POTABLE WATER GUIDELINES AND STANDARDS FOR PARKS CANADA AGENCY

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December 2006

Printed on Recycled Paper Containing Post-Consumer Fibre

EXECUTIVE SUMMARY

Potable Water Guidelines and Standards for Parks Canada Agency (PCA) are designed to meet the specific needs of PCA water supply systems. The Guidelines and Standards take into consideration the unique characteristics pertaining to PCA systems and are designed to be practical, so as they are easy to understand and implement by operational staff. The PCA Guidelines and Standards are built on the principles outlined in the Health Canada Interdepartmental Working Group Drinking Water Guidance Document.

These Guidelines and Standards represent the minimum requirements that must be met to provide potable water to consumers. Operators of PCA potable water systems may exceed the sampling and testing requirements beyond these Guidelines and Standards depending on site specific conditions.

The Potable Water Guidelines and Standards for PCA provide due diligence through detailed, clear and consistent requirements that ensure the provision of safe drinking water.

Major changes incorporated in the PCA Guidelines and Standards include:

- clear and concise definition of system sizes;
- treatment performance based on the characterization of the raw water source;
- updated sampling and testing requirements of microbiological and chemical parameters;
- relief from treatment for groundwater systems that demonstrate good water quality;
- sanitary surveys to identify potential threats to either the source of drinking water or to the treatment process; and
- operational checks (chlorine residual and turbidity monitoring) that minimize operating costs and enhance the provision of safe water.

The Guidelines and Standards include best management practices for water conservation, sampling methods, and source protection. Potable water treatment systems should be designed, constructed, operated and upgraded (as required) to provide safe drinking water given the source water characteristics. Annual review and updating of the Potable Water Guidelines and Standards should be conducted by PCA.

The following diagram provides a summary of the PCA Guidelines and Standards for Potable Water Supplies. Its intent is to provide readily available information to system operators related to the required testing frequencies and conditions. For more details refer to the appropriate sections of this document.

FIGURE ES.1
PCA POTABLE WATER SYSTEMS – GUIDELINES & STANDARDS

MICRO (<3,000 L/day)

SYSTEM SIZE / WATER SOURCE	Surface & GUDI	Ground	Supplied by others
TREATMENT	Primary disinfection & filtration • 99.99% removal of viruses • 99.9% removal of *Giardia* cysts • 99 % removal of *Cryptosporidium* oocysts	Primary disinfection 99% removal of viruses	As required
DISTRIBUTION SYSTEM RESIDUAL	Secondary disinfection, maintain at least: 0.05mg/L free chlorine residual or 0.25mg/L combined chlorine residual		
SANITARY SURVEY (See Template 1 and Flow Sheet 6)	Every 10 years	Every 10 years or every 3 years if system has relief	Every 10 years
RELIEF	N/A	• Only if 36 months of no adverse results exist • Assessment of Well Technician insures well integrity • Sanitary survey conducted every 3 years	N/A
OPERATIONAL CHECKS - CHLORINE RESIDUAL MONITORING: In treatment plant	Sample 2/week	Sample 2/week	N/A
In distribution system	1/week and with microbiological sampling		
OPERATIONAL CHECKS - TURBIDITY MONITORING	2/week	Sample monthly for raw water only	N/A
MICROBIOLOGICAL SAMPLING: Raw water sample	N/A	Every 2 months only if distribution is present	N/A
Treated water sample	Every 3 months	Every 3 months or every 2 months if system has relief	Every 3 months
Sampling reduction for systems with treatment and 24 adverse free operational months	N/A	N/A	N/A
REGULAR CHEMICAL SAMPLING: Inorganic & Organic Parameters (raw water or after treatment)	Once every 10 years for year-round and seasonal systems	Once every 10 years for year-round and seasonal systems	N/A
THM (for chlorinated systems with distribution)	• Every 90 days for year-round systems • As determined by Primary Technical Support Person for seasonal systems	• Every 90 days for year-round systems • As determined by Primary Technical Support Person for seasonal systems	• Every 90 days for year-round systems • As determined by Primary Technical Support Person for seasonal systems
Lead (systems with distribution)	• Yearly for year-round systems • Every 5 years for seasonal systems	• Yearly for year-round systems • Every 5 years for seasonal systems	• Yearly for year-round systems • Every 5 years for seasonal systems
Nitrates/Nitrites (in raw water after treatment)	Every 120 operational days	Every 120 operational days	N/A
CORRECTIVE ACTION	See Flow Sheets 1 through 5 in Appendix VI		

SMALL (3,000-60,000 L/day)

SYSTEM SIZE / WATER SOURCE	Surface & GUDI	Ground	Supplied by others
TREATMENT	Primary disinfection & filtration • 99.99% removal of viruses • 99.9% removal of *Giardia* cysts • 99 % removal of *Cryptosporidium* oocysts	Primary disinfection 99% removal of viruses	As required
DISTRIBUTION SYSTEM RESIDUAL	Secondary disinfection, maintain at least: 0.05mg/L free chlorine residual or 0.25mg/L combined chlorine residual		
SANITARY SURVEY	Every 10 years	Every 10 years or every 3 years if system has relief	Every 10 years
RELIEF	N/A	• Only if 36 months of no adverse results exist • Assessment of Well Technician insures well integrity • Sanitary survey conducted every 3 years	N/A
In treatment plant	Sample 2/week	Sample 2/week	N/A
In distribution system	2/week from different locations and with microbiological sampling		
TURBIDITY MONITORING	2/week	Sample monthly for raw water only	N/A
Raw water sample	N/A	Every 2 months only if distribution is present	N/A
Treated water sample	Monthly	Monthly or every 2 weeks if system has relief	Monthly
Sampling reduction for systems with treatment and 24 adverse free operational months	N/A	N/A	N/A
Inorganic & Organic Parameters (raw water or after treatment)	• Every 5 years (year-round systems) • Once (every 10 years for seasonal systems)		N/A
THM (for chlorinated systems with distribution)	• Every 90 days for year-round systems • As determined by Primary Technical Support Person for seasonal systems	• Every 90 days for year-round systems • As determined by Primary Technical Support Person for seasonal systems	• Every 90 days for year-round systems • As determined by Primary Technical Support Person for seasonal systems
Lead (systems with distribution)	• Yearly for year-round systems • Every 5 years for seasonal systems	• Yearly for year-round systems • Every 5 years for seasonal systems	• Yearly for year-round systems • Every 5 years for seasonal systems
Nitrates/Nitrites (in raw water after treatment)	Every 120 operational days	Every 120 operational days	N/A
CORRECTIVE ACTION	See Flow Sheets 1 through 5 in Appendix VI		

MEDIUM (60,000-360,000 L/day)

SYSTEM SIZE / WATER SOURCE	Surface & GUDI	Ground	Supplied by others
TREATMENT	Primary disinfection & filtration • 99.99% removal of viruses • 99.9% removal of *Giardia* cysts • 99 % removal of *Cryptosporidium* oocysts	Primary disinfection 99% removal of viruses	As required
DISTRIBUTION SYSTEM RESIDUAL	Secondary disinfection, maintain at least: 0.05mg/L free chlorine residual or 0.25mg/L combined chlorine residual		
SANITARY SURVEY	Every 5 years	Every 5 years or every 3 years if system has relief	Every 5 years
RELIEF	N/A	• Only if 36 months of no adverse results exist • Assessment of Well Technician insures well integrity • Sanitary survey conducted every 3 years	N/A
In treatment plant	Daily	Daily	N/A
In distribution system	6 samples/week from different locations collected at least 48 hours apart and with microbiological sampling		
TURBIDITY MONITORING	Daily one grab sample	Sample monthly for raw water only	N/A
Raw water sample	N/A	Every month	N/A
Treated water sample	Every 2 weeks	Every 2 weeks or 1/week if system has relief	Every 2 weeks
Sampling reduction for systems with treatment and 24 adverse free operational months	Every month	Every month	Every month
Inorganic & Organic Parameters (raw water or after treatment)	• Every 3 years (year-round systems) • Once (every 10 years for seasonal systems)	• Every 5 years (year-round systems) • Once (every 10 years for seasonal systems)	N/A
THM (for chlorinated systems with distribution)	• Every 90 days for year-round systems • As determined by Primary Technical Support Person for seasonal systems	• Every 90 days for year-round systems • As determined by Primary Technical Support Person for seasonal systems	• Every 90 days for year-round systems • As determined by Primary Technical Support Person for seasonal systems
Lead (systems with distribution)	• Yearly for year-round systems • Every 5 years for seasonal systems	• Yearly for year-round systems • Every 5 years for seasonal systems	• Yearly for year-round systems • Every 5 years for seasonal systems
Nitrates/Nitrites (in raw water after treatment)	Every 120 operational days	Every 120 operational days	N/A
CORRECTIVE ACTION	See Flow Sheets 1 through 5 in Appendix VI		

LARGE (>360,000 L/day)

SYSTEM SIZE / WATER SOURCE	Surface & GUDI	Ground	Supplied by others
TREATMENT	Primary disinfection & filtration • 99.99% removal of viruses • 99.9% removal of *Giardia* cysts • 99 % removal of *Cryptosporidium* oocysts	Primary disinfection 99% removal of viruses	As required
DISTRIBUTION SYSTEM RESIDUAL	Secondary disinfection, maintain at least: 0.05mg/L free chlorine residual or 0.25mg/L combined chlorine residual		
SANITARY SURVEY	Once every 3 years in addition to a 3rd party audit every 10 years		
RELIEF	N/A	• Only if 36 months of no adverse results exist • Assessment of Well Technician insures well integrity • Sanitary survey conducted every 3 years	N/A
In treatment plant	Daily/continuously	Daily/continuously	N/A
In distribution system	11 samples/week from different locations collected at least 48 hours apart and with microbiological sampling		
TURBIDITY MONITORING	Continuous monitoring	Sample monthly for raw water only	N/A
Raw water sample	N/A	Every month	N/A
Treated water sample	Weekly	Weekly or 2/week if system has relief	Weekly
Sampling reduction for systems with treatment and 24 adverse free operational months	Every 2 weeks	Every 2 weeks	Every 2 weeks
Inorganic & Organic Parameters (raw water or after treatment)	• Yearly (year-round systems) • Once (every 5 years for seasonal systems)	• Every 3 years (year-round systems) • Once (every 5 years for seasonal systems)	N/A
THM (for chlorinated systems with distribution)	• Every 90 days for year-round systems • As determined by Primary Technical Support Person for seasonal systems	• Every 90 days for year-round systems • As determined by Primary Technical Support Person for seasonal systems	• Every 90 days for year-round systems • As determined by Primary Technical Support Person for seasonal systems
Lead (systems with distribution)	• Yearly for year-round systems • Every 5 years for seasonal systems	• Yearly for year-round systems • Every 5 years for seasonal systems	• Yearly for year-round systems • Every 5 years for seasonal systems
Nitrates/Nitrites (in raw water after treatment)	Every 120 operational days	Every 120 operational days	N/A
CORRECTIVE ACTION	See Flow Sheets 1 through 5 in Appendix VI		

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DEFINITIONS

TERM	DEFINITION
Backcountry systems	Non-potable water systems that are under a permanent boil water notice and are not accessible by wheeled vehicles.
Bedrock Well	A bedrock well is completed in the rock underlying surficial unconsolidated material. Fractured bedrock is still bedrock. Unlike overburden wells, bedrock wells are usually in excess of 30m deep and often in excess of 100m deep.
Boil water advisory	A temporary notice to inform users to boil water prior to consuming while corrective action(s) is being carried out. This type of notice must be rescinded.
Boil water notice	A permanent notice to inform users to boil water prior to consuming, e.g. backcountry operations.
Daily flow rate	Amount of water that is provided by a potable water system to consumers.
Distribution system	A plumbing or piping system that is at least 500m from primary treatment or source.
Due diligence	A measure of prudence that is to be expected from, and ordinarily exercised by, a reasonable and prudent person under the particular circumstances.
Grab sample	A water sample taken manually at one particular time and place.
Infiltration Gallery	A sub-surface groundwater collection system, typically shallow in depth, constructed with open-jointed or perforated pipes that discharge collected water into a watertight chamber from which the water is pumped to treatment facilities and into the distribution system. Usually located close to streams or ponds.
Large system	A system that has a daily flow rate greater than or equal to 360,000 litres for more than 95% of the operational time.
Medical Officer of Health	A medical practitioner designated by the province to be responsible for local or regional public health OR a qualified public health professional designated by Health Canada.
Medium system	A system that has a daily flow rate between 60,000-360,000 litres 95% of the operational time.
Microbiological testing	Sampling for total coliform and *Escherichia coli*.
Micro-system	A system that has a daily flow of less than 3,000 litres per day for 95% of the operational time.
Operational time	The time during which a system is supplying potable water.
Operator	Staff member responsible for the maintenance, adjustment or safe operation of a potable water source.

TERM	DEFINITION
Overburden Well	An overburden well is screened in the unconsolidated soil materials (e.g. till, sand and gravel, silts and clay) that lie on top of the bedrock.
Potable water	Water meeting the PCA Guidelines and Standards.
Primary disinfection	A process or series of processes intended to remove or inactivate human pathogens such as viruses, bacteria and protozoa in water.
Primary Technical Support Person	Individual(s), with the appropriate technical background and certification, identified by the Field Unit Superintendent who is the primary contact for all potable water related issues for a potable water system. Potable water related issues include, but are not limited to, notification from designated laboratory of all test results (confirmation of meeting or exceeding guidelines), identification of possible external contamination sources, Ministry of Health contacts and all other external communication sources.
Rapid sand filter	Is a type of filter where water is filtered down through a bed of medium to coarse sand at high velocity.
Sanitary Survey	Sanitary Survey is an investigative onsite review of the water source, equipment, operation, maintenance and monitoring to identify and evaluate factors associated with drinking water which can pose a risk to health.
Seasonal system	A potable water system that is not in operation for 60 or more consecutive days every year.
Secondary disinfection	A process or series of processes intended to provide and maintain a disinfectant residual in a potable water system's distribution system, and in plumbing connected to the distribution system, for the purposes of: (a) protecting water from microbiological re-contamination, (b) reducing bacterial re-growth, (c) controlling biofilm formation, and (d) serving as an indicator of distribution system integrity, and includes the use of disinfectant residuals from primary disinfection to provide and maintain a disinfectant residual in a potable water system's distribution system for the purposes described in clauses (a) to (d).
Secondary Technical Support Person	Individual(s), with the appropriate technical background, identified by the Field Unit Superintendent who serves the role of the primary contact when the primary contact is not available.
Small system	A system that has a daily flow rate between 3,000-60,000 litres for 95% of the operational time.
Shutdown period	A period when no drinking water is delivered to consumers for at least 7 days.

ACRONYMS

ABBREVIATION	PHRASE
ANSI	American National Standards Institute
AMS	Asset Management System
AWWA	American Water Works Association
BDCM	Bromodichloromethane
DBCM	Dibromochloromethane
E. Coli	*Escherichia coli*
GUDI	Groundwater under the direct influence of surface water
IDWG	Interim Drinking Water Guidelines
MAC	Maximum Acceptable Concentration
MCL	Maximum Contaminant Limit
NSF	National Sanitation Foundation
NTU	Nephelometric Turbidity Units
PCA	Parks Canada Agency
PHC	Public Health Consultant
TC	Total Coliforms
TCU	True Colour Units
THM'S	Trihalomethanes
U.S. EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds

1.0 POTABLE WATER GUIDELINES AND STANDARDS

1.1 PURPOSE

This document provides practical guidance on the application of the Guidelines and Standards for the provision of potable water to Parks Canada facilities. This document has been updated to ensure consistency in its application across all Parks Canada Agency's potable water systems. This document is guided by the Health Canada Guidance Document to reflect and meet the needs of PCA operators.

1.2 SYSTEMS CLASSIFICATION

In order to design the requirements for PCA systems, the following classifications have been used. See Table 1.1. These classifications are appropriate for the sizes of PCA systems.

TABLE 1.1
DRINKING WATER SYSTEMS CLASSIFICATION

Classification	Daily Flow Rate[1]
Micro-systems	<3000 L/day for 95% of the operational time
Small systems	3,000-60,000 L/day for 95% of the operational time
Medium systems	60,000-360,000 L/day for 95% of the operational time
Large systems	>360,000 L/day for 95% of the operational time

These flow rates are based on 120 litres per person per day which is equivalent to the following daily populations:

Micro-systems: <25 people,
Small systems: 25-500 people,
Medium systems: 501-3000 people,
Large systems: >3000 people.

It is recommended that all potable water systems have a water meter installed and that daily flows are recorded.

The system classification may change during the year. For example, during summer peak months a system may be considered large whereas during the winter it could be considered medium or small due to the decrease in the number of users. Also, in some facilities there may be large numbers of users, which may render the system a certain classification; however; the average consumption may not correspond to the number of users. In this case, the system classification should be adjusted.

[1] This flow excludes water used for flushing.

1.3 PRINCIPLES OF TREATMENT

1.3.1 Primary Disinfection

Primary disinfection for groundwater raw water supply:
Ensure the provision of water treatment equipment that is designed to be capable of achieving, at all times, primary disinfection of at least 99 percent removal or inactivation of viruses by the time the water enters the distribution system. For example, with groundwater of pH 7-8 and temperature 7-10 degrees Celsius (ºC), this requirement can be met by maintaining a minimum chlorine residual of 0.2 mg/L, measured as free chlorine, after 15 minutes of contact time.

Primary disinfection and filtration for surface water raw and GUDI water supply:
Ensure the provision of water treatment equipment that is designed to be capable of achieving, at all times, primary disinfection of at least 99 percent removal or inactivation of ***Cryptosporidium*** oocysts, at least 99.9 percent removal or inactivation of ***Giardia*** cysts and at least 99.99 percent removal or inactivation of viruses by the time water enters the distribution system. Conditions to achieve these removal credits for different types of treatment technologies are outlined in Appendix I.

