Quality Plan for the

Watershed Evaluation and TMDL Section

December 19, 2025

Division of Environmental Assessment and Restoration
Water Quality Evaluation and TMDL Program
Department of Environmental Protection
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Signature Page

The Undersigned have read and understood this Quality Plan, are charged with managing and improving the quality system, and are responsible for ensuring that all staff properly execute the procedure discussed in the plan.

Kevin O'Donnell Digitally signed by Kevin O'Donnell Date: 2025.12.17 14:50:01 -05'00'

Kevin O'Donnell _____ _____
[Program Administrator] Date

Eric Simpson Digitally signed by Eric Simpson Date: 2025.12.17 14:58:41 -05'00'

Eric Simpson _____ _____
[Environmental Administrator] Date

Woo-Jun Kang Digitally signed by Woo-Jun Kang Date: 2025.12.17 15:12:30 -05'00'

Woo-Jun Kang _____ _____
[Quality Assurance Officer] Date

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1. Introduction

The Florida Department of Environmental Protection (DEP) Quality Assurance (QA) program involves the implementation of a management system (planning, review, training, and assessment) to ensure that data collection, generation, interpretation, reporting, evaluation, and archiving is of sufficient quality to support Department decisions. The effectiveness of our QA program is dependent upon the actions of all DEP staff, from "front line" employees to management, meaning QA is a function distributed throughout our organization. One aspect of our program is to ensure that Department QA activities are carried out according to commitments made to the Environmental Protection Agency as enumerated in the DEP Quality Management Plan (QMP) (Draft Revision 9/2/08).

The DEP Secretary is committed to implementation of the quality assurance requirements in the QMP and as authorized at 403.0623 Florida Statutes (F.S.), and Chapter 62-160 Florida Administrative Code (FAC), the DEP QA Rule. It is the Secretary's intent to carry out these obligations and requirements as detailed in the Department's QA Directive (Most Recently Modified April 3, 2019).

In order to execute the components of the DEP QA Directive, the Watershed Evaluation and TMDL (WET) Section has developed a quality system. This document describes the steps we take to ensure the scientific and legal defensibility of environmental data we generate or use. It details the process of planning, training, execution, assessment, and corrective action we undertake to ensure that environmental data meets our established quality criteria.

2. Basic Elements of Our Quality Plan

Our Quality Plan explains both the process and criteria by which the quality system is managed. The plan is utilized as an instrument of internal communication to inform our staff of current and future quality assurance activities. It discusses how specific QA duties are assigned to responsible staff. We will revise our Quality Plan as needed, and pledge to ensure the consistent application of procedures and criteria for the generation or use of our environmental data. The Quality Plan will also be used as a training document for new staff and as a reference for experienced personnel. The plan and its revisions also serve as an archival record of our formal quality system.

The elements of our plan are consistent with the Department's Quality Management Plan, Quality Assurance Directive and Quality Assurance Rule (62-160 FAC). In addition, we ensure that our plan for all sampling activities, including field-meter testing, is consistent with DEP SOP FA 3300. Our plan addresses all activities associated with sampling, field testing, lab analysis, and data review of any type, including those activities associated with database construction and management. Our plan also discusses how decisions about data use are made based on data quality assessments.

Where appropriate, we cite existing internal and external documents, including training manuals, guidance documents, SOPs, Rules, figures, and tables.

We expect all staff to understand and follow the procedures and criteria as discussed in this plan, and to carry out their assigned responsibilities for effective utilization of our quality system.

2.1 Policy Statement

The Florida Air and Water Pollution Control Act (Section 403.201, Florida Statutes) declares that no wastes are to be discharged into the waters of the state without first being given the treatment necessary to protect the beneficial uses of the waters. The Department of Environmental Protection has the responsibility of regulating discharges into surface waters to assure that discharges receive the treatment necessary to maintain water quality standards. The Department's Watershed Evaluation and TMDL (Total Maximum Daily Load) Section (WET) has the primary responsibility for determining TMDLs for nonpoint source pollutants, and Water Quality-Based Effluent Limits (WQBELs) for dischargers to state surface waters. The TMDLs and WQBELs are derived using mathematical and/or statistical models or water quality studies to determine the assimilative capacity of receiving surface water

bodies. The section's objective in developing a TMDL or WQBEL is to assure that non-point source pollutants and discharges into the surface waters of the state will not degrade receiving water quality below applicable surface water quality standards (Rule 62-302, FAC) or affect the designated uses of the receiving water.

The WET Section staff are committed to using and generating valid and reliable information in establishing TMDLs and WQBELs. This commitment is assured by the adherence to documented quality control procedures and quality assurance protocols throughout the course of all projects undertaken by the Section.

It is our policy to:

- Use scientifically valid and legally defensible data for our decisions affecting protection of the environment.
- Have and implement the Quality System described in this document.
- Adaptively manage our Quality System to be consistent with provisions of the DEP Quality Assurance Management Plan.
- Ensure that each individual is properly trained to execute their assigned functions.
- Implement procedures to evaluate the quality of the data we use and to implement corrective actions when data do not meet our Data Quality Objectives.
- Periodically audit the performance and record-keeping practices of data generators for which we have responsibility.
- Implement quality assurance procedures for the management of our data repositories.
- Perform a yearly systematic assessment of our quality assurance activities, including any corrective actions, with the findings submitted to the Standards and Assessment Section.

2.2 Ethics Statement

All employees of the DEP WET Section are held to high professional ethical standards in the performance of their duties. All employees are required to read, understand, and sign an 'Ethics Statement' attesting to their commitment to honesty and integrity in the performance of their duties. In addition, all employees are required to attend an annual ethics training class. Improper, unethical, or illegal actions will be dealt with according to the published Administrative Directives of the Florida Department of Environmental Protection.

3. Organizational Topics

3.1. Organization

The WET Section is administered by the Water Quality Evaluation and TMDL Program (WQETP) within the Division of Environmental Assessment and Restoration (DEAR). Positions in the WET include administrative/supervisory and professional/technical support. All staff are supervised by and section activities are coordinated by the Section Administrator (SA). The SA evaluates work priorities, assigns projects to appropriate staff, reviews all section work products, and ensures that projects are completed on schedule. The SA also supervises the section's Quality Assurance Officer (QAO) and ensures that quality assurance responsibilities are carried out as required.

The WET sampling activities/field operations are limited to special projects and additional data collection in support of TMDL development. Operations in the field include measuring metered parameters, conducting dye studies, conducting studies on light penetration, measuring stream flow, installing stage recorders, and taking both discrete and composite bottle samples for independent analyses. For the most part, the section depends on ROC staff for in-field data collection with WETS staff only conducting their own field work on an "as-needed" basis. The one exception is in respect to specialized sampling efforts such as lake and stream sediment oxygen demand (SOD) sampling. The field and laboratory SOPs for SOD studies were developed in-house by Dr. Woo-Jun Kang, who

modified them from widely accepted methodologies in the field to best suit the Section's needs and capabilities. Because these SOPs are not derived from standard Department SOPs they are outlined in detail in an appendix to this document.

Each project is assigned to a project leader, who conducts the project with advice from the group leader(s) and their supervisory staff. The project leader is responsible for planning, implementation, and documentation of all procedures followed during the project. The project leader will write a plan of study (POS) that documents planned field sampling activities. The project leader will also coordinate with laboratory staff to schedule all necessary analyses and to prepare sample bottles and preservation supplies. The project leader is also responsible for directing the field sampling, expediting delivery of field data and samples to their appointed destinations, and ensuring that all aspects of the quality assurance plan are followed. Actual field sampling strategies will be developed jointly by the project leader, the project leader's supervisor, and the section's QAO. The SA will designate a "field work leader." The field work leader will not actively participate in sampling, but their duties will primarily consist of planning assistance and problem-solving assistance during the survey. Field work leaders will also conduct QA audits and provide feedback to the project leader on survey performance.

Our Quality Assurance Officer (QAO) **[Woo-Jun Kang]** coordinates and participates in the quality evaluation of program data and provides oversight to ensure that our staff performs their QA functions. The QA Officer may delegate some responsibilities to properly trained and qualified staff, when appropriate. The QAO conducts systems audits of internal and external data generators (lab and field) and conducts sampling performance audits. The QAO also ensures that corrective actions are implemented for data non-conformance incidents as determined by evaluation of the data against our program's Data Quality Objectives. Additionally, the QAO assists program managers in the development of the Quality System and other logistical aspects of its implementation, such as coordinating associated training needs.

Our QAO documents all program QA activities, including training, audits, and corrective actions and provides this information to the DEP Standards and Assessment Section on a periodic basis.

Laboratory analyses are performed by the DEP Central Laboratory in Tallahassee according to its Standard Operating Procedures and Comprehensive Quality Assurance Plan. Suitable containers for wet chemistry are provided by the laboratory. On some surveys, personnel are also responsible for measuring metered parameters under the direction of the field supervisor.

3.2. Job Descriptions

Job descriptions for all staff can be obtained from the Program's Administrative Assistant, DeEdgra Wyche.

3.3. Approved Signatories

Eric Simpson, WET Section Administrator

Woo-Jun Kang, WET Section QA Officer

3.4. Employee Credentials

Employees of the WET section are hired and evaluated according to State of Florida and Department guidelines and/or requirements. Employees who conduct field sampling must have a degree and/or experience in natural, chemical, or physical science. Employees receive on-the-job training for field sampling necessary for their job duties in accordance with the requirements of DEP-SOP FA 3220. Employees are trained by other employees that have demonstrated proficiency in the specific sampling activity. An employee leads a type of sampling event only when that person is proficient in the type of sampling to be performed.

Although our staff routinely are rarely involved in data collection they routinely carry out data usability evaluation, data interpretation, and the generation of DEP work products in a manner that ensures scientific defensibility and adherence to DEP rules and policies. Specifics related to each type of sampling equipment are detailed in Sections 8, 9, and 10 below.

Staff evaluate program data using program Data Quality Objectives (DQOs) and Data Quality Indicators (DQIs) and implement corrective actions as directed by the Quality Assurance Officer. Our DQO's involve:

- Sampler training (Chapter 4),
- Use of defined DEP SOPs either under FS 2100 for surface water sampling, or if an alternative method is used (detailed in Chapter 9),
- Use of DOH/ELCP certified labs for analysis,
- Use of standardized lab methods,
- Use of calibrated instruments (Chapter 9),
- Use of quality control samples (Chapter 10) and
- Overall objective to restore waters to meet designated uses.

Our DQI's are represented by;

- selecting laboratory methods that have the required sensitivity (MDL and PQL) as required by Rule 62-4.246 FAC,
- attain appropriate precision through the use of field and lab duplicates/replicates, (as defined in Chapter 10), and
- avoiding contamination by following procedures in Chapter 9.

Additionally, project meetings are conducted to:

- Review proposed work for conformance with quality criteria,
- Review and evaluate data,
- Interpret data or determine compliance with permits and rules,
- Check calculations, and
- Review documents for errors and completeness.

As a result of these meetings, WET staff provide feedback to the program Quality Assurance Officer for improving the program quality system.

- Woo-Jun Kang acts as the liaison with other units, data providers, data consumers, or other external parties concerning QA matters.
- Woo-Jun Kang answers public or external technical inquiries about data interpretation, approved procedures, suspected QA problems, site-specific issues, etc.

The WET Section's management **[Eric Simpson]** ensures that this quality system is fully operational within our program, designates our Quality Assurance Officer, and provides general oversight. The section administrator also evaluates the above Data Quality Objectives and Data Quality Indicators to ensure they meet our program's needs, and periodically evaluate the effectiveness of staff's data quality activities, including reviewing audit results. The section administrator evaluates corrective action policies and procedures to be implemented when data do not meet program Data Quality Objectives Our manager discusses audit results with the QA Officer, reviews the annual Quality Assurance Report to the Secretary, and discusses findings with the QA Officer.

4.0 Training

All personnel are properly trained to perform their duties. Group leaders periodically assess that our staff performance conforms to the policies and procedures of our unit.

Our training procedures consist of:

- Training for specific QA functions for Project Managers,
- Review of ethics policy by QA Officer for all staff,
- Specific training materials for routine functions and designated QA activities,
- Refresher trainings or delivery of updated information,
- Evaluation of the effectiveness of training for each staff member, and
- Maintain Training Records.

