

The Alberta Gazette

Part I

Vol. 108

Edmonton, Monday, April 30, 2012

No. 8

APPOINTMENTS

Appointments of Non-Presiding Justices of the Peace

(Justice of the Peace Act)

March 23, 2012

Gabriel Tak Yue Chow of Calgary
Katherine Desautels of Calgary
Stephanie Katherine Dorosz of Calgary
Astrid Azucena Hurtarte of Edmonton
Meagan Rose McKinnon of Calgary
Krista Lee McLaughlin of Lethbridge

CHANGES OF NAME

Changes of Name of Non-Presiding Justices of the Peace

(Justice of the Peace Act)

March 23, 2012

Michele Marie Nielsen to Michele Marie Stancin - Edmonton
Tara Dorothy LeBlanc to Tara Dorothy Neil – Fort McMurray

RESIGNATIONS & RETIREMENTS

Retirements of Non-Presiding (Fee) Justices of the Peace

(Justice of the Peace Act)

March 23, 2012

Robert William Chernuka (deceased) of Swan Hills
Lawrence Meardi of McLennan
Gerald Albert Wilkinson of Drumheller

Resignations of Non-Presiding Justices of the Peace

(Justice of the Peace Act)

March 23, 2012

Heather Marie Straty of St. Paul
Anthony Robert Neri of Edmonton

GOVERNMENT NOTICES

Agriculture and Rural Development

Form 15

(Irrigation Districts Act)
(Section 88)

Notice to Irrigation Secretariat:
Change of Area of an Irrigation District

On behalf of the **Bow River Irrigation District**, I hereby request that the Irrigation Secretariat forward a certified copy of this notice to the Registrar for Land Titles for the purposes of registration under section 22 of the *Land Titles Act* and arrange for notice to be published in the Alberta Gazette.

The following parcels of land should be **added** to the irrigation district and the notation added to the certificate of title:

LINC Number	Short Legal Description as shown on title	Title Number
0017 103 060	PLAN 3652HX BLOCK 13	951 102 836
0019 737 782	PLAN 3652HX BLOCK 29	041 472 931
0020 168 556	PLAN 3652HX BLOCK 45	841 144 681
0019 442 152	PLAN 4603HX BLOCK 70	051 105 007
0011 104 841	PLAN 4603HX BLOCK 81	981 050 386
0028 877 322	PLAN 4603HX BLOCK 83	011 163 363
0019 365 668	PLAN 4863HX BLOCK 88	931 098 932

I certify the procedures required under part 4 of the *Irrigation Districts Act* have been completed and the area of the **Bow River Irrigation District** should be changed according to the above list.

Rebecca Fast, *Office Administrator,*
Irrigation Secretariat.

On behalf of the **Western Irrigation District**, I hereby request that the Irrigation Secretariat forward a certified copy of this notice to the Registrar for Land Titles for the purposes of registration under section 22 of the *Land Titles Act* and arrange for notice to be published in the Alberta Gazette.

The following parcels of land should be **removed** from the irrigation district and the notation removed from the certificate of title:

LINC Number	Short Legal Description as shown on title	Title Number
0013 428 313	8010030;8;19	121 064 828
0030 672 562	0413245;5;4	121 053 743

I certify the procedures required under part 4 of the *Irrigation Districts Act* have been completed and the area of the **Western Irrigation District** should be changed according to the above list.

Rebecca Fasst, *Office Administrator,*
Irrigation Secretariat.

Culture and Community Services

Notice of Receipt of a Repatriation Application

(Blackfoot First Nations Sacred Ceremonial Objects Repatriation Regulation)

Pursuant to the First Nations Sacred Ceremonial Objects Repatriation Act(FNSCORA) and the Blackfoot First Nations Sacred Ceremonial Objects Repatriation Regulation made under that Act, the Province of Alberta as represented by the Minister of Culture and Community Spirit hereby gives notice of receipt of two repatriation applications from members of the Siksika Nation for several objects in the Government of Alberta's collections at the Glenbow Museum and the Royal Alberta Museum.

The first application regards the repatriation request for two hoof rattles associated with the Tobacco Dance (AF3703), Natoas necklace (AF1500), Natoas necklace (AF1499), Natoas necklace (AF1502), Natoas necklace (AF1498), Natoas Bundle Crow tail feathers (AF1354), necklace (AF3781), Weather Dance item (AF924), Beaver Bundle drum (AF3798), Badger skin bag (AF4302), Gaming hoop (AF3784), Digging stick (AF4296), Stone hammer (AF3705), Hairpiece (AF2249), and Pipe bowl (AF 2979). These objects are housed in the Glenbow Museum and originated with the Siksika Nation.

The second application is for the repatriation of Buffalo Hooves (unnumbered) and a Natoas Bundle, incomplete (AF862), both from the Glenbow Museum, and a Sundance robe (H66.181.1), Natoas Sundance materials (H66.181.6-31), two wristlets (H65.99.3A&B), and a bison bone (H65.155.22) housed in the Royal Alberta Museum. The robe originated with the Kainai Nation but was last held by a member of the Siksika Nation. The other objects originated with the Siksika Nation.

Any person with interest in these objects, who either wishes to make written representations to the Minister relating to this application or to submit an application of their own, must do so within 30 days after publication of this notice in The Alberta Gazette. For further information, an interested person should contact the Aboriginal Liaison Officer at the Royal Alberta Museum, 12845-102 Avenue, and Edmonton, Alberta T5N 0M6. The Aboriginal Liaison Officer can also be reached by telephone at (780) 453-9155 or by fax at (780) 453-9155 or email- judy.half@gov.ab.ca.

Repatriation of the above objects to the Blackfoot Crossing Historical Park, as the designated representative of the Siksika Nation, may proceed after the 30 day period if the objects listed in the application are determined to meet the criteria of a sacred ceremonial object as defined in FNSCORA, no additional applications or contrary written representations have been made, and the Minister considers repatriation to be appropriate.

Energy

Production Allocation Unit Agreement

(Mines and Minerals Act)

Notice is hereby given, pursuant to section 102 of the Mines and Minerals Act, that the Minister of Energy on behalf of the Crown has executed counterparts of the agreement entitled "Production Allocation Unit Agreement – Erskine Nisku Agreement No. 1" and that the Unit became effective on January 1, 2012.

EXHIBIT "A"
ATTACHED TO AND MADE PART OF AN AGREEMENT ENTITLED
"ERSKINE NISKU AGREEMENT NO. 1"

Tract No.	Land Description (W4M)	Lease Minister's Crown	Royalty Owner	Share of Tract Participation (%)	Working Interest Owner	Share of Working Interest (%)	Tract Participation (%)
1	Twp 39 Rge 21 W4M: Sec 24, LSD 2	Crown Lease #36192 (#103774)	Crown	100%	CNR	100%	19.89%
2	Twp 39 Rge 21 W4M: Sec 13, LSD 10, 15	Freehold Lease dated April 9, 1953 (#103770)	Isabell Norris Joanne Allen Alice Mary Norris Edith Olhausen Audrey J. Viard Gladys H. Anderson Helen M. Combast	100%	CNR	100%	58.53%
3	Twp 39 Rge 21 W4M: Sec 13, LSD 7	Freehold Lease dated September 30, 1955 (#103765)	Erkana Corporation	100%	CNR	100%	21.58%

List of Abbreviations

"CNR" means Canadian Natural Resources, by its managing partner, Canadian Natural Resources Limited

Working Interest Owners:

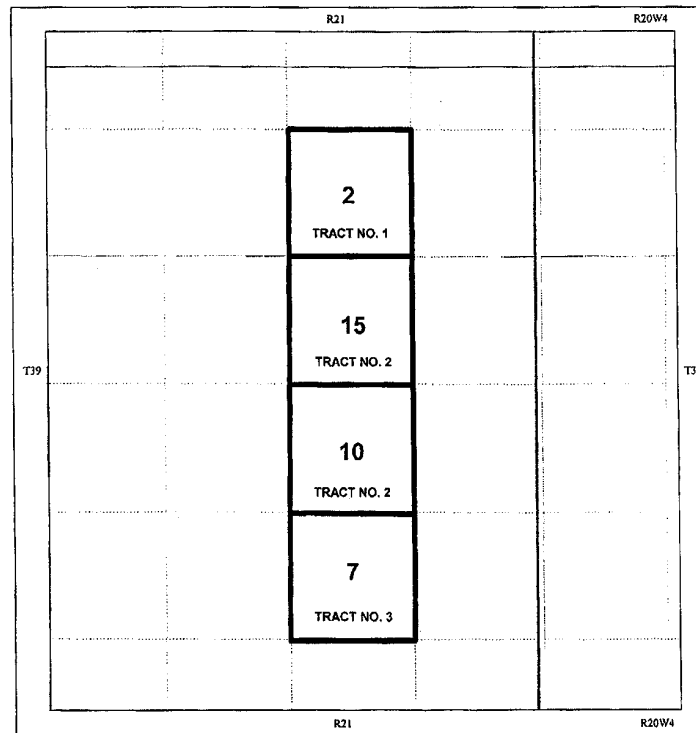
CANADIAN NATURAL RESOURCES
by its managing partner,
Canadian Natural Resources Limited

100%

CORRECTION #2
Effective as of the Effective Date

EXHIBIT "B"

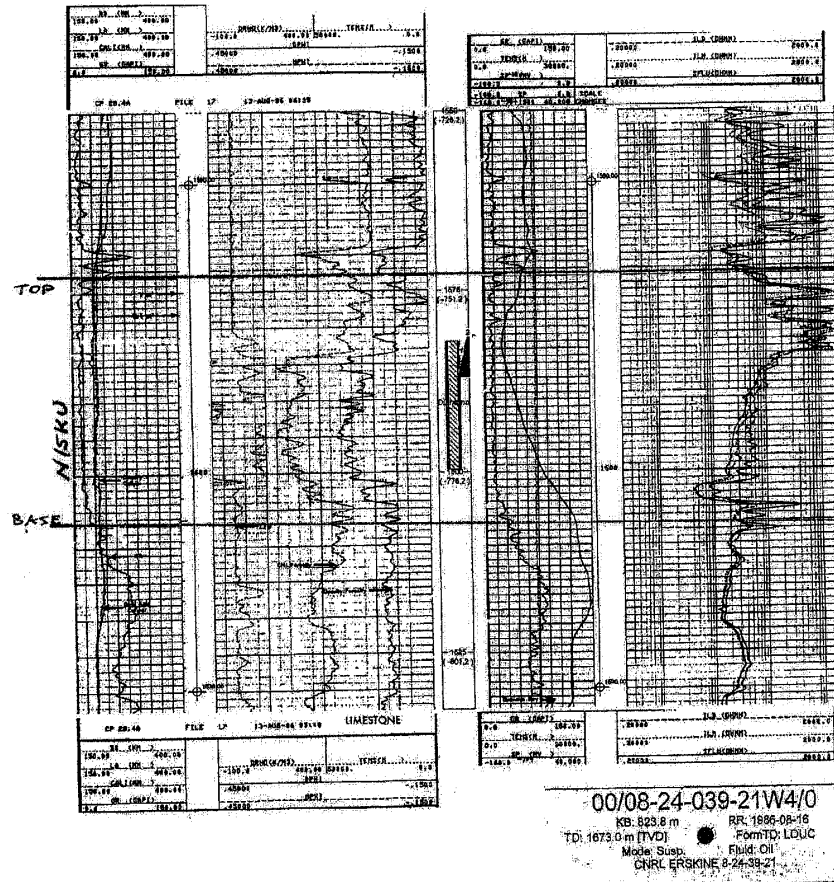
ATTACHED TO AND MADE PART OF AN AGREEMENT ENTITLED
"ERSKINE NISKU AGREEMENT NO. 1"



Effective as of the Effective Date

EXHIBIT "C"

ATTACHED TO AND MADE PART OF AN AGREEMENT ENTITLED
"ERSKINE NISKU AGREEMENT NO. 1"



Notice is hereby given, pursuant to section 102 of the Mines and Minerals Act, that the Minister of Energy on behalf of the Crown has executed counterparts of the agreement entitled "Production Allocation Unit Agreement – Erskine Nisku Agreement No. 2" and that the Unit became effective on January 1, 2012.

EXHIBIT "A"
ATTACHED TO AND MADE PART OF AN AGREEMENT ENTITLED
"ERSKINE NISKU AGREEMENT NO. 2"

Tract No.	Land Description (W4M)	Lease Number	Royalty Owner	Share of Tract Participation (%)	Working Interest Owner	Share of Working Interest (%)	Tract Participation (%)
1	Two 39 Rge 21 W4M: Sec 24 LSD 1	Crown Lease #36192 (#103774)	Grown	100%	CNR	100%	19.45%
2	Two 39 Rge 21 W4M: Sec 13 LSD 9, 16	Freehold Lease dated April 9, 1953 (# 103770)	Isabell Norris Joanne Allen Alice Mary Norris Edith Ohlhausen Audrey J. Ward Gladys H. Anderson Helen M. Combust	100%	CNR	100%	85.54%
3	Two 39 Rge 21 W4M: Sec 13 LSD 8	Freehold Lease dated September 30, 1958 (# 103765)	Ericana Corporation	100%	CNR	100%	15.01%

List of Abbreviations

"CNR" means Canadian Natural Resources, by its managing partner, Canadian Natural Resources Limited

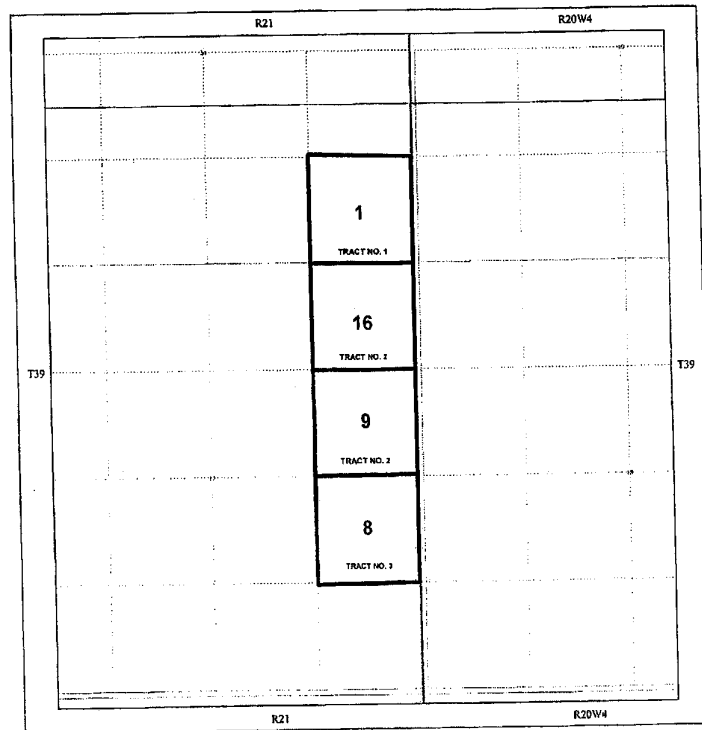
Working Interest Owners:

CANADIAN NATURAL RESOURCES
by its managing partner,
Canadian Natural Resources Limited 100%

CORRECTION #2
Effective as of the Effective Date

EXHIBIT "B"

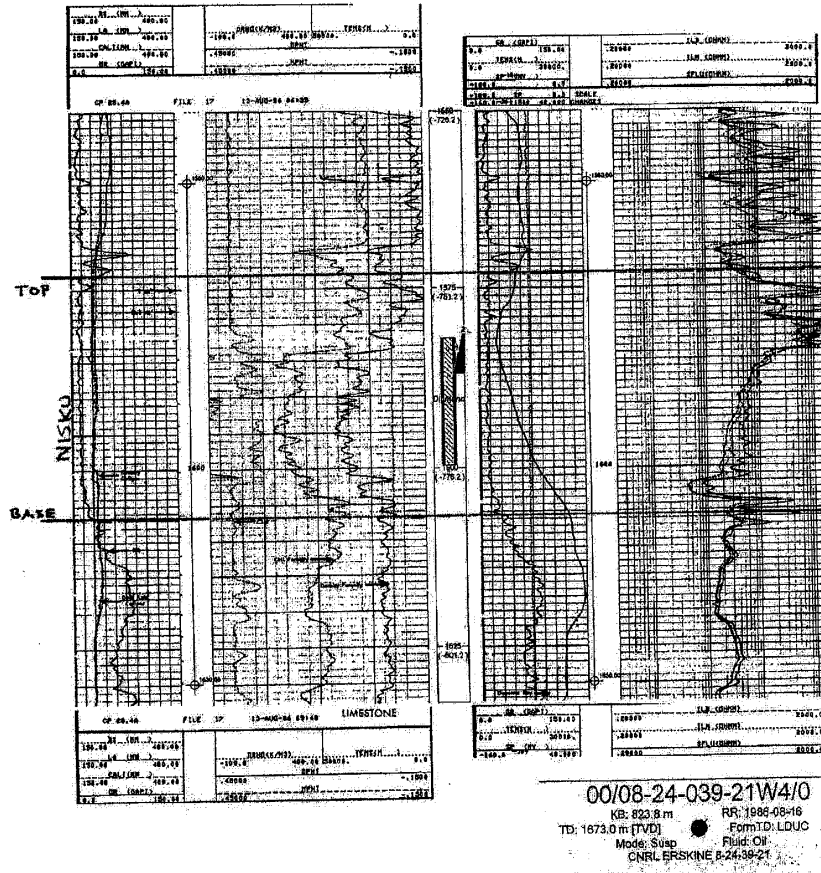
**ATTACHED TO AND MADE PART OF AN AGREEMENT ENTITLED
"ERSKINE NISKU AGREEMENT NO. 2"**



Effective as of the Effective Date

EXHIBIT "C"

ATTACHED TO AND MADE PART OF AN AGREEMENT ENTITLED
"ERSKINE NISKU AGREEMENT NO. 2"



Environment and Water

**CODE OF PRACTICE FOR A WATERWORKS SYSTEM
CONSISTING SOLELY OF A WATER DISTRIBUTION SYSTEM**

Effective June 1, 2012

Made under the *Environmental Protection and Enhancement Act, RSA 2000, cE-12*

TABLE OF CONTENTS

Part

- 1. Definitions**
- 2. General Provisions**
- 3. Administration, Design and Construction Requirements**
- 4. Operational Requirements**
- 5. Limits and Monitoring Requirements**
- 6. Reclamation Requirements**
- 7. Reporting Requirements**
- 8. Record Keeping Requirements**
- 9. Code of Practice Administration**

Schedule 1 Operations Program Contents

PART 1: DEFINITIONS

- 1.1 All definitions in the Act and the regulations under the Act apply except where expressly defined in this Code of Practice.
- 1.2 In this Code of Practice:
- (a) “Act” means the *Environmental Protection and Enhancement Act*, R.S.A. 2000, c.E-12, as amended from time to time;
 - (b) “alternate program” means the Alternate Laboratory Data Quality Assurance Program, as detailed in the Department’s *Laboratory Data Quality Assurance Policy Procedures and Guidelines*;
 - (c) “approved laboratory” means laboratory accredited to the requirements of ISO/IEC 17025 - General requirements for the competence of testing and calibration laboratories, for the drinking water tests methods specified by the Director;
 - (d) “chlorine residual” means free chlorine, or combined chlorine or total chlorine;
 - (e) “continuous” means flow measurement or sample analysis through in-line equipment that creates flow measurements or frequent, discrete sample analysis output;
 - (f) “design capacity” means a production capacity for which the waterworks system was designed, as stated in the engineering drawings and specifications for the waterworks system, provided pursuant to section 3.1.3;
 - (g) “Drinking Water Safety Plan”, (“DWSP”) means a comprehensive assessment of the risk factors that could adversely affect the quality of drinking water delivered to consumers;
 - (h) “DWSP template” means the drinking water safety plan template published from time to time by Alberta Environment and Water on their website;

- (i) “four seasons” is comprised of “spring” - March to May, “summer” – June to August, “fall” – September to November, “winter” – December to February;
- (j) “GCDWQ” means the *Guidelines for Canadian Drinking Water Quality*, published by Health Canada, as amended or replaced from time to time;
- (k) “grab”, when referring to a sample, means an individual sample collected in less than 30 minutes and which is representative of the substance sampled;
- (l) “ISO / IEC” means the International Organization for Standardization / the International Electrotechnical Commission;
- (m) “MAC” means the Maximum Acceptable Concentration, specified in the GCDWQ for a particular parameter;
- (n) “professional engineer” means a professional engineer or registered professional technologist (engineering) under the *Engineering, Geological and Geophysical Professions Act*;
- (o) “regulations” means the regulations under the Act;
- (p) “running annual average” means the arithmetic average of the concentrations of all the most recent samples taken covering a 365 day period;
- (q) “Standards and Guidelines Document” means the Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems, published by the Department, as amended or replaced from time to time;
- (r) “this Code of Practice” means the Code of Practice for a Waterworks System Consisting Solely of a Water Distribution System, published by the Department, as amended or replaced from time to time; and
- (s) “weekday” means Monday, Tuesday, Wednesday, Thursday, or Friday.

PART 2: GENERAL PROVISIONS

Section 2.1: General

- 2.1.1 Any person who constructs, operates or reclaims a waterworks system that consists solely of a water distribution system shall do so in accordance with this Code of Practice.
- 2.1.2 Any conflict between the registration application and the terms and conditions of this Code of Practice shall be resolved in favour of this Code of Practice.
- 2.1.3 The terms and conditions of this Code of Practice do not affect any rights or obligations created under any other authorization issued by the Department.
- 2.1.4 The terms and conditions of this Code of Practice are severable. If any term or condition of this Code of Practice or the application of any term or condition is held invalid, the application of such term or condition to other circumstances and to the remainder of this Code of Practice shall not be affected by that invalidity.
- 2.1.5 If the registration holder monitors for any substances or parameters which are the subject of limits in this Code of Practice more frequently than is required, using procedures authorized in this Code of Practice, then the registration holder shall provide the results of such monitoring as an addendum to the next reports required by this Code of Practice.

Section 2.2: Analytical Requirements

- 2.2.1 With respect to any monitoring required pursuant to this Code of Practice, all samples shall be:
 - (a) collected;
 - (b) preserved;
 - (c) stored;
 - (d) handled; and

- (e) analyzed in accordance with:
 - (i) the *Standard Methods for the Examination of Water and Wastewater*, published by the American Public Health Association, the American Waterworks Association and the Water Environment Federation, as amended or replaced from time to time; or
 - (ii) a method authorized in writing by the Director.
- 2.2.2 Any analysis of a sample required pursuant to this Code of Practice, shall be done only in an approved laboratory, or in accordance with the Department's alternate program.
- 2.2.3 Any analysis of a sample of treated water for bacteriological quality required pursuant to this Code of Practice shall be conducted only by the Provincial Laboratory for Public Health (ProvLab), unless otherwise specified in writing by the Director.

PART 3: ADMINISTRATION, DESIGN AND CONSTRUCTION REQUIREMENTS

Operations Program

- 3.1.1 If the waterworks system was not previously registered, no person shall apply for a registration unless that person has prepared or caused to be prepared a written operations program governing the operation of the waterworks system.
 - 3.1.1.1 A registration holder shall have a written operations program governing the operation of the waterworks system completed by the latter of:
 - (a) the date of application for a registration, or
 - (b) the date specified in a notice issued pursuant to S.8.1(4) of the *Environmental Protection and Enhancement (Miscellaneous) Regulation*, AR 118/93.
 - 3.1.2 The operations program in section 3.1.1.1 shall contain, at a minimum, all of the information in Schedule 1.

- 3.1.3 In addition to the information required in the Act and the regulations, an application for a registration shall contain, at a minimum, the following information:
- 3.1.4
- (a) written confirmation that the person applying for the registration has prepared, or caused to be prepared an operations program;
 - (b) engineering drawings signed and stamped by a professional engineer, for the proposed waterworks system or proposed changes to the waterworks system, including the design capacity of the proposed waterworks system or proposed change;
 - (c) a statement, signed and stamped by a professional engineer, indicating whether the design of the project complies with all the design requirements of:
 - (i) this Code of Practice, and
 - (ii) the regulations under the Act; and
 - (d) in cases in which a design requirement in section 3.1.3 (c) is not met, a statement, signed and stamped by a professional engineer, identifying and justifying the deviation.
- 3.1.5 No person shall install any water treatment equipment that was not included in the registration application unless the Director has been advised in writing in advance of the intention to install and operate that water treatment equipment.
- 3.1.6 No person shall remove any water treatment equipment that was included in the registration application unless the Director has been advised in writing in advance of the intention to remove that water treatment equipment.
- 3.1.7 The registration holder shall complete a drinking water safety plan of the waterworks system:
- (a) on or before December 31, 2013 for registrations issued on or after June 1, 2012; or

- (b) by December 31, 2013 for registrations in existence on June 1, 2012.

3.1.7.1 The drinking water safety plan in 3.1.7 shall:

- (a) identify potential risks to the waterworks system including without limiting the generality of the foregoing:
 - (i) risks associated with the distribution of treated water within the distribution system;
 - (ii) risks associated with the consumer's premises located on the distribution system;and
- (b) prescribe appropriate measures to control and/or reduce such risks to the distribution system;

in accordance with the requirements in the Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems; Part 1 Standards for Municipal Waterworks (2012).

3.1.7.2 The drinking water safety plan in 3.1.7.1 (a) may also consider:

- (a) risks associated with the source of the raw water;
- (b) risks associated with the treatment processes associated with the water treatment works.

3.1.8 The drinking water safety plan in 3.1.7 shall utilise the drinking water safety plan template located at:
<http://www.environment.alberta.ca/apps/regulatteddwq/dwsp.aspx> unless otherwise agreed to in writing by the Director.

3.1.9 The registration holder shall

- (a) maintain, and
- (b) update the drinking water safety plan.

PART 4: OPERATIONAL REQUIREMENTS

4.1.1 The waterworks system shall be

(a) operated; and

(b) maintained

at all times within its design capacity.

4.1.2 Repealed

4.1.2.1 The registration holder shall maintain positive pressure at all points throughout the distribution system where water is being supplied.

4.1.3 Repealed

Certified Operator

4.1.4 At all times, the operation of the waterworks system shall be performed by, or under the direction of, a person who holds a valid certificate of qualification at the applicable level as set out in Table 4-1.

4.1.5 At all times, the number of certified operators available to perform or direct the operation of the waterworks system shall meet or exceed the applicable numbers in Table 4-1.

TABLE 4-1: MINIMUM WATERWORKS SYSTEM OPERATOR CERTIFICATE OF QUALIFICATION REQUIREMENTS

Population Served by Waterworks System	Minimum Number and Minimum Qualifications of Water Distribution Certified Operator(s)
< 500	One operator with a Small Water Systems Certificate
500 - 1500	One operator with a Level I Water Distribution (WD) Certificate
1,501 – 15, 000	One operator with a Level II Water Distribution (WD) Certificate

15, 001 – 50,000	One operator with a Level III Water Distribution (WD) Certificate, and One operator with a Level II Water Distribution (WD) Certificate
50,001 and over	One operator with a Level IV Water Distribution (WD) Certificate, and Two operators with a Level III Water Distribution (WD) Certificate, and One operator with a Level II Water Distribution (WD) Certificate

PART 5: LIMITS AND MONITORING REQUIREMENTS

5.1.1 The quality of potable water distributed by the waterworks system shall comply with the limits in Table 5-1

- (a) at all locations specified in Table 5-2; and
- (b) at all times water is being supplied at that location.

TABLE 5-1: POTABLE WATER QUALITY LIMITS

Parameter	Limit (Maximum unless otherwise specified)
Bacteriological	Zero <i>E. coli</i> organisms per 100 mL Zero Total coliform organisms per 100 mL
Chlorine residual	Greater than or equal to 0.1 mg/L, based on at least 75% of the grab samples taken on a particular day, and Greater than or equal to 0.1 mg/L in 99% of continuous readings.
Lead and Trihalomethanes	Applicable MAC, based on the running annual average.

5.1.2 Repealed

5.1.3 If a sample does not meet one or more of the bacteriological quality limits in Table 5-1, in addition to any reporting or other requirements pursuant to the Act, the regulations, or this Code of Practice, the registration holder shall carry out the corrective actions set out in the *Communication and Action Protocol for Failed Bacteriological Results in Drinking Water for Waterworks Systems Authorized under the Environmental Protection and Enhancement Act*, entered into by Alberta Environment and

Water, the Alberta Provincial Laboratory for Public Health, and Alberta Health and Wellness, Alberta Health Services, and Health Canada, as amended or replaced from time to time.

5.1.3.1 If the first sample result of a chlorine residual sampling event pursuant to 5.1.4 does not meet the residual chlorine limit in Table 5-1, the registration holder shall:

- (a) flush the distribution line in the vicinity of the sample;
- (b) resample and analyze the chlorine residual at the same location; and
- (c) resample and analyze the chlorine residual from a service connection upstream and a service connection downstream from the location where the first sample failed.

5.1.3.2 In the event that the chlorine residual in any of the sample results in sections 5.1.3.1(b) and 5.1.3.1(c) is less than 0.1 mg/L, the registration holder shall immediately report the incident to the Director by telephone at 1-800-222-6514.

Potable Water Monitoring

5.1.4 The potable water in the waterworks system shall be monitored in accordance with Table 5-2, unless otherwise specified in writing by the Director.

TABLE 5-2: POTABLE WATER MONITORING LOCATION AND FREQUENCY

Parameter	Sample type	Monitoring Location	Minimum Monitoring Frequency and Minimum Number of Samples
Bacteriological	Grab	At random location(s) within the water distribution system	For systems serving a population over 1500 or more than 10 kilometres of water distribution system: The frequency and number of samples as set out in the GCDWQ, without any reduction, or For systems serving a population of 1500 or less and having 10 kilometres or less of water distribution system: One sample per 500 population, per month.
Chlorine residual	(a) and either (b) or (c) (a) Grab; and	(a) and either (b) or (c) (a) At the same location as the bacteriological quality sample is collected; and	(a) and either (b) or (c) (a) One sample, taken at the same time as the bacteriological quality sample is collected; and

TABLE 5-2 (continued)

Parameter	Sample type	Monitoring Location	Minimum Monitoring Frequency and Minimum Number of Samples
Chlorine residual (continued)	(b) Grab	(b) At a random location(s) within the water distribution system; or	(b) For systems serving a population of more than 500, or more than 3 kilometres of distribution system: One sample per day, five days per week, including the samples taken at the same time as the bacteriological samples; if a statutory holiday falls on a weekday within that week, the sample is not required on that day, and the frequency may be reduced by one day for each statutory holiday; or For systems serving a population of 500 or less and having 3 kilometres or less of water distribution system: Three samples per week, including the samples taken at the same time as the bacteriological samples, with a minimum of 24 hours between samples; or
	(c) Continuous	(c) At an fixed point in the water distribution system authorized by the Director	(c) One sample, every five minutes, recording all results and reporting the minimum value for each day
Lead	Grab	At a random location(s) within the water distribution system	One sample per year

5.1.5 In the event of a repair within the water distribution system, in addition to the monitoring required in section 5.1.4, the registration holder shall monitor for:

- (a) bacteriological quality, and
- (b) chlorine residual by grab sample:
 - (i) immediately after each repair, and
 - (ii) at sampling points
 - (1) closest to the location of the repair; and
 - (2) on each side of the location of the repair.

Trihalomethanes

5.1.6 Repealed

5.1.6.1 In addition to any other monitoring requirements pursuant to this Code of Practice, the Act or the regulations, trihalomethanes shall be monitored in the waterworks system in the following manner:

- (a) for systems where the registration holder adds chlorine to the water and:
 - (i) the trihalomethane concentrations in any sample in the water entering, or in, the water distribution system are greater than the applicable MAC, or no analytical results are available:
 - (A) one grab sample in each of the four seasons, each year;
 - (B) all samples shall be taken at the location furthest from the point the water enters the water distribution system; and
 - (C) there shall be a minimum of two months between samples; or
 - (ii) the trihalomethane concentrations in all samples in the previous sampling event covering a one year period in the water entering, or in, the water distribution system are less than the applicable MAC:
 - (A) one grab sample in each of the four seasons, every three years;
 - (B) all samples shall be taken at the location furthest from the point the water enters the water distribution system; and

- (C) there shall be a minimum of two months between samples; or
- (b) for systems where the registration holder does not add chlorine to the water and:
 - (i) the trihalomethane concentrations in any sample in the water entering, or in, the water distribution system are greater than the applicable MAC, or no analytical results are available:
 - (A) one grab sample in each of the summer and winter periods, each year;
 - (B) all samples shall be taken at the location furthest from the point the water enters the water distribution system; or
 - (ii) the trihalomethane concentrations in all samples in the previous sampling event covering a one year period in the water entering, or in, the water distribution system are less than the applicable MAC:
 - (A) one grab sample in each of the summer and winter periods, every three years;
 - (B) all samples shall be taken at the location furthest from the point the water enters the water distribution system.

5.1.7 to 5.1.9 Repealed

Additional Measurements

5.1.10 Repealed

5.1.10.1 The total water volume entering the distribution system shall be measured as required to fulfil the requirements of 5.1.11 and where no treatment chemical is added, the total water volume entering the distribution system shall be computed a minimum of once per month.

5.1.11 If any treatment chemical is added to the waterworks system, the dosage of each chemical added shall:

- (a) be calculated in milligrams of chemical per litre of water (mg/L) by measuring the amount of chemical added in a period not exceeding 7 days divided by the total volume of water to which the chemical was added; and

- (b) not exceed the dosage specified as Maximum Use in *Standard 60*, published by the National Sanitation Foundation and the American National Standards Institute (NSF/ANSI), as amended or replaced from time to time, unless otherwise authorized in writing by the Director.

PART 6: RECLAMATION REQUIREMENTS

- 6.1.1 Where the land surface has been disturbed during construction, expansion, modification or repair of any portion of a waterworks system, reclamation of the land surface to equivalent land capability shall be performed following the construction, expansion, modification or repair, in accordance with the Standards and Guidelines Document.
- 6.1.2 Within six months after the waterworks system, or a portion of the waterworks system, permanently ceases operation, the registration holder shall submit a reclamation plan to the Director for the portion of the system that is no longer in operation.
- 6.1.3 No person shall commence reclamation of the waterworks system until that person has received written authorization from the Director for the reclamation.
- 6.1.4 Any person conducting reclamation of the waterworks system shall comply with the reclamation plan, as authorized in writing by the Director.

PART 7: REPORTING REQUIREMENTS

Contravention Reporting

- 7.1.1 In addition to any other reporting required pursuant to this Code of Practice, the Act, or the regulations, the registration holder shall immediately report to the Director any contravention of this Code of Practice, either:
 - (a) by telephone at 1-800-222-6514, or

- (b) by a method
 - (i) in compliance with the release reporting provisions in the Act and the regulations, or
 - (ii) authorized in writing by the Director.

7.1.2 In addition to any other reporting required pursuant to this Code of Practice, the Act, or the regulations, the registration holder shall immediately report to the Director by a method under section 7.1.1, any structural or equipment malfunction in the waterworks system that may affect the quality or supply of potable water.

7.1.3 In addition to the immediate report in section 7.1.1, the registration holder shall provide a report to the Director:

- (a) in writing; or
- (b) by a method:
 - (i) in compliance with the release reporting provisions in the Act and the regulations, or
 - (ii) authorized in writing by the Director

within seven (7) calendar days after the discovery of the contravention, or within another time period specified in writing by the Director, unless the requirement for the report is waived by the Director.

7.1.4 The report required under section 7.1.3 shall contain, at a minimum the following information:

- (a) a description of the contravention;
- (b) the date of the contravention;
- (c) the duration of the contravention;
- (d) the legal land description of the location of the contravention;
- (e) an explanation as to why the contravention occurred;
- (f) a summary of all preventive measures and actions that were taken prior to the contravention;

- (g) a summary of all measures and actions that were taken to mitigate any effects of the contravention;
- (h) a summary of all measures that will be taken to address any remaining effects and potential effects related to the contravention;
- (i) the number of the registration issued under the Act for the waterworks system, and the name of the person who held the registration at the time the contravention occurred;
- (j) the name, address, phone number and responsibilities of all persons operating the waterworks system at the time the contravention occurred;
- (k) the name, address, phone number and responsibilities of all persons who had charge, management or control of the waterworks system at the time that the contravention occurred;
- (l) a summary of proposed measures that will prevent future contraventions, including a schedule of implementation for these measures;
- (m) any information that was maintained or recorded under this Code of Practice, as a result of the incident; and
- (n) any other information required by the Director in writing.

Monthly Reporting

7.1.5 The registration holder shall compile and retain monthly reports.

7.1.6 The monthly report in section 7.1.5 shall include, at a minimum:

- (a) the name, telephone and fax numbers of all certified operators;
- (b) the analytical results for all parameters required to be monitored in accordance with this Code of Practice during the month;
- (c) the locations of all sampling performed during the month in accordance with this Code of Practice;

- (d) the name and manufacturer and batch number(s) of all treatment chemicals added during the month, and each manufacturer as listed in the *Standard 60*, published by the American National Standards Institute and the National Sanitation Foundation, (ANSI/NSF) as amended or replaced from time to time; and
- (e) the results of all required measurements conducted during the month in accordance with this Code of Practice.

Annual Reporting

- 7.1.7 In addition to any other reporting required under the Act, the regulations, and this Code of Practice, the registration holder shall compile an annual report, by February 28 of the year following the calendar year in which the information on which the report is based was collected.
 - 7.1.7.1 Until a notice under section 7.1.9 is issued by the Director, the registration holder shall submit to the Director the annual report in section 7.1.7, by February 28 of the year following the calendar year in which the information on which the report is based was collected.
- 7.1.8 The annual report in section 7.1.7 shall contain, at a minimum, all of the following information:
 - (a) a summary of the monthly reports, specifying the monthly minimum, average, and maximum results for each parameter monitored, excluding bacteriological results, for each month;
 - (b) a summary of the number, results, and sampling dates of the bacteriological samples analyzed for each month;
 - (c) the results of any other compliance monitoring done during the year pursuant to this Code of Practice that was not included in any monthly report; and
 - (d) a description of any problems experienced and corrective actions taken at the waterworks system during the year with respect to environmental matters.

Electronic Reporting

7.1.9 The Director may, by notice in writing, require the registration holder to submit periodic reports:

- (a) in an electronic format; and
- (b) at a different frequency than specified in sections 7.1.5 and 7.1.7.1 of this Code of Practice.

7.1.10 The registration holder who receives a notice as specified in section 7.1.9 shall comply with the notice.

PART 8: RECORD KEEPING REQUIREMENTS

8.1.1 The registration holder shall

- (a) record the following information; and
- (b) maintain and retain the following records for five (5) years from the date the record was created:
 - (i) bacteriological analysis results;
 - (ii) daily records, including, but not limited to:
 - (A) flow meter readings,
 - (B) chlorine concentrations, and
 - (C) treatment chemical dosages;required under this Code of Practice;
 - (iii) all monthly reports required under this Code of Practice; and
 - (iv) records of action taken by the registration holder to correct contraventions of potable water quality limits (MAC), including the following information for each contravention:
 - (A) name and address of the person who discovered the contravention, and
 - (B) copies of all notifications to the public.

- 8.1.2 The registration holder shall maintain the following records for the life of the waterworks system:
- (a) the operations program;
 - (b) copies of all:
 - (i) applications submitted to the Department for a registration regarding the waterworks system, and correspondence related to the registration,
 - (ii) engineering drawings and specifications,
 - (iii) project reports,
 - (iv) construction documents,
 - (v) record drawings,
 - (vi) all reports of inspections conducted by the Department,
 - (vii) all correspondence sent to the Department regarding a proposed extension of a water distribution system, replacement of a portion of a water distribution system, expansion or modification of potable water storage within the water distribution system
 - (viii) all registrations issued under the Act for the waterworks system,
 - (ix) all annual reports, and
 - (x) all reports prepared pursuant to sections 7.1.3 and 7.1.4; and
 - (c) all analytical results required pursuant to this Code of Practice, excluding daily monitoring.
- 8.1.3 The results and records in sections 8.1.1(b) and 8.1.2(c) shall contain, at a minimum, all of the following information:
- (a) the date, location and time of monitoring, and the name of the person collecting the sample;
 - (b) identification of the sample type, including, but not limited to whether the sample is a routine water distribution system sample, repeat sample, source or potable water sample, or other special purpose sample;
 - (c) date of analysis;

- (d) laboratory name and person responsible for performing analysis;
- (e) the analytical method used; and
- (f) the results of the analysis.

8.1.4 The registration holder shall immediately provide any records, reports or data required to be created under this Code of Practice to the Director or an inspector, upon request.

PART 9: CODE OF PRACTICE ADMINISTRATION

9.1.1 This Code of Practice will be reviewed as changes in technological or other standards warrant.

Schedule 1
Operations Program Contents

1. **Routine Operational Procedures, which shall, at a minimum, include:**
 - (a) contact name and telephone numbers for the system owner, system operator, engineering consultants and equipment suppliers;
 - (b) operating instructions
 - (i) general description of treatment process and operating procedures,
 - (ii) performance requirements, and
 - (iii) location of equipment major controls;
 - (c) general maintenance schedule;
 - (d) general maintenance instructions for
 - (i) treatment/process equipment
 - (ii) monitoring equipment, and
 - (iii) pumping equipment; and
 - (e) the schedule and procedures for cleaning and flushing of the entire water distribution system, including potable water storage reservoirs;
 - (f) written agreement between the approval or registration holder that operates the waterworks system supplying water to this waterworks system and the registration holder for this system, including:
 - (i) the minimum chlorine concentration the approval or registration holder supplying the water is obligated to deliver,
 - (ii) a list of all waterworks systems that receive water from this waterworks system, including contact names, telephone numbers, and fax numbers,
 - (iii) a list of all service connections off of any potable water transmission main included in this waterworks system, including contact names, telephone numbers, and fax numbers,

- (iv) the communication and notification protocol or process that is in place between the approval or registration holder supplying the water to this system and the registration holder for this waterworks system.
- 2. **Routine Operational Procedures for Monitoring and Analysis, which shall, at a minimum, include:**
 - (a) operational and compliance tests to be performed;
 - (b) bacteriological quality monitoring plan;
 - (c) methods used for monitoring and analysis;
 - (d) locations of monitoring points; and
 - (e) laboratory data quality assurance information.
- 3. **Emergency Response Plan, which shall, at a minimum, include steps to be taken in the event of the following:**
 - (a) bacteriological results exceeding the prescribed limits;
 - (b) low chlorine residual;
 - (c) equipment breakdown;
 - (d) flood and other natural disasters;
 - (e) water distribution system pipeline break and repair, and the return of the pipeline to service;
 - (f) power failure;
 - (g) the waterworks system becoming inoperable, including steps in providing an alternate potable water supply; and
 - (h) list of contacts – Alberta Environment and Water, Alberta Health, Regional Health Authorities, Fire Department, Disaster Coordinator, and other agencies.
- 4. **Date of last update**

**CODE OF PRACTICE FOR WATERWORKS SYSTEMS
USING HIGH QUALITY GROUNDWATER**

Effective June 1, 2012

Made under the *Environmental Protection and Enhancement Act, RSA 2000, cE-12*

TABLE OF CONTENTS

Part

- 1. Definitions**
- 2. General Provisions**
- 3. Administration, Design and Construction Requirements**
- 4. Operational Requirements**
- 5. Limits and Monitoring Requirements**
- 6. Wastewater Management**
- 7. Reclamation Requirements**
- 8. Reporting Requirements**
- 9. Record Keeping Requirements**
- 10. Code of Practice Administration**

Schedule 1 Operations Program Contents

PART 1: DEFINITIONS

- 1.1 All definitions in the Act and the regulations under the Act apply except where expressly defined in this Code of Practice.
- 1.2 In this Code of Practice:
- (a) “Act” means the *Environmental Protection and Enhancement Act*, R.S.A. 2000, c.E-12, as amended from time to time;
 - (b) “alternate program” means the Alternate Laboratory Data Quality Assurance Program, as detailed in the Department’s *Laboratory Data Quality Assurance Policy Procedures and Guidelines*;
 - (c) “approved laboratory” means laboratory accredited to the requirements of ISO/IEC 17025 - General requirements for the competence of testing and calibration laboratories, for the drinking water tests methods specified by the Director;
 - (d) “Certification Guidelines” means the *Water and Wastewater Operators’ Certification Guidelines*, published by the Department, as amended or replaced from time to time;
 - (e) “chlorine residual” means free chlorine, or combined chlorine or total chlorine;
 - (f) “contact time” for a process unit means T_{10} which is the time taken in minutes for 10% of the water to pass through that unit;
 - (g) “continuous” means flow measurement or sample analysis through in-line equipment that creates flow measurements or frequent, discrete sample analysis output;
 - (h) “CT” means disinfectant residual in mg/L multiplied by the contact time in minutes;
 - (i) “CT_{lowest actual}” means the lowest CT calculated in a particular day, calculated as follows:

$$CT_{\text{lowest actual}} = C \times \frac{T_{10}}{T} \times \frac{V_{\min}}{Q_{\text{peak}}}$$

where: C = lowest recorded daily disinfectant residual concentration (in milligrams per litre) at the point T_{10} is measured;

$$\frac{T_{10}}{T} = 0.1; \quad \text{OR}$$

varies based on the empirical method using typical baffling conditions as per Appendix D in the Standards and Guidelines Document;
OR

varies based on a tracer study, where

T_{10} = the contact time (in minutes) established from the most recent tracer study; and

T = the calculated contact time (in minutes), assuming no short-circuiting and obtained by dividing the treated water contact storage volume that was used to determine T_{10} , by the flow that was used to determine T_{10} ;

$V_{\min}$ = the daily minimum volume (in Litres) of treated water in the disinfection contact reservoir;

Q_{peak} = maximum recorded hourly flow (Litres per minute) or twice the daily average flow (Litres per minute)

- (j) “CT_{required}” means the CT required to demonstrate the specified log reduction of viruses as determined from the CT tables in Appendix B of the *Standards and Guidelines Document*;
- (k) “CT_{performance ratio}” means $CT_{\text{lowest actual}} / CT_{\text{required}}$;
- (l) “design capacity” means the production capacity for which the waterworks system was designed, as stated in the engineering drawings and specifications for the waterworks system, provided pursuant to section 3.1.3;
- (m) “disinfectant residual” means the concentration of free chlorine, chloramine, chlorine dioxide, or ozone used for disinfection;
- (n) “disinfection” means a chemical or physical process of treating water to inactivate microorganisms;
- (o) “Drinking Water Safety Plan”, (“DWSP”) means a comprehensive assessment of the risk factors that could adversely affect the quality of drinking water delivered to consumers;
- (p) “DWSP template” means the drinking water safety plan template published from time to time by Alberta Environment and Water on their website;
- (q) “four seasons” is comprised of “spring” - March to May, “summer” – June to August, “fall” – September to November, “winter” – December to February;
- (r) “GCDWQ” means the *Guidelines for Canadian Drinking Water Quality*, published by Health Canada, as amended or replaced from time to time;
- (s) “grab”, when referring to a sample, means an individual sample collected in less than 30 minutes and which is representative of the substance sampled;
- (t) “high quality groundwater” means groundwater that:
 - (i) does not require treatment to comply with the applicable physical, chemical, and radiological MAC, except for fluoride, specified in the

- GCDWQ, for the parameters listed in the Standards and Guidelines Document,
- (ii) contains a concentration of naturally occurring fluoride of less than or equal to 2.4 mg/L, and
 - (iii) is not under the direct influence of surface water;
- (u) “ISO / IEC” means the International Organization for Standardization / the International Electrotechnical Commission;
 - (v) “log reduction” means the base 10 logarithm of the ratio of raw water concentrations divided by the treated water concentration of total viruses;
 - (w) “MAC” means the Maximum Acceptable Concentration, specified in the GCDWQ for a particular parameter;
 - (x) “professional engineer” means a professional engineer or registered professional technologist (engineering) under the *Engineering, Geological and Geophysical Professions Act*;
 - (y) “regulations” means the regulations under the Act;
 - (z) “running annual average” means the arithmetic average of the concentrations of all the most recent samples taken covering a 365 day period;
 - (aa) “source sanitary survey” means a review of the water source for the purpose of evaluating the adequacy of the condition of the physical components and protection from contamination indicating the vulnerability for degradation of the source water quality;
 - (bb) “Standards and Guidelines Document” means the *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems*, published by the Department, as amended or replaced from time to time;
 - (cc) “this Code of Practice” means the *Code of Practice for Waterworks Systems Using High Quality Groundwater*, published by the Department, as amended or replaced from time to time; and

- (dd) “weekday” means Monday, Tuesday, Wednesday, Thursday, or Friday.

PART 2: GENERAL PROVISIONS

Section 2.1: General

- 2.1.1 Any person who constructs, operates or reclaims a waterworks system that uses high quality groundwater must do so in accordance with this Code of Practice.
- 2.1.2 Any conflict between the registration application and the terms and conditions of this Code of Practice shall be resolved in favour of this Code of Practice.
- 2.1.3 The terms and conditions of this Code of Practice do not affect any rights or obligations created under any other authorization issued by the Department.
- 2.1.4 The terms and conditions of this Code of Practice are severable. If any term or condition of this Code of Practice or the application of any term or condition is held invalid, the application of such term or condition to other circumstances and to the remainder of this Code of Practice shall not be affected by that invalidity.
- 2.1.5 If the registration holder monitors for any substances or parameters which are the subject of limits in this Code of Practice more frequently than is required, using procedures authorized in this Code of Practice, then the registration holder shall provide the results of such monitoring as an addendum to the reports required by this Code of Practice.

Section 2.2: Analytical Requirements

- 2.2.1 With respect to any monitoring required pursuant to this Code of Practice, all samples shall be:
- (a) collected;
 - (b) preserved;
 - (c) stored;

- (d) handled; and
 - (e) analyzed in accordance with:
 - (i) the *Standard Methods for the Examination of Water and Wastewater*, published by the American Public Health Association, the American Waterworks Association and the Water Environment Federation, as amended or replaced from time to time; or
 - (ii) a method authorized in writing by the Director.
- 2.2.2 Any analysis of a sample required pursuant to this Code of Practice, shall be done only in an approved laboratory, or in accordance with the Department's alternate program.
- 2.2.3 Notwithstanding the generality of 2.2.2, any analysis of a sample of treated water for bacteriological quality required pursuant to this Code of Practice shall be conducted only by the Provincial Laboratory for Public Health (ProvLab), unless otherwise specified in writing by the Director.

PART 3: ADMINISTRATION, DESIGN AND CONSTRUCTION REQUIREMENTS

Operations Program

- 3.1.1 If the waterworks system was not previously registered, no person shall apply for a registration unless that person has prepared or caused to be prepared a written operations program governing the operation of the waterworks system.
- 3.1.1.1 A registration holder shall have a written operations program governing the operation of the waterworks system completed by:
- (a) the requirements of 3.1.1, or
 - (b) the date specified in a notice issued pursuant to S.8.1(4) of the *Environmental Protection and Enhancement (Miscellaneous) Regulation*, AR 118/93.
- 3.1.2 The operations program in section 3.1.1.1 shall contain, at a minimum, all of the information in Schedule 1.

- 3.1.3 In addition to the information required in the Act and the regulations, an application for a registration shall contain, at a minimum, the following information:
- (a) analytical results for groundwater intended to be the potable water source;
 - (b) written confirmation that the person applying for the registration has prepared, or caused to be prepared an operations program;
 - (c) engineering drawings signed and stamped by a professional engineer for the proposed waterworks system or proposed changes to the waterworks system, including the design capacity of the proposed waterworks system or proposed change;
 - (d) a statement, signed and stamped by a professional engineer, indicating whether the design of the project complies with all the design requirements of:
 - (i) this Code of Practice, and
 - (ii) the regulations under the Act, and
 - (e) in cases in which a design requirement in section 3.1.3 (d) is not met, a statement, signed and stamped by a professional engineer, identifying and justifying the deviation.
- 3.1.4 No person shall install any water treatment equipment that was not included in the registration application unless the Director has been advised in writing in advance of the intention to install and operate that water treatment equipment.
- 3.1.4.1 No person shall remove any water treatment equipment that was included in the registration application unless the Director has been advised in writing in advance of the intention to remove that water treatment equipment.
- 3.1.5 Repealed

3.1.5.1 The registration holder shall complete a drinking water safety plan of the waterworks system:

- (a) on or before December 31, 2013 for registrations issued on or after June 1, 2012; or
- (b) by December 31, 2013 for registrations in existence on June 1, 2012.

3.1.5.2 The drinking water safety plan in 3.1.5.1 shall:

- (a) identify potential risks to the waterworks systems including without limiting the generality of the foregoing:
 - (i) risks associated with the source of the raw water;
 - (ii) risks associated with the treatment processes associated with the water treatment works;
 - (iii) risks associated with the distribution of treated water within the distribution system;
 - (iv) risks associated with the consumer's premises located on the waterworks system; and
- (b) prescribe appropriate measures to control and/or reduce such risks to the waterworks system;

in accordance with the requirements in the Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems; Part 1 Standards for Municipal Waterworks (2012).

3.1.5.3 The drinking water safety plan in 3.1.5.1 shall utilise the drinking water safety plan template located at <http://www.environment.alberta.ca/apps/regulateddwq/dwsp.aspx> unless otherwise agreed to in writing by the Director.

3.1.5.4 The registration holder shall

- (a) maintain, and
- (b) update the drinking water safety plan.

3.1.6 Repealed

PART 4: OPERATIONAL REQUIREMENTS

4.1.1 The registration holder shall:

- (a) operate, and
- (b) maintain

the waterworks system at all times within its design capacity.

