Milwaukee River Basin Report Card 2019

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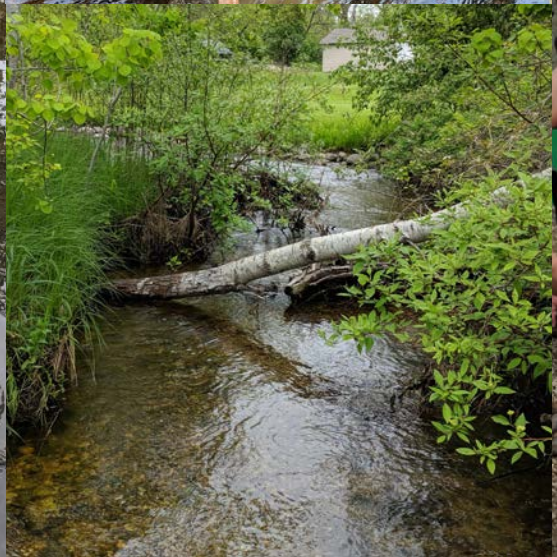

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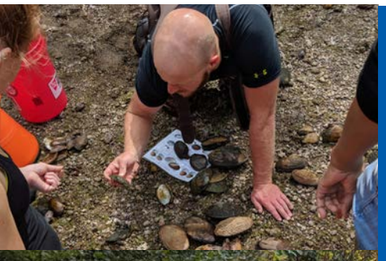

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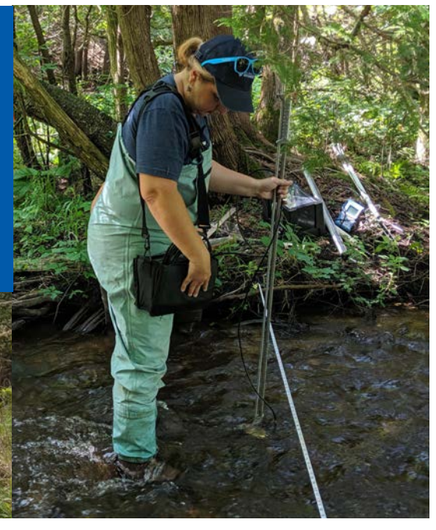


DEAR FRIEND OF THE RIVER,

Whether you are a seasoned water advocate or just getting your feet wet, we would like to welcome you to the 10th Annual Milwaukee River Basin Report Card. This report summarizes water quality data collected in 2019 and dives deeper into some of the challenges and successes happening throughout the Milwaukee River Basin.

The Basin spans nearly 900 square miles across southeastern Wisconsin. Any water that falls in this geographic bowl ends up in tributaries crisscrossing the landscape, eventually flowing into one of the Basin's three major rivers. The Milwaukee, Menomonee and Kinnickinnic Rivers meet in downtown Milwaukee before flowing into Lake Michigan. Over 1.3 million people call the Milwaukee River Basin home, with a large majority of those people relying on Lake Michigan as the source of their drinking water.

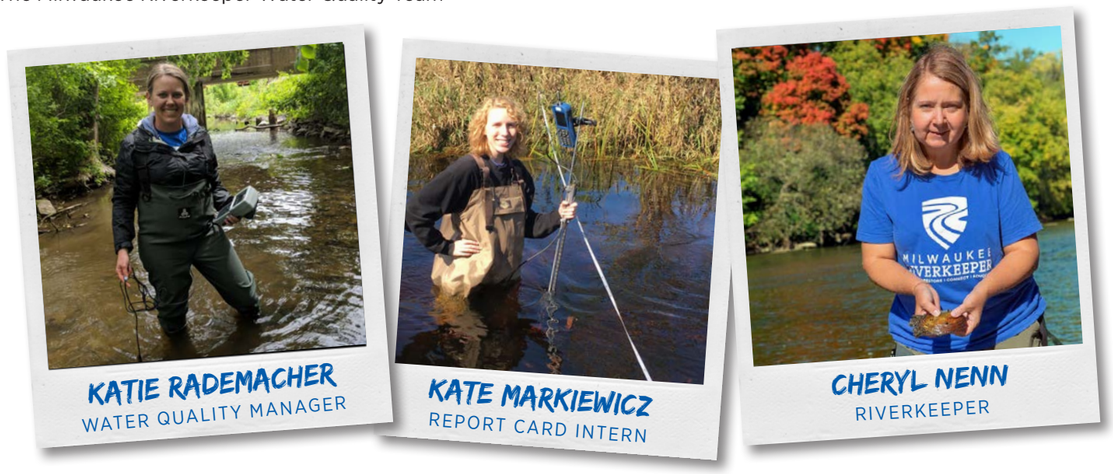
Milwaukee Riverkeeper staff, volunteers, and partner organizations collect data on a variety of water quality parameters. Data is recorded on everything from the river's water clarity to the aquatic bugs who spend the majority of their lives within it. Each of these measurements is graded on an "A" to "F" scale, based on our targets (see Appendix i).

This year, the Milwaukee River Basin received a grade of D+. While it's easy to be dispirited, it's important to remember that, like our own health, the health of a river is the result of decades of choices. While this grade is not as good as we'd like, water quality has substantially improved over the last several decades. We are confident that by continuing to work together, we can do even better in the future.

Before we dive into the rest of the Milwaukee River Basin Report Card, we'd like to thank our volunteer water quality monitors. Without their tireless dedication, achieving our mission would not be possible.

Thank you and enjoy,

The Milwaukee Riverkeeper Water Quality Team



REPORT CARD CREATED IN PARTNERSHIP WITH:

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Fund for Lake Michigan — Clearly making a deep impact.

DATA CONTRIBUTION PARTNERS

Wisconsin Dept. of Natural Resources; GLEC*; MMSD Partners for a Cleaner Environment; Ozaukee County; Ozaukee Fish Passage Program; SEWRPC

Great Lakes Environmental Center, Inc. (GLEC) provided data under a limited term contract with MMSD for monitoring in the Milwaukee River Watershed: Cedar, Pigeon, Ulao, and Mole Creeks. GLEC contractor staff collected samples and delivered to MMSD lab for processing. MMSD and GLEC performed quality control and assurance review of data according to quality assurance plans.

SPECIAL THANK YOU TO GUEST AUTHORS: *Tyler Linton, Doug Endicott, and Dale White of the Great Lakes Environmental Center, Inc.*

MAKING THE GRADE

Volunteers and water quality professionals **COLLECT** physical, chemical and biological water quality data throughout the Milwaukee River Basin year round. Collected data is submitted to the WDNR Surface Water Integrated Monitoring System (SWIMS). We **COMBINE** data from all of our project partners throughout the Milwaukee River Basin to produce the Annual Report Card.

We **COMPARE** water quality data for each parameter to the targets and assign a grade based on the percentage of data points that meet our goals. Targets are based on federal and state standards for water quality, as well as other available guidance. For more information about the water quality parameters, see pages 31 and 32. Overall watershed and subwatershed grades are computed by averaging their respective individual parameter grades.

A All water quality indicators meet desired targets **90 - 100%** of the time. Streams or river segments are capable of supporting fish and other aquatic life.

B Most water quality indicators meet desired targets roughly **80 - 89%** of the time. Most areas are capable of supporting fish and other aquatic life.

C Water quality indicators meet targets **70 - 79%** of the time. These waters have fair conditions for fish and most aquatic life.

D Water quality indicators meet targets **60 - 69%** of the time. Water quality and wildlife habitat of these waters tend to be poor.

F Water quality indicators meet targets **below 60%** of the time. Poor water quality in these streams and river segments result in poor conditions for fish and aquatic life.

We **CALCULATE** the overall Milwaukee River Basin grade by averaging all grades for the three major watersheds. A snapshot of river health is determined by analyzing water quality throughout the Basin for 2019. This Report Card provides us with general information on stream health, challenges in meeting water quality goals, and opportunities for implementing projects and changing practices and policies. Long term trends are also important, and touched on throughout the report.

THANK YOU VOLUNTEERS

Milwaukee Riverkeeper's Volunteer Water Quality Monitors are the eyes and ears of our waterways and, often, are the first to detect and report water quality issues. Our work simply would not happen without the tireless efforts of these individuals.

Milwaukee Riverkeeper's 2019 Water Quality Program by the numbers:

75 volunteers

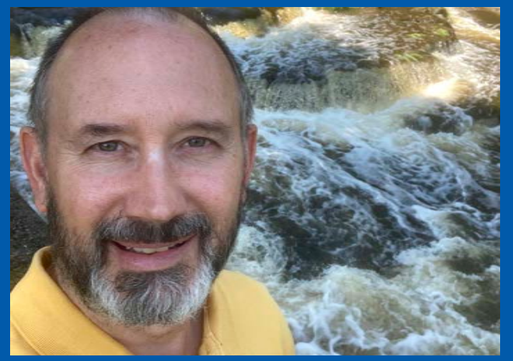
88 sites monitored

602 site visits

903 volunteer hours

To learn more about Milwaukee Riverkeeper's Monitoring Programs, or to become a Water Quality Monitor and help contribute to this report, visit: **milwaukeeriverkeeper.org/protect**

VOLUNTEER SPOTLIGHT



GREG DORO

VOLUNTEER SINCE 2016

Why is volunteering with Milwaukee Riverkeeper important to you?

I grew up dairy farming with my parents and grandparents. I learned early on the importance and necessity of maintaining our critical resources of soil and water. I believe in the mission of Milwaukee Riverkeeper to maintain and improve our waterways, so it was important to me to support their mission. It is also important for me personally because of the kinship and shared interest it provides me with my daughter who is an Environmental Scientist.

What draws you to the river?

The solitude and peacefulness it provides is a welcome break from the busy world and the work I do.

If you were a macroinvertebrate, which one would you be and why?

Dragonfly larva. My wife and I do a lot of kayaking and we always seem to have a dragonfly hop a ride with us.

CHRISTA MARLOWE

VOLUNTEER SINCE 2010

Why is volunteering with Milwaukee Riverkeeper important to you?

I feel I am doing real science, contributing to the scientific knowledge base and providing important data for planning purposes.

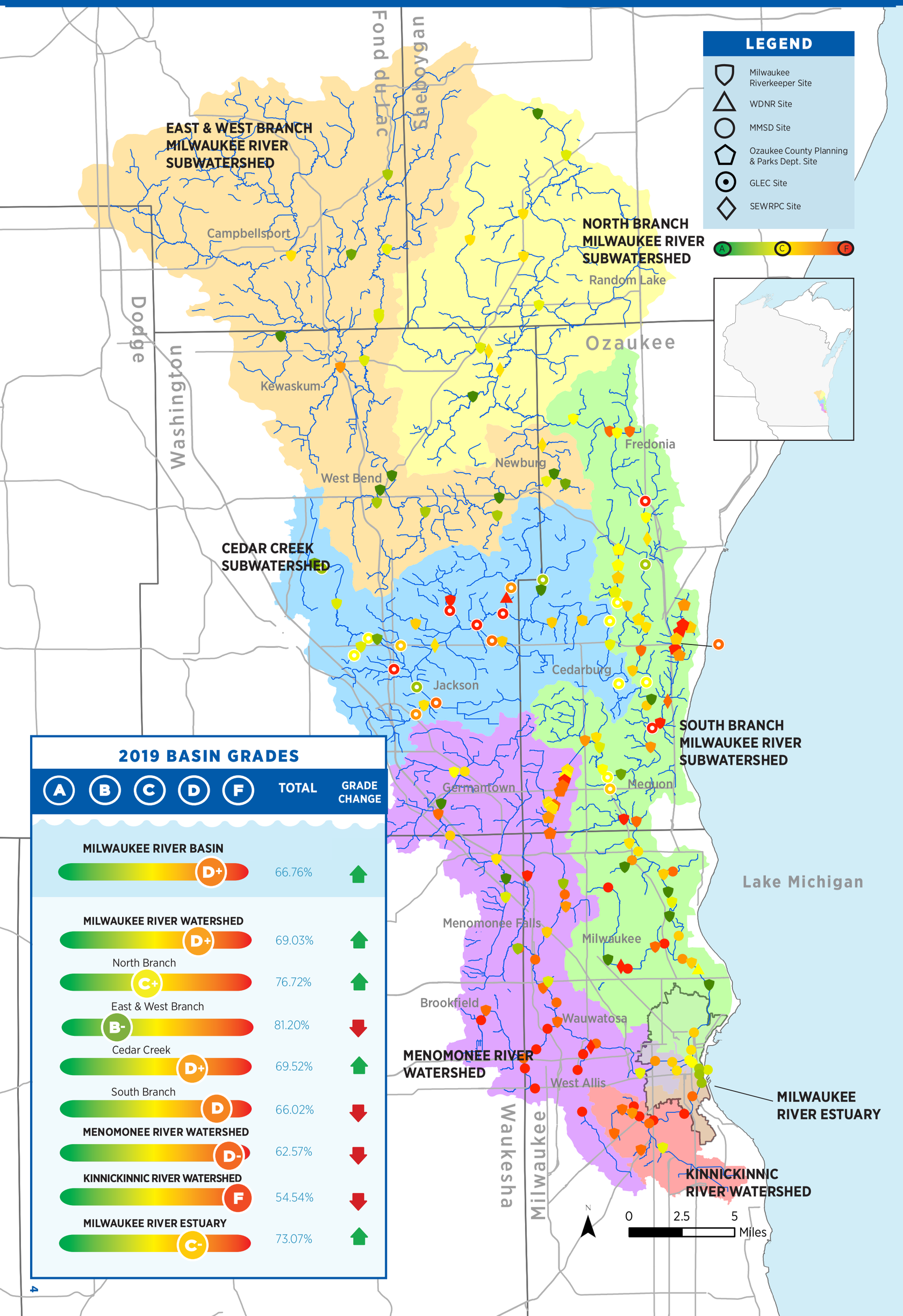
What draws you to the river?

I love being outside. I am also fortunate that both of my streams are tucked into Milwaukee County Parks. These lovely streams are little known secrets in these parks. I feel a special connection with these parks and neighborhoods having monitored those waterways for several years.

If you were a macroinvertebrate, which one would you be and why?

Probably a Dragonfly nymph. They really have it good! They get to hatch and grow in lovely waterways; then one day, they emerge with shiny wings and colorful bodies to dart above and around the water.

