

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

**PUBLIC REVIEW DRAFT – FOR PUBLIC COMMENT**

**Garners Creek Targeted Watershed  
Assessment: A Water Quality Report to  
Restore Wisconsin Watersheds, 2020**

***HUC: 040302040205, Monitored 2016***

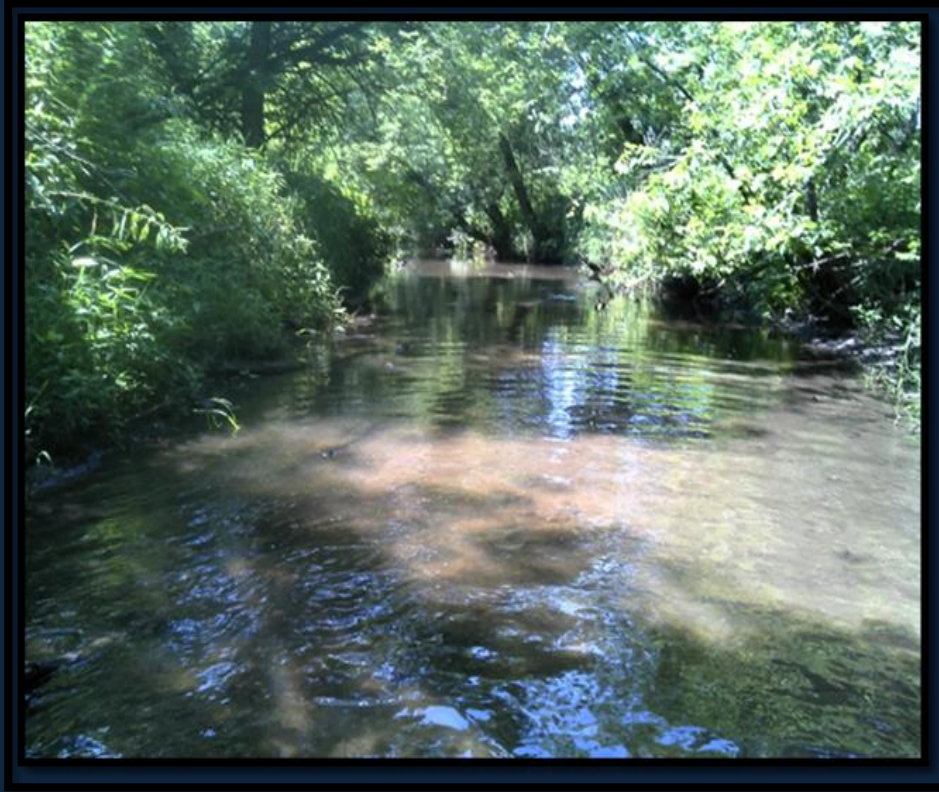
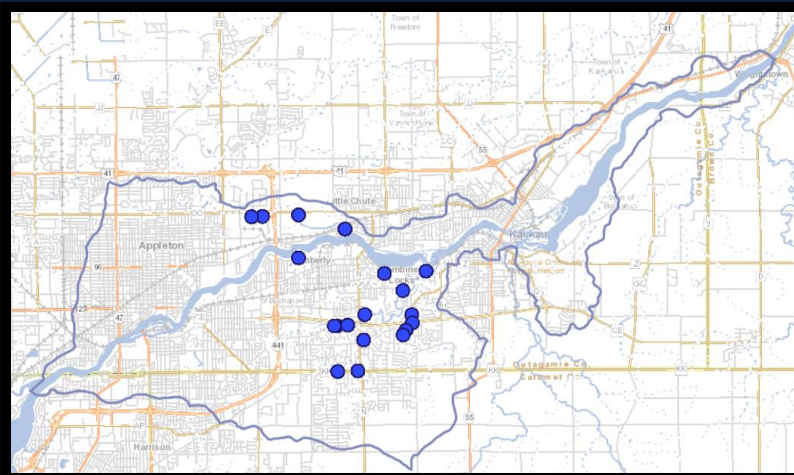


Photo by Andy Hudak, East District Water Quality Biologist  
Wisconsin Department of Natural Resources

To learn more about this area, see this plan on [Wisconsin's TWA Projects Online!](#)  
Or search for Sinsinawa River at Explore [Wisconsin's Waters Online!](#) for more detail



EGAD # 3200-2019-12  
Water Quality Bureau,  
Wisconsin DNR

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## Targeted Watershed Assessment Summary

### About the Watershed

Garners Creek sub-watershed is an extensively urban watershed that lies within the Lower Fox River Basin and is within the heart of the Fox Valley Community. The communities of Appleton, Kimberly, Buchannan, Harrison, and Combined Locks all contribute significant drainage to the approximate 31.25 square miles of this watershed. The Fox River bisects the watershed and roughly 2/3 of the watershed is located south of the River while the remainder of the watershed lies north of the River. Garners Creek is the only major stream within the watershed however multiple small tributary streams to the Fox River are present. Hydrologic modification, stormwater impacts, and streambank erosion and failure is common throughout the watershed.

### Biological Systems and Water Quality

Streams in the Garners Creek sub-watershed are all considered cool-warm transitional headwaters. The streams typically have 4-7 species, many of them dominated by transitional to warm species such as Creek Chub, Green Sunfish, and White Sucker. There was an absence of intolerant species throughout the entire watershed and majority of the total number of fish observed were tolerant to environmental degradation. Overall habitat conditions were mostly in the fair to good category however these scores were likely maintained by a lack of disturbance within 10 m on either side of the stream. Bank erosion and deposition of fine sediment along with the elimination of pool habitat are likely the two most impacted metrics in habitat quality observed. It is evident that significant impacts from altered hydrology and urban development are continuing to limit the aquatic life in these systems. In some locations, extensive streambank stabilization measures have been attempted to protect severely eroding banks only to deflect energy downstream leading to additional bank failures on unprotected banks.

### Study Summary

Streams in the Garners Creek sub-watershed are all considered cool-warm transitional headwaters. The streams typically have 4-7 species, many of them dominated by transitional to warm species such as Creek Chub, Green Sunfish, and White Sucker. There was an absence of intolerant species throughout the entire watershed and majority of the total number of fish observed were tolerant to environmental degradation. Overall habitat conditions were mostly in the fair to good category however these scores were likely maintained by a lack of disturbance within 10 m on either side of the stream. Bank erosion and deposition of fine sediment along with the elimination of pool habitat are likely the two most impacted metrics in habitat quality observed.

It is evident that significant impacts from altered hydrology and urban development are continuing to limit the aquatic life in these systems. In some locations, extensive streambank stabilization measures have been attempted to protect severely eroding banks only to deflect energy downstream leading to additional bank failures on unprotected banks.

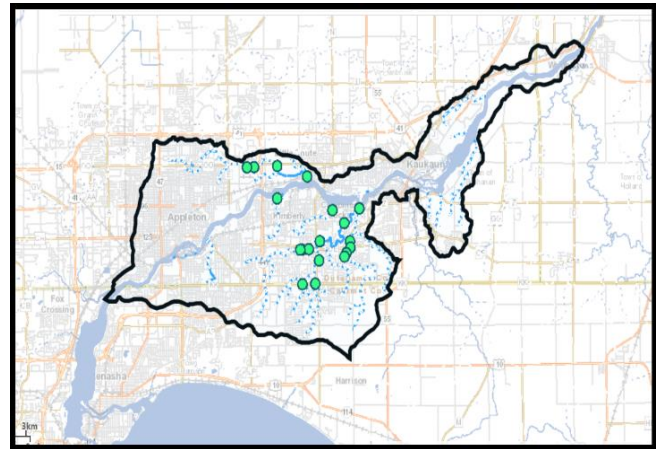
The strategy to improve conditions within Garners Creek and the other small tributaries in this watershed are complex. The permanent loss of wetlands and disconnection of a floodplain are largely the cause for poor water quality conditions. It would be unrealistic to expect any significant gains in wetland acreage or connection to a functioning floodplain to be possible in this highly developed watershed. Strategies should continue to focus on stormwater management and the rate of stormwater delivery to the stream. The streams in the watershed will continually attempt to adjust to the alterations in hydrology which leads to degraded habitat.

Significant effort is need in comprehensive planning and design of streambank stabilization projects to address the hydrologic needs of these streams. Single banks stabilization projects will continue to have negative cumulative impacts on instream habitat and phosphorous and sediment loads to streams in the watershed.

### Recommendations

The strategy to improve conditions within Garners Creek and the other small tributaries in this watershed are complex. The permanent loss of wetland, altered hydrology, and disconnected floodplains are largely the cause for poor water quality conditions. It would be unrealistic to expect any significant gains in wetland acreage or connection to a functioning floodplain to be possible in this highly developed watershed. Strategies should continue to focus on stormwater management and slowing the rate of stormwater delivery to streams. Streams in this watershed will continually adjust to alterations in hydrology leading to significant bank stabilization issues unless stormwater attenuation and floodwater storage alternatives are explored.

Figure 1: Garners Creek Watershed

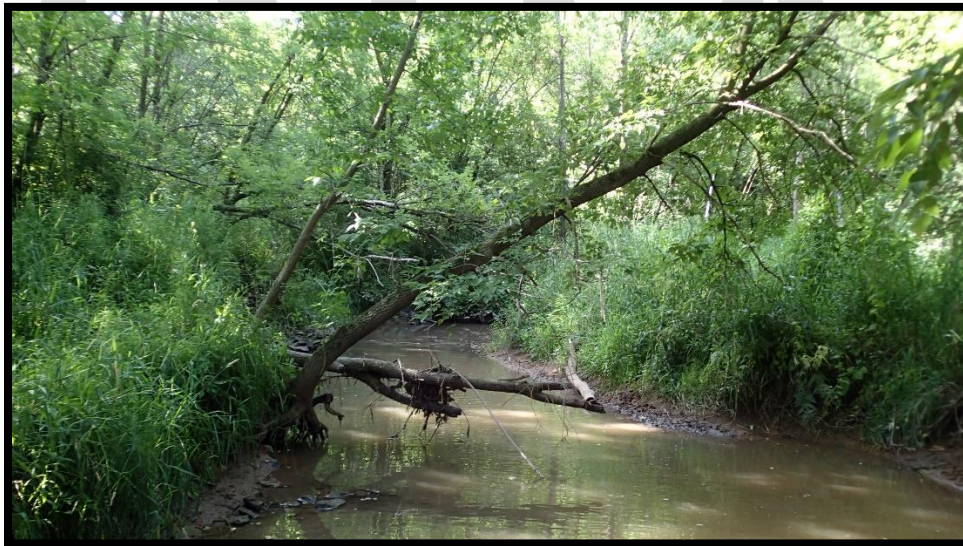


Unnamed Tributary to Fox River at Sunset Park.

Significant effort is needed in comprehensive planning and design of streambank stabilization projects to address the hydrologic needs of these streams. Single bank stabilization projects will continue to have cumulative impacts on instream habitat in addition to phosphorous and sediment loads that continue to impair streams in the watershed.

**Management Recommendations and Priorities**

- ✦ Municipalities and other partners should seek opportunities to install BMP’s for sediment and nutrient reduction from urban sources such as roadways and residential development.
- ✦ Promote landowner infiltration practices. Continue to educate homeowners on the use of rain barrels and rain gardens for water quality and quantity benefits.
- ✦ The Department should continue to work with the Local Municipalities and other interested partners to evaluate the potential for comprehensive bank stabilization projects on Garners Creek and avoid small individual parcel bank stabilization projects.
- ✦ Comprehensive bank stabilization projects should utilize strategies to establish natural stream morphology, contain a significant fish cover component, establish a sustainable rate of sediment transport, and re-develop a floodplain connection.
- ✦ As opportunity arises, removal of concrete lined channels and natural stream restoration should be a high priority especially in small unnamed tributaries north of the Fox River.
- ✦ Protect existing wetlands in the watershed.
- ✦ Conduct follow-up assessments in areas where comprehensive stream bank stabilization projects have been installed or are proposed. (Oakridge Drive and Buchanan Road)
- ✦ The Unnamed Tributary to the Fox River (128000) could be considered for listing on the 303(d) list of impaired waterways for Total Phosphorous with a degraded biological community.
- ✦ Continue monitoring of total phosphorus, orthophosphate and total suspended solids should continue at CTH Z on Garners Creek to track progress over time of lagging effects of BMP installation on water quality.



**Garners Creek at Brookhaven Drive. Photo by Andy Hudak, Wisconsin DNR, East District Biologist**

**Garners Creek Upstream Oakridge Drive Realignment, 2016. Photo by Andy Hudak, Wisconsin DNR, East District Biologist**



## Wisconsin Water Quality Monitoring and Planning

This Water Quality Management Plan was created under the state’s Water Quality Management Planning and Water Resources Monitoring Programs. The plan reflects Water Quality Bureau and Water Resources Monitoring Strategy 2015-2020 goals and priorities and fulfills Areawide Water Quality Management Planning milestones under the Clean Water Act, Section 208. Condition information and resource management recommendations support and guide program priorities for the plan area.

This plan is hereby approved by the Wisconsin DNR Water Quality Program and is a formal update to the Green Bay 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.

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### Basin/Watershed Partners

- Fox Wolf Watershed Alliance
- Garners Creek Stormwater Utility District
- Fox Valley Technical College
- Outagamie County
- Calumet County

### Report Acknowledgements

- Andrew Hudak, Primary Author and Investigator, Eastern District, Wisconsin DNR
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EGAD #3200-2020-TBD

## 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.



Unnamed Tributary to the Fox River Downstream of Pershing Road (concrete). Photo by Andy Hudak, Wisconsin DNR. East District Biologist



## Water Quality Plan Goals

The overall goal of this assessment plan is to evaluate contemporary conditions within the Garners Creek Watershed following significant installation of best management practices. Within the last 10 years, just over \$2 million dollars of Urban Non-point source grants have been awarded to install best management practices that would reduce flooding potential, improve streambank conditions, and enhance water quality in the watershed.

