MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
OCTOBER 2018
STAFF REPORT

Biological and water chemistry surveys of selected stations in the Looking Glass River watershed in Shiawassee and Clinton Counties, Michigan, June-September 2017

Introduction

Biological and physical habitat conditions of selected water bodies in the Looking Glass River watershed, in Shiawassee and Clinton Counties, were assessed by staff of the Michigan Department of Environmental Quality (MDEQ), Surface Water Assessment Section (SWAS), in June-September 2017. Water bodies include Perry Drain #2, Vermillion Creek, and the Looking Glass River. 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.
2) Evaluate biological integrity temporal trends.
3) Satisfy monitoring requests submitted by internal and external customers.
4) Identify nonpoint sources (NPS) of water quality impairment.

Watershed Information

The Looking Glass River watershed is approximately 312 square miles with 178 miles of perennial streams (Michigan Resource Information System [MIRIS], 2007). Most of the watershed is in Shiawassee and Clinton Counties, with small areas in Ingham, Ionia, Livingston, and Eaton Counties. The headwaters begin east and south of the village of Morrice and the city of Perry in Shiawassee County. The river then flows approximately 40 miles to the confluence with the Grand River in the city of Portland (Ionia County).

The watershed is in the Ionia Subsection District Ecosystem (Albert, 1995). The Ionia District consists of gently rolling ground moraine, and land use is dominated by agriculture. The watershed lies within the Lansing Sub-subsection, which consists of undulating topography of ground moraine, which forms well- and moderately-drained areas alternating with poorly- to very poorly-drained depressions. Drainage of a large part of the Lansing District was necessary for agricultural use and the number of drainage ditches ranks third across all sub-subsections in the Ionia Subsection. All stations are in the Southern Michigan/Northern Indiana Drift Plains (SMNIDP) ecoregion (Omernik and Gallant, 2010). The entire Looking Glass River watershed is designated as a warmwater stream (Michigan Department of Natural Resources [MDNR], 1997).

Land use in the Looking Glass River watershed is presented in Table 1 using a subwatershed scale (12-digit Hydrologic Unit Code [HUC]). Cultivated agriculture and hay and pasture land is the dominant land use in many of the subwatersheds. However, Vermillion Creek and Mud Creek watersheds have a large amount of natural areas. The Remy-Chandler Drain subwatershed is dominated by developed land in north East Lansing (United States Department of Agriculture [USDA], Natural Resources Conservation Service [NRCS], 2001).

The amount of impervious area in the Looking Glass River watershed is between 1 and 15% (National Oceanic and Atmospheric Administration [NOAA], 2011). Impervious surfaces are

those areas on the land that cannot effectively absorb water and pass it through to the groundwater table. Examples include: decks, patios, paved roads, crushed stone driveways, parking areas, and sidewalks. Impervious area is closely linked to land use areas of development. The higher amount of impervious cover is directly related to a higher amount of storm water runoff, impacting in-stream biological communities due to pollutants in the runoff and its contribution to flashy flows that scour the stream bottom. The subwatershed with the highest amount of impervious surface is the Remy-Chandler Drain.

The statewide average amount of total wetlands lost since presettlement times is 40% (Fizzell, 2014). In the Looking Glass River watershed, the percentage of wetlands that has been lost since presettlement ranges from 3 to 59% with an average of 24%. The highest percentage of wetlands lost at the 12-Digit HUC watershed level is 59% in the Remy-Chandler Drain watershed (Table 1). Wetlands are important to retain water during precipitation events to reduce runoff and prevent flooding and extreme fluctuations in stream flow, all of which are important to both people and in-stream biological communities. In areas where a large amount of wetland has been lost, there is a larger amount of stress put on in-stream biological communities.

Table 1. Detailed land use of the Looking Glass River watershed, by 12-digit Hydrologic Unit Code watershed groups.

12-Digit HUC	12-Digit HUC Watershed Name	Natural	Developed	Cultivated Agriculture	Hay or Pasture	Other land uses	Lost Wetlands since Human Settlement	Impervious Surface
040500040601	Headwaters Looking Glass River	28%	6%	43%	23%	0%	25%	1%
040500040602	Howard Drain-Looking Glass River	30%	8%	36%	26%	3%	25%	2%
040500040603	Kellogg Drain-Looking Glass River	38%	14%	24%	23%	1%	14%	3%
040500040604	Buck Branch-Vermillion Creek	25%	6%	47%	18%	1%	51%	1%
040500040605	Vermillion Creek	60%	8%	10%	19%	3%	11%	2%
040500040606	Leisure Lakes-Looking Glass River	49%	8%	15%	26%	2%	9%	2%
040500040607	Mud Creek-Looking Glass River	49%	10%	14%	26%	1%	3%	2%
040500040608	Remy Chandler Drain	22%	47%	16%	12%	3%	59%	15%
040500040609	Turkey Creek Drain-Looking Glass River	28%	9%	37%	25%	1%	9%	2%
040500040610	Summers Drain-Looking Glass River	19%	28%	36%	15%	2%	15%	7%
040500040611	Husted and Landenburg Drain-Looking Glass River	21%	9%	50%	18%	2%	20%	2%
040500040612	Looking Glass River	19%	9%	50%	22%	0%	43%	2%

Historical Sampling Efforts and Information

The most recent survey of the Looking Glass River watershed was conducted in 2012 (Lipsey, 2013). Macroinvertebrate community ratings were all excellent or acceptable except for Remy-Chandler Drain at State Street, which was rated poor. Sediment has been identified as the pollutant of concern. However, this should be revisited when drafting the future Integrated Report, because Remy-Chandler Drain has been designated as a Category 4c stream on the Section 303(d) nonattainment list due to it being a maintained county drain (MDEQ, 2016). The designation 4c is given to streams not attaining one or more designated uses but the impairment is not caused by a pollutant. In the case of Remy-Chandler Drain the source of the sediment is most likely storm water contributions and it has not been determined if sediment or high storm water flows are the cause of nonattainment. Habitat ratings throughout the Looking Glass River watershed in 2012 ranged from marginal to excellent. Historic reports from the past two decades are presented and summarized in Table 2.

