Environmental Public Health Field Manual

for

Private, Public and Communal Drinking Water Systems in Alberta

Second Edition
2004

Alberta
HEALTH AND WELLNESS

Statements in this Manual are intended solely as guidance.

Health Agencies may decide to follow the guidance provided in this document, or to act in variance with the guidance, based upon an analysis of site-specific circumstances.

The front cover design…

> *The front cover of this manual includes a small emblem in recognition of the contribution of Dr. John Snow, a pioneer in the field of public health.*
>
> *It was one hundred and fifty years ago this month that Dr. John Snow traced the source of a deadly outbreak of cholera to a water pump located on Broad Street in the City of London. This pump served much of the surrounding neighborhood and it was in this area that over 600 people had become ill and died within 10 days. When Dr. Snow discovered that those people who drank from the Broad Street pump were more likely to become ill or die than those who did not, he removed the handle from the pump and the outbreak very quickly subsided.*
>
> *For his work and because of the methods he used, Dr. Snow is considered widely to be the father of modern public health.*

Environmental Public Health Field Manual for Private, Public and Communal Drinking Water Systems in Alberta, Second Edition © - 2004

Environmental Public Health Field Manual

for Private, Public and Communal Drinking Water Systems in Alberta, Second Edition - 2004

produced by the

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April 2004

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Environmental Public Health Field Manual for Private, Public and Communal Drinking Water Systems in Alberta.

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Canada

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for their partnership funding

in the printing of this manual

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from the

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Public Health Inspectors

June 2004

"For outstanding and meritorious achievements
in the field of public health"

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2004, Second Edition

This Manual will be updated on a regular basis

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We wish to thank other agencies for the technical information they have contributed to the Manual.

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ABBREVIATIONS

AH&W	Alberta Health and Wellness
AE	Alberta Environment
BWA	Boil Water Advisory
BWO	Boil Water Order
CDC	Centers for Disease Control and Prevention (U.S.)
CFU	Colony Forming Units
cm	Centimeter
CT	Concentration Multiply by Time (mg-min/L)
DBP	Disinfection By-Products
DOC	Dissolved Organic Carbon
EC	*Escherichia coli*
ED	Electrodialysis
EH	Environmental Health
EHO	Environmental Health Officer
FAC	Free Available Chlorine
FC	Fecal Coliform
GWI	Groundwater under Influence of Surface Water
HPC	Heterotrophic Plate Count
ID	Infectious Dose
IX	Ion Exchange
L	Litres
m	Meter
MAC	Maximum Acceptable Concentrations
mg	Milligram
mL	Millilitres
MOH	Medical Officer of Health, same as MHO
NOM	Natural Organic Matter
NSF	National Sanitation Foundation
PFRA	Prairie Farm Rehabilitation Administration
PHI	Public Health Inspector
PLPH (M)	Provincial Laboratory for Public Health (Microbiology)
POD	Privately Owned Development
POE	Point-of-Entry
POU	Point-of-Use
ppm	Parts per Million
PVC	Polyvinyl Chloride
RHA	Regional Health Authority
RO	Reverse Osmosis
SOC	Synthetic Organic Contaminant
TACSDW	Technical Advisory Committee on Safe Drinking Water
TC	Total Coliform
TDS	Total Dissolved Solids
THM	Trihalomethanes

UL	Underwriter Laboratory
USEPA	U.S. Environmental Protection Agency
UV	Ultraviolet
VOC	Volatile Organic Compounds
WHO	World Health Organization
µm	Micrometer
µS/cm	Microsecond per centimeter

GLOSSARY

These definitions are not intended to be complete or to have legal interpretations, but rather to help the EHO/PHI have a quick understanding of related drinking water terms in the use of this document.

Boil Water Advisory: A Boil Water Advisory is issued to either private individuals or the public in general advising that a specific water supply is unsafe for human consumption. The advisory will contain specific recommendations that individuals or the public in general may implement to protect public health.

Boil Water Order: A Boil Water Order is an Executive Officer's Order issued pursuant to Section 62 of the Public Health Act. It is issued to the owner and/or the operator of a public or communal drinking water system and includes specific instructions that the owner and/or the operator must follow.

Bored wells: Constructed in low-yielding shallow groundwater aquifers. They are often shallow with less than 30 meters in depth, and have a large diameter casing (45-90 cm).

Communal Water Supply: A communal water supply is one that serves more than one building, lot, or similar place, and where the public has an interest arising out of the need to safeguard the public health. A communal water supply differs from a public water supply in that it involves distribution of the water to at least 2 different places, whether public or private. Examples include, but are not limited to: water co-operatives, trailer parks, campgrounds and ski hills, etc.

Distribution system: A water distribution system means a system of pipes, valves, fittings, storage reservoirs, and appurtenances that is shared by a communal development to convey potable water to two or more service connections.

Drilled wells: Smaller in diameter (10-20 cm) than bored wells, they are usually completed to depths much greater than bored wells.

***Escherichia coli* (*E. coli*):** *E. coli* is a species of bacteria within the coliform group that is an indicator of the presence of feces. The finding of *E. coli* in water indicates recent fecal contamination and the possible presence of enteric pathogens that may adversely affect human health. This is a potentially dangerous situation, the nature of which should be determined by immediate investigation.

Fecal Coliform (FC): The subset of the total coliform group that is more definitive as an indicator of fecal contamination, consists of what are termed the fecal coliforms. However, the term "thermotolerant coliforms" may be more appropriate for this group because they are capable of producing gas from lactose in suitable culture media at $44.5 \pm 0.2^{o}C$. This group comprises the species *Escherichia coli* and, to a lesser degree,

Klebsiella and *Enterobacter* species. *Escherichia coli* has been found to have excellent correlation with fecal contamination from warm-blooded animals. However, fecal coliform bacteria which conform to this definition can belong to genera and species other than *E. coli*, and have been isolated from environmental sources in apparent absence of fecal pollution. This is especially true in waters which receive high levels of carbohydrate–rich industrial effluent.

Groundwater: The water that systems pump and treat from aquifers (natural reservoirs below the earth's surface).

Groundwater under influence of surface water (GWI): Any water beneath the surface of the ground with (i) significant occurrence of insects or other macro-organisms, algae, organic debris, or large-diameter pathogens such as *Giardia lamblia*, *Cryptosporidium*, or (ii) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions.) Alberta Environment shall investigate and make judgement as to whether or not a source is considered as 'under influence'.

Health Agencies: For the purpose of this document, Health Agencies would include all the Regional Health Authorities in Alberta as defined by the Regional Health Authority Act of Alberta and Health Canada agencies.

Heterotrophic Plate Count (HPC) (formerly known as Standard Plate Count): The HPC provides an index of the level of the general bacteria population in the water system. HPC is a procedure for estimating the number of live, heterotrophic bacteria in water and measuring changes during water treatment and distribution. It is valuable for the checking quality of finished water in a distribution system, as an indicator of microbial regrowth and sediment build-up in slow-flow sections and dead ends. In the laboratory, using conditions of standard media, temperature and incubation time, colonies may arise from pairs, chains or clusters of cells and are reported as "colony forming units" (CFU).

Privately owned development (POD): Means a recreational development, school, mobile home park, restaurant, motel, community hall, work camp, holiday trailer park, campsite, picnic site, information centre or other similar development, including such a development owned or operated by the Government,

i) that is on a parcel of land that is not subdivided, and
ii) that is served by a waterworks system that uses as the source of its water supply
    a) surface water, or
    b) groundwater that requires treatment to comply with potable water quality requirements under section 6 of Alberta Regulation 277/2003

but does not include a single family dwelling, a farmstead or a development that is located on land that is included in a condominium plan registered under the Land Titles Act where the condominium is located in a city, town, new town, village, summer village or hamlet.

Private Water Supply: A private water supply is one that serves a single privately-owned residence, building, lot, or similar place, and where the public does not have any interest in such a water supply. Examples include, but are not limited to: owner-occupied residences.

Protozoa: Any of the single-celled, usually microscopic organisms of the phylum or subkingdom Protozoa, which includes the most primitive forms of animal life. In water systems, the protozoa of concern include *Giardia* and *Cryptosporidium.*

Public Water Supply: A public water supply is one that serves a single building, lot, or similar place, and where the public has an interest arising out of the need to safeguard the public health. Examples include, but are not limited to: food establishments, bed & breakfast facilities, gas stations, information centers, golf club houses, etc.

Service connection: Means the potable water service line from a water distribution main to the property being serviced (potable water service line from a water distribution main to a building).

Shock chlorination: The process of introducing a high level of chlorine to the well water. Unlike superchlorination, shock chlorination is a "one time only" occurrence, and chlorine is depleted as water flows through the system. De-chlorination is not required.

Source water: Water in its natural state, prior to any treatment for drinking.

Surface water: The water that systems pump and treat from sources open to the atmosphere, such as rivers, lakes and reservoirs.

Total Coliforms (TC): Total coliforms are a group of closely related bacteria that are, with a few exceptions, not harmful to humans. TC contain various species of the genera *Escherichia, Klebsiella, Enterobacter* and *Citrobacter*. Because TC are common inhabitants of ambient water and may be injured by environmental stresses (e.g. lack of nutrients) and water treatment (e.g., chlorine disinfection) in a manner similar to most bacterial pathogens and many viral pathogens, they are considered as a useful indicator of these pathogens. For drinking water, TC are used to determine the adequacy of water treatment and the integrity of the distribution system. The absence of TC in the distribution system minimizes the likelihood that fecal pathogens are present. TC are used to determine the vulnerability of a system to fecal contamination.

Watershed: The land area from which water drains into a stream, river or reservoir.

Wellhead protection area: The area surrounding a drinking water well or well field which is protected to prevent contamination of the well(s).

INTRODUCTION

Introduction:

Access to a safe water supply is a fundamental need and human right. It is vital for the dignity and health of all people and is a key factor in economic productivity. It is estimated that over 600,000 Albertans do not have access to assured high quality water supplies. They must rely on water supplies that may be variable in quality and both expensive and problematic to treat.

Officials representing the interests of public health, the environment, and the three levels of government recognise and are concerned about the vulnerabilities that currently exist in the provision of safe drinking water. A number of recent outbreaks and water-related concerns have once again underlined the importance of having procedures in place to protect the public from diseases that may be transmitted through contaminated drinking water.

In an effort to effectively address the public health issues pertaining to drinking water, a Technical Advisory Committee on Safe Drinking Water (TACSDW) was established in 2001 and produced this *Environmental Health Field Manual for Private, Public and Communal Drinking Water Systems in Alberta*. This manual requires ongoing input and maintenance to serve as a benchmark, and evolving water issues will require consideration and incorporation into this body of standards and guidance for public health professionals in this province.

This field manual is designed to be used by Health Agencies for the inspection and investigation of public, private and communal drinking water supplies. This manual does not govern POD, which is under the jurisdiction of Alberta Environment. The water systems covered by this manual include:

1. Individual privately owned wells, dugouts, and cisterns

2. Public or privately owned communal groundwater systems that :
   - Are located on one privately owned lot
   - Do not share the water distribution system with another lot owner
   - Do not require treatment to comply with potable water quality requirements under section 6 of Alberta Regulation 277/2003 Potable Water Regulation (does not include chlorination) i.e. does not involve any treatment that is needed to make the water safe to drink (does not include chlorination). The use of ion exchange and iron removal units are not considered processes needed for health reasons.
   - Have fewer than 15 connections, or
   - Have fewer than 3 km of distribution lines

This type of drinking water system may include:

- Campsites
- Community halls
- Farmsteads (includes Hutterite colonies or farms where there are more than one household)
- Holiday trailer parks
- Information centres
- Picnic sites
- Mobile home parks
- Motels
- Non-municipal designated drinking water systems located within the National Parks of Canada
- Recreational developments
- Restaurants
- Schools
- Single family residences not connected to another persons surface water system
- Unincorporated communities that have not been designated as a hamlet by the municipal government act
- Water co-ops
- Work camps

Information may apply to Federal lands under the jurisdiction of Health Canada and National Parks that have entered into an agreement with a local Regional Health Authority, allowing their Executive Officers to have public health jurisdiction within these Federal lands.

CHAPTER 1:

MICROBIAL INDICATORS

1.1 Microbial Indicators

1.2 Guidelines for Microbiological Parameters

This section describes the microbiological indicators used in the testing of drinking water and their implication in public health, and the most recent information on microbiological parameters from Health Canada, *Guidelines for Canadian Drinking Water Quality*.

CHAPTER 1: MICROBIAL INDICATORS

1.1 MICROBIAL INDICATORS

Laboratory results may provide information on levels of Total Coliforms, *Escherichia coli*, and Heterotrophic Plate Count (HPC). This section will briefly outline the rationale for including these indicators and their significance.

Total Coliform (TC)

The presence of Total Coliform bacteria may indicate contamination in a water supply. The absence of coliforms in a water supply is usually interpreted as evidence of safe drinking water, i.e. water free of pathogens and having a low risk of waterborne infectious disease. While the presence of only TC generally does not imply an imminent health risk, it does require a review of all facilities and operations to determine why these organisms are detected in the water system. Differentiation of members of the coliform group is of limited value since the presence of any coliform bacteria renders the water potentially unsafe and unsatisfactory.

Escherichia coli (EC)

E. coli has been demonstrated to be a specific indicator for the presence of fecal contamination. The finding of *E. coli* in water indicates the presence of material of fecal origin and thus a potentially dangerous situation, the nature of which should be determined by immediate investigation.

Heterotrophic Plate Count (HPC)

The HPC enumerates aerobic and facultative aerobic bacteria found in water These bacteria are not normally used as an indicator of disease, and bacteria in this group are not usually directly associated with a specific illness or disease. However, bacteria within the HPC can cause disease, both as primary pathogens and opportunistic pathogens. The HPC is useful for measuring changes during water treatment and distribution. It is valuable for checking quality of finished water in a distribution system as an indicator of microbial regrowth and sediment build-up in slow-flow sections and dead ends.

1.2 GUIDELINES FOR MICROBIOLOGICAL PARAMETERS

The maximum acceptable concentration (MAC) for the bacteriological quality in water is defined by Health Canada, under the *Guidelines for Canadian Drinking Water Quality* (Internet version, April 2003).

The MAC for the bacteriological quality of public, semi-public and private drinking water systems is no coliforms detectable per 100 mL. However, because coliforms are not uniformly distributed in water, and are subject to considerable variation in public

health significance, drinking water that fulfills the following conditions is considered to conform to this MAC:

For public drinking water supply systems:
(1) No sample should contain *Escherichia coli*
(2) No consecutive samples from the same site or not more than 10% of samples from the distribution system in a given calendar month should show the presence of total coliform bacteria.

For semi-public and private drinking water supply systems:
(1) No sample should contain *Escherichia coli* or total coliform bacteria

CHAPTER 2

SAMPLING PROTOCOL

This section describes the acceptable methods and suggested frequency for sampling of water to determine bacterial and chemical parameters.

** Information intended for the public and a generic version is provided on the attached compact-disc for Health Agencies to reproduce*

CHAPTER 2 – SAMPLING PROTOCOL

2.1. CHOOSING A SAMPLING LOCATION

GUIDELINES	REASONS
Avoid faucets that are seldom used	Water may be stagnant or old
Avoid sampling from a dead-end main	Water may be stagnant or old
Avoid a faucet that leaks around the stem	Water may run down the outside of the faucet and contaminate the sample
Avoid any faucet that is dusty, dirty or corroded	Possible sources of contamination
Avoid swing faucets	More susceptible to contamination in the swing connection
Avoid faucets that cannot deliver a smooth stream of water	Contain air bubbles
Avoid sampling from a flexible hose or garden hose	Debris and contamination
Avoid sampling from faucets with aerators or screen *	Debris and contamination
Avoid sampling from faucets that have a carbon point-of-use filter attached *	Debris and contamination
Avoid sampling from: - a dripping faucet - an outside hose bib with an unremovable vacuum breaker - a faucet with an unremovable aerator - a metal fixture with external plastic or rubber inserts	Potential contamination
Choose cold water faucets only	Bacteria may be affected, if hot water is tested
Choose a faucet that is NOT connected to the building's water softener	Debris and contamination
Choose a smooth-end faucet over a threaded-end faucet	Contamination around the threads

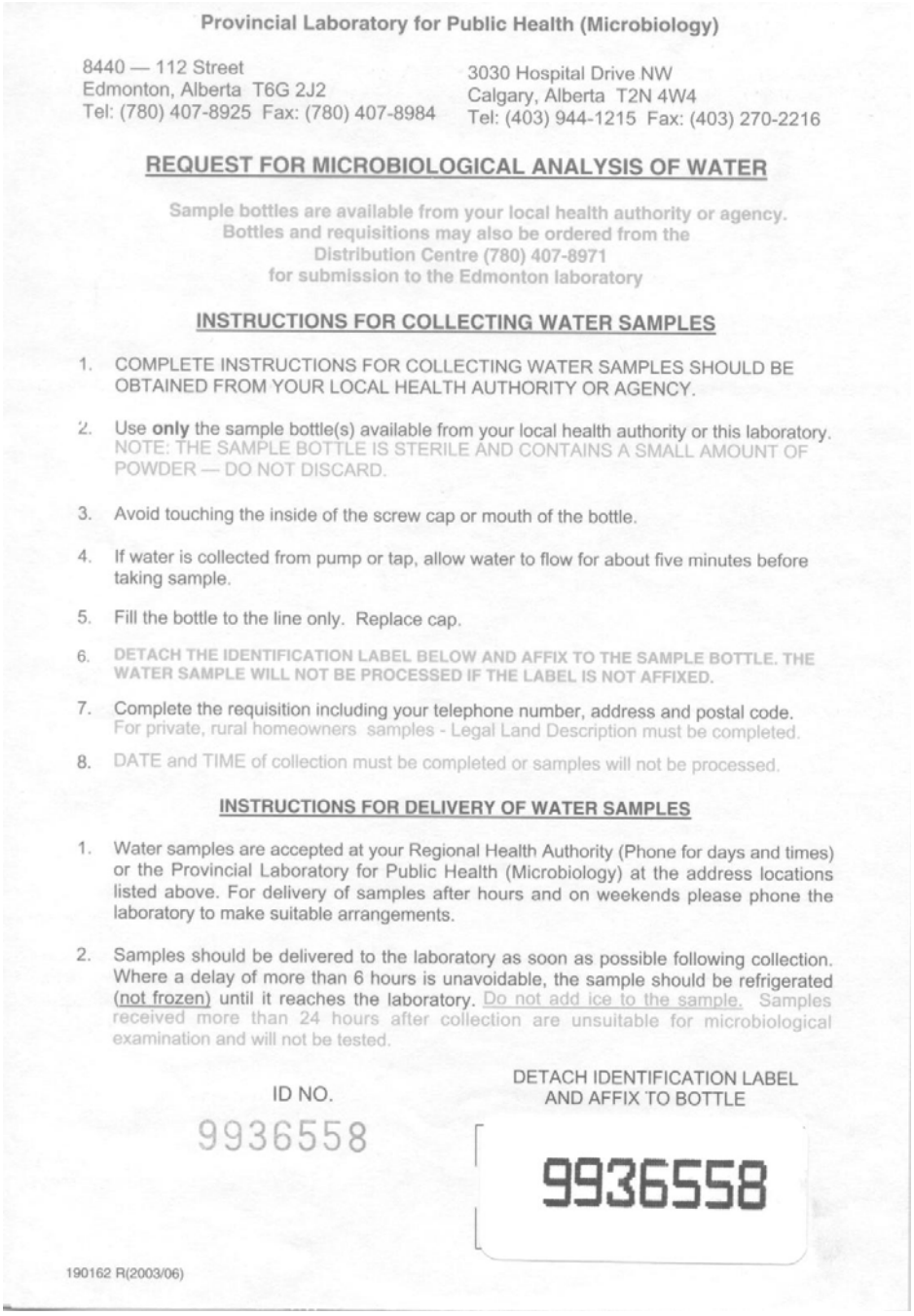
* Water samples taken after a point-of-use filter, aerator or screen may contain higher levels of bacteria. However, since this is the water the public may be drinking, a bacteriological analysis of the water after treatment is appropriate. Chemical testing of the water after treatment to determine the effectiveness of treatment devices is not acceptable.

2.2. DOS AND DON'TS OF COLLECTING WATER SAMPLES

DOs	DON'Ts
…Do choose a good sampling location/point to collect the sample (see 2.1). …Do make sure that hands are clean or washed prior to collecting the sample. …Do collect samples only in the approved sampling container. …Do collect samples from the cold supply only. …Do let the water run for 2-5 minutes before collecting the sample. …Do collect a sufficient amount of sample by filling the sample container to the "fill line" …Do attach the Identification Label onto the sampling container. …Do complete the requisition form including the name address, telephone number, and the date and time the sample was collected. …Do ship samples to the Provincial Laboratory in a cooler filled with frozen ice packs (not ice). …Do make sure that samples arrive at the laboratory within 24 hours after collection (arrival should be between the hours of 8:00 am – 4:00 pm).	…Don't collect samples from garden hoses, outside taps, or other locations that are likely to be dirty. …Don't rinse the sampling container. …Don't discard the sodium thiosulphate. …Don't touch the lip of the sampling container or the underside of the cap …Don't put the cap down while collecting the sample. …Don't allow the water to overflow or splash down the side of the sampling container.

2.3. REQUEST FOR MICROBIOLOGICAL ANALYSIS OF WATER FORM

FIGURE 2.1. REQUEST FOR MICROBIOLOGICAL ANALYSIS OF WATER FORM



Provincial Laboratory for Public Health (Microbiology)

8440 — 112 Street
Edmonton, Alberta T6G 2J2
Tel: (780) 407-8925 Fax: (780) 407-8984

3030 Hospital Drive NW
Calgary, Alberta T2N 4W4
Tel: (403) 944-1215 Fax: (403) 270-2216

REQUEST FOR MICROBIOLOGICAL ANALYSIS OF WATER

Sample bottles are available from your local health authority or agency.
Bottles and requisitions may also be ordered from the
Distribution Centre (780) 407-8971
for submission to the Edmonton laboratory

INSTRUCTIONS FOR COLLECTING WATER SAMPLES

1. COMPLETE INSTRUCTIONS FOR COLLECTING WATER SAMPLES SHOULD BE OBTAINED FROM YOUR LOCAL HEALTH AUTHORITY OR AGENCY.
2. Use **only** the sample bottle(s) available from your local health authority or this laboratory. NOTE: THE SAMPLE BOTTLE IS STERILE AND CONTAINS A SMALL AMOUNT OF POWDER — DO NOT DISCARD.
3. Avoid touching the inside of the screw cap or mouth of the bottle.
4. If water is collected from pump or tap, allow water to flow for about five minutes before taking sample.
5. Fill the bottle to the line only. Replace cap.
6. DETACH THE IDENTIFICATION LABEL BELOW AND AFFIX TO THE SAMPLE BOTTLE. THE WATER SAMPLE WILL NOT BE PROCESSED IF THE LABEL IS NOT AFFIXED.
7. Complete the requisition including your telephone number, address and postal code. For private, rural homeowners samples - Legal Land Description must be completed.
8. DATE and TIME of collection must be completed or samples will not be processed.

INSTRUCTIONS FOR DELIVERY OF WATER SAMPLES

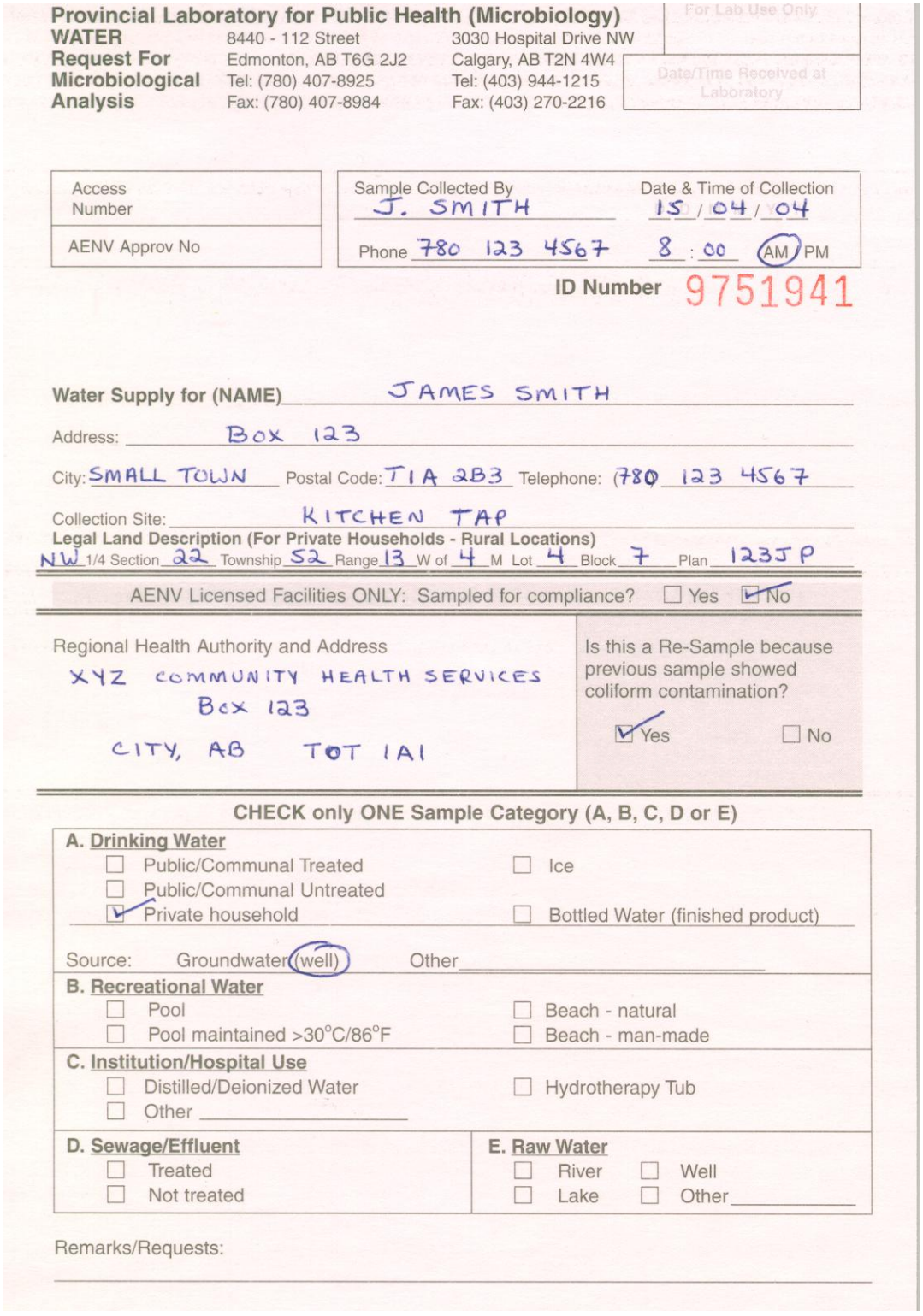
1. Water samples are accepted at your Regional Health Authority (Phone for days and times) or the Provincial Laboratory for Public Health (Microbiology) at the address locations listed above. For delivery of samples after hours and on weekends please phone the laboratory to make suitable arrangements.
2. Samples should be delivered to the laboratory as soon as possible following collection. Where a delay of more than 6 hours is unavoidable, the sample should be refrigerated (not frozen) until it reaches the laboratory. Do not add ice to the sample. Samples received more than 24 hours after collection are unsuitable for microbiological examination and will not be tested.

ID NO.
9936558

DETACH IDENTIFICATION LABEL AND AFFIX TO BOTTLE
9936558

190162 R(2003/06)

FIGURE 2.2. COMPLETED MICROBIAL REQUEST FORM FOR PRIVATE WELL



Provincial Laboratory for Public Health (Microbiology)

WATER Request For Microbiological Analysis

8440 - 112 Street
Edmonton, AB T6G 2J2
Tel: (780) 407-8925
Fax: (780) 407-8984

3030 Hospital Drive NW
Calgary, AB T2N 4W4
Tel: (403) 944-1215
Fax: (403) 270-2216

For Lab Use Only

Date/Time Received at Laboratory

Access Number

AENV Approv No

Sample Collected By: J. SMITH

Phone: 780 123 4567

Date & Time of Collection: 15 / 04 / 04

8 : 00 (AM) PM

ID Number 9751941

Water Supply for (NAME) JAMES SMITH

Address: BOX 123

City: SMALL TOWN Postal Code: T1A 2B3 Telephone: (780) 123 4567

Collection Site: KITCHEN TAP

Legal Land Description (For Private Households - Rural Locations)

NW 1/4 Section 22 Township 52 Range 13 W of 4 M Lot 4 Block 7 Plan 123JP

AENV Licensed Facilities ONLY: Sampled for compliance? ☐ Yes ☑ No

Regional Health Authority and Address

XYZ COMMUNITY HEALTH SERVICES
BOX 123
CITY, AB T0T 1A1

Is this a Re-Sample because previous sample showed coliform contamination?

☑ Yes ☐ No

CHECK only ONE Sample Category (A, B, C, D or E)

A. Drinking Water

- ☐ Public/Communal Treated
- ☐ Public/Communal Untreated
- ☑ Private household
- ☐ Ice
- ☐ Bottled Water (finished product)

Source: Groundwater (well) Other

B. Recreational Water

- ☐ Pool
- ☐ Pool maintained >30°C/86°F
- ☐ Beach - natural
- ☐ Beach - man-made

C. Institution/Hospital Use

- ☐ Distilled/Deionized Water
- ☐ Other
- ☐ Hydrotherapy Tub

D. Sewage/Effluent

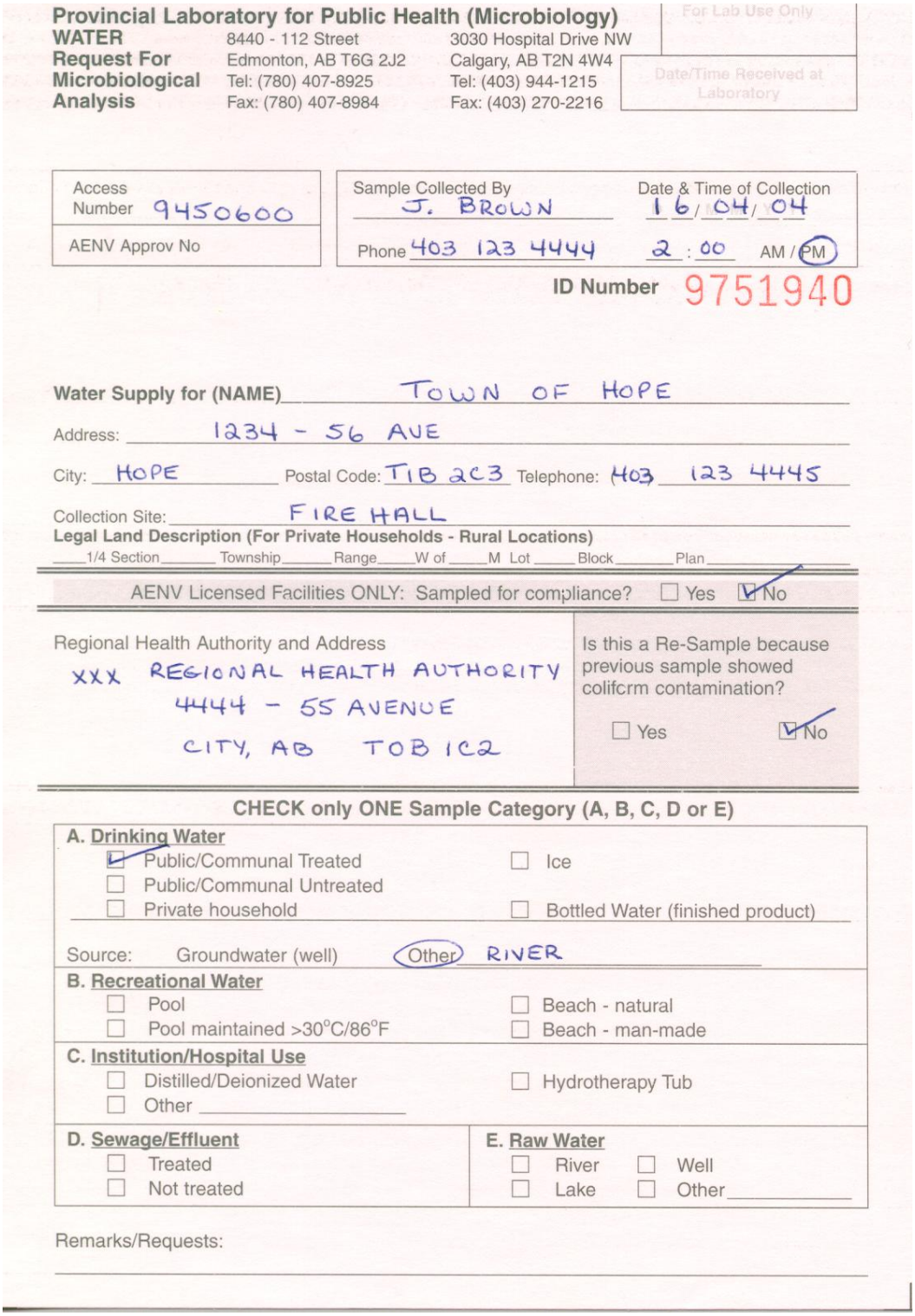
- ☐ Treated
- ☐ Not treated

E. Raw Water

- ☐ River
- ☐ Lake
- ☐ Well
- ☐ Other

Remarks/Requests:

FIGURE 2.3. COMPLETED MICROBIAL REQUEST FORM FOR PUBLIC SYSTEM



Provincial Laboratory for Public Health (Microbiology)

WATER Request For Microbiological Analysis

8440 - 112 Street
Edmonton, AB T6G 2J2
Tel: (780) 407-8925
Fax: (780) 407-8984

3030 Hospital Drive NW
Calgary, AB T2N 4W4
Tel: (403) 944-1215
Fax: (403) 270-2216

For Lab Use Only

Date/Time Received at Laboratory

Access Number 9450600

AENV Approv No

Sample Collected By J. BROWN

Phone 403 123 4444

Date & Time of Collection 16/04/04

2 : 00 AM / PM

ID Number 9751940

Water Supply for (NAME) TOWN OF HOPE

Address: 1234 - 56 AVE

City: HOPE Postal Code: T1B 2C3 Telephone: 403 123 4445

Collection Site: FIRE HALL

Legal Land Description (For Private Households - Rural Locations)

____1/4 Section_____ Township_____ Range____W of ____M Lot ____ Block_____ Plan_____

AENV Licensed Facilities ONLY: Sampled for compliance? ☐ Yes ☑ No

Regional Health Authority and Address

XXX REGIONAL HEALTH AUTHORITY
4444 - 55 AVENUE
CITY, AB T0B 1C2

Is this a Re-Sample because previous sample showed colifcrm contamination?

☐ Yes ☑ No

CHECK only ONE Sample Category (A, B, C, D or E)

A. Drinking Water

☑ Public/Communal Treated ☐ Ice
☐ Public/Communal Untreated
☐ Private household ☐ Bottled Water (finished product)

Source: Groundwater (well) (Other) RIVER

B. Recreational Water

☐ Pool ☐ Beach - natural
☐ Pool maintained >30°C/86°F ☐ Beach - man-made

C. Institution/Hospital Use

☐ Distilled/Deionized Water ☐ Hydrotherapy Tub
☐ Other _____

D. Sewage/Effluent

☐ Treated
☐ Not treated

E. Raw Water

☐ River ☐ Well
☐ Lake ☐ Other_____

Remarks/Requests:

2.4. SUBMISSION OF DRINKING WATER SAMPLES FOR BACTERIOLOGICAL ANALYSIS

The following table is a **RECOMMENDED** frequency schedule for the submission of drinking water samples for bacteriological analysis. This is only a **GUIDELINE** and may be altered to a greater or lesser extent depending on particular circumstances of the water supply. This guideline is intended for water supplies that do not fall under the jurisdiction of Alberta Environment.

