A1. Title and Approval Sheet

Quality Assurance Project Plan for
Tip of the Mitt Volunteer Stream Monitoring Program

Date: 8-23-2011
Version # 3
Organization: Tip of the Mitt Watershed Council

Program and QAPP manager: Kevin L. Cronk
Title: Monitoring and Research Coordinator

Signature: _____

MiCorps Staff Use

Tracking Number:

Funding Source:

MiCorps Reviewer: _____

☐ Approved ☐ Returned for modifications

Signature of reviewer Date

A2. Table of Contents

Page

A3. Distribution List

Bill Dimond, Michigan Department of Environmental Quality, Water Bureau
Laura Kaminski, Great Lakes Commission
Paul Steen, Huron River Watershed Council
Gail Gruenwald, Tip of the Mitt Watershed Council
Kevin L. Cronk, Tip of the Mitt Watershed Council

A4. Project Organization

1. Management Responsibilities –
    1) Kevin L. Cronk, Monitoring and Research Coordinator, Tip of the Mitt Watershed Council, 426 Bay St, Petoskey, MI, 231-347-1181, kevin@watershedcouncil.org Kevin is the primary project manager and quality assurance manager for the volunteer stream monitoring project. Kevin is the project liaison with ultimate authority for this project. His responsibilities include:
        - Update and adhere to the Quality Assurance Project Plan.
        - Attend 8-hour training session provided by MiCorps.
        - Promote volunteer stream monitoring activities and solicit volunteers and stream access permissions from local community.
        - Research and purchase necessary equipment for performing stream monitoring activities.
        - Coordinate and conduct volunteer stream monitoring training sessions.
        - Coordinate volunteer stream monitoring field data collection sessions.
        - Coordinate and implement macroinvertebrate indoor sorting and identification sessions.
        - Catalogue and store collected specimens.
        - Database development, data entry, and data analysis.
        - Write reports and update web-page with latest information on an annual basis to share with volunteers and the general public.
        - Provision of products and deliverables to MiCorps. All data collected will be sent electronically to the MiCorps database manager on an annual basis.
        - Project evaluation.
    2) Lynn D. Buffington, Business Manager, Tip of the Mitt Watershed Council, 426 Bay St., Petoskey, MI, (231) 347-1181. Lynn's responsibilities include:
        - Development and submission of status reports following MiCorps guidance at a frequency included in the contract.
2. Field Responsibilities – Field sampling will be performed by volunteers. Team leaders and collectors will receive training in field data collection methods by Tip of the Mitt Watershed Council staff.
    1) Leaders will organize and coordinate stream monitoring efforts by individual teams. In the field, leaders will complete data sheets, collect water samples, measure stream water temperature, take depth measurements, and communicate with the collector to ensure thorough biological sampling of the site. In addition,

leaders will provide instruction and guidance to team pickers. After field days, leaders will be responsible for returning equipment, biological samples, water samples and data sheets to Watershed Council staff.

2) Collectors will sample all in-stream habitats that exist at the site and provide sample contents to pickers for processing.
3) Pickers will pick macroinvertebrate specimens from sample contents provided by the Collector, presort the macroinvertebrates, and preserve up to 100 specimens per site in alcohol for later identification.

3. Laboratory Responsibilities – Kevin Cronk, Monitoring and Research Coordinator, Tip of the Mitt Watershed Council, 426 Bay St., Petoskey, MI, (231) 347-1181, kevin@watershedcouncil.org will be responsible for calibrating and maintaining the Watershed Council Hydrolab MiniSonde, which will be used to measure conductivity.
4. Corrective Action – Kevin Cronk, Monitoring and Research Coordinator, Tip of the Mitt Watershed Council, 426 Bay St., Petoskey, MI, (231) 347-1181, kevin@watershedcouncil.org will be responsible for initiating, developing, approving, implementing, and reporting corrective actions.

A5. Problem Definition/Background

According to US Census Bureau statistics the number of inhabitants in the northern counties of the Lower Peninsula doubled between 1960 and 2000. Population pressure is expected to increase at even greater rates, resulting in urban area expansion and consequent negative impacts on surface water quality. Chloride data from the Comprehensive Water Quality Monitoring Program (coordinated by Tip of the Mitt Watershed Council) reveal the widespread human impacts as chloride levels have steadily increased in most of the 50+ lakes and streams monitored throughout Antrim, Charlevoix, Cheboygan and Emmet Counties.

Although volunteers have monitored lake water quality in the northern Lower Peninsula for several decades, streams had been largely neglected. A growing number of lake associations expressed interest in monitoring stream water quality to determine the effects of tributaries draining into their lakes, which prompted the Watershed Council to establish the Tip of the Mitt Volunteer Stream Monitoring program. In 2005, volunteers began monitoring streams to collect baseline water quality data, determine the current health of the streams and begin monitoring changes that may result from human influence.

Three areas were originally targeted for this project: the Lake Charlevoix Watershed; Mullett Lake Watershed (sub-watershed of Cheboygan River); and Elk River Chain of Lakes Watershed. These areas were selected because of development pressure, growth patterns, nonpoint source pollution concerns, and interest from lake associations in stream monitoring. Since 2005, the program has expanded to include sites on three other stream systems: the Bear River; Tannery Creek, and Milligan Creek. However, there remain a great many streams in the Watershed Council service area that are not monitored.

The Sturgeon and Maple Rivers are among the largest tributaries that flow into Burt Lake. These rivers are important biologically with a robust trout fisheries, hydrologically in terms of being important sources of water for Burt Lake and the Inland Waterway), and recreationally for anglers, boaters, and others. Due to the value of these river systems and the interest in protecting them expressed by numerous residents, including members of the local chapter of Trout Unlimited, the Tip of the Mitt Volunteer Stream Monitoring program is expanding to include eight additional monitoring sites; four on each river system.

Tip of the Mitt Watershed Council has a long history of providing aquatic resource information and education to government officials and the local community. Having access to such information generates greater interest in the resource from the public and results in increased awareness and understanding of the environmental and economic values of aquatic ecosystems. Government officials, planners and others are more effective at protecting aquatic resources when water quality data are available to aid in the decision-making process during activities such as master planning and zoning. Water resource professionals and the general public are more successful in promoting stewardship of aquatic resources by using stream water quality data during educational activities.

The data generated from this program has been fully utilized and disseminated at the local and regional level. Tip of the Mitt Watershed Council continually publicizes results through a variety of media (newsletters, newspapers, radio, television, and internet). Results from the program are summarized and presented in annual reports that are sent to Watershed Council members, lake/stream associations, local governments, and other organizations/agencies. Problem areas discovered by volunteer monitoring efforts are investigated, collaboratively with local, state, federal and tribal aquatic resource professionals.

A6. Project Description

The goal of the Tip of the Mitt Volunteer Stream Monitoring program is to protect and improve the water quality of the streams of the northern Lower Peninsula of Michigan. Specific objectives of the program include: collect baseline data, characterize stream ecosystems, identify specific water quality problems, determine water quality trends, and inform and educate the public regarding water quality issues and aquatic ecology. As with the Volunteer Lake Monitoring Program, which has been sponsored and coordinated by the Tip of the Mitt Watershed Council for the last 25 years, volunteer stream monitoring activities will continue to be supported by the Watershed Council into the future.

The key to accomplishing the stated goal is fostering stewardship of aquatic resources through community involvement and education. As more people become involved in monitoring activities and receive water quality education, particularly concerning information regarding the health of local streams, the more likely they are to take care of

their streams and become involved in community decision making that could impact water quality. The information gleaned from monitoring activities, such as water quality trends, is shared with and utilized by local governments and citizens for educational and resource management purposes.

This monitoring program focuses on biological monitoring as a tool to assess stream water quality and ecosystem integrity. Aquatic macroinvertebrates are collected and identified to determine diversity in the benthic community and the presence of pollution-sensitive macroinvertebrate families, the results of which are used to gauge the health of the stream reach. In addition to biological monitoring, volunteers collect water samples to measure conductivity, which is a good indicator of impacts to the stream ecosystem caused by urban and agricultural activity within a watershed. Volunteers also record stream water temperature to note variation within a stream system, identify areas that suffer from thermal pollution, and detect changes over time.

The service area for the Tip of the Mitt Watershed Council includes the counties of Antrim, Charlevoix, Cheboygan, and Emmet as well as portions of major watersheds within these four counties that extend into adjacent counties (Appendix A). Based upon input from local residents and lake/stream associations, streams from six major watersheds are included in the monitoring program. Information regarding the streams that are being monitored are presented by watershed:

I. Lake Charlevoix Watershed, Charlevoix County

1) Water body name: Stover Creek
    1. Location: Charlevoix County, longitude: -85.28, latitude: 45.27
    2. Number of sample sites: 2
    3. Previous monitoring efforts: Aquatic macroinvertebrate communities sampled as part of the Tip of the Mitt Volunteer Stream Monitoring program from 2004 to 2011 with total taxa numbers ranging from 7 to 25.
    4. Environment description: largely agricultural and wetland in the headwaters and more urbanized towards the outlet.
2) Water body name: Horton Creek
    1. Location: Charlevoix County, longitude: -85.09, latitude: 45.29
    2. Number of sample sites: 2
    3. Previous monitoring efforts: physical and chemical water quality data collected from 2001 to 2004, results typical for high-quality streams of northern Michigan. Aquatic macroinvertebrate communities sampled as part of the Tip of the Mitt Volunteer Stream Monitoring program from 2005 to 2011 with total taxa numbers ranging from 10 to 25.
    4. Environment description: forested, agricultural and wetland.
3) Water body name: Boyne River
    1. Location: Charlevoix County, longitude: -84.95, latitude: 45.19
    2. Number of sample sites: 4
    3. Previous monitoring efforts: Aquatic macroinvertebrate communities sampled as part of the Tip of the Mitt Volunteer Stream Monitoring program from 2005 to 2011 with total taxa numbers ranging from 8 to 26.