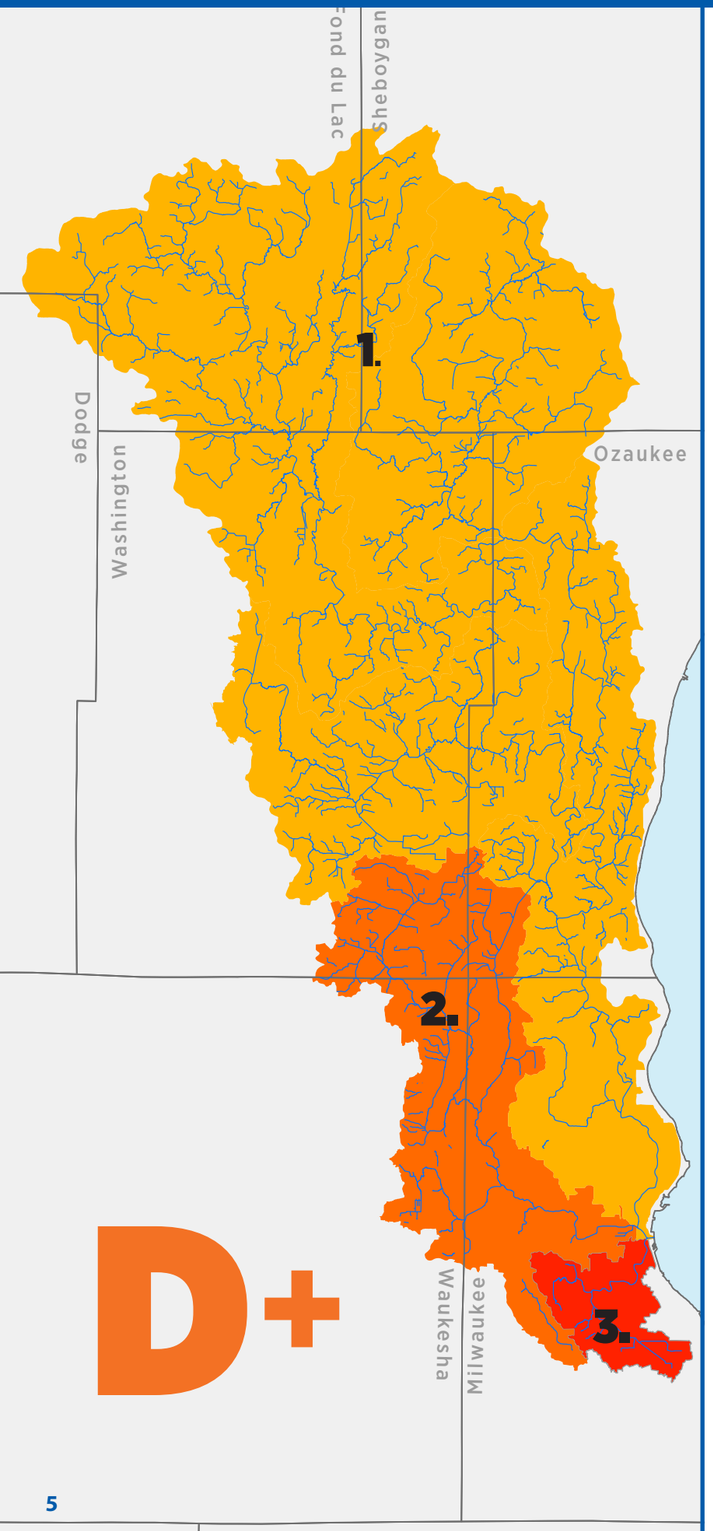
MILWAUKEE RIVER BASIN MAP



2019 BASIN GRADES

	A	B	C	D	F	TOTAL	GRADE CHANGE
MILWAUKEE RIVER BASIN				D+		66.76%	↑
MILWAUKEE RIVER WATERSHED				D+		69.03%	↑
North Branch			C+			76.72%	↑
East & West Branch		B-				81.20%	↓
Cedar Creek				D+		69.52%	↑
South Branch				D		66.02%	↓
MENOMONEE RIVER WATERSHED				D-		62.57%	↓
KINNICKINNIC RIVER WATERSHED					F	54.54%	↓
MILWAUKEE RIVER ESTUARY			C-			73.07%	↑

MILWAUKEE RIVER BASIN | D+



QUICK FACTS

RIVER MILE FACTS

875 mi.
total miles

18 mi.
of trout streams

403 mi.
of impaired waters

2019 BASIN SUMMARY

1. MILWAUKEE RIVER WATERSHED (69.03%) — D+
2. MENOMONEE RIVER WATERSHED (62.57%) — D-
3. KINNICKINNIC RIVER WATERSHED (54.54%) — F

The Milwaukee River Basin received an overall grade of a D+ (66.76%) based on Milwaukee Riverkeeper's analysis of water quality data from the Milwaukee, Menomonee and Kinnickinnic River Watersheds. The Basin saw a slight improvement of nearly 1% from 2018 to 2019. The Basin continues to struggle with phosphorus, bacteria, specific conductivity and turbidity. The rainfall in 2019, exceeded the record breaking rainfall of 2018, and was the wettest year ever recorded in Wisconsin and the Midwest. Exceedingly intense and frequent rainfall may be a contributor to poor water quality seen throughout the Milwaukee River Basin.

BASIN-WIDE CHALLENGES:

PHOSPHORUS
BACTERIA
SPECIFIC CONDUCTIVITY
TURBIDITY

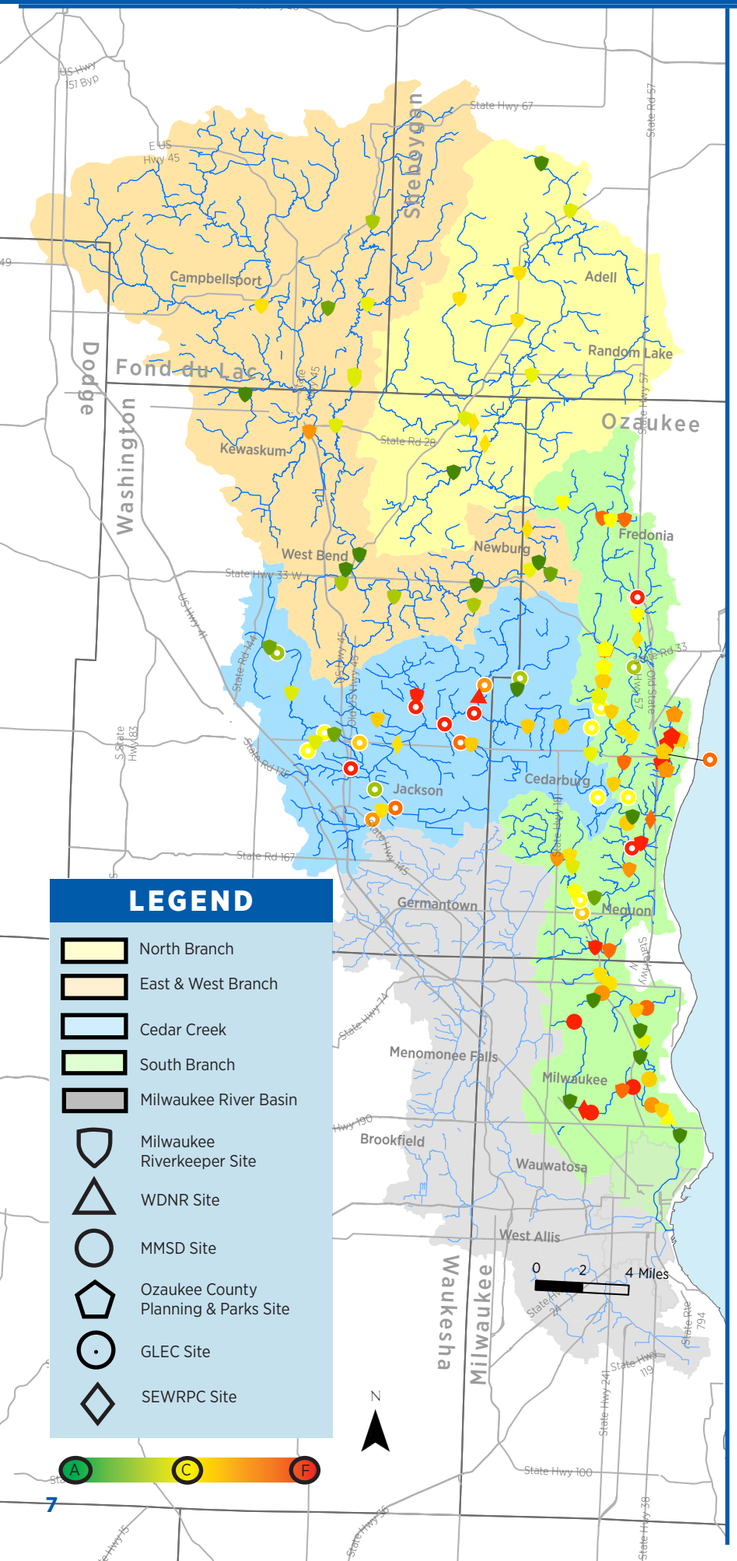
2019 BASIN HIGHLIGHTS

2019 BASIN PARAMETER GRADES

	TOTAL	GRADE CHANGE
BASIN (D+)	66.76%	↑
Temperature (A)	99.91%	↑
Dissolved Oxygen (A)	93.88%	↑
pH (A)	99.38%	↓
Turbidity (C)	74.09%	↓
Phosphorus (F)	48.57%	↑
Chloride (B+)	87.07%	↑
Specific Conductivity (F)	7.25%	↑
Bacteria (F)	41.98%	↑

MACROINVERTEBRATE BIOTIC INDEX
FAIR — 2.30 ↓

MILWAUKEE RIVER WATERSHED | D+



QUICK FACTS

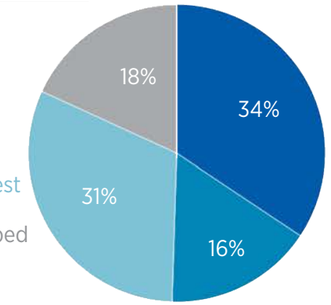
RIVER MILE FACTS

704 mi. total miles

18 mi. of trout streams

317 mi. of impaired waters

LAND USE BREAKDOWN



NOTE: 1% of land use is not included.

2019 MONITORING

125 total sites

1,283 total site visits

Data Contributors:

GLEC, MMSD, Ozaukee Fish Passage Program, SEWRPC, Wisconsin DNR, Milwaukee Riverkeeper

Milwaukee Riverkeeper Data Contribution:

54% sites

36% site visits

53 volunteers

2019 DATA SUMMARY

In 2019, the Milwaukee River Watershed received a D+ (69.03%). Most parameters measured in the Watershed remained fairly stable. While phosphorus and bacteria levels improved since 2018, they still failed to meet water quality standards. Land use, aging infrastructure, human activity, agricultural runoff, and rainfall all impacted the water quality in the Milwaukee River Watershed during 2019. In particular, historic rainfall led to elevated levels of polluted runoff, erosion, and flooding. The Milwaukee River Watershed is large and is separated into the North Branch, East and West Branch, South Branch, and Cedar Creek Subwatersheds. These subwatersheds are reviewed individually in this report, but data from all of the subwatersheds is compiled here to provide a larger picture of water quality within this Watershed.

Both fecal coliform and E. coli bacteria levels in the Watershed continue to be a challenge. All subwatersheds received a failing grade for bacteria, but Cedar Creek and the South Branch Subwatersheds showed slight improvements from 2018. Milwaukee Riverkeeper began implementing a community science pilot program in 2018, with an aim to fill data gaps in areas outside of MMSD's service area, but more work still needs to be done. Further monitoring in the East and West Branch and North Branch Subwatersheds will continue to improve our understanding of bacteria levels in the Milwaukee River Watershed.

Chloride standards were met over 93% of the time, however it is important to note these scores are heavily weighted with data from non-salting months. The South Branch of the Milwaukee River Watershed reported the highest chloride concentrations, likely due to heavy urbanization and high levels of impervious surfaces. Urban streams are more susceptible to chloride pollution due to the inability of paved surfaces to soak up and filter runoff before it enters a waterway. However, in undeveloped areas, chloride can infiltrate groundwater, which can seep back into streams during low flows. Other sources of chloride pollution can include water softeners, industrial discharge, and fertilizers.

Stream restoration, green infrastructure, agricultural best management practices, proper road salt application and management, education and outreach are all efforts happening throughout the subwatersheds of the Milwaukee River Watershed with the goal of improving water quality and wildlife habitat.

2019 WATERSHED PARAMETER GRADES

	A	B	C	D	F	TOTAL	GRADE CHANGE
WATERSHED				D+		69.03%	↑
Temperature	A					99.87%	↑
Dissolved Oxygen	A					93.88%	↓
pH	A					99.22%	↓
Turbidity			C+			77.89%	↓
Phosphorus					F	47.18%	↑
Chloride	A-					92.68%	↑
Specific Conductivity					F	5.83%	↓
Bacteria					F	50.42%	↑

MACROINVERTEBRATE BIOTIC INDEX

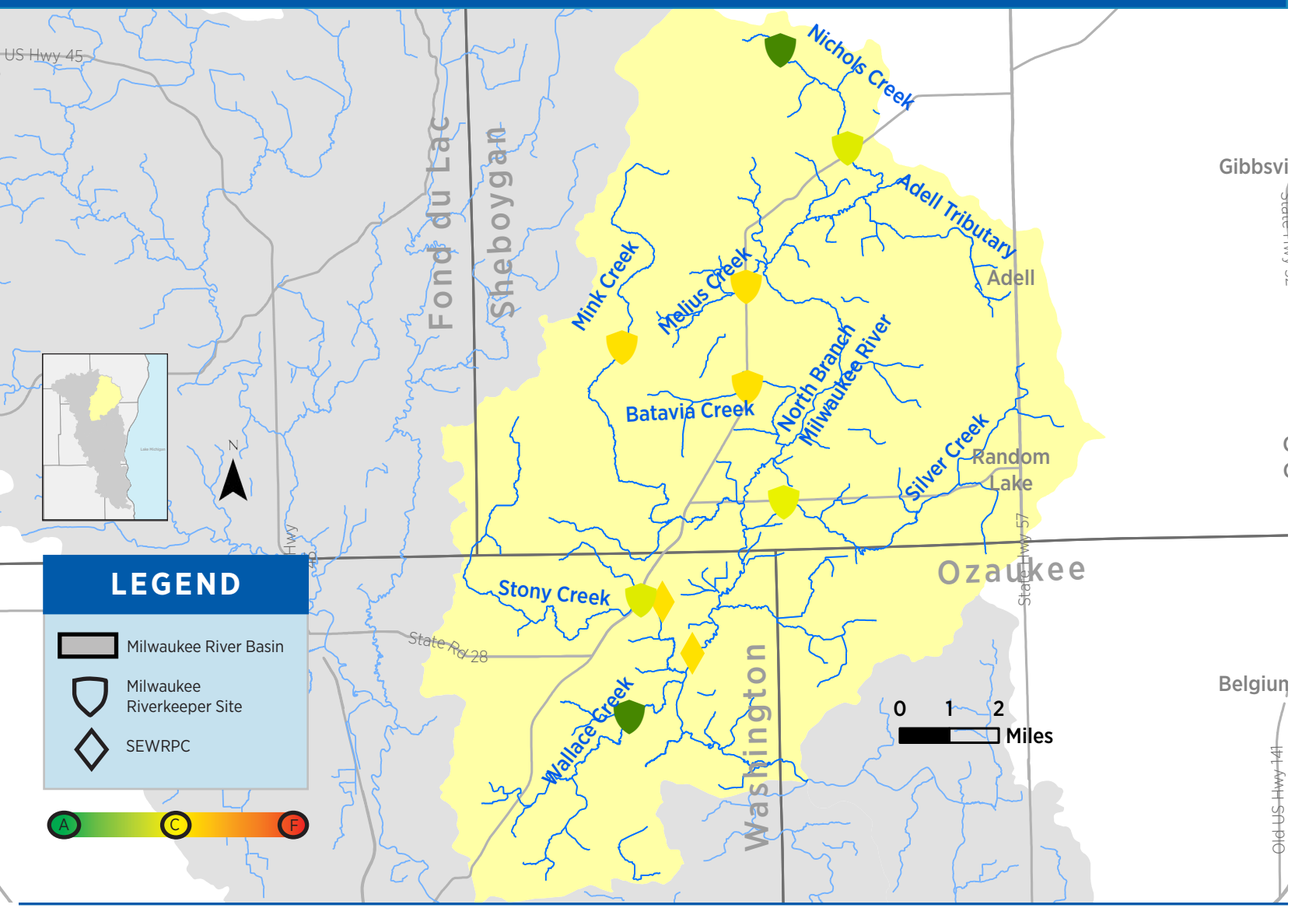
FAIR — 2.29 ↓

DID YOU KNOW?