1.3.2 Backcountry Systems

Treatment is not required for backcountry systems. A "Do Not Drink Water" sign must be posted unless a chemical characterization, of parameters in Appendix III, Tables A, B, and C, is completed. A permanent boil water notice (BWN) may be posted for all backcountry systems if no adverse chemical results are found.

1.3.3 Secondary Disinfection

Secondary disinfection refers to the disinfection effect in the distribution system. The maintenance of a disinfectant residual in the distribution system (secondary disinfection) is intended to maintain (or introduce and maintain) a persistent disinfectant residual to protect the water from microbiological re-contamination, reduce bacterial re-growth, control biofilm formation, and serve as an indicator of the distribution system's integrity (loss of disinfectant residual indicating that the system integrity has been compromised). The potable water system's distribution must be operated such that at all times and at all locations within the distribution system, where there is a daily flow, there is at least a free chlorine residual of 0.05 mg/L at a pH of at least 8.5[2], or a combined chlorine residual of 0.25 mg/L.

[2] A maximum water pH of 8.5 is recommended for free chlorine residual maintenance for two reasons; the disinfecting power of free chlorine is rapidly and progressively reduced as pH levels rise over 7.0, and, pH levels tend to rise naturally in distribution systems as a result of biofilm activity.

The recommended optimum target for free chlorine residual concentration in a water distribution system is 0.2 mg/L at a pH of at least 8.5[2]. The recommended optimum target for combined chlorine residual for systems designed to operate with chloramination is 1.0 mg/L at all locations within the distribution system to suppress bacterial activity that converts ammonia to nitrite and nitrate[3].

The maximum chlorine residual at any time and at any location within the distribution system should not exceed 4.0 mg/L when measured as free chlorine, and 3.0 mg/L when measured as combined chlorine.

In larger water distribution systems, maintenance of the minimum required residual may not be possible without the operation of re-chlorination facilities at one or more points within the distribution system. Rapid decay of the disinfectant residual may occur as a result of a number of other causes such as heavy encrustation or sediment accumulation and biofilm activity and may require investigation and specific corrective action, such as engineered flow velocity increases, and swabbing or pigging/lining and/or main replacement. The operators must ensure the proper operation of the equipment.

1.3.4 Disinfection after Construction or Repairs or Seasonal Start-ups

All parts of potable water systems in contact with drinking water which are taken out of service for inspection, repair or other activities that may lead to contamination before they are put back in service, must be disinfected in accordance with the provisions of the AWWA Standard for Disinfecting Water Mains (C651), or an equivalent procedure that ensures the safety of drinking water that is delivered to consumers. The chemical feed rate should be such that it will produce a concentration of about 50 mg/L when mixed with incoming water. The feed should continue until a residual of 25 mg/L can be measured in the flow at the end of the line. The flow should be stopped and the chlorine allowed to remain in the pipe for at least 24 hours. A higher dose of chlorine can be used for a shorter time. The concentration should be at least 300 mg/L for a 3 hour contact period. At the end of contact period, the chlorinated water should be flushed from the pipeline and disposed of in an environmentally friendly manner. Refer to Appendix VII.

[3] Otherwise, nitrate levels might exceed Health Canada standards.

1.3.5 Sanitary Survey

Sanitary surveys are required to update the information available on the water source and to check the integrity of the potable water system to ensure the provision of safe drinking water. Sanitary surveys may be required to highlight increased requirements for management, treatment, sampling and testing. To ensure proper operation, each system must be subject to a sanitary survey as outlined in Template 1 and Flow Sheet 6 according to the frequencies outlined in Table 1.2. Backcountry systems are not required to conduct sanitary surveys.

TABLE 1.2
FREQUENCY OF SANITARY SURVEYS

<table>
<tr><th>System</th><th>Conducted by</th><th>Frequency of conducting sanitary surveys</th></tr>
<tr><td>Micro</td><td rowspan="5">Certified operator, or professional engineer, or hydrogeologist</td><td>Once every 10 years</td></tr>
<tr><td>Small</td><td>Once every 10 years</td></tr>
<tr><td>Medium</td><td>Once every 5 years</td></tr>
<tr><td>Large</td><td>Once every 3 years. A periodic 3rd party audit is also recommended every 10 years.</td></tr>
<tr><td>Any groundwater system that obtains relief from primary disinfection treatment</td><td>Once every 3 years.</td></tr>
</table>

The breakdown is based on the risk to the users of the drinking water system; therefore, for large systems a shorter interval between surveys is required as more people are at risk.

The frequency of the sanitary surveys represents the minimum frequency provided the potable water system does not change significantly. If there are significant land use changes or system changes, a sanitary survey should be conducted.

1.4 RELIEF

Relief from primary disinfection treatment may apply to a groundwater system, not under the influence of surface water, **only** if certain conditions are met:

- History of safe source water (more than 36 operational months of no adverse result in microbiological or chemical tests),
- On-site inspection of the well and wellhead protection, and
- An assessment by a qualified Well Technician that satisfies the specified conditions related to the construction and condition of the well and ensures the integrity of the well.

If a relief from treatment is granted to a groundwater system, a sanitary survey (see Appendix II, Template 1) must be carried out every 3 years regardless of the system size. It should be pointed out that groundwater systems that have been granted relief and have distribution systems are required to practice secondary disinfection to achieve at least 0.05 mg of free chlorine/L (or 0.25 mg/L of combined chlorine residual if chloramination is used) at any point in the distribution system so that no bacterial re-growth takes place.

For a newly constructed well to obtain relief, it needs to be monitored regularly for 12 operational months and either:

a) supply treated water, and if no adverse results occur relief is granted; or
b) supply untreated water under a BWA while monitoring the system, if no adverse results occur rescind the BWA and obtain relief.

Another type of system that receives relief is that of backcountry operations. Backcountry operations refer to systems that are not accessible by wheeled vehicles and where water is non-potable, thus the systems are under permanent "Do Not Drink Water" or BWN sign. These systems are exempt from the guidelines because of their remote location. A permanent "Do Not Drink Water" or BWN sign must be posted visibly to all the water users.

1.5 GROUNDWATER UNDER DIRECT INFLUENCE OF SURFACE WATER (GUDI)

The following systems are deemed to be supplied by GUDI source(s), unless a professional engineer or professional hydrogeologist concludes that the raw water supply is not GUDI:

1. A drinking water system that obtains water from a well that is not a drilled well.
2. A well that does not have watertight casing that extends to a depth of at least six metres below ground level.
3. A drinking water system that obtains water from an infiltration gallery.
4. A drinking water system that exhibits evidence of contamination by surface water during routine sampling or a sanitary survey (i.e., algae presence –measured as Chlorophyll a- or high nitrate levels).
5. A micro-or small potable water system that obtains water from a well, any part of which is within 15 metres of surface water.
6. A medium or large potable water system that obtains water from an overburden well, any part of which is within 100 metres of surface water.
7. A medium or large potable water system that obtains water from a bedrock well, any part of which is within 500 metres of surface water.

1.6 OPERATIONAL CHECKS

1.6.1 Chlorine Residual

Chlorine testing equipment must be calibrated as per the manufacturer's recommendations.

Primary disinfection:
Chlorine residual should be measured at or near a location where the intended contact time has just been completed. Testing frequency is in Figure 1.1.

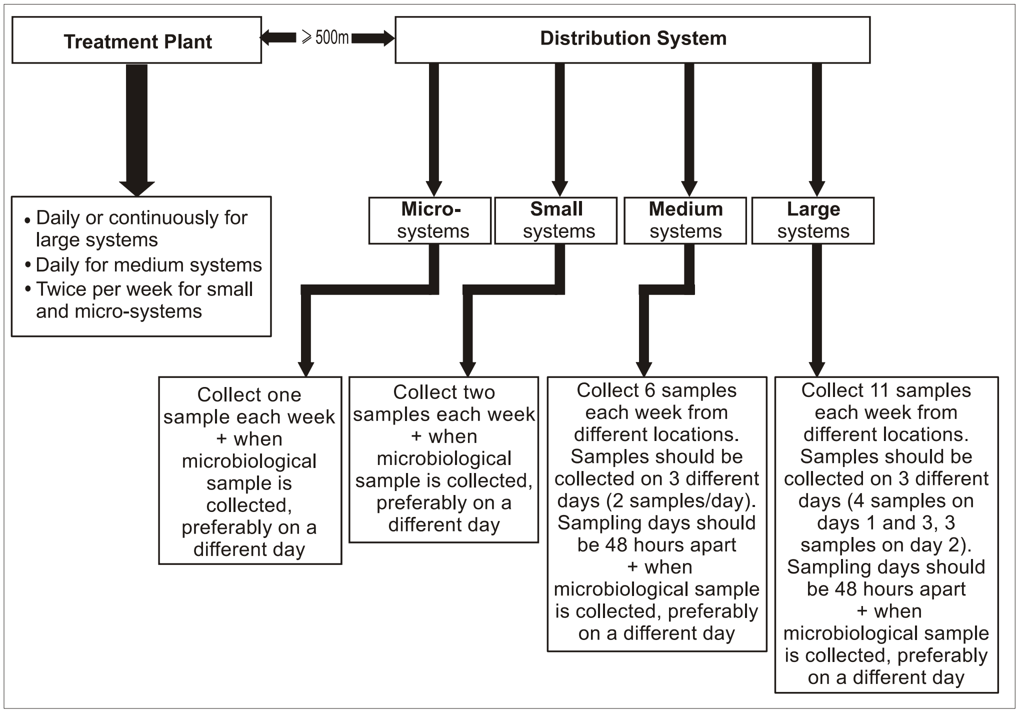
Secondary disinfection:
Chlorine residual should be measured in the distribution sample as follows:

- Large systems: 11 samples should be collected each week. The samples can be collected on three days of the week, provided there is a period of 48 hours between the days of collecting the samples and the samples are taken from different locations. As such, four samples are collected on the first sampling day and then three more collected on the second sampling day, and another four samples collected on the third sampling day.
- Medium systems: 6 samples should be collected per week from different locations. Two samples are to be collected on each of the three sampling days. The sampling days should be 48 hours apart.
- Small systems: two samples should be collected each week[4];
- Micro-systems: one sample should be collected each week immediately following treatment.

When multiple samples are taken on the same day, the samples must come from different locations in the distribution system. A sample for chlorine residual should also be collected when microbiological samples are collected, preferably from locations different than those used for chlorine residual sampling. The purpose is to cover as many different sampling locations as possible. The following figure summarizes the requirement for measuring chlorine residual.

[4] If there is no distribution system, the sample should be collected either at the treatment system and/or the furthest point from the treatment.

FIGURE 1.1
MEASURING CHLORINE RESIDUAL



1.6.2 Turbidity

Turbidity measuring equipment should be calibrated as per the manufacturer's recommendations.

Groundwater sources:
The raw water turbidity should be measured once per month to discern any trend that may indicate direct influence of surface water.

Surface water and GUDI sources:
Do not measure turbidity for raw water. Turbidity is usually measured after filtration and before disinfection, but may be measured after disinfection if UV treatment is used.

For filters that are in series, measure turbidity at the effluent of the last filter. For filters that are in parallel, measure the turbidity at the end of each filter effluent. Use the change in pressure to detect filter failure when possible.

The main purpose of testing for turbidity is to ensure effectiveness of filtration which in turn determines the effectiveness of disinfection, therefore turbidity measurements should not be taken in the distribution system.

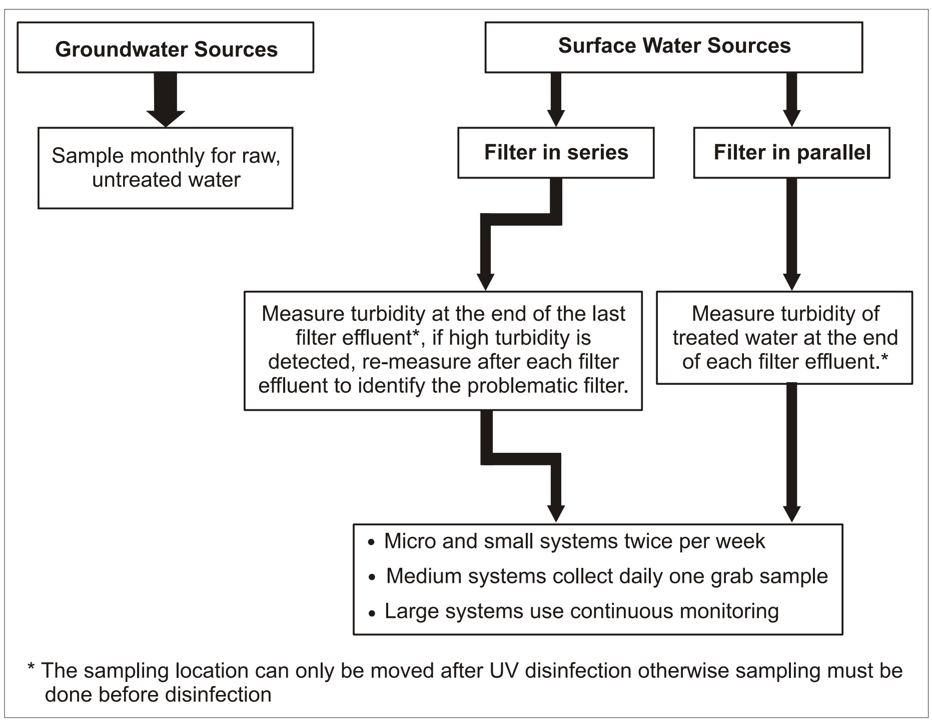
Large systems are required to install continuous monitoring devices for turbidity measurements. For sampling frequency of different systems refer to Table 1.3. As can be noted turbidity measurements in the distribution system are **not** required.

TABLE 1.3
FREQUENCY OF TURBIDITY SAMPLING FOR SURFACE WATER AND GUDI

System classification	Frequency of sampling and method
Micro	2 per week, grab sample
Small	2 per week, grab sample
Medium	1 daily, grab sample
Large	Continuous monitoring

The following figure summarizes the requirement for measuring turbidity.

FIGURE 1.2
TURBIDITY MEASUREMENT FOR SURFACE WATER AND GUDI



1.6.3 Continuous Monitoring Requirements

Continuous monitoring equipment, if used, must meet the requirements outlined in Appendix VIII. Continuous monitoring equipment must cause an alarm to sound in the event there is equipment failure, adverse results, or power failure and must record the date, time, sampling location and result of every test for the parameter, including the record of the result, of every test that causes an alarm to sound.

1.7 MICROBIOLOGICAL TESTING

1.7.1 Minimum Testing

The following table outlines the minimum number of samples to be collected from the system and to be analyzed for Total Coliforms and *Escherichia coli* (*E. coli*).

TABLE 1.4
MINIMUM FREQUENCY OF MICROBIOLOGICAL SAMPLES

System classification	Treatment provided	Sampling reduction for systems with treatment	No treatment (i.e. systems granted relief from primary disinfection treatment)
Micro	One sample every three months	Not applicable	One sample every two months*
Small	One sample every month	Not applicable	One sample every two weeks
Medium	One sample every two weeks	One sample every month (see section 1.7.3)	One sample per week
Large	One sample every week	One sample every two weeks (see section 1.7.3)	Two samples per week

** Minimum of 4 samples annually for seasonal systems or 6 samples for year round systems.*

Remarks:

- Chlorine residual measurements should be taken concurrently at the same location during the sampling of microbiological parameters.
- If a potable water system uses point of entry treatment units, the samples should be taken from locations downstream of the point of entry treatment units.

1.7.2 Sampling Locations

The location of distribution sampling points for microbiological testing should be decided by PCA staff after due consideration of local conditions. At least 50% of samples should be taken from the extremities of the distribution system. Each sample should be labelled to identify its location within the water system.

It is important to identify the locations where there is a long distribution system, because care must be taken to ensure that there is no microbiological growth developing within the distribution network. If microbiological growth is identified, then the proper steps need to be taken to remove the source of microbiological growth.

If there is no distribution system the sample can be collected immediately following treatment and/or from the furthest point from the treatment. For systems with no treatment (i.e., systems that are granted relief from primary disinfection treatment) samples can be collected from the source and/or from the furthest point from the treatment.

1.7.3 Reduction in Sampling Frequency

The reduction in monitoring frequency is only applicable for medium and large systems where treatment is provided. A reduction of the sampling frequency by half can be applied if in the most recent 24 consecutive months of operation there were no adverse results.

In the event that more than one adverse incident results in a Boil Water Advisory (BWA) during the reduced frequency, the operator must revert back to the original frequency until a 24 consecutive month period indicates no adverse result.

1.7.4 Raw Water Samples

Raw water samples should be taken once per month for groundwater systems from each well in the system for large and medium sized systems. For small and micro-systems with distribution systems raw water samples are to be collected once every two months. Raw water samples need not be collected for systems using surface water.

1.7.5 Periods of Shutdown

PCA shall ensure that no potable water is supplied to a user of water after the period of shutdown until samples have been taken and tested and the results of the tests are acceptable.

1.8 CHEMICAL TESTING

1.8.1 Initial Characterization

Every system must undergo a full characterization of its raw water source, for the parameters listed in Tables A, B, C and D in Appendix III. Sites that have completed a chemical characterization based on the PCA Interim Guidelines for Drinking Water Quality between 2002-2006 are deemed to have fulfilled the requirements of an initial chemical characterization.

1.8.2 Regular Minimum Frequency

The requirements for regular chemical testing are shown in Table 1.5 for year round potable water systems and in Table 1.6 for seasonal potable water systems. For large potable water systems organic and inorganic substances that are not detected in three consecutive tests can be removed from the list for a period of 5 years.

