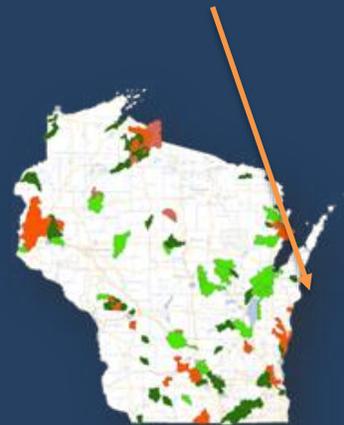
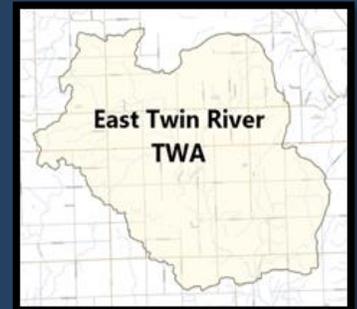


PUBLIC REVIEW DRAFT – FOR PUBLIC COMMENT

# East Twin River Targeted Watershed Assessment: A Water Quality Report to Restore Wisconsin Watersheds, 2020

*East Twin River Watershed (TK02)  
HUC12: 070600050203, Monitored 2016*

*A Watershed Report  
created by the Bureau  
of Water Quality in  
support of the Clean  
Water Act.*



East Twin River at Krok Road "Ditch" (Station ID 10030630)

Photo by: Mary Gansberg, East District Water Quality Biologist  
Wisconsin Department of Natural Resources

To learn more, see on [Wisconsin's TWA Projects Online!](#)  
Read about East Twin River waters in [Explore Wisconsin's Waters Online!](#)



EGAD # 3200-2018-28  
Water Quality Bureau,  
Wisconsin DNR

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## Targeted Watershed Assessment Study Summary

### Study Purpose

The purpose of this study was to assess overall conditions and identify areas of management in the East Twin River Watershed, focusing on the East Twin River and Unnamed Tributaries to the River as well as Krok Creek in Kewaunee County. In 2016, the Kewaunee County Board of Supervisors passed a resolution requesting DNR monitor this area, which is included in the Northeast Total Maximum Daily Load (TMDL) analysis and which hosts impaired waters with chlorides, ammonia, and chromium levels, including total phosphorus. The project results provide a contemporary status and insight into changes in water quality, habitat, and the biological communities in the watershed's upper reaches. [The NE TMDL webpage provides more information.](#) The following are key deliverables from this study:

- Streams in the watershed were monitored to understand their status.
- Presence and sources of impairments were identified.
- Monitoring priorities for future watershed work were identified.
- Management recommendations were developed.
- A presentation to the Kewaunee County Board of Supervisors on the condition.



Figure 1. East Twin R. Watershed (TK02).

### About the Watershed

The East Twin River Watershed is bordered on the east by Lake Michigan in Kewaunee and Manitowoc counties and is 117,493 acres in size. The watershed contains 314 miles of streams and river, 12,446 acres of lakes and 14,181 acres of wetlands. The watershed is dominated by agriculture and wetlands. Streams, ranging from intermittent to perennial, flow southeast through southern Kewaunee County and northern Manitowoc County to the City of Two Rivers where the river enters Lake Michigan. In this watershed there are 12.5 miles of trout water, 26.9 miles of warmwater sport fisheries, 13.6 miles of warmwater forage fisheries, 9.9 miles of limited forage fisheries, and 5 miles of limited aquatic life.

### Biological Communities and Water Quality

Streams in this watershed have impairments from total phosphorus, but the physical habitat and biological communities were meeting the designated uses. Assessment data from 2017 were compared to previous years to determine if water resource conditions changed. An industrial manufacturing facility discharges treated wastewater to the UNT 3000213 to the East Twin River above Cherneyville Road in Kewaunee County. This tributary flows into the East Twin River just downstream of Hwy 29. Previous studies include surveys of the East Twin River (WBIC 84000), Unnamed Tributaries (UNT) to the East Twin River (WBIC 3000211, 3000212, and 3000213) and Krok Creek (WBIC 86700) were conducted and previous studies (2001, 2008, 2009, 2011/2012, and 2015) and water chemistry and temperature data collected in 2011/2012 and 2017.

### Recommendations

This study was designed to create an updated assessment of the overall conditions of the East Twin River Watershed, including assessments of the condition of three Unnamed Tributaries (UNT), the East Twin River and Krok Creek for ecological impairment. Assessment data from 2017 were compared to prior surveys to determine if water quality conditions have changed and if streams are meeting water quality standards. This information was shared with county experts to provide management recommendations for local activities including grants. The following are conclusions and recommendations from the 2017 assessment report:

- ✚ All stream locations assessed exceed water quality criteria for phosphorus and should remain on the 303(d) impaired waters list.
- ✚ Chloride, ammonia, and chromium levels in the streams are below impaired thresholds.
- ✚ Water temperature in UNT 3000213 exceed water quality standards and should remain on the impaired waters list.
- ✚ Ambient chronic toxicity was observed in UNT 3000213 on two occasions in 2017 (July and October). Chronic toxicity was observed on the East Twin River below the confluence with the UNT 3000211 (Station ID 104445) in June but is likely unrelated to UNT 3000213 since no toxicity was found in UNT 3000211 in June.
- ✚ Macroinvertebrate monitoring confirmed fair to good water quality conditions in the East Twin River and UNTs with a slight improvement over the 2011 assessment.
- ✚ Qualitative habitat assessments found mostly good to fair fish and aquatic life habitat available in Krok Creek, the East Twin River and all three UNTs.
- ✚ Watershed-wide non-point sources of nutrient and sediment contributions likely impact the water quality and aquatic life habitat in Krok Creek, the East Twin River and all three UNTs and should be controlled to the extent possible.
- ✚ The overall fish community in the Upper East Twin River watershed is in good to excellent condition.
- ✚ The natural community of the East Twin River at CTH J (Station ID 10008204) should be updated to reflect the current fish community structure of cool-warm headwater.
- The natural community of the East Twin River at Krok Road bridge (Station ID 10020812) should be updated to reflect the current fish community structure of cool-cold headwater.
- The natural community of the UNT 3000211 at Sleepy Hollow Road (Station ID 10029040) should be updated to reflect the current fish community structure of cool-warm headwater.

## Wisconsin Water Quality Monitoring and Planning

This Water Quality Management Plan was created under the state’s Planning and Water Resources Monitoring programs. The plan reflects Water Quality Bureau and Water Resources Monitoring Strategy goals and priorities and fulfills Areawide Water Quality Management Planning milestones under the Clean Water Act. Condition information and resource management recommendations support and guide program priorities for the plan area.

This plan is approved by the Wisconsin DNR and is a formal update to the Twin-Door-Kewaunee Areawide Water Quality Management Plan and Wisconsin’s Statewide Areawide Water Quality Management Plan This plan will be forwarded to USEPA for certification as a formal plan update.

\_\_\_\_\_  
Mary Gansberg, Water Quality Biologist, East District

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Marsha Burzynski, Water Quality Field Supervisor, East District

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Date

### Basin/Watershed Partners

- Kewaunee Land and Water Conservation Department

### Report Acknowledgements

- Mary Gansberg, Primary Author and Investigator, East District, Wisconsin DNR
- Amanda Smith, Program Support, Water Quality Bureau, Wisconsin DNR
- Lisa Helmuth, Program Coordinator, Water Quality Bureau, Wisconsin DNR

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EGAD # 3200-2018-28

## List of Abbreviations

**AEL: Aquatic Entomology Laboratory** at UW – Stevens Point: the primary laboratory for analysis of macroinvertebrate taxonomy in the State of Wisconsin.

**BMP: Best Management Practice.** A land management practice used to prevent or reduce nonpoint source pollution such as runoff, total suspended solids, or excess nutrients.

**DATCP: Wisconsin Department of Agriculture, Trade and Consumer Protection** – the state agency in partnership with DNR responsible for a variety of land and water related programs.

**DNR: Department of Natural Resources.** Wisconsin Department of Natural Resources is an agency of the State of Wisconsin created to preserve, protect, manage, and support natural resources.

**END: Endangered Species** - Wisconsin species designated as rare or unique due to proximity to the farthest extent of their natural range or due to anthropogenic deleterious impacts on the landscape or both.

**ERW: Exceptional Resource Water-** Wisconsin's designation under state water quality standards to waters with exceptional quality and which may be provided a higher level of protection through various programs and processes.

**FMDB: Fisheries Management Database** – or **Fish Database** – the state's repository for fish taxonomy and auto-calculated metrics involving fish assemblage condition and related.

**FIBI: Fish Index of biological integrity (Fish IBI).** An Index of Biological Integrity (IBI) is a scientific tool used to gauge water condition based on biological data. Results indicate condition and provide insight into potential degradation sources. In Wisconsin, specific fish IBI tools are developed for specific natural communities. Therefore, biologists must review and confirm the natural community to use the correct fish IBI tool.

**HUC: Hydrologic Unit Code.** A sequence of numbers that represent one of a series of nested hydrologic catchments delineated by a consortium of agencies including USGS, USFS, and Wisconsin DNR.

**MIBI: Macroinvertebrate Index of biological integrity.** The mIBI is the primary tool used to assess stream macroinvertebrate community condition.

**NC: Natural Community.** A system of categorizing water based on inherent physical, hydrologic, and biological components. Streams and Lakes have uniquely derived systems that result in specific natural community designations for each lake and river segment in the state. These designations dictate the appropriate assessment tools which improves the condition result, reflecting detailed nuances reflecting the modeling and analysis work foundational to the assessment systems.

**Monitoring Seq. No.** Monitoring sequence number refers to a unique identification code generated by the Surface Water Integrated Monitoring System (SWIMS), which holds much of the state's water quality monitoring data except for fisheries taxonomy and habitat data.

**MDM: Maximum Daily Averages** – maximum daily average is a calculated metric that may be used for temperature, dissolved oxygen and related chemistry parameters to characterize water condition.

**NC: Natural Community.** A system of categorizing water based on inherent physical, hydrologic, and biological components. Streams and Lakes have uniquely derived systems that result in specific natural community designations for each lake and river segment in the state. These designations dictate the appropriate assessment tools which improves the condition result, reflecting detailed nuances reflecting the modeling and analysis work foundational to the assessment systems.

**mg/L: milligrams per liter** - a volumetric measure typically used in chemistry analysis characterizations.

**NOAA: National Oceanic and Atmospheric Administration** – a federal agency responsible for water / aquatic related activities involve the open waters, seas and Great Lakes.

**ND: No detection** – a term used typically in analytical settings to identify when a parameter or chemical constituent was not present at levels higher than the limit of detection.

**NRCS: USDA Natural Resources Conservation Service** - the federal agency providing local support and land management outreach work with landowners and partners such as state agencies.

**ORW: Outstanding Resource Water**- Wisconsin's designation under state water quality standards to waters with outstanding quality and which may be provided a higher level of protection through various programs and processes.

**SC: Species of Special Concern**- species designated as special concern due to proximity to the farthest extent of their natural range or due to anthropogenic deleterious impacts on the landscape, or both.

**SWIMS ID.** Surface Water Integrated Monitoring System (SWIMS) identification number is the unique monitoring station identification number for the location of monitoring data.

**TDP:** Total Dissolved Phosphorus – an analyzed chemistry parameter collected in aquatic systems positively correlated with excess productivity and eutrophication in Wisconsin waters.

**TMDL:** Total Maximum Daily Load – a technical report required for impaired waters Clean Water Act. TMDLs identify sources, sinks and impairments associated with the pollutant causing documented impairments.

**TP:** Total Phosphorus - an analyzed chemical parameter collected in aquatic systems frequently positively correlated with excess productivity and eutrophication in many of Wisconsin's waters.

**TWA: Targeted Watershed Assessment.** A monitoring study design centered on catchments or watersheds that uses a blend of geometric study design and targeted site selection to gather baseline data and additional collection work for unique and site-specific concerns for complex environmental questions including effectiveness monitoring of management actions, evaluation surveys for site specific criteria or permits, protection projects, and generalized watershed planning studies.

**TSS:** Total suspended solids – an analyzed physical parameter collected in aquatic systems that is frequently positively correlated with excess productivity, reduced water clarity, reduced dissolved oxygen and degraded biological communities.

**WATERS ID.** The Waterbody Assessment, Tracking, and Electronic Reporting System Identification Code. The WATERS ID is a unique numerical sequence number assigned by the WATERS system, also known as "Assessment Unit ID code." This code is used to identify unique stream segments or lakes assessed and stored in the WATERS system.

**WBIC:** Water Body Identification Code. WDNR's unique identification codes assigned to water features in the state. The lines and information allow the user to execute spatial and tabular queries about the data, make maps, and perform flow analysis and network traces.

**WSLH:** Wisconsin State Laboratory of Hygiene– the state's certified laboratory that provides a wide range of analytical services including toxicology, chemistry, and data sharing.

**WQC:** Water quality criteria – a component of Wisconsin's water quality standards that provide numerical endpoints for specific chemical, physical, and biological constituents.



East Twin River, Photo by Mary Gansberg, DNR East District Water Quality Biologist.

## Water Quality Plan Goals

The purpose of this study was to determine the contemporary status and potential recent changes in water quality, habitat, and the biological communities in the upper reaches of the East Twin River watershed. This plan is designed to present monitoring study results, identify issues, or concerns in the area found during the project, and to make recommendations to improve or protect water quality consistent with Clean Water Act guidelines and state water quality standards.

## Resources

### Watershed

The East Twin River Watershed is bordered on the east by Lake Michigan in Kewaunee and Manitowoc counties and is 117,493 acres in size. The watershed contains 314 miles of streams and river, 12,446 acres of lakes and 14,181 acres of wetlands. The watershed is dominated by agriculture and wetlands. Streams in the East Twin Watershed flow southeastward through southern Kewaunee County and northern Manitowoc County to the City of Two Rivers where the river enters Lake Michigan. Streams within the watershed range from intermittent to perennial. Of the 98.9 stream miles in the basin, 67.9 miles designated fish and aquatic life uses specified. In this watershed there are 12.5 miles of trout water, 26.9 miles of warmwater sport fisheries, 13.6 miles of warmwater forage fisheries, 9.9 miles of limited forage fisheries, and 5 miles of limited aquatic life waters.

### Land Use, Site Characteristics Population

The 101,196-acre watershed is split nearly evenly between Kewaunee and Manitowoc Counties with 42,932 acres (42.5%) in Kewaunee County and 58,264 acres (57.5%) in Manitowoc County (WCD 1966 and 1968). The predominate land use in the watershed is agriculture (69%), although a substantial amount of land is wetland (15%). Other activities account for 16% of the watershed.

### Hydrology

Lake Michigan is a key ecological and socioeconomic feature. It influences the climate, created unique landforms, and is responsible in part for the presence and distribution of rare species. The shoreline constitutes a major flyway for migratory birds. Most of the major cities in this Ecological Landscape are located at the mouths of rivers entering Lake Michigan or Green Bay. Inland lakes are scarce, and all are small. The Fox River drains Lake Winnebago and runs into Green Bay. The other major rivers here run directly into Lake Michigan, and include the Ahnapee, Kewaunee, East Twin, West Twin, Manitowoc, Sheboygan, and Milwaukee.

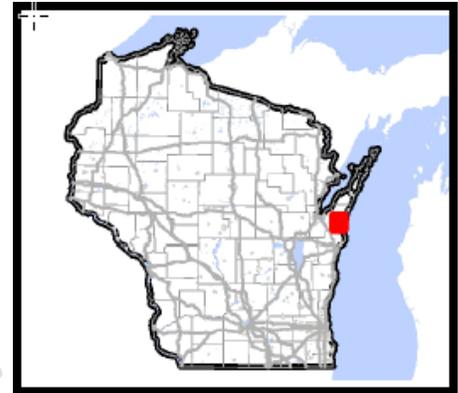
### Soils

Soils in the watershed range from poorly drained organic soils in the north, to gently sloping clays in the central basin to well drained sandy loams near Lake Michigan. Most of the clay-loam soils are fine textured and easily erodible, which can lead to water quality impacts.

### Ecological Landscapes

The East Twin River Watershed lies within the Central Lake Michigan Coastal Ecological Landscape which stretches from southern Door County west across Green Bay to the Wolf River drainage, then southward in a narrowing strip along the Lake Michigan shore to central Milwaukee County (Figure 4). The influence of Lake Michigan leaves the watershed's summers cooler, winters warmer, and precipitation levels greater than at farther inland areas.