The storage of road salt alone can pollute a waterway, with uncovered salt piles losing 20% of their volume annually from washing away in the elements. In an effort to reduce the amount of road salt entering our streams, Milwaukee Riverkeeper hosts workshops focusing on winter maintenance best practices for local, large scale applicators.

Learn more: www.milwaukeeriverkeeper.org/road-salt

NORTH BRANCH MILWAUKEE RIVER SUBWATERSHED | C+



QUICK FACTS

RIVER MILE FACTS

147 mi.
total miles

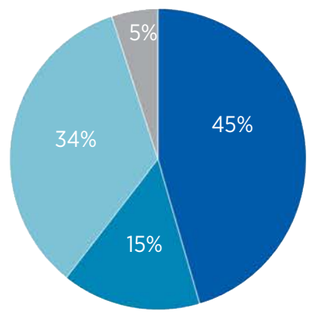
7 mi.
of cold streams

87 mi.
of impaired waters

LAND USE BREAKDOWN

- Agriculture
- Wetland
- Grassland/Forest
- Urban/Developed

NOTE: 1% of land use is not included.



2019 MONITORING

10 total sites

78 total site visits

Milwaukee Riverkeeper Data Contribution:

80% sites

68% site visits

7 volunteers

2019 DATA SUMMARY

The North Branch Subwatershed received a C+ (76.72%), remaining fairly stable from 2018. The Subwatershed struggled with phosphorus, specific conductivity and bacteria levels, challenges facing the Basin as a whole. However, targets were met for all other parameters. Monitoring in the North Branch Subwatershed has steadily increased over the last several years, but could benefit from increased data collection as it continues to be the least monitored subwatershed in the Milwaukee River Basin.

Cold water streams in the North Branch Subwatershed showed improvements to the temperature grade in 2019. Melius Creek, Mink Creek, Stony Creek, and Nichols Creek, all designated cold water streams (≤ 22°C or 72°F), had a cumulative temperature grade improvement, going from a C+ in 2018 to an A in 2019. Dissolved oxygen content also met standards 96% of the time. The combination of cold and oxygen rich waters is critical to support diverse groups of macroinvertebrates and trout species that call cold water streams home.

Phosphorus remains a major issue for this branch of the Milwaukee River Watershed, only meeting standards 35% of the time. Agriculture is the primary land use in this subwatershed (45%), about 10% more than the neighboring East and West Branch Subwatershed, which met phosphorus standards 72% of the time. The small difference in land use percentage and large disparity in phosphorus grade between these neighboring subwatersheds (nearly 36%) is likely due to the type of habitat and connectivity surrounding streams within the North Branch. The North Branch Subwatershed's remaining forests and wetlands are smaller, more spread out and less connected than in the neighboring subwatershed. The Kettle Moraine State Forest, in the East and West Branch, provides a larger and more continuous buffer, or protective barrier, to a significant portion of its streams.

Heavily agricultural areas with traditional farming practices often result in increased runoff of fertilizers and animal manure, contributing to the poor phosphorus grade. High levels of nutrient pollution contributes to eutrophication or the excessive growth of nuisance aquatic plants and algae. Without adequate riparian buffers to increase infiltration and filter runoff, large amounts of these nutrients can enter directly into local waterways. Restoring and connecting riparian habitat adjacent to agricultural land with native plants and trees can help filter excess nutrients like phosphorus and bacteria, before entering the stream.

The National Resources Conservation Service (NRCS) and counties work with local farmers to introduce methods to prevent soil erosion and nutrient runoff, while promoting infiltration where water falls. This work is beneficial to both farmers and our local waterways.

2019 SUBWATERSHED PARAMETER GRADES

	A	B	C	D	F	TOTAL	GRADE CHANGE
SUBWATERSHED			C+			76.72%	↑
Temperature	A					100.00%	↑
Dissolved Oxygen	A					96.00%	↓
pH	A					96.88%	↓
Turbidity	A					100.00%	=
Phosphorus					F	35.48%	↑
Chloride	A					100.00%	=
Specific Conductivity					F	2.13%	↓
Bacteria					F	50.00%	N/A

MACROINVERTEBRATE BIOTIC INDEX

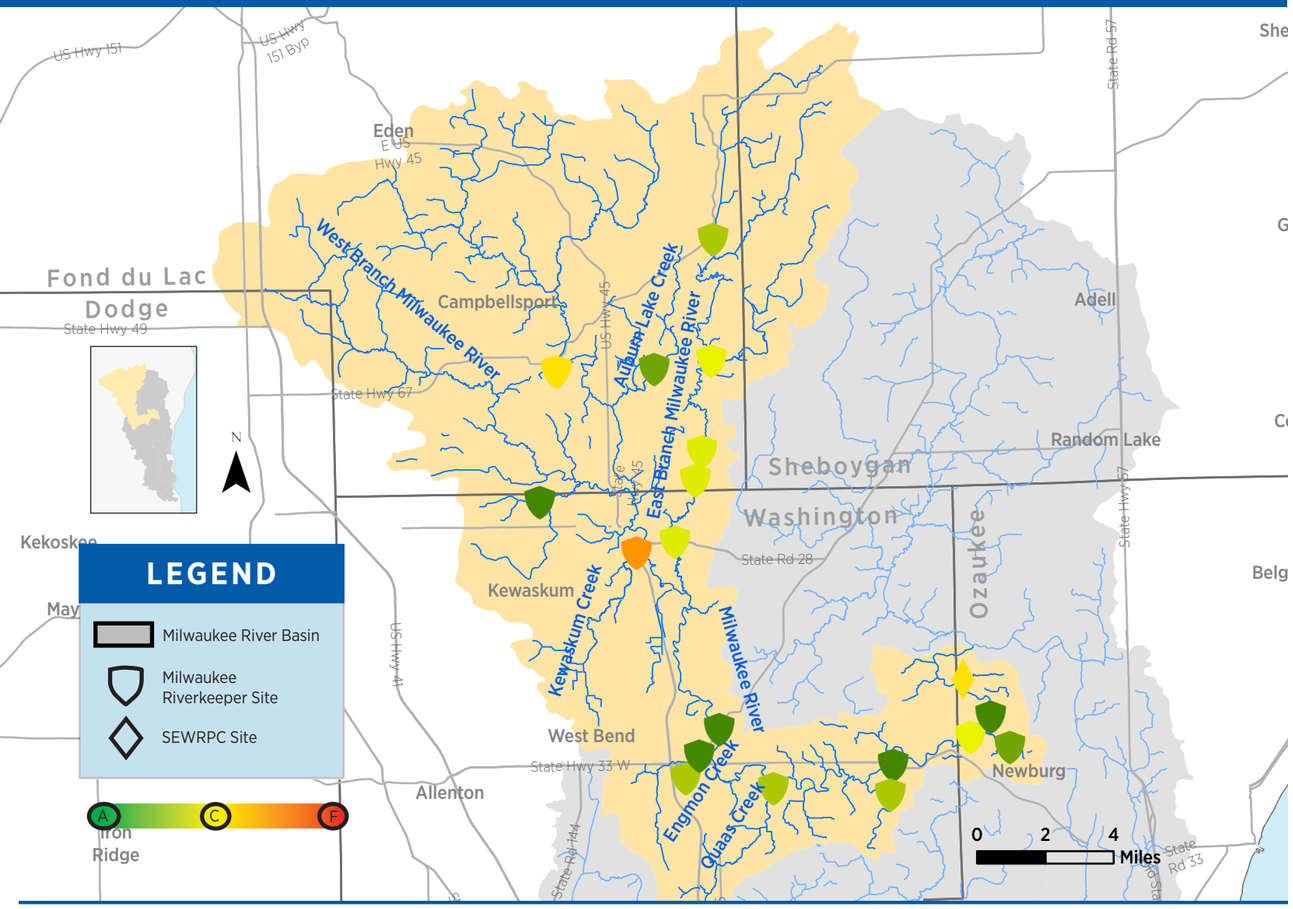
FAIR — **2.44** ↓

DID YOU KNOW?

Milwaukee Riverkeeper is looking for volunteers in this Subwatershed. Contribute to this report, become a Water Quality Monitor.

Learn more: www.milwaukeeriverkeeper.org/protect

EAST & WEST BRANCH MILWAUKEE RIVER SUBWATERSHED | B-



QUICK FACTS

RIVER MILE FACTS

233 mi.
total miles

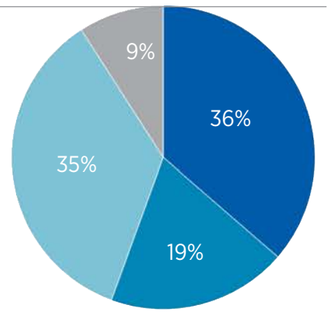
11 mi.
of trout streams

100 mi.
of impaired waters

LAND USE BREAKDOWN

- Agriculture
- Wetland
- Grassland/Forest
- Urban/Developed

NOTE: 1% of land use is not included.



2019 MONITORING

19 total sites

145 total site visits

Milwaukee Riverkeeper Data Contribution:

95% sites

90% site visits

14 volunteers

2019 DATA SUMMARY

The East and West Branch Milwaukee River Subwatershed had the best water quality grade in the Milwaukee River Basin at 81.20%. This Subwatershed grade remained fairly stable and most parameters met water quality standards, except for conductivity and bacteria, which are challenges Basin-wide. Monitoring efforts in this branch have steadily grown over the last several years, providing a more representative picture of water quality in this Subwatershed.

Cold water stream temperatures improved, with 96.3% of cold water stream samples meeting their target temperature (≤ 22°C or 72°F). These cold water streams include Quaas Creek, Kewaskum Creek and Engmon Creek. In addition to air temperature, a lack of shady vegetation, polluted runoff and discharges of hot effluent from industrial processes, can increase stream temperatures. Water temperatures can be lowered by increasing the tree canopy cover along waterways, reducing impermeable surfaces (which reduces runoff), and cooling and reducing industrial discharge before it is released into a waterway. Cold water streams are unique to the East and West and North Branches of the Milwaukee River, and are home to diverse groups of macroinvertebrate and fish species, especially trout that can only survive in cold waters that stay below 72°F (22°C).

The specific conductivity grade in the East and West Branch declined more than any other subwatershed analyzed this year. Specific conductivity reflects the presence of dissolved inorganic materials in water that conducts electricity, such as chloride, and is directly proportional to salinity. Although it is common for conductive minerals to occur naturally from local geology, high conductivity is also an indicator of pollution of heavy metals, nutrients, and other pollutants. Milwaukee Riverkeeper's target for specific conductivity is between 150 to 500 µS/cm, a range that some may think is too stringent. Since there are no federal or state standards for conductivity, we use federal EPA guidance for healthy streams as our current target. Polluted and healthy waterways alike can exceed these ranges for a variety of reasons, and more research is needed to better understand how conductivity impacts stream health.

