A2. Table of Contents

SECTION A: PROGRAM DESCRIPTION AND QUALITY OBJECTIVES

A3. Distribution List

- Macatawa Area Coordinating Council: Tyler Kent, Executive Director; Kelly Goward, Environmental Program Manager
- ODC Network: David Nyitray, President and COO; Jamie Krupka, Chief Program Officer
- Paul Steen, Michigan Clean Water Corps

A4. Program Organization

Management Responsibilities

Program Manager
Macatawa Area Coordinating Council
Kelly Goward, Environmental Program Manager
301 Douglas Ave
Holland MI 49424
616-395-2688

Responsibilities include maintaining the QAPP, maintaining all data sheet, ensuring that data is entered into the MiCorps reporting system in a timely manner, and conducting program evaluations.

Program Expert, Quality Assurance Manager
ODC Network
Jamie Krupka, Chief Program Officer
4214 56th St
Holland MI 49423
616-393-9453

Responsibilities include overseeing staff and volunteer training, sample collection and insect identification. Additional responsibilities include securing, maintaining and storing all necessary equipment.

Marketing and Advertising, Volunteer Recruitment
Macatawa Area Coordinating Council
Mara Gericke, Assistant Planner
301 Douglas Ave
Holland MI 49424
616-395-2688

Responsibilities include developing program marketing materials, advertising the program and recruiting and coordinating volunteers.

Field Responsibilities

Field Leader
ODC Network
Jamie Krupka, Chief Program Officer and Dan Callam, Greenway Manager

Volunteers: Collectors, Transporters, Pickers, Note Takers

Laboratory Responsibilities

ODC Network
4214 56th St
Holland MI 49423
616-393-9453

Corrective Action

The **Program Manager** and **Program Expert** will be responsible for initiating, developing, approving, and implementing corrective actions.

A5. Problem Definition/Background

The purpose of the project is to establish a long-term volunteer stream monitoring program to assess water quality trends over time in the Macatawa Watershed. We need current and future data to track trends and make comparisons over time. The Macatawa Watershed Project, a program of the Macatawa Area Coordinating Council (MACC), in partnership with the ODC Network successfully concluded the Volunteer Stream Monitoring Startup Program in May 2012. A full grant was completed in May 2014. In order to more effectively manage our water resources, we will continue training and water quality data collection with volunteers at our seven established stream locations well into the future.

We are working to address stream quality issues related to the effects of sedimentation, flashiness, temperature extremes, and excessive nutrients. Currently, the Macatawa Watershed is not meeting several designated uses per Part 4 rules (promulgated pursuant to Part 31 of the Natural Resources Environmental Protection Act, 1994 PA451, as amended) including warm-water fishery and other aquatic life and wildlife. It is important to monitor these rivers and streams since Lake Macatawa and all of its major tributaries are included on the State of Michigan's 303(d) list for not attaining water quality standards. The Michigan Department of Environment. Great Lakes and Energy (EGLE) identified turbidity, color, settable solids, suspended solids, and deposits as factors that contribute to non-attainment of designated uses in Lake Macatawa.

Lake Macatawa is one of the most hypereutrophic lakes in the State of Michigan. EGLE completed a phosphorus Total Maximum Daily Load (TMDL) for Lake Macatawa in 1999. The EPA approved the TMDL in 2000. EGLE reported that non-point sources contributed to ninety-one percent of the total phosphorus load, primarily during storm events. Research has documented that the lake suffers from excessive levels of phosphorus and sediment, intense blue green algae blooms (with detectable levels of microcystin) and frequent beach closures due to elevated levels of *E.coli* bacteria.

EGLE conducts monthly grab sampling at five locations in the lake and six tributary locations every other year. The Grand Valley State University's Annis Water Resources Institute has also been conducting water quality monitoring

since 2013, both in-lake and in-stream to monitor effectiveness of wetland restorations. This includes monitoring the fish community in the lake. The Hope College Day 1 Watershed Research Community has also been conducting water quality monitoring at various locations in the watershed for the past few years. Their efforts have focused on bacterial communities in the watershed. EGLE visits the watershed every five years to conduct more in-depth biological and habitat monitoring; however, most of the sites are randomly selected and infrequently revisited. This is the primary water quality data available to assess trends since the development of the TMDL in 2000. In order to help fill this data gap, the MACC and ODC Network started a volunteer stream monitoring program following the MiCorps protocol in 2012. Volunteer monitoring has helped to greatly increase the amount of biological data available to project partners working in the watershed.

Volunteer monitoring is helping to achieve the goal of consistent stream quality data for the Macatawa Watershed. This monitoring is an important way to assess changes over time as we implement practices to reduce non-point source pollution and improve stream habitat. Collecting macroinvertebrate and stream habitat data will help us determine progress towards restoring the impaired designated uses. This program has also helped to establish a long-term local volunteer effort to protect and manage water resources in our watershed.

This work directly supports the goals of the Macatawa Watershed Management Plan. An important goal of the plan is to conduct long term monitoring especially in the critical areas of the watershed. All of the critical agricultural areas of the watershed (30,681 acres), and at least half of the critical urban areas of the watershed (14,568 acres) are included in the coverage of these monitoring sites. Monitoring will allow us to quantitatively gauge the effectiveness of our restoration, protection and enhancement efforts. It is also our goal to communicate current water quality trends to the general public. We believe that insect and habitat monitoring data is more compelling and understandable to the local community than traditional measures of water chemistry. By monitoring the health of streams in the Macatawa Watershed, we will be able to increase community engagement and focus our efforts on areas of the watershed that need the most improvement. Citizens, local government officials and the Macatawa Area Coordinating Council will use the data to better understand the condition of the Macatawa Watershed and as a tool to promote water quality. Having this baseline data is critical in our effort to apply for restoration grants. In areas of the watershed where our monitoring shows good or excellent water quality, we can use the data to advocate for greater protection activities. The data will provide local officials the opportunity to propose and adopt ordinances to improve and protect the watershed. Data can also be used as pre- and post-monitoring to measure the impact of restoration projects.

A6. Program Description

The primary objective of this program is to establish a long-term monitoring program to track changes in water quality over time in the Macatawa Watershed. Macroinvertebrates samples will be collected at seven sampling locations within the Macatawa Watershed twice a year, in the spring and the fall. Collections will be stored at the ODC Network for identification within two weeks of the sample collection. In addition, habitat assessments will be completed every other year in the early spring or late fall (leaf off). Data will be entered and maintained in hard copy and electronic format at the MACC office. Data and photographs from habitat assessments and sampling events will be shared with project partners via DropBox. Project reports will be completed and distributed to project partners. Sampling results will also be shared with the general public on the MACC's website.

A7. Data Quality Objectives

Precision

The following techniques will be reviewed during training and in retraining team leaders every three years: [1] collecting style (must be thorough and vigorous), [2] habitat diversity (include all habitats present and be thorough in each one) and [3] the transfer of collected macroinvertebrates from the net to the sample jars (thoroughness is critical).

Since there is inherent variability in accessing the less common taxa in any stream site and program resources do not allow program managers to perform independent (duplicate) collections of the sampling sites, our goal for quality assurance is conservative. A given site's Stream Quality Index (SQI) score or total diversity (D) measured across macroinvertebrate taxa will be noted as "preliminary" until three spring sampling events and three fall sampling events have been completed. At least two of these six measures will be collected by different volunteer teams. The resulting measures of D and SQI for each site will be compared to the composite (median) results and should be within two standard deviations of the median.

In addition, the Program Manager will seek opportunities to compare results with those from an external sampling group, such as EGLE. Every attempt will be made to collect duplicate samples for comparison when necessary. Sample results that exceed these standards should be then noted as "outliers" and examined to determine if the results are likely due to sampling error or a true environmental variation. If sampling error is determined, the data point should be removed from the data record. Volunteer teams that generate more than one outlier should be observed by the Program Expert at the next sampling event and be considered for retraining.

The Program Expert will make the final identifications for each sample. MiCorps staff will conduct a method validation review with the designated Program Expert to ensure his or her expertise, preferably prior to the first training session held by the Program Expert. This will be conducted with each new Program Expert added to a MiCorps monitoring program. This review will consist of a joint sampling event, with MiCorps staff jointly collecting, sorting and identifying the macroinvertebrates with the Program Expert. Any monitoring issues will be addressed on site. If no major concerns remain, the Program Expert will be considered "certified" by MiCorps.

Bias

Sites will be sampled by different team leaders at least once every three years in each season (two events among seven sampling events, if conducted twice per year) to examine the effects of bias in individual collection styles. The new measure should be within two standard deviations of the median of past measures. Sites not meeting this data quality objective will be evaluated as above by the Program Expert.

Completeness

Following a quality assurance review of all collected and analyzed data, data completeness will be assessed by dividing the number of measurements judged valid by the number of total measurements performed. The data quality objective for completeness for each parameter, for each sampling event is 90%. If the program does not meet this standard, the Program Manager will consult with MiCorps staff to determine the main causes of data invalidation and develop a course of action to improve the completeness of future sampling events.

