GUIDE TO SURFACE WATER QUALITY MONITORING

IN THE CAYUGA LAKE WATERSHED

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Guide to Surface Water Quality Monitoring for the Cayuga Lake Watershed

INTRODUCTION

The Cayuga Lake Watershed (CLW) is home to many municipal agencies, educational institutions, non-governmental environmental organizations and citizens' groups with significant interests in the quality of the lake and its tributaries. As a result, numerous studies and monitoring programs have been, and will continue to be, conducted throughout the watershed. Management of water quality benefits from the assessment of the physical, chemical and biological conditions of the waters and sediments of the lake and its tributaries. Water quality monitoring is a valuable tool for assessing the level of pollutants, identifying emerging problems, documenting changes resulting from water management, and for building understanding of the aquatic ecosystem. Although some information can be obtained from models and expert opinion, water quality sampling or monitoring programs are the primary sources of data.

Water quality monitoring studies have differed widely in purpose and scope, corresponding to the interests and funding of scientific investigators, the information needs of specific agencies and the enthusiasm of volunteers. Such diversity has sometimes been seen as a hindrance to effective, or at least efficient, water quality assessment. Without common goals and sampling protocols, as well as uniform data reporting, it can be difficult to obtain the coherent picture of lake and watershed quality needed for management.

The CLW management process, begun in the late 1990's, collected existing data and information, identified the greatest threats to water quality and outlined strategies to address those threats. The process resulted in two documents. The *Cayuga Lake Watershed Preliminary Watershed Characterization* (Cayuga Lake Watershed Intermunicipal Organization, 2000) detailed the baseline conditions of water resources and identified phosphorus and sediment as the primary threats. Pesticides, volatile organic compounds, heavy metals, pathogens and invasive species were other identified threats. The *Cayuga Lake Watershed Restoration and Protection Plan* (Cayuga Lake Watershed Intermunicipal Organization, 2001) outlined the strategies for water management and argued for a comprehensive monitoring plan. Appendix M of that document, "A Framework for a Cayuga Watershed Monitoring Plan" by Callihan and Kappel, summarized the essential characteristics of a coordinated monitoring plan.

Relatively little progress has been made in formulating a plan since publication of the "Framework", but major monitoring efforts have continued in CLW, including monitoring of sediment and nutrient loads in southern tributaries, lake-wide water column sampling, and heightened interest in water monitoring by citizens. The sampling efforts to date are largely uncoordinated, and as a result, may not inform the management of the CLW as much as they could. A notable exception is the joint Tompkins County Water Resources Council -- Cornell University Partnership that has developed the "Monitoring Plan Southern Basin of Cayuga Lake" (2008).

It is hard to argue against the need for a comprehensive monitoring plan, but given the immense diversity of interests and study questions that drive water quality monitoring in the CLW, it is even harder to see how such a plan for the entire watershed could be developed and implemented. We settled on a simpler step, in the form of this *"Guide to Surface Water Quality Monitoring in the Cayuga Lake Watershed"*, to achieve some of the goals of a comprehensive plan while still accommodating the needs and scopes of current and future monitoring activities. The Guide provides an introduction to study design, five objectives for CLW monitoring and the types of sampling programs that could meet the objectives, and an overview of a data clearinghouse begun as part of this project. Appendices provide supporting information such as questions to inform study design, sample field data sheets and explanations of key parameters suggested in the Guide.

We realize that not all water quality sampling in the CLW will be consistent with the goals of this Guide. Programs will often address needs that are broader or more specific than those described here. We recommend that investigators incorporate the suggestions in the Guide wherever possible into their monitoring programs and projects. Regardless of the extent to which that is done, data, reports and publications are sought for the data clearinghouse.

WATER QUALITY MONITORING PROGRAMS

STUDY DESIGN

"There is a whole lot of monitoring being done that is of diminished value because it was not designed to fulfill any specific objectives."

US EPA Nonpoint Source Information Exchange

Taken together defining the why, how, where, when and who forms a study design. Study design is important for building in objectivity and scientific rigor. Even when the purpose of monitoring is to discern the source of a problem, monitoring must be designed to collect unbiased information. To skew data collection or interpretation to prove what one already believes can lead to faulty management decisions and can create unnecessary community conflict.

