MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
SEPTEMBER 2018

STAFF REPORT

Biological and water chemistry surveys of selected stations in the Black River and Galien River watersheds in Berrien and Van Buren Counties, Michigan, August-September 2017.

1. Introduction

Biological and physical habitat conditions of selected water bodies in the Black River and Galien River watersheds, in Berrien and Van Buren Counties, were assessed by staff of the Michigan Department of Environmental Quality (MDEQ), Surface Water Assessment Section (SWAS), from August-September 2017. Additionally, fish surveys and contracted sediment testing were performed in a small tributary to the lower Grand River. Biosurveys were performed upstream and downstream of a mass sedimentation event that occurred in a small tributary to the lower Grand River. Finally, a trend site in the upper Grand River watershed, that could not be sampled during the 2016 cycle year, was sampled. The primary objectives of the assessments were to:

1) Assess the current status and condition of individual water bodies and determine if Michigan Water Quality Standards (WQS) are being met in the Black River and Galien River watersheds.
2) Satisfy monitoring requests submitted by internal and external customers.
3) Identify nonpoint sources (NPS) of water quality impairment.
4) Evaluate biological community temporal trends.
5) Evaluate biological communities in an unnamed tributary to Lloyd's Bayou (lower Grand River watershed) following a large sedimentation event.
6) Evaluate the fish communities, sediment chemistry, and sediment toxicity in Indian Mill Creek (lower Grand River watershed).
7) Perform a biosurvey at the Cahaogan Creek trend site (upper Grand River watershed) because the site did not have flowing water during the 2016 cycle year.

2. Watershed Information

Watersheds are defined as the area of land (and water) that flows into a river, lake, or wetland. Watersheds are often separated by a line of higher elevation land, such as a ridge or hills. Hydrologic Unit Codes (HUC) are numeric identifiers that were developed by the United States Geological Survey to standardize nomenclature across the nation. Larger watersheds are identified by HUCs with fewer digits in their identifier. As smaller watersheds are nested within larger watersheds, more digits are added. For example, the Dietz Creek subwatershed (HUC 040500040409) is nested within the Eastern Red Cedar River (HUC 0405000404), which is within the upper Grand River watershed (HUC 04050004).

Land cover can have a significant impact on the quality and condition of surface waters. The 2011-era land cover and other characteristics for sampled Black River and Galien River subwatersheds are shown in Table 1, by 12-digit HUC.

Table 1. 2011-era land cover estimates (National Oceanic and Atmospheric Administration [NOAA], 2011) and information on selected indicators of human development by subwatershed, including wetlands lost since settlement (Fizzell, 2015), subwatershed population (United States Census Bureau, 2010 and 2012), and impervious surfaces.

			Total land cover							
Station	HUC-12	Subwatershed name	Developed Land (%)	Agricultural land (%)	Wetland (%)	Forest (%)	Other (%)	Impervious surface (%)	Wetland loss (%)	Population
1	40500020206	Great Bear Lake Drain	8	37	22	27	6	1.3	14	1200
2	40500020210	South Branch Black River	14	48	13	18	7	3.2	14	2700
3	40500020208	Maple Creek-South Branch Black River	8	49	16	22	5	1.6	15	4800
4	40400010204	Spring Creek	7	57	12	11	13	1.8	53	870
5	40400010203	Blue Jay Creek-Galien River	7	67	10	11	5	1.5	19	1500
6	40400010207	Kirktown Creek-Galien River	8	49	11	25	6	2	14	1900
7	40500020208	Maple Creek-South Branch Black River	8	49	16	22	5	1.6	15	4800
8	40400010206	South Branch Galien River	13	35	13	28	12	4.5	3	1900
9	40400010206	South Branch Galien River	13	35	13	28	12	4.5	3	1900
10	40400010206	South Branch Galien River	13	35	13	28	12	4.5	3	1900
11	40400010206	South Branch Galien River	13	35	13	28	12	4.5	3	1900
12	40400010206	South Branch Galien River	13	35	13	28	12	4.5	3	1900

Black River

Both the Black River and Galien River watersheds are contained within the Southern Michigan Northern Indiana Drift Plains ecoregion (Omernik and Gallant, 1988). The Black River watershed is 287 square miles and covers parts of northwest Van Buren and southwest Allegan Counties. The main stem Black River begins at the confluence of the North Branch Black River and Middle Branch Black River where it flows southwest for 4.2 miles and discharges into Lake Michigan in the city of South Haven. The South Branch Black River enters the main stem Black River just east of Interstate 196. Soils in the Black River watershed are dominated by lacustrine sand and gravel, fine-textured glacial till, glacial outwash, and end moraines (Michigan Natural Features Inventory and Michigan Department of Natural Resources [MDNR], 1998). The landscape of the watershed is mostly flat to gently rolling with some steep ravines (Fuller, 2005). Fine sand and poorly-drained loam soils make up the majority of the soil types in the watershed. Portions of the North, Middle, and South Branch Black Rivers and several smaller tributaries are designated trout streams (Table 2).

Agriculture makes up the dominant land use in the watershed, especially in the headwaters. Relatively few urbanized areas are in the watershed. The South Branch Black River flows through the city of Bangor and the main stem Black River flows through the city of South Haven. Downstream of Blue Star Highway the Black River is heavily manipulated with hardened shoreline and several artificial coves to accommodate marina dockage. This section of the river has been dredged several times over the last two decades to accommodate recreational boat traffic.

The South Branch Black River has a long history of perturbations. A headwater area of the South Branch Black River, near the village of Bloomingdale, was once one of the state's highest producers of crude oil. At its peak, 437 oil wells were drilled in the Bloomingdale field. By 1950, all of the oil was depleted. Oil pumping, gasoline refining, and leaking aboveground and underground storage tanks all contributed oil and gas contamination to soil and groundwater. Soil and groundwater sampling in the former Bloomingdale field by staff of the MDEQ, Remediation and Redevelopment Division (RRD), has revealed petroleum volatile organic compounds, polynuclear aromatic hydrocarbons, lead, and diesel range organics at concentrations exceeding drinking water and groundwater-surface water interface criteria. One particularly contaminated site at Pullman Industries has been the focus of remediation efforts. Starting in the 1990s, several underground storage tanks were removed by Pullman Industries. The MDEQ, RRD, has recently began a remediation project at the Pullman site involving soil removal and treatment of contaminated groundwater (MDEQ RRD, 2017).

The South Branch Black River received historic pollution in the form of untreated sewage from the city of Bangor, industrial pollution from Du-Wel Metal Products, and brine waste from a pickle processing plant in Bangor (Fetterolf and Carr, 1962 and 1964; Hull, 1989). Du-Wel Metal Products discharges their industrial waste into Bangor Millpond, which was connected to the South Branch Black River by a small channel. In 2002, 25,000 cubic yards of sediment that was contaminated with PCBs, chromium, and other heavy metals was removed from the pond. Aerial photos of the Du-Wel Metal Products site show that the facility was demolished between 2011 and 2013.

Galien River

The Galien River watershed is 175.3 square miles and covers southwest Berrien County, Michigan, and northern parts of La Porte and St. Joseph Counties, Indiana. The majority of the

watershed is in Berrien County (73.7%). The Galien River originates from Dayton Lake in Bertrand Township and discharges into Lake Michigan in the city of New Buffalo. The topography of the watershed is gently sloping with glacial drift depths of 100-400 feet over bedrock. Over 40 different soil types are in Berrien County with varying degrees of texture, slope, and drainage properties. The majority of the soils in the Galien River watershed are poorly drained on gently sloping landscapes (Fishbeck, Thompson, Carr, and Huber (FTCH), 2003). As a result, many of the headwater tributaries are designated county drains to facilitate water conveyance. The main stem Galien River is also a designated county drain from the Bertrand Township/Galien Township border, which is just downstream of Dayton Lake, to just upstream of the community of New Troy (FTCH, 2003). Land use in the entire watershed is 62% agriculture, 19% forest, 4% urban, 8% water, and 7% other (Duris et al., 2009). Portions of the main stem Galien River and several tributaries are designated trout streams (Table 2).

FTCH (2003) recorded elevated nutrient and *E. coli* concentrations in the Galien River watershed, which they attributed to erosion, cropland runoff, illicit discharges, and livestock access to streams. Currently the main stem Galien River, and all associated tributaries from Flynn Road in Chikaming Township, upstream are not attaining partial and total body contact designated uses because of elevated *E. coli* concentrations. Deer Creek, a tributary to the South Branch Galien River, is not attaining its total and partial body contact designated uses because of elevated *E. coli* and it is not attaining its warm water fishery designated use because of altered flow and substrate conditions. The remaining South Branch Galien River watershed, excluding the Spring Creek subwatershed, is not attaining its total body contact designated use because of elevated *E. coli* (Goodwin et al., 2016).

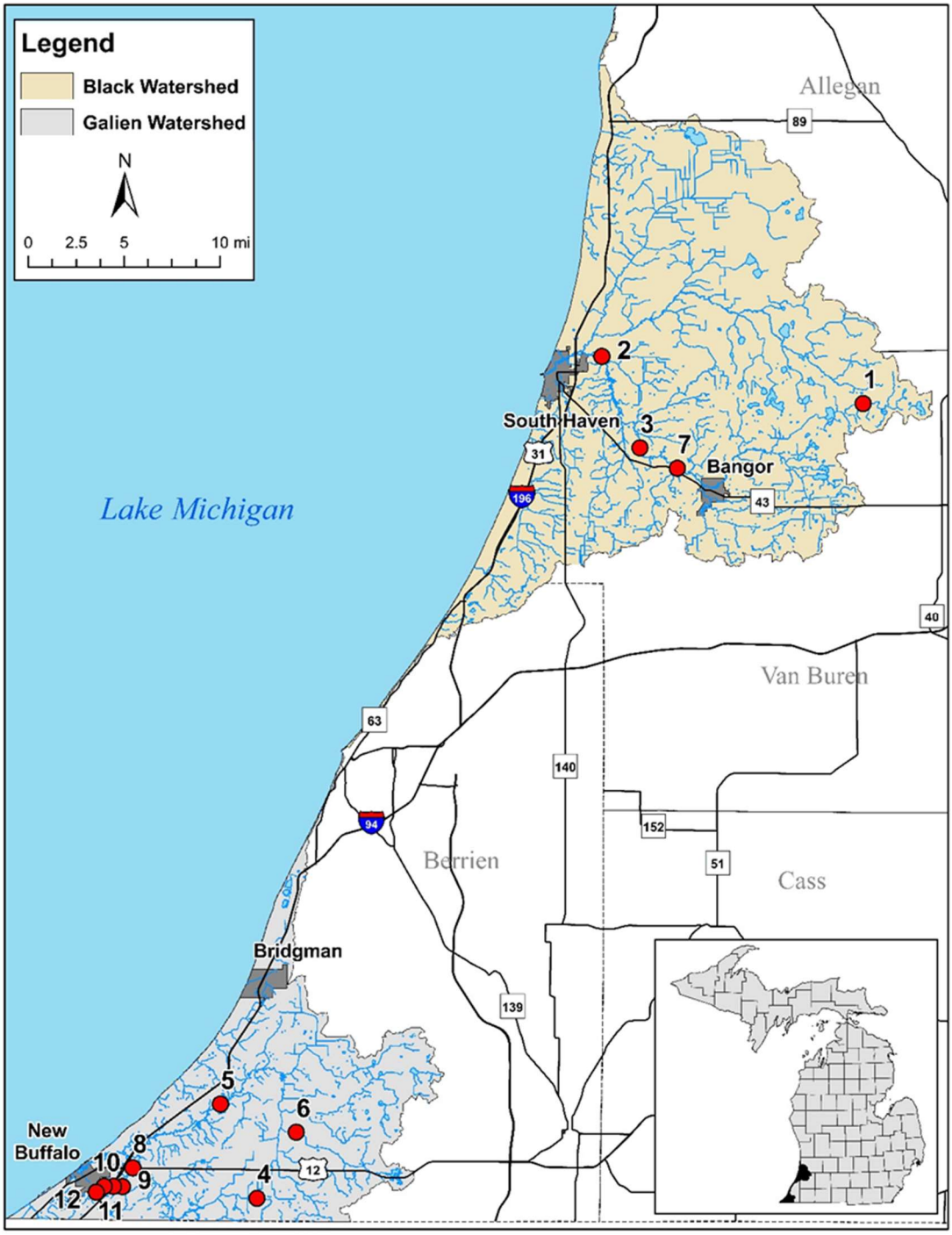

Figure 1. Black and Galien River watersheds. Dots represent 2017 aquatic macroinvertebrate community survey or water sample stations.