4.1.2 Repealed.

4.1.2.1 The registration holder shall maintain positive pressure at all points throughout the distribution system where water is being supplied.

4.1.3 Repealed

Certified Operator

4.1.4 At all times, the operation of the waterworks system shall be performed by, or under the direction of, a person who holds a valid certificate of qualification at the applicable level as set out in Table 4-1.

4.1.5 At all times, the number of certified operators available to perform or direct the operation of the waterworks system must meet or exceed the applicable numbers in Table 4-1.

4.1.6 The registration holder shall obtain a statement of the facility's classification for Water Treatment (WT) from Alberta Environment and Water prior to providing water treatment.

**TABLE 4-1: MINIMUM WATERWORKS SYSTEM OPERATOR
CERTIFICATE OF QUALIFICATION REQUIREMENTS**

Population Served by Waterworks System	Type of Treatment in the Waterworks System	Minimum Number and Minimum Qualifications of Water Treatment Certified Operator(s)	Minimum Number and Minimum Qualifications of Water Distribution Certified Operator(s)
< 500	Class I WT facility or system without treatment	One operator with a Small Water Systems Certificate	
500 – 1,500	System providing ONLY chlorine residual within the distribution system	N/A	One operator with a Level I Water Distribution (WD) Certificate
	System providing virus disinfection or other treatment	One operator with a Water Treatment (WT) Certificate at the Level of the facility classification for water treatment	
1,501 – 15,000	System providing ONLY chlorine residual within the distribution system	N/A	One operator with a Level II Water Distribution (WD) Certificate
	System providing virus disinfection or other treatment	One operator with a Water Treatment (WT) Certificate at the Level of the facility classification for water treatment	One operator with a Level II Water Distribution (WD) Certificate
15,001 – 50,000	System providing ONLY chlorine residual within the distribution system	N/A	One operator with a Level III Water Distribution (WD) Certificate
	System providing virus disinfection or other treatment	One operator with a Water Treatment (WT) Certificate at the Level of the facility classification for water treatment	and One operator with a Level II Water Distribution (WD) Certificate

TABLE 4-1 (continued)

Population Served by Waterworks System	Type of Treatment in the Waterworks System	Minimum Number and Minimum Qualifications of Water Treatment Certified Operator(s)	Minimum Number and Minimum Qualifications of Water Distribution Certified Operator(s)
50,001 and over	System providing ONLY chlorine residual within the distribution system	N/A	One operator with a Level IV Water Distribution (WD) Certificate
50,001 and over (continued)	System providing virus disinfection or other treatment	One operator with a Water Treatment (WT) Certificate at the Level of the facility classification for water treatment	Two operators with a Level III Water Distribution (WD) Certificate and One operator with a Level II Water Distribution (WD) Certificate

PART 5: LIMITS AND MONITORING REQUIREMENTS

5.1.1 The quality of potable water distributed by the registration holder must comply with the limits in Table 5-1

- (a) at all locations specified in Table 5-2, and
- (b) at all times the registration holder is treating and distributing water.

TABLE 5-1: POTABLE WATER QUALITY LIMITS

Parameter	Limit (Maximum unless otherwise specified)
CT _{required} , subject to sections 5.1.3.3 and 5.1.3.4 of this Code of Practice	For systems with continuous monitoring of disinfectant residual, the CT value for 4-log inactivation of viruses specified in the CT Table for the disinfectant used, in Appendix B of the Standards and Guidelines Document, or
	For systems with grab sampling of disinfectant residual, 1.25 times the CT value for 4-log inactivation of viruses specified in the CT Table for the disinfectant used, in Appendix B of the Standards and Guidelines Document.
CT _{performance ratio} , subject to sections 5.1.3.3 and 5.1.3.4 of this Code of Practice	Greater than 1
Bacteriological quality	Zero <i>E. coli</i> organisms per 100 mL Zero Total coliform organisms per 100 mL
The physical, inorganic and organic chemical and pesticide parameters listed in the Compliance Monitoring section of the Standards and Guidelines Document, except fluoride	Applicable MAC, as per the <i>Potable Water Regulation</i> , based on the running annual average.
Disinfectant residual, subject to sections 5.1.3.3 and 5.1.3.4 of this Code of Practice	Greater than or equal to 0.2 mg/L if free chlorine or chloramine is used for disinfection.
Chlorine residual in the distribution system	Greater than or equal to 0.1 mg/L, based on at least 75% of the samples taken on a particular day.
Fluoride - if naturally occurring	Less than or equal to 2.4 mg/L, based on a running annual average.
Fluoride - if fluoridation is practiced	The optimum concentration specified in GCDWQ with daily variation of +/- 0.1 mg/L and monthly average variation of +/- 0.2 mg/L

5.1.2 Repealed

- 5.1.3 If any bacteriological quality sample contains *E. coli* or Total coliform, in addition to any reporting or other requirements pursuant to the Act, the regulations, or this Code of Practice, the registration holder shall carry out the corrective actions set out in the *Communication and Action Protocol for Failed Bacteriological Results in Drinking Water for Waterworks*

Systems Authorized under the Environmental Protection and Enhancement Act, entered into by Alberta Environment and Water, the Provincial Laboratory for Public Health, and Alberta Health and Wellness, Alberta Health Services, and Health Canada, as amended or replaced from time to time.

- 5.1.3.1 If the first sample result of a chlorine residual sampling event pursuant to 5.1.6 does not meet the chlorine residual limit in Table 5-1, the registration holder shall:
- (a) flush the distribution line in the vicinity of the sample;
 - (b) resample and analyze the chlorine residual at the same location as the first sample, and
 - (c) resample and analyze the chlorine residual from
 - (i) a service connection upstream from the location of the first sample, and
 - (ii) a service connection downstream from the location of the first sample.
- 5.1.3.2 In the event that the chlorine residual in any of the sample results in section 5.1.3.1(b) or 5.1.3.1(c) is less than 0.1 mg/L chlorine, the registration holder shall immediately report the incident to the Director by telephone at 1-800-222-6514.
- 5.1.3.3 If a system is registered under the Act at the time this subsection comes into force, the requirements with respect to disinfection CT in Table 5-1 and Table 5-2 do not apply until the virus disinfection standard is applied in accordance with the *Potable Water Regulation*.
- 5.1.3.4 If the Director has exempted the registration holder from 4-log virus reduction performance monitoring, by notice in writing, the requirements with respect to disinfection CT in Table 5-1 and Table 5-2 do not apply.
- 5.1.3.5 If the Director has exempted the registration holder from 4-log virus reduction performance monitoring by notice in writing, the registration holder shall:
- (a) undertake a source sanitary survey of the waterworks system at least once every five years; and

- (b) submit the source sanitary survey to the Director prior to the 5th anniversary of the previous source sanitary survey.
- 5.1.3.6 If iron reduction is practiced and the iron concentration in the water entering the distribution, based on the weekly average of all the results taken, is greater than 0.3 mg/L the registration holder shall:
- 5.1.3.7
 - (a) notify the Director at 1-800-222-6514; and
 - (b) take the corrective action required to reduce the iron concentrations to less than 0.3 mg/L for the next monitoring period.
- 5.1.3.8 If manganese reduction is practiced and the manganese concentration in the water entering the distribution system, based on a weekly average of all the results taken, is greater than 0.08 mg/L the registration holder shall:
 - (a) notify the Director at 1-800-222-6514; and
 - (b) take the corrective action required to reduce the manganese concentrations to less than 0.08 mg/L for the next monitoring period.
- 5.1.3.9 If the concentration of a parameter where treatment is provided to reduce the concentration for aesthetic purposes is greater than the aesthetic objective specified in the GCDWQ, based on the weekly average of all samples taken, the registration holder shall:
 - (a) notify the Director at 1-800-222-6514; and
 - (b) take the corrective action required to reduce the parameter concentration to less than the aesthetic objective for the next monitoring period.

Raw Water Monitoring

- 5.1.4 If a waterworks system practices fluoridation, the registration holder shall monitor raw water for fluoride concentration in the following manner:
- (a) at least once per week; and
 - (b) at a location in the waterworks system prior to the addition of fluoride.
- 5.1.5 If the waterworks system has treatment to reduce iron or manganese, the registration holder shall monitor raw water for iron or manganese as applicable:
- (a) at least once per week; and
 - (b) at a location in the waterworks system prior to any chemical addition or treatment unit.
- 5.1.5.1 If the waterworks system has treatment for an aesthetic parameter listed in the GCDWQ, the registration holder shall monitor raw water for the concentration of that parameter:
- (a) at least once per week; and
 - (b) at a location in the waterworks system prior to any chemical addition or treatment unit.

Potable Water Monitoring

- 5.1.6 The registration holder shall monitor the potable water in the waterworks system in accordance with Table 5-2, unless otherwise specified in writing by the Director.

TABLE 5-2: POTABLE WATER MONITORING LOCATION AND FREQUENCY

Parameter	Type of System	Sample Type	Monitoring Location	Minimum Monitoring Frequency and Minimum Number of Samples
Bacteriological	All systems	Grab	At random location(s) within the water distribution system	The frequency and number of samples as set out in the GCDWQ, without any reduction
Volume for CT calculation, subject to sections 5.1.3.3 and 5.1.3.4	All systems	(a) Calculated, based on continuous depth monitoring or	Clearwell reservoir	(a) One depth measurement every hour, recording all results and reporting the minimum volume for each day, or
		(b) Calculated, based on controlled minimum water volume		(b) Calculated and reported when setting or changing minimum volume control point.
Disinfectant residual (C) for CT calculation, subject to sections 5.1.3.3 and 5.1.3.4	All systems	(a) or (b) (a) Grab or	Prior to entering the distribution system, at the point where the CT is measured	(a) or (b) (a) One sample per day, five days per week; if a statutory holiday falls on a weekday within that week, the sample is not required on that day, and the frequency may be reduced by one day for each statutory holiday, or
		(b) Continuous		(b) One sample, every five minutes, recording all results and reporting the minimum value for each day.

TABLE 5-2 (continued)

Parameter	Type of System	Sample Type	Monitoring Location	Minimum Monitoring Frequency and Minimum Number of Samples
CT _{lowest actual} subject to sections 5.1.3.3 and 5.1.3.4	Systems without continuous disinfection residual monitoring	Calculated	Prior to entering the distribution system, at the point where the CT is measured	(a) One calculation per day, five days per week; if a statutory holiday falls on a weekday within that week, the sample is not required on that day, and the frequency may be reduced by one day for each statutory holiday, or
	or Systems with continuous disinfection residual monitoring			(b) One calculation for each day and one calculation if: i) volume < minimum volume control point, or ii) Flow > flow control point setting.
CT _{required} subject to sections 5.1.3.3 and 5.1.3.4	All systems	Calculated	N/A	One calculation per month.
CT _{performance ratio} subject to sections 5.1.3.3 and 5.1.3.4	Systems without continuous disinfection residual monitoring or	Calculated	Prior to entering the distribution system, at the point where the CT is measured	(a) One sample per day, five days per week; if a statutory holiday falls on a weekday within that week, the sample is not required on that day, and the frequency may be reduced by one day for each statutory holiday, or

TABLE 5-2 (continued)

Parameter	Type of System	Sample Type	Monitoring Location	Minimum Monitoring Frequency and Minimum Number of Samples
CT performance ratio, subject to sections 5.1.3.3 and 5.1.3.4 (continued)	Systems with continuous disinfection residual monitoring			(b) One calculation for each day and one calculation if: i) volume < minimum volume control point, or ii) Flow > flow control point setting.
Flow (Q_{peak}), for CT calculation, subject to sections 5.1.3.3 and 5.1.3.4	All systems	Continuous	Prior to entering the distribution system, at the point where the CT is measured	(a) One sample, every five minutes, recording all results and reporting the maximum value for each day, or
		or Calculated, based on controlled maximum flow.		(b) Calculated and reported when setting or changing maximum flow control point.
Temperature, for CT calculation, subject to sections 5.1.3.3 and 5.1.3.4	All systems	Grab	Prior to entering the distribution system, at the point where the CT is measured	One sample per month.
Chlorine residual	All systems	(a) and either (b) or (c) (a) Grab, and	(a) and either (b) or (c) (a) At the same location as the bacteriological quality sample is collected and	(a) and either (b) or (c) (a) One sample, taken at the same time as the bacteriological quality sample is collected and

TABLE 5-2 (continued)

Parameter	Type of System	Sample Type	Monitoring Location	Minimum Monitoring Frequency and Minimum Number of Samples
Chlorine residual (continued)		(b) Grab	(b) At random location(s) within the water distribution system,	(b) One sample per day, five days per week; if a statutory holiday falls on a weekday within that week, the sample is not required on that day, and the frequency may be reduced by one day for each statutory holiday
		or (c) Continuous	or (c) at the point of entry into the water distribution system	or (c) One sample, every five minutes, recording all results and reporting the minimum value for each day
The physical, organic and inorganic chemical and pesticide parameters listed in the Compliance Monitoring section of the Standards and Guidelines Document, except UV absorbance, trihalomethanes and chloramines	Single well system	Grab	After treatment within the water distribution system	One sample per year. Despite this requirement, if the results of the most recent samples indicate that the applicable MAC has been complied with, the (a) physical and inorganic chemical parameters shall be sampled once every three years, and (b) organic chemical and pesticide parameters shall be sampled once every five years.

TABLE 5-2 (continued)

Parameter	Type of System	Sample Type	Monitoring Location	Minimum Monitoring Frequency and Minimum Number of Samples
The physical, organic and inorganic chemical and pesticide parameters listed in the Compliance Monitoring section of the Standards and Guidelines Document, except UV absorbance, trihalomethanes and chloramines (continued)	Multiple well fields within a single system, in which water is blended prior to entry into the water distribution system	Grab	After treatment within the water distribution system, at a location where the water from all well fields has been blended	One sample per year. Despite this requirement, if the results of the most recent samples indicate that the applicable MAC has been complied with, the (a) physical and inorganic chemical parameters shall be sampled once every three years, and (b) organic chemical and pesticide parameters shall be sampled once every five years.
	Multiple well fields within a single system in which water is not blended prior to entry into the water distribution system	Grab	At the chosen well(s), after treatment, at the point of entry into the water distribution system	At least one well monitored each year, rotated so that all wells have been monitored within the previous 3 years. Despite this requirement, if the results of the most recent samples indicate that the applicable MAC has been complied with, the (a) physical and inorganic chemical parameters shall be sampled once every three years, and (b) organic chemical and pesticide parameters shall be sampled once every five years.

TABLE 5-2 (continued)

Parameter	Type of System	Sample Type	Monitoring Location	Minimum Monitoring Frequency and Minimum Number of Samples
All aesthetic parameters for which treatment is provided, except iron and manganese	All systems practicing treatment for aesthetic parameters other than iron and manganese	(a) or (b) (a) Grab	After treatment, prior to entering the distribution system	(a) or (b) (a) One sample per week
		or (b) Continuous		or (b) One sample, every five minutes, recording all results and reporting the maximum value for each week
Iron	All systems practicing iron reduction	(a) or (b) (a) Grab	After treatment, prior to entering the distribution system	(a) or (b) (a) One sample per day, five days per week; if a statutory holiday falls on a monitoring day within that week, monitoring is not required on that day
		or (b) Continuous		or (b) One sample, every five minutes, recording all results and reporting the maximum value for each day
Manganese	All systems practicing manganese reduction	(a) or (b) (a) Grab or	After treatment, prior to entering the distribution system	(a) or (b) (a) One sample per day, five days per week; if a statutory holiday falls on a monitoring day within that week, monitoring is not required on that day, or

TABLE 5-2 (continued)

Parameter	Type of System	Sample Type	Monitoring Location	Minimum Monitoring Frequency and Minimum Number of Samples
Manganese (continued)		(b) Continuous		(b) One sample, every five minutes, recording all results and reporting the maximum value for each day
Fluoride	All systems practicing fluoridation	(a) or (b) (a) Grab	Prior to entering the distribution system	(a) or (b) (a) One sample per day, seven days per week
		or (b) Continuous		or (b) One sample, every five minutes

5.1.7 In the event of a repair within the water distribution system, in addition to the monitoring required in section 5.1.6, the registration holder shall monitor for:

- (a) bacteriological quality, and
- (b) chlorine residual by grab sample immediately after each repair, and at sampling points:
 - i. closest to the location of the repair; and
 - ii. on each side of the location of the repair.

Trihalomethanes

5.1.8 Repealed

5.1.8.1 In addition to any other monitoring requirements pursuant to this Code of Practice, the Act or the regulations, trihalomethanes shall be monitored in the waterworks system in the following manner:

- (a) for systems where the total organic carbon concentration in the raw water is less than 2 mg/L and:

- (i) the trihalomethane concentrations in any sample are greater than the applicable MAC, or no analytical results are available:
 - (A) the registration holder shall take two grab samples per year, one sample taken during the summer and one sample taken during the winter;
 - (B) the registration holder shall take all samples at a location furthest from the point at which the water enters the distribution system; or
 - (ii) the trihalomethane concentrations in all samples in the previous sampling event are less than the applicable MAC:
 - (A) the registration holder shall take two grab samples every three years, one sample taken during the summer and one sample taken during the winter;
 - (B) the registration holder shall take all samples at a location furthest from the point at which the water enters the distribution system; or
- (b) for systems where the total organic carbon concentration in the raw water is greater than 2 mg/L and:
- (i) the trihalomethane concentrations in any sample are greater than the applicable MAC, or no analytical results are available:
 - (A) the registration holder shall take four grab samples per year, one sample taken during each of the four seasons;
 - (B) the registration holder shall take all samples at a location furthest from the point at which the water enters the distribution system; and
 - (C) there shall be a minimum of two months between samples; or

- (ii) the trihalomethane concentrations in all samples in the previous sampling event are less than the applicable MAC:
 - (A) the registration holder shall take four grab samples every three years, one sample taken during each of the four seasons;
 - (B) the registration holder shall take all samples at a location furthest from the point at which the water enters the distribution system; and
 - (C) there shall be a minimum of two months between samples.

5.1.9 to 5.1.11 Repealed

Additional Measurements

5.1.12 Repealed

5.1.12.1 The registration holder shall measure the total water volume entering the distribution system as required to fulfil the requirements of 5.1.14 and the total water volume entering the distribution system shall be computed a minimum of once per month.

5.1.13 If the waterworks system practices fluoridation, the registration holder shall measure the following on a daily basis:

- (a) the total daily volume of water to which fluoride is added; and
- (b) the total daily weight of fluoride added to the water;

5.1.14 If the registration holder adds any treatment chemical to the waterworks system, the dosage of each chemical, other than fluoride shall:

- (a) be calculated in milligrams of chemical per litre of water (mg/L) by measuring the amount of chemical added in a period not exceeding seven (7) calendar days divided by the total volume of water to which the chemical was added in that time period; and

- (b) not exceed the dosage specified as Maximum Use in *Standard 60*, published by the National Sanitation Foundation and the American National Standards Institute (NSF/ANSI), as amended or replaced from time to time, unless otherwise authorized in writing by the Director.

PART 6: WASTEWATER MANAGEMENT

- 6.1.1 The registration holder shall dispose of wastewater only:
 - (a) to a wastewater collection system, that is part of a wastewater system that is the subject of a valid approval, registration or permit, as applicable, or
 - (b) as otherwise authorized in writing by the Director.

PART 7: RECLAMATION REQUIREMENTS

- 7.1.1 Where the land surface has been disturbed during construction, expansion, modification or repair of any portion of a waterworks system, reclamation of the land surface to equivalent land capability shall be performed following the construction, expansion, modification or repair, in accordance with the Standards and Guidelines Document.
- 7.1.2 Within six months after the waterworks system, or a portion of the waterworks system, permanently ceases operation, the registration holder shall submit a reclamation plan to the Director for the portion of the system that is no longer in operation.
- 7.1.3 No person shall commence reclamation of the waterworks system until that person has received written authorization from the Director for the reclamation.
- 7.1.4 Any person conducting reclamation of the waterworks system shall comply with the reclamation plan, as authorized in writing by the Director.

PART 8: REPORTING REQUIREMENTS

Contravention Reporting

8.1.1 In addition to any other reporting required pursuant to this Code of Practice, the Act, or the regulations, the registration holder shall immediately report to the Director any contravention of this Code of Practice, either:

- (a) by telephone at 1-800-222-6514; or
- (b) by a method:
 - (i) in compliance with the release reporting provisions in the Act and the regulations, or
 - (ii) authorized in writing by the Director.

8.1.2 In addition to any other reporting required pursuant to this Code of Practice, the Act, or the regulations, the registration holder shall immediately report to the Director by a method under section 8.1.1, any structural or equipment malfunction in the waterworks system that may affect the quality or supply of potable water.

8.1.3 In addition to the immediate report in section 8.1.1, the registration holder shall provide a report to the Director:

- (a) in writing; or
- (b) by a method:
 - (i) in compliance with the release reporting provisions in the Act and the regulations, or
 - (ii) authorized in writing by the Director

within seven (7) calendar days after the discovery of the contravention, or within another time period specified in writing by the Director, unless the requirement for the report is waived by the Director.

8.1.4 The report required under section 8.1.3 shall contain, at a minimum, the following information:

- (a) a description of the contravention;
- (b) the date of the contravention;

- (c) the duration of the contravention;
- (d) the legal land description of the location of the contravention;
- (e) an explanation as to why the contravention occurred;
- (f) a summary of all preventive measures and actions that were taken prior to the contravention;
- (g) a summary of all measures and actions that were taken to mitigate any effects of the contravention;
- (h) a summary of all measures that will be taken to address any remaining effects and potential effects related to the contravention;
- (i) the number of the registration issued under the Act for the waterworks system, and the name of the person who held the registration at the time the contravention occurred;
- (j) the name, address, phone number and responsibilities of all persons operating the waterworks system at the time the contravention occurred;
- (k) the name, address, phone number and responsibilities of all persons who had charge, management or control of the waterworks system at the time that the contravention occurred;
- (l) a summary of proposed measures that will prevent future contraventions, including a schedule of implementation for these measures;
- (m) any information that was maintained or recorded under this Code of Practice, as a result of the incident; and
- (n) any other information required by the Director in writing.

Monthly Reporting

- 8.1.5 The registration holder shall compile and retain monthly reports.
- 8.1.6 The monthly report in section 8.1.5 shall include, at a minimum:
- (a) the name, telephone and fax numbers of all certified operators;
 - (b) the analytical results for all parameters required to be monitored in accordance with this Code of Practice during the month;
 - (c) the locations of all sampling performed during the month in accordance with this Code of Practice;
 - (d) the name and manufacturer and batch number(s) of all treatment chemicals added during the month, and each manufacturer as listed in the *Standard 60*, published by the American National Standards Institute and the National Sanitation Foundation (ANSI/NSF), as amended or replaced from time to time; and
 - (e) the results of all required measurements conducted during the month in accordance with this Code of Practice.

Annual Reporting

- 8.1.7 In addition to any other reporting required under the Act, the regulations and this Code of Practice, the registration holder shall compile an annual report, by February 28 of the year following the calendar year in which the information on which the report is based was collected.
- 8.1.7.1 Until a notice under section 8.1.9 is issued by the Director, the registration holder shall submit to the Director the annual report in section 8.1.7, by February 28 of the year following the calendar year in which the information on which the report is based was collected.
- 8.1.8 The annual report in section 8.1.7 shall contain, at a minimum, all of the following information:

- (a) a summary of the monthly reports, specifying the monthly minimum, average, and maximum results for each parameter monitored, excluding bacteriological results, for each month;
- (b) a summary of the number, results, and sampling dates of the bacteriological samples analyzed for each month;
- (c) the results of any other compliance monitoring done during the year pursuant to this Code of Practice that was not included in any monthly report; and
- (d) a description of any problems experienced and corrective actions taken at the waterworks system during the year with respect to environmental matters.

Electronic Reporting

8.1.9 The Director may, by notice in writing, require the registration holder to submit periodic reports:

- (a) in an electronic format; and
- (b) at a different frequency than specified in sections 8.1.5 and 8.1.7.1 of this Code of Practice.

8.1.10 The registration holder who receives a notice as specified in section 8.1.9 shall comply with the notice.

PART 9: RECORD KEEPING REQUIREMENTS

9.1.1 The registration holder shall

- (a) record the following information, and
- (b) maintain and retain the following records for five (5) years from the date the record was created:
 - (i) bacteriological analysis results;
 - (ii) daily records, including but not limited to:
 - (A) flow meter readings,
 - (B) chlorine concentrations,
 - (C) treatment chemical dosages,
 - (D) iron and manganese concentrations, and

- (E) all fluoridation information required under this Code of Practice;
- (iii) all monthly reports required under this Code of Practice; and
- (iv) records of action taken by the registration holder to correct contraventions of potable water quality limits (MAC), including the following information for each contravention:
 - (A) name and address of the person who discovered the contravention, and
 - (B) copies of all notifications to the public.

9.1.2 The registration holder shall maintain the following records for the life of the waterworks system:

- (a) the operations program;
- (b) copies of all:
 - (i) applications submitted to the Department for a registration regarding the waterworks system and correspondence related to the registration,
 - (ii) engineering drawings and specifications,
 - (iii) project reports,
 - (iv) construction documents,
 - (v) record drawings,
 - (vi) all reports of inspections conducted by the Department,
 - (vii) all correspondence sent to the Department regarding a proposed extension of a water distribution system, replacement of a portion of a water distribution system, expansion or modification of potable water storage within the water distribution system,
 - (viii) all registrations issued under the Act for the waterworks system,

- (ix) all annual reports, and
 - (x) all reports prepared pursuant to sections 8.1.3 and 8.1.4, and
 - (c) all physical, organic and inorganic chemical and pesticide analytical results required pursuant to this Code of Practice, excluding daily monitoring.
- 9.1.3 The results and records in sections 9.1.1(b) and 9.1.2(c) shall contain, at a minimum, all of the following information:
- (a) the date, location and time of monitoring, and the name of the person collecting the sample;
 - (b) identification of the sample type, including, but not limited to whether the sample is a routine water distribution system sample, repeat sample, source or potable water sample, or other special purpose sample;
 - (c) date of analysis;
 - (d) laboratory name and person responsible for performing analysis;
 - (e) the analytical method used; and
 - (f) the results of the analysis.
- 9.1.4 The registration holder shall immediately provide any records, reports or data required to be created under this Code of Practice to the Director or an inspector, upon request.

PART 10: CODE OF PRACTICE ADMINISTRATION

- 10.1.1 This Code of Practice will be reviewed as changes in technological or other standards warrant.

Schedule 1
Operations Program Contents

1. **Routine Operational Procedures, which shall, at a minimum, include:**
 - (a) contact name and telephone numbers for the system owner, system operator, engineering consultants and equipment suppliers;
 - (b) operating instructions:
 - (i) general description of treatment process and operating procedures,
 - (ii) performance requirements, and
 - (iii) location of equipment major controls;
 - (c) general maintenance schedule;
 - (d) general maintenance instructions for:
 - (i) treatment/process equipment,
 - (ii) monitoring equipment, and
 - (iii) pumping equipment; and
 - (e) the schedule and procedures for cleaning and flushing of the entire water distribution system, including potable water storage reservoirs.
2. **Routine Operational Procedures for Monitoring and Analysis, which shall, at a minimum, include:**
 - (a) operational and compliance tests to be performed;
 - (b) bacteriological quality monitoring plan;
 - (c) methods used for monitoring and analysis;
 - (d) locations of monitoring points; and
 - (e) laboratory data quality assurance information.
3. **Emergency Response Plan, which shall, at a minimum, include steps to be taken in the event of the following:**
 - (a) bacteriological results exceeding the prescribed limits;

- (b) low chlorine residual;
 - (c) equipment breakdown;
 - (d) flood and other natural disasters;
 - (e) water distribution system pipeline break and repair, and the return of the pipeline to service;
 - (f) power failure;
 - (g) the waterworks system becoming inoperable, including steps in providing an alternate potable water supply.; and
 - (h) list of contacts – Alberta Environment and Water, Alberta Health, Regional Health Authorities, Fire Department, Disaster Coordinator, and other agencies.
4. **Date of last update.**

**STANDARDS AND GUIDELINES FOR MUNICIPAL WATERWORKS,
WASTEWATER AND STORM DRAINAGE SYSTEMS**

Part 1 Standards for Municipal Waterworks
of a Total of 5 Parts

April 2012

Part 1 STANDARDS FOR MUNICIPAL WATERWORKS
April 2012

TABLE OF CONTENTS

FOREWORD to Part 1 - Standards for Municipal Waterworks (2012)	v
DEFINITIONS / ABBREVIATIONS	viii
1.0 Waterworks Systems Standards	1-1
1.1 Potable Water Quality Standards	1-1
1.2 Potable Water Treatment Standards	1-1
1.2.1 Surface Water and GWUDI	1-1
1.2.1.1 Filtration and Disinfection Requirement	1-1
1.2.1.2 Filtration Exemption	1-2
1.2.1.3 Source Water Monitoring Requirements for Filtered Systems	1-2
1.2.1.4 Criteria to Determine GWUDI	1-3
1.2.2 Groundwater	1-3
1.3 Potable Water Treatment Performance Standards	1-4
1.3.1 Filtration	1-4
1.3.1.1 Rapid Sand Filtration	1-4
1.3.1.2 Slow Sand Filtration	1-4
1.3.1.3 Membrane Filtration	1-5
1.3.1.4 Cartridge Filtration	1-5
1.3.2 Disinfection	1-6
1.3.2.1 Chlorine (Free and Combined)	1-6
1.3.2.2 Ultraviolet Light	1-7
1.3.2.3 Chlorine Dioxide	1-8
1.3.2.4 Ozone	1-8
1.3.3 Fluoridation	1-9
1.4 Potable Water Treatment Credits	1-9
1.4.1 Filtration Credit	1-9
1.4.1.1 System Non-compliance with Respect to Turbidity Reduction	1-10
1.4.2 Disinfection Credit	1-10
1.4.3 Other Options Credit	1-10
1.5 Potable Water Treatment Facility Design Standards	1-11
1.5.1 Surface Water and GWUDI	1-11
1.5.1.1 Rapid Sand Filtration	1-11
1.5.1.2 Slow Sand Filtration	1-13
1.5.1.3 Membrane Filtration	1-14
1.5.1.4 Cartridge Filtration	1-20
1.5.2 Groundwater	1-21
1.5.3 Disinfection	1-21
1.5.3.1 Chlorine / Chloramines	1-21
1.5.3.2 Ultraviolet Light	1-29
1.5.3.3 Chlorine Dioxide	1-32

1.5.3.4	Ozone.....	1-33
1.5.4	Fluoridation.....	1-33
1.5.4.1	General Requirements	1-33
1.5.4.2	Chemical Feed	1-34
1.5.4.3	Metering	1-35
1.5.4.4	Alternate Compounds.....	1-35
1.5.4.5	Chemical Storage and Ventilation	1-35
1.5.4.6	Record of Performance Monitoring	1-35
1.5.4.7	Sampling	1-36
1.5.4.8	Safety	1-36
1.5.4.9	Repair and Maintenance	1-36
1.5.5	Health and Safety Act.....	1-37
1.6	Waterworks Systems Operation Standards	1-37
1.6.1	System Operation Program	1-37
1.6.2	Reliability	1-37
1.6.3	Operations.....	1-38
1.7	Potable Water Treatment Chemical Standards.....	1-40
1.7.1	Use, Storage and Handling	1-40
1.7.2	Direct and Indirect Additives.....	1-40
1.7.2.1	Indirect Additives	1-40
1.7.2.2	Direct Additives	1-40
1.8	Potable Water Treatment Plant Waste—Handling and Disposal Standards	1-41
1.8.1	Sanitary Wastes	1-41
1.8.2	Filter Backwash	1-41
1.8.3	Filter-to-Waste	1-41
1.8.4	Sludges	1-41
1.8.4.1	Aluminum Sludge	1-41
1.8.4.2	Lime Sludge	1-42
1.8.4.3	Sludges from Other Coagulants	1-42
1.9	Potable Water Transmission and Distribution Main Standards	1-43
1.9.1	Pipe Performance Standards	1-43
1.9.2	Frost Protection for Mains and Reservoirs	1-43
1.9.2.1	Mains.....	1-43
1.9.2.2	Reservoirs	1-43
1.9.3	Cross-Connection Controls	1-43
1.9.3.1	Horizontal Separation of Water Mains and Sewers.....	1-43
1.9.3.2	Pipe Crossings	1-44
1.9.3.3	Valve, Air Relief, Meter and Blow-Off Chambers	1-44
1.9.3.4	Backflow Prevention and Control	1-44
1.9.4	Disinfection of Mains and Reservoirs	1-44
1.9.4.1	Mains.....	1-44
1.9.4.2	Reservoirs	1-45
1.9.4.3	Discharge of Superchlorinated Water	1-45
1.9.5	Layout.....	1-45
1.10	Potable Water Quality Performance Monitoring Standards.....	1-45
1.10.1	General.....	1-45

1.10.2	Analytical Requirements.....	1-46
1.10.3	Compliance Monitoring.....	1-46
1.10.3.1	Bacteriological.....	1-46
1.10.3.2	Physical Parameters, Organic & Inorganic Chemicals and Pesticides	1-47
1.10.3.3	Turbidity.....	1-49
1.10.3.4	Fluoride	1-49
1.10.3.5	Iron and Manganese	1-50
1.10.3.6	Trihalomethanes and Bromodichloromethane	1-50
1.10.3.7	Disinfection.....	1-53
1.10.4	Issue Oriented and Follow-up Monitoring.....	1-57
1.10.4.1	General.....	1-57
1.10.4.2	Bacteriological.....	1-57
1.10.4.3	Disinfection.....	1-57
1.10.4.4	Fluoride	1-58
1.10.4.5	Turbidity.....	1-58
1.10.4.6	Organic and Inorganic Chemicals, Pesticides, THM and BDCM	1-58
1.11	Potable Water Quality Record Keeping and Reporting Standards.....	1-58
1.11.1	Record Keeping.....	1-58
1.11.1.1	Five Year Records.....	1-58
1.11.1.2	Lifetime Records	1-59
1.11.1.3	Sampling and Analysis Records.....	1-60
1.11.2	Reporting Requirements	1-60
1.11.2.1	Contravention Reporting	1-60
1.11.2.2	Monthly Reporting	1-61
1.11.2.3	Annual Reporting.....	1-62
1.11.2.4	Electronic Reporting	1-62
1.12	Laboratory Data Quality Assurance Standards	1-62
1.13	Facility Risk Assessment Standards	1-63
1.14	Facility Classification and Operator Certification Standards	1-63
APPENDIX 1-A		1-A-1
APPENDIX 1-B		1-B-1
APPENDIX 1-C		1-C-1
APPENDIX 1-D		1-D-1
APPENDIX 1-E		1-E-1

Additional Parts published separately are:

Part 2 Guidelines for Municipal Waterworks
 Part 3 Wastewater Systems Standards for Performance and Design
 Part 4 Wastewater Systems Guidelines for Design, Operating and Monitoring
 Requirements
 Part 5 Stormwater Management Guidelines

FOREWORD TO PART 1 STANDARDS FOR MUNICIPAL WATERWORKS (2012)

Alberta Environment and Water (AEW) is responsible for the Drinking Water and Wastewater Programs for large public systems in Alberta. AEW considers the establishment of standards and guidelines for municipal waterworks, wastewater and storm drainage facilities an integral part of our regulatory program directed at ensuring public health and environmental protection. AEW's objective is to develop comprehensive and scientifically defensible standards and guidelines that are effective, reliable, achievable and economically affordable.

Since publication of the last revision of the Standards and Guidelines, Alberta Environment and Water has embarked on a process of "decoupling" the various components of the January 2006 document into functionally-associated sections to aid those using the document. This process started with the publication of the January 2006 version of the Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems in the Alberta Gazette. A program of separating the component parts of this document is under way and new parts will eventually replace the corresponding sections in the January 2006 Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems. Until the process of "decoupling" is completed with new "Parts" the existing sections of the 2006 Standards and Guidelines document will remain in operation. This part (Part 1 – Standards for Municipal Waterworks) has all activities and/or system components that directly relate to public health protection; activities. System components that are guidance to best practices are included under "Part 2 – Guidelines for Municipal Waterworks."

Alberta Health Services is responsible for the application of the Public Health Act of Alberta. The role of Alberta Health Services, in the spirit of the Public Health Act, applies to all drinking water systems, both large and small, and to all aspects of safe drinking water production and delivery, if there is a concern about health impacts or disease transmission.

The system owners / utilities are responsible for meeting AEW's regulatory requirements and for the production and delivery of safe drinking water to the consumers. They are also responsible for maintaining water distribution system to the service connection, and will assist the home / building owners to identify any water quality issues within building plumbing. However, home / building owners are still responsible for plumbing repairs, system corrections and water quality within their building.

Engineering consultants and / or the system owners / utilities are responsible for the detailed project design and satisfactory construction and operation of the waterworks and wastewater systems.

In accordance with the Potable Water Regulation (277/2003) a waterworks system will be designed so that it meets, as a minimum, the performance standards and design requirements set out in the Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems, published by AEW, as amended or replaced from time to time, or, any other standards and design requirements specified by the Regional Director. AEW last revised its Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems in January 2006.

This present part details all the critical elements of the drinking water program and the associated design and/or performance standards. The key standards are based directly on USEPA's current surface water treatment rule. They are either narrative criteria or numerical

limits for a number of specific parameters, design, construction and operation that ensure a particular environmental quality or public health objective. These are mandatory requirements with which owners are required to comply. If at any time, the performance standards are compromised, the approval / registration holder shall immediately report to the Regional Director, either:

1. by telephone at 1-800-222-6514; or
2. by a method:
 - a. in compliance with the release reporting provisions in the Act and the regulations, or
 - b. as authorized in writing by the Regional Director.

It is recognized that not all existing waterworks systems will meet the standards published in this document. As the new standards will have a direct impact on the safety of drinking water, Alberta Environment and Water expects the upgrading to be done in a reasonable period.

AEW will ensure all approved waterworks systems will meet current standards within 5 years of approval renewal, but no later than ten years after the date of this revised Standard. The Director has the ability under Section 4(3) of the *Potable Water Regulation* to issue a notice to approved or registered waterworks systems identifying specific standards or changes the waterworks system must meet and make and detailing effective dates on which to comply

The key changes in this version from the January 2006 Standards are to sections 1.2.2 and 1.13.

Alberta Environment and Water's policy on disinfection of groundwater systems set out in Information Letters 1/2011 and 2/2011 [<http://environment.alberta.ca/02983.html>] is now incorporated into a revised section 1.2.2 in this document.

The introduction of the requirement for all municipal waterworks systems to complete and maintain a drinking water safety plan is set out in section 1.13. This is a change of emphasis from the previous risk assessment requirement set out in the January 2006 version. A drinking water safety plan is analogous to a "water safety plan" – a term used by the World Health Organization (WHO). In the 4th edition of the WHO's *Guidelines for Drinking-water Quality*¹, WHO state that "the most effective means of securing the safety of a drinking-water supply is through the use of a comprehensive risk assessment and risk management approach that encompasses all steps in the water supply from catchment [watershed] to consumers. The Water Safety Plan approach has been developed to organize and systematize a long history of management practices applied to drinking water and to ensure the applicability of these practices to the management of drinking-water quality. Water safety plans represent an evolution of the concept of sanitary surveys and vulnerability assessments that include and encompass the whole of the water supply system and its operation. The water safety plan approach draw on many of the principles and concepts from other risk management approaches, in particular the multiple-barrier approach and hazard assessment and critical control points (as used in the food and other industries)."

¹ http://whqlibdoc.who.int/publications/2011/9789241548151_eng.pdf

AEW has developed a template and guidance documents to assist in the preparation and maintenance of drinking water safety plans and these can be found at: www.environment.alberta.ca/apps/regulatteddwg/dwsp.aspx. A dedicated email address is also available for anyone wishing to enquire further about the drinking water safety plan approach [aenv.dwsp@gov.ab.ca].

All municipal drinking water systems are expected to have completed a drinking water safety plan by December 31, 2013 and to maintain their plan thereafter at a minimum of once per year.

DEFINITIONS / ABBREVIATIONS

AO	-	Aesthetic Objectives
AEW	-	Alberta Environment and Water
AWWA	-	American Water Works Association
BDOD	-	Biodegradable Dissolved Organic Carbon
BNR	-	Biological Nutrient Removal
BPJ	-	Best Professional Judgement
BPR	-	Biological Phosphorus Removal
BPT	-	Best Practicable Technology
CBOD	-	Carbonaceous Biochemical Oxygen Demand at 5 days and 20 °C
CFID	-	Continuous feed and intermittent discharge
DAF	-	Dissolved Air Flotation
DBP	-	Disinfection By-product
DCS	-	Distributed Control System
DO	-	Dissolved Oxygen
DWSP	-	Drinking Water Safety Plan
DOC	-	Dissolved Organic Carbon
EPEA	-	Environmental Protection and Enhancement Act
F/M	-	Food to Microorganism ratio
G	-	Velocity Gradient
GCDWQ	-	Guidelines for Canadian Drinking Water Quality
GWUDI	-	Groundwater under the direct influence of surface water
HPC	-	Heterotrophic Plate Count
HRT	-	Hydraulic Retention Time
IFID	-	Intermittent feed and intermittent discharge
MAC	-	Maximum Acceptable Concentration
MLSS	-	Mixed Liquor Suspended Solids
NH ₃ -N	-	Ammonia nitrogen
NSF	-	National Sanitation Foundation
NTU	-	Nephelometric Turbidity Unit
ORP	-	Oxidation Reduction Potential
OU	-	Odour Unit
PLC	-	Programmable Logic Controllers
QA/QC	-	Quality Assurance/Quality Control
RBC	-	Rotating Biological Contactor
SAR	-	Sodium Adsorption Ratio
SBR	-	Sequencing Batch Reactor
SRT	-	Sludge Retention Time
TBOD	-	Total Biochemical Oxygen Demand at 5 days and 20 °C
TOC	-	Total Organic Carbon
TP	-	Total Phosphorus
TSS	-	Total Suspended Solids
TTHM	-	Total Trihalomethanes
UC	-	Uniformity Coefficient
USEPA	-	United States Environmental Protection Agency
UV	-	Ultraviolet
WHO	-	World Health Organization

Average daily design flow - The product of the following:

- design population of the facility, and
- the greatest annual average per capita daily flow which is estimated to occur during the design life of the facility.

Co-op - An organization formed by the individual lot owners served by a waterworks system, wastewater system or storm drainage system.

Granular Filter Media:

1. **Effective Size (D_{10})** - Size of opening that will just pass 10% of representative sample of the granular filter media.
2. **Uniformity Coefficient** - A ratio of the size opening that will just pass 60% of the sample divided by the opening that will just pass 10% of the sample.

Groundwater - All water under the surface of the ground.

Maximum daily design flow (water) - Maximum three consecutive day average of past-recorded flows, times the design population of the facility. If past records are not available, then 1.8 to 2.0 times the average daily design flow.

Maximum hourly design flow (water) - 2.0 to 5.0 times the maximum daily design flow depending on the design population.

Owners - Owners of the waterworks systems as defined in the regulations.

Peak demand design flow (water) - the maximum daily design flow plus the fire flow.

Potable Water – As defined in the EPEA. Other domestic purposes in the EPEA definition include water used for personal hygiene, e.g. bathing, showering, washing, etc.

Sodium Adsorption Ratio - A ratio of available sodium, calcium and magnesium in the soil solution which can be used to indicate whether or not the accumulation of sodium in the soil exchange complex will lead to a degradation of soil structure.

$$SAR = \frac{Na}{\left[\frac{Ca}{2} + \frac{Mg}{2} \right]^{1/2}}$$

Note : All concentrations expressed in milliequivalents per litre

Surface water - Water in a watercourse.

Watercourse - As defined in the EPEA.

1.0 Waterworks Systems Standards

This section outlines all the elements of a drinking water program that shall be adhered to for the safe delivery of drinking water. This includes the standards for the following elements:

1. Water quality;
2. Water treatment and performance;
3. Facility design and operation;
4. Water treatment chemicals;
5. Water treatment plant waste;
6. Water transmission and distribution;
7. Water quality monitoring, record keeping and reporting;
8. Data quality assurance;
9. Facility accreditation; and
10. Facility classification and operator certification.

1.1 Potable Water Quality Standards

Potable water in the waterworks system shall meet the health related concentration limits (Maximum Acceptable Concentrations) in the Guidelines for Canadian Drinking Water Quality, published by Health Canada, as amended or replaced from time to time, for the parameters listed in Section 1.10.3 of this document, with the exception noted in Section 1.5.2 (2).

The Regional Director at his discretion may establish more stringent limits for the parameters listed, or establish additional parameters not listed in Section 1.10.3.

If iron or manganese reduction is practiced, then the treated water concentration for iron and manganese shall be 0.3 mg/L and 0.08 mg/L respectively.

1.2 Potable Water Treatment Standards

The level of potable water treatment is dependent on whether the raw water is obtained from a surface supply, groundwater under the direct influence of surface water (GWUDI), or groundwater. Criteria detailed in Section 1.2.1.4, shall be used to determine whether or not a source is under the direct influence of surface water.

1.2.1 Surface Water and GWUDI

1.2.1.1 Filtration and Disinfection Requirement

All waterworks systems, with surface water or GWUDI source, shall be provided with filtration and disinfection. Filtration and disinfection together shall achieve a minimum of 3-log reduction of *Giardia* and *Cryptosporidium*, and 4-log reduction of viruses. However, based on the raw water cysts and oocysts levels, systems shall achieve higher reduction of *Giardia* and *Cryptosporidium* in accordance with the log reduction requirements shown in Table 1.1. New facilities that have not done the source water assessment at the time of application for approval shall achieve a minimum of 3-log reduction of *Giardia* and *Cryptosporidium*, and 4-log reduction

of viruses until the source water assessment is completed. If a system so chooses not to conduct raw water assessment to determine the level of reduction, it shall meet or exceed the maximum 5.5 log reduction of *Giardia* and *Cryptosporidium*, and 4-log reduction of viruses.

In addition, chlorine residual (free, combined or total chlorine) of not less than 0.1 mg/L shall be maintained in the water distribution system.

Table 1.1: Log Reduction Required for Filtered Systems

Raw Water <i>Giardia</i> Levels (cysts / 100 L) ¹	Raw Water <i>Cryptosporidium</i> Level (oocysts / 100 L) ¹	Log Reduction
< 1	< 7.5	3.0 log
> 1 and < 10	> 7.5 and < 100	4.0 log
> 10 and < 100	> 100 and < 300	5.0 log
> 100	> 300	5.5 log

¹ For communities with population larger than 10,000, the levels are based on running annual average of monthly samples over a two year period.

For communities with population less than 10,000, that are triggered based on *E. coli* sampling (see Section 1.2.1.3), the levels are based on running annual average of quarterly samples over a two-year period.

NOTE: *Giardia* and *Cryptosporidium* columns are both used for log reduction determination when granular media depth filtration, or cartridge filtration with >1 micron pore size, is utilized; only the *Cryptosporidium* column is used for log reduction determination if membrane filtration (<1 micron pore size) is utilized.

1.2.1.2 Filtration Exemption

Where a groundwater source is determined to be under the direct influence of surface water (GWUDI) as per Section 1.2.1.4, and where the source water quality conditions are suitable to avoid filtration as determined by the Regional Director, inactivation of *Giardia*, *Cryptosporidium* and viruses may be achieved by disinfection only. Disinfection shall achieve a minimum of 3-log reduction of *Giardia* and *Cryptosporidium*, and 4-log reduction of viruses.

1.2.1.3 Source Water Monitoring Requirements for Filtered Systems²

Systems serving a population of at least 10,000 shall sample for cysts and oocysts monthly for a period of two years. Increase the frequency of monitoring to once a week during the spring run-off periods.

Systems serving a population of less than 10,000 shall first monitor for *E. coli* at least every two weeks for a one-year period. For systems that use sources other than lakes or reservoirs, increase the frequency of monitoring to once a week during the spring run-off periods. No cysts and oocysts monitoring will be required under the following conditions:

1. Systems that use lakes or reservoirs as sources and that have an average *E. coli* concentration of less than 10/100 mL, based on all the samples in a one -year period; or
2. Systems that use sources other than lakes and reservoirs, and that have an average *E. coli* concentration of less than 50/100 mL, based on all the samples in a one- year period.

² This applies to surface systems only and not to GWUDI

Systems meeting the above criteria shall be required to provide filtration and disinfection to achieve a minimum of 3-log reduction of *Giardia* and *Cryptosporidium*, and 4-log reduction of viruses.

Systems serving a population of less than 10,000, triggered into cysts and oocysts monitoring, will sample at least four times per year for a period of two years, or as determined by the Regional Director based on site specific conditions.

Test results below detection limits shall be considered zero in calculating the average value.

Cysts and oocysts shall be sampled, analysed and reported in accordance with the USEPA Method 1623, or as amended.

1.2.1.4 Criteria to Determine GWUDI

AEW characterizes groundwaters as one of two types:

- Groundwater; and
- Groundwater Under the Direct Influence of Surface Water (GWUDI).

A brief description of these two types of groundwater is as follows:

1. Groundwater

A raw water supply which is groundwater means water located in aquifer(s) that are either isolated from the surface, or where the subsurface soils act as an effective filter that removes micro-organisms and other particles by straining and antagonistic effect, to a level where the water supply may already be potable but disinfection is required as an additional health risk barrier.

2. GWUDI

A raw water supply, which is groundwater under the direct influence of surface water, means ground water having incomplete or undependable subsurface filtration of surface water and infiltrating precipitation.

Refer to Appendix 1-E entitled *Assessment Guideline for Groundwater Under the Direct Influence of Surface Water (GWUDI)* for determining whether a groundwater source is GWUDI. Note that a source determined to be GWUDI would require treatment equivalent to that required by a surface water source.

1.2.2 Groundwater

Groundwater systems shall provide disinfection to achieve a minimum of 4-log reduction of viruses³. A disinfectant residual (total chlorine not less than 0.1 mg/L) shall be maintained in the water distribution system.

³ <http://environment.alberta.ca/02983.html>

1.3 Potable Water Treatment Performance Standards

1.3.1 Filtration

1.3.1.1 Rapid Sand Filtration

In order to obtain *Giardia*, *Cryptosporidium* and virus reduction credits, outlined in Section 1.4.1, conventional and direct filtration systems, as shown in Figure 1.1, shall meet the following turbidity standards. In addition to the turbidity requirement, particle reductions standards may also be used, at the discretion of system owner. Particle counts, however, may be monitored to optimize filtration, either for filter-to-waste times, or for monitoring of spikes, or for low-level optimization down to 0.02 or 0.03 NTU.

1. Turbidity Reduction

The treated water turbidity levels from individual filters shall be less than or equal to 0.3 NTU at all times. Exceedance of this limit is allowed up to 1 NTU for a cumulative period of 15 minutes per day per filter for discharge into the clear water tank.

The treated water turbidity levels from individual filters shall be based on continuous measurements of the turbidity and recorded at no more than five-minute intervals (with an on-line turbidimeter) at a point upstream of the combined filter effluent line or the clear water tank.

2. Particle Reduction

Particle counts (particles greater than 2 µm) from individual filters shall not exceed an absolute value of 50 particles/mL. Exceedance of this limit is allowed up to 200 particles/mL for a cumulative period of 15 minutes per day per filter for discharge into the clear water tank.

The particle counts shall be based on continuous measurements of the particles and recorded at no more than five-minute intervals (with an on-line particle counter) at a point upstream of the combined filter effluent line or the clear water tank.

1.3.1.2 Slow Sand Filtration

In order to obtain *Giardia*, *Cryptosporidium* and virus reduction credits, outlined in Section 1.4.1, slow sand filtration systems shall meet the following turbidity standards:

1. Turbidity Reduction

The treated water turbidity levels from individual filters shall be less than or equal to 1 NTU at all times. Exceedance of this limit is allowed up to 3 NTU for a cumulative period of three hours per day per filter for discharge into the clear water tank.

The treated water turbidity levels from individual filters shall be based on continuous measurements of the turbidity and recorded at no more than five-minute intervals (with an on-line turbidimeter) at a point upstream of the combined filter effluent line or the clear water tank.

1.3.1.3 Membrane filtration

Cysts / oocysts / virus reduction credit for membrane filtration system shall be based on product specific challenge testing and verified by direct integrity testing of the membrane, as described in the latest edition of the USEPA Membrane Filtration Guidance Manual⁴. An independent third party in accordance with the criteria outlined in this guidance manual shall perform the challenge tests. The maximum removal credit shall be the lower of the two values established during the challenge test, or the maximum log removal value verified by the direct integrity test during the course of normal operation.

As a minimum standard, the membrane filtration systems shall meet the following turbidity standards, particle reduction standards and direct integrity test standards:

1. Turbidity Reduction

The treated water turbidity levels from individual filter train shall be less than or equal to 0.1 NTU at all times. Exceedance of this limit is allowed up to 0.3 NTU for a cumulative period of 15 minutes per day per filter module for discharge into the clear water tank.

The treated water turbidity levels from individual filter train shall be based on continuous measurements of the turbidity and recorded at no more than five-minute intervals (with an on-line turbidimeter) at a point upstream of the combined filter effluent line or the clear water tank.

2. Particle Reduction

Particle counts (particles greater than 2 µm) from individual filter train shall not exceed an absolute value of 20 particles/mL. Exceedance of this limit is allowed up to 50 particles/mL for a cumulative period of 15 minutes per day per filter train for discharge into the clear water tank. For those membranes that operate under vacuum, where air entrainment may be a problem, exceedance of this limit is allowed up to 200 particles/mL for a cumulative period of 30 minutes per day per filter train.

