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# Data Sources and Methods for the Freshwater Quality in Canadian Rivers Indicator

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## 1. Introduction

The [Freshwater Quality in Canadian Rivers](#) indicator is part of the [Canadian Environmental Sustainability Indicators](#) (CESI) program, which provides data and information to track Canada's performance on key environmental sustainability issues. This indicator is also used to measure progress towards the goals and targets of the [Federal Sustainable Development Strategy](#).

## 2. Description and rationale of the Freshwater Quality in Canadian Rivers indicator

### 2.1 Description

The Freshwater Quality in Canadian Rivers Indicator (WQI) is designed to provide an overall signal of the ability of ambient water in select rivers across Canada to support aquatic life. The data for the national and regional WQI is collected at a subset of monitoring sites across Canada (core sites) in 16 drainage regions where human activities result in a high potential of impaired water quality. It is a water-quality-guideline-driven tool used to distill large amounts of water quality data at a monitoring site into a single index.

Water quality at a monitoring site is considered excellent when ambient water quality never, or very rarely, exceeds guidelines for any selected parameters. When water quality is rated poor, water quality measurements usually exceed their guideline; exceedances at these sites may be large.

### 2.2 Rationale

Clean water is essential to sustain healthy ecosystems and the many benefits they provide us. The WQI provides a national perspective on the overall quality of freshwater for aquatic life in Canada. The WQI assumes that, if measured ambient water quality does not exceed its water quality guideline, it is acceptable for aquatic plants and animals. The WQI provides information about the state of surface freshwater quality and its change through time to inform water resource management.

### 2.3 Recent changes to the indicator

One core site in Ontario has been removed from the analysis because monitoring at that site ended in 2011.

## 3. Data

### 3.1 Data source

Water quality data for 2010 to 2012 were obtained from a number of monitoring programs managed by federal and provincial authorities, as well as by federal-provincial agreements, across the country. The complete list can be found in Annex 1.

Freshwater quality guidelines were obtained from the Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life, the United States Environmental Protection Agency (U.S. EPA), and provincial and territorial sources. A complete list of water quality guidelines used by each jurisdiction can be found in Annex 2.

Drainage regions used in the regional WQI correspond to those defined in Statistics Canada's Standard Drainage Area Classification.<sup>1</sup>

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<sup>1</sup> Statistics Canada (2003) [Standard Drainage Area Classification](#). Retrieved on 17 December, 2014.

The upstream drainage area of core monitoring sites was delineated using Natural Resources Canada's National Hydro Network.<sup>2</sup>

Human activity in the drainage basin of core monitoring sites was characterized using population density from Statistics Canada's 2006 Census of Population, mine locations using Natural Resources Canada's 2006 Census of Mines, point-source pollutant releases from industrial and commercial facilities using Environment Canada's 2007 National Pollutant Releases Inventory, agricultural activity locations using Statistics Canada's 2006 Census of Agriculture, and land cover using Natural Resources Canada's land cover maps.<sup>3,4</sup>

### 3.2 Spatial coverage

The national WQI is calculated using a set of core sites selected to be representative of surface freshwater quality across Canada where human pressure is greatest. The 2010–2012 national WQI was calculated using 172 core sites.

The local WQI is reported for the 172 core sites and 164 additional local sites across Canada for which 2010–2012 data are available. The number of core sites changes year to year because samples are sometimes missed or lost so the site does not have the minimum data required.

#### **Core site selection**

Among Canada's 25 drainage regions, 16 were selected, based on human population density, from the available water quality monitoring network to create the WQI core network (Figure 1). Within the 16 selected drainage regions, core sites were selected to ensure site drainage areas do not overlap and are thus independent of one another. For this analysis, the upstream drainage area of each monitoring site was delineated by Statistics Canada using the National Hydro Network.<sup>5</sup> Where upstream drainage areas of monitoring sites overlapped, the site furthest downstream was retained for the core network, as the downstream site is impacted by the maximum area in the river basin and, to some degree, reflects the cumulative impact of all upstream stresses. For 14 large rivers, including the Athabasca and North Saskatchewan rivers, core sites were established in the upper, mid and lower portions of the river as well as the most downstream sites on each tributary when available. Additional core sites were included on these rivers, because water travels thousands of kilometres from source to mouth. Water quality changes along the way and cannot be summarized by a unique downstream monitoring site. The final selection of core sites ensures monitoring sites are well distributed among provinces, territories and drainage regions.

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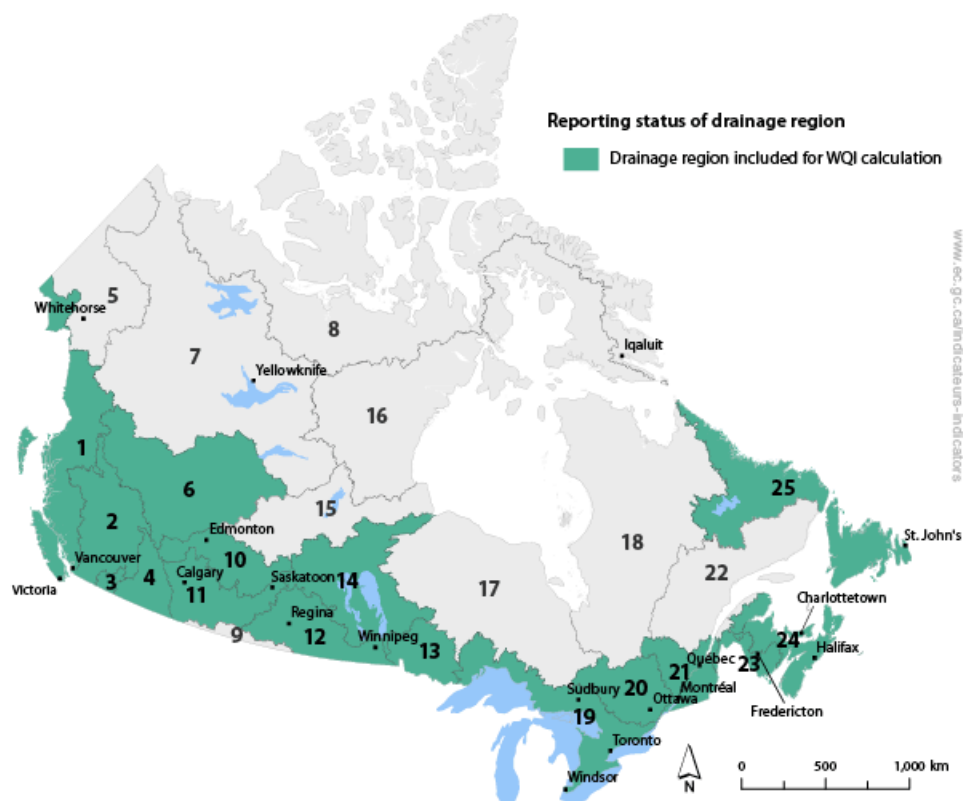
<sup>2</sup> Natural Resources Canada (2007) [National Hydro Network, Canada](#). Retrieved on 17 December, 2014.

<sup>3</sup> Natural Resources Canada (2005) [Multi-Temporal Land Cover Maps of Canada using NOAA AVHRR 1-km data from 1985-2005, 1st edition, Canada Centre for Remote Sensing](#). Retrieved on 17 December, 2014.

<sup>4</sup> Natural Resources Canada (2008) [Land Cover Map of Canada 2005, Canada Centre for Remote Sensing](#). Retrieved on 17 December, 2014.

<sup>5</sup> Henry M *et al.* (2009) Canadian Environmental Sustainability Indicators: Water Quality Index Representivity Report, Statistics Canada.