Table 2. Coldwater designated streams in the upper Grand River watershed (adapted [MDNR, 1997]).

Black River watershed		
Stream	Township, Range, Section	County
S. Br. Black River (main stem)	T1S, R17W, S2 to T2S, R16W, S20	Van Buren
Moon Lake Drain	T1S, R16W, S20	Van Buren
Three Mile Creek	T2S, R16W, S2	Van Buren
Middle Branch Black River Mainstream up to confluence of Spring Brook Creek	T1N, R15W, S22	Allegan
Spicebush Creek	T1N, R16W, S23	Allegan, Van Buren
Barber Creek	T1N, R15W, S21	Allegan, Van Buren
Spring Brook Creek	T1N, R15W, S22	Allegan
North Branch Black River Mainstream from confluence to T1N, R16W, S3	T1N, R16W, S3	Allegan
Galien River watershed		
Galien River from T7S, R19W, S17 upstream (mainstream only)	T7S, R19W, S17	Berrien
East Branch Galien River (T7S, R19W, S17) to Boyle Lake (mainstream only)	T7S, R19W, S17	Berrien
Blue Jay Creek	T7S, R19W, S20	Berrien
South Branch Galien River (T8S, R21W, S36) mainstream only	T8S, R21W, S36	Berrien
Spring Creek (T8S, R20W, S20) upstream to T8S, R20W,S22, excluding tributaries	T8S, R20W, S20	Berrien

3. Historical Sampling Efforts and Information

Some of the earliest biological sampling in the Black River watershed occurred in the South Branch Black River to investigate the effects of raw sewage discharge from the city of Bangor and metal wastewater discharge from Du-Wel Metal Products, also in Bangor. Fetterolf and Carr (1962; 1964) reported communities consisting of only “sludgeworms (Oligochaeta),” leeches, damselflies, and midges immediately downstream of the Du-Wel and sewer discharges. Fetterolf and Carr (1964) found that macroinvertebrate communities as far as 5 miles downstream from Bangor appeared to be affected by the discharge pollution. Hull (1989) reported impacted macroinvertebrate communities downstream from the Du-Wel Metal Products discharge site and an unpermitted discharge from a pickle processing facility. Biosurveys performed during the 2007 (Walterhouse, 2008) and 2012 (Knoll-Wilmes, 2014a) cycle years had macroinvertebrate communities that scored either acceptable or excellent. Recent sampling efforts in 2007 (Wesener, 2009) and 2012 (Knoll-Wilmes, 2014b) in the Galien River watershed have found acceptable macroinvertebrate communities at all stations sampled.

4. Methods

The macroinvertebrate community and physical habitat were qualitatively assessed at 9 stations (Table 3; Figure 1) using the SWAS Procedure 51 (Creal et al., 1996; MDEQ, 1990) for wadeable streams. If a station is at a road crossing, it is sampled upstream unless otherwise noted. The macroinvertebrate communities were assessed and scored with metrics that rate water bodies from excellent (+5 to +9) to poor (-5 to -9). Scores from +4 to -4 are rated acceptable. Negative scores in the acceptable range are considered tending towards a poor rating, while positive scores in the acceptable range are tending towards an excellent rating. Habitat evaluations are based on 10 metrics, with a maximum total score of 200. A station habitat score of >154 is characterized as having excellent habitat, 105-154 is good, 56-104 is marginal, and <56 is poor. Where available, macroinvertebrate community scores are used to determine attainment of the Other Indigenous Aquatic Life and Wildlife (OIALW) designated use and fish community scores are used to assess attainment of the relevant fish designated use. Habitat scores and individual metrics are used to help better understand the biological community scores. Fish scores are similar to macroinvertebrate scores, except that they can range from +10 to -10. However, some factors override the scoring criteria. When fewer than 50 fish are collected in a reach or greater than 2% of the fish have anomalies, then a site is rated as “poor.”

Appendices 1-6 contain the macroinvertebrate, fish community, and habitat assessment results for all water bodies where Procedure 51 biosurveys were performed.

5. Station Selection

Two station-selection methods were used to assess the Black River and Galien River watersheds in 2017: (1) stratified random; and (2) targeted. Five randomly selected stations were assigned to support the SWAS Status (3 stations) and Trend (2 stations) Program. These stations will be used to estimate the watershed attainment status for the OIALW designated use component of Rule 100 (R 323.1100(e)) of the Part 4 Rules, WQS, promulgated under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and will be used as baseline data to facilitate a measurement of biological community temporal trends (MDEQ, 2015).

Seven stations within the Black River and Galien River watersheds were selected for targeted monitoring to support and answer concerns of stakeholders or staff (Table 3). Three stations in the lower Grand River watershed were targeted for sediment sampling and are reported here. Specifically, three sediment samples were taken from Indian Mill Creek in the city of Grand Rapids. The sediment was collected using a PONAR grab sampler, placed in a metal bowl, and homogenized using a metal spoon. A subsample of the sediment was then placed in an 8-ounce glass jar and stored on ice until it was delivered to the Great Lakes Environmental Center Laboratory. At the laboratory, the sediment was analyzed for 34 poly-aromatic hydrocarbons, total organic carbon, and pesticides. Sediment toxicity testing was also performed using *Chironomus dilutus* and *Hyalella azteca*. Fish communities at seven sites were also assessed in Indian Mill Creek. Finally, macroinvertebrate communities were assessed at two targeted sites in the lower Grand River watershed after a culvert failure.

Table 3. Summary of the aquatic habitat and macroinvertebrate community evaluations for selected stations in the Black, Galien, and lower Grand Rivers watersheds, July-September 2017.

Station	Watershed	Stream Name	Road Crossing	STORET	County	TRS	Latitude	Longitude	County Drain	Date	Habitat Rating	Habitat Score	Bug Rating	Bug Score	Fish Rating	Fish Score	Water sample	Sediment sample	Station Type	AUID
1	Black	Haven and Max Drain	CR665/42nd Street	800568	Van Buren	01S14W17S	42.37978	-85.95882	X	8/30/2017	Good	130	Acceptable	2	Acceptable	-2			T	040500020206-02
2	Black	South Branch Black River	70th Street	800572	Van Buren	01S16W06S	42.41533	-86.22527		8/28/2017	Excellent	161	Acceptable	1	.	.			S	040500020210-01
3	Black	South Branch Black River	CR380/20th Avenue	800532	Van Buren	01S16W33S	42.34631	-86.18678		8/30/2017	Marginal	98	Acceptable	4	.	.			Tr	040500020208-01
4	Galien	Unnamed trib to Spring Creek/Chamberlain & Extension Drain	Avery Road	110812	Berrien	08S19W18S	41.77685	-86.572147	X	8/31/2017	Marginal	87	Acceptable	1	.	.			S	040400010204-01
5	Galien	Galien River	Three Oaks Road	110806	Berrien	07S20W23S	41.84787	-86.6097		8/31/2017	Good	130	Acceptable	-4	.	.			S	040400010207-03
6	Galien	Galien River	Pardee Road	110651	Berrien	07S19W33S	41.827198	-86.532659	x	8/31/2017	Poor	55	Acceptable	-1	.	.			Tr	040400010203-01
7	Black	South Branch Black River	CR687/62nd Street	800531	Van Buren	02S16W02S	42.33073	-86.148147		9/1/2017	.	.	.	.	.	.	x		T	040500020208-01
8	Galien	Nokmes Creek	Pulaski Highway	110811	Berrien	08S21W01S	41.79919	-86.69781		9/1/2017	.	.	.	.	.	.	x		T	040400010206-02
9	Galien	Nokmes Creek	Maudlin Street	110807	Berrien	08S21W11S	41.78506	-86.70828		9/1/2017	.	.	.	.	.	.	x		T	040400010206-02
10	Galien	Nokmes Creek	Interstate 94	110809	Berrien	08S21W11S	41.78522	-86.717192		9/1/2017	.	.	.	.	.	.	x		T	040400010206-02
11	Galien	Nokmes Creek	Kinst Road	110808	Berrien	08S21W11S	41.78511	-86.726617		9/1/2017	.	.	.	.	.	.	x		T	040400010206-02
12	Galien	Nokmes Creek	Harbor Country Drive	110810	Berrien	08S21W15S	41.78061	-86.734586		9/1/2017	.	.	.	.	.	.	x		T	040400010206-02
Sites sampled out of cycle year																				
.	Upper Grand	Cahaogan Creek/Portage River Intercounty Drain	DeCamp Rd	330422	Ingham	01N01E15S	42.47012	-84.28762	x	8/29/2017	Marginal	88	Acceptable	-3	.	.			Tr	040500040201-01
.	Lower Grand	Unnamed trib to Lloyds Bayou (downstream)	148th Avenue	700690	Ottawa	08N16W13S	43.074914	-86.156107		7/6/2017	Good	116	Acceptable	-3	.	.			T	040500060712-02
.	Lower Grand	Unnamed trib to Lloyds Bayou (upstream)	149th Avenue	700689	Ottawa	08N16W13S	43.074818	-86.15574		7/6/2017	Excellent	168	Poor	-6	.	.			T	040500060712-02
.	Lower Grand	Indian Mill Creek	Turner Street	410119	Kent	07N12W13S	42.994931	-85.678736		7/14/2017	.	.	.	.	Poor*	-3		x	T	040500060504-02
.	Lower Grand	Indian Mill Creek	Richmond Park	410674	Kent	07N12W14S	42.99813	-85.693389		7/14/2017	.	.	.	.	Poor*	-5		x	T	040500060504-02
.	Lower Grand	Indian Mill Creek	Richmond Dam	410818	Kent	07N12W14S	42.999586	-85.698897		7/14/2017	.	.	.	.	Poor	-8		x	T	040500060504-02
.	Lower Grand	Indian Mill Creek	Lower Sharp DR	410829	Kent	07N12W10S	43.004986	-85.72699		7/14/2017	.	.	.	.	Poor*	-4			T	040500060504-02
.	Lower Grand	Indian Mill Creek	Upper Sharp DR	410830	Kent	07N12W09S	43.008483	-85.730668		7/14/2017	.	.	.	.	Poor	-7			T	040500060504-02
.	Lower Grand	Indian Mill Creek	3 Mile Rd	410581	Kent	07N12W04S	43.015289	-85.733881		7/14/2017	.	.	.	.	Acceptable	-4			T	040500060504-02
.	Lower Grand	Indian Mill Creek	Interstate 96 (upstream)	410828	Kent	07N12W04S	43.022057	-85.730738		7/14/2017	.	.	.	.	Poor	-6			T	040500060504-02

Station type: S/T/Tr = status, targeted, trend station. *Poor fish rating assigned because < 50 fish were sampled at station.

Habitat Scoring Wadeable Stations
Poor < 56 Marginal 56-104 Good 105-154 Excellent >154

Macroinvertebrate Scoring Wadeable Stations
Poor < -4 Acceptable -4 to +4 Excellent > +4

Fish Scoring Wadeable Stations
Poor < -6 Acceptable -5 to +5 Excellent > +4

6. Summary of Findings by Monitoring Objective

Objective 1: Assess the current status and condition of individual waters of the state and determine whether Michigan WQS are being met.

In 2017, five randomly selected status and trend stations within the Black River and Galien River watersheds were sampled to support the attainment status calculation. Based on the probabilistic monitoring aspect of this watershed group survey, 100 +/- 45.1 percent of the randomly selected stations supported the OIALW designated use using biological monitoring procedures. Percent attainment was calculated by dividing the number of random stations that met WQS by the total number of random locations ((5 / 5)100 = 100 percent). This value is coupled with a 95 percent confidence interval to provide our estimation of certainty, meaning there is 95 percent certainty that the true proportion of attainment in the upper Grand River watershed is between 54.9 and 100 percent (MDEQ, 2015).

All six sites (five status and trend plus one targeted site) in the Black River and Galien River watersheds had acceptable macroinvertebrate communities. The one fish community that was assessed in the Black River watershed was acceptable. A trend site that had to be sampled in the upper Grand River watershed was acceptable. A targeted site in the lower Grand River watershed, an unnamed tributary to Lloyd's Bayou, had a macroinvertebrate community that scored poor. Indian Mill Creek, lower Grand River watershed, had six stations with fish communities that scored poor. These results will be considered in determining if the OIALW designated use is being met in the 2020 Section 303(d), 305(b), and 314 Integrated Report.

The macroinvertebrate community and habitat assessment results are located in Appendix 1 and Appendix 2, respectively. Detailed station descriptions and findings are located in Section 8 of this report.

Objective 2: Satisfy monitoring requests submitted by internal and external customers.

