VIRGINIA CBP NON-TIDAL NETWORK MONITORING PROGRAM

QUALITY ASSURANCE/QUALITY CONTROL PROJECT PLAN

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

Revised June 6 2018

Concurrence:

Signature: _____ Date: _____
Cindy Johnson, Chesapeake Bay Program Coordinator, VADEQ

Signature: _____ Date: _____
Chesapeake Bay Program Project Officer, EPA

Signature: _____ Date: _____
Chesapeake Bay Program Quality Assurance Officer, EPA

Signature: _____ Date: _____
Andrew Garey, Chesapeake Bay Program QA Officer, VADEQ

Laboratory Review:

Signature:_____Date:_____
Quality Assurance Manager, DCLS

A2 TABLE OF CONTENTS

APPENDICES

A3 Distribution List

P.Tango, EPA
R. Batiuk, EPA
D. Ghosh, USGS
C. Johnson, VADEQ/CBP
A. Garey, VADEQ/CBP
J. Beckley, VADEQ/CBP
B. Thomas, VADEQ/NRO
J. Talbott, VADEQ/NRO
H.Deihls, VADEQ/PRO
G. Anderson, VADEQ/BRRO
T Sieber, VADEQ/ VRO
E. Basinger,VADCLS
J. Armstrong, VADCLS

List of Acronyms

BMP	Best Management Practices
BRRO	VA Department of Environmental Quality Blue Ridge Office
CAR	Corrective Action Request
CBM	Chesapeake Bay Monitoring
CBMP	Federal-Interstate Chesapeake Bay Monitoring Program
CBLO	Chesapeake Bay Office of Virginia Dept. of Env. Quality
CBP	Chesapeake Bay Program
CBPWQ	**C**hesapeake Bay 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
DUET	Data Upload and Evaluation Tool
EDT	Electronic Data Transfer
EPA-CBLO	Chesapeake Bay Office in Annapolis Maryland
IMNW	Integrated Monitoring Networks Workgroup; formerly the Non-tidal Water Quality Workgroup (NTWG)
MDL	Method Detection Limit
NRO	Northern Regional Office
NTWG	Non-Tidal Water Quality Workgroup of the Chesapeake Bay Monitoring and Assessment Subcommittee
OIS	Office of Information Systems
PMTF	Procedure Modification Tracking Form
PQL	Parameter Quantification Limit
PRO	VA Department of Environmental Quality Piedmont Regional Office
QA	Quality Assurance
QAT	Quality Assurance Tool - Software used to perform QC checks
QC	Quality Control
RIM	USGS River Input Monitoring Program
SOP	Standard Operating Procedure
SSS	Sample Support Services (the sample receiving section of DCLS)
STAC	Scientific and Technical Advisory Committee
TKNW	Total Kjeldahl Nitrogen (whole water)
TN	Total Nitrogen
TP	Total Phosphorus
VADEQ	Virginia Department of Environmental Quality
VNTMP	Virginia Non-tidal Network Tributary Monitoring Program
VTMP	Virginia Tributary Monitoring Program
VRO	Valley Regional Office
WQAP	Water Quality Assessments & Planning
USGS	U.S. Geological Survey
WQM	Water Quality Monitoring portion of the CEDS database program

PROJECT MANAGEMENT

A4 Project/Task Organization

Four regional Department of Environmental Quality (VADEQ) offices supply the field personnel and equipment necessary to sample all of the stations for the Virginia Chesapeake Bay Non-tidal Network (VNTMP); the Northern Regional Office (NRO) in Woodbridge, Piedmont Regional Office (PRO) in Glen Allen, Blue Ridge Regional Office (BRRO) in Roanoke and the Valley Regional Office (VRO) in Harrisonburg. Additional sampling is provided during storm events through a cooperative agreement with the United States Geological Survey (USGS). The project is coordinated through the Central Office of the VADEQ in Richmond.

A4.1 Roles and Responsibilities

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

Principle Investigator: Responsible for the development and implementation of the program.

Program Coordinator: Responsible for the overall management of the program.

Regional Office Water Quality Monitoring and Compliance Managers: Manage day to day operation of the Water Quality Monitoring Programs at the regional office. Supervise regional conductance of the programs in accordance with the Quality Assurance Project Plans.

Senior Environmental Field Personnel and associated staff: Conduct office and field-related duties directly affecting sample collection and handling. Enter raw field data into the water quality module (WQM) of VADEQ's Oracle database after sample collection is completed such that the information may be electronically transmitted to the lab.

Chesapeake Bay Quality Assurance Officer/Database manager: 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). Ensures proper formatting of VADEQ data to meet CIMS database requirements. Reviews and updates (if needed) project plans (QAPjP) and Standard operating procedure manual (SOP) annually. Conducts annual field audits of regional field personnel. Reports QAQC findings to Program Coordinator and, where appropriate, makes a recommendation for corrective action. Primary contact for laboratory in the event of sample related issues.

VADEQ Quality Assurance Coordinator: Conducts/coordinates laboratory portion of the program. Coordinates agencies objectives with DCLS and provides feedback to the various labs regarding QAQC performance.

Office of Information Services Data Manager: Maintains VADEQ's Water Quality Monitoring (WQM) module of the Oracle Database.

Figure 1. Project Organization and Responsibility for VADEQ

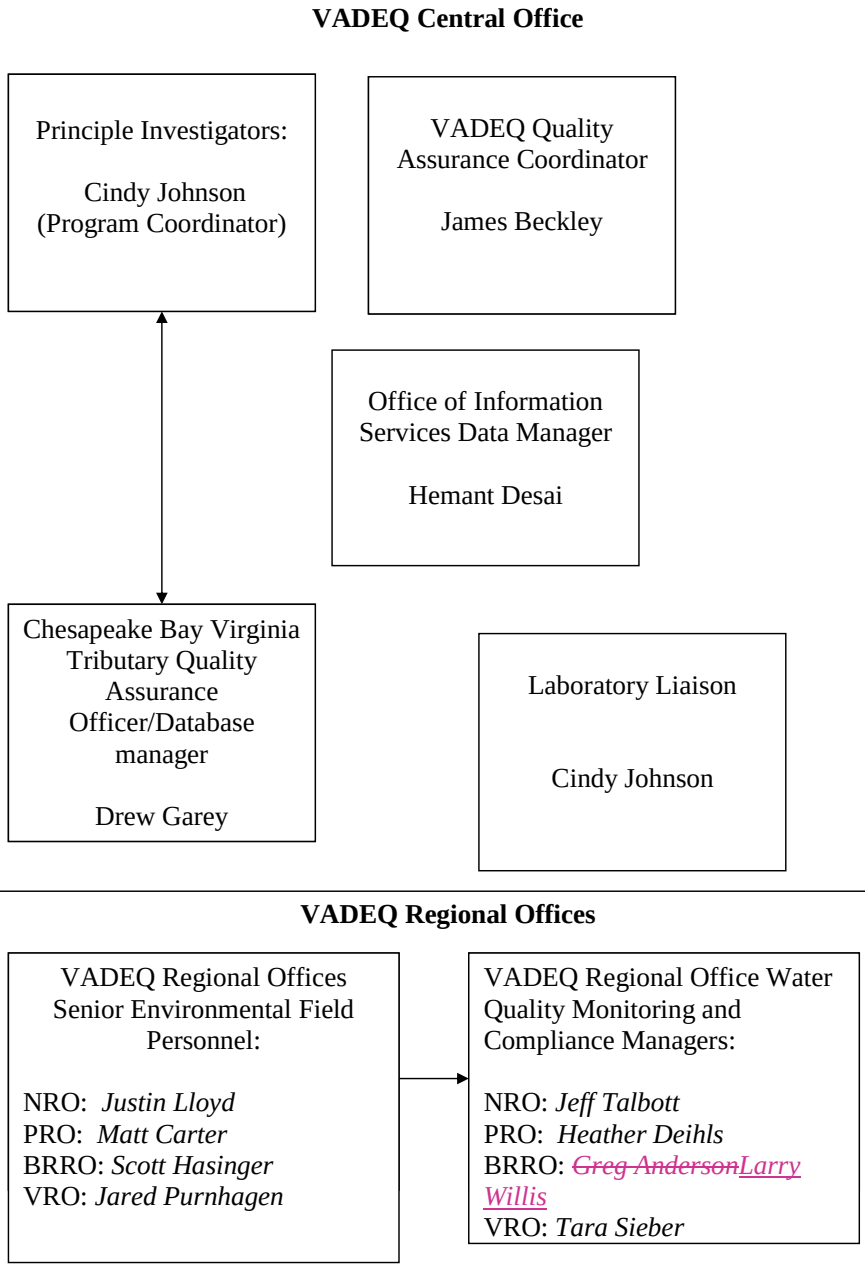
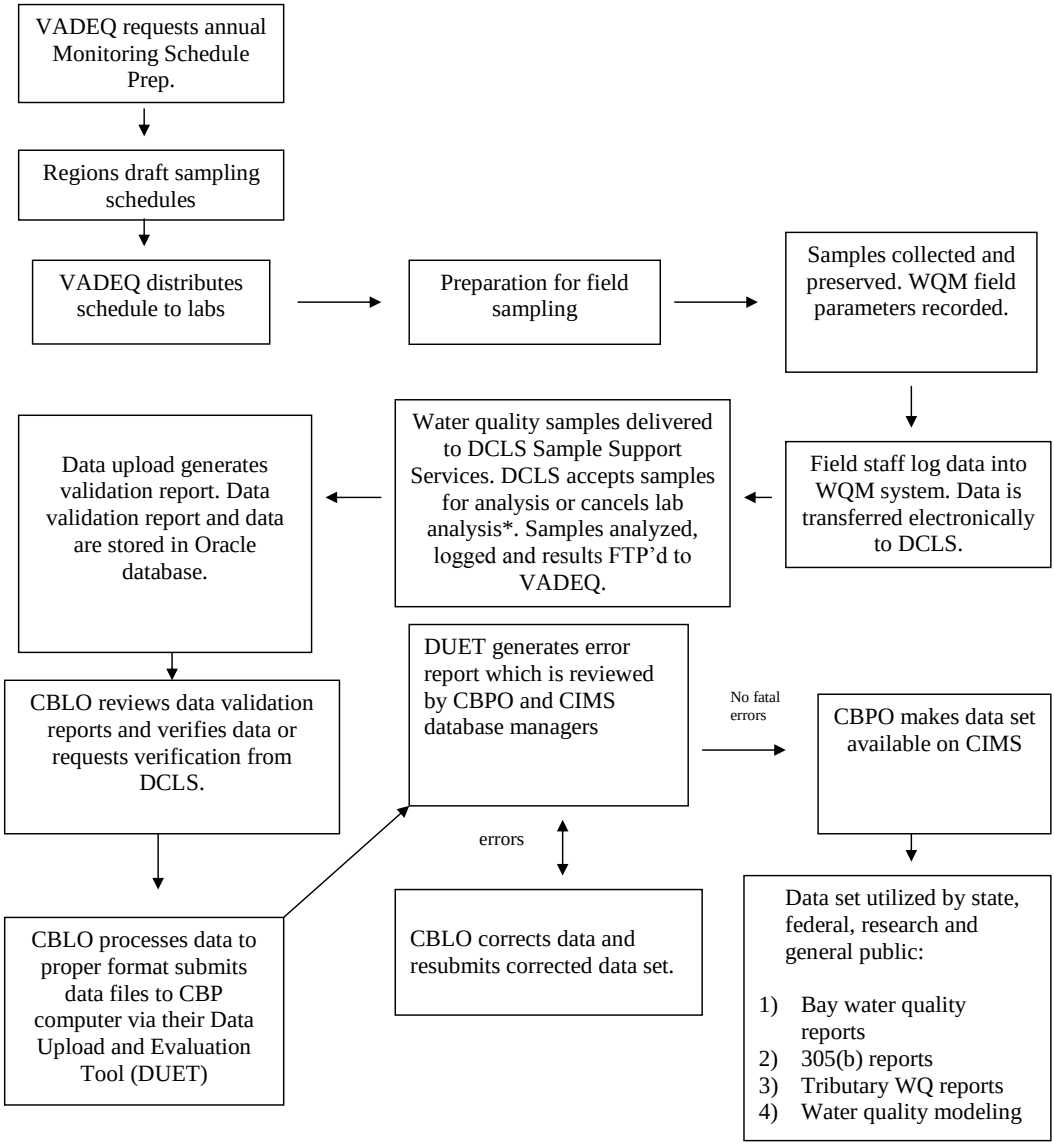


