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MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
SEPTEMBER 2017
STAFF REPORT

BIOLOGICAL SURVEY OF SELECTED STATIONS IN THE CASS RIVER WATERSHED IN SAGINAW, TUSCOLA, GENESEE, LAPEER, SANILAC, AND HURON COUNTIES, MICHIGAN, JUNE-SEPTEMBER 2016.

Introduction

Biological and physical habitat surveys of selected water bodies in the Cass River watershed (HUC8_04080205) were conducted from June to September 2016 as part of the Michigan Department of Environmental Quality (MDEQ), Surface Water Assessment Section's (SWAS) 5-year rotating basin monitoring design. Macroinvertebrate and habitat surveys were completed at 7 probabilistic sites and 10 trend sites following the SWAS Procedure 51 for wadeable streams (MDEQ, 1990). Four additional sites within the Cass River watershed were surveyed to address targeted monitoring requests.

Specific monitoring objectives were to:

1) Assess the current status and condition of individual assessment units and determine whether Water Quality Standards (WQS) are being met
2) Evaluate biological integrity temporal trends
3) Address monitoring requests submitted by internal and external customers
4) Identify nonpoint sources (NPS) of water quality impairment or concern

Watershed Information

The Cass River watershed is located in the thumb region of Michigan's Lower Peninsula. It drains over 580,000 acres and is part of the larger Saginaw Bay watershed (Shiawassee River, Cass River, Flint River, and Tittabawassee River). The mainstem Cass River is a warmwater river formed at the confluence of the North and South Branch Cass Rivers in northeast Tuscola County. The river then flows west to southwest through the communities of Caro, Wahjamega, Vassar, Tuscola, Frankenmuth, and Bridgeport before joining the Shiawassee River south of Saginaw, Michigan. The Cass River watershed is primarily within the Huron Erie Lake Plains Level III Ecoregion characterized by broad, fertile, nearly flat plains with some relic sand dunes, beach ridges, and end moraines (Omernik and Gallant, 2010). The area has been extensively modified to facilitate agricultural drainage, with greater than 40 percent cultivated crop and 16 percent pasture/hay land cover in the watershed (Table 1; Figure 1). The southern portion of the watershed is within the Southern Michigan/Northern Indiana Drift Plains and contains a greater diversity of landforms, soil types, soil textures, and land cover compared to the Huron Erie Lake Plains (Omernik and Gallant, 2010).

Although heavily modified for agriculture use, the Cass River watershed contains greater than 30 percent deciduous forest, woody wetlands, evergreen forests, or mixed forest (Table 1). The largest remaining expanses of forest, and potentially most important due to their proximity to the Cass River, are state and federal lands (~36,000 acres; Figure 2). State game areas alone account for over 31,000 acres within the watershed. In addition, approximately 4,000 acres of

the 9,800-acre Shiawassee National Wildlife Refuge falls within the lower Cass River watershed (Figure 2).

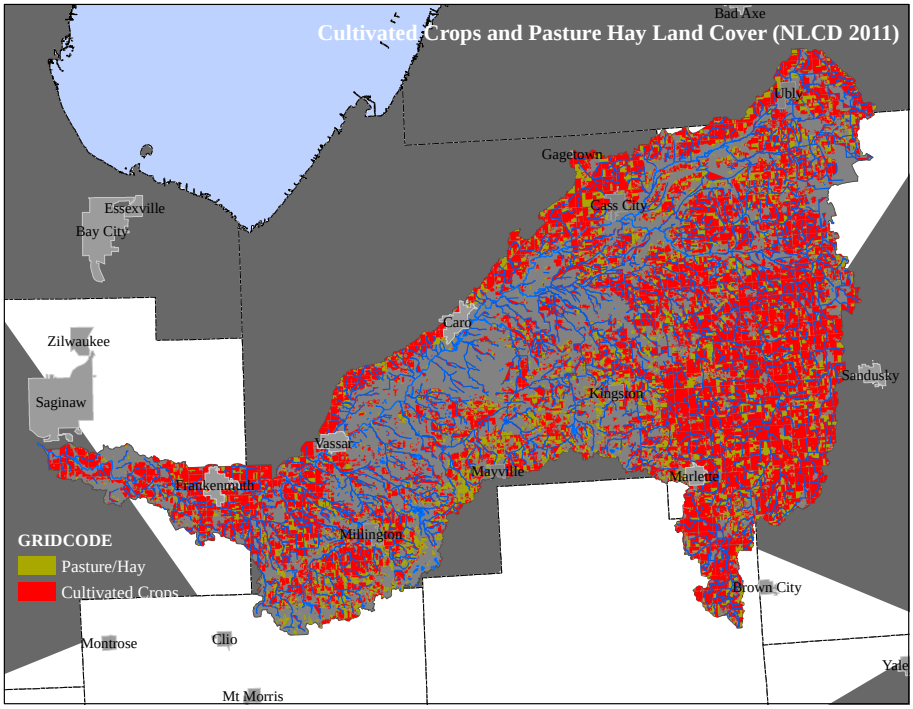


Figure 1. Cultivated Crop and Pasture/Hay Land Cover in the Cass River Watershed (Homer et al., 2015).

The Cass River watershed contains primarily small communities. The most densely populated areas located within the watershed are the city of Frankenmuth, with a population of 4,944 and Bridgeport Charter Township (partially located within the watershed) with a population of 10,514 according to the 2010 Census. Both communities are located in the lower end of the watershed.

Table 1. Land Cover in the Cass River Watershed (Homer et al., 2015).

Land Cover	Percent of Watershed
Cultivated Crops	40.90
Deciduous Forest	18.49
Pasture/Hay	16.06
Woody Wetlands	11.78
Developed, Open Space	4.69
Developed, Low Intensity	2.32
Grassland/Herbaceous	1.96
Emergent Herbaceous Wetlands	0.98
Evergreen Forest	0.86
Mixed Forest	0.73
Developed, Medium Intensity	0.36
Open Water	0.28
Shrub/Scrub	0.27
Barren land	0.17
Developed, High Intensity	0.16

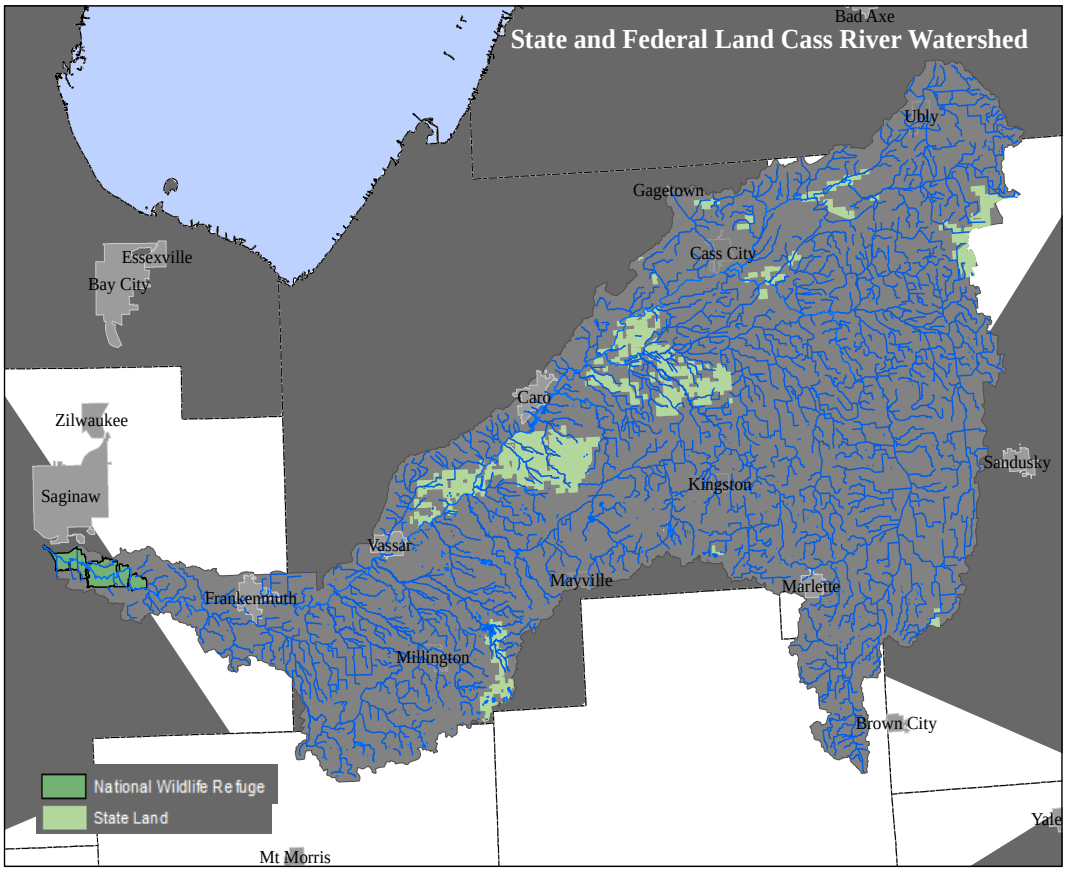


Figure 2.State and Federal Lands in the Cass River Watershed.

Historical Sampling Efforts and Information

Recent biological surveys of the Cass River watershed occurred in 2001, 2006, and 2011. Results of the most recent biological surveys are summarized below:

- In 2001, 26 sites were sampled within the Cass River watershed. Macroinvertebrates scored Poor at 3 sites, Acceptable at 20 sites, Excellent at 2 sites, and were not rated at 1 site. Habitat scored Poor at 3 sites, Fair at 11 sites, Good at 10 sites, Excellent at 1 site, and was not rated at 1 site (Cooper, 2001).

- In 2006, 42 sites were sampled within the Cass River Watershed. Macroinvertebrates scored Poor at 4 sites, Acceptable at 33 sites, and Excellent at 5 sites. Habitat scored Poor at 1 site, Marginal at 15 sites, Good at 22 sites, and Excellent at 2 sites (2 nonwadeable sites not rated; Cooper, 2007).

- In 2011, 32 sites were sampled within the Cass River watershed. Macroinvertebrates scored Poor at 2 sites, Acceptable at 28 sites, and Excellent at 2 sites. Habitat scored Marginal at 13 sites, Good at 18 sites, and Excellent at 1 site (Keiper and Cooper, 2011).

Methods

Biological surveys were completed at 21 sites in the Cass River watershed from June to September 2016 (Table 2, Figure 3). Seven sites were randomly selected using a stratified random site-selection method to determine statewide attainment, and 10 sites were chosen to track temporal trends in biological data following the SWAS's Biological Monitoring Status and Trend Procedure (MDEQ, 2015; Table 2). Four additional sites within the Cass River watershed were sampled to fulfill targeted monitoring requests (Table 2). Three site visits were also completed to address a targeted monitoring request, but biological surveys were not performed. All biological surveys were completed following the SWAS Procedure 51 (MDEQ, 1990).

Procedure 51 assigns a score to macroinvertebrate communities and habitat conditions using metrics that rate macroinvertebrates as Excellent (> 4), Acceptable (+ 4 to - 4), or Poor (< 4) based on the macroinvertebrate community composition and structure, and habitat as Excellent (> 154), Good (105 to 154), Marginal (56 to 104), or Poor (< 56) based on several parameters that describe in-stream and riparian conditions (Creal et al., 1996).

Site Selection

Two site-selection methods were used to assess the Cass River watershed in 2016: (1) stratified random; and (2) targeted. Seventeen randomly selected sites were assigned to support the SWAS Status (7 sites) and Trend (10 sites) Program. These sites will be used in part, to determine attainment status for the Other Indigenous Aquatic Life and Wildlife (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 to facilitate a measurement of biological community temporal trends (MDEQ, 2015).

Targeted sites were solicited from internal and external customers in the fall of 2015. Requests were then ranked following a series of meetings involving Water Resources Division managers, watershed biologists, permit biologists, NPS staff, district staff, and water quality/topic specialists based on the severity of the water quality concern, potential ongoing impacts to surface waters, available resources, division priorities, and other factors. These rankings were then used to determine the requests that will be fulfilled in 2016. Six stations within the Cass River watershed were selected for targeted monitoring in 2016.