*This watershed is one of several included in the USEPA approved Lower Fox River Total Maximum Daily Load (TMDL) Report that outlines nutrient and sediment reduction goals to restore the larger watershed. Between the years of 2015-2017, WDNR monitored all sub-watersheds of the Lower Fox River Basin to document contemporary conditions prior to restoration implementation activities. In 2020, Garners Creek is the subject of a Nine Key Element Plan under development, which will provide one mechanism to reach overall watershed restoration goals.*

## Resources

### About the Watershed

Garners Creek sub-watershed is an extensively urban watershed that lies within the Lower Fox River Basin and is within the heart of the Fox Valley Community. The communities of Appleton, Kimberly, Buchannan, Harrison, and Combined Locks all contribute significant drainage to the approximate 31.25 square miles of this watershed. The federal hydrologic unit code for this area is HUC: 040302040205 and is one of several watersheds nested in the Lower Fox River Basin.

The Fox River bisects the watershed and roughly 2/3 of the watershed is located south of the River while the remainder of the watershed lies north of the River. Garners Creek is the only major stream within the watershed however multiple small tributary streams to the Fox River are present. Hydrologic modification, stormwater impacts, and streambank erosion and failure are common throughout the watershed. The subwatershed spans both portions of the Fox River - Appleton (LF04) and the Plum and Kankapot Creeks (LF03) watershed.

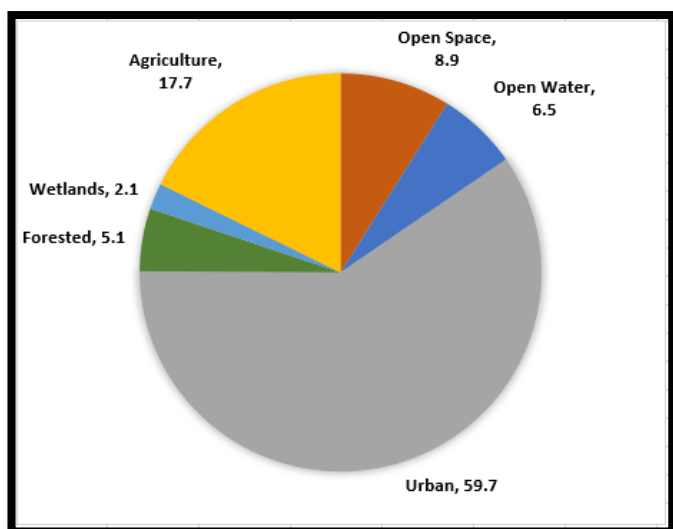
### Location, Size

The Garners Creek sub-watershed is 39.45 mi<sup>2</sup>. Land use in the watershed is primarily Urban consisting of low and high density residential with limited commercial. Only 13 percent of the sub-watershed would be considered undeveloped with wetlands, forested areas, and open water (Figure 2).

### Land Use, Population

Garners Creek watershed is largely urban, with nearly 60%, followed by agriculture, 17%. Figures 2 and 3 illustrate the high density of urban development surrounded by crop rotation agriculture in the watershed. Urban and rural land uses both contribute to water quality issues, with the Lower Fox River Total Maximum Daily Load (TMDL) in an implementation phase to restore healthy levels of nutrients and sediment in the overall region.

Figure 2: Land use in Garner’s Creek Watershed

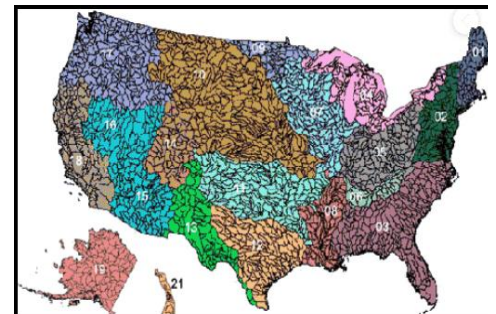


### Hydrologic Unit Codes (HUCs)

HUC is an acronym for Hydrologic Unit Codes. HUCs identify [drainage basins in the United States](#) in a nested arrangement from largest (Regions) to smallest (Cataloging Units). A drainage basin is an area or region of land that catches precipitation that falls within that area and funnels it to a particular creek, stream, river until the water drains into an ocean. A drainage divide is the division between adjacent drainage basins.

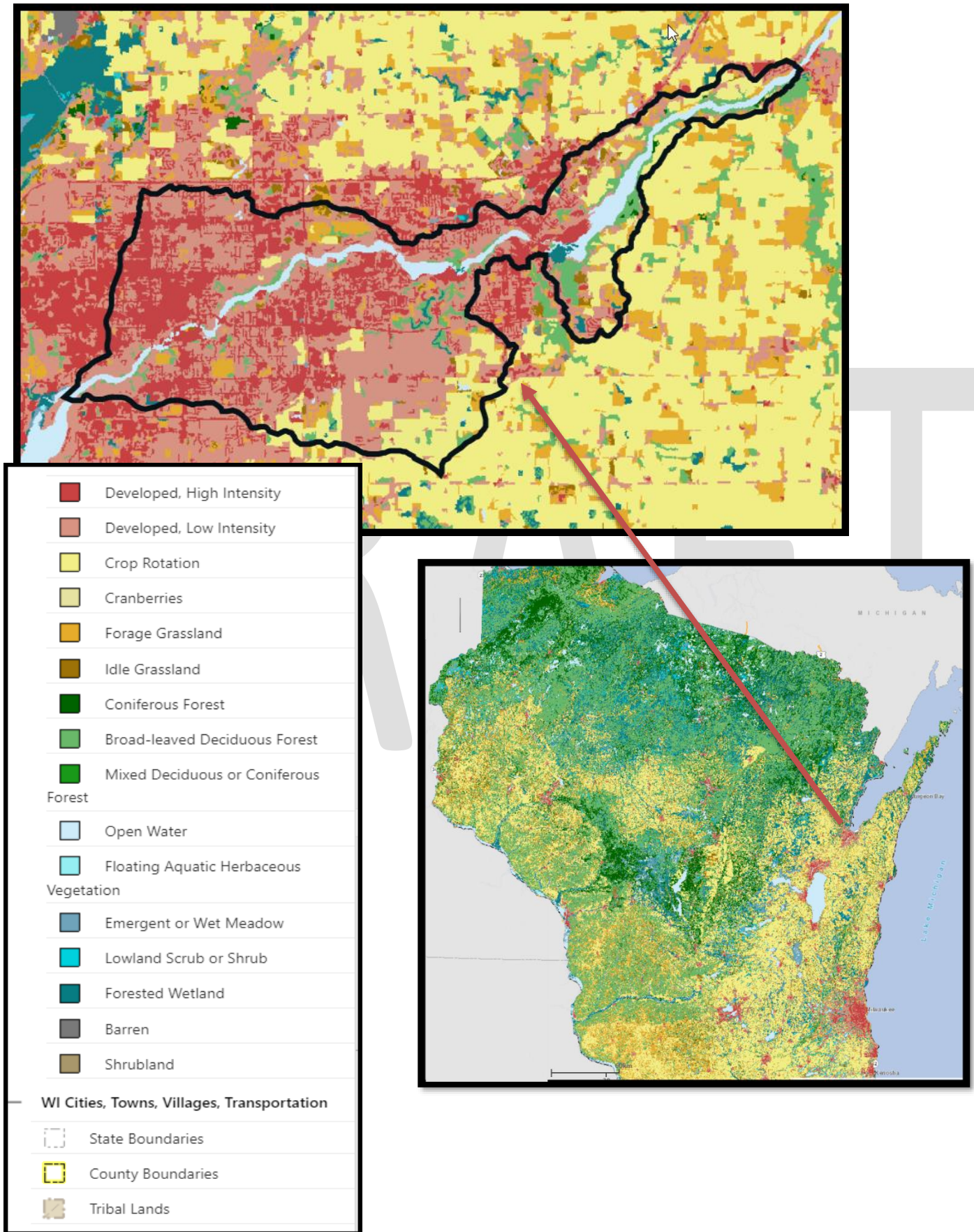
Just as a creek or stream drains into a larger river, a drainage basin is nearly always part of a larger drainage basin. [Drainage basins](#) come in all shapes and sizes, with some only covering an area of a few acres while others are thousands of square miles across. Drainage basins cross artificial boundaries such as county, state, and international borders. The term [watershed](#) is often used in place of drainage basin.

The United States Geological Survey hierarchical system of “watersheds” which are called hydrologic units. Each unit assigned a unique Hydrologic Unit Code (HUC). As of 2020 there are six levels in the hierarchy, represented by hydrologic unit codes from 2 to 12 digits long, called regions, subregions, basins, subbasins, watersheds, and subwatersheds.



Courtesy of Idaho Department of Natural Resources.

Figure 3. Land use in the Garners Creek Watershed (Wisland2)



### Ecological Landscapes

This watershed crosses the boundary of the Central Lake Michigan Coastal Landscape and the Southeast Glacial Plains landscape. The Lake Michigan Coastal Landscape is mostly glacial in origin, with till plains and moraines, reworked and overlain in the western part by Glacial Lake Oshkosh. Beach ridges, terraces, and dunes formed near the shorelines of this glacial lake when sandy sediments were present. At other locations boulder fields were formed when silts and clays were removed by wave action. The Niagara Escarpment is a prominent bedrock feature that runs along the east sides of lower Green Bay and the Fox River Valley. [\[Learn more \[PDF\]\]](#). The Southeast Glacial Plains landscape also consists of glacial till plains and moraines deposited during the Wisconsin Ice Age. [\[Learn more \[PDF\]\]](#)

### Hydrology

The Garners Creek watershed has no natural lakes and very few wetlands. Hydrology has been significantly altered with impervious surface and stormwater contributions significantly altering hydrology of all streams in the watershed. It is not uncommon to encounter stream reaches that have been straightened, converted to roadside ditches, or concrete lined to facilitate the drainage of stormwater. Garners Creek, the most significant stream in the watershed, has seen the greatest impacts from hydrologic modifications and stormwater inputs in the watershed. In 1998, the Village of combined Locks, Town of Buchanan, and Town of Harrison created the multi-jurisdictional Garners Creek Stormwater Utility for the purpose of financing, planning, constructing, operating, and maintaining regional stormwater facilities located within the Garners Creek drainage in the watershed. Goals identified were flood mitigation, peak flow rate reductions, and stormwater restoration and later adjusted to address water quality.

### Impaired Waters

Every two years, Section 303(d) of the Clean Water Act requires states to publish a list of all waters that do not meet water quality standards. The list, also known as the Impaired Waters List, is updated to reflect waters that are newly added or removed based on current information. Impaired waters in this watershed are impaired for historical discharges, mine tailings, and runoff issues. Impaired waters in the Garners Creek sub-watershed include Garners Creek (Table 1).

Figure 4. Garner’s Creek Watershed and Wisconsin’s Ecological Landscapes

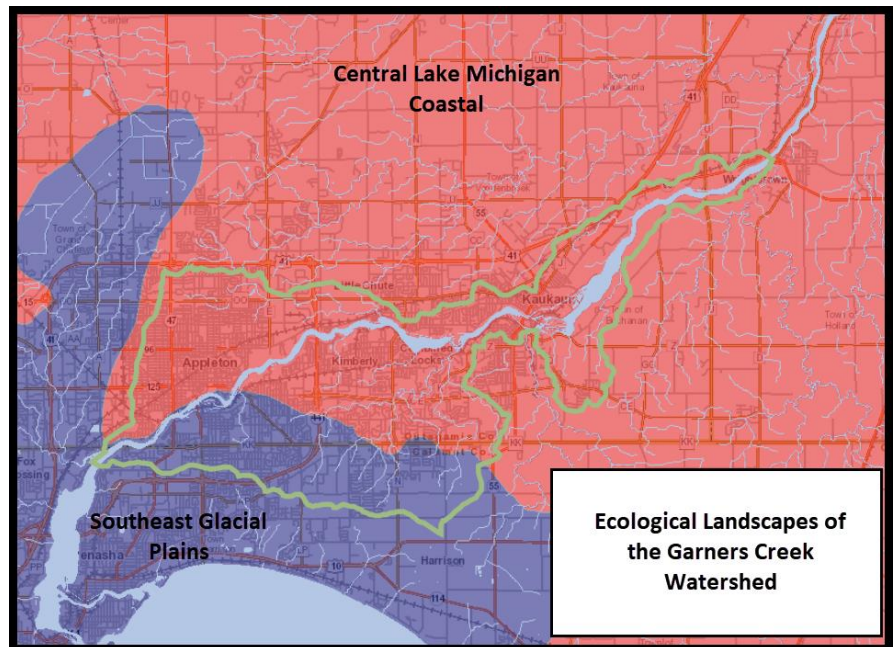


Table 1: Impaired waters in the Garners Creek Watershed.

Local Name	WBIC	Start Mile	End Mile (acres)	Pollutant	Impairment	Sources	303d Status
Garners Creek	127700	0	5	Total Phosphorus	Degraded Biological Community, Degraded Habitat	Highway/Road/Bridge Runoff (Non-construction Related)	TMDL Approved
				Chloride	Chronic Aquatic Toxicity		303d Listed
				Sediment/Total Suspended Solids	Degraded Habitat		TMDL Approved
Unnamed Water	5022162	0	4.71	Total Phosphorus	Degraded Biological Community	Non-Point Source (Rural or Urban)	303d Listed

### Aquatic Invasives

Curly-leaf Pondweed, Eurasian Water Milfoil, Phragmites, Purple Loosestrife, Poison Water Hemlock, and Japanese Knotweed were all identified and vouchered within the watershed. Round Gobies were not observed during surveys however a new population was observed upstream in Little Lake Buttes des Morts in 2015.

## Monitoring Project

### Purpose

Garners Creek is listed on the State's 303(d) list of impaired waterways. Garners Creek Storm Water Utility (GCSWUD) District was formed in 1998 to reduce flooding potential, improve stream bank erosion, and to enhance water quality along Garners Creek and its tributary streams. GCSWUD is formed on an agreement between the Village of Combined Locks, Town of Buchanan, and the Town of Harrison for planning and directing the development, financing, construction, operation, maintenance, regulation, and administration of a joint storm water utility system. In the last 10 years just over \$2 million of Urban grants were awarded in this HUC-12. This project will seek to evaluate contemporary conditions in Garners Creek and small tributaries in the watershed following the formation of the district and resources that have been allocated to improve conditions in the watershed.

