Chapter 2: Methods and Results

In 2011, Conservation Ontario provided a standardized set of indicators and evaluation system for reporting on watershed health conditions. These guidelines improve consistency and use of information across all conservation authorities. Conservation Ontario updated its guidelines in 2017.

The Ausable Bayfield area has been divided into 16 local watersheds (or 'subwatersheds') for reporting purposes. These watersheds represent areas to which people from the local watershed communities can relate.

Watershed boundaries (Map 2) were determined such that each of the 16 watersheds is:

- A section of the main branch of the Ausable or Bayfield River;
- A major tributary to the Ausable or Bayfield Rivers; or
- A group of watercourses that drain directly into Lake Huron (Lakeshore Watersheds).

There are five resource categories that contribute to our understanding of the general watershed condition: forest conditions, wetland cover, overwinter vegetative cover on agricultural lands, and surface water and groundwater quality.

The indicators we evaluated for each category are:

- Forest conditions – percentage of forest cover, forest interior, streamside cover;
- Wetland cover – amount of wetland cover;
- Overwinter vegetative cover on agricultural lands – percentage area of agricultural land covered by wheat, forages, or hay during the winter season.
- Surface water quality – concentrations of total phosphorus and *Escherichia coli* (*E. coli*), and an index of benthic invertebrates (small animals that live in the bottom of streams and indicate stream health); and
- Groundwater quality – concentrations of nitrate and chloride.

FOREST CONDITIONS

2.0 Measures of Ecosystem Quality

2.0.1 Forest Conditions

Methods

Forest cover, forest interior, and streamside forest cover were used to evaluate forest conditions with Geographic Information Systems (GIS). These indicators were expressed as percentages. Forest cover was calculated as the total amount of forested area within a watershed. Forest interior refers to the inner portion of a woodlot after removing a 100 metre buffer around the perimeter of that woodlot. Streamside forest cover refers to the amount of forest cover that fell within a 30 metre zone on both sides of an open watercourse.

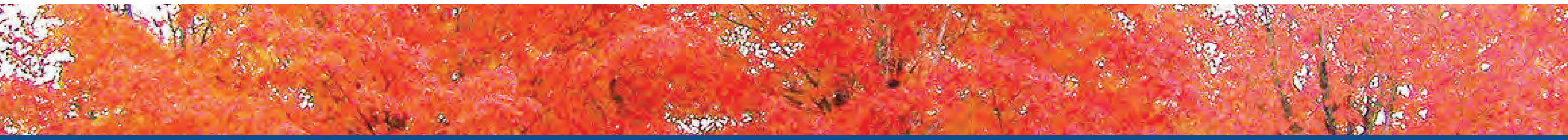
Woodlot information was extracted from the Ausable Bayfield natural heritage layer, which was updated with colour aerial photography from 2015. Each forest indicator was given a point score based on the percentage of cover in a watershed. The point scores for the three forest indicators were then averaged in order to assign a final grade for overall forest conditions in each watershed (Table 1).

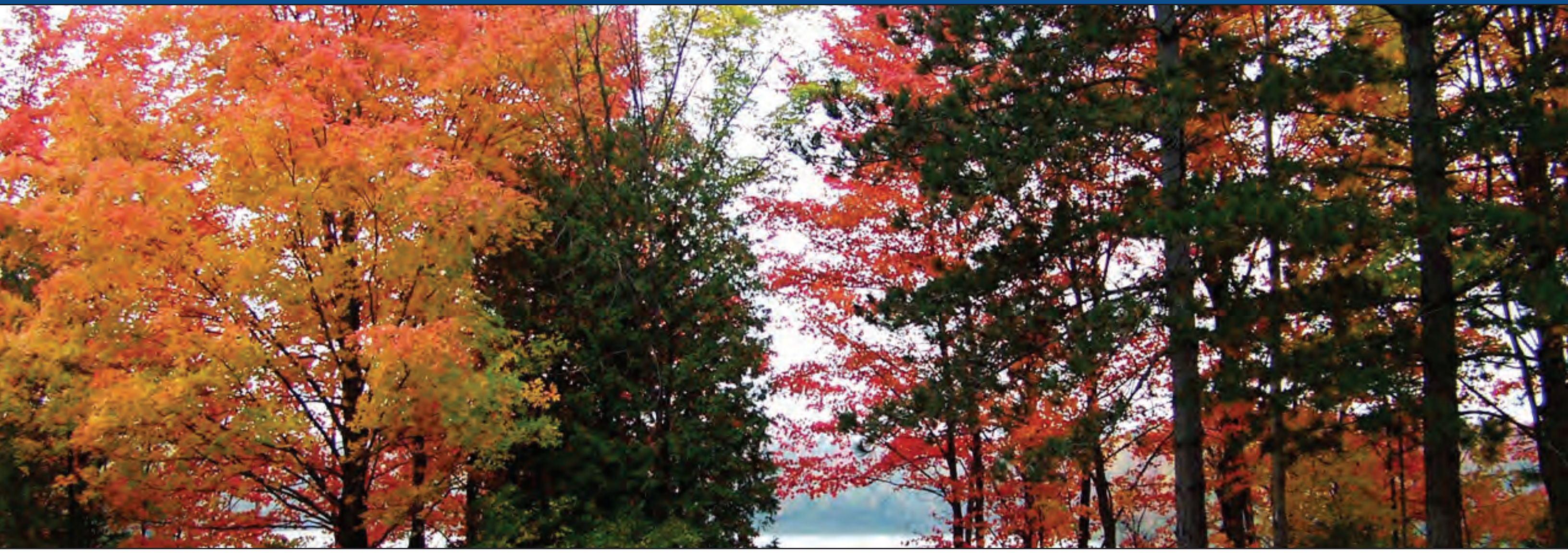
Wooded areas that were mapped included deciduous and coniferous forests, treed swamps, and both young and mature plantations. An important consideration is that a minimum mapping unit of 0.5 hectares (1.2 acres) was used when updating natural heritage features in the Ausable Bayfield watershed. Any heritage feature that was less than 0.5 hectares (1.2 acres) was not likely picked up during this mapping exercise. For this reason, street trees, small windbreaks, or woodland patches were not included in any of the forest cover calculations.

Note that these indicators of forest conditions are reflective of the amount of forest, not forest health or diversity.

Table 1: Forest condition indicator scoring and grading for the Ausable Bayfield watershed (adapted from Conservation Ontario).

Forest Cover (%)	Forest Interior (%)	Streamside Cover (%)	Point Score	Grade	Average Point Score	Final Grade
>35.0	>11.5	>57.5	5	A	>4.4	A
25.1-35.0	8.6-11.5	42.6-57.5	4	B	3.5-4.4	B
15.1-25.0	5.6-8.5	27.6-42.5	3	C	2.5-3.4	C
5.0-15.0	2.5-5.5	12.5-27.5	2	D	1.5-2.4	D
<5.0	<2.5	<12.5	1	F	<1.5	F





Results

Forest cover and interior are limited in the Ausable Bayfield watershed. (Table 2; Figure 1, Map 5)

Forest grades for all watersheds remain unchanged from the 2013 *Watershed Report Card*. Consequently, most watersheds received a D grade for forest cover and an F for forest interior (<2.5%) (Figure 1). Streamside cover received mostly C and D grades (Figure 1). The combined three indicators that measure forest conditions showed that most watersheds continue to receive a D grade. (Figure 1, Map 5).

Table 2: Percentage of forest cover, forest interior, and streamside cover, their associated grades, and overall forest conditions grade for each watershed.

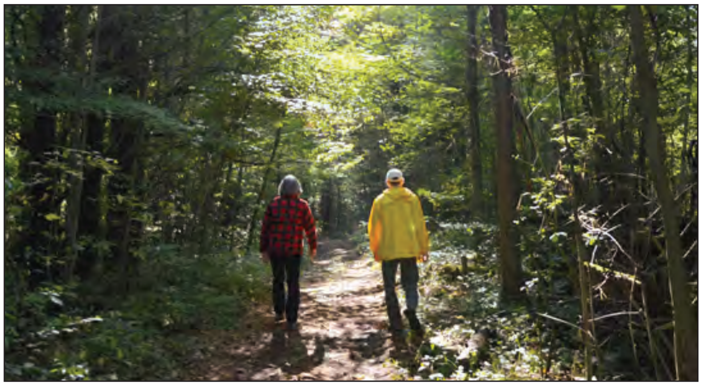
Watershed	Forest Cover		Forest Interior		Streamside Cover		Overall Grade
	Percentage	Grade	Percentage	Grade	Percentage	Grade	
Ausable Headwaters	10.4	D	1.2	F	19.5	D	D
Bannockburn	10.8	D	1.4	F	26.3	D	D
Bayfield Headwaters	7.6	D	0.7	F	17.2	D	D
Bayfield North	30.5	B	9.0	B	63.9	A	B
Black Creek	20.6	C	9.6	B	31.7	C	C
Little Ausable	6.5	D	0.3	F	18.4	D	D
Lower Ausable	20.5	C	4.0	D	46.9	B	C
Lower Parkhill	14.7	D	3.6	D	26.0	D	D
Main Bayfield	22.9	C	4.7	D	54.8	B	C
Middle Ausable	13.6	D	1.9	F	42.7	B	D
Mud Creek	24.3	C	10.7	B	33.8	C	C
Nairn Creek	9.7	D	0.9	F	28.8	C	D
Old Ausable Channel	82.1	A	43.8	A	76.9	A	A
South Gullies	11.7	D	2.1	F	24.2	D	D
Upper Ausable	10.7	D	2.2	F	31.0	C	D
Upper Parkhill	14.1	D	2.3	F	40.3	C	D
Entire ABCA Watershed	14.2		3.3		32.6		

Results *(continued)*

The Old Ausable Channel watershed retains an A grade due to the presence of Pinery Provincial Park in the watershed. Similarly, the Bayfield North watershed retains a B grade as a result of several upland forest habitats (Table 2, Map 5).

The F grades received by most watersheds for forest interior reflect the fragmented nature and small size of the remaining woodlots, and the relatively few large uninterrupted blocks of forest habitat that remain (Table 2, Map 5).

Forest cover, in Ausable Bayfield watersheds, rapidly declined after 1850 as the land was cleared for settlement. The *Ausable Valley Conservation Report* from 1949 documents forest cover in the Ausable watershed at or below 10 per cent.



Forest cover gains were made between the 1950s and 1980s, through land retirement, natural regeneration on farms, and local and provincial tree planting programs. These reforestation efforts are still noticeable today within the landscape. For instance, the Black Creek watershed (C grade) scores higher than the average D grade because of past land acquisition and tree planting efforts in Hay Swamp.