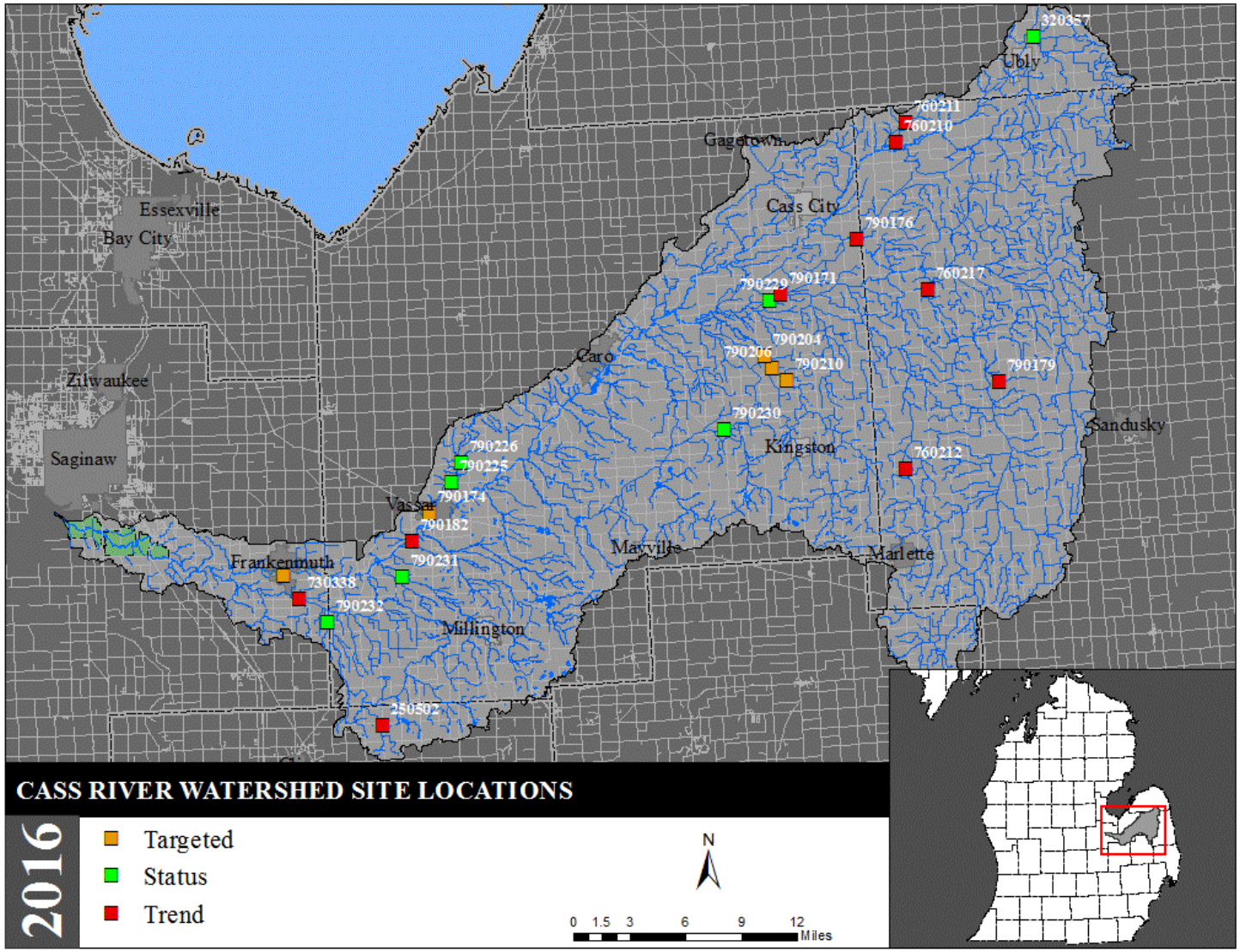


Figure 3. Status, Trend, and Targeted Sites within the Cass River Watershed 2016.

2016 Sampling Results

Table 2. Sites sampled in the Cass River Watershed in 2016.

STATUS									
Waterbody	**Location**	**STORET**	**AUID**	**County**	**Date**	**Macro Score**	**Category**	**Habitat Score**	**Category**
North Branch Cass River	Jurgess Rd	320357	040802050108-01	Huron	8/4/2016	1	Acceptable	98	Marginal
Moore Drain (also Targeted)	Waterman Rd	790225	040802050209-03	Tuscola	7/21/2016	-2	Acceptable	66	Marginal
Unnamed Tributary	Plain Rd	790230	040802050206-02	Tuscola	8/4/2016	0	Acceptable	61	Marginal
North Branch White Creek	Shabbona Rd	790229	040802050202-01	Tuscola	8/4/2016	-1	Acceptable	131	Good
Moore Drain (also Targeted)	Sanilac Rd	790226	040802050209-03	Tuscola	7/21/2016	-4	Acceptable	105	Good
Millington Creek	Ormes Rd	790231	040802050303-01	Tuscola	8/5/2016	0	Acceptable	100	Marginal
Dead Creek	Sargent Rd	790232	040802050304-01	Tuscola	8/5/2016	3	Acceptable	110	Good
TREND									
Waterbody	**Location**	**STORET**	**AUID**	**County**	**Date**	**Macro Score**	**Category**	**Habitat Score**	**Category**
Dead Creek	E Townline Rd	730338	040802050304-01	Saginaw	6/30/2016	-1	Acceptable	130	Good
Dead Creek	Center Rd (south)	250502	040802050304-02	Genesee	6/30/2016	-1	Acceptable	71	Marginal
Turtle Creek	Wheeler Rd	790179	040802050106-02	Sanilac	6/28/2016	-4	Acceptable	70	Marginal
Sanilac Huron Creek	Ritter Rd	760292	040802050109-01	Sanilac	6/29/2016	2	Acceptable	138	Good
White and Moffatt Drain	Dennis Rd	760212	040802050201-01	Sanilac	6/28/2016	-3	Acceptable	84	Marginal
Sanilac Huron Creek	Bay Forestville Rd	760293	040802050109-01	Sanilac	6/29/2016	1	Acceptable	90	Marginal
N B White Creek	McArthur Rd	790171	040802050202-01	Tuscola	6/29/2016	-3	Acceptable	94	Marginal
S B Cass River	Shabbona Rd	760217	040802050106-03	Sanilac	6/28/2016	-4	Acceptable	69	Marginal
S B Cass River	off Kelly Rd	790176	040802050110-01	Tuscola	6/28/2016	-6	Poor	116	Good
Cass River	off Pinkerton Rd	790182	040802050303-02	Tuscola	6/30/2016	5	Excellent	145	Good
TARGETED									
Waterbody	**Location**	**STORET**	**AUID**	**County**	**Date**	**Macro Score**	**Category**	**Habitat Score**	**Category**
South Branch White Creek	Arthur Rd	790210	040802050203-01	Tuscola	9/21/2016	2	Acceptable	131	Good
South Branch White Creek	Phillips Rd	790206	040802050203-01	Tuscola	9/21/2016	-2	Acceptable	154	Good
South Branch White Creek	Mushroom Rd	790204	040802050203-01	Tuscola	9/21/2016	1	Acceptable	139	Good
Moore Drain (also Status)	Sanilac Rd	790226	040802050209-03	Tuscola	7/21/2016	-4	Acceptable	105	Good
Moore Drain (also Status)	Waterman Rd	790225	040802050209-03	Tuscola	7/21/2016	-2	Acceptable	66	Marginal
Moore Drain	Spring St	790174	040802050209-03	Tuscola	7/21/2016	-2	Acceptable	112	Good

Summary of Findings by Monitoring Objective

Objective 1: Assess the current status and condition of individual assessment units and determine whether WQS are being met

In 2016, aquatic macroinvertebrate community and habitat assessments were completed at a total of 21 stations in the Cass River watershed, 7 of which were randomly selected status sites.

Figure 4. North Branch Cass River (downstream of Jurgess Road) 2016.

North Branch Cass River (Downstream of Jurgess Road)

The North Branch Cass River originates from a series of agricultural drains in south-central Huron County. The river then flows southwest joining the South Branch Cass River near Cass City, Michigan to form the mainstem Cass River. One site on the North Branch Cass River, near its origin, was sampled in 2016.

The North Branch Cass River at Jurgess Road is a highly modified and channelized drainage ditch bordered by an agricultural field to the south and mixed deciduous forest to the north. Macroinvertebrates scored Acceptable (1) in 2016 with 27 taxa present, only 5 of which were Ephemeroptera, Plecoptera, and Tricoptera (EPT) taxa (Table 4). The stream is typical of maintained drains in the area, and was characterized by steep banks dominated by herbaceous vegetation. In-stream substrate consisted of fairly firm gravel and cobble substrate covered in algae, transitioning to silt further downstream. Low to moderate in-stream submerged vegetation was present, including invasive curly leaf pondweed. Habitat at this site scored Marginal (98) in 2016 (Table 3).

Figure 5. North Branch White Creek (upstream Shabbona Road) 2016.

North Branch White Creek (Shabbona Road)

White Creek is a major tributary to the middle Cass River. Tributaries to White Creek include Deer Lick Drain, North Branch White Creek, South Branch White Creek, and Butternut Drain. Collectively, these White Creek HUC 12 watersheds (040802050202, 040802050203, 040802050204) make up approximately 11 percent of the Cass River watershed. Only 1 status site was located within the White Creek subwatershed in 2016.

The North Branch White Creek was sampled upstream of Shabbona Road in 2016 (approximately 1.2 miles downstream of the North Branch White Creek Trend site at McArthur Road). At Shabbona Road macroinvertebrates scored Acceptable (-1), while habitat scored Good (131). The stream was well shaded but missing canopy trees on the right bank. The stream had a fair amount of bottom contour complexity with an alternating riffle pool sequence; however, the majority of available substrate was covered in silt. Few mayfly and caddisfly taxa were present, and overall only 19 taxa were found, the most abundant of which was Elmidae (Table 4). This reach also had a fair amount of mussels (e.g., wabash pigtoe, threeridge) present, and invasive rusty crayfish were abundant throughout the reach.

Unnamed Tributary (Plain Road)

Figure 6. Unnamed Tributary (upstream Plain Road) 2016.

The unnamed tributary upstream of Plain Road is a straightened, channelized, and maintained drain. In 2016, macroinvertebrates scored Acceptable (0), while habitat scored Marginal (61) (Tables 3 and 4). The macroinvertebrate community was made up of 28 taxa, 5 of which were EPT taxa. Riparian vegetation consisted entirely of herbaceous vegetation for approximately 15 meters on each side of the stream and there was an obvious lack of riparian woody shrubs and trees, and consequently, in-stream woody debris.

Moore Drain (Waterman Road and Sanilac Road)

Moore Drain is a tributary to the Cass River near Vassar, Michigan. Two sites on Moore Drain were selected as status sites in 2016. This tributary has been extensively modified in recent years and was also evaluated in 2016 as part of a targeted monitoring request (see Objective 3). Macroinvertebrates scored Acceptable (-2) upstream of Waterman Road and Acceptable (-4) upstream of Sanilac Road (Table 4), while habitat scored Marginal (66) upstream of Waterman Road and barely within the Good category (105) upstream of Sanilac Road (Table 3).

Millington Creek (Ormes Road)

Figure 7. Millington Creek (upstream Ormes Road) 2016.

Millington Creek upstream of Ormes Road is a flashy, warmwater tributary to the lower Cass River. The stream in this reach had a decent amount of stable substrate and abundant in-stream woody debris but sediment covered much of the available habitat and overall habitat scored Marginal in 2016 (100; Table 3). Eroding banks were evident just upstream of the bridge and throughout the reach extending from Ormes Road upstream to Vassar Road. Macroinvertebrates at this site scored Acceptable (0) with Amphipods dominating the community and all EPT taxa combined making up only about ~15 percent of the community (Table 4).

Figure 8. Dead Creek (upstream Sargent Road) 2016.

