Department of Public Works and Environmental Services
POLICIES AND PROCEDURES Memorandum No.: SWPD19-03

SUBJECT: Stormwater Planning Division Comprehensive Aquatic Monitoring Program Standard Operating Procedures

Effective: 7/25/2019 Revised: Approval:

I. Purpose

This standard operating procedure (SOP) document covers the comprehensive monitoring program for the Fairfax County Department of Public Works and Environmental Services, Stormwater Planning Division (SWPD), Watershed Assessment Branch (WAB), and applies to all Physical, Chemical and Biological Monitoring conducted in support of the following SWPD programs:

a. Stream Probabilistic Monitoring & Bioassessment
    i. Site Scoping
    ii. Benthic macroinvertebrates
    iii. Fish assemblages
    iv. Habitat assessment
b. Stream Bacteria Monitoring
c. USGS Gaged Network Watershed Monitoring
d. Lakes Monitoring

This document covers equipment, SOPs and quality assurance and quality control (QA/QC) practices associated with the planning, collection, processing, assessment, and reporting of monitoring data collected by the WAB Stream Monitoring Section. Standard operating procedures relevant to safety and health considerations for these monitoring activities are maintained under separate cover in the Fairfax County Stormwater Safety Manual.

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II. Site Selection Methodology

A. Background

This section describes the process used to randomly select probabilistic sites for benthic macroinvertebrate, fish, habitat, bacteria and water quality monitoring for each sampling year.

B. Desktop Selection of Sites

Stream sampling sites are randomly selected using a probabilistic design approach so that inferences on countywide stream health may be made with a high degree of confidence. Random selection of sites occurs from a defined stratum within the sample set of all potential stream sections within the county's borders. All stream segments are stratified by stream order based upon the perennial stream limits created from Fairfax County's perennial stream study which was completed in 2005 (Figure II.1). Using the Geographic Information System (GIS), the perennial stream layer is broken up into first through fifth orders based upon the Strahler stream order classification (Strahler 1957). Each stream order is broken into segments and the lengths of each segment are summed and used to calculate their percentages relative to the total length of streams in the County. These percentages are then used to calculate the number of sites within each stream order that need to be sampled based on a total number of 40 sites (Table II.1).

Table II.1: Target Number for Samples within Fairfax County

Stream Order	Percentage of streams in County	Number of sampling sites
1st	51%	20
2nd	25%	10
3rd	16%	7
4th	5%	2
5th	3%	1
Total	100%	40

This number of sites was chosen because it fit within department capacity, adequately covers the county's 30 watersheds and stream orders, and has large enough statistical power to detect trends across the county within management-relevant time frames. Using simulation to estimate power, we estimated that it would take 11 years of sampling to have greater than an 80% chance of detecting a change of 1.0 Index of Biotic Integrity (IBI) scoring units per year, and 18 years to detect a change of 0.5 scoring units per year (Figure II.2). In other words, 40 sites per year allows us to detect countywide trends between 10 and 20 years of sampling, when we assume relatively small rates of change in our IBI over time.

To select the site to be sampled, all segments within each of the strata (stream orders) are ordinated. A random number generator is then used to select a number along the stream order length. Using GIS, this point along the stream is located and a dot placed to mark its location. This is done for all 40 sites in each of the respective stream orders. A field map is created showing watershed name, tax map number, stream order, site number, aerial photography, streets and street names, address numbers, stormwater infrastructure, sewer lines and manholes, streams, parcels and the candidate site location as a point (example shown in Figure II.3).

A preliminary desktop review of the site is conducted to look for factors (such as proximity to manmade structures, tidal areas, property owners, inputs from other streams and the ability to fit a 100 meter reach) that may deem it unsuitable for sampling. If the site is deemed unsuitable from the preliminary review it is thrown out and a new site selected to replace it.

C. Final Field Selection of Sites

Once the list of candidate sampling locations has been generated, field investigations commence. Sampling locations that are difficult or impossible to access or sample are disqualified and removed from the list of candidate sites. Staff locate the selected site in the field and situate a suitable and representative 100meter reach within the location on the map only if the identified point from the GIS site selection exercise remains inside the newly chosen reach boundaries. Private landowners are notified of access needs for site monitoring during the initial site scoping visit. Accepted sites are photographed, measured and flagged in the field. Information from the field form (Figure II.4), photographs and GPS locations are all logged using a mobile platform application. A flag marked with US/MID/DS is placed on a tree at the upstream, middle and downstream points of the reach and a picture is taken of each (noting the direction the picture is taken in – looking US or DS). This information is utilized for locating the sites on future visits. Flags are removed at the end of the sampling year. Average stream width is observed and an estimated number of backpack electrofisher units and the approximate block net size needed (for summer fish collections) is noted. Field identification of sites continues in this fashion until the target number of sites (for each stratum) is reached.

Disqualifying factors include:

- Substantial inputs from tributary streams inside the 100 meter reach, or within 50-100 meters (depending on stream order) upstream or downstream of the candidate reach;
- Tidal areas
- The presence of hydraulic controls in the channel such as impoundments, off-line diversions, weirs, or large-scale channelization/stabilization structures (i.e.: concrete trapezoidal channels);
- Channels (natural or manmade) greatly impacted by construction or industrial activities, (i.e. quarry sluices, landfill trenches, etc.);
- Areas with limited or restricted access.

If a site is disqualified, another site is selected using the procedure from section B.

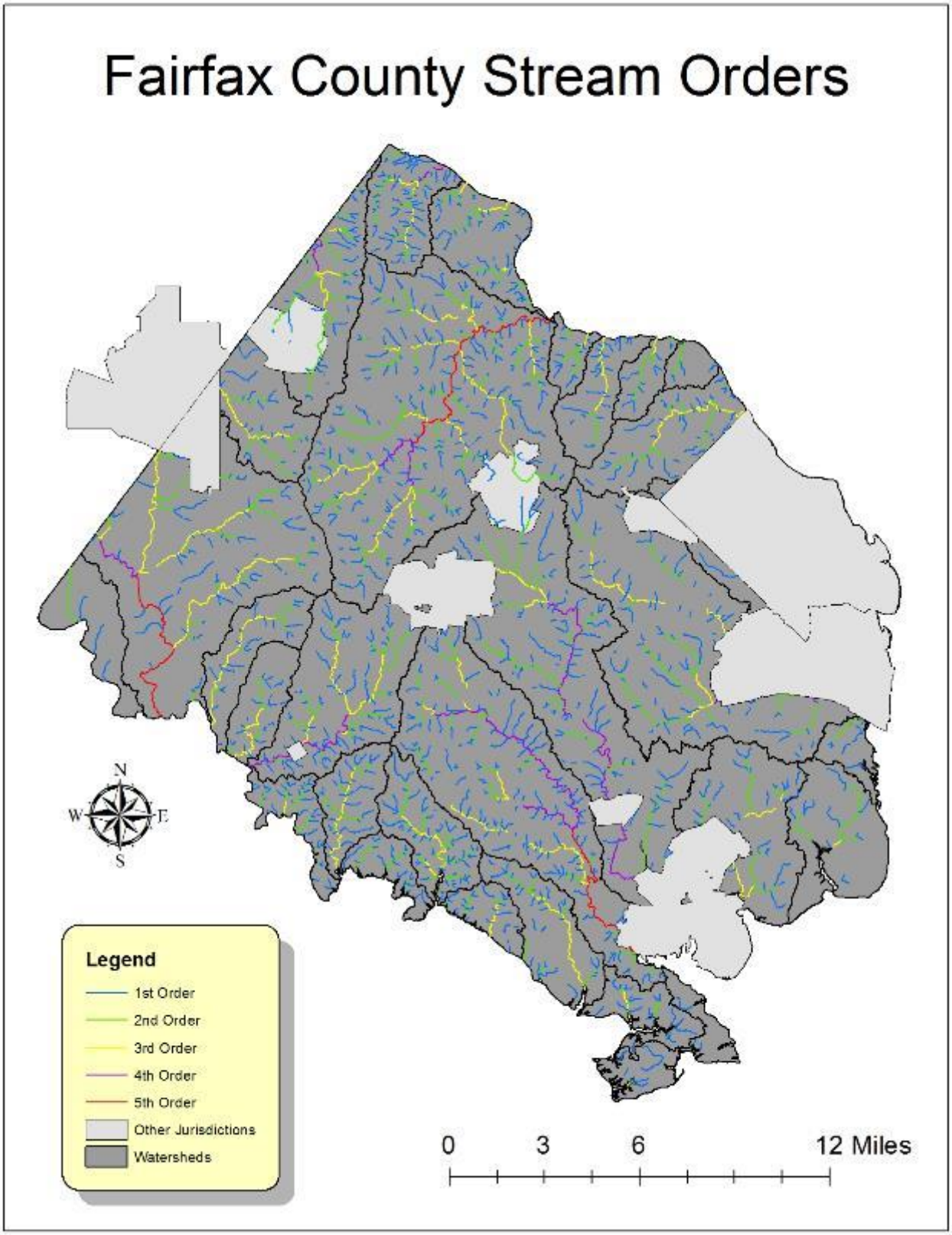

Figure II.1: Fairfax County Stream Orders

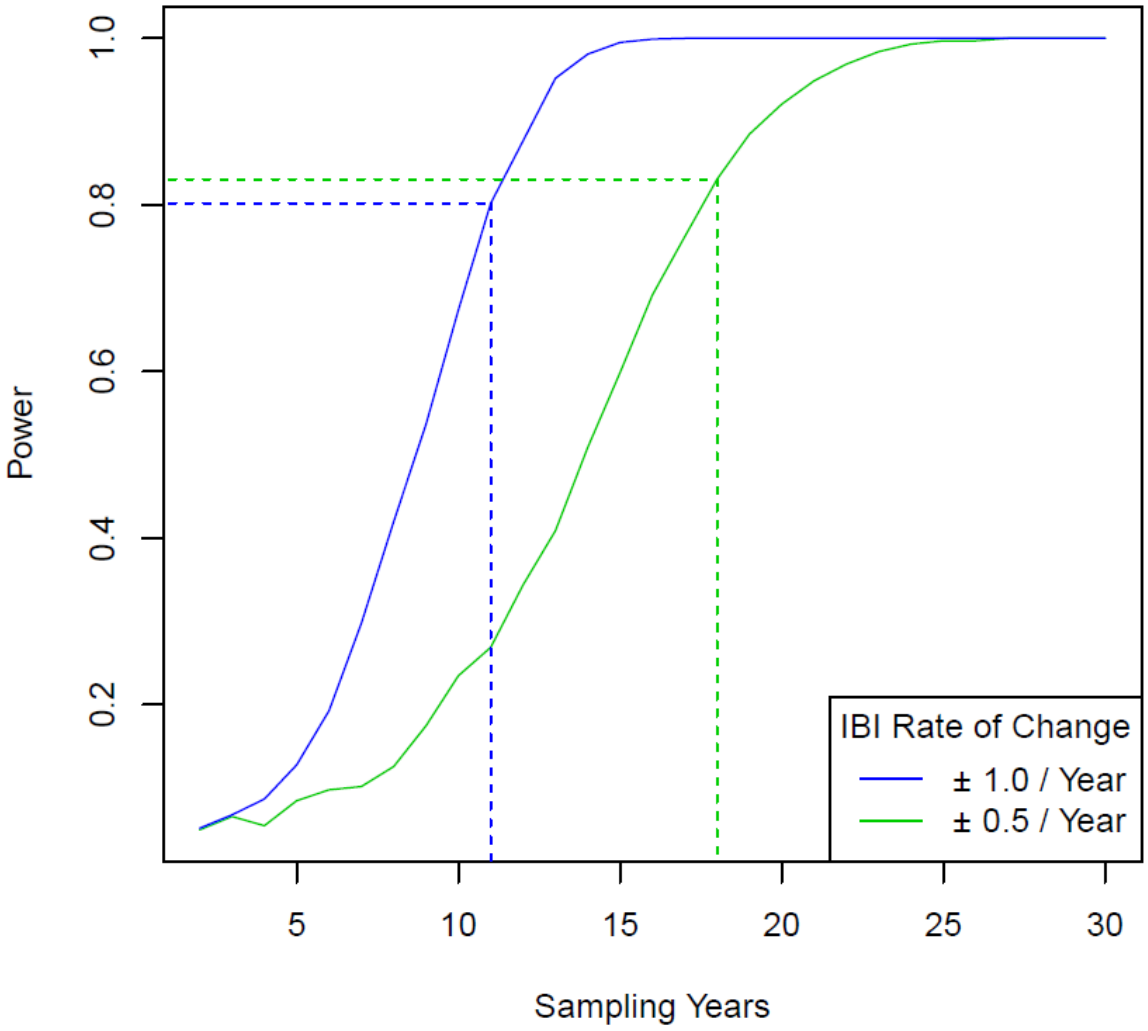

Figure II.2: Estimated Power as a Function of Sampling Duration and IBI Rate of Change. Dashed lines mark the number of years needed to exceed 80% power

D. References

Strahler, A.N. 1957. Quantitative analysis of watershed geomorphology. American Geophysical Union Transactions 38: 913-920.

E. Forms and Data Sheets

Figure II.3: Example Biomonitoring Site Scoping Form (Front)
Figure II.4: Example Biomonitoring Site Scoping Form (Back)

Figure II.3: Example Biomonitoring Site Scoping Form (Front)

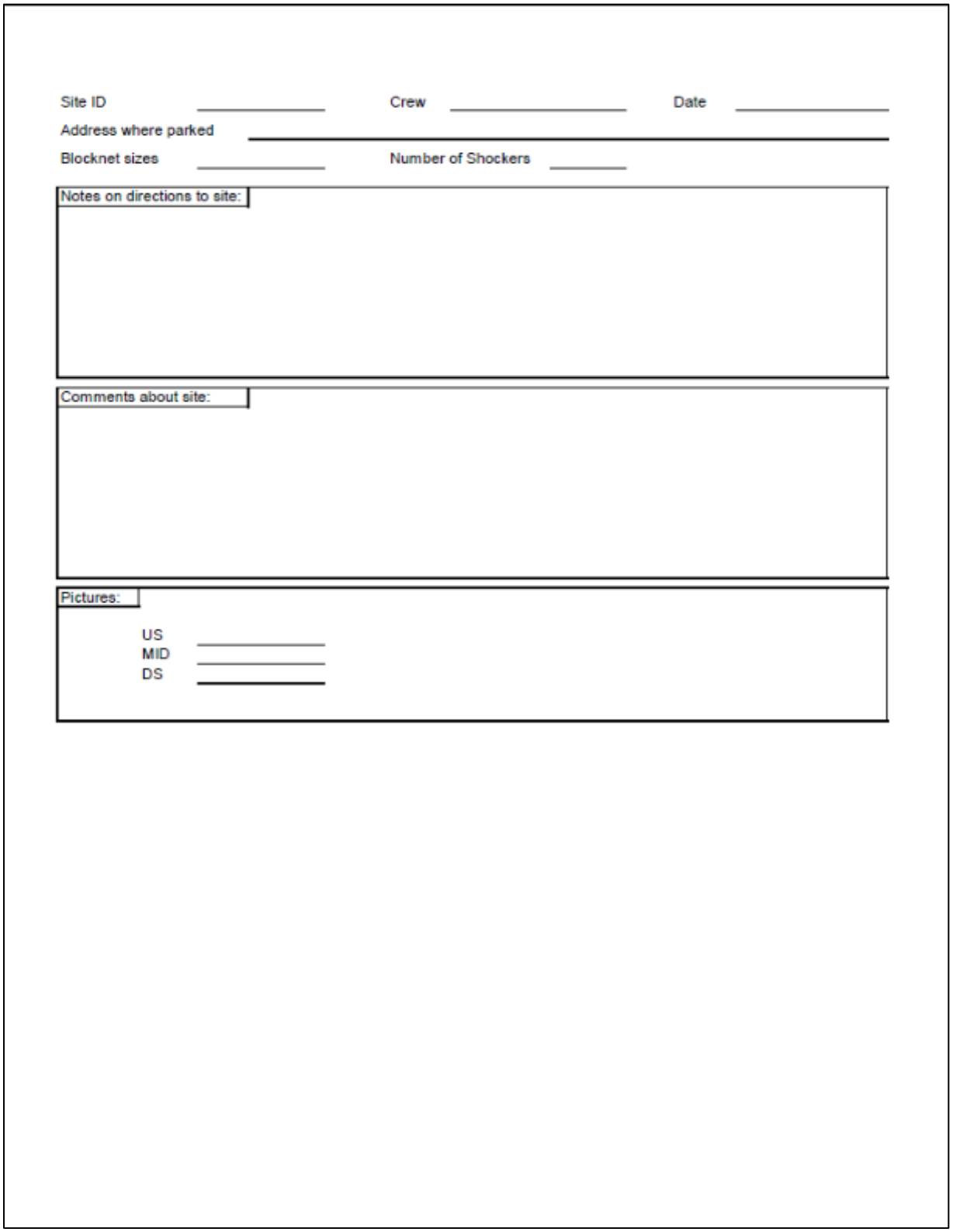

Figure II.4: Example Biomonitoring Site Scoping Form (Back)

III. Benthic Macroinvertebrates

A. Background

Benthic macroinvertebrate communities are a major component of any healthy stream system. They are an important link in the aquatic food web, forming the core diet of many stream fishes. These organisms are also useful indicators of water quality due to their short life spans and their varying tolerances to chemical, organic, and sediment pollution and altered hydrology.

B. Multi-habitat Field Sampling Methods

Since Fairfax County contains two different physiographic provinces (Piedmont and Coastal Plain) that each have a variety of different aquatic habitat types, a sampling method that incorporates all these types of habitats is used. Selected sites are sampled in the early spring between mid-March and mid-April (prior to the spring/summer emergence of many adult aquatic insects). The 100 m sampling reaches are sampled using the "20-Jab" or "multi-habitat" Mid-Atlantic Coastal Streams (MACS) workgroup method (US EPA, 1997). This method was designed specifically for streams with variable habitat structure and adopted for use in EPA's Rapid Bioassessment Protocol III (RBP III) for benthic macroinvertebrate sampling in streams and wadeable rivers (Barbour et al., 1999).

The following field equipment is used for multi-habitat sampling:

- Standard D-frame dip net, 500 µ opening mesh, 0.3 m width (~ 1.0 ft frame width)
- Sieve bucket, with 500 µ opening mesh
- Sieve with 500 µm opening mesh
- Large polyethylene wash tray
- 2 L HDPE Nalgene sample jars, lids & labels (internal and external)
- Forceps
- Packing tape
- Pencils, clipboard & calculator
- Benthic Macroinvertebrate Sampling Data Sheet
- Properly calibrated multi-parameter water quality sonde (See Section IV for calibration procedures)
- Field maps
- Waders and insulated neoprene gloves

Observed habitats within the sample reach are proportionally sampled using 20 approximately 0.5m-long "jabs" with a D-frame net. Habitats are designated as vegetated banks, submerged macrophytes (aquatic vegetation), sand, cobble and snags. Number of jabs per habitat type, as well as water quality data and field observations, are recorded on the Benthic Macroinvertebrate Sampling Data Sheet (Figures III.6-7).

Samples collected in the field have the larger organic debris removed and then are placed in 2 L HDPE jars. Sample jars are labelled both internally and externally with the site code, collection date and time, sample number and the collection team's initials. The collecting team members should ensure that the information on the internal and external labels match each other, as well as the information on the site map and field data sheet. Labeled jars are then transported to the laboratory where they are logged in on

the Benthic Macroinvertebrate Sample Log-In Sheet (see Fig. III.4), preserved with 95% denatured ethanol and stored in flameproof cabinets for later subsampling and taxonomic identification. Samples selected for processing (subsampling, sorting and enumeration) by an outside contractor are also logged in on a Fairfax County Benthic Macroinvertebrate Sample Chain-of-Custody form (see Fig. III.5).

All specimen collections are carried out in accordance with the guidelines set forth in the current Virginia Department of Game and Inland Fisheries (DGIF) Scientific Collection Permit issued to Fairfax County Ecologists on a bi-annual basis.

1. Quality Assurance and Quality Control (QA/QC)

For each monitoring year, five to ten percent of benthic sampling sites are selected for QC verification ("QC Sites"). These are used to evaluate precision and reproducibility of the sampling and analysis techniques. QC Sites are selected randomly from all sites sampled during the monitoring year, and consist of at least one sample collected at a randomly selected stream monitoring site, one sample collected at one of the county's designated fixed-location reference sites, and one sample collected at a USGS monitoring gage site.

At each QC Site, a 100-meter duplicate reach is identified adjacent to the preselected and scoped 100m sampling reach. The duplicate reach may be located upstream or downstream of the primary reach depending on its similarity to the original reach, the presence of tributary streams, stormwater outfalls or other instream factors. The downstream reach is always sampled prior to the upstream reach to avoid biasing the downstream sample. The duplicate reach is sampled on the same collection date as the sampling reach by the same team in accordance with the previously described SOP for benthic macroinvertebrate sample collection.

C. Laboratory Processing

The following laboratory equipment is used to subsample, sort and enumerate benthic macroinvertebrate samples:

- Previously collected benthic sample in 2 L HDPE jars(s)
- 8-inch diameter sieve with 500 µ mesh
- Benthic sample sorting grid (30 squares) with 500 µ mesh (Figure III.1)
- Subsampling square
- Polyethylene wash tray
- Magnifying glasses (optional)
- Dissecting microscopes (optional)
- Fiber-optic light source
- 95% ethanol (denatured)
- 20 ml screwtop glass specimen vials (with teflon lids) and label tape
- Three category or larger laboratory counter with grand total counter
- Petri dishes & extra-fine/jewelers forceps
- Benthic Macroinvertebrate Sorting Log-In Sheet

For each monitoring year, a Benthic Macroinvertebrate Sorting Log-in Sheet (see Fig. III.8) is generated with the site IDs of locations sampled. Field samples selected for in-house subsampling, sorting and enumeration are logged in on the correct record on the Sorting Log-in Sheet. Each sample is thoroughly rinsed with tap water and spread evenly over the surface of a 30 x 36 cm, 500 µ mesh sample sorting tray (Caton, 1991) (Figure III.1) [very large volume samples may be divided into two sorting trays.] The sorting tray is placed in enough water to cover the sample and allowed to hydrate for approximately 10 minutes.

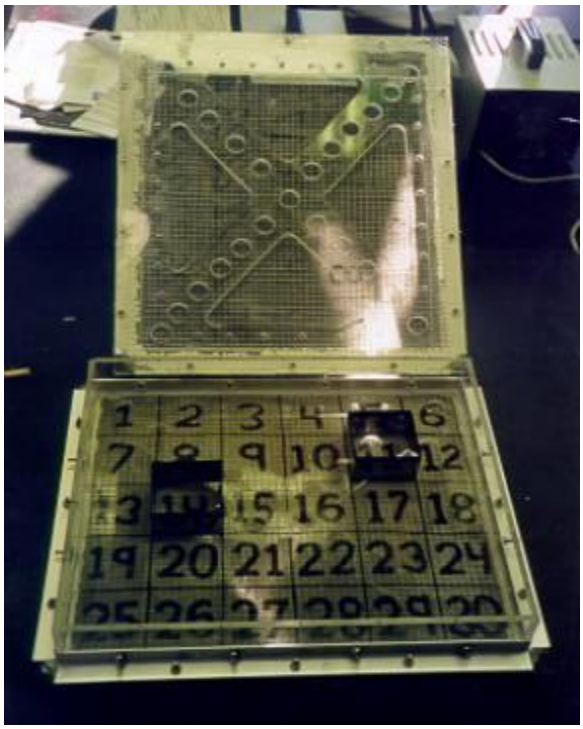

Figure III.1: Benthic Sample Sorting Grid and Subsampling Square

A subsample of individuals is picked or "sorted" from a randomly selected square subdivision marked on the tray's surface (30 total squares). This is accomplished by removing debris and organisms from the randomly selected square, placing this mixture into a white water-filled plastic tray, which is illuminated via fiber optic lights, and carefully removing all organisms (a 2x or 3x magnifying glass may be used for subsampling, and a microscope may be used to verify an organism). Once that square is fully picked, another randomly selected square is then picked until a minimum of 200 (not to exceed 240) organisms are obtained. If a specimen lies across 2 squares, it belongs to the square containing its head. If picking through an entire subsampling square is likely to result in a subsample of greater than 240 organisms, then that square is subsampled in the same manner as before to decrease the likelihood of exceeding 240 organisms. That is, spread the contents of the last square into a smaller tray and randomly subsample until the target number is reached.

Sorted specimens fall into one of three groups: 1) Chironomidae, 2) Oligochaeta, and 3) all others. Organisms that are not counted in the sample include vertebrates (e.g. salamanders, newts, fish), zooplankton (i.e. copepods), non-benthic macroinvertebrates (e.g. springtails, winged adults, terrestrial taxa), or aquatic macroinvertebrate individuals too damaged to identify (e.g. lacking a head). Organisms from each site's subsample are tallied by group and transferred to one of three sample vials (one vial for each respective group), preserved with 95 percent ethanol, and labeled with the following information:

- Site code
- Date collected (found on sample jar label)
- Date sorted
- Sorted by (sorter's initials)
- Particular sample group (C = Chironomidae, O = Oligochaeta, • = others)
- Number of organisms in the particular group vial
- Total number of organisms in the sub-sample

The total number of "squares" from the sorting grid that were picked to reach the 200 organism target number is recorded on the Benthic Macroinvertebrate Sorting Log-in Sheet. In compliance with protocols, after laboratory processing is completed for a given sample, all sieves, pans, trays, etc. that have come in contact with the current sample are rinsed thoroughly, examined carefully and picked free of organisms or debris. Any organisms found are added to the sample residue, which is combined with sorting residue remaining after subsampling (pickate), then re-preserved in 95% ethanol. Processed samples are stored for one year in the event that additional taxonomic verification or investigations are needed, then disposed of in preparation for the next monitoring year.

1. Quality Assurance and Quality Control (QA/QC)

Samples collected from QC sites are processed according to the procedures summarized above with the exception of the following:

Unprocessed sample material and subsample pickate from QC samples are retained in separate 2L jars and preserved in 95% ethanol (EtOH). During QA/QC verification, ten percent of the pickate from each QC subsample is inspected for organisms overlooked during the subsampling process. QC subsamples with too many missed, incorrectly sorted and/or non-benthic organisms are deemed unacceptable. Sorters associated with unacceptable samples may be re-trained by the Chief Taxonomist and/or other experienced SWPD staff.

D. Taxonomic Identification

Once all site samples are subsampled, sorted and enumerated, taxonomic identifications are made to the genus level (whenever possible) using 10x-80x dissecting scopes. Genus level classification of all macroinvertebrate samples are performed using select taxonomic keys (e.g. Pennak 1989, Peckarsky 1990, Wiggins 1995, Merritt, Cummins and Berg 2008, Stewart and Stark 1993 and others as deemed appropriate). Certain specimens may be physically damaged to such an extent that accurate genus-level identification is not possible. In these situations, the lowest possible taxonomic identification is noted on the data sheet. Time constraints prevent the more detailed examinations required to identify taxa such as aquatic worms (Oligochaeta) and midge larvae (Chironomidae) to this level. Therefore, oligochaetes are identified at the class level, and chironomids are identified at the family level. The representatives in each respective taxonomic grouping are enumerated, recorded and summed on the Benthic Macroinvertebrate Identification Sheet (see Figures III.9 and III.10). The final total number of organisms is also recorded along with the date the identification was completed and the taxonomist's initials. All individuals from the subsample are then returned to the 95 percent ethanol solution and stored for one year in the event that additional taxonomic verification or investigations are needed, then disposed of in preparation for the next monitoring year.