TABLE 1.5
CHEMICAL TESTING FREQUENCY- YEAR ROUND POTABLE WATER SYSTEMS

System classification	Inorganic (Table A) & Organic (Table B)	THM'S	Lead	Nitrate &Nitrite
Micro	Once every 10 years, during the sanitary survey.	Once every 90 days	Once every year	Once every 120 days
Small	Once every 5 years			
Medium	Surface water system: Once every 3 years Groundwater System: Once every 5 years			
Large	Surface water system: Once every year Groundwater System: Once every 3 years			

TABLE 1.6
CHEMICAL TESTING FREQUENCY - SEASONAL POTABLE WATER SYSTEMS

System classification	Inorganic (Table A) & Organic(Table B)	THM's	Lead	Nitrate &Nitrite
Micro	Once every 10 years	As determined by the Primary Technical Support Person	Once every 5 years	Once per 120 operational days
Small	Once every 10 years			
Medium	Once every 10 years			
Large	Once every 5 years			

1.8.3 Sampling Locations – Organic and Inorganic

Samples are taken from the point at which water enters the distribution system or plumbing that is connected to the treatment system for inorganic and inorganic parameters (Tables A and B) as well nitrates and nitrites.

For THM's the samples are taken at a point in the distribution system or plumbing that is likely to have the potential of formation of THM's, such as the point of use/end of the line only for systems disinfecting with chlorine/chloramine. THM's sampling is only conducted for primary chlorinated systems.

For lead, samples are taken at a point in the distribution system or plumbing that is likely to have an elevated concentration of lead, such as the point of use/end of the line.

1.8.4 Disinfection By-products

Trihalomethanes (THM's) can occur in chlorinated water as a result of the reaction between the organic material in the water and chlorine added as a disinfectant. THM's include four chemicals: chloroform, bromodichloromethane (BDCM), dibromochloromethane (DBCM) and bromoform.

Health Canada in their Guideline Technical Document for THM's (May 2006), indicated that since chloroform is the trihalomethane most often found in drinking water, and generally at the highest concentration, the THM guideline is based on health risks linked to chloroform.

Although the concentration of BDCM is included in the concentration of THM's (100 µg/L) in the guideline, a separate guideline for BDCM is also deemed necessary. The guideline for BDCM in drinking water is established at a MAC of 0.016 mg/L**.** PCA systems may need to monitor for BDCM, in addition to THM's, and ensure that BDCM concentration is less than 0.016 mg/L. If THM's concentration is less than half MAC for 24 consecutive operational months the testing frequency for both parameters can be reduced to once every 180 days.

1.9 SAMPLING FREQUENCY SCHEDULES

The sampling frequency mentioned in sub-sections 1.7 and 1.8 should adhere to the sampling interval schedule that is indicated in Table 1.7.

TABLE 1.7
REQUIRED SAMPLING INTERVALS FOR DIFFERENT TYPES OF SAMPLING FREQUENCIES

Sampling Frequency	Sampling Interval
Weekly	At least 5 days and not more than 10 days after a sample is taken in the previous week.
Once every 2 weeks	At least 10 days and not more than 20 days after a sample is taken in the previous two-week period
Once every month	At least 20 days, and not more than 40 days, after a sample was taken for that purpose in the previous month.
Once every year	Not more than 30 days before or after the first anniversary of the day a sample was taken in the previous year.
Once every 3 years	Not more than 60 days before or after the third anniversary of the day a sample was taken in the previous 3 -year period.
Once every 5 years	Not more than 90 days before or after the fifth anniversary of the day a sample was taken in the previous 5 -year period.

1.10 ACCREDITED LABORATORIES

Samples for testing must be sent to an accredited laboratory or a laboratory that uses the Standard Methods for the Examination of Water and Wastewater (most current edition) published by the American Public Health Association, the AWWA and the Water Environment Federation as indicated by Canadian Association for Environmental Analytical Laboratories (see **http://www.caeal.ca/**).

1.11 SYSTEMS RECEIVING TRANSPORTED WATER

The Primary Technical Support Person should ensure that the drinking water supplied by PCA/others complies with PCA Potable Water Guidelines and Standards. In addition, at least one sample should be taken from the cistern and tested daily for free chlorine or combined chlorine residual. If the system from which the drinking water is obtained provides chlorination and does not provide chloramination, the test should determine the amount of free chlorine in the water; or determine combined chlorine residual, if chloramination is used. Chlorine can be added to storage to maintain chlorine residual and the residual's leve must be tested at least twice per week.

If transported water is used to supply potable water to micro-systems, measurements of daily chlorine residual may not be required if UV disinfection equipment is installed at the point of entry following the cistern.

The Primary Technical Support Person should make certain that the owner/operator of a water haulage vehicle used to transport water for human consumption shall ensure that:

- all water transported and sold for human consumption meets Health Canada drinking water objectives;
- the tank or similar container used to store and transport the water is used for no other purpose;
- the tank and all hoses and other equipment which may come into contact with drinking water shall be constructed of material in accordance with Canadian Standards Association and be maintained so as not to adulterate or contaminate the water;
- equipment which comes in direct contact with the water is corrosion resistant and non-toxic;
- the tank or similar container used to store and transport drinking water is clearly marked in letters at least 15 cm in height with the words "Drinking Water" or the words "Potable Water"; and
- samples of water from each vehicle are submitted at least once every 3 months.

1.12 POTABLE WATER SUPPLIED BY OTHERS

In instances where treated water enters a PCA distribution system, the Primary Technical Support Person should ensure that the treated water meets or surpasses the PCA Guidelines and Standards for Potable Water. Distribution system sampling strategies for and chlorine residual and microbiological parameters (indicated in subsections 1.6.1 and 1.7) in the PCA Guidelines and Standards should be followed for sampling systems supplied by others.

PCA reserves the right to ask the supplier for records related to monitoring and treatment to ensure that the supplied water meets PCA Potable Water Guidelines and Standards. If the supplier does not meet the Guidelines and Standards, PCA may undertake measures to ensure that the water meets PCA Guidelines and Standards. By requesting this information PCA is deemed to have exercised due diligence.

1.13 ADVERSE RESULTS AND CORRECTIVE ACTIONS

Table 1.8 outlines adverse results of operational parameters and test results and specifies corrective actions. In the following corrective actions, "resample and test" means the following:

(a) for corrective action that arises from testing a water sample for a microbiological parameter,
   (i) take a set of water samples, at approximately the same time, with,
      (A) at least one sample from the same location as the sample that gave rise to the corrective action,
      (B) at least one sample from a location that is at a significant distance upstream from the location described in (A), and
      (C) at least one sample from a location that is at a significant distance downstream from the location described in sub-subclause (A), and
   (ii) conduct, on the samples taken under step (i), the same test that gave rise to the corrective action, or

(b) for corrective action that arises from the test of a water sample for a parameter that is not a microbiological parameter,
   (i) take a water sample from the same location as the sample that gave rise to the corrective action; and
   (ii) conduct on the sample taken under (i), the same test that gave rise to the corrective action.

Template 4 in Appendix II outlines the reporting of adverse results template.

TABLE 1.8
CORRECTIVE ACTIONS

Parameter	Adverse Results	Corrective Actions
Chlorine residual in the treatment plant	Chlorine residual drops to levels lower than acceptable design levels in one reading.	1) Restore disinfection (check feed pumps, contact time tanks, etc.) 2) If chlorine residual level is still low follow manufacturer's recommendation for servicing equipment upstream of the location of adverse result. 3) If problem persists immediately issue a BWA, follow Field Unit Communications Plan and seek professional help. See Appendix VI, Flow sheet 1
Chlorine residual in the distribution system	Two samples collected from the same location 15 minutes apart having a free chlorine residual concentration of less than 0.05 mg/L or combined chlorine residual of less than 0.25 mg/L if the system provides chloramination.	1) Immediately flush the water mains, check chlorine feed equipment and chlorine analyzer, and restore secondary disinfection to ensure that: • a free chlorine residual of at least 0.05 mg/L is achieved at all points in the affected parts of the distribution system, if the system provides chlorination and not chloramination, or • a combined chlorine residual of at least 0.25 mg/L is achieved at all points in the affected parts of the distribution system, if the system provides chloramination. 2) If the required levels of free chlorine or combined chlorine cannot be quickly achieved at all points in the affected area, immediately issue a BWA, follow Field Unit Communications Plan and seek professional help. See Appendix VI, Flow sheet 2
Turbidity	Two samples collected from the same location 15 minutes apart having an NTU >1 1	1) Calibrate the equipment. If the levels are restored return to normal operations. 2) If the levels are still high, backwash, review operational processes, correct any faulty process, replace filters, and follow manufacturer's recommendations. If the levels are restored return to normal operations. 3) Calibrate the equipment. If the levels are restored return to normal operations. 4) If the levels are still high, backwash, review operational processes, correct any faulty process, replace filters, and follow manufacturer's recommendations. If the levels are restored return to normal operations. 5) If the levels are still high, issue a BWA, follow Field Unit Communications Plan and seek professional help. 6) Take corrective action and flush the system. 7) Resample and test. If the levels are restored rescind the BWA and follow Field Unit Communications Plan. If the levels are still high maintain the BWA and seek professional help. See Appendix VI, Flow sheet 3

TABLE 1.8 (Cont'd)
CORRECTIVE ACTIONS

Escherichia coli	Detected in a sample	1) Immediately issue a BWA and follow Field Unit Communications Plan. 2) Check the system: a) Primary disinfection: check the disinfection system (e.g. contact time tank, feeding pumps, UV lamps). b) Secondary disinfection: i. immediately flush the distribution system and ensure that an appropriate level of chlorine residual is achieved at all points in the affected parts of the distribution system and plumbing, and ii. maintain the chlorine residual in the affected parts of the distribution system and plumbing, c) System granted relief: i. if *E. coli* is detected in the raw water shut the well and shock the system (Appendix II, Template 2). ii. if *E. coli* is detected in the distribution system follow actions outlined in 2b Secondary disinfection above. 3) Immediately resample (collect two sets of 3 samples, each taken from different locations, 24-48 hours apart) and test. 4) If the adverse result persists, shut the system and seek professional help. If the results are clean, then rescind the BWA as per Field Unit Communications Plan. See Appendix VI, Flow Sheet 4.
Total coliforms	Detected in a sample	1) Resample and test as soon as reasonably possible from three points: upstream, middle, and downstream if possible. If the result are clean return to normal operations. 2) If the results are still contaminated, check the system: a) Primary disinfection: check the disinfection system (e.g. contact time tank, feeding pumps, UV lamps). b) Secondary disinfection: i. immediately flush the distribution system and to ensure that an appropriate level of chlorine residual is achieved at all points in the affected parts of the distribution system and plumbing, and ii. maintain the chlorine residual in the affected parts of the distribution system and plumbing, c) System granted relief: i. if total coliforms are detected in the raw water shut the well and shock the system (Appendix II, Template 2). ii. if total coliforms are detected in the distribution system follow actions outlined in 2b Secondary disinfection above. 3) Immediately resample (collect two sets of 3 samples, each taken from different locations, 24-48 hours apart) and test. 4) If adverse results persist issue BWA, follow Field Unit Communications Plan, and seek professional help. If the results are clean return to normal operations. See Appendix VI, Flow Sheet 5 and Appendix II, Template 2.
Chemical (Inorganic or Organic)	Level exceeds MAC	1) Resample and test as soon as reasonably possible. 2) If the concentration still exceeds MAC consult with the local health authority and/or appropriate professional resource for technical assistance.

1.14 WARNING NOTICES

Warning notices are required for:

1. do not drink water (e.g. potentially contaminated sources, or backcountry operations that have not undergone a chemical characterization);
2. permanent BWN (e.g. backcountry operations with a chemical characterization, visitor services shall advise backcountry users of the permanent BWN and how to manage their water needs);
3. a temporary BWA to inform users that corrective action is being carried out. This type of notice must be rescinded.

Where required, warning notices should be posted in prominent locations where they are likely to be seen by those using water from the system. Also ensure that there are sufficient copies of the warning notices and instructions on where to post the warning notices. Warning notices must be posted in prominent locations and in both official languages. The warning must be such that it is understood by individuals who may not be able to read, such as children or others who do not understand English or French. A picture of the sign to not drink the water is provided in Appendix IV.

1.15 NOTIFICATION OF ADVERSE RESULTS

The Primary Technical Support Person shall ensure that person operating the laboratory which detected the adverse result reports to:

- The Local Health Authority (provincial or federal) by speaking with a person in their office or, if that is closed, by speaking with a person at the on-call system of the health unit; and
- The primary or secondary technical support person(s) as identified by the Field Unit Supervisor or, by speaking with a person at the on-call system.

A written notice within 24 hours shall be sent by fax from the laboratory to the designated persons above. The Primary Technical Support Person shall contact and develop a working relationship with:

- The Local Health Authority.

If a boil water protocol is initiated, the Primary or Secondary Technical Support Person(s) must contact the following:

- Field Unit Superintendent or Site Superintendent;
- Local Health Authority; and
- Facility Manager.

A BWA and BWN may be initiated by the Primary or Secondary Technical Support Person. A written notice within 24 hours should be sent from the Technical Support Person to the designated persons above. The written notice shall include the actions being taken in response to the adverse test result and the corrective action is being taken. It is recommended that the local health officer be notified of the adverse results.

1.15.1 Protocol for Communication between PCA and Local Health Authority

This protocol applies to PCA potable water systems that are used, or are to be used, for supplying water that is intended for human consumption.

General Roles and Responsibilities:

- The PCA may provide the Local Health Authority with a copy of adverse results and issue resolution reports.
- The Primary or Secondary Technical Support Person may refer complaints about drinking water to Health Canada/Local Health Authority for information purposes.
- When, at the request of PCA, Health Canada/Local Health Authority is interpreting water analysis reports, he or she will provide advice to PCA on health effects related to any indicator of adverse drinking water quality.
- Staff from PCA and Health Canada/Local Health Authority may participate in regularly scheduled annual meetings to promote on-going discussions and information sharing on public health issues related to potable water systems and drinking water. Consideration should be given by the parties to inviting any affected operator or laboratory to the meeting.

1.16 NOTICE OF ISSUE RESOLUTION FOR BOIL WATER ADVISORY

A BWA may be rescinded if the following conditions are met:

- The microbiological quality, turbidity, or disinfectant residual of the treated water in at least two consecutive sets of samples taken within 48 hours of each other has returned to an acceptable level; and
- The treatment, distribution or operation malfunction has been corrected and sufficient water displacement has occurred in the distribution system to eliminate any remaining contaminated water.

The Primary Technical Support Person shall ensure that a written notice is prepared and filed within seven days after the BWA is rescinded, summarizing the action taken and the results achieved. The notice may be sent to:

- Health Canada/Local Health Authority; and
- Field Unit Superintendent.

Refer to Template 5 in Appendix II for a copy of the Notice of Issue Resolution Template.

1.17 ANNUAL REPORT

An annual report shall be prepared by the Primary Technical Support Person. Annual reports may be used as a promotional tool and included in all materials published by the park containing the water system. This will boost the confidence of both staff and visitors in the quality of their water. The annual reports are, also, a good tool for auditing purposes.

An example of an annual report is outlined in Template 3 in Appendix II. The report shall be provided to the Field Unit Superintendent.

1.18 RECORD KEEPING

Primary Technical Support Person must ensure that all documents, records, reports and logs be retained for at least 10 years. Sanitary survey and chemical characterization reports should be kept indefinitely for the life of the water system.

1.19 OPERATOR CERTIFICATION AND TRAINING

Operational checks must be carried out by a certified operator (based on the classification indicated in Table 1.10), or a person working under the supervision of a certified operator, and has been trained by the certified operator. This person must advise the certified operator of all the test results as soon as possible.

The person collecting samples for microbiological and chemical testing must receive appropriate training (see section 2.1).

There is a need to strengthen operator training and certification to ensure the delivery of safe potable water. There are three main factors for certification training:

a) completion of an entry level course for new operators,
b) ensuring adequate time for training; and
c) undertaking certificate renewal that is tied to training.

Based on the current PCA systems classification, Table 1.9 for certification training is recommended to ensure consistency across all the PCA facilities.

TABLE 1.9
TRAINING CERTIFICATION REQUIREMENTS

Position	Minimum Training or Certification Requirements
Certified micro-system operator	PCA Micro-systems Orientation Manual
Certified small system operator	Correspondence course as per Appendix V. PCA will maintain current practice of provincially certified operators and facilities.
Certified medium system operator	PCA will maintain current practice of provincially certified operators and facilities.
Certified large system operator	PCA will maintain current practice of provincially certified operators and facilities.
Person conducting operational checks under the supervision of a certified operator	PCA Micro-systems Orientation Manual (micro and small systems). Correspondence course as per Appendix V (medium and large systems).
Person collecting microbiological and chemical samples	See section 2.1

2.0 BEST MANAGEMENT PRACTICES (BMP)

2.1 BMP FOR THE COLLECTION AND HANDLING OF DRINKING WATER SAMPLES

The water sampling and analyses are intended to ensure the provision of safe potable water. As such, sampling and analytical activities must be carried out in a manner that produces data that accurately describes and represents the quality of the water in the supply system. A *representative* sample is one that reflects the same characteristics of the water source, and can be considered an accurate subset, of the material being measured.

The location, time and method of sample collection must adequately define and isolate the material of interest or concern. For example, when selecting the time and location of distribution system sampling, consideration must be given to peak usage periods, dead ends in the system, the extremities of the distribution system and residential plumbing. The sampler must be cognizant of the conditions that the material sampled represents. Sampling points must be selected to address the intent of monitoring outlined in the guideline.

Best practices must be followed for recording sample information, maintaining chain-of-custody, forms, and for sample labelling, transportation and storage procedures as outlined below.

A water sample arriving at the laboratory must be traceable to its origin, and time and date of collection, and must accurately reflect the concentration at the location and time of sampling. Storage duration is also a consideration and the lag time between sample collection and analysis should be geared toward minimizing changes in concentration.

Table 2.1 outlines recommended practices for sampling requirements. Heterotrophic plate count tests are recommended for large distribution systems (i.e. serving more than 3000 people). These tests are recommended once per month regardless of the source of the water used. They are important as they serve as an indicator of microbial re-growth.