Targeted monitoring requests generated by internal and external customers were approved for 16 stations in the Black, Galien, and lower Grand Rivers watersheds. Detailed station descriptions and findings are provided under Objective 6 (Indian Mill Creek), and in Section 8 of this report. The results of the sediment and fish sampling in Indian Mill Creek have been shared with all interested stakeholders. An unnamed tributary to Lloyd's Bayou (lower Grand River) was sampled to collect habitat and macroinvertebrate data immediately after a culvert failure that resulted in a large sedimentation event. Stations were sampled immediately upstream and downstream of the road crossing.

Max and Haven Drain was sampled to assess a site after habitat improvements were made. Macroinvertebrate scores in 2007, prior to streambank stabilization and habitat improvement was -2. In 2012, post habitat improvement, the macroinvertebrate community scored +2. In 2017 the macroinvertebrate score at Max and Haven Drain remained at +2. The fish community at Max and Haven Drain in 2007 was -2 and -4 in 2012. In 2017, the fish score remained essentially unchanged at -2. Water chemistry samples were collected in South Branch Black River and Nokmes Creek in response to targeted monitoring requests by external customers who were concerned about water quality in those water bodies. Water quality results from the Black River and Galien River watersheds will be shared with interested stakeholders.

Objective 3: Identify NPS of water quality impairment.

The landscape of the Black River and Galien River watersheds is gently sloping and has poorly drained soils, especially in the headwater areas. Agriculture tends to be the dominant land use in both watersheds. To facilitate drainage of the agricultural fields in this landscape, most of the tributaries to the Black and Galien Rivers have been channelized and converted to county drains. Because the soils are poorly drained, many of the agricultural fields in the upper Black River and Galien River watersheds use artificial tile drainage. The artificially drained fields and channelized streams are designed to convey high volumes of water at a fast velocity, which scours the stream banks and fills in stream bottoms with sediment. With few exceptions, a common observation at most of the stations in the Black River and Galien River watersheds was eroding banks, evidence of stream flashiness (fast accumulation of storm water in the stream from its associated basin, resulting in a peak discharge soon after a precipitation event), and sedimentation.

More specific NPS issues observed in the sampled watersheds were:

- Headwater area of Max and Haven Drain was the site of numerous oil wells and leaking storage tanks. Remediation activities in the form of soil removal and groundwater cleanup have recently begun. Suggest sampling fish and macroinvertebrate communities in 2022 to assess whether improvements occur after upstream remediation.
- A culvert failure on March 1, 2017, caused a large sedimentation event in a small, unnamed tributary to Lloyd's Bayou, Grand River. Biosurveys were performed above and below the failure site. Biosurveys will be performed again in 2019 during the lower Grand River watershed year.

Objective 4: Evaluate biological community temporal trends.

The macroinvertebrate communities at the trend sites in the Black River and Galien River watersheds have remained stable during the last three cycle years (Table 4). Detailed descriptions of the trend sites are in Section 8.

Table 4. Trend station macroinvertebrate scores for Black River and Galien River watersheds in 2007, 2012, and 2017.

Black River watershed		2007	2012	2017
Waterbody	Location	Walterhouse (2008)	Knoll-Wilmes (2014a)	This report
South Branch Black River	CR 380/20th Ave	5	5	4
Galien River watershed		Wesener (2009)	Knoll-Wilmes (2014b)	This report
Galien River	Pardee Rd	0	0	-1

Objective 5. Evaluate biological communities in an unnamed tributary to Lloyd's Bayou (lower Grand River watershed) following a large sedimentation event.

On March 1, 2017, during a heavy rainstorm, a culvert failure occurred on 148th Avenue in Spring Lake Township. The culvert failure occurred when a hole developed in the middle of the 30-inch diameter pipe under about 17-18 feet of soil. Soil from the road berm washed out and eventually caused the pavement to collapse on 148th Avenue (Figure 2), causing large amounts of sediment to enter an unnamed tributary to Lloyd's Bayou (Figure 3). A new, 36-inch diameter culvert has since been installed. Every year, culvert failures occur in the state, particularly in the

spring, during large rain events. This stream was sampled to evaluate habitat and macroinvertebrate communities immediately after a culvert failure. This site will continue to be assessed during monitoring cycle years for the lower Grand River watershed.

This particular stream largely originates west of 144th Avenue in Spring Lake Township and flows west into a wetland complex north of M-104. This wetland complex drains to Lloyd's Bayou, one of several large bayous that are connected to the lower Grand River in Ottawa County. All tributaries to these bayous are designated trout streams (MDNR, 1997). The stream begins as two drains, one of which flows past a large auto salvage yard. Land use above 148th Avenue is a mix of industry, forest, and some residential areas.

Figure 2. Collapsed section of 148th Avenue in Spring Lake Township after a culvert failure. Image from: *(The link provided was broken and has been removed.)*

Unnamed tributary to Lloyd's Bayou

The macroinvertebrate community downstream of 148th Avenue, which received the road berm sand after the culvert failure, scored low acceptable (-3; Appendix 1) and habitat scored low good (116; Appendix 2). Only 14 taxa were collected, of which one Trichoptera taxa (Helicopsychidae) was collected, but no Ephemeroptera or Plecoptera taxa were found, indicating poor water and/or habitat quality. Amphipoda made up the majority of the taxa collected. Amphipoda tend to dominate in disturbed systems (Voshell, 2002). Below 148th Avenue, the stream velocity was 0.4 feet per second and habitat was scored using riffle/run habitat parameters. Large sand deposits were present along both sides of the bank (Figure 3). The streambed was composed of about 60% gravel and 40% sand. The large amount of gravel in the streambed was likely from the road berm fill. Habitat such as undercut banks, overhanging vegetation, and large woody debris was sparse. Mature forest is present on both sides of the creek, which provides good canopy cover.

The macroinvertebrate community upstream of 148th Avenue scored poor (-6; Appendix 1) but habitat scored excellent (168; Appendix 2). Only 12 taxa were collected, none of which were Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa, indicating poor water and/or habitat quality. Isopoda dominated the taxa collected (49%) followed by Amphipoda (40%). Amphipoda and Isopoda both tend to dominate in degraded systems. Isopoda are also tolerant of organic pollution (Voshell, 2002). Both the instream habitat characteristics and riparian area along the stream were completely different from downstream of 148th Avenue. Upstream of 148th Avenue the stream velocity was half what is was downstream of the road berm (0.2 feet per second). Immediately alongside the stream was wetland habitat. Habitat was scored using glide/pool habitat parameters. A large pool was formed immediately upstream of the road berm. That along with the wetland vegetation indicated that water had been pooling behind the road for a long time because of an undersized culvert. The stream bottom was all sand with heavy amounts of detritus in it. Overhanging vegetation and aquatic macrophytes were heavy in the stream and large woody debris was moderately available. Large trees are located upland from the stream, which provide canopy cover. Both the upstream and downstream sites will be sampled again during the lower Grand River cycle year of 2019.

Figure 3. Sediment deposition in unnamed tributary to Lloyd's Bayou after culvert failure on March 1, 2017.

Objective 6. Evaluate the fish communities, sediment chemistry, and sediment toxicity in Indian Mill Creek (lower Grand River watershed).

Indian Mill Creek is a tributary to the lower Grand River that flows through Alpine Township, the city of Walker, and the city of Grand Rapids. The lower section of Indian Mill Creek is not attaining its coldwater fishery designation (Rippke, 2011). The lower section of Indian Mill Creek flows through a heavily urbanized section of Grand Rapids. Adjacent to Indian Mill Creek are large auto salvage yards and metal processing facilities. Previous sediment samples collected in 2016 revealed low amounts of poly-aromatic hydrocarbons (PAH), but also low amounts of organic carbon. Because of the low amounts of organic carbon for the PAHs to bind to, there was a potential risk to benthic fauna (Parker and Rippke, 2017). Because of concerns about sediment toxicity to benthic fauna, expanded PAH testing, pesticide screening, and sediment toxicity tests were performed on three sediment samples within the city of Grand Rapids: Richmond Dam, Tamarack Avenue NW, and Turner Avenue NW.

The sediment results for PAHs are presented in Table 5. The sediment chemistry results were analyzed three different ways using three different lines of evidence: Equilibrium Partitioning Sediment Benchmark Toxicity Units (ESBTU), Probable Effects Concentration Quotient (PEC-Q), and direct toxicity tests. These lines of evidence were normalized based on the total organic carbon content in the sediments, which were 0.9% for Richmond Dam, 1.9% for Tamarack Avenue NW, and 1.3% for Turner Avenue NW.

Sediment samples from the three sites were also screened for pesticides, but none were found (Table 6).

ESBTU

ESBTU for the 34 PAHs at the Richmond Dam, Tamarack Avenue NW, and Turner Avenue NW stations were 1.06, 0.98, and 1.98, respectively. Typically, a PAH ESBTU less than, or equal to, 1 indicates that benthic organisms are not expected to be harmed by contamination present in the sediments (United States Environmental Protection Agency [USEPA], 2003). This would suggest that the current concentrations of PAHs may be having detrimental effects on the benthic communities.

PEC-Q

The PEC-Q calculation results in a risk to benthic fauna if the value is greater than 0.5, which is equivalent to 64% to 94% of the organisms not showing a toxic effect. Because the PEC_{PAH} values for the Richmond Dam, Tamarack Avenue NW, and Turner Avenue NW stations were 0.19, 0.22, and 0.37, respectively, we do not expect a detrimental effect on the benthic community based on those calculations.

Sediment toxicity testing

Laboratory sediment toxicity testing did not find any significant mortality in *Chironomus dilutus* in the 10- and 20-day tests. *Chironomus dilutus* growth was only reduced in the 10-day test group in the Richmond Dam sediment. Otherwise, growth was not affected among *Chironomus dilutus* groups. *Hyallela Azteca* survival and growth were reduced in sediments from all three sites.

When analyzing the three lines of evidence for the organic contaminants, two out of three suggested that there could be detrimental effects on benthic invertebrates (Tables 5 and 7).

Future monitoring will focus on a tributary stream that drains the Folkertsma superfund site above the Richmond Dam.

Fish sampling

Seven different sites in Indian Mill Creek were sampled for fish in July 2017 (Figure 4). Only one station, 3 Mile Road, scored acceptable. The rest of the stations scored poor for the fish communities (Appendix 3). Most of the stations that scored poor did so because less than 50 individuals were collected at a station. Only at the two furthest upstream sites were more than 50 individuals collected. These results were consistent with past fish surveys of Indian Mill Creek. Rockafellow (2005) only collected 41 individuals at Richmond Park in 2004. Rippke (2011) only collected 36 individuals at Richmond Park and 121 individuals at 3 Mile Road in 2009. Interestingly, Salmonids were collected at all sites; however, because of the low numbers of fish collected, Indian Mill Creek continues to not attain its coldwater fishery designated use.

A thorough evaluation of Indian Mill Creek by Myers et al. (submitted) details how a gradient of agricultural land use in the headwaters to dense urban land in the lower reach affects the biological communities. Myers et al. (submitted) related the fish data collected for this report with chemical/physical data that were also collected during 2017. The Indian Mill Creek fish community appeared to be largely structured by stream temperature and flow regimes. Salmonids, white sucker (*Catostomus commersonii*), and bluegill (*Lepomis macrochirus*) were associated with stable, coldwater reaches, while small Cyprinids and Johnny darter (*Etheostoma nigrum*) were associated with higher temperature reaches. The fish community in the small dam impoundment was more similar to the community in the slow-flowing, lower stream reach, near the confluence with the Grand River, suggesting that the dam may be artificially affecting the fish community.

Indian Mill Creek also has a history of episodic pollution events. The most notable one occurred in 1998 when ammonia refrigerant was accidentally discharged into it near Bristol Avenue NW. This resulted in a complete fish kill in the lower 3 kilometers of the stream (Hanshue, 1998). A review of the MiWaters Explorer Web site (https://mienviro.michigan.gov/nsite/map/help) revealed that in the last decade 16 facilities in the Indian Mill Creek watershed have been cited either for spilling hazardous materials or illicitly discharging hazardous materials into the creek. The latest illicit discharge incident that was reported in October 2017, involved the discharge of foam adhesive waste into Indian Mill Creek at Alpine Avenue NW. The volume of waste being discharged into the stream was great enough to discolor the entire stream. There may also be other illicit discharges in the Indian Mill Creek watershed that have not been discovered. The episodic pollution events likely affect the fish communities either through direct mortality or causing them to seek refuge in non-polluted areas. Episodic pollution events may be one explanation for the consistently low fish collections below 3 Mile Road.

