



Study Plan for the Biological and Water Quality Study of the St. Marys River Watershed



Division of Surface Water
Ecological Assessment Section
May 26, 2015

**Study Plan for the
Biological and Water Quality Survey
of the
St. Marys River Watershed**

Auglaize, Mercer, Shelby and Van Wert counties, Ohio

May 18, 2015

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Introduction

As part of the TMDL process and in support of the basin approach for National Pollution Discharge Elimination System (NPDES) permitting, an intensive ambient assessment will be conducted during the 2015 field sampling season within the St. Marys River basin (Figure 1). The study area is composed of seventeen 12-digit Hydrologic Unit Code (HUC) watershed assessment units that are wholly contained within the state of Ohio's boundary (Figure 2). A total of 65 sampling stations are allocated to this effort and will provide for the assessment of 23 named and unnamed streams (Tables 2 and 4; Figure 5). Ambient biology, macrohabitat quality, water column chemistry, and bacteriological data will be collected concurrently from most of these sites. Diel water quality (DO, pH, conductivity, and temperature), sediment chemistry (metals, organics, and particle size), nutrients, and fish tissue will be evaluated at selected sampling locations. In addition, water and sediment chemistry will be collected at three locations on the Miami-Erie Canal to characterize potential impacts from the canal to the St. Marys River.



Figure 1. Location of the St. Marys River watershed within the geopolitical boundaries of Ohio.

Primary Sampling Objectives:

- 1) Systematically sample and assess the principal drainage network of the St. Marys River in support of both the TMDL process and NPDES permits;
- 2) Gather ambient environmental information (biological, chemical, and physical) from undesignated or unlisted waterbodies, so as to recommend an appropriate suite of beneficial uses (e.g., aquatic life, recreational);
- 3) Verify the appropriateness of existing unverified beneficial use designations and recommend appropriate use designation to undesignated waters;
- 4) Evaluate baseline ambient biological conditions at selected reference sites;
- 5) Document any changes in the biological, chemical, and physical conditions of the study areas where historical information exists, so as to both evaluate the effectiveness of past, ongoing and future pollution abatement efforts, and to expand the Ohio EPA database for statewide trends analysis (e.g., 305[b], 303[d] listing and de-listing).

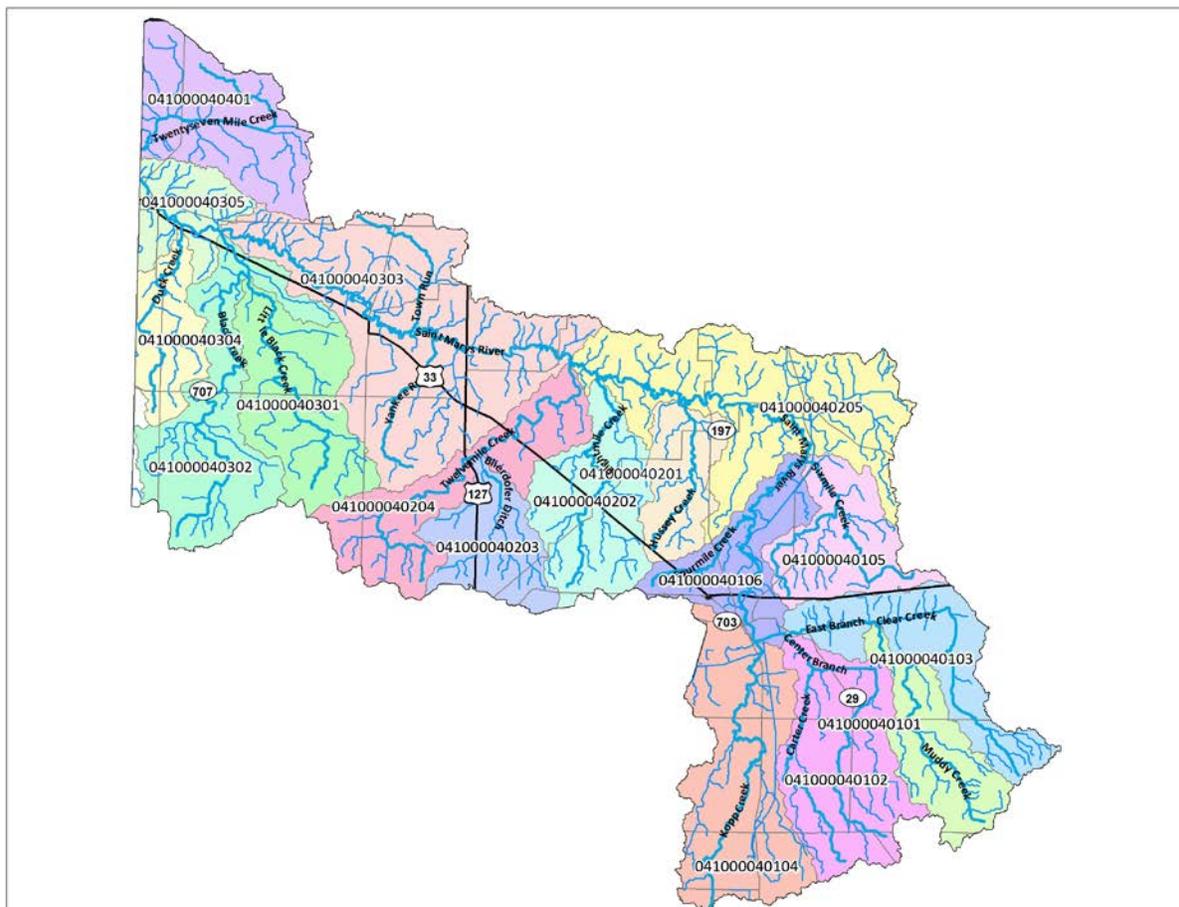


Figure 2. HUC 12 assessment units in the St. Marys River watershed study area.

Issues

Total Maximum Daily Load (TMDL)

Information collected as part of this survey will support TMDL development for the study area. The objectives of the TMDL process are to estimate pollutant loads from the various sources within the basin, define or characterize allowable loads to support the various beneficial uses, and to allocate pollutant loads among different pollutant sources through appropriate controls (e.g., NPDES permitting, storm water management, 319 proposals, NPS controls or other abatement strategies).

The components of the TMDL process supported by this survey are primarily the identification of impaired waters, verification (and redesignation if necessary) of beneficial use(s), collection of ambient information that will factor into the wasteload allocation, and ascribing causes and sources of use impairment. These data are necessary precursors to the development of effective control or abatement strategies.

Aquatic Life Use Designations

Presently, designated aquatic life uses for 5 of the 23 streams contained within the 2015 study area are verified or otherwise affirmed, based upon the results of previous sampling events, including an integrated biosurvey of the St. Marys River by Ohio EPA in 1991 (Ohio EPA 1992), and subsequent rulemakings. The remaining 18 waterbodies are classified as either unverified (identified in the WQS, but have not been subjected to a use attainability analysis) or not listed (absent from WQS). Ohio EPA is obligated to review, evaluate, or recommend (where appropriate) beneficial uses prior to basing any permitting actions on existing, unverified, or wholly unclassified water bodies. A portion of the sampling effort for this survey is allocated to fulfill this obligation.

NPDES Permits

Significant, major and minor NPDES permitted facilities will be evaluated as part of this study. These include both Publically Owned Treatment Works (POTWs) and private entities. A complete list of facilities permitted under the NPDES is presented in Table 1 and depicted in Figure 3.

Nutrients

To support the refinement of nutrient monitoring analytics, nutrient criteria development, and to provide more objective and robust characterization of the sources and effects of nutrient loads within the study area, nutrient monitoring is scheduled for the St. Marys River mainstem and its principal tributaries, as so indicated in Table 4.

Nonpoint Sources

Nonpoint sources related to agricultural activities are likely to be a strong influence on water quality in the St. Marys River basin. An overwhelming percentage of land use (81.69%) is dedicated to cultivated crops alone. Due to a combination of poorly drained hydric soils and low relief, subsurface drainage of farm fields is common, which can result in altered flow hydrology in the receiving streams. Many stream segments in the watershed are also under petition by the county and thus maintained in a channel modified state. Figure 3 depicts both land uses and petitioned stream segments in the St. Marys River study area.