Nutrient studies have been conducted in Perry Drain #2 (Cooper, 2001 and 2002). The purpose of the 2001 study was to determine if the discharge from two wastewater sewage lagoon discharges were having an adverse impact on water quality. The 2002 study objective was to determine if the nutrient load from the Countryside Wastewater Storage Lagoon was being retained within the stream or if it was being transported downstream without adversely impacting water quality. The study indicated that the phosphorus from the effluent is retained within the drain. In 2007, the drain was observed upstream and downstream of the storage lagoon where some filamentous algae were observed, but not nuisance conditions. The stream was also sampled two miles downstream of the lagoon and macroinvertebrates scored acceptable (Lipsey, 2008).

Table 2. Surveys conducted in the Looking Glass River watershed 2001-2013.

Survey Year	Report Citation Report Number	Finding/Comments
2013	Lipsey, T. 2013 MI/DEQ/WRD-13/010	• Macroinvertebrate community samples collected at 10 stations, ratings ranged from poor to excellent. Poor rating was in Remy-Chandler Drain at State Road. • Habitat ratings ranged from marginal to excellent.
2010	Clinton County Conservation District. 2013 MI/DEQ/CMIGRT-10/500	• Mid-Michigan Streambank Erosion Study.
2007	Lipsey, T. 2007 MI/DEQ/WD-03/017	• Aquatic macroinvertebrate community and habitat assessments were conducted at 23 stations. • Macroinvertebrate ratings were nearly all acceptable, with one site rating excellent. • Habitat ratings ranged from poor to excellent. • The fish community was sampled in Clise Drain at Cutler Road and scored poor and was designated as Category 4c due to it being a maintained drain.
2003	Roush, D. 2003. MI/DEQ/WD-03/120	• Aquatic macroinvertebrate community and habitat assessments were conducted at 8 stations. Macroinvertebrate ratings ranged from acceptable to excellent. • Habitat ratings ranged from poor to excellent. • Water and sediment chemistry sample results taken throughout the watershed did not exceed WQS or sediment quality guidelines for the parameters analyzed; except for several Base Neutrals and Acids exceeding the threshold effect in sediment concentrations collected downstream of the southern Clinton County Wastewater Treatment Plant.
2002	Cooper, J. 2002. MI/DEQ/SWQ-02/109	• A nutrient study in Perry Drain #2 • Study indicated nutrient load from the Countryside Wastewater Storage Lagoon was being retained within the stream
2001	Cooper, J. 2001. MI/DEQ/SWQ-01/095	• Macroinvertebrate community samples collected at 3 stations in Perry Drain #2. Two stations rated acceptable, and one station rated poor. Habitat was rated as fair. • Water chemistry results demonstrated an increase in nutrients from upstream to downstream.

Methods

The macroinvertebrate or fish community and physical habitat was qualitatively assessed at three stations using the SWAS Procedure 51 for wadeable streams (Table 3; Creal et al., 1996; MDEQ, 1990). The stations were sampled upstream of road crossings. The macroinvertebrate and fish communities were assessed and scored with metrics that rate water bodies from excellent (+5 to +9 [macroinvertebrates], +5 to +10 [fish]) to poor (-5 to -9 [macroinvertebrates], -5 to -10 [fish]). 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 warmwater fish designated use. Habitat scores and individual metrics are used to help better understand the biological community scores. Additional stations were visited but biomonitoring was not conducted. A summary of these station visits is also included below.

Site Selection

Two site-selection methods are used in watershed surveys: (1) stratified random; and (2) targeted. Stratified random sites support the Status and Trend Program, which is designed to statistically assess the biological conditions of macroinvertebrate communities in Michigan's rivers and streams and determine whether changes are occurring over time (MDEQ, 2015). Targeted sites are chosen through the "Targeted Monitoring Request" process, which involves stakeholders from across Michigan submitting monitoring requests. All survey types are considered when determining support of 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.

2017 Sampling Results

Table 3. Summary of the aquatic habitat and macroinvertebrate community evaluations for selected stations in the Looking Glass River watershed, June-September 2017.

Station #	Stream Name	Road Crossing	STORET #	Township	County	Latitude	Longitude	Habitat Evaluation Rating	Habitat Evaluation Score	Macroinvertebrate or **Fish Community Rating	Macroinvertebrate or **Fish Community Score	S/T/Tr	AUID#
1	Perry Drain #2	Britton Rd.	780155	Perry	Clinton	42.84759	-84.23982	NA	NA	NA	NA	T	040500040603-03
2	Perry Drain #2	Ruess Rd.	780153	Perry	Clinton	42.84777	-84.23972	Marginal	82	**Poor	**-8	T	040500040603-03
3	Vermillion Creek	Old 78 Rd	780226	Woodhull	Shiawassee	42.80190	-84.33790	Good	130	Acceptable	2	Tr	040500040605-03
4	Looking Glass River	Colby Lake Rd	780222	Sciota	Shiawassee	42.86690	-84.32460	Good	112	Acceptable	-4	Tr	040500040606-02
5	Looking Glass River	Babcock Road	190198	Victor	Clinton	42.8695	-84.45288	NA	NA	NA	NA	SV	040500040609-01
6	Looking Glass River	upstream and downstream of Remy-Chandler Drain confluence	NA	Dewitt	Clinton	42.85335	-84.53797	NA	NA	NA	NA	T	040500040609-01 (upstream) 040500040610-01 (downstream)
7	Looking Glass River	upstream of Lowell Road	NA	Watertown	Clinton	42.81814	-84.6419	NA	NA	NA	NA	SV	040500040610-01

S/T/Tr = status, targeted, trend station
NA = Not Applicable

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

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

Summary of Findings by Monitoring Objective

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

In 2017, seven sites within the Looking Glass River watershed were sampled to assess the designated use support status of their associated individual assessment units (Figure 1). At three stations, aquatic macroinvertebrate or fish community and habitat assessments were conducted and it was determined that the OIALW designated use was being met at all stations.