Defining the purpose of water quality monitoring is a critical first step. Having a question or an objective in mind—the why—will guide the determination of what, where, when and how to monitor. "Why" includes articulating why water quality monitoring is needed.

"What" is the selection of what will be monitored in order to meet the objectives. Since it includes what information will be collected in the field, it informs the creation of field data sheets (see Appendix B for sample data sheets). If the data collected are to be considered credible, "how" includes using protocols and quality assurance/quality control (QA/QC) established by US Environmental Protection Agency (Barbour et al. 1999), NYS Department of Environmental Conservation (Bode et al. 2002) or the industry reference *Standard Methods for the Examination of Water and Wastewater* (Clesceri et al 1998) Water samples should be sent to a certified laboratory for chemical analysis, with the exception of analysis

done by experienced researchers at an academic institution. In this case, internal lab QA/QC should be provided along with the study results.

The monitoring objectives direct where and when samples should be taken. "Where" includes the site locations and the number of sampling sites. "When" includes how often data would be collected and the conditions that should be met.

There is much interest in sampling during high flow (storm and snow meltwater) events. The study design should define the conditions that qualify as a storm event. The size of the tributary and its watershed, the specific land use and land cover, and the time of year should be taken into consideration. For example, a study of storm events in Sixmile Creek used the criterion of one standard deviation above the monthly mean discharge as the definition of high flow. This criterion set for each month a unique discharge threshold, measured in cubic feet per second (cfs) (Table 1).

Table 1
Definition of High Flow Events
(Moran, 2005)

Month	**Monthly Mean Discharge (cfs)**	**Standard Deviation (cfs)**	**Threshold for High Flow Event (cfs)**
January	82.9	61.45	144.35
February	90.9	26.98	117.88
March	105	41.02	146.02
April	110	55.14	165.14
May	77.1	57.61	134.71
June	49.9	29.82	79.72
July	20.1	13.2	33.3
August	12.9	14.28	27.18
September	14	7.5	21.5
October	21.8	15.58	37.38
November	44.3	38.58	82.88
December	61.8	55.73	117.53

Appendix A contains two sample sets of questions to consider in the study design process and a completed sample for each. The planning shown in the first example will be required by water monitoring projects that seek Finger Lakes-Lake Ontario Watershed Protection Alliance funds beginning in 2009. It is a good example of information that data users may want to know and that should be documented as part of the metadata (data about data).

Hudson Basin River Watch (River Network, 2000) gives a good summary of the importance of good study design in its list of common problems that result from a poor-quality or the lack of a study design:

- Spending time and money on equipment and procedures that are inappropriate for your purposes
- Looking for the wrong things at the right places or the right things at the wrong places
- Not answering the question you asked, answering a question you did not ask, or, worst of all, not answering a question at all

- Not knowing how to interpret your data, because you didn't have a question or focus when you started your study
- Finding that others are reluctant to use your data, since they do not know how good the data are or how they can be used.

OBJECTIVES

The following five objectives can be used to guide study designs that will contribute to a larger, comprehensive understanding of the water quality with the Cayuga Lake basin.

1. **Characterize the water quality of Cayuga Lake to identify status and trends (Lake Sampling)**.

   The *CLW Preliminary Characterization* and the *CLW Restoration and Protection Plan* identified sediment, phosphorus, and pesticides, volatile organic compounds (VOCs), heavy metals, pathogens and exotic or invasive species as water-quality issues that "pose the greatest long-term challenge to the ecosystem of Cayuga Lake and its watershed." (Cayuga Lake Watershed Intermunicipal Organization, 2001). In a comparison of pesticide levels in several Finger Lakes and Great Lakes, US Geological Survey found pesticide levels to be highest in Cayuga Lake, though they remained below federal and state thresholds (Philips, et al., 1999). It is important to document the current levels and trends of these contaminants within the water column and shallow area sediments.

2. **Determine the tributary mass loads of water contaminants entering the lake (Tributary Mass Load Sampling)**.

   Much, but not all, of the lake's water pollution is brought by the tributaries flowing into it. Determination of tributary mass loads is particularly important for management of the lake's phosphorus and sediment problems. There has been relatively little mass load sampling in the CLW, due to the large expense of the necessary continuous monitoring of quality and discharge. Data may be augmented by modeling studies. For this purpose the data collected are used to calibrate and test models that subsequently can estimate mass loads for other time periods and for evolving land uses and management practices.

