2008 Sampling and Analysis Plan

Project:

Ecological and Water Resources Assessment Project

Assessment of Ecoregional Dissolved Oxygen Regimes

Jointly prepared by:

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July 2008

EPA Project ID No. X-98746601-0
MECWR Project No. 5105

Assessment of Ecoregional Dissolved Oxygen Regimes

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Title and Approval Sheet

This document has been reviewed for technical content and quality, clarity, and style in accordance to internal QA/QC procedures of the Environmental Resources Coalition and MEC Water Resources, Inc.

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EPA Review

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I. MONITORING OBJECTIVES

The Ecological and Water Resources Assessment Project (EWRAP) includes several technical studies to support science-based policy analysis and development. The focus of this study is to assess dissolved oxygen (DO) regimes within selected Missouri ecoregions. Information obtained from this study will provide technical information which may assist regulatory agencies in refining regulatory standards on an ecoregional basis for selected watercourse types.

Segments of Little Drywood Creek (Osage Plains), Heaths Creek (Central Plains) and East Fork Crooked River (Central Plains) are identified as least-disturbed reference streams (Carnahan, 2005, Sarver et al. 2002, Rabeni et al 1997). Monitoring efforts will be conducted to determine warm-weather DO concentrations, assess effects of stream discharge, and measure DO sources and sinks.

II. ASSESSMENT AND ANALYSIS TEAM

The assessment and analysis team consists of a project manager, field manager, QA/QC manager, data analysis lead, and sampling crews. Responsibilities of each position are listed in Table 2.1.

Table 2.1.
Key Project Personnel Responsibilities

Role	Personnel	Responsibilities
Project Directors	Bob Bacon ERC Trent Stober MECWR	• Coordination of Project Resources • Project Facilitation
Project Manager	Chris Zell MECWR	• Implementation of the Sampling Plan • Quality Assurance • Technical Coordination
Field Manager	Nick Muenks MECWR, Bob Bacon ERC, and Randy Niemeyer, MDNR	• Development of Field Itineraries • Coordinate Sampling Events • Mobilize Field Crews • Management of Field Staff and Equipment
Project QA/QC Manager	Steve Walker MECWR	• Collection of field logs, lab results and other program documentation • Circulation of reports results
Data Management	Nick Muenks, John Christiansen, MECWR	• Data Validation • Database Coordination
Data Analysis	Chris Zell, David Carani, and John Christiansen MECWR	• Data Analysis • Report Development
Field Technical Crew	Renee Martin AES, Bob Bacon and Abby Lynn ERC and Lynn Millburg MDNR	• Field Investigations • Sampling Documentation • Field Quality Assurance
Peer Review	Hans Holmberg LTI	• Peer Review of Data Analysis • Peer Review of Project Conclusions

III. DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements developed by data users to specify the quality of data from field and laboratory data collection activities to support specific decisions or regulatory actions. The DQOs describe what data are needed, why the data are needed, and how the data will be used to address the problem being investigated. DQOs also establish numeric limits for the data to allow the data user (or reviewers) to determine whether data collected are of sufficient quality for use in their intended application.

Dissolved oxygen concentrations of interest for this project are 5.0 mg/L and 3.0 mg/L. Currently Missouri's DO water quality criteria for protection of aquatic life is 5.0 mg/L. Data collected as part of this project will allow MDNR to characterize the prevalence of DO conditions less than 5.0 mg/L during summer conditions within study reaches. The National Water Quality Criteria Document for Dissolved Oxygen (Chapman 1986) indicates that DO concentrations below 3.0 mg/L are potentially lethal for several warm-water biota. Continuous data collected as part of this project will allow decision makers to assess exposure to DO concentrations less than 3.0 mg/L during summer conditions within study reaches.

Nutrient and chlorophyll-a levels of interest are dictated by draft nutrient criteria developed for EcoRegion IX "Southeastern Temperate Forested Plains and Hills" (U.S. EPA 2000). MDNR has requested streams within this region be monitored. Draft nutrient criteria, based on aggregated 25th percentile data, are outlined below:

- Total Phosphorus – 37 ug/L
- Total Nitrogen – 0.7 mg/L
- Nitrite + Nitrate – 0.13 mg/L
- Sestonic Chlorophyll-a - 1.0 ug/L
- Periphyton Chlorophyll-a – 20 mg/m^2

Following the seven steps of the DQO process described in detail in EPA QA/G-4, Guidance for the Data Quality Objectives Process, the following quality objectives were developed:

- Data must be of sufficient quality and quantity to characterize dissolved oxygen concentrations during warm-weather periods;

- Data must be of sufficient quality and quantity to determine the prevalence of DO conditions less than 5.0 mg/L during summer conditions within study reaches;

- Data must be of sufficient quality and quantity to assess exposure to dissolved oxygen concentrations less than 3.0 mg/L during summer conditions within study reaches;

- Data must be of sufficient quality and quantity to characterize the influence of flow on dissolved oxygen regimes;

- Data must be of sufficient quality and quantity to estimate dissolved oxygen mass-balances during warm-weather baseflows;

- Data must be of sufficient quality and quantity to provide a summer snapshot of trophic state as compared to draft nutrient criteria for Ecoregion IX; and

- Data must be of sufficient quality and quantity to assess ecoregional or landscape influences (if present) affecting observed DO levels.

The selection of appropriate measurement parameters depends on the objectives of the measurement effort, types of constituents, expected concentrations, and the types of measurements to be performed. Measurements will be made as to yield results that are representative of the media sampled and the site conditions.

To meet objectives, the following quality control parameters will be evaluated: precision, accuracy, completeness, representativeness, and comparability. These parameters will be evaluated by field personnel for field measurements and by the laboratory personnel for laboratory analyses. MEC will perform a final data validation for field and laboratory data.

IV. HEALTH AND SAFETY

Field personnel will be made aware of the potential hazards they may encounter in the field. The hazards will be provided for specific types of field work in a Job Hazard Analysis (JHA) (Appendix D). JHA's will be reviewed by each field person prior to any field investigations. Safety considerations may include but are not limited to dangerous weather, footing, heat stress, UV Exposure, motor vehicles, chemical exposure, microbial pathogens, and awareness of dangerous flora and fauna.

V. SAMPLING FRAMEWORK AND DESIGN

Little Drywood Creek, Heaths Creek, and the East Fork of the Crooked River were selected for assessment of dissolved oxygen regimes in the Osage Plains and surrounding transitional ecoregions. This section provides detailed descriptions of the monitoring locations and procedures that will be carried out for each of these streams. Table 5.1 provides a summary of study site locations and sampling frequencies, and analyses.

A. Monitoring Locations

1. Reference Stream Monitoring Locations

The following monitoring locations have been chosen and permission has been granted by landowners for the following selected reference reaches. If access to monitoring location(s) becomes restricted, alternative location(s) will be selected by ERC and MEC, and will be approved by MDNR prior to collection of environmental data.

a. Little Drywood Creek Monitoring Locations

The reference segment of Little Drywood Creek (Little Drywood) represents streams in the Osage Plains Ecoregion and is located southwest of Nevada, MO in Vernon County (Figure 5.1). The Little Drywood study segment begins just south of County Road 718 (UTM Northing = 4167266 Easting = 378143.8) and flows north for 18.8 miles ending approximately one half mile upstream of the confluence with Moore Branch south of County Road 530 (UTM Northing = 4183004 Easting = 377662.5). The reference segment contains both Class C and Class P stream types. The main focus of the sampling effort will be in the Class C portion of the creek with dissolved oxygen data also being collected in the Class P portion.

Dissolved oxygen will be continuously monitored at three locations in the reference reach of Little Drywood Creek. Two permanent monitoring sites (LDC1and LDC2) will be located within the boundaries of the Bushwhacker Conservation area (Table 5.1 provides site descriptions and UTM coordinates). The third monitoring site will be located at one of three additional stream access points throughout the study reach. The monitoring station will be deployed at each of the following sites for two weeks and then moved to a new location. The monitor will initially be installed at LDC3 and moved downstream to LDC4 then to LDC5 (Table 5.1). This approach was selected to assess spatial variability as well as evaluate dissolved oxygen in Class P reaches of Little Drywood.

b. Heaths Creek Monitoring Locations

Heaths Creek is a Class P stream in the Central Plains ecoregions (EDU 11). Heaths Creek is a transitional stream and is located south and east of the Interstate 70 & the US Highway 65 (Marshall) Junction in Pettis County. The 13.2 mile reference segment begins at Wildwood Road (UTM Northing = 4306613, Easting = 482240) and ends approximately 0.8 miles downstream of Route J.

Heaths Creek will be monitored at three locations (Figure 5.1). The most upstream site (HC1) will be located near the Wanamaker Road crossing, HC2 will be placed near the Major Road crossing and the most downstream site (HC3) will be located near the Walk Road crossing (Table 5.1 provides UTM coordinates and site description).

c. East Fork Crooked River Monitoring Locations

The East Fork Crooked River is located in the Central Plains ecoregion (EDU 11) and north of the Missouri River. The reference segment is located approximately 7 miles northeast of Richmond, MO in Ray County. The class P segment begins approximately 1.6 miles upstream of the Foster Road crossing

(UTM Northing = 4355829.88, Easting = 422867.55) flowing south for 3.9 miles and ending approximately 2.4 miles upstream of its confluence with the Crooked River (UTM Northing = 4351638.14, Easting = 423165.76).

Two sites in the East Fork Crooked River will be continuously monitored for dissolved oxygen (Figure 5.3). The most downstream site (EFCR2) will be located near the 128th Street crossing. The upstream monitor (EFCR1) will be placed just west of Vassmer Road. Table 5.1 provides monitoring station coordinates for East Fork Crooked River.

2. Reference Stream Tributary Monitoring Locations

Discrete dissolved oxygen, temperature, specific conductivity and pH will be collected in classified tributaries that feed the reference stream segment of each study stream. Table 5.2 provides a list and description of the measurement locations. Additional tributary monitoring sites may be added as field schedules allow.

Table 5.1. Monitoring Locations, Frequencies and Analysis Within Reference Streams

Site ID	Site Description	Stream Access Location (UTM) - Northing/Easting	Frequency: Grab Sampling & Discharge Measurement	Frequency: Sonde Servicing [1]	Analysis: Laboratory	Analysis: Field[2]
Little Drywood Creek - Vernon County - Osage Plains Ecoregion						
LDC1	Site 1 in Bushwhacker Conservation Area is approximately 0.20 miles Northwest from the easternmost parking lot off NW 100 Cty. Rd..	4168203 377624	None	Once per week for six weeks between July 1 to September 30	None	Continuous for six weeks between July 1 to September 30
LDC2	Site 2 in Bushwhacker Conservation Area is approximately 0.20 miles Southwest from parking lot off Zebulon Cty. Rd...	4169240 377000	Once per Week	Once per week for six weeks between July 1 to September 30	TN, NH_3N, NO_2+NO_3, TP, Suspended Chl a, TSS, NVSS, CBOD-20, Benthic Chl a (where available)	Continuous for six weeks between July 1 to September 30, discrete pH
LDC3	Site 3 in Bushwhacker Conservation Area is approximately 0.1 miles Upstream of Rt. N Crossing	4173416 377026	None	Once per week for two weeks	None	Continuous for two weeks
LDC4	Rt. F Crossing	4179792 376797	None	Once per week for two weeks	None	Continuous for two weeks
LDC5	Cty. Road 530 Crossing	4181894 377273	None	Once per week for two weeks	None	Continuous for two weeks
Heath's Creek - Pettis County - Central Plains Ecoregion (transitional)						
HC1	Wanamaker Rd Crossing	4306869 484280	None	Once per week for six weeks between July 1 to September 30	None	Continuous for six weeks between July 1 to September 30
HC2	Major Rd. Crossing	4307035 486077	None	Once per week for six weeks between July 1 to September 30	TN, NH3N, NO2+NO3, TP, Suspended Chl a, TSS, NVSS, CBOD-20, Benthic Chl a (where available)	Continuous beginning July 1 until recovery of DO daily minimum to 5.0 mg/L, discrete pH
HC3	Walk Rd. Crossing	4308777 488540	Once per Week	Once per week for six weeks between July 1 to September 30	None	Continuous for six weeks between July 1 to September 30
East Fork Crooked River - Ray County - Central Plains Ecoregion						
EFCR1	West of Vassmer Road		None	Once per week for six weeks between July 1 to September 30	None	Continuous for six weeks between July 1 to September 30
EFCR2	128th Street		Once per Week	Once per week for six weeks between July 1 to September 30	TN, NH_3N, NO_2+NO_3, TP, Suspended Chl a, TSS, NVSS, CBOD-20, Benthic Chl a (where available)	Continuous beginning July 1 until recovery of DO daily minimum to 5.0 mg/L, discrete pH