Physical, chemical and biological water quality data collected by MDEQ, TOMWC, Little Traverse Bay Bands of Odawa, and USGS at many sites throughout the river system.

4. Environment description: forested, wetland and agricultural upstream with urbanized area at outlet. Proposing to discharge Boyne City Waste Water Treatment Plant effluent into wetlands adjacent to river. Some river sections classified as blue ribbon trout stream by the State of Michigan.

4) Water body name: Jordan River
   1. Location: Charlevoix County, longitude: -85.07, latitude: 45.06
   2. Number of sample sites: 4
   3. Previous monitoring efforts: Aquatic macroinvertebrate communities sampled as part of the Tip of the Mitt Volunteer Stream Monitoring program from 2007 to 2011 with total taxa numbers ranging from 14 to 28. Physical, chemical and biological water quality data collected by MDEQ, TOMWC, and USGS at many sites throughout the river system.
   4. Environment description: natural land-cover types in the upper watershed. Agricultural lands and limited residential and urban areas in the lower watershed. Designated natural scenic river and sections classified as blue ribbon trout stream by the State of Michigan.

II. Mullett Lake Watershed, Cheboygan County

1) Water body name: Mullett Creek
   1. Location: Cheboygan County, longitude: -84.59, latitude: 45.53
   2. Number of sample sites: 2
   3. Previous monitoring efforts: water sample collected for analysis by lake association member and showed high nutrients. Aquatic macroinvertebrate communities sampled as part of the Tip of the Mitt Volunteer Stream Monitoring program from 2005 to 2011 with total taxa numbers ranging from 14 to 35.
   4. Environment description: large agricultural operations in headwaters and rest is forested and wetland.
2) Water body name: Kimberly Creek – Little Pigeon River
   1. Location: Cheboygan County, longitude: -84.55, latitude: 45.43
   2. Number of sample sites: 2
   3. Previous monitoring efforts: Aquatic macroinvertebrate communities sampled as part of the Tip of the Mitt Volunteer Stream Monitoring program from 2005 to 2011, total taxa numbers ranging from 12 to 30.
   4. Environment description: forest, wetland, and grassland with substantial agriculture in the upper and mid portions of the watershed.
3) Water body name: Pigeon River
   1. Location: Cheboygan County & Otsego County, longitude: -84.43, latitude: 45.22
   2. Number of sample sites: 2
   3. Previous monitoring efforts: Aquatic macroinvertebrate communities sampled as part of the Tip of the Mitt Volunteer Stream Monitoring program from 2010 to 2011 with total taxa numbers ranging from 9 to 27.

4. Environment description: Landcover in the Pigeon River watershed consists primarily of natural types, including forest, scrub-shrub, grassland and wetland. Limited agricultural and residential areas are found in the lower watershed. The dam just upstream of Pigeon River Country, owned by Song of the Morning Ranch, has failed three times, releasing large quantities of sediments into the river system, negatively impacting fish communities.

III. Elk River Chain of Lakes Watershed, Antrim County

1) Water body name: Eastport Creek
   1. Location: Antrim County, longitude: -85.34, latitude: 45.12
   2. Number of sample sites: 2
   3. Previous monitoring efforts: Fecal coliforms and phosphorus monitored by the Three Lakes Association, which showed high bacteria counts. Aquatic macroinvertebrate communities intermittently sampled as part of the Tip of the Mitt Volunteer Stream Monitoring program from 2005 to 2011 with total taxa numbers ranging from 12 to 29.
   4. Environment description: mix of agricultural, developed and natural.
2) Water body name: Spencer Creek
   1. Location: Antrim County, longitude: -85.26, latitude: 44.86
   2. Number of sample sites: 2
   3. Previous monitoring efforts: Phosphorus and discharge monitored by the Three Lakes Association, which revealed high phosphorus levels. Aquatic macroinvertebrate communities sampled as part of the Tip of the Mitt Volunteer Stream Monitoring program from 2005 to 2008 with total taxa numbers ranging from 4 to 22. Sites on this stream are now monitored by volunteers from the Watershed Center in Traverse City.
   4. Environment description: agriculture scattered throughout, wetlands in headwaters, forested in mid-section, mix of natural and developed in lower section.

IV. Little Traverse Bay Watershed, Emmet County & Charlevoix County

1) Bear River
   1. Location: Emmet County & Charlevoix County, longitude: -84.92, latitude: 45.32
   2. Number of sample sites: 4
   3. Previous monitoring efforts: Physical, chemical and biological water quality data collected by MDEQ, TOMWC, and Little Traverse Bay Bands of Odawa at many sites throughout the river system. Aquatic macroinvertebrate communities sampled as part of the Tip of the Mitt Volunteer Stream Monitoring program from 2005 to 2011 with total taxa numbers ranging from 10 to 26.
   4. Environment description: Primarily forested and wetland with agricultural in the upper watershed (north of Walloon Lake) and urban landcover in the lower watershed.

2) Tannery Creek
    1. Location: Emmet County, longitude: -84.91, latitude: 45.39
    2. Number of sample sites: 2
    3. Previous monitoring efforts: Physical, chemical and biological water quality data collected by MDEQ, TOMWC, and Little Traverse Bay Bands of Odawa at sites throughout the river system. Aquatic macroinvertebrate communities sampled as part of the Tip of the Mitt Volunteer Stream Monitoring program from 2007 to 2010 with total taxa numbers ranging from 7 to 24.
    4. Environment description: Primarily forested and wetland with some agriculture in the upper watershed and urban landcover in the lower watershed.
3) Russian Creek
    1. Location: Emmet County, longitude: -84.95, latitude: 45.35
    2. Number of sample sites: 1
    3. Previous monitoring efforts: Aquatic macroinvertebrate communities sampled as part of the Tip of the Mitt Volunteer Stream Monitoring program from 2007 to 2010 with total taxa numbers ranging from 7 to 24.
    4. Environment description: land-cover consists primarily of forest and wetlands with urban drainage in the headwaters (North Central Michigan College campus) and limited agriculture in the lower section.

V. Burt Lake Watershed, Cheboygan County

1) Maple River
    1. Location: Cheboygan County, longitude: -84.77, latitude: 45.53
    2. Number of sample sites: 4
    3. Previous monitoring efforts: Physical, chemical and biological water quality data collected by MDEQ at sites throughout the river system, results showing generally good water quality. Limited biological monitoring performed by TOMWC near an adjacent golf course with no sign of impairment at that point in time. The Watershed Council monitored macroinvertebrate populations in two locations on the lower Maple River in 1997 and 1998, upstream and downstream of the Hidden River Valley Golf Course to assess impacts from the course. Macroinvertebrate community diversity ranged from 19 to 28 taxa and all sensitive insect orders (Ephemeroptera, Plecoptera, Trichoptera) were found at both sample sites. At that time, the newly constructed golf course did not show any discernable impacts on the macroinvertebrate community. The Michigan Department of Natural Resources surveyed fish populations on the Maple River in 2002 and found three trout species along with a variety of forage fish. Problems noted during the 2002 survey include sedimentation and impoundments.
    4. Environment description: Primarily natural landcover (e.g., forest and wetland) in the watershed with agricultural lands and urban areas mixed in, particularly in the vicinity of Pellston. Dams, both beaver and human, affect the stream ecosystem.

2) Sturgeon River
    1. Location: Cheboygan County, longitude: -84.60, latitude: 45.27
    2. Number of sample sites: 4
    3. Previous monitoring efforts: Physical, chemical and biological water quality data collected by MDEQ at many sites throughout the river system, results showing good water quality. An MDEQ 2005 survey of biological and physico-chemical water quality found that the Sturgeon River and its tributaries are high quality waters and locations surveyed meet the requirements of Michigan Water Quality Standards.
    4. Environment description: Landcover consists primarily of natural types (forest, wetland, scrub-shrub). Urban impacts in the watershed originate from Gaylord in the headwaters, Vanderbilt and Wolverine in mid-watershed, and Indian River toward the mouth. Residential development encroaches on the river in the lower section.

VI. Black Lake Watershed, Cheboygan County

1) Milligan Creek
    1. Location: Cheboygan County, longitude: -84.34, latitude: 45.39
    2. Number of sample sites: 4
    3. Previous monitoring efforts: Physical, chemical and biological water quality data collected by MDEQ at sites throughout the river system. Aquatic macroinvertebrate communities sampled as part of the Tip of the Mitt Volunteer Stream Monitoring program from 2008 to 2011 with total taxa numbers ranging from 8 to 29.
    4. Environment description: Landcover consists primarily of natural types, including forest, wetlands, scrub-shrub, and grassland.

A7. Data Quality Objectives

Precision/Accuracy: Streams monitored in this program are assessed by examining aquatic macroinvertebrate community diversity. Quality control during field data collection, to guarantee precision and accuracy, is accomplished by the Program Manager who accompanies teams to observe their collection techniques and note any divergence from protocols. The Program Manager also performs independent side-by-side collection (duplicate sample) at one of the two sites monitored by the volunteer team. The Program Manager alternates between teams during each sampling event. Considering the number of teams now included in the program, quality control for field data collection is carried out approximately once every five years for each team. As the program expands, the Program manager accompanies new teams during their first macroinvertebrate sampling event and collects duplicate samples.

