

Drinking Water Treatment Standards for Newfoundland & Labrador



Department of Environment and Climate Change
Water Resources Management Division

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Purpose

To establish minimum requirements for drinking water treatment that apply to all public drinking water systems in Newfoundland and Labrador.

Definitions

A “Boil Water Advisory” (BWA) is a public announcement issued by a regulatory agency responsible for drinking water in the province advising the public that they should boil their drinking water prior to consumption.

“CT” is the product of disinfectant concentration (in milligrams per litre), determined before or at the first customer, the corresponding disinfectant contact time (in minutes), and the baffling factor of the contact chamber. Units are milligram minutes per litre. CT tables exist for free chlorine, chlorine dioxide, ozone, chloramines and ultraviolet radiation (UV) (see *Guidelines for the Design, Construction and Operation of Water and Sewerage Systems* or the *Guidelines for the Design of Drinking Water Systems*).

A “disinfection system” is a drinking water treatment process or a series of processes that destroy or inactivate pathogenic organisms by either chemical or physical means and provides both primary and secondary disinfection.

“Distribution system” is the part of a public drinking water system that conveys treated water to consumers comprised of in-ground pipes and other appurtenances.

“Drinking water treatment process” means an individual treatment process that alters, reduces, increases, removes or inactivates one or more water quality parameters.

“Groundwater” is the water contained in interconnected pores in the soil, and crevices in rock, located below the water table in an unconfined aquifer or in a confined aquifer. For the purpose of this document, a raw water supply which is groundwater means water located in subsurface aquifer(s) where the aquifer overburden and soil act as an effective filter that removes microorganisms and other particles by straining and antagonistic effect, to a level where the water supply may already be potable but disinfection is required as an additional health risk barrier.

“Groundwater under Direct Influence of Surface Water” (GUDI) is groundwater having incomplete/undependable subsurface filtration of surface water and infiltrating precipitation, such as wells completed in fractured rock with little to no overburden, and where fractures are directly connected to the surface.

“Log reduction” is a measure of the percent of pathogenic organisms that are removed or inactivated during the treatment process. Log reduction can be achieved by log removal through physical treatment or log inactivation through disinfection. A 1-log reduction equals 90 percent reduction in density of the target organism; a 2-log reduction equals 99 percent reduction; a 3-log reduction equals 99.9 percent reduction, and so on.

A “Potable Water Dispensing Unit” (PWDU) is a small scale water treatment system providing for consumptive water use and that does not have a distribution system.

“Primary disinfection” is a treatment process or a series of processes intended to remove and/or inactivate human pathogens such as viruses, bacteria and protozoa potentially present in raw water before the water is delivered to the first consumer.

“Public drinking water system” is a system for the provision to the public of water for human consumption through a distribution system or PWDU, that is owned by or supplies water to a municipality or local service district, services 14 or more persons per day, and/or has been approved by the Department of Environment, Climate Change and Municipalities and is listed on the Government of Newfoundland and Labrador’s Public Water Supply List.

“Raw water” is water from the supply source prior to any drinking water treatment process.

“Residual” is the concentration of available disinfectant remaining after a given contact time in the distribution system.

“Secondary disinfection” is the maintenance of a disinfectant residual in the distribution system to protect the water from microbiological re-contamination, reduce bacterial re-growth, control biofilm formation, and serve as an indicator of distribution system integrity (loss of disinfectant residual indicating that the system integrity has been compromised).

“Surface water” includes water bodies (lakes, wetlands and ponds) and water courses (rivers, streams, brooks).

“Treated water” is water that has been subjected to a treatment process or processes.

“Water treatment facility” means a public drinking water system that has a drinking water treatment process other than chlorine disinfection. A water treatment facility can include a single treatment process or multiple treatment processes that target specific water quality parameters and that may involve chemical treatment, process adjustment, backwashing or media regeneration (e.g., pH adjustment, iron and manganese removal). A water treatment plant is considered a type of water treatment facility.

“Water treatment plant” means a water treatment facility that is designed to produce drinking water that meets all required drinking water quality standards and guidelines. The plant must use multiple treatment processes for the targeted reduction, increase, removal or inactivation of multiple water quality parameters. To be classified as a water treatment plant, the facility must be listed on the Department of Environment, Climate Change and Municipalities Drinking Water Treatment Plant Inventory List.

Authority

The Department of Environment and Climate Change (ECC) has been designated the lead agency for drinking water quality. Authority for these standards comes from Section 37 and 38 of the *Water Resources Act, 2002*. According to Section 37, “waterworks shall not be undertaken or proceeded with until the person has been granted a permit under this Act for the proposed waterworks”. According to Section 38, “all waterworks in the province shall at all times be maintained, kept in repair and operated in a manner and with those facilities that the minister may direct”.