A section of stream between Ormes Road and Vassar Road (from 43.31632, -83.59837 to 43.31449, -83.590168) was walked as part of an MDEQ, Permits Section, investigation of the old Dykhouse Pickle facility. The stream in this section was sinuous with a good amount of large woody debris, and evidence of high and flashy flows. In-stream habitat was similar to the reach surveyed upstream of Ormes Road.

Dead Creek (Sargent Road)

Dead Creek upstream of Sargent Road is a straightened road-side ditch, but contained a surprising amount of in-stream habitat and complexity. Woody debris was abundant and the stream was well shaded even though riparian width was less than 10 meters on the west bank and was bordered by an agricultural field on the east bank. Concrete slabs stabilized the west bank along the road, but also

provided some in-stream substrate. Overall, habitat for this site scored Good (110) and macroinvertebrates scored Acceptable (3) (Tables 3 and 4).

Objective 2: Evaluate biological integrity temporal trends

Biological integrity temporal trends were evaluated by sampling 10 sites once every 5 years. Two sites were sampled at different locations in different years (i.e., upstream vs. downstream of the road-stream crossing), and therefore, the ability to monitor trends at these sites will not be possible until after the next round of sampling in 2020. For the remaining 8 sites, the majority of macroinvertebrate scores either remained similar (2 sites) or declined over the 15-year period (6 sites) with the exception of Turtle Creek at Wheeler Road and Dead Creek at Center Road, which improved slightly (although Dead Creek likely reverted back to Poor since the 2016 sampling event – see details below).

Sanilac Huron Creek (Bay Forestville Road)

Figure 9. Sanilac Huron Creek (upstream Bay Forestville Road) 2016.

Sanilac Huron Creek is a small tributary to the North Branch Cass River near Sanilac State Game Area. In 2006, Sanilac Huron Creek was sampled downstream of Bay Forestville Road and found to have Acceptable macroinvertebrates (-2) and Marginal habitat (59). In 2011, the stream was sampled upstream of the road-stream crossing, making it difficult to assess trends. The upstream site had Acceptable macroinvertebrates (-4) and Marginal habitat (79). In 2016, it was decided that the upstream site would be sampled and this would become the new trend site. The stream in this reach is a narrow, straightened ditch with grasses and cattails dominating the riparian vegetation and no shrubs or trees present. In-stream substrate was dominated by sand and gravel and some riffles and small pools were evident. Macroinvertebrates scored Acceptable (1) while habitat scored Marginal (90) (Tables 3 and 4).

Sanilac Huron Creek (Ritter Road)

Figure 10. Sanilac Huron Creek (upstream Ritter Road) 2016.

Similar to the Sanilac Huron Creek site at Bay Forestville Road, the site at Ritter Road (~1 mile downstream) was sampled at different locations in 2006 and 2011 making trend analysis difficult. In 2006, Sanilac Huron Creek was sampled downstream of the road-stream crossing and found to have Acceptable macroinvertebrates (1) and Good habitat (105). In 2011, the stream was sampled upstream of the road-stream crossing and found to have Acceptable macroinvertebrates (1) and Good (136) habitat. In 2016, it was decided that the upstream site would be sampled and this would become the new trend site. Substrate at this site consisted of cobble on bedrock with some depositional areas. Most of the stream was bordered by mixed deciduous forest, had abundant overhanging vegetation, and some aquatic macrophytes, but little in-stream woody debris. Macroinvertebrates in this reach scored Acceptable (2) while habitat scored Good (138) (Tables 3 and 4).

Turtle Creek (Wheeler Road)

Figure 11. Turtle Creek (upstream Wheeler Road) 2016.

Turtle Creek is currently listed as not supporting the OIALW, Fish Consumption, Total Body Contact Recreation, and Partial Body Contact Recreation Designated Uses. Turtle Creek is a highly modified county drain and several previous surveys have shown its characteristics, along with a history of illicit connections and pollution problems, are not conducive to high quality macroinvertebrate assemblages. A survey in 1989 noted a poor biological community due to low current velocity and stream flow, and poor habitat (Masterson, 1989). In a 2006 survey of the stream, Turtle Creek was described as a "health hazard" due to illicit sewer connections from the community of Snover and observations of sanitary sewers flowing directly into the creek (Cooper, 2007). Macroinvertebrates scored Poor (-7), as did habitat (54) in the 2006 survey.

In 2007, a wastewater sewage lagoon was placed in service addressing at least some of the illicit connections, and likely resulted in an improvement in water quality. However, in 2011, Turtle Creek macroinvertebrates still scored low Acceptable (-2), while habitat was Marginal (78), and presence of algae was again noted indicating problems may still exist. Similar observations were noted in 2016. In 2016, Turtle Creek had very little current velocity. The riparian areas were similar to previous years and abundant dead algae was found. The stream had a borderline Poor macroinvertebrate score of Acceptable (-4), and Marginal habitat (70) (Tables 3 and 4). A 5-week E. coli study was also completed in 2016 and found that there may still be illicit connections or failing septic systems in the area, indicated by high E.coli in dry weather and during low flows (draft MDEQ Report). The creek will be proposed as part of the draft statewide E. coli TMDL (www.Michigan.gov/ecolitmdl).

South Branch Cass River (Shabbona Road)

Figure 12. South Branch Cass River (upstream Shabbona Road) 2016.

The South Branch Cass River is a maintained drain and is highly modified throughout most of its length. There was a fair amount of cobble throughout the sampled reach; however, most available habitat was covered in silt. As is the case in most maintained drains, the South Branch Cass River in this area was very uniform in depth and contained little habitat complexity. Macroinvertebrates have scored Acceptable in all years; however, the scores have gotten progressively worse since 2006, moving from high acceptable in 2006 (2) to low acceptable in 2016 (-4). The most notable decline is in number of mayfly taxa (5 to 1 taxa), and percent mayfly composition (22.3 to 1.42 percent). Habitat scores have also declined since 2006 (2006: 107; 2011: 69; and 2016: 69), with lower scores for available habitat, bank stability, and vegetative protection.

South Branch Cass River (Kelly Road)

The South Branch Cass River at Kelly Road had poor macroinvertebrates (-6) and Good habitat (116) in 2016. The channel in this reach is fairly uniform with silt lining the margins of the river and sand dominating the middle of the channel. A few gravel patches were noted in parts of the channel, but stable habitat was lacking throughout most of the reach. In-stream vegetation including lily pads in the center of the channel, and emergent vegetation in the margins, made up most of the stable habitat available for colonization. Similar conditions were noted in the

2006 report, although macroinvertebrates scored slightly higher in 2006 (-4) and 2011 (-2). Less available habitat and pool variability, along with greater flashiness noted in 2016 likely led to the lower habitat score in 2016 (116) compared to 2006 (137) and 2011 (128).

White and Moffatt Drain (Dennis Road)

White and Moffatt Drain is a straightened, channelized, drain that flows into the North Branch White Creek in western Sanilac County. Surrounding landscape has changed little in the past 15 years and macroinvertebrates and habitat have remained similar. In 2006, the macroinvertebrate community scored Acceptable (-1), while habitat scored Marginal (88). In 2011, the macroinvertebrate community scored Poor (-5), while habitat scored Marginal (68). In 2016, the macroinvertebrate community scored Acceptable (-3), while habitat scored Marginal (84). Macroinvertebrates in this reach will likely remain at the lower end of Acceptable pending drastic changes in drain maintenance practices and current land use in the surrounding watershed.

Figure 13. White and Moffatt Drain (upstream Dennis Road) 2016.

North Branch White Creek (McArthur Road)

North Branch White Creek is a moderate size, low gradient tributary to the Cass River. Habitat at this site scored higher in 2006 (124), and similar in 2011 (91) and 2016 (94). There was less than desirable available habitat in all years due to siltation. Macroinvertebrates scored Acceptable in all 3 years, although there were fewer mayfly taxa and less percent mayfly and caddisfly composition in 2016, leading to a lower score in 2016 (2006: 0; 2011: 0; 2016: -3). This site also had abundant rusty crayfish and a few dense mussel beds.

Figure 14. North Branch White Creek (upstream McArthur Road) 2016.

Cass River (Pinkerton Road)

The Cass River at Pinkerton Road is a reach typical of the mainstem Cass River between Caro and Frankenmuth, characterized by wide, shallow reaches with shallow pools, occasional riffles, and a good variety of substrate, and in-stream habitat. Emergent vegetation lines the margin of the river in this section and provides excellent habitat for macroinvertebrates. Habitat scored Good in all years and was very similar in 2006 (136), 2011 (138), and 2016 (145). Macroinvertebrates scored Excellent in 2006 (6), 2011 (6), and 2016 (5).

Figure 15. Cass River at Pinkerton Road (looking downstream from top of reach) 2016.

Dead Creek (Center Road)

Dead Creek at Center Road is a maintained drain that has been dredged at least twice in the last 15 years. During the 2006 survey, dredging was occurring during sampling and thought to be the cause of the Poor (-6) macroinvertebrate community and Marginal (69) habitat observed (Cooper, 2007). Macroinvertebrate scores were much higher in

Figure 16. Dead Creek (upstream Center Road) - June 2016.

2011 (Macroinvertebrates: Acceptable (1); Habitat: Good (112)) when dredging was not occurring and similar, although slightly lower, in 2016 (Macroinvertebrates: Acceptable (-1); Habitat: Good (71)). Sometime between sampling in June 2016 and February 2017 this reach was again dredged and riparian habitat removed (personal observation, K. Turek) possibly as part of a culvert replacement (new bridge was constructed around this same time at the road-stream crossing). In February 2017, no vegetation remained and the banks were completely covered in rolled straw. This likely influenced the macroinvertebrate community a great deal, as overhanging riparian vegetation accounted for the majority of available macroinvertebrate habitat at this site. The macroinvertebrate community at this site will likely fluctuate with continued dredging, seeing improvements in the community as the stream recovers until the next dredging when it will likely revert back to a Poor community.

Dead Creek (Townline Road)

Figure 17. Dead Creek (upstream Townline Road) 2016.

Dead Creek at Townline Road had an Acceptable (-1) macroinvertebrate community and Good (130) habitat in 2016 (Tables 3 and 4). This reach had little in-stream vegetation and some overhanging vegetation and rootwads, the majority of which was unavailable to macroinvertebrates due to low flows. There was a good mix of stable substrate and velocity/depth regimes, but also a fair amount of embeddedness. This site scored similar in 2006 (Macroinvertebrates: Acceptable (0); Habitat: Good (145)), and 2011 (Macroinvertebrates: Acceptable (0); Habitat: Good (140)). The slightly lower score in 2016 was due to a decrease in number of mayfly and caddisfly taxa (Table 4). Habitat was similar among years with slightly more embeddedness and sediment deposition in 2016 than previous years. However, flows were also lower in 2016, which may have resulted in the increased deposition and thus embeddedness.

Objective 3: Address monitoring requests submitted by internal and external customers

Three targeted monitoring requests, including 6 sites, were addressed in 2016 on the South Branch White Creek (3 sites), Moore Drain (2 sites), and Cass River at the Frankenmuth Rock Ramp (1 site).

South Branch White Creek 2016177

South Branch White Creek at Phillips Road had a poor macroinvertebrate community in 2011 (-6). However, macroinvertebrate communities at sites approximately 1 mile upstream and 1 mile downstream scored much higher in 2011 (4 and 0, respectively). All sites had similar habitat (Good). It was unknown why the Phillips Road site had poor macroinvertebrates; therefore, macroinvertebrates were resampled to determine the current status of the macroinvertebrate community and to identify potential sources of impairment in this reach. In addition, both the upstream site (Arthur Road) and downstream site (Mushroom Road) were sampled to determine the extent of potential impairment.

When revisited in 2016, the area immediately upstream of the Phillips Road Bridge was wide, deep, wetland-like, and had little flow (very pond like). The reach sampled in 2016 was moved upstream to be more indicative of the South Branch White Creek in the area because the downstream end of the reach sampled in 2011 appeared to be influenced by the bridge on Phillips Road suggesting Procedure 51 may not have adequately characterized the stream in

this section in 2011. The 2016 reach overlapped with the upper end of the reach sampled in 2011 based on site map sketches.