### Site Selection and Study Design

The evaluation was to focus on watershed scale alterations and changes in water quality criteria, the biological community, and habitat. Monitoring was conducted on 7 streams across 19 sites (Table 2). Sites were selected for two primary purposes; 1) to provide an overall evaluation of contemporary conditions of streams in the watershed and 2) to target BMP installations to evaluate potential improvements of instream conditions. Sample stations were established to limit outside influences and set-up using DNR field procedures manuals of 35 times the mean stream width (Modified from Simonson, et al. 1994). Stations were no less than the minimum of 100 meters and no more than the maximum of 400 meters.

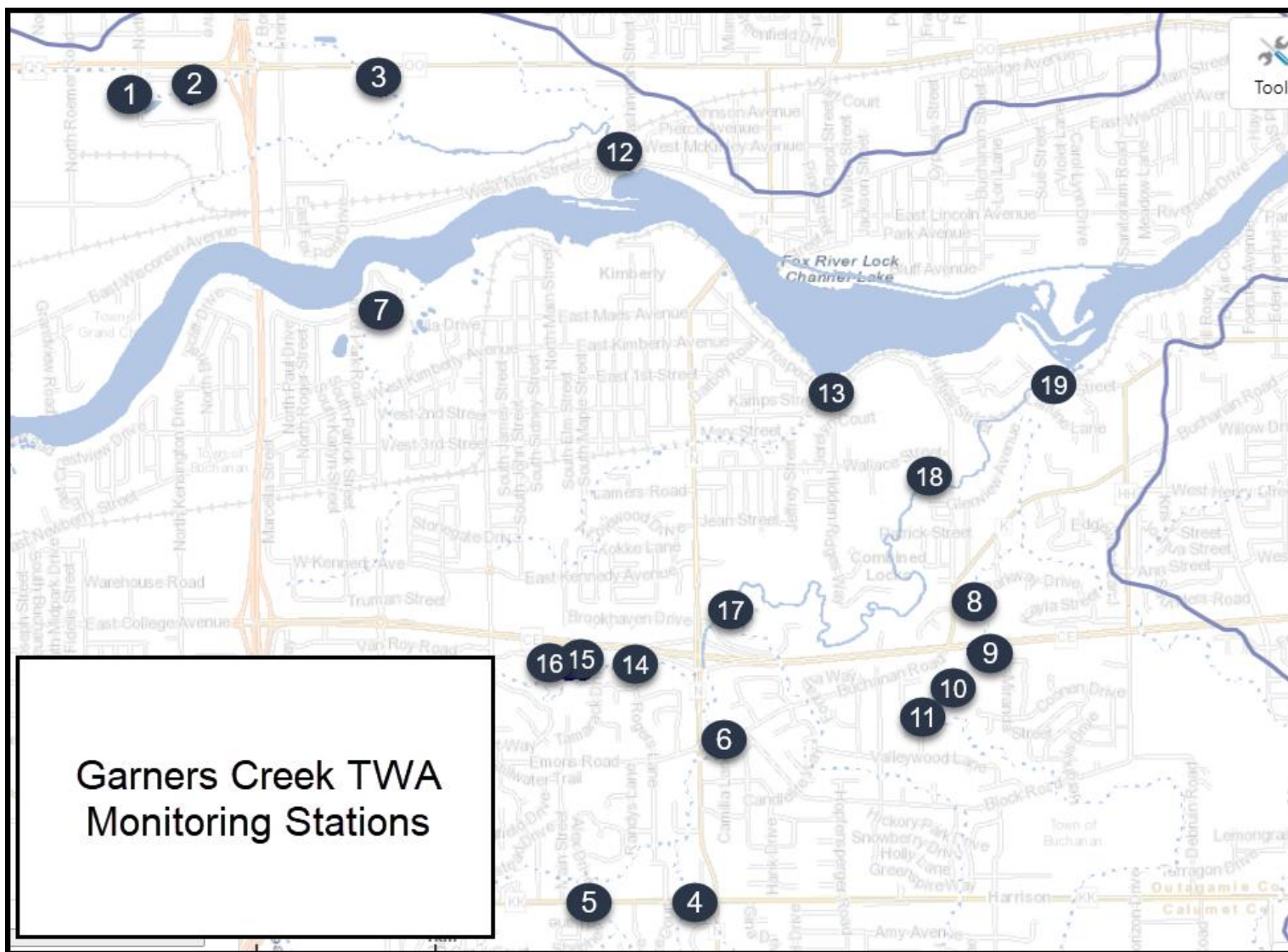
**Table 2: Monitoring Stations in the Garners Creek TWA.**

Map No.	Station ID	Station Name	WBIC	Name
1	10044954	UNT to Fox River - US Pershing Road	128000	Unnamed
2	10044955	UNT to Fox River - DS Pershing Road	128000	Unnamed
3	10044956	UNT to Fox River - CTH OO	128000	Unnamed
4	10047155	UNT to Garners Creek - CTH KK/CTH N	5022198	Unnamed
5	10047154	UNT to Garners Creek - CTH KK/Noe Road	5022136	Unnamed
6	10047107	UNT to Garners Creek - Buchanan Road	5022198	Unnamed
7	10047151	UNT To Fox River - Sunset Park SW Pond	5021600	Unnamed
8	10047156	UNT to Garners Creek - CTH CE (9A)	5022162	Unnamed
9	10047159	UNT to Garners Creek - CTH CE (9D)	5022162	Unnamed
10	10047157	UNT to Garners Creek - CTH CE (9B)	5022162	Unnamed
11	10047158	UNT to Garners Creek - CTH CE (9C)	5022162	Unnamed
12	10044824	UNT to Fox River - Main Street	128000	Unnamed
13	10047152	UNT to Fox River - Prospect Road	5021676	Unnamed
14	10047160	Garners Creek - CTH N (5C)	127700	Garners Creek
15	10047161	Garners Creek- CTH N (5B)	127700	Garners Creek
16	10047162	Garners Creek- CTH N (5A)	127700	Garners Creek
17	10016542	Garners Creek - Brookhaven Road	127700	Garners Creek
18	10047153	Garners Creek - Park Street	127700	Garners Creek
19	10043028	Garners Creek - CTH Z	127700	Garners Creek



Unnamed Tributary to Garners Creek

Figure 5. Garners Creek Watershed Monitoring Sites



Map No.	Station ID	Station Name
1	10044954	UNT to Fox River - US Pershing Road
2	10044955	UNT to Fox River - DS Pershing Road
3	10044956	UNT to Fox River - CTH OO
4	10047155	UNT to Garners Creek - CTH KK/CTH N
5	10047154	UNT to Garners Creek - CTH KK/Noe Road
6	10047107	UNT to Garners Creek - Buchanan Road
7	10047151	UNT To Fox River - Sunset Park SW Pond
8	10047156	UNT to Garners Creek - CTH CE (9A)
9	10047159	UNT to Garners Creek - CTH CE (9D)
10	10047157	UNT to Garners Creek - CTH CE (9B)
11	10047158	UNT to Garners Creek - CTH CE (9C)
12	10044824	UNT to Fox River - Main Street
13	10047152	UNT to Fox River - Prospect Road
14	10047160	Garners Creek - CTH N (5C)
15	10047161	Garners Creek- CTH N (5B)
16	10047162	Garners Creek- CTH N (5A)
17	10016542	Garners Creek - Brookhaven Road
18	10047153	Garners Creek - Park Street
19	10043028	Garners Creek - CTH Z

## Methods, Equipment and Quality Assurance

Collection of total phosphorus (TP), Orthophosphate (ORP) and Total Suspended Solids (TSS), continuous water temperatures, quantitative habitat, fish, and aquatic macroinvertebrates used standard DNR data collection methods and samples were sent to certified laboratories in the state for specific analysis. No specific in-field duplicates, replicates or blanks were collected for the study; however quality assurance sampling procedures were used in the collection and preservation of samples for all parameters.

### Water Chemistry (TP, ORP, TSS)

Water Chemistry samples were collected through citizen volunteers under a grant awarded to the Fox Valley Technical College to support and implement a citizen volunteer network in the Lower Fox River watershed. Standard DNR grab sampling methods were used to collect a total of 18 samples (Table 4). All samples were shipped to Wisconsin State Laboratory of Hygiene (WISLOH) for analysis. The WISLOH entered all sample analysis data into the Surface Water Integrated Monitoring System (SWIMS) database.

### Continuous Temperature

Onset continuous temperature loggers were placed in 3 sites in 2016 and collected water temperature readings at 1-hour intervals to ascertain daily maximum average temperatures throughout the summer, approximately May through October.

### Fish Assemblage

The fisheries assemblage was determined by a quantitative survey involving electroshocking a section of stream with a minimum station length of 35 times the mean stream width (Lyons, 1992). All fish were collected, identified, and counted. All gamefish were measured for length. All other DNR sampling protocols were used to assess the fish community for purposes of calculating the index of biotic integrity. DNR staff entered the fish data into the DNR Fisheries Database.

### Habitat Surveys

Habitat was evaluated throughout each fish survey station. Quantitative habitat survey station lengths were 35 times the mean stream width of the survey station. Following the determination of station length, the station was divided into 12 transects. At each transect, substrate, sedimentation, erosion, water depth, and riparian land use data were collected. DNR staff entered the quantitative habitat data into the DNR Fisheries and Habitat Management Database (FHMD).

### Macroinvertebrates

All sites were sampled using the DNR Guidelines for Collecting Macroinvertebrate Samples from Wadable Streams (2000). A D-shaped kicknet with 600-micron mesh was used at all sites by standing upstream from the net and placing it firmly on the stream bed while digging into the substrate with the heel or toe to free the macroinvertebrates from the substrate. Riffles were targeted at each of the sites, but if none were present then overhanging vegetation, woody debris, or other vegetation would be sampled. For a representative sample of the aquatic macroinvertebrate community, a minimum of 100 aquatic macroinvertebrates collected in each sample was targeted. The aquatic macroinvertebrates were preserved in a 70-80% ethanol solution inside quart "Mason" jars. If necessary, multiple "Mason" jars were used per sample depending upon how much sediment and organic material was collected with the aquatic macroinvertebrates. Within the next 24 hours, the samples were re-preserved with another 70-80% ethanol solution. Samples were taken to the University of Wisconsin-Stevens Point Aquatic Entomology Laboratory (UWSP AEL) for lowest possible taxonomic identification. Staff at the UWSP AEL entered the data into the SWIMS database upon final taxonomic identification.

## Project Results

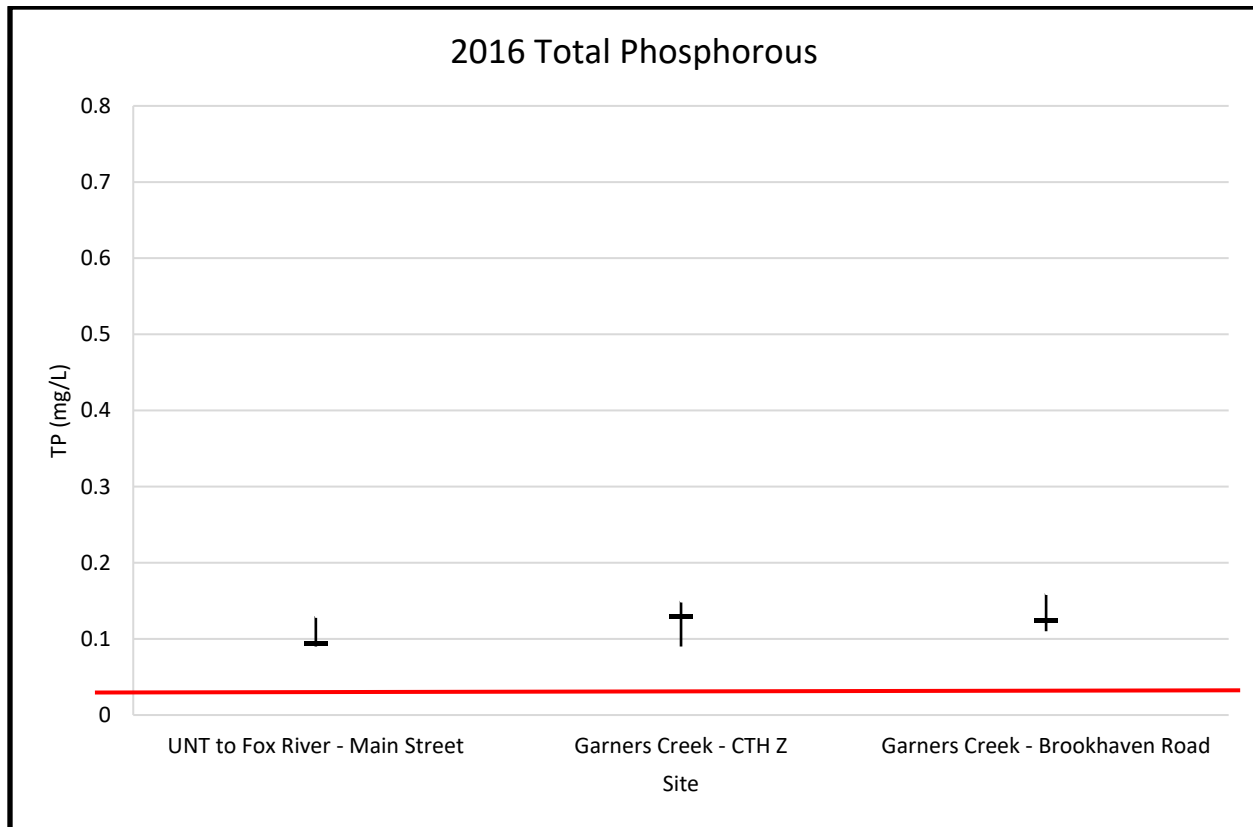
### Total Phosphorus

All inorganic chemistry samples were sent to the WISLOH in Madison for analysis. All sample sites for this project had an average TP concentration (mg/L) exceeding the NR 102 water quality criteria (WQC) for creeks and rivers of 0.075 mg/L (Table 3). Wisconsin Consolidated Assessment and Listing Methodology (WisCALM 2018) requires a parametric statistical approach to assess creek TP data against the applicable water quality criterion found in NR 102. This approach involves the calculation of a 90% confidence limit around the median of a TP sample dataset. If the lower 90% confidence limit (LCL) exceeds the criterion for TP, then that creek segment (assessment unit) is considered to exceed the criterion. The LCLs were calculated for each creek's TP samples (Table 3). Both locations on Garners Creek and the UNT to the Fox River had calculated LCLs that exceeded the water quality criterion for TP (Figure 6 and Figure 7).

