VIRGINIA TRIBUTARY MONITORING PROGRAM

QUALITY ASSURANCE/QUALITY CONTROL PROJECT PLAN

Chesapeake Bay Program
Department of Environmental Quality
629 East Main Street
Richmond, VA. 23219

Revised June 8, 2018

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A3 Distribution List

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List of Acronyms

BioSi	Biogenic Silica
CAR	Corrective Action Request
CBM	Chesapeake Bay Monitoring
CBMP	Federal-Interstate Chesapeake Bay Monitoring Program
CBPO	Chesapeake Bay Program Office (EPA- headquartered in Annapolis, MD)
CBLO	Chesapeake Bay Program Local Office (VADEQ)
CBP	Chesapeake Bay Program (DEQ Central Office, Richmond, VA)
CBPWQ	Chesapeake Bay Program Water Quality
CEDS	**Comprehensive Environmental Data System**
CIMS	Chesapeake Bay Information Management System
CSSP	Coordinated Split Sample Program
DCLS	Division of Consolidated Laboratory Services
DI	Deionized Water
DO	Dissolved Oxygen
DQO	Data Quality Objective
DUET	Data Upload and Evaluation Tool
EDT	Electronic Data Transfer
EPA	**Environmental Protection Agency**
ETMP	Enhanced Tributary Monitory Program
FGDC	Federal Geographic Data Committee
NELAP	National Environmental Laboratory Accreditation Program
NRO	Northern Regional Office
ODU	Old Dominion University
OIS	Office of Information Systems
PAR	**Photosynthetically Active Radiation**
PCN	Particulate Carbon and Nitrogen
PP	Particulate Phosphorus
PRO	Piedmont Regional Office
PMTF	Procedure Modification Tracking Form
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QAT	Quality Assurance Tool - Software used to perform QC checks
QC	Quality Control
SOP	Standard Operating Procedure
SSS	Sample Support Services (a section of DCLS)
TDN	Total Dissolved Nitrogen
TDP	Total Dissolved Phosphorus
TKNW	Total Kjeldahl Nitrogen (whole water)
TN	Total Nitrogen
TP	Total Phosphorus
TRO	Tidewater Regional Office
VADEQ	Virginia Department of Environmental Quality
VELAP	Virginia Environmental Laboratory Accreditation Program
VNTMP	Virginia Non-tidal Monitoring Network
VTMP	Virginia Tributary Monitoring Program
WQAP	Water Quality Assessments & Planning
USGS	U.S. Geological Survey
WQM	Water Quality Monitoring portion of VADEQ’s CEDS database

PROJECT MANAGEMENT

A4 Project/Task Organization

Three regional Department of Environmental Quality (VADEQ) offices supply the field personnel and equipment necessary to sample all of the stations for the Virginia Tributary Monitoring Program (VTMP); the Northern Regional Office (NRO) in Woodbridge, the Piedmont Regional Office (PRO) in Richmond, and the Tidewater Regional Office (TRO) in Virginia Beach. Additional sampling is provided through a cooperative agreement with the US Geological Survey (USGS). USGS obtains water samples on a monthly basis and during storm events from the tidal fresh regions of the tributaries. The project is coordinated through the Chesapeake Bay Program office of VADEQ located in the Central Office in Richmond.

A4.1 Roles and Responsibilities

The organizational structure of VADEQ personnel involved in the VTMP is depicted in Figure 1 and major project operations are depicted in Figure 2. The associated responsibilities for VADEQ personnel are as follows:

Regional Office Senior Environmental Specialist and Field Staff: Conducts office and field-related duties directly affecting sample collection and handling. Enters raw field data into water quality monitoring section of VADEQ's database (WQM) after sample collection is completed so the information may be electronically sent to the lab.

Regional Office Monitoring and Compliance Manager: Manages day to day operation of the VTMP at the regional office. Supervises regional conductance of the program in accordance with this Quality Assurance Project Plan (QAPP).

VADEQ Quality Assurance Coordinator: Responsible for Regional office laboratory audits to ensure equipment is in operable condition and data quality meets DEQ's Data Quality Objectives (DQOs).

Chesapeake Bay Monitoring Program Coordinator: Responsible for the development, implementation and overall management of the program.

Chesapeake Bay Tributary Project Coordinator: Acts as Quality Assurance Officer of the Program. Conducts/coordinates field audits of the program, maintains all data files and conducts data analyses. Reviews data, contacts labs to verify suspect data and corrects data prior to submission to the Chesapeake Bay Information Management System (CIMS) of the Chesapeake Bay Program Office (CBPO). Primary contact with the laboratory for sample related issues. Reports Quality Assurance/Quality Control (QA/QC) findings to Program Manager and, where appropriate, makes a recommendation for corrective action.

Office of Information Services Data Manager: Ensure automated transfers are complete and functioning.

It will be the shared responsibility of the Regional Office Monitoring and Compliance Managers and the Chesapeake Bay Monitoring Program Manager (or designated representatives) to conduct Regional Field evaluations of the Enhanced Tributary Monitoring Program and, if necessary, make recommendations for corrective action requested by Regional or Program personnel.

Figure 1
Project Organization and Responsibility for VADEQ

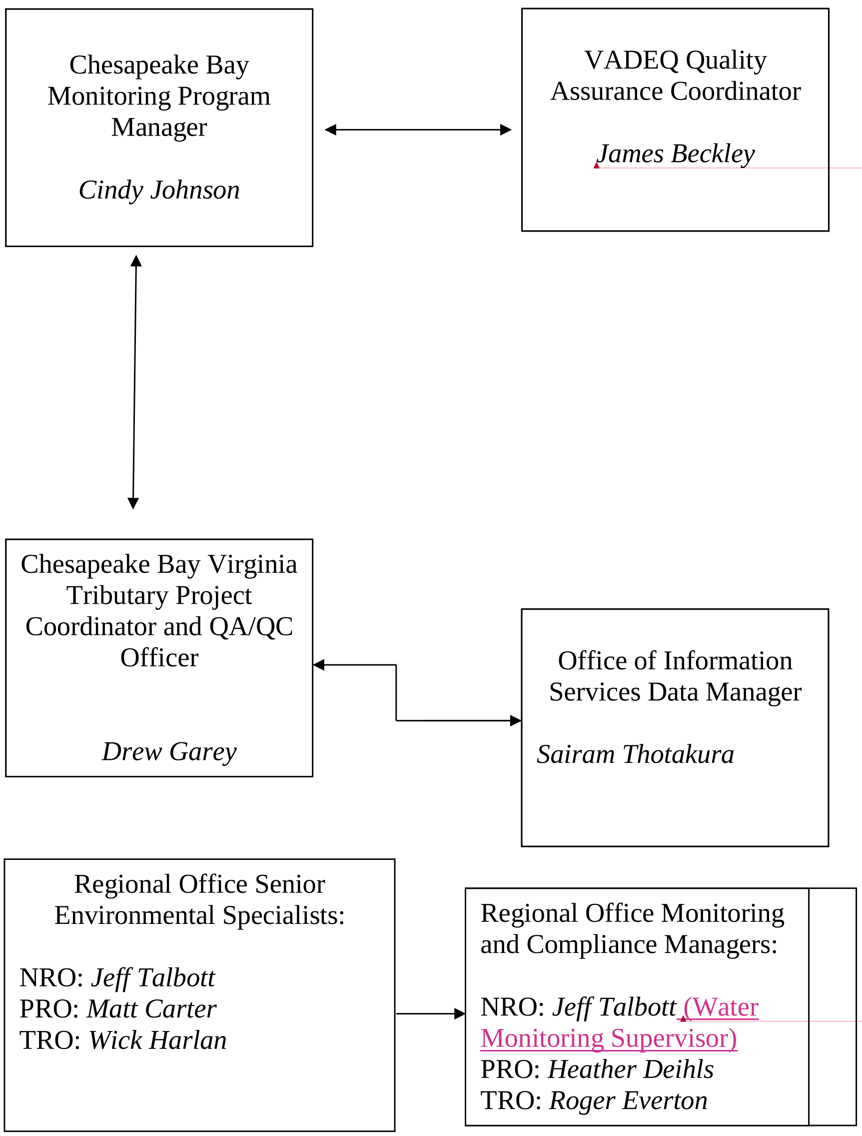

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Figure 2
Program Operating Procedures

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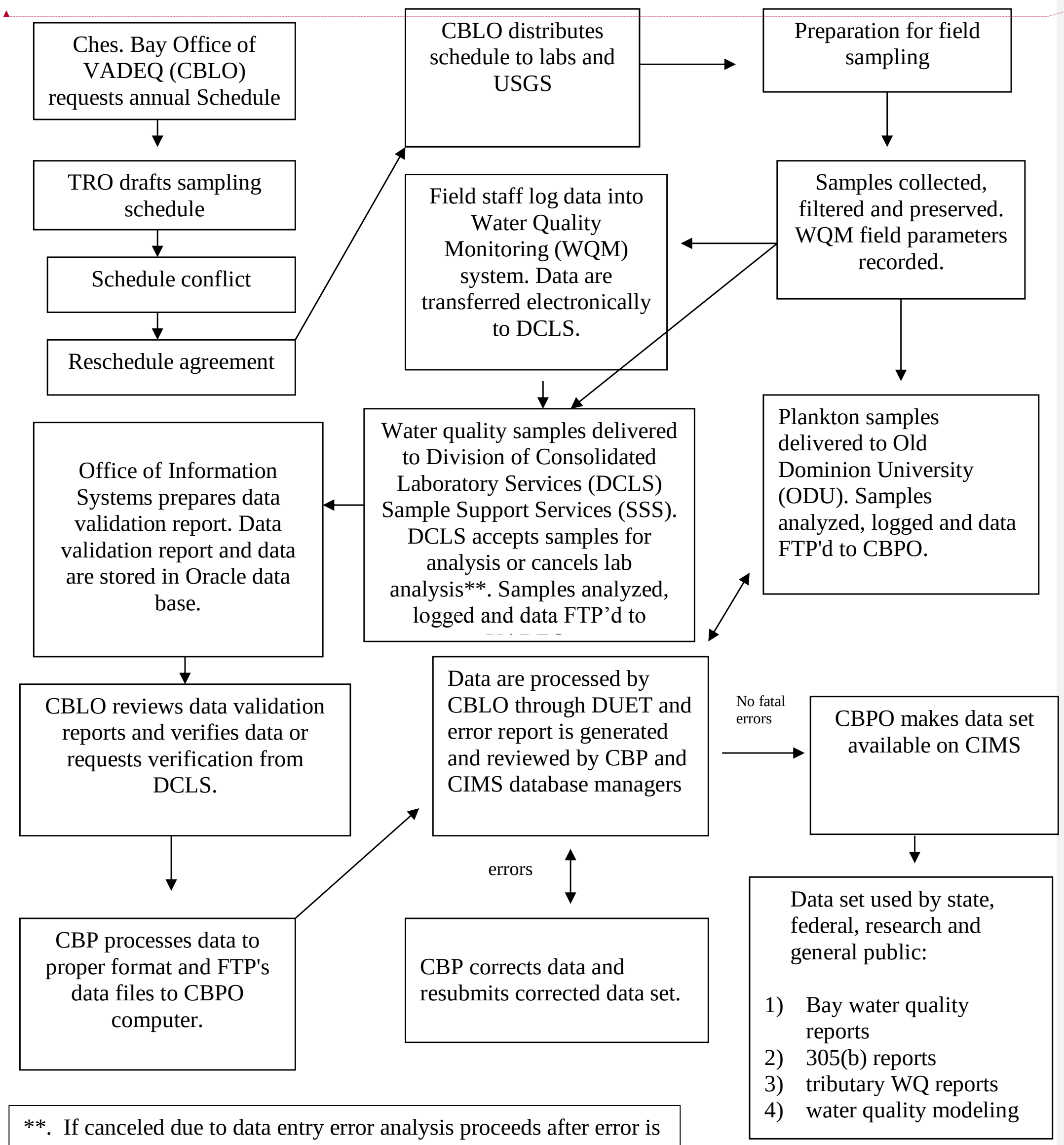

**. If canceled due to data entry error analysis proceeds after error is corrected and analysis re-ordered via WQM.

A5 Problem Definition/Background

The Virginia Tributary Monitoring Program (VTMP) is an ongoing water quality-monitoring program implemented by the Commonwealth of Virginia and its contractors in the summer of 1988 as one component of the overall Federal-Interstate Chesapeake Bay Monitoring Program (CBMP) operating Bay-wide. The CBMP also includes long-term monitoring of phytoplankton communities, benthic communities, and submerged aquatic vegetation as well as occasional special monitoring for such things as sediment toxics or sediment nutrient fluxes. This comprehensive and coordinated monitoring of basic environmental aspects of the Bay provides extensive information for understanding important ecological inter-relationships. This understanding provides a sound scientific basis for support and development of environmental management actions within the Chesapeake Bay Watershed. The main objectives of this monitoring program are:

1) To determine status and trends of nutrient and sediment concentrations in the major Chesapeake Bay tributaries of Virginia;

2) To assess the habitat conditions for aquatic living resources and determine if these conditions meet tidal water quality criteria and standards designed to protect them from nutrient and sediment impacts;

3) To collect phytoplankton samples that will be identified and enumerated by Old Dominion University (ODU) to determine the composition and abundance of phytoplankton assemblages above the pycnocline at stations in the James, York and Rappahannock Rivers, and in the Southern Branch of the Elizabeth River;

4) To collect data used to develop, calibrate, and verify water quality models for Virginia's major Chesapeake Bay tidal tributaries, Specific goals of these models are:

a) To quantitatively characterize the relationships between nutrient loading, eutrophication, depressed oxygen, and critical habitat/living resources where appropriate in the tidal tributaries.

b) To assess the relative effectiveness of point and nonpoint source nutrient controls with respect to eutrophication, depressed oxygen, and critical habitat/living resources in each tributary.

c) To predict the results of nutrient management strategies and controls and their impact on living resources.

The information generated by the VTMP will also allow for better understanding of the temporal and spatial aspects of water quality within the tributaries. This will assist in the development of more informed management decisions and will help:

1) Classify current physicochemical and living resource conditions in the Bay and

Tributaries.
Define geographical areas based on salinity within the Bay (i.e. Polyhaline, Mesohaline, Tidal Fresh segments). Segments are also characterized in relation to water quality criteria developed by the Chesapeake Bay Program such as submerged aquatic vegetation habitat goals and living resources habitat dissolved oxygen goals.

2) Assess ambient water quality conditions against pre-defined State water quality standards and criteria for parameters such as dissolved oxygen, pH, temperature, and ammonia. Assessment results are published in the biennial Virginia Water Quality Assessment 305(b) guides and Total Maximum and Daily Load 303(d) reports.

3) Characterize long-term temporal and spatial trends. Long-term temporal trends are examined in order to assess the overall success of Bay restoration actions, Watershed Implementation Plan goals (WIPs) and characterizations of spatial patterns are used to prioritize watersheds which may need more extensive restoration efforts than others.

VTMP data will also be provided to the public, consultants, environmental organizations, local governments, state agencies and the EPA.

A6 Project/Task Description

The VTMP is composed of monthly water quality sampling in three river basins, encompassing 13 Rappahannock, 10 York and 27 James River stations (note James River stations also include the Elizabeth River). Water for the VTMP is collected in the main channel, from just below the Fall Line to the river mouth, in the James, Rappahannock and York rivers (Tables 2-4; Figures 3-5). Sampling runs are conducted by three regional offices (NRO, PRO, and TRO). Runs are coordinated such that, whenever possible, all samples from a single river basin are collected on the same day. Filtration of samples is conducted in the field and all water quality samples collected are delivered to the Virginia Division of Consolidated Laboratory Services (DCLS) for analysis. At two specific sites on each tributary phytoplankton and dissolved organic carbon are collected from March through October, ensuring simultaneous sampling of water quality and living resources (Tables 2-4). Phytoplankton samples are also collected at two additional sites on the James River as there is a numeric chlorophyll-A standard in that riverbasin. All phytoplankton samples will be delivered to Old Dominion University's (ODU) phytoplankton laboratory for analysis.

All sampling will be coordinated between VADEQ-Chesapeake Bay Program and Regional VADEQ Offices. Samples collected by VADEQ will be analyzed by DCLS or ODU.

A7 Quality Objectives and Criteria

The Data Quality Objectives (DQOs) established for the Chesapeake Bay Monitoring Program can be expressed as a program level goal to *estimate the ecological status and trends of the water quality and living resources within the Chesapeake Bay system with a minimum 95% confidence* (see Quality Assurance Project Plan- Data Analysis Activities for VA DEQ Chesapeake Bay Monitoring Program, 2011). The management objectives and practices that will best accomplish the DQOs for the Chesapeake Bay Program are set by the members of the Chesapeake Executive Council. The initial sampling design that the Executive Council endorsed is outlined in Appendix E of *Chesapeake Bay: A Framework of Action* *(Chesapeake Bay Program (CBP). 1983b. Chesapeake Bay: A framework for action. Main document and Appendices. US Environmental Protection Agency (EPA), Philadelphia, PA)*. Any modifications to the sampling design are reviewed and approved by members of the Scientific, Technical and Reporting (STAR) Team; changes to sampling/analytical methods are approved by the Analytical Methods and Quality Assurance Workgroup.

The VTMP has developed specific data quality goals in order to meet the DQOs of the CBMP. These data quality goals can be expressed in terms of representativeness, completeness, comparability, accuracy and precision. Measurement quality objectives may be set by instrument manufacturer's specifications, subcommittee actions, or by historical data results.

Detailed descriptions of the quality assurance practices for each of the analytical procedures conducted by DCLS for the VTMP can be found in the DCLS Quality Manual (Commonwealth of Virginia Department of General Services, Division of Consolidated Laboratory Services). This document can be made available upon request by contacting Ed Shaw of DCLS (E.Shaw@dgs.virginia.gov). Specific analytical procedures of interest are:

Technical Procedure 2506 Determination of Carbon and Nitrogen in Particulates of Estuarine/Coastal Water Using Elemental Analysis.

Technical Procedure 2-510 The Determination of Chlorophylls A, B, & C in Marine and Freshwater Algae by Visible Spectrophotometry.

Technical Procedure 2-600 Determination of Ammonia Nitrogen by Automated Colorimetry.

Technical Procedure 2-540 Total Dissolved Phosphorus Automated Colorimetric.

Technical Procedure 2-525 Total Dissolved Nitrogen Automated Colorimetric.

Technical Procedure 2602 Determination of Nitrate and/or Nitrite in Brackish or Seawater by Flow Injection Colorimetry.

Technical Procedure 2606 Particulate Phosphorus/ Particulate Inorganic Phosphorus in Estuarine and Coastal Waters by Automated Flow Injection Colorimetry.

Technical Procedure 2601 Orthophosphate Phosphorus in Estuarine and Coastal Waters by Automated Flow Injection Colorimetry.

Technical Procedure 2543 Molybdate Reactive Silica in Water and Wastewater.

DCLS 2544 Total Suspended Solids.

Technical Procedure 2532 Carbon - Total Organic and Dissolved Organic Nonpurgeable.

A7.1 Representativeness

Representativeness is the degree to which sample data represent the actual conditions or concentrations present in the sampled population or area. Sample collection, preservation and handling and sampling design are interactive factors that directly affect field sample representativeness. The sampling design is described in detail in the Project Description. Initially the project design called for a sampling frequency of 20 cruises a year for each river, however, due to budget constraints sampling frequency was reduced to 12 cruises each year for each. Relatively small sample sizes (2-4) each season make it more difficult to detect seasonal trends in data from stations sampled only once per month. Alden et. al concluded that a 12-cruise scenario was statistically less powerful than the 20-cruise scenario but adequate for capturing long-term annual trends. (Alden, et al., 1994. *An Assessment of the Power and Robustness of the Chesapeake Bay Program Water Quality Monitoring Program: Phase II - Refinement Evaluations).*

Staff use reliable QA procedures, including field blanks, field duplicates, and standard operating procedures (SOPs) to ensure representative data. These techniques combined with sample container requirements, sample preservation, and sample holding times will assure the required data confidence level achievement (see Appendix A, *Virginia Chesapeake Bay Tributary Water Quality Monitoring Program Standard Operating Procedures Manual*). Standard Operating Procedures used by the field personnel define sample collection, preservation and handling. Following the procedures stipulated in the SOPs allows minimum standards of field representativeness. Although SOP's detail specific field sampling operations and handling, they allow for best professional judgment of field personnel. If abnormal circumstances occur relative to the sampling and/or site selection, field personnel may document this and take appropriate action. The Corrective Action Plan procedure included as part of the SOP provides a mechanism to identify and correct procedures that affect data representativeness.

A7.2 Comparability

Comparability expresses the confidence with which one data set can be compared with another. Data collected must be comparable within and between VADEQ regions as well as between VADEQ and also to other state agencies participating in the Chesapeake Bay Program. Comparability of monitoring data is achieved as a result of quality products at each phase of the data gathering process. It includes consistent sampling and sample handling procedures, uniform laboratory methods and validation of laboratory data, and procedures for reduction, validation, and reporting of environmental data.

The Analytical Procedures section of this plan includes the analytical method used for each parameter (see also Appendix C). A high confidence level of data is maintained by the consistent integrity of VADEQ sampling procedure and lab analysis. This allows comparisons of data within this program and similar water quality data sets. VADEQ's tidal tributary and ODU's mainstem monitoring program collect the same parameters using nearly identical sampling procedures to ensure spatial comparability between DEQ and ODU data collection.

The VTMP Standard Operating Procedures (SOP; Appendix A) is an essential component of the quality assurance process. Adherence to the SOP ensures that newly collected data are comparable to those in the existing database. This document, which details all field procedures employed, is evaluated and approved annually by the CBPO. The VADEQ Chesapeake Bay QA/QC Officer performs annual audits of all field crews to ensure strict adherence to the SOP.

Additionally, participants in the Federal-Interstate Chesapeake Bay Program have data reporting requirements and are required to participate in quarterly Data Integrity Workgroup (DIW) meetings. The comparability of laboratories analyzing data for the Chesapeake Bay Program is reviewed by DIW participants with the use of field splits and blind audit samples (refer to section B4 or *Chesapeake Bay Coordinated Split Sample Program Implementation Guidelines, Rev. 4* (CBP, 2010) for further details) and data submitted to the Chesapeake Bay Information System (CIMS) database are required to be formatted according to the database design developed by the database managers.

A7.3 Completeness

Completeness is a measure of the amount of valid data obtained compared to the amount that was expected under correct normal conditions. Completeness for the monitoring parameters of the VTMP network should exceed 90% for each parameter (i.e. 90% or more of samples and measurements that were intended to be collected and analyzed within a given year are actually collected and analyzed). Because the DQOs of the VTMP are based on long-term monitoring results, occasional failure to achieve this goal does not preclude the use of data for model calibrations nor does it result in an inability to determine long-term status and trends in the tributaries being monitored. Variation from this goal is usually due to unavoidable problems that cause cancellation of field events such as prolonged adverse weather conditions or equipment failure. To minimize such losses, field personnel are requested to reschedule as often as necessary due to inclement weather. In the case of equipment failure, other regions may be requested to sample on behalf of the affected region (see Section 1.1.2 of the SOP for further details; Appendix A).

Collected samples are occasionally invalidated due to ineffective sample preservation, exceeded holding times, sample mis-identification, inadequate sample volume, loss or breakage. In addition, sample characteristics (very high concentrations or very low concentrations) can compromise the accuracy of the method and thus limit the completeness of the data.

A7.4 Accuracy and Precision

Accuracy refers to the degree that measurements approach the true or accepted value whereas precision is the consistency of replicate measurements. Precision may be expressed as standard deviations from the mean, percent difference between replicate values, or as an absolute difference (i.e. number of measurement units by which two replicates differ).

To assure that the multiprobe instruments used by field personnel are accurate, the instruments are calibrated prior to each use in the field following the instructions in the manufacturer's manual. Upon returning to the regional office a post-cruise calibration check for drift against known standards is conducted. Also annual checks are conducted for temperature calibration at 4° C and 25° C using an NIST thermistor during site visits. Field parameters are rejected for quality assurance reasons if the following criteria are exceeded:

Table 1. Quality Control Rejection Criteria for Field Parameters.

FIELD PARAMETER		CRITERION
[1] Dissolved Oxygen	Clarke cell	±0.49 mg/L
	Optical Probe	±0.3 mg/L
[1] Specific Conductance	0.147 mmhos/cm standard solution	±10% mmhos/cm
	All other conductance standards	±5% mmhos/cm
[1] pH		±0.2 SU
[2] temperature	probe	±1° C
	NIST certified thermistor	±0.5° C
[3]depth		±0.2 m

[1] Post cruise calibration check conducted after each cruise.

[2] Accuracy check conducted once per year via a comparison of two multiparameter instruments. Also annual check conducted against aNIST certified thermistor during site visits (refer to section 2.2.1 of the *Virginia Chesapeake Bay Tributary Water Quality Monitoring Program Standard Operating Procedures Manual* for further details).

[3] Accuracy checked monthly against a known depth (refer to section 3.2.2 of the *Virginia Chesapeake Bay Tributary Water Quality Monitoring Program Standard Operating Procedures Manual* for further details).

Li-cor light sensors are sent to the manufacturer for calibration annually (when possible) or semi-anually. Data obtained from sensors with drifts greater than 10% per year (20% if recalibrated in a 2 year frequency) are flagged as suspect.

Analytical accuracy and precision are the responsibility of the laboratories conducting the analyses. Quality control samples (e.g. blanks, sample spikes and split samples) along with appropriate statistical techniques are used to ensure accuracy and precision in the production of laboratory data. The sensitivity of an analytical method to detect an analyte at low levels can vary depending on the combined factors of the instrument used, sample size and the sample processing steps. Therefore a Method Detection Limit (MDL) is established by the laboratory for each parameter and reported to VADEQ with the analytical results (Table 5). MDLs represent the minimum concentration of an analyte that the lab can detect with 95% confidence.

A8 Special Training Requirements

Training for VTMP personnel is provided as needed by equipment manufacturers, quality assurance personnel and researchers who have developed the sampling methods. Regional field personnel with demonstrated proficiency provide training for new personnel as required. Training takes place in both the regional offices and in the field. Central Office personnel then perform a site visit to observe the new field personnel.

A9 Documentation and Records

Field crews will document all data obtained in the field on field sheets and key the water quality data into WQM by 9:00 am of the mornings following the cruise,excluding Li-Cor, which may be entered at a later date. Since the data generated by this program are not used for legal purposes, a formal chain of custody is not required. However, CBP requires information on problems and events during sampling runs, as well as comments on general trends and modifications to the sampling program. Therefore, the following resources are shared with CBP and used to document all relevant information (copies of all forms can be found in Appendix A of the *Virginia Chesapeake Bay Tributary Water Quality Monitoring Program Standard Operating Procedures Manual*):

1) A **WQM Field Data Sheet** is completed upon arrival at each station. This form is used to record Secchi depth, weather, tidal flow, field measurements (e.g. pH, salinity, water temperature, DO, and specific conductance) and data pertinent to the collection of samples such as type of sample, time collected, and when applicable, volumes filtered.

2) A **Field Summary Report** is completed during each day's sampling run. This form is used to record information specific to each station, as well as calibration data for the multi-probe units. Changes and/or departures from SOP are also noted on this form.