1. Quality Assurance and Quality Control (QA/QC)

QA/QC Taxonomic identification of benthic macroinvertebrate organisms is conducted by the Chief Taxonomist and/or other experienced SWPD staff. Taxonomic identifications of organisms from QC sites are verified by the Chief Taxonomist OR by another experienced taxonomist who did not participate in the original identification. The QC taxonomist performs whole-sample re-identification and completes a second taxonomic bench sheet. Taxonomic counts and identifications generated by the primary and QC taxonomists for each QC sample will be compared. Inconsistencies are resolved and problems addressed through taxonomist interactions.

E. Benthic Macroinvertebrate Index of Biotic Integrity (B-IBI)

The response of a given biological community to environmental degradation can provide a useful measure of overall system health. Such responses, often evident as changes in community structure and composition, can highlight single-source environmental stressors, or the cumulative impact of multiple stressors. Potential measures of relative tolerance and intolerance to stressors will be identified from within the various subcategories (i.e., genus, functional feeding group, and habitat) of the macroinvertebrate communities.

These attributes, or "metrics," were used to construct the foundation of a Benthic Index of Biotic Integrity (B-IBI) for ranking each study site. The multi-metric index has two distinct components; (1) a set of criteria which transforms the metric values into scores that can then be used in the aggregate and (2) narrative "integrity" classes (excellent, good, fair, poor and very poor) which reflect relative correspondence to the numeric rating of the "reference" or undisturbed condition streams (Table III.1).

Table III.1: Classification Ratings Used on the Benthic Macroinvertebrate Index of Biotic Integrity Scores

INDEX SCORE	RATING	DESCRIPTION
80 to 100	Excellent	Equivalent to reference conditions; High biodiversity and balanced community
60 to 80	Good	Slightly degraded site with intolerant species decreasing in numbers
40 to 60	Fair	Marked decrease in intolerant species; shift to an unbalanced community
20 to 40	Poor	Intolerant species rare or absent, decreased diversity
0 to 20	Very Poor	Degraded site dominated by a small number of tolerant species

Benthic macroinvertebrate indices were created separately for the Piedmont and the Coastal Plain areas. An index was created for the Coastal Plain province using metrics taken from the Mid-Atlantic Integrated Assessment data report (Table III.2), Assessment Framework for Mid-Atlantic Coastal Plain Streams Using Benthic Macroinvertebrates (Maxted et al. 1999). For the Piedmont region, the Index of Macrobenthic Biotic Integrity (Jones 2000, personal communication) is used since it provides locally tested metrics and multi-year data for the same reference sites which were used in the Fairfax County Stream Protection Strategy (SPS) Study which was the basis of the bioassessment program (Table III.3). Examples for calculating individual metrics from the taxonomic data for inclusion into the biological indices are given below.

Table III.2: Index of Biotic Integrity Metric Descriptions for Benthic Macroinvertebrates for Coastal Plain (based on Maxted et al. 1999)

METRIC	DESCRIPTION
1. Taxa Richness	Number of different taxa at a site
2. EPT Taxa	Number of Mayfly, Stonefly and Caddisfly taxa at a site
3. Percent Ephemeroptera	Percent of sample that was in the order Ephemeroptera
4. Hilsenhoff Biotic Index	Hilsenhoff Biotic Index – general tolerance/intolerance of the sample
5. Percent Clingers	Percent of individuals whose habitat type is clingers

Table III.3: Index of Macrobenthic Integrity Metric Descriptions for Benthic Macroinvertebrates for Piedmont (Jones 2000, pers. comm.)

METRIC	DESCRIPTION
1. Taxa Richness	Number of different taxa at a site
2. EPT Richness	Number of Mayfly, Stonefly and Caddisfly taxa at a site
3. Percent EPT	Percent of sample that are Mayfly, Stonefly and Caddisfly excluding the tolerant Net-Spinning Caddisflies (Hydropsychidae)
4. Percent Trichoptera w/o Hydropsychidae	Percent of sample that are Caddisflies excluding the tolerant Net-Spinning Caddisflies (Hydropsychidae)
5. Percent Coleoptera	Percent of sample that are beetles
6. Family Biotic Index	General tolerance/intolerance of the sample
7. Percent Dominance	Percent of the most abundant taxa
8. Percent Clingers + Percent Plecoptera	Percent of individuals whose habitat type is clingers plus percent of sample that are stoneflies but are not clingers
9. Percent Shredders	Percent of individuals that uses shredding as its primary functional feeding group
10. Percent Predators	Percent of individuals that uses predation as its primary functional feeding group

Example 1: For metric values that decrease with increasing disturbance (Total Taxa, EPT Richness, % EPT w/o Hydropsychidae, % Trichoptera w/o Hydropsychidae, % Coleoptera, % Clingers plus % Plecoptera, % Clingers, % Shredders, % Ephemeroptera and % Predators).

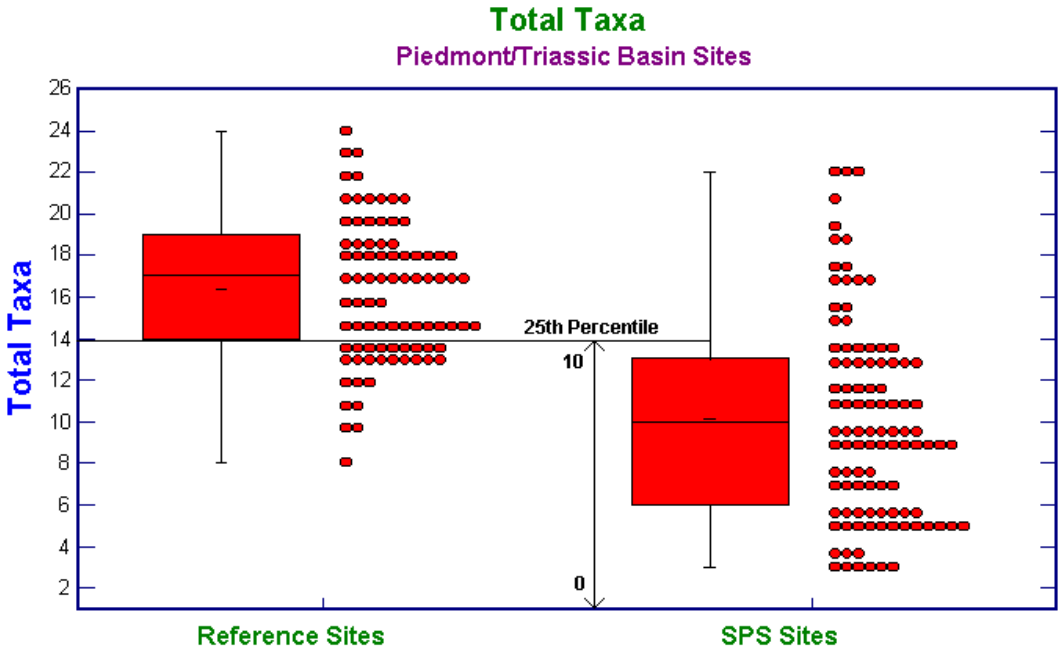

Figure III.2: Box and Whisker Plot of Total Taxa for the Piedmont

Each year, data for total taxa from the Piedmont reference areas and the total taxa data are plotted against each other using a box and whisker plot. The 25th percentile from the reference data was then designated as the "reference condition" value. Therefore, any value above that mark is considered equivalent to reference conditions. The 25th percentile value of the reference data is then divided by 10 to obtain the conversion factor. In this example (Figure III.2) the conversion factor would be 14 (the 25th percentile of the reference conditions) divided by 10 (the upper limit of the 10-point scale), which is 1.4.

Table III.4: Metric Conversion Values for Example 1

Site Values	Converted Values	Final Value
7	5	5
10	7.14	7.14
22	15.71	10
13	9.29	9.29
8	5.71	5.71
5	3.57	3.57
4	2.86	2.86
14	10.00	10
6	4.29	4.29
3	2.14	2.14
17	12.14	10

All the county site values for total taxa are then divided by the conversion factor to convert them to the final 0 to 10 scale. If the resulting value is more than 10, it is rectified to 10. This scaling exercise is conducted on all site values for each metric in the B-IBI. The resulting values for all metrics are then summed to give each site a rating between 0 – 100. Each site is then given a qualitative ranking based on its final rating (Table III.4).

These steps are also performed for the Coastal Plain site data. Unlike the Piedmont sites however, for which spatially and temporally broad reference information is available, the Coastal Plain sites are compared only to the two Kane Creek (least impaired/reference) sites. The metric scores for the Kane Creek sites are used in lieu of the 25th percentile of aggregate reference data for inversely-correlated metrics (Total Taxa, EPT Richness, % Ephemeroptera and % Clingers).

The reference sites data that is used to create the conversion factors is updated every five years. This means that the raw data from the last five years of sampling is added to the existing data and the conversion factors are recalculated. The last update was in 2018 which means a new set of 5-year reference data is scheduled to be added in 2023, 2028, and so on.

Example 2: For metric values that increase with increasing disturbance (i.e. FBI, HBI and Percent Dominance).

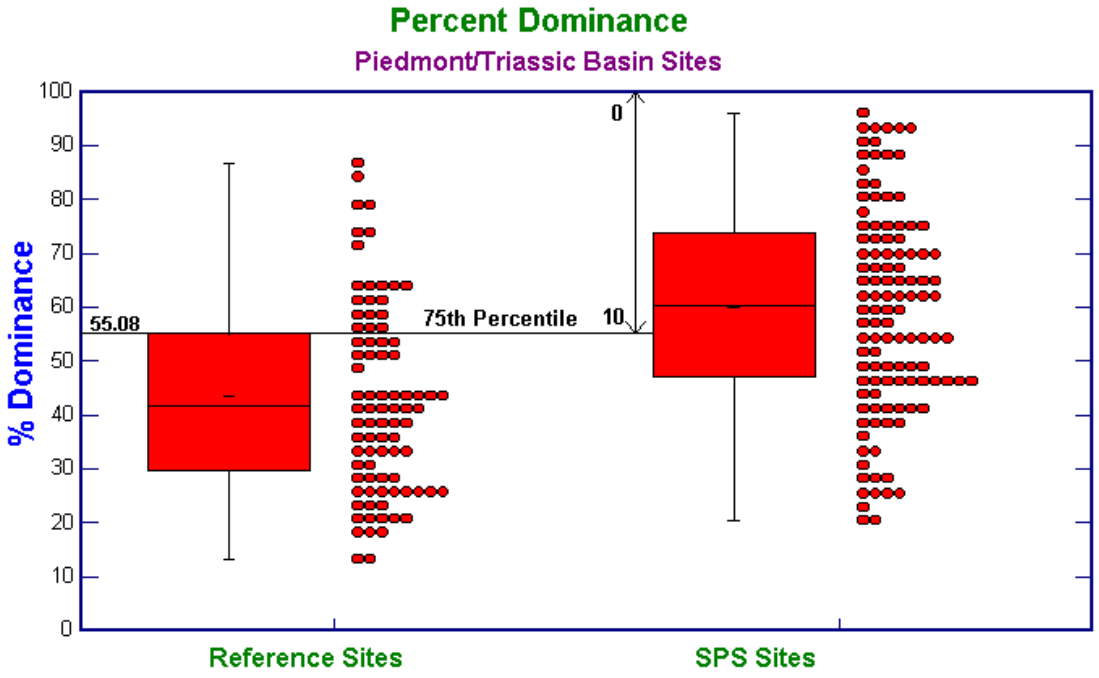

Figure III.3: Box and Whisker Plot of Percent Dominance for the Piedmont

Data for percent dominance from the Piedmont reference areas and all other piedmont sites are plotted against each other using a box and whisker plot. In this case, the 75th percentile from the reference data is designated as the "reference condition" value. The difference between these metrics and those from example 1 is that the best value obtainable is 0 for the metric instead of 100, and the 75th percentile of the reference data, rather than the 25th, is the 10 value on the 0 to 10 scale. In this example (Figure III.3), 100 percent dominance is the 0 value and 55.08 is the 10 value. In order to obtain the conversion factor, the 75th percentile value for the reference condition is subtracted from its upper limits. This value is then

divided into 10 to arrive at the conversion factor. So in this example, the 75th percentile (55.08) is subtracted from the upper limit of this metric (100) to give 44.92.
The final step to obtain the conversion factor is to divide 44.92 by 10, which yields 4.492. Individual values from the monitoring sites for percent dominance are then taken and subtracted from 100. Each value is then divided by the conversion factor to give the 0 to 10 value for that site. If the value exceeds 10, the site is given a value of 10 (Table III.5.). This procedure is also followed for the coastal plain sites using the coastal plain reference data. The converted values for each site are then summed to form a 0 to 100 scale. Since the coastal plain index consists of only 5 metrics, the summed total is doubled to give it a 0 to 100 range (Table III.5).

Table III.5: Metric Value Conversion for Example 2

Site Value	100 - Site Value	Converted Value	Final Value
59.38	40.62	9.04	9.04
49.03	50.97	11.35	10
94.44	5.56	1.24	1.24
88.79	11.21	2.50	2.50
82.14	17.86	3.98	3.98
58.74	41.26	9.19	9.19
90.70	9.30	2.07	2.07
95.83	4.17	0.93	0.93
76.87	23.13	5.15	5.15
95.88	4.12	0.92	0.92
50.72	49.28	10.97	10
49.63	50.37	11.21	10

These steps were also performed for the Coastal Plain site data. Unlike the Piedmont sites however, for which spatially and temporally broad reference information was available, the Coastal Plain sites were only compared to Kane Creek reference sites. The averaged metric scores for the two Kane Creek sites were used in lieu of the 75th percentile of aggregate reference data for the one directly correlated metric (Hilsenhoff Biotic Index).

F. Benthic Macroinvertebrates References

Barbour, M.T., J. Gerritson, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington D.C.

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G. Forms and Data Sheets

Figure III.4: Benthic Macroinvertebrate Sample Log-In Sheet
Figure III.5: Fairfax County Benthic Macroinvertebrate Sample Chain-of-Custody form
Figure III.6 - 7: Benthic Macroinvertebrate Sampling Data Sheet (Front and Back)
Figure III.8: Benthic Macroinvertebrate Sorting Log-In Sheet
Figure III.9 - 10: Benthic Macroinvertebrate Identification Sheet (Front and Back)

Benthic Macroinvertebrate Sample Log-in Sheet						
	Site ID	Watershed	Date collected	Date delivered to lab	Initials	# of container
1						
2						
3						
4						
5						
6						
7						
8						
9						
#						
11						
#						
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Figure III.4: Benthic Macroinvertebrate Sample Log-in Sheet

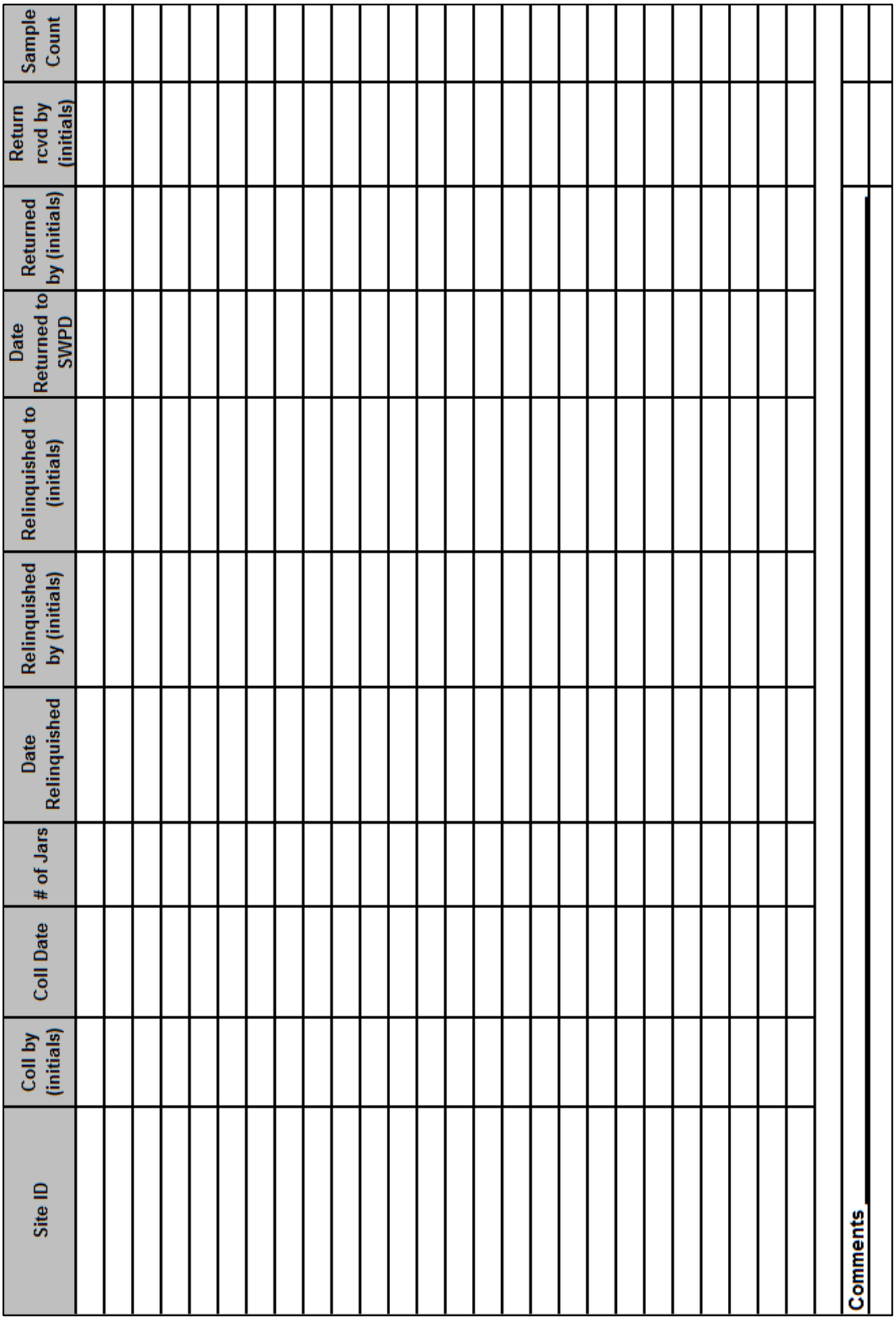


Figure III.5: Benthic Macroinvertebrate Chain-of-Custody Form

Site Code: _____

Benthic Macroinvertebrate Sampling Data Sheets

Watershed:	Date:	Start Time:
Stream Order:	Recorder:	Finish Time:
Investigators:	QC Site: Yes No	

Habitat Types: Field Duplicate Collected Yes / No (circle)

	Tally	# of Jabs:
Sand	_____	_____
Snags	_____	_____
Cobble	_____	_____
Vegetated Banks	_____	_____
Submerged Macrophytes	_____	_____

# of jabs = tally/total number of tallies x 20

* If habitat type is less than 5% of area, do not count it toward jabs

Water Quality

Temperature	°C
% Saturation	%
Dissolved Oxygen	mg/l
Conductivity	µS/cm
Specific Conductance	(µS/cm)/c*
pH	

Weather

Today:	storm/heavy rain	showers (intermittent)
	rain (steady)	sunny
	partly cloudy	cloudy
Past 24 hrs	storm/heavy rain	showers (intermittent)
	rain (steady)	sunny
	partly cloudy	cloudy

Riparian Zone/ Instream Features

Predominant Surrounding Landuse

Forest	Commercial
Field/Pasture	Industrial
Agricultural	Golf Course
Residential	Other _____

Canopy Cover

Open Moderate Heavy

Channelized?

Yes No

Local Streambank and Channel Bottom Erosion

None Low Moderate Heavy

Riparian Zone Width (ft)

LB	RB
0-25	0-25
25-50	25-50
50-75	50-75
75-100	75-100
100+	100+

Possible impairments to benthics (i.e. golf course, industri

Other Comments:

Figure III.6: Benthic Macroinvertebrate Sampling Data Sheet (Front)

Cobble (hard substrate) – Cobble will be prevalent in the riffles (and runs), which are a common feature throughout most mountain and piedmont streams. In many high-gradient streams, this habitat type will be dominant. However, riffles are not a common feature of most coastal or other low-gradient streams. Sample shallow areas with coarse (mixed gravel, cobble or larger) substrates by holding the bottom of the dip net against the substrate and dislodging organisms by kicking the substrate for 0.5 m upstream of the net.

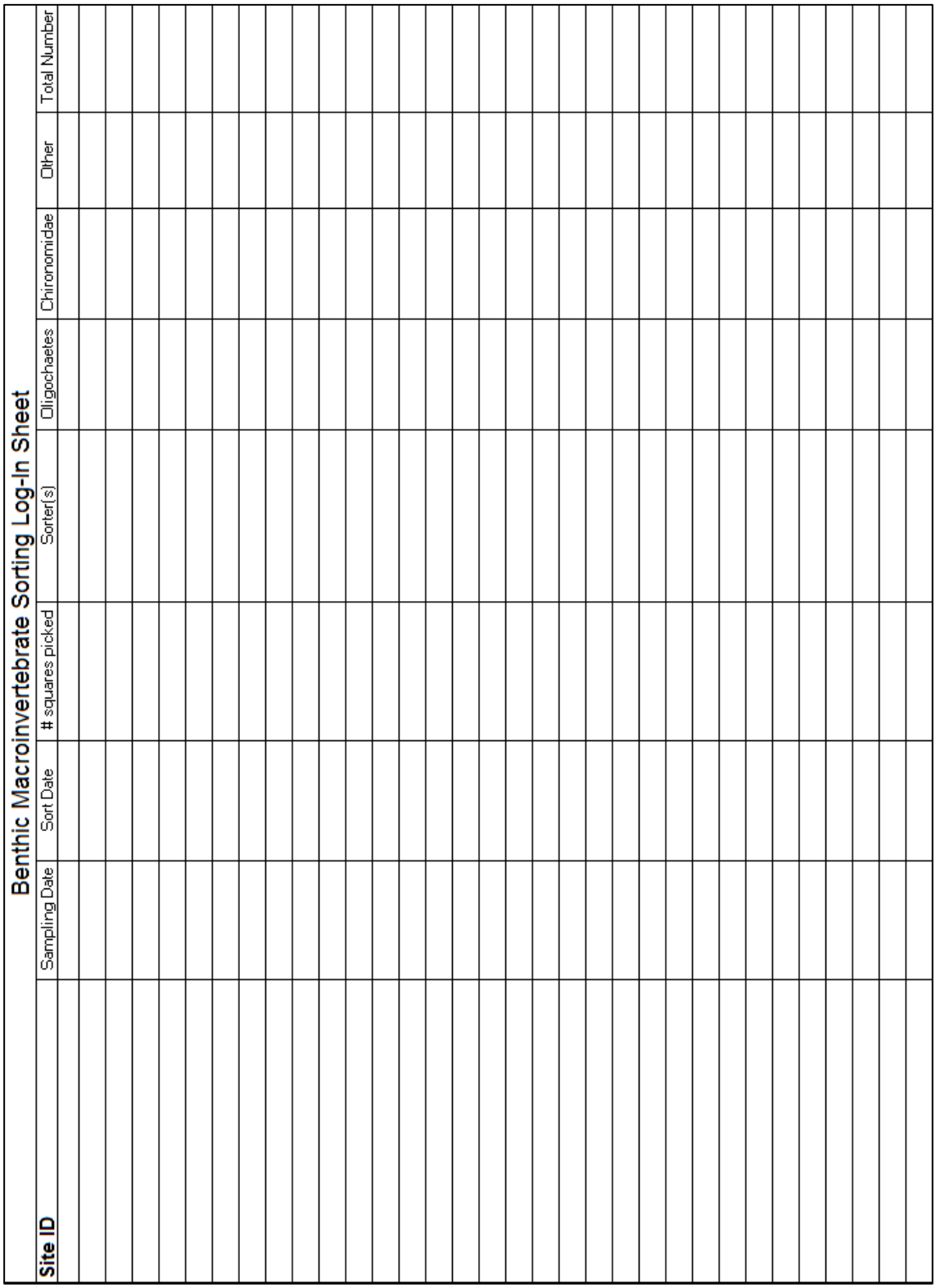
Snags – Snags and other woody debris that have been submerged for a relatively long period (not recent deadfall) provide excellent colonization habitat. Sample submerged woody debris by jabbing in medium-sized snag material (sticks and branches). The snag habitat may be kicked first to help dislodge organisms, but only after placing the net downstream of the snag. Accumulated woody material in pool areas are considered snag habitat. Large logs should be avoided because they are generally difficult to sample adequately.

Vegetated banks – When lower banks are submerged and have roots and emergent plants associated with them, they are sampled in a fashion similar to snags. Submerged areas of undercut banks are good habitats to sample. Sample banks with protruding roots and plants by jabbing into the habitat. Bank habitat can be kicked first to help dislodge organisms, but only after placing the net downstream.

Submerged macrophytes – Submerged macrophytes are seasonal in their occurrence and may not be a common feature of many streams, particularly those that are high-gradient. Sample aquatic plants that are rooted on the bottom of the stream in deep water by drawing the net through the vegetation from the bottom to the surface of the water (maximum of 0.5 m each jab). In shallow water, sample by bumping or jabbing the net along the bottom in the rooted area, avoiding sediments where possible.

Sand (and other fine sediment) – Usually the least productive macroinvertebrate habitat in streams, this habitat may be the most prevalent in some streams. Sample banks of unvegetated or soft soil by bumping the net along the surface of the substrate rather than dragging the net through soft substrates; this reduces the amount of debris in the sample.

Figure III.7: Benthic Macroinvertebrate Sampling Data Sheet (Back)



Benthic Macroinvertebrate Sorting Log-In Sheet

Site ID	Sampling Date	Sort Date	# squares picked	Sorter(s)	Oligochaetes	Chironomidae	Other	Total Number

Figure III.8: Benthic Macroinvertebrate Sorting Log-in Sheet

SITE ID: _____

Benthic Macroinvertebrate Identification Sheet

Taxonomist:	**Identification Start Date:**
	Identification Finish Date:
Watershed:	
	Collection Date:
QC Sample? Y **QC Site? Y N**	**Sorting Date(s):**

Organisms			#	Tally	Exc ?
Order	Family	Genus			
Oligochaeta					
Chironomidae					
Hirudinea					
Isopoda					
Amphipoda					
Decapoda					
Ephemeroptera					
Plecoptera					
Trichoptera					
		Subtotal:			

Figure III.9: Benthic Macroinvertebrate Identification Sheet (Front)

SITE ID: _____

Benthic Macroinvertebrate Identification Sheet

Organisms			#	Tally	Exc ?
Order	Family	Genus			
Odonata					
Hemiptera					
Lepidoptera					
Megaloptera					
Coleoptera					
Diptera					
Gastropoda					
Bivalves					
Acariformes					
Other					
		Subtotal:			
		Total from front:			
		Grand Total:			

Figure III.10: Benthic Macroinvertebrate Identification Sheet (Back)

IV. Fish

A. Background

Fish assemblages represent the apex of most stream communities. Fish typically are at the top of the food web and are sensitive to both natural and anthropogenic changes within a given system and are, therefore, useful indicators of stream ecosystem health. Fish are also more readily understood and appreciated by the public than are other biological components of streams systems. Therefore, they can be useful tools for developing community interest in environmental and water management issues.