2019 SUBWATERSHED PARAMETER GRADES

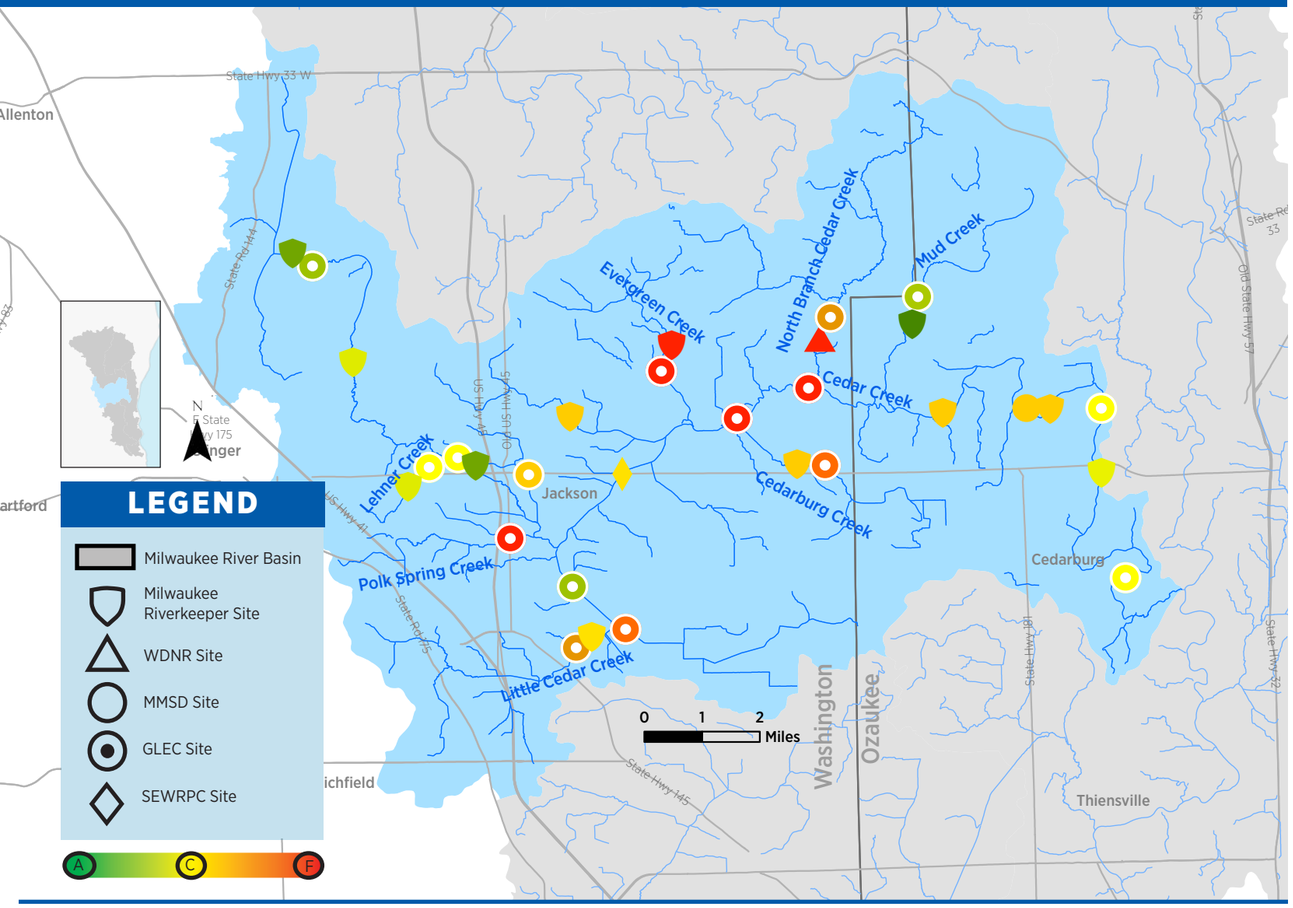
	A	B	C	D	F	TOTAL	GRADE CHANGE
SUBWATERSHED		B-				81.20%	↓
Temperature	A					99.11%	↑
Dissolved Oxygen	A					93.94%	↓
pH	A					100.00%	↑
Turbidity		A				95.83%	↑
Phosphorus			C-			72.00%	↑
Chloride	A					100.00%	=
Specific Conductivity					F	14.10%	↓
Bacteria					F	45.00%	↓
MACROINVERTEBRATE BIOTIC INDEX			FAIR			2.33	↓

DID YOU KNOW?

Milwaukee Riverkeeper's road salt monitors identified an acute chloride exceedance in Engmon Creek during the winter of 2019. Efforts have been focused on testing previously unmonitored streams in rural areas to identify potential chloride impairments.

In 2019, Milwaukee Riverkeeper piloted a bacteria monitoring program, which significantly increased our understanding of bacteria levels in the East and West Branch of the Milwaukee River. Historically, data has not been collected on bacteria in this part of the Basin, but our data identifies bacteria as an issue for this subwatershed. Continued implementation of the bacteria pilot project will help us build a more complete picture of overall water quality in this Subwatershed in the future.

CEDAR CREEK SUBWATERSHED | D+



QUICK FACTS

RIVER MILE FACTS

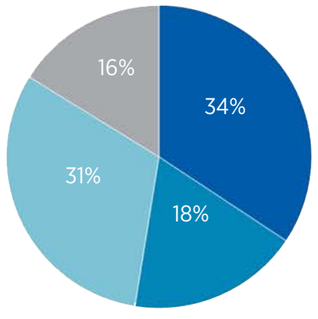
92 mi.
total miles

0 mi.
of trout streams

41 mi.
of impaired waters

LAND USE BREAKDOWN

- Agriculture
- Wetland
- Grassland/Forest
- Urban/Developed



NOTE: 1% of land use is not included.

2019 MONITORING

31 total sites

403 total site visits

Milwaukee Riverkeeper Data Contribution:

39% sites

21% site visits

15 volunteers

2019 DATA SUMMARY

The Cedar Creek Subwatershed received a D+ (69.52%) in 2019, a minimal improvement from 2018. Dissolved oxygen, pH, chloride, and temperature all met water quality standards. While still not meeting phosphorus standards, the Subwatershed saw an improvement of 7% from its 2018 phosphorus grade. Similarly, the Cedar Creek Subwatershed saw a 6% improvement to its bacteria grade, but only met bacteria standards 54.55% of the time.

Habitat surrounding a waterway plays a critical role in protecting it from pollution. Oftentimes, farm fields extend nearly to the water's edge, with much of the natural vegetation cleared. Many parks and golf courses have turf grass lining streams that run through them offering little stream protection. A buffer of deep-rooted vegetation acts as a roadblock intercepting runoff from crop fields and livestock, as well as from urban areas, effectively slowing and filtering out excess nutrients, bacteria, and sediment. Limiting the amount of nutrients entering a waterway is important to maintain healthy levels of aquatic plants and phytoplankton growth. Impoundments in the Subwatershed, or areas where river water is held back by dams, often have issues with excessive algae and plant growth during summer months due to the excessive nutrients in the water.

In 2017, a much dryer year, the Cedar Creek Subwatershed received an A- (92.75%) for turbidity, a contrast to 2019's C+ (76.99%). During heavy rainfall events, water-clouding sediment and pollutants find their way into local waterways through streambank erosion, soil washing away from farm fields, and even dust and sediment from construction sites. State and federal law requires construction work to take preventative measures to ensure sediment-filled runoff does not go directly into local waterways. These measures include installation of sediment filter fencing, filter fabric in storm drains, and regular street sweeping.

Cover crop planting and conservation tillage (or "no till") are common practices to reduce disturbance of soil to limit surface erosion. Keeping soil in place is important to prevent pollution of local waterways, and is also beneficial to farmers who rely on healthy soil for their crops. Cedar Creek Farmers is an active group focusing on educating and incentivizing sustainable farming practices to improve water quality. Adjusting farming practices by minimizing chemical applications, improving manure storage, and establishing buffers in the Cedar Creek Subwatershed will help to improve the poor grades for bacteria, phosphorus, and sediment.

2019 SUBWATERSHED PARAMETER GRADES

	A	B	C	D	F	TOTAL	GRADE CHANGE
SUBWATERSHED				D+		69.52%	↑
Temperature	A					100.00%	=
Dissolved Oxygen	A					94.94%	↓
pH	A					99.54%	↑
Turbidity			C+			76.99%	↓
Phosphorus					F	53.92%	↑
Chloride	A					100.00%	=
Specific Conductivity					F	6.19%	↓
Bacteria					F	54.55%	↑

MACROINVERTEBRATE BIOTIC INDEX

FAIR — 2.31 ↑

DID YOU KNOW?

Increased implementation of initiatives like the Regional Conservation Partnership Program in the Milwaukee River Basin, a part of USDA's Farm Bill, helps to put practices on the ground to reduce agricultural runoff, and helps fund conservation easements on erodible farmland to improve water quality in this and other subwatersheds.

MILWAUKEE RIVERKEEPER®

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We hope you enjoy this edition of our Annual River Report Card. Our work would not be possible without the support of people like you. Milwaukee Riverkeeper works to protect, improve and advocate for water quality, riparian wildlife habitat, and sound land management in the Milwaukee, Menomonee, and Kinnickinnic River Watersheds.

> We envision a future in which people from all walks of life can enjoy the healthy waterways of the Milwaukee River Basin.

Milwaukee Riverkeeper serves as a voice for the Milwaukee, Menomonee, and Kinnickinnic Rivers and works tirelessly for swimmable, fishable, drinkable waters. Our core programming involves water quality monitoring and advocating on behalf of the rivers.

We also coordinate hands-on river restoration projects and organize thousands of volunteers each year in river cleanups. We connect people to water through river-focused events and educate our community about water quality and healthy waterways.

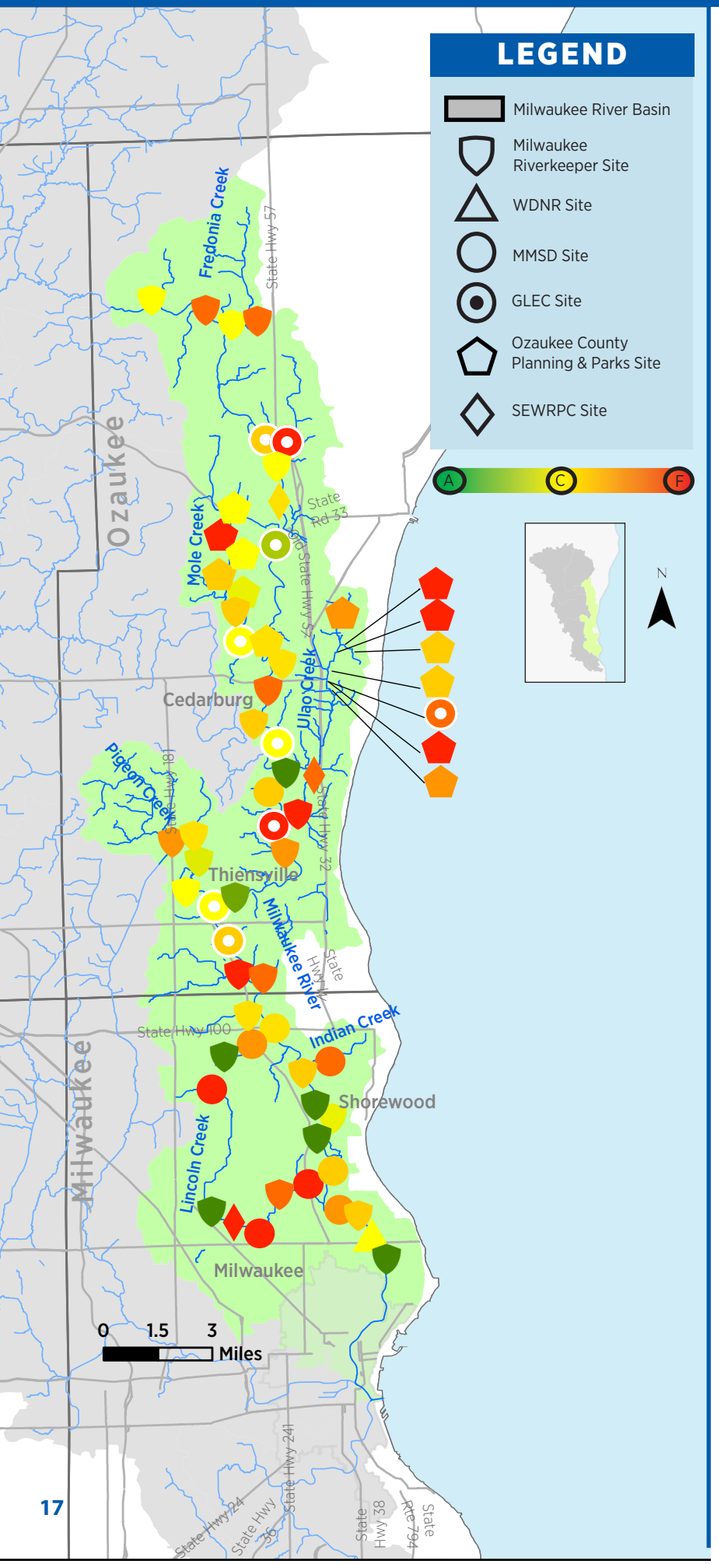
> Donate today to help achieve swimmable, fishable, drinkable waterways.

www.milwaukeeriverkeeper.org/donate

WATERKEEPER® ALLIANCE MEMBER

Milwaukee Riverkeeper is a licensed member of the Waterkeeper Alliance, an international coalition dedicated to clean water and healthy communities.

SOUTH BRANCH MILWAUKEE RIVER SUBWATERSHED | D



QUICK FACTS

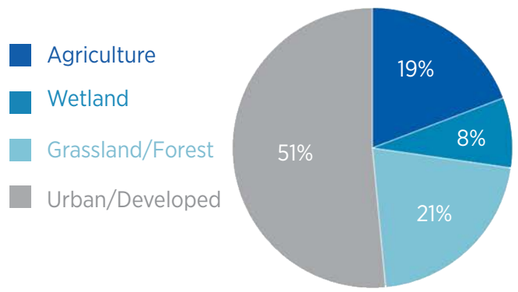
RIVER MILE FACTS

232 mi.
total miles

0 mi.
of trout streams

89 mi.
of impaired waters

LAND USE BREAKDOWN



NOTE: 1% of land use is not included.

2019 MONITORING

65 total sites

657 total site visits

Milwaukee Riverkeeper Data Contribution:

45% sites

30% site visits

24 volunteers

2019 DATA SUMMARY

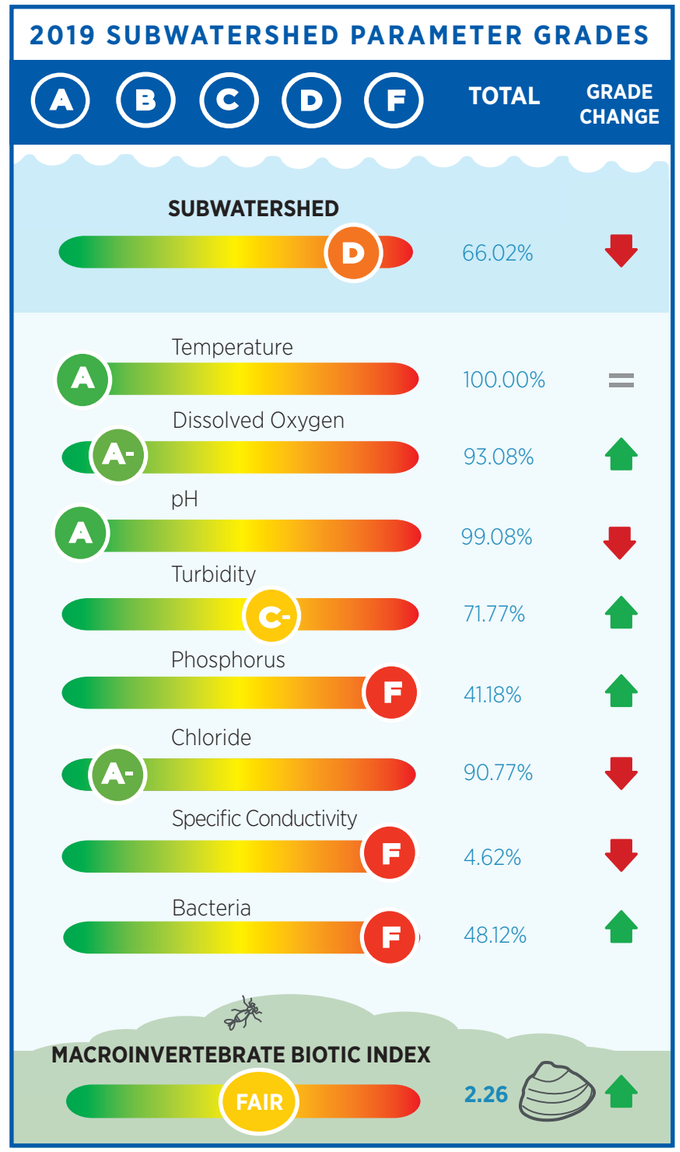
The South Branch Milwaukee River Subwatershed received a D (66.02%) for overall water quality, a minimal change from 2018. The South Branch experienced a 5.13% decrease in chloride grade, while the rest of the water quality parameters remained stable. Phosphorus grades improved significantly, meeting standards nearly 10% more than in 2018. Similar to the rest of the Milwaukee River Watershed, dissolved oxygen, pH, and temperature data met standards. Turbidity remains fair while the Subwatershed faces difficulty meeting standards for bacteria, phosphorus, and conductivity.

