Water Security Agency

Saskatchewan Ministry of Environment

# Municipal Drinking Water Quality Monitoring Guidelines

## Edition 4
## March 2016

## EPB 202

**Note: As of October 1, 2012 The Water Security Agency and Saskatchewan Ministry of Environment share responsibility and authority for the administration of The Environmental Management and Protection Act, 2010, and The Waterworks and Sewage Works Regulations as pertaining to prescribed waterworks or sewage works in Saskatchewan. Therefore, all material contained within this document applies to waterworks or sewage works governed by the Water Security Agency or the Saskatchewan Ministry of Environment in accordance with their assigned responsibility.**

This document replaces the "Municipal Drinking Water Quality Monitoring Guidelines" WQ 148, March 1996 and other previous versions. It is intended for use by individuals concerned with monitoring of drinking water supplies regulated under *The Waterworks and Sewage Works Regulations*

Edition 2 - This edition addresses monitoring criteria changes to address data management system issues of significance to the Water Security Agency, to expand the monitoring criteria for bacteriological and turbidity monitoring, to add definitive requirements for pipelines or similar distribution systems, and to clarify the current recommendations for protozoa and chlorinated disinfection by-products.

Edition 3: This edition addresses changes made to section 2.4 - Turbidity Continuous Monitoring.

Edition 4: This edition includes monitoring requirements related to newly introduced standards for parameters found in Table 3 of the Appendix *to The Waterworks and Sewage Works Regulations* as well as other revisions applicable to previously listed parameters as necessary.

The guidelines will be revised and updated as new information warrants change.

Please forward inquiries concerning the guidelines and waterworks regulated by the Water Security Agency to:

Environmental and Municipal Management Services Division
Water Security Agency
420-2365 Albert Street
Regina, Saskatchewan
S4P 4K1

Phone: (306) 787-0726
Fax: (306) 787-0780

For inquiries pertaining to industrial facilities, please forward to:

Environmental Protection Branch
Ministry of Environment
102-112 Research Drive
SASKATOON SK S7N 3R3

Telephone: (306) 933-7940
Fax: (306) 933-8442

# 1. Introduction

## 1.1 Purpose

Drinking water quality monitoring is important to both the consumer and the owner of waterworks systems. Reasons for monitoring drinking water include:

- assessment and assurance of the safety of water for consumptive purposes;
- suitability of the water to meet consumer's aesthetic needs;
- assessment of water treatment needs and information to implement process adjustments;
- assessment of water source protection and/or concerns;
- provision of information for private, commercial, or industrial users; and;
- determination of drinking water quality trends and identification of potential concerns.

These guidelines are considered a minimum for community monitoring requirements. If special circumstances warrant, the monitoring can be revised in the waterworks operating permit to address the special needs or to address parameters not identified in these guidelines. The guidelines outline the requirements for monitoring of water supplied or used for human consumptive use. This guideline may also be employed when determining monitoring requirements for systems supplying water intended or used for hygienic use or for certain pipeline systems and those requirements will vary somewhat and be less comprehensive. Site specific monitoring requirements are specified in the Permit to Operate for the facility.

## 1.2 Monitoring Factors

There are a number of factors that should be considered during the development of a drinking water monitoring schedule. Samples must be collected in an appropriate manner, from an appropriate location and analyzed using an acceptable method to ensure representative results. The main points to consider when developing monitoring guidelines are:

- water supply variations and susceptibility to quality changes (for example, surface water will be subject to seasonal and hydrological changes while groundwater is often less variable on a short term basis);
- treatment capabilities and performance of the treatment facilities;
- vulnerability of the water supply to potential contamination;
- variations in water quality for some parameters from the time it leaves the water treatment plant/reservoir until the time it reaches the consumers tap;
- the need for and capabilities of conducting on-site measurements;
- past trends in water quality information;
- the laboratory capabilities and cost of monitoring compliance by the owners;
- minimization of effort while providing adequate surveillance;
- size of population (as population increases, users tend to be more diverse, there are more consumers, the systems are more complex, and subject to contamination); and
- the availability of water quality data and information on raw water sources should be considered when establishing drinking water monitoring requirements (The Water Security Agency has a good database on a wide range of parameters that are frequently analyzed at designated surface water sites in the province).

## 1.3 Additional Parameters

Additional parameters for monitoring water supply and treatment are being added to complement the parameters contained in the Guidelines for Canadian Drinking Water Quality--Summary Table, Health Canada (August, 2012), as amended from time to time. Some of the parameters were added because of general drinking water quality interests, while others were related to the type of supply. Additional parameters include the following:

### A. Ground and Surface Water Supplies

- chlorine residuals (total and free) which are important site measurements to determine disinfection availability and persistence;
- calcium, bicarbonate and carbonate which are part of the general chemical category (major ions) and are important for determination of ionic distribution and calculation of dissolved solids by sum of ions. Furthermore it is likely that the Guidelines for Canadian Drinking Water Quality will include total dissolved solids as an aesthetic parameter in the future; and
- conductivity which is a useful field measurement for general approximation of sum of ions.

