SMALL WATER SYSTEM GUIDEBOOK

MAY 2024

HEALTH PROTECTION BRANCH
MINISTRY OF HEALTH

BRITISH COLUMBIA

TABLE OF CONTENTS

1 INTRODUCTION

The development of the technology to deliver safe drinking water to every household is one of the most important advances in protecting public health. When this happened at the beginning of the 20th century, rates of water-borne diseases and infant mortality reduced dramatically.

Today, all Canadians expect to have safe, potable drinking water coming from their taps, but this is not always the case.

Despite British Columbia's abundance of water and pristine wilderness, B.C. has had a history of being the province with the highest rate of water-borne illness in Canada.[1]

As of 2021/2022 approximately 12% of British Columbia's drinking water supply systems are on long-term water quality advisories or boil water notices. Most of these systems are small water supply systems: meaning they serve up to 500 people in a 24-hour period.

As a small water supply system owner or operator, you are probably facing numerous challenges in providing safe drinking water. This guidebook is intended to be the first step in helping you find solutions to these challenges, so you can provide the best possible drinking water for your customers.

1.1 CHALLENGES OF SMALL WATER SYSTEMS

There are more than 4,000 small water systems in British Columbia. Most of them serve fewer than 15 connections. These systems are generally located in small communities or remote areas of the province. They are required to provide the same quality of water as large systems but have many more challenges. These include:

- Inadequate treatment
- Aging infrastructure
- Trouble attracting and retaining trained and certified operators
- Difficulty in accessing laboratory services in a timely manner for testing water samples for *E. coli* and total coliform bacteria
- Lack of funding support for making improvements to infrastructure

Each owner/operator of a small water system has an obligation to provide safe drinking water to users of that system. This is a serious task due to the risk of severe illness to the public if the water

[1] Isaac-Renton, J., Peck, P., & Kendall, P. (2003). "Healthy Drinking Water in British Columbia: A Physician's Update." *British Columbia Medical Journal*, 45(9), 436.

supply system is not built and operated with care. But how do you do this when you are facing such challenges?

The government of British Columbia is working closely with the regional health authorities and other agencies to develop regulatory and logistical solutions that will support small water systems. However, the responsibility for ensuring potable water on a daily basis lies with you, the owner/operator, and your path may not be easy.

You will need to continually work with your community and make difficult decisions (e.g., raising rates for using water) to ensure you are offering the best and safest possible product to your consumers. Knowing as much as possible about your system, the legislation, available options, and resources will help you make informed decisions and protect your system from problems.

1.2 WHAT IS THE SMALL WATER SYSTEM GUIDEBOOK?

The *Small Water System Guidebook* was developed to help you improve delivery of safe drinking water. It is a collection of facts, tips and instructions for owners and operators of B.C. water supply systems serving up to 500 people. The guidebook describes the components of a small water system from source to tap, regulatory requirements, treatment objectives and more. It will help you:

- Assess and minimize the health risks associated with operating a drinking water supply system
- Evaluate your water supply system
- Keep good records and apply due diligence

Use all the resources in this guidebook. They will help you be a successful water supplier and build positive relationships with your community and local Health Authority Drinking Water Officer (DWO). Include everyone in the decision-making process and work with them to find solutions to issues that arise.

WOULD YOU LIKE TO SEE SOME EXAMPLES?

References are made to various forms and documents throughout the guidebook. Examples of some of these can be found in the appendices, including:

- Sample log sheets to record events and test results (Appendix C).
- Disinfecting your Well (Appendix E)
- Information about preparing an annual drinking water report for water users (Appendix D).

Safety information, sampling tips, and a list of chemical sampling criteria are included as well. Note that these are samples. Your local health authority may require slightly different formats or content. Be sure to check with your drinking water officer about the specifics needed in your documents and forms.

1.2.1 THE CHAPTERS AND THEIR CONTENT

This guidebook is split into four main sections, which are further split into chapters on individual topics related to the overall theme of the section. There is also a set of appendices, with supporting material.

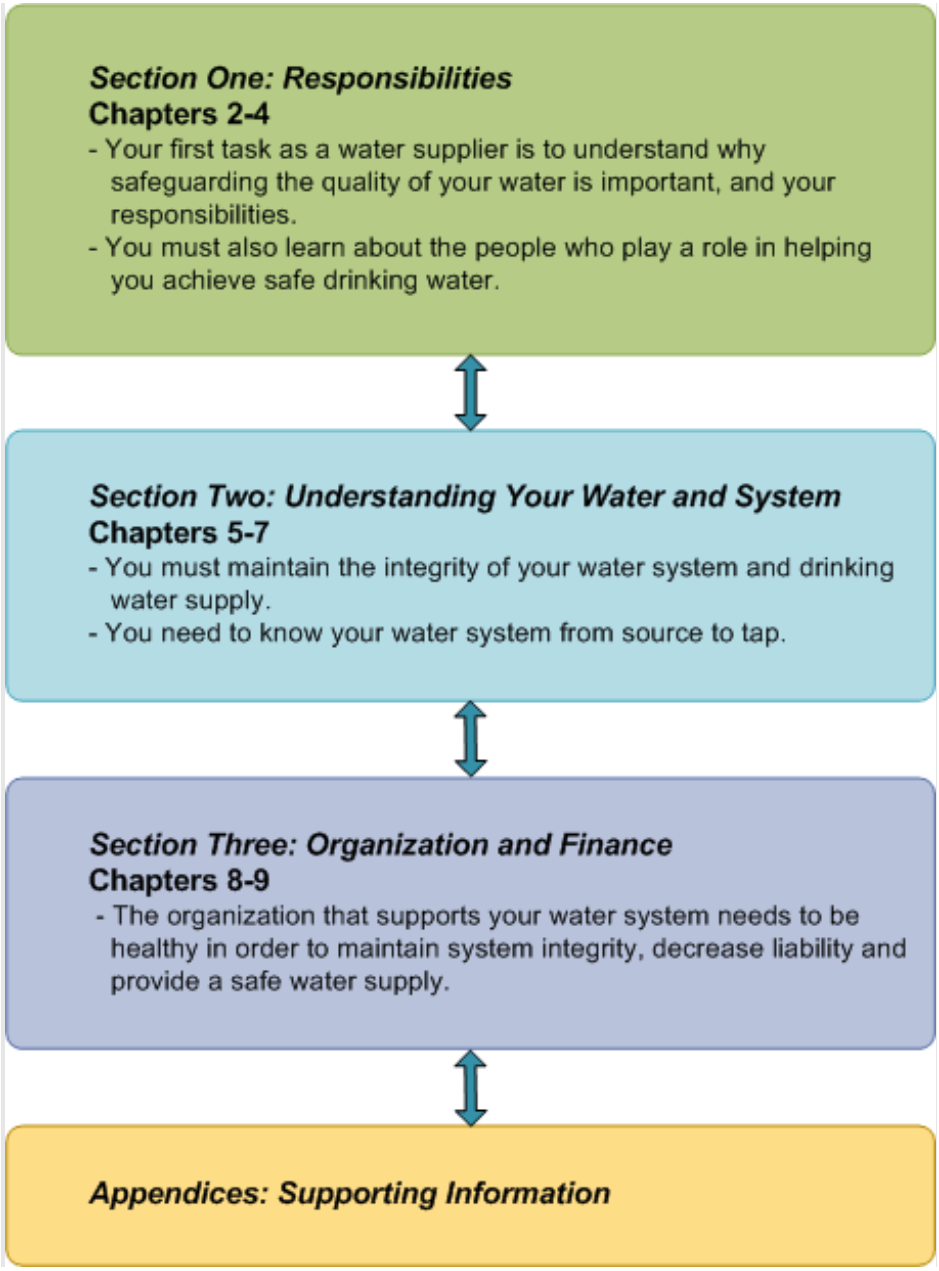


FIGURE 1: COMPONENTS OF THE *SMALL WATER SYSTEM GUIDEBOOK*

2 WHY IS DRINKING WATER SAFETY IMPORTANT?

2.1 DRINKING WATER AND PUBLIC HEALTH

Most people in North America assume that water from the tap is safe to drink. However, any water source can easily become contaminated.

Globally, around 1 in 4 people lack access to a safely managed drinking water system[2]. Contaminated water can transmit diseases such as diarrhoea, cholera, dysentery, typhoid and polio. Contaminated drinking-water is estimated to cause 502,000 diarrhoeal deaths each year[3].

As well as the human health costs (illness, death and long-term disability), there can be major financial costs:

- Businesses are affected by reduced productivity due to illness, employee absence and paid sick time, along with a potential loss of business during a large outbreak.
- The medical system incurs costs from visits to doctors and emergency rooms, hospital stays, diagnostic testing, medications and other treatments (e.g., dialysis).
- Personal finances are affected due to lost wages, medical expenses and the need to purchase items such as bottled water or home water-treatment systems.

WATER: ESSENTIAL FOR HUMAN HEALTH

Our body is made up of nearly 60% water. Our brain is nearly 70% and our lungs are nearly 90% water. We can stay alive without food for almost a month, but only a week without water.

The good news: a well-managed water supply system that integrates current technology and knowledge can nearly eliminate the risk of water-borne illness. The first step is to understand drinking water contamination and water-borne illnesses. This chapter provides a brief overview.

2.1.1 DRINKING WATER CONTAMINATION

Drinking water is used for human consumption, food preparation and other household purposes. Safe drinking water, or "potable" water, is water that is safe to drink and fit for domestic purposes without further treatment. Water sources can become contaminated with feces and other substances that can cause human illnesses through natural and human activities. Some of these activities are easy to detect and others are virtually imperceptible.

[2] https://www.un.org/sustainabledevelopment/water-and-sanitation/

[3] World Health Organization. "Drinking-Water Fact sheet." Reviewed November 2016. Online Source: http://www.who.int/mediacentre/factsheets/fs391/en/. Date sourced: 02-01-2017.

Most animals and birds make their homes around water sources, such as lakes, rivers and reservoirs. They may depend on this water for drinking, food (e.g., fish and vegetation), bathing and cooling on hot summer days. Animals and birds urinate and defecate in and around water sources and many of them die in and around water sources.

Human activity also provides a means for contaminating water sources. Farming both crops and livestock provides opportunities for fertilizer and manure to run off into water sources, including improperly sealed wells. Runoff from forestry practices, mining and construction can lead to water contamination. So can human sewage from poorly designed or improperly functioning sewer or septic systems.

Finally, other natural processes such as heavy rains and spring snow melt can lead to contamination.

Suppliers must take reasonable steps to protect water from known sources of contamination and ensure appropriate treatment is in place.

2.1.2 WHAT ARE WATER-BORNE PATHOGENS?

Micro-organisms – such as bacteria, protozoa and viruses – are everywhere in our environment. They are so small that most cannot be seen with the naked eye. In fact, a pristine-looking glass of water could contain millions of micro-organisms. You would not know it unless you looked at the water through a microscope or put it through laboratory testing. Most micro-organisms do not cause us harm and many are even beneficial. However, there are some micro-organisms, called "pathogens," capable of causing illness or even death in an infected individual.

Water-borne pathogens can live in the water we drink. Most of them cause infection and illness by growing in a person's digestive system. Symptoms of water-borne illness often include cramps, diarrhea, vomiting, muscle aches, weight loss, fever and chills. Severe cases can result in kidney failure, long-term illness and even death. Infants, children, the elderly and people with weakened immune systems are the most severely affected.

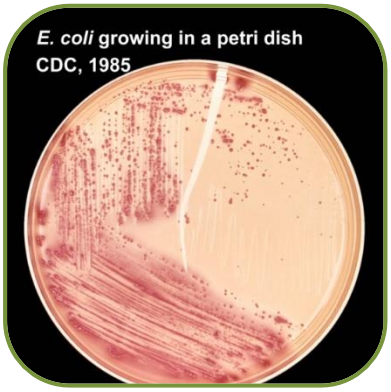
Water-borne pathogens are present in the fecal matter of infected people and animals. Any water source susceptible to animal or human activity is also susceptible to contamination with water-borne pathogens.

PATHOGENS

Pathogens cause illness in humans but may not necessarily cause illness in animals or birds. Do not assume that infected animals or birds are not accessing your water source just because you have not seen any that are sick.

BACTERIA

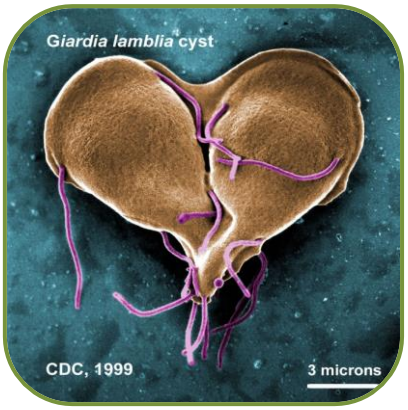
Bacteria are micro-organisms that can easily multiply both inside and outside the body. All they need is warm, wet conditions and a little food. They can colonize the intestines and, in the process, disrupt your digestive processes. Some can produce toxins, or move from the intestines to infect other tissues in the body, making an individual very sick. Examples include:



- *Escherichia coli* (*E. coli*)
- *Campylobacter*
- *Shigella*
- *Salmonella* (includes the bacteria responsible for typhoid fever)
- *Yersinia*
- *Vibrio cholera* (responsible for cholera)

PROTOZOA

Protozoa are also single-celled organisms, but they are generally larger than bacteria. Very few are needed to cause infection in a person. Just one could cause major illness. Protozoa can only survive outside the body in the form of a cyst or oocyst, which act like a cocoon creating protection from the elements and water treatment. The protozoa lie dormant inside the cyst/oocyst until they are ingested by a person or animal.



The protozoa that are prevalent in B.C. water include:

- *Cryptosporidium*
- *Toxoplasma gondii*
- *Giardia lamblia* (also known as “beaver fever”)

VIRUSES

Viruses are the smallest water-borne pathogens. They cannot replicate outside the body, but can survive a long time if environmental conditions are favourable. Once inside the body, viruses hijack the cells to reproduce, damaging the “host” cells.

Enteric viruses (those that affect the digestive system) include:

- rotavirus,
- adenovirus,
- polio,

- hepatitis A,
- norovirus

IMMUNITY

The immune system is the body's defense mechanism against infection from pathogens. When a pathogen enters the body, the immune system forms a complex line of defense to attack and rid it from the body. It is during this process that some of the body's cells create "memories" of the pathogen. If this pathogen enters the body again, these memory cells create antibodies that quickly detect and destroy it before it can cause any problems.

People drinking untreated water may assume their water is safe as they have "never been sick," when in fact they may have been sick but did not associate the illness with the water supply. If this is the case, they may have acquired antibodies to keep them from getting sick again. This is called immunity.

People new to an untreated water supply system (e.g., visitors and new residents) may not have developed immunity to any pathogens existing in the drinking water. Research has found that individuals new to a water supply system are more likely to report cases of water-borne illness than those who have been living with a system for over 10 years.* There is also research demonstrating that people with immune deficiencies, and some children and older adults, may be more vulnerable because their immune systems do not function well.** Any of these people could get seriously ill after drinking contaminated drinking water.

As an owner/operator of a drinking water supply system, you should take into consideration all the people who could come into contact with the drinking water you are supplying.

* Hrudey, S., & Hrudey, E. (2004). *Safe Drinking Water: Lessons for Recent Outbreaks in Affluent Nations*. IWA Publishing, London.
* Said, B., Wright, F., Nichols, G., Reacher, M., & Rutter, M. (2003). "Outbreaks of infectious disease associated with private drinking water supplies in England and Wales 1970-2000." *Epidemiol. Infect*., 130, 469-479.
* Strauss B, King W, Ley A, Hoey J. (2001). *A prospective study of rural drinking water quality and acute gastrointestinal illness. BMC Public Health*, 1(8).
** Risebro, H., Breton, L., Aird, H., Hooper, A., & Hunter, P. (2012). "Contaminated Small Drinking Water Supplies and Risk of Infectious Intestinal Disease: A Prospective Cohort Study." *Plos One*, 7(8): e42767.
** Strauss B, King W, Ley A, Hoey J. (2001).

2.1.3 TURBIDITY

Turbidity refers to the "cloudiness" of water. It can be caused by suspended microscopic particles, such as clay, silt, finely divided organic and inorganic matter, bacteria, protozoa and other microscopic organisms. Events such as runoff from road surfaces, heavy rainfall events, landslides and debris flows increase turbidity. It is measured in "nephelometric turbidity units (NTU)." Water generally becomes visibly turbid above 5.0 NTU.

Turbidity, in and of itself, does not usually pose a threat to human health, but it can be an indicator of the potential presence of human pathogens. For example, levels of *Giardia* and *Cryptosporidium* tend to increase with turbidity levels. Other potential problems with turbid water include:

- Turbidity can cause filters to clog quickly, leading to frequent backwashing and/or replacement.
- Turbidity has the potential to disrupt or overload drinking water disinfection processes, such as UV and chlorination, to the point that they may no longer effectively inactivate pathogens.
- Turbidity can shelter micro-organisms from disinfection.
- Turbidity due to organic matter can react with disinfectants, such as chlorine, to create byproducts that may cause adverse health effects.
- Suspended matter can contain toxins such as heavy metals and biocides.
- Excessive turbidity may be associated with unpleasant tastes and odours.

For all these reasons, turbidity can be used as a parameter to indicate the safety of drinking water. Therefore, turbidity monitoring is recommended.

2.1.4 CHEMICAL HAZARDS

Water can pick up contaminants such as heavy metals (e.g., lead), arsenic, nitrates, pesticides, and gasoline. Some of these substances occur naturally. Others enter the water as a result of human activity.

The effect of these substances on people depends on the chemical properties of the substance and the dose (immediate and long term). An owner/operator of a drinking water supply system should consult with the local DWO and refer to the *Guidelines for Canadian Drinking Water Quality* to determine testing and treatment needs related to chemical contaminants.

2.2 WHAT CAN GO WRONG?

Water-borne disease outbreaks in North America are not common, but they do happen. While it is easy to be complacent about a water source if it does not have a known history of causing illness, a series of incidents has highlighted the fact that safe drinking water today does not guarantee safe drinking water tomorrow. Water suppliers need to be forever vigilant about making water safe.

2.2.1 MILWAUKEE

In 1993, about 400,000 people were infected with *Cryptosporidium* when the municipal water in Milwaukee, Wisconsin became contaminated. An estimated 70 people died during this incident. This was caused by an ineffective filtration process at one of the two treatment plants.[4]

2.2.2 WALKERTON

A major event in Canada occurred in Walkerton, Ontario in 2000. Heavy rains washed cattle manure into the town's shallow well, which was in a farmer's field.[5] The manure contained *E. coli* 0157:H7, a particularly dangerous strain, and *Campylobacter*. This in turn contaminated the town's drinking water. About 2,700 people became infected, with 65 hospitalizations and seven fatalities.

WHAT IS AN OUTBREAK?

An outbreak is the occurrence of more individual cases of a disease than would normally be expected within a defined community, geographical area or season.

2.2.3 NORTH BATTLEFORD, SASKATCHEWAN

An outbreak of water-borne *Cryptosporidium* occurred in North Battleford, Saskatchewan in 2001. The likely cause was a decrease in functioning of a filtration unit following maintenance.[6] An estimated 5,800-7,100 people from the town became ill. North Battleford is located on the Trans-Canada Highway, and hundreds of people from nearby communities and other provinces became ill after visiting the town during the outbreak.

2.2.4 BRITISH COLUMBIA

B.C. has had a history of having one of the highest reported numbers of water-borne disease outbreaks in Canada. Though its record for outbreaks is improving, drinking water supply systems are still put on boil water notices, and small water supply systems are over-represented in this group. There continue to be many individual confirmed cases and there is always the matter of many cases going unreported.

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[4] Corso, P., Kramer, M., Blair, K., Addiss, D., Davis, J. & Haddix, A. (2003). "Costs of Illness in the 1993 Waterborne Cryptosporidium Outbreak, Milwaukee, Wisconsin." *Emerging Infectious Diseases*, 9(4).

[5] O'Connor, D. (2002). *Part One: A Summary. Report of the Walkerton Inquiry: The Events of May 2000 and Related Issues*.

[6] Stirling, R., Aramini, J., Ellis, A., et al. (2001) Waterborne Cryptosporidiosis outbreak, *North Battleford, Saskatchewan, Spring 2001. Canada Communicable Disease Report, 27 (22), 185-92.*

TABLE 1: KEY OUTBREAKS RELATED TO DRINKING WATER IN BRITISH COLUMBIA 1995-2004[7]

Year	Outbreaks
1995	Victoria: Toxoplasmosis (Toxoplasma gondii) – 110 infections confirmed, an estimated 3,000 infected. Source: Assumed that cats or cougars got into the watershed.
1996	Kelowna: Cryptosporidiosis (Cryptosporidium) – 177 infections confirmed, an estimated 10,000 infected. Source: Not confirmed, but believed to be a human sewage contamination in the water source. Cranbrook: Cryptosporidiosis (Cryptosporidium) – 29 infections confirmed, an estimated 2097 households containing at least one resident with diarrhea. Source: Cattle in the watershed.
1997	Princeton: Norwalk-flu-like virus (norovirus) – 88% of the service area affected. Source: A sewage main break contaminated a well.
1998	Chilliwack: Cryptosporidiosis (Cryptosporidium) – 19 infections confirmed. Source: Animals in the watershed. Sunshine Coast: Campylobacteriosis (Campylobacter) – 26 infections confirmed. Source: Unknown, but probably due to animals in the watershed. The drinking water supply was not disinfected and a boil water notice was in effect.
2002	Langdale: Suspected water-borne campylobacteriosis (Campylobacter).
2004	Hagensborg: campylobacteriosis (Campylobacter) – 5 infections confirmed. Source: Wildlife suspected in the watershed. The drinking water supply was untreated surface water and a boil water notice was in effect.

2.2.5 UNREPORTED ILLNESSES

Did you know that the majority of water-borne illnesses go unreported?[8, 9] There is evidence that for every one case of reported water-borne illness, there could be as many as 285 unreported cases.[10] Many infected individuals will only get mild symptoms lasting a couple of days and assume they have a minor "stomach flu." Usually, they do not seek medical attention. This means they do

[7] Adapted from *Progress on the Action Plan for Safe Drinking Water in British Columbia* (Office of the Provincial Health Officer, 2007).

[8] Hrudey, S., & Hrudey, E. (2007). "Published Case Studies of Waterborne Disease Outbreaks – Evidence of a Recurrent Threat." *Water Environment Research*, 79(3), 233–245.

