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SUBJECT	TM 6 – Comparison of Drinking Water Regulation and Compliance for Surface Water

PURPOSE

This memo compares drinking water regulations and compliance frameworks from British Columbia (BC) to other jurisdictions in Canada, the United States and internationally. It's focus is the treatment of surface water for acute health (pathogenic microorganisms) including:

- **Virus Disinfection** – approach for disinfection.
- **Protozoa Objectives** – inactivation targets and how they are achieved.
- **Turbidity Objectives** – turbidity (surrogate) target by technology.
- **Distribution System** – comparison of standards for distribution sampling.

This memo does not cover chronic health concerns related to chemical contaminants or disinfection-by-products which are individually addressed by maximum contaminant levels, nor does it address aesthetic objects for water.

The objective of this memo is to provide context for the Vancouver Island Health Authority's (VIHA) directions to Comox Valley Regional District, regionally, provincially, and internationally.

BACKGROUND

In Canada, drinking water quality guidelines are set out by Health Canada in the Guidelines for Canadian Drinking Water Quality (GCDWQ, 2012). Individual provinces set their own requirements and chose to adopt the GCDWQ.

The GCDWQ, which includes limits on microbial, chemical, physical, radiological substances, is largely influenced and pre-dated by the United States (U.S) Federal Regulations set by the U.S. Environmental Protection Agency (USEPA) and other organizations, such as the Wold Health Organization (WHO). The most current USEPA regulation is the Long Term 2 Enhanced Surface Water Treatment Rule (LT2, 2010). Table 1 summarizes GCDWQ's guidelines specific to pathogenic organisms.

Table 1: Microbiological Parameters

Pathogen	Canadian Guideline
Enteric Protozoa (*Cryptosporidium* and *Giardia*)	3 log (99.9%) removal and/or inactivation
Enteric Virus	4 log (99.99%) reduction[1]
Fecal Escherichia Coli (E-Coli)	No detectible per 100 mL
Total coliform	No detectible per 100 mL

In addition to explicit microbiological guidelines, turbidity guidelines are also set since particles can harbour microorganisms and protected them from disinfection. Furthermore, elevated turbidity is an indicator for increased risk of pathogen exposure. The GCDWQ recognizes that source waters with naturally low turbidity can be exempted from using filtration to achieve the finished turbidity water guidelines. However, GCDWQ states that the "*decision to exempt a waterworks from filtration should be made by the appropriate authority based on site-specific considerations, including historical and on-going monitoring data. To ensure effectiveness of disinfection and for good operation of the distribution system, it is recommended that water entering the distribution system have turbidity levels of 1.0 NTU or less*."[2]

When filtration is applied to surface water, minimum performance levels and measurement exceedances are established for each type of filtration technology. From the Health Canada guidelines, Table 2 outlines the turbidity removal performance requirements and the associated treatment credits by technology. It is consistent with USEPA LT2 Rule and is adopted by all Canadian provinces reviewed herein.

Table 2: Turbidity Limits for Filtration and Pathogen Removal Credits

Treatment Barrier	Turbidity limit for filter performance	*Cryptosporidium* removal credit	Virus removal credit
Conventional Filtration	≤ 0.3 NTU	3 log	2 log
Direct Filtration	≤ 0.3 NTU	2.5 log	1 log
Slow Sand Filtration	≤ 1 NTU	3 log	2 log
Membrane filtration	≤ 0.1 NTU	> 3 log	-

BRITISH COLUMBIA

British Columbia regulates municipal drinking water quality through its Drinking Water Protection Act (DWPA, 2001) and Drinking Water Protection Regulation (DWPR, 2003). The Act and Regulation are administered by regional health authorities, which are given discretion in how to enforce the requirements to meet potable standards.

Treatment Objectives

To assure that the drinking water system will reliably provide safe drinking water, all health authorities follow BC's "Drinking Water Treatment Objective (Microbiological) for Surface Supplies in BC" (2012), which uses the 4-3-2-1-0 moniker for surface water supplies. The *minimum* water treatment objectives defined are:

[1] Increases up to 7-log removal required based on source water. Resulting treated water limit is equivalent to one virus per each million litres of treated water.

[2] Health Canada, 2014 GCDWQ – Summary Table.

- **4 - Virus Reduction:** 4-log (99.99%) reduction in viruses, as a minimum.
- **3 - Protozoa Reduction:** 3-log (99.9%) reduction for both *Giardia* and *Cryptosporidium*.
- **2 - Minimum Number of Treatment Barriers**.
- **1 - Turbidity:** Maximum allowable turbidity of 1 NTU turbidity (or less if filtered).
- **0 - Bacteria:** Zero detectable E. coli (fecal) coliforms and zero total coliforms.

The 4-3-2-1-0 approach is the minimum standard for health authority acceptance, and more strict treatment standards may be directed if water quality deteriorates and presents a higher risk to human health. There are five health authorities in BC:

- Fraser Health Authority;
- Interior Health Authority;
- Vancouver Coastal Health Authority;
- Northern Health Authority; and
- Vancouver Island Health Authority.