**Figure 1: Geographic extent of the 16 drainage regions selected for the core network**



- |                          |                               |                               |
|--------------------------|-------------------------------|-------------------------------|
| 1. Pacific Coastal       | 10. North Saskatchewan        | 19. Great Lakes               |
| 2. Fraser Lower–Mainland | 11. South Saskatchewan        | 20. Ottawa                    |
| 3. Okanagan–Similkameen  | 12. Assiniboine–Red           | 21. St. Lawrence              |
| 4. Columbia              | 13. Winnipeg                  | 22. North Shore–Gaspé         |
| 5. Yukon                 | 14. Lower Saskatchewan–Nelson | 23. Saint John–St. Croix      |
| 6. Peace–Athabasca       | 15. Churchill                 | 24. Maritime Coastal          |
| 7. Lower Mackenzie       | 16. Keewatin–Southern Baffin  | 25. Newfoundland and Labrador |
| 8. Arctic Coast–Islands  | 17. Northern Ontario          |                               |
| 9. Missouri              | 18. Northern Quebec           |                               |

Water quality was also assessed at monitoring sites (local sites) not included in the core network. Information on water quality at individual core and local sites can be found in the [interactive freshwater quality map](#).

### 3.3 Temporal coverage

The WQI was calculated using a minimum of four samples per year from 2010 to 2012 for the majority of sites. A minimum of three samples per year is allowed for northern and remote sites because winter access can be difficult. A sensitivity analysis concluded no significant difference existed in the water quality index score when the mid-winter sample was excluded.<sup>6</sup> Three years of data are used to dampen temporal variability in WQI results caused by annual fluctuations in

<sup>6</sup> Statistics Canada (2007) [Behaviour Study on the Water Quality Index of the Canadian Council of Ministers of the Environment](#). Retrieved on 17 December, 2014.

weather and hydrology.<sup>7</sup> By using a three-year roll-up, the WQI is more representative of the overall freshwater quality at a site. It minimizes the effects of events, such as high or low flow, by avoiding one sample driving the WQI score up or down.

Minimum sampling requirements were not met at 12 core sites: eight in Manitoba, two in Newfoundland Labrador, one in Saskatchewan, and one in New Brunswick. The sites are remote, making sampling during the winter months difficult, dangerous and costly. These sites, however, were closely evaluated by local water quality experts and were included because the data were consistent with previous years and were considered representative of local water quality.

Sample timing and frequency varies among monitoring sites and is set according to the monitoring program objectives. There are up to 56 samples for a given parameter at some sites.

### 3.4 Data completeness

Data quality assurance/quality control (QA/QC) is performed within each monitoring program providing data for the WQI. Each monitoring program follows standardized methods for sample collection in the field. Chemical analyses are performed in Canadian laboratories accredited by the Canadian Association for Laboratory Accreditation or the Standards Council of Canada.

The data undergo an additional QA/QC process by Environment Canada to ensure the dataset meets minimum data requirements and that standards for calculation are respected. This process leads to removal of parameters due to low sampling frequencies or because detection limits are higher than guidelines used in the calculation. Unusually high or low values in the monitoring datasets are double-checked and confirmed through consultation with the data provider. WQI scores and site information from the monitoring programs are stored in a central WQI dictionary, which facilitates the verification of the number of samples, sample timing and the location of monitoring sites, and calculations.

### 3.5 Data timeliness

The WQI was calculated using data from 2010 to 2012, the most recent data available from all monitoring programs. For 10 core sites, data from late December 2009 or early January 2013 were used to meet requirements for minimum number of samples.

## 4. Methods

### 4.1 Computing the Water Quality Index

The Freshwater Quality in Canadian Rivers Indicator (WQI) is calculated using the Water Quality Index as endorsed by the Canadian Council of Ministers of the Environment (CCME).<sup>8</sup> The CCME Water Quality Index consists of three factors: scope, frequency and amplitude (Equation 1).<sup>9</sup> Scope ( $F_1$ ) refers to the percentage of parameters where water quality guidelines are not met; frequency ( $F_2$ ) refers to the percentage of samples where water quality guidelines are not met; and amplitude ( $F_3$ ) refers to the amount by which the water quality guidelines are not met. The score is normalized to produce a score between 1 and 100.

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<sup>7</sup> Government of Canada (2008) [Technical guidance document for Water Quality Indicator practitioners reporting under the Canadian Environmental Sustainability Indicators \(CESI\) initiative 2008, p.15-16](#). Retrieved on 17 December, 2014.

<sup>8</sup> Canadian Council of Ministers of the Environment (2001) [CCME Water Quality Index 1.0 User's Manual](#). (PDF; 84.3 KB) Retrieved on 17 December, 2014.

<sup>9</sup> Canadian Council of Ministers of the Environment (2001) [CCME Water Quality Index 1.0 Technical Report](#). (PDF; 1.40 MB) Retrieved on 17 December, 2014.

$$\text{CCME Water Quality Index} = 100 - \left( \frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732} \right) \quad (\text{Equation 1})$$

Scores are grouped into five categories based on the best available information, expert judgment and the general public's expectations of water quality (Table 1).<sup>10</sup> The WQI adopts the CCME's Water Quality Index categorization.

**Table 1: Score rankings for the CCME Water Quality Index**

<b>Ranking</b>	<b>Interpretation</b>
Excellent (95.0 to 100.0)	Water quality measurements never or very rarely exceed water quality guidelines.
Good (80.0 to 94.9)	Water quality measurements rarely exceed water quality guidelines and, if they do, it is usually by a narrow margin.
Fair (65.0 to 79.9)	Water quality measurements sometimes exceed water quality guidelines and may do so by a wide margin.
Marginal (45.0 to 64.9)	Water quality measurements often exceed water quality guidelines and/or exceed the guidelines by a considerable margin.
Poor (0 to 44.9)	Water quality measurements usually exceed water quality guidelines and/or exceed the guidelines by a considerable margin.

## 4.2 Parameter selection

Provincial and territorial water quality experts select parameters, or chemical substances and physical properties, to be assessed based on knowledge of local water quality stressors. A selection of 8 to 12 parameters per monitoring site is recommended to ensure comparability and consistency in a parameter's relative influence on the final WQI ranking.<sup>11</sup> Typically, at least one form of the following parameters groups is reported at each monitoring site: nutrients (e.g., phosphorus, nitrate, nitrite, total nitrogen), metals (e.g., zinc, copper, lead), physico-chemical parameters (e.g., pH, turbidity) and two to four regionally specific parameters (e.g., chloride, ammonia, dissolved oxygen, pesticides).<sup>12</sup> In calculating the WQI, between 5 and 15 parameters are used to assess water quality at each monitoring site. A sample value must be available for

<sup>10</sup> Canadian Council of Ministers of the Environment (2001) [CCME Water Quality Index 1.0 Technical Report](#). (PDF; 1.40 MB) Retrieved on 17 December, 2014.

<sup>11</sup> Canadian Council of Ministers of the Environment (2006) [A sensitivity analysis of the Canadian Water Quality Index](#). (PDF; 515 KB) Retrieved on 17 December, 2014.

<sup>12</sup> British Columbia Ministry of Environment (1997) [Methods for deriving site-specific water quality objectives in British Columbia and Yukon](#). Retrieved on 17 December, 2014.



each year for at least 33% of the total number of samples in order for a parameter to be included in the WQI.

For all monitoring programs, except British Columbia and Yukon, a common suite of parameters is assessed at all sites with site-specific parameters added as required. In British Columbia and Yukon, parameters are chosen on a site-specific basis. Dissolved oxygen, phosphorus, pH, nitrogen and water temperature are included at these sites when available, along with other site-specific parameters. Annex 2 lists all parameters used by each province and territory to calculate the WQI. The [interactive freshwater quality map](#) lists parameters at each individual site.