Within the Indian Mill Creek watershed both land use and in-stream changes have either occurred or have been proposed. Two large auto salvage yards that were located near Indian Mill Creek have recently closed and contaminated soil has been removed and improved drainage patterns implemented. A metal processing plant that is adjacent to Indian Mill Creek, and that had been cited twice for discharging petroleum products into the creek has also closed down, the city of Grand Rapids is planning on removing the low head dam near Richmond Park, and a large grant was recently awarded to the Grand Rapids Metropolitan Council to implement best management practices in the agricultural headwaters of the stream. Future monitoring of Indian Mill Creek sites is recommended during the 2019 lower Grand River cycle year.

Table 5. Sediment PAH results for Indian Mill Creek. ND = not detected

Site Type	Targeted	Targeted	Targeted
Waterbody Name	Indian Mill Creek	Indian Mill Creek	Indian Mill Creek
Location	Dam upstream of Richmond Park	Tamarack AVE	Turner ST
STORET	410818	410581	410119
Latitude (dd)	42.999583	42.998053	42.994842
Longitude (dd)	-85.699022	-85.693305	-85.67866
Organics-Semivolatiles (µg/kg dry)			
Acenaphthene	ND	ND	ND
Acenaphthylene	ND	ND	ND
Anthracene	ND	ND	ND
Benz[a]anthracene	ND	596	ND
Benzo[a]pyrene	ND	659	ND
Benzo[b]fluoranthene	422	1200	1150
Benzo[e]pyrene	ND	622	ND
Benzo[g,h,i]perylene	ND	633	ND
Benzo[k]fluoranthene	ND	ND	ND
C1-Chrysenes	ND	ND	ND
C2-Chrysenes	ND	ND	ND
C3-Chrysenes	ND	ND	ND
C4-Chrysenes	ND	ND	ND
Chrysene	ND	849	ND
Dibenz[a,h]anthracene	ND	ND	ND
Fluoranthene	555	1470	1780
C1-Fluorenes	ND	ND	ND
C2-Fluorenes	ND	ND	ND
C3-Fluorenes	ND	ND	ND
Fluorene	ND	ND	ND
C1-Fluoranthenes/Pyrenes	ND	455	ND
C2-Fluoranthenes/Pyrenes	1000	2550	2930
C3-Fluoranthenes/Pyrenes	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	ND	516	ND
1-Methylnaphthalene	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND
C1-Naphthalenes	ND	ND	ND
C2-Naphthalenes	ND	ND	ND
C3-Naphthalenes	ND	ND	ND
C4-Naphthalenes	ND	ND	ND
Naphthalene	ND	ND	ND
Perylene	ND	ND	ND
C1-Phenanthrenens/Anthracenenes	ND	475	ND
C3-Phenanthrenens/Anthracenenes	ND	ND	ND
C4-Phenanthrenens/Anthracenenes	ND	ND	ND
C2-Phenanthrenens/Anthracenenes	ND	ND	ND
Phenanthrene	ND	584	905
Pyrene	434	1130	1280
Total organic carbon (%)	0.9	1.9	1.3

Table 6. Sediment pesticide results for Indian Mill Creek. ND = not detected

Site Type	Targeted	Targeted	Targeted
Waterbody Name	Indian Mill Creek	Indian Mill Creek	Indian Mill Creek
Location	Dam upstream of Richmond Park	Tamarack AVE	Turner ST
STORET	410818	410581	410119
Latitude (dd)	42.999583	42.998053	42.994842
Longitude (dd)	-85.699022	-85.693305	-85.67866
Pesticides (µg/kg dry)	ND	ND	ND
4,4' -DDD	ND	ND	ND
4,4' -DDE	ND	ND	ND
4,4' -DDT	ND	ND	ND
Aldrin	ND	ND	ND
alpha-BHC	ND	ND	ND
alpha-Chlordane	ND	ND	ND
beta-BHC	ND	ND	ND
Chlordane, Technical	ND	ND	ND
delta-BHC	ND	ND	ND
Dieldrin	ND	ND	ND
Endosulfan I	ND	ND	ND
Endosulfan II	ND	ND	ND
Endosulfan II	ND	ND	ND
Endosulfan sulfate	ND	ND	ND
Endrin	ND	ND	ND
Endrin aldehyde	ND	ND	ND
Endrin ketone	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND
gamma-Chlordane	ND	ND	ND
Heptachlor	ND	ND	ND
Heptachlor epoxide	ND	ND	ND
Methoxychlor	ND	ND	ND
Toxaphene	ND	ND	ND

Table 7. Sediment toxicity results for Indian Mill Creek.

Site Type			Targeted	Targeted	Targeted
Waterbody Name	Laboratory Control	Water Only	Indian Mill Creek	Indian Mill Creek	Indian Mill Creek
Location			Dam upstream of Richmond Park	Tamarack AVE	Turner ST
STORET			410818	410581	410119
Latitude (dd)			42.999583	42.998053	42.994842
Longitude (dd)			-85.699022	-85.693305	-85.67866
10-day *Chironomus dilutus* % survival	98.8	98.8	98.8	98.8	92.5
20-day *Chironomus dilutus* % survival	88.6	90.6	81.3	81.3	86.5
10-day *Hyalella azteca* % survival	97.5	97.5	80*	22.5*	37.5*
28-day *Hyalella azteca* % survival	98.8	90	65*	23.8*	32.5*
10-day *Chironomus dilutus* growth reduction?	NO	NO	YES	NO	NO
20-day *Chironomus dilutus* growth reduction?	NO	NO	NO	NO	NO
10-day *Hyalella azteca* growth reduction?	NO	NO	YES	YES	YES
28-day *Hyalella azteca* growth reduction?	NO	NO	YES	YES	YES

*Indicates statistically significant decrease in % survival.

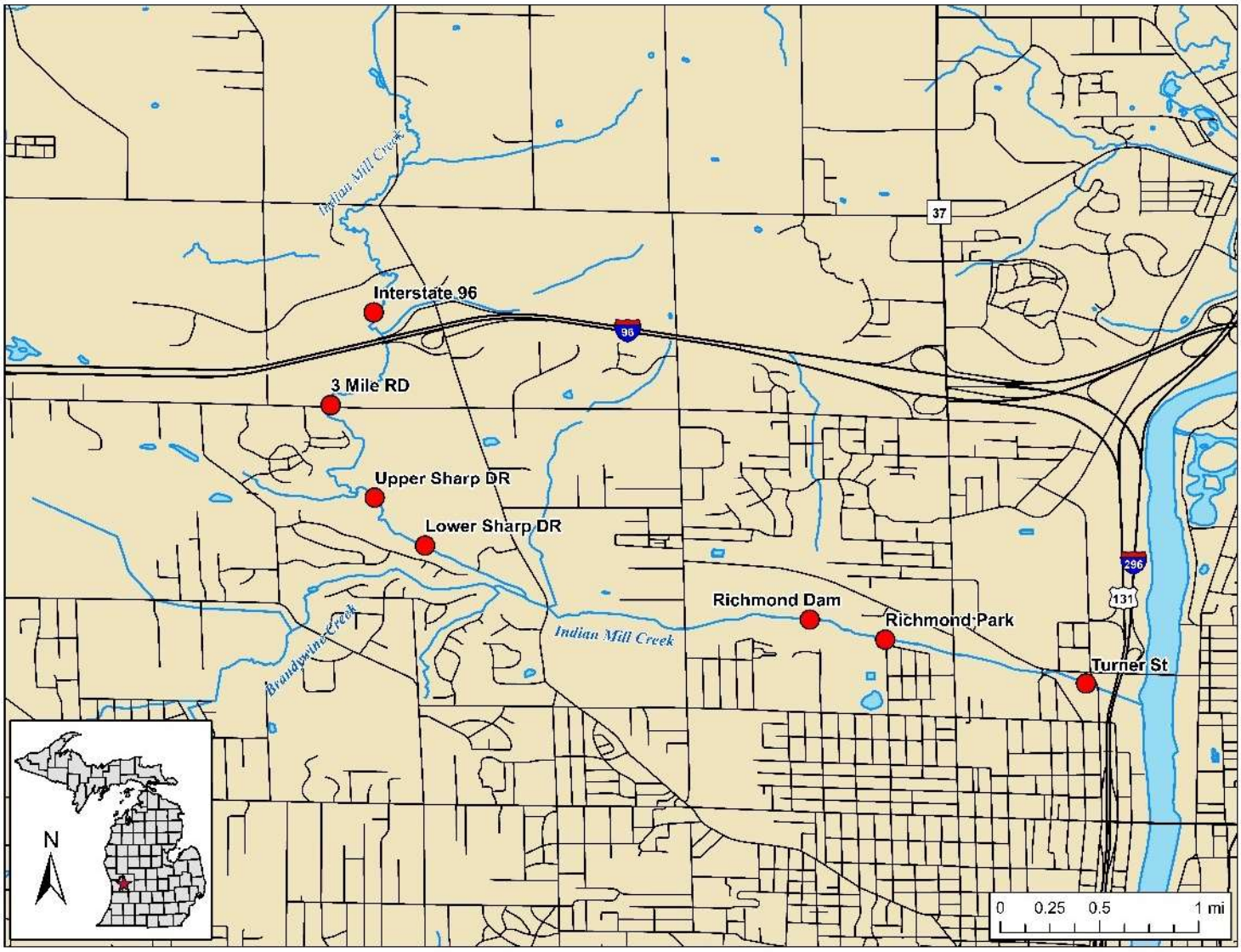

Figure 4. Fish sampling sites in Indian Mill Creek, July 2017.

Objective 7. Perform a biosurvey at Cahaogan Creek trend site (upper Grand River watershed) because the site did not have flowing water during the 2016 cycle year.

Cahaogan Creek at DeCamp Road in Bunker Hill Township is a trend site within the upper Grand River watershed. In 2016 the site could not be sampled because there was no flow. In 2017 the site was revisited and had some flow (0.22 feet per second) so a biosurvey was performed. The macroinvertebrate community scored low acceptable (-3; Appendix 1) and habitat scored marginal (88), which were similar to past scores for that site (Table 8). Twenty-five different taxa were collected but only two Ephemeroptera were collected, indicating poor water and habitat quality. Amphipoda made up the majority of the invertebrates collected. Amphipoda are highly pollution and disturbance tolerant and typically if they are the dominant taxa, that is an indication of disturbance. The sediment was completely composed of silt. Undercut banks, large woody debris and rootwads were absent. Heavy amounts of bur-reed (*Sparganium* spp.) were present in the channel and a moderate amount of overhanging vegetation was available. Cahaogan Creek is a county drain and is referred to as the Portage River Intercounty Drain by the Ingham County Drain Commission office, thus the channel was straight. Row crops are along both sides of the drain with no large trees present for canopy cover. In fact, the drain runs straight for nearly two miles upstream of DeCamp Road with row crops immediately adjacent to it. The greater surrounding area is mostly agricultural with some forested areas.

Table 8. Cahaogan Creek at DeCamp Road (upper Grand watershed) macroinvertebrate and habitat scores in 2006, 2011, and 2017.

	2006	2011	2017
	Holden (2007)	Holden (2012)	This report
Macroinvertebrate score	-4	0	-3
Habitat score	94	62	88

7. Future Monitoring Recommendations

SWAS staff recommend the following sampling be conducted in future years:

- One trend station in the Black River and one trend station in the Galien River.
- Fish and macroinvertebrate sampling will take place in Max and Haven Drain in 2022 after the Pullman site is remediated upstream.
- Sediment were sampled and analyzed for PAHs in a tributary to Indian Mill Creek that drains the Folkertsma superfund site in 2018. Macroinvertebrate sampling will take place in several locations throughout Indian Mill Creek.
- Biosurveys above and below 148th Avenue in Spring Lake Township.

8. Detailed Descriptions of Survey Results

Black and Galien Rivers – Station Descriptions

Black River Watershed

Haven and Max Drain

The Haven and Max Drain was sampled downstream of 42nd Street at Shady Brook Park in the village of Bloomingdale. Fish and macroinvertebrate biosurveys were performed to assess potential improvements following bank stabilization and habitat improvement work. In the last decade a larger culvert was placed downstream of this station as well. MDEQ staff spoke with an employee of the village of Bloomingdale who said that significant flooding used to occur in Shady Brook Park until the under-sized culvert downstream was replaced. The macroinvertebrate and fish communities scored acceptable (2 and -2 respectively; Table 9), which was similar to past surveys (Table 9). Twenty-three different macroinvertebrate taxa were collected, four of which were Ephemeroptera and Trichoptera (Appendix 5). There was not an overwhelming dominance of one taxa in the drain (dominant taxa was 22% of those collected). Rather, Amphipoda, Heptageniidae, and Hydropsychidae dominated the community with similar numbers. All three of those taxa are sensitive to facultative, and may dominate in areas with moderate nutrient inputs (Voshell, 2002). The high numbers of Heptageniidae may have also been from the presence of artificial cobble in the drain. Nine different fish species were collected from the drain, 98% of which, were considered tolerant to degraded habitat and water quality. Johnny darter, bluntnose minnow (*Pimephales notatus*), and blacknose dace (*Rhinichthys atratulus*) were the most common fish collected (Appendix 4).