**Table 3: Total Phosphorus Concentrations and Average in 15 Streams in the Garners Creek Watershed 2016**

SWIMS Station ID	Station Name	May	June	July	Aug	Sept	Oct	Mean	Median	Lower 90% Median	Upper 90% Median
10044824	UNT to Fox River - Main Street	0.138	0.083	0.077	0.157	0.094	0.332	0.11	0.094	0.09	0.13
10043028	Garners Creek - CTH Z	0.769	-	0.130	0.183	0.132	0.088	0.122	0.13	0.09	0.15
10016542	Garners Creek - Brookhaven Road	0.139	0.148	0.099	0.103	0.108	0.212	0.135	0.124	0.11	0.16

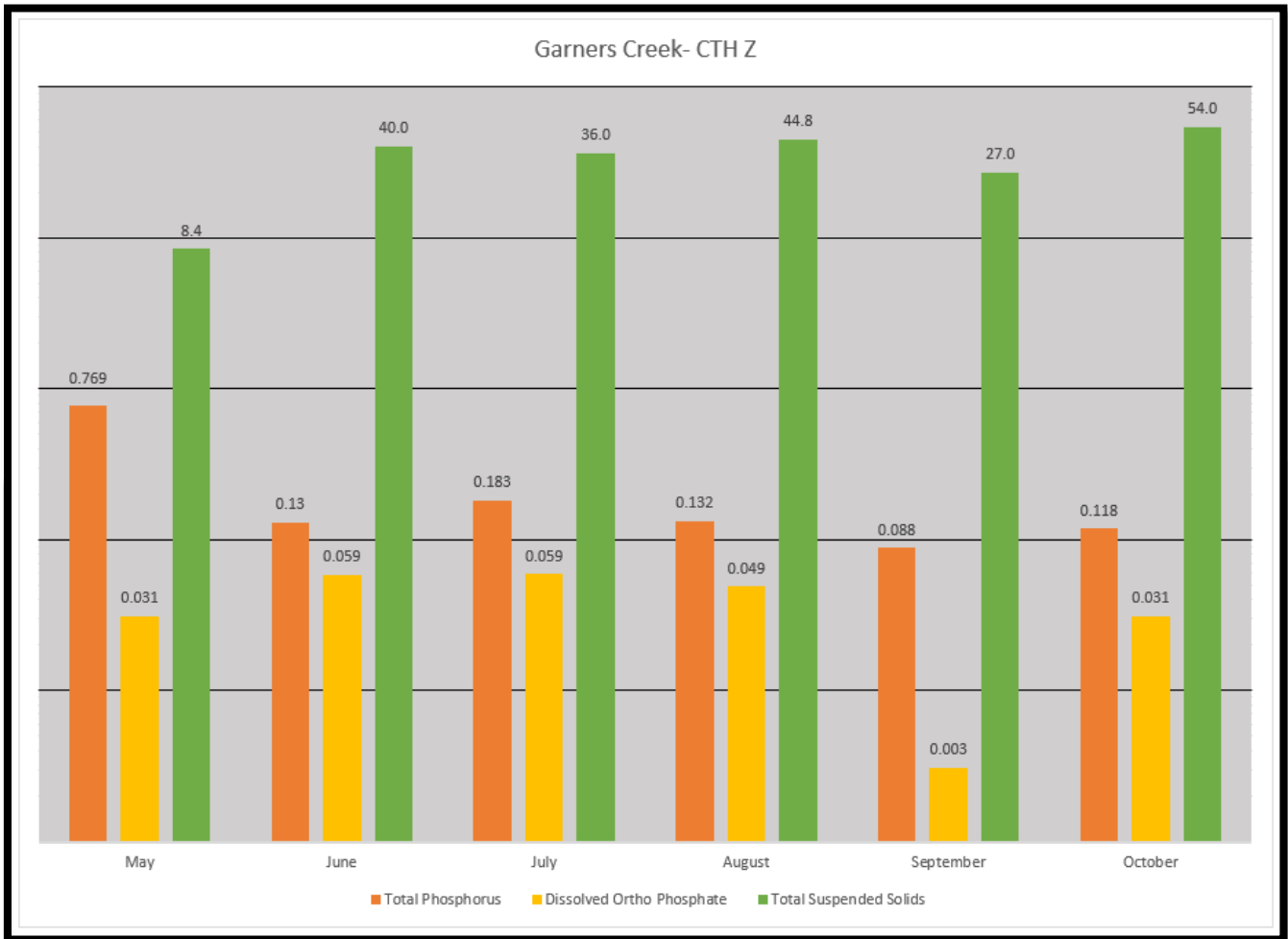
**Figure 6: Lower 90% confidence limit of Total Phosphorus concentrations in 2016 in the Garners Creek Watershed**



**Table 4: Water Chemistry Results at Garners Creek CTH Z-2016**

Garners Creek- CTH Z	Average	Median	L90%CI	U90%CI
TP	0.152	0.131	0.104	0.138
TSS	0.045	24.7	-	-
ORP	26.7	26.7	-	-

Figure 7: Three-year TP results combined (2015-2017)



### Continuous Water Temperature

Continuous water temperature loggers were placed at 3 sites in the Garners Creek Watershed in 2016 (Table 5 and Appendix C). Continuous water temperatures were recorded on 1-hour intervals to assess water temperatures compared to their modeled natural community thermal regime.

Table 5. Continuous Water Temperature monitoring sites in the Garners Creek watershed 2016.

WBIC	Waterbody Name	Station ID	Station Name
128000	Unnamed	10044824	UNT to Fox River - Main Street
127700	Garners Creek	10043028	Garners Creek - CTH Z
127700	Garners Creek	10016542	Garners Creek - Brookhaven Drive

### Fish Assessments

Fish surveys were completed on 19 stream sites between May and September in 2016. Some fish species are tolerant of environmental degradation, some species are moderately tolerant, and some others are intolerant. Based upon the representative fish collected during the survey and their associated tolerance to environmental degradation, a Fish Index of Biotic Integrity (FIBI) was calculated to indicate the water quality of the streams in the Garners Creek Watershed. The FIBI scores range from 0 to 100. Of the 19 fish surveys completed, 14 had a condition of poor and 5 had a condition of Fair (Table 6, Figure 8 and 9).



Table 6: Fish Index of Biodiversity (FIBI) scores and ratings, Garner’s Creek Watershed 2016.

WBIC	Waterbody Name	Map ID	Station	Station Name	Score	Rating	Verif. Natural Community
128000	UNT to Fox River	1	10044954	UNT to Fox River - US Pershing Road	0	Poor	CWHW
128000	UNT to Fox River	2	10044955	UNT to Fox River - DS Pershing Road	0	Poor	CWHW
128000	UNT to Fox River	3	10044956	UNT to Fox River - CTH OO	10	Poor	CWHW
5022198	UNT to Garners Creek	4	10047155	UNT to Garners Creek - CTH KK/CTH N	20	Poor	CWHW
5022136	UNT to Garners Creek	5	10047154	UNT to Garners Creel - CTH KK/Noe Road	20	Poor	CWHW
5022198	UNT to Garners Creek	6	10047107	UNT to Garners Creek - Buchanan Road	40	Fair	CWHW
5021600	UNT to Fox River	7	10047151	UNT To Fox River - Sunset Park SW Pond	20	Poor	CWHW
5022162	UNT to Garners Creek	8	10047156	UNT to Garners Creek - CTH CE (9A)	40	Fair	CWHW
5022162	UNT to Garners Creek	9	10047159	UNT to Garners Creek - CTH CE (9D)	20	Poor	CWHW
5022162	UNT to Garners Creek	10	10047157	UNT to Garners Creek - CTH CE (9B)	40	Fair	CWHW
5022162	UNT to Garners Creek	11	10047158	UNT to Garners Creek - CTH CE (9C)	20	Poor	CWHW
128000	UNT to Fox River	12	10044824	UNT to Fox River - Main Street	20	Poor	CWHW
5021676	UNT to Fox River	13	10047152	UNT to Fox River - Prospect Road	30	Poor	MAC
127700	Garners Creek	14	10047160	Garners Creek - CTH N (5C)	40	Fair	CWHW
127700	Garners Creek	15	10047161	Garners Creek- CTH N (5B)	60	Fair	CWHW
127700	Garners Creek	16	10047162	Garners Creek- CTH N (5A)	10	Poor	CWHW
127700	Garners Creek	17	10016542	Garners Creek - Brookhaven Road	30	Poor	CWHW
127700	Garners Creek	18	10047153	Garners Creek - Park Street	30	Poor	CWHW
127700	Garners Creek	19	10043028	Garners Creek - CTH Z	20	Poor	CWMS

Figure 8: Map of Fish Index of Biodiversity (FIBI) ratings Garner’s Creek Watershed 2016.

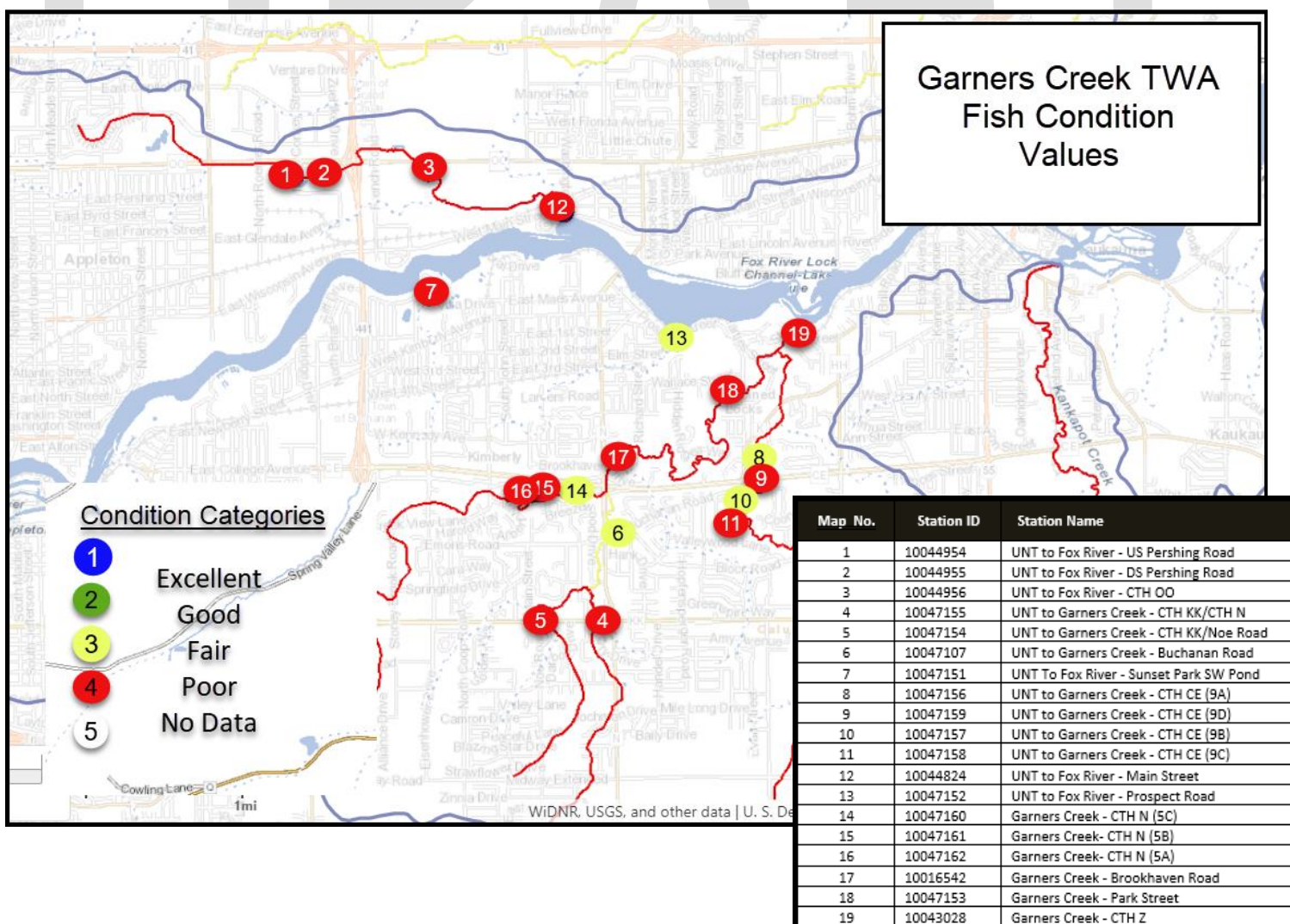
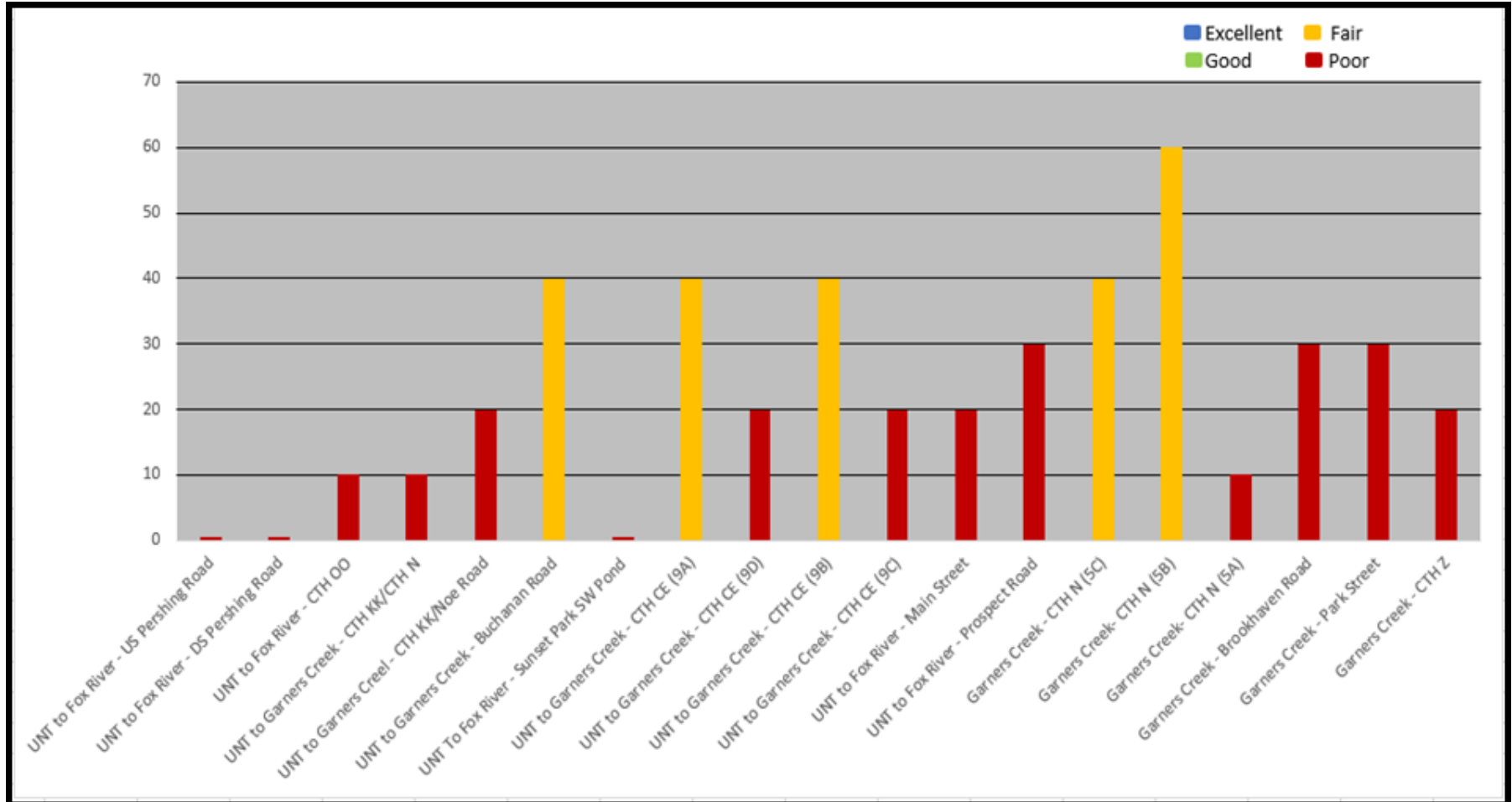