The particle counts shall be based on continuous measurements and recorded at no more than five-minute intervals (with an on-line particle counter) at a point upstream of the combined filter effluent line or the clear water tank.

3. Direct Integrity Test

A direct physical test shall be applied daily to each membrane train to identify and isolate integrity breaches. The direct integrity test shall be applied in a manner such that a 2 µm hole contributes to the response from the test. The direct integrity test shall be capable of verifying the log reduction value awarded to the membrane process.

1.3.1.4 Cartridge Filtration⁵

Cysts / oocysts reduction credit for cartridge filtration system shall be based on product specific challenge testing, as described in the latest edition of the USEPA's LT2ESWTR Toolbox

⁴ Log reduction credits shall be based on the removal efficiency of the smallest target organism.

⁵ GWUDI sources only

Guidance Manual. An independent third party in accordance with the criteria outlined in this guidance manual shall perform the challenge tests.

As a minimum standard, the cartridge filtration systems shall meet the following turbidity standards. In addition to the turbidity requirement, particle reductions standards may also be used, at the discretion of system owner. Particle counts, however, may be monitored to optimize filtration, either for filter-to-waste times, or for monitoring of spikes, or for low-level optimization down to 0.02 or 0.03 NTU.

1. Turbidity Reduction

The treated water turbidity levels from individual filter module shall be less than or equal to 0.3 NTU at all times. Exceedance of this limit is allowed up to 1 NTU for a cumulative period of 15 minutes per day per filter module for discharge into the clear water tank.

The treated water turbidity levels from individual filter module shall be based on continuous measurements of the turbidity and recorded at no more than five-minute intervals (with an on-line turbidimeter) at a point upstream of the combined filter effluent line or the clear water tank.

2. Particle Reduction

Particle counts (particles greater than 2 µm) from individual filter module shall not exceed an absolute value of 50 particles/mL. Exceedance of this limit is allowed up to 200 particles/mL for a cumulative period of 15 minutes per day per filter for discharge into the clear water tank.

The particle counts shall be based on continuous measurements and recorded at no more than five-minute intervals (with an on-line particle counter) at a point upstream of the combined filter effluent line or the clear water tank.

1.3.2 Disinfection

General Performance Requirements

All waterworks systems shall provide disinfection to:

1. inactivate the pathogens not removed by clarification and filtration, and achieve the level of cysts / oocysts reduction as stipulated in Table 1.1;
2. inactivate viruses in surface water, GWUDI, and groundwater systems, and achieve the level of virus reduction as stipulated in Sections 1.2.1 and 1.2.2; and
3. maintain total chlorine residual in the water distribution system.

1.3.2.1 Chlorine (Free and Combined)

CT Concept

Use of the "CT" disinfection concept shall be followed to demonstrate satisfactory treatment since monitoring for very low levels of pathogens in treated water are analytically very difficult.

The CT concept uses the combination of disinfectant residual concentration (mg/L) and the effective disinfection contact time (in minutes) at maximum hourly flows to measure effective pathogen reduction. The residual is measured at the end of the process, and the contact time used is the T_{10} of the process unit (time for 10% of the water to pass). Section 1.10.3.7 provides details on how T_{10} should be determined.

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

Additive CT Values (Disinfection Profiling)

Total log reduction by disinfection for a facility can be determined by summing the CT_{ratio} achieved in individual process units in series. CT_{ratio} is the ratio of CT_{actual} and CT_{required} . Different disinfectants can also be used in different process steps.

Determine the log reduction for the CT achieved, from the CT Tables in Appendix 1-A and 1-B.

Specific Performance Requirements

If free chlorine is used as the primary disinfectant, the CT required for the inactivation of cysts shall be in accordance with the CT Tables in Appendix 1-A, and CT required for the inactivation of viruses shall be in accordance with the CT Tables in Appendix 1-B.

If combined chlorine is used as the primary disinfectant, the CT required for the inactivation of cysts and viruses shall be in accordance with the CT Tables in Appendix 1-B.

If free or combined chlorine is used as the primary disinfectant, the minimum chlorine concentration, at the location where C is measured for the calculation of CT, shall be 0.2 mg/L.

If combined chlorine is used as the primary disinfectant, chlorine should be added ahead of ammonia to have sufficient free chlorine to achieve the required removal of viruses.

Residual disinfectant concentration in the distribution system, measured as total chlorine, free chlorine, or combined chlorine shall be at least 0.1 mg/L in all of the samples taken.

Maximum residual disinfectant concentration, measured as free chlorine shall not exceed 4.0 mg/L, or as combined chlorine shall not exceed 3.0 mg/L, anywhere in the system.

1.3.2.2 Ultraviolet Light

UV Dose (based on the IT Concept that is equivalent to the CT Concept of a chemical disinfectant dose)

Use of UV Dose (the "IT" disinfection concept) shall be used to demonstrate satisfactory treatment since monitoring for very low levels of pathogens in treated water is analytically very difficult. The degree of inactivation of each target pathogen is based on the UV dose applied to the system. UV dose in ideal reactors is defined as the product of intensity of radiation I (mW/cm^2), and the length of time (seconds) the water is exposed to UV radiation.

$$UV \text{ Dose} = IT \text{ (mJ/cm}^2\text{)} = \text{Intensity (mW/cm}^2\text{)} \times \text{Time (s)}$$

For non-ideal field reactors, the delivered dose is validated by empirical methods that involve field reactor performance calibration against an ideal laboratory reactor.

Specific Performance Requirements

If UV light is used as a primary disinfectant, the dose required for the inactivation of cysts, oocysts and viruses shall be in accordance with the IT Tables in Appendix 1-C.

If the UV dose is inadequate to achieve the required virus reduction, then UV shall be followed by another disinfectant such as chlorine with the appropriate CT to achieve the desired results with the target virus.

UV shall be always followed by a secondary disinfectant such as chlorine to maintain a residual in the water distribution system.

1.3.2.3 Chlorine dioxide

CT Concept

Same as for chlorine, see Section 1.3.2.1.

Specific Performance Requirements

If chlorine dioxide is used as the primary disinfectant, the CT required (Concentration C in mg/L x Contact Time T_{10} in minutes) for the inactivation of cysts and viruses shall be in accordance with the CT Tables in Appendix 1-B.

Individual residual oxidants (chlorine dioxide, chlorite and chlorate) shall not exceed the MACs for these substances stipulated in the GCDWQ.

Chlorine dioxide shall be followed by a secondary disinfectant such as chlorine to maintain a residual in the water distribution system.

1.3.2.4 Ozone

CT Concept

As in the case of chlorine and chlorine dioxide, use of the "CT" disinfection concept shall be followed to demonstrate satisfactory treatment since monitoring for very low levels of pathogens in treated water are analytically very difficult.

Specific Performance Requirements

If ozone is used as the primary disinfectant, the CT required (Concentration C in mg/L x Contact Time T_{10} in minutes) for the inactivation of cysts and viruses shall be in accordance with the CT Tables in Appendix 1-B.

Ozone shall be followed by a secondary disinfectant such as chlorine to maintain a residual in the water distribution system.

1.3.3 Fluoridation

When fluoridation is practised, adequate controls shall be maintained at all times to provide a fluoride ion concentration in treated water to meet the optimum concentration in the latest edition of GCDWQ. A monthly average and daily variation shall be within ± 0.1 mg/L and ± 0.2 mg/L respectively.

The Regional Director, under certain circumstances, may allow optimum concentration to be lower than 0.8 mg/L.

1.4 Potable Water Treatment Credits

1.4.1 Filtration Credit

If treated water turbidity or particle count meets the prescribed limits in Section 1.3.1, the inactivation credit for *Giardia*, *Cryptosporidium* and viruses through filtration shall be determined in accordance with Table 1.2.

Table 1.2: *Giardia*, *Cryptosporidium* and viruses reduction credit through filtration

Technology	Cyst/oocyst credit	Virus credit
Conventional filtration	3.0 log	2.0 log
Direct filtration	2.5 log	1.0 log
Slow sand or diatomaceous earth filtration	3.0 log	2.0 log
Microfiltration, ultrafiltration and membrane cartridge filtration ^a	Removal efficiency demonstrated through challenge testing and verified by direct integrity testing	No credit
Nanofiltration and reverse osmosis	Removal efficiency demonstrated through challenge testing and verified by direct integrity testing	Removal efficiency demonstrated through challenge testing and verified by direct integrity testing
Microfiltration, ultrafiltration, nanofiltration, reverse osmosis and membrane cartridge filtration, preceded by coagulation, flocculation and sedimentation	Minimum 3.0 log if removal efficiency demonstrated through challenge testing and verified by direct integrity testing	Minimum 2.0 log if removal efficiency demonstrated through challenge testing and verified by direct integrity testing
Cartridge filtration ^b	Removal efficiency demonstrated through challenge testing. Maximum 2 log credit given with demonstration of at least 3 log removal efficiency in challenge testing	No credit

^a pore size < 1 micron

^b GWUDI only (pore size > 1 micron)

1.4.1.1 System Non-compliance with respect to turbidity reduction

For systems not meeting the turbidity or particle requirements outlined in Section 1.3.1, AEW may grant a limited or no filtration credit for a limited period till the plant can be optimized or upgraded. Plants with no filtration credit shall provide disinfection to achieve at least 3-log reduction of *Giardia* cysts, 3-log reduction of *Cryptosporidium* oocysts and 4-log reduction of viruses, or issue boil water advisories to the consumers served by the plants. [Note: Filtration systems that are unable to achieve a finished water turbidity as outlined in Section 1.3.1, will be required to implement a system evaluation program, and develop an optimization or upgrading plan. System evaluation program will include procedures to determine the log reduction requirement of *Giardia* cysts and *Cryptosporidium* oocysts].

1.4.2 Disinfection Credit

Depending on the disinfectant used, the inactivation credit for *Giardia*, *Cryptosporidium* and viruses through disinfection shall be determined in accordance with the CT Tables in Appendices A or B, or the IT Table in Appendix 1-C.

1.4.3 Other Options Credit

Depending on the raw water quality, filtration alone may not be adequate to achieve the inactivation required for cysts and oocysts. Table 1.3 includes the options available to the system owner for further inactivation of cysts and oocysts. The intent of this approach is to provide systems with flexibility in selecting cost effective compliance strategy to achieve the required log reduction.

Table 1.3: *Giardia*, *Cryptosporidium* and viruses reduction credit through other options (Additional to the credit in Table 1.2)

Options	Treatment Credit with Design and Implementation Criteria
Pre-sedimentation basin with coagulation	0.5 log credit for cysts and oocysts with continuous operation and coagulant addition. Basin shall achieve 0.5 log turbidity reduction based on monthly mean of daily measurements in 11 of the 12 previous months. All flows shall pass through the basins
Two-stage lime softening	0.5 log credit for cysts and oocysts for two-stage softening with coagulant addition. Coagulant shall be present in both clarifiers and includes metal salts, polymers, lime, or magnesium precipitation. Both clarifiers shall treat 100% of flow
Combined filter performance; or Individual filter performance	0.5 log credit for cysts and oocysts if combined filter effluent turbidity is less than 0.15 NTU in 99% of measurements made in a calendar month; or 1.0 log credit for cysts and oocysts if individual filter effluent turbidity is less than 0.1 NTU in 99% of measurements made in a calendar month
Chlorine	Log credit for cysts and viruses on demonstration of compliance with CT tables in Appendices 1-A and 1-B
Chlorine dioxide	Log credit for cysts and viruses on demonstration of compliance with CT tables in Appendix 1-B

Ozone	Log credit for cysts and viruses on demonstration of compliance with CT tables in Appendix 1-B
UV light	Log credit for cysts, oocysts and viruses on demonstration of compliance with IT tables in Appendix 1-C

1.5 Potable Water Treatment Facility Design Standards

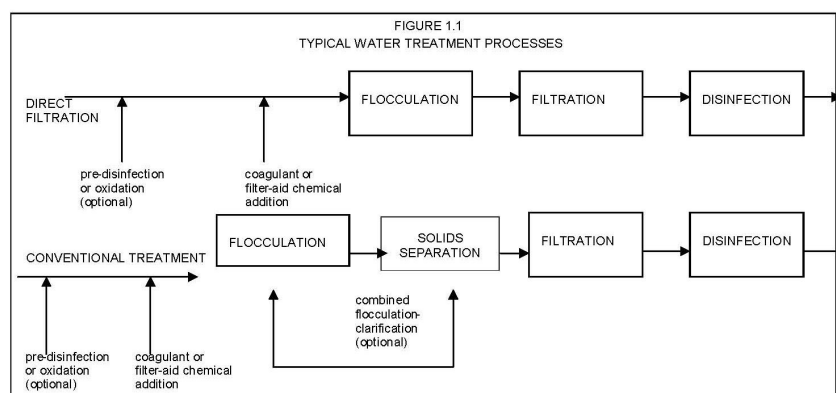
1.5.1 Surface Water and GWUDI

This section identifies the design requirements for those technologies acceptable for treatment of surface water and GWUDI. What are included in this section are minimum requirements to ensure reliable and safe drinking water supplies. These design requirements should be considered in conjunction with acceptable design practices and specific design criteria outlined in Part 2 – Guidelines for Municipal Waterworks.

1.5.1.1 Rapid Sand Filtration

The rapid sand filtration system shall be designed to produce water that meets the drinking water quality and the minimum performance requirements for rapid sand filtration outlined in section 1.3.1.1. Chemically assisted rapid sand filtration of water is a multi-step treatment process that includes chemical mixing, coagulation, flocculation, solids separation and filtration (conventional treatment); or chemical mixing, coagulation, flocculation and filtration (direct filtration), as illustrated in Figure 1.1.

Direct filtration may be used for source water that is consistently low in turbidity, colour and dissolved organic carbon. Water shall be suitable for charge neutralization with low coagulant dosages with the goal of forming a pinpoint sized floc that is filterable, rather than a settleable floc. Direct filtration will be acceptable only if it can be substantiated by undertaking a pilot study using the proposed source water.



The filtration systems shall be designed to produce water that meets the potable water quality standards (section 1.1), potable water treatment standards (Section 1.2), and the potable water treatment performance standards (1.3.1.1). The systems shall meet the following requirements:

1. Chemical Mixing and Coagulation

Chemical mixing and coagulation shall be achieved either in a separate process tank or with an in-line mixing device.

2. Flocculation

To prevent short-circuiting and to permit defined zones of reduced energy input, the flocculation process shall have two or more stages / compartments unless specifically exempted by AEW. A minimum of two flocculation trains shall also be provided unless specifically exempted by AEW.

3. Solids Separation

Solids separation shall be achieved either through sedimentation or through flotation. At least two sedimentation basins or two flotation basins shall be provided unless specifically exempted by AEW.

4. Filtration

Filtration represents the final particulate removal step in water treatment. Rapid sand filtration shall be allowed only in conjunction with chemical pre-treatment of water.

Any sudden increase or decrease on a dirty filter will cause some detriment to filtered water quality for a brief period, for this reason the filters shall be designed for continuous operation.

Filters shall be gravity feed type. Each filter shall be equipped with an on-line turbidimeter with a recorder for continuous monitoring of effluent quality.

a. Filtration Rate

Filter loading rate shall be considered a key factor in the design of a filtration system from both the filtrate quality and filter-run points of view. The filtration rate is dependent on the quality of raw water, the extent of pre-treatment and the characteristics and depth of the filter media. High-rate filtration (> 9 m/h) will be acceptable only if undertaking a filter column study using the proposed source water can substantiate it.

b. Filter to Waste

Water treatment plants shall be designed with filter-to-waste provision; piping shall be designed for the capacity of that filter. Precautions should be made to prevent backflow from the filter-to-waste stream to any component of the potable water supply system. The design should provide for switching filter-to-waste flow to filter-on-line (water production) without changing velocity through the filter to reduce turbidity spikes.

Duration of the filter-to-waste cycle must be tied to the actual turbidity of the wasted water or to a pre-determined time for the turbidity of the wasted water to reach the required limit.

c. Number of Filters

The number of filter units may vary with the plant capacity. For plants with capacity greater than 150 m³/d, a minimum of two filters shall be provided, each capable of independent operation and backwash. Where possible, three filters or more shall be provided; except during repair/emergency, all filters shall be operational. Where only two filters are provided, each filter should have a hydraulic capacity not less than 150% of design filtration rate.

d. Filter Backwash

Filter backwash shall be up-flow water wash, or up-flow water wash with surface wash, or up flow water wash with air scour. Declining rate backwash systems are not acceptable.

1.5.1.2 Slow Sand Filtration

The slow sand filter system shall be designed to produce water that meets the drinking water quality standards and minimum performance requirements for slow sand filtration outlined in Section 1.3.1.2.

1. Filtration

Fluctuating load on the filter upsets the schmutzdecke, resulting in poor quality of filtered water for brief periods. For this reason the filters shall be designed for continuous operation. Each filter shall be equipped with an on-line turbidimeter with a recorder for continuous monitoring of effluent quality.

a. Filtration rates

Filter loading rate is a key factor in the design of slow sand filtration system from both the filtrate quality and filter run lengths points of view. The percent removal of turbidity generally declines with increasing loading rate. Unless specifically exempt by AEW, the optimum filtration rates shall be ascertained by pilot testing over the annual cycle.

b. Filter to Waste

During the filter ripening period, following the start-up of a new filter or a re-built filter bed, filtered water may be of very poor quality. The ripening period typically ranges from about one week to several months. The filters will not meet the minimum performance requirements during the ripening period and the water produced during this period shall be wasted or recycled to the pre-treatment works. Water treatment plants shall be designed with this filter-to-waste provision. Precautions should be made to prevent backflow from the filter-to-waste stream to any component of the potable water supply system.

During the filter-to-waste mode, the filter may be operated at high hydraulic loading rates and wasted water turbidity shall be measured daily until it reaches the acceptable level.

c. Number of Filters

Slow sand filters shall have a minimum of two or more cells so that when one is out of service for scraping or other reasons, another filter bed can continue producing sufficient amounts of water for the community.

Because of the prolonged filter ripening period, systems with two cells shall have each cell capable of producing maximum daily design flow for the community. Systems with more than two cells shall have all cells but one capable of producing maximum daily design flow.

1.5.1.3 Membrane Filtration

Membrane filtration shall be a pressure-driven or vacuum-driven process and remove particulate matter larger than 1 micron (μm) using a non-fibrous engineered barrier. The process shall also have a measurable removal efficiency of a target organism that can be verified through the application of a direct integrity test.

From municipal drinking water point of view, only Micro Filtration System (MF) and Ultra Filtration System (UF) are of interest. This section outlines the design requirements for MF and UF systems.

A Membrane Cartridge Filtration device that utilizes a membrane filtration media capable of removing particulate matter larger than 1 micron, and which can be subjected to direct integrity testing would also satisfy the requirements for membrane filtration.

1. Treatment Objectives

It is critical that the treated water quality objectives are defined prior to the membrane process selection.

MF and UF membrane systems typically used for surface water treatment or GWUDI can only remove the non-dissolved portion of organic carbon. Dissolved organic removal is typically achieved through pretreatment. Pretreatment chemicals and the organic carbon itself can be contributors to membrane fouling and therefore pretreatment processes should be evaluated carefully. Groundwater containing contaminants such as iron, manganese and arsenic may also be treated with membrane filtration.

2. Design Flow Rate

The design flow rate for membrane systems is the net filtered output desired from the membrane system. This shall take into account the loss of feed water used for backwashing and/or rejected from the system (waste stream) and the lost production while a unit or train is out of service for chemical cleaning.

Recovery Rate is the membrane system's final product volume over a given time period divided by the feed water flow volume. In order to achieve the lower recovery rate mode, the raw water feed system and waste-handling systems shall be sized to handle the larger flows.

The design flow rate per membrane train is a function of the total membrane surface area in the module and the flux rate selected. The membrane surface area per train is a physical characteristic dependant on the membrane manufacturer chosen. The flux rate shall be selected in consultation with the membrane manufacturer and the characteristics of the source water being treated. Optimum flux rates should be selected based on pilot results considering the required design production rates with both cold and warm water. Cold water can significantly reduce the flux rate of a membrane system; hence the seasonal demands should be carefully evaluated.

3. Membrane Selection

The style of membrane chosen should best address the feed water conditions, integration with other treatment, hydraulic limitations, residuals, available space and required capacity. Cartridge (pressure) or submerged (vacuum) type systems may be used. Select a membrane manufacturer that adopts and maintains the philosophy of "universal configurations" in order to accommodate future upgrades and products.

4. Piloting

The suitability of using a membrane system for a particular raw water source shall be substantiated or verified by conducting a pilot or demonstration study under "worst case" situations. The objective of the pilot or demonstration study is to assess the performance and reliability of the membrane system during the critical raw water conditions. The study shall also determine how the system would operate as an integrated process, react to various levels of pretreatment, and assess the fouling potentials. Sufficient data shall be collected to select the most economical design flux rate, cleaning regime and cleaning frequency for the full-scale system.

Prior to conducting a pilot study, a plan shall be developed and submitted to AEW for review. The plan shall include, but not be limited to the following information:

- a. Raw water quality data for at least the previous 12-month period highlighting the variations in raw water quality, temperature and seasonal demands.
- b. Proposed piloting schedule including rationale based on an evaluation of the historical raw water quality and seasonal variations. Critical water quality conditions may include, but not be limited to: high turbidity, cold water, high organics, and the presence of algae.
- c. A schematic of the proposed pilot set up along with descriptions of the proposed processes and facilities. A comparison should be included of the proposed full-scale facility with any differences noted and discussed.
- d. A description of the modes of operation to be tested and the parameters to be evaluated. For example: cold and warm temperature flux, percent recovery, trans-membrane pressure, pre-treatment requirements, backwash frequency, backwash duration, backwash method, clean-in-place method and frequency, and post treatment.

- e. Time schedules for each mode of operation. The schedule should address the relationship between the modes of operation and how they relate to the critical water quality conditions.
- f. Parameters to be monitored, including sampling locations, frequency, and method of monitoring or conducting analytical testing. Feedwater quality parameters are to include, but not be limited to: turbidity, TOC, DOC, UV254 absorbance, algae, calcium, magnesium, iron, manganese, total hardness, total alkalinity, pH and temperature.
- g. Quality assurance/quality control procedures to be used (including information on the accredited laboratory to be used).
- h. Description of the analysis to be used for evaluating the data collected.
- i. A description of proposed challenge tests to substantiate the specific pathogen log removal credit requested by AEW.
- j. The proposed plant design capacity ratings as a function of water temperature and other flux rate limitations.
- k. The pilot study shall be run for a sufficient period to obtain meaningful design data. The selection of the test period(s) shall be based on the historical raw water quality data and critical conditions.

The proponent shall prepare the pilot study report documenting the data collected; the analyses performed and summarize the findings and performance recommendations. Recommendations regarding cleaning frequency, integrity testing, maintenance recommendations, anticipated membrane service life and procedures to optimize membrane performance and longevity shall be included. The pilot report shall be submitted to AEW for review.

AEW, at its discretion, may relax or waive the pilot testing requirements where at least one year of acceptable full scale operational data exists from a water treatment plant which uses membranes similar to what is proposed, treats water of similar quality and under similar operating conditions using the same source. The proponent shall provide an in depth report of this full-scale plant data to AEW for review.

5. Pretreatment

Membrane filtration systems can be successfully integrated into various stages of an existing water treatment facility to replace, enhance or provide additional treatment barriers. The determination of the optimal location for integrating a membrane system within an existing treatment facility depends on site and project specific factors.

New or existing pre-treatment systems upstream of the membranes can affect the design of the membrane process. The pre-treatment unit processes that should be evaluated for the integration of membrane filtration systems are as follows:

a. Screening

Provide pre-screening of any membrane system to protect the membranes from damage by debris. The required screen size is a function of the raw water source and quality and the membrane manufacturer's requirements.

b. Oxidation

Oxidation can be integrated with membrane processes to assist with organics (TOC & DOC) and taste and odour reduction. It's recommended that the oxidation process be introduced as far upstream of the membrane process as possible. When using potassium permanganate care should be taken to avoid overdosing. Un-reacted or excess potassium permanganate can affect membrane performance by fouling the membranes or precipitating manganese on the downstream side of the membrane fibres. In addition to AEW's overall approval requirements, the proponent shall obtain approval / sign-off for the use of an oxidant from the membrane manufacturer.

c. Adsorption

Adsorption processes can be integrated with membrane process for removal of organics (TOC and DOC) and taste and odour causing compounds. In addition to AEW's overall approval requirements, use of any adsorbent shall be approved by the membrane manufacturer if used upstream of the membrane filters. Where powdered activated carbon (PAC) is proposed, the specific type of PAC should be approved.

d. Coagulation

Coagulation or enhanced coagulation upstream of the membrane process is typically practiced to precipitate dissolved organic substances (DOC). Pre-treatment coagulation is ideally incorporated into a flocculation or clarification process ahead of the membrane process however with some membrane systems the coagulation process can be combined directly into the membrane reactor vessel. In addition to AEW's overall approval requirements, the membrane manufacturer shall approve the use of any coagulant.

e. Clarification/Sedimentation

Clarification or sedimentation upstream of a membrane process is not always necessarily required. However, utilizing one of the two processes to reduce the solids loading on the membranes can improve membrane performance which could in turn lead to less membrane surface area required and extended life of the membranes. AEW and the membrane manufacturer must approve any upstream processes.

6. Number of Process Trains

A minimum of two independent membrane filter trains shall be provided. When determining the number of additional trains, the equipment turndown limitations, instrumentation limits and the range of seasonal flow variations anticipated shall be considered. Ensure that complete trains can be brought on or taken off line as required. When determining the total amount of membrane area and number of membrane trains to meet system demands, the effect of having one train off-line shall be taken into account. When a train is off-line for cleaning the remaining trains will need to be capable

of operating at a higher flux rate (filtration rate) for the duration of the cleaning cycle in order to meet system demands.

For staged plant capacity, the appropriate infrastructure for the projected future demands should be installed. The piping, valves, tankage and pumping units required for the future demands can be either installed initially or, as a minimum, provisions made for the future trains. The purchase of the additional membrane capacity, however, can be deferred until the future demands are approached and be incrementally installed. Installing excess membranes too far in advance is not recommended due to the limited membrane life expectancy of an installed unit, even if this unit is not in service. The contract with the manufacturer shall ensure the availability of compatible membranes at such time as they are required.

7. System Configuration

System configuration options will depend on the membrane selected. The general arrangements shall provide safe and convenient access to the membrane modules and ancillary equipment for routine inspection, maintenance and repairs with sufficient clearances and means for membrane removal and replacement.

8. Ancillary Equipment Requirements

a. Feed Water or Permeate Pumps & Blowers

Where pumps and air blowers are employed, the number of duty pumps and air blowers required will depend on the number of process trains selected and the anticipated range of flows. A standby unit shall be installed and piped accordingly as a common standby unit for any process train in the event one of the duty units is out of service for maintenance or repair.

b. Isolation Valves & Unions

Isolation valves are required for each individual membrane assembly. The size of the individual modules is such that it is often impractical to isolate individual membrane modules. Instead, isolation valves are to be provided to isolate individual trains [and] membrane assemblies, or subsections of the membrane assemblies

c. Piping and Automated Valves

Some membrane systems operate over a wide range of pressures and have a significant number of automated valves. Select piping materials, restraints, and actuator speed controls suitable for the intended materials, service and to prevent water hammer.

d. Chemical Feed Systems

Chemical feed systems shall have standby pumping units. Refer to Section 1.7 "Potable water Treatment Chemicals Standards" for storage and safe handling of the chemicals.

9. Flow meter

Flow meters shall be provided on:

- a. The main raw water supply line (or individual train raw water supply lines) to measure the feedwater volume entering the membrane system and for flow pacing of any pretreatment chemicals;
- b. Individual permeate lines from each membrane train to measure the filtration rate and volume of each train and pace post disinfection chemicals;
- c. Individual reject or concentrate lines from each train to measure the flow rate and volume of waste stream water for calculating the overall recovery rate of the train;
- d. Individual backwash lines (or use of the permeate flow meters) to measure the backwash flow rate and volume;
- e. The combined filter effluent line and / or the distribution main header leaving the plant; and
- f. Dosing of pre-treatment chemicals and determination of system/unit production rate and recovery.

10. On-line meter

On-line turbidimeter shall be provided on the common feed water line to the membrane trains.

Both on-line turbidimeter and particle counting instruments shall be provided on the permeate discharge from each membrane train. Sample point connections should be provided at each rack or cassette for connection of a portable particle counter to aid in trouble shoot testing in the event of a broken fiber.

Provisions shall be made for pH and residual measurement, either online or at convenient sample points, on each membrane CIP tank to monitor the cleaning solution concentrations.

Pressure gauges and transmitters are also required on each membrane train to measure transmembrane pressures for monitoring the rate of fouling and backpulse pressures to avoid over pressurization and damage to the membrane fibers.

11. Backwashing and Cleaning

Backwashing (back-pulsing) and chemical cleaning frequencies, durations and procedures shall be obtained from the membrane manufacturer, based on pilot study data or similar application data.

Provide neutralization of the cleaning solutions either directly in the process tank where the CIP has taken place, or the solutions should be transferred into a holding tank to ensure sufficient time for neutralization and monitoring prior to discharge.

12. Residuals (Waste) Stream Disposal

Alberta Environment and Water shall be consulted, as early as possible, when considering the use of membrane technologies, to determine the most suitable options for disposal of waste streams from both pilot scale and full scale membrane plants.

13. Integrity Tests

There are five key aspects for achieving an integral membrane system:

- a. performance requirements (meeting the continuous removal of particles greater than one micron in diameter),
- b. type of integrity test,
- c. integrity test criteria and settings (pressures, alarm settings, etc.),
- d. frequency of integrity testing (daily, weekly, etc.), and
- e. management of the process and information (data management, shutdown procedures, etc.).

There are two basic types of integrity testing: continuous indirect monitoring and periodic direct integrity testing. Indirect integrity monitoring includes online particle counting used as a continuous indication of the membrane integrity. In general, sustained particle counts are expected to remain below 20 cts/mL in the filtrate. If filtrate particle counts jump above 20 cts/mL for an extended period, this may be an indication that a membrane fibre has been breached and shall be isolated and checked for integrity.

Direct integrity testing includes such methods as pressure decay, vacuum hold, bubble point, and sonic testing. Direct integrity testing shall be performed at least once daily.

In order to receive the requested log removal credits, an integrity-testing program as outlined in the latest edition of the USEPA's Membrane Filtration Guidance Manual for the proposed plant shall be submitted for approval.

14. Filter-to-Waste Provisions

For those systems that have to be tested on-line during production in the event of a membrane integrity breach, filter-to-waste option shall be provided for diversion to waste.

1.5.1.4 Cartridge Filtration

Cartridge filters are pressure driven separation processes that remove particles larger than one (1) micron using an engineered porous filtration medium, through either surface or depth filtration. Cartridge filters are allowed under the following conditions:

- a. As a primary filter
System capacity: < 1.0 L/s
Source water: GWUDI
Disinfection: filtration followed by UV and Chlorine

- b. As a secondary filter
- | | |
|-----------------|---|
| Primary filter: | Rapid Sand Filtration or Slow Sand Filtration |
| Source water: | Surface |
| Disinfection: | filtration followed by chlorine |

The system design and operation of shall be based on the latest edition of the USEPA's LT2ESWTR Toolbox Guidance Manual.

1.5.2 Groundwater

This section provides the design and operational requirements for groundwater systems.

1. Minimum Requirements

As a minimum standard, well construction shall conform to the requirements of the Water Well Regulation.

All new wells and potentially contaminated wells shall be disinfected in accordance with AWWA standard C654-97, which outlines the procedures for shock chlorination and bacteriological testing for the disinfection of wells supplying potable water.

2. Removal of Fluoride

Naturally occurring fluoride up to a concentration of 2.4 mg/L is acceptable in distributed water. Distributed water with concentration greater than 2.4 mg/L shall be treated to reduce the level to 1.5 mg/L or lower, as determined by the Regional Director.

1.5.3 Disinfection

1.5.3.1 Chlorine / Chloramines

In the production of chloramines, the ammonia residuals in the finished water, when fed in excess of stoichiometric amount needed, shall be limited to inhibit growth of nitrifying bacteria.

1 On-Site Sodium Hypochlorite Generation Systems

As an alternative to chlorine gas or delivered commercial strength sodium hypochlorite, it is permissible to use a weak (0.7 to 0.9%) sodium hypochlorite solution generated on-site. The sodium hypochlorite can either be used for primary or secondary disinfection. The sodium hypochlorite solution is delivered to the treatment process using a system of positive displacement diaphragm metering pumps, peristaltic or centrifugal pumps, eductors or a loop system with metered flow control valves.

Redundancy shall be incorporated into the system to ensure that disinfection of the drinking water is not interrupted when any component of the largest unit is out of service.

a. Generation System Equipment Requirements

All generation equipment shall be NSF 61 approved.

Sodium hypochlorite generation shall not be permitted outside the sodium hypochlorite room, which is defined as the room where sodium hypochlorite is generated and stored. The water softener and brine tank may or may not be located inside the sodium hypochlorite room.

i. Water Softener

The number and size of the water softener(s) will depend on the projected range of flows and the hardness of the make-up water. Water hardness used for generating and diluting the brine solution shall be less than 25 mg/L as CaCO_3 , unless otherwise endorsed by the manufacturer.

ii. Water Heater/Chiller

A water heater or chiller may be required to adjust the temperature of the water used to make up and dilute the brine solution. The number and size of the water heater(s) or chiller(s) will depend on the anticipated range of flows, and their associated water temperatures. Incoming water shall be maintained between 15°C and 27°C, or as recommended by the generation system manufacturer.

iii. Brine Tanks

The brine tank shall be sized to accommodate the maximum day chlorine demand at the maximum flow rate. A standby brine tank shall be provided if the system does not have sufficient sodium hypochlorite storage for a minimum of three days of operation at maximum demand.

Brine solution is corrosive, therefore the material used for all associated storage tanks and piping shall be compatible with the solution. The brine solution shall be stored such that the temperature of the solution does not go below 5°C.

iv. Dosing pumps

Where pumps are employed, the number and size of duty pumps required will depend on the chlorine demand and the anticipated range of flows. At least one standby unit shall be installed and piped accordingly as a common standby unit in the event that one of the duty units is out of service.

v. Isolation Valves and Unions

Sufficient isolation valves and unions shall be provided to allow the removal of any component of the generation equipment for maintenance or repair work without having to take the entire system off line.

b. Hydrogen Gas Byproduct Safety

A minimum of two air blowers shall be provided. When determining the number of additional blowers required, the size and number of generating units and storage tanks shall be considered. At least one standby unit shall be installed and piped accordingly as a common standby unit in the event that one of the duty units is out of service.

Blowers shall be required to dilute the hydrogen gas in the generator outlet piping and the headspace of the storage tanks. The blower shall be designed to achieve a hydrogen-in-air concentration of 1% or less, which corresponds to 25% of hydrogen's lower explosive limit (LEL). The blowers shall vent to outside of the building, and shall be interlocked with the generation process to ensure that sodium hypochlorite is only generated when there is adequate dilution airflow.

A minimum of two hydrogen gas detectors shall be placed in each room, for the generation equipment and the storage tanks. The hydrogen gas detectors shall be located at the highest points in each room or immediately over the generating equipment and storage tanks and be set to alarm at 50% of hydrogen's LEL (2% hydrogen in air) and be interlocked to shut down the generation system.

A flow switch and pressure switch shall be located in the dilution air ducting prior to the exterior vent. The flow switch and the pressure indicator shall be intrinsically safe.

c. Salt Supply and Storage

The salt (sodium chloride) supply shall be NSF 60 approved and also meet any further levels of purity required by the generation equipment manufacturer to ensure no negative impacts on the equipment or the quality of the finished water.

Salt shall be stored in a cool dry place where the humidity does not regularly exceed 75%.

Salt storage capacity shall be for a minimum 30 days at maximum day chlorine demand, unless exempted by the Regional Director.

d. Minimum Generation Capacity

The sodium hypochlorite dosing system shall have the capacity to be turned down to meet the minimum day demand, and not exceed the required "free" or "combined" chlorine residual.

The entire system shall have the capacity to be able to meet the maximum day chlorine demand at maximum plant flow rate, and maintain the required concentration of "free" or "combined" chlorine residual.

The system shall produce a sodium hypochlorite solution that is always below 1% as chlorine.

e. Sodium Hypochlorite Solution Storage Requirements

The sodium hypochlorite solution shall be stored in a location where the ambient temperature is maintained between 5°C and 37°C. A minimum of one day's chlorine storage is required if there is a 100% redundant generation system, equal to the capacity of the largest generation unit, or else a minimum of two day's storage is required along with the ability to use commercial sodium hypochlorite.

The sodium hypochlorite solution shall be stored such that it is not exposed to UV radiation.

The material of construction of the storage tank(s) shall be suitable for storing commercial grade NaOCl (10%-16%). All storage tanks shall be fully enclosed and all piping connections and personnel accesses shall be completely sealed from the building interior.

Level measurement devices (switches, transmitters etc.) shall be located in all storage tanks and shall be intrinsically safe.

f. Sodium Hypochlorite Quality Controls

The quality of the sodium hypochlorite shall be such that the required disinfection objectives are met and that it does not negatively impact the quality of the treated water.

g. Minimum Generation System Controls and Instrumentation

Control of the feed rate shall be:

1. automatic / proportional controlled, whereby the sodium hypochlorite feed rate is automatically adjusted in accordance with the flow changes to provide a constant pre-established dosage for all rates of flow; or
2. automatic / residual controlled, whereby a continuous automatic chlorine analyzer determines the residual chlorine level and adjusts the rate of feed accordingly; or
3. compound loop controlled, whereby the feed rate is controlled by a flow proportional signal and residual analyzer signal to maintain a constant residual.

All systems shall be designed to have, water and brine flow indicator, cell level sensors, cell temperature sensors, tank level indicator, hydrogen dilution airflow pressure indication and dosing point residual indicator.

h. Electrolyzer Cleaning

Chemical cleaning frequencies, durations and procedures shall be in accordance with the recommendation made by the on-site generation system manufacturer.

Acidic cleaning solutions shall be neutralized prior to discharge.

i. Containment

Secondary containment shall be provided around the generation equipment, storage tanks and metering pumps. The containment shall include structures and valving to enable chemical neutralization prior to discharge.

j. Standby Provisions

Either a redundant generation system, equal to the capacity of the largest generation unit, or redundant storage to provide a minimum of two days sodium hypochlorite inventory at maximum chlorine demand and maximum plant flow rate, shall be provided.

The redundant storage shall allow for bulk commercial sodium hypochlorite storage. A mixing system including flow meters must be installed to enable the commercial sodium hypochlorite to be diluted to a 1% solution for proper dose control. The diluted product will be stored in the same storage tanks as the generated sodium hypochlorite is stored. All the necessary safety and ventilation systems shall be provided if the redundant storage approach is selected.

k. Residuals

The Regional Director shall determine the method of disposal of water softener regeneration waste, residual acid waste from cell cleaning, and any waste generated from tank cleaning.

l. Sodium Hypochlorite Generation Room Design Requirements

All rooms in which sodium hypochlorite is being generated shall be designed in accordance with the Alberta Building Code (occupancy, use etc.). If use of commercial sodium hypochlorite is provided in lieu of a redundant generating system, the design shall also comply with commercial sodium hypochlorite storage requirements.

1. Equipment Layout

Equipment layout will depend on the generation equipment selected and the size of the system. The general arrangements shall provide safe and convenient access to the generator cells, brine tank, softener, storage tank, metering pumps and ancillary equipment for routine inspection, cleaning, maintenance and repairs with sufficient clearances and means for equipment removal and replacement. The brine tanks shall be located such that they facilitate salt delivery and minimize the impacts of salt dust during loading.

2. Ventilation

The sodium hypochlorite room ventilation system shall be completely separate from the building ventilation system and be capable of exhausting the air to atmosphere, outside of the building. The air-

handling unit shall provide all the make-up air required for the hydrogen gas blowers, and the required ventilation. The quantity of outside air will be directly proportional to the number of dilution blowers operating.

Hydrogen dilution air outlets shall be above the roofline. The outlet shall be at least 150 mm above the roof and the point of discharge located to preclude contamination of air inlets to buildings or areas used by people. The vents to the outside shall have insect screens. Air inlets shall be louvered near the ceiling; the air temperature adjusted if required, as not to adversely affecting the sodium hypochlorite generation equipment.

3. Power Supply, Transformer/rectifier, for generation module.

The distance between the rectifier and the generation cells must meet the generation system manufacture's requirements.

Conductors and connectors shall be completely enclosed in protective insulation. No opening larger than 6 mm is permitted.

4. Room Access/Egress

Room access and egress shall be in accordance with the Alberta Building Code.

2. Chlorination Equipment Requirements

For all water treatment facilities, chlorine gas under pressure shall not be permitted outside the chlorine room. Chlorine room is the room where chlorine gas cylinders and/or ton containers are stored. Vacuum regulators shall also be located inside the chlorine room. Chlorine gas flow control and monitoring device may or may not be located inside the chlorine room.

For new and upgraded facilities, from the chlorine room, chlorine gas vacuum lines should be run as close to the point of solution application as possible. Injectors should be located to minimize the length of pressurized chlorine solution lines. A gas pressure relief system shall be included in the gas vacuum line between the vacuum regulator(s) and the chlorinator(s) to ensure that pressurized chlorine gas does not enter the gas vacuum lines leaving the chlorine room. The gas pressure relief system shall vent pressurized gas to the atmosphere at a location that is not hazardous to plant personnel; vent line should be run in such a manner that moisture-collecting traps are avoided. The vacuum regulating valve(s) shall have positive shutdown in the event of a break in the downstream vacuum lines.

As an alternative to chlorine gas, it is permissible to use sodium or calcium hypochlorite solution with positive displacement pumping. Anti-siphon valves shall be incorporated in the pump heads or in the discharge piping.

a. Capacity

The chlorinator shall have the capacity to dose enough chlorine to overcome the demand and maintain the required concentration of the "free" or "combined" chlorine.

b. Methods of Control

Chlorine feed system shall be automatic proportional controlled, or automatic residual controlled, or compound loop controlled.

Manual chlorine feed system may be installed for groundwater systems with constant flow rate.

c. Standby Provision

Standby chlorination equipment having the capacity to replace the largest unit shall be provided. For uninterrupted chlorination, gas chlorinators shall be equipped with an automatic changeover system. In addition, spare parts shall be available for all critical equipment.

d. Weigh Scales

Scales for weighing cylinders shall be provided at all plants using chlorine gas. At large plants, scales of the recording and indicating type are recommended. As a minimum, a platform scale shall be provided. Scales shall be of corrosion-resistant material.

e. Securing Cylinders

All chlorine cylinders shall be securely positioned to safeguard against movement. Tonne containers may not be stacked.

f. Chlorine Leak Detection

Automatic chlorine leak detection and related alarm equipment shall be installed at all water treatment plants using chlorine gas. Leak detection shall be provided for the chlorine rooms. Chlorine leak detection equipment should be connected to a remote audible and visual alarm system and checked on a regular basis to verify proper operation. Leak detection equipment shall not automatically activate the chlorine room ventilation system in such a manner as to discharge chlorine gas.

Chlorine leak detection equipment may not be required for very small chlorine rooms with an exterior door (i.e., floor area less than 3 m²).

g. Safety Equipment

The facility shall be provided with personnel safety equipment to include the following: Respiratory equipment; safety shower, eyewash; gloves; eye protection; protective clothing; cylinder and/or toner repair kits.

Respiratory equipment shall be provided which has been approved under the Occupational Health and Safety Act, General Safety Regulation - Selection of Respiratory Protective Equipment. Equipment shall be in close proximity to the access door(s) of the chlorine room.

3. Chlorine Room Design Requirements

Where gas chlorination is practiced, the gas cylinders and/or the ton containers up to the vacuum regulators shall be housed in a gas-tight, well illuminated, corrosion resistant and mechanically ventilated enclosure. The chlorinator may or may not be located inside the chlorine room. The chlorine room shall be located at the ground floor level.

a. Ventilation

Gas chlorine rooms shall have entirely separate exhaust ventilation systems capable of delivering one (1) complete air change per minute during periods of chlorine room occupancy only - there shall be no continuous ventilation. The air outlet from the room shall be 150 mm above the floor and the point of discharge located to preclude contamination of air inlets to buildings or areas used by people. The vents to the outside shall have insect screens. Air inlets should be louvered near the ceiling, the air being of such temperature as to not adversely affect the chlorination equipment. Separate switches for fans and lights shall be outside the room at all entrance or viewing points, and a clear wire-reinforced glass window shall be installed in such a manner as to allow the operator to inspect from the outside of the room.

b. Heating

Chlorine rooms shall have separate heating systems, if forced air system is used to heat the building. Hot water heating system for the building will negate the need for a separate heating system for the chlorine room. Cylinders or containers shall be protected to ensure that the chlorine maintains its gaseous state when entering the chlorinator.

c. Access

All access to the chlorine room shall only be from the exterior of the building. Visual inspection of the chlorination equipment from inside may be provided by the installation of glass window(s) in the walls of the chlorine room. Windows should be at least 0.20 m² in area, and be made of clear wire reinforced glass.

There should also be a 'panic bar' on the inside of the chlorine room door for emergency exit.

d. Storage of Chlorine Cylinders

If necessary, a separate storage room may be provided to simply store the chlorine gas cylinders, with no connection to the line. The chlorine cylinder storage room shall have access either to the chlorine room or from the plant exterior, and arranged to prevent the uncontrolled release of spilled gas. Chlorine gas storage room shall have provision for ventilation at thirty air changes per hour. Viewing glass windows and panic button on the inside of door should also be provided.

In very large facilities, entry into the chlorine rooms may be through a vestibule from outside.

e. Scrubbers

For facilities located within residential or densely populated areas, scrubbers shall be provided for the chlorine room. The scrubbers shall be sized to handle leaks at least equal to full release of chlorine from the largest single container in the room.

1.5.3.2 Ultraviolet Light

1. General

For UV reactors of nominal diameter 300 mm and smaller, the system design shall follow the standards set out in the most recent of the:

- USEPA Ultraviolet Disinfection Guidance Manual; or
- German Association on Gas and Water Technical Standard W 294: UV Systems for Disinfection in Drinking Water Supplies – Requirements and Testing; or
- NWRI / AWWARF Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse.

For UV reactors greater than nominal diameter 300 mm, the system design shall follow the standards set out in the most recent edition of the *USEPA Ultraviolet Disinfection Guidance Manual*.

For privately owned development consisting of a single building, UV reactors certified under ANSI / NSF 55A may be used to provide the required disinfection.

Ultraviolet (UV) light disinfection (using 200-300 nm wavelength) is an acceptable form of treatment for *Cryptosporidium*, *Giardia* and bacteria, but it shall be used in conjunction with at least one other disinfectant (free chlorine, chlorine dioxide, or ozone) to provide the specified log reduction of viruses after filtration credits have been considered and a stable distribution system residual (free chlorine, chloramines).

A UV dose is applied by passing water through an inline reactor containing low or medium-pressure UV lamps contained within quartz sleeves, and with the lamp, baffle spacing and their configuration designed to meet the required application. The UV dose for a field reactor is a validated calculated dose derived from light intensity (I) readings from online UV sensors that are a function of power level to the lamps and lamp age;

contact time (T) that is a function of flow rate and flow path through the reactor; the variable germicidal efficiency of different UV wavelengths; the absorption of different wavelengths by the water; and the impact of all of the above on the dose distribution produced by the reactor under the conditions of operation. The resulting dose distribution is the basis of determining the calculated effective UV dose delivered for any particular target organism, and from that dose, the effective logs reduction achieved. This calculated dose must however be validated to be in agreement with the empirically determined UV dose as determined in a bioassay.

2. UV System Location

The UV units shall be installed generally following filtration; this will provide some protection against fouling of the UV sleeve, and will utilize the water with the highest transmittance to UV in order to minimize the amount of UV equipment needed to deliver a target dose and also to minimize fluctuations in water quality that would require additional equipment to address the poorest of the water qualities. UV can be installed on a combined filter effluent or following individual filters. Reservoir effluent applications are less desirable because of the inability to monitor and address any "off-specification" water that might occur in the reservoir, and the greater risk of lamp/sleeve breakage at the higher water pressures (or high or low pressures from water hammer). Some UV lamps can run hot, and these units shall not be operated without water in the reactor (for medium pressure lamps, a temperature sensor is required to warn of any increase in temperature within the unit).

3. Validation

All UV models shall be validated full-scale (usually by the manufacturer through a third party). Validation is undertaken using acceptable test organisms, and with hydraulics that are defined as standard for such testing. Reactor validation establishes the acceptable operating range of the UV reactor and provides the information for design for specific sites. Daily monitoring confirms that performance continues to be met.

UV System Manufacturers shall validate performance using bioassay tests with organisms such as MS-2 bacteriophage or *Bacillus subtilis* spores for each UV system model. The dose-responses of each test organism should be determined in a collimated beam reactor (an ideal reactor). The bioassay results will be used to define the actual UV dose (Reduction Equivalent Dose or RED for the test organism) that is produced by the reactor being tested under the range of water quality and operating conditions over which the UV system was tested. Systems will need to demonstrate, the actual UV dose (Reduction Equivalent Dose or RED dose for the test organism) that is required to obtain the required RED for a particular target pathogen (e.g. it may require 30-40 mJ/cm² RED dose of a resistant test organism for a unit to meet the required 12 mJ/cm² RED dose for a less UV-resistant pathogen). The use of test organisms that have a similar or a slightly lesser UV sensitivity compared to the target pathogen will minimize the need for RED correction.

Validation of full-scale reactors shall be done on units with essentially the same hydraulic design, baffles and lamp layout as the full-scale installation and similar upstream and downstream piping and valving arrangements.

To obtain credit for UV disinfection, UV reactors shall be purchased from a supplier with formal third party reactor validation data that covers all the water quality and operating conditions to be encountered, and from which doses and organism inactivation levels can be determined for the relevant target design pathogens (e.g. *Giardia* & *Cryptosporidium*, enteric viruses, etc.). The validation certificate and/or report should list the acceptable range of operating conditions for the reactor (Min/Max Flow, UV %T range, lamp power levels, lamp age factor) under which the target design dose and target microbe inactivation levels can be achieved. It should also provide a full explanation of the manufacturers' dose calculation to obtain the desired inactivation levels. Reactors can use low pressure, low pressure / high out-put, or medium-pressure UV lamps.

4. UV % Transmittance (T)

Knowledge of the UV₂₅₄ absorbance/transmittance of the water to be treated is critical when designing for good performance of UV systems. Low UVT is usually due to high levels of dissolved organic material (DOC). Waters with UVT above 90% will usually work well with standard UV systems, 80-90% UVT will require more lamps and/or closer spacing, but waters with UVT less than 80% may require more design consideration and require appropriate validation of performance (it is more difficult to design with UVT less than 80%, since the power required to provide the required UV dose rises sharply as the %T decreases).

UV Percent Transmittance (UVT) is related to UV Absorbance (A) as per the following equation:

$$UVT = 100 \times 10^{-A}$$

Where the wavelength used is 254 nm, e.g. a UV₂₅₄ absorption coefficient of 0.050 cm⁻¹ = 89.1% (1 cm path length).

Design of UV systems should ideally be based on the worst-case water transmittance of at least 12 months of UVT data for each facility (e.g., using the 5th percentile of monthly, bimonthly or weekly samples). If the UVT needs to be improved, then pre-treatment ahead of UV should be considered (enhanced coagulation, PAC or GAC treatment). UVT measurements should be performed on water, as it would enter the reactor (no lab filtration or pH adjustment).

5. Fouling

UV installations may also experience problems due to fouling of the lamp sleeves if levels of iron, manganese, hardness, alum, alkalinity or other chemical parameters are above recommended limits. LSI (Langelier Saturation Index) and CCPP (Calcium Carbonate Precipitation Potential) indices should be close to zero. UV units should have on-line mechanical sleeve cleaning devices or provision for physical-chemical cleaning; this will handle most normal levels of possible contaminants.

6. Power Supply

UV reactors (medium pressure lamps) are sensitive to fluctuating power supply, and can take 5-10 minutes to restart if power drops off (voltage fluctuations, brown-outs,

momentary power-outs). Utilities should evaluate the reliability and quality of their power supply (if necessary backup power generators or UPS power supplies can be considered to limit the down – time of the power failure).

7. Chlorine Residual Reduction

If chlorine or combined chlorine residuals are present entering the UV reactor, the residual will decrease noticeably in passing the reactor. This effect is magnified if the water is receiving a higher UV dose e.g., due to turndown limits. Any chlorine, chloramines or permanganate residual present will decrease the UVT and such decreases should be incorporated into the design.

8. Broken Lamps/Mercury Spillage

Utilities shall develop an emergency response procedure for dealing with broken/cracked lamps/sleeves. The lamps contain a small amount of mercury, typically less than 1 gm per lamp and typically with modern lamp technology around 0.2 mg per watt of electrical power rating of the lamp. Any problems with lamp should be investigated to confirm whether breakage has occurred. The response for dealing with broken / cracked / lamps / sleeves should include notification of AEW, disposal of reactor water to waste where possible, and ongoing monitoring of water quality for mercury levels. One (1) gm of mercury dispersed in 1 ML of water would result in a 1 µg/L concentration (which is the current Health Canada Guideline MAC), so the risk from one lamp breakage is low. Multiple lamp breakages pose a higher risk. Lamp breakage offline (handling, storage, etc) should be handled with small mercury spill kits.

9. Maintenance Program

Utilities should develop a regular maintenance program to calibrate sensors, check lamps, quartz sleeves, lamp cleaning mechanisms, and to carry out UV lamp replacement as per the manufacturer's recommendation.