TABLE 2.1
RECOMMENDED SAMPLING REQUIREMENTS

Parameter	Sample Container	Min. Volume (mL)	Preservative	Max. Holding Time	Storage Conditions	Comments
Total coliforms & *E. coli*	Glass or plastic	250	30 mg sodium thiosulphate	48 hours	5º C+/- 3º C	Transported chilled not frozen
Volatile Organics	40 mL glass vials with Teflon-clad silicon rubber septa	2x40	Sodium thiosulphate pill (10 mg) for chlorinated waters	14 days	Dark 5º C+/- 3º C	Headspace in the sample container will result in an unsuitable sample for analysis
Metals (except mercury)	Glass or plastic	50	Nitric acid to pH<2 done immediately upon collection	60 days	Room temperature for preserved samples	Bottles with aluminium-lined caps are unacceptable
Mercury	Glass	240	0.5-1.0 mL concentrated nitric acid and 5-10 drops of potassium dichromate solution per 250 mL, pH is maintained at <2; sample must be yellow colour	14 days	Room temperature for preserved samples	
Nitrate	Glass or plastic	10	None	7 days	5º C+/- 3º C	Samples may be frozen
Organochlorine Pesticides, total PCBs, Triazene herbicides, Phenoxyacetic acid herbicides and chlorophenols	1 L amber glass with Teflon-lined screw caps	900	None	20 days	Dark 5º C+/- 3º C	
Carbamate pesticides, and Organophosphorus pesticides, and Benzo(a)pyrene	1 L amber glass with Teflon-lined screw caps	900	For chlorinated water add 1mL of 25% w/v sodium thiosulphate solution	20 days	Dark 5º C+/- 3º C	
Cyanide (Free)	Glass or plastic	500	Sodium Hydroxide to pH of about 12	30 days	Room temperature	

2.1.1 Sample Type

In most environmental sampling situations, two types of samples are generally considered: *composite* samples and *grab* samples. *Composite* samples are most appropriate in situations where the sampler is seeking to obtain information on the average value of a system in which a high degree of variability in the characteristics of the system or process being sampled is expected over time.

2.1.2 Sampling Location

2.1.2.1 Raw Water

Raw water refers to the source water for the water supply system. Its characterisation is necessary to decide on treatment requirements. Changes to the temperature, pH, alkalinity, colour, turbidity and biological quality of the source water will affect the efficiency of, and may necessitate alterations to, the treatment process. Raw water characterization with respect to all parameters listed is required.

All raw water samples should be collected prior to any treatment process. For groundwater systems using more than one well supply, grab samples for microbiological testing are required from each well on the system.

Ideally, samples should be collected from a tap located as close as possible to the well. Usually a tap in the pump house is used. Sometimes a continuously running tap is present and provides a fresh representative sample of the raw water. The waste from the tap, however, should not be allowed to drain back into the well.

In surface water systems, samples are generally taken after screening, pre-sedimentation. These samples will reflect any changes in source water quality resulting from these activities.

2.1.2.2 Treated Water

Treated-water sampling locations must be selected to ensure that the samples represent the treated water after all treatment processes are complete. The sampling location must be at the point of entry of the water to the distribution system, after the minimum disinfection contact time and before the first consumer. Samples must be taken prior to standpipe, elevated tank or reservoir storage.

2.1.2.3 Distribution System Water

The selected sampling locations should be points significantly beyond the point of entry to the distribution system. These locations should represent and cover the distribution system, especially locations where the degradation of water quality and disinfection residual are possible and the formation of disinfection by-products is likely. Sampling locations should address elevated storage tanks within the distribution grid, dead ends, ageing water mains, distribution loops, points with the potential for cross connection/back flow and extremities of the distribution system.

2.1.3 Sample Collection

The collection and handling of samples is crucial to obtaining valid data. Person(s) collecting samples should be properly trained, with respect to sample handling considerations, including aseptic procedures for the collection of samples for microbiological testing. Disposable gloves should be worn and care must be taken that the inside of the container and cap do not come into contact with anything other than the atmosphere. If the inside of the sampling container is touched, it must be considered contaminated and should not be used. While the sample is being taken, the exterior of the cap should be held with the fingertips.

2.1.4 Sample Storage and Transportation

It is recommended that all samples be delivered to the laboratory as soon as possible after sampling. Samples should be kept cool (refrigerated) if immediate shipping is not possible. Samples should be packaged to avoid breakage during shipping. Samples must be shipped to arrive at the laboratory before the holding time for the samples has expired.

2.1.5 Chain of Custody

A chain-of-custody is used to ensure the integrity of the sample and resulting data. Each person involved in the chain of possession must sign the custody form when a sample or set of samples is received or relinquished. A chain-of-custody form must accompany samples to the point of receipt by the laboratory. The intent of this form is to document the transfer of custody of the samples from the sample custodian (sampler) to any other person and to the laboratory. It is recommended that the fewest number of people as possible be responsible for sample collection and transfer to the laboratory. If common carriers are used, receipts should be kept and, if packages are mailed, they should be registered and return receipts requested. These should be kept as part of the chain-of-custody documentation.

2.2 BMP FOR WATER EFFICIENCY[5]

Public outreach and education is crucial to the success of any water efficiency program. Engage your customers in water efficiency programs through direct contact, annual reports, and posted signs. This provides a framework for your customers' acceptance and participation in the programs.

Compile a water-use database that stores water supply information and customer data including consumption and number of customers. Information on historical water usage is useful in many ways including projecting future demand and establishing system capacity requirements for sizing facilities. The impact of water conservation measures on demand can only be established if changes in historical consumption patterns can be tracked.

Ensure that all water issues are accounted for. The non-accounted for water consumption could be significant for each individual. Management of this water loss should now be part of every systems normal method of working. The best approach involves completing a water audit and balance, to identify and quantify all areas of water consumption.

Develop a Water Efficiency Program/Plan to achieve a quantifiable goal such as a 10% reduction in water use over a specified time period. The goal is usually established to deal with a specific water problem; for example, the increasing number of customers during the summer months leading to excessive water use. The principal benefits of developing and successfully implementing a water efficiency plan are the saving of time and money through focused action. Water efficiency can provide reductions on both the supply and wastewater sides.

2.3 BMP FOR SOURCE PROTECTION

The development of potable water quality guidelines is only one component of an overall approach to help ensure potable water supplies are kept clean, safe and reliable. The Canadian Council of Ministers of the Environment (CCME) 2004 publication *From Source to Tap* outlines a multi-barrier approach to safe drinking water that contains three major elements:

- source water protection;
- drinking water treatment; and,
- the drinking water distribution system.

Source water includes surface waters, aquifers or groundwater recharge areas. Source water protection based on watershed management involves a coordinated approach among all parties within the watershed to develop short- and long-term plans to prevent, minimize or control potential sources of pollution or enhance water quality. As a minimum, PCA facilities which

[5] These BMPs were developed by Mr. K. Blease of Hetek Engineering.

provide their own potable water should be aware of all potential operations (ranging from septic systems and fuel supplies on-site to industry, highways and rail lines in the watershed) which may adversely influence the quality of their raw water supply. Potable water treatment systems should be designed, constructed, operated and upgraded (as required) to provide safe drinking water given the source water characteristics. A regular review and updating of drinking water guidelines and the treatment systems in place should be conducted by PCA.

The quality of treated water must be maintained at all points in the distribution system. Diligence is required on the part of the system operator to ensure that safe disinfected drinking water arrives at all points throughout the distribution system.

Septic systems are designed to have their effluent discharge into a drainage field where the sewage undergoes some decomposition by microorganisms in the soil, as it works its way down to the groundwater table. To prevent groundwater contamination from the septic systems, the septic system must be inspected annually and pumped out regularly to ensure no chemicals or other additives are added since these can prevent the septic system from functioning properly. If a system is not pumped out frequently enough, solid materials can leave the tank and enter the drainage field. Any substances poured down drains will also enter that drainage field-and eventually reach the groundwater. In addition, every effort should be exercised to limit the amount of water entering the system.

Another component of source protection for groundwater suppliers is safeguarding the wellhead. To prevent surface water from ponding around the top of the well:

- Locate it away from low area or depressions
- Slope the ground surface away from the well and mound the earth around it so that any surface water quickly flows away from the casing
- Provide easy access to the well maintenance, cleaning, treatment, repair, testing and inspection
- The annular space between the drill hole and the outside of the well casing must be sealed to at least 6 meters below ground level
- Well casing should be extended above the ground level by at least 0.4 meters
- Maintain a permanent grassed buffer at least 3 meters around the well
- Contact an appropriate technical resource, if in doubt about well head integrity.

2.4 BMP FOR WELL ABANDONMENT

If a well is not going to be used in the future it must be sealed, plugged with concrete or another suitable material. It is advised that a licensed well contractor should be retained to seal the well properly. The person abandoning the well shall ensure that the following steps are taken:

- Ensure the well has a PCA well tag to identify the well in question.
- All equipment and debris in the well shall be removed, but well casing shall not be removed unless it has collapsed.
- The volume of water in the well shall be estimated and at least that volume of water shall be pumped from the well.
- At least 25 litres of a solution of 50 milligrams of chlorine per litre of water shall be put into the well and the water remaining in the well shall be chlorinated to at least that concentration.
- The well, including the annular space, shall be plugged by, placing a continuous column of an abandonment barrier from the bottom of the well upward to approximately one metre below the ground surface so that it prevents any movement of water, natural gas, contaminants or other material between subsurface formations or between a subsurface formation and the top of the abandonment barrier;
- The well casing shall be removed to a minimum depth of two metres below the ground surface, after the material placed in the well under that paragraph has reached a level of approximately two metres below the ground surface.
- Unless they are used or maintained for future use, the above ground structures associated with the well shall be dismantled and removed.
- Below ground concrete structures, foundations and slabs shall be removed.
- The well shall be sealed at the ground surface by,
  i. placing at least 50 cm in vertical thickness of bentonite chips or pellets in the well opening, with the existing well tag, if any, pushed two centimetres into the top of the bentonite chips or pellets, and
  ii. covering the entire well opening to the ground surface by at least 30 cm in vertical thickness of soil cover to prevent inadvertent or unauthorized access.
- The disturbed area shall, to the extent practical, be re-vegetated and, where applicable rehabilitated in accordance with PCA landscaping Guidelines and Standards for National Historic Sites.

APPENDIX I

DISINFECTION REQUIREMENTS

APPENDIX I - DISINFECTION REQUIREMENTS

Drinking water disinfection treatment requirements are specific to the type of raw water supply. Design of the treatment processes should consider the characterization, variability and vulnerability of the raw water supply. All water supplies should be individually assessed by measuring relevant water quality parameters and utilizing, where chemical disinfection is used, the CT tables provided to determine the appropriate disinfectant dosage.

This section outlines the disinfection (primary disinfection) requirements by the type or raw water supply, with variations based on vulnerability of the raw water supply, and includes any applicable pre-disinfection treatment (filtration) requirements. The CT disinfection concept uses the combination of a disinfectant residual concentration (in mg/L) and the effective disinfectant contact time (in minutes), to quantify the capability of a chemical disinfection system to provide effective pathogen inactivation to the required level. The use of this concept involves determining the CT values required at the actual, often variable, operating conditions (flow, temperature, and pH) and ensuring that the employed disinfection process achieves these values at all times.

Chemical disinfection CT values are calculated by multiplying the disinfectant residual concentration (in mg/L) by the disinfectant contact time (in minutes).

CT = Concentration (mg/L) x Time (minutes)

The following Tables outline CT values for inactivation of virsuses, Girdia and Crypto

TABLE AI.1
CT VALUES FOR INACTIVATION OF VIRUSES BY FREE CHLORINE FOR pH 6-9

Temperature (degrees Celsius)	2 log inactivation (99% removal)	4 log inactivation (99.99% removal)
5	4	8
10	3	6
15	2	4
20	1	3
25	1	2

C is the free chlorine concentration in mg/L
T is the contact time in minutes

For example for a CT value of 6 for a temperature of 10^{o}C and 4 log inactivation:

- if the contact time is 30 min. the Cl residual concentration is 0.2 mg/L

For a Cl residual of 0.2 mg/L for 2 log removal at a temperature of 10:

- CT is 3 and the contact time is 15 min

TABLE AI.2
CT VALUES FOR INACTIVATION OF *GIARDIA* CYSTS BY FREE CHLORINE AT pH 7 AND TEMPEARTURE OF 15^{O}C

Cl(mg/L)	2 log inactivation	3 log inactivation
0.6	48	72
1.0	50	75
2	55	83

TABLE AI.3
CT VALUES FOR INACTIVATION OF VIRUSES AND *GIARDIA* CYSTS BY OZONE

Temperature degrees Celsius	2 Log inactivation *Giardia* Cysts	2 Log inactivation Viruses
5	1.3	0.6
10	0.95	0.5
15	0.63	0.3
20	0.48	0.25
25	0.32	0.15

Ultraviolet (UV) Disinfection

The application of ultraviolet (UV) light is an acceptable primary disinfection process. A particular type and design of UV reactor may be considered acceptable if it has been shown to achieve the required level of disinfection. Standards for the UV equipment should be considered in order to ensure that the required level of disinfection is met for the use of the equipment in question. For point of entry treatment units, ANSI / NSF Standard 55A or equivalent can be used.

UV facilities should be designed taking into account appropriate reliability and redundancy measures, and the light transmission and scale formation/fouling potential in the UV reactor specific to the quality of the raw water supply. A dose of at least 40 mJ/cm^2 is maintained throughout the life time of the lamp. While the use of UV light may be acceptable for the purpose of primary disinfection, it does not provide a disinfectant residual. Where there is a distribution system which requires the provision of secondary disinfection for a drinking-water system, primary disinfection must be followed by another process, normally chlorination, which introduces and maintains a persistent disinfectant residual throughout the distribution system.

For groundwater which is not under the direct influence of surface water, UV light is acceptable as a primary disinfection process.

Drinking water systems that obtain water from a raw water supply which is surface water or groundwater under the direct influence of surface water must have a treatment process that is capable of producing water of equal or better quality than a combination of well-operated chemically assisted filtration and disinfection. The use of UV light may only be acceptable as a primary disinfection process in combination with filtration. The following table outlines the performance of UV disinfection for the inactivation of viruses and protozoa

TABLE AI.4
UV DOSE REQUIRED TO ACHIEVE LOG INACTIVATION OF VIRUSES, BACTERIA AND PROTOZOA

Type	Lamp Type	UV Dose (mJ/cm^2)	
		2 log	4 log
E. coli	Low pressure lamp	2	5.6
Cryptosporidium	Low pressure lamp	5	9.5
Giardia	Low pressure lamp	10	20
Adenovirus (type15) [6]	Low pressure lamp	80[6]	165[6]
Poliovirus	Low pressure lamp	14	30

Since UV dose of 40 mJ/cm^2 is usually used for drinking water disinfection, it can be seen that UV may not be effective in removing Adenovirus.

If primary disinfection is provided by ultra violet light equipment, the operator must ensure that:

- The disinfection equipment has a feature that causes an alarm to sound in the building, or the location where the operator is present in the case of failure;
- Light disinfection equipment and any sensors that form part of the equipment's monitoring system must be checked and calibrated in accordance with the manufacturer's instructions; and
- The equipment is maintained regularly as per manufacturer's instructions. Table I.5 outlines maintenance schedules for UV disinfection equipment.

TABLE AI.5
MAINTENANCE SCHEDULE FOR UV DISINFECTION EQUIPMENT

Task	Frequency
Ballasts inspection	3-6 months
Ballasts replacement	Every 5 years
Chemical cleaning	Monthly
Lamp replacement	5000 hours (7 months) to 8000 hours (11 months)
Mechanical wiper maintenance	Yearly
Sensor calibration	Yearly
Sensor replacement	Yearly or follow manufacturer's recommendations
Sleeve replacement	3-5 years

[6] Is found when there is cross contamination from septic systems/cross connection. In such cases, chlorine should be used.

The advantages and disadvantages of the use of UV disinfection equipment are outlined below.

TABLE AI.6
ADVANTAGES AND DISADVANTAGES OF UV DISINFECTION

Advantages	Disadvantages
No disinfection by products	No taste and odour control
Removal of *Giardia and Cryptosporidium*	Does not remove colour
Low space requirements	No iron and manganese oxidation
Competitive costs	No residual disinfecting capabilities

Performance of different types of filtration technologies is outlined in Table AI.7.

TABLE AI.7
LOG REMOVAL CREDITS OF DIFFERENT FILTRATION TREATMENT TECHNOLOGIES

Treatment Technology	Log Removal Credit		
	Giardia Cysts	Cryptosporidium Oocysts	Viruses
Conventional Filtration	3.0*	2	2
Direct Filtration	2.5 *	2	1
Slow Sand Filtration	3.0 *	2	2
Diatomaceous Earth Filtration	2**	2	1
Cartridge/Bag Filters	2.0 +**	0	0
Membrane Filtration	3.0 +**	2	0.0 to 2.0 +

* *Guidelines for Canadian Drinking Water Quality-Health Canada.*
** *Procedure for Disinfection of Drinking Water in Ontario, 2003 (MOE).*

The following section provides an overview of the different filtration technologies and the conditions required to ensure the desired performance for the removal of *Giardia* cysts and *Cryptosporidium* oocysts.

Conventional Filtration

Conventional filtration is the most common treatment process currently used by drinking water systems that rely on raw water supplies which are from surface sources. This treatment process consists of chemical coagulation, rapid mixing, flocculation and sedimentation followed by rapid sand filtration.

