

**Quality Assurance Project Plan
for the
City of Charleston Tidal Creek Monitoring and Reporting
Program**

**Prepared for the
USEPA EMPACT Program**

By the

**City of Charleston
Department of Public Service
75 Calhoun St., 3rd Floor
Charleston, SC 29401**

**US Geological Survey
Water Resources Investigations
1815 l'on St.
Sullivan's Island, SC 29482**

**Marine Resources Research Institute
South Carolina Department of Natural Resources
Marine Resources Division
P.O. Box 12559
Charleston, SC 29412**

Aquarium

December, 2001

Project Manager

EPA Project Manager

EPA Quality Assurance Manager

Table of Contents

Table of Contents.....	2
Project Management	4
<i>Project Title:</i>	4
Program Distribution List:	4
EPA Distribution List:	4
<i>Project Organization:</i>	5
Agency Responsibilities:	5
Project Management:	5
<i>Problem Definition:</i>	7
<i>Program Objectives and Description:</i>	8
Quality Objectives and Criteria:	9
Measurements/ Data Acquisition	12
<i>Sample Collections and Handling:</i>	12
SCDNR Secchi Disk Readings:	12
SCDNR Water Column Measurements:	12
SCDNR Water Column Samples:	13
SCDNR Phytoplankton Samples:	13
SCDNR Sediment Samples:.....	13
SCDNR Atmospheric Samples:	14
<i>Sample Handling, Tracking and Custody Requirements:</i>	16
SCDNR Water Quality Samples:	16
SCDNR Sediment Samples:.....	16
<i>Analytical Methods Requirements:</i>	17
SCDNR Water Chemistry Sample Processing:.....	17
SCDNR Sediment Composition Processing:	18
<i>Quality Control Requirements:</i>	21
SCDNR Water Chemistry and Phytoplankton Samples:	32
SCDNR Sediment Composition Samples:	33
SCDNR Sediment Contaminant Analyses:	33
<i>Instrument/Equipment Testing, Inspection, and Maintenance Requirements:</i>	34
Calibration Checks and QC Procedures:	34
<i>Instrument Calibration Frequency:</i>	36
<i>Inspection/Acceptance Requirement for Supplies:</i>	37
Assessment and Oversight	38
<i>Assessments and Response Actions:</i>	38
Sample Tracking:	38
Data Reporting Requirements and Evaluation Procedures:	38
<i>Reports to Management:</i>	38
Data Validation and Usability	38

<i>Data Review, Validation and Verification Requirements:</i>	38
<i>Validation and Verification Methods:</i>	39
<i>Reconciliation with User Requirements:</i>	39
References:	40
Appendix: Data Collection and Management Forms	44

Project Management

Project Title:

City of Charleston Tidal Creek Monitoring and Reporting Program

Program Distribution List:

Ms. Laura Cabiness	Director, Charleston Dept. of Public Services, , Project Manager, Quality Assurance Supervisor
Ms. Tracy Vaughn	Charleston Dept. of Public Services, GIS Planner

Other city staff need to be added. All significant participants

Dr. Robert Van Dolah	MRRRI Director, Co-Investigator, SCDNR- MRD Project supervisor
Dr. Denise Sanger	MRRRI Project Lead Co-Investigator,
Dr. Fred Holland	MRRRI Project Co-Investigator
Mr. Martin Levisen	MRRRI Lab Supervisor for Sediment and Datalogger processing
Mr. Kevin Conlon	USGS Project Lead Co-Investigator
Mr. Paul Conrads	USGS Project Co-Investigator
Ms. Celeste Journey	USGS Project Co-Investigator
Mr. Noel Hurley	USGS Project Co-Investigator
Mr. Brady Long	USGS Hydrologic Technician

Etc - rest to be prepared by the City and other subcontractors

EPA Distribution List:

???? USEPA, Project Officer
Additional to be provided by the USEPA

Project Organization:

Agency Responsibilities:

Lead paragraphs on City's role and other subcontractors role need to be prepared and inserted where appropriate

The SCDNR Marine Resources Division will have primary responsibility for monitoring water quality in four creeks during and following storm events in cooperation with USGS staff. As part of this effort, SCDNR staff will visit each creek to collect water and sediment quality samples comparable to those being collected by the USGS. These creeks represent different levels of urban development. The SCDNR will also collect water samples from an atmospheric testing station that will be established at the Ft. Johnson Marine Center in Charleston.

The USGS will have primary responsibility for monitoring stream stage, rainfall, specific conductance, and water temperature at or near the headwaters of four tidal creeks and develop rating curves to compute streamflow. The USGS also will monitor water level and water quality, and collect water samples for selected water-quality constituents in the headwaters of each watershed during eight storm events (two storm events each season), assuming normal hydrologic conditions.

Project Management:

City and other subcontractors to add their paragraphs.

The SCDNR Co- Investigators will be Drs. Robert Van Dolah, Denise Sanger and A. Frederick Holland. Dr. Van Dolah will serve as the project supervisor in his role as the Institute Director and will work closely with Dr. Denise Sanger, who will serve as the lead MRRI investigator for this project. Dr. A. Frederick Holland will assist Drs. Sanger, and Van Dolah in analyzing and interpreting the data.

In addition to serving as the Acting Director for the Marine Resources Research Institute, Dr. Van Dolah is in charge of the MRRI Environmental Research Section and has more than 20 years of experience in managing medium to large research programs involving multiple institutions. Dr. Van Dolah has primary expertise in habitat quality assessments throughout South Carolina and other parts of the southeast, and is serving as the Principal Investigator on a related study entitled the South Carolina Estuarine and Coastal Assessment Program (SCECAP), which is funded in part by the USEPA National Coastal Assessment Program. Dr. Van Dolah will ensure that sample QA/QC protocols are consistent with that program, which already has an established QAPP that has been accepted by the USEPA. Data obtained from SCECAP, which is an ongoing program, will also be used in the analysis of creek condition.

Dr. Denise Sanger is an Assistant Marine Scientist with the South Carolina Marine Resources Research Institute. She is currently managing a study investigating the changes in the ecological processes associated with the impacts of land use changes on tidal creek ecosystems. This is a multi-investigator study that is funded and coordinated by the South Carolina Sea Grant Consortium. The SCMRRI component is actively working with the USGS and Beaufort County. Dr. Sanger has performed extensive research in the proposed study tidal creeks for the past 10 years.

Dr. Fred Holland is the Laboratory Manager of the Hollings Marine Laboratory (HML). The Hollings Marine Laboratory was recently opened to perform research related to the health of the marine environment. The HML is a unique research facility with investigators from the National Oceanic and Atmospheric Administration, the National Institute of Standards and Technology, the Medical University of South Carolina, the University of Charleston, and the South Carolina Marine Resources Research Institute. Dr. Holland has more than 30 years experience in managing research programs funded by the EPA, NOAA, and numerous other agencies.

Mr. Martin Levisen is a Biologist II staff person working in the Environmental Research Section of the MRRI. Mr. Levisen is currently in charge of all QA/QC activities related to sediment processing and water quality multiprobe measurements. He supervises a number of lab technicians conducting this work and ensures that all data are compiled in a high quality manner. Mr. Levisen will assist on this project with supervising and monitoring QA/QC of the samples and data processed for the sediment composition work, and the water quality meter deployments.

The USGS Co-Investigators will be Kevin Conlon, Paul Conrads, Celeste Journey, and Noel Hurley, Jr. Kevin Conlon will serve as the lead USGS investigator for this project. Paul Conrads and Celeste Journey will assist Kevin Conlon in analyzing and interpreting the data. Noel Hurley, Jr. will assist with overall project and personnel coordination and management.

Mr. Noel Hurley, Jr. has served since August 1997 as the Assistant District Chief and Chief of the Hydrologic Investigations Section for the USGS, South Carolina District. The Hydrologic Investigations Section currently consists of 16 engineers, geologists, biologists and graphic illustrators. Recent projects undertaken by this section include surface-water, ground-water, and water-quality assessments, such as: Investigation of the feasibility of using Aquifer Storage Recovery in the Charleston, S.C. area to supply an emergency source of drinking water, Investigation of salt-water intrusion into the Floridian Aquifer in coastal Georgia, Development of flow and transport models for the Catawba and Wateree Rivers, Clear-water scour analysis for selected bridges in S.C., and Development of equations to estimate the magnitude and frequency of peak flow for S.C. streams.

Mr. Kevin Conlon is a Hydrologist with the USGS in Charleston, S.C. He is currently a project member of a study to determine the geochemical and hydrologic

effects of long-term storage of treated surface water in limestone aquifers in Charleston, S.C.

Mr. Paul Conrads

Ms. Celeste Journey

Mr. Brady Long is a Hydrologic Technician with the USGS in Charleston, S.C. Mr. Long will lend support during the sampling phases of the project, and will service the water-quality and water-level instruments located at the four tidal creeks. Mr. Long currently operates and maintains surface-water quality gaging stations located throughout the Tri-County area. He was responsible for all USGS surface-water quality monitoring stations involved with the Charleston Harbor Project 1992-95. Mr. Long is an instructor for the U.S. Department of Interior Motorboat Operator Certification course and is a licensed U.S. Coast Guard Captain.

Problem Definition:

Thirty-seven percent of the population of the United States lived within 60 miles of the coast and coastal ecosystems in 1994 (Cohen and others, 1997). Over the next several decades, the coastal population of the southeastern United States, in particular, is expected to increase at an even faster rate than previous decades (Culliton and others, 1990).

The Charleston (South Carolina) area has experienced significant expansion throughout its 331 years of existence (fig. 1). From its beginnings as a peninsular settlement in 1670, the Charleston area now includes a mix of residential areas, industrial parks, historic neighborhoods, and shopping complexes. During the past twenty years, the population of Charleston County has increased from 277,000 to 320,500 (more than 15 percent), and is projected to reach 366,100 by 2020 (S.C. Budget and Control Board, 2001). Estimated increases in population translates into the addition of approximately 44,500 housing units and 61,400 motor vehicles, and the generation of an additional 13.7 million gallons per day of wastewater (Laura S. Cabiness, U.S. Environmental Protection Agency EMPACT grant, Sorting Code 2001-NCER-J1, see Appendix 1).

Planners and government officials in coastal areas must provide the necessary infrastructure and services to accommodate this growth to avoid increased loadings of point and non-point source pollutants to estuarine environments. The watersheds that drain into the numerous meandering, shallow tidal creeks and salt marshes of the Charleston area will be the preferred sites for much of the projected development.

The creeks and associated marshes provide nursery habitat for many fish and shellfish (Hackney and others, 1976; Weinstein, 1979; Wenner and Beatty, 1993). The juvenile stages of fish and shellfish that occur in tidal creeks are frequently more sensitive to pollution exposure and changes in environmental conditions than adults (Baughman and others, 1989). In addition, these marshes are also important feeding areas for wading birds and large fish (Dodd and Murphy, 1996; Wenner, 1992).

Estimation of pollutant loadings into tidal creeks and determination of the impacts on water and sediment quality in the estuarine portion of tidal creeks is essential information for developing effective stormwater management and remedial action plans. The potential pollutants of concern include metals, polycyclic aromatic hydrocarbons (PAHs), pesticides, organics, and nutrients (Fortner and others, 1996; Kucklick and others, 1997; Sanger and others, 1999a, 1999b). These increased loadings are projected to adversely affect the productivity, biodiversity, and ecological functioning of the many tidal creeks and other aquatic environments of the area (Vitousek and others, 1997).

If tidal creeks and the critical processes that occur within them are to be preserved, resource management and regulatory agencies responsible for sustaining them must identify and understand linkages between human activities in the watershed and ecological characteristics of creek habitats.

To be completed by City of Charleston by extracting text from proposal (introductory material)

Program Objectives and Description:

The U.S. Geological Survey and the South Carolina Department of Natural Resources proposes to work cooperatively with the City of Charleston to achieve project objectives.

The specific objectives of this study are:

- To utilize existing and innovative technologies to quantify stormwater flow, characterize stormwater quality, and compute rainfall-event loading of selected constituents from four small basins having relatively uniform land use;
- To assess the effects of chemical loadings from suburban and urban creeks on water and sediment quality in the headwater portions of estuarine tidal creeks, and determine whether similar effects are observed in tidal creek habitats located further downstream;
- To relate pre- and post-rain event conditions in the monitored watersheds with general conditions observed in more pristine creek systems having similar natural environmental characteristics;
- To measure and characterize atmospheric deposition from a selected site in the Charleston metropolitan area (fig. 1);
- To employ state-of-the-art technology to present this information to the public in as timely a manner as possible; and
- To conduct an extensive education campaign to ensure that this information is relevant and useful to the area's residents.

To be completed by City



Figure 1. Location of selected creeks in the Charleston, South Carolina study area.

