and meet the standards set out in the Guidelines for Canadian Drinking Water Quality 1987, published by authority of the Minister of Health and Welfare.

45. Where it is necessary to transport water for drinking or washing, only sanitary containers and sanitary methods of handling the water shall be used.

46. Wherever a storage container for drinking water is used it shall be:
1. securely covered and closed;
2. used only for the purpose of storing potable water;
3. maintained in a sanitary condition;
4. used in such a way that, when water is drawn from the container, the water does not become contaminated; and
5. disinfected in a manner approved by Health and Welfare Canada at least once each 7 days while in use, and before the container is used following storage.

47. Except where drinking water is provided by a fountain, there shall be provided:
1. an adequate supply of single-use drinking cups in a sanitary container located near the water container; and
2. a non-combustible covered receptacle for the disposal of used drinking cups.

48. The use of a common drinking cup is prohibited.

49. Ice that is added to drinking water or used for the contact refrigeration of foodstuffs shall be made from potable water and shall be stored and handled so as to prevent it from becoming contaminated. Ice handling equipment, as well as the storage area, should be regularly disinfected.

50. Where drinking water is supplied by a drinking fountain:
1. 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; and
2. the fountain shall not be installed in a personal service room containing a toilet.

Plumbing System

18. Every plumbing system that supplies potable water and removes water-borne waste:
1. shall meet the standards set out in the Canadian Plumbing Code; and
2. subject to paragraph 18 shall be connected to a municipal sanitation sewer or water main.

20. For the eventuality that the supply of potable water and water for the removal of water-borne waste is temporarily interrupted, departments shall establish contingency procedures. Such procedures shall be established with the advice of Health and Welfare Canada and in consultation with the appropriate Safety and Health Committee(s).

Appendix 2: Summary of *Guidelines for Canadian Drinking Water Quality*

Summary of Guidelines for Canadian Drinking Water Quality

Prepared by the
Federal–Provincial–Territorial Committee on Drinking Water
of the
Federal–Provincial–Territorial Committee
on Environmental and Occupational Health

A current version of this summary can be found at:
http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/doc_sup-appui/sum_guide-res_recom/index_e.html

Appendix 3: Sample Well Assessment Form

WELL ASSESSMENT FORM
Formulaire d'évaluation des puits

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

SITE LOCATION IDENTIFICATION / Emplacement du site étudié	DESCRIPTION OF WELL LOCATION / Décrire l'emplacement du puits

HOW MANY WELLS ON SITE?/ Nombre de puits sur le site?	POPOULATION BEING SERVED / Nbre. d'utilisateurs	WATER METER / Compteur d'eau
		YES/Oui NO/Non

WELL OPERATOR NAME / Nom du technicien, responsable du puits	WELL OPERATOR TELEPHONE / # de tél du technicien, responsiale 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	WELL LOG AVAILABLE? / Dossier disponible sur le puits?
DRILLED DUG OTHER (SPECIFY) _____ Foré Creusé Autre (Spécifier)	YES/Oui NO/Non ATTACH COPY IF YES Si oui, annexer une copie

DEPTH OF WELL / Profondeur du puits	DIAMETER OF WELL / Diamètre du puits	WELL CAPACITY / Capacité du puits
m	m	L/s

WELLHEAD ENCLOSURE / Enceinte de la tête de puits

PUMP HOUSE MANHOLE OTHER (SPECIFY) _____
Station de pompage Trou d'homme Autre (Spécifier)

PUMP AGE / Age de la pompe	AVERAGE PUMPING RATE / Taux de pompage moyen	ANNUAL VOLUME OF WATER PUMPED / Volume annuel pompé	PUMPING CAPACITY / Capacité de pompage
	L/s	L/s	L/s

TYPE OF STORAGE / Moyen de rétention	STORAGE CAPACITY / Capacité de rétention
TANK CISTERN OTHER (SPECIFY) _____ Réservoir Citerne Autre (Spécifier)	L

PART III: HYDROGEOLOGIC INFORMATION / PARTIE III: PROFIL HYDROGEOLOGIQUE

DEPTH TO PUMPING WATER / Profondeur de captage	WELL ASSOCIATED WITH KNOWN AQUIFER (IF YES, GIVE NAME) / Puits associé à un aquifère connu (si oui, nommer)	TYPE OF AQUIFER / Type d'aquifère
m or/ou feet/pi		

OTHER HIGH CAPACITY WELLS (30L/S) LOCATED WITHIN 300m RADIUS / Autre puits à grand 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 exploité?	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)
Indiquer les résultats et les problèmes associés à chacun des paramètres suivants (10 dernières années).

BACTERIOLOGICAL PARAMETERS/Paramètres bactériologiques COLIFORMS (coliformes)	
DISINFECTION BY-PRODUCTS/Sous-produits de la désinfection BROMODICHLOROMETHANE AND DIBROMOCHLOROMETHANE, CHLOROFORM (bromodichlorométhane 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, fluorure, sulfates, ammoniac, chlorure, 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 Oui NO Non	CHEMICALS USED IN THE TREATMENT PROCESS? /Produits chimiques utilisés dans le traitement?

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

Provided by Canada Border Services Agency

Appendix 4: Bottled Water Dispenser Maintenance

Note: This information can be found on Health Canada's website at:
http://www.hc-sc.gc.ca/fn-an/securit/facts-faits/faqs_bottle_water-eau_embouteillee_e.html under the heading "Questions and Answers on Bottled Water" (sub-heading
"How do I maintain the cleanliness of a water cooler")

Cleaning your water cooler:

- Unplug cord from electrical outlet of cooler.
- Remove empty bottle.
- 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. (This solution should not contain less than 100 ppm available chlorine.) **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.