**B. Surface Water Supplies**

- aluminum is important for surface water plants undertaking aluminum-based coagulation.

## 2. Monitoring Guidelines and Rationale

### 2.1 Bacteriological

Minimum bacteriological monitoring requirements for waterworks relying upon surface and ground water supplies are shown in Table 1.

**Table 1: Bacteriological (Total Coliform, *Escherichia coli* & Background Bacteria) Monitoring Requirements**

| Population | Groundwater Source | Surface Water, Blended or GUDI Source |
|---|---|---|
| 0-100 | 1 per month | 2 per month |
| 101-500 | 2 per month | 1 per week |
| 501-2,000 | 1 per week | 1 per week |
| 2,001-5,000 | 1 per week | 6 per month |
| 5,001-15,000 | 2 per week | 3 per week |
| 15,000-50,000 | 1 per 8,000 pop. per week | 1 per 4,000 pop. per week |
| >50,000 | 1 per 16,000 pop. per week | 1 per 12,000 pop. per week |

Bacteriological determinations, particularly using total coliform bacteria as an indicator of the potential presence of pathogens, has been a standard monitoring tool for many years. In recent times monitoring for Escherichia coli has replaced monitoring for faecal coliform indicators in treated drinking water supplies and most laboratories now employ methodologies that determine both total coliform and *E. coli* at the same time. Typically, monitoring requirements have been related to the population served by a distribution system. Other factors could include the nature of the supply, its susceptibility to bacteriological contamination, and the historical bacteriological records (submissions and incidence of positive detections). Bacteriological water quality monitoring is required for systems supplying water for human consumptive use or hygienic use. Sampling locations should be at representative locations in the distribution system. For those waterworks subject to seasonal population changes the bacteriological monitoring frequency should be adjusted on a seasonal basis in accordance with the frequencies outlined in Table 1.

### 2.2 Chlorine Residual - On-Site

Free chlorine residual monitoring is required by *The Waterworks and Sewage works Regulations* for all communities chlorinating their drinking water. Unless otherwise approved in permit conditions, such as instances where chloramination based disinfection is employed, the permittee of a waterworks shall cause to be maintained:

(a) a free chlorine residual of not less than 0.1 milligrams per litre in the water entering a distribution system; and

(b) a total chlorine residual of not less than 0.5 milligrams per litre or a free chlorine residual of not less than 0.1 milligrams per litre in the water throughout the distribution system.

Surveillance of treated water, for all communities regardless of population size, for chlorine residual is necessary to properly regulate the chlorination process. Both free and total chlorine residual monitoring is necessary to get a complete picture. Chorine residual monitoring is required for systems supplying water for human consumptive use and those hygienic use systems where disinfection is performed in accordance with permit requirements. Chlorine residual determinations must be done on-site.

The minimum basic monitoring is:

- for free chlorine residual, once per day from treated water at the water treatment plant, and
- for free and total chlorine residuals the same frequency and locations used for bacteriological sampling.

Waterworks serving greater than 5,000 consumers should seriously consider employing continuous chlorine residual monitoring at the water treatment plant. Integrating continuous chlorine residual monitoring with an alarm of audible notification system is also recommended. Where surface or blended source waterworks are subject to seasonal, storm induced or other variability in source water quality, increased chlorine residual monitoring at the water treatment plant up is encouraged and may be required if specified in the waterworks operating permit. Where chloramination is employed, typically as a minimum, monitoring for total chlorine residual is to be employed for water entering the distribution system and at the same time and frequency when bacteriological water quality samples are collected from the distribution system. Additional free chlorine and monochloramine monitoring may be required in accordance with permit conditions as a means to determine process performance.

### 2.3 Odour, Taste and Temperature

Odour and taste problems tend to be consumer and site specific. Monitoring is continually carried out by consumers. Incidents of problematic taste and odour should be promptly investigated to determine possible causes. Routine monitoring is not proposed.

Temperature should be periodically monitored at the water treatment plant to gauge treatment efficiency (disinfection and oxidation). For aesthetic considerations, the community may also wish to take temperature measurement in the distribution system. Temperature measurement is site specific and routine monitoring is not required.

### 2.4 Turbidity

The minimum routine monitoring is targeted to water leaving each filter for surface water or GUDI treatment plants, and to water entering the distribution system for groundwater treatment plants (ed note: see 30-2-e of regulations). Distribution sampling, for aesthetic objective purposes, is recommended for operational information and management. Turbidity measurement is required for all waterworks that provide water for human consumptive use, in accordance with Table 2. Routine turbidity measurements are not required by hygienic systems, although it is recommended.

**Table 2: On-Site Turbidity Monitoring Requirements (Minimum)**

| Population | Groundwater Source | Surface Water, Blended or GUDI Source |
|---|---|---|
| 0-100 | 1 per day | 1 per day |
| 101-500 | 1 per day | 1 per day |
| 501-2,000 | 1-2 per day | 1-2 per day |
| 2,001-5,000 | 2 per day | 4 per day |
| 5,001-15,000 | 3 per day | Continuous |
| 15,001-50,000 | 4 per day | Continuous |
| >50,000 | Continuous | Continuous |

Turbidity is an important water quality parameter, especially for surface water containing organic particulates, because it affects bacteriological quality and treatment performance. Depending upon the composition of the turbidity, interference with chlorination can range from negligible to severe.