Quality Objectives and Criteria:

General paragraph to be completed by City. Other paragraphs in following sections to be added by USGS

Special Training Requirements:

All field personnel operating SCDNR boats will: (1) pass a SCDNR boating safety course. All project staff will also attend a minimum of a 1-day training session on all aspects of the use of water sampling equipment and water quality measuring techniques and bottom sediment sampling and processing techniques. The lead investigators will accompany field personnel on all preliminary sampling trips and at least 50% of subsequent trips to ensure high quality samples are collected. All laboratory personnel who process samples will be properly trained and supervised by the appropriate project and laboratory managers. Additional details on staff training and quality assurance measures are provided in later sections.

USGS Training Requirements:

USGS field personnel assigned to this project will be required to have complete the following safety training: American Red Cross First-aid and CPR course, and the USGS Motor Boat Operator Certification course. Field personal will also follow the guild lines set forth in the USGS Water Resources Division Memorandum 99.32 “Water Resources Division Policy for Safety Associated with Discharge Measurements, Sampling, and Related Streamgaging Activities”.

Field personnel will be required to attend training sessions taught by certified USGS personnel on National Water Quality Assessment Program (NAWQA) clean hands sampling protocols and operation, calibration, and servicing of water quality sensors for portable monitoring equipment. In addition, personnel will attend a USGS National Training Center course on the guidelines for continuous monitors. This course presents the general quality-assurance concepts and theory for the operation of continuous water-quality monitors.

Documentation and Records:

All field sampling efforts and samples collected will be recorded on various data forms that have been established by the MRRI. The Basic Station Data form will be used to record the sampling date, location, station depth, time and type of sample collected, unique sample collection number, station code and other pertinent information as required for the project. All samples brought to the laboratory will be logged into the MRRI laboratory using Sample Tracking Data forms for each appropriate laboratory. These forms will be used to monitor and track the location of each sample brought to the laboratory, monitor the status of sample processing and maintain a chain of custody. All SCDNR sample tracking forms will be maintained in master notebooks in each lab under the Lab Manager’s supervision. In some cases, USGS or NOS sample tracking and data forms will be used for water chemistry samples when that agency is collecting or processing the samples. These forms will be used to track the status of sample processing and who processed the sample. All sediment composition data will be

recorded on the Pipet Analysis Bench Sheet form. QA/QC forms will be used as part of our quality check for the sediment samples. A general summary of the sample processing protocols for each major sampling component is provided in the following section.

USGS Documentation and Records

USGS Continuous Water-Quality Monitoring

All field measurements and calibration data of continuous water-quality monitoring equipment and water-quality field meters will be recorded on standard USGS Surface-Water Quality Field Notes sheets (appendix 2). The Field Notes sheets will include at a minimum the following information, (1) project number, (2) location, (3) date and time, (4) field parameters, (5) instrumentation make/model, (6) instrumentation serial numbers (7) persons performing work, (8) weather conditions, (9) sample date and time, (10) unique sample collection number, (11) type of sample collected, (12) preservatives used, (13) laboratory schedules, (14) blanks, and other information required for the project. All Field Notes sheets will be completed on-site while in the field. The original Field Notes sheet is returned to the USGS office and placed in the current folder file for each corresponding station. All USGS Field Notes sheets are completed in ink. Field Notes sheets along with the real-time data will then be used during the records computation phase. The records computation process is to verify the data and document its quality. The primary steps in processing the records are an initial data evaluation, application of corrections and shifts, application of cross-section corrections, and a final data evaluation. The processed data is assembled into a final data package, which is then checked and reviewed by other USGS personnel. Once approved, this final data package is published in the USGS Annual Report and archived within the USGS (Hubbard, 1992). Data collected on paper and electronically will be stored either in the USGS National Water Information System (NWIS) QWDATA data base (Maddy and others, 1997) or in the NWIS Automated Data Processing System (ADAPS) database (Dempster, 1990). The NWIS is the storage medium for water-quality, streamflow, well, and water-use information collected by the USGS.

USGS Discharge Measurements

The USGS current-meter method will be used for the direct measurement of surface-water discharge (Rantz and others, 1982). USGS policy requires spin tests to be performed on current meters before and after each use (Rantz and others, 1982). The spin tests results will be documented in a logbook that is maintained for each instrument. Field personnel will record discharge measurements on standard USGS forms 9-275-F or 9-275-G (appendix 3). The completed measurement form is returned to the USGS office and checked by another USGS employee. Then it will be placed in a current folder for each corresponding station. The measurement forms, along with the real-time data, will then be used during the records computation phase. The records computation process is to verify the data and document its quality. Components of surface-water discharge records are accurate gage-height corrections and shifts, hydrograph, and station analysis. All of these components are compiled into a final data package, which is then checked and reviewed by other USGS personnel. Once approved, this final data package is published in the USGS Annual Report and archived within the USGS (Hubbard, 1992).

USGS Water-Quality Sampling

All sample-collection information will be recorded on standard USGS Surface-Water Quality Field Notes sheets. All Field Notes sheets will be completed on-site at the time sampling occurs. The original Field Notes sheet will be returned to the USGS office and placed in a bound notebook that will be maintained by field personnel. USGS National Water Quality Laboratory (NWQL) Analytical Services Request forms (ASR) (appendix 4), sample tracking and chain of custody forms, will be used to record data and submitted with the samples to the appropriate lab. Protocols for labeling, documenting, and packaging samples will be in accordance with Wilde and others (1999). All water-quality data will be electronically transferred from the databases of NWQL or the USGS Quality Water Service Unit (QWSU) in Ocala, Florida to the NWIS QWDATA database, which is retrieved by the S.C. District Data Base Administrator at least once a week (Wang, 1999). Data analyzed by laboratories other than the NWQL or QWSU will be entered into NWIS database (Hubbard, 1992).

Measurements/ Data Acquisition

Sample Collections and Handling:

SCDNR Secchi Disk Readings:

A secchi disk will be deployed at all sites during the instrument deployment to obtain an estimate of water clarity. Secchi depth readings will be taken to the nearest 0.1 m using a solid white disk. All readings will be collected from the leeward side of the boat if the wind results in water chop and readings will be taken from a location that will reduce surface glare as much as feasible. All field crews will be trained to conduct secchi depth readings using the same procedure

SCDNR Water Column Measurements:

Characterization of the water column will be determined by each of two approaches: point-in-time vertical profiles and continuous, long-term (*i.e.*, multi-day), near-bottom measurements. Hydrolab, YSI or Stevens Greenspan instrumentation (Hydrolab DS3[®] and DS4[®]; YSI 85[®] and 6920[®]; Stevens Greenspan CS304) will be used in conjunction with hand held pH meters (Hanna Instruments pHep[®] 3) to obtain measurements of temperature, salinity, dissolved oxygen, pH, and depth. pH will be measured at the surface only. Instantaneous measurements of all other variables will be taken and recorded at the surface (depth = 0.3 m) mid-depth (if total depth is greater ≥ 2 m) and bottom (~ 0.5 m from bottom). The deployed datalogger instruments will be used to continuously record long-term series of temperature, salinity, conductivity, DO, pH, and depth in near-bottom water (~ 0.5 meters from bottom).

SCDNR Water Column Samples:

Surface measures of total and dissolved nitrate/nitrite nitrogen, ammonia, total and dissolved phosphorus, total organic carbon, biological oxygen demand (BOD₅), turbidity (NTU), total suspended solids (TSS), and total alkalinity will be collected at each site using protocols consistent with the USGS or existing SCDNR SCECAP monitoring programs. All SCDNR samples will be collected by inserting pre-cleaned (acid cleaning followed by DI water rinse) water bottles to a depth of 0.3 m depth inverted and then filling the bottle directly at that depth. The bottles will then be stored on ice until they are brought to the laboratory, where they will be preserved with sulfuric acid (nutrient and TOC samples only). Dissolved nutrient samples will be collected in the same manner, but will be further processed in the field by filtering the water samples through a 0.45 µm pore cellulose acetate filter prior to delivering the dissolved nutrient samples to the laboratory.

SCDNR Phytoplankton Samples:

Estimates of phytoplankton concentration will be made using chlorophyll measurements. In the field, at least one sample of water will be collected 0.3 m below the surface using an inverted bottle. The sample will be kept on ice for transfer to the laboratory.

SCDNR Sediment Samples:

Following the water sample collections, several replicate grab samples will be collected at each station to evaluate sediment characteristics and sediment contaminant levels. All grabs will be thoroughly cleaned with an Alconox solution, and rinsed with both water and a dilute solution of HCL prior to going in the field. The grabs will receive an additional rinse of isopropyl alcohol and seawater between stations. A total of 8-10 grab samples will be collected at each site. All samples will be collected using a stainless steel 0.04 m² Young grab sampler from an anchored boat. The boat will be repositioned between each sample by adjusting the anchor rode to ensure that the same bottom is not sampled twice, and to spread the samples over a 10-20 m² bottom area. In addition, each grab sample will be inspected carefully before being accepted for benthic community assessment. Grab samples will be rejected if they did not close properly or penetrate to a minimum depth of 7 cm. Additionally, the surface of the sediment must not show evidence of winnowing or obvious disturbance.

The grab samples will be used to obtain a sediment composite sample for analysis of sediment composition and contaminants. Only the surficial sediments (upper 5 cm) will be collected from these grabs and combined to produce a composite sediment sample of approximately 6L. The composite sediment samples will be stored in a stainless steel pot covered with a lid to avoid contamination, and chilled on ice throughout processing. When the required amount of sediment has been obtained, the composite sample will be thoroughly stirred with a stainless steel spoon and subdivided into separate containers for use in sediment characterization analyses (sand vs. silt/clay composition, total organic carbon), porewater analyses (pH, salinity, and ammonia), and analysis of sediment contaminants (metals, organics).

At intertidal creek locations, an acid cleaned stainless spoon may be used to collect surficial samples from multiple locations along a 25 m creek segment to obtain a composite sample instead of the grab.

The composite sampling pot and spoons will thoroughly scrubbed to remove any sediment, rinsed with isopropyl alcohol or acetone between sampling sites, and then rinsed in ambient seawater prior to use at the next site to reduce the potential for cross-contamination between sites.

All samples will be kept on ice until brought to the laboratory. Sediment composition and contaminant samples will be stored in plastic containers (either Whirlpak® or screw-cap HDPE jars), or acid cleaned nalgene or glass containers for the contaminant samples.

SCDNR Atmospheric Samples:

As part of this study, the SCDNR will be collecting weekly samples of atmospheric deposition in conjunction with a cooperative effort between the USEPA, SCDHEC, and SCDNR. The sampler will be located at Ft. Johnson and will represent one unit of the National Atmospheric Deposition Program/National Trends Network. The site will also be affiliated with the USEPA National Estuary Program. Samples will be collected and processed following USEPA protocols for the following parameters: hydrogen (acidity as pH), sulfate, nitrate, ammonium, chloride, and base cations (such as calcium, magnesium, potassium and sodium). All sample analyses will be completed by the Illinois State Water Survey's Central Analytical Laboratory and the data will be managed by Illinois State Water Survey data management system in Champaign, Illinois. The USEPA initiated the quality assurance program in May of 1984 in the Coordination Office of the NADP. The project is designed to identify, implement and coordinate quality assurance activities within the NADP/NTN monitoring program. The program supplies the primary funding for the network's Quality Assurance Manager and supports a number of documentation and quality assurance planning activities associated with the network and its data management system.

USGS Streamflow, Stage and Rainfall Measurements:

A USGS streamflow and water-quality monitoring gaging station will be established at or near the headwaters of each of the four tidal creeks, and operated for the duration of the project (Rantz and others, 1982). Stream stage (water-level) will be measured continuously using a bubble-gage sensor in accordance with Rantz and others (1982). Stream stage data will be recorded at fifteen-minute intervals during "normal" flow conditions and at one-minute intervals when predetermined "threshold" values are exceeded. Rainfall data will be collected at one-minute intervals by tipping bucket raingages.

Velocity measurements will be measured using an acoustic velocity meter in accordance with Rantz and others (1982). Also, streamflow measurements using the current-meter method will be made during storm-water events (Rantz and others, 1982).

Rating curve and index velocity methods will be used to determine stream discharge for each USGS gaging site (Rantz and others, 1982).

USGS Real-Time Reporting Capability:

Each gaging station will be equipped with telemetry equipment to routinely transmit provisional stage, flow, and water-quality data in near real time (transmitted at 4-hour intervals) to the Columbia, S.C. office of the USGS. In addition, real-time radio or landline telemetry will be used to contact USGS and City of Charleston personnel at the beginning of a rainfall event that meets a predetermined intensity. USGS personnel will monitor the rainfall and streamflow data and decide if the event meets the criteria for water-quality sampling.

USGS Water-Quality Measurements:

Deployed datalogger instruments will be used to continuously record long-term data for water temperature and conductivity at each of the four sites. Temperature and conductivity data will be collected at fifteen-minute intervals during periods of base flow and at five-minute intervals during runoff events. The pH data will be collected only during sampling events.

