Appendix A.

Monitoring Progress for TMDLs in the Middle Huron Watershed

The MS4s in the Middle Huron River Watershed have already made significant progress toward achieving TMDL pollutant reduction targets. The below sections highlight the progress that has been made through 2022 for each TMDL listed in stormwater permits for municipalities in the watershed. Additionally, detailed, recent-year monitoring results can be obtained in two forms from the HRWC website: the live monitoring report at https://www.hrwc.org/washtenaw-results, and via the map-based data tool InfoStream at https://www.hrwc.org/our-watershed/maps/.

A. *Excessive nutrients (phosphorus) and algae in Ford Lake and Belleville Lake*

Water Sampling Data Summary

In September 1991, a hazardous material response team was summoned to investigate a reported "green paint spill" in Ford Lake. The "paint" was a severe algae bloom. This incident brought EGLE (then MDEQ) field scientists to the lakes to conduct intensive monitoring of the Huron River and its tributaries from 1992-1994; this monitoring formed the basis for the development of the phosphorus TMDL. The primary water quality parameter measured by EGLE was Total Phosphorus (TP).

EGLE has continued to conduct water quality monitoring in the Huron River and in Ford and Belleville Lakes since the development of the TMDL through 2006, and then again in 2009, and then every other year from 2012-18. Each monitoring season, from April to October, state field scientists visited the watershed one time per month to measure nutrients and ambient water quality parameters at two river sites — the Huron River at Bandemer Park, and the Huron River at Michigan Avenue, just upstream of where the Huron enters Ford Lake. In addition, they measured water clarity, chlorophyll a, nutrients, and other water quality parameters at various depths at four locations within each of the two lakes. Every five years, EGLE conducts more intensive and extensive monitoring in the middle Huron through its basin monitoring program. The Huron River Watershed has been monitored through this program in 1997, 2002, and 2007, 2012, and 2017. 2022 would be the next year in which EGLE will monitor the Huron River watershed, but data has not been released from that sampling yet.

In addition to monitoring conducted by the State, in 2002 the Huron River Watershed Council (HRWC) developed a companion monitoring program for nine of the tributaries flowing into the middle Huron. HRWC staff and trained volunteers measure stream discharge, collect grab samples for lab analysis of TP, Nitrate + Nitrite, and Total Suspended Solids, and monitor other water quality parameters. Each site was originally visited one time per month. In 2006, analysis for *E. coli* was added. In 2008, storm sampling was added and monitoring frequency was increased to twice per month. Finally, in 2010, monitoring at stormwater investigative sites was added.Main branch river sites are monitored in Dexter and Ypsilanti to assess upstream and downstream conditions, and 9 tributary sites between those main branch sites are included in the program[1].

[1] For more information including site maps and data reports, visit the program website: https://www.hrwc.org/chemistryandflow/.

The data collected by the State is used to measure progress towards meeting the phosphorus TMDL. Now, HRWC's tributary monitoring program is the only program collecting data on nutrients in the tributaries flowing into the middle Huron. The University of Michigan, in partnership with the City of Ann Arbor, irregularly monitors river sites. One shortcoming of HRWC's program is that it does not monitor Total Nitrogen, which would enable estimating the ratio of TP:TN, an indicator of conditions favorable to the formation of nuisance algal blooms. Dr. John Lehman at the University of Michigan conducted a study of this ratio from 2003-06 and concluded that TP is the limiting nutrient for blooms under most conditions.

A few general comments can be made about the data. TP concentrations entering and within Ford Lake have generally not shown a significant trend. While some months and even years have been approaching or below the TMDL target goal of 30 µg/l, late season samples (especially August) regularly exceed the goal by up to 2X or 3X (see Fig. 1). Similarly, concentrations in Belleville Lake (see Fig. 2) have often been measured above the goal of 30 µg/l. Belleville Lake exceeds the goal more consistently than Ford Lake does.

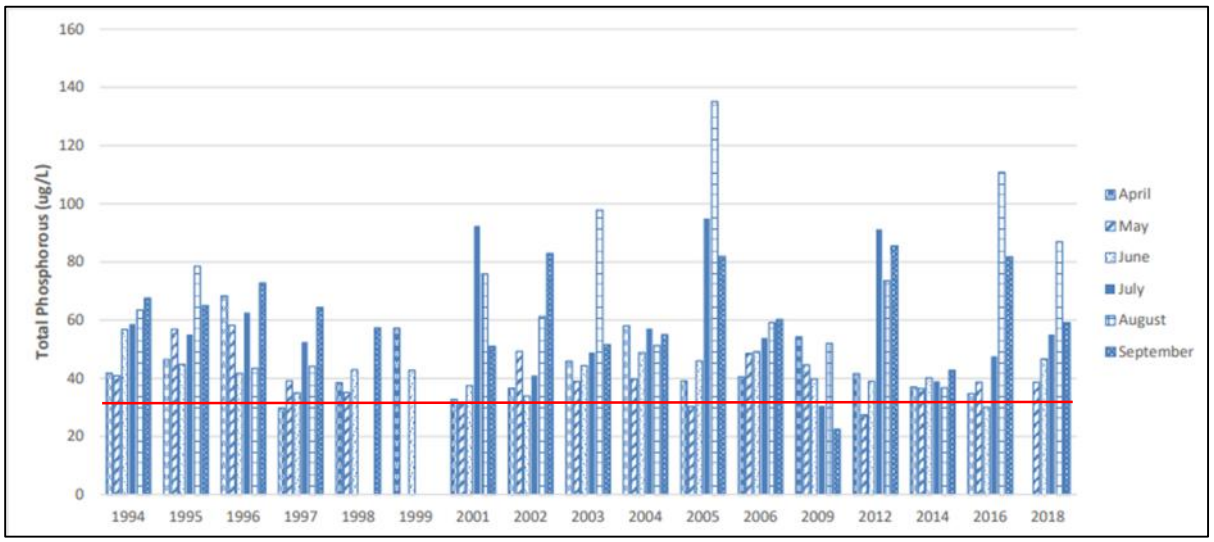

Figure 1. Total phosphorus concentrations in Ford Lake sampled by EGLE in some years from April through September from 1994 to 2018. The TMDL goal of 30 µg/l is included in red.