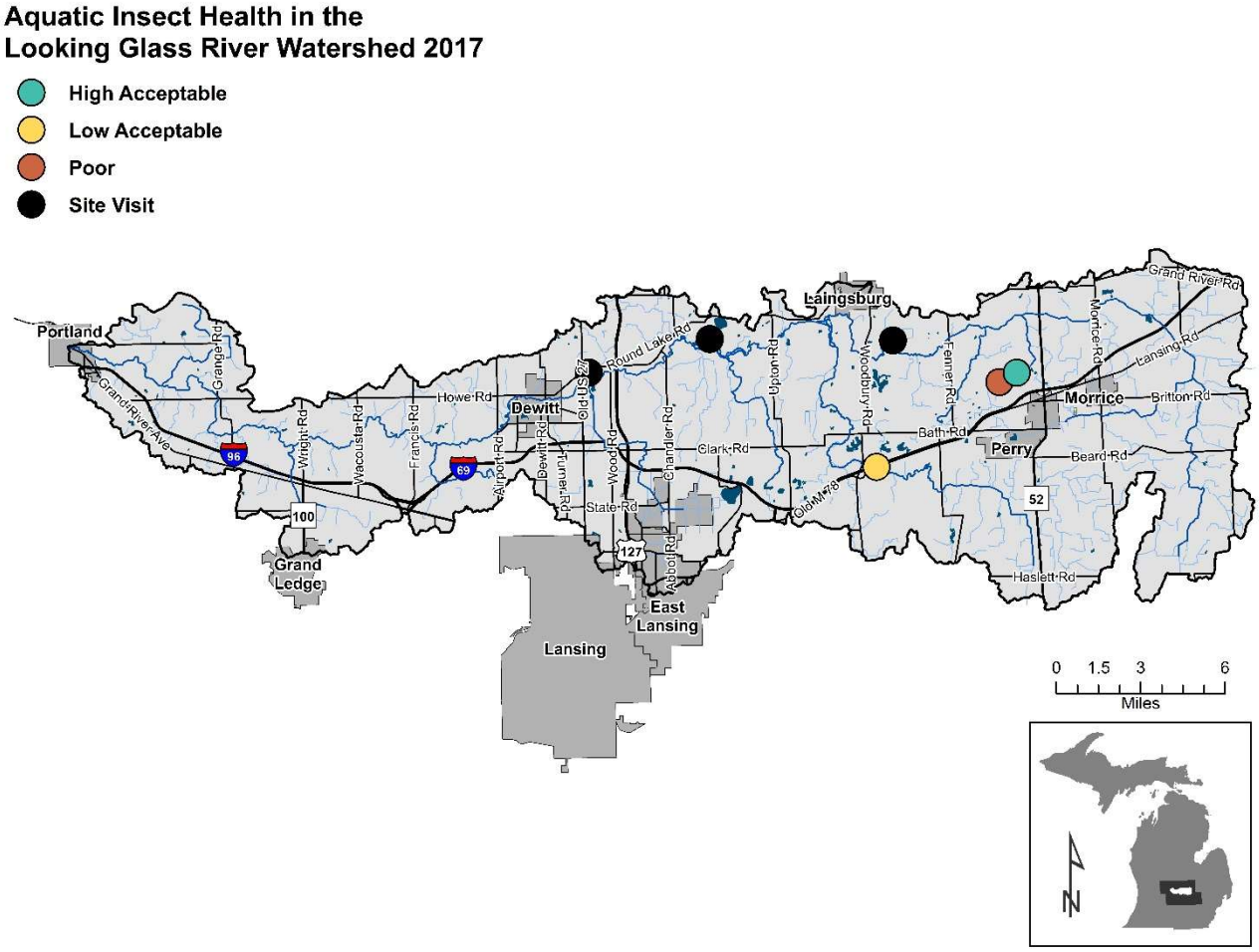

Figure 1. Stations sampled in 2017 in the Looking Glass River watershed, Clinton and Shiawassee Counties, Michigan.

PERRY DRAIN # 2

Perry Drain #2 was sampled at Britton and Reuss Road (Stations 1 and 2). Perry Drain #2 is a maintained agricultural drain that is a tributary to Kellogg Drain. It is listed on the Clean Water Act Section 305(b) list as having insufficient information for the warmwater fisheries designated use due to uncertainty if the dissolved oxygen (DO) WQS is being met (MDEQ, 2016). In 2002, spot checks of DO were inconclusive and additional study was recommended. Continuous monitoring for DO was completed in late March 2017 at both stations and results indicated that although the DO WQS was being met, the average diurnal variation ranged from 1.91 at Britton Road to 3.05 at Ruess Road. A

variation of 1 milligram per liter (mg/L) is expected on average for Michigan's warmwater streams. Therefore, it was determined that there may be DO sags during times of the year when vegetation is more abundant and further monitoring during the growing season would be beneficial.

Habitat and fish community surveys were not conducted at Station 1. At Reuss Road (Station 2), the glide/pool habitat was rated marginal (82, moderately impaired; Table 4). Overhanging grass provided the only cover for fish. Pools were rare, and silt was the dominant substrate type (Figure 2). The macroinvertebrate community scored acceptable at this station in 2012 and at other stations in the Perry Drain #2/Kellogg Drain watershed. Macroinvertebrate community conditions were expected to be similar in 2017 and were not resampled.

The fish community at Reuss Road scored poor (-8; Tables 5 and 6), despite it being a cold system (53 degrees Fahrenheit). Only four species of fish were collected, all of which are considered more tolerant. Continuous pH, DO, and temperature measurements were taken in Perry Drain #2 at several locations in late summer 2017 including at Stations 1 and 2. A separate report will be written to document these measurements. Overall, the results indicate that the DO WQS is being met, yet the warmwater fish community designated use is not being met. This is most likely due to a lack of habitat that is the result of it being a maintained drain. Therefore, Perry Drain #2 will be designated as Category 4c for the warmwater fish designated use in the 2020 Sections 303(d) and 305(b) Integrated Report.

Figure 2. Perry Drain #2 upstream of Reuss Road, Shiawassee County, Michigan, September 2017.

VERMILLION CREEK

Vermillion Creek was sampled at Old-78 (Lansing Road). The glide/pool habitat was rated as good (130; Table 7). The station had a large wooded floodplain that was well connected to the stream. Large woody debris was available but was covered with a layer of silt, negatively impacting colonization potential. The sand and silt substrate was unstable in several areas. Dry ravines were observed, indicating sediment is entering the stream during rain events. The macroinvertebrate community scored acceptable (2; Tables 8 and 9). No stonefly families were found, and amphipods made up nearly 60 percent of the individuals found, indicating there are likely environmental stressors impacting this station.