Order in Council, O.C. 1190-72 requires that all public water supplies be provided with chlorination (disinfection). Minutes of Cabinet, M.C. 2001-0211 provided direction for the adoption of microbiological standards, and identified ECC as the lead Department for the purpose of setting standards and developing protocols on water issues.

Objective

The objective of these drinking water treatment standards is to reduce the risk of enteric illness and other health effects attributable to drinking water, supplied through public drinking water systems.

Background

These treatment standards rely on the *Guidelines for Canadian Drinking Water Quality* (most recent edition) as a primary reference. Contaminant and aesthetic guidelines have been developed for various microbiological, chemical, physical and radiological drinking water quality parameters. There are three main types of microorganisms (pathogens) that pose risk to human health in drinking water: viruses, bacteria and protozoa.

Application

All public drinking water systems shall meet the minimum requirements established by these standards.

These standards and the *Guidelines for the Design, Construction and Operation of Water and Sewerage Systems* or the *Guidelines for the Design of Drinking Water Systems* establish the minimum requirements for all disinfection systems and/or water treatment facilities on public drinking water systems in Newfoundland and Labrador.

Primary Disinfection Standard

The minimum primary disinfection-treatment requirement for all public drinking water systems is 2.0-log reduction of viruses.

Acceptable primary disinfectants include: free chlorine (including mixed oxidants), chlorine dioxide, ozone and ultraviolet radiation (UV). The use of chloramines as a primary disinfectant must be approved by ECC and may be limited based on available contact time.

If chloramines are used, chlorine shall be added ahead of ammonia to have sufficient free chlorine to achieve the required removal of viruses.

Public drinking water systems that do not meet the above standard will automatically be placed on a Boil Water Advisory (BWA).

Continuous on-line monitoring of disinfectant residual is required for all water treatment plants, with a maximum of 5 minute intervals for measurements, as water enters the distribution system or at some point prior to the first consumer.

UV units used for primary disinfection shall provide a minimum dose of 40 mJ/cm².

If chlorine dioxide is used for primary disinfection, the process shall operate in such a manner as to ensure that the maximum chlorine dioxide dose is 1.2 mg/L.

The use of any other primary disinfectant must first be approved by ECC.

Secondary Disinfection Standard

All public drinking water systems are required to maintain a disinfectant residual throughout the distribution system. If the primary disinfection system does not provide the required disinfectant residual in the distribution system, it must be paired with a separate secondary disinfection system. Only chlorine (including mixed oxidants), chloramines, and chlorine dioxide provide a persistent disinfectant residual and can be used for the maintenance of a residual in the distribution system. Specific standards are as follows:

Table 1: Standards for secondary disinfection

Disinfectant	Residual Requirements in the Distribution System	Minimum Residual Before or at the First Customer (where C is measured for the calculation of CT)	Maximum Residual at the First Consumer or Anywhere in the Distribution System
Chlorine (including mixed oxidant disinfection systems)	A detectable free chlorine residual must be maintained in all areas in the distribution system.	0.3 mg/L (as free chlorine)	4 mg/L (as free chlorine)
Chloramines	A combined chlorine residual of 0.25 mg/L must be maintained in all areas in the distribution system.	0.3 mg/L (as combined chlorine)	3 mg/L (as combined chlorine)
Chlorine Dioxide	A chlorine dioxide residual of 0.05 mg/L must be maintained in all areas in the distribution system.	N/A	0.8 mg/L (as chlorine dioxide)

The use of chlorine dioxide as a secondary disinfectant must be approved by ECC and may be limited based on distribution system size and residence time.

The use of any other secondary disinfectant must first be approved by ECC.

For potable water dispensing units (PWDUs) where the finished water is continuously disinfected immediately before being dispensed to the public using UV, or any other method approved by ECC for that unit, no disinfection residual is required.

Microbiological Standards

Microbiological standards are based on the most recent edition of the *Guidelines for Canadian Drinking Water Quality*. For all water sources, the following standards shall apply:

Table 2: Microbiological standards

Parameter	Standard	Application of Standard
<i>Escherichia coli (E. coli)</i>	None detectable per 100 mL	All public drinking water systems.
<i>Total Coliforms</i>	None detectable per 100 mL	All public drinking water systems.