Techniques reviewed in the field include [1] collecting style (must be thorough and vigorous), [2] habitat diversity (must include all habitats and be thorough in each one), [3] picking style (must be pick thoroughly through all materials collected and pick all sizes and types) [4] variety and quantity of organisms (must ensure that diversity and

abundance at site is represented in sample), and [5] the transfer of collected macroinvertebrates from the net to the sample jars (specimens must be properly handled and jars correctly labeled). Side-by-side sampling results (by program manager) are compared with volunteer team results to determine if there is a strong divergence between diversity measures. If diversity scores vary strongly (using an 80% threshold), then follow-up is carried out wherein program manager reviews methods with team members and encourages attendance at future training sessions.

The accuracy of specimen identification is dependent upon the abilities of the experts aiding in the indoor identification session. Identifications made by experts that have not received course work or training in family level aquatic macroinvertebrate identification or better, are reviewed by the Program Manager or by other qualified aquatic macroinvertebrate taxonomists. At least 10% of the samples processed by experts in question will be reviewed to verify results. If more than 10% of specimens were misidentified, then all the samples processed by that expert will be reviewed.

Additionally, MiCorps staff conducted a method validation review with the Program Manager to ensure his expertise. This review consisted of a joint duplicate sampling event. No collecting deficiencies were identified and therefore, additional training in deficient tasks were not required.

A given site's total diversity (# of families) will be compared to the composite (median) results from the past three years and should be within two standard deviations of the median. 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 and resampled if within a two-week time frame from the original sample. Volunteer teams that generate more than one outlier should be observed by the Program Expert at the next sampling event and be considered for an upcoming side by side.

If no sampling error can be determined and the site has a diversity less than two standard deviations from the median, the site will be resampled by the Program Manager to double-check the diversity numbers and to look for any signs of habitat and water quality degradation.

Regarding physical water quality data collection, accuracy and precision are accounted for by following procedures similar to those established for macroinvertebrate data. The Program Manager accompanying the team measures the stream's conductivity and water temperature at the site using a Hydrolab MiniSonde® (calibrated via procedure outlined in the manual prior to sampling event). Results by teams are compared to expert results. Conductivity measurements between team and expert should not vary by more than 50 microSiemens and temperature should not vary by more than 2 degrees Celsius. If results are outside limits of comparability, data collection techniques will be reviewed with leader. Furthermore, measuring equipment will be calibrated and checked to ensure that

it is functioning correctly as detailed in section B5 of this plan. This protocol will help determine the source of error if unacceptable disparity in readings occurs again.

Bias: Sites will be sampled by different teams at least once every three years 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% for all parameters. Sites not meeting this data quality objective will be evaluated as above by the Program Manager.

Completeness: Following a QA/QC 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 95%. 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 for the program are selected following the methodology described in section B1. As indicated, all available habitats are sampled and documented to assure that the site is representative of other stream segments in the subwatershed. Resulting data from the monitoring program are used to summarize the biological conditions of the contributing subwatershed, as an initial screening mechanism. Since there are not enough resources available to allow the program to cover the entire watershed, some subwatersheds may not initially be represented. Additional subwatershed sites are added as resources and volunteers allow.

Comparability: To ensure comparability, all volunteers participating in the program will follow the same sampling methods and use the same units of reporting. The methods are based on MiCorps standards, which will increase comparability with other MiCorps programs. Periodic reviews of sampling events by the Program Manager will ensure adherence to these standard methods.

A8. Special Training/Certifications

The Program Manager coordinates trainings and ensures that all program personnel and volunteers are properly trained. The Program Manager received Volunteer Stream Monitoring Grantee Training provided by MiCorps staff. This training provides information about basic stream monitoring methods established by MiCorps. Topics covered included stream macroinvertebrate sampling and identification (to the order level), habitat assessment, data management and entry into the MiCorps database, attracting and retaining volunteers, and program evaluation. The training included both indoor and field components, and was currently conducted by Huron River Watershed Council and Great Lakes Commission staff.

Volunteer team Leaders and Collectors are trained by the Program Manager in basic stream monitoring methods prior to field day collections. The training covers program

goals and objectives, biological and physical data collection methods, filling out field data sheets, safety issues, and quality assurance practices. A database is maintained by Tip of the Mitt Watershed Council that lists all volunteers that have received training as well as the date of the training. Leaders and Collectors, as well as other volunteers, are encouraged to attend a training at least every three years to refresh their knowledge of program components and to learn about any changes incorporated into the program. Training refreshers are also accomplished through side-by-side monitoring with the Program Manager.

A course that teaches aquatic macroinvertebrate taxonomy to the family level is now offered at North Central Michigan College and taught by Watershed Council staff. Aquatic macroinvertebrate identification review is also made available to volunteer experts.

A9. Documentation and Records

All data, including information recorded on field datasheets, conductivity measurements, and aquatic macroinvertebrate data are entered into and managed in Microsoft Excel workbooks. Paper datasheets are filed and stored at the TOMWC office. Electronic data are stored on a server and backed up daily, with rotating back-up media stored off premises. Computer passwords provide data security. Data will be stored indefinitely at the Watershed Council office.

B1. Study Design (Experimental Design) & Methods

Monitoring Sites:
Monitoring sites were chosen to assess water quality in areas of concerns and to monitor longitudinal variation in stream systems. Watershed Council staff visited potential monitoring sites on target streams and assessed the sites in terms of habitat diversity present, accessibility, and safety. A geographical information system (GIS) was used to develop maps depicting stream channels, sample sites and watershed boundaries, as well as assess landcover in the watershed (Appendix A).

Mullett Creek, a tributary of Mullett Lake, stretches 11 miles through a 10,400-acre watershed in Cheboygan County. Two sites were chosen on Mullett Creek, one near the mouth on M27 and the other at the Crump Road stream crossing. Physical and chemical water quality was monitored at both sites as part of a tributary study from 2005 to 2007 that was funded by the Mullet Lake Area Preservation Society and conducted by Tip of the Mitt Watershed Council. The study revealed relatively high nutrient inputs, in relation to discharge, from the creek into Mullett Lake, which are thought to be a result of extensive agricultural activity in the watershed. The Crump Road site was chosen because it is located just downstream of one of the agricultural operations in question. The mouth of the stream was chosen as the second site to gauge the cumulative impact of

activity in the watershed and to monitor the quality of water flowing from the stream into the lake.

Kimberly Creek is a headwater stream of the Little Pigeon River. Kimberly Creek is approximately 4 miles long and the Little Pigeon River continues 6 more miles before combining with the Pigeon River and flowing into Mullett Lake. The Little Pigeon River watershed encompasses 13,400 acres of land, of which 4000 acres pertain to Kimberly Creek. Although a large percentage of the land cover in the Kimberly Creek watershed consists of forest and wetland, there is also a substantial portion of agriculture in the mid to upper watershed (Table 1). Livestock have access to the stream in some areas, which raise water quality concerns. Furthermore, the creek flows through a quarry and some local residents are concerned about the impact of quarry operations on the water quality of the Creek. Two sites were selected for monitoring, upstream (Montgomery Rd) and downstream (Quarry Rd) of agricultural and quarry activity.

Table 1. *Percent land cover in stream watersheds taken from 2006 CCAP data.*

Land cover	**Bear**	**Boyne**	**Eastport**	**Horton**	**Jordan**	**Kimberly**	**Milligan**
Agriculture	14.31	14.85	30.32	31.70	18.88	16.36	3.70
Barren	0.23	0.25	0.17	0.01	0.19	1.59	0.07
Forested	48.76	55.90	39.84	47.09	56.42	39.25	47.19
Grassland	6.23	9.34	7.36	7.49	7.73	11.60	6.64
Scrub/shrub	2.22	3.14	3.92	2.49	3.37	5.33	4.25
Urban	3.80	5.37	4.64	2.12	2.69	2.90	0.94
Water	6.37	0.66	0.05	0.02	0.59	0.02	0.75
Wetlands	18.09	10.50	13.71	9.08	10.12	22.95	36.46
Total acres	74,263	45,911	2,155	7,397	117,839	3,977	29,698
Land cover	**Maple**	**Mullett**	**Pigeon**	**Russian**	**Stover**	**Sturgeon**	**Tannery**
Agriculture	12.3	27.95	7.04	23.97	39.98	7.22	38.68
Barren	0.1	0.01	0.12	0.00	0.24	0.11	0.02
Forested	46.6	33.46	57.90	22.05	23.78	59.25	20.69
Grassland	9.8	9.24	8.53	0.39	6.06	11.34	8.23
Scrub/shrub	3.1	3.76	4.70	1.02	2.52	4.80	2.69
Urban	2.9	3.94	1.56	35.71	10.25	4.59	11.96
Water	4.7	0.04	0.79	0.00	0.02	1.14	0.01
Wetlands	20.5	21.61	19.36	16.85	17.16	11.55	17.72
Total acres	107,682	10,398	107,937	370	4,242	126,065	2,130

Stover Creek flows 6.9 miles into Lake Charlevoix just south of the City of Charlevoix. The Stover Creek watershed encompasses 4242 acres, dominated by agricultural lands upstream and largely urbanized towards the mouth (Table 1). Both of these land-cover types potentially contribute to water quality degradation from non-point source pollution. Stover Creek was formerly placed on the State's list of streams with impaired water quality and has been targeted for improvement by Tip of the Mitt Watershed Council. Funds donated by the Charlevoix Community Foundation were used by the Watershed Council to coordinate volunteer monitoring activities in 2004 and as well as a volunteer stream clean-up. Three sites were initially monitored, but the furthest upstream site (Ferry Rd) was eliminated due to frequent low discharge conditions that made it difficult

to accurately sample and assess. Sites currently monitored on Stover Creek include the City of Charlevoix Cemetery on highway M66 and the mouth of the creek, which is adjacent to Irish Boat Shop.

