The Watershed Water Quality Report Card Series

Background and Calculation of the PEI Water Quality Indicator

Water and Air Monitoring Section
PEI Department of Environment, Energy and Climate Action

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Methodology for the PEI Water Quality Score (PEI WQS)

Introduction

The PEI Department of Environment, Energy and Climate Action (EECA) has a responsibility to report to Islanders on the health of water in Prince Edward Island. As part of this responsibility EECA makes public an overview of water quality on a watershed basis.

A watershed is an area of land that drains groundwater and surface water into a single estuary, river or stream. Almost all human activities can have a negative effect on water quality. To understand both our water resources and the activities that can impact them it is important to think about them in the context of a watershed

In the past water quality has been reported on using single parameters as in the State of the Environment (SOE) reports or as in the nitrate trend reporting. Although these efforts provide valuable information on the quality of our water resources, they miss the mark of reporting on a watershed basis as they represent either an Island-wide roll-up of results or the results for a discrete sample site. These efforts mostly consider only a single parameter, such as fecal coliforms or nitrates, at a time. The use of single parameter reporting means that many individual parameters must be considered to get an overall picture of water quality.

An alternative is to use a data roll-up or index to report on water quality in Island watersheds. There are many examples of water quality indexes in use around the world and within Canada. PEI already participates in national reporting on fresh water quality in the Canadian Environmental Sustainability Indicators (CESI) initiative. The PEI calculations for the CESI water quality indicator uses a roll-up of results of the results of eight water quality parameters from eleven sample sites, each representing a single stream or river, over a 3 year index period. Although useful to water quality managers in understanding water quality the CESI approach dies not fulfill the option for watershed reporting. Using a roll-up of discrete results from several chemical parameters also does not include some information that Islanders may consider relevant when considering water quality in the province. This may include concerns such as siltation, anoxic events, and contaminants which may be difficult to capture in a grab sample-based monitoring program.

The ***PEI Water Quality Score (PEI WQS)*** bridges these gaps by including both measurements and modeled estimates of some parameters and observations of other water quality concerns which are of relevance to Islanders. To date seven editions have been published by EECA; the 2022 edition is the latest and contains data up to the end of 2021 calendar year.

This document provides detailed information about the calculation of the ***PEI WQS***. This score is calculated using 5 concerns for water quality in PEI:

- Nitrate concentration in streams.
- Anoxic events in estuaries
- Fish kills related to run-off
- Siltation events
- Other concerns (e.g. blue-green algae blooms, high temperature, high nitrate in drinking water, etc.)

Calculation of the PEI WQS

The ***PEI WQS*** is represented by a simple dashboard (speedometer) graphic. The possible scores of 0 – 12 relate to 4 water quality categories:

- Excellent (score 0)
- Good (score 1-4)
- Fair (Score 5- 8)
- Poor (9-12)

The arrow of the speedometer indicates both the total score and the related water quality category.

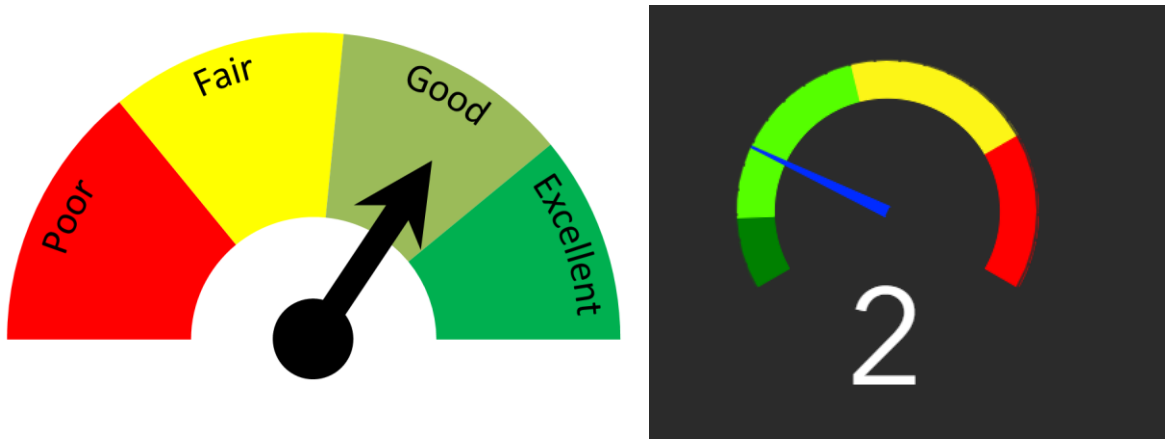

Figure 1. Appearance of the *PEI WQS* graphic in the hardcopy report card document (left) and in the PEI Water Registry (right). In both cases the score is 2 with an overall water quality category of Good.

Water Quality Issues in the PEI WQS Calculation

Watershed Nitrate Concentration

Islanders are concerned about nitrates in the environment. In PEI exceedances of Health Canada's Drinking Water Guidelines for nitrate in drinking water are common. Nitrate concentrations in many Island streams and ponds may also exceed the Canadian Water Quality

Guideline for the protection of Aquatic Life for nitrate. Excess nitrates in our surface waters are also known to cause issues with eutrophication in many of our ponds and estuaries.

