5 NONTIDAL WATER QUALITY MONITORING

Section D. Nontidal WQ Laboratory Methods

Section E. References

Appendix 5-A. An Annual Randomized and Stratified Procedure to Obtain Field QC Samples Representative of Varying Environmental, Weather and Flow Conditions among Nontidal Network Monitoring Sites

Appendix 5-B. CBP Nontidal Water Quality Stations, Locations and Streamflow Gages

SECTION A
PROJECT DESCRIPTION

1. Management Objectives

Chesapeake Bay Program partners are implementing management actions through the Chesapeake Bay TMDL process to reduce nutrient and sediment pollution entering the Chesapeake Bay watershed. The Chesapeake Bay Nontidal Water Quality Network (NTN) was developed in 2004, to estimate nutrient and sediment loadings discharged and trends in loads from each of the 36 tributary strategy basins. In 2009, the objectives were modified to measuring the effectiveness of best management practices at multiple scales.

The NTN includes the nine Chesapeake Bay River Input Monitoring (RIM) stations which require additional parameters for the Chesapeake Bay Estuarine Model. Further information about the RIM monitoring program may be found at the website http://cbrim.er.usgs.gov/loadhighlights.html.

Loadings and trend data, along with data sets on nutrient and sediment sources, Best Management Practices (BMPs), land-use changes and watershed characteristics may be used to assess the factors which affect local stream and river nutrient and sediment concentrations, flow and the resultant loads to downstream waters. The observed concentration trends and calculated loadings data will help the tributary strategy teams to:

1.1. Assess progress toward meeting nutrient and sediment cap load allocations;

1.2. Evaluate the effectiveness of state tributary strategy implementation to improve water-quality of local streams; and

1.3. Determine if tributary strategy implementation in the watersheds will result in achievement of water-quality standards in the Bay.

2. Monitoring and Data Quality Objectives

2.1. The monitoring objectives of the Chesapeake Bay Nontidal Watershed Water-Quality Network are to:

2.1.1. Compute annual loadings of total nitrogen, phosphorus and suspended sediment from tributary strategy basins;

2.1.2. Assess the status and trends of nutrient and sediment concentrations and loads at each station;

2.1.3. Compare concentration data and loadings estimates among rivers; and

2.1.4. Improve calibration and verification of partners' watershed models.

2.2. The data quality objectives for computing loadings and trends in loadings are to: a) accurately sample stream conditions under the range of flow conditions during a given year and b) obtain a sample that is representative of the stream.

2.2.1. The sampling design is a combination of fixed-interval and storm event samples to capture the hydrologic and seasonal variability of nutrient and suspended-sediment concentrations. A minimum of 10 years of data are required to calculate *trends* in loadings. Annual loadings will be estimated for stations having 5 or more years of data. Section 4 below provides additional detail on the sampling design.

2.2.2. *Isokinetic, depth- integrated* samples are collected at equal-width increments across a stream channel to best represent the total nitrogen, phosphorus and sediment concentrations in the discharge. Sampling procedures for the NTN are based on methods in the *USGS National Field Manual for the Collection of Water-Quality Data*. For greater detail, see http://water.usgs.gov/owq/FieldManual/chapter4/pdf/Chap4_v2.pdf.

3. Participating State and Federal Agencies

Sampling is conducted by five State agencies, four USGS Water Science Centers and the Susquehanna River Basin Commission as indicated below. Samples are analyzed by State and USGS laboratories.

State	Sampling Agencies
Delaware	Delaware Department of Natural Resources and Environmental Control
Maryland	Maryland Department of Natural Resources · USGS Maryland-DC-Delaware WSC
New York	New York State Environmental Protection · Susquehanna River Basin Commission
Pennsylvania	USGS Pennsylvania Water Science Center · Susquehanna River Basin Commission
Virginia	USGS Virginia Water Science Center · Virginia Department of Environmental Quality
West Virginia	USGS WV Water Science Center · WV Department of Environmental Protection

4. Sampling Design

4.1. *Parameters:*

TABLE 5.1 Parameters for Chesapeake Bay Nontidal Water Quality Network

Required NTN Parameters	Additional RIM Parameters (Recommended for NTN)
Total Nitrogen, as N (TDN + PN) or (TKN + NO23) or (TN)	**Total Dissolved Nitrogen (TDN)**
Ammonium, as N (dissolved*) (NH4F)	**Particulate Nitrogen (PN)**
Nitrate + Nitrite, as N (dissolved*) (NO23F)	**Total Dissolved Phosphorus (TDP)**
Total Phosphorus, as P (TP) or (TDP + PP)	**Particulate Phosphorus (PP)**
Phosphate, as P (dissolved*) (PO4F)	**Particulate Carbon (PC), or TOC**
Total Suspended Solids (TSS) and/or SSC	**Dissolved Organic Carbon (DOC)**
Suspended Sediment Concentration (SSC)	**Volatile Suspended Solids (VSS)**
SSC-Sand & SSC-Fines (1 storm/quarter)	**Chlorophyll-*a* (corrected) (CHLA)**
Field Parameters: Dissolved Oxygen, Temperature, pH, Specific Conductance	
* *Dissolved fraction is preferred but whole water is acceptable*	

4.2. *Site Specifications*: There are two types of NTN sites – Primary and Supplemental. As of Water Year 2016, there are 111 Primary NTN stations and 12 Supplemental NTN stations. Supplemental stations are also called secondary stations.

4.2.1. Primary sites are characterized as having:

4.2.1.1. The sampling locations within one mile of a continuous stream-flow gage so that the water-quality and discharge information are comparable;

4.2.1.2. Twenty water chemistry samples collected per year over a range of flow conditions (12 monthly routine + 8 storm flow);

4.2.1.3. Total nitrogen, total phosphorous, ammonium, nitrate, phosphate and total suspended solids analyses;

4.2.1.4. Storm samples must also include analyses of suspended sediment concentrations, and each quarter, a sand/fine particle size analysis; and

4.2.1.5. Equal-width increment (EWI), isokinetic, depth-integrated sampling techniques to obtain representative samples.

4.2.2. Supplemental stations do not have storm sampling, but follow primary station criteria such as:

4.2.2.1. Sites are associated with a stream-flow gage to allow computation of loadings trends;

4.2.2.2. Samples must be collected at least monthly;

4.2.2.3. Parameters shall include total nitrogen, total phosphorous and total suspended solids; and

4.2.2.4. Use of isokinetic, depth-integrated sampling techniques to obtain representative samples.

4.3. *Routine Sampling Frequency*

4.3.1. Primary and supplemental stations are sampled once per month on a predetermined schedule. These fixed-interval samples provide samples from a random, unbiased selection of flow conditions.

4.3.2. If high discharge occurs during routine monthly sampling, collect the samples on the scheduled date using procedures for storm event sampling, and including a SSC sample (primary stations only). These samples are to be counted as routine, monthly samples and designated as event type "Routine, Storm Impacted". A routine storm-impacted event has a rising discharge (cfs) of at least twice that of the pre-storm, average daily discharge.

4.4. *Storm Sampling Frequency*

4.4.1. Eight storm-event samples are required per year, preferably with at least one storm event per quarter to capture seasonal effects. Sampling of larger storm events is preferred, but in dry years smaller discharges of at least twice that of the pre-storm discharge may be sampled.

4.4.2. Samples may be collected at any point in the hydrograph, i.e., rising or falling limb, or at peak discharge.

4.4.3. Two samplings are permitted during a single storm event. However, samples must be collected on different days so that two estimates of daily load can be calculated. This practice also applies to taking a storm sample after the collection of a routine storm-impacted sample.

4.4.4. SSC samples are collected each storm sampling day, with a sand/fine particle size analysis each quarter.

4.4.5. Monitor the hydrological conditions leading up to, and predicted for the storm, including:

4.4.5.1. *Rainfall*, e.g., total rainfall over last 24-48 hours, rainfall intensity, current radar and forecast for the next few days;

4.4.5.2. *Current Hydrology*, e.g., stage, rising or falling limb, shape of the storm hydrograph and upstream river conditions; and

4.4.5.3. *Previous Hydrology*, i.e., the size of the storm relative to discharge over the last 6 months.