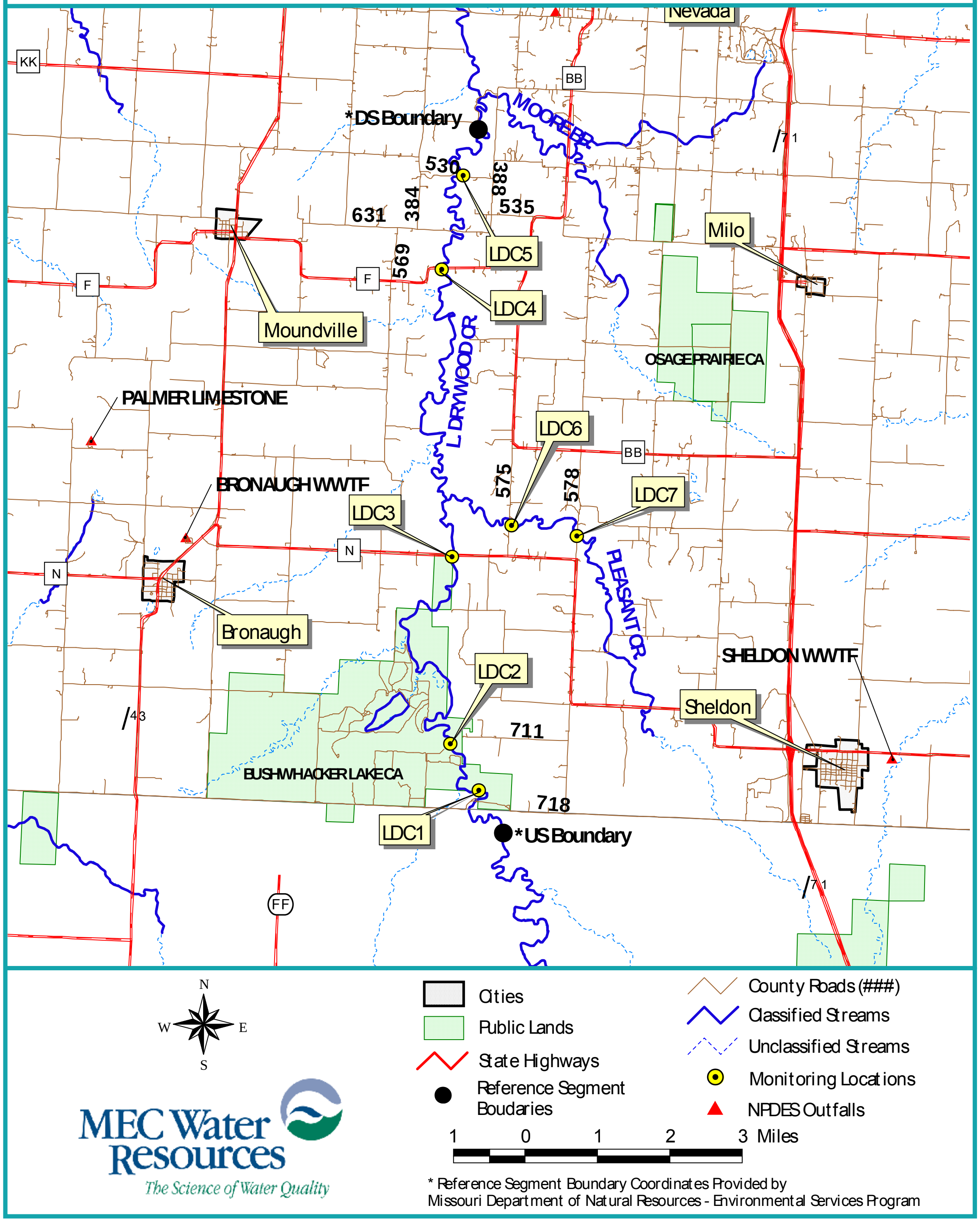
[1] **Sonde Servicing** - Sites HC2 and EFCR2 will have optical dissolved oxygen sensors deployed. These will require less maintenance than the conventional Clarke probes placed at the remaining locations. See section 7.3.13 of "PROCEDURES FOR OPERATION, DEPLOYMENT, AND MAINTENANCE OF YSI 6-SERIES SONDES" for a detailed description of the optical DO sensor and maintenance schedule.

[2] **Field Analysis:** Continuous data will consist of dissolved oxygen, specific conductivity, temperature, water level, barometric pressure, light intensity and photosynthetic active radiation (PAR) (PAR will be collected at a minimum of one location). Sondes at sites LDC2, HC2, EFCR2 and all of the sounds on Little Drywood Creek will remain in the field for extended deployment for no later than November15, 2008.

Table 5.2. Monitoring Locations, Frequencies and Analysis For Reference Stream Tributaries

Site ID	Site Description	Stream Access Location (UTM) - Northing/Easting	Frequency	Analysis
			Discrete Field Measurements	Discrete Field Measurements
Little Drywood Creek - Vernon County - Osage Plains Ecoregion				
LDC6	Pleasant Creek - Cty. Road 575 Crossing	4174095 378355	At least three site visits between July 1 to September 30	Dissolved Oxygen, Temperature, Specific Conductivity, pH
LDC7	Pleasant Creek - Cty. Road 578 Crossing	4173862 379815	At least three site visits between July 1 to September 30	Dissolved Oxygen, Temperature, Specific Conductivity, pH
Heath's Creek - Pettis County - Central Plains Ecoregion (transitional)				
HC4	Greer Branch - Hwy BB	4305680 483362	At least three site visits between July 1 to September 30	Dissolved Oxygen, Temperature, Specific Conductivity, pH
HC5	Long Grove Branch - Anderson Rd.	4305837 486278	At least three site visits between July 1 to September 30	Dissolved Oxygen, Temperature, Specific Conductivity, pH
HC6	Painter Branch - Rains/Reines Rd.	4308710 490845	At least three site visits between July 1 to September 30	Dissolved Oxygen, Temperature, Specific Conductivity, pH
HC7	Marlin Branch - Millers Chapel Rd.	4305177 491555	At least three site visits between July 1 to September 30	Dissolved Oxygen, Temperature, Specific Conductivity, pH

Figure 5.1 - Little Drywood Creek Monitoring Locations



* Reference Segment Boundary Coordinates Provided by
Missouri Department of Natural Resources - Environmental Services Program

Figure 5.2 - Heaths Creek Monitoring Locations

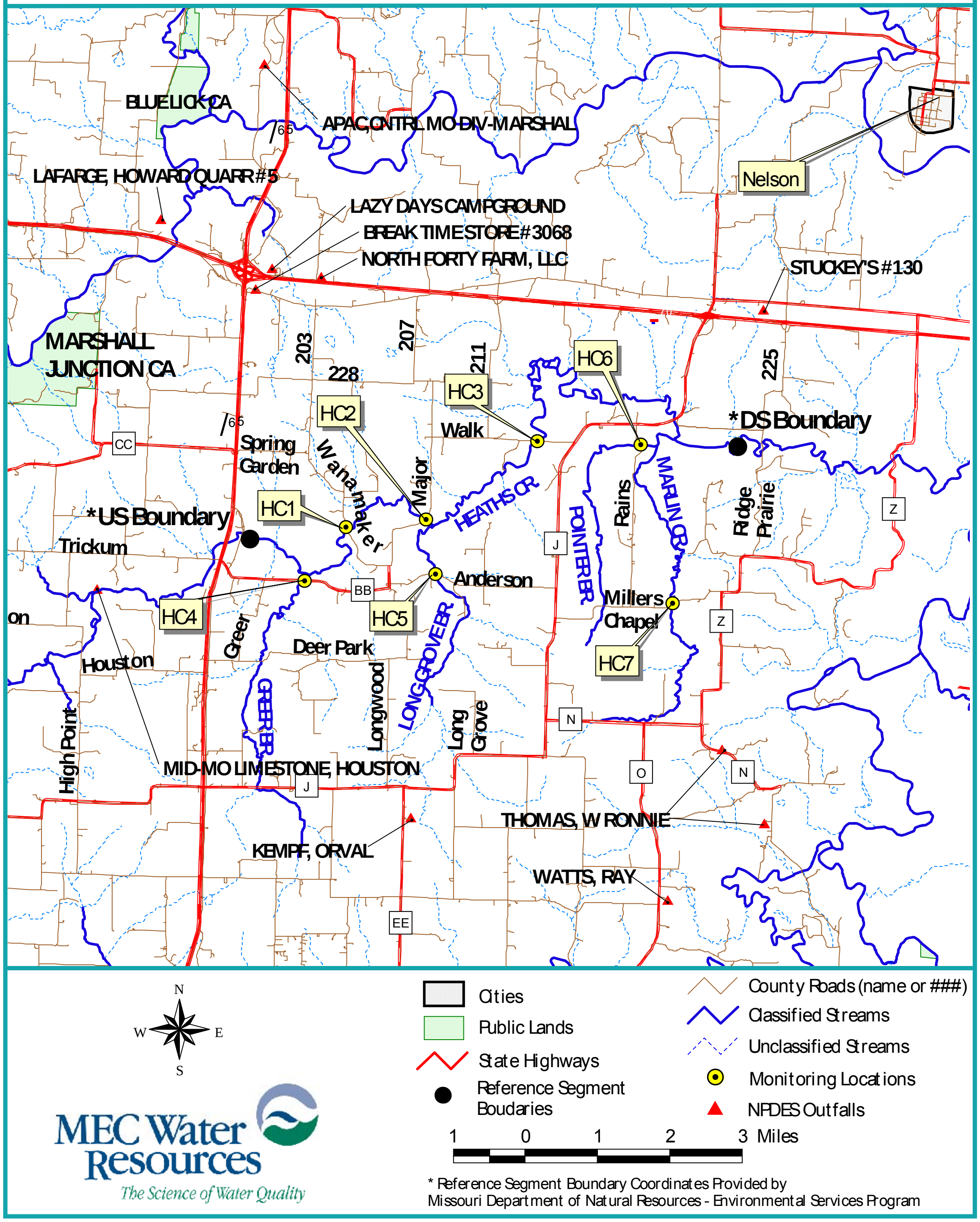
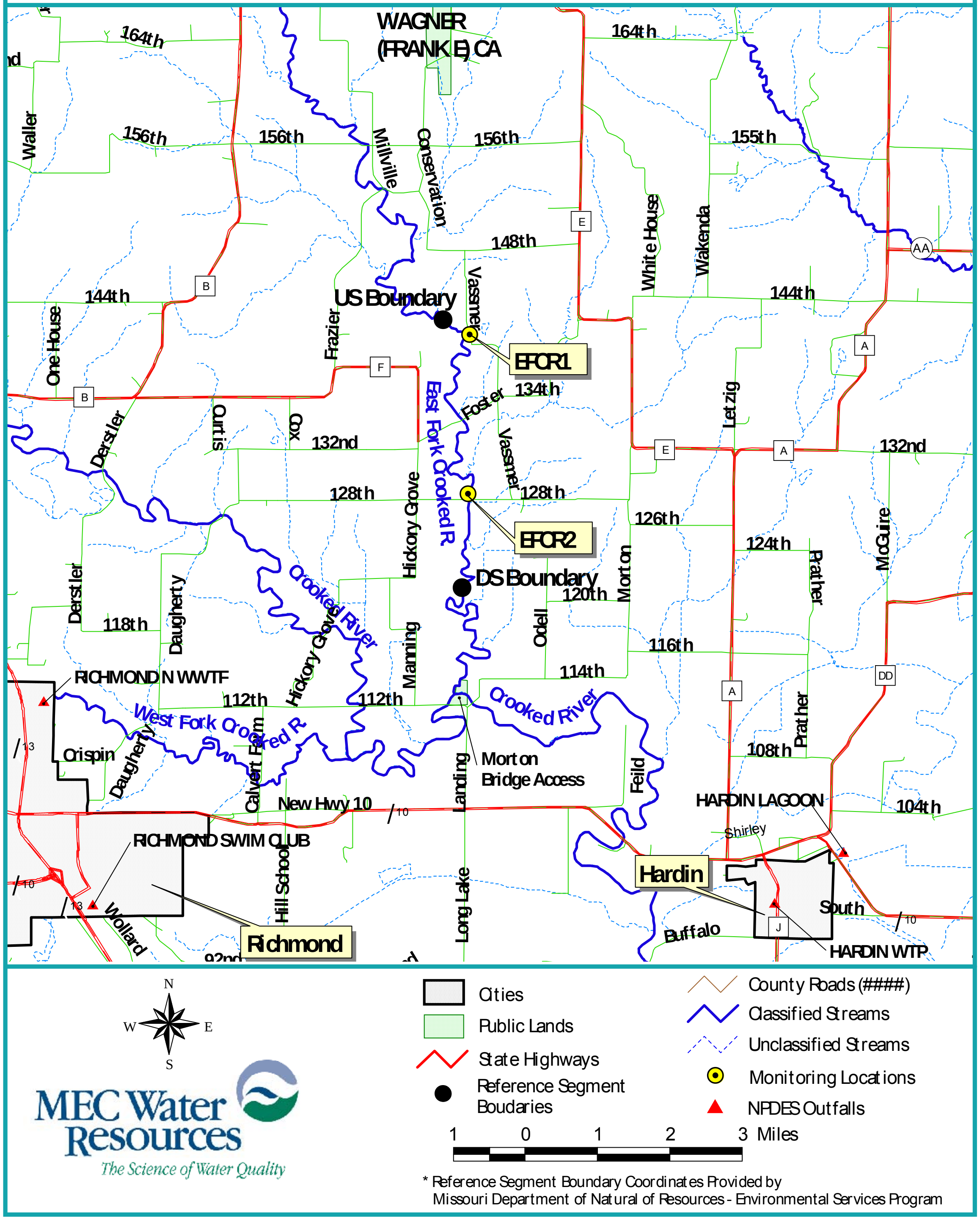


Figure 5.3 - East Fork Crooked River Monitoring Locations



B. Monitoring Design and Frequency

1. Continuous Monitoring

Continuous dissolved oxygen, temperature, conductivity, light intensity, photosynthetically active radiation (PAR), water level and barometric pressure will be collected at reference stream locations for six weeks between July 1, 2008 and September 30, 2008. Extended deployment sites (HC2, EFCR2, and LDC2) will remain deployed until the daily minimum DO remains above 5.0 mg/L for a period of four days or until November 15, 2008 whichever occurs first. These data will be used in the determination of fall DO recovery patterns in reference streams.

Reference stream continuous monitoring stations will consist of a YSI 6-series multiparameter sonde capable of collecting dissolved oxygen, temperature and specific conductivity. These parameters will be logged at 15 minute intervals for the duration of the study. The sondes will be deployed in locations representing the dominant mesotypes in each of the reference streams. A PVC deployment tube will be used at each location to protect the sonde from potential damage during high water events. The deployment tube will be mounted to a post, cage or other semi-permanent structure. The sonde will be placed at the location in the cross section that represents the mean DO concentration. The procedure for determination of the mean concentration is provided in MEC's "PROCEDURES FOR OPERATION, DEPLOYMENT, AND MAINTENANCE OF YSI 6-SERIES SONDES" included as Appendix B.

Each continuous monitoring location will also have an ONSET light intensity (150 – 1200 nm, 0 – 30,000 lumens ft^2) deployed. Light intensity meters will record relative shading data. The light meters will log data at 15 minute intervals. A light meter will also be deployed in an open field at one site for each stream. These meters will serve as a reference for those deployed at the monitoring locations. All light meters will be mounted horizontally to the top of a post. Determination of shading will aid in determination of light affects on in-stream oxygen production

One station per stream, preferably the furthest downstream site (permanently deployed and where applicable) in each stream will include a staff gage, a water level logger, and a barometric pressure logger (baro logger). The staff gage reading will be recorded on the proper datasheet during each station visit. The level and baro loggers will continuously record pressure data at 15 minute intervals. The water level loggers will be mounted to a stationary structure upstream of appropriate controls and the staff gage will serve as a reference point. The baro loggers will be mounted to a structure (tree, fence post etc.) that is outside of the stream banks and above the flood plain. Staff gage and water level data will be used to develop a stage/discharge relationship for each reference stream during the deployment period.. Barometric pressure data will be used to address pressure influences on dissolved oxygen concentrations and correct recorded level for changes in atmospheric pressure.

Photosynthetic Active Radiation (PAR) will be collected at a minimum of one monitoring location among the study streams. PAR will be used to establish a relationship between phototopic energy collected by the Onset light intensity meter and the radiometric energy needed by plants to carry out photosynthesis. The field manager will determine the most suitable location once a brief site survey has been conducted. The PAR sensor will be mounted level near the DO monitoring location and data will be recorded at 15 minute intervals.