Figure 2. Program Operating Procedures



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

Formatted: Indent: First line: 0"

It will be the shared responsibility of the Region's Environmental Managers and the VADEQ CBP Quality Assurance Officer (or a designated representative) to conduct Regional Field evaluations of the Chesapeake Bay Non-tidal Network Program and, if necessary, make recommendations for corrective action requested by Regional or Program personnel.

A5 Problem Definition/Background

In the Chesapeake 2000 Agreement, the Chesapeake Bay Program (CBP) committed to correct the 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, prior to 2004, monitoring efforts within the tributary basins were primarily focused on the tidal portions of the tributaries. The non-tidal network was established to provide additional information, including both modeling predictions and monitoring assessments, needed by the jurisdictions in the non-tidal areas such that State and local government could adequately assess progress in meeting nutrient and sediment allocations for water-quality criteria in the Bay watershed.

The main objectives of this monitoring program are 1) to measure and assess the actual nutrient and sediment concentration and load reductions in the tributary strategy basins, 2) to improve watershed models and 3) to help assess the factors affecting nutrient and sediment distributions and trends across the Bay watershed.

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 and progress toward two-year milestones required by the Chesapeake Bay TMDL. The objective will be met through a network that provides data for: (a) estimating nutrient and sediment loads, (b) computing trends in the loads, concentrations and stream flow**,** (c) providing information to improve calibration and verification of the watershed model, and (d) providing information that will be integrated with other data (such as changes in nutrient sources) to determine the factors affecting the concentrations, loads, and trends.

A list of the VNTMP sites is given in Table 1. Sites have been classified as primary or secondary based on their role in the VNTMP. Both the primary and secondary sites meet the criteria to compute trends in concentration and flow. However, at a subset of these sites ("primary sites"), additional data will be collected to meet the criteria for load computation. Site selections were influenced by (a) the presence of an operating stream gage to measure flow, (b) some existing sample collection (quarterly or monthly), and (c) the completeness of parameters currently being collected at each site. All sites used for load estimates for the network have stream gages co-located with the site. Stations were prioritized according to the following factors: 1) Sites located at the outlets of rivers draining the Tributary Strategy Basins, 2) Sites at the outlet of basins that deliver the largest amounts of nutrients and sediment to the Bay and 3) Sites of importance to watershed modeling efforts especially in regards to areas of large data gaps such as sites in the Coastal Plain.

A6 Project/Task Description

Sample collection and analysis for the VNTMP began in July 2004 and is expected to continue indefinitely assuming continued availability of federal and state resources. Sample

Formatted: Indent: First line: 0"

collection for both the primary and secondary sites will occur monthly and will include samples collected over a range of flow conditions. In Virginia there are 23 primary sites and 11 secondary sites. At the primary sites USGS will collect targeted storm event samples (ideally one-two storms per season) as a component of their River Input Monitoring (RIM) program. A complete list of the non-tidal network stations is given in Table 1.

Table 1. Station Locations

STAID/ Gage Operator	USGS NAME	DEQSTAID/CBP STA ID	DEQ Description	Lat (NAD83)	Long (NAD83)	River	Network Station Type
01654000 / DEQ	Accotink Cr. near Annandale	1AACO014.57	Rt. 620 Br.	38.81133333	-77.23022222	Accotink Cr.	Primary[6] (dropped by DEQ in 2012)
01638480 / DEQ	Catoctin Creek at Taylorstown	1ACAX004.57	Rt. 663	39.254583	-77.5766667	Catoctin Creek	Secondary[7]
01646000 / DEQ	Difficult Run near Great Falls, VA	1ADIF000.86	Rt. 193	38.975833	-77.246111	Difficult Run	Primary[3]
01658500 / USGS	South Fork Quantico Cr. near Independent Hill, VA	1ASOQ006.73	Rt. 619	38.58722222	-77.42888888	Quantico Creek	Primary[3]
01621050 / USGS	Muddy Creek at Mount Clinton, VA	1BMDD005.81	Rt. 726 Bridge	38.486666 6	-78.960555 55	Muddy Creek	Primary[3]
01634000 / USGS	North Fork Shenandoah River near Strasburg	1BNFS010.34	Rt. 55 Br. Warren/ Shenandoah County	38.976444 44	-78.336333 33	Shenandoah River	Primary [3]
01632900 / USGS	Smith Creek near New Market	1BSMT004.60	Rt. 620 Bridge	38.693333 33	-78.643055 55	Smith Creek	Primary[3]
01631000 / USGS	South Fork Shenandoah River at Front Royal	1BSSF003.56	Luray Ave. at water intake at G.S.	38.913722 82	-78.209772 22	Shenandoah River	Primary [3]
01628500 / DEQ	South Fork Shenandoah River	1BSSF100.10	Rt. 708 Br.	38.313055 6	-78.771027 78	Shenandoah River	Primary[1]
01626000 / DEQ	South River near Waynesboro	1BSTH027.85	137 ft downstream of Rt. 664 Br. City of Waynesboro	38.057358 45	-78.907801 71	South River	Secondary
02039500 / DEQ	Appomattox River at Farmville	2-APP110.93	Rt.45 Br. at Farmville (Co. of Prince	37.307402 05	-78.388968 10	Appomattox River	Primary[1]
02011500 / Army Corps of Engineers	Back Cr. near Mountain Grove	2-BCC004.71	Rt. 39 at Gaging Station	38.069861 11	-79.897638 89	Back Creek	Secondary

Formatted: Indent: First line: 0"