Turbidity measurement is a valuable process control tool for surface water treatment. Suitable and easily operated turbidimeters are available for use in water treatment plants. In larger facilities, continuous reading units are becoming common. Frequent monitoring of turbidity, particularly for waterworks obtaining raw water from surface or blended sources will aid in tracking and maintaining treatment process optimization and ultimately, the safety of the water supply. Where surface or blended source waterworks serving less than 2000 consumers are subject to seasonal, storm induced or other variability in source water quality, increased turbidity monitoring up to a frequency of four times per day is encouraged and may be required if specified in the waterworks operating permit. For those waterworks subject to seasonal population changes the turbidity monitoring frequency should be adjusted on a seasonal basis in accordance with the frequencies outlined in Table 2.

**Criteria for Turbidity Continuous Monitoring**

Continuous monitoring for turbidity should include as a minimum:

- Polling of turbidity monitors on each filter on a basis of at least once every five minutes. The five minute polling should be an average of a set of data taken at smaller intervals (each five or 10 or 30 seconds for example),

- Reporting of information returned from polling monitors on each filter, including maximum value, minimum value and mean value at least once every 15 minutes. The 15 minute polling statistics can be maximum, minimum and mean of the five minute averages.
- Report any polling result that exceeds the applicable absolute maximum value (i.e.: 1.0 NTU for surface water - chemically assisted filtration; 0.1 NTU surface water - membrane filtration; 3.0 NTU - slow sand or diatomaceous earth filtration; Groundwater - see permit value).

Turbidity monitoring in the distribution system can also be helpful in understanding the system condition and will become increasingly important as drinking water standards for manganese are introduced in the future. Continuous turbidity monitoring at the point where water enters the distribution system may be advisable for a larger community (City or > 5,000 served) and/or where a larger centre is served by a treated water pipeline. Such monitoring may be of value in ensuring safe drinking water, especially where the source of treated water is remote to the community and aid in distinguishing the source of any changes in treated water turbidity. Significant accumulations of manganese can often occur in water pipelines and drinking water distribution systems, especially in situations where cast iron or ductile iron water mains are employed. In these instances, along with direct monitoring of manganese, operators may be better able to understand the source of manganese in their distribution systems.

### 2.5 Ammonia and Dissolved Organic Carbon

Many raw water sources have exhibited the presence of either naturally occurring ammonia (particularly in groundwater sources) or dissolved organic carbon or in some cases both. While it has not been considered necessary to establish health based guideline's for either of these parameters they can have a potential impact on water quality either through affecting disinfection process's or through the formation of disinfection by-products. The need for monitoring of these parameters will be determined on a site-specific basis. Routine monitoring is not required.

### 2.6 Colour

Colour is primarily of aesthetic interest, but since it is sometimes organic in nature, it can be associated with other water quality concerns such as trihalomethane formation. Groundwater generally contains little colour. Surface water is more susceptible due to vegetation decay cycles and runoff influences. Although colour testing would normally be done on-site, routine monitoring is not required.

### 2.7 pH

The importance of pH in distributed water is normally related to the corrosive or scale forming properties of water and to the efficiency of chlorine disinfection. In raw water, pH can impact on coagulation performance. Water treatment processes such as lime soda softening and high alum dosage coagulation can alter the pH. Surface water can vary seasonally and even daily, especially if there are high densities of algae. Groundwater usually has a stable pH.

Unless pH has an impact on, or is altered by treatment processes in use such as certain membrane filtration systems, it is not an important control measurement. Meters and less accurate colour comparators are available for on-site pH measurements. On-site monitoring should be carried out on water entering the distribution system and may prove useful in understanding the potential implications should a waterworks convert to a nano-filtration or reverse osmosis filtration system. Monitoring of pH may have to be done at various frequencies depending on the size of the facility and supply source. Off-site monitoring is generally not required.

### 2.8 Sulphide (as $H_2S$)

Sulphide can be present in raw surface water due to bacterial decomposition under anaerobic conditions. In groundwater, sulphide can be generated biologically or may originate from a gaseous environment in the aquifer. Sulphide may also be produced in household hot-water heaters. In addition to its distinctive odour, sulphide gas can be corrosive and hazardous in confined spaces.

Any measurement of sulphide as hydrogen sulphide gas dissolved in the water should be done on-site. The need for such analyses will be determined on a site-specific basis. Routine monitoring is not required.

### 2.9 General Chemical (Major Ions)

The composition and concentration of general chemicals identify the water's chemical composition. This will vary among supply sources. A groundwater supply generally will have less variability than a surface water supply, which tends to vary at least on a seasonal basis. In general, samples should be collected from treated water at the water treatment plant as outlined in Table 3.

