SECTION A: PROJECT DESCRIPTION AND QUALITY OBJECTIVES

A1. Title and Approval Sheet

Quality Assurance Project Plan for *Michigan Lake and Stream Associations*

Project Title: Water quality and macroinvertebrate diversity in streams entering and leaving Michigan lakes.

Date: 28 August 2007

Version # 1

Organization: *Michigan Lake and Stream Associations*

QAPP Prepared by: Scott McNaught

Title: Associate Professor of Biology; Director, Michigan Water Research Center, Central Michigan University

Signature: _____ **Date**:_____

Other responsible individual: Pearl Bonnell
Title: Treasurer and Director of Operations, *Michigan Lake and Stream Associations*

Signature: _____**Date**:_____

MiCorps Staff Use

Tracking Number:

MiCorps Reviewer: _____

☐ Approved ☐ Returned for modifications

_____

Signature of reviewer Date

A2. Table of Contents

A3. Distribution List

- **Pearl Bonnell**, MLSA Treasurer and Director of Operations
- **Molly Gordon,** Central Michigan University
- **Ric Lawson,** MiCorps
- **Scott McNaught,** Central Michigan University

A4. Project Organization

***Michigan Lake and Stream Associations* Staff:**

- **Pearl Bonnell**, MLSA Treasurer and Director of Operations

  P.O. Box 303 Phone: 989-257-3583
  Long Lake, MI 48743 Email: pbonnell@mlwsa.org

  Ms. Bonnell will supervise MLSA staff and administer the MiCorps grant. She will help recruit lake association volunteers and will ensure that quarterly progress and financial reports are completed on time.

- **Donald Winne**, MLSA Executive Director

  P. O. Box 249 Phone (269) 273-8200
  Three Rivers, Michigan 49093 Email: dwinne@mlwsa.org

  Mr. Winne will assist Ms. Bonnell in supervising staff and recruiting lake association volunteers.

- **Jennifer Churchill**, Editor of the *Michigan Riparian*.

  P.O. Box 44 Phone: (989) 506-6716
  Carson City, MI 48811 e-mail: editor@churchill3c.com

  Ms. Churchill will advertise volunteer activities and publish articles about stream monitoring in the *Michigan Riparian*.

- **Bruce Bonnell**, MLSA Computer Programmer and Technician, Designs and maintains ML&SA web sites.

  P.O. Box 303 Phone: 989-257-3583
  Long Lake, MI 48743 Email: bbonnell@mlwsa.org

  Mr. Bonnell will post stream monitoring activities and volunteer information on MLSA web site.

- **Jean Roth**, office staff
  Posts data and maintains records for the CLMP program

  7311 N. Chain Lake Rd. Phone 989-257-3583
  South Branch, MI 48761. Email: jroth@mlwsa.org

  Ms. Roth with maintain a database of stream monitoring volunteers. She will be responsible for communication with volunteers via mail, email, and phone.

Science Advisor – Dr. Scott McNaught

Associate Professor of Biology, Central Michigan University
Director, Michigan Water Research Center

160 Brooks Hall
Central Michigan University
Mount Pleasant, MI 48859
Phone: (989)774-1335
Email: mcnau1as@cmich.edu

Dr. McNaught will supervise the project manager, oversee the collection and analysis of macroinvertebrate and water quality samples, implement the QA/QC plan, and write data summaries.

Project Manager – Molly Gordon

217 Brooks Hall
Central Michigan University
Mount Pleasant, MI 48859
Phone: (989)774-2494
Email: gordo1me@cmich.edu

Molly Gordon is a graduate student at Central Michigan University. She received her B.S. degree from CMU in May 2006. As an undergraduate student, Ms. Gordon took classes in limnology and phytoplankton taxonomy. Ms. Gordon will conduct training sessions (macroinvertebrate identification and water quality sample collection) for volunteers at each sampling location and will organize volunteer sampling events. She will also help the Science Advisor write and implement a QA/QC plan, and she will establish and maintain a database for all information collected during this project.

Project Expert (Entomologist) – Molly Gordon or Dr. Donna King

217 Brooks Hall
Central Michigan University
Mount Pleasant, MI 48859
Phone: (989)774-2494
Email: gordo1me@cmich.edu

Molly Gordon is a graduate student at Central Michigan University and has successfully completed a class in aquatic invertebrate taxonomy. Dr. King is a faculty member at Central Michigan University. She is a professional stream ecologist and teaches Freshwater Biology and Aquatic Invertebrates at CMU.

Student technicians – Dan Cibulka, Clay Wilton

217 Brooks Hall
Central Michigan University
Mount Pleasant, MI 48859
Phone: (989)774-2494

Student technicians will help conduct training sessions for volunteers at each sampling location and will assist with collection of invertebrates during volunteer sampling events. Student technicians will calibrate staff gauges by taking stream discharge measurements at selected sites.

Laboratory – Michigan Water Research Center

150 Brooks Hall
Central Michigan University
Mount Pleasant, MI 48859
Phone: (989)774-2494

All macroinvertebrates will be sorted and identified at this location. Ms. Jenny Estabrook will analyze collected water samples for Total Phosphorus and Total Suspended Solids.