4.5. *Composite Samples*

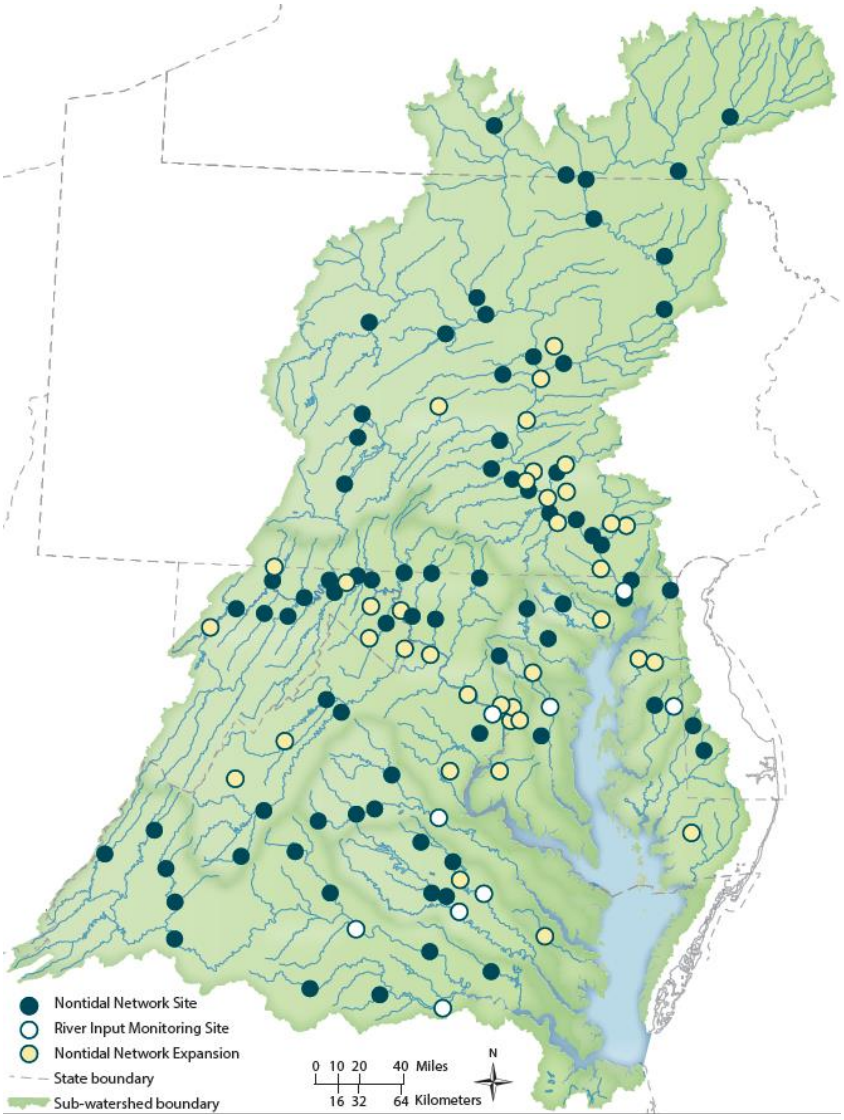
The number of depth-integrated, equal-width interval (EWI) samples varies per station and waterway width. Table 5.3 in Section B.3 describes the minimum number of verticals to be composited at primary stations, for both routine and storm event sampling. To ensure the collection of representative samples, assess the cross-sectional variability of specific conductance, water temperature, dissolved oxygen and pH to determine that the sampling points across each river adequately represented the vertical and horizontal water-quality conditions within the cross-section. Ideally, this would include an analysis of the variability of suspended sediment concentration in the equal-width increments.

5. Sampling Stations and Locations

5.1. Figure 5.1, Chesapeake Bay Nontidal Network Monitoring Stations, shows the locations of the sampling stations relative to state and sub-watershed boundaries.

5.2. Appendix 5-B, *CBP Nontidal Network Water Quality Stations, Locations and Streamflow Gages*, provides a description of each monitoring station, including the nearby USGS stream gage and coordinates for latitude and longitude.

FIGURE 5.1. CHESAPEAKE BAY NONTIDAL NETWORK MONITORING STATIONS



SECTION B
SAMPLING PROCEDURES

1. Equipment

1.1. Samplers*

1.1.1. **DH-81**: A hand-held, depth-integrating suspended sediment and water quality sampler. The DH-81 samplers consist of a 1-L sample bottle, a D-77 sample cap that holds the nozzle, and a DH-81A adapter that snaps over the cap and to which a wading rod is attached. Make sure to collect an isokinetic sample if the discharge velocity is 1.5 ft/s or more. A 5/16-inch nozzle will be sufficient for most discharges over 1.5 ft/s that can be safely waded. If the discharge velocity is < 1.5 ft/s, a DH-81 may be used without a nozzle.

1.1.2. **DH-95**: A hand-line suspended sediment and water-quality sampler, for sampling depths ≤ 15 ft. The DH-95 weighs 29 lbs and is designed to be used with a 1-L bottle. If the discharge velocity is 1.5 ft/s or more, use the appropriate size nozzle and collect a depth integrated, isokinetic sample.

1.1.3. **WBH-96**: A weighted bottle sampler may be used to collect samples where discharge velocities are less than 1.5 ft/s.

1.1.4. **D-95 or D-77**: These heavy samplers must be suspended from a bridge using a cable, reel and bridge board or crane. The D-95 and D-77 bottle samplers may be used to a maximum depth of 15 ft. deep. To collect an isokinetic sample, use a 5/16-inch nozzle and make sure the discharge velocity is 1.5 ft/s or more. If the discharge velocity exceeds 3 ft/s and the depth is > 15 feet, use a D-77 bag sampler equipped with a 1/4 or 5/16-inch nozzle.

* For additional information on samplers see: USGS TWRI, Book 3, Chapter C-2 (http://pubs.usgs.gov/twri/twri3-c2/)

1.2. Churn Splitter: A 4-liter or 8-liter churn splitter is recommended.

1.3. 1-liter Sampler Bottles: A narrow-mouth 1-liter bottle is used with the WBH-96; a wide-mouth 1-liter bottle is used with the DH-81 and DH-95 samplers.

1.4. Sample/lab bottles: Pre-cleaned polyethylene bottles, as specified by the laboratory. Ensure that sample bottles are in a clean state or have been thoroughly cleaned before reuse. Wherever possible, do not reuse sample bottles from high concentration samples for low-level events.

1.5. Preservatives as required by the laboratory, e.g., nitric acid (HNO_3), sulfuric acid (H_2SO_4), magnesium carbonate ($MgCO_3$), etc.

1.6. Filtration apparatus

1.6.1. Filters with a pore size of 0.45 µm are recommended, however, 0.7 µm GFF filters are acceptable.

1.6.2. Filter supports may be capsule, syringe, or a tower unit with a fritted base.

1.7. Vacuum pump and lean Masterflex tubing;

1.8. Water-quality meters for DO, temperature, pH, conductivity;

1.9. Field forms and permanent ink pens;

1.10. Field folders containing the following:

- Site-specific sampling procedures,
- Directions to both the sampling location and gaging station,
- Table of velocities vs. stage height,
- Job Hazard Analysis, and
- Traffic Safety Plans.

1.11. Cleaning supplies (tap water, deionized water, non-phosphate detergent mix, 5% HCl acid rinse, and baking soda to neutralize the used acid-rinsed water);

1.12. Disposable, powderless gloves; and

1.13. Safety equipment: Orange safety vest, flotation device (pfd, float coat), hip-boots, chest waders, and traffic safety cones.

2. Sample Collection – Primary Stations

The procedures that follow are used for the collection of routine, storm event and routine, storm-impacted sample types.

2.1. Determine the number of equal width increments (EWI) in the cross-section based on the width of the stream channel. The minimum number of verticals required is listed in Table 5.3 below. An odd number of vertical samples is specified to facilitate the reporting of median values for the *in-situ* parameters (pH, temperature, specific conductance, and dissolved oxygen).

2.2. Measure the increments according to the procedure in *USGS National Field Manual(NFM) for the Collection of Water-Quality Data, Chapter A4, Collection of Water Samples* (p.45-53) http://water.usgs.gov/owq/FieldManual/chapter4/pdf/Chap4_v2.pdf

2.3. On each sampling day, record the stream discharge or stage height from the gaging station or from real-time reports on the USGS website.

2.4. Select the appropriate sampling device based on flow conditions, safety, and the type of sampling being collected. If the discharge exceeds 1.5 ft/s, depth-integrated, isokinetic samples must be collected at the mid-point of each EWI across the stream channel. This applies to both routine and storm event samples. See Table 5.2 for details.

2.5. Isokinetic, depth-integrating samplers such as the DH-81 and DH-95 are to be used when the velocity of the stream is 1.5 ft/s or greater. Each sampler/nozzle combination has an optimum transit rate for surface to bottom collection. Refer to the NFM (2006), *Appendix A4 -Transit Rate and Volume Guidelines and Filling Times for Isokinetic Samplers.*

2.6. If the velocity of the stream is < 1.5 ft/s it may not be feasible to collect an isokinetic sample. In this case it is acceptable to obtain one or more depth-integrated grab samples. If the stream is at least 2-3 ft. deep, depth integration with a DH-59 sampler is feasible.

2.7. Depth integration: Pre-determine the vertical transit rate by starting at the increment with the largest discharge (depth x velocity) to find the maximum transit rate. Lower and raise the sampler at the same rate – if the sampler overflows, discard the sample and repeat the collection at a faster rate. If under-filled, discard and repeat at a slower rate until the appropriate volume is obtained.