LOOKING GLASS RIVER AT COLBY LAKE ROAD

The Looking Glass River was sampled at Colby Lake Road. The glide/pool habitat was rated good (112; Table 10). The Looking Glass River has been historically straightened and dredged in this portion of the watershed. The riparian area consisted of a mature wooded floodplain and one yard that was mowed to the edge of the river. The water level was very deep and the substrate was very soft consisting almost entirely of silt. The silt may be due partially to the wetland nature of the watershed prior to channelization. There was a large amount of woody debris, the surface of which was covered with silt. The banks were fairly stable due to the natural riparian area and large trees. The macroinvertebrate community scored at the low end of acceptable (-4; Tables 11 and 12). No caddisfly or stonefly taxa were found, and only 2 mayfly taxa consisting of only 5 individuals were found. There was also a relatively large number of surface air breathers.

Objective 2: Evaluate biological integrity temporal trends.

Vermillion Creek at Old-78 (Lansing Road) and the Looking Glass River at Colby Lake Road were randomly selected as trend stations and have been sampled every five years since 2007. These two trend sites will be used to determine statewide trend information, which statistically cannot be summarized until 2021, when a sufficient amount of data has been collected.

Looking over past habitat survey scores since 2007, it can be concluded that in general, the habitat ratings in Vermillion Creek have remained good and have varied only minimally (Table 7). The macroinvertebrate community has scored acceptable (Tables 8 and 9) and has also varied only minimally.

The Looking Glass River at Colby Lake Road habitat has been rated marginal to good, but the score has only varied from 95 to 112 with no one metric indicating a large change (Table 10). The macroinvertebrate community has been rated acceptable, but the scores have bounced from a -3 in 2007 to 2 in 2012 to -4 in 2017 (Tables 11 and 12). In 2017, the same 2 mayfly families (Caenidae and Heptageniidae) were found that were found in 2012, but there were fewer individuals. A single stonefly was found in 2012, which was not found in 2007 or 2017. Trichoptera were found both in 2007 and 2012 but not in 2017.

Objectives 3 and 4: Satisfy monitoring requests submitted by internal and external customers and identify NPS of water quality impairment.

LOOKING GLASS RIVER AT BABCOCK ROAD

In 2012, members of the Friends of the Looking Glass River watershed group had concerns about the amount of duckweed in the Looking Glass River downstream of Babcock Road. MDEQ staff collected water samples for the analysis of nutrients at several stations upstream and one station downstream of Babcock Road. Total Phosphorus results ranged from 0.040 to 0.0484 mg/L and were compared with statewide samples collected from 2005 to 2009. Based on the 2012 sample results, the total

phosphorus conditions appeared to be within the range that would be expected in this region of the state (Lipsey, 2013).

In 2016, the MDEQ received a complaint from a U.S. Fish and Wildlife employee who used a kayak in the same stretch of river downstream of the Babcock Road crossing. He noted there was an extremely bad odor coming from the water throughout the kayak trip and that approximately one mile downstream, the duckweed was so thick that they had to turn around. He and his wife became ill the next day. *E. coli* data collected by the Shiawassee County Conservation District indicates possible exceedances of the total and partial body contact recreation uses throughout the watershed. These data are going to be more closely analyzed by SWAS staff as part of the 2018 Section 303(d) and 305(b) Integrated Report update attainment decisions.

In 2017, we attempted to use a small inflatable boat to travel downstream of Babcock Road. The stretch was very slow moving and large quantities of submerged and floating vegetation prevented us from traveling more than approximately 0.25 miles. The extent of the duckweed was so extensive that in areas where it had collected, it was more than 6 inches deep and smelled extremely noxious when disturbed (Figures 3 [Station A] and 4). This is likely the smell reported by the stakeholder. The smell is due to the duckweed decomposing in very anoxic conditions. The DO levels upstream and downstream of Babcock Road were just above or less than 1.0 mg/L (Table 13). This low level continued at a residential site 1.5 miles downstream (Figures 3 [Station B] and 5) as well as at the Chandler Road crossing located approximately 2.75 miles downstream of Babcock Road (Figures 3 [Station C] and 6). The area upstream of Babcock Road was a ponded wetland (Figures 3 [Station D], 7, and 8). The DO level was only slightly better at 1.61 mg/L. The Upton Road crossing is one mile upstream of Babcock Road and the DO was 5.94 mg/L (Figures 3 [Station E], 9, and 10).

The low flow, pond-like nature, and low DO conditions are likely, at least in part, a result of the area being of low slope and historically wetland in nature before draining and channel alteration occurred to allow for better drainage. Increased nutrient and sediment inputs due to the agricultural land use in of the watershed may also play a part in low DO conditions. Further investigation of the DO concentrations in this warmwater system may be warranted in the future. Temperature, conductivity, total dissolved solids, pH, chlorophyll-a, and blue-green algae indicator measurements were also taken and are provided in Table 13.

Figure 3. Looking Glass River station visits upstream and downstream of Babcock Road.

Figure 4. Decaying and alive duckweed in the Looking Glass River downstream of Babcock Road, September 2017.

Figure 5. Looking Glass River downstream of Babcock Road, September 2017.

Figure 6. Looking Glass River at private residence 1.5 miles downstream of Babcock Road, September 2017.

Figure 7. Looking Glass River upstream of Chandler Road, September 2017.

Figure 8. Looking Glass River upstream of Babcock Road, 2017.

Figure 9. Looking Glass River upstream of Upton Road, September 2017

Figure 10. Looking Glass River downstream of Upton Road, September 2017.

LOOKING GLASS RIVER AT REMY-CHANDLER DRAIN CONFLUENCE

Remy-Chandler Drain is a water body that is maintained as a county drain receiving excessive storm water flow that is impacting macroinvertebrate communities and is not attaining the OIALW designated use. The MDEQ has received previous reports from kayakers of the Friends of the Looking Glass River watershed group that after a rain, a large sediment plume can be observed at the confluence of Remy-Chandler Drain with the Looking Glass River. MDEQ staff visited this location in September 2017 to determine if a sedimentation impact could be measured at the confluence using pebble count quantification measures.

Upon arrival, the Remy-Chandler drain was observed to be at low flow and 6-10 inches deep. It is a riffle run type stream in this reach (Figure 11).

Figure 11. Remy-Chandler Drain upstream of Looking Glass River confluence, looking upstream.