Facility Type / ***Water Source***	Treated Surface Water	Treated Groundwater - Under Influence	Groundwater – Not Under Influence	Water Holding Tanks
Communal Supplies				
Water Co-operatives	W	W	W	W
Mobile Home Parks	W	W	Q	S
Potable Water Haulers	W	W	M	N/A
Public Supplies				
Institutions (hospitals, schools, childcare facilities, group homes, etc.)	W	W	M	M
Food Establishments	W	W	Q	Q
Recreation Areas/Campgrounds/Work Camps	W	W	Q	Q
Bed & Breakfast Facility	W	W	Q	S
Personal Service Facility	W	W	Q	S
Public Facilities (community halls, picnics sites, information centers, rest areas, etc.)	W	W	Q	Q
Rental Housing Premises (hotel/motels, apartments, single-family houses, etc.)	W	W	S	S
Private Supplies				
Private Home Owners	Q	Q	S	S

W = Weekly M = Monthly N/A = Not Applicable
Q = Quarterly S = Semi-Annually

Special Notes:

1. It is important to know the true source or type of water supply. Wells that are less than 15 metres deep are more likely to be under the influence of surface water than wells that are greater than 15 metres deep. Therefore, a careful assessment of the supply should always be conducted.
2. A multiple barrier approach should be applied to all public/communal water systems to reduce the possibility of it becoming a vehicle for the transmission of disease-causing organisms. The frequency of sampling may be altered if sufficient barriers are in place that will provide adequate protection of the water supply.
3. Facilities which may be at a higher risk include: hospitals, institutions, schools, childcare facilities, and homes for the aged/handicapped. Therefore, sampling frequencies may need to be altered when dealing with these types of facilities.
4. The number of people served by the water system may also influence the frequency of sampling. The more people that use the supply, the higher the risk. Therefore, the frequency of sampling may need to be altered.
5. Do not forget the regulatory requirements under the Public Health Act Regulations: water for public human consumption must be potable.

Sampling Notes:

6. Responsibility for collecting and submitting water samples should be placed on the owner/operator of the water supply. Health Agencies should ensure that persons collecting samples are properly trained in the procedure.
7. For new public water supplies or new public facilities, weekly submission of samples may be required for a period of time (weeks, months, years) to develop a history for that supply.
8. RHAs should perform periodic audits of each water supply, when conditions render it to be of poorest quality.
9. For seasonal operations, water samples should be submitted at the frequency determined while the facility is in operation. As a minimum, at least one water sample should be submitted prior to opening for the season.
10. Without proper treatment prior to consumption, surface water supplies and groundwater supplies that are under the influence of surface water are generally regarded as being unsafe to drink. In these instances, there may not be a need to carry out routine bacteriological sampling.
11. Where a Boil Water Order or Boil Water Advisory is in effect, the routine submission of samples is not necessary as the condition of the water is considered UNSAFE for drinking at all times. This does not, however, preclude sampling in order to rescind an Order or Advisory.

2.5. INSTRUCTIONS FOR COLLECTING WATER SAMPLES FOR BACTERIOLOGICAL ANALYSIS

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INSERT LOGO

INSTRUCTION FOR COLLECTING WATER SAMPLES FOR BACTERIOLOGICAL ANALYSIS

Please READ the general information and the procedure before you begin sampling. Take care to follow these instructions to avoid contaminating the sample.

General Information

- Samples will only be accepted if they are collected in the approved sampling container.
- Samples will only be accepted from a water supply that is intended for human consumption.
- Samples will only be accepted when accompanied with a completed requisition form.
- Collect samples from the cold water supply line only.
- Do not rinse the sampling container at any time.
- Do not touch the inside of the bottle cap or the mouth/neck of the sampling container.
- Do not allow the water to overflow or splash down the side of the sampling container.
- Do not collect samples from garden hoses, outside taps, or other locations that are likely to be dirty.
- Check with your local Health Agency for drop-off instructions and shipping times.

Procedure for Collecting Bacteriological Water Samples

1. Keep the sampling container closed until the moment it is filled.
2. Wash your hands with soap and warm water.
3. Do not touch the inside of the bottle cap or the mouth/neck of the sampling container, and do not place the cap on the counter.
4. Allow the cold water to run continuously for 2-5 minutes before collecting the sample. Do not adjust the tap at any time before collecting the sample.
5. Holding the sampling container near the base, fill it past the 200-mL. mark to about the shoulder of the container. DO NOT OVERFILL the container.
6. Replace the cap immediately and make sure it is on securely. DO NOT OVER TIGHTEN.
7. Attach the Identification Label from the requisition form to the sampling container.
8. Complete the requisition form and ensure that the following information is stated:
   - Name, Mailing Address, Postal Code, and **DAYTIME Telephone Number**
   - Site of Collection and Legal Land Description
   - Date and Time the sample was collected
   - Name of Person who collected the sample
   - Indicate if the sample is a “resample”
   - Complete Section A titled: Drinking Water
   - Include any special remarks or requests at the bottom

9. Place the sample and the completed requisition form in the plastic "Ziploc" bag.
10. Refrigerate the sample immediately (below 4º Celsius), and transport it in a cooler filled with ice packs.

Please note that the Provincial Laboratory will not accept samples that are more than 24 hours old - remember to make allowances for travel time. For the operating hours of the Lab, please consult your local Health Agency or the Provincial Laboratory

Insert Contact Info Here

2.6. SCREENING CRITERIA FOR BACTERIOLOGICAL WATER SAMPLES

Health Agencies and the Provincial Laboratory for Public Health, Microbiology [PLPH (M)] should apply the following criteria for screening water samples collected and submitted by the public and various industries. This criterion does not apply to water samples that are collected as part of an inspection or investigation by Regional Health Authorities, Alberta Environment or Health Canada.

Water Sample Form

Critical information must be provided on the form for the lab to process the sample. Critical information includes:

- Name of water source
- Address
- **Daytime** Phone number of contact
- Collection site of sample
- Date and time of sample collection
- Name of sample collector
- Type of sample
- Source of sample
- Identification number label attached to sample container

If this information is not provided on the form the PLPH may not process the sample and it may be discarded.

2.6.1. Drinking Water Sample

Accepted Samples:

- Sampling frequency from private, public and communal systems should follow the submission frequency guideline (sect. 2.4)
- Samples from public and communal systems may be submitted by the operator through the local health agency or directly to the PLPH (M).
- Private system operators (including wells and cistern/water storage tank) and water haulers (from their truck water tanks) must obtain the sample container through the local health agency for screening purposes. Ideally, samples should be submitted through the local health agency to ensure that the critical information has been provided on the requisition form. Samples should be collected at the point of consumption. Water analysis following a treatment device must be authorized by a Public Health Inspector.

Non-Accepted Samples:

- Samples from untreated (i.e. not filtered and not disinfected) surface water supplies such as dugouts, streams, sloughs, lakes, springs and rain barrels. These water sources can be assumed to be contaminated or easily susceptible to contamination so

the sample will have no value. Consumption of surface water without multiple barrier protection is not recommended.

- Samples for agricultural purposes (i.e. suitability for cattle, livestock or fish).
- Samples of bottled water from the bottled water industry (finished product and throughout the treatment process). Producers of bottled water should use accredited private laboratory services for quality control purposes. Bottled water sampled by an RHA, AE or Health Canada will be tested by PLPH (M) for total coliform and *E.coli* only.
- Private submission of bottled water (i.e. from bulk dispensers or water vending machines)
- Private submission of a sample from a public or communal system. Sample must be submitted by the operator of the system.

2.6.2. Other Types of Water Samples

Water samples other than drinking water, such as recreational, environmental or water for institutional systems, may be submitted to the PLPH(M) for bacteriological analysis. Guidelines for submission should be outlined by the health agency based on public health investigation and monitoring requirements.

2.7. REQUEST FOR CHEMICAL ANALYSIS OF DRINKING WATER FORM

FIGURE 2.4. REQUEST FOR CHEMICAL ANALYSIS OF DRINKING WATER FORM

Centre for Toxicology
University of Calgary
B19, 3330 Hospital Drive NW
Calgary, Alberta T2N 4N1 Canada
Tel: (403) 220-5511
Fax: (403) 270-2964

REQUEST FOR CHEMICAL ANALYSIS OF WATER

INSTRUCTIONS FOR COLLECTING WATER SAMPLES

1. Care should be taken to avoid touching the inside of the screw cap or mouth of the bottle. Use **only** the special bottle available from your Regional Health Authority.
2. If water is collected from pump or tap allow water to flow for about five minutes before taking sample.
3. Fill the bottle completely and cap **tightly.**
4. Submit drinking water sample from the primary residence **only.** Where water treatment or purification system is used, submit **only** the raw water supply.
5. DETACH THIS SHEET AND ATTACH ID No. LABEL BELOW TO THE INDICATED SPACE ON THE SAMPLE BOTTLE.
6. Complete the requisition including telephone number, address and postal code.
   LEGAL LAND DESCRIPTION AND WELL DEPTH (if applicable) MUST BE PROVIDED.

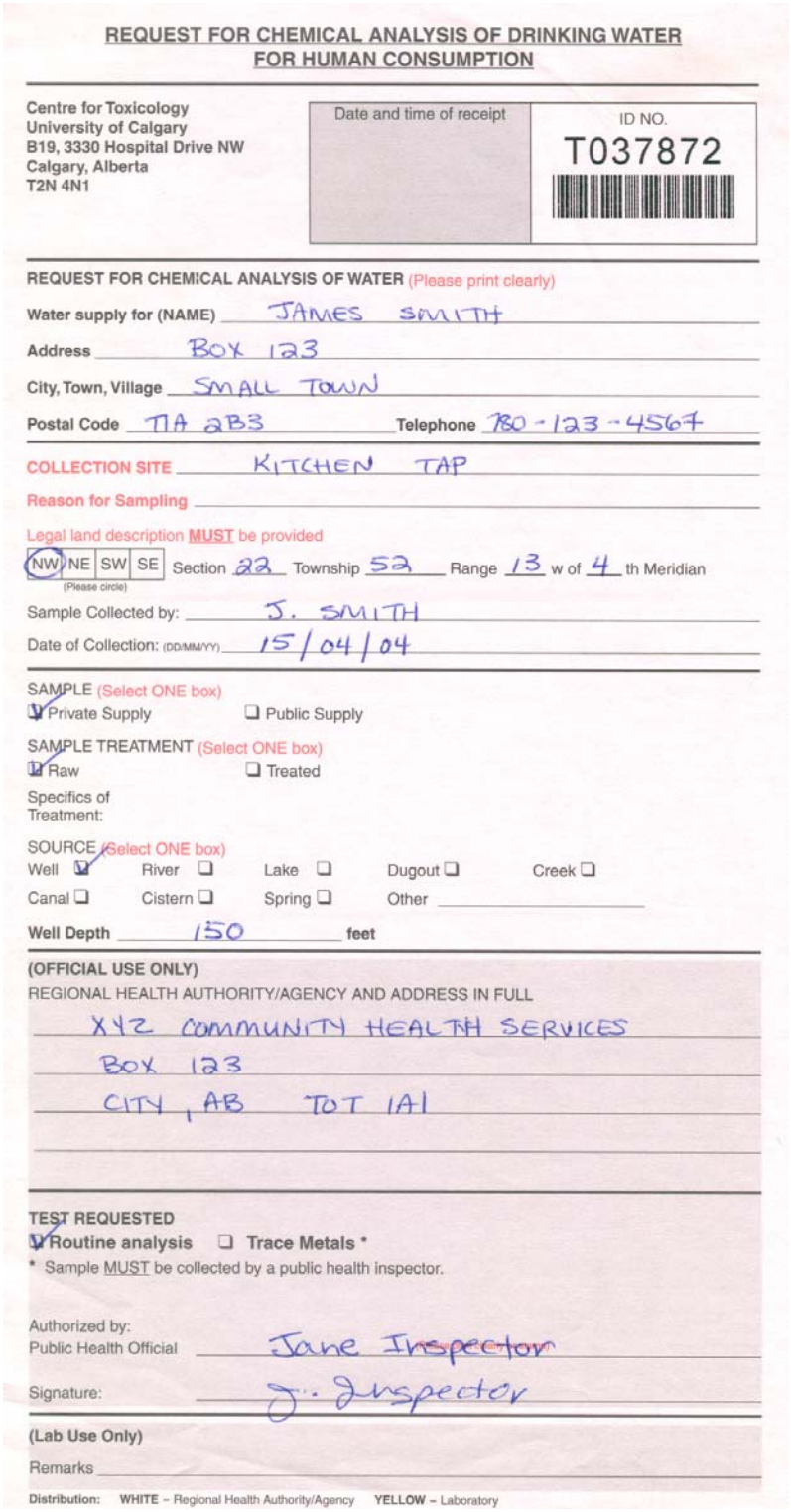
INSTRUCTIONS FOR DELIVERY OF WATER SAMPLES

1. Water samples are accepted at your Regional Health Authority (phone for days and times) or the Centre for Toxicology, University of Calgary, Monday to Friday, 8:30 a.m. to 4:30 p.m.
2. Samples should be delivered to your local Regional Health Authority or laboratory as soon as possible following collection.

IF THE ABOVE INSTRUCTIONS ARE NOT CAREFULLY FOLLOWED THE SAMPLE(S) MAY NOT BE PROCESSED.

ID NO.	- DETACH NUMBER LABEL AT PERFORATIONS - PEEL TAPE AND AFFIX LABEL TO PROPER BOTTLE	ID NO.
T 022403		T 022403
CHEMICAL		CHEMICAL

FIGURE 2.5. COMPLETED REQUEST FOR CHEMICAL ANALYSIS FORM FOR PRIVATE WELL



REQUEST FOR CHEMICAL ANALYSIS OF DRINKING WATER FOR HUMAN CONSUMPTION

Centre for Toxicology
University of Calgary
B19, 3330 Hospital Drive NW
Calgary, Alberta
T2N 4N1

Date and time of receipt

ID NO. T037872

REQUEST FOR CHEMICAL ANALYSIS OF WATER (Please print clearly)

Water supply for (NAME) JAMES SMITH

Address BOX 123

City, Town, Village SMALL TOWN

Postal Code T1A 2B3 Telephone 780-123-4567

COLLECTION SITE KITCHEN TAP

Reason for Sampling

Legal land description MUST be provided

(NW) NE SW SE (Please circle) Section 22 Township 52 Range 13 w of 4 th Meridian

Sample Collected by: J. SMITH

Date of Collection: (DD/MM/YY) 15/04/04

SAMPLE (Select ONE box)
☑ Private Supply ☐ Public Supply

SAMPLE TREATMENT (Select ONE box)
☑ Raw ☐ Treated

Specifics of Treatment:

SOURCE (Select ONE box)
Well ☑ River ☐ Lake ☐ Dugout ☐ Creek ☐
Canal ☐ Cistern ☐ Spring ☐ Other

Well Depth 150 feet

(OFFICIAL USE ONLY)

REGIONAL HEALTH AUTHORITY/AGENCY AND ADDRESS IN FULL

XYZ COMMUNITY HEALTH SERVICES
BOX 123
CITY, AB T0T 1A1

TEST REQUESTED
☑ **Routine analysis** ☐ **Trace Metals** *
* Sample MUST be collected by a public health inspector.

Authorized by:
Public Health Official Jane Inspector

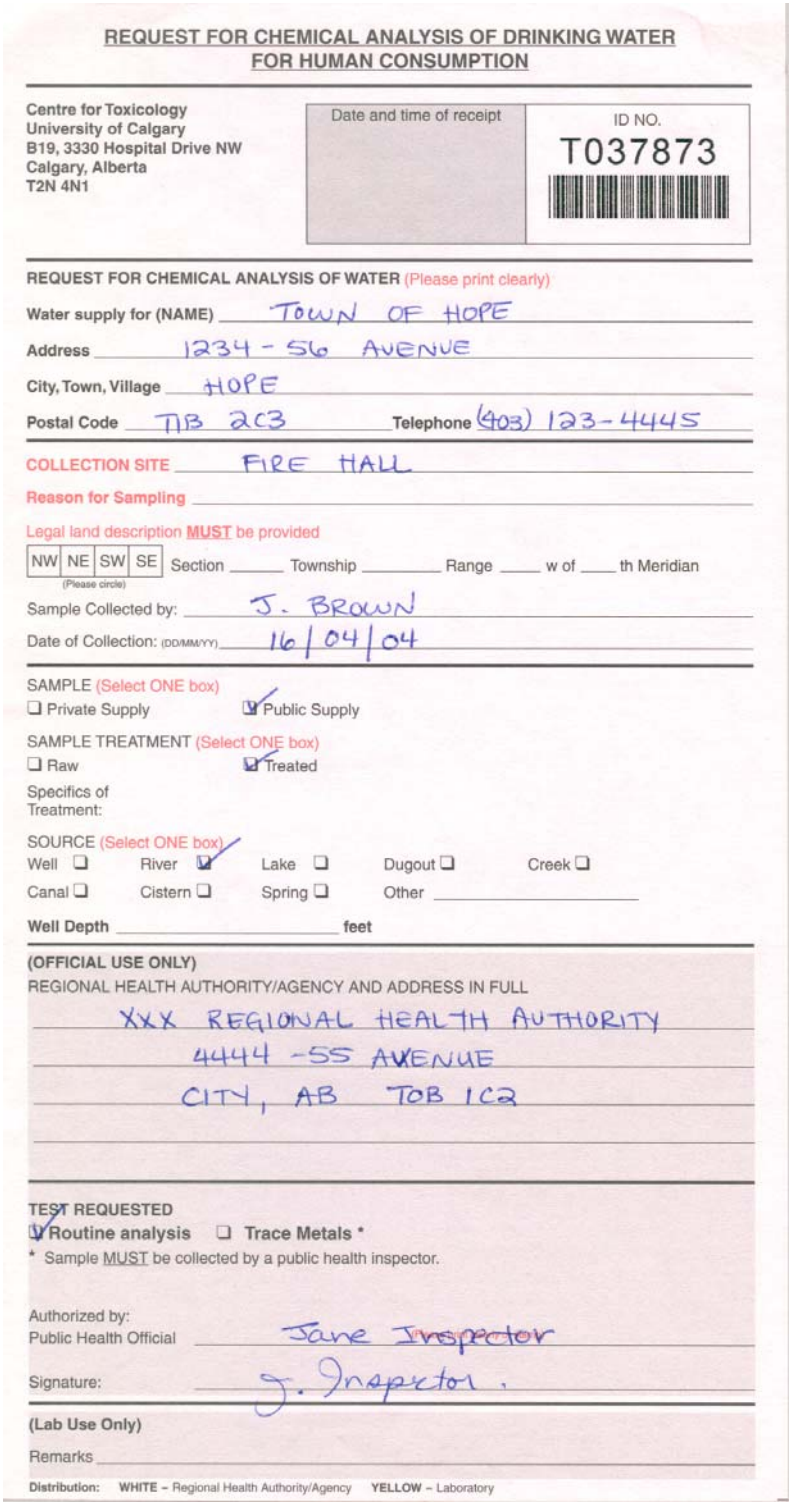
Signature: J. Inspector

(Lab Use Only)

Remarks

Distribution: **WHITE** – Regional Health Authority/Agency **YELLOW** – Laboratory

FIGURE 2.6. COMPLETED REQUEST FOR CHEMICAL ANALYSIS FORM FOR PUBLIC SYSTEM



REQUEST FOR CHEMICAL ANALYSIS OF DRINKING WATER FOR HUMAN CONSUMPTION

Centre for Toxicology
University of Calgary
B19, 3330 Hospital Drive NW
Calgary, Alberta
T2N 4N1

Date and time of receipt

ID NO. T037873

REQUEST FOR CHEMICAL ANALYSIS OF WATER (Please print clearly)

Water supply for (NAME) TOWN OF HOPE

Address 1234 - 56 AVENUE

City, Town, Village HOPE

Postal Code T1B 2C3 Telephone (403) 123-4445

COLLECTION SITE FIRE HALL

Reason for Sampling

Legal land description MUST be provided

NW NE SW SE (Please circle) Section ____ Township ____ Range ____ w of ____ th Meridian

Sample Collected by: J. BROWN

Date of Collection: (DD/MM/YY) 16/04/04

SAMPLE (Select ONE box)
☐ Private Supply ☑ Public Supply

SAMPLE TREATMENT (Select ONE box)
☐ Raw ☑ Treated

Specifics of Treatment:

SOURCE (Select ONE box)
Well ☐ River ☑ Lake ☐ Dugout ☐ Creek ☐
Canal ☐ Cistern ☐ Spring ☐ Other

Well Depth feet

(OFFICIAL USE ONLY)

REGIONAL HEALTH AUTHORITY/AGENCY AND ADDRESS IN FULL

XXX REGIONAL HEALTH AUTHORITY
4444 - 55 AVENUE
CITY, AB T0B 1C2

TEST REQUESTED
☑ Routine analysis ☐ Trace Metals *
* Sample MUST be collected by a public health inspector.

Authorized by:
Public Health Official Jane Inspector
Signature: J. Inspector

(Lab Use Only)

Remarks

Distribution: WHITE – Regional Health Authority/Agency YELLOW – Laboratory

2.8. SUBMISSION OF DRINKING WATER SAMPLES FOR CHEMICAL ANALYSIS

The following table is a **RECOMMENDED** frequency schedule for the submission of drinking water samples for chemical analysis. This is only a **GUIDELINE** and may be altered to a greater or lesser extent depending on particular circumstances of the water supply. This guideline is intended for water supplies that do not fall under the jurisdiction of Alberta Environment.

Facility Type / ***Water Source***	Treated Surface Water	Treated Groundwater - Under Influence	Groundwater – Not Under Influence	Water Holding Tanks
Communal Supplies				
Water Co-operatives	1 RTM	1 RTM	1 R	1 R
Mobile Home Parks	1 RTM	1 RTM	2 R	1 R
Potable Water Haulers	1 RTM	1 RTM	2 R	N/A
Public Supplies				
Institutions (hospitals, schools, childcare facilities, group homes, etc.)	1 RTM	1 RTM	1 R	1 R
Food Establishments	1 RTM	1 RTM	2 R	1 R
Recreation Areas/Campgrounds/Work Camps	1 RTM	1 RTM	1 R	1 R
Bed & Breakfast Facility	1 RTM	1 RTM	2 R	1 R
Personal Service Facility	1 RTM	1 RTM	2 R	1 R
Public Facilities (community halls, picnics sites, information centers, rest areas, etc.)	1 RTM	1 RTM	2 R	1 R
Rental Housing Premises (hotel/motels, apartments, single-family houses, etc.)	1 RTM	1 RTM	2 R	1 R
Private Supplies				
Private Home Owners	1 RTM	1 RTM	2 R	1 R

1 = Every Year
2 = Every 2 Years

R = Routine Chemical Analysis
T = Trace Metals Analysis
M = Mercury Analysis

N/A = Not Applicable

Special Notes

1. Surface water supplies and groundwater supplies that are under the influence of surface water may be subject to contamination from industrial pollutants. Therefore, an analysis for trace metals and mercury should be conducted on these supplies.
2. Although samples for routine chemical, trace metals and mercury analysis may be collected at any time during the year, the months between May, June and July should be considered.
3. Facilities which may be at a higher risk include hospitals, institutions, schools, childcare facilities, and group homes, etc. Sampling frequencies may need to be altered when dealing with these facilities.
4. Samples should be collected yearly, at the start of the operating season, for seasonal operations such as campgrounds, recreation areas, etc.

Sampling Notes

5. Samples for Routine Chemical analysis may be collected by the owner/operator or the Health Agency.
6. Samples submitted for trace metals and mercury should only be collected by the Health Agency and fixed with the proper preservative at the time of collection.
    - Samples for trace metals analysis should be fixed with nitric acid (HNO_3).
    - Samples for mercury analysis should be fixed with nitric acid/potassium dichromate solution ($HNO_3/K_2Cr_2O_7$).

2.9. INSTRUCTIONS FOR COLLECTING WATER SAMPLES FOR CHEMICAL ANALYSIS

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INSERT LOGO

INSTRUCTION FOR COLLECTING WATER SAMPLES FOR CHEMICAL ANALYSIS

Please READ the general information and the procedure before you begin sampling. Take care to follow these instructions to avoid contaminating the sample.

General Information

- Samples will only be accepted if they are collected in the approved sampling container.
- Samples will only be accepted from a water supply intended for human consumption.
- Samples will only be accepted from the raw water supply. A sample will be rejected if it has passed through a water treatment device.
- Samples will only be accepted when accompanied with a completed requisition form.
- Collect samples from the cold water supply line only.
- Do not touch the inside of the bottle cap or the mouth/neck of the sampling container.
- Do not collect samples from taps which have a point-of-use water filter connected.
- Do not collect samples from garden hoses, outside taps, or other locations that are likely to be dirty.

Procedure for Collecting Chemical Water Samples

1. Wash your hands with soap and warm water.
2. Allow the cold water to run continuously for 2-5 minutes before collecting the sample.
3. Fill the sampling container, leaving a little air space to allow the water to expand as it warms up during transportation. DO NOT OVERFILL the container.
4. Replace the cap and make sure it is on securely.
5. Attach the Chemical Identification Label from the requisition form to the sampling container.
6. Complete the requisition form and ensure that the following information is stated:
   - Name, Mailing Address, Postal Code, Telephone Number
   - Collection Site and Reason for Sampling
   - Legal Land Description where the water source is located MUST be provided
   - Date and Time the sample was collected
   - Name of Person who collected the sample
   - Complete remainder of the form
   - Where applicable, the well depth must be stated
7. Place the sample and the completed requisition form in the plastic “Ziploc” bag.
8. Return the sample to your local Health Agency.

Insert Contact Info Here

CHAPTER 3:

RESULT INTERPRETATION

3.1 Result Interpretation

3.2 Interpretation of Bacteriological Water Analysis Reports *

3.3 Interpretation of Chemical Water Analysis Reports *

This section provides information to PHIs/EHOs on how to interpret bacterial results, and standardized chemical and bacteriological water analysis forms for the public

** Information intended for the public and a generic version is provided on the attached compact-disc for Health Agencies to reproduce*

CHAPTER 3: RESULT INTERPRETATION

3.1 RESULT INTERPRETATION

The decision to take immediate corrective actions without waiting for confirmatory results should follow consideration of such factors as water history, sample details, results of other samples taken at the same time, type of system (source, distribution, treatment, residual, etc.), extraordinary system conditions or circumstances, and any other pertinent information. As a precaution, the operator of a water supply with no treatment, and the owner of a private water system, may be advised to boil drinking water or use an alternate source in the interim until further sampling can verify the result. For communal and public systems, a Public Health Inspector/Environmental Health Officer should ideally inspect the water system and collect the sample for verification purposes.

E. coli

The presence of *E. coli* in a communal, public or private water system indicates that the source or the system has been impacted by recent fecal contamination and therefore is unsafe to drink. If a sample contains *E. coli*, the drinking water should be immediately retested to confirm its presence. If resampling confirms the presence of *E. coli*, the corrective actions described in Chapter 6 should be taken immediately.

Total coliforms

The confirmed presence of coliform bacteria in water leaving the treatment facility for a disinfected communal water system indicates inadequate disinfection and the corrective actions described in Chapter 5 should be taken immediately. The presence of total coliforms in the distribution system but not in the water leaving the facility indicates either biofilm regrowth and/or system intrusion. In this scenario *E. coli* are considered a better indicator of microbiological safety. If total coliforms are present but *E. coli* are absent in the distribution system, a boil water advisory is not usually required unless there are additional factors that indicate a potential health hazard (for example, high turbidity, lack of disinfectant residual, etc.). Regardless, measures should be taken immediately to ensure that the source of the problem is found and corrective actions are taken.

In a disinfected public or private supply, the presence of total coliforms can indicate inadequate disinfection and/or re-contamination following treatment. Since these systems do not have an extensive distribution network, regrowth is not usually a problem. Also, these systems may not be monitored as frequently as communal systems and may not have trained staff on hand to quickly deal with problems. Therefore, if the presence of total coliforms is confirmed, the corrective actions described in Chapter 6 should be taken immediately. As a precaution, the owner may be advised to boil drinking water or use an alternate source in the interim regardless of concentrations of coliform bacteria present.

In a non-disinfected groundwater supply, source protection is the only barrier to contamination. The confirmed presence of total coliforms in water entering the distribution of a communal system, or in water from a public or private system, indicates

that a well may be vulnerable to contamination and the corrective actions described in Chapter 6 should be taken immediately. Some jurisdictions will not act upon the occasional presence of low levels of total coliforms in private well water provided a periodic sanitary survey demonstrates that the well is not impacted by surface water.

Resampling

Ideally, a Public Health Inspector/Environmental Health Officer will perform initial resampling for public and communal supplies to minimize the possibility of sampling error.

It should be noted that a single negative sample is not necessarily indicative of a safe water supply. Only a history of data can be used to confirm the long-term integrity of a supply when applied jointly with the verification of the suitability of the system design and its operation and maintenance. If the second sample does not contain *E. coli* or other coliform bacteria, a third sample should be collected. If the third sample contains *E. coli* or other coliform bacteria, then the corrective actions as described in Chapter 6 should be taken immediately. If the third sample is free of *E. coli* or other coliform bacteria, the water should be safe to drink. However, an additional test should be taken after 3 to 4 months on systems with no routine monitoring of bacteriological quality (such as private systems), to ensure contamination has not recurred.

3.2 INTERPRETATION OF BACTERIOLOGICAL WATER ANALYSIS REPORTS

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INSERT LOGO

INTERPRETATION OF BACTERIOLOGICAL ANALYSIS OF WATER ANALYSIS REPORTS

Is My Water Safe to Drink?

Based on the analysis, water samples will be categorized as being Satisfactory, Doubtful, or Unsatisfactory for human consumption.

❑ **SATISFACTORY**: Both Total coliforms and *E. c*oli are "Absent". The water is safe for human consumption **. In order to ensure that it is safe in the future we recommend that you sample your water for bacteria twice per year.

** Notwithstanding the bacteriological results, all surface water supplies, as well as groundwater supplies that are under the influence of surface water, are not considered safe to drink unless they are properly treated first. This usually includes filtration & chlorination, or boiling.

❑ **DOUBTFUL**: Total coliforms are "Present" but *E. coli* is "Absent".

What Should I Do if My Water is Doubtful?
It is recommended that you submit a second sample to confirm the presence of such organisms. Please see attached sheet entitled "Tips for Collecting Water Samples" for proper collection and submission methods. If repeat samples return doubtful you may need to shock chlorinate your well. Contact your local Public Health Inspector for assistance.

❑ **UNSATISFACTORY**: *E. coli* is "Present". The water should NOT be used for human consumption, unless boiled or disinfected prior to consumption. Water is safe to drink if boiled for at least 1 minute.

What Should I Do if My Water is Unsatisfactory?
The **supply from which it was collected should not be used for human consumption** without first being boiled for at least 1 minute. Steps should be taken to identify possible sources of contamination, and corrective measures should be implemented to protect the water supply. In some cases, the source of contamination can be removed and the supply returned to satisfactory quality. In other instances, shock chlorinating the well and distribution system may be effective in bringing the supply back to satisfactory quality. If this is not possible, continuous disinfection of the water supply may be required or a new source of water utilized.

What Does a Bacteriological Analysis Determine?
A bacteriological analysis determines the presence or absence of certain bacteria in a sample of water. By determining this, we can determine whether or not the water supply, from which the sample was collected, is safe to drink.

What Types of Bacteria are Tested?
The Provincial Laboratory of Public Health now performs 2 standard tests on water samples submitted for bacteriological analysis. These tests are:

1. Total Coliforms
   Coliforms are a group of bacteria that are found everywhere in the environment, and they may originate from both faecal and non-faecal sources. The test for total coliforms determines the presence or absence of these bacteria in 100 millilitres of sample. The isolation of coliforms indicates contamination, but it will not determine whether such contamination is from faecal or non-faecal sources. Coliforms may be present in the sample as a result of minor problems in the well (cracked casing, seal around well head is not sound etc), distribution system, or through improper collection of the sample.

2. *E. coli*
   E. *coli* are bacteria that originate from the intestines and wastes of all warm-blooded mammals including humans. The test for *E. coli* determines the presence or absence of such bacteria in 100 milliliters of sample. The isolation of *E. coli* in a water sample indicates recent pollution from human or animal wastes (feces).

Maintaining Your Well
Private water wells are frequently neglected. A well in poor condition may result in a deterioration of the water quality. To check the condition of your well, use the following list to perform a visual inspection:

- The well is fully accessible.
- The sanitary seal or well cap is in place and is watertight.
- There are no cracks or openings in the well casing that may permit access of water, debris or other unwanted items.
- Surface water runoff is directed away from the well and does not collect or pond in the vicinity of the well.
- Sanitary seal or well cap is at least 30 cm above ground surface, not buried.
- The air vent is unobstructed and screened.
- The well is located away from any sources of pollution (sewage, petroleum products etc.) which may potentially contaminate the well or aquifer.

By taking the time to visually inspect your well, you may identify potential problems with your well before they end up costing you money or affecting your health. It is recommended that you sample your well water for bacteria twice per year, preferably in the spring and fall.

Insert Contact Info Here

3.3 INTERPRETATION OF CHEMICAL WATER ANALYSIS REPORTS

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INTERPRETATION OF CHEMICAL WATER ANALYSIS REPORTS

pH Acceptable range for drinking purposes is from 6.5 to 8.5. Levels below 6.5 may be corrosive, while levels above 8.5 may create scaling problems and a bitter taste.

CONDUCTIVITY Most drinking waters have conductivity's below 2000 uS/cm. Conductivity is used to determine the total amount of dissolved solids in the water.

SODIUM For people suffering from hypertension, congestive heart failure or heart disease, recommended limit is 20 mg/L. Over 200 mg/L is considered high. If in doubt consult your physician. No apparent hazard to people in good health.

Note: Water softening devices usually increase sodium concentration, while reverse osmosis and distillation units will reduce it.

POTASSIUM Recommended limit is 20 mg/L. Levels above 100 mg/L may cause a laxative effect, while levels above 340 mg/L may affect taste.

CALCIUM Recommended limit is 200 mg/L. Excessive calcium may contribute to the formation of kidney or bladder stones. Calcium also contributes to the hardness of water.

MAGNESIUM Recommended limit is 150 mg/L. Magnesium is a salt that contributes to the hardness and taste of water. Excessive magnesium may give water a bitter taste, but is normally not a health hazard. Water softeners will reduce the level of magnesium in the water.

HARDNESS Water hardness results from the water accumulating calcium, magnesium, and other minerals as it moves through the earth. The most desirable range of hardness is between 80 and 100 mg/L. Total hardness less than 80 mg/L may result in corrosive water, while hardness above 100 mg/L may result in the need for more soap during bathing and laundering. Excessive hardness may also lead to scale deposits in pipes, heaters, and boilers. Water softeners will reduce hardness to acceptable levels, but will consequently increase sodium concentrations (see Sodium). Hardness values exceeding 500 mg/L are generally unsuitable for domestic purposes without treatment.

IRON Recommended limit is 0.3 mg/L. Excessive iron may result in staining (reddish brown) of laundry, plumbing fixtures, and even hair. High iron levels also encourage the growth of iron bacteria. Iron in drinking water is not a health hazard unless at extreme levels. Iron removal units will reduce iron concentrations.

ALKALINITY Acceptable limit is 500 mg/L. Excessive alkalinity may cause stomach upset and encrustation of utensils, pipes and heaters.

CARBONATE Recommended limit is 350 mg/L. Carbonates are associated with the level of alkalinity.

BICARBONATE Recommended limit is 1000 mg/L. Excessive bicarbonate contributes to the production of scale in water heaters and kettles.

CHLORIDE Recommended limit is 250 mg/L. Excessive chlorides give the water a "salty" taste, usually noticeable over 500 mg/L.

FLUORIDE Recommended limit is 1.5 mg/L. Values over 1.5 mg/L of water may cause dental fluorosis in children between the ages of birth to 13 years. Steps may be taken to reduce the risk of dental fluorosis. For more information contact the Dental Program through your Health Agency.

NITRITE Recommended limit is 1 mg/L.

NITRATE Recommended limit is 10 mg/L.

If these limits are exceeded, human and/or animal wastes contamination should be suspected and an investigation carried out to determine the source.