Field parameters, including temperature, conductivity, pH, and dissolved oxygen, will be measured during storm-events with a datalogger instrument in accordance with Wilde and Radtke (1999). Field measurements should represent the natural conditions of the system at the time of sampling. To ensure quality of the measurements, calibration within the range of field conditions at each site is required.

USGS Storm-Event Water-Quality Samples:

Storm-event samples will be collected by the use of refrigerated automated samplers, but sampling protocol requires that fecal coliform bacteria samples be collected manually. Each site will also be equipped with a backup non-refrigerated automated sampler. Additional depth- and width-integrated samples will be collected in the stream cross section for comparison with the automatically collected point samples. Automated samplers will collect samples at predetermined intervals to cover the hydrograph. The interval will be set after reviewing runoff characteristics recorded at each site. During each sampling event, discrete samples will be collected at three points of the hydrograph: a “first-flush” sample on the rising limb of the hydrograph; a sample near the time of peak flow occurrence; and a sample on the falling limb of the hydrograph. Samples will be decanted and discrete samples will be composited in a pre-cleaned polyethylene churn (Wilde and others, 1999), emptied in polyethylene bottles, preserved as listed in table 3, and sent for analysis for the parameters listed below, except bacteria. A storm-event bacteriological sample will be collected in a 250 mL sterilized bottle (Wide and others, 1999), stored on ice, (Myers and Wilde, 1997), and delivered to a local certified laboratory for analysis within six hours of collection. Samples will be handed and processed using USGS protocol(s), which are described in detail in following sections.

Storm-event samples will be collected over the course of at least 8 storm events (two storm events each season, spring, summer, fall, and winter) during the 12-month data collection period. The USGS National Water-Quality Laboratory (NWQL) in

Denver, Co., will analyze water sample for physical properties, and nutrient, metal, volatile organic compound, PAH/base neutral extractable acid (BNA), pesticide, total organic carbon, and total suspended solid concentrations. The USGS Quality Water Service Unit (QWSU) in Ocala, Florida will analyze five-day biological oxygen demand (BOD) and ultimate BOD concentrations. General Engineering Laboratories, certified by the South Carolina Department of Health and Environmental Control (SCDHEC), will analyze samples for fecal coliform bacteria. For each site, pesticide concentrations will be determined from one water sample collected in the spring. Base neutral extractable acids concentrations also will be determined from one sample collected during the year at each site. The USGS National Water-Quality Laboratory in Denver, Co will analyze these samples.

USGS Suspended Sediment Samples:

Suspended sediment samples will be collected by the use of refrigerated automated samplers. Samples will be collected at predetermined intervals to cover the hydrograph, as described above. The USGS Sediment Laboratory in Kentucky will analyze samples for suspended-sediment concentrations.

Sample Handling, Tracking and Custody Requirements:

SCDNR Water Quality Samples:

Water quality (e.g. nutrient, BOD, turbidity) samples that are brought to the laboratory will be processed immediately according to the sample type. Total and dissolved nutrient samples will be preserved with acid following standardized protocols and delivered to the appropriate laboratory for analyses. Sample tracking / chain of custody forms will be filled out and submitted with the samples.

SCDNR Sediment Samples:

All sediment samples will be logged into the sorting and sediment processing lab inventory file immediately upon receipt from field crews. Standard MRRI Sample Tracking Forms will be used to record the data, and will be maintained and updated in each laboratory by lab staff under the supervision of the appropriate lab manager (see appendix for Laboratory Sample Tracking Forms). Station code and unique MRRI collection numbers will be cross-referenced against Basic Station Data forms (see appendix) to identify any discrepancies. Missing or damaged samples will be reported to the sorting Lab Manager or sediment lab manager for appropriate resolution. Location and processing status will be documented on the appropriate Laboratory Tracking form using MRRI collection numbers as the means for tracking custody of all samples.

The sediments collected for contaminant analyses will be frozen and delivered to the NOS Charleston Laboratory for analyses. All other sediment samples will be held at 4°C at the SCDNR laboratory, except for the sediment composition samples which will be frozen, until they are analyzed or shipped in insulated containers with cold packs to the appropriate laboratory for processing. Field sampling sheets and sample tracking

sheets will be used so that personnel, storage and transfer of samples, and chain of custody are tracked.

Stored samples will be organized according to collection numbers. Storage shelves will be clearly labeled by project and/or batch and will provide appropriate safety measures to comply with OSHA laboratory standards. All preserved benthic samples will be stored out of direct sunlight at approximately 21 degrees Celsius in a 10% buffered formalin solution.

USGS Water Quality Samples:

Samples from each of the four tidal creeks will be labeled with a unique USGS field identification number as the means for tracking each sample. Sample tracking/chain of custody forms (ASR) will be used to record the data and submitted with the samples to the appropriate lab. Protocols for labeling, documenting, and packaging samples will be in accordance with Wilde and others (1999). Water-quality samples, according to the sample type, will be preserved with acid following standardized protocols, put on ice (Myers and Wilde, 1997), and shipped in insulated containers to the USGS National Water-Quality Laboratory (NWIS) in Denver, Co. for analyses. Five-day biological oxygen demand (BOD) and ultimate BOD samples will be collected, stored on ice, and delivered in insulated containers to The USGS Quality Water Service Unit (QWSU) in Ocala, Florida. Bacteriological samples will be collected manually, stored on ice, and delivered in insulated containers to General Engineering Laboratories for analysis within six hours of collection. Federal Express will be the shipping company used for all shipments of samples through out the entire project.

USGS Suspended Sediment Samples:

Suspended sediment samples from each of the four tidal creeks will be labeled with the unique USGS field identification number for that site, as the means for tracking each sample. Protocols for labeling, documenting, and packaging samples will be in accordance with Wilde and others (1999). Samples for analyzes of suspended sediment concentrations will be put on ice and shipped in insulated containers to the USGS Sediment Laboratory in Kentucky.

Analytical Methods Requirements:

SCDNR Water Chemistry Sample Processing:

All water chemistry samples that are analyzed by the SCDHEC will utilize standard SCDHEC (1997) procedures. These procedures involve USEPA certified approaches and meet all quality assurance and precision requirements for that agency. Samples that are not processed by the SCDHEC will utilize a Technicon autoanalyzer and standardized protocols for measuring dissolved nutrient species. Methods and quality assurance protocols are available at www.baruch.sc.edu/baruch/data1.html if the samples are run at the USC Belle W. Baruch Marine Laboratory. If another laboratory is

chosen, the methods will follow that laboratory's protocol and meet EPA requirements. Duplicate samples will be processed for at least 10% of all samples analyzed. Accuracy and precision of the data provided is listed in Table 1.

SCDNR Sediment Composition Processing:

Particle size analyses will be performed by qualified and experienced personnel using a modification of the pipette method described in Plumb (1981). Pipette extractions will be timed to determine percentages of sand (≥ 63 microns) and combined silt/clay (< 63 microns). Results will be recorded on the Sediment Pipette Analysis Bench Sheet (see appendix.). Accuracy and precision of the data provided is listed in Table 1.

SCDNR Sediment Contaminant Samples:

Contaminants to be measured in the sediments and tissues are listed in Table 2, along with information on required detection limits. All contaminants will be analyzed by either the NOAA National Ocean Service (NOS) Charleston Laboratory or another qualified laboratory using the following protocols. If a commercial laboratory is used, extraction and sample preparation methodologies may vary, but the laboratory must meet USEPA standards and be certified by the South Carolina Department of Health and Environmental Control.

Extraction and sample preparation that would be done by the NOAA-NOS laboratory for organics will be similar to those described by Krahn et al.(1988) and Fortner et al. (1997). Samples will then be extracted with CH_2Cl_2 using accelerated solvent extraction [ASE], concentrated by nitrogen blow-down, and cleaned by gel permeation chromatography where necessary. PAHs will be quantified by capillary GC-ion trap mass spectrophotometry (ITMS). Organochlorine pesticides and PCB's will be analyzed using dual column gas chromatography with electron capture detection (GC-ECD) using methods described by Kucklick et al. (1997). Trace metals will be analyzed using methods described by Long et al. (1997) using inductively coupled plasma spectroscopy (ICP) for Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Ni, Sn, Zn and by graphite furnace atomic absorption for Ag, As, Cd, Pb, and Se. Mercury will be analyzed by cold-vapor atomic absorption. Quality control samples (blanks, spikes, and SRMs) will be analyzed for each group of samples for each analytical method. Further details regarding methodologies are provided in Table 2 or can be clarified if requested by the contract officer.

Table 2. Methods and detection limits for contaminants in sediments

Chemical Class	Analyte	CAS Number	Typical Detection Limit	AA	ICP	Hg Cold Vapor	GC/EC D	GC/MS	HPLC/IF D
Metal	Aluminum	7429-90-5	0.088 %			X			
Metal	Arsenic	7440-38-2	0.036 ug/g dry wt	X	X				
Metal	Cadmium	7440-43-9	0.035 ug/g dry wt	X	X				
Metal	Chromium	7440-47-3	0.03 ug/g dry wt	X	X				
Metal	Copper	7440-50-8	0.3 ug/g dry wt		X				
Metal	Iron	7439-89-6	0.0012 %		X				

Metal	Lead	7439-92-1	0.16 ug/g dry wt	X	X		
Metal	Manganese	7439-96-5	0.1 ug/g dry wt		X		
Metal	Mercury	7439-97-6	0.04 ug/g dry wt	X		X	
Metal	Nickel	7440-02-0	1.9 ug/g dry wt		X		
Metal	Selenium	7782-49-2	0.034 ug/g dry wt	X			
Metal	Silver	7440-22-4	0.020 ug/g dry wt	X			
Metal	Tin	7440-31-5	7.8 ug/g dry wt		X		
Metal	Zinc	7440-66-6	0.2 ug/g dry wt		X		
PAH	1-Methylnaphthalene	90-12-0	26.2 ng/g dry wt				X
PAH	1-Methylphenanthrene	832-69-9	24.2 ng/g dry wt				X
PAH	1,6,7 Trimethylnaphthalene	2245-38-7	12.2 ng/g dry wt				X
PAH	2-Methylnaphthalene	91-57-6	36 ng/g dry wt				X
PAH	2,6 Dimethylnaphthalene	581-42-0	24.4 ng/g dry wt				X
PAH	Acenaphthene	83-32-9	42.2 ng/g dry wt				X
PAH	Acenaphthylene	208-96-8	11 ng/g dry wt				X
PAH	Anthracene	120-12-7	22.6 ng/g dry wt				X X
PAH	Benzo(a)anthracene	56-55-3	49.8 ng/g dry wt				X X
PAH	Benzo(a)pyrene	50-32-8	63.2 ng/g dry wt				X X
PAH	Benzo(b+j)fluoranthene	205-99-2 & ??	38.6 ng/g dry wt				X
PAH	Benzo(e)pyrene	192-97-2	29.2 ng/g dry wt				X X
PAH	Benzo(g,h,i)perylene	191-24-2	39.6 ng/g dry wt				X X
PAH	Benzo(k)fluoranthene	207-08-9	33 ng/g dry wt				X X
PAH	Biphenyl	92-52-4	41.2 ng/g dry wt				X
PAH	Chrysene+Triphenylene	218-01-9 & ??	14.2 ng/g dry wt				X
PAH	Dibenz(a,h+a,c)anthracene	53-70-3 & ??	10.6 ng/g dry wt				X
PAH	Fluoranthene	206-44-0	27.8 ng/g dry wt				X X
PAH	Fluorene	86-73-7	18.2 ng/g dry wt				X X
PAH	Indeno(1,2,3-cd)pyrene	193-39-5	61.4 ng/g dry wt				X X
PAH	Naphthalene	91-20-3	65.6 ng/g dry wt				X
PAH	Perylene	198-55-0	36.8 ng/g dry wt				X X
PAH	Phenanthrene	85-01-8	21.8 ng/g dry wt				X X
PAH	Pyrene	129-00-0	20.4 ng/g dry wt				X X
PCB	PCB 101	37680-73-2	1.3 ng/g dry wt			X	
PCB	PCB 104	56558-16-8	1.3 ng/g dry wt			X	
PCB	PCB 105	32598-14-4	1.59 ng/g dry wt			X	
PCB	PCB 118	31508-00-6	0.87 ng/g dry wt			X	
PCB	PCB 126	57465-28-8	1.69 ng/g dry wt			X	
PCB	PCB 128	38380-07-3	0.91 ng/g dry wt			X	
PCB	PCB 138	35065-28-2	2.31 ng/g dry wt			X	
PCB	PCB 153	35065-27-1	1.33 ng/g dry wt			X	
PCB	PCB 154	60145-22-4	1.3 ng/g dry wt			X	
PCB	PCB 170	35065-30-6	2.04 ng/g dry wt			X	
PCB	PCB 18	37680-65-2	1.95 ng/g dry wt			X	
PCB	PCB 180	35065-29-3	1.39 ng/g dry wt			X	
PCB	PCB 187	52663-68-0	0.62 ng/g dry wt			X	
PCB	PCB 188	74487-85-7	1.3 ng/g dry wt			X	
PCB	PCB 195	52663-78-2	1.56 ng/g dry wt			X	
PCB	PCB 201	52663-75-9	1.3 ng/g dry wt			X	

