Water Security Agency

Saskatchewan Ministry of Environment

Municipal Drinking Water Quality Monitoring Guidelines

Edition 3
October 2012

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, 2002, and The Water Regulations, 2002 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. It is intended for use by individuals concerned with monitoring of municipal drinking water. The guidelines apply to waterworks regulated under *The Water Regulations, 2002*

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.

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

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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.

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 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:
- 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 1996, (sixth edition), 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; 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 & Background) Monitoring Requirements

Population	Groundwater Source	Surface Water and Blended 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. 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 Water Regulations, 2002* for all communities chlorinating their drinking water. Unless otherwise approved, 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.

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 33-2-e of Regs) 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 and Blended 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; 0.3 NTU surface water - membrane filtration; 3.0 NTU - slow sand or diatomaceous earth filtration; Groundwater - see permit value).

2.5 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.

2.6 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, 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. 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 not required.

2.7 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.

2.8 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 and Blended 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.		

2.9 Health and Toxicity

Iron, manganese, copper and zinc are usually in the general chemical classification, however they are included in the health and toxicity because this is the parameter grouping the Saskatchewan Research Council uses when analyzing preserved drinking water samples. 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.

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, arsenic, barium, boron, cadmium, chromium, lead, selenium, and uranium.

Lead may warrant special attention for problematic sites. Lead is a special situation as it may be introduced into the water via leaching from lead pipe services or plumbing systems.

Aluminum is not currently listed in the Guidelines for Canadian Drinking Water Quality, 1996, (sixth edition). 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.

Table 4: Health and Toxicity Monitoring Guidelines

Population	Groundwater Source	Surface Water and Blended 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, Arsenic, Barium, Boron, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Selenium, Uranium and Zinc		

2.10 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 and Blended Source
<5000	Nil	Nil
5001-25000	Annually	Annually
>25000	1 per 6 months	1 per 6 months

2.11 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 and Blended Source
<5000	Nil	Nil
5001-25000	Annually	Annually
>25000	1 per 6 months	1 per 6 months

2.12 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 and Blended 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.

2.13 Trihalomethanes (THM) 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 an annual 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. HAAs created during disinfection processes include monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid and dibromoacetic acid. If a community is currently experiencing THMs in excess of the MAC, waterworks owners should consider monitoring HAA levels. No <u>routine</u> monitoring for HAA's is required at the time of the composition of this document.

Table 8: Trihalomethane Monitoring Guidelines

Population	Groundwater Source	Surface Water and Blended Source
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

2.14 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 and Blended 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; 2,3,4,6 Tetrachlorophenol; Trichloroethylene; 2,4,6, Trichlorophenol; and Vinyl Chloride		

2.15 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 and Blended 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		

2.16 Benzo (a) Pyrene (BaP)

BaP is generated by the incomplete combustion of organic material and is generally associated with industrial atmospheric discharges and automobile exhaust. Surface water near industrialized areas is more susceptible to BaP contamination. The monitoring frequencies for BaP are outlined in Table 11.

Table 11: Benzo (a) Pyrene Monitoring Guidelines

Population	Groundwater Source	Surface Water and Blended Source
0-100	Nil	Nil
101-500	Nil	Nil
501-5000	Nil	Nil
5001-10000	1 every 3 years	1 every 2 years
>100000	Annually	Annually

2.17 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.

2.18 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. The monitoring guidelines for pesticides are shown in Table 12.

Table 12: Pesticides Monitoring Guidelines

Population	Groundwater Source	Surface Water and Blended 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, Pentachlorophenol (PCP), Picloram and Trifluralin (Treflan)		

2.19 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, radionuclide monitoring will be considered on a case-by-case basis based on the vulnerability of the water supply. No routine monitoring is required.

Water samples may be initially screened for radioactivity using gross alpha and gross beta activity determinations. 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 0.1 Bq/L and 1 Bq/L respectively, as these are lower than the strictest MACS.

2.20 Protozoa: *Giardia* and *Cryptosporidium*

Giardia and *Cryptosporidium* are very small protozoan organisms and when ingested can result in severe gastrointestinal illness. The establishment of Maximum Acceptable Concentrations for these protozoa in drinking water is not possible at this time as routine analytical methods available for the detection of cysts and oocysts suffer from low recovery rates. Additionally, present analytical methods do not provide any information on the viability or human infectivity of *Giardia* or *Cryptosporidium* cysts. Until better monitoring data and information on the viability and infectivity of cysts and oocysts present in drinking water is available, measures such as waterworks optimization and or wellhead protection should be implemented to reduce the risk waterborne disease outbreaks due to the passage or these organisms through the water treatment process. In general, water treatment technologies in place should achieve at least 3-log reduction in and/or inactivation of cysts and oocysts. No routine monitoring is required at the time of the composition of this document.

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 or independently owned distribution systems, where captured by Section 20 of *The Water 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, and 2.2 Chlorine Residual – On-Site and 2.13 Trihalomethanes. More than one monitoring schedule may be required for a pipeline system based on the location, complexity and number of branch pipelines.

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 2.19 inclusive.