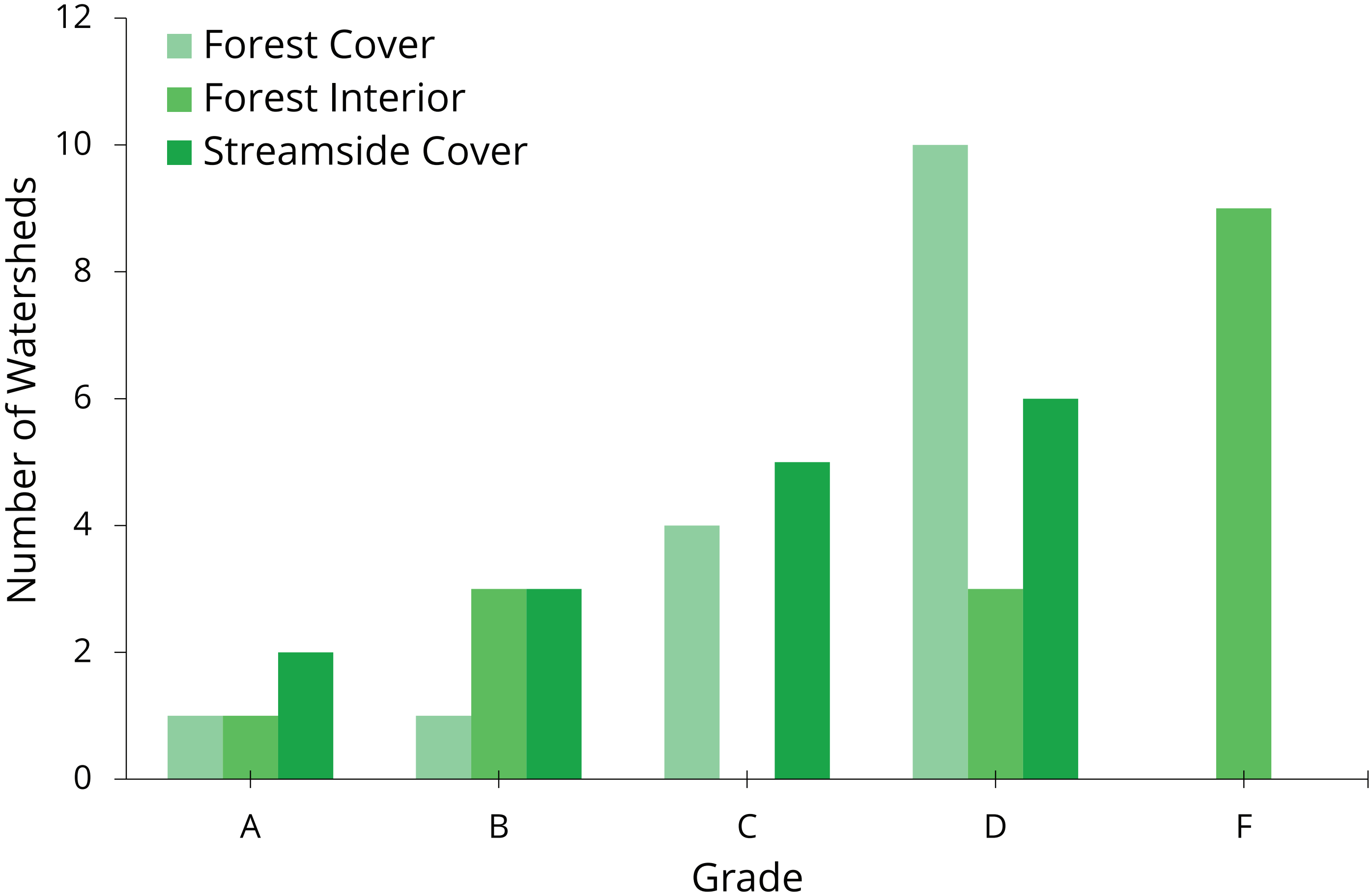
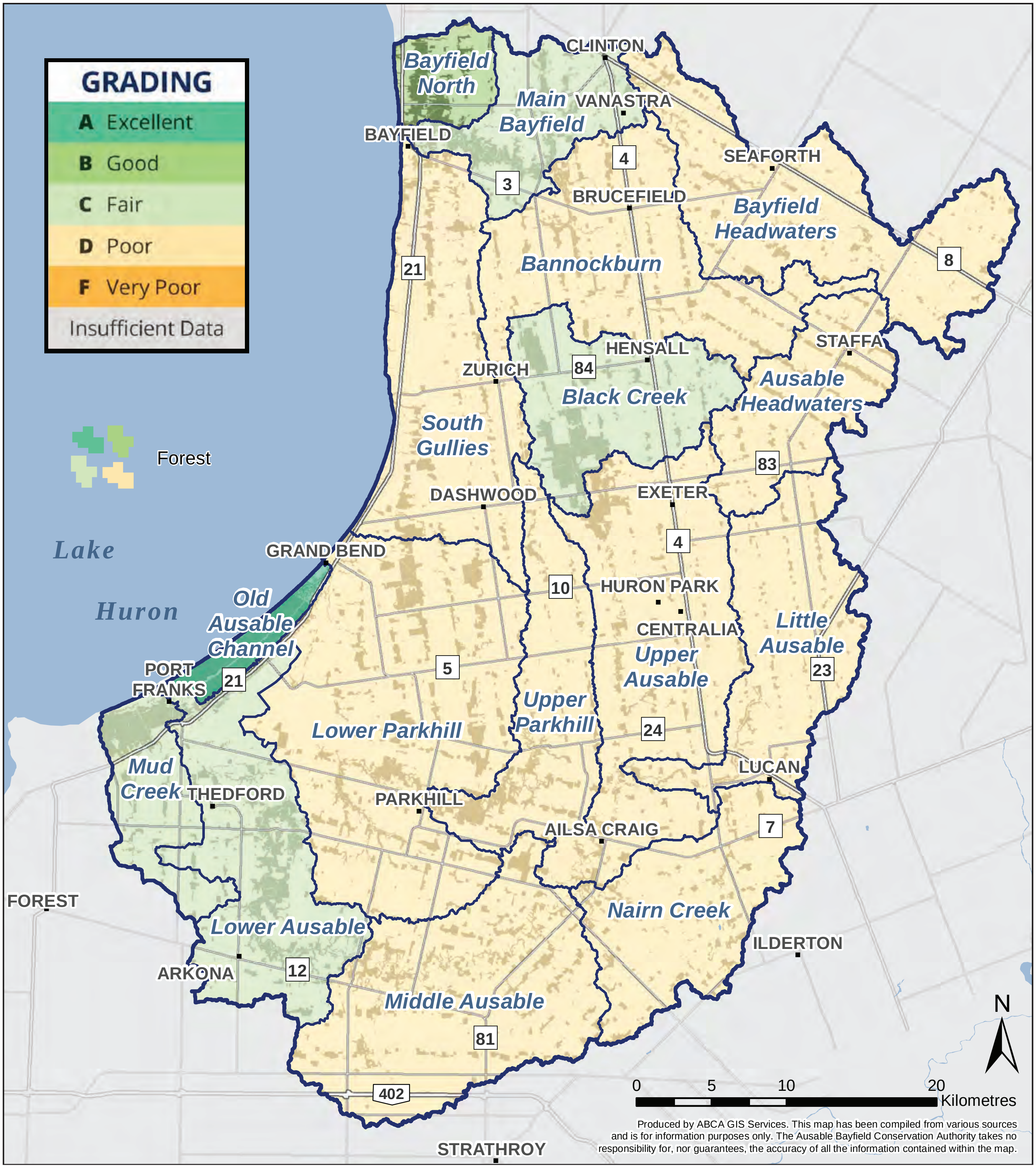


Figure 1: Distribution of grades for forest cover, forest interior and streamside cover for the Ausable Bayfield watersheds.

Land use pressures remain a key challenge to maintaining and increasing forest cover. The productive and valuable farmland in the Ausable Bayfield watershed area is an economic driver for the region.

Raising forest cover in the Ausable Bayfield by one per cent would require planting of approximately 6,000 acres (2,428 hectares) of land for reforestation, and approximately 4,200,000 tree seedlings.



Map 5: Grade distribution of forest conditions in the Ausable Bayfield watershed

Typically, 50 to 100 acres of trees are planted annually. Grade changes in forest cover may be hard to realize. With the gains in forest cover so difficult to come by and the loss of forest by 'a thousand cuts' so difficult to quantify, it is important to protect our existing forests.

Watershed residents can continue to help maintain current forest conditions by planting trees around fields and watercourses, and not trimming or removing small woodlots. Old trees removed along ditches and fencerows should be replanted with young trees in a suitable location. Additionally, the health and biodiversity of declining and stressed woodlots can be improved by planting a variety of tree species. Calculate the number of trees required to counter-balance (offset) your carbon footprint at **footprintstoforests.com** (**http://www.abca.ca/page.php?page=carbon-calculator**) – donate all or part of the amount required, if you wish – and consider tree planting in the spring or autumn.

For landowners who wonder where they might plant trees, an article in a Huron County Federation of Agriculture publication (The Survey) makes four recommendations:

1. Along rivers and one side of municipal drains;
2. Farmsteads;
3. Property lines; and
4. Squaring up a field with trees.

Larger tree plantings by rural landowners and organizations are needed to dramatically change forest conditions (and future land acquisition may be needed as well) but we are reminded that every tree counts.

Tracking forest cover through the watershed report card has had some challenges. Improvements in aerial photography have resulted in classification of some forested areas that were not picked up in lower-resolution imagery from previous years (1999 and 2006) and has made it difficult to compare 'apples to apples.' The minimal percentage

changes in forest cover between 2013 and 2018 may reflect the improved aerial 2015 photography. A more comprehensive analysis might look more closely at each forest polygon. This analysis, done with community support and guidance, will help to develop future solutions.

The importance of doing this monitoring and reporting is that the community needs to track gains (and losses!) even if these numbers are minimal.