In British Columbia and Yukon, metals data may be excluded from the indicator dataset when samples are collected during periods of high turbidity. In these two jurisdictions, metals data are discarded from the indicator calculations during high-turbidity events on the basis that these occurrences of short-term exposure pose low risk to aquatic life. For these sites, the turbidity cut-off is assessed based on long-term monitoring data to take into consideration conditions at the site. A turbidity cut-off is calculated using a regression analysis of long-term turbidity and metal data for that site. Trimming data based on high-turbidity events also improves the correlation between the WQI and indices of benthic community composition, improving the assessment of risk to aquatic life.<sup>13</sup>

### 4.3 Water quality guideline selection

Water quality guidelines for the protection of aquatic life are recommended numerical limits or narrative statements for a variety of chemical substances and physical parameters, which, if exceeded, may impair aquatic life. They are based on existing knowledge of a substance's environmental fate and behaviour and its chronic or acute toxicity. The WQI uses chronic water quality guidelines for the protection of aquatic life. Quebec uses acute water quality guidelines for metals.

Water quality guidelines are selected to be locally relevant and different water quality guidelines are used among and within provinces and territories. The Canadian Water Quality Guidelines for the Protection of Aquatic Life developed by the CCME are recommended if locally relevant.<sup>14</sup> Other sources of guidelines include the United States Environmental Protection Agency (U.S. EPA) or provincial or territorial environment departments. Provincial or territorial water quality experts select the guidelines to use in the WQI. Annex 2 provides a complete list of guidelines used by provinces and territories and their source.

Background concentrations of naturally-occurring substances and other local river characteristics can affect the measured concentration and toxicity of certain substances. In these cases, site-specific guidelines (SSG) are developed using procedures based on background concentrations<sup>15</sup> or a rapid assessment approach.<sup>16</sup> The rapid assessment approach uses long-term monitoring data and corrects for natural events, such as high flows, that may influence results.

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<sup>13</sup> Canadian Council of Ministers of the Environment (2009) [Reducing the Sensitivity of the Water Quality Index to Episodic Events](#). (PDF; 2.78 MB) Retrieved on 17 December, 2014.

<sup>14</sup> Canadian Council of Ministers of the Environment (undated) [Canadian Water Quality Guidelines for the Protection of Aquatic Life](#). Retrieved on 17 December, 2014. For a complete list of guidelines, consult the Factsheets section of the website.

<sup>15</sup> Canadian Council of Ministers of the Environment (2003) [Guidance on the Site-Specific Application of Water Quality Guidelines in Canada: Procedures for Deriving Numerical Water Quality Objectives](#). (PDF; 1.25 MB) Retrieved on 17 December, 2014.

<sup>16</sup> Government of Canada (2008) [Technical guidance document for Water Quality Indicator practitioners reporting under the Canadian Environmental Sustainability Indicators \(CESI\) initiative 2008](#). Retrieved on 17 December, 2014.

#### 4.4 Classification of sites according to human activity

The drainage area of each monitoring site was delineated using the National Hydro Network.<sup>17</sup> Human activity was assessed in the drainage area of core sites and classified according to the criteria presented in Table 2. Data sources are detailed in section 3.1. Agricultural land cover corresponds to land cover classes 26, 27, 28 and 29. Undisturbed land cover corresponds to land cover classes 0, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 30, 31, 32, 33 and 38. A full description of land cover classes is available in the land cover database of Canada.<sup>18</sup> Land use in the drainage area of 16 core sites in Newfoundland and Labrador and Quebec was defined by the organization responsible for the monitoring program based on local knowledge of the drainage area. Land use for two sites in British Columbia was not classified because they are trans-boundary sites and the U.S. portion of the sites' catchment is difficult to classify.

**Table 2: Criteria for the classification of human activity at monitoring sites**

Land use	Criteria
Agriculture	> 20% of drainage area is agricultural land cover
Mining	Presence of at least one mine
Mixed pressures	Agriculture and mining OR Agriculture and population density > 25 persons/km <sup>2</sup> OR Mining and population density > 50 persons/km <sup>2</sup>
Undeveloped	> 95% of drainage area is undisturbed land cover

To evaluate if land use had a significant effect on the WQI score, a chi-square test of independence was performed. The poor and marginal categories and good and excellent categories were grouped for this test to produce adequate sample sizes. The relationship between water quality categories and land use was statistically significant (Chi-squared value ( $\chi^2$ ) = 43.1, degrees of freedom (df) = 6, probability (P) < 0.001).

#### 4.5 Addressing changes in the indicator through time

A subset of 100 sites from 16 drainage regions was selected from the core network to assess changes in the WQI through time. This subset corresponds to all core sites with data available from 2003 to 2012. Changes in water quality were measured by assessing change between the 2003–2005 and 2010–2012 reporting periods. The 2003–2005 period was selected as the starting point of the change analysis as it was the first period with sufficient data available for the analysis.

For this analysis, WQI scores for 2003–2005 to 2009–2011 were recalculated, when necessary, using parameters and guidelines used in the 2010–2012 WQI calculations. Guidelines and parameter selection have evolved over time. Harmonizing parameters and guidelines avoids mistaking methodological changes for water quality change. When historical data were missing

<sup>17</sup> Henry M *et al.* (2009) Canadian Environmental Sustainability Indicators: Water Quality Index Representivity Report, Statistics Canada.

<sup>18</sup> Natural Resources Canada (2008) [Land Cover Map of Canada 2005, Canada Centre for Remote Sensing](#). Retrieved on 17 December, 2014.

for a parameter, the parameter was dropped from the calculation of the score for all periods. In one case, there has been a change in the analytical form of a parameter; in 2012, Quebec began reporting un-ionized ammonia instead of dissolved ammonia. The ammonia data in the older data set were left as dissolved ammonia for this analysis because there is no way to convert between the two forms.

Confidence intervals were computed for freshwater quality scores using a non-parametric bootstrapping method.<sup>19</sup> To compute the confidence interval for a given site, a simulation of 10 000 scores was performed. For each iteration, the parameter suite measured for a given date is resampled randomly from all measurements taken from the same site and a simulated score is calculated. The confidence interval corresponds to the 95<sup>th</sup> percentile of the distribution of simulated scores.

A change in the WQI was considered significant at a site when no overlap existed between confidence intervals for 2003–2005 and 2010–2012 scores. A count of sites with improving, deteriorating and no trend detected in the WQI was compiled for the indicator of change through time.

## 5. Caveats and limitations

The ability of the Freshwater Quality in Canadian Rivers Indicator (WQI) to provide information about freshwater quality relies in large part on the suitability of water quality guidelines. Freshwater quality guidelines are derived from laboratory data that do not consider the impact of flow on sediment loads in a river. Although site-specific guidelines attempt to remove the impact of elevated flows on parameter concentrations, elevated levels of naturally-occurring substances, such as minerals, nutrients, glacier deposits and soils, can lower water quality ratings.

The WQI does not directly measure biological integrity; it measures whether physical and chemical characteristics of freshwaters are acceptable for aquatic life. Although physical and chemical measurements provide good proxies of biological quality, only biological information provides a direct measurement of conditions for aquatic life.

The WQI only assesses the quality of surface waters. Groundwater is not considered in this indicator.

The WQI reflects the overall state of water quality and does not show the impact of spills or other transient events unless these are frequent or long-lasting.