In order to claim the 2.5 log *Giardia* cyst removal, the 2 log *Cryptosporidium* oocyst removal and 2 log virus removal credit, the filtration process must meet the following criteria:

- use a chemical coagulant at all times when the treatment plant is in operation;
- monitor and adjust chemical dosages in response to variations in raw water quality;
- maintain effective backwash procedures, including filter-to-waste or an equivalent procedure during filter ripening to ensure that the effluent turbidity requirements are met at all times;
- continuously monitor filtrate turbidity from each filter; and
- ensure filtered water turbidity of less than or equal to 0.3 NTU in 95% of the measurements each month.

Direct Filtration

Direct filtration process consists of chemical coagulation, rapid mixing and flocculation followed by rapid sand filtration. It is very similar to a conventional filtration process but without the sedimentation step prior to filtration. Generally, the use of direct filtration process is limited to raw water supply source with water turbidity of less than 20 NTU and colour less than 40 TCU.

In order to claim the 2.0 log *Giardia* cyst removal, the 2 log *Cryptosporidium* oocyst removal and 1.0 log virus removal credit, the direct filtration process must meet the conventional filtration criteria above.

Slow Sand Filtration

Slow sand filtration is a biological and physical process, equivalent to chemically assisted filtration, where the processes of adsorption and biological flocculation that take place in the microbial growth formed in the upper sand layer eliminate the need for chemical coagulation and flocculation. Generally, the use of a slow sand filtration process is limited to raw water supply source (or influent water after pre-treatment) having turbidity of less than 10 NTU and colour less than 15 TCU.)

In order to claim the 2.0 log *Giardia* cyst removal, the 2 log *Cryptosporidium* oocyst removal and 2.0 log virus removal credit, the slow sand filtration process must meet the following criteria:

- maintain an active biological layer;
- regularly carry out effective filter cleaning procedures;
- use filter-to-waste or an equivalent procedure during filter ripening periods;
- continuously monitor filtrate turbidity from each filter or take a daily grab sample; or,
- meet the performance criterion for filtered water turbidity of less than or equal to 1.0 NTU in 95% of the measurements each month.

Diatomaceous Earth Filtration (DE)

Filtration using diatomaceous earth involves the passage of water through a layer of diatomite media supported on a fine metal screen, a porous ceramic material or a synthetic fabric supported on a septum. The initial diatomite layer is usually supplemented by a continuous feed of diatomite.
Generally, the use of a DE filtration process is limited to raw supply water source (or influent water after pre-treatment) having turbidity of less than 20 NTU and colour less than 15 TCU.

In order to claim 2.0 log *Giardia* cyst removal, 2 log *Cryptosporidium* oocysts removal and 1.0 log virus removal credit, the DE filtration process must meet the following criteria:

- maintain a minimum thickness of pre-coat;
- maintain effective filter cleaning procedures;
- maintain full recycle or partial discharge to waste of water flow during filter precoat until the recycle stream turbidity falls to below 1.0 NTU;
- continuously monitor filtrate turbidity from each filter; and
- meet the performance criterion for filtered water turbidity of less than or equal to 1.0 NTU in 95% of the measurements each month.

Cartridge/Bag Filters

This technology is designed to meet the low flow requirement needs of small systems. These filters can effectively remove particles from water in the size range of *Giardia* cysts (5-10 microns) and *Cryptosporidium* oocysts (2-5 microns). Cartridge filters do not remove any significant proportion of influent viruses. Generally, the use of cartridge/bag filtration processes is limited to raw supply water source (or influent water after pre-treatment) having turbidity of less than 5 NTU and colour less than 5 TCU.

Cartridge and bag filters are made from fibre, and unlike membranes, have a broad range of pore/opening sizes which allow penetration of a few larger sized particles than the filter rating. This small penetration rate by oversized particles should be taken into consideration along with the quality of the raw water supply.

In order to claim the 2.0 log *Cryptosporidium* oocyst removal credit, the cartridge/bag filtration process must meet the following criteria:

- use filter elements and housing certified for surrogate particle removal evaluation in accordance with testing procedures and manufacturing quality control specified in

ANSI/NSF Standard 53 or equivalent;
- ensure that differential pressures across the filter medium do not exceed ANSI/NSF Standard 61 or manufacturer's rating; and
- meet the performance criterion for filtered water turbidity of less than or equal to 0.2 NTU in 95% of the measurements each month. [Note: Where it can be shown that turbidity results from the presence of inorganic particles of a size less than 2 microns, higher turbidity may be acceptable.]

Membrane Filtration

Membrane filtration processes involve passage of the water through a thin synthetic organic polymer film in a straining filtration step. Membranes that require moderate to low pressures for adequate flow (micro and ultra-filters) must have chemically formed and uniformly sized pores that are 1 micron or less in diameter. Higher pressure membrane filters (nano and reverse osmosis filters) have no pores but allow water to permeate or diffuse through the membrane.

In order to claim 2.0+ log *Cryptosporidium* oocyst removal credit, the membrane filtration process must meet the following criteria:

- maintain effective backwash procedures, including filter-to-waste or an equivalent procedure, to ensure that the effluent turbidity requirements are met at all times;
- monitor integrity of the membrane by continuous particle counting or equivalently effective means (e.g., intermittent pressure decay measurements);
- continuously monitor filtrate turbidity; and
- meet the performance criterion for filtered water turbidity of less than or equal to 0.1 NTU in 95% of the measurements each month.
- ensure the facility is secured and monitored.

APPENDIX II

TEMPLATES

Template 1: **Sanitary Survey**
Template 2: **Disinfection of Small Groundwater Systems**
Template 3: **Annual Report**
Template 4: **Report of Adverse Result**
Template 5: **Notice of Issue Resolution**

Parks Canada

Sanitary Survey

Field Unit:

Name of Park or Site:

Potable Water System Details

System Name:

System Asset #:

System Classification

Micro	**Small**	**Medium**	**Large**	*# of operational months (if classification change during the year)
☐ **Groundwater**	☐ **Surface**	☐ **GUDI**	☐ Supplied by others	

* Groundwater under the influence of surface water

☐ **Seasonal** ☐ **Year Round** Check one **# of months in operation**

Item to Check	Yes	No	N/A	Action Required
Water Source				
Carry out the following activities:				
❑ Is the groundwater supply under the influence of surface water as defined by the Guideline?	☐	☐	☐	
❑ If so :				
▪ Is filtration part of the technology train used to treat raw water?	☐	☐	☐	
▪ Did you have to check with a trained professional (Hydrogeologist and/or professional engineer)?	☐	☐	☐	
▪ Have you reviewed the results of the full characterization and regular chemical testing of raw water (Tables A, B, C and D)?	☐	☐	☐	
▪ Did you observe any trends of water quality indicators such as nitrates, temperature, Chlorophyll a, pH?	☐	☐	☐	
▪ Carry out Well System Checklist if the source of the raw water is from a well(Attachment I)	☐	☐	☐	
▪ Is your water intake in a shallow area?	☐	☐	☐	

Item to Check	Yes	No	N/A	Action Required
Check the following records:				
▪ Did you observe any recent major changes to the source water quality?	☐	☐	☐	
▪ Did you observe any changes in watershed or water recharge area (i.e., livestock operations, sewage or sanitary discharges, or heavy recreational)?	☐	☐	☐	
▪ Did you observe any changes following recent heavy rains or flooding and any drought conditions?	☐	☐	☐	
Sampling Technique:				
Did you follow the best management practices for the collection and handling of drinking water? if not indicate aspects that were not followed:	☐	☐	☐	
Sample History				
❑ Is there a history of adverse microbiological water sample results?	☐	☐	☐	
❑ Is there any history of adverse results from the distribution system?	☐	☐	☐	
❑ For the previous period of 24 consecutive months;	☐	☐	☐	
How many samples were taken?				
Where were the samples taken?				
What are the results of all of the samples (including positive and negative results)?				
Operational History				
❑ Have there been any changes/problems with operation of the distribution system?	☐	☐	☐	
❑ Have any mechanical difficulties or equipment failures occurred?	☐	☐	☐	
❑ Have there been any operational deficiencies?	☐	☐	☐	
❑ Has there been any period where testing of the system was not carried out according to requirements?	☐	☐	☐	
Item to Check	**Yes**	**No**	**N/A**	**Action Required**
❑ Have there been any of the following disruptions in the system recently? Check the appropriate ones and indicated if action is required.	☐	☐	☐	
☐ Low pressure ☐ Cross-connections ☐ Recent construction	☐ Inadequate flushing ☐ Stagnant water (dead ends) ☐ Age and condition of pipes	☐ Bio-film presence ☐ Inadequate flushing		

What corrective actions have been initiated?				
❑ Has the system been temporarily disinfected according to correct procedures?	☐	☐	☐	
❑ Have distribution pipes been flushed thoroughly in the affected area?	☐	☐	☐	
❑ Have water re-samples been taken as required (a minimum of three samples per initial adverse test)?	☐	☐	☐	
Distribution and Plumbing Lines				
❑ Did you monitor for leaks, corrosion and scaling in pipes, decreases in water pressure, dead-ends, and unexplained increases in water usage?	☐	☐	☐	
❑ Did you find wet areas, greener vegetation, or melted snow along distribution lines (to locate potential leaks)?	☐	☐	☐	
❑ Did you fix any leaks, dead-ends, or other mechanical difficulties and equipment failures?	☐	☐	☐	
❑ Did you eliminate any cross-connections through the use of gaps, breakers, or other backflow prevention strategies or devices?	☐	☐	☐	
Treatment				
Disinfection:				
○ Did you check if there was any interruption in the disinfection?	☐	☐	☐	
○ If so, why?				
○ Is there proper residual entering the distribution system?	☐	☐	☐	

Item to Check	Yes	No	N/A	Action Required
What is the residual?				
○ Is the contact time between the point of disinfection and the first consumer adequate?	☐	☐	☐	
○ Are the temperature and pH of the water at the point of disinfection measured and recorded;	☐	☐	☐	
○ Is there adequate spill containment?	☐	☐	☐	
Filtration				
○ Is the filtration process performing as designed?	☐	☐	☐	
○ Did you establish control and assessment features to evaluate the performance of each filter?	☐	☐	☐	

○ Is there parameter(s) to initiate a backwash?	☐	☐	☐	
○ Is there Standard Operating Procedure?	☐	☐	☐	
○ Can the treatment process be interrupted by power outages?	☐	☐	☐	
○ Is there standby available?	☐	☐	☐	
What type of filtration system is being used and what kind of media has been installed?				
What is the turbidity of the effluent water following the backwash?				
What is the turbidity of the backwash?				
○ Is there any visible indication of problems on the surface of the filter i.e., particulate matter remaining on the surface, cracks, holes, depressions in the media surface?	☐	☐	☐	

Item to Check	Yes	No	N/A	Action Required
○ Is the monitoring instrumentation (loss-of-head, effluent flow rate, and filter water turbidity working for all filters?	☐	☐	☐	
Chemical Feed Systems				
▪ Did you record the Chemicals used and amount?	☐	☐	☐	
▪ Did you calibrate the chemical feed system?	☐	☐	☐	
▪ Did you records the chemical dosage and total quantity used?	☐	☐	☐	
Pump and Pumping Facilities				
▪ Is the building protected from flooding?	☐	☐	☐	
▪ Can the equipment be accessed for maintenance?	☐	☐	☐	
What is the number of pumps, and what is their type?				
▪ Did you record the number of pumps, type of pumps, actual capacity and how does it compare to the demand?	☐	☐	☐	
▪ Does the equipment have excessive noise/vibration, leaking water, dirt and grime, leaking lubricants?	☐	☐	☐	
▪ Are the pumping systems equipped with check valves, pressure gauges, flow meters, air/vacuum relief valve, and blow-off line?	☐	☐	☐	
▪ Is there fail safe devices, failure alarm system for the motor control systems	☐	☐	☐	
▪ Is the system secured and monitored?	☐	☐	☐	

Item to Check	Yes	No	N/A	Action Required
Attachment I - Well System Check List				
Well Location:				
❑ Is the Well located at a site where the elevation is higher than the immediate surrounding area;	☐	☐	☐	
❑ Is the Well located at a site where the well is accessible for cleaning, treatment, repair, testing, inspection, and visual examination;	☐	☐	☐	
❑ Is the Well located inside well pits or in other locations that are prone to flooding or surface water contamination;	☐	☐	☐	
❑ If the Well is not a drilled well with watertight casings extending to a depth of 6 metres below ground level, is it located within 30 metres from septic systems and other pollution sources;	☐	☐	☐	
❑ If the Well is a drilled well with watertight casings extending to a depth of more than 6 metres below ground level, is it located at least 15 metres from septic systems and other pollution sources.	☐	☐	☐	
❑ Is the Well secured and access limited to appropriate staff.	☐	☐	☐	
Extended Buried Casings ❑ Is the casing of a properly constructed well extended a minimum of 40 cm above grade.	☐	☐	☐	

Item to Check	Yes	No	N/A	Action Required
<u>Inspect Covers or Sanitary Seals for Cracks and Holes</u> ❑ Are the seals watertight and in good condition; ❑ Is the cover commercially manufactured, vermin-proof, and be able to prevent the entry of surface water and foreign materials ❑ Is the cover secured?	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	
<u>Contact Licensed Well Contractor to Inspect the Inside of the Well</u> ❑ Is the casing clean, free of contamination and watertight? ❑ Did you observe signs of surface water seepage or water running freely into the well, ❑ Did you observe seepage through cracks or stains on the inside of the casing; ❑ Is the seal around the plumbing inlets in poor condition ❑ Is the water seeping in from outside the well; ❑ Are there any debris floating in the well; ❑ Did you compare your well construction to diagrams that show proper design and maintenance techniques? ❑ Did you correct any problems you discover by retaining qualified contractors to carry out necessary repairs.	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	

Item to Check	Yes	No	N/A	Action Required
Inspect the Condition of Air Vents				
❑ Are the air vents extended above the land surface to a height that would prevent the entry of flood water from any anticipated flooding in the area;	☐	☐	☐	
❑ Is the open end of the air vent shielded and screened to prevent entry of foreign materials into the well;	☐	☐	☐	
❑ Is the air vent kept free of obstructions and blocks at all times?	☐	☐	☐	
Inspection of the Area around the Well				
❑ Did you take proper actions to ensure the area around the well a) in a neat and sanitary condition and b) away from all potential contamination sources, such as animals, fuel and equipment?	☐	☐	☐	
❑ Did you look for settling of the ground around the outside of the well casing;	☐	☐	☐	
❑ Did you take proper actions such as mounding the earth around the outside of the well casing if there is no slope or if some of the area is settled,	☐	☐	☐	
❑ Is there a permanent buffer of grass or other vegetation extending at least 150cm from the well casing all directions;	☐	☐	☐	
❑ Are the well secure with locking caps.	☐	☐	☐	

Item to Check	Yes	No	N/A	Action Required
Inspection of the Area around the Water Storage				
❑ Is the casing of a properly constructed reservoir extended a minimum of 40 cm above grade;	☐	☐	☐	
❑ Are the seals watertight and in good condition;	☐	☐	☐	
❑ Is the cover commercially manufactured, vermin-proof, and able to prevent the entry of surface water and foreign materials	☐	☐	☐	
❑ Is the cover secured?	☐	☐	☐	
❑ Are the air vents extended above the land surface to a height that would prevent the entry of flood water from any anticipated flooding in the area;	☐	☐	☐	
❑ Is the open end of the air vent shielded and screened to prevent entry of foreign materials into the well;	☐	☐	☐	
❑ Is the air vent kept free of obstructions and blocks at all times.	☐	☐	☐	

Comments

Signature	**Date (jj/mm/aaaa)**

Template 2
Disinfection of Small Systems that Do Not Use Chlorine

Manual disinfection of small systems is most commonly done using ordinary household bleach.

- Use a fresh unscented liquid bleach product containing 5% sodium hypochlorite.

- Before disinfecting the water distribution system and plumbing, turn off water heaters and storage tanks, and completely drain, in order to fill with chlorinated water. It is not necessary to drain and disinfect tanks and pipes that are connected to a furnace as part of a water or steam-based heating system.

- Once the required amount of bleach (see Table AII.1) has been added to the well, start the water supply pump and open all the taps until you can smell chlorine or test for chlorine residual and then turn the taps off. If there are any taps on the system where chlorine smell or a chlorine residual can not be detected add more bleach into the well until a chlorine smell or a chlorine residual is present and then turn the taps off. Allow the high chlorine solution to sit in the system for about 12 hours. System should be inaccessible at this time.

- After 12 hours, discharge the water which has been sitting in the water lines. Flush all the taps in the system with new water until the smell of chlorine disappears or check chlorine residual. None of the water being flushed should be allowed to enter the septic tank and the tile field.

- After 24 to 48 hours, resample and test the distribution system or plumbing for microbiological parameters. This procedure for manual disinfection should be repeated until adverse microbiological test results are no longer received from two consecutive sets of samples taken 24 to 48 hours apart.

<u>Method for Calculating Amount of Bleach Needed</u>

The **depth of water** in the well will be somewhat less than the **total depth** of the well. For the following calculation, use the depth of water, if known; otherwise use the total depth of the well. The total depth may be found on the well record.

Using Table AII.1, estimate the volume of water in the well, and the amount of bleach required.

TABLE AII.1
VOLUME OF BLEACH REQUIRED PER METRE OF WATER DEPTH
AT 50 mg/L CHLORINE DOSAGE

Well Diameter (inside diameter of casing)	Volume of Water per metre of Water Depth	Volume of Bleach Needed to Disinfect Each Metre of Water Depth
5 cm (2")	2 L	2 mL
10 cm (4")	8 L	8 mL
12.5 cm (5")	12 L	12 mL
15 cm (6")	18 L	18 mL
17.5 cm (7")	24 L	24 mL
20 cm (8")	32 L	32 mL
60 cm (2')	300 L	300 mL
75 cm (2.5')	450 L	450 mL
90 cm (3')	650 L	650 mL

Note: A normal household measuring cup holds about 250 mL.

To obtain the final quantity of bleach to be added to the well, multiply the value in the final column by the number of metres of water depth:

Examples

A drilled well with 15 cm diameter and water depth of 50 m would use 900 mL of bleach for manual disinfection. (18 mL x 50 = 900 mL).