5.0 QAPPs For Modeling and Sampling Design

The primary tool to develop TMDLs for impaired waters is through modeling, either via process-based models or through various statistical approaches. WET has implemented Quality Assurance Project Plans (QAPP) as a means to provide quality assurance on model development and provide integration of all steps from sampling design (if needed), data collection (if needed), modeling, model calibration, and TMDL derivation. This documentation focuses on the model selection, model assumptions, and modeling acceptance criteria. Most data needs are met through the data available in the Impaired Waters Rule (IWR) database which integrates various stages of data validation and verification. However additional targeted data collection may be necessary to either fill in spatial gaps in the available data or to collect other types of data that are beyond the scope of those normally sampled. To those ends our unit performs the following activities concerning sampling:

- Project leads design QAPP which may include project dependent sampling plans, SOPs and QA plans.
- Eric Simpson reviews procedures and methods for compliance with QA plans and requirements.
- Woo-Jun Kang handles requests for use of alternative, new or modified sampling procedures or lab methods.
- Eric Simpson coordinates data reviews, sampling activities, or other QA tasks for timely completion.

6.0 Data Review

Our program understands the need to evaluate the quality and usefulness of environmental data prior to making decisions. We conduct the following review procedures to determine the usability of data for determination of compliance with permits or rules, etc. These procedures are based on our established Data Quality Objectives and Data Quality Indicators, and incorporate the concepts and criteria found in DEP's "Process for Assessing Data Usability", DEP-EA-001/07.

6.1 Data Reduction, Verification, and Validation

Data Reduction

There is relatively little data reduction required for the metered parameters measured by the WET Section staff. Most parameters (DO, temperature, conductivity, pH, fluorescence, incident light, and water level) are read directly from the instrument. Point velocities will also typically be read directly from the Swoffer 2200 optic sensor read-out, but may be calculated from revolution-per-second data.

In cases where metered parameters were taken over the station depth, data will typically be depth averaged (simple arithmetic average) for data presentation (downstream or temporal plots). All plots or tables presenting depth averaged data will indicate that the data has been averaged over the depth. DO data taken using YSI meters will be corrected for the measured salinity and temperature. The saturation DO and percent DO saturation may be calculated using measured salinities and temperatures. Salinity values may be calculated from measured conductivities and temperatures. Flows will be calculated using point velocities measured in the stream cross-section in accordance with procedures recommended by the United States Geological Survey.

Data entered on field sheets are simply entered into computer worksheets for any required processing. Data entry is conducted by either the project leader or by an Environmental Specialist in the WET Section.

Data Verification

Individual sampling team members will be responsible for checking metered parameter data and field calibration integrity. Values will be reviewed in the field for consistency with expected and prior readings. Extreme results will only be accepted after visually inspecting the meter for possible malfunctions, re-calibrating the meter, and re-measuring the parameter in question.

Project leaders will be responsible for checking sample integrity before transferring any bottle samples to non-WET personnel.

Data Validation

The primary procedure for data validation in the field will be the review of the results of the field calibration described in Section 9.0. At a minimum, field calibration will be conducted at the beginning and end of each sample day, before meter disassembly, and after meter assembly. All calibration information will be recorded and be made part of the project files. Individual team members are responsible for field review of the calibration information, and the project leader will re-review the information after the survey.

If either pre- or post-sampling calibration results differ by more than the accuracy of the meter, the project leader shall determine if the data are to be used as estimated data or discarded. The project leader will also be responsible for reviewing all field and laboratory QC data, reviewing all supporting documentation, and checking all data for obvious anomalous values.

Data Reporting

All field and laboratory data for a TMDL or WQBEL project are typically documented in an "Intensive Survey Document." Intensive survey documents usually present the pertinent data in tabular form and then summarize the data either graphically and/or statistically.

7. Documentation

Since accurate documentation is an important factor for determining the success of QA activities, our unit carries out the following record-keeping procedures for the indicated activities to ensure appropriate documentation:

- Sampling,
- Field-testing,
- Data review,
- Calculation checks,
- Data archiving,
- Checks of database entries,
- Document control and maintenance, and
- Record generation, retention, and storage procedures

7.1. Records

Field data and observations for a sampling trip are recorded on one or more field sheets. Water quality meter data, location information, and sample type, and preservation are recorded on the sample submittal form. This information is entered into an electronic format compatible with SIM for uploading to WIN. Prior to laboratory data being entered into LIMS by the Bureau of Laboratories and then uploaded to WIN, a final QA check is performed by the WET Project Manager.

7.2. Control and Maintenance

When a sampling event is planned, the event is scheduled in LIMS. LIMS generates an "RQ" number (Request ID) for the sampling event, which is linked to each sample bottle requested for the event. Sample submittal forms are generated by LIMS using this information. Field and laboratory data that are stored in LIMS are linked to that sampling event's RQ number. Data are recorded and stored by unique location/date identifiers.

7.3. Reports

Annual QA reports will be prepared by the WET Section's QA Officer and submitted to the Environmental Administrator. The Internal System Audits will provide information for the report including:

1. A summary evaluation of the section's procedures.

2. A summary of the quality assurance objectives for measurements of data in terms of precision, accuracy, and method detection limit.

3. A summary of any quality assurance problems experienced during the previous period and the corrective actions taken.

7.4. Data Integrity

QA targets for precision, accuracy, and method detection limits for all sampled metered parameters are shown in **Table 1**. All QA targets are based on manufacturer's specifications. As additional intensive survey data are collected, QA objectives will be calculated and **Table 1** will be updated.

Prior to sample collection, sample bottles will be properly identified with information pertaining to the location, date, time, name of samplers, type of sample (duplicate, field blank, equipment blank, effluent sample), station and replicate number (when applicable) and recorded on the appropriate form. All containers will be labeled using an indelible ink pen or by attaching an identification tag.

7.5 Data Archival

Data generated by WET staff or submitted by regulated entities is stored in various ways depending on the specific program. For example, most data generated by the WET Section is housed in the Department's WIN database while special studies data not suitable for WIN will be retained by the Project Manager and archived on the WET network drive. Original documents or electronic data deliverables are maintained in the WET in accordance with their respective record retention schedules in addition to the various database systems.

Table 1. Quality Assurance Objectives

Component	Analytical Method #	Precision [7] (%) RSD	Accuracy [7] (%) Recovery	MDL
Surface Water Quality				
Temperature	EPA 170.1[1.] 5.0°C	±0.05	±0.7	
Dissolved Oxygen mg/l	EPA 360.1[1.]	±0.05	±1.0	0.1
pH su	EPA 150.1[1.]	±0.05	±0.1	0.1
Specific Conductance umhos/cm	EPA 120.1[1.]	±0.10	±1.0	0.0
Salinity	APHA 210[2.]	±0.10	±0.9	0 %
Light (Lux)	LI-COR[3.]	±0.05	±5.0	3 uE/sec/m
Chlorophyll a	Turner Designs Determined with fluorometer by volume sample	±1%	±4%	
Water Quantity				
Discharge				
Mechanical	USGS[4.]	±0.10	0.1 ft/s	
Electronic	USGS[4.]	±0.10	±2.0	0.01 ft/s
Fluorometry	USGS[4.]	±0.20	±1.0	0 ug/l
Volume	I.S.C.[5.]	±0.20	0.03	0 ml
Depth	SI-TEX[6.]	±0.05	±5.0	0 ft

[1.] Methods for Chemical Analysis of Water and Wastes, 1979.
[2.] American Public Health Association, 1985.
[3.] LI-185B Quantum/Radiometer/Photometer Instruction Manual, 1980.
[4.] Rantz, S.E., 1982.
[5.] Instrument Specialties Company, 1975.
[6.] Bill Burgin, Personal Communication.
[7.] Method Reference Data.

8. Capabilities

8.1. Organization Capabilities

Sampling is limited to in-situ metered parameter measurements, flow measurements and stream/floodplain characteristics, and collection of bottle samples from surface waters for independent laboratory analyses. The WET section conducts field testing according to the SOPs found in DEP-SOP-001/01 and included in this Quality Plan. Sampled parameters have been organized by major analytic group and are shown in **Table 2**. Sampling equipment used by the section is shown in **Table 3**.

8.2. Sampling Procedures

Sampling represents a crucial aspect in the process of establishing a TMDL or WQBEL. The selection of equipment, procedures, sampling design, data compilation, and analysis will be incorporated in the development of the POS. These considerations include:

1. Equipment will be properly assembled, calibrated, and maintained and its selection will depend on specific survey plans.

2. During a survey, equipment will be operated correctly and handled in a manner that will not alter calibration. Precaution will be taken to assure that dissolved oxygen membranes remain moist, calibration settings are not altered, and equipment is not damaged. A calibrated backup meter will be ready and deployed if the primary meter malfunctions.

3. Applicable metering equipment will be adequately rinsed between sampling events with analyte-free DI water to ensure decontamination.

4. Sample containers will be prepared and decontaminated by the central laboratory in Tallahassee according to the laboratory's approved comprehensive QA plan and kept in a safe place to avoid damage. Samples will be iced as they are collected and returned to the DEP Central Laboratory promptly to permit analysis within the proper holding times.

5. The section's Standard Operating Procedures (detailed in this Quality Manual) pertaining to operation of metering equipment will be followed to ensure the proper accuracy and precision of data obtained.

6. The necessary precautions will be taken when handling Rhodamine WT dye to assure sampling equipment is not contaminated and that standards are prepared accurately.

7. A sampling design will be developed to assure that water quality and quantity samples are representative and that the parameters will adequately characterize existing conditions and meet model requirements.

8. The design will consider the necessity of collecting grab, composite, split, or duplicate samples; determine whether they should be collected using manual or automated techniques; and, determine if composite samples will be collected in relation to flow or time.

9. The considerations for sampling wastewaters and various surface water bodies (i.e., rivers, streams, lakes, estuaries) will incorporate EPA recommendations (EPA, 1986; Mills, et al., 1986). When practical, samples will be collected from the least to most contaminated areas. At specific stations, the preferred order of sample collection will be metals, microbiological, and then nutrients.

10. When collecting samples for metal analyses, a clean pair of new, disposable latex gloves will be worn at each station. Sample bottles will be handled so that the gloves do not come in contact with the sample or the interior of the sample container.

11. Data will be examined to determine if reported values are reasonable, that flows balance, that a reference point agrees with expected values and that water quality samples and flows are collected at approximately the same time.

8.3. Field and Laboratory Test Methods

The WET Section conducts field testing according to the SOPs found in DEP-SOP-001/01 and included in this Quality Plan. The WET Section conducts laboratory analysis for tests addressed by FDOH certification according to the procedures stated under the FDEP FDOH certification, number E31780.

Table 2. Sampling Capabilities

Parameter Group	Sample Sources
Classic Metered Parameters: Dissolved Oxygen, pH, temperature, specific conductance, salinity	Surface Water and Wastewater
Nutrients*	Surface Water and Wastewater
Chlorophyll Series*	Surface Water and Wastewater
Microbiologicals*	Surface Water and Wastewater
Trace Metals*	Surface Water and Wastewater
Depth	Surface Water
Light	Surface Water
Transparency	Surface Water
Velocity	Surface Water

* Independent Laboratory Analysis

8.4. Equipment List

Table 3. Sampling Equipment and Appropriate Use

Equipment Type	Use	Permissible Parameter Groups
Water Quality		
1. YSI Model 6920, 6000, XLM 600	Sampling	Temperature, Dissolved Oxygen, Conductivity and Salinity, Turbidity, Chlorophyll a
2. Beckman Model RS5-3 Salinometer	Sampling	Temp, Conductivity, and Salinity

3. LI-COR Model LI-184B with Secchi Disk	Sampling	LUX
4. Secchi Disk	Sampling	Transparency

Water Quantity

1. Turner Designs Model 10 Fluorometer	Sampling	Fluorescence
2. Sontek Flow Tracker	Sampling	Velocity
3. Niskin Current Meter	Sampling	Velocity, Direction, Depth, Temperature, Conductivity, Time
4. Marsh-McBirney Inductance Meter Model 201-D and Mdl 2000	Sampling	Velocity
5. SI-TEX Depth Recorder	Sampling	Depth
6. RD Instruments Acoustic Dopplar Current Profiler	Sampling	Velocity/Direction

Sampling Equipment

1. ISCO Models 2100 and 2700	Discrete or Composite Samples	Nutrients, CBOD
2. Kemmerer and Van Dorn Water Samplers	Grab Samples	Demands
3. Universal Percussion Corer	Sediment Sampling	SOD coring
4. Ponar Dredge	Sediment Sampling	Percent organics, particle size
5. Ekman Dredge	Sediment Sampling	Percent organics, particle size

Table 4. Sampling Equipment and Appropriate Use (Continued)