Chemical Class	Analyte	CAS Number	Typical Detection Limit	AA	ICP	Hg Cold Vapor	GC/ECD	GC/MS	HPLC/CFD
PCB	PCB 206	40186-72-9	1.27 ng/g dry wt						X
PCB	PCB 209	2051-24-3	1.3 ng/g dry wt						X
PCB	PCB 28	7012-37-5	2.54 ng/g dry wt						X
PCB	PCB 29	15862-07-4	1.3 ng/g dry wt						X
PCB	PCB 44	41464-39-5	0.68 ng/g dry wt						X
PCB	PCB 50	62796-65-0	1.3 ng/g dry wt						X
PCB	PCB 52	35693-99-3	0.88 ng/g dry wt						X
PCB	PCB 66	32598-10-0	0.79 ng/g dry wt						X
PCB	PCB 77	32598-13-3	19.5 ng/g dry wt						X
PCB	PCB 87	38380-02-8	1.3 ng/g dry wt						X
Pesticide	2,4'-DDD	53-19-0	0.79 ng/g dry wt						X
Pesticide	2,4'-DDE	3424-82-6	0.75 ng/g dry wt						X
Pesticide	2,4'-DDT	789-02-6	1.87 ng/g dry wt						X
Pesticide	4,4'-DDD	72-54-8	3.16 ng/g dry wt						X
Pesticide	4,4'-DDE	72-55-9	0.43 ng/g dry wt						X
Pesticide	4,4'-DDT	50-29-3	0.21 ng/g dry wt						X
Pesticide	Aldrin	309-00-2	0.17 ng/g dry wt						X
Pesticide	Chlorpyrifos	2921-88-2	1.3 ng/g dry wt						X
Pesticide	Cis-chlordane (alpha-chlordane)	5103-71-9	1.07 ng/g dry wt						X
Pesticide	Dieldrin	60-57-1	2.36 ng/g dry wt						X
Pesticide	Endosulfan ether		1.3 ng/g dry wt						X
Pesticide	Endosulfan I	959-98-8	1.3 ng/g dry wt						X
Pesticide	Endosulfan II	33213-65-9	1.3 ng/g dry wt						X
Pesticide	Endosulfan Lactone		1.3 ng/g dry wt						X
Pesticide	Endosulfan Sulfate	1031-07-8	1.3 ng/g dry wt						X
Pesticide	Gamma-HCH (g-BHC, lindane)	58-89-9	0.99 ng/g dry wt						X
Pesticide	Heptachlor	76-44-8	0.52 ng/g dry wt						X
Pesticide	Heptachlor epoxide	1024-57-3	1.32 ng/g dry wt						X
Pesticide	Hexachlorobenzene	118-74-1	0.81 ng/g dry wt						X
Pesticide	Mirex	2385-85-5	2.03 ng/g dry wt						X
Pesticide	Trans-nonachlor	39765-80-5	1.22 ng/g dry wt						X

USGS Water Chemistry Sample Processing:

All water chemistry samples that are analyzed by the USGS National Water-Quality Laboratory (NWQL) in Denver, Co., USGS Quality Water Service Unit (QWSU) in Ocala, Florida, and the USGS Sediment Laboratory in Kentucky will utilize standard USGS procedures. These procedures involve USEPA certified approaches and meet all quality assurance and precision requirements for that agency. Methods and quality assurance protocols are available at

http://www.nwql.cr.usgs.gov/Public/pubs/QC_Fact/text.html for samples analyzed by the USGS National Water Quality Laboratory. Methods and quality assurance protocols are available at ??? for samples analyzed for five-day biological oxygen demand (BOD) and

ultimate BOD concentrations at the USGS Quality Water Service Unit (QWSU) in Ocala, Florida. Methods and quality assurance protocols are available at http://ky.water.usgs.gov/projects/sed_lab/OFR_98_384.pdf for samples analyzed for suspended-sediment concentrations at the USGS Sediment Laboratory in Kentucky. General Engineering Laboratory in Charleston, S.C, will analyze bacteriological samples. The methods used to analyze bacteria will follow that laboratory's protocol and meet EPA requirements.

Parameters to be measured in water quality samples are listed in Table 3, with NWQL lab codes, methods, and reporting detection limits. Trace elements in whole water will be analyzed using graphite furnace atomic absorption spectrophotometry method (GFAA) for arsenic, cadmium, chromium, copper, lead, molybdenum, nickel, selenium and by inductively coupled plasma spectroscopy method (ICP) for aluminum, iron, lithium and manganese. Mercury will be analyzed by cold vapor atomic fluorescence methods (CVAF). Nutrients will be analyzed by colorimetric-automated-segmented flow methods (C-ASF). This includes Salicylate-hypochlorite (1), Microkjeldahl digestion (2), Cadmium-Reduction-diazotization (3), and Phosphomolybdate (4) methods. Volatile organic compounds in whole water will be analyzed using gas chromatography and mass spectrometry (GC/MS) in accordance with methods described by Connor and others (1997),. Oranochlorine pesticides and gross polychlorinated biphenyl will be analyzed using gas chromatography with electron capture detection methods (GC/ECD). Polar pesticides and metabolites will be analyzed using high performance liquid chromatography-mass spectrometry after solid phase extraction methods (HPLC/MS-SPE) in accordance with (WRIR 01-4134). Broad spectrum, low-level dissolved pesticides will be analyzed using capillary column gas chromatography and mass spectrometry with selected ion monitoring after solid phase extraction with C-18 cartridge (Zaugg and others, 1995). Broad spectrum, low-level pesticides will be analyzed using high performance liquid chromatography after carbopak-B solid-phase extraction (Werner and others, 1996). Base-Neutral plus Acid Extractables will be analyzed using gas chromatography and mass spectrometry methods (GC/MS). Quality control samples (blanks and spikes) will be analyzed, using analytical methods described above, for all parameters.

Table 3. USGS NWQL lab schedules, methods, and detection limits for contaminants in water quality samples.

(GFAA, Graphite Furnace Atomic Absorption Spectrophotometry; ICP, Inductively Coupled Plasma technique; CVAF, Cold Vapor Atomic Fluorescence, C-ASF, Colorimetric - automated-segmented flow; GC/MS, Gas Chromatography/Mass Spectrometry; GC/ECD, Gas Chromatography/Electron Capture Detection; HPLC/MS – SPE, high performance liquid chromatography – mass spectrometry after solid phase extraction (SPE); GC/MS-SIM, capillary column gas chromatography/mass spectrometry with selected ion monitoring after solid phase extraction with C-18 cartridge; HPLC-SPE, High Performance Liquid Chromatography after Carbopak-B Solid-Phase Extraction; µg/l, microgram per liter; ml, milliliter; LRL, lower reporting level; MRL, middle reporting level)

Description of NWQL Lab Schedule 167 – trace elements in whole water, total recoverable.

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level/Unit	Reporting Level Type
aluminum	2351	01105	ICP	7429-90-5	28 µg/L	LRL
arsenic	2162	01002	GFAA	7440-38-2	1.9 µg/L	LRL
beryllium	2353	01012	C	7440-41-7	2.5 µg/L	LRL
cadmium	1555	01027	GFAA	7440-43-9	0.12 µg/L	LRL
chromium	1937	01034	GFAA	7440-47-3	0.8 µg/L	LRL
copper	1559	01042	GFAA	7440-50-8	1.2 µg/L	LRL
Digestion for trace metals	1735	99870	B	-	no.	MRL
Inductively coupled plasma (ICP) setup	2180	na	na	na	na	na
iron	2359	01045	ICP	7439-89-6	12 µg/L	LRL
lead	1561	01051	GFAA	7439-92-1	1 µg/L	LRL
lithium	2361	01132	ICP	7439-93-2	4.4 µg/L	LRL
manganese	2363	01055	ICP	7439-96-5	2.4 µg/L	LRL
mercury	2708	71900	CVAF	7439-97-6	0.011 µg/L	LRL
molybdenum	1999	01062	GFAA	7439-98-7	1.8 µg/L	LRL
nickel	1563	01067	GFAA	7440-02-0	2.0 µg/L	LRL
pH, laboratory	68	00403	A	-	0.1 pH	mrl
selenium	2163	01147	GFAA	7782-49-2	2.0 µg/L	LRL
specific conductance, laboratory	69	90095	A	-	2.6 µS/cm	mrl
zinc	2371	01092	ICP	7440-66-6	25 µg/L	LRL

Description of NWQL Lab Schedule 878 – Nutrients and Microkjeldahl Nitrogen.

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level/Unit	Reporting Level Type
Ammonia, Dissolved	1976	00608	C-ASF1	7664-41-7	0.041 mg/L	LRL
Ammonia+Organic Nitrogen, Total	1986	00625	C-ASF2	17778-88-0	0.10 mg/L	LRL
Nitrite + nitrate, Dissolved	1975	00631	C-ASF3	-	0.047 mg/L	LRL
Phosphorus, Total	1984	00665	C-ASF2	7723-14-0	0.06 mg/L	LRL
Ortho-phosphate, Dissolved	1974	00671	C-ASF4	14265-44-2	0.018 mg/L	LRL

Description of NWQL Lab Schedule 1380 – Volatile organic compounds in whole water.

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level	Reporting Level Type
1,1,1,2-Tetrachloroethane	1484	77562	GC/MS	630-20-6	0.2 µg/L	MRL
1,1,1-Trichloroethane	1309	34506	GC/MS	71-55-6	0.1 µg/L	MRL
1,1,2,2-Tetrachloroethane	1306	34516	GC/MS	79-34-5	0.2 µg/L	MRL
1,1,2-Trichloroethane	1310	34511	GC/MS	79-00-5	0.2 µg/L	MRL
1,1,2-Trichlorotrifluoroethane	1681	77652	GC/MS	76-13-1	0.1 µg/L	MRL
1,1-Dichloroethane	1297	34496	GC/MS	75-34-3	0.1 µg/L	MRL
1,1-Dichloroethylene	1299	34501	GC/MS	75-35-4	0.1 µg/L	MRL
1,1-Dichloropropene	1478	77168	GC/MS	563-58-6	0.2 µg/L	MRL
1,2,3-Trichlorobenzene	1679	77613	GC/MS	87-61-6	0.2 µg/L	MRL
1,2,3-Trichloropropane	1483	77443	GC/MS	96-18-4	0.2 µg/L	MRL
1,2,4-Trichlorobenzene	1673	34551	GC/MS	120-82-1	0.2 µg/L	MRL
1,2,4-Trimethylbenzene	1665	77222	GC/MS	95-63-6	0.2 µg/L	MRL
1,2-Dibromo-3-chloropropane	1354	82625	GC/MS	96-12-8	1 µg/L	MRL
1,2-Dibromoethane	1317	77651	GC/MS	106-93-4	0.2 µg/L	MRL
1,2-Dichlorobenzene	1314	34536	GC/MS	95-50-1	0.1 µg/L	MRL
1,2-Dichloroethane	1298	32103	GC/MS	107-06-2	0.2 µg/L	MRL
1,2-Dichloroethane-d4 (surrogate)	1599	99832	GC/MS	17060-07-0	Percent	null
1,2-Dichloropropane	1301	34541	GC/MS	78-87-5	0.1 µg/L	MRL
1,3,5-Trimethylbenzene	1683	77226	GC/MS	108-67-8	0.2 µg/L	MRL
1,3-Dichloropropane	1480	77173	GC/MS	142-28-9	0.2 µg/L	MRL
1,4-Bromofluorobenzene (surrogate)	1601	99834	GC/MS	460-00-4	Percent	null
1,4-Dichlorobenzene	1316	34571	GC/MS	106-46-7	0.1 µg/L	MRL
2,2-Dichloropropane	1479	77170	GC/MS	594-20-7	0.2 µg/L	MRL
2-Chlorotoluene	1481	77275	GC/MS	95-49-8	0.2 µg/L	MRL
4-Chlorotoluene	1482	77277	GC/MS	106-43-4	0.2 µg/L	MRL
4-Isopropyl-1-methylbenzene	1669	77356	GC/MS	99-87-6	0.2 µg/L	MRL
Acrylonitrile	2309	34215	GC/MS	107-13-1	2.5 µg/L	MRL
Benzene	1287	34030	GC/MS	71-43-2	0.1 µg/L	MRL
Bromobenzene	1698	81555	GC/MS	108-86-1	0.2 µg/L	MRL
Bromochloromethane	1654	77297	GC/MS	74-97-5	0.2 µg/L	MRL
Bromodichloromethane	1295	32101	GC/MS	75-27-4	0.1 µg/L	MRL
Bromoform	1288	32104	GC/MS	75-25-2	0.2 µg/L	MRL
Bromomethane	1304	34413	GC/MS	74-83-9	0.2 µg/L	MRL
Butylbenzene	1671	77342	GC/MS	104-51-8	0.2 µg/L	MRL
Chlorobenzene	1290	34301	GC/MS	108-90-7	0.1 µg/L	MRL
Chloroethane	1292	34311	GC/MS	75-00-3	0.2 µg/L	MRL
Chloroform	1294	32106	GC/MS	67-66-3	0.1 µg/L	MRL
Chloromethane	1318	34418	GC/MS	74-87-3	0.2 µg/L	MRL
cis-1,2-Dichloroethylene	1656	77093	GC/MS	156-59-2	0.1 µg/L	MRL
cis-1,3-Dichloropropene	1326	34704	GC/MS	10061-01-5	0.2 µg/L	MRL
Dibromochloromethane	1291	32105	GC/MS	124-48-1	0.2 µg/L	MRL
Dibromomethane	1009	30217	GC/MS	74-95-3	0.2 µg/L	MRL
Dichlorodifluoromethane	1296	34668	GC/MS	75-71-8	0.2 µg/L	MRL
Dichloromethane	1305	34423	GC/MS	75-09-2	0.2 µg/L	MRL
Ethylbenzene	1303	34371	GC/MS	100-41-4	0.1 µg/L	MRL