B. Field Sampling Methods

The methods employed are based largely upon the EPA's Rapid Bioassessment Protocols V (Barbour et al. 1999). Because of sporadic and sparse occurrence of fish assemblages in first order and intermittent headwater streams, the value and validity of using these assemblages as ecosystem health indicators is questionable. Therefore, Fairfax County samples fish communities in wadeable, non-tidal freshwater, perennially-flowing streams with greater than 300 acre drainage areas (contributing watersheds).

The following equipment is used for sampling:

- Smith-Root, Model LR-20B backpack electrofishers
- 12-volt DC batteries for electrofisher(s)
- Rubber gloves (high-voltage rated, insulated)
- Felt soled, boot-foot chest waders and belts for all participants
- Hand dip-nets, both long- and short-handled (1/8 inch mesh)
- Block nets (i.e. seines)
- Properly calibrated multi-parameter water quality sonde
- Buckets and live well(s) for fish storage and transport
- Fish Field sheets (Figures IV.2-3) printed on waterproof paper & pencils
- Species key and field guide (Jenkins and Burkhead, 1994)

All electrofishing activities are bound to the requirements set forth in the Fairfax County Stormwater Safety Manual.

C. Fish Sampling and Identification

Backpack electrofishing surveys in the biological stream monitoring program are typically conducted from the middle of August through mid-September. Using the Smith-Root Inc. backpack electrofishing units, a single-pass sample is conducted through each selected 100-meter reach (number of electrofisher units is dependent upon stream width and depth). All habitats within the reach are sampled. This includes pools, riffles and runs as well as other types of habitat that may be present. Block nets are deployed at the upstream reach boundary, and collection is conducted in the upstream direction to minimize turbidity introduced from the survey crew while maximizing the capture of immobilized fish that are drifting downstream. All possible precautions are taken to avoid fish mortality. Fish are removed from the electric field as soon as possible. Captured specimens are transported in water-filled buckets and maintained in a portable, in-stream live well for subsequent examinations. Fish are identified to the species level by

ecologists experienced with identifying local taxa. Individuals in each taxonomic category (usually species) are enumerated and recorded in the Fish Field Sheet (Figures IV.2-3). Upon final identification, the fish are then immediately released back into the stream. To minimize the risks of mortality or injury to fish, electrofisher unit voltage and duty cycle settings are adjusted to reflect stream water conductivity and corresponding manufacturer recommendations.

As is the standard practice with fish sampling protocols, juvenile or young-of-year (YOY) specimens, determined to be those individuals under 20 mm total length, are not counted towards the species counts. This is due to their higher mortality rates in the first year of life, as well as ambiguities (or incomplete development) in proper morphological characteristics necessary for accurate identifications in certain species. Species in the *Gambusia* genus are excluded from this practice as the adults frequently measure near 20 mm in total length. Therefore, *Gambusia* individuals measuring less than 10 mm are considered YOY and are not included in the sample counts.

All specimen collections are carried out in accordance with the guidelines set forth in the current Virginia Department of Game and Inland Fisheries (DGIF) Scientific Collection Permit issued to Fairfax County Ecologists on a bi-annual basis.

A uniform fish sampling data sheet is used during the fish sampling session (Figures IV.2 and IV.3) for all county streams.

1. Quality Assurance and Quality Control (QA/QC)

The following QA/QC procedures apply to fish sampling in the field:

- All data are documented on field data sheets. Fish identifications are verified through taxonomist interactions. Photodocumentation of questionable specimens is done when needed.
- On rare occasions, a specimen may be preserved for laboratory identification.

D. Fish References

Barbour, M.T., J. Gerritson, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington D.C.

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E. Forms and Data Sheets

Figure IV.1 - 2: Fish Field Sheet

Site ID _____

RBP Coastal Plain Assessment Scores	
Parameter	**Score**
1) Epifaunal Substrate/Available Cover	_____
2) Pool Substrate Characterization	_____
3) Pool Variability	_____
4) Sediment Deposition	_____
5) Channel Flow Status	_____
6) Channel Alteration	_____
7) Channel Sinuosity	_____
8) Bank Stability	RB:_____
	LB:_____
9) Bank Veg. Protection	RB:_____
	LB:_____
10) Rip. Veg. Zone Width	RB:_____
	LB:_____

RBP Piedmont Assessment Scores	
Parameter	**Score**
1) Epifaunal Substrate	_____
2) Embeddedness	_____
3) Velocity-Depth Regimes	_____
4) Sediment Deposition	_____
5) Channel Flow Status	_____
6) Channel Alteration	_____
7) Frequency of Riffles (or Bends)	_____
8) Bank Stability	RB:_____
	LB:_____
9) Bank Vegetative Protection	RB:_____
	LB:_____
10) Rip. Veg. Zone Width	RB:_____
	LB:_____

Water Quality	
Temperature	°C
% Saturation	%
Dissolved Oxygen	mg/l
Conductivity	µS/cm
Specific Conductance	(µS/cm)/c°
pH	

Weather		
Today:	storm/heavy rain	showers (intermittent)
	rain (steady)	sunny
	partly cloudy	cloudy
Past 24 hrs:	storm/heavy rain	showers (intermittent)
	rain (steady)	sunny
	partly cloudy	cloudy

Riparian Zone/ Instream Features

Predominant Surrounding Landuse	
Forest	Commercial
Field/Pasture	Industrial
Agricultural	Golf Course
Residential	Other _____

Canopy Cover		
Open	Moderate	Heavy

Channelized?	
Yes	No

Local Streambank and Channel Bottom Erosion			
None	Low	Moderate	Heavy

Riparian Zone Width (ft)	
LB	**RB**
0-25	0-25
25-50	25-50
50-75	50-75
75-100	75-100
100+	100+

Possible impairments to fish (i.e. golf course, industrial

Other Comments:

Figure IV.1: Fish Field Sheet (Front)

Site ID:	Sampling start time:	Finish time:	Number of Electorfisher Units
Date:	Recorder:		
	Investigators:		

Species	Number of Individuals	Total
Ameiurus natalis		
Ameiurus nebulosus		
Anguilla rostrata		
Campostoma anomalum		
Catostomus commersoni		
Clinostomus funduloides		
Cyprinella spp.		
Erimyzon oblongus		
Etheostoma blennioides		
Etheostoma flabellare		
Etheostoma olmstedi		
Exoglossum maxillingua		
Fundulus diaphanus		
Gambusia holbrooki		
Hypentelium nigricans		
Lampetra aepyptera		
Lepomis auritus		
Lepomis cyanellus		
Lepomis gibbosus		
Lepomis macrochirus		
Luxilus cornutus		
Micropterus salmoides		
Notemigonus crysoleucas		
Notropis hudsonius		
Notropis procne		
Noturus insignis		
Pimephales notatus		
Rhinichthys atratulus		
Rhinichthys cataractae		
Semotilus atromaculatus		
Semotilus corporalis		
	Grand Total:	

Figure IV.2: Fish Field Sheet (Back)

V. Habitat Assessment

A. Background

The US EPA Rapid Bioassessment Protocol (RBP) method for habitat assessment (Chapter 5.2, Barbour et al. 1999) consists of evaluating ten specific habitat quality parameters, which include riparian, in-stream, and flood plain assessments. Each parameter is scored on a scale of 0 (most impaired) to 20 (optimal). Scores for each site are summed, for a maximum possible score of 200, to obtain an overall rating of habitat quality and to compare sites. The full range of total scores for sites from the lowest to the highest is sub-divided into five evenly spaced segments and subsequently assigned an overall habitat verbal description of excellent, good, fair, poor or very poor.

Fairfax County Stormwater Planning Division (SWPD) uses an adapted version of the EPA assessment to better reflect conditions within the county. SWPD uses EPA's low gradient stream parameters to assess Coastal Plain streams, and EPA's high gradient stream parameters to assess Piedmont and Triassic Basin streams (Table V.1).

Table V.1: Habitat Metrics for Piedmont/Triassic and Coastal Plain Streams

Piedmont/Triassic	Coastal Plain
Epifaunal Substrate/Available Cover	Epifaunal Substrate/Available Cover
Embeddedness	Pool Substrate Characterization
Velocity/Depth Regime	Pool Variability
Channel Alteration	Channel Alteration
Sediment Deposition	Sediment Deposition
Frequency of Riffles/Bends	Channel Sinuosity
Channel Flow Status	Channel Flow Status
Bank Vegetative Protection	Bank Vegetative Protection
Bank Stability	Bank Stability
Riparian Vegetative Zone Width	Riparian Vegetative Zone Width

B. Parameter Descriptions

The following narrative descriptions, which provide additional guidance for evaluating each parameter, are taken and adapted from Chapter 5.2 of Barbour et al. (1999).

1. Epifaunal Substrate / Available Cover (Piedmont & Coastal Plain)

Includes the relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna. A wide variety and/or abundance of submerged structures in the stream provides macroinvertebrates and fish with a large number of niches, thus increasing habitat diversity. As variety and abundance of cover decreases, habitat structure becomes monotonous, diversity decreases, and the potential for recovery following disturbance decreases. Riffles and runs are critical for maintaining a variety and abundance of macroinvertebrates in most Piedmont streams and serving as spawning and feeding refugia for certain fish. The extent and quality of the riffle is an important factor in the support of a healthy biological condition in Piedmont streams. Riffles and runs offer a diversity of habitat through variety of particle

size, and, in many small Piedmont streams, will provide the most stable habitat. Snags and submerged logs are among the most productive habitat structure for macroinvertebrate colonization and fish refugia in Coastal Plain streams. However, "new fall" may be transient and will not yet be suitable for colonization.

2. Embeddedness (Piedmont Only)

Refers to the extent to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (shelter, spawning, and egg incubation) is decreased. Embeddedness is a result of large-scale sediment movement and deposition, and is a parameter evaluated in the riffles and runs of Piedmont streams. The rating of this parameter may be variable depending on where the observations are taken. To avoid confusion with sediment deposition (another habitat parameter), observations of embeddedness should be taken in the upstream and central portions of riffles and cobble substrate areas.

3. Pool Substrate Characterization (Coastal Plain Only)

Evaluates the type and condition of bottom substrates found in pools. Firmer sediment types (e.g., gravel, sand) and rooted aquatic plants support a wider variety of organisms than a pool substrate dominated by mud or bedrock and no plants. In addition, a stream that has a uniform substrate in its pools will support far fewer types of organisms than a stream that has a variety of substrate types.

4. Velocity / Depth Regime (Piedmont Only)

Patterns of velocity and depth are included for Piedmont streams under this parameter as an important feature of habitat diversity. The best streams will have all four patterns present: (1) slow-deep, (2) slow-shallow, (3) fast-deep, and (4) fast-shallow. According to Barbour et al. (1999), general guidance for velocity-depth parameters are 0.5 m depth to separate shallow from deep, and 0.3 m/sec to separate fast from slow. In practice, large order streams should have water deeper than 0.5-1m to be considered deep. Generally speaking, the slow-deep category represents conspicuous pools and undercut banks, while the fast-shallow category represents riffles. The slow-shallow category represents shallow pools, runs in low-gradient streams, edge habitats out of the main flow path, and glides at the end of pools. The fast-deep category represents runs in high and moderate gradient streams (>1 %). The occurrence of these patterns relates to the stream's ability to provide and maintain a stable aquatic environment.

5. Pool Variability (Coastal Plain Only)

Rates the overall mixture of pool types found in streams, according to size and depth. The 4 basic types of pools are large-shallow, large-deep, small shallow, and small-deep, which expands on the Velocity / Depth Regime slow-deep and slow-shallow categories used for Piedmont streams. A stream with many pool types will support a wide variety of aquatic species. Rivers with low sinuosity (few bends) and monotonous pool characteristics do not have sufficient quantities and types of habitat to support a diverse aquatic community.

6. Sediment Deposition (Piedmont & Coastal Plain)

Measures the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition. Deposition occurs from large-scale movement of sediment. Sediment deposition may cause the formation of islands, point bars (areas of increased

deposition usually at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals, or result in the filling of runs and pools. Usually deposition is evident in areas that are obstructed by natural or manmade debris and areas where the stream flow decreases, such as bends. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many organisms.

7. Channel Flow Status (Piedmont & Coastal Plain)

The degree to which the channel is filled with water. The flow status will change as the channel enlarges (e.g., aggrading stream beds with actively widening channels) or as flow decreases as a result of dams and other obstructions, diversions for irrigation, or drought. When water does not cover much of the streambed, the amount of suitable substrate for aquatic organisms is limited. In Piedmont streams, riffles and cobble substrate are exposed; in Coastal Plain streams, the decrease in water level exposes logs and snags, thereby reducing the areas of good habitat. Channel flow is especially useful for interpreting biological condition under abnormal or lowered flow conditions.

8. Channel Alteration (Piedmont and Coastal Plain)

A measure of large-scale changes in the shape of the stream channel. Many streams in urban and agricultural areas have been straightened, deepened, or diverted, often for flood control or irrigation purposes. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams. Channel alteration is present when artificial embankments, riprap, and other forms of artificial bank stabilization or structures are present; when the stream is very straight for significant distances; when dams and bridges are present; and when other such changes have occurred. Scouring is often associated with channel alteration. In Fairfax County, this metric largely measures the amount of infrastructure (e.g., sewer crossings or outfalls) or artificial stabilizing features (e.g., riprap, rock baskets, or imbricated stone) in the stream (including structures associated with Natural Channel Design), because historical channel straightening is difficult to discern and concrete channels are not assessed (Stribling, Pers. Comm. 2016)

9. Frequency of Riffles or Bends (Piedmont Only)

A way to measure the sequence of riffles and thus the heterogeneity occurring in a stream. Riffles are a source of high-quality habitat and diverse fauna, therefore, an increased frequency of occurrence greatly enhances the diversity of the stream community. A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when the stream fluctuates as a result of storms. The absorption of this energy by bends protects the stream from excessive erosion and flooding and provides refugia for benthic invertebrates and fish during storm events. To gain an appreciation of this parameter in some streams, a longer segment or reach than that designated for sampling may be incorporated into the evaluation. The “sequencing” pattern of the stream morphology is important in rating this parameter. In headwaters, riffles are usually continuous and the presence of cascades or boulders provides a [vertical] form of sinuosity and enhances the structure of the stream. A stable channel is one that does not exhibit progressive changes in slope, shape, or dimensions, although short-term variations may occur during floods.

10. Channel Sinuosity (Coastal Plain Only)

Evaluates the meandering or sinuosity of the stream. A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when the stream fluctuates as a result of storms. The absorption of this energy by bends protects the stream from excessive erosion and flooding and provides refugia for benthic invertebrates and fish during storm events. To gain an

appreciation of this parameter in Coastal Plain streams, a longer segment or reach than that designated for sampling may be incorporated into the evaluation. The “sequencing” pattern of the stream morphology is important in rating this parameter. In "oxbow" streams of coastal areas and deltas, meanders are highly exaggerated and transient. Natural conditions in these streams are shifting channels and bends, and alteration is usually in the form of flow regulation and diversion. A stable channel is one that does not exhibit progressive changes in slope, shape, or dimensions, although short-term variations may occur during floods.

11. Bank Stability (Piedmont & Coastal Plain)

Measures whether the stream banks are eroded (or have the potential for erosion). Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks, and are therefore considered to be unstable. Signs of erosion include crumbling, unvegetated banks, exposed tree roots, and exposed soil. Eroded banks indicate a problem of sediment movement and deposition, and suggest a scarcity of cover and organic input to streams. Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

12. Bank Vegetative Protection (Piedmont & Coastal Plain)

Measures the amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone. The root systems of plants growing on stream banks help hold soil in place, thereby reducing the amount of erosion that is likely to occur. This parameter supplies information on the ability of the bank to resist erosion as well as some additional information on the uptake of nutrients by the plants, the control of instream scouring, and stream shading. Banks that have full, natural plant growth are better for fish and macroinvertebrates than are banks without vegetative protection or those shored up with concrete or riprap. This parameter is made more effective by defining the native vegetation for the region and stream type (i.e., shrubs, trees, etc.). In areas of residential and urban development activities disrupting the riparian zone, the growth of a natural plant community is impeded and can extend to the bank vegetative protection zone. Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

13. Riparian Vegetative Zone Width (Piedmont & Coastal Plain)

Measures the width of natural vegetation from the edge of the stream bank out through the riparian zone. The vegetative zone serves as a buffer to pollutants entering a stream from runoff, controls erosion, and provides habitat and nutrient input into the stream. A relatively undisturbed riparian zone supports a robust stream system; narrow riparian zones occur when roads, parking lots, fields, lawns, bare soil, rocks, or buildings are near the stream bank. Residential developments, urban centers, golf courses, and rangeland are the common causes of anthropogenic degradation of the riparian zone. Conversely, the presence of "old field" (i.e., a previously developed field not currently in use), paths, and walkways in an otherwise undisturbed riparian zone may be judged to be inconsequential to altering the riparian zone and may be given relatively high scores. Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

C. Assessment Procedures

Visual RBP habitat assessments should be performed by SWPD staff at all sites where spring benthic macroinvertebrate samples are taken. For sites where both macroinvertebrates and fish are also collected (sites with drainage areas greater than or equal to 300 acres), habitat assessments are conducted at the time fish are sampled (see Figure IV.2). For sites where only macroinvertebrates are collected (sites with

drainage areas less than 300 acres), habitat assessments are conducted in the late summer or early fall concurrent with the fish collection sampling period when fallen leaves have not obscured the stream bottoms and bank foliage is still visible (see Forms and Data Sheets section for blank data sheets). Habitat assessments must take into account the entire sampling reach, which should be viewed by staff before completing the assessment and must be completed by at least two staff members.

1. Quality Assurance and Quality Control (QA/QC)

SWPD is currently developing Quality Assurance/Quality Control procedures for rapid habitat assessment.

D. Habitat Assessment References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

E. Forms and Data Sheets

Figure V.1 - 2: Coastal Plain Habitat Assessment Reference Sheet (Front and Back)
Figure V.3 - 4: Piedmont Habitat Assessment Reference Sheet (Front and Back)
Figure V.5: Coastal Plain Habitat Assessment Data Sheet
Figure V.6: Piedmont Habitat Assessment Data Sheet

US EPA RBP Habitat Assessment Reference Sheet for Coastal Plain Areas (front)				
Habitat Parameter	**Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1) Epifaunal Substrate/ Availible Cover	> 50% of substrate favorable for epifaunal colonization & fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (I.e. logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availablity less than desirable; substrate frequently disturbed or removed.	< 10% stable habitat; lack of habitat is obvious; substrate unstable/lacking.
Score_____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2) Pool Substrate Character-ization	Mixture of substrate materials, with gravel & firm sand revalent; root mats & submerged vegetation common.	Mixture of soft sand, mud or clay; mud may be dominant; root mats & submerged vegetation may be present; boulder and cobble may provide some habitat.	All mud or clay or sand bottom, very little good habitat.	Hard-pan clay or bedrock, no good habitat present.
Score_____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3) Pool Variablity	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present, relative to stream size.	Majority of pools large-deep; very few shallow	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
Score_____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4) Sediment Deposition	<20% of the bottom affected by sediment deposition, little or no enlargement of islands or point bars.	20-50% of the bottom affected; slight deposition in pools; may be some new increase in bar formation, mostly from gravel, sand or fine sediment;	50-80% of the bottom affected; sediment deposits at obstructions, constrictions & bends; moderate deposition of pools prevalent; may be moderate deposition of new gravel, sand or fine sediment on old & new bars.	>80% of the bottom affected; heavy deposits of fine material, increased bar development; score lower if pools are absent due to substantial sediment depostition.
Score_____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5) Channel Flow Status	Water reaches base of both lower banks and fills >75% of channel, minimal amount of channel substrate is exposed.	Water fills 75-50% of the available channel; or <50% of channel substrate is exposed	Water fills 50-25% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools, water fills <25% of channel.
Score_____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Figure V.1: Coastal Plain Habitat Assessment Reference Sheet (Front)

US EPA RBP Habitat Assessment Reference Sheet for Coastal Plain Areas (back)				
6) Channel Alteration	Channelization or dredging absent or minimal, <10% of reach disrupted; no obvious shoring structures; may have recovered from past channelization; stream with normal pattern.	Some channelization present, 10-40% of reach channelized or disrupted; may be recovering from past channelization, stream is developing a normal pattern.	Channelization extensive; shoring sturctures present on both banks; 40-80% of stream reach channelized & disrupted; stream does not have a normal pattern.	Banks shored with gabion or cement; >80% of the stream reach channelized & disrupted, stream is a straight channel. Instream habitat greatly altered or removed entirely.
Score_____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7) Channel Sinuousity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (note- channel braiding is considered normal in coastal plains & other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream increase the stream length 2 - 3 times longer than if it was in a straight line	The bends in the stream increase the stream length 1 - 2 times longer than if it was in a straight line	Channel straight; waterway has been channelized for a long distance
Score_____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8) Bank Stablity	Banks stable; evidence of erosion or bank failure absent/minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank slouging; 60-100% of bank has erosional scars.
Score (RB)__	Right bank 10 9	8 7 6	5 4 3	2 1 0
Score (LB)__	Left bank 10 9	8 7 6	5 4 3	2 1 0
9) Bank Vegetative Protection	>90% of the streambank surfaces covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	<50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation Is very high; vegetation has been removed to 5 centimeters or less in average stubble height
Score (RB)__	Right bank 10 9	8 7 6	5 4 3	2 1 0
Score (LB)__	Left bank 10 9	8 7 6	5 4 3	2 1 0
10) Riparian Vegetative Zone Width	Width of riparian zone >40 meters; human activities (parking lots, roadbeds, clear-cuts, lawns or crops) have not impacted zone.	Width of riparian zone 40-20 meters; human activities have impacted zone only minimally.	Width of riparian zone 20-10 meters; human activities have impacted zone a great deal.	Width of riparian zone <10 meters; little or no riparian vegetation due to human activities
Score (RB)__	Right bank 10 9	8 7 6	5 4 3	2 1 0
Score (LB)__	Left bank 10 9	8 7 6	5 4 3	2 1 0

Figure V.2: Coastal Plain Habitat Assessment Reference Sheet (Back)

US EPA RBP Habitat Assessment Reference Sheet for Peidmont/Triassic Areas (front)				
Habitat Paramete	**Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1) Epifaunal Substrate/ Availible Cover	>70% of substrate favorable for epifaunal colonization & fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (I.e. logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availablity less than desirable; substrate frequently disturbed or removed.	<20% stable habitat; lack of habitat is obvious; substrate unstable/lacking
Score____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2) Embedded-ness	Gravel, cobble & boulder particles in riffles and runs are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble & boulder in riffles and runs particles are 25-50% surrounded by fine sediment.	Gravel, cobble & boulder particles in riffles and runs are 50-75% surrounded by fine sediment.	Gravel, cobble & boulder particles in riffles and runs are >75% surrounded by fine sediment.
Score____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3) Velocity/Dep th Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep & fast-shallow, relative to stream size).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes.	Only 2 of the 4 regimes present (if fast-shallow or slow-shallow are missing, score lower).	Dominated by 1 velocity/ depth regime (usually slow-deep).
Score____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4) Sediment Deposition	<5% of the bottom affected by sediment deposition, little or no enlargement of islands or point bars.	5-30% of the bottom affected; slight deposition in pools; may be some new increase in bar formation, mostly from gravel, sand or fine sediment;	30-50% of the bottom affected; sediment deposits at obstructions, constrictions & bends; moderate deposition of pools prevalent; may be moderate deposition of new gravel, sand or fine sediment on old & new bars.	>50% of the bottom affected; heavy deposits of fine material, increased bar development; score lower if pools absent due to substantial sedimentation.
Score____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5) Channel Flow Status	Water reaches base of both lower banks and fills >75% of channel, minimal amount of channel substrate is exposed.	Water fills 75-50% of the available channel; or <50% of channel substrate is exposed	Water fills 50-25% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools, water fills <25% of channel.

Figure V.3: Piedmont Habitat Assessment Reference Sheet (Front)

US EPA RBP Habitat Assessment Reference Sheet for Peidmont/Triassic Areas (back)				
6) Channel Alteration	Channelization or dredging absent or minimal, <10% of reach disrupted; no obvious shoring structures; may have recovered from past channelization; stream with normal pattern.	Some channelization present, 10-40% of reach channelized or disrupted; may be recovering from past channelization, stream is developing a normal pattern.	Channelization extensive; shoring sturctures present on both banks; 40-80% of stream reach channelized & disrupted; stream does not have a normal pattern.	Banks shored with gabion or cement; >80% of the stream reach channelized & disrupted, stream is a straight channel. Instream habitat greatly altered or removed entirely.
Score____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7) Frequency of riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by stream width is <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important	Occurrence of riffles infrequent; distances between riffles divided by stream width is between 7 to 15	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by stream width is between 15 to 25	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided stream width is a ratio of >25
Score____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8) Bank Stablity	Banks stable; evidence of erosion or bank failure absent/minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank slouging; 60-100% of bank has erosional scars.
Score (RB)__	Right bank 10 9	8 7 6	5 4 3	2 1 0
Score (LB)__	Left bank 10 9	8 7 6	5 4 3	2 1 0
9) Bank Vegetative Protection	>90% of the streambank surfaces covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	<50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation Is very high; vegetation has been removed to 5 centimeters or less in average stubble height
Score (RB)__	Right bank 10 9	8 7 6	5 4 3	2 1 0
Score (LB)__	Left bank 10 9	8 7 6	5 4 3	2 1 0
10) Riparian Vegetative Zone Width	Width of riparian zone >40 meters; human activities (parking lots, roadbeds, clear-cuts, lawns or crops) have not impacted zone.	Width of riparian zone 40-20 meters; human activities have impacted zone only minimally.	Width of riparian zone 20-10 meters; human activities have impacted zone a great deal.	Width of riparian zone <10 meters; little or no riparian vegetation due to human activities
Score (RB)__	Right bank 10 9	8 7 6	5 4 3	2 1 0
Score (LB)__	Left bank 10 9	8 7 6	5 4 3	2 1 0

Figure V.4: Piedmont Habitat Assessment Reference Sheet (Back)

Site ID: _____ **Date:** _____

Initials: _____

RBP Coastal Plain Assessment Scores	
Parameter	**Score**
1) Epifaunal Substrate	_____
2) Pool Substrate Characterization	_____
3) Pool Variability	_____
4) Sediment Deposition	_____
5) Channel Flow Status	_____
6) Channel Alteration	_____
7) Channel Sinuosity	_____
8) Bank Stability	RB:_____
	LB:_____
9) Bank Vegetative Protection	RB:_____
	LB:_____
10) Rip. Veg. Zone Width	RB:_____
	LB:_____

Site ID: _____ **Date:** _____

Initials: _____

RBP Coastal Plain Assessment Scores	
Parameter	**Score**
1) Epifaunal Substrate	_____
2) Pool Substrate Characterization	_____
3) Pool Variability	_____
4) Sediment Deposition	_____
5) Channel Flow Status	_____
6) Channel Alteration	_____
7) Channel Sinuosity	_____
8) Bank Stability	RB:_____
	LB:_____
9) Bank Vegetative Protection	RB:_____
	LB:_____
10) Rip. Veg. Zone Width	RB:_____
	LB:_____

Site ID: _____ **Date:** _____

Initials: _____

RBP Coastal Plain Assessment Scores	
Parameter	**Score**
1) Epifaunal Substrate	_____
2) Pool Substrate Characterization	_____
3) Pool Variability	_____
4) Sediment Deposition	_____
5) Channel Flow Status	_____
6) Channel Alteration	_____
7) Channel Sinuosity	_____
8) Bank Stability	RB:_____
	LB:_____
9) Bank Vegetative Protection	RB:_____
	LB:_____
10) Rip. Veg. Zone Width	RB:_____
	LB:_____

Site ID: _____ **Date:** _____

Initials: _____

RBP Coastal Plain Assessment Scores	
Parameter	**Score**
1) Epifaunal Substrate	_____
2) Pool Substrate Characterization	_____
3) Pool Variability	_____
4) Sediment Deposition	_____
5) Channel Flow Status	_____
6) Channel Alteration	_____
7) Channel Sinuosity	_____
8) Bank Stability	RB:_____
	LB:_____
9) Bank Vegetative Protection	RB:_____
	LB:_____
10) Rip. Veg. Zone Width	RB:_____
	LB:_____

Figure V.5: Coastal Plain Habitat Assessment Data Sheet

Site ID: _____ **Date:** _____ **Site ID:** _____ **Date:** _____

Initials: _____ **Initials:** _____

RBP Piedmont Assessment Scores	
Parameter	**Score**
1) Epifaunal Substrate	_____
2) Embeddedness	_____
3) Velocity-Depth Regimes	_____
4) Sediment Deposition	_____
5) Channel Flow Status	_____
6) Channel Alteration	_____
7) Frequency of Riffles (or Bends)	_____
8) Bank Stability	RB:_____
	LB:_____
9) Bank Vegetative Protection	RB:_____
	LB:_____
10) Rip. Veg. Zone Width	RB:_____
	LB:_____

RBP Piedmont Assessment Scores	
Parameter	**Score**
1) Epifaunal Substrate	_____
2) Embeddedness	_____
3) Velocity-Depth Regimes	_____
4) Sediment Deposition	_____
5) Channel Flow Status	_____
6) Channel Alteration	_____
7) Frequency of Riffles (or Bends)	_____
8) Bank Stability	RB:_____
	LB:_____
9) Bank Vegetative Protection	RB:_____
	LB:_____
10) Rip. Veg. Zone Width	RB:_____
	LB:_____

Site ID: _____ **Date:** _____ **Site ID:** _____ **Date:** _____

Initials: _____ **Initials:** _____

RBP Piedmont Assessment Scores	
Parameter	**Score**
1) Epifaunal Substrate	_____
2) Embeddedness	_____
3) Velocity-Depth Regimes	_____
4) Sediment Deposition	_____
5) Channel Flow Status	_____
6) Channel Alteration	_____
7) Frequency of Riffles (or Bends)	_____
8) Bank Stability	RB:_____
	LB:_____
9) Bank Vegetative Protection	RB:_____
	LB:_____
10) Rip. Veg. Zone Width	RB:_____
	LB:_____

RBP Piedmont Assessment Scores	
Parameter	**Score**
1) Epifaunal Substrate	_____
2) Embeddedness	_____
3) Velocity-Depth Regimes	_____
4) Sediment Deposition	_____
5) Channel Flow Status	_____
6) Channel Alteration	_____
7) Frequency of Riffles (or Bends)	_____
8) Bank Stability	RB:_____
	LB:_____
9) Bank Vegetative Protection	RB:_____
	LB:_____
10) Rip. Veg. Zone Width	RB:_____
	LB:_____

Figure V.6: Piedmont Habitat Assessment Data Sheet

VI. Stream Bacteria Monitoring Program

A. Background

E. coli are a specific species of the coliform bacteria group that is part of the normal intestinal flora of humans and animals and are direct indicators of fecal contamination from these sources in water. Although *E. coli* is generally not harmful itself, the occurrence indicates the possible presence of pathogenic (disease-causing) bacteria, viruses, and protozoans which are correlated with swimming-associated gastroenteritis. There are a number of zoonotic diseases of concern to humans (diseases transferred from animals to humans) if ambient waters are contaminated with fecal material from non-human animal species (EPA, 2003). Of more concern is the potential of human fecal contamination because of the human specific pathogens that are typically found in human sewage (USGS, 2006).