Representativeness

Study sites were selected based on historical sampling data collected by the Michigan EGLE. The seven sites represent six of the eight subwatersheds in the basin, encompass the majority of the agricultural areas in the

watershed and include some urban influences. All available habitats within the study site will be sampled and documented to ensure a thorough sampling of all of the organisms inhabiting the site. Resulting data from the monitoring program will be used to represent the ecological conditions of the contributing subwatershed. Since not enough resources are available to allow the program to cover the entire watershed, some subwatersheds will not initially be represented. Additional subwatershed sites will be added as resources and volunteers allow.

Comparability

To ensure data comparability, all volunteers in the watershed will follow the same sampling and site selection methods and use the same units of reporting. Program directors and/or trainers will learn the standard MiCorps monitoring methods at annual trainings by MiCorps staff and will train their volunteers to follow those methods to ensure comparability of results among all MiCorps programs. To the extent possible, the monitoring of all study sites will be completed on a single day.

A8. Special Training/Certifications

MiCorps training was received by Jamie Krupka, ODC Network. Jamie will be in charge of coordinating training of all volunteers. Initial training was provided to volunteers prior to the first sampling event. Training has been and will be repeated as necessary for new volunteers at subsequent sampling events. All volunteers will be required to attend program training at least once every five years.

A side-by-side sampling event was completed with MiCorps staff prior to the first sampling event.

SECTION B: PROGRAM DESIGN AND PROCEDURES

B1. Study Design and Methods

Seven study sites were selected that represent six of the eight subwatersheds in the Macatawa Watershed. Five sites are located on main stems in each subwatershed before their confluence with either the Macatawa River or Lake Macatawa. Two sites are located on the Macatawa River. All sites are accessible at road-stream crossings or public parks. A watershed map showing all sampling locations is in Appendix A. The seven study locations are as follows:

1. Pine Creek at Stu Visser Trails (North) (42.804715, -86.142747) – MiCorps ID Mac1
2. Noordeloos Creek at Paw Paw Park (East) (42.798003, -86.049477) – MiCorps ID Mac2
3. Upper Macatawa River at the Upper Macatawa Natural Area (East) (42.804474, -85.978854) – MiCorps ID Mac3
4. Peters Creek at Poppen Woods (42.781722, -86.001344) – MiCorps ID Mac4
5. South Branch near Winding Creek Golf Course (42.760768, -85.997873) – MiCorps ID Mac5
6. Macatawa River at Adams Street Landing (42.784151, -86.037402) – MiCorps ID Mac6
7. North Branch at Van Raalte Farm Park (42.779868, -86.060470) – MiCorps ID Mac7

Study site #1 will be relocated upstream of the previous site starting in 2021 (MiCorps ID 1A). The original location (Pine Creek at Ottawa Beach Road), is just upstream of Lake Macatawa and heavily influenced by the water level in the lake. The site proved difficult to sample in 2019 and 2020 due to high water levels in Lake Macatawa backing up into Pine Creek. Starting in 2021, we will move upstream to the next road-stream crossing, which is still located at Stu Visser Trails, a property owned by Park Township.

Each site will be sampled once in the spring and once in the fall. For each sampling event that is not completed on a single day, monitoring by volunteers will be completed within the same two-week period. If a site is temporarily inaccessible, such as due to prolonged high water, the monitoring time may be extended for two additional weeks. If the issue concerning inaccessibility is continued beyond the extended dates, then no monitoring data will be collected during that time and there will be a gap in the data. If a team is unable to monitor their site during the specified time, the Team Leader will contact the Program Manager as soon as possible and no later than the end of the first week in the sampling window in order for the Manager to arrange for another team to complete the monitoring. If no team is available, the Program Manager will, if feasible, sample the site. Otherwise, the site will go unmonitored for that season.

<u>Sampling the benthic community</u>

Multiple collections will be taken from each habitat type present at the site, including riffle, rocks or other large objects, leaf packs, submerged vegetation or roots, and depositional areas, while wading and using a D-frame kick net. A trained Note Taker will record the number of locations sampled within the monitored reach in each habitat type and note the locations sampled on a site map. Collection will start at the downstream end of the site and work upstream. A total of 30 minutes of sampling time will be spent at each site. Transporters will transfer the samples from the Collectors in stream to the Pickers on the stream bank. The trained Pickers will transfer the material from the net into pans, then will pick out samples of all different types of macroinvertebrates from the pans and place them into jars of 70% isopropyl alcohol for later identification. Insects will be collected in one sampling jar for each site and stored at the ODC Network until identification, which will occur no more than two weeks after the collection event. During the collection, the Collectors will provide information to the team Note Taker in response to questions on the data sheet that review all habitats to be sampled, the state of the creek, and any changes in methodology or unusual

observations. The Field Leader will instruct and assist other team members in detecting and collecting macroinvertebrates in the sorting pans, including looking under bark and inside of constructions made of sticks or other substrates. Potential sources of variability such as weather/stream flow differences, season, and site characteristic differences will be noted for each event and discussed in study results. There are places on the data sheet to record unusual procedures or accidents, such as losing part of the collection by spilling. Any variations in procedure will be explained on the data sheet (Appendix B).

At the collection site, all invertebrate sample jars will receive a label written in pencil, stating date, location, name of Field Leader, and number of jars containing the collection from the site, which is placed inside the jar. The data sheet also states the number of jars containing the collection from the site. The Note Taker is responsible for labeling and securely closing the jars, and the Team Leader is responsible for returning all jars and all equipment to the ODC Network office. Upon return to the ODC Network, the collections will be checked for labels, the data sheets checked for completeness and for correct information on the number of jars containing the collection from the site. They will be stored in the ODC Network office until they are examined and counted on the day of identification (no more than two weeks later). The data sheets will be used on the identification day, after which they remain on file for a period of at least 5 years at the Macatawa Area Coordinating Council (MACC) office. At the time of identifying the sample, the sample identifier checks the data sheet and jars to ensure that all the jars, and only the jars, from that collection are present prior to emptying them into a white pan for sorting. If any specimens are separated from the pan during identification, a site label accompanies them. For identification, volunteers sort all individuals from a single jar into look-alike groups, and then are joined by an identification expert who confirms the sorting and provides identification of the taxa present. Specimens will be identified to the level of order. The identifications will be verified by the Program Expert. The abundance of each taxon will be estimated and recorded on the datasheet (rare or common). The total stream quality score will be calculated on the datasheet and used to rank the site as excellent, good, fair or poor. When identification of a sample is complete, the entire collection is placed in a single jar of fresh isopropyl alcohol with a poly-seal cap with a printed label and stored at the ODC Network office for a period of 10 years. Any rare or unique species encountered will be preserved in ethyl alcohol and stored at the ODC Network office indefinitely.

Habitat Assessment

A habitat assessment will be completed at each site during the early spring or late fall every other year. The habitat assessment will be completed in a 300-foot length of stream at each site following the MiCorps Volunteer Stream Monitoring Program Procedures and using the data sheet found in Appendix C. Stream width and depth will be measured to the nearest foot using tape measures and yard sticks or survey rods. Photographs will be taken at each site to document current conditions. Completed data sheets and photos will be returned to the MACC office for data entry and storage.

Parameters

- Macroinvertebrate community will be monitored and identified to order level at least twice annually in April/May or September/October. Literature references used for identification are included in Appendix D.
- Habitat will be monitored every other year of the project in early spring (March/April) or late fall (November).

Timing

- The benthic population is sampled within a 2-week period in April/May and September/October
- The physical characteristics of the sites will be measured once every other year, during the early spring or late fall

Equipment Quality Control

- Check to make sure equipment is in working order and not damaged
- Clean equipment before and after taking it into the field
- Check the expiration date of chemical reagents prior to each use

Field Procedures Quality Control

- Collect replicate samples
- Conduct repeat and/or side-by-side tests performed by separate field crews
- At least once every three years in each season: change the composition of the field crews to maintain objectivity and minimize individual bias
- Review field records before submitting for analysis to minimize errors

Data Analysis Quality Control

- Field datasheets and labels will be verified by volunteers in the laboratory
- Specimen identification will be completed by trained volunteers using referenced identification guides
- Taxa identification will be verified by the Program Expert
- Counts will be verified by at least two volunteers
- Calculations will be completed by at least two volunteers and verified by the Program Manager
- Hard copies of all computer entered data will be reviewed for errors by comparing to field data sheets

Since our evaluation is based on the diversity in the community, we will attempt to include a complete sample of the different groups present, rather than a random sub-sample. We do not assume that a single collection represents all the diversity in the community, but rather we consider our results reliable only after repeated collections spanning at least three years. Our results will be compared with other locations in the same river system that has been sampled in the same way. All collectors will attend an in-stream training session, and most sites are sampled by different collectors at different times to diminish the effects of bias in individual collecting styles. Samples where the diversity measures diverge substantially from past samples at the same site are resampled by a new team within two weeks. If a change is confirmed, the site becomes a high priority for the next scheduled collection. Field checks include checking all data sheets to make sure each habitat type available was sampled, and the team leader examines several picking trays to ensure that all present families have been collected. All lab sorting will be rechecked by an expert before completing identification.