2.8. Beginning at the first increment, lower the sampler at the pre-determined rate until a few inches from the bottom, then immediately raise it to the surface using the same rate. The designated "clean-hands" person removes the sample bottle and empties the contents into the churn splitter. The reel operator should not touch the sample bottles.

2.9. Sample the remaining intervals using the same transit rate as in the first increment, compositing them in the churn splitter. (See Section 4. below.) The volume of sample may be less in the remaining verticals.

3. Sample Collection – Secondary Stations

3.1. It is recommended that secondary stations be sampled according to primary station procedures.

3.2. If it is not possible to collect the number of verticals in Table V.5, at least one depth-integrated sample is to be collected at the centroid of flow. This is the point where half of the flow is to the left, and half is to the right.

3.3. Isokinetic samplers are recommended for discharges ≥1.5 ft/s to produce more representative suspended sediment and total phosphorus data.

Table 5.2. Minimum Requirements for Nontidal Network Sample Types

Station Type	Discharge	Sample Type	Sampler	Number of Samples
Primary	≥ 1.5 ft./s	EWI, Isokinetic Depth-integrated	Hand Held: DH-81 or DH-95 Cable & Reel: D-95 or D-77	See Table 5.3
	< 1.5 ft./s	EWI, Depth-integrated	Weighted Bottle: DH-59	See Table 5.3
Supplemental	≥ 1.5 ft./s	Isokinetic, Depth-integrated	DH-81 or DH-95	1 centroid, or Table 5.3
	< 1.5 ft./s	Depth-integrated	Weighted Bottle: DH-59	1 centroid, or Table V.5

Table 5.3. Minimum Number of Depth-Integrated, EWI Samples at Primary Stations

Width of Waterway (ft.)	Minimum # of verticals*
0-25	**1**
25-100	**3**
100-250	**5**
250-500	**7**
> 500	**9**

*Routine and storm event sampling

4. Compositing

4.1. Empty the EWI subsamples into a pre-cleaned churn splitter. Collect sufficient subsample volumes for at least 3.35 liters of composited sample in a 4-liter churn; or at least 5.25 liters in an 8-liter churn. If the volume of sample in the churn is insufficient, collect a second, identical set of EWI subsamples across the channel.

4.2. Follow the procedures below to fill sample bottles. (Adapted from the USGS National Field Manual, Chapter 5. http://water.usgs.gov/owq/FieldManual/chapter5/pdf/chap5.pdf)

4.3. Take precautions to avoid sample contamination. Prepare a clean work area at the site or in the van for processing samples. Designate a "clean hands" person to churn and handle the sample bottles. The use of disposable, powderless gloves is highly recommended while dispensing and filtering the samples.

4.4. Churn the composite sample at a uniform rate by raising and lowering the disk inside the churn splitter with smooth, even strokes.

4.5. When churning, the disk should touch the bottom on every stroke, and the stroke length should be as long as possible without breaking water surface. Do not break the surface of the water.

4.6. The churning rate should be about 9 inches per second (in/s). Inadequate churning can result in withdrawal of misrepresentative whole-water or suspended-material samples.

4.7. Pre-mix the composite sample by churning for about 10 strokes to uniformly disperse suspended material before subsampling.

4.8. Continue churning while subsampling. Dispense whole water samples first, in the following order:

4.8.1. Suspended Sediment and TSS

4.8.2. Particulate Nitrogen and Carbon

4.8.3. Chlorophyll

4.8.4. Whole water samples

4.8.5. Dissolved parameters to be filtered on site

4.9. Do not interrupt the churning/subsampling process, if possible. If an interruption occurs, reestablish the churning rate and remix the sample by churning ten strokes before resuming subsampling.

4.10. As the volume of composite sample in the churn decreases, adjust the stroke length to maintain a churning rate of about 9 in/s and avoid breaking the surface of the water being sampled.

5. Sample Processing and Preservation

5.1. Whole water samples:

5.1.1. SSC samples from the churn splitter may be held at room temperature for 120 days. Ship the samples prior to September 1st so that the results are available for water-year based data analyses.

5.1.2. If the laboratory is to filter the samples, place whole-water nutrient and TSS samples in a cooler on ice (4 ± 2°C).

5.2. Field Filtered Samples

Samples are filtered in the field using a vacuum or peristaltic pump and a cleaned length of Masterflex tubing. Most sampling groups use Gelman® 0.45 µm pore size capsule filters, although 0.7 µm pore GF/F filters are also acceptable. Hand pumps and syringe filters are also acceptable.

5.2.1. *Dissolved ammonium, nitrite, nitrate + nitrite, orthophosphate, nitrogen, phosphorus, and organic carbon*: Samples for dissolved constituents should be filtered in the field, or before the end of the sampling day. Using a new filter for each sample and rinse the filter and receiving vessel with deionized water and sample water prior to collection.

5.2.2. Collect sufficient sample filtrate to rinse and fill necessary bottles. If required by the laboratory, add acid preservative to the samples for ammonium, nitrate + nitrite and DOC analyses. Place the samples on ice (4°± 2°C).

5.2.3. *Total suspended solids (TSS)*: Shake the sample and pour quickly into a graduated cylinder a known volume (50-1000 mL) and filter the aliquot through a pre-rinsed, tared, 47mm diameter GF/F filter. Rinse the filter and residue three times with DI water, allowing the suction to dry the residue after the final rinse. If the filtrate is to be used for dissolved parameters, dispense the filtrate in the filtration flask into sample bottles before rinsing the filter and residue. Place the TSS filter in a plastic case or foil pouch and immediately put in a cooler on ice (4 ± 2°C).

5.2.4. *Particulate carbon and particulate nitrogen*: Shake the sample and pour quickly into a graduated cylinder a known volume (25-500 mL) of sample and filter through a GF/F filter. Keep the vacuum at or below 10 in. Hg (5 psi) while filtering. Do not rinse the filter. Place the filter into a plastic case or foil pouch and immediately put in a cooler on ice (4 ± 2°C).

5.2.5. *Chlorophyll*:

5.2.5.1. Immediately after collecting the sample, shake and pour quickly into a graduated cylinder to a known volume and filter the sample aliquot through a glass fiber filter to concentrate the algae. Use sufficient sample (100-1500 mL) to produce a green color on the filter pad. To avoid cell damage and loss of contents during filtration, do not exceed a vacuum of 12 in. Hg (≤ 6 psi or ≤ 40 kPa), or a filtration duration greater than 10 minutes. Do not suck the filter dry with the vacuum; instead slowly release the vacuum as the final volume approaches the level of the filter and completely release the vacuum

as the last bit of water is pulled through the filter. Add 1mL of saturated $MgCO_3$ solution during the last few seconds of filtering.

5.2.5.2. Remove the filter from the fritted base with a forceps, fold once with the particulate matter inside, lightly blot the filter with a tissue to remove excess moisture and place it in a Petri dish or other suitable container. Wrap the container in aluminum foil to protect the phytoplankton from light and store the filter at -20°C (-4°F) or colder. Processed filters may be stored on ice in a cooler until the end of the sampling day. The residue on the filter may be stored in the dark at -20°C or colder for 28 days before extracting the pigments.

5.2.5.3. Chlorophyll samples that cannot be filtered immediately after collection may be held at 4 ± 2°C in the dark for 4 hours before the plankton are concentrated, however any delay is strongly discouraged due to the possible growth or lysis of phytoplankton cells.

5.3. Labeling

5.3.1. Follow the sampling agency's protocol for labeling sample bottles.

5.3.2. Sediment bottles for the USGS Sediment Laboratory in Kentucky must be labeled with the following:

5.3.2.1. Collection site numbers

5.3.2.2. Date and Time

5.3.2.3. Discrete or composite sample (if composite, by transect or time)

5.3.2.4. Constituents: SSC and/or particle size. (Both analyses can be done from the same bottle.)

5.4. Sample Handling and Transportation

Deliver the nutrient and TSS samples to the laboratory as soon as possible, preferably at the end of the day, or ship them on ice for next morning delivery. If the water samples must be held overnight, refrigerate them at 4 ± 2°C. Filters for chlorophyll and particulate parameters must be frozen overnight at -20°C (-4°F) or colder.

6. Field Blanks

6.1. *Definition and Purpose*

6.1.1. A NTN field blank (FB) is an aliquot of deionized water, free of the analytes of interest, which is placed in a sample container in the field and treated as a sample in all respects, including exposure to sampling site conditions, processing, filtration, preservation, storage and all analytical procedures. Field blank results are used to evaluate the extent or lack of positive bias in the associated WQ data. Because a field blank is treated exactly like an environmental sample at the laboratory it includes any contamination introduced during laboratory handling and analysis.