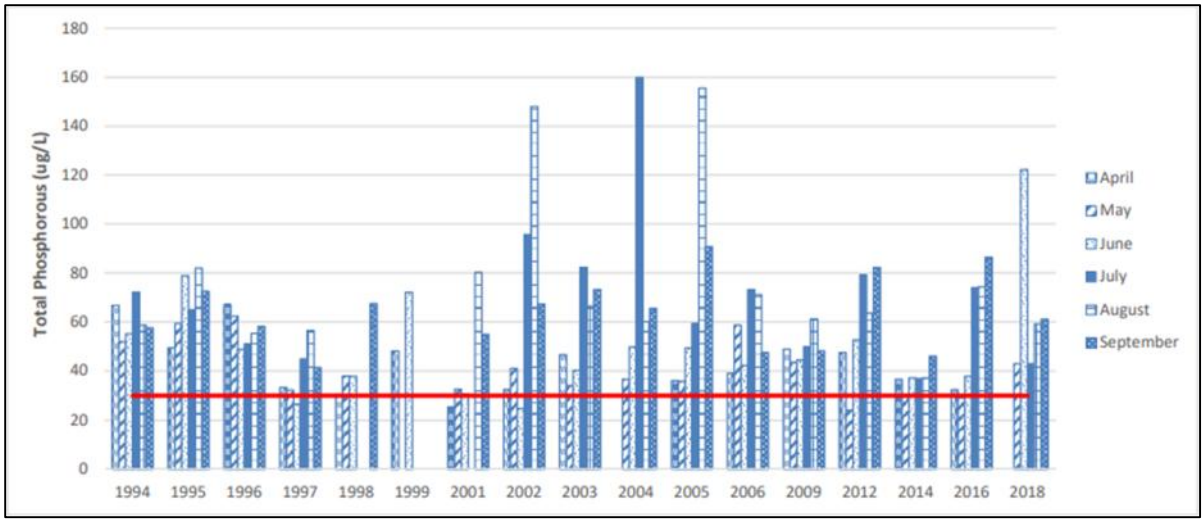

Figure 2. Total phosphorus concentrations in Belleville Lake sampled by EGLE in some years from April through September from 1994 to 2018. The TMDL goal of 30 µg/l is included in red.

Watershed monitoring in the river and tributary streams indicates some trends. First looking at river sites (Fig. 3), TP concentrations fluctuated seasonally around the goal concentration of 30 µg/l at the upstream site at North Territorial Road in Dexter from 2003 through about 2014. Since then, TP concentrations have declined considerably, with only a handful of measures above the goal level. Over the last five years, the mean TP concentration was 29 µg/l. The downward trend is significant.[2] The downstream site just above the inflow to the Ford Lake impoundment in Ypsilanti also shows a downward trend. That trend is also significant.[3] However, concentrations have been higher, with a mean over the last five years of 60 µg/l. While TP in the river appears to be coming down over time, concentrations entering the impoundment system (where the TMDL is targeted) are still well above 30 µg/l.

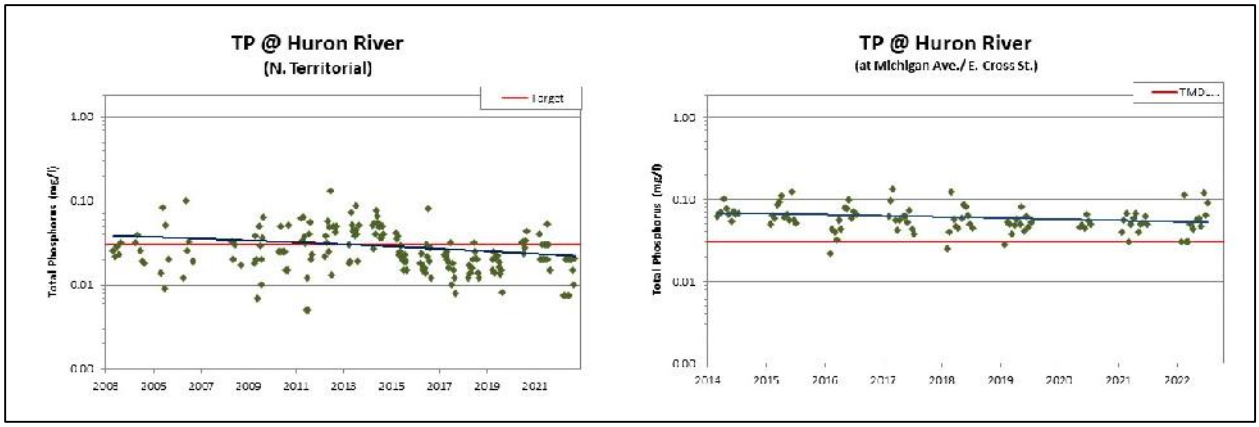

Figure 3. Total phosphorus concentrations from samples at two Huron River sites. The left chart depicts samples from near N. Territorial Rd. somewhat downstream of where the river flows out of Portage Lake from Livingston County. The right chart depicts samples from Riverside Park (between Michigan Ave. and Cross St.), just above where the river becomes the Ford Lake impoundment. The TMDL goal of 0.03 mg/l is shown in red on both charts.

[2] Regression p-value = 0.002.
[3] Regression p-value = 0.025

Generally, total phosphorus concentration trends in Middle Huron tributaries have been mixed, but all show mean concentrations above the TMDL goal concentration. Mean 5-year (2018-2022) TP concentrations in tributaries ranged from 35 µg/l (Boyden Creek) to 119 µg/l (Swift Run). Most mean TP concentrations are driven by high concentrations from samples during high-flow storm events. Five-year geomean TP concentrations for the same two tributaries are 31 µg/l and 84 µg/l respectively. A couple tributaries (Mill Creek and Swift Run) show no trend in TP concentrations over time, but the other seven show declining trends.[4]

Phosphorus Loading

The TMDL estimates that the annual total phosphorus load to Ford Lake is 76,620 lbs/year. This estimate is based on point source reporting, and a land use model. The TMDL states that EGLE monitoring data shows a significant decline in phosphorus concentrations at river monitoring sites that is also consistent with a 20% decline in phosphorus concentrations observed by HRWC and an 11-23% decline observed by Dr. John Lehman. An estimated 31% of the EGLE-estimated phosphorus load was derived from direct point sources, 12% was from stormwater (MS4) sources within the TMDL watershed, and the remainder (57%) was from upstream nonpoint sources.

