

**Lockwood Folly River  
Water Quality Restoration TMDL Development  
Project No. EW08013**

**QUALITY ASSURANCE PROJECT PLAN**

**North Carolina Coastal Federation, Brunswick County  
NC Department of Transportation,  
NC Ecosystem Enhancement Program  
NC Division of Water Quality, NC Shellfish Sanitation Division  
Stantec Consulting**

**July 2007**

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## **DISTRIBUTION LIST (A3)**

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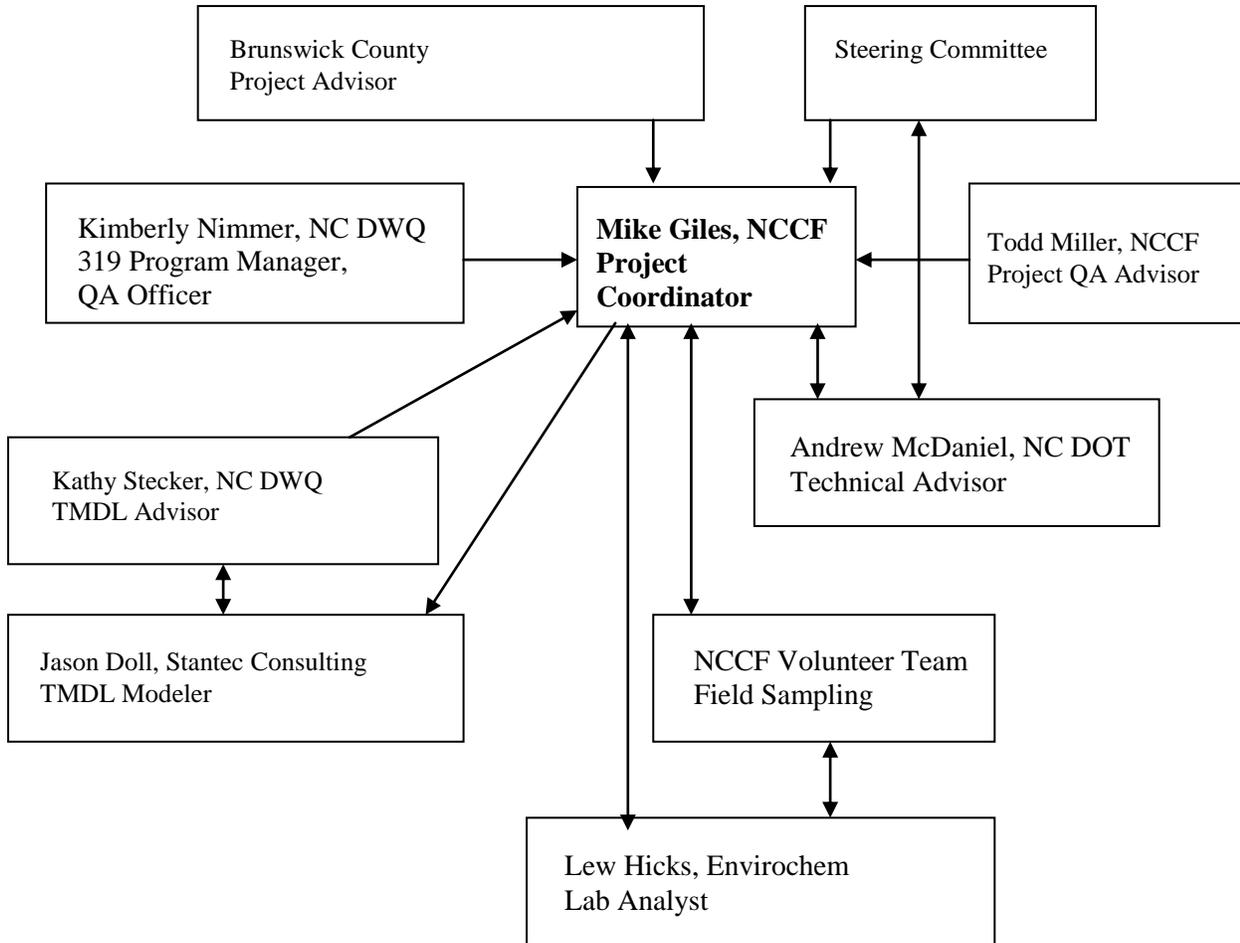
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*\*This QAPP will also be distributed to the members of the Lockwood Folly steering committee and all project volunteers once determined.*

## **PROJECT / TASK ORGANIZATION (A4)**

The listed project advisors and the appointed steering committee will guide the project. The steering committee, a group of twelve local citizens, have yet to be identified, but will be included in subsequent revisions of this document. The over 20 member NCCF Volunteer Team slated to collect water samples is currently being recruited and identified. Again, this group will be included in subsequent revisions.

**Figure 1: Project Organization**



**Table 1: Project Team Members and Responsibilities**

NAME	PROJECT TITLE	RESPONSIBILITY
<b>Mike Giles</b> 910-790-3275	Project Coordinator	Coordinate collection of samples by volunteers
<b>Steve Stone</b> 910-253-2000	Project Advisor	Plan project, stakeholder, and public meetings
<b>Andrew McDaniel</b> 919-250-4100	Technical Advisor	Provide assistance on source assessment, stormwater conveyance mapping and implementation plans
<b>Kathy Stecker</b>	TMDL Advisor	Review TMDLs prior to submittal to EPA for



## **PROBLEM DEFINITION AND BACKGROUND (A5)**

The entire Lockwood Folly River is listed as impaired waters by the NC Division of Water Quality. Water Quality problems have persisted for decades. As far back as 1989, the NC Environmental Management Commission designated the lower portion of the river as being “impacted by pollution,” and imposed new shoreline development standards through the adoption of a water quality management plan (General Statute 143-214.1; 143-215.8A, regulation T15A: 02B.0200). In recent years, new efforts to address continued declines in water quality initiated by the North Carolina Coastal Federation, Brunswick County, NC Department of Transportation, NC Shellfish Sanitation, NC Ecosystem Enhancement Program and Stantec Consulting (project partners) have been aimed at developing a workable and practical watershed management strategy to protect and restore water quality in the river. This 319 project builds upon work currently underway, and allows for refinement of these preliminary strategies to help assure that management actions will be effective and have the capacity to achieve compliance with federal Clean Water Act TMDL requirements for impaired water bodies.

The TMDL-based management strategy that results from this project is likely to serve as a model approach for addressing impairment in other shellfish waters in NC, and should provide valuable science-based guidance on how to address these widespread impairments without the expenditure of extremely limited time and financial resources developing detailed receiving water quality models for every water body. Specifically, this project aims at:

- Documenting sources and transport mechanisms that deliver elevated levels of fecal coliform to the impaired waters (this information, collected by field surveys, land use/land cover data, and other relevant information will supplement monitoring data in identifying sources);
- Using predictive modeling of watershed-scale pollutants develop to a workable TMDL for the river that supports and helps calibrate watershed management actions
- Through simulation of various “what if” scenarios, enable a watershed management strategy to cost-effectively target known and potential pollution sources and pathways
- Devising a Watershed Implementation Plan that adheres to EPA’s 9 Key Elements for watershed management for the Lockwood Folly River
- Engage local decision makers and the public as partners in carrying out management actions by keeping them informed through on-going press releases and other education efforts on project findings
- Provide necessary data to help quantify how much emphasis must be placed on various elements of management strategies such as public education, storm water discharge retrofits, post-development guidelines, land acquisition for preservation and restoration projects; and financial incentives for improved land use practices
- Promotion of partnerships for implementing various elements of the watershed management strategy both through the direct participation of project partners as well as new partners such as the Clean Water Management Trust Fund.