10. Contingency Plan

Utilities shall have in place a contingency plan for the possibility of total UV system outage.

11. Redundancy

The system shall be designed such that with the largest unit out of service, the remaining units shall provide the required disinfection.

1.5.3.3 Chlorine dioxide

Chlorine dioxide provides good cysts and virus protection but its use is limited by the restriction on the maximum residual of 0.5 mg/L ClO₂/chlorite/chlorate allowed in finished water. This limits usable residuals of chlorine dioxide at the end of a process unit to less than 0.5 mg/L. The effectiveness of chlorine dioxide also decreases with decrease in temperature.

Where chlorine dioxide is approved for use as an oxidant, the preferred method of generation is to entrain chlorine gas into a packed reaction chamber with a 25% aqueous solution of sodium chlorite (NaClO_2).

Warning: Dry sodium chlorite is explosive and can cause fires in feed equipment if leaking solutions or spills are allowed to dry out.

1.5.3.4 Ozone

Ozone is a very effective disinfectant for cysts, oocysts and viruses. Ozone becomes less effective in cold waters, which limits its application for oocyst inactivation under cold-water conditions. Ozone CT values shall be determined for the ozone basin alone; an accurate T_{10} value shall be obtained for the contact chamber, residual levels measured through the chamber and average ozone residual calculated. Ozone does not provide a system residual and should be used as a primary disinfectant only in conjunction with free and/or combined chlorine.

Ozone does not produce chlorinated by-products (such as trihalomethanes) but it may cause an increase in such by-product formation if it is fed ahead of free chlorine; ozone may also produce its own oxygenated by-products such as aldehydes, ketones or carboxylic acids. Any installed ozonation system shall include adequate ozone leak detection alarm systems, and an ozone off-gas destruction system.

Ozone may also be used as an oxidant for removal of taste and odour or may be applied as a pre-disinfectant.

Ozone production, operation and maintenance of ozonator shall be in accordance with USEPA's Alternative Disinfectants and Oxidants Guidance Manual – April 1999.

1.5.4 Fluoridation

1.5.4.1 General Requirements

In addition to the specific criteria outlined in this Section, all requirements specified under Section 1.7 – Potable Water Treatment Chemicals Standards should also be complied if fluoridation is practiced.

Any person proposing to add fluoride to a potable water supply shall apply for and obtain an approval or registration or an amendment to an approval or registration from AEW. This application shall contain the following information:

1. a copy of the bylaw of the municipal council, which provides the authority to fluoridate;
2. the number of the appropriate approval or registration issued with respect to the existing municipal plant; and
3. an engineering report, including:
 - a. a description of the proposed fluoridation equipment,
 - b. a statement identifying the fluoride compound that is proposed to be added,
 - c. a description of chemical storage and ventilation,
 - d. a description of the water metering used at the water treatment plant,

- e. the generic name of the chemical to be used as the source of fluoride ion, and its fluoride content,
- f. a current chemical analysis of the fluoride content of the raw water,
- g. the name and qualifications of the person directly responsible for the operation of the proposed fluoridation process,
- h. the type of equipment proposed at the water treatment plant to determine the fluoride concentration of the water, and
- i. the description of the testing procedure to be used to determine the fluoride level of the water.

1.5.4.2 Chemical Feed

The equipment used for feeding the fluoride to water shall be accurately calibrated before being placed in operation, and at all times shall be capable of maintaining a dose within 5% of the rate at which the machine is set.

The following chemical feed practices apply:

1. Where a dry feeder of the volumetric or gravimetric type is used, a suitable weighing mechanism shall be provided to check the daily amount of chemical feed;
2. Hoppers should be designed to hold a 24-hour supply of the fluoride compound and designed such that the dust hazard to operators is minimized;
3. Vacuum dust filters shall be installed with the hoppers to prevent dust from rising into the room when the hopper is filled;
4. Dissolving chambers are required for use with dry feeders, and the dissolving chambers shall be designed such that at the required rate of feed of the chemical the solution strength will not be greater than 1/4 of that of a saturated solution at the temperature of the dissolving water. The construction material of the dissolving chamber and associated piping shall be compatible with the fluoride solution to be fed;
5. Solution feeders shall be of the positive displacement type and constructed of material compatible with the fluoride solution being fed;
6. The weight of the daily amount of fluoride fed to water shall be accurately determined;
7. Feeders shall be provided with anti-siphon valves on the discharge side. Wherever possible, positive anti-siphon breakers other than valves shall be provided;
8. A "day tank" capable of holding a 24-hour supply of solution shall be provided for systems not equipped with on-line continuous fluoride monitors;
9. All equipment shall be sized such that it will be operated in the 20 to 80 percent range of the scale, and are capable of feeding over the entire pumpage range of the plant;
10. Alarm signals are recommended to detect faulty operation of equipment; and
11. The fluoride solution should be added to the water supply at a point where any treatment processes following the point of addition would not remove the fluoride and where it will be mixed with the water. It is undesirable to inject the fluoride compound or solution directly on-line unless there are provisions for adequate mixing.

1.5.4.3 Metering

Metering of the total water to be fluoridated shall be provided, and the operation of the feeding equipment is to be controlled unless specifically exempted by AEW. Control of the feed rate shall be:

1. Automatic / proportional controlled, whereby the fluoride feed rate is automatically adjusted in accordance with the flow changes to provide a constant pre-established dosage for all rates of flow; or
2. Automatic / residual controlled, whereby a continuous automatic fluoride analyzer determines the residual fluoride level and adjusts the rate of feed accordingly; or
3. Compound loop controlled, whereby the feed rate is controlled by a flow proportional signal and residual analyzer signal to maintain a constant residual.

1.5.4.4 Alternate Compounds

Any one of the following fluoride compounds may be used:

1. Fluorosilicic acid;
2. Sodium fluoride; or,
3. Sodium silicofluoride.

Other fluoride compounds may be used if approved by AEW.

1.5.4.5 Chemical Storage and Ventilation

The fluoride chemicals storage area shall be marked "FLUORIDE CHEMICALS ONLY". The storage area should be in close proximity to the feeder, kept relatively dry, and provided with pallets, if using bagged chemical, to allow circulation of air and to keep the containers off the floor.

1.5.4.6 Record of Performance Monitoring

Accurate daily records shall be kept. These records shall include:

1. the daily reading of the water meter, which controls the fluoridation equipment or that which determines the amount of water to which the fluoride is added;
2. the daily volume of water fluoridated;
3. the daily weight of fluoride compound in the feeder;
4. the daily weight of fluoride compound in stock;
4. the daily weight of the fluoride compound fed to the water; and
5. the fluoride content of the raw and fluoridated water determined by laboratory analysis, with the frequency of measurement as follows:
 - a. treated water being analyzed continuously or once daily, and
 - b. raw water being analyzed at least once a week.

1.5.4.7 Sampling

In keeping the fluoride records outlined in Section 1.5.4.6, the following sampling procedures are required:

1. A sample of raw water and a sample of treated water shall be forwarded to an approved independent laboratory for fluoride analysis once a month;
2. On new installations or during start-ups of existing installations, weekly samples of raw and treated water for a period of not less than four consecutive weeks (or for a period as required by AEW) shall be submitted to either AEW or other designated laboratory to determine the fluoride concentration; and
3. In addition to the reports required, AEW may require other information that is deemed necessary.

1.5.4.8 Safety

The following safety procedures shall be maintained:

1. All equipment shall be maintained at a high standard of efficiency, and all areas and appliances shall be kept clean and free of dust. Wet or damp cleaning methods shall be employed wherever practicable;
2. Personal protective equipment shall be used during the clean-up, and appropriate covers shall be maintained over all fluoride solutions;
3. At all installations, safety features are to be considered and the necessary controls built into the installation to prevent an overdose of fluoride in the water. This shall be done either by use of day tanks or containers, anti-siphon devices, over-riding flow switches, sizing of pump and feeders, determining the length and duration of impulses, or other similar safety devices as approved by AEW;
4. Safety features shall also be provided to prevent spills and overflows as determined by AEW;
5. Individual dust respirators, chemical safety face shields, rubber gloves, and protective clothing shall be worn by all personnel when handling or being exposed to the fluoride dust;
6. Chemical respirators, rubber gloves, boots, chemical safety goggles and acid proof aprons shall be worn where acids are handled;
7. After use, all equipment shall be thoroughly cleaned and stored in an area free of fluoride dusts. Rubber articles shall be washed in water, and hands shall be washed after the equipment is stored; and
8. All protective devices, whether for routine or emergency use, shall be inspected periodically and maintained in good operating condition.

1.5.4.9 Repair and Maintenance

Upon notifying AEW and the appropriate Regional Health Authority, a fluoridation program may be discontinued permanently or temporarily when necessary to repair or replace equipment. If discontinued temporarily, fluoridation shall commence immediately after the repair or

replacement is complete. Records shall be maintained and submitted during the period that the equipment is not in operation.

1.5.5 Health and Safety Act

The design and construction of all components of the waterworks system shall conform to the safety provisions of the Alberta Occupational Health and Safety Act and Regulations.

1.6 Waterworks Systems Operation Standards

1.6.1 System Operation Program

The proper operation and maintenance of waterworks system is essential to ensure ongoing sustained production and delivery of the best quality drinking water that is both wholesome and protective of public health. Thus, the system owner / operator shall develop an operation program to include routine operational procedures, monitoring and analytical procedures, emergency response planning, corrective action measures, cross-connection controls, etc. to ensure a reliable and well operated waterworks system. The operations program shall contain, at a minimum, all of the information in Table 1.4.

1.6.2 Reliability

The waterworks system shall provide an adequate quantity of safe drinking water in a reliable manner at all times. In determining whether a proposed public water system or an expansion or modification of an existing system is capable of providing an adequate quantity of water, the owner shall consider the immediate as well as the reasonably anticipated future needs of the system's consumers.

The owner shall prepare a Bacteriological Quality Monitoring Plan to include at a minimum, a system map or diagram showing the locations of:

1. water source;
2. storage, treatment and pressure regulation facilities;
3. distribution system;
4. pressure zones; and
5. sample collection sites.

The plan should be revised or expanded at any time the plan no longer ensures representative monitoring of the system. The Bacteriological Monitoring Plan should be made available to AEW for inspection upon request.

The owner shall ensure that the system is operated and maintained properly, and has appropriate backup facilities to protect against failures of the power supply, treatment process, equipment, or structure. Security measures shall address the safety of water source, water treatment processes, water storage facilities and the distribution system.

Water pressure at the customer's property line shall be maintained at the approved design pressure under maximum hourly design flow conditions. The minimum distribution pressure during peak demand design flow shall be 150 kPa.

1.6.3 Operations

1. The waterworks system shall be managed and operated in accordance with the AEW approval or the appropriate code of practice for the facility. The facility shall meet the minimum treatment performance requirements as outlined in Section 1.3, and the treated water shall meet the water quality as outlined in Section 1.1.
2. The plant shall be operated within its design capacity to supply treated water.
3. The owner shall not establish nor maintain a by-pass to divert water around any feature of a treatment process unless the Regional Director has approved the by-pass.
4. The owner shall not operate the plant when critical treatment equipment is inoperable.
5. The owner shall take preventative or corrective action when results of an inspection conducted by the Regional Director or monitoring reports indicate conditions, which are currently or may become a detriment to system operations.
6. The owner shall endeavour to protect waterworks systems from contamination due to cross-connections.
7. The owner shall develop and implement a cross-connection control program. The scope and complexity of the program should be directly related to the size of the system and the potential public health risk.

When an existing cross-connection poses a potential health or system hazard, the owner shall shut off water service until the cross-connection has been eliminated or controlled by the installation of a proper backflow prevention assembly.

Table 1.4
Operations Program Contents

1. Routine Operational Procedures, which shall, at a minimum, include:
 - a. contact name and telephone numbers for the system owner, system operator, engineering consultants and equipment suppliers,
 - b. operating instructions:
 - i. general description of treatment process and operating procedures;
 - ii. performance requirements; and
 - iii. location of equipment major controls
 - c. general maintenance schedule; and
 - d. general maintenance instructions for:
 - i. treatment / process equipment;
 - ii. monitoring equipment; and
 - iii. pumping equipment; and
 - e. the schedule and procedures for cleaning and flushing of the water distribution system, including potable water storage reservoirs.
2. Routine Operational Procedures for Monitoring and Analysis, which shall, at a minimum, include:
 - a. operational and compliance tests to be performed,
 - b. bacteriological quality monitoring plan,
 - c. methods used for monitoring and analysis,
 - d. locations of monitoring points; and
 - e. laboratory data quality assurance information.
3. Emergency Response Plan, which shall, at a minimum, include steps to be taken in the event of the following:
 - a. bacteriological results exceeding the prescribed limits,
 - b. turbidity / particle counts exceeding the limits,
 - c. chemical overfeed,
 - d. no chemical or coagulant feed,
 - e. low chlorine residual,
 - f. equipment breakdown,
 - g. flood,
 - h. water distribution system pipeline break and repair, and the return of the pipeline to service,
 - i. power failure,
 - j. the waterworks system becoming inoperable, including steps in providing an alternate potable water supply, and
 - k. list of contacts; Alberta Environment and Water, Alberta Health Services, Fire Department, Disaster Coordinator, and other agencies.
4. Date of last update.

1.7 Potable Water Treatment Chemical standards

1.7.1 Use, Storage and Handling

The use, storage and handling of any hazardous chemicals at the water treatment plant shall be in accordance with the federal and provincial legislation for Workplace Hazardous Materials Information System (WHMIS).

1.7.2 Direct and Indirect Additives

The American National Standards Institute and National Sanitation Foundation Standards (ANSI/NSF) 60 and 61 shall be used to control potential adverse human health effects from products in contact with or added to water directly for treatment or indirectly during treatment, storage or transmission as follows:

1.7.2.1 Indirect Additives

All substances, materials or compounds (e.g. pipes, coatings, filter media, solders, valves, gaskets, lubricants, resins, process equipment, etc.) that may come in contact with water in the waterworks being treated to be potable and water that is potable shall conform to ANSI/NSF Standard 61 for health effects and the product certified for potable use by an agency accredited by the Standards Council of Canada, e.g. NSF, CSA, UL, etc.

The following exceptions apply:

- Any materials listed in the current NSF Standard 61 "Annex C".
- Existing waterworks (unless otherwise notified by the Regional Director).
- Portland cement based concrete. However, the Portland cement, any admixtures used in the concrete and concrete coatings shall be certified.
- If NSF certification does not exist for any substance, material or compound, the Regional Director, at his discretion, may approve formal food grade certification by a recognized agency (Health Canada, FDA, etc.).

1.7.2.2 Direct Additives

All substances, materials or compounds (e.g. coagulants, disinfectants, polymers, fluoride, ammonia, phosphates, caustic soda, etc.) that are added to water in the waterworks being treated to be potable and water that is potable shall conform to ANSI/NSF Standard 60 for health effects and the product certified for potable use by an agency accredited by the Standards Council of Canada, e.g. NSF, CSA, UL, etc.

The following exception applies:

- Materials, which are insoluble and non-reactive with the water or with other materials in the water and which are fully removed as part of the process (e.g. ballast sand, etc.). These materials shall be considered as materials that come in contact with the water.

Note: AWWA standards are recommended for setting specifications and checking product quality.

1.8 Potable Water Treatment Plant Waste – Handling and Disposal Standards

Provision shall be made for adequate treatment and/or disposal of all water treatment plant wastes. These include sanitary wastes, filter backwash, filter-to-waste and sludges.

1.8.1 Sanitary Wastes

All sanitary wastes from water treatment plants shall be handled by direct discharge to a sanitary sewer system or to an approved or registered wastewater treatment facility. No wastewater lines shall pass through potable water reservoirs.

1.8.2 Filter Backwash

Backwash wastewater may be discharged directly to a sanitary sewer system, if the sewers and the wastewater treatment plant can withstand the hydraulic surges.

Backwash wastewater is not to be discharged directly to an open body of water, unless it can be demonstrated that there are no significant adverse effects on the receiving body of water. Based on the quantity and quality of backwash waste and the sensitivity of the receiving body of water, AEW may request for an impact assessment study to ascertain the need for backwash waste treatment before discharging to the environment.

Recycle of filter backwash water will be permitted for a conventional system if the filter backwash water receives off-line treatment, or is equalized to minimize turbidity spikes and restrict the recycle flow to less than 10% of the raw water flow. Equalized filter backwash water shall be returned to a location upstream of the coagulant dosage point, so that all processes of a conventional plant are employed. Direct recycle of filter backwash water to a location upstream of the coagulant dosage point will be permitted providing that the conventional process is designed to accommodate the variations in raw water feed quality and flow rates that will occur. Recycling of filter backwash water will not be permitted for a direct-filtration system unless it receives off-line treatment.

1.8.3 Filter-to-Waste

Filter-to-waste may be discharged directly to a sanitary sewer system, if the sewers and the wastewater treatment plant can withstand the hydraulic surges. Filter-to-waste may also be recycled back into the head works without further treatment, or recycled back immediately upstream of the filters if the flow does not exceed 10% of the total inflow into the filters.

1.8.4 Sludges

Sludges generated at water treatment plants shall be treated and handled in a manner approved by AEW. The following sections deal with the various coagulant and softening sludges, and also outline the alternative methods of treatment and disposal.

1.8.4.1 Aluminum Sludge

Approval for the disposal of aluminium sludge shall be obtained on a site-specific basis. The following methods of handling and disposing of aluminum sludge may be used:

1. Direct discharge to a wastewater treatment plant or sanitary sewer. Consideration should be given to the potential beneficial and adverse effects on the wastewater treatment facility.
2. Lagooning. Lagoons can be used as permanent storage facilities, long-detention settling lagoons to provide freeze/thaw cycle with supernatant disposal, or drying beds using evaporation.
3. Mechanical thickening and dewatering. Once thickened and dewatered to approximately 20% solids, sludge can be placed at an approved disposal site, usually a landfill site used exclusively for sludge.
4. Direct discharge to a stream. This option will be approved only where there is a negligible environmental impact and it has been demonstrated that the aesthetics and downstream water users will not be affected. This option should only be considered if alternate management options are unavailable.
5. Land disposal. Land disposal to a sanitary landfill site or agricultural land of dilute or thickened and dewatered sludge is potentially harmful and shall be thoroughly reviewed with the approving authority prior to implementation.
6. Alum recovery. Alum recovery and re-use at water treatment plants is not considered a viable option; concerns with recovery costs and recycle of organics and heavy metals are the major reasons for rejection of this sludge handling alternative. It may, however, be feasible to recover water treatment plant alum sludge for re-use at a wastewater treatment plant utilizing chemical precipitation of phosphorus.
7. Reduction of sludge quantity. A reduction in the quantity of solids is possible by utilizing a number of management practices including pre-sedimentation by raw water storage, the use of polymer, or the effective design and operation of the coagulation/flocculation facilities.

1.8.4.2 Lime Sludge

Handling and disposal methods are similar to those for alum sludge (see Section 1.8.4.1), however under no circumstances may lime sludge be discharged directly to any watercourse in Alberta. Application shall be made to AEW for disposal of lime sludge on a case specific basis.

Because of potential deposition problems, the practice of lime sludge disposal to sewers is not recommended.

1.8.4.3 Sludges from Other Coagulants

There are a number of coagulants (such as ferric/ferrous compounds, polymers, polyelectrolytes and sodium aluminate), which are an alternative to aluminium-based coagulants. The handling and disposal of these other chemical sludges shall be approved by AEW on a site specific basis.

1.9 Potable Water Transmission and Distribution Main Standards

1.9.1 Pipe Performance Standards

Where pipe performance standards exist, all materials that are used in the construction of the plant, transmission and distribution systems shall meet or exceed AWWA and/or CSA standards.

1.9.2 Frost Protection for Mains and Reservoirs

1.9.2.1 Mains

To prevent freezing and damage due to frost, pipes shall have a minimum cover above the crown of the pipe of:

1. 2.5 m, or
2. the depth of frost penetration for the location based on the coldest three years during the past 30 years, or, where this period of record is not available, the coldest year during the past 10 years with an appropriate safety factor.

Where these minimum frost protective covers cannot be achieved, AEW may allow an exemption if the owner can demonstrate incorporation of appropriate special precautions in the selection of pipe, bedding and insulation material.

1.9.2.2 Reservoirs

All treated water reservoirs, holding tanks, or storage water facilities shall have suitable watertight roofs to prevent reintroduction of contaminants that the treatment plant was designed to remove. A suitable cover shall be provided for access into the reservoir. Covers shall be made be watertight, and constructed so as to provide drainage away from the cover and prevent entrance of contamination into the stored water.

Reservoirs and appurtenances (such as overflows and vents) shall be designed to prevent reservoir contamination and damage from freezing. Elevated tanks and standpipes shall be insulated and hot water re-circulated, or heat traced, to prevent problems associated with ice formation.

1.9.3 Cross-Connection Controls

There shall be no physical connection between any waterworks systems and a sanitary or storm sewer that may allow the passage of wastewater into the potable water supply. Further, to prevent potential contamination, and avoid re-growths, no cooling water shall be returned into the potable water system.

The following cross-connection controls are necessary to preclude the entrance of contaminants into the water distribution system.

1.9.3.1 Horizontal Separation of Water Mains and Sewers

A watermain is defined as a pipeline that conveys water and forms an integral part of the water distribution system as defined in EPEA.

Unless otherwise approved by AEW, the minimum horizontal separation between a watermain and a storm or a sanitary sewer or manhole shall be 2.5 m, the distance being measured centre to centre.

Unusual conditions including excessive rock, dewatering problems, or congestion with other utilities may prevent the normal required horizontal separation of 2.5 m. Under these condition(s), AEW may approve a lesser separation distance, provided that the crown of the sewer pipe is at least 0.5 m below the watermain invert.

Where extreme conditions prevent the 2.5 m separation and vertical separation cannot be obtained, the sewer shall be constructed of pipe and joint materials, which are equivalent to watermain standards.

Under no circumstances shall the horizontal separation be less than 1.0 m.

1.9.3.2 Pipe Crossings

Under normal conditions, water mains shall cross above sewers with a sufficient vertical separation to allow for proper bedding and structural support of the water and sewer mains.

Where it is necessary for the watermain to cross below the sewer, the watermain shall be protected by providing:

1. a vertical separation of at least 0.5 m from watermain crown to sewer invert;
2. structural support of the sewer to prevent excessive joint deflection and settling; and
3. centering of the length of watermain at the point of crossing so that the joints are equidistant from the sewer.

1.9.3.3 Valve, Air Relief, Meter and Blow-Off Chambers

Chambers or pits containing valves, blow-offs, meters, or other water distribution appurtenances shall not be directly connected to a storm or sanitary sewer, nor shall blow-offs or air relief valves be directly connected to any sewer.

1.9.3.4 Backflow Prevention and Control

Backflow preventers shall be installed at any location where a connection is made to an approved waterworks system for the purpose of serving a hamlet, municipal development, privately owned development or a truck fill station located outside the service boundary of the approved waterworks system. Backflow preventers shall be installed in accordance with the latest edition of the Cross Connection Control Manual, published by AWWA (Western Canada Section).

1.9.4 Disinfection of Mains and Reservoirs

1.9.4.1 Mains

All new water mains shall be disinfected and flushed before being put into service in accordance with the latest edition of AWWA Standard C651 for Disinfecting Water Mains.

For existing water mains that are repaired, the line must be flushed until chlorine residual and turbidity levels are within normal operating ranges (average turbidity < 2.0 NTU and total chlorine residual > 0.1 mg/L), before putting the main back into service. Samples must be collected at the same time to determine the bacteriological quality of the water. The existing main may be returned to service prior to the completion of bacteriological testing in order to minimize the time customers are without water.

1.9.4.2 Reservoirs

Treated water storage reservoirs shall also be disinfected and flushed before being put into service, in accordance with the latest edition of AWWA Standard C652 for Disinfecting Reservoir.

1.9.4.3 Discharge of Superchlorinated Water

Chlorinated water used for disinfection of mains and reservoirs shall not be directly drained into the storm sewer or into an open body of water; dechlorination is required before being discharged into the environment.

Super chlorinated water may be discharged into a wastewater system, if the sewer by-law of the municipality allows this discharge.

1.9.5 Layout

Water distribution systems shall be designed to eliminate dead-end sections, whenever possible. In cases where newly constructed dead-end mains are unavoidable, flushing devices shall be installed to prevent stagnation and to facilitate return to service procedures following repairs. These devices may include hydrants, blow-off valves, stand pipes equipped with gate valves or other devices designed to adequately flush dead-end mains.

1.10 Potable Water Quality Performance Monitoring Standards

1.10.1 General

Establishing reasonable and appropriate monitoring requirements for waterworks facilities is a key factor in ensuring safe drinking water. Alberta Environment and Water considers monitoring to fall into one of the following general categories:

1. Operational monitoring (See section 2.3.8);
2. Treatment Performance and Compliance monitoring; and
3. Follow-up or Issue Oriented monitoring.

"Operational monitoring" consists of the sampling regime for proper operation of the waterworks system. The use of these parameters by the system operator to monitor operation is discretionary.

"Treatment Performance and Compliance monitoring" and "Follow-up or Issue Oriented monitoring" consists of the sampling regime that is required to ensure ongoing sustained

production and delivery of high quality of drinking water. These are minimum mandatory requirements, and shall be complied with.

1.10.2 Analytical Requirements

1. With respect to any monitoring required pursuant to this Section, all samples shall be collected, preserved, stored, handled; and analyzed in accordance with:
 - a. the *Standard Methods for the Examination of Water and Wastewater*, published by the American Public Health Association, the American Waterworks Association and the Water Environment Federation, as amended or replaced from time to time; or
 - b. a method authorized in writing by the Regional Director.
2. With respect to monitoring of cysts and oocysts, all samples shall be collected, preserved, stored, handled; and analyzed in accordance with the USEPA Methodology 1623.
3. Any analysis of a sample required pursuant to this Section, shall be done only in an approved laboratory, unless otherwise specified in writing by the Regional Director.
4. Only the Alberta Provincial Laboratory shall conduct any analysis of a sample for bacteriological quality required pursuant to this Section for Public Health, unless otherwise specified in writing by the Regional Director.
5. Where on-line instruments are specified or allowed, such instruments shall be kept maintained and calibrated in accordance with the manufacturer's recommendations.

1.10.3 Compliance Monitoring

This section outlines the specific parameters that have to be monitored to ensure that water is safe, including the sampling locations and the monitoring frequencies.

1.10.3.1 Bacteriological

All systems shall comply with the following with respect to meeting monitoring frequency and bacteriological quality in potable water:

1. **Sampling Location**

Bacteriological samples shall be collected from representative points after treatment and throughout the distribution system after the first service connection.
2. **Monitoring Frequency**

The number of required routine samples shall be in accordance with the GCDWQ, or as directed by AEW. The sampling shall be evenly distributed through the sampling period.

3. Invalid Samples

When a bacteriological sample is determined invalid by the laboratory, the owner shall:

- a. not include the sample in the required number of samples; and
- b. collect and submit for analysis, an additional drinking water sample from the same location as each invalid sample within twenty-four hours of notification by the laboratory or AEW.

4. Compliance Criteria

Compliance criteria for bacteriological quality shall be in accordance with GCDWQ.

1.10.3.2 Physical Parameters, Organic & Inorganic Chemicals and Pesticides

1. Parameters to be monitored

A complete analysis shall consist of the primary and secondary substances and should include all physical parameters, organic and inorganic chemicals and pesticides. The primary substances are those substances with MACs in the GCDWQ and which are known to cause adverse effects on health. The secondary substances are those substances with AOs in the GCDWQ with limits below those considered to constitute no health hazard and the parameters with Operational Guidance Value, and some of the parameters without guidelines identified in the GCDWQ:

- a. Physical parameters (Primary and Secondary)
colour, pH, total dissolved solids, turbidity and UV absorbance (not in the GCDWQ);
- b. Inorganic chemicals (Primary)
antimony, arsenic, barium, boron, bromate, cadmium, chloramines, chromium, cyanide, fluoride, lead, mercury, nitrate and nitrite, selenium, and uranium;
- c. Inorganic and Organic Chemicals (Secondary)
aluminum, ammonia, calcium, chloride, copper, hardness, iron, magnesium, manganese, silver, sodium, sulphate, sulphide, total organic carbon, xylenes (total) and zinc
- d. Organic Chemicals and Pesticides (Primary)
Atrazine +metabolites, benzene, benzo(a)pyrene, bromoxynil, carbon tetrachloride, chlorpyrifos, cyanazine, cyanobacterial toxins (as microcystin – LR – for surface water systems only), diazinon, dicamba, dichlorobenzene 1, 2-, dichlorobenzene 1,4-, dichlorethane 1, 2-, dichloromethane, 2, 4- dichlorophenol, 2, 4-D, diclofop-methyl, diuron, dimethoate, ethylbenzene, glyphosate, malathion, methoxychlor, metolachlor, metribuzin, monochlorobenzene, nitrilotriacetic acid (NTA), pentachlorophenol, picloram, simazine, terbufos, tetrachloroethylene, tetrachlorophenol 2, 3, 4, 6-, toluene, triallate, trichloroethylene, trichlorophenol 2, 4, 6-, trifluralin, vinyl chloride.

For specific systems, the Regional Director, at his or her discretion, may revise the list of primary and secondary substances to be monitored.

2. Sampling Location

- a. The samples shall be collected from a point representative of each source, after treatment, and prior to entry to the distribution system. The point of collection shall be designated as "Sampling Location" and confirmed by AEW.
- b. For multiple sources or well fields within a single system, in which water is blended prior to entry into the distribution system, the samples should be collected after treatment, within the water distribution system, at a location where the water from all well fields has been blended.

Each sample shall be taken at the same point unless conditions make another sampling point more representative of the water produced by the treatment plant.
- c. For multiple sources or well fields within a single system, in which water is not blended prior to entry into the distribution system, the samples should be collected after treatment at least in one of the wells, at the point of entry into the water distribution system.
- d. When treatment is provided for one or more contaminants, AEW would require sampling before treatment for the affected parameter. The "Source Sampling Location" for raw water supply should be confirmed by AEW. For groundwater supply requiring treatment, each well should be sampled at the source.

Note: Lead and copper sampling shall be done within the distribution system on a flushed cold-water sample.

3. Monitoring Frequency

- a. The frequency of monitoring conducted to determine compliance with the MACs and AOs for the primary and secondary substances shall be once per year for groundwater supplies and twice per year, once in the summer and once in the winter, for surface water supplies at each designated "Sampling Location". For groundwater requiring treatment, one additional sample shall be required at each "Source Sampling Location."
- b. For high quality groundwater systems, where the results of sampling indicate that AOs and MACs have not exceeded, the frequency of monitoring may be reduced to once every three years for physical and inorganic chemical parameters, and once every five years for organic chemical and pesticide parameters.
- c. For waterworks systems consisting solely of a water distribution system, no monitoring is required for organic chemicals and pesticides. Physical and inorganic chemical parameters shall be monitored once every three years.
- d. Where the results of sampling indicate that MACs have been exceeded, AEW will require that one additional confirmation sample be collected as soon as possible (but not to exceed two weeks) after the initial sample results are received. Systems that exceed the MACs in confirmation samples shall monitor quarterly beginning in the next quarter after the violation occurred, or as directed by AEW. The owner may revert back to the frequencies specified in sub-section 1.10.3.2(3)(a) above, provided that the system is reliably and consistently

producing water below the MACs. AEW will make this determination based on a minimum of two quarterly samples for groundwater systems, and a minimum of four quarterly samples for surface water systems.

- e. For high quality water well fields within a single system, in which water is not blended prior to entry into the distribution system, at least one well shall be monitored each year, and rotated so that all wells have been monitored within the previous three years.

4. Compliance

- a. For systems that are monitoring once a year, the system is out of compliance, if the level of a substance at any sampling point is greater than the MAC. If a confirmation sample is required by AEW, the determination of compliance will be based on the average of the two samples.
- b. For systems that are monitoring at a frequency greater than once a year, compliance with the MACs is determined by a running annual average at any sampling point. If the average at any sampling point is greater than the MAC, then the system is out of compliance. Any sample below the detection limit shall be calculated at zero for the purpose of determining the annual average.

1.10.3.3 Turbidity

All systems requiring turbidity reduction shall comply with the following:

1. Source Water Turbidity Monitoring

Source water turbidity shall be monitored at least once per day on a representative sample collected before the addition of any chemicals.

2. Treated Water Turbidity Monitoring

For rapid sand filtration, slow sand filtration, membrane filtration and cartridge filtration systems, treated water turbidity shall be monitored at all individual filters / filter modules upstream of the clear water tank, and at the combined filter effluent line. The measurements shall be made continuously at no more than five-minute intervals with an on-line turbidimeter.

3. Compliance

System compliance for turbidity shall be in accordance with the Performance Standards detailed in Section 1.3.1.

1.10.3.4 Fluoride

All systems practicing fluoridation shall comply with the performance monitoring and performance requirements detailed in Section 1.5.4.6 and Section 1.3.3 respectively.

1.10.3.5 Iron and Manganese

All systems practicing iron and manganese reduction shall comply with the following:

1. Source Water Monitoring

Source water iron and manganese shall be monitored at least once per week, at a location prior to any chemical addition or treatment unit.

2. Treated Water Iron and Manganese Monitoring

Treated water iron and manganese shall be monitored after treatment, at the point of entry into the water distribution system. If monitored by taking grab samples, the frequency of sampling shall be based on one sample per day, five days per week, except on statutory holiday if it falls on a monitoring day within that week. If monitored continuously, one sample should be taken every five minutes with an on-line meter.

3. Compliance

Compliance criteria for iron and manganese, where iron and manganese removal are practiced, shall be 0.3 mg/L and 0.08 mg/L respectively.

1.10.3.6 Trihalomethanes and Bromodichloromethane

1. Sampling Location and Monitoring Frequency

a. Surface Water Systems serving a population greater than 10,000 people

Surface water systems, providing water treated with chlorine shall monitor as follows:

i. Collect four samples per treatment plant every month. For systems that exceed the MAC, increased frequency may be required during peak by-product formation periods. The samples should be taken within a twenty-four hour period. One of the samples should be taken at the water treatment plant, one from the extreme end of the distribution system and the other two samples from representative locations in the distribution system. The samples should be analyzed for total trihalomethanes (TTHM) and bromodichloromethane (BDCM).

ii. If the TTHM results from the same location (based on running annual average from the previous 12 months), and the BDCM results (based on any single result) are less than the respective MAC, subsequent monitoring shall be conducted, at a minimum, in the following manner:

A. Collect four samples per treatment plant every three months, unless otherwise authorized in writing by the Regional Director. The samples should be taken within a twenty-four hour period. One of the samples should be taken at the water treatment plant, one from the extreme end of the distribution system and the other two samples from representative locations in the distribution system. The samples should be analyzed for TTHM and BDCM.

b. Surface Water Systems serving a population less than 10,000 people

Surface water systems, providing water treated with chlorine shall monitor as follows:

- i. Collect four samples per treatment plant every three months. The samples should be taken within a twenty-four hour period. One of the samples should be taken at the water treatment plant, one from the extreme end of the distribution system and the other two samples from representative locations in the distribution system. The samples should be analyzed for total TTHM and BDCM.
- ii. If the TTHM results (based on running annual average from the previous 12 months) and the BDCM results (based on any single result) are less than the respective MAC, subsequent monitoring shall be conducted, at a minimum, in the following manner:
 - A. Collect one sample per treatment plant every three months from the extreme end of the distribution system, unless otherwise authorized in writing by the Regional Director. The sample should be analyzed for total TTHM and BDCM.

c. High Quality Groundwater Systems

- i. New and existing systems with no TTHM or BDCM data, and with total organic carbon (TOC) > 2 mg/L in the raw water:

These systems shall monitor every quarter at the furthest point in the distribution system for one year to establish seasonal variations. If no sample exceeds 100 µg/L for TTHMs and 16 µg/L for BDCM, then the frequency of monitoring may be reduced to once every three years or as determined by the Regional Director.

- ii. New and existing systems with no TTHM or BDCM data, and with TOC < 2 mg/L in the raw water:

These systems shall monitor twice a year, once in the summer and once in the winter, at the furthest point in the distribution system to establish seasonal variations. If no sample exceeds 100 µg/L for TTHMs and 16 µg/L for BDCM, then the frequency of monitoring may be reduced to once every three years or as determined by the Regional Director.

- iii. Existing Systems with historical data and TOC < 2 mg/L in the raw water:

If there are samples collected under current disinfection practices:

- A. covering two or more seasons (summer/winter) and indicate less than 100 µg/L TTHM and less than 16 BDCM, would require sampling once every three years at the furthest point in the distribution system, or as determined by the Regional Director,

- B. covering only one season (summer/winter) and indicate less than 100 µg/L TTHM and less than 16 µg/l BDCM, would require additional sampling to identify seasonal variation (summer/winter). If none of the samples exceed TTHM concentration of 100 µg/L, or BDCM concentration of 16 µg/L, then the frequency of monitoring may be reduced to once every three years or as determined by the Regional Director, and
 - C. that indicate more than 100 µg/L of TTHM or more than 16 µg/L of BDCM, would require standard frequency of testing of four times per year at the furthest point in the distribution system and reassessment after one year.
 - iv. Existing Systems with historical data and TOC > 2 mg/L in raw water:
If there are samples collected under current disinfection practices:
 - A. covering all four seasons and indicate less than 100 µg/L TTHM and less than 16 µg/l BDCM, would require sampling at the furthest point in the distribution system once every three years, or as determined by the Regional Director,
 - B. covering less than four seasons and indicate less than 100 µg/L TTHM and less than 16 µg/l BDCM, would require additional sampling at the furthest point in the distribution system to establish seasonal variations. If none of the samples exceed the TTHM and BDCM limits, then the sampling may be reduced to once every three years or as determined by the Regional Director, and
 - C. that indicate more than 100 µg/L of TTHM or more than 16 µg/L of BDCM in any sample, would require standard frequency of testing of 4 times per year at the furthest point in the distribution system and reassessment after one year.
 - v. Where the disinfection process is altered resulting in increased application of the disinfectant, monitoring shall commence as outlined in Sections i and ii, as a new system.
- d. Systems consisting solely of distribution system
 - i. Where water is obtained from a regional system and no re-chlorination or other disinfectant is added, then the monitoring results available from the regional system and from their distribution system may be used for determining the frequency of monitoring required. Based upon the available information from the regional supplier the TTHM and BDCM monitoring frequency shall be as follows:

Where there are samples:
 - A. covering two or more seasons (summer/winter) and indicate less than 100 µg/L TTHM and less than 16 µg/l BDCM, would require sampling once every three years, or as determined by the Regional Director,

- B. covering only one season (summer/winter) and indicate less than 100 µg/L TTHM and less than 16 µg/L BDCM, would require additional sampling to identify seasonal variation. If none of the samples exceed TTHM concentration of 100 µg/L, or BDCM concentration of 16 µg/L, then the frequency of monitoring may be reduced to once every three years or as determined by the Regional Director, and
- C. that indicate more than 100 µg/L of TTHM or more than 16 µg/L of BDCM require standard frequency of testing of 4 times per year and reassessment after one year.

Note: The Regional Director, at his discretion, may exempt or reduce the frequency of monitoring for communities on a regional system, if TTHM and BDCM monitored downstream of these communities are below the respective MAC.

- ii. Where water is obtained from a regional system, and re-chlorination or other disinfectants are added, the monitoring frequency shall be as follows:
 - A. samples shall be collected to cover every quarter and if no sample exceeds 100 µg/L for TTHMs and 16 µg/L for BDCM after one year, then the frequency of monitoring may be reduced to once every three years or as determined by the Regional Director, and
 - B. if the TTHM concentrations exceed 100 µg/L, or BDCM concentrations exceed 16 µg/L, then the system shall be continued to be monitored every quarter, and reassessed after one year.

2. Compliance

Compliance with the MAC for TTHM is determined by a running annual average of all samples taken at the same location during any twelve-month period. If the average exceeds the MAC, then the system is out of compliance.

Compliance with the MAC for BDCM is based on any single sample exceeding the limit.

If TTHM or BDCM result exceeds the applicable MAC, then the initial monitoring program shall be continued or recommenced.

1.10.3.7 Disinfection

- 1. Establishing the level of reduction for cysts, oocysts and viruses
 - a. The Regional Director will first determine the total level of cysts and oocysts reduction required through filtration and disinfection, based on the source water quality (Section 1.2.1).
 - b. The Regional Director will then determine the allowable filtration credit based on the type and performance of filtration system. For systems not meeting the

turbidity requirements outlined in Section 1.3.1, The Regional Director may grant reduced filtration credit or no filtration credit, as per Section 1.4.1.1.

- c. Based on sub-sections i and ii, the Regional Director will establish the level of cysts, oocysts and viruses reduction required through disinfection.

The Regional Director will periodically review the data, and would adjust, as necessary, the level of disinfection the owner should provide to protect the public health.

2. The owner shall calculate the total level of reduction of cysts, oocysts and viruses achieved, each day the system is in operation. The total level of reduction achieved will be based on:
 - a. cysts, oocysts and virus reduction credit granted by the Regional Director for filtration, and
 - b. the level of reduction of cysts, oocysts and viruses achieved through disinfection CT_{Actual} or IT_{Actual} .

Chlorine

1. Monitoring disinfectant concentration
 - a. The residual disinfectant concentration "C" used for the calculation of "CT" shall be measured continuously at no more than five-minute intervals with an on-line analyser. "C" shall be measured at the same point where "T" is measured for the "CT" calculation, and
 - b. the residual disinfectant concentration within the distribution system shall be measured:
 - i. continuously after the clear water tank at the point of entry into the water distribution system; or
 - ii. at least once daily, at representative points within the water distribution system; and
 - iii. at the same time and at the same location as the bacteriological quality sample is collected.

Note: For waterworks systems using high quality groundwater, and for waterworks systems consisting solely of a water distribution system, frequency of monitoring may be reduced to five days per week excepting statutory holidays.
2. Determination of disinfectant contact time (T_{10})
 - a. T_{10} values can be significantly different from calculated detention times, T , (volume/flow) and shall be determined by tracer study or by reference to typical baffling conditions. Use of the T_{10} ensures that 90% of the water will be better treated than the minimum.
 - b. T_{10} shall be calculated at maximum hourly flow.

- c. For pipelines, T_{10} is calculated by dividing the internal volume of the pipe by the maximum hourly flow rate through that pipe.
 - d. For all other system components, tracer studies or empirical methods shall be used to determine T_{10} .
- 3. Tracer studies
 - a. Tracer studies shall be conducted on all system components for which similar contact times are not documented.
 - b. Three tracer studies shall be done for different flow conditions at various depths of clear-water tanks.
 - c. The tracer studies shall be conducted in accordance with good engineering practices using methods acceptable to AEW.
- 4. Empirical Methods

Empirical methods may be used to calculate T_{10} , if the owner can demonstrate that system components have configuration similar to components on which tracer studies have been conducted. See Appendix 1-D for illustration of typical baffling conditions in reservoirs.
- 5. Determining the level of reduction for cysts, oocysts and viruses achieved
 - a. In order to determine the level of reduction of cysts, oocysts and viruses, the owner shall monitor the following daily:
 - i. temperature of the disinfected water at each residual disinfectant concentration sampling point used for CT calculations;
 - ii. if using chlorine, pH of the disinfected water at each chlorine residual disinfectant concentration sampling point used for CT calculations;
 - iii. the filled capacity/depth of the clear water tank during maximum hourly flow (based on historical information), to determine T_{10} ; and
 - iv. the disinfectant concentration "C" of the water at the point for which "T" is calculated, as per sub-section (1) above.
 - b. The log reduction through disinfection shall be calculated each day the system is in operation. CT_{actual} shall be determined using the lowest recorded value for "C" and " T_{10} " at the maximum hourly flow. $CT_{required}$ shall be referenced from the Tables in Appendix 1-A or Appendix 1-B.
- 6. Compliance

The system will be considered in compliance with the requirement to inactivate cysts, oocysts and viruses when CT_{actual} due to disinfection, exceeds the $CT_{required}$ for that facility. CT_{actual} for cysts and oocysts may be less than $CT_{required}$ for cysts and oocysts for a maximum of one day a month; CT_{actual} for viruses shall exceed the $CT_{required}$ at all times.

Ultraviolet Light

If UV light is used as the primary disinfectant, to receive UV disinfection credit, utilities shall install and operate UV installations under the following conditions.

1. Utilities shall demonstrate a UV dose for the reactor, using the results of a UV validation test and ongoing monitoring, for the inactivation of cysts and oocysts and in accordance with the UV dose / inactivation Tables in Appendix 1-C.
2. The UV reactor shall be validated by a full-scale bioassay by an independent third party against acceptable test organisms, with similar hydraulics and lamp/baffle layout as the utility installation.
3. The UV Validation Certificate shall be supplied by the manufacturer and shall list the acceptable valid operating range of the reactor with information on maximum/minimum flows, UV %T, and UV dose.
4. Doses for viruses are significantly higher than for protozoans, so UV is not a recommended technology for virus inactivation. UV light shall be followed by a secondary disinfectant such as chlorine to meet virus reduction requirements and to maintain a residual in the water distribution system.
5. Surface water and GWUDI systems with filtration shall meet the turbidity requirement of 0.3 NTU, for water entering the UV reactor, unless exempted by the Regional Director. For GWUDI systems without filtration, the turbidity of water entering the UV reactor shall not exceed 1 NTU, unless exempted by the Regional Director.
6. Provision should be made to shut down the plant or bypass the water to waste if the UV dose drops below the IT_{required} (bypass capabilities are recommended). Under this circumstance, then no more than 1% of the water in a month, and no more than 2% of the water per day shall pass the UV units without the required level of treatment. The utility shall monitor daily the amount of time the reactor is off, or operating outside the validated performance range, while water is passing through it.
7. UV intensity sensor readings, flow through the reactors, and temperature and lamp status, shall be monitored continuously, average and minimum UV dose per reactor and per plant shall be calculated daily, and UV %T of the water entering the reactor shall be monitored at least once daily.
8. UV sensors shall be calibrated monthly against a reference sensor, and the reference sensor checked annually by the supplier or an independent third party. Data demonstrating stable sensor performance may be used, at the discretion of AEW, to decrease calibration frequencies.
9. Appropriate startup, shutdown, emergency and maintenance procedures shall be in place.
10. The log reduction through UV disinfection shall be calculated each day the system is in operation. IT_{actual} shall be the lowest recorded dosage for that day. IT_{required} shall be the Reduction Equivalent Dose for the UV reactor achieved during the validation process.
11. The system will be considered in compliance with the requirement to inactivate cysts, oocysts and viruses when IT_{actual} due to disinfection, exceeds the IT_{required} for that facility. IT_{actual} may be outside the validated performance dose as detailed in item 6 above.

1.10.4 Issue Oriented and Follow-up Monitoring

1.10.4.1 General

1. Follow-up action by the owner is required when the system does not meet the minimum potable water quality stipulated in Section 1.1 or the minimum performance requirements for treatment stipulated in Sections 1.3.
2. When a violation of MAC or minimum performance requirements for treatment occurs, the municipality shall:
 - a. notify the Regional Director in accordance with Section 1.11,
 - b. determine the cause of the contamination or operational problems, and
 - c. take action as directed by the Regional Director.

1.10.4.2 Bacteriological

When bacteriological quality of the potable water fails, the follow-up monitoring, notification of the problem, corrective actions and public health intervention shall be in accordance with Alberta Environment and Water's and Health's policy titled Communication and Action Protocol for Failed Bacteriological Results (including potential failures) in Drinking Water for Waterworks Systems Authorized under the Environmental Protection and Enhancement Act, as amended or replaced from time to time.

1.10.4.3 Disinfection

1. When CT_{actual} or IT_{actual} is less than the CT_{required} or IT_{required} , the owner shall:
 - a. stop water production until the CT_{actual} or IT_{actual} exceeds the CT_{required} or IT_{required} ,
 - b. notify the Regional Director in accordance with section 1.11, and
 - c. undertake corrective actions established in consultation with the Regional Director.
2. If the residual disinfectant concentration at the location where "C" is measured for the calculation of "CT", measured as free or combined chlorine, is less than 0.2 mg/L, the owner shall:
 - a. take immediate actions (usually increasing disinfectant dosage and/or cleaning clear-water tank),
 - b. increase the monitoring frequency until the residual meets the specified limit, and
 - c. notify the Regional Director in accordance with section 1.11.
3. If chlorine residual entering or within the distribution system is less than 0.1 mg/L, the owner shall:
 - a. take immediate actions (usually flushing and/or increasing disinfectant dosage) to obtain the residual, and

- b. increase the monitoring frequency until the residual is detectable.

1.10.4.4 Fluoride

1. The fluoridation system shall be shut down if the owner is unable to test fluoride concentrations.
2. If the daily fluoride residual varies outside the approved range (typically 0.8 mg/L +/- 0.2 mg/L), the owner shall:
 - a. resample and check calculated dosage,
 - b. adjust and recalibrate the feed rate, and
 - c. take a sample to verify that proper fluoride residual levels have been obtained.
3. If the fluoride residual levels exceed 1.5 mg/L or if the fluoride residual levels vary outside the approved range (typically 0.8 mg/L +/- 0.2 mg/L) on two consecutive days, the owner shall:
 - a. resample and check calculated dosage,
 - b. notify the Regional Director in accordance with Section 1.11, and
 - c. undertake corrective actions established in consultation with the Regional Director.

Note: The optimum concentration +/- 0.2 mg/L applies if the Regional Director approves the optimum concentration to be less than of 0.8 mg/L.

1.10.4.5 Turbidity

1. If individual filter treated water turbidity exceeds 0.3 NTU for more than 15 minutes per day, the owner shall:
 - a. notify the Regional Director in accordance with Section 1.11, and
 - b. undertake corrective actions established in consultation with the Regional Director.

1.10.4.6 Organic and Inorganic Chemicals, Pesticides, THM and BDCM

For organic and inorganic chemicals, pesticides, THMs and BDCM, follow-up monitoring shall be conducted in accordance with the procedures outlined in section 1.10.3.2 and 1.10.3.6.

1.11 Potable Water Quality Record Keeping and Reporting Standards

1.11.1 Record Keeping

All records shall bear the signature of the operator responsible for the waterworks system. Municipalities shall keep these records available for inspection by the Regional Director and send the records to the Regional Director if requested.

1.11.1.1 Five Year Records

The municipalities shall record the following information and maintain the following records for at least five years from the date the record was created:

1. Bacteriological analysis results;
2. Turbidity analysis results;
3. Daily records, including but not limited to:
 - a. flow meter readings,
 - b. chlorine concentrations,
 - c. turbidity analysis results, and
 - d. information on level of inactivation of *Giardia* cysts, *Cryptosporidium* oocysts and viruses achieved through disinfection:
 - i. temperature at each residual concentration sampling point;
 - ii. pH if using chlorine;
 - iii. peak flow;
 - iv. filled capacity/depth of clearwater tank;
 - v. disinfectant contact time T, and corresponding concentration C; and
 - vi. inactivation ratio;
 - e. treatment chemical dosages,
 - f. iron and manganese concentrations,
 - g. all fluoridation information required under Section 1.5.4,
 - h. all electronic and monthly reports submitted to AEW, and
 - i. records of action taken by the municipality to correct contraventions of potable water quality limits (MAC or IMAC), including the following information for each contravention:
 - i. name and address of the person who discovered the contravention; and
 - ii. copies of all notifications to the public.

1.11.1.2 Lifetime Records

The municipality shall maintain the following records for the life of the waterworks system:

1. The system operations program;
2. copies of all:
 - a. applications submitted to AEW for the approval or registration regarding the waterworks system and correspondence related to the approval or registration,
 - b. engineering drawings and specifications,
 - c. project reports,
 - d. construction documents,
 - e. record drawings,
 - f. all reports of inspections conducted by AEW,

- g. all correspondence sent to AEW regarding a proposed extension of a water distribution system, replacement of a portion of a water distribution system, expansion or modification of potable water storage within the water distribution system,
 - h. all approvals or registrations issued under the Act for the waterworks system,
 - i. all annual reports, and
 - j. all reports prepared pursuant to 1.11.2, and
- 3. all physical, organic and inorganic chemical and pesticide analytical results required pursuant to any approval or code, excluding daily monitoring.

1.11.1.3 Sampling and Analysis Records

The results and records in 1.11.1.1 and 1.11.1.2 (2) shall contain, at a minimum, all of the following information:

- 1. the date, location and time of monitoring, and the name of the person collecting the sample;
- 2. identification of the sample type, including, but not limited to whether the sample is a routine water distribution system sample, repeat sample, source or potable water sample, or other special purpose sample;
- 3. date of analysis;
- 4. laboratory name and person responsible for performing analysis;
- 5. the analytical method used; and
- 6. the results of the analysis.