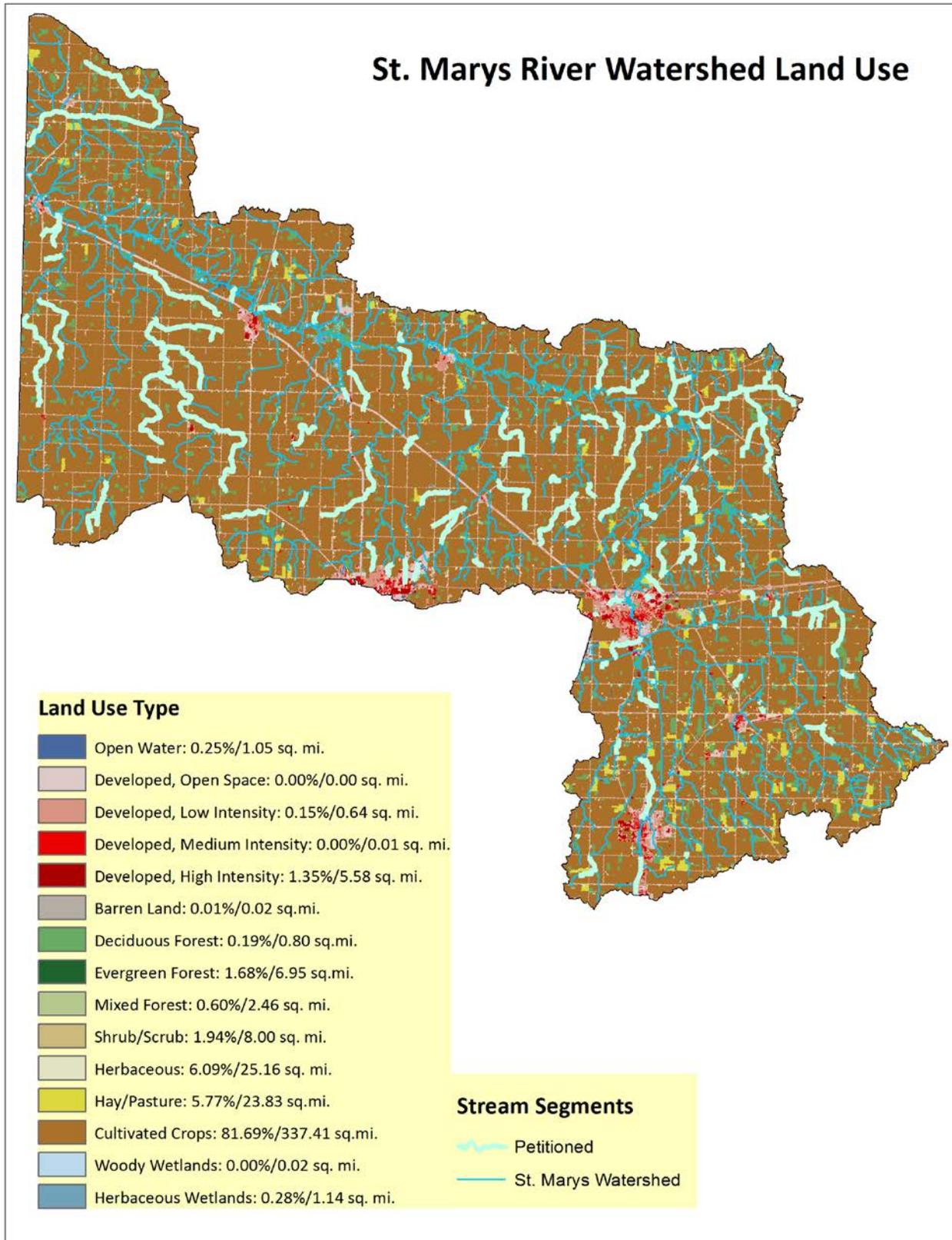


Figure 3. Land use in the St. Marys River watershed, showing petitioned stream segments. Data courtesy of National Land Cover Dataset 2011 (Jin, et al. 2013) and Auglaize, Mercer, and Van Wert counties, Ohio.

Sampling Effort

Water Quality

Water column chemistry samples will be collected from 66 ambient stations within the study area. Water column grab samples and standard field parameters will be collected/measured six times from all locations. Sampling frequency station density, flow regime, and other field considerations shall comport with the current Ohio EPA sampling protocol. BOD-5 sampling will be conducted at six historical sampling locations on the St. Marys River, for the purposes of trends assessment, as well as three locations on the Miami-Erie Canal (Table 4). Datasonde® deployment is requested for 30 locations. The deployment of continuous monitors should coincide with typical low summer/fall flows (i.e., approaching Q_{710}). The Modeling section will be responsible for sonde deployment.

Bacteriological Sampling

The collection of water samples for bacteriological analysis is scheduled for 35 stations. Samples will be collected during at least 8 -12 times per bacteria monitoring station during the recreational season, with stations placed approximately every 5-7 miles on Primary Contact Recreation Class A waters and at least one bacteria monitoring station placed at the outlet of each HUC 12 Watershed Assessment Unit (WAU). In addition, bacteriological samples will be collected at wastewater treatment plant effluent outfalls.

Nutrient Monitoring

Water column samples in support of nutrient monitoring and assessment efforts will be collected at 30 locations. DSW Modeling staffs are responsible for the collection of specific parameters supporting nutrient monitoring and assessment. Sampling protocols are found in the attached memorandum from DSW supervisors Holly Tucker and Cathy Alexander date 3/10/2014. As the St. Marys River basin drains approximately 400 mi² at the Ohio-Indiana border, the non-large river sampling regime is prescribed.

Substrate and water column samples for the analysis of benthic chlorophyll-a, dissolved phosphorus, and alkalinity must be collected concurrently with either the Datasonde® set or retrieval or the interval between these two activities.

Sediment Chemistry

Sediment samples are to be collected from 8 locations within the study area employing methods and procedures specified in Ohio EPA (2015a Appendix III). The sediment sampling sites include three locations on the Miami-Erie Canal to characterize potential impacts from the canal to the St. Marys River and five locations on the St. Marys main stem to evaluate long-term trends.

Fine grained multi-incremental sediment samples will be collected in the upper four inches of bottom material using either clean stainless steel scoops or dredges. Samples will be homogenized and split into 500 ml amber glass jars with Teflon lined lids for organic compound testing and 250 ml HPDE containers for metals testing. They will then be secured inside coolers with wet ice and delivered to the Ohio EPA Division of Environmental Services (DES) for analysis. Pollutants to be tested and their analytical methods are listed in the table of chemical/physical parameters (Table 6).

Data will primarily be used as a resource to help determine causes and sources of aquatic life impairment. More detailed follow up studies may be recommended in some instances. To determine the potential for sediment contaminants to exert adverse effects, the data will first be compared to Ohio sediment reference values and consensus-based sediment quality guidelines. This constitutes a Tier I

assessment as described in *Guidance on Evaluating Sediment Contaminant Results* (Ohio EPA, 2010). No further assessment is needed if the sediment passes the screening. If not, it's considered above levels of concern and further evaluation is needed using the Tier II process. This process estimates bioavailability using total organic carbon to normalize pollutant concentrations.

Analysis will include a full organic scan (BNAs, PCBs, TOC, and pesticides), a full metals scan (including mercury and silver), and sediment particle size. Please note, due to very limited practical benefit, demonstrated over many years, analysis for sediment VOCs is not recommended for any sediment samples. Given the limited laboratory allocation, sediment and metal-organic sampling stations were chosen to evaluate areas likely to demonstrate contamination, aid in elucidating longitudinal trends in sediment contamination relative to a known source(s), characterization of sentinel sites, and to further characterize ecoregional sediment reference sites. Locations of selected sediment sampling stations are listed in Table 4. The allocation and placement of additional sediment sampling within the study area will be at the discretion of Southwest District staff.

Benthic Macroinvertebrate Assessment

The condition of the macroinvertebrate community will be evaluated at 57 locations. Artificial substrate samples (quantitative) will be deployed and retrieved by Macroinvertebrate Evaluation Group (MEG) staff at 25 stations within the study area. Qualitative benthic macroinvertebrate samples (natural substrates) will be collected at 32 stations. Locations of all benthic macroinvertebrate sampling stations and type of sample required are listed in Table 4.

Fish Community Assessment

The condition of the fish assemblages within the study area will be evaluated at 57 locations. Multiple pass fish community samples will be collected at 25 sites by Fish Evaluation Group (FEG) staff. Single pass fish community samples will be collected at 32 stations. Single pass evaluations are limited to headwaters, barring reference sites or significant permit issues. The locations of all fish sampling stations are listed in Table 4.

Fish Tissue

In support of the consumption advisory program, fish tissue samples are to be collected from 6 of the 15 fish monitoring stations within the St. Marys River study area possessing a drainage area greater than 50 mi². As indicated in Table 4, all six stations are located on the St. Marys River proper.