STAID/ Gage Operator	USGS NAME	DEQSTAID/CBP STA ID	DEQ Description	Lat (NAD83)	Long (NAD83)	River	Network Station Type
02015700 / DEQ	Bullpasture River at Williamsville	2-BLP000.79	Rt. 614 Br. at gaging station	38.19527778	-79.57072222	Bullpasture River	Secondary
02042500 / USGS	Chicahominy River near Providence Forge	2-CHK035.26	Rt. 618 at gaging station	37.43611111	-77.06111111	Chickahominy River	Primary[3]
02020500 / DEQ	Calfpasture River above Mill Cr. at Goshen	2-CFP004.67	Downstream of Rt. 42 Br.	37.98716666	-79.49408333	Calfpasture River	Secondary
02041000 / DEQ	Deep Cr. near Mannboro	2-DPC005.20	Rt. 153 Br.	37.28403928	-77.86861092	Deep Cr.	Secondary
02037618 / DEQ [4]	James River at Boulevard Bridge (Nickel Bridge)	2-JMS113.20	Rt. 161 Br.	37.53141666	-77.48369444	James River	Primary [3]
02024752 / DEQ[5]	James R. at Blue Ridge Pkwy	2-JMS279.41	Blue Ridge Pkwy Br. above Big Isl.	37.55546246	-79.36701020	James River	Primary [1]
02031000 / DEQ	Mechums River near White Hall	2-MCM005.12	Rt. 614 Bridge at gaging station	38.10269164	-78.59293242	Mechums River	Secondary
02024000/ USGS	Maury River Near Buena Vista	2-MRY014.78	Rt. 60 at Ben Salem Wayside	37.75222222	-79.39194444	Maury River	Secondary
02034000 / DEQ	Rivannah River at Palmyra	2-RVN015.97	Rt. 15 Bridge	37.85777777	-78.26611111	Rivannah River	Primary[1]
01667500 / DEQ	Rapidan River near Culpeper	3-RAP030.21	Rt. 522 Br.	38.35901857	-77.97333049	Rapidan River	Primary [3]
01665500 / DEQ	Rapidan R. Rt. 29	3-RAP066.54	Rt. 29	38.27985275	-78.34084042	Rapidan River	Secondary
01666500 / DEQ	Robinson River near Locust Dale	3-ROB001.90	Rt. 614 Br.	38. 32533333	-78. 09458333	Robinson River	Secondary
01664000 / USGS	Rappahannock River at Remington	3-RPP147.49	Rt. 15/29 Br.	38.53012442	-77.81360454	Rappahannock River	Primary[1]
01669520 / USGS	Dragon Swamp at Mascot, VA	7-DRN010.48	Rt. 603 Br.	37.63361111	-76.69583333	Dragon Swamp	Primary[3]
01671100 / DEQ	Little River near Doswell	8-LTL009.54	Rt. 685 Br.	37.87291790	-77.51331695	Little River	Secondary

Formatted: Indent: First line: 0"

STAID/ Gage Operator	USGS NAME	DEQSTAID/CBP STA ID	DEQ Description	Lat (NAD83)	Long (NAD83)	River	Network Station Type
01674000 / USGS	Mattaponi River near Bowling Green	8-MPN094.94	Rt. 605 Br.	38.06183333	-77.38600000	Mattaponi River	Primary[1]
01671020 / DEQ	North Anna River at Hart Corner near Doswell	8-NAR005.42	Rt. 30 Br. (Morris Br.)	37.85	-77.42805556	North Anna River	Primary[3]
01673800 / DEQ	Po River near Spotsylvania	8-POR008.97	Rt. 208 Br.	38.17130556	-77.59455556	Po River	Secondary
02041650/ DEQ	Appomattox River at Matoaca	2-APP016.38/ TF5.0A	Rt. 600 Br (Chesterfield County)	37.22543	-77.6428	Appomattox River	Primary [2]
01673000/ USGS	Pamunkey River near Hanover	8-PMK082.34/ TF4.0P	Rt. 614 Bridge	37.76792	-77.3319	Pamunkey River	Primary [2]
02035000/ USGS	James River at Cartersville	2-JMS157.28/ TF5.0J	Rt. 45 Bridge at Cartersville	37.67111	-78.0858	James River	Primary [2]
01668000/ USGS	Rappahannock River near Fredericksburg	3-RPP113.37/ TF3.0	USGS cableway	38.32235	-77.5178	Rappahannock River	Primary [2]
01674500/ USGS	Mattaponi River near Beulahville	8-MPN054.17/ TF4.0M	Rt. 628 Br.	37.88403	-77.163	Mattaponi River	Primary [2]
01674182 /USGS	Polecat Creek	8-PCT000.76	Rt. 301 Br.	37.96025	-77.343556	Polecat Creek	Primary[3]

[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 VADEQ Chesapeake Bay Office as Virginia River Input Monitoring Program sites.
[3] These Fall line sites will be sampled for base flow (monthly routine sampling) and targeted storm events by USGS in cooperation with the VADEQ Chesapeake Bay Office as Virginia River Input Monitoring Program sites.
[4] The site number is 02037618 however the gage number for this site is 02037500 former site location of 2-JMS117.35 at Richmond.
[5] Gauge 02024752 (Blue Ridge) was installed in 2006. Data from gauge 0205500 (Holcomb Rock) is used for status and trends until a period of 5 years of data are available for the Blue Ridge site.
[6] Routine monitoring of Accotink Creek was dropped by VADEQ 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.
[7] Routine monitoring of Catoctin Creek was dropped by VADEQ in October 2012. USGS-MD conducted ambient monthly monitoring (CBP parameters) at the site using CBP protocols until July 2015, when DEQ-NRO resumed sampling this station as a secondary station.

Parameters: The analyses that will be performed for the VNTMP sites are listed in Table 2.

Compiling, managing, and submitting the data: Quality-control procedures currently in place for the Chesapeake Bay water quality monitoring program will be used to evaluate the completeness and quality of the data (see program operating procedures, Figure 2). The data will be stored in the VADEQ CEDS database as well as submitted to the CBP for inclusion in the Non-tidal Water-quality

Formatted: Indent: First line: 0"

database of the Chesapeake Information Management System (CIMS). The data will increase the number of sites in the watershed for load and trend computations conducted by the USGS and other investigators (CBP project: Long-term Analysis of Water Quality, Habitat, and Living Resource Data). The data will also be used to improve the CBP environmental indicators for loads and trends to help inform the jurisdictions and public about progress in reducing nutrients and sediment in the Bay watershed.

Table 2. Parameters, detection limits and preservation requirements for the VNTMP.

PARAMETER	STORET PARAMETER /CIMS PARAMETER	STATION TYPE	COLLECTION PROCEDURE	PRESER-VATION	METHOD REPORTING LIMITS	CBP (CIMS) METHOD (unless noted otherwise)
Temperature	00010/WTEMP	All	Multiprobe			F01
pH	00400/PH	All	Multiprobe			F01
Dissolved Oxygen	00299/DO	All	Multiprobe			F01/F04
Specific Conductance	00094/SPCOND	All	Multiprobe			F01
Total Nitrogen	00600/TN	All [1]	Whole Water	ICE	0.1 mg/L	L01
Total Nitrate + Nitrite	00630/NO23W	All [1]	Whole water	ICE	.04 mg/L	L01
Whole water Ammonium	00610/NH4W	All [1]	Whole Water	ICE	.04 mg/L	L01
Total Phosphorus	00665/TP	All [1]	Whole Water	ICE	.01 mg/L	L01
Orthophosphate (low level, dissolved)	OPWLF/PO4F	All	Whole water	ICE	.002 mg/L[3]	L01
Fixed Suspended Solids	00540/FSS	All	Whole water	ICE	3 mg/L	L01
Total Suspended Solids	00530/TSS	All	Whole water	ICE	3 mg/L	L01
Total Suspended Sediment[2]	SSC-TOTAL/ SSC_TOTAL	Primary Sites	Whole water	ICE	.0001 mg/L	L01
Suspended Sediment >0.62 um[2]	SSC-COURSE/ SSC_COURSE	Primary Sites	Whole water	ICE	.0001 mg/L	L01
Suspended Sediment <0.62 um[2]	SSC-FINE/ SSC_FINE	Primary Sites	Whole water	ICE	.0001 mg/L	L01
Fecal Coliform (colonies)	31616/ FCOLI_C	All	Whole water	ICE		L01

[1] Different components of these constituents (i.e. the dissolved and particulate components of nitrogen and phosphorus and dissolved ammonia) and lower detection limits are reported for River Input Monitoring sites sampled since 1984 (refer to Table 3; in Moyer, D. L., 2016. *Quality Assurance Project Plan for the Virginia River Input Monitoring Program*.). The River Input Monitoring Program also collects some additional parameters such as Chlorophyll a and Silica at those sites.

[2] These parameters are collected by USGS monthly from sites where both routine sampling and targeted storm events are conducted. Suspended sediment samples are only collected during selected high flow events (i.e. not during routine scheduled sampling) for sites where USGS only monitors targeted storm events.

[3] Method Detection Limit

A7 Quality Objectives and Criteria

The non-tidal monitoring network is conducted in cooperation with the Integrated Monitoring Networks workgroup (IMNW). The IMNW is comprised of representatives from all the States in the Chesapeake Bay watershed, River Basin Commissions, and the Federal Government. The workgroup developed an initial list of candidate sites for the tributary strategy basins in consultation with State Tributary Strategy Coordinators and watershed modeling staff. The approach for the objectives and design of the non-tidal network was also presented to the Scientific and Technical Advisory Committee (STAC), which provided a positive endorsement. The initial design will be assessed for how well the sites represent conditions in the watershed and provide data for the watershed model.

Formatted: Indent: First line: 0"

Modifications to the candidate sites will be made based on this assessment and any modifications to the sampling design will be reviewed and approved by the IMNW prior to implementation.