2.0.2 Wetland Cover

Methods

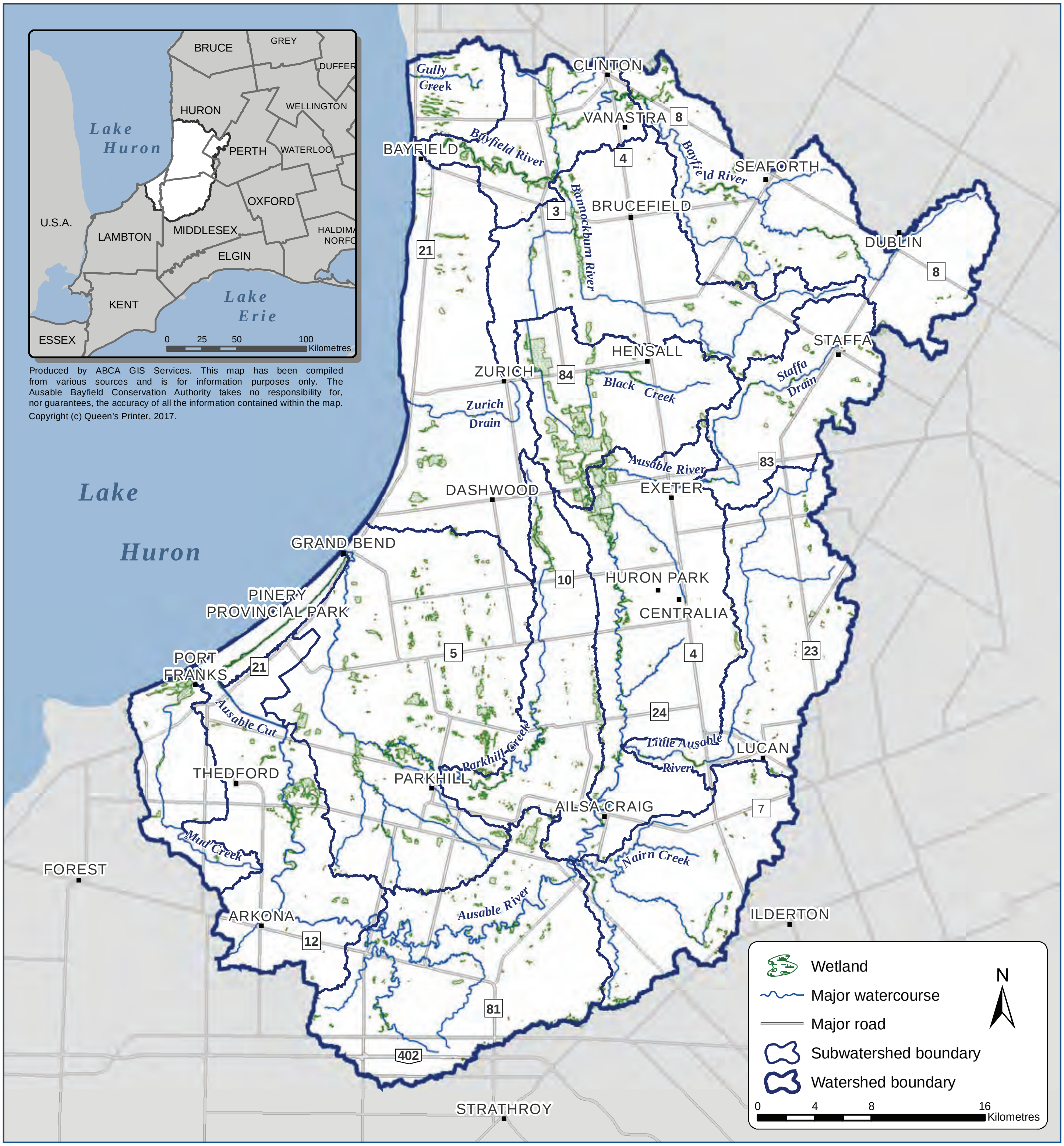
Wetland cover was mapped with Geographic Information Systems (GIS) and the Ausable Bayfield natural heritage layer. Unlike forest conditions, however, wetland conditions were only based on one indicator: amount of wetland cover. For the purposes of this 2018 report, wetlands were defined as land that is seasonally or permanently flooded by shallow water, as well as land where the water table is close to the surface. The percentage of wetland cover by subwatershed was not completed for this round of reporting as there have been recent revisions to the definition of wetland. Consequently, the delineation of the wetland areas in accordance with this new definition had not been finalized in time for the completion of this report.

Results

Wetlands are limited in the Ausable Bayfield watershed at just two to three per cent of the area (Map 6).

The largest wetland in the watershed is the provincially significant Hay Swamp located in the Black Creek Watershed.

WETLAND COVER



Map 6: Distribution of wetland cover in the Ausable Bayfield watershed

OVERWINTER VEGETATIVE COVER

ON AGRICULTURAL LANDS

2.0.3 Overwinter Vegetative Cover on Agricultural Lands

In our highly-utilized landscape, rain gardens and other low-impact development can reduce the effects of urbanization. Best management practices such as cover crops and improved crop diversity, with hay and other forage, are important in rural areas.

The health of soil and downstream water quality can be impacted by the amount and duration of vegetative plant cover on agricultural lands during the year.

Methods

Agricultural land use is the total area of agricultural land within a watershed and it is expressed as a percentage. Overwinter vegetative cover is the total area of agricultural land covered by wheat, forages, or hay during the winter season, and it is also expressed as a percentage. If all fields were in a corn-soybean-wheat rotation, a minimum of 30 per cent of overwinter vegetative cover might be expected. The percentage of overwinter vegetative cover on agricultural lands was not assigned a point score or final grade.

Agricultural lands with overwinter cover were calculated using the Ontario Ministry of Agriculture, Food, and Rural Affairs agricultural layer and aerial photography from 2010 and 2015. With Geographic Information Systems (GIS), agricultural fields were classified as vegetative or non-vegetative using the Modified Soil Adjusted Vegetative Index (MSAVI). This index uses differences in light reflectance to classify the landscape. Fields with high vegetative cover emit reflectance values that are higher than fields with bare soil.

A very important consideration is that the MSAVI is limited to the detection of 'living' vegetative cover. Therefore, it is unable to detect fields that may be covered by cover crops that have been sprayed or tilled under for 'green manure'. The MSAVI is also dependent upon the aerial photography and the season in which the photography has been flown. The progression of the growing season also affects the MSAVI. For instance, the spring of 2010 was warm and the wheat fields were very obvious in the aerial photos from that year. In 2015, the cold, wet spring delayed the growth of wheat fields. Consequently, the MSVAI resulted in a lower percentage of overwinter vegetative cover on agricultural land in 2015 compared to 2010.

Results

In the Ausable Bayfield area, overwinter cover ranged from six to twenty-six per cent. The South Gullies, Bannockburn, Bayfield North, Main Bayfield, and Bayfield Headwaters had the highest overwinter cover percentages. The lowest percentages were found in Upper Parkhill, Lower Parkhill, Nairn Creek, Middle Ausable, and Lower Ausable. Please consult the individual report cards for values.

As remote sensing techniques improve, the ability to track this land management indicator will also improve. If you are interested in this analysis, please contact us and share your thoughts.

Plant cover keeps soil healthy and limits erosion, runoff

Soil forms the basis for growing the food we eat. It is vital to protect this valuable resource, especially as the global demand for food grows. Increased urbanization and intensification of competing land uses create the potential to cause losses and degradation of the soil resource. We need to value soil for its role in our food security, protection of water quality, and as a driver of the rural economy.

Soil should not be considered a renewable natural resource. Once soil is lost, it is very hard to get it back again.

Healthy soils with good infiltration help to reduce surface runoff and topsoil loss, and can result in improved water quality. In our predominantly agricultural area, the community highlighted a need to monitor soil health in a *Conservation Strategy* produced for the Ausable Bayfield area in 2012. Since this time, the ABCA has looked at the idea of soil health at different scales including side-by-side trials at the field scale, subwatershed risk-based assessments, and watershed-wide soil health sampling.

Recent local research by Ausable Bayfield Conservation has highlighted the role of covered soils to store water, which ultimately helps to limit runoff.

In this *Watershed Report Card* we report on, but do not grade, an important determinant of soil health – percentage of overwinter vegetative cover on agricultural lands. As this is a first attempt to measure soil management, we value any feedback from the larger watershed community. We hope to continue to develop a better understanding of the link between field measurements and watershed-scale evaluation.

For an overview of the Ausable Bayfield Watershed Report Card 2018 please consult the eight-page summary brochure.

SURFACE WATER QUALITY

2.0.4 Surface Water Quality

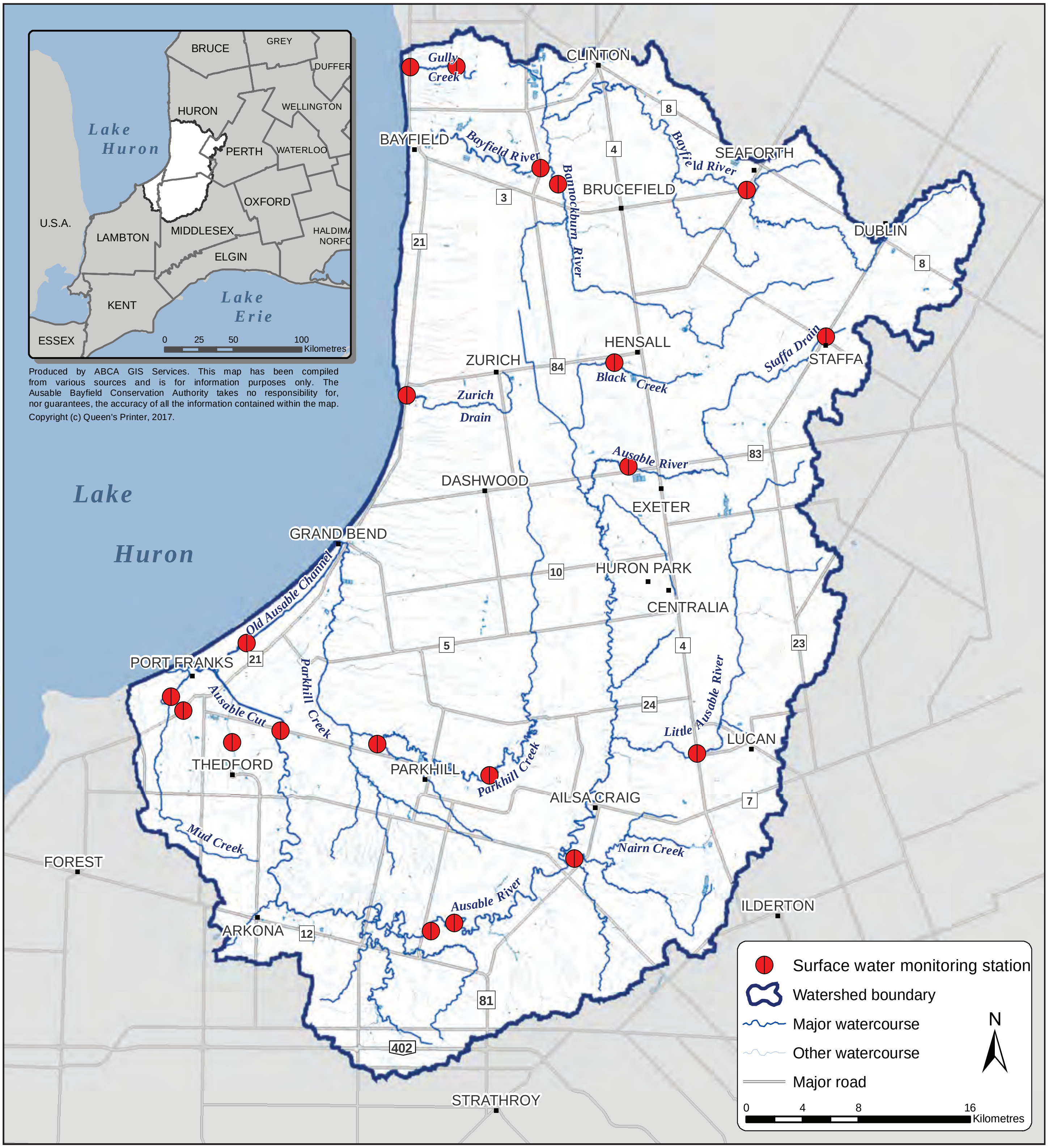
Methods

Since the early 1960s, the Ausable Bayfield Conservation Authority (ABCA) has partnered with the Ontario Ministry of the Environment and Climate Change (MOECC) to take surface water quality samples at locations within the Ausable Bayfield watersheds through the Provincial Water Quality Monitoring Network (PWQMN). There are nine PWQMN sites within the Ausable Bayfield area at present.