The objectives of this program are to 1) characterize bacteria levels in county streams using the ProbMon framework and to 2) identify possible sources of contamination (e.g. sewage inputs) needing to be addressed. Ancillary data (nutrients and water chemistry) are also collected to complement our monitoring dataset in Fairfax County.

This section contains the following:

- Monitoring Program Overview
- Field Protocol for Sample Collection
- Sample Documentation
- Data Analysis and Reporting
- Forms and Data sheets

B. Stream Bacteria Monitoring Program Overview

As recommended by the EPA and VDEQ, Fairfax County completed its transition in 2005 to using *E. coli,* versus fecal coliform, as the primary indicator of possible fecal contamination. The basis behind this change stems from the 1986 EPA findings and the VDEQs 2003 memorandum that *E. coli* exhibits a stronger correlation to swimming borne illnesses for humans than fecal coliform.

Nutrient samples and water chemistry were added to the monitoring program to further evaluate water quality conditions, contributing to a robust dataset for the probabilistic monitoring program on an annual basis. The suite of parameters collected will provide information about the presence of pathogenic material and deposition and mobilization of nutrients commonly used in detergents and fertilizers.

1. Site Selection Protocol

In 2005, the Stormwater Planning Division incorporated bacterial sampling into its probabilistic monitoring (stratified random approach) program. Each year new sites are randomly selected to be sampled throughout the year for the comprehensive biological program. This includes indicators such as benthic macroinvertebrates, fish, bacteria, nutrients and water chemistry. This site selection methodology is discussed in greater detail in Section II.

2. Virginia Department of Environmental Quality (DEQ) Standards

The Water Quality Standards which became effective on January 15, 2003, included the new bacteria standards in 9 VAC 25-260-170.A. The current bacteria standards in 9 VAC 25-260-170.A.2 are shown in the table below:

Table VI.1: VDEQ Water Quality Standards for E. Coli and Enterococci

Name	Geometric Mean	Single Sample Maximum
Fresh Water E. coli (N/100mL)	126	235
Saltwater Enterococci (N/100 mL)	35	104

The suggested geometric mean correlates to the 1986 EPA recommended level of one-half of the density at which a health risk occurred. Again, EPA decrees that only one indicator should be used at a time, therefore we focus on *E. coli* in Fairfax County. The geometric mean criteria in the water quality standards are for two or more samples taken during any calendar month. VDEQ interprets the bacteria standards as follows:

- Where effluent sampling is performed more than once per month, the geometric mean applies.
- Where effluent sampling is performed once per month or less, the single sample maximum applies.
- Sampling frequency for this program is less than once per month, so the single sample maximum of 235/100 ml is the standard that applies for Fairfax County.

The data used to calculate the geometric mean indicator densities corresponding to the accepted gastrointestinal illness rates are for "steady state" dry weather conditions; this is typically 48 hours after measurable rainfall. Henceforth, samples should be collected during dry weather periods to establish so-called "steady state" conditions (EPA, 1986).

C. Field Protocol for Bacteria Monitoring Program

This section provides details of the protocols to be followed during bacteria monitoring events and includes descriptions of safety procedures, sampling frequency, proper sampling equipment, and sampling protocols.

1. Sampling Frequency

The typical sampling year includes 40 randomly selected sites throughout Fairfax County. Sampling frequency for bacteria and nutrients has been modified over the years, transitioning from a seasonal collection conducted quarterly to samples taken in April, June, August, October and a winter sample. This condenses the program into the primary growing season for bacteria, along with a reference sample in the colder months.

2. Field Work Preparation

a) Equipment Checklist

Before heading out into the field, staff should assemble the following equipment:

- Field Data Sheets
- Sampling Route
  - Driving Directions
  - Site Locations
- Weatherproof Labels for Bottles
- Coolers and wet ice for samples
- Permanent markers/Pens
- Multi-Parameter Water Quality Sonde
- Nitrile Gloves
- Paper Towels
- Clipboard
- IDEXX 120 mL disposable vessels. Factory-sealed and sterilized. (Check to ensure factory seal has not been removed)
- High Density Polyethylene 250 mL sample bottles

Bacteria sampling involves using sealed 120 ml bottles to take grab samples from the stream to determine the concentration of E. coli in the water. In addition to the assessment of bacteria, sterile, 250 ml HDPE bottles are used to collect samples to assess nitrate/nitrite and total phosphorous as secondary tests for possible human inputs. Finally, chemical parameters, such as pH, water temperature, dissolved oxygen, and specific conductance are taken at time of bacteria sampling using multi-parameter water quality sonde (See Figure VI.1).

Figure VI.1: Sampling Materials(clockwise from top left: 120ml IDEXX sample bottle, 250ml HDPE sample bottle, YSI multi-parameter water quality sonde)

b) Water Quality Sonde Calibration

Calibration of the water quality sonde must be completed prior to sample collection. Calibration procedures can be found in a separate document for instrumentation and provide a step-by-step guide to ensure accuracy of the sonde. A few steps to follow prior to calibration:

- All buffers and standards should be at a similar temperature as the stream in order to ensure accurate calibrations. For winter months, this requires staff to either keep them on ice or place them in the refrigerator the night before.
- Check to make sure that the sonde has a charged battery - for backup, bring 2 'C' batteries in the field.

The sonde can be calibrated either in the office or from the back of the vehicle prior to leaving for the sampling run. Calibration readings should be entered in the Calibration and Maintenance Log.

3. Sample Collection

This section describes the steps to be completed and the areas of the form to be filled out. Please see Figure VI.2 for a copy of the field form.

a) Field Measurements

Some basic tips for using the water quality sonde in field monitoring:

- The unit should be on for about 10 minutes before readings are taken.
- Place the sonde guard on the unit to protect the probes during readings.
- Ensure the probes are fully immersed in flowing water upstream of any other collection activity.
- Allow the readings to stabilize before taking a reading, especially in winter months.
- Always write out measurements to the full precision of the instrument.
- Record results on the data sheet and note anything unusual in the comments section if necessary

b) Sampling Information

Ideally, all samples should be taken in the center of the stream flow along a riffle or other flowing water. Ensure that collectors sample away from the stream bank, facing upstream in the main current. Never sample stagnant water. The outside curve of the stream is often a good place to sample, since the main current tends to hug this bank. In shallow stretches, carefully wade into the center current to collect the sample. Do not allow disturbed substrate, particulates, or suspended sediments to contaminate sample.

During summer months, it is possible that stream flow will not be sufficient to obtain a quality sample. If there is not enough flow to collect, please note on data sheet that 'no flow' or 'low flow' conditions were observed.

c) Grab Samples

Two grab samples (E. coli and Nutrient bottles) are to be collected at each site. All grab sample labels should include the following information:

- Sample Date
- Sample Time
- Site Identification
- Sample Collector

As mentioned previously, all samples should be taken in a reach with well mixed, flowing water. Be sure that grab samples are taken downstream of water quality measurements to ensure accuracy. Be aware of any disturbed sediments from sonde placement and avoid collection of this water. For nutrient samples, rinse bottle with sample water three times before filling. E. coli bottles should not be rinsed prior to collection.

All nutrient and bacteria samples should be stored in a cooler with wet ice. As an additional precaution, be sure that the bottles remain upright in the cooler, as it is possible that the lids are not completely sealed.

d) Sample Drop-off

Once all sites in the sampling route have been completed, staff will immediately transport samples to the Fairfax County Health Department Laboratory. The samples will then be processed according to the analyte suite listed in Table VI.2 within the applicable holding times.

D. Analytes

Parameters to be tested will provide information about the presence of pathogenic material and deposition and mobilization of nutrients commonly used in detergents and fertilizers. The analyte suite is shown below in Table VI.2.

Table VI.2: Field and Laboratory Analytes with Method Detection and Reporting

Parameter	Method Detection Limit	Reporting Limits	Method	Holding Time
pH	NA	NA	Field Measurement	Analyze at collection
Dissolved Oxygen	NA	NA	Field Measurement	Analyze at collection
Specific Conductance	NA	NA	Field Measurement	Analyze at collection
Temperature	NA	NA	Field Measurement	Analyze at collection
Nitrate plus Nitrite Nitrogen	0.026 mg/L	0.1 mg/L	EPA 353.2	28 Days
Total Coliform	< 1 MPN/100 mL	1 MPN/100 mL	Colilert MPN	8 Hours
Total Phosphorus	0.0080 mg/L	0.03 mg/L	SM 22nd Ed. 4500 P-E	28 Days
Escherichia coli	<1 MPN/100 mL	1 MPN/100 mL	Colilert MPN	8 Hours

1. Sample Documentation of Field Monitoring

For sample events, a dedicated field form (Figure VI.2) is used to document the following information:

- Sample ID
- Sample Date
- Sample Time
- Field Collectors
- Field Measurements

2. Chain of Custody

Chain of custody (COC) forms, used for all samples, are a permanent record of transfer of sample custody. For this program, the field form serves as the COC. Field staff need only to indicate laboratory delivery date and time during drop-off of samples at top of form. Field staff should have Health Department staff make a copy of signed chain of custody and retain for their records.

E. Bacteria Data Analysis and Reporting

1. Bacteria Monitoring Data Input

Fairfax County Health Department staff will mail results (typically within three weeks) to Watershed Assessment Branch staff. This information will then be entered into the WAB Database under 'Bacteria Sampling'. All information from the field form, in addition to the grab sample results, should be entered:

- Site ID
- Sample Date
- Sample Time
- Sample Collectors
- Field Measurements
- E. coli
- Total Coliform
- Nitrite/Nitrate
- Total Phosphorus

2. E. coli Exceedance Procedures

As staff input data, all sites with E. coli values greater than or equal to the single sample maximum of 235 colony forming units per 100 mL will be entered into a separate spreadsheet. Site ID, sample date, and E. coli value should be entered. This will serve as a basis for possible additional follow-up investigations. Best professional judgement is utilized for values found to be significantly higher in consecutive sampling events. E. coli values greater than 1,000 cfu per 100 mL should be flagged as a potential sewer leak and additional synoptic sampling visits should be conducted at these sites to potentially isolate the source(s) of bacteria.

F. Bacteria References

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VDEQ. 2003. Guidance Memo No. 03-2007, Implementation of Bacteria Standards in VPDES Permits. Available at: http://www.deq.virginia.gov/waterguidance/pdf/032007.pdf 12pp.

G. Forms and Data Sheets

Figure VI.2: Bacteria Monitoring Field Form

Water Chemistry: Streams Bacteriological Study

Fairfax County Health Dept, Laboratory
10310 Layton Hall Drive, Fairfax VA 22030

Sampling Zone 4
Report Results to: Chris Mueller; 703-324-5007
Time samples received by Health Department (initial and indicate time):
_____

Date Collected: _____
Collected by: _____

Meter type: _____

FIELD RESULTS

Sample ID #	*Address/Location*	*Comments*	*Time of Sample*	*pH*	*Sample Temp (°C)*	*Dissolved Oxygen (mg/L)*	*Specific Conductance (µS/cm)/c°*
CU1701	5724 Flagler Dr						
CU1702	ECL Park						
LR1701	5272 Meadow Estates Dr						
DF1704	11595 Avondale Dr						
DF1705	3170 Ariana Dr						
DF1706	3195 Ariana Dr						
DF1707	2650 Oakton Glen Dr						
DF1703	10611 Hannah Farm Rd						
DF1713	10710 Hunters Valley Rd						
DF1708	1595 Spring Hill Rd						
Dup-Zone 4							

ADDITIONAL COMMENTS ***Take Dup-Zone 4***

Figure VI.2: Bacteria Monitoring Field Form

VII. Lake Monitoring Program

A. Background

These instructions provide the necessary information to accurately collect water quality measurements and retrieve nutrient and suspended sediment samples from open water bodies included in the Lake Monitoring Program within Fairfax County. This SOP is to be used by any Fairfax County staff tasked with retrieving lake water quality samples associated with this project. Please be aware that this SOP is intended as a dynamic document – certain policies and procedures will be modified as needed. Future changes to lake monitoring procedures will be incorporated into this document.

B. Prerequisites

There must be a minimum of three (3) field staff involved with an individual monitoring event. Due to the County safety policy regarding field work from a boat and the adjacency to deep water, one individual must remain onshore as a "spotter," or onsite safety personnel during the period of time the boat is occupied and on the water. In-lake water quality monitoring and sample retrieval requires two personnel in the sampling vessel (typically a 14-foot jon boat). All staff must have annual jon boat operations and lake monitoring safety training documented before heading into the field. Before heading out into the field, staff should assemble the following equipment:

- Stormwater gate key (On keychains for vehicles 6008 and 5180, spares with Branch Chief)
- FCPA gate key #7174 and bollard key (On keychains for vehicles 6008 and 5180, spares with Branch Chief) – Royal Lake
- Field Data Sheets – one for each lake
- Field Sample Data Sheets – one for each lake
- Influent – Effluent Sample Sheet (one sheet for all lakes)
- Chain of Custody Form/Log Sheet for Noman Cole lab – one for each lake
- Lake Monitoring binder with site maps, monitoring locations, & directions, etc.
- Permanent markers
- Clipboard with pens/pencils
- Thermometer
- 2-3 large coolers with ice for water samples (3 coolers if monitoring 2 lakes)
- Ice – contact Government Center cafeteria staff
- *Cubetainers* [4L cubic HDPE bottles] approximately 10-12 per lake
- 2 – multi parameter water quality probes
    - YSI Pro Plus (or 6920) calibrated, with 0.5 meter markings on cable to probe
    - Other multi parameter probe
- YSI mount for gunwale of boat
- Van Dorn grab sampler with messenger (0.5 meter markings on rope)
- Secchi disk
- Measuring tape with weight (has small carabiner at end)

- Boating gear
  - Life preservers (flotation vests) for all participants
  - 2 Anchors and anchor line
  - 2 Oars
  - Trolling motor
  - 2 marine batteries, charged
  - Jon Boat plug (stored in glove compartment of vehicle #5180)
  - Throwable (seat cushion) floatation devices
  - Hand operated bilge pump
  - Safety whistle
  - 14-foot Jon boat on a trailer
  - Trailer towing hitch and key
  - Optional – depth finder

C. Procedures

1. Notification and Lake Order Determination

Lake sampling is a planned monthly event that takes place the third week (Wednesday and Thursday) of each month, from March/April through October/November, unless otherwise noted due to holidays, severe weather, or other determinations by staff. Fairfax County staff alerts the Noman Cole lab in advance (24-48 hours) to prepare for sample delivery. It is imperative that County staff head into the field as early as possible on sampling dates in order to deliver samples to lab in a timely manner.

To reduce sampling bias, the sampling runs alternate the lake(s) to be sampled and the order of sampling. The following table is an example of the sampling rotation among three lakes, for 8 months:

Table VII.1: Sample Monitoring Rotation

Month	Lake 1	Lake 2	Lake 3
April	Woodglen	Huntsman	Barton
May	Woodglen	Barton	Huntsman
June	Barton	Huntsman	Woodglen
July	Woodglen	Huntsman	Barton
August	Barton	Woodglen	Huntsman
September	Barton	Huntsman	Woodglen
October	Woodglen	Barton	Huntsman
November	Barton	Woodglen	Huntsman

*Assumes Lake 1 & 2 occur on the same day, with Lake 3 sampled on the day immediately following or preceding the 2-lake-day.

The sampling schedule for the year should be set prior to the first sampling event. Noman Cole lab should be provided a preliminary schedule for the year by March. However, due to weather and other office-related priorities, the schedule and dates are adjusted a few times per year. Before altering monitoring dates, staff should communicate with the Noman Cole lab to ensure they are able to handle additional samples on a given date.

2. Lake Monitoring Stations

The monitoring stations for the lake water quality samples are determined prior to the inclusion of a new lake to regular monitoring. The current lakes (Barton, Huntsman, Royal and Woodglen) have 3-4 in-lake water quality stations, 1-2 major inputs (influents) and 1 major output (effluent). The in-lake monitoring stations were determined based upon the initial or proposed lake bathymetry. In each lake there is at least one monitoring station in a forebay, one mid-lake, and one near the deepest portion of the lake near the outfall structure. Additional sampling locations may be situated in other areas throughout the lake, as needed.

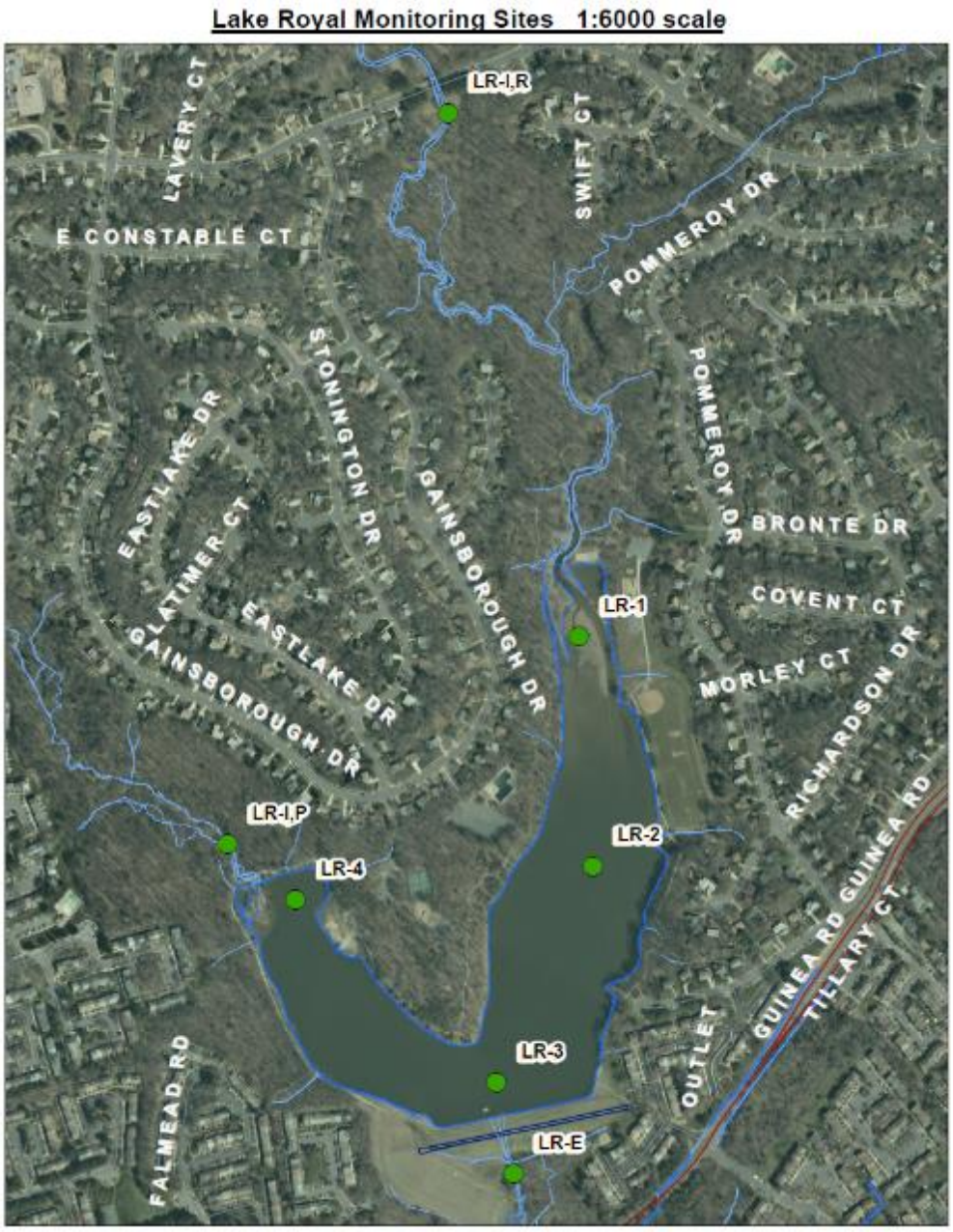


Figure VII.1: Lake Monitoring Locations Using Aerial Imagery (Ex. Lake Royal); Note: LR-1 was located in a proposed forebay.

A series of maps are generated for each lake with the locations of the monitoring stations overlaying aerial photographs of the station area, and the anticipated bathymetry field staff will encounter (see Figures VII.1 and VII.2). To ensure consistency, these maps are retained and provided to field staff collecting samples. Influent and effluent samples are collected at a riffle or location where water moves relatively fast and is not directly influenced by the current lake water surface elevation (back water). Current maps of monitoring stations are found in the Lake Monitoring binder.

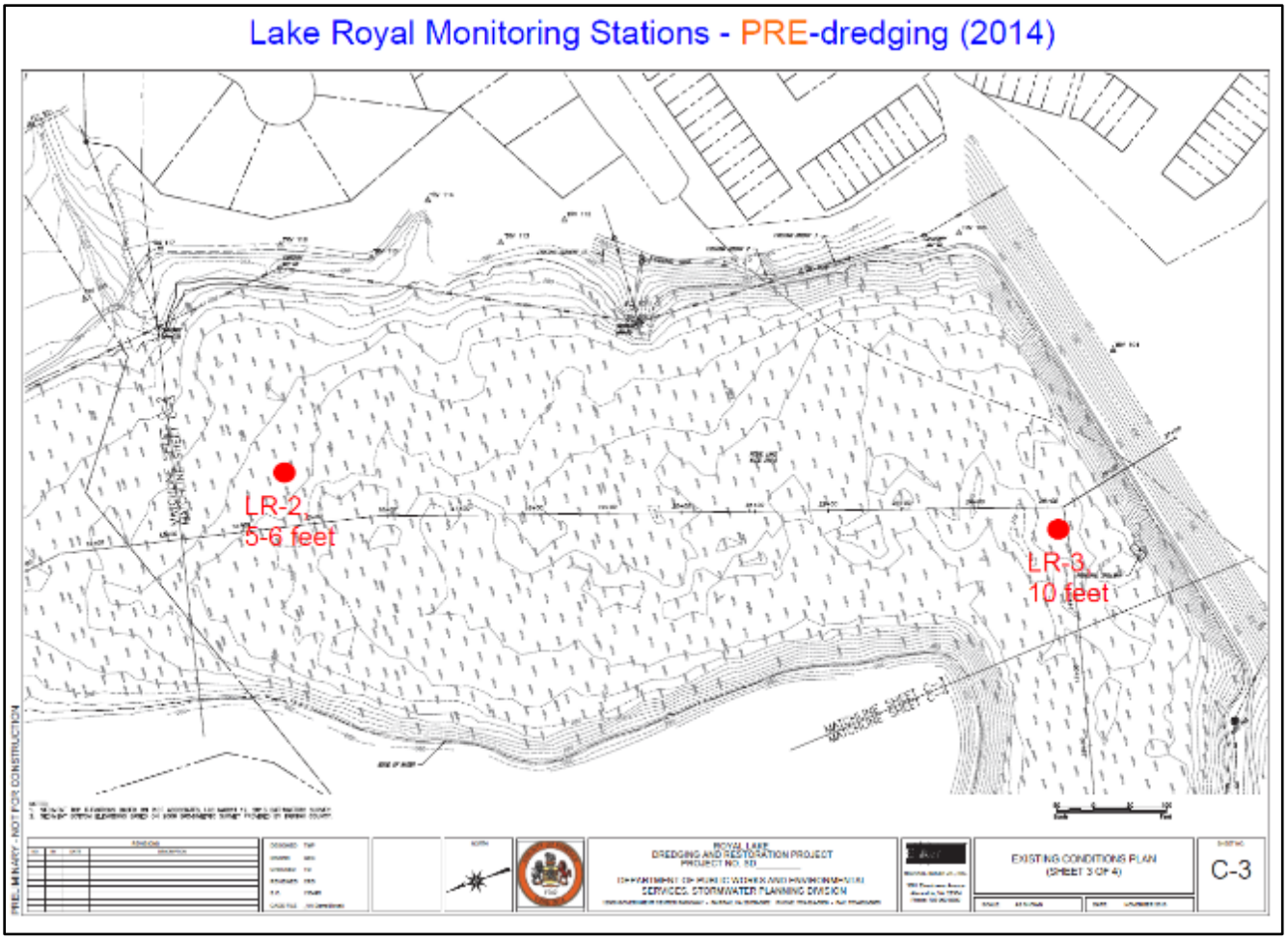


Figure VII.2: Example Map Showing Pre-Dredge Bathymetry (Lake Royal)

3. Field Work Preparation

a) Multi-parameter sonde (head unit & cable with 0.5m markings)

The water quality sonde must be calibrated prior to sample collection. The full SOP is located in the Forms and Data Sheets section and provides a step-by-step guide to ensure accuracy of the multi-parameter sonde. Equipment to assemble prior to calibration:

- pH, Conductivity and Turbidity Standards
- Distilled Water
- Nitrile Gloves
- Paper Towels

Check to make sure that the sonde has a charged battery (the rechargeable battery pack should be used). For backup, bring 4 'C' batteries in the case. The sonde can be calibrated either in the office or from the back of the truck prior to leaving for the sampling run. Calibration readings should be entered in the calibration binder.

b) Equipment

Ensure all of the equipment listed in Section C. of this document is assembled and in working order. Charge at least two marine 12-volt batteries in a well-ventilated location overnight to ensure both are fully charged before heading out for field work.