Figure 2 The East Twin River Watershed



Watershed Code	TK02
Watershed Name	East Twin River
Watershed Size (Acres)	117493.03
Watershed Size (SQ Miles)	183.58
24K Hydro Stream Miles	314.7
24K Hydro Lake Acres	12446.75
WI Wetland Inventory Acres	14181.41

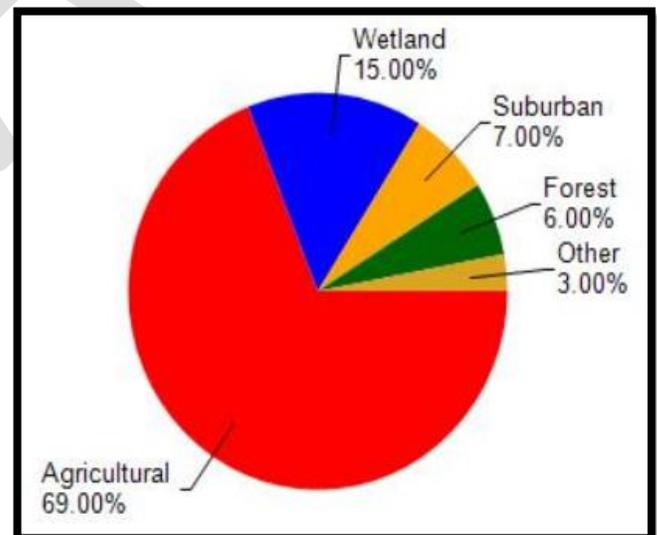


Figure 3. Land use in the East Twin River watershed (TK02).

### Hydrogeology

Dolomites and shales underlie the glacial deposits that blanket virtually all of the Central Lake Michigan Coastal Ecological Landscape. The dolomite Niagara Escarpment is the major bedrock feature, running across the entire landscape from northeast to southwest. Series of dolomite cliffs provide critical habitat for rare terrestrial snails, bats, and specialized plants. The primary glacial landforms are ground moraine, outwash, and lake plain. The topography is generally rolling where the surface is underlain by ground moraine, variable over areas of outwash, and nearly level where lacustrine deposits are present. Important soils include clays, loams, sands, and gravels. Certain landforms, such as sand spits, clay bluffs, beach and dune complexes, and ridge and swale systems, are associated only with the shorelines of Lake Michigan and Green Bay.

Historically areas of poorly drained glacial lake plain supported wet forests of tamarack, white cedar, black ash, red maple, and elm. Emergent marshes and wet meadows were common in and adjacent to lower Green Bay, while Lake Michigan shoreline areas featured beaches, dunes, interdunal wetlands, marshes, and highly diverse ridge and swale vegetation. Small patches of prairie and oak savanna were present in the southwestern portion of this landscape.

### Trout Waters

DNR trout streams in this watershed are listed in Table 1. High quality trout waters (Class I) have sufficient natural reproduction to sustain populations of wild trout, at or near carry capacity. Class II streams may have some natural reproduction, but not enough to utilize available food and space. Stocking maintains a sport fishery but these streams have good survival and carryover of adult trout, often producing some fish larger than average size. Class III are marginal trout habitat with no natural reproduction occurring. There is no carryover of trout from one year to the next.



Figure 4. Ecological Landscapes of the East Twin River Watershed (TK02).

Table 1. Trout streams in the East Twin River Watershed (TK02).

Water Name	WBIC	Start Mile	End Mile	Trout Class
East Twin River	84000	26.4	34.18	Class II
East Twin River	84000	34.18	40.91	Class I
Jambo Creek	84300	0	3.91	Class II
Tisch Mills Creek	85500	0	2.26	Class II

### Outstanding and Exceptional Resource Waters

Wisconsin Outstanding Resource Waters (ORWs, Table 2) and Exceptional Resource Waters (ERWs) provide outstanding recreational opportunities, support valuable fisheries and wildlife habitat, have good water quality, and are not significantly impacted by human activities. The East Twin River is an exceptional resource water from mile 34.18 to 49.90, which is also the Class I Trout Stream section.

Table 2. ORW/ERWs in the East Twin River Watershed (TK02).

Water Name	WBIC	ORW/ERW	Start Mile	End Mile
East Twin River	84000	ERW	34.18	40.91

### Impaired Waters

Section 303(d) of the Clean Water Act requires states to publish a list of waters that do not meet water quality standards. This “Impaired Waters List” reflects waters that are newly added or removed based on new information. Impaired waters in this watershed are impaired for historical discharges and runoff issues (Table 3). The headwaters of the East Twin River down to CTH B are currently on the Clean Water Act Section 303(d) list of impaired waters for phosphorus. The UNTs 3000211, 3000212 and 3000213 in their entirety are on the impaired waters list for phosphorus. UNT 3000213 is on the impaired waters list for water temperature.

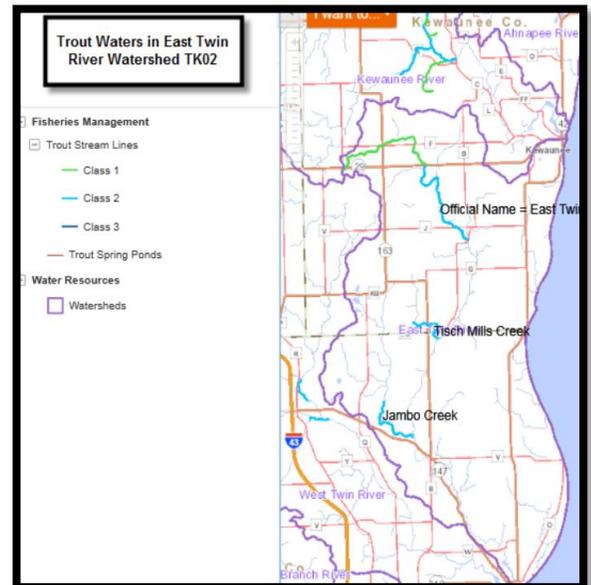


Figure 5. Trout streams East Twin River Watershed

Table 3. Impaired waters in the East Twin River Watershed (TK02).

Official Name	Local Name	Start Mile	End Mile	WBIC	County	Pollutant	Impairment	Status
<a href="#">East Twin River</a>	<a href="#">East Twin River</a>	0	10.49	84000	Manitowoc	Total Phosphorus	Impairment Unknown	TMDL Development
<a href="#">East Twin River</a>	<a href="#">East Twin River</a>	0	10.49	84000	Manitowoc	Mercury	Mercury Contaminated Fish Tissue	303d Listed
<a href="#">East Twin River</a>	<a href="#">East Twin River</a>	0	10.49	84000	Manitowoc	PCBs	PCBs Contaminated Fish Tissue	303d Listed
<a href="#">East Twin River</a>	<a href="#">East Twin River</a>	10.49	26.4	84000	Kewaunee, Manitowoc	Total Phosphorus	Impairment Unknown	TMDL Development
<a href="#">East Twin River</a>	<a href="#">East Twin River</a>	26.4	34.18	84000	Kewaunee	Total Phosphorus	Impairment Unknown	TMDL Development
<a href="#">East Twin River</a>	<a href="#">East Twin River</a>	34.18	40.91	84000	Kewaunee	Total Phosphorus	Degraded Biological Community	TMDL Development
<a href="#">Harpt Lake</a>	<a href="#">Harpt Lake</a>			84600	Manitowoc	Total Phosphorus	High Phosphorus Levels	TMDL Development
<a href="#">Jambo Creek</a>	<a href="#">Jambo Creek</a>	8.1	10.1	84300	Kewaunee	Total Phosphorus	Impairment Unknown	TMDL Development
<a href="#">Krok Creek</a>	<a href="#">Krok Creek</a>	0	0.68	86700	Kewaunee	Total Phosphorus	Degraded Biological Community	TMDL Development
<a href="#">Krok Creek</a>	<a href="#">Krok Creek</a>	0.68	3.33	86700	Kewaunee	Total Phosphorus	Degraded Biological Community	TMDL Development
<a href="#">Lake Michigan</a>	<a href="#">Point Beach State Park Beach, Lake Michigan</a>	0	1.51	20	Manitowoc	E. coli	NA	Water Delisted
<a href="#">Lake Michigan</a>	<a href="#">Neshota Park Beach, Lake Michigan</a>	0	0.68	20	Manitowoc	E. coli	NA	Water Delisted
<a href="#">Lake Michigan</a>	<a href="#">Lake Michigan</a>	0	261.05	20	Door, Kenosha, Kewaunee, Manitowoc, Milwaukee, Ozaukee, Racine, Sheboygan	Mercury	Mercury Contaminated Fish Tissue	303d Listed
<a href="#">Lake Michigan</a>	<a href="#">Lake Michigan</a>	0	261.05	20	Door, Kenosha, Kewaunee, Manitowoc, Milwaukee, Ozaukee, Racine, Sheboygan	PCBs	PCBs Contaminated Fish Tissue	303d Listed

Official Name	Local Name	Start Mile	End Mile	WBIC	County	Pollutant	Impairment	Status
<a href="#">Lake Michigan</a>	<a href="#">Selner Park Beach (City Of Kewaunee), Lake Michigan</a>			20	Kewaunee	E. coli	Recreational Restrictions - Pathogens	303d Listed
<a href="#">Molash Creek</a>	<a href="#">Molash Creek</a>	0	7.76	90100	Manitowoc	Total Phosphorus	Impairment Unknown	TMDL Development
<a href="#">Shea Lake</a>	<a href="#">Shea Lake</a>			85400	Kewaunee	Total Phosphorus	High Phosphorus Levels, Excess Algal Growth	Proposed for List
<a href="#">Two Rivers Harbor</a>	<a href="#">Two Rivers Harbor</a>			47	Manitowoc	Unknown Pollutant	Chronic Aquatic Toxicity	303d Listed
<a href="#">Unnamed</a>	<a href="#">Local Water</a>	0	3.38	3000211	Kewaunee	Total Phosphorus	High Phosphorus Levels	TMDL Development
<a href="#">Unnamed</a>	<a href="#">Unnamed Stream</a>	0	1.93	3000212	Kewaunee	Total Phosphorus	Degraded Biological Community	TMDL Development
<a href="#">Unnamed</a>	<a href="#">Unnamed Stream</a>	0	0.38	3000213	Kewaunee	Unknown Pollutant	Elevated Water Temperature	303d Listed
<a href="#">Unnamed</a>	<a href="#">Unnamed Stream</a>	0	0.38	3000213	Kewaunee	Total Phosphorus	High Phosphorus Levels	TMDL Development
<a href="#">Unnamed</a>	<a href="#">Local Water</a>	0	6.37	5020832	Manitowoc	Total Phosphorus	Degraded Biological Community	TMDL Development
<a href="#">West Twin River</a>	<a href="#">West Twin River</a>	0	5.9	87000	Manitowoc	Unknown Pollutant	Elevated Water Temperature	303d Listed
<a href="#">West Twin River</a>	<a href="#">West Twin River</a>	0	5.9	87000	Manitowoc	Total Phosphorus	Low DO	TMDL Development
<a href="#">West Twin River</a>	<a href="#">West Twin River</a>	0	5.9	87000	Manitowoc	PCBs	PCBs Contaminated Fish Tissue	303d Listed

## Monitoring Project Details

### Purpose

This targeted watershed assessment was designed to sample streams that may be impaired. This assessment provided biological, habitat, and chemistry data for site specific determinations of conditions which was used to compare with previous monitoring conducted in 2011.

### Site Selection and Study Design

This study involved the collection of fish community, macroinvertebrate, water chemistry, and qualitative habitat data at several sites in the watershed. The upper reaches of the East Twin River, Unnamed Tributaries, and Krok Creek were monitored at 13 locations. Parameters included habitat assessments, aquatic toxicity (WET), continuous water temperature, invertebrates, water chemistry grab samples, and fish surveys. Habitat assessments were conducted at all 13 locations one time in the summer of 2017. Aquatic toxicity samples were collected at 5 locations at the same time the water chemistry samples are collected. Continuous temperature monitors (HOBO's) will be installed at 6 sites for the entire 2017 summer. Macroinvertebrates were collected at 9 locations in fall 2017. Water samples were collected to analyze chloride, total phosphorus, and ammonia from monthly samples, May through October, at 8 sites. Fish surveys were conducted by DNR Fisheries staff.

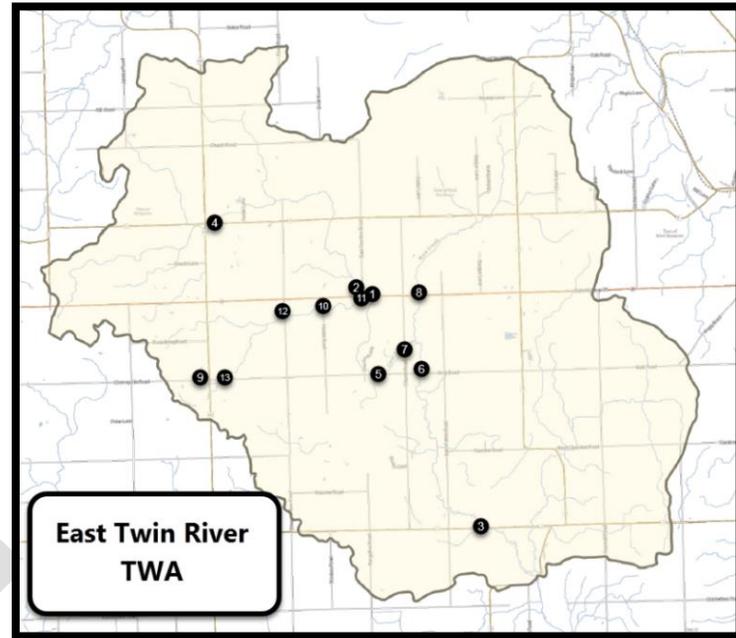


Figure 6. Monitoring sites in the East Twin River watershed (TK02).

### Monitoring included

- Six monthly water chemistry samples during the growing season for total phosphorus, chloride, and ammonia.
- Continuous temperature meters at seven locations during the growing season.
- Quantitative and qualitative habitat assessments.
- Fish surveys at five locations.
- Macroinvertebrate samples at nine locations.

### Monitored Streams

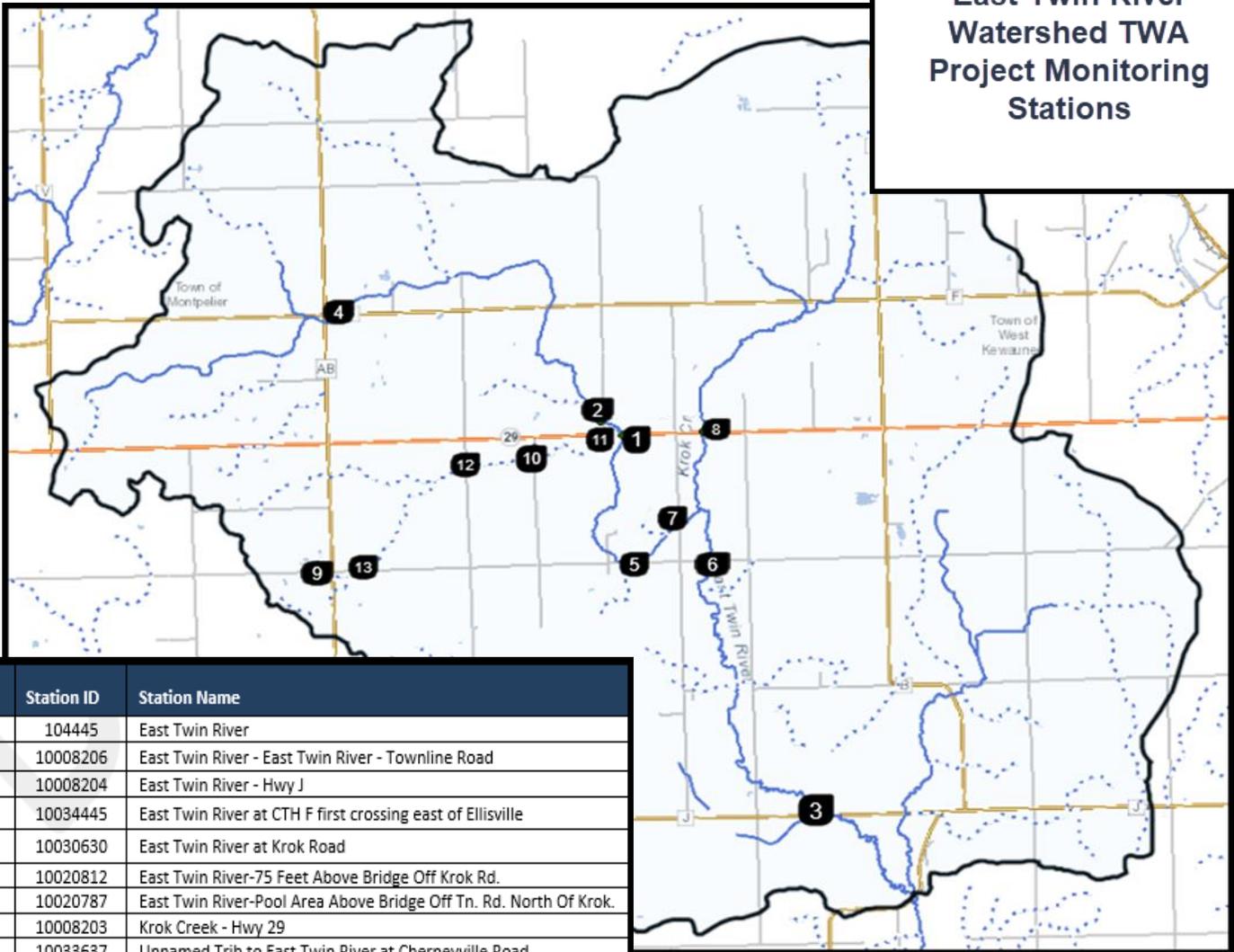
Studied streams include the East Twin River (WBIC 84000), Unnamed Tributaries (UNT) to the East Twin River (WBIC 3000211, 3000212, and 3000213), Krok Creek (WBIC 86700), and East Twin River at Krok Road “Ditch” (Station ID 10030630). Previous evaluations of conditions of the same streams in the Upper East Twin River watershed’s current report were conducted in 2001, 2008, 2009, 2011/2012, and 2015.