The objectives of the network are 1) to measure and assess the actual nutrient and sediment concentration and load reductions in the tributary strategy basins across the watershed, 2) to improve watershed models, and 3) to help assess the factors affecting nutrient and sediment distributions and trends.

The objectives will be met by having a network producing data for:

a. Computing trends in concentrations and stream flows.
b. Estimating nutrient and sediment loads and computing trends in loads.
c. Providing information to improve calibration and verification of watershed models.
d. Providing information that can be used with other data to determine the factors affecting trends in concentrations and loads.
e. Developing indicators that can be used to communicate progress for obtaining load reductions for tributary strategies and other appropriate Chesapeake 2000 commitments of the CBP.

The network is designed for all sites to meet the criteria to compute trends in concentrations and flows with additional data collected at a subset of sitesfor load computations. Data from both site types (particularly the primary sites) will be used to improve watershed models. The trend data, along with data sets on nutrient sources, best management practices (BMP's), land-use change, and watershed characteristics will be used to help assess the factors affecting nutrient concentrations and loads in the watershed. This information will be used to develop indicators to help assess progress of the tributary strategies in the watershed for attaining water-quality criteria in the Bay. Other indicators to help assess watershed conditions will be developed to meet the needs of the appropriate Chesapeake 2000 commitments.

Specific data quality goals for the VNTMP have been developed to best support the overall objective of the program: to characterize the water quality of the major Virginia tributaries to Chesapeake Bay. Measurement of the quality for the various measurements obtained for the VNTMP in both the field and in the laboratory 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 the VA Division of Consolidated Laboratory Services (DCLS) for the VNTMP, can be found in the listed SOPs and in the DCLS Quality Manual 2016 (available from DCLS upon request):

Primary and secondary sites:

Technical Procedure 11808 Determination of Ammonia Nitrogen by Automated Colorimetry
Technical Procedure 11810 Determination of Nitrate-Nitrite Nitrogen by Automated Colorimetry
Technical Procedure 11846 Phosphorus – Orthophosphate, Low level, Automated
Technical Procedure 11820Low Level Total Phosphorous By Semi-Automated Colorimetry
Technical Procedure 11824 Total Suspended Solids.
Technical Procedure 11841 Total Nitrogen, Automated Colorimetric

Formatted: Indent: First line: 0"

Primary sites only:

Technical Procedure 11835 Determining Sediment Concentration in Water Samples

Commented [GA1]: DCLS- Please verify that this information is correct

A 7.1 Representativeness

Representativeness is the degree to which sample data represent the actual conditions or concentrations present in the sampled population or area. Study design, sample collection, and preservation and handling are interactive factors that directly affect sample representativeness. The study design is described in detail in the Project Description. Due to funding constraints relatively small sample sizes will be collected each season (1 collection per month for secondary sites and 1 collection per month plus 8 storm events for primary sites). Therefore sites were chosen with as much background data available as possible. Alden et. al found that in a long-term program, 12 collections per year was statistically less powerful than 20 collections per year but was 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).*

The Virginia CBP Non-tidal monitoring coordination effort involves joint data collection by both VADEQ and USGS with both agencies using historically different field collection methodologies. Prior to implementing the sampling design agreed upon by the IMNW (refer to *Sampling Procedures and Protocols for the Chesapeake Bay Nontidal Water Quality Network. June 1, 2007* in Appendix E), the sampling design for VADEQ personnel consisted of obtaining a grab sample from the stream surface at single site considered to be most representative of in-stream conditions at the time of sample collection (usually mid-stream). This protocol changed in 2007 to include multiple sampling points and isokinetic sampling (wherein sampled volume is proportional to discharge) when site conditions warrant. This change is expected to produce analytical results that more accurately represent environmental conditions at the time of sampling. Data collections by the Department of Natural Resources (MDDNR) in Maryland have undergone similar changes and are expected to demonstrate a similar pattern. Virginia expects that observed differences in data due to method changes will probably be site and flow specific however the effects of the method changes on trend analyses may be unavoidable at some sites.

The sampling protocol at the primary sites is based on USGS River Input Monitoring (RIM) field collection methods (Moyer, D. L, 2016. *Quality Assurance Project Plan for the Virginia River Input Monitoring Program*. U.S. Geological Survey) and consists of using an isokinetic sampler (USGS sampler DH- 95 or DH-81) or a weighted bottle sampler (USGS weighted bottle sampler WBH-96) to collect a depth-integrated sample from up to 9 sampling points across the river channel. The type of sampler used is dependent upon stream flow and the number of sampling points is determined from the stream width at the time of sampling. The samples from each section are composited using a sample churn splitter. Laboratory sample bottles are then filled using the churn splitter. Initially VADEQ's sample collection methods differed for primary sites and secondary sites with collections at secondary sites consisting of a single vertically integrated sample from center of flow in the absence of storm flow conditions. However, in 2010 VADEQ phased in equal width and depth integrated sampling at most of its secondary sites. Primary sites are sampled monthly, on a regular basis as well as during targeted storm events. Secondary sites are sampled monthly, but not during targeted storm events.

In the sampling phase, the staff uses reliable Quality Assurance (QA) procedures (field blanks, field duplicates, and standard operating procedures) to ensure representative data. These techniques combined with sample container requirements, sample preservation, and sample holding times will assure required data confidence level achievement (see *Virginia Chesapeake Bay Non-tidal*

Formatted: Indent: First line: 0"

Network Water Quality Monitoring Program Standard Operating Procedures,2017, hereafter referred to as the SOP and included in Appendix A). The SOP defines sample collection, preservation and handling and statistical sampling techniques and stipulates the minimum standards of field representativeness. Although the SOP details specific field sampling operations and handling, it also provides a mechanism for including the judgment of field personnel. If abnormal circumstances do occur relative to the sampling and/or site selection, a Corrective Action Form is available to field personnel to document the circumstances and take appropriate action.

A7.2 Comparability

Comparability expresses the confidence with which one data set can be compared with another. There are several components to data comparability for the VNTMP. Data collected must be comparable within and between VADEQ regions and between VADEQ and other agencies, states, and laboratories participating in the program.

Data generated within VADEQ are ensured to be comparable via a system of written documentation, field audits and the collection of quality assurance and quality control samples. The program-specific SOP provided in Appendix A, as well as an agency-standard SOP (*Standard Operating Procedures Manual for the Department of Environmental Quality Office of Water Quality Monitoring and Assessment* (VADEQ 2017)) are provided to all field personnel. Personnel are observed in the field by the agency QA officer to ensure the collection techniques detailed in the SOP are followed, including the collection of field replicates and equipment blanks such that the data generated are repeatable, comparable and, where applicable, defensible.

The Integrated Monitoring Networks Workgroup (IMNW) has developed a set of protocols to be used by all the states currently monitoring water quality for the non-tidal network (see Appendix E). The protocols outlined in the IMNW document are based upon the protocols specified in the USGS National Field Manual and were developed to ensure comparable methods for all participating agencies. Additionally, training of VADEQ field personnel was provided by USGS and USGS continues to provide support to field personnel as needed.

The Division of Consolidated Laboratory Services (DCLS) is accredited by the National Environmental Accreditation Program (NELAP) and has clear and precise SOPs for their analyses. A high confidence level of data is maintained by the consistent integrity of VADEQ sampling procedures and lab analysis. This allows comparisons of data within this program and similar water quality data sets.

The VNTMP is being conducted as a component of the Federal-Interstate Chesapeake Bay Program (CBP) and as such will adhere to the CBP data reporting requirements and practices. Representatives of the VNTMP participate in quarterly Data Integrity Workgroup (DIW) meetings ensuring the comparability of laboratories analyzing data for the Chesapeake Bay Program with the use of field splits and blind audit samples (refer to section B4 or *Chesapeake Bay Coordinated Split Sample Program Implementation Guidelines, Revision 4* (CBP, 1989) for further details). Additionally data submitted to the Chesapeake Bay Information System (CIMS) are required to be formatted according to the database design developed by the database manager.

Comparability of monitoring data is achieved as a result of quality products at each phase of the data gathering process. It includes representative sampling and sample handling procedures, uniform laboratory methods and validation of laboratory data, and procedures for reduction, validation, and reporting of environmental data.

Formatted: Indent: First line: 0"

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 is a condition to be achieved in order to meet the data requirements of the program. Estimates of completeness for the monitoring parameters of the VNTMP should exceed 95% for all its monitoring parameters (i.e. at least 95% of data points intended to be collected over a given time period are actually collected) . Because the data quality objectives of the VNTMP are based on long-term monitoring results, occasional failure to achieve this goal does not preclude the use of the dataset for model calibrations nor does it result in an inability to determine long-term status and trends in the tributaries being monitored. In general, any variation from this goal is due to unavoidable circumstances such as prolonged adverse weather conditions or equipment failure. Other factors that occasionally invalidate samples include ineffective sample preservation or storage, exceeded sample holding times, sample misidentification, inadequate sample volumes, loss and breakage. In addition, sample characteristics (e.g. extreme high or low analyte concentrations) can compromise the accuracy of the method and thus limit the completeness of the data.

To minimize sample losses due to adverse weather conditions or equipment failure, field personnel are requested to reschedule as often as necessary to minimize loss of data (refer to Section 1.3 Scheduling and Rescheduling of Runs in the SOP; Appendix A).