Nitrate and Nitrite concentrations above limits are dangerous to pregnant women and infants under 3 months of age because of their ability to cause Methaemoglobinaemia, or Blue Baby Syndrome, in which the blood loses its ability to carry sufficient oxygen. Nitrates and Nitrites can be removed by distillation and reverse osmosis units. Water softeners do not remove nitrates/ nitrites. Boiling the water will increase nitrate/nitrite concentrations.

SULPHATE Recommended maximum concentration is 500 mg/L. Excess sulphate levels may have a laxative effect on new users and produce an objectionable taste. Regular users tend to become accustomed to high sulphate levels. Your physician should be consulted if sulphate levels exceed 500 mg/L.

CATION/ANION BALANCE These numbers are laboratory quality control accuracy checks for instrumentation and process.

Comments: _____

Inspector: _____

Insert Contact Info Here

CHAPTER 4:

SITE INVESTIGATION

4.1 Wells
- 4.1.1 Siting
- 4.1.2 Design and Construction
- 4.1.3 Management and Maintenance

4.2 Dugout Water Supplies
- 4.2.1 Location
- 4.2.2 Design and Construction
- 4.2.3 Operating System
- 4.2.4 Management

4.3 Cisterns

For more information on these topics, clients should be referred to the Alberta Environment or Prairie Farm Rehabilitation Administration offices for copies of the publications "*Water Wells That Last for Generations*" or "*Quality Farm Dugouts*".

CHAPTER 4: SITE INVESTIGATION

4.1 WELLS

4.1.1 Siting

In general, wells should be located so that the risk of contamination is minimized and that the well is accessible for monitoring and maintenance. Several factors should be considered in assessing contamination risk, including the type of well construction, the sources of contamination, and the slope and drainage of the area in which the well is located.

Access

- A well must be accessible for cleaning, testing, monitoring, maintenance and repair.

Slope

- The well should be located in a high area, up-slope from any potential contamination sources such as septic systems, barnyards or surface water bodies.
- If the well is in an area that frequently experiences surface runoff, diversion terraces or ditches should be constructed at least 15 m (50 feet) up-slope from the well to intercept and divert surface runoff around the well site.
- If a well is located on a flood plain, check to ensure that the casing extends above flood levels
- Ensure that the ground surrounding the well is sloped away from the well to prevent any surface runoff from collecting around the well.

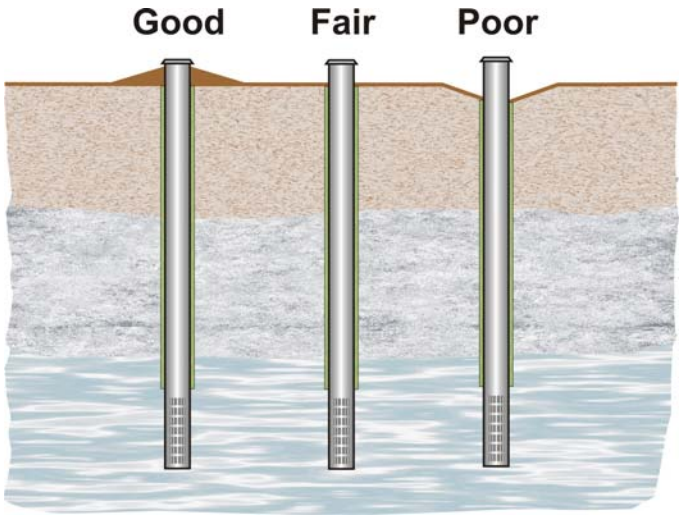

Figure 4.1: The ground surrounding the well should be mounded to prevent surface runoff from ponding around the well site. Source: AAFC-PFRA

Most contaminants enter the well either around the outside of the well casing, or through the top. In general, wells should be located in areas with good surface drainage so that runoff water is directed away from the well. In regions with poor drainage, surface water runoff may move toward the well, and create a greater risk of contamination.

Well Pits

- Under the Water Act, new wells may not be located in well pits.
- Older wells that are located in well pits should be retrofitted with pitless adaptors and the well pit should be filled in.
- Well pits that remain in use should be properly ventilated before being entered, and all care should be taken to ensure the pit is sealed from water and animal contamination

Under the Water Act, new wells may not be located in well pits. Well pits significantly increase the risk for groundwater contamination. They provide a place for surface water or shallow groundwater to collect which can then contaminate the aquifer by seeping around the outside of the well casing or flowing into the well from the top. Well pits are also susceptible to contamination by small animals and insects.

Well pits are also potential safety hazards. In some wells, changes in atmospheric pressure cause wells to expel air from the bedrock into the well pit or take air in from the well pit. As a result, well gases and/or low oxygen levels may be present in the well pit, which could lead to asphyxiation of people entering the pit. Furthermore, a potential buildup of methane gas in a well pit could lead to an explosion.

Pitless adapters are mechanical devices that provide frost free, sanitary well connections.

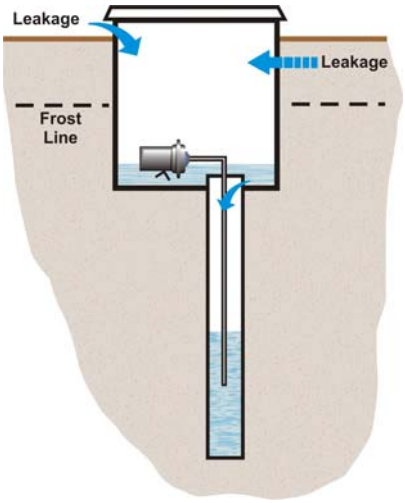

Figure 4.2: Well pits can lead to contamination and are no longer legal in Alberta. Source: AAFC-PFRA

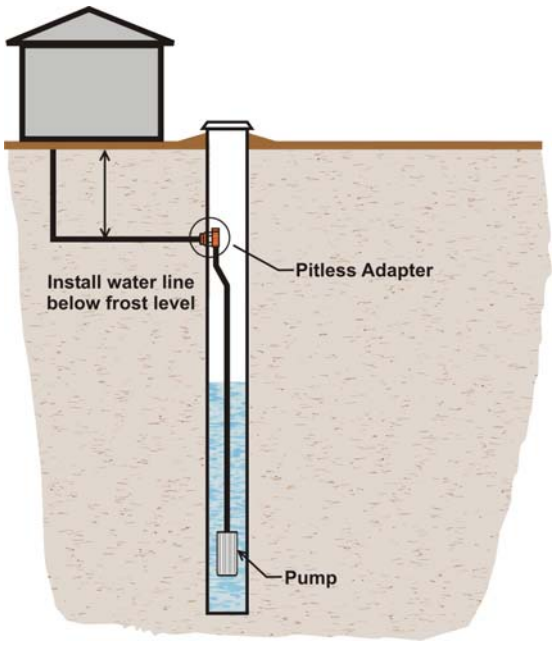

Figure 4.3: Pitless adapters provide a frost-free sanitary well connection. Source: AAFC-PFRA

Pumphouses

- Pumphouses must be designed to ensure that water does not collect on the pumphouse floor.
- Pumphouses must be ventilated properly to ensure gases do not collect in the enclosed space.
- Pumphouses must be designed to ensure that animals cannot gain entry.

A well may be located in a pumphouse building that houses the well and the pump provided the building is at ground level.

Minimum Separation (Setback) Distances

Provincial regulations outline the minimum distance requirements for wells as follows:

a) 10 m from a watertight septic tank
b) 15 m from a sub-surface weeping tile effluent disposal field or evaporation mound
c) 50 m from sewage effluent discharge to the ground
d) 100 m from a sewage lagoon
e) 50 m from above-ground fuel storage tanks
f) 3.25 m from existing buildings
g) 2 m from overhead power lines if:
    - the line conductors are insulated or weatherproofed and the line is operated at 750 volts or less
h) 6 m from overhead power lines if the well:
    - does not have a pipe and sucker rod pumping system
    - has a PVC or non-conducting pipe pumping system

- has well casing sections no greater than 7 m

i) 12 m from overhead power lines for all other well constructions
j) 500 m from a sanitary landfill, modified sanitary landfill or dry waste site

Note: If the well is used for municipal purposes, the minimum distance requirements are 100 m for a) to e) above.

There are other potential contamination sources for which no minimum distance requirements exist under the provincial regulations. Some of these include things like pesticide/fertilizer storage, silage storage, animal barns, livestock pens, and manure storage facilities. Some recommended minimum distance setbacks that have been derived from the U.S. and other provinces for these sources are:

- 50 m from above-ground fertilizer and pesticide storage containers
- 50 m from silage storage
- 100 m from livestock yards and animal barns
- 100 m from any manure storage facilities

The recommended setback distances represent a minimum distance. The actual acceptable distance is dependent on the type of contaminant and soil, slope of the land and groundwater hydraulics. In some cases, the setback distances may need to be greater than the minimum distance prescribed in regulations or guidelines in order to be effective in reducing risk.

4.1.2 Design and Construction

Properly designed and constructed wells will minimize the risk of surface pollution and influence. There are five construction factors that can influence the risk for contamination: type of well, casing material, intake, seals and caps, and post-construction disinfection.

Type of Wells

Bored wells pose the highest risk of contamination through surface water influence.

Bored wells are constructed in low-yielding shallow groundwater aquifers. They are often shallow (less than 30 m deep) and have a large diameter casing (45-90 cm). The large diameter casing provides a storage reservoir that can potentially be contaminated from surface water and from animals that fall into the well.

Drilled wells are smaller in diameter (10-20 cm) and are usually completed to depths much greater than bored wells. The aquifer into which the well is drilled is less susceptible to pollution from surface sources because of its depth. Often there is a confining bedrock layer above the aquifer through which water cannot easily percolate.

Local geology determines the length of time for pollutants to contaminate well water. In some places, this process happens quickly - less than one year. Areas with thin, sandy soil cover or cracked and exposed bedrock are particularly vulnerable. On the other hand, thick clay soils absorb some pollutants. This may delay - but not prevent - the day when a well becomes contaminated.

The well age is an important factor in predicting the likelihood of high nitrate concentrations. A well constructed more than 70 years ago is likely to be at the center of the farmstead. The well may be shallow and is probably surrounded by many potential contamination sources. Older well pumps are more likely to leak lubricating oils. Older wells are also more likely to have thinner casing that is corroded through.

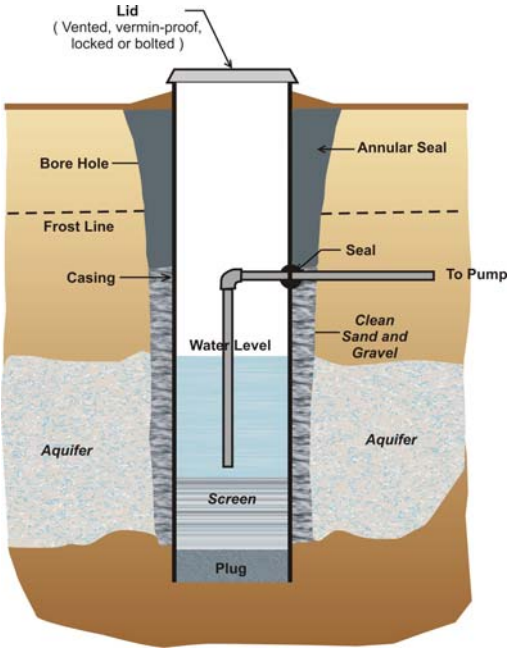

Figure 4.4: Example of a bored well. Source: AAFC-PFRA

Well Casing

- Well casing should extend at least 20 cm above the ground surface or pumphouse floor
- Well casing of wells that are not equipped with a watertight cap should extend at least 60 cm above the highest flood record
- If plastic casing is used, the well should be protected at the ground surface with steel casing that is firmly anchored in the ground.
- The space between the borehole and the casing (the annulus) should be sealed with an impervious material (e.g. bentonite or cement) to prevent any surface contamination.
- Visually inspect the well casing with a flashlight for holes or cracks at the surface or down the inside.
- Listen for water running down into a well - a signal that the casing is leaking.

- Try moving the casing by pushing against it. A moving casing is an indication of problem with the integrity of the well.
- Check whether the casing is plastic or steel. Steel casing is more prone to corrosion.

Wells that are properly constructed will minimize surface water influence. Wells constructed in Alberta must use casing materials that are new and uncontaminated. Casing may be made of plastic or steel. Steel casing is more prone to corrosion and poses a higher risk for leakage and contamination than plastic casing. In Alberta, well construction materials are regulated through the Water Act and must meet or exceed standards set by the Canadian Standards Association or the American Society of Testing and Materials.

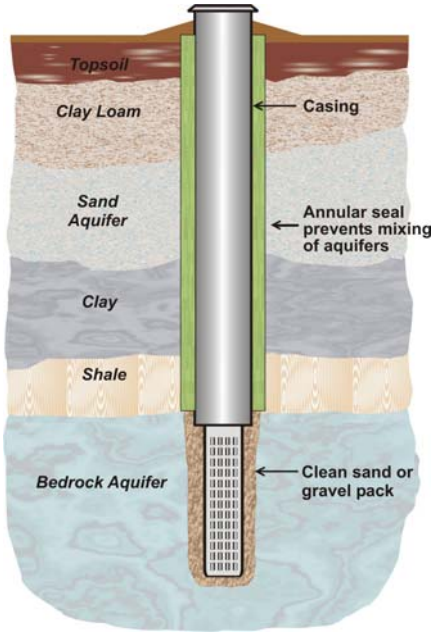

Figure 4.5: Illustration of a sealed annulus. The sealed annulus prevents surface water from draining into the borehole and also prevents intermixing of aquifers. Source: AAFC-PFRA

Intakes

- Ensure that the pumping water level is not below the top of the intake screen, slot openings, or perforations
- Wells completed in loose material like fine sand, gravel or soft sandstone, should have a screen for the intake in order to keep sediment out of the well.

Water moves into the well from the aquifer through either a manufactured screen or through slots or perforations in the casing. Screens are usually made from stainless steel because they are strong and withstand corrosion. Screens should always be used in aquifers composed of loose materials to ensure that fine sediment does not enter the well.

If the pumping water level goes below the top of the screen or casing slots/perforations, oxygen may enter the aquifer, which could enhance bacterial growth and reduce the well yield.

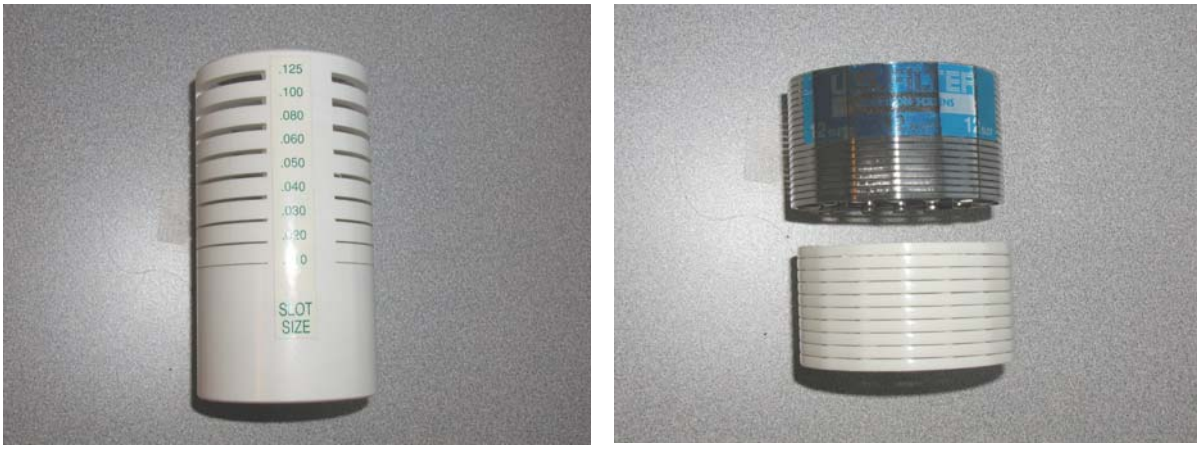

Figure 4.6: Examples of a slotted liner (left), stainless steel screen (top right) and plastic screen (bottom right).

Well Caps and Seals

- The water well must be securely covered to prevent the entry of surface water and foreign materials into the water well.
- On a bored well, the cap must have a minimum 5 cm overlap with the casing.

Well caps and seals are devices used to cover the top of the well casing to prevent the entry of surface water and foreign materials (e.g. rodents, insects etc). A sanitary well seal differs from a well cap in that a seal has a gasket and a cap does not. Well caps and seals should be vented to allow pressure equilibrium. The vent pipe must be screened to reduce contaminant entry, placed high enough not to be flooded, and face the ground.

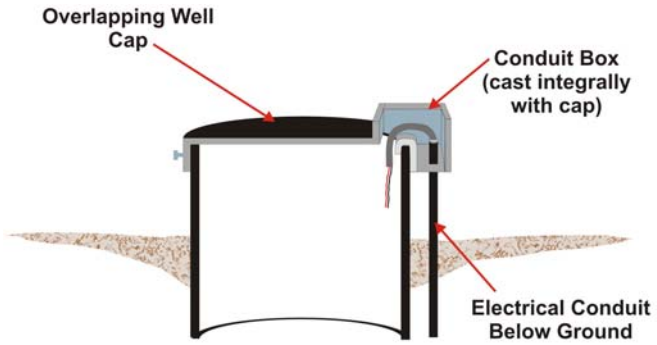

Figure 4.7: Example of a well cap.
Source: AAFC-PFRA

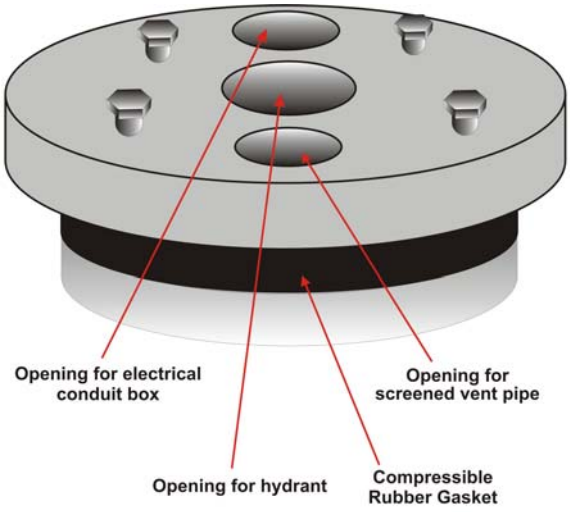

Figure 4.8: Example of a well seal. Source: AAFC-PFRA

4.1.3 Well Management and Maintenance

- Encourage well owners to take water level readings every 1-3 months
- Encourage well owners to have the water quality tested regularly (see Chapter 2).
- Wells should be shock chlorinated on a regular basis (spring and fall for wells that typically have iron bacteria, less frequently for other wells)
- Anti-backflow devices should be installed on all faucets with hose connections.
- Anti-backflow devices should be used when filling pesticide sprayer tanks directly from a well hydrant.

Good well maintenance includes regular testing of well water level and quality, keeping the well area clean and accessible, ensuring potential contamination sources are kept as far away from the well as possible, and periodically having the well mechanics checked.

An effective monitoring program will identify changes in water levels and quality before they become serious problems. Regular water level measurements will indicate whether water levels have changed significantly. This can help spot problems such as pumping the well at a greater rate than the aquifer is capable of producing, a plugged screen (or slotted casing) which can diminish well's efficiency, disturbance of the aquifer from nearby construction, or reduced groundwater recharge. Regular water quality testing can help identify problems such as aquifer contamination, problems with a well's structure, or lack of routine maintenance (e.g. buildup of iron bacteria).

Wells should undergo disinfection on a routine basis. Bacteria may be introduced during drilling of a well or when pumps are removed for maintenance. Some bacteria (particularly iron and sulphate reducing bacteria) exist naturally in the groundwater, but it is still important to periodically reduce their population to combat staining, plugging, smell and reduced yield. Shock chlorination is the easiest and most effective way to periodically disinfect the well (see Chapter 5).

4.2 DUGOUT WATER SUPPLIES

Dugout water may contain microorganisms which may be harmful. Dugout water is not designed for human consumption without proper treatment and disinfection.

4.2.1 Location

The location of a dugout can influence the quality of the water in the dugout. The runoff water that fills the dugout should be as clean as possible and enough water should be collected so that changes to the water quality within the dugout are minimized.

Protecting the water source – Best Management Practices

It is important that the land that contributes surface runoff into a dugout is managed to reduce the potential for contaminants to enter the dugout. Inquire about the land use in the area that contributes runoff to the dugout and determine whether best management practices are in place.

Best management practices that help to reduce transport of sediments, nutrients and pesticides into dugouts include:

- Constructing grassed waterways along preferential flow routes into the dugout
- Minimizing manure and fertilizer use by adding only what is needed for optimum yield. This requires the farmer to complete soil nutrient tests.
- Ensuring manure or fertilizer applications do not coincide with runoff events like spring snowmelt
- Minimizing pesticide use by following integrated pest management practices
- Practicing reduced-tillage farming. Keeping stubble on the field over winter helps reduce transport of sediments during runoff events.
- Practicing contour cropping. This reduces the potential for gully erosion by reducing the velocity of runoff water as it moves downhill.

Runoff Supply – Ensure there is enough water

Dugouts should always be sized to hold at least a two-year water supply. Smaller dugouts tend to have lower water quality because a higher percentage of the water is in contact with the sediments.

4.2.2. Design and Construction

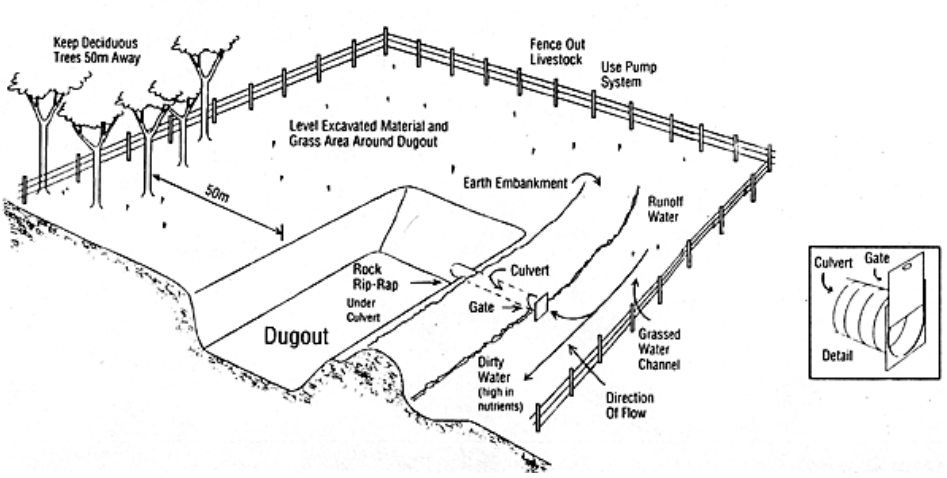

Figure 4.9: Components of a well-planned dugout. Source: AAFC-PFRA

Slopes

Dugouts should have:

- Steep slopes
- Leveled and grassed spoil piles
- Side and end slope protection from erosion

Steeper slopes help reduce the growth of emergent vegetation (e.g. cattails) and other aquatic plants that contribute organic matter and nutrients to the water. Historically, dugouts on the prairies were constructed with 1.5:1 side-slopes and 4:1 end slopes because of the equipment that was available for construction. Equipment now exists that is capable of digging deeper excavations with steep side- and end-slopes. Steep slopes can be a safety hazard and precautions should be taken to reduce potential for drowning.

The spoil pile that is produced when the dugout is constructed should be leveled to maintain bank stability and grassed to provide a filter that reduces the transport of soil and nutrients into the dugout. If a spoil pile is located at the edge of a dugout and is not leveled it can erode or slump into the water. Spoil piles can also reduce wind mixing by acting as windbreaks. A lack of wind mixing reduces the transfer of oxygen into the water.

The dugout side and end slopes can be subjected to erosion through wave action, particularly in windy areas of the prairies. Protection of the side and end slopes can be done with a combination of grass, rocks (rip rap), heavy plastic or geo-textile materials.

Inlet Structure

- The water inlet to the dugout should be able to be closed off

A gated culvert should be used to control the inflow of water into the dugout. This allows the owner to prevent poor quality water from entering the dugout. The first flush of water during snowmelt can be high in nutrients or salts depending on where it is derived from. Keeping this water out of the dugout will improve dugout water quality. A gated culvert is also useful during heavy spring and summer rains to prevent runoff water containing high sediment loads from entering the dugout. When water is pumped into a dugout, care should be taken to prevent erosion from occurring at the water entry point.

Fencing

- All dugouts should be fenced

All animals should be excluded from the dugout. A fence should be constructed around the dugout to exclude large animals from watering directly from the dugout. Smaller muskrat fencing should be considered if a dugout has persistent muskrat problems. A muskrat fence consists of sturdy mesh screening held up with T-bar that is angled away from the water at a point about one-third from the top. The screening is trenched in about 15 cm and the total fence height should be about 90 cm.

Sedimentation

- In locations where soil is highly erodable, a second dugout could be used as a settling pond.

If construction costs permit, two dugouts can be constructed adjacent to one another. The first dugout can be used as a settling pond so that sediment and organics are allowed to settle out of the water column. High quality water can then either be pumped or allowed to flow by gravity to the other dugout. If a new dugout is being constructed to replace and old one, the old one could be kept as a settling pond.

4.2.3 Operating Systems

Intake systems

- All dugouts should be equipped with floating intake systems

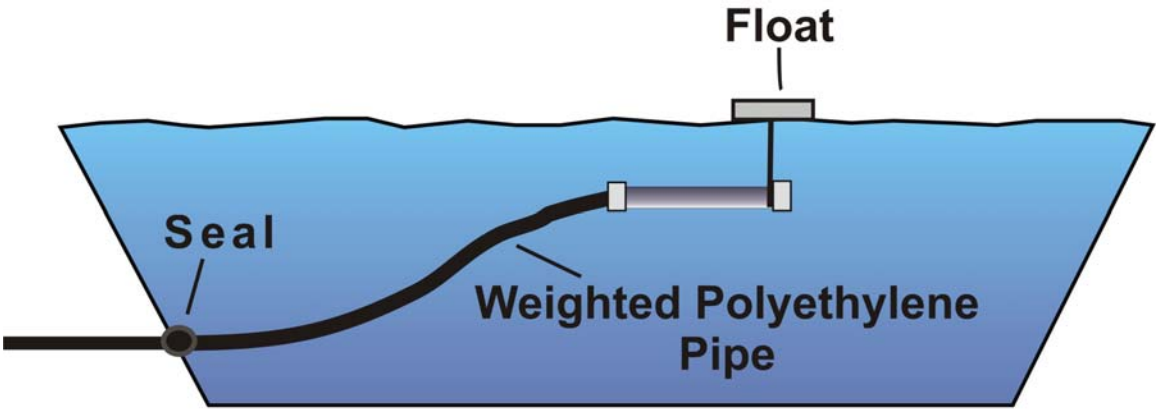

Figure 4.10: Example of a floating intake system. Source: AAFC-PFRA

The water in the top few feet of a dugout is usually of much higher quality than the water at the bottom or at the edges of a dugout. Dugouts that are not aerated properly will become depleted of oxygen, resulting in very poor quality water, particularly in the bottom two-thirds of the dugout.

Floating intake systems are recommended for use because they draw water from near the surface where better quality water exists. A submersible pump is usually housed in a wet well beside the dugout. If a jet pump is used, a wet well is not required. The screen assembly is hooked directly to the suction line and a check-valve is installed next to the pump.

Gravel-filled trenches between the dugout and a wet well are not recommended. Although they may be effective filters in the first few years of use, they eventually plug with soil, plant material, microorganisms and biofilms. High levels of biological activity result in low oxygen levels which leads to the release of hydrogen sulphide gas and high levels of dissolved solids such as iron and manganese.

The use of horizontal piping placed at or near the bottom of the dugout to convey water to a wet well is not recommended. The quality of the water at the bottom of the dugout is generally poor.

Wet Wells

- The material in the bottom of a large-diameter wet well should be cleaned out every few years.
- New installations should use smaller diameter PVC casing with a pitless adapter.

The dissolved oxygen levels are much lower in large diameter wet wells than in the dugout water because of slow replenishment with fresh dugout water. Conditions in the wet well can be similar to those that develop in gravel-filled trenches. Smaller-diameter PVC casing has less water storage and is constantly supplied with fresh dugout water.

Aeration Systems

- All dugouts should have 24-hour continuous aeration year-round.
- All aeration systems should use a diffuser. Open-ended hoses are not recommended.
- The diffuser should be placed at the bottom of the dugout in the deepest part of the dugout.

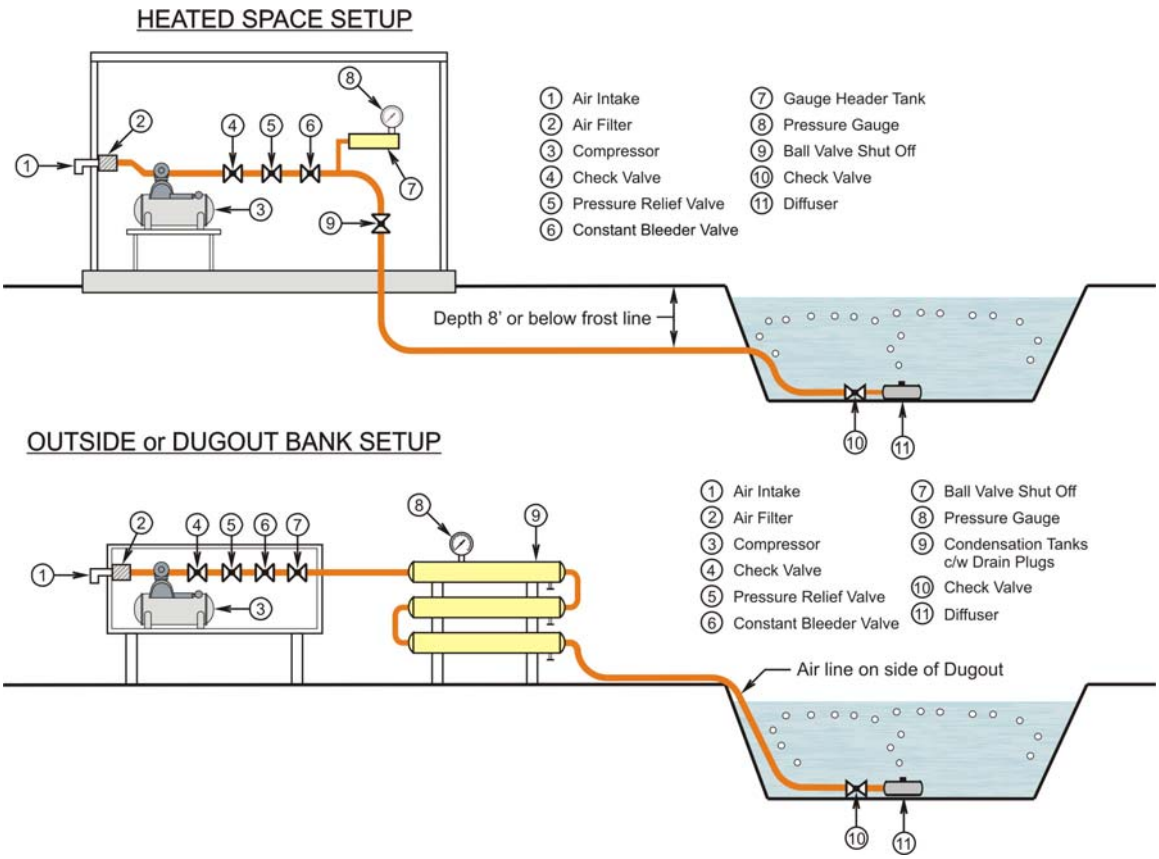

Figure 4.11: Components of an aeration system where the compressor is located in a heated space (top) or outside (bottom). Source: AAFC-PFRA

Aeration circulates the water in a dugout, which allows the oxygen entrained in the surface water to mix with the rest of the dugout water. If oxygen is present throughout the dugout water, nutrient concentrations in the dugout will be reduced. Lower nutrient concentrations will help reduce algae growth. The higher oxygen concentrations brought about because of aeration also reduce hydrogen sulphide, manganese and iron concentrations in the dugout.

A diffuser is a device that is used to release air into the water. Diffusers that create fine to medium sized bubbles are more efficient at circulating the dugout water than an open-ended hose.

4.2.4 Dugout Management

Sediment removal

- Excavation of accumulated sediment from a dugout on a 5-10 year basis helps improve water quality

Excavation can be expensive. It is important to make careful cost estimates prior to cleaning a dugout. Sometimes construction of a new dugout is more economical.

Vegetation Control

- Grassed buffers around the dugout should be mowed regularly
- If possible, aquatic plants should be removed before they die and decompose
- Remove willows and shrubs and other saplings that are growing around the banks of the dugout

Grassed waterways and buffer strips should be mowed regularly to ensure that the grass remains an effective sediment trap. If it is too long, the water just flattens the grass and it can no longer trap sediment.

The decomposition of plant matter will use up oxygen in the dugout and contribute nutrients to the water. It is best if aquatic plant matter can be removed, and terrestrial plant matter kept out of the dugout.

Animal Removal

- Muskrats should be trapped and removed from the dugout.
- Dugouts that have a history of muskrat problems should use specially designed muskrat fencing.

Muskrats disturb the sediments causing high turbidity in the dugout. As well, muskrats are a potential source of pathogens. Muskrats should be trapped out. A muskrat fence consists of sturdy mesh screening held up with T-bar that is angled away from the water

at a point about one-third from the top. The screening is trenched in about 15 cm and the total fence height should be about 90 cm.

Chemical treatments

- Copper sulphate is only effective on cyanobacteria (blue-green alage) blooms
- Most dugout treatment products are not registered by Canada's Pest Management Regulatory Agency for application to dugouts used for consumptive purposes
- Reward or Reglone A is the only herbicide that may be used for plant and algae control in farm dugouts used for consumptive purposes.

Copper sulphate is most effective in the early summer prior to when large cyanobacteria blooms develop. Copper sulphate is not effective on green algae. If copper is applied during a cyanobacteria bloom, there may be an immediate release of cyanobacterial toxins. When copper sulphate is used to control cyanobacteria, it is recommended that a waiting period of 14 days be maintained prior to consumption to allow cyanobacteria toxins to dissipate

Reward and Reglone A are non-selective herbicides with diquat as the active ingredient. Following treatment with these products, water should not be consumed for 14 days to allow for dissipation of the chemical and any potential cyanobacteria toxins that may have been released.

4.3 CISTERNS

Cisterns are used to store water delivered from water haulers or used to collect rainwater.

- Cisterns filled with raw water should not be used for drinking or in-house domestic use unless a multi-barrier treatment system is in place.
- Cisterns filled with treated water should be disinfected by a bleach solution once every four months to control bacteria and algae growth.
- Cisterns filled with treated water should be flushed and checked for cracks every few years.
- Encourage cistern owners to regularly test the water quality of the stored water (Chapter 2)

Cisterns are generally constructed from concrete, fiberglass or polyethylene. Concrete and fiberglass cisterns may be buried whereas polyethylene tanks are normally installed above grade. When cisterns are buried, precautions must be taken to ensure that contaminants cannot enter the cistern. Tanks should be located in an area that is free draining and the ground surface over the cistern should be raised to ensure surface drainage is away from the cistern. On all cisterns, the air vent must be screened to keep out insects and rodents, and the vent opening should face downwards to keep air borne contaminants out. Lines through the cistern walls should be made through leak proof connections.

If surface catchment waters and roof drains make up any part of the water supply in the cistern, the water cannot be relied upon to produce bacteria free results. Water collected this way may be contaminated from many sources such as bird droppings, dust, pollution, animal waste or soil. Untreated surface water is not approved for drinking or household purposes and it is recommended therefore that no plumbing connections be made between the cistern and the main water supply in these situations. Colour coding of the water lines is recommended. The cistern water should only be used for outside applications such as lawn and garden watering, or car washing.