The South Branch is the most urbanized of the Milwaukee River Watershed's four subwatersheds; over 50% of its land use is developed. Less than 30% of the land use contains wetlands, grasslands, or forests, with the remaining 20% used for agriculture. Heavily developed areas can negatively impact water quality due to the impervious nature of most of their surfaces. When runoff is unable to soak into the ground, it travels along the surface, collecting and carrying pollutants. Eventually, that polluted water may enter a storm sewer that drains into a waterway or flow directly into a waterway without the opportunity to be absorbed or filtered by vegetation or soil.

Common sources of phosphorus in urban areas include animal waste, sewage and leaf litter. Manure used as fertilizer can be carried into waterways as a source of phosphorus. Stream and wetland restoration projects in the South Branch continue to improve the Subwatershed's resilience to flooding and nutrient pollution. The ongoing Mole Creek project, led by WDNR and Ozaukee County, is transforming portions of the historically channelized creek back to a natural meandering stream. To date, straight channels have been replaced with 4,900 feet of meandering stream that includes high quality fish habitat. This project is also restoring surrounding riparian habitat and better connecting the stream to adjacent wetlands and floodplains.

Macroinvertebrate surveys are conducted by volunteers as a method to determine ecosystem health. The presence of different macroinvertebrates, who spend at least a portion of their lives within the stream, indicates water quality due to the organisms' differing sensitivities to pollutants, oxygen levels, and temperature. Using groups of macroinvertebrates as water quality markers, or bio-indicators, is another way to understand overall ecosystem health and water quality. The average biotic index score observed in this Subwatershed was "fair", in line with the South Branch's overall water quality grade, and the biotic index score observed in the other subwatersheds of the Milwaukee River Watershed.

2019 SUBWATERSHED PARAMETER GRADES

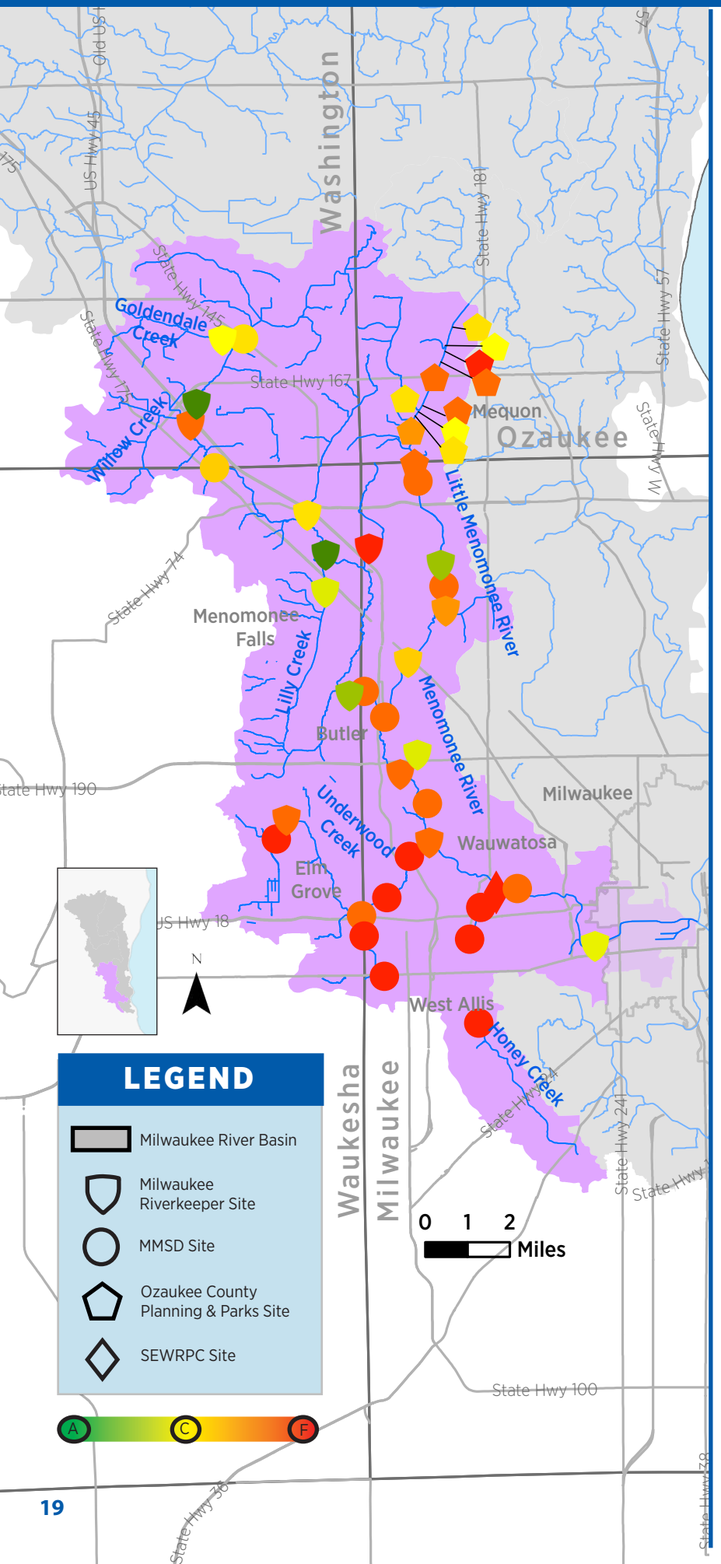


DID YOU KNOW?

The Milwaukee River Greenway Coalition works to protect 847 acres of floodplain and riverfront habitat in the environmental corridor from the former North Ave dam to Silver Spring Road. Hike or paddle this 8 mile stretch of river!

Learn More: bit.ly/MKEwatertrail

MENOMONEE RIVER WATERSHED | D-



QUICK FACTS

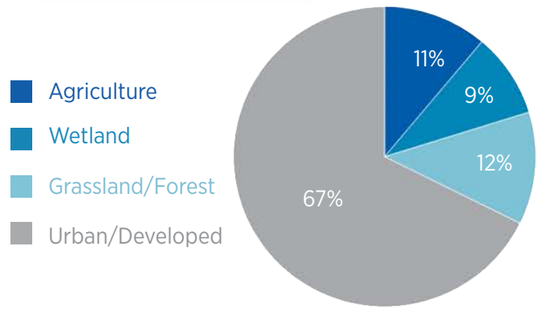
RIVER MILE FACTS

134 mi.
total miles

0 mi.
of trout streams

71 mi.
of impaired waters

LAND USE BREAKDOWN



NOTE: 1% of land use is not included.

2019 MONITORING

45 total sites

442 total site visits

Data Contributors:

MMSD · Ozaukee County Fish Passage Program · Milwaukee Riverkeeper

Milwaukee Riverkeeper Data Contribution:

36% sites

22% site visits

18 volunteers

2019 DATA SUMMARY

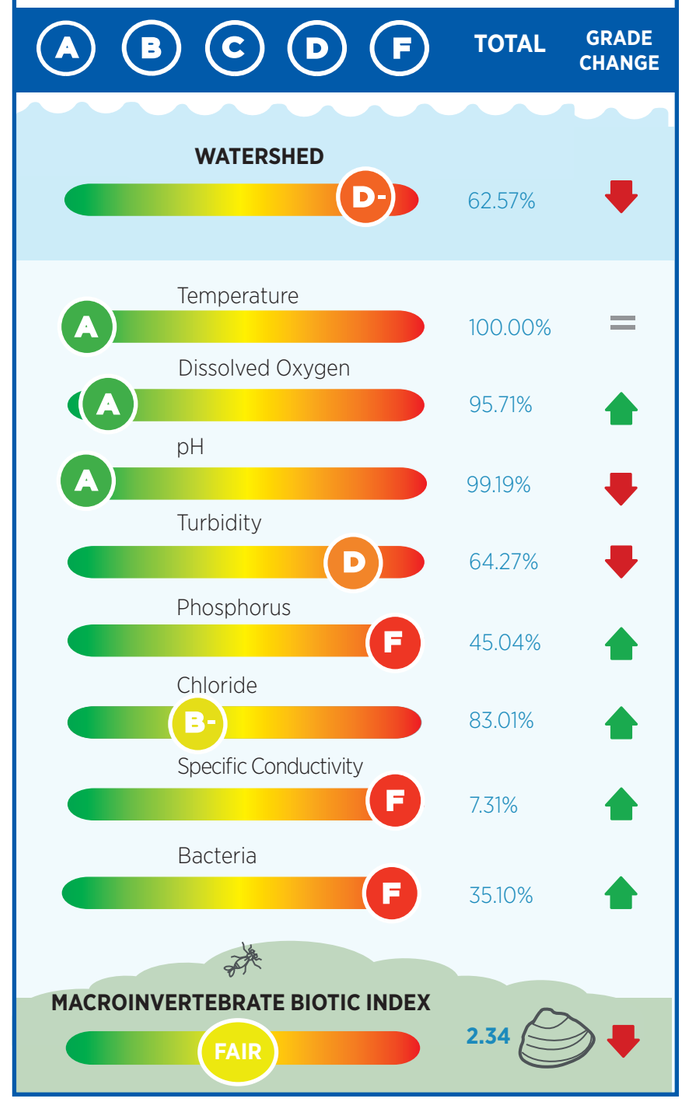
In 2019, the Menomonee River Watershed grade made no gains, stalling at a D- (62.57%). Consistent with trends throughout the Basin, the Menomonee River Watershed struggled with bacteria, phosphorus and specific conductivity. The Watershed saw improvements to dissolved oxygen levels and continued to have a poor turbidity score.

Dissolved oxygen improved a notable 6.54%, scoring an A (95.71%) in 2019. Dissolved oxygen is critical to life within the stream and is impacted by the combination of water temperature, photosynthesis, respiration, decay and diffusion. In 2019, the biotic index score for this Watershed was 2.35 or fair. The biotic index captures the health of a watershed over time by looking at the variety of aquatic insects within the stream based on their tolerance to a range of oxygen conditions. As dissolved oxygen improves, these waterways become more suitable to macroinvertebrates.

Turbidity in the Menomonee River Watershed continues to be the worst in the Basin, only meeting standards 64.27% of the time. Erosion, sediment-filled runoff and non-absorbing land surfaces all contribute to turbidity in this heavily developed Watershed, especially during the record breaking rainfall of 2019. Turbidity can pose a real threat to streams, potentially interfering with dissolved oxygen, photosynthesis, temperature, habitat, and animal growth. When suspended solids restrict light from reaching photosynthesizing organisms, less oxygen may be produced. Instead, light and heat is absorbed by the particles, which in turn can raise the water temperature. Sediment that is washed into a waterway through erosion or runoff can physically impede fish movement and survival. Sediment accumulation in gills hinders growth and reduced visibility in the water column makes it harder for predatory fish to hunt.

The Ozaukee County Planning and Parks Department is working to improve habitat and stream function by restoring several reaches of the Little Menomonee River, which flows south for approximately 11 miles from its headwaters in the City of Mequon to its confluence with the Menomonee River near Butler. In 2019, Ozaukee County restored stream and wetland habitat along 1,270 feet of the Little Menomonee River just upstream of Mequon Road. This project improves habitat for a variety of wildlife species, meanders the stream and better connects it to the floodplains, provides more flood storage, and improves water quality. Continued monitoring over the next few years will document both biological and water quality improvements over time.