HRWC assessed monitoring data collected since 2003 through 2018 to estimate loading from tributary drainages at multiple times since the original TMDL was developed. Most recently, HRWC worked with Dr. Tim Maguire formerly of the University of Windsor to develop landscape-adjusted, April-September seasonal loading estimates for multiple drainages in the Middle Huron watershed using monitoring data from HRWC's Chemistry and Flow Monitoring Program. Across the five most recent years in the dataset (2014-2018), total phosphorus loads ranged from 6,149 to 34,410 lbs per season with an average of 18,692 lbs/season. This 6-month mean translates to an estimate of 37,384 lbs for a complete year. This represents a 53% reduction in phosphorus loading from the estimate in the original TMDL. Part of this decrease in loading comes from a general decrease in TP concentrations, but a larger reduction is likely occurring during storm runoff events.

Despite this decline in phosphorus loading to Ford Lake, neither Ford nor Belleville Lake is showing any trend in lake phosphorus concentrations (see previous), based on periodic lake monitoring by EGLE. Because of this, the revised TMDL set new loading goals. EGLE used two lake models to estimate that each lake would need to reach a total phosphorus concentration of 30 µg/l to reach a healthy aquatic trophic status. The revised TMDL sets annual and daily load targets for Ford Lake as found in Table 1. The Belleville Lake targets rely primarily on load reductions from Ford Lake upstream, internal lake management, and stormwater MS4 reductions.

Table 1. Ford Lake TMDL Loading and Target Load Goals

	EGLE Current Load Estimate (lbs/yr)	TMDL Goal (lbs/yr)	Reduction (%)	TMDL Goal (lbs/day)
Nonpoint Load Allocations				
Huron River Upstream	19,000	15,000	21%	41.1
Urban	3,000	800	73%	2.2
Agriculture	19,000	7,000	63%	19.2
Other	500	500	0%	1.4

[4] All regression slopes were negative (declining), with regression p-values ranging from 0.006 to 0.072.

Internal Load	2,000	480	76%	1.3
Precipitation, Deposition	130	130	0%	0.4
LA Total	**43,630**	**23,910**	**45%**	**65.5**
Point Waste Load Allocations				
WWTPs				
Ann Arbor	22,000	8,980	59%	24.6
Chelsea	600	560	7%	1.5
Dexter	270	180	33%	0.5
Loch Alpine	510	95	81%	0.3
Thornton Farms	200	45	78%	0.1
Other				
Chrysler-Chelsea Proving	40	40	0%	0.1
Sweepster	100	100	0%	0.3
Thetford/Norcold	40	40	0%	0.1
UM Power Plant	20	20	0%	0.1
Ann Arbor Drinking Water Plant	30	30	0%	0.1
Point WLA Total	23,810	10,090	58%	27
Aggregate Stormwater MS4s	9,180	2,500	73%	7
WLA Total	32,990	12,590	62%	34
Margin of Safety	NA	Implicit (0)		0
Total Load	76,620	36,500	52%	100

The TMDL target goal requires that the entire Middle Huron watershed reduce phosphorus loading by 52% from the EGLE loading estimate. This load from upstream sources has certainly been reduced, based on EGLE and HRWC monitoring. However, since lake concentrations have not changed significantly, it is necessary to continue to reduce loading from upstream sources. It is likely that it will require many years of low loading, in addition to active lake management, to reduce in-lake phosphorus concentrations and, in turn, nuisance algal blooms.

Creekshed Breakdown

In an effort to determine critical areas for reducing phosphorus inputs, HRWC continues to monitor the watershed and estimate loading and changes in loading from tributary creeksheds and subsections of the Middle Huron watershed. Table 2 presents two sets of estimates of total phosphorus loading. The first estimates are based on four years of early monitoring program data and were produced using USGS P-load software. The second set were produced by a landscape-integrated GIS model that incorporated stream discharge and TP concentrations collected across the entire Huron River watershed for five years through 2018. Both are established in the table as mass-balance models. At certain river monitoring points, any unaccounted amount of surplus or deficit in the total load is balanced with a “other sources (sinks)” category.

Table 2. Estimates of Total Phosphorus Loading

Location	TP Mean Daily Load Est. (2003-2006)	TP Mean Daily Load Est. (2014-18)	Difference (%)
Huron @ N. Territorial (upstream)	38.34	59.15	35.2%
Mill Creek	25.26	40.72	38.0%
Boyden Creek		4.60	
Honey Creek	5.07	3.43	-47.8%

Allens Creek	3.41	3.42	0.23%
Subtotal to Wall St.	72.08	111.32	35.25%
Other sources/(sinks)	88.3	49.06	-80.0%
Huron @ Wall St.	160.38	160.38	0.00%
Traver Creek	0.83	2.70	69.24%
Millers Creek	0.28	4.49	93.77%
Malletts Creek	15.32	10.79	-41.99%
Swift Run	1.2	14.55	91.75%
Subtotal to Geddes Pond	178.01	192.91	7.72%
Ann Arbor Wastewater Treatment Plan	49.62	60.23	17.62%
Fleming Creek	5.84	4.56	-28.03%
Superior Drain	0.7	29.29	97.61%
Subtotal to Ford Lake	234.17	286.99	18.40%
Other sources/(sinks)	-102.63	-184.85	44.48%
Huron @ Ford Lake (US-12)	131.54	102.14	-28.78%

Certain caveats for the 2014-2018 model should be considered. Due to the erratic nature of discharge from Allens Creek, loading estimates for that tributary are extremely variable and unreliable. To account for that, P-load was used to estimate Allens Creek loads. Since no additional monitoring data was collected at the Wall Street station and the mean flow was very similar to the 2003-06 period, the load estimates at that location were nearly identical. The estimate for the river at N. Territorial Road is also likely overestimated due to a lack of sufficient data upstream. Finally, the Superior Drain estimate used five years ending in 2013 since HRWC stopped sampling that site in 2013.

The bottom line suggests that phosphorus loading has decreased by 29% since sampling began in 2003. The results suggest that Swift Run is the best target for loading reduction in the target watershed given the overall size of phosphorus load. Traver and Millers Creeks also show increasing loads, but their total contribution is much lower. Malletts Creek is also a good target, given the size of the load and the number of sources. However, loading decreased by 42% from efforts and practices to date already, so allowing more time for recent practices to achieve their full potential may be the best approach in that creekshed. Mill Creek and Superior Drain are also good targets for reduction activities.

B. *Excessive bacteria (E. coli) in the Huron River and multiple tributaries in the watershed*

Sampling Effort and Data Summary

In August 2001, a TMDL for *E. coli* was established for the Huron River downstream of Argo Dam to Geddes Dam. To remove the reach from the impaired waters list, it will need to meet the water quality standard (WQS) for pathogens. For the TMDL, the standard organism count of 130 per 100 milliliters (ml) as a 30-day geometric mean between May 1 to October 31 was used, as that is the monthly standard for full-contact waters. Following the establishment of the TMDL, an implementation plan was compiled by affected stakeholders.