3) The **Procedure Modification Tracking Form** (PMTF) is completed only if a major change in the SOP has occurred. Examples of this type of situation would be station relocations, or a change in sample collection methodology. Copies of PMTF's are kept on file with each regional office, and the originals are sent to CBP within two working days of completion of field work.

4) A **Li-Cor Data Sheet** is used at the plankton stations for recording light attenuation data obtained during a run.

5) A **Field Filtration Log** may be used to track filtration times for samples not filtered on the boat. Regional staff typically use WQM field sheets to track filtration times, however. **All filtration is to be completed within 2 hours of sampling**.

6) A **Laboratory Notebook** is to be maintained by each region.
This notebook is used to record instrument calibration data, notes on instrument testing and/or modifications, and notes on instrument performance, problems and repair. Equipment inventories and field checklists can also be kept in this notebook, as well as miscellaneous data not originally recorded on the field data sheets (e.g. Winkler DO).

7) A **Corrective Action Request Form** (CAR) is used to document problems and steps needed, or taken, for correction. CAR forms may originate in regions, headquarters, or

the labs. The main reason to use a CAR is the need to permanently change any procedure.

8) A **CBP Tributary Site Visit Form** is used to document audits performed by the CBP staff annually. This ensures field preparation and sampling procedures are followed according to SOP.

These resources are primarily for documentation and review purposes, and may be important components in the overall analysis of the Monitoring Program, and each region's role in meeting program objectives. However, resolution of problems or disruptions in sampling that may lead to missing or compromised data require immediate communication and action, and take the highest priority with regard to effort.

Every spring the Project Plan and SOP for the VTMP will be reviewed and updated as needed. If no changes are needed, a statement verifying that the Project Plan and SOP has been reviewed and is up-to-date will be submitted to the CBP. Any modifications to the documents will be reviewed and approved by the regional personnel conducting the sampling, the principal investigators and DEQ's Quality Assurance Coordinator. Once approved, final versions will be made available to all interested parties by placing downloadable copies on the CIMS and VADEQ websites.

Analytical results are reported to VADEQ in electronic format and are uploaded to WQM daily. The field and analytical data are submitted to CIMS through their Data Upload and Evaluation Tool (DUET) where they are made available to researchers and the general public. Metadata documenting the procedures used by VTMP since its inception in 1988 are also available on the CIMS website.

Hard copies of field generated documentation must be retained by the Chesapeake Bay office for a minimum of 5 years and electronic formats must be retained for 10 years. Laboratories must retain bench sheets and QA/QC information for at least 3 years.

A10 Additional Areas of Interest to the VA Chesapeake Bay Program

The Federal - Interstate Chesapeake Bay Monitoring Program (CBMP) was implemented as a coordinated effort to restore and protect the Chesapeake Bay and its living resources. Because the Chesapeake Bay is a large and complex ecosystem, several separate monitoring program components are used to identify and quantify possible factors affecting its health. A brief description of programs being conducted in addition to the VTMP either by VADEQ or through cooperative agreements with VADEQ to aid in our goals as outlined in the 2000 Chesapeake Bay Agreement are given below.

A.10.1 Chesapeake Bay Mainstem Monitoring Program

The design of the long-term Chesapeake Bay Mainstem Monitoring Program is described in Appendix E of "Chesapeake Bay: A framework for action" (Chesapeake Bay Program (CBP). 1983b. Chesapeake Bay: A framework for action. Main document and Appendices. US Environmental Protection Agency (EPA), Philadelphia, PA).

Implemented in 1984, the program began with 22 stations in Maryland and 28 in Virginia and consisted of monthly sampling in the late fall and winter months and twice monthly sampling in spring and summer. Whenever possible, sampling was coordinated between Virginia and Maryland to provide a synoptic picture of the Bay each month.

The Virginia Mainstem Monitoring Program currently consists of 27 sites sampled monthly throughout the year except in June and August when sampling occurs twice monthly (refer to the 2014 Scope of work for the Virginia portion of the main bay monitoring and log of significant changes in Appendix G). Sampling is still coordinated with the Maryland schedule as much as possible to continue to provide a synoptic picture of the Bay.

A10.2 River Input Monitoring Program

The River Input Monitoring Program (RIM) was initiated in Virginia on July 1, 1988 to characterize the status and trends of nutrients and sediment loads to the Bay from the non-tidal watersheds of the major Bay tributaries. The program initially consisted of sampling at the Fall Line for base flow and storm events in the James, Rappahannock, Appomattox, Mattaponi and Pamunkey Rivers. VADEQ sampled 3 of the Fall Line stations monthly from 1988 until March 2003. The collection methods that were used by VADEQ to monitor the Fall Line stations are given in Appendix I and documentation of the naming convention for the Rappahannock River Fall Line station can be found in Appendix D. Since that time the program has been expanded to include sites in the North and South Forks of the Shenandoah River, the North Anna River, the Chickahominy River, the Rapidan River, the Smith River and the Rivanna River. In 2012 USGS began storm targeted sampling at sites already monitored for baseflow on the Appomattox, Rappahannock and Mattaponi Rivers and implemented baseflow and storm sampling at a new site on Polecat Creek. The current Scope of Work and a log of significant changes to the RIM program are documented in Appendix E.

A.10.3 Shallow Water Monitoring Program

One of the most important strengths of the Federal - Interstate Chesapeake Bay Monitoring Program is its flexibility - the willingness of the participants to review and redesign the Program to meet restoration goals. Such reviews of the status of the Bay and attainment of goals resulted in the establishment of a near shore-monitoring component in 2003 and a non-tidal network in 2004. These programs were initiated to provide additional data to better assess water quality monitoring data against new criteria developed by the Bay Program and published in *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries* (U.S. EPA 2003) and in 2006 in *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries 2006* Addendum (U.S. EPA 2006).

The near shore monitoring component was initiated as a cooperative agreement with the Virginia Institute of Marine Science (VIMS) in 2003 and consists of the deployment of continuous monitoring devices and data flow cruises that track throughout a select tributary or Bay segment in the polyhaline, oligohaline and mesohaline portions of the river from April through September of each year. The program was designed to rotate through Virginia's major tributaries on a 3 year basis. The York system was sampled in 2003 through 2005. The James System was sampled in 2006 through 2008. The Rappahannock and Potomac systems were sampled in 2007 through 2009.

The Mobjack Bay and segment CB5 were sampled in 2010 through 2012. In 2012, the Chesapeake Bay Program (CBP) shallow water monitoring segments sampled included the Mobjack Bay Polyhaline (MOBPH), Chesapeake Bay 6 Polyhaline (CB6PH), Rappahannock River Mesohaline (RPPMH) and York River Polyhaline (YRKPH) using continuous monitoring (CONMON), continuous buoy or fixed profilers, or monthly underway (DATAFLOW) sampling. In 2013 through 2015 the Chesapeake Bay Program shallow water monitoring segments consisted of Chesapeake Bay 5 Mesohaline (CB5MH) segment and the Pocomoke Sound Mesohaline (POCMH). For 2016 – 2018 monitoring will focus on the entire eastern shore encompassed by segment CB7PH including the major tidal creeks along the segment. All data collected for the Virginia Shallow water monitoring program may be found on the VIMS Virginia Estuarine and Coastal Observing website at http://www3.vims.edu/vecos/. Additionally, some aspects of continuous monitoring and dataflow have continued through other non-CBP efforts (e.g. by Hampton Roads Sanitation District (HRSD), and National Estuarine Research Reserve (NERRS)) during other years not described here. Data generated by HRSD and VIMS is available. Analytical data generated by VIMS for the project will be submitted to the CIMS website. The Scope of Work for the VIMS shallow water program can be found in Appendix J.

In 2008 VIMS utilized a computer-controlled towed sampler (Sea Sciences, Inc.) to analyze water quality parameters from the surface to the Bay's bottom water. The Acrobat undulated vertically while being towed to provide real-time water column data for temperature, specific conductance, dissolved oxygen (DO), chlorophyll, turbidity, and colored dissolved organic matter. The Acrobat was also outfitted with a mini-rosette system for underway collection of calibration samples. Acrobat surveys were conducted monthly in the lower York River in 2008 and 2009. Surveys were conducted in a sawtooth path to facilitate 3D interpolation of all parameters and computation of both hypoxic volume and depth-integrated, water column chlorophyll biomass. The data collected were to be appropriate for assessing DO and chlorophyll concentrations against new Chesapeake Bay Program criteria for sub-surface open water, deep water, and deep channel designated uses, and for computation of the 30-day mean and instantaneous minimum DO criteria. Due to funding constraints use of the Acrobat was suspended for the Bay program in 2009.

A10.4 Virginia CBP Non-tidal Network

In the Chesapeake 2000 Agreement, the Chesapeake Bay Program (CBP) committed to correct nutrient and sediment – related problems in the Bay and its tidal tributaries to remove them from the impaired water list. To achieve improved water-quality in the Bay, nutrient and sediment allocations have been developed for tributary basins in the Bay watershed. However, monitoring efforts within the tributary basins have primarily been focused in the tidal portions of the tributaries. Additional information, including both modeling predictions and monitoring assessments, is needed by the jurisdictions in the non-tidal areas such that State and local government can adequately assess progress in meeting nutrient and sediment allocations for water-quality criteria in the Bay watershed.

A list of the Virginia Chesapeake Bay Non-tidal Network stations is provided in Appendix K. A total of 36 sites will be monitored for water quality in the non-tidal portions of the Potomac, James, York, and Rappahannock Rivers. Eighteen sites will be sampled by VADEQ on a monthly basis for base flow of which six will be monitored by USGS for targeted storms and USGS will sample an additional 18 sites for base flow and storm targeted events (5 traditional RIM sites and 12 sites added between 2006 and 2012) as a part of their River Input Monitoring Program. Site selection was based on 1) location to the outlet of rivers draining the Tributary Strategy Basin 2) locations delivering the largest amounts of nutrients and sediment to the Chesapeake Bay or its tributaries and 3) importance to watershed modeling efforts for closing areas of large data gaps such as in the area of the Coastal Plain. In an attempt to eliminate duplicative sampling, two sites (the Accotink and Catoctin sites) were dropped by DEQ in 2012 due to either Maryland-DNR or USGS-MD performing the sampling instead. In 2015, DEQ resumed sampling at one of these sites (Catoctin at Taylorsville) and USGS resumed the Accotink when Maryland-DNR discontinued sampling those locations.

The specific objective of the non-tidal network is to measure and assess the concentration, load and trends of nutrients and sediment in the Bay watershed. The information will be analyzed to help evaluate progress toward, and factors influencing, the reduction of nutrients and sediment to attain the water-quality criteria in the Bay.

A10.5 NOAA/NOS Pathogen Sampling

In 2007 the Bay Program began sampling for pathogens for the NOAA/NOS Cooperative Laboratory. Surface samples are assayed for *Mycobacterium genus, Vibrio parahaemolyticus* and *Vibrio vulnificus.* Samples were initially collected quarterly at all sites on the James, York and Rappahannock rivers; however, in 2011 sampling occurred monthly at plankton stations only. In 2012 pathogen sample frequency was reduced to collection only at plankton sites in June, July and August. In 2014 sample collection was further reduced to July and August due to budget constraints. DEQ continues to sample for pathogens for the NOAA/NOS laboratory under the same sample schedule utilized in 2014 per request from NOAA (contact Ava Schein, ava.schein@noaa.gov).

MEASUREMENT/DATA ACQUISITION

B.1 Program Design

B1.1 Sampling Stations

The VTMP stations, located in the tidal reaches of the James, York, and Rappahannock Rivers, are listed and described in Tables 2-5 and shown in Figures 3-5. The station selections represent three different regions of each river based upon salinity; oligohaline, mesohaline and polyhaline . See the following link for a description of the Chesapeake Bay analytical segments:

http://www.chesapeakebay.net/images/maps/cbp_28727.pdf

In some instances the legacy STORET locations differ from those in the field due to necessary changes in sampling location (e.g. bridge relocation associated with station TF4.4). Historical STORET latitudes and longitudes are listed in Appendix F.

B1.2 Sampling Frequency

The schedule for the sampling year is prepared in advance by the Tidewater Regional Office (TRO) (See Section 1.1.1 of Appendix A, *Virginia Chesapeake Bay Tributary Water Quality Monitoring Program Standard Operating Procedures Manual). Whenever possible,* sampling will be performed sequentially upstream, beginning at the mouth of the river.

Weather permitting, each monitoring station will be sampled once each month. One tributary will be monitored each week with the James River run conducted first, the Rappahannock second, and the York third (Appendix A) The Elizabeth River will consist of two runs that will be conducted on consecutive days the same week as the Rappahannock River run. This will allow time each month for cases of cancellation and/or rescheduling.

Rescheduled runs may be performed during the first open field day. Rescheduling of tributary sampling will be based on least disruption to the original schedule, and coordination between the regional offices and the analysis laboratories. DCLS must be notified of rescheduling by WQM and by email due to time constraints for standards with their analytical equipment. Protocols for rescheduling field events are provided in Section 1.1.2 of the SOP (Appendix A)

B.2 Sampling Methods

A full description of the sampling methods utilized by VADEQ for the VTMP is given in the SOP (Appendix A). Multiple personnel should be trained in all aspects of the field sampling procedures to ensure backup personnel are available as needed.

B2.1 Field Measurements

Field measurements will be taken according to the procedures outlined in the *Virginia Chesapeake Bay Tributary Water Quality Monitoring Program Standard Operating Procedures*

Manual (Appendix A). Field measurements obtained include the following:

1. Secchi depth is recorded at all stations except for TF5.2 because the station is sampled from a high bridge and water depth is prohibitively shallow .

2. A vertical profile of temperature, dissolved oxygen, conductivity, salinity and pH are determined using multiparameter water quality meters and associated probes. Details on operation and calibration of water quality meters can be found in the *SOP in Appendix A* and maintenance procedures can be found in the instrument's operating manuals. Copies of the manuals should be kept on file at each region.
   The vertical profile starts at one meter above the bottom (where bottom depth is rounded to the nearest whole number) and is obtained at each meter to a depth of one meter below the surface.

3. Light Attenuation
   Light Attenuation is only evaluated at the six stations monitored for phytoplankton (RET3.1, TF3.3, RET4.3, TF4.2, RET5.2 and TF5.5; Tables 2-4). An initial underwater light reading is obtained just below the surface (approximately 0.1 meter). Subsequent readings are taken in 0.5-meter increments until light levels decline to or below 10 micro-Einsteins or 20 percent of the 0.1 meter reading. A second sensor on the boat deck is used to measure, and thus account for, incident sunlight. Rough sea conditions, strong tidal currents and light reflection off of the side of the boat adversely affect the determination of precise depths. As such, when conditions have become too rough, light attenuation measurements are not recorded.

TABLE 2. Main Station Location and Information for Rappahannock River Basin

(note: latitudes and longitudes shown below are utilized for sample collection and in some instances may not match those utilized in the legacy STORET database. Refer to Section 1.4 of Appendix A for further information).

RAPPAHANNOCK RIVER BASIN

River	VADEQ CBP Sta. No.	CIMS Sta No.	VADEQ STORET	Location Description	NAD 83 Latitude	NAD 83 Longitude
Rapp.	TF3.0*	TF3.0*	3-RPP113.37	Cableway at I95	38°19'20.5	-077°31'05.0"
Rapp.	TF3.1*	TF3.1*	3-RPP110.57	Fredericksburg Fall Line	38°19'12.5"	-077°28'16.9"
Rapp.	TF3.1D*	TF3.1D*	3-RPP107.91	100 yds below Fredericksburg STP	38°17'15.5"	-077°26'54.9"
Rapp.	TF3.1C*	TF3.1C*	3-RPP107.33	100 yds below FMC discharge	38°16'50.5"	-077°26'32.9"
Rapp.	TF3.1F	TF3.1F*	3-RPP106.01	Upstream of Fredericksbrg Ctry Club		38°16'10.3"
	-077°25'44.3"					
Rapp.	TF3.1A*	TF3.1A*	3-RPP104.47	Below Massaponax STP	38°15'19.5"	-077°24'41.9"
Rapp.	TF3.1E	TF3.1E	3-RPP098.81	Buoy 112	38°14'40.9"	-077°19'30.3"
Rapp.	TF3.1B	TF3.1B	3-RPP091.55	Buoy 89	38°14'46.4"	-077°14'00.4"
Rapp.	TF3.2	TF3.2	3-RPP080.19	Port Royal	38°10'28.8"	-077°11'11.8"
Rapp.	TF3.2A	TF3.2A	3-RPP064.40	Blind Point	38°06'46.6"	-077°03'17.4"
Rapp.	TF3.3	TF3.3	3-RPP051.01	Buoy 40 Plankton, Benthos	38°01'06.5"	-076°54'33.4"
Rapp.	RET3.1	RET3.1	3-RPP042.12	Buoy 10 Plankton, Benthos	37°55'02.3"	-076°49'19.9"
Rapp.	RET3.2	RET3.2	3-RPP031.57	Buoy 16	37°48'41.7"	-076°42'43.0"
Rapp.	LE3.1	LE3.1	3-RPP025.52	Buoy 11	37°45'33.3"	-076°36'57.3"
Rapp.	LE3.2	LE3.2	3-RPP017.72	Near Buoy 8 Benthos	37°40'08.9"	-076°33'01.7"
Corr.	LE3.3	LE3.3	3-CRR003.38	Buoy 6	37°41'18.3"	-076°28'27.9"
Rapp.	LE3.4	LE3.4	3-RPP010.60	Orchard Point	37°37'54.8"	-076°26'41.5"

* Stations TF3.1D, TF3.1C and TF3.1A discontinued as Bay Program stations in November 1995. Station TF3.0 is only sampled by USGS. Station TF3.1 has been collected from 3 different locations for the VTMP (See Appendix D for further information) and was discontinued as a Bay Program station in April 2001. Most are still sampled for VADEQ's Ambient Water Quality Monitoring Program. Station TF3.1F was added in 2008 as a deep water site in the upper reaches of the Rappahannock River. The traditional Bay Program parameters are not collected at this site.

Figure 3. Rappahannock River Basin Stations

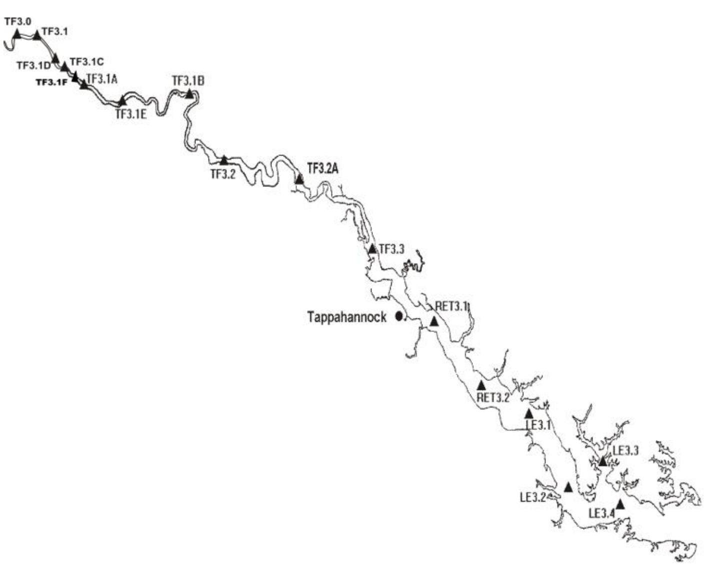

Table 3. Main Station Location and Information for York River Basin
(note: latitudes and longitudes shown below are utilized for sample collection and in some instances may not match those utilized in the legacy STORET database. Refer to Section 1.4 of Appendix A for further information).

YORK RIVER BASIN

River	VADEQ CBP Sta. No.	CIMS Sta. No.	VADEQ STORET	Location Description	NAD 83 Latitude	NAD 83 Longitude
Pam.	TF4.1*	TF4.0P*	8-PMK082.34	Hanover Fall Line	37°46'03.0"	-077°19'57.0"
Pam.	TF4.2	TF4.2	8-PMK034.17	Whitehouse Plankton, Benthos	37°34'47.9"	-077°01'16.6"
Matt.	TF4.3*	TF4.0M*	8-MPN054.17	Beulahville Fall Line	37°53'02.0"	-077°09'55.0"
Matt.	TF4.4	TF4.4	8-MPN029.08	Walkerton	37°43'22.1"	-077°01'32.8"
Pam.	RET4.1	RET4.1	8-PMK006.36	South of Lee Marsh	37°31'32.3"	-076°52'03.4"
Matt.	RET4.2	RET4.2	8-MPN004.39	Muddy Point	37°34'16.5"	-076°47'49.7"
York	RET4.3	RET4.3	8-YRK031.39	Buoy 57 Plankton, Benthos	37°30'31.3"	-076°47'20.0"
York	LE4.1	LE4.1	8-YRK022.70	Buoy 44 Benthos	37°25'07.8"	-076°41'28.5"
York	LE4.2	LE4.2	8-YRK011.14	Buoy 34	37°17'25.6"	-076°34'41.2"
York	LE4.3	LE4.3	8-YRK001.64	Buoy 24 Benthos	37°14'02.1"	-076°25'51.4"

* VADEQ discontinued sampling stations TF4.1 and TF4.3 for the Bay Program in March 2003. USGS continues to sample both stations for the Bay Program and VADEQ continues to sample the stations for the Ambient Water quality program.

Figure 4. York River Basin Stations

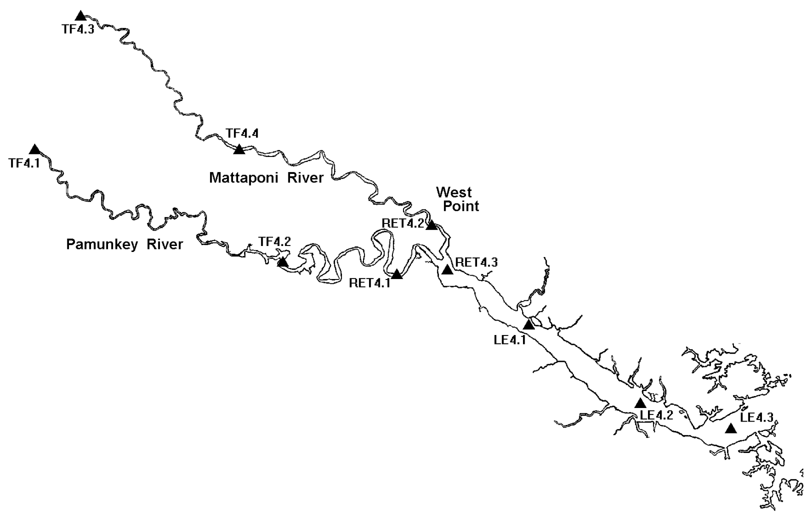

Table 4. Main Station Location and Information of the James River Basin

(note: latitudes and longitudes shown below are utilized for sample collection and in some instances may not match those utilized in the legacy STORET database. Refer to Section 1.4 of Appendix A for further information).

JAMES RIVER BASIN

River	VADEQ CBP Sta. No.	CIMS Sta. No.	VADEQ STORET	Location Description	NAD83 Latitude	NAD 83 Longitude
James	TF5.1*	TF5.0J	2-JMS157.28	Cartersville Fall Line	37°40'15.0"	-078°05'10.0"
James	TF5.2	TF5.2	2-JMS110.30	Mayo's Bridge Head of Tide	37°31'49.8"	-077°26'02.4"
James	TF5.2A	TF5.2A	2-JMS104.16	Buoy 166	37°27'00.0"	-077°25'07.8"
James	TF5.3	TF5.3	2-JMS099.30	Buoy 157	37°24'11.2"	-077°23'33.8"
James	TF5.4A*	TF5.0A	2-APP016.38	Rout 600 Bridge Fall Line	37°13'28.0"	-077°28'32.0"
App.	TF5.4	TF5.4	2-APP001.53	Buoy 8	37°18'44.6"	-077°17'28.8"
James	TF5.5	TF5.5	2-JMS075.04	Buoy 107 Plankton, Benthos	37°18'45.5"	-077°13'58.1"
James	TF5.5A	TF5.5A	2-JMS069.08	Buoy 91	37°18'05.9"	-077°07'42.2"
James	TF5.6	TF5.6	2-JMS055.94	Buoy 74	37°16'21.8"	-076°59'26.1"
Chick.	RET5.1A	RET5.1A	2-CHK006.14	Buoy 10	37°18'44.3"	-076°52'36.2"
James	RET5.2	RET5.2	2-JMS042.92	Swann's Point Plankton, Benthos	37°12'10.6"	-076°46'55.9"
James	LE5.1	LE5.1	2-JMS032.59	Buoy 36, Benthos	37°12'10.7"	-076°38'54.0"
James	LE5.2	LE5.2	2-JMS021.04	Buoy 12-13 Benthos	37°03'21.6"	-076°35'35.0"
James	LE5.3	LE5.3	2-JMS013.10	Buoy 15	36°59'25.6"	-076°28'31.6"
James	LE5.4	LE5.4	2-JMS005.72	Buoy 9 Benthos	36°57'17.5"	-076°23'33.9"
Eliz.	LE5.6	LE5.6	2-ELI002.00	Buoy 18	36°54'16.4"	-076°20'18.1"
Eliz.	LFB01	LFB01	2-LAF003.82	Granby St. Bridge	36°53'21.7"	-076°15'53.2"
Eliz.	LFA01	LFA01	2-LAF001.15	Hermitage Pt.	36°54'29.6"	-076°18'52.7"
Eliz	ELD01	ELD01	2-ELI004.79	Degaussing St. (Confl. WB)	36°51'56.0"	-076°19'44.0"
Eliz.	WBB05	WBB05	2-WBE004.44	Drum Point	36°49'45.0"	-076°23'45.0"
Eliz.	ELE01	ELE01	2-ELI006.92	Nauticus Pier	36°50'54.0"	-076°17'53.0"
Eliz.	EBB01	EBB01	2-EBE002.98	N&W RR. Bridge	36°50'10.0"	-076°14'40.0"
Eliz.	ELI2	ELI2	None**	Off SE corner of Craney Is.	36°52'53.9"	-076°20'19.2"
Eliz.	SBE2	SBE2	None**	Southern branch off Atlantic Wood	36°48'48.1"	-076°17'24.9"
Eliz.	SBE5	SBE5	None**	Southern branch off Virginia Power	36°45'54.5"	-076°17'59.7"
Eliz.	EBE1	EBE1	None**	Eastern branch, West side Berkley br.	36°54'27.6"	-076°17'16.7"
Eliz.	WBE1	WBE1	None**	Western br., North side Hwy 17	36°50'38.5"	-076°21'38.8"
Eliz.	SB-A-01	SB-A-01	None***	South End of Norshipco Piers	36°49'37.6"	-076°17'30.0"
Eliz.	SB-C-01	SB-C-01	None***	Mouth of Paradise Creek	36°47'58.2"	-076°17'33.7"
Eliz.	SB-D-01	SB-D-01	None***	Mouth of St. Julian Creek	36°46'44.8"	-076°18'36.0"
Eliz.	SB-D-04	SB-D-04	None***	Southern branch of Elizabeth E.	36°44'10.0"	-076°17'42.0"

* VADEQ discontinued sampling stations TF5.1 and TF5.4A for the Bay Program in April 2001. USGS continues to sample both stations for the Bay Program and VADEQ continues to sample the stations for the Ambient Water quality program.