A properly constructed cistern that is filled with treated water from an approved source and delivered by an approved/licensed water hauler should provide water that is safe to drink. The cistern, however, should still be periodically inspected, cleaned and disinfected. A simple batch disinfection of the cistern water to be used for human consumption can be achieved by adding 40 mL of household bleach for every 1,000 L of water (or 5 to 6 oz. per 1,000 gallons). This is a temporary measure and periodic sampling is recommended. Any cistern that requires entry into it for maintenance/cleaning should be considered a confined space. Hazardous gases or low oxygen levels may be present and therefore only individuals trained in confined space entry should enter a cistern to clean it. It is recommended that a licensed professional be contacted for further information regarding cistern cleaning.

- Cisterns should be emptied once every three years to remove sediments and to minimize bacteria population and other contaminants in the tank
- Cisterns should be inspected annually for cracks
- Vent holes and screens should also be inspected on a regular basis to check for holes where animals may enter
- Cisterns should be disinfected by a bleach solution once every four months to control bacteria and algae growth

CHAPTER 5

WATER TREATMENT FOR PRIVATE AND COMMUNAL SYSTEMS

This section describes the acceptable methods the treatment of private, public and communal water and recommended guidelines for the delivery of water to the public

** Information intended for the public and a generic version is provided on the attached compact-disc for Health Agencies to reproduce*

CHAPTER 5 – WATER TREATMENT FOR PRIVATE AND COMMUNAL SYSTEMS

5.1. WATER TREATMENT FOR PRIVATE AND COMMUNAL SYSTEMS

Depending on the source of the water, treatment may be required to ensure the water is microbiologically safe and palatable. Groundwater is usually high in mineral content, with hardness, iron and total dissolved solids as the major concerns. Groundwater usually does not contain harmful microorganisms, but depending on the aquifer and well system, can be contaminated through surface infiltration, surface water contamination (groundwater under influence), and abandoned wells. Surface water has a greater potential of being contaminated by pathogens, including *E. coli* and *Cryptospordium*. As a result, proper disinfection is needed for all surface water supplies. Since surface water may contain other organic compounds that may interfere with the effectiveness of disinfectant, filtration is usually required. Proper filtration will also lower the level of dissolved natural organic matter (NOM) in the water that may have the potential to form harmful disinfection by-products (DBP) with disinfectants. The ideal system is a multi-barrier approach to treating surface water consisting of watershed protection, filtration and disinfection.

No water should enter a communal distribution system unless it has been disinfected with a residual disinfectant.

The minimum treatment for surface water source is filtration followed by disinfection.

The minimum concentration of free chlorine and chloramine that must be maintained in the distribution system is 0.2 mg/L and 0.5 mg/L, respectively.

The need to chlorinate or disinfect water from a groundwater source for public system should be reviewed by Health Agencies on a case-by-case basis. Disinfection is not a requirement for groundwater well supplying water to private homes, bed and breakfast operations or public well supply. Groundwater wells should be disinfected for community halls, campgrounds, restaurants and schools.

If the system is contaminated, the best solution is to identify and eliminate the source of contamination. Should contamination continue and cannot be controlled, consider changing the raw water source as an alternative to treating contaminated water.

COMMON TREATMENT SYSTEMS:

Disinfection

Disinfection eliminates pathogens by the addition of chemicals or the use of a photochemical process. It should be noted that all disinfectants can produce potentially harmful DBP when reacting with NOM in the water, or by natural decomposition. Once formed, DBPs are costly and difficult to remove from drinking water, and therefore it is better to remove these precursors prior to the addition of disinfectants to minimize the formation of DBP. Some of the common disinfectants used are:

Chlorination, chlorine dioxide, UV and ozone

Chlorine dioxide, chloramine and gas chlorination are usually not suitable for smaller systems.

Filtration

Filtration can be in the form of:

- Membrane: Pressure-driven process whereby water is pushed through a permeable membrane leaving particles behind. Example: micro-filtration and ultra-filtration. For groundwater, there is a need to evaluate the potential for chemical scaling of membranes. For surface water, there is a need to test potential for source water to foul membranes and determine whether pretreatment is required to remove particulate matter ahead of membranes

- Mechanical filtration: Relies on sand or other media to trap contaminants. This may include cartridge filters, bag filters, diatomaceous earth filters and granular media filters. Source water should be tested to determine the ability of an adsorptive system to remove contaminants.

For more effective filtration, coagulants should be added and large particles allowed to settle. Aluminum sulfate (alum) is usually effective in lowering the level of dissolved organic carbon (DOC). Low temperature affects turbidity, particle counts and total residual aluminum, but not DOC and colour reduction. Turbidity of treated water usually increases as the temperature decreases. The optimum pH for alum at all temperatures is about 6.0 for DOC removal and 6.5 for turbidity removal.

5.2 POINT-OF-USE AND POINT-OF-ENTRY DRINKING WATER TREATMENT DEVICES

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Alberta Health & Wellness

DRINKING WATER TREATMENT DEVICES

CONTENT

- The proper water treatment devices can remove harmful bacteria or chemicals in your drinking water.
- Consult with your Environmental Health Officer for the best type of treatment unit.

CHOOSING A WATER TREATMENT DEVICE

In the rural area or smaller communities, there may be a need to further treat the water prior to drinking. A home owner may choose to install a home water treatment device to add a factor of safety or to address concerns about the quality of the water.

Point-of-Use (POU) equipment treats the water that is used at a single tap, while the rest of the water in the building remains untreated. POU equipment is primarily used to treat contaminants like lead and aesthetic contaminants like sulfur. These contaminants are a concern in water used for drinking and cooking.

Point-of-Entry (POE) equipment treats most or all of the water before it is distributed, either throughout a small community or at a single building. POE equipment includes processes that remove health-related contaminants like volatile organic compounds (VOCs) or is used to soften water by removing scale-forming chemicals.

There are many effective and different POU or POE devices, but no single technology is effective for treating or removing all of the possible contaminants. A specific technology or combination of technologies is usually applied to treat a specific problem at hand. This booklet provides a simple guideline on choosing a POU or POE treatment device.

Water treatment devices can help to improve water quality

TYPES OF TREATMENT DEVICES

Home water treatment devices available on the market can generally be categorized into four basic types of systems:

1. Filtration:

Filtration is used to remove small particles in the water. In many cases, particles may be soluble in water and must undergo chemical reactions to bring the particles out of solution so that they can be removed by the filters. Filters can also be effective in removing chemicals and bacteria. Examples of filters include activated carbon filters, microfilters (ceramic candles), manganese greensand filters, activated alumina filters and pour-through filters.

2. Ion exchange:

Ion exchange systems exchange one type of ion in the water with another. The most common use of ion exchange systems is to soften hard water or demineralization.

3. Disinfection:

These devices use chemicals such as chlorine, ozone, or other oxidants to remove harmful bacteria or viruses. Non-chemical disinfection can also be achieved by using distillation or ultraviolet lights.

4. Other Treatments:

The use of reverse osmosis (RO) or electrodialysis (ED) are designed to remove specific contaminants in the water.

New products and devices are also briefly outlined.

FILTRATION

Filters are used to remove taste, odour, chlorine and hydrogen sulphide and may be combined with other treatment processes.

Home filtration units use a media, such as carbon, to adsorb organic contaminants and ions that cause taste and odour problems. Particles are trapped on the porous material while allowing water to pass through the material. Filters can be made of sand, fibres, anthracite, or ceramics. Depending on their design, some units can remove chlorination by-products, pesticides and harmful bacteria and viruses. Mechanical filters cannot remove dissolved constituents in the water and are ineffective at removing hardness, salt, nitrates, some organics and most metals. As filters remove particles, they get clogged and have to be replaced or cleaned. The more solids in the water, the faster the filter will become clogged. The filter media must therefore be replaced on a regular basis.

CARBON FILTERS

Activated carbon is a form of charcoal, and in carbon filters, exists as carbon blocks or granular carbons. Carbon is effective in removing many organic compounds, pesticides, radon, tastes, odours and chlorine.

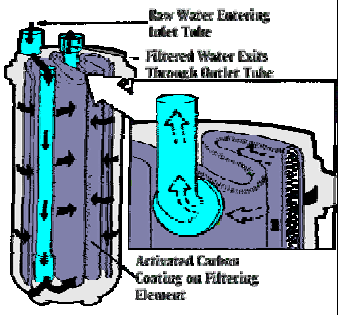
The effectiveness of carbon filters depends on the pore (hole) size. Different carbon filters are designed for the removal of different compounds– some are effective only for chlorine and taste and odour, while others are effective in removing the smallest harmful organism such as viruses, *Giardia* (beaver fever) and *Cryptosporidium*. To determine the effectiveness of carbon filters, look for the seal of approval by the National Sanitation Foundation (NSF) which approves filters based on its effectiveness. For example, under Standard 53, NSF would approve some filters with a pore size of less than 'absolute one micron' to be effective in the removal of the smaller parasites such as *Cryptosporidium*. Usually, only carbon block and precoated activated carbon filters are effective in reducing heavy metals such as lead and mercury.

Limitation:

- Carbon filters foster bacterial growth on the trapped organic substances and may release bacteria into the water. Although some units contain silver, the filters may still have bacteria. *Carbon filters should only be used on water that is treated and meets guidelines for microbiological safety*, and these filters should be flushed for at least 30 seconds before being used. Post filtration disinfection is sometimes needed.

- The carbon filters must be replaced regularly to maintain their adsorptive capacity. Change or replace the filter frequently and follow manufacturer's advice for servicing.

- Carbon filters are not effective in the removal of inorganics such as hardness, iron, nitrate or fluoride.



Contaminants are adsorbed onto the carbon media

POUR-THROUGH FILTERS

Pour-through pitcher filters are inexpensive and can reduce a variety of impurities, depending on filter design. They are usually effective in the removal of taste and odour in water, chlorine, and can remove dissolved organics (benzene, carbon tetrachloride) and heavy metals (lead and cadmium).

Limitation:

- Not effective for microorganisms.
- Limited in the amount of water that can be filtered per day.
- Filtered water may require refrigeration to control bacterial regrowth.

Oxidizing Filters

Oxidizing filters use chemicals or air to oxidize contaminants such as iron, manganese and hydrogen sulfide so they become insoluble, and are then removed by filtration. There are four basic types of oxidizing filters: (1) natural manganese greensand; (2) zeolite coated with manganese oxide; (3) chlorine followed by sand filter; and (4) aeration followed by filtration.

Greensand filters can remove up to 6 ppm hydrogen sulfide, and up to 10 ppm of iron if the water pH is 6.7 or higher. Zeolite requires less backwash water and softens the water as it removes iron and manganese. Chlorine, followed by filters are effective in removing dissolved or oxidized iron and manganese greater than 10 mg/L. Pressure-type aerators can remove dissolved iron and manganese up to 25mg/L.

Limitation:

- All filters need to be regenerated on a regular basis. For example, Potassium permanganate is used to regenerate the greensand once it becomes depleted of oxygen.

- Oxidizing agents such as permanganate may be needed to control the growth of iron bacteria and the formation of gelatinous slime on the filter.

- Aeration is not recommended for water containing organic iron complexes as iron bacteria will clog the aspirator and filter.

Manganese oxidized soluble irons and the filter remove the precipitate

Activated Alumina

Activated alumina is a filter media made by treating aluminum ore so that it becomes porous and highly adsorptive. There are various types of activated alumina, each with different properties and should be chosen specifically to remove the contaminant of concern. Activated alumina can remove a variety of contaminants, including fluoride, arsenic, lead and selenium.

Limitation:

The medium requires periodic cleaning with an appropriate regenerant such as alum or acid in order to remain effective. Similar to carbon filters, bacteria regrowth can occur. This system is usually ineffective in the removal of microorganisms and other minerals other than those listed.

Water enters mechanical filter and contaminants are trapped in the filter while water passes through.

Microfiltration

Microfilters are mechanical filters with a pore size of less than 0.2 microns, and are used to remove small amounts of suspended material such as sediment, sand, rust and precipitated iron particles from the water. Water line pressure forces water through the filter material, trapping foreign particles. These filters can be cleaned and reused a number of times before they lose effectiveness. Filters can be made of sand, fibres, anthracite, or ceramic. Ceramic candle is a type of microfilter in which bacteria and particles are filtered through the candle pores. The candle usually contains silver to minimize bacterial growth.

Some of these filters are approved by NSF for the removal of turbidity and *Cryptosporidium*.

Limitation:

- Not effective in removing chemicals such as lead, chlorine, nitrate, and pesticides.

- Not effective in removing dissolved or very fine particles.

- Some mechanical filters can be backwashed to remove trapped particles, but many require cartilage replacement when water flow slows appreciably

- Occasional abrasion of the candle surface is required to remove material and to restore a normal flow rate. Some studies recommended replacement instead of cleaning candles after removing *Cryptosporidium.*

- Most microfilters are not effective against viruses.

Ion Exchange (IX)

Ion Exchange units can be used to remove any charged (ionic) substances from water, but are usually used to remove hardness and nitrate.

IX units can remove different dissolved inorganic minerals such as calcium, magnesium, and sulfates from the water. A cation exchange unit typically uses sodium or potassium chloride, and can be used to remove lead, radium and is commonly used to soften water. An anion exchange resin uses chloride or hydroxide anions and can be used to remove mercury, nitrates, arsenic and various staining agents.

Inside an IX unit, one type of ion in the water is used to replace another type on the resin. For example, calcium and magnesium in the water are exchanged for sodium or potassium. Eventually, the resin becomes saturated and must be regenerated. This is done by flushing the material in the softening tank with salt or potassium brine. An IX unit should only be used for iron and manganese removal if the concentration is less than 1 mg/L.

Softening

Hardness is measured in grains per gallon (gpg), parts per million (ppm) or gm/L

One gpg = 17.1 ppm or mg/L

Water softeners do not remove particles like filtration nor do they reduce dissolved minerals like reverse osmosis. Softeners replace one ion with another, and are designed to remove ions that cause hardness in water (Calcium and magnesium). Hard water can result in the buildup of scale on appliances such as a kettle or iron; resulting in a lack of suds in the water, and the build up of film on shower doors etc.

A water softener exchanges the calcium with sodium ions giving soft water.

Water must first be pretreated to reduce the suspended solids and total dissolved solids (TDS) load to the IX unit. Water softeners will remove small amounts of dissolved iron (5 to 10 pm). However, if there is oxidized iron or iron bacteria in the water, the resin will become coated or clogged and lose its softening ability. Cation exchange units are rated by NSF for their efficiency (Standard 44).

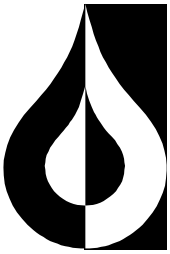
Limitations:

- Although softening water makes it more suitable for washing and prevents deposits in appliances and pipes, the water is not generally recommended for drinking and cooking due to its increased sodium content. Persons on a strict low sodium diet should discuss with their dietitians, the use of a softener which will increase the sodium concentration. For consumers that are concerned about sodium, water softeners are available that use potassium as the exchange ion. A potassium unit, however, should not be used by a predialysis patient on a low protein diet.

- Soft water is also more 'corrosive' and may lead to the leaching of lead into the drinking water.

- Waste water from the softener contains a high level of salt and cannot be discharged into septic tanks or surface water.

NSF/ANSI Standard 44 set standards for residential cation exchange water softener systems.



Soft water is high in sodium and may not be suitable for drinking

DISINFECTION

Disinfection of water may be needed on a temporary or continuous basis to control microbial contamination. Disinfection kills or inactivates biological contaminants present in a water supply. This can be achieved by the addition of a chemical (chlorine or ozone), or by boiling (distillation). Ultra-violet light can also be used to kill microorganisms in the water. One problem for many of the disinfectants is the formation of by-products. Some of these disinfection by-products (DBP) can be very harmful if the concentrations get too high, and may limit the use of some disinfectants.

CHLORINATION

Chlorine is added to the water to oxidize and breakdown bacteria and organic contaminants. Chlorine is effective for most harmful bacteria and viruses, and is also used to treat taste, odour and colour problems in water. Chlorine is also effective in the removal of iron, hydrogen sulfide and colloidal inorganics in the water. Chlorine should be used on a regular basis to control iron bacteria in wells.

Chlorine is the most common disinfectant used in water treatment because it is a proven technology, easy to use and relatively inexpensive to operate. To be effective, there must be proper control of chlorine dosage and contact time. There should also be testing of residual concentration. Homeowners should purchase a unit that is certified under ANSI/NSF Standard 60 as being acceptable for disinfection of potable water. Common household laundry bleach with 5.25% sodium hypochlorite should only be used for emergency and not as a regular source of chlorine in water treatment. Household bleach contains other materials that are not intended for human consumption.

Limitation:

- Chlorine and chlorine products are not effective in destroying hard-shelled cysts such as *Cryptosporidium*.

- In the presence of some organic compounds, chlorine may react to give harmful DBP such as trihalomethanes.

- Chlorine may add taste and odour to the water.

- Care should also be taken in the handling of chlorine equipment as chlorine is hazardous and very corrosive.

- Chemical fed pumps require frequent maintenance.

Disinfection or the oxidation of the water may be required to control microbial contamination of the water. It is also sometimes used to oxidize iron.

Ozone is effective in destroying *Cryptosporidium.*

OZONATION

Air or oxygen can be converted by a generator to produce ozone. Ozone is a stronger disinfectant than chlorine and can inactivate *Cryptosporidium* and will also react with many more organic compounds than chlorine. Similar to chlorine, to be effective, there must be proper control of the dosage and contact time.

Limitation:

- Ozone gas is an irritant and a pollutant in the air. Ozone gas generated must be properly captured and neutralized (by carbon filters).

- Ozone can corrode many materials, including plastics. There must be tight control of any gas being generated.

- The system is more expensive than chlorine to set up and run.

- When treating water with high bromine levels, there may be production of high levels of DBPs.

- Since ozone is very effective in breaking down organic compounds into smaller components, ozonated water can also be a good source of nutrients for bacterial regrowth.

- Ozonated water should not be stored for any length of time without the use of residual disinfectants such as chlorine.

Ultraviolet (UV) System

Ultraviolet light can be effective against Giardia and Cryptosporidium if the water quality is acceptable.

UV radiation can be used to destroy almost all harmful organisms in the water. Filtered water is passed into an exposure chamber where it is exposed to an UV lamp. The use of an UV light has the advantage of not adding any chemicals to the water, resulting in no taste or odour. It is compatible with other systems and no storage of water is required. It is effective against bacteria, viruses and protozoa such as *Cryptosporidium* and *Giardia*. It is also easy to maintain once installed.

Limitations:

- Pre-filtration is required to produce relatively clean water for UV treatment. Suspended particles, turbid or coloured water will interfere with the effectiveness of UV.

- It must constantly be monitored for an increased level of bacteria counts.

- The system requires electricity to operate.

- It is not effective for the removal of contaminants such as organics, heavy metals or salts.

- Depending on the unit, flow rate may be limited. A flow control device should be installed to regulate flow.

- Lamp and sleeves require regular cleaning.

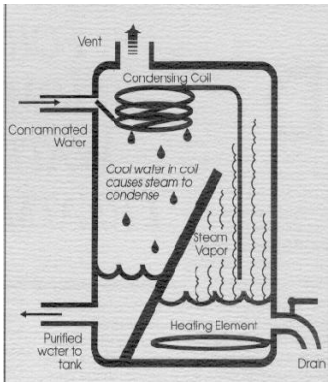
- Intensity of UV emitted by the lamp gradually decreases and eventually the unit becomes ineffective. The decrease in output can be caused by a weak or burned-out light or by sediment coating the lamp. To avoid this problem, an alarm system should be installed. Less expensive models may not have a transmittance monitoring device that may warn owners of decrease in UV output.

- UV radiation can decrease the chlorine level in treated water and should be closely monitored.

- UV may increase the level of formaldehyde in the water and should be monitored.

- Studies have found *E. coli* that have been inactivated by UV can repair itself, and under certain conditions, recover gradually (photoreactivation). If UV-treated water is stored for a prolonged period, it should be further treated with a disinfectant with residual power.

NSF/ANSI Standard 55 set standards for UV microbiological water treatment systems.



Steam is collected after boiling, resulting in very pure water

Distillation

Distillation is very effective in producing contaminant-free water. In distillation, water is first boiled in a chamber which creates steam that rises and leaves virtually all contaminants behind in the boiling chamber. Distillers remove bacteria, minerals, trace amounts of metals, many organic chemicals, and nitrates. The boiling process also kills all microorganisms. The steam is then collected and condensed into clean, distilled water. Impurities remain in the boiling chamber and are either automatically or manually flushed out depending on the system. Distillation units are rated by NSF for their efficiency (Standard 62).

Limitation:

- Most residential distillation units use either air or water cooled condensers. Air cooled units produce less wasted water, fewer service problems and are easier to use and install. A water cooled unit may need 8 to 15 gallons of water to produce one unit of distilled water.

- Most units use about three kilowatt hours of electricity to produce one gallon of water.

- Contaminants that boil at less than, or close to, the same temperature as water (example: gasoline, benzene and toluene) will be vaporized along with the water and can concentrate in the receiving chamber. A quality system should have a vent in the condensing coil to release these VOCs prior to the vaporization of water. These features are not found on cheaper distillers.

- Frequent cleaning is required, especially for hard water.

- The process removes beneficial minerals and makes water taste flat or bland.

- The process is slow, generating half-a-gallon of water per hour.

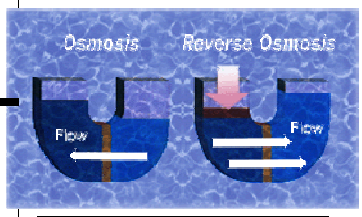
- The treated water must be cooled before consumption, providing opportunity for recontamination.

- In general, the energy input required for distillation is very high, resulting in a much more expensive unit to operate and to maintain when compared to other systems.

Other Treatments

There are other treatment devices on the market that do not fall into the above three categories. These systems can also be very effective and are designed to remove specific contaminants in the water.

Reverse Osmosis (RO)



RO units are effective in removing up to 95% of contaminants.

RO can effectively remove nearly all contaminants, including inorganics (lead, nitrate and sodium), pesticides, heavy metals, and microbiological contaminants. RO is particularly effective when used in series.

RO removes contaminants from water using a semi-permeable membrane that permits only water, and not dissolved ions such as sodium, to pass through its pores. The most common type of membranes are cellulose acetate and polyamide. To be effective, RO units usually require pre– and post-treatment of water, including the use of particulate pre-filters, followed by an activated carbon filter. Although not designed for microbial removal, RO units can prevent the passage of viruses and *Cryptosporidium* through the membrane. RO units are rated by NSF for their efficiency (Standard 58)

Limitation:

- The wastewater (brine solution) cannot be discharged into septic system.
- The membrane is prone to fouling.
- RO does not remove soluble organics of low molecular weight.
- Hardness can hinder the working of the unit by clogging its pores. RO should not be used on water with hardness exceeding 171 mg/L as $CaCO_3$ unless it is being first treated with a softener.
- RO should not be used on water that contains high iron concentrations or coliform bacteria.
- Some units waste 50 to 70% of the water they process.
- Units are usually large and bulky.
- Chlorine may damage the membranes.
- Damaged membranes are not easy to detect and need to have an electronic monitoring system.
- Efficiency is dependent on water pressure in the home. A pressure of at least 40 psi is needed.
- They require a technician to install and service them.
- High capital and operational costs.

Electrodialysis (ED)

ED is an electro-membrane process in which ions are transported through ion permeable membranes. The process is similar to reverse osmosis, but use currents to electrically charge ions to be transferred through the membrane instead of forcing water through the membrane under high pressure. ED are selective in the minerals that can be removed, but are effective for most heavy metals (arsenic, chromium, cadmium, lead, and mercury) and some ions, such as nitrates and fluoride. It is not as effective for bacteriological removal as RO.

Electrodialysis uses an electrical current to attract ions for removal by the membrane.

New Products

- Ionic silver is being tested, and under certain conditions is effective in the control of bacteria and viruses.
- The use of copper-silver ionization has been found to be effective in the control of *Legionella*.
- Electrolyzed oxidizing water is being used as a disinfectant to inactivate various harmful organisms in food, and can be effective for water disinfection.
- Chlorine dioxide can be effective in the inactivation of various harmful microorganisms and reduce taste and odour in water.

For information on these and other new products, please contact your local authorities (Page 10).

QUICK REFERENCE GUIDE FOR IMPURITIES REMOVAL

X = Effective
S = Some models only
L = Limited effect or limited to selected compounds only
SOCs = Synthetic organic contaminants, including pesticides, herbicides and insecticides
VOCs = Volatile organic compounds

PARAMETERS	Carbon filter	Pour Thru Filter	Oxidize Filter	Alumina	Microfilters	Ion Exchange	Chlorination	Ozonation	UV	Distillation	RO	Electro-dialysis
MICROORGANISMS												
Bacteria/Viruses							x	x	x	X	x	
Cryptosporidium/Giardia	s				s			x	x	x	x	
MINERALS												
Fluoride				x		x				x	x	x
Hardness						x				x		
Hydrogen Sulphide	x		x									
Iron/Manganese			x		x	L	L			x		
Nitrates						s				x	x	x
Sodium						s				x	x	
TDS										x	x	
CHEMICALS												
Chlorine	x	x								x	x	
Heavy Metals	X	L		L		L				x	x	x
Lead	x			x						x	x	
SOCs	x							s		x	L	
Radon	x					x						
VOCs	x	L						x		L	L	
PHYSICAL PARAMETERS												
Colour	s	L	L		L			x		x	x	
Taste & Odour	x	x						x		x	x	
Turbidity	x		x	x	x					x	x	

SUMMARY OF TREATMENT DEVICES

TYPE	ADVANTAGES	LIMITATIONS	REQUIREMENTS
Activated Alumina	Effective for arsenic, fluoride and lead removal.	Will not remove other minerals and microorganisms. Bacteria can grow on media.	Replacement of spent cartilage
Carbon filters	Remove taste, odour, organics, chlorine, pesticides, low levels of hydrogen sulphide. Some are effective for *Giardia* and *Cryptosporidium.*	Should be used only on microbiologically safe water, and should be flushed before use. Bacteria growth may occur in the filter if not maintained. Not very effective against inorganics such as hardness, iron, nitrate or fluoride.	Regular replacement of cartilage, periodic backwashing
Chlorination	Proven technology and effective for bacteria and viruses. Also effective for iron, hydrogen sulfide and colloidal iron removal. Recommended for emergency disinfection of water and regular maintenance of wells.	May require additional filters to remove protozoan cysts, requires handling of hazardous chemicals. May add taste and odour to the water. Chlorination may produce disinfection by-products.	Test kit, feed pumps
Distillation	Effective against all pathogens and most contaminants.	Batch system and uses lots of energy, water-cooled units waste water; slow process; bland tasting water; limited volume. May concentrate volatile organics.	Electricity and frequent cleaning especially with hard water
Electrodialysis	Effective for some minerals.	Not effective for microorganisms.	Electricity
Ion Exchange	Hardness, barium, radium nitrate, sulfate, calcium, magnesium, and iron (<1 mg/L).	Produce soft water that may be corrosive; waste water discharge; waste large amount of water.	Requires backwashing and regeneration (with sodium or potassium chloride), replacement of spent resin and cartilages
Microfilters (ceramic candles and others)	Inexpensive, simple. Effective for suspended solids.	May not be effective against viruses, lead and other organics..	Backwashing or cleaning
Oxidizing filters	Remove iron, manganese, hydrogen sulphide.	May clog or reduce effectiveness due to bacterial growth.	Backwashing and regular regeneration, replacing media
Ozonation	Effective against all pathogens.	High operational cost and an indoor air quality issue. No residual	Electricity, cleaning and maintenance of ozone generator and treatment tanks
Pour-through filters	Inexpensive, effective for taste, odour and chlorine removal. Effective for some heavy metals and dissolved organics.	Not effective for microorganisms, limited water can be processed per day, and water subject to bacterial regrowth.	Replacement of filters
Reverse osmosis	Inorganic salts (lead, nitrate and sodium), can be effective against viruses and protozoa.	Susceptible to clogging, scale build up, tearing of membranes, some membranes get damaged by chlorine, uses large amount of water; will not remove all organics (such as chloroform).	Adequate water pressure and flushing.
Softeners	Hardness (calcium and magnesium).	Elevate sodium content, waste water, corrosive water.	Electricity
Ultra violet Light	Effective against all bacteria, viruses and protozoa such as *Giardia* and *Cryptosporid-*	Needs water that is relatively clear, nd will not remove chemicals.	Electricity, regular monitoring and cleaning of bulk housing, replacement of UV bulks

Iron removal

Iron is a common concern for groundwater. The removal of iron is dependent on the types and concentration of iron, and often require a combination of devices. The most often used devices are:

1. Cation-exchange Softener

Treat up to 3 mg/L, iron that is in ferrous state. Ferric iron will clog exchanger. Iron is filtered from water by softener's resin bed and is removed during regeneration. Resin-cleaning compound (Sodium hydrosulphite or phosphoric acid) is needed to clean unit.

2. Oxidation (iron filters):

a) Air injection

Air is introduced and oxidize soluble iron to form rust particles and strained out by filter (usually carbon filter). Can treat up to 30 ppm of iron. Require retention tanks, air release valves and mixing devices.

b) Chlorination-filtration

For water with high iron concentration, there is a need to oxidize before removal by ion exchange or filtration. Special iron filter performs both oxidizing and filtering steps followed by carbon filter to remove excess chlorine.

c) Manganese greensand (oxidation filter)

See oxidizing filters

d) Aeration and settling

Outdoor settling basin and aeration can remove some iron in the water

NOTE: For colloidal iron, there may be a need to add polymers to form larger clumps, followed by oxidation and filtration

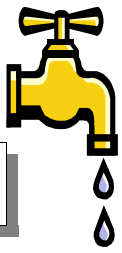
3. Chemical sequestration

(Polyphosphate)

Water is treated with an organic compound (polyphosphate) to form complex with metallic ions to prevent changing to ferric state and coming out of solution. Remain suspended in water and no staining

4. Iron Bacteria:

Can be controlled by shock chlorination



All systems have limitations and have specific uses.

Alberta Health & Wellness

Technical Advisory Committee on Safe Drinking Water

- Alberta Health and Wellness
- Alberta Environment
- Calgary Health Region
- Capital Health
- Chinook Regional Health Region
- David Thompson Health Region
- East Central Health Region
- Peace Country Health
- Health Canada, Healthy Environment & Consumer Safety Branch
- Health Canada, First Nations & Inuit Health Branch
- Prairie Farm Rehabilitation Administration
- Provincial Laboratory for Public Health (Microbiology)

NF/2004

Points to remember in selecting your POU or POE devices:

- Contact your local Health Agency to have your water tested for chemical and bacterial quality.

- Discuss the results with your Public Health Officer/Environmental Health Officer to determine what improvement is needed.

- Decide on the improvement that is needed for your water, and the system or combination of systems that are best to accomplish the task and options available.

- Select reputable dealers. Shop around for the best price and service. Consider the capital, cleaning, maintenance, chemical, electricity and replacement cost of the system.

- Consider safety issues relating to the operation of the devices

- Check for approval logos from independent organization such as NSF, ANSI, UL or Water Quality Association (WQA) for the removal or treatment of the parameters of concern.

- Standards Council of Canada has accredited the following agencies to certify drinking water treatment devices as meeting appropriate NSF/ANSI standards: Canadian Standards Association International, NSF International , Underwriters Laboratories Inc., Quality Auditing Institution, International Association of Plumbing ad Mechanical officials

- Realize the operational limitation and maintenance that is required for each type of system.

- Maintain your system according to manufacturer recommendation.

- Understand any warranty provided with the equipment.

- Test your water on a regular basis.

AGENCIES THAT CAN PROVIDE ASSISTANCE TO YOUR WATER PROBLEM

Alberta Agriculture, Food and Rural Development
www.agric.gov.ab.ca/
Alberta Environment
www3.gov.ab.ca/env/
Alberta Health & Wellness
www.health.gov.ab.ca/
Health Canada
www.hc-sc.gc.ca/

Prairie Farm Rehabilitation Administration
www.agr.gc.ca/pfra/pfintroe.htm

Regional Health Authorities

Useful web sites:
- *www.nsf.org*
- *www.ul.com*
- www.wqa.org
- www.csa-international.org
- www.iapmo.org

5.3 WATER TREATMENT ALTERNATIVES – INFORMATION FOR HEALTH AGENCIES

Thermal Treatment

Heat is a simple, single step process that inactivates all enteric pathogens. A wide range of boiling times are described in the literature. The WHO and CDC guideline of boiling water for five to ten minutes is recommended for highly contaminated, worse- case water as found in disaster areas where sewage pipes have ruptured, or in over crowded refugee camps. Shorter boiling times can safely be used where the water is less suspect, particularly given the fact that pathogen destruction actually begins at temperatures below boiling and continues during the cool down phase. The process of pasteurization uses this principle to kill foodborne enteric pathogens and spoilage organisms between 65-70°C within one to five minutes. For all but the most contaminated water, bringing the water to a rolling boil for one minute will be sufficient to provide safe drinking water. Although the boiling point of water is elevation dependant (inverse to elevation), adjustments to boiling time are not usually required. Please refer to section 6.4.6 for information on the proper boiling of water.

The following chart shows thermal destruction points for given pathogenic microorganisms.

Micro-organism	Time/Temperature
Giardia/E.Histoytica Cysts	60°C for 2-3 minutes
Cryptosporidium oocysts	65°C for 2 minutes
Enteric Viruses	within seconds at 80-100°C
Enteric Bacteria	within seconds at 80-100°C

Advantages of Thermal Treatment:

- Reliable destruction of all pathogens, including viruses and parasitic cysts
- Relatively simple procedure with easily recognizable endpoint

Disadvantages of Thermal Treatment:

- High fuel requirement
- Time consuming
- Imparts a “Flat Taste” to the water (improved by re-aerating or adding flavor crystals)
- Risk of scalding

Halogen Treatments

Halogens (chlorine and iodine) are excellent disinfectants for bacteria, viruses, *Giardia*, and amebic cysts, excluding *Cryptosporidium*, and are readily available in inexpensive commercial kits. As an alternative to commercial kits, household bleach is an inexpensive and highly effective form of chlorine (5.25% chlorine), while tincture of iodine (2%) is readily available at drug stores. Destruction of pathogens by a halogen is a function of the concentration of halogen multiplied by contact time ("concentration x time" or " CT value"). An increase in one factor allows a decrease in the other. The effectiveness of halogens is greatly influenced by water temperature and clarity of the water being treated. In cold water, the contact time should be increased, as outlined in the following table:

Concentration of halogen	**Contact time in minutes at various water temperatures**		
	5 ^{o}C	15 ^{o}C	30 ^{o}C
2 ppm	240	180	60
4 ppm	180	60	45
8 ppm	60	30	15

NOTE: *These contact times have been extended from the usual recommendations to account for recent data that prolonged contact time is needed in very cold water to kill Giardia cysts.*

Water which contains an excessive amount of organic material will require increased concentrations of halogen, or should be treated by filtration/coagulation prior to treatment (see coagulation) to prevent the formation of trihalomethanes.

Vegetative bacteria are extremely sensitive to halogens. Viruses and *Giardia* require higher concentrations or longer contact times, and *Cryptosporidium* oocysts are highly resistant and for practical considerations require physical removal or destruction by heat if suspected in the source water. The following figure shows experimental data for 99.9% destruction with selected halogen at neutral pH:

Experimental data for 99.9 % kill with Chlorine

	Concentration	Time	Temperature
Giardia (consistent with *E. histolytica*)	0.5 mg/l	6-24 hrs	3-5°C
	4.0 mg/l	60 min	3-5°C
	8.0 mg/l	30 min	3-5°C
	3.0 mg/l	10 min	15°C
	1.5 mg/l	10 min	25°C
Enteric viruses	0.5 mg/l	40 min	20°C
	0.3 mg/l	30 min	3°C
E.coli	0.03 mg/l	5 min	2-5°C

Experimental data for iodine

	Concentration	Time	Temperature
Giardia and Ameba cysts	3.0 mg/l	15 min	20°C
	7.0 mg/l	30 min	3°C
Enteric viruses	6.3 mg/l	10 min	25°C
E.coli	1.0 mg/l	1 min	2-5°C

Chlorine Dioxide:

A relatively new water treatment kit has become available which utilizes stabilized chlorine dioxide as the halogen. When combined with phosphoric acid (supplied with the kit), chlorine dioxide is released into the water. The advantage of chlorine dioxide is its increased oxidation potential over simple chlorine, with reported effectiveness against all pathogens, including *Cryptosporidium*. These kits are currently under review by the USEPA and NSF.