1.11.2 Reporting Requirements

1.11.2.1 Contravention Reporting

- 1. The owner shall immediately report to the Regional Director any contravention of the Approval or the Code, either:
 - by telephone at 1-800-222-6514
 - or
 - a. by a method:
 - i. in compliance with the release reporting provisions in the Act and the regulations; or
 - ii. authorized in writing by the Regional Director.
- 2. The owner shall immediately report to the Regional Director by a method under sub-section 1, any structural or equipment malfunction in the waterworks system that may affect the quality or supply of potable water.
- 3. In addition to the immediate report in sub-section 1, the municipality shall provide a report to the Regional Director:
 - a. in writing, or

- b. by a method:
 - i. in compliance with the release reporting provisions in the Act and the regulations; or
 - ii. authorized in writing by the Regional Director within seven (7) calendar days after the discovery of the contravention, or within another time period specified in writing by the Regional Director, unless the requirement for the report is waived by the Regional Director.
- 4. The report required under sub-section 3 shall contain, at a minimum, the following information:
 - a. a description of the contravention,
 - b. the date of the contravention,
 - c. the duration of the contravention,
 - d. the legal land description of the location of the contravention,
 - e. an explanation as to why the contravention occurred,
 - f. a summary of all preventive measures and actions that were taken prior to the contravention,
 - g. a summary of all measures and actions that were taken to mitigate any effects of the contravention,
 - h. a summary of all measures that will be taken to address any remaining effects and potential effects related to the contravention,
 - i. the number of the approval or registration issued under the Act for the waterworks system, and the name of the person who held the approval or registration at the time the contravention occurred,
 - j. the name, address, work phone number and responsibilities of all persons operating the waterworks system at the time the contravention occurred,
 - k. the name, address, work phone number and responsibilities of all persons who had charge, management or control of the waterworks system at the time that the contravention occurred,
 - l. a summary of proposed measures that will prevent future contraventions, including a schedule of implementation for these measures,
 - m. any information that was maintained or recorded under an Approval or a Code of Practice, as a result of the incident, and
 - n. any other information required by the Regional Director in writing.

1.11.2.2 Monthly Reporting

The owner shall compile monthly reports.

- 1. The monthly report in shall include, at a minimum:
 - a. the name and telephone number of all operators in direct charge,
 - b. the analytical results for all parameters required to be monitored in accordance with an Approval or a Code of Practice during the month,

- c. the locations of all sampling performed during the month in accordance with an Approval or a Code of Practice,
- d. the name and manufacturer of all treatment chemicals added during the month, and each manufacturer as listed in the *Standard 60*, published by the American National Standards Institute and the National Sanitation Foundation (ANSI/NSF), as amended or replaced from time to time, and
- e. the results of all required measurements conducted during the month in accordance with an Approval or a Code of Practice.

1.11.2.3 Annual Reporting

- 1. In addition to any other reporting required under the Act, the regulations, an Approval or a Code of Practice, the owner shall submit to the Regional Director an annual report, by February 28 of the year following the calendar year in which the information on which the report is based was collected.
- 2. The annual report shall contain, at a minimum, all of the following information:
 - a. a summary of the monthly reports, specifying the monthly minimum, average, and maximum results for each parameter monitored,
 - b. the results of any other compliance monitoring done during the year pursuant to an Approval or a Code of Practice, that was not included in any monthly report, and
 - c. a description of any problems experienced and corrective actions taken at the waterworks system during the year with respect to environmental matters.

1.11.2.4 Electronic Reporting

- 1. The Regional Director may, by notice in writing, require the owner to submit periodic reports:
 - a. in an electronic format; and
 - b. more frequently than specified in Sections 1.11.2.2 and 1.11.2.3.
- 2. The registration holder who receives a notice as specified in sub-section 1 shall comply with the notice.

1.12 Laboratory Data Quality Assurance Standards

All analytical data submitted to the Department shall be analysed by laboratories accredited to the requirements of ISO/IEC 17025 - General requirements for the competence of testing and calibration laboratories, for the drinking water tests methods specified by the Regional Director. The exception to this requirement is the analysis done by municipalities in accordance with AEW's Alternate Laboratory Data Quality Assurance Program.

Accreditation to the laboratory shall be granted by an agency that meets the requirements of ISO 17011 - Conformity assessment - General requirements for accreditation bodies accrediting conformity assessment bodies, or its predecessor ISO Guide 58, General Criteria for the Operation and Mutual Recognition of Laboratory Accreditation Systems; and is a full member signatory to the International Laboratory Accreditation Cooperation.

1.13 Facility Risk Assessment Standards

Municipalities / system owners/operators shall undertake a risk assessment of the waterworks systems from source to tap using a drinking water safety plan approach as set out by the World Health Organization in their "Guidelines for Drinking-water Quality" (4th edition). The development of a drinking water safety plan may be made utilizing the AEW Drinking Water Safety Plan Template located at <http://www.environment.alberta.ca/apps/regulattedwg/dwsp.aspx> (the "DWSP"). The DWSP shall be initially established a) within 12 months of a new approval/registration issued or renewed on or after June 1, 2012 or b) by December 31, 2013 for approvals/registrations in existence on June 1, 2012. The DWSP shall be a) maintained and b) updated by the approval/registration holder in response to any change in the drinking water system or the associated risks. The drinking water safety plan shall be available to AEW upon request.

1.14 Facility Classification and Operator Certification Standards

Alberta Environment and Water classifies all waterworks facilities based on staff recommendations and review by the Alberta Operator Certification Advisory Committee. The system owner or authorized representative may also request a review of a facility classification. The classification of a water distribution system is based upon the population served by that facility, while the classification of a water treatment facility is based on the degree of difficulty of operating that facility. The facility classification shall be based on AEW's *Water and Wastewater Operators' Certification Guidelines*, as amended or replaced from time to time.

Specified waterworks systems in Alberta shall have certified operators to supervise and/or carry out day-to-day operation of the system. The level of operator certification is the same as the classification of the facility. The operator certification shall be based on AEW's *Water and Wastewater Operators' Certification Guidelines*, as amended or replaced from time to time.

APPENDIX 1-A

CT VALUES FOR INACTIVATION OF *GIARDIA* CYSTS BY FREE CHLORINE

Adopted from Optimizing Water Treatment
Plant Performance Using the Composite
Correction Program (1991), prepared by
Process Applications Inc., Fort Collins,
Colo., for the US Environmental Protection
Agency, Office of Drinking Water,
Cincinnati, Ohio

TABLE 1-A-1
CT VALUES FOR INACTIVATION OF *GIARDIA* CYSTS BY FREE CHLORINE AT 0.5°C OR LOWER

Chlorine Concentrations (mg/L)	pH <= 6						pH = 6.5						pH = 7.0						pH = 7.5					
	Log Inactivations						Log Inactivations						Log Inactivations						Log Inactivations					
<= 0.4	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
0.6	23	46	69	91	114	137	27	54	82	109	136	163	33	65	98	130	163	195	40	79	119	158	198	237
0.8	24	47	71	94	118	141	28	56	84	112	140	168	33	67	100	133	167	200	40	80	120	159	199	239
1	24	48	73	97	121	145	29	57	86	115	143	172	34	68	103	137	171	205	41	82	123	164	205	246
1.2	25	49	74	99	123	148	29	59	88	117	147	176	35	70	105	140	175	210	42	84	127	169	211	253
1.4	25	51	76	101	127	152	30	60	90	120	150	180	36	72	108	143	179	215	43	86	130	173	216	259
1.6	26	52	78	103	129	155	31	61	92	123	153	184	37	74	111	147	184	221	44	89	133	177	222	266
1.8	26	52	79	105	131	157	32	63	95	126	158	189	38	75	113	151	188	226	46	91	137	182	228	273
2	27	54	81	108	135	162	32	64	97	129	161	193	39	77	116	154	193	231	47	93	140	186	233	279
2.2	28	55	83	110	138	165	33	66	99	131	164	197	39	79	118	157	197	236	48	95	143	191	238	285
2.4	28	56	85	113	141	169	34	67	101	134	168	201	40	81	121	161	202	242	50	99	149	198	248	297
2.6	29	57	86	115	143	172	34	68	103	137	171	205	41	82	124	165	206	247	50	99	149	199	248	298
2.8	29	58	88	117	146	175	35	70	105	139	174	209	42	84	126	168	210	252	51	101	152	203	253	304
3	30	59	89	119	148	178	36	71	107	142	178	213	43	86	129	171	214	257	52	103	155	207	258	310
	30	60	91	121	151	181	36	72	109	145	181	217	44	87	131	174	218	261	53	105	158	211	263	316
Chlorine Concentrations (mg/L)	pH = 8.0						pH = 8.5						pH <= 9.0											
	Log Inactivations						Log Inactivations						Log Inactivations											
<= 0.4	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0						
0.6	46	92	139	185	231	277	55	110	165	219	274	329	65	130	195	260	325	390						
0.8	48	95	143	191	238	286	57	114	171	228	285	342	68	136	204	271	339	407						
1	49	98	148	197	246	295	59	118	177	236	295	354	70	141	211	281	352	422						
1.2	51	101	152	203	253	304	61	122	183	243	304	365	73	146	219	291	364	437						
1.4	52	104	157	209	261	313	63	125	188	251	313	376	75	150	226	301	376	451						
1.6	54	107	161	214	268	321	65	129	194	258	323	387	77	155	232	309	387	464						
1.8	55	110	165	219	274	329	66	132	199	265	331	397	80	159	239	318	398	477						
2	56	113	169	225	282	338	68	136	204	271	339	407	82	163	245	326	408	489						
2.2	58	115	173	231	288	346	70	139	209	278	348	417	83	167	250	333	417	500						
2.4	59	118	177	235	294	353	71	142	213	284	355	426	85	170	256	341	426	511						
2.6	60	120	181	241	301	361	73	145	216	290	363	435	87	174	261	348	435	522						
2.8	61	123	184	245	307	368	74	148	222	296	370	444	89	178	267	355	444	533						
3	63	125	188	250	313	375	75	151	226	301	377	452	91	181	272	362	453	543						
	64	127	191	255	318	382	77	153	230	307	383	460	92	184	276	368	460	552						

1-A-1

TABLE 1-A-2
CT VALUES FOR INACTIVATION OF *GIARDIA* CYSTS BY FREE CHLORINE AT 5°C

Chlorine Concentrations (mg/L)	pH <= 6						pH = 6.5						pH = 7.0						pH = 7.5					
	Log Inactivations						Log Inactivations						Log Inactivations						Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<= 0.4	16	32	49	65	81	97	20	39	59	78	98	117	23	46	70	93	116	139	28	55	83	111	138	166
0.6	17	33	50	67	83	100	20	40	60	80	100	120	24	48	72	95	119	143	29	57	86	114	143	171
0.8	17	34	52	69	86	103	20	41	61	81	102	122	24	49	73	97	122	146	29	58	88	117	146	175
1	18	35	53	70	88	105	21	42	63	83	104	125	25	50	75	99	124	149	30	60	90	119	149	179
1.2	18	36	54	71	89	107	21	42	64	85	106	127	25	51	76	101	127	152	31	61	92	122	153	183
1.4	18	36	55	73	91	109	22	43	65	87	108	130	26	52	78	103	129	155	31	62	94	125	156	187
1.6	19	37	56	74	93	111	22	44	66	88	110	132	26	53	79	105	132	158	32	64	96	128	160	192
1.8	19	38	57	76	95	114	23	45	68	90	113	135	27	54	81	108	135	162	33	65	98	131	163	196
2	19	39	58	77	97	116	23	46	69	92	115	138	28	55	83	110	138	165	33	67	100	133	167	200
2.2	20	39	59	79	98	118	23	47	70	93	117	140	28	56	85	113	141	169	34	68	102	136	170	204
2.4	20	40	60	80	100	120	24	48	72	95	119	143	29	57	86	115	143	172	35	70	105	139	174	209
2.6	20	41	61	81	102	122	24	49	73	97	122	146	29	58	88	117	146	175	36	71	107	142	178	213
2.8	21	41	62	83	103	124	25	49	74	99	123	148	30	59	89	119	148	178	36	72	109	145	181	217
3	21	42	63	84	105	126	25	50	76	101	126	151	30	61	91	121	152	182	37	74	111	147	184	221

Chlorine Concentrations (mg/L)	pH <= 8.0						pH = 8.5						pH <= 9.0					
	Log Inactivations						Log Inactivations						Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<= 0.4	33	66	99	132	165	198	39	79	118	157	197	236	47	93	140	186	233	279
0.6	34	68	102	136	170	204	41	81	122	163	203	244	49	97	146	194	243	291
0.8	35	70	105	140	175	210	42	84	126	168	210	252	50	100	151	201	251	301
1	36	72	108	144	180	216	43	87	130	173	217	260	52	104	156	208	260	312
1.2	37	74	111	147	184	221	45	89	134	178	223	267	53	107	160	213	267	320
1.4	38	76	114	151	189	227	46	91	137	183	228	274	55	110	165	219	274	329
1.6	39	77	116	155	193	232	47	94	141	187	234	281	56	112	169	225	281	337
1.8	40	79	119	159	198	238	48	96	144	191	239	287	58	115	173	230	288	345
2	41	81	122	162	203	243	49	98	147	196	245	294	59	118	177	235	294	353
2.2	41	83	124	16	5207	248	50	100	150	200	250	300	60	120	181	241	301	361
2.4	42	84	127	169	211	253	51	102	153	204	255	306	61	123	184	245	307	368
2.6	43	86	129	172	215	258	52	104	156	208	260	312	63	125	188	250	313	375
2.8	44	88	432	175	219	263	53	106	159	212	265	318	64	127	191	255	318	382
3	45	89	134	179	223	268	54	108	162	216	270	324	65	130	195	259	324	389

1-A-2

TABLE 1-A-3
CT VALUES FOR INACTIVATION OF *GIARDIA* CYSTS BY FREE CHLORINE AT 10°C

Chlorine Concentrations (mg/L)	pH <= 6						pH = 6.5						pH = 7.0						pH = 7.5					
	Log Inactivations						Log Inactivations						Log Inactivations						Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<= 0.4	12	24	37	49	61	73	15	29	44	59	73	88	17	35	52	69	87	104	21	42	63	83	104	125
0.6	13	25	38	50	63	75	15	30	45	60	75	90	18	36	54	71	89	107	21	43	64	85	107	128
0.8	13	26	39	52	65	78	15	31	46	61	77	92	18	37	55	73	92	110	22	44	66	87	109	131
1	13	26	40	53	66	79	16	31	47	63	78	94	19	37	56	75	93	112	22	45	67	89	112	134
1.2	13	27	40	53	67	80	16	32	48	63	79	95	19	38	57	76	95	114	23	46	69	91	114	137
1.4	14	27	41	55	68	82	16	33	49	65	82	98	19	39	58	77	97	116	23	47	70	93	117	140
1.6	14	28	42	55	69	83	17	33	50	66	83	99	20	40	60	79	99	119	24	48	72	96	120	144
1.8	14	29	43	57	72	86	17	34	51	67	84	101	20	41	61	81	102	122	25	49	74	98	123	147
2	15	29	44	58	73	87	17	35	52	69	87	104	21	41	62	83	103	124	25	50	75	100	125	150
2.2	15	30	45	59	74	89	18	35	53	70	88	105	21	42	64	85	106	127	26	51	77	102	128	153
2.4	15	30	45	60	75	90	18	36	54	71	89	107	22	43	65	86	108	129	26	52	79	105	131	157
2.6	15	31	46	61	77	92	18	37	55	73	92	110	22	44	66	87	109	131	27	53	80	107	133	160
2.8	16	31	47	62	78	93	19	37	56	74	93	111	22	45	67	89	112	134	27	54	82	109	136	163
3	16	32	48	63	79	95	19	38	57	75	94	113	23	46	69	91	114	137	28	55	83	111	138	166
Chlorine Concentrations (mg/L)	pH <= 8.0						pH = 8.5						pH <= 9.0											
	Log Inactivations						Log Inactivations						Log Inactivations											
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0						
<= 0.4	25	50	75	99	124	149	30	59	89	118	148	177	35	70	105	139	174	209						
0.6	26	51	77	102	128	153	31	61	92	122	153	183	36	73	109	145	182	218						
0.8	26	53	79	105	132	158	32	63	95	126	158	189	38	75	113	151	188	226						
1	27	54	81	108	135	162	33	65	98	130	163	195	39	78	117	156	195	234						
1.2	28	55	83	111	138	166	33	67	100	133	167	200	40	80	120	160	200	240						
1.4	28	57	85	113	142	170	34	69	103	137	172	206	41	82	124	165	206	247						
1.6	29	58	87	116	145	174	35	70	106	141	176	211	42	84	127	169	211	253						
1.8	30	60	90	119	149	179	36	72	108	143	179	215	43	86	130	173	216	259						
2	30	61	91	121	152	182	37	74	111	147	184	221	44	88	133	177	221	265						
2.2	31	62	93	124	155	186	38	75	113	150	188	225	45	90	136	181	226	271						
2.4	32	63	95	127	158	190	38	77	115	153	192	230	46	92	138	184	230	276						
2.6	32	65	97	129	162	194	39	78	117	156	195	234	47	94	141	187	234	281						
2.8	33	66	99	131	164	197	40	80	120	159	199	239	48	96	144	191	239	287						
3	34	67	101	134	168	201	41	81	122	162	203	243	49	97	146	195	243	292						

1-A-3

TABLE 1-A-4
CT VALUES FOR INACTIVATION OF *GIARDIA* CYSTS BY FREE CHLORINE AT 15°C

Chlorine Concentrations (mg/L)	pH <= 6						pH = 6.5						pH = 7.0						pH = 7.5					
	Log Inactivations						Log Inactivations						Log Inactivations						Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<= 0.4	8	16	25	33	41	49	10	20	30	39	49	59	12	23	35	47	58	70	14	28	42	55	69	83
0.6	8	17	25	33	42	50	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86
0.8	9	17	26	35	43	52	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88
1	9	18	27	35	44	53	11	21	32	42	53	63	13	25	38	50	63	75	15	30	45	60	75	90
1.2	9	18	27	36	45	54	11	21	32	43	53	64	13	25	38	51	63	76	15	31	46	61	77	92
1.4	9	18	28	37	46	55	11	22	33	43	54	65	13	26	39	52	65	78	16	31	47	63	78	94
1.6	9	19	28	37	47	56	11	22	33	44	55	66	13	26	40	53	66	79	16	32	48	64	80	96
1.8	10	19	29	38	48	57	11	23	34	45	57	68	14	27	41	54	68	81	16	33	49	65	82	98
2	10	19	29	39	48	58	12	23	35	46	58	69	14	28	42	55	69	83	17	33	50	67	83	100
2.2	10	20	30	39	49	59	12	23	35	47	58	70	14	28	43	57	71	85	17	34	51	68	85	102
2.4	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86	18	35	53	70	88	105
2.6	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88	18	36	54	71	89	107
2.8	10	21	31	41	52	62	1	225	67	49	62	74	15	30	45	59	74	89	18	36	55	73	91	109
3	11	2	132	42	53	63	13	25	38	51	63	76	15	30	46	61	76	91	19	37	56	74	93	111
Chlorine Concentrations (mg/L)	pH <= 8.0						pH = 8.5						pH <= 9.0											
	Log Inactivations						Log Inactivations						Log Inactivations											
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0						
<= 0.4	17	33	50	66	83	99	20	39	59	79	98	118	23	47	70	93	117	140						
0.6	17	34	51	68	85	102	20	41	61	81	102	122	24	49	73	97	122	146						
0.8	18	35	53	70	88	105	21	42	63	84	105	126	25	50	76	101	126	151						
1	18	36	54	72	90	108	22	43	65	87	108	130	26	52	78	104	130	156						
1.2	19	37	56	74	93	111	22	45	67	89	112	134	27	53	80	107	133	160						
1.4	19	38	57	76	95	114	23	46	69	91	114	137	28	55	83	110	138	165						
1.6	19	39	58	77	97	116	24	47	71	94	118	141	28	56	85	113	141	169						
1.8	20	40	60	79	99	119	24	48	72	96	120	144	29	58	87	115	144	173						
2	20	41	61	81	102	122	25	49	74	98	123	147	30	59	89	118	148	177						
2.2	21	41	62	83	103	124	25	50	75	100	125	150	30	60	91	121	151	181						
2.4	21	42	64	85	106	127	26	51	77	102	128	153	31	61	92	123	153	184						
2.6	22	43	65	86	108	129	26	52	78	104	130	156	31	63	94	125	157	188						
2.8	22	44	66	88	110	132	27	53	80	106	133	159	32	64	96	127	159	191						
3	22	45	67	89	112	134	27	54	81	108	135	162	33	65	98	130	163	195						

1-A-4

TABLE 1-A-5
CT VALUES FOR INACTIVATION OF *GIARDIA* CYSTS BY FREE CHLORINE AT 20°C

Chlorine Concentrations (mg/L)	pH <= 6					pH = 6.5					pH = 7.0					pH = 7.5								
	Log Inactivations					Log Inactivations					Log Inactivations					Log Inactivations								
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<= 0.4	6	12	18	24	30	36	7	15	22	29	37	44	9	17	26	35	43	52	10	21	31	41	52	62
0.6	6	13	19	25	32	39	8	15	23	30	38	45	9	18	27	36	45	54	11	21	32	43	53	64
0.8	7	13	20	26	33	39	8	15	23	31	38	46	9	18	28	37	46	55	11	22	33	44	55	66
1	7	13	20	26	33	39	8	16	24	31	39	47	9	19	28	37	47	56	11	22	34	45	56	67
1.2	7	13	20	27	33	40	8	16	24	32	40	48	10	19	29	38	48	57	12	23	35	46	58	69
1.4	7	14	21	27	34	41	8	16	25	33	41	49	10	19	29	39	48	58	12	23	35	47	58	70
1.6	7	14	21	28	35	42	8	17	25	33	42	50	10	20	30	39	49	59	12	24	36	48	60	72
1.8	7	14	22	29	36	43	9	17	26	34	43	51	10	20	31	41	51	61	12	25	37	49	62	74
2	7	15	22	29	37	44	9	17	26	35	43	52	10	21	31	41	52	62	13	25	38	50	63	75
2.2	7	15	22	29	37	44	9	18	27	35	44	53	11	21	32	42	53	63	13	26	39	51	64	77
2.4	8	15	23	30	38	45	9	18	27	36	45	54	11	22	33	43	54	65	13	26	39	52	65	78
2.6	8	15	23	31	38	46	9	18	28	37	46	55	11	22	33	44	55	66	13	27	40	53	67	80
2.8	8	16	24	31	39	47	9	19	28	37	47	56	11	22	34	45	56	67	14	27	41	54	68	81
3	8	16	24	31	39	47	10	19	29	38	48	57	11	23	34	45	57	68	14	28	42	55	69	83

Chlorine Concentrations (mg/L)	pH <= 8.0					pH = 8.5					pH <= 9.0												
	Log Inactivations					Log Inactivations					Log Inactivations												
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0					
<= 0.4	12	25	37	49	62	74	15	30	45	59	74	89	18	35	53	70	88	105					
0.6	13	26	39	51	64	77	15	31	46	61	77	92	18	36	55	73	91	109					
0.8	13	26	40	53	66	79	16	32	48	63	79	95	19	38	57	75	94	113					
1	14	27	41	54	68	81	16	33	49	65	82	98	20	39	59	78	98	117					
1.2	14	28	42	55	69	83	17	33	50	67	83	100	20	40	60	80	100	120					
1.4	14	28	43	57	71	85	17	34	52	69	86	103	21	41	62	82	103	123					
1.6	15	29	44	58	73	87	18	35	53	70	88	105	21	42	63	84	105	126					
1.8	15	30	45	59	74	89	18	36	54	72	90	108	22	43	65	86	108	129					
2	15	30	46	61	76	91	18	37	55	73	92	110	22	44	66	88	110	132					
2.2	16	31	47	62	78	93	19	38	57	75	94	113	23	45	68	90	113	135					
2.4	16	32	48	63	79	95	19	38	58	77	96	115	23	46	69	92	115	138					
2.6	16	32	49	65	81	97	20	39	59	78	98	117	24	47	71	94	118	141					
2.8	17	33	50	66	83	99	20	40	60	79	99	119	24	48	72	95	119	143					
3	17	34	51	67	84	101	20	41	61	81	102	122	24	49	73	97	122	146					

1-A-5

TABLE 1-A-6
CT VALUES FOR INACTIVATION OF *GIARDIA* CYSTS BY FREE CHLORINE AT 25°C

Chlorine Concentrations (mg/L)	pH <= 6						pH = 6.5						pH = 7.0						pH = 7.5					
	Log Inactivations						Log Inactivations						Log Inactivations						Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<= 0.4	4	8	12	16	20	24	5	10	15	19	24	29	6	12	18	23	29	35	7	14	21	28	35	42
0.6	4	8	13	17	21	25	5	10	15	20	25	30	6	12	18	24	30	36	7	14	22	29	36	43
0.8	4	9	13	17	22	26	5	10	16	21	26	31	6	12	19	25	31	37	7	15	22	29	37	44
1	4	9	13	17	22	26	5	10	16	21	26	31	6	12	19	25	31	37	8	15	23	30	38	45
1.2	5	9	14	18	23	27	5	11	16	21	27	32	6	13	19	25	32	38	8	15	23	31	38	46
1.4	5	9	14	18	23	27	6	11	17	22	28	33	7	13	20	26	33	39	8	16	24	31	39	47
1.6	5	9	14	19	23	28	6	11	17	22	28	33	7	13	20	27	33	40	8	16	24	32	40	48
1.8	5	10	15	19	24	29	6	11	17	23	28	34	7	14	21	27	34	41	8	16	25	33	41	49
2	5	10	15	19	24	29	6	12	18	23	29	35	7	14	21	27	34	41	8	17	25	33	42	50
2.2	5	10	15	20	25	30	6	12	18	23	29	35	7	14	21	28	35	42	9	17	26	34	43	51
2.4	5	10	15	20	25	30	6	12	18	24	30	36	7	14	22	29	36	43	9	17	26	35	43	52
2.6	5	10	16	21	26	31	6	12	19	25	31	37	7	15	22	29	37	44	9	18	27	35	44	53
2.8	5	10	16	21	26	31	6	12	19	25	31	37	8	15	23	30	38	45	9	18	27	36	45	54
3	5	11	16	21	27	32	6	13	19	25	32	38	8	15	23	31	38	46	9	18	28	37	46	55
Chlorine Concentrations (mg/L)	pH <= 8.0						pH = 8.5						pH <= 9.0											
	Log Inactivations						Log Inactivations						Log Inactivations											
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0						
<= 0.4	8	17	25	33	42	50	10	20	30	39	49	59	12	23	35	47	58	70						
0.6	9	17	26	34	43	51	10	20	31	41	51	61	12	24	37	49	61	73						
0.8	9	18	27	35	44	53	11	21	32	42	53	63	13	25	38	50	63	75						
1	9	18	27	36	45	54	11	22	33	43	54	65	13	26	39	52	65	78						
1.2	9	18	28	37	46	55	11	22	34	45	56	67	13	27	40	53	67	80						
1.4	10	19	29	38	48	57	12	23	35	46	58	69	14	27	41	55	68	82						
1.6	10	19	29	39	48	58	12	23	35	47	58	70	14	28	42	56	70	84						
1.8	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86						
2	10	20	31	41	51	61	12	25	37	49	62	74	15	29	44	59	73	88						
2.2	10	21	31	41	52	62	13	25	38	50	63	75	15	30	45	60	75	90						
2.4	11	21	32	42	53	63	13	26	39	51	64	77	15	31	46	61	77	92						
2.6	11	22	33	43	54	65	13	26	39	52	65	78	16	31	47	63	78	94						
2.8	11	22	33	44	55	66	13	27	40	53	67	80	16	32	48	64	80	96						
3	11	22	34	45	56	67	14	27	41	54	68	81	16	32	49	65	81	97						

1-A-6

APPENDIX 1-B

CT VALUES FOR INACTIVATION OF *GIARDIA* CYSTS AND VIRUSES BY VARIOUS DISINFECTANTS

Adopted from Straw Man Regulations for
Ground Water Disinfection, US Environmental
Protection Agency, Office of Drinking Water,
Washington, D.C. (June 1990)

TABLE 1-B-1
CT VALUES FOR INACTIVATION OF VIRUSES BY FREE CHLORINE*+

Temperature (°C)	Log Inactivation					
	2.0		3.0		4.0	
	pH		pH		pH	
	6-9	10	6-9	10	6-9	10
0.5	6	45	9	66	12	90
5	4	30	6	44	8	60
10	3	22	4	33	6	45
15	2	15	3	22	4	30
20	1	11	2	16	3	22
25	1	7	1	11	2	15

*Data adapted from Sobsey (1988) for inactivation of Hepatitis A virus (HAV) at pH = 6, 7, 8, 9 and 10 and temperature = 5°C. CT values include a safety factor of 3.

+CT values adjusted to other temperatures by doubling CT for each 10°C drop in temperature.

TABLE 1-B-2
CT VALUES FOR INACTIVATION OF *GIARDIA* CYSTS BY CHLORINE DIOXIDE +*

Inactivation	Temperature (°C)					
	≤1	5	10	15	20	25
0.5 log	10	4.3	4	3.2	2.5	2
1 log	21	8.7	7.7	6.3	5	3.7
1.5 log	32	13	12	10	7.5	5.5
2 log	42	17	15	13	10	7.3
2.5 log	52	22	19	16	13	9
3 log	63	26	23	19	15	11

*Data adapted from Sobsey (1988) for inactivation of Hepatitis A virus (HAV) at pH = 6.0 and temperature = 5°C. CT values include a safety factor of 2.

+CT values adjusted to other temperatures by doubling CT for each 10°C drop in temperature.

TABLE 1-B-3
CT VALUES FOR INACTIVATION OF VIRUSES BY CHLORINE DIOXIDE PH 6-9*+

	Temperature (°C)					
Inactivation	≤1	5	10	15	20	25
2 log	8.4	5.6	4.2	2.8	2.1	1.4
3 log	25.6	17.1	12.8	8.6	6.4	4.3
4 log	50.1	33.4	25.1	16.7	12.5	8.4

*Data adapted from Sobsey (1988) for inactivation of Hepatitis A virus (HAV) at pH = 6.0 and temperature = 5°C. CT values include a safety factor of 2.

+CT values adjusted to other temperatures by doubling CT for each 10°C drop in temperature.

TABLE 1-B-4
CT VALUES FOR INACTIVATION OF *GIARDIA* CYSTS BY OZONE *+

	Temperature (°C)					
Inactivation	≤1	5	10	15	20	25
0.5 log	0.48	0.32	0.23	0.16	0.1	0.08
1 log	0.97	0.63	0.48	0.32	0.2	0.16
1.5 log	1.5	0.95	0.72	0.48	0.36	0.24
2 log	1.9	1.3	0.95	0.63	0.48	0.32
2.5	2.4	1.6	1.2	0.79	0.6	0.4
3 log	2.9	1.9	1.43	0.95	0.72	0.48

*Data adapted from Sobsey (1988) for inactivation of Hepatitis A virus (HAV) at pH = 6.0 and temperature = 5°C. CT values include a safety factor of 2.

+CT values adjusted to other temperatures by doubling CT for each 10°C drop in temperature.

TABLE 1-B-5
CT VALUES FOR INACTIVATION OF VIRUSES BY OZONE*+

	Temperature (°C)					
Inactivation	≤1	5	10	15	20	25
2 log	0.9	0.6	0.5	0.3	0.25	0.15
3 log	1.4	0.9	0.8	0.5	0.4	0.25
4 log	1.8	1.2	1.0	0.6	0.5	0.3

*Data adapted from Roy (1982) for inactivation of poliovirus for pH = 7.2 and temperature = 5°C. CT values include a safety factor of 3.

+CT values adjusted to other temperatures by doubling CT for each 10°C drop in temperature.

TABLE 1-B-6
CT VALUES FOR INACTIVATION OF *GIARDIA* CYSTS BY CHLORAMINE pH 6-9*+

	Temperature (°C)					
Inactivation	≤1	5	10	15	20	25
0.5 log	635	365	310	250	185	125
1 log	1270	735	615	500	370	250
1.5 log	1900	1100	930	750	550	375
2 log	2535	1470	1230	1000	735	500
2.5	3170	1830	1540	1250	915	625
3 log	3800	2200	1850	1500	1100	750

*Data adapted from Sobsey (1988) for inactivation of Hepatitis A virus (HAV) at pH = 6.0 and temperature = 5°C. CT values include a safety factor of 2.

+CT values adjusted to other temperatures by doubling CT for each 10°C drop in temperature.

TABLE 1-B-7
CT VALUES FOR INACTIVATION OF VIRUSES BY CHLORAMINE*+

	Temperature (°C)					
Inactivation	≤1	5	10	15	20	25
2 log	1243	857	643	428	321	214
3 log	2063	1423	1067	712	534	356
4 log	2883	1988	1491	994	746	497

*Data adapted from Roy (1982) for inactivation of poliovirus for pH = 7.2 and temperature = 5°C. CT values include a safety factor of 3.

+CT values adjusted to other temperatures by doubling CT for each 10°C drop in temperature.

APPENDIX 1-C

IT VALUES FOR INACTIVATION OF *GIARDIA* CYSTS, *CRYPTOSPORIDIUM* OOCYSTS AND VIRUSES BY UV LIGHT

Adopted from Ultraviolet Disinfection Guidance Manual, US Environmental
Protection Agency, Office of Drinking Water,
Washington, D.C. (June 2003, Draft)

UV Dose Requirements Used During Validation Testing¹

	Log Inactivation							
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
<i>Cryptosporidium</i>	1.6	2.5	3.9	5.8	8.5	12	-	-
<i>Giardia</i>	1.5	2.1	3.0	5.2	7.7	11	-	-
Virus	39	58	79	100	121	143	163	186

¹ 40 CFR 141.729(d)

Note: The above IT doses are based on collimated beam bench tests. In determining the actual dosage for individual reactors, various factors need to be applied as per the USEPA, DVGW W-294, or AWWARF / NWRI standards.

APPENDIX 1-D

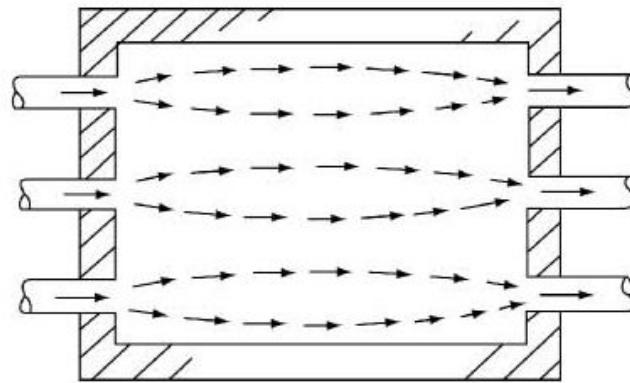
TYPICAL BAFFLING CONDITIONS

TYPICAL BAFFLING CONDITIONS**

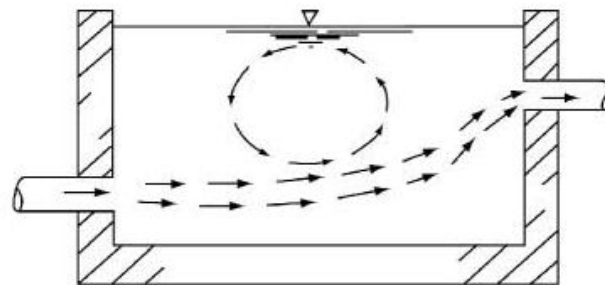
Baffling Condition	T ₁₀ /T Ratio	Baffling Description
Unbaffled (mixed flow)	0.1	None, agitated basin, very low length to width ratio, high inlet and outlet flow velocities
Poor	0.3	Single or multiple unbaffled inlets and outlets, no intra-basin baffles
Average	0.5	Baffled inlet or outlet with some intra-basin baffles
Superior	0.7	Perforated inlet baffle, serpentine or perforated intra-basin baffles, outlet weir or perforated launders
Perfect (plug flow)	1.0	Very high length to width ratio (pipeline flow), perforated inlet, outlet, and intra-basin baffles

**Based on "Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems using Surface Water Sources", USEPA, October 1990.

Poor Baffling Conditions - Rectangular Contact Basin



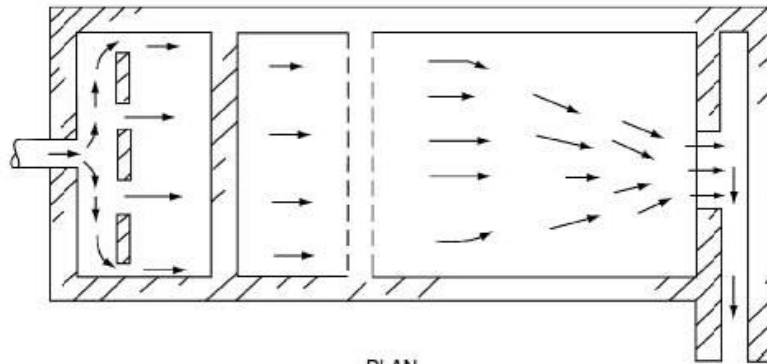
PLAN



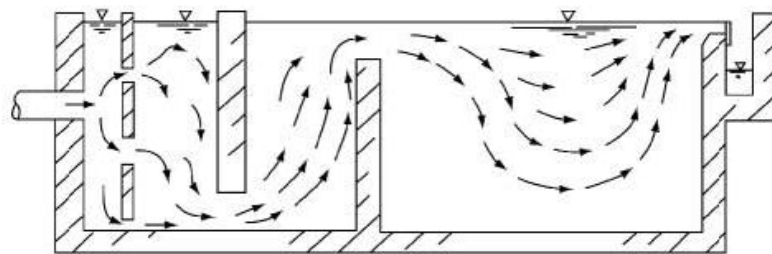
SECTION

1-D-2

Average Baffling Conditions - Rectangular Contact Basin



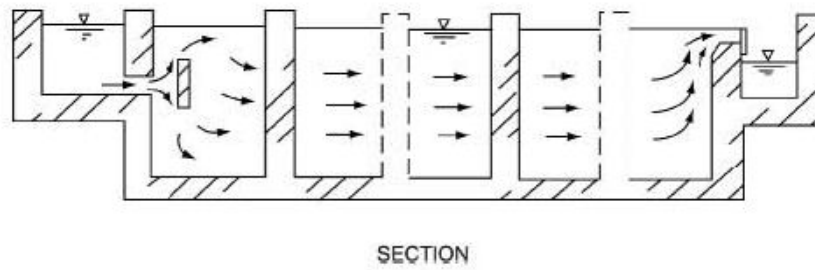
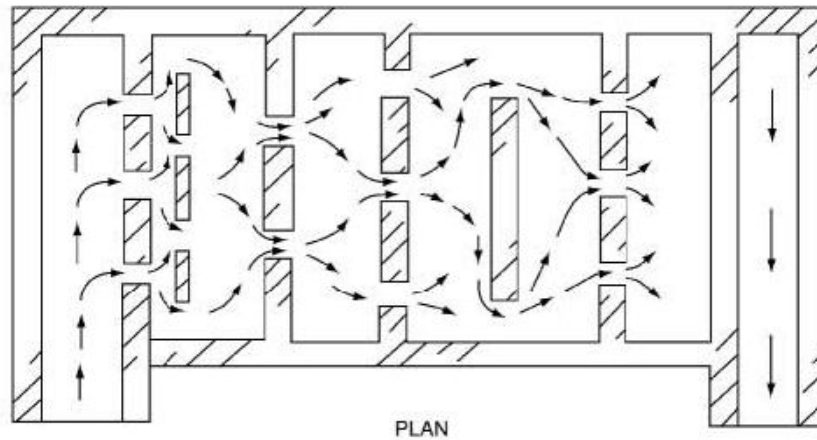
PLAN



SECTION

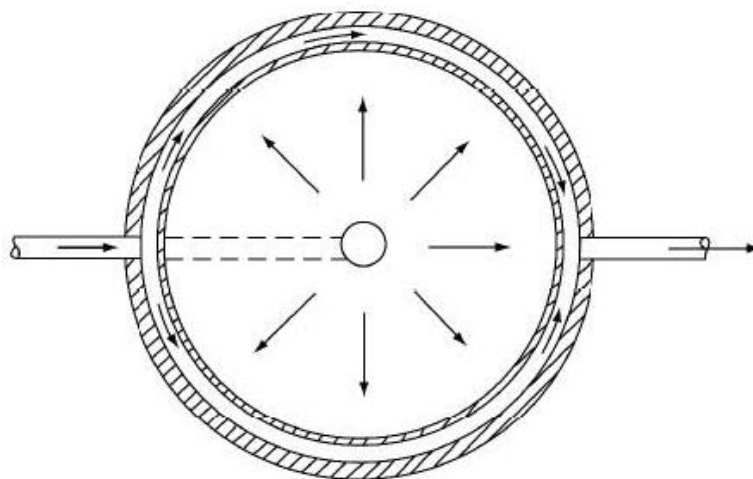
1-D-3

Superior Baffling Conditions - Rectangular Contact Basin

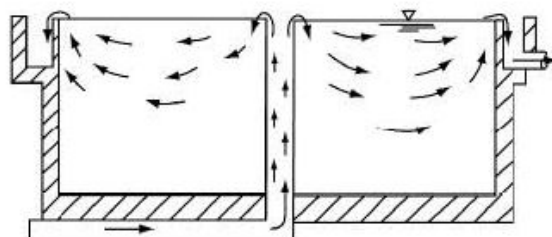


1-D-4

Poor Baffling Conditions - Circular Contact Basin



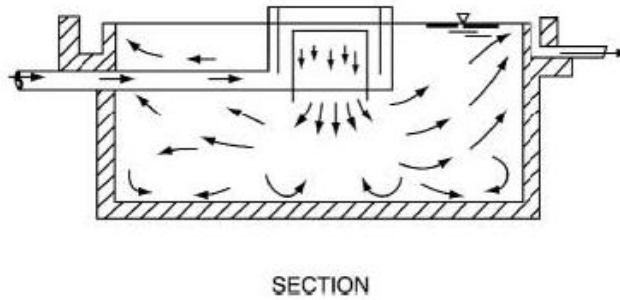
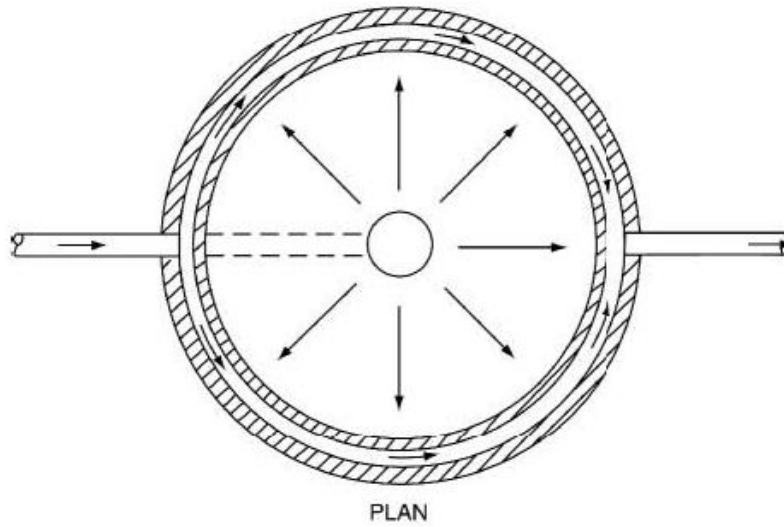
PLAN



SECTION

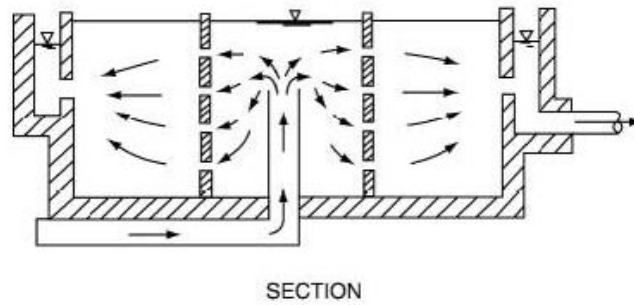
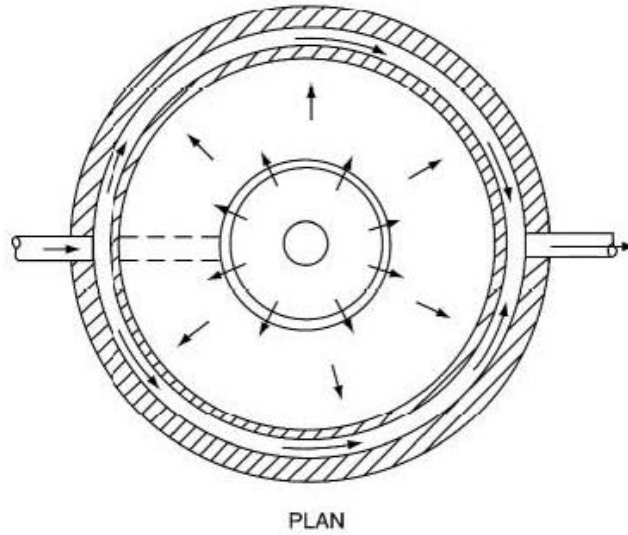
1-D-5

Average Baffling Conditions - Circular Contact Basin



1-D-6

Superior Baffling Conditions - Circular Contact Basin



1-D-7

APPENDIX 1-E

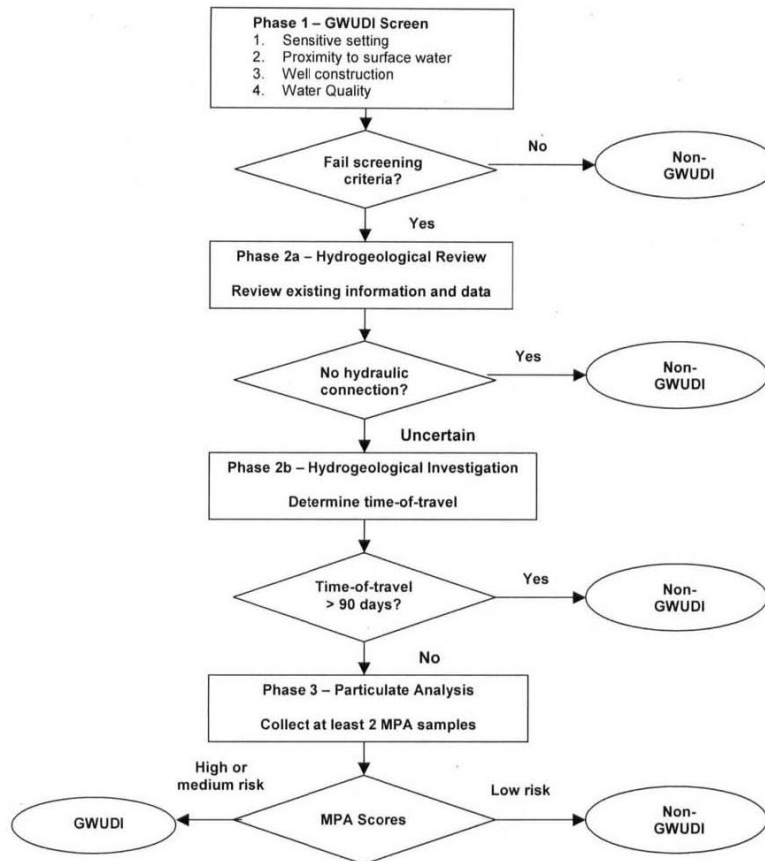
Assessment Guideline for Groundwater Under the Direct Influence of Surface Water (GWUDI)

General

Groundwater under the direct influence of surface water (GWUDI) refers to groundwater supply sources that are vulnerable to contamination by pathogens from nearby surface water or infiltrating precipitation. Groundwater sources that are determined to be GWUDI require treatment equivalent to that required for surface water sources as specified in Section 1.2.1. Waterworks systems using "high quality groundwater" must not be under the direct influence of surface water according to the *Potable Water Regulation (Alberta Regulation 277/2003)*.

This assessment guideline presents the protocol for determining whether a source is GWUDI or non-GWUDI. The assessment is to be carried out by a qualified hydrogeologist or groundwater engineer who is a member of APEGGA. The assessment is divided into three phases, which is outlined in the flow chart in Figure 1. The concept of the guideline is to initially flag potential GWUDI sources, followed by more detailed investigations to determine whether or not a source is GWUDI.

Figure 1: GWUDI Assessment Flowchart



1-E-2

PHASE 1 – GWUDI Screen

The purpose of the screening is to rapidly identify obvious non-GWUDI sources that do not require a detailed assessment. The screening criteria are as follows:

1. ***Sensitive Setting*** – the source shall not be a:
 - a. spring, infiltration gallery, shallow collector system, artificial recharge system, bored well or dug well
 - b. well with a production zone less than 15m below ground surface
 - c. well in an unconfined aquifer
 - d. well completed in fractured or karst bedrock exposed at or near the land surface.
2. ***Proximity to surface water*** – the source shall not be located within 100m of any permanent, intermittent or seasonal surface water body, including ponds, sloughs, lakes, rivers, streams, dugouts, lagoons, reservoirs, irrigation canals or ditches, gravel pits, mining pits or any other open water features.
3. ***Well Construction*** – The source shall be a drilled well which meets the requirements under the current version of the *Alberta Water (Ministerial) Regulation (Alberta Regulation 205/98)*. A drilled well shall have a surface seal that prevents surface water from migrating down the annulus of the well. A drilled well shall be constructed in a manner such that only water from the producing interval enters the well. The wellhead shall be well graded and drained and show no signs of poor construction or deterioration.
4. ***Water Quality*** – The raw or treated water from the source shall not exhibit evidence of contamination by surface water. This means significant occurrence of insects, insect parts, and other microorganisms such as total coliforms (on a regular basis), *E. coli*, algae, *Giardia*, *Cryptosporidium*, or viruses; or significant and relative rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH, closely correlating to climatological or surface water conditions.

Should a drinking water source not meet any of the above criteria, the source is flagged as potentially GWUDI, and the assessment is to proceed to Phase 2 or the source can be declared as GWUDI.

If the criteria under #1 and #2 are met but not the criteria under #3 and #4, instead of proceeding to Phase 2, system owners may modify the well construction to ensure the criteria under #3 and/or #4 are met.

PHASE 2a –Hydrogeological Review

The objective the hydrogeological review is to determine if a water source can be designated as GWUDI or non-GWUDI based on existing data and knowledge. It may identify factors not considered in the screening process. The following information is normally required for this evaluation:

- geological / lithological data, including depth and thickness of production zones, overlying confining beds and other subsurface units
- depth of surface water bodies, penetration of any confining units by surface water bodies
- cross-section(s) showing site stratigraphy in relation to surface water bodies
- any history of flooding
- pumping test results (recharge boundaries , hydraulic connection to surface water)
- hydraulic conductivity testing of confining units
- comparison of any historic groundwater level and surface water level monitoring
- comparison of any historic groundwater quality and surface water quality data
- estimate of time-of-travel between surface water and the source where possible.

If there is reasonable uncertainty as to whether a source is vulnerable to the direct influence of surface water, further assessment is required. Proceed to Phase 2b or declare the source as GWUDI.

PHASE 2b –Hydrogeological Investigation

The objective of the hydrogeological investigation is to determine if there is an existing or potential hydraulic connection that could allow rapid recharge of the well by surface water or precipitation. This phase can be combined with Phase 2a under one hydrogeological investigation.

The hydrogeological investigation will require determination of the time-of-travel between a surface water body and a source well. Various methods are available to determine time-of-travel, including water quality hydrograph analysis, computer modeling, analytical methods or tracer tests. The choice of method should take into account the proximity of the surface water body and/or anticipated travel times. For instance, hydrograph analysis of water quality parameters such as temperature, conductivity and pH may be the best option for surface water bodies that are very close to a source well in the same aquifer. It is recommended that monitoring of these parameters be collected on a weekly basis for a minimum of one year, unless a hydraulic connection is recognized early in the program.

Computer modeling involves using particle-tracking techniques to determine time-of-travel, in a similar manner to capture zone modeling. This option may be best suited to situation where greater travel times are anticipated and sufficient information is available. Note that this option may require further intrusive work (e.g. drilling, pumping test, monitoring, etc.) in order to obtain

suitable information for the modeling work. Model assumptions and sensitivity analysis must be included in the final report.

Should the time-of-travel be determined to be less than 90 days, proceed to Phase 3 or declare the source as GWUDI.

PHASE 3 – Microscopic Particulate Analysis

The results of Phase 2b may determine that there is a hydraulic connection between a source well and a nearby surface water body. However if the subsurface units provide sufficient natural filtration to remove most surface water organisms and debris, the well source may be exempted as GWUDI.

Microscopic Particulate Analysis (MPA) is used to determine if there are significant surface water particulates reaching the well source. The test involves filtering approximately 4,500 litres of water to concentrate organisms and debris, which are then identified and quantified under a microscope by an accredited laboratory. The laboratory shall classify the result as low, medium or high risk.

A minimum of two MPA samples shall be collected, during periods when there is the greatest possibility for surface water to impact a source well (i.e. worst-case situation). This will usually be after a significant storm or snow melt event. *The sampling time can only be determined after the time-of-travel has been determined under Phase 2.* If lag time is not used to determine the sampling times, there is a strong possibility that the result will not reflect a worst-case situation. It is recommended that at least one sample be collected in the spring.

The MPA analysis and scoring is to be conducted according to the *Consensus Method for Determining Groundwaters Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis* (USEPA, 1992). Under this method, samples are scored as follows:

- <10 low risk
- 10 – 19 medium risk
- >20 high risk

A water well source shall be declared GWUDI upon a *medium* or *high-risk* score, unless remedial action and/or further sampling demonstrate otherwise.

GWUDI Determination

A qualified hydrogeologist or groundwater engineer who is a member of APEGGA shall conduct GWUDI assessments. Professional judgment shall be used to evaluate all the evidence collected in the final determination of whether a water source is GWUDI or non-GWUDI. Generally, all well sources that do not exhibit any evidence of a current or potential direct connection with surface water or are determined to have a time-of-travel greater than or equal to 90 days to any nearby surface water bodies will be considered non-GWUDI. Evidence for a well source being GWUDI is generally more conclusive than evidence it is not GWUDI. Where uncertainty or doubt exists, it is best to adopt a cautionary approach and consider the source GWUDI.

1-E-5

References

AWWARF (American Water Works Association Research Foundation). 2001. *Investigation of Criteria for GWUDI Determination*.