Monitoring stations will be visited weekly during the six week deployment period. Following the six week deployment the stations will be removed with the exception of the three extended deployment stations at sites (HC2, EFCR2 and LDC2). Visits to each site will include maintenance, calibration and downloading of the continuous data sondes. Sonde maintenance and calibration procedures are provided in MEC's "PROCEDURES FOR OPERATION, DEPLOYMENT, AND MAINTENANCE OF YSI 6-SERIES SONDES" included as Appendix B.

The each of the extended deployment stations (HC2, EFCR2 and LDC2) will have a data sonde equipped with an optical dissolved oxygen sensor, which is specifically designed for extended deployment even in highly productive environments. During 2007, ERC and MEC performed a calibration stability study, which help determine the appropriate interval between a probe servicing events for the extended deployment period. The results for this study showed that the sonde calibration maintained stability for over two weeks, Based on the calibration stability data from this study, we recommended and MDNR concurred that a two week sonde servicing interval was appropriate during the extended deployment . Therefore, all data sondes will be serviced at a two week interval unless stream conditions (i.e. significant rain event) occurs after which the site will be visited to inspect station components.

Light intensity, PAR, water level and barometric pressure data will be downloaded during each site visit. Data will be downloaded to a laptop computer using the instrument manufacturer's software package. After downloading the data, they will be reviewed in the field to determine the status of the instrument. These data will be stored in the appropriate site location file on the laptop until they can be retrieved after returning to the office.

2. Discrete Sampling

a. Reference Stream Locations

Discrete sampling will be conducted at the designated locations in each stream (detailed in section V.A.1). Sampling will consist of water chemistry samples, benthic algae samples, pH measurements and staff gage readings. Personnel will collect discrete samples during each site visit for the six week deployment period. Discrete sampling will not be conducted during the extended deployment period with the exception of a staff gage and flow reading.

Water chemistry grab samples will be obtained by lowering the sample container to one-third of the stream depth at the centroid of the stream flow. This methodology is acceptable since most sampling locations will be in relatively small streams that are typically well mixed. Grab samples may be obtained by wading into the stream from downstream of the sampling location. Field staff should be careful not to suspend sediments while wading. Grab sample containers will be rinsed three times with water obtained at the sampling location prior to obtaining the sample. A more detailed description of sampling procedures is provided in Appendix A-1. Collection of pH readings will occur when grab sampling is conducted and will follow procedures described in "MECWR SOP-007 pH of Water" (Appendix A-4).

Benthic algae sampling will be conducted each visit at the site designated for water quality sample collection. Benthic chlorophyll-a will be sampled from natural substrates within stream mesotypes having observable periphyton communities. A minimum of five replicates will be collected within each mesotype located within an assessment reach that extends ten-times bankfull width upstream and ten-times bankfull width downstream. Appendix A-3 provides a more detailed description of sampling procedures that will be used to collect benthic cholorphyll-a. In streams where course substrate is unavailable woody debris will be sampled for benthic algae. Woody debris will be sampled using the cylinder scrape method as described in Moulton et. al. (2002).

Open channel flow measurements will be collected when conditions allow. Flow measurements will be used in developing a stage/flow relationship for each reference stream. Flow measurements will be made at least once each week at the reference stream locations where water level data will be collected. Methods used to collect discharge data are documented in "MECWR SOP-012 Flow Measurements" (Appendix A-5). A staff gage will be deployed at each flow measurement location and will be read during each site visit. Staff gage data will serve as a reference point for the stage/flow relationship.

b. Tributary Locations

Discrete dissolved oxygen, temperature, specific conductivity and pH will be collected within classified tributaries to reference segments of the study streams on an opportunistic basis. Discrete measurements will be collected from each site on three occasions between July 1, 2008 and September 30, 2008. Measurements will be collected before 9:00 AM the morning of the reference stream visit. Readings will be taken at road crossings designated in Table 5.2. Collection of the discrete measurements will provide insight to dissolved oxygen minima occurring within smaller classified waters within reference drainages.

VI. COORDINATION OF SERVICING/SAMPLING EVENTS

The ERC Field Manager will determine the monitoring schedule for the reference streams. The field manager will contact the Limnology Laboratory at the University of Missouri-Columbia and ES&S Laboratory managers two days prior to sampling activities. Field personnel will conduct equipment inspections and calibrations prior to field activities. The field crew will be responsible for collection of samples and coordination of drop off dates and times with the laboratories. The laboratories will be responsible for providing the following items and services associated with investigations described in Section IV:

- Sample containers**;**
- Sample preservatives other than ice (if needed);
- Laboratory analysis.

ERC personnel will provide sample collection services and complete chain of custody forms for all sampling activities. Sample collection personnel will coordinate with laboratory personnel for delivery of samples. Carbonaceous biological oxygen demand samples have a maximum 48-hour holding time before analysis must be initiated. Therefore, it is recommended that sampling personnel delivery samples to the lab within forty hours of collection.

VII. DOCUMENTATION OF SERVICING/SAMPLING

Field forms will be used to record sample collection, field measurement and field observation information. Any information that is deemed relevant to sample collection or analysis should be recorded on the field forms. The field sheets will contain at a minimum the following information:

- Monitoring site identification;
- Date;
- Time of arrival
- Weather conditions
- Names of field crew;
- Sample Information (date/time, volume, ID#,)
- Sonde calibration and QA information
- Water quality field measurements;
- Stream Discharge measurement information
- Field observations.
- Time of departure;

VIII. FIELD MEASUREMENTS AND OBSERVATIONS

Dissolved oxygen, temperature, conductivity, pH, water level and open-channel flow will be measured using appropriate field instruments concurrent with sample collection at each of the reference stream sampling locations. Field measurement should be taken in-situ and as near to mid-depth and mid-flow as possible. Table 8.1 lists the parameters, measurement method, and detection limits of the sampling equipment.

Table 8.1. Field Measurement Methods

Reference Method	Parameter	Meter	Detection Limits
APHA 4500-O G	Dissolved Oxygen	YSI Model 85 or 600 XLM Handheld Meter (or equivalent)	0.2 mg/L
ASTM D888-05 Method-C	Luminescent Dissolved Oxygen	YSI ROX Sensor (or equivalent)	0.1 mg/L
APHA 2550-B	Temperature	YSI Model 85 Handheld Meter (or equivalent)	0.5 °C
APHA 2510-B	Conductivity	YSI Model 85 Handheld Meter (or equivalent)	20 uS/cm
APHA 4500-H^+-B	pH	Oakton PC10 Portable Meter or Corning pH 10 Meter	0.1 SU
USGS TWRI Manual Book 3, Chapter A6	Velocity	SonTek Flow Tracker Acoustic Doppler Velocitymeter (ADV) (or equivalent)	±0.001 (0.001 to 4.0 m/s) Or ±0.003 (0.003 to 13 ft/s)
APHA 4500-O G APHA 2550-B	Continuous DO & Temperature	YSI Model 600 XLM & 6600 Data Sonde (or equivalent)	0.2 mg/L (DO) 0.5 °C (Temp.)
Differential Pressure Transducer	Stream Level	YSI Model 600 XLM (or equivalent)	0.03 feet
APHA -10300B.	Periphyton Collection	N/A	1 mg Chla/m^2

Field instruments will be calibrated before each sample collection event. Upon completion of field activities, instrumentation will be checked for calibration. Information pertaining to instrument calibrations and maintenance checks will be recorded on the proper data forms. Information regarding calibrations will include: date/time, parameter, personnel, equipment type, associated calibration specifications, and general observations. Field personnel should have redundant field instruments available in case primary instruments malfunction.

Field measurements will be conducted following the standard operating procedures described in Appendix A and B. Field instruments will be calibrated before initiating monitoring activities for each event or at the beginning of each monitoring day. All calibration and maintenance activities will be documented on appropriate field documentation forms. Sampling crews should record pertinent site observations such as debris (especially on monitoring equipment) flow, visual and odor characteristics. These observations will be documented on the proper field sheets. In addition to recording site observations, sampling personnel should take pictures of monitoring locations when they deem it necessary for site descriptions.

IX. SAMPLE COLLECTION, HANDLING AND DELIVERY

This section outlines procedures for sample collection, handling, delivery, and documentation.

A. Sample Collection

Water quality grab samples will be collected at each monitoring site as described in Section VI. Grab samples will be obtained by lowering the sample container to one-third of the stream depth at the centroid of the stream flow. This methodology is acceptable since most sampling locations will be in relatively small streams that are typically well mixed. Grab samples may be obtained by wading into the stream from downstream of the sampling location. The field staff should be careful to not suspend sediments while wading. Grab sample containers should be rinsed three times with water obtained at the sampling location prior to obtaining the sample.

ERC will be responsible for filling the sample containers during collection monitoring site on East Fork of the Crooked River and Heaths Creek and MDNR will be responsible for filling the sample containers on Little Drywood Creek. Each field team (ERC and MDNR) will transport the sample containers to the University of Missouri Limnology Laboratory and ES&S Laboratories. Also each field team (ERC and MDNR) will complete a chain of custody form developed by MEC accompany each delivery. At a minimum ten percent of all laboratory analyses will be blind duplicates. One field blank will be collected during each field day by each of the field steams. Sample volumes, container preservatives and holding times for are included in Table 9.C.1.

Labels will be prepared by completing the appropriate fields. Samples will then be placed in a cooler and packed with ice. The field personnel will arrange for transport of the sample containers to the laboratories. Field team personnel will complete a chain of custody form to accompany each sample delivery. Sample processing will be completed at the laboratory.

Table 9.1. Recommended Sample Container, Preservative, and Holding Times for Selected Methods.

Parameter	Container[a]	Sample Volume (mL)	Preservative[b]	Maximum Holding Times [c]
CBOD-20	P or G	1,000	<4°C	48 Hours
Total Nitrogen	P or G	10	<4°C	28 Days
Nitrite + Nitrate	P or G	60	<4°C	28 Days
Ammonia Nitrogen	P or G	60	<4°C	28 Days
Total Phosphorus	P or G	10	<4°C	28 Days
Total Suspended/Volatile Solids	P or G	250	freeze with desiccant	30 Days
Sestonic Chlorophyll-a	P or G	250	freeze with desiccant	30 Days (Dark)
Benthic Chlorophyll-a	P or G	60	freeze with desiccant	30 Days (Dark)

(a) (a) Polyethylene (P), glass (G).
(b) Sample preservation should be performed immediately upon sample collection. All water quality processing including sample filtration will occur at the laboratory. Extra raw water for nutrient analysis will be saved refrigerated or frozen less than the maximum hold time and used in case initial analysis are inconclusive.
(c) Samples will be analyzed as soon as possible after collection.

The times listed are maximum times that samples may be held before analysis is initiated. Samples may be held for longer periods of time if the monitoring laboratory has data on file to show that the specific types of samples under study are stable for the longer time. Some samples may not be stable for the maximum time period given in the table. The monitoring laboratory is obligated to hold the sample for a shorter period if knowledge exists to show this is necessary to maintain sample stability.

B. Sample Labeling Requirements

Each sample container will be labeled with the following information in indelible ink:

- Project name
- Site identification number
- Date (m/d/y) of sample collection
- Time (24:00) of sample collection
- Field personnel name/initials
- Type of sample: grab, composite, etc.
- Sample preservative, if used
- Analysis Type
- Sample number

A chain-of-custody (COC) form (Appendix C) will be included with each shipping container identifying, at a minimum, the following information for each sample in the container:

- Unique sample number according to the Sample Identification System
- Time and date of sample collection
- Name of person collecting sample
- Preservative used, and what kind used, if any
- Analysis to be performed
- Sample matrix and volume
- Any special instructions such as turnaround time
- QC samples

The COC is signed by the sampling personnel who are responsible for the care and custody of the sample(s) until they are properly transferred or delivered to laboratory personnel. All samples will be accompanied by a COC record. When transferring possession, the individuals relinquishing and receiving the samples will sign, date, and note the time on the COC. The company from which the samples are relinquished and to which they are delivered, and the reason for transfer, will be noted. This record documents the transfer of samples from the custody of the sampler to that of another person or laboratory.

E. Quality Assurance/Quality-Control Samples

Quality assurance protocols are a critical component for any monitoring study. Quality Assurance/Quality control (QA/QC) samples provide critical information about the validity of methods by which samples are collected and analyzed during a monitoring study. QA/QC samples often include field blanks as well as field duplicates.

Field blanks will be collected to assess possible contamination during sampling procedures and sample handling. Blanks will consist of deionized or distilled water and collection will incorporate those methods used to transfer samples into the proper laboratory containers. One field blank will be collected for each stream.

Field duplicates will be used to estimate sampling and laboratory analysis consistency and precision. Duplicate samples will be collected at the same time and location by filling two bottles with sample. The duplicate will be placed in coolers with the regular samples. One duplicate sample will be collected for each stream.

F. Handling and Delivery

Each field team (ERC and MDNR) will be responsible for transportation of sample containers to the laboratories as described above in Section IX A. However in the event the filed personnel cannot deliver samples to the laboratory, shipment may be necessary to meet holding times. Environmental samples will be packaged and shipped as described below if shipping is used. Samples will be shipped per Department of Transportation (DOT) and International Air Transportation Association (IATA) guidelines.

- All sample containers will be placed in waterproof metal or equivalent plastic ice chests or coolers only.
- After the pertinent information is on the sample label and tag, if required, the tag is secured around the sample container lid.
- Cushioning material is placed in the bottom of the cooler.
- The bottles are sealed in clear plastic bags, with labels and tags clearly visible. The enclosed are placed upright in the cooler so that they do not touch during transit.
- Ice bags are placed around, among, and on top of the sample bottles.
- The cooler is filled with cushioning material.
- Paperwork (the COC) is placed in a waterproof plastic bag and closed.
- The cooler drain is taped shut.
- The cooler lid is secured with tape by wrapping it around the cooler in at least two places without covering any labels.
- Completed shipping label is attached to the top of the cooler.
- If needed, numbered and signed custody seals are affixed on front right and back left of the cooler. The seals are covered with wide, clear tape.
- Samples will be express-shipped (overnight) to the laboratory under COC protocols previously discussed.