6.1.2. A field blank is prepared in the field and used to demonstrate that: (1) equipment has been adequately cleaned to remove contamination introduced by samples obtained at previous sites; (2) sample collection and processing have not resulted in contamination; and (3) sample handling and transport have not introduced contamination. (USGS 1997.) Quality-Control Design for Surface Water Sampling in the National Water-Quality Assessment Program

6.1.3. Field blanks are required for laboratory parameters only and include all nitrogen, phosphorus, carbon, TSS and sediment species routinely requested by each Data Collector. Field blank data for state-required parameters such as alkalinity, chloride, sulfate, etc., may be submitted and made available through CEDR.

6.2. Site Selection and Frequency (For representative of bias estimates)

6.2.1. Each sample collection group listed in Appendix A, Table 5-A.2, is to collect FBs throughout the year, in proportion to the number of NTN stations that are routinely sampled. A minimum frequency of 1 blank per station per year is required. If a sampling group has fewer than 4 stations, the collection of quarterly blanks is recommended.

6.2.2. Collect the field blanks during storm and routinely-scheduled events throughout the year to ensure that a variety of flow conditions and seasonal variability of concentrations are well represented. Appendix 5-A describes an unbiased randomized procedure to obtain FBs representative of the variations in these conditions throughout the year and from year to year.

6.3. Preparation of Field Blanks

FBs are to be prepared at the sampling site **prior to** collecting the water-quality samples. They are created by pouring blank water into the sample collection bottle and transferring it to the churn splitter. This process is repeated the same number of times routinely required to obtain the associated WQ sample at that NTN Monitoring site. The composite sample is then sub-sampled, processed, preserved and handled exactly the same as done for the WQ samples.

6.4. Reporting Field Blank Results

6.4.1. Laboratories are to quantify and report all field blank results above the method detection limit (MDL) to ensure that low-level contamination is not a significant contributor to low-level WQ concentrations just above the reporting limit.

6.4.2. For FBs >MDL, data collectors and/or agency staff will investigate potential sources of contamination and assess the significance of the contamination. Corrective action is required for significant problems, especially for chronic detections above a reporting limit.

6.4.3. Agencies will assign all FB detections ≥ MDL with one of the Problem Codes cited below.

- **UB** – Concentration of field blank reflects initial or isolated occurrence of contamination; source of contamination under investigation.

- **BB** – Spurious or persistent contamination which appears to affect the field blanks only. Contamination is related to the manner, equipment or supplies used to obtain the blank, such as contaminated source water.
- **CB** – Spurious or persistent contamination, which appears to reflect the manner, equipment or supplies used to obtain blanks AND associated water quality samples.

The use of these problem codes informs end-users of FB data of the implications of the contaminated FB. It also permits aggregation (normalization) of FB results beyond the individual Data Collector level. For further information, see report by the USGS NAWQA monitoring program[1].

6.4.4. Definition of Biased WQ Data

DUET has initially adopted a decision criterion that if a FB concentration is ≥ 10% of the associated WQ concentration, the latter is considered biased and electronically assigns the Problem Code "BM" to the water-quality data collected on that day.

7. Field duplicates

7.1. Definition and Purpose

7.1.1. A field duplicate sample set consists of two samples collected and processed so that the samples are considered to be essentially identical in composition. The purpose of collecting field duplicate samples is twofold: 1) to estimate the reproducibility of water-quality sample measurements and 2) to provide water-quality data from those samples.

7.1.2. Field duplicate (split) samples are usually taken in the field from a single container (e.g., churn) which contains a composite stream sample. Field duplicate samples (FS1 & FS2) provide a measure of the variability introduced during sample processing and laboratory analysis.

7.1.3. Alternatively, collectors may choose to prepare concurrent duplicates, which consist of concurrently collected EWI samples that are poured into two separate containers (e.g., churns) and then processed as individual samples. These duplicate samples (S1 & S2) include the added variability of filling the sampler bottle with water.
Note: Sequentially collected and processed duplicates are unacceptable.

7.2. Site Selection and Frequency (For representative precision estimates)

7.2.1. Each sample collection group is to prepare field duplicate samples throughout the year that are representative of the WQ samples being collected, through randomized site selection, and with stratification across flow conditions.

[1] *Quality of Nutrient Data from Streams and Ground Water Sampled During Water Years 1992–2001,* by David K. Mueller and Cindy J. Titus. URL: http://pubs.usgs.gov/sir/2005/5106/pdf/sir2005-5106.pdf

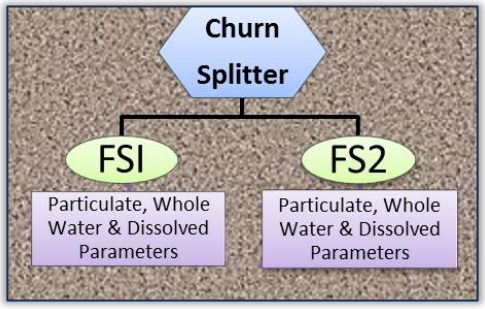
7.2.2. The minimum number of field duplicates is 2 pairs of duplicate samples per station per year, which is 10% of the samples. The number of field duplicates for supplemental sites is one per station per year since fewer samples are collected.

7.2.3. Sample collection groups, or "data collectors" in Table 5-A.2, with more than 12 stations may limit the number of pairs of duplicate samples to 24 per year (i.e., 2 pairs per month), making sure that all stations have at least one duplicate pair per year.

7.2.4. Appendix 5-A describes a randomized procedure to obtain duplicate samples representative of the variations in water quality conditions throughout the year and from year to year.

7.3. Preparing Duplicate Samples

7.3.1. A split duplicate (FS1/FS2) sample pair is prepared by dividing a single volume of water into two sets of samples. Mix and dispense the particulate and whole water duplicates first, then the dissolved parameter FS1/FS2 sets last. (See Fig. A)



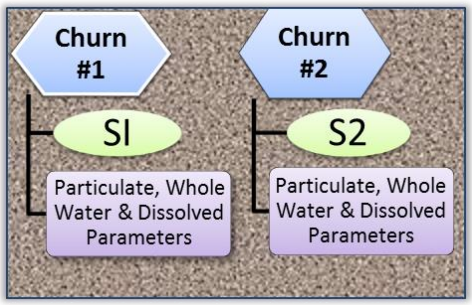


Figure A. Field Split Duplicates ***Figure B. Concurrent Field Duplicates***

7.3.2. A concurrent field duplicate pair is prepared by collecting a second aliquot of sample immediately after the first at each equal-width increment (EWI). Place two or more aliquots from a single EWI into two separate churn splitters. Process the water from each churn to prepare a pair of concurrent duplicate samples. Label and report concurrent duplicates as sample types S1 and S2.

(See Fig. B)

7.4. Reporting Field Duplicate Results

7.4.1. It's important for laboratories to report analytical results for field duplicates to at least 3 significant figures to obtain the most accurate estimates of precision[2]. Low concentrations near the MDL are typically reported to one or two significant figures but in the case of field duplicate samples, request that the lab submit unrounded low-concentration data to at least 3 figures. For example, the value 0.005 has only one significant figure and the raw, unrounded version of this value is needed.

7.4.2. Another exception for field duplicate data involves those rare cases where one or both field duplicates fails a consistency check (e.g., TDP > TP). Data collection groups should evaluate both field duplicates for consistency and assign an appropriate problem code for failures, however, unlike normal data, failed duplicate results must be reported along with the problem code "NQ". This practice is necessary to obtain representative QC data, even if the sample data would normally be censored.

After the precision calculations are completed, DUET will censor the "NQ" coded data prior to uploading to CIMS. Similarly, the unrounded low concentration data will be rounded to the appropriate decimal place prior to the upload. All original duplicate sample data, including the unrounded and uncensored results, will be archived and made available through a request to the CBP NTN Project Data manager.

7.5. Precision Problem Codes

DUET will calculate the Relative Percent Difference (RPD) using field duplicates to assess a combined field and laboratory precision. If RPD values exceed 30% for particulate parameters (i.e., PN, PP, PC, TSS, SSC and Chlorophyll), or 20% for dissolved and total N, P, or C parameters, *and* both reported values are above the reporting limit, the Precision Problem Code "HI" will be added to the CIMS database. These control limits are subject to change once sufficient duplicate data are generated from which to establish different precision objectives.

8. Documentation and Records

Field sheets, calibration records, log books and laboratory forms must be maintained to permit a complete historical reconstruction of the data back to the calibration standards, sample volumes and preservatives used. A unique sample number or ID must be assigned to each sample processed. See Chapter 2.4 for

[2] *Review of Trace Element Blank and Replicate Data Collected in Ground and Surface Water for the National Water-Quality Assessment Program, 1991–2002,* by Lori E. Apodaca, David K. Mueller, and Michael T. Koterba. URL: http://pubs.usgs.gov/sir/2006/5093/sir_2006-5093.pdf

additional document control protocols.

9. Decontamination

9.1. Cleaning procedures are detailed in the USGS NFM, *Chapter 3.2.1 – Cleaning of Equipment Used to Sample for Inorganic Constituents*. Two deviations from the National Field Manual are permitted: 1) the time for soaking the churn splitter in detergent solution may be less than 30 minutes, and 2) the use of 5% HCl for rinsing equipment is optional.