In order to more effectively monitor water quality in the Ausable Bayfield watersheds, the ABCA also samples seven additional water quality stations to these routine monitoring sites. There is also an extensive monitoring program currently running in the Bayfield North watershed. The enhancement of the water quality monitoring program provides the community with information about more watersheds.

Monthly grab samples were collected at a monitoring site in each watershed between the months of March and November (Map 7, Table 3). The samples were analyzed for a variety of water quality indicators, including total phosphorus and *Escherichia coli* (*E. coli*).

Yearly in October, benthic invertebrate samples were also collected at a monitoring station in each watershed, except the Old Ausable Channel (OAC) (Map 7, Table 3). The habitat for benthic invertebrates in the OAC, a wetland, is different from the other riverine sites and would not make for meaningful comparisons.



Map 7: Surface water quality monitoring stations in the Ausable Bayfield watershed

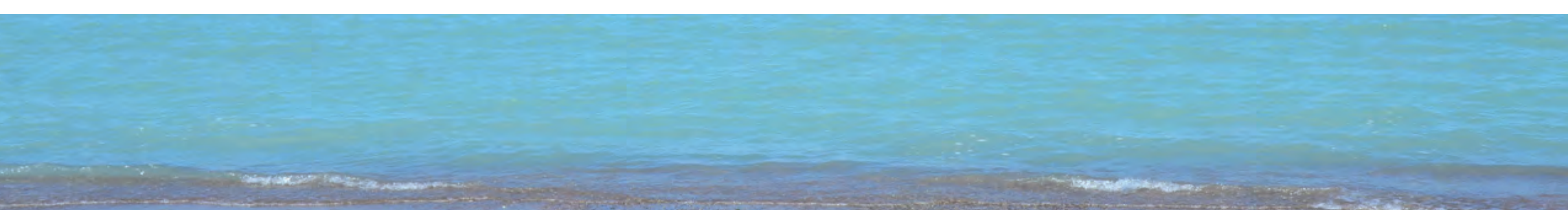


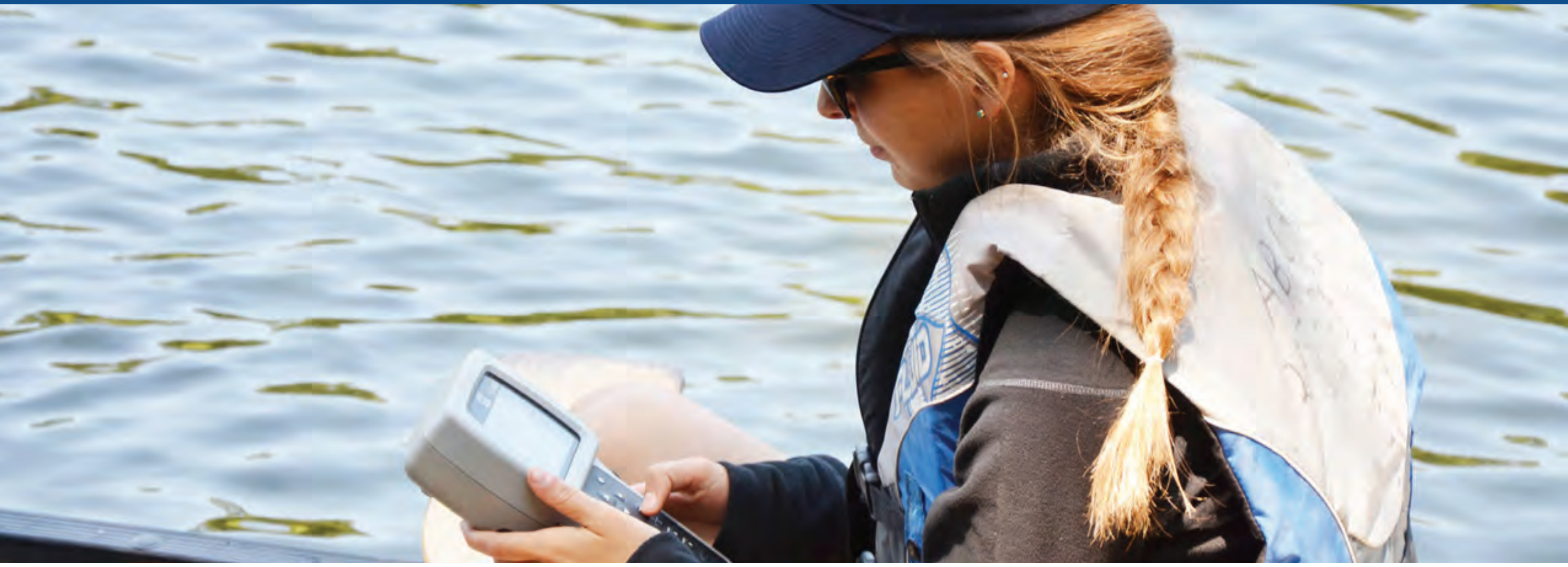
Table 3: Data used to determine watershed report card grades for surface water quality conditions throughout the Ausable Bayfield watershed.

Watershed	Site	Total Phosphorus Years of Data	Total Phosphorus Number of Samples	*Escherichia coli (E. coli)* Years of Data	*Escherichia coli (E. coli)* Number of Samples	Benthic Invertebrates Years of Data	Benthic Invertebrates Number of Samples
Ausable Headwaters	HASTAF1	2012-2016	43	2012-2016	43	2012-2016	5
Bannockburn	MBBAN1	2012-2016	44	2012-2016	44	2012-2016	5
Bayfield Headwaters	MBSEA1	2012-2016	44	2012-2016	44	2012-2016	5
Bayfield North	GULGUL5	2012-2016	43	–	–	–	–
	GULGUL2	–	–	2012	8	2012-2016	5
Black Creek	MABLA2	2012-2016	44	2012-2016	44	2012-2016	5
Little Ausable	MALIT2	2012-2016	43	2012-2016	44	2012-2016	5
Lower Ausable	MABOG1	2012-2016	43	2012-2016	43	-	-
	MADECK2	-	-	-	-	2013-2016	4
Lower Parkhill	MPMCIN1	2012-2016	44	2012-2016	44	2012-2016	5
Main Bayfield	MBVAR1	2012-2016	43	2012-2016	42	2012-2016	5
Middle Ausable	MASPR1	2012-2016	43	2012-2016	43	–	–
	MAGLAS1	–	–	–	–	2012-2016	5
Mud Creek	MMOUTER1	2012-2016	44	2012-2016	44	-	–
	HMUD21	–	–	–	–	2012-2016	5
Nairn Creek	MANAIRN1	2012-2016	44	2012-2016	44	2012-2016	5
Old Ausable Channel	OACDAM1	2012-2016	44	2012-2016	44	–	–
South Gullies	GULZUR8	2012-2016	44	2012-2016	42	2012-2016	5
Upper Ausable	MAEXE1	2012-2016	44	2012-2016	44	2012-2016	5
Upper Parkhill	MPMCGUF1	2012-2016	44	2012-2016	44	2012-2016	5

Methods – Total Phosphorus

Phosphorus is a nutrient that limits the growth of algae and aquatic plants. When phosphorus is added to an aquatic system, the first response is increased algae and plant growth, which can be beneficial to aquatic life. Beyond a certain point, however, phosphorus becomes over-abundant and produces excessive growth of algae and aquatic plants (eutrophication), which is detrimental to streams and rivers. The Provincial Water Quality Objective (PWQO) for total phosphorus is 0.03 mg/L, to prevent eutrophication.

Sources of phosphorus include human and animal waste, fertilizers, detergents, and soil erosion.



Methods – Total Phosphorus
(continued)

The 75th percentile total phosphorus concentration was calculated for data collected from each site between 2012 and 2016 (Table 3). The 75th percentile represents the value below which 75 per cent of the values occur. This value was used as opposed to a median value (50th percentile) to account for the tendency of samples to be collected during dry weather periods.

The 75th percentile concentration of total phosphorus was converted to a point score and a grade for each watershed according to the Conservation Ontario guidelines (Conservation Ontario 2017) (Table 4).

Regression analyses were performed to evaluate trends in total phosphorus concentrations for the period of March 2000 to November 2016. A parametric approach (linear trend test) was used to evaluate the trends in monthly concentrations (i.e., improving trend, no trend, declining trend) for normally distributed datasets. However, if the water quality datasets were non-normally distributed, a non-parametric approach (Mann-Kendall trend test) was used instead. A Shapiro-Wilk test was completed to determine normality of the datasets. A trend was found to be statistically significant when the magnitude of the change was large relative to the variation of the data around the trend line (i.e., p-value < 0.05).

Table 4: Surface water quality indicator scoring and grading for the Ausable Bayfield watersheds (adapted from Conservation Ontario).

Total Phosphorus (mg/L) – 75th Percentile	*Escherichia coli* (cfu*/100 mL) – Geometric Mean	Benthic Invertebrates (Modified Family Biotic Index†)	Point Score	Grade
<0.020	0-30	<4.25	5	A
0.020-0.030	31-100	4.26-5.00	4	B
0.031-0.060	101-300	5.01-5.75	3	C
0.061-0.180	301-1000	5.76-6.50	2	D
>0.180	>1000	6.51-10.00	1	F

* cfu – colony forming units
† based on New York State tolerance values

Results – Total Phosphorus

As in the 2013 report card, most subwatersheds exceeded the objective set by the Ontario Ministry of the Environment and Climate Change (MOECC) of 0.03 mg/L (Figure 2). Grades ranged from A to D, with most subwatersheds receiving a C or D grade (Figure 3). The Old Ausable Channel and the Main Bayfield watersheds had the lowest total phosphorus concentrations, which were approximately 0.02 mg/L.

Without a dataset that links concentrations to flow data, it is challenging to discuss trends over time. In Gully Creek, in the Bayfield North watershed, we have a comprehensive monitoring program and although we moved the longer-term water quality station we have demonstrated a decreasing trend in total phosphorus concentrations in this area (Bittman and Veliz 2017). Another consideration with the total phosphorus data, is that the MOECC laboratory method for measuring total phosphorus concentrations changed in November 2012. We evaluated this change with our total phosphorus concentrations and were satisfied the new method provided comparable results.