3. **Characterize the water quality of tributaries to identify status and trends (Tributary Water-quality Sampling)**

   Tributaries may be threatened by contaminants or stresses that affect the stream health but are not significantly detrimental to the lake. The tributaries are valued for recreation and aesthetics, drinking water, irrigation and wildlife habitat and deserve protection.

4. **Characterize the long-term ecological health of the lake and tributaries (Biological Integrity Sampling).**

Sampling for chemical and physical parameters frequently provides only a snapshot of conditions when and where the samples are taken. Ecological sampling is useful for detecting the effects of impairments that are not present at the time of sampling, for evaluating habitat health and for determining the biological integrity of surface waters. Ecological sampling may include bioassessments of fish and benthic macroinvertebrate communities, periphyton, and single species monitoring (trout, salmon, and freshwater mussels are often used). Biological indices, a composite of different indicators, can be developed.

5. Encourage citizen participation in the measurement of watershed quality (Citizen Monitoring)

The future of the CLW is in the hands of the thousands of people who live in and visit the region. To the extent that people care about the watershed's lands and waters, the watershed will be protected and enhanced for generations to come. One way to encourage such stewardship is through involvement of students and other citizens in water-quality monitoring. Monitoring conducted by citizen volunteers increases public awareness and knowledge about water quality and its protection. Citizen monitors are encouraged follow the guidelines in this document and provide data that supports monitoring objectives 1 through 4.

MONITORING GUIDELINES

Monitoring guidelines are provided for each of the first four objectives listed above. Under each objective the parameters are clustered into primary and secondary tiers. The primary parameters provide the most valuable information for assessing surface water health across studies and over time. Secondary parameters provide very useful additional information and are included for consideration when resources allow. It is not necessary to measure every parameter included in either tier. Some study questions of specific and limited intend may be best served by measuring selected parameters from each tier, for example a study focused on invasive species might consist of monitoring few chemical parameters and focus on the populations of invasive and disrupted-native species. A table listing the primary and secondary parameters for each objective appears in Appendix C. An introduction to key primary parameters appears in Appendix D.

1. Lake Sampling

Two major types of lake monitoring are water-column sampling and near-shore (shallow water) sampling. Water-column sampling attempts to measure an integrated, or overall, response of the lake to contamination. Of particular concern is the lake's trophic status, as indicated by phosphorus, turbidity, chlorophyll-*a* and dissolved oxygen. Some invasive species, such as spiny water flea, can also be detected by water-column sampling. During seasons when the lake is stratified, the water column sample should be sampled in both the epilimnion (the warm upper layer) and hypolimnion (lower layer of cold water).

"Near-shore" refers to the depth at which rooted plants can grow. Sampling can be adequately done at the end of a dock. Sampling for pathogens and pathogen indicators is important because of contact recreation such as swimming. Concern about pathogens in the south end of the lake is growing as evidenced by a 2008 New York State section 303(d) list of impaired water bodies showing

pathogens added to the 2002 listing for phosphorus and silt/sediment (NYSDEC, 2008). Near-shore monitoring allows study of the lake bottom including sediment sampling for heavy metals, macroinvertebrates, as well as attached or rooted invasives such as zebra mussels and Eurasian watermilfoil.

In summary, we suggest the following primary and secondary parameters for lake sampling:

a. Water Column:	Primary	1. Total phosphorus
		2. Soluble reactive phosphorus
		3. Dissolved oxygen
		4. Temperature
		5. Turbidity (Secchi disk)
		6. Chlorophyll-*a*
		7. Atrazine
	Secondary	8. Invasive organisms
		9. pH
b. Near-shore	Primary	1. *E. coli*
		2. Invasive plants
		3. Invasive animals
	Secondary	4. Fecal coliforms
		5. Pesticides (particularly atrazine)
		6. Benthic macroinvertebrates
		7. Heavy metals (Pb, Cr, Cu, Zn, Cd, Hg)

2. Mass Load Sampling

The primary purpose of mass load sampling is to determine the contributions of phosphorus, sediment, and perhaps pesticides into the lake. (See Appendix D for a discussion of concentrations versus mass load.) This type of monitoring is time-consuming and expensive. Little can be learned from intermittent or short-term sampling since concentrations of these contaminants in stream flow are highly variable. Sampling needs to capture the high loads carried by snowmelt during late winter and early spring. During storms, hourly, or more frequent, sampling is often required because concentrations change so rapidly. During low-flow periods weekly, or less frequent, sampling may be adequate since concentrations are relatively stable.