A5. Problem Definition/Background

Since 1974, Michigan has maintained a volunteer lake monitoring program, which is currently being managed by the Michigan Lake and Stream Associations (MLSA) in cooperation with the Department of Environmental Quality (DEQ) and Michigan State University (MSU). This program has over 200 lake associations with over 400 individual participants who annually monitor total phosphorus, chlorophyll a, Secchi disk transparency and, in selected sites, dissolved oxygen and aquatic plant diversity.

The Cooperative Lake Management Program (CLMP) has focused on monitoring the water quality of Michigan's inland lakes. However, Michigan's streams have largely been ignored. MSLA would like to institute a pilot program to begin monitoring water quality in Michigan's streams. Over 50 lake associations have expressed interest in monitoring the water quality of streams that enter and leave their lakes. Therefore, initial participants in the volunteer stream monitoring program would be associations whose lake includes a wadable inlet and outlet stream. Target sites include tributary lakes in the Grand, Muskegon and Chippewa River watersheds. These watersheds were chosen because they represent a variety of land use patterns, development pressures, and pollution concerns.

Many of the 36,000 miles of streams in the State of Michigan pass through lake ecosystems. When a stream enters a lake, it deposits sediment, nutrients, and contaminants gathered from the upstream watershed. Sediments accumulate in the lake basin. Nutrients stimulate the growth of algae and aquatic plants. Contaminants such as organic pesticides and pathogenic bacteria endanger lake-side residents. If one is interested in lake health, it is important to

understand and quantify the quality and quantity of water entering a lake through inlet streams.

Lake systems, in turn, affect the health of their outlet streams. In many instances, it is the surface water that exits a lake through the outlet. Surface water typically has low sediment concentrations but may have high nutrient concentrations depending on the trophic status of the lake. Moreover, the surface water is warm and often above the limit of many stream organisms. Downstream communities may be dramatically different from those upstream of a lake. At greater distances from the lake, downstream communities may become more like upstream communities depending on the amount of riparian vegetation and stream-side development.

A6. Project Description

The primary goal of the proposed program is to protect and improve the water quality of streams in the State of Michigan. Specific objectives include 1) quantifying ecosystem health of primary inlet and outlet streams by collecting baseline data on macroinvertebrate communities and water quality, 2) examining the effects of inlet streams on lake ecosystems by estimating the volume of nutrients and sediment deposited by the inlet stream, 3) examining the effects of lake ecosystems on outlet streams by comparing macroinvertebrate communities near the lake outlet (100 m) and far downstream of the lake (500 m), 4) identifying specific water quality problems in inlet and outlet streams, and 5) educating citizens about stream health.

Baseline data on invertebrate communities, phosphorus and sediment will let lake associations and community residents know current water quality status and allow them to look for future changes in water quality. If water quality in inlet streams deteriorates, community residents can examine upstream reaches of the watershed for possible causes. If water quality in the outlet stream deteriorates, residents can examine lake water quality and near shore sources of pollution.

Site Description

Streams and associated lakes from 3 major watersheds have been selected for the proposed monitoring program. Sites in the Chippewa, Grand and Muskegon watersheds were chosen because these watersheds are dominated by agriculture and residential development pressure is higher. Streams in agriculture-dominated watersheds can be expected to contribute high sediment and nutrient loads to downstream lakes. Additional study sites on these 3 watersheds and other watersheds will be added as interest in stream monitoring grows among MLSA members.

1. Chippewa River Watershed (Isabella, Clare, Midland, Montcalm Co.)
   a. Coldwater Lake (Figure 1, Isabella Co.)

      Stream sampling sites: 1 inlet, 2 outlet
      Past monitoring efforts: none
      Land use: 50% Forest, 30% Agriculture, 20% Residential
   b. Lake Isabella (Figure 1, Isabella Co.)

      Stream sampling sites: 2 inlet, 2 outlet
      Past monitoring efforts: *E. coli*
      Land use: 30% Forest, 50% Agriculture, 20% Residential
2. Grand River Watershed (Barry, Eaton, Ingham, Ionia, Jackson, Kent, Montcalm, Ottawa Co.)
   a. Big Portage Lake (Figure 2, Jackson Co.)

      Stream sampling sites: 2 inlet, 2 outlet
      Past monitoring efforts: none
      Land use: 60% Forest, 35% Agriculture, 5% Residential
   b. Muskellunge Lake (Figure 3, Montcalm Co.)

      Stream sampling sites: 1 inlet, 2 outlet
      Past monitoring efforts: none
      Land use: 10% Forest, 85% Agriculture, 5% Residential
3. Muskegon River Watershed (Clare, Mecosta, Muskegon, Newaygo, Osceola Co.)
   a. Blue, Mecosta and Round Lakes (Figure 4, Mecosta Co.)

      Stream sampling sites: 2 inlet, 2 outlet
      Past monitoring efforts: none
      Land use: 70% Forest, 30% Agriculture, 0% Residential
   b. Hess and Brooks Lakes (Figure 5, Newaygo Co.)

      Stream sampling sites: 2 inlet, 3 outlet
      Past monitoring efforts: none
      Land use: 50% Forest, 50% Agriculture, 0% Residential
   c. Big Lake (Figure 6, Osceola Co.)

      Stream sampling sites: 2 outlet
      Past monitoring efforts: none
      Land use: 20% Forest, 80% Agriculture, 0% Residential
   d. Hicks Lake (Figure 7, Osceola Co.)