Modelled nitrate concentrations were used in the initial edition of the Watershed Water Quality Report Card series (2016) to determine the score for the watershed nitrate component. This was because not all Island watersheds had recently collected nitrate data and because only a modelling approach could produce a concentration that is representative of the entire watershed. In subsequent discussion with community-based watershed groups it was determined that an approach where measurement data is used was preferred, giving opportunity for data collected by the groups to be utilized. Measured surface water nitrate concentrations, where available, have been used in the Watershed Water Quality Report Card Series, since the 2017 version of the report.

Modelled nitrate concentrations represent an average nitrate concentration for the entire watershed. The model that is used produces a watershed concentration that, for PEI, is also analogous to the baseflow (the portion of streamflow that comes from groundwater) nitrate concentration. In order to use measured nitrate data in the place of modeled nitrate data in the calculation of water quality scores, measured nitrate and modelled nitrate concentrations need to be comparable.

Since Island streams are known to be predominately groundwater during low flow, mean nitrate results from data collected during the summer months (June – September) is used. In order to account for inter-annual variation at least 2 – 3 years of sampling results is needed. Since the goal of the Watershed Water Quality Report Card series is to provide a timely assessment of water quality, recent data, from the current year of the assessment plus the 1 or 2 previous years, is preferred. Older data is used if recent data is unavailable and there is no reason to suspect that the nitrate concentrations have changed significantly over time.

Variability within a dataset is often observed. To account for variability a minimum of five samples are used in calculating a mean for a sample site. If less than five samples exist for a watershed, the measured values are still used however the range of the nitrate results and the number of samples is provided in the water quality score calculation rather than the mean of the results.

Data that is highly variable can have a large influence on the sample means, especially if the number of samples is small (i.e. < 30). In order to reduce the influence of variation on the data extreme outliers (observations that lie an abnormal distance from other values in a set of results) are removed from the data (Figure 2) using the following method.

The small amount of data available means that a normal distribution is unlikely. Due to this non-normal assumption outliers are identified using the inter-quartile distance approach. Excel is used to calculate values for the lower quartile (or 1st percentile) above which 75% of the data is found and the lower quartile (or 3rd percentile) above which 25% of the data is found. The inter-quartile range (IQR), or range which represents the central 50% of the data, is determined by subtracting the lower quartile from the upper quartile. Extreme outliers were identified as being

more than 3x the IQR above the upper quartile (upper outlier value) or being less than 3x the quartile range below the lower quartile (lower outlier value) (Figure 2).

Individual stream results may not represent the entire watershed. The nitrate results from each individual stream site will reflect concentrations that are influenced by land use in the drainage area of that site only. Local land use can vary quire significantly from stream to stream and even from site to site in the same stream. This may be offset by using results from sites that are the farthest downstream in each stream.

Many watersheds also do not have a single stream that can be sampled at a single downstream location as many systems have several tributaries. Where multiple tributaries exist, their results are averaged in an area-weighted approach that produces a result more analogous with a modelled concentration for the whole watershed (Figure 2). Of course, any tributaries or stream areas which are downstream of a given measurement site are not accounted for in these nitrate measurements. Neither will any areas which have direct drainage to a downstream estuary. If land use in these areas is dissimilar to that of the drainage area represented by a monitoring site or combination of monitoring sites, the nitrate value produced from the monitoring results will not truly represent the entire watershed. An indication of this is conveyed in the ***Status*** portion of the Water Quality Report Card page by indicating the proportion of the watershed represented by the measured result. The inference being that the smaller the proportion the less likely it is to represent the entire watershed.

Often multiple agencies (e.g. local community watershed groups, researchers, provincial government, and federal government) collect data from the same sites. All available sources of measured nitrate data are used in this assessment as they are identified (Figure 2) as long, as the data is acceptable.

Some nitrate data collected by watershed groups during 2020 were deemed unacceptable for use in the 2021 and 2022 versions of the PEI WQS calculation due to some unusually high results that could not be adequately explained, but which may have been related to the performance of a field meter. These results were excluded from these calculations following discussion with the PEI Watershed Alliance. While the 2021 data was generally better, there were still some instances of unusual results in the watershed groups' data. This was again assumed to be due to the performance of a field meter. All 2021 data was examined on a site by site basis. Consequently, a small amount of nitrate data collected in 2021 was excluded from use in the water quality score calculation.

Even with the sampling coverage provided by EECA, community watershed groups and other agencies there are watersheds for which there are no measured nitrate results. The alternative approach for these sites is the use of a modeled watershed concentration. Virtually all island watersheds were modelled for average nitrate-nitrogen concentration using a land-use area weighted approach (Jiang *et al*. 2015). The model produces a watershed concentration that, as discussed above, is also analogous to the baseflow contribution to surface water flow for PEI.

The model currently employed uses land use data collected in the period of 2006-2010 to make predictions of watershed nitrate levels. It is estimated that a lag time of 5-8 years exists between

land use and when the impact of that land use is observed in surface water nitrate levels in Island watersheds. The current model therefore best represents watershed nitrate concentrations for the period of 2011 to 2018 so it is getting dated in terms of utility to the PEI WQS calculation. It is anticipated that most modelling results will be replaced with measurement data or an updated model within the next few years. Additional provincial sampling has been planned by EECA to meet this need with sampling beginning in the 2023 field season.