The headwaters of Horton Creek are located less than a mile from Little Traverse Bay, but the creek winds 6.2 miles through an 8850-acre watershed before emptying into the north side of Lake Charlevoix. The watershed is under threat of development due to proximity to the growing urban areas of Petoskey and Charlevoix, and also contains a relatively high percentage of agricultural landcover. Horton Bay Club, a private association with land holdings at the mouth of the creek, is concerned about the health of the creek and potential impacts on the quality of receiving waters at Horton Bay. The Club contracted the Tip of the Mitt Watershed Council to monitor physical and chemical water quality parameters, including bacteria, from 2001 to 2005. Water quality data collected by volunteers supplement this data set and help monitor the impacts of development in the watershed. Two sites were chosen on Horton Creek, one near the mouth on Boyne City Rd and the other towards the headwaters on Church Road. Although greater habitat diversity at the Boyne City Road stream crossing may limit comparisons with data collected at the Church Road crossing, an upstream monitoring station is needed to gauge the cumulative impacts of development in the watershed.

The Boyne River flows into the east end of Lake Charlevoix from a 45,900 acre watershed. The main channel extends 6 miles inland before splitting into the North Branch (6.2 miles) and the South Branch (11.2 miles). The Boyne River contains portions that are considered to have very high water quality, such that it has been classified as a "blue-ribbon" trout stream. However, the Boyne River is not without problems. The river contains many impoundments that likely have thermal impacts on cold water fisheries. Although much of the watershed is forested, development pressure is increasing, particularly around the urban areas of Boyne City and Boyne Falls, and poses a threat to water quality. Furthermore, a proposed option to discharge treated waste water into the lower reaches of the Boyne River during construction of a new waste water treatment plant in Boyne City, put the water quality in the lower section of the Boyne River in jeopardy. Due to the fact that the Boyne River has two major branches, four sample sites were chosen. Volunteers monitor water quality in the headwaters of the North Branch on Thumb Lake Road and on the South Branch at Dobleski Road. Monitoring is also conducted mid-way through the river at Dam Road and toward the mouth of the river at Old City Park on East Street in Boyne City.

Eastport is a small tributary on the north end of Torch Lake that flows 2.3 miles through a 2153 acre watershed. The Three Lakes Association is concerned about water quality of the creek due to testing that has revealed high bacteria counts and moderately high phosphorous levels. There is also a relatively high percentage of agricultural landcover in the watershed. Sites selected for this tributary include the Farrell Road stream crossing in the headwaters and the Highway M88 stream crossing towards the mouth. Both sites have been visited and have a good array of habitats.

Spencer Creek flows 5.7 miles through a 6505 acre watershed into the southeast end of Torch Lake. The Three Lakes Association coordinated a project to model phosphorus inputs into Torch Lake and recorded levels above the EPA recommended threshold of 50 parts per billion in Spencer Creek. The source of phosphorus is unknown, but may be due to agriculture activities scattered throughout the watershed or urban impacts in the lower section. Due to TLA interest and concern for the health of this creek, volunteers monitored stream water quality at two sites; upstream at McPherson Road and downstream at Coy St. in the village of Alden. This stream is now monitored by volunteers in a program coordinated by the Watershed Center of Grand Traverse Bay.

The Maple River is located primarily in Emmet County, with a small piece near the mouth extending into Cheboygan County. The West Branch Maple River originates in the Pleasantview Swamp and Larks Lake, flowing past the Pellston Regional Airport and through the village of Pellston before reaching the Lake Kathleen impoundment. The East Branch, which is much smaller and warmer than the West Branch, begins at Douglas Lake and converges with the West Branch at Lake Kathleen. The West Branch supports a robust brook trout fishery while the East Branch is considered a marginal trout stream due to elevated water temperatures. Downstream of Lake Kathleen, the river has a mixed cold-water fishery of brook trout, rainbow trout, and brown trout. Monitoring sites are upstream and downstream of anthropogenic stressors (e.g., impoundments and urban areas) to assess impacts. Monitoring sites, from upstream to downstream, include: Pleasantview Road, Robinson Road, Woodland Road, and Brutus Road.

The Sturgeon River is located primarily in Cheboygan, though its headwaters extend into both Charlevoix and Otsego Counties. The headwaters are located near the expanding urban area of Gaylord while the lower section passes through and is invariably impacted by the community of Indian River. Furthermore, due to growing awareness of the Sturgeon River's reputation as a high quality stream and its proximity to resort communities on Burt and Mullett Lakes, the lower section of the river has experienced rapid development in recent years. Monitoring sites will be established upstream and downstream of anthropogenic stressors (e.g., impoundments and urban areas) to assess impacts. Monitoring sites, from upstream to downstream, include: Sturgeon Valley Road, Roadside Park on M27, Webb Rd, and M68 in Indian River.

Methods:
Volunteers monitor stream water quality by collecting physical and biological data two times per year, during the months of May and September (Table 2). Physical monitoring includes water temperature and conductivity. Biological monitoring consists of collecting a representative sample of the benthic community.

Water temperature is measured by volunteers using hand-held thermometers to note longitudinal variations in the stream system and impacts on the macroinvertebrate community. Temperature data provide valuable insight into stream systems that contain impoundments and help gauge thermal impacts from streams that flow through urban areas. Water samples collected by volunteers are used to measure conductivity. Conductivity measurements have been demonstrated to be a good surrogate indicator of

human activity in a watershed and are therefore pertinent for streams that flow through or near urban areas.

Table 2. *Annual events schedule for volunteer stream monitoring program.*

Event	Date	Participants
Fall Training	September (2nd week)	Leaders, Collectors, Pickers
Fall Field Day	September (3rd week)	Leaders, Collectors, Pickers
Fall Indoor Sorting	October (1st week)	Leaders, Collectors, Pickers, Experts
Fall Indoor ID	October (2nd to 4th week)	Experts
Spring Training	May (1st week)	Leaders, Collectors, Pickers
Spring Field Day	May (2nd week)	Leaders, Collectors, Pickers
Spring Indoor Sorting	June (1st week)	Leaders, Collectors, Pickers, Experts
Spring Indoor ID	June (2nd to 4th week)	Experts

The biological evaluation of stream water quality consists of a complete sample of the different groups present rather than a random sub-sample because it is based upon community diversity. 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. During field data collection efforts, volunteers attempt to collect specimens from the benthic community from all habitats present at the site. Macroinvertebrates collected from the benthic community are identified to the family level and tallied to calculate diversity indices. Diversity scores are used to rate the health of the stream ecosystem and provide a basis for trend analyses. Results from this program are compared with other data sets available through DEQ and other agencies/organizations for the site in question and compared with locations in the same river system included in this program.

B2. Study Methods

For each sampling event, monitoring by volunteers will be completed within the same two week period each year. If a site is temporarily inaccessible, due to factors such as 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 be responsible to see that the site is monitored unless sufficient redundancy has been included in the monitoring schedule that additional data is not needed.

Field macroinvertebrate data collection: Upon arriving at the site, the leader and collector will inspect the sampling gear to ensure that it is clean. If there is debris or aquatic life on any of the equipment, water withdrawn from the stream with a clean container will be used to clean the equipment at a distance of not less than 100 feet from

any water body. The Leader will instruct and assist other team members in techniques for finding and collecting macroinvertebrates in the sorting pans.

A trained aquatic macroinvertebrate Collector will collect numerous samples at each site with the goal of sampling each habitat type (i.e. riffles, runs, pools, woody debris, etc.) in the stream reach three times. The Collector will also gather rocks, logs, sticks and other debris to collect macroinvertebrates from. Sites on small streams will be sampled for a minimum of 30 minutes while those on large streams will be sampled for at least one hour. D-frame nets will be used to sample all habitat types, the contents of the net will be emptied into shallow white trays, and volunteers will pick aquatic organisms from the tray.

The aquatic macroinvertebrates found by volunteers will be presorted into like groups in cells of an ice-cube or other divided tray. The team member with the greatest knowledge of aquatic macroinvertebrate taxonomy will select a variety of presorted organisms that represents the diversity found at the site and store them in 70% ethanol for later identification. Volunteer teams are encouraged to collect a minimum of 100 specimens, but an emphasis will be placed on collecting a variety of aquatic organisms as opposed to quantity.

The Leader will fill out all sections of the field datasheet. The Collector will provide information to the team Leader in response to questions on the data sheet that review all habitats to be sampled, stream conditions, and any changes in methodology or unusual observations. Potential sources of variability in the stream reach being sampled, such as weather, stream flow, turbidity, and erosion, will be noted on the datasheet. The field data sheet will include sections to record unusual procedures or accidents, such as losing part of the collection by spilling. The Leader will draw a site sketch on the back of the field datasheet that depicts physical features in and around the stream, the locations and types of habitats sampled, where water sample was collected, and other pertinent information (Appendix B).

The Leader and Collector will decide together whether a site needs to have an extended collection time or other variations in procedure. Before leaving the site, the Collector will thoroughly rinse the net to ensure that no organisms are transported to the next site and the Leader will inspect the site to make sure that no equipment or refuse is left behind.

Field physical parameter data collection: Each team will be provided with clean containers that will be used to collect water samples at each site. The Leader will collect water from the middle of the stream at mid-depth, rinsing container and lid three times with stream water before collecting the final water sample. Water samples will not be frozen because freezing affects conductivity readings. Instead, water will simply be placed in the bucket containing monitoring supplies and then delivered to the Watershed Council office on Indoor Sorting Day. Watershed Council staff will measure conductivity of all water samples using a Hydrolab Mini-Sonde® that has been calibrated prior to use.

A handheld thermometer will be used by the Leader to measure water temperature. The thermometer will be placed in the middle of the stream and left in the water for a minimum of five minutes before reading. The Leader will record the water temperature to the nearest degree Celsius.