Data on counts for *E. coli* and fecal coliform bacteria vary widely throughout this river section and the contributing tributaries. Historical data indicate that Lower Geddes Pond has consistently exhibited the highest bacteria concentrations among all Huron River reaches in the

Ann Arbor area. Additional sampling conducted in 2001 by EGLE corresponds with the findings of the historical data and indicates that the listed reach and its tributaries exceeded the WQS for *E. coli*.

The results of 2002 sampling for the implementation plan indicated that Geddes Pond exceeded the 30-day geometric mean for full body activities during the second half of July and all of August. There was one additional sampling event that exceeded the full body activity daily maximum standard (300 *E. coli* per 100 ml) in September. Each tributary sampled had elevated *E. coli*, and seemed to be influenced by wet weather events. Allens Creek typically had high *E. coli* concentrations and had visual evidence of illicit connections. Millers Creek, at the east and west branches at Plymouth Road, were typically higher than other locations. Sampling on Malletts Creek was started in July and showed high *E. coli* concentrations for the period sampled. Early season sampling on Swift Run Creek indicated elevated concentrations at various locations. However, the last four weeks of sampling were dry or stagnant. Traver Creek *E. coli* concentrations decreased later in the sampling season, but some of the highest concentrations overall were found at the creek mouth.

DNA sampling was also conducted during one sampling event on August 27, 2002, in the hopes of determining whether sources of *E. coli* were human or non-human. Unfortunately, the results were inconclusive from this early DNA investigation.

Bacteria sources have been determined to consist of a range of wet and dry weather-driven sources. However, the primary loading of pathogens enters the Huron River directly through the tributaries and storm sewers within the listed reach. Potential pathogen sources for the listed waterbody include sources typically associated with urban and suburban runoff because the immediate watershed is primarily composed of urban and suburban land covers and uses. Source evaluation indicates that bacteria loads from a large part of Ann Arbor enter Geddes Pond/Huron River via the storm water system. Bacteria loads are also delivered to Geddes Pond/Huron River by tributaries that drain a large portion of the Ann Arbor area. Other pathogen sources for Geddes Pond/Huron River likely include upstream inputs, illicit sewer connections, pet and wildlife feces, and a small number of malfunctioning septic systems. Agricultural land uses located in the upstream reaches of the Traver Creek watershed make livestock and horse feces other likely sources.

Since the bacteria standard is concentration-based, and bacteria are living organisms, rather than chemical pollutants, the TMDL is also concentration-based, rather than mass loading based like most other types of TMDLs. Further, since low concentrations were detected to be coming from river sources, the focus was placed on tributary sources. Based on this reasoning, and considering other relevant factors, monthly average concentration maxima were established for each of the tributaries that match state WQ standards

Since a concentration standard is used, a total loading of bacteria from the creeks was not established for the TMDL. However, loading allocations were established for each creekshed based on these allowable concentrations and monthly stream flow averages. Based on this information, no fixed pathogen loading figures have been established, nor specific reduction targets.

HRWC has monitored each of the major tributaries (though not direct drainages) in the watershed for *E. coli* since 2006 (Table 3). HRWC volunteers generally collect single samples twice per month from April through September, rather than triplicate samples monthly, though

there are some exceptions where triplicate sampling has been incorporated. However, the methods do not exactly replicate EGLE standard methods. HRWC results would be expected to be somewhat more variable, and therefore may overstate concentration levels.

All of the tributaries along the Middle Huron River watershed have average bacteria counts (whether calculated as means or geomeans) that are above the TMDL targets (and state standard for full-body contact). Trends in the data suggest that conditions in the tributaries are becoming less conducive to bacteria growth over time, however. All show declining trends, and the trends in two of these tributaries are statistically significant (Table 3). Geomeans for the most recent five years are all close to (with Traver Creek below) the standard for a single sample set (300 bacteria per 100 ml), but occasional high counts still occur in all tributaries.

Table 3. Measured *E. coli* Concentrations for the Subwatersheds of the Huron River, 2006-2022.
Average *E. coli* Concentration (per 100 ml), (April-September)

Tributary	17-year mean	5-year mean	5-year geomean	17-year Trend	Trend p-value*
Allens Creek	3,304	1,335	355	**Decline**	**0.02**
Traver Creek	779	716	264	Decline	0.13
Millers Creek	781	637	363	**Decline**	**0.03**
Malletts Creek	1,643	2,146	426	Decline	0.57
Swift Run	1,969	1,261	387	Decline	0.33
Direct Drainage	NA	NA	NA	NA	NA

**Significance determined by ANOVA via regression analysis for variation since beginning of dataset. Probability <0.05 in red.*

Since the TMDL sets a seasonal limit (May through October), HRWC also evaluated monthly geomeans to determine if there are any seasonal patterns (Table 4). Bacteria counts are at their lowest across all sites in April, before the TMDL takes effect, and all tributaries are either below the TMDL or within 30% of it then. Concentrations in May also are a bit lower than the rest of the season, but there do not appear to be substantive differences between the months of June through September. HRWC does not monitor in October. If anything, remedial activities should be focused on the June to September period to have the greatest impact.

Table 4. Monthly geomean *E. coli* concentrations (per 100 ml) (2015-2019)

Tributary	April	May	June	July	August	September
Allens Creek	272.94	279.39	467.14	576.39	2,429.19	3,976.15
Traver Creek	45.81	213.39	586.33	440.41	510.68	665.25
Millers Creek	78.03	240.06	731.96	596.17	516.31	462.80
Malletts Creek	152.49	168.31	555.03	414.45	388.60	388.75
Swift Run	129.04	209.95	729.80	672.83	802.14	671.31
Direct Drainage	NA	NA	NA	NA	NA	NA

In addition to the continuous monitoring program, HRWC also conducted a bacteria study in 2020-21 of Huron River drainages, as part of a larger study of Lake Erie drainages, funded by EGLE. A report on the results of that study was shared with EGLE separately, but a summary of results from this TMDL area is below.

Within the TMDL watershed, sites matching those from annual monitoring included Allens, Traver, and Malletts Creeks. Additionally, a river site at the Fuller Road bridge was sampled. Table 5 includes the five-week sampling results. The river site was shown to be meeting the state standard for the five-week period and each sample set. The tributary sites had bacteria counts that exceed the standards. Traver and Malletts Creek five-week geomeans are comparable to the current 5-year geomeans. Allens Creek was quite different, however, with a five-week geomean that was almost 3 times the 5-year monitoring geomean.