Tryon River Calculation of Average Measured Watershed Concentration

SSWA001/MSC 96

Station Drainage Area (ha)	1466
Proportion of total	0.40

Date	Watershed Group Nitrate Result (mg N/L)	CLE Nitrate Result (mg N/l)
6/30/2015		3.40
7/10/2015		3.70
7/21/2015		3.60
8/11/2015	3.57	
8/19/2015		3.60
8/25/2015	3.21	
9/1/2015	1.56	
9/3/2015		3.50
9/15/2015	2.36	
9/22/2015	2.44	
6/9/2016	3.81	
6/16/2016	4.00	
6/30/2016	3.50	
7/21/2016	6.01	
8/4/2016	3.77	
8/12/2016	4.22	

Number of Samples	16
Average (all data) (mg N/l)	3.52
Median (mg N/l)	3.59
Standard Deviation (mg N/l)	0.92
3rd Quartile (mg N/l)	3.78
1st Quartile (mg N/l)	3.35
InterQuartile Distance (mg N/l)	0.43
Upper Outlier (mg N/l)	5.06
Lower Outlier (mg N/l)	2.07
Average (Outliers removed) (m	**3.48**
Area Weighted Average (mg N/	**1.40**

SSWA019/MSC 97

Station Drainage Area (ha)	2168
Proportion of total	0.60

Date	Watershed Group Nitrate Result (mg N/L)	CLE Nitrate Result (mg N/l)
6/30/2015		4.5
7/10/2015		4.80
7/21/2015		4.80
8/19/2015		5.00
9/3/2015		5.00
6/30/2016	6.14	
7/21/2016	8.92	
8/12/2016	6.11	

Number of Samples	8
Average (all data)	**5.66**
Median	5.00
Standard Deviation	1.36
3rd Quartile	6.12
1st Quartile	4.80
InterQuartile Distance	1.32
Upper Outlier	10.07
Lower Outlier	0.85
Area Weighted Average	**3.38**

Total Area Sampled (ha)	3634
Watershed Nitrate (mg/l) (Area Weighted Average of All Sampled Areas)	**4.78**
Total Watershed Area	5204.98
Proportion of Watershed Measured	0.70

red text indicates A statistical Outlier

Outliers are determined as 3X the interquartile distance from the 1st and 3rd quartiles.

Figure 2. Example calculation of watershed nitrate concentration. Uses an area weighted approach for multiple streams in watershed, with determination of outliers in the data.

The measured or modelled concentrations are used for the calculation of the watershed nitrate score portion of the PEI WQS. Nitrate scores are assigned as follows:

- Concentration < 0.5 mg/N/l. Score is 0 - very low range.
- Concentration < 1.5 mg N/l. Score is 0 – low range.
- Concentration 1.5 to <3 mg N/l. Score is 1- moderate range.
- Concentration 3 to < 5 mg N/l. Score is 2 – high range.
- Concentration >5 mg N/l. Score is 3 – very high range.

Three threshold values are utilized in the scoring for this part of the ***PEI WQS***. The concentration chosen as the low threshold is 1.5 mg N/l because it is a concentration considered to reflect a relatively low level for nitrate in PEI watersheds. A concentration of 3 mg N/l is the CCME WQG for aquatic life and stream concentrations that exceed this level represent an alert level above which there may be some impact on aquatic life. Watershed nitrate concentrations at or above 5 mg N/l are considered high for PEI.

These threshold concentrations are not related to the occurrence of eutrophication and/or anoxic events in ponds or estuaries (see below).

Frequency of Anoxic Events in Estuaries

Unfortunately, Islanders have become very familiar with the occurrence of anoxic events in PEI estuaries. Anoxia is the result of a process in which excess primary productivity results in degraded water quality. Most Islanders would place anoxic events high on a list of environmental concerns for PEI. Although related to nitrate loading (loads are a function of both concentration and water flow or volume) in watersheds the occurrence of anoxic events in island estuaries is also related to flushing rates in these bodies of water. That is why some relatively low stream/groundwater nitrate concentrations can result in anoxia in some systems while other much higher concentrations do not result in anoxia in others. Since flushing rates differ from system to system the loading that can cause anoxic events also differs from watershed to watershed.

The occurrence of anoxic events in the downstream estuary is used in the calculation the ***PEI WQS***. Scores for the occurrence of anoxia are assigned as follows:

- No anoxic events reported in an estuary in the last 5 years or no downstream estuary. Score is 0
- 1 anoxic event reported in an estuary in the last 5 years. Score is 1
- 2-3 anoxic events reported in an estuary in the last 5 years. Score is 2
- 4 – 5 anoxic events reported in an estuary in the last 5 years. Score is 3.

Frequency of Fish Kills

Fish kills are also an issue of great concern to Islanders. Fish kills can occur for a variety of reasons including natural causes (e.g. disease), anoxic events, the presence of contaminants in water due to spills and run-off, as well as some other environmental factors (e.g. high temperature).