While the DWPR relies on the GCDWQ as the primary reference, each jurisdiction recognizes site specific conditions may influence the level of apparent risk and therefore the resulting treatment approach. Table 3 presents the treatment approach for the largest surface water supplies in BC by population size (i.e. servicing more than 20,000 persons) and their compliance to meet the treatment objectives. As shown, each one of the four authorities in BC has both filtered and unfiltered supply systems.

Table 3: Summary of Surface Water Treatment Facility by Populations > 20,000 persons

Population Center	Treatment	Restricted Watershed	Compliance with Guideline	Health Authority
Metro Vancouver – Capilano & Seymour	Filtered	Yes	Yes - 2009	Coastal
Metro Vancouver – Coquitlam	Un-Filtered (2)	Yes	Yes - 2013	Fraser
Abbotsford – Norrish Creek	Filtered	Partial	Yes – 2002	Fraser
Abbotsford – Cannell Lake	Un-Filtered (1)	Yes	In progress - 2017	Fraser
Kelowna – Okanagan Lake (5)	Un-Filtered (1)	No	Yes – 2014	Interior
Kelowna – Mission Creek (BMID)	Un-Filtered (3)	No	In progress - 2017	Interior
Kamloops – Thompson River	Filtered	No	Yes – 2005	Interior
Nanaimo	Filtered	Partial	Yes – 2016	Vancouver Island
Victoria	Un-Filtered (1)	Yes	Yes	Vancouver Island
Vernon – Duteau	Un-Filtered (3)	Partial	In progress - 2018	Interior
Vernon – Kalamalka	Un-Filtered (1)	No	Yes	Interior
Penticton	Filtered	No	Yes	Interior
Campbell River – John Hart	Un-Filtered (1)	Partial	Yes	Vancouver Island
West Kelowna – Powers Creek	Filtered	No	Yes	Interior
West Kelowna – Rose Valley	Un-Filtered (4)	No	In progress - 2018	Interior
West Kelowna (WFN) – Okanagan Lake	Un-Filtered (4)	No	No	AANDC
Courtenay / Comox – Comox Source	Un-Filtered (4)	Partial	In progress - 2019	Vancouver Island

Notes:

1) UV and chlorine; turbidity consistently less then 1.0 NTU.
2) Ozone, UV, and chlorine; turbidity consistently less then 1.0 NTU.
3) UV, and chlorine; clarification (gravity settling or DAF) maintains turbidity less than 1.0 NTU.
4) Chlorine only – system not in compliance.
5) There are four (4) active intakes.

Treatment Credits

Similar to Health Canada's GCDWQ, BC health authorities require that surface water turbidity levels be less than 1 NTU at the point of disinfection. The guidelines state that a water supplier with turbidity levels > 1 NTU should notify the public of the increased health risk, and that a turbidity level > 5 NTU should trigger a Boil Water Notice. The guidelines also recommend filtration for all surface water sources. Since elevated turbidity is associated with the risk of an increased presence of microorganisms, removal of turbidity by filtration is given credit for protection against pathogens.

OTHER PROVINCES IN CANADA

Drinking water in **Quebec** is regulated by the Ministry of Sustainable Development, Environment and Climate Change through the Environment Quality Act.

Drinking water quality in **Ontario** is regulated by the Ministry of Environment through the Safe Drinking Water Act and Regulations[3]. While Ontario's reduction for *Cryptosporidium* is 2.0-log, it requires filtration for all surface water.

Drinking water in **Alberta** is regulated by the Alberta Environment and Sustainable Resource Development department. Regulations related to drinking water are provided in the Standards and Guidelines for Municipal Waterworks, Wastewater, and Storm Drainage Systems[4].

US EPA

Under the LT2, the US EPA sets out treatment objectives for filtered and unfiltered water systems that considers source water protozoa (oo)cyst levels. Log credits can be achieved through multiple approaches include various treatment technologies, monitoring, and operational practices. Water suppliers are required to monitor their source water quality to quantify the concentration of *Cryptosporidium* in the water supply. *Cryptosporidium* is used as it is more tolerant of conventional disinfection methods and therefore the focus of physical removal methods such as filtration and solids separation.

For surface water the minimum treatment is 4-log virus, 3-log *Giardia* and 2-log *Cryptosporidium*. Depending on the results of the source water monitoring the following additional treatment is required for *Cryptosporidium* (beyond 2-log):

Table 4: US Additional Pathogen Removal Requirements

Category	*< 0.075 oocysts/L*	0.075 - < 1.0 oocysts/L	1.0 - < 3.0 oocysts/L	> 3.0 oocysts/L
Conventional Filtration	-	1 log	2 log	2.5 log
Direct Filtration	-	1.5 log	2.5 log	3 log
Slow Sand Filtration	-	1 log	2 log	2.5 log
Membrane Filtration	-	-	1 log	1.5 log

[3] Ontario water quality is defined in Regulation O. Reg. 170/03 Drinking Water Systems and O. Reg. 169/03 Drinking Water Standards.

[4] Part 1 – Standards for Municipal Waterworks and Part 2 – Guidelines for Municipal Waterworks (April 2012).