[9] Said, B., Wright, F., Nichols, G., Reacher, M., & Rutter, M. (2003). "Outbreaks of infectious disease associated with private drinking water supplies in England and Wales 1970-2000." *Epidemiol. Infect.*, 130, 469-479.

[10] Hrudey, S., & Hrudey, E. (2007). "Published Case Studies of Waterborne Disease Outbreaks – Evidence of a Recurrent Threat." *Water Environment Research*, 79(3), 233–245.

not undergo laboratory tests to confirm a case of water-borne illness, so health agencies cannot track the actual number of cases of illnesses.

Even if cases are laboratory confirmed, it is not always easy to determine the source of illnesses. Tracing an illness back to a specific source can be difficult for a variety of reasons, including:

- Food can also be a source of many of these same pathogens.
- It can often take several days after ingestion for symptoms to appear. By the time the investigation is underway, the pathogens in the source may be gone.

The moral of this story: A lack of reported cases of water-borne illnesses is not evidence that the water you are producing is not making people sick.

2.2.6 SMALL WATER SYSTEMS

Detecting outbreaks in small communities can be even more challenging. To explain, we will start with the Milwaukee example. Milwaukee had a population of about 1.6 million people in 1993 and an estimated 400,000 people got sick; that is one-quarter of the population. Only 11% of this group sought medical attention, but this was enough people (approximately 44, 000) to trigger an investigation; the medical community knew this was not a coincidence.[11]

Compare this to a community of 20 people. If drinking water was to cause illness in one-quarter of that population, it would amount to five people. Of these people, there is a strong possibility that only one (or none) of them would seek medical attention. If there are few or no reported cases, the outbreak might not be flagged for investigation, and no one would know to check the drinking water for issues.

Even with these challenges related to detecting water-borne illnesses, evidence demonstrates that people receiving their drinking water from a small water system or private supply have the greatest risk of acquiring a water-borne illness.[12]

2.3 WHAT CAN YOU DO?

Your role as drinking water supplier to your neighbours and community is a serious responsibility. You deliver an important service that maintains the health of all those that receive your water and this makes you an important part of your community. The responsibility may seem daunting, but this guidebook will help you understand your role and how you can maintain the integrity of your water supply system and the drinking water supply.

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[11] Corso, P., Kramer, M., Blair, K., Addiss, D., Davis, J. & Haddix, A. (2003). "Costs of Illness in the 1993 Waterborne Cryptosporidium Outbreak, Milwaukee, Wisconsin." Emerging Infectious Diseases, 9(4).

[12] Said, B., Wright, F., Nichols, G., Reacher, M., & Rutter, M. (2003). "Outbreaks of infectious disease associated with private drinking water supplies in England and Wales 1970-2000." *Epidemiol. Infect*., 130, 469-479.
Risebro, H., Breton, L., Aird, H., Hooper, A., & Hunter, P. (2012). "Contaminated Small Drinking Water Supplies and Risk of Infectious Intestinal Disease: A Prospective Cohort Study." *Plos One*, 7(8): e42767.

There are a number of resources available to support you as a drinking water supplier. Many links to digital resources can be found throughout this Guidebook. You can also reach out to networks of your fellow small water system owner/operators, ask questions, share stories, and access training opportunities through two key resources:

Thompson Rivers University hosts the Small Water Systems Online Help Centre, which compiles "everything small water system operators need to know about regulations, treatment, distribution, operations (including water quality monitoring) and maintenance."

The BC Water & Waste Association hosts the BC Small Water Systems Community Network to "support small water systems owners and trustees, along with their employees and volunteers throughout British Columbia by connecting them with each other, and connecting them with the diverse and interconnected community that supports small water systems, and their resources."

The most common factors in water-borne disease outbreaks include:

- Complacency.
- Failure to thoroughly understand the water supply system.
- Failure to recognize warning signs internal or external to the system.
- Failure to respond to changes or seek help.
- Failure to put resources towards addressing water supply issues.[13]

The following actions will help keep you on track:

- Understand and follow the terms and conditions of your operating permit.
- Understand and follow your obligations under the *Drinking Water Protection Act* and Drinking Water Protection Regulation, as well as other associated legislation.
- Understand your source water characteristics and provide the necessary treatment to protect your customers.
- Ensure that you and those who work with you are trained in the proper operation of your equipment.
- Practice regular maintenance and monitoring of all aspects of your system and keep detailed, up-to-date records.
- Develop a good relationship with your drinking water officer that includes an open line of communication.

[13] Allen, M., Edberg, S., Clancy J., & Hrudey, S. (2012). *Drinking Water Microbial Myths – A Primer for Utility Managers, Engineers, & Non-Microbiologists*. Canadian Water and Wastewater Association National Conference, Kelowna, British Columbia, October 21-24, 2012.

- Communicate frequently with your system's users.
- Have a sound business plan and structure and appropriate governance structure.
- Practice good financial management that includes setting realistic rates to reflect the actual cost of providing drinking water.

Ensuring that your water supply system is producing safe drinking water is challenging. You can address this challenge by gaining the knowledge and the tools to maintain your system. Additionally, invite your community to work with you. The more it understands the necessity of safe drinking water, and everything needed to make it happen, the easier it will be for you to make decisions in the best interest of the system and your community.

DEMONSTRATING DUE DILIGENCE

Owners/operators of small water systems should show compliance with their operating permit's conditions by using good record-keeping practices. This is part of demonstrating due diligence. Records are reviewed by DWOs during routine inspections. On rare occasions, there could be a court challenge from someone who believes they have been harmed by the water supply system. Your records will show the steps taken to avoid harm. (Appendix C has sample log sheets.) Important factors to record include:

- Chlorine log.
- Maintenance log (e.g., flushing, cleaning, reservoir maintenance, security, repairs, filter backwashing, checking filters, pumps, well casings, UV lamps and chemical feeders).
- Bacteriological sampling results (available online on health authority website).
- Chemical sampling results (available online on health authority website) and exceedances.
- Emergency response and contingency plan.
- Inspection reports and responses to deficiencies.
- Record of user complaints and actions taken.
- Annual report to users.

3 DEFINING THE ROLES: WHO DOES WHAT?

Many people and organizations contribute to providing safe drinking water in British Columbia. This chapter provides a brief description of the roles of some of the key players.

1. PROVINCIAL GOVERNMENT MINISTRIES

MINISTRY OF HEALTH

The Ministry of Health (MoH) provides leadership and expertise to promote community environmental health. It develops policy, legislation, and guidelines for public health risk management in collaboration with government partners, stakeholders, local government and the public. Some key pieces of legislation and regulation are:

- *Drinking Water Protection Act* (DWPA)
- Drinking Water Protection Regulation (DWPR)
- *Public Health Act*
- Sewerage System Regulation
- Health Hazards Regulation

See the Ministry's Health Protection website by searching: how drinking water is protected in BC for more information.

PROVINCIAL HEALTH OFFICER

The Office of the Provincial Health Officer (PHO) has an oversight and accountability role under the *Drinking Water Protection Act*. The PHO can review decisions by DWOs. The PHO prepares an annual report on the status of drinking water in B.C. The PHO is supported in these roles by the Provincial Drinking Water Officer.

MINISTRY OF WATER, LAND AND RESOURCE STEWARDSHIP

The Ministry of Water, Land and Resource Stewardship develops policy and legislation related to water stewardship and sustainability. It is responsible for source-to-tap watershed planning and aquifer protection, water quality objective setting, and implementing programs related to source water protection, including designated community watersheds. It also develops ambient water quality guidelines including source drinking water quality guidelines. If you need information or guidance related to water stewardship, you will generally work with this ministry as it administers water licences and regulates water utilities and water users' communities. Contact the Ministry through FrontCounterBC.

Key pieces of legislation administered by this ministry related to drinking water include the *Water Sustainability Act* with the accompanying Groundwater Protection Regulation, the *Land Act*, the *Water Utility Act*, and the *Water Users' Communities Act*.

MINISTRY OF ENVIRONMENT & CLIMATE CHANGE STRATEGY

The Ministry of Environment and Climate Change Strategy (ENV) promotes environmental stewardship and sustainability by enhancing environmental protection, public health and safety, including monitoring and reporting on water quality. The Ministry conducts lake sampling and monitors for harmful algae blooms that can pose a risk to drinking water sources. Under the *Environmental Management Act*, the Environmental Protection Division works to prevent pollution, and promote and restore environmental quality.

MINISTRY OF MUNICIPAL AFFAIRS

The Local Government Infrastructure & Finance Branch of the Ministry of Municipal Affairs oversees the local government financial system and supports local government infrastructure through the administration of several capital funding programs.

The branch supports the development of sustainable drinking water infrastructure by:

- Working with improvement districts, regional districts and municipalities to improve governance and financial stability of water supply systems under their jurisdictions.
- Providing capital infrastructure funding for local government.

Key pieces of ministry legislation related to drinking water are the *Local Government Act* and the *Community Charter*. Further information is available on the Ministry of Municipal Affairs' website.

2. HEALTH AUTHORITIES

HEALTH AUTHORITY

There are a total of seven health authorities in B.C. Five regional health authorities – Northern, Interior, Vancouver Coastal, Fraser, and Island - deliver local health services for the B.C. Ministry of Health. First Nations Health Authority (FNHA) works in partnership with First Nations communities, using BC's guidelines in providing advice to First Nations. The health authorities work with the Ministry of Health to set and implement province-wide policy for drinking water. Provincial Health Services Authority (PHSA) works collaboratively with all of the above-mentioned partners to better serve patients through an integrated system of care. The B.C. Centre for Disease Control (BCCDC) is a part of the PHSA and provides laboratory testing for water samples.

The Regional Health authorities have a wealth of information for water suppliers because they are responsible for implementing the *Drinking Water Protection Act*. The health authorities employ the

medical health officers, DWOs, environmental health officers and public health engineers responsible for administering the *Drinking Water Protection Act* locally. These knowledgeable people issue operating permits and construction permits and act as an important resource for drinking water supply system owners, operators and users.

Contact your health authority for more information on available drinking water services. Appendix A has contact information, including websites, for B.C.'s health authorities. Additionally, the Ministry of Health maintains a list of health authority drinking water contacts.

MEDICAL HEALTH OFFICER

Medical health officers (MHOs) are located in each health authority. They are appointed by Cabinet and have overall responsibility for the implementation of the *Public Health Act* and the *Drinking Water Protection Act* in their health authority.

DRINKING WATER OFFICERS AND ENVIRONMENTAL HEALTH OFFICERS

Drinking water officers (DWOs) administer and enforce drinking water legislation and use provincial drinking water guidelines, known as the Drinking Water Officers' Guide, in making decisions. They provide surveillance and monitoring of drinking water supply systems that may affect the public's health. As well, they review the design, construction, maintenance and operation of drinking water supply systems, with an emphasis on co-operation and leadership among interested parties.

DWOs' numerous duties can include:

- Acting on notice to threats to drinking water quality.
- Conducting inspections.
- Issuing operating permits.
- Monitoring bacteriological and chemical quality of water supply systems.

Unless the Minister of Health appoints someone else to be the DWO for a specific area, this responsibility defaults to a medical health officer. A medical health officer has the authority to designate an environmental health officer (EHO), or, in some cases, a public health engineer to perform the duties of a DWO.

PUBLIC HEALTH ENGINEERS

Public health engineers are professional engineers who work for the health authorities on public health issues. Those involved in drinking water issues have approval from a DWO, or a DWO designation from a local medical health officer. They are generally responsible for reviewing construction permit applications and issuing construction permits. Additionally, they serve as a technical resource to field DWOs, occasionally assisting them with inspections.

3. WATER SUPPLIER

The water supplier or owner is responsible for the ongoing operation/management of the water supply system, or for hiring a qualified operator. The operator must ensure that the water supply system is operated according to the legislation and operating permit on a day-to-day basis, but the owner is ultimately responsible for the safety of the water the system produces.

When parts of the water supply system are owned by different people or jointly owned, then all of the owners are the "water supplier." In this case, the DWO may ask for one person to be named to receive and provide information. If a delegate is not named, the DWO may assign an owner to be the contact person. See Chapter 8: Business Structure and Governance for information about business structure and governance for water supply systems.

WATER USERS' COMMUNITIES

These are water licensees who have joined together to store/ distribute water. They are administrated under the *Water Users' Communities Act*.

Water suppliers are responsible for providing safe drinking water, meeting legislative requirements, and notifying the public and health authorities about water quality problems or the potential for health risk. Water suppliers must also provide users with a yearly report about the quality of their drinking water.

4. WATER USERS

Water users are the people who drink and use the water in their homes and businesses, and financially support water supply systems. They are important partners of the water supply system. They may also be the direct owners of small systems. Communicating with water users keeps them informed, which helps build a positive, trusting relationship.

All members of the public – including water suppliers and water users – are responsible for reporting threats, such as a toxic spill or other potential health hazard, to a DWO.

5. SERVICE PROVIDERS

WELL DRILLERS AND PUMP INSTALLERS

Well drillers and pump installers must be qualified as per the *Water Sustainability Act*. A person needs specialized knowledge to construct wells and install pumps for the prevention of groundwater contamination. The Groundwater Protection Regulation outlines requirements for the safe installation and closure of a well. For more information, see Chapter 4: *Regulatory Framework for Drinking Water Supply Systems*.

CONSULTANTS/CONTRACTORS

Consultants are people with expert knowledge, education and experience in specific fields related to drinking water (e.g., environmental health, engineering or hydrogeology). Consultants include professional engineers involved in system design and hydrologists involved in assessing the groundwater recharge area. Some very small water supply systems hire contractors to help with submitting applications for permits to health authorities.

Contact your local health authority early in the planning stage to get an idea of the type of services that may be required for your particular project. That will help you determine if a consultant is needed and what expertise they should have.

LABORATORIES

Water suppliers must take water samples and send them to laboratories approved by the Provincial Health Officer for microbiological analyses.

Approved water laboratories test and analyze samples for microbiological, chemical and physical content. The labs must notify the water supplier, the DWO and the MHO if test results do not meet specific standards. In turn, the water supplier must immediately report to the DWO that they have received the report from the laboratory.

A list of approved labs is available on the Provincial Health Services Authority website.

6. SOCIETIES AND ASSOCIATIONS

ENVIRONMENTAL OPERATORS CERTIFICATION PROGRAM

The Environmental Operators Certification Program (EOCP) has established classification systems for water and wastewater systems, as well as standards and processes for certifying system operators.

Under the Drinking Water Protection Regulation, certification is required for water supply systems and operators serving more than 500 people. Small water system operators are not always required to have certification. This requirement, if in place, is specified as a condition on their operating permit.

The EOCP does not provide training for the certification but has established an online training registry to help connect trainers with those seeking training in nearby communities. To learn more, see Appendix B: *Educational Opportunities*.

BC WATER & WASTE ASSOCIATION

The BC Water & Waste Association (BCWWA) is a nonprofit association dedicated to safeguarding public health and the environment by sharing skills, knowledge and experience in the water and wastewater industries.

BCWWA offers training for water supply system operators. It provides networking and knowledge-sharing opportunities for water and wastewater industry professionals in B.C. and Yukon.

Its website is a good resource for best practices documents and information on training. The BCWWA provides a large number of courses, many of which provide background knowledge towards EOCP certification.

BCWWA also hosts the BC Small Water Systems Community Network to support small water system owners, employees and volunteers with practical resources, connection and learning opportunities.

SUSTAINABLE INFRASTRUCTURE SOCIETY

The Sustainable Infrastructure Society is a nonprofit organization offering a range of programs to help community water supply systems in B.C. access affordable resources. This society works with individual water suppliers, regional water associations, and government agencies delivering services. Sustainable Infrastructure Society programs help small water systems find flexible liability and other insurance coverage, affordable water treatment, and access to financing. In addition, it provides links to asset management and water rate setting services.

WATER SUPPLY ASSOCIATION OF B.C.

The Water Supply Association of B.C. (WSABC) represents the interests of water suppliers throughout the Southern Interior of B.C. Its members provide irrigation and drinking water to thousands of acres of agriculture and over 200,000 people. The WSABC has represented its members' water supply concerns since 1923. It continues to actively follow issues such as source water protection, drinking water safety, changes in water treatment technology, and competent allocation and management of water resources.

BRITISH COLUMBIA GROUND WATER ASSOCIATION

The British Columbia Ground Water Association provides professional and technical leadership for the advancement of the groundwater industry and in the protection, promotion, and responsible development and use of groundwater resources in British Columbia.

COASTAL WATER SUPPLIERS ASSOCIATION

The Coastal Water Suppliers Association (formerly known as the Vancouver Island Water Distributors) has serviced Coastal and Vancouver Island water suppliers since 1971. It provides ongoing support and awareness to coastal water suppliers and their associates.

Full voting membership is open to improvement districts, municipalities, regional districts and private water suppliers. Consultants, individuals, and companies that provide goods or services to the water supply industry can become associate nonvoting members.

4 REGULATORY FRAMEWORK FOR DRINKING WATER SUPPLY SYSTEMS

Drinking water legislation is part of the Province's ongoing work to improve British Columbia's drinking water protection. This chapter is a brief summary of basic legislated requirements for the provision of safe water by the owner/operator of a water supply system to its users. This information is not meant to be a substitute for legal advice in specific circumstances. The rest of this guidebook will help you understand how to meet these requirements.

4.1 SPECIFIC LEGAL OBLIGATIONS UNDER THE DRINKING WATER PROTECTION ACT AND REGULATION

The *Drinking Water Protection Act* and the Drinking Water Protection Regulation apply to:

- **All** domestic water supply systems in B.C. – to provide protection from threats to water supply systems. For example, drinking water legislation supports both water supply systems and individual homeowners to address concerns about potential sources of contamination of their water supply system.
- **All** water supply systems – to regulate their operation and the delivery of potable water. This includes requirements for operating permits, construction permits and regular monitoring.

FIND ACTS / REGULATIONS
Visit the BC Laws website: http://www.bclaws.ca/.

DRINKING WATER PROTECTION ACT

The *Drinking Water Protection Act* outlines requirements for domestic water suppliers to make sure that water is safe to drink (potable) for end users. Water suppliers must also meet any additional requirements under the Drinking Water Protection Regulation and the water supply system's operating permit, as set by the local DWO.

DRINKING WATER PROTECTION REGULATION

The Drinking Water Protection Regulation sets out specific requirements for drinking water supply systems. These requirements include treatment, construction and operation of water supply systems, monitoring, reporting, and public notification in the event that water becomes undrinkable.

SINGLE-FAMILY RESIDENCES

A single-family residence on its own water supply system is exempt from most of the requirements of the *Drinking Water Protection Act* (e.g., construction and operating permits). It does, however, benefit from the parts of the act related to threats to drinking water and source water protection. Property owners are responsible for the safety of the water. Where a single-family residence on its own water supply system is a rental property, the *Public Health Act* requires landlords to supply tenants with potable water. Health authorities may be able to advise an owner on understanding and improving the safety of their single-family water supply system.

4.1.4 POTABLE WATER

A water supplier must supply water that is safe to drink and fit for domestic purposes without further treatment and meets any requirements set out in the operating permit or regulations.

There is an exception in the Drinking Water Protection Regulation. Water supply systems are not required to meet potability requirements in the distribution system if:

- The system does not supply water for human consumption or food preparation (e.g., it supplies water for industrial processes, irrigation, or other agricultural purposes), and is not connected to a water supply system that provides water for human consumption and food preparation purposes.

  OR

- Each recipient of the water from a small system has a point of entry (POE) or point of use (POU) treatment system that makes the water potable.

In each of these circumstances, the water supplier must ensure the location of nonpotable discharge and nonpotable water piping are identified by markings that are permanent, distinct and easily recognized.

DRINKING WATER OFFICERS' GUIDE

The *Drinking Water Officers' Guide* is a guide to the *Drinking Water Protection Act*.

4.1.5 SURFACE WATER AND GROUNDWATER AT RISK OF CONTAINING PATHOGENS (GARP)

Drinking water must be disinfected if it is supplied by a source that uses surface water or groundwater that is at risk of containing pathogens (GARP). See Chapter 6: *Water Supply Systems and Treatment Objectives* for more information about drinking water treatment objectives and expectations.

POINT-OF-ENTRY (POE) AND POINT-OF-USE (POU) SYSTEMS

Point-of-Entry (POE) and Point-of-Use (POU) treatment systems are an alternative to centralized water supply systems. They pump raw, untreated water to each connection, and provide users with a treatment device that either treats all the water entering the property/home (POE) or treats the water where needed, such as kitchen and bathroom taps (POU).

The Drinking Water Protection Regulation gives small water supply systems the option of using this technology. There are only some situations in which this is financially and practically appropriate. Responsibility for ensuring each device is maintained remains with the water supplier. Speak to your drinking water officer if you are considering this as an option. For more information, see Section 6.5.

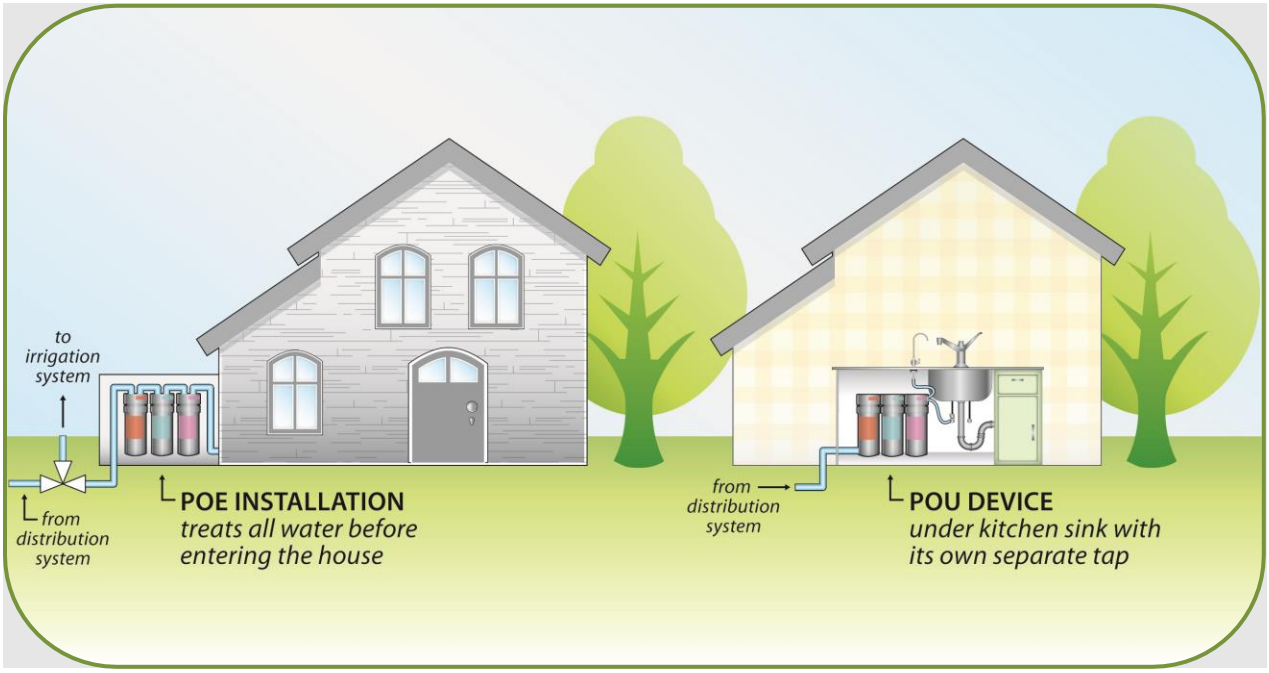


FIGURE 2: POE AND POU DEVICES

4.1.6 CONSTRUCTION PERMITS

Every new drinking water supply system, or upgrade to an existing system, must have a construction permit from the health authority **before** construction begins. Construction permits are normally issued by the public health engineer.

