Guidance for Michigan Clean Water Corps (MiCorps) member programs for developing Quality Assurance Program Plans (QAPPs) for Volunteer Benthic Macroinvertebrate Monitoring and the MiCorps Habitat Analysis

Adapted from MDEQ guidance for Water Quality Monitoring Studies

Version 4.0

Last updated November 2014

All volunteer monitoring programs participating as MiCorps member programs, or grantees receiving federal or state monies for the purpose of conducting water quality monitoring, are required to prepare a quality assurance program plan (QAPP). A QAPP is a written document that provides the framework for how environmental data will be collected to achieve program objectives and describes the procedures that will be implemented to obtain data of known and adequate quality. The QAPP must be prepared by the member organization or grantee (or their consultant) and approved by MiCorps staff prior to study and analysis. This document has been prepared in conjunction with a QAPP Review Checklist (see separate document at www.micorps.net/resourcesqa.html) to facilitate the preparation of approvable QAPPs for water quality monitoring studies. The use of this document is intended to improve the quality of draft QAPPs so that minimal revisions are necessary. You will probably find it helpful to look at the check list as you write your QAPP.

Many sections of this guidance can be copied directly into the QAPP, but groups can edit text as needed to meet the needs of their organization.

Components of a QAPP

In general, there are ten major components of a QAPP. Since MiCorps is currently focused on programs monitoring macroinvertebrates and assessing habitat, this guidance is tailored to that type of monitoring. Programs that include an emphasis on water chemistry sampling are not currently covered by MiCorps and will need to address additional components.The components, along with the sections in which they are included, are:

Section A:

- A program overview and description, including the person(s) responsible for carrying out the program.
- Data Quality Objectives (DQO).

Section B:

- Sampling methods and other operating procedures.
- Equipment maintenance procedures.
- Data management and analysis procedures.
- Internal quality control checks.

Section C:

- Data validation and reporting.
- Performance and system audits.
- Data quality assessment and reporting.
- Corrective action for addressing all quality assurance/quality control noncompliance problems.

SECTION A: PROGRAM DESCRIPTION AND QUALITY OBJECTIVES

A1. Title and Approval Sheet

Fill in the information on the cover sheet form (www.micorps.net/documents/qapp_cover.doc). Once the QAPP is complete, make sure to have the cover signed by all necessary parties. Initial QAPP drafts should be submitted electronically to Paul Steen, MiCorps Program Manager, at psteen@hrwc.org. After the QAPP has been accepted, the approval sheet should be signed, scanned, and emailed to MiCorps. A copy with MiCorps approval signature will be returned for inclusion with the original program documentation. All approved QAPPs will be posted on www.micorps.net.

A2. Table of Contents

Please develop a table of contents indicating the page number for each major section, following the same headers as given in this guidance and in the review checklist (i.e. Distribution list should be marked as A3.)

A3. Distribution List

Indicate the name and organization for each individual who will receive the QAPP.

A4. Program Organization

Identify key personnel (including advisors) within the program team and include their organizational affiliation and contact information. List their roles and responsibilities in the program and identify lines of authority and reporting responsibility. An organizational chart may be included to illustrate lines of responsibility. **Be sure to indicate the person or position responsible for maintaining primary QA oversight** (i.e. the QA Manager).

This section of the QAPP shall also indicate personnel roles with the following responsibilities (individuals may

have multiple responsibilities):

1. Management Responsibilities – All managers and their respective responsibilities shall be listed. This includes the grantee and subcontractors.
2. Field Responsibilities – All field sampling personnel and their respective responsibilities shall be listed. A single term "volunteers" or volunteer roles (e.g. collectors, pickers) is preferable to listing all volunteers.
3. Laboratory Responsibilities – The identity of any laboratories and key laboratory staff associated with the program shall be listed. The location of the laboratory (city and state) and the parameters that will be tested at each laboratory shall be included. For macroinvertebrate programs, the lab would be the location where collections are sorted and identified.
4. Corrective Action – Program personnel responsible for initiating, developing, approving, and implementing corrective actions shall be listed.

A5. Problem Definition/Background

Describe the purpose or goals of monitoring along with the expected outcomes or actions to be taken based on results. Include the major questions or issues to be addressed and background information.
This section may be extracted from your program proposal.