Miscellaneous

1.	Engineers Tape	2.	Tag Line Sampling	3.	Linear Recorder
4.	Rain Gage	5.	Vertical Water Sampler	6.	Horizontal Water Sampler
7.	Rhodamine Dye Drum Kit	8.	Secchi Disc	9.	Anemometer
10.	Tag Line w/Board	11.	Cloth Tape	12.	Engineers RP
13.	Optical Tape	14.	Flagging Tape (specify)	15.	Optical Comp.
16.	Hand Compass	17.	Staff Gage	18.	Float Sticks (specify)
19.	Dye Injector Kit	20.	Motor	21.	Marine Compass
22.	Life Jackets	23.	Battery	24.	Cushions
25.	Paddles	26.	Anchor	27.	Fire Extinguisher
28.	Signal Kit	29.	Q-Beam	30.	Air Horn
31.	First Aid Kit	32.	Bug Repellent	33.	2 Cycle Oil
34.	Boom Assembly	35.	Boots	36.	Waders (chest)
37.	Waders (hip)	38.	Snake Leggings	39.	Mechanics Tool Box
40.	Shovel	41.	Machete	42.	12 Volt Battery
43.	Magnetic Stirrer	44.	Cordless Drill	45.	Walkie Talkies
46.	Sledge Hammer	47.	Lantern	48.	Flash Light
49.	Rubber Gloves	50.	Binoculars	51.	SLR Camera
52.	Nikon Camera	53.	Chain Saw	54.	Bolt Cutters
55.	Trimble Navigator GPS	56.	Garmin GPS	57.	Cellular Phones

8.5. Sample Custody

8.5.1. Objectives

The primary objectives of the sample custody procedures described in this section are to maintain the identity of individual sample bottles as they are transferred from the field to the laboratory for analysis, and to properly document that holding times are being met. The field custody procedure described in Section 8.5.2 will be the normal WET custody protocol, while the legal chain-of-custody procedure listed in Section 8.5.3 will only be used in unusual circumstances. The project leader will be responsible for reviewing required sample custody procedures with all field staff prior to each survey and for checking samples prior to change of custody to non-WET personnel.

8.5.2. Field Custody

Field custody begins in the WET laboratory when the sample bottles are received from the DEP Central Laboratory. Central Laboratory personnel will provide a signed copy of the DEP Chain-of-Custody form with the samples. This will be used to document all subsequent custody transfers and will be kept with the project file.

Sample bottles will be received by the project manager who will sign the form, verify that the sample bottles are clean and pre-labeled (with blank labels), and verify that sufficient bottles have been provided. The project manager will then supervise the field teams as they organize and subdivide the bottles to ensure that each field team has the correct bottles.

When practical, all label information except date/time will be filled in by the field teams prior to the survey. Bottle labels will include a unique sample identification number consisting of the station number and date.

Once in the field, the samplers will fill in the sample/date/ time immediately before taking and filling the sample bottle. Two separate forms will be filled out in addition to the label information. The following information will be recorded on a field data sheet: date, time, location, station number, station description, samplers, weather, sample depth, and any field measurements (DO, temperature, salinity, and pH). The data sheet will also indicate the type of bottle samples collected (sample, blank, or duplicate), note any field decontamination performed, and the sampling sequence. Any errors in the field record sheets will be deleted with a single line through the incorrect entry and initialed by the sampler. Field sheets will be stored in a 3-ring binder and will be transferred to the project leader at the end of each sampling day.

A sample submittal form will also be filled out for each group of samples taken at an individual station. Information recorded on the form includes: sample identification number, submitting agency, collection date and time, sample depth, matrix type, sample location, county of origin, samplers names and signatures, field parameter values, analyses requested, sample containers submitted, preservatives used (amount acid used and pH check verification), and any general comments. This form will be kept with the samples and will be submitted with the samples to the laboratory.

When logistics and sample holding times allow, WET personnel will transport the samples directly to the laboratory. WET staff will ensure that samples remain iced to 4°C (or in the case chlorophyll *a* filters, frozen) during transportation. If a common carrier is required to transport the samples, the project leader will be responsible for making sure that samples are packed in sufficient ice for the duration of the trip, the coolers are properly bound with strapping tape and will not open during transport, and the sample submittal forms are either placed inside the cooler in a sealed plastic bag or are securely attached to the outside of the cooler. The project manager will retain all shipping receipts and place them in the project file.

8.5.3. Legal Chain-of-Custody

The above described chain-of-custody procedures will be modified slightly whenever legal action is probable or pending (e.g., whenever a TMDL or WQBEL is disputed and resampling is required). The legal chain-of-custody procedure will include the use of custody tags for individual samples and the use of evidence tape on all coolers.

9. Equipment and Instruments

9.1 *In-situ* Metered Parameter Measurements

The WET uses a variety of electronic meters to measure in-situ water quality parameters including dissolved oxygen, temperature, pH, conductivity, salinity, and light. Important, general considerations regarding the section's metered sampling procedures include the following:

a. Each piece of equipment will be assembled, calibrated, and checked to see that batteries are charged and that it is functioning properly.

b. The sensor probe will be placed in the sample location, allowed to equilibrate, and then measurements will be obtained.

c. Sample observations will be recorded on the appropriate recording form and the equipment will be prepared to collect additional sampling measurements.

d. After all sample measurements have been obtained, a quality control check for drift will be performed, and the equipment will be disassembled and properly stored.

9.1.1. YSI Models 6920, 6000, and XLM 600 Multi Parameter Meter

CALIBRATION PROCEDURES:

Procedure to be performed upon complete assembly of unit.

DISSOLVED OXYGEN:

Place approximately 1/8 inch of water in the bottom of the calibration cup. Engage only 1 thread of the calibration cup onto the sonde to ensure that the DO probe is vented to the atmosphere. Ensure that the DO probe and the thermistor are NOT in contact with the water. Wait at least 10 minutes for the air in the calibration cup to become water saturated and for the temperature to equilibrate.

From the Calibrate menu, select “Dissolved Oxy” and then “DO %”.

Enter the barometric pressure in mmHg. At sea level use 760. (See YSI manual for additional information).

Observe and log the DO charge reading (DO ch) and ensure that the reading ranges between 25 and 75. Observe the temperature and DO readings and when they show no significant change for approximately 30 seconds, then press “Enter”. The screen will indicate that the calibration has been accepted and prompt you to press “Enter” again to return to the Calibrate menu.

CONDUCTIVITY:

Prior to calibration, put the sonde into the Run mode and let the sensors make readings in air. The conductivity reading should be less than 3 uS/cm. If the readings are much higher (>10 uS/cm), follow the probe cleaning procedures before calibrating the sonde if necessary.

Pour enough standard into the calibration/transport cup to fully immerse the conductivity cell and thermistor. The calibration standard used should be within the same range as the water to be sampled. However, standards with less than 1 mS/cm (1000 uS/cm) are NOT absolutely necessary. However. WET occasionally uses 147-180umhos for fresh water.

Note:
Recommended Calibration Standards:
Freshwater: 1 mS/cm standard
Brackish water: 10 mS/cm standard
Seawater: 50 mS/cm standard

Place the probe into the standard and make sure that the probe is completely immersed past the vent hole. Gently tap the side of the calibration cup to dislodge any air bubbles trapped inside the cell.

Allow at least 1 minute for temperature equilibrium to occur before proceeding.

From the Calibrate menu, select “Conductivity” then “SpCond” to calibrate for Specific Conductance (or temperature-compensated conductivity). Enter the value of the standard in mS/cm at 25oC then press “Enter”.

NOTE: The value entered MUST be in mS/cm. Multiply the value in uS/cm by 1000 to convert to mS/cm

Observe the conductivity readings until they stabilize and do not significantly change for approximately 30 seconds and then press “Enter”. The screen will indicate that calibration has been accepted and will prompt you to press “Enter” again to return to the Calibrate menu.

Escape out of the Calibrate menu back to the Main menu.

Note: Select “Advanced” and then “Cal Constant”. Record the Cond cell constant which should range between 4.5 and 5.5

Rinse the sensors in tap or DI water and then proceed to calibrate pH.

pH

2- or 3-Point Calibration Procedure:

Place enough pH 7 buffer into the calibration cup to immerse the pH probe, reference junction, and thermistor. Allow at least 1 minute for temperature equilibration before reading.

From the Calibrate menu, select “ISE1 pH” and then choose “2-Point” or “3-Point” depending on the calibration procedure required. For example, if the water to be monitored has a pH of 7.5, then there is no need to calibrate the probe with a pH 4 buffer – a 2-point calibration will be sufficient.

Enter “7.0” when prompted for the first pH value. ALWAYS begin with pH 7. Observe the pH

reading and record the pH mV reading. The pH mV should range between –40 to +40. When the values show no significant change for approximately 30 seconds, press “Enter”. The display will indicate that the calibration has been accepted and will prompt you to enter a second pH value.

NOTE: While calibrating pH, it is recommended that the pH mV readings are recorded.

After the pH 7 calibration is accepted, press “Enter” again to continue. Rinse the sensors in tap water or DI before rinsing them in the second buffer.

Place enough buffer (pH 4 or 10) into the calibration cup to immerse the pH probe, reference junction, and thermistor. Allow at least 1 minute for temperature equilibration before reading. Observe the pH reading and record the pH mV reading. The pH mV should range between 140 to 220 in pH 4 buffer and –140 to –220 in pH 10. Press “Enter” when the pH reading shows no significant change for approximately 30 seconds. Press “Enter” again to return to the Calibrate menu or to proceed to the third pH calibration buffer.

NOTE: Subtract the pH 7 mV from the pH 4 or 10 mV. This difference must be greater than 165 mV. While the pH probe may continue to calibrate with less than 165 mV, this indicates that the pH probe will soon need replacement.

If a 3-Point calibration is being performed, follow the directions above.

Rinse the sensors in tap water or DI and prepare the sonde to calibrate for Turbidity if necessary.

Turbidity:

Note: Always start with the zero (0) NTU standard first.
Always use the black cal cup.

Pour the 0 NTU cal standard into the calibration cup. Pour down the side as to not aerate the sample. Secure the sonde into the calibration cup by engaging 1 thread.

Verify that there are no air bubbles on the probe face then run the wiper at least once (you may remove the wiper if necessary). Wait out the probe’s sampling period before accepting the first calibration point. Then press “Enter”. At the low end the display should read 0.

Pour out the 1st standard then pour in the second standard using the same care not to create bubbles.

Calibrate the second point, typically 123 NTU. Again, wipe the probe at least once before pressing the “Enter” button. Upon completion the display should read “123”.

9.1.2. Beckman Salinometer

A Beckman model RS5-3 Salinometer is used to measure in-situ temperature, conductivity, and salinity. A complete field unit consists of a transistorized meter, sensor, and cable.

CALIBRATION

Once in the field, the meter will be assembled and then field calibrated according to the following procedure.

1. Perform the zero adjustment procedure listed for specific conductance calibration.

2. Loop the wire of a 50 ohms resistor through the dry cell.

3. Turn the selector knob to “COND” and adjust the conductivity crank knob until 49.5 micromhos/cm is displayed.

4. The midscale value of zero should be indicated on the meter. Repeat the calibration procedure, if necessary.

5. Remove 50 ohms resistor.

9.1.3. LI-COR Photometer

A LI-COR Photometer is used to measure in-situ photosynthetically active radiation (400-700nm) and solar irradiance (400-1100nm). A complete field unit consists of a battery powered transistorized meter, a pyranometer sensor, an underwater quantum sensor, a sensor selector, cables, and a lowering frame.

ASSEMBLY

1. Attach a 5-10 pound weight to the base of the lowering frame.

2. Attach the secchi disk to the threaded bolt.

3. Place the plastic washer onto the base of the underwater quantum sensor, and set the sensor in the bracket. Attach the sensor to the base using the three bolts, lock washers, and nuts.

4. Place a small amount of stopcock grease on the o-ring built into the base of the sensor. Align the gray arrow mark on the cable with the gray arrow mark on the sensor and lightly push the cable connector on to the sensor. Then attach the cable's screw on connector.

5. Adjust the secchi disk so that the top of the disk corresponds to the top of the sensor bulb.

6. Locate the patch cable and connect the male end to the meter's sensor input coupler, and the female end to the output coupler on the sensor selector. Screw in both couplers.

7. Assemble the pyranometer sensor by attaching the sensor to the leveling base using the attachment screw.

8. Attach the pyranometer calconnector (small black bar jack labeled pyranometer sensor) to the pyranometer cable. The serial number on the calconnector (5608) should match the serial number of the pyranometer. (The calconnector may have been previously attached. If so, you still need to check the serial numbers.)