The Watershed Implementation Plan will prescribe measures to reduce fecal coliform loading and will help local governments prioritize the order in which these measures should be implemented and will be a sound basis to seek funding for their implementation

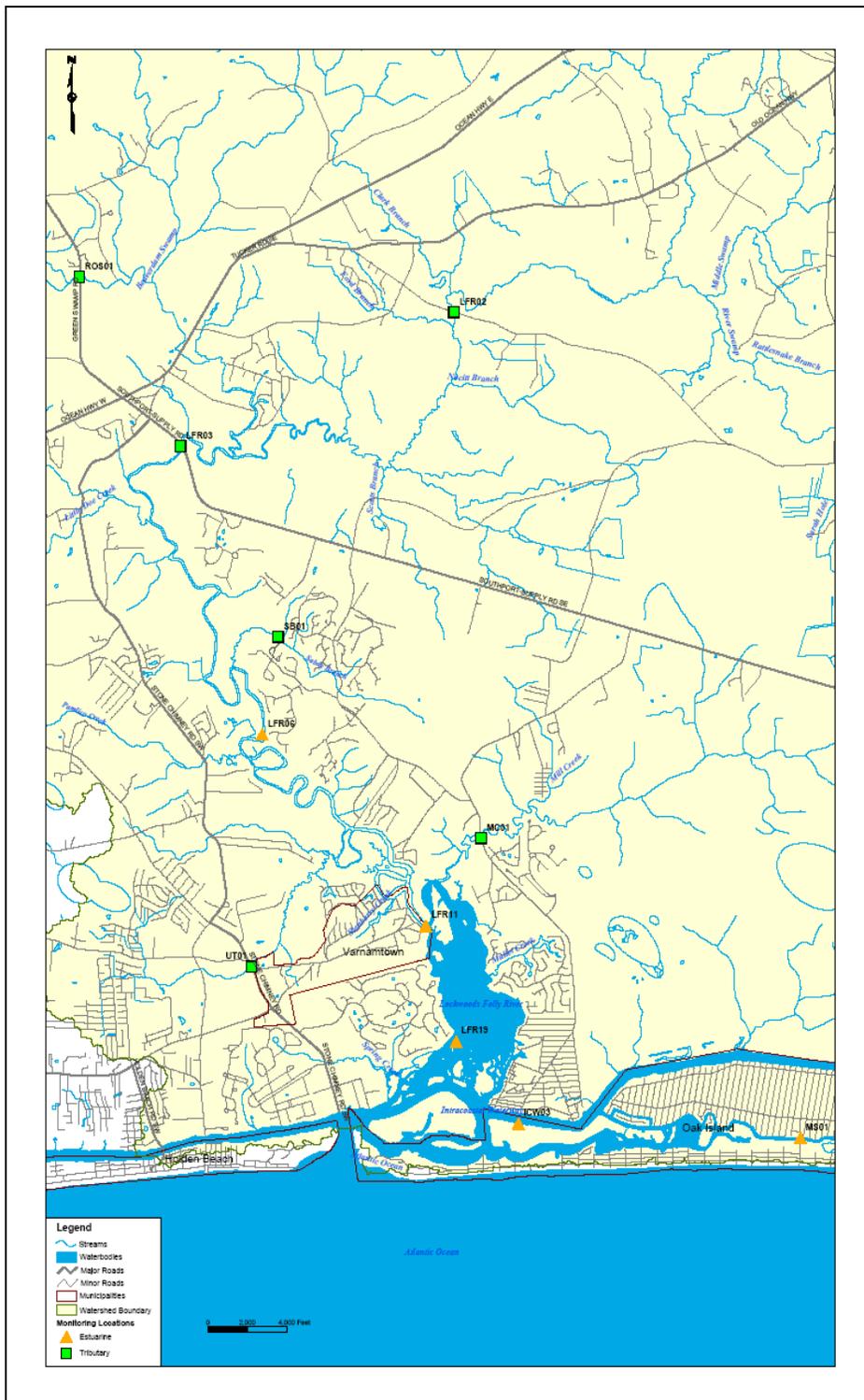
## **PROJECT / TASK DESCRIPTION (A6)**

The Lockwood Folly River is listed as “High Priority” waters in North Carolina’s draft 2004 303-d list. To meet the project goals, NCCF and Stantec Consulting of Raleigh will assess the targeted waterbodies for fecal coliform loading. Stantec will complete the TMDL modeling and the development of the Watershed Implementation Plan and NCCF will hold stakeholder meetings, and produce a tabloid insert for the local newspaper.

***Figure 2: Project Monitoring Locations***

<b>Station</b>	<b>Location</b>	<b>Latitude (DecDeg)</b>	<b>Longitude (DecDeg)</b>	<b>Est/Trib</b>
LFR02	Lockwoods Folly R at SR 1501 near Supply/ Shellfish special study station LF10	34.0284	-78.2177	T
LFR03	Lockwoods Folly R at NC 211 at Supply/ Shellfish special study station LF8	34.0108	-78.2636	T
LFR06	Lockwoods Folly R near Sandy Hill	33.9722	-78.2503	E
LFR11	Lockwoods Folly R at Varnamtown/ Shellfish special study station LF1	33.9465	-78.2232	E
LFR19	Lockwoods Folly R at CM R6 NW Sunset Harbor (west channel)	33.931	-78.2183	E
ROS01	Royal Oak Swamp at SR 1501	34.0335	-78.2805	T
MC01	Shellfish special study station LF9	33.9582	-78.2139	T
ICW03	ICW at Sunset Harbor	33.92	-78.208	E
MS01	Montgomery Slough at SR 1105 (S Middleton Ave)	33.9178	-78.1609	E
UT01	UT to Lockwoods Folly River at SR1119	33.9412	-78.2522	T
SB01	Sandy Branch off SR 1251 beding Winding River	33.9801	-78.2402	T

**Figure 2. Monitoring Site Locations**



**Table 2: Project Target Waterbodies**

River Basin	Lumber River Basin
Watershed(s)	Lockwood Folly watershed
Watershed size	~88,000 acres
303(d) listed Stream	Yes <b>X</b> No
If yes for 303(d) listed stream, the priority of TMDL development is:	HIGH
HUC(s) (14 digit USGS Hydrologic Unit Codes)	03040207020010, 03040207020020, 03040207020030, 03040207020040, 03040207020050
County	Brunswick
USGS. 7.5 minute topographic quadrangle map(s) in project area	See attachment
Position coordinates of project location	Latitude 33°56'9.60" N Longitude 78°12'51.81" W

**Watershed Restoration Plan**

The objectives of this proposal are to use tools to analyze fecal coliform contamination in the Lockwood Folly River so as to develop an effective TMDL and water quality management plan that will restore impaired water quality. Primary project components include: watershed characterization and source assessment, TMDL monitoring, development of modeling tools, a TMDL water quality management plan, and extensive stakeholder involvement.

**Table 2a. Impaired Waters in the Lockwood Folly River Watershed**

Name	Assessment Unit Number	Stream Classification	Reason for Listing	Acres
Portions of Lockwoods Folly River	15-25-1-(16)	SA HQW	Shellfish harvesting closure: fecal coliform	606.2
Mullet Creek	15-25-1-19			5.7
Spring Creek	15-25-1-21			2.4
Mill Creek	15-25-1-18-(2)			2
Portions of the Intracoastal Waterway	15-25			~304
Montgomery Slough	15-25v			~101.2

## **EXISTING ACTIVITIES IN THE LOCKWOOD FOLLY RIVER WATERSHED**

The project builds upon the current watershed management activities now underway for the Lockwood Folly River. These include the N.C. Ecosystem Enhancement Program (NCEEP) Lockwood Folly Watershed Plan project, the watershed management strategy being developed by the county's Lockwood Folly River Roundtable, and a previously funded NCSU 319 project. All three of the on-going projects have been coordinating their work. The development of a TMDL based watershed management plan for the Lockwood Folly River is timely and would help to refine and implement these existing watershed management activities.

### **Lockwood Folly River Watershed Protection Demonstration Project**

With funding from the US EPA, Brunswick County commenced a watershed project in the Lockwood Folly River watershed beginning in early 2005. The county hired the North Carolina Coastal Federation as its contractor to help implement this project. The project has prepared a watershed-based strategy to maintain and restore water quality in the watershed. The strategy promoted land use practices that are compatible with water quality standards. The objective is to demonstrate the use of watershed-based permitting of individual developments through the Phase II NPDES storm water permit as a tool to protect and restore water quality threatened by storm water.

The project included the following components: land suitability analysis, an eight person watershed roundtable appointed by the county commissioners, evaluation of the effectiveness of existing water quality protection programs, pollution surveys and monitoring, fiscal impact analysis, outreach/education/training, land acquisition strategy, a model watershed-based permit, and demonstration of watershed-based management alternatives. The Roundtable consists of citizens and local decision-makers selected by the county to represent the various community and economic interests in the watershed. Their objective is to recommend a set of watershed strategies to the county commissioners aimed at improving and protecting water quality.

The project includes the following components: land suitability analysis, an eight person watershed roundtable appointed by the county commissioners, evaluation of the effectiveness of existing water quality protection programs, pollution surveys and monitoring, fiscal impact analysis, outreach/education/training, land acquisition strategy, a model watershed-based permit, and demonstration of watershed-based management alternatives. The Roundtable consists of citizens and local decision-makers selected by the county to represent the various community and economic interests in the watershed. Their objective is to recommend a set of watershed strategies to the county commissioners aimed at improving and protecting water quality.

Environmental Health has completed a shoreline survey of the project area and constructed a GIS database of the area during the summer of 2005. This survey included locating and inspecting storm water pipes and ditches and visible septic systems. There were no centralized sewer systems in the study area, however, package treatment plants were located and examined to determine if they contributed to fecal coliform loading. Watershed surveys were also completed to better estimate populations of humans, pets, livestock, and wildlife. These surveys will also be used to define watershed boundaries and record the location of storm water conveyance systems.