Figure 9 FIBI Scores for Streams in the Garners Creek Watershed



**Macroinvertebrates**

In the fall of 2016, macroinvertebrate samples were collected from 8 streams for calculating the macroinvertebrate Index of Biotic integrity (MIBI). Some aquatic macroinvertebrate species are tolerant of environmental degradation, some species are moderately tolerant, and some others are intolerant. Based upon the representative macroinvertebrate samples collected and their associated tolerance to environmental degradation, the MIBI was calculated to indicate the water quality condition of the stream (Table 7, Figures 10 and 11).. The MIBI scores ranged from 2.27 to 4.48 which demonstrated these sites are likely impacted from environmental degradation.

**Table 7: Macroinvertebrate Index of Biotic Integrity scores and rating in the Garner’s Creek Watershed in 2016.**

WBIC	Waterbody Name	Map ID	Station	Station Name	Score	Rating
5021600	Unnamed	7	10047151	UNT to Fox River - DS Sunset Park SW Pond	4.12	Fair
5022162	Unnamed	9	10047159	UNT to Garners Creek - CTH CE (9D)	2.27	Poor
128000	Unnamed	12	10044824	UNT to Fox River - Main Street	3.97	Fair
127700	Garners Creek	14	10047160	Garners Creek - US CTH N (5C)	4.48	Fair
127700	Garners Creek	15	10047161	Garners Creek - US CTH N (5B)	4.06	Fair
127700	Garners Creek	16	10047162	Garners Creek - US CTH N (5A)	3.57	Fair
127700	Garners Creek	17	10016542	Garners Creek - Brookhaven Road	3.69	Fair
127700	Garners Creek	19	10043028	Garners Creek - CTH Z	4.15	Fair



**Unnamed Tributary to the Fox River at County Highway OO**

Figure 10 mIBI Scores for Streams in the Garners Creek Watershed:

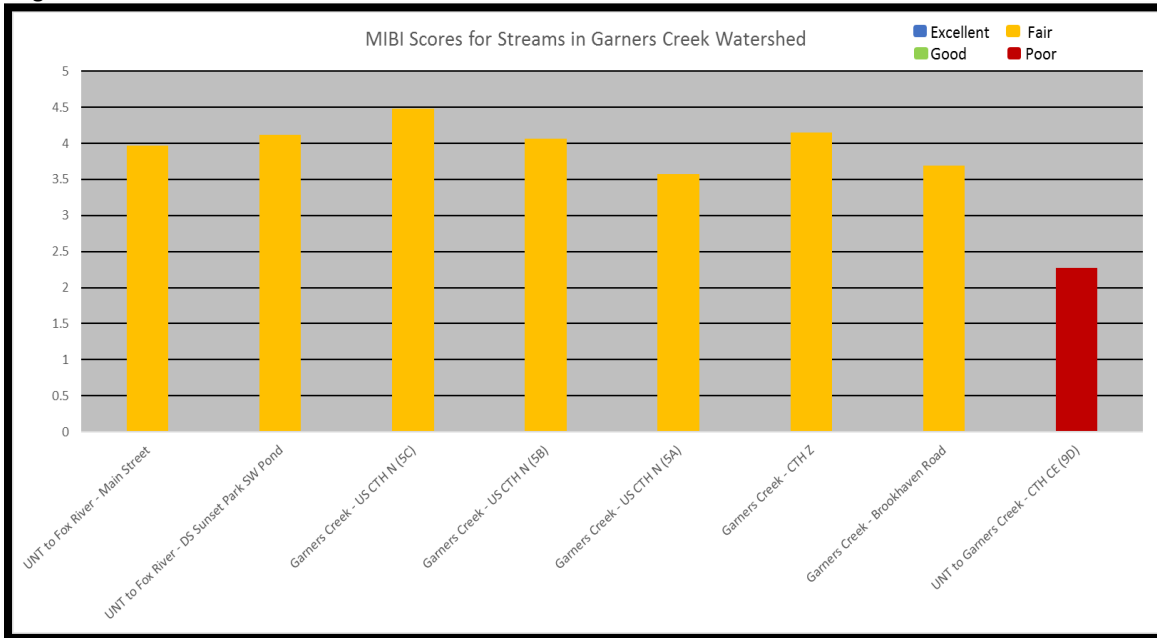
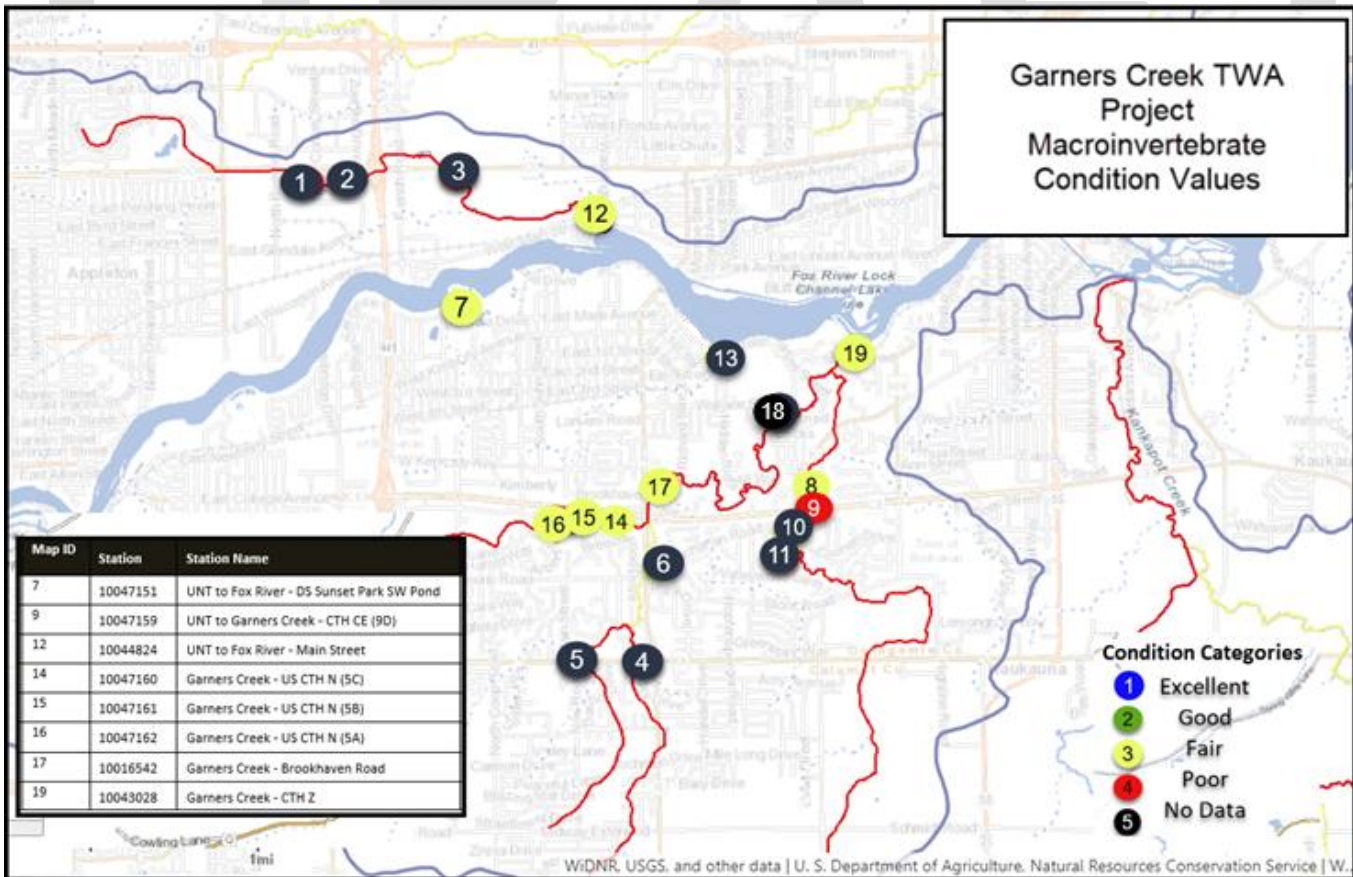


Figure 11 Map of mIBI Values for Streams in the Garners Creek Watershed:



### Habitat Assessments

Quantitative habitat assessments evaluate a representative stream reach (35 X Mean Stream Width) for the quantity and quality of habitat for fish and compare the habitat to reference streams in Wisconsin. Based upon the assessment data collected during the 2016 surveys, a habitat rating was calculated for the 19 small streams less than 10m wide (Table 8, Figures 12 and 13). The habitat rating scores were relatively similar for all streams and half scored in the Fair range and half scored in the Good range. The greatest factor influencing the score and rating of Fair to Good is the undisturbed buffer width, bank erosion, the width to depth ratio, and riffle to riffle ratio. Cover for fish is largely absent from the stream.



Garners Creek  
upstream of Oakridge  
Drive Realignment/  
CTH N.



Garners Creek at  
County Highway Z.

**Table 8: Habitat Index of Integrity scores and rating in the Garners Creek Watershed in 2016.**

Name	WBIC	Map ID	SWIMS ID	Station Name	AU	MSW (m)	Buffer Score	Erosion Score	Pool Score	W:D Score	Riff:Riff Score	Bend: Bend Score	Fine Sed. Score	Fish Cover Score	Score Small	Rating Small
Unnamed	128000	1	10044954	UNT to Fox River - US Pershing Road	5690561	3	15	15	0	10	0	10	0	0	50	Good
Unnamed	128000	2	10044955	UNT to Fox River - DS Pershing Road	5690561	3	0	15	0	0	0	0	15	0	30	Fair
Unnamed	128000	3	10044956	UNT to Fox River - CTH OO	5690561	3.5	15	5	0	10	10	0	0	5	45	Fair
Unnamed	5022198	4	10047155	UNT to Garners Creek - CTH KK/CTH N	6775499	3	5	10	3	10	0	-	5	10	43	Fair
Unnamed	5022136	5	10047154	UNT to Garners Creek - CTH KK/Noe Road	3993934	3	0	10	0	5	0	-	5	0	20	Poor
Unnamed	5022198	6	10047107	UNT to Garners Creek - Buchanan Road	6775596	3	5	5	7	10	5	-	10	10	52	Good
Unnamed	5021600	7	10047151	UNT To Fox River - Sunset Park SW Pond	6854394	3	10	5	3	10	5	-	0	5	38	Fair
Unnamed	5022162	8	10047156	UNT to Garners Creek - CTH CE (9A)	3993962	3	15	5	3	10	15	15	5	0	53	Good
Unnamed	5022162	9	10047159	UNT to Garners Creek - CTH CE (9D)	3993962	3	15	5	3	10	15	15	5	5	58	Good
Unnamed	5022162	10	10047157	UNT to Garners Creek - CTH CE (9B)	3993962	4	15	5	3	10	15	15	5	0	53	Good
Unnamed	5022162	11	10047158	UNT to Garners Creek - CTH CE (9C)	3993962	4	15	5	3	10	15	10	5	0	53	Good
Unnamed	128000	12	10044824	UNT to Fox River - Main Street	5690561	4	15	5	7	10	5	-	0	5	47	Fair
Unnamed	5021676	13	10047152	UNT to Fox River - Prospect Road	3996446	3	5	0	0	0	0	-	10	0	15	Poor
Garners Creek	127700	14	10047160	Garners Creek - CTH N (5C)	108445	3	15	15	10	10	15	5	5	5	75	Excellent
Garners Creek	127700	15	10047161	Garners Creek- CTH N (5B)	108445	3	15	15	0	10	10	15	5	0	60	Good
Garners Creek	127700	16	10047162	Garners Creek- CTH N (5A)	108445	3	10	5	3	10	15	5	5	5	53	Good
Garners Creek	127700	17	10016542	Garners Creek - Brookhaven Road	108445	5	10	5	3	5	15	0	5	0	43	Fair
Garners Creek	127700	18	10047153	Garners Creek - Park Street	108445	7	10	5	10	10	15	-	5	0	55	Good
Garners Creek	127700	19	10043028	Garners Creek - CTH Z	108445	7	10	10	7	10	15	15	5	10	67	Good

Figure 12: Habitat Index of Integrity scores and rating in the Garners Creek Watershed in 2016.