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level	Reporting Level Type
Hexachlorobutadiene	1675	39702	GC/MS	87-68-3	0.2 µg/L	MRL
Isopropylbenzene	1659	77223	GC/MS	98-82-8	0.2 µg/L	MRL
n-Propylbenzene	1661	77224	GC/MS	103-65-1	0.2 µg/L	MRL
Naphthalene	1677	34696	GC/MS	91-20-3	0.2 µg/L	MRL
sec-Butylbenzene	1667	77350	GC/MS	135-98-8	0.2 µg/L	MRL
Set number	1934	99931	A	-	no.	null
Styrene	1328	77128	GC/MS	100-42-5	0.1 µg/L	MRL
tert-Butyl methyl ether(MTBE)	1652	78032	GC/MS	1634-04-4	0.2 µg/L	MRL
tert-Butylbenzene	1663	77353	GC/MS	98-06-6	0.2 µg/L	MRL
Tetrachloroethylene	1307	34475	GC/MS	127-18-4	0.1 µg/L	MRL
Tetrachloromethane	1289	32102	GC/MS	56-23-5	0.2 µg/L	MRL
Toluene	1308	34010	GC/MS	108-88-3	0.1 µg/L	MRL
Toluene-d8 (surrogate)	1600	99833	GC/MS	2037-26-5	Percent	null
trans-1,2-Dichloroethylene	1300	34546	GC/MS	156-60-5	0.1 µg/L	MRL
trans-1,3-Dichloropropene	1327	34699	GC/MS	10061-02-6	0.2 µg/L	MRL
Trichloroethylene	1311	39180	GC/MS	79-01-6	0.1 µg/L	MRL
Trichlorofluoromethane	1312	34488	GC/MS	75-69-4	0.2 µg/L	MRL
Vinyl chloride	1313	39175	GC/MS	75-01-4	0.2 µg/L	MRL
Xylene	1330	81551	GC/MS	1330-27	0.2 µg/L	MRL

Description of NWQL Lab Schedule 1324 - Organochlorine pesticides and gross polychlorinated biphenyls, whole water, recoverable.

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level	Reporting Level Type
2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl" (PCB 207) (surrogate)	2513	99779	GC/ECD	52663-79-3	0.1 pct	MRL
Aldrin	350	39330	GC/ECD	309-00-2	0.013 µg/L	LRL
alpha-Endosulfan	349	39388	GC/ECD	959-98-8	0.015 µg/L	LRL
alpha-HCH-d6 (surrogate)	2512	99776	GC/ECD	-	N/A pct	MRL
"Chlordane, technical mix"	351	39350	GC/ECD	57-74-9	0.10 µg/L	MRL
Dieldrin	355	39380	GC/ECD	60-57-1	0.006 µg/L	LRL
Endrin	356	39390	GC/ECD	72-20-8	0.014 µg/L	LRL
Heptachlor	357	39410	GC/ECD	76-44-8	0.014 µg/L	LRL
Heptachlor epoxide	358	39420	GC/ECD	1024-57-3	0.009 µg/L	LRL
Isodrin (surrogate)	1611	90567	GC/ECD	465-73-6	N/A pct	MRL
Lindane	359	39340	GC/ECD	58-89-9	0.006 µg/L	LRL
Mirex	544	39755	GC/ECD	2385-85-5	0.006 µg/L	LRL
p,p'-DDD	352	39360	GC/ECD	72-54-8	0.007 µg/L	LRL
p,p'-DDE	353	39365	GC/ECD	72-55-9	0.006 µg/L	LRL
p,p'-DDT	354	39370	GC/ECD	50-29-3	0.009 µg/L	LRL
p,p'-Methoxychlor	400	39480	GC/ECD	72-43-5	0.015 µg/L	LRL
Polychlorinated biphenyls	392	39516	GC/ECD	1336-36-3	0.10 µg/L	MRL
Sample volume	1808	99865	A	-	mL	MRL
set number, schedule 1324	1840	99806	A	-	no.	MRL
Toxaphene	360	39400	GC/ECD	8001-35-2	1.0 µg/L	MRL

Description of NWQL Schedule 2060 – Polar pesticides and metabolites in filtered water.

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level/Unit	Reporting Level Type
2,4,5-T (surrogate)	5597	99958	HPLC/MS-SPE	93-76-5	0.1 percent	null
2,4-D	5532	39732	HPLC/MS-SPE	94-75-7	0.021 µg/L	MRL
2,4-D methyl ester	5533	50470	HPLC/MS-SPE	1928-38-7	0.0086µg/L	MRL
2,4-DB	5534	38746	HPLC/MS-SPE	94-82-6	0.016 µg/L	MRL
2-Hydroxyatrazine	5535	50355	HPLC/MS-SPE	2163-68-0	0.008 µg/L	MRL
3(4-Chlorophenyl)-1-methyl urea	5536	61692	HPLC/MS-SPE	5352-88-5	0.024 µg/L	MRL
3-Hydroxycarbofuran	5537	49308	HPLC/MS-SPE	16655-82-6	0.0058 µg/L	MRL
3-Ketocarbofuran	5538	50295	HPLC/MS-SPE	16709-30-1	1.5 µg/L	MRL
Acifluorfen	5539	49315	HPLC/MS-SPE	50594-66-6	0.0066 µg/L	MRL
Aldicarb	5540	49312	HPLC/MS-SPE	116-06-3	0.04 µg/L	MRL
Aldicarb sulfone	5541	49313	HPLC/MS-SPE	1646-88-4	0.02 µg/L	MRL
Aldicarb sulfoxide	5542	49314	HPLC/MS-SPE	1646-87-3	0.0082 µg/L	MRL
Atrazine	5543	39632	HPLC/MS-SPE	1912-24-9	0.009 µg/L	MRL
Barban (surrogate)	5598	90640	HPLC/MS-SPE	101-27-9	0.1 percent	null
Bendiocarb	5544	50299	HPLC/MS-SPE	22781-23-3	0.025 µg/L	MRL
Benomyl	5545	50300	HPLC/MS-SPE	17804-35-2	0.0038 µg/L	MRL
Bensulfuron-methyl	5546	61693	HPLC/MS-SPE	83055-99-6	0.015 µg/L	MRL
Bentazon	5547	38711	HPLC/MS-SPE	25057-89-0	0.011 µg/L	MRL
Bromacil	5548	04029	HPLC/MS-SPE	314-40-9	0.033 µg/L	MRL
Bromoxynil	5549	49311	HPLC/MS-SPE	1689-84-5	0.017 µg/L	MRL
Caffeine	5550	50305	HPLC/MS-SPE	58-08-2	0.0096 µg/L	MRL
Caffeine-C13 (surrogate)	5599	99959	HPLC/MS-SPE	-	0.percent	null
Carbaryl	5551	49310	HPLC/MS-SPE	63-25-2	0.028 µg/L	MRL

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level	Reporting Level Type
Carbofuran	5552	49309	HPLC/MS-SPE	1563-66-2	0.0056 µg/L	MRL
Chloramben methyl ester	5553	61188	HPLC/MS-SPE	7286-84-2	0.018 µg/L	MRL
Chlorimuron-ethyl	5554	50306	HPLC/MS-SPE	90982-32-4	0.0096 µg/L	MRL
Chlorothalonil	5555	49306	HPLC/MS-SPE	1897-45-6	0.035 µg/L	MRL
Clopyralid	5556	49305	HPLC/MS-SPE	1702-17-6	0.013 µg/L	MRL
Cycloate	5557	04031	HPLC/MS-SPE	1134-23-2	0.013 µg/L	MRL
Dacthal monoacid	5558	49304	HPLC/MS-SPE	887-54-7	0.011 µg/L	MRL
Deethylatrazine	5559	04040	HPLC/MS-SPE	6190-65-4	0.028 µg/L	MRL
Deethyldeisopropylatrazine	5561	04039	HPLC/MS-SPE	3397-62-4	0.01 µg/L	MRL
Deisopropylatrazine	5560	04038	HPLC/MS-SPE	1007-28-9	0.044 µg/L	MRL
Dicamba	5562	38442	HPLC/MS-SPE	1918-00-9	0.012 µg/L	MRL
Dichlorprop	5563	49302	HPLC/MS-SPE	120-36-5	0.013 µg/L	MRL
Dinoseb	5564	49301	HPLC/MS-SPE	88-85-7	0.012 µg/L	MRL
Diphenamid	5565	04033	HPLC/MS-SPE	957-51-7	0.026 µg/L	MRL
Diuron	5566	49300	HPLC/MS-SPE	330-54-1	0.015 µg/L	MRL
Fenuron	5567	49297	HPLC/MS-SPE	101-42-8	0.031 µg/L	MRL
Flumetsulam	5568	61694	HPLC/MS-SPE	98967-40-9	0.011 µg/L	MRL
Fluometuron	5569	38811	HPLC/MS-SPE	2164-17-2	0.031 µg/L	MRL
Imazaquin	5570	50356	HPLC/MS-SPE	81335-37-7	0.016 µg/L	MRL
Imazethapyr	5571	50407	HPLC/MS-SPE	81335-77-5	0.017 µg/L	MRL
Imidacloprid	5572	61695	HPLC/MS-SPE	138261-41-3	0.0068µg/L	MRL
Linuron	5573	38478	HPLC/MS-SPE	330-55-2	0.014 µg/L	MRL
MCPA	5574	38482	HPLC/MS-SPE	94-74-6	0.016 µg/L	MRL
MCPB	5575	38487	HPLC/MS-SPE	94-81-5	0.015 µg/L	MRL
Metalaxyl	5576	50359	HPLC/MS-SPE	57837-19-1	0.02 µg/L	MRL
Methiocarb	5577	38501	HPLC/MS-SPE	2032-65-7	0.008 µg/L	MRL

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level	Reporting Level Type
Methomyl	5578	49296	HPLC/MS-SPE	16752-77-5	0.0044 µg/L	MRL
Methomyl oxime	5579	61696	HPLC/MS-SPE	13749-94-5	0.011 µg/L	MRL
Metsulfuron methyl	5580	61697	HPLC/MS-SPE	74223-64-6	0.025 µg/L	MRL
Neburon	5581	49294	HPLC/MS-SPE	555-37-3	0.012 µg/L	MRL
Nicosulfuron	5582	50364	HPLC/MS-SPE	111991-09-4	0.013 µg/L	MRL
Norflurazon	5583	49293	HPLC/MS-SPE	27314-13-2	0.016 µg/L	MRL
Oryzalin	5584	49292	HPLC/MS-SPE	19044-88-3	0.017 µg/L	MRL
Oxamyl	5585	38866	HPLC/MS-SPE	23135-22-0	0.012 µg/L	MRL
Oxamyl oxime	5586	50410	HPLC/MS-SPE	30558-43-1	0.013 µg/L	MRL
Picloram	5587	49291	HPLC/MS-SPE	1918-02-1	0.019 µg/L	MRL
Propham	5588	49236	HPLC/MS-SPE	122-42-9	0.0096 µg/L	MRL
Propiconazole	5589	50471	HPLC/MS-SPE	60207-90-1	0.021 µg/L	MRL
Propoxur	5590	38538	HPLC/MS-SPE	114-26-1	0.008 µg/L	MRL
Sample volume	5600	99840	A	-	1 mL	mrl
Set number	5601	99750	A	-	no.	mrl
Siduron	5591	38548	HPLC/MS-SPE	1982-49-6	0.016 µg/L	MRL
Sulfometuron-methyl	5592	50337	HPLC/MS-SPE	74222-97-2	0.0088 µg/L	MRL
Tebuthiuron	5593	82670	HPLC/MS-SPE	34014-18-1	0.0062 µg/L	MRL
Terbacil	5594	04032	HPLC/MS-SPE	5902-51-2	0.0098 µg/L	MRL
Tribenuron-methyl	5595	61159	HPLC/MS-SPE	101200-48-0	0.0088 µg/L	MRL
Triclopyr	5596	49235	HPLC/MS-SPE	55335-06-3	0.022 µg/L	MRL

Description of NWQL Schedule 2001 - Broad-spectrum, low-level dissolved pesticides extractable by solid phase extraction with a C-18 cartridge.