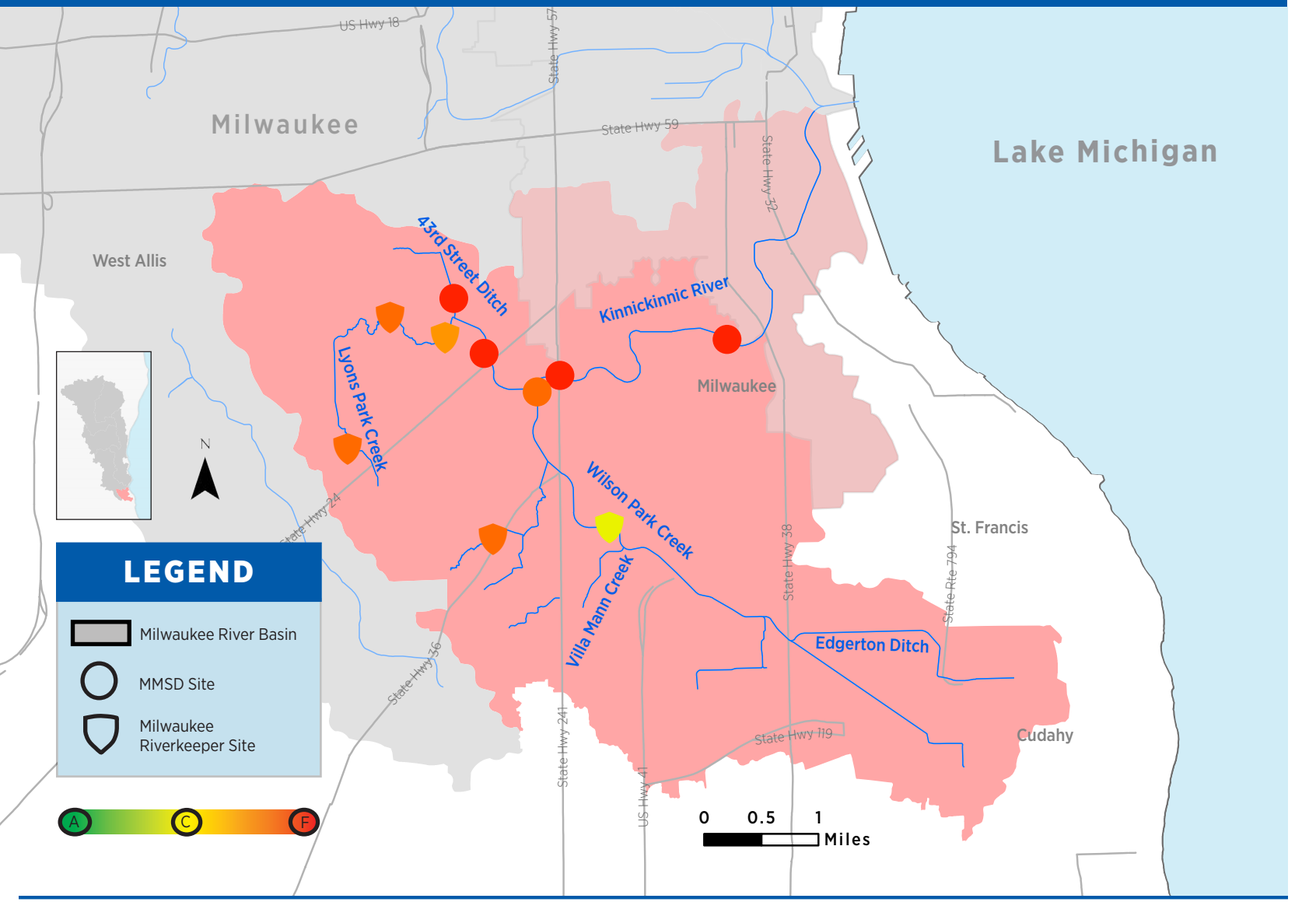
2019 WATERSHED PARAMETER GRADES



DID YOU KNOW?

In 2019, the Wisconsin Department of Natural Resources issued a watershed-based stormwater permit to municipalities of the Menomonee River Watershed. This permit requires source identification and reduction of bacteria, improvements in stormwater ordinances, and enhanced education and public outreach efforts.

KINNICKINNIC RIVER WATERSHED | F



QUICK FACTS

RIVER MILE FACTS

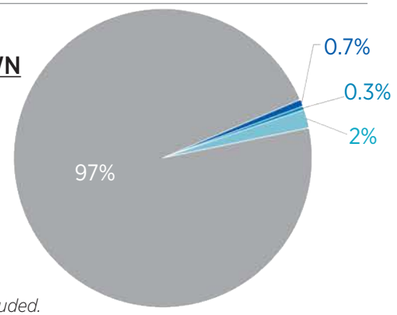
37 mi.
total miles

0 mi.
of trout streams

20 mi.
of impaired waters

LAND USE BREAKDOWN

- Agriculture
- Wetland
- Grassland/Forest
- Urban/Developed



NOTE: 1% of land use is not included.

2019 MONITORING

10 total sites

136 total site visits

Data Contributors: MMSD, Milwaukee Riverkeeper

Milwaukee Riverkeeper Data Contribution:

50% sites

27% site visits

8 volunteers

2019 DATA SUMMARY

The Kinnickinnic River Watershed has the lowest grade in the Milwaukee River Basin, meeting water quality standards only 54.54% of the time. This Watershed saw the greatest decrease in grade from 2018, dropping nearly 7%. The phosphorus grade dropped 5% in 2019, while all other watersheds within the Basin saw some improvements in phosphorus scores. Turbidity, specific conductivity, chloride, and bacteria parameters also scored poorly, a consistent trend for this heavily urbanized watershed. Despite the overall low grade, dissolved oxygen, water temperature, and pH levels all met water quality standards.

Rainfall events continue to increase in frequency and intensity; 2018 and 2019 were some of the wettest years on record in Southeast Wisconsin. Frequent rainfall events transport pollution and stir up sediment in waterways, leading to higher turbidity and decreased clarity. Turbidity grades in the Watershed have dropped 10% annually since 2017. In 2019, turbidity grades fell below the water quality target.

The Kinnickinnic River Watershed is the most developed area within the Milwaukee River Basin and all of Wisconsin. The Watershed's land use is 97% urban, leaving much of the land surfaces impervious and unable to absorb rainfall. High levels of runoff carry pollutants including road salt, leaked vehicle fluids, fertilizers, and trash into local waterways. Streams in the Watershed were straightened and channelized with concrete in the 1960s. These major changes were done to quickly flush stormwater away from developed neighborhoods, thought to be best practice at the time. The concrete channelization caused larger flooding issues, degraded aquatic habitat and created public safety hazards. Failing concrete channels and other infrastructure has prompted action from MMSD, Milwaukee County Parks, and community partners, including Sixteenth Street Community Health Center and Milwaukee Riverkeeper, to restore the waterways to more natural, healthy systems that slow the movement of water, improve water quality, address safety concerns, and provide improved habitat for wildlife.

The restoration project in Pulaski Park removed over 1,900 feet of failing concrete channel, replacing it with a natural streambed and banks. These efforts combat the effects of heavy urbanization by recreating a more natural stream shape, and more diverse in-stream habitat. Riffles were added to provide valuable habitat and increased dissolved oxygen for invertebrates and fish. The meandering shape of a river slows the water down in an effort to reduce bank erosion, a contributing factor of turbidity. The shape allows for water to spill over onto floodplains and creates backwater pools, which reduces flooding and increases safety. Present and future restoration projects will return some natural ecological function to this developed Watershed.

2019 WATERSHED PARAMETER GRADES

	A	B	C	D	F	TOTAL	GRADE CHANGE
WATERSHED					F	54.54%	↓
Temperature	A					100.00%	=
Dissolved Oxygen	A					96.88%	↑
pH	A					100.00%	=
Turbidity				D+		68.25%	↑
Phosphorus					F	35.48%	↓
Chloride				D		66.42%	↓
Specific Conductivity					F	4.65%	↓
Bacteria					F	16.28%	↓

MACROINVERTEBRATE BIOTIC INDEX

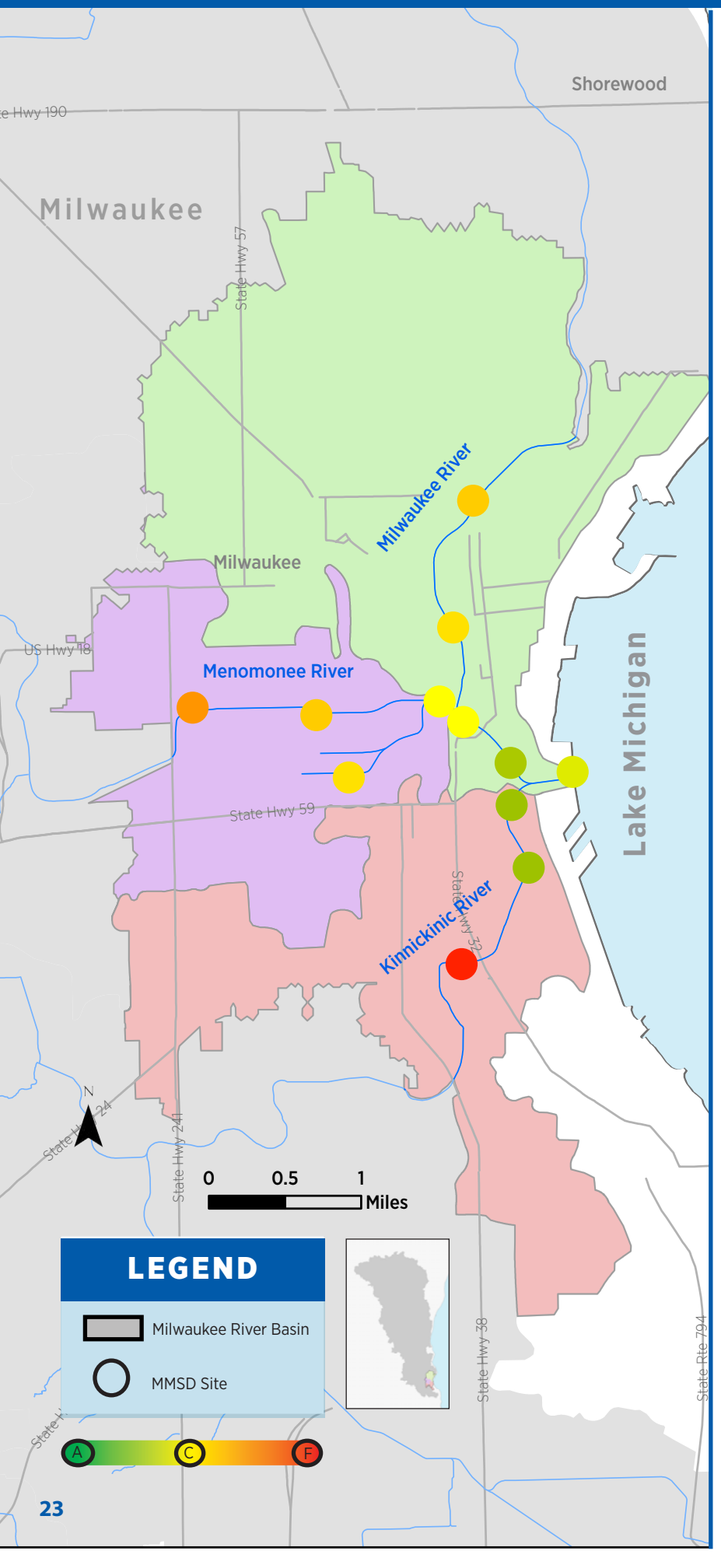
POOR — 1.83 ↓

DID YOU KNOW?

Simple actions like reducing water usage during rain events helps keep polluted stormwater and sewage overflows from entering our waters.

Text WATERDROP to 797979 to be alerted to conserve water during heavy rain events.

MILWAUKEE RIVER ESTUARY | C-



QUICK FACTS

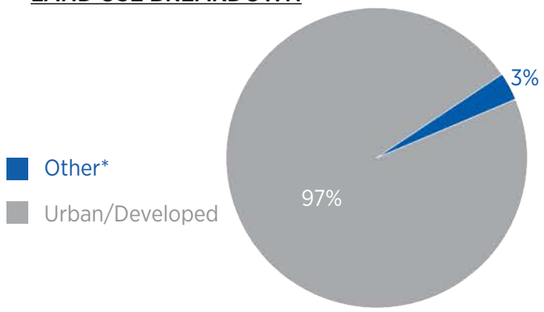
RIVER MILE FACTS

9 mi. total miles

0 mi. of trout streams

9 mi. of impaired waters

LAND USE BREAKDOWN



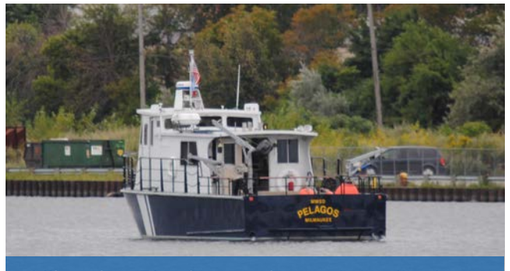
**Includes grassland and other unidentified land uses*

2019 MONITORING

12 total sites

185 total site visits

Data Contributors: MMSD



Milwaukee Riverkeeper does not monitor in this area due to deep river depths that make it unsafe or inaccessible for volunteers. MMSD primarily monitors this area from their research vessel, the Pelagos.

2019 DATA SUMMARY

The Milwaukee River Estuary received a C- (73.07%) in 2019, an improvement of 4.15% from 2018. Most notably, improvements to turbidity and phosphorus helped to boost this grade. In the Estuary, the Menomonee, Kinnickinnic, and Milwaukee Rivers join together before flowing into Lake Michigan. Seiches, the large scale sloshing movement of Lake Michigan, make water levels in the Estuary fluctuate and mix with river water. This unique area is heavily impacted by Lake Michigan and has been graded separately from its respective watersheds. In 2019, record high water levels in Lake Michigan and historic rainfall wreaked havoc on the Estuary and the downtown river reaches. Flooding, wave action and strong winds damaged waterfront properties, reduced boat clearance under bridges and resulted in large amounts of trash loading to the waterways.

The decrease in the volume of combined sewer overflows (CSOs) from 2018 to 2019, may have contributed to the observed improvement of turbidity and phosphorus grades in 2019. Turbidity improved almost 10% from 2018, returning to levels recorded in previous years. CSOs can occur in the Estuary when intense rainfalls and resulting stormwater overwhelms the combined sewer system. CSOs have decreased drastically since the completion of the Deep Tunnel in 1994, but more frequent, heavy rainfall events as a result of climate change have increased CSOs in the last several years. In 2019, two CSOs discharged 563 million gallons of untreated wastewater into local rivers, a significant decrease from 2018's 1,271 million gallons discharged. MMSD has prioritized construction of green infrastructure practices to manage and catch stormwater, which promotes infiltration of rain and snowmelt into the ground, and diverts water from entering the Deep Tunnel and connected sewers.

Another influence from Lake Michigan is the impact of invasive mussels. These small, highly invasive mussels filter up to one quart of water per day, consuming plankton, the foundational organisms of the aquatic food web. Invasive mussels are found throughout the Milwaukee Harbor and thankfully have not migrated further upriver. Clear, low-turbidity water from Lake Michigan, where trillions of invasive mussels are continually filtering nutrients from the water, influences turbidity within the Estuary.