(1) Safety

- Ensure all staff have been trained on jon boat safety, specific lake monitoring protocols, have read through the activities hazard analysis, and have signed (annually) the activities hazard analysis review (Figure VII.16) before participating in lake water quality monitoring.
- Check all personal floatation devices (PFDs) and throwable floatation before daily use. Check all PFDs for expiration dates annually.

(2) Boat & trailer

- Uncover the boat and hitch the trailered boat to the truck (vehicle #5180). Ensure the bow and stern of the boat are properly secured to the trailer. Ensure the trailer is properly hitched (locked hitch, safety chains, etc.) to the truck *and* that the trailer lights are working as directed in the Jon Boat Safety and Operations document.
- At the lake, load and prepare monitoring equipment, safety and operational gear, and ensure the boat is fully prepared for monitoring.
- Properly launch the boat following instructions in Jon Boat Safety and Operations document.
- No staff should ride in a trailered boat during launch or trailering/egress unless the stern of the boat is over open water AND all participants agree it is safe to do so. For example, when trailering the boat from the water, pull the bow over dry land and have the crew safely exit the boat before pulling the boat and equipment onto dry land.

4. Field (*in-situ*) Monitoring and Sample Collection

a) Monitoring Stations

Use available mapping to determine proper location of the monitoring station. Make every attempt to sample as close to the designated location as possible where practicable.

(1) Nomenclature

For ease of communicating among WAB staff, all lakes and lake stations are designated as “Lake [insert lake name]” or “[insert lake name].” (Ex. Lake Royal or Royal). Please note these are not always the official lake designations used by the County, communities or other agencies.

(2) Site numbering

All stations begin with a two-character alphanumeric code for the lake followed by a hyphen and a numeric designation for in-lake samples.

- ***LB*** for Barton
- ***LH*** for Huntsman
- ***LR*** for Royal
- ***LW*** for Woodglen

For instance, LB-1 and LH-5 are monitoring stations/sites at Lake Barton and Lake Huntsman, respectively. Influent and Effluent stations use the letter "I" and "E" to indicate the type. Therefore, LR-E would indicate the effluent station at Lake Royal.

(3) Sample numbering

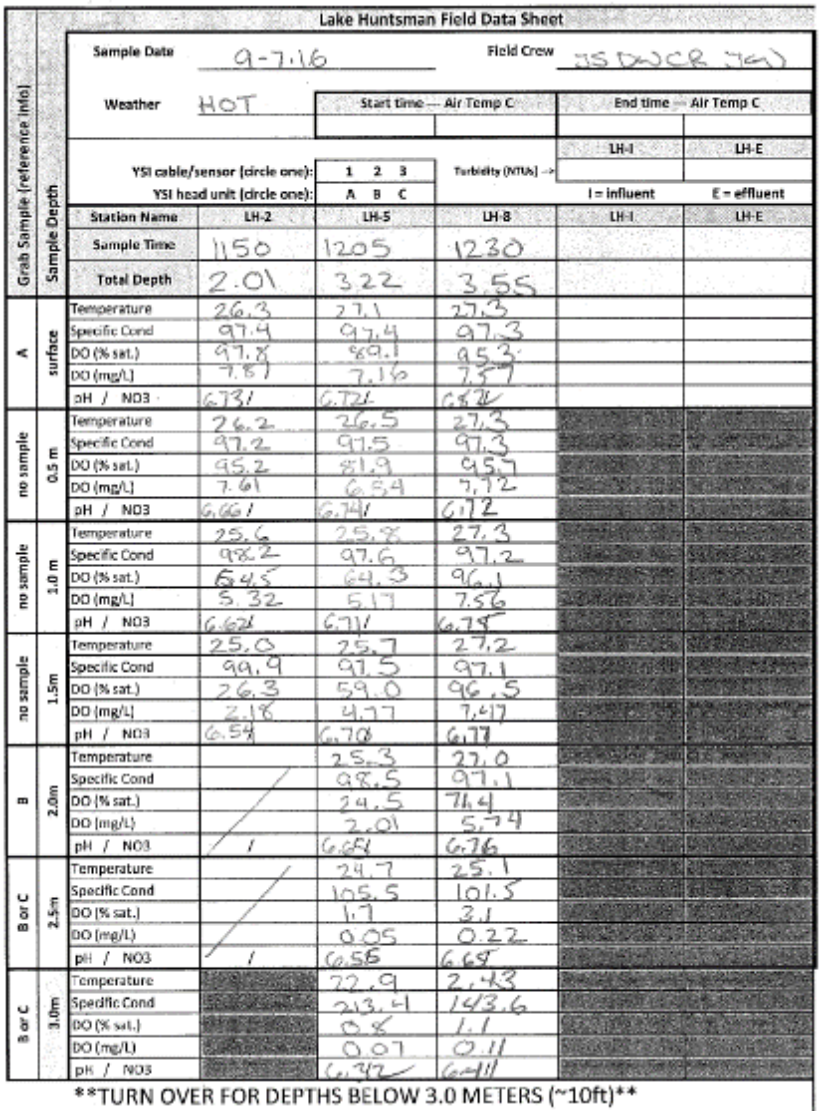
In-lake water quality samples use the above designations and add an additional alphanumeric character to help define depth:

- ***A*** for surface
- ***B*** next depth sample
- ***C*** next depth sample, etc.

For instance, LH-8A is a surface sample at Lake Huntsman, Station #8; and, LB-3C is the deepest of three (deeper than LB-3A and LB-3B) water quality samples taken at Lake Barton, Station #3. In most cases, effluent and influent stations use the site code as the sample code.

(4) Field Data Sheet

Upon reaching the first destination, be sure the station, data, crew, and weather information are entered on the Field Data Sheet form (printed on waterproof paper). All measured data should be entered onto the form using the precision/capability of the equipment – DO NOT ROUND. An example of a completed Data Sheet is provided in Figure VII.3 and a blank form in (Figures VII. 13 and VII.14).



Lake Huntsman Field Data Sheet

Sample Date: 9-7-16 Field Crew: JS DWCR JGJ

Weather: HOT Start time — Air Temp C: End time — Air Temp C:

YSI cable/sensor (circle one): 1 2 3 Turbidity (NTUs) → LH-I: LH-E:

YSI head unit (circle one): A B C I = influent E = effluent

Grab Sample (reference info)	Sample Depth	Station Name	LH-2	LH-5	LH-8	LH-I	LH-E
		Sample Time	1150	1205	1230		
		Total Depth	2.01	3.22	3.55		
A	surface	Temperature	26.3	27.1	27.3		
		Specific Cond	97.4	97.4	97.3		
		DO (% sat.)	97.8	89.1	95.3		
		DO (mg/L)	7.81	7.16	7.57		
		pH / NO3	6.73 /	6.72 /	6.82		
no sample	0.5 m	Temperature	26.2	26.5	27.3		
		Specific Cond	97.2	97.5	97.3		
		DO (% sat.)	95.2	81.9	95.7		
		DO (mg/L)	7.61	6.54	7.72		
		pH / NO3	6.66 /	6.74 /	6.72		
no sample	1.0 m	Temperature	25.6	25.8	27.3		
		Specific Cond	98.2	97.6	97.2		
		DO (% sat.)	64.5	64.3	96.1		
		DO (mg/L)	5.32	5.17	7.56		
		pH / NO3	6.62 /	6.71 /	6.75		
no sample	1.5m	Temperature	25.0	25.7	27.2		
		Specific Cond	99.9	97.5	97.1		
		DO (% sat.)	26.3	59.0	96.5		
		DO (mg/L)	2.18	4.77	7.47		
		pH / NO3	6.54 /	6.70 /	6.77		
B	2.0m	Temperature		25.3	27.0		
		Specific Cond		98.5	97.1		
		DO (% sat.)		24.5	71.4		
		DO (mg/L)		2.01	5.74		
		pH / NO3	/	6.68 /	6.76		
B or C	2.5m	Temperature		24.7	25.1		
		Specific Cond		105.5	101.5		
		DO (% sat.)		1.7	3.1		
		DO (mg/L)		0.05	0.22		
		pH / NO3	/	6.56 /	6.69		
B or C	3.0m	Temperature		22.9	2.43		
		Specific Cond		213.4	143.6		
		DO (% sat.)		0.8	1.1		
		DO (mg/L)		0.07	0.11		
		pH / NO3		6.32 /	6.41 /		

TURN OVER FOR DEPTHS BELOW 3.0 METERS (~10ft)

Figure VII.3: Lake Field Measurement Data Sheet (Ex. Lake Huntsman Sept 2016)

b) Field Measurements

Staff conduct both water quality field measurements using a multi-parameter quality sonde (e.g. YSI; see Figure VII.4) and by taking at least one water sample at each location. Data obtained by the multi-parameter sonde is documented on the lake Field Data Sheet (Figure 3). Secchi disc depth measurements and water quality sample information is recorded on the lake Sample Sheet (Figures VII.3, VII.13 and VII.14). All data should be recorded to the highest level of precision provided by each instrument.

c) Station instructions for taking field measurements & samples while in boat:

(1) Multi-parameter sonde

The multi-parameter sonde operates in a similar fashion to the sondes used in other aspects of field monitoring. Some basic tips for use:

- The unit should be on for about 5-10 minutes before readings are taken.
- Place the sonde guard on the unit to protect the probes during readings.
- Ensure the probes are fully immersed in flowing water upstream of any other collection activity.
- Allow the readings to stabilize before taking a reading, especially in winter months.
- Always write out measurements to the full precision of the instrument. For example, if DO is 6.78 mg/L, write 6.78, not 6.8.

1) Record start/end time & air temperature (in the shade) when at the lake.
2) Determine sampling locations on the water using maps, bathymetry, depth finder, tape measure, etc.
3) Anchor boat – try not to lower anchor more than once (stirs sediment which can foul samples and confound data) – release/lower anchor slowly to bottom. In most conditions and all stations over 1.25m depth staff should use two anchors.
4) Determine water depth at the station using a tape measure with a weight. Record total depth on both data sheets in the associated column (sampling location).
5) Use a multi-parameter sonde head unit to obtain water quality information using the long-cabled sonde (has white markings every 0.5m) at surface and every 0.5m (~1.5ft) depth (Figure VII.4). Record data on the lake Field Data Sheet. Do not take water measurements or samples within 0.10m of the bottom (Ex. If the total depth is 3.62m, staff would obtain data from 3.50m depth). Data from the sonde will be used for #6.
6) Determine depths to take water quality samples (can indicate on field data sheet or verbally alert staff) – see steps 9 & 10 below
7) Staff should obtain a surface water sample in top 0.3m at all in-lake stations. Be sure to fully submerge opening (5-10cm below surface). Do not tilt the bottle to fill. This helps reduce floating particulates in the sample.
8) Obtain a bottom sample al all monitoring stations with a total depth 2.0m (6ft) or greater. The sample should be taken at the nearest 0.5m to bottom.
9) If lake is stratified (obvious thermocline/oxycline):
   - Take one surface and one bottom sample, if necessary (as directed in a. and b., above)
   - Take 1 water sample near middle of thermocline if total depth <= 3.0m (<=10ft)
   - Take 2 water samples one near top and one near bottom of thermocline if total depth > 3.0m (10ft)
10) If lake is well-mixed:
   - Collect surface sample only for depths less than 2.0 m (6 ft)
   - Take surface & bottom samples only for locations <= 3.0m (10ft) depth

- Take surface, bottom and mid-depth for locations >3.0m (10ft) depth; alternatively, take 3 samples at deepest location

11) Take Van Dorn (water) sample at depths determined in the field, based upon lake conditions and protocols (above), then empty into sample bottle. Detailed instructions are provided below.
    - Label sample bottle using marker such as Figure VII.6.and store on ice
    - Record depth and time of sample on the lake Sample Sheet.
12) Obtain Secchi depth measurements (4X) – record descending and ascending for each pass on lake Sample Sheet. Secchi disc is affixed to tape measure by a small carabineer.
13) Record depth measurements in meters.
14) Measure/round to nearest millimeter.
15) Obtain influent/effluent samples. For more detailed procedures see below.
    - Obtain surface water samples from flowing water
    - Use multi-parameter sondes for field data and record turbidity (if calibrated) for influent/effluent

Figure VII.4: YSI Probe, Cable and Guard (with 0.5m Markings)

- Bathymetry and Secchi depths
  Staff utilize a tape measure with metric marking in millimeters to conduct both bathymetric (water column) and Secchi disc depth measurements. There is a small carabiner attached to the end of the measuring tape, which extends the depth 3.0cm. All measurements of depth and water clarity should be adjusted (post-processing) by adding 0.030 meters to the recorded values.

Figure VII.5: 50-Meter Tape measure with cm/mm, Weight and Secchi Disk

- Types of samples
  Grab samples are collected at each site. For a standard (or normal) lake monitoring water quality sample, staff should use an opaque 4-Liter (1-gal) polyethylene bottle called a cubetainer. These are typically brown in color with white caps. Both the nutrient and suspended sediment are processed from the same sample. All samples should be filled to at least the 3250ml mark on the side of the cubetainer to provide enough volume for the lab to conduct water quality analyses.

  There are two types of water quality grab samples: in-lake (open water) samples and in-stream (influent & effluent) samples. The number and depth of the samples for open water monitoring stations is determined in section D.3.c.i.a)6) and will change throughout the year. If an influent or effluent location is dry or without flowing water, indicate “dry” or “no flow,” on the associated data sheets.

Figure VII.6: One-Gallon/4L Cubetainer Sample Bottle, with Labeling

- In-lake (open water) samples

  Label the cubetainer with the station number and the date using a permanent marker. Label the bottle cap with the station number. Record the depth and time on the lake 'Sample Sheet' (Figure VII.8). Sample times can be rounded to the nearest 5 minute increment - XX:00, XX:05, XX:10, XX:15. Rinse cubetainer three times before filling with water from the depth of the sample.

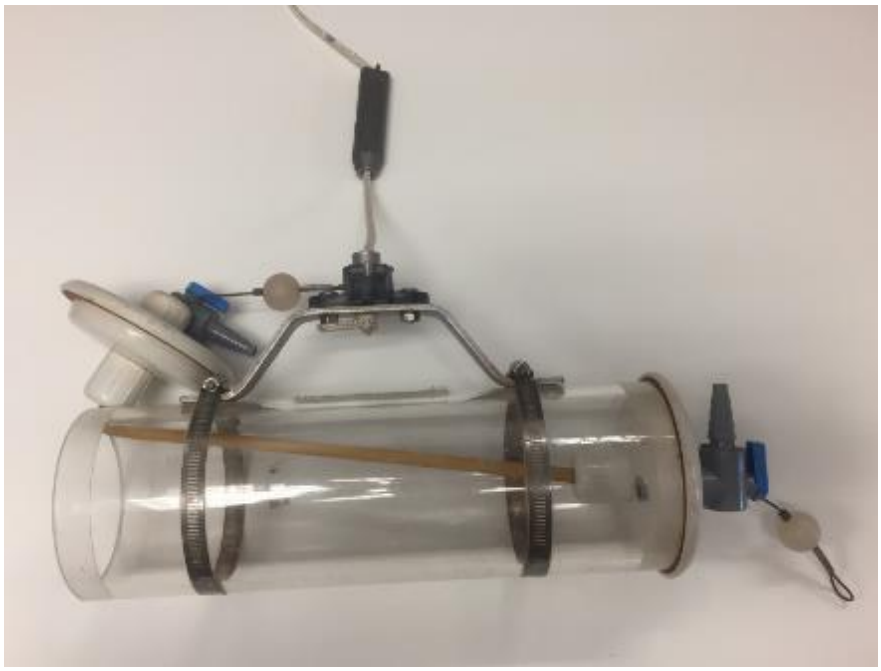
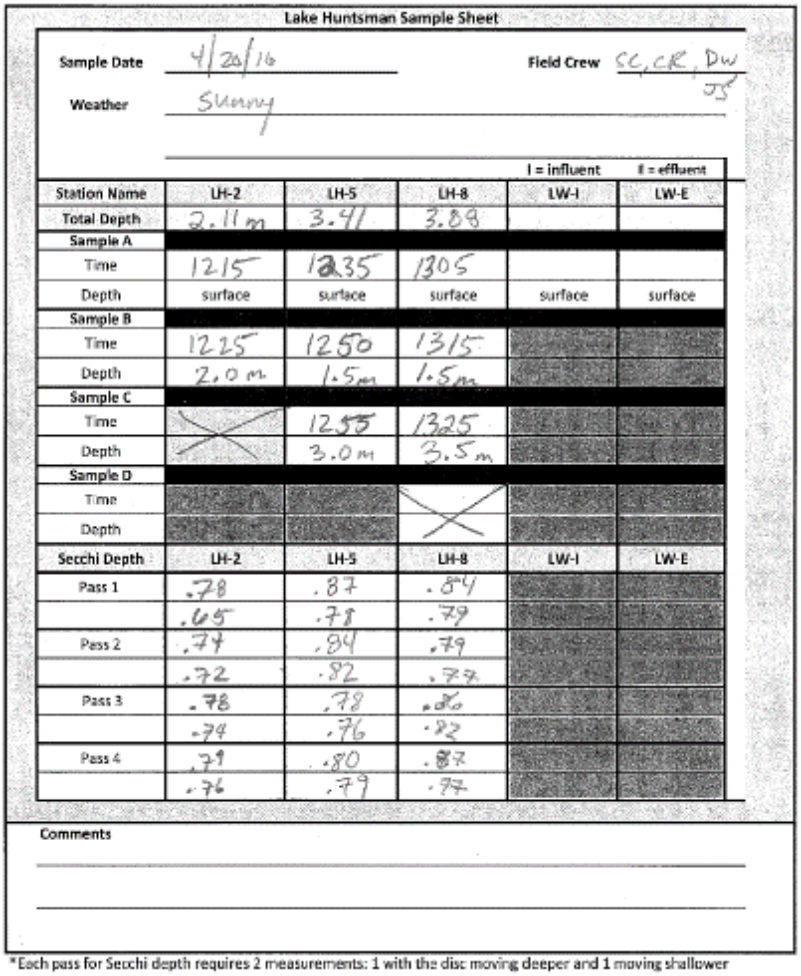


Figure VII.7: Van Dorn Water Sampler

Samples should only be collected at 0.5m intervals (eg. 0.5m, 1.0m, 1.5m, 2.0m, etc). If the field staff deems it necessary to take a water (Van Dorn) sample at a different interval (0.25m), the staff must take corresponding water chemistry measurements at the same depth using a multi-parameter water quality sonde. The Van Dorn sampler (Figure VII.7) has black markings on the white rope every 0.5m, to allow staff to determine the depth when collecting a sample. To properly rinse and fill a cubetainer (one 4L sample), staff are required to collect two (2) Van Dorn samples from the same depth.



Lake Huntsman Sample Sheet

Sample Date 4/20/16 Field Crew CC, CR, DW, JS

Weather Sunny

				I = influent	II = effluent
Station Name	LH-2	LH-5	LH-8	LW-I	LW-E
Total Depth	2.11m	3.41	3.89		
Sample A					
Time	1215	1235	1305		
Depth	surface	surface	surface	surface	surface
Sample B					
Time	1225	1250	1315		
Depth	2.0m	1.5m	1.5m		
Sample C					
Time	X	1255	1325		
Depth	X	3.0m	3.5m		
Sample D					
Time			X		
Depth			X		

Secchi Depth	LH-2	LH-5	LH-8	LW-I	LW-E
Pass 1	.78	.87	.84		
	.65	.78	.79		
Pass 2	.74	.84	.79		
	.72	.82	.77		
Pass 3	.78	.78	.86		
	.74	.76	.82		
Pass 4	.79	.80	.87		
	.76	.79	.77		

Comments

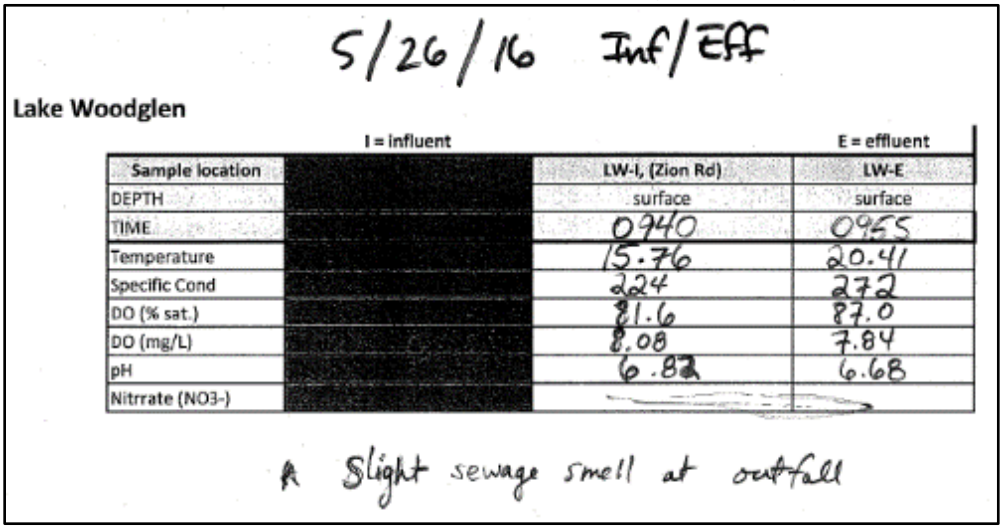
*Each pass for Secchi depth requires 2 measurements: 1 with the disc moving deeper and 1 moving shallower

Figure VII.8: Lake Sample Sheet (Ex. Lake Hunstman April 2016)

- In-stream (influent & effluent) samples

  Label the cubetainer with the station number and the date using a permanent marker. Label the bottle cap with the station number. Record the time and water quality parameters (Figure VII.9) on the lake 'Sample Sheet.' Sample times can be rounded to the nearest 5 minute increment - XX:00, XX:05, XX:10, XX:15. Rinse bottle three times before filling. Ideally, all influent and effluent samples should be taken in the center of the stream along a riffle or other flowing water. Care should be observed

to make sure the influent locations have not been directly influenced by the lake water surface elevation (back water).



5/26/16 Inf/Eff

Lake Woodglen

I = influent E = effluent

Sample location	[redacted]	LW-I, (Zion Rd)	LW-E
DEPTH		surface	surface
TIME		0940	0955
Temperature		15.76	20.41
Specific Cond		224	272
DO (% sat.)		81.6	87.0
DO (mg/L)		8.08	7.84
pH		6.82	6.68
Nitrrate (NO3-)			

A Slight sewage smell at outfall

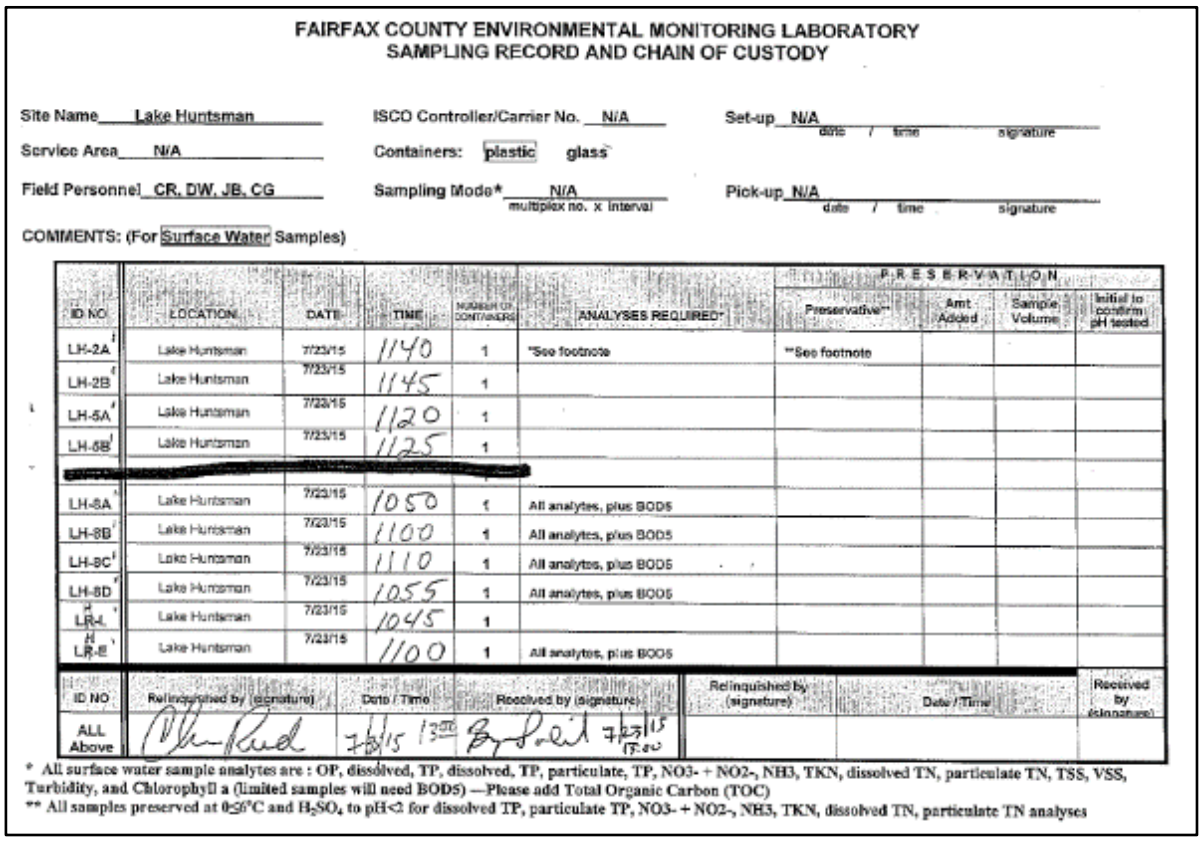
Figure VII.9: Lake Influent-Effluent Sample Sheets (Ex. Lake Huntsman April 2016)

5. Storage & Sample Drop off

Water quality samples should be stored in a cooler with fresh ice until delivered to the Noman M. Cole Lower Potomac Pollution Control Plant laboratory. As an additional precaution, be sure that the bottles remain upright in the cooler, as it is possible that the lids are not completely sealed.

a) Water quality samples – *Cubetainers*

- The water quality samples within the 4-liter (1-gal) HPDE *cubetainers* should be dropped off at the Noman Cole Wastewater Treatment Plant lab. This procedure is similar to the dropoff of samples from USGS monitoring programs.
- At Noman Cole, drive in the main entrance and then take a left. At the gate use the swipe card or ask the guard to open the gate. Once through the gate turn right immediately, then right again once you pass the building. Enter the first set of glass doors on the building to your right. In this area there will be a refrigerator for sample storage.
- Verify the sample bottles match the "Sampling Record and Chain of Custody" forms (one form for each lake) (Figure VII.10)
- Sign and date/time the "Sampling Record and Chain of Custody" form(s) (Figure VII.10)
- Be sure to notify lab staff of samples in the refrigerator and obtain lab staff signature on "Sampling Record and Chain of Custody" form(s)
- Copy the completed and signed "Sampling Record and Chain of Custody" form(s) and maintain for our records. The Noman Cole lab keeps the originals. Bring the copy back to the office to be scanned.