Table 4. Monitoring Stations in the East Twin River Targeted Watershed Assessment

Waterbody (WBIC)	MAP ID	Station ID	Station Name
East Twin River (84000)	1	104445	East Twin River Below Hwy 29
	2	10008206	East Twin River - Townline Road
	3	10008204	East Twin River - Hwy J
	4	10034445	East Twin River at CTH F first crossing east of Ellisville
	5	10030630	East Twin River at Krok Road
	6	10020812	East Twin River-75 Feet Above Bridge Off Krok Rd.
	7	10020787	East Twin River-Pool Area Above Bridge Off Tn. Rd. North Of Krok.
Krok Creek (96700)	8	10008203	Krok Creek - Hwy 29
Unnamed (3000213)	9	10033637	Un Trib to East Twin River at Cherneyville Road (West Crossing)
Unnamed (3000211)	10	10030304	Un Tributary to East Twin River at Hrabik Road
	11	10033921	Un Tributary to East Twin River at stream mouth
Unnamed (3000212)	12	10029040	Un Tributary to East Twin River at Sleepy Hollow
	13	10029041	Un Tributary to East Twin River at Cherneyville Rd (East Crossing)

Figure 7. Map of upper East Twin River watershed along with sampling station IDs.

**East Twin River  
Watershed TWA  
Project Monitoring  
Stations**



MAP ID	Station ID	Station Name
1	104445	East Twin River
2	10008206	East Twin River - East Twin River - Townline Road
3	10008204	East Twin River - Hwy J
4	10034445	East Twin River at CTH F first crossing east of Ellisville
5	10030630	East Twin River at Krok Road
6	10020812	East Twin River-75 Feet Above Bridge Off Krok Rd.
7	10020787	East Twin River-Pool Area Above Bridge Off Tn. Rd. North Of Krok.
8	10008203	Krok Creek - Hwy 29
9	10033637	Unnamed Trib to East Twin River at Cherneyville Road
10	10030304	Unnamed Tributary to East Twin River at Hrabik Road
11	10033921	Unnamed Tributary to East Twin River at stream mouth
12	10029040	Unnamed Tributary to East Twin River at Sleepy Hollow
13	10029041	Unnamed Tributary to East Twin River at Cherneyville Rd

Table 5. Monitoring Stations and Parameters Studied.

Map No.	Station ID	Water	WBIC	Location	*Water Chem.	Toxicity	Temp.	Macro-Invertebrates	Habitat	Fish
1	104445	East Twin River	84000	Below Hwy 29	X	X		X	X	
2	10008206	East Twin River	84000	Townline Rd.	X	X	X	X	X	X
3	10008204	East Twin River	84000	CTH J	X		X	X	X	X
4	10034445	East Twin River	84000	CTH F, Ellisville				X	X	
5	10030630	East Twin River	84000	Krok Rd. "Ditch"	X		X	X	X	X
6	10020812	East Twin River	84000	Krok Road Bridge					X	
7	10020787	East Twin River	84000	Church Road					X	
8	10008203	Krok Creek	86700	Hwy 29	X		X	X	X	
9	10033637	Unnamed	3000213	Cherneyville Rd. west crossing	X	X	X		X	
10	10030304	Unnamed	3000211	Hrabik Rd.	X	X	X	X	X	
11	10033921	Unnamed	3000211	Stream mouth off Hwy 29	X	X			X	
12	10029040	Unnamed	3000211	Sleepy Hollow Rd				X	X	X
13	10029041	Unnamed	3000212	Cherneyville Rd. east crossing				X	X	X

Note: X means that sampling occurred at the specific station for the indicated parameter

## Methods, Equipment and Quality Assurance

Monitoring was conducted at several locations along the reaches of the East Twin River and the Unnamed Tributaries to the East Twin River (Table 2) following DNR Field Procedures Manuals and guidelines for proper collection and preservation techniques and included the following assessments.

### Water Chemistry Sampling

Grab samples were collected once per month throughout the growing season (May through October) at four sites in the East Twin River, one site in Krok Creek, one site in the unnamed stream (3000213), and two sites in the unnamed stream (3000211). Water sampling dates were selected in the spring for all sampling events to eliminate bias. Samples were sent to be analyzed for total phosphorus, ammonia, and chloride contents at the Wisconsin State Laboratory of Hygiene. One additional sample was taken from Unnamed Tributary (300212) and sent to be analyzed for chromium at the Wisconsin State Laboratory of Hygiene.

- [Guidelines and Procedures for Surface Water Grab Sampling \(Dec. 2005 Version 3\)](#)

### Continuous Temperature

Water temperature data loggers (HOBO brand) were placed in East Twin River, Unnamed Tributary to East Twin River (3000213 and 3000211), and Krok Creek from May to October 2017. The loggers recorded temperature every hour.

- [Guidelines and Standard Procedures for Continuous Temperature Monitoring Wisconsin DNR May 2004 \(Version 1\)](#)

### Ambient toxicity testing

Grab Samples were collected throughout the growing season (May through October) at two locations on the East Twin River and three locations on the Unnamed Tributary. The samples were delivered to the Wisconsin State Laboratory of Hygiene to be tested for acute and chronic toxicity using zooplankton, minnows, and algae.

### Macroinvertebrate Evaluation

Macroinvertebrate samples were obtained by kick sampling and collecting using a D-frame net at nine monitoring locations along the reaches of the East Twin River and the Unnamed Tributaries to the East Twin River. Samples were preserved and sent to the University of Wisconsin-Stevens Point for analyses. The Hilsenhoff biotic Index (HBI) and Macroinvertebrate Indices of Biotic Integrity (M-IBI) were calculated for each sample collected. HBI is a measure of organic pollution with scores from 0 (excellent) to 10 (very poor). M-IBI uses several metrics to assess overall stream conditions with scores from 10 (excellent) to 0 (poor).

- [Guidelines for Collecting Macroinvertebrate Samples in Wadeable Streams](#)
- [Wadeable Macroinvertebrate Field Data Report Form 3200-081 \(R 08/14\)](#)

### Habitat Evaluation

Aquatic life habitat was evaluated at several sites along the East Twin River and the Unnamed Tributaries to the East Twin River and recorded on the Wadeable Stream Qualitative Fish Habitat form. The host of variables measured included depth and width parameters, bottom characteristics, plant growth, percent shading from vegetation, fish cover, streambank erosion and surrounding land use. A score based on habitat evaluation of 100 (excellent) to 0 (poor) was assigned to each location assessed.

- [Guidelines for Qualitative Physical Habitat Evaluation of Wadeable Streams](#)
- [Qualitative Habitat Rating less than 10m Form \(3600-532A\) \(R 6/07\)](#)

### Fish Assemblage

The method for fish collection was conducted by electroshocking a section of stream with a minimum station length of 35 times the mean stream width (Lyons, 1992). A backpack shocker with a single probe was used at all five of the locations surveyed. Fish were identified and the number of each species present was tallied. The Index of Biotic Integrity (F-IBI) based on the fish community at each sampling location was calculated. F-IBI scores range from 100 (excellent) to 0 (poor) which relates community structure to community health to water quality. The fisheries assemblage was collected with the following methods:

- [Wadeable Stream Fish Community Evaluation Form 3600-230 \(R 7/00\)](#)
- [Guidelines for Assessing Fish Communities of Wadeable Streams in Wisconsin](#)

## Project Results

In this East Twin River TWA study, the objective of choosing the sampling locations was to quantify stream health in the overall watershed and to measure any potential impact to stream health. Unnamed tributary (UNT) 3000213 flows into UNT 3000212 then 3000211 and ultimately the East Twin River. Several monitoring stations were selected on the UNTs with the furthest downstream site on UNT 3000211 at its confluence with the East Twin River near Hwy 29. Two stations on the East Twin River (Station IDs 10008206 and 10034445) were selected upstream of this confluence to monitor background reference conditions. In addition, monitoring Station ID 10008203 on Krok Creek provided an additional reference station in a nearby tributary of the East Twin River. Monitoring station ID 104445 on the East Twin River was established downstream of the outlet of UNT 3000211 to detect any possible impacts from the tributary. Finally, a monitoring station about 3.7 miles downstream of the UNT outlet was monitored (Station ID 10008204) quantifying any potential widespread impact of this tributary on the East Twin River.

Along with evaluating existing data, current data collected in 2017 were assessed against the *Wisconsin 2018 Consolidated Assessment and Listing Methodology* (WisCALM, 2017) guidance to determine if the streams are meeting water quality standards. The streams surveyed during this project are currently assessed against standards relating to the assigned fish and aquatic life use designations as shown in Table 1. Fish and Aquatic Life use categories evaluated with this project include Cold Water Community (COLD) and Default Fish and Aquatic Life (DFAL). Currently in WisCALM, streams and rivers are being evaluated for placement in a revised aquatic life use classification system, in which the new fish and aquatic life use subclasses are referred to as *Natural Communities*. Natural community classification is important when evaluating the Fish Index of Biotic Integrity (F-IBI). Natural communities in the Upper East Twin River study area include macroinvertebrate, cool-cold headwater, and cool-warm headwater streams.

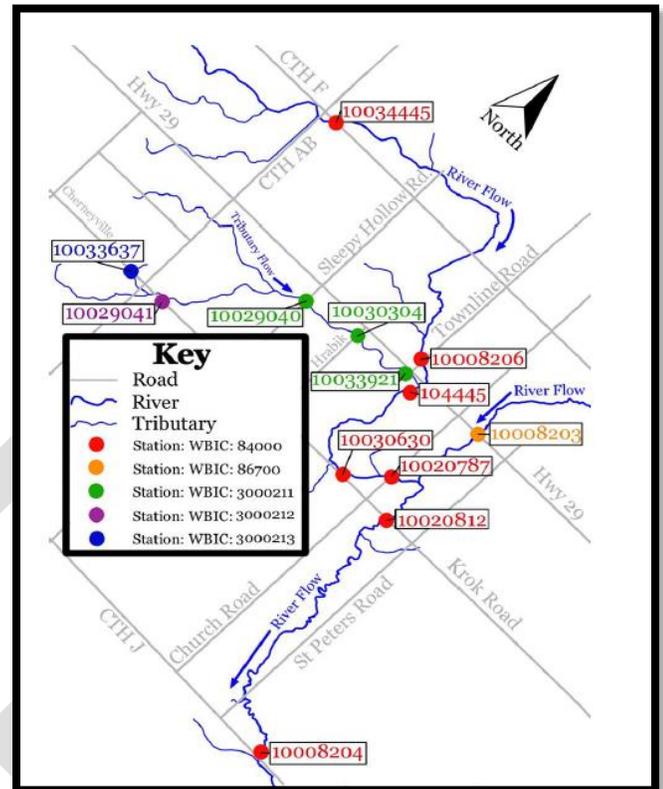


Figure 8. Local Streets and Monitoring Stations.

Classification of stream communities by river reach in the study watershed.	
Location	Classification (according to WI Admin Code NR 102)
Headwaters of the East Twin River down to State Highway 29 (Hwy 29)	Cold Water Community – Class 1 Trout and Exceptional Resource Waters
State Highway 29 (Hwy 29) down to CTH B	Cold Water Community – Class 2 Trout Waters
Unnamed Tributaries to the East Twin River	Fish and Aquatic Life (DFAL) Communities
Krok Creek	Cold Water Community

Water quality criteria thresholds for cold water and DFAL uses are specified in NR 102 and WisCALM as follows:

- Dissolved oxygen: cold water <6 mg/l, DFAL <5 mg/l.
- Water temperature: cold water >73°F, DFAL >86°F.
- Chloride: acute toxicity >757 mg/l, chronic toxicity >395 mg/l.
- Total phosphorus: >0.075 mg/l.

The headwaters of the East Twin River down to CTH B are currently on the Clean Water Act Section 303(d) list of impaired waters for phosphorus. The UNTs 3000211, 3000212 and 3000213 in their entirety are also on the impaired waters list for phosphorus. UNT 3000213 is on the impaired waters list for water temperature.

## Water Chemistry

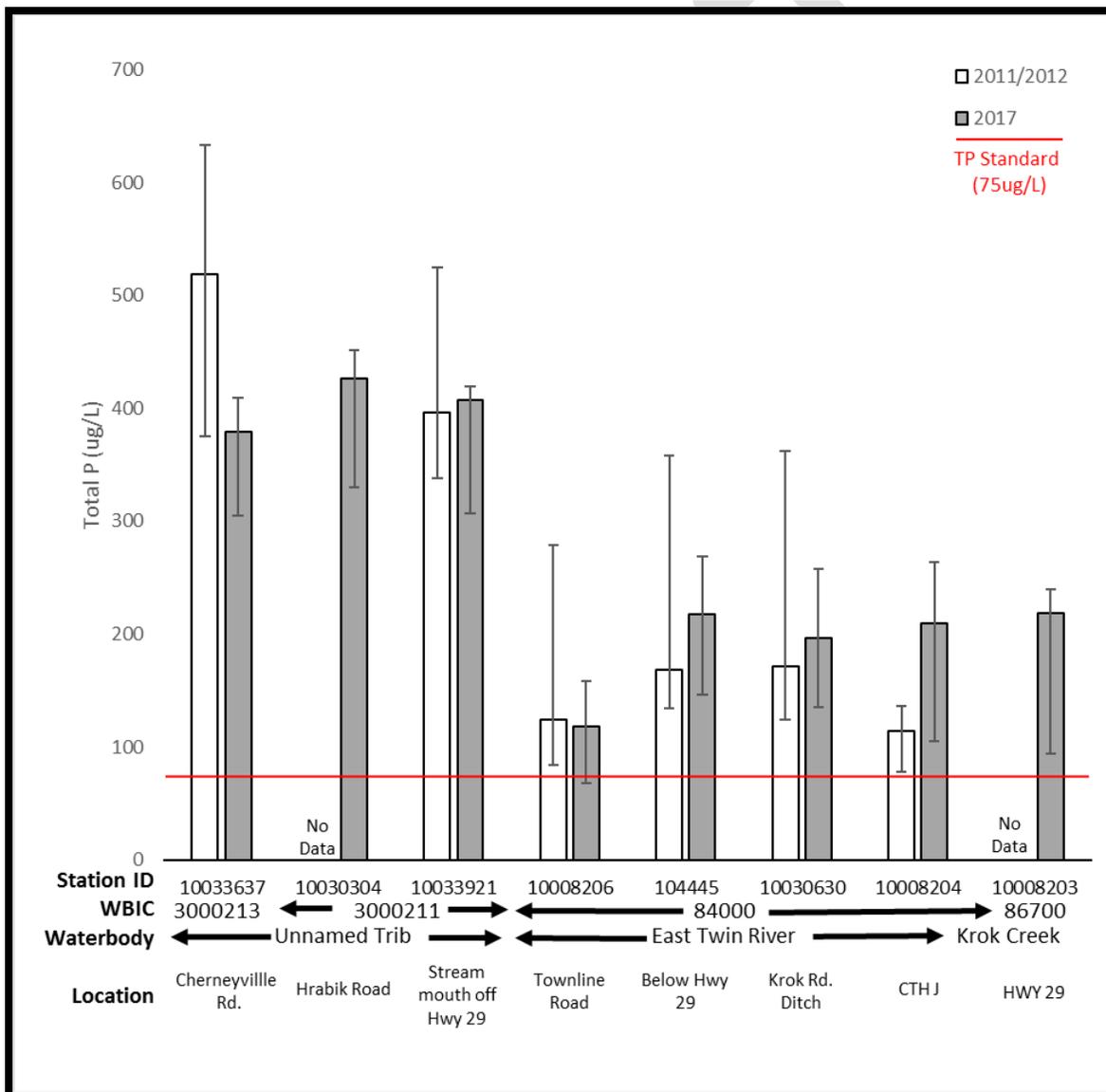
### Total Phosphorus

As specified in NR 102 of the Wisconsin Administrative Code, the total phosphorus criterion of 0.075 mg/l is established for the unnamed tributaries, East Twin River and Krok Creek. The protocol for impairment decisions requires six monthly samples to be collected between May and October. The department’s listing methodology for impaired waters (WDNR, 2017) lists waters where the median concentration and 90% confidence interval values exceeds 0.075 mg/l on wadable streams.

As shown in Figure 9, the median and 90% confidence interval values for total phosphorus at all monitoring locations in 2011 clearly exceed the 0.075 mg/l impairment threshold. In 2017, all stations exceeded the criteria except for the East Twin River at Townline Road (Station ID 10008206), where the lower 90% confidence interval was just below 0.075 mg/l.

The East Twin River is currently listed as impaired from its headwaters down to CTH B for total phosphorus. Krok Creek and the UNTs 3000211, 3000212 and 3000213 are also listed as impaired for phosphorus.