**Table 3: General Chemical Monitoring Guidelines**

| Population | Groundwater Source | Surface Water, Blended or GUDI Source |
|---|---|---|
| 0-100 | 1 per 2 years | 1 per 3 months every 2 years |
| 101-500 | 1 per 2 years | 1 per 3 months every 2 years |
| 501- 5000 | 1 per 2 years | 1 per 3 months every 2 years |
| 5001-100000 | 1 per 6 months | 1 per 3 months |
| >100000 | 1 per 6 months | 1 per 3 months |
| General Chemicals are classified as the following parameters: Alkalinity (as $CaCO_3$), Bicarbonate, Calcium, Carbonate, Chloride, Conductivity, Fluoride (for non-fluoridating communities), Hardness (as $CaCO_3$), Magnesium, Nitrate, Sodium, Sulphate and Total Dissolved Solids. | | |

### 2.10 Health and Toxicity

Samples for monitoring of the health and toxicity parameter grouping should be collected from treated water at the water treatment plant.

In much of Saskatchewan's groundwater, concentrations of iron and/or manganese frequently exceed the Guidelines for Canadian Drinking Water Quality and removal processes are routinely employed. Regular on-site iron and manganese measurements are important for process control in facilities intending to remove these constituents. Monitoring for manganese in the distribution system will become increasingly important as this component of a waterworks can act as a reservoir for manganese, particularly where cast iron or ductile iron water mains are in service.

Copper and zinc generally occur below the Guidelines for Canadian Drinking Water Quality in Saskatchewan raw water supplies. These constituents can increase in distribution systems due to corrosion of zinc-bearing materials including copper piping and fittings.

The Health and Toxicity grouping also includes aluminum, antimony, arsenic, barium, boron, cadmium, chromium, lead, selenium, silver, and uranium.

Lead may warrant special attention for problematic sites or systems know to employ lead service lines or lead water mains. Lead is a special situation as it may be introduced into the water via leaching from lead pipe services or plumbing systems. Readers are advised to consider and follow Health Canada’s document entitled “Guidance on Controlling Corrosion in Drinking Water Distribution Systems” in assessing the quality of water at the tap (see: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/corrosion/index-eng.php). This document is also helpful in understanding copper and iron related water quality concerns at the consumer’s tap.

Aluminum is not currently listed in the Guidelines for Canadian Drinking Water Quality--Summary Table, Health Canada (August, 2012). Dissolved aluminum levels in raw water are typically quite low. However, aluminum concentrations may be increased in treated water following coagulation with aluminum salts. Occasional aluminum determinations of raw and treated water at water treatment plants using aluminum salt coagulation are useful to determine if significant aluminum carryover is occurring.

Monitoring guidelines for health and toxicity parameters are outlined in Table 4 and are to be collected from the water treatment plant reservoir before entry to the distribution system. Additional guidance for monitoring manganese in drinking water distribution systems is pending.

**Table 4: Health and Toxicity Monitoring Guidelines**

| Population | Groundwater Source | Surface Water, Blended or GUDI Source |
|---|---|---|
| 0-100 | 1 per 2 years | 1 per 2 years |
| 101-500 | 1 per 2 years | 1 per 2 years |
| 501-5000 | 1 per 2 years | 1 per 2 years |
| 5001-25000 | Annually | Annually |
| >25000 | 1 per 6 months | 1 per 6 months |

Health and Toxicity are classified as the following parameters: Aluminum, Antimony, Arsenic, Barium, Boron, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Selenium, Silver, Uranium and Zinc

### 2.11 Cyanide

Monitoring requirements for cyanide are shown in Table 5. Cyanide can exist in many forms. The free cyanide is a concern with respect to human toxicity. Cyanide concentrations in groundwater and surface water are typically very low. Significant cyanide concentrations are most often a result of a site-specific pollutant source.

**Table 5: Cyanide Monitoring Guidelines**

| Population | Groundwater Source | Surface Water, Blended of GUDI Source |
|---|---|---|
| <5000 | Nil | Nil |
| 5001-25000 | Annually | Annually |
| >25000 | 1 per 6 months | 1 per 6 months |

### 2.12 Mercury

Mercury enters water supplies naturally and via man-made sources. Mercury concentrations in groundwater and surface water tend to be very low. Adherence of mercury onto sediments typically results in higher concentrations in bottom sediments. Monitoring guidelines are shown in Table 6.

**Table 6: Mercury Monitoring Guidelines**

| Population | Groundwater Source | Surface Water, Blended or GUDI Source |
|---|---|---|
| <5000 | Nil | Nil |
| 5001-25000 | Annually | Annually |
| >25000 | 1 per 6 months | 1 per 6 months |

### 2.13 Fluoride

Fluoride is often added to drinking water for the prevention of dental decay. Excessive fluoride concentrations may cause mottling (brown spots) on teeth. Split samples should be periodically obtained to compare off-site and on-site measurements. Off-site fluoride monitoring guidelines are shown in Table 7.