The most accurate way to measure loading is with long-term, continuous, concurrent measurements of discharge and concentrations. This is especially true of small tributaries, where a rapid response to wet weather earns the

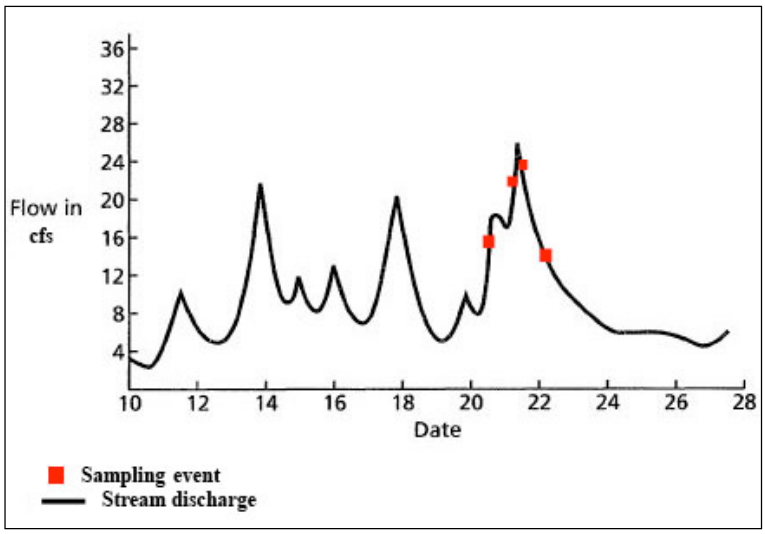

Figure 1
Hydrograph Showing Sampling During Rising and Falling Limbs

descriptor "flashy". Larger, less flashy systems do not need to be sampled quite as time intensively though at a minimum sampling twice during both the rising and falling limb is recommended (Figure 1).
The time of sampling should be noted in "watch time" (the actual time on a watch, which might be in standard or daylight savings time).

Mass load sampling information can be used to improve the results obtained from water-quality models that simulate the movement of precipitation and pollutants. Although each water-quality model has its own unique purpose and built-in assumptions, field data can greatly improve the results obtained from modeling. As long as limitations are taken into account, modeling can reduce the amount of sampling needed to predict water quality. For example, the NYS DEC has been encouraging the use of modeling to understand stormwater runoff and to comply with "Phase II" stormwater regulations.

Primary Parameters	1. Total phosphorus
	2. Soluble reactive phosphorus
	3. Sediment as Total Suspended Solids (TSS)
	4. Discharge
Secondary Parameters	5. Pesticides (particularly atrazine)

3. Tributary Water-quality Sampling

This sampling is meant to monitor the health of the tributaries or sub-watersheds and to identify potential or actual sources of pollution. An initial watershed inventory that evaluates current land and water uses, threats and community values can help identify key issues to inform study questions.

Where possible, a recent map should be obtained, delineating the stream's watershed and indicating patterns of land use/land cover. Locations along the stream should be identified where sampling may take place at least annually and preferably on or about the same date each year, between July and September. Sampling during storm flow events is more informative of loads and major pollutants, sampling during baseflow periods is more indicative of typical water quality in the tributary.

Primary Locations for Sampling: For major lake tributaries, such as Yawger Creek or Salmon Creek, at least 3 locations should be sampled: in the headwaters, at mid-river and near the entry to the lake but not under the influence of the lake. It is important, especially for sampling of macroinvertebrates, that the location not be influenced by the lake: for some minor tributaries the location may be well above the lake level. Monitoring in the headwaters will not give information about specific pollution sources but can be used for comparison with the parameters downstream. Additional sampling locations may be selected to be representative of stream reaches using information such as soil types, slope, land use, etc.

For minor or short tributaries, such as the many minor tributaries that are often unnamed on the east and west lakeshores, one location near the entry to the lake is sufficient. Monitoring at the mouths

of a number of tributaries should be accomplished rather than enhanced monitoring of any one tributary.