A dug well with diameter of 90 cm and water depth of 12 m would use 7.8 L of bleach for manual disinfection. (650 mL x 12 = 7800 mL or 7.8 L).

Parks Canada

Potable Water System Annual Report

Report Period From : ________ (dd/mm/yy) To : ________ (dd/mm/yy)

Field Unit: ________

Name of Park or Site: ________

POTABLE WATER SYSTEM DETAILS

System Name ________

System Asset # ________

System Classification

☐	Measured flow	☐	Estimated flow	check one

	Micro		Small		Medium		Large	***** # of operational months (if classification change during the year)

☐	Groundwater	☐	Surface	☐	GUDI *	☐	Supplied by others	check one

*Groundwater under the influence of surface water

☐	Seasonal	☐	Year Round	check one		# of months in operation

SANITARY SURVEY

Requirement (Frequency*)	**Planned** (mm/yy)	**Actual** (dd/mm/yy)

*Based on System Classification. Surveys not required for backcountry systems.

OPERATIONAL CHECKS

Parameter	**Planned Testing** (Frequency*)	**Actual Testing** (Frequency)	**Range** (min/max values)	**Number of test exceedances**
Chlorine Residual (treated)				
Chlorine Residual (distribution)				
Turbidity (raw)				
Turbidity (treated)				

*Based on System Classification.

MICROBIOLOGICAL TESTING

Parameter	**Planned Testing** (Frequency*)	**Actual Testing** (Frequency)	**Range** (min/max values)	**Number of test exceedances**
E *coli* (raw)				
E *coli* (treated)				
E *coli* (distribution)				
Total coliform (raw)				
Total coliform (treated)				
Total coliform (distribution)				

Microbiological Testing: Exceedences

Parameter	**MAC**	**Actual**

CHEMICAL TESTING

One-Time Full Characterization (Tables A, B, C and D): Complete?

☐	No	If not, provide date for proposed completion.	
☐	Yes	If yes, provide date.	

Regular Chemical Testing: Required Schedule / Dates Completed

Test	**Requirement** (*Frequency)	**Planned** (mm/yy)	**Actual** (dd/mm/yy)
Inorganic (Table A) [1,2]			
Organic (Table B) [1,2]			
THM'S[1,2]			
Lead[1]			
Nitrate & Nitrite	Once / 120 operational days		

*Frequency: [1] Based on System Classification, [2] For year-round systems only

Chemical Testing: Exceedences

Parameter	**MAC**	**Actual**

IMPROVEMENTS / EQUIPMENT REPLACEMENT / CALIBRATIONS

Date	**Description / Cost**

REPORTS

Required attachments include Incident Response Reports, Organic / Inorganic Test Results, other pertinent information.

# of Attachments	**Description**

Signature	**Date (dd/mm/yy)**

Parks Canada

Report of Adverse Result

Field Unit:

Name of Park or Site:

Potable Water System Details

System Name:

System Asset #:

System Classification

☐ **Micro** ☐ **Small** ☐ **Medium** ☐ **Large** *# of operational months (if classification change during the year)

☐ **Groundwater** ☐ **Surface** ☐ **GUDI** ☐ Supplied by others

* Groundwater under the influence of surface water

☐ **Seasonal** ☐ **Year Round** Check one ☐ **# of months in operation**

Item to Check	Action
1) Location of the adverse result	
2) Date the adverse result	(dd/mm/yyyy)
3) Who conducted the sampling	
4) Why was sampling initiated	
5) Sample contaminant details	
6) Date of notifying local health authority	(dd/mm/yyyy)
7) Name of health authority official	
8) Name of the person of the health authority	
9) Date of the 1st re-sampling	(dd/mm/yyyy)
10) Who conducted the sampling	
11) Results of the re-sampling	
12) Date of the 2nd re-sampling	(dd/mm/yyyy)
13) Who conducted the sampling	
14) Results of the re-sampling	
15) Incident resolution	
16) Background (if there is a history of the site)	

Signature **Date (dd/mm/yyyy)**

Parks Canada

Notification of Issue Resolution

Field Unit:

Name of Park or Site:

Potable Water System Details

System Name:

System Asset #:

System Classification

☐ **Micro** ☐ **Small** ☐ **Medium** ☐ **Large** *# of operational months (if classification change during the year)

☐ **Groundwater** ☐ **Surface** ☐ **GUDI** ☐ Supplied by others

* Groundwater under the influence of surface water

☐ **Seasonal** ☐ **Year Round** *(Check one)* ☐ **# of months in operation**

Please answer the following questions about your water system :

Location of the adverse result

Incident Resolution : please mark the appropriate resolution taken and the date on which it was conducted

Resolution	Yes	No	N/A	Date of taking action (dd/mm/yyyy)
Backwashing filter(s)	☐	☐	☐	
Disinfection equipment repair	☐	☐	☐	
Flushing of distribution system	☐	☐	☐	
Changing of cartridge filter	☐	☐	☐	
Calibration of measuring equipment devices e.g. turbidity and chlorine residual metres	☐	☐	☐	
Fixing a leaky system	☐	☐	☐	
Others : please specify				

Signature **Date (dd/mm/yyyy)**

APPENDIX III

Tables A, B and C for Organic, Inorganic and Radionuclide Parameters

TABLE A. Inorganic Parameters

Parameter	MAC (mg/L)
Antimony	0.006
Arsenic	0.025
Barium	1
Boron	5
Cadmium	0.005
Chromium	0.05
Lead	0.01
Mercury	0.001
Selenium	0.01
Sodium	200
Uranium	0.02
Fluoride	1.5
Nitrate/Nitrite	10 (as N)

TABLE B. Organic Parameters

Parameter	MAC(mg/L)
Alachlor	0.005
Aldicarb	0.009
Aldrin + Dieldrin	0.0007
Atrazine + N-dealkylated metobolites	0.005
Azinphos-methyl	0.02
Bendiocarb	0.04
Benzene	0.005
Benzo(a)pyrene	0.00001
Bromoxynil	0.005
Carbaryl	0.09
Carbofuran	0.09
Carbon tetrachloride	0.005
Chlordane (Total)	0.007
Chlorpyrifos	0.09
Cyanazine	0.01
Diazinon	0.02
Dicamba	0.12
1,2-Dichlorobenzene	0.2
1,4-Dichlorobenzene	0.005
Dichlorodiphenyltrichloroethane (DDT) + metabolites	0.03
1,2-Dichloroethane	0.005
1,1-Dichloroethylene (vinylidene chloride)	0.014
Dichloromethane	0.05
2-4 Dichlorophenol	0.9
2,4-Dichylorophenoxy acetic acid (2,4-D)	0.1
Diclofop-methyl	0.009
Dimethoate	0.02
Dinoseb	0.01
Diquat	0.07
Diuron	0.15
Glyphosate	0.28

TABLE B. Organic Parameters (Cont'd)

Parameter	MAC
Heptachlor + Heptachlor Epoxide	0.003
Lindane (Total)	0.004
Malathion	0.19
Methoxychlor	0.9
Metolachlor	0.05
Metribuzin	0.08
Monochlorobenzene	0.08
Paraquat	0.01
Parathion	0.05
Pentachlorophenol	0.06
Phorate	0.002
Picloram	0.19
Polychlorinated Biphenyls (PCB)	0.003
Prometryne	0.001
Simazine	0.01
THM'S (NOTE: show latest annual average)	0.1
Temephos	0.28
Terbufos	0.001
Tetrachloroethylene	0.03
2,3,4,6-Tetrachlorophenol	0.1
Triallate	0.23
Trichloroethylene	0.005
2,4,6-Trichlorophenol	0.005
2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	0.28
Trifluralin	0.045
Vinyl Chloride	0.002

TABLE C. Radionuclide Parameters

RADIOLOGICAL PARAMETERS	MAC[7]
Gross alpha activity	0.5 Bq/L
Gross beta activity	1 Bq/L
Uranium	20 µg/L
Lead-210	0.1 Bq/L
Radium-226	0.5 Bq/L
Radium-228	0.2 Bq/L

Monitoring of Radioactivity in Drinking Water Sources

As discussed in Health Canada (2006), for the initial screening of radioactivity in new drinking water supplies, or in supplies with no historical radioactivity data, water samples should be analyzed for the common radionuclides known to occur in Canadian water supplies, along with the measurement of gross alpha and gross beta radioactivity. (This presumes that artificial sources of radioactivity are not known to be present.) The common radionuclides in surface waters include total uranium (usually measured in chemical form in µg/L), radium-226 (Ra-226), radium-228, and lead-210 (radionuclides measured in becquerels per litre, Bq/L)[8]. With the exception of Ra-228 which is from the natural thorium (Th-232) radioactive decay series, the other analytes are from the natural uranium (U-238) decay series.

For initial screening purposes, the measured uranium and radionuclide concentrations may be compared to their respective Maximum Acceptable Concentrations (MACs). [It should be noted that the MACs refer to annual average concentrations.] As cautioned by Health Canada (2006), gross radioactivity screening is imprecise, with either false positive or false negative results being distinct possibilities. Health Canada does not recommend specific numerical values for gross alpha and beta screening of drinking water supplies. However, Health Canada also suggests that screening levels of 0.5 Bq/L and 1 Bq/L for gross alpha and beta activities, respectively, as recommended by WHO (2004), can offer some guidance on appropriate levels to be used for screening purposes.

If the gross alpha activity exceeds the suggested screening level, the potential alpha contributions from the measured uranium and Ra-226 should be assessed. If the gross beta activity exceeds the suggested screening level, and the level is not explained by the measured Ra-228 or Pb-210 levels, the samples should also be analyzed for the naturally occurring beta emitter potassium-40

7 As proposed by Health Canada (2006).

8 The U.S. Environmental Protection Agency recommends the initial monitoring of gross alpha, Ra-226, Ra-228 and uranium [if the gross alpha level exceeds 15 picocuries/L (0.56 Bq/L)] in new drinking water sources (U.S. EPA 2002). New sources may also have to sample for beta and photon (gamma radiation) activity if required by the State.

(K-40). The gross beta activity minus the K-40 activity should then be compared to the gross beta screening level. (There is no MAC for K-40 because its level in the body is homeostatically controlled and is not influenced by variations in environmental levels.)

Any unexplained gross alpha or beta levels above screening levels would require confirmatory analyses and site-specific consideration of other potential sources of radioactivity.

TABLE D. Chemical/Physical Objectives- Not Health Related

Parameter	Objective	Type of Objective[a]
Alkalinity (as $CaCO_3$)	30-500 mg/L	OG
Aluminium	0.10 mg/L	OG
Chloride	250 mg/L	AO
Colour	5 TCU	AO
Copper	1 mg/L	AO
Dissolved organic carbon	5 mg/L	AO
Ethylbenzene	0.0024 mg/L	AO
Hardness (as $CaCO_3$)	80-100 mg/L	OG
Iron	0.30 mg/L	AO
Manganese	0.05 mg/L	AO
Odour	Inoffensive	AO
Organic Nitrogen	0.15 mg/L	AO
pH	6.5-8.5 (no units)	AO
Sodium	[b]	AO
Sulphate	500[c]	AO
Sulphide	0.05mg/L	AO
Taste	Inoffensive	AO
Temperature	15 degrees Celsius	AO
Toluene	0.024 mg/L	AO
Total dissolved solids	500 mg/L	AO
Xylenes	0.30 mg/L	AO
Zinc	5.0 mg/L	AO

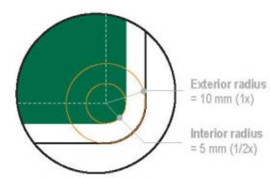
a) Short forms:
Aesthetic objective-AO, Operational guideline- OG, True colour units- TCU

b) The aesthetic objective for sodium in drinking water is 200mg/L. The Medical Officer of Health should be notified when the sodium concentration exceeds 20mg/L so that this information may be disseminated to local physicians for their use with patients on sodium restricted diets.

c) When sulphate levels exceed 500mg/L water may have a laxative effect on some people.

APPENDIX IV

"Do Not Drink Water" Sign



Corner Radius Detail

Parks Canada Parcs Canada

Canada

SUBSTRATE

.125" sheet aluminum alloy 5052-H38 powder coated PC Heritage green face, back and all edges.

MESSAGE COLOUR BREAK

- (A) PC Heritage Green, pms 553
- (B) White 3M Scotchlite 3290 engineer grade
- (C) Black 3M Scotchcal 220-12
- (H) CSA Red 3M Scotchlite 3272 engineer grade

POSTS

Quantity:
Material:
Finish:

ADDITIONAL NOTES:

SITE		CLIENT
NP / NHS / NPR / NMCA		Parks Canada
SIGN		CLASS
PC_Q2-06_1-1-042_e1		Q2
QUANTITY	X SIZE	SPEED/DISTANCE
TBD	10 mm	6 m
VEHICULAR / PEDESTRIAN		SCALE
Pedestrian		1:2
DRAWN BY		DATE DD / MM / YY
SSC		20 / 06 / 06
REVISED BY		DATE DD / MM / YY
APPROVED BY		DATE DD / MM / YY
DRAWING NO.		
PC_Q2-06_1-1-042_e1		10mm 1/4" check drawing scale

NOTES

- All dimensions in millimetres unless otherwise stated
- Contractor will check all drawings and dimensions and clarify any discrepancies with the designer prior to fabrication
- Contractor will refer to the sign schedule for content and fabrication/installation details and clarify any discrepancies with the client prior to fabrication
- Signs must be finished to the highest possible standards as outlined in Parks Canada Standards and Guidelines for Exterior Signage Interim #1 or latest edition of these guidelines
- All parts must be tested to ensure proper fit and tolerances
- Bolt holes and fasteners must not interfere with graphic sign face
- Post type and installation height to be confirmed by park/site
- All sharp edges shall be broken, de-burred and otherwise made smooth
- All aluminum components (sheet, tube, angle, extrusions, caps, etc.) to be powder coated, PC Heritage Green, pms 553.

APPENDIX V

I. Correspondence Courses for Small Systems Operation and Maintenance

II. Micro-systems' Training Module Course (PCA)

I. CORRESPONDENCE COURSES FOR SMALL SYSTEMS OPERATION

The Sacramento State University provides online courses for drinking water systems training through their Office of Water Programs. The courses may be viewed at this website: http://www.owp.csus.edu/onlinecourses.php

The following is an example of some of the courses offered for Small Water Systems:

WAT 702A – Water Sources and Treatment – Upon completion of this course, operators should understand the components of a water supply system from source to customer, understand the diverse responsibilities of a water system operator, know the requirements for certification and how to prepare for obtaining and maintaining certification, understand the hydrologic cycle and its impact on water sources, be able to conduct a sanitary survey as part of selecting a water source, be able to access and use the EPA website for the Safe Drinking Water Act, and be able to identify components of water treatment systems and their purposes. Also included: solution techniques for solving water treatment plant math problems.

WAT 702B – Wells – Upon completion of this course, operators should be able to set up a wellhead protection program, identify parts of a well and pump system, maintain and rehabilitate a well, operate and maintain a well pump and hydropneumatic pressure tank, inspect a well and pumping system, disinfect wells and pumps, keep accurate records of a well and pumping system, remove sand from water mains, troubleshoot problems in wells and pumping systems, select a well site, describe types of wells and drilling methods, test and evaluate a well and pump, and abandon and plug a well no longer productive or needed.

WAT 702C – Small Water Treatment Plants – Upon completion of this course, operators should understand treatment requirements and methods for surface water and groundwater, be able to operate coagulation, flocculation, sedimentation, filtration, and disinfection treatment processes for a surface water treatment plant, be able to institute a corrosion control program to protect treatment and distribution infrastructure, understand the operation of solids-contact clarification and slow sand filter systems, be able to operate iron and manganese removal and water softening processes for treatment of groundwater, and be able to set up effective maintenance and safety programs for a treatment works.

WAT 702D – Disinfection – Upon completion of this course, operators should understand the purpose for disinfection and the applicable regulations, the factors influencing disinfection effectiveness, the physical and chemical means of disinfection and the critical factors affecting each. Operators should also be able to disinfect wells, pumps, mains, and tanks, to operate various types of chlorination equipment, to determine and set chlorination rates, to measure chlorine residual, to handle chlorine and chlorine equipment safely, and to solve disinfection math problems.

II. Micro-systems' Training Module Course

1.0 Sampling Potable Drinking Water

1.1 Why Sample?

The Parks Canada Agency is responsible for providing potable (Fit to drink) drinking water to staff and visitors within National Parks. Parks Canada uses the multi barrier approach to ensure the safe delivery of potable water. This approach involves having a thorough knowledge of a water supply from source to tap. The multi barrier approach uses a risk management style that identifies all potential hazards to a water source. Barriers are put in place to reduce and eliminate the risk of contamination. Sampling is an integral part of fulfilling the delivery of safe water to all users and ensures treatment equipment is functioning. As the designated micro systems operator it is ***your*** responsibility to perform the duties described within this document thereby ensuring the quality of the drinking water.

1.2 Definition of Micro-system

A Micro system is any water delivery system that serves less than 25 people per day.

1.3 Operator Certification

1.3.1 Micro System Certification

Upon successful completion of the Micro Systems Certification an individual may ***sample*** systems under 25 people per day and record associated data.

1.3.2 Provincial Certification

All systems, regardless of size, must be under the supervision of a provincially certified water treatment/ distribution operator. A provincially certified operator must make all operational adjustments. This person is referenced within this document as the 'Technical Support Person'

1.4 Testing Frequency

The Technical Support Person establishes the Micro system Operator's regular duties as well as the frequency and type of testing performed.

1.5 Record Keeping

All data must be documented and submitted to the Technical Support Person as per their instructions.