      Stream sampling sites: 2 outlet
      Past monitoring efforts: none
      Land use: 60% Forest, 40% Agriculture, 0% Residential

Figure 1: Location of stream monitoring sites on streams entering and leaving Lake Isabella and Coldwater Lake, Isabella County, Michigan. A second inlet site to Coldwater Lake, not present on the map, is located where the Coldwater River crosses Denver Road.

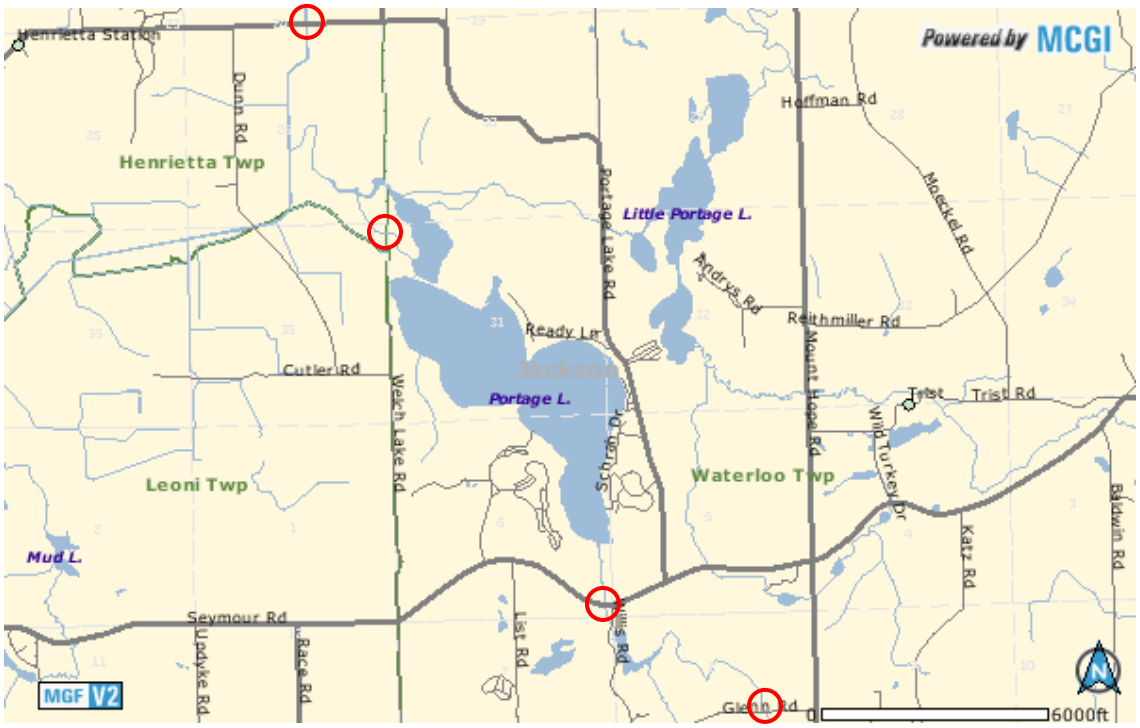

Figure 2: Location of potential stream monitoring sites on streams entering and leaving Big Portage Lake, Jackson County, Michigan.

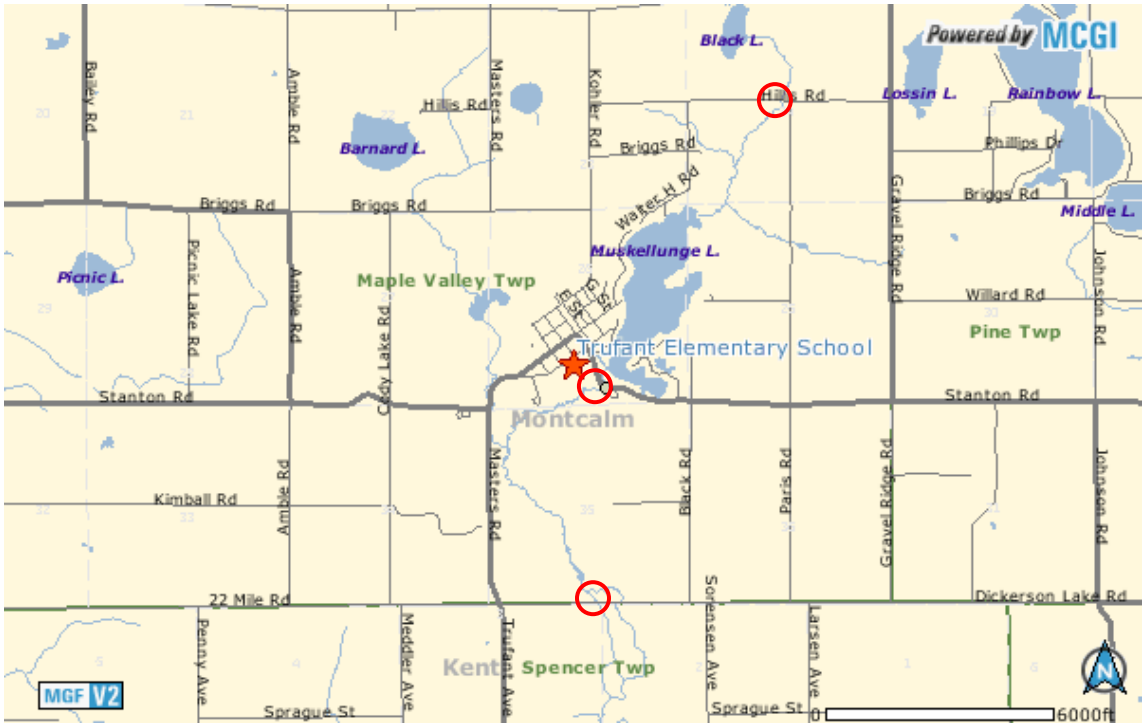

Figure 3: Location of stream monitoring sites on streams entering and leaving Muskellunge Lake, Montcalm County, Michigan.