B2. Instrument/Equipment Testing, Inspection and Maintenance

Macroinvertebrates will be collected using D-frame kick nets that are firmly attached to poles and free of holes. Collectors may use waders that are clean, dry and do not leak. The collected materials will be transferred into light colored pans. Macroinvertebrates will be extracted from the pans using forceps (with tips that meet) or plastic spoons and placed in collection jars (with poly seal tops) containing isopropyl alcohol. For identification purposes, preserved specimens will be placed into pans and then sorted into ice cube trays using forceps. Habitat assessments will be completed with the use of a tape measure and yard stick or survey rod. Prior to sampling, sample identification or habitat assessment, the Program Expert will inspect all equipment for damage or other problems. Any issues will be resolved by either repairing or replacing equipment. Problems encountered during field collection or laboratory analysis will be documented on the

data sheets and resolved accordingly. Spare equipment will be kept on hand in case of damage or improper operation during field or laboratory work. When not in use, all equipment will be stored at the ODC Network office.

B3. Inspection/Acceptance for Supplies and Consumables

The primary consumable that will be used during sample collection and identification is isopropyl alcohol. At least 2, one-quart containers will be on hand during sampling to ensure enough for each sample collection jar. Purchase dates will be written on each bottle in marker. No isopropyl alcohol will be used after the manufacturer's suggested expiration date. This is an accepted method for short-term preservation of macroinvertebrate specimens and is allowed by the Michigan Clean Water Corp for Stream Monitoring. The supply of isopropyl alcohol will be stored at the ODC Network office in a cool, dry location in a tightly closed container. The Program Expert will be responsible for the storage and use of isopropyl alcohol.

B4. Non-direct Measurements

This section is not applicable to this project.

B5. Data Management

Macroinvertebrate and habitat assessment data will be entered into the MiCorps data exchange system within 2 weeks of collection. Data sheets will be filed at the MACC office for a period of at least five years. Data sheets will also be scanned and saved in digital files. Digital files, including any photographs, will be stored on the MACC server (password protected) and backed up in a cloud-based storage service (Dropbox). Results will be shared publicly on the MACC website. The Program Manager will be responsible for maintaining all data and datasheets.

<u>Macroinvertebrates</u>
Data will be summarized for reporting into four metrics: all taxa, sensitive, somewhat-sensitive, and tolerant taxa. Units of measure are families counted in each metric. A Stream Quality Index (SQI) will be computed. The method for calculating that metric is included in Appendix B.

<u>Habitat</u>
Specific measures will be used from habitat surveys to investigate problem areas at each site. The percentage of stream bed composed of fines (sand and smaller particles) will be calculated and changes will be tracked over time as an indicator of sediment deposition.

SECTION C: SYSTEM ASSESSMENT, CORRECTION AND REPORTING

C1. System Audits and Response Actions

- Side by side sampling took place in which an outside expert from MiCorps observed and approved the methodology used by the Program Manager and Program Expert (2012).
- Data sheets will incorporate essential QAPP procedures, such as the number of net samples taken from each type of habitat.
- Volunteer team leaders trained by MiCorps will ensure that quality assurance protocols are followed and report any issues possibly affecting data quality.

For the first three years of sampling, protocols will be followed per the QAPP guidelines. Each year after that, the total diversity reported by each team at a sample site must be within two standard deviations of the diversity previously found at the site. Sites with results greater than two standard deviations will be re-sampled by experts to verify or discard such unusual results, which could be the result of less-than- thorough sampling.

If deviation from the QAPP is noted at any point in the sampling or data management process, the affected samples may be deleted from the data set. Re-sampling will be conducted if warranted and feasible, given that the deviation is noted soon after occurrence and volunteers are available. Otherwise, a gap may be left in the monitoring record. All corrective actions, such as above, will be documented and communicated to MiCorps.

C2. Data Review, Verification and Validation

Standardized data forms will be used by all volunteers at every sampling event. Data sheets will be reviewed in field for completeness and accuracy of data. During identification and metric calculation, metrics will be reviewed by at least two volunteers and verified by the Program Expert prior to data entry. Macroinvertebrate identification will be verified by the Program Expert. Microscopes and dichotomous keys will be used when necessary to aid in positive identification. Such methods of identification will be noted on the data sheets. The total diversity reported by each team must be within two standard deviations of the diversity previously found at the site (after a three year preliminary assessment), as verified by the Program Manager. Sites with results greater than two standard deviations will be re-sampled by experts to verify or discard such unusual results, which could be the result of less-than-thorough sampling.

Data will be entered into a spreadsheet for long-term storage by the Program Manager within two weeks of data collection and verified for accuracy by a volunteer within two weeks of data entry. Results will be summarized on the MACC website and reported to project partners annually within 30 days of the fall sampling event. All data will be entered into the MiCorps online database within two weeks of project data entry, noting any data quality issues.

C3. Reconciliation with Data Quality Objectives

Precision of the data collected will be determined based on comparing data from multiple collections at the same location and also comparing new data to previous data collected at the same location by other entities. This evaluation will occur soon after data is collected when previous data is available. If previous data is not available, then an assessment will be made after at least three spring and fall sampling events have been

completed. Measures of diversity and stream quality index for each site should be within two standard deviations of the median results. In cases where the results are greater than two standard deviations of the previous results, the site will be resampled or the data will be discarded.

At least once every three years, sites will be sampled by different Team Leaders to avoid introducing bias into the data. New data must be within two standard deviations of the median of previous data collected at the same site. If a site does not meet this objective, then it will be evaluated by the Program Expert. Completeness will be evaluated as described in section A7 within 2 weeks of data processing. If the data does not meet the minimum 90% completeness measure, then the Program Manager will consult with MiCorps staff to determine a plan to improve the completeness of sampling.

Representativeness of sampling will be ensured during stream sampling by the Team Leader.

Data comparability will be ensured by requiring all volunteers to be trained to use the same methods and procedures for sample collection, identification and calculations. Training will be provided as necessary to new volunteers and procedures will be reviewed by all volunteers prior to each sampling event. To the extent possible, all sites will be sampled on a single day. If a site is not sampled, then it must be sampled within two weeks of the original sampling or that site will go unmonitored for that season.

All data quality comparisons will be completed as soon as possible following data collection and analysis and any limitations in the data will be reported to the Project Manager and all data users.

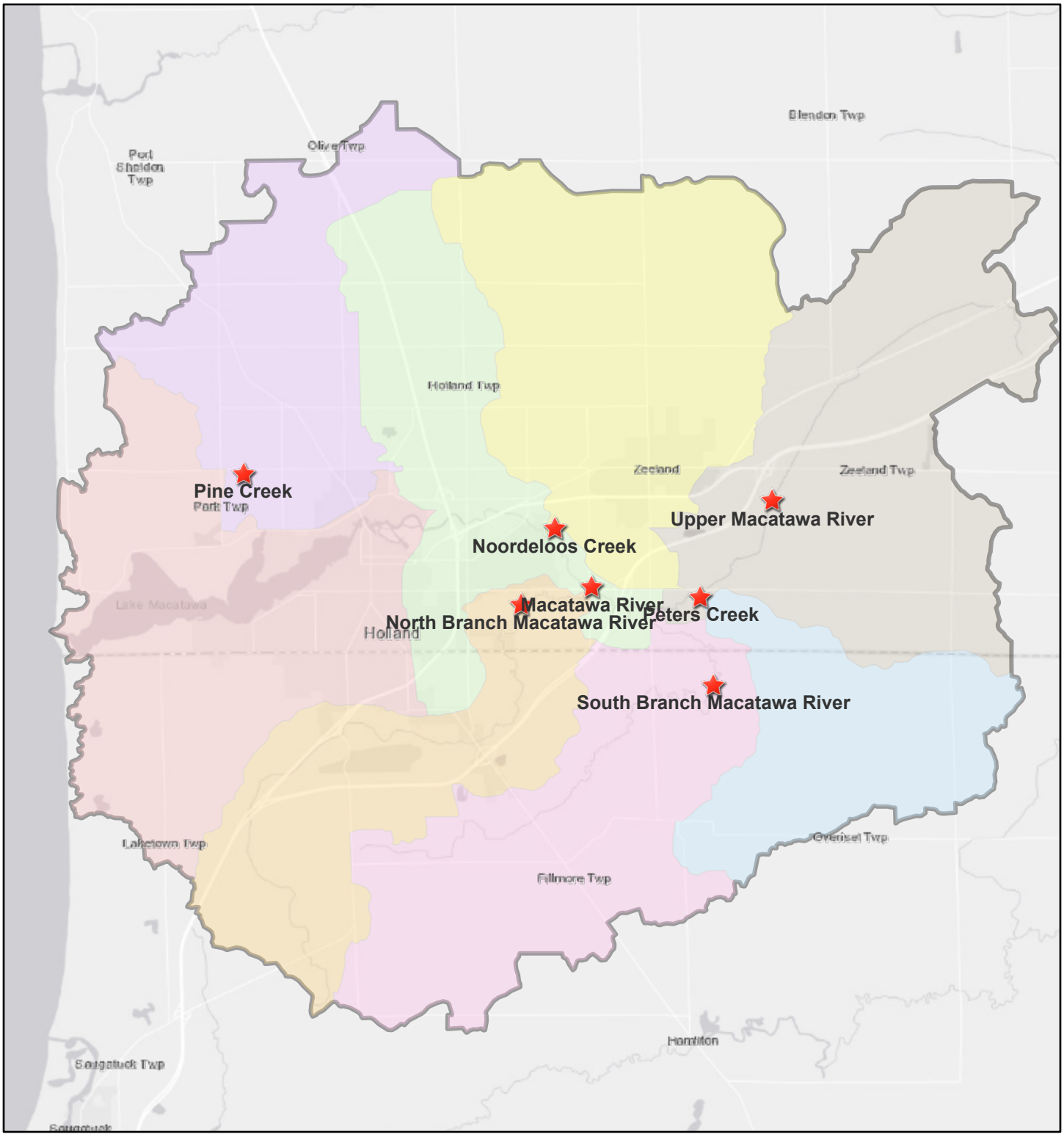
C4. Reporting

A summary report will be completed by the Project Manager after each sampling event to provide a summary of the event, document volunteer participation, verify that data quality objectives were met, document any problems encountered, and provide a summary of the data, including charts and pictures as appropriate. The report will be distributed to project partners and posted on the MACC's website. In addition, Team Leaders and volunteers will be asked to complete periodic surveys regarding the project's progress and success. The results will be summarized in a report that will be distributed to the project partners.