If the water quality does not meet expectations (based on soil types, land uses, regulatory standards, etc.), more detailed sampling should be pursued to determine cause/source. One way to accomplish this is to sample at bridge crossings moving from the mouth of the stream to the headwaters. Targeted sampling can be located where changes in water quality are found. See the Hudson Basin River Watch (River Network, 2000) for more detailed information on the chemical, physical and biological sampling of streams.

Secondary Locations for Sampling: For major lake tributaries additional locations should be selected to help define the contributions of the feeder streams. Samples can be collected in the feeder stream or near its junction with the main stream depending on access. For larger feeder streams, monitoring should be prioritized – the mouth of each, then the headwaters and finally the mid-point of the streams.

Sampling Parameters: Minimally, total phosphorus, nitrate nitrogen, and sediments should be evaluated. For the latter, total suspended solids is the recommend common measure, except if the study calls for comparing data with USGS data collected at gaging station; then suspended sediment should be sampled for instead. If suitable instruments are available (e.g., Hydrolab and flow meter), on-site measurements of physical and chemical characteristics should be made: temperature, pH, conductivity, and dissolved oxygen, and water velocity and stream cross-section area.

<u>Primary Parameters</u>

Water Chemistry	1. Total phosphorus 2. Nitrate nitrogen ($N0_3$-) 3. Sediment as Total Suspended Solids (TSS)
Pathological	4. *E. coli* 5. Total coliforms
Physico-chemical	6. Temperature 7. Dissolved Oxygen (DO) 8. pH 9. Conductivity/specific conductance

<u>Secondary Parameters</u>

Water Chemistry	10. Chloride 11. Alkalinity
Physical	12. Discharge
Pathological	13. *Cryptosporidium*
Ecological	14. Invasive organisms

15. Percent canopy cover
16. Periphyton (attached algae)
17. Width of forested riparian zone

Biological Integrity Sampling

Ecological sampling, also known as bioassessment, offers information on biological integrity that is not provided by periodic chemical assessment. A grab sample may miss a contaminant that has passed through the sampling site before or after a water sample has been collected. Since the organisms live in the water over time, the structure of the biological community reflects the long-term status of water quality, not just its status at a particular point in time. Further, ecological sampling is the best method for assessing for concerns that are not dependent on physio-chemical factors. Examples include the effects of invasive species and disruptions to the food chain due to over fishing.

Data collected from bioassessment and monitoring activities can be evaluated and integrated into one biological indicator or index that incorporates the taxonomic and functional characteristics of the biological community. Such a biotic indices or an index of biotic integrity (IBI) is a measure of the overall ecosystem health. The development of a single, simplified parameter that reflects the health of the waterbody can assist in summarizing the consequences of human activities on a watershed. To be of value IBIs are usually developed for a given region or area and must take into account normal variations in communities and populations. Developing an IBI that gives accurate assessment requires experienced professionals. A number of authors have described protocols for bioassessment of surface waters using various groups of organism (e.g., fish, mussels, and periphyton, as attached algae is known).

Use of IBIs can indicate thresholds below which communities are deemed unsustainable and unhealthy. This is particularly useful in determining water quality policy guidelines and in communicating the health of surface waters to the general public. The numeric values of IBIs provide a straightforward method of classifying a community and/or habitat in various categories of quality, especially those in need of attention and/or restoration. IBIs have been used elsewhere to confirm the recover of a waterbody placed on the 303(d) list of impaired waters. Development of an IBI or similar metric is desirable, however it is not a short-term objective.

Without the construction of an IBI, bioassessment based on the community structure of benthic macroinvertebrates (mostly immature stages of insects) is probably most appropriate for this watershed. The sensitivity and reliability of such assessment depends on the taxonomic level to which the species found can be identified. Study of these small, bottom dwelling organisms often interests citizen volunteers and can improve their commitment to monitoring projects. Citizen volunteers can be trained to identify these organisms to the taxonomic level of the family. Analysis to this level has been found to produce reliable estimates of water quality (O' Leary et al. 2004). Identification to species or even genus usually requires assistance from an entomological expert.