In 2016, the macroinvertebrate community at Phillips Road was considered Acceptable (-2) and habitat conditions were characterized as Good (154). Differences in habitat scoring from 2011 to 2016 were most likely due to the shift in the reach sampled as well as higher flows in 2016, which also likely led to differences in how the stream was scored (considered riffle/run in 2011 and glide/pool in 2016). In 2016, both the upstream and downstream South Branch White Creek sites scored similar to what they had in 2011. The macroinvertebrate community at the upstream site (Arthur Road) scored Acceptable (2), while habitat conditions were considered Good (131). The macroinvertebrate community at the downstream site (Mushroom Road) also scored Acceptable (1), while habitat conditions scored Good (139). It is also important to note that at the time of the 2016 survey, the area west of Arthur Road and north of Bond Road was being actively logged as samples were taken. Therefore, riparian habitat conditions likely changed somewhat drastically, even later the same day it was sampled (e.g., canopy trees were in the process of being removed but were scored as fairly good, because at the time, they were present).

Moore Drain 2016178 and 2016179

Three sites on Moore Drain (Spring Street, Waterman Road, and Sanilac Road) were sampled in 2016 to reevaluate attainment status following a major flood control project in the watershed. In 2006, macroinvertebrates were rated as Poor at Spring Street, which was the only site that had historically been sampled in this subbasin (HUC12_040802050209). The 2006 survey noted that the stream channel contained sufficient quantities of stable substrate material to support a relatively diverse macroinvertebrate community; however, relatively few macroinvertebrates were found. Flashy in-stream conditions were noted, and considered to be limiting the biological community in the stream. This section of stream was listed as not supporting the OIALW designated use due to direct habitat alteration, other flow regime alterations, and Mercury exceedances. Since the 2006 sampling event, a large flood control project was completed on Moore Drain altering the hydrology of this drain. Alterations included: addition of a drain outlet structure, addition of a berm composed of earthen materials and sheet metal, replacement of 5 existing culverts, addition of a detention pond with a weir to redirect flood flows, addition of a diversion pipe located off the detention pond, construction of flood transport area directly downstream of Moore drain outlet, dredging of the upstream channel, and removal of riparian vegetation. It was not known how this flood control project may have affected the macroinvertebrate community. Flows may have become more stable and conducive to colonization; however, the project also included near complete removal of canopy cover and woody riparian vegetation within approximately 15-30 meters of the stream channel. The addition of flap gates at outlets may also impede upstream movement/colonization from the Cass River and essentially isolate the drain from the Cass River. Reevaluation of macroinvertebrate community and habitat conditions using Procedure 51 at Spring Street was necessary considering habitat alteration and other flow regime alterations were 2 causes for this drain not meeting its OIALW designated use. Sampling at 2 upstream sites (Waterman Road and Sanilac Road) also allowed a comprehensive view of stream.

Habitat conditions scored Good (112) at Spring Street, Marginal (66) at Waterman Road, and Good (105) at Sanilac Road in 2016. Macroinvertebrate communities were Acceptable at Spring Street (-2), Acceptable at Waterman Road (-2), and Acceptable (-4) at Sanilac Road. The Waterman Road and Sanilac Road sites had not been previously sampled. As noted previously in 2006 at the Spring Street site, there was some in-stream habitat consisting of rock substrate (bricks and concrete), and vegetation, although most surfaces were covered in

filamentous algae making it non-ideal for colonization. Habitat, in general, scored similar in 2006 and 2016 at Spring Street and no notable improvements in physical habitat were observed. A lack of non-herbaceous riparian vegetation at the stream margins, as well as in-stream woody debris, was evident throughout Moore Drain. Although the project may have improved some aspects of flow, the available habitat for macroinvertebrates likely has not improved since 2006 and it is not recommended that the attainment status be changed at this time.

One State listed Species of Special Concern freshwater mussel, *Venustaconcha ellipsiformis*, was also found downstream of Spring Street in 2016. It is unknown whether or not the species occurred in the drain prior to the project or at what densities it may have occurred; however, the Cass River contains some of the densest populations of *V. ellipsiformis* in the state so its occurrence is not surprising. One of the largest populations on record with Michigan Natural Features Inventory was found in Goodings Creek in 2003-2004 (Badra, 2004). Goodings Creek is a tributary that flows into the Cass River approximately 1 mile downstream of the mouth of Moore Drain.

Figure 18. Venustaconcha ellipsiformis found in Moore Drain downstream of Spring Street (~30-35 millimeters in size).

Figure 19. Moore Drain: (A.) Downstream of Spring Street; (B.) Upstream Spring Street; (C.) Downstream Waterman Road; (D.) Upstream Waterman Road; (E.) Downstream Sanilac Road; (F.) Upstream Sanilac Road.

Frankenmuth Dam 2016176

In October 2015, the SWAS received aerial photos of the Frankenmuth dam/rock ramp site. Photos indicated that there may be nuisance algae/plants at this site; however, presence of algae/plants could not be confirmed from photos. A site visit was conducted in October 2015 and nuisance algae/plants were not found. Even so, this site has several upstream storm water inputs, mowed riparian areas, and nutrient rich tributaries that may contribute to nuisance algae/plant growth. Site visits were again made in June, July, and August 2016 to determine the extent of algae/plant growth. While visiting the site in June, filamentous algal growth was obvious near the center of the ramp, whereas little live algae was apparent by August. The algae also appeared to be mostly isolated to hard rock substrate and shallow areas in the immediate vicinity of the rock ramp and quickly vanished in the deeper, slower moving water below the ramp. This section of the river is known to have relatively high nutrient concentrations, and the growth seen following construction may not necessarily be due to an increase in nutrients but more likely an increase in the ability to express indicators of nutrient enrichment, such as algal growth. The current hard, shallow, well-lit conditions created by the ramp provide an ideal surface for nutrient expression compared to pre-rock ramp conditions.

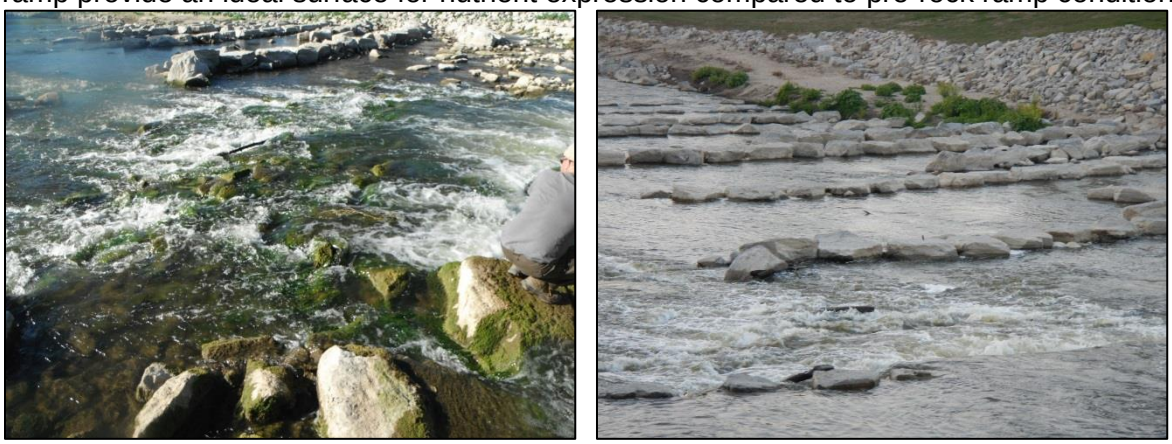


Figure 20. Frankenmuth Rock Ramp: (A.) June 2016; (B.) August 2016.

Objective 4: Identify NPS of water quality concern

Riparian Buffers and BMPs

Arguably the greatest NPS concern throughout the Cass River watershed is the lack of riparian protection in headwater tributaries to the Cass River. Improved riparian buffers and farming practices in many areas would result in improved water quality in the Cass River. One particular site observed during the 2016 surveys was on Millington Creek at Ormes Road. Indicators of flashy flows and little riparian vegetation were observed and the majority of outside bends were highly eroded (Figure 21). This erosion is likely contributing large amounts of sediment to Millington Creek and subsequently the lower Cass River. However, this was only one of relatively few sites assessed in 2016, and higher priority areas within the watershed may exist.

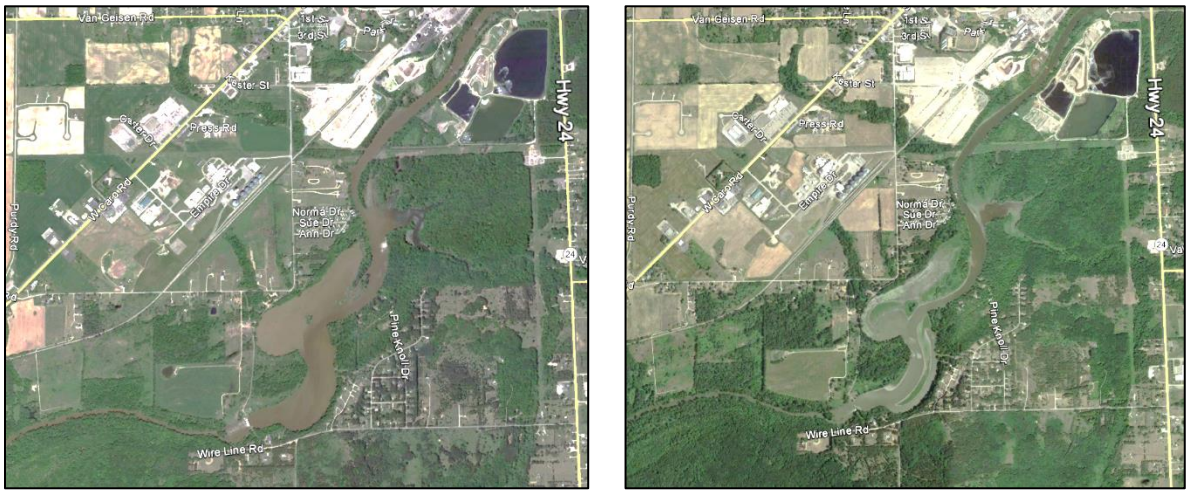
Figure 21. Example of Millington Creek Erosion (note: riparian width here was <10 feet).

Dams

Two dams remain on the mainstem Cass River today, 1 in Frankenmuth and 1 near Caro. The Frankenmuth dam was first built in the 1850s to provide a water supply to a local mill. The dam has since been repaired and reconstructed several times, but until 2015 remained relatively unchanged. In 2015, with the help of a Michigan Department of Natural Resources Dam Management Grant, the dam head was lowered and the addition of a 350-foot long rock ramp now enables at least some fish passage above the dam.

The Caro dam was first built in the early 1900s for water supply to the Michigan Sugar Company, and was later reconstructed to generate power for Caro. Today, the dam is privately owned and no longer serves its original purpose, but remains an important historical feature to many of the area's residents. In 2014, there was a failure of 1 of the gates of the dam that lowered the effective head, and returned the impounded area above the dam to a near river state (Figure 22). The future of the dam is unknown, but if removed, would restore connectivity throughout the river and would create a nearly free-flowing river (with the exception of the Frankenmuth impoundment).

Figure 22. Caro Impoundment in 2011 (left) and 2016 (right).



Conclusions and Future Monitoring Recommendations

The mainstem Cass River has decent riparian vegetation in many areas, a good variety of in-stream habitat, and contains good quality macroinvertebrate communities including abundant freshwater mussel populations throughout much of its extent. In contrast, the majority of tributaries to the Cass River are highly modified and straightened drainage ditches with little riparian vegetation, flashy flows, and are composed of more tolerant communities. Although the majority of tributaries scored Acceptable for macroinvertebrates in 2016, many sites were borderline severely impaired with 30 percent of sites scoring -3 or -4, 35 percent of sites (7 of 20) scoring -1 or -2, and no sites scoring excellent. Similarly, all sites had habitat characterized as either slightly impaired (11) or moderately impaired (10) and none were characterized as non-impaired. In addition, the majority of trend sites in the watershed have shown declining macroinvertebrates over the last 15 years, and although only 8 sites were assessed, the fact that 6 of these have gotten progressively worse and none have improved, highlights the need to continue to focus on improving the water quality of tributaries to the Cass River.