APPENDIX A

MAP OF SAMPLING LOCATIONS

Macroinvertebrate Sampling Locations



11/30/2020, 3:15:34 PM

1:200,000

0 1.25 2.5 5 mi

0 2 4 8 km

Sampling Locations

Subwatersheds

- Lake Macatawa tributaries
- Lower Macatawa River
- Noordeloos Creek
- North Branch Macatawa River
- Peters Creek
- Pine Creek
- South Branch Macatawa River
- Upper Macatawa River
- Macatawa Watershed

Esri, HERE, NPS

APPENDIX B

STREAM MACROINVERTEBRATE DATASHEET

MiCorps Site ID#:_____

Michigan Clean Water Corps

Stream Macroinvertebrate Datasheet

Stream Name: _____

Location:_____ (Circle one: *Upstream* or *Downstream* of road?)

Date:_____ Collection Start Time:_____ (AM/PM)

Major Watershed:_____ HUC Code (if known):_____

Latitude:_____ Longitude:_____

Monitoring Team:

Name of Person Completing Datasheet:_____

Collector:_____

Other Team Members:_____

Stream Conditions: Average Water Depth:_____ feet

Is the substrate covered with excessive silt? ____ No ____ Yes (describe:_____)

Substrate Embeddedness in Riffles: ____ 0-25% ____ 25-50% _____ > 50% ____ Unsure

Did you observe any fish or wildlife? ( ) Yes ( ) No If so, please describe:_____

Macroinvertebrate Collection: Check the habitats that were sampled. Include as many as possible.

____ Riffles
____ Cobbles
____ Aquatic Plants
____ Runs
____ Stream Margins
____ Leaf Packs
____ Pools
____ Undercut banks/Overhanging Vegetation
____ Submerged Wood
____ Other (describe:_____ _____)

Did you see, but not collect, any **live crayfish**? (___ Yes ___ No), or **large clams**? (___ Yes ___ No)
remember to include them in the assessment on the other side!

Collection Finish Time: _____(AM/PM)

Datasheet checked for completeness by:_____ Datasheet version 10/08/05
Data entered into MiCorps database by:_____ Date:_____

MiCorps Site ID#:_____

Michigan Clean Water Corps

IDENTIFICATION AND ASSESSMENT

Use letter codes [**R** (rare) = 1-10, **C** (common) = 11 or more] to record the approximate numbers of organisms in each taxa found in the stream reach.

*** Do NOT count empty shells, pupae, or terrestrial macroinvertebrates***

Group 1: Sensitive

_____ Caddisfly larvae (Trichoptera)
EXCEPT Net-spinning caddis
_____ Hellgrammites (Megaloptera)
_____ Mayfly nymphs (Ephemeroptera)
_____ Gilled (right-handed) snails (Gastropoda)
_____ Stonefly nymphs (Plecoptera)
_____ Water penny (Coleoptera)
_____ Water snipe fly (Diptera)

Group 2: Somewhat-Sensitive

_____ Alderfly larvae (Megaloptera)
_____ Beetle adults (Coleoptera)
_____ Beetle larvae (Coleoptera)
_____ Black fly larvae (Diptera)
_____ Clams (Pelecypoda)
_____ Crane fly larvae (Diptera)
_____ Crayfish (Decapoda)
_____ Damselfly nymphs (Odonata)
_____ Dragonfly nymphs (Odonata)
_____ Net-spinning caddisfly larvae
(Hydropsychidae; Trichoptera)
_____ Scuds (Amphipoda)
_____ Sowbugs (Isopoda)

Group 3: Tolerant

_____ Aquatic worms (Oligochaeta)
_____ Leeches (Hirudinea)
_____ Midge larvae (Diptera)
_____ Pouch snails (Gastropoda)
_____ True bugs (Hemiptera)
_____ Other true flies (Diptera)

STREAM QUALITY SCORE

Group 1:
_____ # of R's * 5.0 = _____
_____ # of C's * 5.3 = _____
Group 1 Total = _____

Group 2:
_____ # of R's * 3.0 = _____
_____ # of C's * 3.2 = _____
Group 2 Total = _____

Group 3:
_____ # of R's * 1.1 = _____
_____ # of C's * 1.0 = _____
Group 3 Total = _____

Total Stream Quality Score = _____
(Sum of totals for groups 1-3; round to nearest whole number)

Check one:
_____ Excellent (>48)
_____ Good (34-48)
_____ Fair (19-33)
_____ Poor (<19)

Identifications made by:_____

Rate your confidence in these identifications: Quite confident Not very confident
5 4 3 2 1

Datasheet checked for completeness by:_____ Datasheet version 10/08/05
Data entered into MiCorps database by:_____ Date:_____

MiCorps Site ID#:_____

Michigan Clean Water Corps

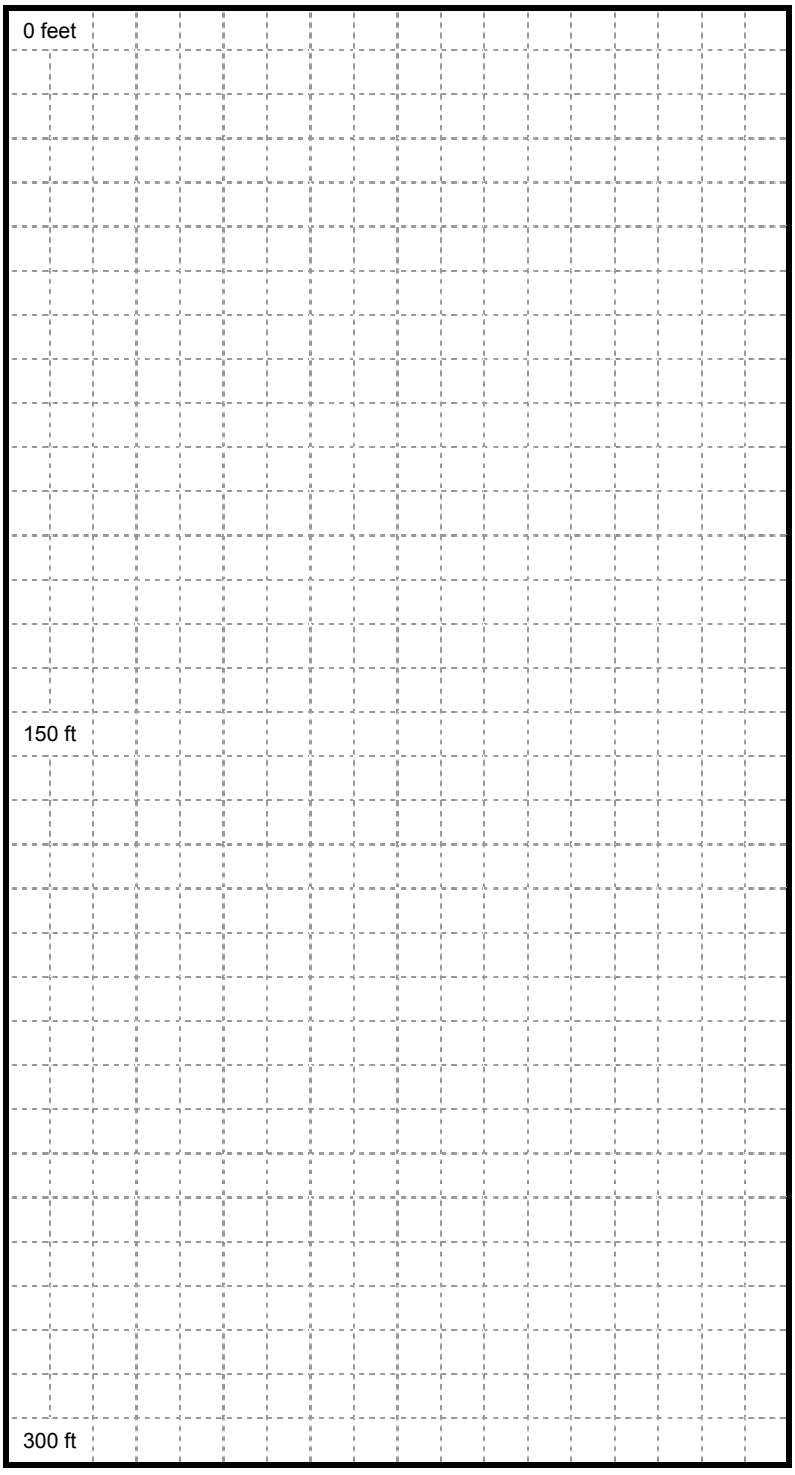
Site Sketch

Stream Name:_____ Location:_____

Date:_____ Drawn by:_____

Draw a bird's-eye view of the study site. Include enough detail that you can easily find the site again! Include the following items in the sketch:

- Direction of water flow
- Which way is north
- Large wood in the water
- Vegetation
- Bank features
- Areas of erosion
- Riffles
- Pools
- Location of road
- Trees
- Fences
- Parking lots
- Buildings
- Any other notable features



APPENDIX C

STREAM HABITAT ASSESSMENT

STREAM HABITAT ASSESSMENT

I. Stream, Team, Location Information

Site ID:_____ Date:_____ Time:_____

Location:_____

Name(s):_____

II. Stream and Riparian Habitat

A. General Information *Circle one or more answers as appropriate*						Notes and Observations: Give further explanation when needed.
1	Average Stream Width (ft)	< 10	10-25	25-50	>50	
2	Average Stream Depth (ft)	<1	1-3	>3	>5	
3	Has this stream been channelized? (Stream shape constrained through human activity- look for signs of dredging, armored banks, straightened channels)	Yes, currently	Yes, sometime in the past	No	Don't know	
4	Estimate of current stream flow	Dry or Intermittent	Stagnant	Low	Medium	High
5	Highest water mark (in feet above the current level)	<1	1-3	3-5	5-10	>10
6	Which of these habitat types are present?	Riffles	Deep Pools	Large woody debris	Large rocks	Undercut bank
		Overhanging vegetation	Rooted Aquatic Plants	Other:	Other:	Other:
7	Estimate of turbidity	Clear	Slightly Turbid (can partially see to bottom)		Turbid (cannot see to bottom)	
8	Is there a sheen or oil slick visible on the surface of the water?	No	Yes			
9	If yes to #8, does the sheen break up when poked with a stick?	Yes (sheen is most likely natural)		No (sheen could be artifical)		
10	Is there foam present on the surface of the water?	No	Yes			
11	Is yes to #10, does the foam feel gritty or soapy?	Gritty (foam is most likely natural)		Soapy (foam could be artifical)		
The following are optional measurements not currently funded by MiCorps						
8	Water Temperature					
9	Dissolved Oxygen					
10	pH					
11	Water Velocity					

MiCorps Site ID#:_____ Date:_____

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II. Stream and Riparian Habitat (continued)

B. Streambed Substrate

Estimate percent of stream bed composed of the following substrate.

If group will take transects and pebble counts (in Section IV), check this box and record the measured percentages. ☐

Substrate type	*Size*	*Percentage*
Boulder	>10" diameter	
Cobble	2.5 - 10" diameter	
Gravel	0.1 - 2.5" diameter	
Sand	coarse grain	
Fines: Silt/Detritus/Muck	fine grain/organic matter	
Hardpan/Bedrock	solid clay/rock surface	
Artificial	man-made	
Other (specify)		

C. Bank stability and erosion.

Summarize the extent of erosion along <u>each bank separately</u> on a scale of 1 through 10, by circling a value below. Left/right banks are identified by looking downstream.

Excellent	Good	Marginal	Poor
Banks Stable. No evidence of erosion or bank failure. Little potential for problems during floods. < 5% of bank affected.	Moderately stable. Small areas of erosion. Slight potential for problems in extreme floods. 5-30% of bank in reach has areas of erosion.	Moderately unstable. Erosional areas occur frequently and are somewhat large. High erosion potential during floods. 30-60% of banks in reach are eroded.	Unstable. Many eroded areas. > 60% banks eroded. Raw areas frequent along straight sections and bends. Bank sloughing obvious.
LEFT BANK 10 - 9	LEFT BANK 8 - 7 - 6	LEFT BANK 5 - 4 - 3	LEFT BANK 2 - 1 - 0
RIGHT BANK 10 - 9	RIGHT BANK 8 - 7 - 6	RIGHT BANK 5 - 4 - 3	RIGHT BANK 2 - 1 - 0

You may wish to take photos of unstable or eroded banks for your records. Record date and location.

Comments:

MiCorps Site ID#:_____ Date:_____

Michigan Clean Water Corps

II. Stream and Riparian Habitat (continued)

D. Plant Community

Estimate the percentage of the stream covered by overhanging vegetation _____%

Using the given scale, estimate the relative abundance of the following:

Plants in the stream:		*Plants on the bank/riparian zone:*	
Algae on Surfaces of Rocks or Plants	Filamentous Algae (Streamers)	Shrubs	Trees
Macrophytes (Standing, Floating Plants)	**0= Absent 1= Rare 2= Common 3= Abundant 4= Dominant**	Grasses	**0= Absent 1= Rare 2= Common 3= Abundant 4= Dominant**
Identified species (optional)		Identified species (optional)	

E. Riparian Zone

The riparian zone is the vegetated area that surrounds the stream. Right/Left banks are identified by looking downstream.

1. Left Bank

Circle those land-use types that you can see from this stream reach.

Wetlands Forest Residential Lawn Park Shrub, Old Field Agriculture

Construction Commercial Industrial Highways Golf Course Other_____

2. Right Bank

Circle those land-use types that you can see from this stream reach.

Wetlands Forest Residential Lawn Park Shrub, Old Field Agriculture

Construction Commercial Industrial Highways Golf Course Other_____

3. Summarize the size and quality of the riparian zone along each bank separately on a scale of 1 through 10, by circling a value below.

Excellent	Good	Marginal	Poor
Width of riparian zone >150 feet, dominated by vegetation, including trees, understory shrubs, or non-woody macrophytes or wetlands; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	Width of riparian zone 75-150 feet; human activities have impacted zone only minimally.	Width of riparian zone 10-75 feet; human activities have impacted zone a great deal.	Width of riparian zone ,10 feet; little or no riparian vegetation due to human activities.
LEFT BANK 10 - 9	LEFT BANK 8 - 7 - 6	LEFT BANK 5 - 4 - 3	LEFT BANK 2 - 1 - 0
RIGHT BANK 10 - 9	RIGHT BANK 8 - 7 - 6	RIGHT BANK 5 - 4 - 3	RIGHT BANK 2 - 1 - 0

MiCorps Site ID#:_____ Date:_____

III. Sources of Degradation

1. In what ways is this stream degraded, if any?

2. Does a team need to come out and collect trash?

3. Based on what you can see from this location, what are the potential causes and level of severity of this degradation? Only judge what you can see from the site.

(Severity: S – slight; M – moderate; H – high) (Indicate all that apply)							
Crop Related Sources	**S**	**M**	**H**	Land Disposal	**S**	**M**	**H**
Grazing Related Sources	**S**	**M**	**H**	On-site Wastewater Systems	**S**	**M**	**H**
Intensive Animal Feeding Operations	**S**	**M**	**H**	Silviculture (Forestry)	**S**	**M**	**H**
Highway/Road/Bridge Maintenance and Runoff	**S**	**M**	**H**	Resource Extraction (Mining)	**S**	**M**	**H**
Channelization	**S**	**M**	**H**	Recreational/Tourism Activities (general)	**S**	**M**	**H**
Dredging	**S**	**M**	**H**	• Golf Courses	**S**	**M**	**H**
Removal of Riparian Vegetation	**S**	**M**	**H**	• Marinas/Recreational Boating (water releases)	**S**	**M**	**H**
Bank and Shoreline Erosion/ Modification/Destruction	**S**	**M**	**H**	• Marinas/Recreational Boating (bank or shoreline erosion)	**S**	**M**	**H**
Flow Regulation/ Modification (Hydrology)	**S**	**M**	**H**	Debris in Water	**S**	**M**	**H**
Invasive Species	**S**	**M**	**H**	Industrial Point Source	**S**	**M**	**H**
Construction: Highway, Road, Bridge, Culvert	**S**	**M**	**H**	Municipal Point Source	**S**	**M**	**H**
Construction: Land Development	**S**	**M**	**H**	Natural Sources	**S**	**M**	**H**
Urban Runoff	**S**	**M**	**H**	Source(s) Unknown	**S**	**M**	**H**

Additional comments:

MiCorps Site ID#:_____ Date:_____

IV. Optional quantitative measurements

A. Transects and Pebble Counts

To take quantitative stream habitat measurements, conduct 5-10 transects of your stream reach. Required equipment: tape measure long enough to stretch across the stream, and graduated rod or stick to measure water depth. Data sheet is on the next page.

Directions:
1) Determine stream width.
2) Use the rod to measure depth (D) and substrate (S) at more than 10 but less than 20 regular intervals along the entire transect. (For streams less than 10 feet wide, measure every ½ foot, for streams about 10 feet wide, measure every foot, etc.)
3) At every depth measurement, identify the single piece of substrate that the rod lands on (can be arbitrary).
4). For every measurement, enter the reading on the tape measure, the depth, and the substrate on the data sheet on the next page.

Data use: The depth and tape measure reading can be used to produce stream cross-section profiles. The pebble count can be used to give a more accurate percentage breakdown of the stream substrate than simply making an eyeball estimate (see Section II-B).

B. Bank Height

Vertical banks higher than 3 feet are usually unstable, while banks less than 1 foot, especially with overhang, provide good habitat for fish. While doing the transects, measure the bank heights and record the angle of the bank (right, acute, or obtuse) as indicated on the data sheet. Left/right banks are identified by looking downstream.