A7.4 Accuracy and Precision

Accuracy refers to the degree to which measurements approach the true or accepted value while precision measures the proximity or closeness of 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.

Analytical accuracy and precision are the responsibility of the laboratories conducting the analyses. Quality control 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 the combined factors of the instrument used, sample size and the sample processing steps. Therefore Method Detection Limits (MDLs) are established by the laboratory for each parameter and reported to VADEQ with their analytical results. MDLs represent the minimum concentration of an analyte that the lab can see and qualitatively state that the analyte is present with 95% confidence the signal is caused by the analyte. Current MDLs for parameters analyzed for the VNTMP by DCLS are given in Table 2.

To assure the multi-parameter field 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 manuals. Prior to sampling at each station, field personnel visually inspect the instrument for indications of drift greater than ±5% percent saturation for dissolved oxygen and upon returning to the regional office conduct a calibration check for drift against known standards. In addition, annual checks are conducted for temperature calibration at 0-4° C and 25-30° C during site visits. Field parameters will be rejected for Quality Assurance reasons if the following criteria are exceeded:

Formatted: Indent: First line: 0"

Table 3. Quality Control Rejection Criteria for Field Parameters

FIELD PARAMETER		CRITERIA
[1] Dissolved Oxygen	Clark Cell	±0.49 mg/L
	Optical Probe	±0.3 mg/L
[1] Specific Conductance	0.147	±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] Calibration check conducted after each sampling run.
[2] Accuracy check conducted once per year via a comparison of two multi-parameter instruments. Also annual check conducted against an NIST certified thermistor during site visits (refer Temperature Calibration Check sections for the individual multiparameter water quality instruments in *Standard Operating Procedures Manual for the Department of Environmental Quality Office of Water Quality Monitoring and Assessment* (VADEQ 2017) for further details).
[3] Accuracy checked monthly against a known depth (refer to *Standard Operating Procedures Manual for the Department of Environmental Quality Office of Water Quality Monitoring and Assessment.* Department of Environmental Quality. 2014. for further details).

A8. Special Training Requirements/Certification

Regional field personnel at VADEQ are required to demonstrate proficiency in all sampling methods used for sample collection of samples to the VADEQ Quality Assurance Coordinator. Both the QA coordinator and experienced regional field personnel provide training to new personnel. Additional training was provided to field personnel by the Richmond USGS office for sampling protocols that are used exclusively for the non-tidal water quality monitoring network. Training takes place both in the regional offices and in the field. Annual site visits are conducted by the VADEQ CBP QA Officer to assure the continued proficiency of field personal and adherence to the procedures specified in the agency's SOP. Additionally, USGS has agreed to conduct site visits of the regional personnel every 1-2 years to ensure reasonable consistency with the RIM program protocols.

Formatted: Indent: First line: 0"

A9. Documentation and Records

Complete documentation of the sampling runs is an important part of the monitoring program. Field crews document all data obtained in the field on field sheets and key the water quality data into Water Quality Monitoring (WQM) component of VADEQ's Comprehensive Environmental Data System (CEDS) by 9:00 am of the morning following the run. Since the data generated by this program are not used for legal purposes, a formal chain of custody sheet is not required. Field sheets and any information concerned with specific problems and/or events during a sampling run, as well as comments on general trends and modifications to the sampling program will be maintained and kept at VADEQ's central office. The following forms will be used to document this type of information:

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

2) 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 relocation, or a change in sample collection methodology. In cases such as this, the PMTF would be sent to CBO at the end of each sampling period. The originals of each report will be kept on file with each regional office, and the originals should be scanned and emailed to CBO within two working days of completion of the fieldwork for that period (i.e. each region does one report per month).

3) 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, repair, etc. Equipment inventories and field checklists can also be kept in this notebook, as well as miscellaneous data not originally recorded on the WQM data sheets (Winkler DO, etc).

4) 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.

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

While these resources are primarily for documentation and review purposes, they 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. Field personnel that encounter conditions that require cancellation or modification of planned sampling events, or those that may in any way compromise data integrity should contact Central Office as soon as possible (contact Cindy Johnson at: 804-698-4385 or Drew Garey at 804-698-4253). Generally, phone conversations to immediately address the issue should be followed up with e-mail correspondence in order to document the issue for future reference (Cindy Johnson: Cindy.Johnson@deq.virginia.gov ; Drew Garey:

Formatted: Indent: First line: 0"

andrew.garey@deq.virginia.gov). Central office will retain hard copies of documentation received from the regional offices for a minimum of 5 years and electronic formats for 20 years.

Every spring this Project Plan and the SOP for the VNTMP (Appendix A) will be reviewed and updated on an as needed basis. 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 VADEQ's Quality Assurance Coordinator. Once approved, final versions will be made available to all interested parties by placing downloadable copies in the CIMS and VADEQ websites.

Analytical results are reported to VADEQ in electronic format by data upload into the analytical table of the CEDS database. The laboratory must retain all bench sheets and QAQC information for at least 3 years. The analytical data are submitted to CIMS through the Data Upload and Evaluation Tool (DUET) where they are made available to researchers and the general public. Also a metadata record is available on the CIMS website completely documenting the procedures that are used by the VNTMP.

MEASUREMENT/DATA ACQUISITION

B1 Program Design

B1.1 Stations

The sampling location descriptions for the Virginia Non-tidal Tributary Monitoring Program (VNTMP) stations are listed in Table 1. Water quality data are collected over select sites in tributaries of the Potomac, James, York, and Rappahannock Rivers. Initial site selection was based on 1) the presence of an operating stream gage to measure flow 2) some existing sample collection (quarterly or monthly) and 3) the completeness of parameters being collected at each site. The final site selection was based on 1) proximity to the outlet of rivers draining the Tributary Strategy Basin 2) nutrient and sediment loads delivered 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.

B1.2 Sampling Frequency

VADEQ sampling schedules are the responsibility of each region conducting water quality monitoring. Schedules are entered into the Monthly Field Monitoring Screen of the WQM module of the CEDS database by the 25th day of the month proceeding sample collections. Scheduling of routine sampling events should occur as closely as possible to the beginning of each month to allow for rescheduling due to inclement weather or other factors that may disrupt the initial sampling schedule.

B.1.2.1 Primary Sites

There are three types of primary sites for the VNTMP: 1) those sampled monthly for base flow by VADEQ personnel and by USGS during storm events, 2) 6 RIM sites sampled exclusively

Formatted: Indent: First line: 0"

by USGS for base flow and storm events since 1988 and 3) 11 RIM add-on sites that are sampled exclusively by USGS for base flow and storm events but with a reduced set of parameters. In all cases sites are sampled monthly for base flow. USGS targets 8 storm events per year at add-on and cooperatively sampled sites and 8-15 total storm events at the traditional RIM sites (refer to Table1).

B.1.2.2 Secondary Sites

Samples are collected monthly from secondary sites, exclusively by VADEQ. These sites are not sampled during targeted storm events.

B2 Sampling Methods

Sampling protocols used by the VNTMP can be found in the SOP (Appendix A) and in the USGS *Quality Assurance Project Plan for the Virginia River Input Monitoring Program* (Appendix B). VADEQ will obtain field data and water quality samples from an odd number of equal width increments (up to 9) across the bridge. The number of increments will be determined by the total width of the stream at the time of sampling. Field parameters collected with the multiparameter meter (dissolved oxygen, pH, temperature and conductivity) will be obtained from the surface water at approximately 0.3 meters depth and from the center of each increment. The median value for each parameter will be entered into the database. Water quality samples at all sites will consist of a composite of integrated samples from each of the equal width increments. Field data for USGS will consist of the median of the data collected from each of 10 evenly spaced sites across the span of the tributary and water quality samples will consist of a composite of integrated samples from each of the 10 sites. If the total stream width is less than 100 feet, then USGS will employ 5 sites as sampling points. When stream velocity is greater than 1.5 ft/s and does not exceed the constraints of sampling with the isokinetic nozzles samples will be collected using DH-95 or DH-81 isokenteic sampling gear.

B2.1 Field Measurements

Both VADEQ and USGS will obtain field data from bridges using multi-parameter water quality monitoring instruments (e.g. Hydrolab, YSI or InSitu multimeter or other industry accepted instrument). Operation and calibration protocols for the multi-parameter instruments used by VADEQ personnel can be found in the *Standard Operating Procedures Manual for the Department of Environmental Quality Office of Water Quality Monitoring and Assessment* (VADEQ 2014) and those of USGS in *Quality Assurance Project Plan for the Virginia River Input Monitoring Program* (see Appendix B). Maintenance of the multi-parameter instruments is performed as recommended in the Operating Manuals for the individual instruments. Field measurements recorded will include pH, specific conductance, water temperature and dissolved oxygen.

B2.2 Water Quality Samples

Water quality samples collected by USGS and VADEQ are obtained via methods that are dependent upon the gage height of the tributary at the time of sampling (for USGS methods refer to Appendix B; for VADEQ's methods refer to Appendix A). A complete list of the physical and analytical parameters to be obtained by both agencies is provided in Table 2 and a list of the

Formatted: Indent: First line: 0"

Laboratory analytical methods and procedures is given in Section A.7. Sample preservations and holding times may be found in Appendix D.