Table 5. Summary of E. coli Results, 2020-2021

Site ID	Site Description	Week 1 GM (#/100 ml)	Week 2 GM (#/100 ml)	Week 3 GM (#/100 ml)	Week 4 GM (#/100 ml)	Week 5 GM (#/100 ml)	30-day GM (#/100 ml)
MH04	Allens @ Main St.	386	564	8,757	75	5,086	939
MH05B	Traver @ Broadway	463	605	187	201	190	288
HR10	Huron River @ Fuller Rd.	135	93	28	81	11	50
MH07	Malletts @ Chalmers Dr.	142	586	296	823	267	352

Microbial source tracking was also conducted as part of the study for any E. coli sample results that exceeded 1,000 #/100ml. For the TMDL area, that only included two Allens Creek samples. The results of those samples are in Table 6 below. These results showed that one sample showed strong evidence of human-sourced bacteria and canine-sourced bacteria. The other sample did not show any evidence of selected sources of bacteria DNA. Due to the extensive underground network of storm sewers in the Allens Creek catchment, canine scent tracking was not conducted within the watershed.

Table 6. Summary of MST Results.

Site ID	Site Description	Sample Date	DNA Concen-tration (ng/ul)	Human HF183 (GC/100 ml)[1]	Human B. theta (GC/100 ml)[1]	Bovine (GC/100 ml)[1]	Canine (GC/100 ml)[1]
MH04	Allens @ Main St.	7/28/2020	23.1	108,888	4,880	ND	5,590
MH04	Allens @ Main St.	8/11/2020	3.5	ND	ND	ND	ND

The more recent results from the bacteria study indicate that the main stem of the Huron River is currently meeting the state's standards for bacteria, so the river itself should not be a focus for remediation. EGLE should consider adjusting the TMDL to reflect this. However, tributary streams are not meeting the standards. The entire area should be targeted for bacteria reduction activities. While progress can be seen in the data trends, more effort is necessary to meet water quality standards and return these creeks to full recreational use. Particular targets for remedial activities are Allens, Malletts and Swift Run creeks, as these are the largest drainages that likely contribute the most bacteria to the river and ponded waters where most recreation occurs. Additional follow-up IDEP investigation is recommended for Allens Creek, due to the evidence of human septic sources. The City of Ann Arbor has conducted IDEP investigation in this area. Refer to the City's reports for details and results.

C. *Excessive bacteria (E. coli) in Honey Creek*

A TMDL was developed and approved in 2009 to address the bacteria impairment in Honey Creek. Subsequently, a watershed management plan was developed and approved by EGLE in 2014 to implement activities to address the goals in the TMDL. Following that, HRWC and partners conducted an implementation project to carry out a number of recommended activities from the WMP. Below is an analysis from the WMP with some updates from monitoring following implementation.

The study of the Honey Creek watershed was designed to identify likely sources of bacterial contamination to the creek. Water sampling points were distributed at tributary end points to isolate watershed sections geographically. Samples were evaluated for bacterial genetics to determine likely animal sources. Stream reaches with consistently high bacteria counts were surveyed for visible signs of bacteria sources. Key watershed areas were evaluated with a windshield survey to identify residential and agricultural practices that may be contributing bacteria to Honey Creek. Finally, interviews were conducted with representatives of area residents to confirm practices.

Water quality sampling indicated that there were occasional sample events at all sites that exceeded the single sample TBC standard. However, several sites were more generally below the standard and even below or near the 30-day standard. These areas will not be the focus of remedial efforts.

Through the course of investigation, it was determined that multiple sources are contributing bacteria to Honey Creek. All five species markers that were selected for bacteria source tracking (human, bovine, canine, equine and goose) were positively identified in multiple samples at multiple locations. However, some markers are more critical to human health and others were more predominant at specific sample sites. The presence, especially the predominance, of the human marker in samples is of particular concern. The presence of human source markers in bacteria was identified in samples from all critical areas. The human marker predominated in subwatershed 15 (see Figure 4). Sampling in area 15 also suggested a non-runoff source. This combined information suggests that subwatershed 15 should be a high-priority target for investigation and remediation of human fecal contamination sources. Other critical areas should also be investigated for human sources, however, due to the presences and relative predominance of human sources throughout sampling in critical areas.

Other sources are more difficult to define geographically. Bovine, or cow manure source markers were identified in all but one sample, even in subwatersheds such as 17 that have little agricultural land use area. Similarly, canine markers were identified in all critical areas. Likewise, goose source markers were found in all source areas, though that source did not predominate in areas 1 or 7. Equine or horse fecal source markers were found in all critical areas, though less often in areas 7 and 15. Surprisingly, it was a predominant source in a sample from area 17 despite little evidence of horse ownership in that subwatershed, though there was evidence of horse traffic in the area. Identification and remediation of horse sources in area 17 are likely localized to the end of that stream, as little evidence of horses was found elsewhere.