Sentinel Sites

To aid in the development of a TMDL models(s), sentinel sites have been established at 11 designated locations. At each sentinel site, samples are collected monthly beginning prior to the typical onset of field sampling season, and will include analysis for routine water chemistry parameters, pesticides (methods 608, 515.1, 525.2, and 547), and stream stage. Regarding the latter, stream stage will be measured at the water line against a designated bridge piling or abutment to the nearest 100th of a foot. Sampling events at sentinel sites should cover the range of stream flow from the 10th to 90th percentile discharge. The locations of sentinel sites are indicated in Table 4.

QUALITY ASSURANCE

Ohio EPA Manuals

All biological, chemical, data processing, and data analysis methods and procedures adhere to those specified in the Surface Water Field Sampling Manual for water column chemistry, bacteria and flows (Ohio EPA 2015a), Biological Criteria for the Protection of Aquatic Life, Volumes II - III (Ohio EPA 1987, 1989a, 2015b), 2015 Updates to the Biological Criteria for the Protection of Aquatic Life, Volume II (Ohio EPA 2015c), The Qualitative Habitat Evaluation Index (QHEI); Rationale, Methods, and Application (Ohio EPA 1989b, 2006) for habitat assessment, Surface Water Field Sampling Manual – Appendix III for sediment sampling (Ohio EPA 2015a), and Ohio EPA Fish Tissue Collection Guidance Manual (Ohio EPA 2012) for fish tissue sampling.

Geo-Referenced Site Labels

The sites listed in the study plan table are coded with EA3 Station IDs that link data across several tables. They must be included on all field, lab and sample sheets and reported with all data results. If for some reason a location other than the one listed in the study plan is sampled, and that location is a trivial distance away from the one listed in the table and is fully representative of the EA3 Station, use the river mile listed in the study plan, and simply record the location information separately. An exact river mile can be assigned later to an Absolute Location Point (ALP) if warranted. If the location is not representative of the site listed on the study plan due to distance or a confounding factor, it should probably not be sampled, but if it is, it should be separated as a new station.

Use Attainment

Attainment/non-attainment of aquatic life uses will be determined by using biological criteria codified in Ohio Administrative Code (OAC) 3745-1-07, Table 7-17. Numerical biological criteria are based on multimetric biological indices including the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), indices measuring the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community.

Performance expectations for the basic aquatic life uses [Warmwater Habitat (WWH), Exceptional Warmwater Habitat (EWH), and Modified Warmwater Habitat (MWH)] were developed using the regional reference site approach (Hughes et al. 1986; Omernik 1987). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Attainment of an aquatic life use is FULL if all three indices (or those available) meet the applicable criteria, PARTIAL if at least one of the indices did not attain and performance did not fall below the fair category, and NON if all indices either fail to attain or any index indicates poor or very poor performance.

Recreational use attainment will be determined using *E. coli* bacteria. *E. coli* is now the primary indicator organism for the potential presence of pathogens in surface water resulting from the presence of untreated human or animal wastes, and is the basis for recreational use water quality criteria in Rule 3745-1-07 of the Ohio Administrative Code (OAC).

Stream Habitat Evaluation

Physical habitat is evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by Ohio EPA for streams and rivers in Ohio (Ohio EPA 1989b, 2006). Various attributes of the available habitat are scored based on their overall importance to the establishment of viable, diverse aquatic faunas. Evaluations of type and quality of substrate, amount of instream cover, channel morphology, extent of riparian canopy, pool and riffle development and quality, and stream gradient are among the metrics used to evaluate the characteristics of a stream segment, not just the characteristics of a single sampling

site. As such, individual sites may have much poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values higher than 60 were generally conducive to the establishment of warmwater faunas while those which scored in excess of 75-80 often typify habitat conditions which have the ability to support exceptional faunas.

Biological Community Assessment

Macroinvertebrates will be collected from artificial substrates and from the natural habitats. Quantitative sampling will be conducted at reference sites and at sites with drainage areas in excess of 20 mi². Qualitative sampling will be conducted in headwater sites with drainages smaller than 20 mi². The artificial substrate collection provides quantitative data and consists of a composite sample of 5 modified Hester-Dendy (HD) multiple-plate samplers colonized for six weeks. At the time of the artificial substrate collection, a qualitative multi-habitat composite sample is also collected. This sampling effort consists of an inventory of all observed macroinvertebrate taxa from the natural habitats at each site with no attempt to quantify populations other than notations on the predominance of specific taxa or taxa groups within major macrohabitat types (e.g., riffle, run, pool, and margin). Fish will be sampled at each sampling location with pulsed DC current. Two passes will be conducted at sites larger than 20 mi² and at reference sites. Detailed biological sampling protocols are documented in Ohio EPA (2015b).

Fish Tissue

The collection, field processing, and short-term storage of fish tissue samples shall adhere to the methods and protocol specified in Ohio EPA (2015b).

Sediment

Fine grained multi-incremental sediment samples will be collected in the upper 4 inches of bottom material using either decontaminated stainless steel scoops or Ekman dredges. Collected sediment will be placed into appropriate containers, placed on ice (to maintain 4°C) and shipped to the Ohio EPA lab. Sampling and decontamination protocols will follow those listed in Ohio EPA (2015a Appendix III).

Surface Water

Surface water grab samples will be collected from the upper 12 inches of river water into appropriate containers. Collected water will be preserved using appropriate methods, as outlined in Ohio EPA (2015a) and shipped via courier to the Ohio EPA lab for analysis. Field measurements of dissolved oxygen, pH, temperature, and conductivity will be made using YSI 650 MDS and Professional Plus meters along with all grab samples for surface water chemistry. Datasonde® continuous recorders will be placed at select locations to evaluate diurnal measurements of dissolved oxygen, pH, temperature, and conductivity.

Bacteria

Water samples will be collected into appropriate containers, cooled to 4°C, and transported and submitted to the lab for analysis within 6 hours of collection. All samples will be analyzed for *E. coli* bacteria using US EPA approved methods (STORET Parameter Code 31648).

Chlorophyll-*a*

Benthic chlorophyll-*a* samples will be collected and preserved using appropriate methods, as outlined in Ohio EPA (2015a Volume II) and delivered to the Ohio EPA Division of Environmental Services lab for analyses. Alkalinity must be requested as a routine water quality parameter at all study sites along with the routine field parameters, especially temperature and pH.

Field Quality Control Samples

Ten percent of the sediment, water, and bacteria samples will be submitted to the lab as field duplicates. One Datasonde® recorder site will have two instruments placed in the river as field duplicates. Field blanks will occur at a minimum of 5 percent of the water samples. Field instruments will be calibrated daily, using manufacturer guidelines and requirements noted in Ohio EPA (2015a). Matrix spike duplicates will be collected for organic water samples at a minimum of 5 percent.

Field Staff and Other Contacts

Ohio EPA	Ohio DNR	DNR Wildlife Officers
<p><u>DSW Central Office</u> EAS Charles Boucher: (614) 836-8776-Fish Angela Dripps: (614) 839-8798-Macroinvertebrates Jeff DeShon: (614) 836-8780 (manager) Holly Tucker: (614) 836-8777 (supervisor) TMDL Cathy Alexander: (614) 644-2021 (manager) Angela Defenbaugh: (614) 728-2384 Modeling Joshua Griffin: (614)644-2872 Standards Chris Skalski: (614) 644-2144 - Rules Gary Klase: (614) 644-2865 - Fish Tissue</p> <p><u>DSW Southwest District Office</u> Joshua "Joby" Jackson: (937)285-6029 (supervisor) Michelle Waller: (937)285-6028-Water Quality</p>	<p><u>District 2:</u> 952 Lima Avenue Findlay, OH 45840 (419)424-5000</p> <p><u>District 5:</u> 1076 Old Springfield Pike Xenia, OH 45385 (937)372-9261</p>	<p><u>Auglaize Co.</u> Mark Schemmell (937)372-5639 <u>Mercer Co.</u> Ryan Garrison (937)372-5639 ext. 5210 <u>Shelby Co.</u> Tim Rourke (937)372-5639 ext. 5213 <u>Van Wert Co.</u> Brad Buening (419)429-8395</p>
	County Sheriffs	
Hospitals (see attached map)	<p><u>Auglaize County</u> Allen F. Solomon 1051 Dearbaugh Ave. Wapakoneta, Ohio 45895 (419)739-6565</p> <p><u>Shelby County</u> John R. Lenhart 555 Gearhart Road Sidney, OH 45365 (937)498-1111</p>	<p><u>Mercer County</u> Jeff Grey 4835 State Route 29 Celina, Ohio, 45822 (419)586-5770</p> <p><u>Van Wert County</u> Thomas M. Riegenbach 113 N. Market St. Van Wert, OH 45891 (419)238-3866</p>
<p>Joint Township District Memorial Hospital 200 St. Clair Ave. St. Marys, OH 45885 (419) 394-3335</p> <p>Mercer County Community Hospital 800 W. Main St. Coldwater, OH 45828 (419) 678-2341</p> <p>Van Wert County Hospital 1250 S. Washington St. Van Wert, OH 45891 (419)238-2390</p>	<p>Police Departments</p> <p><u>Celina</u> 225 N. Main St. Celina, Ohio 45822 (419) 586-2345</p> <p><u>New Bremen</u> 214 N. Washington Street New Bremen, OH 45869 (419) 629-3036</p> <p><u>Rockford</u> 151 East Columbia Street Rockford, Ohio 45882 (419) 586-7724</p>	<p><u>St. Marys</u> 222 Indiana Ave. St. Marys, OH 45885 (419) 394-2325</p> <p><u>New Knoxville</u> 101 S. Main Street New Knoxville, OH 45871 (419) 753-2404</p>

Table 1. Facilities regulated under the NPDES within the St. Marys River basin.