FAIRFAX COUNTY ENVIRONMENTAL MONITORING LABORATORY
SAMPLING RECORD AND CHAIN OF CUSTODY

Site Name Lake Huntsman | ISCO Controller/Carrier No. N/A | Set-up N/A (date / time signature)
Service Area N/A | Containers: plastic glass
Field Personnel CR, DW, JB, CG | Sampling Mode* N/A (multiplex no. x interval) | Pick-up N/A (date / time signature)
COMMENTS: (For Surface Water Samples)

ID NO	LOCATION	DATE	TIME	NUMBER OF CONTAINERS	ANALYSES REQUIRED*	PRESERVATION Preservative**	Amt Added	Sample Volume	Initial to confirm pH tested
LH-2A	Lake Huntsman	7/23/15	1140	1	*See footnote	**See footnote			
LH-2B	Lake Huntsman	7/23/15	1145	1					
LH-5A	Lake Huntsman	7/23/15	1120	1					
LH-5B	Lake Huntsman	7/23/15	1125	1					
[redacted]									
LH-8A	Lake Huntsman	7/23/15	1050	1	All analytes, plus BOD5				
LH-8B	Lake Huntsman	7/23/15	1100	1	All analytes, plus BOD5				
LH-8C	Lake Huntsman	7/23/15	1110	1	All analytes, plus BOD5				
LH-8D	Lake Huntsman	7/23/15	1055	1	All analytes, plus BOD5				
LR-L	Lake Huntsman	7/23/15	1045	1					
LR-E	Lake Huntsman	7/23/15	1100	1	All analytes, plus BOD5				

ID NO	Relinquished by (signature)	Date / Time	Received by (signature)	Relinquished by (signature)	Date / Time	Received by (signature)
ALL Above	[signature]	7/23/15 1350	[signature]			

* All surface water sample analytes are : OP, dissolved, TP, dissolved, TP, particulate, TP, NO3- + NO2-, NH3, TKN, dissolved TN, particulate TN, TSS, VSS, Turbidity, and Chlorophyll a (limited samples will need BOD5) —Please add Total Organic Carbon (TOC)
** All samples preserved at 0≤6°C and H_2SO_4 to pH<2 for dissolved TP, particulate TP, NO3- + NO2-, NH3, TKN, dissolved TN, particulate TN analyses

Figure VII.10 . Sampling Record & Chain of Custody (Ex. Lake Hunstman July 2015)

6. Records Management

County staff should retain electronic copies of the paperwork – see Watershed Assessment Branch program manager to drop off paperwork. Hard copies are scanned and entered into an electronic data management system.

a) Data Entry QA/QC

- Once all of the data have been entered, a random 10% check of each field data sheet and sample sheet should occur to check for recording errors and data entry.
- If a sheet passes the 10% QA/QC check, nothing else is needed.
- If one or more errors are found within the 10% QA/QC, the erroneous data is corrected, and an additional 10% check is conducted. This continues until no additional errors are found.
- Statistical methods to check for outliers can be employed to identify outlying errors, but are not required.
- If one suspects a laboratory error, please contact the Noman Cole lab as soon as possible.

D. Forms and Data Sheets

Figure VII.11: Blank Lakes Chain of Custody Form
Figure VII.12: Blank Lakes Sample Form
Figure VII.13 - 14: Blank Lakes Field Data Sheet (Front and Back)
Figure VII.15: Blank Lakes Influent/Effluent Data Sheet
Figure VII.16: Blank Activities Hazard Analysis Review Training Sign-In Sheet

FAIRFAX COUNTY ENVIRONMENTAL MONITORING LABORATORY
SAMPLING RECORD AND CHAIN OF CUSTODY

Site Name_____ ISCO Controller/Carrier No. __N/A____ Set-up N/A
date / time signature

Service Area____N/A_____ Containers: plastic glass

Field Personnel_____ Sampling Mode* N/A
multiplex no. x interval Pick-up N/A
date / time signature

COMMENTS: (For Surface Water Samples)

ID NO	LOCATION	DATE	TIME	NUMBER OF CONTAINERS	ANALYSES REQUIRED*	PRESERVATION			
						Preservative**	Amt Added	Sample Volume	Initial to confirm pH tested
					See footnote	See footnote			

ID NO	Relinquished by (signature)	Date / Time	Received by (signature)	Relinquished by (signature)	Date / Time	Received by (signature)
ALL Above						

* Surface water sample analytes are : OP, dissolved, TP, dissolved, TP, particulate, TP, NO3- + NO2-, NH3, TKN, dissolved TN, particulate TN, TSS, VSS, Turbidity, Chlorophyll a, BOD5

** All samples preserved at 0≤6°C and H_2SO_4 to pH<2 for dissolved TP, particulate TP, NO3- + NO2-, NH3, TKN, dissolved TN, particulate TN analyses

Figure VII.11: Blank Lakes Chain of Custody Form

Lake Sample Sheet

Sample Date _____ Field Crew _____

Weather _____

_____

I = influent E = effluent

Station Name							
Total Depth							
Sample A							
Time							
Depth	surface	surface	surface	surface	surface	surface	surface
Sample B							
Time							
Depth							
Sample C							
Time							
Depth							
Secchi Depth							
Pass 1							
Pass 2							
Pass 3							
Pass 4							

Comments

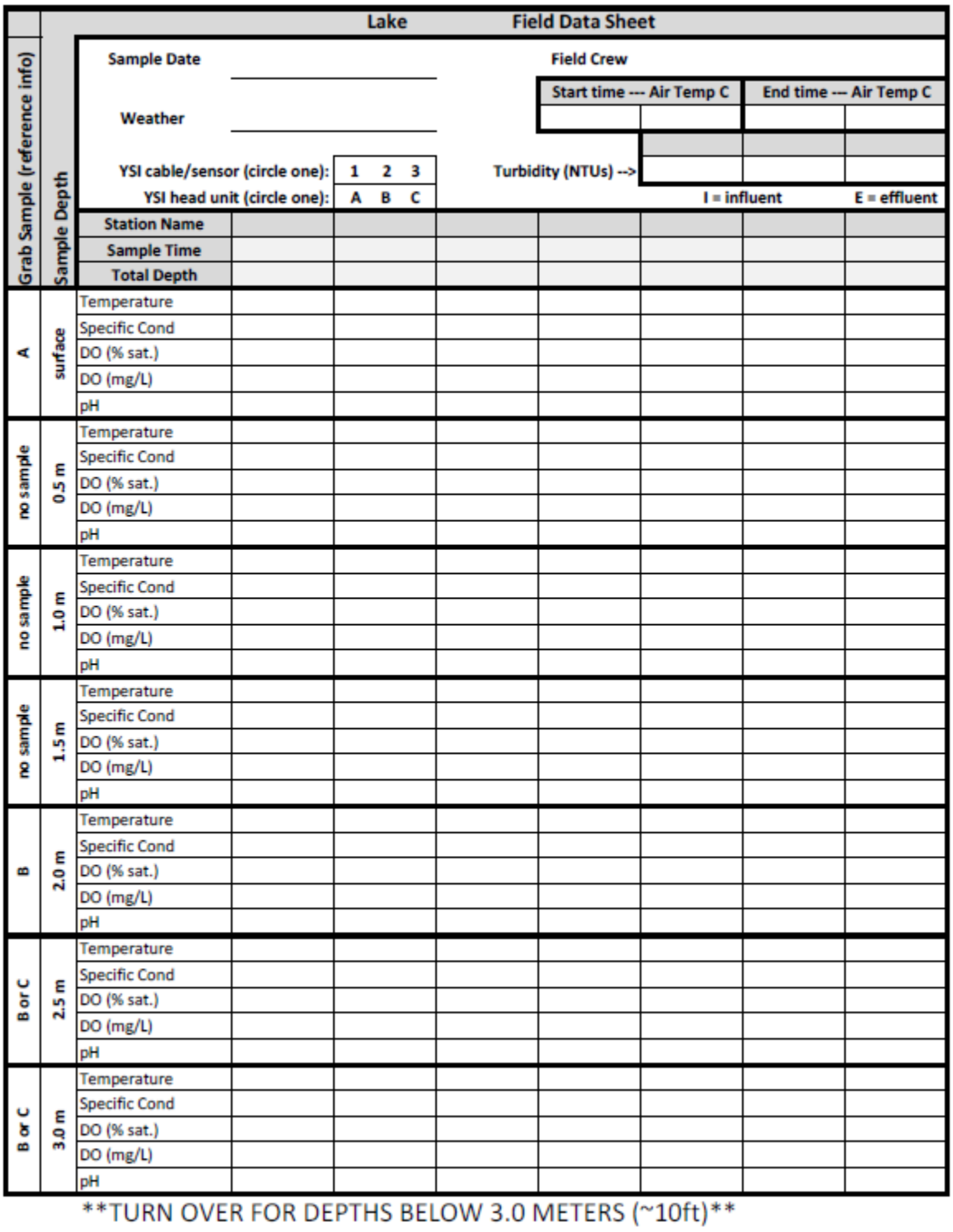
_____

_____

_____

*Each pass for Secchi depth requires 2 measurements: 1 with the disc moving deeper and 1 moving shallower

Figure VII.12: Blank Lakes Sample Form



Lake Field Data Sheet

Sample Date _____ Field Crew

Weather _____

	Start time --- Air Temp C		End time --- Air Temp C	

YSI cable/sensor (circle one): 1 2 3 Turbidity (NTUs) -->

YSI head unit (circle one): A B C I = influent E = effluent

Grab Sample (reference info)	Sample Depth								
		Station Name							
		Sample Time							
		Total Depth							
A	surface	Temperature							
		Specific Cond							
		DO (% sat.)							
		DO (mg/L)							
		pH							
no sample	0.5 m	Temperature							
		Specific Cond							
		DO (% sat.)							
		DO (mg/L)							
		pH							
no sample	1.0 m	Temperature							
		Specific Cond							
		DO (% sat.)							
		DO (mg/L)							
		pH							
no sample	1.5 m	Temperature							
		Specific Cond							
		DO (% sat.)							
		DO (mg/L)							
		pH							
B	2.0 m	Temperature							
		Specific Cond							
		DO (% sat.)							
		DO (mg/L)							
		pH							
B or C	2.5 m	Temperature							
		Specific Cond							
		DO (% sat.)							
		DO (mg/L)							
		pH							
B or C	3.0 m	Temperature							
		Specific Cond							
		DO (% sat.)							
		DO (mg/L)							
		pH							

TURN OVER FOR DEPTHS BELOW 3.0 METERS (~10ft)

Figure VII.13: Blank Lakes Field Data Sheet (Front)

Grab Sample (circle one)	Sample Depth	Lake Field Data Sheet							
		Sample Date _____ Field Crew _____							
								I = influent	E = effluent
		Station Name							
		Sample Time							
		Total Depth							
C or D	3.5 m	Temperature							
		Specific Cond							
		DO (% sat.)							
		DO (mg/L)							
		pH							
C or D	4.0 m	Temperature							
		Specific Cond							
		DO (% sat.)							
		DO (mg/L)							
		pH							

Additional Notes:

Figure VII.14: Blank Field Data Sheet (Back)

Influent - Effluent Lakes Monitoring Data Sheet

Lake _____

	I = Influent	I = Influent	E = effluent
Sample location			
DEPTH	surface	surface	surface
TIME			
Temperature			
Specific Cond			
DO (% sat.)			
DO (mg/L)			
pH			
Turbidity			

Date _____

Lake _____

	I = Influent	E = effluent
Sample location		
DEPTH	surface	surface
TIME		
Temperature		
Specific Cond		
DO (% sat.)		
DO (mg/L)		
pH		
Turbidity		

Date _____

Figure VII.15: Blank Lakes Influent-Effluent Field Data Sheet

ACTIVITY HAZARD ANALYSIS REVIEW

Activity:_____

Date Reviewed:_____ Time Reviewed:_____

Review Facilitator Name:_____

Facilitator Signature:_____

	Printed Name (legibly please!)	Signature
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		

Flip over for more spaces

Figure VII.16: Blank Activities Hazard Analysis Review Training Sign-In Sheet

VIII. USGS Storm Event Monitoring – Sample Retrieval

A. Background

In June of 2007, a Joint Funding Agreement (JFA) between the DPWES Stormwater Planning Division and the United States Geological Survey (USGS) was noted and signed by the Board of Supervisors. This agreement established a network consisting of five automated continuous stream gaging stations (four constructed in 2007 and one in 2012) and 15 less-intensively monitored sites Countywide. The automated stations collect flow data and water quality data every 15 minutes, which is posted to a USGS web page (https://va.water.usgs.gov/fairfax/index.html) within two hours of collection.

These stations also capture storm event samples to be analyzed for sediment and nutrient levels (nitrogen and phosphorus). This study is designed to be an ongoing, long-term monitoring effort to describe current conditions and trends in both water quality (e.g. nutrients and sediment) and water quantity. Ultimately, the information gathered will be used to evaluate the benefits of projects implemented under the watershed planning program.

This section provides the necessary information for Fairfax County staff to retrieve nutrient and sediment samples from the five (5) autosamplers associated with this monitoring program.

B. Prerequisites

All field staff involved in this sample retrieval must be accompanied by a partner, as the autosamplers are located in remote areas and retrieval of samples could be arduous without assistance, depending on the number of samples collected. Before heading out into the field, staff should assemble the following equipment:

- USGS Gage house keys (on vehicle keychains)
- Noman Cole gate key swipe card
- Cooler(s) with wet ice
- Paper Towels
- Clean bottles to restock autosamplers – full autosampler will require 24 bottles)
- Bottle lids
- Storm Event Sample Log (provided by USGS via email)

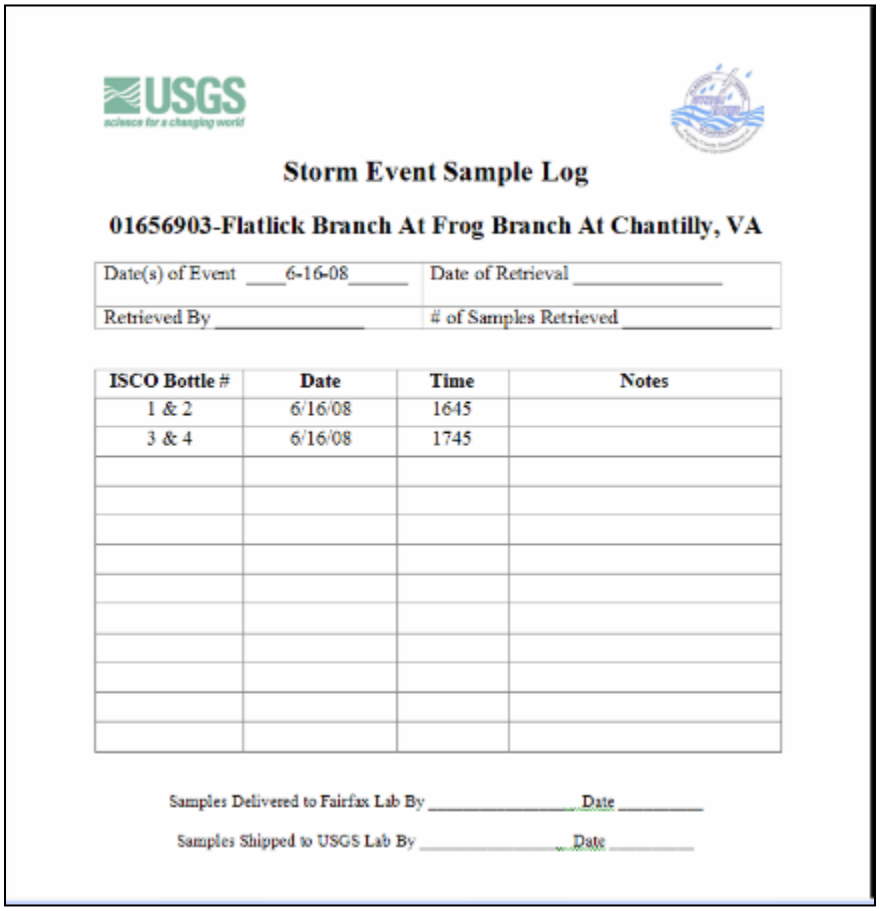
C. Field Procedures

1. Notification

The autosamplers are programmed to collect in stream samples once specified flow and turbidity conditions are met during a storm event. USGS is alerted when an autosampler collects samples. Fairfax County is then notified in order to pick up samples and deliver them to Noman Cole Lab as soon as possible. Immediate pickup is required because the holding time for nutrient samples is 48 hours – in order to ensure sample integrity, the lab requests that samples be delivered the morning after any storm event that triggers the autosamplers. County staff will use best professional judgment in retrieving the samples. In certain instances, it may be possible to retrieve the samples on the day of the event, but in most cases retrieval will be done first thing the following morning. As the Noman

Cole lab is open on Saturdays, Friday storm events may need to be retrieved as well during exceptional storm events. This must be coordinated with the laboratory prior to the anticipated storm.

Once the autosamplers have completed collection of a storm event, USGS will email a storm event sample log for each gage station to County staff. These documents will list the sites where samples were collected and instruct the field staff on which bottles to pull from the sampler (not all filled bottles will need to be retrieved). See Figure VIII.1 below:



Storm Event Sample Log

01656903-Flatlick Branch At Frog Branch At Chantilly, VA

Date(s) of Event ____6-16-08_____	Date of Retrieval _____
Retrieved By _____	# of Samples Retrieved _____

ISCO Bottle #	Date	Time	Notes
1 & 2	6/16/08	1645	
3 & 4	6/16/08	1745	

Samples Delivered to Fairfax Lab By _____ Date _____

Samples Shipped to USGS Lab By _____ Date _____

Figure VIII.1: Storm Event Sample Log

Note: *Although only the bottles listed will need to be collected, it is imperative to bring enough clean replacement bottles to refill each gage that you visit. Each gage holds 24 one-liter bottles. It is possible that the gage collected water in each of these 24, although USGS will not need every sample. For example, if only one station is visited, 24 clean bottles will need to be brought into the field. If two stations are visited, 48, and so on. Additionally, there is the possibility that a requested bottle was not filled as a result of a sampler malfunction. If this occurs, simply note the malfunction on the log sheet.*

2. Field Work

a) Intro

Once storm event information is collected, field staff will prepare to visit the necessary stations and collect samples for delivery to the laboratory. This SOP lists the procedure for one station. Other than noting the specific bottles required for collection from each particular site as noted on the Storm Event Sample Log, all procedures will remain the same.

Figure VIII.2: Dead Run Autosampler Shelter

Upon arrival at the site, unlock the shelter. Be mindful that the shelter could become a haven for wildlife, so open carefully! Unlock the upper hatch on the autosampler head to reveal the program display (Figure VIII.3).

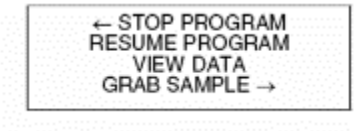
Figure VIII.3: ISCO Controller Display

If the autosampler has successfully collected samples in all 24 bottles the display will read ***Program Complete***; if the sampler has attempted to fill all 24 bottles but was unable to fill some or all of the bottles the display will also read ***Program Complete with Errors***. You will be able to remove samples at this juncture.

If the program is still running, the display will read something similar to: ***Bottles 3, 4 After 1 pulse***. The bottle number is dependent on how many samples have been collected. For example, it may read ***Bottles 15, 16 After 1 pulse***. The display may also read ***Errors have occurred during program***. This means that the sampler tried to grab a sample but failed to do so, in which case there may be unfilled bottles that are considered filled by the sampler. Regardless, it is necessary to first stop the program.

To stop the autosampler program:

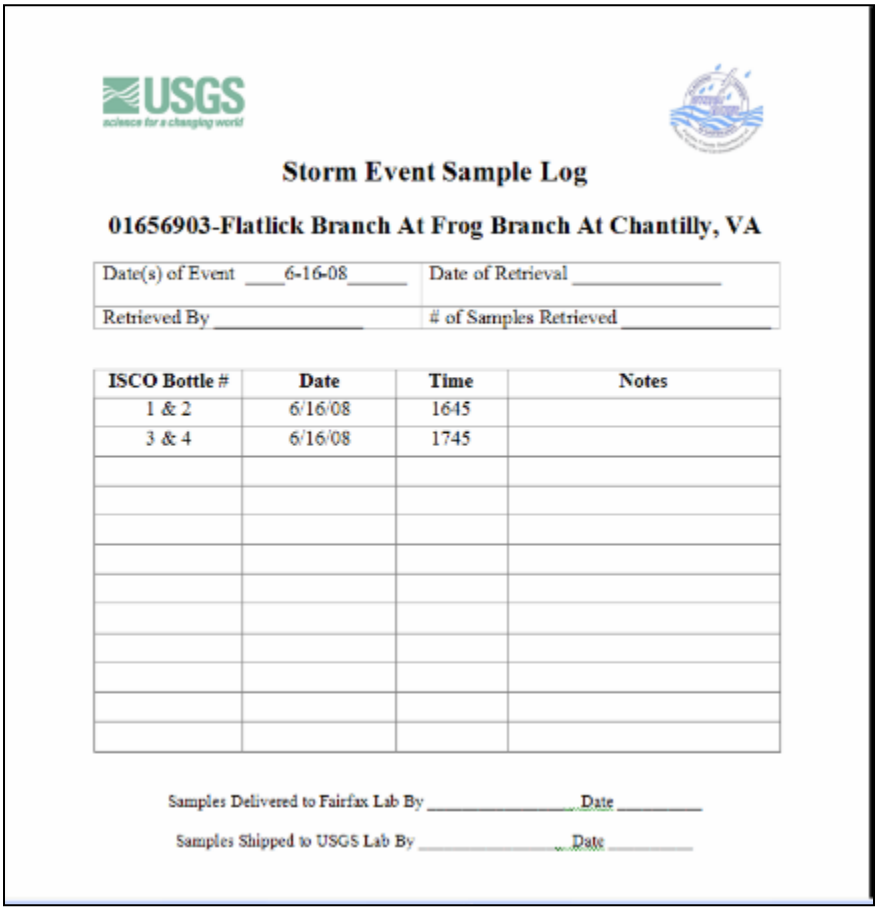
The sampling program may be interrupted by pressing the (**red**) Stop key **twice** while the sampler is waiting for the next sample event. Pressing Stop places the sampler into *Manual Paused* operation and records a manual pause in the sample event log. The manual paused state displays a scrolling menu with several options (see example below).



b) Sample Retrieval

Use the Arrow keys to scroll through the manual paused options, select Stop Program and hit the enter key. The display will read Program: Extended 1 stopped. Sample retrieval can now begin.

By consulting the storm event sample log, field staff will be able to determine the bottles to retrieve. For this example refer to Figure VIII.4, which requires bottles 1,2,3 and 4 to be collected:



Storm Event Sample Log

01656903-Flatlick Branch At Frog Branch At Chantilly, VA

Date(s) of Event 6-16-08	Date of Retrieval
Retrieved By	# of Samples Retrieved

ISCO Bottle #	Date	Time	Notes
1 & 2	6/16/08	1645	
3 & 4	6/16/08	1745	

Samples Delivered to Fairfax Lab By _____ Date _____

Samples Shipped to USGS Lab By _____ Date _____

Figure VIII.4: Storm Event Sample Log Example

The bottles are contained in a rack with a circular configuration (Figure VIII.5). ***Bottle 1 should be the third bottle to the left of the front notch*** (about 7 o'clock). Before removing the rack, place the lids on the bottles so the samples do not spill. If lids were not brought on the sampling trip, extras are located in the center of the rack within a zip top bag. To determine which bottles need to be capped, recall that the distributor arm (which pumps water into the bottles) moves in a counterclockwise direction. There are two alternate methods to determine where Bottle #1 is located in the rack:

Method 1

If the program is not complete, the display will read something like ***Bottles 15, 16 After 1 pulse.*** This means that the next samples to be taken are bottles 15 and 16 – and that the distributor arm is currently over Bottle 14. You then count backwards to find Bottle #1. Bottle #1 is usually 3 bottles to the left of the front center of the rack. See arrow on Figure VIII.5 below.

Method 2

In order to determine the location of Bottle #1, direct the distributor arm to move to that location. To move the arm:

Select ***Other Functions*** from the main menu. Next, select ***Manual Functions*** followed by ***Move Distributor Arm.*** You can select Bottle #1 and the arm will rotate to that position.

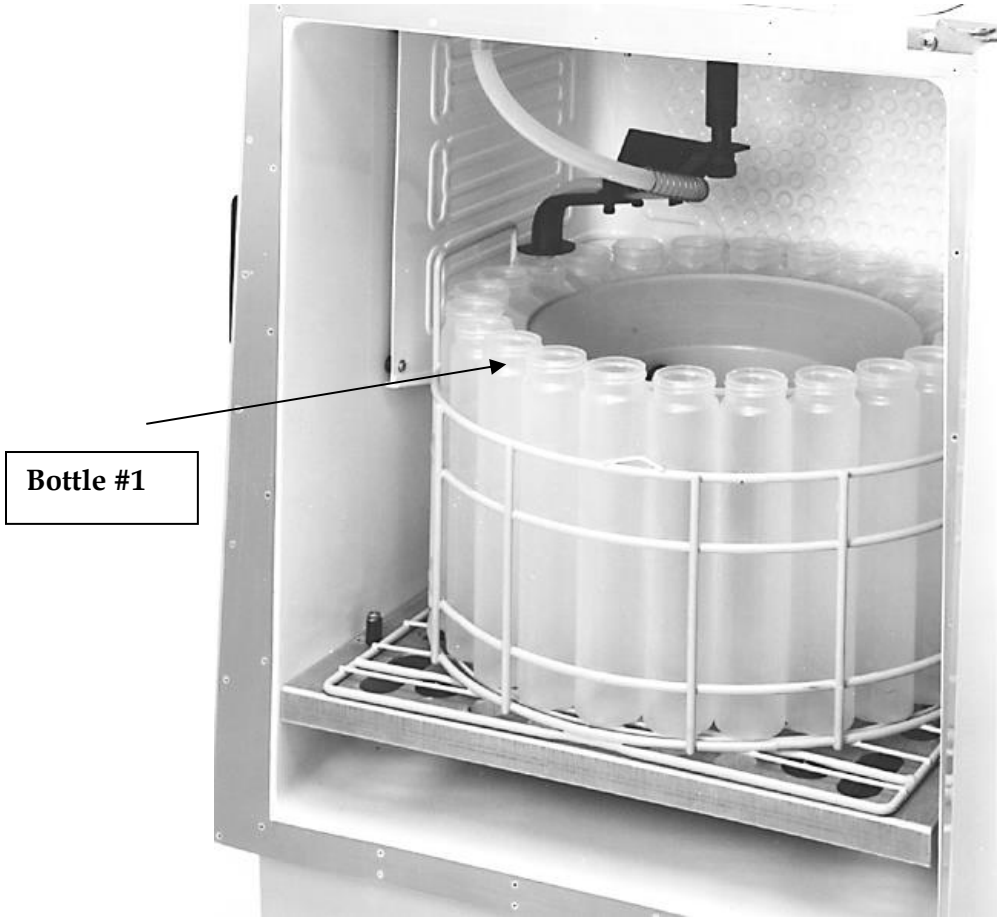


Figure VIII.5: 24-Bottle Kit with 300ml Bottles

Once capped, remove the bottles by unhooking the three bungee cords that keep the bottle rack in place.