2019 ESTUARY PARAMETER GRADES

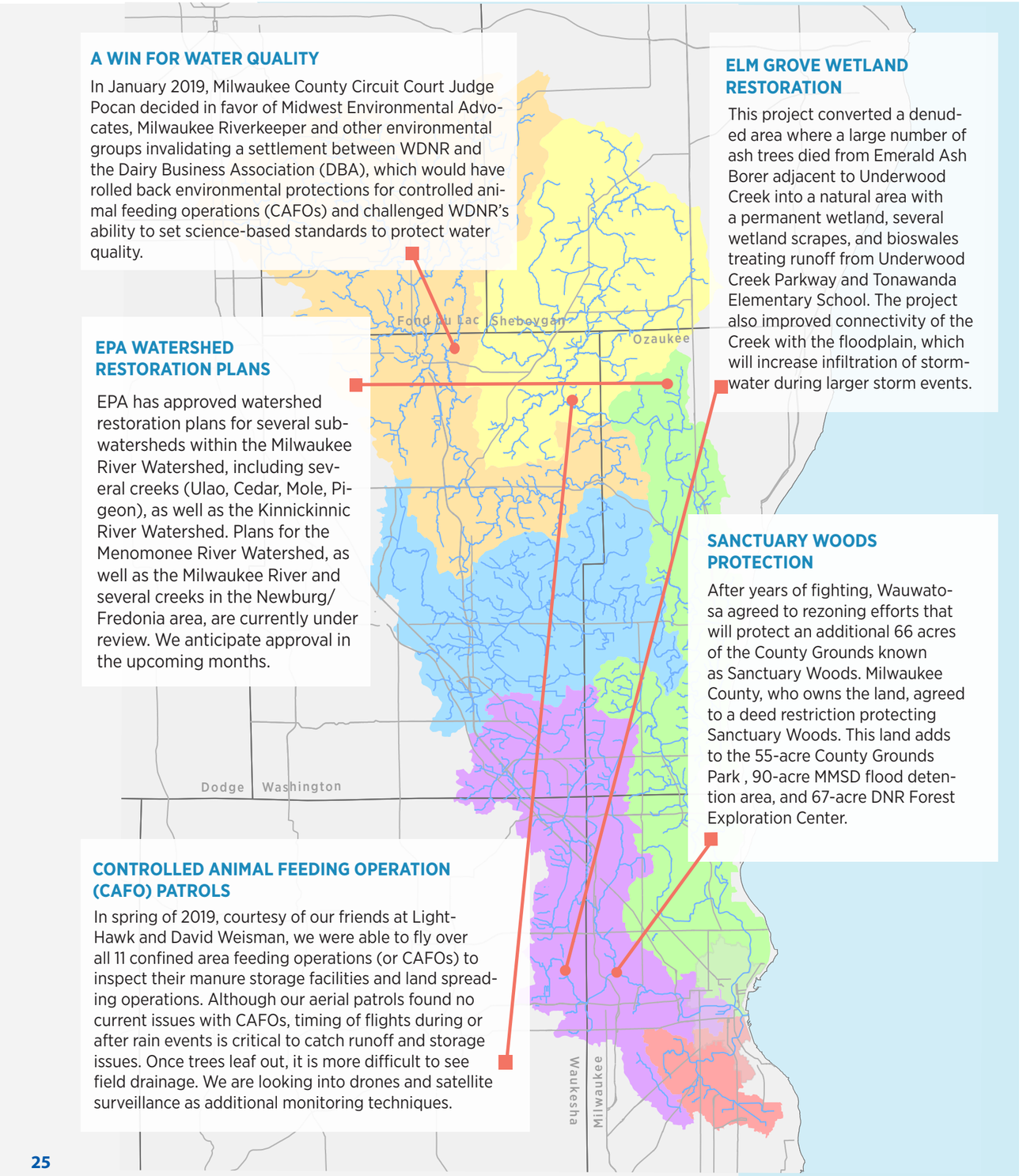
	A	B	C	D	F	TOTAL	GRADE CHANGE
ESTUARY			C-			73.07%	↑
Temperature	A					100.00%	=
Dissolved Oxygen		B+				88.17%	↑
pH	A					100.00%	=
Turbidity		B-				80.65%	↑
Phosphorus			C-			70.97%	↑
Chloride	A					98.41%	↑
Specific Conductivity					F	15.05%	↑
Bacteria					F	44.24%	↑
MACROINVERTEBRATE BIOTIC INDEX						N/A	

DID YOU KNOW?

River otters were spotted in the downtown area of Milwaukee in the winter of 2019! The presence of river otters is evidence of improving water quality and riparian habitat that can support these semi-aquatic mammals.

Historic and current industrial discharges, treated and untreated wastewater, and stormwater runoff influence the Estuary's water quality. Restoration projects, as part of the Milwaukee River Estuary Area of Concern, focus on removing legacy pollutants, preventing future contamination, revitalizing habitats, and providing safe conditions for recreational use.

ON PATROL WITH MILWAUKEE RIVERKEEPER



A WIN FOR WATER QUALITY

In January 2019, Milwaukee County Circuit Court Judge Pocan decided in favor of Midwest Environmental Advocates, Milwaukee Riverkeeper and other environmental groups invalidating a settlement between WDNR and the Dairy Business Association (DBA), which would have rolled back environmental protections for controlled animal feeding operations (CAFOs) and challenged WDNR's ability to set science-based standards to protect water quality.

EPA WATERSHED RESTORATION PLANS

EPA has approved watershed restoration plans for several subwatersheds within the Milwaukee River Watershed, including several creeks (Ulao, Cedar, Mole, Pigeon), as well as the Kinnickinnic River Watershed. Plans for the Menomonee River Watershed, as well as the Milwaukee River and several creeks in the Newburg/ Fredonia area, are currently under review. We anticipate approval in the upcoming months.

ELM GROVE WETLAND RESTORATION

This project converted a denuded area where a large number of ash trees died from Emerald Ash Borer adjacent to Underwood Creek into a natural area with a permanent wetland, several wetland scrapes, and bioswales treating runoff from Underwood Creek Parkway and Tonawanda Elementary School. The project also improved connectivity of the Creek with the floodplain, which will increase infiltration of stormwater during larger storm events.

SANCTUARY WOODS PROTECTION

After years of fighting, Wauwatosa agreed to rezoning efforts that will protect an additional 66 acres of the County Grounds known as Sanctuary Woods. Milwaukee County, who owns the land, agreed to a deed restriction protecting Sanctuary Woods. This land adds to the 55-acre County Grounds Park , 90-acre MMSD flood detention area, and 67-acre DNR Forest Exploration Center.

CONTROLLED ANIMAL FEEDING OPERATION (CAFO) PATROLS

In spring of 2019, courtesy of our friends at LightHawk and David Weisman, we were able to fly over all 11 confined area feeding operations (or CAFOs) to inspect their manure storage facilities and land spreading operations. Although our aerial patrols found no current issues with CAFOs, timing of flights during or after rain events is critical to catch runoff and storage issues. Once trees leaf out, it is more difficult to see field drainage. We are looking into drones and satellite surveillance as additional monitoring techniques.

THE STATE OF OUR RIVERS | CHERYL NENN

Despite our collective efforts in 2019, the Milwaukee River Basin continues to struggle with phosphorus, bacteria, specific conductivity and turbidity problems. It took decades to degrade these rivers, and it's going to take some time before we see grades that we can be proud of. The Kinnickinnic River Watershed continues to have the worst grade in the Basin; the extensive amount of impervious surfaces paired with record breaking rainfall in 2019 was a bad combination. The East and West Branch Subwatershed continues to have the best water quality, which is in large part due to the beautiful natural areas of the Kettle Moraine North State Park. Increased monitoring efforts in 2019, supplemented by GLEC, have continued to improve our understanding of pollutant loading in the Basin.

Improving water quality in the Milwaukee River Basin is a team effort. While this Report Card emphasizes stream chemistry or "chemical" health, we are proud of some great restoration work happening to improve physical and biological stream health in our watersheds, including work to remove barriers to fish passage; improve stream form, function, and connectivity; and enhance habitat for fish and aquatic life.

We have worked with many partners and stakeholders in the Milwaukee River Basin to advance restoration projects, and develop various watershed restoration plans. These plans detail current pollutant sources, reductions needed, as well as prioritized projects that could help achieve our water quality goals. These plans also provide recommendations for regulations and policies at the local level to better protect streams.

While plans do not equate to water quality improvements, they do provide a road map for future work and make municipalities eligible for federal funding to finance these expensive projects. Despite grades that are lower than we'd like, stormwater projects are being constructed by municipalities and community groups, farmers are working together to improve soil health and reduce runoff in a more coordinated way, and Milwaukee is finally getting federal funds to clean up legacy contamination in the Milwaukee River Estuary Area of Concern. These efforts are hard to grade!

The last member of the team is you! We are all watchdogs for our waterways, and are responsible for their protection. If you notice anything questionable or spot areas of bad runoff, please let us know (and take pictures if you can)!
Report pollution here: www.milwaukeeriverkeeper.org

By working together, we can achieve real progress in cleaning up our waters.

DONATE: **www.milwaukeeriverkeeper.org/donate**

STAY CONNECTED:

CREATING A GROUNDSWELL OF CHANGE

There were serious rollbacks to many environmental laws at the federal level in 2019. Rollbacks to the Clean Water Act would remove protections for approximately 55% of the State's wetlands and 1 in 3 of our ephemeral streams. We are working with partners to defeat these and many other rollbacks to critical federal laws. Despite good work to obtain public input on Wisconsin's water quality problems, and the Water Quality Task Force drafting 11 bills, none of the state legislation passed.

If we want real change to happen, it's critical that you use your voice to make an impact. Tell your elected officials that our communities need swimmable, fishable, drinkable waters.

Learn more at: www.milwaukeeriverkeeper.org

CLIMATE CHANGE AND THE MILWAUKEE RIVER BASIN

The effects of climate change have become increasingly present over the last several decades, and the Midwest is not left behind when it comes to feeling the heat. Since the industrial revolution, the increase of CO2 and other greenhouse gas emissions from human activity has led to a rapid increase in global climate temperatures. We often hear about melting ice caps, rising sea levels, and intense hurricanes, but what is happening in our own backyards?

According to the Environmental Protection Agency (EPA), temperature records over the last century have shown increasing averages throughout the seasons, leading to more extreme weather patterns. Storms have intensified, as seen over the last two years of historic rainfall, culminating in what are now the wettest years of Wisconsin's recorded history. Heavy precipitation leads to runoff events, carrying pollutants into local waterways. The Milwaukee River Basin grades from 2018 and 2019 demonstrate the consequences of excessive amounts of runoff, with many grades negatively impacted from increased phosphorus, bacteria, and specific conductivity. Widespread flooding in spring 2019 was another symptom of the changing climate. Municipalities along the Milwaukee River, including Cedarburg and Thiensville, experienced floodwaters creeping up to businesses' doorsteps and into residents' basements and garages. Heavy rainfall paired with seasonal snowmelt caused many rivers across Wisconsin to reach record high levels during that time, making roads impassable, prompting evacuations, and leading Governor Evers to declare a state of emergency in several areas.

Lake Michigan has also seen record highs from the influx of rain water. High water levels have amplified erosion along its shoreline that put lakeshore properties in jeopardy, submerged structures along the coast that pose dangerous threats to boaters, and backed up water into sewers causing public health risks. Many properties along the Estuary, where dredged portions of the rivers are highly influenced by lake levels, constantly run sump pumps to clear water from their basements. Combined sewer overflows are almost inevitable during more frequent, long and intense rain events, as storm-water and wastewater combine in the Deep Tunnel waiting to be processed at the wastewater treatment plant. The Deep Tunnel often reaches capacity before all the stored water can be processed, resulting in the dumping of untreated wastewater to rivers throughout the southern part of the Milwaukee River Basin.

While spring and winters get wetter, summers are also projected to become drier causing more weather extremes within a single year. Significant portions of the Milwaukee River Watershed are utilized as agricultural land, which could be strained by droughts or inundated by storms. Heavy storms can wash away fertile topsoil, reducing crop yields and depositing heavy loads of sediment into our local waterways. The stress that extreme weather conditions pose to crops creates uncertainty in our food supply and hurts local farming economies.

Wisconsin's notoriously cold winters are warming up as well. While many people may enjoy having less snow to shovel, snow cover is important to regulate the Earth's temperatures and recharge critical water resources. A layer of snow acts like a blanket over the landscape, insulating and protecting soil, plants, and other organisms from the harsh winter air. In addition, snow has a high reflective quality, reflecting the sun's heat energy away from the earth's surface. So, snow acts as an important regulator; keeping life below its surface warm enough to survive while keeping the ambient air temperatures cool. Snow is even valuable when it melts, as snow meltwater refills and recharges streams and groundwater.

Ice plays an important role in protecting environments within and around the Basin as well. Since the 1970s, ice cover on the Great Lakes has trended downward, but still experiences extreme fluctuations (Wang, et al., 2018). Years with little ice cover have led to extensive damage from winter storm surges, notably by the Port of Milwaukee and Milwaukee County Parks where millions of dollars in damages have occurred in recent years. Nearshore ice in particular helps minimize the impact of large waves on the shore and without it, the full force of the waves pummel the shoreline, causing erosion, property damage, and flooding. Even fish species like whitefish rely on ice to protect overwintering eggs from the battering of waves.

In both lakes and rivers, the presence of ice helps to maintain cold waters, which are vital to certain species of fish and invertebrates. As climate change progresses, coldwater streams in the Basin may struggle to maintain adequate temperatures, putting trout and other sensitive fish populations at risk. Escalated evaporation and greenhouse gas emissions may occur over winter months when a cap of ice has not formed over a waterbody. Less ice cover generally means more water evaporation, although any water level losses in recent years have been negated by intense rainfall. The importance of ice extends beyond the water column; terrestrial animals benefit from the winter roadways as they seek food, and even humans find enjoyment skating or fishing on the surface. Globally, seasonal ice cover on rivers has declined by nearly seven days (Yang, Pavelsky, Allen, 2020).

The health and vitality of the Milwaukee River Basin is susceptible to the disturbances climate change is causing— ecosystems that have long been in balance with seasonal climate variations will have to adapt quickly to a more extreme environment. Efforts to promote resiliency to these imminent climate changes are underway, with a lot of focus on making changes to water infrastructure, energy systems, and the way we use and manage our critical natural resources. Reestablishing vegetation buffers adjacent to wetlands, riparian habitats along streams, and lakeshores better stabilizes the land and lessens the impacts of floods by promoting infiltration of water. These vegetated areas soak up water reducing the volume traveling downstream, while also filtering sediment and pollutants before they can enter waterways. Removing dams and obstructions in streams is important to allow fish and other aquatic organisms to travel to different habitats for spawning as well as to move to different areas when water levels drop, temperatures become too warm (or oxygen levels too low), or areas ice up.

As we look forward, there is no doubt action must be taken to mitigate human impacts on the climate and to adapt to the challenges we face. Simple steps can be taken on an individual level to reduce our carbon footprints and act as stewards for the environment, such as reducing single use plastics, planting native vegetation, lowering energy consumption, and transitioning to more energy-efficient vehicles and appliances. It is equally as important to act as environmental advocates by voting and holding governments and businesses accountable for actions that degrade ecosystems, pollute our waters, and contribute to greenhouse gas emissions. Finally, volunteering to collect data on water quality and the impacts of climate change to our waters helps us gather information that validates calls to action and helps monitor the success of climate adaptation and management efforts. Through local action, we can join the global fight against climate change to create a better future for ourselves, the next generations, and the planet as a whole.