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Appendix A

Standard Operating Procedures –Field Investigations

Appendix A-1. Surface Water Sampling

1 Introduction

This standard operating procedure (SOP) is applicable to the collection of representative liquid samples, both aqueous and non-aqueous, from streams, rivers, lakes, ponds, lagoons, and surface impoundments. It includes samples collected from depth, as well as samples collected from the surface. These typically applicable procedures have been adapted from the U.S. EPA Surface Water Sampling SOP No. 2013, dated 11/17/94 and may be varied or changed as required, dependent upon site conditions or equipment and procedural limitations. The actual procedures used should be documented in the field notes, especially if changes are made.

There are two primary interferences or potential problems with representative surface water sampling. These include cross contamination of samples and improper sample collection. Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems as follows:

- Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary; and
- Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area.

2 Materials

The following materials shall be available, as required, during sampling. Back-up field instruments/equipment should be available, if required.

- Personal protective equipment;
- Cleaning equipment;
- Appropriate sampling apparatus and accessories;
- Appropriate sample bottles, preservatives (if required) and sample bottle labels;
- Ziploc™-type bags;
- Insulated coolers, ice, and appropriate packing material;
- Chain of Custody records and custody seals; and
- Field documentation forms, field log book, waterproof pen, camera and film.

3 Preparations

- Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed;
- Obtain the necessary sampling and monitoring equipment to suit the task. Consider sample volume, depth, deployment circumstances (e.g. bridge configuration) type of sample, sampler composition materials, and analyses to be conducted;
- Decontaminate or pre-clean equipment and ensure that it is in working order; and
- Prepare scheduling and coordinate with MEC staff, AES and ES&S Laboratories, if appropriate.

4 General Sample Collection Procedures

1. Record pertinent data on the field documentation form.

2. Label all sample containers with the date, time, site location, field crew, and other requested information.
3. Don appropriate personal protective equipment.
4. Clean all sampling equipment prior to sample collection.
5. If field preservation is required, place appropriate preservative into the sample container prior to sample collection.
6. If any quality control samples are specified in the work plan, they will be collected in the following manner:
   - Duplicate samples should be collected at the same time or immediately following one another in accordance with the above procedures; and
   - Field blanks, such as samples of water or reagents used to clean sampling equipment, should be collected directly into the sample bottle from the appropriate sampling device. The AES Laboratory will provide water for field blanks.
7. Record sample collection information on the field documentation form and store the samples in an iced cooler.
8. Handle, pack, and deliver appropriate samples to AES and ES&S Laboratory

5 Equipment-Specific Sample Collection Procedures

a) Dip Sampler **-** A dip sampler is useful in situations where a sample is to be recovered from locations where direct access is limited (e.g. bridge). The line or long handle on such a device allows access from a safe location. Sampling procedures are as follows:

   1. Assemble the device in accordance with the manufacturer's instructions.
   2. Extend the device to the sample location and collect the sample by dipping the sampler into the stream.
   3. Retrieve the sampler and transfer the sample to the appropriate sample container.

b) Direct Method **-** For streams, rivers, lakes, and other surface waters, the direct method may be used to collect water samples from the surface directly into the sample bottle. When using the direct method, do not use pre-preserved sample bottles as the collection method may dilute the concentration of preservative necessary for proper sample preservation. The procedures are as follows:

   1. Using adequate protective clothing, access the sampling location by appropriate means.
   2. For shallow stream locations, collect the sample under the water surface while pointing the sample container upstream. The container must be upstream of the collector. Avoid disturbing the substrate.
   3. For lakes and other impoundments, collect the sample under the water surface avoiding surface debris.

6 Safety

Advanced planning can eliminate many safety hazards. For safety reasons, all sampling should occur in pairs when possible. If possible, the sampling crew should also carry a cellular phone or other communication device, an emergency contact list, and basic safety equipment. The crew should be aware of potential hazards at a monitoring site and any change in weather conditions.

Appendix A-2. Field Water Quality Measurements

1 Introduction

Water quality parameters, such as dissolved oxygen, specific conductance, pH, open-channel flow, temperature, and secchi depth may be measured in the field during surface water sampling activities. These parameters may be measured using individual or multi-sensor probes, as available and appropriate for each situation.

2 Materials

The following materials, as required, shall be available during field measurement of water quality:

- Personal protective equipment;
- Temperature, pH, conductivity, turbidity, dissolved oxygen, and velocity meters, as required;
- Manufacturer's operating manuals for each instrument;
- Calibration solutions appropriate for each instrument;
- Tools necessary for field maintenance of instruments;
- Extra batteries for the meters;
- Cleaning materials;
- Distilled/deionized water; and
- Appropriate forms and field notebook.

3 Procedures for Field Water Quality Measurements

1. Calibrate and operate all meters in accordance with manufacturer’s operating manuals. Record calibration on the appropriate field form.
2. Setup instruments and take in-situ surface water measurements by placing meter probes at the designated location in the water body. Temperature, pH, conductivity, measurements may be taken from samples collected with a sampling device.
3. Measure and record the meter readings for each parameter:
    - Allow instrument readings to stabilize before recording, as appropriate.
4. Rinse probes off in distilled/deionized water, if required.
5. Log results and observations in field documentation form.

Appendix A-3. Benthic Algae Sampling

1 Introduction

Benthic algae sampling may be conducted during water quality assessments. Collection of samples will be done on a reach by reach basis (reach is equal to 30 to 40 stream widths). Within each reach five replicates will be collected. In streams where course substrate is unavailable woody debris will be sampled for benthic algae. Woody debris will be sampled using the cylinder scrap method as described in Moulton et. al. (2002).

2 Materials

The following materials, as required, shall be available during field measurement of water quality:

- Personal protective equipment
- Large Plastic Funnel;
- Small portable cooler;
- Brushes (soft bristle, course bristle, wire bristle) as required;
- Scalpel or other scrapping device ;
- Pruning Shears
- Folding Camp Saw
- Film canister lid;
- Proper sample containers;
- Sample Labels;
- Distilled/deionized water; and
- Appropriate forms and field notebook.

3 Procedures for Collection of Benthic Algae Samples

1. Determine the reach area length – 20 times the bankfull width of the stream
2. Randomly select a piece of substrate within the reach.
3. Press the film container firmly against the substrate to protect algae underneath it.
4. Using the appropriate brushes (usually the wire brush to initially clean) and/or scrapping tools (scalpel etc.) remove all algae from the surface of the substrate around the film container lid. Rinse the rock with deionized water as needed during this step to determine if algae remains.
5. Remove the film container lid and remove the algae sample that was preserved.
6. Place the sample in a 60mL sample container.
7. Rinse the surface of the substrate and tools used into the sample container.
8. Collect a total of five replicates randomly within each reach.
9. Fill out field form information and sample label. Place label on the sample container.
10. Place samples in a cooler immediately and cool to <4^{o}C.

Appendix B

STANDARD OPERATING PROCEDURES FOR OPERATION, DEPLOYMENT AND MAINTENANCE OF YSI 6-SERIES SONDES

STANDARD OPERATING PROCEDURES FOR OPERATION, DEPLOYMENT AND MAINTENANCE OF YSI 6-SERIES SONDES

April 3, 2007

Prepared By: ______________________________________ **Date:**____________
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1.0 INTRODUCTION

Accurate and complete data are important to any water quality evaluation. It is important that equipment used for collection of these data be properly programmed and maintained for accuracy and reliability. The following text is a guide for operation and maintenance of the YSI 6-series sondes for water quality monitoring. This is **NOT** a substitute for the manufacturer's operations manual. The YSI 6-series Operations Manual should be thoroughly reviewed prior to operation of any YSI 6-series instrument. The manual will provide important information which may not be covered in this document.

2.0 PERSONNEL QUALIFICATIONS

Field personnel should have a working knowledge of equipment and procedures required to properly maintain that equipment. Personnel should also have completed MEC sonde training or received training from a qualified MEC employee. In addition, MEC employees should complete and sign a **project specific training form**, which indicates that they have received and understand the training required to operate and maintain the YSI sondes.

3.0 HEALTH AND SAFETY

Activities involved in the deployment and maintenance of sondes and the collection of DO data may include exposure to harsh chemicals and environmental hazards. The chemicals involved may include but are not limited to acid, basic and corrosive solutions. Environmental hazards may include but are not limited to exposure to wastewater in streams, working from a boat, tripping, slipping, and falling. Personnel should be aware of these conditions and take the proper precautions to protect themselves.

4.0 EQUIPMENT NEEDS

The following items should be available to laboratory or field personnel prior to testing or performing maintenance on any sonde:

- 650 MDS Handheld display
- Quality assurance (QA) sonde, freshly calibrated for verification DO readings
- Sonde guard for QA sonde
- Extra sonde that is functioning properly
- 8' field cable (connects the 650 and the sonde)
- 100' field cable (connects the 650 and the sonde) **-** required only when servicing locations where the stream bed is not accessible.
- YSI 6570 maintenance kit (DO probe membranes, bottle of KCl solution, Conductivity brushes, DO probe reconditioning kit, spare O-rings, silicone grease, syringe, and probe installation/replacement tool)
- YSI 6144 Kit (includes: wiper pads)**- required when the Reliable Oxygen (ROX) Sensor or the Rhodamine probe is in use on a sonde**
- YSI 6628 Kit (for replacement of wiper assembly – includes: 2 new wiper assemblies with preinstalled wiper and setscrews) – **required when the ROX Sensor or the Rhodamine probe is in use on a sonde**
- Small (e.g. 16 oz.) bottle of deionized water
- Small scissors or razor blade (for trimming membrane)
- Extra C batteries for 650 (4)
- Extra batteries for sondes – **600 XLM requires 4 AA batteries, 6600 requires 8 C batteries**
- Wetted towel used in DO calibration of sonde

5.0 INSTRUMENT LOG BOOKS

Records of all instrument maintenance and calibrations should be kept in an instrument log. The instrument log should be a composition type notebook. Each log should contain information such as date, calibration data, and any maintenance that was performed on the instrument (e.g. change membrane, recondition probe etc.). The log should also document any changes made to the instrument programming. The information contained in the instrument log will aid in troubleshooting any instrument problems as well has provide evidence of proper maintenance. An example of an instrument log book entry is provided as Attachment 1.

A three ring binder should also be used to store any information from YSI pertaining to service or maintenance of the sondes. The binder should be organized with tabs for each specific instrument. All records of service, repair, or testing conducted by YSI should be retained in each specific instrument’s section.

6.0 SETUP AND FIELD SONDE TESTS PRIOR TO DEPLOYMENT

Sonde programming and maintenance checks prior to deployment are important for the collection of accurate and reliable data. Before deploying an instrument, there are a number of procedures that should be followed to ensure the instrument will function properly once installed. Programming and maintenance should be conducted close to the deployment date; however, there should be enough time allowed to address any problems that may arise during testing.

6.1 YSI 6-series Sonde Programming

6.1.1 Unattended Sampling Programming with Rapid Pulse DO probe

Programming determines when, how and what the instrument records to memory. Connect to the sonde using a computer or the 650 hand-held display. Once attached to the sonde and the sonde menu has been accessed, the date and time should be checked. Any changes to the date and time can be made by accessing the “System” menu of the sonde. Also in the “System” menu is an option to set the “Instrument ID.” The instrument ID is the unique identifier that will make sure any data that is collected is associated with a particular instrument. The Instrument ID should be set as the instrument’s serial number.

The user should review any existing files in the sonde “File” menu and determine if they need to be saved. If not, then all files should be cleared from the sonde directory.

When setting up a sonde for long-term deployment, users should place the sonde in unattended sampling mode. Unattended sampling allows the user to select the frequency and duration at which measurements are taken. Typically, unattended samples are collected at fifteen minute intervals over the study period. The study period can be defined with a beginning and ending date and time. However, in most applications the “Stop logging” point is left open by entering a date that is in the distant future (e.g. 1/1/2050). This will ensure that the monitor will not stop logging while deployed. A file must then be created to which the sonde will log selected data. The file name can contain seven characters and should be named in a way to describe the sampling location and perhaps the date deployed. For instance “C151005” would describe Cuivre River, site 1, deployed May 10, 2005.

Along with the sampling type and interval, the user must select parameters to log. This is set up in two different locations in the sonde menu. First, the attached sensors must be turned on in the “Sensor” menu of the sonde. The sensors that should be selected on the sonde are determined by the monitoring objectives. For instance, if conducting a dye study and DO, temperature or conductivity are not required parameters then the user would select only the “Rhodamine 6130” sensor. Table 1 illustrates the “Sensor” menu with sensors enabled that are typical of a long term DO monitoring project employing the Rapid Pulse DO probe. For discussion of the ROX DO probe setup see Section 6.1.1.a.

Table 1: Sensors Enabled for typical stream monitoring*

```
------------(*) indicates sensors enabled------------
        1-(*)Time
        2-(*)Temperature
        3-(*)Conductivity
        4-(*)Dissolved Oxy
        5-( )ISE1 pH
```

6-( )ISE2 Orp
7-( )Optic-T Rhodamine-6130
8-( )Optic-C NONE
9-(*)Battery

*If rhodamine dye and/or pH will be monitored then the rhodamine and/or pH sensor should also be enabled.

Once the sensors have been selected, the user must then select the output the sonde will place in the sampling file. These outputs can be selected in the "Report" menu. The selected outputs will depend on what the sampling protocols require. Table 2 presents outputs typical of a dissolved oxygen monitoring study. Table 3 depicts how the Advanced Setup menu should appear when conducting unattended sampling, this is the default for the menu. This menu is located under the "Advanced" option of the main menu and should **NOT** be changed.

Table 2: Parameters Reported to Unattended Data File*

-------------(*) indicates parameters reported--------------

1-(*)Date	8-( )Sal ppt
2-(*)Time hh:mm:ss	9-(*)DOsat %
3-(*)Temp F	A-(*)DO mg/L
4-(*)SpCond uS/cm	B-(*)DOchrg
5-( )Cond	C-( )Rhodamine
6-( )Resist	D-(*)Battery volts
7-( )TDS	

* If rhodamine dye and/or pH will be measured then rhodamine and/or pH should be selected as a reported parameter.

Table 3: Advanced Setup Menu

------------(*) indicates selected parameters -------------

1-(*)VT100 emulation
2-( )Power up to Menu
3-( )Power up to Run
4-( )Comma radix
5-(*)Auto sleep RS232
6-(*)Auto sleep SDI12
7-( )Multi SDI12
8-( )Full SDI12
9-( )Sample and hold

Upon completion of the programming setup, the sonde should be tested for proper functioning prior to deployment. As described in the previous paragraph, the files saved on the sonde should be cleared to ensure there will be ample room for data collection. Once the sonde memory is cleared, the technician should prepare the sonde(s) for an unattended sampling test in the laboratory. The unattended tests should be conducted with at least two similar instruments for comparison purposes.