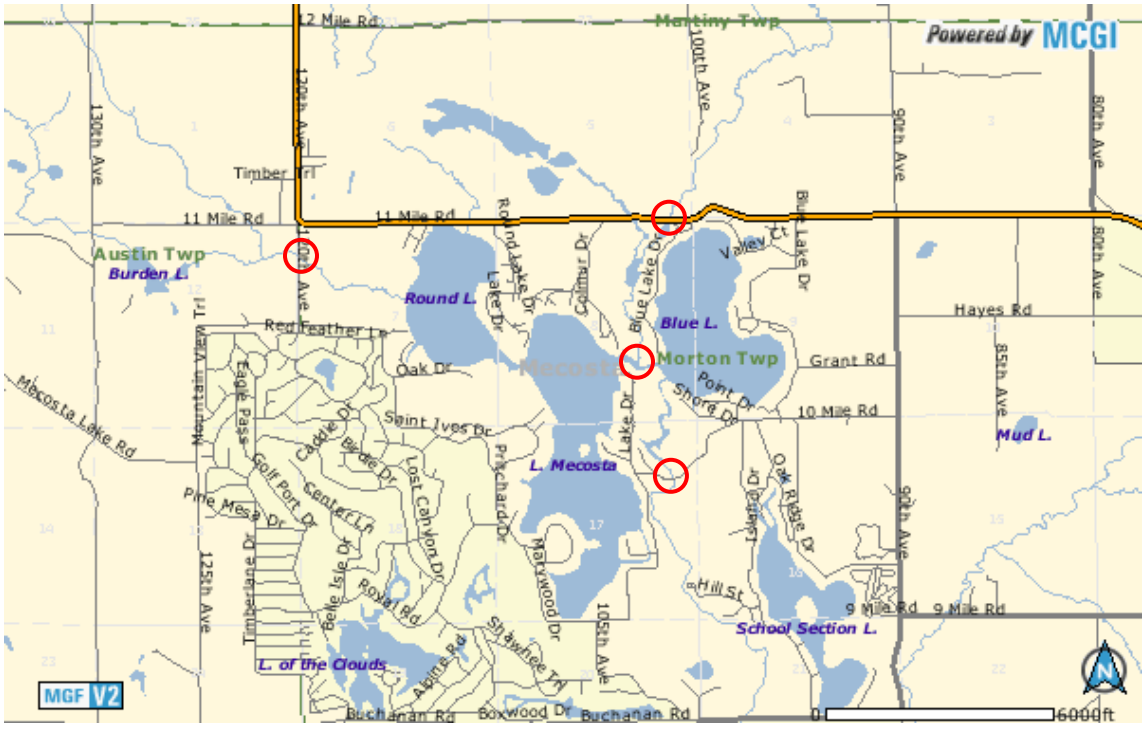

Figure 4: Location of potential stream monitoring sites on streams entering and leaving Blue-Mecosta-Round Lakes, Montcalm County, Michigan.

Figure 5: Location of potential stream monitoring sites on streams entering and leaving Hess and Brooks Lakes, Newaygo County, Michigan.