Contact your local public health engineer or DWO for an application package. The water supplier does not have to pay a fee for a construction permit. The application is reviewed to make sure the proposed work follows provincial legislation and health policies.

Under certain circumstances, the requirement for a construction permit may be waived by the issuing official. Examples of circumstances in which issuing officials may choose to waive a construction permit include:

- For emergency repairs;
- For routine maintenance;
- Replacement of one part with the same type of part;

KEEP A COPY OF YOUR CONSTRUCTION PERMIT

Once you have assembled the information necessary for your construction permit, keep a copy in a binder or folder in a safe location. You may need to refer to it when you write your annual reports and other communications.

- If an issuing official has waived the need for a permit;
- The system is exempt from the regulations;
- The work is so minor that it does not need a permit; or
- There is little health risk associated with the change.

Check with your local health authority before beginning any construction or upgrades to see if your system may be exempt. An application may be required even if the requirement for a construction permit is waived.

Information requested by local health authorities for a construction permit may vary throughout the province, as site conditions are different. Your public health engineer may ask for detailed information such as:

- Owner/operator contact information.
- Information on any existing operating permit.
- Source data – groundwater (e.g., Is your well drilled, dug or driven? Is it an artesian well?).
- Source data – surface water (e.g., Is your source a lake, stream, or spring?).
- Aquifer/source protection plan.
- Length of operation (e.g., continuous, seasonal or limited).
- Purpose (e.g., subdivision, strata).
- Plans and specifications of equipment (e.g., water main lengths of each size, class and type).
- Source water data (chemical, physical and bacteriological) on raw untreated water.
- Water quality concerns for all health-based and aesthetic parameters.
- Treatment works: pre-treatment, filtration, disinfection, treatment and storage.
- Design flow and population served.
- Cross-connection prevention program.
- Labeling of the location of non-potable discharge and non-potable water piping.
- Manufacturers' specifications.
- Well log.
- Location map, site plan and schematic diagrams.
- Engineered plans (or consultant plans, with permission from the public health engineer).

Note: Construction permit applications vary between health authorities. Please check with your local health authority to receive the correct application form.

4.1.7 OPERATING PERMITS

Every small water system, except those supplying a single-family residence, must have a current operating permit from the local health authority, which is issued by your DWO. The DWO usually asks for detailed information about your water supply system.

The DWO may put terms and conditions on your operating permit. These are system specific, as each system will have unique site conditions and characteristics. The DWO may discuss how to plan for addressing specific concerns before finalizing or amending the permit's conditions. The operator is responsible for compliance. Some examples of terms and conditions that may be required on the operating permit:

- A minimum frequency for bacteriological sampling.
- A minimum frequency for chemical sampling.
- Specific sampling requirements, such as for fluoride, arsenic or nitrate.
- Updating of an emergency response and contingency plan by a certain date.
- A specific level of operator training.
- A minimum chlorine content for water hauling.

Note: Application forms for an operating permit vary between health authorities. Please check with your local health authority to receive the correct application form.

4.1.8 OPERATOR TRAINING

Small water systems are not required to meet operator training certification requirements **unless** this is specifically stated in the operating permit from the local health authority. The DWO can specify what type of training is required, based on the size and complexity of the water supply system.

A certified operator is accredited by the Environmental Operators Certification Program (EOCP). This person may be able to provide service to several water supply systems if reasonably close to their site locations.

Note: Appendix B: Educational Opportunities provides examples of courses and programs, ranging from six hours to two years. The EOCP Training Registry may help identify appropriate courses offered in your area.

4.1.9 EMERGENCY RESPONSE AND CONTINGENCY PLANS

All water suppliers must have written emergency response and contingency plans. Emergencies can occur when the main operator is unavailable. Therefore, your completed emergency response and contingency plan should be posted where it can be easily seen and acted upon if the regular operator is not available. It is a good idea to periodically talk through or even walk through your

plan to practice it and confirm that it is effective. The Ministry of Health's *Emergency Response and Contingency Planning for Small Water Systems* is a recommended planning resource which has a number of excellent templates to help with planning for a variety of small water supply systems.

4.1.10 MONITORING

Bacteriological and chemical water sample monitoring is required by the Drinking Water Protection Regulation. The Regulation (Schedule B) requires systems serving less than 5,000 people to take at least four *E. coli* and total coliform samples per month. However, variations on this requirement may be specified by a DWO and may appear on the operating permit based on the history of the systems, or site conditions.

The monitoring frequency of chemical sampling is specified by the DWO. This frequency typically ranges between one and five years, depending on the nature of the source. In addition, specific parameters such as arsenic may require testing more frequently when they are a concern. See Chapter 7: Identifying and Addressing Vulnerabilities and Risk for more information about monitoring and sampling.

4.1.11 LABORATORY REPORTS

Laboratories must immediately report to water suppliers, the DWO and the medical health officer (MHO) if water sample test results for fecal coliform or *E. coli* do not meet specified standards. Water suppliers must immediately advise the DWO that they have been notified by the laboratory in such cases. Laboratories may also advise DWOs of other information on request.

4.1.12 NOTIFYING DRINKING WATER OFFICER OF THREATS

You must notify the drinking water officer of any threats or potential threats (e.g., spills/releases of chemicals, manure, farm waste, garbage, road construction and forestry activities) to drinking water as soon as you become aware of them.

4.1.13 PUBLIC NOTICE OF THREATS

If there is reason to believe there is a threat to the water supplied by a drinking water supply system, the DWO may request or order a water supplier to give public notice to the users of the system. If the water supplier becomes aware of a threat to their system and the DWO cannot be reached right away, the water supplier must immediately notify users of the water supply system of the possible hazard. The Drinking Water Protection Regulation Section 10 provides direction on how to do this; by posting a sign at every sink or drinking water fountain accessible to the public, and advise any person who may use the domestic water system for a domestic purpose. For ease of access in an emergency, this process should also be clearly laid out in your emergency response and contingency plans.

PUBLIC NOTIFICATION LEVELS AND THEIR DEFINITIONS

Water Quality Advisory: Used when a public health threat from the water supply system is higher than considered normally acceptable, but is not serious enough to warrant, or will not be resolved by, a *boil water notice*. The advisory will usually describe actions that can be taken to reduce risks.

Boil Water Notice: Used when testing reveals *E. coli* or other coliform organisms in the water supply, and/or the system fails to meet drinking water treatment objectives, and the associated public health threat from the water supply system can be effectively addressed by boiling the water.

Do Not Use Water Notice: Used when a significant health risk or public health threat exists in the water supply system that cannot be adequately addressed by a water quality advisory or *boil water notices*. (e.g., oil/ pesticide spill, microcystins detected in the drinking water etc.).

4.1.14 DRINKING WATER OFFICER AUTHORITY

Drinking water officers have the authority to make requests or orders to water suppliers. Water suppliers must comply with those requests or orders.

These may include:

- Floodproofing your well.
- Conducting a water source and system assessment.
- Addressing cross-connection issues.
- Developing a drinking water protection plan.
- Making information public about assessments or other issues.
- Doing other work as requested.

IS YOUR WATER SUPPLY SYSTEM ON A BOIL WATER NOTICE?

Health authorities have committed to the Ombudsperson to resolve boil water notices as quickly as possible.

4.1.15 RECONSIDERATION AND REVIEW

Under Section 39.1 of the *Drinking Water Protection Act*, water suppliers have the legislative right to request a review or reconsideration of certain types of decisions made by the drinking water officer. This applies to decisions pertaining to:

- Water source and system assessments. (Section 19 of the *Drinking Water Protection Act*)
- Hazard abatement and prevention orders. (Section 25)
- Orders respecting contraventions. (Section 26)
- Requests respecting plan initiation. (Section 31)
- A decision resulting from a reconsideration. (Section 39.1)

The water supplier can request the DWO to reconsider decisions if there is new information related to the matter. If the DWO reconsiders the matter, the DWO could come to the same decisions as was initially made, or vary or reverse the initial decision.

The water supplier can also request an independent review of decisions made by the DWO and this request should be directed to the Office of the Provincial Health Officer. The review can be done by the Provincial Health Officer or a medical health officer approved by the Provincial Health Officer. The review is based on the record and may agree with the initial decision, or vary or reverse the initial decision. It could also be referred back to the DWO, with or without instructions.

4.1.16 ANNUAL REPORTS

The Drinking Water Protection Regulation requires that an annual report be made available to all water supply system users within six months of the end of the calendar year (before July). The report must contain the results of monitoring required by the regulation, operating permit or DWO.

In addition, the *Drinking Water Protection Act* requires the following information to be made public in accordance with the regulation, and any terms and conditions placed on the operating permit by the DWO:

- The water supplier's emergency response and contingency plan.
- Results of monitoring required by the regulation, operating permit or DWO, subject to any applicable time limits established by the regulation.
- If applicable, its current water source and system assessment.
- If applicable, its current assessment response plan.
- Other information required to be made public by the regulation, its operating permit or DWO.

Water users are often interested in learning about their water supply system. The annual report provides an opportunity for water suppliers to share important information about their water supply system, significant recent events and water topics in general (e.g., water conservation). The report may also provide information about any local concerns, such as notice of any threats to the drinking water supply system, or levels of fluoride and/or sodium where they are significant. It may also list repairs completed or needed, major expenditures, vandalism and other general information about the water supply system. See the Guide for Communicating with Water Users for an annual report template.

YOUR ANNUAL REPORT

Your annual report could be delivered as a written notice to each individual user, posted as a notice on a community board or published on the water supply system website.

If the report is posted on a website, include a link to the local health authority website for current bacteriological and chemical results, dates of water supply system inspections, and additional information.

4.2 *PUBLIC HEALTH ACT* AND REGULATIONS

The *Public Health Act* creates the authority to make regulations related to public health matters. The Act also provides the authority to public health officials to conduct inspections and take actions to prevent health hazards. It addresses reporting of diseases and hazards, as well as current and emerging public health and environmental health issues. It includes regulations related to drinking water such as the Sewerage System Regulation and the Health Hazards Regulation. The Health Hazards Regulation contains setback requirements related to the distance a well should be from potential sources of contamination, and the requirement of landlords to provide tenants with potable water.

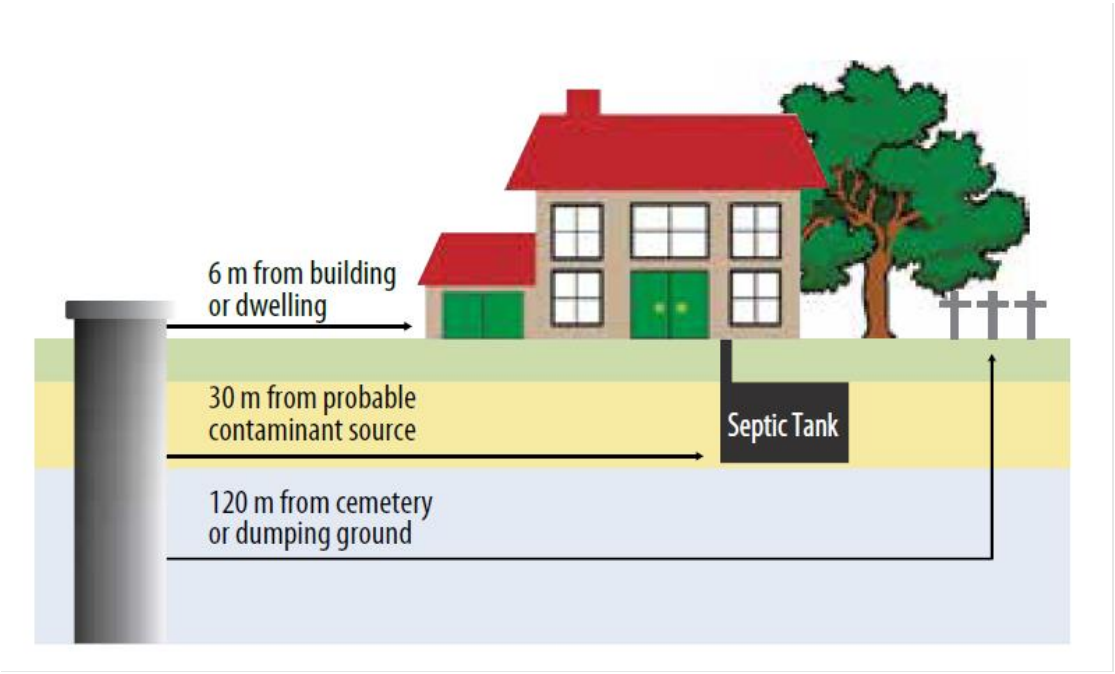


FIGURE 3: REGULATED SETBACKS
Best Practices for Dug Wells, ENV, 2013

4.3 *WATER SUSTAINABILITY ACT* AND REGULATIONS

4.3.1 *WATER SUSTAINABILITY ACT*

Taking water from surface or groundwater sources requires a licence issued under the *Water Sustainability Act*. The Ministry of Water, Land and Resource Stewardship is responsible for developing policy and legislation related to water stewardship and sustainability and oversees the on-the-ground issuing and monitoring of water licences. Direct applications or questions to FrontCounterBC.

4.3.2 GROUNDWATER PROTECTION REGULATION

The Groundwater Protection Regulation falls under the *Water Sustainability Act*. The regulation requires that all water wells in B.C. be properly constructed, maintained and – at the end of their service – deactivated and eventually closed to protect groundwater supplies.

Wells must be drilled by a qualified well driller, except for excavated (dug) wells up to 15 metres (50 feet) deep. Pumps for water wells must be installed by or under the direct supervision of a qualified well pump installer. Registered well drillers and pump installers have identification cards issued by the Ministry of Water, Land and Resource Stewardship. It maintains registries of qualified well drillers and qualified well pump installers.

There are some things a well owner can do without hiring a contractor:

- Disinfecting the pump and well. (Appendix D: *Disinfecting your Well*)
- Ensuring the pump house is in good repair and kept free of chemicals and other contaminants, such as pesticides, fertilizers and gasoline.
- Attaching or replacing a damaged or lost well identification plate.
- Capping the well, with a commercially available sanitary cap.
- Taking water quality samples to ensure the well water is potable. (Appendix F: *Instructions for Collecting Samples*).

5 UNDERSTANDING AND MAPPING A WATER SOURCE

5.1 INTRODUCTION

This chapter will provide you with a basic understanding of the water cycle and the differences between groundwater and surface water sources. You will learn how your local conditions can affect your particular water source.

For guidance on any of the concepts introduced in this chapter, you may:

- Seek further advice from your DWO or a consultant.
- Access the Source Water Protection Toolkit. This resource helps to simplify the source protection planning process and has guidance targeted to water suppliers, planners, and elected officials.

5.2 THE WATER CYCLE

The amount of water on the earth is constant, but its form (liquid, ice/snow or vapour) and location is always changing. The process by which water continuously moves between the earth and the atmosphere is the "hydrological cycle," also known as the "water cycle." This is the planet's system of recycling water.

There are four main stages of the water cycle:

Evaporation and Transpiration: As indicated in Figure 4, the sun heats up the water that has collected in the streams, rivers, lakes, ocean and even snow pack. The water **evaporates** (transforms into vapour or steam) and rises into the atmosphere. Further evaporation of water through the leaves of plants adds to this process. This is called **transpiration**.

Condensation: Once the vapour enters the atmosphere it begins to cool and **condense**, changing back into liquid. The air can hold onto the liquid,forming clouds. The clouds will travel in the atmosphere.

Precipitation: Eventually, clouds become heavy with condensation and the air cannot hold the water any longer. The water falls back to the earth in the form of rain, snow, sleet or hail. This is called **precipitation**.

Collection: After the precipitation hits the ground, it **collects** both above and below ground before beginning the process of evaporation/transpiration all over again.

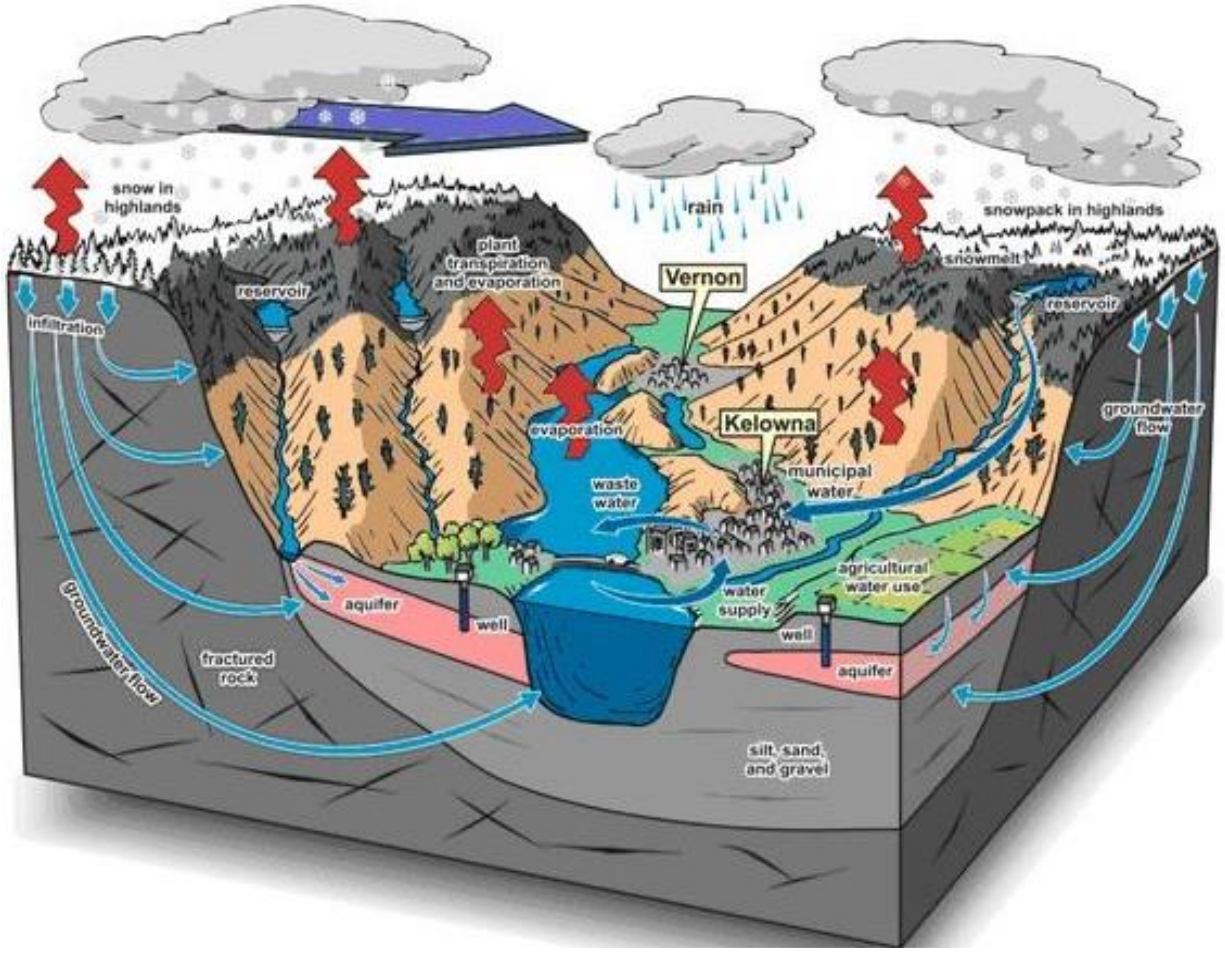


FIGURE 4: THE WATER CYCLE IN ACTION: OKANAGAN BASIN WATERSCAPE – OUR WATER CYCLE

Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2007 and Courtesy of Natural Resources Canada, Geological Survey of Canada [LivingWaterSmart.ca].

5.3 WATER SOURCES

Choosing a safe source water location is one of the most important things you can do for your water supply system. The goal is to start with a source with the best possible water quality and keep it that way. The process of how a watershed collects water is of vital importance to understanding drinking water sources.

Water can collect both above and below ground. Water that collects above ground in snowpack or bodies of water such as springs, ponds, creeks, streams, rivers, lakes and oceans is referred to as

"surface water." "Groundwater" refers to water that has infiltrated or seeped into the ground and collected in underground "storage units" called "aquifers."

5.3.1 SURFACE WATER

The area of land that drains to a surface water source is called a "watershed." Surface water movement follows the topography of the landscape and flows downhill via streams and rivers. Therefore, the watershed for a surface water source includes any connected water flow that is at a higher elevation.

All water has the capacity to collect, suspend and carry materials as it flows. Water is also a universal solvent in that it has the ability to dissolve many substances. These two factors make surface water directly affected by any landscape and shoreline that it touches, and open to contamination from animal and human waste.

There is a great deal of surface water in British Columbia, and it supplies the majority of the drinking water to the province. Surface water is always at risk for contamination from disease-causing pathogens (e.g., viruses, bacteria and parasites) due to its vulnerability to:

- Human activity such as development, logging, industry, agriculture, livestock production, road building and recreation.
- Animal activity near water bodies, including disturbance of stream beds, feces, urine, or animal carcasses decaying in or near a water source.
- Natural/weather events such as flooding, erosion, landslide, torrential rain, spring freshet and other seasonal water quality changes.