[Includes Dinitroaniline, Amide, Acetanilide, Organophosphorus, and Organonitrogen (triazine) pesticides]

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level/Unit	Reporting Level Type
2,6-Diethylaniline	4016	82660	GC/MS-SIM	79-66-8	0.0017 µg/L	LRL
Acetochlor	4053	49260	GC/MS-SIM	34256-82-1	0.0041 µg/L	LRL
Alachlor	4001	46342	GC/MS-SIM	15972-60-8	0.0024 µg/L	LRL
alpha-HCH	4023	34253	GC/MS-SIM	319-84-6	0.0046 µg/L	LRL
alpha-HCH-d6(surrogate)	4024	91065	GC/MS-SIM	-	0.1 percent	MRL
Atrazine	4003	39632	GC/MS-SIM	1912-24-9	0.007 µg/L	LRL
Azinphos-methyl	4004	82686	GC/MS-SIM	86-50-0	0.05 µg/L	LRL
Benfluralin	4005	82673	GC/MS-SIM	1861-40-1	0.010 µg/L	LRL
Butylate	4006	04028	GC/MS-SIM	2008-41-5	0.002 µg/L	MRL
Carbaryl	4007	82680	GC/MS-SIM	63-25-2	0.041 µg/L	LRL
Carbofuran	4008	82674	GC/MS-SIM	1563-66-2	0.020 µg/L	LRL
Chlorpyrifos	4009	38933	GC/MS-SIM	2921-88-2	0.005 µg/L	LRL
cis-Permethrin	4036	82687	GC/MS-SIM	54774-45-7	0.006 µg/L	LRL
Cyanazine	4010	04041	GC/MS-SIM	21725-46-2	0.018 µg/L	LRL
Dacthal	4011	82682	GC/MS-SIM	1861-32-1	0.0030 µg/L	LRL
Deethylatrazine	4002	04040	GC/MS-SIM	6190-65-4	0.006 µg/L	LRL
Diazinon	4013	39572	GC/MS-SIM	333-41-5	0.005 µg/L	LRL
Diazinon-d10(surrogate)	4014	91063	GC/MS-SIM	100155-47-3	0.1 percent	MRL
Dieldrin	4015	39381	GC/MS-SIM	60-57-1	0.0048 µg/L	LRL

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level	Reporting Level Type
Disulfoton	4018	82677	GC/MS-SIM	298-04-4	0.021 µg/L	LRL
EPTC	4019	82668	GC/MS-SIM	759-94-4	0.0020 µg/L	LRL
Ethalfuralin	4020	82663	GC/MS-SIM	55283-68-6	0.009 µg/L	LRL
Ethoprophos	4021	82672	GC/MS-SIM	13194-48-4	0.005 µg/L	LRL
Fonofos	4022	04095	GC/MS-SIM	944-22-9	0.0027 µg/L	LRL
Lindane	4025	39341	GC/MS-SIM	58-89-9	0.0040 µg/L	LRL
Linuron	4026	82666	GC/MS-SIM	330-55-2	0.035 µg/L	LRL
Malathion	4027	39532	GC/MS-SIM	121-75-5	0.027 µg/L	LRL
Metolachlor	4029	39415	GC/MS-SIM	51218-45-2	0.013 µg/L	LRL
Metribuzin	4030	82630	GC/MS-SIM	21087-64-9	0.006 µg/L	LRL
Molinate	4031	82671	GC/MS-SIM	2212-67-1	0.0016 µg/L	LRL
Napropamide	4032	82684	GC/MS-SIM	15299-99-7	0.007 µg/L	LRL
p,p'-DDE	4012	34653	GC/MS-SIM	72-55-9	0.0025 µg/L	LRL
Parathion	4033	39542	GC/MS-SIM	56-38-2	0.007 µg/L	LRL
Parathion-methyl	4028	82667	GC/MS-SIM	298-00-0	0.006 µg/L	LRL
Pebulate	4034	82669	GC/MS-SIM	1114-71-2	0.0016 µg/L	LRL
Pendimethalin	4035	82683	GC/MS-SIM	40487-42-1	0.010 µg/L	LRL
Phorate	4037	82664	GC/MS-SIM	298-02-2	0.011 µg/L	LRL
Prometon	4039	04037	GC/MS-SIM	1610-18-0	0.015 µg/L	LRL
Propachlor	4040	04024	GC/MS-SIM	1918-16-7	0.010 µg/L	LRL
Propanil	4041	82679	GC/MS-SIM	709-98-8	0.011 µg/L	LRL
Propargite	4042	82685	GC/MS-SIM	2312-35-8	0.023 µg/L	LRL
Propyzamide	4038	82676	GC/MS-SIM	23950-58-5	0.0041 µg/L	LRL
Sample volume	4051	99856	GC/MS-SIM	-	1mL	MRL
set number, schedule	na	na	na	na	na	na
2001	4052	99818	A	-	no.	MRL
Simazine	4043	04035	GC/MS-SIM	122-34-9	0.011 µg/L	LRL

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level	Reporting Level Type
Tebuthiuron	4045	82670	GC/MS-SIM	34014-18-1	0.016 µg/L	LRL
Terbacil	4046	82665	GC/MS-SIM	5902-51-2	0.034 µg/L	LRL
Terbufos	4047	82675	GC/MS-SIM	13071-79-9	0.017 µg/L	LRL
Terbuthylazine	4139	04022	GC/MS-SIM	5915-41-3	0.1 µg/L	MRL
Thiobencarb	4044	82681	GC/MS-SIM	28249-77-6	0.0048 µg/L	LRL
Tri-allate	4049	82678	GC/MS-SIM	2303-17-5	0.0023 µg/L	LRL
Trifluralin	4050	82661	GC/MS-SIM	1582-09-8	0.009 µg/L	LRL

Description of NWQL Lab Schedule 2050 – Broad spectrum, low-level pesticides extractable with by SPE on Carbopak-B cartridge.

[Chlorobenzoic acid and chlorophenoxylic acid herbicides; carbamate and organochlorine insecticides]

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level/Unit	Reporting Level Type
2,4,5-T	5409	39742	HPLC-SPE	93-76-5	0.040 µg/L	LRL
2,4-D	5408	39732	HPLC-SPE	94-75-7	0.11 µg/L	LRL
2,4-DB	5407	38746	HPLC-SPE	94-82-6	0.10 µg/L	LRL
2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex)	5444	39762	HPLC-SPE	93-72-1	0.025 µg/L	LRL
3-Hydroxycarbofuran	5449	49308	HPLC-SPE	16655-82-6	0.11 µg/L	LRL
4,6-Dinitro-2-methylphenol	5402	49299	HPLC-SPE	534-52-1	0.25 µg/L	LRL
4-Bromo-3,5-dimethylphenyl-n-methylcarbamate (BDMC) (surrogate)	5452	99835	HPLC-SPE	672-99-1	0.10%	MRL
Acifluorfen	5410	49315	HPLC-SPE	50594-66-6	0.05 µg/L	LRL
Aldicarb	5411	49312	HPLC-SPE	116-06-3	0.21 µg/L	LRL
Aldicarb sulfone	5413	49313	HPLC-SPE	1646-88-4	0.20 µg/L	LRL
Bentazon	5414	38711	HPLC-SPE	25057-89-0	0.035 µg/L	LRL
Bromacil	5415	04029	HPLC-SPE	314-40-9	0.09 µg/L	LRL

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level	Reporting Level Type
Bromoxynil	5416	49311	HPLC-SPE	1689-84-5	0.07 µg/L	LRL
Carbaryl	5417	49310	HPLC-SPE	63-25-2	0.024 µg/L	LRL
Carbofuran	5418	49309	HPLC-SPE	1563-66-2	0.29 µg/L	LRL
Chloramben methyl ester	5531	61188	HPLC-SPE	7286-84-2	0.14 µg/L	LRL
Chlorothalonil	5421	49306	HPLC-SPE	1897-45-6	0.13 µg/L	LRL
Clopyralid	5423	49305	HPLC-SPE	1702-17-6	0.42 µg/L	LRL
Dacthal monoacid	5447	49304	HPLC-SPE	887-54-7	0.07 µg/L	LRL
Dicamba	5426	38442	HPLC-SPE	1918-00-9	0.043 µg/L	LRL
Dichlobenil	5404	49303	HPLC-SPE	1194-65-6	0.049 µg/L	LRL
Dichlorprop	5401	49302	HPLC-SPE	120-36-5	0.050 µg/L	LRL
Dinoseb	5400	49301	HPLC-SPE	88-85-7	0.09 µg/L	LRL
Diuron	5427	49300	HPLC-SPE	330-54-1	0.056 µg/L	LRL
Fenuron	5405	49297	HPLC-SPE	101-42-8	0.07 µg/L	LRL
Fluometuron	5430	38811	HPLC-SPE	2164-17-2	0.06 µg/L	LRL
Linuron	5432	38478	HPLC-SPE	330-55-2	0.021 µg/L	LRL
MCPA	5433	38482	HPLC-SPE	94-74-6	0.08 µg/L	LRL
MCPB	5434	38487	HPLC-SPE	94-81-5	0.13 µg/L	LRL
Methiocarb	5436	38501	HPLC-SPE	2032-65-7	0.07 µg/L	LRL
Methomyl	5437	49296	HPLC-SPE	16752-77-5	0.02 µg/L	MRL
Neburon	5403	49294	HPLC-SPE	555-37-3	0.017 µg/L	LRL
Norflurazon	5439	49293	HPLC-SPE	27314-13-2	0.042 µg/L	LRL
Oryzalin	5440	49292	HPLC-SPE	19044-88-3	0.28 µg/L	LRL
Oxamyl	5441	38866	HPLC-SPE	23135-22-0	0.02 µg/L	MRL
Picloram	5442	49291	HPLC-SPE	1918-02-1	0.09 µg/L	LRL
Propham	5443	49236	HPLC-SPE	122-42-9	0.09 µg/L	LRL
Propoxur	5450	38538	HPLC-SPE	114-26-1	0.12 µg/L	LRL

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level	Reporting Level Type
sample volume, schedule 2050	5454	99848	A	-	mL	MRL
set number, schedule 2050	5451	99820	A	-	no.	MRL
Triclopyr	5446	49235	HPLC-SPE	55335-06-3	0.07 µg/L	LRL

Description of NWQL Schedule 1494 – Base-Neutral plus Acid Extracbles (combined extracts of mono- and polycyclic aromatic hydrocarbons), in whole water.

Parameter Name	NWQL Lab Code	NWIS Parameter Code	Method	CAS Number	Reporting Level/Unit	Reporting Level Type
2-Fluorobiphenyl(surrogate)	2327	49279	GC/MS	321-60-8	0.1 percent	MRL
Acenaphthene	1066	34205	GC/MS	83-32-9	1.8 µg/L	LRL
Acenaphthylene	1067	34200	GC/MS	208-96-8	1.8 µg/L	LRL
Anthracene	1068	34220	GC/MS	120-12-7	2.0 µg/L	LRL
Benz[a]anthracene	1070	34526	GC/MS	56-55-3	2.4 µg/L	LRL
Benzo[a]pyrene	1073	34247	GC/MS	50-32-8	2.8 µg/L	LRL
Benzo[b]fluoranthene	1071	34230	GC/MS	205-99-2	3.0 µg/L	LRL
Benzo[ghi]perylene	1074	34521	GC/MS	191-24-2	2.8 µg/L	LRL
Benzo[k]fluoranthene	1072	34242	GC/MS	207-08-9	3.2 µg/L	LRL
Chrysene	1082	34320	GC/MS	218-01-9	2.7 µg/L	LRL
Dibenz[a,h]anthracene	1083	34556	GC/MS	53-70-3	3.4 µg/L	LRL
Fluoranthene	1096	34376	GC/MS	206-44-0	2.4 µg/L	LRL
Fluorene	1095	34381	GC/MS	86-73-7	2.0 µg/L	LRL
Indeno[1,2,3-cd]pyrene	1101	34403	GC/MS	193-39-5	3.0 µg/L	LRL
Naphthalene	1103	34696	GC/MS	91-20-3	1.8 µg/L	LRL
Nitrobenzene	1104	34447	GC/MS	98-95-3	2.0 µg/L	LRL
Phenanthrene	1108	34461	GC/MS	85-01-8	2.0 µg/L	LRL
Pyrene	1109	34469	GC/MS	129-00-0	2.2 µg/L	LRL
Sample volume	1814	99855	A	-	1 mL	
set number, schedule 1383	1874	99813	A	-	no.	
Terphenyl-d14(surrogate)	2329	49278	GC/MS	1718-51-0	0.1 percent	MRL

Quality Control Requirements:

SCDNR Water Chemistry and Phytoplankton Samples:

As noted previously, most water chemistry measurements will be completed by the SCDHEC using their standardized quality control requirements (SCDHEC, 1997), which have been approved by the USEPA. The majority of these samples are not required for the Coastal 2000 initiative. The dissolved chemistry measurements will be completed by another laboratory that also has an existing quality control protocol. Additionally, at least 10% of all dissolved nutrient samples will analyzed in duplicate

using a sample split or replicate sample, to ensure that the results meet the QA/QC requirements listed in Table 1.