The fish kills considered here are the result of events such as run-off and contaminant spills. This information is drawn from a list of documented fish kills maintained by the province. Scores for fish kills are assigned as follows:

- No fish kills recorded in the last 10 years. Score is 0
- 1 fish kill recorded in the last 10. Score is 1.
- Two or more fish kills recorded in the last 10 years. Score is 2.

Fish kills associated with anoxic events and certain other environmental factors are not included in this category. All anoxic events are likely to result in the death of some aquatic life due to very low oxygen levels in the water; Anoxic events are already considered in the score calculation.

Fish kills which are the result of environmental factors such as high temperature are rare and are captured under the ***Occurrence of Other Issues*** below. Fish and shellfish mortality associated with natural causes such as disease or post-spawning mortality, are also not included as the ***PEI WQS*** is intended to highlight issues that are of human origin.

Occurrence of Siltation Events

Siltation is also an issue of concern for water quality in PEI. It is acknowledged that siltation is a difficult issue to measure adequately at the watershed level at this time. Most monitoring done to date has been based on a grab sample program conducted during both event and non-event times. This is inadequate as a monitoring tool as it is difficult to know when to sample in order to capture the worst conditions. Grab samples generally require very large number of samples in order to fully capture the range of conditions in any given waterbody.

Some attempts have been made to monitor streams using continuous optical measurements of turbidity, but in practice this is difficult due to issues with keeping equipment calibrated. Although the province now has a proven acoustic method to monitor siltation continuously in 5 Island streams, it is unlikely that there would ever be enough resources to implement such an intensive monitoring effort in all Island watersheds.

In lieu of data on siltation a qualitative assessment of the occurrence of sediment laden run-off (red water) events in watersheds is used in the calculation of the ***PEI WQS***. Some of this information comes from local observation of the occurrence of run-off in these watersheds. A survey on the occurrence of siltation and the presence of other concerns for aquatic health was distributed to local community watershed groups in the spring of 2021 and used to provide siltation scores for the 2020 - 2022 editions of the report cards. Nineteen groups responded providing siltation information for sixty-six watersheds. Scores were assigned as follows:

- Infrequent (occurring only in the biggest run-off events where there is significant rainfall or snowmelt) red water events. Score is 0.
- Frequent red water events (occurring in most but not all rainfall or snowmelt events which result in run-off from surrounding land to streams). Score is 1.
- Very Frequent red water events (occurring in virtually all rainfall or snowmelt events which result in run-off from surrounding land in streams). Score is 2.

Professional opinion on the occurrence of siltation events is also used to provide a score for this water quality issue. This opinion may based on observation of the frequency of siltation events in some watersheds (as above) or on the presence of certain risk factors such as land use, field sizes, land slope, the absence of mitigating factors such as soil conservation works, as well as the presence of unpaved roads and other works which may present an erosion source.

Occurrence of Other Issues

Although using four factors (nitrate concentration, frequency of anoxic events and the occurrence of fish kills and siltation events) in the calculation of the ***PEI WQS*** would provide a reasonable picture of water quality in Island watersheds, there are other issues that can occur that may be of concern in PEI. Examples of such issues include high surface water temperatures, cyanobacteria blooms, anoxia in freshwater ponds and high drinking water nitrate. Since these issues can differ from watershed to watershed assigning a specific grouping and score for each possible other issue is not a reasonable approach. Instead all issues other than nitrate concentration, frequency of anoxic events, fish kills and siltation events, are considered collectively in the "Other" category.

As is the case for siltation "Other" encompasses factors for which there may be little or no available measurement data. Instead qualitative information for such factors may come from local observation of the occurrence of incidents in these watersheds.

A survey on the occurrence of siltation and the presence of other issues in watersheds was distributed to local community watershed groups in the spring of 2021 and used to provide such qualitative assessment of Other issues for the 2020 - 2022 versions of the report cards. Nineteen groups responded providing information on issues of concern for forty-seven watersheds.

Information on "Other" issues also comes from complaints received by EECA from members of the public. The public is usually a very good source for identifying issues such as soil erosion, algal blooms, and anoxic events as they occur.

Some quantitative data is currently available for use in the calculation of the "Other" category score. Summary groundwater (well) results for nitrate by watershed is available on the PEI Open Data Portal. Summary nitrate data from the last 5 years is used, with small sub-watersheds aggregated into larger ones as necessary. An average value of 3 mg N/l for groundwater nitrate is considered to keep most drinking water wells in PEI watersheds below the Health Canada Drinking Water Guideline, so this is considered a threshold value for this data.

Some community-based watersheds currently collect surface water temperature data using loggers which collect water temperatures at frequent intervals during the year. For the purposes of this assessment, data from July and August, generally the warmest months in PEI, were used for sites with a minimum of 100 continuous records. Thresholds of 20° and 25° C were used as indicators of stress to aquatic species, particularly brook trout. Metrics such as the percentage of samples exceeding these thresholds as well as daily average temperature, daily maximum temperature, and the mean weekly maximum temperature are used to summarize and compare the data.