SPRING FRESHET

Spring freshet is the time of year when all the snow and ice are melting. A massive amount of water is released, which can flood areas around water sources.

This provides a route of contamination for whatever materials are on the flooded land. During spring freshet, water sources can be heavily turbid and contain far more disease-causing pathogens than usual.

As noted in Chapter 2: *Why is Drinking Water Safety Important?*, the consequences of consuming pathogens in drinking water are varied, but can include serious, long-lasting illnesses or even death.

5.3.2 GROUNDWATER

In some geographic areas, groundwater is the only viable and economic source of water supply for individual and community water supply systems. Consequently, groundwater provides drinking water to one quarter of B.C. residents and accounts for 9% of the total water consumption in the province. The aquifers in which the water is stored are water-saturated layers of sand, gravel or fractured rock. There are many different types of aquifers, for example:

- **Confined**: Confined aquifers have a layer of nonporous (impermeable) material such as granite or clay between the water and the surface.
- **Unconfined**: Unconfined aquifers do not have a layer of nonporous material between the water and the surface.
- **Perched**: A perched aquifer is a type of unconfined aquifer. It sits or is "perched" above an underlying aquifer, separated from the main groundwater below by an impermeable layer.

The water contained within aquifers has the ability to move through the spaces in the sand, gravel and rocks. The study of the process of underground water distribution and movement is called hydrogeology. The flow of groundwater usually matches surface water movement in that it follows the topography of the landscape and flows downhill. The area of ground where surface water seeps into the ground (infiltration) and moves downward through the spaces in the sand, gravel and rocks (percolates) from the surface into an aquifer is called the "aquifer recharge area." It is the porous surface-level space that contributes water to an aquifer.

Although some groundwater can stay locked up in the ground, most groundwater eventually flows into a body of surface water. Groundwater can reach the surface through natural cracks in the ground known as springs or flowing artesian wells (see *What is a Well?*, below). Groundwater is usually accessed by drilling a well or digging a hole (a "dug well") to penetrate the aquifer. Water is generally drawn from the aquifer using a pump.

The various layers of sand, gravel and rock the water travels through can act as a natural filtration system against pathogens. More layers and time spent moving through those layers generally equates to increased filtration and better removal of pathogens. As a result, groundwater is often of good quality. However, not all sources of groundwater are safe from pathogens, and many sources of groundwater are at risk of containing pathogens. This is termed "Groundwater at risk of containing pathogens" or "GARP."

WATER TABLE

The "water table" is the level below which the ground is saturated with water.

This can change depending on the time of year. During drought periods, the water table may be far below the surface. If you have a water table well, your well could dry up during this time.

In rainy periods, the water table could be right up at the surface, meaning the ground is completely saturated. This can lead to flooding.

Another factor to consider concerns the ability of water to dissolve susceptible minerals and chemicals in the ground from the moment it begins to seep into the ground. Even though travel through the ground can filter out pathogens, it can also result in water with higher concentrations of dissolved materials. This can affect water hardness, pH and taste.

Since water may travel long distances before reaching your well, it can also come into contact with, and transport, naturally occurring hazardous substances such as arsenic, or contaminants such as pesticides and petroleum products not found in the ground immediately surrounding your water

source. For these reasons, it is critical that you do not assume that your groundwater source is either potable or palatable (has an agreeable taste and odour).

WHAT IS A WELL?

A well is an artificial opening in the ground made for extracting and using groundwater. There are generally three methods used in British Columbia for creating the hole for a well: dug/excavated, drilled, and driven sand points. Wells are usually built into either unconsolidated sediment (e.g., sand and gravel) or bedrock.

Local conditions such as topography and type of aquifer will determine the kind of well you have to build. For example, the water in a confined aquifer is under hydraulic pressure; therefore, the water rises above the aquifer when a well taps into it. This type of well is called an "artesian well." The "piezometric surface**"** is the level to which the water in an artesian aquifer will rise. Sometimes the piezometric surface is above ground level: this is referred to as a "flowing artesian well."

Another type of well is a "water table well," which draws water from an unconfined aquifer. This type of aquifer is not generally under hydraulic pressure; therefore, the water needs help from a pump to get to the surface. Each of these types of well is constructed in a manner that deals with the issues created by the nature of the given aquifer.

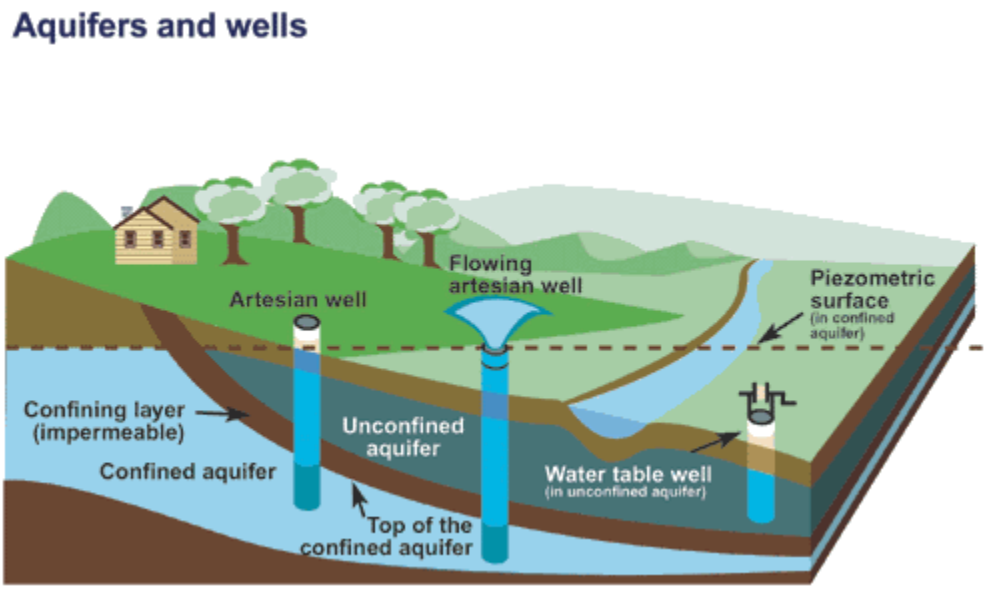


FIGURE 5: AQUIFERS AND WELLS
US Geological Survey: https://www.usgs.gov/media/images/aquifers-and-wells

5.4 MAPPING YOUR WATER SOURCE

You should know where your water comes from and the current condition of that raw, untreated water. This is the first step in assessing the risks to your water source, which will ultimately help determine the type and level of treatment you will need to produce safe drinking water.

Start by delineating or mapping the area around the source and defining a well protection area (groundwater) or watershed boundary (surface water). A "well protection area" is the area around the well where land-use activities have the most potential to affect the quality and quantity of water that flows into the well.

Identifying these critical areas that influence the quality of your source water will tell you where to look for potential risks to your drinking water. Knowing these risks will help narrow your water quality priorities. The following sections provide information needed for undertaking this process for both groundwater and surface water sources. You can concentrate on the section that applies to your water source.

AQUIFER CLASSIFICATION MAPPING

The Ministry of Environment & Climate Change Strategy's (ENV's) Aquifer Classification Mapping program has mapped over 800 aquifer locations in the province. The goal of classifying aquifers is to inventory and prioritize them for planning, managing and protecting B.C.'s groundwater resource. Aquifer maps provide considerable information on water supply sources. ENV's Aquifers website shows the areas already mapped and those being considered for mapping. The website also has information on:

- Aquifers of the Capital Regional District
- Guide to using the B.C. Aquifer Classification Maps
- Querying the Aquifer Database
- Aquifer Classification System B.C. Water Resource Atlas
- iMapBC Web Mapping

If your watershed is designated as a Community Watershed under the *Forest & Range Practices Act*, its boundaries may already be mapped. Go to https://catalogue.data.gov.bc.ca/dataset/community-watersheds-current and enter "1:50,000 BC Watershed Atlas Maps" in the Search box to find your watershed.

5.4.1 GROUNDWATER SOURCE

Groundwater protection requires understanding capture zones, time of travel zones and well protection area delineation. This section is based on the *Well Protection Toolkit*.

DELINEATING A WELL CAPTURE ZONE

The "well capture zone" ("well recharge zone") is the geographic area of land above and below the ground surface that contributes water to your well. Precipitation (e.g., rain or snow) or contamination (e.g., failing septic fields) in the capture zone – and fertilizers, oil spills, or other chemicals – can end up in your well water. Delineating or mapping the well capture zone provides the information you need to further define the well protection area.

WELL PROTECTION TOOLKIT

The *Well Protection Toolkit* is a six-step process for well-protection planning – so a community can prevent contamination of its well water supply.

It is strongly recommended that you read Step 2 of the *Well Protection Toolkit* for information about defining the well capture zone. If you choose to use methods other than Calculated Fixed Radius (CFR) or Arbitrary Fixed Radius (AFR), it is recommended that you hire a professional groundwater consultant. Always remember that your DWO and public health engineer are available for consultation.

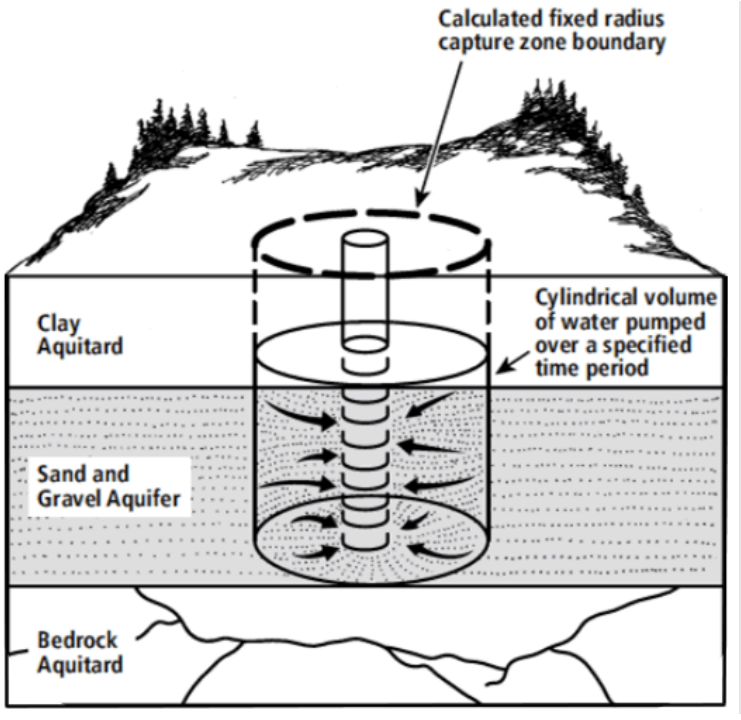


FIGURE 6: EXAMPLE OF CALCULATED FIXED RADIUS (CFR)
(*Well Protection Toolkit*, Step 2, ENV)

TIME OF TRAVEL ZONES (FOR WELLS)

The well capture zone can be divided into subareas based on "time of travel": the time it takes for water to penetrate from the surface and move to your aquifer and then to your well. Pathogens can only survive for a certain amount of time in the ground. This makes time of travel relevant to determining if your groundwater is at risk of containing pathogens, and future treatment decisions.

The capture zone is generally divided into one-year, five-year and ten-year time of travel zones, with the one-year area usually being the closest to the well and the five- and ten-year areas farther away. Knowing how long it will take for water to travel to the well allows you to know how long it will take contaminants to travel to your well. This provides a means of prioritizing well-protection activities (i.e., focus on the one-year area as a first priority).

Step 2 of the *Well Protection Toolkit* provides explanations of tools such as numerical modeling that can be used to determine the travel time zones within your capture zone. These tools should only be undertaken with consultation from a groundwater consultant. For an example of capture zone delineation, see Figure 7, below.

PUMPHOUSES

Well pumphouses can offer protection for the source. But sometimes they are also used to store contaminants (e.g., gasoline and paint) that can pollute the well. Remove all contaminants from the pumphouse.

The wellhead must be accessible to heavy equipment – to remove the pump for repair or replacement, and/or work on the well pipe and casing.

WELL PROTECTION AREA DELINEATION

A well protection area is the area around the well where land-use activities have the potential to affect the quality and quantity of water flowing into the well. Determining the well protection area requires information on pumping rates, aquifer transmissivity, ambient hydraulic gradient, aquifer porosity and aquifer boundary. Much of this information can be found in the well driller's log.

In many cases, the well protection area will be similar to the well capture zone. In other cases, when there is uncertainty about the size of the capture zone, it may be worthwhile to delineate a well protection area larger than the capture zone, such as a watershed boundary or a water district boundary.

Both the well capture zone and the well protection area should be reviewed annually because conditions can change. For example, new wells may be located nearby, your water supply system might add new connections, new information on your aquifer may become available, or industrial activities may be proposed within your well protection area.

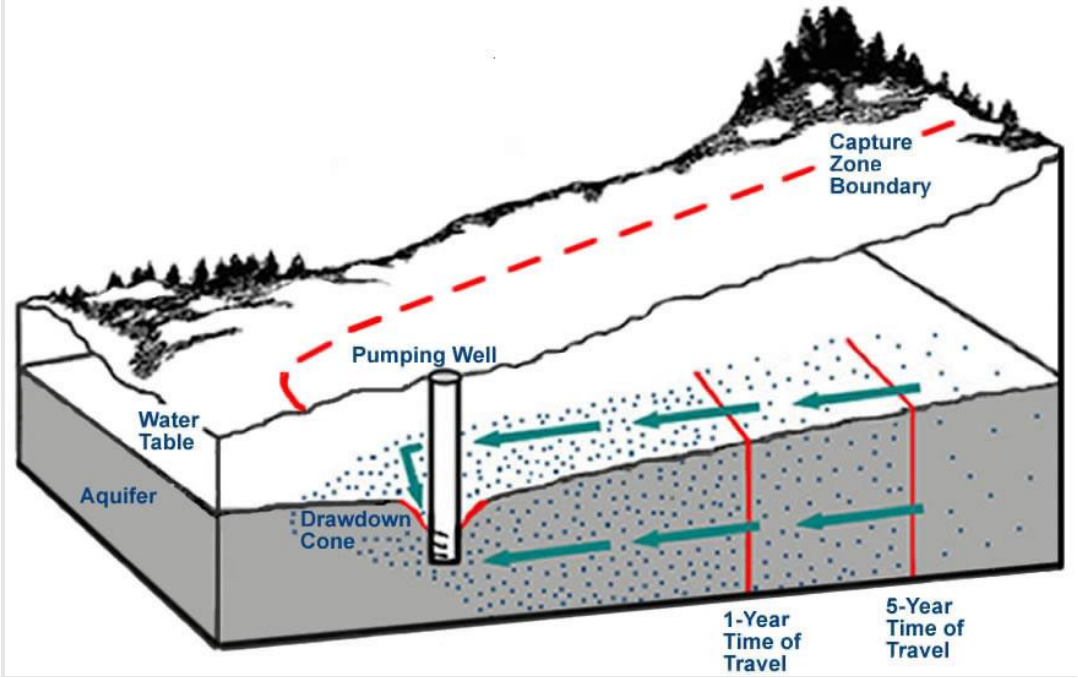


FIGURE 7: EXAMPLE OF CAPTURE ZONE DELINEATION
(*Well Protection Toolkit*, Step 2, BC Ministry of Environment)

5.4.2 SURFACE WATER SOURCE

Evaluating surface water sources involves watershed area delineation and watershed characterization.

WATERSHED AREA DELINEATION

To delineate the contributing watershed boundary for a surface water source, use a suitably scaled topographic map or an online tool such as iMapBC. iMapBC provides access to over 500 map datasets stored in the BC Geographic Warehouse. Mark the points of highest elevation in the area above your intake and connect the points.

Figure 8 shows the watershed boundary and the land area where water drains downslope to your intake. For more information about delineating the watershed area, see Module 1, Section 2 of the Comprehensive Drinking Water Source-to-Tap Assessment Guideline (Ministry of Health).

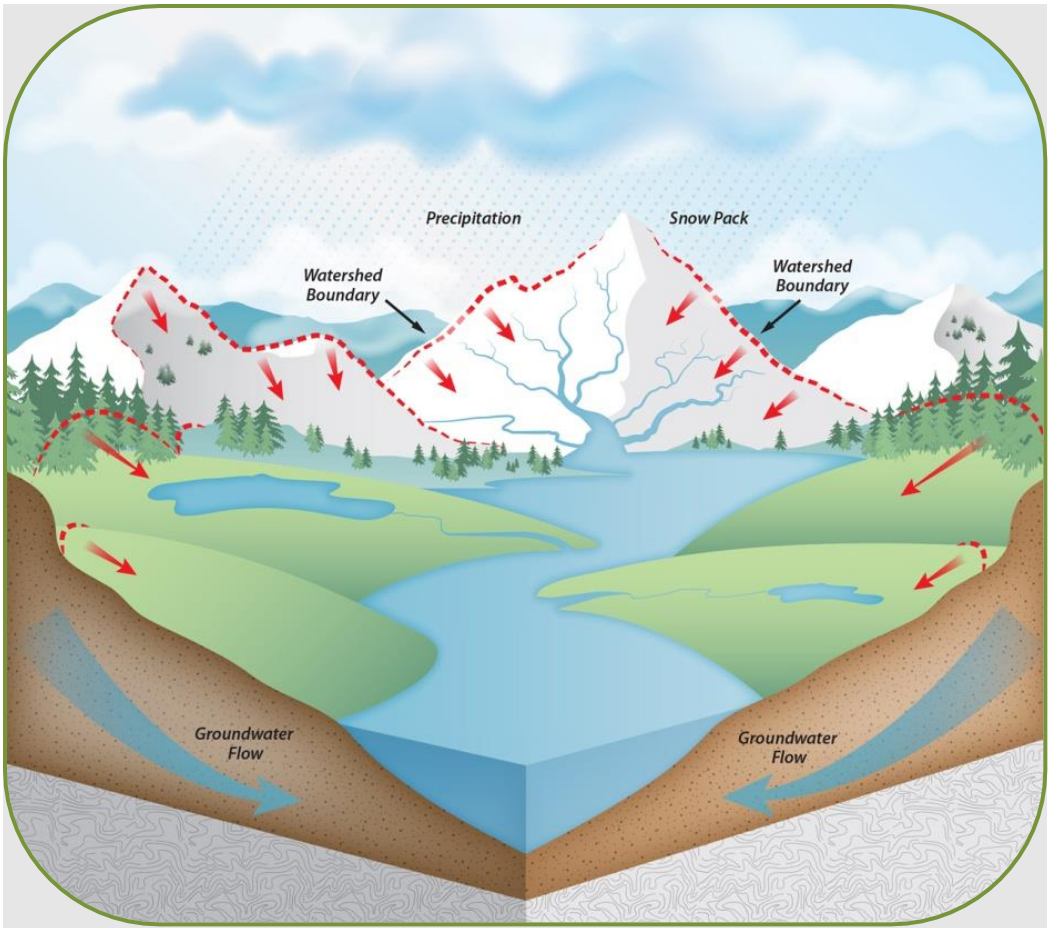


FIGURE 8: EXAMPLE OF WATERSHED DELINEATION FOR A SURFACE SOURCE

WATERSHED CHARACTERIZATION

Watershed characterization is the process of evaluating and analyzing the source water characteristics and the land within the watershed area. This provides insight into the factors that will influence water quality and quantity. Watershed characterization generally involves a visual examination of the watershed. If possible, look at the area from above. You may do this from a height of land, through aerial photographs or by using free software such as Google Earth.

Watershed characterization can give you important information about the characteristics of the watershed (e.g., hills, gullies, vegetation, stream beds, wildlife corridors and evidence of human activity). Figure 9, showing a portion of Haida Gwaii, provides an example.

The road construction and industrial activities above the residential homes are clearly visible, as are the creeks and the ocean on the right. Each of these features could affect the quantity and quality of this community's water source, depending on the location of the intake for their water

supply system. For more information about watershed characterization see Module 1, Section 2 of the Comprehensive Drinking Water Source-to-Tap Assessment Guideline.

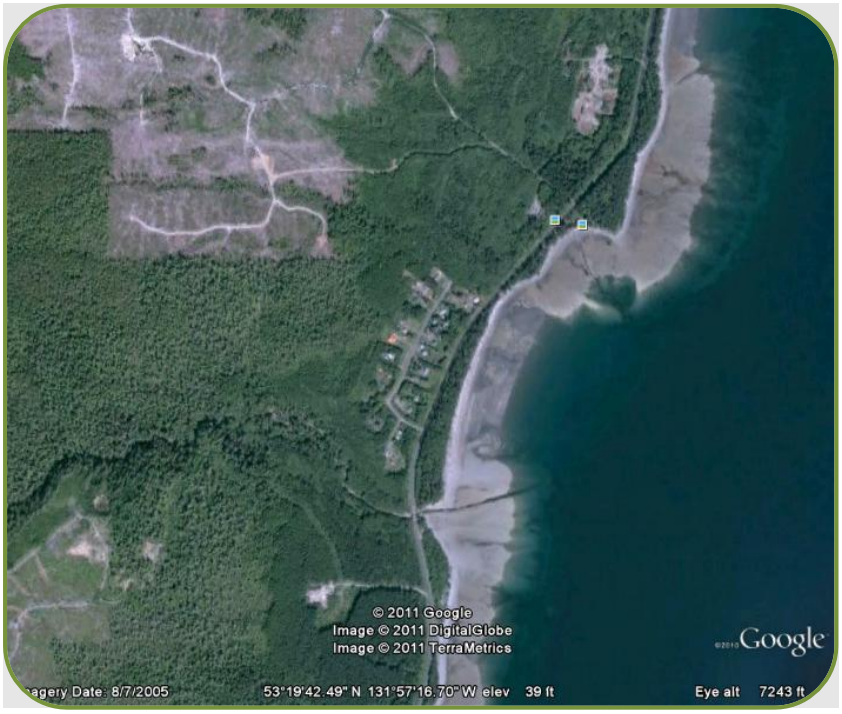


FIGURE 9: PORTION OF HAIDA GWAII
Google Earth, 2005

PROTECTING A WATERSHED

There are many things you can do to protect the area immediately surrounding your intake, which has the greatest impact on your water quality.

These actions could include:

- Building a fence with a locked gate (if that is an option).
- Putting up signs (e.g., "This is a source of drinking water.").
- Develop agreements with local landowners to restrict certain activities near the source.
- Regularly inspect your source, particularly near the intake, for sources of contamination.