**Figure 9. Total phosphorus 2011/2012 and 2017. Bars indicate median values during each field season; error bars indicate the 90% confidence interval.**

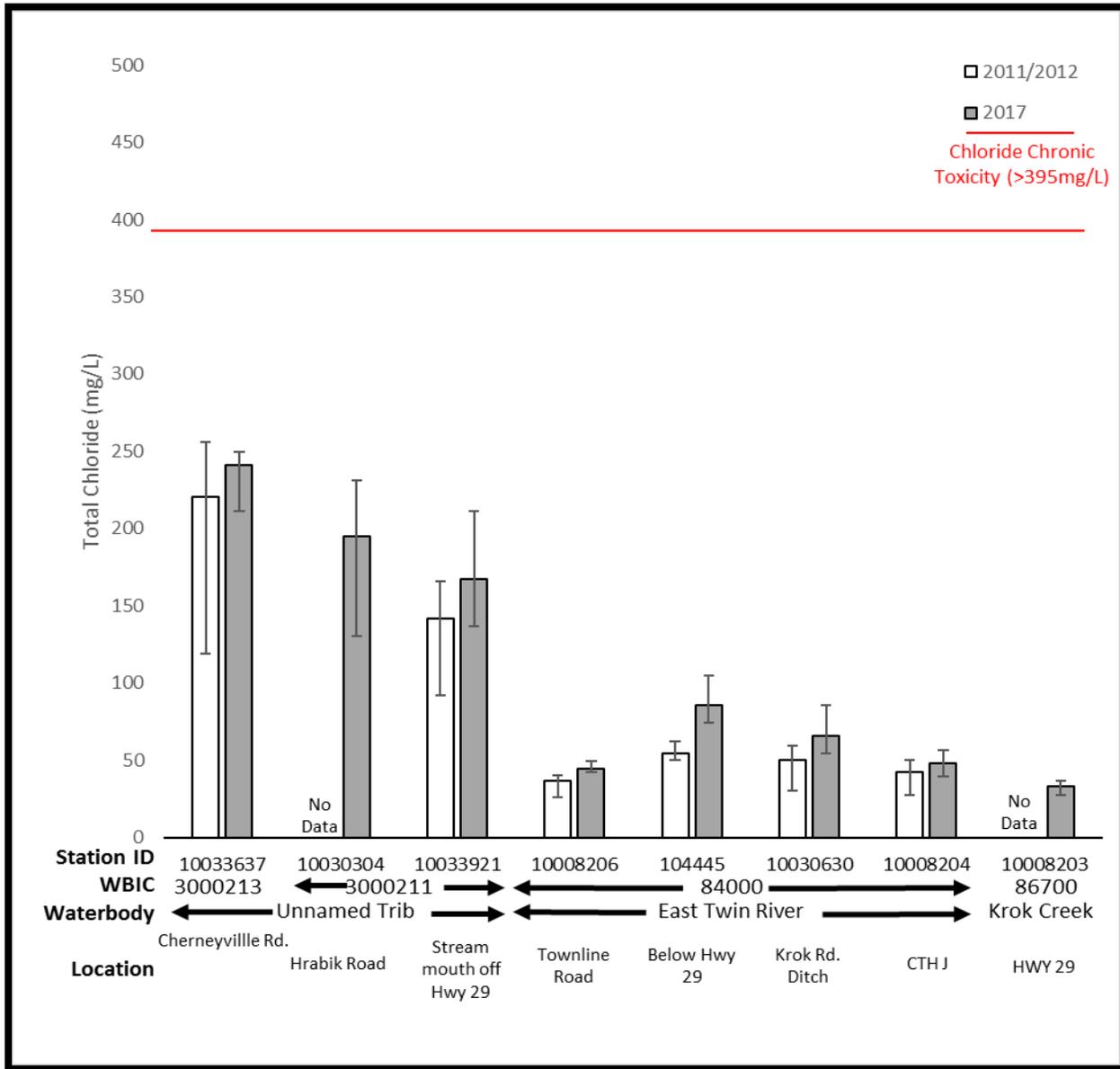


### Chloride

The protocol for impairment decisions established in 2018 WisCALM for chloride requires at least two values within a 3-year period. Six monthly chloride samples were collected at the same time the phosphorus samples were collected. The criterion for chronic toxicity is 395 mg/l and for acute toxicity it is 757 mg/l.

As shown in Figure 10, none of the chloride samples collected on the UNTs 3000213 and 3000211, the East Twin River or Krok Creek exceeded established thresholds for chronic toxicity in 2011/2012 or 2017. Although they did not exceed any thresholds, it is apparent that higher concentrations of chloride are observed in the UNTs compared to the reference streams.

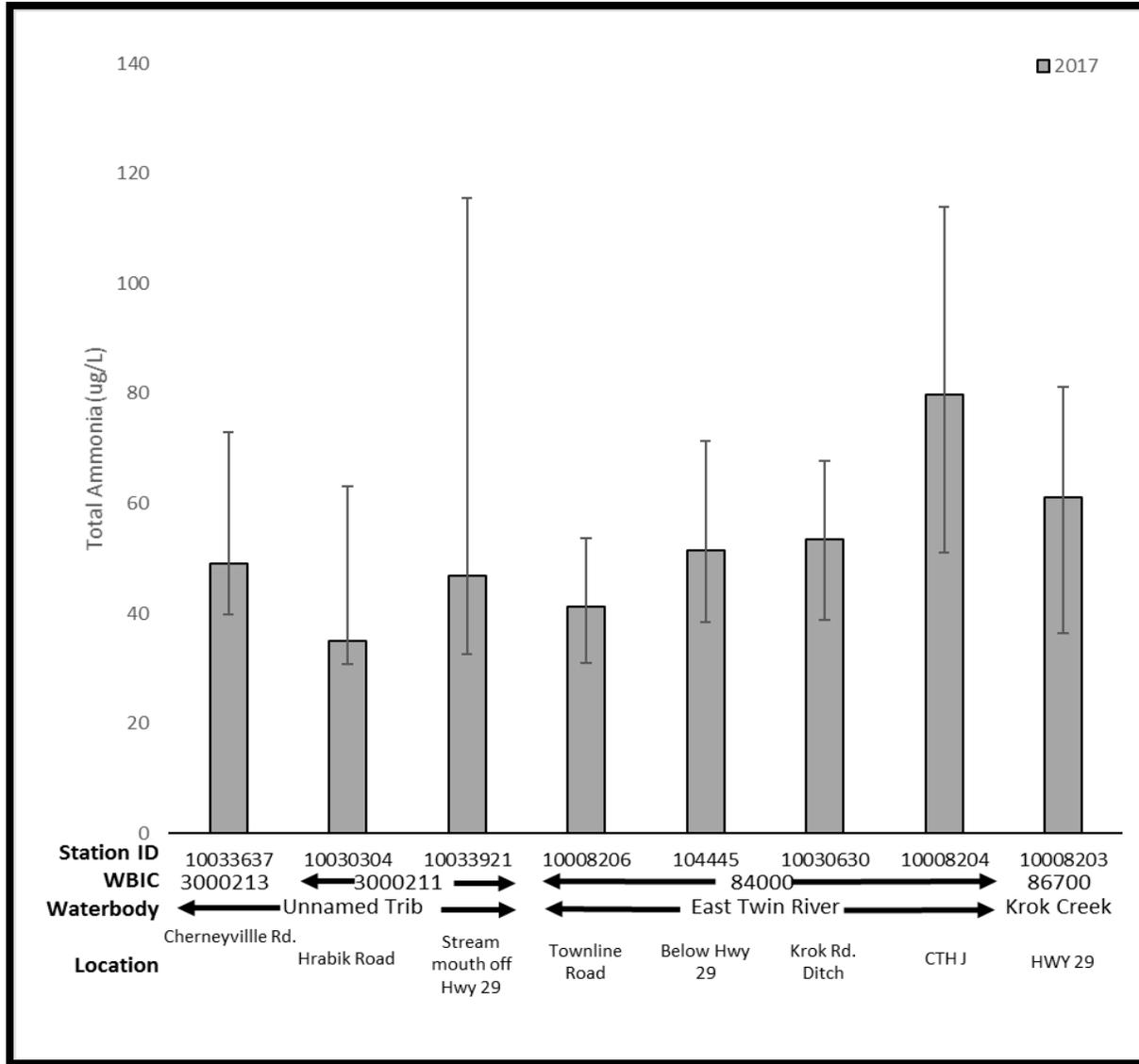
**Figure 10. Chloride from all stations from sampling taken in 2011/2012 and 2017.** Bars indicate median values during each field season, and error bars indicate the 90% confidence interval.



**Ammonia**

Figure 11 displays total ammonia results from 2017. Six monthly samples were collected at the same locations and times as the other water samples. Ammonia was not collected in 2011 and 2012. The data suggest none of the ammonia sample results were high enough to cause ammonia toxicity to aquatic life according to the methods of the Environmental Protection Agency (2013) and Wisconsin Administrative Code NR105.

**Figure 11. Total ammonia from all stations in 2017.** Bars indicate median values during field season, and error bars indicate the 90% confidence interval.



**Chromium**

Six monthly water samples were collected at one location on UNT 3000213 (Station ID 10033637). Three sampling events did not detect chromium but the other three samples document levels slightly above the detection limit of 1.0 ug/l (1.48, 1.32, and 1.7 ug/l). As specified in Wisconsin Administrative Code NR 105, the chronic criterion for chromium is 326 ug/l. Thus, the low levels detected would not be considered toxic to aquatic life.

**Continuous Water Temperature**

Water temperatures were logged hourly at three stations on the East Twin River and one each on UNTs 3000211 and 3000213 in 2011. The same stations plus the addition of one on Krok Creek were monitored in 2017. Average daily temperature throughout each field season by Station ID are summarized in Figure 13 for 2011 data and in Figure 12 for 2017 data.

Figure 12 . Average daily temperature values at all stations sampled during 2011.

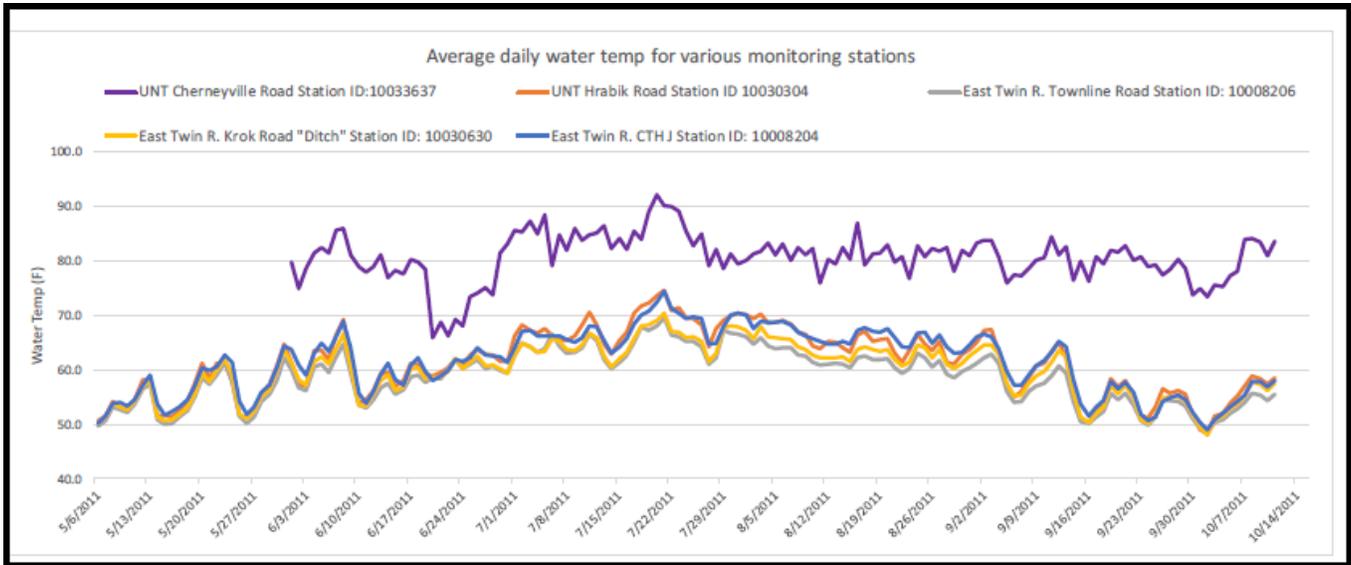
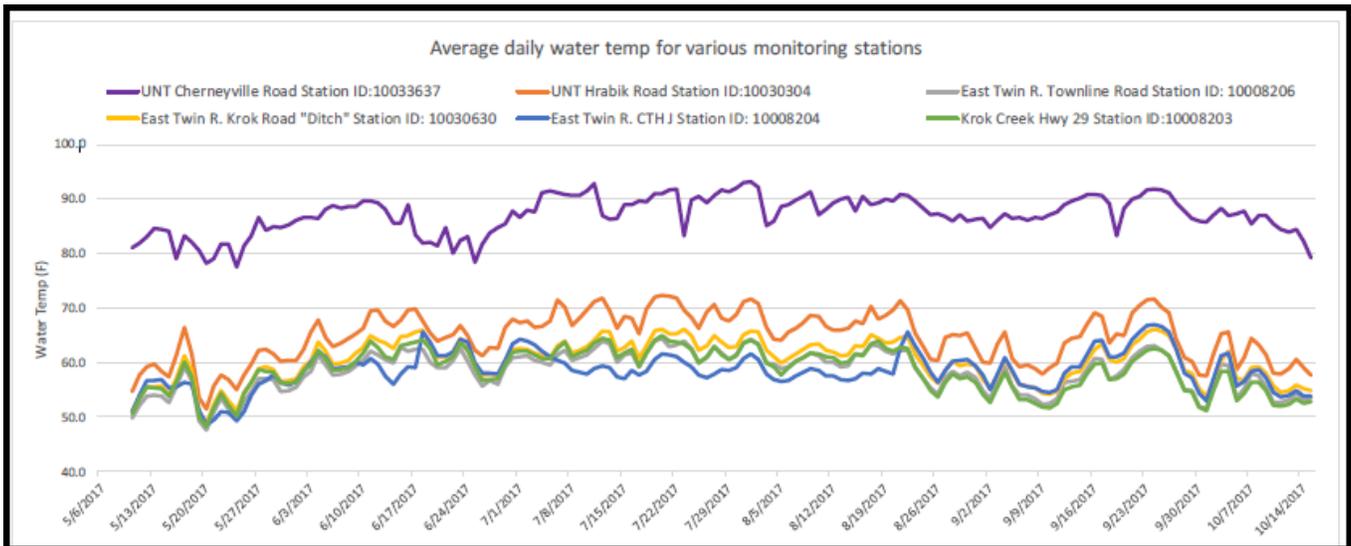


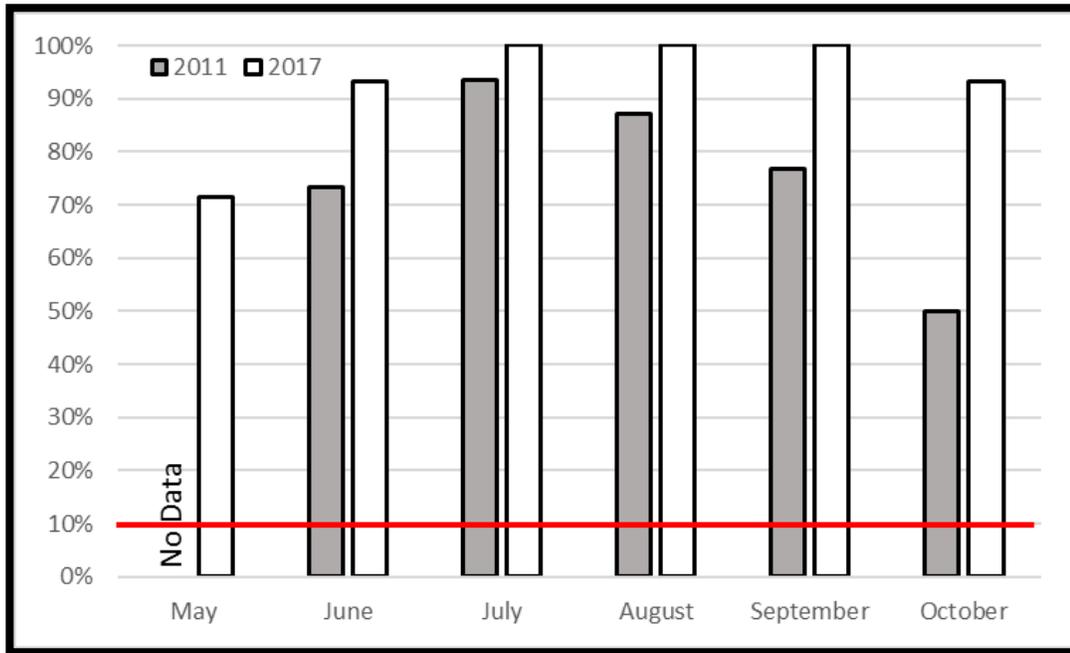
Figure 13. Average daily temperature values at all stations sampled during 2017.



Water temperature of the East Twin River met the cold-water quality criteria (maximum summer temperature of 73°F) at all stations except for the furthest downstream station at CTH J (Station ID 10008204). The East Twin River at CTH J exceeded water quality criteria in July and August of 2011, however in 2017, water quality criteria were met in all months.