The selection of core sites is intended to represent freshwater quality in the portion of Canada where the majority of Canadians live. Monitoring sites used to calculate this indicator do not cover all potential water quality issues in Canada. Northern Canada is under-represented in the WQI.

The WQI allows flexibility in the selection of parameters and guidelines. This flexibility allows local and regional water quality concerns to be reflected in the indicator. As a result, it can be difficult to compare WQI scores among sites; the WQI categories assigned based on the scores, however, are comparable.

Analytical limitations and time requirements for the development of water quality guidelines affect the selection of parameters. Only parameters for which water quality guidelines exist can be included in the indicator. However, the absence of a water quality guideline for a parameter does not mean the parameter is unimportant.

The WQI scores are sensitive to the number of parameters and samples used in their calculation. The number of parameters varies from 5 to 15 depending on the monitoring site, and between 9

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<sup>19</sup> El Shaarawi AM (2011) Environmental Indicators: Their development and Application. Environment Canada.

and 60 samples can be used for a given parameter. In general, as the number of parameters, or samples, used to calculate the index increases, the score decreases because there is a greater chance of a guideline exceedance.<sup>20</sup>

The change-through-time analysis includes 100 sites. It does not have the same representativeness of Canadian surface water quality as the national indicator because many core sites began sampling after 2003.

Freshwater quality varies naturally with precipitation levels. Although the WQI uses a three-year rolling average to dampen the influence of rain and snowfall on the WQI score, care must be taken in comparing one period to another. Long-term trend analysis is considered to be more meaningful than a simple year-to-year comparison.

## 6. References

British Columbia Ministry of Environment (1997) [Methods for deriving site-specific water quality objectives in British Columbia and Yukon](#). Retrieved on 17 December, 2014.

Canadian Council of Ministers of the Environment (undated) [Canadian Water Quality Guidelines for the Protection of Aquatic Life](#). Retrieved on 17 December, 2014. For a complete list of guidelines, consult the Factsheets section of the website.

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<sup>20</sup> Painter S and Waltho J (2004) Canadian Water Quality Index: A Sensitivity Analysis. Environment Canada.

Natural Resources Canada (2005) [Multi-Temporal Land Cover Maps of Canada using NOAA AVHRR 1-km data from 1985-2005, 1st edition, Canada Centre for Remote Sensing](#). Retrieved on 17 December, 2014.

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Statistics Canada (2009) [Standard Drainage Area Classification \(SDAC\) 2003](#). Retrieved on 17 December, 2014.

## Annex 1: Monitoring programs providing data on ambient water quality

Province/ territory	Monitoring program	Organization(s)
All Canada	Federal Water Quality Monitoring and Surveillance Division (WQMSD) network (NWT, YK, BC, AB, SK, MB, ON, QC, NB, NS, NL, PEI – transboundary and interprovincial monitoring sites, federal lands)	Environment Canada
Alberta	Long-term River Network monitoring program	Alberta Environment and Sustainable Resource Development
British Columbia	Canada–British Columbia Water Quality Monitoring Agreement	British Columbia Ministry of Environment, WQMSD Environment Canada
Manitoba	Ambient water quality monitoring network	Manitoba Water Stewardship
New Brunswick	Canada–New Brunswick Water Quality Monitoring Agreement	WQMSD Environment Canada, New Brunswick Department of Environment
New Brunswick	Long-range Transport of Atmospheric Pollutants Program	WQMSD Environment Canada
New Brunswick	Surface water monitoring network, National Parks project	New Brunswick Department of Environment and local government
Newfoundland and Labrador	Canada–Newfoundland and Labrador Water Quality Monitoring Agreement	WQMSD Environment Canada, Newfoundland and Labrador Department of Environment and Conservation
Nova Scotia	Long-range Transport of Atmospheric Pollutants Program	WQMSD Environment Canada
Nova Scotia	Nova Scotia Automated Surface Water Quality Monitoring Network	Nova Scotia Environment
Ontario	Provincial Water Quality Monitoring Network with the Conservation Authorities	Ontario Ministry of the Environment and Climate Change
Prince Edward Island	Canada–Prince Edward Island Water Quality Agreement	WQMSD Environment Canada, Prince Edward Island Department of Environment, Energy and

Province/ territory	Monitoring program	Organization(s)
		Forestry
Quebec	Canada–Quebec Water Quality Agreement	WQMSD Environment Canada, Ministère du Développement durable, Environnement et Lutte contre les changements climatiques du Québec
Quebec	Réseau-Rivières	Ministère du Développement durable, Environnement et Lutte contre les changements climatiques du Québec
Saskatchewan	Saskatchewan Ministry of Environment Surface Water Quality Monitoring Program	Saskatchewan Ministry of Environment
Northwest Territories and Nunavut	Parks Canada Western Arctic Parks water quality monitoring program (Aulavik & Tuktoyaktuk); Environment Canada-Parks Canada water quality monitoring program in Eastern Arctic Parks (Quttinirpaaq & Auyuittuq); Environment Canada-Parks Canada water quality monitoring program in Nahanni National Park; Government of Northwest Territories water quality programs in the Northwest Territories basins (Coppermine, Yellowknife, Lockhart, Slave, Hay, Liard, Peel, Snare, Burnside River basins)	WQMSD Environment Canada, Parks Canada, Government of Northwest Territories (Environment and Natural Resources)
Yukon	Canada-Yukon Water Quality Monitoring Network; Parks Canada Western Arctic Parks water quality monitoring program (Ivvavik National Park)	Yukon Environment, WQMSD Environment Canada, Parks Canada

## Annex 2: Water quality guidelines used by each province and territory

Abbreviations used in the following tables:

- 2,4-dichlorophenoxyacetic acid (2,4-D)
- 2-methyl-4-chlorophenoxyacetic acid (MCPA)
- calcium carbonate (CaCO<sub>3</sub>)
- hexavalent chromium (Cr(VI))
- litre (L)
- micrograms (µg)
- milligrams (mg)
- nephelometric turbidity units (NTU)
- nitrogen (N)
- site-specific guidelines (SSG)

### Water quality guidelines used by Alberta

Parameter	Form	Guideline	Source
2,4-D <sup>[A]</sup>	total	4 µg/L	1
Aluminium <sup>[A]</sup>	dissolved	0.005 mg/L for pH < 6.5 0.1 mg/L for pH ≥ 6.5	1
Ammonia	un-ionized	19 µg/L	1
Arsenic	total	5 µg/L	1
Cadmium <sup>[A]</sup>	total	$e^{1.0166 \cdot \ln[\text{hardness}] - 3.924}$ µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	3
Chloride <sup>[B]</sup>	dissolved	120 mg/L	1
Copper <sup>[A]</sup>	total	7 µg/L	4
Copper <sup>[B]</sup>	total	2 µg/L for hardness < 90 mg [CaCO <sub>3</sub> ]/L $0.2 \cdot e^{0.8545 \cdot \ln[\text{hardness}] - 1.465}$ µg/L for hardness > 90 mg [CaCO <sub>3</sub> ]/L	2
Lead	total	$< e^{1.273 \cdot \ln[\text{hardness}] - 4.705}$ µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	4
MCPA <sup>[A]</sup>		2.6 µg/L	1
Mercury <sup>[A]</sup>	total inorganic	0.026 µg/L	1
Nickel <sup>[B]</sup>	total	$e^{0.76 \cdot \ln[\text{hardness}] + 1.06}$ µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	2
Nitrogen	total	1 mg N/L	4



Parameter	Form	Guideline	Source
Oxygen	dissolved	6.5 mg/L	1 4
pH <sup>[B]</sup>		between 6.5 and 9	1
Phosphorus	total	0.05 mg/L	4 5
Selenium <sup>[A]</sup>	total	2 µg/L	2
Zinc	total	7.5 µg/L for hardness ≤ 90 mg [CaCO <sub>3</sub> ]/L 7.5 + 0.75*(hardness-90) for hardness > 90 mg [CaCO <sub>3</sub> ]/L	2

<sup>A</sup> Applies to sites monitored under provincial monitoring programs.