RIPARIAN ZONES

Riparian zones along rivers, creeks and lakes protect surface water by providing plant cover that filters pollutants and prevents erosion. Riparian zones are protected under the Riparian Areas Regulation.

The water supply system owner/operator may make changes in the riparian zone only with the co-operation of the land owner and authorities, as appropriate.

6 WATER SUPPLY SYSTEMS AND TREATMENT OBJECTIVES

6.1 WHY IS TREATMENT NECESSARY?

Treatment requirements are based on the needs of your system (e.g., source water quality and risks). The information in Chapter 5: *Understanding and Mapping a Water Source* is essential for making these decisions. Your DWO and public health engineer can advise you on the best options for your system.

PLEASE REMEMBER!

Source water quality changes naturally throughout the year. You must deliver safe drinking water under all types of operating conditions.

There are three main types of microorganisms (pathogens) that pose risks to human health in water: viruses, bacteria and protozoa. These pathogens have many recreational, industrial, agricultural and natural sources. They can contaminate surface water sources, "groundwater at risk of pathogens" (GARP sources), and water in the distribution system. When people consume water contaminated with pathogens, consequences can include serious long-lasting illnesses or even death. This is why all water suppliers using surface water and/or GARP sources in British Columbia **must provide disinfection**.

No single action or process can address all the possible threats to drinking water safety. A "multi-barrier approach" is a system of procedures, processes, and tools - that when used together and applied from source to tap - can reduce the risks of drinking water threats.

Water disinfection is only one part of this multi-barrier approach. Choosing the right intake location and protecting water sources are essential steps. Also, filtration, disinfectants and other forms of water treatment are effective ways for treating pathogens and other hazards in water. Finally, the distribution system needs protection from microbial regrowth, contaminant intrusion or backflow/back siphonage.

6.2 WATER SUPPLY SYSTEM BASICS

The design of your water supply system should be highly dependent on the source (i.e., groundwater or surface water/GARP) and the characteristics of the raw water (e.g., microbial quality, chemical contaminants and aesthetics: turbidity, colour, taste and odour).

Generally, there are three main stages to delivering potable water:

1. Source water intake
2. Treatment
3. Storage and distribution

Water supply systems using groundwater determined to be at low risk of containing pathogens can often use simpler treatment processes than surface water supply systems do. However, there are many circumstances in which some or all of the processes involved in treatment must also be used for groundwater. See section 6.3, *Surface Water, Groundwater and GARP*, for details.

ARE THERE CHEMICAL CONTAMINANTS IN YOUR WATER SUPPLY SYSTEM?

Contact your local drinking water officer and public health engineer for Information on treatment for chemical contaminants and to learn what is best for your system.

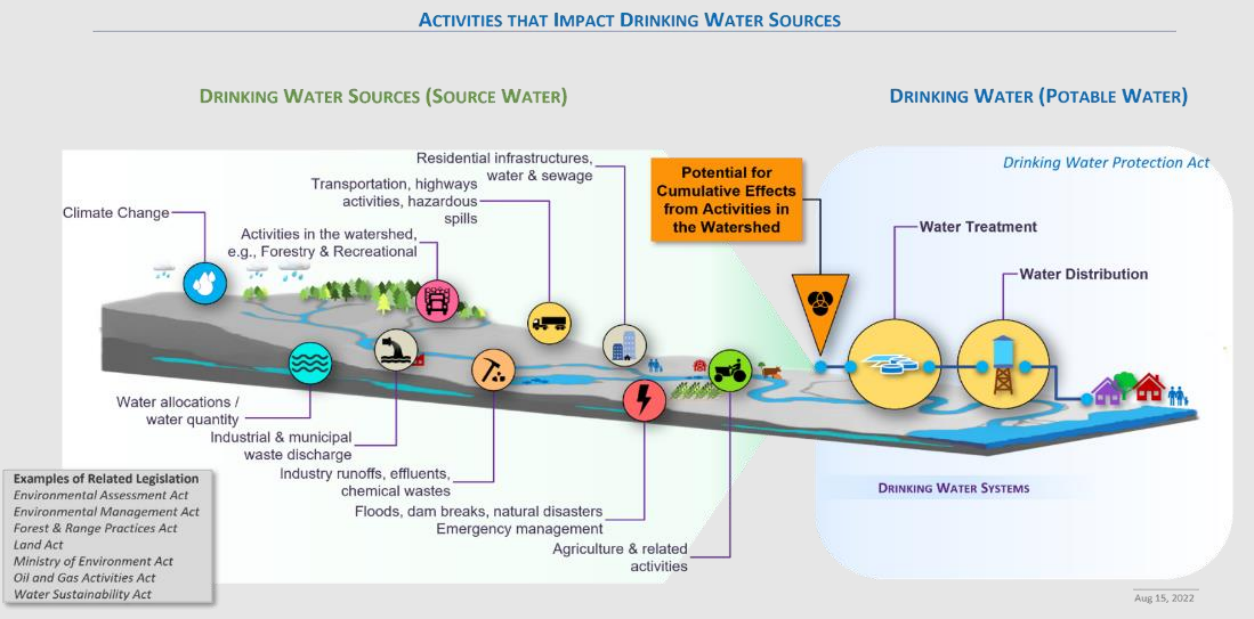


FIGURE 10: DRINKING WATER SOURCES AND WATER SUPPLY SYSTEM

6.2.1 SOURCE WATER INTAKE

Wells are used for the intake of groundwater. Surface water intakes generally make use of screens and filters to keep large debris, animals/fish, and vegetation out of the water supply system. They should be strategically located at an appropriate depth within the surface water source to maximize quality. Pumps provide the pressure needed to move the water from the intake into the system and beyond.

WELL CONSTRUCTION

The Groundwater Protection Regulation provides specific requirements for well construction in B.C. These requirements govern:

- Surface seals: prevents contaminants from entering the well.
- Sanitary well cap: prevents direct and unintended entry into the well of any water or undesirable substances at the surface of the ground, including floodwater, pond water and contaminants.
- Well casing stickup: helps flood-proof the wellhead; should be graded to drain surface water away from the wellhead.
- Well identification (ID) plate attachment, alteration, protection and replacement.
- Artesian Flow: The management and maintenance of artesian flow (i.e. Controlling or stopping artesian flow).
- Deactivating or decommissioning a well.

6.2.2 TREATMENT

There are five general steps to treating water. This is usually referred to as primary treatment. As noted above, each water supply system's circumstances and needs are unique and it is not always necessary to use all five steps:

- **Coagulation**: Coagulation is considered a pre-treatment step and is the first step involved in the chemical clarification of water (the other two steps are flocculation and sedimentation). It involves adding a chemical (e.g., aluminum sulfate) to the water to encourage suspended particles to cling together.
- **Flocculation**: This is the next step in the process of chemical clarification and considered a pre-treatment step. It involves the addition of polymers to the water that clump the small particles together to form "flocs."
- **Sedimentation**: This mixture of water and flocs is next pumped into a settling tank that allows the flocs to settle to the bottom. Once this sedimentation occurs, the water can be pumped to the next section of processing.
- **Filtration**: There are various means of achieving physical filtration of unsettled flocs, contaminants, and pathogens. Filtration systems can make use of several different materials to achieve the desired result. For example, slow sand filtration uses various layers of sand and gravel to filter water. Membrane technology and biologically active carbon filtration are other means of physically removing contaminants and pathogens from water.
- **Disinfection**: All surface water and GARP in B.C. must be disinfected. Disinfection inactivates a micro-organism by destroying the cell wall or interfering with its metabolic processes. This can be achieved by adding chemicals (e.g., chlorine or ozone), using heat, or ultraviolet (UV) light radiation at germicidal wavelengths.

Chlorine is the most used means of achieving disinfection because it is relatively inexpensive, and effective against bacteria and viruses. However, chlorine has limited effectiveness against the protozoa *Cryptosporidium*. Often, more than one form of disinfection is used in sequence as a multi-barrier approach to address risks from pathogens and contaminants in water.

Each step, as discussed above, can be achieved through a combination of various methods and technologies with each having advantages and disadvantages. Source water quality, cost, and number of connections must be considered in the design of a water supply system's treatment process. What might be appropriate for a large water supply system might not be appropriate for a small system. Consult with your DWO and public health engineer before choosing the combination that is appropriate for your small water system.

Other processing steps that may be worth exploring for some systems include: pre-sedimentation, aeration and re-carbonation, adsorption (e.g., using activated carbon), ion exchange, adding soda or lime to soften water, and adding fluoride to protect against tooth decay.

DISINFECTION BYPRODUCTS

Disinfection byproducts can form when organic compounds in the water react with an oxidizing agent, such as chlorine. Learn your source water characteristics so you can optimize the treatment process. For example, pretreatment can remove most organics, leaving very little to react with the chlorine.

6.2.3 STORAGE AND DISTRIBUTION

Once the water is treated, it is ready for distribution to service users via a series of reservoirs, pipes and pumps. Careful consideration should be made to monitoring and maintaining the distribution system because water quality can degrade as it moves through the system. Some systems make use of storage tanks that collect water during low-use times for release during high-use times. This contributes to consistency in water delivery and can be important for maintaining water pressure. The following is a list of actions you can take that will help you protect your distribution system:

- Secondary disinfection of water[14]
- Biofilm control programs
- Cross-connection control/backflow prevention programs
- Disinfection of water mains
- Disinfection of storage facilities

[14] The *British Columbia Guidelines (Microbiological) on Maintaining Water Quality in Distribution Systems* provides general guidelines on using a preventative, multi-barrier approach to maintaining potable water in the water supply distribution system and includes specific guidance for implementing the best risk management practice of secondary disinfection. The guidelines are consistent with the Act, regulation and *Guidelines for Canadian Drinking Water Quality* (Health Canada, 2012a).

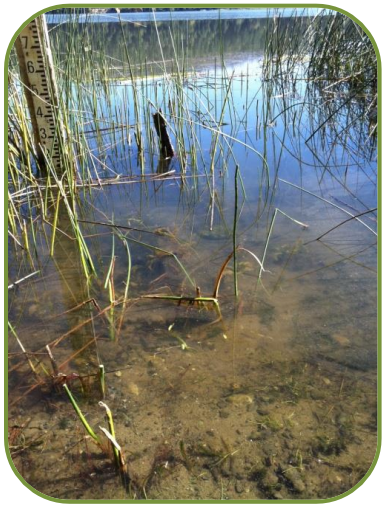
- Corrosion control programs
- Unidirectional flushing programs
- Distribution-system maintenance programs (reducing leakage/breakage)
- Hydraulic integrity testing (pressure and transitory contamination)
- Booster stations for secondary disinfection
- Monitoring water age (checking for places where the water may become stagnant)
- Water storage protection

SECONDARY DISINFECTION

Drinking water distribution systems (particularly if the system is aging) can be vulnerable to biological contamination through leaks in pipes, from improper/illegal connections, as well as re-growth of inactive pathogens that may remain in the system. Secondary disinfection is the process of maintaining a disinfectant residual in the distribution system to protect water as it moves through it.

Chlorine and chloramines provide a disinfectant residual; meaning the chemicals remain active in the water throughout the distribution system. Ultraviolet radiation (UV) provides disinfection only at the point of treatment and therefore does not provide a disinfectant residual.

6.3 SURFACE WATER AND GARP



All water has the capacity to collect, suspend and carry materials as it flows. Therefore, surface water is directly affected by the landscape and shoreline it touches, and open to contamination from animal and human waste. As a result, surface water is always at risk of containing disease-causing pathogens.

The circumstances for groundwater contamination are much more complicated. Despite being underground, pathogens can still be carried into an aquifer under the right conditions. Groundwater sources vulnerable to contamination are called “groundwater at risk of containing pathogens” (GARP). Potential sources of pathogens may include human sewage, agricultural waste stockpiles, animal feces and contaminated surface water.

Shallow, unconfined groundwater sources are most vulnerable. Water percolating to deep, confined aquifers is often naturally filtered to the point that pathogens are no longer present. Section 5 of the Drinking Water Protection Regulation states that drinking water must be disinfected if the source is surface water or if the DWO believes there is evidence that the groundwater source is at risk of containing pathogens (a GARP source).

The Ministry of Health has developed the Guidance Document for Determining Groundwater at Risk of Containing Pathogens (GARP)[15] which will help health authorities and water suppliers determine if a groundwater source is at risk (disinfection required) or at low risk (no disinfection required).

This guidance document outlines a staged approach for assessing GARP with initial screening, more intensive hydrogeological investigations if required, and long-term monitoring. The first assessment stage uses a screening tool that looks at historical water monitoring data, well location and construction, and aquifer characteristics. Your DWO may request that a GARP assessment be completed.

All wells, not just new wells, should be reviewed to determine whether they draw from a GARP source. Past outbreaks (e.g., Walkerton, Ontario in 2000) demonstrated that excellent bacteriological water quality results under normal conditions do not necessarily mean that a well is free from hazards. Extreme weather events or changes in the water supply system can adversely affect well water quality, especially if a source of pathogens is nearby. For example, a shallow well may produce good quality water under normal conditions but have elevated risk during spring floods. If in doubt, consider a well a GARP source that requires treatment, until it can be demonstrated that it is at low risk under all circumstances.

Disinfection is required for all wells drawing groundwater that is considered to be GARP and all drinking water drawn from a surface water source.

6.4 TREATMENT OBJECTIVES

This section explains **minimum performance targets** (i.e., the bare minimum you need to do) for reducing pathogens in your water supply and an overview of circumstances in which specific types of treatment are needed.

The Ministry of Health developed the Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia (Surface Water Treatment Objectives) and the Drinking Water Treatment Objectives (Microbiological) for Groundwater Supplies in British Columbia as minimum performance targets for treating both surface and groundwater supplies. These

treatment objectives are also considered, with some exceptions, to apply to GARP sources and are based on the Guidelines for Canadian Drinking Water Quality. It is common for health authorities to request this approach for new water supply system installations or as a goal with a set timeline for upgrading existing water supply systems.

The Surface Water Treatment Objectives provide targets for reducing the three main types of pathogenic micro-organisms:

- viruses
- bacteria
- protozoa

Given the site-specific conditions of water supply systems, it is necessary to apply the objectives according to risk assessments of individual cases. Contact your DWO to confirm the necessary treatment objectives when planning or upgrading water supply systems.

COMMON FILTRATION METHODS

- Conventional filtration (coagulation, sedimentation, granular media)
- Direct filtration (coagulation, granular media)
- Slow sand filtration
- Diatomaceous earth filtration
- Membrane filtration (microfiltration, ultrafiltration, nanofiltration, reverse osmosis)
- Approved bag filters
- Approved cartridge filters

The Groundwater Treatment Objectives help guide the reduction of risks from bacteria, protozoa, and viruses by disinfection of groundwater at risk of containing pathogens. This document provides guidance for establishing microbiological treatment objectives for drinking water systems drawing from groundwater sources in British Columbia (BC) to achieve potable water as set out in the *Drinking Water Protection Act* (DWPA).

Treatment systems for surface water and groundwater at risk of pathogens (GARP) are expected to achieve at least the following objectives to reduce the risk of water-borne illness:

- 4-log (99.99%) reduction or inactivation of enteric viruses;
- 3-log (99.9%) reduction or inactivation of *Giardia* and *Cryptosporidium;*
- Less than or equal to 1.0 nephelometric turbidity unit (NTU) of turbidity; and
- No detectable *E.coli*, fecal coliform and total coliform.

These objectives are achieved through a multi-barrier approach that consists of at least **two treatment processes**. Specific details of each of these objectives are described in further detail below.

6.4.1 WHAT IS A LOG REDUCTION?

A “log reduction” is a mathematical method of demonstrating the difference between the number of “live” pathogens that you have in your treated water compared to your raw water. It demonstrates the effectiveness of your treatment system.

One log equates to a 10-fold reduction; therefore:

- 1-log reduction = number of pathogens in raw water ÷ 10
- 2-log reduction = number of pathogens in raw water ÷ 100
- 3-log reduction = number of pathogens in raw water ÷ 1000
- 4-log reduction = number of pathogens in raw water ÷ 10,000

Log reductions, as referenced in the both the *Groundwater* and *Surface Water Treatment Objectives* are based on the capabilities of the various filtration and disinfection technologies. The technologies employed should have the combined capability of reducing each given pathogen by the target measure (e.g., treatment should have the ability to perform a 4-log reduction or inactivation of viruses).

The treatment objectives are set based on an assumed level of pathogen in the raw water and a target level of pathogen in the treated water – this is considered a minimum requirement. Water with really high levels of pathogens may require a greater log reduction (e.g., 7-log reduction of viruses).

6.4.2 4-LOG (99.99%) REDUCTION OR INACTIVATION OF ENTERIC VIRUSES

A 4-log reduction of viruses is the minimum requirement for all water supply systems with a risk of enteric viruses in the water source. As noted earlier, this risk is most likely to occur in surface water or GARP sources. Enteric viruses are easily inactivated using chlorine. The cost of installing a liquid chlorination system is relatively low and the operation is relatively simple.

An increasingly common method of disinfection is ultraviolet light (UV), but the effectiveness of UV varies considerably for different types of viruses. For example, adenovirus is a specific virus found in human fecal matter that can cause illness in children and immune-compromised adults. It is very resistant to UV light and requires a very powerful UV dose to inactivate – many UV treatment units are unable to deliver this dose. For this reason, UV treatment for adenovirus must often be combined with another method of disinfection to ensure a 4-log reduction of viruses is achieved. Your DWO may determine that your raw water source has a low risk of containing fecal matter and adenovirus. In these cases, disinfection for rotavirus, which can be inactivated by UV, is normally required.

6.4.3 3-LOG (99.9%) REDUCTION OR INACTIVATION OF PROTOZOA (*GIARDIA* AND *CRYPTOSPORIDIUM*)

All surface water sources in B.C. are at risk of containing protozoa, which can be easily introduced by wild or domestic animals. Therefore, a 3-log reduction of *Giardia* and *Cryptosporidium* is necessary even for systems with a surface water source at low risk for these parasites and no known disease outbreak. GARP wells that are hydraulically connected to contaminated surface water sources may also become contaminated and require a 3-log reduction. A higher reduction

level may be required in cases of known outbreaks or identified risks. Secure groundwater sources are generally exempt from this treatment requirement.

Giardia may be inactivated by large doses of chlorine, ozone or chlorine dioxide combined with long exposure time to the disinfectant. *Cryptosporidium* is notably resistant to chlorine. Under proper operating conditions, filtration (to less than 1 micron) can effectively remove *Giardia* and *Cryptosporidiu*m. Effective filtration depends on source water conditions, and methods of filtration and operation.

UV disinfection is highly effective for inactivating both *Giardia* and *Cryptosporidium*. Commercially available UV systems with a certified or validated dose rate of 40 mJ/cm^2 can achieve the required 3-log inactivation.

6.4.4 TWO TREATMENT PROCESSES FOR SURFACE WATER AND GARP SOURCES (DUAL TREATMENT)

Some pathogens are more resistant to certain forms of treatment than others. No one form of treatment technology is effective at reducing all risks. A multi-barrier approach (which for treatment involves combining two or more treatment methods) is the best way to ensure the inactivation targets are met for pathogenic organisms of interest. For example, to provide the most effective protection, the Guidelines for Canadian Drinking Water Quality recommends that filtration and one form of disinfection be used to meet the treatment objectives.

A second form of disinfection (e.g., chlorination and UV disinfection) may be considered instead of filtration if certain filtration exclusion criteria are met. The filtration exclusion criteria can be found in the Surface Water Treatment Objectives. If your system qualifies for an exemption, the criteria for exemption need to be reassessed on an ongoing basis to confirm continued validity. It should not be considered a permanent exemption since source water quality and watershed conditions can change over time.

6.4.5 LESS THAN OR EQUAL TO 1.0 NTU OF TURBIDITY

Turbidity of treated surface water and GARP should be maintained at less than 1.0 NTU. This is the generally accepted limit endorsed by the Guidelines for Canadian Drinking Water Quality.

Sedimentation and/or filtration are useful for reducing turbidity in water and should be done before disinfection is applied. This is to maximize disinfection effectiveness and to reduce disinfection byproduct formation. Filtration can remove micro-organisms as well. Depending on the filtration technology used, elevated levels of turbidity in water can be reduced to between 0.1 and 1.0 NTU.

The presence of suspended organic matter (e.g., decomposing plant matter) is uncommon in groundwater supply systems. Additionally, inorganic turbidity such as colloidal or well construction materials may not pose any health risk unless the suspended material interferes with disinfection

processes. It should, however, be considered an important signal that a groundwater source may be contaminated. Turbidity in groundwater can indicate the infiltration of surface runoff, subsurface waste discharge (such as from onsite sewerage systems) or a direct hydraulic connection to surface water with unknown quality.

Periods of elevated turbidity may indicate potential contamination of your water source or treatment system failure. You should speak to your DWO about requirements to monitor for turbidity and report turbidity events.

The Decision Tree for Responding to a Turbidity Event in Unfiltered Drinking Water is a standard process to be followed when assessing turbidity events in water supply systems that meet the filtration exemption criteria set out in the Ground Water and Surface Water Treatment Objectives. The decision tree is now included in Part B of the Drinking Water Officers' Guide.

This tool can be used by decision makers to plan for future turbidity events when developing emergency response and contingency plans. In addition, it can be used to quickly assess an unanticipated turbidity event. This document is not intended to provide guidance for determining if a drinking water supply system is in compliance with provincial treatment objectives or to be used as an alternative to providing appropriate treatment.

6.4.6 NO DETECTABLE *E.COLI*, FECAL COLIFORM AND TOTAL COLIFORM

E. coli and other fecal coliforms are members of the total coliform group of bacteria, but *E. coli* is the only member found exclusively in the feces of humans and other animals. Other members of the total coliform group (including fecal coliforms) are found naturally in water, soil and vegetation, as well as in feces. The presence of *E. coli* and other fecal coliforms in water indicates not only recent fecal contamination, but also the possible presence of intestinal disease-causing bacteria, viruses and protozoa.

The treatment target for all water supply systems, as required under the Drinking Water Protection Regulation, is no detection of *E. coli*, fecal coliform and total coliform, based on the sampling frequency set out in Schedule B of the DWPR or as established by a DWO. *E. coli* and coliforms are easily controlled with chlorine or UV light and can be reduced by filtration. Treatment that achieves the 4-log reduction of viruses and 3-log reduction of *Cryptosporidium and Giardia* should be more than enough to kill bacteria. DWOs will take immediate action, in accordance with appropriate health authority policies, if water sampling detects any *E. coli* or fecal coliform.