> *Example:*
> *"The primary goals of the Adopt-A-Stream Program of volunteer monitoring are to provide reliable data about the conditions of the entire river system, educate the watershed residents about what the river needs from them and engage residents and communities in actions to protect the river system. The primary actions we envision taking based on monitoring results are to report the trends and conditions of the stream sections studied. As clarified in other sections of this document, we do not present any results on the ecological conditions until we have three years of benthic community data plus a habitat assessment and one season of temperature measurements. In the event that an extreme change in benthic macroinvertebrates and habitat is observed (such as oil in the sediment and an impoverished community), we will notify the appropriate authorities about the unverified results immediately and stay in contact with them as they investigate the situation. Our goal is to assist in removing causes of stream deterioration."*

A6. Program Description

This section of the QAPP shall include a brief description (i.e. summary or abstract) of the entire program, its specific objectives and how the program is designed to obtain the information necessary to accomplish the objectives. This section may be extracted from your program proposal.

A7. Data Quality Objectives

This section of the QAPP addresses the data quality objectives (DQO) and requirements used to decide whether or not data are acceptable to use in program reporting and the MiCorps Data Exchange. **This is a critical section of the QAPP, has direct implications for program methods and should be viewed as the foundation of the QAPP.** Please consider the guidance in this section carefully. Each QAPP must discuss precision, bias, completeness, representativeness and comparability.

You will find below the suggested language for section A7. This wording can be used as is, or it can be altered to meet certain programmatic goals.

Suggested language:

Precision/Accuracy:

Accuracy is the degree of agreement between the sampling result and the true value of the parameter or condition being measured. Accuracy is most affected by the equipment and the procedure used to measure the parameter. Precision refers to how well you are able to reproduce the result on the same sample, regardless of accuracy.

The purpose of this project is to gauge stream health by measuring the total diversity of macroinvertebrate taxa. 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 multiple independent (duplicate) collections of the sampling sites, our goal for precision and accuracy is conservative. A given site's Stream Quality Index (SQI) score or total diversity (D) measure across macroinvertebrate taxa will be noted as "preliminary" until three spring sampling events and three fall sampling events have been completed.

Precision and accuracy will be maintained through following standardized MiCorps procedures. The Program Manager must be trained in MiCorps procedures at the annual MiCorps training led by MiCorps staff. MiCorps staff also conduct a method validation review (the "side-by-side" visit) with the Program Manager to ensure their expertise, preferably prior to the first volunteer leader training session. This review consists of supervising the Program Manager's macroinvertebrate sampling and sorting methodology to ensure that they are consistent with MiCorps protocol. All cases of collecting deficiencies are promptly followed (during that visit) by additional training in the deficient tasks and a subsequent method validation review may be scheduled for the following collecting season. Upon request, MiCorps staff may also verify the accuracy of the program's macroinvertebrate identification. If a problem arises with a subset of macroinvertebrates, a thorough check may be requested. (The side-by-side visit was held on xxx with MiCorps Program Manager Paul Steen).

Precision and accuracy will be maintained by conducting consistent volunteer team leader training. Volunteer team leaders will be trained up joining the program, and retrained every three years (at a minimum). Techniques under

review shall include:

- collecting style (must be thorough and vigorous);
- habitat diversity (must include all available habitats and be thorough in each one);
- picking style (must be able to pick thoroughly through all materials collected and pick all sizes and types of macroinvertebrates);
- variety and quantity of organisms (must ensure that diversity and abundance at site is represented in sample);
- transfer of collected macroinvertebrates from the net to the sample jars (specimens must be properly handled and jars correctly labeled).

Precision and accuracy will be maintained through careful macroinvertebrate identification. Volunteers may identify macroinvertebrates in the field, but these identifications and counts are not official. All macroinvertebrate samples are stored in alcohol to be identified at a later identification session. Volunteers can be designated as identification experts as determined by the judgment of the Program Manager. All field identifications and counts will be checked by an expert with access to a scope, keys, and field guides. The Program Manager will check at least 10% of the specimens processed by experts to verify results (with a concentration on hard to identify taxa). If more than 10% of specimens checked were misidentified, then the Program Manager will review all the specimens processed by that expert and reassess if that person should be considered an expert for future sampling events.

Bias: At every sample site, a different team will sample there at least once every three years to examine the effects of bias in individual collection styles. Measures of D and SQI for these samples will be compared to the median results from the past three years and each should be within two standard deviations of the median. If the sample falls outside this range, then the Program Manager needs to conduct a more thorough investigation to determine which team or individuals is likely at fault. The Program Manager will accompany teams to observe their collection techniques and note any divergence from protocols. The Program Manager may also perform an independent collection (duplicate sample) no less than a week after the team's original collection and no more than two weeks after.