9. Disconnect the female plug from the pyranometer calconnector and plug the calconnector into the sensor #1 port of the sensor selector. Tighten the screws.

10. Attach the quantum sensor calconnector to the BNC cable (cable extending from the underwater sensor). The serial number on the calconnector (373) should match the serial number of the quantum sensor.

11. Disconnect the female plug from the calconnector, and plug the calconnector into the sensor #2 port. Tighten the screws.

9.2 In-Situ Water Quantity Sampling Procedures

Water quantity measurements are routinely collected during intensive surveys to determine the flow, time-of-travel, and geometry of the studied water body.

9.2.1 Discharge

Discharge (the volume rate of flow for a stream, river, or canal at any cross-section) will primarily be determined using current meters. Mechanical and/or electronic current meters are used in conjunction with the wading rod or cable suspension methods to determine discharge. These measurements are sometimes used as point velocities to calibrate model velocities, but are more frequently used to determine the volume rate of flow through a defined cross-section along a river/stream/canal. To determine discharge, the cross-section of the water body is divided into subsections, and the velocity, width, and depth of each subsection is measured and recorded. The sum of the products of the individual subsection observations provides an estimate of discharge using the following basic formula:

$$Q = \sum_{i=1}^{n} (A_i \times V_i)$$

where

Q = discharge in cfs
A_i = cross-sectional area of subsection i (ft^2)
V_i = velocity of subsection i (ft/s).

The USGS (1982) has developed a standard technique to determine discharge using subsection velocity measurements. This technique for calculating flow, called the Mid Section method, is described in detail in a subsequent section. While the basic methodology is independent of the type of flow meter used, it is important to select a proper flow site and the appropriate meter before taking flow measurements.

General Considerations:

Prior to taking flow measurements, project managers should survey the study area and carefully select flow sites that will allow the most accurate flow measurements. Sites without islands, or braided channels. In very shallow slow moving streams, constricted areas are usually the most convenient and allow greater accuracy because the constriction reduces the width of each subsection and increases the current velocity.

Flow sites should have a uniform flow and should be free of eddies, slack water, and excessive turbulence. In addition, the stream bed should be free of boulders or aquatic vegetation (Rantz, 1982). It may be necessary to physically remove obstructions in the stream both at and upstream of the flow site. Such modifications as would be allowed under Chapter 373.406(6) Florida Statutes allow for more accurate flow measurements and should not affect the actual stream flow.

1. The field sampler will be either certified by the section equipment manager in the use of all equipment and familiar with its limitations or under the direct supervision of a certified staff.

2. Prior to deployment, staff must perform a calibration and a check of instruments to confirm that they are functioning properly and that batteries are fully charged. See Section 9.2.3 below for descriptions of individual meter procedures for calibration and instrument functionality.

3. Site selection
   The site should be that which will provide the most accurate measure of flow. Note, this does not necessitate the flow site be the same location for other data collection. Flow measurements should be collected within a 30 meter distance of water quality sample collection site (with no other sources of water between flow and water quality sites) to be recorded as the same location, otherwise two locations should be recorded. It is most often easier to select a water quality sample location within a 30 meter distance of a good flow

sampling location than always finding a good flow sampling station near a water quality station. When the water quality sampling site is in close proximity to the flow site, the bottle collection should always be upstream of the flow transect and far enough as to not interfere with the flow measurement. Additionally, staff should keep the 15-minute time to preservation in mind when selecting the water quality sampling site.

Public vs. Private lands

a) It is preferable that sites be on public lands requiring no special permissions for access to the waterbody.

b) If the only suitable site is on private lands, permission from the property owner or their agent must be obtained prior to accessing the sampling site. It is preferable to have written consent, although email or oral consent is acceptable. In all cases, the project manager should create a written record of the permission to access. Include a description of property (street address and/or tax ID), date/time/location when access was granted, and the name of the person granting access (relation to property owner if not owner). The Project Manager should sign this documentation and retain it in project files.

Wadeable site

a) Able to be accessed safely from the edge, such that one should not have to drop to the water, nor have sides so steep or of a composition as to endanger the sampler in gaining access to the waterbody.

b) Water depth will be > 0.3 and ≤3.8 feet.

c) Record latitude/longitude of the site. If unable to obtain site GPS location then record distance and direction along the stream to a location (upstream or downstream of road/bridge) where the GPS location can be obtained.

d) Site is safe for potential conflicts with wildlife, for example alligators or debris (glass, metal).

e) Site allows tag line to be deployed perpendicular to flow from right edge to left edge of water.

f) Flow velocities and conditions will be such that the sampler is not endanger of being knocked over by current or debris being carried in the water column. This includes that bottom consistency is not such that the sampler is endanger of becoming stuck, sinking below 4 feet in depth, and provides suitable footing for both sampler safety and proper operation of the equipment.

g) If possible, the linear section for which flow is being collected should be straight for 5 times the stream width in the upstream and 3 times the width in the downstream direction.

h) Walk the selected stream cross-section before starting measurements, making mental note of depth gradients, points of channeling, or other relative dramatic changes in depth to estimate flow variances. Cross-sectional areas should be divided into the appropriate number of subsections so that no more than 10% of total discharge flows through a subsection (Rantz, 1982). The default number of intervals is 20 equal intervals. This may not be appropriate in streams that significant channels or highly altered depths. In streams with highly variant depth gradient or significant channelized areas, the sampling intervals should be adjusted to capture the greater flow in deeper and more rapidly flowing cross-sections. Again, the goal is for each interval to represent <10% of the total flow.

i) Within an area centered on the selected site (approximately 3 meters in the upstream direction, or 3 times stream width * deepest depth) the site should be free of any obstructions or vegetation that would create turbulent flow affecting measurement accuracies. It may be necessary to physically remove obstructions or vegetation in the stream both at and upstream of the flow site. Such modifications as would be allowed under Chapter 373.406(6) Florida Statutes allow for more accurate flow measurements and should not affect the actual stream flow.

j) Record estimated quality of measurement location and the basis of estimate on the field sheet.

k) If there is a need to change the site at which routine flow data collection is made, document conditions in field notes both for basis of primary location being unacceptable on the respective sampling trip, and the basis of alternative site selection. Include in field notes the basis of any alterations to SOP in collection of flow measures, such as reduced number of cross-sections, non-uniform interval for velocity collection, issues reducing S/N such as obstacles in flow path, highly curvilinear stream section, etc.

4. After sample collection, all equipment will be disassembled, properly packaged, and stored for transportation. Any equipment problems will be brought to the attention of the environmental technician for maintenance or repairs.

In some cases, flow will be measured directly using the "bucket" method. This application should be limited to measuring discharges from pipes/drainage structures/weirs or small tributaries with depths less than 0.3 feet. Consideration will be given to ensure the entire discharge can be collected within the bucket during a predetermined interval.

Current Meter Selection

Our primary recommendation for wadeable streams is to use the SonTek FlowTracker. The exceptions would be in some clear spring runs or cases with FlowTracker Signal/Noise ratios below 4.

The FlowTracker is the preferred current meter as it records all the details of the measurements, has greater sensitivity than the other meters, and is much easier (quicker) to use. The Marsh-McBirney can also be used under conditions that are not suitable for a wading measurement, such as with a longer rod (WET has a 10 ft rod) or attached to the sounding unit of the bridgeboard and used from a bridge.

Current meters should not be changed or substituted during a transect. If a meter malfunctions mid-way through a cross-section, then the entire transect should be repeated with a new meter. It is also recommended that the same type of current meter is used at a site during subsequent intensive surveys.

Setting up the cross-section The Mid-Section Method

The following instructions describe the measurements associated with measuring stream flow using the Mid Section method. Record on the field data flow sheet the location of the site, the date and time, the names of sampling team members, the type and identification number of the meter used, and any calibration information. When using the FlowTracker, include the total flow, mean stream width, mean depth, and mean velocity on the field datasheet, as all other information is recorded in the meter. When using any other stream flow meter all fields on the Discharge Measurement Notes form (see Appendix 6 for example) should be completed.

1. Secure the end of a tag line (tape measure) perpendicular to the right bank of the stream (facing downstream). Then extend the line across the stream and secure the other end of the tag line to the left bank. Make sure that the tape is tight and that the numbers are visible. The tape may have distance in both tenths of a foot and inches, be consistent with units.

2. Read and record the tape measurements corresponding to both the left and right edges of the water and calculate the total width of the stream. Then typically divide the stream into approximately 15-20 locations (intervals). There will be cases when more or less locations are warranted. If unsure, review the FlowTracker training video. While it is generally easier if the intervals are of equal width, it is optional to vary the interval widths if the flow varies significantly along the cross-section. Use smaller intervals where the velocity is greatest or there is a rapid change in depth.

3. Starting at the right edge of the water and standing on the downstream side of the tape with the rod behind the tape, the hydrologist should move along the tape the length of the first subsection. For the FlowTracker, use the attached protocol. With the Marsh-McBirney, the depth should be measured at this spot and then both the depth and the tape reading should be recorded.

4. If the depth is greater than 2.5 feet, then the velocity should be measured at two points in each vertical at depths corresponding to two tenths and eight tenths of the total depth. If the depth is less than 2.5 feet, then the velocity should be measured at a depth of six tenths the total depth. For each of these point measurements, the depth is measured from the surface down. When taking the velocity measurements, the

hydrologist must be careful to stand in a position that does not interfere with the current. The USGS recommends that the current meter be placed at least three inches downstream from the tape measure and that the hydrologist stand at least 1.5 feet downstream of the meter.

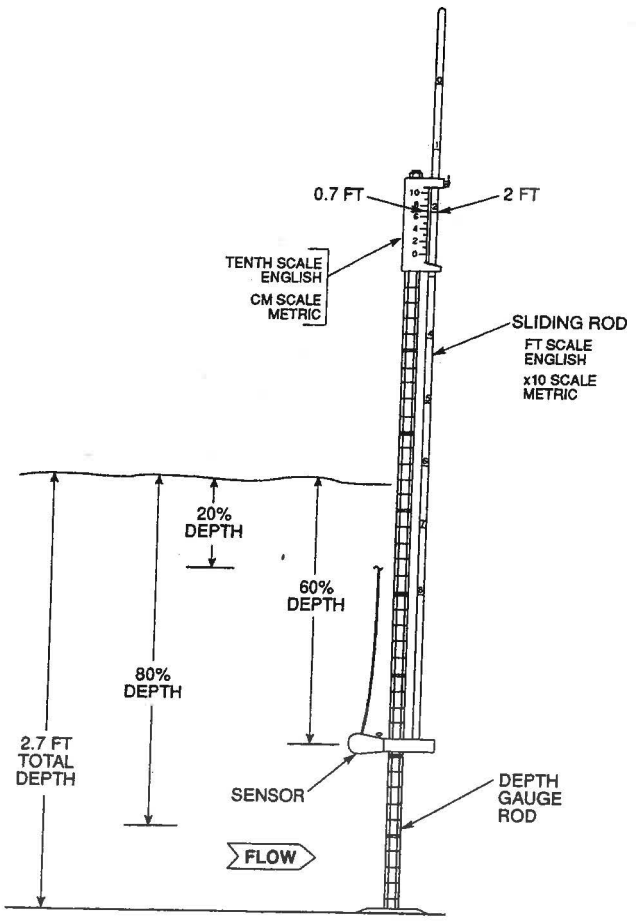
5. Repeat steps 3 and 4 at each position corresponding to the distance of successive subsections. Continue the procedure until reaching the left edge of the water.

Sample Depths for Velocity Measurements

As was described previously, the velocity is measured at two points in each vertical (the two-point method) when the depth is greater than 2.5 feet. According to USGS, the average of these two observations provides an accurate estimate of the mean velocity in the vertical. In shallow water (depth less than 2.5 feet), only the six tenth depth is sampled because the current meter would be too close to the water surface for the two tenths depth and too close to the bottom for the eight tenths depth.

The section's top-setting wading rods are designed to easily adjust to the six tenths depth. To set the rod (**Figure 1**), first measure the depth of the water (to the nearest tenth of a foot) on the fixed support rod. Then adjust the sliding support rod so that the top scale reads the depth of the water. This automatically adjusts the meter to the six tenths depth.

Note that the sample depth terminology can be confusing when using the wading rod because the sample depths are referenced to the water surface and the natural tendency is to adjust the wading rod from the bottom up. For example, if the total depth is four feet, then the six tenths depth is 2.4 feet (4 x .6 = 2.4) from the surface. This means that the current meter should be positioned 1.6 feet off the bottom (the remaining 4 tenths of the depth).