Data use: Calculate the percentage of banks with right, obtuse, and acute angles. Right angles indicate higher erosive potential, while acute angles improve the habitat structure of a stream.

V. Final Check

This data sheet was checked for completeness by: _____

Name of person who entered data into data exchange: _____

Date of data entry:_____

VI. Credits

This habitat assessment was created for the MiCorps Volunteer Stream Monitoring Program from a combination of habitat assessments from the Huron River Watershed Council, the Friends of the Rouge River, and the Michigan Department of Environmental Quality. Version 1.0, June 2009.

MiCorps Site ID#:_____ Date:_____

Michigan Clean Water Corps

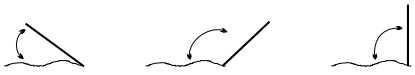
STREAM TRANSECT DATASHEET

B: Boulder -- more than 10”
C: Cobble -- 2.5 - 10”
G: Gravel – 0.1 – 2.5”
S: Sand -- fine particles, gritty
F: Fines: Silt/Detritus/Muck
H: Hardpan/Bedrock
A: Artificial
O: Other (specify)

T= Reading on tape
D = Depth
S = Substrate

	EXAMPLE			Transect #			Transect #			Transect#		
Stream Width	13.3 feet											
	T	**D**	**S**	**T**	**D**	**S**	**T**	**D**	**S**	**T**	**D**	**S**
Beginning Water's Edge:	1.5											
1	2.5	0.4	G									
2	3.5	0.4	G									
3	4.5	0.4	G									
4	5.5	0.2	C									
5	6.5	0	S									
6	7.5	0.6	S									
7	8.5	0.7	G									
8	9.5	0.7	G									
9	10.5	0.6	C									
10	11.5	0.7	B									
11	12.5	0.4	G									
12	13.5	0.3	F									
13	14.5	0.2	F									
14												
15												
16												
17												
18												
19												
Ending Water's Edge	14.8											
Bank Side	**L**	**R**		**L**	**R**		**L**	**R**		**L**	**R**	
Bank Height	1.7 feet	0.5 feet										
Does the bank have an undercut?	N	Y										
If so, how wide is it?		1 ft										
Bank Angles: Sketch												

Sketch examples:



Undercut (Acute) Obtuse Right

APPENDIX D

MACROINVERTEBRATE IDENTIFICATION GUIDES

Key to Macroinvertebrate Life in the River

(Sizes of illustrations are not proportional.)

Shells

Single Shell

spiral, opening on left

Pouch Snail

spiral, opening on right

Gilled Snail

coiled

Orb Snail

conical

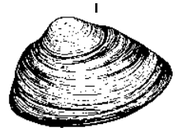
Limpet

Double Shell

small, whitish, tan or brown

Pill or Fingernail Clam

large, 2 to 8 inches, dark-colored

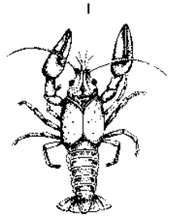


Freshwater Mussel

Legs

10+ Legs

lobster-like



Crayfish

shrimp-like, swims on side

Scud or Amphipod

walks on bottom

Aquatic Sowbug or Isopod

Four Pairs of Legs

tiny, often brightly colored

Water Mite

runs on top of water

Fishing Spider

Three Pairs of Legs

Wings

Beetle-Like, Wings Hard

small, crawls on bottom

Riffle Beetle

swims moving hind legs alternating

Water Scavenger Beetle

back legs move at same time

Predaceous Diving Beetle

swims on surface

Whirligig Beetle

"Crawls" through water, spotted

Crawling Water Beetle

Leathery Wings

tan, lives on surface

Marsh Treader

dark, lives on surface

Water Strider

grasping front legs, up to three inches

Giant Water Bug

swims on back, back white

Backswimmer

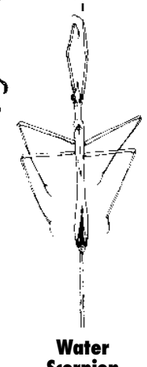
swims right-side-up, back black

Water Boatman

long breathing tube, grasping front legs

Water Scorpion 'Nepa'

long, stick-like



Water Scorpion 'Ranatra'

No Wings

No Obvious "Tails"

brown, leatherlike, six legs, usually "C"-shaped

Riffle Beetle Larva

six legs and prolegs on abdomen

Pyralid Caterpillar

suction cup-like

Water Penny

large body, hinged mouth

Dragonfly Larva

green, tan, orange or white body

Caddisfly Larva

lives in stone case

Caddisfly Larva

lives in stick house

Caddisfly Larva

One or Two "Tails"

dark head, green or tan body, two brush-like tails

Caddisfly Larva

small, "spines" on side

Alderfly Larva

large mouth parts, "spines" on side

Dobsonfly Larva

"tails" long and stiff, long antennas

Stonefly Larva

flat gills on abdomen

Mayfly Larva

hangs from surface, large mouth parts

Predaceous Diving Beetle Larva

Three "Tails"

long "tails," gills on abdomen

Mayfly Larva

long "tails," gills on abdomen

Mayfly Larva

large legs, feathery gills

Mayfly Larva

plate-like "tails," no gills on abdomen

Damselfly Larva

side view of "tails"

Worm-Like

Suckers, expands and contracts, body segmented

Leech

reddish brown, segmented body

Tubifex Worm

glides along bottom, body not segmented

Flatworm or Planaria

tan to brown, long

Horsehair Worm

body with bristles, no suckers

Bristle Worm

distinct head, red, green or tan, twists

Midge Larva

small, hair-like, swims in "S" shape

Nematode or Threadworm

Microscopic

apostrophe-shaped

Cyclops or Copepod

round

Seed and Clam Shrimp

swims with a jerk, using antennas

Water Flea or Daphnia

No Legs

With Tentacles, Brushes or "Tails"

long breathing tube

Rat tailed Maggot Larva

two fringed "tails"

Water Snipe Fly Larva

smooth, "stiff," small head

Horse Fly Larva

large, grey with tentacles

Crane Fly Larva

white or grey with tentacles

Crane Fly Larva

big "head," active

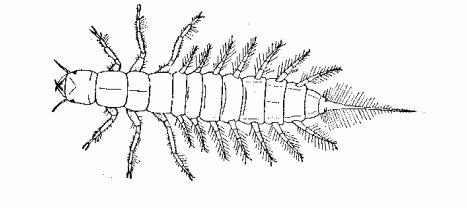
Midge Pupa

black, attaches to hard surfaces

Black Fly Larva

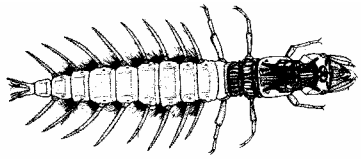
AQUATIC MACROINVERTEBRATE
Identification Guide

LOW POLLUTION TOLERANCE (PTI = 3)

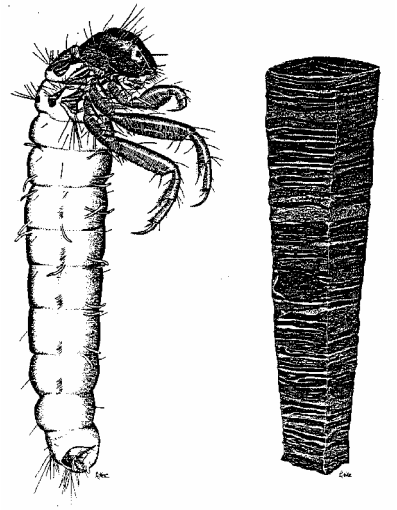


Fishfly Larva (O. Megaloptera)

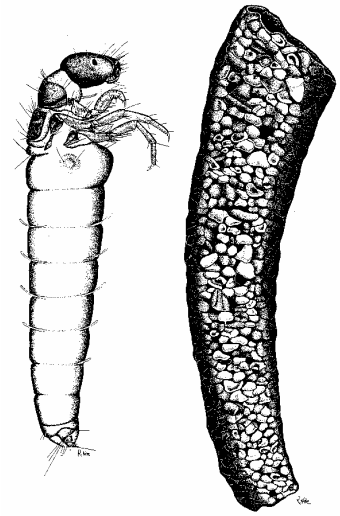
Snipefly Larva (O. Diptera)



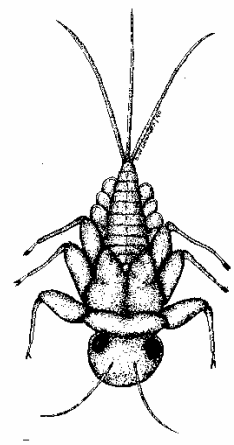
Dobsonfly Larva (O. Megaloptera)



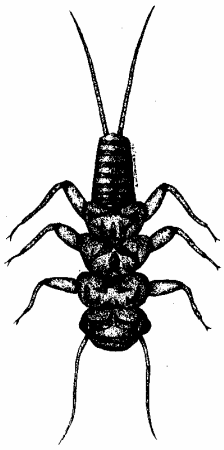
Caddisfly Larva (O. Trichoptera)
plant-matter case



Caddisfly Larva
gravel case

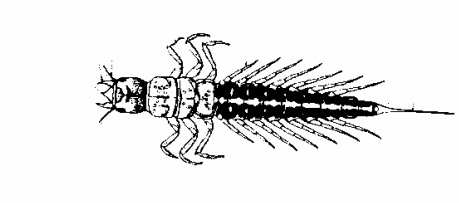


Mayfly Nymph
(O. Emphemeroptera)