**Table 7: Off-Site Fluoride Monitoring Guidelines**

| Population | Groundwater Source | Surface Water, Blended or GUDI Source |
|---|---|---|
| 0-100 | 1 per month | 1 per month |
| 101-500 | 1 per month | 1 per month |
| 501-5000 | 1 per week | 1 per week |
| 5001-100000 | 1 per week | 1 per week |
| >100000 | 1 per week | 1 per week |
| **Note:** For communities not fluoridating refer to the monitoring under General Chemical section. This monitoring schedule is for communities artificially adding fluoride to drinking water or where fluoride levels consistently exceed the maximum acceptable concentration | | |

On site testing at the water treatment plant for all communities artificially adding fluoride is required daily regardless of population size.

### 2.14 Trihalomethanes (THM), Haloacetic Acids (HAA) and Other Chlorinated Disinfection By-Products

Trihalomethanes are generated during the water treatment process as a by-product of free chlorine reactions. The term THMs refers to the total concentration of chloroform, bromodichloromethane, dibromochloromethane and bromoform compounds. Significant levels of THMs may occur when the raw water is obtained from a surface water supply. However, there may be specific situations where groundwater may be of a quality to produce THMs. Samples should be collected from representative locations in the distribution system in accordance with Table 8. To calculate a THM value, the winter, spring, summer and fall readings will be averaged to calculate running locational annual average value. THM values illustrate seasonal variability, therefore, it is necessary to sample on a seasonal basis.

In addition to THM's other substances such as Haloacetic Acids (HAA) are created in minute concentrations during chlorine based disinfection processes. Some of the more prevalent HAAs created during disinfection processes include monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid and dibromoacetic acid. The term $HAA_5$ refers to the total concentration of these five compounds.

Communities reliant on surface water supplies, mixed surface and ground water supplies, groundwater under direct influence of surface water (GUDI supplies) and those true groundwater systems with elevated Total Organic Carbon concentrations in their raw water supplies are to monitor THM and HAA concentrations in accordance with Table 8 at the most relevant location and where anticipated peak concentrations can be anticipated in the distribution system. In the case of THM monitoring peak concentrations can typically be found at the most distant ends of the distribution system and/or in locations where water stagnates within the mains due to low flow. Monitoring locations for HAA's is to be performed at the same location as monitoring for THM's in small community systems. For systems serving more than 2000 people, initial monitoring to determine just where peak concentrations in the distribution system is occurring is recommended, since in larger systems peak concentrations of HAA's often occurs at a midpoint within the distribution system. Periodic monitoring for THM and HAA at the treatment plant/reservoir may also prove valuable in assessing the effectiveness of treatment changes intended to reduce the concentration of disinfection byproducts or following significant changes in disinfectants employed or contact time.

Sequential pipeline systems served by a common source with long line lengths require special consideration as to monitoring requirements for THM's and HAA's. Please see part 3 of this document regarding monitoring of these parameters in pipeline systems.

**Table 8: Trihalomethane and Haloacetic Acid Monitoring Guidelines**

| Population | Groundwater Source | Surface Water, Blended, GUDI and Susceptible Groundwater Sources |
|---|---|---|
| 0-100 | Nil | 1 sample every 3 months during each spring, summer, fall and winter |
| 101-500 | Nil | 1 sample every 3 months during each spring, summer, fall and winter |
| 501-5000 | Nil | 1 sample every 3 months during each spring, summer, fall and winter |
| 5001-100000 | Nil | 2 samples every 3 months during each spring, summer, fall and winter |
| >100000 | Nil | 2 samples every 3 months during each spring, summer, fall and winter |

## 2.15 Synthetic Organic Chemicals

It is expected that the detection of the many synthetic organic chemicals in Saskatchewan's groundwater and surface water would be very rare. Detection of any of these chemicals would most likely be associated with a site-specific pollution event, hence the monitoring frequencies, outlined in Table 9, are low.

**Table 9: Monitoring Guidelines for Synthetic Organic Chemicals**

| Population | Groundwater Source | Surface Water, Blended or GUDI Source |
|---|---|---|
| 0-100 | Nil | Nil |
| 101-500 | Nil | Nil |
| 501-5000 | Nil | Nil |
| 5001-100000 | 1 every 3 years | 1 every 2 years |
| >100000 | Annually | Annually |
| Synthetic organic chemicals are classified as the following parameters: Carbon Tetrachloride; 1,2 Dichlorobenzene; 1,4 Dichlorobenzene; 1,2 Dichloroethane; 1,1 Dichloroethylene; Dichloromethane; 2,4 Dichlorophenol; Monochlorobenzene; Tetrachloroethylene; 2,3,4,6 Tetrachlorophenol; Trichloroethylene; 2,4,6, Trichlorophenol; and Vinyl Chloride | | |

## 2.16 Benzene, Toluene, Ethylbenzene and Xylenes (BTEX)

Due to the volatile nature of these chemicals, concentrations in surface water are generally very low. Detectable values in groundwater are normally associated with site-specific pollution sources particularly the petroleum industry. BTEX monitoring frequencies are outlined in Table 10.