(Set for 0.6 tenths measurement)

Figure 1. Schematic of Deployed Top-setting Wading Rod

9.2.1.1. Sontek Flow Tracker

The FlowTracker is the newest addition to the WET Section's velocity collection equipment. The flow tracker uses the proven technology of the SonTek/YSI Acoustic Doppler Velocimeter (ADV) from a simple handheld interface. This ADV technology provides several advantages over older equipment. These advantages are…

- Accurate velocity measurements in a remote sampling volume
- 2D or 3D velocity measurements (depending on probe configuration)
- Invariant factory calibration – no periodic recalibration required
- Excellent performance for low and high flows – accuracy 1% of measured velocity

Figure 2. FlowTracker Key Pad

Operation:

The following steps describe the data collection sequence when in **General Mode**.

1. Run pre-deployment diagnostics before taking the instrument to the field (see equipment manual)
2. Check **Setup Parameters.**
3. From the **Main Menu**, press **3** to **Start Data Run**.
4. Specify file name and extension (or press **Abort** or **End Section** to return to the **Main Menu**).

5. Input site and operator name; these are optional values used only to document the data set.
6. At any point, press **8** for **QC Menu** to access a variety of special functions
7. You are prompted to conduct an automatic QC test
a. Press **1** to run the automatic QC test, and follow on screen instructions.
b. Press **2** to skip the test and begin data collection.
8. Station information will be displayed (right).
a. Press **Set Location** to set location 1 (**L1**) and location 2 (**L2**) values.
b. Press **Set Depth** to set water depth (**Dep**).
c. Press **Set Meas Depth** to set measurement depth (**MDep**).
d. When the probe is located at the desired station, press **Measure** to start data collection.
9. When the station is complete, a summary of velocity and quality control data is shown.
a. Press **1** to accept the measurement and move on to the next station.
b. Press **2** to repeat the measurement (using the same station number).
10. When a measurement is accepted, the FlowTracker displays the next station. Repeat Steps 6 through 9 to add additional stations.
11. Use the **Prev/Next Station** keys to scroll through completed stations. Three screens are available for each completed station; press **Enter** to scroll through the screens.
12. When all stations are done, press **End Section** to close the file and view summary data.
a. Press **Enter** to move between the file summary screens.
b. Press **Prev Station** from any file summary screen to view station data; scroll through all station data using the **Next Station** and **Prev Station** keys.
c. When done, reviewing data press **Calculate Discharge** (cannot repeat any measurement once Calculate Discharge is pressed)
d. press **0** to exit and return to the main menu.
e. **Return to the Main Menu before turning the system off to ensure all data has been saved**

9.2.1.2 Marsh-McBirney Model 201D Flow Meter

The Marsh-McBirney Model 201D portable flow meters are used to measure stream velocity. This meter measures water velocity by creating a magnetic field and measuring the voltage produced when water (a conductor) flows through the field. The unit consists of a case containing the electronics, a sensor, and a sensor cable. The meter is powered by six size D batteries.

CALIBRATION

Following assembly, a calibration check should be performed to see if the internal circuitry is functioning properly.

1. Turn the selector switch to the CAL position and the time constant switch to 2.

2. After approximately 10 seconds, the reading should be on or between 9.8 and 10.2.

3. Should the readings differ from this range, turn the meter off and check the batteries. Repeat steps 1 and 2.

4. If the unit fails the CAL test after the battery charge, the unit will be sent to the manufacturer for maintenance.

9.2.1.3. RD Instruments Acoustic Doppler Current Profiler

The RD Instruments ADCP is used to measure stream velocity. This equipment measures water velocity by transmitting sound at a fixed frequency and listening to echoes returning from small particles in the water. The transducer can be attached to a boat and used in deeper waters.

SELF TEST

1. Connect the ADCP to a laptop computer and start the WinRiver software.

2. Check the ADCP clock and correct if necessary. Always use local time.

3. Run the PT200 self test to verify proper operation.

9.2.1.4 Marsh McBirney Mdl 2000 Flow-mate Current Meter

Intended to augment not replace the Mdl 201D the WET group also uses the Mdl 2000 Flow-Mate to conduct waded field velocities. Unlike the 201D the model has two operating modes: Real-Time and Recall. In the Real-time mode velocities from the sensor are displayed. In the Recall mode velocities from memory are displayed. . When coupled with accessories the Flo-Mate allows the user to conduct waded measurements more efficiently.

CALIBRATION

The following calibration procedures will be performed with the unit in water with 0 velocity conditions.

1. Secure probe assembly to 4' rod then place in 5 gal bucket filled ¾ way with water.
2. Wait 5 minutes for 0 flow conditions to be achieved.
3. Press the on button and let unit cycle through startup display noting settings.
4. Press recall and store buttons simultaneously then press the down arrow button (3) times to start countdown procedure.
   Note: Upon completion the unit will beep 3 times then shut down.
5. Restart unit by pressing ON button then note reading. It should reflect a reading of 0.00 velocity.

9.2.1.5. General Oceanics Model 6011 MkII Current Meter

The WET has two General Oceanics Model 6011 MkII portable current meters (Niskin Winged current meters) which can measure in situ current direction, current speed, conductivity, pressure, and temperature. The model 6011 MkII is a microprocessor controlled data logger capable of making long term records (up to a year). It calculates current velocity by measuring the tilt angle of its housing unit and measures direction by a solid-state flux-gate compass. The internal microprocessor can vector average individual readings and record the averages in a RAM cartridge.

The system consists of the Niskin winged current meter, meter standoff, suspension cable and stop, data storage cartridge, and a RAM Reader which is used for processing the data. The Niskin current meter should only be used at depths greater than six feet because the combined length of the standoff and the meter is five feet. For best results, the depth at the mooring site should be at least 10 feet.

CALIBRATION

1. The microprocessor controlled design makes actual internal calibration unnecessary. The instrument provides a self-test to determine if it is functioning properly. Check to see if the self-test red light and the trigger reset red light flash when activated.

2. Cross calibration of conductivity, temperature, and velocity probes in the field should be conducted with a Marsh-McBirney flow meter and Hydrolab/YSI. Check direction at the mooring site with a hand-held compass. Record the data on the field data sheet. Refer to the SOP Manual for operating these other meters. If any of the probes do not cross calibrate, the meter should be sent back to the factory for repairs. This determination can only be made after down-loading the cartridge and examining the data.

9.2.3 Time of Travel, Dispersion, and Dilution

9.2.3.1 Turner Designs Model 10 Fluorometer

The WET utilizes a Turner Designs Model 10 Series fluorometer and Rhodamine WT dye to determine time of travel, dispersion, and dilution in receiving water bodies. A complete field unit consists of a meter, optional strip chart recorder, 12-volt battery, influent and effluent hoses, and a pump. The fluorometric equipment will be calibrated prior to each survey and will be properly assembled and checked to determine that it is functioning properly.

Time-of-Travel Measurements

Dye injection sites and dye monitoring stations will be selected prior to conducting a time-of-travel dye study. Where possible, dye (Rhodamine WT) will be injected at the head of the first stream reach and monitored at the end of each downstream reach (stream reaches are demarcated by a significant change in stream cross-sectional area, a change in stream slope, or a tributary input). Rhodamine WT dye will be injected in a manner to assure complete mixing, and monitoring equipment will be positioned at a distance downstream that is at least ten times the stream's width to allow a sufficient distance for mixing (Fisher, et al., 1979).

Multiple dye injections will generally be avoided. If they are required due to excessively long travel times, they will be planned very carefully to avoid intermixing of the dye patches. At specific dye injection stations, dye will be injected either in the center of the stream or across the stream cross-section. The volume of dye injected will be pre-calculated to give an in-stream dye concentration within the upper range of the fluorometer (316 ppb). The calculation should be based on the expected stream flow with the dye volume adjusted in the field as necessary.

Chlorophyll *a* Measurements

The fluorometer can also be set up for in vivo measurement of chlorophyll. For chlorophyll measurements, the light source will be changed to a 10-045 blue lamp, the excitation filter will be changed to a 10-050 color specification 5-60 filter, the reference filter will be changed to a 10-052 color specification 3-66 filter, and the emission filter will be changed to a 10-051 color specification 2-64 filter.

Chlorophyll measurements can be taken with the fluorometer set up for flow through operation or curette operation. When set up for flow through operation, the fluorometer can be used to map out relative chlorophyll measurements over the study area. If quantitative measurements are needed, staff will determine the site-specific relationship between fluorometer readings and chlorophylls measured using the spectrophotometric method. To determine this relationship, at least twenty duplicate samples will be taken with one sample analyzed fluorometrically and the duplicate analyzed spectrophotometrically. The chlorophyll data base can then be expanded to the fluorometer-only samples by using the relationship calculated for the duplicate samples.

9.2.4. Morphometry

The WET utilizes the RD Instruments ADCP referenced above to determine depth contours of lakes, rivers, streams, and estuaries.

9.3. Sample Collection

Bottle samples will be collected for those parameters that cannot be analyzed in-situ using section field meters. The specific parameters requiring laboratory analysis that will be sampled are listed in **Table 9.1**. The type of sample containers, sample volume, choice of preservation, and the maximum sample holding time for each parameter are shown in the table. Pre-cleaned sample bottles will be provided by the laboratory. Section personnel will be responsible for pre-labeling, rinsing, collecting, recording, handling, and returning samples for laboratory analysis in a manner that will ensure sample integrity. Pre-preserved sample bottles will not be used to collect samples.

Prior to sample collection, sample bottles will be properly identified with information pertaining to the location, date, time, name of samplers, type of sample (duplicate, field blank, equipment blank, effluent sample), station and replicate number (when applicable) and recorded on the appropriate form. All containers will be labeled using an indelible ink pen or by attaching an identification tag.

9.3.1. Sample Collection Protocol

Sampling for nutrients and chlorophyll *a* by WET shall be in accordance with the procedures set forth in the February 15, 2002 memo section 3 copied below.

TO: Directors of District Management

FROM: Jerry Brooks, Deputy Director
Division of Water Resource Management

DATE: February 15, 2002

SUBJECT: Making and Using Chlorophyll a Measurements
Under the Total Maximum Daily Load Program

3) Where should the ambient water samples be collected?

Samples should generally be taken from a depth of ½ meter or mid-Secchi depth. Mid-Secchi depth is preferred, but in cases where the Secchi disk is visible all the way to the bottom or where sampling at mid-Secchi depth is not practical, the ½ meter depth should be used. In waters less than ½ meter deep, samples should be collected at mid-depth. Samples can be collected at one or more stations within a water segment (represented by a single waterbody ID), but staff should keep in mind the time and space requirements in the IWR for collecting independent samples (i.e., at least one week apart for sites located within 200 meters of one another). In cases where chlorophyll samples are collected as part of a depth profile, the median value will be used to represent the sample for that day and location.

The sampling protocol for collecting bottle samples from shallow surface waters where the Secchi depth is clear to the bottom and the shallow water depth prevents submerging the sample container is listed below. When following this protocol, pre-preserved sample bottles should not be used as collection containers.

1. Facing upstream, place the labeled sample container in the water, tipping its mouth in the direction of the current. Partially fill the bottle, lightly cap, shake the bottle, uncap, and then rinse it out. Repeat this procedure twice to assure that the container is adequately rinsed.

2. Invert the sample bottle and place it in the water at the selected depth. Then tip its mouth in the direction of the current and allow water to flow into the container. Completely fill the container (or to within 1/2 inch of its mouth when a preservative is being added) being careful to avoid disturbing and collecting any sediments or floating material.

3. Bring the sample bottle to the surface, add preservatives if appropriate, tightly cap the bottle, and place it in an ice chest with sufficient ice to bring the sample to 4°C. Then ship or transport the samples to the laboratory for analysis.