<sup>B</sup> Applies to sites monitored under federal monitoring programs, including the Prairie Provinces Water Board.

#### Alberta Water Quality Guideline Sources:

- 1 Canadian Council of Ministers of the Environment (2007) [Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1](#). Retrieved on 17 December, 2014.
- 2 Government of Canada (2008) [Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators \(CESI\) initiative 2008](#). Environment Canada and Statistics Canada. Retrieved on 17 December, 2014.
- 3 United States Environmental Protection Agency (2001) [2001 Update of Ambient Water Quality Criteria for Cadmium. Document EPA 822-R-01-001](#). Retrieved on 17 December, 2014.
- 4 Alberta Environment (1999) [Surface water quality guidelines for use in Alberta](#). (PDF; 134 KB) Retrieved on 17 December, 2014.
- 5 Prairie Provinces Water Board (1992) [Master Agreement on Apportionment. Schedule E: Agreement on Water Quality](#). Retrieved on 17 December, 2014.

### Water quality guidelines used by British Columbia

Parameter	Form	Guideline	Source
Alkalinity		20 mg [CaCO <sub>3</sub> ]/L	1
Arsenic	total	5 µg/L	2
Cadmium	total	$10^{(0.83(\log_{10}[\text{hardness}]) - 2.46)}$ µg/L for hardness > 50 mg [CaCO <sub>3</sub> ]/L	2
		0.09 µg/L for hardness < 50 mg [CaCO <sub>3</sub> ]/L	3
		SSG <sup>[A]</sup> (certain sites)	
Chloride	total dissolved	120 mg/L	2
Chromium	total	SSG <sup>[A]</sup>	1
			3
			5
			6
			7
			9
			10
			12
Copper	total	2 µg/L for hardness < 90 mg [CaCO <sub>3</sub> ]/L $0.2 * e^{0.8545 * \ln[\text{hardness}] - 1.465}$ µg/L for hardness > 90 mg [CaCO <sub>3</sub> ]/L SSG <sup>[A]</sup>	4
			5
			10
			12
			13
			14
Cyanide	weak acid dissociable	5 µg/L	2
Fluoride	total	0.3 mg/L (BC08NM001) 0.35 mg/L (BC08NN0021)	15
Iron	total	0.3 mg/L	4
Lead	total	1 µg/L for hardness < 50 mg [CaCO <sub>3</sub> ]/L	4
		$e^{1.273 * \ln[\text{hardness}] - 4.705}$ µg/L for hardness > 50 mg [CaCO <sub>3</sub> ]/L	16
		SSG <sup>[A]</sup>	
Manganese	total dissolved	SSG <sup>[A]</sup>	11

Parameter	Form	Guideline	Source
			17
Molybdenum	total	73 µg/L	2 18
Nickel	total	$e^{0.76 \cdot \ln[\text{hardness}] + 1.06}$ µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	4
Nitrate	total dissolved	2.93 mg N/L	4
Nitrite	total	0.02 mg N/L	19
Nitrogen	total, total dissolved	0.7 mg/L	19
Oxygen	dissolved	SSG <sup>[A]</sup>	2 20 21
pH		SSG <sup>[A]</sup>	2 3 13 20
Phosphorus	total and total dissolved	0.025 mg/L	4 22
Selenium	total dissolved	2 µg/L	4 23
Silver	total	0.05 µg/L for hardness < 100 mg [CaCO <sub>3</sub> ]/L 1.9 µg/L for hardness > 100 mg [CaCO <sub>3</sub> ]/L SSG <sup>[A]</sup>	4 24
Sulphate	dissolved	50 mg/L	25
Temperature		SSG <sup>[A]</sup>	26
Thallium	total	0.8 µg/L	2
Uranium	total	10 µg/L	1
Zinc	total	7.5 µg/L	3 5 10 11

Parameter	Form	Guideline	Source
			27

<sup>A</sup> SSG denotes that different site-specific guidelines or formulas were used at sites. For details on the derivation of site-specific guidelines, consult BCMOE (1997).<sup>28</sup>

### British Columbia Water Quality Guideline Sources:

- 1 British Columbia Ministry of Environment (2006) [A compendium of working water quality guidelines for British Columbia](#). Retrieved on 17 December, 2014.
- 2 Canadian Council of Ministers of the Environment (2007) [Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1](#). Retrieved on 17 December, 2014.
- 3 Butcher GA (1992) [Lower Columbia River, Hugh Keeleyside dam to Birchbank water quality assessment and objectives: Technical appendix](#). British Columbia Ministry of the Environment, Lands and Parks. (PDF; 9.87 MB) Retrieved on 17 December, 2014.
- 4 Government of Canada (2008) [Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators \(CESI\) initiative 2008](#). Environment Canada and Statistics Canada. Retrieved on 17 December, 2014.
- 5 British Columbia Ministry of Environment (2000) [Ambient water quality assessment and objectives for the Lower Columbia River: Birchbank to the US border](#). Retrieved on 17 December, 2014.
- 6 Environment Canada (2005) Site-specific water quality guidelines for the Beaver River at Park Gate Highway 1 for the purpose of national reporting. Tri-Star Environmental Consulting.
- 7 Environment Canada (2005) Site-specific Water Quality Guidelines for the Kicking Horse River above Field, BC for the purpose of national reporting. Tri-Star Environmental Consulting.
- 8 Environment Canada (2005) [Site-specific Water Quality Guidelines for the Kootenay River at Kootenay Crossing for the purpose of national reporting](#). (PDF; 591 KB) Tri-Star Environmental Consulting. Retrieved on 17 December, 2014.
- 9 Environment Canada (2005) [Site-specific Water Quality Guidelines for the Liard River at Upper Crossing for the Purpose of National Reporting](#). (PDF; 444 KB) Tri-Star Environmental Consulting. Retrieved on 17 December, 2014.
- 10 Environment Canada (2005) [Site-specific Water Quality Guidelines for the Skeena River at Usk for the purpose of national reporting](#). (PDF; 709 KB) Tri-Star Environmental Consulting. Retrieved on 17 December, 2014.
- 11 Swain LG (1990) [Okanagan area, Similkameen River sub-basin water quality assessment and objectives](#). British Columbia Ministry of Environment. Retrieved on 17 December, 2014.
- 12 British Columbia Ministry of Environment (1987) [Water quality criteria for copper: Overview report](#). Retrieved on 17 December, 2014.