**Table 10: Benzene, Toluene, Ethylbenzene and Xylene Monitoring Guidelines**

| Population | Groundwater Source | Surface Water, Blended or GUDI Source |
|---|---|---|
| 0-100 | Nil | Nil |
| 101-500 | Nil | Nil |
| 501-5000 | Nil | Nil |
| 5001-100000 | 1 every 3 years | 1 every 2 years |
| >100000 | Annually | Annually |
| BTEX involves the parameters: Benzene, Toluene, Ethylbenzene, and Xylenes that are all volatile organic chemicals | | |

## 2.17 Benzo (a) Pyrene (BaP), Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA)

BaP is generated by the incomplete combustion of organic material and is generally associated with industrial atmospheric discharges and automobile exhaust. It may also be found in source waters that received treated wastewater effluents. Surface water near industrialized areas is more susceptible to BaP contamination. PFOS and PFOA are found in similar locations but are also found in locations affected by land spreading of septic tank waste as well as land or water affected by Aqueous Film-Forming Foam (AFFF). New raw water sources should be characterized upon commissioning of use and existing groundwater supplies should be characterized where susceptible to contamination as noted above. The monitoring frequencies for BaP, PFOS and PFOA are outlined in Table 11.

**Table 11: Benzo (a) Pyrene, Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) Monitoring Guidelines**

| Population | Groundwater Source | Surface Water, Blended or GUDI Source |
|---|---|---|
| 0-100 | Nil | Nil |
| 101-500 | Nil | Nil |
| 501-5000 | Nil | Nil |
| 5001-100000 | 1 every 3 years | 1 every 2 years* |
| >100000 | Annually | Annually* |

*Quarterly monitoring may be necessitated when BaP, PFOS or PFOA has been detected in previous samples and in water sources susceptible to contamination.

### 2.18 Nitrilotriacetic Acid (NTA)

Nitrilotriacetic acid (NTA) is most commonly used to replace phosphates in laundry detergents. As a result, the main source of NTA to the aquatic environment is via industrial or municipal liquid effluents. Because of rapid NTA degradation in most sewage treatment processes, effluent concentrations are usually very low. Groundwater and surface water typically have negligible NTA concentrations. No routine monitoring is required.

### 2.19 Pesticides

Since the potential for pesticide detection may vary seasonally because local use also varies, and since there have been very few problems in Saskatchewan, pesticide monitoring is minimal. New raw water sources should be characterized upon commissioning of use. The monitoring guidelines for pesticides are shown in Table 12. Guidelines for Pentachlorophenol have been withdrawn from the national drinking water quality guidelines, but remains in Saskatchewan’s listing of parameters as of January 2016.

**Table 12: Pesticide Monitoring Guidelines**

| Population | Groundwater Source | Surface Water, Blended or GUDI Source |
|---|---|---|
| 0-100 | Nil | Nil |
| 101-500 | Nil | Nil |
| 501-5000 | Nil | Nil |
| 5001-100000 | 1 every 3 years | 1 every 2 years |
| >100000 | Annually | Annually |
| Pesticides to be analyzed for in Saskatchewan are: Atrazine, Bromoxynil (Buctril), Carbofuran, Chloropyrifos, Dicamba (Banvel), 2,4 Dichlorophenoxyacetic acid (2,4-D), Diclofop-Methyl (Hoe Grass), Dimethoate, Malathion, 2-Methyl-4-Chlorophenoxyacetic Acid (MCPA), Pentachlorophenol (PCP), Picloram and Trifluralin (Treflan) | | |

### 2.20 Chlorate and Chlorite

Chlorate and Chlorite are compounds that may be found in drinking water when chlorine dioxide is used as a disinfection process. Chlorate can also be found in trace levels in hypochlorite solutions or when these solutions are not stored and/or used appropriately. Chlorine dioxide for primary disinfection should not exceed a maximum feed rate of 1.2 mg/L, an operational measure that will help ensure that chlorate and chlorite drinking water quality standards will be met. Optimization of on-site chlorine dioxide generation processes is also important to ensure that chlorine dioxide will not be overly contaminated with chlorite. The use of only NSF/ANSI 60 certified disinfectants will minimize exposure to consumers via drinking water due to trace chlorate residuals found in hypochlorite disinfectants.

Monitoring requirements for chlorate and chlorite are essential for communities that employ chlorine dioxide primary disinfection as component of their drinking water treatment processes. In medium and larger waterworks, chlorite concentrations tend to occur mid-way within the distribution systems whereas maximum chlorate concentrations tend to occur at distal ends of the distribution system or where water stagnates within water mains. Monitoring of smaller systems service less than 1000 people should be performed in distant ends of the distribution system. Sampling for these parameters should be undertaken on a frequency in accordance with Table 13 at locations as noted above. In all cases where there are significant adjustments in chlorine dioxide primary disinfectant levels, further treated water monitoring should be undertaken to determine the effect of such changes on chlorate and chlorite formation in the treated water supply.