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Table 3. Habitat evaluation for selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

	North Branch Cass River	Unnamed Tributary	North Branch White Creek	Millington Creek
	Jurgess Rd. (downstream)	Plain Rd.	Shabonna Rd.	Ormes
	8/4/2016	8/4/2016	8/4/2016	8/5/2016
	RIFFLE/RUN	GLIDE/POOL	RIFFLE/RUN	RIFFLE/RUN
	320357	790230	790229	790231
HABITAT METRIC				
Substrate and Instream Cover				
Epifaunal Substrate/ Avail Cover (20)	13	6	8	12
Embeddedness (20)*	13		14	15
Velocity/Depth Regime (20)*	14		11	12
Pool Substrate Characterization (20)**		4		
Pool Variability (20)**		1		
Channel Morphology				
Sediment Deposition (20)	12	10	16	6
Flow Status - Maint. Flow Volume (10)	9	9	9	8
Flow Status - Flashiness (10)	5	2	3	2
Channel Alteration (20)	6	6	13	18
Frequency of Riffles/Bends (20)*	4		14	7
Channel Sinuosity (20)**		1		
Riparian and Bank Structure				
Bank Stability (L) (10)	4	7	9	2
Bank Stability (R) (10)	4	7	9	4
Vegetative Protection (L) (10)	3	3	8	3
Vegetative Protection (R) (10)	3	3	6	5
Riparian Vegetation Zone Width (L) (10)	1	1	8	1
Riparian Vegetation Zone Width (R) (10)	7	1	3	5
TOTAL SCORE (200):	98	61	131	100
HABITAT RATING:	MARGINAL	MARGINAL	GOOD	MARGINAL
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).				
Date:	8/4/2016	8/4/2016	8/4/2016	8/5/2016
Weather:	sunny	sunny	sunny	sunny
Air Temperature: ^{o}F		85	85	75
Water Temperature: ^{o}F	72	91	76	72
Ave. Stream Width: Feet	7	16	25	20
Ave. Stream Depth: Feet	0.3	0.6	2	1
Surface Velocity: Feet/Second				
Estimated Flow: Cubic Feet/Second				
Stream Modifications:	dredged,canopyremoval	dredged,canopyremoval,relocated	dredged,relocated	canopyremoval
Nuisance Plants (Y/N):	N	N	N	N
STORET No.:	320357	790230	790229	790231
County Code:	32	79	79	79
TRS:	15N13E15	12N10E26	13N11E19	11N07E35
Latitude (dd):	43.72615	43.42884	43.52758	43.32171
Longitude (dd):	-82.91945	-83.266	-83.21311	-83.61425
Ecoregion:	smnitp	smnitp	smnitp	smnitp
Stream Type:				
USGS Basin Code:	4080205	4080205	4080205	4080205
* Applies only to Riffle/Run stream Surveys				
** Applies only to Glide/Pool stream Surveys				

Table 3 continued. Habitat evaluation for selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

	Dead Creek					
	Sargent Rd.					
	8/5/2016					
	RIFFLE/RUN					
	790232					
HABITAT METRIC						
Substrate and Instream Cover						
Epifaunal Substrate/ Avail Cover (20)	14					
Embeddedness (20)*	17					
Velocity/Depth Regime (20)*	15					
Pool Substrate Characterization (20)**						
Pool Variability (20)**						
Channel Morphology						
Sediment Deposition (20)	9					
Flow Status - Maint. Flow Volume (10)	9					
Flow Status - Flashiness (10)	2					
Channel Alteration (20)	10					
Frequency of Riffles/Bends (20)*	7					
Channel Sinuosity (20)**						
Riparian and Bank Structure						
Bank Stability (L) (10)	3					
Bank Stability (R) (10)	7					
Vegetative Protection (L) (10)	4					
Vegetative Protection (R) (10)	8					
Riparian Vegetation Zone Width (L) (10)	1					
Riparian Vegetation Zone Width (R) (10)	4					
TOTAL SCORE (200):	110					
HABITAT RATING:	GOOD					
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).						
Date:	8/5/2016					
Weather:	partlycloudy					
Air Temperature: ^{o}F	80					
Water Temperature: ^{o}F	72					
Ave. Stream Width: Feet	10					
Ave. Stream Depth: Feet	1					
Surface Velocity: Feet/Second						
Estimated Flow: Cubic Feet/Second						
Stream Modifications:	anopyremoval,relocated					
Nuisance Plants (Y/N):	N					
STORET No.:	790232					
County Code:	79					
TRS:	10N07E7					
Latitude (dd):	43.28727					
Longitude (dd):	-83.69551					
Ecoregion:	smnitp					
Stream Type:						
USGS Basin Code:	4080205					
* Applies only to Riffle/Run stream Surveys						
** Applies only to Glide/Pool stream Surveys						

Table 3 continued. Habitat evaluation for selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

	Dead Creek		Turtle Creek		White & Moffatt Drain		North Branch White Creek	
	Center Road		Wheeler Road		Dennis Road		McArthur Road	
	GLIDE/POOL		GLIDE/POOL		GLIDE/POOL		GLIDE/POOL	
	250502		790179		760212		790171	
HABITAT METRIC								
Substrate and Instream Cover								
Epifaunal Substrate/ Avail Cover (20)	3		3		6		6	
Embeddedness (20)*								
Velocity/Depth Regime (20)*								
Pool Substrate Characterization (20)**	8		10		13		14	
Pool Variability (20)**	1		2		5		8	
Channel Morphology								
Sediment Deposition (20)	13		11		6		11	
Flow Status - Maint. Flow Volume (10)	6		10		10		10	
Flow Status - Flashiness (10)	7		6		5		4	
Channel Alteration (20)	6		6		7		13	
Frequency of Riffles/Bends (20)*								
Channel Sinuosity (20)**	1		1		1		5	
Riparian and Bank Structure								
Bank Stability (L) (10)	8		6		6		5	
Bank Stability (R) (10)	8		5		7		4	
Vegetative Protection (L) (10)	4		4		3		7	
Vegetative Protection (R) (10)	4		4		8		4	
Riparian Veg. Zone Width (L) (10)	1		1		1		2	
Riparian Veg. Zone Width (R) (10)	1		1		6		1	
TOTAL SCORE (200):	71		70		84		94	
HABITAT RATING:	MARGINAL		MARGINAL		MARGINAL		MARGINAL	
	(MODERATELY		(MODERATELY		(MODERATELY		(MODERATELY	
	IMPAIRED)		IMPAIRED)		IMPAIRED)		IMPAIRED)	
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).								
Date:	6/30/2016		6/28/2016		6/28/2016		6/29/2016	
Weather:	Sunny		Partly Cloudy		Cloudy		Sunny	
Air Temperature:		Deg. F.	65	Deg. F.	65	Deg. F.	75	Deg. F.
Water Temperature:	70	Deg. F.	70	Deg. F.	65	Deg. F.	68	Deg. F.
Ave. Stream Width:	1.5	Feet	9	Feet	14	Feet	33	Feet
Ave. Stream Depth:	0.25	Feet	1.5	Feet	0.75	Feet	1.5	Feet
Surface Velocity:	0.13	Ft./Sec.	0.06	Ft./Sec.	0.36	Ft./Sec.	0.22	Ft./Sec.
Estimated Flow:	0.04875	CFS	0.81	CFS	3.78	CFS	10.89	CFS
Stream Modifications:	moval/Relocated		Relocated		Relocated		Canopy Removal/Relocated	
Nuisance Plants (Y/N):	N		N		N		N	
Report Number:								
STORET No.:	250502		790179		760212		790171	
Stream Name:	Dead Creek		Turtle Creek		White & Moffatt Drain		North Branch White Creek	
Road Crossing/Location:	Center Road		Wheeler Road		Dennis Road		McArthur Road	
County Code:	25		76		76		79	
TRS:	09N07E09		12N13E20		11N12E08		13N11E20	
Latitude (dd):	43.20586		43.4586		43.3935		43.5321	
Longitude (dd):	-83.64091		-82.9705		-83.0733		-83.19996	
Ecoregion:	SMNITP		SMNITP		SMNITP		SMNITP	
Stream Type:	Warmwater		Warmwater		Warmwater		Warmwater	
USGS Basin Code:	4080205		4080205		4080205		4080205	
* Applies only to Riffle/Run stream Surveys								
** Applies only to Glide/Pool stream Surveys								

Table 3 continued. Habitat evaluation for selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

	South Branch Cass River		South Branch Cass River		Cass River	
	Shabonna Road		Kelly Road		Off Pinkerton Road	
	GLIDE/POOL		GLIDE/POOL		RIFFLE/RUN	
	760217		790176		790182	
HABITAT METRIC						
Substrate and Instream Cover						
Epifaunal Substrate/ Avail Cover (20)	4		3		17	
Embeddedness (20)*					13	
Velocity/Depth Regime (20)*					10	
Pool Substrate Characterization (20)**	10		10			
Pool Variability (20)**	1		1			
Channel Morphology						
Sediment Deposition (20)	17		14		14	
Flow Status - Maint. Flow Volume (10)	10		10		9	
Flow Status - Flashiness (10)	3		3		4	
Channel Alteration (20)	6		19		20	
Frequency of Riffles/Bends (20)*					14	
Channel Sinuosity (20)**	4		14			
Riparian and Bank Structure						
Bank Stability (L) (10)	2		6		7	
Bank Stability (R) (10)	2		6		6	
Vegetative Protection (L) (10)	3		8		7	
Vegetative Protection (R) (10)	3		8		8	
Riparian Veg. Zone Width (L) (10)	2		5		7	
Riparian Veg. Zone Width (R) (10)	2		9		9	
TOTAL SCORE (200):	69		116		145	
HABITAT RATING:	MARGINAL		GOOD		GOOD	
	(MODERATELY		(SLIGHTLY		(SLIGHTLY	
	IMPAIRED)		IMPAIRED)		IMPAIRED)	
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).						
Date:	6/28/2016		6/28/2016		6/30/2016	
Weather:	Sunny		Sunny		Sunny	
Air Temperature:	70	Deg. F.	65	Deg. F.	70	Deg. F.
Water Temperature:	77	Deg. F.	78	Deg. F.	70	Deg. F.
Ave. Stream Width:	52	Feet	90	Feet	100	Feet
Ave. Stream Depth:	1.5	Feet	2	Feet	1	Feet
Surface Velocity:	0.32	Ft./Sec.	0.17	Ft./Sec.	1.56	Ft./Sec.
Estimated Flow:	24.96	CFS	30.6	CFS	156	CFS
Stream Modifications:	Dredged		None		None	
Nuisance Plants (Y/N):	N		N		N	
Report Number:						
STORET No.:	760217		790176		790182	
Stream Name:	ranch Cass River		South Branch Cass River		Cass River	
Road Crossing/Location:	Shabonna Road		Kelly Road		Off Pinkerton Road	
County Code:	76		79		79	
TRS:	13N12E27		13N11E12		11N07E24	
Latitude (dd):	43.5317		43.57295		43.3492	
Longitude (dd):	-83.0434		-83.11758		-83.60207	
Ecoregion:	SMNITP		SMNITP		SMNITP	
Stream Type:	Warmwater		Warmwater		Warmwater	
USGS Basin Code:	4080205		4080205		4080205	
* Applies only to Riffle/Run stream Surveys						
** Applies only to Glide/Pool stream Surveys						

Table 3 continued. Habitat evaluation for selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