Habitat in the Haven and Max Drain scored good (130; Table 9). The dominant sediment type was sand; however, some cobble and gravel were present in riffles. Rootwads were heavy, especially along the right bank, and overhanging vegetation was moderate. Other habitat types such as undercut banks, large woody debris, and macrophytes were sparse. The banks did not show signs of flashiness and minimal erosion was noted. Along the right bank, mature trees dominate the immediate riparian area. Along the left bank is Shady Brook Park, which has a mowed lawn to the drain. Upstream of the station is a mix of urban land use in the village of Bloomingdale, agriculture, and forest. This station is also downstream of the Pullman Industries Superfund site that is currently being remediated by the MDEQ, RRD. MDEQ staff recommend additional sampling during the next cycle year to assess potential impacts of upstream remediation.

Table 9. Haven and Max Drain at 42nd Street macroinvertebrate, fish, and habitat scores in 2007, 2012, and 2017.

	2007	2012	2017
	Walterhouse (2008)	Knoll-Wilmes (2014a)	This report
Macroinvertebrate score	3	2	2
Fish score	-2	-4	-2
Habitat score	101	141	130

South Branch Black River

The South Branch Black River was sampled at County Road 380/20th Avenue in Geneva Township. The macroinvertebrate community scored high acceptable (4; Appendix 5)

and habitat scored marginal (98; Appendix 6). This station is a trend site, and the macroinvertebrate and habitat scores were similar to those in previous years (Table 10). Fourteen different taxa were collected, of which five were EPT, indicating intermediate habitat and water quality. Baetidae, Hydropsychidae, and Chironomidae were the dominant taxa. Typically, dominance by those taxa is indicative of moderate disturbance. The bottom substrate was almost all sand with the only rocks and boulders near the bridge. Large woody debris and rootwads were moderately available as habitat. Other habitats types such as undercut banks, overhanging vegetation, and macrophytes were either sparse or absent. Pool variability was very low, with most of the flow uniform. The river exhibited signs of flashiness with banks scoured greater than 20 inches above the water surface. The immediate riparian area contained mature trees that provide good canopy cover. There is more riparian vegetation along the right bank. Along the left bank, 66th Street is 60-80 feet away from the river and is parallel to it for over 400 feet. The greater surrounding area is mostly agriculture and forest.

Table 10. South Branch Black River at CR 380/20th Avenue macroinvertebrate and habitat scores in 1992 2007, 2012, and 2017.

	1992	2007	2012	2017
	Heaton (1997)	Walterhouse (2008)	Knoll-Wilmes (2014a)	This report
Macroinvertebrate score	Excellent*	5	5	4
Habitat score	fair*	106	112	98

*Different scoring calculations used than in 2007, 2012, and 2017.

The South Branch Black River was also sampled at 70th Street in Geneva Township. The macroinvertebrate community scored acceptable (1; Appendix 5) and habitat scored excellent (161; Appendix 6). Twenty-one different taxa were present, of which seven were EPT. Chironomidae and Amphipoda made up the majority of the taxa found. Typically, an abundance of those taxa is indicative of degraded water and habitat. The bottom substrate was mostly sand and silt. The river was about 58-feet wide when we sampled and along the left side of the river was too deep to sample. Rootwads were readily available as habitat and undercut banks and large woody debris were moderately available. Overhanging vegetation and macrophytes were either absent or sparse. The river was slow flowing at the time of sampling. In some calm areas, duckweed was growing and planktonic green algae was visible throughout the water column. The banks were well protected and did not exhibit signs of scour. The riparian area was composed of mature trees, which provide good canopy cover. The greater surrounding area contains a mix of agricultural, forest, and residential land use.

Galien River watershed

Unnamed tributary to Spring Creek/Chamberlain and Extension Drain

An unnamed tributary to Spring Creek was sampled at Avery Road in Galien Township. That water body is a county drain that is also known as the Chamberlain and Extension Drain by the Berrien County Drain Commission. The macroinvertebrate community scored acceptable (1; Appendix 5) and habitat scored marginal (87; Appendix 6). Sixteen different taxa were collected, of which five were EPT taxa. Chironomidae made up almost half of the taxa collected. Typically, an abundance of Chironomidae is indicative of degraded water and habitat quality. The bottom substrate consisted of mostly sand with small amounts of gravel. Overhanging vegetation was very heavy from grasses growing next to the drain. All other habitat types such as large woody debris, undercut banks, rootwads, and macrophytes were either sparse or absent. At this location, the drain was straight with no pools or flow variability. The banks did not exhibit signs

of flashiness. On both sides of the drain were row crops. The greater surrounding area is mostly agricultural with some forested areas.

Galien River

The Galien River was sampled at Three Oaks Road in Chikaming Township. The macroinvertebrate community scored low acceptable (-4; Appendix 5) and habitat scored good (130; Appendix 6). Eighteen different taxa were collected, of which only three were EPT indicating low water and habitat quality. Corixidae, which are very tolerant to environmental stressors (Voshell, 2002), made up over half of the taxa collected. Most of the substrate at the station was silt except in one area where an old road crossing used to be. The stream bottom there contained rocks and sand. In the silt substrate anaerobic gasses bubbled up when we walked through it. Large woody debris and rootwads were moderately available. Other habitat types such as undercut banks, overhanging vegetation, and macrophytes were either sparse or absent. The stream banks showed evidence of flashiness with bank scour occurring 9-18 inches above the water surface. The banks otherwise were well-protected and the riparian area was dominated by mature trees, which provide good canopy cover. The greater surrounding area is a mix of agriculture and forest.

The Galien River was also sampled at Pardee Road in Weesaw Township. The macroinvertebrate community scored acceptable (-1; Appendix 5) and habitat scored poor (55; Appendix 6). This section of the Galien River was in the headwater region and is managed as a county drain. The depth was less than 1 foot at the time of sampling, pools were absent, and flow was uniform throughout the sampled area. Twenty-one different taxa were collected, but only four were EPT, indicating poor water and habitat quality. Amphipoda made up almost half of the taxa collected. Typically, an abundance of Amphipoda is indicative of degraded water and habitat quality (Voshell, 2002). This was a trend site and the macroinvertebrate score was similar to previous years, but habitat scored lower (Table 11). The substrate was mostly sand and silt with some rocks near the road crossing. Undercut banks, large woody debris, and rootwads were moderately available but overhanging vegetation and macrophytes were either sparse or absent. The banks were nearly vertical and actively eroding. Flashiness was evident with scour occurring more than 20 inches above the water surface. Mature trees are on the banks immediately adjacent to the drain, which provide canopy cover. Beyond the trees on the right side of the drain is Elm Valley Road and beyond the trees on the left bank is a row crop. The greater surrounding area is mostly agriculture.

Table 11. Galien River at Pardee Road macroinvertebrate, fish, and habitat scores in 2007, 2012, and 2017.

	2007	2012	2017
	Wesener (2009)	Knoll-Wilmes (2014b)	This report
Macroinvertebrate score	0	0	-1
Habitat score	88	90	55

Black and Galien Rivers – water sampling

Nutrient samples were collected in the South Branch Black River at 62nd Street. The nutrient results in the South Branch Black River were similar to other rivers throughout the state (Roush, 2013) and there was no obvious expression of excess nutrients at the site such as attached algae present.

Nokmes Creek, a small tributary to the Galien River, was sampled at five road crossings in 2017 (Figure 5) and at four locations in 2018 (Figure 6). Targeted sampling occurred here because of summer conductivity spikes at the Maudin Street crossing. When we collected water samples in 2017, flow was minimal. Conductivity readings were particularly high starting at Interstate 94 and at the lower two sites (Table 12), confirming other observations. At the next site upstream from Interstate 94, Kinst Road, there was a sharp decline in conductivity. Aluminum was also higher at the two lower sites.

Nokmes Creek was revisited in August 2018. Similar to 2017, water flow was minimal. A more concentrated area was inspected in 2018 (Figure 6), including local agricultural facilities. Drains along local roads and farms were all dry at the time of the 2018 inspection. The conductivity of Nokmes Creek exhibited a similar pattern to what was observed in 2017, with conductivity peaking downstream of the east-bound Interstate 94 weigh station. During the latest survey of Nokmes Creek, sonde measurements were also taken upstream of the west-bound Interstate 94 weigh station (Figure 6). We observed that conductivity increased by 221 microsiemens per centimeter from the culvert entrance at the westbound Interstate 94 weigh station to the culvert outlet at the eastbound Interstate 94 weigh station (Table 13). Both in the 2017 and 2018 visits, the culvert outlet was covered with iron-oxidizing bacteria (Figure 7).

During our 2018 visit, MDEQ staff did not observe any discoloration in Nokmes Creek from iron-oxidizing bacteria where it enters the Interstate 94 culvert. However, MDEQ staff walked the entire length of the culvert underneath Interstate 94 and observed numerous groundwater seeps entering the culvert junctions that had thick iron bacteria slimes (Figure 8). Groundwater contains many dissolved solids that increase surface water conductivity. During both visits to Nokmes Creek, stream flow was very low, suggesting that groundwater was the main source of water to it during the summer, albeit in low amounts. In most Michigan streams, discharge volume is lowest in the summer and higher during the winter. When water volume is lowest, the concentration of dissolved solids increases in a water body, thus increasing conductivity (Allan, 1995).

Nokmes Creek appears to be a borderline ephemeral stream. During the summer, low amounts of groundwater with high concentrations of dissolved solids appears to be its main source of water. During the winter, the stream flow likely becomes more precipitation-driven. Most likely the precipitation runoff has a lower amount of dissolved solids in it than the groundwater, and dilutes the concentration of solids in the stream. This could explain the observation of lower surface water conductivity in the winter than in the summer in Nokmes Creek.

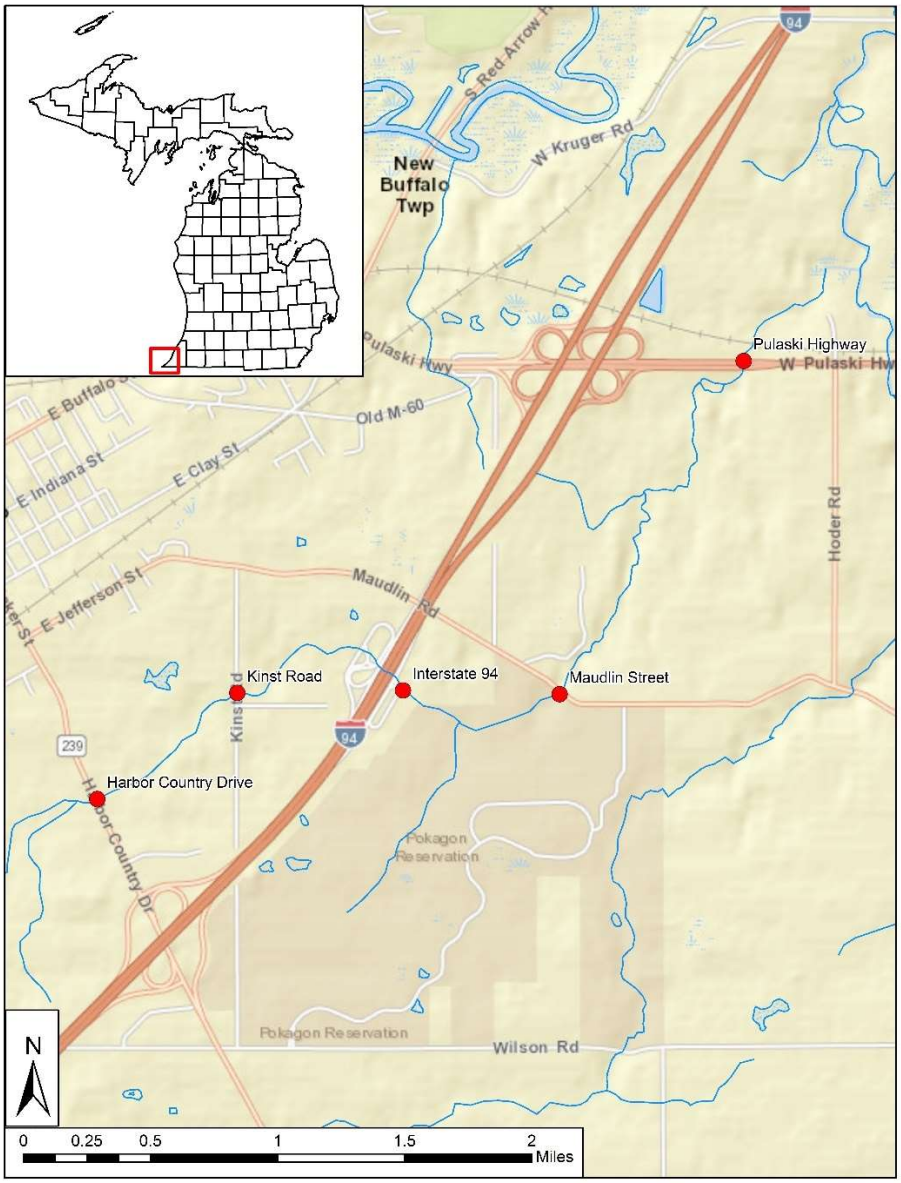

Figure 5. Water sampling sites in Nokmes Creek, September 1, 2017.