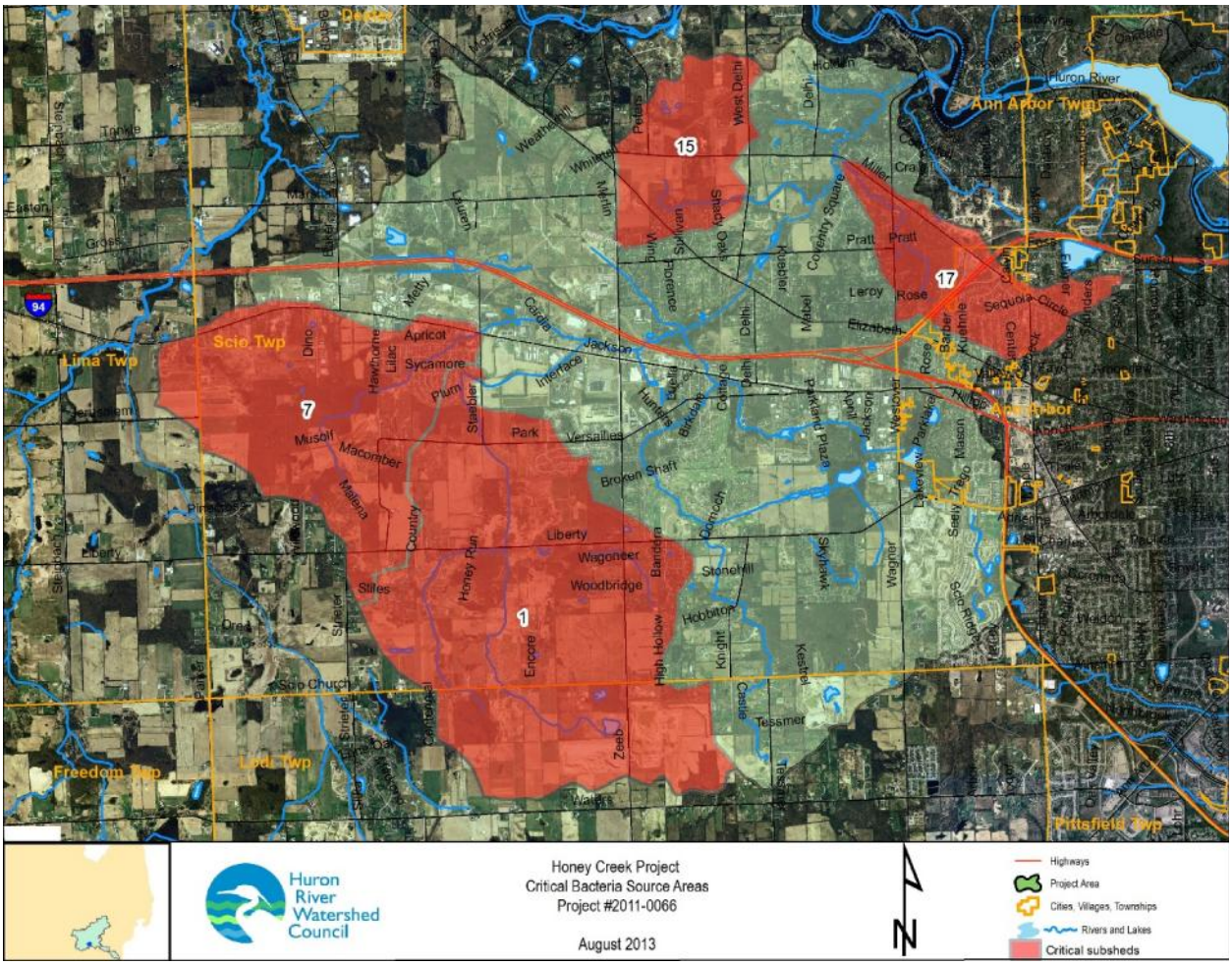

Figure 4. Critical bacteria source subwatershed areas in the Honey Creek watershed. Numbers indicate subwatershed designation and are referenced to downstream sampling stations.

The implementation project included activities to address all the different bacteria sources and critical areas. The post project data summary from 2020 concludes that Honey Creek continues to exceed the state standards for bacteria levels and that implementation efforts have not had enough time to show results in lowered bacteria counts. Standard monitoring continued through 2022 near the Honey Creek outflow. In the last five years (2018-2022), Honey Creek samples exceeded the single sample event standard of 300 bacteria per 100 ml 55% of the time. The mean count was 538 per 100 ml over this period, and the geomean was 322 #/100ml.

Three Honey Creek sites were also part of the study of Michigan drainages to Lake Erie: the outflow site (MH03) and sites at the two main upper branches (HC14, and HC15). Table 7 includes the five-week sampling results. None of the sites meet the 30-day standard of 130 #/100 ml, nor would they meet the single event standard of 300 #/100 ml. Site HC15 was particularly high, with a 30-day geomean of 1,807 #/100 ml. That was the area where human markers were previously found. It appears that Honey Creek continues to be impaired by high bacteria levels.

Table 7. Summary of E. coli Results from Honey Creek sites

Site ID	Site Description	Week 1 GM (#/100 ml)	Week 2 GM (#/100 ml)	Week 3 GM (#/100 ml)	Week 4 GM (#/100 ml)	Week 5 GM (#/100 ml)	30-day GM (#/100 ml)
MH03	Honey @ Wagner	440	526	733	412	238	441
HC15	Honey @ Delhi	575	1,465	2,230	2,914	3,522	1,807
HC14	Honey @ Zeeb	439	508	529	477	567	502

D. *Aquatic biota impairment in Malletts Creek*

The reach of Malletts Creek from its confluence with the Huron River at South Pond Park upstream to Packard Road has been listed as an impaired water due to poor fish and macroinvertebrate monitoring results. The impairment is based on data collected by EGLE in August 1997. A TMDL was established to address this impairment in August 2004.

Data collected by EGLE in 2002 and 2003 at two sites in the Malletts Creekshed indicated that fish and macroinvertebrate populations were acceptable. Habitat assessments conducted during the same time rated the sites as "good." However, individual measures of flow and bank stability suggested unstable conditions. Also, HRWC data through 2005 for lower Malletts sites consistently rated the sites as "poor." For these reasons, the TMDL was established.

The primary sources of concern for poor fish and macroinvertebrate conditions are hydrologic alteration and excessive sedimentation due to urban and suburban development. Reductions in storm sewer runoff rates and solids loads from both commercial and municipal storm water runoff sites, along with reduced stream bank erosion through more stable flow management are necessary to reduce impacts on the aquatic life.

Biota impairments do not lend themselves to direct loading calculations. Because of this fact, along with the concern about sediment dynamics in the system, the focus of loading calculations for the TMDL establishment was on total suspended solids (TSS). While the primary goal is to improve fish, macroinvertebrate, and habitat measures, TSS measurements will be used by EGLE to further assess improvements in Malletts Creek as a secondary goal. This secondary goal is represented by a mean annual, in-stream TSS concentration target of 80 mg/l to characterize wet weather runoff/washoff events. The mean annual target concentration of 80 mg/l TSS is based on a review of existing conditions and published literature on the effects of TSS by the EGLE. This secondary numeric target may be overridden by achievement of the biological and habitat numeric targets. However, if the TSS numeric target is achieved, but the biota or habitat numeric targets are not achieved, then the TSS target may have to be reevaluated.

This secondary goal has the added benefit of being consistent with goals to reduce phosphorus loading under the Ford and Belleville Lakes TMDL. According to the Malletts Creek Restoration Plan, the plan targets a 50% reduction in total phosphorus, which is characterized as "…functionally equivalent to the mean TSS concentration of 80 mg/l."

At the time of the TMDL development, the estimated total annual TSS load from all NPDES permitted storm water discharges (there are no point sources identified), was approximately 651 tons (1.3 million pounds). Additional non-point source discharge (outside of stormwater areas) and background sources account for 51 tons, for an overall total load of 702 tons (1.4 million pounds). The TMDL target load of 596 tons of TSS will require a 15% overall reduction in loading (106 tons) – 16% reduction in storm water sources and 45% reduction in agricultural sources.