- 13 British Columbia Ministry of Water, Land and Air Protection (1997) [Water quality assessment and objectives for the Fraser River from Moose Lake to Hope](#). (PDF; 12.5 MB) Retrieved on 17 December, 2014.
- 14 British Columbia Ministry of Water, Land and Air Protection (2004) Water quality assessment and objectives for the Elk River for the purpose of national reporting.
- 15 Warrington PD (1995) [Ambient water quality criteria for fluoride](#). British Columbia Ministry of Environment. Retrieved on 17 December, 2014.
- 16 British Columbia Ministry of Environment (1987) [Water quality criteria for lead: Overview report](#). Retrieved on 17 December, 2014.
- 17 Nagpal NK (2001) [Ambient water quality guidelines for manganese: Overview report](#). British Columbia Ministry of Environment. Retrieved on 17 December, 2014.
- 18 Environment Canada (2005) [Site-specific Water Quality Guidelines for the Sumas River at the international boundary for the purpose of national reporting](#). (PDF; 414 KB) Tri-Star Environmental Consulting. Retrieved on 17 December, 2014.
- 19 Nordin RN and Pommen LW (2001) [Water quality criteria for nitrogen \(nitrate, nitrite, and ammonia\): Overview report](#). British Columbia Ministry of Environment and Parks. Retrieved on 17 December, 2014.
- 20 British Columbia Ministry of Water, Land and Air Protection (1998) [Water quality assessment and recommended objectives for the Salmon River](#). MacDonald Environmental Sciences Ltd. Retrieved on 17 December, 2014.
- 21 Swain LG (1987) [Takla-Nechako areas, Nechako River water quality assessment and objectives](#). British Columbia Ministry of Environment and Parks. Retrieved on 17 December, 2014.
- 22 Ontario Ministry of the Environment and Energy (1994) [Water management policies, guidelines, provincial water quality objectives](#). Retrieved on 17 December, 2014.
- 23 Nagpal NK (2001) [Ambient water quality guidelines for selenium](#). British Columbia Ministry of Environment. Retrieved on 17 December, 2014.
- 24 British Columbia Ministry of Environment (1996) [Ambient water quality criteria for silver](#). Retrieved on 17 December, 2014.
- 25 British Columbia Ministry of Environment (2000) [Ambient water quality guidelines for sulphate: Overview report](#). Retrieved on 17 December, 2014.
- 26 British Columbia Ministry of Environment (2001) [Water quality guidelines for temperature: Overview report](#). Retrieved on 17 December, 2014.
- 27 British Columbia Ministry of Environment (1999) [Ambient water quality guidelines for zinc: Overview report](#). Retrieved on 17 December, 2014.
- 28 British Columbia Ministry of Environment (1997) [Methods for deriving site-specific water quality objectives in British Columbia and Yukon](#). Retrieved on 17 December, 2014.

**Water quality guidelines used by Manitoba**

<b>Parameter</b>	<b>Form</b>	<b>Guideline</b>	<b>Source</b>
2,4-D		4 µg/L	1
Ammonia <sup>[A]</sup>	total as N	Calculation based on pH and temperature	2 3
Ammonia <sup>[B]</sup>	un-ionized	19 µg/L	4
Arsenic <sup>[A]</sup>	extractable, total	150 µg/L	5
Arsenic <sup>[B]</sup>	total	5 µg/L	1
Cadmium <sup>[A]</sup>	extractable, total	$[e^{0.7409 \cdot \ln[\text{hardness}] - 4.719}] \cdot [1.101672 - \{\ln[\text{hardness}](0.041838)\}]$ µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	6
Chloride <sup>[B]</sup>	dissolved	120 mg/L	1
Copper <sup>[A]</sup>	extractable, total	$[e^{0.8545 \cdot \ln[\text{hardness}] - 1.702}] \cdot (0.96)$ µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	2
Copper <sup>[B]</sup>	total	2 µg/L for hardness < 90 mg [CaCO <sub>3</sub> ]/L 0.2 * $[e^{0.8545 \cdot \ln[\text{hardness}] - 1.465}]$ µg/L for hardness > 90 mg [CaCO <sub>3</sub> ]/L	4
Iron <sup>[A]</sup>	total	0.3 mg/L	4
Lead	extractable, total	$e^{1.273 \cdot \ln[\text{hardness}] - 4.705} \cdot 1.46203 - \ln[\text{hardness}] \cdot 0.145712$ µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	4
MCPA		2.6 µg/L	1
Nickel <sup>[A]</sup>	extractable, total	$e^{0.8460 \cdot \ln[\text{hardness}] + 0.0584 \cdot 0.997}$ µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	5
Nickel <sup>[B]</sup>	total	$< e^{0.76 \cdot \ln[\text{hardness}] + 1.06}$ µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	4
Nitrate <sup>[A]</sup>	total dissolved	2.9 mg N/L	4
Nitrogen <sup>[B]</sup>	total	1 mg N/L	7
Oxygen <sup>[A]</sup>	dissolved	5 mg/L	4

Parameter	Form	Guideline	Source
Oxygen <sup>[B]</sup>	dissolved	6.5 mg/L	1
pH		between 6.5 and 9	1
Phosphorus	total	0.05 mg/L	2 7
Suspended sediments <sup>[A]</sup>	total	Maximum increase of 25 mg/L for high flow and turbid waters above background levels	4
Zinc <sup>[A]</sup>	total	$e^{(0.8473 \cdot \ln[\text{hardness}] + 0.884)} \cdot 0.986 \mu\text{g/L}$ where hardness is measured as mg [CaCO <sub>3</sub> ]/L	2 6
Zinc <sup>[B]</sup>	total	7.5 µg/L for hardness ≤ 90 mg [CaCO <sub>3</sub> ]/L 7.5 + 0.75*(hardness-90) for hardness > 90 mg [CaCO <sub>3</sub> ]/L	4

<sup>A</sup> Applies to sites monitored under provincial monitoring programs.

<sup>B</sup> Applies to sites monitored under federal monitoring programs (Prairie Provinces Water Board).

#### Manitoba Water Quality Guideline Sources:

- 1 Canadian Council of Ministers of the Environment (2007) [Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1](#). Retrieved on 17 December, 2014.
- 2 Manitoba Water Stewardship (2011) [Manitoba water quality standards, objectives, and guidelines](#). (PDF; 905 KB) Retrieved on 17 December, 2014.
- 3 United States Environmental Protection Agency (1999a) [Update of Ambient Water Quality Criteria for Ammonia. Document EPA 822-R-99-014](#). (PDF; 790 KB) Retrieved on 17 December, 2014.
- 4 Government of Canada (2008) [Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators \(CESI\) initiative 2008](#). Environment Canada and Statistics Canada. Retrieved on 17 December, 2014.
- 5 United States Environmental Protection Agency (2009) [National Recommended Water Quality Criteria](#). Retrieved on 17 December, 2014.
- 6 United States Environmental Protection Agency (1999b) [National recommended water quality criteria – correction. Document EPA 822-Z-99-001](#). (PDF; 340 KB) Retrieved on 17 December, 2014.
- 7 Prairie Provinces Water Board (1992) [Master Agreement on Apportionment. Schedule E: Agreement on Water Quality](#). Retrieved on 17 December, 2014.

### Water quality guidelines used by New Brunswick

Parameter	Form	Guideline	Source
Ammonia	un-ionized	19 µg/L	1
Arsenic	total	5 µg/L	2
Chloride	total	120 mg/L	2
Copper	total	2 µg/L for hardness < 90 mg [CaCO <sub>3</sub> ]/L 0.2*e <sup>0.8545*ln[hardness]-1.465</sup> µg/L for hardness > 90 mg [CaCO <sub>3</sub> ]/L	1
Iron	total	0.3 mg/L	1
Nitrate	total	2.9 mg N/L	1
Oxygen	dissolved	6.5 mg/L	2
pH		between 6.5 and 9	2
Phosphorus	total	0.03 mg/L	1
Turbidity		10 NTU (SSG <sup>[A]</sup> )	2
Zinc	total	7.5 µg/L for hardness ≤ 90 mg [CaCO <sub>3</sub> ]/L 7.5 + 0.75*(hardness-90) for hardness > 90 mg [CaCO <sub>3</sub> ]/L	1

<sup>A</sup> SSG denotes that different site-specific guidelines or formulas were used at sites. Specific site information is available upon request.