The following describes the analysis used for the Program Manager's duplicate sampling:

Resulting diversity measures by teams are compared to Program Manager's results and each should have a relative percent difference (RPD) of less than 40%. This statistic is measured using the following formula:

RPD = [(Xm - Xv) / (mean of Xm and Xv)] x 100, where Xm is the Program Manager measurement and Xv is the volunteer measurement for each parameter.

Teams that do not meet quality standards are retrained in the relevant methods and the Program Manager will re-evaluate their collection during the subsequent sampling event.

It is also possible that the Program Manager can conclude that all sampling was valid and the discrepancy between

samples is due to natural variation (such as the site changing over time or unrepresentative sampling conditions).

Completeness: Completeness is a measure of the amount of valid data actually obtained versus the amount expected to be obtained as a specified in the original sampling design. It is usually expressed as a percentage. For example, if 100 samples were scheduled but volunteers sampled only 90 times due to bad weather or broken equipment, the completeness record would be 90%.

Following a quality assurance review of all collected and analyzed data, data completeness is 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 develops a course of action to improve the completeness of future sampling events.

Representativeness: Study sites are selected to represent the full variety of stream habitat types available locally. 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 watershed.

Sampling after extreme weather conditions may result in samples not being representative of the normal stream conditions. The Program Manager will compare suspect samples to the long term record as follows:

Measures of D and SQI for every sample will be compared to the median results from the past three years and each should be within two standard deviations of the median. If the sample falls outside this range, it can be excluded from the long-term data record (though can be included in an "outlier" database.).

Comparability: Comparability represents how well data from one stream or study site can be compared to data from another. To ensure data comparability, all volunteers participating in the monitoring program follow the same sampling methods and use the same units of reporting. The methods for sampling and reporting are based on MiCorps standards that are taught at annual trainings by MiCorps staff. The Program Manager will train volunteers to follow those same methods to ensure comparability of monitoring results among other MiCorps programs. To the extent possible, the monitoring of all study sites will be completed on a single day, and certainly within a two-week time frame.

If a Program Manager leaves the position and a new Program Manager is hired, the new hire will attend the next available training given by MiCorps staff.

End suggested language

A8. Special Training/Certifications

Identify any specialized training or certifications that are required. MiCorps training or equivalent should be included for program managers and program leaders. Volunteer team leaders should be trained for

macroinvertebrate and habitat assessment by the Program Manager (or other program leader).

SECTION B: PROGRAM DESIGN AND PROCEDURES

B1. Study Design and Methods

Describe your study design in detail. Include planned frequency of monitoring each site, study locations and the methodology used to select sites and for volunteers to find sites. A watershed map locating all study sites and an example of the maps that will be used by volunteers should be included. Indicate the information that is critical to the monitoring program and which information is for context information or other uses. Identify potential sources of variability and how this variability will be reported. For macroinvertebrate collection, groups should monitoring twice a year, in spring and in the fall. For habitat assessments, groups should monitor at a frequency of their choosing. Every three to five years is acceptable but this can happen more frequently if the group suspects a site is changing rapidly.

This section of the QAPP shall include a list and description of study methods that will be used to monitor each parameter (macroinvertebrates and habitat). Include standard operating procedures (SOPs) for each procedure with sufficient detail to indicate how the quality of resulting data will be confirmed. Include methods used to preserve the macroinvertebrate collections and to prevent contamination from sites previously sampled with the same equipment (e.g., net). Add a detailed list of all monitoring equipment (see recommendations on the MiCorps website at http://www.micorps.net/documents/Stream%20Equipment%20List.pdf) and the location where equipment is normally stored. Include actions to be taken (by whom) when problems occur. SOPs should be included as appendices to the QAPP.

Other details to make sure are included in this section:

- frequency and time frame of monitoring
- taxonomic level of macroinvertebrate identification, such as order or family, etc.
- literature and equipment used for identifying macroinvertebrates and analyzing samples
- chain of custody for macroinvertebrate samples
- Equipment Quality Control
    - Check to make sure equipment is in working order and not damaged
    - Clean equipment after taking it into the field
    - Label equipment with their dates of purchase and dates of last usage
    - Check the expiration date of chemical reagents prior to each use
    - Check the batteries of all equipment that requires them
    - Make sure equipment is calibrated appropriately before conducting each test

Example language for Macroinvertebrate collection:

The benthic population is sampled within a 2-week period in mid-April and mid- October. All equipment to be used

for this sampling is listed in Appendix xx, and the SOPs are given in Appendix xx.

To sample the benthic community, 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 kicknet. The trained Collector will transfer the material from the net into white pans. The remaining volunteers (Pickers) will pick out samples of all different types of macroinvertebrates from the pans and place them into jars of 70% ethyl alcohol for later identification. During the collection, the Collector will provide information to the team Streamside Leader 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 Streamside 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 should be explained on the data sheet. (See appended data sheet.)