The Looking Glass River just upstream of the confluence of Remy-Chandler Drain is quite deep (more than 4 feet) and slow moving. There is a large amount of floating vegetation and sediment deposits with vegetation growing on them (Figures 12 and 13). Sedimentation was also observed at the mouth of Remy-Chandler Drain (Figures 14-16).

Figure 12. Looking Glass River upstream of Remy-Chandler drain confluence, facing upstream.

Figure 13. Looking Glass River upstream of Remy-Chandler Drain confluence, facing downstream.

Figure 14. Remy-Chandler Drain confluence with the Looking Glass River, photo taken while standing on sediment deposition and facing the mouth of Remy-Chandler Drain.

Figure 15. Sediment deposition in a dry backwater area at mouth of Remy-Chandler Drain. Photo was taken facing the east while standing and the confluence of the drain and Looking Glass River.

Figure 16. Sedimentation at the mouth of the Remy-Chandler Drain. Photo taken at the mouth of the drain, facing upstream in the Looking Glass River.

Upstream of the deep and slow-moving portion, the Looking Glass River looks very similar to upstream road crossings (Figure 17). It is an average of 2 feet deep with deeper pools. There are many floating macrophytes (lilies and duckweed) present along the edges. The river bottom is dominated by firm sand covered with 4-6 inches of fine silt.

Figure 17. Looking Glass River upstream of Remy-Chandler confluence, looking upstream.

Downstream of the confluence the Looking Glass River is much shallower (6 inches) and gravel and sand substrate are present (Figure 18). The substrate looks more similar to what is found downstream in the city of Dewitt, indicating that flow and possibly slope increases at this confluence allowing sediment to be transported downstream.

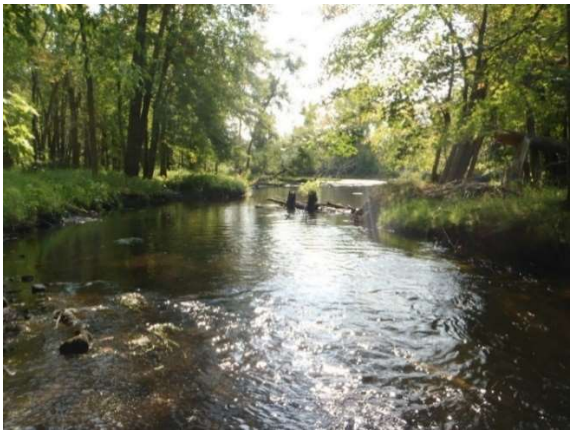

Figure 18. Looking Glass River downstream of Remy-Chandler Drain confluence, looking upstream.

Although it was obvious that the Remy-Chandler Drain transports and deposits a large amount of sediment at the confluence of the drain with the Looking Glass River, it is not apparent that a change in sedimentation could be measured downstream of the confluence when compared to upstream. In addition, due to the wetland nature of the Looking Glass River and the siltation and sedimentation that happens in the agriculturally dominated watershed upstream of the confluence, it would be difficult to quantify the amount of sedimentation caused by the drain without continuous water quality monitoring or much more in-depth and expansive pattern, profile, and dimension measurements. Regardless of these measurements, best management practices (BMP) that would address sedimentation load in the Remy-Chandler Drain watershed would be beneficial.

LOOKING GLASS RIVER UPSTREAM OF LOWELL ROAD

A monitoring request was received from the Clinton County Conservation District regarding complaints they received in 2016 of a sewage smell approximately one mile upstream of Lowell Road. In 2017, MDEQ staff kayaked from Airport Road downstream approximately 2 miles to Lowell Road to determine if a smell was noticeable and observe if there was an indication of an illicit connection. No unusual smells were noted. A large water pump used for water withdrawal was documented at 42.81852, -84.62866 (Figure 19) and reported to the appropriate MDEQ staff to determine if appropriate permits were in place.

Figure 19. Water withdrawal pump on the Looking Glass River, Clinton County, Michigan, September 2017.

Conclusions and Future Monitoring Recommendations

In 2017, aquatic macroinvertebrate or fish community and habitat assessments were conducted at a total of 3 stations in the Looking Glass River watershed (Table 1). The OIALW designated use is being met at 2 of the stations but the warmwater fish community is impaired in Perry Drain #2, due to drain maintenance-related activities limiting habitat availability. The drain will be noted as such in the 2020 Sections 303(d) and 305(b) Integrated Report.

The Shiawassee County Conservation District recently updated the Upper Looking Glass Watershed Management Plan (ULGWMP) that was originally developed by the Clinton Conservation District in 2008 (Clinton County Conservation District, 2008). The Upper Looking Glass River watershed comprises 12 subbasins above the Remy-Chandler Drain watershed. One purpose of the ULGWMP is to identify primary pollutants, and sources and causes of those pollutants. Secondly, the plan will improve cooperation between local officials, landowners, and others in an effort to protect, restore, and enhance the natural resources of the watershed (Shiawassee Conservation District, 2018). The ULGWMP points out the priority pollutants as viewed by stakeholders for each land use type. For agricultural land areas, pathogens due to cropland runoff, livestock access, and manure application and storage are the number one concern. In natural areas, sediment followed closely by pathogens were the primary concerns, and in urban areas chemicals due to illicit connections, impervious surface runoff, and septic systems are of concern.

Sediment impacts aquatic life by covering up natural substrates needed for survival or spawning, damaging gills needed to breath, and carries other pollutants such as nutrients to the stream. Sedimentation is often caused by runoff and soil erosion from crop lands, storm water runoff from urban areas, and construction in developing areas. Sediment deposits and sedimentation impacts have been observed throughout the Looking Glass River watershed in the past and continued to be observed in 2017. Efforts to reduce sedimentation through protection, restoration, and conservation practices should continue in the Looking Glass River watershed.

As noted earlier in this report *E. coli* data collected by the Shiawassee County Conservation District (2018) indicate levels are exceeding the partial and total body contact recreation WQS. If the watershed is put on the nonattainment list due to pathogen exceedances, the Statewide *E. Coli* Total Maximum Daily Load (TMDL) currently in draft, will apply. A TMDL is a document that describes the process used to set pollutant loads for a water body not meeting WQS. Pollutant load reductions from sources in the watershed are implemented through existing programs such as permits, through voluntary programs, and the work of local stakeholders.