6.1.2 Unattended Sampling Programming with the YSI Reliable Oxygen Sensor (ROX)

The YSI ROX sensor uses the luminescence-lifetime technique to measure dissolved oxygen. This method is capable of providing accurate and reliable data while decreasing the maintenance and calibration that is currently required using the rapid pulse technique. This section describes slight programming changes that will need to be made if the ROX sensor is to be used on a 6920 or 6600 sonde.

A new ROX sensor is preprogrammed with the proper calibration constants. These constants will be transfered to the sonde once the sensor is installed and run. If, however, the user is replacing the optical DO membrane then the new constants (which come with each 6155 membrane) will need to be entered into the sonde before the ROX probe will function properly. Section 7.3.2 describes the entry of constants and ROX sensor calibration in more detail.

As in Section 6.1.1 the user will need to enter the “Sensor” menu. Table 4 shows how the menu may appear if a ROX sensor is attached to one of the optical ports on the sonde (ROX can be used in any optical port). After enabling the optical DO sensor the “Dissolved Oxy” option (which is the rapid pulse probe) will appear disabled. The ROX and rapid pulse sensors cannot both be selected.

Table 4: Sensors Enabled for typical stream monitoring using ROX sensor

------------(*) indicates sensors enabled------------

1-(*)Time
2-(*)Temperature
3-(*)Conductivity
4-( )Dissolved Oxy
5-( )ISE1 pH
6-( )ISE2 Orp
7-( )Optic-T Rhodamine-6130
8-(*)Optic-C Dissolved Oxy
9-(*)Battery

After the ROX sensor is enabled the user can enter the “Report” menu to select the desired data to be output. Table 5 shows how the “Report” may appear when the ROX sensor is enabled. Take notice that the percent saturation and concentration for dissolved oxygen now have an “O” (optical) preceding the DO and there is no option for DO charge.

Table 5: Parameters Reported to Unattended Data File*

-------------(*) indicates parameters reported--------------

1-(*)Date	8-( )Sal ppt
2-(*)Time hh:mm:ss	9-(*)ODOsat %
3-(*)Temp F	A-(*)ODO mg/L
4-(*)SpCond uS/cm	B-( )Rhodamine
5-( )Cond	C-(*)Battery volts
6-( )Resist	
7-( )TDS	

6.1.3 Discrete Sampling Programming

Discrete sampling programming is the same as the unattended programming. Therefore, any sensors that are selected and reported will be shown when in discrete sampling mode. The YSI 6-series sondes have a built in "Discrete Sampling" feature in the sonde's "Run" menu that allows a user to log discrete samples to a file, even if the sonde is running in unattended sampling mode.

6.2 Maintenance and Testing of Probes Prior to Deployment

Sondes being tested require maintenance and calibration of the attached probes. The MEC Water Resource sondes typically have the following probes attached: 6562 DO probe, and 6560 temperature/conductivity probe. Additional sensors such as the 6150 ROX probe, the 6130 rhodamine probe (which may be attached if the sonde is a 6920 or 6600 model) and the 6561 pH probe are also used by MEC, but on less frequent basis.

6.2.1 Rapid Pulse Dissolved Oxygen Probe

Preparation of the DO probe(s) begins the day before testing by reconditioning the probe electrodes and replacing the probe membrane and o-ring (see sections 7.3.4 and 7.3.5 for complete procedures on probe reconditioning and membrane replacement). The calibration cup, containing a small amount of water, must be placed back on the sonde where it remains until the next day (approximately 6 to 8 hours) before continuing testing. This time period is required to allow the new membrane to "relax" after being stretched. If not done in this manner, the probe calibration may be prone to error. Next, an aerator is placed in a bucket or other large container of tap water and allowed to run overnight to saturate the water with oxygen. The aerator should be large enough to saturate the amount of water in the container to be used. The next day the sonde is fitted with the probe guard and a moist towel must be tightly wrapped around the guard covering all of the holes. Run the sonde with moist towel for at least 20 minutes ("burn in time") and then calibrate it according to the procedure described in Section 7.3.1.

6.2.2 Reliable Oxygen Senor (ROX)

A new ROX sensor is factory calibrated through its range of measurement. If the membrane has been replaced, the new membrane constants (each membrane comes with unique constants) will need to be entered (section 7.3.2). A new sensor or one with a new membrane will require calibration prior to testing to ensure the accuracy specification is met. The ROX sensor should be tested in a bucket of air saturated water along side at least one other instrument (either ROX or rapid pulse). The testing procedures are presented in section 6.3.

6.2.3 Conductivity and Temperature Probes

Temperature and conductivity probes also require maintenance prior to calibration and testing. Clean the conductivity openings with the brush provided in the 6570 maintenance kit. Dip the brush in clean water and insert into each opening 15-20 times. Once the openings are clean, the exterior and all other surfaces around the probe should be thoroughly cleaned to prevent conductivity standard contamination. Using a calibration standard near the expected field concentrations, (e.g. YSI 3161 standard = 1mS/cm) calibrate the conductivity probe according to Section 7.3.1 calibration procedures.

Temperature is factory calibrated on YSI 6-series sondes and does not require operator calibration. However, it is beneficial to compare temperature readings from various sources to ensure that the temperature probe is functioning properly. If the temperature probe is reading incorrectly, all other sonde sensors may report erroneous data.

6.2.4 Rhodamine Probe

When rhodamine is to be monitored it is important to be sure the probe is clean and will function properly before deployment. The rhodamine probe is self-cleaning, however, the wiper assembly or wiper pad should be replaced prior to testing and deployment. The rhodamine probe can be zeroed or calibrated. Zeroing the probe allows the technicians a relative measurement of rhodamine. However, most of MEC Water's applications will require the probe to be calibrated using the 2-point method. The procedure for calibrating the rhodamine probe is described in Section 7.3.3.

6.2.5 Depth and Level Sensors

YSI 6-series sondes are available with two different types of depth measuring devices, a depth sensor or a level sensor. Both utilize a pressure transducer, however, one measures absolute (air and water) pressure (depth) while the other is vented to the atmosphere measuring only water pressure (level). Both require cleaning prior to deployment to be sure they are able to accurately measure pressure. The 600XL and XLM have a small cap with holes that covers the transducer. Using the syringe provided in the 6570 maintenance kit gently force clean water into each hole and ensure the water exits through the other hole(s). Flush with water until the water comes out clean. The 6920 and 6600 transducer port is slightly different. It is typically a port that passes though the sonde and in the center is the opening for the transducer. Again using the syringe gently flush the port with clean water until the port is clean.

When a vented level sonde is being deployed it you must check the desiccant on the vent tube. If the desiccant is blue then it will not require changing, however, if it is pink in color then it must be changed prior to deployment.

After cleaning, the pressure transducer is allowed to dry and then calibrated. Calibration of the pressure sensor must be conducted in air (NOT SUBMERGED), and consists of zeroing the sensor. See Section 7.3.4 for a detailed discussion of this procedure.

6.2.6 pH Probe

The pH probe may not require cleaning prior to testing. It requires cleaning only if deposits or contaminants appear on the glass bulb and/or the platinum surfaces or the probe's response is slow. If cleaning is required, users must be extremely careful when handling the probe, as the glass bulb is very fragile.

Begin cleaning by removing the probe from the sonde. Rinse the probe with clean water and making sure not to get the connections wet. Using a cotton swab soaked with clean water gently remove any foreign material from the bulb, platinum button and reference electrode junction. **Be careful not to wedge the cotton swab between the glass bulb and plastic guard – this could result in damage to the bulb.**

If these steps do not restore good pH readings it may be necessary to do further cleaning:

1. Soak the probe for 10 to 15 minutes in water with a little dishwashing liquid.
2. With a cotton swab soaked with the water GENTLY wipe the bulb

3. Rinse with clean water.
4. Wipe the bulb with a clean soaked cotton swab.
5. Rerinse with clean water.

If these steps fail to address the pH problem then:

1. Soak the probe in one molar (1 M) hydrochloric acid (HCl) for 30 to 60 minutes. **Follow all safety precautions when using HCl.**
2. Remove the probe from the HCl and rinse with clean water
3. Using a cotton swab soaked with clean water wipe the probe
4. Rerinse with clean water
5. Soak probe in clean water for an hour stirring occasionally

To remove biological contamination:

1. Mix a 1 to 1 solution of chlorine bleach
2. Soak probe for 1 hour
3. Rinse the probe with clean water
4. Soak the probe in clean water for 2 hours to remove bleach
5. Rerinse probe

After cleaning the pH probe, make sure the connections are dry before reinstalling it on the sonde. Recalibrate the probe following the procedures detailed in section 7.3.5.

6.3 Testing the Sonde and Probes

After all of the probes have been cleaned and calibrated, unattended sample testing can begin. Set up an unattended file unique for each sonde being tested. For example, use the sonde's serial number for a file name. This will ensure the test data can be matched to the proper instrument. Other unique file names are adequate. Record the sonde serial number, instrument ID and file name for each of the test sondes. Place the sonde(s) in the container of air saturated water and allow them to run overnight. The next day, remove the sondes, stop logging and download the files to the computer. The dissolved oxygen saturation values should be near 100% - depending on the elevation, (usually about 98% for the Columbia area). DO charge (rapid pulse) should be within the manufacturer's specifications (25 to 75) and have a voltage greater than 5.0 (YSI 600) or 12 (YSI 6600/6920). In addition to DO, view the conductivity to determine if the calibrations were accurate. Once it is determined that the sondes are working properly they can be deployed.

7.0 FIELD PROCEDURES FOR DEPLOYMENT AND MAINTENANCE

Instruments should be cleaned and tested prior to deployment as described in the previous sections. Failure to clean and test instruments could result in deployment of faulty equipment and missing data. The following sections describe equipment, datasheets, procedures and general field observations involved in deploying and maintaining these instruments.

7.1 Equipment

7.1.1 Equipment List

Equipment needed for deployment and maintenance are listed in Section 4.0 of this document.

7.1.2 Quality Assurance (QA) Sonde

The Quality Assurance (QA) sonde is used to check the accuracy of instruments deployed in the field. The QA sonde should be calibrated each day of use and should be in good working order. If the QA sonde is not working properly, all of the maintenance procedures carried out on the field equipment may be subject to error.

7.2 Data Records

Data sheets for deployment are the same as those used for maintenance checks. The datasheets should be developed prior to the beginning of field operations and include fields for all data needed for data validation and equipment troubleshooting. An example of this datasheet is provided in Attachment 2. The data records are arranged on the datasheet in the same order as the collection of the data should occur.

7.3 Procedures

The following sections provide step-by-step procedures for calibrating maintaining and deploying the various sonde probes.

7.3.1 YSI 6562 Rapid Pulse Dissolved Oxygen Probe Calibration

When preparing to calibrate the DO probe (using the % Saturation method) of a YSI 6-series sonde the field crew should have the equipment listed in Section 4.0 at their disposal. The membrane on the DO probe should be new or clean and in good condition.

1. With the sonde guard in place, wrap a wetted towel around the guard, making sure to cover all openings. The damp towel will transfer moisture into the air surrounding the DO probe and ideally bring it to vapor saturation.
2. After wrapping the towel around the sonde, place it in a shady area which will help the temperature stabilize.
3. Connect to the sonde menu using the 650 MDS and enter the “Run” menu.
4. Select “Discrete Sampling” from that menu. On this screen the sampling interval should be defaulted to 0.5 seconds.
5. Select “Start Sampling” and the screen should change, showing the various parameters setup on the sonde.
6. Watch the temperature and DO% saturation readings until they remain stable (this may take at least 5 to 10 minutes). Record the final DO % saturation reading on the datasheet under “Initial DO%”.
7. Once the readings have stabilized press escape to return to the main sonde menu and enter the “Calibration” menu.
8. Select “Dissolved Oxy” then “DO %”. The menu will then prompt the user to enter the barometric pressure.

   NOTE: If using the 650MDS it will not be necessary to enter the pressure because the 650MDS is equipped with a barometer and will automatically enter the correct pressure.
9. Press enter at this point to begin calibration process. If the sonde is set up for unattended sampling and the “Autosleep RS232” is ON, the sonde will automatically calibrate after a period of 40 to 60 seconds.

   NOTE: If the sonde is set up for discrete sampling and the “Autosleep RS232” is “OFF”, the user will need to watch the readings for several minutes and determine when they are stable. At that time, the sonde can be manually calibrated by selecting the “Calibrate” option.
10. **Record the DO % saturation after calibration.** The temperature, DO charge, battery voltage and DO gain (in the “Advanced” menu under “Cal Constants”) should also be recorded.
11. After calibration is complete select “Continue”, this will return the user to the calibration screen.

7.3.2 YSI 6150 Reliable Oxygen Sensor (ROX) Calibration

Calibration of the ROX sensor involves several steps that will ensure the specified accuracy of the sensor. Each sensor has a replaceable membrane which has slightly different characteristics than another. To provide the most accurate data YSI has established a set of three constants and a zero value for each membrane to be placed on a sensor. When the sensor is new from the factory these constants are already stored in the sensor memory. However, when a membrane must be replaced, YSI provides a set of constants unique to that membrane. These “replacement” constants must be entered into the sonde’s memory which will then transfer them to the sensor memory.

1. To add new constants, enter the “Calibrate” menu and select “Optic-* Dissolved Oxy table 6 illustrates this menu.

Table 6: Calibration menu for ROX sensor

1-ODO sat %
2-ODO mg/L
3-Enter cal sheet
4-View cal sheet

2. Select “Enter cal sheet.” Upon selecting this option the user will be prompted to enter each constant as it appears on the documentation provided with the ROX sensor membrane. The constants are coded in such a way that the programming will be able to recognize if a constant were enter erroneously. This ensures that the user will enter the correct numbers.
3. After the constants have been entered they can be viewed by selecting “View cal sheet” from the calibration menu.
4. Typically calibration of the ROX sensor will be accomplished using the “ODO sat %” option. This option allows the user to select a 1-p0int or 2-point calibration. The 1 point calibration will be sufficient for most applications, particularly for field calibrations
5. The 1-point calibration can be conducted following the same procedure described in section 7.3.1.

7.3.3 Conductivity Probe Calibration

Calibration of the conductivity probe should be conducted at the beginning of each field season prior to deployment. Standards for calibration should have concentrations near the expected field conditions. Natural waters typically have conductivity values between 0.1 and 1.0 mS/cm (milli siemens per centimeter), therefore the calibration standard should be 0.1 mS/cm.