Table 5. Physical Chemical "Bottle Sample" Parameters

Parameter	Container	Preservation	Min. Sample	Maximum Holding Time
Alkalinity	P, G	4°C	25 mL	14 days
Ammonia	P, G	4°C, pH <2 using reagent-grade H_2SO_4	50 mL	36 hours
Carbonaceous Biochemical Oxygen Demand	P, G	4°C	---	48 hours
Chloride	P, G	none	---	28 days
Chlorophyll a	P, G	$MgCO_3$ prior to filtration	---	48 hours prior to filtration 28 days post filtration
Conductivity	P, G	none	25 mL	none
Fluoride	P	none	---	28 days
Kjeldahl and Organic Nitrogen	P, G	4°C, pH <2 using pesticide-grade H_2SO_4	100 mL	28 days
Metals	P, G	pH <2 using trace-metals grade HNO_3 (Hg = 28 days)	100 mL	6 mos
Nitrate-Nitrite	P, G	4°C, pH <2 using pesticide-grade H_2SO_4	---	28 days
Orthophosphate	P, G	4°C, field Filtered	---	48 hours
Oxygen, Winkler	G (Bottle & Top)	Fix on site and store in dark	---	8 hours
pH	P, G	4°C, no air space	25 mL	No holding time if on site, unlimited in received sample(our goal is to determine pH of sample as tested)

Table 6. Physical Chemical "Bottle Sample" Parameters

Parameter	Container	Preservation	Min. Sample	Maximum Holding Time
Phosphorus, Total	P, G	4°C, pH <2 using pesticide-grade H_2SO_4	50 mL	28 days
Residue, Filterable	P, G	4°C	50 mL	7 days
Residue, Nonfilterable (TSS)	P, G	4°C	50 mL	7 days
Salinity	P, G	none	25 mL	30 days
Specific Conductance	P, G	4°C	50 mL	28 days
Sulfate	P, G	4°C	50 mL	28 days
Turbidity	P, G	4°C	50 mL	48 hours

The sampling protocol for collecting bottle samples from deeper surface waters where remote sampling devices are needed to sample at a specific depth is:

1. If sampling from a boat, anchor boat and take samples from the bow.

2. Set trip mechanism on remote sampler (Kemmerer or Van Dorn) and rinse sampler with surface water.

3. Lower sampler to appropriate depth and trigger sampler with messenger device.

4. Raise sampler, partially fill the sample bottle with the sample water, lightly cap and shake the bottle, uncap, and then pour out rinseate (no rinsing for microbiological samples).

5. Fill the container (repeat steps 1 and 2 if an additional sample is needed), add preservatives if appropriate, tightly cap the bottle, and place it in an ice chest with sufficient ice to bring the sample to 4° C. Then ship or transport the samples to the laboratory for analysis.

9.3.2. Use of Automated Sampling Devices

The ISCO MODELS 1680 and 2700 samplers are portable automated sample collection devices. Both models are designed to collect either discrete or composite samples at equal time or flow intervals. The samplers can collect up to 24 discrete samples with a maximum volume of 1000 ml each, or can collect one composite sample with a maximum volume of 9500 ml. The samplers are generally used in conjunction with the fluorometer to determine time-of-travel or dispersion or at sewage treatment plants to obtain a composite effluent sample.

Both models consist of three separate sections. The lowest section comprises the sampling tub which holds the plastic sample bottles. The middle display unit section contains the pumps, meters, electronic circuitry, and the programming controls. The upper section serves as the sampler cover.

Instructions for programming the samplers are written on the lid of the display unit section and are virtually self explanatory. The programming instructions for each model are also included in this document to provide additional clarification if necessary. Assembly instructions are the same for the two models and are detailed below.

ASSEMBLY

1. Unlatch the three black rubber draw catches and remove the cover section. Unlatch the three stainless steel latches, and lift off the display unit section.

2. Examine the sampling bottles in the tub. Make sure the containers are in the right position, clean, uncapped, and the correct size. If samples are to be analyzed for nutrients, pre-acidify every other sample bottle and program the sampler to take two bottles per sample. Replace the display unit onto the tub unit and relatch the metal bracket clamps.

3. Uncoil the tygon tubing extending from the intake to the peristaltic pump. Make sure there are no cuts or cracks in the tubing, that the hose properly fits the intake and pump connections, and that the hose clamps are secure.

4. Check to see if either a Ni-Cad battery pack or an AC power pack is in place and connected to the unit. With the AC power pack, the unit can be powered from an AC power source. The Ni-Cad battery pack must be used in remote locations.

5. Place the unit in the desired sampling location on a relatively flat surface. Set the intake at the desired depth and sampling location. Make sure the suction line slopes downhill so that it will drain completely during purging.

COMPOSITING

While both ISCOs have the capability to take direct composite samples, composite samples will typically be manually prepared by mixing discrete samples of equal volume. After the sampling program is completed, all un-acidified sample bottles will be capped, removed from the ISCO, shaken, poured into a clean (per DEP-SOP-1/01 FC 1000) plastic bucket, and mixed thoroughly. The samples will then be collected from the bucket. Sample bottles will be labeled as composite samples, and the volume of the subsamples will be recorded on the label. The bucket will then be triple rinsed with analyte-free water, shaken to remove excess rinseate, and the compositing procedure repeated for the acidified samples. Microbiological samples will not be composited.

9.3.3. Wastewater Sampling

Special considerations for sampling wastewater includes:

1. Prior to any sampling, samplers should, if possible, obtain a brief characterization of the effluent and determine if any special sampling equipment or special sampling procedures are required.

2. Samples should be collected at the NPDES compliance point were possible. When not possible (discharge canal, not accessible for grab samples, etc) collect samples sufficiently downstream from all entering waste streams so that the effluent is well mixed and representative of the final discharge.

3. In open conveyance systems, the sample location should be mid-depth, near the center of the flow channel.

4. If the sample is taken from an effluent tap, the tap will be turned on and allowed to run for one minute before the sample is taken.

9.3.4. Microbiological Sampling

Special considerations for microbiological sampling include:

1. Samples will be taken without rinsing and all samples are grab samples.

2. Sample containers are kept closed until they are filled.

3a. If bottles are used, the stopper and cap are removed as a unit and care is taken to not contaminate the inner surface of the stopper or cap and neck of bottle. The bottle is grasped at the base with one hand and plunged mouth down into the water. The bottle is then tipped slightly upward to fill the bottle. After removal of the bottle from the water body, a small portion of the sample is poured out to allow an air space of 2.5 to 5 cm above each sample and the bottle is tightly stoppered.

3b. If Whirlpak bags are used, the tops are torn off, the bag held so that the mouth of the bag is in front of the hands, the bag immersed while still closed, the bag is opened into the current, and the full bag drawn up through the surface mouth first. If the water is static, the bag is opened while slowly being moved through the water. The bag is then sealed by folding the bag at least three times and then bending the wire ties in half and twisting them together.

4. The sample containers are labeled and placed on wet ice for transport to the laboratory. To meet the 6-hour holding time, samples will be taken directly to the laboratory for analysis.

9.4. Sample Preservation

Preservation requirements for each bottle sample parameter are shown in **Table 9.1.** As shown in the table, preservatives are limited to wet ice, reagent grade H_2SO_4 (nutrient samples), and reagent grade HNO_3 (metal samples). Fresh reagent grade preservatives will be supplied by the DEP Central Laboratory for each sampling event. Preservatives will be transported in plastic bottles provided by the laboratory, and added to the samples using disposable polypropylene droppers.

Acids will initially be added at a rate of 2 ml per liter of sample, for both samples and blanks. The efficacy of the pH adjustment will then be checked in the field by pouring a few drops of the sample onto narrow range pH paper. If additional acid is required, the same stock of acid will be used to supply the additional acid, and the amount used will be recorded on the field sheet for the sample. The pH will be checked at each station during the first sampling run of each survey and will be checked during subsequent sample runs at each station where additional acid was needed.

Because chlorophyll *a* samples must be filtered within 24 hours, there will be times when logistic constraints will require that WET staff filter the samples in the field. For the filtration, samples will be agitated, split into equal volume subsamples, and then filtered through Whatman 0.45 um, 5.5 cm diameter GF/C filters. Approximately 1 mL of a magnesium carbonate suspension will be added as the last of the sample passes through the filter. The filters will be dried by maintaining the vacuum for approximately 15 seconds after all water has been filtered. Following filtering, the filters will be folded in quarters with the sample inside, wrapped in foil, labeled, and frozen for analysis by the DEP Central Laboratory.

9.5. Sample Dispatch

Samples will typically be brought to a central field location for packing and dispatch to the DEP Central laboratory. Samples are usually segregated by site (and sampling run) and placed into insulated coolers packed with sufficient wet ice to keep the samples at 4°C for the duration of the trip to the laboratory. Any breakable sample bottles (microbiological sample bottles) will be wrapped in bubble wrap or a similar packing material to avoid breakage.

Sampling paperwork will be placed in a zip lock bag and taped to the inside top of the cooler. If coolers are to be transported via express mail, they will be secured with strapping tape. If possible, section personnel will deliver the coolers directly to the laboratory.

9.6. Cleaning and Decontamination Procedures

All equipment will be cleaned in the laboratory and transported to the field pre-cleaned and ready to use. If equipment is re-used during a survey, it will be field cleaned. Equipment that is used only once will be tagged as "used" and returned to the laboratory for cleaning. All decontamination protocols will be documented in the appropriate field records.

9.6.1. Laboratory Decontamination Procedures

Sample Containers

All sample containers, including the ISCO sample bottles, are obtained precleaned from the DEP Central Laboratory.

Glassware/Filtration Equipment

Any glassware used in the laboratory will be cleaned according to DEP-FM 4000. Cleaned glassware will be placed in cabinets and on shelves designated for their storage. Dirty glassware will be stored in a separate area. Non-glass components of section filtration equipment will be cleaned according to DEP-FM-4000.

Sampling Equipment

Remote sampling equipment will be cleaned in the laboratory according to DEP FM 4000, FC 1000, FC 1190, and FC 1180. As recommended in this cleaning protocol, a 10-15% reagent grade hydrochloric acid rinse will be used instead of the nitric acid rinse. Tygon tubing used in the ISCO samplers will be cleaned using the following protocol:

1. Remove tubing (and intake screen) from ISCO and flush with soapy solution of hot tap water and Liquinox.

2. Rinse exterior and interior thoroughly with hot tap water.

3. Rinse exterior and interior thoroughly with deionized water.

4. Re-place tubing on ISCO, or if tubing will be used as replacement tubing, wrap tubing and cap ends with aluminum foil.

9.6.2. Field Decontamination Procedures

Sample Containers

Sample containers will not be cleaned in the field. When using automatic samplers, sufficient sets of pre-cleaned bottles will be brought to the field so that no field cleaning will be necessary.

Sampling Equipment

When trace metal samples are being taken, remote sampling equipment (Kemmerer or Van Dorn) will be cleaned in the field according to DER-SOP-001/01. As recommended in this cleaning protocol, a 10-15% reagent grade hydrochloric acid rinse will be used instead of the nitric acid rinse. The protocol will be the same as the laboratory protocol except that hot water will not be used and the cleaning environment will not be contaminant free.

If metals are not sampled, the samplers will be rinsed with analytic free water immediately after use, and then rinsed several times with sample water from the next sample.

Equipment specific field decontamination procedures include:

1. Sufficient pre-cleaned tygon tubing will be brought to the field so that field cleaning of ISCO tygon tubing will not be necessary.

2. Fluorometer tubing will be field rinsed by running the submersible pump for at least five minutes.

3. Field probes will be rinsed with deionized water between stations and then rinsed with sample water from the next sample. At the end of the sampling day, field meters will be wiped to remove particles, rinsed with tap water, and dried (air dried if possible).

9.7. Analyte-free Water

Milli-Q deionized water from the DEP Central Laboratory is used for making all standards, and deionized water from the DEP Laboratory Building system is used for sample blanks and to rinse field probes. These analyte-free waters have been repeatedly analyzed, and the analytes covered by this CompQAP are below the detection limit for each analyzed parameter. The DEP Chemistry Section monitors the quality of both sources and maintains records of this monitoring. Chemistry Section personnel have agreed to notify WET personnel if they discover problems with the deionized water system. Analyte-free waters are stored in containers provided by the DEP Central Laboratory.

10. Quality Control Measures

10.1. Quality Control Measures

10.1.1. Field Quality Controls

10.1.1.1. Field Blanks

Field blanks will be prepared on-site by filling the appropriate sample containers with analyte-free DI water, adding appropriate preservatives, sealing the containers, and completing the appropriate documentation. The field blanks will be treated, transported, and stored with the regular samples collected for the same sample group. Field blanks will be taken at a minimum rate of 5% per analyte group.

10.1.1.2. Equipment Blanks

Equipment (rinseate) blanks will also be prepared for each parameter group sampled using remote sampling equipment that must be decontaminated in the field for subsequent sampling. Equipment blanks will be prepared in the field by collecting, in the appropriate container for the parameter group, an analyte-free DI water rinse from the equipment (e.g., Van Dorn bottle) before any samples are collected (first equipment blank) and after execution of the last step of the proper field decontamination protocol (second equipment blank).

Preservatives will be added to the equipment blanks when appropriate for the parameter group. The equipment blanks will be treated, stored, and transported with the regular samples collected for the sample group.