In 2022, the following recommendations should be considered as resources allow:

1) BMPs that reduce sediment and increase habitat diversity and epifaunal substrate should be encouraged. If BMPs including road crossing replacements are planned for these watersheds, and it is a priority for NPS staff to show success, before and/or after surveys may be conducted.
2) There are additional water bodies in the Looking Glass River watershed that are on the Section 303(d) list of impaired and threatened waters but were not sampled in 2017 (Table 14). These water bodies as well as those that have not been assessed for one or more designated use should be considered when developing monitoring plans in the future. More information regarding water bodies that are impaired can be found in the 2016 Sections 303(d) and 305(b) Integrated Report (MDEQ, 2016).
3) Currently, the Maple River and Looking Glass River watersheds are lumped together when considering random status site determinations. This resulted in all status sites being selected from the Maple River watershed and two trend stations being selected in the Looking Glass River watershed. This may happen again in the future, and therefore targeted monitoring suggestions by local watershed stakeholders are extremely important.

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Table 4. Habitat evaluation for Perry Drain #2 in the Looking Glass River watershed, Michigan, August 2017.

	Perry Drain #2 at Reuss Road 8/25/2017 Station 2
HABITAT METRIC	**GLIDE/POOL**
Substrate and Instream Cover	
Epifaunal Substrate/ Available Cover (20)	3
Embeddedness (20)*	
Velocity/Depth Regime (20)*	
Pool Substrate Characterization (20)**	6
Pool Variability (20)**	2
Channel Morphology	
Sediment Deposition (20)	5
Flow Status - Maintenance Flow Volume (10)	8
Flow Status - Flashiness (10)	8
Channel Alteration (20)	10
Frequency of Riffles/Bends (20)*	
Channel Sinuosity (20)**	8
Riparian and Bank Structure	
Bank Stability (L) (10)	8
Bank Stability (R) (10)	8
Vegetative Protection (L) (10)	3
Vegetative Protection (R) (10)	5
Riparian Vegetative Zone Width (L) (10)	3
Riparian Vegetative Zone Width (R) (10)	5
TOTAL SCORE (200):	**82**
HABITAT RATING:	**Marginal**
Weather:	Sunny
Air Temperature: ºF	67
Water Temperature: ºF	53
Average Stream Width: Feet	8
Average Stream Depth: Feet	0.5
Surface Velocity: Feet/Second	
Estimated Flow: Cubic Feet/Second	
Stream Modifications:	
Nuisance Plants (Y/N):	
STORET No.:	780153
County Code:	78
TRS:	05N02E08
Latitude (dd):	42.8475855
Longitude (dd):	-84.239824
Ecoregion:	SMNIDP
Stream Type:	Warmwater
USGS Basin Code:	04050004

*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).

Table 5. Qualitative Fish Sampling for Perry Drain #2 at Ruess Road, Shiawassee County, Michigan, August 2017.

TAXA	Station 2 Perry Drain #2 Ruess Rd 8/25/2017
Umbridae (mudminnows)	
Umbra limi (Central mudminnow)	50
Cyprinidae (minnows and carps)	
Semotilus atromaculatus (Creek chub)	12
Centrarchidae (sunfish)	
Lepomis cyanellus (Green sunfish)	17
Percidae (perch)	
Etheostoma nigrum (Johnny darter)	1
TOTAL INDIVIDUALS	**80**
Number of hybrid sunfish	0
Number of anomalies	0
Percent anomalies	0.000
Percent salmonids	0.000
Reach sampled (ft)	300
Area sampled (sq. ft)	2,400
Density (# fish/sq. ft)	0.033
Gear	bps

Table 6. Fish Metric Evaluation for Perry Drain #2 at Ruess Road, Shiawassee County, Michigan, August 2017.

	Perry Drain #2 at Ruess Road 8/25/2017 Station 2	
METRIC	**Value**	**Score**
TOTAL NUMBER OF TAXA	4	-1
NO. OF DARTER, SCULPIN, MADTOM TAXA	1	0
NUMBER OF SUNFISH TAXA	1	0
NUMBER OF SUCKER TAXA	0	-1
NUMBER OF INTOLERANT TAXA	0	-1
PERCENT TOLERANT	100.00	-1
PERCENT OMNIVOROUS TAXA	77.50	-1
PERCENT INSECTIVOROUS TAXA	22.50	-1
PERCENT PISCIVOROUS TAXA	0.00	-1
% SIMPLE LITHOPHILIC SPAWNER TAXA	0.00	-1
Total Score		**-8**
Fish Community Rating		**POOR**

Table 7. Habitat evaluation for Looking Glass River at Colby Lake Road, Shiawassee County, Michigan, 2007, 2012, and 2017.

	Station 3 Vermillion Creek at Lansing Road (Old 78)		
	8/1/2007	7/31/2012	8/14/17
HABITAT METRIC	**GLIDE/POOL**	**GLIDE/POOL**	**GLIDE/POOL**
Substrate and Instream Cover			
Epifaunal Substrate/ Available Cover (20)	4	10	8
Embeddedness (20)*			
Velocity/Depth Regime (20)*			
Pool Substrate Characterization (20)**	7	9	11
Pool Variability (20)**	12	9	9
Channel Morphology			
Sediment Deposition (20)	5	4	7
Flow Status - Maintenance Flow Volume (10)	9	7	9
Flow Status - Flashiness (10)	2	5	5
Channel Alteration (20)	15	17	15
Frequency of Riffles/Bends (20)*			
Channel Sinuosity (20)**	13	18	14
Riparian and Bank Structure			
Bank Stability (L) (10)	4	2	8
Bank Stability (R) (10)	4	2	8
Vegetative Protection (L) (10)	9	8	9
Vegetative Protection (R) (10)	9	8	9
Riparian Vegetative Zone Width (L) (10)	9	9	9
Riparian Vegetative Zone Width (R) (10)	8	6	9
TOTAL SCORE (200):	110	114	130
HABITAT RATING:	**GOOD**	**GOOD**	**GOOD**
Weather:	Partly Cloudy	Partly Cloudy	Sunny
Air Temperature: ºF	75	80	77
Water Temperature: ºF	73	75	68
Average Stream Width: Feet	12	15	16
Average Stream Depth: Feet	2	2	1
Surface Velocity: Feet/Second			0.109713796
Estimated Flow: Cubic Feet/Second			3.476830202
Stream Modifications:	Dredged	None	Dredged
Nuisance Plants (Y/N):	N	N	N
STORET No.:	780226		
County Code:	78		
TRS:	05N01E28		
Latitude (dd):	42.80146		
Longitude (dd):	-84.33945		
Ecoregion:	SMNIDP		

Table 8. Qualitative macroinvertebrate community sampling results for Vermillion Creek at Lansing Road, Shiawassee County, Michigan, 2007, 2012, and 2017.