At the collecting site, all invertebrate sample jars receive a label written in pencil or printed with a laser printer, stating date, location, name of collector, and number of jars containing the collection from this site, which is placed inside the jar. The data sheet also states the number of jars containing the collection from this site. The Streamside Leader is responsible for labeling and securely closing the jars, and returning all jars and all equipment to the Program Manager. Upon return to the Program building, the collections are checked for labels, the data sheets are checked for completeness and for correct information on the number of jars containing the collection from the site, and the jars are secured together with a rubber band and site label and placed together in one box. They are stored in the central office until they are examined and counted on the day of identification (one or two weeks later). The data sheets are used on the identification day, after which they remain on file indefinitely. 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. These identifications are then verified by the Program Managers per section A7. When identification of a sample is complete, the entire collection is placed in a single jar of fresh alcohol with a poly-seal cap and a printed label inside the jar and stored at the program office indefinitely. The alcohol is carefully changed (to avoid losing small specimens) in the jars every few years.

Since our evaluation is based on the diversity in the community, we 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 are compared with other locations in the same river system that have been sampled

in the same way. All collectors attend an in-stream training session, and a different team will be sent to a site at least once every two years at a minimum, but when possible collectors will be sent to different sites every collection event to diminish the effects of bias in individual collecting styles. Samples where the diversity measures diverge substantially (using the critera in A7) 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.

Example language for habitat analysis:

Streamside Leaders and Collectors, with Pickers assisting as well, will complete a Habitat Assessment once a year during the fall season immediately following the macroinvertebrate sampling or at least within two weeks of the sample event. The Habitat Assessment will follow the procedure and datasheet given in Appendix xx. A site sketch will accompany the assessment. The Habitat Assessment is a critical piece of the monitoring process and will be used to monitor changes in stream habitat over time, which may result in changes in water quality and corresponding macroinvertebrate diversity.

As many of the parameters within the Habitat Assessment are qualitative, personal bias is inherent. To account for bias and personal discrepancies, Streamside leaders will have on hand a copy of MiCorps Stream Monitoring Procedures, which details the qualitative criteria, and helps clarify questions. Streamside leaders will read questions aloud to their group and form consensus on question answers. Since the information reviewed in the Habitat Assessment hold considerable educational value for volunteers and the goals of the MiCorps program, it is important that Streamside Leaders inform other group members of the purpose of the Assessment and encourage feedback from the group. However, final decisions on the scoring remains the responsibility of only those team members who have undergone the volunteer training and have been certified by the Program Manager. All final Habitat Assessment data sheets will be reviewed by the Project Manager for correctness and completeness. There are places on the data sheet to record unusual procedures or accidents. Any variation in procedure should be explained on the data sheet.

As a critical role of the Habitat Assessment is to inform us of any areas of habitat degradation that could impact water quality, any concerns noted in the data sheet will be reviewed by the Project Manager and appropriate action will be taken to resolve and/or address noted concerns including informing appropriate authorities.

End example language

B2. Instrument/Equipment Testing, Inspection, and Maintenance

Critical instruments and equipment used in the monitoring program should be listed in section B1 (or in an appendix referenced from B1). B2 should be the section that describes the testing, inspection and maintenance procedures for the equipment. Indicate the testing needs to verify proper function. For macroinvertebrate monitoring, the critical equipment to maintain includes nets (firmly attached to poles and free of holes) collection jars (with poly seal tops), forceps (with tips that meet), and waders that are clean, dry and do not leak. Describe inspection procedures and include the individual(s) responsible for inspection and maintenance. Indicate how deficiencies will be resolved and documented. Note where the equipment is stored.

B3. Inspection/Acceptance for Supplies and Consumables

Prepare a list of monitoring supplies and consumables. Record when they were purchased and dates when they should be replaced. Note criteria for acceptance for use in the program, along with any procedures for storage and retrieval and who is responsible for this activity.

B4. Non-direct Measurements

This section is not necessary for most programs. Summarize any data or information that is used in conjunction with volunteer collected data but you did not measure directly (e.g. model outputs, data from agency databases, etc.). The specific use should be described along with acceptance criteria and the nature of its uncertainty.

B5. Data Management

Indicate how data and records will be maintained and reported. Include the method of data storage and back up and who (list title) will be responsible for maintaining records. Identify how long and where records will be maintained. Include copies of all data collection forms and a description of the qualifications of volunteer data collectors.