	South Branch White Creek		South Branch White Creek		South Branch White Creek	
	Arthur Road		Phillips Road		Mushroom Road	
	RIFFLE/RUN		GLIDE/POOL		RIFFLE/RUN	
	790210		790206		790204	
HABITAT METRIC						
Substrate and Instream Cover						
Epifaunal Substrate/ Avail Cover (20)	9		13		7	
Embeddedness (20)*	15				17	
Velocity/Depth Regime (20)*	11				12	
Pool Substrate Characterization (20)**			16			
Pool Variability (20)**			11			
Channel Morphology						
Sediment Deposition (20)	14		16		13	
Flow Status - Maint. Flow Volume (10)	9		10		9	
Flow Status - Flashiness (10)	7		8		5	
Channel Alteration (20)	17		18		18	
Frequency of Riffles/Bends (20)*	6				9	
Channel Sinuosity (20)**			13			
Riparian and Bank Structure						
Bank Stability (L) (10)	7		9		7	
Bank Stability (R) (10)	7		9		7	
Vegetative Protection (L) (10)	8		7		8	
Vegetative Protection (R) (10)	8		8		8	
Riparian Veg. Zone Width (L) (10)	5		9		9	
Riparian Veg. Zone Width (R) (10)	8		7		10	
TOTAL SCORE (200):	131		154		139	
HABITAT RATING:	GOOD (SLIGHTLY IMPAIRED)		GOOD (SLIGHTLY IMPAIRED)		GOOD (SLIGHTLY IMPAIRED)	
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).						
Date:	9/21/2016		9/21/2016		9/21/2016	
Weather:	Partly Cloudy		Cloudy		Cloudy	
Air Temperature:	75	Deg. F.	75	Deg. F.	75	Deg. F.
Water Temperature:	64	Deg. F.	62	Deg. F.	64	Deg. F.
Ave. Stream Width:	20	Feet	30	Feet	16	Feet
Ave. Stream Depth:	1	Feet	1.5	Feet	1	Feet
Surface Velocity:	0.64	Ft./Sec.	0.24	Ft./Sec.	0.9	Ft./Sec.
Estimated Flow:	12.8	CFS	10.8	CFS	14.4	CFS
Stream Modifications:	Canopy Removal		None		None	
Nuisance Plants (Y/N):	N		N		N	
Report Number:						
STORET No.:	790210		790206		790204	
Stream Name:	uth Branch White Creek		South Branch White Creek		South Branch White Creek	
Road Crossing/Location:	Arthur Road		Phillips Road		Mushroom Road	
County Code:	79		79		79	
TRS:	12N11E17		12N11E07		12N11E07	
Latitude (dd):	43.460507		43.47473		43.48452	
Longitude (dd):	-83.19778		-83.21312		-83.22045	
Ecoregion:	SMNITP		SMNITP		SMNITP	
Stream Type:	Warmwater		Warmwater		Warmwater	
USGS Basin Code:	4080205		4080205		4080205	
* Applies only to Riffle/Run stream Surveys						
** Applies only to Glide/Pool stream Surveys						

Table 3 continued. Habitat evaluation for selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

	Moore Drain		Moore Drain		Moore Drain	
	Sanilac Rd.		Waterman Rd.		Downstream Spring Street	
	GLIDE/POOL		GLIDE/POOL		RIFFLE/RUN	
	790226		790225		790174	
HABITAT METRIC						
Substrate and Instream Cover						
Epifaunal Substrate/ Avail Cover (20)	7		6		8	
Embeddedness (20)*					10	
Velocity/Depth Regime (20)*					10	
Pool Substrate Characterization (20)**	14		5			
Pool Variability (20)**	10		6			
Channel Morphology						
Sediment Deposition (20)	12		6		12	
Flow Status - Maint. Flow Volume (10)	10		10		10	
Flow Status - Flashiness (10)	5		1		4	
Channel Alteration (20)	6		5		10	
Frequency of Riffles/Bends (20)*					13	
Channel Sinuosity (20)**	1		1			
Riparian and Bank Structure						
Bank Stability (L) (10)	8		3		7	
Bank Stability (R) (10)	8		5		7	
Vegetative Protection (L) (10)	7		6		6	
Vegetative Protection (R) (10)	7		6		9	
Riparian Veg. Zone Width (L) (10)	5		3		2	
Riparian Veg. Zone Width (R) (10)	5		3		4	
TOTAL SCORE (200):	105		66		112	
HABITAT RATING:	GOOD (SLIGHTLY IMPAIRED)		MARGINAL (MODERATELY IMPAIRED)		GOOD (SLIGHTLY IMPAIRED)	
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).						
Date:	7/21/2016		7/21/2016		7/21/2016	
Weather:	Sunny		Sunny		Partly Cloudy	
Air Temperature:	80	Deg. F.	80	Deg. F.	85	Deg. F.
Water Temperature:	68	Deg. F.	75	Deg. F.	78	Deg. F.
Ave. Stream Width:	5.5	Feet	8	Feet	8.5	Feet
Ave. Stream Depth:	0.75	Feet	1	Feet	0.3	Feet
Surface Velocity:	0.25	Ft./Sec.	0.09	Ft./Sec.	1.7	Ft./Sec.
Estimated Flow:	1.03125	CFS	0.72	CFS	4.335	CFS
Stream Modifications:	Dredged		Dredged		Dredged	
Nuisance Plants (Y/N):	N		N		N	
Report Number:						
STORET No.:	790226		790225		790174	
Stream Name:	Moore Drain		Moore Drain		Moore Drain	
Road Crossing/Location:	Sanilac Rd.		Waterman Rd.		Downstream Spring Street	
County Code:	79		79		79	
TRS:	12N08E29		12N08E32		11N07E07	
Latitude (dd):	43.40869		43.39399		43.36993	
Longitude (dd):	-83.54815		-83.56002		-83.58385	
Ecoregion:	SMNITP		SMNITP		SMNITP	
Stream Type:					Warmwater	
USGS Basin Code:	4080205		4080205		4080205	
* Applies only to Riffle/Run stream Surveys						
** Applies only to Glide/Pool stream Surveys						

Table 3 continued. Habitat evaluation for selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

	Dead Creek				
	Townline Road				
	RIFFLE/RUN				
	730338				
HABITAT METRIC					
Substrate and Instream Cover					
Epifaunal Substrate/ Avail Cover (20)	11				
Embeddedness (20)*	10				
Velocity/Depth Regime (20)*	8				
Pool Substrate Characterization (20)**					
Pool Variability (20)**					
Channel Morphology					
Sediment Deposition (20)	13				
Flow Status - Maint. Flow Volume (10)	7				
Flow Status - Flashiness (10)	8				
Channel Alteration (20)	13				
Frequency of Riffles/Bends (20)*	15				
Channel Sinuosity (20)**					
Riparian and Bank Structure					
Bank Stability (L) (10)	8				
Bank Stability (R) (10)	8				
Vegetative Protection (L) (10)	8				
Vegetative Protection (R) (10)	8				
Riparian Veg. Zone Width (L) (10)	6				
Riparian Veg. Zone Width (R) (10)	7				
TOTAL SCORE (200):	130				
HABITAT RATING:	MARGINAL				
	(MODERATELY				
	IMPAIRED)				
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).					
Date:	6/30/2016				
Weather:	Sunny				
Air Temperature:		Deg. F.			
Water Temperature:	76	Deg. F.			
Ave. Stream Width:	15	Feet			
Ave. Stream Depth:	0.5	Feet			
Surface Velocity:	0.39	Ft./Sec.			
Estimated Flow:	2.925	CFS			
Stream Modifications:	Dredged				
Nuisance Plants (Y/N):	N				
Report Number:					
STORET No.:	730338				
Stream Name:	Dead Creek				
Road Crossing/Location:	Townline Road				
County Code:	73				
TRS:	10N06E02				
Latitude (dd):	43.30684				
Longitude (dd):	-83.72575				
Ecoregion:	HELP				
Stream Type:	Coldwater				
USGS Basin Code:	4080205				
* Applies only to Riffle/Run stream Surveys					
** Applies only to Glide/Pool stream Surveys					

Table 3 continued. Habitat evaluation for selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

	Sanilac Huron Creek		Sanilac Huron Creek			
	Ritter Rd. (Upstream)		Bay Forestville Rd.			
	6/29/2016		6/29/2016			
	RIFFLE/RUN		RIFFLE/RUN			
	760292		760293			
HABITAT METRIC						
Substrate and Instream Cover						
Epifaunal Substrate/ Avail Cover (20)	10		9			
Embeddedness (20)*	18		12			
Velocity/Depth Regime (20)*	11		11			
Pool Substrate Characterization (20)**						
Pool Variability (20)**						
Channel Morphology						
Sediment Deposition (20)	15		13			
Flow Status - Maint. Flow Volume (10)	10		10			
Flow Status - Flashiness (10)	9		8			
Channel Alteration (20)	12		6			
Frequency of Riffles/Bends (20)*	8		5			
Channel Sinuosity (20)**						
Riparian and Bank Structure						
Bank Stability (L) (10)	8		4			
Bank Stability (R) (10)	8		4			
Vegetative Protection (L) (10)	6		3			
Vegetative Protection (R) (10)	7		3			
Riparian Vegetation Zone Width (L) (10)	8		1			
Riparian Vegetation Zone Width (R) (10)	8		1			
TOTAL SCORE (200):	138		90			
HABITAT RATING:	GOOD		MARGINAL			
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).						
Date:	6/29/2016		6/29/2016			
Weather:	sunny		sunny			
Air Temperature: ^{o}F	70		60			
Water Temperature: ^{o}F	64		58			
Ave. Stream Width: Feet	6		4.5			
Ave. Stream Depth: Feet	0.5		0.75			
Surface Velocity: Feet/Second						
Estimated Flow: Cubic Feet/Second						
Stream Modifications:	dredged,canopyremoval,relocated		canopyremoval,relocated			
Nuisance Plants (Y/N):	N		N			
STORET No.:	760292		760293			
County Code:	76		76			
TRS:	14N12E16		14N12E9			
Latitude (dd):	43.64759		43.6623			
Longitude (dd):	-83.0714		-83.06058			
Ecoregion:	smnitp		smnitp			
Stream Type:						
USGS Basin Code:	4080205		4080205			
* Applies only to Riffle/Run stream Surveys						
** Applies only to Glide/Pool stream Surveys						

Table 4. Qualitative macroinvertebrate sampling results at selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

TAXA	North Branch Cass River Jurgess Rd. (downstream) 8/4/2016 320357	Unnamed Tributary Plain Rd. 8/4/2016 790230	North Branch White Creek Shabonna Rd. 8/4/2016 790229	Millington Creek Ormes 8/5/2016 790231
PLATYHELMINTHES (flatworms)				
Turbellaria	3	3	2	
ANNELIDA (segmented worms)				
Hirudinea (leeches)	6	1	4	
Oligochaeta (worms)	9	7	1	2
ARTHROPODA				
Crustacea				
Amphipoda (scuds)		22		57
Decapoda (crayfish)	1	2	10	17
Isopoda (sowbugs)	25		3	17
Arachnoidea				
Hydracarina	8	8		1
Insecta				
Ephemeroptera (mayflies)				
Baetidae			1	2
Caenidae	15	79		
Ephemeridae		9		
Heptageniidae		2	3	8
Odonata				
Anisoptera (dragonflies)				
Aeshnidae	1	1	1	5
Gomphidae		2		
Libellulidae		1		
Zygoptera (damselflies)				
Calopterygidae	1	3		2
Coenagrionidae	4	10		5
Hemiptera (true bugs)				
Belostomatidae	1			
Corixidae	7			
Mesoveliidae	1	1	2	4
Veliidae		1	3	
Trichoptera (caddisflies)				
Helicopsychidae	51	4		
Hydropsychidae	16		9	17
Hydroptilidae	23			
Leptoceridae	5	2	1	1
Limnephilidae			4	1
Uenoidae				5
Coleoptera (beetles)				
Dytiscidae (total)		1		
Haliplidae (adults)	2	3		
Hydrophilidae (total)	1			2
Psephenidae (adults)		1		
Dryopidae				2
Elmidae	83	17	105	32
Diptera (flies)				
Ceratopogonidae		4		
Chironomidae	28	20	25	25
Dixidae			1	
Empididae	1			
Tipulidae			1	