## **Watershed Monitoring Program**

Monthly wet weather and dry weather sampling for fecal coliform from downstream to upstream will aid in identifying “hot spots.” Field observations, land use/land cover data (assumed from previous studies), and other relevant information will also be used to supplement monitoring data and identify likely significant sources. Once “hot spots” are identified, additional sampling will be conducted to target sources of fecal coliform contamination as appropriate.

The monthly fecal coliform samples collected by NCCF volunteers will be analyzed by DWQ-approved Envirochem Laboratory in Wilmington, N.C. A stationery flow meter will record flow for a length of time at one site to support TMDL model calibration. This sampling contributes directly to the bacteria source assessment and will inform the TMDL modeling and the implementation strategies. The most up-to-date information will be used to support the TMDL assessment.

The NCCF will convene a group of stakeholders who will serve as project advisors. This group will include local landowners, citizens, public officials, and state agency representatives. This group will be organized in the second quarter of the project, and then will meet once for each of the project quarters (Table 3). These stakeholder meetings will also aim to resolve conflict, shape the modeling decision and assumptions, inform the TMDL allocation decision (i.e., where to seek reductions), and identify BMP sites for the Watershed Implementation Plan.

Stantec Consulting will use an EPA- and DWQ-approved watershed model Hydrological Simulation Program-Fortran or HSPF or a similar water shed model to develop a TMDL model for the project target water bodies. They will use the Tidal Prism Model or a similar modeling framework (EPA- and DWQ-approved) for response modeling of the receiving water. Stantec will also be responsible for preparing Watershed Implementation Plans (WIPs) for the TMDL waters. The WIPs will adhere to EPA’s 9 Key Elements for WIPs. In addition they will:

- Address two general pathogen categories: 1) at the source (e.g., failing septic systems); and 2) treat water after contamination (e.g. stormwater).
- Address dry and wet weather sources.
- Identify at least 6 BMP sites and prescribe specific treatments to reduce fecal coliform loading and possible land acquisition for future water quality protection.
- Include schedules for obtaining funding to implement BMPs and schedules to implement BMPs once funding has been secured.

To raise awareness of the project and actions needed to restore shellfish waters, an eight-page, color newspaper tabloid that describes the project and the monitoring results will be prepared and inserted in local newspapers for distribution to about 5,000 households during the seventh quarter of the project. The tabloid will be written and designed by NCCF’s experienced communications staff. A public workshop will be held after the publication of the tabloid. Additionally, Brunswick County officials will be briefed at the end of each year at planning board and County Commission meetings.

The following is an outline of the project timetable. The completion dates may be revised depending on volunteer scheduling and training, and coordination of activities between involved agencies.

**Table 3: Project Timetable**

<b>Project Milestone Schedule</b>	
Time Period/Date	Activities (List specific outputs or activities that will be achieved during each quarter)
First Quarter (Aug 07-Oct. 07)	Establish baseline water quality monitoring program. Perform field reconnaissance; assess current watershed planning activities and strategies. Form advisory working group to include project partners, local officials, citizens, and other stakeholders, including representatives of DWQ. Begin work on watershed loading and receiving waters models using EPA and DWQ-approved models. Develop QAPP for monitoring effort and submit for approval.
Second Quarter (Nov. 07-Jan 08)	Present project plan to county commission, planning board, local government meetings, minimum of three presentations. Meet with working group to review plan. Design watershed survey for bacteria source assessment. Begin to monitor water quality—eleven sites (6 tributary - by volunteers - and 5 estuary – by project coordinator) monthly from November 2007-July 2008, then weekly from August-October 2008. Monitor stream flow. Take media representatives on monitoring field trip. Develop feature stories for newspapers that circulate in county. Model development by Stantec will begin in the second quarter.
Third Quarter (Feb. 08-April 08)	Monitor water quality on same basis. Collect stream cross-section data. Collect supplementary information on estuarine bathymetry. Meet with working group and technical experts (cooperative extension, engineers added as needed for input). Monitor stream flow.
Fourth Quarter (May 08-July 08)	Continue to monitor water quality. Update county and local governments and working group on project progress at regular meetings—three presentations. News releases of annual progress and citizen steps. Monitor stream flow.
Fifth Quarter (Aug 08-Oct 08)	Continue to monitor water quality. Newsletter articles and press tours highlighting project.

Sixth Quarter (Nov 08-Jan 09)	Complete modeling and write TMDL reports and finalize management plan. Deliver TMDL modeling drafts to NCDWQ and other partners for comments. Hold public briefings with decision-makers to obtain input. Incorporate comments and complete TMDL reports. Present final TMDL reports and plan to Brunswick County planners and commission, local government councils, and working group. Coordinate information and implementation plans with ongoing watershed planning efforts.
Seventh Quarter (Feb 09-Apr 09)	Finish TMDL implementation plans. Identify and prioritize at least six sites for potential BMPs in the 303(d) listed areas and possible land for acquisition for future water quality protection. Prepare final report and public-oriented brochure about findings and steps to take for good stewardship. Release to media.
Eighth Quarter (May 09-July 09)	Finish all project commitments. Complete final report. Present TMDLs, watershed management plan implementation report and recommendations about how to act upon specific watershed strategies to county decision-makers and at state and national conferences that are focused on what to do about impaired shellfish waters.

## **QUALITY OBJECTIVES AND CRITERIA (A7)**

The data quality objectives here pertain to volunteer collection of water samples. Lab sample analysis by Envirochem Laboratory and TMDL development by Stantec Consulting will follow NCDWQ-approved QA/QC procedures.

### Precision

Agreement among the collected water samples will be determined through replicate samples. Four replicate samples (two completely separate sample bottles collected at the same site) will be taken from each site during the course of the year (one every three months for one year), both to be analyzed by Envirochem Laboratory. Additionally, four split samples will be taken from each site during the course of the year (one every three months for one year), all to be analyzed by Envirochem Laboratory. Variation among these duplicate samples must meet confidence limits used by Envirochem Laboratory. Note that a range of precision is not available for any bacterial parameters, including fecal coliform and enterococci. Precision for the stationary flow meter, salinity, and temperature will adhere to the specific instrument DQOs. Replicate measurements

will also be taken for each physical/chemical parameter. Precision for all parameters must meet the objectives set in Table 4. If a volunteer parameter measure fails to meet precision, an additional replicate measure should be taken. The value in error will be discarded and an average will be taken of the two more closely related values to meet precision objectives.

**Table 4: Data Quality Objectives for Volunteer Collected Fecal Coliform Samples and Physical/Chemical Parameters**

Parameter	FECAL COLIFORM	ENTEROCOCCUS	FLOW	TURBIDITY/ TRANSPARENCY	TSS	RAIN LEVEL	SALINITY	TEMPERATURE
Method	Grab sample	Grab sample	Timed transect	Secchi disk / transparency tube	Grab sample	Rain gauge	Hydrometer	Hydrometer
Range	No. of colony-forming units (CFU)	No. of colony-forming units (CFU)	Cubic feet per second	Feet / 0 - 60 cm	milligrams per liter	0 - 6 inches	1.000 - 1.060 specific gravity	0 - 40 °C or 30 - 105 °F
Detection Limit	1 CFU	1 CFU	Not available	0.1 foot / 1 cm	1-2 ppm	0.1 inches	0.001	1 °C
Precision	Not available	Not available	10%	0.2 foot / 2 cm ± 10 %	± 10%	0.2 inches ± 10%	0.002 ± 10%	1 °C ± 10%
Accuracy	Not available	Not available	Not available	0.1 foot / 1 cm	Not available	0.2 inches ± 10%	0.001	1 °C
Calibration Method	Standard reference materials	Standard reference materials	N/A	N/A	Standard reference materials	N/A	Standard instrument procedures	Standard instrument procedures

\*Fecal Coliform and Enterococcus:  
 container – sterilized plastic bottles  
 minimum sample size – 275 ml each  
 preservation – cooled to ≤ 4 deg. Celsius  
 maximum holding time – 6 hours

Accuracy

The fecal coliform samples cannot be compared to any standard or “true value.” Envirochem Laboratory DQOs could determine sample accuracy through positive control samples or negative control samples. Hydrometers and the stationary flow meter are to be calibrated and maintained according to standard operating procedures for the instrument. Accuracy of volunteers’ records of rainfall data will be checked against the local National Weather Service total storm rainfall maps. Volunteer measurements for flow will not have a comparable value by which to ensure accuracy. Accuracy ranges for transparency/turbidity and all other parameters are listed in Table 4. Accuracy ranges for the stationary flow meter are listed in Table 5. Accuracy ranges for the YSI Model 85 multi-parameter probe are listed in Table 6.