9.2. Start the cleaning procedures as early as possible after processing. Soak the churn splitter as close to 30 minutes as feasible given the time constraints of the day. Do preservation, paperwork, and packing of samples in the interim.

9.3. If cleaning the equipment for reuse in the field (e.g., sampler, churn splitter, filtration units), it is recommended that a 5-gallon polyethylene container for each solution below be transported in the vehicle.

9.3.1. Detergent water (0.1 percent v/v ratio of Liquinox: tap water)

9.3.2. Tap water

9.3.3. 5% Hydrochloric Acid, ACS grade (this rinse is optional)

9.3.4. Deionized Water

SECTION C

FIELD MEASUREMENTS

1. Field Measurement Procedures

1.1. *Parameters: In-situ* field measurements shall be collected for pH, dissolved oxygen, temperature, and specific conductance (at 25°C).

1.2. *Equipment:* A multi-parameter instrument or a combination of meters that can provide these same measurements.

1.3. Calibration

1.3.1. All probes must be calibrated according to the manufacturers' recommended methods. Field staff must document calibration, maintenance and repair information for each instrument and sensor in logbooks using permanent ink.

1.3.2. *Specific Conductance sensor*: The conductivity sensor must be calibrated against a reference solution, according to manufacturer's specifications. As a minimum, conductivity should be verified before and after each sampling date using standards that bracket the expected range.

1.3.3. *pH sensor*: The pH sensor should be calibrated at the beginning of every sampling event using two standard solutions of pH 4, pH 7 or pH10 buffer solutions. The standards should bracket the expected pH of the streams. Follow the manufacturer's instruction for cleaning and storing the pH probe. If the post calibration drift is ± 0.2 pH units or more, censor all pH data back to the last calibration with the problem code "V".

1.3.4. *Dissolved oxygen (DO) sensor*: The DO sensor must be fully calibrated at the beginning and end of each multiple-day cruise according to manufacturer's specifications. DO sensors may be calibrated against water-saturated air or air-saturated water.

Check the DO calibration at the beginning of each sampling day. If daily checks drift by $\pm$ 0.3 mg DO/L or more, the sensor must be serviced and recalibrated before using again. If post-calibration drift is $\geq$ 0.5 mg/l, censor all DO data back to the last calibration with the problem code "V".

1.3.5. *Temperature sensor*: Check the agreement of the thermistor reading at least once a year against a NIST certified thermometer over a range of temperatures.

1.4. Procedure

1.4.1. Temperature, and DO measurements **must** be collected *in-situ* at the center of each width increment from which samples are collected. Do not take measurements on a discrete sample and avoid taking measurements near the stream banks, or in sections with turbulence or high velocities.

1.4.2. Lower the sensors below the surface and allow at least one minute to equilibrate. When stable, record the values on the field data sheet or data logger. Move to the next EWI in the cross-section and repeat the procedure.

1.4.2.1. Record all readings and report the median temperature and median DO values within the cross-section.

1.4.3. Specific Conductance should be measured *in-situ* at the center of each EWI increment. (If this is not feasible, measure the conductivity of a composite sample dispensed from the churn splitter. Do not take conductivity and pH measurements on the same discrete sample because the pH electrode solution may contaminate the sample and affect the specific conductance.)

1.4.3.1. The use of a temperature-compensating instrument is recommended so that manual temperature corrections are unnecessary.

1.4.3.2. Lower the conductivity sensor below the surface and gently move it up and down to remove trapped air bubbles. Continue moving until the meter display stabilizes. Record the value on the field data sheet and then move to the next EWI in the cross section and repeat the procedure above.

1.4.3.3. Record all readings and report the median specific conductance and pH values to three or more significant figures.

For more detailed guidance, consult the U.S. Geological Survey procedures in the *National field manual for the collection of water-quality data*. (http://pubs.water.usgs.gov/twri9A)

SECTION D

NONTIDAL WQ LABORATORY METHODS

Analytical methods for Chesapeake Bay nontidal samples are fully described in Chapter 6, Section D. Table 5.5 below lists the method used for each parameter and a reference to the Chesapeake Bay Program (CBP) method. CBP analytical methods contain specifications for the analysis of tidal and nontidal samples and are written in Chapter 6 of *Methods and Quality Assurance for Chesapeake Bay Program Water Quality Monitoring Programs* (this document).

Table 5.5. Laboratory Methods for Chesapeake Bay Nontidal Water Quality Network

Parameter	Method	Chapter 6 Section
Ammonium, as N (dissolved) (NH4F)	EPA 350.1	**D.2**
Nitrate + Nitrite, as N (dissolved) (NO23F)	EPA 353.2	**D.5**
Total Dissolved Nitrogen (TDN), and Total Nitrogen, as N (TN)	Standard Methods, Method 4500-N C-2011, or 4500-P J. (alkaline persulfate digestion)	**D.1 and D.5**
Particulate Nitrogen (PN)	EPA 440.0	**D.9**
Total Phosphorus, as P (TP)	EPA 365.1 or 365.4	**D.8**
Total Dissolved Phosphorus (TDP)	Alkaline persulfate (SM 4500-P J-2011) or acid digestion, then EPA 365.1	**D.1 and D.8**
Ortho Phosphate, as P (dissolved) (PO4F)	EPA 365.1	**D.8**
Particulate Phosphorus (PP)	Combustion & acid extraction, then EPA 365.1	**D.10**
Total Organic Carbon (TOC)	Standard Methods, Method 5310 B-2011	**D.7**
Dissolved Organic Carbon (DOC)	Standard Methods, Method 5310 B-2011	**D.7**
Particulate Carbon (PC)	EPA 440.0	**D.9**
Suspended Sediment Concentration (SSC)	ASTM 3977-97, Method B (filtration)	**None**
Suspended Sediment, Coarse (> 62µm) (SSC_SAND)	ASTM 3977-97, Method C (wet sieve)	**None**
Suspended Sediment, Fine (< 62µm) (SSC_FINE)	ASTM 3977-97, Method C	**None**
Total Suspended Solids (TSS)	Standard Methods, Method 2540 D-2011, or USGS I-3765	**D.11**
Volatile Suspended Solids (VSS)	Standard Methods, Method 2540 E-2011, or USGS I-3765	**D.12**
Chlorophyll-*a* (CHLA)	Standard Methods, Method 10200 H	**D.3**

SECTION E

REFERENCES

1. Chesapeake Bay Program. 2004. *Establishing a Chesapeake Bay Nontidal Watershed Water-Quality Network*, Sept. 2004. Prepared by the Chesapeake Bay Program Nontidal Water Quality Monitoring Workgroup. http://archive.chesapeakebay.net/pubs/subcommittee/msc/ntwqwg/Nontidal_Monitoring_Report.pdf

2. U.S. Geological Survey, variously dated. *National field manual for the collection of water-quality data*. U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1-A9, available online at http://pubs.water.usgs.gov/twri9A.

3. U.S. Geological Survey. 1999. *Field methods for the measurement of fluvial sediment.* U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chapter C2, available online at http://pubs.usgs.gov/twri/twri3-c2/.

4. U.S. Geological Survey. 2005. *A guide to the proper selection and use of federally approved sediment and water-quality samplers.* USGS Open-File Report 2005-1087, available online at http://pubs.usgs.gov/of/2005/1087/pdf/OFR_2005-1087.pdf

Appendix 5-A

An Annual Randomized and Stratified Procedure to Obtain Field QC Samples Representative of Varying Environmental, Weather and Flow Conditions among Nontidal Network Monitoring Sites

Background and Perspective on QC Sampling Design and Process

The QC sampling design and process described below provides a completely randomized design which over time will provide representative QC samples that cover a data collector's stations every water year (WY), at the frequency required for Field Blanks (FBs) and Duplicate Samples (DSs), and for both non-storm and storm or storm-impacted flows during different seasons (just not at the same station). However, if this design process is repeated every new WY, it also will provide QC data for every station that accounts for Seasonal x WY variations in the environmental conditions at each station.

The QC sampling design and process for each WY must be done twice—once for FB collection and again for DS collection. We do not want to make the collection of FBs and DSs totally dependent upon one another for pragmatic reasons. It also is much easier to design their collection independently. That said, both types of QC samples could be collected during the same sample visit to a station when the independent designs indicate both types of QC samples are to be collected for similar flow conditions during a similar time period and field crews aren't heavily pressed to also sample many other stations as well.

The QC sampling design and process described below is meant to provide a common starting point for all NTN sampling groups to determine QC sampling for a given WY. As the WY actually unfolds, logic and common sense and safety issues will influence whether or not one can collect the targeted QC sampling of flow conditions at a given station during the specified time period that this design initially provides. For example, if the design indicates DSs are to be collected at three specific NTN Stations sometime during the months of October through December, and Hurricane Charley hits, does the field crew give up sampling at ten of their NTN Stations in order to collect WQ samples at only 7 of these stations and the DSs as dictated by the design at 3 of those 7 stations? Common sense would say no. But the field crew might take DSs at one of these stations because the water quality at that Station under such storm conditions is extremely important (for example, that particular Station among all others is a huge contributor to nutrients and suspended sediment at high flows).