Indoor identification: Two weeks after the field data collection, volunteers attend an indoor session to sort samples collected at each site. All specimens from a monitoring site are emptied together into a sorting tray. Taxonomic experts help volunteers sort aquatic macroinvertebrates into similar groups (e.g., aquatic insects sorted into orders). After a sample is sorted, groupings of similar macroinvertebrates are placed in separate containers filled with ethanol. Labels placed in each container provide the stream name, sample site location, and date collected. All containers with sorted macroinvertebrates from a particular site are placed together in a bag for later identification by experts.

A separate "expert-only" session is coordinated within two weeks of the sorting session. At this session, volunteer experts with macroinvertebrate taxonomic identification skills identify specimens to the family level. Aquatic macroinvertebrate identifications are checked by the Program Manager as necessary. Family names and the number of specimens belonging to each family are recorded on the ID data sheet (Appendix C). Results at each site are tallied on the ID datasheet to determine index scores. Once identification is complete, all specimens collected at a site are packed into a glass jar with a poly-seal lid and a label with sample site information and sampling date is put inside the jar. If necessary, the Program Manager coordinates additional experts-only sessions to complete sample identification.

Equipment: Field sampling gear includes D-frame nets, sorting trays, waders, and a bucket that contains glass jars full of ethanol and with poly-seal lids, a plastic sample bottle, a thermometer, at least three forceps, at minimum of two eye-droppers, two or more ice-cube trays, a measuring tape, a meter stick, and pencils. All equipment is stored in the Tip of the Mitt Watershed Council office and made available for pick-up by volunteers prior to sampling events. After field sampling, equipment is returned directly to the Watershed Council office or to staff during the indoor sorting session. Equipment is maintained by Watershed Council staff.

B3. Sample Handling and Custody

At the sample site, volunteers write relevant information on a label, including stream name, location, date, and number of containers used to collect specimens, which is placed inside every container used at the site. The field datasheet includes a section to record the number of containers used at the site. Containers used for collecting water samples have the stream name and site location written with indelible marker on label tape that is affixed to the container. The team leader is responsible for putting labels in containers, securely closing the containers, and returning all containers and equipment to the Program Manager. Upon delivery to the Program Manager, all containers are checked for labels. All containers from an individual site are secured together with a rubber band and

placed together in a bag that includes a site label. In addition, datasheets are checked for completeness and to verify that the correct number of containers from the sample site is indicated on the data sheet.

Samples are stored in the Watershed Council office until the indoor session (one or two weeks later). Conductivity is measured for water samples following the indoor session. Team leaders turn field datasheets into the Program Manager, information is entered into a database, and then, datasheets are filed and stored at the Watershed Council office for a minimum of 10 years.

During the indoor session, the Program Manager or other trained personnel check the datasheets and containers to ensure that all the containers, and only the containers, 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. Samples that are sorted, but not identified during the indoor session are placed in multiple containers for each broad taxonomic grouping (usually order-level) and a site label is placed in each container. After sorting specimens, ethanol used in the field will be discarded and specimens will be stored in fresh 70% ethanol. All containers with sorted specimens from an individual site are placed together in a bag labeled with site information, which are then stored for later identification.

During subsequent "expert-only" identification sessions, experts work on one site at a time, identifying all organisms from that site, before packing specimens in a container for long-term storage. All specimens from an individual site are stored in glass containers with Polyseal lining to ensure safe, long-term storage. Labels made of heavy-gauge paper are inserted into containers to provide relevant information, such as stream name, sample site location, and date collected. The containers are checked periodically for alcohol content and refilled as necessary. In the event that the container or lid is found to be faulty, all contents and label are transferred to a new container that is filled with alcohol. Preserved samples are securely stored for a minimum of five years at the Tip of the Mitt Watershed Council office for future reference.

B4. Analytical Methods

Aquatic macroinvertebrates collected by volunteers during sampling events are identified to the family level or lowest taxonomic level possible. Although reference literature for taxonomic identification is dependent upon the preference of the expert, copies of *Aquatic Insects of North America* by R. W. Merritt and K. W. Cummins, *Aquatic Insects of Wisconsin* by W. L. Hilsenhoff, and *Guide to Aquatic Invertebrates of the Upper Midwest* by R.W. Bouchard, Jr. are available during indoor identification sessions. Volunteer experts record specimen identifications from an individual site on a datasheet that includes a list of aquatic macroinvertebrate order and family names most commonly found in Northern Michigan streams. Stereo microscopes with up to 65x magnification are also available during indoor identification sessions to aid the experts. If unable to

process all samples during the identification sessions, Tip of the Mitt Watershed Council staff will complete the identification process.

Three biotic diversity indices are used to rate the water quality of each stream, make comparisons between streams and perform trend analyses within the same stream over time. Diversity indices to be used include: Total Taxa, EPT, and a Hilsenhoff Sensitivity Index. The Total Taxa index is the total number of families found at a sample site during one sample event. The EPT index is the total number of families belonging to the Ephemeroptera, Plecoptera, and Trichoptera orders found at a sample site during one sample event. A system developed by William L. Hilsenhoff to rate the sensitivity of aquatic macroinvertebrates is used to total the number of sensitive families (those receiving ratings of 0, 1, & 2 by Hilsenhoff). All biotic diversity index scores are calculated on the aquatic macroinvertebrate identification datasheet and all information from the datasheet is entered into a Microsoft Excel® workbook.

Descriptive statistics are used to present data for annual stream monitoring reports. Statistical analysis of data will be performed to examine variation between sample sites and trends within sites over time, though statistical procedures for data analysis have not yet been determined. Before conducting statistical analysis, Tip of the Mitt Watershed Council staff will consult with professional statisticians for guidance in choosing the correct statistical procedure and performing statistical analyses.

B5. Quality Control

Equipment Quality Control:

1. Hydrolab Surveyor® unit must be checked and charged if necessary before each event.
2. Calibration solution standards must be checked to ensure that they are not expired and that there is sufficient volume to perform calibrations.
3. Hydrolab MiniSonde® must be calibrated before each field event according to the Hach Company standard calibration procedure from the Hydrolab manual, using a two point calibration with standard solutions. If the Hydrolab will not calibrate correctly or if experiencing any other technical problems, the unit must be sent into the Hach Company for service. If the Hydrolab is not ready for use during the sampling event, the Watershed Council will use a backup YSI conductivity meter that has been calibrated according to specifications. Hydrolab and calibration solutions will be securely stored in the laboratory of the Watershed Council office.
4. Thermometers must be inspected physically for damage prior to use. In addition, thermometers will be checked to verify that they are functioning correctly, by emersion into both boiling and ice water. If the thermometer is damage or not working correctly, it will be disposed of properly and replaced with a new unit.
5. D-frame nets must be inspected for damage and repaired or replaced as necessary.
6. Containers for water sample collection must be checked for damage and cleanliness and cleaned or replaced as necessary.
7. All equipment must be cleaned, dried and stored securely after sampling events.

Field Procedures Quality Control:

1. Replicate water samples must be collected during side-by-side field data collection when a new volunteer team starts monitoring and then every 3-5 years thereafter. A program manager or qualified expert will accompany the team and collect a replicate water sample to verify accuracy of conductivity measurements.
2. Replicate water temperature data must be collected during side-by-side field data collection when a new volunteer team starts monitoring and then every 3-5 years thereafter. A program manager or qualified expert will accompany the team and collect replicate water temperature data to verify accuracy.
3. Replicate benthic macroinvertebrate sampling must be performed during side-by-side field data collection when a new volunteer team starts monitoring and then every 3-5 years thereafter. A program manager or qualified expert will accompany the team and collect benthic macroinvertebrate data to compare diversity indices with those of the team and thus, verify quality control in collection techniques and thoroughness.
4. Once every three years, volunteer monitoring teams are switched to different sites than what they normally monitor to check for potential sampling bias.

Indoor Sorting and Identification Quality Control

1. All containers with macroinvertebrate specimens must be checked by a program manager upon receipt from the volunteer team to assure that they contain labels and are secured together with a rubber band and site label, and placed together in one bag.
2. Field datasheets used by volunteers must be checked for completeness and to verify that the correct number of containers from the sample site is indicated on the form.
3. Prior to identification, datasheets and containers must be checked to ensure that all containers, and only containers from that collection are present prior to emptying them into a white pan for sorting.
4. During the indoor session, if any specimens are separated from the pan during sorting and identification, a site label must accompany them.
5. All samples must be checked and verified by a qualified expert.
6. Following identification, all specimens from the sample site in question must be stored in 70% ethanol in an air-tight container and a label included in the container that includes all relevant information (e.g., stream name, sample site location, and sample event date.).

Data Analysis Quality Control

1. Field datasheets must be reviewed for errors upon receipt by a program manager to minimize errors before entry into a database and subsequent analysis.
2. Calculations for diversity indices must be verified by a program manager to minimize errors before entry into a database and subsequent analysis.
3. Data entered into the computer must be reviewed by comparing hard copy print outs of database with field data sheets.
4. Data analysis methods must be reviewed on a five year basis by qualified professionals.

A quality control check list was developed for use by project managers (Appendix D).

B6. Instrument/Equipment Testing, Inspection, and Maintenance

D-frame nets are inspected before each sampling event to ensure that they are intact. If the nets have come loose from the frame, they are fixed, and if holes or tears are found in the netting, nets are replaced prior to use. Containers for collecting water samples are also be inspected before each event and cleaned or replaced as necessary.

The Hydrolab MiniSonde® Multiprobe and YSI Model 30 Conductivity Meter are used regularly by Watershed Council staff for a variety of projects and thus, are tested, inspected, and maintained on a continual basis. Maintenance for this equipment is tracked in a spreadsheet. Watershed Council staff return equipment to respective companies of origin if service is required.