Benthic macroinvertebrate sampling should follow protocols for rapid bioassessment like those described for the NYS DEC in Bode et al. (2002). This should begin with a visual-based habitat assessment of the physical qualities of the stream channel, the stream bank and the riparian vegetation so that changes can be monitored through time (see Appendix B for a sample field data sheet).

a. Lake:	Primary	1. Zooplankton composition 2. Phytoplankton composition
	Secondary	3. Fish
a. Tributary:	Primary	4. Macroinvertebrates
	Secondary	5. Fish

DATA CLEARINGHOUSE

Water-quality monitoring data are potentially useful beyond the group or organization that collects the data. To this end the Cayuga Lake Watershed Network is working to collect and make publicly available on the World Wide Web data, reports and publications about water quality in the CLW. These are being posted at http://ecommons.library.cornell.edu; search for Cayuga Lake Watershed. According to the website "The eCommons Digital Repository … is open to anyone affiliated with Cornell University (faculty, staff, students, or groups/organizations) as a place to capture, store, index, preserve and redistribute materials in digital formats that may be useful for educational, scholarly, research or historical purposes." Previously established partnerships with Cornell to study and protect Cayuga Lake make this collaboration possible.

Overtime, data will also be posted at The Knowledge Network of Biocomplexity, http://knb.ecoinformatics.org. According to the website "The Knowledge Network for Biocomplexity (KNB) is a national network intended to facilitate ecological and environmental research on biocomplexity. For scientists, the KNB is an efficient way to discover, access, interpret, integrate and analyze complex ecological data from a highly-distributed set of field stations, laboratories, research sites, and individual researchers."

Geospatial data will also be posted in repositories that specialize in Geographic Information System (GIS) data such as the New York State GIS Clearinghouse, http://www.nysgis.state.ny.us and the Cornell University Geospatial Information Repository (CUGIR), http://cugir.mannlib.cornell.edu.

Data will not be analyzed or evaluated for accuracy. In an ideal world, data from different sources would be collected and analyzed according to common protocols and published in standard formats to facilitate comparisons, aggregation and interpretation. This uniformity is difficult to achieve given the different study questions and entities undertaking sampling. The focus will be to collect and post data and adequate metadata to allow the end user to evaluate the quality and usefulness of the data sets. Data sets and metadata will be formatted according to standard criteria. Cayuga Lake Watershed Network staff and a Cornell University librarian have customized the "Best Practices for Preparing Environmental Data Sets to Share and Archive" available at http://daac.ornl.gov/PI/bestprac.html.

A system for posting only metadata or links to data sets and information that is already available via the World Wide Web in being developed. Real-time data, such as from US Geological Survey gaging stations, is an example of information already electronically available on the Web. Some

creators of data and information may not want primary data publicly available to all. These types of situations are most efficiently handled by posting metadata and contact information in the central CLW repository.

Water management professionals and researchers have expressed interest in a data clearinghouse for years. We realize that some issues concerning data quality and comparability will not be solved by these repositories of data and information. However, it should make data from various efforts more accessible and useful to others. The beginning of a data clearinghouse is a significant outcome of this monitoring guidance project.

APPENDIX A

Two Sample Study Design/Project Plan Formats

I. Excerpted from <u>Finger Lakes-Lake Ontario Watershed Protection Alliance Quality Assurance Project Plan</u>

Beginning in 2009, water monitoring projects that seek Finger Lakes-Lake Ontario Watershed Protection Alliance (FL-LOWPA) funds will be required to submit a quality assurance project plan. Details are available in the *Guidance for FL-LOWPA Supported Water Quality Monitoring Programs.* The select information from the associated planning worksheets is provided below reformatted to save space.

Quality Assurance Project Plan (QAPP)

The pages listed under the various topics below refer to the *Guidance for FL-LOWPA supported Water Quality Monitoring Programs.* Additional detail can be found in Chapter 4 of the USEPA document, *The Volunteer Monitor's Guide to Quality Assurance Project Plans….*

1. Project Planning (p.2-3)

a) What are the objectives of the monitoring program?
b) How will the data be used?
c) How will you evaluate your results? i.e., compare to State WQ standards, State established- reference conditions, historical data?

2. Project Design (p.3)

a) Include the following information in **Table 1:**
   - Sample ID
   - Description of sampling location
   - Location (i.e, latitude/longitude, UTM, permanent landmark , etc.)
   - Rationale for selecting sampling site
   - Flow and/or other important site characteristics
   - Parameters/constituents to be measured/analyzed
   - Sampling frequency (note special sampling conditions such as storm-events, high flow, etc).
   - Type of sampling (grab, depth or width integrated, profile, etc.)

b) How will the data be processed, analyzed and reported?