- 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 solution from reservoir through faucet(s).
- Rinse reservoir thoroughly with clean tap water, draining water through faucets, to remove traces of the bleach solution.

NOTE: Clean your bottled water cooler with every bottle change.

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.
- Place new bottle on cooler.

[1] Adapted from instructions provided by Ken Orom, Calgary Board of Education, and Ken Reynolds, Calgary Health Services.

Appendix 5: Water Main 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 6: Sample of Water Quality Analysis Summary

Microbiological parameters

	Total coliforms (counts/100ml)	**Fecal coliforms** (counts/100ml)
MAC or IMAC	*(indicator of adverse water quality if detected in treated water)*	*(indicator of adverse water quality if detected in treated water)*
Number of samples	46	46
Number of detectable results	0	0
Sampling date	04/01 - 06/30	04/01 - 06/30
Range	N/A	N/A
Exceedence?	No	No
Typical source of contaminant	Indicates possible presence of fecal matter	Definite indicator of fecal contamination

Parameters related to microbiological quality

	Turbidity (NTU)	**Free chlorine - plant** (mg/l)	**Free chlorine - system** (mg/l)
MAC or IMAC	1	-	-
Number of samples	90	360	360
Number of detectable results	90	360	360
Sampling date	04/01 - 06/30	04/01 - 06/30	04/01 - 06/30
Range	0.16 - 0.29	0.35 - 0.45	0.35 - 0.45
Exceedence?	No	N/A	N/A
Typical source of contaminant	Indicates presence of particles in water due to treatment difficulties	See below	See below

Inorganic parameters

	Fluoride (mg/l)	**Nitrate** (mg/l)
MAC or IMAC	1.5	10
Number of samples	360	1
Number of detectable results	360	1
Sampling date	04/01 - 06/30	04/01 - 06/30
Range	0.7 - 1.1	1.2
Exceedence?	No	N/A
Typical source of contaminant	Added to prevent tooth decay	Natural component of water at this level

Volatile organics

	Trihalomethanes (mg/l)
MAC or IMAC	0.1
Number of samples	1
Number of detectable results	1
Sampling date	04/01 - 06/30
Range	0.067*
Exceedence?	No
Typical source of contaminant	By-product of chlorination

*THMs MAC is based on a running average of four quarterly samples. This value is the average of the most recent four detects.

Pesticides and PCBs - none

Appendix 7: Guidance for Issuing and Rescinding Boil Water Advisories

Note: The *Guidance for Issuing and Rescinding Boil Water Advisories* (Revised March, 2001) can be found at http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/doc_sup-appui/boil_water-eau_ebullition/index_e.html

Appendix 8: Distribution System

Table 1: Investigation of Water Distribution Systems (42)

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 components of the distribution system

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[9] but should not be used to protect against back- pressure[10] conditions. (9, 32) The selection, installation, maintenance and repair of these devices is to be done in accordance with Standard B64.10.01.

Valves
Valves are one of the more important devices in the distribution system as they are used for various purposes including 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 for isolation of 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 are 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.(42)

Water storage
Ground storage reservoirs are large tanks made of concrete or metal which are located at ground level, while 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.(39)

[9] Back siphonage is the flow of water into the potable water system pipes caused by the sudden reduction of pressure in the potable water supply system

[10] Backpressure is a condition in which a facility's system pressure is greater than the supplier's system pressure.

Appendix 9: Roles and Responsibilities

Examples

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 the drinking water program, 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 *Guidelines for Canadian Drinking Water Quality* (GCDWQ, 1996 which is superceded annually by the *Summary Table of Guidelines for Canadian Drinking Water Quality*). (51)

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 that all requirements of the drinking water program are met. This duty is met through a commitment to the implementation, validation and verification of program elements, as well as through the appropriate response 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 that water consumers have access to safe drinking water. S/he must assess the facility to identify any risks to drinking water quality. S/he must 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 which follows best management practices as detailed in Section 7.0. Other management duties include:

- Assessing the facility to identify risks to occupational and environmental health, specific to the purveyance of 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 7.2)

- Securing services from qualified, accredited laboratories and consultants, as required (see Section 7.3)
- Developing a records system for potable water management (see Section 7.5)
- Developing incident and emergency response plans, including a communications plan (see Section 7.6)
- Preparing an annual report on all aspects of the drinking water system, including incidents and remedial actions
- Developing public information packages (27, 33)
- Encouraging the use of best management practices for system operations
- Ensuring that a third party evaluation/audit procedure is in place *(and that cooperation is provided to ensure that all information is available to the auditor?)* (see Section 7.7)

The manager or operator-in-charge must 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 7.6.

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 7.6 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 Responsible Authorities. 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 and are then responsible for following the sampling procedures outlined in Section 7.3 in order to ensure consistent and accurate test results. If a portable lab has been used, staff must ensure that the QA/QC procedures are followed. If a laboratory service is used, staff must verify that the laboratory service is accredited to perform testing of specific parameters. *See Section 7.3.2.1 for details*

Drinking Water Monitor

In remote and isolated locations, including underdeveloped 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 for interpretation of the results and recommendations for further action upon determining that E.Coli and/or total coliforms exceed the *Guidelines for Canadian Drinking Water Quality* or when there are unusual changes in disinfection residual
- Ensuring this analysis is performed in accordance with appropriate laboratory procedures
- Conducting quarterly record reviews to ensure the appropriate records are being maintained
- Keeping abreast of new information and procedures, including the Quality Assurance Plan (28)

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 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 the lines of communication by acting as liaisons between employees and management.(51)

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