Table 12. Chemical/physical data for South Branch Black River and Nokmes Creek collected on September 1, 2017.

Station Number	7	12	11	10	9	8
Site Type	Targeted	Targeted	Targeted	Targeted	Targeted	Targeted
Waterbody Name	South Branch Black River	Nokmes Creek	Nokmes Creek	Nokmes Creek	Nokmes Creek	Nokmes Creek
Location	CR687/62nd Street	Harbor Country Drive (furthest upstream)	Kinst Road	Interstate 94	Maudlin Street	Pulaski Highway (furthest downstream)
STORET	800531	110810	110808	110809	110807	110811
Inorganics-General Chemistry (mg/l)						
Ammonia	0.02	0.12	0.22	1.00	0.09	0.22
Kjeldahl nitrogen	0.23	0.64	0.62	1.50	0.73	1.00
Nitrate/nitrite	0.350	0.560	ND	0.061	0.220	0.062
Nitrate-calculated	0.350	0.530	ND	0.051	0.190	0.034
Nitrite	ND	0.029	ND	0.010	0.025	0.028
Ortho phosphate	0.021	0.022	0.015	0.017	0.055	0.058
Total phosphorus	0.029	0.049	0.028	0.028	0.090	0.130
Inorganics-Metals (µg/l)						
Aluminum	.	200	30	120	1300	1300
Arsenic	.	ND	ND	ND	1.7	1.7
Barium	.	74	56	130	67	92
Cadmium	.	ND	ND	ND	ND	ND
Chromium	.	ND	ND	ND	1.5	1.6
Copper	.	2.7	ND	ND	1.4	1.3
Lead	.	ND	ND	ND	ND	1.3
Mercury	.	ND	ND	ND	ND	ND
Selenium	.	ND	ND	ND	ND	ND
Silver	.	ND	ND	ND	ND	ND
Zinc	.	8	29	ND	6.4	8.3
Water quality sonde measurements						
Temperature (°C)	15.1	15.6	15.5	15.5	16.3	15.1
Dissolved oxygen (mg/l)	7.61	5.03	3.03	4.14	4.58	2.84
Conductivity (µS/cm)	511	716	550	1654	1445	1093
pH	8.09	7.96	7.3	6.92	7.59	7.38

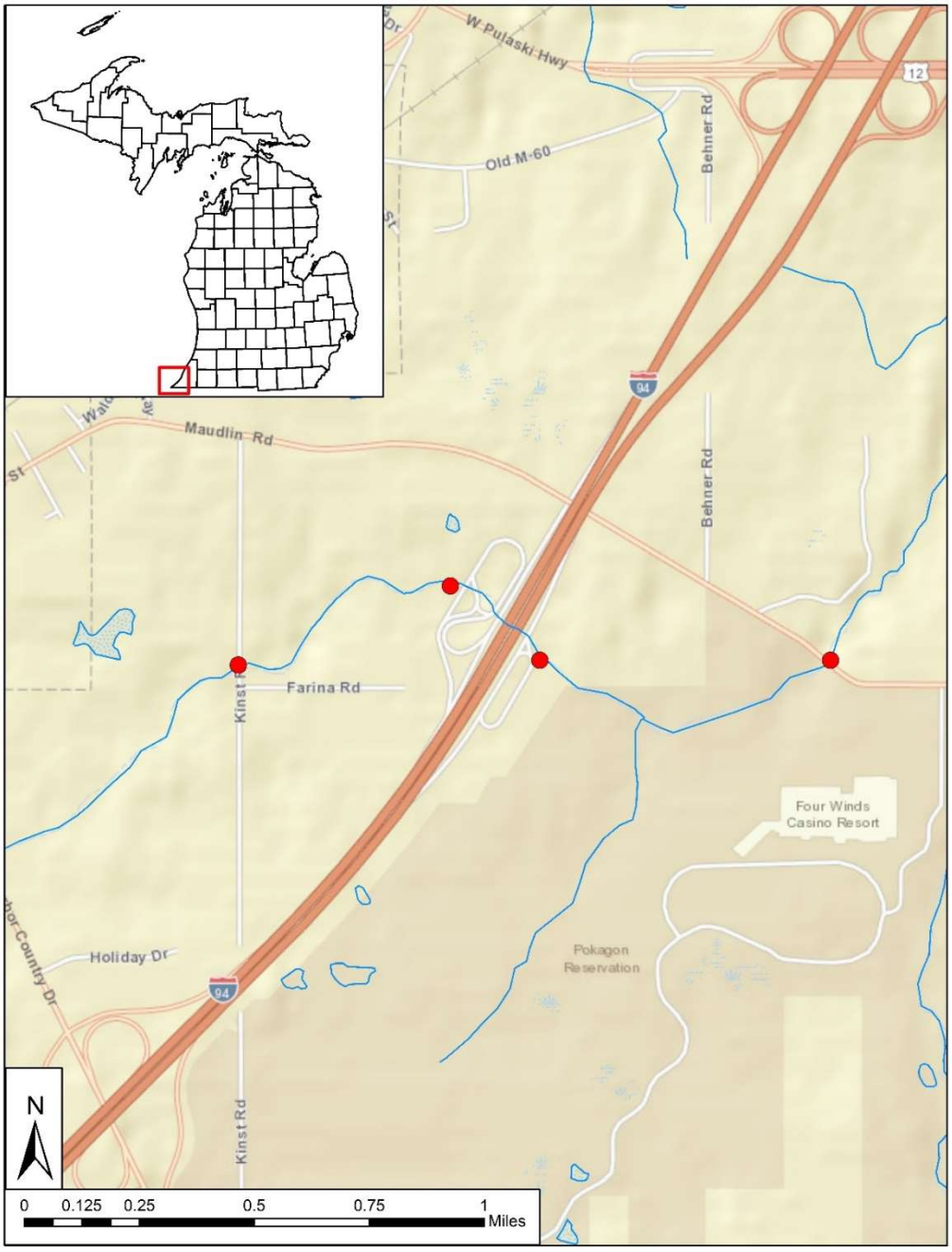

Figure 6. Water sampling sites in Nokmes Creek, August 1, 2018.

Table 13. Chemical/physical data for Nokmes Creek collected on August 1, 2018.

Waterbody Name	Nokmes Creek	Nokmes Creek	Nokmes Creek	Nokmes Creek
Location	Kinst RD (furthest upstream)	West-bound I-94 weigh station	East-bound I-94 weigh station	Maudin RD (furthest downstream)
Water quality sonde measurements				
Temperature (°C)	20.14	20	18.48	20.24
Dissolved oxygen (mg/l)	5.81	6.29	6.8	7.51
Conductivity (µS/cm)	504	705	926	814
pH	6.73	6.96	6.81	7.27

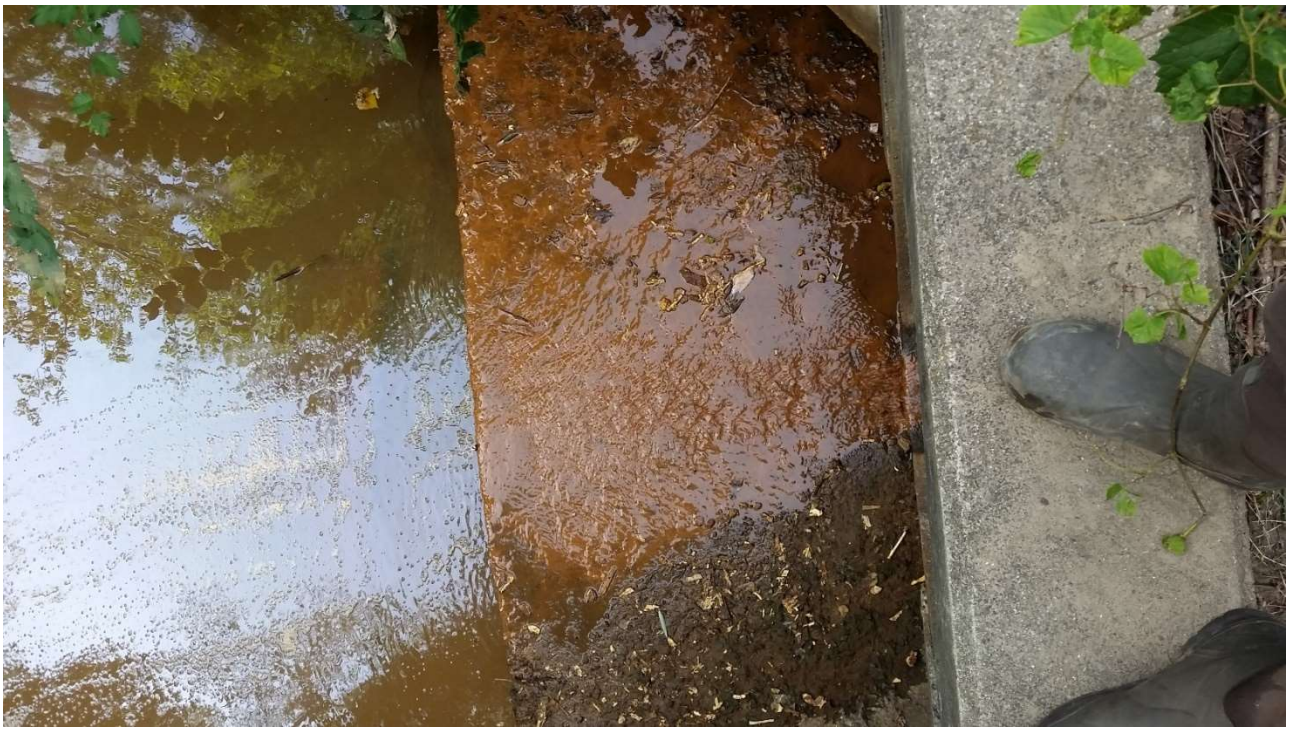

Figure 7. Culvert and water discolored by iron-oxidizing bacteria at Nokmes Creek culvert outlet, west-bound Interstate 94 weigh station.

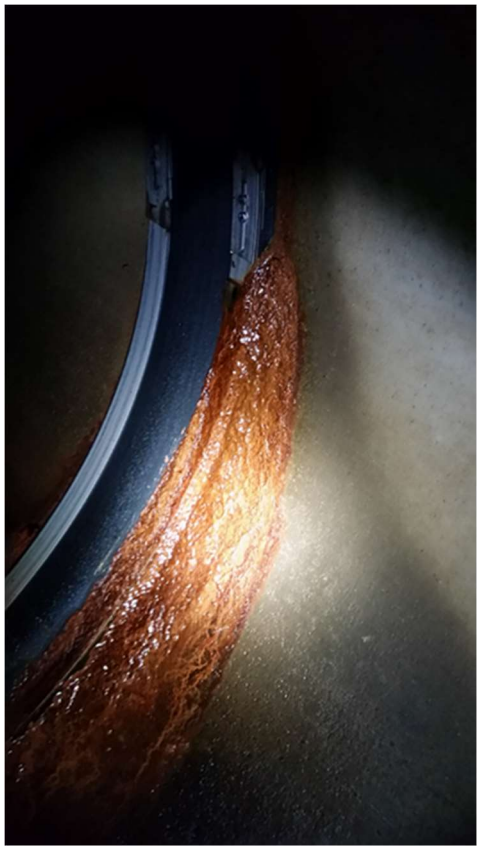

Figure 8. Groundwater seep with bacterial slime from iron-oxidizing bacteria in Nokmes Creek culvert underneath Interstate 94.