3. Data Quality (p.4)

Enter values for parts a, b, c, and d in accompanying Table 2

a) **Measurement Range (MR)**- Range of measurement possible with equipment and/or analytical procedures used. For laboratory analysis the minimum reporting limit (detection limit) is critical. *Place values in **Table 2**_____.*
b) **Accuracy**- Means the measure of confidence that describes how close a measurement is to its "true" value. If contracting for lab services, communicate with lab as to internal quality controls. See manual(s) for field instrument accuracy. *Place values in **Table 2**.*
c) **Precision**- Commonly done by comparing the difference between values of duplicate samples and comparing this difference to a pre-determined allowable difference. (You will need to determine how

many duplicate samples you will run- See Section 8.) For water quality constituents, USEPA guidance for precision is ± 20%. *Place value in **Table 2**.*

d) **Completeness**- The number of samples that need to be collected to meet the "completeness" objective. (Note- typical number is 90% of proposed samples collected.) *Place value in **Table 2**.*

e) **Representativeness**- How will the locations, number and time of sampling ensure the data collected is truly representative of the condition of the waterbody?

f) **Comparability-** To ensure comparability with any future project phase, will you use standardized or identical:
   - sampling methods?_____
   - analytical methods?_____
   - units of reporting?_____
   - sample site selection?_____
   - other?_____

4. Personnel Training (p.5)

a) Identify person familiar with FL-LOWPA supported monitoring activities, plans and related procedures (relevant SOPs, safety protocols, etc.) that will provide guidance to county and related personnel on an as needed basis.

b) Describe any specialized training or other procedures:

5. Data Collection and Documentation (p. 5-6)

a) Sampling methods used - Enter the sampling equipment, container, preservative and maximum holding times for each parameter in **Table 2.**

b) How will the locations of sampling sites be recorded (GPS, permanent landmarks etc.)?

c) How will the sampling area site conditions be described?

d) Are there any procedures for decontamination or equipment cleaning?

6. Sampling Labeling, Handling, Chain-of Custody (p.6).

a) What information is included on the sampling labels?

b) What are the procedures for tracking the collection, delivery, and/or shipping of samples to the laboratory for analysis?

c) Where will the data results and records be kept? (Optional: Attach copies of field and laboratory data records kept for the project.)

7. Analytical Methods (p. 6)

a) **In Table 2**, list the analytical methods being used along with the field or lab equipment used for analyzing each parameter. If a contract lab is being used, list the analytical procedure.

b) If methods and/or equipment differ from standard procedures, describe the analytical methods and equipment being used or attach your Standard Operation Procedures (SOP). Note in **Table 2.**

8. Quality Control-QC (p.7)

a) Sampling: How many and what type of quality control samples such as duplicates/triplicates, field blanks, replicates, maintaining voucher specimens (biological) etc. will be taken? Your duplicates / triplicates will be used to see if you meet your precision objectives. For water quality analyses, it is suggested that one duplicate sample be run for every twenty samples or one per sampling event.

b) Laboratory QA/QC**:** If you are you using a contract laboratory for chemical analyses, reference your lab's QA/QC plan here:

c) What action will you take if the QC samples reveal an analytical or sampling problem?

d) Instrument Calibration/ Frequency
   - How is sampling and analytical equipment calibrated and how often?

- What types of standards and/or certified equipment is used to calibrate sampling instruments?
- How are maintenance and calibration records maintained for each instrument?
- For biological sampling equipment, what are the routine procedures ensuring equipment is clean and working properly?

e) Quality of other data sources: List any other data or informational sources that you will use such as historical information, topographic maps, aerial maps, or reports from other monitoring groups. Discuss any limitations on the use of this data resulting from concern over its quality.

9. Data Storage, Management, Validation and Verification (p.7)

a) How will you check for accuracy and completeness of field/lab forms?
b) How will you minimize and correct errors in calculations, data entry to forms or databases and included in reports?
c) How will you validate and verify data? (see examples p.7)
d) Who reviews data in order to accept, reject, or qualify the data?
e) If errors are found, how are they corrected or accounted for?
f) Does your laboratory have a protocol for data review?

10. Overall Program Assessment and Oversight (p.8)

a) How are your overall field, lab and data management activities overseen and evaluated?
b) How are problems identified and corrected?