Thermometers are inspected physically for damage and compared to other thermometers and/or the Hydrolab to verify that they are functioning correctly, prior to the sampling event. If equipment has been damaged or is malfunctioning, replacement thermometers are purchased by the Tip of the Mitt Watershed Council. All equipment is stored in the Tip of the Mitt Watershed Council office.

B7. Instrument/Equipment Calibration and Frequency

Conductivity is measured using a Hydrolab MiniSonde® Multiprobe. Prior to use, the MiniSonde® receives a two-point calibration based upon procedures provided in the manual, using a standard potassium chloride solution of 447 µS at 25° Celsius. The following are specs provided by Hach Company for the Hydrolab MiniSonde® 4a Multiprobe: Range: 0-100 mS/cm, Accuracy: +/- 0.5% of reading +/- 0.001 mS/cm, Resolution: 0.001.

If calibration fails, the procedure is repeated until calibration is successful. If unable to calibrate successfully, conductivity is measured with a back-up unit (YSI Model 33 Conductivity meter) that is properly calibrated prior to use.

B8. Inspection/Acceptance for Supplies and Consumables

A list of monitoring supplies and consumables, including dates of purchase and projected replacement, has been developed in a Microsoft Excel workbook (Appendix E). Supplies will be maintained by program managers and stored at the Watershed Council office.

B9. Non-direct Measurements

Data from the Michigan Department of Environmental Quality (DEQ) streams database may or may not be used to make comparisons between sites, with the same site, or for trend analysis. Information about stream data collected by DEQ can be found at the following website: http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3728---

,00.html. Data from other agencies or organizations, such as the Little Traverse Bay Band of Odawa Indians, may be used for the same purposes. All data generated outside the Tip of the Mitt Volunteer Stream Monitoring program are only used if field methods are similar and specimens have been identified to the same taxonomic level (usually family).

B10. Data Management

Tip of the Mitt Watershed Council staff ensure that field datasheets are turned in with collected specimens when brought in by volunteers from the field. Following the indoor session, information from both field datasheets and specimen identification datasheets is inputted into a comprehensive stream water quality Microsoft Access® database, designed and created by Watershed Council staff. Either program managers or a single trained volunteer inputs the data into the database. All inputted data are verified with raw data from datasheets.

Once a year, all new data are exported to a compatible format and sent to MiCorps for inclusion in the MiCorps data exchange. Digital data are stored on the Watershed Council server, which is backed up daily, a copy of which is taken home each week day by a designated staff person. Hard-copy data sheets are stored at the Watershed Council office for a period of at least ten years. If the program were to be discontinued, the Watershed Council would consult with MiCorps staff regarding the fate of stored data.

C1. Assessments and Response Actions

Volunteer team leaders trained by Tip of the Mitt Watershed Council or MiCorps monitor to ensure that quality assurance protocols are followed and report any issues possibly affecting data quality. Program managers accompany groups in the field to perform side-by-side sampling and verify the quality of work by the volunteer team. Details of this process and assessment of data quality are outline in section A7. Response to quality control problems is also included in section A7.

If deviation from the QAPP is noted at any point in the sampling or data management process, the affected samples are flagged in the database and are not used for stream assessment or comparisons. Re-sampling is conducted if feasible, given that the deviation is noted soon after occurrence and volunteers are available. Otherwise, a gap must be left in the monitoring record and the cause noted. All corrective actions are documented and communicated to MiCorps.

C2. Reporting

Throughout the duration of this project funded by DEQ (next two years), quality control reports will be included with quarterly project reports that are submitted to the Great

Lakes Commission and DEQ. After, quality control reports will be generated as quality control issues occur and shared internally with staff members involved in the project as well as the executive director of the Watershed Council and will be sent to MiCorps. Quality control reports will provide information regarding and 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.

Watershed Council staff publish yearly reports to share results of the program with volunteers, lake and stream associations, and the general public. Data and reports are made available through the Watershed Council web page (http://www.watershedcouncil.org).

D1. 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. A program manager or a single trained volunteer reviews data before it is stored in a computer or file cabinet. After data has been compiled and entered into a computer file, they are verified with raw data from field and identification datasheets. Volunteer experts conduct identification with the aid of dissecting microscopes (with a maximum enlargement of 65x), consultation with dichotomous keys (*Guide to Aquatic Insects of the Upper Midwest*, Bouchard, *Aquatic Insects of Wisconsin*, Hilsenhoff and *Aquatic Insects of North America*, Merritt and Cummins), and the use of a reference collection on-hand at the Watershed Council office. Identification results from volunteer experts are confirmed by experienced aquatic entomologists.

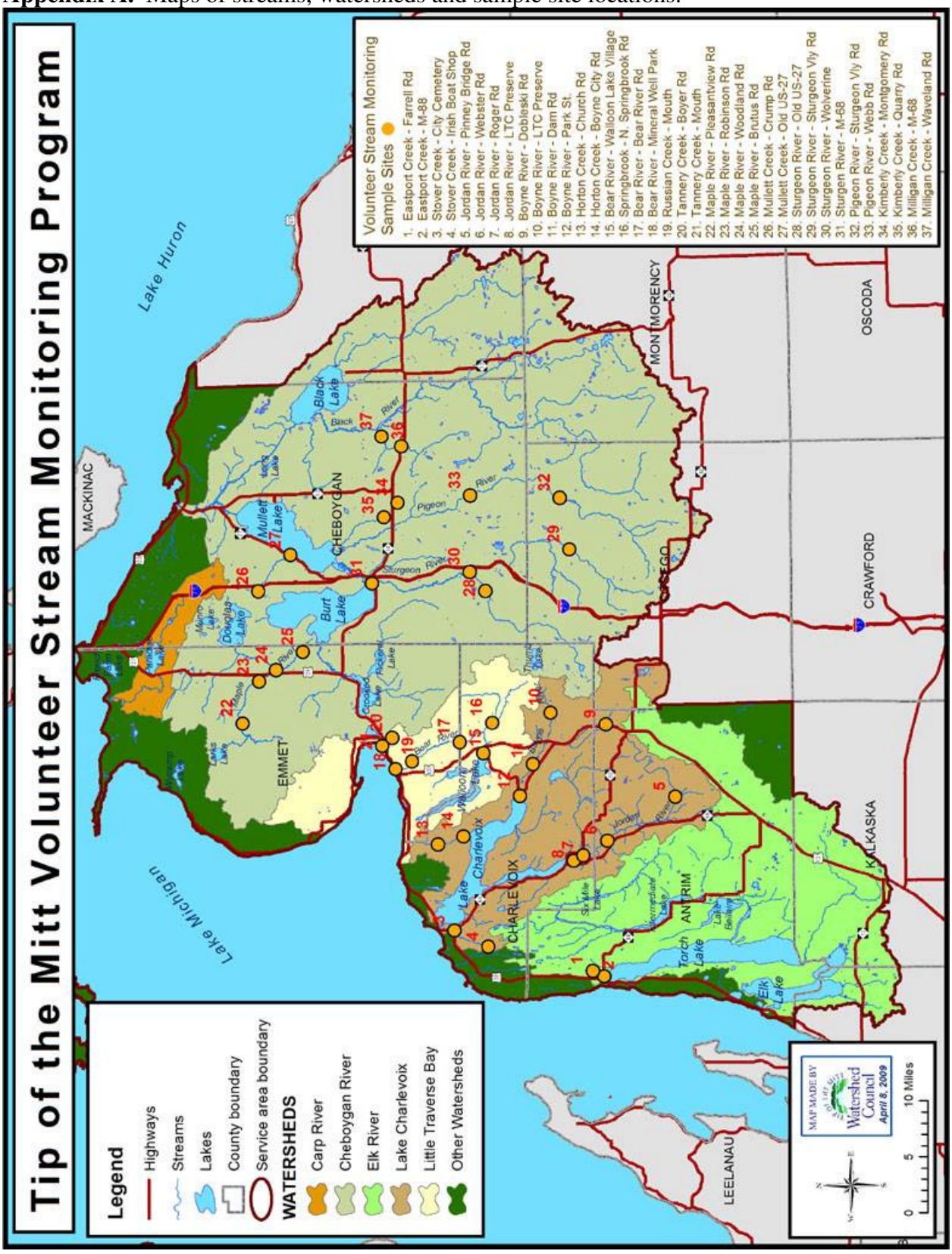
Experts who assist in macroinvertebrate identification quality control include:

1. Kevin Cronk, Tip of the Mitt Watershed Council, M.S. in Aquatic Ecology, University of Michigan, coursework in aquatic macroinvertebrate taxonomy.
2. Kathy Colby, Biology Professor at -North Central Michigan College, coursework in aquatic macroinvertebrate taxonomy.
3. Mike Winnell, M.S. University of Michigan, 30 years experience in aquatic macroinvertebrate identification with Freshwater Benthic Services, Inc.

D2. Reconciliation with Data Quality Objectives

Data quality objectives are reviewed on an annual basis to ensure that objectives are met. Any data quality problems are reported to program managers and MiCorps for assessment and corrective actions. In addition, data quality issues are recorded as a separate item in the database and provided to all data users. Specific response to and reconciliation of problems that occur in data quality are outlined in section A7.

Appendix A. Maps of streams, watersheds and sample site locations.



Appendix B. Tip of the Mitt stream monitoring datasheet.

TOMWC Site ID#:_____

Watershed Council

Tip of the Mitt Stream Monitoring Datasheet

Stream Name: _____ **Major Watershed:** _____

Location: _____ (Please circle: *Upstream* or *Downstream* of road?)