Nova Scotia Department of Environment and Labour. 2002. *Protocol for Determining Groundwater Under the Direct Influence of Surface Water*.

Ontario Ministry of Environment. 2001. *Terms of Reference: Hydrogeological Study to Examine Groundwater Sources Potentially Under the Direct Influence of Surface Water*.

Ontario Ministry of Environment. 2001. *Delineation of Wellhead Protection Areas for Municipal Groundwater Supply Wells Under the Direct Influence of Surface Water*.

Saskatchewan Environment. 2004. *Groundwater Under the Direct Influence of Surface Water (GUDI) Assessment Guideline*.

USEPA. 1991. *Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems using Surface Water Sources*.

USEPA. 1992. *Consensus Method for Determining Groundwater Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (MPA)*.

**STANDARDS AND GUIDELINES FOR MUNICIPAL WATERWORKS,
WASTEWATER AND STORM DRAINAGE SYSTEMS**

Part 2 Guidelines for Municipal Waterworks
of a Total of 5 Parts

April 2012

Part 2 GUIDELINES FOR MUNICIPAL WATERWORKS

April 2012

TABLE OF CONTENTS

FOREWORD to Part 2 Guidelines for Municipal Waterworks (2012)	v
DEFINITIONS / ABBREVIATIONS	vii
2.0 Waterworks Systems Guidelines.....	2-1
2.1 Design Criteria.....	2-1
2.1.1 Water Quantity Requirements	2-1
2.1.2 System Capacity	2-1
2.1.3 Raw Water Supply and Water Treatment.....	2-1
2.1.4 Water Distribution.....	2-1
2.2 Raw Water Supply.....	2-2
2.2.1 Source Water Protection	2-2
2.2.1.1 Surface Water or Groundwater under Direct Influence of Surface Water Sources.....	2-3
2.2.1.2 Groundwater.....	2-4
2.2.1.3 Summary	2-5
2.2.2 Water Source/Quality	2-5
2.2.3 Site Selection Criteria	2-5
2.2.4 Surface Water Supply	2-6
2.2.4.1 Intakes.....	2-6
2.2.4.2 Screening	2-7
2.2.4.3 Pumping	2-7
2.2.4.4 Raw Water Storage	2-8
2.2.5 Groundwater Supply.....	2-10
2.2.5.1 Siting of Wells.....	2-10
2.2.5.2 Well Protection	2-10
2.2.5.3 Pumphouse Design	2-10
2.2.5.4 Well Disinfection.....	2-11
2.3 Water Treatment	2-11
2.3.1 Rapid Sand Filtration.....	2-11
2.3.1.1 General Guidelines.....	2-11
2.3.1.2 Chemical Mixing and Coagulation.....	2-13
2.3.1.3 Flocculation	2-15
2.3.1.4 Solids Separation	2-17
2.3.1.5 Filtration.....	2-21
2.3.1.6 Flow Measurements	2-25
2.3.2 Slow Sand Filtration	2-26
2.3.2.1 Requisite Conditions	2-26
2.3.2.2 Filter Media.....	2-27
2.3.2.3 Filter Depth.....	2-27
2.3.2.4 Filtration Rates	2-27

2.3.2.5	Headloss	2-28
2.3.2.6	Hydraulics.....	2-28
2.3.2.7	Gravel Support.....	2-30
2.3.2.8	Flow Measurements.....	2-30
2.3.4	Lead and Copper.....	2-31
2.3.5	Iron and Manganese Control.....	2-31
2.3.5.1	Removal of Iron and Manganese	2-31
2.3.5.2	Control of Iron and Manganese.....	2-32
2.3.6	Controls and Instrumentation	2-33
2.3.6.1	General.....	2-33
2.3.6.2	Measurement List.....	2-33
2.3.6.3	Degree of Automation in Plant Control.....	2-35
2.3.6.4	Alarms and Status Indication.....	2-36
2.3.6.5	Control Equipment (Automatic Systems)	2-37
2.3.6.6	Network Security	2-38
2.3.6.7	Historical Data	2-38
2.3.7	Colour Codes for Water Treatment Plant Piping	2-39
2.3.8	Laboratory Requirements.....	2-39
2.3.9	Operational Monitoring	2-40
2.3.10	Water Treatment Chemicals.....	2-42
2.3.10.1	Labels and Material Safety Data Sheets	2-42
2.3.10.2	Storage and Handling.....	2-42
2.4	Water Transmission and Distribution Mains.....	2-44
2.4.1	Pipe Sizing	2-44
2.4.2	Valves and Hydrants	2-45
2.4.2.1	Valve Placement	2-45
2.4.2.2	Fire Flows and Hydrants	2-45
2.4.3	Pumping	2-45
2.5	Potable Water Storage	2-46
2.5.1	Sizing.....	2-46
2.5.2	Phasing	2-46
2.5.3	Alternative Types.....	2-46
2.5.4	Site Selection	2-46
2.5.5	Design Considerations	2-47
2.5.5.1	Multi-Cell Provision.....	2-47
2.5.5.2	Access.....	2-47
2.5.5.3	Vents	2-47
2.5.5.4	Drains and Overflows	2-47
2.5.5.5	Circulation	2-47
2.6	Watering Point.....	2-48
2.7	Water Systems Security and Protection.....	2-48
2.7.1	Vulnerability Assessment	2-48
2.7.2	Emergency Reaction Plans	2-48
2.7.3	Physical Security.....	2-49
2.7.3.1	Personnel	2-49
2.7.3.2	Training	2-49

2.7.3.3	Access Control	2-50
2.7.3.4	Perimeter Security	2-50
2.7.3.5	Detection Systems	2-50
2.7.4	SCADA Security	2-51
2.7.4.1	Critical Cyber Assets	2-51
2.7.4.2	Identification of Connections	2-51
2.7.4.3	Authentication and Access	2-51
2.7.4.4	Anti-Virus	2-51
2.7.4.5	Operating Systems	2-51
2.7.4.6	Network Logging	2-52
2.7.5	Excavations and Open Trenches	2-52
2.7.6	Reservoirs	2-52
2.8	Facility Risk Assessment	2-52
2.9	Conservation and Reclamation	2-56
APPENDIX 2-A		2-A-1

Additional Parts published separately are:

Part 1 Standards for Municipal Waterworks
Part 3 Wastewater Systems Standards for Performance and Design
Part 4 Wastewater Systems Guidelines for Design, Operating and Monitoring
Requirements
Part 5 Stormwater Management Guidelines

FOREWORD TO PART 2 GUIDELINES FOR MUNICIPAL WATERWORKS (2012)

Alberta Environment and Water (AEW) is responsible for the Drinking Water and Wastewater Programs for large public systems in Alberta. AEW considers the establishment of standards and guidelines for municipal waterworks, wastewater and storm drainage facilities an integral part of our regulatory program directed at ensuring public health and environmental protection. AEW's objective is to develop comprehensive and scientifically defensible standards and guidelines that are effective, reliable, achievable and economically affordable.

Since publication of the last revision of the Standards and Guidelines, Alberta Environment and Water has embarked on a process of "decoupling" the various components of the January 2006 document into functionally-associated sections to aid those using the document. This process started with the publication of the January 2006 version of the Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems in the Alberta Gazette. A program of separating the component parts of this document is under way and new parts will eventually replace the corresponding sections in the January 2006 Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems. Until the process of "decoupling" is completed with new "Parts" the existing sections of the 2006 Standards and Guidelines document will remain in operation. This Part (Part 2) details system components that are guidance to best practices in providing safe drinking water and should be read in conjunction with Part 1 – Standards for Municipal Waterworks (2012).

Alberta Health Services is responsible for the application of the Public Health Act of Alberta. The role of Alberta Health Services, in the spirit of the Public Health Act, applies to all drinking water systems, both large and small, and to all aspects of safe drinking water production and delivery, if there is a concern about health impacts or disease transmission.

The system owners / utilities are responsible for meeting AEW's regulatory requirements and for the production and delivery of safe drinking water to the consumers. They are also responsible for maintaining water distribution system to the service connection, and will assist the home / building owners to identify any water quality issues within building plumbing. However, home / building owners are still responsible for plumbing repairs, system corrections and water quality within their building.

Engineering consultants and / or the system owners / utilities are responsible for the detailed project design and satisfactory construction and operation of the waterworks and wastewater systems.

In accordance with the Potable Water Regulation (277/2003) a waterworks system will be designed so that it meets, as a minimum, the performance standards and design requirements set out in the Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems, published by AEW, as amended or replaced from time to time, or, any other standards and design requirements specified by the Regional Director. AEW last revised its Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems in January 2006.

This present part is intended to provide general guidance on how to achieve a certain level of system performance or reliability. Good engineering and best management practices are included in this Part. These are not mandatory requirements but they establish the minimum quality of the facility expected when the system owner/ utility applies for an approval.

In this version of Part 2 – Guidelines for Municipal Waterworks the only changes from the January 2006 version of the Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems are in the listing of the Appendices. The 2006 Appendix D is now located in Part 1 – Standards for Municipal Waterworks as Appendix 1-D; Appendix F from the 2006 document is now in this present part as Appendix 2-A. There is no change to the content of the Appendices.

DEFINITIONS / ABBREVIATIONS

AO	-	Aesthetic Objectives
AEW	-	Alberta Environment and Water
AWWA	-	American Water Works Association
BDOC	-	Biodegradable Dissolved Organic Carbon
BNR	-	Biological Nutrient Removal
BPJ	-	Best Professional Judgement
BPR	-	Biological Phosphorus Removal
BPT	-	Best Practicable Technology
CBOD	-	Carbonaceous Biochemical Oxygen Demand at 5 days and 20 °C
CFID	-	Continuous feed and intermittent discharge
DAF	-	Dissolved Air Flotation
DBP	-	Disinfection By-product
DCS	-	Distributed Control System
DO	-	Dissolved Oxygen
DOC	-	Dissolved Organic Carbon
DWSP	-	Drinking Water Safety Plan
EPEA	-	Environmental Protection and Enhancement Act
F/M	-	Food to Microorganism ratio
G	-	Velocity Gradient
GCDWQ	-	Guidelines for Canadian Drinking Water Quality
GWUDI	-	Groundwater under the direct influence of surface water
HPC	-	Heterotrophic Plate Count
HRT	-	Hydraulic Retention Time
IFID	-	Intermittent feed and intermittent discharge
MAC	-	Maximum Acceptable Concentration
MLSS	-	Mixed Liquor Suspended Solids
NH ₃ -N	-	Ammonia nitrogen
NSF	-	National Sanitation Foundation
NTU	-	Nephelometric Turbidity Unit
ORP	-	Oxidation Reduction Potential
OU	-	Odour Unit
PLC	-	Programmable Logic Controllers
QA/QC	-	Quality Assurance/Quality Control
RBC	-	Rotating Biological Contactor
SAR	-	Sodium Adsorption Ratio
SBR	-	Sequencing Batch Reactor
SRT	-	Sludge Retention Time
TBOD	-	Total Biochemical Oxygen Demand at 5 days and 20 °C
TOC	-	Total Organic Carbon
TP	-	Total Phosphorus
TSS	-	Total Suspended Solids
TTHM	-	Total Trihalomethanes
UC	-	Uniformity Coefficient
USEPA	-	United States Environmental Protection Agency
UV	-	Ultraviolet
WHO	-	World Health Organization

Average daily design flow - The product of the following:

- design population of the facility, and
- the greatest annual average per capita daily flow which is estimated to occur during the design life of the facility.

Co-op - An organization formed by the individual lot owners served by a waterworks system, wastewater system or storm drainage system.

Granular Filter Media:

1. **Effective Size (D_{10})** - Size of opening that will just pass 10% of representative sample of the granular filter media.
2. **Uniformity Coefficient** - A ratio of the size opening that will just pass 60% of the sample divided by the opening that will just pass 10% of the sample.

Groundwater - All water under the surface of the ground.

Maximum daily design flow (water) - Maximum three consecutive day average of past-recorded flows, times the design population of the facility. If past records are not available, then 1.8 to 2.0 times the average daily design flow.

Maximum hourly design flow (water) - 2.0 to 5.0 times the maximum daily design flow depending on the design population.

Owners - Owners of the waterworks systems as defined in the regulations.

Peak demand design flow (water) - the maximum daily design flow plus the fire flow.

Potable Water - As defined in the EPEA. Other domestic purposes in the EPEA definition include water used for personal hygiene, e.g. bathing, showering, washing, etc.

Sodium Adsorption Ratio - A ratio of available sodium, calcium and magnesium in the soil solution which can be used to indicate whether or not the accumulation of sodium in the soil exchange complex will lead to a degradation of soil structure.

$$SAR = \frac{Na}{\left[\frac{Ca}{2} + \frac{Mg}{2} \right]^{1/2}}$$

Note : All concentrations expressed in milliequivalents per litre

Surface water - Water in a watercourse.

Watercourse - As defined in the EPEA.

2.0 Waterworks Systems Guidelines

2.1 Design Criteria

2.1.1 Water Quantity Requirements

A general correlation exists between the available quantity of drinking water and the level of public health within a community. The waterworks system shall be capable of providing sufficient quantities of water to meet the needs of consumers, meaning that the proposed source of supply should adequately meet the demand of consumers without any adverse effects on other water users. Water quantity requirements should be based on an assessment of all existing and possible future domestic, institutional, commercial and industrial demands, and should also consider possible water demands for fire fighting purposes.

Water is also a natural resource, which should be managed and used in a responsible manner. Water conservation measures that eliminate water misuse or wastage should be implemented; water metering is a particularly effective method of encouraging the responsible use of water. The use of water saving fixtures, upgrading or replacement of leaking water distribution piping, water use restrictions, and proper water treatment plant operation are other water saving measures which should be considered when determining water requirements.

2.1.2 System Capacity

Various components of waterworks systems should have a design life that is compatible with the function of the component. For example, a water treatment plant should be designed for a minimum period of 10 years with provision for expansion to handle a 20 or 25-year design flow. Intakes and outfall structures, which have high base construction costs, should be designed for the entire design horizon which is at least 20 to 25 years. Storage facilities, on the other hand, should be phased to avoid operational problems (such as increased chlorine demand or oversized pumps) which are associated with excess storage and detention times.

2.1.3 Raw Water Supply and Water Treatment

The raw water supply and water treatment plant should be designed for at least 110% of the projected maximum daily design flow. This compensates for accumulated in-plant losses of up to 10% of the produced treated water.

2.1.4 Water Distribution

Water distribution system should be designed to handle a normal operating pressure between 350 kPa and 550 kPa under a condition of maximum hourly design flow. Distribution system pressures above 550 kPa should be reviewed against the Canadian Plumbing code to determine specific building/household requirements to avoid damage to internal building/household piping.

In order to provide adequate service, the minimum distribution pressure during peak demand design flow should be 150 kPa.

In addition to the maximum operating pressures, there are transient pressures due to pump starts and stops, power failures, or rapid valve operation. Pumps should be designed to

minimize these surges, and water mains should be designed to withstand these surges, in addition to the maximum operating pressure.

At the discretion of municipalities, distribution mains may be located on lands controlled by the municipality.

2.2 Raw Water Supply

2.2.1 Source Water Protection

Source protection is used to control or minimize the potential for introduction of chemicals or contaminants in source waters, including water used as a source of drinking water. Since almost all water, both surface and groundwater may be a potential source; this really is about the protection of all water resources. Thus, source protection is really the equivalent of, or at least a component of a watershed management plan that usually focus on general (ambient) water quality. The focus in a comprehensive plan will be on contaminants that pose a threat to human health as well as aquatic life.

A waterworks utility needs to have a comprehensive, source-to-tap plan in order to ensure safe drinking water. A source protection plan is only one of the elements of a source-to-tap plan. The utility need not take on the source protection responsibility alone, and in fact, likely can't accomplish it without the involvement and cooperation of others. The source protection component may be achieved in conjunction with other efforts such as watershed management planning and this will serve to perform the first barrier in the multi-barriers in the source-to-tap approach. The watershed management planning process will quite likely involve a wide range of participants including, but not limited to, federal, provincial and municipal governments, watershed groups, stakeholders, and the public. The waterworks utility needs to be a participant in this process as a stakeholder.

In late 2003, the Government of Alberta released *Water for Life: Alberta's Strategy for Sustainability*. Alberta Environment and Water will lead this initiative but the strategy is based on a shift to shared governance through partnerships, including federal, several provincial ministries, municipal and non-government organizations. This strategy will form the framework for province-wide water management planning. The planning areas will be based on watershed scale planning areas. It is this process that waterworks utilities should be preparing to participate.

The goal of a successful plan is to provide guidance in making decisions, by anyone with the authority to do so, so that the outcome is consistent and coordinated. For example, a municipal development authority may use the plan to make decisions on land use. Another example is a provincial government authority making a decision regarding a point-source discharge. The plan communicates the desires, intentions, and possible consequences of decisions.

The waterworks utility's perspective and input into the process needs to be on contaminants that may not be adequately controlled by the treatment system of a waterworks system. Typically, a water treatment system is designed based on the quality of the source water at the time of initial construction or a major upgrade. In order for the treatment system to function well in producing an acceptable product water quality, the source water quality must remain within the anticipated range of quality.

If contaminants are introduced into the system for which the treatment system was never designed or intended to remove, the contaminant has the potential of passing through the process and being present in the finished water. Increased concentrations of contaminants for which the system was designed may result in breakthrough due to exceeding the design criteria. Contaminants that appear and will remain present in the source water after design and construction of the plant effectively reduce the design life of the system. This is a significant impact on the capital investment.

A reduction in contaminants in the source water may have the benefit of improving the finished water quality and potentially extending the design life of the facility thereby providing benefits over and above simply protecting the investment.

A source protection plan must identify the threshold within which the source water is of adequate quality. This is accomplished by reviewing the ability of the selected or existing technology to reduce or remove any given contaminant. Any additional contaminants or concentration of contaminants would therefore threaten the ability of the treatment system to produce adequate quality water.

The plan must examine the source for the existence, or potential for introduction of, contaminants that are above or outside the acceptable range. Once these contaminants are identified, the potential source of the contaminants can be determined and control measures implemented.

Control measures are not limited to eliminating the practice of the activity within the upstream watershed, but may include multiple levels of providing protection that will effectively eliminate the threat and provide satisfactory protection of the finished water quality.

2.2.1.1 Surface Water or Groundwater under Direct Influence of Surface Water Sources

Surface water sources are the most difficult to protect since they may be subject to both point source and non-point source contaminant introduction. The number and type of contaminants are as diverse as the number of activities that may occur in the watershed upstream of the intake. In addition, the travel time to an intake for any given contaminant is likely to be much shorter than for a groundwater source. This results in the area to be considered within the plan to be extended much further upstream to provide adequate detection and reaction time.

Most conventional surface water treatment systems are designed for removal of suspended sediments and organics such as parasites and microbes. These systems typically are not intended to remove dissolved substances although some incidental removal may be accomplished. The normal method of determining the efficiency of the physical treatment is log reduction of particles. Turbidity is used as an indirect measurement of the number of particles in water. Turbidity reduction to below a specified level is assumed to have achieved the required log reduction.

The initial pre-design water quality characterization must identify the level of log reduction required for the source water. If the value of this parameter in the source water is constant, the system should continue to perform adequately. However, if the parameter is not constant, and over time varies above the initial assessment value, the treatment system will effectively have its useful life shortened. An unplanned upgrade will be required to maintain the same level treatment as was originally anticipated for the life of the facility.

The presence and baseline concentrations for other chemicals such as pesticides should be evaluated. Although most of these contaminants are likely to be well below levels of concern, monitoring the trend over time will allow review of the adequacy of the protection plan in controlling these chemicals.

Source protection measures may include programs for:

- land use/buffer zones,
- agricultural tillage practices,
- stormwater management,
- material disposal and recycling,
- landfills,
- used oil collection,
- pesticide container collection,
- hazardous waste round up,
- private sewage systems siting, construction and management,
- shoreline and riparian area restoration,
- and many others.

2.2.1.2 Groundwater

Waterworks systems that are served by high quality groundwater sources are not immune to potential contamination and require source protection just like surface sources. The main difference is in identification of the potential points of entry of contaminants into the aquifer. For the most part, these will be point sources such as the wellhead itself, other wells that utilize the same aquifer as a source, or areas of high permeability and recharge. In addition, the delineation of the aquifer may be somewhat more difficult as the extent of the source is not as readily identified.

Each well provides a potential conduit for contaminants into the aquifer. Although control of many of these wells will not rest with the protected system's owner, an education program for private owners will certainly reduce the risk of accidental contamination. Simply knowing the number and types of wells, including their intended use, will provide the ability to identify hazards and prepare contingency plans.

Unused wells also present a hazard to the aquifer. The owners of the wells may be reluctant to permanently abandon (plug and seal) these wells, and wish to retain them as a back-up source. However, the reason for seeking an alternate supply was likely that the well was inadequate in meeting the demands or it suffered partial or complete failure.

Every well, including the protected system's well, whether or not the wells are used regularly or kept for backup, need to be properly sited, constructed, and protected. Wells must be sited on relatively high ground such that water will not pool around the casing. The well construction must ensure that the well is completed in a single aquifer to prevent cross-contamination. The annular space surrounding the casing must be sealed to prevent vertical movement along the

casing. The top of the casing must extend above the ground to the highest recorded flood water level.

The presence and baseline concentrations for other dissolved chemicals should be evaluated. Although most of these contaminants are likely to be well below levels of concern, monitoring the trend over time will allow review of the adequacy of the protection plan in controlling these chemicals.

2.2.1.3 Summary

Source protection for waterworks utilities can be accomplished by preparing for, and participating in the *Water for Life; Alberta's Strategy for Sustainability* process. Waterworks owner's can prepare for this process by identifying potential partners, issues and concerns pertinent to their facility, and identifying potential solutions. Each utility will likely share concerns with other neighbouring facilities in the same area and can collaborate to share information and efforts.

Successful development and adoption of a source protection plan, even one that is shared with others, will be of great benefit to the overall source-to-tap protection system.

2.2.2 Water Source/Quality

Raw water from a selected source should be of sufficient quality such that it can be economically treated to produce finished water which complies with the potable water quality (Section 1.1) and the treatment requirements outlined in Section 1.2. Factors that influence the choice of the raw water source should include reliability, treatability, environmental impact, and economics. The choice of filtration process should be based on total coliform count, turbidity and TOC as presented in Table 2.1.

As the level of treatment required would be dependent on the raw water quality, the owners may develop watershed protection programs to reduce any potential risk of source pollution. The owners may maintain a sanitary control area around all sources for the purpose of protecting them from existing and potential sources of contamination. The owners may also develop a watershed control program, identifying land ownership and activities which may adversely affect source water quality and develop watershed control measures, including documentation of ownership and relevant written agreements and monitoring of activities and water quality.

2.2.3 Site Selection Criteria

Several factors that should be considered when selecting a site for new or expanded water supply and treatment works include:

1. isolation from non-compatible land uses;
2. facility location with respect to the raw water source, the area(s) being serviced, and proximity to associated utilities;
3. physical site problems including susceptibility to flooding, subsurface geology, or proximity to natural watershed areas; and
4. adequacy of the site for future expansion.

TABLE 2.1
Generalized Capabilities of Filtration / DAF Systems
to Accommodate Raw Water Quality Conditions

Treatment	General Restrictions			
	Total Coliforms (#/100 mL)	Turbidity (NTU)	TOC	Protozoa
Conventional filtration	< 20,000***	No restrictions	No limit	< 3 log
Direct filtration**	< 500	< 7-14	< 3	< 2.5 log
Slow sand filtration	< 800	< 10	< 2	< 3 log
Membrane Filtration	N/A	< 100 NTU	< 2	Based on challenge test
DAF		< 100	No limit	N/A

* Shall insure control of disinfection by-products

** When TOC > 3 mg/L turbidity reduction is impaired

*** When total coliforms > 20,000/100 mL, or TOC > 10 mg/L, additional treatment may be required

Note: Ideally pilot testing should be conducted to demonstrate the efficacy of the treatment alternatives.

2.2.4 Surface Water Supply

2.2.4.1 Intakes

1. Sizing

For the reasons discussed under Section 2.1.2, intakes should be sized for an extended design period (as compared to a phased design), which is usually about 20 to 25 years.

2. Design

Intake design should account for wave action and should provide adequate protection against the effects of ice and boat anchors. Intakes should be identified with buoys or reflectors where in proximity to shipping or recreational activities. The designer should be familiar with the requirements as legislated under the Navigable Waters Act.

The inlet should be located to prevent bottom sediments from being picked up. For small intakes, consideration should be given to providing means for back-flushing the intake, if practical.

The design of river intakes differs from that for lakes and stagnant water bodies in that more secure anchoring is required to resist bottom scouring and stream velocities. River intakes should be equipped with trash racks and should also be located well upstream from potential sources of pollution.

River hydrology must be considered where the riverbed is subject to movement. Design the intake to minimize drawing in Frazil ice.

All intakes in fish bearing waters require Federal Department of Fisheries and Oceans approval.

An acceptable alternative design to direct intake is an infiltration gallery intake. This type of intake is suitable when the riverbed is composed of gravels and rocks or if the floodplain is demonstrated to have a high water table that is connected to the nearby watercourse. Items to be considered are:

- a. the sediment load in the river (may necessitate backwashing or aeration provisions);
- b. the use of filter cloth; and
- c. the depth of perforated infiltration pipes (to be located as deep as possible in the aquifer so as not to be affected by seasonal fluctuations).

2.2.4.2 Screening

1. Sizing

Screen mesh size should be governed by the surface raw water quality and the species of fish present in the raw water supply. Screen size requirements shall be in accordance with requirements of the provincial department of Fish and Wildlife or the federal Department of Fisheries and Oceans.

2. Location and Type of Screen

Screens may be constructed either at the intake structure itself or in-plant just prior to the raw water pumping facilities. For small treatment plants with in-plant screens, two (2) fixed screens in series will suffice, while for larger plants the use of at least two (2) mechanically cleaned screens operating in parallel is recommended. A combination of fixed and mechanically cleaned screens may be used for medium capacity plants. Screens at the intake should comply with the requirements stipulated by the federal and provincial departments of Fish and Wildlife or the federal Department of Fisheries and Oceans.

3. Washing

Fixed screens should have lifting lugs for removal and washing. Screen waste should not be returned to a raw water storage area.

2.2.4.3 Pumping

Pumps should be specified so that the full range of flows anticipated can be provided with pumps operating in the vicinity of their optimum efficiency points, with due regard to the hydraulic design of the discharge piping. This is often accomplished by selecting pumps that have wide band efficiencies and a relatively flat operating curve.

The number of pumps should be consistent with the pattern of flow required and the method of flow control. It is recommended that at least three pumps be provided for operating flexibility; a minimum of two pumps are required, one as standby. Pump capacities should be such that with

the largest unit out of service, the remainder will be able to supply the treatment plant capacity as stated in section 2.1.3.

Provision should be made for an individual pressure gauge on each pump and an isolating valve and check valve on the discharge side. Dry well pumps should be provided with suction side valves. The use of slow opening pump discharge should be considered at raw water pumping stations remote from the treatment plant. Piping should be arranged to allow ready disassembly from pump to shut off valves, and include a flexible type coupling to permit proper alignment of the piping and pump. Couplings shall be adequately protected against thrust. Pump elbows should be supported to remove all bending moments, either steady or shock, from pump nozzles.

The station design should allow for future additional pumping units and where possible, the pipe work should be large enough for an increase in pump size to be accommodated. Adequate space should be provided for the installation of these additional units, and to allow safe servicing of all equipment.

Adequate space should be provided for removal of pumps, and in the case of vertical turbine pumps it may be necessary to provide a roof access for removing the units and sectional discharge pipes so that they can be completely removed from the raw water well.

All piping should be arranged so that there is sufficient room to service all valves and other parts, and to permit their removal with minimum disturbance to the system. A bridge crane, monorail, lifting hooks, hoist or other adequate facilities should be provided for servicing or removing equipment.

Pumps should be mounted on bases above the floor level, and all access openings into the well shall have suitable curbs around them to prevent floor drainage entering the well. The station floor should be sloped to floor drains. Floor drainage back to the raw water well is not permitted. Drainage from pumps on to the floor is not acceptable.

The pumps should be capable of supplying the water over the entire range of flows to be treated. This could be achieved through the provision of pumps with variable speed motors or through control valves. Where control valves accomplish this, it is normal practice to use butterfly valves operating in a range to maintain stable control and avoid cavitation. At small treatment plants where substantial seasonal variations in flow exist, it may be necessary to provide duplicate flow control systems - one suitable for very low flows (which normally occur in winter) and one suitable for the plant design flow.

2.2.4.4 Raw Water Storage

Raw water storage improves water quality by providing presedimentation of solids, ensures an adequate supply when a stream or lake source is intermittent, and provides standby against failure of intake facilities. It also enables the operator to avoid the undesirable practice of drawing water during periods of poor raw water quality, allowing a low rate of withdrawal at the source.

1. Facility Planning

The designer should assess the need, location, and sizing of the raw water storage reservoir before proceeding with final design. Reservoir sizing should be determined by

assessing the availability of water and the nature of upstream activities. The designer should also consider any potential adverse effects on the water intake, storage, or treatment facilities; and should include design features to minimize the effects of fluctuating raw water turbidity.

2. Multi-Cell Provision

Raw water reservoirs should be constructed with a minimum of two cells. This will enable the plant operator to withdraw raw water from the second cell when the first cell is being filled or repaired. Each cell should be sized to retain about 75% of the annual raw water needs. In areas of drought, the number and storage capacity of each cell should be increased to overcome long-term droughts.

Control structures should enable the plant operator to isolate each cell, to drain each cell, and to enable the cells to be operated in series or in parallel. A bypass around the reservoirs may also be provided to obtain water during those periods when reservoirs are out of service.

Each cell should be deep enough to restrict light penetration within the depth of the reservoir to discourage the development of ideal habitats for aquatic plants.

Inside slopes of the cells should be armoured, where required, to prevent erosion. The impact of ice formation on winter storage should be accounted for in the design.

3. Reservoir Management

The owners of raw water reservoirs should have a reservoir management program that identifies the current condition of the reservoir, the necessary storage capacity, and the necessary management procedures to respond to changes in reservoir conditions.

The reservoirs should be managed to avoid any difficulties with algae, taste, odour, colour, iron and manganese in drinking water. In-reservoir management techniques should address problems with algae, weeds, low dissolved oxygen, and loss of storage capacity.

Artificial circulation, aeration, phosphorus precipitation, sediment removal, dilution, and flushing are reservoir management techniques that should be adopted to improve the water quality. Use of algaecides is not allowed due to the toxicity of the algaecide and the potential for algae cells to be ruptured resulting in the release of cyanotoxins from certain species of algae.

4. Lining

Raw water reservoirs should be designed to minimize seepage. Reservoirs should be lined in accordance with Section 4.2.1.4 pertaining to wastewater stabilization pond liners. This standard is based upon AEW's publication entitled Design and Construction of Liners for Municipal Wastewater Stabilization Ponds.

2.2.5 Groundwater Supply

2.2.5.1 Siting of Wells

Wells should be located to avoid proximity to sources of pollution and/or flooding. Wells shall be at least 100 m upgradient from pollution sources such as septic tanks, drainage fields, cesspools, or wastewater stabilization ponds; wells should not be located near sanitary landfill sites, underground fuel storage tanks, or cemeteries. Reasonable access shall be provided for repair and maintenance.

2.2.5.2 Well Protection

In order to protect the finished supply structure from external contamination, the following should be provided:

1. Watertight construction to at least 2 m below ground level. This depth may be increased if local conditions present a danger of surface contamination;
2. an annular opening of at least 40 mm outside the protective casing, filled with an approved grouting material; and
3. other precautions in the design to seal off undesirable subsurface formations and surface contamination.

2.2.5.3 Pumphouse Design

The design criteria for well pumping stations generally follow those presented for raw surface water pumping, and standby-pumping facilities should be provided which are capable of maintaining normal servicing standards. In addition, the following special considerations apply:

1. The elevation of the top of the production well casing should be 200 mm above the established ground level or the pumphouse pit floor, and at least 200 mm above the highest recorded flood level;
2. A pump pedestal should be provided around the surface casing to support the full weight of the pump and to prevent any weight from being placed on the production casing or any associated well casing;
3. A water-tight seal should be provided between the pump base plate (or submersible discharge head) and the pump pedestal, and between the well casing and the pump discharge column to prevent the entrance of contaminants;
4. An aperture for air venting with proper screening should be provided to the production well surface casing. Where there are indications of excessive quantities of explosive or toxic gases in the water, both the well casing and pump columns should be vented to the outside of the pumphouse (protection against freezing is required);
5. Return pipes that will permit water to be recirculated down the well should be avoided as they may cause contamination of the well. In cases where recirculation is proposed because of severe water shortages, the proponent should provide design details with the application for a permit;
6. The well should not be located within 1.2 m of an exterior wall of the pumphouse, and should be centred under a hatchway in the roof which is at least 1 (one) metre square to

facilitate access. Also, to accommodate redevelopment of wells, access for service rigs should be provided;

7. Well water quality monitoring should be provided by including a suitable sampling point. Water level monitoring should be provided by including at least one opening in the well head which allows vertical access to the inner casing for equipment installation;
8. Either an electric resistance tape or a water level measuring airline should be installed (clamped to the pump column) complete with a suitably calibrated pressure gauge;
9. The piping layout in the pumphouse should include an in-line free discharge pipe to the outside of the building to permit future testing of the well; and
10. A flow measurement device should be provided.

2.2.5.4 Well Disinfection

Prior to the use of a water well for domestic consumption, the well should be disinfected. Chlorine should be applied to ensure that a concentration of 50 mg/L is present in the well for a period of twelve hours. Dosage should be computed on the basis of water required to provide mixing throughout the entire well volume.

2.3 Water Treatment

2.3.1 Rapid Sand Filtration

The following guidelines have been prepared to document the desirable ranges, and the normal, minimum or maximum acceptable levels for the various design parameters used in the design of rapid sand filtration systems. This document is not a design manual per se as documentation of all parameters relating to water treatment plant design is beyond the scope of these guidelines, but an attempt has been made to include the parameters of greatest importance from the process and reliability standpoints as a guide.

2.3.1.1 General Guidelines

Process Selection

1. Raw Water Characteristics

The raw water quality is the single most important factor in determining the type and the extent of treatment required for a particular source of water. Thus, a thorough evaluation of the raw water types should precede the selection of a treatment process. The major raw water characteristics are microbiological quality, turbidity, pH, alkalinity, colour, TOC, TSS, iron, manganese, algal counts, temperature and UV absorbance at 254 nm.

Preferably at least a five-year history that characterizes the main raw water types should be collected. While this is possible for locations where a water treatment plant already exists, it could be impractical for new locations. Therefore, data that characterizes the main water types for at least one year should be collected as a minimum. Facilities that are located upstream and/or downstream from a proposed site may provide valuable information on the raw water characteristics.

2. Enhanced Coagulation

It is recommended that treatment plants using surface waters/GWUDIs should practice enhanced coagulation for disinfection by-products (DBP) precursor removal. TOC content of the source water is generally a good predictor of DBP formation potential, and enhanced coagulation is based on the organic content and driven by the TOC levels. Pre-chlorination should not be practiced at high TOC levels.

Enhanced coagulation is defined by achieving the removal percentages prior to the point of continuous disinfection given the source water alkalinity and TOC concentrations as shown on Table 2.2.

TABLE 2.2: TOC Removal Percentage

Influent TOC mg/L	Influent Alkalinity, mg/L		
	0-60	60-120	> 120
0-2	No action	No action	No action
2-4	40%	30%	20%
4-8	45%	35%	25%
> 8	50%	40%	30%

3. Coagulant Residuals

Aluminium levels in finished water have become a concern for systems using aluminium-based coagulants, particularly for systems producing water with elevated pH. Thus, municipalities should take steps to reduce the amount of aluminium below Health Canada's Operational Guidance Value of 100 µg/L, in the finished water, especially for those plants practicing lime softening.

4. Jar Tests

As bench-scale testing of the treatment often gives meaningful insight to full-scale results, it is recommended that jar tests be done on the raw water. For high TOC waters, jar tests should investigate TOC or UV₂₅₄ removal as well as turbidity removal. Jar test data should statistically establish the treatment requirements of the source water with respect to the process and the water treatment chemicals that are being proposed. The recommended apparatus are a paddle type jar tester, 2.0 litre square beakers, and automatic pipettes. Provisions should be made to ensure that the water temperature during the jar tests is constant and representative of the design conditions. A description of the techniques used, the jar tests results and the conclusions made based on the jar tests should be included in the pre-design report.

5. Pilot Tests

Where practical, pilot studies should be conducted, and specifically when a non-conventional treatment process is proposed or a new water source is being developed. Piloting should be done for sufficient length of time to statistically verify the proposed

treatment process. A description of the apparatus, the results and the conclusions made based on the pilot studies should be included in the pre-design report.

Optimization Capability

Unit processes should be designed in order to provide the operator with the flexibility to optimize and integrate each unit. Package plant installations should not be excluded from the requirement to provide the same optimization capabilities as larger plants.

Bypasses to waste should be provided for each process unit and the piping sized for the design capacity of the unit.

Manual or automatic sampling capabilities should be provided at each stage of the process. Multiple sampling locations should be provided for a unit such as a clarifier or flocculator.

Prior to commissioning, a tracer study should be conducted in order to prepare a blueprint of the plant hydraulics that can be used for plant optimization and for troubleshooting future problems. A tracer study should be performed at the initial and at the design flow rate and should quantify actual detention as opposed to theoretical detention times for each operating unit. As an alternative, tracer data supplied by the manufacturer for package plants and proprietary systems would be acceptable. The data from the tracer studies should be included in the as-built plans and/or the operating manual.

For plants with throughput in excess of 10 ML/d, an actual hydraulic grade line at initial and design flow rates should be measured. This data should be submitted with the design hydraulic grade line as part of the as-built plans and/or the operating manual.

Plant Automation

Computer control systems should be provided for all new and upgraded water treatment plants. These will enable the operator to monitor and/or change critical plant operating parameters by means of a computer or a programmable logic controller. Section 2.3.6.3 identifies those parameters for which monitoring may be automated.

2.3.1.2 Chemical Mixing and Coagulation

Chemical mixing is often the first and also an important step in the process train. Mixing is critical for uniform dispersion of the coagulant with the raw water in order to avoid over or under treatment of the water. An understanding of water chemistry and the process of coagulation - flocculation is extremely important in the design of the components of a rapid-mix unit. The water quality, mode of destabilization and the type of coagulant all play a part in the selection and design of the appropriate unit.

Some general comments pertinent for the design of chemical mixing and design criteria for various types of rapid-mix units are as follows:

1. General Comments
 - a. The designer should establish the initial and ultimate design flow capacities for each of the different raw water types. The mixers that are selected should be capable of delivering the required energy input for each of these flow rates and

raw water types. Unless it can be demonstrated that raw water quality and plant throughput will not significantly change, the rapid mixer should be capable of delivering a range of energy inputs.

- b. Simultaneous addition of a primary coagulant and a flocculant aid to a single rapid mixer is not recommended. An optimum time of separation should be derived from jar or pilot tests or should be at a minimum of two minutes. It is not unusual to add flocculant aids at the flocculator.

Flocculant aids should be mixed into the process stream either mechanically or hydraulically and a maximum energy of mixing should be determined so as not to shear the polymer chain.

- c. Dilution of polyaluminum coagulants is not recommended. To avoid precipitation of hydroxide forms, alum should not be diluted to below 0.5% (pH of solution is approximately 3.0) and ferric salts should not be diluted to below 2.5% (pH of solution is approximately 2.0).
- d. In-line mechanical mixer should be the option of choice for primary coagulants due to its versatility.

Mixing systems consisting of a back mix reactor or a channel with one or more mechanical flash mixers are not recommended for primary coagulants since they usually result in a lack of instantaneous mixing, short circuiting, and a mixing time that is excessive for metal salts. These systems are acceptable for chemicals other than primary coagulants.

- e. Injection of chemicals into a pump suction is not recommended since this results in inadequate control of mixing energy and possible pump damage. Hydraulic rapid mixing of a primary coagulant through venturi meters, parshall flumes, weirs and orifices are also not recommended for primary coagulants since these devices provide inadequate control of mixing energy into the process. They are acceptable for chemicals other than primary coagulants.
- f. High energy mixing is not required for chemicals that are not used for coagulation. As a guideline these chemicals can be injected a minimum of 30 pipe diameters or channel widths away from the point of coagulant addition.

The materials used in construction of the chemical mixing system should be corrosion resistant.

Static mixers are not recommended for mixing applications with highly variable flow rates, since at low flow rates, insufficient mixing is often provided.

2. Design Criteria

Rapid Mixing for coagulants
 $G > 3,000 \text{ s}^{-1}$

Rapid Mixing for Polymers
 $G = 400 \text{ to } 800 \text{ s}^{-1}$

3. Scale-up Criteria

$$\text{Constant value} = N^{5/8} D^{5/9}$$

Where:

N = rotational speed, rpm
D = mixer diameter, m

2.3.1.3 Flocculation

Some general comments pertinent for the design of flocculation system and design criteria for various types of flocculators are as follows:

1. General Comments

- a. All systems should employ proper compartmentalization so as to avoid short-circuiting.
- b. Except in very small plants a minimum of two flocculation trains should be provided.
- c. For conventional treatment the flocculation units should be located as close as possible or adjacent to the solids separation units.
- d. The inlet and outlet design should prevent short-circuiting and the destruction of floc.
- e. A drain or pumps should be provided in order to handle sludge removal.
- f. For mechanical flocculators an infinitely variable speed mixer is recommended for the last stage. Two or three speed motors are acceptable for the preceding stages.
- g. Baffles may be used in order to improve the efficiency of mixing. Two or four baffles are recommended and they should penetrate 1/8 to 1/12 of the width across the individual mixer compartment.
- h. Alternative and proprietary designs will be judged on their own merit. Prior to design, pilot testing of the alternative or proprietary systems should be conducted and the results should be included in the pre-design document. As indicated earlier, scale-up based on geometrically similar units with constant $N^{5/8}D^{5/9}$ is recommended.
- i. If there is a significant pH depression, the materials that are used for construction should be corrosion resistant. Alternatively, corrosion control measures (e.g. cathodic protection, coatings) could be used.
- j. Diffused air systems are not recommended due to the high rate of energy consumption and inefficiency. An exception would be if volatile inorganic or organic compounds need to be removed.
- k. Water jet mixing is not recommended due to the high shearing force of the jet that tends to restrict floc size.
- l. Hydraulic flocculators are not recommended for applications with highly variable flow rates; insufficient flocculation energy is often provided.

2. Design Criteria

a. Vertical Turbine Flocculators

$G = 100$ to 10 s^{-1} (tapered)
 $t = 15$ to 40 minutes (for conventional treatment)
 $G \times t = 20,000$ to $200,000$
Stages = 2 (for direct filtration applications) to 4 , typically 3
Maximum tip speed = 2.0 m/s
Blade Area/Tank Area = 0.1% to 0.2%
 $D/T = 0.2$ to 0.4 (D = blade length, T = equivalent tank diameter)
Shaft speed = 8 to 25 RPM

- Recommended for direct filtration (higher energy/shorter detention time) and conventional systems (lower energy/longer detention times).

b. Horizontal Paddle Flocculators

$G = 50$ to 10 s^{-1} (tapered)
 $t = 30$ to 40 minutes
 $G \times t = 20,000$ to $110,000$
Floc stages = 3 to 2
Maximum tip speed = 1.0 m/s
Blade Area/Tank Area = 5% to 25%
Shaft speed = 1 to 5 RPM
Minimum number of paddles per shaft = 3

- Recommended for conventional treatment systems.

Note: Baffled Walls for Mechanical Mixers

Typical orifices size = 100 mm to 150 mm , rectangular or round, evenly distributed.

Maximum velocity of water through the orifices in the first stage 0.20 m/s

Maximum velocity of water through the orifices in the last stage = 0.35 m/s .

Maximum velocity of water through orifices that connect directly into a sedimentation tank = 0.25 m/s .

Headloss through the ports should be less than 1 cm in order to prevent floc break up.

At the bottom of the baffle, clearance should be provided for the washing and removal of sludge.

The top of the baffle should be slightly submerged in order to promote the passage of scum.

Baffled walls contribute a G of 5 to 25 s^{-1} and this may be incorporated into the overall mixing requirement.

c. Baffled Channel Flocculators or Hydraulic Flocculators

Commonly called "around-the-end" or "over and under"

"G" = $12.7 (h/t)^{0.5}$ at 4° , where t = residence time in seconds, and h = headloss in metre

G = 50 to 5 s^{-1} (tapered)

t = 20 to 45 minutes

Maximum flow velocity = 1.0 m/s, downstream sections will have much lower velocities.

Typical headloss = 0.2 to 1.0 m

Minimum water depth = 3.3 m

Minimum distance between baffles = 0.75 m

Minimum number of channels = 2

Typical headloss across the tank = 0.3 to 0.2 m

- Recommended for conventional treatment where plant flow variation is small.
- Adjustable baffle walls are recommended for varying raw water conditions.

2.3.1.4 Solids Separation

1. Sedimentation

Some general comments pertinent for the design of sedimentation/clarification system and design criteria for various types are as follows:

a. General Comments

- i. The minimum number of sedimentation tanks should be two in separate trains with dedicated filters except in very small plants.
- ii. Bottom slope can vary from <1% to 8% depending on the sludge removal method.
- iii. Sludge should be automatically removed by mechanical means. Steep sided hoppers shaped bottoms (e.g. $>45^\circ$) by themselves are inadequate for sludge removal unless the sludge bed is not allowed to compact.
- iv. Installation of a grit chamber at the low lift pumps is recommended if raw water contains a large amount of silt and sand.
- v. If there is a significant pH depression, the materials that are used for construction should be corrosion resistant. Alternatively corrosion control measures (e.g. cathodic protection, coatings) are recommended.
- vi. An overflow to waste should be provided.
- vii. A by-pass for the sedimentation unit may be provided to permit direct filtration during maintenance of the tank or when water conditions are suitable for direct filtration. Disinfection should be capable of providing the required inactivation of *Giardia* and *Cryptosporidium* during the direct filtration mode.

b. Design Criteria

i. Horizontal-flow type (Rectangular basin without high rate settling modules)

Surface Loading Rate = 0.83 to 2.5 m/h
Water Depth = 3 to 5 m
Detention Time = 1.0 to 3 hours
Length/Width = Minimum 4/1, Recommended 5/1
Maximum Length = 75 m
Maximum Width = 25 m
Freeboard = 0.2 m (typical)
Weir Loading < 11 m³/m.h.
Reynolds Number < 2000
Froude Number > 10⁻⁵

Due to the potential for short-circuiting and dead spaces, rectangular basins should not be designed with 180° horizontal bends along the flow path.

ii. Horizontal-flow type (Rectangular basin with high rate settling modules)

Surface Loading Rate (Flow/Projected area of basin covered by modules)
= 2.3 to 5.0 m/h (cold water: < 10°C)
= 7.5 to 8.8 m/h (warm water: > 10°C)

Water Depth = 3.2 m (minimum due to mechanical sludge removal) to 5.0 m.

Maximum Area Covered by Tube or Plate Settlers = 75%, from the back wall forward to the inlet.

Weir (Launderer) Loading < 15 m³/m.h.

Approach velocity to modules = 0.2 m/min (typical)

- Higher surface loading rates may be acceptable when a heavy floc is generated. Natural conditions or the use of a flocculant aid can produce rapidly settling floc.
- The surface loading rate is also a function of the type of high rate settling module.
- A continuous sludge removal system is recommended if high rate settlers are employed.
- Due to the potential for short-circuiting and dead spaces, rectangular basins should not be designed with 180° horizontal bends along the flow path.

Note:

A. For perforated inlet baffles in rectangular basins that are not part of the flocculator

- Ports should be uniformly distributed across the entire cross section.

- While maintaining the structural integrity of the baffle wall, a maximum number of ports should be provided in order to minimize the velocity of the jets and the dead zones between ports.
 - Maximum velocity of the water jet entering the sedimentation tank should be 0.25 m/s.
- B. For long rectangular tanks, provision should be made for the design and installation of an intermediate diffuser wall(s). These walls may be installed at or after plant start-up.
- C. For Outlets for Rectangular Basins
- Long finger launderers with or without adjustable weir plates are recommended.
 - Submerged orifice pipes and troughs are acceptable.
 - Significantly higher weir loading rates may be allowed if the weirs are evenly distributed over a substantial portion of the surface (20% to 70%).
- iii. Up-flow Type (Radial, without high rate settling modules)
- Circular or square in shape
Surface loading rate = 1.3 to 1.9 m/h
Water Depth = 3 to 5 m
Detention time = 1 to 3 hours
Weir Loading < 7 m³/m.h.
- These are usually proprietary designs.
 - Recommended for plants where raw water flow and quality is constant.
- iv. Reactor Clarifier
- Flocculation time = 20 minutes, and up to 40 minutes in cold water
Surface loading rate < 3 m/h for alum/ferric coagulants
Detention time = 1 to 2 hours
Weir Loading < 15 m³/m.h.
- These are usually proprietary designs.
 - Tube settlers may be added in order to improve performance as plant throughput increases.
 - Recommended for water softening or conventional treatment where the raw water quality is constant.
- v. Solids Contact Clarifiers (with high rate settling modules)
- Flocculation time = 20 minutes typically and up to 40 minutes in cold water
Surface loading rate < 5 m/h for alum and < 9 m/h for lime

Detention time = 1 to 2 hours
Weir Loading = 7.5 to 15 m³/m.h.
Slurry recirculation rate = 3 to 10 times the raw water inflow rate

- Surface loading rate may be reduced in cold weather conditions
- Lower values for recirculation are used for coagulation.
- Higher values for recirculation are used for lime/soda ash softening.
- These are usually proprietary designs.
- If high rate settling modules are not used, the loading rates would be about a third of what is recommended.
- Recommended for water softening or conventional treatment.

2. Dissolved Air Flotation (DAF)

a. General Comments

- i. The minimum number of DAF units should be two.
- ii. DAF is a particularly useful process where the floc is light (such as often occurs with low-turbidity raw waters) or where the suspended particles (such as algae) tend to float rather than sink.
- iii. Uniform withdrawal of the clarified water, from the bottom area of the units, is recommended to minimize short-circuiting.
- iv. DAF should be considered only in conjunction with chemical pre-treatment.
- v. Suitability of DAF for a particular raw water source should be substantiated/verified by a pilot study.

b. Design Criteria

- i. Bubble diameter = 20 to 100 microns
This is typically achieved by air saturation in a pressurized vessel; larger bubbles will shear rather than float the floc particles.
- ii. Surface loading rate = 5 to 15 m/h
Dependent on factors such as water quality and temperature, tank configuration, and size and characteristics of suspended particles.
- iii. Saturation pressure = 450 to 725 kPa
Recycle rates = 6 to 10% of the total process flow
Air requirements = 8 to 10 grams/m³ of raw water
Design of the recycle water injection nozzles shall ensure even distribution across the inlet, and minimize tendencies for the air bubbles coalesce near the point of injection.
- iv. Inlet baffle should be placed at an angle greater than 45° to the horizontal (typically 60° to 75°).

Cross flow velocities between the top of the weir and the water surface = 0.7 to 1.0 m/min.

- v. Floating sludge removal system - Mechanical removal by reciprocating scraper.

Hydraulic removal will result in dilution of the waste sludge.

2.3.1.5 Filtration

1. Filtration Systems

Where possible, the filtration system should be designed and operated to reduce turbidity levels as low as possible, with a goal of treated water turbidity of less than 0.1 NTU at all times.

There are basically three types of rapid sand filtration systems. They are: declining rate filtration; influent flow splitting; and constant rate filtration.

a. Declining Rate Filtration

In declining rate filtration, filter influent enters through specially designed manifolds to provide virtually equal head to all filters. The filter outlet contains a restriction limiting filtration rate through a clean bed to the maximum allowable rate, and filtration rate declines as the bed plugs. An advantage of this method is that it avoids potential water quality deterioration caused by high shearing forces on a dirty bed which can occur in constant rate filtration as design headloss is approached. Disadvantages include the need for special care in start-up of filters by gradually opening of the effluent valve, and a loss of operating flexibility, which is particularly significant in larger plants.

b. Influent Flow Splitting

Influent flow splitting employs free fall weirs as a means of providing equal flow to multiple filters, thus avoiding the need for, and cost of, effluent control systems. The disadvantages include the potential for flocculated particles to shear passing the weir, thus impairing the filtration process; and that weir settings are normally made to accommodate a single plant flow rate. Changes in plant flow cause different losses in influent channels and the influent flow are no longer equally divided.

c. Constant Rate Filtration

The most commonly used method is known as constant rate filtration. In this method the filter effluent piping contains a flow measuring device, frequently a venturi flow meter, and an automatically controlled modulating butterfly valve. The filtration rate is set to a pre-determined value by positioning the effluent valve accordingly and filtration is continued at that rate by the effluent valve gradually opening to compensate for increased headlosses as the filter bed plugs. The rate is maintained until clearwell level exceeds a level typically 300 mm below the design top water level. At this point the filtration rate decreases proportionally to the 'freeboard' in the clearwell until the filter reaches

its lower operating limits at which time it is shut off. This should be set to occur just before the clearwell is full.