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Appendix 1. Qualitative macroinvertebrate results, by station, in the lower and upper Grand River watersheds in Ottawa and Ingham Counties, Michigan, July-August 2017.

METRIC	Unnamed tributary to Lloyd's Bayou 148th AVE (downstream) 7/6/2017 STATION 1 Value	Score	Unnamed tributary to Lloyd's Bayou 148th Ave (upstream) 7/6/2017 STATION 2 Value	Score	Cahaogan Creek Decamp Road 8/29/2017 STATION 3 Value	Score
TOTAL NUMBER OF TAXA	14	1	12	0	25	1
NUMBER OF MAYFLY TAXA	0	-1	0	-1	2	0
NUMBER OF CADDISFLY TAXA	1	0	0	-1	0	-1
NUMBER OF STONEFLY TAXA	0	-1	0	-1	0	-1
PERCENT MAYFLY COMPOSITION	0.00	-1	0.00	-1	5.60	0
PERCENT CADDISFLY COMPOSITION	4.87	0	0.00	-1	0.00	-1
PERCENT DOMINANT TAXON	39.33	-1	49.13	-1	53.73	-1
PERCENT ISOPOD, SNAIL, LEECH	14.23	-1	49.13	-1	7.09	0
PERCENT SURFACE AIR BREATHERS	1.12	1	1.16	1	11.19	0
TOTAL SCORE		-3		-6		-3
MACROINVERTEBRATE COMMUNITY RATING		Acceptable		Poor		Acceptable

TAXA	Unnamed tributary to Lloyd's Bayou 148th AVE (downstream) 7/6/2017 STATION 1	Unnamed tributary to Lloyd's Bayou 148th Ave (upstream) 7/6/2017 STATION 2	Cahaogan Creek Decamp Road 8/29/2017 STATION 3
PLATYHELMINTHES (flatworms)			
Turbellaria	10	19	
ANNELIDA (segmented worms)			
Hirudinea (leeches)			
Oligochaeta (worms)	3		
ARTHROPODA			
Crustacea			
Amphipoda (scuds)	105	140	144
Decapoda (crayfish)			3
Isopoda (sowbugs)	37	170	11
Insecta			
Baetidae			14
Heptageniidae			1
Odonata			
Anisoptera (dragonflies)			
Aeshnidae	1	1	2
Gomphidae			1
Libellulidae			26
Zygoptera (damselflies)			
Calopterygidae	2	2	
Coenagrionidae		1	8
Hemiptera (true bugs)			
Belostomatidae			5
Corixidae			6
Gerridae	1	1	
Mesoveliidae	2	1	1
Notonectidae		1	3
Pleidae			6
Trichoptera (caddisflies)			
Helicopsychidae	13		
Lepidoptera (moths)			
Pyralidae			1
Coleoptera (beetles)			
Dytiscidae (total)			1
Haliplidae (adults)			3
Hydrophilidae (total)			2
Dryopidae			1
Diptera (flies)			
Athericidae	40	1	
Chironomidae	30	8	14
Culicidae		1	
Simuliidae	20		
Tipulidae	2		
MOLLUSCA			
Gastropoda (snails)			
Lymnaeidae	1		
Physidae			1
Planorbidae			4
Viviparidae			3
Pelecypoda (bivalves)			
Sphaeriidae (clams)			5
TOTAL INDIVIDUALS	267	346	268

Appendix 2. Habitat evaluation for selected stations by station, in the lower and upper Grand River watersheds in Ottawa and Ingham Counties, Michigan, July-August 2017.

	STATION 1	STATION 2	STATION 3		
	Unnamed tributary to Lloyd's Bayou	Unnamed tributary to Lloyd's Bayou	Cahaogan Creek		
	148th Ave (upstream)	148th AVE (downstream)	Decamp Road		
	7/6/2017	7/6/2017	8/29/2017		
	GLIDE/POOL	RIFFLE/RUN	GLIDE/POOL		
HABITAT METRIC					
Substrate and Instream Cover					
Epifaunal Substrate/ Avail Cover (20)	15	13	7		
Embeddedness (20)*		6			
Velocity/Depth Regime (20)*		14			
Pool Substrate Characterization (20)**	15		8		
Pool Variability (20)**	10		1		
Channel Morphology					
Sediment Deposition (20)	19	10	11		
Flow Status - Maint. Flow Volume (10)	10	9	9		
Flow Status - Flashiness (10)	9	9	9		
Channel Alteration (20)	19	16	7		
Frequency of Riffles/Bends (20)*		17			
Channel Sinuosity (20)**	17		0		
Riparian and Bank Structure					
Bank Stability (L) (10)	10	1	9		
Bank Stability (R) (10)	10	1	9		
Vegetative Protection (L) (10)	10	1	9		
Vegetative Protection (R) (10)	10	1	9		
Riparian Vegetation Zone Width (L) (10)	6	9	0		
Riparian Vegetation Zone Width (R) (10)	8	9	0		
TOTAL SCORE (200):	168	116	88		
HABITAT RATING:	EXCELLENT	GOOD	MARGINAL		
Date:	7/6/2017	7/6/2017	8/29/2017		
Weather:	Sunny	Sunny	Cloudy		
Air Temperature: °F		84			
Water Temperature: °F	66	68	62		
Ave. Stream Width: Feet	4	3.3	8		
Ave. Stream Depth: Feet	0.2	0.2	0.5		
Surface Velocity: Feet/Second	0.906446002	0.424795322	0.224074074		
Estimated Flow: Cubic Feet/Second	0.700984908	0.341252242	0.824592593		
Stream Modifications:			Dredged		
Nuisance Plants (Y/N):	N	N	N		
STORET No.:	700689	700690	330422		
County Code:	70	70	33		
TRS:	xxxxxxx	xxxxxxx	01N01E15		
Latitude (dd):	43.074818	43.074914	42.47012		
Longitude (dd):	-86.15574	-86.156107	-84.28762		
Ecoregion:	SMNITP	SMNITP	SMNITP		
Stream Type:	Warmwater	Warmwater	Warmwater		
USGS Basin Code:	405006	4050006	4050004		
* Applies only to Riffle/Run stream Surveys	** Applies only to Glide/Pool stream Surveys				
Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).					

Appendix 3. Qualitative fish results, by station, in Indian Mill Creek, Kent County, Michigan, July 2017.

TAXA	Turner St STATION 1	Richmond Park at Tamarack NW STATION 2	Richmond Park u/s dam STATION 3	Sharp DR (lower) STATION 4
Petromyzontidae (lampreys)				
Ichthyomyzon unicuspis (Silver lamprey)	1			
Ichthyomyzon castaneus ammocoete (Chestnut)	1			
Salmonidae (trouts)				
Oncorhynchus mykiss (Rainbow trout)	2	9	2	12
Salmo trutta (Brown trout)	2	9	3	1
Cyprinidae (minnows and carps)				
Semotilus atromaculatus (Creek chub)			1	4
Rhinichthys atratulus (Blacknose dace)				1
Catostomidae (suckers)				
Catostomus commersoni (White sucker)	8	6	16	
Gasterosteidae (sticklebacks)				
Culaea inconstans (Brook stickleback)			1	
Centrarchidae (sunfish)				
Lepomis cyanellus (Green sunfish)	7	2		3
Lepomis gibbosus (Pumpkinseed sf)				2
Lepomis macrochirus (Bluegill sf)	1			7
Micropterus dolomieu (Smallmouth bass)	1			
Percidae (perch)				
Etheostoma nigrum (Johnny darter)			2	5
Gobiidae (gobies)				
Neogobius melanostomus (Round goby)	3			
TOTAL INDIVIDUALS	26	26	25	35
Number of hybrid sunfish	0	0	0	0
Number of anomalies	0	0	0	0
Percent anomalies	0.000	0.000	0.000	0.000
Percent salmonids	15.385	69.231	20.000	37.143
Reach sampled (ft)			-	
Area sampled (sq ft)				
Density (# fish/sq ft)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Gear				

Table 1B. Fish metric evaluation of

METRIC	STATION 1 Value	STATION 1 Score	STATION 2 Value	STATION 2 Score	STATION 3 Value	STATION 3 Score	STATION 4 Value	STATION 4 Score
TOTAL NUMBER OF TAXA	9	0	4	-1	6	0	8	0
NO. OF DARTER, SCULPIN, MADTOM TAXA	0	-1	0	-1	1	0	1	0
NUMBER OF SUNFISH TAXA	2	0	1	0	0	0	3	0
NUMBER OF SUCKER TAXA	1	0	1	0	1	0	0	-1
NUMBER OF INTOLERANT TAXA	5	1	2	-1	2	-1	2	-1
PERCENT TOLERANT	57.69	-1	30.77	0	76.00	-1	37.14	0
PERCENT OMNIVOROUS TAXA	30.77	0	23.08	0	68.00	-1	14.29	1
PERCENT INSECTIVOROUS TAXA	42.31	0	7.69	-1	12.00	-1	48.57	0
PERCENT PISCIVOROUS TAXA	3.85	0	0.00	-1	0.00	-1	0.00	-1
% SIMPLE LITHOPHILIC SPAWNER TAXA	30.77	0	23.08	0	64.00	1	2.86	0
TOTAL SCORE		-1		-5		-4		-2
FISH COMMUNITY RATING		Poor (<50 fish)		Poor (<50 fish)		Poor (<50 fish)		Poor (<50 fish)

Appendix 3. Qualitative fish results, by station, in Indian Mill Creek, Kent County, Michigan, July 2017.

TAXA	Upper Sharp DR STATION 5	Three Mile RD STATION 6	Boy Scout property STATION 7
Salmonidae (trouts)			
Oncorhynchus mykiss (Rainbow trout)	3	4	
Salmo trutta (Brown trout)	3	7	2
Umbridae (mudminnows)			
Umbra limi (Central mudminnow)	1		
Cyprinidae (minnows and carps)			
Campostoma anomalum (Central stoneroller)		1	
Semotilus atromaculatus (Creek chub)	17	9	46
Rhinichthys atratulus (Blacknose dace)	7	23	17
Catostomidae (suckers)			
Catostomus commersoni (White sucker)	3	12	12
Erimyzon sucetta (Lake chubsucker)		1	
Centrarchidae (sunfish)			
Lepomis cyanellus (Green sunfish)	1	2	
Lepomis gibbosus (Pumpkinseed sf)	3		
Lepomis macrochirus (Bluegill sf)	2		
Percidae (perch)			
Etheostoma nigrum (Johnny darter)	1	7	1
TOTAL INDIVIDUALS	41	66	78
Number of hybrid sunfish	0	0	0
Number of anomalies	0	0	0
Percent anomalies	0.000	0.000	0.000
Percent salmonids	14.634	16.667	2.564
Reach sampled (ft)			-
Area sampled (sq ft)			
Density (# fish/sq ft)	#DIV/0!	#DIV/0!	#DIV/0!
Gear			

Table 1B. Fish metric evaluation of

METRIC	STATION 1 Value	STATION 1 Score	STATION 2 Value	STATION 2 Score	STATION 3 Value	STATION 3 Score
TOTAL NUMBER OF TAXA	10	0	9	0	5	-1
NO. OF DARTER, SCULPIN, MADTOM TAXA	1	0	1	0	1	0
NUMBER OF SUNFISH TAXA	3	0	1	0	0	-1
NUMBER OF SUCKER TAXA	1	0	2	0	1	-1
NUMBER OF INTOLERANT TAXA	2	-1	2	-1	1	-1
PERCENT TOLERANT	73.17	-1	80.30	-1	97.44	-1
PERCENT OMNIVOROUS TAXA	68.29	-1	66.67	-1	96.15	-1
PERCENT INSECTIVOROUS TAXA	17.07	-1	15.15	-1	1.28	-1
PERCENT PISCIVOROUS TAXA	0.00	-1	0.00	-1	0.00	-1
% SIMPLE LITHOPHILIC SPAWNER TAXA	24.39	0	53.03	1	37.18	0
TOTAL SCORE		-5		-4		-8
FISH COMMUNITY RATING		Poor		Acceptable		Poor

Appendix 4. Qualitative fish results in the Haven and Max Lake Drain, Van Buren County, Michigan, August 2017.