**Table 5: Data Quality Objectives for Discharge**

Parameter	DISCHARGE
Method	Stationary Flow meter
Instrument	Sigma 930 Long-Term Area Velocity Meter
Units	Cubic feet per second
Velocity Range	(-1.52 to 6.10 m/s)
Velocity Accuracy	± 2 % of readings
Depth Range	0.18' to 11.5'
Depth Accuracy	± .023'
Calibration Method	Standard instrument procedures

**Table 6: Data Quality Objectives for YSI Model 85**

Parameter	SALINITY	TEMPERATURE	DISSOLVED OXYGEN
Range	0 to 80 ppt	-5 to + 95 deg. C	0 to 200% , 0 to 20mg/l
Detection Limit	0.1 ppt	0.1 deg. C	0.1% , 0.01 mg/l
Accuracy	± 2% or ± 0.1 ppt	± 0.1 deg. C	± 2% , ± 0.3 mg/l

Representativeness

The extent to which measurements represent the true environmental conditions will be considered in project design and sampling site selection in the first quarter of this project. Stormwater outfalls and ditches to be assessed will be selected based on the best representation of NCDOT roadway drainage area and distribution into the best representative water body in the closed shellfishing area. Samples taken from the embayments will be near NCDEH Shellfish Sanitation sites and EEP/DWQ monitoring sites that have already been determined to be representative of the water body.

Comparability

The Lockwood Folly River project ensures comparability by using a volunteer sampling method outlined in the *Volunteer Estuary Monitoring: A Method's Manual* and *Volunteer Stream Monitoring* for fecal coliform sample collection using sterilized, plastic bottles and all physical/chemical parameters. The protocols found in Appendix A will mirror the EPA standard protocols for volunteers, but may be modified to fit the scope of the project under the guidance of technical advisors and steering committee members. The fecal coliform samples collected are also to be analyzed at Envirochem Laboratory in Wilmington, N.C., a DWQ-certified lab using standard methods and quality control procedures.

Completeness

Completeness will be measured by the total number of samples collected and analyzed against the goals outlined in the project design. Since using volunteers to collect the samples, it is understood that personal circumstances may arise disabling volunteers from committing to sampling at a moment's notice. When one site cannot be sampled during a rain event due to risky boating conditions or site conditions, that site may be left out of the data record. If more than two sites cannot be sampled, another sampling day will be added to the schedule for that month. The project aims for 90% completeness. Data that is not recorded by the stationary flowmeter due to instrumentation problems is acceptable as long as there is 90% completeness overall and recorded data meets the needs of the TMDL model.

## **SPECIAL TRAINING / CERTIFICATIONS (A8)**

The Project Coordinator will be responsible for scheduling, coordinating, and administering all volunteer training sessions. No person but the Project Coordinator is authorized to train volunteers, though he may ask N.C. Shellfish Sanitation Section for help to train volunteers on collection techniques. The Project Coordinator has had previous experience with Durham County in watershed planning, sampling, and restoration, and will be trained in the latest methods by Stantec Consulting Ltd. Volunteers will be advised not to follow methodology given by another individual. Before collection of any samples, the volunteers will be required to attend training sessions scheduled by the Project Coordinator and must display knowledge of the project objectives and goals. The volunteers must demonstrate proper protocols for field collection of samples, including quality control samples.

The Project Coordinator is responsible for coordinating with N.C. DOT the collection of samples along state roadways. DOT has strict safety standards associated with any kind of work within its right of way. Sampling in those areas along roads may require a temporary lane closure for safety reasons. The Project Coordinator will get the approval from the appropriate DOT division for this type of activity.

The Project Coordinator is responsible for signing off on sampling data sheets turned in at the end of the sampling day by the volunteers. If they are not completed properly, the Project Coordinator will again instruct the volunteer on how to properly fill out the sheets. If the Project Coordinator suspects that protocols are not being properly followed remedial training sessions may be scheduled as necessary.

Table 7 shows the record to be kept by the Project Coordinator of all volunteer training activities. Topics to be covered at each training session are described in detail below the table. Initial, six-month, and remedial training sessions (if needed) are to be recorded.

***Table 7: Volunteer Training Record***

*\*when the volunteer completes a training level, the date of completion will be entered.*

Volunteer Name	Training Level	A	B	C	D	E	F
	Initial						
	Six-month						
	Remedial						

**A**     Background and Project Objectives

The Project Coordinator has issued and gone through the Volunteer Manual containing the proper background material on fecal coliforms, stormwater pollution, the project goals and objectives, and proper sampling protocols. The volunteer has read all materials included.

**B**     Sampling Site Visitation

The Project Coordinator leads the volunteer through the sampling site. The Project Coordinator will ensure the volunteer can get to the site and knows the exact location for

sampling. The volunteers should also be familiar with the location of the designated central meeting location.

C Field Safety and Equipment Maintenance

The Project Coordinator instructs the volunteer on proper field attire and safety measures, such as usage of gloves, boots and protective eyewear, and washing of hands after each sample collection. The Project Coordinator also instructs the volunteer on the proper handling and storage of field equipment, and maintenance of equipment as necessary.

D Data Management

The Project Coordinator demonstrates how to properly label sample bottles, complete the Volunteer Monitoring Data Sheets, and equipment maintenance logs. The volunteer will be required to demonstrate proper labeling of practice sample bottles and completion of practice data sheets.

E Fecal Coliform Sample Collection

The Project Coordinator demonstrates how to properly collect and store the samples until delivery to Envirochem Laboratory. The volunteer must be able to accurately show they can perform the same methodology. The Project Coordinator will also educate volunteers on quality control samples and how to properly collect them. The volunteer must be able to show they understand the QC schedule (Table 8) and accurately demonstrate how to collect these samples.

F Physical/Chemical Monitoring

The Project Coordinator demonstrates how to properly use the monitoring equipment to find temperature, salinity, turbidity, and flow. Volunteers should be able to demonstrate the correct methodology for these parameters, as well as, measurement of stage height and total rainfall.

## **DOCUMENTATION AND RECORDS (A9)**

The volunteers will complete the Volunteer Monitoring Data Sheet (Appendix B) on-site. Originals will be checked, signed, and kept by the Project Coordinator. Copies will be distributed back to each Site Team to be held in Volunteer Manuals for each site. The Project Coordinator will enter all data into an Excel spreadsheet and complete all necessary calculations. The Project Coordinator is responsible for maintaining and operating the stationary flow meter. All data is to be collected by the Project Coordinator, entered, and stored on NCCF's data file server. A back-up copy of all electronic data will be kept off-site.

The Project Coordinator will complete chain-of custody forms (Appendix D) and deliver them to Envirochem Laboratory with the collected water samples. Envirochem will hold a copy of this form and the original will be returned to the Project Coordinator with the lab results. Lab results are to be held by Envirochem for three years after completion of the project.

Stantec Consulting is responsible for maintaining electronic copies of fecal coliform sample results, stationary flow meter data, and physical/chemical parameter data through the duration of the project. TMDL model development procedures and input data are to be kept on file three years after completion of the project. Copies of this data and subsequent analyses should be distributed to the Project Coordinator and the TMDL Advisor. Original Watershed Implementation Plans are to be kept by Stantec Consulting, and distributed and held by the Project Coordinator, the Project Advisor, and the Steering Committee.

Presentations and information distributed at public meetings, to the Steering Committee, and at town planning meetings should be held by the Project Coordinator and Project Advisor.

The Project Coordinator will complete quarterly reports on all monitoring activities and data collected, which will be reviewed by project partners and the 319 Program Manager for approval. The Project Coordinator and Project QA Advisor should maintain all data and information included in the Final Report produced by the North Carolina Coastal Federation. Copies of the report are to be distributed to all involved parties (Distribution List).

## **SAMPLING PROCESS DESIGN (B1)**

NCDEH Shellfish Sanitation and the NC Coastal Federation will perform shoreline surveys along the Lockwood Folly River to identify stormwater conveyances. Fecal coliform samples will be taken from the tributaries and estuaries as described in Figure 2. Sampling sites have been selected to maintain consistency with NC DWQ sampling sites, but may be modified throughout the project to locate contamination “hot spots” as part of the source assessment. The design for source assessment will become more concrete after an intensive investigation of the project area within the First Quarter. Sources investigated during the source identification will include water fowl and septic tanks, among others.

Monthly samples will be collected for both wet weather and dry weather conditions. Sampling dates will be assigned at the discretion of the Project Coordinator and will be coordinated with Envirochem Laboratory and the Volunteer Team in order to capture both wet and dry events. The Project Coordinator will collect estuary samples by boat within the same hour if conditions allow. Site Teams of two volunteers local to the tributary sampling sites will record site conditions at the time of sampling following the Field Monitoring Data Sheet in Appendix A, and measure flow in the channel if possible. Back-up volunteers will be trained at each site in case a member of the Site Team cannot sample on a scheduled day due to personal circumstances. In addition, sample collectors will record the temperature of the water, salinity, stage height, secchi depth/transparency of the water, and total rainfall levels.