Scores in the "Other" category are assigned as follows:

- No other issues. Score is 0.
- Infrequent other issues (e.g. occurring in only one or scattered years, occurring in only a few discrete or logged samples, having the 5-year average groundwater nitrate value > 3 mg N/l, etc.). Score is 1.
- Frequent other issues (e.g. occurring in more than a few discrete samples, occurring in significant number of logged samples, occurring in more than one year, having the 5-year average groundwater nitrate value > 5 mg N/l, etc.). Score is 2.

Scores are additive in the "Other" category. For example, the occurrence of infrequent anoxia in a freshwater pond accompanied by an average groundwater nitrate concentration of > 3 mg N/l (but less than 5 mg N/l) would result in an "Other" score of 2, however "Other" scores will never exceed 2. For example, the very frequent occurrence of high temperatures recorded in a freshwater pond accompanied by an average groundwater nitrate concentration of > 5 mg N/l would result in an 'Other" score of 2 not 4.

Assigning Water Quality Categories.

The calculation of the final ***PEI WQS*** involves summing the 5 individual issue scores. This results in possible scores of 0 to 12 (Table 1).

Table 1. Thresholds and scoring for calculation of the *PEI WQS*

Score	N03-N	Anoxic Events	Fish Kills	Siltation	Other Events	Category Range	Category
0	<1.5 mg/l	0 in last 5 years or no estuary	0 in last 10 years	Infrequent red water events	no other events	0	EXCELLENT
1	1.5 - <3 mg/l	1 in last 5 years	1 in last 10 years.	Frequent red water events	Infrequent other events. Average GW nitrate > 3 mg N/l	1-4	GOOD
2	3- < 5 mg/l	2 or 3 in last 5 years	2 or more in the last 10 years	Very frequent red water events	Frequent other events, Average GW nitrate > 5 mg N/l.	5-8	FAIR
3	>5 mg/l	4 or 5 in last 5 years				9-12	POOR

Verification of Results

The robustness of the ***PEI WQS*** calculation was examined for the 2017 Quality Report Card Series where calculated scores were compared to expert opinion of water quality in each watershed (Table 2). Although there was good agreement between the assigned categories and expert opinion, some watersheds differed (Table 2). Seven watersheds had categories that were worse than expert opinion and two watersheds were better than expert opinion. This was not unexpected as roll-ups of this type often result in some degree of disparity with other local knowledge. It should be noted that the categories are rather broad and, in most cases, (6 of 9) the disparaging scores are close to the category assigned by the water quality expert (Table 2).

Comparison of WQS Results Between Report Card Editions

It is expected that the water quality scores used in the Watershed Water Quality Report Card series, will not remain constant but will change from time to time for various reasons. For example:

- Measured nitrate results may improve or get worse over time
- Anoxic events and fish kills may occur in some years and not in others.
- Elevated water temperatures and low dissolved oxygen concentrations may only become apparent as logger sites are added by groups and data becomes available.
- New concerns and issues may pop up as land use pressures surface.
- Conditions may improve as watershed groups and stakeholders take measures to address issues such as soil erosion.

The methodology for the calculation of the ***PEI WQS*** has changed since the first edition (2016) as described throughout this document. In summary:

- Use of measured vs. modeled surface water nitrate concentrations in the calculation of watershed nitrate score beginning with the 2017 edition.

- The addition of watershed groundwater nitrate concentrations in the "Other" scores beginning in the 2017 edition in order to capture drinking water nitrate concerns.
- Surface water temperature logger data collected by community-based watershed groups was added to the calculation beginning with the 2018 edition.
- The *Siltation* and *Other* scores were updated through survey input from nineteen local watershed groups beginning with the 2019 edition and the addition of professional opinion based on the presence of risk factors in the 2021 edition.

These factors have resulted in some differences in the ***PEI WQS*** and category assignment between the seven editions (2016-2022) published so far (Table 3).

Table 2 Comparison of PEI ***WQS*** results (2017) to expert opinion of watershed water quality for 41 watersheds.