TAXA	Haven & Max Lake Drain Downstream CR665/42nd Street 8/30/2017 STATION 1
Umbridae (mudminnows)	
Umbra limi (Central mudminnow)	2
Esocidae (pikes)	
Esox americanus (Grass Pike)	1
Cyprinidae (minnows and carps)	
Semotilus atromaculatus (Creek chub)	16
Pimephales notatus (Bluntnose minnow)	25
Rhinichthys atratulus (Blacknose dace)	27
Catostomidae (suckers)	
Catostomus commersoni (White sucker)	1
Centrarchidae (sunfish)	
Lepomis cyanellus (Green sunfish)	9
Lepomis gibbosus (Pumpkinseed sf)	1
Percidae (perch)	
Etheostoma nigrum (Johnny darter)	27
TOTAL INDIVIDUALS	109
Number of hybrid sunfish	
Number of anomalies	
Percent anomalies	
Percent salmonids	
Reach sampled (ft)	
Area sampled (sq ft)	
Density (# fish/sq ft)	
Gear	

Table 1B. Fish metric evaluation of

METRIC	Haven & Max Lake Drain Downstream CR665/42nd Street 8/30/2017 STATION 1 Value	Score
TOTAL NUMBER OF TAXA	9	1
NO. OF DARTER, SCULPIN, MADTOM TAXA	1	0
NUMBER OF SUNFISH TAXA	2	1
NUMBER OF SUCKER TAXA	1	0
NUMBER OF INTOLERANT TAXA	0	-1
PERCENT TOLERANT	98.17	-1
PERCENT OMNIVOROUS TAXA	65.14	-1
PERCENT INSECTIVOROUS TAXA	33.94	0
PERCENT PISCIVOROUS TAXA	0.92	-1
% SIMPLE LITHOPHILIC SPAWNER TAXA	25.69	0
TOTAL SCORE	-2	
FISH COMMUNITY RATING	Acceptable	

Appendix 5. Qualitative macroinvertebrate results, by station, in the Black River and Galien River watersheds in Berrien and Van Buren Counties, Michigan, August-September 2017.

	Haven & Max Lake Drain Downstream CR665/42nd Street 8/30/2017 STATION 1		South Branch Black River 70th Street 8/29/2017 STATION 2		South Branch Black River County Road 380 / 20th Avenue 8/30/2017 STATION 3		Unnamed tributary to Spring Creek Avery Rd 8/31/2017 STATION 4	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	23	0	21	0	14	0	16	0
NUMBER OF MAYFLY TAXA	3	1	2	0	2	0	3	1
NUMBER OF CADDISFLY TAXA	1	-1	5	1	2	0	2	0
NUMBER OF STONEFLY TAXA	0	-1	0	-1	1	1	0	-1
PERCENT MAYFLY COMPOSITION	26.13	1	10.80	0	32.54	1	20.30	1
PERCENT CADDISFLY COMPOSITION	18.12	0	5.63	0	23.02	0	3.01	-1
PERCENT DOMINANT TAXON	21.95	0	30.52	0	27.78	0	47.74	-1
PERCENT ISOPOD, SNAIL, LEECH	0.70	1	0.00	1	0.00	1	0.75	1
PERCENT SURFACE AIR BREATHERS	1.74	1	14.08	0	0.40	1	0.00	1
TOTAL SCORE		2		1		4		1
MACROINVERTEBRATE COMMUNITY RATING		Acceptable		Acceptable		Acceptable		Acceptable

TAXA	Haven & Max Lake Drain Downstream CR665/42nd Street 8/30/2017 STATION 1	South Branch Black River 70th Street 8/29/2017 STATION 2	South Branch Black River County Road 380 / 20th Avenue 8/30/2017 STATION 3	Unnamed tributary to Spring Creek Avery Rd 8/31/2017 STATION 4
PLATYHELMINTHES (flatworms)				
Turbellaria				4
ANNELIDA (segmented worms)				
Oligochaeta (worms)	11	1	5	12
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	63	65	15	21
Decapoda (crayfish)	6	1	1	
Insecta				
Ephemeroptera (mayflies)				
Baetidae	13	1	70	49
Ephemerellidae				3
Heptageniidae	61	22	12	2
Odonata				
Anisoptera (dragonflies)				
Aeshnidae	4	1		1
Zygoptera (damselflies)				
Calopterygidae	13	28	8	6
Plecoptera (stoneflies)				
Peltoperlidae			1	
Hemiptera (true bugs)				
Corixidae		8		
Gerridae	1			
Mesoveliidae	1			
Pleidae		3		
Veliidae		7		
Megaloptera				
Corydalidae (dobson flies)				1
Sialidae (alder flies)	3	1	1	4
Trichoptera (caddisflies)				
Brachycentridae		2	6	7
Hydropsychidae	52	1	52	
Leptoceridae		2		1
Philopotamidae		6		
Polycentropodidae		1		
Coleoptera (beetles)				
Dytiscidae (total)	1	5		
Hydrophilidae (total)	1			
Elmidae	20	2	2	1
Diptera (flies)				
Chironomidae	13	47	57	127
Culicidae	1	7		
Simuliidae	17		21	25
Stratiomyidae			1	
Tabanidae	1	2		
Tipulidae	1			
MOLLUSCA				
Physidae	1			2
Viviparidae	1			
TOTAL INDIVIDUALS	287	213	252	266

METRIC	Galien River Three Oaks RD 8/31/2017 STATION 1 Value	Score	Galien River Upstream Pardee Road 8/31/2017 STATION 2 Value	Score
TOTAL NUMBER OF TAXA	18	0	21	0
NUMBER OF MAYFLY TAXA	2	0	2	0
NUMBER OF CADDISFLY TAXA	1	-1	2	0
NUMBER OF STONEFLY TAXA	0	-1	0	-1
PERCENT MAYFLY COMPOSITION	10.84	0	3.76	0
PERCENT CADDISFLY COMPOSITION	1.20	-1	3.38	-1
PERCENT DOMINANT TAXON	53.41	-1	48.87	-1
PERCENT ISOPOD, SNAIL, LEECH	0.40	1	0.38	1
PERCENT SURFACE AIR BREATHERS	56.63	-1	1.88	1
TOTAL SCORE		-4		-1
MACROINVERTEBRATE COMMUNITY RATING		Acceptable		Acceptable

TAXA	Galien River Three Oaks RD 8/31/2017 STATION 1	Galien River Upstream Pardee Road 8/31/2017 STATION 2
ANNELIDA (segmented worms)		
Hirudinea (leeches)		
Oligochaeta (worms)	20	3
ARTHROPODA		
Crustacea		
Amphipoda (scuds)	24	130
Decapoda (crayfish)	1	3
Isopoda (sowbugs)	1	
Insecta		
Ephemeroptera (mayflies)		
Baetidae	25	7
Heptageniidae	2	3
Odonata		
Aeshnidae		11
Zygoptera (damselflies)		
Calopterygidae	5	50
Hemiptera (true bugs)		
Corixidae	133	
Gerridae	3	
Mesoveliidae	3	
Pleidae		2
Veliidae	1	1
Megaloptera		
Corydalidae (dobson flies)		1
Sialidae (alder flies)		2
Trichoptera (caddisflies)		
Brachycentridae		5
Hydropsychidae	3	4
Coleoptera (beetles)		
Dytiscidae (total)	1	
Elmidae	4	2
Diptera (flies)		
Athericidae	1	
Chironomidae	20	27
Culicidae		2
Dixidae	1	1
Simuliidae		6
Tabanidae	1	4
Tipulidae		1
MOLLUSCA		
Physidae		1
TOTAL INDIVIDUALS	249	266

Appendix 6. Habitat evaluation for selected stations in the Black River and Galien River watersheds in Berrien and Van Buren Counties, Michigan, August-September 2017.

	STATION 1	STATION 2	STATION 3	STATION 4	STATION 5
	Haven & Max Lake Drain	South Branch Black River	South Branch Black River	Unnamed tributary to Spring Creek	Galien River
	Downstream CR665/42nd Street	70th Street	County Road 380 / 20th Avenue	Avery Rd	Three Oaks RD
	8/30/2017	8/29/2017	8/30/2017	8/31/2017	8/31/2017
	RIFFLE/RUN	GLIDE/POOL	GLIDE/POOL	GLIDE/POOL	GLIDE/POOL
HABITAT METRIC					
Substrate and Instream Cover					
Epifaunal Substrate/ Avail Cover (20)	10	15	8	6	11
Embeddedness (20)*	13				
Velocity/Depth Regime (20)*	15				
Pool Substrate Characterization (20)**		10	7	6	8
Pool Variability (20)**		19	5	1	7
Channel Morphology					
Sediment Deposition (20)	15	16	10	16	16
Flow Status - Maint. Flow Volume (10)	8	9	9	9	9
Flow Status - Flashiness (10)	9	9	1	9	4
Channel Alteration (20)	15	19	17	6	15
Frequency of Riffles/Bends (20)*	13				
Channel Sinuosity (20)**		10	6	0	6
Riparian and Bank Structure					
Bank Stability (L) (10)	8	8	5	9	9
Bank Stability (R) (10)	9	8	5	9	9
Vegetative Protection (L) (10)	6	9	4	7	9
Vegetative Protection (R) (10)	6	9	4	7	9
Riparian Vegetation Zone Width (L) (10)	3	10	7	1	9
Riparian Vegetation Zone Width (R) (10)	0	10	10	1	9
TOTAL SCORE (200):	130	161	98	87	130
HABITAT RATING:	GOOD	EXCELLENT	MARGINAL	MARGINAL	GOOD
Date:	8/30/2017	8/29/2017	8/30/2017	8/31/2017	8/31/2017
Weather:	Sunny		Sunny	Partly Cloudy	
Air Temperature: °F	58				
Water Temperature: °F	58	60	60	58	62
Ave. Stream Width: Feet	7.7	58	34.3	8.3	34
Ave. Stream Depth: Feet	0.8		1.3	0.9	1.5
Surface Velocity: Feet/Second	0.772727273		1.409090909	1.12037037	0.606896552
Estimated Flow: Cubic Feet/Second	4.785757576		61.88727273	8.343024691	30.81416092
Stream Modifications:	Habitat Improvement	None	None	Dredged	Canopy Removal
Nuisance Plants (Y/N):	N	N	N	N	N
STORET No.:	800568	800572	800532	110812	110806
County Code:	80	80	80	11	11
TRS:	01S14W17	01S16W06	01S16W33		xxxxxxx
Latitude (dd):	42.37978	42.41533	42.34631	41.77685	41.84787
Longitude (dd):	-85.95882	-86.22527	-86.18678	-86.57214	-86.6097
Ecoregion:	SMNITP	SMNITP	SMNITP	SMNITP	SMNITP
Stream Type:	Warmwater	Coldwater	Coldwater		
USGS Basin Code:	4050002	4050002	4050002	4040001	4040001
* Applies only to Riffle/Run stream Surveys	** Applies only to Glide/Pool stream Surveys				
Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).					

	STATION 6				
	Galien River				
	Upstream Pardee Road (Along Elm Valley Road)				
	8/31/2017				
	GLIDE/POOL				
HABITAT METRIC					
Substrate and Instream Cover					
Epifaunal Substrate/ Avail Cover (20)	8				
Embeddedness (20)*					
Velocity/Depth Regime (20)*					
Pool Substrate Characterization (20)**	7				
Pool Variability (20)**	1				
Channel Morphology					
Sediment Deposition (20)	1				
Flow Status - Maint. Flow Volume (10)	9				
Flow Status - Flashiness (10)	1				
Channel Alteration (20)	11				
Frequency of Riffles/Bends (20)*					
Channel Sinuosity (20)**	1				
Riparian and Bank Structure					
Bank Stability (L) (10)	2				
Bank Stability (R) (10)	2				
Vegetative Protection (L) (10)	5				
Vegetative Protection (R) (10)	5				
Riparian Vegetation Zone Width (L) (10)	1				
Riparian Vegetation Zone Width (R) (10)	1				
TOTAL SCORE (200):	55				
HABITAT RATING:	**POOR**				
Date:	8/31/2017				
Weather:	Partly Cloudy				
Air Temperature: ^{o}F					
Water Temperature: ^{o}F	59				
Ave. Stream Width: Feet	17				
Ave. Stream Depth: Feet	0.5				
Surface Velocity: Feet/Second	0.890723541				
Estimated Flow: Cubic Feet/Second	7.167355426				
Stream Modifications:	Relocated				
Nuisance Plants (Y/N):	N				
STORET No.:	110651				
County Code:	11				
TRS:	07S19W33				
Latitude (dd):	41.827198				
Longitude (dd):	-86.532659				
Ecoregion:	SMNITP				
Stream Type:	Coldwater				
USGS Basin Code:	4040001				
* Applies only to Riffle/Run stream Surveys	** Applies only to Glide/Pool stream Surveys				
Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).					