6.5 POINT-OF-ENTRY AND POINT-OF-USE TREATMENT SYSTEMS

Small water systems may not have to meet the potability requirements of the DWPA if each recipient of water from the system has a point-of-entry (POE) or point-of-use (POU) treatment system that treats the water when it enters the building or at the tap where it is used. POE/POU systems are required to meet the same potability standards as treatment systems used in

centralized water supply systems. Also, the water supplier must ensure that non-potable water discharge locations and non-potable water piping are identified by markings that are permanent, distinct and easily recognized.

The operation and maintenance of individual POE/POU treatment systems are the responsibility of the water supply system. POE/ POU systems are regulated and must have a construction permit before installation. They must also have an operating permit that includes monitoring criteria.

You may consider using POE or POU units in the following situations:

- Where most of the total water supplied is used for irrigation or other non-potable use, and only a small quantity needs treatment.
- If a small water system supplier finds it is more cost effective than centralized treatment – generally for water supply systems with less than 40-50 connections.
- If there is a chronic chemical contaminant such as arsenic in the source water. In this case, they may also be used in combination with centralized treatment.
- If there is customer resistance to certain forms of conventional treatment.

THE INFORMATION IN YOUR CONSTRUCTION PERMIT CAN AID YOUR SOURCE-TO-TAP SCREENING/ ASSESSMENT.

Much of the information required for a source-to-tap screening/assessment is similar to that required for your construction permit.

Installation may include a number of pieces of equipment (i.e., filters and disinfection units), which are assembled together to treat water to a desired standard. These devices are installed at the home or facility of the water end user. As part of the approval process, the health authorities ensure that a service agreement is in place. Contact your health authority for further information on these units.

In 2007, the Ministry of Health commissioned a report entitled Application of "Point of Entry" and "Point of Use" Water Treatment Technology in British Columbia. This report provides an introduction to POE/ POU technology and gives examples of POE/ POU applications for some water quality categories.

The nonprofit Sustainable Infrastructure Society has a POE/POU program to help assess the suitability of POE/POU water treatment systems. For more details, you can review their Guide Book: Planning and Implementation of "Point-of-Entry" and "Point-of-Use" Water Treatment Systems in British Columbia

7 IDENTIFYING AND ADDRESSING VULNERABILITIES AND RISK

Up until this point, you have learned about the various factors involved in providing safe drinking water to your consumer and the regulatory requirements you must fulfill as a drinking water supplier.

Along with focusing on the water going through your treatment system, you must look at the entire system. Consider the following:

- The activities upstream of your intake.
- The quality of the water entering your intake.
- The security and safety of the water supply as it travels through the distribution system to the consumer's tap.

This chapter will help you understand some potential indicators that may signify trouble before it becomes a problem. It will give you an overview on how to screen and assess your water supply system from source to tap to identify those vulnerabilities. You will learn how to use this assessment to reduce risk and plan for emergencies.

DO YOU THINK FORESTRY ACTIVITIES AND/OR RANCHING ARE AFFECTING YOUR WATER SOURCE?

Contact the forest licensee or the Ministry of Water, Land and Resource Stewardship through FrontCounterBC. To make a complaint or inquiry, contact the Forest Practices Board at https://www.bcfpb.ca/

7.1 ASSESSING VULNERABILITIES

There are some common elements to each of the tools, but the required level of detail will vary. The following is an outline of some activities that will be required as you complete your screening/assessment.

Delineate Your Water Source: As described in Chapter 5: *Understanding and Mapping a Water Source*, you should delineate your water source and identify potential sources of contamination. Potential sources include:

- roads, parking or vehicle storage
- buildings (leaky plumbing, old wells, chemical or pesticide storage, septic fields)
- livestock, animals, manure piles or other agricultural use
- landfills or refuse storage
- wildlife

Your search should increase in intensity as you get closer to your intake. The closer the source of contamination is to the intake, the greater the risk to your drinking water. Potential sources of contamination should be removed if possible.

Review Test Results: You should review chemical, physical and bacteriological test results of the raw and treated water. Specific adverse test results (e.g., high *E. coli*, nitrates, or arsenic levels) suggest the need to look more closely for the sources of these contaminants.

Inspect Supply Components: Walk through the existing treatment system and visually inspect all supply components. The items you will be inspecting generally include:

- source screen intakes
- filtration
- disinfection equipment
- storage tanks (raw and treated)
- distribution system

Creating and regularly updating a schematic diagram can be helpful to this process.

Inspect Records: This involves viewing operation and maintenance records and highlighting significant factors that indicate equipment weaknesses in the treatment chain.

Research the History: A great deal of important information can be found by researching the history of the water supply system's infrastructure to determine dates of original construction and major upgrades. Keeping dated photographs of the equipment can be useful.

7.2 MONITORING

Problems with the potential to negatively affect your system can exist anywhere from source to tap. You need to have the ability to quickly recognize the signs of a potential problem so you can take action before there is any threat to public health. Regular monitoring of measurable indicators is one ways to recognize issues.

Monitoring involves routinely and regularly carrying out the following (see Appendix C for sample log sheets):

- Taking water samples.
- Monitoring turbidity levels.
- Checking free chlorine residual levels.
- Inspecting treatment equipment.
- Monitoring pressures.

Each of these activities allows you to become familiar with your system's normal operating parameters. Knowing your system well enough to recognize changes in these parameters will help you identify when something is amiss and take action to correct it before it becomes a problem.

7.2.1 RED FLAGS

The following is a list of potential signs of trouble you may encounter during routine monitoring or during your regular, day-to-day operations. This should not be considered an exhaustive list, but something to get you thinking about what trouble might look like in your system:

- Customers are experiencing gastrointestinal illness.
- Water sampling indicates the presence of total coliforms, fecal coliforms or *E. coli*.
- Turbidity monitor indicates that turbidity is greater than the system's validated parameters.
- Customers complain about the colour, odour or taste of the water.
- Water pressure drops unexpectedly.
- Chlorine levels cannot be maintained in the treatment and/or distribution system.
- Equipment is cracked and/or leaking.
- There is a main break.
- There is evidence of recent animal activity near the intake.

If any of these issues come to your attention, you should contact your DWO immediately and check your emergency response and contingency plan. See section *7.3, Source-to-Tap Screening and Assessment*, for appropriate steps to fix the problem.

7.3 SOURCE-TO-TAP SCREENING AND ASSESSMENT

Another way to determine the vulnerabilities of your system is to conduct a source-to-tap screening and assessment. Note: you may need assistance in completing this. This is an onsite review of the water source, treatment facilities, pumps, pipes, storage, and distribution up to the property line of the consumer. It can be completed voluntarily or by order of the DWO (as per the *Drinking Water Protection Act*). The purpose of the screening and assessment is to carry out a comprehensive inspection of the drinking water supply system and to determine if the system is producing safe drinking water consistently and reliably. The following questions should be answered upon completing this process:

- Is the water supply system in compliance with regulations?
- Is the source protected and physical components in good condition?
- Is treatment appropriate for the water characteristics?
- Is water storage constructed and maintained to keep water safe?
- Is the distribution system adequate to deliver water quality/quantity needed?
- Are pumps/pump facility and controls adequate and in good condition?
- Are monitoring, reporting and data current and confirmed?
- Are the management and operators qualified and funded adequately?

A completed source-to-tap screening and assessment should include:

1. A source protection plan that uses information collected during a source assessment (e.g., data from the delineation of your watershed/recharge zone).
2. An inventory, or listing, of the physical and operational components of an existing water supply system from source to tap noting their condition, security and suitability.
3. A summary of the potential risks associated with your water supply system and other information related to the operation and integrity of the system. This should include:
    i. Collection of reports submitted to the health authority or water users.
    ii. Any complaints received and responses issued.
    iii. Any corrective actions taken to hazardous events.
    iv. Proposed improvements scheduled or anticipated.
    v. Inventory of components assessed in the following broad categories: source screening, filtration, other treatment, disinfection equipment, and storage (raw and treated).

This chapter provides a basic overview of source-to tap-screening and assessment. The Ministry of Health has produced various tools to aid in the screening/assessment process and they are discussed in the next section:

- *Drinking Water Source-to-Tap Screening Tool*
- *Water System Assessment User's Guide*
- *Comprehensive Drinking Water Source-to-Tap Assessment Guideline*

The tools vary in terms of ease of use and comprehensiveness. If you have a groundwater source, the *Well Protection Toolkit* – discussed in Chapter 5: *Understanding and Mapping a Water Source* – can provide additional information to aid you in the process. You should consult with your DWO for advice on which tool would be most appropriate for your needs. If possible, enlist the aid of the DWO when completing any of these tools. A professional consultant (depending on the tool used) may also be required.

7.3.1 DRINKING WATER SOURCE-TO-TAP SCREENING TOOL

In 2004, the Province developed the Drinking Water Source-to-Tap Screening Tool as a method for assessing risk in drinking water supply systems.

This self-screening tool is the least complex of the available source to tap assessment tools and is an approachable first step for use by water systems with limited resources. It should be completed by the water supplier (voluntarily or as required by the local DWO) and submitted to the DWO. If significant risks are identified, the DWO can determine if a water supplier needs to undertake a more comprehensive source-to-tap assessment to further analyze and mitigate the risks.

The tool includes 97 questions designed to inventory and assess the:

- administration, management and operation of the water supply system
- water source
- water treatment system
- water storage system
- distribution system
- tap water quality

WATER SAMPLING (ALL WATER SOURCES)

An important component of routine monitoring is sampling the water and testing for microbiological, chemical and physical characteristics. Your local health authority can guide you with respect to proper sampling techniques and contacts for approved laboratories.

All water supply systems are required by the *Drinking Water Protection Act* to take regular bacteriological samples. Your drinking water officer will determine and indicate on your operating permit how often you need to take samples and where to take them from. These samples will be tested for total coliform bacteria and *E. coli*. E.coli is an indicator of fecal matter.

A baseline chemical and physical analysis of your source water, together with the completion of a source-to tap screening/assessment should provide you and your drinking water officer with the information you need to establish a monitoring program that matches your situational needs (e.g., a list of substances that should be routinely evaluated).

Maximum acceptable concentrations for chemical parameters are set out in the *Guidelines for Canadian Drinking Water Quality*. These will help you determine an appropriate treatment protocol for your particular water characteristics. A list of typical testing parameters and their accepted limits, as well as instructions for collecting drinking water samples are in the appendices.

Water sampling is only a snapshot in time. A water sample that is free of contamination on one day does not guarantee contaminant-free water the next day or the following week. Water sampling should be done regularly and is only one of many considerations you and your DWO should use to make decisions.

7.3.2 WATER SUPPLY SYSTEM ASSESSMENT

The Water System Assessment User's Guide, and associated assessment forms, is a source-to-tap assessment designed to be completed by the water supply operator or the DWO. It was developed in 2012 to fill a gap between the *Drinking Water Source-to-Tap Screening Tool* and the *Comprehensive Drinking Water Source-to-Tap Assessment* (below). The intention is to offer an alternative that will allow for developing an action plan to reduce risks to and in a water supply system, without the added cost and time commitment of a comprehensive assessment.

The full assessment is designed to enable quick and efficient data collection and can be completed in about one day. It consists of the following assessment forms:

- **Hazard Assessment**: The questions in this form take you step by step through your water supply system. They are designed to cover the water supply system from the water source through to the customer's taps.
- **Risk Rating**: This form breaks the potential problems (hazards) down to try to identify how serious they are (risk).
- **Risk Grouping**: This form orders the hazards into similar groupings to help you see areas that need the most work. This will add perspective to help you deal with the risks to your system.
- **Action Plan**: This will be a short report to develop timelines and prioritize system improvements.

These assessment forms are available in Microsoft Excel or hard copy, and both will yield the same results. If you are able to use the computer version, though, you will have access to extra features such as information brought forward to the next form and automatic calculations.

The *Water System Assessment User's Guide* explains how to use the forms and provides helpful tips to get you started. It includes suggestions and examples to help you understand where problems may arise. The appendices provide guidance to answering questions in the hazard assessment, as well as information about useful resources.

7.3.3 COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

The Comprehensive Drinking Water Source-to-Tap Assessment Guideline is a tool to help water suppliers develop a more comprehensive understanding of the risks to drinking water safety and availability of their system. This is the most comprehensive and time-consuming assessment tool produced by the Ministry of Health and should only be completed with the assistance of a qualified professional.

This guideline can be applied as a voluntary measure by water suppliers wanting to understand risks to drinking water safety in their systems, but it may not be the most cost-effective approach for assessing a small water system. A DWO can order this assessment if significant risks to a water supply system are identified through the *Drinking Water Source-to-Tap Screening Tool* or by some other means. This order can include completing the entire assessment, or taking a more targeted

approach and using only the modules that will address the risks identified through the screening tool.

The professionals conducting the assessments, DWOs and water suppliers are the intended audiences for this guideline. It provides a structured, consistent approach to evaluating risks to drinking water. The purpose is to help water supply systems learn how to operate more effectively, as well as ensuring the best possible water quality and assured quantity.

The guideline consists of an introduction, which should be reviewed in detail for information on the assessment process prior to commencing and eight modules.

THREATS TO DRINKING WATER QUALITY

Under Section 29 of the Drinking Water Protection Act, anyone who is concerned that there is a threat to his/her drinking water may request that a DWO investigate the situation. This applies to all domestic water supply systems, including those that supply a single-family dwelling. The request should be in writing and include detailed specifics of why the individual thinks there is a threat. The DWO will review the request and decide if an investigation is warranted. The DWO will give reasons for not pursuing an investigation or, if an investigation is deemed warranted, provide the results to stakeholders. If you think there is a potential threat or health risk to your water supply system, contact your DWO to discuss how to resolve or minimize the risk.

7.4 EMERGENCY RESPONSE AND CONTINGENCY PLANNING

The information you get during routine monitoring, a source-to-tap screening and assessment – and even emergency situations – can provide valuable knowledge and experience you can use to inform your emergency response and contingency planning. An emergency response and contingency plan will outline what to do and who to call in case of disruption (e.g., power outage or drop in water pressure) or contamination of your water supply system. Emergencies can occur at any time. Careful planning and preparation will help you react quickly, accurately and efficiently. This will minimize panic and confusion, and allow you to reduce or eliminate the risk of the event affecting your consumers' health.

All water supply systems must have written emergency response and contingency plans. Emergencies can occur when the main operator is unavailable. Therefore, your completed emergency response and contingency plan should be posted where it can be easily seen and acted upon if the regular operator is away. It is a good idea to periodically talk through or actually walk through your plan to practice it and confirm that it is effective. The Ministry of Health document, Emergency Response and Contingency Planning for Small Water Systems is a recommended resource for planning.

8 BUSINESS STRUCTURE AND GOVERNANCE

All water suppliers, for both large and small water supply systems, need to think about ensuring the long-term sustainability of their drinking water systems. This goes beyond the day-to-day physical operation. You need to consider the organization, the administration, and management of your system. This means thinking about running your water supply system like a business or nonprofit corporation. Even a water supply system with only a few connections will benefit from having a business structure and governance model.

This chapter will provide you with an overview of the various business structures that can apply to water supply systems in B.C., as well as the advantages and challenges of each. Additionally, you will learn the basics of governance (decision making and accountability) and its importance to your system's success. This will help you ensure that your system's operational management can deal with the everyday challenge of providing safe drinking water to users.

8.1 BUSINESS STRUCTURE

An important consideration for any water supply system is choosing how its business or corporate structure will be set up. This often depends on a system's "ownership" type. Ownership options include, but are not limited to:

- Private Ownership – Drinking water systems can be privately owned and operated as sole proprietorships, societies, partnerships, stratas or corporations regulated by the Comptroller of Water Rights, under the *Water Utility Act*.
- Water Utility – Becoming a water utility provides additional structure and oversight to your business framework that is specific to water supply systems.
- Co-operatives and Water Users' Communities – Groups of individuals) may collectively own a water supply system and make decisions about it. WUCs are regulated under the *Water Users' Communities Act*.
- Local Government or Improvement District – Systems may be owned and operated by a local government or improvement district.
- Good Neighbour System – Many systems do not have any formal organization. They operate through an informal agreement, known as a "good neighbour system."

PUBLIC VS. PRIVATE OWNERSHIP

Private Ownership: the water supply system is owned and controlled by one person, a business or society, or a number of partners or shareholders.

Public Ownership: the water supply system is operated by an improvement district or local government.

The business structure of your system will lay out the basis for establishing internal decision making and accountability processes.

8.1.1 UNINCORPORATED PRIVATE WATER SUPPLY SYSTEMS

Many private water supply systems in B.C. are not incorporated. These systems exist under two main categories:

- Informal arrangements between neighbours.
- Private ownership by an individual or partners.

STRATEGIC PLANNING OR CREATING A BUSINESS PLAN IS ABOUT PLANNING FOR TOMORROW, TODAY

Even very small systems should have a written long-term plan that considers the future needs of the water supply system. Defining the system goals will help identify priorities, financial planning and overall management. Put these plans on paper and share them with your customers!

INFORMAL ARRANGEMENTS

Informal arrangements in B.C. usually exist as a group of dwellings on separate land titles sharing a source and water supply system. These systems can be as small as two to four connections to neighbouring houses and generally consider themselves as shared systems, or good-neighbour systems.

Shared systems tend to be governed by informal agreements or may have no agreements at all. Either of these cases can lead to a lack of clear ownership, accountability and oversight. Often there is no financial plan and no plan for system maintenance or upgrades, which can be very expensive. As funding is limited to investment by those sharing the system, problems may go unresolved if agreements for investing in the system cannot be reached. This puts the safety of the drinking water supply at risk over the long term. Additionally, the liability associated with an unsafe water supply can reduce property values.

If your system is a "good neighbour system," it is worth approaching your neighbours to draw up a formal legal agreement that includes a system of accountability, as well as maintenance and repair schedules, a financial plan and a contingency fund. This may also require obtaining a water licence or buying/leasing the land where your well is situated, and seeking utility status. See section 8.1.2 Incorporated Private Water Systems for details. The benefits of moving to other more formal ownership and governance models are discussed further in this chapter.

INDIVIDUAL OWNERSHIP

This form of business structure includes systems owned and operated by a single homeowner supplying water to their neighbours. Other examples of individual ownership include systems operated to serve a broader, unincorporated business owned by an individual. This could include some:

- mobile home parks
- campsites

- worksites
- business and commercial enterprises

These systems are considered to be unincorporated sole proprietorships and may or may not be registered as such. They are owned and operated by a single owner/decision maker, but some are organized as unincorporated partnerships. This business structure tends to have fewer operating restrictions and simpler decision-making processes, but raising funds for repairs or upgrades can be extremely challenging.

A sole proprietor or unincorporated partnership is responsible for all debts and obligations related to the system.[16] This means that if the water makes someone sick, the sole proprietor or the people in the partnership are accountable. Both business and personal assets can be affected if a consumer makes a claim against the system.

Financial planning and regular maintenance are key activities for system owners/decision makers. Funding is often limited to customer fees or owner investment in the system. If your system's operation supports a broader business, it may be worth including its cost and maintenance in the wider business plan for your establishment.

You can also incorporate. Seek legal advice if you are interested in this. The BC Corporate Registry offers information about the registration and incorporation of a sole proprietorship or partnership.

[16] Small Business BC. (N.D.). *How to Choose the Right Business Structure for You*. Retrieved from: *http://smallbusinessbc.ca/article/how-to-choose-the-right-business-structure-for-your-small-business/*

IS YOUR SYSTEM SUSTAINABLE?

Small water systems, especially ones with less than 50 connections, are at higher risk for becoming financially and operationally unsustainable over the long term. Unlike larger systems, small systems have limited financial, human and operating resources. As an owner or operator, you need to consider if your system can survive as an autonomous system. Determine what your system's plan is for the following:

- Raising funds for replacing aging infrastructure or upgrading to meet regulatory requirements.
- Getting staff/volunteers the skills that they need to do their job properly.
- Replacing key staff/volunteers if they become ill, retire or move away.
- Providing services if the system becomes bankrupt and dissolves.

All systems need a strategy for addressing these and other issues. Evaluating if your current business structure and governance model can adapt to short- and long-term events is an important step in ensuring your system's survival. Each owner/operator should periodically question whether or not the system is really operationally and financially sustainable in its current state. If you are having trouble addressing these issues, it may be worth looking at other options such as:

- Shifting to a different business structure.
- Amalgamating with neighbouring systems.
- Incorporating a smaller system into a larger system.
- Approaching your local regional district or municipality to take over the operation of this system.
- Selling the system to a reputable private provider.
- Contracting operations/management to an outside provider.

This chapter provides information on options for structuring and governing your system. This is not always easy, but worth the effort if it means having safe drinking water for you and your neighbours.

8.1.2 INCORPORATED PRIVATE WATER SUPPLY SYSTEMS

Many small water systems in B.C. are sole proprietorships and unincorporated residential systems. These systems could benefit from formal incorporation – creating a legal entity that owns the system and is separate from the owners or shareholders. These benefits include:

- Increased stability of the organization, which enhances its ability to raise funds (e.g., establish rates and borrow money from a bank).
- Limited liability of owners/members.
- Continuity of system operations should the membership change (e.g., people buying and selling homes connected to the system) or the system exchanges hands.
- The water supply system, as opposed to individual members/owners, can own property, apply for easements and rights of way, open bank accounts and enter into contracts. This eases processes if membership changes or the system exchanges hands.
- Incorporated water supply systems must fulfill the requirements of the legislation overseeing their administration or business structure, as well as those of the *Drinking Water Protection Act*.

There are several options in B.C. for incorporating a private drinking water supply system:

- water users' community
- strata
- corporation
- society
- co-operative association

WATER USERS' COMMUNITIES

A water users' community is a public body incorporated under Part 3 of the *Water Users' Communities Act*. This requires a Certificate of Incorporation from the Comptroller of Water Rights.

A water users' community is a co-operative governance model formed by six or more different water licensees. Each member must hold a water licence and agree to share a water works system. The licensees can apply to the Comptroller of Water Rights to become a water users' community. This gives them the right to bundle their water licences (each member retains "ownership" over their individual water rights) and collectively divert, store and deliver water. A water users' community may:

- Acquire, hold and control property and licences.
- Acquire, construct, hold, maintain, improve, replace and operate works.
- Levy assessments on its members and enforce payment of those assessments by suit in a court of competent jurisdiction.