Since the original TMDL evaluation, conditions in Malletts Creek have improved significantly. HRWC monitors sites throughout the watershed for aquatic insect diversity and sensitive family counts. The downstream site in Malletts Creek at Chalmers Road has seen a steady and significant increase in insect diversity in both Spring and Fall sampling. Three-year average insect families are 9.4 families, and EPT were 2.4 families. The Fall 2018 count of 14 is the highest on record for the site, and would move the site from a poor to a fair rating. Sensitive families and winter stoneflies have not yet returned to the site, however. The Chalmers Road site also received a habitat rating of 68.5 in 2016 (most recent evaluation), which is conducive to diverse biota populations.

HRWC also monitors the Chalmers Road site for TSS twice per month, April through September. TSS concentrations are generally low, with a mean concentration of 22 mg/l. However, TSS can exceed 80 mg/l target during larger storm events. In the most recent 5 years, the TSS concentration only exceeded the 80 mg/l target twice (both in 2018; see Figure 5). Hydrologically, Malletts Creek has a high flashiness index at 0.64, but the rating has trended down since 2010. This is likely due to the moderating effect of the regional wetland restoration and detention project in Mary Beth Doyle Park. A natural creek with a drainage area the size of Malletts Creek would be expected to have a stream flow of 93 cfs following a 50% (2-year return interval) storm of 2.35". The modeled flow for Malletts Creek following a storm of this size is 499 cfs, and the estimate from survey data is 1,007 cfs. Both estimates are multiple times greater than peak flows expected in a natural creek. USGS recorded a peak flow of 1,050 cfs following a 2-inch storm.

Overall, it appears that flows in Malletts Creek may still be somewhat flashy and present high peak flows. However, recent data indicates that efforts to moderate high flows and restore the downstream banks may be working. High levels of sedimentation have not occurred in recent years and habitat conditions may be improving to allow a greater diversity of aquatic life. Generally, it appears that Malletts Creek may be meeting the TMDL targets at the downstream sampling station. ***It should be re-evaluated to determine if the TMDL can be removed***; DNR fish sampling and new EGLE macroinvertebrate sampling should be conducted at Chalmers Road to start this process.

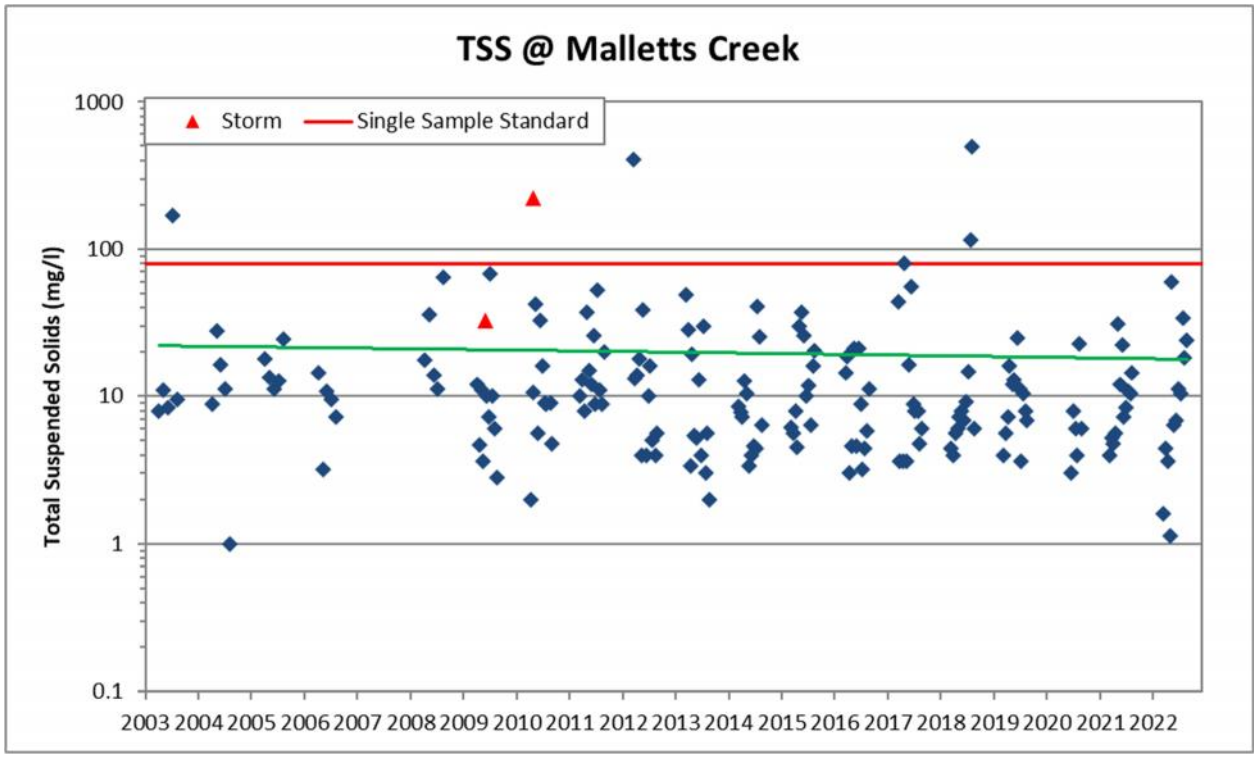

Figure 5. TSS samples by year from Malletts Creek at Chalmers Dr. The red line depicts the storm standard, and the green trend line indicates a slight downward trend in concentration.

E. *Aquatic biota impairment in Swift Run*

The reach of Swift Run from its confluence with the Huron River at South Pond Park upstream to Ellsworth Road has been listed as an impaired water due to poor macroinvertebrate monitoring results. The listed impairment is based on data collected by EGLE in August 1997. A TMDL was established to address this impairment in November 2004.

Data collected by EGLE in 1997 at Hogback Road rated the macroinvertebrate community as "poor." Further sampling by EGLE in 2003 at Shetland Drive also rated macroinvertebrate communities as poor. Habitat assessments conducted during the same times rated the Hogback site as "fair" or moderately impaired, and the Shetland site as "good." However, individual measures of flow and bank stability suggested unstable habitat conditions at both sites. For these reasons, the macroinvertebrate community was considered impaired and the TMDL was established.