SCDNR Sediment Composition Samples:

Quality control for the sediment analysis procedures will be accomplished by other trained laboratory personnel reanalyzing a 10% subset of samples from each batch of samples. Criteria for acceptance require that a difference of no greater than 10% may exist in the dominant component, representing either sand or silt/clay combined for each sample. If the absolute difference between the original number and the second (QA/QC) number is greater than 10% then a different technician will complete a third analysis. The values closest to the third value will be entered into the database. If more than 10% of the data from a batch are in error, then the Lab Manager and Principal Investigators will meet to discuss an appropriate plan for re-processing the sample batch using the archived sediment and re-training lab staff as necessary. Quality control procedures will be applied to the reanalyzed batch as well. Re-analyses and QA/QC checks are dependent upon having enough sediment to complete the various re-analyses.

SCDNR Sediment Contaminant Analyses:

The subcontracting laboratory that processes the sediment chemistry samples will need to have an acceptable QA/QC method acceptable to the USEPA. In the event that the NOS-Charleston Laboratory is selected to process the samples, the quality assurance protocols that have been previously accepted by the USEPA will be used. These include the following:

To determine the reliability of the PAH data, including an evaluation of the efficiency of extraction methods and interferences that may be introduced in the sample preparation scheme, blanks and standard reference material (SRM) will be analyzed using GC-ITMS. The percent recovery of the certified values in the SRM will be determined. A standard reference material obtained from NIST will be used to evaluate the efficiency of extraction methods for removing PAHs from sediment.

Pesticide QA/QC methods will be similar to those described for PAHs. A NIST SRM will be analyzed for organochlorine compounds to obtain information on the reliability of the pesticide data collected.

Metals QA/QC methods will include several precautions to avoid contamination during metals analysis. All labware will be washed thoroughly with soap and water, rinsed with tap water, rinsed three times with distilled water, and soaked in a 50% concentrated nitric acid bath before use. Two types of blanks will be analyzed as a check for contamination. The first blank will consist of a 15% nitric acid solution and will be used as the endpoint of the daily calibration curve. The second blank (a method blank) will be a solution that was processed using the extraction procedure to check for contamination that may arise during the digestion process. The limit of detection (LOD) for each element analyzed will be determined from the blank information as the mean blank plus three times the standard deviation. To evaluate the efficiency of the nitric acid microwave digestion procedure, a NIST SRM will be analyzed.

USGS Water Chemistry Samples:

Rigorous quality-assurance (QA) and quality-control (QC) procedures will be followed, with at least 10 percent of the analyses made for QA purposes (Wilde and others, 1999; Wagner and others, 2000). Samples for QA/QC will include (1) field and equipment blanks to ensure that the sampler, intakes lines, churns, and bottles are not contaminating samples; (2) split samples to document reproducibility of laboratory results; and (3) concurrent samples to demonstrate that the automatically-collected point sample is representative of the cross-sectional mean concentration. Standard reference samples also are used at the USGS laboratories as part of their QA/QC procedures.

To document the quality of field measurements, all USGS personnel involved in the collection of water-quality data are required to participate in the National Field Quality Assurance (NFQA) Program (Stanley and others, 1992; Stanley and others, 1998). The NFQA Program uses standard reference solutions to test the accuracy of field meters with respect to alkalinity, pH, and specific conductance. The Regional Hydrologist and the District Water-Quality Specialist review results of the NFQA Program.

Project reviews are conducted periodically by S.C. District management, technical advisors, or discipline specialists to ensure compliance with the project workplan or proposal. Project reviews are used to ensure that data collection, analysis, and reporting are done in accordance with USGS policy.

Instrument/Equipment Testing, Inspection, and Maintenance Requirements:

All project staff operating the YSI, Hydrolab or Stevens Greenspan instrumentation will be required to demonstrate proficiency in their performance the collection of water-quality samples and data. Particular emphasis will be placed on the proper maintenance and calibration of the monitoring instruments.

Calibration Checks and QC Procedures:

All YSI 85 instruments will be calibrated for DO on site prior to each deployment of the probe. Calibration of the dissolved oxygen sensor is based on a reading of 100% saturation in a water-saturated air environment. Following deployment, the DO reading will again be checked in an air saturated environment and the percent saturation recorded. System calibration of salinity will be based on a standard of 19.55 ‰ stabilized at 25⁰C. System calibration of conductivity is rarely required due to the factory calibration of the YSI[®] 85. However, a weekly check will be performed and recorded to verify reliability. The maximum acceptable deviations that will be allowed are $\pm 10\%$ from the 100% saturation value for dissolved oxygen and $\pm 10\%$ from the salinity standard. Temperature is a fixed function set by the manufacturer and cannot be adjusted by the user. However, the instruments will be checked against a hand-held mercury thermometer.

Maintenance of the meters will consist of replacement of the dissolved oxygen

membrane cap, replacement of potassium chloride (KCl) electrolyte, and cleansing of the conductivity cell every two to four weeks or as needed if calibration standards can not be met. The YSI 85 will be used to measure salinity/conductivity and dissolved oxygen while on station at surface, mid-depth, and bottom. Supplemental pH data will be acquired from the surface using a handheld Hanna pH meter. The KCl solution within the DO sensor will be replaced weekly and the membrane will be changed every two weeks. The pH meter will be calibrated to standards of 7.0 and 10.0 immediately prior to taking a reading at each station, and the calibration will be re-checked after each measurement.

Hydrolab, YSI and Stevens Greenspan instruments used to monitor long-term water quality parameters are equipped with an array of probes. Only one brand of equipment will be selected for all sites to ensure consistency and maximize comparability of the data. The specific instruments to be used will be dependent on availability at the time monitoring is required. For the YSI and Hydrolab instruments, calibration of the dissolved oxygen sensor is based on a water-saturated air environment as the standard. For pH, a two-point calibration curve is established with standard buffer solutions of pH 7.0 and 10.0. The salinity/conductivity probe is calibrated using a KCL standard selected for relevance to estuarine conditions. The depth sensor, a pressure activated transducer, is set to a zero pressure while out of the water. Temperature is a fixed function set by the manufacturer and cannot be adjusted in the field. The instrument reading will be checked against a hand-held mercury thermometer. For the Stevens Greenspan probes, slightly different, but comparable methods are used to calibrate the probes and check accuracy following deployment. These instruments are currently being tested against a YSI multiprobe to evaluate their accuracy and comparability of data recorded. They may be the preferred instrumentation since the DO probes can be left in estuarine waters for extended periods of time, thereby allowing for a much more significant database than could be obtained with either the YSI or Hydrolab probes using comparable manpower commitments.

The deployable YSI and Hydrolab instruments have proven to be dependable if properly maintained and correctly calibrated, and can be relied on to perform within the range of accuracy that SCDNR-MRD requires for the basic water-quality parameters of temperature, salinity, conductivity, DO, pH, and depth. The Stevens multiprobe shows comparable promise in dependability and accuracy and will be used if preliminary tests indicated that the water quality data collected is comparable or better than the YSI or Hydrolab units. All units used by field crews will be calibrated prior to launch according to manufacturer's specifications. All calibrations will be documented on the Datalogger Service and Log Sheet (see Table 3 for acceptable calibration variance). If any of the parameters do not calibrate within acceptable variance, sensors will be serviced in the lab to correct the problem.

Immediately prior to deployment, all units selected for long-term deployment will be rechecked to insure steady readings and reliable performance. Following a deployment period, the performance will again be evaluated in the laboratory by comparing readings against calibration standards. The results will be documented on the

same data sheet used prior to deployment. The follow-up QC check after retrieval helps to ascertain that the instrument was functioning properly during the logging run (within tolerances stated in Table 3). If the instrument's values exceed the tolerance range, the field team will consult with the Principal Investigator for further instructions regarding re-deployment.

Instrument Calibration Frequency:

As noted above, all YSI 85 and pH instruments will be calibrated on site at each station visited using the procedures described above. The datasondes/ multiprobes used will be calibrated within six days (generally within 1-4 days) prior to deployment, and then checked for post-deployment readings within 1-4 days (generally the next day) following retrieval at each site that an instrument is deployed. Acceptable differences are shown in Table 3.

Table 3. Maximum acceptable differences for instrument calibration and field QC checks.

<u>Instrument</u>	<u>Frequency of Check</u>	<u>Parameter</u>	<u>Checked against</u>	<u>Maximum Acceptable Difference</u>
Hydrolab YSI, Stevens multiprobes	Pre and post deployment calibration	Temperature	Thermometer	± 2.5°C
		Salinity	KCl standard	± 1.6 ppt
YSI 85	each station	% Sat. D.O.	100% air saturation	± 10 %
		pH	pH buffer solutions	± 0.7 pH units
Hanna pHep	each station	% Sat. D.O.	100% air saturation	± 10 %
		pH	pH buffer solutions	± 0.7 pH units

USGS Calibration Checks and QC Procedures:

USGS Water level and stream velocity:

Stream stage (water-level) will be measured continuously using a bubble-gage stage recorder in accordance with Rantz (1982). The proper calibration and maintenance will be in accordance with the equipment manufacturer's guidelines.

Velocity measurements will be measured using an acoustic velocity meter. The proper calibration and maintenance will be in accordance with the equipment manufacturer's guidelines. Also, streamflow measurements using the current-meter method will be made in accordance with Rantz (1982) during storm-water events. Methods followed by USGS personnel for inspecting, repairing, and cleaning current-meters are described in Smoot and Novak (1968), Buchanan and Somers (1969), and Rantz and others (1982). USGS quality control for current-meters is that a spin test is required before and after each discharge measurement and prior to each field trip to indicate potential drift (Rantz, 1982). Spin-tests results are archived for each instrument (Office of Surface Water Memorandum 89.07).

USGS Continuous Water Quality Monitoring Parameters:

Deployed Hydrolab Minisonde instruments will be used to continuously record long-term data for water temperature and conductivity at each of the four sites (Wilde and Radtke, 1999). The use of trade names is for identification only and does not constitute endorsement by the U.S. Government. Temperature and conductivity data will be collected at fifteen-minute intervals during periods of base flow and at five-minute intervals during runoff events. The pH data will be collected only during sampling events. Inspection of the long-term deployed Hydrolab instruments will be at two to four week intervals as needed. The proper calibration and maintenance for the Hydrolab Minisonde will be in accordance with the Hydrolab Minisonde User's Manual (1997). Calibrated field Hydrolabs will be used to compare readings with the deployed Hydrolab to indicate potential drift. All information related to the sensor inspection and calibrations will be documented on standard USGS Surface-Water Quality Field Notes sheets in a bound notebook that will be maintained by field personnel.

USGS Storm-Event Water-Quality Parameters:

Field parameters, including temperature, conductivity, pH, and dissolved oxygen, will be measured during storm-events with a Hydrolab Minisonde instrument in accordance with Wilde and Radtke (1999). The proper calibration and maintenance for the Hydrolab Minisonde will be in accordance with the Hydrolab Minisonde User's Manual (1997). Field measurements should represent the natural conditions of the system at the time of sampling. To ensure quality of the measurements, calibration within the range of field conditions at each site is required.

The calibration of the dissolved oxygen sensor is based on a reading of 100% saturation in a water saturated air environment. The USGS calibrated accuracy of the DO sensor should be within the lesser of 5 percent or +/- 0.3 mg/L (Wagner and others, 2000). The calibration of the conductivity sensor is calibrated using a KCL standard that is equivalent to the specific conductance of the field conditions. The calibrated accuracy of the sensor should be within 5 percent for specific conductance values less than or equal to 100 uS/cm, or within 3 percent for specific conductance values more than 100uS/cm (Wagner and others, 2000). The calibration of the pH sensor is a two-point calibration curve established with standard buffer solutions of pH 7.0 and 10.0. The accuracy of the pH sensor should be at least +/- 0.1pH unit. The temperature sensor is factory-calibrated and cannot be adjusted. The accuracy of the temperature sensor should be within +/- 0.2 ° C.