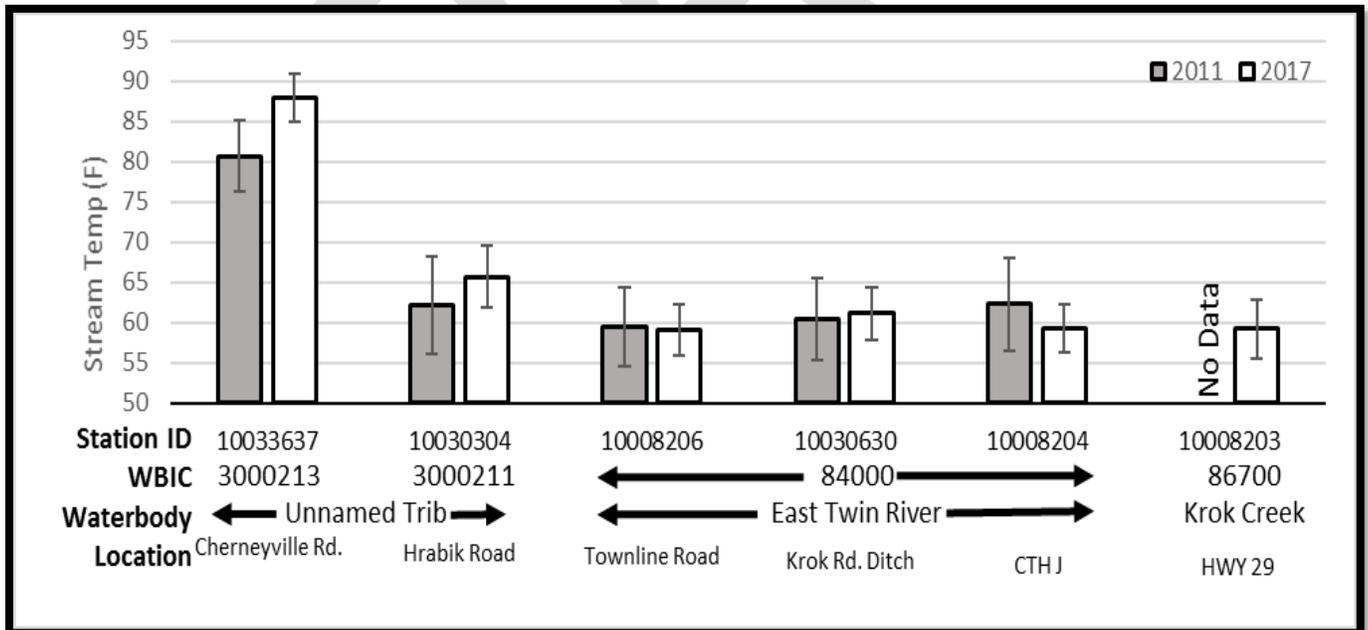
Water temperature in UNT 3000213 at the Cherneyville Road (Station ID 10033637) exceeded the DFAL temperature criteria (maximum summer temperature of 86°F) for all months monitored in both 2011 and 2017 as shown in Figure 8. Water temperature approximately 2 miles downstream in UNT 3000211 at Hrabik Road (Station ID 10030304) met DFAL temperature criteria for all months monitored.

**Figure 14: Percentage of exceedance values of the Wisconsin Admin. Code for acute temperature criteria for UNT at Cherneyville Road (Station ID 10033637).** All values were greater than 10% of daily maximum values, indicating an exceedance of acute criteria for every month of the record.



Water temperatures were warmer at UNT 3000213 and 3000211 in 2017 than 2011 (Figure 9). Otherwise, temperatures collected in 2017 at all other sites were similar to temperatures in 2011.

**Figure 15. Average of all average daily temperature values for each field station monitored in 2011 and 2017 between June 1 and October 15th of each calendar year.** Error bars indicate standard deviation of all averaged daily values.



## Ambient Toxicity Testing

### Fathead Minnow (*Pimephales promelas*) Toxicity:

#### Acute Toxicity:

- 2011: No acute toxicity observed at any sampling sites.
- 2017: No acute toxicity observed at any sampling sites.

#### Chronic Toxicity:

- 2011: Chronic toxicity was found in UNT 3000213 Cherneyville Road (Station ID 10033637) in May and June of that year.
- 2017: No chronic toxicity as indicated by statistical differences between fish growth in surface water samples and controls, was found at any of the sites.
  - However, on two occasions survival and growth was noticeably lower in the surface water than in control treatments in the chronic fathead minnow toxicity test.
  - In June, survival in the sample collected in the UNT 3000213 (Station ID 10033637) was 15% lower than the control. In September, survival at the same site was 21% lower than the control. Growth was also lower than at any of the other sites on both of these dates, although these differences were not found to be statistically significant.



Image from gallery.nanfa.org.

Fathead Minnow  
<https://www.situbiosciences.com>

### Water Flea (*Ceriodaphnia dubia*) Toxicity:

#### Acute Toxicity:

- 2011: Acute toxicity was observed in May at UNT 3000213, Cherneyville Road (Station ID 10033637).
- 2017: No acute toxicity observed at any sampling sites.

#### Chronic Toxicity:

- 2011: Chronic toxicity was found in UNT 3000213, Cherneyville Road (Station ID 10033637) and in UNT 3000211, Hrabik Road (Station ID 10030304) in May. Chronic toxicity was also found in UNT 3000211 at the stream mouth (Station ID 1033921), and in the East Twin River below this confluence (Station ID 104445), and at the Townline Road site (Station ID 10008206) in July.
- 2017: Chronic toxicity was found in two samples collected during the field season. Reproduction was found to be significantly lower in June at the East Twin River below the confluence of UNT 3000211 (Station ID 104445) and at the UNT 3000213 (Station ID 10033637) in October. The October sample showed both significantly lower reproduction and lowered survival (20% lower than the control).



Ceriodaphnia dubia  
<http://www.amaab.org/>

### Green Algae (*Selenastrum capricornutum*) Toxicity:

#### Chronic Toxicity:

Tables associated with toxicity measurements can be found in Appendix B.

- 2011: Chronic toxicity was found at UNT 3000213 (Station ID 10033637) and at the UNT 3000211 at Hrabik Road (Station ID 10030304) in June. Chronic toxicity was also found at the East Twin River below UNT 3000211 at Station ID 104445 in July, however, the reduction in growth of this sample was below the level of concern normally used for algae tests (50% of the control).
- 2017: UNT 3000213 (Station ID 10033637) showed noticeably lower green algae growth in the July and August samples, although only the July sample was found to be statistically different from the control.



Selenastrum capricornutum [UTEX Culture Collection](#)

**Macroinvertebrates <sup>1</sup>**

Macroinvertebrate samples were collected at multiple sites in the project area to calculate a Macroinvertebrate Index of Biological Integrity (M-IBI). The M-IBI is composed of various metrics used to interpret macroinvertebrate data. 2017 M-IBI categorical results for the East Twin River and UNT sites were either the same as 2011 or better as shown in Table 6.

- The East Twin River at CTH F (Station ID 10034445) went from poor in 2011 to good in 2017.
- At Krok Road “Ditch” (Station ID 10030630) M-IBI went from fair to good.
- The other three sites remained the same as either fair or good.
- Krok Creek (Station ID 10008203) was also assessed in 2017 and received a good M-IBI rating.
- UNT 3000212 Cherneyville Road (Station ID 10029041) received poor M-IBI scores in 2008 and 2011 but a fair score in 2017.
- UNT 3000211 at Sleepy Hollow Road (Station ID 10029040) and Hrabik Road (Station ID 10030304) received a fair M-IBI scores all years assessed.

**Table 6. Macroinvertebrate Values and Condition**

Waterbody Name (WBIC)	Station ID	Station Name	2017 M-IBI <sup>1</sup> Condition	2011 M-IBI Condition	2008 M-IBI Condition
East Twin River (84000)	104445	Below Hwy 29	4.6	4.5	--
	10008206	Townline Road	3.8	4.3	--
	10008204	CTH J	6.9	3.3	--
	10034445	CTH F, Ellisville	7.1	1.6	--
	10030630	Krok Road “Ditch”	6.2	2.9	--
Krok Creek (86700)	10008203	Hwy 29	5.0	--	--
Unnamed (3000211)	10030304	Hrabik Road	3.3	3.9	--
	10029040	Sleepy Hollow Road	3.2	4.0	4.0
Unnamed (3000212)	10029041	Cherneyville Road east crossing	2.7	0	0

<sup>1</sup> M-IBI (Macroinvertebrate Indices of Biological Integrity) Score/Condition Category

7.5 – 10 / Excellent

5.0 – 7.49 / Good

2.51 – 4.99 / Fair

0 – 2.5 / Poor

-- No Data Collected

<sup>1</sup> 1 M-IBI (Macroinvertebrate Indices of Biological Integrity) Score/Condition Category 7.5 – 10 / Excellent 5.0 – 7.49 / Good 2.51 – 4.99 / Fair 0 – 2.5 / Poor -- -- No Data Collected

## Habitat Assessments <sup>2</sup>

Aquatic habitat was evaluated at monitoring stations in the project area as shown in Table 7. Habitat values ranged from poor to good in 2017. In general, habitat values in the East Twin River and UNTs were similar or slightly lower in 2017 compared to 2011. The East Twin River at CTH F went from a good rating in 2011 to a poor rating in 2017. Habitat assessments were completed at only two locations on the UNT in 2008 and both received a fair rating.

Table 7. Habitat Values and Condition

Waterbody Name (WBIC)	Station ID	Station Name	2017 Habitat Condition Score	2011 Habitat Condition Score	2008 Habitat Condition Score
East Twin River (84000)	104445	Below Hwy 29	67	77	--
	10008206	Townline Road	62	80	--
	10008204	CTH J	62	52	--
	10034445	CTH F Ellisville	18	72	--
	10030630	Krok Road "Ditch"	62	58	--
	10020812	Krok Road Bridge	50	67	--
	10020787	Church Road	43	67	--
Krok Creek (86700)	10008203	Hwy 29	67	--	--
Unnamed (3000213)	10033637	Cherneyville Road west crossing	45	60	--
Unnamed (3000211)	10030304	Hrabik Road	73	82	--
	10033921	Stream mouth off Hwy 29	55	68	--
	10029040	Sleepy Hollow Road	50	80	45
Unnamed (3000212)	10029041	Cherneyville Road east crossing	25	--	35

Habitat Score (Based on Simonson et al. (1994))  
 Score/Condition Category  
 >75 / Excellent  
 50-74 / Good  
 25-49 / Fair  
 <25 / Poor  
 -- -- No Data Collected

<sup>2</sup> Habitat Score (Based on Simonson et al. (1994)) Score/Condition Category >75 / Excellent 50-74 / Good 25-49 / Fair <25 / Poor -- -- No Data Collected

## Fish Natural Communities

- Based on fish survey data available, the modeled and verified natural community (Table 8) of the East Twin River was a cool-cold headwater at both Townline Road (Station ID 10008206) and Krok Road “Ditch” (Station ID 10030630). The modeled natural community at CTH J (Station ID 10008204) was warm headwater but verified as a cool-warm headwater based on the fish assemblage. The modeled natural community at Krok Road bridge (Station ID 10020812) was cool-warm headwater but verified as cool-cold headwater.
- UNT 3000212 at Cherneyville Road (Station ID 10029041) was modeled as a macroinvertebrate stream but due to lack of fish no verification was completed.
- UNT 3000211 at Sleepy Hollow Road (Station ID 10029040) was modeled as a cool-cold headwater but was verified as a cool-warm headwater based on the fish community.

**Table 8. Fish and Habitat Data**

Station ID	Station Name	Modeled Natural Community	Confirmed Natural Community	FIBI Used	FIBI Value Condition	Habitat Values
10008206	East Twin R - Townline Road	CCHW	CCHW	SS IBI	80	62
10008204	East Twin R - Hwy J	WH	CWHW	SS IBI	100	62
10030630	East Twin R - Krok Road	CCHW	CCHW	SS IBI	100	67
10020812	East Twin R - 75 Ft US Bridge Krok Rd.	CWHW	CCHW W	SS IBI	--	50
10033637	UNT to East Twin - Cherneyville Rd	Macroinvert	N/A	SS IBI	--	45
10029040	UNT to East Twin R - Sleepy hollow	CCHW	CWHW	SS IBI	80	50



**Photo: East Twin River at Townline Road (SWIMS Station 10008206)**

**Fisheries Assemblage <sup>3</sup>**

Fish surveys were completed at multiple sites in the project area (Table 5). The Fish Index of Biological Integrity (F-IBI) was calculated and the scores over multiple years are presented in Table. In 2017, fish surveys were completed at three locations on the East Twin River and two on the UNTs 3000211 and 3000212.

**Table 9. Fish Inventory of the East Twin and Unnamed Tributaries**

Waterbody (WBIC)	East Twin River (84000)															Unnamed (3000212)		Unnamed (3000211)		
	10008206					10030630					10008204					10020812	10029041		10029040	
Station ID	Townline Road					Krok Road "Ditch"					CTH J					Krok Road Bridge	Cherneyville Road east crossing		Sleepy Hollow Road	
Species	2001	2009	2011	2015	2017	2009	2011	2015	2017	2001	2009	2011	2015	2017	2015	2008	2017	2008	2017	
Brook Trout	3	20	18	16	5			1	3						2					
Central Mudminnow	8	42	14	8	22	78	55	30	28	21		105	70	53	54	4		3	2	
Brook Lamprey	2	7	3		1					2	4	3								
Mottled Sculpin	41	78	39	12	68	7	3	16	8	11	27	29	18	37	11			4		
White Sucker	1	1				13	9	9	6	44	34	31	21	62				4		
Creek Chub		1		1	5	20	6	34	9	48	111	61	56	74	3		11	175	89	
Pearl Dace	10	13		3	3	42	1	68	5	5	15	3	10	8	62			9	1	
Common Shiner						1		29		29	68	5	29	68	7			1		
Hornyhead Chub									1	13	34	24	27	39						
Brook Stickleback	11			2					1	2	3	26	2					6		
Southern Redbelly Dace										18	28	12	16	12				1		
Redside Dace						1	7	1		3	7	1	1						1	
Finescale dace				2																
Johnny Darter	1				2					18	3	6	1	6	1					
Blacknose Dace		1				1				5	7	3		4				49	14	
Rainbow Trout									1		1		2	4						
Longnose Dace	1									1	1			2						
Yellow perch													1							
Green Sunfish					1				1				2	5					1	
Brown Trout										2			9	6						
Pumpkinseed Sunfish																		1		
Bluntnose Minnow										4										
<b>Total</b>	<b>78</b>	<b>163</b>	<b>74</b>	<b>44</b>	<b>107</b>	<b>163</b>	<b>74</b>	<b>194</b>	<b>64</b>	<b>223</b>	<b>339</b>	<b>315</b>	<b>265</b>	<b>381</b>	<b>140</b>	<b>4</b>	<b>11</b>	<b>253</b>	<b>108</b>	

Previous fisheries and habitat reports are available on the WDNR website: <http://dnr.wi.gov/topic/Fishing/reports/index.html>

**Fish Condition**

Fish Index of biological integrity (F-IBI) scores indicate the East Twin River at Townline Road (Station ID 10008206) was in good condition (in 2017). In previous years, fish IBI scores were fair to excellent.

In 2017 F-IBI score in the East Twin River at Krok Road "Ditch" (Station ID 10030630) was excellent and had also received excellent to fair scores in previous surveys.

A fish survey conducted in the East Twin River at Krok Road bridge (Station ID 10020812) received a good rating in 2015. F-IBI scores were excellent all years surveyed at CTH J (Station ID 10008204).

F-IBI scores rated the UNT 3000211 at Sleepy Hollow Road (Station ID 10029040) as good in 2017 and excellent in 2008. Surveys in 2008 and 2017 did not result in enough fish captured at Cherneyville Road east crossing (Station ID 10029041) to calculate an F-IBI score.

<sup>3</sup> 1 F-IBI (Fish Indices of Biological Integrity) Score/Condition Category 91 -100 / Excellent 61 - 90 / Good 31 - 60 / Fair 0 - 30 / Poor -- -- No Data Collected NA – Not enough fish to calculate IBI

Table 10: Small Stream Fish IBI Scores for all years of study

Waterbody (WBIC)	Station ID	Station Name	2017 F-IBI Condition	2015 F-IBI Condition	2011 F-IBI Condition	2009 F-IBI Condition	2008 F-IBI Condition	2001 F-IBI Condition
East Twin River (84000)	10008206	Townline Road	80	90	40	90	--	100
	10030630	Krok Road "Ditch"	100	100	50	100	--	--
	10020812	Krok Road Bridge	--	90	--	--	--	--
	10008204	CTH J	100	100	100	100	--	100
Unnamed (3000211)	10029040	Sleepy Hollow Road	80	--	--	--	100	--
Unnamed (3000212)	10029041	Cherneyville Road east crossing	NA	--	--	--	NA	--

<sup>1</sup> F-IBI (Fish Indices of Biological Integrity)  
Score/Condition Category  
 91 -100 / Excellent  
 61 - 90 / Good  
 31 - 60 / Fair  
 0 - 30 / Poor  
 -- -- No Data Collected  
 NA – Not enough fish to calculate IBI

Table 11: Reference Tables for Fish IBI and Habitat Values

(Small stream IBI for Warm Transition Headwaters)

<u>Condition (Rating) Categories for Small Stream Fish Index of Biotic Integrity (fIBI)</u>	
fIBI	Condition
91-100	excellent
61-90	good
31-60	fair
0-30	poor

<u>Condition (Rating) Categories for Qualitative Habitat</u>	
Score	Condition
>75	excellent
50-75	good
25-49	fair
< 25	poor

Table 12: Stream classification temperature ranges from Lyons, et. al., 2009.