As another example, what happens if for the same design results above, the region is locked into a severe drought during this time period? Does the field crew not take any DSs at these three stations because there aren't any storms or storm impacted flows? Again, common sense would dictate that one obtain the QC data for non-storm impacted flows because that in the end was the extended flow condition at each of these stations during the period QC samples were to be taken at these stations. However, one also might spread out the DS sample collection at these three stations during this three-month period on the off chance that a storm could occur in the latter part of the period, rather than take all three DS at these three stations in the last month of the period.

The QC sampling design and process described below also uses some very simple tools and processes to randomize the QC sampling design. Other truly randomizing tools and techniques no doubt exist and can be used. However, the four-step sequence used makes it simple to carry out the design.

Randomized Design and Design Process for NTN Quality-Control Sampling

The process described below is for Field Blank (FB) collection for one WY. It is simply repeated for Duplicate Sample (DS) collection for that WY taking into account that twice as many DSs than FBs are to be collected at a NTN station each WY. The process for FBs and DSs would be repeated each WY before sample collection began for that WY. Repeating these processes prior to the upcoming WY is essential to ensuring sampling is representative of varying environmental, weather and flow conditions that can occur at each station within a WY from WY to WY.

For each Data Provider x Data Collector combination in Table 5-A.1 for which your agency collects samples:

1. **Determine the Number of FBs to collect:** Equals the number of NTN stations being monitored that WY by the NTN Data Collector; given one FB is to be collected per station per WY. Be sure to annually update to reflect actual stations in that group for the upcoming new WY.

2. **Determine Order of FB Collection at those Stations**: Place an identical type, but station ID labeled, marker for each of the N stations in a bag; shake and select one marker from the bag without replacement; repeat process until all N markers have been withdrawn. List each marker station ID in the order in which it was withdrawn. The order of stations selection is the order in which FBs are collected at those stations during the WY.

3. **Determine EVENT_TYPEs for which FBs will be Collected:** For **1st** station in ordered list, flip a fair coin to determine whether the FB will be collected during a routine (R or RSI) Event_Type or a storm (S) Event_Type. Assign all other "odd" numbered stations in the ordered list the same Event_Type as that determined for the 1st Station; assign all remaining and "even" numbered stations on the ordered list the other Event_Type.

4. **Determine who collects FBs at Stations where more than one Agency group collects data:** At shared monitoring stations, FB collection is logically distributed among data collectors on the FB Event Types (e.g., USGS-VAWSC collects storm FBs, VADEQ Regional Offices collect routine event types at their shared stations) and or their intra-annual periods of monitoring (e.g., NYSDEC collects FBs for only routine events for half the WY they conduct monitoring; SRBC collects FBs for routine events during the other half of the WY they conduct monitoring; in addition, SRBC collects FBs for all storms throughout the WY).

5. **Determine when FBs actually are collected during the WY:** Using the table below, and given the total number of FBs to be collected (N) in the WY, determine the type and number of FB collection periods, over which the N FBs will be distributed in accordance with the order in which they were listed. This timing schedule effectively provides for the uniform distribution of FB collection throughout the WY across environmental conditions (possible weather x flow (Event_Types) x

station setting).

6. **Final Adjustments to FB collection:** Use of a fixed protocol requiring one FB be collected at each NTN station every WY doesn't provide representative FB data throughout the WY if N is very small (2 stations). It also could adversely affect WQ sampling at many stations during storm or storm-impacted conditions because of the required high frequency of FB collection each WY when N is very large (12 or more stations).

Table 5-A.1
Scheduling Nontidal Network (NTN) field blank (FB) or duplicate sample (DS) collection for a Water Year

Number of FBs or Duplicate Pairs per WY	Schedule for Field Blank (FB) or Duplicate Sample (DS) collection
1	Not applicable at present
2	Semiannual: Collect one FB (DS) in each of two sequential 6-month periods of WY
3	Triennially: Collect one FB (DS) in each three sequential 4-month periods of WY
4	Quarterly: Collect one FB (DS) in each of four sequential 3-month periods in the WY
5	Quarterly: Collect one FB (DS) in each of four sequential 3-month periods in the WY, randomly select one 3-month period in which 5th FB (DS) is collected
6	Triennially: Collect two FBs (DSs) in each of three sequential 4-month periods in WY
7	Triennially: Collect two FBs (DSs) in each of three sequential 4-month periods, randomly selected one 3-month period in which the 7th FB is collected
8	Quarterly: Collect two FBs (DSs) in each of four sequential 3-month periods of WY
9	Triennially: Collect three FBs (DSs) in each of three sequential 4-month periods of WY
10	Triennially: Collect three FBs (DSs) in each of three 4 month-periods, randomly selected one three-month period when 10 FB (DS) is collected
11	Quarterly: Collect three FBs (DSs) in three 3-month periods, randomly selecting one 3-month period in WY when only two FBs (DSs) are collected
12	Quarterly: Collect three FBs (DSs) in each of four sequential 3-month periods month in WY
13	Quarterly: Collect three FBs (DSs) in each of four 3-month periods month in WY, randomly select one 3-month period when 13th FB (DS) is collected
14	Triennially: Collect five FBs (DSs) in each of two 4-month periods in WY, randomly select one 4-month period when 14th FB is collected
15	Triennially: Collect five FBs (DSs) in each of three sequential 4-month periods in WY
16	Quarterly: Collect four FBs (DSs) in each of four sequential 3-month periods of the WY
17	Quarterly: Collecting four FBs (DSs) in each of four sequential 3-month periods, randomly selected one 3-month period in which 17th FB is collected
18	Triennially: Collect six FBs (DSs) in each of three 4-month periods of WY
19	Quarterly: Collect five FBs (DSs) in each of three 3-month periods, randomly selected one 3-month period in which 4 FBs (DSs) are collected
20	Quarterly: Collect five FBs (DSs) in each sequential 3-month period of WY
21	Triennially: Collect seven FBs (DSs) in each sequential 4-month period of WY
22	Triennially: Collect seven FBs (DSs) in each sequential 4-month period of WY, randomly selected one 4-month period in which 22nd FB (DS) is collected
23	Quarterly: Collect six FBs (DSs) in each of four 3-month periods, randomly select one 3-month period in which five FBs (DSs) are collected
24	Quarterly: Collect six FBs (DSs) in each of four sequential 3-month periods of WY

Table 5-A.2

Minimum Number of Field Blank and Duplicate Samples for CBP Nontidal Network Collection Groups

(Based on Water Year 2015 Monitoring Stations)