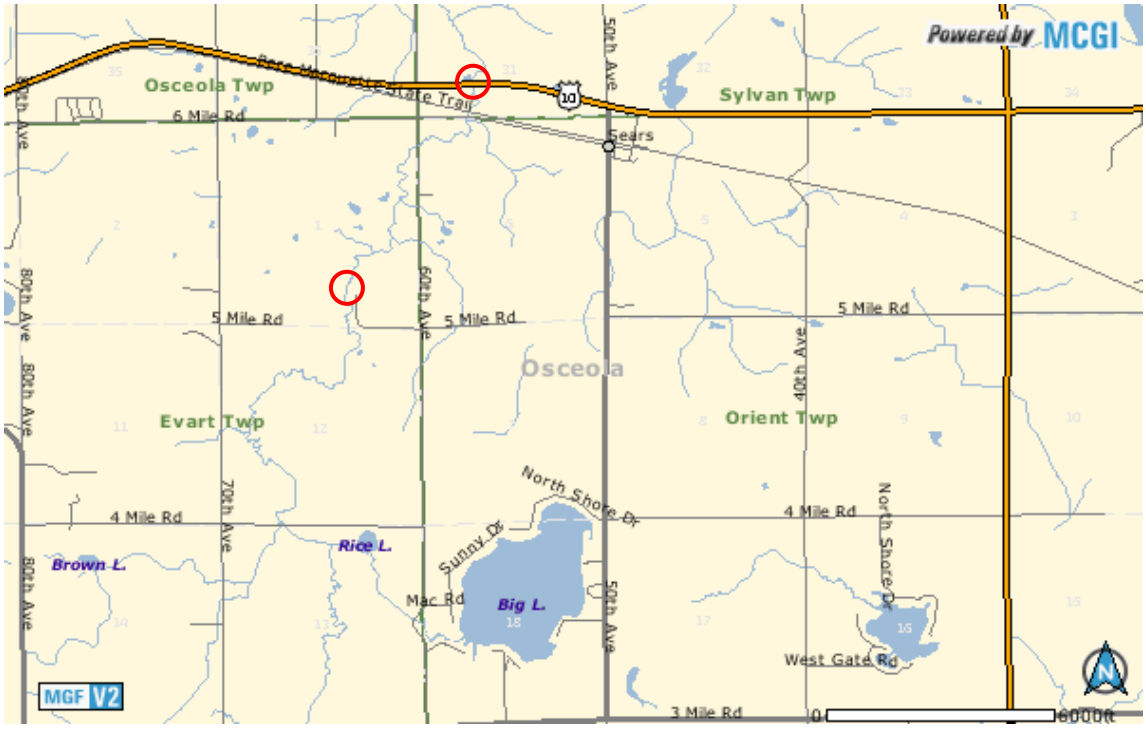

Figure 6: Location of potential stream monitoring sites on streams leaving Big Lake, Osceola County, Michigan.

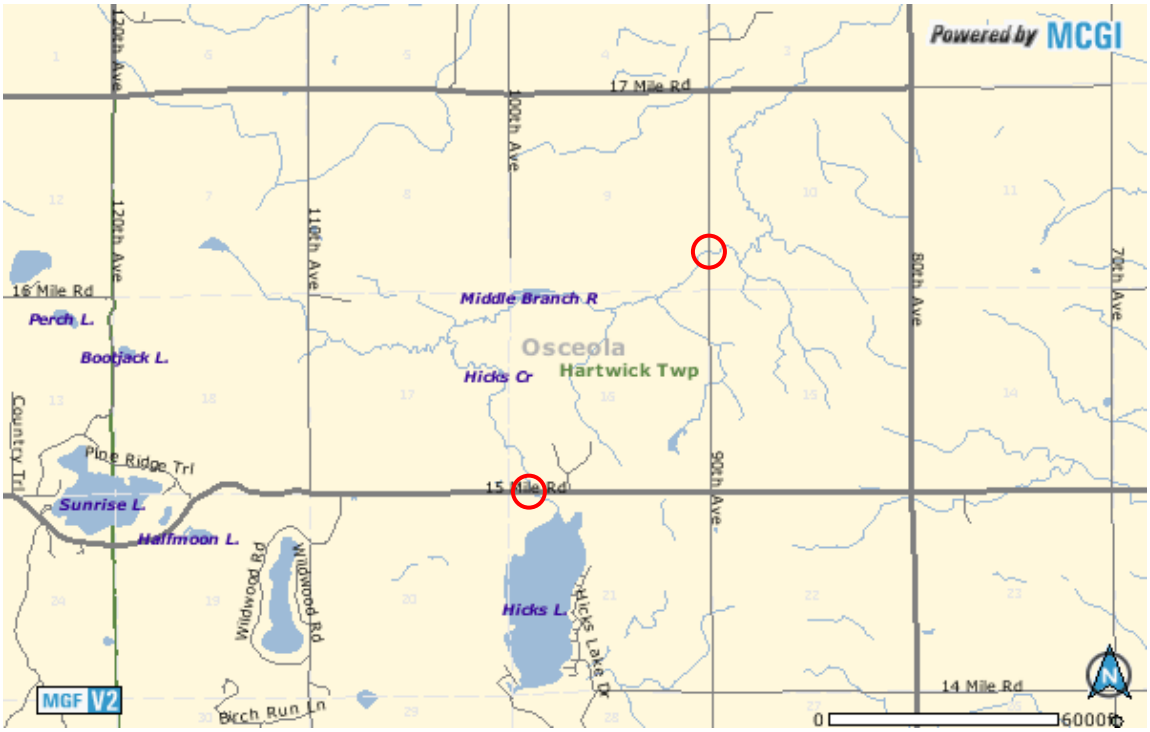

Figure 7: Location of potential stream monitoring sites on streams leaving Hicks Lake, Osceola County, Michigan.

Measurement Parameters

- **Benthic macroinvertebrates**: Collected from two upstream and two downstream sites on one day during May and September. All invertebrates will be identified to order (family if possible).
- **Habitat**: water temperature, dissolved oxygen, stream side vegetation, benthic habitat type.
- **Water quality**: Total phosphorus, total suspended solids
- **Water flow**: Staff gauge height (water level), stream discharge calibration (if time permits)

Macroinvertebrate Monitoring

1. Macroinvertebrates will be collected with D-frame dip nets along a 100-m stretch of river. Invertebrates will be collected from all habitat types during a 30-minute sampling period to ensure a qualitative representation of the total diversity at the site.