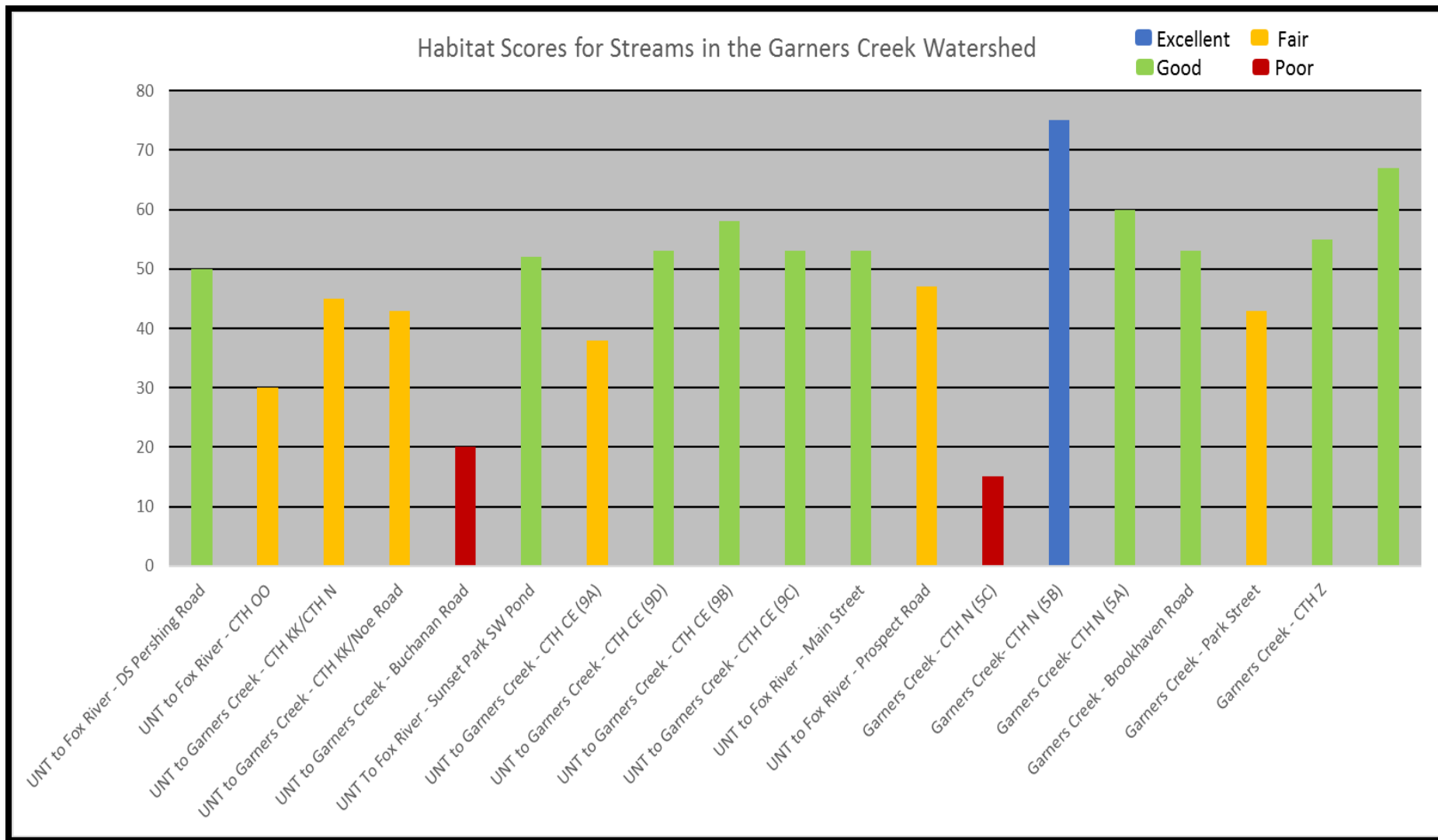
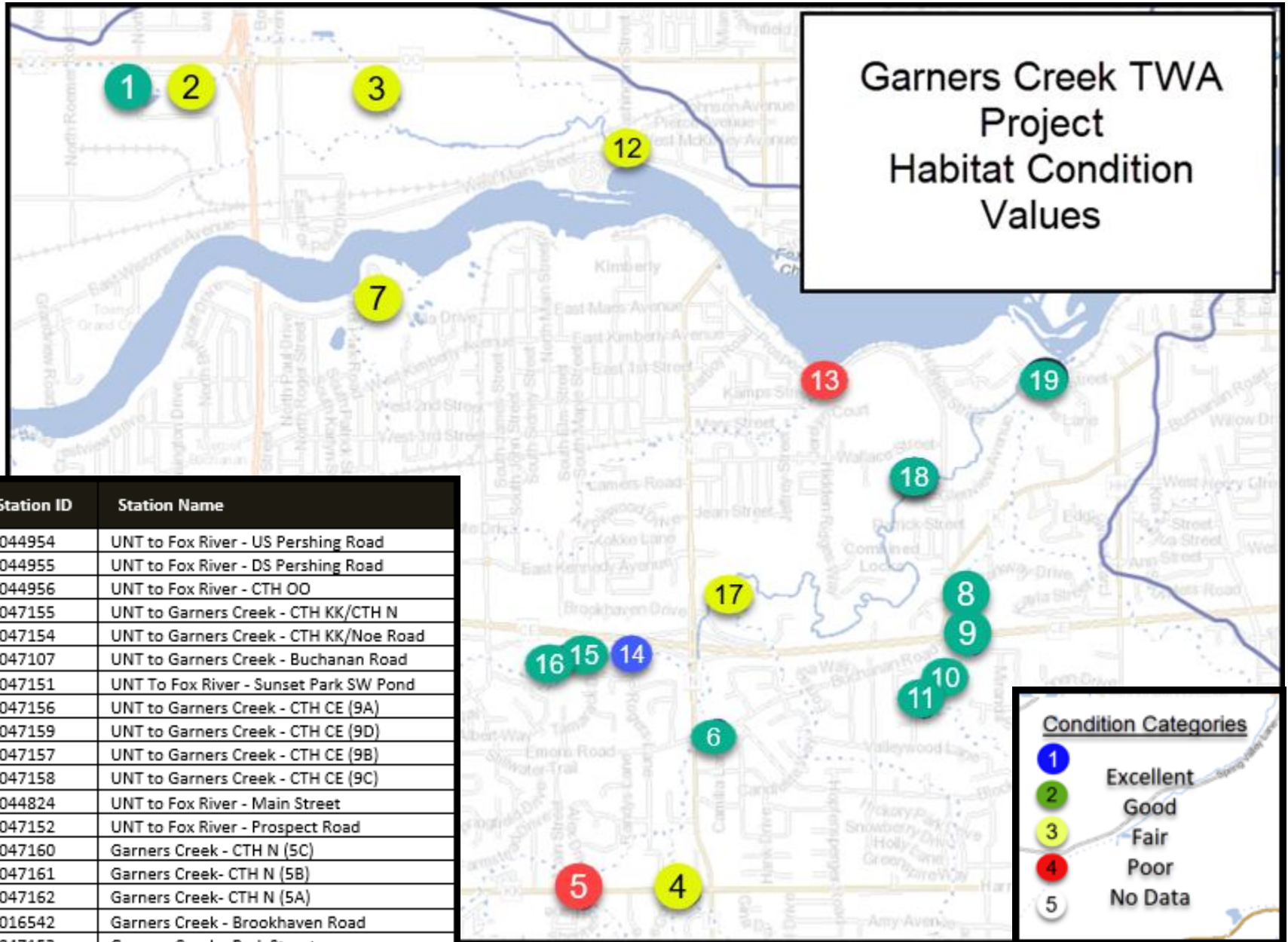


Figure 13: Map of Habitat Index of Integrity scores and rating in the Garners Creek Watershed in 2016.



Map No.	Station ID	Station Name
1	10044954	UNT to Fox River - US Pershing Road
2	10044955	UNT to Fox River - DS Pershing Road
3	10044956	UNT to Fox River - CTH OO
4	10047155	UNT to Garners Creek - CTH KK/CTH N
5	10047154	UNT to Garners Creek - CTH KK/Noe Road
6	10047107	UNT to Garners Creek - Buchanan Road
7	10047151	UNT To Fox River - Sunset Park SW Pond
8	10047156	UNT to Garners Creek - CTH CE (9A)
9	10047159	UNT to Garners Creek - CTH CE (9D)
10	10047157	UNT to Garners Creek - CTH CE (9B)
11	10047158	UNT to Garners Creek - CTH CE (9C)
12	10044824	UNT to Fox River - Main Street
13	10047152	UNT to Fox River - Prospect Road
14	10047160	Garners Creek - CTH N (5C)
15	10047161	Garners Creek- CTH N (5B)
16	10047162	Garners Creek- CTH N (5A)
17	10016542	Garners Creek - Brookhaven Road
18	10047153	Garners Creek - Park Street
19	10043028	Garners Creek - CTH Z



## Discussion

### Fish Community and Conditions

All streams monitored in this HUC 12 were modeled and verified to be cool-warm transitional headwaters except for Garners Creek at CTH Z which was consistent with a mainstem stream. (Lyons, 2008). The classification for these streams as small headwaters streams is consistent with observed conditions and fish communities captured in stream surveys. The proximity of the Fox River and its influence on the fish community in the Lower segments of Garners Creek is present to the approximate end of the station at CTH Z and allows for resident fish which are consistent with large rivers to be encountered such as Longnose Gar and Freshwater Drum. When the correct IBI's were applied, impact to the fish community from environmental degradation is highly evident. This is further supported by the overwhelmingly dominance of tolerant species vs absence of intolerant species captured during surveys. There was a smaller than expected diversity observed with only 18 species captured throughout the stream surveys and 12 of the 19 sites containing only 4-7 species. The most dominant species as far as percent of the total catch and number of surveys (n=12) was the Creek Chub (40%). Only the Green Sunfish was captured at more site (n=18) and was 20% of the overall catch percentage. The other dominant species included the White Sucker (17%) and Fathead Minnow (8%). All other species comprised 5% or less of the total catch.

### Habitat Condition

Overall habitat conditions were mostly in the fair to good category however these scores were likely bolstered by several metrics that were favorable in this watershed as observed by the biologist. The undisturbed buffer width was maintained at many locations as was the erosion score. Coincidentally the streams are highly entrenched in an urban landscape and set within valleys which limits the ability of development to encroach within the 10m buffers. There has also been extensive riprap installed throughout the watershed. It was noted this often occurred within the sample reach that seemingly artificially inflated the erosion score metric. In some locations, extensive streambank stabilization measures have been attempted to protect severely eroding banks only to deflect energy downstream leading to additional bank failures on unprotected banks. When looked at in a broader context, while a riprap protected bank may have corrected one bank erosion issue it often leads to the manifestation of increased downstream erosional issues.



The installation of rock riprap also led to an apparent increase of the score to the metrics for riffle to rifle and width to depth ratio in some cases. It was often observed that rip-rap installation may have failed or been incorrectly installed which altered stream morphology indirectly falsely improving the habitat score.



It was not uncommon that the riparian corridors were dominated by degraded woodlots consisting of a few legacy oak trees with an understory dominated by buckthorn, prickly ash, garlic mustard and reed canary grass. It is important to note that cover for fish was largely absent from all streams within the watershed. What little cover did exist was in the form of a few woody debris jams, overhanging vegetation, and submergent vegetation at CTH Z.

### Macroinvertebrate Condition

The macroinvertebrate data also showed a consistent trend with all mIBI scores in the low fair to poor range. The HBI indicates that organic loading may be minimal which is not unexpected with the urban landscape. The macroinvertebrate IBI has shown the combination of watershed land cover and local riparian and instream conditions strongly influence one another (Weigel, 2003). This relationship was reaffirmed through Biologists' observations and comparison of the F-IBI, M-IBI, and the habitat scores within the watershed. It is evident that significant impacts from altered hydrology and urban development are continuing to limit the aquatic life in these systems. The higher gradient, flashy nature of the stream compounds the effects of stormwater input from the urbanization within the watershed.

### Water Chemistry

Growing season total phosphorous concentrations were very consistent between the 2 streams and 3 sites monitored in 2016. The department's listing methodology for impaired waters (WDNR, 2013) recommends listing sites where the median phosphorus concentration exceeds 0.075 mg/l on wadeable streams and 0.1 mg/l on rivers. The impairment listing protocol uses a 90% confidence interval about the median for listing streams and rivers. Garners Creek continues to be impaired by TP concentrations and the UNT to the Fox River exceeds the criteria which would indicate this stream is also likely impaired by TP. Total Suspended Solids and Orthophosphate concentrations were also collected at CTH Z on Garners Creek. The Lower Fox River TMDL sets a target for TSS in the Lower Fox at 18 mg/l. The average concentration observed in Garners Creek for Total Suspended solids between 2015 and 2017 is 26.7 mg/l and the median is 24.7 mg/l. This would indicate that TSS is a concern in Garners Creek. When comparing the TP, TSS, and ORP results during that same time period, it is evident that the likely source for TP within Garners Creek is from the TSS load and likely from particulate P bound to soil.

### Oak Ridge Drive Project Assessment (SWIMS ID: 10047160, 10047161, 10047162)

A large comprehensive stream bank stabilization project had recently been permitted and constructed along the stream banks of Oak Ridge Drive on Garners Creek west of CTH N and south of CTH CE. **See Figure 5.** This segment of stream corridor was highly degraded with a dominance of bow elder, green ash, and buckthorn. Significant bank failure was occurring and had the potential for infrastructure damage to homes in the area.

Figure 14. Garners Creek 2015- Pre-streambank restoration.