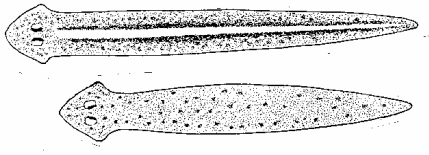


Stonefly Nymph
(O. Plecoptera)

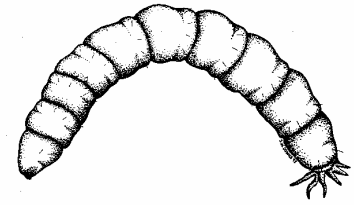
MEDIUM POLLUTION TOLERANCE (PTI = 2)



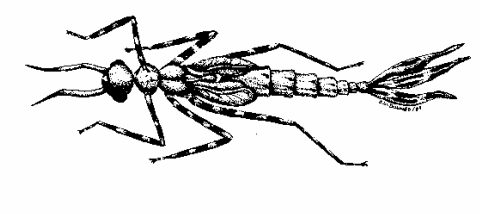
Alderfly Larva (F. Sialidae)



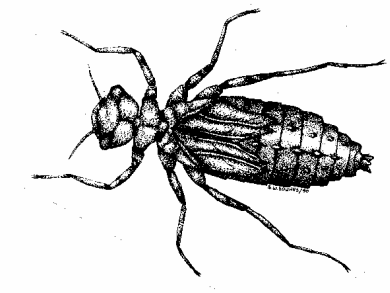
Flatworms (C. Turbellaria)



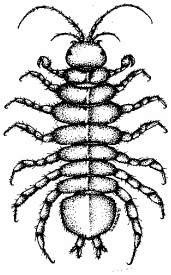
Cranefly Larva (F. Tipulidae)



Damselfly Nymph (O. Odonatia)



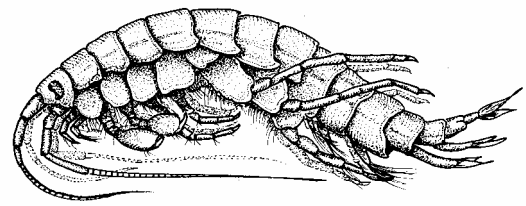
Dragonfly Nymph (O. Odonatia)



Aquatic Sowbug (O. Isopoda)

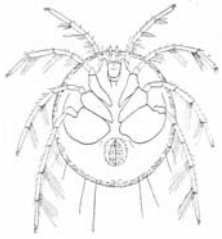
AQUATIC MACROINVERTEBRATE
Identification Guide

MEDIUM POLLUTION TOLERANCE (PTI = 2)



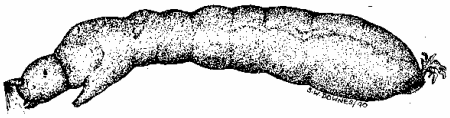
Freshwater Scud (O. Amphipoda)

Aquatic Snails (C. Gastropoda)

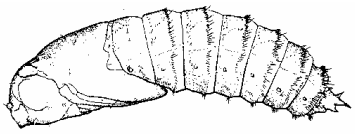


Water Mites (C. Arachnida)

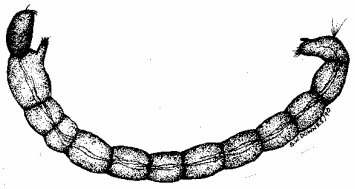
HIGH POLLUTION TOLERANCE (PTI = 1)



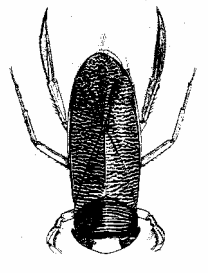
Blackfly Larva (F. Simuliidae)



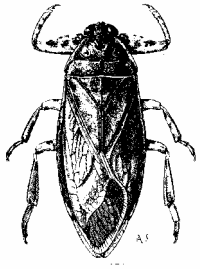
Horse/Deerfly Larva (F. Tabanidae)



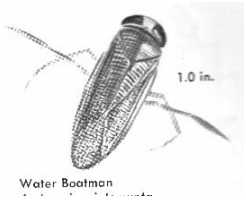
Midge Larva (F. Chironomidae)



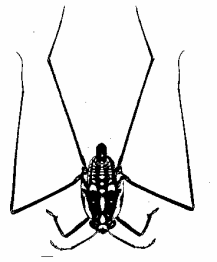
Backswimmer (F. Corixidae)



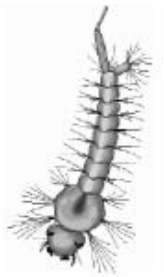
Giant Water Bug (G. Lethocerus)



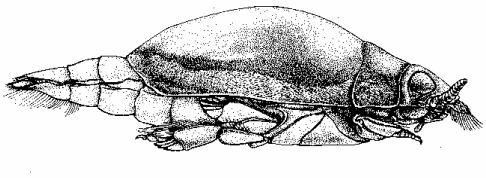
Water Boatman (F. Corixa)



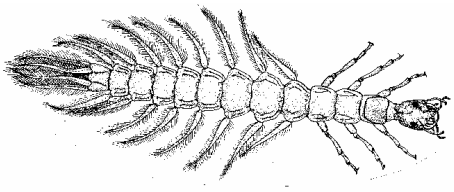
Waterstrider (F. Gerridae)



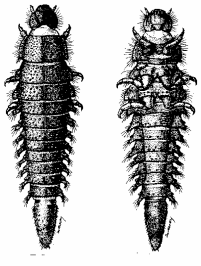
Mosquito Larvae (O. Diptera)



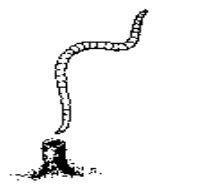
Whirligig Beetle (F. Gyrinidae)



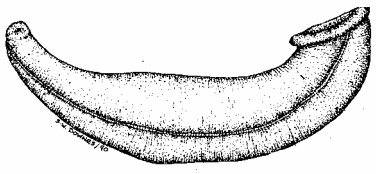
Whirligig Beetle Larva (F. Gyrinidae)



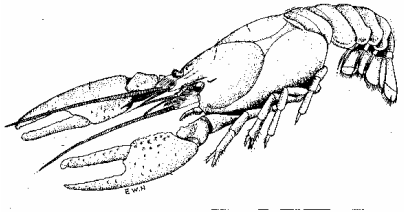
Riffle Beetle (F. Elmidae)



Aquatic Worms (Oligochaeta)



Leech (C. Hirudinea)



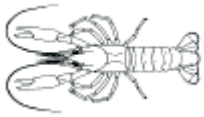
Crayfish (O. Decapoda)

Dichotomous Key to Common Aquatic Invertebrates

1.

1-1 Having segments (jointed) legs. (**Go to 2**)





1-2 Does not have segmented legs. (**Go to 15**)

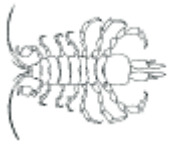


2.

2-1 Having only six segmented legs. (**Go to 3**)



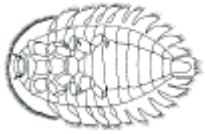
2-2 Having more than six segmented legs. (**Go to 12**)


3.

3-1 Body elongated (loner than it is wide); legs not concealed beneath the body. (**Go to 4**)

3-2 Body disk or oval shaped and very flat.



Order Coleoptera; family **Psephenidae** (Water penny)

4.

4-1 Two or three distinct tail filaments that may appear hair-like webbed or paddle shaped. (**Go to 5**)



4-2 No tail filaments; tail consisting of a single long filament; tail having hooks that may or may not have filaments. (**Go to 7**)



See acknowledgements on page eight

5.

5-1 Two or three hair-like tail filaments (may appear webbed); plate-like, filamentous or feathery gills attached to the sides of the abdomen.

Order **Ephemeroptera** (Mayflies)

5-2 Two or three hair-like or paddle shaped tails; no gills attached to the abdomen. (**Go to 6**)

6.

6-1 Two hair-like tail filaments; no gills attached to the abdomen.

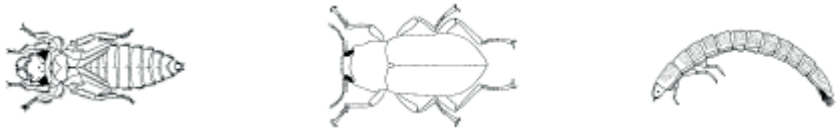
Order **Plecoptera** (Stoneflies)

6-2 Three broad paddle-shaped tails, which are actually gills; no gills attached to the abdomen.

Order Odonata; sub-order **Zygoptera** (Damselflies)

7.

7-1 Abdomen is hardened; body is plated or skin is hardened. (**Go to 8**)



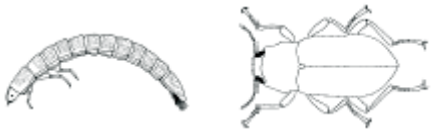
7-2 Abdomen is soft, not hardened or plated. (**Go to 9**)

8.

8-1 Wide abdomen; large eyes; scoop-like lower lip (labium) that covers most of the mouthparts; may have pointed structures on the end of the abdomen.