2. Dip net samples will be combined in an enamel pan and at least 100 invertebrates will be selected from the pan and placed in a sample bottle.
3. The sample will be preserved with ethanol for later identification in the presence of a trained expert.
4. Invertebrates will be identified to order (family, in some instances) following the MiCorps data sheet. All invertebrates will be classified as 'sensitive', 'somewhat sensitive', or 'tolerant' according to MiCorps tolerance rating.

Tasks

1. **MLSA** will develop and submit to **MiCorps** a Quality Assurance Project Plan (QAPP) within 60 days of contract start date. **MLSA** will implement the QAPP throughout the duration of project.
2. **MLSA** will schedule a joint sampling evaluation event with Project Manager and MiCorps staff.
3. **MLSA** will solicit volunteers from Lake Associations who currently participate in the Cooperative Lake Management Program (CLMP). The study locations in this proposal were chosen from a list of Lake Associations that participate in the CLMP.
4. **MLSA** will contact riparian owners for stream access permission.
5. **MLSA** will coordinate and conduct a training session for volunteer leaders. One volunteer from each Lake Association will be designated the "stream leader." **MLSA** and the Project Manager will contact the stream leader to schedule training and sampling events. The training session will include and indoor component (overview of project, program goals, field data collection methods, and importance of quality data) and an outdoor component (field collection methods and stream habitat analysis). **MLSA** will record the names of all volunteers who attend training sessions.
6. **MLSA** will coordinate and conduct three sampling events for lake association and community volunteers using MiCorps funding. Four-person teams will collect samples during fall 2007, spring 2008, and fall 2008. **MLSA** will continue and expand the inlet-outlet stream monitoring program after MiCorps funding expires.
    a. **MLSA** will assign volunteer groups to sites and provide equipment and data sheets.
    b. **MLSA** will mail information to volunteers regarding the location and times for training sessions.
    c. **MLSA** and the Project Manager will help volunteers collect and analyze macroinvertebrates and water samples from at least two sites on the primary inlet and outlet stream. The first site will be located within 100 meters of the lake. The second site will be located at least 100 meters from the first site. On the outlet stream, the second site will be located at

least 500 m from the first site to minimize the effect of the lake water and atypical flow patterns on the stream community.

d. **MLSA** and the Project Manager will help volunteers record weather conditions, stream habitat characteristics, and land use surrounding the stream site. Volunteers will measure water temperature and dissolved oxygen using hand-held meters during each sampling event.

7. **MLSA** will send collected water samples to the *Michigan Water Research Center* at Central Michigan University where they will be analyzed for Total Phosphorus (TP) and Total Suspended Solids (TSS).
8. **MLSA** will install staff gauges in each stream so that volunteers can record water levels.
9. **MLSA** will coordinate and implement a training session for macroinvertebrate identification and enumeration.
10. **MLSA** staff will create and maintain electronic files with volunteer information and collected stream data. The stream leader will be responsible for sending all collected data to the **MLSA** office.
11. **MLSA** will mail graphs and tables, along with a brief summary of the data, to lake association personnel and local stakeholders. **MLSA** will post data summaries on its web site and publish results in the Michigan Riparian magazine.
12. **MLSA** will be report all data collected by volunteers and analyzed by the *Michigan Water Research Center* to **MiCorps** within 3 months following each sampling event. Water quality, stream habitat, and macroinvertebrate data for streams entering and leaving each study lake will be compiled in an Excel spreadsheet. **MLSA** will submit data to MiCorps Data Exchange Network semi-annually.
13. **MLSA** will submit quarterly status and financial reports following MiCorps guidelines. **MLSA** will develop and submit a final report following MiCorps guidelines.

A7. Data Quality Objectives

Precision: Precision evaluates how consistently a program produces results. Along with bias, precision measures get as close to the accuracy (how close the measurements are to the true value) of results as is possible when conducting biological monitoring.

The following techniques will be reviewed during training and in retraining of team leaders every three years: [1] collecting style (must be thorough and vigorous), [2] habitat diversity (must 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) measure 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 (mean) results and each should have a relative percent difference (RPD) of less than 40%. This statistic will be measured using the following formula:

RPD = [(X - mean) / (mean)] x 100,

where X is the individual measurement for each parameter. The Project Expert will also verify all identifications made by the volunteer teams. An error rate (% correct) should be calculated for each identified sample. The RPD of identifications should be less than 15%.

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 Project Expert at the next sampling event and be considered for retraining.

Additionally, MiCorps staff will conduct a method validation review with the designated Project Expert to ensure his or her expertise, preferably prior to the first training session held by the Project Expert. This will be conducted with each new Project 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 project expert. Any monitoring issues will be addressed on site. If no major concerns remain, the Project Expert will be considered "certified" by MiCorps.

Bias: Bias is a measure of systematic error. Bias can be introduced by the methods used in all sampling events or by individual samplers or teams.

Sites will be sampled by different team leaders at least once every three years in each season (two events among six sampling events, if conducted twice per year) to examine the effects of bias in individual collection styles. An RPD between the new measure and the mean of past measures should be less than 40%. Sites not meeting this DQO will be evaluated as above by the Program Expert.

Completeness: Completeness is a measure of the proportion of data obtained that is judged to be valid. Completeness combines the results from all teams to give the manager a measurement of how the program is functioning overall.

Following a QA 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: This refers to the degree to which the measured data reflect the true conditions in the environment being studied.