**Table 13: Chlorate and Chlorite Monitoring Guidelines for Waterworks Employing Chlorine Dioxide Primary Disinfection**

| Population | Groundwater | Surface Water, Blended or GUDI Source |
|---|---|---|
| 0-100 | Annually | Semi-annually, summer and winter |
| 101-500 | Annually | Semi-annually, summer and winter |
| 501-5000 | Annually | Semi-annually, summer and winter |
| 5001-100000 | Semi-annually, summer and winter | Quarterly – once each season |
| >100000 | Semi-annually, summer and winter | Quarterly – twice each season |

### 2.21 Bromate

Bromate compounds may be found in drinking water as a result of water treatment process and the use of disinfectants rather than as a natural contaminant of raw water supplies. Given the sedimentary nature of Saskatchewan soils bromide exists in our raw water supplies. Bromate compounds may be formed when ozonation processes are used to treat drinking water. Bromate also exists in trace levels in hypochlorite disinfectant solutions as a remnant of the disinfectant manufacturing processes. The use of only NSF/ANSI 60 certified disinfectants will minimize exposure to consumers via drinking water due to trace bromate residuals found in hypochlorite disinfectants. Waterworks which are employing breakpoint chlorination may be required to monitor bromate concentrations on a site specific basis if maximum disinfectant use levels are being exceeded. Bromate concentrations in treated water supplies reliant on surface water sources may vary seasonally.

Monitoring requirements for bromate are essential for communities that employ ozonation as component of their drinking water treatment processes. In the case of waterworks reliant on groundwater, monitoring may be reduced in frequency if the standard of 0.01 mg/L is achieved and if no significant changes in average concentration after three years of monitoring is observed. In all cases where there are significant adjustments in ozonation treatment levels, further treated water monitoring should be undertaken to determine the effect of such changes on bromate formation in the treated water supply. All samples should be collected from a point before treated water enters the distribution system.

**Table 14: Bromate Monitoring Guidelines for Waterworks Employing Ozonation**

| Population | Groundwater | Surface Water, Blended or GUDI Source |
|---|---|---|
| 0-100 | Annually | Semi-annually, summer and winter |
| 101-500 | Annually | Semi-annually, summer and winter |
| 501-5000 | Annually | Semi-annually, summer and winter |
| 5001-100000 | Semi-annually, summer and winter | Quarterly – once each season |
| >100000 | Semi-annually, summer and winter | Quarterly – twice each season |

### 2.22 Microcystin toxins.

Microcystins are a type of toxin produced by cyanobacteria (blue-green algae). Microcystins are considered to be hepatotoxins (toxic to the liver) and are one of several types of toxins that may be produced as a result of cyanobacterial blooms in surface water sources in Saskatchewan. Microcystin-LR is a secondary metabolite produced by a common cyanobacteria species and has found to be the most frequently occurring and often studied form of cyanobacterial toxin. Some Saskatchewan surface waters tend to be susceptible to algal blooms due to their nutrient rich nature, coupled with warm and sunny summer conditions. Elevated toxin concentrations are most often encountered during the die-off of heavy algal blooms and may be highest in the locale where algal blooms accumulate in downwind areas on shorelines. The major route of human exposure to Microcystin toxins is via drinking water.

Monitoring requirements for Microcystin-LR and/or total Microcystin toxins in general are outlined in Table 15. Generally waterworks reliant on surface water supplies susceptible to algae blooms should develop an action plan as a means to prepare for monitoring and management of raw and treated water potentially affected by blue-green algae blooms. Often monitoring of the source water supply where water intakes may receive water affected by a decaying algae bloom is the first step. Screening of raw water samples using enzyme-linked immunosorbent assay (ELISA) test kits is an acceptable first step in determining total Microcystin concentrations. Monitoring of raw and treated supplies may be necessary to detect the onset of elevated Microcystin concentrations in a source supply and thereafter monitoring of treated water quality may become necessary when raw water total Microcystin levels exceed the standard of 0.0015 mg/L. Monitoring of raw and treated water may be required as a means to ensure treated water meets the standards.

**Table 15: Microcystin Toxin Monitoring Guidelines**

| Population | Groundwater or GUDI Source | Surface Water or Blended Source |
|---|---|---|
| 0-100 | Nil | Following detection of significant algal blooms affecting a water intake |
| 101-500 | Nil | Following detection of significant algal blooms affecting a water intake |
| 501-5000 | Nil | Following detection of significant algal blooms affecting a water intake |
| 5001-100000 | Nil | Monthly during algal bloom period |
| >100000 | Nil | Monthly during algal bloom period |

### 2.23 Radiological

Radionuclides are derived from natural sources such as weathering of rocks that contain radioactive substances and by man-made sources such as nuclear weapons testing, nuclear power generation, and uranium mining or milling operations. Most radionuclides readily adhere to sediments and do not occur in significant amounts, in the water column. Groundwater tends to be more susceptible to radionuclide contamination.

In Saskatchewan, radionuclide contamination of water supplies is uncommon and tends to be very site specific. As a result, generally radionuclide monitoring will be considered on a case-by-case basis based on the vulnerability of the water supply. Waterworks serving a population of greater than 100,000 people are to perform annual monitoring for gross alpha, gross beta, lead-210, radium-226, tritium, strontium-90, iodine-131, cesium-137 and potassium-40. New raw water sources should be characterized upon commissioning of use for radioactivity using gross alpha and gross beta activity determinations. For all communities other than those with waterworks serving more than 100,000 people compliance with the Guidelines for Canadian Drinking Water Quality may be inferred if the measurements for gross alpha and gross beta activity are less than 0.5 Bq/L and 1 Bq/L respectively, as these are lower than the strictest Maximum Acceptable Concentrations given the likely proportion of any common alpha or beta emitters. If either the gross alpha or gross beta activity levels are exceeded upon initial screening then the treated water supply should be monitored for the suite of radiological isotopes as noted above consistent for the gross alpha or beta exceedence.