### Garners Creek 2015- Pre-streambank restoration

The project included bank shaping, streambank realignment, integrated bank treatment, log cross vanes, native buffer establishment and fish cover. Unfortunately, no pre-construction surveys were completed. It is also important to note that an older small stream stabilization project was completed within a portion of the downstream sample location. Post construction surveys were targeted within the restored segments of stream including above and below the project site to ascertain spatial differences in restored vs non-restored reaches. Habitat above the project was rated as good however this reach had a poor fish IBI and a lower MIBI.

The restored reach appeared to have benefited habitat scores not only in the stream within the restored reach but also extended benefits downstream. A significant 50-point increase in the FIBI score occurred within the restored reach and 30 points at the DS reach further supporting the evidence that the restored reach may have extended benefits downstream. The restored reach was the highest scoring reach surveyed in the watershed in 2016. The MIBI scores also improved in the restored reach and improved further in the downstream reach. It is difficult to determine the exact extent that the comprehensive stream restoration improved conditions in Garners Creek however, it is evident that aquatic habitat and overall conditions improved within and downstream of the restored reach providing ecosystem benefits for aquatic life.

Figures 15. Garners Creek 2016- Post Restoration Images



Integrated bank stabilization treatment with a rock toe.



Cross log-vanes for habitat and sediment and stream feature improvements



Slope and bank stabilization using vegetation with no hard armoring or toe protection



Log Vanes for sediment sequestration and bank stabilization



Riparian corridor vegetation management- previously Buckthorn dominated

## Management Actions

### Management Priorities and Goals

It is evident that significant impacts from altered hydrology and urban development are continuing to limit the aquatic life in these systems. Strategies should continue to focus on stormwater management and the rate of delivery to the stream. Comprehensive bank stabilization projects should utilize strategies to establish natural stream morphology, contain a significant fish cover component, establish a sustainable rate of sediment transport, and re-develop floodplain connectivity. Single bank stabilization projects will continue to have cumulative impacts on instream habitat contributing to phosphorous and sediment impairments in the watershed

### Recommendations

- ✦ Municipalities and other partners should seek opportunities to install BMP's for sediment and nutrient reduction from urban sources such as roadways and residential development.
- ✦ Promote landowner infiltration practices. Continue to educate homeowners on the use of rain barrels and rain gardens for water quality and quantity benefits.
- ✦ The Department should continue to work with the Local Municipalities and other interested partners to evaluate the potential for comprehensive bank stabilization projects on Garners Creek and avoid small individual parcel bank stabilization projects.
- ✦ Comprehensive bank stabilization projects should utilize strategies to establish natural stream morphology, contain a significant fish cover component, establish a sustainable rate of sediment transport, and re-develop a floodplain connection.
- ✦ As opportunity arises, removal of concrete lined channels and natural stream restoration should be a high priority especially in small unnamed tributaries north of the Fox River.
- ✦ Protect existing wetlands in the watershed.
- ✦ Conduct follow-up assessments in areas where comprehensive stream bank stabilization projects have been installed or are proposed. (Oakridge Drive and Buchanan Road)
- ✦ The Unnamed Tributary to the Fox River (128000) could be considered for listing on the 303(d) list of impaired waterways for Total Phosphorous with a degraded biological community.
- ✦ Continue monitoring of total phosphorus, orthophosphate and total suspended solids should continue at CTH Z on Garners Creek to track progress over time of lagging effects of BMP installation on water quality.

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## Appendix B: Stream Narratives

### Garners Creek, [Read more in Explore Your Waters](#)

Garners Creek is a 5-mile long tributary stream to the Fox River. Land use in the watershed is predominantly urban with some limited areas of agricultural lands isolated near the headwaters. The urbanization along the banks of Garners Creek has significantly altered the hydrology and these impacts are severely limiting the aquatic life in this stream. The fish community is dominated by species tolerant to environmental degradation and the FBI rated from poor to fair. The habitat scores rated fair to good. The stream is highly entrenched in areas and severe bank erosion exists due to the flashy flow regime of this stream. Habitat scores are bolstered in areas where bank stabilization measures have been installed however these small piece by piece projects have incurred cumulative impacts to downstream reaches where stabilization measures are absent. Total Phosphorous concentrations exceed the State's water quality criteria for phosphorous and high suspended solids load continue to impair this stream.

### UNT to Fox River (128000), [Read more in Explore Your Waters](#)

The Unnamed Tributary to the Fox River is a 4.26-mile-long small tributary stream to the Fox River. This stream is highly impacted by urban development, hydrologic modification, and alterations to the flow regime due to impervious surfaces in the headwaters. As it approaches the Fox River it flows through agricultural lands. Coincidentally, adequate buffers exist in the lower segments since the narrow, steep valley slopes do not allow for farm equipment access. The fish community is dominated by species tolerant to environmental degradation and the FBI rated poor at all sites. The habitat scores rated fair to good however portions of the stream in the urbanized headwaters are concrete lined channels. Impervious surfaces and the flashy nature of the stream continue to cause severe bank erosion in the mid to lower reaches of the stream. Total Phosphorous concentrations exceed the State's water quality criteria for phosphorous and high suspended solids load continue to degrade stream conditions. This stream could be considered listing on the State's 303(d) list of impaired waterways.

### UNT to Garners Creek (5022162), [Read more in Explore Your Waters](#)

The Unnamed Tributary to Garners Creek is a 4.71-mile long Tributary to Garners Creek. The headwaters of this tributary originate as surface water flow through the only remaining agricultural land use south of the Fox River. Limited buffers exist in this location and agricultural impact are likely contributing to impacts observed in the stream. As it flows north and approaches the confluence with the Garner 's Creek it becomes highly entrenched as it flows through an urbanized area set back from the valley slopes. The fish community is dominated by species tolerant to environmental degradation the FBI and MIBI rated poor however habitat scored good at all sites. Adequate buffers exist, and the stream maintains excellent morphology with numerous bends and riffles. Severe bank erosion, deposition of fines, and suspected high sediment and nutrient loads all contribute to poor aquatic life conditions.

### UNT to Garners Creek (5022198) , [Read more in Explore Your Waters](#)

The Unnamed Tributary to Garners Creek is a 2.78-mile long Tributary to Garners Creek. The headwaters of this tributary originate as surface water flow through high and low density residential. Limited buffers exist in this location and impervious surfaces are likely contributing to impacts observed in the stream. As it flows north and approaches the confluence with the Garner 's Creek it becomes highly entrenched as it flows through an urbanized area set back from the valley slopes. The fish community is dominated by species tolerant to environmental degradation the FBI and rated fair however habitat scored good. Severe bank erosion and limited buffers exist within this reach however this reach contains the largest areas of pools and fish habitat in the watershed. Deposition of fines and suspected high sediment and nutrient loads all contribute to fair aquatic life conditions on this stream.

### UNT to Fox River (5021676) , [Read more in Explore Your Waters](#)

The Unnamed Tributary to the Fox River is 1.83-miles long. The headwaters of this tributary originate as surface water flow through high and low density residential portions of the stream are enclosed. Limited buffers exist on this stream and conditions are further impacted by the proximity of a railroad grade along the entire day-lighted portion of the stream. The fish community is dominated by species tolerant to environmental degradation and the FBI and habitat rated poor. This stream may never support a healthy fish assemblage and is severely habitat limited.

### UNT to Fox River (5021600) , [Read more in Explore Your Waters](#)

The Unnamed Tributary to the Fox River is 0.8-miles long. The headwaters of this tributary originate as surface water flow through high density residential and portions of the stream are enclosed. The stream is highly manipulated and an online stormwater pond has been constructed 0.4 miles from the confluence of the Fox. The lower portion of this stream flows along Sunset Park and the

proximity to the Fox along with available cover for fish provide recreational opportunities at this location. The fish community however is dominated by species tolerant to environmental degradation and the FIBI and habitat rated poor to fair respectively. This stream may never support a healthy fish assemblage and is severely habitat limited to the extent where the influence of the Fox River negates the habitat limited reaches of the stream.

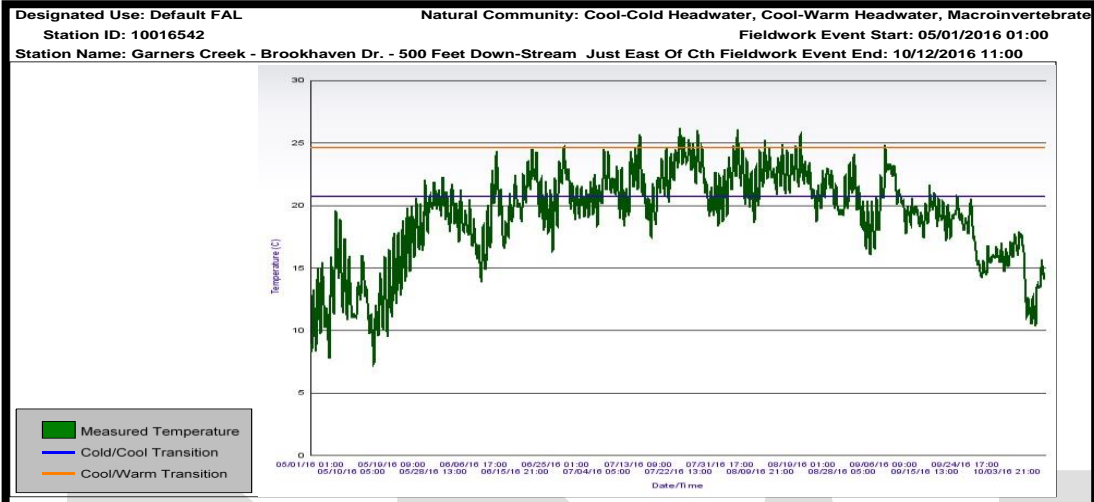
**UNT to Garners Creek (5022136) , [Read more in Explore Your Waters](#)**

The Unnamed Tributary to Garners Creek is 1.85-miles long. The headwaters of this tributary originate as surface water flow through high density residential. Limited buffers exist as it flows north through high density residential land toward the confluence of Garners Creek. Impervious surfaces affect the hydrology of the stream and streambank stabilization measures have been installed to address bank erosion. The fish community is dominated by species tolerant to environmental degradation and the FIBI and habitat rated poor.

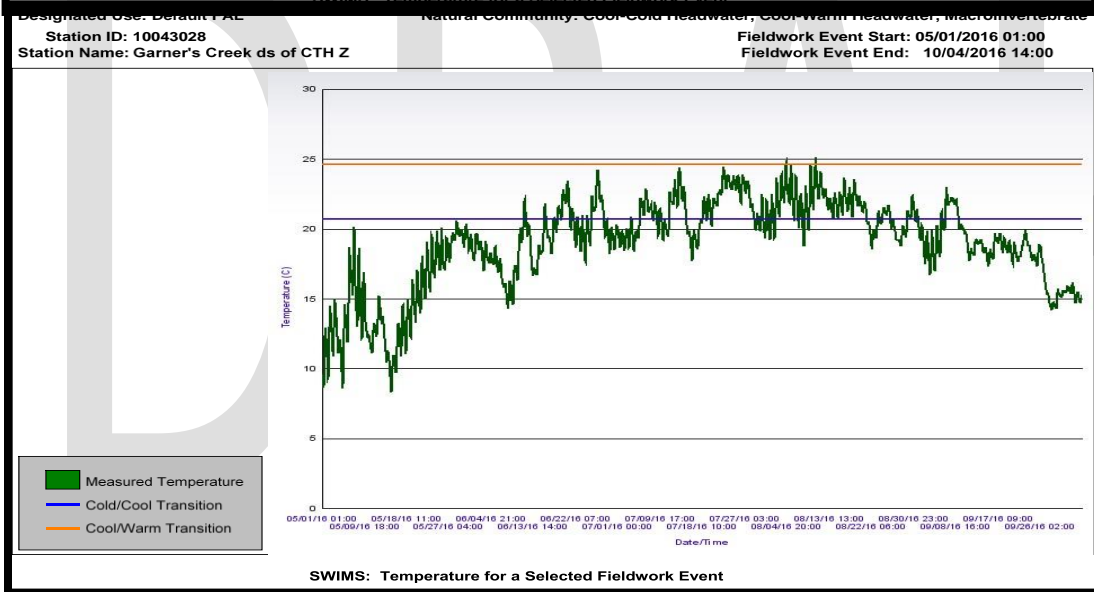
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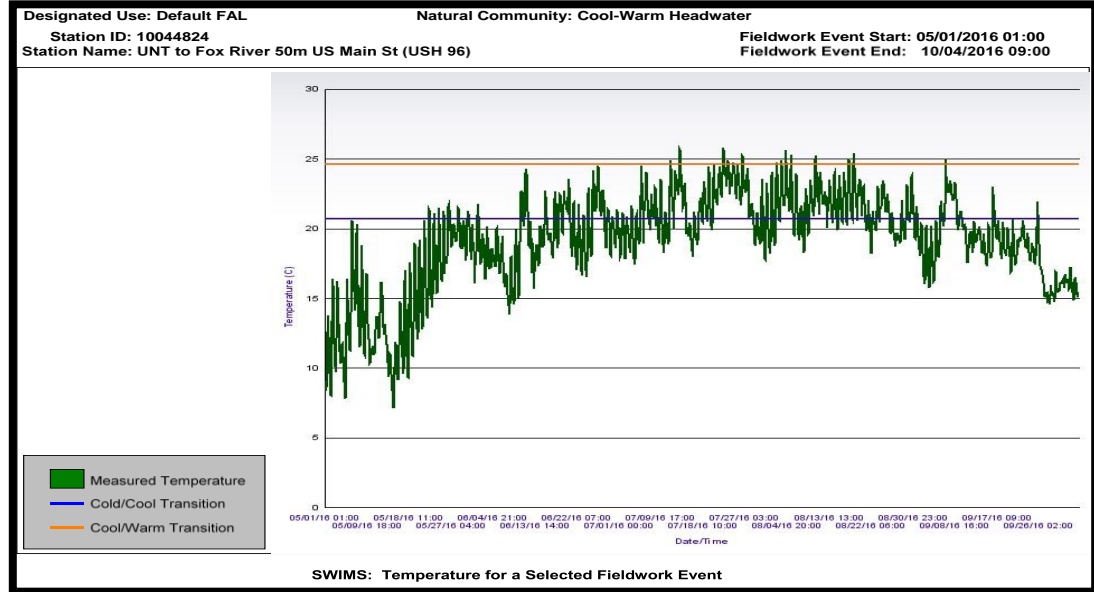
### Appendix C: Stream Temperature Graphs