#### New Brunswick Water Quality Guideline Sources:

- 1 Government of Canada (2008) [Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators \(CESI\) initiative 2008](#). Environment Canada and Statistics Canada. Retrieved on 17 December, 2014.
- 2 Canadian Council of Ministers of the Environment (2007) [Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1](#). Retrieved on 17 December, 2014.



### Water quality guidelines used by Newfoundland and Labrador

Parameter	Form	Guideline	Source
Chloride	dissolved	120 mg/L	1
Copper	total	2 µg/L for hardness < 90 mg [CaCO <sub>3</sub> ]/L 0.2*e <sup>0.8545*ln[hardness]-1.465</sup> µg/L for hardness > 90 mg [CaCO <sub>3</sub> ]/L	2
Iron	total	SSG <sup>[A]</sup>	2 3
Lead	total	e <sup>1.273*ln[hardness]-4.705</sup> µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	2
Nickel	total	e <sup>0.76*ln[hardness]+1.06</sup> µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	2
Nitrate	total dissolved	3 mg N/L	2
Oxygen	dissolved	9.5 mg/L	1
pH		SSG <sup>[A]</sup>	1 3
Phosphorus	total	0.03 mg/L	2
Zinc	total	7.5 µg/L for hardness ≤ 90 mg [CaCO <sub>3</sub> ]/L 7.5 + 0.75*(hardness-90) for hardness >90 mg [CaCO <sub>3</sub> ]/L	2

<sup>A</sup> SSG denotes that different site-specific guidelines or formulas were used at sites. Specific site information is available upon request.

#### Newfoundland and Labrador Water Quality Guideline Sources:

- 1 Canadian Council of Ministers of the Environment (2007) [Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1](#). Retrieved on 17 December, 2014.
- 2 Government of Canada (2008) [Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators \(CESI\) initiative 2008](#). Environment Canada and Statistics Canada. Retrieved on 17 December, 2014.
- 3 Khan AA *et al.* (2005) Application of CCME procedures for deriving site-specific water quality guidelines for the CCME Water Quality Index. *Water Quality Research Journal* 40(4):448-456.

### Water quality guidelines used by Northwest Territories

Parameter	Form	Guideline	Source
Ammonia	un-ionized, dissolved	Lentic-lotic sites: 19 µg/L	1
		Lotic sites: SSG <sup>[A]</sup> (mean + 2 standard deviations)	2
Arsenic	total	5 µg/L	3
Chloride	dissolved	Lentic-lotic sites: 120 mg/L	2
		Lotic sites: SSG <sup>[A]</sup> (mean + 2 standard deviations)	3
Copper	total	Lentic-lotic sites: 2 µg/L for hardness < 90 mg [CaCO <sub>3</sub> ]/L $0.2 * e^{0.8545 * \ln[\text{hardness}] - 1.465}$ µg/L for hardness > 90 mg [CaCO <sub>3</sub> ]/L	1 2
		Lotic sites: SSG <sup>[A]</sup> (mean + 2 standard deviations)	
Iron	total	Lentic-lotic sites: 0.3 mg/L	1
		Lotic sites: SSG <sup>[A]</sup> (mean + 2 standard deviations)	2
Lead	total	Lentic-lotic sites: $e^{1.273 * \ln[\text{hardness}] - 4.705}$ µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	1 2
		Lotic sites: SSG <sup>[A]</sup> (mean + 2 standard deviations)	
Nitrate and nitrite	total dissolved	Lentic-lotic sites: 2.93 mg N/L	1
		Lotic sites: SSG <sup>[A]</sup> (mean + 2 standard deviations)	2
Nitrite	dissolved	SSG <sup>[A]</sup> (mean + 2 standard deviations)	
Oxygen	dissolved	5 mg/L	3
pH		Lentic-lotic sites: between 6.5 and 9	2
		Lotic sites: SSG <sup>[A]</sup> (mean + 2 standard deviations)	3
Phosphorus	total	Lentic-lotic sites: 0.03 mg/L	1
		Lotic sites: SSG <sup>[A]</sup> (mean + 2 standard deviations)	3
Zinc	total	Lentic-lotic sites: 30 µg/L	2
		Lotic sites: SSG <sup>[A]</sup> (mean + 2 standard deviations)	3

<sup>A</sup> SSG denotes that different site-specific guidelines or formulas were used at sites. Specific site information is available upon request.

#### Northwest Territories Water Quality Guideline Sources:

- 1 Government of Canada (2008) [Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators \(CESI\) initiative 2008](#). Environment Canada and Statistics Canada. Retrieved on 17 December,

2014.

- 2 Lumb A *et al.* (2006) Application of CCME Water Quality Index to monitor water quality: A case study of the Mackenzie River basin, Canada. *Environmental Monitoring and Assessment* 113:411-429.
- 3 Canadian Council of Ministers of the Environment (2007) [Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1](#). Retrieved on 17 December, 2014.

### Water quality guidelines used by Nova Scotia

Parameter	Form	Guideline	Source
Chloride	total	120 mg/L	1
Copper	extractable	2 µg/L for hardness < 90 mg [CaCO <sub>3</sub> ]/L $0.2 * e^{0.8545 * \ln[\text{hardness}] - 1.465}$ µg/L for hardness > 90 mg [CaCO <sub>3</sub> ]/L	2
Iron	extractable	0.3 mg/L	2
Lead	extractable	$e^{1.273 * \ln[\text{hardness}] - 4.705}$ µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	2
Nickel	total	$e^{0.76 * \ln[\text{hardness}] + 1.06}$ µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	2
Nitrate	dissolved	3 mg N/L	2
Oxygen	dissolved	6.5 mg/L	1
pH		between 6.5 and 9	1
Phosphorus	total	0.03 mg/L	2
Zinc	extractable	7.5 µg/L for hardness ≤ 90 mg [CaCO <sub>3</sub> ]/L $7.5 + 0.75 * (\text{hardness} - 90)$ for hardness > 90 mg [CaCO <sub>3</sub> ]/L	2

#### Nova Scotia Water Quality Guideline Sources:

- 1 Canadian Council of Ministers of the Environment (2007) [Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1](#). Retrieved on 17 December, 2014.
- 2 Government of Canada (2008) [Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators \(CESI\) initiative 2008](#). Environment Canada and Statistics Canada. Retrieved on 17 December, 2014.

### Water quality guidelines used by Ontario

Parameter	Form	Guideline	Source
Ammonia	un-ionized	19 µg/L	1 2
Chloride	total	120 mg/L	1
Chromium	total	2 µg/L guideline for Cr(VI) adjusted to total chromium	1
Nickel	total	$e^{0.76 \cdot \ln[\text{hardness}] + 1.06}$ µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	2
Nitrate	total dissolved	2.93 mg N/L	2
Phosphorus	total	0.03 mg/L	2 3
Zinc	total	7.5 µg/L for hardness ≤ 90 mg [CaCO <sub>3</sub> ]/L 7.5 + 0.75*(hardness-90) for hardness > 90 mg [CaCO <sub>3</sub> ]/L	2

#### Ontario Water Quality Guideline Sources:

- 1 Canadian Council of Ministers of the Environment (2007) [Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1](#). Retrieved on 17 December, 2014.
- 2 Government of Canada (2008) [Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators \(CESI\) initiative 2008](#). Environment Canada and Statistics Canada. Retrieved on 17 December, 2014.
- 3 Ontario Ministry of the Environment and Energy (1994) [Water management policies, guidelines, provincial water quality objectives](#). Retrieved on 17 December, 2014.