** These stations were sampled and analyzed for VADEQ by Old Dominion University until 2010 and by VADEQ beginning December 2010. ODU generated data are not available in Legacy STORET or VADEQ's CEDS2000 system.

***Old Dominion University discontinued these sites in FY05-06 due to budget constraints.

Figure 5. James River Basin Stations

Figure 5a. Station locations in the James River.

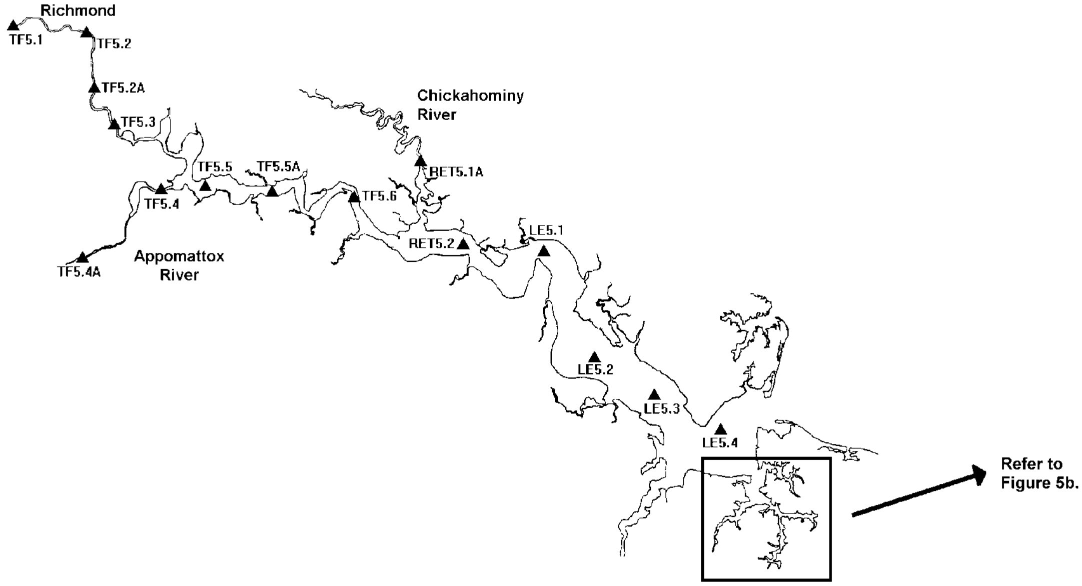

Figure 5b. Station locations in the Elizabeth River. Stations designated by a circle were formerly sampled and analyzed by Old Dominion University (ODU) as a part of the Chesapeake Bay Mainstem program. Due to budget constraints ODU discontinued sampling these sites in 2010 and DEQ took over the sampling effort. Stations designated with a square continue to be sampled by VADEQ personnel and analyzed by the Division of Consolidated Laboratory Services. Data collected by ODU is not retained in the Legacy STORETdatabase or in VADEQ's CEDS2000 database.

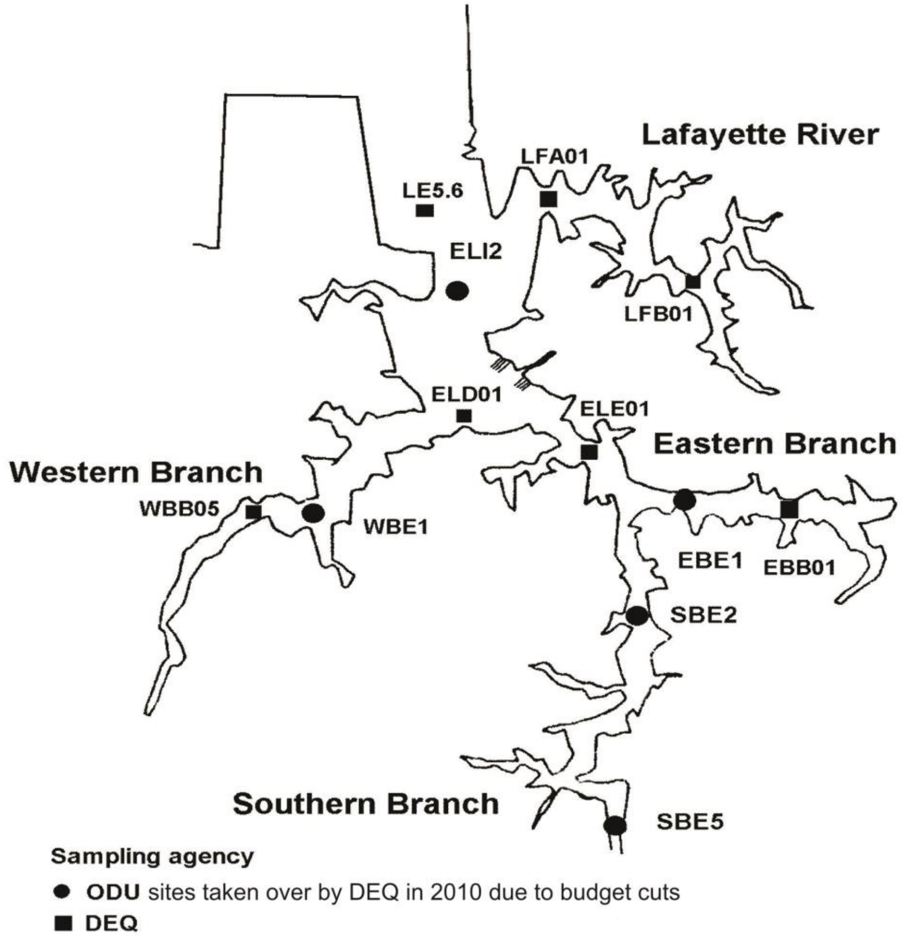

Table 5. Monitoring Parameters

PARAMETER	STORET PARAMETER	COLLECTION PROCEDURE	PRESER-VATION	PERFORMS ANALYSIS	DETECTION LIMITS	CBP (CIMS) METHOD (unless noted otherwise)
Temperature	00010	Mulitprobe Meter		Field		F01
pH	00400	Mulitprobe Meter		Field		F01
Dissolved Oxygen	00299	Mulitprobe Meter		Field		F01
Conductivity	00094	Mulitprobe Meter		Field		F01
Salinity	00096	Mulitprobe Meter		Field		F01
Secchi Depth	00078	Secchi Disk		Field		F01
PAR Light Attenuation Collected at Plankton sites only	N/A	Li-Cor		Field		F01
Dissolved Organic Carbon Collected at Plankton sites only	49573	Filtrate	H2SO4, ICE	DCLS	0.10 mg/L	L01
Nitrate Nitrogen (NO_3 as N)	Not submitted Calculated	Filtrate	ICE	DCLS	0.002 mg/l	L01
Nitrite Nitrogen (NO_2 as N)	00613	Filtrate	ICE	DCLS	0.002 mg/l	L01
Nitrate + Nitrite (NO_2+NO_3)	00631	Filtrate	ICE	DCLS	0.002 mg/l	L01
Ammonium (NH_4 as N)	00608	Filtrate	ICE	DCLS	0.003 mg/l	L01
Particulate Nitrogen	49570	Filter 25mm diameter 0.7 um pore size	ICE	DCLS	.03 mg/l****	L01
Total Dissolved Nitrogen	49571	Filtrate	ICE	DCLS	0.011 mg/l	L01
Total Phosphorus	00665	Whole water	ICE	DCLS	0.003 mg/l	L01frsh/ L04 sal
Total Dissolved Phosphorus	49572	Filtrate	ICE	DCLS	0.003 mg/l	L01
Particulate Phosphorus	49567	GF/F Filter 47mm diameter 0.7 um pore size	ICE*	DCLS	.0013 mg/l**	L01
Orthophosphate (PO_4 as P)	00671	Filtrate	ICE	DCLS	0.002 mg/l	L01
Dissolved Silica (Si as SiO_2) Collected at Plankton sites only	00955	Filtrate	ICE	DCLS	0.03 mg/l	L01
Particulate Carbon	49569	GF/F Filter 25mm diameter 0.7 um pore size	ICE*	DCLS	.050 mg/l***	L01
Fixed Suspended Solids	00540	Whole water	ICE	DCLS	3 mg/l *****	L01
Total Suspended Solids	00530	Whole water	ICE	DCLS	3 mg/l *****	L01
Volatile Suspended Solids	Not submitted Calculated	Whole water	ICE	DCLS	3 mg/l *****	L01
Turbidity	00076	Whole water	ICE	DCLS	0.1 NTU*****	L01
Chlorophyll a	Calculated	GF/F Filter 47 mm diameter 0.7 um pore size	ICE*, 3ml MgCO3	DCLS	0.5 ug/L *****	L01
Phaeophytin a	Calculated	GF/F Filter 47 mm diameter 0.7 um pore size	ICE*,3 ml MgCO3	DCLS	0.5 ug/L *****	L01

* If stored over 24 hours filters must be frozen.
** Per volume of 250 mL, actual limit of detection based on 0.32 µg of Phosphorous per filter

*** Per volume of 100 mL, actual limit of detection based on 5.0 µg of Carbon per filter
******** Per volume of 100 mL, actual limit of detection based on 3.0 µg of Nitrogen per filter.
***** Reporting Limit

B2.2 Water quality samples

Water quality samples are collected at one meter below the surface and one meter above the bottom (with bottom depth rounded to the nearest meter) for each station except for VTMP stations collected from bridges, where only surface samples are collected (TF5.2, TF3.1F and Fall Line stations; see location descriptions, Tables 2-4). Table 5 contains a list of all parameters to be analyzed, and various field and lab preservative techniques required for them. Refer to Appendices B and C for method detection limits, collection containers required, preservation methods and holding times. For samples requiring filtration a direct current vacuum filtration unit is used to filter samples onboard the boat (preferred) or immediately after offloading samples onshore. All filtration must be completed within 2 hours of sample collection. Immediately after collection, samples are placed in an ice-filled cooler and cooled to 4º+/- 2º C in order to minimize biological activity. Whole water samples, the filtrate and filters are delivered to DCLS as soon as possible (generally the same day or the day after sampling). Samples collected by VADEQ are delivered by overnight courier, whereas those collected by partner agencies (e.g. USGS) are often delivered in person. Complete sample collection, preservation and transport procedures are listed in the SOP (Appendix A) and fall-line sampling is further described in in the U.S. Geological Survey publication: *Quality Assurance Project Plan for the Virginia River Input Monitoring Program* (Moyer, Douglas L. 2016).

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B2.3 Phytoplankton Samples:

From March through October, phytoplankton samples are obtained from the surface at stations RET3.1, TF3.3, RET4.3, TF4.2, RET5.2 and TF5.5; Tables 2-4). Dissolved Organic Carbon samples are also collected from the surface waters at these sites. Phytoplankton samples are then preserved prior to transfer to ODU. The preserved samples do not require cooling and may be held at ambient temperature. PRO transports the samples to drop-off sites where the samples are retrieved by ODU personnel and transported to ODU. TRO collects the samples and transports them directly to the phytoplankton laboratory at ODU. Laboratory personnel process the samples upon receipt.

B3 Analytical Methods

Analytical methods used for the VTMP are Standard Methods, approved United States Environmental Protection Agency (EPA) methods or those developed and approved by the Data Integrity Workgroup of the Chesapeake Bay Program. A complete list of current and historical parameters sampled for the VTMP and their methods are given in Appendix B and the laboratory SOPs for current analyses are available from DCLS upon request (email: E.Shaw@dgs.virginia.gov).

B4 Quality Assurance Objectives

Because the data generated in this program are going to be used to assist critical decisions that affect tributary waters, it is essential that high QA/QC be maintained. Field, laboratory and data management personnel should use established procedures to ensure data accuracy, precision, representativeness, comparability and completeness necessary for a successful program.

B4.1 Quality Assurance Definitions

Accuracy - Refers to the degree that measurements approach the true or accepted value. Accuracy may be expressed as the difference between results and the true value, i.e., percent difference

Comparability - Expresses the confidence with which one data set can be compared with another. Comparability is achieved by assuring a given confidence level for data.

Completeness - A measure of the amount of valid data obtained from a measurement system compared to the amount expected under correct normal conditions.

Data Reduction - Procedures used in the analysis of samples to calculate the concentration of the measured parameter in appropriate concentration units.

Data Validation - Procedures used to review data in order to identify outliers, errors, and quality control problems that may result in the rejection or qualification of sample data.

Detection Limits - The minimum concentration of analyte that can be identified with 99% confidence that the analyte concentration is greater than zero. Detection limits vary with brands of instrumentation, methods and with analysts.

Field Blank - Measures the contamination occurring during the field sampling phase of the measurement process. At random sampling sites the blank sample (deionized water) is filtered through the filter apparatus (for dissolved parameters), poured into containers and preserved in a similar manner to the field samples being collected.

Field Duplicate - Refers to duplicate samples taken in the field and analyzed as discrete samples. Duplicate samples for the VA Tributary Water Quality Monitoring Program are collected from the same source following the procedures listed in Section 3.3.3. B "Field Duplicates" of the VTMP SOP (FS1 and FS2 as defined by the CBPO).

Lab Duplicate - Refers to laboratory replicate analyses performed on the same sample.

Method Blank - A reagent blank prepared in the lab using all the reagents used in the analysis in order to evaluate interference and/or carry over contamination occurring during the analytical procedure. A reagent blank is treated identically to an actual sample.

Outliers - Data values that lie outside the statistically defined parameter limits. Apparent outliers may be invalid, qualified, or accepted based on quality assurance data for blanks and duplicates.

Performance Audit - Utilizes test samples of known composition to evaluate laboratory accuracy. Generally performance audits are included as a part of more general systems audits.

Precision - Measures the proximity or closeness of replicate values for a parameter within a data set. Precision may be expressed in terms of standard deviations with appropriate units of measurement, or as percent.

Quality Assurance - A system of activities whose purpose is to provide the user with assurance that the product meets defined standards of quality.

Quality Control - Those procedures or activities whose purpose is to control the quality of the product so that it meets the needs of a user.

Standard Operating Procedure - A written, approved procedure for routine use which describes in detail the steps necessary for performing repetitive tasks.

Spiked Sample - Refers to samples to which a known amount of analyte is added to evaluate recoveries from the sample matrix. Also called matrix spikes. Spikes are usually prepared in the laboratory.

Standard Reference Materials - Samples that are certified to contain a specified quantity of analyte are purchased from a national supply company and given to the laboratory for analysis. The laboratory result is compared with the certified quantity as a measurement of laboratory precision.

System Audit - Systematic and spot checks of equipment, facilities and procedures for compliance with the quality assurance plan.

B4.2 QA/QC Sampling Methods

B4.2.1 Field QA Procedures

The primary QA\QC mechanism currently utilized in the tributary monitoring effort is the use of equipment blanks, , field duplicates, source blanks and a CBP Coordinated Split Sample Program (CSSP).

Equipment blanks are considered representative of the usual procedures involved in field sampling, sample handling and sample transport. The VTMP collects equipment blanks such that the total number of blanks equals approximately 10% of the total number of field samples. Equipment blank results indicate the level of sample contamination which reduces accuracy in determining field concentrations. Equipment blank contamination should not exceed 20 percent of the expected concentration range for each sample parameter. Higher levels of contamination may render the data unreliable.

Filtration blanks are considered representative of the usual procedures involved in processing samples for particulates, chlorophyll a and the dissolved nutrient components, sample handling and sample transport. The VTMP collects filtration blanks once a month for all parameters except DOC. DOC filtration blanks will be collected at a frequency of approximately 10% of the number of DOC samples collected. Determining the level of filtration blank contamination provides an indication of the possible level of sample cross contamination. The filtration blank contamination that is detected should not exceed 20 percent of the expected concentration range for each dissolved sample parameter or 30% for sediments and filter parameters. Higher levels of contamination may render the data unreliable.

Duplicate samples are submitted to DCLS from each tributary for field quality control samples. Stations are rotated and duplicate samples are collected from both surface and bottom depths (where applicable) to obtain duplicates of approximately 10% of the field samples collected. The field duplicate data are used to determine the overall precision of the field and laboratory procedures.

A monthly sample will also be obtained from the DI water source and sent to the laboratory for analysis. This will test the purity of the DI water which is utilized during field filtration procedures and equipment blanks. A DI water source blank will also be obtained in cases where the equipment blanks indicate a possible source of contamination.

Standard operating procedures for preparation and handling of equipment blanks and field duplicate samples can be found in the *Virginia Chesapeake Bay Tributary Water Quality Monitoring Program*

Standard Operating Procedures Manual (Appendix A). The field blanks and duplicate results are entered into a database and will be used to empirically establish an expected normal range for each parameter (1st through 99th percentile of values). Once these expected ranges have been established they will be used to identify extreme values that may indicate problems with field operations. Comparing new data to the expected range serves as a basis for accepting, qualifying or rejecting data.

Internal QA/QC also includes calibration, operational checks and maintenance of field equipment. These procedures, as well as the time intervals between which they are executed, are based on the recommendations of equipment manufacturers. All relevant documentation associated with these procedures (e.g. manufacturer's instruction manuals and parts diagrams) are kept on file in each regional office.

B4.2.2 Laboratory QA Procedures

The procedures to measure accuracy and precision vary with each laboratory. This is due to differences in sample matrices, the level of instrument automation and analytical techniques (i.e. calorimetric, gravimetric, etc.). Laboratory quality control samples that are used to determine accuracy and precision should make up approximately 10% of the total number of samples analyzed. Accuracy is generally determined by recoveries from laboratory spike samples, blanks, or by using reference samples. Quality control samples for accuracy determinations should make up 5% of the total number of samples analyzed. Laboratory duplicate samples are used to measure precision and generally make up 5% of the samples analyzed.

DCLS uses control charts to evaluate the accuracy and precision of each analytic procedure. Detailed information about the corrective procedures used by each laboratory is found in the Bureau of Chemistry Quality Assurance Project Plans.

Table 5 contains detection limits for the laboratory-analyzed parameters. These values are an indication of the lowest level that the laboratory can distinguish from background noise. Results at this level are considered not quantifiable, but are an indication of the presence of the analyte. The VADEQ staff uses these values on a routine basis to interpret water quality condition data. In instances where information about accuracy, precision, and detection limits is needed for a particular data set, VADEQ personnel obtain this information from the laboratory.

In addition to obtaining internal QA samples, laboratories participating in the Chesapeake Bay Tributary program participate in the Chesapeake Bay Coordinated Split Sample Program (CSSP). The Monitoring Subcommittee of the Chesapeake Bay Program introduced the CSSP in 1988 to assess the comparability of water quality results from participating laboratories. The CSSP consists of two components based on sample salinity regimes and concentration ranges: 1) a mainstem component and 2) a tributary component. Samples from the mainstem component are obtained from a Chesapeake Bay mainstem station (MCB4.4) following CSSP Procedural Guidelines (Chesapeake Bay Program. 1991. Chesapeake Bay Coordinated Split Sample Program Implementation Guidelines, Revision 3. EPA Chesapeake Bay Program, Annapolis, MD) and tributary samples are obtained from station PMS10 on the Potomac River. For each component split samples are obtained for between 3-5 laboratories and the analysis results are compared for agreement.

When inter-laboratory agreement is low the labs and organizations investigate their methodologies for significant differences and then take actions to make the results more comparable. Because split sample variability can be introduced in the field or laboratory setting, the CSSP was designed to include all elements of the measurement system: field sampling, sample handling, laboratory analysis, data handling and the state or municipal agency that supervise the water quality monitoring program. Thus corrective steps may include changing field methods, laboratory methods or both.

B4.3 Preventive Maintenance

To insure proper instrument performance preventive maintenance is scheduled at specific time intervals. It is necessary to maintain analytical and field instrument and ancillary equipment in good operating condition in order to minimize major repairs, down time, and inaccurate observations.

Laboratory instrument Standard Operating Procedures includes preventive maintenance procedures as well as performance checks and calibration procedures. Appropriate maintenance is scheduled based on the results of performance checks or after a specified number of hours of operation. Specific procedures for laboratory instruments are included in the individual Laboratory Project Plans.

For the VTMP, preventive maintenance schedules are established for all field equipment. If performance checks or calibration procedures indicate a problem, appropriate maintenance is conducted immediately or the equipment is returned to the manufacturer for service. Defective equipment is not used until repaired and satisfactory performance results are achieved.

Each Regional Office has responsibility for ensuring that the preventive maintenance schedule is followed. A logbook is kept at each region to document maintenance performed on each instrument. The logbook is reviewed by senior field staff periodically to identify equipment that has a high repair record and to determine which specific items require more frequent repairs. Depending on replacement difficulty these items may be added to a list of critical spare parts maintained at each Regional Office.

B5 Instrument Calibration and Frequency

Specific procedures for the calibration of field instruments may be found in Appendix A in the *Virginia Chesapeake Bay Tributary Water Quality Monitoring Program Standard Operating Procedures*.

B6 Sample Custody and Handling

Sample custody procedures are an integral part of the laboratory and field operations. Since the data generated by this program are not used for legal purposes, formal chain-of-custody procedures are not required. Sample custody procedures are contained in the SOP Manual and insure the integrity of the samples received at the labs. Field sampling operations include:

- Procedures for filling out WQM scheduling, WQM sheets and sample label tags,
- Procedures for preparing samples for shipment and WQM, and
- Documentation of sample custody in the field.

Upon completion of a sampling run, the coolers containing the iced water samples should be delivered to the laboratories as soon as possible. Phytoplankton samples are delivered to the ODU plankton laboratory on the day of collection and the water quality samples are delivered to DCLS at approximately 7:00 am by the DCLS selected courier. Once samples have been received at Sample Support Services (SSS), DCLS will have sample custody responsibility. Every cooler used by VADEQ must contain a sample bottle filled with colored solution to be utilized by DCLS to confirm the temperature of water samples at the time of their arrival. These procedures are described in detail in the DCLS accessioning SOPs (available upon request – please contact E.Shaw@dgs.virginia.gov at DCLS).

B6.1 Requirements for Analyzing Samples:

Sample tags must be attached to every water sample collected and sent to DCLS for analysis. See Appendix A, *Virginia Chesapeake Bay Tributary Water Quality Monitoring Program Standard Operating Procedures Manual*, for the correct procedures for filling out sample tags.

DIS/CBM WQM sheets are used for water samples collected by the Tributary Water Quality Monitoring Program to DCLS for analysis in the event scheduling is not possible through WQM. Procedures for filling out WQM sheets are described in Section 3.1.2 of the *Virginia Chesapeake Bay Tributary Water Quality Monitoring Program Standard Operating Procedures Manual.*

DCLS will cancel the analysis of any sample under the following conditions:

- No sample tag attached.
- No WQM information accompanying the samples.
- Sample tag and CBM WQM information does not exactly match and the issue cannot be resolved.
- Temperature of samples exceeds 6 º Celsius.
- Sample is not properly preserved for parameters where acid preservation is required.
- Holding time requirements for water samples have been exceeded (>48 hrs. for nutrients, >7 days for solids), unless otherwise noted on the CBM lab sheets (USGS storm event samples).

Cooler and chlorophyll bottles are returned to the regions by the courier on a regular basis.

B7 Data Management

B7.1 Data Recording

Samples are collected and preserved according to accepted SOP methods. Samples are then transported to DCLS SSS by a DCLS selected courier. SSS (DCLS) personnel log in samples and distribute them to the appropriate laboratory for analysis. After analysis, the data results are transformed into the correct concentration units, keyed into LIMS (Laboratory Information Management System) by the chemist completing the analysis and reviewed by the appropriate laboratory personnel. Upon approval the results are shipped back to VADEQ via FDT transfer and uploaded into the WQM. In the event that hard-copy data sheets are used to submit the samples to DCLS (e.g. due to a CEDS/WQM system failure) the results are printed out onto laboratory sheets and given to the VADEQ Laboratory Liaison.

Data go through a series of screens and reviews to identify invalid, qualified or QA supported data. The qualified and QA supported data are then entered into the EPA-CBLO (Annapolis, MD) databases for access to users. The data flow path for the reporting scheme is illustrated below.

Data Collection and Reporting Pathway

A) Sample Collection and Filtration
(Regional Office Sampling Crew)
B) DCLS/SSS
(Sample log in and distribution)
C) Laboratory analysis
D) DCLS/SSS
Sample records and log out
E) VADEQ Validation
(CBP and OIS)

F) Chesapeake Bay Data Base
(CIMS Annapolis)
G) Users

B7.2 Data Validation

Reduction, Validation and Reporting procedures for environmental data are necessary to ensure that accurate information is recorded. Data reduction occurs in the laboratory and is the responsibility of the lab. VADEQ is accountable for data validation.

Presently, quarterly field duplicate or split samples are collected and processed as described in the previous section. With the VTMP program, approximately 10% of the samples submitted to the labs will be quality control samples (field blanks and field duplicates). Results from these quality control samples will be used to establish control limits for the validation system. Because of the volume of data generated and the complexity of the validation process, it is important that an appropriate computer system and software be utilized which will allow for the implementation of the data validation system.

Data are validated through a series of quality control checks, screens, audits, qualifications, verifications and reviews. These procedures compare the generated data with established criteria to assure that the data are adequate for their intended uses.

Criteria established from historical parameter values will be used to identify both outliers and data within the established ranges for each parameter. Comparing quality control sample results with established parameter ranges for field blanks and field duplicates will further validate data within the control limits for this initial screen. A review of field documentation will be conducted for data whose quality control samples fall outside the control limits. This review will be used to determine if the staff noted any irregular conditions during sample collection and handling which might have affected the data. Results from the quality control screen and documentation review will be used to accept, qualify or reject data for inclusion in the EPA-CBLO and VADEQ databases.

Outliers that occur during the initial historical screening will go through a similar evaluation sequence in order to validate the data. In cases where quality control samples and field documentation provide evidence of questionable data, these outliers will be rejected or confirmed for inclusion into the EPA-CBPO and VADEQ databases as qualified data. Data will not be discarded solely because the values lie outside the acceptable range for a parameter. Where there are no QA/QC problems, apparent outliers will be entered into the databases and eventually become part of the historical database. Figure 2 illustrates the flow diagram for data validation prior to data entry into the EPA-CBPO and VADEQ databases.

In most cases rejected data will be qualified and retained but rejected data will not be entered into the EPA-CBPO database. Where possible, the Chesapeake Bay Office or a Regional Office will initiate corrective action to address the reason for rejection. Quality assurance audits are used to assess and approve sample collection, handling, preservation and field measurement procedures. Labs must utilize spikes, quality check samples, duplicates, EPA reference materials and EPA performance audits for each laboratory to ensure data validity.

For the initial screening, parameter limits will be developed using historical monitoring data. These ranges of data variation will be established using relevant geographic and environmental considerations and appropriate statistical analysis.

For the quality control screen, field blanks and field duplicate data will be collected in order to develop background information. Appropriate statistical analysis will then be used to develop an acceptable range of parameter variation for blank samples and field duplicates. For duplicate samples the precision can be expected to vary with concentration.