Advantages of Halogen Treatment:

- Relatively simple to use (convenient commercial kits available)
- Effective destruction of enteric bacteria and viruses; protozoans with increased contact time

Disadvantages of Halogen Treatment:

- Requires increased contact time for reliable destruction of parasites, not very effective against *Cryptosporidium*
- May impart objectionable tastes and/or odours
- Adversely affected by cold water temperatures
- Potentially may reduce with extended storage time
- May stain
- Prolonged use of iodine (> few months) should be avoided. Iodine ingestion may unmask thyroid problems or hypersensitive reactions. Use of iodine is not recommended for people with thyroid disease, history of iodine allergy, or pregnant women due to the increased risk of neonatal goiter.

Filters

Unlike boiling or addition of halogens, both of which strive to kill any pathogens present, water filters do not kill pathogens but physically remove them from the water. The ability of a water filter to remove pathogens from water is a function of the effective pore size of the filter matrix, which is usually composed of activated carbon, ceramic, glass fiber, or a combination of these. Various filter efficiency rating are used, including average (50%), nominal (approximately 70%), and absolute (100%) removal of the stated particle size. To ensure the filter is capable of producing safe drinking water, a filter must screen down to the size of the smallest microorganism it is attempting to remove, using an absolute (100%) efficiency rating. The following table outlines the absolute pore size required to remove specific pathogens:

Average maximal pore size for removal of specific micro-organisms

Micro-organism	Micrometers (µm)
Parasitic eggs and larvae	20
Giardia, E. histolytica	5
Cryptosporidium	1-2
Enteric bacteria	0.2-0.4
Viruses	0.01

For practical purposes, (mainly water production time and pumping effort required), most water filters are not manufactured with less than 0.3 to 0.4µm pore size, and therefore are not capable of removing enteric viruses. As a consequence, additional treatment by heat or halogen will be required to destroy enteric viruses in the water. To address this problem, many water filters are designed to include passage of the water through an iodine-impregnated resin to destroy enteric viruses. Careful monitoring of the volumes of water treated by the unit is necessary to prevent depleting the iodine reserve and producing unsafe water from the unit.

Pitcher-type Filters:

Various inexpensive "pitcher type' water purifiers are available on the market which are designed primarily to reduce taste and odour concerns in water. These filters provide little to no protection from pathogenic microorganisms. Anti-microbial agents added to the filter are primarily designed to prevent microbial growth on the filter material itself, and are not for treating processed water.

Desalinators:

Water desalinators are commercially available to produce safe potable water from seawater. Most manual desalinators tend to be expensive and require a great deal of time and pumping effort to produce sufficient quantities of water. While they are invaluable in survival situations (lifeboats), they tend to be impractical for everyday use.

Sedimentation / Coagulation:

Where the source water contains large amounts of sediment or is excessively cloudy, pre-treatment by sedimentation and/or coagulation is an excellent method to improve taste, reduce the amount of halogen required, or extend the useful life of water filters. Sedimentation of larger particles can be achieved by simply allowing the water to stand undisturbed for one to two hours prior to treatment. Coagulation involves mixing the water with a coagulant aid, usually alum (aluminum potassium sulfate) which causes the smaller particles to form into larger particles (floc) which then settle out or are filtered through a paper filter. The coagulation process generally takes 30 to 60 minutes to complete and in addition to clarifying the water, will actually remove many of the pathogens present, especially *Giardia* and some *Cryptosporidium*.

Advantages of filters:

- Relatively time efficient
- Lighter and more compact than fuel needed for boiling
- Do not add objectionable tastes or odours

Disadvantages of filters:

- Relatively expensive
- Heavier and bulkier than halogen treatment kits and require routine maintenance
- Most are not effective at removing enteric viruses

5.4 WATER TREATMENT ALTERNATIVES FOR CAMPERS, HIKERS AND TRAVELERS

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WATER TREATMENT ALTERNATIVES – INFORMATION FOR CAMPERS, HIKERS AND TRAVELERS

Why Do I Need to Treat Water?
No untreated natural surface water should be considered safe for human consumption without proper treatment. Even the cleanest-looking natural surface water could be contaminated with disease-causing bacteria, viruses, and/or protozoans including *Giardia*, which causes "beaver fever".

Canadian wilderness waters are generally of excellent quality, but to ensure a safe and enjoyable experience, backcountry users should be prepared to boil, chemically treat, or filter all drinking water. Drinking water in many developing countries around the world may also require pre-treatment to remove dangerous microbes. Whether you are travelling in a Canadian wilderness area or foreign country, you will need to consider water treatment to ensure a safe trip.

Contact your local community health center travel specialist for more information on the area that you plan to visit.

What Options Do I Have To Treat Suspect Water?
While there are numerous products on the market that claim to provide safe water treatment, the effectiveness of each product can vary dramatically. A good source of information on specific water treatment devices can be found on the Internet at *www.nsf.org*.

Regardless of the product in question, the treatment method generally falls into one or more of the following categories; thermal treatment, halogen treatment, or physical removal. Specifics of these methods are described below.

1) **<u>Thermal Treatment</u>**
   Thermal treatment relies on heat to destroy dangerous microbes. Heat has been shown to be very effective in destroying all types of disease causing microbes.

   To ensure adequate disinfection of water by boiling, ensure that a "rolling boil" (bubbles break the surface) is maintained for a minimum of one minute.

   While thermal treatment has been shown to be very effective in destroying disease-causing microbes, it is relatively labor intensive, requires a fuel source, and does produce a "flat" taste to the water. To improve the taste of boiled water, re-aerate by pouring back and forth between two clean containers after boiling and cooling, or add juice crystals.

2) Halogen Treatment

Halogen treatment relies on chlorine, iodine, chlorine dioxide, or other halogen to destroy dangerous microbes in source waters. There are numerous halogen treatment products available on the market. Regardless of which product you choose, follow the manufacturers' instructions carefully and ensure that the product has been independently tested to verify its effectiveness. Household chlorine bleach or tincture of iodine can be used to disinfect drinking water. The following table outlines the amount of chlorine or iodine to use.

Disinfectant	Type of Water	Amount	Contact Time
Chlorine (5%)	clear/warm	2 drops/litre	30 minutes
Chlorine (5%)	cloudy/cold	4 drops/litre	40-60 minutes
Iodine (2%)	clear/warm	5 drops/litre	several hours
Iodine (2%)	cloudy/cold	10 drops/litre	several hours

While chlorine effectively destroys bacteria, viruses, and most protozoa such as *Giardia* (with longer contact times), it is not very effective at destroying the highly resistant *Cryptosporidium* oocyst and therefore if *Cryptosporidium* is a concern, a secondary form of treatment is necessary, such as boiling or filtering. New treatment kits are becoming available which utilize stabilized chlorine dioxide in place of simple chlorine. These kits are showing promise as a single step treatment method, which is effective against all pathogens, including *Cryptosporidium.*

While using a halogen to destroy dangerous microbes is relatively simple, inexpensive, and effective, chlorine and iodine may impart an objectionable taste and/or odor to the water. The effectiveness of this treatment method is also adversely affected by cold or cloudy water, and demands relatively long contact times.

3) Physical Removal

Physical removal relies on various types of filtering material including charcoal, glass fiber, ceramic, and activated carbon, to physically remove dangerous microbes from water. Unlike boiling or halogen treatment which destroy microbes in water, filters simply remove them. The effectiveness of a given water filter is dependant on the effective pore size of the filtering material. For a filter to provide safe drinking water, the filter must have an absolute effective pore size rating of 0.2 to 0.3 microns to effectively remove bacteria and protozoa. Average or nominal one micron filters do not remove all dangerous microbes from water. It is important to remember that all but the most advanced water filters do not remove viruses, and therefore a secondary form of treatment is necessary.

What Do I do if I Have Further Questions?

If you require further information on water treatment devices contact your local public health inspector at a location listed below.

Insert Contact Info Here

5.5 BULK WATER

5.5.1 Health Standards for Bulk Water Hauling

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HEALTH STANDARDS FOR BULK WATER HAULING

Section 3(1) of the *Food and Food Establishments Regulation* (Alberta Regulation 328/2003) under the *Public Health Act*, requires that a person shall not operate a food establishment unless that person holds a valid and subsisting permit for that food establishment from the regional health authority (RHA).

As defined in the said regulation:

> **"Food"** means any substance, including water and ice, intended for use in whole or in part for human consumption, but does not include a drug, medication or health related product regulated under the *Pharmaceutical Profession Act* or the *Food and Drugs Act* (Canada).
>
> **"Food establishment"** means **premises** where food that is intended for consumption by the public is served, **offered for sale**, displayed, packaged, **stored** or handled.
>
> **"Premises"** includes any place or **vehicle**.

For the purposes of this standard, **"Bulk Water"** shall be defined as potable water intended for human consumption that is dispensed from an approved transport vehicle (water truck) to a storage facility.

For the purposes of this standard, **"Health Agency"** shall be defined as a Regional Health Authority or Health Canada.

Pursuant to the requirements of the *Food Regulation*, all persons engaged in the business of transporting or distributing bulk water must obtain a Food Establishment Permit from the local RHA.

Note: Persons engaged in delivering water loaded into their truck and delivered to facilities entirely within the jurisdiction of Health Canada, i.e. First Nations Communities, may be exempt from this permitting requirement. If a water truck operator located in a First Nations Community wishes to obtain water outside the community or deliver water outside the community, they must obtain a Food Establishment Permit from the local RHA.

The holder of a Food Establishment Permit who transports or distributes bulk water shall ensure that the following standards are met:

1. A copy of the current Food Establishment Permit must be available in the water hauling vehicle and must be immediately produced on request. Permits are specific to individual water hauling companies. A Food Establishment Permit issued to a water hauling company will list the water hauling vehicles approved by the RHA for operation by that company. Any water hauling vehicle not listed on the Food Establishment Permit must not be used for transporting or distributing potable water.

2. Water hauling vehicles are subject to inspections by the appropriate Health Agency. The owners of water hauling vehicles shall make their vehicles available for inspection at a date, time and location that is acceptable to a Public Health Inspector or Environmental Health Officer employed with any Health Agency.

3. All bulk water supplied and/or transported must be obtained from:
   a) an approved municipal water source; or
   b) a water source that is approved by the appropriate Health Agency.

4. Water tanks and associated equipment that have been approved for bulk water shall not be used for any other purpose (i.e. hauling non-potable water), unless prior written approval has been obtained from the appropriate Health Agency.

5. Bulk water tanks must be clearly and permanently labelled **FOR DRINKING WATER USE ONLY** (or similar wording approved by the appropriate Health Agency), in contrasting letters at least 15 cm (6 inches) tall.

6. Water tank interiors must be composed of or coated with food grade contact material that is non-corrodible (e.g. stainless steel, fibreglass, plastic, approved epoxy liner). Hoses, nozzles and other equipment used in the transport and delivery of water must also be constructed of food grade materials. All equipment must be maintained in good repair.

7. Appropriate measures must be taken to protect the water and its source, storage tank, and all other equipment from contamination during filling, storage, transportation and delivery.
   - Hoses and nozzles used for water intake or discharge shall be protected in such a manner that precludes their contamination when not in use.
   - All pump lubricants must be food grade.
   - Visual inspections must be conducted daily to ensure access/fill hatch seals are in good repair and are providing a proper seal.
   - Movable equipment (hoses, nozzles, etc.) should be cleaned and sanitized daily using a solution of 100 ppm household bleach, or equivalent in the sanitizing procedure.
   - Equipment and a written procedure for emergency disinfection following a contamination incident (example: hose falling on the ground) must be kept in the truck (See attached “Procedures for Emergency Disinfection).

- Tanks must be sanitized at least twice a year, after any contamination or after a failed bacteriological water analysis (See attached 'Procedures for Cleaning and Disinfecting of Potable Water Tanks').

8. Operators of bulk water hauling vehicles must ensure that potable water is protected from contamination. If an operator is hauling water from a well that is approved by the appropriate Health Agency and the source is not chlorinated, it is recommended that steps be taken, in consultation with the appropriate Health Agency, to institute chlorination that will provide a free available chlorine residual of 0.2 ppm after 20 minutes contact time. Chlorine residual monitoring equipment, monitoring procedures and chlorination procedures must be discussed with the appropriate Health Agency. A chlorine residual in water entering a distribution system, in this case a water truck, is very important to ensure a multi-barrier approach in the provision of safe, potable drinking water.

9. Operators of bulk water hauling services must ensure that chemical and bacteriological analysis of the hauled water supply is conducted in accordance with a frequency and sampling methodology acceptable to the appropriate Health Agency. Frequencies set forth in the latest edition of the "*Environmental Public Health Field Manual for Private, Public and Communal Drinking Water Systems in Alberta*" should be considered as the minimum standard. Hauled water supplies shall not exceed the maximum acceptable concentrations for chemical and microbiological parameters outlined in the current edition of the *Guidelines for Canadian Drinking Water Quality*.

10. Operators of bulk water hauling services shall keep an activity log book in the water hauling vehicle and make this vehicle available to a Public Health Inspector or Environmental Health Officer for examination upon request. Logbook records should include:

    a) the date, time and location of each water fill
    b) the date, time and location of each water delivery
    c) the volume of water delivered to each site
    d) chlorine residuals, if appropriate (see #8 above)
    e) the date and time of equipment disinfection
    f) comments or observations regarding problems encountered with the water supply or water hauling vehicle equipment.
    g) equipment maintenance (water tank, hoses, nozzles, valves, pumps, etc.).

Call your local Public Health Inspector or Environmental Health Officer if you require further information.

Insert Contact Info Here

5.5.2 Guidelines For Water Truck Inspections

As a general principle an inspection of a water truck should ensure compliance with the "Health Standards for Bulk Water Hauling" and should attempt to ensure that no nuisance conditions or other contraventions of the Public Health Act are occurring.

This document is not intended to be an exhaustive list of all potential problem areas; rather it is a guide to keep the inspector "on track". The following are points to consider when conducting your inspection.

1) Paperwork
   - Ensure that the logbook is in the truck and is being properly filled out. Make sure all information required as per the Health Standards for Bulk Water Hauling is included.
   - Ensure that water is only collected from approved sites.
   - Ask to see a copy of the Food Establishment Permit and ensure that it is current.
   - Compare the serial number on the water tank with the serial number on the permit.
   - Compare the license plate number on the water truck with the license plate number on the permit.
   - Is the operator submitting water samples as required?

2) Exterior
   - Ensure the exterior of the truck is properly labelled.
   - Ensure hoses are properly labelled.
   - Ensure hoses are stored or protected in a manner that precludes contamination during transport.

3) Interior
   - Is the interior of the water truck tank food-grade? (Stainless steel, fibreglass, plastic, approved epoxy liner)
   - Check the seal on the access/fill hatch on top of the water tank to ensure it is in good repair and provides a tight seal.
   - Look inside the tank, flashlight usually required, for signs of visible dirt or deterioration of tank interior (liner chipping, etc.)

4) Other
   - Is a non-lubricated pump used (Teflon)? If no, is the lubricant food-grade?
   - Are equipment and supplies (solution container, household bleach and instructions) available to sanitize nozzles and hose caps if a contamination incident occurs (i.e. dropping the hose on the ground)?
   - Review proper water sample collection technique with the operator.

- Review cleaning/sanitizing procedures and frequency for movable equipment.
- Review cleaning/sanitizing procedures and frequency for the water tank.
- Are there any other problems/concerns that may cause a nuisance condition?

5.5.3 Procedures For Cleaning & Disinfection Of Potable Water Tanks

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PROCEDURES FOR CLEANING & DISINFECTION OF POTABLE WATER TANKS

1. Drain water from the tank.

2. Wash and remove dirt from the inside surfaces of the tank by means of a high pressure hose (i.e. steam).

3. Remove wash water and sediments from the bottom of the tank. These can be vacuumed out.

4. Rinse inside surfaces of the tank with potable water. Again remove the wash water.

5. Disinfect the inside surfaces of the tank as well as the distribution lines as follows:
   a) Fill the tank with potable water.
   b) Add 8 L of household bleach to every 4,500 L (1000 gal) of water (100 ppm chlorine solution) and mix well.

6) Run water from the water hose until the smell of chlorine is detected in the water.

7) Shut off the water hose. Let the chlorine solution sit in the water tank and system for at least 20 minutes.

8) Completely drain the chlorine solution from the tank to waste.

9) Cleaning and disinfecting of the water tank should be done twice a year or as required.

Contact your local Public Health Inspector or Environmental Health Officer for more information.

Insert Contact Info Here

5.5.4 Procedures For Emergency Disinfection Of Water Trucks

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PROCEDURES FOR EMERGENCY DISINFECTION OF WATER TRUCKS

If a water hose, nozzle or other equipment is accidentally contaminated during the course of water delivery and it can be effectively sanitized at the site, considerable time can be saved. The alternative is to return to the base and clean and sanitize the contaminated piece of equipment there.

The most common causes of contamination to hose ends and nozzles are dropping them on the ground or the falling off of a protective cover. The following procedures are designed for these types of contamination.

Equipment Required

- Household bleach
- Covered, clean and sanitized plastic container at least 8 litres, approximately two gallons, in size or larger.
- Measuring spoon for measuring bleach.
- Personal protective equipment (goggles with side shields, appropriate gloves, appropriate apron or smock)

Procedure

- Run potable water from the water truck through the hose, nozzle or other contaminated equipment to remove any visible dirt.
- Fill plastic container with potable water from the water truck and thoroughly rinse all visible dirt from the hose end, nozzle or other contaminated equipment.
- Discard the rinse water and thoroughly rinse the plastic container with potable water from the water truck.
- Fill the plastic container with potable water from the water truck to a level that will allow complete immersion of the contaminated equipment. It is a good idea to mark the levels of water that you may be using on your container. This allows direct filling without having to measure the water to determine the amount of chlorine to add.
- Put on appropriate personal protective equipment.
- Add chlorine bleach to create a 200 ppm solution. This requires approximately 1 teaspoon of bleach, or 5 ml, per litre of water. An eight-litre solution will require approximately 8 teaspoons, or 3 tablespoons or 40 mL of household bleach.
- Completely immerse the equipment to be sanitized in the solution and allow a 2-minute contact time.
- The equipment is now ready to use. **Note:** This procedure is only effective when visible dirt and soil can be completely rinsed off the piece of equipment prior to sanitizing. If the visible soil cannot be removed, the piece of equipment must be properly washed, rinsed and sanitized prior to use.

Contact your local Public Health Inspector or Environmental Health Officer if you have further questions.

Insert Contact Info Here

5.6 WATER COOLERS AND BOTTLED WATER

5.6.1 Cleaning and Maintenance of Water Coolers

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CLEANING AND MAINTENANCE OF WATER COOLERS

Frequency of Cleaning

It is recommended that water coolers be thoroughly cleaned and disinfected with every bottle change.

Cleaning the Water Cooler

Note: this procedure is most easily performed when replacing an empty water bottle.

1. Disconnect the water cooler from the electrical outlet.

2. Remove the empty water bottle and completely drain the remaining water through the spigots.

3. Remove the "no-spill" guard and baffle (if applicable) – take care not to break or damage these components. These items can be cleaned in a dishwasher or manually in the kitchen sink.

4. Fill the reservoir with a disinfectant solution (section 5.6.4), and scrub the interior of the reservoir with a clean long-handled, soft-bristled brush.

5. Drain some of the disinfectant solution through the spigots, and allow the solution to sit for at least 2 minutes (to be effective) but no longer than 5 minutes (to prevent corrosion).

6. Drain the disinfectant solution from the reservoir through the spigots, into a bucket, and dispose of the solution into the sanitary system.

7. Rinse the reservoir thoroughly by filling it with clean tap water or bottled water 2-3 times. Drain the rinse water through the spigots into a bucket and dispose into the sanitary system. Rinsing the reservoir will remove traces of the disinfectant.

8. Replace the baffle and the "no-spill" guard.

9. Place water bottle on top of water cooler.

10. Depress spigots until the water flows freely.

11. Connect the water cooler to the electrical outlet.

Cleaning Plastic Parts

12. Periodic cleaning of the drip tray, spigot paddles, "no-spill" guard, baffles, and the exterior of the water cooler is recommended. This should be done when the water cooler is cleaned and disinfected. Removable parts can be cleaned in a dishwasher (see manufacturer's instruction) or manually.

13. All removable parts should be washed in hot soapy water, rinsed with clean water and then disinfected using a disinfectant solution (see section 5.6.4).

14. Allow the parts to thoroughly dry, or dry with a clean cloth.

15. The exterior of the water cooler should be thoroughly wiped with a clean hot soapy cloth.

16. Do not use abrasive cleansers, which can scratch surfaces.

Maintenance

Note: always disconnect the water cooler from the power supply before any cleaning or performing other activities with the cooler.

17. At regular intervals, inspect the wire grid located across the back of the water cooler for lint and dust build up. Vacuum or clean with a brush. Regular cleaning will help to keep the cooler running efficiently and economically.

18. The compressor is hermetically sealed and requires no lubrication. Most units are also fitted with an automatic reset overload protection switch.

19. Disconnect the water cooler from the electrical outlet whenever it is out of water.

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5.6.2 Choosing A Location For Water Coolers

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CHOOSING A LOCATION FOR WATER COOLERS

1. Locate the water cooler in a well-ventilated area, away from air vents, doorways and other dusty environments.

2. Leave at least 5 cm (2 inches) of clearance around the back of the cooler to allow for ventilation of the wire grid.

3. Locate the water cooler within reach of a suitable grounded electrical outlet.

4. Locate the water cooler out of direct sunlight and away from heating vents (this will help prevent algae growth).

5. Locate the water cooler where the floor is level. If the water cooler does not sit level on the floor, use a shim under one of the feet on the base of the cooler to bring it level.

6. Do not locate the water cooler in areas where the temperature may fall below freezing.

7. Do not use the water cooler or bottle as a shelf for plants or storage of other objects.

8. Keep the area around the water cooler free of dust and dirt.

Insert Contact Info Here

5.6.3 Bottled Water Storage

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Bottled Water Storage

1. Store full bottles of water indoors in a clean, cool, dry, well-ventilated space.
2. Do not store bottles of water in rooms or areas used for chemicals, paints, janitorial supplies, or radioactive articles.
3. Do not store bottles of water in direct sunlight or near heating vents.
4. Do not store water for more than 30 days. Like many other food products, bottled water normally contains low numbers of bacteria. During prolonged storage at room temperature, these bacteria can multiply rapidly.

Inappropriate Bottled Water Uses

5. Because bottled water normally contains low numbers of bacteria, it is recommended that you:

- Do not use bottled water to clean contact lenses.
- Do not use bottled water for babies or infants (unless boiled first).
- Do not use bottled water if you are a member of any immune deficient population (unless boiled first).

Bottled Water Hygiene

6. Wash hands thoroughly with warm water and soap after using the washroom, after handling dirty items, and always BEFORE touching water containers. Water coolers can become contaminated with bacteria that originate from non-sanitary practices.
7. Do not touch the end of the water cooler spigots with your hands or any items that have come in contact with your mouth (glasses, cups, small water bottles, etc.).

Replacing a Water Bottle on a Water Cooler

8. Wash hands thoroughly with warm water and soap before handling the "new" bottles.
9. Remove the empty water bottle.
10. Wipe the neck and shoulder of the "new" bottle with a clean hot soapy cloth, and also wipe the top of the water cooler and the lip of the reservoir.
11. Remove the cap or seal from the "new" bottle and place it on the cooler, centering the bottle on the "no-spill" probe tip.

Insert Contact Info Here

5.6.4 Preparing a Disinfection Solution

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Preparing a Disinfectant Solution

Directions

1. In a large clean food-grade container, dilute 15 mL of non-perfumed bleach (~5% chlorine) into 5 L of clean warm water.

2. When mixing or using disinfectant solutions, protect yourself by wearing Personal Protective Equipment described below.

Personal Protective Equipment

- Safety glasses with side shields.
- Disposable gloves (natural latex, rubber, nitrile, or PVC).
- Waterproof apron, smock or coverall.

Insert Contact Info Here

5.7 SHOCK CHLORINATION

5.7.1 Technical Information On Shock Chlorination Of Wells

For the purpose of this manual, shock chlorination is a remediation strategy used to temporarily disinfect a private groundwater well in order to control unacceptable levels of microorganisms within the well systems.

In providing information to the public on the shock chlorination process, public health officials should consider the following:

1. Purpose of chlorination
2. Health effect of consuming water with high levels of chlorine
3. Effect of chorine on well structure and pump components
4. Concentration of chlorine to be used for shock chlorination
5. Type of chlorine
6. Proper disposal of chlorinated water

1. Purpose of Chlorination

Shock chlorination should be used

- As a form of public health protection when the well water has tested positive for an indicator organism such as *E. coli*, showing the water may be contaminated and not suitable for human consumption, or
- For the control of nuisance organisms such as high levels of iron and sulfur reducing bacteria. Although these organisms are of aesthetic concern, high concentrations may interfere with proper testing of indicator organisms

Chlorination to Control Contamination

Shock chlorination is a process designed to inactivate pathogens within the well and distribution system. If microbial contamination has been introduced to the well directly or by means of poor siting or well design, shock chlorination should effectively reduce bacteria levels. Shock chlorination implicitly assumes that the origin of contamination is from the well and is not an aquifer problem. Shock chlorination is NOT intended to provide disinfection of the aquifer beyond the immediate location of a well.

Since shock chlorination is not designed to disinfect the groundwater supply, the water may remain unsafe if the bacteria continually enter the well from the aquifer. The effect of a single, large dose of liquid bleach is short-lived and variable. Shock chlorination in fact, can give homeowners a false sense of security as they assume the water is safe to drink for weeks or months. If the pollution source is continuous and from outside the well, a high bacterial count can return within days. Relatively fast recovery of total heterotrophic bacteria would suggest the problem may be related to biofilm formation in the well and not due to groundwater contamination.

An effective shock chlorination process should disinfect:

- entire well depth (well casing)
- formation around the bottom of the well
- gravel pack and the immediate area of the aquifer around the casing
- pump and associated piping
- some water treatment equipment
- distribution system

There is also no need to chlorinate a flowing artesian well. If it is determined that coliforms are present, chlorine should be applied at or below the lowest aquifer producing the artesian condition in an amount that will produce a chlorine concentration of at least 25 mg/L in the flowing water[1].

Chlorination to Control Nuisance Organisms

While shock chlorination with chlorine can reduce the population of iron or sulphur reducing bacteria, it is not effective in penetrating biofilm or scales where the bacteria may be surviving. Depending on the water quality, there may be a need for regular shock chlorination, such as each spring and fall, as a regular maintenance procedure to control these nuisance organisms. The oxidation process from the use of high chlorine concentration may loosen slime layers resulting in coloured water that must be properly flushed out and removed.

2. Health Effects of Consuming Water with High Levels of Chlorine

EHO/PHI should be aware of potential negative health effects of consuming water with high chlorine should a homeowner fail to follow a proper flushing process.

Administration of chlorine to rats and mice has failed to produce any specific toxic responses at concentrations in excess of 250 mg/L. A study sponsored by the National Toxicology Program (NTP) in 1988 observed kidney changes with chlorine at 275 mg/L[2]. Chlorine in water may be fatal to some animals at 1000 ppm[3].

The formation of disinfection by-product (DBP) should not be a major concern. DBPs are formed through the reaction of chlorine with precursors generally known as natural organic matters (NOM) such as humic or fulvic acids, producing trihalomethanes or other DBPs. NOM, however, is not likely to be present in any significant amount in groundwater. For wells that may be under the influence of surface water, the shock chlorination process is designed to provide a one-time inactivation of the water in the well casing. The formation of DBP therefore is considered to be a lesser health concern

[1] AWWA Standard, Disinfection of Wells, ANSI/AWWA C654-03, Sept 17 2003.
[2] Southern Research Institute, Birmingham, AL. 1988. A Final Report on Toxicity and Carcinogenicity Testing of Chloramine (C56382) in B6C3F1 Mice. Report to National Toxicology Program, Contract No. NO1-ES-45037
[3] De Zuane, J., 1990. Handbook of Drinking Water Quality: Standards and Controls. New York: Van Nostrand Reinhold

since (1) microbial health risk is real while chemical risk from the ingestion of DBP is only a projection, and the risk is usually a factor of 100 or less than a health risk relating to the consumption of water contaminated by microbes; and (2) shock chlorination is a one-time treatment process while safe DBP consumption level is based on continuous life-long consumption.

3. Effects of High Chlorine on Well Structure and Pump Components

While there are concerns regarding the effects of chlorine on well structure and pump components, the exact concentration that may produce a negative effect is not well defined as it may depend on other water parameters. High chlorine concentrations can be corrosive to pitless units, pumps, well casings and pipelines. There are some indications that over 500 ppm chlorine can damage fixtures and corrode copper and stainless steel[4]. There are also safety concerns regarding the public handling of very high bleach solutions. High chlorine creates reddish water and dangerous chlorine odour but does not increase the efficiency of chlorine penetrating scales and biofilm.

4. Concentration of Chlorine to be Used for Shock Chlorination

Liquid or granular chlorine is tremendously alkaline, resulting in an increase in pH when mixed with water. Chlorine is 100% biocidal at a pH of 5.5, but is 100% oxidative at a pH over 10. When 50 ppm chlorine is mixed into water with a natural pH of 7.1, pH will rise to 8.0 giving a 12% biocidal effectiveness. As the pH rises, chlorine becomes more oxidative in nature. At 200 ppm, chlorine mixed into water with a natural pH of 7.1, the pH will rise to over 9.0 and decrease the biocidal effectiveness to 2%. At 1,000 ppm, the pH may be over 10 and the biocidal effectiveness becomes less than 1%.

In high oxidative state, chlorine can create severe corrosion on metals (discoloration), produces chlorine gas, and is slow to kill bacteria. Higher chlorine concentrations (500-2000 ppm), however, may be needed due to high chlorine demand where there are conditions such as high alkalinity, hardness and turbidity.

There does not seem to be any consistency in the amount of chlorine to be used in shock chlorination treatment of a well. Table 5.1 provides a quick review of some of the recommended chlorine levels for shock chlorination in the US and Canada.

[4] AWS Technical Report: Sanitizing Pipelines and Distribution Systems b Shock-Chlorination, AWS Inc., 2003

Table 5.1. Recommended Chlorine Levels for Shock Chlorination of Wells

Source	Year	Chlorine Level	Contact Time	Retest	Other info
Missoula, Montana		1000	12-24 hrs	1 wk	Iron bacteria
Kansas State	1998	500	12 (24-72) hrs	1 wk	
Ohio	2000	500	8 hrs	Days	To control slime, iron, Mn, TOC
CGWA (Canadian Groundwater Assoc.)		250	8 hrs		Info given to Alberta Water Well Drilling Assoc.
Health Canada	2003	250	12-24 hrs	48 hrs	For new wells
U. Nebraska	1996	200	2-3 hrs (prefer overnight)		
U. Georgia	2003	200	8 ((12-24) hrs		
Purdue U	1993	200	12 (24) hrs	1 wk	
Colorado Sate U		200	Overnight	1 wk	
Oregon State	2002	100	6-12 hrs	3 days	
Missoula, Montana		100	12-24 hrs	1 wk	Coliform
Nova Scotia		100	12 hrs	5 days	>24 affect pump
AWWA	2003	50	12-24 hrs		
Health Canada	2003	50	12-24 hrs	48 hrs	For existing wells

Chlorine Level Needed to Control Pathogens

In the control of pathogens, 200 mg/L for 8 hours would provide a CT value of 96,000 mg-min/L, ten times what is required for 2-log *Cryptosporidium* removal, the pathogen with the greatest chlorine resistance. Bacterial pathogens such as *E. coli* would be inactivated very quickly at this concentration. The length of time that the chlorine should remain in the closed-off well system appears to be related to the time needed for the chlorine to be reduced to a safe level rather than a needed contact time for pathogen removal.

If a water sample result shows a low HPC and is positive for *E. coli*, then the use of 50 mg/L chlorine for 8 hours should be sufficient to remove any pathogen (CT 24000) and would minimize to damage to any plumbing components. If water samples show high HPC and are positive for *E. coli*, higher CT is needed to reach the pathogens that may be harboured within the biofilm.

Chlorine Level Needed to Remove Nuisance Organisms

A higher chlorine concentration and contact time may be needed to remove bacteria within the biofilm that can harbour iron and sulfur reducing bacteria. There is, however, no guideline value since the amount of biofilm within each well system is not known and is variable. One way of determining the effectiveness of shock chlorination is to measure the chlorine residual. As part of the shock chlorination process, after filling all the pipes

with chlorinated water, test the water at each fixture to verify that there is at least 50 to 100 ppm chlorine. After the water sits for 12 hours, retest for chlorine residual. If the water contains less than 10 ppm of chlorine, it is an indication that the slime, scale, and odour-producing bacteria have interacted with the chlorine and have used up all of the chlorine (chlorine demand), and the shock chlorination procedure may need to be repeated. The presence of a chlorine residual after 12 hours indicates that there was sufficient chlorine to remove the organics within the well system. A lack of chlorine residual would indicate all available chlorine was used to oxidize organics and a second chlorination may be required[5].

Based on information from other jurisdictions, it would appear that the use of 200-250 mg/L should be sufficient in reducing the nuisance microorganism population around the biofilm.

5. Type of Chlorine

Calcium Hypochlorite: granular or pellet chlorine is generally available in 65-70% available chlorine. Granular chlorine should be mixed at the surface as a liquid and injected into the well. The pellets do not dissolve easily in cold water and can remain in the bottom of a well for years. The use of calcium hypochlorite in high alkaline or hard water (>180 ppm calcium hardness) will precipitate calcite as a pasty substance. This can cause severe plugging and a reduction in well yield. It is also very difficult to remove. Calcium pellets can cause “burns” and safety precautions should be taken in handling the pellets.

Sodium hyphochlorite: Liquids are available as common household bleach with approximately 5.5% available chlorine and commercial grades with up to 12% available chlorine. Do not use the scented brands of bleach because they can leave a residual. The shelf life of household bleach is such that the potency declines 20-25% every month. Even a newly purchased product may not provide very accurate chlorine dosage.

6. Safe Disposal of Chlorinated Water

Chlorinated water can be harmful to vegetation and biota. Homeowners should check with their local sewer department for conditions of disposing heavily chlorinated water into the sanitary sewer. Not more than 400 Litres of chlorinated water should be discharged into a septic tank. For surface discharge, flush chlorinated water into an area where desirable vegetation will not be harmed, such as a gravel driveway, and away from any surface body of water. If the wastewater contains high concentrations of chlorine, measures should be taken to either impound the highly chlorinated water or to neutralize the chlorine (with sodium bisulfite, sodium metabisulfite or sodium sulfite[6]) before discharge.

[5] AWS Inc., AWS Technical Report: Sanitizing Pipelines & Distribution Systems by Shock-Chlorination, 2003.
[6] AWWA Standard, Disinfection of Wells, ANSI/AWWA C654-03, Nov 1, 2003.

5.7.2 Shock Chlorination Procedure For Contaminated Wells

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SHOCK CHLORINATION PROCEDURE FOR CONTAMINATED WELLS

This shock chlorination procedure is designed for disinfecting groundwater wells that have been tested positive for E. coli or fecal coliform. For disinfecting wells to control iron or sulfur bacteria, please refer to "SHOCK CHLORINATION PROCEDURE FOR IRON AND SULFUR BACTERIA" or contact your Environmental Health Officer or Public Health Inspector

BEFORE YOU START

- Store sufficient water to meet family needs for 24 hours, including the water required for animals. Note that the water is not safe for drinking and must be boiled for 1 minute or treated before being used. Consult with your Environmental Health Officer or Public Health Inspector on proper ways of disinfecting your water supply.

- Before attempting to chlorinate the well, it is essential to check the following:
  - All repairs to the well should be completed before the chlorination process
  - Check the condition of the well: location, well casing, and sanitary seal (well cap)
  - Check the condition of the plumbing system: leaking pipes, pressure tank and cross connections

- Shock chlorination is a process designed to inactivate harmful bacteria within the well and distribution system. If the bacteria have been introduced to the well directly or by means of poor siting or well design, shock chlorination should effectively reduce the bacteria levels. Shock chloriantion is NOT intended to provide disinfection of the aquifer beyond the immediate location of a well.