Regardless of the constraints, we understand the community wants to know if things are improving. Further analysis showed that Lower Parkhill (2003-2016) and Main Bayfield (2000-2016) have an overall decreasing trend in total phosphorus concentrations, while Nairn Creek (2003-2016) and Mud Creek (2003-2016) have an overall increasing trend.

Due to the cumulative nature in which phosphorus impacts downstream bodies of water, such as Lake Huron, it is important for all of us to **ACT** (**A**void; **C**ontrol; and **T**rap and treat) on sources of phosphorus on our properties. In addition to sources of human and animal waste, fertilizers and detergents, soil erosion can contribute to phosphorus concentrations because phosphorus binds to soil particles.

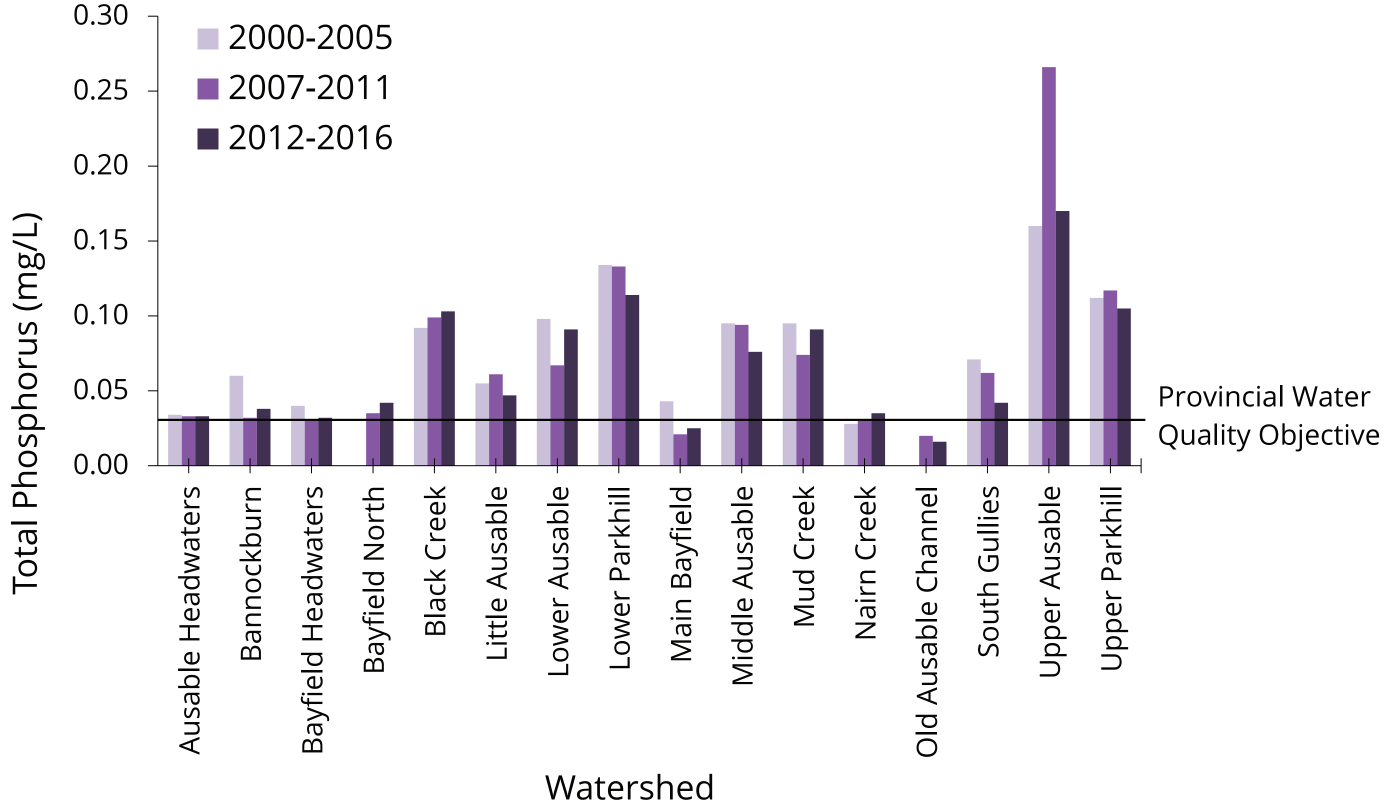


Figure 2: Concentrations of total phosphorus across all Ausable Bayfield watersheds. The black line represents the Provincial Water Quality Objective (0.03 mg/L).

Methods – Escherichia coli

Escherichia coli (*E. coli*) are fecal coliform bacteria commonly found in the intestines of animals and humans. Their presence in water is a strong indication of recent sewage or animal waste contamination, and that there is potential for other disease-causing organisms to exist. Conservation Ontario (2017) therefore recommended that concentrations of *E. coli* also be used as an indicator for the *Watershed Report Card*.

Concentrations of *E. coli* in surface water can be relatively low (<10 colonies per 100 mL) and very high (>10,000 colonies per 100 mL). The average concentration would inflate the typical conditions, so the geometric mean is calculated instead. It is calculated as the nth root of the product of n numbers. The geometric mean of *E. coli* concentrations was converted to a point score and grade for each watershed according to Conservation Ontario guidelines (2017) (Table 4). The Recreational Water Quality Guideline for *E. coli*, for people to swim or bathe in water, is 100 cfu/100 mL.

Escherichia coli data were also summarized for a five-year period (Table 3). It is hoped that a five-year reporting period will help to avoid making conclusions about concentrations that are limited to a wet or dry year.

Regression analyses were performed to evaluate trends in *E. coli* data for the period of March 2000 to November 2016. A parametric approach (linear trend test) was used to evaluate the trends in monthly concentrations (i.e., improving trend, no trend, declining trend) for normally distributed datasets. However, if the water quality datasets were non-normally distributed, a non-parametric approach (Mann-Kendall trend test) was used instead. A Shapiro-Wilk test was completed to determine normality of the datasets. A trend was found to be statistically significant when the magnitude of the change was large relative to the variation of the data around the trend line (i.e., p-value < 0.05).

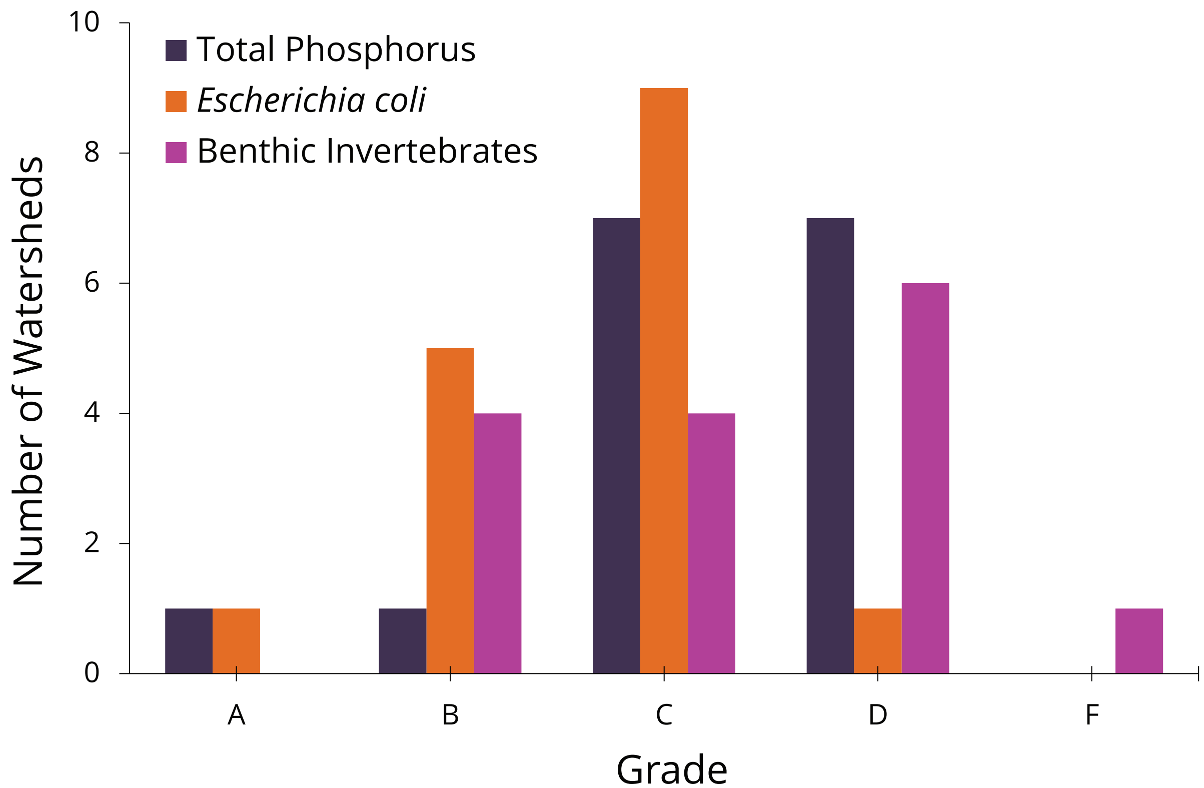


Figure 3: Distribution of grades for total phosphorus and *Escherichia coli (E. coli)* concentrations, and benthic invertebrates for the Ausable Bayfield watersheds.

Results – Escherichia coli

Concentrations of *E. coli* in the different watersheds continued to exceed the Recreational Water Quality Guideline of 100 cfu/100 mL (Figure 4). Grades ranged from A to D, with most watersheds receiving a C grade (Figure 3). Although there were still some higher concentrations (which may suggest a local point source), six watersheds met, or were below, the Recreational Water Quality Guideline, compared with only one watershed in the 2007 report card. Further analysis shows that four watersheds had an overall decreasing trend in *E. coli* concentrations: Ausable Headwaters, Bayfield Headwaters, Black Creek, and Main Bayfield. One watershed had an overall increasing trend, the Old Ausable Channel, however, this is most likely due to a larger variability in the recent data since the geometric mean for the watershed is 9 cfu/100 mL. The Old Ausable Channel received the only A grade, which can be attributed to the surrounding natural land use. Note that the Bayfield North watershed was only sampled for *E. coli* in 2012.