Study sites are selected to represent the full variety of stream habitat types available locally, emphasizing the inclusion of riffle habitat. 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 sub-watershed.

Comparability: Comparability is a measure of the confidence with which one data set or method can be compared to another. At the core of this measure is the degree to which sampling methods are identical across all sampling events. The primary goal is for the data from all input and output streams to be comparable, despite being measured by different people at different times.

To ensure data comparability, all volunteers in the watershed will follow the same sampling methods and use the same units of reporting. Program managers and trainers will learn standard MiCorps monitoring methods at annual training sessions and will train 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. 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 Project 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 Project Manager will, if feasible, sample the site. Otherwise, the site will go unmonitored for that season.

A8. Special Training/Certifications

Project Manager and Science Advisor are required to attend an 8-hour MiCorps training event.

Volunteer team leaders are required to attend training events conducted by the Project Manager. An initial training session will include an indoor component (overview of project, program goals, field data collection methods, and importance of quality data) and an outdoor component (field collection methods

and stream habitat analysis). A second training session will focus on identification of stream invertebrates.

Individuals listed below have been trained by MiCorps.

- Scott McNaught – Science Advisor
- Molly Gordon – Project Manager
- Dan Cibulka – Student technician
- Clay Wilton – Student technician

SECTION B: PROJECT DESIGN AND PROCEDURES

B1. Study Design and Methods

MLSA will help lake associations collect and analyze macroinvertebrates and water samples from two sites on the primary inlet and outlet streams. On the inlet stream, the first site will be located within 100 meters of the lake. The second site will be located at least 100 meters from the first site. On the outlet stream, the second site will be located at least 500 m from the first site to minimize the effect of the lake water on the stream community. Three-person teams will collect samples twice each year during the spring and fall.

Macroinvertebrates will be collected with D-frame dip nets along a 100-m stretch of river. Invertebrates will be collected from all habitat types during a 30-minute sampling period. Volunteers will examine dip net samples in white enamel pans and will pick out macroinvertebrates and place them into a wide-mouth sample jar. After approximately 100 invertebrates have been selected from all dip net samples, the sample jars will be labeled and alcohol (95% ethanol) will be added (3:1 alcohol:water) as a preservative. In the laboratory,invertebrates will be identified to order (family, if possible) and will be classified as ‘sensitive’, ‘somewhat sensitive’, or ‘tolerant’ according to MiCorps ratings.

Volunteers will record weather conditions, stream habitat characteristics, and land use surrounding the stream site following MiCorps protocols and using MiCorps data forms. Volunteers will measure water temperature and dissolved oxygen using hand-held meters.

Volunteers will collect water quality samples by filling 500-ml polyethylene bottles in an upstream direction. Sample bottles will be stored on ice and transferred to a refrigerator within 2 hours. Samples will be sent to the Michigan Water Research Center (MWRC) at Central Michigan University (CMU) where they will be analyzed for Total Phosphorus (TP) and Total Suspended Solids (TSS).

Stream discharge (volume per second) will be estimated to facilitate calculation of phosphorus and sediment loads entering and leaving each lake. Flood and low water discharge records for each stream will be retrieved from the MDEQ Land and Water Management Division web site. To estimate discharge values during sampling events and throughout the year, volunteers will install staff gauges in each stream and record water levels. In the future, staff gauge values

can be calibrated by measuring stream depth, width and velocity 5-10 times throughout the year and relating discharge measurements to staff gauge height.

All data collected by volunteers and analyzed by the Michigan Water Research Center will be reported to the MiCorps within 3 months following each sampling event. Water quality and macroinvertebrate data for streams entering and leaving each study lake will be compiled in an Excel spreadsheet. Graphs and tables, along with a brief summary of the data, will be mailed to lake association personnel and local stakeholders. Data summaries will also be posted on the MLSA web site and published in the Michigan Riparian magazine.

B2. Sample Handling and Custody

At the collecting site, all invertebrate sample jars receive a label written in pencil, 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 will also note the number of jars containing the collection from this site. The team leader is responsible for labeling and securely closing the jars, and for returning all jars and all equipment to the Project Manager.

Upon return to Central Michigan University, the collections will be checked for proper labeling. The data sheets will be checked for completeness and for correct information regarding the number of jars containing the collection from the site. The jars will be secured together with a rubber band and site label and placed together in one box. They will be stored at Central Michigan University until they are examined and counted on the day of identification (one or two weeks later). The data sheets will be used on the identification day, after which they remain on file indefinitely.

On the day of identification, the sample identifier will check the data sheet and jars to ensure that all 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 will accompany them. For identification, volunteers will sort all individuals from a single jar into look-alike groups, and then will be joined by an identification expert who confirms the sorting and provides identification of the taxa present. These identifications are then verified by the Program Expert. 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 will be changed in the jars every few years.

B3. Analytical Methods

Parameters:

- *Benthic macroinvertebrates*: Collected from two upsteam and two downstream sites on one day during May and September. All invertebrates will be identified to order (family if possible) according to the MiCorps data sheet.

- *Habitat*: Water temperature, dissolved oxygen, pH, stream side vegetation, benthic habitat type, and land use will be recorded using the MiCorps data sheet.
- *Water quality*: Total phosphorus and total suspended solids samples will be collected and results reported to MiCorps.
- *Water flow*: Staff gauge height (water level) will be recorded during each sampling event. A stream discharge versus staff gauge height relationship will be determined once every 3-5 years for each stream system.