When required, equipment blanks will be taken at a rate of one blank or 5% (whichever is greater) per analyte group. If 10 or less samples are collected, only one blank (either from pre-cleaned equipment or from equipment cleaned in the field) will be taken per analyte group.

10.1.1.3. Field Duplicates

For each bottle sample parameter, at least one sample or 10% of the samples, whichever is greater, will be collected in duplicate during each survey. Similarly, for metered parameters measured in the field, at least one duplicate sample will be analyzed for every 10 field measurements.

10.1.2. Methods Used to Ensure Accuracy

10.1.2.1. Equipment Calibration

All equipment will, at a minimum, be calibrated and checked according to manufacturer's instruction. All equipment will be calibrated or checked prior to sampling (see **Table 9.1**), and all DO meters will receive an additional annual calibration check against Winkler titration. All laboratory calibration will be entered into the log book for each meter (maintained by laboratory technician), and all field calibration data will be recorded on field sheets (maintained by project manager).

10.1.2.2. Standard Receipt and Traceability

The majority of standard solutions used by the WET are purchased from a chemical supply company as needed. Additional standard solutions may occasionally be obtained from the DEP Chemistry Laboratory. Upon arrival at the lab, the standards are logged in by the environmental technician and then stored in storage cabinets at approximately 25°C. The environmental technician will maintain a log of the sources, dates of receipt, and expiration dates of each standard. The technician will also periodically check the expiration date of all standards and will promptly dispose of all expired chemicals.

Table **7. Calibration Acceptance Criteria (pH, Specific Conductance, Temperature, Dissolved Oxygen, Turbidity, and Total Residual Chlorine**

Table FT 1000-1: Field Testing Acceptance Criteria	
Parameter	**Acceptance Criteria**
pH (FT 1100)	± 0.2 Standard pH Units of buffer or more stringent program criteria
Specific Conductance (FT 1200)	± 5% of standard value
Temperature (FT 1400)	± 0.2°C of NIST-traceable value (with correction factors) Verification over range of applicable values
Dissolved Oxygen (FT 1500)	± 0.3 mg/L of theoretical value (see Table FT 1500-1)
Turbidity (FT 1600)	0.1-10 NTU: ± 10% of standard value 11-40 NTU: ± 8% of standard value 41-100 NTU: ± 6.5% of standard value > 100 NTU: ± 5% of standard value
Total Residual Chlorine (FT 2000)	0.995 calibration curve correlation coefficient ± 10% of primary standard value ± 10% of secondary standard value Color comparator acceptance criterion: ± 10% of primary standard value

Table 8. Calibration Acceptance Criteria Specialized Instruments

Instrument	Calibration Type	No. of Standards	Acceptance/Rejection Frequency	
Beckman RS-3	Continuing	1	Temperature = ±0.5° Conductivity = ±0.05 uhos Salinity = ±0.03%	Prior to Use
LI-COR	Continuing	N/A	N/A	Prior to Use
Model 10 Fluorometer	Continuing	4	Fluorescence ±1% of Full Scale	Prior to Use
Marsh-McBirney Model 201	Continuing	N/A	V = ±2%	Prior to Use

10.1.2.3. Standard Sources and Preparation

Standard sources used by the WET are listed in **Table 10.3**. The WET routinely prepares two types of standards, a potassium chloride standard for conductivity/salinity calibration and a dye standard for fluorometer calibration. Preparation protocols for each standard are listed below.

Potassium Chloride Standard

Prior to weighing the KCL crystals for the following standards, they will be dried in an oven for approximately four to five hours at approximately 175°C.

Preparation of 1.0 M Standard

1. Weigh out 74.456 grams of KCL crystal.
2. Add the crystals to a 1 liter volumetric flask.
3. Fill one-third of the container with de-ionized water.
4. Swirl the container to mix the solution.
5. Fill the remaining container with de-ionized water to the 1 liter volume.
6. Mix the solution by inverting the container.

Preparation of 0.1 M Standard

1. Place 100 ml of the 1.0 M standard solution into a 1 liter volumetric flask.
2. Fill the container half full with de-ionized water.
3. Swirl the container to mix the solution.
4. Fill the remaining container to the 1 liter volume.

5. Mix the solution by inverting the container.

Preparation of 0.01 Standard

1. Obtain 100 ml of the 0.1 M standard solution and add this to a 1 liter volumetric flask.

2. Repeat steps 2 through 5 from the 0.1 M standard preparation.

Table 9. Standard Sources and Preparation

Instrument Group	Standard Sources	How Received	Source Storage	Preparation From Source	Lab Stock Storage	Preparation Frequency
pH Meters pH	Fisher Scientific Chemical Co.	Solution 4, 7 & 9 @ 25°C	Storage Cabinets	Source Stock	Storage Cabinets	As Needed
Conductivity Meters	Fisher Scientific Chemical Co.	Solutions 1 M KC1 @ 25°C	Storage Cabinets	Source Stock	Storage Cabinets	As Needed
Model 10 Fluorometers	Compton Knowles	20% WT @ 25°C	Storage Cabinets	Primary Stock Used For Prep. of Intermediate Stock And Intermediate Stock Used For Preparation of Working Stock	Storage Cabinets	Quarterly

Preparation of the 0.001 M Standard

1. Obtain 1 ml of the 1.0 standard solution and place this in a 1 liter volumetric flask.

2. Repeat steps 2 through 5 from the 0.1 M standard preparation.

Verification

Once the standards have been prepared, check the conductivity of each using a previously calibrated conductivity meter. The conductivity of each standard solution is shown below.

Standard Solution (moles)	Conductivity us/cm
1.0	111900.0
0.1	12900.0
0.01	1413.0
0.001	147.0

Rhodamine Dye Standard

The dye received from the manufacturer is a 20% solution. This solution must be diluted to 200 ppb for use as a calibration standard. When each keg of dye is received, the lot number of the keg should be recorded prior to preparation of standards.

1. Preparation of 200 ppm intermediate solution.

    a. Fill a clean 1000 ml volumetric flask approximately half full with distilled water.

    b. Inject 1 ml of 20% dye (raw) into the volumetric flask using an automatic pipetter.

    c. Fill the flask with distilled water. The flask should be filled to the volume line with the bottom of the meniscus on the line.

    d. Mix by inversion until well mixed.

    e. Reserve approximately 5 ml of the solution and discard the rest.

2. Preparation of 200 ppb standard (secondary).

    a. Rinse the 1000 ml flask thoroughly (at least 3 times) and fill half way with distilled water.

    b. Add 1 ml of solution from above.

    c. Fill with distilled water above.

    d. Mix well as above.

    e. Save approximately 100 ml in a tightly capped bottle.

    f. Label bottle with concentration, date, dye lot number, and name.

The 200 ppb standard must be diluted to 20, 2.0, and 0.2 ppb each time a calibration is run.

1. Preparation of 20 ppb working standard.

    a. Fill 100 ml volumetric flask half way with distilled water.

    b. Add 10 ml of 200 ppb secondary standard.

    c. Fill with distilled water as in above.

    d. mix well and pour into cuvette.

2. Preparation of 2.0 ppb working standard.

    a. Fill 100 ml volumetric flask half way with distilled water.

    b. Add 1.0 ml of 200 ppb secondary standard.

    c. Fill with distilled water as above.

    d. Mix well and pour 10-20 ml into a cuvette, discard the remainder.

3. Preparation of 0.2 ppb working standard.

    a. Fill 1000 ml volumetric flask half way with distilled water.

b. Add 1.0 ml of 200 ppb working standard.

c. Fill with distilled water as above.

d. Mix well and pour 10-20 ml into a cuvette, discard the remainder.

4. Preparation of distilled water blank. Pour 10-20 ml of distilled water into a cuvette.

10.1.3. Precision

Precision will be determined by evaluating duplicate metered parameter measurements. The formula for evaluating duplicate measurements is defined as:

$$\frac{A-B}{\frac{A+B}{2}} \times 100 = \% \text{ Relative Difference}$$

where A and B represent the two different measurements.

Confidence intervals will be established for precision data generated for a parameter during a given time period. A 95% confidence interval for precision (P) is determined as:

Precision values for each metered parameter will be determined in the next year and updated annually, thereafter.

10.2. Corrective Actions

All meters requiring calibration will be calibrated according to the manufacturer's instructions or to procedures adopted for that particular purpose. Acceptance criteria and recommended corrective action for each meter are shown in **Table 10.4**. If a meter fails to calibrate within the acceptance criteria, the environmental technician will recalibrate the meter using new standards (if contamination is suspected). For meters not requiring calibration via standards or reagents, the meter will be disassembled, reassembled, and recalibrated. Instruments failing to calibrate on the second attempt will not be utilized until the repair is completed. Equipment will be repaired by the environmental technician or returned to the factory for repair.

When in the field, team members will determine the operational status of each piece of sampling equipment. If duplicate measurements for a given meter do not agree within 10 percent, the field team will recalibrate the meter. The meter will be determined inoperative if simple maintenance (replace DO membrane on DO probe, for example) and re-assembly does not correct the problem. If equipment is determined inoperative, back-up equipment will be used (if available) to continue the sampling effort. At the end of each sampling day, team members will notify the project leader of any equipment problems.

10.3. Deviations from Procedures

Other quality control measures relating to bottle sampling (field blanks, trip blanks, and spikes) apply to both WET Section sampling procedures and the laboratory analysis. If the Central laboratory informs the WET Section that these QC measures indicate there may be a problem in the sampling procedure, the section QAO will review proper sampling protocols with all appropriate staff.

Table 10. Corrective Action Table

QC Activity	Acceptable Criteria	Recommended Corrective Action
YSI DO Meter	Instrument Response +/- 1% overall	Replace electrolyte and membrane. Check battery voltage, and recalibrate.
Fluorometer Calibration	Instrument Response +/- 1%	Recalibrate using new standards.
Beckman RS-3 Calibration	Instrument Response +/- 0.05 umhos/cm	Recalibrate using new standards. Check 50 ohm resistor. Check battery.
Marsh-McBirney	Instrument Response Calibration 9.8 and 10.2 within 10 seconds.	Check batteries and replace if necessary, then recalibrate.

10.4. Performance and Systems Audits

Audits and Corrective Actions

Audits provide objective feedback concerning the effectiveness of our program's quality system and may identify areas in need of improvement. Therefore, our unit performs the following activities as discussed below:

- Conducts one or more audits per year and compiles audit reports,
- Handles complaints and other reports received from data users and the public concerning data quality,
- Reports exceptions to established procedures and criteria, and
- Devises and implements corrective actions for problems with procedures, data reviews, etc.

Report Compilation

To provide the Secretary with information regarding DEP's ongoing QA efforts, our unit describes and compiles the results of all appropriate QA activities, and relays it to the Standards and Assessment Section for an annual report

10.4.1. Internal System Audits

The WET QAO will conduct an annual, qualitative audit of the WET sampling system. This audit will include:

1. an on-site inspection of the physical facilities used for maintenance, calibration, and storage of field equipment,

2. a visual inspection of all field meters shown in **Table 8.2** and a review of the maintenance logs for each meter,

3. a detailed review of field sampling protocols, field calibration procedures, field decontamination procedure, and field custody documentation,

4. an examination of randomly selected field, laboratory, and auxiliary data records,

5. a determination whether planned quality control procedures are being implemented, and

6. a list of deficiencies that must be addressed to correct or improve the sampling system.

10.4.2. External System Audits

There are currently no regularly scheduled audits from external sources.

10.4.3. Performance Audits

Performance audits are not directly applicable to the field measurements conducted by the WET and will not routinely be conducted. The WET QAO may intermittently submit blind blank or spike samples to the DEP Central Laboratory as an external performance audit of laboratory analytical performance.

11. Consumer Relations

11.1. Review of Proposed Work

Proposed field sampling is scheduled under the supervision of the Section Administrator. A sampling schedule is available to Section personnel on a calendar posted near the desk of the WET Section's Administrative Assistant. Proposed laboratory work is scheduled through LIMS.

11.2. Complaints

The WET Section is committed to resolving complaints and implementing suggestions for improvement. All informal complaints, suggestions, or requests for information are directed to the appropriate supervisor for resolution. If an immediate resolution cannot be attained, the matter is passed to the Section Administrator, who can investigate and direct the resolution. Formal written complaints are logged with the section and, after investigation and resolution, are responded to in writing. Copies of responses are kept for reference.