2. General Design Consideration

The design of gravity filters should provide:

- a. adequate headroom above the filter to permit inspection and operation and maintenance, and provide reasonable access to the filters for observation (e.g., a walkway along the length and width of the filters for package plants),
- b. an overflow sized for the filter/plant capacity to prevent flooding, unless provided elsewhere in the raw water supply system and relief from flooding caused by improper operation of the backwash pump,
- c. means of cleaning influent pipes or conduits where solids loadings are high,
- d. effluent piping designed hydraulically for flows of up to 50% in excess of filtration design capacity to accommodate potential peak demands, provided that the water quality is not compromised,
- e. effluent piping arranged to prevent backflow of air into the filter,
- f. piping for filter to waste to be designed at full filter flow capacity,
- g. design to accommodate measurement of turbidity during production and filter-to-waste modes,
- h. operation with a minimum water depth in excess of the design terminal headloss to prevent negative pressure and air binding of the filter as described in subsection 5 – Headloss,
- i. an acceptable method of regulating flow as described in subsection 1 - Filtration Systems, and
- j. controls as described in Section 2.3.6 - Controls and Instrumentation.

Wash water troughs should be designed so that a clearance is maintained between the bottom of the trough and the level of the expanded media during backwashing.

The bottom of trough to the top level of the static media should not be less than 200 mm, and in some cases should be higher, and the trough capacity should be such that the maximum wash water rate can be accommodated with at least 50 mm freeboard. Trough spacing should be such that each trough serves equal filter areas, and a maximum horizontal travel for suspended particles to reach a trough of 1.0 m is recommended. Troughs should be located so that they do not obscure filters or affect accessibility.

3. Filter Media

The quality of filtered water is a function of both media size and media depth. The selection of filter media determines not only the filter effluent quality but also the filter backwash regime, and thus the backwash requirements become an integral part of the media decision. For instance, the greater the uniformity coefficient of the media, the larger the backwash rate required to fluidize the coarser grains thus provided.

Dual-media filters have some advantages over single-media filters in terms of filter run lengths, headloss, hydraulic loading rate, etc. For dual-media filters, the size of the sand layer shall be selected to be compatible with the anthracite that has been selected. The bottom sand layer should have approximately the same or somewhat higher flow rate for fluidization than the anthracite to ensure that the entire bed fluidizes at the selected backwash rate. Further, the effective sizes of the sand and anthracite should be selected to achieve the goal of coarse-to-fine filtration without causing excessive media mixing.

The particle size and the depth of the media selected for a given filter application depends on the kind of suspended solids to be removed by the filter. This is best established by pilot studies. Typical design data is shown in Table 2.3.

Sieve analyses should be performed and the values plotted to ascertain sand size distribution.

Deep bed filtration, i.e. > 2.0 m, may be used in conjunction with the policies and procedures outlined in AEW's policy - Unproven or Innovative/Alternative Technologies.

4. Filtration Rates

Filter loading rate is an important parameter in the design of a water treatment plant; and in general the filters may be designed to be operated with the loading rate in the range 2 m/h to 9 m/h.

Low filtration rates do not ensure good quality of water; what is more critical is the chemical pre-treatment and the filter design. With adequate chemical pre-treatment and filter design, filtration rate of up to 15 m/h may be applied without deterioration of the filtrate quality. However, high-rate filtration (i.e. 9 m/h < rate < 15 m/h) should be substantiated by a filter column study using the proposed source water under the full range of anticipated water conditions.

Filtration rates higher than 15 m/h may be used only in conjunction with the policies and procedures outlined in AEW's policy - Unproven or Innovative/Alternative Technologies.

TABLE 2.3: Typical Design Data For Dual-Media Filters

	RANGE	TYPICAL
Anthracite		
depth, mm	300 to 600	450
effective size, mm	0.8 to 2.0	1.2
uniformity coefficient	1.3 to 1.8	1.5
Sand		
depth, mm	150 to 300	300
effective size, mm	0.4 to 0.8	0.5
uniformity coefficient	1.2 to 1.2	1.4
Ratio of coal size to sand size (D_{30} coal/ D_{10} sand)	-	3

5. Headloss

The total head available or head loss on a filter is the difference in elevation between the water levels on the inlet and outlet side of the filters. This is a critical parameter for influent flow splitting and constant rate filters. For a specific media and flow rate, the total headloss and the time to reach a fixed headloss depend on the volume of floc retained by the filter. Thus headloss is closely associated with the filter run lengths; operation of a filter with long filter runs and high headlosses will result in break-through of the flocs.

Typical headloss for gravity filtration may be in the range from 0.3 m (clean bed) to 2.5 m (final). The filters may be operated with run lengths between 12 and 72 hours, with 24 hour runs being typical.

If the headloss at any level in the filter bed exceeds the static head, a vacuum is created, resulting in air binding in the zone of negative pressure. In order to eliminate the problem of negative pressure, the filter should be designed to discharge the effluent water at a level above the sand media surface.

6. Filter Backwash

Three basic methods are available for filter backwash: Up flow water wash without auxiliary scour, up flow water wash with surface wash, and up flow water wash with air scour. The suitability of a washing method is related to influent water quality, filtering media and bed configuration, and underdrain design. Consequently, not all washing methods are applicable in all cases, and different methods may or may not yield similar results in a particular case. Declining rate backwash systems are not acceptable.

Required backwashing rates are variable and depend on water temperature, filter type and washing method. Water velocity required to achieve the same bed expansion increases as the temperature increases, thus backwash systems should be designed for the warmest wash water temperature.

a. Up flow Water Wash Without Auxiliary Scour

For the washing to be effective, backwash rate should be sufficient to fluidize the bed with 30 to 40% expansion. The relatively weak cleaning action of water wash without auxiliary scour generally renders it unsuitable for filters removing large quantities of suspended solids.

When water wash is used alone, a rise rate of 32 m/h to 54 m/h should be applied. Backwash duration may vary between 3 to 15 minutes, depending on how dirty the filter is.

b. Up flow Water Wash With Surface Wash

Surface wash is generally applied to supplement up flow backwash where mud ball formation is likely to be a problem. Either a fixed-nozzle or rotary wash system may be used; rotary systems are preferred because they provide better cleaning action, lower water requirements, and less obstruction for filter access.

For optimum results, a combined surface and water wash should be designed to be operated in three phases. First, surface wash is activated and operated alone for 1 to 3 minutes. Water wash is then applied simultaneously at a low rate to achieve a bed expansion of less than 10 percent for 5 to 10 minutes. The final phase involves application of wash water only at a higher rate to achieve 30 to 40 percent bed expansion for 1 to 5 minutes.

Rotary surface wash system should be designed to add 1.5 m/h to 2.0 m/h to the wash water flow; and, fixed nozzle system to deliver 2 m/h to 9 m/h.

Because surface wash systems constitute a possible connection between filtered and unfiltered water, backflow prevention devices shall be provided in supply lines.

c. Up flow Water Wash With Air Scour

There are three approaches to use auxiliary air scour in backwashing filters.

Air scour alone for 3 to 5 minutes followed by low-rate water wash for 5 to 15 minutes could be applied for single media-filters with 0.2 to 1.2 mm media. Air scour should be designed to inject air at 18 to 27 m³/m².h; and water wash at 12 m/h to 18 m/h.

The second approach, which is suitable for dual-media filters, is to apply air scour alone for 3 to 5 minutes followed by water wash for 5 to 10 minutes. Bed stratification would occur during backwash cycle. The air scour should be designed to inject air at 54 to 90 m³/m².h, and water wash at 12 m/h to 18 m/h.

The third approach is to have simultaneous air scour and water wash followed by water wash alone. During the initial stage, air scour rate of 18 to 90 m³/m².h should be used with a water flow of about 18 m/h for approximately 5 to 10 minutes. This is followed by water wash only for about 5 to 10 minutes at a rate of one to two times that of the previous cycle used with air scour.

2.3.1.6 Flow Measurements

Flow meters should be provided on:

1. the main raw water supply line to measure the total flow entering the plant;
2. individual filters. This may be necessary for constant rate filtration to ensure that each filter receives the same flow; and for declining rate filtration to initiate backwashing of filters;
3. the combined filter effluent line and/or on the distribution main head to measure water usage by the community; and
4. the backwash line to measure and check the volumes of water used for backwashing the filters.

2.3.2 Slow Sand Filtration

The slow sand filter is a sand filter operated at very low filtration rates, frequently without the use of coagulation in pre-treatment. The sand used is smaller than that for a rapid filter, and this, plus the low filtration rate, results in the solids being removed almost entirely in a thin layer on the top of the sand bed. This layer, composed of dirt and micro and macroorganisms from the water (i.e. the schmutzdecke), becomes the dominant filter medium as the filter cycle progresses.

When the head loss becomes excessive, the filter shall be cleaned by draining it below the sand surface and physically removing the schmutzdecke. Typical cycle lengths may vary from 3 to 6 months depending on the source water quality and the filtration rate.

2.3.2.1 Requisite Conditions

Source water quality and community size are the key factors that should be considered in the selection of slow sand filtration to treat surface water.

1. Water Quality

Raw water quality determines the length of time between scraping options, and slow sand filtration shall be limited to raw waters that will permit filter runs of at least three months before terminal headloss is reached.

The mix of water quality characteristics causing headloss is unique to each situation and cycle lengths cannot be predicted without pilot plant testing. Unless specifically exempt by AEW, suitability of slow sand filtration for treatment and run-length shall be ascertained by pilot testing to cover all four seasons of the year.

Some waters with high algae content form a mat on the filter surface causing a rapid increase in headloss. Further, the decay of algae on the schmutzdecke may cause taste and odour problems in the effluent water. Thus source waters subject to algae blooms may not be acceptable for slow sand filtration unless the bloom season is short enough that only minimal interruption of normal operation is likely.

Though low turbidity of source water is not always indicative of long filter run-lengths, water with high turbidities can blind off the filter with a layer of sediments on top of the filter bed. Thus source waters with high turbidities may not be acceptable for slow sand filtration, unless the turbidities are attenuated by the use of sedimentation basins or roughing filters.

Slow sand filtration is not effective in removing colour, and source waters with high colour are not acceptable for slow sand filtration.

Slow sand filtration is ineffective in removing dissolved organic carbon, and because of potential disinfectant by-products, source waters with high dissolved organic carbon (DOC) may not be acceptable for slow sand filtration if chlorination is practised for disinfection. However, in some cases, ozone ahead of slow sand filtration has proven to increase run length and increase biodegradation of organic compounds, i.e. DOC converted to BDOC. This is considered an alternative technology and will be approved

only in conjunction with the policy, "Unproven or Innovative/Alternative Technologies" in the Municipal Policies and Procedures Manual.

2. Community Size

Slow sand filtration is considered appropriate for use by "small" communities. At some point in population size, slow sand filtration becomes more expensive than rapid sand filtration. Also, at some point as population increases, communities will have the requisite resources to effectively and reliably operate a rapid sand filtration system. The point of crossover on both curves depends upon the community context, and should be considered in ascertaining the suitability of slow sand filtration for that community.

2.3.2.2 Filter Media

Ideally the effective size (D_{10}) of the sand should be just small enough to ensure a good quality effluent and to prevent penetration of clogging matter to such a depth that it cannot be removed by surface scraping.

The recommended sand size is $D_{10} = 0.2$ to 0.3 mm with uniformity coefficient (UC) = 1.5 to 2.0. Media having a sand size with $D_{10} \geq 0.3$ mm and UC > 2 may be acceptable if a pilot study ascertains that acceptable removals are obtained.

The sand being considered should be washed to remove dust/fine particles to avoid long start-up times. Sieve analysis should be performed and the values plotted to ascertain sand size distribution.

2.3.2.3 Filter Depth

The depth of sand bed is determined by the number of years of operation desired before re-sanding is needed. The years of operation are calculated as follows:

$$Y = \frac{D_i - D_f}{R \cdot f}$$

in which

- Y = period of operation, yr
- D_i = initial sand bed depth, mm
- D_f = final sand bed depth, mm
- R = sand depth removal per scraping, mm
- f = frequency of scraping, number/yr

Generally sand bed depth should be between 1 to 1.3 m in depth at the start of operation, a deeper bed may be used if desired. The minimum bed depth should be greater than 0.5 m, assuming the filter is biologically mature. A staff gauge to measure sand bed elevations should be placed on the wall/bank of the filter to denote minimum and maximum sand levels.

2.3.2.4 Filtration Rates

Hydraulic loading rate for the maximum daily design flow may vary between 0.1 m/h and 0.4 m/h. The system should be designed so that when one of the filters is removed from operation for scraping, the combined loading rate of the remaining filters may not exceed the design filter hydraulic loading rate. While the hydraulic loading rate may vary during the annual

cycle and generally increase as the population grows, the flow should be steady over the daily cycle.

2.3.2.5 Headloss

Headloss within a slow sand filter is caused by flow through the schmutzdecke and the sand bed; but mostly through the schmutzdecke.

The clean bed headloss is usually about 0.01 m, depending on the hydraulic loading rate, the temperature and the sand media characteristics. Acceptable headloss limit is economic rather than technical because there is no evidence that higher headloss would cause breakthroughs.

Typical headloss for slow sand filtration may be in the range from 0.1 m (clean bed) to 2.0 m (final). The rate of headloss increase is crucial to the determination of whether slow sand should be selected as the filtration technology because the length of filter runs depend on the rate of headloss increase. This can be analyzed only by pilot plant testing. In general, the rate of headloss increases with time, and the marginal benefits of continuing the filter run decrease rapidly after a certain period.

2.3.2.6 Hydraulics

1. Distribution

Delivery of the entire flow to a filter to one point in the filter bed would result in bed erosion. The consequence of such a condition is short-circuiting of flow through the sand bed. To control bed erosion, the inlet should be designed to distribute and dissipate the kinetic energy. One approach is to distribute the influent flow around the filter bed; the lateral pipe should be large enough that the exit velocity would be sufficiently low. Distribution pipe should be placed approximately 0.3 m from the top of sand bed. For open basins, the impacts of ice cover must be considered.

2. Collection

Filters should always operate with a uniform hydraulic loading rate over the sand bed and this is dependent on underdrain collection system.

Collection of the filtered water is through slotted or perforated pipes surrounded by gravel support. The underdrain system should be designed using the manifold hydraulic principle; that is, the headloss within the main pipe should be small compared with the headloss through the orifices in the main pipe. If this principle were maintained, then the hydraulic loading rate across the filter bed would be uniform.

Spacing of the underdrain varies from 1.0 m to 2.0 m; closer spacing is preferred, as it would provide an added certainty of uniform loading of the filter.

3. Drainage

To scrape the sand bed, the headwater shall be drained to a level just below the sand bed surface. Provision should be made in the design to drain the top portion of the headwater directly either through the influent pipes or through a separate pipe.

4. Backfilling after Scraping

After scraping the de-watered filter shall be backfilled with treated water. Provision should be made in the design to backfill the filter through the underdrain system; backfilling from the top can result in entrapment of air bubble which may cause air binding and disruption of the flow.

The treated water may come from an adjacent operating filter or from the clearwater tank. Water from clearwater tank, if used, should be free of chlorine. The headwater should be backfilled to the level of the influent distribution orifices, which is usually placed about 0.3 m above the sand bed to provide the water cushion. Valves and pipings should be provided to accomplish the aforementioned tasks.

5. Flow Control

Flow to the plant should be controlled on the influent side downstream from the influent flow meter. The flow into the plant should be steady over a twenty-four hour period. The treated water storage tank should have an overflow weir with drainage pipeline to waste or recycle, if continuous operation of the filters is desired.

6. Tailwater Control

Tailwater control is necessary so that the water level in the filter can be raised to about 0.3 m above the sand bed immediately after scraping in order to dissipate the kinetic energy of the influent flow.

The design of the system should have a movable weir plate that can be raised or lowered during operation. The initial position of the weir crest, at the start of a filter run, should be about 0.3 m above the top of the sand bed, but the plate should be adjustable enough that it can be lowered to the elevation of the surface of the sand bed once the head loss across the sand bed is greater than 0.3 m.

7. Headloss Measurements

Piezometers should always be installed in filters to measure head-loss. One piezometer should be connected to the headwater above the sand bed, and a second one to the tailwater basin. The piezometers should be 25 to 50 mm in diameter mounted side-by-side, with float balls and scales, to permit easy measurements of water levels.

8. Avoiding Negative Pressures

Negative pressures within the filter bed cause the formation of gas bubbles, which may cause "air binding" and thereby disrupt the flow patterns of water movement through the sand bed.

In order to avoid negative pressures, the system should be designed so that the weir crest for the tailwater elevation control may not be lower than the level of the sand bed during operation.

2.3.2.7 Gravel Support

The function of the gravel support is to support the sand bed and to permit uniform drainage of the overlying sand. In order to have uniform drainage and minimal headloss, the gravel support shall be graded with finer material at the top and coarser material at the bottom.

1. Size

The gravel support should be designed so that the top layer of the gravel support should not permit migration of sand from the sand bed, nor should the gravel of any layer find its way to a lower level. The bottom layer should not permit entry of gravel to the underdrain orifices. The following rules should be followed in the design of the gravel support layers:

- a. $d_{90} \text{ (given layer)} / d_{10} \text{ (given layer)} \leq 1.4$
- b. $d_{10} \text{ (lower layer)} / d_{10} \text{ (upper layer)} \leq 4$
- c. $d_{10} \text{ (top layer)} / d_{15} \text{ (sand)} \geq 4$
- d. $d_{10} \text{ (top layer)} / d_{85} \text{ (sand)} \leq 4$
- e. $d_{10} \text{ (bottom layer)} \geq 2.d \text{ (drain orifice diameter)}$.

2. Depth

The thickness of each layer should be greater than three times the diameter of the largest stone. At the same time, as a practical matter, the minimum thickness of gravel layers should be 50 to 70 mm for finer material and 80 to 120 mm for coarser gravel.

2.3.2.8 Flow Measurements

Flow meters should be provided on:

1. the influent side for the whole plant; and
2. volumetric flow meter on the exit side for the whole plant.

The flow meters for the individual filters are used to ensure that each filter receives the same flow and to measure the volumes of water filtered between scrapings. The volumetric flow meter would indicate the amount of water used by the community.

Aesthetic Objectives

Potable water quality should meet the Aesthetic Objectives (AO) in the Guidelines for Canadian Drinking Water Quality, published by Health Canada, as amended or replaced from time to time.

The water distribution system should be cleaned and flushed periodically to keep the turbidity less than 5 NTU.

2.3.4 Lead and Copper

Waterworks system should produce non-corrosive water to minimize lead and copper corrosiveness. It is recommended that the owners conduct corrosion control studies unless they can show that corrosion control is already optimized. Corrosion control studies should compare the effectiveness of pH and alkalinity adjustment, calcium adjustment, and addition of a phosphate or silica-based corrosion inhibitor.

The owners should work with AEW to establish a protocol for optimizing corrosion control.

2.3.5 Iron and Manganese Control

Iron and manganese exist in water in both the insoluble and soluble oxidation states. The insoluble iron and manganese are readily removed by filtration. However, the removal of soluble iron and manganese poses a more serious problem, particularly when these metals are organically bound.

Presence of soluble iron and manganese in water may lead to complaints from the consumers as a result of staining of laundry or bathroom fixtures. Water containing iron and manganese also promotes the growth of iron bacteria in mains, with accompanying increases in friction loss.

2.3.5.1 Removal of Iron and Manganese

1. Oxidation/Filtration

Removal of soluble iron and manganese by contact adsorption using pre-coated filter media is the option of choice for treating waters with moderate amounts of iron and manganese in groundwater (<5 mg/L of iron and <1 mg/L of manganese). The filter media that could be used are:

- a. Manganese greensand (natural greensand coated with manganese dioxide);
- b. Pyrolusite (pure manganese dioxide).

Key to the success of contact oxidation process is the re-generation of manganese dioxide coating on the media, either on a continuous basis or on an intermittent basis.

Dual media filtration is recommended if iron removal is the main objective. Continuous regeneration operation is also recommended where iron removal is the main objective with or without the presence of manganese. This method involves the feeding of a pre-determined amount of an oxidant (potassium permanganate or chlorine), directly to the raw water prior to the filters. If chlorine is used for waters containing ammonia, sufficient chlorine should be fed to go beyond breakpoint to produce free chlorine for regeneration of the media. The oxidant demand should also be determined taking into consideration the presence of DOC and H₂S.

TABLE 2.4: Design Criteria for Iron and Manganese Removal

Design Parameter	Main Component To Be Removed	
	Iron	Manganese
Regeneration of media	Continuous	Intermittent
Bed type	Dual media	Single media
Depth of bed	Anthracite - 375 to 450 mm MnO ₂ media - 450 to 200 mm	MnO ₂ media > 750 mm
pH	2.2 to 8.5	7.0 to 8.5
Filter loading rate *	4 to 13 m/h	4 to 13 m/h
Headloss	1.5 m (maximum)	1.5 m (maximum)
Backwash	Sufficient for 40% bed expansion	Sufficient for 40% bed expansion

*a. The higher the concentration of iron and manganese, the lower the loading rates for equivalent run lengths. For optimum design parameters a pilot plant shall be operated.

*b. For intermittent regeneration process, higher loading rate of up to 2.0 m/h may be allowed depending on raw water conditions.

Intermittent regeneration is recommended for waters where only manganese or manganese with small amounts of iron is to be removed. This method involves feeding of a pre-determined amount of an oxidant after a specified quantity of water has been treated. Frequently, intermittent regeneration is done during the backwash cycle. Typical design criteria for iron and manganese removal using oxidation/filtration process are shown in Table 2.4.

2. Aeration/Chemically Assisted Filtration

Aeration followed by chemically assisted filtration is effective in treating waters with fairly high content of iron (>5 mg/L) and manganese (>1 mg/L). Without coagulation and flocculation, the oxidized iron may take 12 to 24 hours or more for effective settling, whereas in properly coagulated water, settling will take place in approximately two hours. If manganese is present, pre-treatment with one or more oxidants (chlorine, chlorine dioxide, potassium permanganate or ozone) is required.

Design criteria are similar to the requirement outlined in Section 2.3.1 - Rapid Sand Filtration.

2.3.5.2 Control of Iron and Manganese

Iron and manganese concentrations in drinking water may be controlled by blending water from different sources so that the combined iron and manganese concentrations are below the aesthetic objectives stipulated in the GCDWQ.

If iron and/or manganese control with sequestering agents is proposed, the total concentrations may remain greater than the aesthetic objectives. Sequestering is generally ineffective with hard waters; pilot testing may be required to verify the performance of the proposal.

2.3.6 Controls and Instrumentation

2.3.6.1 General

Controls and instrumentation should be appropriate for the plant size, complexity, criticality, and number of staff and their skills for each plant. To achieve this, the designer should develop a control philosophy that will enable the plant staff to effectively monitor and control the plant and major equipment, the treatment process, water production and; plant wastes. The following design guidelines represent a minimum standard that shall be achieved. Specific enhancements may be required depending on the water treatment process employed.

2.3.6.2 Measurement List

For plants of 1 ML/d capacity and greater, the following instruments should be provided as a minimum for the relevant processes listed. For smaller plants, pH measurement and fluoride residual may be by bench testing but all other instruments are appropriate for the relevant processes listed.

1. Raw Water Instrumentation:
 - Low-level switches to shut down the raw water pumps. These should be hard-wired to the starters
 - Running and trip indication for raw water pumps
 - Raw water turbidity, pH, pressure, flow rate, and flow volume
2. Rapid Mixer:
 - Running and trip indication
3. Flocculators:
 - Running and trip indication
 - Speed if variable speed type
4. Solids Contact Clarifiers:
 - Recirculator speed indication
 - Running and trip indication
 - Level indication
 - Blow down valve status

Turbidity and pH following clarification
5. Proprietary Clarifiers

Instrumentation for proprietary types of clarifiers including ballasted flocculation and DAF should be as recommended by the manufacturer. However, effluent turbidity and pH are recommended in all cases.

6. Softening:
 - If lime softening is used, pH following recarbonationRecarbonation CO₂ flow present
7. Filter (granular) Instrumentation:
 - Turbidity on each individual filter effluent and filter to waste. This can be a single instrument for each filter if piping arrangement permits.
 - For constant rate filters: differential head loss across the filter media
 - Filter flow rate
 - Provide open and close limit switches or position on all filter valves and status on backwash equipmentFilter run time
Filter effluent particle counters are optional but are encouraged.
8. Filter (membrane) Instrumentation:

Instrumentation is normally packaged in with the system to meet the manufacturer's needs. However, the following are recommended regardless:

Turbidity and particle counters on each individual filter train effluent.
Filter train flow rate
Pressure differential
 - Filter train status (on-line, backwash, clean, off-line etc.)
9. Backwash Instrumentation:
 - Running and trip indication for backwash pump(s)
 - Running and trip indication for air blowers (if air scour is used)
 - Backwash flow rate and flow total
 - Surge protection for air blowers
10. Clearwell & Distribution Pump Instrumentation:
 - Level indication for clearwell and other tanks
 - Low-level switches to shut down the distribution pumps. These should be hard wired to the motor starters.
 - Turbidity, chlorine residual, fluoride residual (if fluoridation is practised), pH, pressure, flow rate, and flow total on plant discharge.
 - For variable speed pumps, indicate the pump speed
11. Chemical Systems:
 - Running and trip indication for chemical loading, batching and pumping equipment
 - Low and high level indication in storage bins, silos or tanks

- Level indication for tanks
 - Weigh scales for hydrofluosilicic acid day tanks or storage if no day tank is used
 - Weigh scales for gaseous feed chemicals such as chlorine or sulphur dioxide
 - Speed indication on variable speed pumps
 - Rotameters for carrier water feed systems
 - Chemical feed flow rate is mandatory unless day tank is provided
 - Chlorine alarm
 - UV – provided by the vendor but some additional instruments are usually required such as flow meters and valve status for each reactor.
12. Miscellaneous Instrumentation:
- Run time meters on all pumps and major electrically driven equipment
 - Speed, run time, oil pressure and temperature gauges, fault signal switches and manual start and shut down on engines
 - Where the plant is automated or operated remotely from either within the plant or outside, provide open and close limit switches or position on all major valves, status on all major equipment and security instruments including door switches, remote resets, building temperature switches and smoke alarms.
 - Any additional instrumentation recommended by equipment manufacturers.

2.3.6.3 Degree of Automation in Plant Control

The control system may be manual or automatic or a combination thereof. Regardless, the system should be designed to promote safety of staff and the public, energy efficiency, conserve water, and reduce waste while meeting the treated water quality standards and demands under all anticipated conditions. Discuss the operating philosophy with plant staff and owners to determine the appropriate degree of automation.

In the case of a manual system, all equipment is started and stopped by the operator, all backwash sequences and other process operations are controlled by the operator, and chemical and pump rates are manually adjusted. This requires that the plant be attended continuously while in operation, perhaps with more than one operator.

In the case of an automatic system, all equipment is started and stopped by the control system, with chemical feed rates and pump rates adjusted automatically to maintain the system levels, discharge pressures, etc. This may allow unattended plant operation or operation with few staff, but requires a more complex and expensive control system, with associated maintenance. Provide the ability to manually operate all equipment.

There are a wide range of combinations of manual and automatic control systems. For conventional process systems with rapidly varying raw water conditions, fully automated plants should not normally be considered.

2.3.6.4 Alarms and Status Indication

All alarms shall be latched until the Operator has acknowledged them. If the alarm is indicated by a lamp, it shall flash until acknowledged then remain steady until the alarm clears. If it is indicated on a computer screen, an appropriate colour code or symbol shall be used to indicate for each alarm whether it has been acknowledged. Automated systems should log the time at which the alarm occurred, the time it was acknowledged and the time it cleared. Logs may be printed on paper or recorded electronically.

Valve and equipment status should use a consistent method of symbols and colours, whether the status is indicated through lamps or on a colour computer screen. Be certain that the colour-coding scheme is consistent with any existing equipment displays elsewhere in the plant.

As a minimum, provide the following alarms:

- high turbidity on the raw water, clarifier effluent (if applicable), filter effluent, and plant discharge
- high and low pressure on the raw water line
- high flow rate on the raw water line
- high and low water level in clarifiers or flocculators
- high torque on process rotating elements (e.g., basin mixers, flocculators, solids contact clarifier recirculator and rakes)
- high water level in process basins and open surface channels
- high and low level in chemical storage tanks
- high and low chemical feed rates
- high flow rate on each individual filter (also low flow rate on declining rate filters)
- high and low water levels in each clearwell, pumpwell, and reservoir
- high and low pH on the raw and treated water (if on-line measurements are provided)
- high and low chlorine residual on the plant discharge (where on-line measurements are provided)
- high head loss on the filters (if influent flow splitter or constant rate type)
- trip or failure to run on each pump and process motors
- high and low pressure on the plant discharge line
- high flow rate on the plant discharge line
- chlorine gas detection in the chlorine storage, metering and injector rooms
- chlorine scale low weight (where scales are equipped with transmitters)
- valve operation failure (where valves are provided with limit switches).

More alarms may be required where additional treatment processes are provided. Alarms should be provided for all control system interlocks that can shut down equipment or systems. In plants that are left unattended for periods of time, provide an automatic telephone dialler, cellular communication or pager system for annunciation of alarms.

2.3.6.5 Control Equipment (Automatic Systems)

1. Programmable Logic Controllers and Distributed Controls Systems.

Automatic systems should use either Programmable Logic Controllers (PLCs) or a Distributed Control System (DCS). The operator interface may be in the form of traditional control panels (i.e.: lights, gauges and switches), electronic control panels (with text and/or graphics) and computers.

2. Operator Interface

The operator interface may consist of a local hard wired control panel or mimic, character based input/output panel, personal computer or workstation depending on system size, process complexity, control system functions and operator interface manufacturer. Where personal computers or workstations are used, select the hardware based on reliability, software compatibility, vendor support and suitability for continuous operation in the plant environment. Provide the hardware and software necessary to facilitate back up of both the system and the collected data. The operator interface software may provide the operator with interactive control and monitoring of the plant, handle and annunciate alarms, log and trend events and process variables and generate the required reports. Process control and logic should be performed by the PLC or DCS and not the operator interface computer or workstation. Where outside access is provided for remote control of the operator interface or other control components (e.g., PLC) provide adequate security.

3. Communication Networks

Plant communication networks shall be considered. Installing communication networks may assist operations and maintenance personnel with the following functions:

- device diagnostic data is available
- remote calibration is possible
- device alarm status is available
- distributed control by locating PLCs or RTUs in close proximity to devices being monitored
- plant data can be made available for use by management
- loop error is reduced

Plant communication networks can be broken into four types, Sensor Networks, Device Networks, Control Networks and Enterprise networks. Sensor and Device networks are primarily focused on communication with primary elements such as push buttons, temperature transmitters and valve actuators. Control networks provide backbone communication between computers, PLCs and DCSs. Enterprise networks are, for example, local area networks (LAN) and are used to provide information that help to manage the plant. An example of an Enterprise network would be providing data in a spreadsheet format that can be used to assist management in filling out reports for regulatory monitoring.

2.3.6.6 Network Security

Control system security should be considered for mitigation of internal and external threats. Plant internal security at a minimum should include password protection to the control system, allowing only authorized users into development software, plant control software and enterprise software. Control systems should be connected only if suitable hardware and software security devices are in place to prevent unauthorized access to the system. Control systems that are connected to an intranet or wireless system should include provisions to restrict access to the control system by unauthorized personnel.

After the initial installation, the security system should be monitored and upgraded regularly. Improvements should include the upgrading of firewalls and routers, changing passwords and teaching plant personnel on the importance of network security.

2.3.6.7 Historical Data

The control system's historical data should be stored electronically and backed up on removable media such as tape or compact disk. The historical data, and the necessary hardware and software to access the data, should be kept for a period of time as defined in 1.11.1 - Record Keeping.

Historical data collection should include:

- all parameters required to be monitored in accordance with an Approval or a Code of Practice or defined elsewhere in these documents;
- alarms; and
- operator changes, such as set points or control modes.

Data collection frequency will depend on the parameter being monitored and how quickly the parameter changes. At a minimum, data should be collected at a steady time interval that will allow for recreation of parameter without significant error. Various historian software packages have built-in computer algorithms that will minimize data collection while still maintaining the parameter's trend. The collection frequency should be adjusted to allow for proper tracking of the parameter, e.g. seasonal adjustment of raw water turbidity during spring run off.

2.3.7 Colour Codes for Water Treatment Plant Piping**TABLE 2.5: Recommended Colour Coding for Water Treatment Plant Piping**

Piping to be Identified	Basic Colour	Bands	
		No.	Colour
Raw or unfinished water	Dark Green	-	-
Clarified Water	Dark Green	1	Black
Filtered Water	Dark Green	2	Black
Filtered and Chlorinated (Potable) Water	Blue	1	-
Backwash Water	Light Green	-	-
Chemical Feed Lines	Pink	-	-
Coagulant	Pink	1	Black
pH Control	Pink	2	Black
Taste and Odour	Pink	3	Black
Fluoride	Pink	1	Green
Chlorine and Water	Pink	1	Yellow
Chlorine Gas	Yellow	-	-
Plumbing (Waste)	Brown	-	-
Electrical	Purple	-	-
Compressed Air	White	-	-
Heating	Silver	-	-
Fire Protection	Red	-	-
Natural Gas	Orange	-	-

Notes:

1. Entire length of pipe to be painted in basic colour.
2. Bands, if required, are to be placed as follows:
 - (a) at 9 m intervals, and/or
 - (b) where the pipe enters and leaves a room.
3. Individual bands are to be 25 mm wide, and a 25 mm space is to be left between bands where multiple bands are required.

2.3.8 Laboratory Requirements

All water treatment plants should have laboratory facilities for analytical testing as required in the terms and conditions of the operating approval. The capability of the laboratory should commensurate with the size and the complexity of water treatment operation. Before undertaking the detailed design of the laboratory facility, contact should be made with AEW to confirm the testing requirements.

Minimum laboratory requirements for surface water treatment plants are as follows:

1. Lab equipment

pH - pH meter
Chlorine - chlorine residual titrator or colorimetric test kit
Turbidity - turbidimeter
Colour - colour meter (spectrophotometer or colour comparator)

Tap aspirator/filter apparatus for colour samples
Glassware (beakers, measuring cylinders, sample bottles, flasks, pipettes, burettes)
Balance (top-loading) - if any chemical has to be weighed out
Clean lab bench area, with sink, adequate lighting, and storage.

2. Lab chemicals/standards

pH buffer solutions for calibration
Hydrochloric acid for cleaning pH probes and titrators
Distilled water or reagent grade water for rinsing
Turbidity standards
Colour standards
Reagents for any colorimetric tests
Lab grade dishwashing detergent.

2.3.9 Operational Monitoring

Operational monitoring and associated reporting requirements would be established on a site-specific basis. The nature of the water supply source, the type of treatment system employed and the size/capabilities of the owner should be considered when establishing operational monitoring requirements. Operational monitoring requirements are established both for specific process control purposes, and to ensure that a facility receives good operational attention on a regular basis.

Table 2.6 outlines the operational monitoring requirements that would apply to waterworks systems.

TABLE 2.6: Operational Monitoring Requirements

Parameter	Point of Measurement	Requirement/Objective	Minimum Monitoring
Raw water turbidity	Before addition of any chemical or treatment process	None	See Section 1.10.3.3
Treated water turbidity	Immediately after filtration before entering the Clearwater tank	See Section 1.3.1	See Section 1.10.3.3
Raw water flows	Entering the treatment plant	Not to exceed treatment plant's design capacity	Once per day for total daily flow
Treated water flows	Entering the Clearwater tank or the distribution system	None	Once per day for total daily flow
Raw water <i>Giardia</i> levels	Entering the treatment plant	None	See Section 1.2.1.1
Raw water pH	Before addition of any chemical	None	Once per day using grab sampling
Raw water iron and manganese	Before addition of any chemical	None	Once per week using grab sampling
Chemicals used	Feed point	The chemical dosage should not exceed the recommended maximum concentration authorized by AEW	Volume/Weight/Concentration of chemicals used daily or weekly
Treated water pH	Entering the distribution system	6.5-8.5 (exceptions are acceptable if disinfection is not compromised)	Once per day using grab sampling
Treated water aluminum (if aluminum based coagulant is used)	Entering the distribution system	Not to exceed 100 µg/L for conventional plants, and not to exceed 200 µg/L for other types of treatment	Once per week using grab sampling
Turbidity within distribution system	Random location throughout the distribution system	Not to exceed 5 NTU	Once per week using grab sampling
Treated water iron	Immediately after filtration before entering the Clearwater tank	Not to exceed 0.3 mg/l	Five times per week, twenty-four hours apart using grab sampling
Treated water manganese	Immediately after filtration before entering the Clearwater tank	Not to exceed 0.05 mg/l	Five times per week, twenty-four hours apart using grab sampling

Notes:

Monitoring of these parameters is not required during the calendar days the treatment plant is not operated or during statutory or civic holidays.

Raw and treated water turbidity monitoring are also required from a compliance point of view.

Raw water *Giardia* levels will be based on the running annual average of monthly samples over a two-year period (See Table 1.1)

Raw water flow rates should be reported in m³/d.

Specified monitoring for iron and manganese is required only for plants treating for these parameters.

2.3.10 Water Treatment Chemicals

2.3.10.1 Labels and Material Safety Data Sheets

Federal and provincial legislation requires hazardous products at worksites to be labeled and information be made available to workers through Material Safety Data Sheets. It also requires employers to train workers and workers to be knowledgeable with the Workplace Hazardous Materials Information System (WHMIS).

Most chemicals used for water treatment are "controlled products". "Controlled products" are hazardous products at the worksite that meet certain criteria, will either be labelled with a supplier label or worksite label, in accordance with the requirements specified in the latest edition of WHMIS.

For appropriate use of the chemical, water treatment operators should be aware of the chemical purity (concentration), shelf life, expiry data, and maximum dosage and use restrictions. This information can usually be found on the supplier labels but may be added to the worksite label for ease in use.

More specific information on the hazardous ingredients, hazards, health and safety risks, safe handling instructions, emergency and first aid measures, are contained on a Material Safety Data Sheet (MSDS). MSDS obtained from the supplier and not more than three years old shall be available at the worksite for all "controlled products" unless it is laboratory product where the label may contain all the information required on a MSDS.

Storage buildings and outside storage tanks should be labelled or placarded with the name of the product and/or hazards of the products.

2.3.10.2 Storage and Handling

1. General Provisions

Storage should be provided for at least thirty days of consumption at the maximum anticipated chemical usage rate, allowing for variations in chemical dosage and flow in that period. Alternatively, the systems should have a program in place to ensure unlimited supply of those chemicals. Storage capacity for essential chemicals should be at least sixty days, with ninety days preferred. Where deliveries of chemicals may be interrupted by adverse weather conditions in isolated locations, provision should be made for increased storage capacity taking into consideration that some chemicals degrade with time, e.g. NaOCl. Where deliveries at short notice can be assured and the material is not essential to the production of safe water, then requirements may be reduced. If practical, there should also be sufficient storage space to accommodate 'full load' deliveries.

Chemical storage areas should be segregated from the main areas of the treatment plant, with separate storage areas provided for each chemical. Where chemicals in storage may react dangerously with other materials in storage, e.g. chlorine, fluoride and ammonia or strong acids and alkalis, segregated storage should be provided. The storage and feed equipment areas should be arranged for convenience of operation and observation, and located to provide easy access for chemical deliveries.

It is strongly recommended that all chemical storage be at or above the surrounding grade. Where subsurface locations for chemical storage tanks are proposed, these locations should be free from sources of possible contamination, having drainage for ground waters, chemical spills, and overflows. Where above grade storage is provided, due consideration should be given to the method of unloading chemicals. In general, storage areas should be arranged to prevent any chemical spills. Floor surfaces should be smooth and impervious, slip-proof, and sloped so as to drain rapidly; walls and floors should be protected with a chemical-resistant finish. Storage areas should have eye-wash and/or deluge shower facilities, adequate facilities for cleaning up chemical spills, space for cleaning and storage of the recommended protective equipment, and adequate warning signs to identify hazards. It is recommended that all doors in chemical buildings open outward, and that corridors or space between storage areas be a minimum of 1.5 m wide to permit the safe movement of materials.

Chemical ventilation systems should be arranged so that air is exhausted outside the building and also so that slight negative pressures are maintained where dry chemicals are in use, as a dust control measure. Where large amounts of dust are anticipated, appropriate local exhaust systems and filters or scrubbers should be provided in the ventilation system. Ventilation systems should be designed specifically for corrosive service, and special measures taken in dust systems to prevent build-up of static or other explosive conditions.

2. Liquid Chemicals

All bulk storage tanks should have an adequately sized fill line, sloped to drain into the tank. The fill line should be adequately identified at the end that is remote from the tank, and provision should be made to drain this fill line if required.

Each tank should have an adequate vent line, with a down-turned end. Where venting outside the room is required, the vent should be provided with an insect screen.

All tanks should have an overflow which is adequate for the rate of fill proposed for the tank, sloped down from the tank with a down turned end with free discharge located where it can be readily noticed. Overflow shall not be directly discharged into storm drainage system or to a watercourse. If discharged into the sanitary sewer system, the overflow pipes shall not connect directly to the sewer, and where they pass into a receiving sump or conduit they shall terminate at least two pipe diameters above the maximum level in the sump. Each tank should also be provided with means to indicate the level of contents in the tank, and where an external level gauge is provided a shut-off valve at the tank connection is recommended.

All storage tanks should also be surrounded by a structure to contain the volume of the largest tank in the event of a rupture or spill.

In small treatment plants, day-tanks should be provided for the liquid chemicals. Flow meters should be provided for all liquid chemical systems without day tanks.

3. Dry Chemicals

Where dry chemicals are to be used, provision should be made to minimize handling and dust problems. From a materials handling perspective, granular materials should be preferred to powders.

Particular care should be taken to protect workers and mechanical and electrical equipment from fine dust. Where exhaust fans, filters, and conveying systems are used, grounding should be provided to prevent the build-up of static electricity. Dust control equipment should also be protected against moisture accumulation.

Bulk storage silos should be provided with adequately sized fill openings, and fill lines where necessary should be smooth internally with long radius elbows. Silos should have suitable level indicating devices and shall be equipped with a pressure relief valve when pneumatic fill systems are provided.

If powdered activated carbon (PAC) is used, spark-free lighting and electrical systems should be provided. Provision shall also be made to scrub or filter the carrier air, when dry PAC is off-loaded into silos.

4. Hypochlorite Solution

Municipalities should purchase hypochlorite solution with low levels of chlorate. Steps should be taken to avoid formation of chlorate ions in the solution. Hypochlorite solutions should:

- contain less than 1500 mg chlorate/L;
- have a pH greater than 12;
- be used within a relatively short time frame after delivery (within 3 months);
- be stored in a cool dry location where the temperature does not exceed 30°C, away from sunlight; and
- contain less than 0.08 mg/L of transition metals.

Manufacturers are able to produce bleach that has a lower initial concentration of chlorate; municipalities should specify hypochlorite solutions with a chlorate concentration as low as possible to ensure that they will meet the Canadian drinking water quality guideline.

2.4 Water Transmission and Distribution Mains

Where local municipal standards and guidelines for transmission and distribution mains exist, then those standards and guidelines may be followed.

2.4.1 Pipe Sizing

Water mains designed to carry fire flows should have a minimum inside diameter of 150 mm. For smaller distribution systems without fire flow provision, hydraulic calculations should verify that the proposed pipe sizes are sufficient to sustain the minimum operating pressure as defined in Section 2.1.4.

2.4.2 Valves and Hydrants

2.4.2.1 Valve Placement

Water distribution systems should have shut-off valves located to allow any pipeline to be isolated for repairs.

Air release valves should be placed at all significant high points in the transmission system, and should also be considered at high points in the water distribution system. In addition, drain valves should be placed at low points of large mains to permit drainage during repairs to the distribution system.

2.4.2.2 Fire Flows and Hydrants

The provision of fire protection is solely the decision of the Local Authority.

Where hydrants are provided, the leads should be valved for easy maintenance. Where groundwater levels are above the hydrant drain port, the drains should be plugged and the barrels pumped dry for winter conditions.

For details regarding fire protection requirements in municipal waterworks system design, the designer should refer to the most current Fire Underwriters Survey publication entitled Water Supply for Public Fire Protection - A Guide to Recommended Practice.

2.4.3 Pumping

In general, the requirements for treated water pumping station are similar to those outlined in Section 2.2.4.3 for raw water pumping station.

The distribution system by pumping should be designed with at least two pumps. With one pump out of service, the remaining pumps should be able to deliver the maximum hourly design flow at not less than 150 kPa.

In order to supply water economically during low demand periods, at least one pump should be provided with a variable speed motor or an appropriately sized, small pump may be installed.

Standby power or an auxiliary gas or diesel powered pump should be provided to supply water during power outages or other emergencies. Fuel should be stored above ground and outside the water treatment plant building in compliance with the security assessment plan.

2.5 Potable Water Storage

2.5.1 Sizing

The total water storage requirements for a given water supply system where the treatment plant is only capable of satisfying the maximum daily design flow may be calculated using the following empirical formula:

$$S = A + B + (\text{the greater of C or D})$$

where S = Total storage requirement, m³

A = Fire storage, m³

B = Equalization storage (approximately 25% of projected maximum daily design flow), m³

C = Emergency storage (minimum of 15% of projected average daily design flow), m³

D = Disinfection contact time (T₁₀) storage to meet the CT requirements, m³, as detailed in 1.10.3.7.

The level of fire protection is the responsibility of the municipality. The level of storage may be further reduced if the water treatment plant is capable of supplying more than the maximum daily design flow or if there is sufficient flow data to support a lower peaking factor than would be normally used for the given population range.

The designer should recognize that the given formula for calculating treated water storage requirements shall be supplemented with the storage required for the operation of the water treatment facility, i.e. filter backwash and domestic use.

2.5.2 Phasing

Treated water storage requirements should be calculated using a first phase projected demand of no more than 10 years (refer to Section 2.1.2). Present worth cost analysis may show that longer design periods are more economical, however the failure to properly phase the storage requirements can result in operational problems due to oversized pumping facilities and/or problems with maintaining the required chlorine residual if the available storage is excessive.

2.5.3 Alternative Types

There are many alternative methods for the provision of treated water storage at either the water treatment plant or in the water distribution system. The choice of underground, ground level, or elevated storage will depend on factors such as the service area size, topography, and economics. Each alternative should be investigated to choose the best overall method of storage based on specific project conditions.

2.5.4 Site Selection

An economical site selection will depend on the type of reservoir, but in general the major factors to consider are soils conditions, compatibility with future expansion requirements, and site access.

In cases where it may be necessary to provide two-way flow direction during periods of high demand, it is recommended that the storage facility be located on the opposite site of the high demand centre from that at which the supply facilities discharge to the distribution system.

2.5.5 Design Considerations

2.5.5.1 Multi-Cell Provision

Underground or ground level storage reservoirs should be constructed with two cells for ease of maintenance. This can often be accomplished as a result of phasing requirements. Flexibility should be built in to operate the cells in series or parallel; or pump from either cell. When planning the type of reservoir, the designer shall ensure that treated water is not stored or conveyed in a compartment adjacent to untreated water if the two compartments are separated by a single wall.

2.5.5.2 Access

Treated water storage reservoirs should have convenient access to the interior for cleaning and maintenance. Ensure access is secure.

2.5.5.3 Vents

Reservoirs should be vented by specially designed vent structures. On ground level structures, vents should terminate in an inverted 'U' construction, the opening of which is at least 200 mm above the roof or sod, having a cover using suitable non-corrodible screen cloth. Design or enclose vents to prevent the possibility of contaminants being introduced either accidentally or through a malicious act.

2.5.5.4 Drains and Overflows

Where feasible, storage reservoirs should be provided with a drain. There shall be no direct connection between any storage reservoir drain or overflow and a storm or sanitary sewer. Overflows should be located at sufficient elevation to prevent the entrance of surface water. A backflow preventer should be installed on all overflows.

Freezing of overflow lines may result in rising water levels, frozen vents, and collapse of the reservoir by vacuum action. To prevent this occurrence, overflows should be designed with a large inlet weir to allow a substantial flow that is less likely to freeze. It is also desirable to have the overflow discharge to a warm environment.

2.5.5.5 Circulation

It is most desirable to have perfect plug flow through the clear water tank at the water treatment plant. Such a design would ensure that all water entering the tank had the same detention time to ensure a high a T_{10} value (> 0.6). Baffling design and inlet and outlet design can lead to a near plug flow operation. Refer to Appendix 1-D¹ for illustration of typical baffling conditions.

¹ See Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems: Part 1 – Standards for Municipal Waterworks

Balancing reservoirs within the distribution system should be designed to achieve complete mixed flow to avoid poor mixing and circulation, poor turnover rate and excessive detention time.

2.6 Watering Point

Watering point can be either a truck fill station or a barrel fill station.

The truck fill supply should have a minimum pumping capacity of 1000 L/min to minimize the truck fill time; a separate pump should be provided for barrel fill supply. All water supplied from the facility should be metered.

An exterior overhead truck fill arm should be installed. The design shall be such that there will be no cross contamination during or after filling the truck or barrel. If the truck fill is operated in freezing conditions, drain the area to minimize ice build-up due to spillage.

An exterior coin meter activated pump control should be installed so that no person needs to enter the building. The panel should include start and stop buttons, a pump selector switch, and an adjustable maximum run timer or volume control.

2.7 Water Systems Security and Protection

Water systems have been identified as part of the Critical Infrastructure of the province and they must be protected from the threat of terrorism and other forms of criminal behaviour. The following provisions will ensure that water systems operators have accurately assessed the threats to their water systems and introduced appropriate mitigations to ensure continuity of operation and the safety of the public.

2.7.1 Vulnerability Assessment

The waterworks system serving a population greater than 25,000 people should undertake a Security Vulnerability Self Assessment every two years, and systems serving a population less than 25,000 people should undertake the assessment every five years. The system owner / operator should provide certification of performance of the self-assessment submitted to AEW for review and follow up.

(See Appendix 2-A for details)

2.7.2 Emergency Reaction Plans

The system owner / operator should develop an Emergency Reaction Plan (ERP), it is recommended that the ERP should be developed to the standard set out by The Canadian Standards Institute in CSA z 731. This ERP should be based on the results of the vulnerability assessment and should include response to natural disasters, terrorist acts, and other acts of criminality and system failures.

Emergency Reaction Plans should be reviewed and updated annually to ensure contact information is accurate and the specified resources remain available.

Emergency Reaction Plans should be tested regularly to ensure appropriateness and deliverability. Every test should be documented including any lessons learned and the plan should be updated if required.

2.7.3. Physical Security

The system owner / operator should implement physical protection systems and measures to protect their investment in capital assets and ensure that the safety and security of the public water systems is not compromised by criminal acts.

Physical Protection Systems should incorporate security policies, designs, barriers, devices and systems that offer high degrees of Deterrence, Detection, Delay and Response. These are the basic security principles and can be defined as follows

Deterrence – Make the target unattractive to an adversary by increasing the perception of security. This can be achieved by use of signage, access control and overt uniformed security.

Detection - ensures that if an adversary does decide to attack an asset, that they are detected as early as possible. Detection is achieved by alarm systems, CCTV, Security guards, public and staff.

Delay – Security should incorporate a layered approach with a number of barriers to impede the attacker's progress. Delay is essential to allow for an appropriate response. Layered security is achieved by fencing, locked doors, access control and good design.

Response – Having detected an adversary there should be an appropriate response. In some cases this is achieved by remote assessment using cameras, in other cases this is a response by security guards or plant staff.

2.7.3.1 Personnel

The system owner / operator should consider appointing a Security Manager or other senior manager whose prime responsibility is addressing the security needs of the water utility. This person would be responsible for completion of the vulnerability assessment, implementation of appropriate security measures and delivery of security awareness training. The security manager should be supported by senior management and be adequately resourced.

The system owner / operator should consider initial and periodic background checks on employees and on-site contractors. Appropriate policies should be developed and implemented governing the performance of such screening and the criteria for adverse employment decisions.

2.7.3.2 Training

The system owner / operator should develop and deliver security awareness training to all staff on a regular basis. This training should include awareness on the Emergency Reaction Plans and specific roles and responsibilities contained within the plan.

The aim of security training is to establish a culture of security within the water utility. All staff are responsible for the security of the system and security considerations should be built into all

operations. All staff should be aware of the role they play in securing the assets, from ensuring doors are locked, to challenging strangers and reporting or investigating suspicious incidents.

2.7.3.3 Access Control

The system owner / operator should establish some form of access control to its facilities; especially those concerned with water treatment or treated water storage. Access control can take many forms from simple key control to installation of electronic card access systems. The objective of access control is to prevent unauthorised personnel from gaining access to critical assets or components of the water system.

The following are examples of access controls:

- use of non-reproducible high security keys that should be signed in and out on a daily basis. Issuance of master keys should be limited and all keys should be accounted for by an audit on a regular basis.
- use of ID cards to identify all authorized staff and contractors.
- use of Security Guards to validate the credentials of all staff, contractor and other visitors.
- use of electronic card access or biometric systems to gain access to facilities.

2.7.3.4 Perimeter Security

Water treatment facilities should be fenced to exclude the public from the facility and to protect the water system from unlawful intrusion. Establishing a fence also creates a defensible space for the installation of intrusion detection systems and will deter an opportunistic intruder and provide a platform for the detection of a determined intruder.

Fences should be at least seven (7) feet high topped with three strands of barbed wire. Fences should have a minimum of three (3) metres of clear zone on either side to remove anything, which may hide an adversary or assist them in compromising the fence. Fences should be maintained to ensure they have adequate tension and that the fabric is not suffering from corrosion.

Fences should also be considered for raw water sources, wellheads, and treated water storage and distribution components such as pumping stations.

2.7.3.5 Detection Systems

The system owners / operators of water treatment plants and facilities should ensure that intrusion detection systems (alarm systems) are installed to detect an unlawful intruder. Such systems should be monitored by a ULC Certified monitoring company or by the municipalities own security staff.