Class and/or Subclass	June-Aug Mean	July Mean	Maximum Daily Mean
Coldwater	< 17.0	<17.5	< 20.7
(Coolwater) Cold transition	17.0 - 18.7	17.5 - 19.5	20.7 - 22.6
(Coolwater) Warm transition	18.7 - 20.5	19.5 - 21.0	22.6 - 24.6
Warmwater	> 20.5	> 21.0	> 24.6

## Discussion

This study assessed the condition of the East Twin River, its unnamed tributaries and Krok Creek for ecological status. Overall stream health was determined by evaluating chemical, physical and biological parameters against Wisconsin Assessment and Listing Methodology Guidelines. Assessment data from 2017 were compared to prior survey data to determine if water quality conditions have changed and if streams are meeting water quality standards.

### Impairment Status

- ✦ Sampling data confirm that the East Twin River, Krok Creek and the unnamed tributaries 3000212, 3000213 and 3000211 in their entirety are on the impaired waters list for phosphorus.
- ✦ Chloride, ammonia and chromium concentrations all met water quality standards. Based off the data collected, these water quality constituents do not pose a threat to aquatic life in the streams assessed.
- ✦ Despite non-point source influences throughout the entire watershed, the phosphorus and chloride concentrations were the highest in UNT 3000213.

### Water Temperature

Water temperature of the East Twin River at all stations except at CTH J met cold water quality criteria.

East Twin River at CTH J (Station ID 10008204) exceeded water quality criteria in July and August of 2011, however in 2017, the water quality criteria were met in all months. During July and August of 2011 when cold water criteria for temperature was not met, the daily maximum temperature was exceeded 12 and 8 days respectively by 0.7-3.3°C. Taking into consideration the accuracy of +/- 0.53°C of the continuous data collection meters, it can only be assumed that 9 and 2 days respectively did not meet the cold criteria for temperature. This leaves only the month of July in 2011 that did not fully meet cold water criteria for temperature on the East Twin River at CTH J. This single month of failing to meet cold water criteria could be sufficient to propose this segment of the East Twin River to be listed as impaired for temperature. However, this is not recommended. Based on knowledge of this stream and its location at the lower reaches of the East Twin River Class II trout waters, it is likely this segment is naturally on the transition between a cold and warm classification.

Water monitoring data confirm that UNT 3000213 clearly exceed water quality standards for temperature and should remain on the impaired waters list. Temperatures at Cherneyville Road (Station ID 10033637) exceeded the DFAL temperature criteria for all months monitored in both 2011 and 2017. Water temperature approximately 2 miles downstream in UNT 3000211 at Hrabik Road (Station ID 10030304) met DFAL temperature criteria for all months monitored.

Ambient acute toxicity was not observed in 2017 at any station monitored although chronic toxicity was observed in the UNT 3000213 (Station ID 10033637) in July and October and in the East Twin River below Hwy 29 (Station ID 104445) in June.

In comparison, acute toxicity was observed in 2011 in UNT 3000213 (Station ID 10033637) in May. Chronic toxicity was observed in UNT 3000213 in May and June and in the UNT 3000211, Hrabik Road (Station ID 10030304) in May. However, chronic toxicity was also observed in the East Twin River at Townline Road (Station ID 10008206), below Hwy 29 (Station ID 104445), and at the mouth of the UNT 3000211 (Station ID 10033921) in July indicating possible larger-scale watershed problems.

The macroinvertebrate communities indicate that water quality conditions in the East Twin River is in fair to good condition both upstream and downstream from the confluence of UNT 3000211. The macroinvertebrate communities indicate fair to poor water quality condition in the upper reaches of UNT 3000212 at Cherneyville Road (Station ID 10029041) and fair conditions at two sites on UNT 3000211 at Sleepy Hollow Road (Station ID 10029040) and Hrabik Road (Station ID 10030304). Substrate type and watershed-wide non-point sources of nutrient and sediment contributions likely impact the water quality and macroinvertebrate habitat in both the East Twin River and the UNTs.

Blue Iris Environmental, Inc. conducted a cursory evaluation of the stream inhabitants of the East Twin River at three locations on July 1, 2009 (West, 2009). The full survey report is provided in Appendix C. Although a variety of taxa were noted at each of the three locations and ranged from abundant to present, the survey technique used was not meant to create a M-IBI value and therefore it is not possible to rate the overall stream health based on the 2009 results. The taxa Plecoptera (Stonefly) was observed in this survey and in 2017 by the WDNR at the Krok Road site while Ephemeroptera (mayfly) were only observed in 2009 at that site. Stoneflies are considered intolerant to pollution.

Fish and aquatic life habitat was assessed at multiple locations in the watershed. Qualitative habitat is rated based on riparian buffer width, amount of bank erosion, percent of pools, riffle and runs, substrate type and cover for adult fish. These metrics combined give an overall score for available habitat. In general, habitat in the East Twin River can be considered in good condition. At Church Road (Station ID 10020787) the extensive amount of fine sediment and lack of riffles limit a variety of habitat and therefore it only received a fair score. East Twin River at CTH F (Station ID 10008204) received a poor score since the stream is extremely small and shallow at this location. A previous good score in 2011 showed deeper water and less fine sediment accumulation.

The fish indices of biological integrity (F-IBI) and the macroinvertebrate indices of biological integrity (M-IBI) were used to determine whether current water quality conditions support the Fish and Aquatic Life designated uses.

Natural communities are defined for streams and rivers using model-predicted flow and temperature ranges associated with specific fish and/or macroinvertebrate communities. Segments are initially classified into natural communities based on landscape-scale statistical models that predict long-term flows and temperatures from watershed characteristics such as watershed size, surficial and bedrock geology, topography, climate, and land cover. These predictions represent the realistic potential Natural Community of the segment under current land-cover and climate conditions in the absence of significant site-specific human impacts, such as local riparian degradation. Correct natural community classification is currently a critical step in applying the correct F-IBI to evaluate water quality influences on the fish community and to provide an accurate bio-assessment. Misclassified streams could be assessed with the incorrect IBI, and their environmental condition may be misjudged. The Department has a guidance document that can correct misclassifications (Lyons, 2013). The procedures were followed to correctly assign a natural community at all fish surveys stations so the correct application of the IBI was used.

The East Twin River from its headwaters downstream towards CTH J aligns with a cool cold headwater stream classification in that it is a small perennial stream with cool to cold summer water temperatures. Coldwater fish range from absent to abundant, transitional fish from common to dominant, and warmwater fish from absent to common. Small-stream fish range from very common to dominant (50-100% of individuals), medium-stream fish from absent to very common (0-50% of individuals), and large-river fish from absent to uncommon (0-10% of individuals).

As the East Twin River approaches CTH J the stream begins a transition from a cool-cold headwater towards a cool-warm headwater stream with cool to warm summer temperatures. Coldwater fish range from absent to common, transitional fish from common to dominant, and warmwater fish from absent to abundant. Small-stream fish range from very common to dominant, medium-stream fish from absent to very common, and large-river fish from absent to uncommon. The natural community verification of the East Twin River at CTH J can place the stream in either a cool-cold headwater or a cool-warm headwater stream based on the percentage of coldwater and warmwater fish species observed. The percentage catch of coldwater species is outside the range for a cool-warm headwater stream and the percentage catch of warmwater species is outside the range of a cold-cold headwater stream. Based upon available fish data, classification as a Class II trout stream, and continuous water temperature data the East Twin River at CTH J is best represented and is verified as a cool-warm headwater stream.

UNT 3000211 at Sleepy Hollow Road (Station ID 10029040) has a verified natural community classification as a cool-warm headwater stream. The modeled natural community classification as a cool-cold headwater stream is likely inaccurate based on fish surveys conducted in 2008 and 2017. The fish community in this stream aligns with a *cool-warm headwater stream*. In any given year, the number of coldwater species may range from absent to common in these headwater streams. They are differentiated by the percent of the overall catch consisting of coldwater, transitional, and warmwater species. In 2008, four mottled sculpin, a cold-water intolerant species, were observed and made up 2% of the total catch. In 2017, mottled sculpin were absent. The remainder of the catch in both years was almost entirely transitional species which are common to abundant in both cool-warm and cool-cold headwater streams. It is also important to note that a high percentage of species captured in both years were *tolerant of environmental degradation and outside the expected range for either stream community*. This is a significant indicator when there is an absence of intolerant species observed in surveys. However, in both years, intolerant species were observed (mottled sculpin or reddsides).

The capture of the species in this survey allows a new natural community classification to be assigned and indicates human-caused impacts are likely not a significant factor in the overall fish community structure. UNT 3000212 at Cherneyville Road (Station ID 10029041) was classified as a macroinvertebrate stream which is consistent with surveys conducted in 2008 and 2017 in that it had a low abundance of fish. These macroinvertebrate streams are very small, almost always intermittent streams with a wide range of summer temperatures. No or few fish (< 25 per 100 m of wetted length) are present, but a variety of aquatic invertebrates may be common, at least seasonally. M-IBI in 2017 supported this by receiving a fair rating at this

location. The low abundance of fish surveyed on this site does not indicate an aquatic life impairment, only that this stream is not conducive to supporting a fish community throughout the year and that a macroinvertebrate stream classification system is justified.

The overall fish community in the Upper East Twin River watershed is in good to excellent condition. Two key metrics that provide insight into the index include number of intolerant species and number of tolerant species. Up to four species intolerant of environmental degradation have been captured in surveys throughout the years surveyed with no decline in abundance or elimination from sites. The intolerant species observed include brook trout, mottled sculpin, residue dace, and brook lamprey. Of these, both the brook trout and mottled sculpin are considered coldwater species. It is also important to note that throughout all survey stations and years, a degraded tolerant fish community was not observed indicating human based influence of degradation did not significantly alter the fish community assemblage.

In 2006, a significant fish kill of multiple species occurred from a wastewater treatment plant failure at the current location of Agropur, Inc. (Trega Foods) facility. This kill was documented in the East Twin River from the confluence of UNT 3000211 downstream to the confluence of Krok Creek. No pre-fish kill data exists for this stretch of the East Twin River but 84 dead brook trout ranging in size from 4-14" were collected representing 3+ year classes of brook trout. This generally represents a catch per effort mile of 41.4 through this stretch of river. Post fish-kill surveys were conducted at Krok Road "Ditch" (Station ID 10030630) and zero brook trout were captured 2009 and 2011. In 2015, one 8.2" brook trout was captured representing one year class. In 2017, three brook trout ranging in size between 2.5-7.9" were captured representing two year classes. The catch per effort mile for these surveys were 15.3 and 48.3 respectively. The current brook trout size structure and year class distribution may indicate that the population has not fully recovered, however it does appear based on population density that the brook trout population is on a track for recovery. Furthermore, based on the F-IBI ratings of good to excellent, it appears the overall fish community has recovered from the fish kill of 2006. Note that the additional surveys above and beyond the normal DNR fish survey schedule was conducted to assess brook trout population recovery from this incident.

**Conclusions and Recommendations** This study assessed the condition of three UNTs, the East Twin River and Krok Creek for ecological impairment. Assessment data from 2017 were compared to prior surveys to determine if water quality conditions have changed and if streams are meeting water quality standards.

## Recommendations

- ✦ All stream locations assessed exceed water quality criteria for phosphorus and should remain on the 303(d) impaired waters list.
- ✦ Chloride, ammonia, and chromium levels in the streams are below impaired thresholds.
- ✦ Water temperature in UNT 3000213 exceed water quality standards and should remain on the impaired waters list.
- ✦ Ambient chronic toxicity was observed in UNT 3000213 on two occasions in 2017 (July and October). Chronic toxicity was observed on the East Twin River below the confluence with the UNT 3000211 (Station ID 104445) in June but is likely unrelated to UNT 3000213 since no toxicity was found in UNT 3000211 in June.
- ✦ Macroinvertebrate monitoring confirmed fair to good water quality conditions in the East Twin River and UNTs with a slight improvement over the 2011 assessment.
- ✦ Qualitative habitat assessments found mostly good to fair fish and aquatic life habitat available in Krok Creek, the East Twin River and all three UNTs.
- ✦ Watershed-wide non-point sources of nutrient and sediment contributions likely impact the water quality and aquatic life habitat in Krok Creek, the East Twin River and all three UNTs and should be controlled to the extent possible.
- ✦ The overall fish community in the Upper East Twin River watershed is in good to excellent condition.
- ✦ The natural community of the East Twin River at CTH J (Station ID 10008204) should be updated to reflect the current fish community structure of cool-warm headwater.
- ✦ The natural community of the East Twin River at Krok Road bridge (Station ID 10020812) should be updated to reflect the current fish community structure of cool-cold headwater.
- ✦ The natural community of the UNT 3000211 at Sleepy Hollow Road (Station ID 10029040) should be updated to reflect the current fish community structure of cool-warm headwater.



East Twin River, Photo by Mary Gansberg, WDNR.

## Appendix A. Whole Effluent Toxicity (WET) Testing methods

### Ambient Acute Ceriodaphnia dubia Toxicity Test

This method is used for measuring the short-term, static-renewal acute toxicity of water samples to the freshwater cladoceran *Ceriodaphnia dubia*. During this test, *C. dubia* that are less than 24 hours old are continuously exposed for 48 hours to 100% samples of East Twin River water as well as a laboratory water control. The lab water control is either moderately hard water (MHW) or dechlorinated Madison tap water depending on which water the *C. dubia* were cultured in. There are 4 replicates set per treatment and each replicate has five *C. dubia*. Therefore, each acute treatment has 20 *C. dubia* exposed in the acute test. The test solutions are renewed after 24 hours. There is no food provided to the *C. dubia* after setting the acute test. Light is provided 16 hours a day and the test is conducted at 20°C. A 2.5% CO<sub>2</sub> treatment is used to control pH drift during the test. Survival is recorded daily. The percent survival per replicate is used to determine statistical difference ( $p \geq 0.05$  is not significant) between the treatments (river samples and the control) using SAS®. This method is based on EPA Test Method 2002 and the State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, Ed. 2.

### Ambient Chronic Ceriodaphnia dubia Toxicity Test

This method is used for measuring the short-term, static-renewal chronic toxicity of water samples to the freshwater cladoceran *Ceriodaphnia dubia*. During this test, *C. dubia* that are less than 24 hours old are continuously exposed for seven days to 100% samples of East Twin River water as well as a laboratory water control. The lab water control is either moderately hard water (MHW) or dechlorinated Madison tap water. There are 10 replicates with one female *C. dubia* set for both the control and all the East Twin River samples. The test solutions are renewed daily and each test beaker is supplied with food which includes YFC and algae. Light is provided 16 hours a day and the test is conducted at 25°C. A 2.5% CO<sub>2</sub> treatment is used to control pH drift during the test. Survival and reproduction are recorded daily. The mean neonates per female in 3 broods is used to determine statistical difference ( $p \geq 0.05$  is not significant) between the treatments (all river samples and the control) using SAS®. This method is based on EPA Test Method 1002 and the State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, Edition 2.

### Ambient Acute Pimephales Promelas Toxicity Test

This method is used for measuring the short-term, static-renewal acute toxicity of water samples to the freshwater minnow *Pimephales promelas* (fathead minnow). During this test, juvenile (4-14 day old) *P. promelas* are continuously exposed for 96 hours to 100% samples of East Twin River water as well as a lab water control. The lab water control for this test is always dechlorinated Madison tap water which is the water the fish are cultured in. There are 4 replicates of 10 fish each per treatment. Therefore, each acute *P. promelas* treatment has 40 fish that are exposed. Treatments are renewed daily with fresh test solutions for the duration of the test period. Each test beaker is fed brine shrimp on day 2 (after ~48 hours). Light is provided 16 hours a day and the test is conducted at 20°C. A 2.5% CO<sub>2</sub> treatment is used to control pH drift during the test. Survival is monitored each day when the solutions are renewed. The percent survival per replicate is used to determine statistical difference ( $p \geq 0.05$  is not significant) between the treatments (river samples and the control) using SAS®. This method is based on EPA Test Method 2000 and the State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, Edition 2.