Permit #	Entity	5-Year Ave. (MGD)	Design (MGD)	Type	Permit Expiration	Receiving Stream (RM)	County
2IN00164	Thieman Stamping Company	0.0009	0.002	Industrial	12/31/2014	Carter Creek (~4.7)	Auglaize
1PR00034	The Way International	0.028	0.05	Municipal	7/31/2013	Center Branch (8.0)	Shelby
2PA00059	New Knoxville STP	0.225	0.35	Municipal	7/31/2013	Center Branch (5.18)	Auglaize
2PG00093	Sharlon Subdivision	0.003	0.0075	Municipal	8/31/2015	Center Branch (2.3)	Auglaize
2PG00092	Pleasantview Estates Subdivision	0.024	0.02	Municipal	3/31/2012	East Branch (0.9 from UT)	Auglaize
2PP00026	ODOT Rest Area 7-33	0.002 (2 years)	0.01	Municipal	11/30/2012	East Branch (3.3 via trib)	Auglaize
2PB00034	New Bremen WWTP	0.754	0.9	Municipal	12/31/2015	Wierth Ditch (~2.4)	Auglaize
2PG00105	Forest Lane Subdivision	0.004	0.01	Municipal	1/31/2012	Wierth Ditch (1.25)	Auglaize
2IW00240	Saint Marys WTP	0.104	--	Industrial	2/29/2016	Armstrong Ditch (2.5)	Auglaize
2PR00178	Easy Campgrounds	0.00061 (1 year)	0.00675	Municipal	6/30/2014	UT (3.1) to Ankerman Creek (0.9)	Auglaize
2PD00026	Saint Mary's STP	1.92	3.0	Municipal	1/31/2016	St. Marys River (98.6)	Auglaize
2IJ00082	CON-AG Inc.	0.067	0.6697	Industrial	9/30/2012	St. Marys River (~93.98)	Auglaize
2PG00120	Country Time Subdivision WWTP	0.0032 (4 years)	0.008	Municipal	2/29/2016	Twelvemile Creek (8.5)	Mercer
2PA00058	Mendon WWTP	0.08	0.1	Municipal	4/30/2014	St. Marys River (69.54)	Mercer
2IN00183	BP Amoco Oil Corp Bulk Plant Rockford	0.00041	--	Industrial	4/30/2012	St. Marys River (~58.65)	Mercer
2PG00119	Deerfield Subdivision WWTP	0.0021 (4 years)	0.1	Municipal	2/29/2016	St. Marys River (63.0)	Mercer
2PD00001	Rockford STP	0.399	0.25	Municipal	2/29/2016	St. Marys River (~57.84)	Mercer
2IJ00041	Stoneco Rockford Quarry (Shelly Materials)	--	4.8	Industrial	6/30/2016	St. Marys River (54.5)	Mercer
2PA00013	Willshire WWTP	0.081	0.0665	Municipal	5/31/2012	St. Marys River (43.15)	Van Wert
2IZ00132	Willshire WTP	0.007 (3 years)	--	Industrial	10/31/2017	Bowen Ditch (to St Mary's River at 43.2)	Van Wert

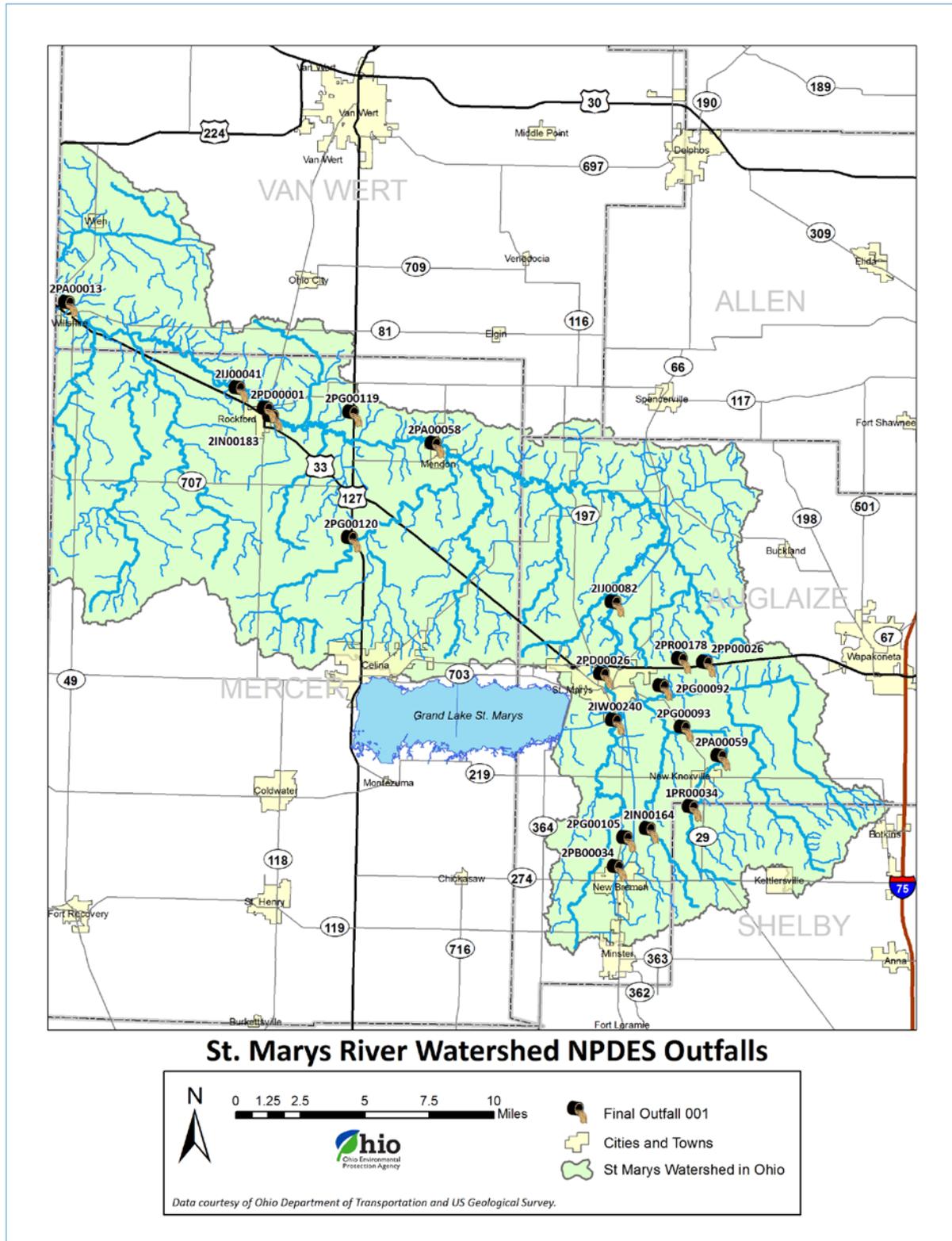


Figure 4. NPDES discharges to the St. Marys River watershed, by permit number (see Table 1 for entity information).

Table 2. Drainage hierarchy and named tributary confluences, St. Marys River basin.