Timing:

- Benthic macroinvertebrates will be sampled within a 2-week period in mid-May and mid-September;
- Habitat characteristics of the sites will be measured once every 3 to 5 years, during the summer or fall.
- Water quality (TP, TSS) will be monitored twice annually in mid-May and mid-September.
- Stream discharge will be monitored on 5-10 occasions (spanning low and high water) once every 3-5 years using a Marsh-McBirney velocity meter.

Equipment:

- YSI temperature and oxygen probes:
- Marsh-McBirney velocity meter:

B4. Quality Control

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. All available habitats within the study site will be sampled and documented to ensure ***representativeness***. In the field, all data sheets will be checked to make sure each habitat type available was sampled. The team leader will examine several picking trays to ensure that representatives from dominant invertebrate groups have been collected. 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. We will estimate ***precision*** of diversity and stream quality indices by calculating relative percent difference.

In the laboratory, sorting will be checked by an expert before identification is complete. The Project Expert will verify all identifications made by the volunteer teams. An error rate (% correct) will be calculated for each identified sample. The RPD of identifications should be less than 15%.

All team leaders 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 will be re-sampled by a new team within two weeks. If a change is confirmed, the site becomes a high priority for the next scheduled collection.

We will evaluate all data sheets for ***completeness.*** We will assess percent complete by dividing the number of measurements judged valid by the number of total measurements performed. If less than 90% of the data are complete, 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.

To ensure data ***comparability***, all volunteers in the watershed will follow the same sampling methods and use the same units of reporting. The program manager and trainers will learn standard MiCorps monitoring methods at annual training sessions and will train 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. 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 Project 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 Project Manager will, if feasible, sample the site. Otherwise, the site will go unmonitored for that season.

B5. Instrument/Equipment Testing, Inspection, and Maintenance

- D-frame nets: firmly attached to poles and free of holes. Stored at CMU.
- Collection jars: poly seal tops intact. Stored at CMU.
- Forceps: tips meet and are not bent or rusted. Stored at CMU.
- Waders: clean, dry and do not leak. Stored indoors at CMU.
- Staff gauges: clean, legible, attached to immovable post or structure.
- YSI temperature and oxygen probes: Temperature will be checked for accuracy in ice water and with an NIST calibrated thermometer once per year. The oxygen probe will be calibrated prior to each use according to manufacture instructions (sit in saturated air for 15 min., set to 100% oxygen saturation). Stored at various Lake Associations or in MLSA office.
- Marsh-McBirney velocity meter: Calibrate once per year by setting meter in still pail of water (zero velocity) for 10 minutes. Stored indoors at CMU.

B6. Inspection/Acceptance for Supplies and Consumables

Supplies	Purchase date	Replacement date
White plastic trays	August 2007	August 2012
Forceps	August 2007	August 2012
Hand lenses	August 2007	August 2012
500-ml polyethylene bottles	August 2007	August 2012
250-ml polyethylene bottles	August 2007	August 2012
Ethanol (95%)	August 2007	August 2008
Office Supplies	August 2007	April 2008
Training Materials	August 2007	April 2008

Trays, forceps and hand lenses will be purchase from Forestry Suppliers. Bottles and ethanol will be purchase from Fisher Scientific.

B7. Data Management

- The Project Manager will enter raw data into a Microsoft Excel spreadsheet. All data will be backed up monthly and a CD will be kept off premises. Computer passwords provide data security. Data sheets will be filed at the MLSA central office for a period of at least five years.
- 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.

SECTION C: System Assessment, Correction and Reporting

C1. System Audits and Response Actions

- Side-by-side sampling will take place in September 2008 during which a team of our volunteers and an outside expert will sample the same stream. Agreement in sample composition between the two should be 70% or greater.
- 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 monitor compliance with quality assurance protocols and report any issues possibly affecting data quality.
- The total diversity reported by each team must equal at least 70% of the diversity previously found at the site. Sites with results less than 70% 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

- MLSA will use standardized field data sheets to facilitate spot-checking. The Program Manager and field assistants can quickly examine the field data sheets to ensure that they are completely and correctly filled out.
- The Program Manager will review the data before it is stored in a computer or file cabinet.
- The Program Manager or his/her designate will spot check computer entries to be sure they match data on field collection sheets.
- MLSA will ask a qualified entomologist to confirm macroinvertebrate identifications. A reference collection of macroinvertebrates will be created for each lake-stream location.
- Reports on progress will be submitted to MiCorps as required, with all quality issues noted.

C3. Reconciliation with Data Quality Objectives

If any data do not meet the DQOs listed in section A7, they will be examined to determine if the results are likely due to sampling error or a true environmental variation. If sampling error is suspected, the data point will be removed from MLSA and MiCorps databases. Volunteer teams that generate more than one aberrant data point will be observed by the Project Manager at the next sampling event and be considered for retraining.

C4. Reporting

Quality control reports will be prepared for each lake-stream location following macroinvertebrate enumeration in the spring and fall. Status reports will address all applicable DQOs listed in section A7. A printed or electronic copy of the status report will be sent to each lake-stream team leader and to the MiCorps office along with spring and fall quarterly project reports.