Flow will be recorded from two stationary flow meters placed in Royals Oak Swamp at Green Road and the lower Sandy Branch at the end of Beaver Dam Road off Goley Hewett Road at monthly intervals (at least 10 to 12), as is needed for model development. Once calibrated, the model can be used to predict flows at other locations.

## **SAMPLING METHODS REQUIREMENTS (B2)**

Volunteers will be notified by the Project Coordinator of scheduled sampling days. The Project Coordinator will coordinate the collection of the 275 ml sample (sterilized, plastic bottle provided by Envirochem Laboratory) from each site for a total of 11 samples. Samples will be collected as surface grab samples following the method in the EPA's Volunteer Estuary Monitoring: A Method's Manual. Refer to Appendix A for a description of the sampling protocol. For each sample taken, a Volunteer Monitoring Data Sheet will be completed (Appendix B), including sample information, site conditions, rainfall, stage height, temperature, salinity, dissolved oxygen and secchi depth/transparency. All samples will be kept in a cooler on ice (1-4 deg. Celsius) for a maximum of six hours until delivery to Envirochem Laboratory.

Volunteers will collect water grab samples from piers and channels following the standard protocol in Appendix A. The Site Teams will maintain equipment provided by the Project Coordinator until the time of sampling (Appendix C).. All equipment will be prepared a day prior to the scheduled sampling day by the volunteers, except for the cooler, which will be prepared just before sampling begins. All volunteers will be given a rain gage to keep in their yards. Rain gauges will be purchased from Forestry Suppliers Taylor See Through Rain Gauge Model 89068.

The start time of rainfall will be recorded on data sheets. After 30 minutes of rainfall, the volunteers will collect the samples from the selected sites. Volunteers will also prepare and collect QC samples as outlined in the Quality Control Requirements section of this document. The Volunteer Monitoring Data Sheets (Appendix B) should be completed with sample information, site conditions and measures for all physical and chemical parameters. Time of collection, rain level at the sampling site, stage height, temperature of the outfall water and/or temperature of the channel, transparency or secchi depth (if feasible), and salinity channel water should be recorded. The Project Coordinator will collect dissolved oxygen in addition to this same data at the estuary sites.. The Project Coordinator will record data on a separate field monitoring data sheet (Appendix B). All sample collectors should label all sample bottles with site name, sample number, date, time and initials. Samples should be stored in a cooler on ice (1-4 deg. Celsius) for up to six hours. All samples collected by volunteers and the Project Coordinator will be taken to the designated central meeting location where the Project Coordinator will collect and deliver the samples to the Envirochem Laboratory for analysis. All sample collections and delivery to the Envirochem Laboratory must occur within six hours. The volunteers should also record the ending time of the rain and the final rain level from their yards or in close proximity to the monitoring site. All final volunteer monitoring data sheets will be returned to the Project Coordinator and checked for completeness.

### **Temperature, Salinity, and Dissolved Oxygen**

Volunteers will measure temperature and salinity by collecting water from the sampling sites with the hydrometer following the method in Appendix A. All data will be recorded on the volunteer monitoring data sheets. The Project Coordinator will measure temperature, salinity, and dissolved oxygen at the estuary sampling sites using the YSI Model 85 multi-parameter probe following standard instrument methods. A vertical profile to determine the thermocline and halocline will be determined at the sampling sites as well.

**Flow**

The Project Coordinator will maintain the stationary flow meters (Sigma 930 Long-Term Area Velocity Meter) at Royal Oak Swamp at Green Road and at the end of Beaver Dam road off Goley Hewett Road. Water level sensors connected to data loggers for recording of water levels at 15-minute or hourly intervals will be deployed at the two sites. Data will be retrieved once a month and compiled into a computer spreadsheet. Maintenance and recalibration of the instrument will occur after each download following standard instrument procedures. The Project Coordinator is also responsible for checking the flow meters once a week to ensure the instruments have not sustained damage and are still collecting data. If problems arise, they will be tended to immediately.

**Rain Level**

Volunteers will record the start of rain on their field data sheets. They will record the time when one-half inch of rain has accumulated in their yard gauge. Once on-site, they will record the time and rain level in the gauge. They will also record the end time of rain and the final rain total from their yard gauges. These rain levels will be checked against the Wilmington NWS radar storm rainfall total maps.

**Stage Height**

A staff with 0.1-meter markings will be placed at each tributary site. Volunteers will record the height of the water to the nearest 1/10<sup>th</sup> meter when they collect the sample.

**Turbidity/Transparency**

The Project Coordinator will measure transparency by secchi depth at both the estuary sampling sites following the protocol outlined in Appendix A (*Volunteer Estuary Monitoring: A Method's Manual*). The secchi disk will be lowered until it is no longer visible. It will be recorded when the bottom is visible without use of the secchi disk. The volunteers at the tributary sites will use a transparency tube to measure transparency following the method in Appendix A. The Project Coordinator will measure transparency by this method if a secchi disk cannot be used.

If complications arise during sample collection, it should be explained on the monitoring data sheet under "Comments" (Appendix B). The volunteers will collect a 275 ml grab sample as outlined in the protocol (Appendix A). If site conditions are too risky for sample collection or parameter measurement, this will be recorded. Equipment problems that prevent measurement of physical and chemical parameters on-site will also be recorded and included in instrument maintenance logs (Appendix E).

**Safety Considerations**

Volunteers will be instructed on proper safety measures for field sampling. Rubber gloves, protective eyewear, rubber boots and the proper rain gear should be worn during sampling. The volunteers will use hand-sanitizer after sampling and will be provided with a first aid kit for emergencies. If the site becomes flooded or is too dangerous to sample, the volunteer will be instructed not to take risks with personal safety and record on data sheets that sampling could not be performed due to risky site conditions.

## **SAMPLE HANDLING AND CUSTODY REQUIREMENTS (B3)**

Both the volunteers and the Project Coordinator will hold sterile sample bottles provided by Envirochem Laboratory until the time of sampling. Volunteers will label each sample with the date, time, sample number, site name and initials, and record the proper information on the Volunteer Monitoring Data Sheets (Appendix B) once the sample is collected. These data sheets will be completed and returned to the Project Coordinator. Volunteers will keep copies. Collected samples will be stored in a cooler with ice packs (1-4 deg. Celsius) until delivery to Envirochem Laboratory. Samples will be delivered within six hours of collection to the lab for the start of analysis. The Project Coordinator will record the date, time, total number of samples, and signature on the chain-of-custody form (Appendix D) to be delivered to Envirochem Laboratory. Envirochem will follow their approved protocols for analysis, storage, and disposal of the samples. Envirochem will return the chain-of-custody forms to the Project Coordinator with the lab results.

## **ANALYTICAL METHODS REQUIREMENTS (B4)**

Physical and chemical parameters analyzed by the Project Coordinator and the Volunteer Team will follow EPA standard methodology (*Volunteer Estuary Monitoring, Volunteer Stream Monitoring*) and specific instrument methods.

The DWQ-approved laboratory, Envirochem in Wilmington, N.C., will perform the fecal coliform, enterococcus, and TSS analysis using standard methods. Approved QA/QC procedures will be followed. Results from QC samples and corrective action for lab analysis error will be recorded and reported to the Project Coordinator.

## **QUALITY CONTROL REQUIREMENTS (B5)**

Quality control for observational and recorded data (site conditions and data sheets) will be addressed in training sessions semi-annually for the duration of the project. Remedial sessions will be administered as necessary.

Quality control samples for fecal coliform will be taken to ensure valid data are being collected. Quality control samples for the volunteer sample collection consist of field blanks, replicate samples, and split samples. Each type of QC sample will be collected three times throughout the duration of the project if volunteers are to collect samples for twelve months. The schedule (Table 8) will be modified if twelve months of sampling is not required. If Site Teams are monitoring more than one site, they will collect QC samples for all their designated sites. The Project Coordinator will follow a similar schedule for collecting QC samples from the embayments and boundary conditions dependent on the number of samples to be collected.

### **Field Blanks**

Deionized water provided by the laboratory shall be taken into the field, poured into a sample bottle, labeled, and recorded on the data sheet as a regular water sample. It will be stored on ice,

delivered to the lab, and analyzed as all other samples. This sample should be below detection limits. The purpose of this sample is to check for transport, storage, and field handling bias and cleanliness of sample bottles. The hypothetical schedule for collection of these samples is shown below in Table 8.

Replicate Samples

The Project Coordinator will prepare and the Site Teams will collect two 275 ml samples (replicates) that will be sent to the lab for analysis. The hypothetical schedule for collection of these samples is shown below in Table 8.