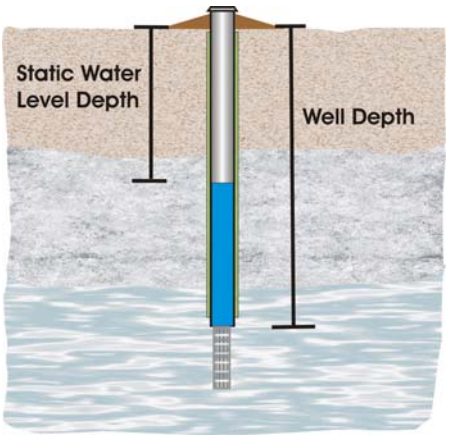
- Unless you are familiar with water wells, and are comfortable working with chemicals, the process should be done by a licensed water well contractor or licensed plumber. If you have point-of-use or point-of-entry home water treatment devices, consult with your water treatment company before starting with chlorination.

- Chlorine is a strong oxidizing agent and is highly corrosive. It may cause skin and eye damage, or irritation to the nose and/or throat. Use goggles and rubber gloves when handling this material. It is also recommended that protective clothing (splash apron) and rubber boots be worn. Always provide adequate ventilation when using chlorine.

- Materials Required
  - A clean water tank with a holding capacity of at least 1,360 litres (300 gallons)
  - Garden hose
  - Appropriate volume of chlorine or bleach solution

PROCEDURE FOR SHOCK CHLORINATION

1. Measure the well depth and the static or resting water level, then calculate the depth of the water in the well using the following formula:



Depth of water = Total well depth – Static water level depth

To measure how much water is in the casing, carefully drop a weighted fishing line into the well until you hear it hit the water (static water level). Mark the fishing line, and measure the distance to the water level. Subtract this amount from the total casing length (well depth).

2. Using Table 1, determine the amount of water and chlorine solution required. Pump the recommended amount of water into a clean water storage container. A clean galvanized stock tank or pick-up truck box lined with a 4 mil thick plastic sheet is suitable.

3. Mix the recommended amount of chlorine with the water to give the recommended 50 ppm chlorine solution.

Table 1. Amount of Chlorine and Water Required to Obtain 50 ppm chlorine solution

Casing Diameter		**Volume of Water Needed per 1 ft (30 cm) of water in casing**		**Millilitres of 5.25% Bleach needed per 1 ft (30 cm) of water**	**Millilitres of 12% Industrial Bleach needed per 1 ft (30 cm) of water**
(in)	(mm)	(Gallons)	(Litres)	(millilitres)	(millilitres)
4	100	1.1	5	4.75	2.1
6	150	2.4	10.9	10.5	4.55
8	200	4.2	19.1	18	8

4. Household bleach is easy to obtain, inexpensive and already in liquid form for easy mixing. **Use fresh bleach that does not contain detergent or other additives.** Industrial bleach, usually in the form of calcium hypochlorite, is used to disinfect swimming pools and can be found in hardware stores and pool equipment outlets. This material should be handled with care since the dust will irritate the eyes, nose, mouth and skin. Calcium hypochlorite is also highly corrosive when wet.

5. Loosen and remove the well cap, be careful not to contaminate the cap. Caution should be taken when removing the well cap, as bare wires may be exposed posing an electrical hazard.

6. Attach a clean hose to an outside spigot and place the hose into the well casing. If there is no outside spigot, attach a hose and siphon the solution into the well. Turn the hose on and wash down the interior of the well casing in a swirling motion from top to bottom.

7. Open one hot faucet first and let the water run, then open the cold water faucet farthest from the pressure tank and let the water run until a strong chlorine odor is detected. Open the remaining cold faucets one at a time (including dishwashers, washing machines etc) in the distribution system until the water coming out has a chlorine-like odour.

Caution: Do not let all of the water faucets run at the same time because you may loose system prime or damage your pump.

Shut the faucets off after testing for chlorine if you are using a chlorine test kit.

8. It is best to verify the chlorine concentrations by using a test kit. Chlorine test papers are available through restaurant or swimming pool suppliers. There should be at least 10 ppm of chlorine in all faucets. If chlorine is not present or is weak at any faucet, it is an indication it is being used up in cleaning the well and you may need to add small amounts of chlorine into the well to maintain or increase the desired chlorine concentration.

9. Make sure the chlorine reached the whole system by completing the following:

- Starting at any location, open the remaining hot water faucets one at a time until each faucet has been run. Allow hot water to run at least 30 to 60 seconds until a strong chlorine odor and/or a noticeable drop in water temperature is detected. In some cases, the water heater may have to be completely emptied before chlorine concentration can be detected at the faucet. Shut the faucet off after proper concentration is noted.
- All the toilets should be flushed at least once. Check chlorine concentration inside the water tank above the toilet.
- Unfinished plumbing that has been capped (plumbing dead ends) should be flushed. If necessary, provide a temporary faucet. Plumbing that is no longer in use should be removed from the distribution system. Contact a licensed plumber to perform the work. Check chlorine concentration and shut each faucet off after proper concentration is noted.

- All outside spigots and household appliances connected to the water supply (i.e. dishwasher, washing machine, ice maker, etc.) must be disinfected. Check chlorine concentration and shut faucets off after the proper concentration is noted.
- If fire suppression is present, partly drain the system storage tank so the pump turns on and begins drawing chlorinated water into the system and the tank. Then shut the pump off and check chlorine concentration at the storage tank outlet drain.
- Disconnect the water feed line to the furnace humidifier and turn the valve on and allow the water to run until a proper chlorine concentration is noted.

10. After completing the chlorination, rinse the well cap with chlorinated water and turn the outside spigot off. Replace the well cap to form a watertight seal. All bolts and screws must be reattached. If any parts are lost or broken, replace them as necessary.

11. Once the chlorinated water has reached all the appliances, fixtures and faucets, let the chlorinated water stand in the well and plumbing system for 12-hours.

WHILE THE CHLORINE IS IN THE SYSTEM DO NOT DRINK THE WATER. CONTACT WITH THE WATER MAY CAUSE SKIN, EYE AND NOSE IRRITATION.

12. When the chlorine has been contained in the well for 12-hours, start flushing the chlorine from the system by running an outside spigot to a culvert or drainage ditch until you can no longer detect chlorine in the water. NOTE: Do not run the well excessively to avoid damaging the well pump, and avoid running the water into or onto the septic system. Flush the chlorinated water into an area where desirable vegetation will not be harmed, such as a gravel driveway and away from any surface body of water.

13. After the chorine has been flushed from the well, flush the hot and cold water faucets, appliances and fixtures, one at a time. The length of time for flushing depends on the concentration of chlorine, depth of the well, formation type, the pH and the size of the distribution system. It will usually take 4 to 8 hours to flush the well after a standard well chlorination. The water may become discolored during flushing because the chlorine may have loosened the hard water deposits in the plumbing.

Caution: The chlorine must be completely flushed from plumbing system. Chlorine may damage the rubber and plastic parts in the faucets and plumbing.

14. Backwash all filters and softeners and regenerate any water treatment equipment. Consult your water treatment equipment supplier for any specific procedures required for backwashing and regenerating any water treatment equipment.

15. Take another water sample for analysis after seven (7) days.

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5.7.3 Shock Chlorination Procedure For Iron And Sulfur Bacteria

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SHOCK CHLORINATION PROCEDURE FOR IRON AND SULFUR BACTERIA

This shock chlorination procedure is designed for disinfecting groundwater wells to control iron and sulfur bacteria. For disinfecting wells that have tested positive for E. coli or fecal coliform, please refer to "SHOCK CHLORINATION PROCEDURE FOR CONTAMINATED WELLS" or contact your Environmental Health Officer or Public Health Inspector

BEFORE YOU START

- Store sufficient water to meet family needs for 24 hours, including the water required for animals.

- Shock chlorination does not completely eliminate iron and sulfur reducing bacteria from the water system, but will hold it in check. To control the iron bacteria, you must repeat the procedure each spring and fall as a regular maintenance procedure. If your well has never been shock chlorinated or has not been done for some time, it may require two or three treatments before you notice a significant improvement.

- Before attempting to chlorinate the well, it is essential to check the following:
  - All repairs to the well should be completed before the chlorination process
  - Check the condition of the well: location, well casing, and sanitary seal (well cap)
  - Check the condition of the plumbing system: leaking pipes, pressure tank and cross connections

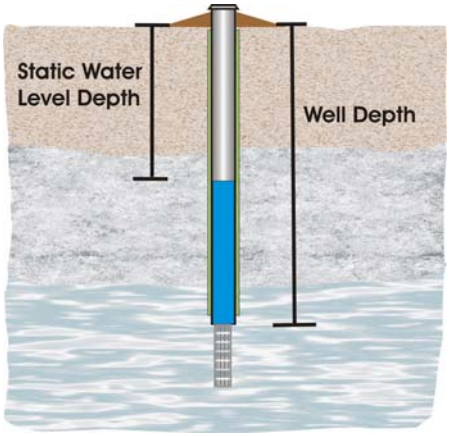
- Unless you are familiar with water wells, and are comfortable working with chemicals, the process should be done by a licensed water well contractor or licensed plumber. If you have point-of-use or point-of-entry home water treatment devices, consult with your water treatment company before starting with chlorination.

- Chlorine is a strong oxidizing agent and is highly corrosive. It may cause skin and eye damage, or irritation to the nose and/or throat. Use goggles and rubber gloves when handling this material. It is also recommended that protective clothing (splash apron) and rubber boots be worn. Always provide adequate ventilation when using chlorine.

- Materials Required
  - A clean water tank with a holding capacity of at least 1,360 litres (300 gallons)
  - Garden hose
  - Appropriate volume of chlorine or bleach solution

PROCEDURE FOR SHOCK CHLORINATION

1. Measure the well depth and the static or resting water level, then calculate the depth of the water in the well using the following formula:



Depth of water = Total well depth – Static water level depth

To measure how much water is in the casing, carefully drop a weighted fishing line into the well until you hear it hit the water (static water level). Mark the fishing line, and measure the distance to the water level. Subtract this amount from the total casing length (well depth).

2. Using Table 1, determine the amount of water and chlorine solution required. Pump the recommended amount of water into a clean water storage container. A clean galvanized stock tank or pick-up truck box lined with a 4 mil thick plastic sheet is suitable.

3. Mix the recommended amount of chlorine with the water to give the recommended 250 ppm chlorine solution.

Table 1. Amount of Chlorine and Water Required to Obtain 250 ppm chlorine solution

Casing Diameter		**Volume of Water Needed per 1 ft (30 cm) of water in casing**		**Millilitres of 5.25% Bleach needed per 1 ft (30 cm) of water**	**Millilitres of 12% Industrial Bleach needed per 1 ft (30 cm) of water**
(in)	(mm)	(Gallons)	(Litres)	(millilitres)	(millilitres)
4	100	1.1	5	380	10.5
6	150	2.4	10.9	520	22.8
8	200	4.2	19.1	90	40

4. Household bleach is easy to obtain, inexpensive and already in liquid form for easy mixing. **Use fresh bleach that does not contain detergent or other additives.** Industrial bleach, usually in the form of calcium hypochlorite, is used to disinfect swimming pools and can be found in hardware stores and pool equipment outlets. This material should be handled with care since the dust will irritate the eyes, nose, mouth and skin. Calcium hypochlorite is also highly corrosive when wet.

5. Loosen and remove the well cap. Caution should be taken when removing the well cap, as bare wires may be exposed posing an electrical hazard.

6. Attach a clean hose to an outside spigot and place the hose into the well casing. If there is no outside spigot, attach a hose and siphon the solution into the well. Turn the hose on and wash down the interior of the well casing in a swirling motion from top to bottom.

7. Open one hot faucet first and let the water run, then open the cold water faucet farthest from the pressure tank and let the water run until a strong chlorine odor is detected. Open the remaining cold faucets one at a time (including faucets, dishwashers, washing machines etc) in the distribution system until the water coming out has a chlorine-like odour. Shut the faucets off after the proper concentration is noted. **Caution: Do not let all of the water faucets run at the same time because you may loose system prime or damage your pump.** Shut the faucets off after testing for chlorine if you are using a chlorine test kit.

8. It is best to verify the chlorine concentrations by using a test kit. Chlorine test papers are available through restaurant or swimming pool suppliers. There should be at least 50 ppm of chlorine in all faucets. If chlorine is not present or is weak at any faucet, it is an indication it is being used up in cleaning the well and you may need to add small amounts of chlorine into the well to maintain or increase the desired chlorine concentration.

9. Make sure the chlorine reached the whole system by completing the following:

- Starting at any location, open the remaining hot water faucets one at a time until each faucet has been run. Allow hot water to run at least 30 to 60 seconds until a strong chlorine odor and/or a noticeable drop in water temperature is detected. In some cases, the water heater may have to be completely emptied before chlorine concentration can be detected at the faucet. Shut the faucet off after proper concentration is noted.
- All the toilets should be flushed at least once. Check chlorine concentration inside the water tank above the toilet.
- Unfinished plumbing that has been capped (plumbing dead ends) should be flushed. If necessary, provide a temporary faucet. Plumbing that is no longer in use should be removed from the distribution system. Contact a licensed plumber to perform the work. Check chlorine concentration and shut each faucet off after proper concentration is noted.
- All outside spigots and household appliances connected to the water supply (i.e. dishwasher, washing machine, ice maker, etc.) must be disinfected. Check chlorine concentration and shut faucets off after the proper concentration is noted.

- If fire suppression is present, partly drain the system storage tank so the pump turns on and begins drawing chlorinated water into the system and the tank. Then shut the pump off and check chlorine concentration at the storage tank outlet drain.
- Disconnect the water feed line to the furnace humidifier and turn the valve on and allow the water to run until a proper chlorine concentration is noted.

10. After completing the chlorination, rinse the well cap with chlorinated water and turn the outside spigot off. Replace the well cap to form a watertight seal. All bolts and screws must be reattached. If any parts are lost or broken, replace them as necessary.

11. Once the chlorinated water has reached all the appliances, fixtures and faucets, let the chlorinated water stand in the well and plumbing system for 12-hours. **WHILE THE CHLORINE IS IN THE SYSTEM DO NOT DRINK THE WATER. CONTACT WITH THE WATER MAY CAUSE SKIN, EYE AND NOSE IRRITATION.**

12. When the chlorine has been contained in the well for 12-hours, start flushing the chlorine from the system by running an outside spigot to a culvert or drainage ditch until you can no longer detect chlorine in the water. NOTE: Do not run the well excessively to avoid damaging the well pump, and avoid running the water into or onto the septic system. Flush the chlorinated water into an area where desirable vegetation will not be harmed, such as a gravel driveway and away from any surface body of water.

13. After the chorine has been flushed from the well, flush the hot and cold water faucets, appliances and fixtures, one at a time. The length of time for flushing depends on the concentration of chlorine, depth of the well, formation type, the pH and the size of the distribution system. It will usually take 4 to 8 hours to flush the well after a standard well chlorination. The water may become discolored during flushing because the chlorine may have loosened the hard water deposits in the plumbing. **Caution: The chlorine must be completely flushed from plumbing system. Chlorine may damage the rubber and plastic parts in the faucets and plumbing.**

14. Backwash all filters and softeners and regenerate any water treatment equipment. Consult your water treatment equipment supplier for any specific procedures required for backwashing and regenerating any water treatment equipment.

15. Test the chlorine residual in the faucet. If there is less than 2 mg/L of chlorine the water is safe to use. If you do not have a chlorine testing kit, it is recommended that the water not be used for drinking, making infant formula or washing fruits and vegetables. The water, however, can be used for flushing toilets and washing dishes. The water should be safe for drinking after another 12-hours in the distribution system (a total of 24-hours).

16. Take another water sample for analysis after seven (7) days

Insert Contact Info Here

CHAPTER 6

COMMUNICATION AND ACTION PROTOCOL

6.1 Roles and Responsibilities of Regional, Provincial and Federal Health Agencies

6.2 Protocol for Failed Bacteriological Results in Drinking Water for Private and Communal Drinking Water Systems
- 6.2.1 AH & W Boil Water Advisories/Orders Report Form
- 6.2.2 Follow-up Procedure and Intervention
- 6.2.3 Public Health Intervention – Boil Water Advisory
- 6.2.4 Rescinding a Boil Water Order/Advisory
- 6.2.5 Boil Water Advisory/Orders Report Form

6.3 Infrastructure Failure

6.4 Boil Water Advisory, Boil Water Orders and Other Public Health Interventions
- 6.4.1 Sample Boil Water Order *
- 6.4.2 BWA Operational Emergency Contact List
- 6.4.3 Fact Sheet, Emergency Water Storage *
- 6.4.4 Fact Sheet, Emergency Water Storage During a BWA *
- 6.4.5 Fact Sheet, How to Use Water Safely During a BWA *
- 6.4.6 Fact Sheet for Professionals: Art and Science of Boiling Water During a Boil Water Advisory *
- 6.4.7 BWA, Sample Letter *
- 6.4.8 BWA Draft Newspaper Advertisement *
- 6.4.9 BWA Draft Newspaper Press Release *
- 6.4.10 BWA Draft Radio Script *
- 6.4.11 BWA Sample Pamphlets *
  - General Public and Media
  - Hotels and Restaurants
  - Grocery and Convenience Stores

Hospitals and Long Term Care Facilities
Swimming Pools
Dental Offices
Day Care Centers

6.4.12 Procedure for Rescinding BWA

6.5 Guidelines For Failed Bacteriological Results In Drinking Water For Recreation Areas With Hand-Pumps And/Or Sampling Inaccessible Water Supplies

6.6 Blue-Green Algae Fact Sheet *

This section outlines the role of Health Agencies in drinking water safety and the acceptable actions Health Agencies in their dealing with unacceptable bacteriological results, and defines the communication protocol between the Provincial Laboratory for Public Health (Microbiology) Health Agencies. Fact sheets and draft scripts to serve as examples for Health Agencies are also included in case a boil water advisory has to be ordered.

** Information intended for the public and a generic version is provided on the attached compact-disc for Health Agencies to reproduce*

CHAPTER 6 – COMMUNICATION AND ACTION PROTOCOL

6.1 ROLES AND RESPONSIBILITIES OF REGIONAL, PROVINCIAL AND FEDERAL HEALTH AGENCIES

Regional Health Authorities (RHA) and Health Canada's Safe Environments Programme and Environmental Health Services within Alberta have a primary role in ensuring the safety of drinking water supply by enforcing legislation, participating in the development of "*Guidelines for Canadian Drinking Water Quality*" and providing education/advice to the water purveyors and public at large. The legal responsibility of a RHA in ensuring the safety of drinking water lies within the Public Health Act. Section 11 of the Nuisance and General Sanitation Regulation 243/2003 states that:

> "…Water must be potable. Where a person provides a source of water that the person intends to be used or realizes or ought to realize will be used by the public for human consumption, the person shall ensure that the water is potable…"
>
> and section 12 states:
>
> "…Where under any law a potable water supply is required to be provided in or at any public place, the owner of the public place shall ensure that the equipment used for the transmission, treatment and storage of the water is maintained in adequate operating condition and in a clean and sanitary condition…"

To achieve this goal, environmental public health officials must cooperate with Alberta Environment and local utilities to ensure that the water delivered to the public is safe for consumption. The importance of water safety is reflected in the "*Common Reference System and Operational Standards for Alberta Regional Health Authority Environmental Health Programs*," or commonly referred to as the "Blue Book." One of the program areas defined as essential is "Safe Drinking Water." The goal of the program is to reduce the waterborne adverse health effects related to water consumption.

Health Canada in collaboration with Indian and Northern Affairs Canada, helps First Nation communities ensure safe drinking water on their lands. Under the Drinking Water Safety Program of Environmental Health Services, Health Canada works in partnership with the First Nations to monitor drinking water quality in First Nation communities.

Water Quality and Health Bureau of the Safe Environments Program in collaboration with the provincial and territorial governments develops guidelines for new substances and upgrades the existing "Guidelines for Canadian Drinking Water Quality." These guidelines provide the basic tools to all levels of government across Canada to develop and promulgate stringent drinking water standards specific to their jurisdictional needs.

To meet these objectives, the role of Health Agencies in ensuring the safety of drinking water within Alberta should therefore include prevention, protection, promotion and education:

1. Preventing waterborne outbreaks from occurring by:
    - Determining the quantity & quality of source water, types of contaminants such as chemicals, radiological and microbiological and their sources; and
    - Working with all levels of government and Utilities to identify critical control points within treatment processes for effective monitoring, control and management including determining treatment efficiency in the removal or inactivation of harmful agents found in source water

2. Protecting the public and minimizing the impact of waterborne outbreaks through:
    - Early detection of enteric cases within the community using active monitoring and passive surveillance systems; and
    - Effective and timely declaration of water quality advisories such as “Boil Water” or “Do not Drink Water” and the ability to provide complete, and accurate information to the public regarding the water quality status.

3. Act as one of the central resources for health information and promote water safety through:
    - Effective partnership, collaboration and cooperation with all levels of government and Utilities in promoting water safety; and
    - Provide accurate and timely information to the public on the safety of their water supply

6.2 PROTOCOL FOR FAILED BACTERIOLOGICAL RESULTS IN DRINKING WATER FOR PRIVATE, PUBLIC AND COMMUNAL DRINKING WATER SYSTEMS

Introduction:

It is estimated that over 600,000 Albertans derive their drinking water from supplies and systems that fall outside of the licensing and approvals process of Alberta Environment. Officials who represent the interests of public health, the environment and various levels of government recognize and are concerned about the vulnerabilities that may exist with these supplies and in particular the need for early and effective notification in situations where health may be at risk.

To this end, this protocol is designed to provide a consistent and effective means of addressing public health risks associated with microbiological contamination of private, public and communal drinking water systems.

Microbiological contamination in water supplies:

Testing for bacteria in drinking water is an important monitoring tool for ensuring microbiologically safe drinking water. Evidence of the presence of Total Coliform/*E. coli* bacteria may indicate a potential health risk requiring follow-up action.

6.2.1 Roles and Responsibilities

A) Regional Health Authorities and Health Canada

- Monitor submission of water samples and resamples from supplies to ensure compliance and appropriate follow-up as needed,
- Interpret laboratory results and determine when remedial action, including "Boil Water Advisories/Orders" need to be implemented and rescinded,
- Respond to notification of failed bacteriological results from laboratory, and
- Provide and maintain a current list of emergency contact personnel and their contact numbers to the laboratory.

Note: While it is understood that conditions and circumstances may dictate otherwise, it is preferred that water sample submissions be submitted to the Provincial Laboratory for Public Health (Microbiology), early within the week (Mondays, Tuesdays, Wednesdays) in order to avoid, as much as possible, the need for after hours, holiday and weekend emergency response reporting and the further necessity of courier or special delivery services.

B) Provincial Laboratory for Public Health (Microbiology)

- Within the hours 0800 - 1530, Monday to Friday, FAX all notifiable results to the local health agency.

- Outside of the hours of 0800 - 1530 and on statutory holidays and weekends PHONE the local health agency emergency contact and FAX all notifiable results to the local health agency.

- Notifiable results are defined as:
- The presence of one or more Total Coliform/*E. coli* per 100 mL

6.2.2 Follow-up Procedure and Intervention

The local health agency, upon being notified of a failed bacteriological result (see Chapter 3.1. for Result Interpretation) may initiate an emergency response strategy based upon their determination of the degree of risk and according to their range of jurisdiction.

The health agency should attempt to notify the operator of a communal or public system directly within 24 hours of receiving the failed result. If contact by telephone is unsuccessful after 24 hours, a site visit should be considered. Contact with the owner of a private system should also be attempted within 24 hours of receiving a notifiable result. However, indirect contact, such as providing the result and interpretation via telephone voice message, is satisfactory. If telephone contact cannot be established with the home owner, the bacteriological report and interpretation should be mailed to the owner.

As a precaution, the operator/owner of a water supply with no treatment may be advised to boil drinking water, or use an alternate source in the interim, until further sampling can verify the result. In the case of a public or communal system, where the health of the public is at imminent risk, a Public Health Inspector should ideally inspect the water system and collect the sample for verification purposes within 24 hours following the initial notification.

Repeat Samples

In the event that repeat samples are required, the local health agency will verify that:

- In the case of a communal system, the system owner/operator has been instructed to collect and submit for analysis repeat samples that are upstream, downstream and at the same location as the site showing the contamination.
- In the case of a public system, the owner/operator has been instructed to collect and re-submit for analysis repeat sample(s) in numbers and locations as required by the Executive Officer.
- In the case of a private supply, the owner has been instructed to collect and submit for analysis repeat samples in numbers and at a location in accordance with the advice of the Executive Officer.

  Note: Repeat samples must be clearly identified as such on the laboratory requisition form. When repeat samples are to be submitted, after hours or on weekends and holidays, the PLPH (M) must be notified in advance in order to co-ordinate transportation and receiving schedules. During after hours and

weekends the PLPH (M) will communicate all results of repeat samples to the local health agency by FAX and PHONE.

6.2.3 Public Health Intervention - Boil Water Order/Advisory

Boil Water Order: An Executive Officer may, in the case of a public or communal drinking water system, and where he/she deems it appropriate in the interest of safe guarding the publics' health, issue a Boil Water Order pursuant to section 62 of the Public Health Act. It is the responsibility of the health agency to monitor and verify that the Boil Water Order has been implemented and followed to the satisfaction of the Executive Officer.

> **Note:** A Boil Water Order is an Order issued by an Executive Officer pursuant to Section 62 of the Public Health Act. The Order may require the operator of a water system to advise consumers using that system (via posting, local media releases, door-to door canvassing, or whatever other measures the Executive Officer deems appropriate) that water used for drinking purposes must be boiled for a prescribed period of time prior to consumption. Boil Water Orders are intended as a temporary measure to allow remedial work on a drinking water system; they are not intended as an on-going method of treatment.
>
> **Note:** The Health Agency should ensure that it maintains an updated contact list of high-risk groups using the water utility and that this list is contacted during a Boil Water Advisory (see Chapter 6.4.2).

Boil Water Advisory: As an alternative to a Boil Water Order, and where conditions or circumstances are deemed appropriate the Executive Officer may issue a Boil Water Advisory.

> **Note:** A Boil Water Advisory is usually initiated for the same reasons as a Boil Water Order. It differs, however, in that it takes into consideration the limits of jurisdiction on privately owned facilities and, as such, is issued advising individuals that the water should not be used for drinking purposes unless it has been boiled for a prescribed period of time prior to consumption.
>
> **Note:** Local health agencies will notify Alberta Health and Wellness, Environmental Health Strategies, during regular working hours of all Boil Water Orders or Advisories issued and rescinded in relationship to communal and public drinking water systems.

6.2.4 Rescinding a Boil Water Order/Advisory

> The Boil Water Order/Advisory will be rescinded when the local health agency is satisfied that the conditions or concerns giving rise to the action have been satisfactorily remedied or otherwise addressed.

6.2.5 BOIL WATER ADVISORIES/ORDERS REPORT

Regional Health Authority:_____

Community	Effective Date	Reasons	EHO/PHI Name	Remedial Measures	Estimated Duration	New, Continued	Date Cancelled (Lifted)

6.3 INFRASTRUCTURE FAILURE

Boil Water Advisory and No-Drinking Water Advisory Scenario:

The primary function for public health agencies during infrastructure failure is to ensure an adequate supply of water for essential function and protection of the public from exposures to pathogens and chemicals in the water supply.

Quantity of water available in emergencies is generally limited to meeting very basic survival needs of drinking, food preparation, and personal hygiene, and may not include bathing, showering, laundering or watering of plants and gardens. Water of unknown quality could be used to meet these non-priority water needs. Quality of emergency water is generally lower than that of the normal drinking water supply.

Priority in emergencies is to avoid immediate threats such as waterborne disease and dehydration. Other considerations such as short-term exposure to contaminants known to have lifetime exposure risks are discounted. Related priority is to provide an adequate supply of water for fire suppression.

There are basically four levels of responses by pubic health agencies during an infrastructure failure. These are dependent upon the severity and types of failure.

1. Failure to deliver adequate or safe water to a defined number of neighbourhoods or communities only i.e. limited disruption or loss of water

   Example: Cross-connection and back-siphonage, sinkholes, leaking underground gasoline storage tanks and contaminated soil, main breaks and distribution line breakage, and power loss confined to certain sectors.

   In this scenario, the basic infrastructure is still intact. While the delivery of safe water is restricted or interrupted, the primary function for public health agencies would be disease prevention and to work with utilities to allow a re-direction of water to the affected communities. Due to the proximity to other service lines or fire hydrants, emergency lines can be attached to provide temporary delivery of potable water.

   Action Summary: cooperate with utility and municipality to ensure the delivery of an adequate supply of potable water

2. Failure to deliver adequate or safe supply of water to the whole community.

Example: Complete power failure, extreme weather conditions (hurricane, ice storms, flood, earthquake, tidal wave), terrorism, and chemical or biological contamination.

The primary function of the public health agency for total infrastructure failure is to find and deliver an adequate supply of water to essential services and for the whole community, and to set up a system to ensure the portability of the water used by the public for consumption.

In the failure to deliver an adequate or safe supply of water, there are potentially three scenarios:

2-A Microbial Contamination

Example: Presence of bacteria or protozoan in the water supply, or high turbidity indicating the increase risk or potential for microbial contamination.

Action Summary: Declare a Boil Water Advisory.

2-B Chemical Contamination

Example: The presence of toxic chemical(s) such as arsenic or blue-green algae toxins in the water supply. Boiling cannot render the water safe for consumption, and there may be a need to avoid skin (dermal) contact and reduce inhalation of vapours. Although the waste disposal system is still functional, wastewater treatment plants must be notified as to the cause as some toxic chemicals may affect the effectiveness of waste digestion. This is the most likely scenario for bio-terrorism.

Action Summary: Declare No-Drinking Water Advisory

2-C Total infrastructure failure

Example: Flooding or other natural disaster resulting in no water delivery to the whole community. Besides the concerns with the potability of water, there are also concerns with personal hygiene and waste disposal. Priority must be given to essential services.

Action Summary: Set up central stations for water delivery and waste disposal.

STEPS IN DECLARING A NO-DRINKING WATER ADVISORY

The basic responsibilities of public health agencies during infrastructure failure include:
1. Safe water delivery;
2. Waterborne disease prevention and outbreak detection; and
3. Other water-related issues during infrastructure failure.

I. SAFE WATER DELIVERY

Objectives:

- Ensure a safe and adequate supply of water can be delivered to essential services such as emergency centres and hospitals
- Ensure an adequate supply of water can be delivered to the community (note: ideally, the water should be potable. However, there may be a potential for other compounding factors that may make it necessary for the water to be further disinfected prior to consumption. The primary goal should therefore be delivery of an adequate water supply, especially during complete infrastructure failure)
- Set up a testing protocol for the water to ensure safety of the water supply
- Approve and inspect water haulers and water dispensing stations
- Provide information to the public on the safe receiving and storage of water
- Provide information to the public on the use of point-of-use devices, emergency water disinfection strategies or boil water protocols to ensure a safe supply of water

The delivery of adequate water during an infrastructure failure can be best achieved by proper emergency planning prior to the event. Public health agencies should be an integral part of a municipal emergency planning team, with representation at the control centre and representation on the media communication team.

During emergency planning for infrastructure failure, the following issues should be considered:

- Determine the availability of an alternate safe drinking water supply from neighbouring communities
- Assess the adequacy of the alternate drinking water supply and the safe delivery or transportation system
- Evaluate the functionality of the dispensing system

For severe events leading to complete infrastructure failure, the first 48 hours is usually the most chaotic and, in many cases, most critical for survival. There must be an adequate supply of water for emergency crews, essential food services, fire suppression, health care centers and other emergency services. Public health agencies should work closely with utilities to secure sufficient water for these uses.

Temporary water supplies that may be used include swimming pools, bottled water plants, packaged ice plants and water vending machines. These facilities or operations have basic water treatment devices on site and may have the storage capacity to provide potable water for a short period of time. Public health agencies may also want to consider working with camping stores to control and distribute point-of-use water treatment

devices (see section 5.2). There are also commercial packaged water treatment plant companies in Canada and the US that can ship packaged units within 24-hours. These units can treat and provide temporary potable water for up to 100,000 individuals. If water is available through a well or spring, the source water must be fenced off, covered, and controlled. If possible, make immediate arrangements to store water and to distribute water at collection points away from the source to avoid direct contamination.

In general, the amount of water needed for displaced population is estimated as:

10 liters x no. of people x days = Liters/person/day (L/p/d)

Feeding centers – 20-30 L/p/d
Health Care Centers – 40-60 L/p/d

Water can be distributed to individuals in a number of ways depending on local conditions. Uncontrolled access by individual consumers to primary water sources must be avoided. A distribution system should have a sufficient number of taps or outlets relative to the size of the population to ensure that people do not wait for long periods to have access. Equity in the distribution of water is an extremely important consideration. Ideally, no dwelling should be located further than 100 meters from a distribution point if the use of a vehicle is not possible.

As part of the emergency planning, information brochures such as the proper storage of water by homeowners during severe weather conditions should be prepared.

II. WATERBORNE DISEASE PREVENTION AND OUTBREAK MANAGEMENT

Objectives:

- Prevent the outbreak of waterborne diseases;
- Minimize community exposure during an outbreak by setting up an early detection and warning system; and
- Minimize public concerns and anxiety through proper outbreak management

Outbreak Prevention

Waterborne disease outbreaks can be averted through proper system monitoring and effective communication. There must be a functional working relationship between the utilities and public health agencies. This may include the setting up of critical control points throughout the distribution system, and defining parameters for monitoring. Failure to meet monitoring criteria should result in notification to proper authorities of the possibility of infrastructure failure. It would be the responsibility of public health agencies to work with utilities to determine the likelihood of a potential waterborne outbreak, and advise the community of the proper precautionary practices, including the issuance of a boil water advisory. Prompt action and decision may prevent widespread waterborne disease outbreak during an infrastructure failure.

Outbreak Detection

The probability of detecting a waterborne outbreak depends on both knowledge and resources (both microbiological and personnel). Rapid recognition of the possibility of an outbreak and a timely start to the investigation greatly increase the likelihood of determining the cause. Without an effective surveillance system, it is unlikely that an outbreak can be identified in its early stage.

Prior planning is needed for proper outbreak management. There is a need to identify the agencies and allied professionals (physicians and laboratories) that need to be involved. Prior agreement with them over their roles must be obtained. The monitoring of outbreaks can be categorized as active or passive.

Active Monitoring:

Disease rates are monitored in day care centres, hospitals, long-term care facilities, schools and correctional institutions and religious institutions. Other databases that can be examined include hospital emergency room visits, family physician visits, health information hot-line calls, and the sale of over-the-counter anti-diarrheal medications.

Passive Surveillance:

Notifiable diseases reported to public health agencies should be analyzed on a routine basis to determine the background and benchmark of the number of enteric disease cases within the community. With sufficient data, it is possible to provide information on the most-likely causes, expected cases per month, seasonal variations and other factors that influence enteric rates. Fluctuation in the rates can provide early indication that there may be a potential outbreak of enteric diseases within the community.

Outbreak Management

Once a potential waterborne outbreak has been identified and confirmed through case definition, the public health agencies have the responsibility of conducting further investigations. The objectives of these investigations are to determine the size and nature of the outbreak and its cause. This would allow the implementation of control measures to reduce the number of exposure cases. There is a need for effective communication of the information through the media to the public. The transmission of messages must be through a credible source to ease public concerns and fear, and must also be clear and precise to alleviate rumors.

The public must be given the proper and appropriate information on the risk reduction activities they can undertake to minimize the possibility of contracting waterborne disease through their activities.