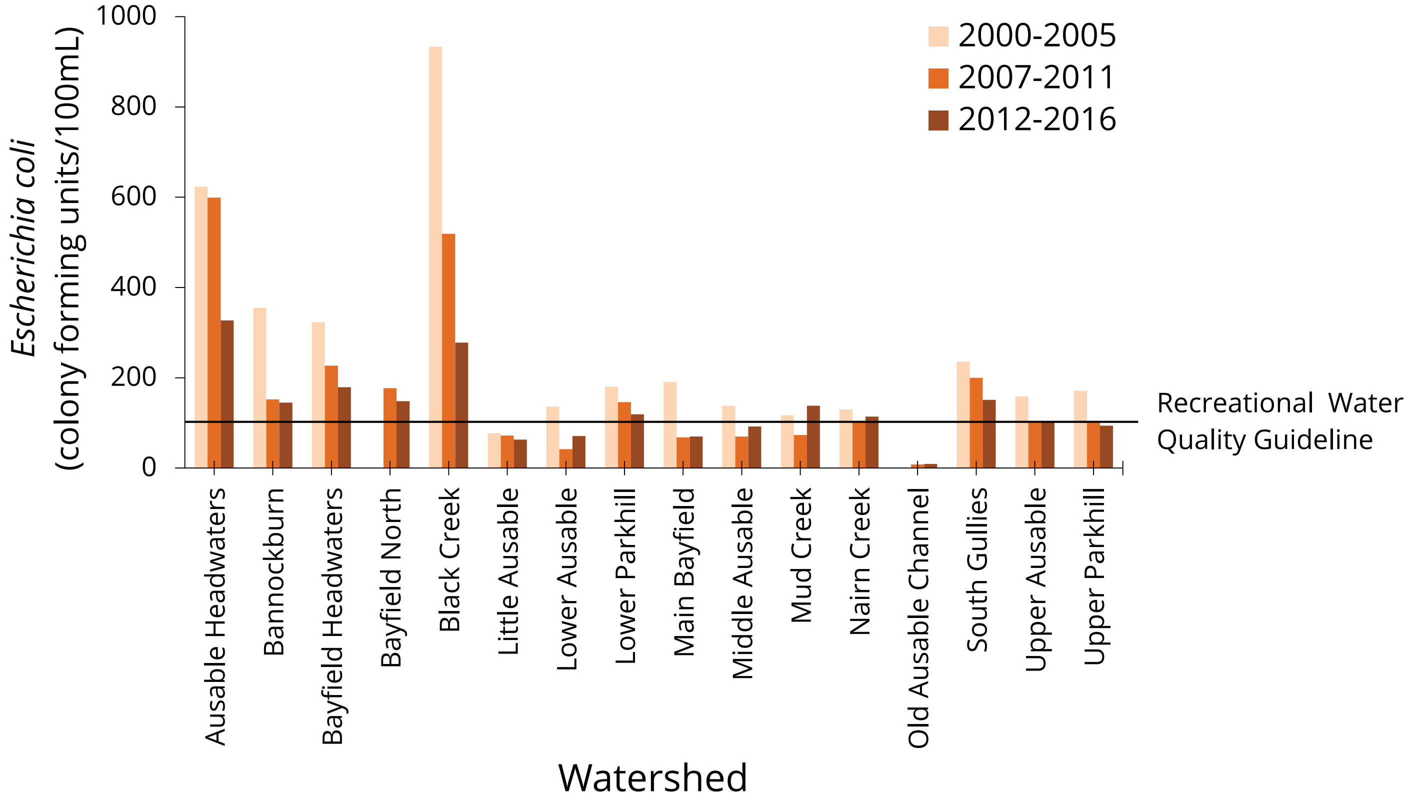


Figure 4: Concentrations of *Escherichia coli (E. coli)* across all Ausable Bayfield watersheds. The black line represents the Recreational Water Quality Guideline (100 cfu/100 mL).

Methods – Benthic Invertebrates

Benthic macroinvertebrates are commonly used as indicators of aquatic environmental quality. Invertebrates are animals without backbones, such as insects, crustaceans, molluscs, and worms. 'Benthic' refers to the bottom of lakes and rivers, where these invertebrates are found. 'Macro' refers to the subset of larger or visible invertebrates: generally ¼ to ½ millimetre in length.

Each species that makes up this assortment will have a different tolerance to the variety of stressors and pollutants that may be present in the local environment. Tolerance values between one and ten can be assigned to these animals, with one meaning intolerant to pollution and ten meaning tolerant. The tolerance values for invertebrates present at a particular site were used to calculate the *Hilsenhoff 1988 Family Biotic Index* (FBI), as modified by New York State (Smith et al. 2009). The FBI index provided a score for each watershed (Table 4) that reflected the environmental quality within the area that these organisms were surveyed. The presence of pollution-intolerant species generally indicates a healthy aquatic environment.

Benthic invertebrate communities reflect not only water chemistry, but also substrate (i.e., stream bottom) conditions. Substrate conditions vary across watersheds, so efforts were made to be as consistent as possible when sampling benthic sites. Sampling sites for the *Watershed Report Card* process were of the highest quality substrate that supports the best possible invertebrate communities.

Benthic monitoring sites are now sampled on an annual basis, however, some sites had been sampled on an alternating year schedule in the past. In addition, there is no benthic invertebrate monitoring site for the Old Ausable Channel watershed as this habitat is more like a wetland and other sites are riverine.

Results – Benthic Invertebrates

The benthic invertebrate scores for most watersheds increased slightly over the scores from the 2013 report card, which means a minor shift towards poorer conditions (Figure 5). The FBI values were generally between four and seven, indicating that there were a variety of animals (both tolerant and intolerant to organic pollution) at each monitoring site. Grades ranged from B to F, with most watersheds receiving a D grade (Figure 3).

The Middle Ausable (4.51), Main Bayfield (4.70), Nairn Creek (4.70), and Bayfield North (4.96) watersheds received a B grade (i.e., benthic invertebrates found there are less tolerant to pollution). The Black Creek site had the highest FBI value (6.62), suggesting that this site was more degraded than others in this area. The Mud Creek watershed also had a higher FBI value (6.50), indicative of degraded water quality.

Note that there are no comparisons to the previous report card for the Mud Creek watershed, as the benthic monitoring site has been moved since the last report card.

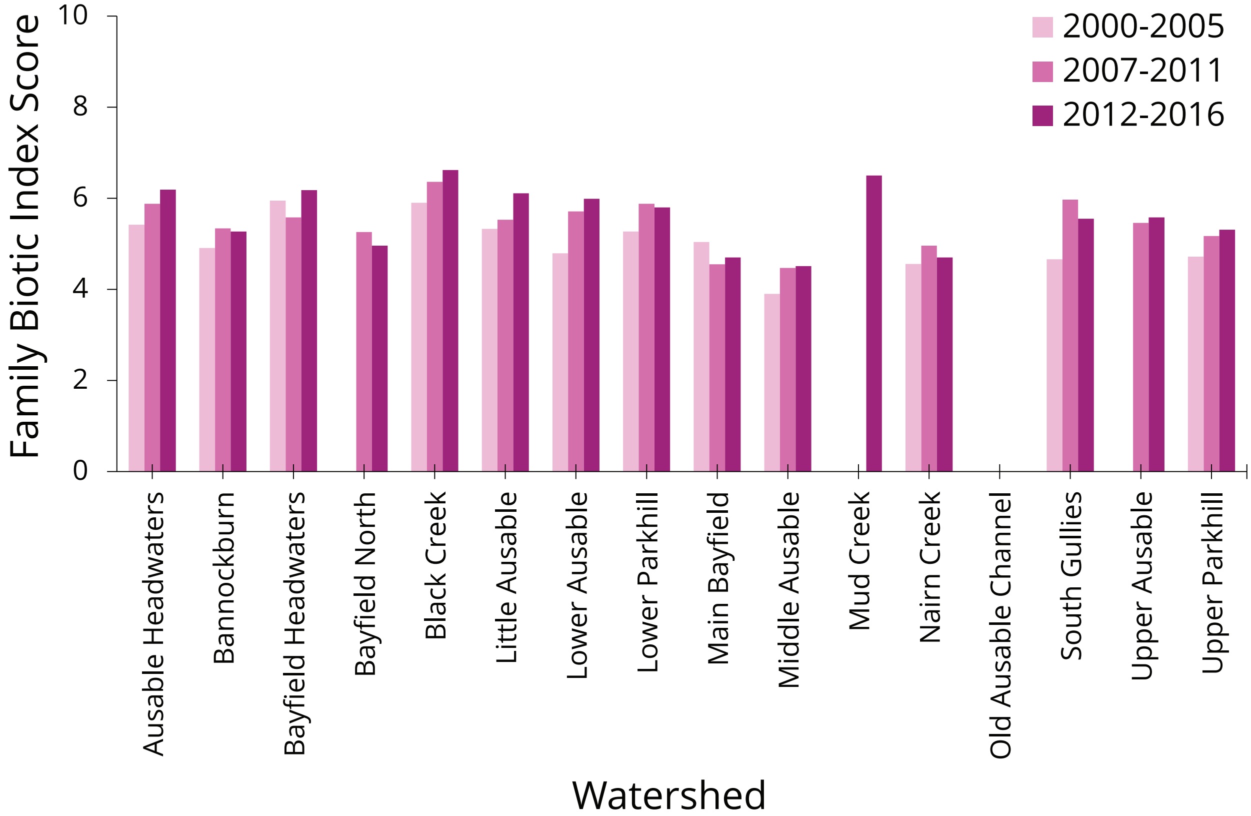


Figure 5: Benthic invertebrate Family Biotic Index (FBI) scores across Ausable Bayfield watersheds. A score of 1 represents a healthy watershed and a score of 10 represents a degraded watershed.

Methods – Overall Surface Water Quality

As with forest conditions, the point scores for each water quality indicator (total phosphorus, *E. coli*, and benthic invertebrates) were averaged to determine an overall point score for a watershed. This point score was then given a final grade for each watershed (Table 5).