Split Samples

The Project Coordinator will prepare and the Site Teams will collect one 500 ml sample that will be sent to the lab and split by the lab analyst into two samples for analysis. The hypothetical schedule for collection of these samples is shown below in Table 8.

Laboratory Blank

Envirochem Laboratory will analyze a blank sample using deionized water. One will be prepared for every sample analysis. The purpose of this sample is to check the precision of the lab analyst’s technique in preparing/handling the samples, and check for contaminated equipment or reagents. Again, the sample should be below detection limits.

Envirochem Laboratory will address all other quality control samples by their standard QC procedures.

Variation for duplicate values (replicate and split) must not exceed the range for precision and accuracy outlined in Table 4. Data that do not meet project precision and accuracy objectives are not entered in the project data system and will not be used in reports.

**Table 8: Hypothetical Field QC Sample Collection Schedule**

<b>Site/Month</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>
<b>Site 1</b>	FB		S	R	FB		S	R	FB		S	R
<b>Site 2</b>	R	FB		S	R	FB		S	R	FB		S
<b>Site 3</b>	S	R	FB		S	R	FB		S	R	FB	
<b>Site 4</b>		S	R	FB		S	R	FB		S	R	FB

\*each Site Team will collect the same QC sample at both sampling times per month (dry and wet).

\*FB = field blank (one 275 ml with deionized water)

R = field replicate (two 275 ml collections)

S = laboratory split (500 ml collection)

Data quality objectives for water temperature, turbidity/transparency, and salinity must be met (Tables 4 and 6). Replicate measurements will be taken for each to diminish equipment error, handler bias, and subjective assessments.

## **INSTRUMENT/EQUIPMENT CALIBRATION, TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS (B6, B7)**

Sterilized sampling bottles provided by Envirochem Laboratory will remain capped and kept in dry coolers until prepared for the next sampling. All field equipment utilized by the volunteers will be kept at the Site Team Leaders residence until the time of sampling. Field equipment should be checked the day before sampling to ensure it is in working order. Problems should be noted on the Instrument Maintenance Log (Appendix E-Table 9) and brought to the attention of the Project Coordinator. Volunteers should obtain replacement equipment from the Project Coordinator as necessary.

The Sigma 930 Long-Term Area Velocity Meters (stationary flow meter) will be checked weekly by the Project Coordinator to ensure that data is still being collected and there has been no damage to the instruments. A more thorough inspection will occur monthly at the time of data download and instrument recalibration. Calibration will follow the manufacturer's instructions. If damage has been sustained, it will be fixed immediately. If data collection terminates before the scheduled download period, that data will be considered lost and the instrument will be reset to collect. Downloaded data will be immediately analyzed to look for error and extreme results. If unrealistic data is found, the instrument will be brought in for more thorough inspection and correction. All problems and subsequent maintenance will be kept in the Instrument Maintenance Log (Appendix E).

The YSI Model 85 Salinity, Temperature, Dissolved Oxygen, and Conductivity multi-parameter probe will be recalibrated for each parameter on the sampling day (Appendix E-Table 10) following the manufacturer's instructions. Calibration reagents will be kept and replaced according to the manufacturer's recommendations. Extreme data results will be discounted, and the instrument will be recalibrated and checked for internal errors. All problems and subsequent maintenance will be kept in the Instrument Maintenance Log (Appendix E-Table 9).

Laboratory equipment used to analyze fecal coliform samples will be inspected, maintained, and calibrated according to Envirochem Laboratory's internal procedures.

## **INSPECTION AND ACCEPTANCE REQUIREMENTS FOR SUPPLIES (B8)**

Volunteers will be responsible for making sure all field equipment is in working condition. If not, they are to report problems to the Project Coordinator. The Project Coordinator will manage all field equipment. The Project Coordinator will inspect all new equipment before it's distributed to the volunteers. Ben Meadows Company will supply most field equipment, except for the stationary flow meter (Hach) and hydrometers (Aquatic Eco-Systems Inc.). Some items may be purchased from local retailers. All equipment will be deemed appropriate by the project advisors and steering committee before purchase.

## **DATA MANAGEMENT (B10)**

The Site Team Leaders will review field data sheets for completeness before leaving the field. The Project Coordinator will inspect and sign the forms at the end of the sampling day. If any sheets contain errors, omissions, or are unclear, the volunteer who completed the sheet will be contacted for clarification. Field observational data will be entered into an Excel spreadsheet within one week of the sampling day.

Results from Envirochem Laboratory will be checked against the field data sheets and chain-of-custody forms to make certain all samples collected have a representative value. If omitted samples or those with errors do not have accompanying lab explanation of results, the Project Coordinator will contact the lab manager. Data outside the range of project data quality objectives will be omitted. Viable data will be entered into an Excel spreadsheet within one week of receipt of results.

Data will be compiled quarterly to time with the stakeholder meeting schedule and DWQ reporting schedule. As a QC check, the Project Coordinator and the QA Advisor will review the data for accuracy, precision, and completeness. All finalized data and reports will be reviewed by a second individual on the project team as a QC check.

Copies of field and lab data will be sent to Stantec Consulting for TMDL development. Stantec will manage model data and information. Models will be used to estimate loads from the flow data and laboratory analysis. Copies will be given to the Project Coordinator and TMDL Advisor.

## **ASSESSMENTS AND RESPONSE ACTIONS (C1)**

The Project Coordinator and the QA Advisor will be responsible for reviewing the volunteer field activities. The Project Coordinator will accompany each Site Team in the field once during the duration of the monitoring project. Volunteers will be evaluated; remedial training will be issued on-site as needed.

A review of laboratory sample results and quality control samples will be completed quarterly. If duplicate values are not within the range of precision and accuracy as specified by data quality objectives on more than one occasion, Envirochem Laboratory methodology will be further evaluated and volunteers will be re-trained on correct sampling procedures.

The progress of volunteer field activities and the data collected will be presented quarterly at stakeholder meetings. This committee will review the quality of the data and concerns will be addressed. The DWQ QA Officer may review all field/laboratory activities and data as requested.

Kathy Stecker, DWQ's TMDL advisor, will assess the TMDL model developed by Stantec Consulting. Changes will be documented.

Laboratory data will be compared to QC objectives in a quarterly QC audit.

Steering Committee will review calculations and data interpretations made by the Project Coordinator.

## **REPORTS TO MANAGEMENT (C2)**

The Project Coordinator will prepare quarterly reports following the DWQ reporting schedule. These reports will include data results, interpretation of results (if possible), information on project status, information on volunteer activities successes/failures, and results of QC audits. Quarterly reports to the steering committee and stakeholders will mirror these DWQ reports.

The TMDL Modeler will complete the TMDL report by end of the Sixth Quarter (Table 3). The TMDL Advisor will review the draft, and comments will be inserted into the final document. All stakeholders and the steering committee will receive this document. The TMDL report, laboratory results, and the shoreline survey will be used to prepare the final project report. The Project Coordinator, in conjunction with stakeholders and the steering committee, will provide interpretation of project results and recommendations for BMP sites. The final report (and raw data as requested) will be distributed to all involved parties and the DWQ office after quality assurance has been reviewed and approved.

All analyses and reports will be used to create presentations for the town planning board and outreach materials for the general public.

## **DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS (D1)**

The Project Coordinator, under the guidance of the project advisors and steering committee, has the discretion to reject or qualify data returned by Envirochem Laboratory and the Volunteer Team. The QA Officer and TMDL Advisor reserve the right to review raw data and the decisions made concerning rejected and qualified data. Project advisors will review calculations and assessments made by the Project Coordinator. The QA Officer will confirm that data has been entered and managed appropriately by the Project Coordinator, and that there have been no errors or omissions during data entry or transfer. Throughout the course of the project, the project advisors and steering committee will review protocols and data to ensure the data collected continues to meet the project objectives and end use.

## **VALIDATION AND VERIFICATION OF METHODS (D2)**

As written into the Volunteer Monitoring Protocol (Appendix A), measurement values that seem erroneous will be reassessed. If an outlier is determined instantly, it will be discarded and the reassessed values retained. If there is no problem with the sampling equipment, measurement

values that continue to seem erroneous will be recorded along with any notes by the volunteer. The data's rejection or qualification will be at the discretion of the Project Coordinator. If data errors occur due to instrumentation problems, the volunteers should attempt to remedy the problem and collect a new set of data for the parameter.

The Project Coordinator will review all data returned by the volunteers during data entry. Outliers, inconsistencies, or nonsensical entries will be flagged by the Project Coordinator for review by the volunteer who recorded the data, project advisors and the steering committee as necessary. After consultation, a decision will be made by the Project Coordinator to reject or retain the data. Discussion of rejected data should be included in quarterly reports, especially if results were rejected because values did not meet DQOs. Project advisors, the steering committee and the DWQ QA Officer will validate these decisions.