### Ambient Chronic Pimephales Promelas Toxicity Test

This method is used for measuring the short-term, static-renewal chronic toxicity of water samples to the freshwater minnow *Pimephales promelas* (fathead minnow). During this test, larval ( $\leq 24$  hour old) *P. promelas* are continuously exposed for 7 days to 100% samples of East Twin River water as well as a lab water control. The lab water control for this test is always dechlorinated Madison tap water. There are 10 replicates for each treatment and each replicate is set with two fish. Therefore, 20 fish are exposed per chronic treatment. When the test is shut down 2 replicates are combined for weighing purposes so that there are 5 replicate weight results. Treatments are renewed daily with fresh test solution for the duration of the test period. Each test beaker is fed brine shrimp 2-3 times per day. Light is provided 16 hours a day and the test is conducted at 25°C. A 2.5% CO<sub>2</sub> treatment is used to control pH drift during the test. Survival is monitored each day when the solutions are renewed. Survival and growth (dry weight) are measured at the end of the test to determine if there is an effect on the minnows. Statistical significance of mean dry weight per replicate for all treatments (East Twin River water samples and lab control) is determined using SAS® ( $p \geq 0.05$  not significant). This method is based on EPA Test Method 1000 and the State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, Edition 2.

### Ambient Chronic Selenastrum capricornutum Toxicity Test D

During this test, algal cells are continuously exposed for 96 hours to 100% East Twin River water samples and a moderately hard water control. Light and shaking are provided 24 hours a day and the test is conducted at 25°C. River water is filtered through a GF/A filter prior to test preparation to remove indigenous algae. Nutrients are added to all test solutions to stimulate algal growth. Four replicates of each treatment are set on a microplate which is measured using a plate reader at the end of the test. Chlorophyll content (relative fluorescent units) at 96 hours is compared between all treatments to assess the impact on growth. Algal growth (chlorophyll content measured as RFU) is assessed using SAS® ( $p \geq 0.05$  is not significant) to determine statistically significant differences. This method is based on EPA method 1003.0 and the State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, Edition 2.

Chemistry Alkalinity and hardness of East Twin River samples and lab water is measured on samples collected and preserved on the initial set day. East Twin River ammonia levels are also determined using preserved sample from the initial day. All test waters have pH, dissolved oxygen and conductivity measured on fresh test solutions prior to renewal. After renewal, the water is measured for pH and DO.

## Appendix B: Toxicity Test Rests in Tables

Fathead Minnow Acute Tests – Survival %

SITE DESCRIPTION	STATION NO.	05/09/2017	06/20/17	07/25/17	08/22/17	09/19/17	10/17/17
Lab Water Control	NA	100.0	100.0	100.0	100.0	100.0	100.0
ETR-3 East Twin River below Highway 29	104445	100.0	100.0	100.0	100.0	97.5	100.0
ETR-5 East Twin River at Townline Road	10008206	100.0	100.0	100.0	100.0	100.0	97.5
UT-4 Unnamed tributary at stream mouth	10033921	100.0	100.0	100.0	100.0	100.0	100.0
UT-7 Unnamed tributary at Hrabik Road	10030304	97.5	100.0	97.5	100.0	100.0	100.0
UT-8 Unnamed tributary at Cherneyville Rd.	10033637	100.0	100.0	100.0	100.0	100.0	100.0

*Ceriodaphnia dubia* (waterflea) Acute Tests – Survival %

SITE DESCRIPTION	STATION NO.	05/09/2017	06/20/17	07/25/17	08/22/17	09/19/17	10/17/17
Lab Water Control	NA	95.0	35.0	100.0	100.0	100.0	95.0
ETR-3 East Twin River below Highway 29	104445	100.0	95.0	100.0	100.0	95.0	100.0
ETR-5 East Twin River at Townline Road	10008206	95.0	100.0	100.0	100.0	100.0	100.0
UT-4 Unnamed Tributary at stream mouth	10033921	95.0	95.0	100.0	100.0	100.0	100.0
UT-7 Unnamed Tributary at Hrabik Road	10030304	88.8*	95.0	100.0	100.0	100.0	100.0
UT-8 Unnamed Tributary at Cherneyville Rd.	10033637	90.0	100.0	100.0	100.0	100.0	100.0

\* Replicate was set with 4 organisms instead of 5 due to lab accident. 1 mortality in that replicate = 75% survival, which resulted in a lower overall mean.

Fathead minnow Chronic Tests – Growth (mean mg/fish)

SITE DESCRIPTION	STATION NO.	05/09/2017	06/20/17	07/25/17	08/22/17	09/19/17	10/17/17
Lab Water Control	NA	0.441	0.435	0.301	0.335	0.384	0.330
ETR-3 East Twin River below Highway 29	104445	0.511	0.444	0.354	0.462	0.410	0.399
ETR-5 East Twin River at Townline Road	10008206	0.439	0.437	0.353	0.453	0.398	0.389
UT-4 Unnamed Tributary at stream mouth	10033921	0.503	0.453	0.343	0.446	0.454	0.389
UT-7 Unnamed Tributary at Hrabik Road	10030304	0.527	0.427	0.394	0.464	0.444	0.436
UT-8 Unnamed Tributary at Cherneyville Rd.	10033637	0.506	*0.422	0.357	0.454	**0.372	0.434

\*Survival = 85% (control 100%)

\*\*Survival = 74% (control 95%)

*Ceriodaphnia dubia* (waterflea) Chronic Tests – Reproduction (mean neonates/female)

SITE DESCRIPTION	STATION NO.	05/09/2017	06/20/17	07/25/17	08/22/17	09/19/17	10/17/17
Lab Water Control	NA	25	28	27	23	16	33
ETR-3 East Twin River below Highway 29	104445	28	18	32	26	21	39
ETR-5 East Twin River at Townline Road	10008206	32	27	24	26	18	43
UT-4 Unnamed tributary at stream mouth	10033921	24	36	37	21	18	37
UT-7 Unnamed tributary at Hrabik Road	10030304	31	33	39	23	20	35
UT-8 Unnamed tributary at Cherneyville Rd.	10033637	32	31	27	22	19	26*

\*Survival = 80% (control 100%)

*Selenastrum capricornutum* (green algae) Chronic Test – Mean Growth (fluorescence)

SITE DESCRIPTION	STATION NO.	05/09/2017	06/20/17	07/25/17	08/22/17	09/19/17	10/17/17
Lab Water Control	NA	698	687	658	652	624	657
ETR-3 East Twin River below Highway 29	104445	779	763	701	668	708	687
ETR-5 East Twin River at Townline Road	10008206	774	732	698	643	678	689
UT-4 Unnamed Tributary at stream mouth	10033921	811	815	717	635	666	696
UT-7 Unnamed Tributary at Hrabik Road	10030304	806	836	733	634	657	694
UT-8 Unnamed Tributary at Cherneyville Rd.	10033637	821	777	631	619	615	665

## Appendix C: References

- Gansberg, M. 2009. Fish and Aquatic Life Use Designation Summary-Unnamed Tributary to East Twin River – Cherneyville Road (WBIC 3000211).
- Gansberg, M. 2009. Fish and Aquatic Life Use Designation Summary-Unnamed Tributary to East Twin River – Sleepy Hollow Road (WBIC 3000212).
- Gansberg, M., Hogler, S. 2012. Water Quality Surveys of the East Twin River (84000) and Unnamed Tributary (3000211, 3000212, & 3000213) to the East Twin River, Kewaunee County – 2011 and 2012.
- Hogler, S., Surendonk, S. 2009. Upper East Twin River Trout Survey.
- Hogler, S., Surendonk, S., Lange, R. 2015. East Twin River Trout Survey.
- Hogler, S., Cahow, J. 2001. East Twin River Baseline Monitoring Report.
- Lyons, J. 1992. Using the Index of Biotic Integrity (IBI) to Measure Environmental Quality in Warmwater Streams of Wisconsin U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station, General Technical Report NC-149. St. Paul, Minnesota.
- Lyons, J., Wang, L., Simonson, T.D., 1996. Development and validation of an index of biotic integrity for coldwater streams in Wisconsin. *N. Am. J. Fish. Manage.* 16, 241–256.
- Lyons, J. 2013. Methodology for Using Field Data to Identify and Correct Wisconsin Stream “Natural Community” Misclassifications. Version 4, May 16, 2013.
- Simonson T.D., J. Lyons and P.D. Kanehl. 1994. Guidelines for Evaluating Fish Habitat in Wisconsin Streams. U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station, General Technical Report NC-164.
- U.S. Environmental Protection Agency. 2013. Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater. Retrieved January 31st, 2018 from <https://www.epa.gov/sites/production/files/2015-08/documents/aquatic-life-ambient-water-quality-criteria-for-ammonia-freshwater-2013.pdf>
- Weigel, B.M. 2003. Development of stream macroinvertebrate models that predict watershed and local stressors in Wisconsin. *Journal of the North American Benthological Society* 22:123–142.
- West, W. 2009. Report of Findings, Biological Survey of East Twin River, Kewaunee County, WI. Blue Iris Environmental, Inc. Wisconsin Department of Natural Resources. 2017. Wisconsin 2018 Consolidated Assessment and Listing Methodology (WisCALM) for CWA Section 303(d) and 305(b) Integrated Reporting. 3200-2017-02.
- Wisconsin Department of Natural Resources. 2005. Surface Water Assessment Team, Guidelines and Procedures for Surface Water Grab Sampling, Version 3.
- Wisconsin Department of Natural Resources. 2004. Guidelines for Designating Fish & Aquatic Life Uses for Wisconsin Surface Waters. PUBL-WT-807-04 First Edition.
- Wisconsin Department of Natural Resources. 2000. Guidelines for Collecting Macroinvertebrate Samples from Wadable Streams.
- Wisconsin Department of Natural Resources. 2007. Guidelines for Qualitative Physical Habitat Evaluations of Wadeable Streams.
- Wisconsin Department of Natural Resources. 2001. Guidelines for Assessing Fish Communities of Wadeable Streams in Wisconsin.
- Wisconsin Department of Natural Resources. 2004. Guidelines and Standard Procedures for Continuous Temperature Monitoring, Version 1.
- Wisconsin Department of Natural Resources. 2008. State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, 2nd Edition.

## Appendix D. Blue Iris Environmental Report of Findings, Biological Survey of East Twin River, Kewaunee County 2009

*Blue Iris Environmental, Inc.*

June 20, 2009

Joe Musial  
E4640 Pheasant Road  
Algoma, WI 54201

Dear Mr. Musial

RE: Report of Findings  
Biological Survey of East Twin River, Kewaunee County, WI

At your request, Blue Iris Environmental, Inc. (Blue Iris) has conducted a biological assessment of macroinvertebrates (and fish if observed) inhabiting portions of East Twin River in Kewaunee County, WI. Blue Iris conducted the survey on July 1, 2009 at three locations along East Twin River. The survey was not meant to be either qualitative or quantitative merely a cursory evaluation of stream inhabitants. This evaluation might be used to provide a preliminary assessment of water quality and/or establish a basis for more in depth evaluations. Blue Iris did not retain any specimens but did record observations which are presented herein.

Observations of instream macroinvertebrates were taken at the following locations:

- Location A - East Twin River – north of Hwy 29 on Town Line Road
- Location B - East Twin River – along Church Road
- Location C - East Twin River – along Kroc Road

At each station, Blue Iris made observation upstream of the culvert and traversed an area approximately 50 to 100 yards upstream. Observations of inhabitants were recorded in a one hour effort per site. Observations included searches of bottom sediments, undercut banks, overhanging vegetation, submerged logs, as well as near shore vegetation (search for evidence of dragonfly and damselfly).

Stream temperatures ranged from 54°F at Location A to 56°F at the other two locations. Substrate at Location A included a bottom with finely washed gravel in the center with soft sediment along the sides. Substrate at Location B had slightly more soft sediment throughout the stretch with numerous sticks and woody deposits on the bottom. Substrate at Location C was nearly all sand bank to bank with some rock and scant aquatic vegetation. All sites were canopied with scrub (alder) and hardwood over story.

Summary of Findings:

Taxa	Location A	Location B	Location C
Annelida			
Hirudinea (leech)	C2sp		
Crustacea			
Amphipoda (scuds)	A	C	A
Decapoda (crayfish)	C	C	C
Isopoda	C		
Mollusca			
Gastropoda (snails)	A	P	P
Pelecypoda (clams)		P	
Insecta			
Ephemeroptera (mayflies)			P2sp
Odonata			
Anisoptera (dragonfly)	C	P	C3sp
Zygoptera (damselfly)	P		
Plecoptera (stonefly)			P
Hemiptera (true bugs)	P	P	P
Coleoptera (beetles)			P
Trichoptera (caddisfly)	A3sp*	C2sp	C
Diptera (fly)			
Tabanus	P		
Chironomids	C		P
Fish			
Mud minnow		2	
Stickleback	1	1	

A = Abundant

C = Common

P = Present

\*A3sp = abundant, 3 species noted

## Appendix E: Water Quality Standards Attainment Table

NAME	START MILE	END MILE	SIZE	WBIC	COUNTY	LAST MONITORED	CONDITION	TROUT CLASS	ORW ERW
East Twin River	0	10.49	10.5 Miles	84000	Kewaunee, Manitowoc	2019	Poor		
East Twin River	10.49	26.4	15.9 Miles	84000	Kewaunee, Manitowoc	2017	Poor		
East Twin River	26.4	34.18	7.8 Miles	84000	Kewaunee, Manitowoc	2019	Poor	CLASS II	
East Twin River	34.18	40.91	6.7 Miles	84000	Kewaunee, Manitowoc	2017	Poor	CLASS I	ERW
Unnamed Stream	0	0.62	0.6 Miles	5020429	Kewaunee		Unknown		
Jambo Creek	0	3.91	3.9 Miles	84300	Kewaunee, Manitowoc	2018	Good	CLASS II	
Jambo Creek	3.91	8.1	4.2 Miles	84300	Kewaunee, Manitowoc	2015	Unknown		
Jambo Creek	8.1	10.1	2.0 Miles	84300	Kewaunee, Manitowoc	2015	Poor		
Johnson Creek	0	4.43	4.4 Miles	84100	Manitowoc	2019	Good		
Krok Creek	0	0.68	0.7 Miles	86700	Kewaunee	2018	Poor		
Krok Creek	0.68	3.33	2.7 Miles	86700	Kewaunee	2018	Poor		
Molash Creek	0	7.76	7.8 Miles	90100	Manitowoc	2019	Poor		
Tisch Mills Creek	0	2.26	2.3 Miles	85500	Kewaunee, Manitowoc	2019	Good	CLASS II	
Tisch Mills Creek	2.26	5.51	3.3 Miles	85500	Kewaunee, Manitowoc	2015	Fair		
Unnamed Stream	0	0.05	0.1 Miles	5022803	Manitowoc		Unknown		
Unnamed	0	0.16	0.2 Miles	84900	Kewaunee		Unknown		
Unnamed Stream	0	0.26	0.3 Miles	5019058	Kewaunee		Unknown		
Unnamed Stream	0	0.27	0.3 Miles	5021569	Manitowoc		Unknown		
Unnamed Stream	0	0.37	0.4 Miles	5018725	Kewaunee		Unknown		
Unnamed Stream	0	0.38	0.4 Miles	3000213	Kewaunee	2017	Poor		
Unnamed Stream	0	0.4	0.4 Miles	5022485	Manitowoc		Unknown		
Unnamed Stream	0	0.43	0.4 Miles	5022066	Manitowoc		Unknown		
Unnamed Stream	0	0.44	0.4 Miles	5021236	Manitowoc		Unknown		
Unnamed Stream	0	0.45	0.5 Miles	5019407	Kewaunee		Unknown		
Unnamed Stream	0	0.45	0.5 Miles	5018009	Kewaunee		Unknown		
Unnamed Stream	0	0.45	0.5 Miles	5020458	Kewaunee		Unknown		
Unnamed Stream	0	0.46	0.5 Miles	5021331	Manitowoc		Unknown		
Un Creek	0	0.47	0.5 Miles	90200	Manitowoc		Unknown		
Unnamed Stream	0	0.47	0.5 Miles	5021125	Manitowoc		Unknown		
Unnamed Stream	0	0.47	0.5 Miles	5020760	Manitowoc		Unknown		
Unnamed Stream	0	0.48	0.5 Miles	5019629	Kewaunee		Unknown		
Unnamed Stream	0	0.48	0.5 Miles	5022105	Manitowoc		Unknown		
Unnamed Stream	0	0.5	0.5 Miles	5022909	Manitowoc		Unknown		
Unnamed Stream	0	0.51	0.5 Miles	5021639	Manitowoc		Unknown		