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Appendix: Laboratory Incubation Method of Sediment Oxygen Demand in Lake and Stream Sediments

Scope and Application

This document describes field and laboratory methods to be used for collecting sediment core samples and incubating the sediment core barrels in the laboratory to measure sediment oxygen demand (SOD). The laboratory incubation method for SOD measurements has been tested using sediment cores collected from rivers and lakes. This document includes the details of field and laboratory preparation and procedure for SOD determination.

Summary of the Method

The described procedure is based on the field method to collect sediment cores using the Universal Percussion Corer and the laboratory incubation method to incubate the sediment cores at *in situ* temperature for SOD measurement. The sediment core samples and water samples can be carried to the laboratory within 48 hours prior to the incubation. A Hach IntelliCal™ LDO (Luminescent Dissolved Oxygen) probe is inserted into the top of each core barrel (sediment (sample) and water (reference)) and sealed off to measure the rate of the dissolved oxygen (DO) depletion within the core barrels during the 24-hour incubation. The SOD rate can be determined by the difference in the slopes of DO readings between a core sample and a reference (i.e., absence of sediment)

Field Equipment and Supplies

Coring Equipment and Supplies:

1. Universal Percussion Corer unit purchased from Aquatic Research Instruments™: a manufactured core head with a check valve, and rubber boot coupler with 5/16" nut driver in the toolbox carry case.
2. Pre-cleaned, clear poly carbonate core barrel (68 mm ID x 71 mm OD) with a length of 60 cm supplied by the manufacture.
3. Aluminum Holobar Extension rods with a length of 1.2 meters.
4. Bronze gravity weights and/or slide assembly head for deep lakes.
5. Poly end caps supplied by the manufacture

Other Supplies for Coring:

1. Bucket with the core holder lid.
2. Electrical tape.
3. Two 1-L water sample containers per SOD site.
4. Two anchors.
5. Boat (Jon boat or Gheenoe, depending on the size of a lake) water conditions, and accessibility of a boat ramp.

Field Collection of Sediment Cores

The Universal Percussion Corer can be manually operated from a small boat like Jon boat or Gheenoe with adequate workspace for at least 2 people on board to collect samples.

Pre-sampling Trip Preparation

1. Reserve a boat via the SharePoint website (https://floridadep.sharepoint.com/dear/vrs/Lists/Vehicle_Reservation_Form/Item/newifs.

aspx) and make arrangements for a certified Florida Department of Environmental Protection (DEP) boat operator, pursuant to Directive DEP 270 and 620.

2. Prepare field sheets required by Watershed Evaluation and TMDL Section's Quality Plan, two 1-L water sample containers, coring equipment, and other supplies based on the check list (see the items with bold letters in Attachment #1 for more details).
3. Calibrate Hach Intellical™ LDO probes followed by the manufacture's user manual for Model LDO10101. Note that the IntelliCal LDO optical probe has no membranes which reduces calibration frequency. The calibration is recorded in the probe and the data log, which can be sent to a personnel computer.
4. Make sure that the calibration icon on the upper left corner of the meter display shows "OK." Record the date and time of calibration, probe serial number, DO meter used, and calibration status in the logbook located in the laboratory (see the attachment #2).
5. Calibrate a YSI instrument (Models 6920 and 6000) for water column water quality measurements followed by the procedure described in Watershed Evaluation and TMDL Section's Quality Plan.
6. The incubator should be turned on and maintained at ambient temperature prior to field sampling.
7. Clean the polycarbonate core barrels with distilled water to make sure that there is no residual debris present if the barrels were used previously. Scrub the inside and outside of the barrels with a brush if necessary.
8. Pre-mark a line on each of core barrels where the top of the sediment core is desired to reach. If 60-cm long core tubes are used, pre-mark the line at 38 cm from the bottom of the core tube. This will give a consistent distance between the top of the sediment and LDO probe throughout sampling locations.

Deployment of Universal Percussion Corer

1. When a sampling site appropriate to the project goals is selected, anchors should first be dropped at the opposite side of the sampling location to minimize impacts by sediment resuspension in water and sediment core samples. In general, a boat must be secured using two anchors to minimize movement.
2. Fill out the sediment coring field sheet with general information (see Attachment #3).
3. Conduct water column (surface and bottom) DO and other field parameters using a YSI.
4. Fill out the approved water quality field sheet for YSI measurements (see Attachment #4).
5. Measure total water depth using the depth meter or a secchi disc and record this data on the water quality field sheet to calculate how many 1.2 meter-aluminum holobar extension rods should be connected and determine how far the core tubes will be pushed down to sediment.
6. Connect the aluminum holobar extension rods by lining up the threads on each rod and securely tightening the rods.
7. Attach the core barrel to the core head and fully insert the core barrel into the head.
8. Secure the lower band clamps of the rubber boot assembly using the hex driver. DO NOT touch or tighten the upper band clamps.
9. Lower core assembly slowly over the side of the boat and ensure that the core barrel is at a 90° angle to the water prior to reaching the sediment surface. Do not let go or allow the corer to freefall through the water column.
10. When approaching the sediment surface with the corer, slow its decent further and allow the corer to gently enter the sediment. Take every precaution to not disturb the top layer of the sediment.
11. Push the corer down until the desired sediment core length is reached to recover the sediment core no more than 40 cm.
12. Gently pull the corer straight up with care, and ensure the bottom of the core barrel stays in the water.
13. Lean over the side of the boat and place a plug over the bottom of the core barrel using a ploy end cap before breaking the air-water interface to prevent loss of sediment.

14. Once the poly end cap has been secured, continue to pull the core barrel out of the water in a 90° angle and place on a secure location of the boat deck.
15. Allow the core barrel to sit at a 90° angle and seal the bottom of the core barrel using electrical tape to prevent any air intrusion.
16. Unscrew the lower band clamps using the screwdriver. Do not unscrew the upper band clamps.
17. Place a poly end cap on the top of the core barrel and seal it with black electrical tape.
18. Label the core barrel with the site name, and collection date and time.
19. Fill out the sediment coring field sheet with a total length of the core and general characteristics of the sediment collected (i.e., sediment type, sediment color, lamination, sand wedge, etc).
20. Secure the core barrels in a carrier bucket (filled with ice)

Laboratory Incubation Method for SOD

Laboratory Equipment and Supplies

1. Temperature-adjustable incubator by Fisher Scientific
2. Core extrusion disks purchased from Aquatic Research Instruments
3. Push rod or soda cans
4. Rubber stoppers (#13.5) for LDO probes
5. HQ40d meters by HACH
6. Kimwipes
7. BOD bottles or appropriate containers for LDO probe calibration
8. Electrical black type
9. Laboratory Stand and Clamp

Laboratory Preparation

1. Place two calibrated probes and a DO meter per SOD site on the table in the laboratory. One probe is for sample core barrel and the other one for reference core barrel.
2. Connect the probe to the meter by attaching the probe cable to the handheld and make sure that the cable locking nut is securely connected to the meter.
3. Turn on the meter by pushing the on/off button in the middle of the handheld display.
4. Adjust the temperature of the incubator to the measured ambient water temperature. Allow about an hour for the incubator to reach this temperature.
5. Ensure that Calibration Status Indicator that appears on the upper left corner of the handheld display shows the words “OK”.
6. Enter an operator ID and a sample ID by pushing the button in the lower left side and in the upper left side of the handheld, respectively. The operator ID should be a last name of operator and sample ID (for example, sample ID: IstoS5) should be the core ID to be incubated.
7. Set up the incubation duration and intervals of the measured readings by pressing the meter option button on the lower right side of the handheld meter. The incubation time should be no less than 24 hours and the interval mode no less than 30 min.
8. Place one reference core barrel per site using one of the clean polycarbonate barrels.
9. Plug the bottom of a clean core barrel with one or two core extrusion disks and locate it at the same level as the top layer of the sediment in the core barrel.
10. Gently pour the ambient water sampled from the field to the reference core barrel up to the top.
11. Over a sink, plug the top of the reference core barrel with a rubber stopper equipped with a LDO probe, being careful to not create air bubbles inside the core barrel.
12. Seal the bottom and top of the core barrel with electrical tape.
13. Gently open the top of the sediment sample core barrel without disturbing the top layer of unconsolidated sediment.
14. Adjust the sample height, if necessary, by pushing up the sediment core from the bottom using an extrusion disk and a push rod or a coke can.

15. Gently pour ambient water to fill up the top of the core barrel in case the top water is not enough.
16. Plug the top of the sample tube with a rubber stopper equipped with a LDO probe, being careful to not create air bubbles inside the core barrel.

SOD Incubation

1. Make sure that the incubator temperature is consistent with ambient water conditions at the collection site.
2. Place the sample and the reference barrels in the bucket with holes in the top lid. Make sure that LDO probe cables are not tangled.
3. Manually move the bucket with the tubes into the incubator.
4. Make sure that the meter is working properly by pressing the "Start" button. It will read DO, pressure, and temperature for both bore barrels, and store them automatically. The readings can be viewed by pressing the "Data Log" button. Use this button to check the reading and calibration logs.
5. Press the "Start" button on the handheld to begin the measurement of DO simultaneously from both core barrels.
6. The measurements will stop automatically when the incubation time (programed in 5.2.7.) is over. The sample and reference measurements are automatically stored each time a sample is measured in the interval mode. Note that check standard measurements are also stored automatically each time
7. After examining the DO readings and the calibration logs, keep the sediment samples at 4°C in the incubator until SOD rates are calculated and accepted.

Data Management and SOD Rate Calculation

Data Transfer Directly to a Computer

1. Install the HQ40d PC application software to transfer the data directly to a computer. The software can be downloaded from the company website (https://www.hach.com/).
2. Make sure that the meter is connected to AC power and is connected to the PC with a USB cable.
3. Turn on the meter by pushing the "On/Off" button.
4. Open the application on the computer. Click on the green triangle in the menu bar to connect the device.
5. Push the "Folder Key" on the handheld meter and select "Send Data Log" using the arrow button. Wait for the display to show "Transfer Complete." The data is downloaded as a comma separate values file.
6. Save the .txt file with an appropriate name in the computer.

SOD Rate Calculation

1. Upload the downloaded data file (.txt) to Excel Spreadsheet for each meter/sample/control.
2. Examine all sample measurements and check standard in the downloaded data to make sure all passed. The calibration status should be "OK" if the calibration is passed.
3. Plot sample and reference DO concentrations versus incubation time duration.
4. Look at the plot where the change in DO concentrations in the sample tube barrel is linear with time after an initial stabilization period. The stabilization should take 2-5 hours. Then, a linear regression analysis can be performed with the DO concentrations that show a linear decrease over time.
5. Determine the slope of the sample oxygen depletion line through linear regression.
6. Determine the slope of the reference oxygen depletion through linear regression.

7. Calculate the difference of these two values. SOD rates ($g/m^2/day$) were calculated as the sediment DO depletion rate (mg/L/hr), multiplied by 0.024 conversion factor, multiplied by the volume of the core barrel and divided by the surface area of sediment core as follows:

$$SOD_s = -0.024\ (V/A)(b_{sam} - b_{ref})$$

where SOD_s is the sediment oxygen demand rate in $g/m^2/day$ at water temperature; V is the volume of the tube in liters: A is the area of the sediment layer in the core barrel in square meters (m^2); $b_{sam} - b_{ref}$ is the slope of the DO concentration with time after subtracting the slope measured in the reference core barrel.

8. Correct the measured SOD_s values to 20ºC by using a Q10 (or Van't Hoff) equation which corresponds to a factor of 1.065 as follows:

$$SOD_{20} = SOD_s/1.065^{(T-20)}$$

where SOD_{20} is the SOD rate at 20°C, and T is the water temperature during the incubation in Celsius.

Quality Control

All YSI and LDO probes will be calibrated before use in the field and laboratory. Check Standard will be performed automatically and stored. Make sure that all values are passed. SOPs will be used as reference during field and laboratory activities to maintain quality control.

Safety/Hazardous Waste Management/Pollution Prevention

Review the Laboratory Health and Safety Plan (accessible on the intranet at https://www.fldepnet.org/content/dear/bureau-laboratorie-safety-documents). Wear safety glasses, gloves, closed toe shoes, and lab coats at all times while handling samples and reagents. Sample waste, excess reagents, and waste exiting the flow cell may be poured down the sink while flushing with water.

SOD References

DB Environmental, Inc. 2007. Sediment Oxygen Demand in Six Lakes of the Upper St. Johns River Basin. Final Report to St. Johns River Water Management District. Palatka, Florida.

U.S. Environmental Protection Agency. 2015. Standard Operating Procedure for Sediment Oxygen Demand. Science and Ecosystem Support Division, Athens, Georgia.