### Water quality guidelines used by Prince Edward Island

Parameter	Form	Guideline	Source
Nitrate	total dissolved	SSG <sup>[A]</sup>	1
Oxygen	dissolved	6.5 mg/L	2
pH		between 6.5 and 9	2
Phosphorus	total	SSG <sup>[A]</sup>	1
Suspended sediments	total	29 mg/L (SSG <sup>[A]</sup> )	2

<sup>A</sup> SSG denotes that different site-specific guidelines or formulas were used at sites. Specific site information is available upon request.

#### Prince Edward Island Water Quality Guideline Sources:

- 1 Government of Canada (2008) [Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators \(CESI\) initiative](#). Environment Canada and Statistics Canada. Retrieved on 17 December, 2014.
- 2 Canadian Council of Ministers of the Environment (2007) [Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1](#). Retrieved on 17 December, 2014.

### Water quality guidelines used by Quebec

Parameter	Form	Guideline	Source
Ammonia	un-ionized	19 µg/L	1
Atrazine <sup>[A]</sup>		1.8 µg/L	1
Bentazone <sup>[A]</sup>		0.51 mg/L	2
Chlorophyll a		8 mg/L	3
Copper <sup>[A]</sup>	extractable	2 µg/L for hardness < 90 mg [CaCO <sub>3</sub> ]/L 0.2*e <sup>0.8545*ln[hardness]-1.465</sup> µg/L for hardness > 90 mg [CaCO <sub>3</sub> ]/L	3
Dicamba <sup>[A]</sup>		10 µg/L	1
Metolachlor <sup>[A]</sup>		7.8 µg/L	1
Nickel <sup>[A]</sup>	total	e <sup>0.76*ln[hardness]+1.06</sup> µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	3
Nitrate and nitrite	total dissolved	3 mg N/L	1 3
pH		between 6.5 and 9	1 2
Phosphorus	total	0.03 mg/L	2
Turbidity		10 NTU	3
Zinc <sup>[A]</sup>	total	7.5 µg/L for hardness ≤ 90 mg [CaCO <sub>3</sub> ]/L 7.5 + 0.75*(hardness-90) for hardness > 90 mg [CaCO <sub>3</sub> ]/L	3

<sup>A</sup> Only applies to sites monitored under federal monitoring programs.

#### Quebec Water Quality Guideline Sources:

- 1 Canadian Council of Ministers of the Environment (2007) [Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1](#). Retrieved on 17 December, 2014.
- 2 Ministère du Développement durable, Environnement, Faune et Parcs (2009) [Critères de qualité de l'eau de surface](#). Retrieved on 17 December, 2014.
- 3 Government of Canada (2008) [Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators \(CESI\) initiative 2008](#). Environment Canada and Statistics Canada. Retrieved on 17 December, 2014.

### Water quality guidelines used by Saskatchewan

Parameter	Form	Guideline	Source
2,4-D		4 µg/L	1
Ammonia	un-ionized	19 µg/L	2
Arsenic	total	5 µg/L	1
Chloride	dissolved	120 mg/L	1
Copper	total	2 µg/L for hardness < 90 mg [CaCO <sub>3</sub> ]/L 0.2*e <sup>0.8545*ln[hardness]-1.465</sup> µg/L for hardness > 90 mg [CaCO <sub>3</sub> ]/L	2
Lead	total	e <sup>1.273*ln[hardness]-4.705</sup> µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	2
MCPA		2.6 µg/L	1
Nickel	total	e <sup>0.76*ln[hardness]+1.06</sup> µg/L where hardness is measured as mg [CaCO <sub>3</sub> ]/L	2
Nitrogen	total	1 mg N/L	3
Oxygen	dissolved	6.5 mg/L	1
pH		between 6.5 and 9	1
Phosphorus	total	0.05 mg/L	3 4
Zinc	total	7.5 µg/L for hardness ≤ 90 mg [CaCO <sub>3</sub> ]/L 7.5 + 0.75*(hardness-90) for hardness > 90 mg [CaCO <sub>3</sub> ]/L	2

#### Saskatchewan Water Quality Guideline Sources:

- 1 Canadian Council of Ministers of the Environment (2007) [Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1](#). Retrieved on 17 December, 2014.
- 2 Government of Canada (2008) [Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators \(CESI\) initiative 2008](#). Environment Canada and Statistics Canada. Retrieved on 17 December, 2014.
- 3 Alberta Environment (1999) [Surface water quality guidelines for use in Alberta](#). (PDF; 134 KB) Retrieved on 17 December, 2014.



- 4 Prairie Provinces Water Board (1992) [Master Agreement on Apportionment. Schedule E: Agreement on Water Quality](#). Retrieved on 17 December, 2014.

### Water quality guidelines used by Yukon

Parameter	Form	Guideline	Source
Arsenic	total	5 µg/L	1
Chromium	total	SSG <sup>[A]</sup>	2
Copper	total	2 µg/L for hardness < 90 mg [CaCO <sub>3</sub> ]/L 0.2 * e <sup>0.8545 * ln[hardness] - 1.465</sup> µg/L for hardness > 90 mg [CaCO <sub>3</sub> ]/L	3
Lead	total	1 µg/L for hardness < 50 mg [CaCO <sub>3</sub> ]/L e <sup>1.273 * ln[hardness] - 4.705</sup> µg/L for hardness > 50 mg [CaCO <sub>3</sub> ]/L	3
Nitrate	total dissolved	2.93 mg N/L	3
Nitrite	total	0.02 mg N/L	4
Nitrogen	dissolved	0.7 mg N/L	3
Oxygen	dissolved	8 mg/L	5
pH		between 6.5 and 9	1
Phosphorus	total	0.025 mg/L	3
Selenium	total	2 µg/L	3
Silver	total	0.05 µg/L for hardness < 100 mg [CaCO <sub>3</sub> ]/L 1.9 µg/L for hardness > 100 mg [CaCO <sub>3</sub> ]/L	3
Temperature		SSG <sup>[A]</sup>	3
Zinc	total	7.5 µg/L for hardness ≤ 90 mg [CaCO <sub>3</sub> ]/L 7.5 + 0.75 * (hardness - 90) for hardness > 90 mg [CaCO <sub>3</sub> ]/L	3

<sup>A</sup> SSG denotes that different site-specific guidelines or formulas were used at sites. Specific site information is available upon request.

#### Yukon Water Quality Guideline Sources:

- 1 Canadian Council of Ministers of the Environment (2007) [Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table, Update 7.1](#). Retrieved on 17 December, 2014.
- 2 Environment Canada (2005) [Site-specific Water Quality Guidelines for the Liard River at Upper Crossing for the Purpose of National Reporting, Tri-Star Environmental Consulting](#). (PDF; 444 KB) Retrieved on 17 December, 2014.

- 3 Government of Canada (2008) [Technical guidance document for water quality index practitioners reporting under the Canadian Environmental Sustainability Indicators \(CESI\) initiative 2008](#). Environment Canada and Statistics Canada. Retrieved on 17 December, 2014.
- 4 Nordin RN and Pommen LW (2001) [Water quality criteria for nitrogen \(nitrate, nitrite, and ammonia\): Overview report](#). British Columbia Ministry of Environment and Parks. Retrieved on 17 December, 2014.
- 5 British Columbia Ministry of Environment (1997) Ambient Water Quality Criteria for Dissolved Oxygen. British Columbia Ministry of Environment, Water Management Branch. Victoria, BC. Retrieved on 17 December, 2014.  
[Overview Report](#)  
[Technical Appendix](#)

**[www.ec.gc.ca](http://www.ec.gc.ca)**

Additional information can be obtained at:

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Gatineau, QC K1A 0H3

Telephone: 1-800-668-6767 (in Canada only) or 819-997-2800

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