1.6 Guidelines

The Parks Canada Agency follows the 2006 PCA Water Quality Guidelines. The guideline compliments the *Guidance For Providing Safe Drinking Water in Areas of Federal Jurisdiction - Version 1* (August, 2005) and the Guidelines for Canadian Drinking Water Quality

2.0 What to sample and What to Look For (Guidelines/Standards/MAC)

2.1 Chlorine Residuals

Chlorine is the primary disinfectant used in water treatment by the Parks Canada Agency. Chlorine is a powerful oxidant that inactivates pathogenic bacteria and viruses. One beneficial aspect of chlorine is it continues working in water after it has been added, which is known as the residual effect. One of the required tests in a water-monitoring program is a measure of this residual or “free chlorine” within the water distribution system or supply.

When chlorine is added to water a chemical process occurs. Three important chlorination terms are as follows:

- **Chlorine Dosage** is the chlorine added to the water.
- **Chlorine Demand** is the amount of chlorine required to react with organic and inorganic substances within the water to a level where all the Chlorine is used.
- **Chlorine Residual** is the level of Chlorine not consumed by the organic and inorganic demand and can also be termed free chlorine or available chlorine.

2.2 Turbidity

Turbidity is simply the cloudiness of water. It consists of suspended, un-dissolved organic and inorganic matter. In surface water turbidity can be made up silt, algae, organic matter from living animals. In ground water turbidity is mainly caused by inorganic silt particles. Turbidity is measured in nephelometric turbidity units or NTU. Chlorine, UV and other disinfectants are less effective in cloudy (turbid) water. The particulate use up some of the chlorine as they react with it (demand), and the surface of the particulate provides some physical protection to microorganisms.

2.3 Ultra Violet (UV) disinfection

An Ultraviolet (UV) disinfection system transfers electromagnetic energy to an organism’s genetic material (DNA and RNA). When UV radiation penetrates the cell wall of an organism, it destroys the cell's ability to reproduce. The effectiveness of a UV disinfection system depends on the characteristics of the water (including turbidity), the intensity of UV radiation (determined in part by the age of the UV source, and the cleanliness of the unit), the amount of time the microorganisms are exposed to the radiation (flow rate), and the configuration of the UV source. UV disinfection is effective at inactivating most viruses, spores, and protozoan cysts such as Giardia and Cryptosporidium. UV provides no residual disinfection.

2.4 Bacteriological (E. Coli / Total Coliforms)

Microbiological pathogens are the most significant threat to public health related to drinking water. Ingestion can result in illness, permanent damage to internal organs, or in severe cases death. Microbiological pathogens are microscopic organisms like viruses, bacteria, and protozoa. Parks Canada uses certified laboratories to carry out its bacteriological water testing. Water samples are tested using the presence absence method for two groups of bacteria, Total Coliforms and E. Coli. These indicator organisms are a sign of contamination or a failure of the treatment process. These bacteria are collected in a sample bottle and are routinely analysed via a **presence / absence** test.

- Total Coliforms are a group of closely related mostly harmless bacteria that live in soil, water, and vegetation. The extent of which they are present indicate the general quality of the water, and the likelihood of contamination from the ground surface.
- E. Coli bacteria are found in the intestinal tract of warm-blooded animals and humans. The presence of E. Coli bacteria in potable water is indicative of fecal contamination and is an immediate health concern.

The presence of either type of bacteria indicates the need for further investigation, sampling and possible shock chlorination. If a water sample tests positive a resample is required. **The resample will be a quantitative test** where the bacteria colonies are grown and a counted to determine levels of contamination.

2.5 Chemical Analysis

Water is also analysed to determine its chemical makeup. Chemical and radiological contaminants present in water can impact people over extended time periods of consumption. Groundwater sources tend to have higher amounts of dissolved minerals than surface water sources. This is due to the contact time with minerals as it percolates through the earth. While not a health concern they do affect the aesthetics (taste, smell and odour) of the water and sometimes require treatment. The type of land use around a water source can also affect the chemical, organic and bacterial quality. For these reasons, all potable water within Parks Canada has been sampled and tested for its chemical makeup as part of the ‘Sanitary Survey’ to determine a baseline. The Technical Support Person can review this data with the Micro Systems Operator.

2.6 Exceedences and Abnormalities

Water quality testing that exceeds the targets identified by the Technical Support Person must be reported and documented immediately to the Technical Support person. The Technical Support Person will advise the appropriate course of action.

3.0 Fundamentals of Sampling Procedures (Where, When and How)

3.1 Free Chlorine Residual Sampling Procedures (HACH Pocket Colorimeter #2 – Cat. No. 58700-00)

a) Open water source and allow to run for 1 minute
b) Take 2 vials and rinse them in the water
c) Fill the two vials to the level indicated on the vial, which is either a line or bottom of the white diamond.
d) Open Chlorine free reagent pillow and add to 1 vial (Should turn pink).
e) Fasten the lids and shake the vial with the reagent.
f) Wipe and dry the outside of the vial with a clean paper towel.
g) Put the sample *without the reagent* in the Chlorine analyzer.
h) Close lid.
i) Press the 'Zero' button (Provides reference).
j) Put the sample *with the reagent (pink)* into the Chlorine analyzer.
k) Press the 'Read' button.
l) Record the # and the time and date.

Note: There are several brands and types of pocket Chlorine test kits some have two locations for the vials and a dial meter to compare the colors is used and the operator selects the best matching color for the chlorine level. Ensure that the pocket chlorine test kit has a smallest increment of 0.01 mg/L.

3.2 Turbidity Sampling Procedures (HACH 2100P Portable Turbidimeter)

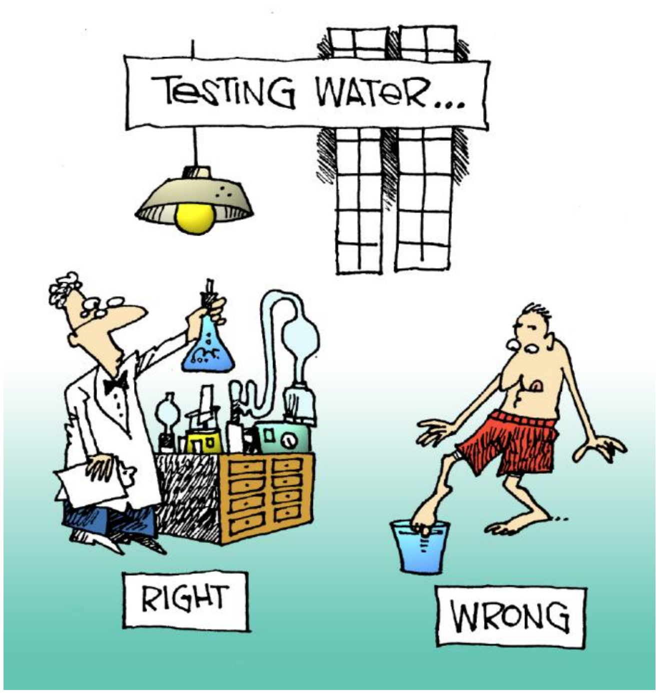
a) Take the clear zero sample vial from the chlorine process without the reagent and wipe it with the silicone impregnated dust cloth.
b) Turn on the Turbidimeter by pushing the I/O button with the lid closed.
c) Allow the unit to self calibrate.
d) Put the vial into the Turbidimeter with the white diamond facing forward and hit the 'Read' button.
e) Record the #.
f) Dump Vials and rinse.

* Note- The parameters that you are testing for must be established by the PCA designated Technical Support Person

3.3 Bacteriological sampling Procedures

a) Normally samples may be collected from Sunday through Thursday   Samples must be taken after 10 am to ensure delivery within the specified period. For weekend samples the laboratory must be contacted and suitable arrangements made. (Check with your laboratory and transportation service to review time requirements so that the samples arrive at the laboratory in a timely manner).

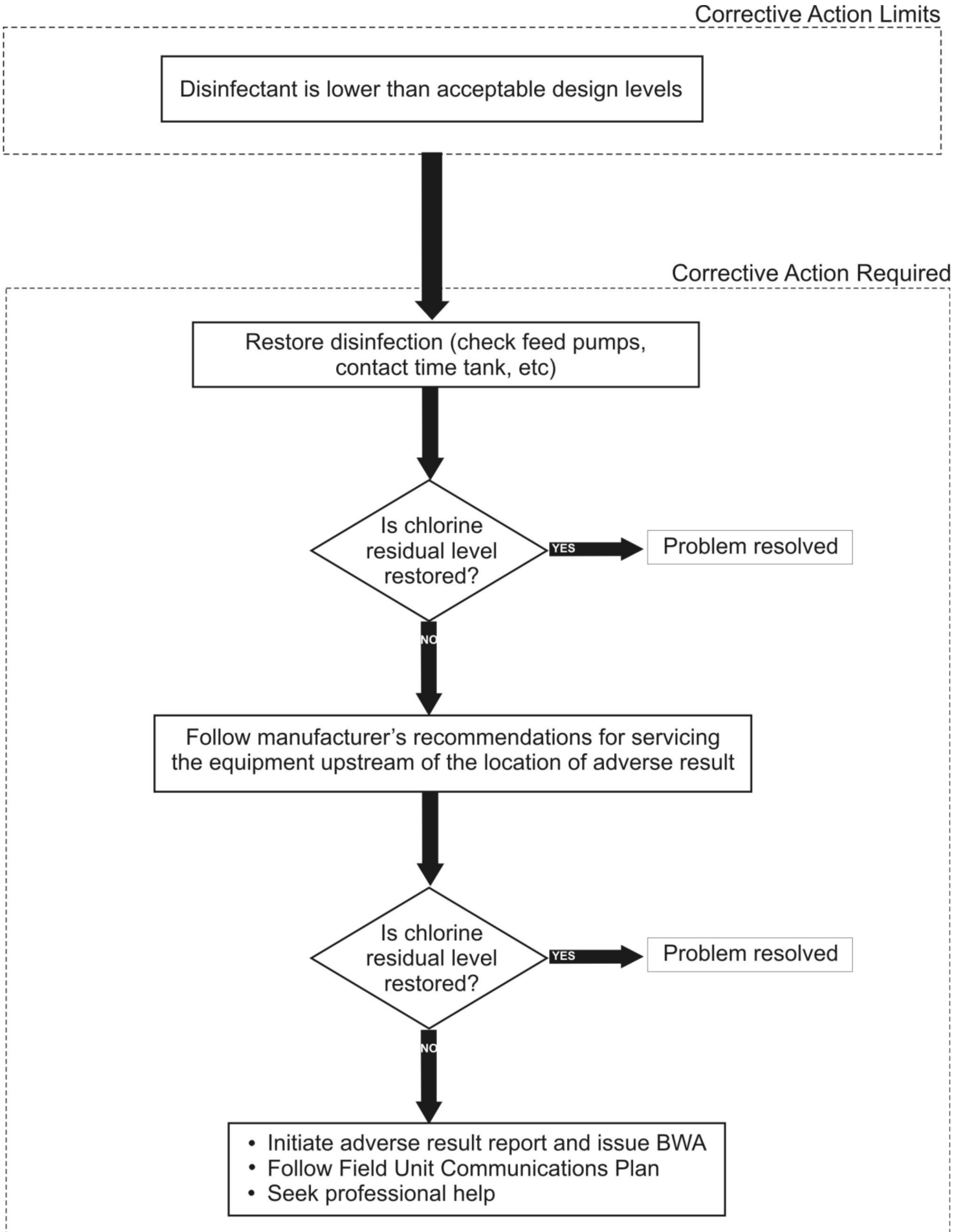
b) Use only sample bottles provided by the local health authority.
c) The sample bottle contains a small amount of powder to neutralise residual chlorine, DO NOT RINSE OR DISCARD.
d) If water is collected from a tap or pump, allow the water to flow for about 5 minutes before collecting sample.
e) Fill the bottle to fill line only, then replace cap. Avoid touching the inside of the screw cap, or the mouth of the bottle.
f) A requisition / Chain of Custody form must be completed for each sampled site. Each sample spot has a site-specific label that must be completed, and attached to the form. The site-specific label is associated to the individual site Access number. All requested information must be filled in including phone number, date and time of collection. Refer to your specific lab for instructions on labelling and forms.
g) The requisition form has an identification label. Detach this label and affix firmly to the dry sample bottle.
h) Put the sample bottle and requisition form in the provided zip lock bag.
i) Store sample bottles in a cooler with an ice pack.
j) Shipment and delivery of bacteriological samples.
k) Samples are packed in a cooler complete with an icepack for shipping.
l) Samples should be delivered to the lab as soon as possible after collection. The sample should be kept cool (but not allowed to freeze).
m) **Samples must reach the lab within 24 hours of collection to be suitable for microbiological examination.** (48 hours may be acceptable for remote locations)



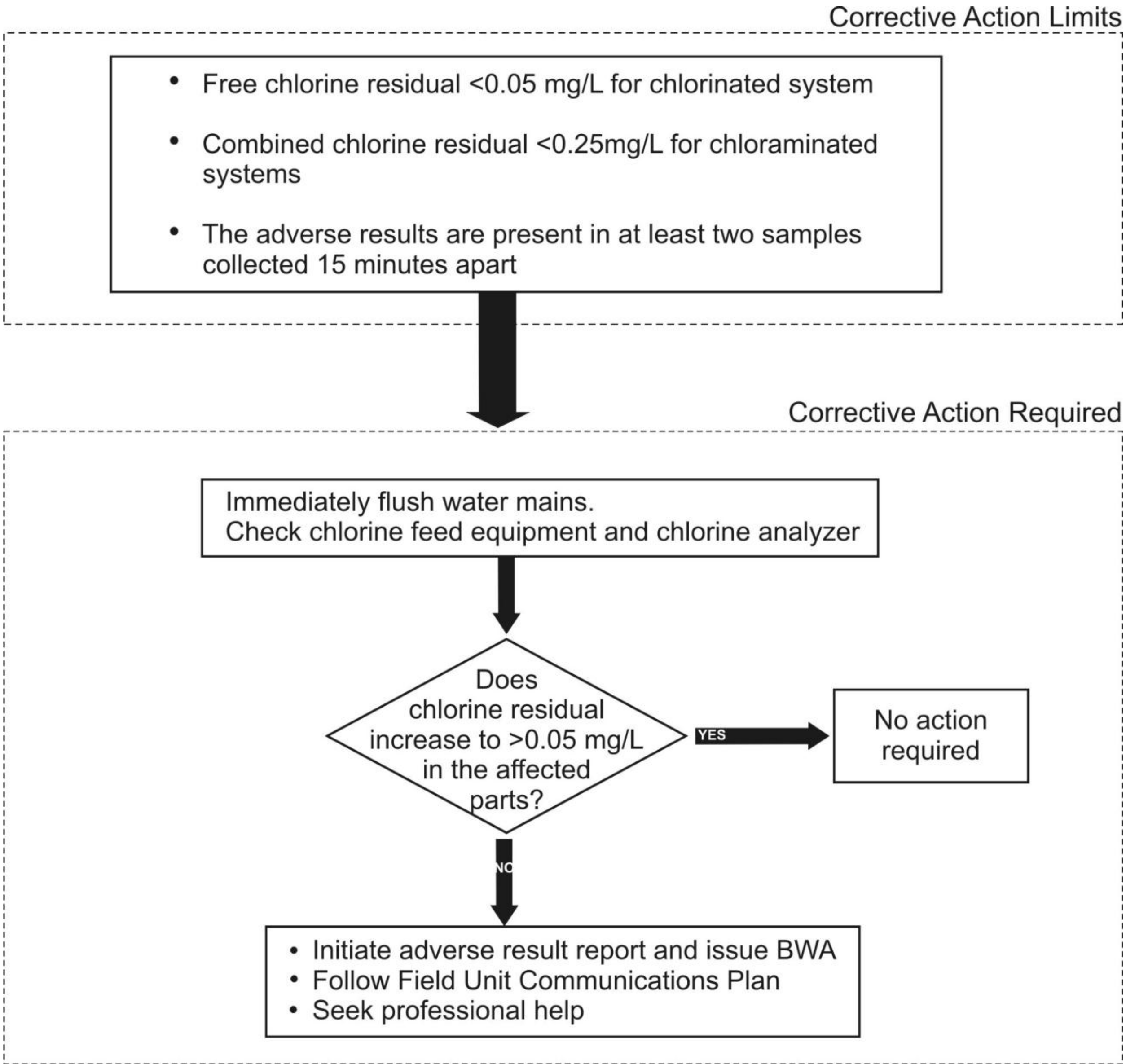
APPENDIX VI

FLOW SHEETS FOR CORRECTIVE ACTIONS

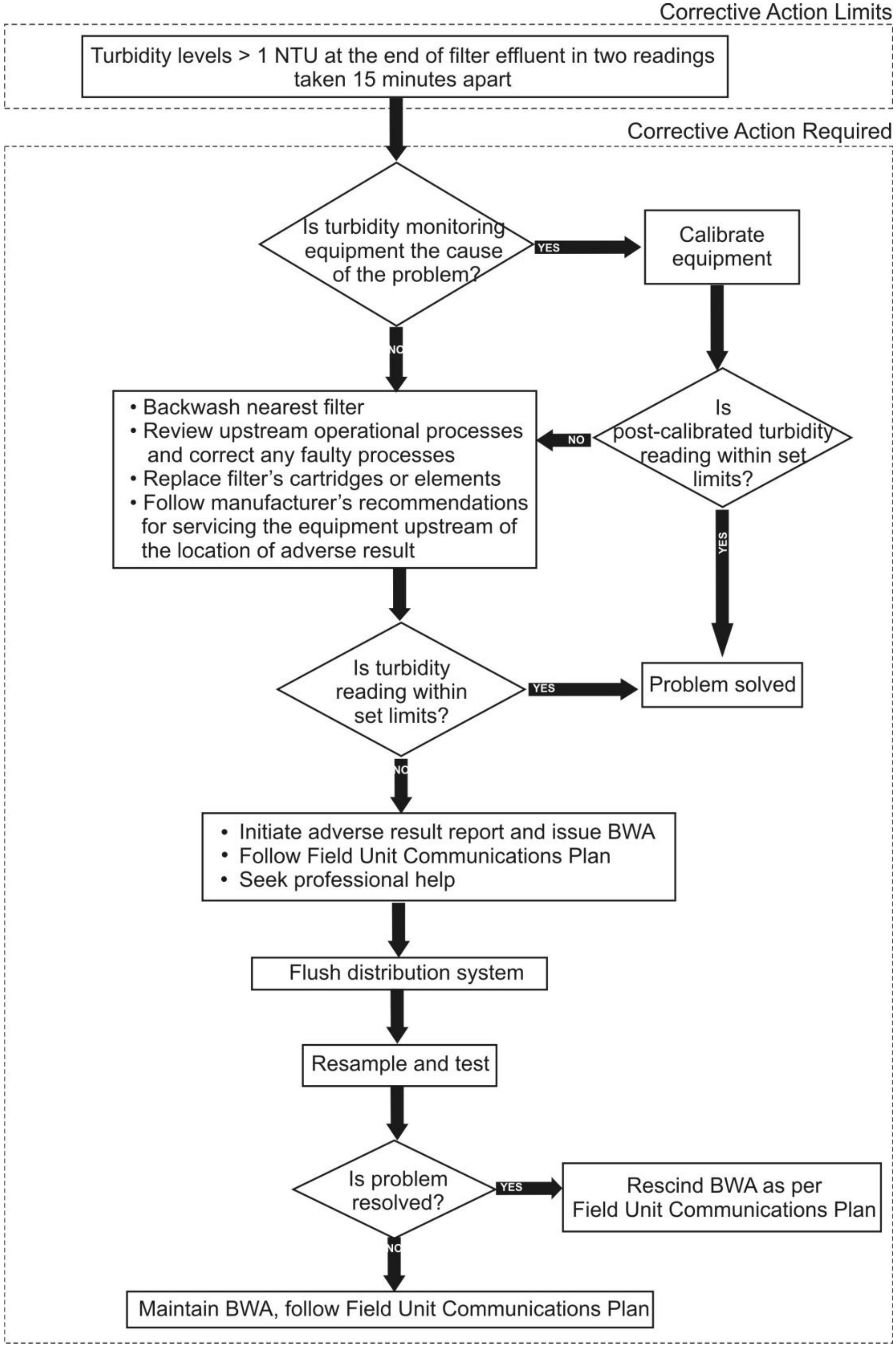
FLOW SHEET 1: CORRECTIVE ACTION FOR CHLORINE RESIDUAL ADVERSE RESULT IN TREATMENT