Watershed	Measured N03-N	NO3 Score	Years with Anoxia in Last 5	Anoxia Score	Run-off Related Fish Kills Last 10 Years	Fish Kill Score	Siltation Events	Other Events	Total Score	Category	Expert Opinion Category	Other Category Description
Augustine Cove	4.2	2	0	0	0	0	1	2	5	Fair	Good	Infrequent issues with stream DO. Average GW nitrate > 3.0. mg/l.
Bear River	0.3	0	0	0	0	0	0	0	0	Excellent	Excellent	
Boughton	0.4	0	4	3	0	0	1	0	4	Good	Good	
Brudenell	2.0	1	1	1	0	0	1	1	4	Good	Good	Average GW nitrate > 3.0 mg/l.
Cape Traverse	5.0	2	0	0	0	0	2	2	6	Fair	Good	Average GW nitrate > 5.0 mg/l.
Cardigan	0.7	0	0	0	0	0	1	0	1	Good	Good	
Covehead/Brackley	2.8	1	4	3	0	0	2	1	7	Fair	Fair	Average GW nitrate > 3.0 mg/l.
Desable	1.4	0	0	0	0	0	1	2	3	Good	Good	Frequent complaints of odors from decaying sea lettuce.
Dunk	3.5	2	0	0	1	1	2	2	7	Fair	Fair	Average GW nitrate > 5.0 mg/l.
Enmore River	0.4	0	0	0	0	0	0	0	0	Excellent	Excellent	
Grand	0.9	0	1	1	0	0	1	0	2	Good	Good	
Hillsborough	0.4	0	0	0	0	0	2	2	4	Good	Good	Anoxic event in a freshwater pond 2012. Average GW nitrate > 3.0 mg/l.
Hunter/Clyde	1.1	0	5	3	0	0	2	0	5	Fair	Poor	
Jacques	0.5	0	0	0	0	0	0	1	1	Good	Excellent	Average GW nitrate > 3.0 mg/l
Kildare	4.5	2	5	3	1	1	2	2	10	Poor	Poor	High temperatures in pond at the head of tide. Average GW nitrate > 3 mg/l.
MacLaurins	2.9	1	0	0	0	0	0	0	1	Good	Excellent	
Mill	3.0	1	5	3	2	2	2	2	10	Poor	Poor	Average GW nitrate > 5.0 mg/l.
Montague/Valleyfield	1.5	1	1	1	0	0	2	1	5	Fair	Fair	Average GW nitrate > 3.0 mg/l.
Morell	0.9	0	1	1	0	0	0	1	2	Good	Good	Average GW nitrate > 3.0 mg/l.
Murray River	0.1	0	0	0	0	0	1	1	2	Good	Good	Occasional cyanobacteria blooms.
North Lake	1.3	0	0	0	0	0	0	1	1	Good	Excellent	Average GW nitrate > 3.0 mg/l.
North River	2.9	1	0	0	1	1	2	0	4	Good	Good	
Orwell/Vernon	1.8	1	0	0	0	0	2	1	4	Good	Good	Average GW nitrate > 3.0 mg/l.
Ox/Sheep	0.7	0	0	0	0	0	1	0	1	Good	Good	
Percival	0.7	0	0	0	0	0	0	0	0	Excellent	Excellent	
Pinette	1.1	0	0	0	0	0	1	1	2	Good	Good	Average GW nitrate > 3.0 mg/l.
Souris	2.2	1	1	1	0	0	1	1	4	Good	Good	Average GW nitrate > 3.0 mg/l.
Southwest	5.0	3	5	3	0	0	2	2	10	Poor	Poor	Anoxic event in a freshwater pond 2016. Average GW nitrate > 3.0 mg/l.
St. Chrystostome	1.2	0	0	0	0	0	0	0	0	Excellent	Excellent	
St. Peter's	0.4	0	2	2	0	0	1	1	4	Good	Good	Average GW nitrate > 3.0 mg/l.
St. Philip	3.5	2	0	0	0	0	0	2	4	Good	Good	Frequent reports of issues of fish and habitat conditions in stream.
Tracadie/Desroches	0.8	0	0	0	0	0	1	0	1	Good	Good	
Trout River (Coleman)	1.7	1	5	3	3	2	2	1	9	Poor	Poor	Average GW nitrate > 3.0 mg/l.
Trout/Stanley	2.3	1	5	3	0	0	2	1	7	Fair	Poor	Average GW nitrate > 3.0 mg/l.
Tryon	4.8	2	0	0	1	1	2	2	7	Fair	Fair	Infrequent issues with stream DO. Average GW nitrate > 5.0 mg/l.
Tyne Valley/Bideford	0.5	0	1	1	0	0	1	1	3	Good	Good	Release from peat mining facility.
Westmoreland	2.6	1	0	0	0	0	1	2	4	Good	Good	Infrequent issues with stream DO. Average GW nitrate > 3.0 mg/l.
West River	1.6	1	0	0	1	1	2	2	6	Fair	Good	Turbid water, low light limited growth of macro-algae and marine plants in estuary. Average GW nitrate > 3.0 mg/l.
Wheatley	3.0	2	5	3	0	0	2	1	8	Fair	Poor	Average GW nitrate > 3.0 mg/l.
Wilmot	6.1	3	0	0	0	0	2	2	7	Fair	Fair	Average GW nitrate > 5.0 mg/l.
Winter River	1.4	0	5	3	0	0	2	2	7	Fair	Fair	High temperature in ponds.
											Better than Expert Opinion	
											Worse than Expert Opinion	

Table 3 Comparison of water quality scores and categories for watersheds in the last 7 editions of the report card series (2016-2022).