Consideration should be given to the installation of exterior intrusion detection systems, such as:

- fence line intrusion detection
- exterior passive infra-red sensors

- microwave sensors
- buried magnetic sensitive cable
- digital closed circuit television systems

Consideration should be given to the installation of intrusion detection systems onto treated water storage access hatches.

2.7.4 SCADA Security

The municipalities / system owners / operators should take steps to ensure the availability, confidentiality and integrity of computer systems used to control water treatment, distribution or quality monitoring. Where possible, SCADA systems should not be on the same network as other business or municipal computing systems.

2.7.4.1 Critical Cyber Assets

The system owners / operators should quantify their critical cyber assets, that is the components of their SCADA network, without which the ability to deliver on their mission is compromised.

Critical cyber assets should be protected, physically and logically, from the threat of unauthorised access.

2.7.4.2 Identification of Connections

All network connections on a SCADA system that utilise a routable protocol should be identified. These connections should be configured to prevent unauthorized access.

2.7.4.3 Authentication and Access

All SCADA systems should be configured to require strong authentication of users. This can be achieved through the use of passwords that are changed periodically and require alphanumeric content. Other methods of authentication can be considered including use of tokens or biometric authentication.

Legacy passwords and old user accounts should be deleted.

Users should assign the minimum level of access required for them to do their job. Administrator or super user type access should be highly restricted and should not be the default user level.

2.7.4.4 Anti-Virus

The municipalities / system owners / operators should consider installation of anti-virus applications on SCADA systems which have network connectivity. Anti-virus systems should be kept updated with the most current signature files.

2.7.4.5 Operating Systems

The system owners / operators should ensure that SCADA operating systems are kept up to date with current patches. Operators should consider development of a SCADA test

environment to test newly released patches prior to deployment in the SCADA production environment.

2.7.4.6 Network Logging

The municipalities / system owners / operators should install logging services onto their SCADA systems to track activity such as, users log-on, rejected log-on attempts, user log-off, unauthenticated user sessions, system faults and intrusion attempts.

Network intrusion detection systems should also be considered, but only if the resources are available to monitor and react to network incidents.

2.7.5 Excavations and Open Trenches

In order to ensure public safety, Local Authorities responsible for the construction shall secure excavations and open trenches during non-working periods by installing fences/barricades and/or warning lights/signs.

2.7.6 Reservoirs

To guard against trespassing and vandalism, treated water storage reservoirs should be fenced, and entrance gate, access manholes, and valves or vent houses should be locked.

The reservoirs should also have water-tight roofs and hatches, and any openings should have suitable covers to prevent the entrance of birds, animals, insects or dust and be designed or enclosed to prevent the possibility of contaminants being introduced either accidentally or through a malicious act. Consideration should be given to the installation of secondary hatches and intrusion detection systems.

Where a raw water reservoir is located near developed areas or agricultural land, fencing is required to discourage attempts by children to gain entry and to preclude the entrance of domestic animals. Fencing should be located outside the toe of the berm; chain link fence is recommended. Fishing will not be permitted in raw water reservoirs.

2.8 Facility Risk Assessment

The municipalities / system owner /operator may undertake a self-assessment of the facility every two years to establish the risk factor. The self-assessment report should be submitted to AEW for review and follow-up. Facility assessment is necessary to assure the general public and AEW that municipalities / system owners/operators are committed to take the required action to reduce any potential risk in providing safe drinking water to the consumer.

System owners / operators may use the criteria tabled below for facility risk assessment.

Table 2.7
Waterworks System Assessment Criteria

Source		Treatment Assessment		Monitoring and Operational Assessment
Surface water	Groundwater	GWUDI	Groundwater	Surface water and Groundwater
<u>Quantity</u> - Can the source provide a secure, long-term supply of raw water? If yes, is the raw water storage system adequate? - Have there been trends in supply variability over the past 10 years?	<u>Quantity</u> - Has hydrogeological assessment been done to determine the long-term feasibility of the source? If yes, is the supply adequate? If no, has there been a history of well yield problems over the past 10 years?	<u>Design Criteria</u> - Does the existing treatment process meet current design standards related to the following: - chemical feed and mix - flocculation - clarification - sedimentation - filtration (media, membrane, loading rates, filter-to-waste, backwash, etc.)	<u>Design Criteria</u> - Does the system include components for the treatment of health-related or aesthetic parameters? If yes, does the system meet the treatment standards? - Is the existing system adequate to provide for 4-log reduction of viruses? - Is sufficient disinfection residual provided in the distribution system on a consistent basis?	<u>Monitoring</u> - Does the system provide on-line, continuous monitoring for disinfectant residual (all systems) and turbidity (for surface water supply systems only)? If yes, is there an alarm method to provide the operator with immediate notification if pre-set limits are exceeded?
<u>Quality</u> - Has an assessment of the raw water supply been done to determine cysts/ooocysts removal requirements? - Are there persistent raw water quality problems related to organics, colour, parasites, or blue/green algae? - Does the raw water quality fluctuate frequently?	<u>Quality</u> - Has an assessment of the water quality been done? - Is the supply suspected to be under the influence of surface water (GWUDI)? - Are there health-related parameters for which treatment is required? - Are there aesthetic parameters for which treatment is required?	<u>Capacity</u> - Does the system produce adequate quantities of treated water to meet maximum daily flow? Will the capacity be fully utilized in the next 10 years?	<u>Capacity</u> - Does the system produce adequate quantities of treated water to meet the standards for maximum daily flow? Will the capacity be fully utilized in the next 10 years?	<u>System Operation</u> - Does the system owner employ the facility certified operator directly, or is an operator provided under contract? - Is there a succession plan in place to ensure continued operation by a certified operator? - Has there been a recent history of the owner having difficulties maintaining a certified operator? - Has the system owner prepared an emergency response plan to deal with emerging problems related to the water source, treatment, or distribution system?

Table 2.8
Waterworks System Risk Factor
Source Assessment Summary

Source	1 (minimum risk)	2	Ranking Criteria 3	4	5 (high risk)	Assigned Rank
Quantity	Assessment done. Adequate for present and future needs	No assessment done. Appears to be adequate for present needs	Assessment done. Adequate for present needs but not for future needs	No Assessment done. Appears inadequate for present needs	Assessment done. Inadequate for present and future needs	
Quality	Water quality assessment done, no problems confirmed	Water quality assessment done, no apparent problems	No water quality assessment done, no apparent problems	No water quality assessment done, problems evident	Water quality assessment done, confirmed problems	
Source Protection	Assessment done, no mitigative measures needed	Assessment done, but action taken to mitigate issues	No assessment done, no apparent concerns	No assessment done, problems evident but no action taken	Assessment done, problem confirmed, no action taken to alleviate problems identified	
Overall Rank						

Table 2.9
Treatment Assessment Summary

Treatment	1 (minimum risk)	2	Ranking Criteria 3	4	5 (high risk)	Assigned Rank
Design criteria	The plant meets the design standards	Rating not used	Rating not used	Rating not used	One or more critical component not meeting design standards	
Capacity	Evaluation done. The plant operates within design capacity at present and for future needs	Evaluation done. The plant operates within design capacity at present, but would not meet future needs.	No evaluation done, no immediate concerns	Evaluation done, intermittent, shortages identified, nearly at 90% capacity	Evaluation done, plant has exceeded capacity, persistent shortages at present	
Performance - Filtration (Surface & GWUDI)	Individual filter turbidity < 0.1 NTU at all times	Individual filter turbidity < 0.3 NTU at all times	Combined filter turbidity < 0.3 NTU at all times	Combined filter turbidity < 0.3 NTU at least 95% of the time	Combined filter turbidity > 0.3 NTU more than 5% of the time	
Performance - Fe & Mn removal (Groundwater)	Meets 0.05 mg/L manganese & 0.3 mg/L iron	Rating not used	Meets only one parameter (iron or manganese)	Rating not used	Does not meet 0.05 mg./L manganese & 0.3 mg/L iron	
Performance - Disinfection + filtration: meets 3-log cysts, 3-log oocysts and 4-log virus reduction (Surface & GWUDI)	Meets the prescribed CT / IT requirement, and meets THM standard	Rating not used	Meets CT requirement but not the THM standards	Meets the THM standards but not the CT requirement	Does not meet CT or THM standards	
Performance - Disinfection: meets 4-log reduction virus reduction (Groundwater)	Meets the prescribed CT / IT requirement, and meets THM standard	Rating not used	Meets CT requirement but not the THM standards	Meets the THM standards but not the CT requirement	Does not meet CT or THM standards	
Overall Rank						

Table 2.10
Monitoring and Operation Assessment Summary

Operations Management	1 (minimum risk)	2	Ranking Criteria 3	4	5 (high risk)	Assigned Rank
Monitoring turbidity	On-line, individual filter and combined filter	Rating not used	Online combined filter only	Rating not used	Grab, combined filter only	
Monitoring Disinfection (at point where CT is estimated)	Continuous on-line	Rating not used	Grab daily	Rating not used	Grab less than daily	
Operations (Facility)	Certified operator at appropriate level, cover off, succession plan available	Rating not used	Certified operated at appropriate level, no cover off, no succession plan available	Rating not used	No certified operator at appropriate level, no cover off, no succession plan available	
Operations (SOP/ERP)	SOP/ERP in place	Rating not used	Either SOP or ERP in place but not both	Rating not used	SOP/ERP not available	
Overall Rank						

2.9 Conservation and Reclamation

The system owner / operator shall ensure that the requirements outlined in the AEW documents *Reclamation Assessment Criteria for Pipelines*, 2001 Draft (Alberta Pipeline Environmental Steering Committee, 2001), as amended, as well as the *Reclamation Criteria for Wellsites, Batteries and Associated Facilities – 1995 Update*, as amended, are met.

Achieving pipeline reclamation success requires an understanding, and the sound management of topographic, soil and vegetation characteristics. Equivalent land capability, based on a comparison of pre-activity (pre-disturbance or control data) versus reclaimed land capabilities on that right-of-way, is considered the standard at which a pipeline operator has met the requisite land surface conditions. Other non-land conditions may also apply. Equivalent land capability is defined as "the ability of the land to support various land uses after conservation and reclamation that are similar to those existing prior to an activity being conducted on the land, but that the individual land uses will not necessarily be identical". System owner / operator shall contact the Regional Director and the landowner and obtain information regarding appropriate land capabilities, subsequent land uses and revegetation strategies.

The three primary land components requiring reclamation management (topography, soil and vegetation) generally co-vary such that changes in vegetation growth patterns, health and population structure are often attributable to changes in soil and topographic characteristics.

TOPOGRAPHY

Surface contour and drainage re-establishment along the pipeline alignment shall be reclaimed to be comparable to pre-disturbance land conditions.

SOIL

Soil Salvage and Handling

Topsoil, upper subsoil and spoil shall be salvaged and stockpiled separately, unless otherwise authorized. Two-lift soil handling can provide a means to salvage upper subsoil and spoil together, provided no "problem" soils (e.g., saline, sodic, rocky) are encountered. When conditions permit the use of overstripping soil handling procedures, all salvaged topsoil admixed with upper subsoil shall be stored separately from spoil.

Topsoil and upper subsoil salvage operations shall be suspended when wet or frozen field conditions, wind velocities, or any other field condition or pipeline construction method may result in soil quality degradation or loss. Operations shall only recommence when those conditions no longer exist. Refer to *DRAFT AEW Manual on Soil Conservation and Pipeline Construction* (1995), as amended, for further guidance.

Soil Storage

Topsoil, upper subsoil and spoil are required to be stockpiled separately. When two-lift soil handling procedures are used, upper subsoil and spoil may be stockpiled together. When conditions permit the use of overstripping soil handling procedures, all salvaged topsoil admixed with upper subsoil shall be stored separately from spoil.

All stockpiles shall be stabilized to prevent wind and water erosion, and constructed with stable foundations.

Soil Replacement

The system owner / operator shall make every effort to progressively reclaim the pipeline alignment when construction is completed, unless the timing of clean up and reclamation have been scheduled to accommodate changes in soil conditions (e.g., frozen).

Salvaged spoil are required to be replaced in the trench and contoured appropriately such that all upper subsoil is spread evenly over the replaced spoil, and that all topsoil shall be spread evenly and contoured over the replaced upper subsoil or spoil.

Topsoil and upper subsoil replacement operations shall be suspended when wet or frozen field conditions, wind velocities, or any other field condition or pipeline construction method will result in the degradation or loss of soil quality. Operations shall only recommence when those conditions no longer exist.

Upper subsoil and spoil compaction shall be alleviated through mechanically breaking, fracturing or shattering prior to topsoil replacement. The approval holder shall also alleviate replaced topsoil compaction in a manner controlled to avoid topsoil mixing with upper subsoil or spoil. Refer to *DRAFT AEW Manual on Soil Conservation and Pipeline Construction* (1995), as amended, for further guidance.

The size and density of coarse fragments (i.e. gravel, rock or stones) within the reclaimed soil profile and on the reclaimed pipeline alignment surface shall be comparable with the adjacent undisturbed land. In forested areas, rollback shall be placed for access management and erosion control.

All works, buildings, structures, facilities, equipment, apparatus or machinery used during construction or reclamation that will not be used for the operation of the pipeline shall be dismantled and removed. All constructed access roads for the pipeline alignment that are not remaining as surface improvements or as a designated property access shall be reclaimed.

VEGETATION

The pipeline alignment shall be stabilized; surface contoured and revegetated using a suitable seed mixture. An effective weed control program shall be in place until new vegetation on the pipeline alignment is re-established and is self-sustaining.

Where the pipeline alignment crosses native prairie areas, native seed mixtures and revegetation practices compatible with those outlined in the document *A Guide for Minimizing the Impact of Pipeline Construction On the Native Prairie Ecosystem* (Alberta Environment and Water, and Alberta Sustainable Resource Development, 2003), as amended, shall be used. Material handling and storage times in aid of native species regeneration are advised. Pipelines shall be constructed in a manner such that the surface disturbance on native prairie, and the degradation or loss of adjacent, undisturbed native prairie is minimized.

APPENDIX 2-A

Security Self-Assessment Guide For Owners and Operators of Alberta Drinking Water Systems

Security Self-Assessment Guide For Owners and Operators of Alberta Drinking Water Systems

Introduction

Water systems are critical to every community. Protection of public water systems should be a high priority for local officials and water systems owners and operators to ensure an uninterrupted water supply, which is essential for public health and safety.

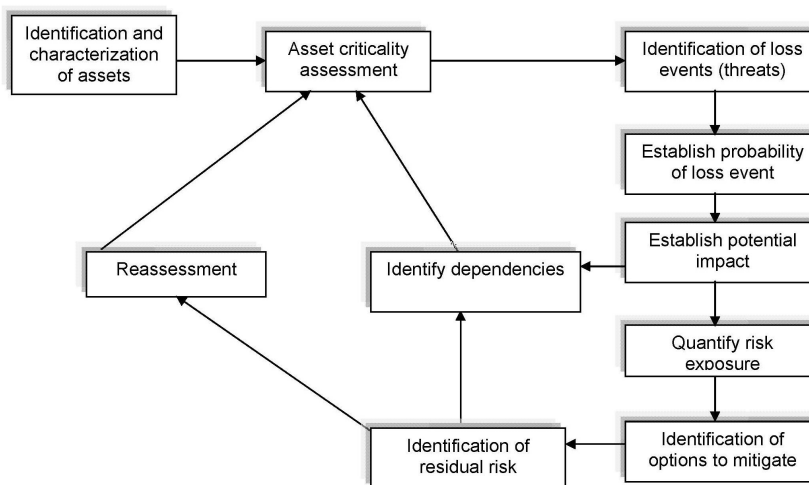
Adequate security measures will help to prevent loss through criminal behaviour including acts of terrorism and every-day vandalism. Proper planning will not only help to prevent such incidents but will mitigate their impact and assist in rapid recovery.

This security self-assessment guide is designed to help water systems determine possible vulnerable components and identify security measures that should be considered in order to protect the system and the customers it serves.

How to use this self-assessment guide

This document is designed for use by water system personnel when performing vulnerability assessments. Assessments should include, but not be limited to a review of physical facilities, distribution systems, treatment facilities, physical barriers, water collection, water storage, computer networks, chemical storage and handling procedures and operational methods. In other words the scope of this vulnerability assessment should be to review the security of the total water system from source to tap.

The self-assessment has a number of steps as shown on this process overview:



2-A-1

a. Identification and characterization of assets

A complete list of all the assets of the total water system should be drafted together with description of these assets and their contribution to the water system (Addendum 2).

b. Assets criticality assessment

All critical assets or water system components should be identified. A critical asset is an asset that, if destroyed or lost would prevent the water system from delivering safe clean water in sufficient quantity or at sufficient pressure.

Additional factors which should be considered when assessing criticality of an assets or components are:

- Interdependency with critical infrastructure or services, e.g. hospitals, power facilities, major customers
- Single points of failure
- Availability of redundant back ups
- Replacement time of components or assets
- Potential for loss of public confidence.

c. Identification of loss events (threats)

This could be as simple as a list of potential threats that a water system might face, or it could be specific to a particular system or geographic location. Common threats to be considered are:

- Vandalism
- Unlawful trespass
- Computer hacking
- Disgruntled employee
- Criminal contamination
- Accidental contamination
- Labour dispute

d. Establish Probability of loss event

The probability that a threat could occur should be quantified. Individual water systems will decide how probability should be quantified however a rating of High, Medium or Low probability could be used. When assessing probability a number of factors should be considered;

- Relevant history of similar events
- The crime rate in each area

- Major changes in socio-economic or demographic situation
- Intelligence of threats from other agencies

It is recognized that although some objective input on probability may be received from sources such as Alberta Environment and Water, the Police or RCMP, assessment of probability remains largely subjective. The following table could be used as a means to express probability.

1 Unlikely	2 Moderate	3 Likely	4 Almost Certain
3% to 15%	15% to 50%	50% to 70%	> 70%
Small likelihood but could well happen	Less than 50-50 chance	More than 50-50 chance	Almost certain that it will happen, very frequent occurrence
Once in 50 years	Once in 20 years	Once in 10 years	Once per year or more
Low level of threat	Medium level of threat	High level of threat	Imminent threat of attack

e. Establish potential impact

The impact of each loss event should be considered in detail and not just in terms of the ability to affect water quality. For example introduction of a small amount of a chemical contaminant into a treat water storage reservoir would have little or no impact on water quality; however this could have serious impact upon public confidence in the water system.

When considering impact, considerable time must be spent on identification of dependant infrastructure and critical customers. If we were to decide that that a loss of supply to < 500 customers was a moderate impact, but one of those customers was the only hospital in a region, then the impact of that loss event should be considered to have a much higher impact, especially if sustained for a long period of time.

The following table could be used to assist when assessing potential impact. System operators will need to develop their own descriptions and thresholds for what they consider to be Minor, Moderate, Major and Catastrophic events.

	1 Minor	2 Moderate	3 Major	4 Catastrophic
Health and Safety of Employees and Public				
Total Financial Loss				
Loss of Treatment				
Loss of Pressure				
Loss of Supply				
Environmental Impact				
Reputation Impact				
Public Confidence				
Political Impact				
Loss of Control Ability				

f. Quantify Risk Exposure

Risk can be considered to be the product of Probability x Impact. By using the table below we can assess the risk exposure for each identified threat.

For Example: The incidence of graffiti is very high in some areas. If we considered this as a threat or loss event then we would follow the process above which would show that the probability is almost certain, as our crews have to clean this up on a regular basis. When we consider impact we assess that the impact is minor is all of the assessed areas. When we assess the risk using the matrix we find that this is a Medium level of risk that should be managed by introduction of mitigations and procedural security measures.

IMPACT	Catastrophic				
	Major				
	Moderate				
	Minor				
		Unlikely	Moderate	Likely	Almost certain
		PROBABILITY			

	Indicates a Low level of risk - minimal security measures necessary. Risk should be managed through the introduction of mitigation strategies or changes in procedural security, or accepted as a low business risk.
	Indicates a Medium level of risk – Risk should be managed by the introduction of mitigation strategies and high levels of procedural security.
	Indicates a High level of risk – Maximum-security measures should be in place, providing layers of Deterrence, Delay, High probability of detection and rapid effective response. Insurance coverage essential but may not be able to provide adequate coverage to prevent significant liability. Due diligence is required, including utilisation of appropriate expertise and validation of assessed data.
	Indicates a Severe level of risk. - Maximum security measures should be in place, together with recovery plans, mutual aid agreements and availability of critical spares.

- g. Identification of countermeasures, their costs and trade-offs.
 - i. Identify potential security countermeasures to reduce the vulnerabilities.
 - ii. Estimate the cost of the countermeasures.
 - iii. Conduct a cost-benefit and trade-off analysis.
 - iv. Prioritize options and recommendations for senior management.

The results of the Threat and Risk analysis can then be plotted and recorded on the matrix shown at Addendum 3. This form can also be used to show recommended mitigations and ongoing mitigation strategies.

Self-Assessment Worksheet

A self-assessment work sheet is shown at Addendum 4. This guideline will assist operators to ask the right questions when reviewing the security regimes in place at various plants and facilities. The guideline is designed to prompt operators to look at various security aspects and determine a course of action appropriate to their operation. This guideline is not intended to be a security manual or to deliver advice or instruction to operators on the exact security measures to be installed at each facility. Operators should seek specialized security advice from qualified practitioners if they have no internal resources assigned to the security function.

Upon completion of this self-assessment system owners/ operators should complete the certificate shown at Addendum 1 and forward this to Alberta Environment and Water.

ADDENDUM 1

**Certification of Completion of Security Self Assessment
Drinking Water System**

To: Alberta Environment and Water

Name of Water System:

Administrative Address of Water System:

I certify that on ----(Date)---- a Security Self-assessment was performed on the above-indicated Drinking Water system. I further certify that the information in this self-assessment has been completed to the best of knowledge and that the appropriate parties have been notified of the assessment and the recommended steps to be taken to enhance the security of the water system. Furthermore a copy of the completed self-assessment will be retained at the administrative offices, in a secure location, and will be available for inspection by Alberta Environment and Water as requested.

I further certify that -----(Name)----- has been delegated with the responsibility for security as it pertains to this water system.

Yours sincerely;

Signed

DATE

ADDENDUM 2

Component type	Number & Location	Description	Criticality or Single Point of Failure	Comments
Source Water				
Ground Water				
Surface Water				
Other				
Treatment Plant				
Buildings				
Pumps				
Process controls				
Treatment chemical storage				
Laboratory chemicals and storage				
Other				
Storage				
Reservoirs				
Storage tanks				
Pressure tanks				
Other				
Power Supply				
Primary power supply				
Auxiliary power supply				
Other				
Distribution System				
Pumps				
Pressure reducing valves				

ADDENDUM 2

Component type	Number & Location	Description	Criticality or Single Point of Failure	Comments
Pressure sustaining valves				
Other valves				
Hydrants				
Back flow preventers				
Other				
Communications & Control				
SCADA Assets				
- RTU's				
- PLC's				
- IED's				
- Control terminals				
- Servers				
- Switches / firewalls etc.				
Telephony systems				
Cell phone systems				
Radio systems				
Business network systems				
Other				
Administration				
Office buildings				
Computer systems				
File storage				
Service vehicles				
Personnel				
Other				

ADDENDUM 2

Component type	Number & Location	Description	Criticality or Single Point of Failure	Comments
Critical Infrastructure Customers				
Power plants				
Hospitals				
Schools				
Food processing plants				
Major industry				
Other				

ADDENDUM 3

Threat and Risk Assessment							
ASSET	Water Treatment Plant					CRITICALITY	HIGH
Threat or hazard	Vulnerability	Prob.	Impact	Risk	Recommended mitigation(s)	Residual risk	Ongoing mitigation
Vandalism (EXAMPLE)	Facilities are not fenced	Moderate	Moderate	MED	Consider installation fencing Install signage	LOW	- Staff awareness and vigilance - Maintenance program for fences

ADDENDUM 4

Drinking Water systems Security Self-Assessment worksheet		
Name of Water System		
Number of customers served		
Administrative address		
Security manager name (Or manager with Security Responsibility)		
Telephone number		
Date review completed		
Persons involved in review process		
Date of review of outstanding action items		
Question	Answer	Action Needed / Taken
Personnel		
Have you appointed a security manager or senior manager with responsibility for security of the water system?		
When hiring personnel do you perform background checks or require criminal record checks?		
Do you have a security awareness training program?		

ADDENDUM 4

Drinking Water systems Security Self-Assessment worksheet		
When terminating employees do you have a defined 'End of Service' process, which disables logical and physical access and requires the return of keys, ID cards and other security related items?		
Have water system personnel been advised to report security vulnerability concerns or suspicious behaviour to the Security Manager or department?		
Emergency Reaction Plans		
Do you have a written Emergency Reaction Plan (ERP) which conforms to Canadian Standards Association standard CSA z731?		
Is there someone designated with the responsibility to ensure the ERP is updated and reviewed?		
Has the ERP been tested in the last year?		
Are records kept of all ERP tests? When was the ERP last reviewed and updated?		
Are the contact lists shown in the ERP up to date with correct information?		
Have first responders (Fire, EMS) been made aware of the plan and contributed to its formation or review?		
Do you have a Business Continuity Plan (BCP)?		

ADDENDUM 4

Drinking Water systems Security Self-Assessment worksheet		
When was the BCP last tested, reviewed and updated?		
Who is responsible for the maintenance of the BCP?		
Physical Security		
Is access to critical components of the water systems restricted to authorized personnel only?		
How is access control achieved?		
Are employees and authorized contractors required to carry or display ID badges?		
Do you use non-reproducible keys?		
If so, how is distribution of these keys achieved?		
Do you perform regular audits of keys and require that keys be signed in and out?		
Are buildings locked when not in use?		
Is there a process or control in place to ensure buildings are locked?		
Are service vehicles locked when not in use?		
Is critical equipment stored in vehicles?		

ADDENDUM 4

Drinking Water systems Security Self-Assessment worksheet		
Do you use an electronic card access system? Are different levels of access granted to employees and contractors based on the principle of the least amount of access necessary to perform their role? Are access levels routinely audited to ensure currency? What procedures are in place to deal with employees who transfer to other responsibilities?		
Have buildings been designed to incorporate Crime Prevention Through Environmental Design (CPTED) principles? Are new buildings required to incorporate CPTED principles? Are new building plans subject to approval from the security manager or architect with CPTED experience?		
Are critical buildings fenced? Are fences at least 2130 mm high with 3 strands of barbed wire on top to prevent climb over? Are fences subject to regular inspection and maintenance?		

ADDENDUM 4

Drinking Water systems Security Self-Assessment worksheet		
Is a clear zone of 3 metres in place on either side of all fence lines? Are gates properly secured with high security locks, electronic access control or high security padlocks? Is adequate "No Trespass" signage in place beside the main entrance and at all four corners of each facility, as required by the Trespass to Premises Act? Is this signage in good condition and legible? Are there adequate warning signs in place to warn of site dangers? High Voltage, Deep Water, Chemicals etc.?		
Are intrusion detection systems installed? Where and how are these monitored? What is the response to an alarm activation?		
Are reservoir and tank access hatches and vents locked? Are tamper proof hinges and locks used on reservoir and tank access hatches? Are these regularly inspected?		

ADDENDUM 4

Drinking Water systems Security Self-Assessment worksheet		
Are any intrusion detection systems installed on reservoir or tank access hatches?		
Is there a response plan for alarm activations involving reservoir and tank access hatches?		
Is the area around critical components free of objects which may be used for breaking and entering (e.g. Large rocks, cement blocks, pieces of wood, ladders, valve keys and other tools)?		
Do you have a neighbourhood watch program for you water system?		
Do wellheads, pumps and treatment facilities have back up power supplies?		
If so, when were these last tested?		
Is there a preventative maintenance program in place for back up generators?		
Is there spill containment in place for diesel fuel tanks required by back-up generators?		
Do secured manhole covers or secondary locking devices protect critical valves?		
Are these inspected on a regular basis?		

ADDENDUM 4

SCADA Security		
Does access to SCADA systems require a user name and a strong password?		
Are passwords changed on a regular basis?		
Are controls in place to stop the sharing of passwords?		
Are separate accounts created for contractor access to SCADA?		
Are user accounts removed from SCADA upon termination of employees or contracts?		
Is there a single point of accountability for SCADA systems?		
Have all SCADA connections with the Internet or modems been identified and documented?		
Are these connections protected by firewalls or other forms of connection that authenticates user sessions?		
Have redundant or obsolete connections been removed or deactivated?		
Are SCADA operating systems properly patched?		
Is there a process in place to ensure prompt patching of identified vulnerabilities?		
Are patches tested prior to deployment?		

ADDENDUM 4

Are SCADA applications properly patched and upgraded with the latest version?		
Is there a process in place to ensure SCADA applications are promptly patched and to ensure currency of the latest version?		
Is the SCADA System connected to a business or administration network?		
Is the SCADA system properly partitioned from the business network?		
Do you have a disaster recovery plan for SCADA systems?		
Has this plan been tested and reviewed?		
Are details of your water system posted on an Internet site?		
Have these details been reviewed to ensure that no information is displayed which may be used to compromise the water system?		

Finance

Hosting Expenses Exceeding \$600.00
For the Period October 1, 2011 – December 31, 2011

Function: Tobacco Tax Collectors Meeting.

Purpose: Stakeholder Consultations.

Dates: October 20, 2011

Location: Calgary, Alberta

Amount: \$665.41

Function: Fuel Tax Direct Remitters Meeting.

Purpose: Stakeholder Consultations.

Dates: November 10, 2011

Location: Calgary, Alberta

Amount: \$736.32

Insurance Notice

(Insurance Act)

Effective March 5, 2012, Euler Hermes American Credit Indemnity Company changed its name to **Euler Hermes North American Insurance Company**.

Brad Geddes
Deputy Superintendent of Insurance.

Health and Wellness

Hosting Expenses Exceeding \$600.00
For the period January 1, 2012 to March 31, 2012

Date Paid: March 6, 2012

Function: Pillar Integration Committee Meeting – Outcome Mapping

Purpose: Meeting with Pillar Integration Committee Leads and Enablers from both Alberta Health & Wellness and Alberta Health Services.

Amount: \$671.29

Date of Function: February 15, 2012

Location: Nisku, AB

Date Paid: March 16, 2012

Function: Slave Lake Recovery Working Group

Purpose: On-site meeting to assess the recovering of Slave Lake and surrounding areas.

Amount: \$797.94

Date of Function: February 28, 2012

Location: Slave Lake, AB

Date Paid: March 30, 2012
Function: National Forum on Emergency Preparedness and Response
Purpose: Emergency Preparedness and Response (EPR) Forum.
Amount: \$2,000.70
Date of Function: January 17, 2012
Location: Edmonton, AB

Infrastructure

Contract Increases Approved Pursuant to Treasury Board Directive 08/93

Contract No: 18400
Contractor: Gateway Mechanical Services Inc.
Reason for Increase: The project scope was increased in response to unforeseen site conditions. Change orders were issued for additional variable-air volume boxes, air-handler humidifier modification, replacement of a damaged breaker in a motor-control centre, and boiler piping modification. It was necessary to have the additional work completed by the original contractor in order to avoid project completion delay and further client department disruption.
Contract Amount: \$1,630,000.00
% Increase: 12
Amount of Increase: \$198,466.13
Date Approved: April 18, 2011

Justice

Office of the Public Trustee
Interest Rate on Public Trustee Guaranteed Accounts
(Public Trustee Act)

The following information is provided in accordance with section 2(3) of the Public Trustee Investment Regulation for the fiscal year ending March 31, 2012:

- (a) The average effective annual interest rate paid by the Public Trustee on guaranteed accounts during the year was 3.31%.
- (b) The average reference rate during the year was 2.97%.
- (c) The ratio of the average referred to in (a) to the average referred to in (b), expressed as a percentage rounded to the first decimal place is 111.2%.

Cynthia M. Bentz
Public Trustee.

Safety Codes Council

Corporate Accreditation

(Safety Codes Act)

Pursuant to section 28 of the Safety Codes Act it is hereby ordered that

Shell Canada Limited, Accreditation No. C000102, Order No. 2852

Having satisfied the terms and conditions of the Safety Codes Council is authorized to administer the Safety Codes Act for **Building**

Consisting of all parts of the Alberta Building Code including applicable Alberta amendments and regulations on industrial and related facility properties owned by or under the care and control of Shell Canada Limited.

Accredited Date: April 11, 2012

Issued Date: April 11, 2012.

Corporate Accreditation – Amendment

(Safety Codes Act)

Pursuant to section 28 of the Safety Codes Act it is hereby ordered that

BP Canada Energy Group ULC, Accreditation No. C000112, Order No. 0293

Due to the name change from BP Canada Energy Company and having satisfied the terms and conditions of the Safety Codes Council is authorized to administer the Safety Codes Act within their jurisdiction for **Electrical**

Consisting of all parts of the Canadian Electrical Code, Code for Electrical Installations at Oil & Gas Facilities.

Accredited Date: October 16, 1995

Issued Date: April 10, 2012.

Pursuant to section 28 of the Safety Codes Act it is hereby ordered that

BP Canada Energy Group ULC, Accreditation No. C000112, Order No. 0985

Due to the name change from BP Canada Energy Company and having satisfied the terms and conditions of the Safety Codes Council is authorized to administer the Safety Codes Act within their jurisdiction for **Fire**

Consisting of all parts of the Alberta Fire Code, including investigations, including applicable Alberta amendments and regulations.

Accredited Date: May 9, 1997

Issued Date: April 10, 2012.

Pursuant to section 28 of the Safety Codes Act it is hereby ordered that

Devon Canada Corporation, Accreditation No. C000105, Order No. 0391

To clarify original accreditation date and having satisfied the terms and conditions of the Safety Codes Council is authorized to administer the Safety Codes Act within their jurisdiction for **Electrical**

Consisting of all parts of the Canadian Electrical Code, Code for Electrical Installations at Oil & Gas Facilities.

Accredited Date: December 3, 1995

Issued Date: April 13, 2012.

Municipal Accreditation - Amendment

(Safety Codes Act)

Pursuant to section 26 of the Safety Codes Act it is hereby ordered that

Regional Municipality of Wood Buffalo, Accreditation No. M000195, Order No. 0587

Due to the name change from Municipality of Wood Buffalo (Urban) and having satisfied the terms and conditions of the Safety Codes Council is authorized to provide services under the Safety Codes Act within their jurisdiction for **Building**

Consisting of all parts of the Alberta Building Code, including applicable Alberta amendments and regulations.

Accredited Date: December 21, 1995

Issued Date: April 2, 2012.

Pursuant to section 26 of the Safety Codes Act it is hereby ordered that

Regional Municipality of Wood Buffalo, Accreditation No. M000195, Order No. 0986

Due to the name change from Municipality of Wood Buffalo and having satisfied the terms and conditions of the Safety Codes Council is authorized to provide services under the Safety Codes Act within their jurisdiction for **Electrical**

Consisting of all parts of the Canadian Electrical Code, Code for Electrical Installations at Oil and Gas Facilities and Alberta Electrical Utility Code.

Accredited Date: May 12, 1997

Issued Date: April 2, 2012.

Pursuant to section 26 of the Safety Codes Act it is hereby ordered that

Regional Municipality of Wood Buffalo, Accreditation No. M000195, Order No. 0588

Due to the name change from Municipality of Wood Buffalo (Urban) and having satisfied the terms and conditions of the Safety Codes Council is authorized to provide services under the Safety Codes Act within their jurisdiction for **Fire**

Consisting of all parts of the Alberta Fire Code, including investigations, including applicable Alberta amendments and regulations.

Accredited Date: December 21, 1995

Issued Date: April 2, 2012.

Pursuant to section 26 of the Safety Codes Act it is hereby ordered that

Regional Municipality of Wood Buffalo, Accreditation No. M000195, Order No. 0589

Due to the name change from Municipality of Wood Buffalo (Urban) and having satisfied the terms and conditions of the Safety Codes Council is authorized to provide services under the Safety Codes Act within their jurisdiction for **Gas**

Consisting of all parts of the Natural Gas and Propane Installation Code and Propane Storage and Handling Code including applicable Alberta amendments and regulations.

Excluding Natural and Propane gas highway vehicle conversions.

Accredited Date: December 21, 1995

Issued Date: April 2, 2012.

Pursuant to section 26 of the Safety Codes Act it is hereby ordered that

Regional Municipality of Wood Buffalo, Accreditation No. M000195, Order No. 0590

Due to the name change from Municipality of Wood Buffalo (Urban) and having satisfied the terms and conditions of the Safety Codes Council is authorized to provide services under the Safety Codes Act within their jurisdiction for **Plumbing**

Consisting of all parts of the National Plumbing Code and Alberta Private Sewage Systems Standard of Practice including applicable Alberta amendments and regulations.

Accredited Date: December 21, 1995

Issued Date: April 2, 2012.

Seniors

Hosting Expenses Exceeding \$600.00
For the period October 1, 2011 to December 31, 2011

Function: Persons with Developmental Disabilities Provincial Community Leadership Awards

Event Date: September 13, 2011

Amount: \$5,129.52

Purpose: Annual event in recognition of individuals, families and organizations who are committed to building welcoming communities that are inclusive of people with developmental disabilities.

Location: Leduc, AB

Function: Private Guardian Symposium

Event Date: September 29, 2011

Amount: \$924.00

Purpose: This one day symposium assisted private guardians with the responsibility to make decisions and consents for their represented adults. Also, they had the opportunity to learn about other Ministry programs such as Assured Income for the Severely Handicapped and Persons with Developmental Disabilities.

Location: Lacombe, AB

Service Alberta

Notice of Intent to Dissolve

(Cooperatives Act)

Peace Country Tender Beef Coop Ltd.

Notice is hereby given that a Notice of Intent to Dissolve was issued to **Peace Country Tender Beef Coop Ltd.** on April 2, 2012.

Dated at Edmonton, Alberta, April 2, 2012.

Brock Ketcham, *Director of Cooperatives.*

Solicitor General and Public Security

**Designation of Qualified Technician Appointment
(Intoxilyzer 5000C)**

Royal Canadian Mounted Police
Korkosh, Sandra Louise

(Date of Designation April 4, 2012)

Sustainable Resource Development

Alberta Fishery Regulations, 1998

Notice of Variation Order 03-2012

Commercial Fishing Seasons

The close times and quotas set out in Schedule 8 to the Alberta Fishery Regulations, 1998 in respect of the waters listed in the Schedule to this Notice have been varied by Variation Order 03-2012 by the Director of Fisheries Management in accordance with section 3 of the Alberta Fishery Regulations, 1998.

Where fishing with gill nets is permitted during an open season established by the Order, the gill net mesh size has been specified in the Order.

Pursuant to Variation Order 03-2012 commercial fishing is permitted in accordance with the following schedule.

**SCHEDULE
PART 1**

Item - 1

Column 1 Waters – In respect of: (97) Scope Reservoir (13-14-W4)

Column 2 Gear - Gill net not less than 140 mm mesh

Column 3 Open Time - 08:00 hours April 3, 2012 to 16:00 hours April 5, 2012.

Column 4 Species and Quota - 1) Lake whitefish: 9,050 kg; 2) Walleye: 170 kg; 3) Yellow perch: 1 kg; 4) Northern pike: 450 kg; 5) Tullibee: 1 kg; 6) Lake trout: 1 kg.

**Hosting Expenses Exceeding \$600.00
For the period October 1, 2011 to December 31, 2011**

Name: Alberta Urban Municipalities Association (AUMA) 2011 Fall Convention

Date(s): September 28 and 29, 2011

Amount: \$5,151.92

Purpose: Alberta Transportation meetings with municipalities to discuss their Transportation and Infrastructure priorities.

Location: Calgary, AB

Name: Alberta Traffic Safety Plan Enforcement Meeting with Stakeholders

Date(s): October 20 and 21, 2011

Amount: \$6,062.27

Purpose: Enforcement is an integral part of the Traffic Safety Plan. The Ministry leads the government's vision to protect the safety of Albertans using our transportation networks, as well as the safety of our highways and railways.

Location: Kananaskis, AB

Name: Bus Modernization Rural Information Sessions

Date(s): October 19, 20, 23, 24, 25, 26 and November 1, 2011

Amount: \$678.28

Purpose: The bus modernization stakeholder information sessions are being held to raise awareness of the new policy framework and action plan to implement a modern regulatory approach for the bus system across the province.

Location: Consort, Wetaskiwin, Cold Lake, Swan Hills and Grande Prairie, AB

ADVERTISEMENTS

Irrigation District Notice

Enforcement Return

(Irrigation Districts Act)

Bow River Irrigation District

Notice is hereby given that the Justice of the Court of Queen's Bench of the Judicial District of Lethbridge has fixed Tuesday, May 8, 2012 as the day on which at 1:30 p.m., the court will sit in the Court House, Lethbridge, Alberta for the purpose of confirmation of the Rate Enforcement Return of the Bow River Irrigation District for the year 2010 and prior years.

7-8

Richard Phillips, P. Eng., *General Manager.*

Lethbridge Northern Irrigation District

Notice is hereby given that the Court of Queen's Bench of Alberta has fixed Tuesday, May 8, 2012 as the day on which at 1:30 p.m., the Court will sit in the Courthouse, 320 – 4 Street South, Lethbridge, Alberta for the purpose of confirmation of the Rate Enforcement Return for the Lethbridge Northern Irrigation District covering rates assessed for the year 2010.

7-8

Alan Harrold, *General Manager.*

Notice of Certificate of Intent to Dissolve

(Business Corporations Act)

Notice is hereby given that a Certificate of Intent to Dissolve was issued to **828398 Alberta Ltd.** on April 13, 2012.

Dated April 13, 2012.

Sam Rowan, *President.*

Notice is hereby given that a Certificate of Intent to Dissolve was issued to **828403 Alberta Ltd.** on April 13, 2012.

Dated April 13, 2012.

Harold Lillis, *President.*

Notice is hereby given that a Certificate of Intent to Dissolve was issued to **828423 Alberta Ltd.** on April 13, 2012.

Dated April 13, 2012.

Stuart Affleck, *President.*

Notice is hereby given that a Certificate of Intent to Dissolve was issued to **828426 Alberta Ltd.** on April 13, 2012.

Dated April 13, 2012.

Allan Bain, *President.*

Notice is hereby given that a Certificate of Intent to Dissolve was issued to **828429 Alberta Ltd.** on April 13, 2012.

Dated April 13, 2012.

George Balzer, *President.*

Public Sale of Land

(Municipal Government Act)

Athabasca County

Notice is hereby given that under the provisions of the Municipal Government Act, Athabasca County will offer for sale, by public auction, in the Athabasca County Administration Building, 3602 – 48 Avenue, Athabasca, Alberta, on Friday, June 29th, 2012, at 10:00 a.m., the following lands:

Legal Description	Acres	Title Number
Pt. SE-16-66-20-4	73.70	072 475 798+1

Each parcel will be offered for sale subject to a reserve bid and to the reservations and conditions contained in the existing Certificate of Title.

Conditions: sale subject to approval of sales agreement

Athabasca County may, after the public auction, become the owner of any parcel of land that is not sold at the public auction.

Terms: cash or certified cheque. 10% deposit and balance within 30 days of date of public auction. G.S.T. may apply.

Redemption may be affected by payment of all arrears of taxes and costs at any time prior to the sale.

Dated at Athabasca, Alberta, April 16, 2012.

Brian Pysyk, *Director of Corporate Services.*

Municipal District of Opportunity No. 17

Notice is hereby given that under the provisions of the Municipal Government Act, the Municipal District of Opportunity No. 17 will offer for sale, by public auction, in the Municipal Office, Wabasca, Alberta, on Tuesday, July 17, 2012, at 10:00 a.m., the following lands:

C of T or Linc #	Plan	Blk	Lot
802 119 851	7921853	12	11
812 252 024	7722738	2	2
852 071 974	7921557	24	1
952 216 527	8321796		16

982 013 666	8620788	6	6
982 147 497	8321796		80
982 293 362	8321796		11
032 180 948	0322723	1	4B
032 180 948 +1	0322723	1	4C

Each parcel will be offered for sale subject to a reserve bid and to the reservations and conditions contained in the existing Certificate of Title.

Terms: Cash or Certified Cheque; A deposit of \$100 at time of the sale (non-refundable); and balance including GST within 10 days of the public auction.

The Municipal District of Opportunity No. 17 may, after the public auction, become the owner of any parcel of land that is not sold at the public auction.

Redemption may be effected by payment of all arrears of taxes and costs at any time prior to the sale.

Dated at Wabasca, Alberta, March 27, 2012.

Dennis Egyedy, *Chief Administrative Officer.*

Town of Devon

Notice is hereby given that, under the provisions of the Municipal Government Act, the Town of Devon will offer for sale, by public auction, at the Town Office, 1 Columbia Ave West, Devon, Alberta, on Tuesday, June 26, 2012, at 10:00 a.m., the following lands:

Lot	Block	Plan
18	1	2654TR
18	6	3091TR
7	24	4494TR

Each parcel will be offered for sale, subject to a reserve bid and to the reservations and conditions contained in the existing certificate of title.

The property is being offered for sale on an "as is, where is" basis, and the Town of Devon makes no representation and gives no warranty whatsoever of the adequacy of services, soil conditions, land use districting, building and development conditions, absence or presence of environmental contamination, vacant possession or the developability of the subject land for any intended use by the successful bidder. No terms or conditions will be considered other than those specified by the Town of Devon. The successful bidder will be required to execute a Sale Agreement in a form

and substance acceptable to the Town of Devon. No further information is available at the auction regarding the lands to be sold.

The Town of Devon may, after the public auction, become the owner of any parcel of land not sold at the public auction.

Terms of the sale are Cash, Bank Draft or Certified Cheque. A 30% deposit is payable upon acceptance of the bid at public auction. The balance of the accepted bid is due within 15 days, or the deposit will be forfeited and the Town will consider the next bid.

Redemption may be affected by payment of all arrears of taxes and costs at any time prior to the sale.

Dianna Doyle, *Director of Finance*.

Town of Killam

Notice is hereby given that under the provisions of the Municipal Government Act, the Town of Killam will offer for sale, by public auction, in the town office, located at 4923 – 50th Street, Killam, Alberta, on Monday, June 25, 2012, at 10:00 a.m., the following lands:

Lot	Block	Plan	Line #
2	5	RN97	0015251317

Each parcel will be offered for sale subject to a reserve bid and to the reservations and conditions contained in the existing Certificate of Title.

The Town of Killam may, after the public auction, become the owner of any parcel of land not sold at the public auction.

Terms: Cash or Certified cheque.

Redemption may be affected by payment of all arrears of taxes and costs at any time prior to the sale.

Dated at Killam, Alberta, April 12, 2012.

Kimberly Borgel, *CAO*.

Town of Oyen

Notice is hereby given that under the provisions of the Municipal Government Act, the Town of Oyen will offer for sale, by public auction, in the Town of Oyen Council Chambers, 201 Main Street, Oyen, Alberta, on Tuesday, June 12, 2012, at 2:00 p.m., the following land:

Roll Number	Lot	Block	Plan	Certificate of Title
23400	7	17	7936CC	781 187 549

The parcel will be offered for sale subject to a reserve bid, and to the reservations and conditions contained in the existing certificate of title.

The Town of Oyen may, after the public auction, become the owner of any parcel of land not sold at the public auction.

Terms: Cash or Certified Cheque at time of sale.

Redemption may be affected by payment of all arrears of taxes and costs at any time prior to the sale.

Dated at Oyen, Alberta, April 5, 2012.

Hermann Minderlein, *Chief Administrative Officer.*

Village of Edgerton

Notice is hereby given that under the provisions of the Municipal Government Act, the Village of Edgerton will offer for sale, by public auction, in the village office, 5017 – 50 Avenue, Edgerton, Alberta, on Tuesday, June 26, 2012, at 10:00 a.m., the following lands:

Lot	Block	Plan	C. of T.	Linc
11	37	8420167	072114838	0011182870
25 & 26	5	5681AC	022326812	0023999568

Each parcel will be offered for sale subject to a reserve bid and to the reservations and conditions contained in the existing Certificate of Title.

The Village of Edgerton may, after the public auction, become the owner of any parcel of land that is not sold at the public auction.

Terms: Cash or certified cheque.

Redemption may be effected by payment of all arrears of taxes and costs at any time prior to the sale.

Dated at Edgerton, Alberta, April 12, 2012.

Al Gordon, *Chief Administrative Officer*.

Village of Irma

Notice is hereby given that under the provisions of the Municipal Government Act, the Village of Irma will offer for sale, by public auction, at the Village of Irma Office at 4919 50 Street, Irma, Alberta, on Friday, June 15, 2012, at 10:00 a.m., the following land:

Block	Plan	Linc
B	6110HW	0016388282

The parcel will be offered for sale, subject to a reserve bid and to the reservations and conditions contained in the existing certificate of title.

Terms of Sale: Cash or certified cheque, a 10% deposit, and the remaining balance due within 20 days of the date of the public auction.

The exterior must be updated and building must pass licensed inspection within 12 months of auction date.

The land is being offered for sale on a "As is, where is" basis, and the Village of Irma makes no representation and gives no warranty whatsoever as to the adequacy of services, soil conditions, land use districting, building and development conditions, absence or presence of environmental contamination, or the ability to develop the subject land for any intended use by the successful bidder.

The Village of Irma may after the public auction, become the owner of the parcel of the land not sold at the public auction.

Auction shall be cancelled by payment of all arrears of taxes and costs at any time prior to the sale.

For address and reserve bid information please contact the Village of Irma Office at (780)-754-3665

Village of Minburn

Notice is hereby given that, under the provisions of the Municipal Government Act, the Village of Minburn will offer for sale, by public auction, in the Village of Minburn Administration Office located at 5001 – 50 Street Minburn, Alberta, on Tuesday, June 19, 2012, at 10:00 a.m., the following lands:

Lot	Block	Plan	Certificate of Title #
2	4	6100R	162I54
A	2	5687BK	072 737 082
A	2	5687BK	072 737 082+1

Each parcel will be offered for sale, subject to a reserve bid and to the reservations and conditions contained in the existing certificate of title.

The properties are being offered for sale on an “as is, where is” basis, and the Village of Minburn makes no representation and gives no warranty whatsoever as to the adequacy of services, soil conditions, land use districts, building and development conditions, absence or presence of environmental contamination, or the developability of the subject land for any intended use of the Purchaser.

No bid will be accepted where the bidder attempts to attach conditions precedent to the sale of any parcel(s). No terms or conditions of sale will be considered other than those specified by Village of Minburn.

The Village of Minburn may, after the public auction, become the owner of any parcel of land not sold at the public auction.

All bidders or their Agents must be present at the Public Auction.

Terms: Cash or Certified Cheque. The above properties may be subject to G.S.T.

Redemption may be affected by payment of all arrears of taxes and costs at any time prior to the sale.

Dated at Minburn, Alberta, April 10, 2012.

Patricia Shewchuk, *Chief Administrative Officer*.

NOTICE TO ADVERTISERS

The Alberta Gazette is issued twice monthly, on the 15th and last day.

Notices and advertisements must be received ten full working days before the date of the issue in which the notices are to appear. Submissions received after that date will appear in the next regular issue.

Notices and advertisements should be typed or written legibly and on a sheet separate from the covering letter. An electronic submission by email or disk is preferred. Email submissions may be sent to the Editor of The Alberta Gazette at albertagazette@gov.ab.ca. The number of insertions required should be specified and the names of all signing officers typed or printed. Please include name and complete contact information of the individual submitting the notice or advertisement.

Proof of Publication: Statutory Declaration is available upon request.

A copy of the page containing the notice or advertisement will be mailed to each advertiser without charge.

The dates for publication of Tax Sale Notices in The Alberta Gazette are as follows:

<i>Issue of</i>	<i>Earliest date on which sale may be held</i>
May 15	June 25
May 31	July 11
June 15	July 26
June 30	August 10
July 14	August 24
July 31	September 10
August 15	September 25
August 31	October 11
September 15	October 26
September 29	November 9
October 15	November 25
October 31	December 11

The charges to be paid for the publication of notices, advertisements and documents in The Alberta Gazette are:

Notices, advertisements and documents that are **5 or fewer pages**.....\$20.00
Notices, advertisements and documents that are **more than 5 pages**\$30.00

Please add 5% GST to the above prices (registration number R124072513).

PUBLICATIONS

Annual Subscription (24 issues) consisting of:

Part I/Part II, and annual index – **Print version**..... \$150.00

Part I/Part II, and annual index – **Electronic version** \$150.00

Alternatives:

Single issue (Part I and Part II) \$10.00

Annual Index to Part I or Part II \$5.00

Alberta Gazette Bound Part I \$140.00

Alberta Gazette Bound Regulations \$92.00

Please note: Shipping and handling charges apply for orders outside of Alberta.

The following shipping and handling charges apply for the Alberta Gazette:

Annual Subscription – Print version..... \$50.00

Individual Gazette Publications..... \$6.00 for orders \$19.99 and under

Individual Gazette Publications..... \$10.00 for orders \$20.00 and over

Please add 5% GST to the above prices (registration number R124072513).

Copies of Alberta legislation and select government publications are available from:

Alberta Queen's Printer
5th Floor, Park Plaza
10611 – 98 Avenue
Edmonton, Alberta T5K 2P7

Phone: 780-427-4952
Fax: 780-452-0668
(Toll free in Alberta by first dialing 310-0000)

qp@gov.ab.ca
www.qp.alberta.ca

Cheques or money orders (*Canadian funds only*) should be made payable to the Minister of Finance and Enterprise. Payment is also accepted by Visa, MasterCard or American Express. No orders will be processed without payment.