B3 Analytical Methods

A list of analytical methods to be used for Virginia's non-tidal network is provided in Section A.7 and the corresponding CIMS parameter names and method codes are provided in Table 2. All analyses will be conducted by DCLS except for the suspended sediment analysis collected at the USGS RIM sites (see primary[2] sites in Table 1). Those analyses are conducted by the USGS Kentucky sediment lab. Analytical methods used for the VNTMP will be Standard Methods or approved EPA methods. Analytical practices are documented in the Virginia Division of Consolidated Laboratory Services Quality Manual, 1-500, and individual SOPs (available from DCLS upon request).

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 QAQC 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 the result 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 through explicit, written standard operating procedures, thorough and frequent field training and follow-up site visits to observe sampling events and correct any inconsistencies that occur.

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 Limit - The lowest concentration or amount of the target analyte that can be determined to be different from zero by a single measurement at a stated degree of confidence.

Equipment Blank - Measures the contamination occurring during the field sampling phase of the measurement process. At random sampling sites the blank sample (deionized water) is poured

Formatted: Indent: First line: 0"

into containers and preserved in a similar manner to the field samples being collected. Referred to as "Field Blank" by the CBP.

Field Duplicate - Refers to duplicate samples taken in the field and analyzed as discrete samples.

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 - Extreme low or high data values that lie outside of the range between the 1st and 99th percentile of all previous data (exclusive). Apparent outliers may be invalid, qualified, or accepted based on quality assurance data for blanks and duplicates.

Performance Audit - Uses 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 values for a parameter within a data set. Precision may be expressed in a number of ways, including standard deviations from the mean value, the percent difference between two values, or in absolute differences, expressed in the measurement units for a given parameter (i.e. difference, in mg/l dissolved oxygen between two replicate measurements) .

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 QAQC Sampling Methods

B4.2.1 Field QA Procedures

Formatted: Indent: First line: 0"

The primary QAQC mechanism that will be used in the VNTMP 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 VNTMP collects one equipment blank per station per year. Determining the level of equipment blank contamination provides indication of the possible level of sample contamination. The equipment blank contamination that is detected should not exceed 20 percent of the expected concentration range for each sample parameter. Higher levels of contamination may render the data unreliable. Note, equipment blanks are commonly referred to as "field blanks" by the CBP.

Duplicate samples are submitted to DCLS for field quality control samples. Two duplicate samples are collected per year for every primary station. One duplicate per year is collected at every secondary station. The quality control samples are prepared and analyzed for all parameters of interest and in some instances for a sample matrix. The field duplicate data are used to determine the overall precision of the field and laboratory procedures.

A quarterly 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 used for equipment blanks. A DI water source blank will also be obtained in cases where the equipment blanks indicate a possible source of contamination and a reagent blank will be collected whenever a new bottle of acid preservative is used.

Standard operating procedures for preparation and handling of equipment blanks and field duplicate samples are contained the *Virginia Chesapeake Bay Non-tidal Water Quality Monitoring Program Standard Operating Procedures Manual* (Appendix A). The equipment blanks and duplicate results will be entered into a database and will be used to empirically establish an expected range for each parameter. Once these expected ranges have been established they will be used to identify possible problems with field operations and as a basis for accepting, qualifying or rejecting data obtained from field samples.

All quality control samples will be collected, preserved, and handled using the same protocols for routine samples described herein. The SOP identifies the specific procedures to be followed for the collection and identification of duplicate and blank samples.

Internal QAQC assurance also includes protocols for ensuring proper field instrument and equipment performance. These QAQC procedures are accomplished by use of recommended calibration, operational checks and maintenance procedures to field instruments at period-specific intervals.

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

Formatted: Indent: First line: 0"

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.

Using accuracy and precision data, standard deviations are calculated and used to prepare control charts. Control charts are drawn with "warning" and "out of control" limits which the laboratory uses to plot and visually assess accuracy and precision data in each sample run. Warning limits (corresponding to 95% confidence levels) are two standard deviations from the mean. Out of control limits (corresponding to 99% confidence levels) are three standard deviations from the mean. In the event of an "out of control" situation, the laboratory initiates appropriate corrective action. Detailed information about the corrective action procedures used by DCLS can be found in the VA *DCLS Quality Manual, 1820*, available from DCLS upon request).

Table 2 contains reporting limits for the laboratory-analyzed parameters. These values are an indication of the lowest level of reliable analytical accuracy that may be expected for the method identified in the table for each parameter. VADEQ staff uses these values on a routine basis to interpret water quality condition data. In instances where actual information about accuracy, precision, and detection limits is needed for a particular data set, the VADEQ Laboratory Liaison Officer obtains this information from the laboratory.

In addition to obtaining internal QA samples, laboratories participating in Chesapeake Bay Monitoring programs 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: a mainstem component and a tributary component. Samples from the mainstem component are obtained from a Chesapeake Bay mainstem station (MCB4.4) following CSSP Procedural Guidelines (CBP 1991) 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 action 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.

DCLS and USGS laboratories also participate in a nation-wide Standard-Reference Sample (SRS) quality-assurance program conducted through the USGS Branch of Quality Assurance of the National Water Quality Laboratory. The SRS is designed to evaluate both laboratory performance and to monitor results for long-term trends in bias and accuracy of the analytical methodologies. In addition, statute 2.2-1105 of the *Code of Virginia* requires that all data submitted to VADEQ come from an accredited environmental laboratory through the Virginia Environmental Laboratory Accreditation Program (VELAP).

B4.3 Preventive Maintenance

Formatted: Indent: First line: 0"

To ensure 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 will be included in the individual Laboratory Project Plans.

For the VNTMP, preventive maintenance schedules are established for all equipment used in the field. 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 will not be used until repaired and satisfactory performance results are achieved.

Each Regional Office is responsible for ensuring that the preventive maintenance schedule is followed. Maintenance performed for each instrument is documented in a logbook maintained by the regions. The logbook is reviewed by the Environmental Specialist Senior 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 the manufacturer's instruction manuals and in the *Standard Operating Procedures Manual for the Department of Environmental Quality Office of Water Quality Monitoring and Assessment*. (VADEQ 2017). Instruction manuals for all instruments used must be kept on file at each regional office.

B6 Sample Custody and Handling

Sample custody procedures are an integral part of 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 ensure 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. Water quality samples are delivered to DCLS by 7:00 am by DCLS selected courier. Once samples have been received in Sample Support Services (SSS), DCLS will have sample custody responsibility. Every cooler used by VADEQ will contain a colored water sample to be used by DCLS to confirm the temperature of water samples at the time of their arrival. The solution color is usually red and the samples must be at the appropriate temperature

Formatted: Indent: First line: 0"

when DCLS receives the samples. These procedures are described in detail in the individual laboratory accessioning SOP.

B6.1 Requirements for Analyzing Samples:

Sample tags must be attached to every water sample collected and sent to DCLS for analysis. Refer to *Standard Operating Procedures Manual for the Department of Environmental Quality Office of Water Quality Monitoring and Assessment* (VADEQ 2017) for the correct procedures for filling out sample tags.

DIS/CBM EDT sheets are used for water samples collected by the Non-tidal network Water Quality Monitoring Program to DCLS for analysis in the event scheduling is not possible through WQM. Procedures for filling out EDT sheets are described in Section 3.1.2 of the *Standard Operating Procedures Manual for the Department of Environmental Quality Office of Water Quality Monitoring and Assessment* (VADEQ 2014).

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

- No sample tag attached.
- No WQM information accompanying the samples.
- Sample tag and WQM information do not match exactly.
- Temperature of samples exceeds 4 º +/-2 º Celsius.
- Holding time requirements for water samples have been exceeded (>48 hrs. for nutrients, >7 days for solids), unless otherwise noted on the lab sheets (USGS daily solids only).

Coolers and reusable sample bottles are returned to the regions by the courier on a regular basis.

B7 Data Management

B7.1 Data Recording

The operating procedures for sample collection and data management for Virginia's non-tidal network program are depicted in Figure 2. Samples are collected, preserved and transported according to accepted SOP methods to sample support services (SSS) by a DCLS selected courier. SSS 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 the LIMS system (the DCLS database system; 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 CEDS database. In the event 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) Data Bases for access to users. The data flow path for the reporting scheme is illustrated below.

Formatted: Indent: First line: 0"

Data Collection and Reporting Pathway

A) Sample Collection
(Regional Office Sampling Crew)
B) DCLS/Sample Support Services
(Sample log in and distribution)
C) Laboratory analysis
D) DCLS/Sample Support Services
Sample records and log out
E) VADEQ Validation
(CBO 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, monthly field duplicate or split samples are collected and processed as described in the previous section. With the VNTMP program, quality control samples submitted to the labs will consist of equipment 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 used 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-CBLO 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 QAQC problems, apparent outliers will be entered into the databases and eventually

Formatted: Indent: First line: 0"

become part of the historical database. Figure 2 illustrates the flow diagram for data validation prior to data entry into the EPA-CBLO and VADEQ databases.

Rejected data will be retained but not entered into the EPA-CBLO and VADEQ databases. 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 use 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, equipment 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 and requires participation.

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 *Standard Operating Procedures Manual for the Department of Environmental Quality Office of Water Quality Monitoring and Assessment* (VADEQ 2014).