Funds for operating and maintaining the system can be collected by assessment roll. (The manager of the water users' community prepares an assessment roll for the purpose of collecting funds for operational costs. This statement includes the manager's estimate of the monies needed and the amount payable by each member. The amount payable is proportional to the member's interest in the water users' community.) The water users' community can enforce payment through legal proceedings, or water can be turned off to users that do not pay.

JOINT WORKS AGREEMENTS

A joint works agreement allows for sharing the responsibilities and costs of building and maintaining a water distribution system common to two or more licensees. A water users' community is an example of an incorporated joint works agreement. Two or more water licensees can form a joint works agreement without incorporating as a water users' community, but they do not get some of the advantages a water users' community has (e.g., applying for easements). Also, the owners remain liable for any issues.

Some systems have formed a joint works agreement and incorporated as a society. This does not give users all the benefits of forming a water users' community, but does protect them from liability and provide them with the general advantages of incorporation discussed earlier. Other circumstances in which joint works agreements are formed include:

- A water users' community chooses to share water works with someone who is not a member of the water users' community. In this circumstance, the water users' community can choose to form a joint works agreement with the non-member.
- The Comptroller can impose a joint works agreement on a group of individual licencees and appoint someone to run it. This is done when the Comptroller determines that joint works would conserve water or avoid duplication of work.

Any group of water licensees wishing to form a joint works agreement should seek legal advice. See General Information on Joint Works Agreement for a Water Licence at http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-licensing-rights/water-licences-approvals

CORPORATIONS, SOCIETIES AND CO-OPERATIVE ASSOCIATIONS

Many water supply systems throughout B.C. are organized as corporations, societies or co-operative associations. These legal business structures are administered under various pieces of legislation (i.e., *Business Corporations Act*, *Societies Act* and *Cooperative Association Act*) and they are not exclusive to water supply systems. Incorporating under any of these business structures not

only provides the benefits discussed at the beginning of this section, but also provides the advantage of having legislation with a basic structure for governance built into it.

The choice of legal structure should be heavily dependent on the system of ownership (e.g., collective or individual ownership) that would work best for your system. For example, a small water system that is owned by a sole proprietorship would probably want to incorporate as a business, whereas a system owned by a group of users may want to investigate becoming a society or co-operative association. If you are considering using any of these legal business structures to incorporate your water supply system, it would be worth seeking legal advice about which one would best suit your circumstances.

The Corporate Registry offers information about registering partnerships and incorporating corporations, societies and co-operatives associations.

WATER UTILITIES

A water utility is a person/business that owns or operates equipment or facilities for delivering domestic water service to five or more persons or to a corporation for compensation. Under the *Water Utility Act* and the *Utilities Commission Act*, the Comptroller of Water Rights (Comptroller) is responsible for regulating water utilities serving thousands of households in B.C. For more information, see Water Utilities. Utilities can have a variety of ownership/management structures. They can be managed by a sole proprietor, partnership, corporation or society. Systems operated by a local government (e.g., municipality or regional district), improvement district or water users' community are not utilities.

Water utilities are usually created by developers to serve a rural land development where community water service is required for subdivision approval and there is no other water supplier in the area. The application process requires a Certificate of Public Convenience and Necessity (CPCN), which is granted by the Comptroller. Anyone operating a water supply system serving five or more people on more than one land parcel should contact the Comptroller to determine if the water utility designation is needed.

Becoming a water utility provides more structure and oversight to your business framework that is specific to water supply systems. The Comptroller of Water Rights ensures that the water supply system is properly designed and constructed before lots are sold. This is part of the approval process. Also, a developer must establish a contingency fund and make sure the utility's customers get acceptable water service at reasonable rates. The Comptroller must approve changes in water rates. For a good selection of publications related to utilities, see: http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-licensing-rights/private-water-utilities/water-utilities-information-bulletins

STRATAS

A strata corporation is responsible for managing and maintaining the common property and assets of a strata development on behalf of the strata development's owners. The specific obligations of the strata corporation are usually performed by the strata council, or agents or employees that it hires. Once certain conditions are met, strata councils can govern water supply systems

independent of the Comptroller of Water Rights and without a Certificate of Public Convenience and Necessity.

The water supply systems for strata corporations are often developed as utilities. However, once more than 50% of the lots are sold, the Comptroller of Water Rights gives oversight to the strata corporation. At this point, the water supply system ceases to be legislated under the *Water Utility Act* and comes under the *Strata Property Act*.

Not all strata corporations have an independent water supply system. If you are unsure about your water supply system, check with the Comptroller of Water Rights, your improvement district or local government. The Office of Housing and Construction Standards offers a good selection of publications related to stratas.

IRRIGATION DISTRICTS

Irrigation districts were originally incorporated to provide irrigation water. Now, though, residential growth is putting pressure on some districts to provide drinking water.

8.1.3 PUBLIC WATER SUPPLY SYSTEMS

A public water supply system can be operated by an incorporated improvement district, regional district or municipality.

IMPROVEMENT DISTRICTS

Improvement districts (including irrigation districts and waterworks districts) are responsible for providing local services for a community's residents. Government oversight is provided through the Local Government Act and the Ministry of Municipal Affairs. Improvement districts vary in size, from small subdivisions to larger communities. They are usually in rural areas within the boundaries of a regional district.

Improvement districts focus on providing services such as drinking water, irrigation or fire protection. Typically, an improvement district provides one or two services. These services are financed by taxation, user fees or borrowing from a financial institution. Every improvement district is governed by a board of elected representatives who are property owners in the area.

THE PROVINCE IS NO LONGER CREATING IMPROVEMENT DISTRICTS

Many improvement districts have incorporated as municipalities or transferred their services to municipalities or regional districts.

It is recommended that the staff and board of the water supply system in an improvement district consult with property owners about managing the service. However, consultation is not always required. For example, the board has the authority to set water consumption rates as well as property tax amounts needed to fund the operational and capital costs. See Chapter 9, *Financial Management*, for details.

If borrowing, the board must adopt a bylaw that authorizes a maximum amount to be borrowed. The improvement district must provide evidence of property owner's approval of the project and

the amount it wishes to borrow before the Inspector of Municipalities will register the bylaw. This approval is usually gained by a referendum, vote at the AGM, or counter petition process.

LOCAL GOVERNMENTS

Local governments, such as regional districts and municipalities, are administered under the *Local Government Act* and the *Community Charter*. Local governments may offer services such as water and sewer systems. They are overseen by the Ministry of Municipal Affairs.

A municipality is an incorporated village, town, district or city with an elected governing council, which is comprised of a mayor and councilors. Municipal councils can provide a wide variety of services (e.g., drinking water) to meet their community's needs. Municipalities have flexibility in their ability to generate revenue to finance operations. This is done primarily through the property tax system, but also includes the ability to charge fees for services.

The boundaries of regional districts are large and span nearly the entire geographic area of the province. Each of B.C.'s 27 regional districts are divided into smaller areas called electoral areas. Regional districts are modeled as a federation composed of municipalities and electoral areas, each of which has representation on the regional board. Municipal representatives are appointed from elected councils, whereas electoral area representatives are elected. A regional district can also provide a wide variety of services (e.g., water), but not all communities within the regional district necessarily participate in all the services.

8.1.4 ACQUISITION AND AMALGAMATION

Some local governments have strategies for acquiring or amalgamating small public and private water supply systems. This can help small systems that do not have economies of scale or access to the resources (e.g., financial or technical) to provide potable water to their users. See Chapter 9, *Financial Management*, for details.

Local governments have access to resources that are not always available to many small water systems, such as:

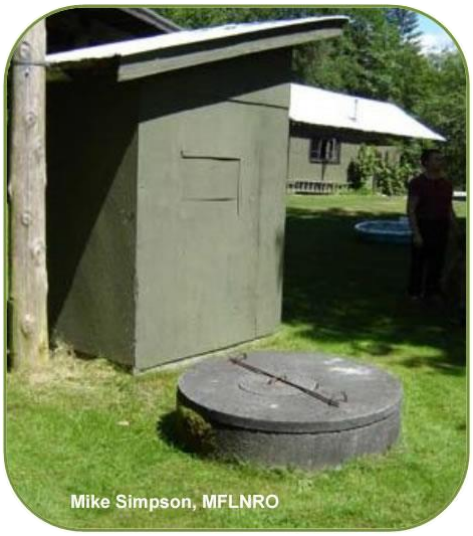
- government funding programs and grants
- training for operators
- technical assistance
- transfer of liability to the local government's insurance
- ability to borrow money
- long-term stability with respect to management of the system
- more sophisticated management technology
- shared assets

- economies of scale

However, many local governments are not willing to take on systems with financial difficulties. Also, the owners, operators and users of a small water system will lose a certain amount of autonomy and local decision-making abilities if they choose to join with a local government. There may be large up-front costs to amalgamation, such as system upgrade costs and engineering inspection fees. Finally, water rates may increase. Despite all of these challenges, in many circumstances the benefits and long-term gain will outweigh the negatives.

If your small water system is considering amalgamation or acquisition with a local government, contact it first for details on the process.

8.2 GOVERNANCE



Once you have determined the business structure most suitable for your system, it is time to create a plan for how your system will be internally governed. Governance refers to the internal decision-making rules that are in place to ensure accountability in the management of your water supply system. It ensures decisions made and resulting actions reflect the principles and goals of the system.

ENCOURAGE A CULTURE OF ACCOUNTABILITY AND COLLABORATION

Having a legal business structure and system of governance is meaningless if no one is going to do what they say. It is vital to have an appropriate system of accountability and actually hold people to account.

Practically speaking, governance may be thought of as a roadmap of policies and procedures that lay out the roles and responsibilities of those running your water supply system.

All water supply systems need to make decisions related to financial planning, asset management, communications and the actual physical operation of the system. These may include decisions such as setting rates, investing in infrastructure, borrowing funds, investing in the systems and acquiring assets.

These polices should be clearly documented and communicated with all stakeholders, investors, partners and users, so they know how decisions are made.

A well-defined governance structure should include policies on:

- Defining responsibilities.
- Ensuring that key individuals have the skills to perform those responsibilities.
- Ensuring that material, financial, and human resources are adequate.
- Allocating resources effectively.
- Tracking expenditures and revenues.
- Implementing and assessing taxation/rate structures.
- Communicating on relevant bylaws, guidelines, policies, standards and operating procedures.
- Enforcing compliance with all applicable legislation, including establishing accountability and consequences.

It may seem a little daunting to develop a system of governance for your water supply system – where do you start and what factors need to be considered? Successful governance structures have certain key elements in common:

- All stakeholders (e.g., user representatives, board of directors and system operators) are involved in defining the governance structure.
- The policies, decision-making processes, and roles and responsibilities are identified up front.
- The principles that must be considered when making decisions are defined.
- All decisions in the day-to-day operations (i.e., management of operations) of the water supply system – including finances, asset management, communications and mechanical operations – are made in accordance with the governance framework.
- People undertaking these responsibilities have, or are willing to acquire, the knowledge and skills they need to perform their duties (and have the freedom and support to do so).

The good news is that the legislation overseeing your business structure (e.g., *Water Sustainability Act*, *Water Utility Act*, *Societies Act*, *Strata Property Act* or *Local Government Act*) will lay out the requirements for much of your governance system. All you need to do is fill in the details, such as the following:

- Identifying who oversees the system: Is it an individual or a group of people such as a board of directors? If it is a group of people, who needs to be represented within that group?
- Identifying how big decisions are made: What types of decisions are voted on? Who gets to vote? How does the voting process work?
- Determining details about annual general meetings (AGMs): Are annual general meetings required? How many meetings per year are needed?
- Identifying requirements for annual reporting and other forms of public/membership communication, keeping in mind that public communication and annual reporting are also

requirements of the *Drinking Water Protection Act* and the Drinking Water Protection Regulation.

When determining the details of the governance structure, a representative from each stakeholder group (e.g., owners, society/water users' community members, community members, system operators) should be involved to ensure that all interests are considered. For a small four-connection system, this may include a representative from each connection. A larger system may have to be a little more selective in the number of people involved in the process, as too many voices can make it difficult to get the job done, but there should still be representation from each group of stakeholders with a vested interest in the process.

Do your research when filling in the details of your governance plan and seek help where and when you can:

- Contact the government agency that oversees the legislation for your business structure or the Comptroller of Water Rights.
- Contact other water supply systems that have already been through the process.
- Take an introductory course on governance. For example, if you have a board of directors, everyone could be required to take an online course about making boards work. Additionally, the BC Water and Waste Association (BCWWA) offers training specific to small water systems.
- Seek legal advice.

PRINCIPLES

The principles of good governance are a set of standards your organization will use to guide the decisions you make. They should be coherent and ranked according to priority. These principles depend on the culture and context of the individual organization and should be developed with meaningful participation of all stakeholders. This helps ensure that the principles reflect the needs of everyone involved. According to *Good Governance in Restructuring Water Supply: A Handbook*,* the most frequently occurring principles for water management include:

- Protecting public health and safety.
- Environmental protection.
- Accountability of stewardship and performance.
- Transparency.
- User participation.
- Balancing equity, efficiency and effectiveness in performance.
- Financial sustainability.

* Bakker, K. (N.D.). *Good Governance in Restructuring Water Supply: A Handbook*.

9 FINANCIAL MANAGEMENT

British Columbians are fortunate that fresh water is abundant and readily available throughout most of the province. Unfortunately, this has contributed to the assumption that the water coming from the tap should be cheap, if not free.

However, the infrastructure, operator training, materials and supplies, regular maintenance, water testing and loan payments required to deliver the service all cost money. As with any other product or service, funds need to be supplied by the people that use the service. We need to start thinking of safe drinking water as a valuable product that requires financial investment.

Historically, British Columbians have enjoyed some of the lowest rates for water in Canada, and the world. In many cases, low rates have resulted in situations where not enough money has been put aside to replace aging infrastructure such as pipes, pumps and reservoirs, or to make upgrades when necessary.[17]

Sound financial management helps reduce financial surprises for customers and ensures that the funds entrusted to the system managers are used effectively and efficiently. It also helps to:

- Ensure there are enough funds for day-to-day expenses.
- Set water rates that reflect the true cost of service.
- Justify water rates to users.
- Budget for infrastructure (capital) upgrades.
- Negotiate reasonable timelines for regulatory compliance with health authorities.
- Explain future plans to customers and decision makers.
- Prepare successful loan applications.
- Demonstrate due diligence to regulators and lenders.
- Reduce the possibility of omitting important activities.
- Maintain long-term sustainability.

THE THREE LOWS

The "3 lows" that could threaten the sustainability of your water supply system are:

- low investment
- low quality of service
- low revenue

Water supply systems that generate low revenue by charging low rates generally do not have the money to invest in infrastructure and human resources. This leads to poor service, which makes it difficult to argue for raising rates. It then becomes an ongoing cycle.

Financial management provides decision makers with some of the information they need to make decisions and predict costs for property owners. It helps create and maintain a robust, sustainable system for providing clean water.

This chapter will provide you with some basic information about setting rates and financial management for your water supply system. You should consider financial management when

[17] Bakker, K. (N.D.). *Good Governance in Restructuring Water Supply: A Handbook*.

making decisions about governance and engaging in strategic planning. Seek out other tools and resources if you need more information. It may help to engage the services of an accountant or other specialist in this area.

9.1 COMPONENTS OF FINANCIAL MANAGEMENT

Sound financial management extends beyond good record keeping. The following introduces the basics of some more advanced concepts of financial management and control.

B.C. HAS ONE OF THE HIGHEST RATES OF WATER USAGE IN CANADA

Low, fixed water rates are partially responsible for this phenomenon. People paying higher rates per cubic metre tend to use less water. To reduce household costs they think carefully about their water use.

9.1.1 FINANCIAL CONTROLS

Controls are policies and procedures that guide the day to day management of finances. Controls ensure that money is used in the way it is supposed to be used – as directed by the decision makers. There are a variety of controls that may be put in place. Some common controls are:

- A financial officer who is responsible for reporting to decision makers.
- Regular review of financial transactions by decision makers.
- Authorization structures for purchases of a certain size or type.
- Multiple signatures on cheques.
- Lockdown procedures for cash and cheques.

A specialist with experience in business management can help create controls that suit your organization.

9.1.2 FINANCIAL STATEMENTS

Financial statements look back over a specific period to illustrate the flow of funds through the organization during that period (e.g. Revenues received and Expenditures made), and provide a picture of its current financial position (List of Assets, Liabilities, Equity). They also help decision makers to plan for the short and long term operation of the system. They can be used to help generate operating budgets, manage cash flow, develop capital (long term financial) plans, set aside reserve funds, and apply for loans.

Financial statements should be relevant – they should provide useful information to the decision makers in a timely manner. The statements should also be reliable – they should reasonably and accurately represent the operations and position of the organization.

A water supply system may be required or may wish to have a third party analyze and attest to the relevance and reliability of the statements. The highest level of assurance that may be provided is an audit opinion by a qualified auditor. However, there are other levels of assurance that may be adequate for the needs of the organization.

9.1.3 BUDGET

A budget lays out the sources and uses of funds for a future time period. A financial plan, or operating budget, helps decision makers and financial staff to work together to plan cash flow in the near term. Sources of funds may include fees, debt, interest earnings and transfers from surplus or reserve funds. Uses of funds include operating costs, administration costs, capital purchases, debt servicing costs and transfers into reserve funds. A budget is a living document and may be amended as circumstances change.

9.1.4 CAPITAL PLAN

Capital Plans (also known as capital budgets or long term financial plans), are often made for longer terms, such as twenty years, to reflect the longer lives of the physical assets such as reservoirs. Water supply systems require significant investment in capital assets: collection, treatment and distribution structures. To manage this system, financial and operations staff should work together to determine the following:

- An inventory of the current infrastructure including the estimated remaining life of its components.
- A measure of the expected growth in the system – the infrastructure required to service new development and when that infrastructure will need to be constructed.
- The total cost of renewing and replacing existing infrastructure and providing new infrastructure.

With this information, financial staff and decision makers can plan to steadily raise the funds to renew, replace and grow the water supply system and ensure long-term sustainability.

9.1.5 RESERVE FUNDS

Capital assets are expensive, occasional purchases. A portion of funds that are being collected each year should fund large future purchases. Some of the funds should also be set aside, typically annually, and used only for the purpose of replacing capital assets. An Operating Reserve and an Emergency Reserve should also be established. Other reserve funds may be required for various purposes. “Reserve fund” is the term used for these commitments; money should be withdrawn from a fund only for the intended purpose of the fund. See Section 9.4, *Putting Theory into Practice: Financial Best Management Practices*.

9.1.6 DEBT

If the water supply system is eligible, it may be able to borrow money to finance capital asset purchases. The need for debt should be anticipated in the capital (long-term financial) plan and the expected debt servicing cost incorporated into the plan.

BUSINESS STRUCTURE AND FINANCES

The legislation that regulates your business structures may contain provisions about fundraising, setting rates, establishing reserve funds and collecting fees. Different business structures offer different challenges in this regard. For example, the trustees of an improvement district have the authority to set rates and levy taxes sufficient to maintain the service, but property owners vote to provide authorization for the district to borrow for capital purposes. Approval from the Comptroller of Water Rights, under the *Water Utility Act*, is required to raise the water rates for privately owned water, including societies. If you are not sure what approvals are required, check with the government agency overseeing the legislation governing your water supply system.

9.2 REVENUE AND RATES

9.2.1 REVENUE

Developers generally install the initial infrastructure for a water supply system – including extensions to serve a new development – to the water utility with no expectation of a return on investment. However, once the system is operating, the main revenue sources for small water systems are generated by user fees, taxes or further investment by the system owners. When more funds are needed, options tend to be limited to raising rates, seeking investment in the system or seeking loans from financial institutions. Receiving funding or grants from government is generally not an option, and small systems should plan to be financially self-sufficient.

Small systems can reduce expenses and develop efficiencies by pooling resources or amalgamating some or all of their operations with neighbouring systems or local government.

9.2.2 SETTING RATES

The infrastructure and human resources needed to move the water from source to tap are not free. For example, regular maintenance and operator training cost money.

It is important to set realistic rates for your consumers to cover the full cost of production and delivery. This means setting rates that take into account both regular operating costs and reasonably foreseeable expenses such as asset renewal, and future capital purchases.

When setting rates for water usage you should consider the costs associated with:

- regular maintenance
- operating and financing costs
- planned replacements
- contribution to reserve funds
- debt repayment and interest expenses
- inflation
- upgrading to meet standards
- operator training
- insurance covering liability, property, directors and officers, and mechanical breakdown[18]
- wages
- rent

Any system that does not charge enough to cover these costs is at risk of becoming unsustainable.

9.3 COMMUNICATION

Communicating the system's financial position to customers, shareholders, health authorities and other stakeholders is critical to ensuring support for the system. This can explain why fees are reasonable (or need to be changed), and help negotiate reasonable timelines for implementing changes. Annual reports are an effective communications tool.

[18] See http://www.WaterBC.ca for information on insurance coverage.

AFFORDABILITY OF WATER: WHAT ARE APPROPRIATE RATES?

Small water supply systems face the same complexities in delivering safe water as larger systems do. However, the cost to provide water is often higher for small systems. Large water supply systems are aided by economies of scale, which means their fixed costs are spread out over a large number of households. More households = lower cost per household. (Fixed costs are costs that will be more-or-less the same, regardless of the amount of water used – e.g., operator training, capital and insurance.)

With small water supply systems, each household is responsible for a greater proportion of the overall costs of the system. This is particularly significant for systems under 50 connections. With very little financial aid available from government, a small water supply system needs to operate under the assumption that the rates it sets are the only means by which the system can be financially maintained. Each water utility must be evaluated on its own revenue requirements in determining appropriate rates.

No one likes to pay fees, and there will be resistance to a proposal to increase rates. What is appropriate? Think of how much a person pays for picking up a coffee. Now consider how much water the average household probably uses each day, such as drinking water, washing dishes and laundry, showering and flushing the toilet. Is it appropriate that we pay at least the same price for our treated water?

9.4 PUTTING THEORY INTO PRACTICE: FINANCIAL BEST MANAGEMENT PRACTICES

The Union of BC Municipalities and the Province worked with the Sustainable Infrastructure Society to develop six financial best management practices (BMPs) for small water systems in B.C. The BMPs are tools and worksheets to help system operators develop a financial plan by following practical and proven methods used by successful water supply systems to operate sustainably:

BMP A: Create a basic asset inventory.
BMP B: Create an asset management plan.
BMP C: Create a five-year operating plan.
BMP D: Create a long-term financial (capital) plan.
BMP E: Implement sustainable rates and charges.
BMP F: Create a communications plan.