1. Thoroughly clean the probe and all surrounding surfaces. No salt deposits should be present on the probes. If present, rinse sonde thoroughly to remove deposits.
2. Once cleaned and thoroughly dried, the probe is rinsed with a small amount of the calibration standard. When calibrating a conductivity probe on the large 6600 or 6920, a small container large enough to completely submerge the sensor can be used to reduce the amount of standard used. If calibrating a 600 XLM the calibration cup can be used.
3. Carefully immerse the sensor in the standard and slightly agitate it to remove air bubbles that may be trapped in the conductivity ports. Let the sensor sit in the standard for at least one minute to allow the temperature to stabilize.
4. Select “Calibrate” from the sonde’s main menu.
5. Select “Conductivity” then “Sp Cond” from the following menus. (Conductivity is generally calibrated using the specific conductivity so that temperature will be compensated for automatically).
6. Once “Sp Cond” has been selected the screen will prompt the user to enter the calibration value of the standard being used and then press Enter.
7. Observe the readings on the display until there is no significant change over a 30 second period, at which time the user should press enter and the calibration will be complete.
8. Rinse the standard off the sonde using tap water.

7.3.4 YSI 6130 Rhodamine Probe Calibration

The rhodamine probe can be attached to the 6600 or 6920 sondes and is typically used in dye trace studies that employ rhodamine dye as a means of measure time of travel in streams or other water bodies. Rhodamine probes can be calibrated using 1-point, 2-point or 3-point calibrations. For most applications a two point calibration is recommended. A 1-point calibration is used to zero the probe in a standard with a 0 ug/L concentration. Zeroing the rhodamine sensor follows similar procedures as the 2-point calibration of the sensor. **For a 2-point calibration one solution must have a concentration of 0 ug/L and must be calibrated first. The other solution should be near the predicted concentration.** The following steps describe the 2-point rhodamine calibration:

1. Make sure wiper pad is new.
2. Thoroughly clean the probe and all surrounding surfaces.
3. Place approximately 200 mL of 0 ug/L solution (distilled or deionized water into the sonde’s calibration cup and immerse the probes into the solution.
4. With the sensor enabled select “Calibration” from the main sonde menu, select “Optic T Rhodamine-6130”.
5. After this selection the user will be prompted to select between “1-point”, “2-point”, or “3-point” calibration; select “2-point”
6. Input “0 ug/L” when asked to enter the concentration of the standard and press “Enter”.
7. Real-time readings will be displayed. At this time select “Clean Optics” and do so 1 to 2 times to remove air bubbles from the optics.
8. Allow time for the temperature and readings to stabilize, once stable press “Enter” and the sensor will be calibrated to the first solution.
9. Remove the sonde from the first solution and dry thoroughly.
10. Place the sonde in a second solution with a known rhodamine concentration (near the predicted study concentration).
11. Enter the concentration value and press “Enter”
12. Again clean the optics 1 to 2 times and watch the readings until they are stable.
13. Select “Enter” to confirm the calibration.
14. Select “Enter” again to return to the calibrate menu.
15. Thoroughly rinse and dry the sonde and calibration cup to remove residual rhodamine.

7.3.5 pH Probe Calibration

The 6561 pH probe can be used with 600XLM, 6600 or 6920 sondes. pH is calibrated using a 2-point calibration (1-point calibration is used to adjust a previous calibration). This method utilizes two buffer solution with pH values of 4, 7 or 10. Typically one of those solutions is the pH 7 buffer and the other is 4 or 10 whichever is closest to the predicted field measurements. The following steps can be used to perform a two point calibration.

1. Clean and dry the sonde’s calibration cup.
2. Place the proper amount of solution in the cup (25 mL for a 600XLM and 300 mL for a 6600).
3. Check the “Sensor” menu to make sure the pH sensor is enabled.
4. Immerse the pH sensor in the pH 7 buffer solution, allowing at least one minute for temperature to equilibrate.
5. Select “Calibration” from the sonde menu.
6. Select “ISE1 pH” in the calibration menu then “2-point” from the next menu. Input the value of the pH buffer and press Enter.
7. View the pH readings until there is no significant change after 30 seconds, press Enter to calibrate the probe.
8. Press Enter to proceed to the calibration of the next buffer solution.
9. Remove the sonde from the pH 7 buffer, rinse it with water, and thoroughly dry. Do the same with the calibration cup.
10. Add the proper amount of pH 4 or 10 buffer (whichever is closer to the predicted pH of the sample) to the calibration cup.
11. Input the value of the pH buffer to be used for the second point and press Enter.
12. Follow the step 7 and 8 to complete the calibration.
13. Thoroughly rinse the buffer solution from the sonde and calibration cup.

7.3.6 YSI 6562 Rapid Pulse Dissolved Oxygen Probe Membrane Changing Procedure

The dissolved oxygen probe (6562) membrane should be changed prior to testing and deployment and **at least once every 30 days during field deployment**. The membrane may also need to be replaced for other conditions that can occur during deployment.

Replace the DO membrane if:

1. there is an oily film present on the membrane after the membrane has been cleaned,
2. there are wrinkles in the membrane,
3. air bubbles are present under the membrane,
4. there are significant deposits of electrolyte visible and
5. if DO charge is higher or lower than factory recommendations (25 to 75 units).

Figure 1 illustrates the following steps to replace the membrane on the 6562 dissolved oxygen probe.

1. Begin membrane replacement by removing the o-ring and old membrane.
2. Rinse the probe with deionized water to remove the old potassium chloride (KCl) solution.
3. Dry probe tip with lens cleaning tissue and rinse probe tip with a small amount of the KCl solution.
4. Remove a new membrane from the membrane kit making sure to ONLY touch the edges (oil from your hands can decrease membrane permeability).
5. Hold one edge of the membrane against the probe with the thumb of your left hand.
6. Place electrolyte on the probe until a large meniscus is formed.
7. Grab the unsecured edge of the membrane between the thumb and index finger of your right hand.
8. Quickly and firmly stretch the membrane over the probe face and with the index finger of your left hand secure the edge of the membrane against the probe.
9. Place the o-ring on the probe by starting at one of the sides where the membrane is folded and rolling the o-ring over the other end of the fold, making sure not to touch the membrane with your fingers, until it is secured in the o-ring groove.
10. Inspect the membrane for wrinkles and air bubbles.

Figure 1 Membrane Replacement

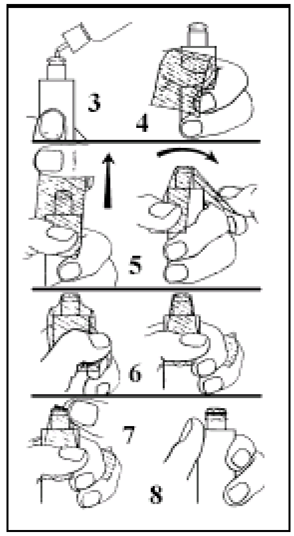


Image source: YSI 6-Series Environmental Monitoring Systems Operations Manual

11. Remove wrinkles by lightly tugging on the membrane edges. If that does not work, remove membrane and follow the previous steps to replace the membrane. If air bubbles are present remove the membrane and follow the previous steps to replace it.
12. Trim excess membrane using a small pair of scissors or a sharp utility knife. Rinse the sonde and probes with water to remove any KCl that may be on them (KCl is a corrosive solution to metals).

After the membrane of the dissolved oxygen probe is replaced it will require some time to acclimate. As previously described, this is usually 6 to 8 hours; however, with a sonde that is deployed in the field this may not be feasible. If possible, the sonde may be replaced with a replicate instrument while the field sonde is taken back to the lab for membrane replacement. This requires redundant equipment. In the case of multiple sites this would require a large investment for replicate instruments. Therefore, YSI has recommended that the field sonde (after membrane change) be run in discrete sampling mode for a minimum of 20 minutes. This "burn in time" will bring the electrolyte and membrane within 95% of the readiness accomplished when the sonde is left to sit overnight and then burned in for 20 minutes.

7.3.7 YSI 6562 Rapid Pulse Dissolved Oxygen Probe Reconditioning Procedure

The 6562 dissolved oxygen probe should be reconditioned (resurfaced) if the silver electrodes are more than 10% tarnished (black in color). Tarnished electrodes can result in reduced electrical current through the KCl solution, decreasing the probes ability to accurately read dissolved oxygen.

1. Remove the o-ring and membrane from the dissolved oxygen probe.
2. Rinse the electrolyte from the probe using deionized water and dry using a lens cleaning tissue.
3. Holding a FINE sanding disk (provided in the YSI 6035 reconditioning kit) under your thumb stroke it across the probe face, as if lighting a match, until the electrodes are shiny as illustrated in Figure 2. **Strokes should be parallel to the gold electrode located between the two silver electrodes.** Usually 10 to 15 strokes are necessary to adequately remove the discoloration, but more can be done if needed.

Figure 2: DO Probe Reconditioning

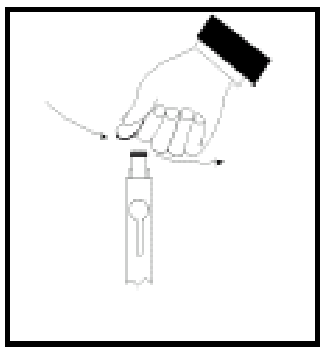


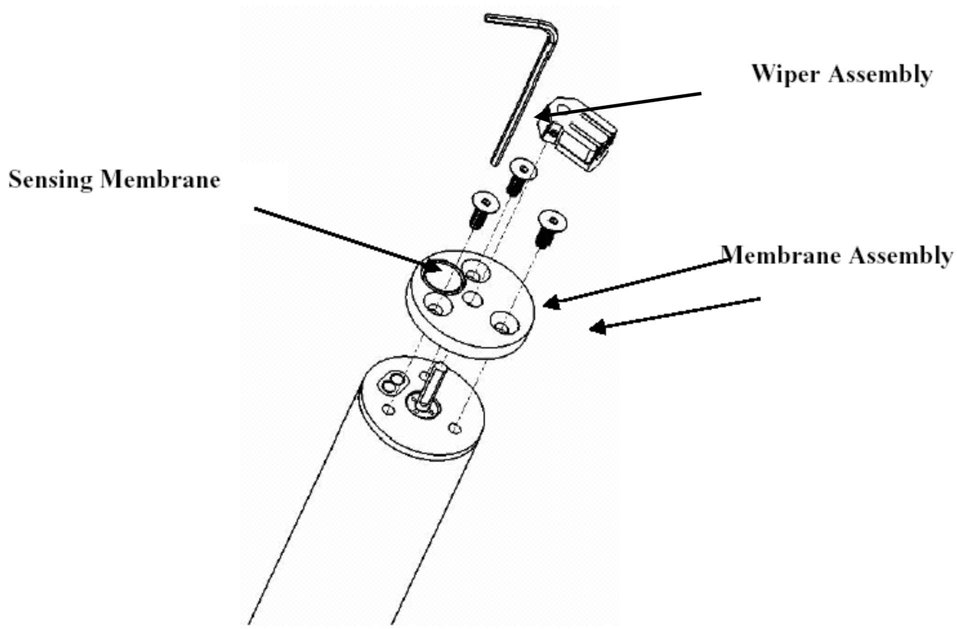
Image source: YSI 6-Series Environmental Monitoring Systems Operations Manual

4. Thoroughly rinse the probe face with deionized water to remove any dust left from sanding
5. Dry the probe with a lens cleaning tissue and if grit remains rinse the probe again
6. Once cleaned, replace the membrane following the steps in the previous section.

7.3.8 YSI 6150 Reliable Oxygen (ROX) Sensor Membrane Cap Replacement Procedure

The ROX sensor (6150) is fitted with a membrane assembly (6155) that is attached to the probe. The membrane of the ROX sensor requires replacement after one year of use unless it has been damaged or the user suspects something may be wrong. The membrane can be replaced with the probe either installed or uninstalled on the sonde. It is recommended the membrane be replaced in a controlled environment unless absolutely necessary to replace in the field. Figure 3 is a breakdown of the ROX sensor.

Figure 3: YSI 6150 ROX Sensor Breakdown



1. Remove the wiper assembly
2. Remove the three screws from the membrane assembly using the hex wrench provided with the 6155 kit. Place the screws in a secure location.
3. After removing the new membrane from its packing the membrane assembly should be dried completely paying special attention to the sensor cavity. To do so use a lens tissue and gentle dry the assembly completely. If needed a small amount of compressed air can be used. **DO NOT APPLY HEAT** to the assembly.
4. Check to be sure the o-ring is in place around the sensor membrane cavity.
5. Next place the membrane assembly on the probe over the wiper shaft, aligning the screw holes. **Make certain that the sensor membrane is located over the fiber optics of the probe. If not correctly aligned the sensor will not function properly.**
6. After aligning the screw holes and sensor membrane start one screw and tighten slightly.
7. Place the remaining screws in the holes and slightly tighten to ensure proper alignment of all screws.
8. Tighten all three screws using the hex wrench. **PLACE THE LONG END OF THE WRENCH INTO THE SCREW AND BE SURE NOT TO OVERTIGHTEN THE SCREWS.**
9. Replace the wiper on the shaft and tighten the screw, make certain that it is not over tightened.

7.3.9 YSI 6150 ROX sensor and 6130 Rhodamine Probe Wiper Replacement Procedures

The 6130 rhodamine probe is equipped with a wiper pad assembly that cleans the optics on the probe face. During deployment tiny particles build up on the wiper pad and in the bristles of the brush which can damage the probes they are cleaning. Therefore it is important to routinely replace the wiper pad or wiper pad assembly.

To replace the wiper pad:

1. Remove the wiper assembly from the probe by loosening the set screw.
2. Remove the old wiper pad.
3. Place a new wiper pad (provided in the YSI 6144 kit) in the retainers on the wiper assembly. **The wiper pad has a soft surface on one side and mylar surface on the other. Make sure the wiper pad is installed so the SOFT side will contact the probe face.**
4. Once the pad is secure in the retainers, trim the excess from the ends making them nearly flush with the wiper assembly.
5. Install the reconditioned assembly with the set screw aligned with the flat face on the drive shaft.
6. Gently press on the brush/wiper assembly against the probe face until the wiper pad is about half of its original thickness.
7. Tighten the set screw against the flat surface. **Do NOT over tighten, over tightening will strip the threads in the wiper assembly.** The wiper assembly should line up 180 degrees from the optical sensors of the probe. **Make sure not to rotate the drive shaft manually this may cause damage to the internal gears**. If they are not lined up as described allow the sonde to position the wiper automatically.

To replace the wiper assembly

1. Remove the old wiper assembly by loosening the set screw.
2. Follow steps 5 to 7 from the previous procedure to install the new wiper assembly.

7.3.10 Site Selection for Placement of Water Quality Data Sondes

Upon arrival at a predetermined monitoring location it will be important to place the sonde at a point in the stream that is most representative of the water quality in the section of stream being measured. The following procedures can be used to determine where to place the sonde in the stream.