### 2.24 Protozoa: *Giardia* and *Cryptosporidium*

*Giardia* and *Cryptosporidium* are very small protozoan organisms and when ingested can result in severe gastrointestinal illness, long lasting or more serious health effects. The establishment of Maximum Acceptable Concentrations for these protozoa in drinking water is not possible at this time for several reasons but primarily as routine analytical methods available for the detection of cysts and oocysts suffer from low recovery rates. Rather a health based 3-log reduction in and/or inactivation of cysts and oocysts treatment goal has been employed as a means to manage potential protozoan contamination of drinking water supplies. Measures such as source water vulnerability assessments, sanitary surveys, waterworks treatment optimization and or wellhead protection should be implemented to reduce the risk waterborne disease outbreaks due to the entry and passage or these organisms through the water treatment process.

Raw water monitoring requirements for water entering a water treatment plant for giardia and cryptosporidium protozoan threats are outlined in Table 16. Additional monitoring of raw and/or treated water quality may be required for systems reliant on surface water, blended and GUDI sources in the event of an operational upset affected treated water or significant environmental event that may affect raw water quality. Generally waterworks reliant on surface water sources should develop or conduct a vulnerability assessment as part of their operational assessment activities or as a component of a Waterworks System Assessment. More in-depth characterization of raw water sources can be helpful in understanding when monitoring should be performed and when the greatest potential for increases in protozoan contaminant concentrations may occur.

**Table 16: Giardia and Cryptosporidium Monitoring Guidelines**

| Population | Groundwater Source | Surface Water, Blended or GUDI Source |
|---|---|---|
| 0-100 | Nil – Vulnerability assessment as part of operational assessment | Nil – Vulnerability assessment as part of operational assessment |
| 101-500 | Nil – Vulnerability assessment as part of operational assessment | Nil – Vulnerability assessment as part of operational assessment |
| 501-5000 | Nil – Vulnerability assessment as part of operational assessment | Nil – Vulnerability assessment as part of operational assessment and following upsets or significant events that may affect raw water quality |
| 5001-100000 | Nil – Vulnerability assessment as part of operational assessment | Semi-annually and following upsets or significant events that may affect raw water quality |
| >100000 | Nil – Vulnerability assessment as part of operational assessment | Quarterly and following upsets or significant events that may affect raw water quality |

## 3. Pipeline and Similar Distribution Systems

This section is intended to clarify monitoring requirements for pipelines and independently owned distribution systems which provide water from a separately owned approved municipal source or other separately owned approved source. Pipeline systems that treat and distribute their own source of water are classified as waterworks and are subject to the same water source type and population based monitoring requirements as identified in sections 2.1 to 2.24 inclusive.

Pipeline systems or independently owned distribution systems, where captured by Section 17 of *The Waterworks and Sewage Works Regulations*, receiving water from a separately owned and approved treatment facility and/or treated water pipeline, are subject to water source type and population based monitoring as identified in sections 2.1 Bacteriological, 2.2 Chlorine Residual – On-Site and 2.14 Trihalomethanes, Haloacetic Acids and Other Chlorinated Disinfection By-Products. A water pipeline may monitor for free and total chlorine residual entering the pipeline system or for free and total chlorine residual at a representative location within the pipeline's distribution system. The monitoring sites chosen may depend on the presence of any re-chlorination equipment along the pipeline however compliance with minimum disinfectant residual requirements must be informed by the monitoring locations selected. For pipelines serving fewer than 15 service connections, an exemption from the monitoring requirements of Section 2.14 may be considered. More than one monitoring schedule may be required for a pipeline system based on the location, complexity and number of branch pipelines. One-time assessment for anticipated peak Haloacetic Acid concentrations may be required to determine concentrations of these contaminants where treated water is being supplied by a connected municipal supplier. Monitoring of all sequentially connected pipelines for Trihalomethanes and one-time assessment for Haloacetic Acids is system specific and subject to permit specific requirements.  In the end, it may not be necessary to monitor all sequentially connected pipeline systems for THM's and/or HAA's if the occurrence of these substances in the system is understood and levels of contaminants can be reasonably established.

Guidance on monitoring of Limited Scope Pipelines is governed under "WSA 504 – Limited Scope Water Pipeline Protocol".  Under that protocol limited scope pipelines are to perform bacteriological water quality monitoring on a minimum of a monthly basis.  Where chlorine residual levels in pipelines supplying potable water to a limited scope pipeline has not otherwise been confirmed, and where system specific configuration allows the collection of representative samples, site specific permit based monitoring requirements for determination of chlorine residual may be considered as a means to further assure safe water.