<p>St. Marys River 04-500-000 → Tributary to the Maumee River (confluence in Indiana)</p> <p>Twentysevenmile Creek 04-500-001 → Tributary to St. Marys River at RM 41.42 (Indiana)</p> <p> Tributary to Twentysevenmile Creek (3.1) 04-500-002 →Tributary to Twentysevenmile Creek at RM 3.1</p> <p>Duck Creek 04-505-000 → Tributary to St. Marys River at RM 44.94</p> <p>Black Creek 04-503-000 → Tributary to St. Marys River at RM 46.64</p> <p> Little Black Creek 04-504-000 → Tributary to Black Creek at RM 1.92</p> <p>Town Run 04-506-000 →Tributary to St. Marys River at RM 60.80</p> <p>Yankee Run 04-508-000 →Tributary to St. Marys River at RM 63.38</p> <p>Twelvemile Creek 04-510-000 →Tributary to St. Marys River at RM 71.30</p> <p> Blierdofer Ditch 04-511-000 →Tributary to Twelvemile Creek at RM 7.92</p> <p>Eightmile Creek 04-513-000 →Tributary to St. Marys River at RM 72.95</p> <p>Hussey Creek 04-514-000 →Tributary to St. Marys River at RM 78.77</p> <p>Prairie Creek 04-501-000 →Tributary to St. Marys River at RM 86.76</p> <p>Sixmile Creek 04-515-000 →Tributary to St. Marys River RM 89.12</p> <p> Ankerman Creek 04-515-001 →Tributary to Sixmile Creek at RM 2.41</p> <p>Kopp Creek 04-524-000 →Tributary to St. Marys River at RM 100.17</p> <p> Tributary to Kopp Creek (5.41) 04-524-002 Wierth Ditch 04-524-001 →Tributary to Kopp Creek at RM 8.00</p> <p>Center Branch 04-518-000 →Confluence with East Branch forms St. Marys River at RM 100.35</p> <p> Carter Creek 04-519-000 →Tributary to Center Branch at RM 1.73</p> <p>East Branch 04-500-006 →Confluence with Center Branch forms St. Marys River at RM 100.35</p> <p> Clear Creek 04-517-000 →Confluence with Muddy Creek forms East Branch at RM 3.61</p> <p> Muddy Creek 04-520-000 →Confluence with Clear Creek forms East Branch at RM 3.61</p>
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Table 3. Ohio EPA laboratory and field sampling load for the 2015 St. Marys River survey. Total number of water column analytes does not include field parameters.

Sample Type	No. of Lab Parameters	No. Sites	Passes	Total Samples/Parameters
Conventional Water Quality (total)	--	66	6	396/--
Nutrient and Demand	12	66	6	396/4752
Metals	13	66	3	198/2574
Dissolved Orthophosphate	1	30	6	30/180
BOD5	1	6	6	36
Pathogen (<i>E. coli</i>)^a	1	36	10	360
Nutrients^b	4	30	1	30/120
Water Column Organics				-/-
Sentinel Sites EPA Methods (608,515.1, 525.2, 547)	Full Scan	11	3	33/Full Scan
Datasonde[®]	--	30	1	NA
Sediment	--	8	1	-/-
Sediment Metals**	10	8	1	-/80
Sediment Organic	(Full Scan)#	8	1	-/Full Scan
Sediment Particle Size	NA	8	1	-/-
Sentinel Sites	37	11	10	110/4070
Fish Tissue				
Metals, including Hg	(FT Suite)	6	1	-/-
Organics, including chlordane	(Full Scan)	6	1	-/Full Scan
Fish Stations (total)	--	57	1-2	82
2x	--	25	2	50
1x	--	32	1	32
Macroinvertebrate (total)	--	57	NA	--
Quantitative (Hester-Dendy)	--	25	NA	--
Qualitative (Natural Substrates)	--	32	NA	--
<p>a – Eight to twelve runs are planned for bacteriological sampling for <i>E. coli</i>.</p> <p>b - Samples must be concurrent with either the set or retrieval of the Datasonde[®] continuous monitor.</p> <p>** - Ohio EPA sediment samples will be analyzed for the following metals: Al, Ag, As, Cd, Cr, Cu, Pb, Fe, Mn, Ni, and Zn.</p> <p># - Full Scan includes BNAs, PCBs, Pesticides, and TOC.</p>				

Table 4. Sampling locations in the St. Marys watershed, 2015. Brown shaded rows indicate wastewater effluent sampling. Sampling key: F2=Fish 2 pass, F=Fish 1 pass, MQ=Quantitative macroinvertebrate, Mq=Qualitative macroinvertebrate, C=Water column chemistry, C5=Water column chemistry plus BOD5, D=Datasonde®, N=Nutrient, B=Bacteria, Sn=Sentinel, Sd=Sediment, FT=Fish tissue.

Station	Location	RM	DA	Sample Type	HUC12	Latitude	Longitude	Map #
St. Marys River 04-500-000 WWH								
510010	At St. Marys at Aqueduct Road	100.47	67.10	F2,MQ,C5,D,N	041000040106	40.535300	-84.377200	1
P01K11	At St. Marys, dst Kopp Creek @ Greenville St.	100.12	101.00	F2,MQ,C,D,N,B	041000040106	40.534845	-84.383904	2
P01W12	St. Marys WWTP outfall 001 to St. Marys River	98.60	102.00	C5,B	041000040106	40.550922	-84.392557	3
P01K10	Downstream St. Marys WWTP	98.50	103.00	F2,MQ,C5,D,N,B,Sd	041000040106	40.552500	-84.393099	4
510020	North of St. Marys @ Glynwood Road	95.12	106.00	F2,MQ,C5,D,N,B,Sn,Sd	041000040106	40.582200	-84.392199	5
P01K05	South of Kossuth at Barbara-Werner Road	87.80	135.00	F2,MQ,C,D,N,B	041000040205	40.640300	-84.354399	6
P01S09	North of St. Marys at SR 116	80.51	166.00	F2,MQ,C5	041000040205	40.654400	-84.420299	7
P01S08	East of Mendon at Gallman Road	75.07	184.00	F2,MQ,C5,D,N,B,Sn,Sd	041000040205	40.664700	-84.465599	8
302591	At Mendon at Celina-Mendon Road	70.40	251.00	F2,MQ,C	041000040303	40.676827	-84.518683	9
303083	Mendon WWTP Outfall 001 to St. Marys River	70.25	251.30	C,B	041000040303	40.678052	-84.520401	10
P01K04	North of Mercer at US 127	65.70	261.00	F2,MQ,C	041000040303	40.681100	-84.580599	11
P01K03	East of Rockford at Frysinger Road	61.50	279.00	F2,MQ,C,D,N,B	041000040303	40.690600	-84.612500	12
P01W07	Rockford WWTP outfall 001 to St. Marys River	57.84	295.00	C,B	041000040303	40.695600	-84.645100	13
P01W08	At SR 118	57.82	295.00	F2,MQ,C,D,N,B	041000040303	40.695400	-84.646400	14
P01K02	Downstream Rockford at Townline Road	52.13	303.00	F2,MQ,C,D,N,B Sn,Sd	041000040303	40.717800	-84.689400	15
P01K01	Southeast of Willshire at Horner Road	47.48	309.00	F2,MQ,C	041000040303	40.734200	-84.737200	16
303088	St. Marys River adj US 33 east of Willshire	45.60	366.68	F2,MQ,C,D,N	041000040305	40.735479	-84.762574	17
510170	At Willshire at SR 81	43.48	386.00	F2,MQ,C,D,N,,Sn,Sd	041000040305	40.749400	-84.790299	18
303089	Willshire WWTP Outfall 001 to St. Marys River	43.12	388.23	C,B	041000040305	40.752260	-84.793800	19
Muddy Creek 04-520-000 WWH*								
303062	Bay Road	5.40	9.33	F,Mq,C	041000040101	40.494644	-84.278557	20
303063	Washington Road	0.45	15.60	F,Mq,C,D,N,B	041000040101	40.540379	-84.299646	21
Center Branch 04-518-000 WWH*								
P01K28	At New Knoxville @ end of road near ponds	6.60	5.90	F,Mq,C	041000040102	40.491100	-84.321099	22