Quality control samples will be evaluated following the guidelines in the Chesapeake Bay Program publication *Recommended Guidelines for Sampling and Analyses in the Chesapeake Bay Monitoring Program* (Chesapeake Bay Program, currently under revision) to identify compromised samples. Field documentation associated with outliers will be subjected to a retrospective review to determine if reasons exist to invalidate the data. In cases where QC limits are exceeded, VADEQ personnel will review sampling documentation and procedures to identify appropriate corrective action.

B7.2.1 Corrective Action Plan

The corrective action plan is a closed-loop system for correcting problems that affect data validity.

This action plan provides a mechanism for reporting problems, recommending corrective action and implementing the approved corrective action. It also identifies responsible personnel, establishes normal pathways for corrective action and is designed to encourage problem reporting and operating-level problem solving. Specific procedures for the corrective action plan are contained in Appendix A *Virginia Chesapeake Bay Tributary Water Quality Monitoring Program Standard Operating Procedures Manual*.

The corrective action request procedure is primarily utilized to document and implement procedural changes. The main reason to implement the corrective action process would be the need to permanently change a procedure. This may be due to:

- The procedure causing possible contamination to samples.
- The need to clarify a procedure.
- A methodology is inconsistent with new analysis/studies.

In order for the corrective action plan to work, all personnel associated with the program must report all suspected abnormalities. This is especially important to field personnel because identification and correction of problems in sample collection and handling is essential for an effective program.

CAR forms that originate in the regions are forwarded to the regional Office Monitoring and Compliance Manager for review and recommendations (for TRO, the CAR is also forwarded to the Water Quality Monitoring Supervisor). The regional Monitoring and Compliance Manager forwards the form to the CBP Monitoring Program coordinator for review, recommendations, and a final decision on appropriate corrective action. After resolution of the problem, the CBP Monitoring Program coordinator provides copies of the completed form to appropriate regional personnel, and headquarters QA/QC staff. The Monitoring and Compliance Manager has responsibility for implementation of the corrective action at the regional level. The QA/QC staff in headquarters may provide additional comments or recommendations to CBPO and regions for review. A copy of the Corrective Action Request Form can be found in Appendix A in *Virginia Chesapeake Bay Tributary Water Quality Monitoring Program Standard Operating Procedures Manual*.

In cases where the problem is not resolved, the CBP Monitoring Program coordinator will complete the CAR form, make appropriate copies, and implement the corrective action.

CAR forms that originate in DCLS or headquarters are forwarded to headquarters QA/QC for review, recommendations, or concurrence. Then, if appropriate, these forms are forwarded to the CBP and Regional Office Monitoring and Compliance Manager for a final decision and subsequent implementation.

It is the responsibility of the originator to notify management in the regions, and the QA officer in headquarters, if the corrective action system is not operating effectively. In this situation, the originator may elect to call or send a CAR form directly to headquarters QA/QC officer.

Although problems may require long term action to correct, the CAR originator will normally receive notification of the disposition of the problem within ten (10) workdays. If the originator has not received a copy of the completed CAR form within 14 working days, the originator will send a copy of the initial request directly to headquarters QA/QC officer.

B7.3 Data Reduction

Data reduction is the process of calculating the actual concentration of an analyte from the results of a laboratory analysis. The laboratories have established procedures for cross checking calculations and checking for transmittal errors. For documentation of data reduction procedures, each lab should maintain laboratory records and bench sheets. Laboratory operating procedures describing data reduction are referenced in the individual laboratory Project Plans.

B7.4 Data Transmittal

Data is automatically shipped to the DCLS ftp site at 10:00 pm and 9:00 am. If technical problems arise during data entry and the 9:00 am deadline will not be met, the regions have a call list of DCLS personnel to contact in the event of problems. If the problem cannot be resolved, the WQM field sheets are faxed to DCLS SSS ((804) 648-4480). Also, the regions may call Cindy Johnson (804-698-4385) at CBP to assist with any problems that may arise.

Once the analyses are performed by DCLS, the data are shipped electronically from the LIMS database at DCLS to the Oracle database managed by the Office of Information Systems at VADEQ who uploads the data daily toWQM. DCLS provides all results, including those that are below the MDL, and those that are below the level that can be reliably quantified by the lab (i.e. the parameter quantification limit; PQL). Results below these levels are qualified in CEDS using the comment codes T for those below the MDL and QQ for those above the MDL but below the PQL. Specific values for the MDL and PQL are also provided. Results below the MDL are not provided for data requests unless specifically requested and approved by authorized DEQ personnel. The qualifiers T and QQ are retained with all uncensored data (i.e. estimated values below PQL or MDL). The data are then downloaded by the Database Manager who performs additional QA analyses through a series of SAS and Microsoft ACCESS queries and verifies the data integrity via checks that mimic those performed by the DUET tool. The raw data is then processed through additional ACCESS queries to convert field headings and data into CIMS format (see the Water Quality Database/Database Design and Data Dictionary on the Chesapeake Bay Program's website).). Once the dataset is correctly formatted, the file is uploaded to the EPA-CBPO via the the Data Upload and Evaluation Tool (DUET). DUET produces an error report that is reviewed by the VTMP Database Manager or their representative and the CIMS database manager (Mike Mallonee) prior to electronic import into the CIMS database.

Whenever possible, data shipments to CIMS will occur quarterly. However, in the absence of quarterly submittal, data collected October through September will be provided to CIMS no later than

December 31 and the remainder of the calendar year will be submitted by March 31.

B7.5 Data Transformation

Personnel at the Chesapeake Bay Program data center conduct further QA/QC. Data believed to be questionable are verified with field sheets or by personnel at DCLS and data are then made available to the public on the Chesapeake Bay Internet site

ASSESSMENT PROCEDURES

The Program and Performance Audits verify that procedures specified in this Project Plan are being followed. These audits ensure the integrity of the reported data. For this program, audits are divided into four major topic areas:

- Laboratory (System and Performance)
- Program (System)
- Field Sampling (System and Performance)
- Validation and Reporting (System)

C1 Laboratory Audits

The internal audits used to evaluate the laboratory will examine:

- Sample blank
- Procedures
- Quality assurance
- Data reduction and reporting

The specific make-up of the audit team and procedures to conduct laboratory audits are contained in the individual laboratory project plans. In addition, external audits are conducted by the EPA and NELAP and may include laboratory systems and performance audits.

C2 Program Audits

Program audits evaluate the VTMP to determine whether the overall network has a sound technical basis and that data produced meet program objectives. Agency management will identify when these program audits will be conducted. Following the completion of the evaluation a report with recommendations will be prepared for Agency management.

C3 Field Sampling Audits

Standard field sampling and operating techniques and other requirements as established in the project plan and procedures manual are evaluated through Field sampling audits. The primary audit elements for the VTMP are:

- Key personnel and responsibilities
- Sampling methodology and handling procedures
- Field instrument performance
- Field documentation procedures
- QA procedures
- Problem identification
- Previous recommendation follow ups

The audit team will usually be comprised of one or more Central Office staff who prepare the final audit report with recommendations for corrective actions if needed. The report will be forwarded to the regional environmental field manager and the VTMP Manager. Specific audit procedures and a schedule to conduct the audits will be developed.

The Regional Environmental Field Manager also has the choice of conducting internal regional audits on a periodic basis. These audits may review staff operations with requirements established in the project plan and the field procedure manual.

C4 Validation and Reporting Audits

Audit procedures for data validation and reporting will be developed in conjunction with CBLO data validation systems. Such procedures that are developed will undergo periodic review and update by VADEQ and CBLO staff.

Appendix A

Virginia Chesapeake Bay
Tributary Water Quality Monitoring Program
Standard Operating Procedures Manual

(Revised July 1, 2016)

Appendix B

Historic and Current Analytical Detection Limits

Revised 7/1/2014

VIRGINIA TRIBUTARY DETECTION LIMITS*
(printed November 7, 2018~~June 8, 2018~~)

PARAMETER	MDL (mg/l)	N	MRL (mg/l)	PERIOD	METHOD	CIMS Method
Total Kjeldahl Nitrogen (Whole water)	0.1	7	5.0	Jul. 1984 - Jan. 1995	EPA 351.2	L02
	0.2	1	4.0	February 4, 1995		
	0.1*****		4.0	Feb. 1995 – Jan 1994		
Nitrite	0.01	>2958	1.0	Jul. 1984 - Jan. 1994	EPA 353.2	L01
	0.002			Jan 1994 - Jan 1998	USGS I-4540-85	L01
	0.002		0.5	Jan 1988 - Oct. 1998		
	0.002		0.01	Oct. 1998 – July 2013		
	0.002		0.01	August 2013 - present	EPA 353.2	L01
Ammonium	0.1	63	5.0	Jul. 1984 - June 1987	EPA 350.1	L01
	.05	177	5.0	Aug. 1984 - Dec. 1987		
	.04	>607	2.0	Jan 1988 - Jan 1994	USGS I-4523-85	
	.004			Jan 1994 - Jan. 1998		
	.004		0.5	Jan 1998 - Oct. 1998		
	.004		0.02	Oct. 1998 – May 2007		
	.006		0.02	May 2007 – June 2007		
	.004		0.02	July 2007 – June 2012		
	.003		0.01	July 2012 - June 2013	EPA 350.1	
	0.003		0.01	July 2013 - present	EPA 350.1	
Nitrate, Nitrate & Nitrite	.05	1025	2.0	Jul. 1984 - Jan. 1988	EPA 353.2	L01
	.04	>571	2.0	Feb. 1988 - Jan. 1994		
	.004			Jan. 1994 - Jan. 1998		
	.004		.05	Jan. 1998 - Oct. 1998		
	.004		0.02	Oct. 1998 - June 2012		
	0.004		0.02	July 2012- July 2013		
	0.002		.01	August 2013 - present	EPA 353.2	L01
Total Phosphorus (low level)	.01	11	0.5	July 1984 - Jan. 1994	EPA 365.4	L01
	.002			Jan 1994 - Jan. 1998		
	.002		0.8	Jan 1998 - Oct. 1998		
	.002		0.01	Oct. 1998 - Present		
Total Phosphorus (regular) (c)	0.02	0	0.1	July 1984 - Present	EPA 365.4	

VIRGINIA TRIBUTARY DETECTION LIMITS*
(printed November 7, 2018~~June 8, 2018~~)

PARAMETER	MDL (mg/l)	N	MRL (mg/l)	PERIOD	METHOD	CIMS Method
Total Dissolved Phosphorus	.01	>403	0.5	July 1984 - Jan 1994	EPA 365.4	L05
	unk		.091	Jan 1994 - Dec 1994 (a)	EPA 365.2	L01
	.001			Mid 1995 - Oct 1998	ASTM 4500-N-C followed by EPA 365.1	L01
	.001		0.8	Jan 1998 - Oct 1998		
	.001		0.1	Oct 1998 – May 2007		
	.003		0.015	May 2007 – Present		L01
BioSi (BiSi)	0.000		3.8	Feb 1994 - Nov. 1994 (a)		L01
PIP	unk		unk	Feb 1994 - Dec 1994 (a)	Flow injection	L01
	0.0013**		0.0065**	August 2013 – present		
Orthophosphorus	.01	>1494	0.5	July 1984 - Jan. 1994	EPA 365.3	L01
	.002			Jan. 1994 - Jan 1998		
	.002		0.8	Jan 1998 - Oct 1998	EPA 365.1	
	.002		0.05	Oct. 1998 – July 2013		
	0.002		0.01	August 2013 – present	EPA 365.1	L01
Total Organic Carbon	1.0	>6	35.0	July 1984 – Aug 1996	EPA415.1	
Dissolved Organic Carbon	0.36		8.104	Jan 1994 - Dec 1994 (a)		L02
	0.4		2.0	April 2007 – May 2015	SM5310 B	L01
	0.1		1.0	May 2015-Present		
Silicon (In CEDS database as SiO2. SiO2 is divided by 2.14 to calculate the parameter SIF stored in the CIMS database).	1.0	63	25.0	July 1984 - April 1985	EPA370.1	L01
	0.03	>63	0.1	April 18, 1985 - Present	USGS I 2700-85	
Total Suspended Solids	5	79		July 1984 - June 1988	EPA160.2	L01
	3	2		July 3, 1985		
	1	>4		July 1988 - March 1991		
	3		30	March 1991 - Jan. 1998		
	3			Jan 1998 - Oct. 1998		
	3			Oct. 1998 – Nov. 2009		
	1		3	Nov 2009 – Present	USGS I3753-85	L01
Fixed Suspended Solids	5	79		April 1988 - June 1988	EPA 160.4	L01

VIRGINIA TRIBUTARY DETECTION LIMITS*
(printed November 7, 2018~~June 8, 2018~~)

PARAMETER	MDL (mg/l)	N	MRL (mg/l)	PERIOD	METHOD	CIMS Method
	1	>30		July 1988 - March 1991		
	3			March 1991 - Jan. 1998		
	3		30	Jan 1998 - Oct. 1998	EPA 160.4	L01
	3		75	Oct. 1998 – Nov. 2009		
	1		3	Nov. 2009 – Nov. 2010	USGSI3753 -85	L01
	1		3	Nov 2010 – Jan. 2012	EPA 160.4	L01
	1		3	Jan 2012 – present	USGS –I-3766-85	L01
Total Volatile Solids	5	77		April 1988 - June 1988	EPA 160.4	
	0	32		July 1988 - Feb. 1989		
	1	>101		July 1988 - March 1991		
	3			March 1991 - Jan 1998		
	3		20	Jan 1988 – July 2004		
Chlorophyll a (ug/l)	3.1	>540		July 1985 - June 1991	EPA446.0	L01
	0.36			July 1991 – September 1998		
	0.1		0.5	September 1998 – Present		
Total Dissolved Nitrogen	0.02		1.278	Jan 1994 - Dec 1994 (a)	EPA365.2	L01
	.004			Jan. 1995 – May 2007	SM4500N-C followed by EPA 353.2	
	.011		0.055	May 2007 - Present		
Particulate Phosphorus	.003		.078	Jan 1994 - Dec 1994 (a)	CBP Guidelines Aug 1996	L01
	.001			Jan. 1995 – Nov. 12, 2001		
	.0008**			Nov. 12, 2001 – May 2007		
	.0013**			May 2007 – June 2013		
Particulate Phosphorus	0.0013		0.0065**	July 2013 – present	Flow injection	L01
Particulate Carbon (b)	.096		3.820	Jan 1994 - Dec 1994 (a)	EPA 440	L01
	0.1			Jan. 1995 – Aug. 1999		

VIRGINIA TRIBUTARY DETECTION LIMITS*
(printed November 7, 2018June 8, 2018)

PARAMETER	MDL (mg/l)	N	MRL (mg/l)	PERIOD	METHOD	CIMS Method
	.064			Aug. 1999 – Nov. 12, 2001		
	.020***			Nov. 12, 2001 – May 2007		
	0.05***		0.250 ***	May 2007 - Present		
Particulate Nitrogen (b)	.018		0.550	Jan 1994 - Dec 1994 (a)	EPA 440	L01
	.01			Jan. 1995 – Aug. 1999		
	.076			Aug 1999 – Nov 12, 2001		
	.010****			Nov 12, 2001 – May 2007		
	0.03***		0.15 ***	May 2007 - Present		

* Prior to 1999 some parameter detection limits, critical limits and methodologies were different for Fall Line stations. Those values are given in the Virginia Fall Line Table on the next page. Values listed from 1999 onward are the same for all stations sampled for the Virginia Tributary Monitoring Program.
a) These parameters limits are those for VA fall line and tributary analyses performed by VIMS in CY94.
b) As of 7/3/97, these parameters are not censored in the database.
c) There should have been few or none of this analysis requested.
** Per volume of 250 ml, actual limit of detection based on 0.2 ug of Phosphorous per filter
*** Per volume of 100 ml actual limit of detection based on 5.0 µg of Carbon per filter
******** Per volume of 100 ml, actual limit of detection based on 3.0 µg of Nitrogen per filter.
***** Reporting Limit

VIRGINIA FALL LINE DETECTION LIMITS* (printed November 7, 2018~~June 8, 2018~~)

PARAMETER	MDL (mg/l)	N	MRL (mg/l)	PERIOD	METHOD (a)
Total Kjeldahl Nitrogen (Whole water)	0.1	0	2.0	July 1984 - June 1986	I-4552-85
	0.1		4.0	July 1986 – Jan. 1994	EPA351.2
Nitrite	0.01	20	1.0	Jul. 1984 - June 1986	USGS I-2540-85
	0.01	>246	1.0	Jul. 1986 - Jan. 1994	
	0.002			Jan 1994 – July 2013	
	0.002		0.010	August 2013- present	EPA 353.2
Ammonium	.01	23	1.5	Jul. 1984 - June 1986	I-2523-85
	.05	28	5.0	July 1986 - Dec. 1987	EPA350.1
	.04	>90	2.0	Jan 1988 - Jan 1994	USGS I-4523-85
	.004		0.05	Oct. 1998 – May 2007	
	.006			May 2007 – June 2007	
	0.004			July 2007 – June 2013	
	0.003		0.01	July 2013 - present	EPA 350.1
Nitrate, Nitrate & Nitrite	.09	20	5.0	Jul. 1984 - June 1986	I-2545-85
	.05	5	2.0	July 1986 - Jan. 1988	EPA353.2
	.04	>13	2.0	Feb. 1988 - Jan. 1994	
	.004		0.02	Jan. 1994 – July 2013	
	0.002		0.01	August 2013 - present	
Total Phosphorus (low level)	.01	6	1.0	July 1984 - June 1986	I-2600-85
	.01	>1	0.5	July 1986 - Jan. 1994	EPA 365.4
	.002			Jan 1994 – June 2013	
	.002		0.01	July 2013 - present	
Total Phosphorus (regular) (c)	0.02	2	0.1	July 1986 - Present	EPA 365.4
Total Dissolved Phosphorus	.01	16	1.0	July 1984 - June 1986	I-2600-85
	unk		.091	Jan 1994 - Dec 1994 (a)	EPA 365.2
	.01	>17	0.5	July 1986 - Mid 1995	SM 4500-N-C followed by EPA 365.1
	.001		0.1	Oct 1998 – May 2007	
	.003		0.015	May 2007 – Present	

VIRGINIA FALL LINE DETECTION LIMITS* (printed November 7, 2018June 8, 2018)

PARAMETER	MDL (mg/l)	N	MRL (mg/l)	PERIOD	METHOD (a)
Orthophosphorus	.01	29	1.0	July 1984 - June 1986	I-2601-85
	.01	>40	0.5	July 1986- Jan. 1994	EPA 365.3
	.002		0.010	Jan. 1994 – July 2013	EPA 365.1
	0.002		0.01	August 2013 – present	
Total Organic Carbon	0.1	0	40.0	July 1984 - June 1986	O-3100-83
	0.4*****		2.0	July 1986 – Present (MDL and MRL values represent most recent as of 6/14)	SM 5310 B
DOC	0.4 0.1		2.0 1.0	Aug 2003- May 2015 May 2015-Present	SM 5310 B
Silicon	0.1	0	NA	July 1984 - June 1986	I-1702-85
	0.03		0.1	June 1986 - Present	I-2700-85
Total Suspended Solids	5			April 1988 - June 1988	I-3765-85
	1			July 1988 - March 1991	
	1		3	March 1991 - Present	
Fixed Suspended Solids	5			April 1988 - June 1988	I-3766-85
	1			July 1988 - March 1991	
	1		3	March 1991 - Present	
Total Volatile Solids	5			April 1988 - June 1988	EPA 160.4
	0			July 1988 - Feb. 1989	
	1			July 1988 - March 1991	
	1		3	March 1991 - Present	
Chlorophyll a (ug/l)	3.1			July 1985 - June 1991	EPA 446.0
	0.36			July 1991 - Sept. 1998	
	0.1		0.5	September 1998 - Present	
Total Dissolved Nitrogen	.004			Jan. 1995 – May 2007	
	.011		0.055	May 2007 - Present	SM4500 N-C followed by EPA 353.2
Particulate Phosphorus	.001			Jan. 1995 – Nov. 12, 2001	
	.0008**			Nov. 12, 2001 – May 2007	

VIRGINIA FALL LINE DETECTION LIMITS* (printed November 7, 2018June 8, 2018)

PARAMETER	MDL (mg/l)	N	MRL (mg/l)	PERIOD	METHOD (a)
	.0013**			May 2007 – July 2013	CBP Guidelines Aug 1996
Particulate Phosphorus	0.0013**		0.0065 **	August 2013 – present	Flow injection
Particulate Carbon (b)	0.1			Jan. 1995 – Aug. 1999	EPA 440
	.064			Aug. 1999 – Nov 12, 2001	
	.020***			Nov. 12, 2001 – May 2007	
	0.05***		0.25 ***	May 2007 - present	
Particulate Nitrogen (b)	.01			Jan. 1995 – Aug. 1999	EPA 440
	.076			Aug. 1999 – Nov 12, 2001	
	.010****			Nov 12, 2001 – May 2007	
	0.03***		0.015 ***	May 2007 - Present	

* Prior to 1999 some parameter detection limits, critical limits and methodologies were different for Fall Line stations. Those values are given in the Virginia Fall Line Table above. Values listed from 1999 onward are the same for all stations sampled for the Virginia Tributary Monitoring Program and can be found in the previous table entitled Virginia Tributary Detection Limits.

a) Methods beginning with □I□ or □O□ indicate analyses by USGS Denver lab.

b) As of 7/3/97, these parameters are not censored in the database.

c) There should have been few or none of this analysis requested.

** Per volume of 250 ml, actual limit of detection based on 0.2 µg of Phosphorous per filter

*** Per volume of 100 ml actual limit of detection based on 5.0 µg of Carbon per filter

******** Per volume of 100 ml, actual limit of detection based on 3.0 µg of Nitrogen per filter.

***** Reporting Limit

Appendix C

Sample Container Information and Holding Times

(Revised 7/1/2015)

ID	Description	Container size	Sample size	Preservation	Analytes	Holding Time
CBNUT-3	Dissolved nutrients	High density poly-ethylene bottle	250 ml	On ice to 4°C; Frozen if kept longer than 24 hr.	Ammonia	28 days
					Dissolved NO2 + NO3	28 days
					Nitrate	28 days
					Nitrite	28 days
					Ortho Phosphate as P	28 days
					Total Dissolved Nitrogen	28 days
					Total Dissolved Phosphorus	28 days
FCHLR	Field Filtered Chlorophyll	Glass Fiber Filter pad	Determined in Field	On ice to 4°C; Frozen if kept longer than 24 hr.	630B (before HCl)	28 days
					647B (before HCl)	
					664B (before HCl)	
					665A (after HCl)	
					750A (after HCl)	
					750B (before HCl)	
					Aliquot	
					B/A ratio (Monochromatic determination)	
					Cell Path	
					Chlorophyll A (Monochromatic determination)	
					Chlorophyll A (Trichromatic determination)	
					Chlorophyll B (Monochromatic determination)	
					Chlorophyll C (Monochromatic determination)	
					Extract volume	
					Pheophytin A (Monochromatic determination)	
					Volume filtered	
FCMFEC QENT	Fecal Coliform, CFU *E. coli*, MPN Enterococci, CFU	Sterile plastic bottle with 100 ml line containing sodium thiosulfate	100 ml	On ice to 4°C	Fecal Coliform, CFU *E. coli*, MPN Enterococci, CFU	26hr.
NME7	Non-metal analysis (group 7)	1 qt. Cubitainer	1 Liter	On ice to 4°C	Fixed Suspended Solids	7 days
					Total Suspended Solids	7 days
					Turbidity	48 hrs
					Volatile Suspended Solids	7 days
NTNP-3 Plankton sites and container	Dissolved nutrients	High density poly-ethylene bottle	250 ml	On ice to 4°C; Frozen if kept longer than 24 hr.	Ammonia	28 days
					Dissolved NO2 + NO3	28 days
					Nitrate	28 days
					Nitrite	28 days

ID	Description	Container size	Sample size	Preservation	Analytes	Holding Time
blanks only					Ortho Phosphate as P	28 days
					Silica (not frozen)	28 days
					Total Dissolved Nitrogen	28 days
					Total Dissolved Phosphorus	28 days
PNC	Particulate Nitrogen Particulate Carbon	Glass Fiber Filter Pad	Determined in the Field	On ice to 4°C; Frozen if kept longer than 24 hr.	Particulate Carbon	28 days
					Particulate Nitrogen	28 days
PP	Particulate Phosphorus	Glass Fiber Filter Pad	Determined in the Field	On ice to 4°C; Frozen if kept longer than 24 hr.	Particulate Phosphorus	28 days
DOCFF	Dissolved Organic Carbon	Filtrate	2 – 40 ml vials	H_2SO_4; preserved on ice	Dissolved Organic Carbon	28 days

Appendix D

History of Station TF3.1

Station TF3.1 Issue

Situation: Data collected under the station name of 'TF3.1[1]" has been collected at three different locations. Data analysis needs to be aware of this because two of the stations are upriver from Embry dam and one station is down river from the Dam. The presence of the dam could cause significant variation in the data. All data collected by VADEQ and stored as station "TF3.1[1]" was collected below the dam. All data collected by USGS and stored as station "TF3.1[1]" was collected above the dam. The stations are:

Rt1 Bridge – This is the correct station ("TF3.1[1]", 3-RPP110.57). It is located approximately 2-4 miles downriver from Rt95 Bridge and approximately 1-2 miles downriver from Embry dam. This is the location always used be VADEQ sampling personnel. VADEQ sampling personnel have sampled this station 1/mo since 1985. This station is located at the true geographic "Fall Line". The river here can have several separate channels during low flow periods, making it more difficult to collect representative samples.

USGS "Cableway" – This is official USGS station 01668000. It is located approximately 1 mile upriver from Rt95 Bridge. USGS has always used this station for CBP fall line sampling on the Rappahannock. It is easier to get a truly representative sample here.

Rt. 95 - This station is the backup station for USGS sampling in cases where the cableway is inaccessible due to high river flows. It has been sampled only 4 times as of 2/5/99. It is approximately .5 mile upriver from Embry Dam and approximately 1 mile down river from the cableway. There is probably no effect of sampling here rather than the cableway because of the high river flow conditions anytime this station is sampled.

Problems with past CBP data analysis results: None. USGS has always performed the VA fall line data analysis for the CBP. USGS has been aware of the situation and did not use any data collected by VADEQ at this station.

Problems with Legacy STORET database: This database may have data submitted by VADEQ (Identifiable by collection agency=21vaswcb) and stored under station name "3-RPP110.57" which was collected by both VADEQ and USGS (i.e. both above and below the Dam). This would probably only be for 1985 – 1995. USGS data has not been submitted to STORET by VADEQ since approximately. 1/1/1996. USGS has also uploaded Rappahannock fall line data to STORET under the station name of "01668000" and collection agency=112WRD. This STORET data is the USGS collected at the "cableway" only.

Problems with NWIS database: None. VADEQ data for station "TF3.1[1]" has never been submitted to this database.

Problems with CBP CIMS database: This data base may have data stored under station name "TF3.1[1]" which was collected by both VADEQ and USGS (i.e. both above and below the Dam). This would probably only be for 1985 – 1995 (Note: VADEQ used an "S_agency" code in submissions, which distinguished between USGS and VADEQ collected data, but this apparently has been removed somewhere in processing).