Taxa	Station 3 Vermillion Creek at Lansing Road (Old 78)		
	8/1/2007	7/31/2012	8/14/17
ANNELIDA (segmented worms)			
Hirudinea (leeches)			1
Oligochaeta (worms)	1	4	5
ARTHROPODA			
Crustacea			
Amphipoda (scuds)	40	71	148
Decapoda (crayfish)	3	1	2
Isopoda (sowbugs)	1		4
Arachnoidea			
Hydracarina		1	
INSECTA			
Ephemeroptera (mayflies)			
Baetidae		2	3
Caenidae	16	1	1
Ephemeridae		1	1
Heptageniidae	16	4	3
Odonata			
Anisoptera (dragonflies)			
Aeshnidae	2	3	1
Gomphidae	1	1	2
Zygoptera (damselflies)			
Calopterygidae		4	11
Coenagrionidae		11	4
Plecoptera (stoneflies)			
Perlidae		1	
Hemiptera (true bugs)			
Corixidae		16	8
Gerridae		2	2
Notonectidae	3	1	1
Pleidae	1	1	
Megaloptera			
Corydalidae (dobson flies)		2	1
Sialidae (alder flies)	11	1	12
Trichoptera (caddisflies)			
Helicopsychidae	1		
Hydropsychidae	3	12	12
Leptoceridae	10	8	1
Limnephilidae	2	1	1
Molannidae	5		
Philopotamidae	1		
Polycentropodidae		6	1
Coleoptera (beetles)			
Haliplidae (adults)	1		1
Dryopidae	7		7
Elmidae	81	19	13
Gyrinidae (larvae)		1	
Diptera (flies)			
Chironomidae	30	96	4
Simuliidae			2

Taxa	Station 3 Vermillion Creek at Lansing Road (Old 78)		
	8/1/2007	7/31/2012	8/14/17
Tabanidae	1	5	1
Tipulidae	2	1	
MOLLUSCA			
Gastropoda (snails)			
Ancylidae (limpets)	1		1
Hydrobiidae	1		1
Physidae	23		
Planorbidae	3		1
Viviparidae			1
Pelecypoda (bivalves)			
Sphaeriidae (clams)	1	3	
TOTAL INDIVIDUALS	268	280	257

Table 9. Macroinvertebrate metric evaluation for Vermillion Creek at Lansing Road, Shiawassee County, Michigan, 2007, 2012, and 2017.

METRIC	Vermillion Creek at Lansing Road (Old 78)					
	8/1/2007		7/31/2012		9/14/2017	
	Value	Score	Value	Score	Score	Value
TOTAL NUMBER OF TAXA	28	1	29	1	32	1
NUMBER OF MAYFLY TAXA	2	0	4	1	4	1
NUMBER OF CADDISFLY TAXA	6	1	4	0	4	0
NUMBER OF STONEFLY TAXA	0	-1	1	1	0	-1
PERCENT MAYFLY COMPOSITION	11.94	0	2.86	-1	3.11	0
PERCENT CADDISFLY COMPOSTITION	8.21	0	9.64	0	5.84	0
PERCENT DOMINANT TAXON	30.22	0	34.29	0	57.59	-1
PERCENT ISOPOD, SNAIL, LEECH	10.82	-1	0.00	1	3.50	1
PERCENT SURFACE AIR BREATHERS	2.24	1	7.14	0	5.06	1
TOTAL SCORE		**1**		**3**		**2**
MACROINVERTEBRATE COMMUNITY RATING	ACCEPTABLE		ACCEPTABLE		ACCEPTABLE	

Table 10. Habitat evaluation for Looking Glass River at Colby Lake Road, Shiawassee County, Michigan, 2007, 2012, and 2017.

	Station 4 Looking Glass River at Colby Lake Road		
	8/1/2007	7/31/2012	8/14/17
HABITAT METRIC	**GLIDE/POOL**	**GLIDE/POOL**	**GLIDE/POOL**
Substrate and Instream Cover			
Epifaunal Substrate/ Available Cover (20)	3	9	5
Embeddedness (20)*			
Velocity/Depth Regime (20)*			
Pool Substrate Characterization (20)**	6	6	6
Pool Variability (20)**	5	6	5
Channel Morphology			
Sediment Deposition (20)	5	6	5
Flow Status - Maintenance Flow Volume (10)	9	8	9
Flow Status - Flashiness (10)	5	6	6
Channel Alteration (20)	15	11	13
Frequency of Riffles/Bends (20)*			
Channel Sinuosity (20)**	13	6	15
Riparian and Bank Structure			
Bank Stability (L) (10)	4	6	8
Bank Stability (R) (10)	5	6	8
Vegetative Protection (L) (10)	9	8	8
Vegetative Protection (R) (10)	4	8	6
Riparian Vegetative Zone Width (L) (10)	3	8	10
Riparian Vegetative Zone Width (R) (10)	9	7	8
TOTAL SCORE (200):	95	101	112
HABITAT RATING:	**MARGINAL**	**MARGINAL**	**GOOD**
Weather:	85	80	70
Air Temperature: ºF		76	66
Water Temperature: ºF	23	20	28
Average Stream Width: Feet	3	2	2
Average Stream Depth: Feet			0.294188034
Surface Velocity: Feet/Second			17.57283191
Estimated Flow: Cubic Feet/Second	No Dredging	Dredged	
Stream Modifications:	N	N	N
Nuisance Plants (Y/N):	85	80	70
STORET No.:	780226		
County Code:	78		
TRS:	06N01E34		
Latitude (dd):	42.8669		
Longitude (dd):	-84.3246		
Ecoregion:	SMNIDP		

Table 11. Qualitative macroinvertebrate community sampling results for the Looking Glass River at Colby Lake Road, Shiawassee County, Michigan, 2007, 2012, and 2017.