Important: *Each "sample" collected consists of two bottles filled – one for sediment, and one for nutrients. Therefore, in the above example, Bottles #1 and #2 are for one "sample", while Bottle #3 and Bottle #4 are for a separate sample. With a 24-bottle rack, this means that a maximum of 12 "samples" can be collected. For the purpose of this project,* ***all odd-***

numbered bottles will be designated "sediment" and all even-numbered bottles will be designated "nutrient."

c) Sample Labeling

To label the samples, first fill out the relevant fields on the storm event sample log. These include:

- Date of retrieval
- Retrieved By
- # of Samples Retrieved

Each bottle will be affixed with a yellow label to be filled out - the team should bring dry yellow labels in the field with them. Not all fields need to be filled out. Each bottle should have the following information:

- Station Name (Flatlick Branch, Difficult Run, SF Little Difficult or Dead Run)
- Station Number (can be found on the Storm Event Sample Log)
- Date bottle was filled
- Time bottled was filled
- Lab Destination

If it is a sediment sample (odd #), then the Lab is ***USGS***. If it is a nutrient sample (even #), then the Lab is ***FFX.*** See Figure VIII.6 for an example.

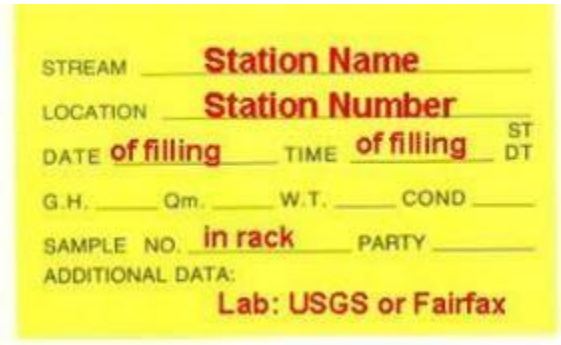


Figure VIII.6: Sample Bottle Label

d) Final Steps

Once all bottles are labeled, they should be transferred to the cooler with ice. This is especially important for nutrient samples (even-numbered bottles). While sediment samples do not need to be refrigerated, they can be placed in the cooler (if there is room) for transport purposes. As an additional precaution, be sure that the bottles remain upright in the cooler, as it is possible that the lids are not completely sealed.

Once you have collected the required samples, dump out all other filled bottles, bag them and return them to the Gov't Center for eventual acid washing and reuse. When dumping unused samples remove as much sediment as possible by thoroughly mixing the sample and shaking the bottle as it is dumped. Fairfax Co. and USGS will arrange for a monthly dropoff of used bottles and replenish the supply of clean bottles.

Restock the bottle rack with the clean bottles brought to the site. Each bottle should have its lid removed and placed in a zip-lock bag (to remain in the center of the rack). Be sure that there are 24 lids in the bag – restock with supplies from storage closet when necessary. Place gray rack cover over bottles and secure it in place using the three attached bungee cords.

Check the kit's alignment by rotating the distributor arm via the keypad. **Do not rotate the distributor manually. Moving the arm manually damages the distributor drive.** To move the arm:

Select ***Other Functions*** from the main menu. Next, select ***Manual Functions*** followed by ***Move Distributor Arm.*** You can select a bottle # and the arm will rotate to that position. Check to see that the arm is aligned directly above the bottle opening.

If you see any misalignment, adjust the posts and ramps until the discharge tube at the end of the arm stops over each bottle. Adjustment of the posts and ramps should not be required often.

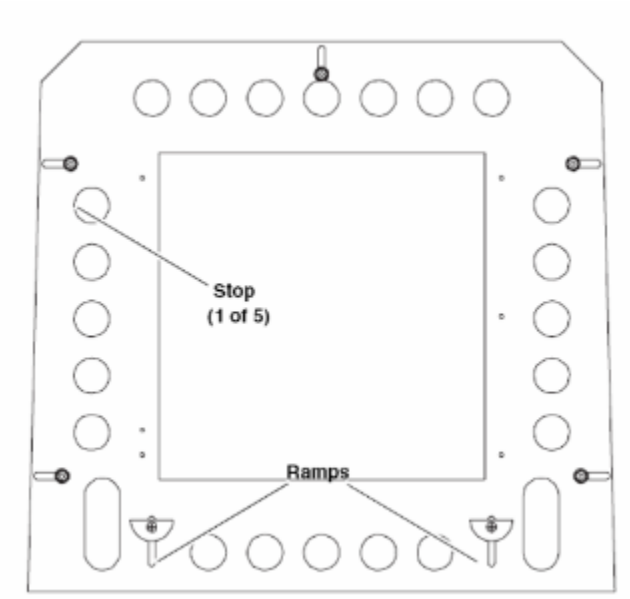


Figure VIII.7: Autosampler Base for Bottle Rack

e) Reset Programs

Autosampler:

- To reset the autosampler, scroll through display until you reach “Run Program”
- Hit enter. The display should now read, “Start Bottle #1”
- Hit enter. Program should restart, with distributor arm cycling around until it reaches bottle #1. The arm should be just above bottle opening
- Close the refrigerator door and the display head hatch
- Autosampler is now ready to resume collection

Sutron 9210 Data Logger:

This device is located along the left-hand side of the shelter inside a gray enclosure (see Figure VIII.8).

- Hit select, and scroll to “Display Values”
- Hit select, and scroll to “reset sampler”
- Hit select, and scroll to right to “# of samples collected”
- Hit select and verify that the “# of samples collected” has been reset to zero.
- Close and latch the gray enclosure – the display on the 9210 will time out and turn the display off.

Figure VIII.8: Sutron 9210 Data Logger

f) Disable Sutron 9210 Data Logger

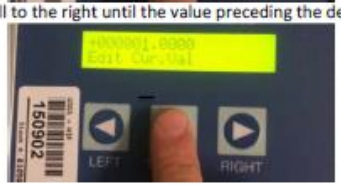
In some cases it may be necessary to disable the sampling program when timely retrieval will not be possible (weekend storms, monthly sampling overlap, etc). This is accomplished by accessing the Sutron 9210 either directly or remotely. This is the preferred approach for enabling and disabling sampling, as opposed to stopping the program on the ISCO, because USGS can then remotely re-enable using the cellular modems. The ISCO program should still be reset and at Bottles 1,2. See Figure VIII.9 for further detail.

Disable/Enable sampling from the 9210 display

1. Press the middle button to turn on the 9210 display
2. Scroll to the right and press the middle button on the **"Calibrate (*)"** screen.

3. Scroll to the right and press the middle button on the **"Sampler On"** screen.

4. Scroll to the right until the value preceding the decimal is underscored.

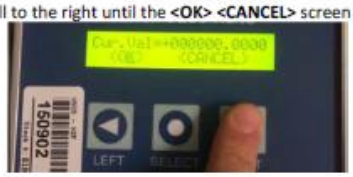


5. Press the middle button to change the underscore to a blinking cursor.

6. Press the left button to change the current value from 1 to 0 to turn off the sampler,
-OR-
Press the right button to change the current value from 0 to 1 to turn on the sampler.

7. Press the middle button to change the blinking cursor to an underscore

8. Scroll to the right until the **<OK> <CANCEL>** screen is displayed



9. Press the middle button on **<OK>** to confirm your change or **<CANCEL>** to make no changes. You will be returned to the **"Sampler On"** Screen after your selection.
10. Scroll to the right until you reach the **"Exit Cal?"** screen and press the middle button

11. Scroll to the Exit XLITE (*) screen and press the middle button to turn off the display

Figure VIII.9: Disable/Enable Sutron Data Logger

This concludes the field work portion at the monitoring station. Before leaving the site, be certain to:

- restock the bottle rack and ensure the distributor arm is lined up correctly
- close the refrigerated autosampler and latch shut
- reset programs on the autosampler and Sutron data logger
- lock the shelter

D. Sample Shipment

1. Sediment Samples (Odd #)

Sediment samples need to be shipped to a USGS laboratory in Louisville, KY. Sediment samples only need to be shipped once a full cooler's worth of samples has been accumulated. The sediment lab form should be filled out as bottles are placed in a cooler for eventual shipment (Figure VIII.10). The same form can be used for multiple storm events for each station, as the date and ID will be present on individual samples. However, a **separate form is needed for each site**.

U. S. GEOLOGICAL SURVEY SEDIMENT LAB ANALYSIS REQUEST
SW / SEDIMENT SAMPLE INFORMATION AT A SITE (SLAR v. 1.04)

This is _X_ of _X_ sites [cases] in this case [shipment]. _X_ total bottles in this case.

Lab_____ Date Shipped _____ Date Rec'd _____ by____
Possibly Hazardous? Yes No Explain_____

Station No. 01656903 Station Name Flatlick Branch Above Frog Branch At Chantilly, VA Time Datum _____ [ie., PDT]
Shipped by_____ jdiastra @usgs.gov Phone No 804-261-2648 Billing Account No. 2482-9ROXA Project Chief jdiastra @usgs.gov
Parameter Family: ☐Suspended Hydrologic Condition:____ Hydrologic Event: J District Code VA

Enter in table below: Sampling Method (82398)
Suspended: EWI(10) Single-Vertical(30) Multiple-vertical (40) Pumping (900) Grab (70)
Lab Analysis Codes Requested: (C) Concentration (SF) Sand-Fine

INDIVIDUAL BOTTLE INFORMATION -- 1 line for each bottle (arrow/ditto down to duplicate) Grey columns required

Pos. No. in Case	Sample Start Date (mm-dd-yy)	Start or Mean Time (24hr)	Sample End Date (mm-dd-yy) OPTIONAL	End Time (24hr) OPT.	Medium	Sample Type	Set ID	Bottle No. in Set	Gage Height	Water Temperature (° C)	Sampling Method (see codes above)	Lab Analysis Code(s) Requested (above)	Collector Initials	Remarks	(for Lab use only) Bottle Condition codes	(for Lab use only) Lab Sample ID
1	07-10-08	0630			9	9		3			900	C, SF				
2	07-10-08	0700			9	9		5			900	C, SF				
3	07-10-08	1345			9	9		7			900	C, SF				
4					9	9					900	C, SF				
5					9	9					900	C, SF				
6					9	9					900	C, SF				
7					9	9					900	C, SF				
8					9	9					900	C, SF				
9					9	9					900	C, SF				
10					9	9					900	C, SF				
11					9	9					900	C, SF				
12					9	9					900	C, SF				
13					9	9					900	C, SF				
14					9	9					900	C, SF				
15					9	9					900	C, SF				
16					9	9					900	C, SF				
17					9	9					900	C, SF				
18					9	9					900	C, SF				
19					9	9					900	C, SF				
20					9	9					900	C, SF				

Figure VIII.10: USGS Sediment Laboratory Form

Pre-paid FedEx labels are to be printed for shipment – see Fairfax County project manager for labels. Once the cooler is full, be sure that all bottles are secure, form is in cooler and tape all edges. Bring to mail center for shipping:

FedEx Authorized ShipCenter
Mail Center
12210 Fairfax Towne Center
Fairfax, VA 22033
(703) 691-2126

2. Nutrient Samples (Even #)

Nutrient samples need to be delivered to the laboratory at the Noman M. Cole Lower Potomac Pollution Control Plant in Lorton, VAat the conclusion of the sample collection – this should be your first stop after all sites have been visited.

At Noman Cole, drive in the main entrance and then take a left. At the gate use the swipe card or ask the guard to open the gate. Once through the gate turn right immediately, then right again once you pass the building. Enter the first set of glass doors on the building to your right. In this area there will be a refrigerator to place the samples in. A copy of the storm event sample log should accompany the samples. There is a copy machine located in the lab. The USGS project manager will inform lab staff that samples are incoming.

E. Record Management

County staff should retain copies of both the sediment sample form and the storm event sample log. See the county program manager to drop off paperwork.

F. Forms and Data Sheets

Figure VIII.11: Fairfax Stream Monitoring Network
Figure VIII.12: USGS Network Site Codes
Figure VIII.13: Storm Event Sample Log

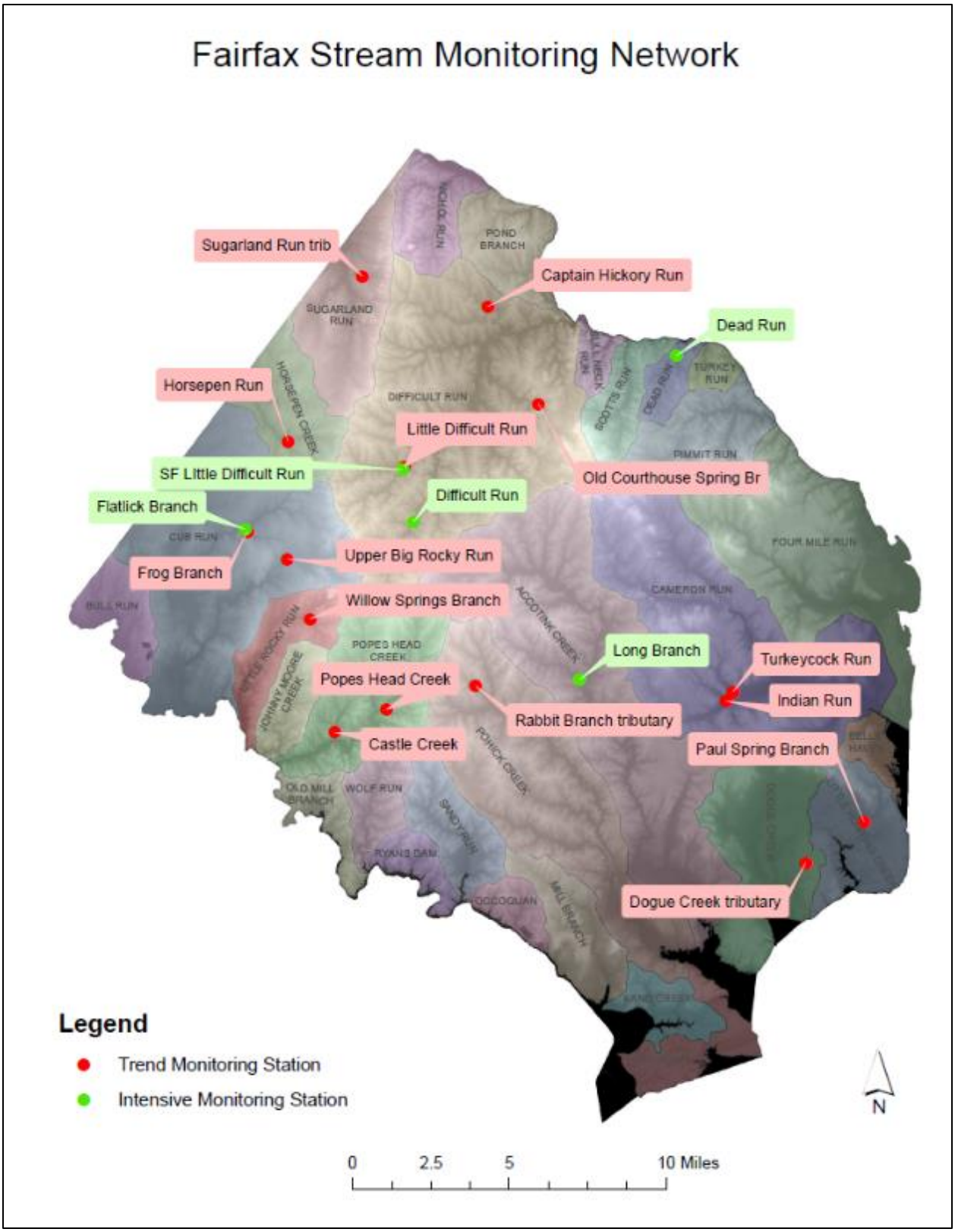


Figure VIII.11: Fairfax Stream Monitoring Network

USGS Network Site Codes

Site Number	Site Name	Group	Watershed
0164425950	Horsepen Run above Horsepen Run Trib Nr Herndon, VA	expansion	Horsepen
01644343	Sugarland Run Trib below Crayton Road Nr Herndon, VA	expansion	Sugarland
01645704	Difficult Run Above Fox Lake Nr Fairfax, VA	original	Difficult
01645745	Little Difficult Run Nr Vienna, VA	original	Difficult
01645762	SF Little Difficult Run Ab Mouth Nr Vienna, VA	original	Difficult
01645844	Old Courthouse Spring Branch nr Vienna, VA	original	Difficult
01645940	Captain Hickory Run at Rt 681 Nr Great Falls, VA	original	Difficult
01646305	Dead Run at Whann Avenue nr Mclean, VA	original	Dead
01652789	Indian Run at Bren Mar Drive at Alexandria, VA	original	Cameron
01652860	Turkeycock Run at Edsall Road at Alexandria, VA	original	Cameron
01653717	Paul Spring Br Ab North Branch Nr Gum Springs, VA	expansion	Little Hunting
01653844	Dogue Creek Trib at Woodley Drive at Mount Vernon, VA	expansion	Dogue
01654500	Long Branch at Route 620 nr Annandale, VA	expansion	Accotink
01655305	Rabbit Branch Ttrib above Lake Royal Nr Burke, VA	expansion	Pohick
01656903	Flatlick Branch Above Frog Branch at Chantilly, VA	original	Cub
0165690673	Frog Branch Above Flatlick Branch at Chantilly, VA	original	Cub
0165694286	Big Rocky Run at Stringfellow Rd Nr Chantilly, VA	original	Cub
01657100	Willow Springs Branch at Route 29 Nr Centreville, VA	expansion	Little Rocky
01657322	Popes Head Creek Trib Nr Fairfax Station, VA	original	Popes Head
01657394	Castle Creek at Newman Road at Clifton, VA	original	Popes Head

Intensive Sites (fully gaged sites)
Less-Intensive Sites (partial record gages)

Figure VIII.12: USGS Network Site Codes

Storm Event Sample Log

01645704 - Difficult Run ab. Fox Lake nr. Fairfax, VA

Date(s) of Event 9/28 - 9/29 Retrieval Date:_____

Retrieved By:_____ # Samples Retrieved:_____

9/28/16	13:45	1 - 2	
9/28/16	15:00	5 - 6	
9/29/16	03:30	7 - 8	
9/29/16	04:30	11 - 12	
9/29/16	05:30	15 - 16	
9/29/16	06:15	17 - 18	
9/29/16	08:45	23 - 24	

Samples Delivered to Fairfax Lab By:_____ Date:_____
Samples Recieved at Fairfax Lab By:_____ Date:_____
Samples Shipped to USGS Lab By:_____ Date:_____

Figure VIII.13: Storm Event Sample Log

IX. USGS Monthly Monitoring – Sample Retrieval

A. Purpose/Background

In June of 2007, a Joint Funding Agreement (JFA) between the DPWES Stormwater Planning Division and the United States Geological Survey (USGS) was noted and signed by the Board of Supervisors. This agreement established a network consisting of five automated continuous stream gaging stations (four constructed in 2007 and one in 2012) and 15 less-intensively monitored sites Countywide. The automated stations collect flow data and water quality data every 15 minutes, which is posted to a USGS web page (https://va.water.usgs.gov/fairfax/index.html) within two hours of collection.

This study is designed to be an ongoing, long-term monitoring effort to describe current conditions and trends in both water quality (e.g. nutrients and sediment) and water quantity. Ultimately, the information gathered will be used to evaluate the benefits of projects implemented under the watershed planning program.

This section will provide the necessary information to accurately retrieve monthly nutrient and sediment grab samples from the network of 20 sites within Fairfax County. Five (5) of these sites are continuous record gages employing ISCO autosamplers. The remaining 15 sites are partial record gages where the samples/data are primarily collected manually. These sites are equipped with a staff plate, a pressure transducer (and housing) and crest stage gages.

B. Prerequisites

All field staff involved in this sample retrieval must be accompanied by a partner, as the sites are located in remote areas and retrieval of samples could be arduous without assistance. Before heading out into the field, staff should assemble the following equipment:

- USGS Gage Keys (on vehicle keychains)
- Noman Cole gate key swipe card (for after hour drop-off)
- Monthly Event Field Form (provided by USGS via email)
- Monthly Sample Log Sheet for Noman Cole (provided by USGS via email)
- 1 Liter HDPE bottles for run + duplicate + extra
    - Weatherproof labels for HDPE bottles
- Labels for Nutrient Bottles (provided by USGS via email)
- Route Directions
- Coolers for nutrient samples
- Ice –Contact Cafeteria Staff
- Crate with 500 ml glass bottle Sediment Bottles
- HOBO Shuttle (used to download pressure transducer data)
- Engineer's Ruler
- Permanent markers/Pens
- Thermometer
- YSI Exo3 water quality meter
- Calibration instructions for meter

- Buffers and Standards for Calibration
  - 4, 7 and 10 pH Buffer
  - 100 NTU Turbidity Standard
  - 50, 250 and 1,000 uS/cm Conductivity Standard
- Distilled Water
- Nitrile Gloves
- Paper Towels
- Clipboard

C. Procedures

1. Notification and Run Determination

This sampling is a scheduled monthly event that takes place on the second Tuesday of each month, unless otherwise noted due to holidays or severe weather. USGS alerts the Noman Cole lab in advance to prepare for sample delivery. It is imperative that County staff head out into the field as early as possible in order to deliver samples to lab in a timely manner to allow nutrient samples to be processed within allowable holding times.

Monthly sampling runs are split evenly between the County and USGS teams (10 sites each). To reduce sampling bias, the runs are randomized. Figure IX.1 illustrates the current monthly sampling assignments.

As noted on the monthly sampling schedule, four months out of the year have been identified as '**TARGETED WET'.** *For these months, USGS is responsible for all 20 sites and will attempt to collect samples during a storm event. County staff do not participate in these monitoring runs.*

Monthly Sampling Schedule

Sampling Date	Sampling Route USGS	Fairfax County
October 9, 2012	2A	2B
November 13, 2012	2A	2B
December 11, 2012	3B	3A
Jan. **TARGETED WET**	4A & B	
February 12, 2013	3A	3B
March 12, 2013	2A	2B
April **TARGETED WET**	1 A & B	
May 14, 2013	2B	2A
June **TARGETED WET**	4 A & B	
July 9, 2013	2B	2A
August 13, 2013	3B	3A
Sept. **TARGETED WET**	3 A & B	

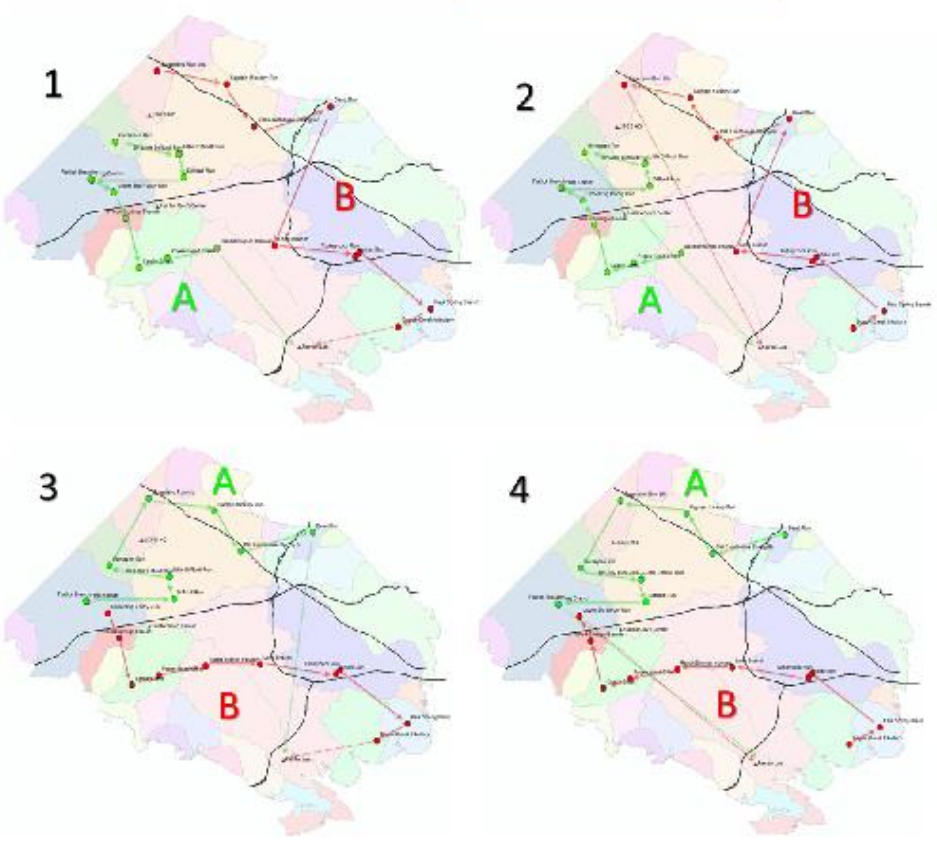


Figure IX.1: Monthly Sampling Schedule

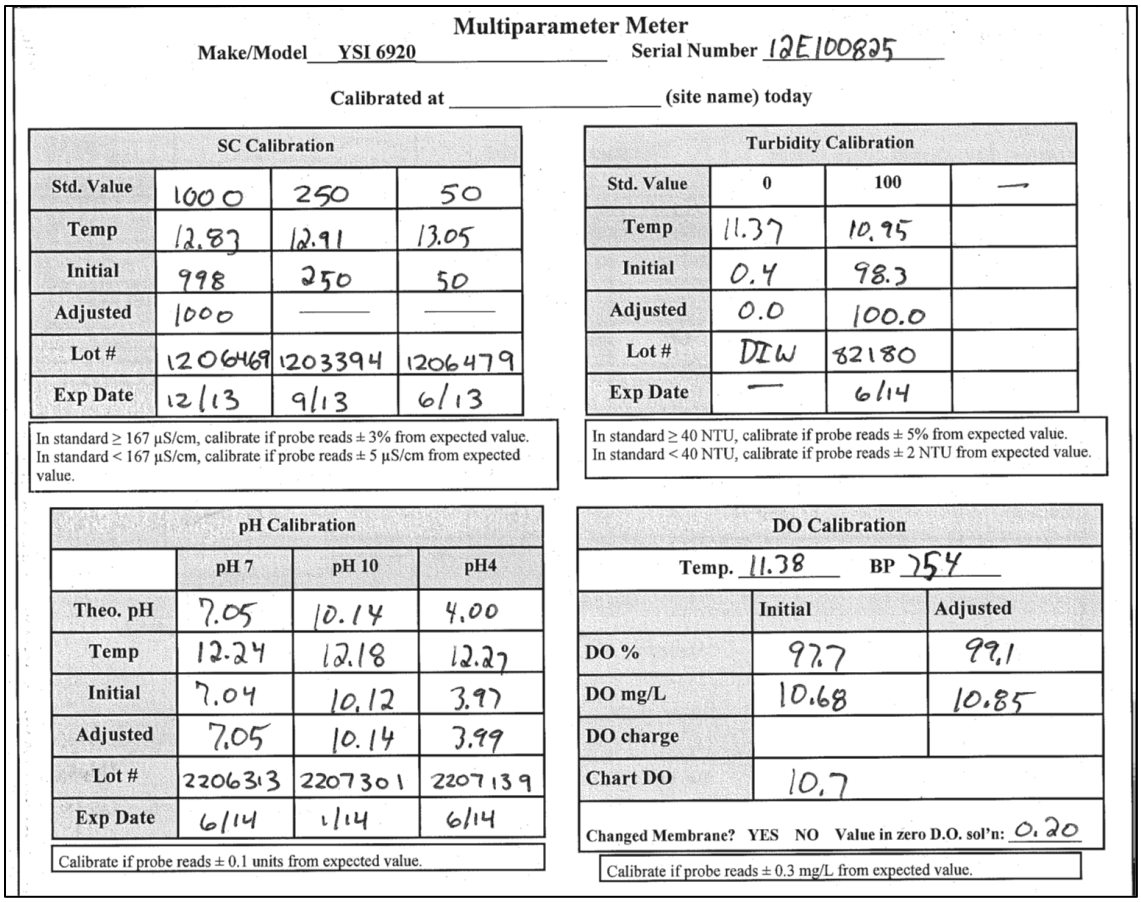
2. Field Work Preparation

a) YSI Exo3 Calibration

Calibration of the water quality sonde must be completed prior to sample collection. The YSI EXO Calibration Manual can be found in a separate instrumentation document and will provide a step-by-step guide to ensure accuracy of the meter. A few steps to follow prior to calibration:

- All buffers and standards should be at a similar temperature as the stream in order to ensure accurate calibrations. For winter months, this requires staff to either keep them on ice or place them in the refrigerator the night before.
- Check to make sure that the sonde has a fully charged batter.
- The sonde can be calibrated either in the office or from the back of the truck prior to leaving for the sampling run.