### **RECONCILIATION WITH USER REQUIREMENTS (D3)**

Data quality objectives will be reviewed every quarter of the project and collected data will be assessed against these objectives. If the data collected fails to meet the project specifications for model development or accurate source assessment, the project will be reviewed and revisions to the project plan will be submitted to the DWQ Quality Assurance Officer for approval.

Six-month training sessions and remedial sessions as needed are intended to remedy sample collection errors. Rejected data will be discussed in reports and should be considered in final project evaluation.

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## **APPENDIX A: VOLUNTEER MONITORING PROTOCOL**

### ***Sampling Preparation Completed by the Project Coordinator***

Consult the QC sampling schedule and notify all volunteers of sampling day and time. Ensure all volunteers and/or back-up teams are notified and have all assigned necessary equipment to perform the required sampling.

### ***Preparing for Field Sample Collection:***

- The Project Coordinator will notify Site Team Leaders of upcoming sampling days at least two days in advance (primarily wet weather sampling, dry weather sampling may be scheduled further in advance). The Site Team Leader should notify all members of their team. Backup volunteers will be contacted if a Site Team member cannot make the scheduled sampling day.
- Consult the QC field schedule (Table 8) and pick up the appropriate sterilized, plastic, sampling bottles provided from the N.C. Coastal Federation office..
- Prepare equipment according to the equipment checklist (Appendix C) and the weather forecast.
- Review all monitoring protocols and site descriptions. Know exactly where you are supposed to sample.

### ***Collection of Field Samples (Wet Protocol)***

- Monitor the weather and record the start time of rain.
- Prepare the cooler with ice and load equipment. To prevent water from accumulating in the cooler and submerging the samples, pack the cooler with ice placed into sealable plastic bags, water frozen in plastic bottles, or ice packs.
- The Project Coordinator will start a phone chain to the Site Team Leaders to give an estimated meeting time for all volunteers to drop their bottles at the designated central meeting location. Site Team Leaders will contact their Team partner to organize the meeting time for sample collection (should be scheduled at least one hour prior to the bottle drop-off meeting time).
- Travel to the sampling site, arriving about 30 minutes after rain began. Record the following visual observations and site data on the Volunteer Monitoring Data Sheet before the collection of samples:
  - Date and time of fecal sample bottle collection
  - Site conditions or visible sources of pollution
  - Weather at the time and over the past 24 hours
  - Rain level in site gauge, gauge number, and time
  - Tidal stage
  - Stage height
  - Water surface conditions (glassy, small ripples, slight chop, heavy chop/whitecaps)
- Put on disposable gloves before collecting any sample. Wear rubber boots if there is shallow, flowing water around the sample area. Put on protective eyewear to ensure safety from water that may be splashed.

- Sample bottle should be submerged approximately six inches under the surface of the water and the lid removed, making sure you do not touch the inside of the lid or bottle. Once the sample bottle reaches the sampling depth, it should be turned upstream, against the tidal flow to capture water from upstream/flowing water of person and the sample bottle filled within an inch of the top. Do not allow rainwater to enter the sample bottle to prevent contamination of the sample. Each sample should be taken with clean sanitary gloves.

- Label the bottle using a waterproof marker with sample information in the following format:

YYMMDD – Site Number – Sample Number (QC ID)  
Volunteers' Initials

For Example: It is November 3, 2007, you are John Doe, your partner is Bob Smith, and this is Site 4, Sample 2 (replicate).

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- Place the bottle immediately in the cooler on ice and record the sample number on the data sheet.
- Label the sample as described above, record the sample number on the data sheet, and place the bottle immediately in the cooler on ice.
- Quality control field blank samples should be prepared if indicated by the QC schedule. A 500-ml. sterilized, plastic bottle should be filled with deionized water, labeled, and placed on ice the same as all other samples.
- Discard used gloves appropriately. Wash hands and areas of exposed skin thoroughly. Anti-bacterial hand soap, hand sanitizer, or anti-bacterial wipes are preferred. Do not touch eyes, ears, nose, or mouth until hands have been washed.
- Rinse rubber boots with de-ionized water to prevent bacterial contamination and wear from salt buildup.
- Fill in the physical and chemical monitoring data on the data sheet according to the methods listed below.
- Travel to the designated central meeting location. The Project Coordinator should collect all samples and deliver them to Envirochem Laboratory within six hours of the first sample that was collected.
- Record the end time and level of the rain from your yard rain gauge. Make sure all information is filled out completely and thoroughly on the data sheets. Return the original

data sheets to the Project Coordinator at NCCF within one week of the sampling day. Make copies of all data sheets and keep them in your Volunteer Binder.

\*The Project Coordinator is responsible for completing the chain-of-custody form and delivering all samples to Envirochem Laboratory in Wilmington, N.C. within six hours of sample collection. He will also receive another set of sterilized, plastic sampling bottles for use during the next scheduled sampling day.

### ***Collection of Field Samples (Dry Protocol)***

Dry weather is defined as a 72-hour period with no more than 0.1 in of precipitation within the study area watershed. Volunteers will keep daily rainfall records to verify that a 72 hour rain free period has preceded a dry weather sampling trip. The sampling protocol remains the same as above, except rain gage levels do not need to be monitored and volunteers only need to collect channel samples.

## ***Physical/Chemical Parameter Sampling Protocols and Background Information***

### **STAGE HEIGHT**

Record the level of the channel water to the nearest tenth of a meter from the wooden staff at the sampling site if the depth allows measurement.

### **TIDAL STAGE**

Consult the tide chart provided monthly by the Project Coordinator. Determine whether the tide is coming in or going out. Record the time of the last high/low tide and the next high/low tide.

### **TEMPERATURE AND SALINITY (following the standard instrument protocol if different than outlined here and *Volunteer Estuary Monitoring: A Method's Manual, EPA, Chapters 13 & 14*)**

#### ***Why are we measuring them?***

An estuary's water temperature is a function of depth; season; amount of mixing due to winds, storms and tides; degree of stratification within the estuary; temperature of water flowing in from tributaries; and human influences, such as stormwater and industrial wastewater. Salinity is the amount of dissolved salts in water. It increases with depth, and like temperature, is the primary factor in determining the stratification of an estuary. Fresh water will sit on top of salt water, but storms, tides, winds, and inflowing river water can disrupt stratification and promote mixing. Salinity controls the plants and animals that can live in an area of the estuary. Salinity changes can allow salinity-specific diseases to afflict an area, such as those harmful to oysters. Salinity also encourages flocculation, or aggregation of fine particles suspended in river water, increasing the turbidity of estuarine waters. Salinity also affects the dissolved oxygen content in estuaries. As salinity increases, the amount of oxygen water can hold decreases. Salinity can be measured by conductivity, chlorinity, a refractometer, or a hydrometer. Here, we are using hydrometers to measure specific gravity, which can be converted to parts per thousand (ppt).

#### ***How are we measuring them?***

1. Collect water from the sampling site in the dry glass column. Try not to disturb bottom sediments.

2. Insert the hydrometer and allow three to five minutes for stabilization.
3. Record the salinity in units of specific gravity, and record temperature in degrees Celsius.
4. Empty the column and fill with a second water sample. Repeat the same process.
5. Empty the column and rinse thoroughly with de-ionized water to prevent fecal contamination and salt buildup.

## **TRANSPARENCY/TURBIDITY (Chapter 15, Volunteer Estuary Monitoring: A Method's Manual, EPA)**

### ***Why are we measuring it?***

Turbidity is the degree of water clarity or relative cloudiness/muddiness. Suspended soil particles, algae, planktonic species, and fragments of dead plants (detritus) contribute to turbidity and can be aggravated by wave action, human activities, runoff, and storms. Suspended particles absorb heat, increasing the temperature of the water, and decreasing the amount of dissolved oxygen available for life. One approach to assess turbidity is to measure transparency (an integrated measure of light scattering and absorption) instead of turbidity. Water clarity/transparency can be measured using a Secchi disk or transparency tube. The Secchi disk can only be used in deep, slow moving rivers; the transparency tube, a comparatively new development, is gaining acceptance in programs around the country but is not yet in wide use.

### ***How are we measuring it? Transparency Tube***

1. Collect a water sample in a bucket from about mid-depth of the waterbody or from the outfall. Avoid stagnant water and bottom sediments, and collect water away from the shoreline.
2. Place the transparency tube on a white surface (sheet of blank paper) in an open, but shaded area. If there is only full sun, turn your back to it.
3. Swish the water in the bucket taking care to not produce air bubbles until it is homogenous. Slowly pour it down the inside wall of the tube as to not create bubbles. Staring down vertically through the tube, stop pouring water when the black and white pattern at the bottom of the tube disappears. Pour intermittently to ensure you haven't missed the disappearance point.
4. When you can no longer see the black and white pattern, look at the ruler on the side of the tube and record the depth onto the data sheet.