Data Provider	Data Collector	Event Type	Monitoring Location Name (WY 2015)	Field Blank & Duplicate Samples (minimum per year)
DEDNREC	DEDNREC	R, RSI, S, ONS or OS	304191, 302031.	2 Field Blanks 4 Field Duplicates
USGSWV	USGSWV	R, RSI, S, ONS or OS	01595300, 01614000, 01636500, 01604500, 01608500, 01611500, 01613030, 01616400, 01616500, 01618100.	10 Field Blanks 20 Field Duplicates
SRBC (NY)	SRBC	R, RSI, S, ONS or OS	01502500, 01503000, 01529500.	3 Field Blanks 6 Field Duplicates
SRBC	SRBC or NYSDEC	R, RSI, S, ONS or OS	01515000, 01531000	2 Field Blanks 4 Field Duplicates
MDDNR	MDDNR	R, RSI, S, ONS or OS	TUK0181, BEL0053, DER0015, GUN0258, NPA0165, GWN0115, PXT0972, TF1.2, GEO0009, WIL0013, ANT0047, CAC0148, MON0546, LXT0200, MGN0062, NWA0016, WCK0001, MKB0016, CON0180, LIC0042, TOC0037, ANT0366, SID0015, TOW0030.	24 Field Blanks 24 Field Duplicates
USGSMD	USGSMD (Maryland RIM)	R, RSI, S, ONS or OS	01491000, 01578310, 01594440, 01646580.	4 Field Blanks 8 Field Duplicates
USGSMD	USGSMD	R, RSI, S, ONS or OS	01648010, 01651770, 01651800, 01493112, 01581752, 01658000.	6 Field Blanks 12 Field Duplicates
PADEP	SRBC	R, RSI, S, ONS or OS	WQN0201, WQN0214, WQN0273, WQN0301, WQN0305, WQN0401, WQN0204, WQN0210, WQN0223, WQN0229, WQN0243, WQN0263, WQN0271, WQN0272, WQN0302, WQN0404, WQN0445, WQN0448, WQN0226, WQN0281, WQN0282.	21 Field Blanks 24 Field Duplicates
PADEP	USGSPA	R, RSI, S, ONS or OS	WQN0202, WQN0203, WQN0212, WQN0217, WQN0317, WQN0410, WQN0224, WQN0259, WQN0269, WQN0278, WQN0280, WQN0284, WQN0285, WQN0286, WQN0462.	15 Field Blanks 24 Field Duplicates
VADEQ	USGSVA (Virginia RIM+)	R, RSI, S, ONS or OS	TF5.0A, TF4.0P, TF5.0J, TF3.0, TF4.0M, 2-JMS113.20	6 Field Blanks 12 Field Duplicates
VADEQ	USGSVA	R, RSI, S, ONS or OS	1BNFS010.34, 1BSMT004.60, 1BSSF003.56, 2-CHK035.26, 2-JMS113.20, 3-RAP030.21, 8-NAR005.42, BMDD005.81, 1ADIF000.86, 7-DRN010.48, 1ASOQ006.73, 8-PCT000.76, 1AACO014.57.	13 Field Blanks 24 Field Duplicates
VADEQ	VADEQ/SCRO or USGSVA	R, RSI, S, ONS or OS	2-JMS279.41, 2-APP110.93.	2 Field Blanks 4 Field Duplicates
VADEQ	VADEQ/NRO or USGSVA	R, RSI, S, ONS or OS	3-RPP147.49, 8-MPN094.94.	2 Field Blanks 4 Field Duplicates
VADEQ	VADEQ/VRO or USGSVA	R, RSI, S, ONS or OS	2-RVN015.97, 1BSSF100.10.	2 Field Blanks 4 Field Duplicates
VADEQ	VADEQ/NRO (Secondary)	R, RSI, or ONS	3-RAP066.54, 3-ROB001.90, 8-POR008.97, 1ACAX004.57, 1ACAX004.57.	5 blanks, 5 duplicates (quarterly)
VADEQ	VADEQ/VRO (Secondary)	R, RSI, or ONS	1BSTH027.85, 2-BCC004.71, 2-BLP000.79, 2-CFP004.67, 2-MCM005.12, 2-MRY014.78.	6 blanks, 6 duplicates
VADEQ	VADEQ/PRO (Secondary)	R, RSI or ONS	8-LTL009.54, 2-DPC005.20.	2 blanks, 2 duplicates (quarterly)

Appendix 5-B

CBP Nontidal Network Water Quality Stations, Locations and Streamflow Gages (123 stations)

FIPS State Code	USGS Stream Gage	Location Name	Monitoring Location Description	Latitude Measure	Long. Measure	Data Collector
DC	01648010	01648010	Rock Creek at Joyce Road at Washington, DC	38.9602	-77.0421	USGSMD
DC	01651770	01651770	Hickey Run at New York Avenue at Washington, DC	38.9171	-76.9693	USGSMD
DC	01651800	01651800	Watts Branch at Washington, DC	38.9011	-76.9422	USGSMD
DE	01488500	304191	Marshyhope Creek near Adamsville, DE	38.8497	-75.6733	DEDNREC
DE	01487000	302031	Nanticoke River near Bridgeville, DE	38.7292	-75.5614	DEDNREC
MD	01619500	ANT0047	Antietam Creek near Sharpsburg, MD	39.4504	-77.7317	MDDNR
MD	01495000	BEL0053	Big Elk Creek at Elk Mills, MD	39.6571	-75.8224	MDDNR
MD	01637500	CAC0148	Catoctin Creek near Middletown, MD	39.4258	-77.5590	MDDNR
MD	01614500	CON0180	Conococheague Creek at Fairview, MD	39.7158	-77.8245	MDDNR
MD	01580520	DER0015	Deer Creek near Darlington, MD	39.6235	-76.1648	MDDNR
MD	01599000	GEO0009	Georges Creek at Franklin, MD	39.4936	-79.0447	MDDNR
MD	01582500	GUN0258	Gunpowder Falls at Glencoe, MD	39.5506	-76.6359	MDDNR
MD	01589300	GWN0115	Gwynns Falls at Villa Nova, MD	39.3428	-76.7264	MDDNR
MD	01613525	LIC0042	Licking Creek at Pectonville, MD	39.6777	-78.0365	MDDNR
MD	01593500	LXT0200	Little Patuxent River at Guilford, MD	39.1678	-76.8513	MDDNR
MD	01493500	MGN0062	Morgan Creek near Kennedyville, MD	39.2800	-76.0146	MDDNR
MD	01486000	MKB0016	Manokin Branch near Princess Anne, MD	38.2139	-75.6714	MDDNR
MD	01639000	MON0546	Monocacy River at Bridgeport, MD	39.6965	-77.2395	MDDNR
MD	01586000	NPA0165	North Branch Patapsco River at Cedarhurst, MD	39.5011	-76.8835	MDDNR
MD	01651000	NWA0016	NW Branch Anacostia River near Hyattsville, MD	38.9523	-76.9661	MDDNR
MD	01591000	PXT0972	Patuxent River near Unity, MD	39.2393	-77.0562	MDDNR
MD	01610155	SID0015	Sideling Hill Creek near Bellegrove, MD	39.6495	-78.3441	MDDNR
MD	01594526	TF1.2	Western Branch at Upper Marlboro, MD	38.8143	-76.7509	MDDNR
MD	01613095	TOC0037	Tonoloway Creek near Hancock, MD	39.7064	-78.1528	MDDNR
MD	01609000	TOW0030	Town Creek near Oldtown, MD	39.5532	-78.5550	MDDNR
MD	01491500	TUK0181	Tuckahoe Creek near Ruthsburg, MD	38.9671	-75.9431	MDDNR
MD	0158175320	WCK0001	Wheel Creek near Abingdon, MD	39.4817	-76.3405	MDDNR

FIPS State Code	USGS Stream Gage	Location Name	Monitoring Location Description	Latitude Measure	Long. Measure	Data Collector
MD	01601500	WIL0013	Wills Creek near Cumberland, MD	39.6619	-78.7803	MDDNR
MD	01578475	WQN0263	Octoraro Creek near Richardsmere, MD	39.6903	-76.1281	SRBC
MD	01493112	01493112	Chesterville Branch near Crumpton, MD	39.2571	-75.9401	USGSMD
MD	01581752	01581752	Plumtree Run near Bel Air, MD	39.4964	-76.3478	USGSMD
MD	01658000	01658000	Mattawoman Creek near Pomonkey, MD	38.5961	-77.0560	USGSMD
MD	01491000	01491000	Choptank River near Greensboro, MD (RIM)	38.9972	-75.7861	USGSMD
MD	01578310	01578310	Susquehanna River at Conowingo, MD (RIM)	39.6587	-76.1741	USGSMD
MD	01594440	01594440	Patuxent River near Bowie, MD (RIM)	38.9558	-76.6933	USGSMD
MD	01646580	01646580	Potomac River at Chain Bridge, Washington, DC (RIM)	38.9296	-77.1169	USGSMD
NY	01502500	01502500	Unadilla River at Rockdale, NY	42.3778	-75.4064	SRBC
NY	01503000	01503000	Susquehanna River at Conklin, NY	42.0353	-75.8033	SRBC
NY	01529500	01529500	Cohocton River near Campbell, NY	42.2525	-77.2169	SRBC
NY	01515000	01515000	Susquehanna River near Waverly, NY	41.9856	-76.5017	SRBC, NYSDEC
NY	01531000	01531000	Chemung River at Chemung, NY	42.0022	-76.6350	SRBC, NYSDEC
PA	01619000	ANT0366	Antietam Creek near Waynesboro, PA	39.7169	-77.6078	MDDNR
PA	01576000	WQN0201	Susquehanna River at Marietta, PA	40.0544	-76.5311	SRBC
PA	01576787	WQN0204	Pequea Creek at Martic Forge, PA	39.9058	-76.3284	SRBC
PA	01574000	WQN0210	West Conewago Creek near Manchester, PA	40.0822	-76.7203	SRBC
PA	01567000	WQN0214	Juniata River at Newport, PA	40.4783	-77.1295	SRBC
PA	01562000	WQN0223	Raystown Branch Juniata River at Saxton, PA	40.2158	-78.2656	SRBC
PA	01555500	WQN0226	East Mahantango Creek near Dalmatia, PA	40.6111	-76.9122	SRBC
PA	01555000	WQN0229	Penns Creek at Penns Creek, PA	40.8667	-77.0486	SRBC
PA	01576754	WQN0273	Conestoga River at Conestoga, PA	39.9464	-76.3681	SRBC
PA	01568000	WQN0243	Sherman Creek at Shermans Dale, PA	40.3233	-77.1692	SRBC
PA	01570000	WQN0271	Conodoguinet Creek near Hogestown, PA	40.2522	-77.0214	SRBC
PA	01573560	WQN0272	Swatara Creek near Hershey, PA	40.2983	-76.6681	SRBC
PA	01571000	WQN0281	Paxton Creek near Penbrook, PA	40.3083	-76.8500	SRBC
PA	01565000	WQN082	Kishacoquillas Creek at Reedsville, PA	40.6547	-77.5833	SRBC
PA	01540500	WQN0301	Susquehanna River at Danville, PA	40.9581	-76.6195	SRBC
PA	01536500	WQN0302	Susquehanna River at Wilkes-Barre, PA	41.2508	-75.8811	SRBC