Performance Standards for Drinking Water Treatment Facilities

A drinking water treatment facility must meet the maximum acceptable concentration (MAC) from the *Guidelines for Drinking Water Quality in Newfoundland and Labrador* for the water quality parameter or parameters being targeted for alteration, reduction, increase, removal or inactivation by the drinking water treatment process or processes that comprise the water treatment facility.

Performance Standards for Drinking Water Treatment Plants

The water treatment plant must produce water that meets the *Guidelines for Drinking Water Quality in Newfoundland and Labrador*, the above microbiological standards for *E. coli* and Total Coliforms, and the following performance standards for water treatment plants. Performance standards for water treatment plants are based on the most recent edition of the *Guidelines for Canadian Drinking Water Quality*. For all water sources and all types of water treatment plants, the minimum treatment standards shown in Table 3 shall apply.

Table 3: Performance standards for water treatment plants

Parameter	Standard	Application of Standard
<i>Giardia</i> (cysts)	3 log reduction and/or inactivation	<ul style="list-style-type: none"> Water treatment plants. PWDUs. Public drinking water systems that have experienced <i>Giardia</i> outbreaks.
<i>Cryptosporidium</i> (oocysts)	3 log reduction and/or inactivation	<ul style="list-style-type: none"> Water treatment plants. PWDUs. Public drinking water systems that have experienced <i>Cryptosporidium</i> outbreaks.
Enteric viruses	4 log reduction and/or inactivation	<ul style="list-style-type: none"> Water treatment plants. PWDUs. Public drinking water systems that have experienced a waterborne virus outbreak.
Dissolved Organic Carbon (DOC)	<p>If average source water DOC < 5.0 mg/L¹, maximum treated water DOC of 2.0 mg/L.</p> <p>If average source water DOC ≥ 5.0 and <8.0 mg/L¹, maximum treated water DOC of 2.5 mg/L.</p> <p>If average source water DOC ≥ 8.0 mg/L¹, maximum treated water DOC of 3.0 mg/L.</p>	<ul style="list-style-type: none"> Water treatment plants. PWDUs.

¹Source data used to determine treatment bin must be representative at least the spring, summer and fall seasons.

For water treatment plants, a minimum of 0.5-log reduction of *Giardia* and 2.0-log reduction of viruses must be provided by the primary disinfection portion of the overall water treatment system. The remaining log removal credits must be provided by other treatment processes.

Log Reduction

This section outlines how log reduction can be achieved using various water treatment processes and drinking water management approaches.

Disinfection

Log reduction credits for primary disinfection for individual pathogens, including that achieved using free chlorine, chlorine dioxide, ozone, chloramines and UV disinfection, must be determined by calculating the CT achieved in the public drinking water system and referencing it to log reduction in the appropriate CT tables. The CT calculation is based on the following equation:

$$CT = \text{Concentration}^1 \text{ (mg/L)} \times \text{Time (minutes)} \times \text{Baffling Factor}$$

¹ Concentration of disinfectant available after contact time has been achieved.

Details on how to determine log reduction can be found in the *Guidelines for the Design, Construction and Operation of Water and Sewerage Systems* or the *Guidelines for the Design of Drinking Water Systems*.

Filtration

Filtration processes meeting required turbidity limits can apply the noted log removal credits for viruses, *Giardia* and *Cryptosporidium*. Log reduction credits assigned to different filtration processes are as shown in Table 4.

Table 4: Log Reduction Credits Assigned to Different Treatment Processes

Treatment Process	Viruses	<i>Giardia</i>	<i>Cryptosporidium</i>
Conventional Filtration ¹	2.0-log	3.0-log	3.0-log
Direct Filtration ²	1.0-log	2.5-log	2.5-log
Slow Sand Filtration	2.0-log	3.0-log	3.0-log
Diatomaceous Earth Filtration	1.0-log	3.0-log	3.0-log
Microfiltration	May be eligible for virus removal credits when preceded by a coagulation step. Removal efficiency demonstrated through challenge testing and verified by direct integrity testing ³ .	Removal efficiency demonstrated through challenge testing and verified by direct integrity testing ³ .	Removal efficiency demonstrated through challenge testing and verified by direct integrity testing ³ .
Ultrafiltration	Removal efficiency demonstrated through challenge testing and verified by direct integrity testing ³ .	Removal efficiency demonstrated through challenge testing and verified by direct integrity testing ³ .	Removal efficiency demonstrated through challenge testing and verified by direct integrity testing ³ .
Reverse Osmosis/ Nanofiltration	Requires challenge and direct integrity testing ³ .	Requires challenge and direct integrity testing ³ .	Requires challenge and direct integrity testing ³ .
Cartridge Filters	None.	Requires challenge testing ⁴ .	Requires challenge testing ⁴ .
Riverbank filtration/in-situ filtration	Site-specific determination ⁵ .	Site-specific determination ⁵ .	Site-specific determination ⁵ .