Site Selection in the Water Body

Determining where to place a water quality monitor in a stream can be difficult when considering representativeness. It is important to select a site that is well mixed, such as a narrow channel with elevated velocities such as a run upstream of a riffle, while also considering potential problems or threats to the monitoring station (channel shifts, flood debris, dead zones etc.) In large rivers it may be more feasible to locate a monitoring station on a bridge abutment where it is less prone to flood damage. In this situation it may be appropriate to measure the vertical variability in the water column to determine the most representative depth to place the monitor. Selection of the most representative site should always be driven by water quality factors while also considering the following (Wagner et al.):

Table 7: Consideration for Monitoring Site Selection

1. Representative of cross-sectional variability
2. Constraints of channel configuration
3. Range of streamflow (from low flow to flood)
4. Velocity of streamflow
5. Turbulence
6. Avoidance of high-water debris damage
7. Range of values for water-quality physical properties
8. Protection from vandalism
9. Safety hazards
10. Type of installation
11. Difficulty and cost of installation
12. Ability to install monitor in representative location
13. Accessibility of site
14. Frequency of service interval to meet data-quality objectives
15. Rate of fouling
16. Proximity to cross-section measuring location
17. Event related (for example, flooding event)

Once a specific location in the stream is determined it will be important to take a cross sectional profile of the site to select the most representative position in the cross section of the stream.

Cross Sectional Placement of Water Quality Data Sondes

When placing a monitor at a stream location, a cross section of the stream should be taken to determine the most representative location. Selection of the proper location can be accomplished by using a discharge weighted (even discharge increment or EDI) or area weighted method (even width increment or EWI). The EWI method should typically be used to determine the arithmetic mean values in the cross section. However, for sites with significant “dead zones” or zones of limited conveyance, the EDI method should be used. When incorporating the EWI method a minimum of 10 and maximum of 20 equal width measurements should be taken across the stream or river. The EDI method requires a minimum of 5 measurements across the stream or river.

Cross sectional depth may also need to be considered when determining a deployment location. For shallow water applications a mid-depth measurement is sufficient, however, in deeper waters it may be necessary to perform measurements at two (20% and 80% depth) or more vertical locations to determine if stratification is present. If stratification is observed then it will be necessary to place the sonde in vertical location which represents the vertical mean of the water column.

Small streams with relatively low flows are often subject to rapid changes in water quality parameters (e.g. DO, temperature). These changes may have some impact on the determination of cross sectional mean values. As the measurements are being conducted physicochemical conditions may be changing. To address this issue it may be necessary to deploy a “rate-of-change” instrument immediately up stream to the cross section area in order to monitor rapidly changing conditions. This will allow the technicians to correct for time-variable changes and determine the “true” cross section variation.

Once a mean cross sectional value is determined, the approximate location to place the monitor can be selected by comparing the mean value with the measurements taken across the stream channel. Place the monitor where the measurement location value closely approximates the cross-sectional mean value. This should minimize the need for cross sectional corrections. Keep in mind when placing a monitor at a location with observed stratification, the sonde will need to be placed at a representative vertical depth as well. Table 4 also provides a list of items to consider when selecting a monitoring site. Once a representative location has been determined the field sonde can be deployed.

Throughout the monitoring period it will be necessary to the perform cross section measurements at the monitoring site to determine if changes have occurred to the stream which may affect the representativeness of the monitor’s location. After the initial deployment a cross section should be taken midway through and near the end of the monitoring period. To represent varying flow conditions these measurements should target flows different from those observed at the time of deployment. This information indicates if the monitoring location is representative during flows other than those initially observed at the site.

7.3.11 Initial Sonde Deployment Procedures for Unattended Sampling

Field personnel should have the proper equipment for maintenance when deploying the sonde

1. Upon reaching the approximate location of deployment, field personnel should prepare a datasheet to record all data to be collected during the deployment (datasheet appearance may be dependant on the data requirement of the project).
2. Calibrate the QA sonde DO probe at this time (once per day).
3. Using the 650 and 8-foot field cable, connect to the QA sonde and follow the procedure from Section 7.3.1.
4. Once calibrated, escape out of the sonde menu to the 650 menu and disconnect the sonde.
5. Leave the moist towel wrapped around the QA sonde and place in a shaded area.
6. Connect the field cable to the field sonde and 650 and then enter the sonde menu. In the “Run” menu set the sonde to log in unattended sampling and create a new file (the site name – e.g. M1060106) which should be recorded on the datasheet. Be sure the sampling interval is set to 15 minutes (this interval may be more or less frequent depending on the project). All other parameters for the field sonde should have already been checked or setup prior to going into the field.
7. Calibrate the field sonde DO probe and record all pertinent data on the datasheet. **No other sensors should be calibrated in the field.**
8. After field sonde calibration has been completed, the sonde should be run in discrete sampling mode and placed in the deployment pipe for collection of data.
9. After the temperature has stabilized, allow the sonde to take readings for another 60 seconds.
10. Once this period has elapsed, record the readings in the “Field Sonde Post Calibration Reading” cells provided on the datasheet.
11. Remove the field sonde from the pipe and wrap the moist towel around it again and place it in the shade.
12. Attach the QA sonde to the field cable and place it into the pipe. Record the readings to the datasheet in the cells for “2^{nd} QA Sonde Readings”.
13. Compare the dissolved oxygen readings of the field and QA sondes. They should be within the factory specifications (field sonde and QA sonde readings should be within +/- 4%** of the reading or 0.4 mg/L** whichever is greater). If they correspond to the specifications then the field sonde is considered to be working properly. If they are not within specifications see Section 8.0 for troubleshooting sonde issues.
14. Prior to deploying field sonde, record the DO gain (under the Advanced/Cal constants menu) on the datasheet. In addition to the gain, check and record the sonde “Status” (accessed from the main sonde menu), the days of battery life, voltage, and if the sonde is actively logging.
15. Escape out of the sonde menu to the menu of the 650 (this should be recorded under “Was Run Mode Exited before Sonde was Disconnected?”).
16. Disconnect the field sonde from the cable and replace the pressure cap. Place the sonde back into the pipe and tighten the plug to deter tampering with the equipment.

7.3.12 Routine Maintenance Procedures for a Deployed Sonde (see section 7.3.13 for additional information if the deployed sonde has a YSI ROX sensor installed)

Upon arrival to the continuous water quality monitoring station, the field crew should prepare a datasheet to record readings and observations taken while servicing the station. Information to be recorded upon arrival should include: Sampling site, Date, time of arrival, weather conditions, air temperature, water depth (if applicable), crew members present, date of last site visit and the barometric pressure (read from 650). One crew member should record data while the other calibrates the QA sonde according to the procedure described in Section 7.3.1. It is important to calibrate the QA sonde **each day** of use because it will be used as the reference point for all maintenance given to the field sonde(s). The site should be inspected for any damage to the housing or equipment. Note if there is an excessive amount of debris in or on the deployment pipe.

The datasheet is setup as a step-by-step guide to collecting the information that will be needed when the data is analyzed. The following instructions are tailored for a two member crew. One crew member would collect readings and operate the sondes while the other would perform cleaning, maintenance and also record data to the datasheet.

NOTE: If the monitoring station is located in a pool with minimal flows collect readings from the edge of the pool with the QA sonde prior to entering the pool to service the field sonde.

Initial Field Sonde Reading

1. Remove the field sonde from the pipe, remove the pressure cap and attach the sonde to the field cable
2. Connect the field cable to the 650 MDS and place the sonde into the pipe.
3. Once in the water, enter the "Sonde menu" then "Run" then "Discrete Sampling." The interval should be set at 0.5 seconds.
4. Watch the temperature until it is stable; 60 seconds later collect the readings from the display that are required to complete the "Field Sonde Reading at Time of Arrival" record.
5. Once the readings have been collected, escape back to the 650 menu, remove the sonde from the pipe, and disconnect it from the cable.

QA Sonde Reading

After the first field sonde readings have been taken, attach the QA sonde to the cable and place it in the pipe. Enter the discrete sampling menu of the QA sonde and select start sampling (the interval should be 0.4 seconds). Collect the readings in the same manner as the field sonde readings. Record the readings in the "1st QA Sonde Readings" record. While one crew member is working with the QA sonde to collect the readings the other should be inspecting and cleaning the field sonde.

Inspecting and Cleaning the Field Sonde

The crew member responsible for inspecting and cleaning the sonde should first record what the sonde looks like. The following is a list of examples of what to look for during the inspection and cleaning of the sonde and probes:

- visible damage to the sonde
- condition of the DO membrane (clean, intact, air bubbles, wrinkles, oily film present, electrodes have black coloration)
- biological growth (biofouling) on any parts of the sonde
- condition of other probes

Once these observations have been noted the crew member should clean the sonde with a moist towel to remove biofouling. The DO probe membrane can be lightly brushed with a CLEAN wet towel, or a soft bristle paint brush to remove any film that may be present. Next, clean the conductivity openings using the cleaning brush provided in the 6570 maintenance kit by brushing each opening 15 to 20 times.

NOTE: If the sonde is fitted with a rhodamine probe, inspect the wiper pad for damage. If the wiper pad is deteriorated or has imbedded particles then it must be replaced (see Section 5.3.6 for wiper pad replacement). The wiper pad can be replaced without the need to the wiper assembly.

Field Sonde Reading After Cleaning
Once the field sonde has been inspected and cleaned and the initial QA sonde readings have been recorded, it will be necessary to take more readings with the field sonde.

1. Disconnect the QA sonde from the field cable, wrap a moist towel around the sonde guard and place it in a shaded area.
2. Connect the field sonde to the field cable and lower into the deployment pipe to obtain another set of readings. These readings will tell the data analyst if biofouling has attributed to any of the drift that may have occurred.
3. Follow the steps in the previous paragraphs to collect the data and record the readings in the “Field Sonde Reading After Cleaning” record on the data sheet.
4. Remove the sonde from the pipe. If any defects were observed with the membrane or the probe electrodes were tarnished, then these problems should be addressed.
5. If the membrane requires changing due to air bubbles or wrinkles, see Section 5.3.4.
6. If the electrodes have black deposits on them follow the procedures in Section 5.3.5 to recondition the probe.
7. After addressing any problems with the DO probe membrane or electrodes the sonde should be recalibrated (Section 5.3.1). Make sure there are no water droplets present on the DO membrane. Then wrap a moist towel around the sonde guard (the towel must cover all openings). This will cause the air inside the towel to become saturated with water vapor which is important when calibrating the DO probe.
8. Place the sonde in a shaded area to allow temperature to stabilize; this may take 10 minutes.

Downloading the Data
While the air around the probes of the field sonde is equilibrating crew members should download the data collected during the last deployment. These data are downloaded from the sonde to the 650 handheld unit. To download the latest data:
1. Connect to the sonde’s main menu and enter the “File” option.
2. Select “Upload” (Not Quick Upload) which will give you the option of entering the start and stop dates.
3. Enter the start date (which is generally the last date the site was visited) and the start time (generally 0:00 hours to include all of the day).
4. “Proceed” Once the start date and time have been entered.
5. The next screen will give you the option of selecting the file format. Always upload files as “PC6000” files. This will give the data analyst the most capabilities once the file is placed in a computer.

Viewing the Data
After the file has been uploaded to the 650 it is important to view the file, particularly the last three logged readings collected prior to the time the sonde was removed from the water for maintenance.
1. In the “File” menu of the sonde select “View File” then “Proceed”.

2. Scroll to the end of the file by pressing and holding the down arrow. The 650 will beep once the end of the file is reached.
3. Determine which readings were taken prior to the sonde's removal from the water by looking at the time, temperature and conductivity readings. The last unattended logged reading will have the following characteristics:
   • the reading was recorded prior to removal of the sonde (based on time),
   • a similar temperature to the previous readings,
   • a similar conductivity value to the previous readings (which should NOT be near zero).
4. Record all parameters for the last three logged readings on the datasheet in the appropriate locations.

DO Probe Calibration

The sonde's dissolved oxygen probe will be recalibrated next.

1. Return to the sonde menu after recording the last recorded data.
2. Enter the "Run" menu and select "Discrete Sampling" then "Start Sampling".
3. **Watch the DO % Sat readings closely. They should start at a number larger than 100% and drop to near 100% in about a minute**. If they do not do this and they start out low and then go high, there is a potential problem with the DO probe (see Section 6.0 to troubleshoot this problem).
4. While watching the readings, also observe DO charge. This number should be between 25 and 75. If DO charge is not within this range there may be problems with the membrane, electrolyte, electrodes or the probe may be bad (see Section 6.0 to troubleshoot this problem).
5. Run the sonde in this mode for about 5 to 10 minutes to make sure readings are stable. Once stable press escape back to the main sonde menu.
6. **Wait at least 5 more minutes before continuing to the calibration procedure.** Calibration procedures are described in Section 5.3.1.
7. Once calibration is complete and the "Field Sonde Calibration Reading" data has been recorded on the datasheet, readings will be taken in the sample water.

DO Measurement

1. Place the field sonde into the pipe.
2. Run the sonde in discrete sampling mode and wait until temperature has stabilized. After a minute, collect the readings and record them to the datasheet ("Field Sonde Post Calibration Reading").
3. Exit to the main sonde menu and select "Status".
4. Record the days of battery life, voltage and if the sonde is actively logging.
5. **Exit all sonde menus back to the 650 main menu before disconnecting the field cable**.
6. Pull the field sonde out of the pipe, disconnect it from the field cable, wrap the towel back around the probe and place the pressure cap back on to it.
7. Attach the field cable to the QA sonde and lower it into the pipe.
8. Collect the readings for the "2nd QA Sonde Readings" record using discrete sampling mode. The field sonde and the QA sonde reading should be within 0.4 mg/L of one another. If they are not there may be some problem with one of the sondes that will need to be addressed before leaving the station. See section 8.0 for troubleshooting.
9. Remove the QA sonde from the pipe and lower the field sonde back into place.
10. Record the departure time when sonde maintenance is complete.

7.3.13 Routine Maintenance Procedures for a Sonde Deploy with a ROX sensor

Upon arrival to the continuous water quality monitoring station, the field crew should prepare a datasheet to record readings and observations taken while servicing the station following the same initial steps as in Section 7.3.12. The procedures and menus are similar with some exceptions. The ROX sensor will not require calibration at each station visit therefore reducing maintenance time.

NOTE: If the monitoring station is located in a pool with minimal flows collect readings from the edge of the pool with the QA sonde prior to entering the pool to service the field sonde.