WORLD HEALTH ORGANIZATION

WHO Standards for drinking water is a health-based treatment goals which sets the minimum requirements in a drinking water system. The standards are often followed by less affluent communities to manage and assess risks associated to the available drinking water in the area and the community's affordability. In managing health risks from ingesting lower quality drinking water, WHO adopts an epidemiological approach, whereby quantitative microbial risk assessment (QMRA) is used to evaluate infectious risks from human pathogens and manage waterborne microbial hazards. A maximum acceptable level of risk of 10^{-6} disability-adjusted life year or DALY/person/year is established by WHO as a health target. This target is equivalent to 32 seconds loss[5] of "healthy" life/person/year and is adopted in the Canadian Drinking Water Guidelines for viruses. Also like Health Canada's GCDWQ, a minimum of 0.2 mg/L chlorine residual at any points of use is required to avoid deterioration of water quality during conveyance.

NEW ZEALAND

New Zealand regulations for pathogenic organisms are per the 2008 Drinking Water Standards for New Zealand (DWSNZ). These standards, like the LT2 approach, account for the risk raw water source. Table 5 shows the three categories of surface water DWSNZ defines.

Table 5: NZ Protozoa Removal Requirements by Water Source

Surface Water Category	Log Credits Required
Pastoral catchment with frequent high concentrations of cattle, sheep, horses, or humans, or a waste treatment outfall upstream.	5 log
Pastoral catchment with frequent low concentrations of cattle, sheep, horses, or humans.	4 log
Forest, bush, scrub, or tussock catchment with no agriculture activity.	3 log

Interestingly, DWSNZ does not have a limit on viruses, but relies on E. coli limits as indicator.

SUMMARY

Table 6 provides a comparison of the international jurisdictions reviewed herein. The values in italic are the most notable differences to Canada.

Table 6: International Comparison to Pathogen Reduction

Log Reduction by Target Pathogen	Health Canada	USEPA	NZ	Australia	UK
Virus	4	4	*None*	*None*	*None*
Protozoa – *Giardia*	3	3	*3 to 5 [a]*	*None*	*None*
Protozoa - *Cryptosporidium*	3	*2 to 5. 5 [a]*	*3 to 5 [a]*	*None*	*None*
Turbidity Limit	< 1	*note b*	< 1	< 0.2	< 1
Mandatory Filtration	No	No	No	No	No

Notes:

a) Depending on raw water's concentration of oocysts, or relative risk level. In practice, few NZ supplies are required to meet 5-log.

b) If filtered, turbidity limit is per filtration type - see Table 2.

Table 7 compares the drinking water guidelines across Canadian provinces and the GCDWQ set by Health Canada. The values in italic are the most notable differences to BC. Table 6 and 7

[5] Another expression for this level would be 29 days of lost life per 1,000 persons based on lifespan of 80 years.

show that most jurisdictions are largely consistent with each other. This is to be expected since the body of research in developing the standards is the same.

Table 7: Canadian Province Comparison to Pathogen Reduction

Log Reduction by Target Pathogen	Health Canada	BC	QC	ONT	AB	NS	SA
Virus	4	4	4	4	4	4	4
Protozoa – *Giardia*	3	3	3	3	3	3	3
Protozoa - *Cryptosporidium*	3	3	3	*2*	*3.0 to 5.5*	3	3
Turbidity Limit	< 1	< 1 [a]	< 1 [a,b]	< 1 [b]	< 1 [b]	< 1 [b]	< 1 [b]
Mandatory Filtration	No	No	No [c]	*Yes*	*Yes*	*Yes*	*Yes*

Notes:

a) Less than 1 NTU for unfiltered. If filtered, turbidity limit is per filtration type - see Table 2.
b) Turbidity limit is per filtration type - see Table 2.
c) Quebec default position is filtration but some sources may apply for filtration exemption based on raw water quality where average turbidity is < 1 NTU, but two forms of disinfection are required.

Internationally, Health Canada is most comparable to the US and New Zealand but provides a more simplified approach to source water sampling for protozoa. Its reference document "Guidelines for Canadian drinking Water Quality: Guideline Technical Document - Enteric Protozoa; *Giardia* and *Cryptosporidium*" (2012) addresses this approach.

Within Canada, BC is most similar to Quebec and primarily aligned with Health Canada. Ontario's and Alberta's regulations are much more prescriptive with Alberta being the most prescriptive for both treatment objectives and requirements for the design and operation of treatment facilities. British Columbia and Quebec are the exceptions of the provinces reviewed in term of mandatory filtration for all surface water sources. Within British Columbia, VIHA is consistent with the other health authorities and there is no evidence that their approach to drinking water is either more or less intensive than other authorities in the province. In the letter dated May 4, 2016 from Dr. Charmaine Enns to Ms. Claire Bayless, the direction from VIHA to provide 3-log inactivation for *Cryptosporidium* instead of 2.5-log inactivation is consistent with all other provinces (except Ontario) and is consistent with all other provincial health authorities.

In summary, the direction provided by VIHA to CVRD is consistent with best practices within Canada and North America.

REFERENCES

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