III. WATER-RELATED ISSUES DURING INFRASTRUCTURE FAILURE

Objectives
- Proper alternative liquid waste and sewage disposal
- Provide adequate supply of water for fire suppression
- Provide information to the public on personal hygiene, food and infant formula preparation

The provision of potable water without proper waste disposal will not decrease the rate or the risk of contracting enteric diseases. Complete infrastructure failure may also result in the lack of basic liquid waste disposal, leading to a potential increase in vermin population and a corresponding increase in the risk of disease transmission. These factors may compound the fragile health conditions of the community. There may be a need to set up temporary emergency shelters in schools, arenas or community halls to house displaced persons. Such centers have the advantage of providing potable water, waste disposal and adequate food services to centralized locations. The maintenance of basic public health needs in these centers is also the responsibility of public health agencies.

The public may also need proper instructions to prepare food and infant formula with minimal water and perhaps lack of electrical power. Information should also be provided in general sanitation and personal hygiene. There may also a need to advise the public on various methods of water conservation.

The provision of adequate water supply for fire suppression is a joint responsibility between officials from the fire department and utility.

6.4 BOIL WATER ADVISORY, BOIL WATER ORDERS AND OTHER PUBLIC HEALTH INTERVENTIONS

6.4.1 Sample Boil Water Order

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EXECUTIVE OFFICER'S BOIL WATER ORDER

To: Mr. Owen MeDough
Proprietor, Beaver Fever Trailer Park
P.O. Box 123 Beaver Fever, Alberta

WHEREAS, pursuant to Section 2(1) of the Public Health Act, RSA 2000, c. P-37, Nuisance and General Sanitation Regulation, AR 243/2003, "No person shall create, commit or maintain a nuisance."

AND WHEREAS, a nuisance as defined in section 1(f) of the Public Health Act, Nuisance and General Sanitation Regulation, "means a condition that is or might become injurious or dangerous to the public health, or might hinder in any manner the prevention or suppression of disease".

AND WHEREAS, the **Safe Water Health Region** has jurisdiction as it relates to the administration and enforcement of the Public Health Act, and the Nuisance and General Sanitation Regulation within the municipality of the Town of Beaver Fever.

AND WHEREAS, Frank Cannon, Executive Officer of Safe Water Health Region on June 30, 2004 and pursuant to section 59(1) and 59(2) of the Public Health Act, inspected and carried out other such actions as it relates to determining the potability of the drinking water serving the Beaver Fever Trailer Park, and has determined that the following conditions exist which, in his opinion, constitutes a nuisance, to wit:

(Note: You can add whatever statement is germane to the issue prompting the action. Examples as follows:)

- Water samples taken and submitted to the Provincial Laboratory for Public Health (Microbiology) on June 29, 2004 have been analyzed and reported as positive for the presence of *E.coli* microorganisms.
- Repeated measurements of turbidity in the drinking water supply serving the Beaver Fever Trailer Park in excess of the Guidelines for Canadian Drinkign Water Quality.
- Equipment failure of the pump that regulates required amounts of chlorine to the water treatment process for the drinking water supply serving the Beaver Fever Trailer Park.

AND WHEREAS, the said executive officer of health has identified you as being the owner and the representative agent of the said premises and, for the purpose of this matter, the person responsible for matters pertaining to the drinking water of the Beaver Fever Trailer Park.

TAKE NOTICE, therefore, that pursuant to section 62(4)(d) of the Public Health Act, Chapter P-37, the undersigned Executive Officer hereby **ORDERS** you to:

A) Advise all residents of the Beaver Fever Trailer Park not to drink the water from the water supply serving the trailer park unless that water has been boiled and cooled as outlined in the attached instruction sheet; and

B) Carryout whatever measures are necessary to correct the conditions stated above to the satisfaction of an executive officer of the said regional health authority by July 5, 2004.

AND FURTHER TAKE NOTICE, that this ORDER is effective immediately.

Dated at Beaver Fever, Alberta this 30th day of June A.D. 2004.

Signed: _____
Executive Officer

The above conditions were noted at the time of inspection and may not necessarily reflect all deficiencies. You are advised that further work may be required to effectively prevent the public health nuisance.

You Have the Right to Appeal to the Public Health Appeal Board

Section 5 (2) of the Public Health Act provides that:

A person who: a) is directly affected by a decision of a regional health authority, and
b) feels himself or herself aggrieved by the decision

may appeal the decision to the Board.

You must serve your notice of appeal to the Board and regional health authority on the prescribed form within 10 days upon receiving the decision complained of, and the notice of appeal is considered sufficiently served if it is left at an office of the Board or regional health authority.

For further details on the process to initiate your right to appeal you may contact the Public Health Appeal Board Office at 24th Floor, Telus Plaza North Tower, 10025 Jasper Avenue, Edmonton, Alberta T5J 2N3 or phone 780-427-2813.

This Order remains in effect pending the results of the appeal

6.4.2 BWA Operational Emergency Contact List

The emergency contact list should contain the phone and fax numbers of primary and secondary contacts, including their day time, after-hour, 24-hour phone or pager, and secretaries' numbers.

The numbers should be tested once per year.

Internal Contacts

Regional Health Authority:
Chief Executive Officer, MOH, Communication and Board Chairman
Regional Public Health Offices and Community Health Centers
EH management, EH staff and support staff

External Operational Contacts

Alberta Health and Wellness
Environmental Health, Provincial MOH

Health Canada:

Utility:
Corporate Office, Laboratory Service, Communication, all water treatment plants

Alberta Environment:
Regional engineer or technologist

Health & Associated Agencies
Surrounding RHAs
Provincial Laboratory For Public Health (Microbiology)
DKML Laboratory

Municipalities
City and County Councils
Mayor and Reeves offices
Citizen Action Centre

Internal Operational Contacts

Health Link
Acute care hospital emergency rooms
Home Care

External Operational Contacts and High Risk Contacts

1. Hospitals, including engineering, administration, pharmacy, housekeeping and food services
2. High risk clinics: HIV, dialysis, cancer, pediactric and transplant clinics
3. Long term care facilities
4. Medical Association
5. Dental Association
6. Senior lodges
7. Other institutions, including jails and correctional services
8. Media (newspaper, radio, TV)
9. School boards
10. Restaurant association
11. Franchise restaurant regional offices
12. Food retailer regional offices
13. Food Safety Info Line
14. Water haulers and water depots
15. Swimming pool
16. Family & Social Services
17. Family day home organizations
18. Shopping malls
19. Major tourist sites
20. Airport authority and caterer
21. Primary food processors that may be closed during a BWA. Example: Tofu, sprouts, mushroom, produce, sandwich, soy milk, non-carbonated beverages, commissaries, water vending machines, and ice and bottled water manufacturers

6.4.3 Fact Sheet - Emergency Water Storage

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EMERGENCY WATER STORAGE

How much water do I need?

A normally active person needs to drink at least 2 liters of water each day. Hot environments can double that amount. Children, nursing mothers and ill people will need even more. You will also need water for food preparation and hygiene. You can minimize the amount of water your body needs by reducing activity and staying cool.

Store at least four litres (1 gallon) per person per day: two for drinking, and two for food preparation, hygiene and dishwashing. In preparation for an emergency, have at least a three-day supply of food and water for each member of your family. 72 hours is the minimum planning period. Emergency services planning by local and state governments is based on the assumption that households will take care of their own food and water needs for the first 72 hours. Plan for two-weeks, particularly in remote areas.

Plan for water for any pets. Your veterinarian or humane society can provide guidelines for pet water needs.

How do I prepare water for emergency use?

There are two choices: the first is storing water, and the second is to have on hand the supplies necessary for treating water when needed. Both methods have advantages and disadvantages.

The primary advantage of storing water for emergency use is that it is ready to use when needed and the level of contaminants is generally known. The disadvantages are space for storage and the weight of stored water.

Storage of water would depend on the source:

- City water from municipal water sources is already treated so no additional treatment is necessary. Fill clean, food-grade containers with tap water and screw on lids
- Water from a well or spring that is known to be free of bacteria but is not chemically treated should be purified by either adding bleach or by boiling.

The primary advantage of treating water is space saving and the ability to ensure a longer supply of water for consumption. Disadvantages are the unknown treated water quality, not all treatment units are effective for all contaminants, the maintenance of the equipment, and the need of power for some water treatment systems.

Treatment of water would depend on the source of contamination, and whether the treatment unit is designed to remove the chemical or microbial organism of concern. Please refer to the Drinking Water Manual for proper use of point-of-use or point-of-entry treatment systems.

What kind of container should I use for storing water?

Store your water in thoroughly washed plastic, glass, fibreglass or enamel-lined metal containers. Never use a container that has held toxic substances. Plastic containers, such as soft drink bottles, are best. You can also purchase food-grade plastic buckets or drums.

A good water container is airtight, breakage resistant, and heavy enough to hold water. Good choices include 100-200 Litres (25-50 gallon) food grade plastic barrels, 20 Litres (five-gallon) plastic jugs or collapsible water carriers available through camping supply stores, and the two- or four-litre soda pop bottles. Glass bottles are acceptable, but have a higher chance or breakage during emergency or long-term storage. Remember that water weighs approximately 1 kg (10 Imperial pounds) per Litre- do not store more than 15 litres (5 gallons) of water (about 15 kg or 50 pounds) in an container that is meant to be portable. Milk containers are not recommended because they do not seal well. The only time milk jugs can be used is when stored in a chest freezer. In case of power outage, the frozen jug of water will help to protect food from thawing. The water from the milk jug should be used first because it is not properly sealed.

Store your water away from gasoline, kerosene, pesticides or similar substances. Polyethylene plastics can be permeated by hydrocarbon vapours.

Before storing your water, treat it with a preservative, such as chlorine bleach to prevent the growth of microorganisms. Use liquid bleach that contains 5.25% sodium hypochlorite and no soap. Add 4 drops of bleach per quart of water (for two-litre bottles) (or two scant teaspoons per 40 litres), and stir. Seal your water containers tightly, label them with the date of preparation, and store in a cool dark place, but prevent from freezing. Rotate water every six months.

Once a container is opened, use the water rather than re-storing it. The flat taste associated with stored water can be improved by pouring water from one container to another.

For commercially bottled water, keep the water in its original sealed container. Once opened, use it and do not store it further. Rotate the water at least every six months.

What other emergency water sources are there?

If a disaster catches you without a stored supply of clean water, you can use the water in your hot-water tank, pipes and ice cubes. As a last resort, you can use water in the reservoir tank of your toilet.

Water pipes: To use the water in your pipes, open the highest faucet in the house to let air into the pipes, and draw water from the lowest faucet in the house. Remember to turn off the water heater until more water is pumped in.

Waterbeds: Waterbeds hold up to 1,500 litres, but some waterbeds contain toxic chemicals that are not fully removed by many purifiers. If you designate a waterbed in your home as an emergency resource, drain it yearly and refill it with fresh water containing 60 mL (two ounces) of bleach per 450 litres (120 gallons).

Hot Water Tanks: To use the water in your hot-water tank, be sure the electricity or gas is off, and open the drain at the bottom of the tank. Start the water flowing by turning off the water intake valve and turning on a hot water faucet. Do not turn on the gas or electricity when the tank is empty. The water from the hot water tank may contain particles of iron and other minerals. You may remove this sediment by filtering the water through sterile cheese cloth, or a clean kitchen towel which was washed with liquid chlorine laundry bleach the last time it was laundered, or let the sediment settle to the bottom of a large container and dip relatively clear water from the top.

Swimming Pool: Water from a swimming pool should only be used for hygiene purposes. The pool water may contain high levels of chemicals that may be harmful if consumed in large concentration.

Emergency outside water sources: rainwater, ponds or rivers, untested wells and springs.

SOURCE:
Government of Canada, Office of Critical Infrastructure Protection and Emergency Preparedness, Mar 12, 2003, *www.ocipep.gc.ca/info_pro/checklist/bef_fdwtkit_e.asp*

US Federal Emergency Management Agency, *www.fema.gov*

American Red Cross: *www.redcross.org*

Insert Contact Info Here

6.4.4. Fact Sheet – Emergency Water Storage During A BWA

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INSERT LOGO

EMERGENCY WATER STORAGE DURING A BOIL WATER ADVISORY

1. *How do I treat or disinfect water being stored for drinking during a boil water advisory?*
   All water must be boiled before storage. Heat the water to a rolling boil for one minute. After it is cooled, pour the water repeatedly from one container to another to eliminate the flat taste.

2. *How should I store treated water?*
   Water should be stored in clean/disinfected plastic food grade bottles or containers.

   Select safe "food-grade" containers for water. DO NOT USE empty containers that have been used for storage of any chemicals such as bleach and detergent. Plastic milk jugs are not recommended because they do not seal well.

   Suggestions: Use 2-litre soft drink bottles with tight-fitting screw cap lids. One can also purchase food-grade plastic containers at department or camping supply stores. A good water container is airtight, breakage resistant, and heavy enough to hold water. Remember that each litre of water weighs approximately 1 kg. Do not store more than 100L of water in any container that is meant to be portable.

   Containers must be disinfected before use. Containers can be disinfected by either pouring boiling water into the container, or by using a 1:10 ratio dilution of bleach to water to clean the containers.

   NOTE: Do not use scented bleaches, coloursafe bleaches or bleaches with added cleansers. These products contain additives that are not designed for human consumption.

3. *How long can I store the treated water?*
   Water kept in well sealed containers can be kept for at least six months. Write the fill date on each container so you will remember when to replace the water.

   To increase the shelf life of the water, store in a cool dark place and group the containers together in dark plastic bags to prevent its exposure to light.

   Commercial bottled water should be kept in its original sealed container and can be kept for a year. Once opened, use it and do not store it further. Rotate every six months for best quality.

Insert Contact Info Here

6.4.5 Fact Sheet – How To Use Water Safely During A BWA

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HOW TO USE WATER SAFELY DURING A BOIL WATER ADVISORY

1. How do I use water when a Boil Water Advisory has been issued?

The water should **NO**T be used for drinking, making infant formula and juices, cooking, making ice, washing fruits, vegetables or brushing teeth. For these purposes, boiled or treated or bottled water should be used. The water should be brought to a rapid rolling boil for one minute. If there are children in the home, place the pot on the back burner to avoid scalds. Boil only as much water in the pot as you can comfortably lift without spilling. Discard all ice made previously and disinfect the ice cube trays. Make ice using cooled water that was previously boiled.

2. What is the purpose of boiling or treating the water?

Boiling the water destroys all the disease-causing microorganisms (pathogens) and is considered potable after cooling.

3. Can I take a bath or shower?

Adults and teens may take baths or showers with untreated water. Older children could also be given a shower with a hand-held showerhead, avoiding the face. Due to the likelihood that young children will drink bath water, they should be given a sponge bath instead of bathing them in a tub.

4. Can I use the water for handwashing?

If the Boil Water Advisory has been issued, water can be used for handwashing following the described procedure below on water treatment or boiling:

a) Add 45 mL (1.5 oz) of liquid household bleach in 45 litres of water. Mix and let it stand for at least 20 minutes prior to use.

b) Boil the water to a rapid rolling for one minute and cool it to the temperature that won't burn the skin when used for handwashing.

5. How else can I disinfect my hands?

You can use alcohol-based hand disinfectants, containing more than 60% alcohol. There are other kinds of gels or solutions also available in the market that can effectively disinfect the hands. These products are widely used in health care settings after washing hands or in situations when water is not available. The wet wipes used for cleaning babies at diaper change are not effective for disinfecting hands and should not be used for this purpose.

6. Can the dishwasher be used to clean and disinfect utensils?

If your dishwasher has a hot temperature settings or uses disinfectant, it can sanitize dishes. If your dishwasher does not have a hot temperature setting, make sure after finishing the cycle, to soak the dishes for one minute in a solution of 30 mL (1 oz) of bleach mixed with 13.5 litres of lukewarm water. Let the dishes air-dry.

7. Should I change the way I'm doing laundry?

No. Continue doing laundry the way you usually do.

8. Is the water safe to fill wading pools for children?

No. The water is not safe for use in wading pools. Water usually gets into the mouths of small children, providing a possibility of infection.

9. I have a water filtration device installed. Does this make the water safe for drinking or cooking?

No. Filtered water should also be brought to a rolling boil for one minute before drinking or using it for cooking. The units should be back-washed or disinfected after the Boil Water Advisory has been rescinded. Contact your manufacturer or local Health Agency for more information.

10. How do I disinfect counter tops, chopping boards or utensils?

Counter tops, chopping boards or utensils should be washed with soap and sanitized with disinfected water. Mix 60 mL (1/4 cup) of bleach into 4.5 litres of water for this purpose. Do not reuse or store this solution. It must be made daily as the sanitizing solution loses its strength with time.

11. Can I brush my teeth with untreated water?

No. Untreated water may contain harmful microorganisms. Infection can occur even by swallowing only a small amount of water. Use cooled water that was previously boiled for brushing teeth. Approved bottled water is also acceptable.

12. Can I use bottled water or buy water from vending machines?

It would depend on when the water is bottled and how it is bottled. Local plants or vending machines that use the local water are acceptable only if the water undergoes acceptable further treatment to remove the contamination. Check with your Health Agency to determine if a certain brands of bottled water or vending machines are acceptable. Bottled water packaged or manufactured from out-of-town is acceptable.

13. Can I drink coffee from a coffee maker?

Coffee makers usually produce water at around 70^{o}C, and is sufficient to inactivate bacteria such as *E. coli,* protozoa such as *Cryptosporidium*, and viruses such as Hepatitis A and Norovirus. However, a sufficient amount of time is needed to ensure that all harmful organisms are destroyed. It is therefore recommended that hot coffee be held for at least 5 minutes before consumption. Check with your local Health Agency for more information.

Insert Contact Info Here

6.4.6 Fact Sheet For Professionals – Art And Science Of Boiling Water During A Boil Water Advisory

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FACT SHEET FOR PROFESSIONALS: ART AND SCIENCE OF BOILING WATER DURING A BOIL WATER ADVISORY

1. How long should water be boiled during a boil water advisory?

Boiling water is recommended to inactivate or destroy pathogenic microbes that may be in contaminated water. Enteric bacteria such as *E. coli* and *Salmonella* are killed rapidly at temperatures over 60^{o}C, and a temperature of 72.4^{o}C for 1 minute is needed to inactivate *Cryptosporidium.* Hepatitis A virus and Norovirus (Norwalk-Like Virus) are rapidly inactivated at temperatures above 65^{o}C. For viruses, the inactivation rate is also dependent upon the composition of the media. Norovirus is protected by bivalence cations such as calcium. A temperature of 85^{o}C may be needed to inactivate Norovirus in molluscs. For most food products, however, a temperature of 70^{o}C for 2 minutes is usually sufficient.

Based on the above information, there is no need to boil water for a long period of time. Although heating water to boiling is not needed, it is the only end point that can be easily recognized by the public without the use of a thermometer. It is therefore recommended that the public bring the water to a rolling boil for one minute to ensure all the pathogens have been inactivated. Keeping the water covered during boiling (or in a kettle) and then allowing the water to cool slowly after boiling can add an extra margin of safety.

One minute should be added to the above boiling times if the water is cloudy (turbid) or highly coloured to ensure proper mixing and that all the pathogens are exposed to the high temperature.

2. Is there a need to increase boiling time because of altitude?

Since the boiling point of water decreases with altitude, to ensure that a proper time-temperature relationship can be achieved to destroy all pathogens, there is a need to increase the time of boiling.

Heating temperature is affected by atmospheric pressure. At sea level, water boils at 100^{o}C (212^{o}F), but in high-altitude regions, the boiling point is much lower. For about every 152 m (500 feet) of ascent, the boiling point is lowered by 1^{o}F. At 2,133 m (7,000 foot) elevation, water would boil at about 92^{o}C (198^{o} F). At 3,400 m (11,000 feet), the water would boil at 84^{o}C (183^{o}F).

Also, affecting the boiling point is the barometric pressure. The proper boiling point of the water is therefore equal to the boiling point at a specified altitude,

plus or minus boiling point barometric correction. For example, the boiling point at 2,100 m (7,000 feet) is 93^{o}C (199.3^{o}F). If the barometric pressure is 27.6 mm of Hg, the actual temperature is 199.3 minus 3.96^{o}F, or 195.3^{o}F (90.7^{o}C). If the barometric pressure is 31.4 mm Hg, the actual boiling temperature is 199.3 plus 2.38, or 201.7^{o}F (94.3^{o}C).

Taking into account the atmospheric and barometric pressure, to ensure the water is safe:

- From sea level to 2,100 m (7000 feet), rolling boil for one minute. This would include the City of Banff in Alberta (Canada's highest town at 1,383 m) and Lake Louise (highest permanent settlement in Canada at 1,536 m);
- From 2,100 m to 3,400 m (7000 to 11,000 feet), rolling boil for 2 minutes with the lid on to reduce water lost and maintain high temperature (Example, Columbia Ice Field in Alberta and Mexico City); and
- Over 3,400 m (11,000 feet), rolling boil for 3 minutes with the lid on to reduce water lost.

Therefore for the general public, there is no need to increase boiling time anywhere in Canada to compensate for altitude.

For full discussion of boiling water at higher altitudes, please refer to C*ommunicable Disease Corner*, Volume 6, Issue 3, March 2002.

3. What is a rolling boil?

As the temperature reaches 80^{O}C, small bubbles will begin to form. The bubbles are the air that was dissolved in the water at room temperature coming out of solution, since air becomes less soluble as the temperature increases. As temperature continues to increase, bubbles collapse on the bottom, and are the precursors to true boiling. When the bulk of the water becomes hot enough, the bubbles will break free of the bottom and rise and break free at the top. This is often called a rolling boil and is the point of true boiling. The presence of bubbles is not a good indication of boiling. Rolling boil of one minute is recommended to ensure the water is brought to a proper boil even though all pathogens are inactivated instantly at 100^{O}C.

Aerating the water by pouring the water from one container to another, or adding a tiny pinch of salt may improve the taste of the water.

4. Is it safe to use electric kettles with auto shut-off during a boil-water advisory?

Yes. All pathogens are killed or inactivated instantly at 100^{o}C. Rolling boil for one minute is recommended to ensure the public brings the water to a proper boil, and not to stop boiling just because there are bubbles in the water. Electric kettles with auto shut off is activated at 100^{o}C and the water is safe to drink if the concern is with microbiological agents. Scale formation in the kettle should not make a difference to the boiling temperature.

5. How about coffee makers?

Most commercial coffee makers produce hot water at around 70^{o}C for perking coffee. A proper time-temperature relationship is needed to render the water safe from all microbial pathogens (see Question 1). It is therefore recommended that perked coffee be held for at least 5 minutes before consumption.

Insert Contact Info Here

6.4.7 BWA Sample Letter

(Adopted from Safe Water Program, Protocol for the Issuance of a Boil Water or a Drinking Water Advisory, Ministry of Health and Long-Term Care, Ontario, 2001)

BOIL WATER ADVISORY

To the Consumers of

_____
Water System

Date: _____

The Executive Officer of _____, Mr. _____, is advising users of the above water system to bring your water to a rolling boil for at least one minute prior to using it for domestic purposes, including drinking, making infant formula and juices, brushing teeth, washing raw foods and making ice.

The Boil Water Advisory is being issued because testing found the presence of _____ in water samples taken at _____.

The advisory measure will remain in place until the Executive Officer is satisfied the water is safe to drink.

Information about the boil water advisory, and the proper measures you can take to ensure the water is safe to use, is available from the _____ office at _____, or at the RHA's web site at *www.*_____*.ab.ca*.

For more information, please contact _____ at _____

6.4.8 Draft Newspaper Advertisement

BOIL WATER ADVISORY

Effective immediately, the Health Agency is advising all residents in the _____ to boil their tap water for at least one minute at a full boil, before drinking the water. You should also boil the water before washing vegetables or anything else you eat or drink.

Be sure to boil the water before you brush your teeth or clean your dentures and do not use ice cubes unless they have been made with boiled water.

Your tap water remains safe for washing clothes and bathing. It is recommended, however, that sponge bathes be given to small children that may swallow bath water.

Effective immediately, the following restrictions also apply:

- e.g. day cares, swimming pools, etc.
- xxx
- xxx

This restriction is in effect until further notice in the following communities:
Example: Edmonton, St. Albert, etc.

Utility and Alberta Environment continuously monitor the quality of water in this region and we are working to rectify this situation as quickly as possible.

On (date and time), we found indications of xxx in the water supply, which is equivalent to … We acted immediately to (notify the public, intensify our monitoring, xxx)

Xxx can result in xxx symptoms. The xxx is likely to have been caused by xxx in combination with the high spring runoff we have experienced this year. We anticipate the restriction on drinking water to last at least the next two weeks.

As instructed by the Health Agency, utility will assist in keeping the media and public updated about the status of this present advisory.

For up-to-date information, please call _____ or *Health Link* at_____ . You can also visit our website at _____ or _____.

6.4.9 Draft Newspaper Press Release

Health Agency and utility are advising residents in the _____ region to boil water for one minute before drinking. This precautionary measure should be followed until further notice. Regular updates will be available as further testing is done and until the boil water advisory is canceled.

This Advisory is issued based on a report from utility that unusually high levels of Giardia/Cryptosporidium *cysts have appeared in the treated water at utility's water treatment plants. If a sufficiently high number of* Giardia/Cryptosporidium *cysts are swallowed, they can cause symptoms such as diarrhea, nausea, stomach cramps and headaches***.**

The presence of *Giardia/Cryptosporidium* cysts is typically higher in the North Saskatchewan River at this time of year due to the melting snow upstream. The run-off carries various particles and animal debris downstream. Given the large amount of snow this winter, the run-off is greater than usual.

Utility's laboratory performs over _____ tests per year on drinking water at its facility in _____, including voluntary testing for *Giardia* and *Cryptosporidium*. Utility will step up its testing efforts to monitor the particle levels in the raw water from the North Saskatchewan River and the treated water from the water treatment plants. Health Agency will maintain close contact with utility to monitor the testing results.

Contacts:

6.4.10 Draft Radio Script

The following is an important water advisory from the Health Agency for all residents serviced by Utility Water Services Inc.

Effective immediately, the Health Agency is advising all residents in the area to boil their tap water for at least one minute, at a full boil, before drinking or using the water for any kind of internal consumption.

Your tap water remains safe for washing clothes or bathing – but you should avoid brushing your teeth or using ice cubes unless the water has been boiled.

There will be some restrictions (such as day cares…)

Health Agency and Utility will assist in keeping the media and public updated about the status of this advisory.

For up-to-date information, please call _____ or *Health Link* at _____. You can also visit our websites at *www._____.ca* or *www._____.ab.ca*.

6.4.11 BWA Sample Pamphlets

Sample BWA pamphlets for
- Media and General Public
- Hotels and Restaurants
- Grocery and Convenience Stores
- Hospitals and Long Term Care Facilities
- Swimming Pools
- Dental Offices
- Child Care Centers

Information should be provided to:
- *Health Link*
- Citizen Action Lines
- Seniors Health Line
- Front line staff
- Tourist information

Signs should be posted at:
- Schools
- Public taps
- Swimming pools
- Beaches
- Pay-taps and water depots
- Major sporting centers
- Tourist information and major tourist sites
- Campgrounds

Insert Logo

BOIL WATER ADVISORY

General Public and Media

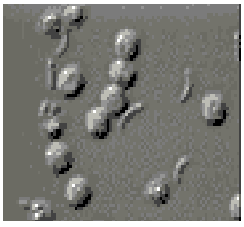
Health Agency **is advising all residents to boil their water**

Name of Health Agency is asking all residents with water serviced by ***Utility***, the water treatment company, to boil their water until further notice.

Health Agency has been informed by ***Utility*** that due to unusually high levels of the parasite *Cryptosporidium* (krip-tow-spo-rid-dee-um) or *Crypto* in the river, the water treatment plants are not able to achieve removal to safe levels.

Although the treatment plant usually produces very clean and safe water, the system is having problems in removing *Crypto* during the recent spring run-off.

On MM/DD/YY, xx *Cryptosporidium* eggs (oocysts) were found in 1,000 liters of drinking water leaving the xxx water treatment plant. 1,000 liters of water is like filling two bathtubs full. The average person has to consume about 100 of these oocysts to get sick. The chances of anyone drinking enough water with these eggs in it is remote.



Cryptosporidium **is a small parasite that can give you severe diarrhea**

The levels of parasites are low. ***Health Agency*** and ***Utility***, however, are not taking any chances and are advising all residents to boil their water until further notice. We anticipate levels returning to normal within 1-2 weeks.

As of today, no cases of *Cryptosporidium* disease have been traced to the drinking of tap water within ***"Name of Region"***.

What is Crypto and what are the symptoms?

Crypto is a small parasite that is commonly found in all surface water. Common sources of *Crypto* are human and cattle sewage.

Normally, water plants are able to remove these parasites by clarification and filtration.

If you are infected with this parasite, symptoms will appear after 2 to 12 days, and may include explosive and watery diarrhea, stomach cramps, fatigue, nausea, vomiting, or a slight fever. There is no effective medication to control *Crypto* infection. People experiencing diarrhea should consult their physician to prevent dehydration, and to submit a stool sample for proper diagnosis.

For people with a normal immune system, symptoms normally will last for 2 weeks or less. After infection, individuals can pass the eggs in their stool and may give the disease to others if they do not wash their hands properly.

Crypto can be a life-threatening concern for individuals who are immuno-compromised, on chemotherapy, or on immuno-suppressive medication such as transplant patients

Who is affected?
This boil water advisory applies to all communities serviced by ***Utility***. Major centers affected and the associated ***Health Agencies*** are listed below.

(Example)

Communities Regional Health Authorities	Aspen RHA 780-939-3388	Capital Health 780-413-7927	East Central RHA 780-679-2980	Health Canada 780-495-5114
Andrew				
Ardrossan		X		
Beaumont		X		
Bruderheim				
Calmar		X		
Namao		X		
Radway				
Redwater				
Riviere Qui Barre	X			
Ryley			X	
St. Albert		X		
Sherwood Park		X		
Spruce Grove				X
Stony Plain				X
Thorhild				
Tofield			X	
Vegreville				
Viking			X	

What should I do?
- Boil all water (100°C) used for drinking for 1 minute. This would include water used for making infant formula and juices, washing and rinsing fruits and vegetables.
- Boiled water can be left at room temperature or in the refrigerator for general use.
- Hot beverages such as tea, coffee and hot chocolate are safe if the water reaches 65°C for 10 minutes.
- Water that is used for brushing teeth should also be from an approved source (see below).
- Do not use ice made by ice-making units from domestic refrigerators. Use water that has been boiled or processed by an approved method (see below) for making ice. Discard all ice made in the last three days.
- Do not drink from public drinking fountains.
- If you receive water from a water truck, check with the company as to the source of the water.

Please note that you can only contract *Crypto* through drinking the water. Using tap water for bathing, showering or washing clothes does not pose a health concern.

Besides boiling water, other alternatives are:

- Use bottled water or commercial ice that has undergone acceptable processes for cyst removal. Please note that not all bottled water or ice is safe, and not many carbon filters will remove *Crypto* cysts. Only products that have been processed by the following methods are acceptable for cysts removal:
    - Distillation
    - Reverse osmosis
    - Filter size of 1 micron **absolute** or less
    - Any other methods approved by the National Sanitation Foundation (NSF) **Standard 53** for cyst removal.

Contact your Health Agency for more information.

Acceptable Bottled Water or Packaged Ice

Bottled water or packaged ice that is prepared within ***Health*** region and have been prepared by acceptable methods for oocyst removal are listed below. This list will be updated when new information is available.

Contact your ***Health Agency*** for more information.

What should I do after the Boil Water Advisory is lifted

- Flush all water-using fixtures for 1 minute
- Run all cold water faucets and drinking fountains for 1 minute before using the water
- Drain all cisterns, and flush with clean water
- Drain and flush the ice-making system in your refrigerator
- Backwash pool filters, drain water and superchlorinate system
- Run water softeners through a regeneration cycle
- Drain and refill hot water heaters set below 45°C (normal setting is 60°C)
- Contact your Regional Health Authority for more information.

Should you be working if you are infected?

Anyone who shows symptoms of *Crypto* (two or more watery diarrhea episodes per day, stomach cramps, nausea, vomiting or a slight fever) must not be involved in preparing food in commercial establishments, working in child care centres, hospitals or long term care facilities if they will be involved directly with patient care.

Contact your physician to submit a stool sample for proper diagnosis.

Source: Some of the information adopted from '*Cryptosporidium* and Water: A Public Health Handbook', Working Group on Waterborne Cryptosporidiosis, 1997.

Insert Contact Info Here

Insert Logo

BOIL WATER ADVISORY

Hotels and Restaurants

This information sheet is designed to be used in conjunction with the Boil Water advisory information sheets for the General Public and Media.

What special precautions should be taken in hotels and restaurants?

Cryptosporidium or *Crypto* can be easily passed from one person to another by improper hygiene, or through the ingesting of cysts in food or drinking water.

All workers who show symptoms for Crypto must be excluded from working at the establishment (see back page).

To prevent the spread of the disease, employees must:

1. *Observe good personal hygiene*
   - ♦ Wash hands with soap and warm running water before handling food, and after going to the washroom

2. *Boil all water used for drinking, making juice from concentrates and other beverages, ice making and for washing ready-to-eat fruits and vegetables.*
   - ♦ Water can be boiled the night before, and cooled at room temperature or in the refrigerator.
   - ♦ Tea, coffee and other beverages that are prepared with hot water heated to 65°C for 10 minutes are acceptable.
   - ♦ Bottled water that is prepared by distillation, reverse osmosis, or through a filter rated at 1 micron absolute is also acceptable.
   - ♦ Disconnect ice-tea and ice making machines unless the product has undergone further processes approved for cyst removal.
   - ♦ Disconnect ice cream scoop dipperwells. Clean scoops after each use.

Chlorine is not effective in destroying *Crypto*

Proper dish washing methods

- ♦ **Commercial dishwashing machines with a final rinse temperature of 82°C for 10 seconds**
- ♦ **Three-compartment sink with a final rinse temperature that exceeds 45°C for 20 minutes, or 77°C for 2 minutes**
- ♦ **For low temperature dish and glass washing machines:**
  - ♦ **run dishes through machine twice (may have problem with hot water supply), or**
  - ♦ **Pour boiling water over clean dishes, or**
  - ♦ **Submerge clean dishes in boiling water**

3. *Properly disinfect food contact surfaces.*
   No disinfectant is guaranteed to be completely effective against *Crypto*. Hydrogen peroxide (3%), however, is usually effective. To reduce the level of potentially infectious *Crypto*, clean and disinfect counter tops frequently with peroxide.

4. *Protect food from contamination*
   - ♦ Unless water used for hand washing has been boiled or treated, it is recommended all food handlers wear gloves when handling any ready-to-eat food such as sandwiches and salads.
   - ♦ Only properly treated water should be used in washing and rinsing raw food.

Hotel Operators

- Hotel operators should inform their clients of the Boil Water Advisory, and to avoid drinking water from the tap. Clients should be informed to use bottled water or water that has undergone proper treatment for brushing teeth.
- Disconnect ice making machines on all floors and drinking fountains that use regular tap water. Only use ice from approved manufacturers.

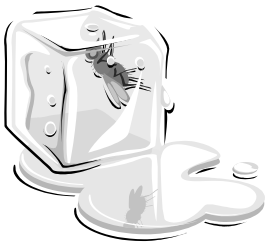
What to do after the boil water advisory is lifted?

* Flush all water-using fixtures for 1 minute
* Drain and flush all roof-top cisterns
* Run cold water faucets and drinking fountains for 1 minute before using the water
* Run drinking fountains for 1 minute before using the water
* Drain and flush all ice-making machines
* Run water softeners through a regeneration cycle
* Drain and refill hot water heaters
* Contact your Health Agency for more information

When can workers return?

Any food workers who show symptoms of Crypto (two or more watery diarrhea episodes per day, stomach cramps, nausea, vomiting or a slight fever) must not be involved in food preparation, and must be excluded from the establishment.

Notify your local Health Agency that a staff member may have *Crypto*.



Staff should contact their physician to submit a stool sample for a proper diagnosis.

The staff will be excluded from working in any food establishment until he or she has submitted two consecutive stool samples that are negative for the parasite.

All water must be boiled or properly treated, including water for brushing teeth

Source: Some of the information adopted from '*Cryptosporidium* and Water: A Public Health Handbook', Working Group on Waterborne Cryptosporidiosis, 1997.