Station	Location	RM	DA	Sample Type	HUC12	Latitude	Longitude	Map #
P01S07	Just upstream New Knoxville WWTP	5.20	12.40	F,Mq,C,D,N,B	041000040102	40.505300	-84.305600	23
303064	New Knoxville WWTP outfall 001 to Center Branch	5.18	12.40	C,B	041000040102	40.506428	-84.304953	24
P01S05	At Glynwood-New Knoxville Road	3.22	14.20	F,Mq,C,D,N,B	041000040102	40.521697	-84.316717	25
303024	At Plattner Road	0.35	28.65	F2,MQ,C,D,N,B Sn	041000040102	40.534027	-84.358237	26
Carter Creek 04-519-000 WWH*								
P01S03	West of New Knoxville at SR 219	1.86	7.80	F,Mq,C	041000040102	40.495300	-84.349700	27
Clear Creek 04-517-000 WWH*								
303065	At Burr Oak Road	5.40	6.81	F,Mq,C	041000040103	40.518518	-84.250450	28
P01K27	East of St. Marys at Bay Road	1.32	13.4	F,Mq,C,D,N,B	041000040103	40.547800	-84.278099	29
East Branch 04-500-006 Undesignated								
303025	East Branch at SR 29	0.25	37.12	F2,MQ,C,D,N,B Sn	041000040103	40.539323	-84.359130	30
Kopp Creek 04-524-000 WWH								
500560	North of New Bremen at Montezuma Road	8.88	4.60	F,Mq,C,B	041000040104	40.465800	-84.387800	31
500550	North of New Bremen at lane off SR 66	7.62	13.8	F,Mq,C,D,N,B	041000040104	40.474400	-84.378100	32
500540	South of St. Marys dst SR 219	4.10	21.16	F2,MQ,C	041000040104	40.495972	-84.395849	33
P01K29	South of St. Marys @ SR 66	0.80	28.00	F2,MQ,C,D,N,B Sn	041000040104	40.526100	-84.379700	34
Wierth Ditch 04-524-001 MWH								
303066	New Bremen WWTP outfall 001 to Wierth Ditch	2.40	4.30	C,B	041000040104	40.442583	-84.379809	35
500580	North of New Bremen @ SR 66	0.45	6.90	F,Mq,C,B	041000040104	40.468600	-84.377200	36
Unnamed Tributary to Kopp Creek at RM 5.41 04-524-002 WWH*								
500590	At Piqua-St. Marys Road	0.30	4.6	F,Mq,C	041000040104	40.480800	-84.397800	37
Miami-Erie Canal 04-500-999 and 04-500-004 (from Grand Lake) MWH								
303070	Adjacent SR 66 @ Sixmile Creek aqueduct	17.00	n/a	C5,Sd	041000040105	40.626332	-84.346683	38
303092	Adj. Beech Rd. @ St. Marys River aqueduct	24.50	n/a	C5,Sd	041000040106	40.537778	-84.378213	39
302069	From Grand Lake, at St. Marys, downstream SR 66	0.20	n/a	C5,Sd	041000040106	40.531994	-84.377038	40
Sixmile Creek 04-515-000 WWH*								
303067	Near Lock Fourteen Road	2.50	6.44	F,Mq,C	041000040105	40.605410	-84.329809	41
303068	At St. Marys-Kossuth Road	1.06	16.2	F,Mq,C,D,N,B	041000040105	40.619324	-84.342539	42
Ankerman Creek 04-515-001 Undesignated								

Station	Location	RM	DA	Sample Type	HUC12	Latitude	Longitude	Map #
303069	At mouth via Sixmile Creek	0.10	7.00	F,Mq,C	041000040105	40.605872	-84.330367	43
Fourmile Creek 04-516-000 WWH*								
303071	At St. Marys River Road	0.10	5.56	F,Mq,C	041000040106	40.597197	-84.387133	44
Hussey Creek 04-514-000 WWH*								
303072	At Salem-Noble Road	2.40	6.80	F,Mq,C	041000040201	40.626255	-84.427558	45
303073	At Hesse Road	0.10	11.30	F,Mq,C,D,N,B	041000040201	40.655022	-84.437122	46
Eightmile Creek 04-513-000 WWH*								
303074	At Davis Road	6.55	12.70	F,Mq,C	041000040202	40.618882	-84.486328	47
302592	Southeast of Mendon at Mercer Road	1.22	21.80	F2,MQ,C,D,N,B ,Sn	041000040202	40.655300	-84.485299	48
Blierdofer Ditch 04-511-000 MWH								
303077	At Morrow Road	2.50	6.40	F,Mq,C	041000040203	40.596843	-84.556891	49
P01K21	North of Celina at Oregon Road	1.70	10.50	F,Mq,C,D,N,B	041000040203	40.608300	-84.555600	50
Twelvemile Creek 04-510-000 WWH*								
P01K19	Northwest of Celina at Hoenie Road	11.01	11.60	F,Mq,C	041000040204	40.606700	-84.599700	51
P01K17	South of Mendon, dst Celina-Mendon Road	1.80	36.10	F2,MQ	041000040204	40.655601	-84.510912	52
P01S01	Near Mendon at Neptune-Mendon Rd.	0.70	37.50	C,D,N,B,Sn	041000040204	40.665600	-84.508300	53
Prairie Creek 04-501-000 WWH*								
303078	At Easley Road	2.75	6.65	F,Mq,C	041000040205	40.661666	-84.318082	54
P01K16	At SR 197	0.40	10.80	F,Mq,C,D,N,B	041000040205	40.651335	-84.343547	55
Little Black Creek 04-504-000 WWH*								
303079	At SR 707	6.85	10.10	F,Mq,C	041000040301	40.654848	-84.693962	56
303080	At Jordan Road	1.00	23.62	F2,MQ,C,D,N,B	041000040301	40.705829	-84.718230	57
Black Creek 04-503-000 MWH								
303081	At Strable Road	10.7	13.19	F,Mq,C	041000040302	40.640499	-84.756512	58
303082	At Winkler Road	2.50	25.00	F2,MQ,C,D,N,B	041000040302	40.713323	-84.734551	59
P01S02	Southeast of Willshire at US 33	0.90	54.00	F2,MQ,C,D,N,B Sn	041000040302	40.726400	-84.737799	60
Yankee Run 04-508-000 WWH*								
303084	At US 33	1.40	6.10	F,Mq,C	041000040303	40.668861	-84.608438	61
Town Run 04-506-000 WWH*								
303085	At SR 117	1.25	7.10	F,Mq,C	041000040303	40.705059	-84.613882	62
Duck Creek 04-502-000 WWH*								
303086	At Settler Road	4.70	6.44	F,Mq,C	041000040304	40.694770	-84.794721	63
303087	Downstream County Line Road	1.05	15.62	F,Mq,C,D,N,B	041000040304	40.728118	-84.773742	64
Twentysevenmile Creek 04-500-001 Undesignated								
303090	At Clayton Road	4.10	14.00	F,Mq,C	041000040401	40.793588	-84.765754	65
P01K12	At OH/IN state line	1.20	28.20	F2,MQ,C,D,N,B Sn	041000040401	40.778041	-84.801344	66

Station	Location	RM	DA	Sample Type	HUC12	Latitude	Longitude	Map #
<i>Unnamed Tributary to Twentysevenmile Creek @ RM 3.1 04-500-002 Undesignated</i>								
303091	@ Wren-Landeck Rd.	0.40	7.40	F,Mq,C	041000040401	40.800842	-84.784911	67

*Unverified aquatic life use.