Inspection/Acceptance Requirement for Supplies:

Project staff who receive supplies will immediately check the order to ensure that all items meet order specifications. Any problems will be identified to the Project Supervisors for each agency involved for resolution.

Assessment and Oversight

Assessments and Response Actions:

Sample Tracking:

All samples will be tracked using a comprehensive system for labeling of sample containers, recording sampling information in the field, and tracking sample shipments using chain of custody forms. The laboratory responsible for processing each sample must designate a sample custodian, sign for the incoming field samples, and verify sample custody records. This individual is required, upon receipt of samples, to record all tracking information. Laboratory personnel should be aware of the required sample holding times and conditions. Any discrepancies in the tracking form and the shipment should be noted immediately upon receipt. The laboratory supervisor should notify the Project Leader within five working days of any discrepancy that is not immediately resolved.

Data Reporting Requirements and Evaluation Procedures:

To be developed by City

Reports to Management:

All subcontractors will provide status reports on a quarterly basis . As data components are completed, the data will be summarized and provided to all participating and interested agencies via electronic distribution and through the Internet. A final project report will also be prepared by each subcontractor. These reports will then be integrated by the City, USGS and SCDNR partners into a comprehensive summary report describing all aspects of the study. These summary reports will also be made available on the Internet.

Data Validation and Usability

Data Review, Validation and Verification Requirements:

As noted in previous sections, audits of data quality will be conducted routinely prior to any data being entered into the Access database or provided on the Internet. This will be done by comparing printouts of the electronic files with the original field and laboratory data forms, or evaluating for obvious data outliers in electronic data files obtained from the deployed instrumentation. All errors encountered will be re-entered. Project Managers and the Principal Investigators from each agency will review all data processing and data deliverables created by their agency as part of their job responsibilities.

Validation and Verification Methods:

Validation and data verification methods are described in previous sections. Chain of custody for data will be maintained through the life of the project. The Project Manager will be responsible for resolving any issues that arise.

Reconciliation with User Requirements:

Prepared by City

References:

(needs to be edited , additional references added, etc.)

- ASTM. 1993. ASTM standards on Aquatic Toxicology and Hazard Evaluation. Sponsored by ASTM Committee E-47 on Biological Effects and environmental Fate. ASTM Publication Code Number (PCN): 03-547093-16. 538p.
- Baughman, D.S., Moore, D.W., and Scott, G.I., 1989, A comparison and evaluation of field and laboratory toxicity test with fenvalerate on estuarine crustaceans: *Environmental Toxicology and Chemistry* 8, p. 417-429.
- Buchanan, T.J., and Somers, W.P., 1969, Discharge measurements at gaging stations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A8, 65 p.
- Cohen, J.E., Small, C., Mellinger, A., Gallup, J., and Sachs, J., 1997, Estimates of coastal populations: *Science*, volume 278, p. 1211-1212.
- Connor, B.F., Rose, D.L., Noreiga, M.C., Murtagh, L., and Abney, S.R., 1997, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory – determination of 86 volatile organic compounds in water by gas chromatography/mass spectrometry, including detections less than reporting limits: U.S. Geological Survey Open-File Report 97-829.
- Culliton, T.J., Warren, M.A., Goodspeed, T.R., Remer, D.G., Blackwell, C.M., and McDonough, J.L., 1990, The second report of a coastal trends series: 50 years of population change along the nation's coasts 1960-2010: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Rockville, MD. 41 p.
- Dempster, G.R., Jr., comp., 1990, National Water Information System user's manual, v. 2, chap. 3, automated data processing system: U.S. Geological Survey Open-File Report 90-116 (variously paged).
- Dodd, M.G. and Murphy, T.M., 1996, The status and distribution of wading birds in South Carolina, 1988-1996: Final Report, 66 p.
- Fortner, A.R., M. Sanders, and S.W. Lemire. 1996. Polynuclear aromatic hydrocarbons and trace metal burdens in sediment and the oyster, *Crassostrea virginica* (Gmelin), from two high salinity estuaries in South Carolina. *In: Sustainable Development in the Southeast Coastal Zone*. F.J. Vernberg, W.B. Vernberg and T. Siewicki, eds. University of South Carolina Press, Columbia, SC, USA, pp. 445-477.

- Hackney, C.T., Burbank, W.D., and Hackney, O.P., 1976, Biological and physical dynamics of a Georgia tidal creek: Chesapeake Science 17940, p. 271-280.
- Holland, A.F., Riekerk, G.H.M., Lerberg, S.B., Zimmerman, L.E., Sanger, D.M., Matthews, T.D., Scott, G.I., Fulton, M.H., Thompson, B.C., Daugomah, J.W., DeVane, J.C., Beck, K.M., and Diaz, A.R., 1996, The tidal creek project, interim report, Charleston Harbor Project, 230 p.
- Hubbard, E.F., 1992, Policy recommendations for management and retention of hydrologic data of the U.S. Geological Survey: U.S. Geological Survey Open-File Report 92-56, 32 p.
- Hydrolab Corporation, 1997, DataSonde 4 and Minisonde water quality Multiprobes user's manual, Hydrolab Corporation, Austin TX., variously paginated.
- Hyland, J.L., T.J. Herrlinger, T.R. Snoots, A.H. Ringwood, R.F. Van Dolah, C.T. Hackney, G.A. Nelson, J.S. Rosen, and S.A. Kokkinakis. 1996. Environmental quality of estuaries of the Carolinian Province: 1994. Annual statistical summary for the 1994 EMAP-Estuaries Demonstration Project in the Carolinian Province. NOAA Technical Memorandum NOS ORCA 97. NOAA/NOS, Office of Ocean Resources Conservation and Assessment, Silver Spring, MD. 102p.
- Hyland, J.L., L. Balthis, C.T. Hackney, G. McRae, A.H. Ringwood, T.R. Snoots, R.F. Van Dolah, and T.L. Wade. 1998. Environmental quality of estuaries of the Carolinian Province: 1995. Annual statistical summary for the 1995 EMAP Estuaries Demonstration Project in the Carolinian Province. NOAA Technical Memorandum NOS ORCA 123 NOAA/NOS, Office of Ocean Resources Conservation and Assessment, Silver Spring, M.D. 143p.
- Krahn, M.M., C.A. Wigren, R.W. Pearce, L.K. Moore, R.G. Boger, W.D. McLeod, Jr., S.L. Chan, and D.W. Brown. 1988. New HPLC cleanup and revised extraction procedures for organic contaminants, National Oceanic and Atmospheric Administration Technical Memorandum NMFS F/NWC-153: 23-47.
- Kucklick, J.R., S. Sivertsen, M. Sanders and G. Scott. 1997. Factors influencing polycyclic aromatic hydrocarbon concentrations and patterns in South Carolina sediments. *J. Exper. Mar. Bio.* 213: 13-29.
- Maddy, D.V., Lopp, L.E., Jackson, D.L., Coupe, R.H., Schertz, T.L., and Garcia, K.T., 1997, National Water Information System user's manual, v. 2, chap. 2, water-quality system: U.S. Geological Survey, Version 1.2, Sept. 11, 1997 (variously paged).
- Myers, D.N., and Wilde, F.D., 1999, Biological indicators in Techniques of Water-Resources Investigations Book 9 Hand books for Water-Resources Investigations

- National Field Manual for the Collection of Water-Quality Data, variously paginated.
- Plumb, R.H. Jr. 1981. Procedures for handling and chemical analyses of sediment and water samples. Tech. Rept. EPA ICE-81-1 prepared by Great Lakes Laboratory, State University College at Buffalo, NY, for the U.S. Environmental Protection Agency/Corps of Engineers Technical Committee on Criteria for Dredge and Fill Material. Published by the U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.
- Rantz, S.E., and others, 1982, Measurements and computation of streamflow, volumes 1 and 2: U.S. Geological Survey Water-Supply Paper 2175, 631 p.
- Sanger, D.M., Holland, A.F., and Scott, G.I., 1999a, Tidal creek and salt marsh sediments in South Carolina coastal estuaries: I. Distribution of trace metals: Archives of Environmental Contamination and Toxicology 37, p. 458-471.
- Sanger, D.M., Holland, A.F., and Scott, G.I., 1999b, Tidal creek and salt marsh sediments in South Carolina coastal estuaries: II. Distribution of organic contaminants: Archives of Environmental Contamination and Toxicology 37, p. 458-471.
- Smoot, G.F., and Novak, C.E., 1968, Calibration and maintenance of vertical-axis type current meters: U.S. Geological Survey Techniques of Water-Resources Investigations, book 8, chap. B2, 15 p.
- South Carolina Budget and Control Board Division of Research and Statistical Services, 2001, The South Carolina Statistical Abstract 2000: 422 p.
- South Carolina Department of Health and Environmental Control, 1997. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Office of Environmental Quality Control. Columbia, SC.
- Stanley, D.L., Shampine, W.J., and Schroder, L.J., 1992, Summary of the U.S. Geological Survey National Field Quality-Assurance Program from 1979 through 1989: U.S. Geological Survey Open-File Report 92-163, 14 p.
- Stanley, D.L., Boozer, T.M., and Shroder, L.J., 1998, Summary of the U.S. Geological Survey National Field Quality Assurance Program from 1979 through 1997: U.S. Geological Survey Open-File Report 98-392, 11 p.
- Sutron Corporation, 1997?, Sutron Accububble Self Contained Bubbler System user's manual, Sutron Corporation, Sterling, Virginia, variously paginated.
- Vitousek, P.M, Mooney, H.A., Lubchenco, J., and Melillo, J.M., 1997, Human domination of the earth's ecosystems, Science 25, p. 494-499.

- Wagner, R. J., Mattraw, H.C., Ritz, G.F., and Smith, B.A., 2000, Guidelines and standard procedures for continuous water-quality monitors: site selection, field operation, calibration, record computation, and reporting: U.S. Geological Survey Water-Resources Investigations Report 00-4252, 53 p.
- Wang, Wuncheng, 1999, Quality-Assurance Plan for Water-Quality Activities in the South Carolina District: U.S. Geological Survey, South Carolina District office. 65 p.
- Weinstein, M.P., 1979, Shallow marsh habitats as primary nurseries for fishes and shellfish, Cape Fear River, North Carolina: Fishery Bulletin 77930, p. 339-357.
- Wenner, C, 1992, Red drum: natural history and fishing techniques in South Carolina: Marine Resources Division, South Carolina Wildlife and Marine Resources Department, Charleston, SC. 40 p.
- Wenner, E.L. and Beatty, H. R., 1993, Utilization of shallow estuarine habitats in South Carolina, U.S.A., by post larval and juvenile stages of *Penaeus spp.* (Decapoda: Penaeidae): Journal of Crustacean Biology 13(2), p. 280-295.
- Werner, S.L., BurkhardWernet, M.R., and DeRusseau, S.N., 1996, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory – Determination of Pesticides in water by Carbopak-B Solid-Phase Extraction and High-Performance Liquid Chromatography: U.S.Geological Survey Open-File Report 96-216.
- Wilde, F.D., Radtke, D.B., Gibs, J., and Iwatsubo, R.T., 1998, Chapter A1. Preparation for Water Sampling, in Techniques of Water-Resources Investigations Book 9 Handbooks for Water-Resources Investigations National Field Manual for the Collection of Water-Quality Data, Variousy paginated.
- ,1999, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water Resources Investigations, Handbooks for Water Resources Investigations Book 9, chapters A3-A6.
- Zaugg, Steven D., Sandstrom, M.W., Smith, S. G., and Fehlberg, K.M., 1995, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory – Determination of pesticides in water by C-18 Solid-Phase Extraction and Capillary-column gas chromatography/Mass spectrometry with selected-ion monitoring: U.S. Geological Survey Open-File Report 95-181, 60p.

Appendix: Data Collection and Management Forms

APPENDIX 1: Application for Federal Assistance submitted August 2, 2001 to U.S. Environmental Protection Agency by the City of Charleston Department of Public Service, Principle Investigator - Laura S. Cabiness, EMPACT Program Sorting Code 2001-NCER-J1, “Tidal creek monitoring and reporting program”, 18 p.

APPENDIX 2: USGS Surface-Water Quality Field Notes form.

APPENDIX 3: USGS Discharge Measurement forms # 9-275-F and 9-275-G.

APPENDIX 4: USGS National Water Quality Laboratory Analytical Services Request Form.

Paper copies of text of web pages (URL) cited in document:

“Quality Control at the U.S. Geological Survey National Water Quality Laboratory”

“ Quality-Assurance Plan for the Analysis of Fluvial Sediment By the Northeastern Region, Kentucky District Sediment Laboratory”