TAXA	North Branch Cass River Jurgess Rd. (downstream) 8/4/2016 320357	Unnamed Tributary Plain Rd. 8/4/2016 790230	North Branch White Creek Shabonna Rd. 8/4/2016 790229	Millington Creek Ormes 8/5/2016 790231
MOLLUSCA				
Gastropoda (snails)				
Hydrobiidae	5	12		
Physidae	6	3		1
Planorbidae	3	11		
Pelecypoda (bivalves)				
Sphaeriidae (clams)	2	13	8	9
Unionidae (mussels)			1	
TOTAL INDIVIDUALS	309	243	185	217

METRIC	North Branch Cass River Jurgess Rd. (downstream) 8/4/2016 320357 Value	Score	Unnamed Tributary Plain Rd. 8/4/2016 790230 Value	Score	North Branch White Creek Shabonna Rd. 8/4/2016 790229 Value	Score	Millington Creek Ormes 8/5/2016 790231 Value	Score
TOTAL NUMBER OF TAXA	27	1	28	1	19	0	22	0
NUMBER OF MAYFLY TAXA	1	0	3	0	2	0	2	0
NUMBER OF CADDISFLY TAXA	4	0	2	0	3	0	4	0
NUMBER OF STONEFLY TAXA	0	-1	0	-1	0	-1	0	-1
PERCENT MAYFLY COMPOSITION	4.85	0	37.04	1	2.16	-1	4.61	0
PERCENT CADDISFLY COMPOSITION	30.74	1	2.47	-1	7.57	0	11.06	0
PERCENT DOMINANT TAXON	26.86	0	32.51	0	56.76	-1	26.27	0
PERCENT ISOPOD, SNAIL, LEECH	14.56	-1	11.11	-1	3.78	1	8.29	0
PERCENT SURFACE AIR BREATHERS	4.53	1	4.12	1	2.70	1	2.76	1
TOTAL SCORE		1		0		-1		0
MACROINVERTEBRATE COMMUNITY RATING		Acceptable		Acceptable		Acceptable		Acceptable

Table 4 continued. Qualitative macroinvertebrate sampling results at selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

TAXA	Dead Creek Sargent Rd. 8/5/2016 790232
ARTHROPODA	
Crustacea	
Amphipoda (scuds)	1
Decapoda (crayfish)	1
Arachnoidea	
Hydracarina	3
Insecta	
Ephemeroptera (mayflies)	
Baetidae	13
Caenidae	1
Tricorythidae	1
Odonata	
Anisoptera (dragonflies)	
Aeshnidae	12
Zygoptera (damselflies)	
Calopterygidae	4
Coenagrionidae	1
Hemiptera (true bugs)	
Gerridae	1
Mesoveliidae	2
Megaloptera	
Corydalidae (dobson flies)	2
Sialidae (alder flies)	1
Trichoptera (caddisflies)	
Helicopsychidae	4
Hydropsychidae	57
Hydroptilidae	2
Limnephilidae	1
Coleoptera (beetles)	
Hydrophilidae (total)	2
Elmidae	78
Diptera (flies)	
Chironomidae	64
Tipulidae	9
MOLLUSCA	
Gastropoda (snails)	
Ancylidae (limpets)	1
Physidae	2
Pelecypoda (bivalves)	
Sphaeriidae (clams)	1
TOTAL INDIVIDUALS	266

Dead Creek
Sargent Rd.
8/5/2016
790232

METRIC	Value	Score
TOTAL NUMBER OF TAXA	25	1
NUMBER OF MAYFLY TAXA	3	1
NUMBER OF CADDISFLY TAXA	4	0
NUMBER OF STONEFLY TAXA	0	-1
PERCENT MAYFLY COMPOSITION	5.64	0
PERCENT CADDISFLY COMPOSITION	24.06	0
PERCENT DOMINANT TAXON	29.32	0
PERCENT ISOPOD, SNAIL, LEECH	1.13	1
PERCENT SURFACE AIR BREATHERS	1.88	1
TOTAL SCORE		3
MACROINVERTEBRATE COMMUNITY RATING		Acceptable

Table 4 continued. Qualitative macroinvertebrate sampling results at selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

TAXA	Dead Creek Center Road 6/30/2016 250502	Turtle Creek Wheeler Road 6/28/2016 790179	White & Moffatt Drain Dennis Road 6/28/2016 760212	North Branch White Creek McArthur Road 6/29/2016 790171
PLATYHELMINTHES (flatworms)				
Turbellaria		20	9	
ANNELIDA (segmented worms)				
Hirudinea (leeches)	7	16	12	1
Oligochaeta (worms)	1	22	11	2
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	12			
Decapoda (crayfish)	1	2	3	4
Isopoda (sowbugs)	3	1	8	30
Arachnoidea				
Hydracarina	5	19	5	
Insecta				
Ephemeroptera (mayflies)				
Baetidae	5	1	2	
Caenidae		1	4	
Heptageniidae				13
Odonata				
Anisoptera (dragonflies)				
Aeshnidae	1	2	4	1
Libellulidae	1	2	1	
Zygoptera (damselflies)				
Calopterygidae				3
Coenagrionidae	1	6	5	
Hemiptera (true bugs)				
Corixidae		15	46	43
Gerridae	1	2	1	
Mesoveliidae	3			
Notonectidae			1	
Pleidae	1	1		
Megaloptera				
Corydalidae (dobson flies)			1	
Sialidae (alder flies)	1			
Trichoptera (caddisflies)				
Brachycentridae	1			
Hydropsychidae	1			4
Hydroptilidae				6
Leptoceridae	1		11	
Limnephilidae				7
Phryganeidae	1	1	2	
Coleoptera (beetles)				
Dytiscidae (total)	3	4	4	
Gyrinidae (adults)		1	1	
Haliplidae (adults)	3	4	1	3

TAXA	Dead Creek Center Road 6/30/2016 250502	Turtle Creek Wheeler Road 6/28/2016 790179	White & Moffatt Drain Dennis Road 6/28/2016 760212	North Branch White Creek McArthur Road 6/29/2016 790171
Hydrophilidae (total)	3	1	5	
Elmidae	23	20	9	31
Haliplidae (larvae)		5	1	
Diptera (flies)				
Ceratopogonidae	1	29	1	
Chironomidae	162	88	129	109
Culicidae	2			
Dixidae	1			
Simuliidae			4	
Stratiomyidae	1			
Tabanidae		2	1	
Tipulidae	1			
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)				5
Lymnaeidae	8			
Physidae	58	40	5	19
Planorbidae	37	53	57	
Pelecypoda (bivalves)				
Sphaeriidae (clams)	15		18	23
Unionidae (mussels)				1
TOTAL INDIVIDUALS	365	358	362	305

METRIC	Dead Creek Center Road 6/30/2016 250502 Value	Score	Turtle Creek Wheeler Road 6/28/2016 790179 Value	Score	White & Moffatt Drain Dennis Road 6/28/2016 760212 Value	Score	North Branch White Creek McArthur Road 6/29/2016 790171 Value	Score
TOTAL NUMBER OF TAXA	32	1	25	1	29	1	18	0
NUMBER OF MAYFLY TAXA	1	1	2	0	2	0	1	-1
NUMBER OF CADDISFLY TAXA	4	1	1	-1	2	0	3	0
NUMBER OF STONEFLY TAXA	0	-1	0	-1	0	-1	0	-1
PERCENT MAYFLY COMP.	1.37	-1	0.56	-1	1.66	-1	4.26	0
PERCENT CADDISFLY COMP.	1.10	-1	0.28	-1	3.59	-1	5.57	0
PERCENT DOMINANT TAXON	44.38	-1	24.58	0	35.64	0	35.74	0
PERCENT ISOPOD, SNAIL, LEECH	30.96	-1	30.73	-1	22.65	-1	18.03	-1
PERCENT SURF. AIR BREATHERS	4.66	1	7.82	0	16.30	0	15.08	0
TOTAL SCORE		-1		-4		-3		-3
MACROINV. COMMUNITY RATING		ACCEPT.		ACCEPT.		ACCEPT.		ACCEPT.

Table 4 continued. Qualitative macroinvertebrate sampling results at selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

TAXA	South Branch Cass River Shabonna Road 6/28/2016 760217	South Branch Cass River Kelly Road 6/28/2016 790176	Cass River Off Pinkerton Road 6/30/2016 790182
PLATYHELMINTHES (flatworms)			
Turbellaria	1	3	2
ANNELIDA (segmented worms)			
Hirudinea (leeches)	4	3	
Oligochaeta (worms)		3	
ARTHROPODA			
Crustacea			
Amphipoda (scuds)	4	1	6
Decapoda (crayfish)	3	2	1
Isopoda (sowbugs)		5	4
Arachnoidea			
Hydracarina	8	3	1
Insecta			
Ephemeroptera (mayflies)			
Baetidae			14
Caenidae	4	2	1
Ephemerellidae			3
Heptageniidae			6
Isonychiidae			3
Polymitarcyidae			5
Tricorythidae			6
Odonata			
Anisoptera (dragonflies)			
Aeshnidae	3	2	
Gomphidae			1
Zygoptera (damselflies)			
Coenagrionidae	16	3	
Plecoptera (stoneflies)			
Perlidae			2
Hemiptera (true bugs)			
Belostomatidae	1	1	
Corixidae	15	111	1
Gerridae	2	1	
Mesoveliidae			1
Naucoridae		1	
Notonectidae		1	
Pleidae	2		
Veliidae			2
Trichoptera (caddisflies)			
Brachycentridae			1
Glossosomatidae			2
Helicopsychidae			4
Hydropsychidae	1		132
Hydroptilidae			2

TAXA	South Branch Cass River Shabonna Road 6/28/2016 760217	South Branch Cass River Kelly Road 6/28/2016 790176	Cass River Off Pinkerton Road 6/30/2016 790182
Leptoceridae		1	3
Philopotamidae			1
Phryganeidae	6	5	2
Polycentropodidae			7
Coleoptera (beetles)			
Dytiscidae (total)	1		
Gyrinidae (adults)	1	1	
Haliplidae (adults)	3	8	
Hydrophilidae (total)	3	1	1
Elmidae	21	12	51
Gyrinidae (larvae)			1
Psephenidae (larvae)			1
Diptera (flies)			
Ceratopogonidae	1		
Chironomidae	84	47	20
Tipulidae			5
MOLLUSCA			
Gastropoda (snails)			
Ancylidae (limpets)	5		7
Hydrobiidae			3
Lymnaeidae	2	1	2
Physidae	70	26	1
Planorbidae	16	1	
Pleuroceridae			1
Viviparidae			1
Pelecypoda (bivalves)			
Sphaeriidae (clams)	4		1
Unionidae (mussels)	1		1
TOTAL INDIVIDUALS	282	245	309

METRIC	South Branch Cass River Shabonna Road 6/28/2016 760217 Value	Score	South Branch Cass River Kelly Road 6/28/2016 790176 Value	Score	Cass River Off Pinkerton Road 6/30/2016 790182 Value	Score
TOTAL NUMBER OF TAXA	27	1	25	1	40	1
NUMBER OF MAYFLY TAXA	1	-1	1	-1	7	1
NUMBER OF CADDISFLY TAXA	2	0	2	0	9	1
NUMBER OF STONEFLY TAXA	0	-1	0	-1	1	1
PERCENT MAYFLY COMP.	1.42	-1	0.82	-1	12.30	0
PERCENT CADDISFLY COMP.	2.48	-1	2.45	-1	49.84	1
PERCENT DOMINANT TAXON	29.79	0	45.31	-1	42.72	-1
PERCENT ISOPOD, SNAIL, LEECH	34.40	-1	14.69	-1	6.15	0
PERCENT SURF. AIR BREATHERS	9.93	0	51.02	-1	1.62	1
TOTAL SCORE		-4		-6		5
MACROINV. COMMUNITY RATING		ACCEPT.		POOR		EXCELLENT

Table 4 continued. Qualitative macroinvertebrate sampling results at selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