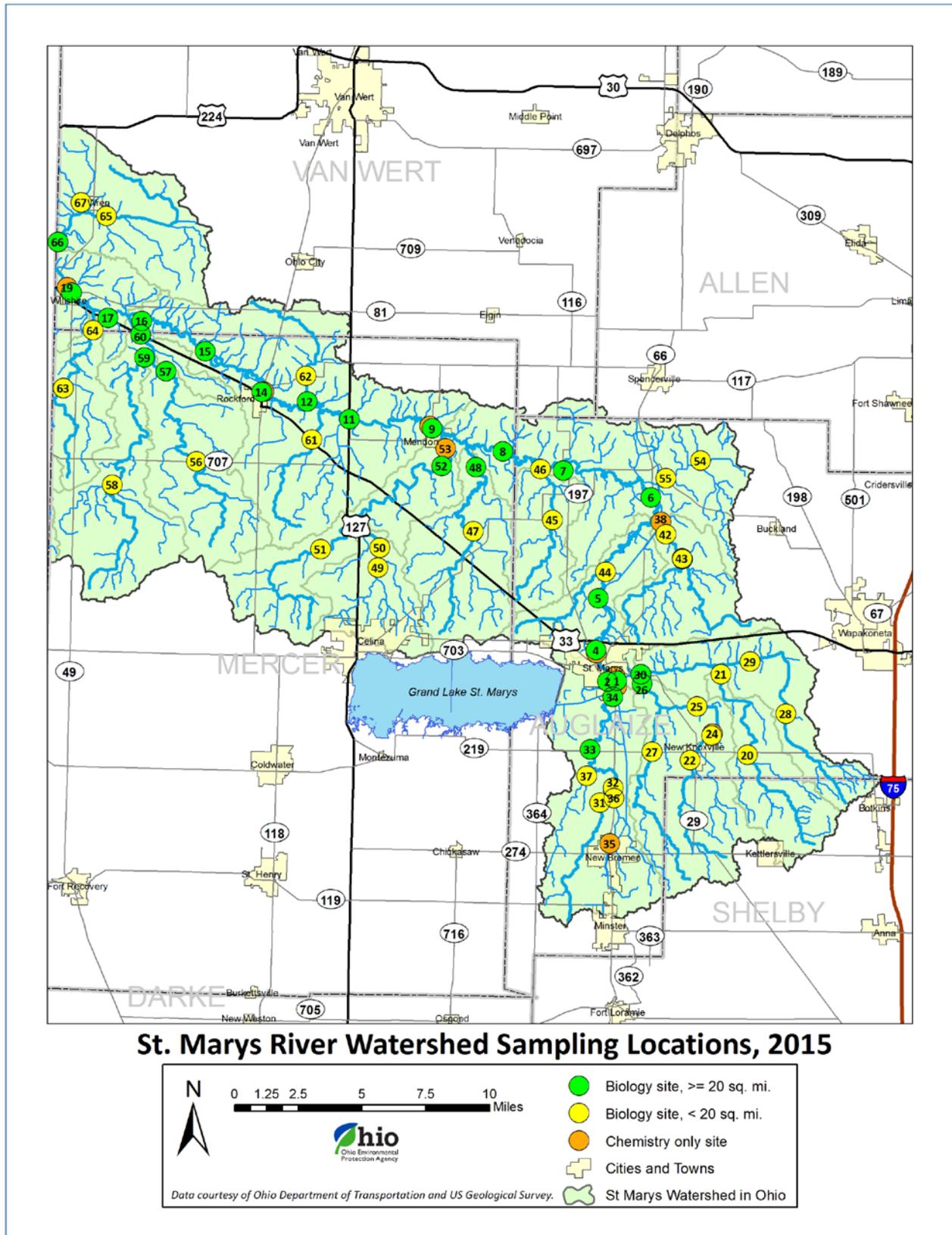


Figure 5. Distribution of the 67 proposed monitoring stations within the 2015 St. Marys River study area.

Table 5. List of chemical/physical water quality parameters to be analyzed/measured in surface water, sediment, and fish tissue samples from the St. Marys River basin sampling locations. Not all sites will be sampled for all parameters. Water samples will be collected 6 times; sediment once. Bacteria samples will be collected 8-12 times during the recreation season. Select sampling locations will be monitored for dissolved oxygen, pH, temperature, and conductivity using Datasonde® continuous recorders.

Parameters	Test Method	Water	Sediment	Fish Tissue
cBOD, 5 day	SM 5210B	X		
BOD, 5 day	SM 5210B	X		
SOLIDS, SUSPENDED (TSS)	USEPA 160.2	X		
AMMONIA	USEPA 350.1	X		
Alkalinity	USEPA 305.1	X		
TKN	USEPA 351.2	X		
NITRATE-NITRITE	USEPA 353.1	X		
Nitrite	USEPA 354.1	X		
Chloride	USEPA 325.1	X		
COD	USEPA 410.4	X		
TOTAL PHOSPHORUS	USEPA 365.4	X		
DISSOLVED PHOSPHORUS	USEPA 365.4	X		
ICP 1 (Al,Ba,Ca, Fe, Mg, Mn, Na, Ni, K, Sr, Zn, Hardness)	USEPA 200.7	X		
Water Column chlorophyll-a	USEPA 455	X		
ICP 3 (Al,Ba,Ca,Fe,Mg,Mn,Na,K,Sr,Zn)	USEPA 200.7		X	
ICPMS 1 (As,Cd,Cr,Cu,Ni,Pb,Se)	USEPA 200.9, SM 3113B	X		X
ICPMS 2 (As,Cd,Cr,Cu,Ni,Pb,Se)	USEPA 200.9, SM 3113B		X (+ Ag)	
MERCURY, TOTAL	USEPA 245.1,7470A,7471A	X	X	X (245.1)
pH – grab	Field Sonde	X field		
Conductivity – grab	Field Sonde/ USEPA 120.1	X field/lab		
Dissolved Oxygen – grab	Field Sonde	X field		
Temperature – grab	Field Sonde	X field		
GLYPHOSATE	USEPA 547	X		
Herbicides	USEPA 515.1 & 525.2	X		
SVOCs (BNAS)	USEPA 625/ USEPA 8270C		X	
Pesticides/PCBs/ Chlordane	USEPA 608/ USEPA 8081A, 8082	X	X	X (OEPA 590.1)
<i>E. coli</i>	USEPA 1103.1/ 640.1	X		
Percent Solids	SM 2540G		X	X

Table 6. Recommended sediment parameters, and required methods and reporting limit.

Parameter	Method	Reporting Limit
Standard Suite		
% solids	SM 2540G	0%
total organic carbon	OEPA 335.2	0.1%
total phosphorus	USEPA 365.4	50 mg/kg
zinc	USEPA 200.7	8 mg/kg
copper, nickel, lead	USEPA 200.8	0.8 mg/kg
cadmium, silver	USEPA 200.8	0.08 mg/kg
mercury	USEPA 7471A	0.02 mg/kg
semi volatile organics	USEPA 8270	0.4-2.0 mg/kg



INTEROFFICE MEMO

To: DWS WQ Staff (through Supervisors), MAS and EAS

From: Holly Tucker and Cathy Alexander

Date: March 10, 2014

Subject: Chlorophyll *a*, BOD5, Sonde site selection (revision #3)

The incorporation of chlorophyll *a* (chl-*a*) sampling into TMDL stream surveys has become more routine with the development of the Trophic Index Criteria and related nutrient work. This memo documents the approach that should be followed when including chl-*a* sampling in TMDL study areas. *The following information applies to first year sampling where all sites (except effluent and mixing zones) are sampled for biology and normal chemistry.*

I. Nutrient sampling at sites with drainage area (DA) > 500 mi²: District and Central Office staff

- a. Sestonic chl-*a* should be sampled at all sites with DA >500 mi² every time they are visited from June to October, until EAS has enough data to complete the analysis for enrichment breakpoints in larger rivers.
- b. Any time a chemistry sample is taken at a site with DA > 500 mi², the Large River lab template should be used.
 - i. The Large River template includes BOD5, which is necessary when sampling sestonic chl-*a* at sites with DA >500 mi².
 - ii. MAS will add CBOD20 to the Large River template when sampling these sites (Districts do not need to do this).
- c. Any sites with DA >500 mi² selected to be nutrient sites (see III) should also be sampled by MAS for benthic chl-*a*, if possible.

II. Nutrient sampling at sites with DA < 500 mi²

- a. Both benthic and sestonic chl-*a* samples should be taken at any site with DA <500 mi² designated as a nutrient site, if possible.
 - i. MAS staff are responsible for both benthic and sestonic chl-*a* samples at these sites, unless otherwise decided in study planning.
 - ii. BOD5 is also optional at these sites, as decided upon during study planning.
- b. MAS will use one of the modeling templates (which include CBOD20) when sampling at these sites.
 - i. Lab templates that fall under this category include Inland Lake Tributaries, WQM Modeling Conventional and WQM Modeling Non-Metals.

III. Nutrient site selection

- a. Nutrient sites are a subset of Datasonde® sites and are identified during study planning as being potentially stressed due to nutrient enrichment; these sites may include: longitudinal series bracketing WWTPs, HUC pore-points, or paired or stratified samples to document non-point enrichment.
- b. These are sites where both sestonic and benthic chl-*a* are sampled and Datasonde® meters are deployed to capture dissolved oxygen swings.
- c. The MAS is limited to 24 nutrient sites per survey, based on the level of effort to collect benthic samples. Typically, Datasonde® sites are limited to 30 per survey due to equipment availability.

IV. Data use

- a. Data can be used to obtain TIC scores for the assessment of nutrient enrichment as a cause of impairment or for the understanding of causes/sources (e.g., ag., WWTPs, unsewered areas, etc.) but not to be presented in the TSD until we are closer to completing the rules. When the project teams are established, the EAS, MAS and district WQ supervisors will determine who will be responsible for assessing nutrient data, calculating the TIC, and writing up the conclusions and that information will be posted on the DSW intranet project page.
- b. Data are also used by the MAS for the development of models such as QUAL2K and/or to understand nutrient dynamics in other models that do not explicitly include chl-*a*.
- c. Data are also used by EAS (Bob Miltner) to continue refinements to the TIC and via sestonic chl-*in larger rivers* for development of the larger river nutrient criteria.

Datasonde®, BOD5 and chl-*a* Sampling Recommendations

The table below summarizes when BOD5 and Chl-*a* may be planned for sampling.