Suggested resolution: the CIMS database should establish a new station identifier for the USGS cableway station (e.g. TF3.0U). A list of USGS collection dates for this station should be obtained from USGS. This list should be used to change station ID as appropriate from TF3.1[1] to TF3.0U. Data for the few times that Rt95 location is sampled by USGS should be stored under the single new station designation also.

1) This station Identifier is changed to TF3.0 at some point in CBP CIMS processing.

Note: The modification of the CIMS database enabling it to contain both tidal data and the USGS non-tidal information necessitated the aforementioned problem to be addressed. In September 2000 the following station designations were assigned to clarify the station sites:

The USGS cableway is designated as TF3.0 in CIMS. This station is identified as 3-RPP113.37 in VADEQ's CEDS2000 database and station 01668000 in the USGS RIM database.

USGS's alternate sampling site, the Rt. 95 bridge, is designated as TF3.1W in CIMS and as 3-RPP112.47 in VADEQ's CEDS2000 database. The station is not differentiated from the cableway in the RIM database.

VADEQ's Fall Line sampling site Rt. 1 is designated as TF3.1. The data previously stored in CIMS will be changed from TF3.0 to TF3.1 prior to the migration of the RIM data into the database. This station is identified as 3-RPP110.57 in VADEQ's CEDS2000 database and sampling of this station for the Bay Program was discontinued as of April 2000. VADEQ stopped submitting station TF3.1 data under the TF3.0 format in July 2000 data.

Appendix E

Virginia Tributary Water Quality Monitoring Stations and Current Station Status

Virginia Tributary Water Quality Monitoring Stations Current Station Status

River	Station	River Mile	Agency	Monitoring Type	Frequency Monitored	Comments
Rappahannock River						
Rappahannock	TF3.1	3-RPP110.57	NRO	Ambient	Discontinued as VADEQ CBPWQ 03-01-01.	Surface sample only. Originally named TF3.0 in CHESSIE and CIMS but changed to TF3.1 with the upload of USGS RIM data to CIMS in FY2000.
Rappahannock	TF3.0	3-RPP113.37	USGS	Fall Line	Once per month + 21 storm events by USGS	Surface sample only. This is USGS"s cableway site located a few miles upstream of VADEQ's TF3.1. USGS did not sample for chlorphyll until May 2003.
Rappahannock	TF3.1W	3-RPP112.47	USGS	Fall Line	Rarely used. Alternate sampling site for TF3.0.	This is USGS's alternate sampling site for storm events in which the cableway is not safe to use. Not distinguished from TF3.1 in RIM database.
Rappahannock	TF3.1F	3-RPP106.01	NRO	CBPWQ	Once per month	Implemented 04/08/2008 for deepwater site in upper region.Only surface water samples collected. Primarily interested in field parameters for this site.
Rappahannock	TF3.1D	3-RPP107.91	NRO	Ambient	Discontinued as CBPWQ station.	Discontinued as CBP monitoring station as of 10/1994. Continues as Agency ambient station.
Rappahannock	TF3.1C	3-RPP107.33	NRO		VADEQ discontinued sampling this station completely in June 1988.	Submitted to CIMS in May and June 1988 only.
Rappahannock	TF3.1A	3-RPP104.47	NRO	Ambient	Discontinued as CBPWQ station	Discontinued as CBP monitoring station as of 10/1994. Continues as Agency ambient station.
Rappahannock	TF3.1E	3-RPP98.81	NRO	CBPWQ	Once per month	
Rappahannock	TF3.1B	3-RPP091.55	NRO	CBPWQ	Once per month	
Rappahannock	TF3.2	3-RPP080.19	NRO	CBPWQ	Once per month	
Rappahannock	TF3.2A	3-RPP064.40	NRO	CBPWQ	Once per month	Started as station in 1994. Sampled by PRO until January 2010.
Rappahannock	TF3.3	3-RPP051.01	PRO	CBPWQ, Ambient, Plankton, Benthos	Once per month	
Rappahannock	RET3.1	3-RPP042.12	PRO	CBPWQ, Ambient Plankton, Benthos	Once per month	
Rappahannock	RET3.1N	3-RPP041.96	PRO	CBPWQ	Discontinued	FY 1994 ETMP sampling only. Discontinued and unused for other purposes.

River	Station	River Mile	Agency	Monitoring Type	Frequency Monitored	Comments
Rappahannock	RET3.1S	3-RPP042.23	PRO	CBPWQ	Discontinued	FY 1994 ETMP sampling only. Discontinued and unused for other purposes.
Rappahannock	RET3.2	3-RPP031.57	PRO	CBPWQ	Once per month	
Rappahannock	LE3.1	3-RPP025.52	PRO	CBPWQ, Ambient	Once per month	PRO started sampling this site in Jan 2010. It was TRO's site prior to that.
Rappahannock	LE3.2	3-RPP017.72	PRO	CBPWQ, Ambient, Benthos	Once per month	PRO started sampling this site in Jan 2010. It was TRO's site prior to that.
Rappahannock	LE3.2N	3-RPP017.95	TRO	Transect, ETMP only	Discontinued	FY 1994 ETMP sampling only. Discontinued and unused for other purposes.
Rappahannock	LE3.2S	3-RPP017.29	TRO	Transect, ETMP only	Discontinued	FY 1994 ETMP sampling only. Discontinued and unused for other purposes.
Corrotoman	LE3.3	3-CRR003.38	PRO	CBPWQ, Ambient	Once per month	PRO started sampling this site in Jan 2010. It was TRO's site prior to that.
Rappahannock	LE3.4	3-RPP010.60	PRO	CBPWQ, Ambient	Once per month	PRO started sampling this site in Jan 2010. It was TRO's site prior to that.
YORK RIVER						
Pamunkey	TF4.1	8-PMK082.34	USGS	Ambient, Fall line	1/mo. + 21 storm events by USGS	Named TF4.0P in Chessie and is a surface sample only. USGS did not take chlorophyll during its sampling events until May 2003.
Pamunkey	TF4.1A	8-PMK048.80	PRO	ETMP sampling only for CBP, Ambient	Once per month	Sampled under ETMP during FY1994 and has been discontinued as a CBP station. Continues only as an agency ambient water quality monitoring station.
Pamunkey	TF4.2	8-PMK034.17	PRO	CBPWQ, Plankton, Benthos	Once per month	
Mattaponi	TF4.3	8-MPN054.17	USGS	Fall line	Once per moonth + 21 storm events by USGS	Named TF4.0M in Chessie and is a surface sample only. USGS did not take chlorophyll during its sampling events until May 2003.
Mattaponi	TF4.4	8-MPN029.08	PRO	CBPWQ	Once per month	
Mattaponi	TF4.4A	8-MPN017.46	PRO	ETMP only for CBP, Ambient for VADEQ	Once per month	Sampled under ETMP during FY1994 and has been discontinued as a CBP station. Continues only as an agency ambient water quality monitoring station.
Pamunkey	RET4.1	8-PMK006.36	TRO	CBPWQ	Once per month	
Mattaponi	RET4.2	8-MPN004.39	PRO	CBPWQ	Once per month	
York	RET4.3	8-YRK031.39	TRO	CBPWQ,	Once per	

River	Station	River Mile	Agency	Monitoring Type	Frequency Monitored	Comments
				Plankton, Benthos	month	
York	RET4.3N	8-YRK031.40	TRO	CBP ETMP	Discontinued	Sampled under ETMP during 1994 only, since discontinued.
York	RET4.3S	8-YRK031.38	TRO	CBP ETMP	Discontinued	Sampled under ETMP during 1994 only, since discontinued.
York	LE4.1	8-YRK022.70	TRO	CBPWQ, Ambient, Benthos	Once per month	
York	LE4.2	8-YRK011.14	TRO	CBPWQ	Once per month	
York	LE4.2N	8-YRK011.24	TRO	CBP ETMP	Discontinued	Sampled under ETMP during 1994 only, since discontinued.
York	LE4.2S	8-YRK011.13	TRO	CBP ETMP	Discontinued	Sampled under ETMP during 1994 only, since discontinued.
York	LE4.3	8-YRK001.64	TRO	CBPWQ	Once per month	
York	LE4.3N	8-YRK001.33	TRO	CBP ETMP	Discontinued	Sampled under ETMP during 1994 only, since discontinued.
York	LE4.3S	8-YRK001.86	TRO	CBP ETMP	Discontinued	Sampled under ETMP during 1994 only, since discontinued.
JAMES RIVER						
James	TF5.1	2-JMS157.28	USGS	Ambient, Fall line	Once per /month. + 21 storm events by USGS	Named TF5.0J in the Chessie database. Surface sample only. USGS did not take chlorophyll samples until May 2003. Discontinued as VADEQ CBPWQ station 03-01-01
James	TF5.2	2-JMS110.30	PRO	CBPWQ, Ambient	Once per month	
James	TF5.2A	2-JMS104.16	PRO	CBPWQ	Once per month	
James	TF5.3	2-JMS099.30	PRO	CBPWQ	Once per month	
Appomattox	TF5.4A	2-APP016.38	USGS	Fall Line	Once per month plus 21 storm events	USGS did not take chlorophyll samples until May 2003. PRO discontinued sampling this station for CBPWQ in June 1999.
Appomattox	TF5.4	2-APP001.53	PRO	CBPWQ	Once per month	
James	TF5.5	2-JMS075.04	PRO	CBPWQ, plankton, benthos	Once per month	
James	TF5.5A	2-JMS069.08	PRO	CBPWQ	Once per month	Sampled since 1988.
James	TF5.5AN	2-JMS069.00	PRO	ETMP Transect	Discontinued	Sampled under ETMP during 1994 only, since discontinued.
James	TF5.5AS	2-JMS068.80	PRO	ETMP Transect	Discontinued	Sampled under ETMP during 1994 only, since discontinued.
James	TF5.6	2-JMS055.94	PRO	CBPWQ,	Once per month	
James	TF5.6A	2-JMS050.57	PRO	ETMP, Ambient	Once per month, for	Sampled under ETMP during 1994 only, since discontinued.

River	Station	River Mile	Agency	Monitoring Type	Frequency Monitored	Comments
					ambient only	
Chickahominy	RET5.1A	2-CHK006.14	PRO	CBPWQ,	Once per month	
James	RET5.2	2-JMS042.98	TRO	CBPWQ, Ambient, Plankton	Once per month	
James	RET5.2N	2-JMS042.96	TRO	ETMP, Transect	Discontinued	Sampled under ETMP during 1994 only, since discontinued.
James	RET5.2S	2-JMS042.52	TRO	ETMP, Transect	Discontinued	Sampled under ETMP during 1994 only, since discontinued.
James	LE5.1	2-JMS032.59	TRO	CBPWQ,	Once per month	
James	LE5.2	2-JMS021.04	TRO	CBPWQ, Ambient, Benthos,	Once per month	
James	LE5.2N	2-JMS021.34	TRO	ETMP, Transect	discontinued	Sampled under ETMP during 1994 only, since discontinued.
James	LE5.2S	2-JMS021.74	TRO	ETMP, Transect	discontinued	Sampled under ETMP during 1994 only, since discontinued.
James	LE5.3	2-JMS013.10	TRO	CBPWQ	Once per month	
James	LE5.4	2-JMS005.72	TRO	CBPWQ, Ambient, Benthos	Once per month	
Elizabeth	LE5.6	2-JMS002.00	TRO	CBPWQ	Once per month	
Elizabeth	EBB01	2-EBE002.98	TRO	CBPWQ, Ambient	Once per month	Began as CBP station in CY2000.
Elizabeth	EBE1	2-EBE000.40	TRO	CBPWQ	Once per month	WQ collected by ODU at this site 1989-2009. Picked up by TRO January 2010.
Elizabeth	ELD01	2-ELI004.79	TRO	CBPWQ, Ambient	Once per month	Began as CBP station in CY2000.
Elizabeth	ELE01	2-ELI006.92	TRO	CBPWQ, Ambient	Once per month	Began as CBP station in CY2000.
Elizabeth	ELI2	2-ELI003.52	TRO	CBPWQ	Once per month	WQ collected by ODU at this site 1989-2009. Picked up by TRO January 2010.
Lafayette	LFA01	2-LAF001.15	TRO	CBPWQ, Ambient	Once per month	Began as CBP station in CY2000.
Lafayette	LFB01	2-LAF003.83	TRO	CBPWQ, Ambient	Once per month	Began as CBP station in CY2000.
Elizabeth	SBE2	2-SBE001.98	TRO	CBPWQ	Once per month	WQ collected by ODU at this site 1989-2009. Picked up by TRO January 2010.
Elizabeth	SBE5	2-SBE006.26	TRO	CBPWQ	Once per month	WQ collected by ODU at this site 1989-2009. Picked up by TRO January 2010.
Elizabeth	WBB05	2-WBE004.44	TRO	CBPWQ, Ambient	Once per month	Began as CBP station in CY2000.
Elizabeth	WBE1	2-WBE002.11	TRO	CBPWQ	Once per month	WQ collected by ODU at this site 1989-2009. Picked up by TRO January 2010.

GENERAL NOTES:

1) USGS did not sample for chlorophyll until May 2003.
2) VADEQ Ambient sampling may vary spatially and temporally (i.e. notation of an ambient station may be

incorrect).
3) Fall line stations (TF3.1/TF3.2, TF5.1/TF5.0J, TF5.4A/TF5.0A, TF4.1/TF4.0P, TF4.3/TF4.0M) are sampled at the surface only.
4) ETMP = Enhanced Tributary Monitoring Program, a special sampling conducted in 1994 only. Many parameters analyzed by VIMS laboratory.
5) Ambient station notation indicates the station is sampled for unfiltered TP, Ammonia, TDN, NO2 + NO3, BOD, Fecal coliform, hardness, and COD.
6) Frequencies column indicates CBPWQ and USGS sampling only.
7) PRO has three ambient stations on the Chickahominy River (Walker's Dam, Route 5 bridge and at river mile 2-CHK014.33)

Appendix F

Legacy STORET
Latitude and Longitude Information (NAD27)

Legacy STORETLatitude and Longitude Information

(note: latitudes and longitudes shown below are those of the legacy STORETdatabase and in some instances may not match those utilized for sample collection. Refer to Section 1.4 of Appendix A for further information).

VADEQ River	CBP Sta. No.	CIMS Sta No.	VADEQ STORET	Location Description	NAD 27 Latitude	NAD 27 Longitude
Rapp.	TF3.1	TF3.1*	3-RPP110.57	Fredericksburg Fall Line	38º19'12.0"	-077º28'18.0"
Rapp.	TF3.1D	TF3.1D*	3-RPP107.91	100 yds below Fredericksburg STP	38º17'15.0"	-077º26'56.0"
Rapp.	TF3.1C	TF3.1C*	3-RPP107.33	100 yds below FMC discharge	38º16'50.0	-077º26'34.0"
Rapp.	TF3.1A	TF3.1A*	3-RPP104.47	Below Massaponax STP	38o15'19.0"	-077º24'43.0"
Rapp.	TF3.1E	TF3.1E	3-RPP098.81	Buoy 112	38º14'42.0"	-077º19'35.0"
Rapp.	TF3.1B	TF3.1B	3-RPP091.55	Buoy 89	38º14'44.0"	-077º14'02.0"
Rapp.	TF3.2	TF3.2	3-RPP080.19	Port Royal	38º10'29.0"	-077º11'19.0"
Rapp.	TF3.2A	TF3.2A	3-RPP064.40	Blind Point	38º06'43.0"	-077º03'07.5"
Rapp.	TF3.3	TF3.3	3-RPP051.01	Buoy 40 Plankton, Benthic	38º01'07.0"	-076º54'30.0"
Rapp.	RET3.1	RET3.1	3-RPP042.12	Buoy 10 Plankton, Benthic	37º55'12.0"	-076º49'18.0"
Rapp.	RET3.2	RET3.2	3-RPP031.57	Buoy 16	37º48'30.0"	-076º42'48.0"
Rapp.	LE3.1	LE3.1	3-RPP025.52	Buoy 11	37º45'38.0"	-076º37'16.0"
Rapp.	LE3.2	LE3.2	3-RPP017.72	Near Buoy 8 Benthic	37º40'13.0"	-076º33'16.0"
Corr.	LE3.3	LE3.3	3-CRR003.38	Buoy 6	37º41'36.0"	-076º28'24.0"
Rapp.	LE3.4	LE3.4	3-RPP010.60	Orchard Point	37º38'00.0"	-076º27'48.0"
Pam.	TF4.1	TF4.0P	8-PMK082.34	Hanover Fall Line	37º46'04.0"	-077º19'56.0"
Pam.	TF4.2	TF4.2	8-PMK034.17	Whitehouse Plankton, Benthos	37º34'47.3"	-077º01'19.9"
Matt.	TF4.3	TF4.0M	8-MPN054.17	Beulahville Fall Line	37º53'02.0"	-077º09'54.0"
Matt.	TF4.4	TF4.4	8-MPN029.08	Walkerton	37º43'22.3"	-077º01'26.3"
Pam.	RET4.1	RET4.1	8-PMK006.36	South of Lee Marsh	37º31'30.0"	-076º52'12.0"
Matt.	RET4.2	RET4.2	8-MPN004.39	Muddy Point	37º34'18.0"	-076º47'36.0"
York	RET4.3	RET4.3	8-YRK031.39	Buoy 57 Plankton, Benthos	37º30'24.0"	-076º47'18.0"
York	LE4.1	LE4.1	8-YRK022.70	Buoy 44 Benthic	37º25'06.0"	-076º41'36.0"
York	LE4.2	LE4.2	8-YRK011.14	Buoy 34	37º17'30.0"	-076º34'13.0"
York	LE4.3	LE4.3	8-YRK001.64	Buoy 24 Benthic	37º13'56.0"	-076º26'00.0"
James	TF5.1*	TF5.0J	2-JMS157.28	Cartersville Fall Line	37º40'13.0"	-078º05'13.0"
James	TF5.2	TF5.2	2-JMS110.30	Mayo's Bridge Head of Tide	37º31'49.8"	-077º26'02.4"
James	TF5.2A	TF5.2A	2-JMS104.16	Buoy 166	37º26'59.1"	-077º25'12.0"
James	TF5.3	TF5.3	2-JMS099.30	Buoy 157	37º24'10.6"	-077º23'31.0"
James	TF5.4A*	TF5.0A	2-APP016.38	Rout 600 Bridge Fall Line	37º13'31.0"	-077º38'35.0"
App.	TF5.4	TF5.4	2-APP001.53	Buoy 8	37º18'41.0"	-077º17'49.0"
James	TF5.5	TF5.5	2-JMS075.04	Buoy 107Plankton, Benthos	37º18'46.0"	-077º13'59.0"
James	TF5.5A	TF5.5A	2-JMS069.08	Buoy 91	37º18'00.0"	-077º07'30.0"
James	TF5.6	TF5.6	2-JMS055.94	Buoy 74	37º16'29.0"	-076º59'18.5"
Chick.	RET5.1A	RET5.1A	2-CHK006.14	Buoy 10	37º18'43.0"	-076º52'22.0"
James	RET5.2	RET5.2	2-JMS042.92	Swann's Point Plankton, Benthos	37º12'36.4"	-076º47'36.2"
James	LE5.1	LE5.1	2-JMS032.59	Buoy 36, Benthos	37º12'24.0"	-076º39'06.0"
James	LE5.2	LE5.2	2-JMS021.04	Buoy 12-13 Benthos	37º03'28.1"	-076º35'00.0"
James	LE5.3	LE5.3	2-JMS013.10	Buoy 15	36º59'24.0"	-076º27'36.0"
James	LE5.4	LE5.4	2-JMS005.72	Buoy 9 Benthos	36º57'18.0"	-076º23'30.4"
Eliz.	LE5.6	LE5.6	2-ELI002.00	Buoy 18	36º54'12.0"	-076º20'00.0"
Eliz.	LFB01	LFB01	2-LAF003.82	Granby St. Bridge	36º53'25.0"	-076º15'58.0"
Eliz.	LFA01	LFA01	2-LAF001.15	Hermitage Pt.	36º54'30.0"	-076º19'08.0"
Eliz	ELD01	ELD01	2-ELI004.79	Degaussing St. (Confl. WB)	36º51'56.0"	-076º19'44.0"
Eliz.	WBB05	WBB05	2-WBE004.44	Drum Point	36º49'45.0"	-076º23'45.0"
Eliz.	ELE01	ELE01	2-ELI006.92	Nauticus Pier	36º50'54.0"	-076º17'53.0"
Eliz.	EBB01	EBB01	2-EBE002.98	N&W RR. Bridge	36º50'10.0"	-076º14'40.0"

Appendix G

Virginia
Chesapeake Bay Monitoring Program
Mainstem Scope of Work and Log of Significant Changes

Revised 07/23/2016

Commented [DG1]: Remove page numbers 27-30 in Appendix G

Scope of Work
Chesapeake Bay Monitoring Program
7/1/2017 – 7/15/2018

Introduction:

A five-year EPA study completed in 1982 identified widespread declines in the water quality and living resources of Chesapeake Bay. The 1985 Chesapeake Bay Restoration and Protection Plan identified the need for restoration activities and a monitoring program to measure the success of these activities. On June 28, 2000, the Chesapeake Bay Program adopted a new Bay agreement, "Chesapeake 2000: A Watershed Partnership" that will guide the next decade of restoration in the Chesapeake Bay watershed. Two main goals in the new agreement are 1) "Achieve and maintain the water quality necessary to support the aquatic living resources of the Bay and its tributaries and to protect human health" and 2) "Restore, enhance and protect the finfish, shellfish and other living resources, their habitats and ecological relationships to sustain all fisheries and provide for a balanced ecosystem". The projects funded by this scope of work support these goals by monitoring traditional water quality indicators as well as living resource components of the Bay ecosystem, like plankton and benthos, which support fisheries.

As described in the Chesapeake Bay Monitoring Strategy, monitoring water quality is necessary for three principal reasons: 1) to determine if water quality conditions meet water quality goals and regulatory criteria established to protect living resources from nutrient and sediment impacts, 2) to diagnose the likely causes of non-attainment and assess progress towards improvements still needed to meet the tidal water quality goals and criteria, and 3) to support continued refinement, calibration and validation of the Chesapeake Bay Water Quality Model and multi-species management models. Benthos and phytoplankton species abundances, distributions, and composition are needed to ensure that food of sufficient quality and quantity are available to sustain targeted fish populations and to support refinement, calibration and validation of multi-species management models.

Contents:

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A: Water Quality Monitoring Component

I. Principal Investigator: Dr. John Donat (ODU)

II. Project Coordinator: Dr. John Donat (ODU)

III. Analytical Support Staff: Suzanne Doughten (ODU)

IV. Introduction and Management Objectives:

The Chesapeake Bay Mainstem Water Quality Monitoring Program, initiated in 1984, is a multi-purpose program conducted by ODU. Water quality conditions are monitored at 27 stations in the Bay Mainstem. The objectives are to 1) to determine if water quality conditions meet water quality criteria necessary to protect living resources from nutrient and sediment impacts, 2) to diagnose the likely causes of non-attainment and assess progress towards improvements still needed, and 3) to support continued refinement, calibration and validation of the Chesapeake Bay Water Quality Model and multi-species management models. The program also provides information necessary to measure effectiveness of point and non-point source programs in reducing nutrient input to the Bay.

Ambient nutrient concentrations are relevant to the evaluation of phytoplankton habitat quality requirements as well as part of a set of diagnostic requirements for assessing suitability of water quality for survival and growth of Submerged Aquatic Vegetation Communities (SAV).

Suspended solids have two principal impacts on aquatic organisms. Along with algae, they can significantly reduce light penetration, impacting survival of SAV and disrupting light-dependent daily water column migrations of zooplankton. Elevated concentrations of suspended solids can also affect feeding rates of organisms like oysters and clams, which filter their food from overlying waters

Almost all tidal and non-tidal aquatic organisms require oxygen to survive, therefore, evaluations of dissolved oxygen habitat requirements are an important monitoring goal.

V. Stations

27 Stations, as listed below and shown in Figure.

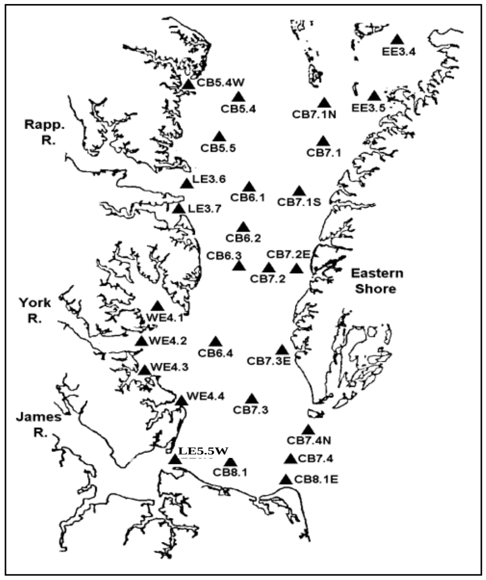
STATION	LATITUDE (NAD83)	LONGITUDE (NAD83)	DESCRIPTION
EE 3.4	37.90833	-75.79167	Pocomoke Sound
EE 3.5	37.79638	-75.84472	Pocomoke Sound Channel
CB 5.4W	37.81332	-76.29508	Mouth of Great Wicomico
CB 5.4	37.80000	-76.17500	Deep Main Channel
CB 5.5	37.69193	-76.19027	Main Channel
CB 6.1	37.58833	-76.16250	Main Channel, Lower End off of Rapp. River
CB 6.2	37.48667	-76.15667	Central Bay
CB 6.3	37.41243	-76.15782	Central Bay Channel (Wolftrap)
CB 7.1	37.68350	-75.98997	Eastern Shore Channel, Northern End
CB 7.1N	37.77512	-75.97492	Tangier Sound Channel
CB 7.1S	37.58117	-76.05833	Eastern Shore Channel
CB 7.2	37.41147	-76.08058	Eastern Shore Channel
CB 7.2E	37.41140	-76.02505	Eastern Shore, Side Channel
LE 3.6	37.59687	-76.28528	Mouth of Rappahannock
LE 3.7	37.53067	-76.30712	Mouth of Piankatank
WE 4.1	37.31167	-76.34667	Mobjack Bay
WE 4.2	37.24167	-76.38667	Mouth of York
WE 4.3	37.17667	-76.37333	Mouth of Poquoson
WE 4.4	37.11000	-76.29333	Mouth of Back River
CB 6.4	37.23638	-76.20833	Central Bay, Off York River
CB 7.3	37.11667	-76.12527	Lower Bay Channel
CB 7.3E	37.22850	-76.05417	Eastern Shore Channel, Southern End
CB 7.4	36.99550	-76.02083	Baltimore Channel, Bay Mouth
CB 8.1	36.99517	-76.17833	Lower Bay between James and Thimble Shoals
CB 8.1E	36.94717	-76.03517	Thimble Shoals, Bay Mouth
CB 7.4N	37.06217	-75.98333	North Channel, Bay Mouth
LE 5.5-W	36.99883	-76.31350	Mouth of James

Parameters to be measured at each station:

- \# Temperature & pH: by probe every meter until 15 meters then every 2 meters until 1 meter above bottom.
- \# Salinity and Specific Conductance: by probe every meter until 15 meters then every 2 meters until 1 meter above bottom.
- \# Dissolved Oxygen: by probe every meter until 15 meters then every 2 meters until 1 meter above bottom.
- Secchi Disk depth: (20-cm disk)
- Incident Radiation (onboard sensor)
- Incident Radiation ("up" sensor)
- Dissolved Organic Carbon (surface only and only in conjunction with all phytoplankton stations/dates)
- **+ Silicate (filtered): surface and bottom
- **+ Particulate Carbon: surface and bottom
- **+ Total Suspended Solids: surface and bottom
- **+ Fixed Suspended Solids: surface and bottom
- **+ Chlorophyll a and Pheophytin (1): surface and bottom
- **+ Particulate Nitrogen: surface and bottom
- **+ Dissolved Persulfate Nitrogen: surface and bottom
- **+ Nitrate + Nitrite (filtered): surface and bottom
- **+ Nitrite (filtered): surface and bottom
- **+ Ammonia (filtered): surface and bottom
- **+ Particulate Phosphorus: surface and bottom
- **+ Dissolved Phosphorus: surface and bottom
- **+ Dissolved Orthophosphate: surface and bottom

1) Report wavelengths 750b, 664b, 647b, 630b, 750a, 665a (a, b=after/before acidification) extract volume, sample volume, spectrophotometer light path.