Order Odonata; sub-order **Anisoptera** (Dragonflies)

8-2 Entire body is hardened; tail may have tiny hooks or filaments.



Order Coleoptera; family **Elmidae** (Riffle beetle)

9.

9-1 Pairs of fleshy or thin filaments extending from the abdomen. (**Go to 10**)

9-2 No pairs of abdominal filaments. (**Go to 11**)

10.

10-1 Fleshy or thin filaments attached to the abdomen, may have tufts of gills beneath; short forked-tail; large chewing mouthparts on the head.

Order Megaloptera; family **Corydalidae** (Fishfly/Hellgrammite)

10-2 Fleshy or thin filaments attached to the abdomen; single filament-like tail extends from the end of the abdomen; large chewing mouthparts on the head.

Order Megaloptera; family **Sialidae** (Alderfly)

11.

11-1 Two forked hooks at the end of the abdomen, which may be very small; feathered or branched tail-like structures usually cover the hooks. The invertebrate may be inside a case built from streambed materials such as small pebbles, sand grain, leaves etc.

Order **Trichoptera** (Caddisflies)

11-2 Soft abdomen; has pairs of caterpillar-like legs that may not be fully developed; abdomen may be smooth of may be covered by filaments or hairs.

Order **Lepidoptera** (Aquatic moth)

12.

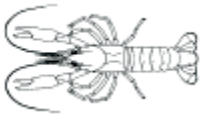
12-1 Body is dorsally flattened (wider than it is high); has a thin plated fan-like tail. (**Go to 13**)

12-2 Body is dorsally flattened (wider than it is high); seven pairs of walking legs, the first is claw-like and may be slightly enlarged. Looks like the terrestrial pill-bug (roly-poly).

Order **Isopoda** (Aquatic sowbug)

13.

13-1 Body is long; has five pairs of walking legs, the first pair are usually enlarged forming claws; has a large fan-like tail. (**Go to 14**)

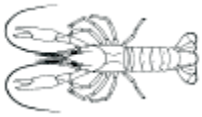



13-2 Body is flattened from side-to-side (higher than it is wide); seven-pairs of walking legs, first two are claw-like the remaining legs are simple. Has a habit of swimming sideways.

Order **Amphipoda** (Scud/sideswimmer)

14.

14-1 Body mostly dorsally flattened; five-pairs of legs, first three-pairs with hinged claws and the first pair of claws are greatly enlarged; abdomen terminates in a flipper-like structure.



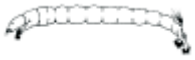
Order **Decapoda** (Crayfish)

14-2 Body is flattened from side-to-side (higher than it is wide); five pairs of walking legs, the first are not enlarged forming a claw.

Order Decapoda; family **Palaemonidae** (Freshwater shrimp)

15.

15-1 Having a distinct head. (**Go to 16**)



15-2 Does not have a distinct head. (**Go to 20**)

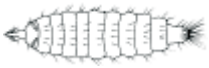


16.

16-1 Having a distinct head and one or more tiny pro-legs, which are leg-like appendages but are not segmented. (**Go to 17**)

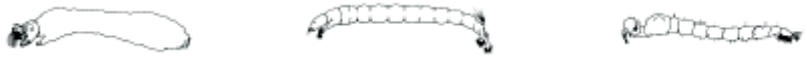


16-2 Having a distinct head or the head region is obvious; no legs or pro-legs attached to the thorax. (**Go to 19**)


17.

17-1 Body is very small (less than ½ inch); body appears inchworm like and may be widened towards the end of the abdomen. (**Go to 18**)

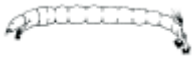


17-2 Very distinct body with dramatic indentations; suckers on each segment on the underside of the body.

Order Diptera; family **Blephariceridae** (Net-wing midge)

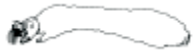
18.

18-1 Hardened clearly visible head; long worm-like body; two pairs of prolegs with terminal hooks. Some kinds may be red in color.



Order Diptera; family **Chironomidae** (Non-biting midge)

18-2 Head hardened and rounded bearing a pair of labral fans (mouth brushes); prolegs on lower thorax; lower third of the abdomen is swollen (vase-like) and terminates in a ring of hooks.



Order Diptera; family **Simuliidae** (Black fly)

19.

19-1 Body is flattened dorsally with a leathery feel; head is reduced but visible; thorax is broader than the head; spiracles at the end of the abdomen for breathing.

Order Diptera; family **Stratiomyidae** (Soldier fly)

19-2 Soft-elongated body flattened from top to bottom; no individual segments; sides of the body constricted towards the front forming a head that is often somewhat triangular shaped; two eyespots situated on top of the head gives the animal a cross-eyed appearance.

Class **Turbellaria** (Flatworm)

20.

20-1 Body has distinct pro-legs and may have whelps; head is very small and reduced into the body; may not be visible. (**Go to 21**)

20-2 Body has no pro-legs but may have whelps; head is very small and reduced into the body; may not be visible. (**Go to 22**)

21.

21-1 Body long (caterpillar-like); head reduced but may be visible; prolegs on most abdominal segments; abdomen ends in a fringed tail.

Order Diptera; family **Athericidae** (Watersnipe fly)

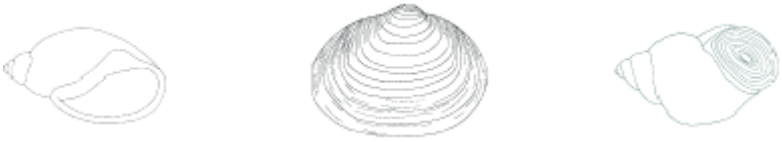
21-2 Body elongated; head reduced or pulled into the thorax; prolegs present on most abdominal segments; prolegs longer on segment eight; abdomen is blunt on the end or terminates in welts.

Order Diptera; family **Empididae** (Dance fly)

22.

22-1 Body not covered by a hard shell. (**Go to 23**)

22-2 Body covered by one or more hard shells. (**Go to 26**)



23.

23-1 Body worm-like and separated by numerous segments; may or may not have suckers at the ends. (**Go to 24**)

23-2 Soft-plump caterpillar-like body; may have whelps along its length; internal structures may be visible. (**Go to 25**)

24.

24-1 Body dorsally flattened with 34 segments, which are divided so there appears to be more; suction disks present on one or both ends; eyespots may be present.

Class **Hirudinea** (Leech)

24-2 Body elongated (worm-like); divided into many segments most having bundles of small hairs; no eyespots or suckers present

Class **Oligochaeta** (Aquatic worm)

25.

25-1 Rounded head capsule, often reduced and barely visible; ventral welts on some abdominal segments; abdomen terminates into a disc surrounded by lobes or tentacle-like projections of varying shapes.

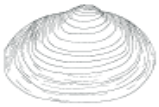
Order Diptera; family **Tipulidae** (Crane fly)

25-2 Body spindle shape both ends tapered; head reduced usually not visible; creeping welts with small hooks present on abdominal segments one through seven; no prolegs.

Order Diptera; family **Tabanidae** (Horse fly)

26.

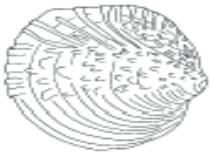
26-1 Body is soft, usually not visible; enclosed in two oblong or rounded shells, hinged together (**Go to 27**)



26-2 Body is soft; enclosed in a single spiraled, coiled or flattened shell. (**Go to 29**)

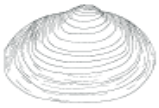
27.

27-1 Hinged shell, variable in shape but maybe somewhat oblong; has many indentations and ridges on the tops and sides of the shell.



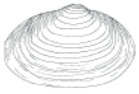
Class Bivalvia; family **Unionidae** (Mussel)

27-2 Hinged shell, much more rounded in shape than above; the shell has ridges. (**Go to 28**)



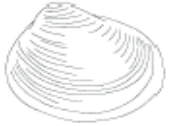
28.

28-1 Shell very small and rounded, light colored; ridges spaced close together and are usually not raised.



Class Bivalvia; family **Sphaeriidae** (Pea clam)

28-2 Shell much more rounded, brown in color usually lighter than mussels; raised separated ridges along the top and sides of the shell.



Class Bivalvia; family **Corbiculidae** (Asian clam)

29.

29-1 Has a flat lid-like structure called an operculum that can seal the body of the snail inside the shell; the whorls of the shell bulge out distinctively to the sides (inflated); shells often extended into a spiral shape.

Class Gastropoda; sub-class **Prosobranchia** (Operculate snails)

29-2 No operculum; the whorls of the shell do not distinctly bulge out to the sides; often the shells of most kinds are shaped like a low flat cone or coiled flat instead of being extended in a spiral shape. (**Go to 30**)

30.

30-1 Shell is spiraled or coiled in one plane; no operculum.

Class Gastropoda; sub-class **Pulmonata** (Non-operculate snails)

30-2 Shell is a low fiat cone or domed shape; no operculum.

Class Gastropoda; sub-class Pulmonata; family **Ancylidae** (Limpet snail)

Style of this dichotomous key adapted from:

Kellogg, L. 1994 Second Edition. Save Our Streams Monitor's Guide to Aquatic Macroinvertebrates. Izaak Walton League of America

Illustrations from:

Bouchard, R. W. Jr. 2010. Guide to the Aquatic Invertebrates of the Upper Midwest. Used with permission