Watershed	2016		2017		2018		2019		2020		2021		2022	
	Score	Category	Score	Category	Score	Category	Score	Category	Score	Category	Score	Category	Score	Category
Augustine Cove			5	Fair	5	Fair	6	Fair	4	Good	4	Good	4	Good
Bains Creek							0	Excellent	0	Excellent	0	Excellent	0	Excellent
Baltic River							8	Fair	8	Fair	9	Poor	9	Poor
Barbara Weit River							6	Fair	6	Fair	6	Fair	7	Fair
Bear River	0	Excellent	0	Excellent	0	Excellent	0	Excellent	1	Good	1	Good	1	Good
Belle River							0	Excellent	0	Excellent	0	Excellent	1	Good
Bentick Cove											5	Fair	5	Fair
Big Pierre Jacques River							6	Fair	6	Fair	6	Fair	6	Fair
Black Marsh							0	Excellent	0	Excellent	1	Good	0	Excellent
Black Pond											4	Good	4	Good
Black Pond Brook							1	Good	1	Good	1	Good	1	Good
Blackett's Creek											0	Excellent	0	Excellent
Boughton	3	Good	4	Good	4	Good	3	Good	3	Good	3	Good	3	Good
Brae River							3	Good	3	Good	3	Good	3	Good
Bristol Creek							0	Excellent	0	Excellent	0	Excellent	0	Excellent
Brooks River							0	Excellent	0	Excellent	0	Excellent	0	Excellent
Brown's Creek											4	Good	4	Good
Brudenell River	3	Good	4	Good	4	Good	2	Good	2	Good	2	Good	2	Good
Campbellton							7	Fair	6	Fair	6	Fair	5	Fair
Cape Kildare							1	Good	1	Good	1	Good	1	Good
Cape Traverse			6	Fair	6	Fair	7	Fair	6	Fair	5	Fair	5	Fair
Cardigan River	1	Good	1	Good	1	Good	2	Good	3	Good	3	Good	4	Good
Chapel Creek							2	Good	3	Good	2	Good	3	Good
Cousins Pond							4	Good	4	Good	5	Fair	5	Fair
Covehead / Brackley Bays	6	Fair	7	Fair	7	Fair	6	Fair	7	Fair	7	Fair	7	Fair
Cow Creek											0	Excellent	0	Excellent
Cross River											2	Good	1	Good
Crossman's Brook							5	Fair	5	Fair	4	Good	4	Good
Dalton's Brook											3	Good	4	Good
Deroche Pond							2	Good	2	Good	2	Good	2	Good
Desable River			3	Good	3	Good	3	Good	3	Good	2	Good	2	Good
Dunk River	7	Fair	7	Fair	6	Fair	7	Fair	7	Fair	9	Poor	9	Poor
East Lake											3	Good	3	Good

Table 3 – continued

Watershed	2016		2017		2018		2019		2020		2021		2022	
	Score	Category	Score	Category	Score	Category	Score	Category	Score	Category	Score	Category	Score	Category
Enmore River			0	Excellent	0	Excellent	0	Excellent	0	Excellent	0	Excellent	0	Excellent
Flat River							0	Excellent	0	Excellent	0	Excellent	0	Excellent
Foley's Pond							4	Good	4	Good	4	Good	4	Good
Fortune River											1	Good	2	Good
Fox River											1	Good	1	Excellent
Freeland Creek							1	Good	1	Good	0	Excellent	0	Fair
French River											8	Fair	7	Excellent
Goose River											0	Excellent	0	Good
Graham's Creek											1	Good	1	Good
Grand River	3	Good	2	Good	1	Good	2	Good	2	Good	3	Good	2	Good
Greek River											0	Excellent	0	Excellent
Haldimand River											1	Good	1	Good
Hay River											0	Excellent	1	Good
Hebron							2	Good	1	Good	2	Good	2	Good
Hillsborough River	3	Good	4	Good	4	Good	4	Good	4	Good	4	Good	4	Good
Hope River					5	Fair	3	Good	3	Good	3	Good	4	Good
Hornes Creek							2	Good	2	Good	2	Good	2	Good
Hunter/Clyde River	6	Fair	5	Fair	5	Fair	5	Fair	5	Fair	5	Fair	5	Fair
Indian River							6	Fair	6	Fair	6	Fair	5	Fair
Jacques River			1	Good	1	Good	1	Good	1	Good	1	Good	0	Excellent
Kildare / Montrose Rivers	9	Poor	10	Poor	11	Poor	11	Poor	10	Poor	10	Poor	10	Poor
Little Harbour											2	Good	2	Good
Little Miminegash							6	Fair	6	Fair	6	Fair	6	Fair
Little Pierre Jacques							4	Good	4	Good	3	Good	3	Good
Little Tignish River							4	Good	4	Good	5	Fair	4	Good
Llewellyn's Creek											1	Good	2	Good
Lower New Annan											5	Fair	5	Fair
Luke's Creek							0	Excellent	0	Excellent	0	Excellent	1	Good
Mackie's Pond											6	Fair	6	Fair
MacLaurin's Creek			1	Good	2	Good	1	Good	1	Good	1	Good	1	Good
MacWilliams Brook							4	Good	4	Good	4	Good	4	Good
Mill Creek											5	Fair	6	Fair
Mill River	9	Poor	10	Poor	10	Poor	11	Poor	11	Poor	11	Poor	10	Poor