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PA	01531500	WQN0305	Susquehanna River at Towanda, PA	41.7653	-76.4411	SRBC
PA	01553500	WQN0401	West Branch Susquehanna River at Lewisburg, PA	40.9681	-76.8736	SRBC
PA	01542500	WQN0404	West Branch Susquehanna River at Karthaus, PA	41.1175	-78.1092	SRBC
PA	01548005	WQN0445	Bald Eagle Creek near Beech Creek Station, PA	41.0801	-77.5475	SRBC
PA	01549760	WQN0448	West Branch Susquehanna R. at Jersey Shore, PA	41.2023	-77.2521	SRBC
PA	01570500	WQN0202	Susquehanna River at Harrisburg, PA	40.2547	-76.8864	USGSPA
PA	01554000	WQN0203	Susquehanna River at Sunbury, PA	40.8344	-76.8269	USGSPA
PA	01571500	WQN0212	Yellow Breeches Creek near Camp Hill, PA	40.2247	-76.8983	USGSPA
PA	01558000	WQN0217	Little Juniata River at Spruce Creek, PA	40.6126	-78.1406	USGSPA
PA	01556000	WQN0224	Frankstown Branch Juniata R. at Williamsburg, PA	40.4631	-78.1997	USGSPA
PA	01577500	WQN0259	Muddy Creek at Castle Fin, PA	39.7725	-76.3161	USGSPA
PA	01573710	WQN0269	Conewago Creek near Falmouth, PA	40.1511	-76.6900	USGSPA
PA	01573695	WQN0278	Conewago Creek near Bellaire, PA	40.1953	-76.5678	USGSPA
PA	015765195	WQN0280	Big Spring Run near Mylin Corners, PA	39.9959	-76.2640	USGSPA
PA	01576767	WQN0284	Pequea Creek near Ronks, PA	40.0091	-76.1618	USGSPA
PA	01573160	WQN0285	Quittapahilla Creek near Bellegrove	40.3426	-76.5627	USGSPA
PA	01575585	WQN0286	Codorus Creek near Pleasureville, PA	40.0186	-76.6933	USGSPA
PA	01534000	WQN0317	Tunkhannock Creek near Tunkhannock, PA	41.5573	-75.8944	USGSPA
PA	01549700	WQN0410	Pine Creek below Little Pine Cr. near Waterville, PA	41.2831	-77.3222	USGSPA
PA	01553850	WQN0462	Chillisquaque Creek near Potts Grove, PA	40.9744	-76.8000	USGSPA
VA	01654000	1AACO014.57	Accotink Creek near Annandale, VA	38.8113	-77.2302	USGSVA
VA	01646000	1ADIF000.86	Difficult Run near Great Falls, VA	38.9758	-77.2461	USGSVA
VA	01658500	1ASOQ006.73	S F Quantico Creek near Independent Hill, VA	38.5872	-77.4289	USGSVA
VA	01621050	1BMDD005.81	Muddy Creek at Mount Clinton, VA	38.4867	-78.9606	USGSVA
VA	01634000	1BNFS010.34	N F Shenandoah River near Strasburg, VA	38.9768	-78.3367	USGSVA
VA	01632900	1BSMT004.60	Smith Creek near New Market, VA	38.6935	-78.6428	USGSVA
VA	01631000	1BSSF003.56	S F Shenandoah River at Front Royal, VA	38.9137	-78.2098	USGSVA
VA	02042500	2-CHK035.26	Chickahominy River near Providence Forge, VA	37.4358	-77.0608	USGSVA
VA	02037500	2-JMS113.20	James River near Richmond, VA	37.5631	-77.5472	USGSVA
VA	01667500	3-RAP030.21	Rapidan River near Culpeper, VA	38.3590	-77.9733	USGSVA
VA	01669520	7-DRN010.48	Dragon Swamp at Mascot, VA	37.6336	-76.6967	USGSVA

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VA	01671020	8-NAR005.42	North Anna River at Hart Corner near Doswell, VA	37.8501	-77.4278	USGSVA
VA	01674182	8-PCT000.76	Polecat Creek at Route 301 near Penola, VA	37.9603	-77.3436	USGSVA
VA	01668000	TF3.0	Rappahannock River near Fredericksburg, VA (RIM)	38.3224	-77.5178	USGSVA
VA	01674500	TF4.0M	Mattaponi River near Beulahville, VA (RIM)	37.8843	-77.1630	USGSVA
VA	01673000	TF4.0P	Pamunkey River near Hanover, VA (RIM)	37.7679	-77.3319	USGSVA
VA	02041650	TF5.0A	Appomattox River at Matoaca, VA (RIM)	37.2250	-77.4756	USGSVA
VA	02035000	TF5.0J	James River at Cartersville, VA (RIM)	37.6711	-78.0858	USGSVA
VA	01664000	3-RPP147.49	Rappahannock River at Remington, VA	38.5289	-77.8203	VADEQ/NRO, USGSVA
VA	01674000	8-MPN094.94	Mattaponi River near Bowling Green, VA	38.0618	-77.3860	VADEQ/NRO, USGSVA
VA	02039500	2-APP110.93	Appomattox River at Farmville, VA	37.3074	-78.3890	VADEQ/SCRO, USGSVA
VA	02024752	2-JMS279.41	James River At Blue Ridge Pkwy near Big Island, VA	37.5555	-79.3672	VADEQ/SCRO, USGSVA
VA	01628500	1BSSF100.10	South Fork Shenandoah River near Lynnwood, VA	38.3129	-78.7700	VADEQ/VRO, USGSVA
VA	02034000	2-RVN015.97	Rivanna River at Palmyra, VA	37.8579	-78.2658	VADEQ/VRO, USGSVA
VA	01665500	3-RAP066.54	Rapidan River near Ruckersville, VA (secondary)	38.2799	-78.3408	VADEQ/NRO
VA	01666500	3-ROB001.90	Robinson River near Locust Dale, VA (secondary)	38.3251	-78.0953	VADEQ/NRO
VA	01673800	8-POR008.97	Po River near Spotsylvania, VA (secondary)	38.1712	-77.5950	VADEQ/NRO
VA	01638480	1ACAX004.57 (CVA0046)	Catoctin Creek at Taylorstown, VA (secondary)	39.2548	-77.5764	VADEQ/NRO
VA	02041000	2-DPC005.20	Deep Creek near Mannboro, VA (secondary)	37.2840	-77.8686	VADEQ/PRO
VA	01671100	8-LTL009.54	Little River near Doswell, VA (secondary)	37.8729	-77.5133	VADEQ/PRO
VA	01626000	1BSTH027.85	South River near Waynesboro, VA (secondary)	38.0574	-78.9078	VADEQ/VRO
VA	02011500	2-BCC004.71	Back Creek near Mountain Grove, VA (secondary)	38.0696	-79.8970	VADEQ/VRO
VA	02015700	2-BLP000.79	Bullpasture River at Williamsville, VA (secondary)	38.1953	-79.5706	VADEQ/VRO
VA	02020500	2-CFP004.67	Calfpasture River above Mill Creek at Goshen, VA (secondary)	37.9874	-79.4942	VADEQ/VRO
VA	02024000	2-MRY014.78	Maury River near Buena Vista, VA (secondary)	37.7522	-79.3919	VADEQ/VRO
VA	02031000	2-MCM005.12	Mechums River near White Hall, VA (secondary)	38.1027	-78.5929	VADEQ/VRO
WV	01595300	01595300	Abram Creek at Oakmont, WV	39.3672	-79.1782	USGSWV
WV	01604500	01604500	Patterson Creek near Headsville, WV	39.4431	-78.8222	USGSWV
WV	01608500	01608500	South Branch Potomac River near Springfield, WV	39.4469	-78.6544	USGSWV
WV	01611500	01611500	Cacapon River near Great Cacapon, WV	39.5822	-78.3100	USGSWV

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WV	01613030	01613030	Warm Springs Run near Berkeley Springs, WV	39.6405	-78.2185	USGSWV
WV	01614000	01614000	Back Creek near Jones Springs, WV	39.5118	-78.0365	USGSWV
WV	01616400	01616400	Mill Creek at Bunker Hill, WV	39.3344	-78.0534	USGSWV
WV	01616500	01616500	Opequon Creek near Martinsburg, WV	39.4236	-77.9389	USGSWV
WV	01618100	01618100	Rockymarsh Run at Scrabble, WV	39.4831	-77.8318	USGSWV
WV	01636500	01636500	Shenandoah River at Millville, WV	39.2819	-77.7894	USGSWV