NAME	START MILE	END MILE	SIZE	WBIC	COUNTY	LAST MONITORED	CONDITION	TROUT CLASS	ORW ERW
Unnamed Stream	0	0.53	0.5 Miles	5021226	Manitowoc		Unknown		
Unnamed Stream	0	0.53	0.5 Miles	5020629	Manitowoc		Unknown		
Unnamed Stream	0	0.54	0.5 Miles	5021209	Manitowoc		Unknown		
Unnamed Stream	0	0.55	0.6 Miles	5019540	Kewaunee		Unknown		
Unnamed Stream	0	0.55	0.6 Miles	5018817	Kewaunee		Unknown		
Unnamed Stream	0	0.55	0.6 Miles	5021245	Manitowoc		Unknown		
Unnamed Stream	0	0.56	0.6 Miles	5019717	Kewaunee		Unknown		
Unnamed Stream	0	0.56	0.6 Miles	5022249	Manitowoc		Unknown		
Unnamed Stream	0	0.57	0.6 Miles	5019988	Kewaunee		Unknown		
Unnamed Stream	0	0.57	0.6 Miles	5022757	Manitowoc		Unknown		
Unnamed Stream	0	0.58	0.6 Miles	5020900	Manitowoc		Unknown		
Unnamed Stream	0	0.58	0.6 Miles	5020513	Manitowoc		Unknown		
Unnamed Stream	0	0.58	0.6 Miles	5021866	Manitowoc		Unknown		
Unnamed Stream	0	0.61	0.6 Miles	5020376	Kewaunee		Unknown		
Unnamed Stream	0	0.62	0.6 Miles	5022414	Manitowoc		Unknown		
Unnamed Stream	0	0.63	0.6 Miles	5019454	Kewaunee		Unknown		
Unnamed Stream	0	0.64	0.6 Miles	5018931	Kewaunee		Unknown		
Unnamed Stream	0	0.65	0.7 Miles	5021565	Manitowoc		Unknown		
Unnamed Stream	0	0.65	0.7 Miles	5021444	Manitowoc		Unknown		
Unnamed Stream	0	0.65	0.7 Miles	5019139	Kewaunee		Unknown		
Unnamed Stream	0	0.65	0.7 Miles	5020242	Kewaunee		Unknown		
Unnamed Stream	0	0.65	0.7 Miles	5021439	Manitowoc		Unknown		
Unnamed Stream	0	0.67	0.7 Miles	5021205	Manitowoc		Unknown		
Unnamed Stream	0	0.68	0.7 Miles	5022209	Manitowoc		Unknown		
Unnamed Stream	0	0.68	0.7 Miles	5021583	Manitowoc		Unknown		
Unnamed Stream	0	0.68	0.7 Miles	5021594	Manitowoc		Unknown		
Unnamed Stream	0	0.68	0.7 Miles	5022656	Manitowoc		Unknown		
Unnamed Stream	0	0.69	0.7 Miles	5020540	Manitowoc		Unknown		
Unnamed Stream	0	0.7	0.7 Miles	5021932	Manitowoc		Unknown		
Unnamed Stream	0	0.71	0.7 Miles	5022731	Manitowoc		Unknown		
Unnamed Stream	0	0.74	0.7 Miles	5022483	Manitowoc		Unknown		
Unnamed Stream	0	0.75	0.8 Miles	5020585	Manitowoc		Unknown		
Unnamed Stream	0	0.77	0.8 Miles	5019465	Kewaunee		Unknown		
Unnamed Stream	0	0.77	0.8 Miles	5019465	Kewaunee		Unknown		
Unnamed Stream	0	0.77	0.8 Miles	5019249	Kewaunee		Unknown		
Unnamed Stream	0	0.79	0.8 Miles	5020850	Manitowoc		Unknown		
Unnamed Stream	0	0.79	0.8 Miles	5019171	Kewaunee		Unknown		
Unnamed Stream	0	0.81	0.8 Miles	5019657	Kewaunee		Unknown		
Unnamed Stream	0	0.81	0.8 Miles	5018357	Kewaunee		Unknown		
Unnamed Stream	0	0.81	0.8 Miles	5021022	Manitowoc		Unknown		
Unnamed Stream	0	0.84	0.8 Miles	5020712	Manitowoc		Unknown		

NAME	START MILE	END MILE	SIZE	WBIC	COUNTY	LAST MONITORED	CONDITION	TROUT CLASS	ORW ERW
Unnamed Stream	0	0.84	0.8 Miles	5020440	Kewaunee, Manitowoc		Unknown		
Unnamed Stream	0	0.84	0.8 Miles	5019654	Kewaunee		Unknown		
Unnamed Stream	0	0.84	0.8 Miles	5018914	Kewaunee		Unknown		
Unnamed Stream	0	0.84	0.8 Miles	5021741	Manitowoc		Unknown		
Unnamed Stream	0	0.85	0.9 Miles	5018807	Kewaunee		Unknown		
Unnamed Stream	0	0.85	0.9 Miles	5022169	Manitowoc		Unknown		
Unnamed Stream	0	0.86	0.9 Miles	5022061	Manitowoc		Unknown		
Unnamed Stream	0	0.87	0.9 Miles	5020992	Manitowoc		Unknown		
Unnamed Stream	0	0.88	0.9 Miles	5018221	Kewaunee		Unknown		
Unnamed Stream	0	0.88	0.9 Miles	5020837	Manitowoc		Unknown		
Unnamed Stream	0	0.88	0.9 Miles	5021140	Manitowoc		Unknown		
Unnamed Stream	0	0.9	0.9 Miles	5021677	Manitowoc		Unknown		
Unnamed Stream	0	0.9	0.9 Miles	5021647	Manitowoc		Unknown		
Unnamed Stream	0	0.91	0.9 Miles	5022641	Manitowoc		Unknown		
Unnamed Stream	0	0.94	0.9 Miles	5020742	Manitowoc		Unknown		
Unnamed Stream	0	0.95	1.0 Miles	5019622	Kewaunee		Unknown		
Unnamed Trib 22n, 24e, 31 Nesw	0	1	1.0 Miles	85700	Kewaunee		Unknown		
Unnamed Trib 22n, 23e, 24 Nenw	0	1	1.0 Miles	85800	Kewaunee		Unknown		
Unnamed Trib 21n, 24e, 4 Nwnw	0	1	1.0 Miles	86100	Manitowoc		Unknown		
Unnamed Trib 22n, 24e, 28 Nwnw	0	1	1.0 Miles	86200	Kewaunee		Unknown		
Unnamed Stream T21nr24e S25	0	1	1.0 Miles	90300	Manitowoc		Unknown		
Unnamed Trib T21n, R24e, S25 Nene	0	1	1.0 Miles	85100	Kewaunee		Unknown		
Unnamed Stream	0	1	1.0 Miles	5018987	Kewaunee		Unknown		
Unnamed Stream	0	1.05	1.1 Miles	5020087	Kewaunee		Unknown		
Unnamed Stream	0	1.05	1.1 Miles	5022763	Manitowoc		Unknown		
Unnamed Stream	0	1.09	1.1 Miles	5021696	Manitowoc		Unknown		
Unnamed Stream	0	1.11	1.1 Miles	5019992	Kewaunee		Unknown		
Unnamed Stream	0	1.13	1.1 Miles	5021396	Manitowoc		Unknown		
Unnamed Stream	0	1.15	1.2 Miles	5022902	Manitowoc		Unknown		
Unnamed Stream	0	1.16	1.2 Miles	5020362	Kewaunee		Unknown		
Unnamed Stream	0	1.18	1.2 Miles	5019705	Kewaunee		Unknown		
Unnamed Stream	0	1.18	1.2 Miles	5018985	Kewaunee		Unknown		
Unnamed Stream	0	1.19	1.2 Miles	5019081	Kewaunee		Unknown		
Unnamed Stream	0	1.19	1.2 Miles	5020393	Kewaunee		Unknown		
Unnamed Stream	0	1.23	1.2 Miles	5022182	Manitowoc		Unknown		
Unnamed Stream	0	1.23	1.2 Miles	5018530	Kewaunee		Unknown		

NAME	START MILE	END MILE	SIZE	WBIC	COUNTY	LAST MONITORED	CONDITION	TROUT CLASS	ORW ERW
Unnamed Stream	0	1.25	1.3 Miles	5018636	Kewaunee		Unknown		
Unnamed Stream	0	1.27	1.3 Miles	5022014	Manitowoc		Unknown		
Unnamed Stream	0	1.27	1.3 Miles	5022202	Manitowoc		Unknown		
Unnamed Stream	0	1.28	1.3 Miles	5019355	Kewaunee		Unknown		
Unnamed Stream	0	1.31	1.3 Miles	5018644	Kewaunee		Unknown		
Unnamed Stream	0	1.35	1.4 Miles	5019833	Kewaunee		Unknown		
Unnamed Stream	0	1.37	1.4 Miles	5019180	Kewaunee		Unknown		
Unnamed Ditch	0	1.39	1.4 Miles	86600	Kewaunee		Excellent		
Unnamed Stream	0	1.4	1.4 Miles	5021653	Manitowoc		Unknown		
Unnamed Stream	0	1.42	1.4 Miles	5021000	Manitowoc		Unknown		
Unnamed Stream	0	1.42	1.4 Miles	5021772	Manitowoc		Unknown		
Unnamed Stream	0	1.44	1.4 Miles	5021894	Manitowoc		Unknown		
Unnamed Stream	0	1.44	1.4 Miles	5022445	Manitowoc		Unknown		
Unnamed Stream	0	1.45	1.5 Miles	5019806	Kewaunee		Unknown		
Unnamed Stream	0	1.45	1.5 Miles	5021266	Manitowoc		Unknown		
Unnamed Stream	0	1.49	1.5 Miles	5022214	Manitowoc		Unknown		
Unnamed Stream	0	1.54	1.5 Miles	5021512	Manitowoc		Unknown		
Unnamed Stream	0	1.57	1.6 Miles	5019251	Kewaunee		Unknown		
Unnamed Stream	0	1.62	1.6 Miles	5022364	Manitowoc		Unknown		
Unnamed Stream	0	1.63	1.6 Miles	5017856	Kewaunee		Unknown		
Unnamed Stream	0	1.65	1.7 Miles	5019016	Kewaunee		Unknown		
Unnamed Stream	0	1.7	1.7 Miles	5019920	Kewaunee		Unknown		
Unnamed Stream	0	1.7	1.7 Miles	5022207	Manitowoc		Unknown		
Unnamed Stream	0	1.72	1.7 Miles	5020126	Kewaunee	1985	Unknown		
Unnamed Stream	0	1.77	1.8 Miles	5022248	Manitowoc		Unknown		
Unnamed Stream	0	1.88	1.9 Miles	5019231	Kewaunee		Unknown		
Unnamed Stream	0	1.91	1.9 Miles	5020884	Manitowoc		Unknown		
Unnamed Stream	0	1.93	1.9 Miles	3000212	Kewaunee	2017	Poor		
Unnamed Stream	0	1.95	2.0 Miles	5019145	Kewaunee		Unknown		
Unnamed Stream	0	1.96	2.0 Miles	5021902	Manitowoc		Unknown		
Unnamed Trib T21n, R23e S09 Ssw	0	2	2.0 Miles	84500	Kewaunee, Manitowoc		Unknown		
Unnamed Trib 22n, 24e, 33 Swse	0	2	2.0 Miles	86500	Kewaunee		Unknown		
Unnamed Trib 23n, 23e, 22 Nene	0	2	2.0 Miles	86900	Kewaunee		Unknown		
Unnamed Stream	0	2.04	2.0 Miles	5022492	Manitowoc		Unknown		
Unnamed Trib 23n, 24e, 20 Nenw	0	2.05	2.1 Miles	86800	Kewaunee		Unknown		
Unnamed Stream	0	2.07	2.1 Miles	5020364	Kewaunee, Manitowoc		Unknown		
Unnamed Stream	0	2.07	2.1 Miles	5019298	Kewaunee		Unknown		
Unnamed Stream	0	2.17	2.2 Miles	5020155	Kewaunee		Unknown		

NAME	START MILE	END MILE	SIZE	WBIC	COUNTY	LAST MONITORED	CONDITION	TROUT CLASS	ORW ERW
Unnamed Stream	0	2.19	2.2 Miles	5019444	Kewaunee		Unknown		
Unnamed Stream	0	2.29	2.3 Miles	5019760	Kewaunee		Unknown		
Unnamed Stream	0	2.33	2.3 Miles	5018926	Kewaunee		Unknown		
Unnamed Stream	0	2.5	2.5 Miles	5022643	Manitowoc		Unknown		
Unnamed Stream	0	2.51	2.5 Miles	5017852	Kewaunee		Unknown		
Unnamed Stream	0	2.53	2.5 Miles	5021058	Manitowoc		Unknown		
Unnamed Stream	0	2.82	2.8 Miles	5018632	Kewaunee		Unknown		
Unnamed	0	2.84	2.8 Miles	5019981	Kewaunee		Unknown		
Unnamed Stream	0	2.84	2.8 Miles	5020517	Manitowoc	2016	Unknown		
Unnamed Trib 22n, 24e, 9swsw	0	2.86	2.9 Miles	86300	Kewaunee		Unknown		
Unnamed Stream	0	2.89	2.9 Miles	5022177	Manitowoc		Unknown		
Unnamed Trib 22n, 24e, 32swne	0	3.04	3.0 Miles	86000	Kewaunee, Manitowoc		Unknown		
Unnamed Stream	0	3.1	3.1 Miles	5022137	Manitowoc		Unknown		
Unnamed Stream	0	3.24	3.2 Miles	5018675	Kewaunee		Unknown		
Unnamed Stream	0	3.29	3.3 Miles	5021445	Manitowoc		Unknown		
Unnamed Stream	0	3.31	3.3 Miles	5021049	Manitowoc		Unknown		
Local Water	0	3.38	3.4 Miles	3000211	Kewaunee	2017	Poor		
Unnamed Trib T21n, R23e, S15 Nene	0	4	4.0 Miles	84400	Manitowoc		Unknown		
Unnamed Trib 22n 24e S9 Nsw	0	4.16	4.2 Miles	86400	Kewaunee	2018	Fair		
Unnamed Stream	0	4.43	4.4 Miles	5021530	Manitowoc		Unknown		
Local Water	0	6.37	6.4 Miles	5020832	Manitowoc	2015	Poor		
Un Creek	0.01	2.17	2.2 Miles	90500	Kewaunee		Unknown		
Unnamed Trib 22n, 24e, 25 Nwne	0.01	7.16	7.2 Miles	90400	Kewaunee		Fair		
West Twin River	0	5.9	5.9 Miles	87000	Manitowoc	2019	Poor		
Two Rivers Harbor			11.4	47	Manitowoc	1986	Poor		
Neshota Park Beach, Lake Michigan	0	0.68	0.7 Acres	20	Brown, Door, Kenosha, Kewaunee, Manitowoc, Marinette, Milwaukee, Oconto, Ozaukee, Racine, Sheboygan	2018	Unknown		
Point Beach State Park Beach, Lake Michigan	0	1.51	1.5 Acres	20		2018	Unknown		
Selner Park Beach (City Of Kewaunee), Lake Michigan			1.0 Acres	20			Unknown		
Pioneer Park Beach, Lake Michigan			0.6 Acres	20		1979	Unknown		
Lake Michigan	0	261.05	261.1 Acres	20		2020	Good		
Chada Lake			5.7 Acres	85000	Kewaunee	2017	Unknown		
Engledinger Lake			52.3 Acres	85300	Kewaunee	2017	Fair		
Harpt Lake			32.2 Acres	84600	Manitowoc	2020	Poor		

NAME	START MILE	END MILE	SIZE	WBIC	COUNTY	LAST MONITORED	CONDITION	TROUT CLASS	ORW ERW
Heidman Lake (Bolt)			23.3 Acres	85200	Kewaunee	2017	Good		
Mott Lake			7.0 Acres	84700	Manitowoc	2017	Good		
Seidel Lake			11.5 Acres	83100	Kewaunee	2017	Unknown		
Shea Lake			31.5 Acres	85400	Kewaunee	2020	Poor		
Un Lake			15.2 Acres	83700	Manitowoc	2011	Unknown		
Local Water			6.3 Acres	5547768	Kewaunee		Unknown		
Local Water			2.7 Acres	5547861	Kewaunee		Unknown		
Local Water			3.2 Acres	5550071	Kewaunee		Unknown		
Local Water			3.5 Acres	5552390	Manitowoc		Suspected Poor		
Local Water			2.2 Acres	5553409	Manitowoc		Unknown		
Local Water			4.8 Acres	5553597	Manitowoc		Unknown		
Local Water			3.0 Acres	5553611	Manitowoc		Unknown		
Local Water			4.6 Acres	5553945	Manitowoc		Unknown		
Local Water			10.5 Acres	5553957	Manitowoc		Unknown		
Local Water			31.9 Acres	5553972	Manitowoc		Unknown		
Local Water			2.6 Acres	5547540	Kewaunee		Unknown		
Local Water			2.8 Acres	5553786	Manitowoc		Unknown		
Local Water			5.0 Acres	5554866	Manitowoc		Unknown		
Local Water			5.6 Acres	5547537	Kewaunee		Unknown		
Local Water			4.5 Acres	5553470	Manitowoc		Unknown		

This water quality standards assessment table reflects the condition of waters in the study area watershed. This table data is stored in the Water Assessment Tracking and Electronic Reporting System (WATERS) and is updated on an ongoing basis via monitoring data and assessment calculations. The following definitions apply:

- Current Use – current condition of water based on monitoring data.
- Attainable Use – “ecological potential” of water based on water type, natural community, lack of human-induced disturbances.
- Supporting Attainable Use – decision on whether the water’s current condition is supporting its designated use under “water quality standards”.
- Designated Use – the water’s classified use under NR102, Wisconsin Water Quality Standards, for Fish and Aquatic Life.
- Impairments – documented impacts on water condition due to pollution sources or changes in hydro-geomorphological changes.
- Assessment – field indicates what type of data or information supports the decisions in the table (current, attainable, and supporting attainable).
- Impaired Water Status – This column indicates the status of the impaired water for TMDL development.