Date: _____ **Water Sample Collected** Yes No **#of Jars Used:** _____

Collection Start Time: _____ (AM/PM) **Collection End Time:** _____ (AM/PM)

Monitoring Team {please put number of years with program in parentheses, e.g. "Mary Smith (3)"}:

Name of Person Completing Datasheet: _____

Collector: _____

Other Team Members: _____

Stream Conditions: Water temperature: _____ (°C or °F) Average Water Depth: _____ (ft)

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

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

Water turbidity/clarity (circle): Clear Somewhat turbid (cloudy) Very turbid (muddy)

Weather (today and note rain from last few days): _____

_____

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

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

Did you see, but not collect, any **live crayfish**? (___ Yes ___ No), or **large clams**? (___ Yes ___ No)
Other wildlife & fish? (___ Yes ___ No) Describe: _____

_____

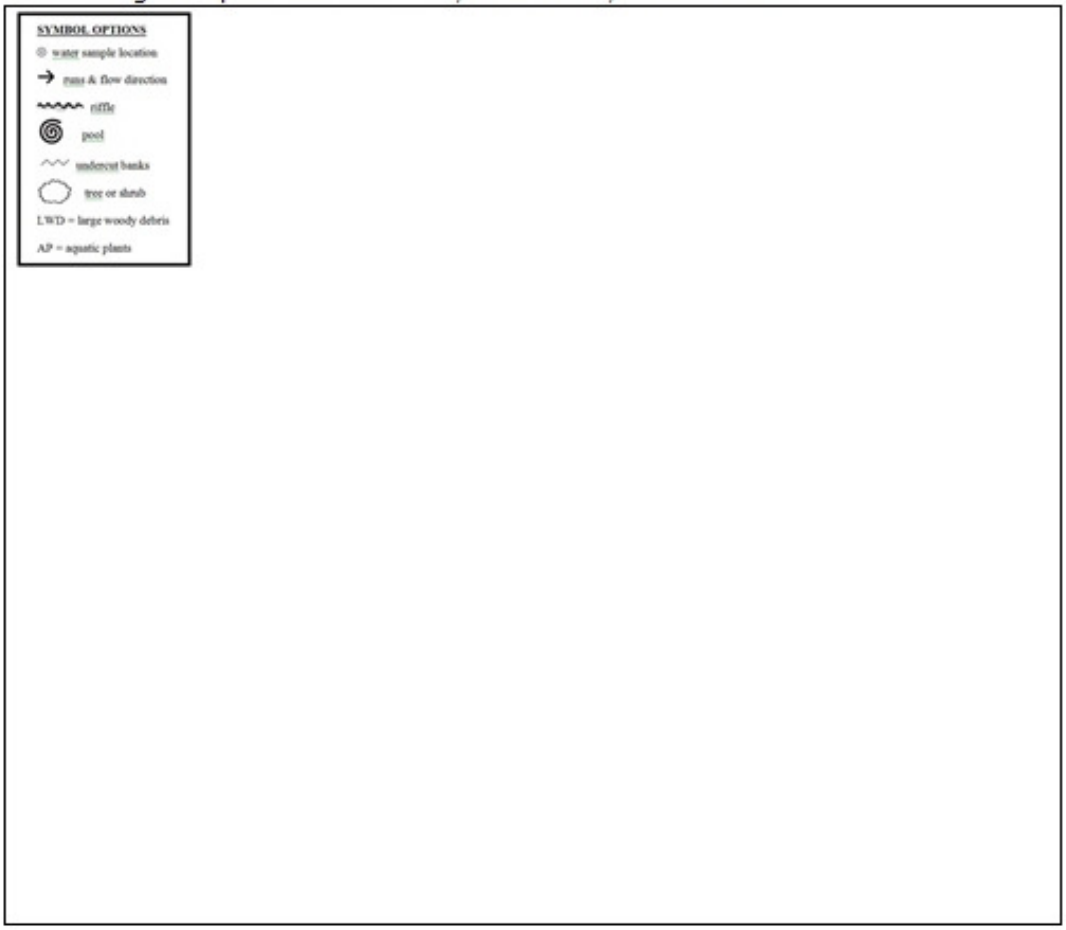
Datasheet checked for completeness by: _____ Datasheet version 5/23/11
Data entered into TOMWC database by: _____ Date: _____

TOMWC Site ID#:_____

Stream Name:_____Location:_____

SITE SKETCH

Please make a sketch showing the length and shape of the stream reach that was sampled by your volunteer group. Remember to include where water sample was collected, approximate locations of habitat types (riffles, runs, pools, woody debris, etc.), approximate distances of stream length sampled and stream width, flow direction, and north arrow.



Other comments (were there any changes in methodology or unusual observations?):_____

_____

_____

_____

_____

_____

_____

Datasheet checked for completeness by:_____ Datasheet version 5/23/11

Data entered into TOMWC database by:_____ Date:_____

Appendix C. Tip of the Mitt aquatic macroinvertebrate identification datasheet.

Macroinvertebrate Identification Datasheet

Volunteer Stream Monitoring Program

Tip of the Mitt Watershed Council

Stream Name:_____ Date Collected:_____

Site location:_____ Site ID:_____

Volunteers sorting:_____

_____

Expert identifier:_____ Checked by:_____

Order	Family	Sensitive	Count	TOTAL
Amphipoda	Gammaridae	NO		
Amphipoda	Hyallelidaee	NO		
Coleoptera	Dryopidae	NO		
Coleoptera	Dytiscidae	NO		
Coleoptera	Elmidae	NO		
Coleoptera	Gyrinidae	NO		
Coleoptera	Haliplidae	NO		
Coleoptera	Hydrophilidae	NO		
Coleoptera	Psephenidae	NO		
Collembola	*(Springtails)*	NO		
Decapoda	Cambaridae	NO		
Diptera	Athericidae	YES		
Diptera	Ceratopogonidae	NO		
Diptera	Chironomidae	NO		
Diptera	Dixidae	YES		
Diptera	Empididae	NO		
Diptera	Simuliidae	NO		
Diptera	Stratiomyidae	NO		
Diptera	Tabanidae	NO		
Diptera	Tipulidae	NO		
Ephemeroptera	Baetidae	NO		
Ephemeroptera	Baetiscidae	NO		
Ephemeroptera	Caenidae	NO		
Ephemeroptera	Ephemeridae	NO		
Ephemeroptera	Ephemerellidae	YES		
Ephemeroptera	Heptageniidae	NO		
Ephemeroptera	Isonychiidae	YES		
Ephemeroptera	Leptohyphidae	NO		
Ephemeroptera	Leptophlebiidae	YES		
Ephemeroptera	Metrotopodidae	YES		
Gastropoda	Ancylidae	NO		
Gastropoda	Lymnaeidae	NO		
Gastropoda	Physidae	NO		
Gastropoda	Planorbidae	NO		
Gastropoda	Pleuroceridae	NO		
Gastropoda	Valvatidae	NO		
Gastropoda	Viviparidae	NO		
Heteroptera	Belostomatidae	NO		
Heteroptera	Corixidae	NO		
Heteroptera	Gerridae	NO		
Heteroptera	Mesoveliidae	NO		

Order	Family	Sensitive	Count	TOTAL
Heteroptera	Notonectidae	NO		
Heteroptera	Pleidae	NO		
Heteroptera	Veliidae	NO		
Hirudinea	*(Leeches)*	NO		
Hydracarina	*(Mites)*	NO		
Isopoda	Asellidae	NO		
Lepidoptera	Pyralidae	NO		
Megaloptera	Corydalidae	YES		
Megaloptera	Sialidae	NO		
Nematomorpha	*(Horsehair worms)*	NO		
Odonata	Aeshnidae	NO		
Odonata	Calopterygidae	NO		
Odonata	Coenagrionidae	NO		
Odonata	Cordulegastridae	NO		
Odonata	Corduliidae	NO		
Odonata	Gomphidae	YES		
Odonata	Libellulidae	NO		
Oligochaeta	*(Aquatic worms)*	NO		
Pelecypoda	Dreissenidae	NO		
Pelecypoda	Sphaeridae	NO		
Plecoptera	Capniidae	YES		
Plecoptera	Leuctridae	YES		
Plecoptera	Nemouridae	YES		
Plecoptera	Perlidae	YES		
Plecoptera	Perlodidae	YES		
Plecoptera	Pteronarcyidae	YES		
Plecoptera	Taeniopterygidae	YES		
Trichoptera	Brachycentridae	YES		
Trichoptera	Glossosomatidae	YES		
Trichoptera	Helicopsychidae	NO		
Trichoptera	Hydropsychidae	NO		
Trichoptera	Lepidostomatidae	YES		
Trichoptera	Leptoceridae	NO		
Trichoptera	Limnephilidae	NO		
Trichoptera	Molannidae	NO		
Trichoptera	Philopotamidae	NO		
Trichoptera	Phryganeidae	NO		
Trichoptera	Polycentropodidae	NO		
Trichoptera	Psychomyiidae	YES		
Trichoptera	Rhyacophilidae	YES		
Trichoptera	Uenoidea	NO		
Turbellaria	*(Flat worms)*	NO		
			Total Families:	
			EPT Families:	
			Sensitive Families:	

Appendix D. Quality control check list.