\*If the transparency tube has a water release valve, fill the tube up completely and slowly release water until the black and white pattern appears. Close the valve and record this depth.

### ***Protocol for the Project Coordinator***

The Project Coordinator will use a different data sheet than the volunteer (Appendix B). Site conditions, weather, rain level, tidal stage, and stage height remain the same as the volunteer protocol above. The following protocols differ:

#### Fecal Coliform Sampling at the Estuary sites.

From the boat, check to see if a tide or current is running by examining the movement of water or surface debris. If running, sample on the upstream side. Do not sample in stagnant water. Wearing gloves hold the bottle about six inches under the surface of the flow and open the lid.

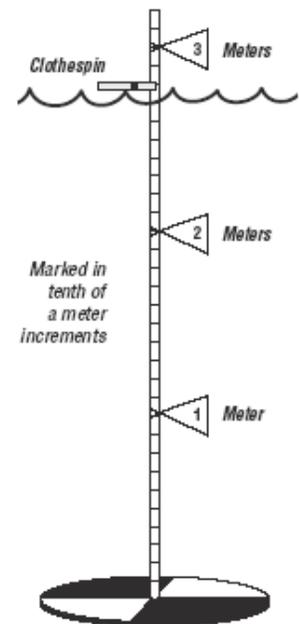
Allow the bottle to fill within one inch of the top. Cap the bottle, label it as in #6 above, record the sample number on the Project Coordinator's data sheet (Appendix B), and place the bottle in the cooler (1-4 deg. Celsius). Make sure to not allow rainwater falling from the sky to get into the bottle, as it will dilute the sample!

### Temperature, Salinity, and Dissolved Oxygen

The YSI Model 85 multi-parameter probe is used for all measurements. Using a weighted line, find the depth of the embayment water. Lower the probe into the water so the sensors are just below the surface (1 foot). Allow the instrument to stabilize. Record the temperature, salinity, and percent saturation (dissolved oxygen) on the Project Coordinator's data sheet (Appendix B). Continue to lower the instrument and take measurements every 0.5 meters until the instrument is within 0.1 meter the bottom. Rinse the sensors with de-ionized water when finished and store the instrument properly.

### Transparency/Turbidity – Secchi Depth (Chapter 15, Volunteer Estuary Monitoring: A Method's Manual, EPA)

1. Take the secchi depth measurement from the shaded side of the boat. If all areas have full sun, position your body as to block the sun's glare. Attempt to always sample from the same location to meet data quality objectives.
2. While not wearing sunglasses, lower the Secchi disk beneath the water until it is no longer visible. Raise the disk until it becomes visible again. Lower and raise the disk until the exact vanishing point is found. Record this depth to the nearest 1/10 meter on the Project Coordinator's data sheet (Appendix B). Repeat a second time. Average the two distances.  
*\*If the submerged Secchi disk remains visible until reaching the bottom, record "visible until bottom (VUB)" and the depth of the water where the measurement is being taken. Use the transparency tube following the protocol above.*
3. Rinse Secchi disk with de-ionized water to prevent fecal contamination and wear from salt buildup.



# APPENDIX B: VOLUNTEER MONITORING DATA SHEET

**VOLUNTEERS** \_\_\_\_\_

**DATE** \_\_\_\_\_ **TIME** \_\_\_\_\_

**SITE #** \_\_\_\_\_

**SAMPLES COLLECTED** \*record ID on sample bottle, and indicate replicate (R), field blank (FB), or split (S).

\_\_\_\_\_  
\_\_\_\_\_

**RAIN GAGE (for wet sampling only)**

TIME	GAGE #	RAIN LEVEL(inches)
Start: _____	_____	_____
1/2 " _____	_____	_____
Site: _____	_____	_____
End: _____	_____	_____

**RAIN GAGE (for dry sampling only)**

Rainfall during last 72 hrs. \_\_\_\_\_

**Water Surface Conditions** \_\_\_\_\_

**Water Temperature(s) (°C)**

Channel \_\_\_\_\_ Avg. \_\_\_\_\_

**Salinity (specific gravity)**

Channel \_\_\_\_\_ Avg. \_\_\_\_\_

**Stage Height** \_\_\_\_\_

**Transparency** \_\_\_\_\_ Avg. \_\_\_\_\_

**Tidal Stage** IN OUT High \_\_\_\_\_

Low \_\_\_\_\_

**WEATHER NOW:**

- Storm (heavy rain)
- Rain (steady rain)
- Showers (intermittent rain)
- Overcast
- Clear/Sunny

**PAST 24 HOURS:**

- Storm (heavy rain)
- Rain (steady rain)
- Showers (intermittent rain)
- Overcast
- Clear/Sunny

**SITE CONDITIONS:**

- Presence of waterfowl or other animals?
- What kind? \_\_\_\_\_
- Floating debris?
- Oil slicks?
- Algal blooms?
- Water color? \_\_\_\_\_
- Water odor?
- Heavy erosion?

**COMMENTS:**

**Project Coordinator's Signature / Date**

\_\_\_\_\_

# PROJECT COORDINATOR'S FIELD MONITORING DATA SHEET

DATE \_\_\_\_\_ TIME \_\_\_\_\_

Water Surface Conditions \_\_\_\_\_

SITE # \_\_\_\_\_

Stage Height \_\_\_\_\_

**SAMPLES COLLECTED** \*record ID on sample bottle, and indicate replicate (R), field blank (FB), or split (S).

**Tidal Stage** IN OUT High \_\_\_\_\_  
Low \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

**Secchi Depth** \_\_\_\_\_ Avg. \_\_\_\_\_

**SITE CONDITIONS:**

**Transparency** \_\_\_\_\_ Avg. \_\_\_\_\_

- Presence of waterfowl or other animals?
- What kind? \_\_\_\_\_
- Floating debris?
- Oil slicks?
- Algal blooms?
- Water color? \_\_\_\_\_
- Water odor?
- Heavy erosion?

**YSI MODEL 85**

Depth (ft)	Temp (C)	Salinity	DO (mg/l)
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

**WEATHER NOW:**

**PAST 24 HOURS:**

- |  |  |
|--|--|
| <input type="checkbox"/> Storm (heavy rain)          | <input type="checkbox"/> Storm (heavy rain)          |
| <input type="checkbox"/> Rain (steady rain)          | <input type="checkbox"/> Rain (steady rain)          |
| <input type="checkbox"/> Showers (intermittent rain) | <input type="checkbox"/> Showers (intermittent rain) |
| <input type="checkbox"/> Overcast                    | <input type="checkbox"/> Overcast                    |
| <input type="checkbox"/> Clear/Sunny                 | <input type="checkbox"/> Clear/Sunny                 |

**Rain Gage (for wet sampling only)**

TIME	GAGE #	RAIN LEVEL(inches)
Start: _____	_____	_____
1/2 " _____	_____	_____
Site: _____	_____	_____
End: _____	_____	_____

**Comments:**

## **APPENDIX C: FIELD MONITORING EQUIPMENT CHECKLIST**

- Volunteer Manual (with Data Sheets, chain-of-custody forms, site maps, and directions)
- Rubber gloves
- Rubber boots (not required but you may find them useful)
- Secchi Disk or transparency tube
- Hydrometer
- De-ionized water jug
- 2 sterilized, plastic bottles (500 ml) from Envirochem Laboratory
- Cooler (with frozen ice packs)
- Waterproof markers
- Raingear (raincoat or poncho, if necessary)
- Protective eyewear
- Hand sanitizer, anti-bacterial wipes, or anti-bacterial soap
- First aid kit (with standard supplies listed in Chapter 7 of the EPA's *Volunteer Estuary Monitoring: A Method's Manual*)

**APPENDIX D: CHAIN-OF-CUSTODY FORM**

**DATE** \_\_\_\_\_

**DATE RESULTS  
DELIVERED** \_\_\_\_\_

**VOLUNTEER SIGNATURE**  
\_\_\_\_\_

**RESULTS DELIVERED BY**  
\_\_\_\_\_

**SITES:** \_\_\_\_\_

**PROJECT COORDINATOR  
SIGNATURE**  
\_\_\_\_\_

**TOTAL # OF  
SAMPLES DELIVERED** \_\_\_\_\_

**DELIVERY TO PROJECT  
COORDINATOR**

**DATE** \_\_\_\_\_ **TIME** \_\_\_\_\_

**PROJECT COORDINATOR  
SIGNATURE**  
\_\_\_\_\_

**DELIVERY TO ENVIROCHEM LAB**

**DATE** \_\_\_\_\_ **TIME** \_\_\_\_\_

**SIGNATURE OF ENVIROCHEM LAB  
ANALYST**  
\_\_\_\_\_

**COMMENTS:**