Pictured: Gov. Evers declared 2019 the "Year of Clean Drinking Water" and formed a Climate Change Taskforce.

Sources:
Yang, X., Pavelsky, T.M. & Allen, G.H. The Past and Future of Global River Ice. Nature 577, 69–73 (2020).

Wang, et al. Great Lakes Ice Climatology Update of Winters 2012-2017. NOAA Technical Memorandum GLERL-170 (2018).

MONITORING STREAM FLOW AND NUTRIENT LOADS
IN THE UPPER MILWAUKEE RIVER WATERSHED

Science staff at Great Lakes Environmental Center, Inc. (GLEC) began a two-year partnership with Milwaukee Metropolitan Sewerage District in September 2017. The project aimed to better understand stream reaches within the Milwaukee River Watershed where impairments to beneficial uses of both water quality and recreation were identified and water quality objectives were not met. The causes of impairment in studied streams include degraded biological communities, degraded habitat, elevated water temperatures, and low concentrations of dissolved oxygen (DO). Resulting impairments are related to one or more of the following pollutants: sediment, total suspended solids (TSS), total phosphorus (TP), and fecal indicator bacteria (fecal coliform, or FC and *Escherichia coli, or E. coli*).

Surface water quality data, continuous stage (water level) and stream flow measurements, the measurement of a volume of water that passes a given location within a period of time (cubic feet per second), were collected at 25 representative sites within the Milwaukee River Watershed (Figure 1). Monitoring locations for this project can be seen throughout this report card identified by the ⊙ symbol. Monthly water samples were analyzed by MMSD lab staff for TSS, TP, FC and *E. coli*. In stream measurements were taken for dissolved oxygen (DO), pH, water temperature and specific conductance; stage and discharge were measured monthly at the 25 sites during ice-off conditions beginning September 2017 through November 2019. Samples were also collected at four of the 25 sites during seven wet weather events.

Using flow and pollutant concentration data, pollution loads can be calculated in an effort to identify the impacts and potential sources of different pollutants. Once a waterway in Wisconsin continually does not meet water quality standards for a specific pollutant, it is deemed impaired and placed on Wisconsin Department of Natural Resources' 303(d) list. For those waterways that are impaired, it is required by the Clean Water Act that a Total Maximum Daily Load (TMDL) is created. A TMDL is the amount of a pollutant a waterbody can receive and still meet water quality standards. Understanding loads of a pollutant within the waterway helps to determine the source or sources of pollution, which can be targeted for best management practices to help reduce pollution and get a stream back into a healthy condition.

Stream flow or discharge is important to understand, as it impacts concentration and loading of pollutants. Extended ice cover in early 2018, resulted in lower than average stream flow in March-April. Additionally, unusually dry and hot conditions in August 2018, resulted in lower than historical average flow in the main branch of the Milwaukee River. Flows were higher than average in the fall of 2017 and May and June 2018. Stream flows in Cedar Creek were also higher than average in May through August 2018 – in the latter cases due to heavy spring rains. Most significantly, much higher than average flows were measured at sites in both Cedar Creek and the Milwaukee River beginning in the fall 2018 through most of 2019 due to greater than historic average rainfall. In fact, 2019 was the wettest year ever across Wisconsin and the Midwest.

Observed record amounts of precipitation, were reflected in the stream flow discharges from the study period, as well as the pollutant concentrations. In September-November 2018, the daily Milwaukee River flow exceeded the 90th percentile daily flow 42 times and exceeded the maximum recorded daily flow on 15 days (data going back to 1981). In 2019, September-November daily Milwaukee River flow rates were even higher: discharge exceeded the 90th percentile daily flow 76 times and exceeded the maximum recorded daily flow on 24 days. In September-November 2019, the daily Milwaukee River stream flow exceeded the 90th percentile daily flow for 66 consecutive days.

The water quality monitoring results indicated strong seasonal patterns of elevated values during summer at all sites for fecal coliform and *E. coli*, and to a lesser degree total suspended solids followed by total phosphorus. High flow (both wet weather and seasonal) was found to be a strong determinant of elevated fecal coliform and *E. coli* at all sites. Pollutant loadings increased substantially during wet weather and likely due to

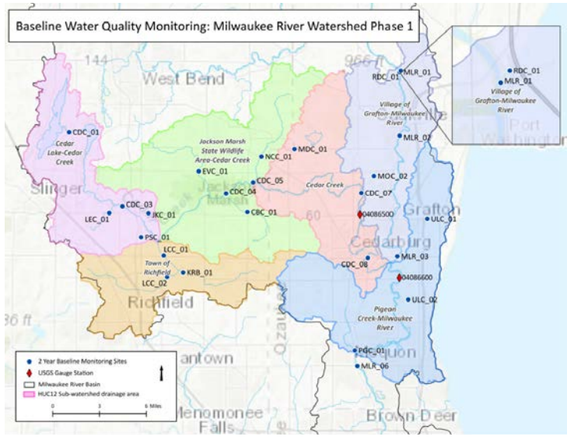


Figure 1. *Locations (N=25) for collection of water quality data (TSS, TP, FC, E. coli, DO, pH, specific conductance, water temperature and turbidity) and continuous stage and discharge measurements in portions of the Milwaukee River Watershed.*

increased number and intensity of rainfall and resulting runoff events. Pollutant loadings were generally higher in 2018 and 2019 compared to 2017, consistent with the increasing trends in annual stream flow and rainfall.

The mean annual daily pollutant loadings from minor tributaries were relatively small compared to sites along the main stem of Cedar Creek and the Milwaukee River. Dividing the mean annual daily loading by the contributing drainage area of each water body sampling site provides an estimate of pollutant

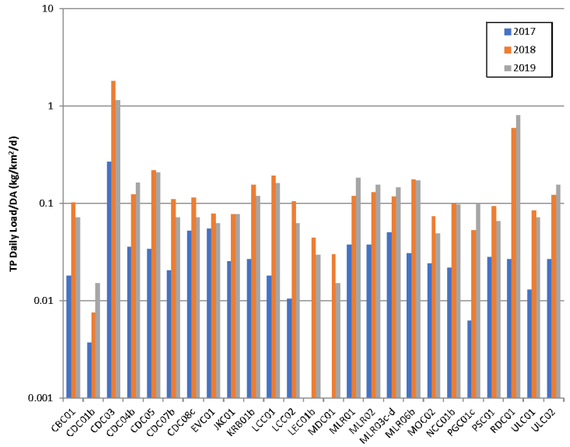


Figure 2. *Total phosphorus (TP) pollutant yield by site and calendar year.*

yield. Normalization of loads by drainage area to calculate pollutant yield helps identify prominent contributing pollution sources. As observed in Figure 2, we can infer that high TP pollutant yields at one Cedar Creek site downstream of Mayfield Road (CDC03) is likely coming from substantial row cropping and agriculture in the contributing watershed.

This monitoring collaboration creates real opportunities for identification and mitigation of adverse impacts of excessive nutrients and other pollution within the upper Milwaukee River Watershed. When coupled with routine monitoring of biological parameters, decision-makers and stakeholders alike gain strategic information to aid in achieving the ultimate goal of reducing pollution to our rivers and delisting specific stream reaches for water quality impairments from the Wisconsin Department of Natural Resources' 303(d) list.

GLEC hired students from University of Wisconsin-Milwaukee's School of Freshwater Sciences and Milwaukee Riverkeeper staff to collect data for this project.

ABOUT THE AUTHOR

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Great Lakes Environmental Center, Inc. (GLEC) is an national contracting firm offering applied environmental sciences, research, and compliance assistance focused on water quality and the protection of aquatic ecosystems. The dedicated employee-owners at GLEC often set the standard in their respective fields by consistently applying core philosophies of scientific excellence, corporate responsibility, environmental stewardship, and dedication to fulfilling client needs.

OUR WATER QUALITY PARAMETERS

Water quality data is assessed against a set of ideal targets to determine the health of our waterways. Where there is a regulatory standard or federal guidance for a parameter, that is generally listed as the goal. In some cases, we created our own targets based on what we feel is the reasonable potential of our streams to support fish and recreational activities.

WATER TEMPERATURE: Each aquatic organism's survival is limited by its tolerance to changes in water temperature. As a result, temperature ranges can be used to classify aquatic ecosystems. Drastic changes in water temperature can have significant impacts on aquatic life and biodiversity of streams. It is also important to note that temperature impacts the amount of dissolved oxygen water can hold.

Warm Stream < 31.7°C
Cold Stream < 22.0°C

DISSOLVED OXYGEN: Dissolved oxygen (DO) is a measure of the amount of oxygen dissolved in a volume of water. The amount of oxygen found in our rivers is influenced by stream velocity, substrate, and water temperature. Generally speaking, as temperature increases, dissolved oxygen decreases and vice versa. Oxygen is essential for every organism's survival in some concentration. Therefore, not only is DO an important water chemistry parameter, it can be a limiting feature for aquatic life.

Warm Stream > 5.0 mg/L
Cold Stream > 6.0 mg/L

pH LEVEL: pH is a measure of the amount of hydrogen (H+) ions in water. pH ranges from 0 to 14 (0 being the most acidic, 14 being the most basic) with a value of 7 representing a "neutral" solution. Milwaukee River Basin streams generally run on the basic side of neutral, with values typically between 7 or 8 on the pH scale

pH 6 - 9

TURBIDITY: Turbidity, or water clarity, affects both the light and energy inputs available to aquatic ecosystems. Our volunteers measure turbidity using transparency tubes. These are clear, plastic tubes that are filled and/or emptied of stream water until they reveal a black and white pattern on the bottom of the tube (similar to a lake secchi disc). A height of at least 54.7 cm of stream water in a 120 cm transparency tube indicates healthy water. A turbidity level of <10 NTU is ideal for aquatic life, and was used as the target for stream health. This is equivalent to 54.7 cm or greater. MMSD does not use transparency tubes but instead uses sensors to directly test the turbidity values of water in units of FNU (a similar turbidity unit to NTU). A turbidity level of <10 FNU was used as a target for MMSD data.

<10 NTU
<10 FNU

PHOSPHORUS: Phosphorus, measured as Total P, is an essential nutrient for plants, animals, and aquatic life. Phosphorus is typically low to absent in natural freshwater systems. Human activities have led to large inputs of phosphorus into our rivers and lakes. These activities include fertilization of lawns and agricultural fields, sewage treatment discharge, and the addition of phosphorus into our water supply as an anti-corrosion inhibitor for old, lead pipes. Excess phosphorus entering our waterways causes growth of nuisance algae as well as a cascade of water quality problems. Monthly water samples are shipped to the State Lab of Hygiene for total phosphorus analysis.

Large Streams < 0.1 mg/L
Small Streams <0.075 mg/L

MACROINVERTEBRATES: To grade river health based on aquatic macroinvertebrate surveys, Milwaukee Riverkeeper volunteers use a simple biotic index. This survey was developed by a group of Wisconsin scientists, which is specifically designed for streams in Wisconsin. Index score classifications range from Good-Fair-Poor. Due to macroinvertebrates relative immobility, they provide a good overall indicator of the health of a certain stream segment and tend to be classified per tolerance to a range of oxygen conditions.

"Good" (2.6 – 3.5)

CHLORIDE: High chloride concentrations in rivers and streams are toxic to aquatic organisms. Road salt runoff constitutes a large source of chloride. Elevated levels of chloride can disrupt an organism's ability to maintain a natural internal water balance, which leads to impaired survival, growth, and/or reproduction. High levels of chloride can be acutely or instantly toxic to fish, lower levels of chloride over a longer period of time or chronic exposure can be just as toxic.

Chloride (Acute) <757 mg/L
Chloride (Chronic) <395 mg/L

CONDUCTIVITY: Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by charged particles (ions), which can be both positive (cation) and negative (anion). Anions include chloride, nitrate, sulfate, and phosphate. Conductivity in streams is naturally affected by geology. Bedrock streams tend to have lower conductivity whereas streams passing through clay soils tend to have higher conductivity. Human originated discharges to streams -- such as discharge of industrial waste (e.g., heavy metals), sewage, or other "charged" contaminants such as chloride, phosphate, and nitrate -- can raise conductivity.

150 – 500 µS/cm*

**Milwaukee Riverkeeper acknowledges that the current target for conductivity contained in U.S. EPA guidance may be too stringent; however, for consistency with previous years analysis, the target has remained the same. Further research needs to be done to determine an appropriate target moving forward.*

BACTERIA: High bacteria concentrations impact not only stream health, but also public health. Regulatory agencies such as MMSD and WDNR regularly test for fecal coliform and *E. coli* bacteria in surface waters. In 2018, Milwaukee Riverkeeper trained a pilot group of volunteers to monitor bacteria using a low cost method. Future plans include monitoring bacteria in areas outside of MMSD's service area.

Fecal coliform <200 CFU/100mL
***E. coli* <235 CFU/100mL**

DATA SUMMARY

LOCATION	OVERALL	WATER TEMPERATURE	DISSOLVED OXYGEN	PH	TURBIDITY	PHOSPHORUS	MACRO-INVERTEBRATES	CHLORIDE*	CONDUCTIVITY*	BACTERIA
MILWAUKEE RIVER BASIN	D+	A	A	A	C	F	FAIR	B+	F	F
MILWAUKEE RIVER WATERSHED	D+	A	A	A	C+	F	FAIR	A-	F	F
North Branch Milwaukee River Subwatershed	C+	A	A	A	A	F	FAIR	A	F	F
Cedar Creek Subwatershed	D+	A	A	A	C+	F	FAIR	A	F	F
East & West Branch Milwaukee River Subwatershed	B-	A	A	A	A	C-	FAIR	A	F	F
South Branch Milwaukee River Subwatershed	D	A	A-	A	C-	F	FAIR	A-	F	F
MENOMONEE RIVER WATERSHED	D-	A	A	A	D	F	FAIR	B-	F	F
KINNICKINNIC RIVER WATERSHED	F	A	A	A	D+	F	POOR	D	F	F
MILWAUKEE RIVER ESTUARY	C-	A	B+	A	B-	C-	-	A	F	F

***NOTE:** Milwaukee Riverkeeper volunteer baseline data was collected and analyzed from May – November. MMSD collects data year round. This heavily impacted our final chloride and conductivity grades. MMSD only monitors sites in the Menomonee and Kinnickinnic River Watersheds, and the southern portion of the South Branch Milwaukee River Subwatershed. Hence, the grades in the southern half of the Basin are heavily skewed towards MMSD data. Also, grades for the upper half of our Basin had comparatively fewer data points.

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