** See Special Condition 1
+ See Special Condition 6
\# See Special Condition 10



Frequency of Sampling: Fifteen (15) sampling events (twice monthly sampling in July and August 2017, monthly sampling September 2017 through May 2018 and twice monthly sampling June 2018. Sampling dates are established to insure that Bay-wide sampling (e.g. including Maryland mainstem stations) occurs within the same reasonable time period and that water quality sampling occurs concurrently with sampling by the plankton monitoring component (see schedule in Table 1). All stations must be sampled within a four-day period during each sampling event. Exceptions to this shall be allowed in cases where weather causes unsafe sampling conditions. The contractor shall ensure compliance with the sampling schedule through the development and use of contingency plans.

VI. Field Sample Collection:

Data will be collected and analyses run in order to supply measurements of the parameters listed above (with the exception that the second July cruise will only be samples for field measured parameters with no sampling for solids, nitrogen, phosphorus, or silica). All collections of water column grab samples and subsequent sample handling will be undertaken following the protocols described in "Work/Quality Assurance Project Plan for Chesapeake Bay Mainstem Water Quality Monitoring Program (For the Period: July 1, 2017 through June 30, 2018)". At each station, grab samples will be collected and analyzed for the designated parameters. These grab samples will be collected at 1.0 meter below the surface and 1.0 meter above the bottom. Both grab samples will correspond with a physical profile sampling depth. Any changes in methods will be made only in accordance with the current protocol approved by the CBP Analytical Methods and Quality Assurance Workgroup. Any significant emergency deviations will be reported to DEQ.

In-Vivo Fluorescence measurements:

1. Vertical Profiling:

At each station, a vertical profile of in-vivo fluorescence (IVF) will be collected. IVF readings will be taken at 0.5 m (weather permitting), 1 m, 2 m, 3 m and at 3 m intervals thereafter to the bottom. As appropriate, water will be collected for calibration purposes. Vertical profiling will be conducted only when the vessel used is capable of performing vertical profiles.

2. Horizontal Profiling:

Between stations, a horizontal profile of chlorophyll fluorescence, Salinity, will be collected from a Hull pump located on the hull of the sampling vessel. Beginning station location and time will be recorded. GPS readings are recorded throughout the cruise. Ending station location and time will be recorded. This process will be carried out between all feasible stations dependent upon weather, time, and logistical constraints.

Note: The R/V Slover collects the water temperature, bathymetry and transmissometry but the Bay Program has no way to accept the data.

3. Fluorescence calibration:

Calibration will be undertaken by collecting and filtering water passing through the fluorometer and subsequently analyzing the filtered material for Chlorophyll A. This will be done for the surface and bottom sample depths at each station (note: these surface and bottom chlorophyll samples will also serve as the routine chlorophyll data collection for each station). Calibration samples will be also be collected occasionally during horizontal profiling.

4. Fluorescence Quality Assurance:

All analyses will be performed according to standard operating procedures as described in the contractors Quality Assurance Project Plan(s).

5. Parameters:

VERTICAL PROFILE: Chlorophyll Fluorescence collected at each station (Vessel permitting).
HORIZONTAL PROFILE: Chlorophyll Fluorescence collected underway between stations (Vessel permitting).
GRAB SAMPLES (i.e. calibration samples): Chlorophyll (wavelengths 750b, 664b, 750a, 665a, (a, b=after/before acidification), extract volume, sample volume, spectrophotometer light path)

VII. Quality Assurance:

The ODU will maintain an updated "Work/Quality Assurance Project Plan for Chesapeake Bay Mainstem Water Quality Monitoring Program (For the Period: July 1, 2017 through June 30, 2018)". The current QAPjP will be reviewed by April 15, 2018 and if required a new QAPjP will be submitted at that time. If any data discrepancies or errors in the original raw data are discovered by the users of the data base, DEQ, EPA-CBP or ODU within two years of payment for the data, the contractor agrees to rectify those problems within the 90 day period following notification by DEQ. ODU will follow the protocols described in the "Work/Quality Assurance Project Plan for Chesapeake Bay Mainstem Water Quality Monitoring Program (For the Period: July 1, 2017 through June 30, 2018)" when participating in the CBP Coordinated Split Sample Program (CSSP).

ODU will designate a Quality Assurance Officer who will oversee the implementation of the quality assurance programs for the Virginia Mainstem Monitoring Program. This individual will work with the Quality Control Officers for each laboratory and field operation to ensure that all elements of the Quality Assurance Project Plans and associated standard operating procedures are implemented.

Special Conditions:

1. At stations CB5.4, CB5.5, CB6.1, CB6.2, CB6.3, CB6.4, CB7.3 and CB7.4, two additional samples will be taken, one just above and one just below the pycnocline, for each indicated parameter. These additional samples should correspond with physical profiling samples. Actual depth of sample will be determined by calculations stated in the QAPjP. When a pycnocline is not detected, samples will be collected at one third and two thirds of the depth of the water column.

2. Sampling dates will be coordinated with the State of Maryland to insure that samples are collected within the same reasonable time period.

3. Any deviations from the prearranged sampling dates, or any problems that occur during a cruise, must be reported as soon as practical to the Department of Environmental Quality Project Officer and will also be recorded in the CIMS data documentation files.

4. All analyses will be performed according to methods and protocols agreed to by the Chesapeake Bay Program. Any emergency deviations must be reported to the DEQ Project Officer and will also be recorded in the data documentation served via CIMS.

5. ODU will participate in a quarterly Mainstem CSSP split (See Table 1 for Schedule). The procedures followed will be those given in the (CSSP) guidelines. ODU will also perform or ensure delivery of these samples from the field to VIMS and DCLS laboratories if requested by DEQ.

6. ODU will participate in a quarterly Tributary CSSP split (See Table 2 for schedule). The procedures followed will be those given in the (CSSP) guidelines. ODU will also perform or ensure delivery from the field of the CSSP samples to VIMS and DCLS laboratories if requested by DEQ.

8. ODU will participate in on-site laboratory inspections and analyze performance evaluation sample sets at not more than quarterly frequency as deemed necessary by DEQ.

9. The contractor will maintain up-to-date Quality Assurance Project Plan(s) and submit to the DEQ any changes in their plan(s) or standard operating procedures. The plan(s) must be implemented to the satisfaction of DEQ.

10. ODU will participate in the Data Integrity Workgroup (DIW) meetings and activities designed to assure Bay-wide coordination of the collection and analysis methods of water quality data.

11. At stations deeper than 15 meters it is important to collect data of sufficient resolution to enable determination of the depth of any existing pycnocline. Therefore, at stations where depths exceeding 15 meters, if the change in DO exceeds 1.0 mg/l OR if the change in specific conductance equals or exceeds 1,000 micromhos/cm over any 2.0 m interval, readings shall be taken at the 1.0 m interval between these two readings. Alternatively, the contractor may decide to collect vertical profile data at 1 meter intervals through the whole water column. This special condition procedure is only necessary during the time period of June 1 through September 30.

12. The second cruise in July is only to assess dissolved oxygen concentrations, so no nutrient water samples or in-vivo fluorescence measurements will be collected.

VIII. Deliverables:

1. Data: Water quality data for July 2017 through June 2018 will be posted on an Internet server in DUET ACCESS format every two months. This posting will occur within 60 days from the end of the second calendar collection month (see deliverables schedule, attachment G). FGDC compliant Level 3 metadata will be updated as appropriate with each data submission (e.g. laboratory/field procedure changes, significant personnel changes).

2. Data served via DUET must meet the data dictionary standards, documentation requirements, and conform to the data set formats described in "Data Upload and Evaluation tool (DUET) User Guide Version 2.0". The data will meet the quality assurance objectives for measurement data as described in "Work/Quality Assurance Project Plan for Chesapeake Bay Mainstem Water Quality Monitoring Program (For the Period: July 1, 2017 through June 30, 2018)" before posting via DUET. These data must pass the established quality assurance range checks in order to be posted to DUET. Data of quality insufficient to meet agreed criteria for precision and accuracy may result in non-payment.

3. It is the responsibility of the contractor to attest to the quality of the data and to sign-off on that data set. An electronic letter from the contractor will be transmitted to the DEQ and EPA Monitoring Coordinators at the time of posting to CIMS stating that a particular data set has been judged to be free of known errors, detailing any minor exceptions still unresolved and assuring that the data set is of adequate quality for posting on DUET. The contractor will continue to resolve any problems in the data sets within the following two-month period.

4. Quality Assurance (QA) data will be reported as requested by DEQ and also submitted to CBCC in computerized DUET format. This QA data will include laboratory replicates, percent recovery, and field split data. If needed, a new QAPjP for the period of July 1, 2018 through June 30, 2018 will be submitted by April 15, 2018.

5. Horizontal and vertical fluorescence data will be submitted in quality assured, finished format to the CBCC via tape or file. Data formats are as specified in the most recent approved version of the "Users Guide to CBP Biological Monitoring and Living Resources Data". The data, along with associated methodology and quality assurance documentation, will be sent to and verified by the CBCC.

6. Station location information (i.e. latitude and longitude coordinates in decimal degrees for all sites for which data are collected and accurate within 10-25 meters or 5 decimal places in decimal degrees) will be posted via DUET. Significant deviations from these locations occurring in actual sampling will be reported via the "Event" table with each submission. ODU will adhere to the CBP policy that all data submitted to the CBP shall utilize the North American 1983 Datum (NAD83) horizontal reference and the North American Vertical Datum 1988 (NAD88) vertical reference.

TABLE 1. Sampling schedule for July 2017 through July 2018
(Subject to change based upon CBP-TMAW discussions and ODU ability to re-schedule)

Month	Dates
July	10-13
July	24-27
August	7-10 *
August	28-31
September	18-21
October	16-19
November	13-16*
December	11-14
January	TBD
February	TBD
March	TBD
April	TBD
May	TBD
June	TBD
June	TBD

* Scheduled cruises for CSSP Mainstem split sample collection.
TBD = To be determined in December 2017.

TABLE 2. Schedule for CSSP Tributary (Potomac) split sample collection (subject to change).
TBD = To be determined in December 2017

Month	Day
Sept 2017	11
Dec. 2017	11
March 2018	TBD
June 2018	TBD

B: Benthic Monitoring Component

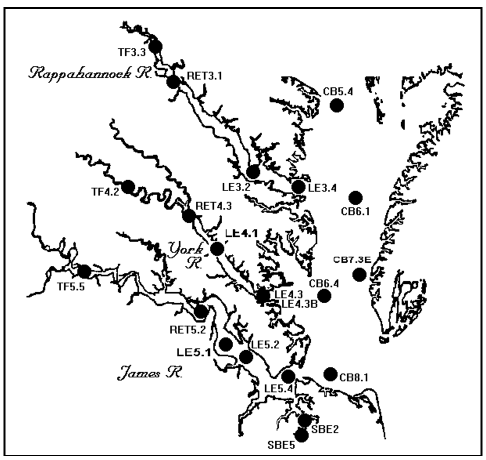
I. Principal Investigator: Dr. Dan Dauer (ODU)

II. Project Coordinator: Dr. Dan Dauer (ODU)

III. Introduction and Management Objectives:

The 1987 Bay Agreement identified benthic monitoring as an important part of the Living Resources Monitoring Plan for the Chesapeake Bay. The newest Bay agreement, Chesapeake 2000: A Watershed Partnership, states that "The health and vitality of the Chesapeake Bay's living resources provide the ultimate indicator of our success in the restoration and protection effort. The Bay's fisheries and the other living resources that sustain them and provide habitat for them are central to the initiatives we undertake in this Agreement."

Benthic organisms are important secondary producers, providing key linkages between primary producers (phytoplankton) and higher trophic levels (crabs, bottom feeding fish, and water birds). Benthic invertebrates are among the most important components of estuarine ecosystems and may represent the largest standing stock of organic carbon in the Chesapeake Bay. Benthic organisms such as hard clams and soft-shell clams are economically important. Others such as polychaete worms and shrimp-like crustaceans contribute significantly to the diets of economically important blue crabs and bottom-feeding juvenile and adult fish like spot, croaker, striped bass, and white perch.



This component monitors benthic macrofauna and sediment in the lower Chesapeake Bay and in major tributaries (James, Rappahannock, York, and Pamunkey) that enter the lower Bay. The objectives are:

1. To characterize the health of regional areas of the lower Chesapeake Bay as indicated by the structure of the benthic community. These characterizations will be based upon application of benthic restoration goals and criteria to data collected by a probability-based sampling design within the lower Chesapeake Bay. A probability-based sampling design allows calculation of confidence intervals around estimates of condition of the benthic communities. Confidence intervals provide managers with full knowledge of the strength or weakness of the data upon which their decisions will be based. In addition, probability-based data allows managers to estimate the actual area (number of acres) throughout the system (e.g., tributaries, areas of concern) in which ecological conditions differ from reference areas or goals.

2. To conduct trend analyses on long-term data at fixed- point stations to relate temporal trends in the benthic communities to changes in water and/or sediment quality. Trend analyses will be updated annually as new data are available.

3. To warn of environmental degradation by producing an historical data base that will allow annual evaluations of biotic impacts by comparing trends in status within probability-based strata and trends at fixed-point stations to changes in water and/or sediment quality.

IV. CBP Station Locations:

Twenty-one fixed-point monitoring stations correspond with Chesapeake Bay water quality monitoring stations as identified below and shown in the figure above . Other stations will be selected randomly as described in section V.

STATION	DESCRIPTION	LATITUDE (NAD83)	LONGITUDE (NAD83)
CB5.4	Main Bay, Upper	37.7999	-76.1742
CB6.1	Main Bay, Off Rappahannock R.	37.5893	-76.1602
CB6.4	Main Bay, Off York River	37.2370	-76.2021
CB7.3E	Main Bay, Off Old Plantation Fl.	37.2553	-77.9468
CB8.1	Main Bay, Off James River	36.9852	-77.8330
LE3.2	Rappahannock River Upstream Buoy R8	37.6701	-76.5551
LE3.4	Rappahannock River, Orchard Pt.	37.6335	-76.4652
LE4.1	York River, N44	37.4183	-76.6933
LE4.3	York River, off VIMS, shoal	37.2430	-76.4861
LE4.3B	York River, off VIMS, channel	37.2311	-76.4743
LE5.1	James River, Hog Point	37.2131	-75.2931

STATION	DESCRIPTION	LATITUDE (NAD83)	LONGITUDE (NAD83)
LE5.2	James River, Buoy C 12-13	37.0574	-76.5914
LE5.4	James River, Buoy 9	36.9534	-76.3916
RET3.1	Rappahannock River, Buoy 10	37.9209	-76.8204
RET4.3	York River, C57, Below West Point	37.5114	-76.7884
RET5.2	James River, Swann's Point	37.2129	-76.7930
SBE2	Elizabeth R. off Atl. Wood	36.8136	-76.2897
SBE5	Elizabeth R. off VEPCO	36.7690	-76.2983
TF3.3	Rappahannock River, N40	38.0185	-76.9089
TF4.2	Pamunkey River at White House	37.5964	-76.9743
TF5.5	James River, Red Buoy 10	37.3131	-77.2311

V. Sampling Frequency, field procedures, and Replication:

1) Chesapeake Bay Routine Samples:

A) Twenty-one (21) fixed-point stations (indicated in table and figure) sampled once. Complete field sampling procedures are given in "Quality Assurance/Quality Control Plan, Benthic Biological Monitoring Program of the Lower Chesapeake Bay (July 1, 2014 to June 30, 2017)". At each fixed-point station four replicate box core samples are collected. Box core samples are collected using a spade-type-coring device consisting of a rectangular corer (10.5 cm X 17.5 cm X 35 cm) with a hinged cutting arm that seals the box sample in situ. Each box core sample has a surface area of 182 cm^2 and a minimum depth of penetration of 25 cm. One of the four replicate samples is archived and the other three replicates are analyzed to quantitatively characterize the macrobenthic community. A subsample of the surface sediment from the archived replicate is taken for sediment particle size analysis and for determination of total volatile solids. Bottom temperature, salinity, and dissolved oxygen are measured at each sampling station.

B) One summer sampling within each of four strata to supplement data collected at fixed-point stations. The four strata to be sampled are 1) the James River, 2) the York River (including the Pamunkey and Mattaponi Rivers), 3) the Rappahannock River and 4) the Mainstem of the Bay. Sampling design and methodologies for this probability-based sampling are based upon procedures developed by EPA's Environmental Monitoring and Assessment Program (EMAP, Weisberg et al. 1993) and will allow unbiased comparisons of conditions (1) between strata (e.g. tributaries) of the lower Chesapeake Bay within the same collection year and (2) within tributaries for data collected between different years. The consistency of sampling design and methodologies for probability-based sampling between the Virginia and Maryland benthic monitoring programs will allow Bay-wide characterizations of the condition of the benthos for the Chesapeake Bay. Within each stratum-of-concern a probability-based sampling design is applied. The number of samples within each stratum will be 25 and sites will be selected using a GIS system. At each of the 25 randomly allocated sites a sample of the benthic community will be collected using a 0.04m2, Young grab. A subsample of the surface sediment is collected from a second grab sample for sediment particle size analysis and for determination of total volatile solids. Bottom temperature, salinity, and dissolved oxygen are measured at each sampling station. Estimating areal extent of the benthic condition departs from traditional approaches to environmental monitoring which generally estimate average condition without known confidence intervals. Random sampling within a stratum allows the calculation of a known confidence interval for the stratum.

C) NCAA Special Study: One summer sampling from up to 50 sites for the DEQ Estuarine Probabilistic Monitoring program (i.e. equivalent to National Coastal Condition Assessment - NCCA). There will be 10% field duplicates so that the total number of samples sent to ODU for analysis may be 55. These probabilistic sites will be within minor tidal tributaries to the Bay or in Atlantic coastal drainages, to include estuarine embayments as well as tidal streams, with the sampling period of 15 July through 30 September. Teams from DEQ's Tidewater, Piedmont, and Northern Regional Offices will carry out all fieldwork following protocols established during the previous 10 years of Virginia's Estuarine Probabilistic Monitoring Program and the current National Coastal Condition Assessment Program.

DEQ will provide for delivery of the sieved and properly fixed and labeled benthic samples to the ODU Benthic Taxonomy Laboratory. DEQ will also provide the ancillary water column and habitat data associated with each sample. (At a minimum, substrate particle size distribution and TOC content and near-bottom salinity and dissolved oxygen concentration. Turnaround time from the state laboratory [DCLS] is 21 days for the results of sediment particle size & TOC analyses; near bottom salinity [ppt] and DO [mg/L] will be available immediately.

VI. CBP Lab Analysis:

1) Chesapeake Bay Routine Samples:

Complete lab analysis procedures are given in "Quality Assurance/Quality Control Plan, Benthic Biological Monitoring Program of the Lower Chesapeake Bay (July 1, 2014 to June 30, 2017)". Benthic community structural parameters that will be measured include:

- Species diversity
- Species richness
- Species evenness
- Community abundance
- Community biomass
- Abundance of all species
- Biomass of all species

- Abundance of opportunistic species
- Biomass of opportunistic species
- Abundance of equilibrium species
- Biomass of equilibrium species
- Depth distribution of species
- Depth distribution of abundance
- Depth distribution of biomass

VII. Quality Assurance:

The quality assurance procedures for Chesapeake Bay routine field sampling, laboratory analysis and data management as outlined in the "Quality Assurance/Quality Control Plan, Benthic Biological Monitoring Program of the Lower Chesapeake Bay (July 1, 2014 to June 30, 2017)" will be followed. This document will be revised if any procedures change. The current QAPjP will be reviewed by April 15, 2018 and if needed a new QAPjP will be submitted at that time.. Species lists will be exchanged with Maryland investigators on a regular basis, and any taxonomic identification problems will be coordinated with Maryland investigators.

IIX. Deliverables:

1) Finished format, quality assured data will be submitted to the Chesapeake Bay Program Data Center (CBPDC) via FTP or XML data transfer. Data formats are as specified in the "2000 User's Guide to Chesapeake Bay Program Biological and Living Resources Monitoring Data". The raw data will be due May 15, 2018. Data submitted will include the following parameters:

- Benthic Taxonomic Counts
- Benthic Biomass Measurement
- Benthic Sediment Assessment Measurement
- Benthic Water Quality Measurement
- Benthic Biological Sampling Event Information
- Benthic General Sampling Event Information
- Benthic Index of Biotic Integrity calculations for each biological event
- QA Recounts of Taxonomic data
- FDGC Compliant meta data record (may be done or updated annually)
- Data documentation for cross-referencing the EPA names of stations collected under the EPA National Coastal Assessment Program with the CBP name.

2) Raw data for calculation of IBI scores for summer 2017 CBP random samples will be made available by January 15, 2018 to VERSAR, Inc.
3) If needed, a new QAPjP for CBP Sample collection during the period of July 1, 2017 through June 30, 2018 will be submitted by April 15, 2018.
4) For samples collected as described above under V.C (i.e. NCCA), ODU will provide to DEQ calculated Benthic IBI and Estuarine Condition scores and associated metrics for the individual samples based on the below considerations. These data will be due 5/15/2018.
   a. For all samples collected, calculate the CBP B-IBI scores following the procedures described by Llansó and Dauer (2002). Based upon on on-going re-calibration of the B-IBI, specific procedures may be modified and implemented for the 2017 random, fixed and NCCA samples The CBP B-IBI was developed solely from data collected within the estuarine portions of the Chesapeake Bay drainage, and its appropriateness has only been demonstrated for the characterization/assessment of sites within the Bay watershed. Its use in non-CBP waters will be for limited, comparative purposes only.
   a. For all samples collected, calculate the Mid-Atlantic B-IBI scores following the procedures described by Llansó et al. (2002). The MAIA B-IBI was derived from data collected throughout the Middle Atlantic Region, and is appropriate for the characterization of all of Virginia's estuarine waters, as well as for comparisons with other areas throughout the Middle Atlantic Region.
   b. For all samples collected, calculate the EMAP Benthic Index of Estuarine Condition for the Virginian Biogeographic Province following the procedures described by Paul et al. (2001). The EMAP index was derived from data collected throughout the Virginian

Maritime Province, and is appropriate for the characterization of all of Virginia's estuarine waters, as well as for comparisons with other areas throughout the Middle Atlantic Region.

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C: Phytoplankton Monitoring Component

I. Principal Investigator: Dr. Todd Egerton (ODU)

II. Project Coordinator: Dr. Todd Egerton (ODU)

III. Introduction and Management Objectives:

The 1987 Bay Agreement identified phytoplankton monitoring as an important part of the Living Resources Monitoring Plan for the Chesapeake Bay. The newest Bay agreement, Chesapeake 2000: A Watershed Partnership, states that "The health and vitality of the Chesapeake Bay's living resources provide the ultimate indicator of our success in the restoration and protection effort. The Bay's fisheries and the other living resources that sustain them and provide habitat for them are central to the initiatives we undertake in this Agreement."

Applicable to the goals of this agreement are the results obtained from the phytoplankton component which represents the primary carbon production source within the Chesapeake Bay and its tributaries. Phytoplankton are the food base for most of the Bay's filter feeding organisms, including zooplankton, oysters, many benthic macroinvertebrates, and fish at certain stages in their larval to adult life cycle. Due to their position at the base of the Bay's food web, restoring healthy phytoplankton assemblages is a critical part of restoring other living resources within the Bay. High levels of phytoplankton also contribute to the decline of submerged aquatic vegetation via shading and are the Bay living resource most directly linked to water quality conditions, responding rapidly during warmer months to changes in the availability of nitrogen, phosphorous, and light. Another concern is the increasing presence of toxin and/or bloom producing phytoplankton that may impact severely the health status of these waters and influence the economic status related to the finfish and shellfish harvesting.

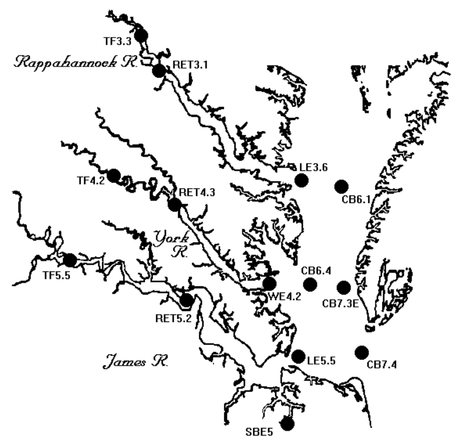

Figure 1) Phytoplankton

Phytoplankton Abundance and Biomass

Phytoplankton represents the major component of the Bay's primary productivity. The distribution of this biomass in space and time determines whether it fuels anoxia or becomes incorporated into higher levels of the food web. For example, seasonal phytoplankton dynamics, such as the spring diatom biomass bloom that is an important food source for zooplankton and some fish, are influenced by weather and pollutant loading patterns.

Excessive biomass production during blooms occurs when phytoplankton species increase rapidly under certain water quality conditions. For example, a large pulse of nutrients into a poorly flushed embayment can lead to a local bloom. These biomass blooms have fueled the expansion of anoxia in bottom waters by providing excessive organic material for bacterial decomposers. Observations suggest that the frequency of algal blooms has increased in some parts of the Bay.

Phytoplankton Community Species composition

Different nutrient species (e.g., ammonia, nitrate) and nutrient ratios (e.g., C:N:P:Si, DIN:DIP, NO3 :NH4) affect phytoplankton species competitive abilities, changing the species composition of phytoplankton assemblages. Chemical contaminants, particularly heavy metals, can also directly affect phytoplankton assemblages. Some of the blooms mentioned above are formed by toxin-producing algal species that can seriously impact shellfish and fish populations, and cause human health problems. Anecdotal observations suggest that the prevalence of these potentially toxic species may be increasing. With the excessive standing crop of phytoplankton present in the Bay today, most phytoplankton-eaters are rarely limited by the abundance of their food source. However, changes in phytoplankton assemblages that result in dominance by less desirable species can stress the feeding abilities of phytoplankton-consumers and impact higher levels of the food chain. As existing nutrient and sediment reduction strategies are implemented, more desirable phytoplankton assemblages should develop. Also, if sediment and nutrient load reductions are implemented simultaneously, decreases in available nutrients should not be expected to cause food-limitation in phytoplankton consumers. Instead, a more balanced phytoplankton community species structure will pass more quickly and efficiently to filter-feeding organisms and the relationship between phytoplankton and their consumers will improve.