As with the TMDL for biota in Malletts Creek to the west, the primary sources of concern for poor macroinvertebrate conditions in Swift Run are hydrologic alteration and excessive sedimentation due to urban/commercialized development. Reductions in storm sewer runoff rates and solids loads from both commercial and municipal storm water runoff sites, along with reduced stream bank erosion through more stable flow management are necessary to reduce impacts on the aquatic life.

Biota impairments also do not lend themselves to direct loading calculations. Because of this fact, along with the concern about sediment dynamics in the system, the focus of loading

calculations for the TMDL establishment was on total suspended solids (TSS). While the primary goal is to improve fish, macroinvertebrate, and habitat measures, TSS measurements will be used by EGLE to further assess improvements in Swift Run as a secondary goal. This secondary goal is represented by a mean annual, in-stream TSS concentration target of 80 mg/l to characterize wet weather runoff/washoff events. The mean annual target concentration of 80 mg/l TSS is based on a review of existing conditions and published literature on the effects of TSS by EGLE. This secondary numeric target may be overridden by achievement of the biological and habitat numeric targets. However, if the TSS numeric target is achieved, but the biota or habitat numeric targets are not achieved, then the TSS target may have to be reevaluated.

This secondary goal has the added benefit of being consistent with goals to reduce phosphorus loading under the Ford and Belleville Lakes TMDL. According to the Malletts Creek Restoration Plan, a target of 50% reduction in total phosphorus is established, which is characterized as "…functionally equivalent to the mean TSS concentration of 80 mg/l."

At the time of the TMDL development, the estimated total annual TSS load from NPDES permitted stormwater discharge (no point sources were identified), was approximately 256 tons (511,844 pounds). Additional non-point source discharge and background sources account for 20 tons, for an overall total load of 276 tons. The TMDL target load of 269 tons of TSS requires only a 3% overall reduction in loading (<1% reduction in stormwater sources and 45% reduction in agricultural sources), or a total load reduction of 7.6 tons per year. It was later determined that the City of Ann Arbor's landfill was misidentified as agricultural land, so most of the focus will need to be on practices to reduce peak flow rates and sedimentation from stormwater sources.

Since the original TMDL evaluation, conditions in Swift Run have not changed significantly. HRWC monitors sites throughout the watershed for aquatic insect diversity and sensitive family counts. The downstream site in Swift Run at Shetland Drive has seen a modest and statistically insignificant increase in insect diversity in Fall and no perceptible change in Spring sampling. One sensitive family was discovered in Fall 2004, but not again since. All biota indicators suggest the site continues to have poor conditions for diverse populations of aquatic life.

HRWC also monitors the Shetland Drive site for TSS twice per month, April through September. TSS concentrations are generally moderate, with a mean concentration of 33 mg/l. However, TSS regularly exceeds the 80 mg/l target during storm events, though not as much in recent years (see Figure 5). In the most recent 5 years, the TSS concentration exceeded the 80 mg/l target twice, both in 2018. Further, the hydrology in Swift Run continues to be quite flashy. Swift Run has the highest flashiness index rating (0.82) of all the tributaries studies by HRWC. A natural creek with a drainage area similar to Swift Run would be expected to have a stream flow of 52 cfs following a 50% (2-year return interval) storm of 2.35". The modeled flow for Swift Run following a storm of this size is 189 cfs, and the estimate from survey data is 398 cfs. Both estimates are multiple times greater than peak flows expected in a natural creek, but the differences are not as big as some other Huron River tributaries. HRWC measured a peak flow of 273 cfs during a 2.6" rain event, which is consistent with these estimates. Generally, it appears that Swift Run is not meeting the TMDL targets at the downstream sampling station.

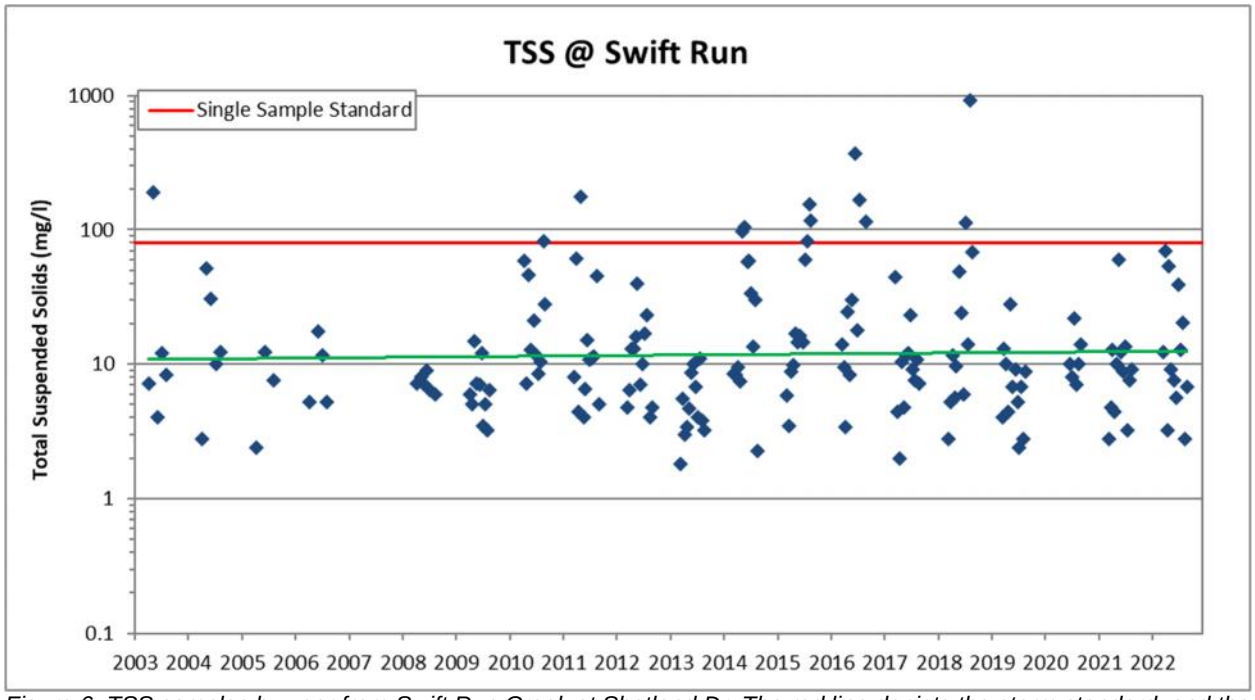

Figure 6. TSS samples by year from Swift Run Creek at Shetland Dr. The red line depicts the storm standard, and the green trend line indicates no significant trend in concentration.