Tip of the Mitt Volunteer Stream Monitoring Program Quality Control Check List

Date: _____ Name of program manager: _____

Prior to sampling event:

1. Charge Hydrolab Surveyor unit [ ]
2. Check calibration solutions (expiration and quantity) [ ]
3. Calibrate Hydrolab MiniSonde [ ]
4. Check thermometers for damage & accuracy [ ]
5. Check nets for damage and repair/replace if necessary [ ]
6. Check water sample containers for damage & cleanliness [ ]

During sampling event:

7. Review and guide volunteer leading procedures [ ]
8. Review and guide volunteer collecting techniques [ ]
9. Review and guide volunteer picking techniques [ ]
10. Collect replicate water sample for conductivity analysis [ ]
11. Collect replicate water temperature measurements [ ]
12. Collect replicate macroinvertebrate sample [ ]

After sampling event:

13. Ensure that containers have labels inside [ ]
14. Secure containers with rubber band and label [ ]
15. Review field data sheet for errors and completeness [ ]
16. Review data sheet for correct number of containers [ ]
17. Clean, dry and store equipment [ ]

Indoor sorting and identification:

18. Ensure all (and only) jars from site are present [ ]
19. Ensure site labels accompany and specimens removed [ ]
20. Ensure that all samples are reviewed by an expert [ ]
21. Store samples (with labels) in ethanol [ ]

Data review and analysis:

22. Review field records for errors prior to data entry [ ]
23. Repeat all diversity calculations prior to data entry [ ]
24. Compare database records with hard copies [ ]

Appendix E. Sample list of monitoring supplies and consumables.

Item	Quantity	Price	Total	Vendor	Purchase Date	Funding source
Pocket Seine	3	33.15	$113.27	BioQuip	10/28/2004	CCCF
Sorting Trays (12 well)	8	3.35	$26.80	BioQuip	10/28/2004	CCCF
Larval tray - sorting	4	9.5	$38.00	BioQuip	10/28/2004	CCCF
Petri dishes - disposable	20	3.95	$79.00	BioQuip	10/28/2004	CCCF
Teasing needles	6	0.5	$3.00	BioQuip	10/28/2004	CCCF
Transparent rulers	6	0.55	$3.30	BioQuip	10/28/2004	CCCF
Fiberoptic light	1	298.45	$298.45	BioQuip	10/28/2004	CCCF
Forceps, straight point	6	6.25	$37.50	BioQuip	10/28/2004	CCCF
Forceps, narrow tip	6	2.65	$15.90	BioQuip	10/28/2004	CCCF
Dropping pipette	6	0.5	$3.00	BioQuip	10/28/2004	CCCF
Petri dish, glass	2	10.8	$21.60	BioQuip	10/28/2004	CCCF
Stereo microscope	1	442	$442.00	BioQuip	10/28/2004	CCCF
D-frame net, 12"	4	52.25	$209.00	BioQuip	10/28/2004	CCCF
AQUATIC NET 12"D SHAPE.	10	$53.80	$538.00	BioQuip	9/1/2005	MiCorps
AQUATIC NET BAG D-SHAPE, 12"	10	$12.70	$127.00	BioQuip	9/1/2005	MiCorps
FORCEPS, NARROW TIP	50	$4.45	$222.50	BioQuip	9/1/2005	MiCorps
STEREO MICROSCOPE, 15X EYEPCS	1	$327.00	$327.00	BioQuip	9/1/2005	MiCorps
STEREO MICROSCOPE, 20X EYEPCS	1	$442.00	$442.00	BioQuip	9/1/2005	MiCorps
FIBEROPT LIGHT SOURCE 20W	2	$313.00	$626.00	BioQuip	9/1/2005	MiCorps
SIEVE KIT, 4/KIT WIRE MESH #5,10,60,230	1	$59.85	$59.85	BioQuip	9/1/2005	MiCorps
Medicine Dropper, Plastic, 3 1/2 in, Pk 12	4	$3.35	$13.40	Carolina	9/1/2005	MiCorps
Ethanol, 95%, Lab Grade, 20 L	2	$79.95	$159.90	Carolina	9/1/2005	MiCorps
Bottle, Polyethylene, Widemouthed, 500 mL	20	$1.65	$33.00	Carolina	9/1/2005	MiCorps
Write-On Label Tape, Bel-Art, 1 in x 40 yd	2	$12.60	$25.20	Carolina	9/1/2005	MiCorps
Unitary Wash Bottle, Widemouthed, 250 mL	2	$4.00	$8.00	Carolina	9/1/2005	MiCorps
Unitary Wash Bottle, Widemouthed, 500 mL	2	$4.85	$9.70	Carolina	9/1/2005	MiCorps
Dissecting Needle, Plastic Handle, Straight	5	$0.90	$4.50	Carolina	9/1/2005	MiCorps
Gratnell Storage Tray, Yellow, Small	5	$5.75	$28.75	Carolina	9/1/2005	MiCorps
Gratnell Tray Insert, 8 Compartment	5	$6.75	$33.75	Carolina	9/1/2005	MiCorps
Gratnell Clip-On Lid	5	$3.20	$16.00	Carolina	9/1/2005	MiCorps
Thermometer Armors, 12″	10	$6.35	$63.50	WARD'S	9/1/2005	MiCorps
Red Alcohol Thermometers, -20° to +110°C	10	$4.35	$43.50	WARD'S	9/1/2005	MiCorps
Tray with Pour Lip	10	$12.25	$122.50	WARD'S	9/1/2005	MiCorps
Meter Stick, Wood	10	$3.25	$32.50	WARD'S	9/1/2005	MiCorps
2 Ounce (oz) Flint (Clear) Glass AC Jar	288	$0.43	$146.54	M Jacob&Sons	9/2/2005	MiCorps
38-400 Black Phenolic Polyseal Liner	288	$0.15	$43.44	M Jacob&Sons	9/2/2005	MiCorps
Waders, lug sole	9	$59.95	$553.30	Cabela's	9/9/2005	MiCorps
Waders, felt sole	2	$49.95	$99.90	Cabela's	9/9/2005	MiCorps
McCafferty ID Books	2	$55.57	$111.14	Amazon	9/13/2005	MiCorps
Forceps, fine-tipped	12	$5.95	$81.40	BioQuip	6/7/2006	TOMWC
STORAGE TRAY,GRATNELL,SM,YLW	10	$5.75	$72.45	Carolina	3/27/2007	PHSACF
FORCEPS,ECO DISSECTING,NICKEL	15	$1.30	$19.50	Carolina	3/27/2007	PHSACF
736907-MEDICINE DROP,PL PK12	2	$3.50	$7.00	Carolina	3/27/2007	PHSACF
MEDICINE DROPPER, PLASTIC	24	$0.00	$0.00	Carolina	3/27/2007	PHSACF

BOTTLE, WASH, WIDE, 500ML, EA	3	$3.80	$11.40	Carolina	3/27/2007	PHSACF
THERM, RED, TOTAL,-20-110C,EA	2	$4.70	$9.40	Carolina	3/27/2007	PHSACF
SORTING TRAY, 12 WELL, WITH LID	10	$3.90	$60.28	BioQuip	3/27/2007	PHSACF
AQUATIC NET 12"D SHAPE .	2	$56.50	$113.00	BioQuip	3/27/2007	PHSACF
AQUATIC NET 12"D SHAPE .	2	$56.50	$140.92	BioQuip	10/12/2007	PHSACF
SHELL VIALS, 1/4 DR.	4	$21.60	$86.40	BioQuip	10/12/2007	PHSACF
Economy Dissecting Forceps	12	$1.10	$24.17	Ward's	10/12/2007	PHSACF
Thermometer Armors, 12&Prime	5	$7.25	$36.25	Ward's	10/12/2007	PHSACF
Celsius Red Alcohol Thermometers,	5	$4.35	$21.75	Ward's	10/12/2007	PHSACF
Watchmaker Forceps	3	$6.75	$20.25	Ward's	10/12/2007	PHSACF
Cabela's Felt Sole Waders	2	$54.95	$122.85	Cabela's	10/12/2007	PHSACF
STORAGE TRAY,GRATNELL,SM,YLW	5	$5.75	$35.70	Carolina	10/15/2007	PHSACF
Econ. Dissecting Forceps, 4 1/2"	12	$0.00	$0.00	Ward's	10/24/2007	PHSACF
THERM, RED, 6", PRTL,-10-110C	5	$5.05	$31.20	Carolina	7/1/2009	TOMWC
FL-ETHANOL 95% 20L	1	$103.95	$151.22	Carolina	9/10/2010	TOMWC
THERM,EASY-READ,PART,-20-110C	2	$11.75	$23.50	Carolina	9/10/2010	TOMWC
AQUATIC NET 12"D SHAPE .	5	$58.20	$326.71	BioQuip	9/8/2011	MiCorps
DROPPING PIPETTE .	12	$0.55	$6.60	BioQuip	9/8/2011	MiCorps
14-LED Microscope Dual LED-14M-YA	1	$126.42	$126.42	AmScope	9/9/2011	MiCorps
Fiber Optic Dual HL250-AY	1	$230.30	$230.30	AmScope	9/9/2011	MiCorps
3.5X-90X Binocular Stereo SM-2BZ	1	$430.32	$430.32	AmScope	9/9/2011	MiCorps
Bottles, glass			$0.00	M Jacob&Sons	9/9/2011	MiCorps
Lids, polyseal			$0.00	M Jacob&Sons	9/9/2011	MiCorps
STORAGE TRAY,GRATNELL,SM,YLW	12	$6.55	$144.19	Carolina	9/12/2011	MiCorps
THERM,SAFE,OPEN,PLAST,-5-50C	6	$11.95	$71.70	Carolina	9/12/2011	MiCorps
FL-ETHANOL 95% 20L	1	$104.95	$104.95	Carolina	9/12/2011	MiCorps
Nalgene 50 mL bottles	10	$2.03	$20.30	US Plastic Corps	9/12/2011	MiCorps
Tape measures, 100' SAE	5	$6.14	$37.76	ProMax	9/21/2011	MiCorps
Waders, Cabelas	6		$0.00	Cabela's	9/21/2011	MiCorps