The corrective action request procedure is primarily used 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.

Formatted: Indent: First line: 0"

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 VADEQ QA officer for review and recommendations. The VADEQ QA officer reviews and recommends an appropriate corrective action. The recommended corrective action will be discussed with the program manager, the regional office monitoring and compliance manager and the field specialists involved in sample collection. After resolution of the problem, the VADEQ QA officer provides copies of the completed form to appropriate regional personnel. The regional office monitoring and compliance manager has the responsibility for implementation of the corrective action at the regional level. Whenever possible, modifications to the VNTMP will be documented in the project plan in a Log of Significant Changes. A copy of the Corrective Action Request Form can be found in *Standard Operating Procedures Manual for the Department of Environmental Quality Office of Water Quality Monitoring and Assessment* (VADEQ 2014).

CAR forms that originate in DCLS or VADEQ headquarters are forwarded to the QAQC officer for review, recommendations, or concurrence. Then, if appropriate, these forms are forwarded to the 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 QAQC 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 the VADEQ QA 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 the VADEQ QAQC 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

Scheduling of all sample runs and cancellations will be reported via WQM. Each Regional Office will also record samples collected and field data in WQM for each sampling run. Following is a brief outline of the procedure. For the complete method see the WQM Manual written by OIS.

- Collect samples and profile at a station, record on WQM field sheet

Formatted: Indent: First line: 0"

- Process samples
- Deliver all samples to regional offices for courier delivery to lab or, in cases when a courier is unavailable, deliver the samples to the lab.
- Return to office enter all data into WQM (this must be done prior to 9:00 am the following morning)
- In WQM, record each sample sent to DCLS at each station and field data profile
- Check data
- Ship data to OIS (occurs automatically)
- Scan the WQM field sheets and email them to CBLO (CBLO will be doing QC on the data entry).

Data are automatically shipped to the DCLS FTP site at 10:00 pm and 9:00 am. If technical problems arise during insertion of data into WQM and the 9:00 am deadline will not be met; the regions have a call list of DCLS personnel to contact based on specific problems that may be encountered. 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) or Drew Garey (804-698-4253) at CBLO 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 into the agency's CEDSdatabase. 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 electronically downloaded by the VNTMP Database manager who performs additional QA analyses on the data through a series of Microsoft ACCESS queries that verify the data integrity and mimic the checks that are performed by the DUET tool. The raw data are then processed with SAS programs 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-CBLO via DUET. DUET produces an error report that is reviewed by the VNTMP Database Manager or a suitable representative and the CIMS database manager (Mike Mallonee) prior to electronic import into the CIMS database.

Once the data has undergone the QA process, the data is imported via the FTP process to the CIMS database in Annapolis, MD. Whenever possible, data shipments to CIMS will occur quarterly. However, in the absence of quarterly submittal, data will be submitted in accordance with the deliverable deadlines laid out in the active VNTMP grant.

B7.5 Data Transformation

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

Formatted: Indent: First line: 0"

ASSESSMENT PROCEDURES

Program and Performance Audits verify that procedures specified in this Project Plan are being used. 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 blanks
- 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 VADEQ and may include laboratory systems and performance audits.

C2 Program Audits

Program audits evaluate the VNTMP to determine whether the overall network has a sound technical basis and that data produced meet program objectives. The 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, 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 VNTMP are (see site visit summary form in Appendix A of *Virginia Chesapeake Bay Non-tidal Water Quality Monitoring Program Standard Operating Procedures Manual* for further details):

- 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 and are conducted annually. Central Office staff prepares the final audit report consisting of the site visit summary and recommendations for corrective action when problems are identified. The report will be forwarded to the field personnel, the regional office monitoring and compliance manager, and the VNTMP program coordinator.

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 CBP data validation system. Such procedures that are developed will undergo periodic review and update by VADEQ and CBP staff.

Appendix A

Virginia Chesapeake Bay Non-tidal Network Monitoring Program Standard Operating Procedures Manual

Appendix B

Quality Assurance Project Plan
For the
Virginia River Input Monitoring Program

Effective August 2016

Field Code Changed

QUALITY ASSURANCE PROJECT PLAN

for the

Virginia River Input Monitoring Program

Prepared by

Douglas L. Moyer
U.S. Geological Survey
1730 E. Parham Road
Richmond, VA 23228

for
Virginia Department of Environmental Quality
Chesapeake Bay Office
PO Box 1105
Richmond, VA 23218

Effective August 2016

Approvals:

Douglas Moyer, Project Manager, USGS	Date
Douglas Chambers, Acting Water-Quality Specialist, USGS	Date
Cindy Johnson, Project Officer, VDEQ	Date
Cindy Johnson, Quality Assurance Officer, VDEQ	Date
Peter Tango, Project Officer, US EPA	Date
Rich Batiuk, Quality Assurance Officer, US EPA	Date

Appendix C

Sample Container Information and Holding Times for DCLS Analyses

Collecting Agency	ID	Description	Container size	Sample size	Preservation	Analytes	Holding Time
DEQ & USGS at RIM II [1]	BAYT3-2	Dissolved Nutrients and suspended solids	Half gallon Cubitainer	2 liters	On ice to 4°C	Total Suspended Solids	7 days
						Fixed Suspended Solids	7 days
						Total Nitrate + Nitrite as N	48 hr.
						Total Ammonia as N	48 hr.
						Total Nitrogen	28 days Frozen
						Ortho phosphate as P	28 days frozen
USGS	DOCFF	Dissolved Organic Carbon, Field filtered	2-40 ml clear vials with Teflon faced silicone septa	80 ml	Sulfuric acid to pH <2; On ice to 4°C	Dissolved Organic Carbon	28 days
USGS	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	
DEQ	FCMFECQENT	Fecal Coliform, MPN and E. coli	Sterile plastic bottle with 125 ml	125 ml	On ice to 4°C	Fecal Coliform, MPN	24 hr.

Collecting Agency	ID	Description	Container size	Sample size	Preservation	Analytes	Holding Time
			line, containing Sodium Thiosulfate			E.coli	24 hr.
DEQ & USGS RIM and RIM II sites	TPLL	Total Low Level Phosphorus	250 ml HDPE bottle	250 ml	Sulfuric acid to pH <2; On ice to 4°C	Total Phosphorus	28 days
USGS RIM sites	BAYR2	Chesapeake Bay River Input Monitoring Program Nutrients	1 gallon cubitainer	4 liters	On ice to 4°C	Total Suspended Solids	7 days
						Fixed Suspended Solids	7 days
						Volatile Suspended Solids	7 days
						Turbidity	48 hours
						Suspended Inorganic Carbon	28 days
						Suspended Inorganic phosphorus – Lab filtered, Frozen	28 days
						Particulate Nitrogen – Lab filtered, Frozen	28 days
						Particulate Carbon – Lab filtered, Frozen	28 days
						Particulate Phosphorus – Lab filtered, Frozen	28 days
						Total Dissolved Nitrogen – Lab filtered, Frozen	28 days
						Total Dissolved Phosphorus – Lab filtered, Frozen	28 days
						Total Nitrogen	28 days
DEQ & USGS RIM II sites	BAYT3-2	Chesapeake Bay River Input Monitoring Program Nutrients	1 gallon cubitainer	4 liters	On ice to 4°C	Total Suspended Solids	7 days
						Fixed Suspended Solids	7 days
						Total Nitrite Plus Nitrate (mg/l as N)	2 days
						Whole water Ammonia (mg/l as N)	2 days
						Dissolved Orthophosphate – Lab filtered, Frozen	28 days

Collecting Agency	ID	Description	Container size	Sample size	Preservation	Analytes	Holding Time
						Total Nitrogen (mg/l as N)	28 days
USGS RIM sites	CNTF-4	Dissolved nutrients	1 qt cubitainer	1 qt.	Filter immediately; On ice to 4°C	Ammonia (frozen)	28 days
						Dissolved NO2 + NO3 (frozen)	28 days
						Nitrate (frozen)	28 days
						Nitrite (frozen)	28 days
						Ortho Phosphate as P (frozen)	28 days
						Silica (not frozen)	28 days
USGS RIM II	SSC-C2 [2]	Suspended Sediment Concentration	1 qt cubitainer (*filled only half way; 500mL sample needed only*)	1 qt.	On ice to 4°C	% Sediment Finer than .062 mm	120 days
						Suspended Sediment Concentration >62 um	120 days
						Suspended Sediment Concentration <62 um	120 days
						Total Suspended Concentration	120 days

[1] RIM sites are 5 stations sampled by USGS since 1988 (TF3.0, TF4.0M, TF4.0P, TF5.0, TF5.0A). RIM II sites (also referred to as Add-on sites) are sites added to the non-tidal network since its inception in 2003 and sampled for a reduced number of parameters (e.g. total nitrogen rather than the total nitrogen components of particulate nitrogen and total dissolved nitrogen).

[2]Suspended Sediment Concentration is also analyzed at the RIM sites but by the USGS Kentucky Lab.