TAXA	South Branch White Creek Arthur Road 9/21/2016 790210	South Branch White Creek Phillips Road 9/21/2016 790206	South Branch White Creek Mushroom Road 9/21/2016 790204
ANNELIDA (segmented worms)			
Hirudinea (leeches)	1		
Oligochaeta (worms)	5	9	8
ARTHROPODA			
Crustacea			
Amphipoda (scuds)		60	5
Decapoda (crayfish)	10	3	4
Insecta			
Ephemeroptera (mayflies)			
Baetidae	9	4	1
Caenidae	15	11	6
Heptageniidae	64	17	19
Leptophlebiidae	21		
Odonata			
Anisoptera (dragonflies)			
Aeshnidae	1	4	2
Gomphidae	1		4
Zygoptera (damselflies)			
Calopterygidae	7	72	31
Coenagrionidae		12	16
Hemiptera (true bugs)			
Corixidae		15	2
Nepidae		2	
Veliidae		1	
Megaloptera			
Corydalidae (dobson flies)	1		2
Sialidae (alder flies)			3
Trichoptera (caddisflies)			
Hydropsychidae	25	5	51
Limnephilidae		2	
Phryganeidae		1	1
Polycentropodidae			1
Coleoptera (beetles)			
Dytiscidae (total)		3	1
Haliplidae (adults)		5	
Hydrophilidae (total)			1
Dryopidae	1		1
Elmidae	16	18	119
Diptera (flies)			
Athericidae	3		
Ceratopogonidae			2
Chironomidae	58	17	19
Culicidae		7	
Dixidae			1

TAXA	South Branch White Creek Arthur Road 9/21/2016 790210	South Branch White Creek Phillips Road 9/21/2016 790206	South Branch White Creek Mushroom Road 9/21/2016 790204
Stratiomyidae			1
Tabanidae	2		4
Tipulidae	3		4
MOLLUSCA			
Gastropoda (snails)			
Ancylidae (limpets)		4	1
Lymnaeidae			1
Physidae		8	3
Pelecypoda (bivalves)			
Sphaeriidae (clams)		1	
Unionidae (mussels)	1		
TOTAL INDIVIDUALS	244	281	314

METRIC	South Branch White Creek Arthur Road 9/21/2016 790210 Value	Score	South Branch White Creek Phillips Road 9/21/2016 790206 Value	Score	South Branch White Creek Mushroom Road 9/21/2016 790204 Value	Score
TOTAL NUMBER OF TAXA	19	0	23	0	29	1
NUMBER OF MAYFLY TAXA	4	1	3	0	3	0
NUMBER OF CADDISFLY TAXA	1	-1	3	0	3	0
NUMBER OF STONEFLY TAXA	0	-1	0	-1	0	-1
PERCENT MAYFLY COMP.	44.67	1	11.39	0	8.28	0
PERCENT CADDISFLY COMP.	10.25	0	2.85	-1	16.88	0
PERCENT DOMINANT TAXON	26.23	0	25.62	0	37.90	-1
PERCENT ISOPOD, SNAIL, LEECH	0.41	1	4.27	0	1.59	1
PERCENT SURF. AIR BREATHERS	0.00	1	11.74	0	1.59	1
TOTAL SCORE		2		-2		1
MACROINV. COMMUNITY RATING		ACCEPT.		ACCEPT.		ACCEPT.

Table 4 continued. Qualitative macroinvertebrate sampling results at selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

TAXA	Moore Drain Sanilac Rd. 7/21/2016 790226	Moore Drain Waterman Rd. 7/21/2016 790225	Moore Drain Downstream Spring Street 7/21/2016 790174
PLATYHELMINTHES (flatworms)			
Turbellaria	9		
ANNELIDA (segmented worms)			
Hirudinea (leeches)	8	1	3
Oligochaeta (worms)	8	17	5
ARTHROPODA			
Crustacea			
Amphipoda (scuds)	1	1	81
Decapoda (crayfish)	1	1	2
Isopoda (sowbugs)	25	1	4
Arachnoidea			
Hydracarina	8	2	2
Insecta			
Ephemeroptera (mayflies)			
Baetidae	10	5	
Caenidae		3	1
Heptageniidae			1
Odonata			
Anisoptera (dragonflies)			
Aeshnidae	3	2	2
Zygoptera (damselflies)			
Calopterygidae			3
Coenagrionidae	22	39	3
Hemiptera (true bugs)			
Belostomatidae	1	1	
Corixidae	5	1	
Mesoveliidae			1
Notonectidae		1	
Veliidae	12	1	
Trichoptera (caddisflies)			
Helicopsychidae			2
Hydropsychidae			7
Leptoceridae	2	2	1
Molannidae			1
Lepidoptera (moths)			
Pyralidae			1
Coleoptera (beetles)			
Dytiscidae (total)	1		
Gyrinidae (adults)		1	
Haliplidae (adults)	2	1	
Hydrophilidae (total)	13	1	1
Dryopidae	1		
Elmidae	9	61	29
Haliplidae (larvae)	3		

TAXA	Moore Drain Sanilac Rd. 7/21/2016 790226	Moore Drain Waterman Rd. 7/21/2016 790225	Moore Drain Downstream Spring Street 7/21/2016 790174
Lampyridae (larvae)	1		
Diptera (flies)			
Athericidae	2		
Ceratopogonidae		5	2
Chironomidae	76	77	51
Culicidae	2	1	
Dixidae	1		1
Simuliidae			1
Stratiomyidae	1		
Tabanidae	2	3	
Tipulidae			2
MOLLUSCA			
Gastropoda (snails)			
Lymnaeidae	1		
Physidae	464	32	49
Pelecypoda (bivalves)			
Sphaeriidae (clams)		4	26
Unionidae (mussels)			1
TOTAL INDIVIDUALS	694	264	283

METRIC	Moore Drain Sanilac Rd. 7/21/2016 790226 Value	Score	Moore Drain Waterman Rd. 7/21/2016 790225 Value	Score	Moore Drain Downstream Spring Street 7/21/2016 790174 Value	Score
TOTAL NUMBER OF TAXA	28	1	25	1	27	1
NUMBER OF MAYFLY TAXA	1	0	2	0	2	0
NUMBER OF CADDISFLY TAXA	1	-1	1	-1	4	0
NUMBER OF STONEFLY TAXA	0	-1	0	-1	0	-1
PERCENT MAYFLY COMP.	1.44	-1	3.03	0	0.71	-1
PERCENT CADDISFLY COMP.	0.29	-1	0.76	-1	3.89	-1
PERCENT DOMINANT TAXON	66.86	-1	29.17	0	28.62	0
PERCENT ISOPOD, SNAIL, LEECH	71.76	-1	12.88	-1	19.79	-1
PERCENT SURF. AIR BREATHERS	5.33	1	3.03	1	0.71	1
TOTAL SCORE		-4		-2		-2
MACROINV. COMMUNITY RATING		ACCEPT.		ACCEPT.		ACCEPT.

Table 4 continued. Qualitative macroinvertebrate sampling results at selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

TAXA	Dead Creek Townline Road 6/30/2016 730338
ANNELIDA (segmented worms)	
Oligochaeta (worms)	2
ARTHROPODA	
Crustacea	
Amphipoda (scuds)	9
Decapoda (crayfish)	3
Isopoda (sowbugs)	11
Arachnoidea	
Hydracarina	1
Insecta	
Ephemeroptera (mayflies)	
Baetidae	6
Tricorythidae	4
Odonata	
Anisoptera (dragonflies)	
Aeshnidae	4
Gomphidae	1
Zygoptera (damselflies)	
Calopterygidae	6
Coenagrionidae	20
Hemiptera (true bugs)	
Corixidae	2
Gerridae	1
Notonectidae	1
Veliidae	6
Megaloptera	
Sialidae (alder flies)	1
Trichoptera (caddisflies)	
Helicopsychidae	4
Hydropsychidae	48
Leptoceridae	14
Coleoptera (beetles)	
Dryopidae	1
Elmidae	125
Psephenidae (larvae)	2
Scirtidae (larvae)	1
Diptera (flies)	
Chironomidae	54
Stratiomyidae	1
Tabanidae	1
Tipulidae	8
MOLLUSCA	
Gastropoda (snails)	
Physidae	10

TAXA	Dead Creek Townline Road 6/30/2016 730338
Planorbidae	2
Pleuroceridae	3
Pelecypoda (bivalves)	
Sphaeriidae (clams)	11
Unionidae (mussels)	1
TOTAL INDIVIDUALS	364

METRIC	Dead Creek Townline Road 6/30/2016 730338 Value	Score
TOTAL NUMBER OF TAXA	32	1
NUMBER OF MAYFLY TAXA	2	0
NUMBER OF CADDISFLY TAXA	3	0
NUMBER OF STONEFLY TAXA	0	-1
PERCENT MAYFLY COMP.	2.75	-1
PERCENT CADDISFLY COMP.	18.13	0
PERCENT DOMINANT TAXON	34.34	-1
PERCENT ISOPOD, SNAIL, LEECH	7.14	0
PERCENT SURF. AIR BREATHERS	3.02	1
TOTAL SCORE		-1
MACROINV. COMMUNITY RATING		ACCEPT.

Table 4 continued. Qualitative macroinvertebrate sampling results at selected stations in the Cass River watershed Saginaw, Tuscola, Genesee, Lapeer, Sanilac, and Huron Counties June-September 2016.

TAXA	Sanilac Huron Creek Ritter Rd. (Upstream) 6/29/2016 760292	Sanilac Huron Creek Bay Forestville Rd. 6/29/2016 760293
PLATYHELMINTHES (flatworms)		
Turbellaria		1
ANNELIDA (segmented worms)		
Hirudinea (leeches)	2	5
Oligochaeta (worms)	3	44
ARTHROPODA		
Crustacea		
Amphipoda (scuds)	36	
Decapoda (crayfish)	4	1
Isopoda (sowbugs)	4	48
Arachnoidea		
Hydracarina	11	12
Insecta		
Ephemeroptera (mayflies)		
Baetidae		1
Caenidae	3	1
Heptageniidae	13	
Odonata		
Anisoptera (dragonflies)		
Aeshnidae	1	2
Zygoptera (damselflies)		
Calopterygidae	1	1
Coenagrionidae	1	1
Plecoptera (stoneflies)		
Perlidae	1	1
Hemiptera (true bugs)		
Belostomatidae	1	
Corixidae	1	2
Gerridae		1
Mesoveliidae	1	
Trichoptera (caddisflies)		
Helicopsychidae	1	
Hydropsychidae	16	2
Limnephilidae	4	1
Coleoptera (beetles)		
Dytiscidae (total)	1	1
Haliplidae (adults)		1
Hydrophilidae (total)	4	3
Elmidae	40	36
Haliplidae (larvae)		1
Lampyridae (larvae)	1	
Scirtidae (larvae)	1	
Diptera (flies)		
Chironomidae	127	119
Simuliidae	1	
Tabanidae	2	
MOLLUSCA		
Gastropoda (snails)		
Lymnaeidae	11	10
Physidae	4	26
Planorbidae	26	3
Pelecypoda (bivalves)		
Sphaeriidae (clams)		1
TOTAL INDIVIDUALS	326	328

METRIC	Sanilac Huron Creek Ritter Rd. (Upstream) 6/29/2016 760292 Value	Score	Sanilac Huron Creek Bay Forestville Rd. 6/29/2016 760293 Value	Score
TOTAL NUMBER OF TAXA	30	1	27	1
NUMBER OF MAYFLY TAXA	2	1	2	1
NUMBER OF CADDISFLY TAXA	3	0	2	0
NUMBER OF STONEFLY TAXA	1	1	1	1
PERCENT MAYFLY COMPOSITION	4.91	0	0.61	-1
PERCENT CADDISFLY COMPOSITION	6.44	0	0.91	-1
PERCENT DOMINANT TAXON	38.96	-1	36.28	0
PERCENT ISOPOD, SNAIL, LEECH	14.42	-1	28.05	-1
PERCENT SURFACE AIR BREATHERS	2.45	1	2.74	1
TOTAL SCORE		2		1
MACROINVERTEBRATE COMMUNITY RATING		Acceptable		Acceptable