Example:
Raw data will be entered and managed in Microsoft Excel workbooks. Data will be entered into the MDE within a month of the collection data. All data is backed up bi-weekly and a tape is kept off premises. Computer passwords provide data security.

Describe the system that you will use to store and manage the monitoring data from field collection to analysis. Include locations of storage, details about how the data is handled at each step and the individuals responsible for each step. Also include the name or description of the database management software (e.g. Access, Excel, etc.) that will be used to store and analyze the study data.

Examples:

- *Data will be entered from data sheets directly into the online MiCorps database by a single, trained volunteer for storage within the MiCorps data exchange system. Data sheets will be filed at the central office for a period of at least five years.*
- *Data will be entered by the data manager into the program's MS Access database for long- term storage. Once a year, all new data will be exported to a MiCorps compatible format and sent to MiCorps for inclusion in their data exchange system. Data sheets will be filed at the central office for a period of at least five years.*

- Describe any metrics, indicators or other measures that will be calculated from the raw field or lab data and

include methods of computation. Include units of measure if applicable. Describe statistical analyses used to analyze the aquatic community data.

Example:

- *Macroinvertebrates: Data are summarized for reporting into four metrics: all taxa, insects, EPT (Ephemeroptera + Plecoptera + Trichoptera), and sensitive taxa. Units of measure are families counted in each metric. The Stream Quality Index (SQI) from the MiCorps datasheet is also computed. The method for calculating that metric is included in Appendix X*
- *Habitat: specific measures are used from habitat surveys to investigate problem areas at each site. The percentage of stream bed composed of fines (sand and smaller particles) is calculated and changes are tracked over time as an indicator of sediment deposition.*

Some suggestions for data analysis quality control include:

- Check all calculations twice
- Hard copies of all computer entered data should be reviewed for errors by comparing to field data sheets
- Have qualified professionals review your data analysis methods and results periodically.

SECTION C: System Assessment, Correction and Reporting

This section of the QAPP describes the performance and system audits that will be used to assess the capability and performance of your program. Groups are welcome to follow the cookie cutter wording below, but are welcome to change wording to meet their programmatic needs.

Suggested language.

SECTION C: System Assessment, Correction and Reporting

C1. System Audits and Response Actions

Volunteer Team Leaders trained by the Program Managers ensure that quality assurance protocols are followed and report any issues possibly affecting data quality. When significant issues are reported, the Program Manager may accompany groups in the field to perform side-by-side sampling and verify the quality of work by the volunteer team. In the event that a group is determined to have done a poor job sampling, a performance audit to evaluate how people are doing their jobs of collecting and analyzing the data is accomplished through side-by-side sampling and identification. During side-by-side sampling a team of volunteers and an outside expert sample the same stream. The statistic for checking this side-by-side sample is given in the Bias section (A7).

A system audit is conducted following each spring and fall monitoring event to evaluate the process of the project. The system audit consists of the Program Manager, any other program leader, and one or two

active volunteers, and is a start to end review of the monitoring process and how things could be improved for the next event.

If deviation from the QAPP is noted at any point in the sampling or data management process, the affected samples will be flagged and brought to the attention of the Program Manager and the team that collected the sample. Re-sampling is conducted as long as the deviation is noted soon after occurrence and volunteers are available (two week window). Otherwise, a gap must be left in the monitoring record and the cause noted. All corrective actions are documented and communicated to MiCorps staff.

Details of the process for assessing data quality are outlined in section A7. Response to quality control problems is also included in section A7.

C2. Data Review, Verification, and Validation

A standardized data-collection form is used to facilitate spot-checking to ensure that forms are completely and correctly filled out. The Program Manager or a single trained volunteer reviews the data forms before they are stored in a computer or file cabinet. After data has been compiled and entered into a computer file, it is verified with raw data from field survey forms.

C3. Reconciliation with Data Quality Objectives

Data quality objectives are reviewed annually to ensure that objectives are being met. Deviations from the data quality objectives are reported to the Program Manager and MiCorps staff for assessment and corrective action. Also, data quality issues are recorded as a separate item in the database and are provided to the Program Manager and data users. Response to and reconciliation of problems that occur in data quality are outlined in Section A7.

C4. Reporting

Throughout the duration of this program, quality control reports are included with quarterly project reports that are submitted to MiCorps. Quality control reports provide information regarding problems or issues arising in quality control of the project. These could include, but are not limited to: deviation from quality control methods outlined in this document relating to field data collection procedures, indoor identification, data input, diversity calculations and statistical analyses. Program staff generates annual reports sharing results of the program with volunteers, special interest groups, local municipalities, and relevant state agencies. Data and reports are made available via the organization's web page.