IV. Station Locations:

Seven (7) tributary stations and seven (7) Mainstem stations for Phytoplankton sampling corresponding to water quality monitoring stations as identified below and shown in Figure 1.

TRIBUTARY STATIONS

STATION	LATITUDE (NAD83)	LONGITUDE (NAD83)	DESCRIPTION
TF5.5	37.31265	-77.2328	Buoy 107
RET5.2	37.20294	-76.7822	Swanns Point
TF4.2	37.57999	-77.0213	Whitehouse
RET4.3	37.50869	-76.7889	Buoy 57
TF3.3	38.01847	-76.9093	Buoy 40
RET3.1	37.9173	-76.8222	Buoy 10
SBE5	36.76903	-75.7017	Southern Branch off Virginia Power

MAINSTEM STATIONS

STATION	LATITUDE (NAD83)	LONGITUDE (NAD83)	DESCRIPTION
CB 6.1	37.58833	-76.16250	Main Channel, Lower End off of Rapp. River
LE 3.6	37.59687	-76.28528	Mouth of Rappahannock
CB 6.4	37.23638	-76.20833	Central Bay, Off York River
CB 7.3E	37.22850	-76.05417	Eastern Shore Channel, Southern End
CB 7.4	36.99550	-76.02083	Baltimore Channel, Bay Mouth
LE 5.5W	36.99883	-76.31350	Mouth of James
WE 4.2	37.24167	-76.38667	Mouth of York

V. Sampling Frequency and Replication:

Mainstem Stations: Phytoplankton and autotrophic picoplankton samples will be collected once per month by the Old Dominion University water quality monitoring component of this Chesapeake Bay Monitoring Program, July 2017 through June 2018 for a total of twelve (12) collections. At each station, four phytoplankton (2 AP and 2 BP), and four picoplankton (2 AP, 2 BP), will be collected for a total of 288 phytoplankton and 288 Picoplankton samples.

Tributary Stations: Phytoplankton and Picoplankton samples will be collected once per month by the Virginia Department of Environmental Quality personnel July through October 2017, and March through June 2018 for a total of eight (8) collections. At each station, two AP phytoplankton and two AP picoplankton samples will be collected for a total of 112 phytoplankton and 112 picoplankton samples.

a) All sampling schedules will be provided by DEQ in order to be coordinated with Mainstem and tributary water quality monitoring dates.
b) Sampling of Mainstem stations will occur on the same day (within ½ hour) as ODU water quality monitoring data collection.
c) Sampling of the 7 tributary stations will occur at the same time (within ½ hour) as water quality collections, both performed by DEQ to the maximum extent practicable.
d) ODU personnel will pick-up the upper tributary phytoplankton and picoplankton samples from Virginia DEQ personnel at sites mutually (DEQ & ODU) agreed upon.

VI. Field Sampling:

A. Phytoplankton and Picoplankton

Complete field sampling procedures are given in the "Work/Quality Assurance Project Plan for Monitoring Phytoplankton and Picoplankton in the Lower Chesapeake Bay and Tributaries Effective date July 1, 2017)".

At mainstem stations, two 15-liter composite samples will be collected with one each from above pycnocline (AP) and below the pycnocline (BP). At tributary stations, only a single 15-liter composite sample will be collected. 500-ml subsamples of the composite samples will be fixed with Lugol solution and preserved with buffered formalin for phytoplankton; 125-ml samples preserved in Gluteraldehyde will be used for picoplankton analysis.

B. Other Associated Field Data

The routine chlorophyll sample data collected by the water quality monitoring component will serve as the chlorophyll data for this component.

C. DEQ Observation

DEQ personnel have the right to accompany the field crew on all sampling cruises.

VII. Laboratory Analysis:

A. Phytoplankton and Picoplankton

Laboratory analysis procedures are given in the "Work/Quality Assurance Project Plan for Monitoring Phytoplankton and Picoplankton in the Lower Chesapeake Bay and Tributaries (Effective date July 1, 2017)". For newly identified taxa – shape codes, biovolumes, and carbon estimates should be made using common Chesapeake Bay Protocol described in the white paper document: Methodology Applied in the Calculation of Chesapeake Bay Program Phytoplankton Composite Metrics and Index of Biotic Integrity (PIBI).

Phytoplankton samples will be examined with an inverted plankton microscope following the Utermohl analysis procedure. Picoplankton will be examined using an Epifluorescence microscope procedure. All phytoplankton samples will be identified to the lowest practical taxonomic level. These procedures will process a total of 392 phytoplankton and 392 Picoplankton samples during the 12 month contract period.

IIX. Quality Assurance:

The quality assurance procedures given in "Work/Quality Assurance Project Plan for Monitoring Phytoplankton and Picoplankton in the Lower Chesapeake Bay and Tributaries (Effective date July 1, 2017)" will be followed. Any changes to these procedures will be documented in the plan(s). If needed, a new QAPjP for the period of July 1, 2017 through June 30, 2018 will be submitted by April 15, 2017. In the event of any questions regarding species identification, the principal investigator will contact other experts in the field for species verification.

IX. Deliverables:

Finished format, quality assured data will be submitted to CIMS. Data formats are as specified in the "2000 User's Guide to Chesapeake Bay Program Biological and Living Resources Monitoring Data". Data (including QA recounts) for the period July 2017 through September 2017 will be due January 1, 2018. Data (including QA recounts) for the period October 2017 through June 2018 will be due October 15, 2018. Any 2017 Split sample program data will be due 11/15/2018. A new QAPjP for the period of July 1, 2017 through June 30, 2018 will be submitted by October 15, 2017 if needed.

Phytoplankton Monitoring deliverables include:

- Complete Phytoplankton Taxonomic List
- For New Taxa Not Previously Identified:
    - Shape description, typical cell size dimensions, and estimated carbon conversion factor for biomass estimation.
- Phytoplankton Taxonomic Counts
- Phytoplankton Sampling Event Information
- QA Recounts of Taxonomic data
- FDGC Compliant Meta data record (may be done or updated annually)

Picoplankton Monitoring deliverables include:

- Picoplankton Taxonomic Counts
- Picoplankton Sampling Event Information
- QA Recounts of Taxonomic data
- FDGC Compliant Meta data record (may be done or updated annually)

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D: Baseline Status and Trend Analyses for Chesapeake Bay Program Management Decisions

I. Principal Investigators

Dr. Daniel M. Dauer, Old Dominion University
Mr. Michael F. Lane, Old Dominion University

II. Project Summary

This project will provide integration of basinwide and baywide water quality and biological monitoring information by, 1) providing analyses, development and application of analytical tools, and 2) synthesis reports and presentations useful to Chesapeake Bay restoration and decision-making. It will also help determine the effectiveness of management actions and assess progress towards reaching water quality criteria, 2-year nutrient and sediment reduction milestones, and other Chesapeake Bay program goals and commitments. In addition, as identified by the Chesapeake Bay Monitoring Realignment Process, this project provides the assessments needed to address Management and Communication priorities which are: 1) answering "How to de-list tidal segments of the Chesapeake Bay?" ; 2) determining the effectiveness of management actions in the watershed; 3) directly linking pollution reductions to restoration activities, allowing us to identify successful management actions; 4) expanding assessments down to the smaller-scale ecosystem level for more regionalized, management-relevant interpretation of results; and 5) highlighting the utility of long-term trends to the management decision making process and understanding the reasons behind changes over time. The results of the entire project will be a stronger, more thorough and integrated understanding of the progress of management actions to improve the water quality and protect and restore living resources of Chesapeake Bay, several new indicators and analysis methods for assessing, interpreting and explaining to management or the public how the current water quality conditions are influenced by watershed activities (both management and natural). These activities will support an iterative adaptive management approach of setting goals, monitoring progress, and revising monitoring and goals as necessary. This contract is the first six months of what is a multi-year project. The following project and task descriptions may not be completed during this first contract period. Therefore the deliverable due dates will be determined as the project is performed.

III. Description of Objective

1) What is the ultimate goal of the project?

Environmental monitoring is a program of measurement, analysis and synthesis that predicts and quantifies environmental conditions and incorporates that information effectively into decision making in environmental management by federal, state and local governments. Statistical analytical support that assists in the management decision-making process includes two primary objectives: 1) the assessment of current environmental conditions or ecosystem health relative to management goals (specifically, assessment of potential impacts to water quality due to accelerated restoration efforts) and 2) the identification of long-term trends in environmental conditions indicative of progress towards those goals or the lack thereof. Current conditions and long-term trends are the fundamental indicators of the success of any management actions applied and are essential for the interpretation, development and understanding of other indicators and/or analytical approaches. Without understanding where we are currently, and how far we have come (good or bad), we cannot make decisions for what current and future management actions are needed.

2) What will be accomplished?

Current conditions (status) will be evaluated using a relative status method to be based on management-relevant benchmarks, including the new two-year nitrogen, phosphorus and sediment milestones, water quality criteria; TMDL loadings caps; nutrient limitation thresholds; SAV habitat thresholds; or other measures of living resources conditions, such as the Chesapeake Bay Water Quality Index (WQI), the Phytoplankton Index of Biotic Integrity (P-IBI), SAV coverage as a percent of its restoration goal, and/or the Benthic Index of Biotic Integrity (B-IBI). Additional indicators may be analyzed as developed and recommended by the TSS and/or various GITs and/or their partner organizations. The current relative status indicator scores recent data against a benchmark of data from the first six years of monitoring. We proposed to modify this indicator to create two new indicators. A new relative status indicator may be developed by scoring current data against the distribution of recent observations. A new reference status indicator may score current data against the desirable distribution. The desirable distribution may be derived from management benchmarks (as listed above). Parameters assessed will be: total nitrogen and phosphorus, dissolved inorganic nitrogen and phosphorus, water clarity, summer bottom layer dissolved oxygen, chlorophyll a and total suspended solids; other parameters will be included as needed for linkages to watershed management activities and implementation goals.

Long-term trends will also be assessed. To be effective, environmental managers require trend results that describe and quantify changes in water quality and living resource conditions as observed and those that represent changes in water quality resulting from management actions independent of sources of natural variability the predominant being freshwater flow. Trend analyses should also distinguish between trends that are linear and non-linear and account for natural seasonal variability and/or auto-correlation effects. The statistical techniques should minimize Type I and II errors caused by the inherent characteristics (e.g. missing and censored values, lack of normality, heteroscedasticity, etc.) of the data. The primary statistical test used for trend analysis will be the Seasonal Kendall test for monotonic trends; this has been the method used by CBP partners for program-wide trends analysis since 1994. Non-linear trend analysis using a quadratic regression method is incorporated into the analysis programs to help interpret the results.

This project will also examine trend analysis methodologies to address outstanding issues with non-linear trends, flow-adjustment, censoring of data, etc. to further enhance the capability of the Bay Program partners to detect changes over time due both to natural (flow, temperature, etc) and management efforts (BNR upgrades, BMP implementation, etc.). The revised approach may include a series of tests rather than a single analysis. This may include: 1) tests for autocorrelation effects and correction as necessary using residuals and 2) models with autoregressive terms, linear time (T) and nonlinear time (T2) terms, seasonal terms (either month or sine and cosine), and a freshwater flow term (monthly averages of USGS fall-line data). Independence of trend and flow effects will be assessed using the regression approaches. Shape and direction of the trends reported for both models will be based on the significance of the T and T2 terms, as well as the sign and magnitude of the their respective regression coefficients. Finally, the nonparametric seasonal Kendall test for monotonic trends may also be calculated to assess linear trends perhaps missed due to: 1) possible violations of the assumptions of the parametric approaches and 2) loss of power and robustness related to high numbers of missing values and values below method detection limits.

Parameters assessed for long-term trends will include: 1) surface measurements of total nitrogen, dissolved inorganic nitrogen, total phosphorus, dissolved inorganic phosphorus, chlorophyll a, total suspended solids, 2) Secchi depth, and 3) bottom measurements of dissolved oxygen. Other parameters will be included as needed for linkages to living resource indicators, watershed management activities and implementation goals. Whenever possible, trend analyses will be conducted on segment specific monthly mean or median values, unless data are collected in specific seasons appropriate to living resource indicators (such as WQI, P-IBI and B-IBI).

In addition to characterizing status and detecting significant trends, an attempt will be made to explain those results in relation to watershed stressors and/or management activities whenever possible. Status and trend results will be examined in relation to patterns in point and non-point sources loadings, land-use patterns, and any available information on BMPs made available from the CBP. CBP environmental managers currently specify water quality goals, target remediation efforts and monitor the response of those efforts at a site specific scale and a spatial scale that corresponds to the Bay Program segmentation scheme; all statistical analyses will be conducted and results presented will be reported at this spatial scale.

IV. Tasks Under this Objective

1) Current conditions (status) determination- refine and apply methods to evaluate the current conditions (status) of water quality components in relation to water quality criteria, assessing effectiveness of two-year nitrogen, phosphorus and sediment reduction milestones; 2) Trend determination -determine the long-term (1985-present) trends in key tidal water quality and habitat parameters and further develop the trends analysis to more fully account for anthropogenic impacts and natural variability (e.g. seasonal, hydrodynamic, climatic) and expand the current linear and non-linear models into multi-metric models; 3) Develop and assess linkages – integrate ambient water quality and habitat analyses and watershed information, nutrient and sediment loadings and living resources information and present this as comprehensive assessments in reporting products for the public audience through the CBP and DEQ websites; 4) Provide coordination and analytical support for specialized projects and ensure integration between those projects and the interpretation of the long-term data into management-relevant information and indicators; 5) Perform water quality criteria assessments as directed by DEQ; and 6) CBP coordination - coordinate all analysis tasks with the CBP Management Board, CBP Goal Implementation Teams (GIT) and Technical Services Support (TSS) Team.

V. Outputs for this Objective

1) Methods documentation to include definition of data source(s) used; all analysis method steps from raw data to completed analysis product; p-values and other assessment criteria; any special considerations that need to be included in the analysis by others to allow for reproducibility; SAS or other software code used for analysis;
2) Analytical summaries in the form of electronic tables, graphs, printouts or similar materials produced for data for 1985-end of previous year (trends) or current conditions (status) from all long-term tidal segments in VA;
3) Project analysts/PIs will participate in meetings of TSS and its workgroups to ensure collaboration with other analysis projects and CBP committees. The specific programmatic outputs listed here may change due to the needs and guidance of the TSS and it's workgroups as they evolve.

A. DATA SUBMITTAL

Deliverable	Due
7/2017 Mainstem Water Quality and QA data posted via CIMS	10/31/2017
8/2017 Mainstem Water Quality and QA data posted via CIMS	10/31/2017
9/2017Mainstem Water Quality and QA data posted via CIMS	12/31/2017
10/2017 Mainstem Water Quality and QA data posted via CIMS	12/31/2017
11/2017 Mainstem Water Quality and QA data posted via CIMS	2/28/2018
12/2017 Mainstem Water Quality and QA data posted via CIMS	2/28/2018
1/2018 Mainstem Water Quality and QA data posted via CIMS	4/30/2018
2/2018 Mainstem Water Quality and QA data posted via CIMS	4/30/2018
3/2018 Mainstem Water Quality and QA data posted via CIMS	6/30/2018
4/2018 Mainstem Water Quality and QA data posted via CIMS	6/30/2018
5/2018 Mainstem Water Quality and QA data posted via CIMS	8/31/2018
6/2018 Mainstem Water Quality and QA data posted via CIMS	8/31/2018
Submission of 7/2017 - 9/2017 in-vivo Fluorescence data	12/31//2017
Submission of 10/2017 - 12/2017 in-vivo Fluorescence data	4/15/2018
Submission of 1/2018 - 6/2018 in-vivo Fluorescence data	10/15/2018
Submission of 7/2017 - 9/2017 Phytoplankton data	1/15/2018
Submission of 10/2017 - 6/2018 Phytoplankton data	10/15/2018
Submission of 8/2017 multi-lab CSSP Mainstem field split data	10/31/2017
Submission of 11/2017 multi-lab CSSP Mainstem field split data	1/31/2018
Submission of 2/2018 multi-lab CSSP Mainstem field split data	4/30/2018
Submission of 5/2018 multi-lab CSSP Mainstem field split data	7/31/2018
Submission of 9/2017 multi-lab CSSP Tributary field split data	11/30/2017
Submission of 12/2017 multi-lab CSSP Tributary field split data	2/28/2018
Submission of 3/2018 multi-lab CSSP Tributary field split data	5/31/2018
Submission of 6/2018 multi-lab CSSP Tributary field split data	8/31/2018
Submission of CBP Random station raw data (SAS format to Versar)	1/15/2018
Submission of CBP Fixed and Random station EPA format data (to CBP)	5/15/2018
Calculated IBI value data submission for all stations (to CBP)	5/15/2018
NARS/NCAA Random station species counts/biomass data and indices (to DEQ)	5/15/2018

C. QUALITY ASSURANCE PLANS

Water Quality Monitoring QAPjP for the period of July 1, 2018 through June 30, 2019 (if needed)	4/15/2018
Benthic Monitoring QAPjP for the period of July 1, 2018 through June 30, 2019 (if needed)	4/15/2018
Phytoplankton and Primary Productivity QAPjP for the period of July 1, 2018 through June 30, 2019 (if needed)	4/15/2018

D. SEMI-ANNUAL PROGRESS REPORTS

A single report will be submitted semi-annually which will contain the following for each task of this contract: Summary Statement; Conformance to Sample Collection and Analysis Requirements; Data Submittal Status; Quality Assurance/Quality Control Status; Statement of Work Planned for Next Reporting Period; and a QA Checklist. The report will be submitted in MS Word format.

Semi-Annual Progress Report for 7/2017 - 12/2017	1/15/2018
Semi-Annual Progress Report for 1/2018 - 6/2018	7/15/2018

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Appendix H

Virginia
Tributary Monitoring Program
Log of Significant Changes

Revised 7/1/2015

Date initiated	Procedural Changes
November 11, 1985	Tributaries silica data is changed from total SiO_2 to dissolved SiO_2
March 1988	Stations TF3.1A, TF3.1B are added to the sampling regime.
April 1988	1. TRO starts collecting samples from station RET5.2 (formally sampled by PRO). 2. RET5.1 on the Chickahominy River is moved from the Shipyard landing to Buoy 10. 3. On the James River, PRO begins sampling TF5.5A (Buoy 91 on the James River) and TF5.2A (Buoy 166). 4. Tributary analyses begin to include suspended solids. 5. NRO and PRO no longer perform routine DO checks with Winkler titration. TRO continues to collect Winkler DO at the first and last stations of each cruise as a check for marine radar interference of the Hydrolab.
1988	All regions implement the collection of field blanks and duplicates.
January 1, 1989	VCU begins to analyze chlorophyll samples for the VTMP. Prior to that (1984 – Dec. 1988) the samples were analyzed by the State Water Control Board.
October 1989	PRO implements sampling fall line and tributary stations on the same day.
July 23, 1990	DCLS begins analyzing samples for TOC for Tributary stations. TOC data submitted to CIMS prior to July 23, 1990 was analyzed for the Tributary Program by AMRL.
April 2, 1992	1. NRO begins sampling stations TF3.1 and TF3.2 (formally sampled by PRO) to improve sampling efficiency and address a courier problem with NRO samples. 2. CBO staff becomes responsible for picking up NRO's samples and delivering them to DCLS and VCU.
December 1993	PRO takes over stations RET3.2 (3-RPP031.57, buoy 16), RET3.1 (3-RPP042.12, buoy 10) and TF3.3 (3-RPP051.01, buoy 40) from TRO.
January 1994	1. All regions begin to obtain light attenuation (Li-Cor) readings. 2. Implemented field filtration in van (13 mm PCN, 50mm PIP & PhosP and BioSi). USGS begins field filtration using in-line filtration and disposable filters. 3. The Virginia Tributary Monitoring program changes methods for TN and TP parameters in order to directly measure particulate fractions and also move away from the Kjeldahl nitrogen analysis to the more accurate persulfate digestion procedure. From 1984-

1994 data for TN is calculated as TKNW + NO23W (or TKNW + NO2W + NO3W) results and TP is measured directly. In 1994 TP is calculated from PhosP (PP) + TDP, and TN from TDN + PN. VIMS is contracted to analyze for the particulate parameters: PC, PN, PhosP (PP) as well as PIP, BioSi, TDP, TDN, and DOC. The VIMS results are submitted to CIMS from 01/01/94 through 02/01/95 but not entered into the STORET LEGACY database. DCLS continued to analyze for NO2F, NO3F, NO23F, NH4F, PO4F, SIO2, TURB, TSS, VSS, FSS and TOC but discontinue TKNW and TDP analyses. DCLS results are submitted to both CIMS and LEGACY STORET databases (note NO3F and VSS are calculated parameters that are only kept in CIMS when the directly measured parameters such as NO23F are not available). TKNW and TDP data for 1994 can be found in the legacy STORET database as Regional offices occasionally continued to request those analyses for CBP/AQM stations from DCLS, but the results were not submitted to CIMS. (Note: TDP submitted 1984-1994 was obtained by DCLS using a TECHNICON Auto-analyzer via EPA method 365.4, a block digestion analysis utilizing acid persulphate as the digestion solution. TDP submitted by VIMS 01-1994 through 02-01-95 was also obtained with a TECHNICON Auto-analyzer via EPA method 365.2, which calls for an alkaline persulphate digestion . TDP that was submitted to CIMS since 02-1995 have been obtained via a SKALAR instrument utilizing EPA method 365.1, which is also an alkaline persulphate digestion method.)
4. The Chesapeake Bay Program purchases SKALAR instruments for Maryland and Virginia (DCLS). DCLS begins testing the SKALAR for PC, PN, TDN, TDP, PP, NO2F, NO23F and PO4F for intra and inter-laboratory comparison studies only. These data were not stored into any databases.

September 1994 DCLS implements EDT for Ches. Bay Tributary-monitoring data. Prior to then data were manually keyed into STORET (currently called LEGACY STORET).

January 1995 1. PIP, BioSI and DOC are discontinued.
2. Regional personnel begin field filtering on boats (Boats had to be refitted for field filtration so some regions were filtering at the vehicle upon docking).

February 1995 DCLS starts providing to CIMS analytical results from their SKALAR instrument for PC, PN, PP, and TDN utilizing the same methods as VIMS in 1994. DCLS also begins to analyze samples for TDP but change methods from EPA method 365.2 (utilized by VIMS in 1994) to EPA method 365.1. DCLS also changes instrument from TECHNICON to SKALAR for NO3F, NO2F, NH4F and PO4F analyses for CIMS data; Analytical methods remained the same. DCLS continues to analyze Silica on the Technicon instrument. All data are submitted to both CIMS and STORET.

March 1995 Filter diameter size changed to 25 mm for PCN analyses.

January 1997 TRO begins sampling RET4.2 (Muddy Point) sampled by PRO from August 1994 – December 1996.

January 1998 PRO takes over sample collections at station RET4.2 (Muddy Point).

February 1998 A split sample program is initiated as VTMP begins the process of switching its chlorophyll analysis to DCLS in an effort to consolidate laboratory services. The split samples are collected February through December. Data analyzed by VCU is submitted to CIMS through September 1998 and data from DCLS is submitted to CIMS beginning in October 1998. VCU results are incomplete for October and December. Data for DCLS was submitted to CIMS for the Elizabeth River stations EBB01, ELE01, ELD01, LFA01, LFB01 and WBB05 from January 1998 - October 1998 at the request of the Tidewater Regional office in 2000 to ensure all the data were available in one location and because those stations were sampled for the Elizabeth River Project utilizing Chesapeake Bay Program methods.

August 6, 1998 A laboratory audit of VCU is conducted by Rick Hoffman and Mary Ellen Ley due to anomalies observed in VCU's chlorophyll data during trend analyses and the need to ensure consistency between labs due to changes in the acidification process for chlorophyll analysis (see July 15, 1998 Draft Chesapeake Bay Chlorophyll Data and Methods in the AMQAW meeting folder 1998-2000). The audit revealed VCU was experiencing interference at 750nm possibly due to turbidity from sediment, VCU was utilizing an incorrect extraction volume, and 2-3 filter pads were used to filter a constant 1 L volume and then processing them together. The VCU data were analyzed by Elgin Perry and found there was no consistent trend of chlorophyll results to turbidity. Additionally, after analyzing the split sample data for DCLS and VCU, it was determined that no correction factor should be applied.

October 1998 DCLS begins processing chlorophyll samples for VADEQ (formally processed by VCU).

December 1998 DCLS courier service began to pick up samples from the regions.

January 1999 Dry PNC blanks are no longer utilized for background information on PC/PN analyses, instead DCLS begins using blanks filtered with DI for their background.

May 1999 1. Regions begin field filtering chlorophyll samples. Some regions begin collecting equipment blanks and duplicates. However, due to problems in processing the paperwork for the duplicates, the regions were requested to hold off collecting any further duplicate

	samples until further notice. 2. Responding to a request from DCLS to return to dry filter pads for PNC background information, the regions begin sending 5 "muffled" PNC filter pads as soon as they are muffled to DCLS.
June 1999	Stopped performing USGS-VADEQ split at Appomattox R. fall line. Split was initiated in 1995 to assess effect of USGS vs. VADEQ field processing procedures. Analysis of 95-98 data showed field differences do not create significantly different data (see May 20, 1999 letter L. Sprague to R. Hoffman).
August 1999	1. All regions again begin collecting duplicate samples and equipment blanks. Due to a miscommunication some regions use all paper and some EDT one sample and send paper for the other. 2. VADEQ and ODU begin coordinating collection of plankton sampling and water monitoring sampling on the James and York Rivers (stations LE5.5, RET5.2, TF5.5, RET4.3, and TF4.2).
September 1999	1. DCLS request the regions return to the procedure of submitting a dry PNC filter pad for each sampling run for background information. 2. Regions initiate reading surface Li-cor meter data at 0.1 m. Previous practice was to obtain surface data with probe just below the surface. 3. All regions begin collecting QA sampling for surface and bottom depths at a given station that is determined by the regions. Stations are altered such that QA will be collected all the stations of a river. 4. All regions begin to acid wash all reused containers prior to each use in the field.
October 1999	Other CB collectors (e.g. ODU, MDDNR) indicate that they read initial surface Li-cor meter data just below the surface but that in the database the depth is indicated as 0.1 meters. All regions revert to obtaining readings just below the surface.
January 2000	Due to personnel problems PRO begins to filter all samples requiring filtering at the regional office on the York River. This means that nutrient samples and chlorophyll samples may not be filtered for as many as 2-4 hours after collection.
June 2000	1. NRO begins obtaining readings from churn splitter for station TF3.1. Prior to then 5 hydrolab pH values were averaged without log normalization as obtained from each transect across the bridge. The raw data is available at NRO for readings obtained 1997-2000. 2. NRO also begins to calibrate and post-calibrate the hydrolab prior to/after each run. Previous practice was to calibrate when screen results looked abnormal. 3. PRO returns to the practice of filtering samples on station with the exception of the fall line stations (TF4.1, TF4.3 and TF5.1).
October 18, 2000	All regions begin utilizing the sampling time for all samples

collected at a station including QA/QC samples. Previously the bottom sample times were recorded as the actual time sampled rounded to the nearest 5 min increment and 5 min were added to that time for surface samples. When QA/QC samples were obtained they were recorded as being obtained 5 minutes after the surface samples. CIMS has always recorded all sample times as the first time recorded for a station.