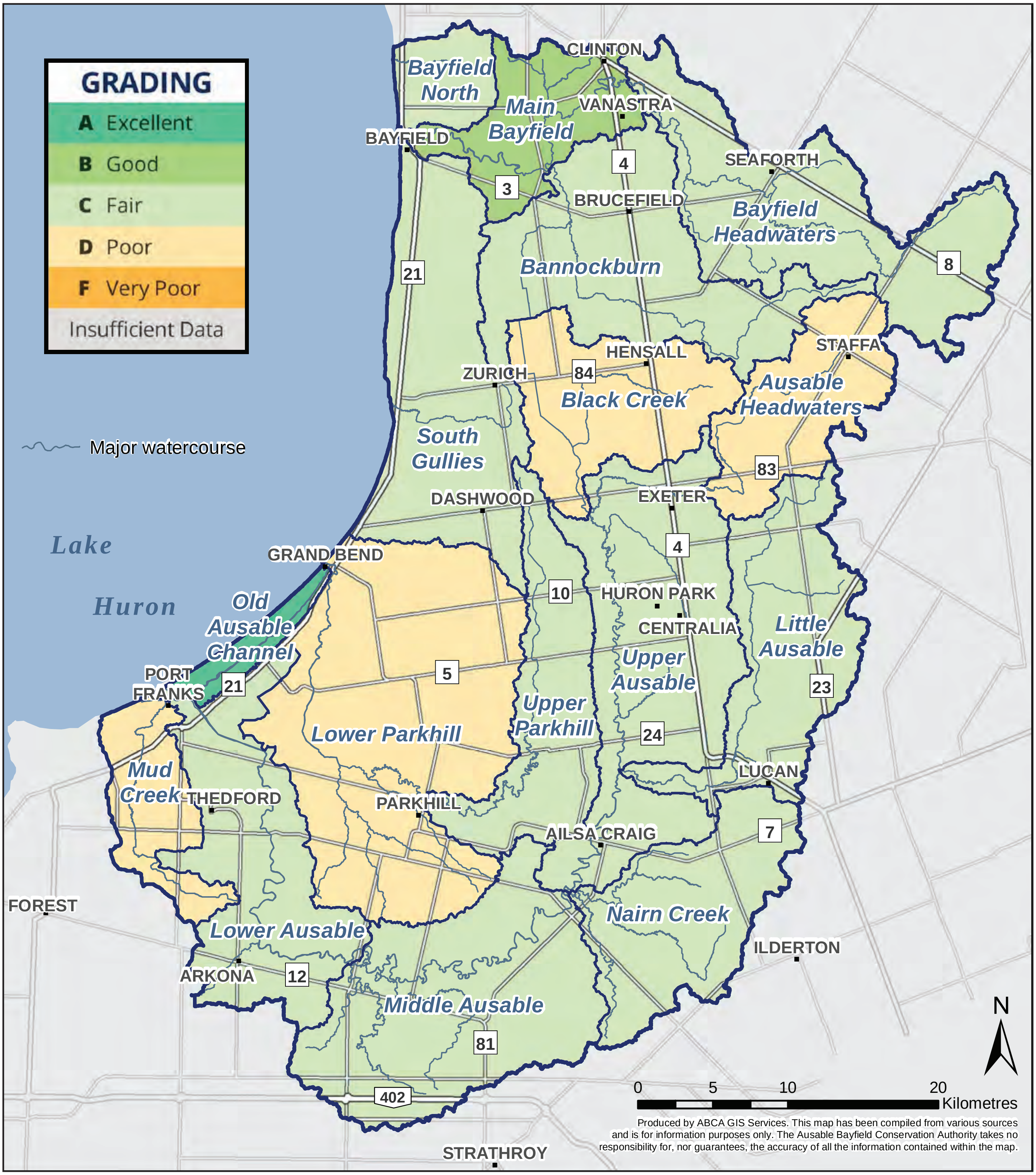
Results – Overall Surface Water Quality

Indicators for surface water quality conditions within the Ausable Bayfield area indicate fair conditions, as most subwatersheds received a C grade (Figure 3, Map 8). Only the Old Ausable Channel watershed received an A grade. Water quality was excellent within the channel, most of which is within Pinery Provincial Park.

Table 5: Overall surface water quality scoring and grading for the Ausable Bayfield watersheds (adapted from Conservation Ontario).

Average Point Score	Overall Surface Water Quality Grade
>4.4	A
3.5-4.4	B
2.5-3.4	C
1.5-2.4	D
<1.5	F

The Main Bayfield watershed received a B grade. Further evaluation of the conditions in this watershed has been undertaken since 2013, as this area is a priority, sentinel watershed for the *Healthy Lake Huron – Clean Water, Clean Beaches* initiative (**healthylakehuron.ca**).



Map 8: Grade distribution of overall surface water quality conditions in the Ausable Bayfield watershed

GROUNDWATER QUALITY

2.0.5 Groundwater Quality

Methods

Similar to the surface water monitoring program, the Provincial Groundwater Monitoring Network (PGMN) is a partnership between the Ontario Ministry of the Environment and Climate Change (MOECC) and local conservation authorities. This program was started in 2003, and there are 14 monitoring wells within the Ausable Bayfield watershed at present (Map 9). Sampling at all monitoring wells occurred once a year and samples were analyzed for various indicators. Conservation Ontario (2017) recommends that nitrate and chloride be used as indicators of groundwater quality.

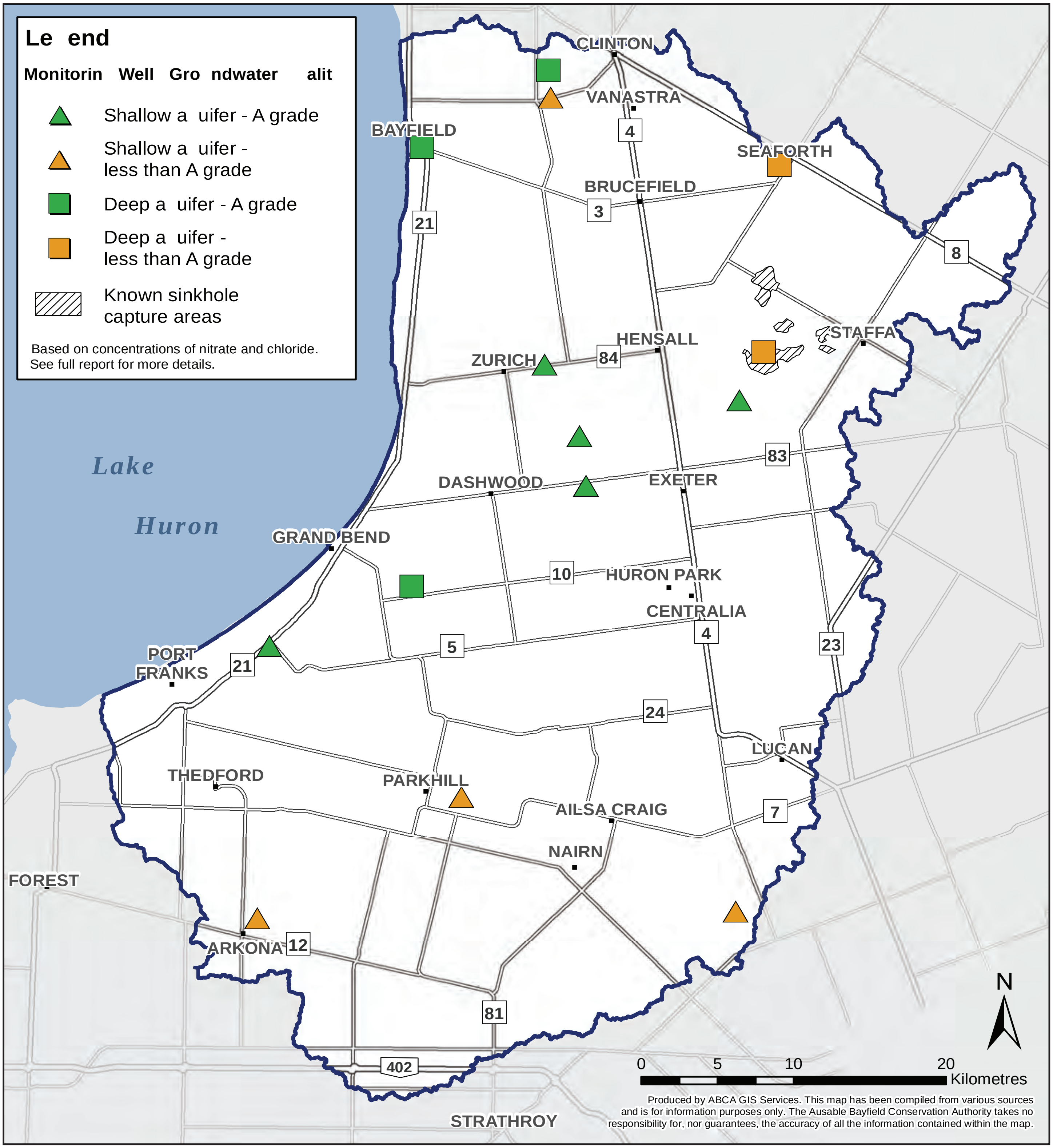
Conservation Ontario (2017) recommends using the 75th percentile for nitrate and chloride concentrations over the ten-year period from 2007 to 2016. With limited groundwater data collected (one sample per year for a total of 10 sampling points) and the sensitivity of the drinking water resource, Ausable Bayfield Conservation felt that the maximum nitrate

or chloride concentration should be used to assess groundwater quality. This maximum concentration for each indicator was then compared to the Conservation Ontario grading system (Table 6). Two grading categories were used, with a monitoring well receiving either an ‘A grade’ or ‘Less than A grade.’ We hope that this reporting approach better informs people of issues that may impact their own wells in the vicinity of a monitoring well.

Table 6: Groundwater quality indicator scoring and grading for monitoring wells throughout the Ausable Bayfield watersheds (adapted from Conservation Ontario 2017).

Nitrate* (mg/L)	Chloride (mg/L)	Grade
0-2.5	0-62.5	A
2.6-5.0	62.6-125.0	Less than A
5.7-7.5	125.1-187.5	Less than A
7.6-10.0	187.6-250.0	Less than A
>10.0	>250.0	Less than A

*Nitrate = Concentrations of nitrogen that are in the form of nitrate and nitrite.



Map 9: Groundwater quality conditions at the 14 provincial monitoring wells in the Ausable Bayfield watershed

Results

Reporting on groundwater conditions is more difficult than reporting on surface water quality conditions for several reasons.

Surface water and groundwater move differently – one over the land surface, and the other through soil and bedrock into aquifers (underground rock formations/structures that carry water). Flowpaths are typically downward or horizontal through these aquifers and, since it is hard to see these interactions underground, we can only infer the source of water for individual monitoring wells. Most importantly, groundwater boundaries differ from surface water boundaries, which can make grading on a watershed scale irrelevant. Groundwater quality grades provided in this report card were therefore given to each monitoring well, not each watershed like the other indicators. Different aquifers exist throughout the region, and have the potential to be quite localized so it is important to monitor water quality at private drinking water wells regularly, even if the water scores an A grade for the local monitoring well.

This *Watershed Report Card* refers to bedrock wells as deep wells, and overburden wells as shallow wells.

Although there were three wells that received less than an A grade due to concentrations of nitrate, most of the provincial monitoring wells approximated the detection limit (0.05 mg/L) most of the time (Map 9). The Ontario (and Canadian) Drinking Water Quality Standard for nitrate (nitrate + nitrite as nitrogen) is 10 mg/L. Concentrations above 10 mg/L in drinking water can have adverse effects on infants less than six months old. The Sinkhole well near Staffa very closely approached this standard, and the TR9 well near Clinton exceeded it four times over the ten-year period (Table 7). Concentrations of nitrate at the Nairn well were not close to the drinking water standard, but they were not typical of the barely detectable concentrations found at most wells for most of the time. Although nitrogen can occur naturally in rocks and groundwater, runoff from fertilizer and manure applications, as well as faulty septic systems, can result in high nitrate concentrations.

Table 7: Groundwater monitoring wells in the Ausable Bayfield area that received a 'less than A' grade for nitrate or chloride concentrations.