Insert Contact Info Here

Insert Logo

BOIL WATER ADVISORY

Grocery and Convenience Stores

This information sheet is designed to be used in conjunction with the Boil Water advisory information sheets for the General Public and Media.

What special precautions are necessary in grocery and convenience stores?

Cryptosporidium or *Crypto* can be easily passed from one person to another by improper hygiene, or through the ingestion of cysts in food or drinking water.

All workers who show symptoms for Crypto must be excluded from working at the establishment (see back page).

To prevent the spread of the disease, employees must:

1. *Observe good personal hygiene*
   - Wash hands with soap and warm running water before handling food, and after going to the washroom

2. *Boil all water used for drinking, making juice from concentrates and other beverages, ice making and for washing ready-to-eat fruits and vegetables*
   - Water can be boiled the night before, and cooled at room temperature or in the refrigerator
   - Bottled water that is prepared by distillation, reverse osmosis, or through a filter rated at 1 micron 'absolute' is also acceptable
   - **Disconnect vegetable spraying sprinkler systems.**

Only properly treated water should be used in washing and rinsing of raw food. Use acceptable treated water in spray bottles to keep your vegetables moist.

- **Disconnect water vending machines unless the product has undergone processes approved for cyst removal**
- Use only prepackaged ice from approved manufacturers to keep food cold in all display cases.
- **Disconnect ice vending machines and crushed ice drink machines unless the product has undergone further processes approved for cyst removal**

Discard all ice and crushed ice products made from machines.

3. *Properly wash all utensils*
   - Utensils should be properly disinfected in commercial dishwashing machines with a final rinse temperature of 82°C for 10 seconds, or a three-compartment sink with a final rinse that exceeds 45°C for 20 minutes, or

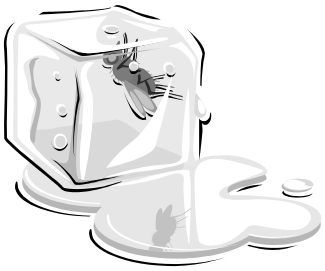
What to do after the boil water advisory is lifted?

- Flush all water-using fixtures for 1 minute
- Run cold water faucets for 1 minute before using the water
- Run vegetable spraying sprinklers for 1 minute before using the water
- Run water softeners through a regeneration cycle
- Drain and refill hot water heaters, and reset to at least 45°C
- Clean and disinfect counter tops
- Flush and clean ice-making machines

When can workers return?

Any food workers who show symptoms of Crypto (two or more watery diarrhea episodes per day, stomach cramps, nausea, vomiting or a slight fever) must not be involved with food preparation, and must be excluded from the establishment.

Notify your local Health Agency, that a staff member may have *Crypto*.



Staff should contact their physicians to submit stool sample for proper diagnosis.

The staff will be excluded from working in any food establishment until he or she has submitted two consecutive stool samples that are negative for the parasite.

Make sure the ice used for all displays is from a plant that used methods approved for cyst removal

Source: Some of the information adopted from '*Cryptosporidium* and Water: A Public Health Handbook', Working Group on Waterborne Cryptosporidiosis, 1997.

Insert Contact Info Here

Insert Logo

BOIL WATER ADVISORY

Hospitals and Long Term Care Facilities

This information sheet is designed to be used in conjunction with the Boil Water advisory information sheets for the General Public and Media.

What special precautions need to be taken in hospitals and long term care facilities?

Cryptosporidium or *Crypto* can be easily passed from one person to another by improper hygiene such as dirty hands, or through the ingesting of cysts in food or drinking water.

Care-givers who are symptomatic must be excluded from duties that involve food handling and direct patient care (see back page).

To prevent the spread of the disease, care-givers must:

1. *Observe good personal hygiene.*
   - ♦ Wash hands with soap and warm running water before food preparation, after going to the washroom, and before and after changing diapers.

2. *Boil all water used for drinking, making juice from concentrates and infant formula, and for washing ready-to-eat fruits and vegetables. This also includes water used for brushing teeth, or ice made with regular tap water.*
   - ♦ Water can be boiled the night before, and cooled at room temperature or in the refrigerator.
   - ♦ Tea, coffee and other beverages that are prepared with hot water heated to 65°C for 10 minutes are acceptable.
   - ♦ Bottled water that is prepared by distillation, reverse osmosis, or through a filter rated at 1 micron 'absolute' is also acceptable.
   - ♦ Disconnect all drinking fountains

3. *Properly sanitize all toys and counter tops*
   No disinfectant is guaranteed to be completely effective against *Crypto*. Hydrogen peroxide (3%), however, is usually effective. To reduce the level of potentially infectious *Crypto*, clean and disinfect toys, table tops, and high chairs at least twice daily.

4. *Diaper changing*
   - ♦ Use disposable gloves when changing diapers.
   - ♦ Disinfect and clean area. (see above)

5. *Protect food from contamination*
   Unless water used for hand washing has been boiled or treated, it is recommended all food handlers wear gloves when they handle any ready-to-eat food such as sandwiches and salads.

6. *Infection control*
   - Use only disinfected water to treat skin wounds, or for other patient care activities.
   - Monitor patients closely for signs and symptoms of gastrointestinal illness.

What to do after the boil water advisory is lifted?

- Flush all water-using fixtures
- Run cold water faucets for 1 minute before using the water
- Run drinking fountains for 1 minute before using the water
- Run water softeners through a regeneration cycle
- Replace ice in refrigerators
- Drain and refill hot water heaters set below 45°C (normal setting is 60°C)
- Clean and disinfect all toys and diapering areas
- For Renal Dialysis Units, sample water for chemical analysis to ensure compliance with AAMI Standards

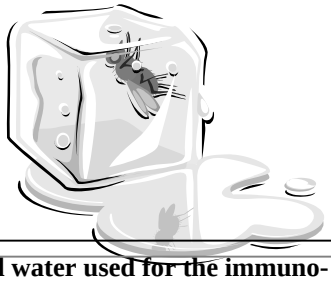
Should care-givers be working when symptomatic?

Care givers who are symptomatic for Crypto (two or more watery diarrhea episodes per day, stomach cramps, nausea, vomiting or a slight fever) must not be involved with food preparation or any direct patient care.

Notify your local Health Agency, or the Infection Control staff in your institutions, that a patient or staff member may have *Crypto* infection.

Patients and care-givers should contact their physician to submit stool sample for proper diagnosis.

The care-giver will be excluded from attending the facilities until he or she has submitted two consecutive stool samples that are negative for the parasite.



All water used for the immuno-compromised must be boiled or properly treated, including water for brushing teeth and making ice

Source: Some of the information adopted from '*Cryptosporidium* and Water: A Public Health Handbook', Working Group on Waterborne Cryptosporidiosis, 1997.

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BOIL WATER ADVISORY

Swimming Pools

This information sheet is designed to be used in conjunction with the Boil Water advisory information sheets for the General Public and Media.

What special precautions should be taken by swimming pool operators?

Cryptosporidium or *Crypto* can be easily passed from one person to another in a pool through the ingestion of pool water contaminated by feces.

There is no need to close down the pool during a boil water advisory unless otherwise specified by your Health Agency.

Crypto is a special problem for pools since it is highly resistant to chlorine. Once a pool is contaminated (for example, through a fecal accident, or by rinsing a diaper in the pool), it can remain a source of infection for pool users for prolonged periods of time. The oocysts are very small and can pass through sand and most cartridge filters. A diatomaceous earth filter is more effective, but may take up to 2 1/2 days to remove the majority of the oocysts (assuming a 6-hour turnover and good capture).

Chlorine is not very effective against Crypto. A CT value of 9600 is needed to destroy the oocysts.

(C = concentration of free chlorine mg/L, and T = time in minutes).

To prevent the spread of the disease, pool operators should:

- *Prohibit staff who show symptoms of Crypto from swimming in the pool* (see back page).
- Shut-off all drinking fountains.
- Maintain the recirculation and filtration equipment to provide maximum filtration.
- Monitor pool water chemical concentrations closely to ensure all are at optimal levels.

Signs should also be posted advising users and parents:

1. Persons who have diarrhea or have had diarrhea during the previous 14 days should not enter the pool.
2. Babies and small children who do not have control of their bowels should wear close fitting swimsuits or underwear in order to better control solid or semi-solid stool.
3. Do not change diapers at pool side.
4. All users must have cleansing shower before entering pool.
5. Assist small children in making frequent visits to the bathroom to prevent fecal accidents.
6. Do not drink pool water.
7. Notify pool staff of a fecal accident in water.

If a fecal accident does occur in the pool, the pool should be closed immediately.

If the fecal waste can still be seen in the pool, the recirculation pump should immediately be shut off, and the fecal matter be vacuumed to the sanitary sewer and NOT back to the pool filter. See back page for proper process for clean up after a fecal accident to control *Crypto*.

How do I disinfect the pool after a fecal accident?

- Close the pool and notify your local Regional Health Authority
- Add chlorine to raise the disinfectant residual to at least 20 ppm. Stabilize the pH to 7.2 to 7.8 so the chlorine is effective, and run the recirculation equipment for 8 hours. Note that high levels of chlorine can cause a purple interference colour if phenol red is used to test for pH. If this happens, neutralize the sample with a small amount of sodium thiosulfate.

Check with your supplier to make sure your pool equipment can withstand the high chlorine concentration

- Clean and brush down the walls of the pool, the skimmer housings, and skimmer baskets with detergent solution.
- Backwash the filter thoroughly.
- Drain all whirlpools.
- Disinfect the filter:
  - *Sand filters*– Add a gallon of chlorine bleach (sodium hypochlorite) directly into the filter and let stand for 4-6 hours (more may be needed with filters over 36" diameter). Backwash again.
  - *Cartilage filters*– Remove the cartridge and clean the filter casing thoroughly with a 200 ppm solution of chlorine bleach (sodium hypochlorite). Allow to stand for several hours. Clean the cartridge thoroughly and soak in a 200 ppm solution of bleach. Rinse and allow to dry completely.
  - *Diatomaceous Earth* (DE) Filters– Clean the DE off the filters, dispose of the DE, and soak the tank and septums in a 100 ppm solution of bleach.

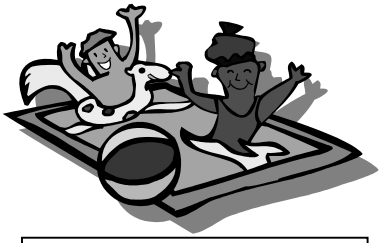
    To make 100 ppm of bleach solution, use 6.7 mL of household bleach (6%) to every 4.5 L (1 gallon) of water.
  - Restart the recirculation system and neutralize the chlorine slowly until normal values are obtained.
  - Balance the water and reopen.
  - Monitor the disinfectant levels carefully.

Raising the pool water temperature to at least 65°C for 10 minutes is also effective in destroying *Crypto.*

Can sick staff still swim in the pool?

Staff who show symptoms for Crypto (two or more watery diarrhea episodes per day, stomach cramps, nausea, vomiting or a slight fever) must NOT be swimming in the pool.

Notify your local Health Agency, that a staff member may have *Crypto*. The staff member should contact their physician to submit a stool sample for proper diagnosis. The staff member will be excluded from swimming in the pool until he or she has submitted two consecutive stool samples that are negative for the parasite.



Public or staff members that have diarrhea should NOT use the pool

Source: Some of the information adopted from '*Cryptosporidium Fact Sheet for Swimming Pool Operators'*, State of Wisconsin, Department of Health and Social Services, BC Health and Disease Surveillance, Oct 12, 1992, and NCID, CDC.

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BOIL WATER ADVISORY

Dental Offices

This information sheet is designed to be used in conjunction with the Boil Water advisory information sheets for the General Public and Media.

What special precautions should be taken in dental offices?

Cryptosporidium or *Crypto* can be easily passed from one person to another by improper hygiene.

Workers who show symptoms must be excluded from duties that involve direct patient care (see back page).

Crypto is a special concern for immunocompromised patients, such as HIV-positive individuals, chemotherapy and transplant patients, and congenitally immuno-compromised individuals.

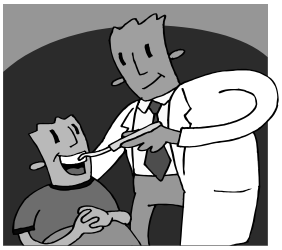
To prevent spread of the disease, operators must:

1. Reschedule appointments for high-risk individuals until after boil water advisory has been lifted

- Warn your patients before treatment that they are at greater risk for cryptosporidiosis if they are immunocompromised. Explain to all patients the current situation regarding water and indicate what procedures your office is following to protect their health.

2. Boil all water used for drinking, ice making and for patient care

- Provide properly disinfected water for patients to rinse their mouths.
- Water can be boiled the night before, and cooled at room temperature or in the refrigerator.
- Tea, coffee, and other beverages that are prepared with hot water heated to 65°C for 10 minutes are acceptable.
- Bottled water that is prepared by distillation, reverse osmosis, or a filter rated at 1 micron absolute is also acceptable.



Provide properly disinfected water for patients to rinse their mouths

3. Observe good personal hygiene

- Wash hands with soap and warm running water before treating patients, and after going to the washroom.

4. Properly disinfect counter tops

No disinfectant is guaranteed to be completely effective against *Crypto*. Hydrogen peroxide (3%), however, is usually effective. To reduce the level of potentially infectious *Crypto*, clean and disinfect patient contact surfaces more frequently.

5. *Disconnect high-speed handpieces*
Turn off the water to high-speed handpieces. Instead, flow disinfected water out of a bulb syringe when using the high-speed handpieces.

What to do after the boil water advisory is lifted?

- Flush all water-using fixtures for 1 minute before using the water
- Run cold water faucets for 1 minute before using the water
- Run drinking fountains for 1 minute before using the water
- Run water softeners through a regeneration cycle
- Drain and refill hot water heaters set below 45°C

Turn off the water supply to high-speed handpieces

When can workers return?

Any workers who are symptomatic for Crypto (two or more watery diarrhea episodes per day, stomach cramps, nausea, vomiting or a slight fever) must not be involved in direct patient contact.

Notify your local Health Agency, that a staff member may have *Crypto* infection.

Staff should contact their physicians to supply a stool sample for proper diagnosis. Infected staff will be excluded from any direct patient care until he or she has submitted two consecutive stool samples that are negative for the parasite.

Source: Some of the information adopted from '*Cryptosporidium* and Water: A Public Health Handbook', Working Group on Waterborne Cryptosporidiosis, 1997.

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BOIL WATER ADVISORY

Day Care Centres

This information sheet is designed to be used in conjunction with the Boil Water advisory information sheets for the General Public and Media.

What special precautions should you take in a child care center?

Cryptosporidium or *Crypto* can be easily passed from one person to another by improper hygiene, such as dirty hands.

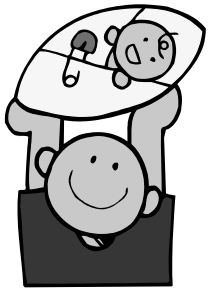
It is recommended that children and care-givers who show symptoms of Crypto be excluded from attending the center (see back page).

To prevent the spread of the disease, care-givers must:

1. *Observe good personal hygiene.*
   - ♦ Wash hands with soap and warm running water before food preparation, after going to the washroom, and before and after changing diapers.
   - ♦ Supervise children to wash their hands with soap and warm running water after going to the washroom, and before eating food.

2. *Boil all water used for drinking, making juice and infant formula, making ice, and for washing ready-to-eat fruits and vegetables. This also includes water used for brushing teeth.*
   - ♦ Water can be boiled the night before, and cooled at room temperature or in the refrigerator.

3. *Separate diapered and non-diapered children.*
   - ♦ *Crypto* can be present in children who do not show any symptoms. When the risk of infection is high, such as in an outbreak situation or during a boil water advisory, separating diapered and non-diapered children will minimize chances of infection.



Wash hands before and after every diaper change

4. *Discontinue the use of wading pools and water play tables during high-risk periods.*
   - ♦ Wading pools and water play tables can become a reservoir for *Crypto* during high-risk periods.

5. *Properly wash all dishes*
   - ♦ Dishes and utensils should be properly sanitized in dishwashing machines that have a dry cycle or a final rinse that exceeds 45°C for 20 minutes, or 77°C for 2 minutes.

6. *Disinfect toys and counter-tops*

   No disinfectant is guaranteed to be completely effective against *Crypto*. Hydrogen peroxide (3%), however, is usually effective. To reduce the level of potentially infectious

Crypto, clean and disinfect toys, table tops, and high chairs at least twice daily. Dishwasher-safe toys may be washed in a domestic dishwasher with an acceptable drying cycle (see item 5). Cloth toys may be washed and heat-dried in a clothes dryer for 30 minutes.

7. Diaper changing

- Use disposable gloves when changing diapers.
- Disinfect and clean area.

What do I do after the boil water advisory is lifted?

- Flush all water-using fixtures
- Run cold water faucets for 1 minute before using the water
- Run drinking fountains for 1 minute before using the water
- Drain all water play-tables and wading pools, disinfect and refill
- Run water softeners through a regeneration cycle
- Drain and refill hot water heaters set below 45°C
- Clean sand play-tables with disinfection solution
- Clean and disinfect all toys and diapering areas

Can sick children still attend day care?

Children and staff who show symptoms for Crypto (two or more watery diarrhea episodes per day, stomach cramps, nausea, vomiting or a slight fever) should NOT attend a child care center.

Notify your local Health Agency, that a child or staff member may have *Crypto* infection.

Parents of children or care givers should contact physicians so the child or infected care givers can submit stool sample for proper diagnosis.

The child or care-giver will be excluded from attending the child care center until he or she has submitted two consecutive stool samples that are negative for the parasite.

Source: Some of the information adopted from 'Cryptosporidium and Water: A Public Health Handbook', Working Group on Waterborne Cryptosporidiosis, 1997

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6.4.12 Procedure For Rescinding A BWA

Factors to consider in rescinding a BWA:

Source Water Quality:

Source water quality indicators have returned to acceptable levels

Treatment Effectiveness:

Treatment or operational deficiency has been corrected. The turbidity, particle counts or disinfectant residual of the treated water in at least two consecutive sets of samples has returned to an acceptable level

Distribution and Finished Water Quality:

Distribution system malfunction has been corrected. Sufficient finished water displacement has occurred in the distribution system to eliminate water that was or might have been contaminated. Finished water quality indicators have returned to acceptable levels and are within regulatory limits and successive pathogen monitoring shows acceptable results. If the BWA was issued because a pathogen was detected and that pathogen is no longer being detected, then the inadequacies of the pathogen detection methods must be considered before rescinding a BWA

Epidemiologic Evidence:

In the case of an outbreak, advisories are usually rescinded after the above conditions have been met and when surveillance indicates that the incidence of the illness in the community has returned to the background levels. Owing to lengthy incubation periods for some pathogens and their secondary spread, new cases of illness may occur after the period of contamination has passed. Conversely, a lack of new cases may indicate that the boil water advisory is being followed and not that the causative situation has been rectified.

SOURCE: Health Canada, Guidelines for Canadian Drinking Water Quality: Supporting Document, 2001; and Working Group on Waterborne Cryptosporidiosis, *Cryptosporidium* and Water, 1997.

6.5 GUIDELINES FOR FAILED BACTERIOLOGICAL RESULTS IN DRINKING WATER FOR RECREATION AREAS WITH HAND-PUMPS AND/OR SAMPLING INACCESSIBLE WATER SUPPLIES

Compliance Monitoring For Bacteriological Water Quality

Unless otherwise specified by either an Executive Officer, the operator of the Recreation Area will be responsible for collecting bacteriological water samples in accordance to the Provincial Laboratory of Public Health's bacteriological sampling protocol.

Unless otherwise specified by an Executive Officer, the minimum sampling frequency for Recreation Areas using groundwater as a water source, should be one bacteriological sample per week. Sampling frequency may be varied based on site-specific conditions, at the discretion of the Executive Officer. Additional sampling may be required if poor water quality is suspected or Maximum Acceptable Concentration (MAC) for bacteriological quality is exceeded.

Maximum Acceptable Concentration (MAC)

Drinking water that fulfills the following conditions will be considered to be in compliance with the coliform MAC for non-chlorinated and chlorinated water systems:

1. No sample should contain the presence of *Escherichia coli*;
2. No sample should contain the presence of total coliform organisms.

Public Health Response To Unsatisfactory Water Results

Upon receiving notification of the unsatisfactory water results, the Executive Officer will take the following actions for hand-pump and/or sampling inaccessible water supplies with the following results:

a) For Final Results containing the presence of *Escherichia coli*, the Executive Officer will take the following actions:

- Attempt immediate contact of the operator of the Recreation Area.
- Require a repeat bacteriological water sample of the Recreation Area. These samples will be clearly identified as "Resamples" on the requisition forms.
- Evaluate the health risk to the public by determining factors that include but are not limited to; the characteristics of the population at risk including population size and sensitivity, previous bacteriological results, sampling technique, and well characteristics such as construction and location.
- Based on the above risk assessment, consider a Boil Water Advisory including posting a Boil Water Advisory sign.
- Consider additional remedial action that may include but are not limited to; shock chlorination of the well, well maintenance and repairs, and removing the pump handle.

b) For Final Results containing the presence total coliforms, the Executive Officer shall advise the owner that a resample is required.

For repeat bacteriological water samples containing the presence of *Escherichia coli* and/or total coliforms, the Executive Officer **will** issue a Boil Water Advisory to the Recreation Area and require the posting of a Boil Water Advisory sign.

Public Health Intervention

Boil Water Advisory
An Executive Officer may issue a Boil Water Advisory if in his/her opinion a condition presents itself as a potential public health concern that requires immediate intervention to safeguard the public's health. Such conditions include but are not limited to:

1. One of a combination of physical (including turbidity), bacteriological or chemical analyses that in his opinion presents a public health concern.
2. Structural or equipment malfunction or concerns exist for the water source or distribution system
3. Increase in the number of cases of illness associated with the Recreation Area.
4. Bacteriological water quality functions in an unpredictable manner indicating the water system may be impacted by external environmental conditions.
5. Failure of a facility to maintain the required bacteriological quality sampling frequency.
6. A satisfactory bacteriological quality water sample has not been obtained from the specific Recreation Area prior to the operating season.
7. Available treatment is inadequate for the water source and distribution system (ex. Groundwater under the influence of surface water requires treatment consistent of surface water).

If repeat samples contain the presence of *Escherichia coli*, a Boil Water Advisory is to be issued to the Recreation Area served by the water system. For repeat bacteriological water samples containing the presence of *Escherichia coli* and/or total coliforms, the Executive Officer **will** issue a Boil Water Advisory to the Recreation Area and require the posting of a Boil Water Advisory Sign.

The Executive Officer will ensure that Boil Water Advisory notice is communicated to the operators of the Recreation Area. The operator of the Recreation Area is responsible for communicating the Boil Water Advisory to the consumers.

Boil Water Advisory Sign
A Recreation Area that is issued a Boil Water Advisory by an Executive Officer will post signs stating that the water may be "not safe for drinking, recommend boiling water prior to consumption" or something of a similar nature (see example). **Signs must be conspicuously posted at each site along the unsatisfactory water system where the public may collect water.**

Boil Water Order

In addition to a Boil Water Advisory, an Executive Officer may issue a Boil Water Order pursuant to Section 62 of the *Public Health Act* to the owner/operator of the Recreation Area. The Boil Water Order includes specific instructions that the owner/operator of the Recreation Area must follow to protect the public health.

Rescinding a Boil Water Advisory/Boil Water Order

The Boil Water Advisory and/or Boil Water Order will be rescinded when the Executive Officer is satisfied that a risk to the public health no longer exists. This may be determined according to the following criteria:

a) The treatment or distribution malfunction has been corrected and sufficient water displacement has occurred, in the distribution system, to eliminate the remaining contaminated water.
b) At least two consecutive sets of repeat samples collected in consecutive days are within MAC.
c) Any other actions or verifications deemed necessary to assure that the public health is being protected
d) The Executive Officer is confident that the water system is not impacted by external environmental conditions.

Establishing the Cause of Contamination

Environmental Health should coordinate the effort with the owner/operator of the Recreation Area to determine the cause of microbial contamination, and ensure that measures are put in place so that the incident will not be repeated.

RECREATION AREA REGULATION

Section 9 of the *Recreation Area Regulation* states that “Potable water shall be provided in a quantity and manner sufficient to adequately operate and maintain the recreation area.”

Section 11 of the *Recreation Area Regulation* states that ”Where the owner provides a non-potable water supply in a recreation area, a notice containing the words ‘Not Safe for Drinking’ or similar words and a symbol indicating that the water is not safe for drinking shall be conspicuously posted at the water supply area.”

Warning!

The safety of this water supply cannot be guaranteed

Boil Water Before Use

Boiling water for 2 minutes
kills harmful germs

Health Agency Name
Contact number for Park or RHA

6.6 FACT SHEET – BLUE GREEN ALGAE

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FACT SHEET - BLUE-GREEN ALGAE

Blue-green algae, or "pond scum" has the scientific name of *Cyanobacteria.* With the right temperature and conditions, blue-green algae can grow in shallow, warm, slow moving or still water, resulting in a *bloom*. Blue-green algae can carry within their cells toxic chemicals called *Cyanobacterial toxins.* Some of these toxins are known to attack the liver (hepatotoxins) or the nervous system (neurotoxins); others simply irritate the skin. These toxins are usually released into water when the blue-green algae rupture or die.

If you come into contact with water with blue-green algae bloom, there is a risk of being exposed to these toxins. The risk would depend on the activities (see Table 1).

Table 1. Risk Activities and Potential Contact with Blue Green Algae Toxins

RISK CATEGORY	NATURE AND INTENSITY OF USE	EXAMPLES
High	Waters that are either consumed by people or animals or used for activities involving immersion or appreciable skin contact	Domestic water consumption, swimming, diving, sail-boarding, water skiing, paddling, livestock watering
Medium	Waters for which the risk of ingestion of blue-green algal material or of toxins is small and appreciable skin contact with blooms is unlikely.	Canoeing, sailing, rowing, standing waters that are used for spray irrigation of crops
Low	Waters that are inaccessible or not used or are used only for angling, or other non-contact activities	Fishing, pleasure cruising, passive shoreline recreation (picnicking, walking)

<u>Drinking Water:</u>
Drinking water with the toxin may result in nausea, headache, vomiting, abdominal pain, diarrhea, gastroenteritis, muscle weakness, pneumonia and paralysis. Boiling water will not destroy the toxins. Boiling will kill the algae, but in doing so, will release more toxins in the water. Since boiling can result in the evaporation of water, boiling may further concentrate the toxin. Contact your Health Agency to determine a safe alternative source of drinking water

<u>Skin Contact:</u>
Contact with blue-green algae through water-based activities including bathing or showering can result in skin rashes, swollen lips, eye irritation and redness, ear ache and

itchiness, sore throat, hay fever-like symptoms, asthma and possibly promotion of skin tumours. The risk of problems is likely to grow as contact time increases.

Do not wade or swim in water containing concentrated algae. Note that the wearing of wet suits in the water may result in greater risk of skin irritation because algal material trapped inside the suit may be in close contact with the skin for a long period.

Eating fish or shellfish from algae-affected water:
Some blue-green algae can produce neurotoxin that can bioaccumulate in edible mussels, clams and other shellfish. The toxins are retained even after freezing and boiling the mussels. Both carp and crayfish have also been found to have detectable levels of toxin in their muscles and viscera. The liver and gastrointestinal tract of fish caught in algae infested waters are likely to be poisonous and should not be consumed. There is limited information available on the likelihood of toxin concentration in fish, and common sense dictates not to consume any fish caught in water where the presence of these toxins is confirmed.

Irrigating with algae-affected water:
Toxins from blue-green algae can be lethal to both plants and animals. Based on current knowledge, an affected water source should not be used for watering edible plants if there is an alternate supply. If there is no alternative supply, direct spray on the edible part of the plants should be avoided. This is particularly important with plants such as cabbages, lettuces, tomatoes, and strawberries.

Prior to use, vegetables and fruits should always be thoroughly washed and rinsed with non-toxic water. Research has shown that dried blue-green algal cells can remain toxic for several months.

Irrigated pastures may cause problems with stock because of the potential for long-term poisoning over many months or years. The effects of sunlight may reduce the level of some toxins, however, other toxins can be persistent and remain active for many months. Where an irrigation system produces a spray all efforts should be made to avoid contact or inhalation of the spray. Contact with the outer layer of the blue-green algal cells may cause allergic reactions. Spray irrigation systems are often used on golf course and agricultural fields.

The presence of algae and blue-green algae in water can cause clogging of filters, meters, valves and sprinklers.

Household Usage- Washing clothes and dishes:
Contaminated water should not be used for washing clothes or dishes where a safe source of water is available. Should such a source not be available, the following precautions are recommended:

- Use rubber gloves to avoid contact with the water
- Rinse dishes with non-toxic water or remove surplus water with a tea towel

- Give clothes a final rinse with non-toxic water and dry them in open air exposed to the sun

Animals and Pets:
Stock deaths have occurred after drinking contaminated water. If an algal bloom is suspected, farmers should prevent animal access to the affected water and provide alternate supplies where possible. It is most important that animals are not fenced into small areas where the only source of water has a covering of algal scum.

Dogs are particularly susceptible, as they tend to lick their coats after swimming. It is critical that pets are kept from getting into blue-green algae blooms and surrounding water.

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CHAPTER 7:

DISINFECTANTS AND PATHOGEN REFERENCE CHART

REFERENCES, RESOURCES AND WEB STIES

FUTURE CONSIDERATIONS

Blue Green Algae, Turbidity, Protozoan Outbreak Sampling Protocol, Outbreak Action Protocol, Cistern Approval, Criteria for Chemical Water Analysis, Monitoring Equipment for Small Flow Systems, Inspection Forms for Small Flow Systems, Cross-Connections, Approval for Non-Regulated Small Systems, Chemical versus Microbial Risk, Disinfection By-Products, Small Flow Testing Equipment

DISINFECTANT AND PATHOGEN REFERENCE CHART

CT value (mg-min/L) for 3 Log removal or inactivation at pH 6-9 and temperature of 10^{o}C. UV dose given in mJ/cm^{2}

	Chlorine (FAC 0.2-0.5 mg/L)	Chloramine	Ozone	Chlorine Dioxide	UV	Comments on Pathogen
E. coli	0.034-0.05 [1]	95-180 [1]	0.02 [1]	0.4-0.75 [1]	4.1	
Virus	4 [2]	1,067 [2]	0.8 [2]	12.8 [2]	143 [3 *]	Norovirus ID_{50} 6 x 10^{3} PDU
Giardia lamblia	104 [2]	1,540 [2]	1.43 [2]	23 [2]	11 [3]	ID_{50} 50
Cryptosporidium	9600 (2 log)	64,000 (2 log)	4-9 (2 log) [2]	70 (<1 log) [2]	12 [3]	ID_{50} 132
Legionella	Shock chlorination dose of 20-50 mg/L needed. Survive 2.5 mg/L for 10 min		1-2 mg/L effective but no residual and cannot control regrowth	0.2 mg/L	20	Survive in biofilm and warm water (temp 20-50^{o}C), optimal at 35-45, ID 10^{5} Control: - flush stagnant line - heat water to 60^{o}C for 30 min every 2 months (90% kill in 2 minutes) - copper-silver ionizer
Pseudomonas	FAC at 1-3 mg/L at pH 7.2-7.8 can prevent overgrowth	Effective in controlling growth in biofilm – reduce 90% of nosocomial outbreaks	Not effective for use for biofilm in distribution systems	60		Survive in biofilm and warm water and increase density to 10^{4}-10^{6} within 24 hours without disinfectants May be isolated as HPC ID 10^{8}-10^{9}
MAC (varies with strain) [4]	551-1552	91-1710	0.01-0.17 but not effective for use in distribution system	0.1-11		Survive in biofilm ID 10^{4}-10^{7}

	Chlorine	Choramine	Ozone	Chlorine Dioxide	UV	Comments on Pathogens
DBP formed	Trihalomethane (THM) Haloacetic acid (HAA5) Haloaceto-nitriles MX	Dichloro-acetic acid, Cyanogen chloride, NDHM, di and tri-chloramine	Bromate, aldehydes, ketones, hydrogen peroxide	Chlorite, chlorate, chloral hydrate, bromate ion (in presence in light)	Aldehydes	
Limitation and comments	Unstable and cannot penetrate biofilm	Less effective than chlorine but provides better residual time and biofilm penetration	No residual, promote bacteria regrowth by forming assimilated organic carbon		No residual, operation limited by iron and hardness of water, lower chlorine residual	

[1] WHO.int/
[2] USEPA, *Alternative Disinfectants and Oxidants Guidance Manual*, April 1999
[3] USEPA, *UV Disinfection Guidance Manual*, June 2003.
[4] Taylor RH, *Applied and En. Microbiology*, 64(4):1702-1705, Apr 2000

* For groundwater with high iron levels (0.65 ppm) with a safety factor of 1.5 for the most resistant virus. In most cases, 36 mJ/cm^2 would provide 3-log virus inactivation

REFERENCES, RESOURCE AND WEB SITES

Canadian Government Sites

Health Canada water quality
http://www.hc-sc.gc.ca/ehp/ehd/bch/water_quality.htm

Canadian Provincial Regulations
http://www.caeal.ca/provregs.html

Government of BC, Water Resource Information
http://wlapwww.gov.bc.ca/wat/wtrhome.html

Government of BC, Ministry of Water, Land and Air Protection, Water Quality
http://wlapwww.gov.bc.ca/wat/wq/wqhome.html

Government of BC, Ministry of Health Services, Drinking Water Program
http://www.hlth.gov.bc.ca/protect/water.html

Government of Alberta, Alberta Environment, Water
http://www3.gov.ab.ca/env/water.html

Government of Alberta, Water Act
http://www.qp.gov.ab.ca/Documents/acts/W03.CFM

Government of Alberta, Water (Ministerial) Regulation
http://www.qp.gov.ab.ca/documents/regs/1998_205.cfm

Government of Alberta, Water For Life
http://www.waterforlife.gov.ab.ca/

Saskatchewan Water
http://www.saskwater.com/

Manitoba Conservation, Water Branch
http://www.gov.mb.ca/natres/watres/

Ontario Ministry of Environment, Water
http://www.ene.gov.on.ca/water.htm

Ontario Clean Water Agency
http://www.ocwa.com/

PEI, Fisheries, Aquaculture and Environment
http://www.gov.pe.ca/fae/wr-info/index.php3

Nova Scotia, Environment and Labour
http://www.gov.ns.ca/enla/

U.S. Environmental Protection Agency

Wetlands, Oceans and Watersheds
http://www.epa.gov/OWOW/

Ground Water and Drinking Water
http://www.epa.gov/OGWDW/

Office of Water
http://www.epa.gov/ow/

Associations:

Alberta Water and Wastewater Operators Association
http://www.awwoa.ab.ca/

American Water Works Association
http://www.awwa.org/

Atlantic Canada Waterworks Association
http://www.acwwa.ns.ca/awwa/index.html

British Columbia Water and Waste Association
http://www.bcwwa.org/

Canadian Ground Water Association
http://www.cgwa.org/

Canadian Water and Wastewater Association
http://www.cwwa.ca/e_index.htm

Canadian Water Resources Association
http://www.cwra.org/

International Water Association
http://www.iwahq.org.uk/template.cfm?name=home

National Sanitation Foundation
http://www.nsf.org/

Ontario Water Works Association
http://www.owwa.com/

Underwriters Laboratories
http://www.ul.com/

Water Quality Association
http://www.wqa.org/

Western Canada Water and Wastewater Association
http://www.wcwwa.ca/index.html

Fact Sheets and Publications:

Agriculture and Agri-Food Canada, Alberta Environment and Alberta Agriculture Food and Rural Development. 2000. *Water Wells that last for generations*, Third Edition.

Agriculture and Agric-Food Canada. 2002. Quality Farm Dugouts. Alberta Agriculture Food and Rural Development. Edmonton, Alberta.

PFRA Water Quality Matters Series:
http://www.agr.gc.ca/pfra/water/wqualite.htm

Other Sits:

World Health Organization, Water and Sanitation
http://www.who.int/water_sanitation_health/Training_mat/GDWAtrtoc.htm

Water Health Connection
http://poseidon.aomc.org/