Site Type	BOD5	Sestonic Chl-<i>a</i>	Benthic Chl-<i>a</i>^C	CBOD20^E
Chemistry Site (Non-nutrient)	Yes ^A if site > 500mi ²	Yes ^A if site > 500 mi ²	No ^D	Optional (MAS)
Datasonde® Site (Non-nutrient)	Yes ^A if site > 500 mi ²	Yes ^A if site > 500 mi ²	No ^D	Yes (MAS)
Nutrient Site (DA > 500 mi ²)	Yes ^A	Yes ^A	Yes ^E (MAS)	Yes (MAS)
Nutrient Site (DA < 500 mi ²)	Optional ^B	Yes ^E (MAS)	Yes ^E (MAS)	Yes (MAS)

- A - Sestonic chl-*a* should be sampled at all sites site with DA >500 mi² visited from June to October. If sestonic chl-*a* is sampled, then BOD5 should also be sampled. The Large River chemistry sampling template, which already includes BOD5, should always be used on sites site with DA >500 mi².
- B - For sites with DA <500 mi², the decision to sample BOD5 should be made during the study planning process, especially for sites expected to have high sestonic chl-*a* values. Sampling for BOD5 in smaller streams is expected to be rarely needed outside the large river criteria development sites.
- C - As long as physically possible to sample.
- D - Benthic chl-*a* sampling may be done at a non-nutrient site at the discretion of field staff when they encounter a highly enriched stream where the data would be beneficial.
- E - Benthic chl-*a* and CBOD20 data collection is the responsibility of MAS staff; for nutrient sites site with DA <500 mi², sestonic chl-*a* would also be handled by the MAS unless decided otherwise in study planning.

REFERENCES

- Hughes, R. M., D. P. Larsen, and J. M. Omernik. 1986. Regional reference sites: a method for assessing stream pollution. *Env. Mgmt.* 10(5): 629-635.
- Jin, S., Yang, L., Danielson, P., Homer, C., Fry, J., and Xian, G. 2013. A comprehensive change detection method for updating the National Land Cover Database to circa 2011. *Remote Sensing of Environment*, 132: 159 – 175.
- Karr, J.R. and D.R. Dudley. 1981. Ecological perspective on water quality goals. *Env. Mgmt.* 5(1): 55-68.
- Ohio Environmental Protection Agency. 2013a. Surface water field sampling manual for water column chemistry, bacteria and flows. Version 4.0, January 31, 2013. Div. of Surface Water, Columbus, Ohio.
- Ohio EPA. 2015a. Surface water field sampling manual for water column chemistry, bacteria and flows. Version 5.0, July 31, 2015. Division of Surface Water, Columbus, Ohio. 41pp.
http://epa.ohio.gov/dsw/document_index/docindx.aspx
- Ohio EPA. 2015b. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Surface Water, Ecological Assessment Section, Columbus, Ohio. June 26, 2015.
- Ohio EPA. 2015c. 2015 Updates to Biological criteria for the protection of aquatic life: Volume II and Volume II Addendum. Users manual for biological field assessment of Ohio surface waters. Division of Surface Water, Ecological Assessment Section, Columbus, Ohio. May 8, 2015.
- Ohio EPA. 2012. Fish tissue collection manual, cooperative fish issue monitoring program, Division of Surface Water. April 12, 2012. 21pp
www.epa.state.oh.us/portals/35/fishadvisory/FishCollectionGuidanceManual12.pdf
- Ohio EPA. 2010. Guidance on evaluating sediment contaminant results. Division of Surface Water, Standards and Technical Support Section, Columbus, Ohio.
http://epa.ohio.gov/portals/35/guidance/sediment_evaluation_jan10.pdf
- Ohio EPA. 2006. Methods for assessing habitat in flowing waters: Using the Qualitative Habitat Evaluation Index (QHEI). Ohio EPA Tech. Bull. EAS/2006-06-1. Revised by the Midwest Biodiversity Institute for Div. of Surface Water, Ecol. Assess. Sect., Groveport, Ohio.
<http://epa.ohio.gov/portals/35/documents/QHEIManualJune2006.pdf>
- Ohio EPA. 1992. Biological and Water Quality Study of the St. Marys River, Auglaize and Mercer counties (Ohio). Division of Water Quality Planning and Assessment. Columbus, Ohio, USA. OEPA Technical Report EAS/1992-11-10.
- Ohio EPA. 1989a. Addendum to biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Planning and Assessment, Surface Water Section, Columbus, Ohio.
<http://www.epa.state.oh.us/dsw/bioassess/BioCriteriaProtAqLife.html>

Ohio EPA. 1989b. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Water Quality Planning and Assessment, Columbus, Ohio.

<http://www.epa.state.oh.us/dsw/bioassess/BioCriteriaProtAqLife.html>

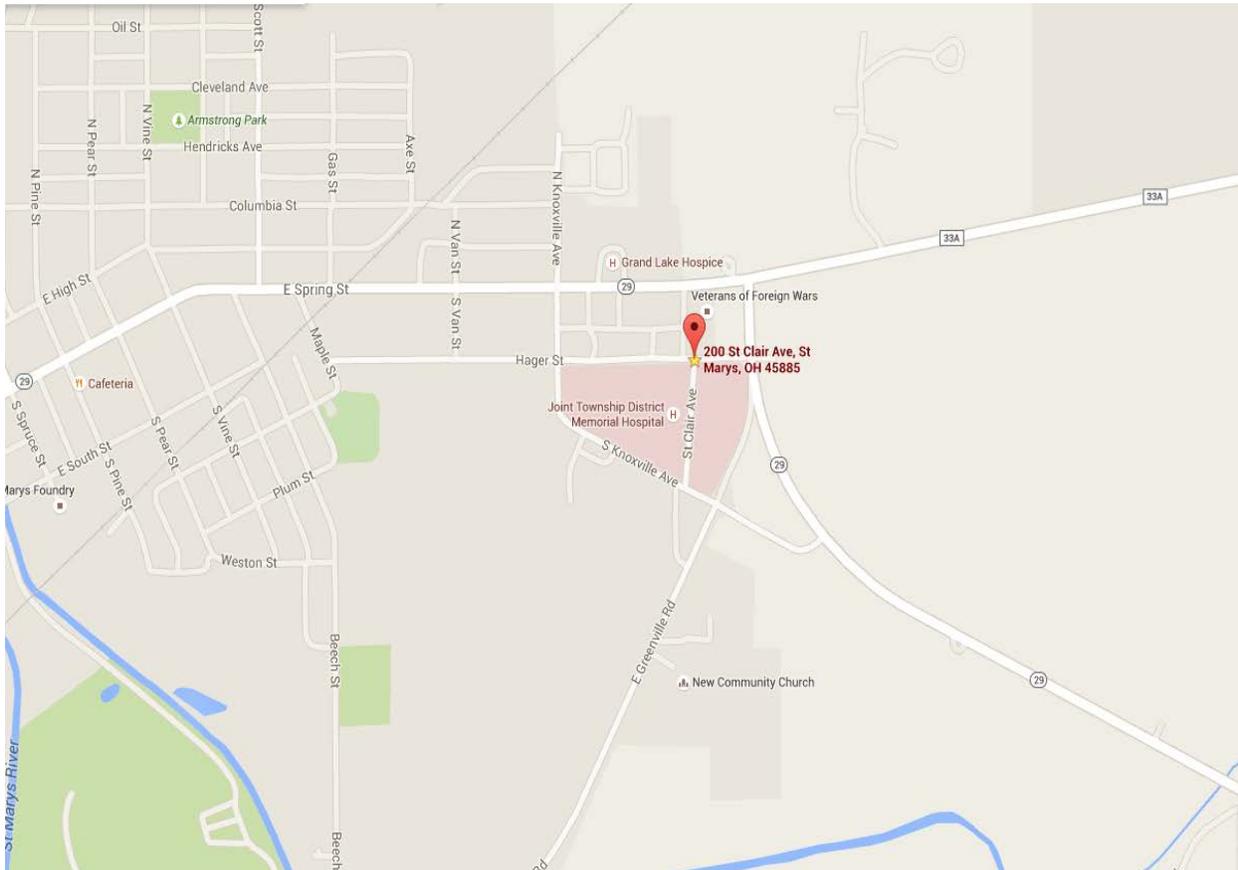
Ohio EPA. 1987. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio

<http://www.epa.state.oh.us/dsw/bioassess/BioCriteriaProtAqLife.html>

Omernik, J.M. 1987. Ecoregions of the conterminous United States. *Ann. Assoc. Amer. Geogr.* 77(1): 118-125.

Appendix A: Hospital Maps

Joint Township District Memorial Hospital



Mercer County Community Hospital