Table 3 – continued

Watershed	2016		2017		2018		2019		2020		2021		2022	
	Score	Category	Score	Category	Score	Category	Score	Category	Score	Category	Score	Category	Score	Category
Miminegash River							3	Good	2	Good	2	Good	3	Good
Montague / Valleyfield River	5	Fair	5	Fair	3	Good	2	Good	4	Good	4	Good	4	Good
Morell River	1	Good	2	Good	2	Good	4	Good	4	Good	4	Good	3	Good
Murray River	2	Good	2	Good	2	Good	1	Good	1	Good	1	Good	2	Good
Nail Head							0	Excellent	0	Excellent	0	Excellent	0	Excellent
Nail Pond							2	Good	2	Good	2	Good	2	Good
Naufrage River											1	Good	1	Good
Nicolle Point											0	Excellent	0	Excellent
Norris' Pond											4	Good	4	Good
North Lake	0	Excellent	1	Good	1	Good	1	Good	1	Good	1	Good	1	Fair
North River	4	Good	4	Good	4	Good	7	Fair	6	Fair	6	Fair	6	Fair
Orwell/Vernon Rivers	3	Good	4	Good	4	Good	4	Good	4	Good	4	Good	5	Fair
Ox / Sheep River			1	Good	1	Good	0	Excellent	0	Excellent	0	Excellent	0	Excellent
Percival River	0	Excellent	0	Excellent	0	Excellent	2	Good	2	Good	2	Good	1	Good
Pinette River	2	Good	2	Good	2	Good	1	Good	1	Good	0	Excellent	0	Excellent
Platte River											6	Fair	6	Fair
Pollard Brook							2	Good	2	Good	2	Good	2	Good
Prevost Cove											6	Fair	6	Fair
Priest Pond Creek											0	Excellent	0	Excellent
Rayner's Creek											7	Fair	7	Fair
Rayner's Pond							0	Excellent	0	Excellent	0	Excellent	0	Excellent
Rollo Bay											4	Good	4	Good
Round Pond							3	Good	3	Good	3	Good	3	Good
Savage Harbour											0	Excellent	0	Excellent
Schooner Creek											1	Good	1	Good
Shipyard River							4	Good	4	Good	4	Good	4	Good
Skinner's Pond							1	Good	1	Good	1	Good	1	Good
Souris River	4	Good	4	Good	4	Good	4	Good	5	Fair	5	Fair	5	Fair
South River											0	Excellent	0	Excellent
Southwest River	9	Poor	10	Poor	9	Poor	8	Fair	8	Fair	8	Fair	8	Fair
St. Chrystostome			0	Excellent	0	Excellent	0	Excellent	0	Excellent	0	Excellent	0	Excellent
St. Peters Bay	3	Good	4	Good	3	Good	3	Good	3	Good	3	Good	2	Good
St. Philip Shore			4	Good	4	Good	4	Good	4	Good	3	Good	3	Good

Table 3 - Continued

Watershed	2016		2017		2018		2019		2020		2021		2022	
	Score	Category	Score	Category	Score	Category	Score	Category	Score	Category	Score	Category	Score	Category
Stewart's Creek							2	Good	2	Good	2	Good	3	Good
Sturgeon River											1	Good	1	Good
Thompson Creek											0	Excellent	0	Excellent
Tignish River							5	Fair	6	Fair	5	Fair	5	Fair
Tracadie Bay	1	Good	1	Good	2	Good	2	Good	3	Good	3	Good	3	Good
Trout River - Bideford	4	Good	3	Good	2	Good	1	Good	1	Good	1	Good	1	Good
Trout River - Foxley	9	Poor	9	Poor	9	Poor	7	Fair	6	Fair	7	Fair	7	Fair
Trout River - Stanley	6	Fair	7	Fair	7	Fair	6	Fair	5	Fair	5	Fair	6	Fair
Tryon River			7	Fair	6	Fair	7	Fair	5	Fair	5	Fair	5	Fair
Waite's Creek											8	Fair	7	Fair
West River	5	Fair	6	Fair	7	Fair	7	Fair	6	Fair	7	Fair	7	Fair
Westmoreland River			4	Good	4	Good	4	Good	3	Good	3	Good	3	Good
Wheatley River	6	Fair	8	Fair	8	Fair	6	Fair	6	Fair	6	Fair	7	Fair
White's Cove											4	Good	4	Good
Wilmot River	7	Fair	7	Fair	7	Fair	8	Fair	8	Fair	8	Fair	8	Fair
Winter River	7	Fair	7	Fair	7	Fair	8	Fair	8	Fair	8	Fair	8	Fair

Red Text = Worsening of Score/category
Green Text = Improvement in Score/Category

Although there are some differences from edition to edition, it is notable how consistent the results have been over each edition of the ***Watershed Water Quality Report Cards***. In general, categories do not vary by more than a single point, and categories have changed only rarely. While some differences can be attributed to changing methodology (e.g. the addition of groundwater nitrate as an issue or adding temperature logger data) it is important to consider that these additions to the ***WQS*** calculation were made to more accurately reflect water quality in each watershed. In most cases, the score differences have been due to changing environmental conditions.

Afterword

The purpose of the ***PEI WQS*** is to provide Islanders with an overview of water quality on a watershed basis and to provide a mechanism for comparison between watersheds. It is hoped that the ***PEI WQS*** will be a valuable tool that will assist Islanders in understanding the current threats to the quality our surface water resources and underline the need for management activities that will serve to protect or restore them.

The Watershed Water quality Report Card Series is updated on a regular basis and made available as a report on the EECA website. Beginning in the spring of 2022 the results for the report cards are also available as part of the water quality section of the PEI Water Registry.

References

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