Taxa	Station 4 Looking Glass River at Colby Lake Road		
	8/1/2007	7/31/2012	8/14/17
PORIFERA (sponges)	2		1
BRYOZOA (moss animals)	1		
ANNELIDA (segmented worms)			
Hirudinea (leeches)		4	1
Oligochaeta (worms)	1	4	3
ARTHROPODA			
Crustacea			
Amphipoda (scuds)	189	32	91
Decapoda (crayfish)		5	1
Isopoda (sowbugs)			3
Arachnoidea			
Hydracarina	2		2
INSECTA			
Ephemeroptera (mayflies)			
Baetiscidae	1		
Baetidae	3		
Caenidae		2	1
Heptageniidae	1	39	4
Odonata			
Anisoptera (dragonflies)			
Aeshnidae		1	
Libellulidae	1	1	1
Zygoptera (damselflies)			
Calopterygidae	1	27	11
Coenagrionidae		4	24
Plecoptera (stoneflies)			
Perlidae		1	
Hemiptera (true bugs)			
Belostomatidae	4	1	1
Corixidae	36	90	50
Nepidae	1		
Notonectidae	1		1
Pleidae	12		3
Saldidae	5		
Veliidae	3		
Megaloptera			
Sialidae (alder flies)	4	2	7
Trichoptera (caddisflies)			
Hydropsychidae	1	8	
Leptoceridae	2		
Limnephilidae	1	4	
Polycentropodidae	1	1	
Coleoptera (beetles)			
Dysticidae	13		10
Haliplidae (adults)	1	1	20
Hydrophilidae		17	
Dryopidae	1		
Elmidae	4	3	2
Gyrinidae (larvae)			

Taxa	Station 4 Looking Glass River at Colby Lake Road		
	8/1/2007	7/31/2012	8/14/17
Diptera (flies)			
Chironomidae	10	12	33
Culicidae	1		
Tabanidae			3
MOLLUSCA			
Gastropoda (snails)			
Ancylidae (limpets)	1	1	
Hydrobiidae	3	1	
Physidae			
Pelecypoda		3	1
TOTAL INDIVIDUALS	307	281	274

Table 12. Macroinvertebrate metric evaluation for the Looking Glass River at Colby Lake Road, Shiawassee County, Michigan, 2007, 2012, and 2017.

METRIC	Looking Glass River at Colby Lake Road					
	8/1/2007		7/31/2012		9/14/2017	
	Value	Score	Value	Score	Score	Value
TOTAL NUMBER OF TAXA	30	1	25	1	23	0
NUMBER OF MAYFLY TAXA	3	0	2	0	2	0
NUMBER OF CADDISFLY TAXA	4	0	3	0	0	-1
NUMBER OF STONEFLY TAXA	0	-1	1	1	0	-1
PERCENT MAYFLY COMPOSITION	1.63	-1	14.59	0	1.82	-1
PERCENT CADDISFLY COMPOSTITION	1.63	-1	4.63	0	0.00	-1
PERCENT DOMINANT TAXON	61.56	-1	32.03	0	33.21	0
PERCENT ISOPOD, SNAIL, LEECH	1.30	1	2.14	1	1.46	1
PERCENT SURFACE AIR BREATHERS	25.41	-1	39.15	-1	23.72	-1
TOTAL SCORE		**-3**		**2**		**-4**
MACROINVERTEBRATE COMMUNITY RATING	ACCEPTABLE		ACCEPTABLE		ACCEPTABLE	

Table 13. Water quality data for sites visited upstream and downstream of Babcock Road, Clinton Township, Michigan, September 2017.

Road Crossing	Latitude	Longitude	Temperature Degrees Celsius	DO Percent Saturation	DO mg/L	Specific Conductivity µS/cm	Total Dissolved Solids mg/L	pH	BGA PC RFU	BGA PC µg/l	CHL RFU	CHL µg/l	time
Upton Rd.	42.86640	-84.40929	21.68	67.7	5.94	744	483	7.84	0.06	0.05	1.112	4.17	12:19
upstream of Babcock pond area	42.86985	-84.45145	23.46	19	1.61	712	462	7.44	0.321	0.34	2.96	11.2	11:22
downstream Babcock	42.86999	-84.45452	23.39	11.5	0.97	708	460	7.39	0.274	0.29	2.887	10.92	10:21
2nd furthest downstream Babcock	42.87045	-84.45569	23.40	13.3	1.13	708	460	7.41	0.75	0.82	6.802	25.79	10:27
3rd furthest downstream Babcock	42.87015	-84.45695	23.41	13.1	1.12	708	460	7.41	0.264	0.28	2.979	11.27	10:39
Looking Glass behind 4598 Round Lake Rd.	42.87164	-84.47140	21.65	9.8	0.86	695	451	7.32	0.818	0.9	3.186	12.06	12:46
Chandler Rd.	42.86144	-84.48430	22.73	9.8	0.85	691	449	7.38	0.066	0.06	1.479	5.57	13:02

BGA = Phycocyanin Blue-Green Algae Sensor, CHL RFU = Chlorophyll Relative Fluorescence Unit, mg/L (milligrams per liter), µg/l (micrograms per liter), µS/cm (micro-siemens per centimeter)

Table 14. Water bodies in the Looking Glass River watershed that are not meeting one or more designated uses and are therefore considered impaired or have insufficient information (MDEQ, 2016) and should be considered for sampling in the future.

AUID	Water body Description	Designated Use Not Met or Insufficient Information	Pollutant	Status
040500040603-03	Perry Drain #2 and Austin (Kellogg) Drain	WWF	D.O.	3
040500040604-01	Buck Branch and Vermillion Creek	OIALW	Nuisance Vegetation/Nutrients	3
040500040608-01	Remy-Chandler Drain	PBC/TBC	Pathogens	3
040500040608-03	Remy-Chandler Drain	OIALW	None-Flow regime alterations due to storm water	4c
040500040609-03	Clise Drain	WWF	Habitat alterations due to drain maintenance	4c

*The water bodies above and most other water bodies in the Looking Glass River watershed are also not attaining the total body contact and partial body contact water quality standard due to pathogens and fish consumption advisories due to PCB levels in the fish and in the water column.

WWF = Warmwater Fishery

OIALW = Other Indigenous Aquatic Life and Wildlife

4c = not attaining designated use but the impairment is not caused by a pollutant