SWIMS: Temperature for a Selected Fieldwork Event



SWIMS: Temperature for a Selected Fieldwork Event



SWIMS: Temperature for a Selected Fieldwork Event

### Appendix D: Fisheries, Habitat, Macroinvertebrate Tables 2016

Stream - Site	UNT to Fox River (Concrete Channel) Pershing Road	UNT to Fox River (Restored Channel) Pershing Road	UNT to Fox River CTH 00	UNT to Garners Creek CTH KK/CTH N	UNT to Garners Creek CTH KK/ Noe Road	UNT to Garners Creek Buchanan Road	UNT to Fox River Sunset Park SW Pond	UNT to Garners Creek 200m DS CTH CE (9A)	UNT to Garners Creek 30m US CTH CE (9D)	UNT to Garners Creek 330m US CTH CE (9B)	UNT to Garners Creek 520m US CTH CE (9C)	UNT to Fox River Main Street	UNT to Fox River Prospect Road	Garners Creek 375m US CTH N (5C)	Garners Creek 850m US CTH N (5B)	Garners Creek 1000m US CTH N (5A)	Garners Creek Brookhaven Road	Garners Creek Park Street	Garners Creek CTH Z	Total
Stream Order	2	2	2	2	2	3	1	2	2	2	2	2	1	2	2	2	3	3	3	
Mean Stream Width	3	3.0	3.5	3	3	3.5	3	3.00	3	4.00	4	4	3	3.0	3	3	5	7	7	
Station Length	105	105	125	105	105	130	105	105	105	140	140	140	105	105	105	105	225	245	245	
Nat. Comm. Classification	CWHW	CWHW	CWHW	MAC	MAC	CWHW	MAC	CWHW	CWHW	CWHW	CWHW	CWHW	MAC	CWHW	CWHW	CWHW	CWHW	CWHW	CWHW	CWHW
Verified Natural Community	CWHW	CWHW	CWHW	CWHW	CWHW	CWHW	CWHW	CWHW	CWHW	CWHW	CWHW	CWHW	MAC	CWHW	CWHW	CWHW	CWHW	CWHW	CWHW	CWMS
<b>Fish Species</b>																				<b>Total</b>
Black Bullhead									1	1							1			3
Black Crappie								1												1
Bluegill						2		2		1				29	43	9	4	3	15	108
Bluntnose Minnow						4	7	4		2		7	3	3	10		41	12	35	128
Brook Stickleback								2	7	7	7		2						1	26
Common Carp							1			1		2	1		1				3	9
Creek Chub				108	34	77		25	31	12	10			40	40	49	341	103		870
Emerald Shiner																			3	3
Fathead Minnow	2	42	38	37	6	4	1					29	3		3				2	167
Freshwater Drum																		2	1	4
Green Sunfish		15	11	38	1	31	2	28	12	11	29	34	2	26	52	15	50	57	21	435
Johnny Darter						5											6	3	3	17
Largemouth Bass														1			2		3	6
Longnose Gar																			1	1
Pumpkinseed											1								1	2
White Sucker			7	12		33	6	7	5		5	41		8	14	10	86	101	25	360
Yellow Bullhead														1		1				2
Yellow Perch												4						8	3	15
<b>Totals</b>	<b>2</b>	<b>57</b>	<b>56</b>	<b>195</b>	<b>41</b>	<b>156</b>	<b>17</b>	<b>69</b>	<b>56</b>	<b>35</b>	<b>52</b>	<b>117</b>	<b>11</b>	<b>108</b>	<b>163</b>	<b>84</b>	<b>533</b>	<b>289</b>	<b>116</b>	<b>2157</b>
# species	1	2	3	4	3	7	5	7	5	7	5	6	5	7	7	5	9	9	13	
<b>18 Total Species</b>																				
<b>IBI Score</b>																				
Coldwater	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coolwater (CC)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coolwater (Cw)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P 20
Warmwater CS FAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Warmwater CS NR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Small Stream (Intermittent)	P 0	P 0	P 10	P 20	P 20	F 40	P 20	F 40	P 20	F 40	P 20	P 20	P 30	F 40	F 60	P 10	P 30	P 30	-	
E= Excellent																				
G= Good																				
F= Fair																				
P= Poor																				



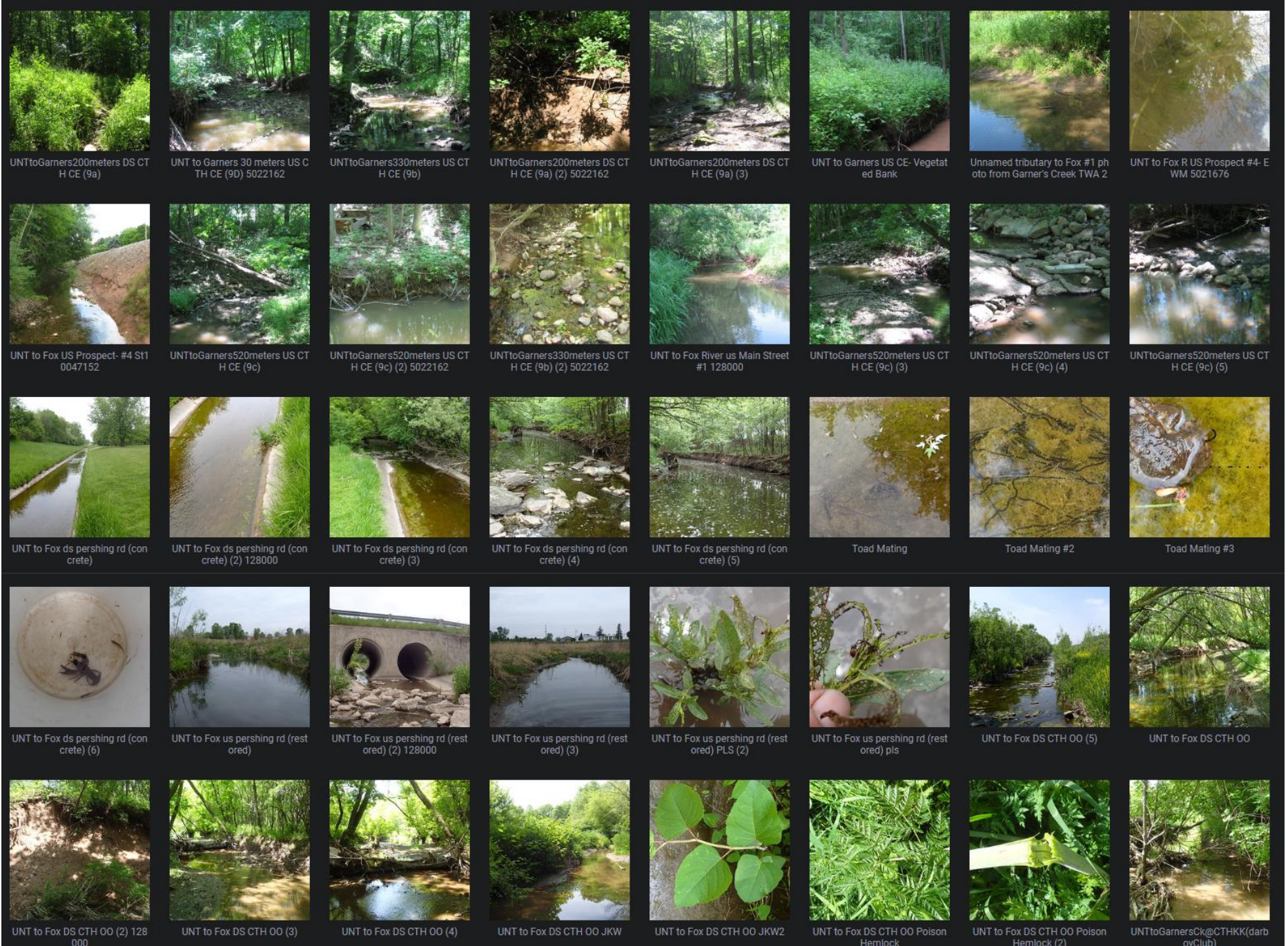
### Appendix E: Garners Creek Watershed Water Quality Standards Attainment

Stream Name	Local Name	WBIC	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Sources	Assessment	Qual	DNR Category
Fox River	Lower Fox River (DePere Dam To Middle Appleton Dam)	117900	7.39	32.18	WWSF	WWSF	Not Supporting	Default FAL	Low DO	Industrial Point Source Discharge, Non-Point Source (Rural or Urban), Discharges from Municipal Separate Storm Sewer Systems (MS4)	Monitored	B1, B4, P3	Category 5A
Fox River	Lower Fox River (Appleton Dam To L. Winnebago Outlet)	117900	32.18	40.09	FAL	FAL	Not Supporting	Default FAL	Low DO	Upstream Source	Monitored	B1	Category 5A
Garners Creek	Garners Creek	127700	0	6.99	WWSF	WWSF	Not Supporting	Default FAL	Chronic Aquatic Toxicity, Degraded Biological Community, Degraded Habitat	Non-Point Source (Rural or Urban), Highway/Road/Bridge Runoff (Non-construction Related)	Monitored	P3, B3, T3	Category 5W
Unnamed	Unnamed Stream	128000	0	1.61	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed	NA	Category 3
Unnamed	Unnamed Stream	128600	0	1.61	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed	NA	Category 3
Unnamed	Unnamed Trib to Fox River	5021600	0	0.8	FAL	FAL	Fully Supporting	Default FAL	NA	NA	Monitored	B3	Category 2
Unnamed	Garners Creek	5021676	0	1.83	FAL	FAL	Fully Supporting	Default FAL	NA	NA	Monitored	T2	Category 2
Unnamed	Unnamed Tributary to Garners Creek	5022136	0	1.85	FAL	FAL	Supporting	Default FAL	NA	NA	Monitored	B2	Category 2
Unnamed	Unnamed Trib to Garners Creek	5022162	0	4.71	FAL	FAL	Not Supporting	Default FAL	Degraded Biological Community	Non-Point Source (Rural or Urban)	Monitored	P3, B3	Category 5W
Unnamed	Un Trib to rners Creek	5022198	0	0.87	FAL	FAL	Supporting	Default FAL	NA	NA	Monitored	B3	Category 2

Stream Name	Local Name	WBIC	Start Mile	End Mile	Current Use	Attainable Use	Supporting Attainable Use	Designated Use	Impairments	Sources	Assessment	Qual	DNR Category
Unnamed	Un Trib to Garners Creek	5022198	0.87	2.78	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed	NA	Category 3
Unnamed	Unnamed	5022241	0	1.6	FAL	FAL	Supporting	Default FAL	NA	NA	Monitored	B3	Category 2
Unnamed	Unnamed	5022391	0	1.92	FAL	FAL	Fully Supporting	Default FAL	NA	NA	Monitored	P3, B3	Category 2
Unnamed	Unnamed Stream	5022562	0	0.45	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed	NA	Category 3
Unnamed	Unnamed Stream	5022696	0	0.73	FAL	FAL	Not Assessed	Default FAL	NA	NA	Not Assessed	NA	Category 3
Unnamed	Local Water	5554199	0	2.61	FAL	FAL	Not Assessed	Default FAL	NA	NA	No Assessment	NA	Category 3
Unnamed	Local Water	5555265	0	2.97	FAL	FAL	Not Assessed	Default FAL	NA	NA	No Assessment	NA	Category 3

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# Appendix F. Photos of the Garners Creek Watershed





UNTtoGarnersCk@cTHKK (2)(d arboyClub)5022198



UNTtoGarnersCk@cTHKK (3)(d arboyClub)



UNTtoGarnersCk@cThKK-Noe P ink Iris



UNTtoGarnersCk@cThKK-Noe P ink Iris (2)



UNTtoGarnersCk@cThKK-Noe la wn scraps



UNTtoGarnersCk@cThKK-Noe



UNTtoGarnersCk@cThKK-Noe b ad restoration



UNTtoGarnersCk@cThKK-Noe b ad restoration (2)



UNTtoGarnersCk@cThKK-Noe b ad restoration (3)



UNTtoGarnersCk@cThKK-Noe b ad restoration (4)



UNTtoGarnersCk@cThKK-Noe (2)



UNTtoGarnersCk@cThKK-Noe (3)



UNTtoGarners@buchanan



UNTtoGarners@buchanan (2) 5022198



UNTtoFoxR@sunsetpark



UNTtoFoxR@sunsetpark (2) 5021600



GarnersCreekDS-OakridgeDr-re alignment-Phraq



GarnersCreekDS-oakridgeDr-re alignment-phraq (2)



GarnersCreekDS-oakridgeDr-re alignment-err



GarnersCreekDS-Oakridge-reali gn



GarnersCreekDS-oakridge-reali gn (2)



GarnersCreek-Within-Realign



GarnersCreek-Within-Realign (2)



GarnersCreek-Within-Realign (3)



GarnersCreek-Within-Realign-m eadow



GarnersCreek-Within-Realign-lo g



GarnersCreek-Within-Realign-ba nk



GarnersCreek-Within-Realign-sh ed



GarnersCreek-Within-Realign (4)



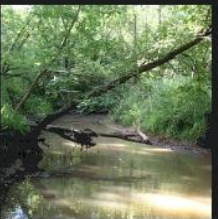
GarnersCreek-USoakridgeDrRea lignment



GarnersCreek@Brookhaven Ban ks



Garners Creek at Z



GarnersCreek@Brookhaven



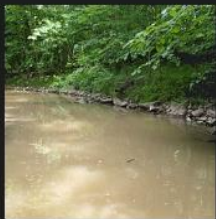
GarnersCreek@Brookhaven (2)



GarnersCreek@Brookhaven (3)



GarnersCreek@Brookhaven (4)



GarnersCreek@parkstreet



GarnersCreek@cThZ



GarnersCreek@cThZ (2)



GarnersCreek@cThZ Banks