Well Name (Nearest Urban Area)	Type of Well	Indicator with less than an A grade	Maximum Concentration between 2007-2016	Standard or Guideline
Sinkhole (Staffa)	Deep	Nitrate	9.7 mg/L	10.0 mg/L
TR9 (Clinton)	Shallow	Nitrate	18.3 mg/L	10.0 mg/L
Nairn (Nairn)	Shallow	Nitrate	4.6 mg/L	10.0 mg/L
Seaforth (Seaforth)	Deep	Chloride	315.0 mg/L	250.0 mg/L
Rock Glen (Arkona)	Shallow	Chloride	90.0 mg/L	250.0 mg/L
Parkhill (Parkhill)	Shallow	Chloride	84.8 mg/L	250.0 mg/L

The Canadian Drinking Water Quality Guideline for chloride is 250 mg/L. Chloride in drinking water is generally not considered harmful for consumption, although most people find water with concentrations above 250 mg/L unpleasant to drink. The Rock Glen well near Arkona had chloride concentrations that ranged from 70 to 90 mg/L from 2007 to 2016. These values were typically higher than what was observed at the other monitoring wells (i.e., close to 10 mg/L). The Parkhill well also received a 'Less than A grade' because it had one chloride reading of 85 mg/L in 2011. The Seaforth well approached the guideline five times and exceeded it once over the ten-year period (Table 7). High chloride concentration can occur naturally, which can be related to the type of rock coming into contact with the water. High chloride concentrations can also come from human sources (e.g., road salt), so the cause of high concentrations needs to be evaluated.

Note that two out of the six wells that did not receive an A grade are deep wells (i.e., bedrock wells) (Table 7). It is unknown whether the high chloride concentrations in the Seaforth well are naturally occurring, but it is likely that the high nitrate concentrations in the Sinkhole well are a result of surface water contamination through the known sinkholes in that area. Deep wells are not precluded from contamination.

Properly maintaining wellheads and reducing nutrient inputs into surface water limits the potential for contaminants to reach groundwater sources.

Visit **abca.ca** for more information on water well stewardship. Grants may be available to help upgrade or decommission existing wells.

The Need for Integrated Watershed Management

Watersheds may be abstract for most of us but they are the units that can be nested and understood at different scales (e.g., Lake Huron, Bayfield River, and local backyard creek, or municipal drain). Thinking of watersheds in this way has management implications for the individual and to local and more regional levels of government.

Everything in a watershed is connected. Our actions upstream and on the landscape affect water, soil, and living things downstream. Cumulative effects of land management decisions may only be noticed in downstream waterways. Consequently, managing water requires a comprehensive approach. We protect drinking water through municipal wellhead protection. We also protect drinking water through treatment facilities. We also need to enhance water and soil across our landscape and deal with other water-related issues (e.g., major floods, and extended drought).

Integrated watershed management is not a new idea. It continues to emerge as important, however, because we can use watersheds to simultaneously address multiple environmental issues.

2.1 Summary

Forest conditions remain limited in the Ausable Bayfield watershed. The slight reported increases in forest cover and forest interior that occurred since the 2013 report card may reflect more detailed mapping for the 2018 *Watershed Report Card*. Mapping technologies should be more equivalent in the future, improving the comparison of forest conditions over time.

Wetland cover in the Ausable Bayfield watershed is also limited. Although no comparison can be made to prior conditions, (due to definition and mapping updates), additional water storage features on the landscape are needed to help to reduce soil erosion.

Most subwatersheds have remained steady in terms of water quality. Compared with the 2007 report card, in which only one subwatershed met the recreational guideline for *Escherichia coli* (*E. coli*), six subwatersheds now meet this guideline. Furthermore, the Main Bayfield watershed has had measurable improvements in concentrations of both total phosphorus and *E. coli*.

Groundwater quality throughout the Ausable Bayfield watershed is generally good. Several wells, however, approached the drinking water standard for nitrate or the guideline for chloride, and therefore received grades less than A. All landowners drinking from private wells should test their wells.

Surface water and groundwater quality results reflect natural features (e.g., soil characteristics, topography) and land use, which vary from watershed to watershed. Low forest and wetland cover, combined with predominantly clay soils, intensive agricultural and, in some areas, urbanization, contribute to water quality conditions that need improvement.

We encourage individuals and agencies to continue to strive to achieve A grades. However, Ausable Bayfield Conservation is also aware that A grades may not be practical due to natural factors, and the high agricultural productivity of the land. The goal of local individuals, community groups, agencies, and governments may therefore be to improve specific values. For example, *E. coli* in the Black Creek watershed was 933 cfu/100 mL in the 2007 report card, and is currently 278 cfu/100 mL. A reasonable goal would be to decrease this concentration to below 200 cfu/100 mL. If we continue to take enough of these small steps forward, we will create healthier watersheds together.

2.2 Next Steps

What can I do as an individual or as part of a community?

Can an individual make a difference? Yes. 'Thumbs Up' projects in Ausable Bayfield watersheds have highlighted landowners and communities that have protected and enhanced their local environment. Going forward, each *Watershed Report Card* suggests appropriate conservation actions that individuals can take on their properties, community actions, and actions by agencies.

It can be helpful to think of a range of environmental actions that include *save* (policies that help to protect some areas), *seed* (planting trees or creating wetlands), and *steward* (rural and urban best management practices – BMPs that mitigate some land use activities). These approaches can be taken at different scales (e.g., Lake Huron, Bayfield River, and local backyard creek, or municipal drain). One might reflect on regional areas where additional natural features are needed. This can also be a consideration for private landowners – are there places on my property that could be more natural?

In southern Ontario, much of the landscape is developed for agriculture or urbanized. For instance, in the Ausable Bayfield Conservation area, more than 75 per cent of the land is used for agricultural production. Stewardship practices, or best management practices, continue to be important.

There are many different practices that could be considered BMPs. An ACTion (i.e., Avoid; Control; Trap and Treat) framework puts practices into three tiers (Figure 6).

The first tier avoids water movement. Reduced tillage, cover crop use, and natural cover are examples of *avoid* practices. The improved soil health that results helps to infiltrate water where it lands, therefore avoiding runoff. According to the United States Department of Agriculture, as little as a one per cent increase in soil organic matter can hold 27,000 gallons of water per acre.

The second tier controls the movement of water by holding it back. Berms and rain gardens are examples of these measures.

A third management strategy is to trap or treat the water in primary aquatic systems. This is accomplished through strategies such as buffers and stormwater ponds.

The hierarchical approach to implementing best management practices can be helpful. The avoid types of BMPs are most important and conservation efforts should focus on these practices across the landscape.

Avoid practices can then be complemented with a suite of practices to control; and trap and treat pollutants.

It is also important to evaluate our collective actions. The *Watershed Report Card*, which is produced every five years, provides an opportunity for this evaluation. With every new report card, we can measure our efforts, and determine the best ways to continue to protect and enhance the watershed together.

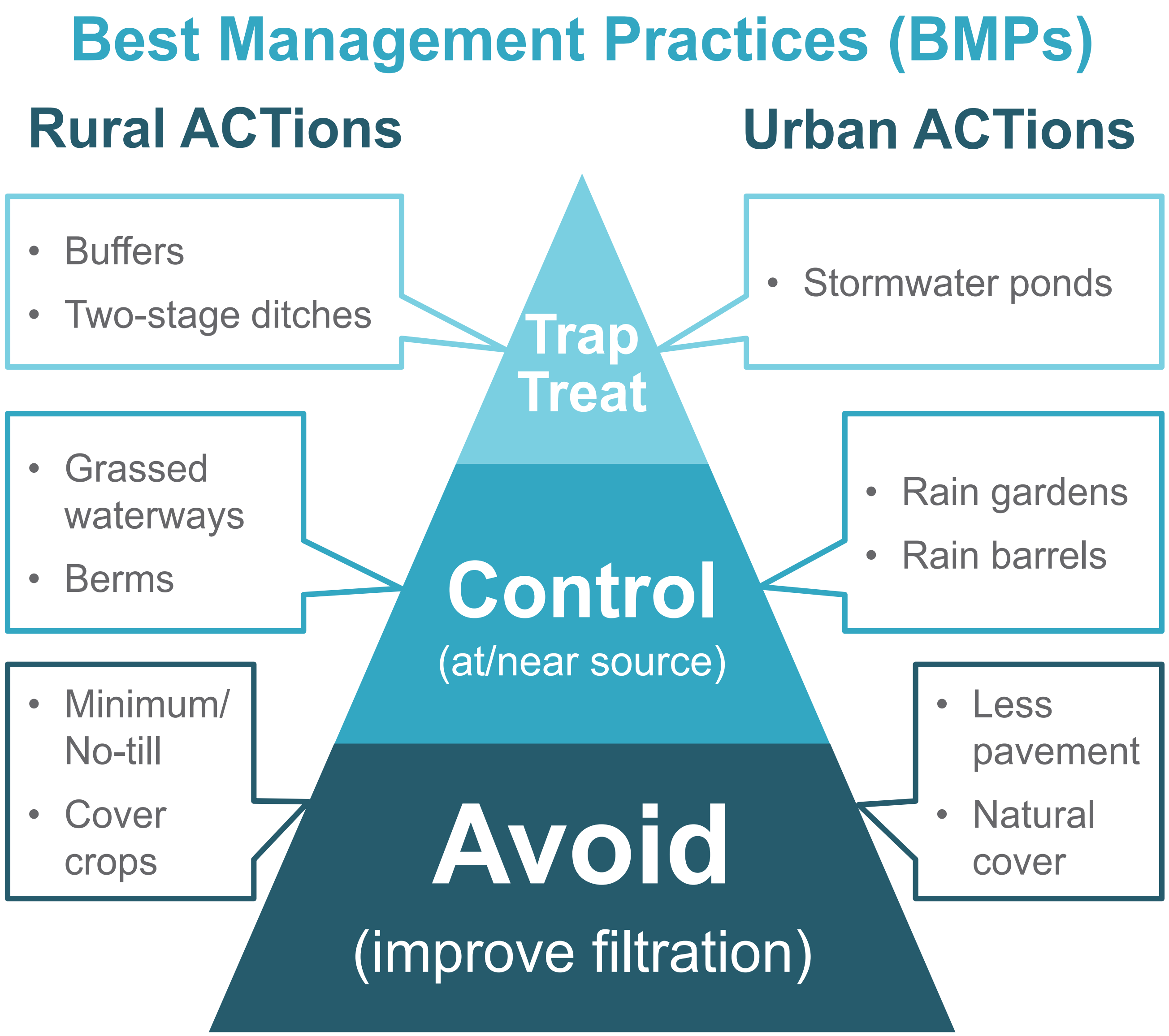


Figure 6: ACTion best management practices (BMPs) that Avoid (improve infiltration); Control (at or near the source); and Trap and Treat pollutants (adapted from Tomer et al. 2013).