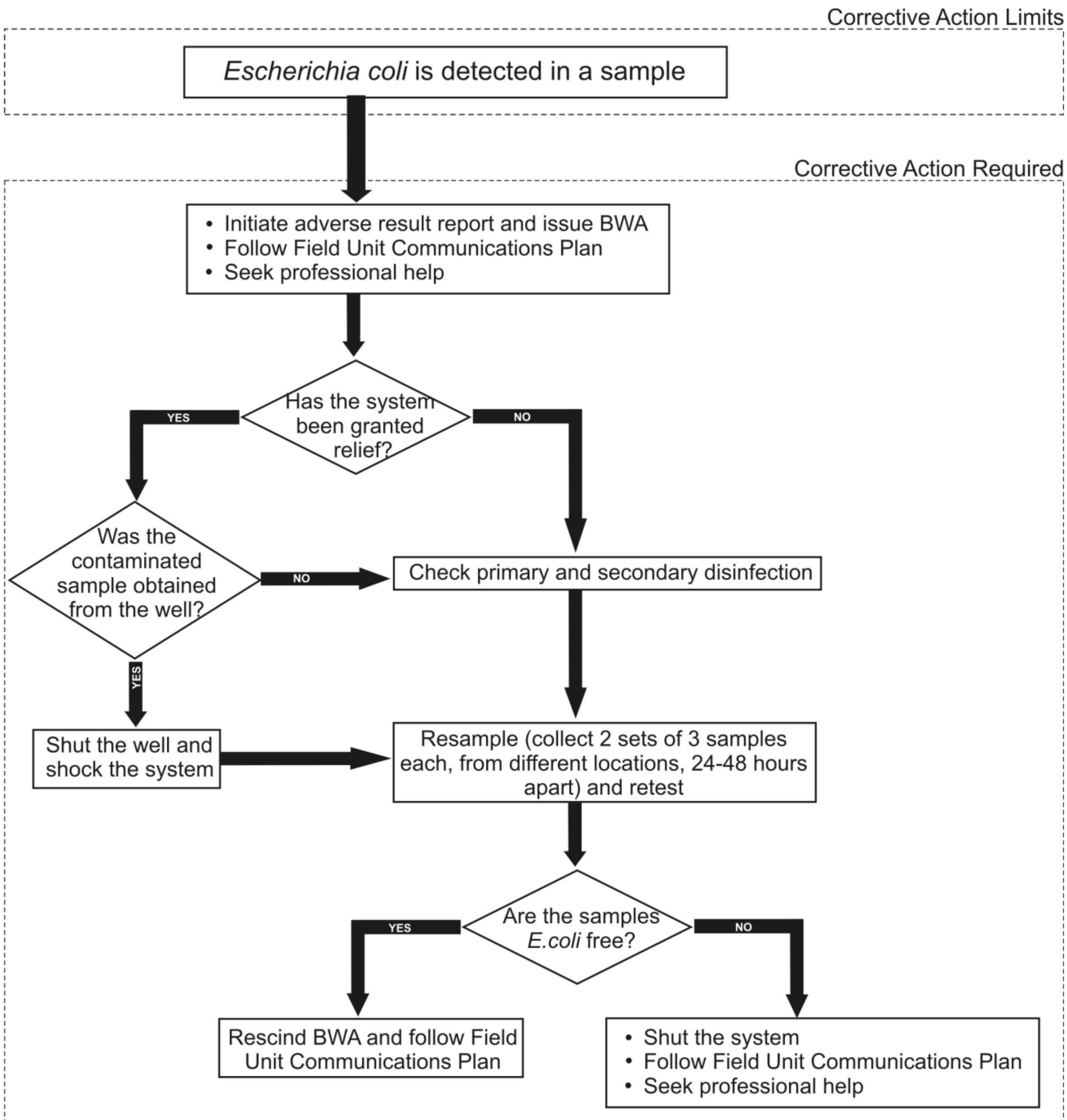
FLOW SHEET 2: CORRECTIVE ACTION FOR CHLORINE RESIDUAL ADVERSE RESULT IN THE DISTRIBUTION SYSTEM



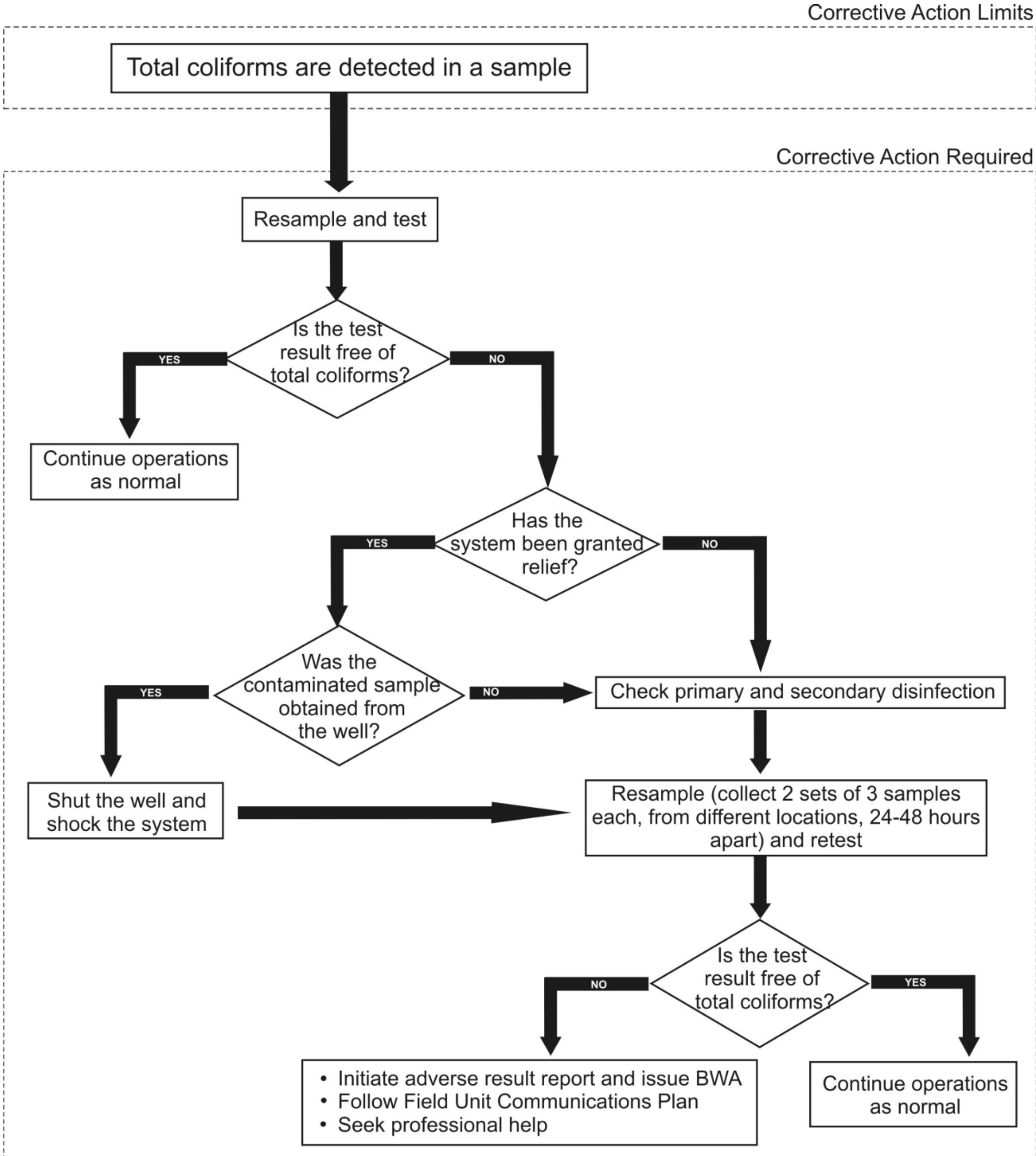
FLOW SHEET 3: CORRECTIVE ACTION FOR TURBIDITY ADVERSE RESULTS



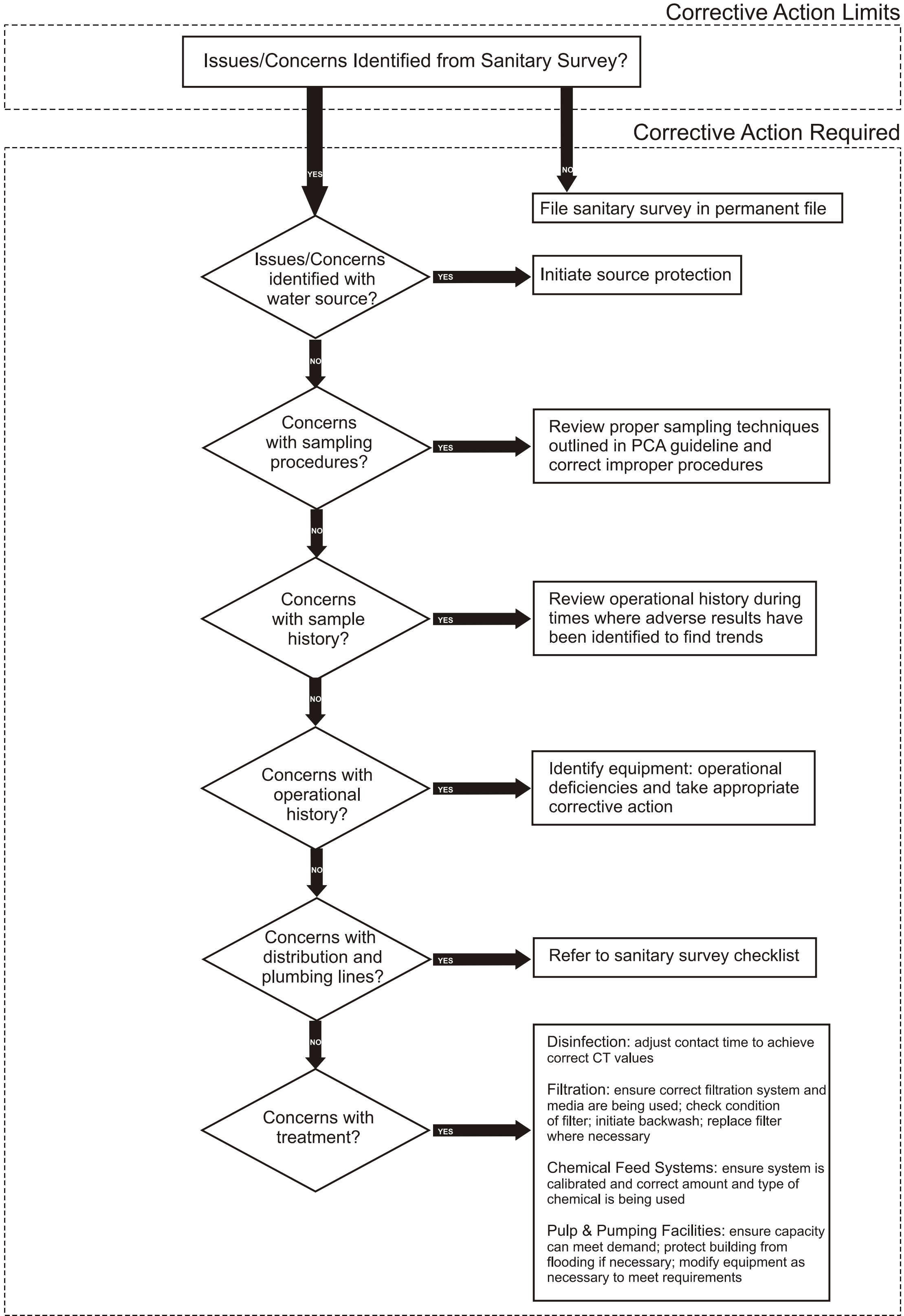
FLOW SHEET 4: CORRECTIVE ACTION FLOW SHEET FOR *E. COLI*



FLOW SHEET 5: CORRECTIVE ACTION FLOW SHEET FOR TOTAL COLIFORMS



FLOW SHEET 6: SANITARY SURVEY RESULTS FLOW SHEET



APPENDIX VII

DECHLORINATION

APPENDIX VII - DECHLORINATION

The Canadian Environmental Quality Guidelines, as well as most of the provincial regulations, require that chlorine residual concentration should not exceed 2 µg/L for discharges to receiving waters. As a result, dechlorination of chlorinated water is mandatory prior to discharge. There are a number of chemical and non-chemical methods for dechlorination. The non-chemical dechlorination method is used for discharges where the amount of water is limited since the dechlorination process requires some time to affect the chlorine reduction. The most common methods are:

- retention in holding tanks where chlorine residual is decreased after a few days,
- flow over pavement or gravel however; reduction of chlorine residual is minimal unless the water flows over a long distance e.g. 1 km.

The chemical dechlorination method entails the use of chemical agents such as activated carbon, sulphur dioxide, sodium bisulphite, sodium sulphite, and sodium thiosulfate. It should be noted that activated carbon is seldom used for it is more expensive than the other agents. The following table outlines the dose of each dechlorination agent to achieve the threshold of 2 µg/L.

TABLE AVII.1
DECHLORINATION AGENTS, FORMS AND DOSES

Dechlorination Agent	Forms Available	Dose at pH 7.0 (mg/mg Cl)
Sulphur dioxide	Gas	0.99
Sodium bisulphite	Powder/crystal	1.61
Sodium thiosulfate	Powder/crystal	1.9
Sodium sulphite	Powder/crystal	1.96

APPENDIX VIII

CONTINUOUS MONITORING REQUIREMENTS

APPENDIX VIII - CONTINUOUS MONITORING REQUIREMENTS

Continuous Monitoring Requirements

The following standards should be fulfilled when continuous monitoring is required:

The continuous monitoring equipment must test for the parameter with at least the minimum frequency specified in the following table for the parameter, and record the date, time, sampling location and result of every test for the parameter including the record of the result of every test that causes an alarm to sound along with the sampling location and the date and time of the test.

- The continuous monitoring equipment must cause an alarm to sound immediately at the location where the equipment conducts tests or the location where a person is present, if a person is not always present at the location where the equipment conducts tests:
  - if the equipment malfunctions,
  - in the case of power failure,
  - if a test result for a parameter is above the maximum alarm standard, or
  - if the result is below the minimum alarm standard specified in the following table.
- Test results are to be examined, within 72 hours after the tests are conducted by a certified operator or a person trained by a certified operator.
- The following table lists the minimum testing frequencies for continuous monitoring.

TABLE AVIII.1
MINIMUM TESTING FREQUENCIES FOR CONTINUOUS MONITORING

Parameter	Minimum Testing & Recording Frequency	Maximum Alarm Standard	Minimum Alarm Standard
Free chlorine residual required to achieve primary disinfection	5 minutes	Not applicable	0.1 mg/L less than the concentration of free chlorine residual that is required to achieve primary disinfection
Free chlorine residual and total chlorine residual measured for the purpose of determining combined chlorine residual required to achieve primary disinfection	5 minutes	Not applicable	0.1 mg/L less than the concentration of combined chlorine residual that is required to achieve primary disinfection
Free chlorine residual in a distribution sample	1 hour	Not applicable	0.05 mg/L
Free chlorine residual and total chlorine residual measured for the purpose of determining combined chlorine residual in a distribution sample	1 hour	Not applicable	0.25 mg/L
Turbidity at the end of the filter effluent	15 minutes	1.0 NTU	Not applicable