Appendix D

Chesapeake Bay
Non-tidal Water Quality Monitoring Work Group
Sampling Procedures and Protocols

~~Revised 11/18/2008~~

Non-Tidal Water Quality Monitoring- Chapter V Field Procedures

(Currently under revision)

Refer to the following link for a copy of the above referenced document:

Appendix E

Virginia Non-tidal Network
Log of Significant Changes

Revised 3/31/2015

Formatted: Left

Please Also refer to Appendix B of the **Virginia Tributary Monitoring Program Quality Assurance/Quality Control Project Plan for additional information regarding significant changes specific to the River Input Monitoring Program (RIM) conducted by the USGS under a cooperative agreement with VADEQ.**

May 20, 1999	Sample processing techniques used by VADEQ (Appendix A) are compared to those used by USGS (http://pubs.water.usgs.gov/twri9A3/). Duplicate samples are obtained approximately monthly from Jan. 1995 – Dec. 1998 from the Appomattox River at Matoaca (2-APP016.38). Wilcoxon signed-rank tests indicate no significant differences between methods (at $p > 0.10$) for all constituents evaluated. These included dissolved silica, dissolved nitrate, dissolved nitrite, dissolved nitrate+nitrite, dissolved ammonia, dissolved nitrogen, particulate nitrogen, dissolved phosphorus, dissolved orthophosphorus and particulate phosphorus. p-values for test of no significant difference between methods ranged from 0.18 to 0.91.
June 18, 2002	USGS replaces D-74 and D-77 samplers with D-95 and D-96 samplers.
May 30, 2003	USGS reduces routine sampling frequency from twice monthly to once monthly. USGS adds a standard operating procedure for the collection of chlorophyll samples.
July 1, 2003	The following parameters are added for monitoring at USGS Virginia River Input Monitoring sites: Chlorophyll a, particulate inorganic carbon, particulate inorganic phosphorus, dissolved organic carbon, percentage of total suspended sediment comprised of sand, silt and clay (sediment analyses to be conducted by USGS Kentucky District Sediment Laboratory).
July 1, 2005	TKN is added to the list of parameters collected at the non-tidal monitoring sites. The parameter group code for TPLL is changed to TNUTL.
July 13, 2005	VRO begins isokinetic sampling at all VNTMP sites.
September 29, 2005	SCRO begins isokinetic sampling at all VNTMP sites.
February 2006	NVRO moves station 3-RPP147.10 upstream approximately 2000 feet to the RT 29 Bridge and changes the site name to 3-RPP147.49. Sampling previously occurred from the business RT.

	29 bridge. The region switches from secondary site protocols to primary site protocols (i.e. equal width increment sampling) as Hubbard creek enters the Rappahannock on the left side of the stream (upstream of the bridge) and region wants to ensure sampling is representative. Station 8-MPN094.79 was also moved upstream 0.2 mi for safety reasons and the site name was changed to 8-MPN094.94.
March 1, 2006	The WQM database is modified to only accept field parameters to the 10ths decimal place. Per conversations with the manufacturer and based on the information provided to the agency QA coordinator regions were instructed to truncate field parameters rather than round based on the hundredths decimal place.
March 1, 2007	USGS implements sample collections at two add-on sites: station 2-CHK035.26 on the Chickahominy River and station 8-NAR005.42 on the North Anna River.
July 1, 2007	USGS begins conducting base flow sampling on the James River at the Nickle Bridge (also referred to as the Boulevard Bridge/station 2-JMS113.20).
October 1, 2008	NRO implements Equal Width and Depth Integrated Sampling at stations 1AACO014.57 and 1ACAX004.57.
October 23, 2008	NRO implements Equal Width and Depth Integrated Sampling at Stations 8-MPN094.94 and 8-POR008.97.
November 06, 2008	VRO implements Equal Width and Depth Integrated Sampling at stations 1BSTH027.85 and 2-MCM005.12.
November 12, 2008	VRO implements Equal Width and Depth Integrated Sampling at stations 2-BCC004.71 and 2-BLP000.79 and NRO at stations 3-RAP066.54 and 3-ROB001.90.
January 13, 2009	VRO implemented Equal Width and Depth Integrated Sampling at 2-CFP004.67.
February 09, 2009	VRO implemented Equal Width and Depth Integrated Sampling at 1BSSF100.10.
	Inaccuracies in gage height measurements were noted at the Blue Ridge Parkway site (2-JMS279.41/02025500). The type of gage installed at the site was believed to be the cause of the inaccuracies. Therefore a new gage was installed in February 2009.

September 2009	Sampling location on Accotink Creek had to be moved 150-200 feet upstream from original sampling location due to accumulation of debris that altered stream flow. For details refer to Accotink_Cr_movement.doc (email from Phil Hurst dated Dec 02, 2009).
January 20, 2010	Completion of new Bridge on Rt. 15 allows VRO to begin sampling the Rivannah River using equal width and depth integrated sampling protocols for the non-tidal network. Site was dropped from the network in 2004 due to safety issues prior to bridge construction. VRO also drops Piney River as a non-tidal network site (2-PNY005.29).
April 15, 2010	USGS implements sampling at the Smith Creek site using add-on station parameters (eg. No dissolved nutrients except for Orthophosphate, total N, total P, total NH3 and total NO23).
July 11, 2010	A large tree fell on the gage house at Accotink Creek destroying it (refer to Jeff Talbott email dated 7/22/2010). Gage replacement was completed 08/10/2010.
January 28,2011	USGS implements storm targeted sampling on the Rivannah River.
September 09, 2011	USGS implements storm targeted sampling on the Accotink River.
October 2011	USGS implements storm targeted sampling on Quantico Creek (12th) and Muddy Creek (20th).
July 13, 2011	USGS implements storm targeted sampling on Difficult Run.
July 2012	The South Fork of the Shenandoah at Lynnwood (1BSSF100.10), Rappahannock River at Remington (3-RPP147.49), Mattaponi River near Bowling Green (8-MPN094.94) and the Appomattox River at Farmville (2-APP110.93) are upgraded to primary sites and a primary site is implemented on Pole Cat Creek. DLCS implements the use of a new Lachat system (analytical instrument used to analyze ammonia) to replace the Skalar system purchased in 1996. The ammonia analysis was immediately switched to the Lachat system due to interference issues on the Skalar. The analytical parameters that are affected by this change are: ammonia, nitrite, nitrate plus nitrite, orthophosphate, PP/PIP, and nitrate plus nitrite (whole water).

October 2012	Accotink Creek (1AACO014.57) and Catoctin Creek (1ACAX004.57) were dropped from VADEQ's monitoring network in October of 2012. Catoctin Creek is monitored by Maryland DNR as a primary site, so VADEQ dropped it as a secondary site. Baseflow on Accotink Creek is monitored by USGS-Maryland for a non-RIM project, however CBP protocols are used and CBP parameters are collected, so VADEQ dropped baseflow monitoring of the station. USGS-Virginia continues to monitor this site for storm events.
January 2015	USGS-Virginia took over routine sampling of Accotink Creek (1AACO014.57) from USGS-Maryland. USGS-Virginia will also continue to monitor this site for storm events. DCLS implements the use of a new Ion Chromatograph (ICS2100) system on January 8th, 2015. There are no changes to the methods, MDLs, Storet codes, submissions, or data recovery.
July 2015	Maryland DNR discontinued sampling 1ACAX004.57 in June 2015. VADEQ NRO resumed sampling this station as a secondary station in July 2015.

Formatted: Indent: Hanging: 2"

Appendix F

Virginia Non-tidal Network Regional Contact Information

Region	Name	Primary contact	Phone number	Fax extension	E-mail address
VRO	Jared Purnhagen	y	(540) 574-7839	(540) 574-7878	Jared.purnhagen@deq.virginia.g
VRO	Phillip Hurst		(540) 578-7810	(540) 574-7878	Phillip.hurst@deq.virginia.gov
BBRO-L	Mike Shaver	y	(434) 582-6234	(434) 582-5125	Michael.shaver@deq.virginia.go
BBRO-L	Scott Hasinger		(434) 582-6222	(434) 582-5125	Scott.hasinger@deq.virginia.go
BBRO-L	Kelly Hazlegrove		(434) 582-6242	(434) 582-5125	Kelly.hazlegrove@deq.virginia.g
NRO	Jeff Talbott	y	(703) 583-3092	(703)-583-3821	Jeff.talbott@deq.virginia.gov
NRO	Justin Lloyd		(703) 583-3827	(703)-583-3821	justin.loyd@deq.virginia.gov
PRO	Matt Carter	y	(804) 527-5065	(804) 527-5106	matthew.carter@deq.virginia.go
PRO	Garth Jenkins		(804) 527 -5007	(804) 527-5106	nathaniel.jenkins@deq.virginia.g
CO	Cindy Johnson	y	(804) 698-4385	(804)698-4116	Cindy.Johnson@deq.virginia.go
CO	Drew Garey	y	((804)698-4253	(804)698-4116	Andrew.Garey@deq.virginia.go

Formatted: Normal, Centered, Indent: Left: 0", Don't keep with next
Formatted: Centered, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Centered, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Centered, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Centered, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Centered, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Centered, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Centered, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Centered, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Centered, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Centered, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted: Adjust space between Latin and Asian text, Adjust space between Asian text and numbers
Formatted ...
Formatted ...
Formatted ...
Formatted ...
Formatted ...
Formatted ...
Formatted ...
Formatted ...
Formatted ...
Formatted ...
Formatted ...
Formatted ...
Formatted ...
Formatted ...
Formatted ...
Formatted ...
Formatted: Centered, Indent: Left: 0"