January 1, 2001 PRO modified their sampling processes to try to shorten time in the field. Past practices caused field personnel to be in the field 10-12 hours per day. For safety reasons PRO stopped filtering on the boat on all runs and began filtering on shore. All regions were asked to begin documenting time filtered in April 2001.

February 2001 DCLS begins reporting Optical Density values utilized to calculate chlorophyll and pheophytin to the 4^{th} decimal place. Prior practice was to report OD values to 3 decimal places. Chlorophyll and pheophytin values reported by DCLS were based on OD values with 4 decimal places. Therefore, prior to February 2001 chlorophyll values calculated with OD values in WQM and CIMS will not totally agree with the chlorophyll values reported in those databases.

March 1, 2001 1. VADEQ discontinues sampling stations TF3.1 and TF5.1 for the Bay Program. This was done because station TF3.1 data has never been used in CBP data analyses and USGS analyses indicates loss of VADEQ collected data at TF5.1 will not effect the power to detect concentrations or loads at this station.
2. PRO no long obtains pH readings from the churn splitter. Instead readings are recorded from the in-situ reading taken at the location most representative of the majority of riverflow. Regions had noticed that pH obtained from the splitter was often higher than any ambient stream readings. USGS had also noticed this anomaly and utilize ambient values rather than values obtained from the composite sample.
3. NRO changed its run id in WQM from NRAP1 to NBR02 and begins sampling in time sequencing fashion downstream to upstream order such that they sample their first station after PRO finishes their last station.
4. PRO started adding MgCO3 to their surface 2L brown Nalgene bottles because of their change in procedure to filtering on shore. The sample in that container was then utilized for PNC, PP, NTNP and CHLA analysis.

July 2001 PRO discontinued adding MgCO3 to their surface 2L brown Nalgene bottles.Split samples were obtained from the Surface and Bottom of 6 stations and a Wilcoxon matched pairs sign rank test was performed on the PNC, PP, NTNP and CHLA results to determine if the addition of MgCO3 had caused a significant difference in the results. $p<.05$ for all compared analytes so the data was submitted to CIMS.

September 2001 1. NRO begins obtaining Secchi readings from shaded side of boat. Prior to that Secchi readings were taken on the sunny side of boat.
2. TRO has to indefinitely relocate station 2-ELI006.92 from 36°50'54.0" and 76°17'53.0" to 36°50'54.3" and 76°18'04.9" due to its close proximity to a military interest (USS Wisconsin at Nauticus).

October 2001 All regions begin collecting replicate Li-Ccor readings for Dr. Gallegos of the Smithsonian Instititute. One profile is collected prior to the collection of water quality samples and the replicate profile after. The duration of the study was one year.

February 2002 NRO changes launch/retreival site from Fredericksburg City dock to Little Falls.

April 2002 Regions begin sampling pH at all depths. Previous practice was to only record pH with the surface and bottom profiles.B.

March 2003 1. PRO drops Fall Line station monitoring (stations 8-MPN054.17 and 8-PMK082.34). USGS continues to sample these stations monthly.
2. VADEQ discontinues requesting laboratory duplicates to be conducted on field duplicates.

April 24, 2003 All Chesapeake Bay Monitoring Participants agree to remove Dissolved Oxygen field data when post cruise calibration checks indicate drift of 0.5 mg/l or more. VTMP SOP changed to indicate post cruise calibration data supplied to CO for QA purposes will be the instrument values obtained the day after sampling when the post cruise calibration check indicates excessive drift when returning from sampling.

April 2003 Regions add TNUTL samples to the CBP monitoring to try to determine the cause of a step trend that resulted from changing analyses for the measurements of TP and TN in 1994 (refer to log for January 1994 above for details). Samples were collected in September and October of 2002 and April through October of 2003.

August 2003 NRO moves station 3-RPP080.19 38 yards downstream from the Route 301 bridge in Port Royal. Previous practice was to moor under the bridge to sample. Lat Long changed from 38° 10’ 29.00” and -77° 11’ 19.00” to 38° 10’ 21.0” and -77° 11’ 04.9”.

February 23, 2004 The Army Corp of Engineers reopened 71 miles of the Rappahannock Mainstem and 35 miles of the Rapidan River to fish passage (USGIF press release) by demolishing Embry dam. The dismantling of Embry Dam began in February 23 2004. The dam was located at 38.32180, -77.48970. N 38°19'18" W 77°29'23"

April 2007 1) Regions start collecting 1 meter incremental profiles from 1 meter above bottom to 1 meter below surface. Previously profiles were collected at odd depths only.

2) Regions drop Li-Cor profiles at all sites except plankton stations (2-JMS042.92, 2-JMS075.04, 3-RPP042.12, 3-RPP051.01, 8-YRK031.39 and 8-PMK034.17).

3) PRO and TRO begin field filtering for DOC from the surface samples at the Plankton sites.

May 2008 1) The regions change the muffling procedure for PNC from 15 min to 1.5 hours.

2) Regions agree to utilize GPS to ensure sampling is conducted within 0.2 nautical miles of the listed coordinates for each site and list any deviation from listed coordinates on field data sheets.
3) Regional offices begin verifying datasonde depths at the beginning of each cruise.
4) Regional offices begin washing field filtration equipment with Liquinox prior to acid washing.

December 2009 1) Rappahannock River Run changed due to budget constraints. Better aligns run with regional assessment needs. TRO's sites picked up by PRO. NRO picked up station 3-RPP064.40.

2) ODU drops their Elizabeth River sites EBE1, ELI2, SBE2, SBE5 and WBE1.

January 2010 TRO picks up the 5 Elizabeth River sites dropped by ODU and moves 2-ELI002.00 from their James River run to the Elizabeth River run. PRO begins sampling TRO's 4 Rappahannock River sites (LE3.1, LE3.2, LE3.3 and LE3.4) and NRO begins sampling PRO's station TF3.2A.

July 2012 DLCS implements the use of a new Lachat system (analytical instrument used to analyze ammonia) to replace the Skalar system purchased in 1996. The Skalar system is decommissioned immediately.

August 2013 DCLS implements the use of the LACHAT flow injection system for analysis of nitrite, nitrate, orthophosphate ,and particulate phosphorus (including inorganic).

July 2014 Virginia adds an Option 3 to the Section 3.3.3 B "Field Duplicate" procedure in the Tributary SOP. Option 3 allows FS1 and FS2 samples to be collected by filling a large pre-cleaned gallon container and then sub-sampling from this container. The container must be inverted prior to decanting to ensure homogonous sub-sampling. This procedure is approved by CBPO and is currently employed by Maryland DNR for duplicate sample collection.

January 2015 DCLS implements the use of a new Ion Chromatograph (ICS2100) system on January 8th, 2015. There are no changes to the methods, MDLs, STORETcodes, submissions, or data recovery.

APPENDIX I

VADEQ SAMPLING METHODS
FOR
FALL LINE STATIONS

(Discontinued 2003)

Commented [DG2]: Or Stations? Please check Table of Contents comment

The River Input Monitoring Program (RIM) was initiated in Virginia on July 1, 1988 to "characterize the occurrence of selected nutrients and suspended solids and their relation to flow conditions and to time of year." (Belval, Donna L. 1991. Quality Assurance Project Plan for Virginia Fall Line Monitoring Program. U.S. Geological Survey). Initially the program consisted of baseflow and instantaneous high flow (storm events) sample collections in the James and Rappahannock Rivers. Collections in the Appomattox, Mattaponi and Pamunkey Rivers were added to the program the following year. USGS and VADEQ (then known as the Virginia State Water Control Board (VSWCB)) alternated monthly collections on each tributary (except the Appomattox which was sampled exclusively by USGS) to collect a total of 24 baseflow samples each year. All instantaneous high flow samples were collected by USGS. Changes in the RIM program are documented in Appendix L. In 2003 a comparison of the Maryland RIM program and the Virginia RIM program was conducted and some changes were instituted to increase their comparability. As a result of the comparison, the Virginia RIM program reduced the required number of baseflow sample collections from 24 to 12 per year at each site and VADEQ personnel were requested to discontinue their monitoring of the Fall Line stations through the VTMP program. Listed below are the procedures VADEQ personnel utilized to sample the Fall Line stations from 1988 - 2003.

1. Obtain dissolved oxygen, water temperature and conductivity measurements.
   These measurements are made in-situ with a Hydrolab at mid depth for each composite sample location. These values are averaged and the average is recorded.
2. Take a mid-depth sample from each horizontal composite site utilizing an alpha bottle (or some other suitable sampling device). Acid wash bucket churn splitter and bucket and cover. Rinse bucket and churn splitter one time prior to collecting samples.

   a. Determining Pamunkey River composite sites:
   1. The bridge is marked off on down streamside from left to right. The Left mark is at 0' and the right is between 290 to 300'. Single stripe marks represent 10' increments, double stripes 50' increments and triple stripes 100'.
   2. Locate extent of water on left and right banks under bridge. Get width of river by subtracting the left bank from the right bank.
   3. Divide the width of the river by 5. This will be the distance between sample stations.
   4. Take half of the distance between sample stations and place first station this distance from the left bank.
   5. The next station is located by adding the distance between stations determined in step 3.
   6. Repeat step 5 to locate next 3 sample stations.
   7. Ambient pH should be recorded from the site most representative of the River.

   b. Mattaponi River composite sites:
   1. Bridge is marked off on downstream side from left to right in 5' increments; each single stripe = 5', a double stripe =50' and each triple strip = 100'.
   2. The four sites are sampled at 53', 65', 73' and 85'.

3. Place an equal amount of water (1 Liter) from each location in a churn splitter and mix well.
4. Place one liter composite water in cube container for nutrient analysis and 1 liter in a cube container for solids analysis.
5. Obtain chlorophyll sample.

If no mid depth sample was deeper than 1 meter, use churn splitter water chlorophyll analysis sample. If any composite was deeper than 1 meter, a new composite of 1meter samples is taken and used for chlorophyll sample analysis.

Sample Preservation

Immediately after collection, samples shall be filtered and/or covered in ice.

- Samples will be cooled to 4 degrees Celsius in order to minimize biological activity.
- Make sure that the appropriate sample tags are secured to the container.
- Make sure sample caps are tight to prevent contamination or leakage.
- Place sample containers upright in cooler and surround with ice.
- If bagged ice is utilized, the ice must be removed from the plastic bags and poured around the sample containers.

APPENDIX J

Virginia's Shallow Water Monitoring Program Scope of Work

(Updated ~~7/1/2016~~ May 2017)

Proposal Submission to

Virginia DEQ

By

THE VIRGINIA INSTITUTE OF MARINE SCIENCE
COLLEGE OF WILLIAM AND MARY

2017-2018 Water Quality Monitoring For Bay Water Quality Standards Assessment

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Dr. Kenneth A. Moore
Principal Investigator

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Dr. William Reay
Co-Principal Investigator

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Katherine Davis, Assistant Director of Sponsored Programs

____
Dr. Mark Luckenbach
Associate Dean for Research and Advisory Services

May 2017

Scope of Work

2017-2018 Water Quality Monitoring For Bay Water Quality Standards Assessment

I. Introduction and Management Objectives:

This project collects valuable data to perform water quality assessments for preparation of the biennial 305b/303d Integrated Report as well as the 2006 General Assembly House Bill 1150 (Chesapeake Bay and Virginia Waters Clean-up and Oversight Act). Virginia's regulatory definition of a "clean" Bay is attainment of water quality standards. Emphasis is on a newly developed sub-categories of aquatic life designated uses (i.e. Shallow Water, Open Water, Deep Water, Deep Channel, Migratory and Spawning) and associated numeric and narrative water quality criteria for dissolved oxygen, submerged aquatic vegetation (i.e. seagrass presence or water clarity, and phytoplankton (i.e. chlorophyll). The need to obtain water quality data of a three year consecutive assessment period is to: 1) evaluate the effectiveness of public fund expenditures to restore water quality in Virginia's Chesapeake Bay and 2) to assess attainment of the numeric water quality criteria, is critical elements of the restoration and evaluation process.

VIMS is the Commonwealth's scientific advisor on this and other natural resource issues as defined in 25 separate sections of the Virginia Code, and the institute has ongoing water quality monitoring programs, and is in a unique position to fulfill the needs of the Commonwealth. As an important part of our advisory mandate, VIMS faculty and staff have actively and broadly participated in the Chesapeake Bay Program (CBP) since the beginning and are therefore greatly aware of the expectations, successes, and inherent limitations of the CBP through time. These experiences coupled with development and applied assessment of new technologies and ongoing monitoring efforts with VADEQ and CBP put VIMS in a unique position to conduct a broad-scale enhanced water quality assessment program in support of the Commonwealth's intensified restoration effort.

The information delivered in this project provides a comprehensive, high-resolution view of the quality of the aquatic environment that far exceeds the information in spatial extent, temporal coverage, and precision produced in the long term Chesapeake Bay monitoring program. The work proposed here covers the period of July 1, 2017 through June 30, 2018 as we work toward the goal of initially assessing all Bay segments. This project is the second calendar year of the three year assessment period. The goal is to meet the Commonwealth's objective of assessing the status of water quality conditions relative to existing standards and criteria in all of the tidal waters of Virginia's Chesapeake Bay shallow water regions, tributaries and embayments. It remains consistent with and provides further information using monitoring protocols already in place in Virginia and Maryland. In addition, it provides an in depth, long term understanding diagnostic, and cause and effect information for water quality conditions in the Commonwealth's Chesapeake Bay tributaries and embayments that affect important living resources and strong economic benefits of those systems.

III. Segments:

During the period of July 2017 through June 2018 (FY2018) the entire Virginia Chesapeake Bay Program (CBP) Eastern Lower Chesapeake Bay Segment (CB7PH) including its numerous tidal tributary creeks extending along Virginia's Chesapeake Bay Eastern Shore from Virginia segments Pocomoke Mesohaline (POCMH) and Tangier Mesohaline (TANMH1) in the north to CB8PH in the south at Fisherman's Island will be sampled for standards attainment. This will be accomplished using continuous monitoring (CMON) stations, monthly underway (DATAFLOW) cruise sampling as well as discrete water quality sampling at 25 fixed locations throughout the study area. All data will be reviewed and subject to quality assurance protocols and submitted to the Chesapeake Bay database (CIMS) or provided to users via the Virginia Estuarine and Coastal Observing System (VECOS) database and web site. Also, VIMS will support web and data service for the Hampton Roads Sanitation District (HRSD) partner for DATAFLOW sampling in the James, Lafayette and Elizabeth Rivers, as well as the Chesapeake Bay National Estuarine Research Reserve in Virginia (CBNERRVA) and other VIMS CMON stations in the York for the 2017-18 grant period.

IV. Sampling Frequency:

The overall field sampling period will be July – November 2017 and March-June 2018. Sampling frequency will be monthly for the DATAFLOW mapping cruises. Sampling frequency for the CMON will be at 15-minute intervals for the entire sampling period.

V. Field Sampling:

DATAFLOW Mapping System

DATAFLOW is a compact, self-contained surface water quality mapping system, suitable for use in a small boat operating at speeds of about 25 KT. The system collects water through a pipe ("ram") deployed on the transom of the vessel, pumps it through an array of water quality sensors, and then discharges the water overboard. The entire system from intake ram tube to the return hose are shielded from light to negate any effect high intensity surface light might have on phytoplankton in the flow-through water that is being sampled. A blackened sample chamber is also used to minimize any effect of light on measurements by the fluorescence probe.

Field sampling procedures for FY2017 will follow those described in "Quality Assurance Project Plan for the Water Quality Monitoring For Bay Water Quality Standards Assessment (Effective: January 1, 2016)". A revised and updated Quality Assurance Plan which was developed and submitted by VIMS for the three-year segment assessment period from CY 2016 through CY 2018.

Fixed Station and Continuous Monitoring Systems

The specific goal of the fixed station continuous monitoring system is to assess water quality standards as well as quantify short-term variability and long-term changes in water quality constituents in specific shallow water areas. Twenty five verification stations will be sampled throughout CB7PH (4-5 verification stations per cruise day plus analytical duplicates of samples) during monthly DATAFLOW cruises during the 2017-18 assessment period. Five fixed continuous monitoring (CMON) stations first installed in March 2016 will be sampled from July 1, 2017 through November 30, 2017 and again from March 1, 2018- June 30, 2018. Each fixed CMON station will be monitored at 15-minute intervals for: water temperature, conductivity, salinity, percent saturation, dissolved oxygen concentration, water depth, pH, chlorophyll and turbidity. All water quality data loggers (YSI 6600 V2 EDS or YSI EXO Datasondes) will be deployed at known depths above the bottom at each site.

Specific fixed station locations and continuous underway monitoring cruise tracks including the location of 25 verification stations within CB7PH were determined prior to initial CY2016 sampling in March 2016 after consultation and approval by Virginia DEQ Chesapeake Bay Monitoring Coordinator (Ms. Cindy Johnson). The review included many considerations such as assurance of comprehensive and representative coverage of the entire study area including the large tidal tributary creeks within this segment, locations as close as possible to long-term water quality trend stations established by Virginia DEQ, and locations within current or historical areas of submerged aquatic vegetation growth.

VI. Laboratory Analysis:

Approximately four to five discreet, subsurface water samples will be taken during each DATAFLOW daily cruise, as well as one duplicate and one DI water field blank. Upon return to the VIMS laboratory the water samples will be processed by the Analytical Services Center for chlorophyll and suspended sediments using EPA approved procedures. Additionally, at each verification station light attenuation will be measured from in situ light profiles using EPA approved Li-Cor, Inc. underwater quantum sensors. Samples will be taken at the fixed stations at each YSI switch out and will include chlorophyll and suspended sediments as well as a light attenuation profile. A vertical profile of temp, salinity and dissolved oxygen measurements will also be taken at each verification station and fixed station visit.

VII. Quality Assurance:

The quality assurance procedures will follow those documented in: Quality Assurance Project Plan for the Water Quality Monitoring For Bay Water Quality Standards Assessment (Effective: July 1, 2016). A new quality assurance document which was developed and submitted by VIMS covering the three-year CB7PH March-November assessment period of 2016 through 2018.

VIII. Special Conditions:

- All data collection, data analysis, and data management will be performed according to methods and protocols discussed, developed and approved through the appropriate workgroup of the Federal-Interstate Chesapeake Bay Program and Va. DEQ. These protocols and methods need to be compatible and consistent with those used in other Bay tidal waters to ensure Bay-wide comparability of monitoring information.
- Data will be used to generate CFD curves to determine attainment/non-attainment of numerical standards for water clarity, dissolved oxygen and chlorophyll in CBP segments that are being monitored as required.
- The principal investigator(s) or appropriate designee will participate in all meetings, conference calls and discussions of the Data Integrity Workgroup.
- VIMS will assist DEQ in the assessment of these data for purposes of Clean Water Act 305b/303d analysis of impaired waters.

- VIMS ASC will participate in the Chesapeake Bay Coordinated Split Sample Program. The procedures followed will be those given in the CBP CSSP guidelines.
- Data will be used to determine attainment/non-attainment of numerical standards for water clarity and dissolved oxygen as well as other regulatory and management uses in CB7PH.
- Data collection activities and budget may be modified if necessary due to changes in either monitoring priorities or funding availability. Changes in data collection activities due to monitoring priorities and not effecting total contract costs (e.g. changing data collection activities from one segment to another) may be modified by written agreement between VIMS principal investigator Dr. Kenneth Moore or Dr. William Reay and the DEQ Chesapeake Bay Monitoring Coordinator (Ms. Cindy Johnson).

IX. Deliverables and Invoice Schedule;

- This assessment program will provide water quality monitoring coverage for near shore shallow and surface water areas within the Virginia Eastern Lower Chesapeake Bay segment (CB7PH) including its numerous tributary creeks.
- Data from this study will be served to DEQ, EPA and the general public through the www.vecos.org website/web service and analyses and summarization will be provided to DEQ to assist in Clean Water Act 305b/303d attainment evaluations and other purposes.
- Quality assured data for CY2017 will be submitted to the EPA CBPO for incorporation into the CIMS database by March 15, 2018 or provided to users via the VECOS database.
- Interim and annual final status and progress reports summarizing data collection, analysis, and management activities will be submitted to DEQ per the following schedule.

Proposal Submission to

Virginia DEQ

By

THE VIRGINIA INSTITUTE OF MARINE SCIENCE
COLLEGE OF WILLIAM AND MARY

2016-2017 Water Quality Monitoring For Bay Water Quality Standards Assessment

<u>Principal Investigator</u>:

Dr. Kenneth A. Moore, Professor,
Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, VA

April 2016

APPENDIX K

Eastern Shore and Nontidal Stations Important to the Virginia portion of the Chesapeake Bay

Revised 07/23/2016

Office	USGS STAID	DEQSTAID	DEQ Description	Lat (NAD83)	Long (NAD83)	River	Network Station Type
USGS	01654000	1AACO014.57	Rt. 620 Br.	38.81133333	-77.23022222	Accotink Cr.	Primary[4]
NRO	01638480	1ACAX004.57	Rt. 663	39.255	-77.5766667	Catoctin Creek	Secondary[5]
USGS	01646000	1ADIF000.86	Rt. 193	38.97583333	-77.2461111	Difficult Run	Primary[3]
USGS	01658500	1ASOQ006.73	Rt. 619	38.58722222	-77.42888888	Quantico Creek	Primary[3]
USGS	01621050	1BMDD005.81	Rt. 726 Bridge	38.4866666	-78.96055555	Muddy Creek	Primary[3]
USGS	01634000	1BNFS010.34	Rt. 55 Br. Warren/ Shenandoah County	38.97644444	-78.33633333	Shenandoah River	Primary[3]
USGS	01631000	1BSSF003.56	Luray Ave. at water intake at G.S.	38.91372282	-78.20977222	Shenandoah River	Primary [3]
VRO	01628500	1BSSF100.10	Rt. 708 Br.	38.3130556	-78.77102778	Shenandoah River	Primary[1]
VRO	01626000	1BSTH027.85	137 ft downstream of Rt 664 Br. City of Waynesboro	38.05735845	-78.90780171	South River	Secondary
SCRO	02039500	2-APP110.93	Rt.45 Br. at Farmville (Co. of Prince Edward)	37.30740205	-78.38896810	Appomattox River	Primary[1]
VRO	02011500	2-BCC004.71	Rt. 39 at Gaging Station	38.06986111	-79.89763889	Back Creek	Secondary
VRO	02015700	2-BLP000.79	Rt. 614 Br. at gaging station	38.19527778	-79.57072222	Bullpasture River	Secondary
USGS	02042500	2-CHK035.26	Rt. 618 at gaging station	37.43611111	-77.06111111	Chickahominy River	Primary[3]
VRO	02020500	2-CFP004.67	Downstream of Rt. 42 Br.	37.98716666	-79.49408333	Calfpasture River	Secondary
PRO	02041000	2-DPC005.20	Rt. 153 Br.	37.28403928	-77.86861092	Deep Cr.	Secondary
USGS	02037500	2-JMS113.20	Rt. 161 Br.	37.53141666	-77.48369444	James River	Primary[3]
SCRO	02024752	2-JMS279.41	Blue Ridge Pkwy Br. above Big Island	37.55546246	-79.36701020	James River	Primary [1]
VRO	02031000	2-MCM005.12	Rt. 614 Bridge at gaging station	38.10269164	-78.59293242	Mechums River	Secondary
VRO	02024000	2-MRY014.78	Rt. 60 at Ben Salem	37.75222222	-79.39194444	Maury River	Secondary

Office	USGS STAID	DEQSTAID	DEQ Description	Lat (NAD83)	Long (NAD83)	River	Network Station Type
			Wayside				
VRO	02034000	2-RVN015.97	Rt 15 Br.	37.85805556	-78.26694444	Rivannah River	Primary[1]
USGS	01667500	3-RAP030.21	Rt. 522 Br.	38.35901857	-77.97333049	Rapidan River	Primary [3]
NRO	01665500	3-RAP066.54	Rt. 29	38.27985275	-78.34084042	Rapidan River	Secondary
NRO	01666500	3-ROB001.90	Rt. 614 Br.	38.32533333	-78.09458333	Robinson River	Secondary
NRO	01664000	3-RPP147.49	Rt. 15/29 Br.	38.53012442	-77.81360454	Rappahannock River	Primary[1]
USGS	01669520	7-DRN010.48	Rt. 603 Br.	37.63361111	-76.69583333	Dragon Swamp	Primary[3]
PRO	01671100	8-LTL009.54	Rt. 685 Br.	37.87291790	-77.51331695	Little River	Secondary
NRO	01674000	8-MPN094.94	Rt. 605 Br.	38.06183333	-77.386	Mattaponi River	Primary[1]
USGS	01671020	8-NAR005.42	Rt. 30 Br. (Morris Br.)	37.85	-77.42805556	North Anna River	Primary[3]
NRO	01673800	8-POR008.97	Rt. 208 Br.	38.17130556	-77.59455556	Po River	Secondary
USGS	01674182	8-PCT000.76	Rt. 301 Br.	37.96025	-77.343556	Polecat Creek	Primary[1]
USGS	01632900	1BSMT004.60	Rt. 620 Br.	38.69345016	-78.64279350	Smith Creek	Primary[1]
USGS	02041650	2-APP016.38	Rt. 600 Br (Chesterfield County)	37.22543	-77.6428	Appomattox River	Primary [2]
USGS	02035000	2-JMS157.28	Rt. 45 Bridge at Cartersville	37.67111	-78.0858	James River	Primary [2]
USGS	01668000	3-RPP113.37	USGS cableway	38.32235	-77.5178	Rappahannock River	Primary [2]
USGS	01674500	8-MPN054.17	Rt. 628 Br.	37.88403	-77.163	Mattaponi River	Primary [2]
USGS	01673000	8-PMK082.34	Rt. 614 Bridge	37.76792	-77.3319	Pamunkey River	Primary [2]

[1] These sites will be sampled jointly by VADEQ and USGS. These sites have been added to the USGS River Input Monitoring Program and may be referred to as “RIM ADD ON” sites.
[2] These Fall line sites have been sampled since 1984 by USGS in cooperation with the VA DEQ Chesapeake Bay Office as Virginia River Input Monitoring Program sites.
[3] These Fall line sites will be sampled for both base flow (monthly routine sampling) and targeted storm events by USGS in cooperation with the VA DEQ Chesapeake Bay Office as Virginia River Input Monitoring Program sites.
[4] Routine monitoring of Accotink Creek was dropped by DEQ in October 2012. USGS-MD conducted ambient monthly monitoring (CBP parameters) at the site using CBP protocols until January 2015, when USGS-VA began the routine monitoring of Accotink Creek. USGS-VA continues to conduct storm sampling.
[5] Routine monitoring of Catoctin Creek was dropped by DEQ in October 2012. Maryland DNR conducted ambient monthly monitoring (CBP parameters) at the site using CBP protocols until June 2015. DEQ-NRO resumed monthly sampling at this site as a secondary station in July 2015.