These tools build on each other and should be used in sequence, but several can be used independently. You may choose to apply one or two to start and implement other BMPs when you have the resources in the future. These resources and others can be found on the WaterBC website.

10 APPENDICES

This chapter provides some templates and additional information:

APPENDIX A: CONTACT INFORMATION FOR HEALTH AUTHORITIES

B.C has five regional health authorities that deliver health services to meet the needs of the population within their respective geographic regions and employ DWOs. You can find your health authority by looking up your community name here: https://www2.gov.bc.ca/gov/content/health/about-bc-s-health-care-system/partners/health-authorities/regional-health-authorities

TABLE 2: HEALTH AUTHORITIES INFORMATION

Health Authority	Contact Information
Fraser Health Authority	**Drinking Water Safety Program – Abbotsford Health Protection Office** 400-2777 Gladwin Road Abbotsford B.C. V2T 4V1 Phone: 604-870-7900 Fax: 604-852-1558 https://www.fraserhealth.ca/health-topics-a-to-z/drinking-water
Interior Health Authority	**Small Water System – Drinking Water Officer** Central contact for the small water suppliers to contact the Duty Drinking Water Officer during regular work hours: IHSWS@interiorhealth.ca Phone: 1-866-457-5648 https://www.interiorhealth.ca/health-and-wellness/environmental-health-and-hazards/drinking-water
Northern Health Authority	**Drinking Water Information** Suite 600 – 299 Victoria Street Prince George BC V2L 5B8 To contact a health officer, call the Health Protection central line at: 250-565-7322. https://www.northernhealth.ca/services/environmental-health/drinking-water
Vancouver Coastal Health Authority	**Drinking Water Information** 12th Floor – 601 West Broadway Vancouver BC V5Z 4C2 Phone: 604-675-3800 Fax: 604-736-8651 https://www.vch.ca/en/health-topics/drinking-water **Local Offices** **Sechelt** 5571 Inlet, Box 1040 Sechelt BC V0N 3A0

	Phone: 604-885-5164 **North Shore** 6th Floor – 132 West Esplanade North Vancouver BC V7M 1A2 Phone: (604) 983-6793 **Squamish** 1140 Hunter Place, Box 220 Squamish BC V8B 0A2 Phone: 604-892-2293
Island Health Authority	**Health Protection – Environmental Services** 201 – 771 Vernon Ave Victoria, B.C. V8X 5A7 Phone: 250-519-3401 Fax: 250-519-3402 https://www.islandhealth.ca/learn-about-health/drinking-water **Health Protection local offices:** https://www.islandhealth.ca/our-locations/health-protection-environmental-services-locations

Drinking Water Systems on First Nations' Lands	Drinking water system operators and customers on First Nations' lands with questions about water quality should contact their Environmental Health Officers with the B.C. First Nations Health Authority (FNHA). **First Nations Health Authority:** Phone: (604)-693-6500 1-866-913-0033 (toll-free) **Find your local FNHA Environmental Health Officer:** www.fnha.ca/what-we-do/environmental-health For information regarding funding programs related to drinking water systems, drinking water operators should contact their capital management officer at Indigenous Services Canada. **Indigenous Services Canada – B.C. Region:** Email: infopubs@aandc-aadnc.gc.ca Phone: 1-800-665-9320 (toll free) Fax: 604-775-7149 https://www.sac-isc.gc.ca/eng/1100100021003/1612465942223

APPENDIX B: EDUCATIONAL OPPORTUNITIES

Operator Training

Operators of larger water supply systems must meet operator certification and training requirements as set out in the Drinking Water Protection Regulation. However, small water systems do not have to meet these requirements **unless specified by the DWO on the operating permit**.

There are many societies, associations, schools and private training providers that offer valuable training for water supply system owners and operators. Below is a short and non-exhaustive list of places where water system training can be found.

BCWWA

BC Water & Waste Association (BCWWA) offers many training courses to support both water and wastewater system operators, in BC and the Yukon. Training includes certification exam preparation, continuing education unit (CEU) credits, and networking opportunities. BCWWA has a group of courses specifically targeted for Small Water Systems.

EOCP

Environmental Operators Certification Program (EOCP) provides a system of facility classification (ex. Drinking water treatment plant or distribution system) and certification for Operators of those facilities but does not offer courses. However, EOCP has established an online training registry to help connect trainers with people seeking training in nearby communities.

British Columbia Small Water Systems Online Help Centre

The Small Water Systems Online Help Centre was developed and is maintained by Thompson Rivers University and is designed to help small water systems operators work to deliver safe drinking water that meets BC legislative requirements. There are many free webinars and courses offered through the Help Centre.

APPENDIX C: SAMPLE LOG SHEETS

Here are some examples that you can adapt for your own use.

TABLE 3: DESCRIPTION OF UNITS

Short Form	Meaning
L	litres
m	metres
mg/L	milligrams per litre
psi	pounds per square inch
u (or µ)	micron
UVT	ultraviolet transmissivity

TABLE 4: SMALL WATER SYSTEM WITH FILTRATION, UV POST CHLORINATION AND STORAGE

Date	Time	Pressure (psi) P1	Pressure (psi) P2	Pressure Drop (psi) P1 –P2	Flow Meter (m3)	Reservoir Level (m)	Initials

TABLE 5: UV OPERATION

Date	Time	UV Intensity	UVT	Date Last Cleaned	Remarks	Initials

TABLE 6: HYPOCHLORINATOR OPERATION

Date	Time	Chlorine Solution Volume (L)	Combined Residual in Storage tank (mg/L)	Free Residual in Storage Tank (mg/L)	Initials

TABLE 7: CHLORINE READINGS IN DISTRIBUTION SYSTEM

Date	Time	Location	Combined Residual (mg/L)	Free Residual (mg/L)	Initials

TABLE 8: FILTER OPERATION

Date	Time	Filter No. 1, 5µ Last Changed	Filter No. 2, 1µ Last Changed	Flow Totalized (m3)	Initials

TABLE 9: MAINTENANCE LOG

Date	Component	Comments

APPENDIX D: DISINFECTING YOUR WELL

You will need to disinfect your well in any of these situations:

- The well is new.
- Well equipment is installed or reinstalled after repair.
- There has been a recent event that contaminated the well (e.g., flooding).
- Bacteria tests show contamination.

Even if you stop further contamination of your well, the bacteria that are already there can still cause problems such as an increased risk of illness, and unpleasant tastes or smells.

The method outlined below describes a general procedure to disinfect your well as a precaution, or when bacteria tests show contamination. If you have any questions about this procedure, contact a DWO or environmental health officer for advice.

Note: This instruction applies to all types of wells — drilled, driven or dug.

- The amount of chlorine needed to provide a 50 ppm concentration of chlorine in the well casing is listed in the chart at the end of this section.
- Pour unscented household bleach (5% chlorine) directly into the well.
- Make sure the bleach gets all the way to the bottom of the well through the drill pipe, well head or simply by adding the bleach to an open or dug well – preferably through a hose inserted to the bottom.
- Start the pump and open all taps, beginning with the farthest tap from the well.
- Wait until you smell chlorine at the tap. Close the taps one by one, and then stop the pump.
- Close the valve or plug.
- Leave the chlorinated water in the system for up to 24 hours. This is a very strong chlorine solution (about what you should use for cleaning floors). **DO NOT DRINK THE WATER.**
- Pump out water until the chlorine smell disappears.
- Do not drain this water into a stream, ditch or storm drain that connects with any fish-bearing streams. Discharging it through a lawn sprinkler will allow the chlorine to dissipate in the air.
- Monitor the water frequently and treat it again as necessary.
- Control the factors that limit the effectiveness of chlorine, e.g., cloudiness and high levels of iron, manganese and hydrogen sulphide.

TABLE 10: AMOUNT OF BLEACH SOLUTION REQUIRED TO DISINFECT WATER SUPPLY SYSTEMS

Diameter of Well or Pipe		Bleach (5% Chlorine) Per Depth of Water in Well or Pipe	
Centimetres	**Inches**	**Per 3 Metres**	**Per 10 Feet***
5	2	5 ml	1 tsp
10	4	20 ml	4 tsp
15	6	50 ml	10 tsp
20	8	100 ml	7 tbsp
25	10	150 ml	1/2 cup + 2 tbsp
30	12	200 ml	3/4 cup + 1 tbsp
60	24	800 ml	3.5 cups
90	36	2.3 L	2 quarts
120	48	3.4 L	3 quarts
150	60	5.7 L	5 quarts
180	72	8.0 L	7 quarts
240	96	13.6 L	3 gal
****Note:*** 1 cup = 227 ml = 16 tbsp (tablespoons) = 48 tsp (teaspoons) 1 quart = 4 cups = 946 ml 1 gallon = 4 quarts = 16 cups = 3.785 L = 3785 ml			

Adapted from: *Safe Water Supply – Vital to Your Health*, page 18.

For wells that are newly drilled, modified, recently contaminated or have new equipment installed, a higher level of disinfection may be warranted. For these situations, disinfecting the well with at least 200 mg/L of chlorine for 12 hours is recommended. Detailed instructions can be found in the fact sheet entitled Water Well Disinfection using the Simple Chlorination Method.

APPENDIX E: TYPICAL CHEMICAL ANALYSIS FOR WATER QUALITY PARAMETERS

The parameters used in health authority chemical analysis forms follow the water quality guidelines issued by Health Canada in the *Guidelines for Canadian Drinking Water Quality.* Northern Health's form is provided here as an example.

REFERENCES:

Guidelines for Canadian Drinking Water Quality – Summary Tables. Table 2: *Guidelines for Chemical and Physical Parameters.*

CHEMICAL ANALYSIS FORM, NORTHERN HEALTH AUTHORITY

Core Parameters	Guideline
☐ ***E. Coli***	**[none detected]**
☐ **Total Coliforms**	**[none detected]**
☐ HPC (1)	[≈100-500 CFU/mL]
☐ Alkalinity	[≈ 30-500 mg/L]
☐ Chloride	[250 mg/L]
☐ Colour	[15 TCU]
☐ Electrical Conductivity	[≈800 µS/cm]
☐ **Fluoride**	**[1.5 mg/L]**
☐ Hardness	[≈250 mg/L]
☐ Langelier Saturation Index	[≈ -2 to +2]
☐ **Metals Scan**	**[varies]** (2)
☐ **Nitrogen Species]** (3)	
Ammonia	[≈1.5 mg/L]
Organic N	[≈ 0.5 mg/L]
Nitrate	**[10 mg/L]**
Nitrite	**[1 mg/L]**
☐ pH	[6.5 – 8.5]
☐ Sulphate	[500 mg/L]
☐ Total Dissolved Solids (TDS)	[≈500mg/L]
☐ Total Organic Carbon (TOC)	[2.5 mg/L]
☐ **Turbidity**	**[≈1 NTU]**
May require ...	**Guideline**
☐ UV Transmittance (UVT) (4)	[-'80%]
☐ **Disinfection By-Products (DBPs)** (5)	
THMs	**[0.100 mg/L]**
HAAs	**[0.080 mg/L]**
☐ Tannins & Lignins (6)	[-' 0.400 mg/L]
☐ Iron & Sulphate Bacteria (7)	[presence]
Sulphide (8)	[0.050 mg/L]
☐ **Hydrocarbons** (9)	
Benzene	**[0.005 mg/L]**
Toluene	**[0.024 mg/L]**
Ethylbenzene	**[0.002 mg/L]**
Xylenes	**[0.300 mg/L]**

Colours:
red -3 health parameter
violet -3 aesthetic
black -3 treatment options

General Comments

1. The sampler must make arrangements for receiving and shipping of chemical/physical sample bottles and coolers with an accredited private lab.
2. Analysis of additional parameters may be required based on the results of the initial analysis and on potential impact by nearby sources of contamination. The required parameters should be confirmed with the health authority before sampling.
3. The analytical detection limit must be *less than 10% of the Guideline for Canadian Drinking Water Quality* where applicable. Other analyses must provide sufficient information to reasonably assess the water suitability for domestic use and to determine what, if any, treatment might be needed. Analyses must be conducted in accordance with the procedures prescribed in *Standard Methods* (latest edition).
4. Analyses should be for total or closely equivalent concentrations, to represent potential quality problems.
5. A copy of all analytical results must be sent to the Drinking Water Officer responsible for the water system.

Notes

(1) May be omitted if bacterial growth is not found during Total Coliform test – lab to note "*Other bacterial growth not present.*"

(2) *Total metals* required. *Dissolved metals* optional, but recommended if turbidity is elevated. Scan to include both high and low level metals: *Aluminum (if coagulant used),* ***Antimony (0.006)***, ***Arsenic (0.010)***, ***Barium (1)***, ***Boron (5)***, ***Cadmium (0.005)***, *Calcium (~100),* ***Chromium (0.050)***, *Copper (0.500), Iron (0.300),* ***Lead (0.010)***, *Magnesium (~30), Manganese (0.050 -* ***0.500)***, *Molybdenum, Nickel, Phosphorus, Potassium,* ***Selenium (0.010)***, *Silver, Sodium (20-200), Zinc (5)* [expand scan if zone is mineralized to include ***Mercury (0.001)*** and ***Uranium (0.020)***].

(3) Required for source water characterisation. If all are < 1 mg/L as N, later samples may be analysed for **Total N** only.

(4) Required if UV disinfection is being considered as part of the water treatment process. The test must be conducted on a RAW, UNFILTERED water sample. [Modified version of *Standard Method* 5910B where the sample is not filtered or pH adjusted.]

(5) Required if chlorination is used or proposed and TOC>2.5 mg/L. For new sources, specify "*DBP* ***formation potential***." Different DBPs are required for chlorine dioxide or ozone disinfection.

APPENDIX F: INSTRUCTIONS FOR COLLECTING SAMPLES

PHSA Laboratories
Public Health Microbiology & Reference Laboratory

655 West 12th Avenue
Vancouver, B.C. V5Z 4R4
Ph: 604-707-2620 Fax: 604-707-2600
www.phsa.ca/bccdcpublichealthlab

Collection of Drinking Water Samples for Coliform Testing

A. Sampling Kit

PHMRL Sampling Kit Contains :

1. Sterile sample bottle (with sodium thiosulphate)
2. Requisition form
3. Zip lock plastic bag
4. Rubber band
5. Pen (not supplied)

B. Fill in Requisition and Bottle Label

Requisition Information Required :

1. Contact information – Health Authority and Water Supplier
2. Date and time of collection
3. Water system information
4. Precise sampling site (exact location)
5. Sender address
6. Tests requested

Sample Bottle Label Information Required :

1. Precise sampling site (exact location)
2. Submitter's information

C. Transport

Transport :

1. Ship samples in cooler with sufficient ice packs to maintain temperature at <8°C.
2. Ship samples early in the week by same day or overnight courier.
3. Samples exceeding 30 hours holding time (from collection to testing) will not be tested.

Page 1

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D. Remove attachment

How To Collect Samples :

1. **Tap without attachments - run water for 2 to 3 minutes before collecting sample.**
2. **Tap with mixing faucet - remove attachments such as aerators, filters, hoses, screen or splash guard, run hot water for 2 minutes and then cold water for 2 to 3 minutes before sampling.**

E. Collect sample

3. **Remove cap of sample container without touching the mouth of the bottle or the inside of the cap.**
4. **Without rinsing, fill with water sample to 200 mL fill line (marked on the container).**

N.B. Collect water sample only from the cold water tap

F. Replace bottle cap

5. **Replace cap of sample container securely (tight).**
6. **Place requisition inside zip lock plastic bag and wrap it around sample container with rubber band.**
7. **See Transport instructions on the other side for shipping samples.**

Page 2

APPENDIX G: GLOSSARY

A

Act: A statute or law made by a legislative body.

Aquifer: A wet underground layer of water-bearing gravel, sand, silt, or clay.

Aquifer recharge area: The area where surface water drains into the ground (infiltration) and moves downward (percolates) from the surface into an aquifer.

B

Bacteria: Single-celled micro-organisms that are found in all environments, including the human digestive tract. While most species are harmless, certain bacteria can cause disease.

C

Coliforms: A group of bacteria found naturally in water, soil, and vegetation, as well as in feces. Fecal coliforms found in drinking water are an indicator of the potential presence of feces.

Contaminants: Pollutants or impurities.

***Cryptosporidium*:** A parasite that enters lakes and rivers through sewage or animal waste. It usually causes mild gastrointestinal symptoms but can sometimes be severe or even fatal for people with weak immune systems.

Cysts/oocyst: Thick-walled spore able to survive for lengthy periods outside a host (e.g., in the environment, in water etc.) Microbiological cysts are a stage in the life cycles of *Cryptosporidium* and *Giardia*.

D

Disinfection: A treatment process to reduce the numbers of disease-causing organisms.

Disinfection byproducts: A chemical compound formed by the reaction of an oxidizer such as chlorine with a precursor (e.g., natural organic matter such as decomposing leaves) in a water supply. Chronic exposure to DBPs may increase risk of cancer.

Drinking water: Potable water that is safe to drink without further treatment.

Drinking water hazard: Anything in drinking water that may be a risk to public health.

Due diligence: The care that a reasonable person takes to avoid harm to other people or their property.

E

***E. coli*:** A coliform bacteria found in intestines. Water sampling tests for *E. coli* as this indicates the presence of fecal contamination and potential pathogens.

Enteric: Related to the intestines. Enteric illnesses are those that affect the gastrointestinal system, such as *Cryptosporidium*, *Giardia*, *E. coli* and other water-borne illnesses.

Escheat: Transfer of a water supply system to the Crown when the water supply system is left without ownership.

Exceedances: Above an allowable limit, level, number, or quantity, such as pollutants in a waste stream.

G

GARP (groundwater at risk of containing pathogens): Any groundwater supply likely to be contaminated from any source of pathogens.

GCDWQ (Guidelines for Canadian Drinking Water Quality): Health-based and aesthetic guidelines published by Health Canada which sets standards for bacteriological, chemical, and physical parameters.

***Giardia lamblia*:** Sometimes called "beaver fever," this parasite enters surface water such as lakes and rivers through sewage and animal waste, including from animals such as mice, beaver, moose or domestic animals. It causes diarrhea, vomiting, and cramps.

Governance: Administrative processes of the management structure of the water supply system which dictates how decisions are made, who is allowed to make them, and how finances are directed, controlled, collected and accounted for.

Groundwater: Water that has infiltrated or seeped into the ground and collected in aquifers.

I

Immune compromised/deficiency: People with immune systems that are weakened or completely absent. This is often associated with diabetes, HIV-infection, transplant medications and chemotherapy.

Immune system: The body's defense mechanism against infection. When a pathogen enters the body, the immune system forms a complex line of defense to attack and rid it from the body.

Immunity: The immune system's ability to resist a specific pathogen, acquired by the development of antibodies from a previous exposure to that pathogen.

Infiltration gallery: A series of trenches with slotted pipe and staged sand/gravel/riprap that prescreens raw water.

L

Legislation: Laws, including acts and regulations, enacted by a government.

Log-reduction (logarithmic reduction): A mathematical means of indicating the difference between the numbers of "live" pathogens that you have in your treated water when compared to your raw water – it is a demonstration of the effectiveness of your treatment process(es).

M

Microbiological organisms: Organisms of microscopic size (i.e., bacteria, parasites, and viruses).

Multi-barrier approach: Having more than one level of protection to increase public safety.

N

Nonporous: A surface that water or air cannot penetrate, without any tiny holes to absorb liquid.

NSF 55Class A Systems: Ultraviolet light treatment units that inactivate micro-organisms in drinking water to a safe level, including bacteria, protozoa and viruses. (NSF 55-Class B systems have less disinfecting power and are designed for supplemental bactericidal treatment of drinking water.)

NTU (Nephelometric Turbidity Units): A measurement unit for water turbidity.

O

Outbreak: The occurrence of more individual cases of a disease than would normally be expected within a defined community, geographical area or season.

P

Palatable water: Water that is pleasant to drink.

Parameters: Any of a set of chemical, physical and/or biological properties that determine the characteristics of something.

Pathogen (infectious agent or germ): A microbiological organism that can cause disease or illness in its host.

Potable water: Water that is safe to drink without further treatment. It does not cause human illness and it meets all regulatory requirements.

Point-of-Entry: A treatment device located at the point where drinking water enters the premises.

Point-of-Use: A treatment device located immediately before the point where drinking water is drawn for consumption, such as a kitchen tap.

Precursor: A substance that is transformed into another compound through a reaction with another chemical.

Protozoa: Single-celled micro-organisms, generally larger than bacteria. Some protozoa can cause illness when ingested – as few as one of these can cause illness. Protozoa can only survive outside of the body in the form of a cyst or oocyst. The protozoa lays dormant inside of its cyst/oocyst until it is ingested by a person or animal causing infection.

R

Raw water: Intake water before any treatment or use.

Regulation: Subordinate legislation made under the authority of an act. Whereas an act gives the policy and framework, a regulation generally gives the detail.

Riparian zone: The land area along the edges of a water body, e.g., stream banks or shoreline, as far back as there are water influences.

S

Source-to-tap assessment/screen: An onsite review of the water source, treatment facilities, pumps, pipes, storage, and distribution up to the property line of the consumer.

Schematic: A drawing of the water supply system with all its components.

Small water supply system: A water supply system that serves up to 500 individuals during any 24 hour period.

Surface water: Water that collects above ground in snow pack or bodies of water such as springs, ponds, creeks, streams, rivers, lakes and oceans.

T

Treatment train: Several treatment technologies combined in a specific order.

Turbidity: Cloudiness or opacity in water, resulting from light being scattered by solids, particles and other pollutants. Turbidity is a water quality indicator.

V

Virus: The smallest of the water-borne pathogens. They cannot replicate outside of the body, but can survive for long-periods of time given favourable conditions in the environment. Once inside the body, viruses hijack the cells of the body to reproduce. The 'host' cells are damaged by this process which can cause illness.

W

Watershed: The area of land that drains to a surface water source. Surface water movement follows the topography of the landscape and flows downhill via streams and rivers. Therefore, the watershed for a surface water source includes any connected water-flow that is at a higher elevation.

Water supply system: A domestic water supply system, which serves more than a single-family residence.

Well protection area: The area around a well where land-use activities have the most potential to affect the quality and quantity of water that flows into the well.