Initial Field Sonde Reading

1. Remove the field sonde from the pipe, remove the pressure cap and attach the sonde to the field cable
2. Connect the field cable to the 650 MDS and place the sonde into the pipe.
3. Once in the water, enter the "Sonde menu" then "Run" then "Discrete Sampling." The interval should be set at 0.5 seconds.
4. Watch the temperature until it is stable; 60 seconds later collect the readings from the display that are required to complete the "Field Sonde Reading at Time of Arrival" record.
5. Once the readings have been collected, escape back to the 650 menu, remove the sonde from the pipe, and disconnect it from the cable.

QA Sonde Reading

After the first field sonde readings have been taken, attach the QA sonde to the cable and place it in the pipe. Enter the discrete sampling menu of the QA sonde and select start sampling (the interval should be 0.4 seconds). Collect the readings in the same manner as the field sonde readings. Record the readings in the "1st QA Sonde Readings" record. While one crew member is working with the QA sonde to collect the readings the other should be inspecting and cleaning the field sonde.

Inspecting the Field Sonde

The crew member responsible for inspecting and cleaning the sonde should first record what the sonde looks like. The following is a list of examples of what to look for during the inspection and cleaning of the sonde and probes:

- visible damage to the sonde
- condition of the DO membrane (clean, intact, air bubbles, wrinkles, oily film present, electrodes have black coloration)
- biological growth (biofouling) on any parts of the sonde
- condition of other probes

Once these observations have been noted the crew member should clean the sonde with a moist towel to remove biofouling. The ROX probe has a wiper assembly which keeps fouling and debris off the sensor membrane. **ONLY IF ABSOLUTELY NECESSARY** the ROX membrane can be lightly wiped with a **CLEAN WET LENS TISSUE**, to remove any film or particles that may be present. Next, clean the conductivity openings using the cleaning brush provided in the 6570 maintenance kit by brushing each opening 15 to 20 times.

Inspect the wiper pad for damage. If the wiper pad is deteriorated or has imbedded particles then it must be replaced (see Section 7.3.9 for wiper pad replacement). The wiper pad can be replaced without the need to replace the wiper assembly.

Downloading the Data

Crew members should download the data collected during the last deployment. These data are downloaded from the sonde to the 650 handheld unit. To download the latest data:

1. Connect to the sonde's main menu and enter the "File" option.
2. Select "Upload" (Not Quick Upload) which will give you the option of entering the start and stop dates.
3. Enter the start date (which is generally the last date the site was visited) and the start time (generally 0:00 hours to include all of the day).
4. "Proceed" Once the start date and time have been entered.
5. The next screen will give you the option of selecting the file format. Always upload files as "PC6000" files. This will give the data analyst the most capabilities once the file is placed in a computer.

Viewing the Data

After the file has been uploaded to the 650 it is important to view the file, particularly the last three logged readings collected prior to the time the sonde was removed from the water for maintenance.

1. In the "File" menu of the sonde select "View File" then "Proceed".
2. Scroll to the end of the file by pressing and holding the down arrow. The 650 will beep once the end of the file is reached.
3. Determine which readings were taken prior to the sonde's removal from the water by looking at the time, temperature and conductivity readings. The last unattended logged reading will have the following characteristics:
   • the reading was recorded prior to removal of the sonde (based on time),
   • a similar temperature to the previous readings,
   • a similar conductivity value to the previous readings (which should NOT be near zero).
4. Record all parameters for the last three logged readings on the datasheet in the appropriate locations.

DO Measurements

After the sonde and probes have been checked and the proper files downloaded the crew will need to take a final field sonde and QA reading to make sure the field sonde is working properly. Ideally the two sondes would be placed side-by-side for the readings. However resources may limit the ability to conduct readings this way.

1. Connect the field sonde to the field cable and lower into the deployment pipe to obtain the readings.
2. Run the sonde in discrete sampling mode and wait until temperature has stabilized. After a minute, collect the readings and record them to the datasheet ("Field Sonde Post Calibration Reading").
3. Exit to the main sonde menu and select "Status".
4. Record the days of battery life, voltage and if the sonde is actively logging.
5. **Exit all sonde menus back to the 650 main menu before disconnecting the field cable**.
6. Pull the field sonde out of the pipe, disconnect it from the field cable, wrap the towel back around the probe and place the pressure cap back on to it.
7. Attach the field cable to the QA sonde and lower it into the pipe.
8. Collect the readings for the "2nd QA Sonde Readings" record using discrete sampling mode.

9. Remove the QA sonde from the pipe and lower the field sonde back into place if the readings are within 0.3 mg/L of one another. If they are not troubleshooting will be required (Section 8.0).
10. Record the departure time when sonde maintenance is complete.

If the ROX sensor membrane must be replaced (Section 7.3.8) then the cal constants will need to be entered and the sonde recalibrated. Calibration of the ROX probe is accomplished in the same manner as with Rapid Pulse probe Section 7.3.1.

NOTE: The ROX sensor must be kept in a moist environment. If it is allowed to dry out there will be a period of hydration after redeployment during which the readings may not be accurate. Drying out will not however damage the sensor. See Appendix M in the YSI 6-series Operations Manual.

8.0 TROUBLESHOOTING GUIDE

Rapid Pulse DO Probe

1. **Symptom:** DO readings are too high or low compared to the reference sonde, DO charge is between 25 and 75, electrodes have no black tarnish.
   Possible Causes: The calibration was bad or the membrane is bad.
   Solution: Recalibrate the sonde. If symptom still arises, change the membrane and then recalibrate again.

2. **Symptom:** DO % saturation starts low and begins to rise.
   Possible Cause: Probe is contaminated by Hydrogen Sulfide*** (H2S) (common at intake sites) or the probe is going bad.
   Solution: Recondition probe and recalibrate. If the symptom continues, replace DO probe (replacement of DO probe should **NOT** occur in the field).

3. **Symptom:** DO Charge is lower than 25 and electrodes have no black tarnish.
   Possible Cause: The electrolyte is contaminated.
   Solution: Replace electrolyte and membrane and recalibrate.

4. **Symptom:** DO Charge is higher than 75
   Possible Causes: Electrodes are tarnished or Sonde left on continuously.
   Solution: Recondition the probe and recalibrate.

5. **Symptom:** DO % saturation remains extremely high (e.g. 200%).
   Possible Cause: DO probe is bad.
   Solution: Replace DO probe.

6. **Symptom:** DO readings responding very slowly.
   Possible Cause: Hydrogen sulfide*** contamination, membrane bad or electrodes tarnished.
   Solution: Recondition probe and recalibrate.

   If the DO probe does not respond to theses solutions the sonde may be malfunctioning. To determine if the sonde is working properly, remove it from the field and take it back to the lab/office. Thoroughly dry the sonde, paying special attention to the area where the DO probe attaches to the sonde. Connect the sonde to the 650 and run it in the discrete sampling mode. While running, take the probe wrench provided in the YSI 6570 maintenance kit and remove the DO probe. Once removed, the DO charge readings should be between 1.2 and -0.8. If they are not, then there is likely a problem with the sonde itself and it will need to be returned to YSI for further evaluation.

***Hydrogen Sulfide (H2S) has adverse effects on rapid pulse dissolved oxygen sensors. H2S is a gas created as organic material is decomposed and oxygen is depleted in the bottom layer of deep lakes. H2S permeates through the DO probe membrane. It then replaces oxygen under the membrane and reacts with the KCI solution to give erratic readings. During mid to late summer when H2S is present in lakes, the sondes will have problems measuring DO accurately.

ROX DO sensor

1. **Symptom:** Software errors when attempting to calibrate the ROX probe.
   Possible Cause: Moisture under the membrane assembly.
   Solution: Remove the membrane assembly from the probe face as shown in Section 7.3.8 and make certain that there is no moisture present under the membrane assembly. If moisture is present, gently remove it with lens cleaning tissue and, if possible, by a compressed air stream. Make certain that the O-ring which seals the membrane assembly to the probe face is in the groove and undamaged. Then replace the membrane assembly and check the probe performance

2. **Symptom:** data (either in Discrete Sample or Unattended Sample studies becomes more erratic than usual.
   Possible Cause: Moisture under the membrane assembly.
   Solution: Remove the membrane assembly from the probe face as shown in Section 7.3.8 and make certain that there is no moisture present under the membrane assembly. If moisture is present, gently remove it with lens cleaning tissue and, if possible, by a compressed air stream. Make certain that the O-ring which seals the membrane assembly to the probe face is in the groove and undamaged. Then replace the membrane assembly and check the probe performance

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If these solutions do not fix the problem, replace the membrane of the sensor (Section 7.3.8). If after replacement of the membrane the probe is still malfunctioning, contact YSI technical support.

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9.0 REFERENCES

YSI 6 6-Series Environmental Monitoring Systems

Wagner, R. J. et al. U.S. Geologic Survey. 2000. TWRI 00-4252: Guidelines and Standard Procedures for Continuous Water Quality Monitors: Site-Selection, Field Operation, Calibration, Record Computation, and Reporting. Reston, Virginia

Attachment 1

EXAMPLE - Sonde Calibration File - Would be placed in Log Book for this Instrument

Date	Time	Instrument Serial Number	Calibration Constant Type	Value
3/28/2006	5:58:49	00010A62	Conductivity gain	1
3/28/2006	5:58:49	00010A62	DO gain	0.971084
3/28/2006	5:58:49	00010A62	DO local gain	1.015228
3/28/2006	5:58:49	00010A62	Pressure offset PSI	-14.3483
3/28/2006	5:58:49	00010A62	TDS constant	0.65
3/28/2006	5:58:49	00010A62	Pressure offset PSI	-14.4045
3/28/2006	5:59:23	00010A62	Rhod Offset	-5.37134
3/28/2006	5:59:23	00010A62	Rhod A1	100
3/28/2006	5:59:23	00010A62	Rhod M1	97.19185
3/28/2006	5:59:23	00010A62	Rhod A2	200
3/28/2006	5:59:23	00010A62	Rhod M2	194.3837

Attachment 2

MEC Water Resources
Water Quality Monitoring Data Sheet

Project Name/Number: ________________________
Sampling Site: _________________________
Date: ________________

General Information			
Arrival Time:	**Departure Time:**	**Barometric Pressure (mmHg):**	**Date of Last Site Visit:**
Weather:		**Field Crew Members (name):**	
Temp (approx.):	**Water Depth (ft):**		

Site Information

Sonde Readings	Time	Sonde Depth (m)	Spec. Cond. (uS/cm)	Water Temp. (°C)	DO (mg/L)	DO %	DO Charge (25 to 75)	Volts
Field Sonde Reading at Time of								
1st QA Sonde Readings								
Field Sonde Reading After								
Field Sonde Last Three Logged Readings Date:								
Field Sonde Calibration		_ _ _ _ _			Initial DO %	Cal DO %		
Field Sonde Post Calibration								
2nd QA Sonde Readings								

Batteries Replaced: Y N	Days of Battery Life Left:	Voltage:
DO gain (Range 0.75 to 1.25):	Sonde Logging Active: Y N	
Sonde & probe condition:		
Was Run Mode Exited before Sonde was Disconnected?: Y N		Field Crew Initials:
Gage Height	Flow:	Mean Veloctiy:
Comments:		

Appendix C

Example Chain of Custody Form

MEC Water Resources
1000 N. College Ave., Suite 4
Columbia, MO 65201
Phone: (573)443-4100 Fax: (573)443-4140

FIELD SHEET AND CHAIN OF CUSTODY RECORDS

Project Name / No.	Number of Samples:
Collector's Name and Affiliation (Please Print)	Number of Containers:

Sample Number	Sample Description	Collected		Analysis Requested													Comments
		Date	Time	$CBOD_5$	TP	TN	TSS	VSS	NO_2+NO_3	NH_3	TDN	TDP	Chl-a	Other	Comp	Grab	

CHAIN OF CUSTODY RECORD				IF SHIPPED	DELIVERED		PICKED UP	
Relinquished By:		**Received By:**	**Date/Time**		Date	Time	Date	Time
☐ Sealed	☐ Shipped	☐ Sealed		Carrier				
☐ Sealed	☐ Shipped	☐ Sealed		Carrier				
☐ Sealed	☐ Shipped	☐ Sealed		Carrier				
☐ Sealed	☐ Shipped	☐ Sealed		Carrier				

Appendix D

Job Hazard Analysis Sheet

MEC Water Resources The Science of Water Quality	**JOB HAZARD ANALYSIS (instructions on last page)**	1. **Primary Job/Project:** Stream/River Work	2. **Date Prepared:** 6/16/2006

3. TASKS/PROCEDURES	4. HAZARDS	5. ABATEMENT ACTIONS
Climbing up and down stream bank	Slip, Trip, or Fall	Scout out safest place to climb up and down stream bank. Avoid relatively steep banks and banks with poor footing, when possible. Do not overload. Use a properly sized backpack to avoid overloading. If necessary, make multiple trips up and down bank rather than overload. Maintain at least one free hand when climbing a bank.
Wading in stream	Drowning	Wear a personal flotation device (PFD). Rule of thumb: Don't wade a stream if stream depth x velocity > 10 ft^2/s.
	Pathogen Ingestion	Do not drink stream water. Wash hands with antibacterial soap prior to eating after being in stream.
	Slip, Trip, or Fall	Maintain at least one free hand while wading. Wear hip boots or chest waders.
Non-task specific/general hazards	Tornado	Seek shelter immediately if there is a sudden, violent change in weather involving wind, rain, hail, or funnel-shaped clouds. Avoid occupying vehicles or mobile homes. If you are caught outside, find a ravine, ditch, of culvert and lie flat.
	Thunderstorms	Seek shelter inside a vehicle or building if available. If outside, do not congregate. If caught in the open, crouch down low, but do not lie flat on the ground.
	Temp and Sun Exposure	Drink water in moderate amounts on a scheduled basis – do not wait until you are thirsty. Avoid alcohol, caffeine, and soda. Wear lightweight clothing and a wide-brimmed hat. Wear sunscreen on all exposed skin to avoid burning and skin cancer. Wear sunglasses with polarized lenses to protect eyes, reduce glare, and improve vision, especially when working on water. Be knowledgeable of the symptoms of heat exposure related illnesses.
	Stinging/Biting Insects	Knowledge and avoidance of such insects. Knowledge of allergies to bites and stings. Do not wear perfume or cologne. Be observant of where you walk. Observe overhangs and limbs before entering beneath them.
	Animal Bites	Do not approach wildlife.
	Prolonged Standing/Walking	Be in good physical condition. Take breaks as required.
	Cold Exposure	Wear proper clothing. Be aware of exposure duration and limit duration if necessary. Be knowledgeable of the symptoms of cold exposure related illnesses. Do not wade in water deeper than hip boots or chest waders.