¹Includes chemical mixing, coagulation, flocculation, clarification or dissolved air floatation, and rapid gravity filtration.

²Includes chemical mixing, coagulation, flocculation and rapid gravity filtration.

³Challenge testing and direct integrity testing shall follow the method outlined in the USEPA Membrane Filtration Guidance Manual or an acceptable equivalent.

⁴Challenge testing shall follow the method outlined in the latest edition of the USEPA's LT2ESWTR Toolbox Guidance Manual.

⁵As required by the WRMD.

Continuous on-line monitoring of turbidity is required for individual filters in a water treatment plant, with a maximum of 5 minute intervals for measurements. The turbidity of the effluent of any filtration process used for pathogen removal credit must meet the requirements shown in Table 5.

Table 5: Effluent Turbidity Requirements for Different Filtration Processes

Treatment Process	Effluent Turbidity
Conventional Filtration	≤0.3 NTU 95% of the time ¹ , never to exceed 1.0 NTU
Direct Filtration	≤0.3 NTU 95% of the time ¹ , never to exceed 1.0 NTU
Slow Sand Filtration	≤1.0 NTU 95% of the time ¹ , never to exceed 3.0 NTU
Diatomaceous Earth Filtration	≤1.0 NTU 95% of the time ¹ , never to exceed 3.0 NTU
Membrane Filtration (microfiltration, ultrafiltration, nanofiltration/reverse osmosis)	≤0.1 NTU 99% of the time ² , never to exceed 0.3 NTU
Cartridge Filters	≤1.0 NTU 95% of the time ¹ , never to exceed 3.0 NTU

¹95% of a) measurements made or b) the time each calendar month.

²99% of a) measurements made or b) the time each calendar month.

Water treatment plants with conventional or direct filtration that achieve 0.15 NTU 95% of the time each calendar month in combined filter effluent are eligible to receive an additional 0.5-log removal credit for *Giardia* and *Cryptosporidium*. Water treatment plants with conventional or direct filtration that achieve 0.15 NTU 95% of the time each calendar month in individual filter effluent are eligible to receive an additional 1.0-log removal credit for *Giardia* and *Cryptosporidium*.

Alternative Treatment

Log removal credits assigned to alternative treatment processes are as shown in Table 6.

Table 6: Log removal Credits for Alternative Treatment Processes

Treatment Process	Viruses	<i>Giardia</i>	<i>Cryptosporidium</i>
Pre-sedimentation or pre-dissolved air floatation basin with coagulation	None	0.5 log credit with continuous operation and coagulant addition. All flows shall pass through the basins.	0.5 log credit with continuous operation and coagulant addition. All flows shall pass through the basins.

Other Treatment Technologies

In the case of the provision of treatment technology other than those discussed in this standard, before using the technology, it must be demonstrated and documented that the technology achieves the required level of pathogen removal or inactivation, and be approved by ECC.

Source Water Protection

A 0.5-log removal credit for *Giardia* and *Cryptosporidium* for implementing a source water protection program may be approved by ECC for public drinking water systems if the following criteria are met:

1. A Drinking Water Source Protection Plan has been completed and approved by ECC for the source as per the requirements of the *Municipal Guide to the Development of a Watershed Management Plan*.
2. A source inspection is undertaken and an inspection report submitted to ECC on at least an annual basis.
3. Submission to ECC of an annual Drinking Water Source Protection Plan status report.

Corrective Actions

If required primary, secondary and/or microbiological standards cannot be met, a BWA will be issued for that public drinking water system. Public drinking water systems that do not meet the microbiological standard for *E. coli*, or that have had source waters test positive for waterborne viruses, *Giardia* or *Cryptosporidium*, shall investigate the cause and take necessary corrective action.

If a chemical or radiological drinking water parameter exceeds the health based MAC from the *Guidelines for Drinking Water Quality in Newfoundland and Labrador*, a Non-Consumption Advisory will be issued for that public drinking water system at the discretion of the Medical Officer of Health. Corrective action shall be taken to address the cause of the Non-Consumption Advisory.

Corrective action must occur in a timely manner and address all deficiencies with the public drinking water system in order to meet required drinking water treatment standards. If corrective action is not taken the owner of the public drinking water system shall be considered out of compliance with their Permit to Operate a Drinking Water System (Water Distribution and/or Water Treatment) and in violation of the *Water Resources Act, 2002*.