Calibration readings should be entered on the back of the field form (Figure IX.2) for the first site – the site name should then be referenced on each subsequent field form instead of re-entering the calibration values.



Multiparameter Meter

Make/Model YSI 6920 Serial Number 12E100825

Calibrated at _____ (site name) today

SC Calibration			
Std. Value	1000	250	50
Temp	12.83	12.91	13.05
Initial	998	250	50
Adjusted	1000	———	———
Lot #	1206469	1203394	1206479
Exp Date	12/13	9/13	6/13

In standard ≥ 167 µS/cm, calibrate if probe reads ± 3% from expected value.
In standard < 167 µS/cm, calibrate if probe reads ± 5 µS/cm from expected value.

Turbidity Calibration			
Std. Value	0	100	—
Temp	11.37	10.95	
Initial	0.4	98.3	
Adjusted	0.0	100.0	
Lot #	DIW	82180	
Exp Date	—	6/14	

In standard ≥ 40 NTU, calibrate if probe reads ± 5% from expected value.
In standard < 40 NTU, calibrate if probe reads ± 2 NTU from expected value.

pH Calibration			
	pH 7	pH 10	pH4
Theo. pH	7.05	10.14	4.00
Temp	12.24	12.18	12.27
Initial	7.04	10.12	3.97
Adjusted	7.05	10.14	3.99
Lot #	2206313	2207301	2207139
Exp Date	6/14	1/14	6/14

Calibrate if probe reads ± 0.1 units from expected value.

DO Calibration		
Temp. 11.38 BP 754		
	Initial	Adjusted
DO %	97.7	99.1
DO mg/L	10.68	10.85
DO charge		
Chart DO	10.7	

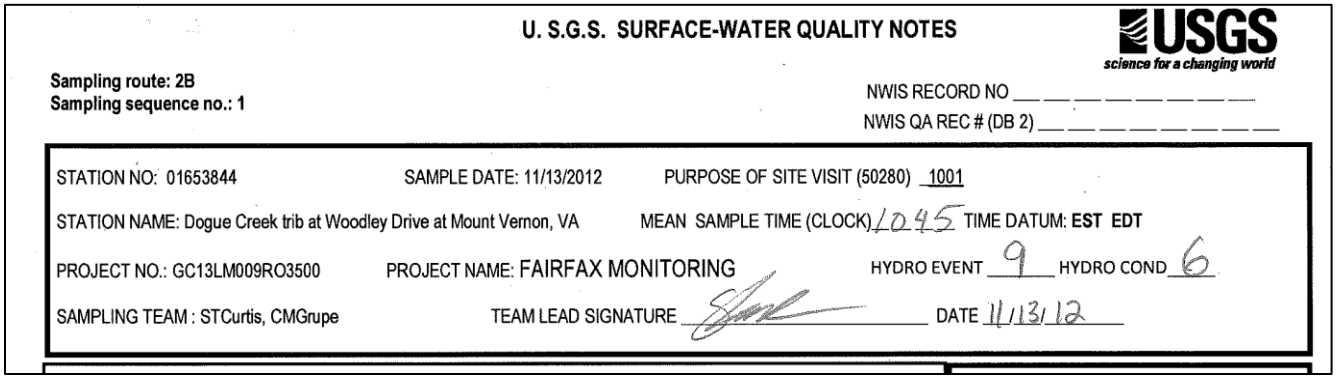
Changed Membrane? YES NO Value in zero D.O. sol'n: 0.20

Calibrate if probe reads ± 0.3 mg/L from expected value.

Figure IX.2: Calibration Entry

b) Route Planning

The top of the USGS-provided field forms (Figure IX.3) indicate the route name and sampling route (sequence) for each run. As each monthly event will have a different sequence of sites, be sure to take along proper sampling route directions (e.g. 4A, 2B, etc.).



U. S.G.S. SURFACE-WATER QUALITY NOTES

USGS science for a changing world

Sampling route: 2B
Sampling sequence no.: 1

NWIS RECORD NO ___ ___ ___ ___ ___ ___ ___ ___
NWIS QA REC # (DB 2) ___ ___ ___ ___ ___ ___ ___ ___

STATION NO: 01653844 SAMPLE DATE: 11/13/2012 PURPOSE OF SITE VISIT (50280) 1001

STATION NAME: Dogue Creek trib at Woodley Drive at Mount Vernon, VA MEAN SAMPLE TIME (CLOCK) 1045 TIME DATUM: **EST EDT**

PROJECT NO.: GC13LM009RO3500 PROJECT NAME: FAIRFAX MONITORING HYDRO EVENT 9 HYDRO COND 6

SAMPLING TEAM : STCurtis, CMGrupe TEAM LEAD SIGNATURE _____ DATE 11/13/12

Figure IX.3: Top of Field Form

3. Sample Collection

a) Field Form

As indicated in the previous section, the field form notes the sampling sequence for each run. When you reach your first destination, be sure that all information is entered on the appropriate form. This section will describe the steps to be completed and the areas of the form to be filled out. Please see the Forms and Data Sheets section for an example form.

b) Field Measurements

Figure IX.4 shows how to fill out the field measurements at a typical site in base flow conditions. If samples are taken during a storm event, staff will need to take separate gage height readings at the beginning and end of sampling at the site.

The YSI Exo3 works in a similar fashion to the sondes used in other aspects of field monitoring. Some basic tips for use:

- The unit should be on for about 10 minutes before readings are taken.
- Place the sonde guard on the unit to protect the probes during readings.
- Ensure the probes are fully immersed in flowing water upstream of any other collection activity.
- Allow the readings to stabilize before taking a reading, especially in winter months.
- Always write out measurements to the full precision of the measurement. For example, if stage is 0.60, please write 0.60, not 0.6. Stage, Dissolved Oxygen, Water Temperature, and pH should all be recorded to the hundredth.

In addition to the sonde parameters, both gage height (variable) and air temperature (thermometer) need to be recorded. Gage height can be found at most locations on the staff plate. In some instances, a reference mark will have to be used instead. Reference point elevations are included in the notes section of the field form for Indian Run, Popes Head Creek, and Castle Creek.

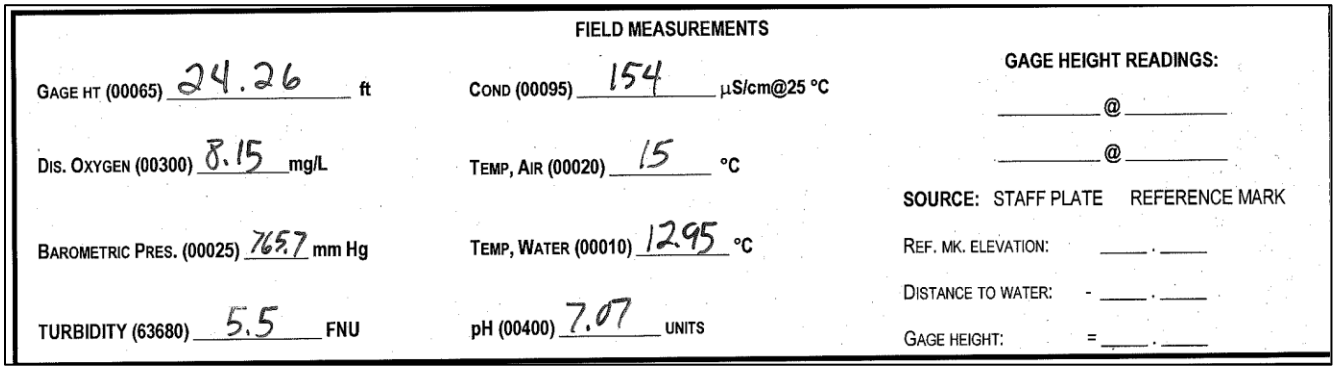
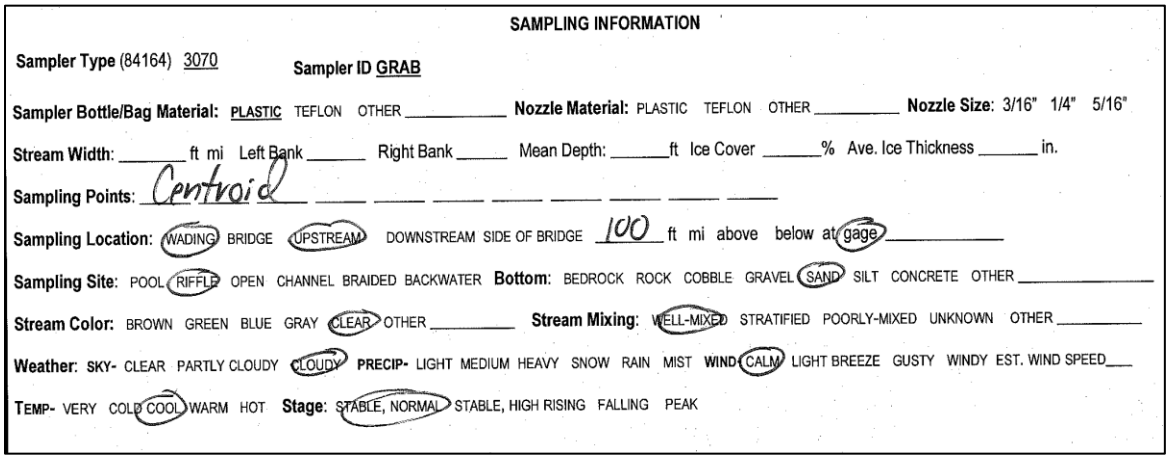


Figure IX.4: Field Measurements

c) Sampling Information

Located just below the field measurements section is a section to describe the environment in which you are sampling. Ideally, all samples should be taken in the center of the stream along a riffle or other flowing water. This information, along with water and weather conditions should be transcribed in the sampling information section. Figure IX.5 is an example of how to fill out this section.



SAMPLING INFORMATION

Sampler Type (84164) 3070 Sampler ID GRAB

Sampler Bottle/Bag Material: PLASTIC TEFLON OTHER _____ Nozzle Material: PLASTIC TEFLON OTHER _____ Nozzle Size: 3/16" 1/4" 5/16"

Stream Width: _____ ft mi Left Bank _____ Right Bank _____ Mean Depth: _____ft Ice Cover _____% Ave. Ice Thickness _____ in.

Sampling Points: Centroid

Sampling Location: WADING BRIDGE UPSTREAM DOWNSTREAM SIDE OF BRIDGE 100 ft mi above below at gage _____

Sampling Site: POOL RIFFLE OPEN CHANNEL BRAIDED BACKWATER Bottom: BEDROCK ROCK COBBLE GRAVEL SAND SILT CONCRETE OTHER _____

Stream Color: BROWN GREEN BLUE GRAY CLEAR OTHER _____ Stream Mixing: WELL-MIXED STRATIFIED POORLY-MIXED UNKNOWN OTHER _____

Weather: SKY- CLEAR PARTLY CLOUDY CLOUDY PRECIP- LIGHT MEDIUM HEAVY SNOW RAIN MIST WIND CALM LIGHT BREEZE GUSTY WINDY EST. WIND SPEED___

TEMP- VERY COLD COOL WARM HOT Stage: STABLE, NORMAL STABLE, HIGH RISING FALLING PEAK

Figure IX.5: Sampling Information

d) Grab Samples

Two grab samples are to be collected at each site. Both the nutrient and sediment sample should be given the same time. ***Always round the sample time to the nearest 15 minute increment - XX:00, XX:15, XX:30, XX:45.***

For a 'Regular' field sample, staff must fill out both the time and the sample type on the field form. A 'Regular' sample refers to the first sample taken at the site. If there is no replicate to be taken, then the sample type is ***'9'. Replicate samples must be taken at one site per route***. The location of this replicate is dictated by the field form sent by USGS. As noted on the field form, if a replicate sample is collected, staff must label both the regular and replicate '**7**'. The sample times should be noted 15 minutes apart, even if they are taken concurrently. Figure IX.6 illustrates both examples below.

Time: Label Fairfax replicates 15 minutes past regular samples and blanks 5 minutes before regular samples.
Sample Type: A regular sample is Sample Type 9. If a replicate is collected, label both regular and replicate 7. If a blank is collected, label the blank Sample Type 2 and the regular sample Sample Type 9.

Sample Type	Time	Medium	Sample Type	Dupl. Type 99105	
Regular	1000	WS	9		
Replicate		WSQ	7	30 (split)	

Time: Label Fairfax replicates 15 minutes past regular samples and blanks 5 minutes before regular samples.
Sample Type: A regular sample is Sample Type 9. If a replicate is collected, label both regular and replicate 7. If a blank is collected, label the blank Sample Type 2 and the regular sample Sample Type 9.

Sample Type	Time	Medium	Sample Type	Dupl. Type 99105	
Regular	1215	WS	7		
Replicate	1230	WSQ	7	30 (split)	

Figure IX.6: Sample Time and Type

(1) Nutrient Sample

Collected in a 1-Liter (32 oz) HDPE bottle. The labels contain all site information other than time (label is from the documents emailed by USGS – see Figure IX.7). Record the time on the label and rinse bottle three times before filling. Sample should be taken in reach with flowing water.

Station #: 01653844
Dogue Creek trib at Woodley Drive at Mount Vernon, VA
Date: 11/13/2012 Time: _____
Collector:
USGS / Fairfax SWPD Monthly Nutrient Sample
Sequence: 1

Figure IX.7: Label information

(2) Sediment Sample

Collected in a 500 ml glass bottle. The bottle has a yellow label that must be filled out with the following information:

Station Number	Top of Field Form
Location	Station Name on Field Form
Date	Date of Sampling Run
Time	xx:00, xx:15, xx:30, xx:45
Medium	**WS** - Regular Sample; **WSQ** - Replicate
Sampling Method	**70** - Grab Sample
Sample Type	**9** - Regular Sample; **7** for Replicate Site
Hydro Condition	**9** - Stable normal stage*
Hydro Event	**9** - Routine; J - Storm
* A full list of conditions is found on the back of each field form	

Figure IX.8: Sediment Label Information

The sediment bottles are sent pre-labeled and should not be rinsed prior to collection. Bottle should be filled up to section where neck begins to narrow. See Figure IX.9 below.

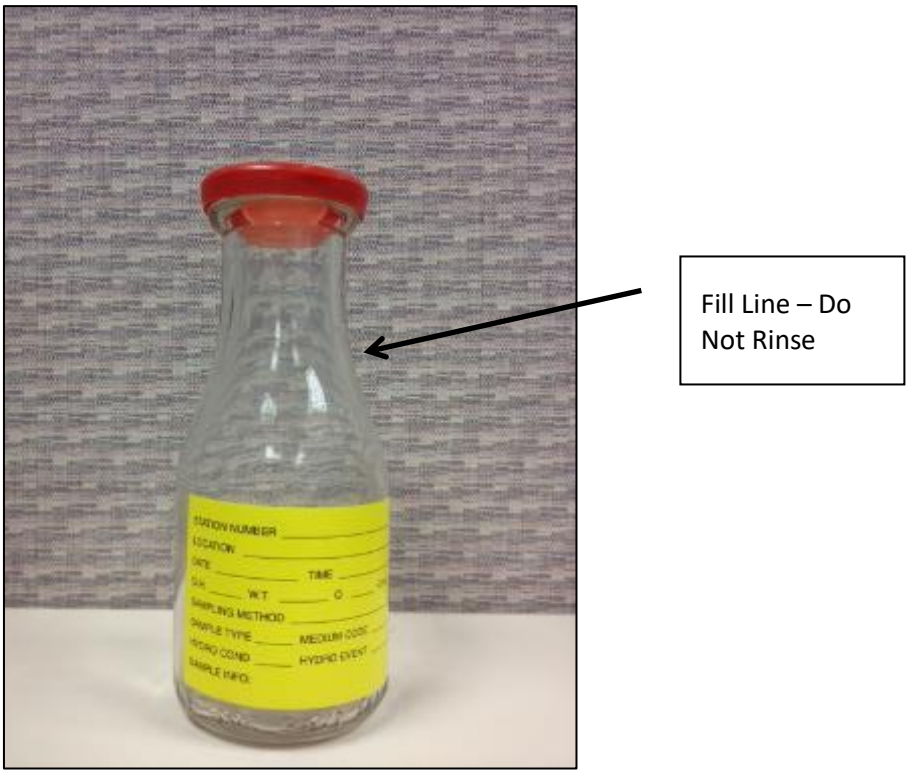


Figure IX.9: Sediment Bottle

Nutrient samples should be stored in a cooler with ice. Sediment bottles should be stored in the crate in the sequence they were collected in. As an additional precaution, be sure that the bottles remain upright in the cooler, as it is possible that the lids are not completely sealed.

e) HOBO Shuttle and Logger

The final task to be completed at each site location is to download data from the in-situ water level logger (Figure IX.10). This requires the use of the HOBO waterproof shuttle (Figure IX.11).

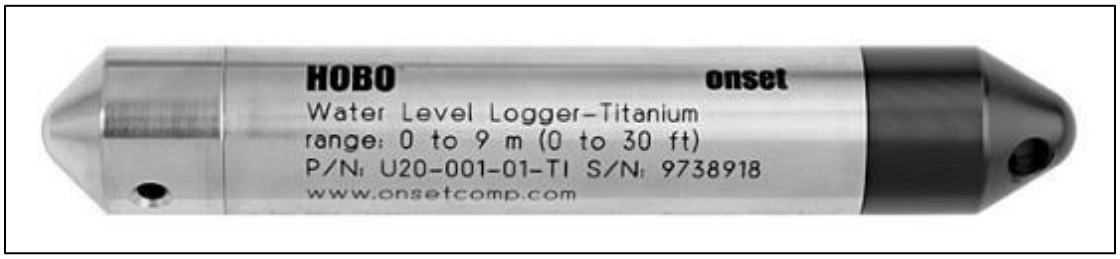


Figure IX.10: Water Level Logger

Figure IX.11: Waterproof Shuttle

The water level logger has been deployed at each site (unless noted on the field form) by securing it within a metal U-channel with a swinging gate mechanism. The HOBO locations document (Figure XI.14 found in Forms and Data Sheets) describes the location of the logger at each site. Once you locate the U-channel, carefully swing the metal clasp open and remove the logger.

- Unscrew the black plastic end cap from the logger by turning it counter-clockwise.
- Insert the logger into the shuttle with the flat on the logger aligned with the arrow on the shuttle (Figure IX.12). Gently twist the logger to be sure that it is properly seated in the coupler (it should not turn).
- Briefly press the coupler lever against the body of the shuttle to activate data transfer (pressing hard enough that the coupler bends). Readout should begin immediately. The amber LED on the shuttle blinks continuously while readout is in progress. *Do not remove the logger when the amber LED is blinking.* The data transfer is complete once the green light is illuminated. This may take several attempts.
- Screw the black end cap onto the logger and carefully replace in the metal u-channel. Be sure that that the black end cap is facing up – the metal end of the logger should be in the down position when inserted into the water. While holding the logger in place, swing the metal gate shut – it should be tight against the metal nut on the u-channel.

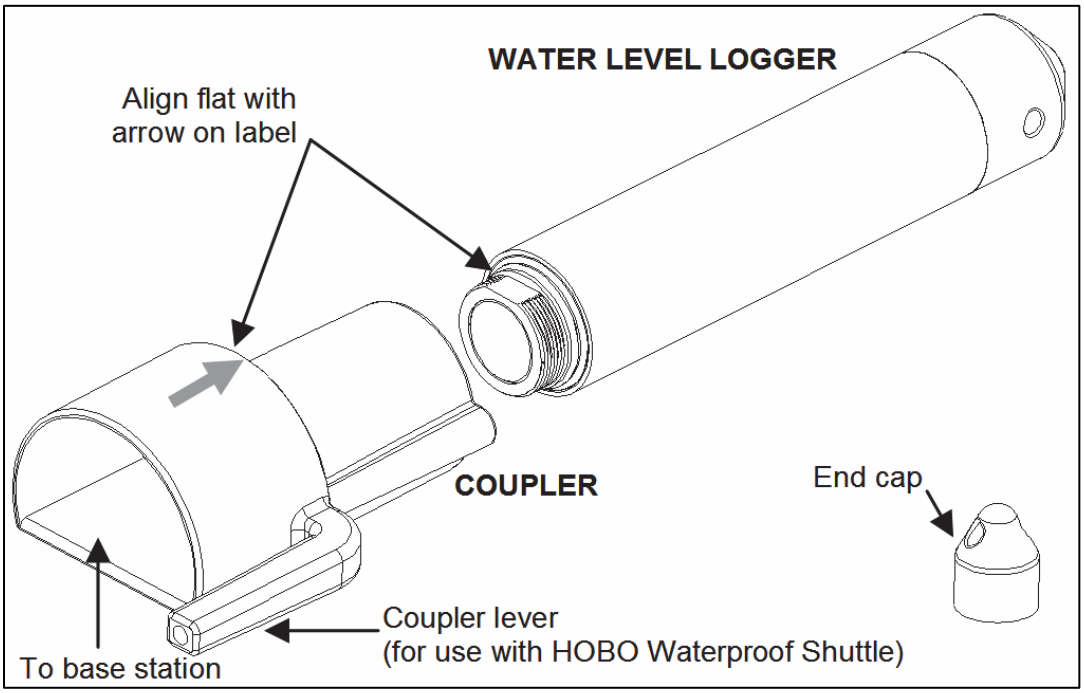


Figure IX.12: Attachment of Logger to Shuttle

4. Sample Shipment

Once all sites in the sampling route have been completed, staff will need to send the samples to the appropriate dropoff points.

a) Nutrient Samples – HDPE Bottles

Nutrient samples need to be delivered to the laboratory at the Noman M. Cole Lower Potomac Pollution Control Plant in Lorton, VA at the conclusion of the sample collection – this should be your first stop after all sites have been visited.

At Noman Cole, drive in the main entrance and then take a left. At the gate use the swipe card or ask the guard to open the gate. Once through the gate turn right immediately, then right again once you pass the building. Enter the first set of glass doors on the building to your right. In this area there will be a refrigerator to place the samples in. The USGS project manager will inform lab staff that samples are incoming. Hand off the completed *Monthly Sample Log Sheet* to Lab Staff after making a copy for records. There is a copy machine located in the lab.

b) Sediment Samples – Glass Bottles

Sediment samples need to be shipped to a USGS laboratory in Louisville, KY within the supplied milk crate. To ensure safety of samples, each bottle lid should be wrapped with electrical tape. The crate comes with plastic ties that are used to secure the lid for shipping. Include the sediment shipping form in a plastic bag within the crate. Each site has its own page to be filled out. See Forms and Data Sheets section for example. Pre-paid FedEx labels are to be printed for shipment – see Fairfax County project manager for labels. Bring to mail center for shipping:

FedEx Authorized ShipCenter
Mail Center
12210 Fairfax Towne Center
Fairfax, VA 22033
(703) 691-2126

D. Record Management

County staff should retain copies of both the sediment sample form and the storm event sample log – See Fairfax County program manager to drop off paperwork.

E. Forms and Data Sheets

Figure IX.13: USGS Network Site Codes
Figure IX.14: HOBO Location Descriptions
Figure IX.15: Monthly Sample Log Sheet
Figure IX.16: Field Form (Part 1)
Figure IX.17: Field Form (Part 2)
Figure IX.18: Sediment Shipping Form

Site Number	Site Name	Group	Watershed
0164425950	Horsepen Run above Horsepen Run trib Nr Herndon, VA	expansion	Horsepen
01644343	Sugarland Run trib below Crayton Road nr Herndon, VA	expansion	Sugarland
01645704	Difficult Run Above Fox Lake Nr Fairfax, VA	original	Difficult
01645745	Little Difficult Run Nr Vienna, VA	original	Difficult
01645762	SF Little Difficult Run Ab Mouth Nr Vienna, VA	original	Difficult
01645844	Old Courthouse Spring Branch nr Vienna, VA	original	Difficult
01645940	Captain Hickory Run At Rt 681 Nr Great Falls, VA	original	Difficult
01646305	Dead Run At Whann Avenue nr Mclean, VA	original	Dead
01652789	Indian Run At Bren Mar Drive At Alexandria, VA	original	Cameron
01652860	Turkeycock Run At Edsall Road At Alexandria, VA	original	Cameron
01653717	Paul Spring Br Ab North Branch Nr Gum Springs,	expansion	Little Hunting
01653844	Dogue Creek trib at Woodley Drive at Mount Vernon, VA	expansion	Dogue
01654500	Long Branch at Route 620 nr Annandale, VA	expansion	Accotink
01655305	Rabbit Branch trib above Lake Royal Nr Burke, VA	expansion	Pohick
01656903	Flatlick Branch Above Frog Branch At Chantilly, VA	original	Cub
0165690673	Frog Branch Above Flatlick Branch At Chantilly, VA	original	Cub
0165694286	Big Rocky Run At Stringfellow Rd Nr Chantilly, VA	original	Cub
01657100	Willow Springs Branch at Route 29 Nr Centreville, VA	expansion	Little Rocky
01657322	Popes Head Creek Trib Nr Fairfax Station, VA	original	Popes Head
01657394	Castle Creek At Newman Road At Clifton, VA	original	Popes Head

Intensive Sites (fully gaged sites)
Less-Intensive Sites (partial record gages)

Figure IX.13: USGS Network Site Codes

Site Number	Site Name	Location Description
0165694286	Big Rocky	LEW approx. 30 ft DS of staff plate close to bank
01645940	Captain Hickory Run	REW approx. 1 ft either US or DS of staff plate
01657394	Castle Creek	REW just US of crest stage gage
01646305	Dead Run	Gage Site - No HOBO
01645704	Difficult Run	Gage Site - No HOBO
01653844	Dogue Creek	LEW beside staff plate
01656903	Flatlick Branch	Back left of gage house, resting on 2x4 close to the roof
0165690673	Frog Branch	REW approx. 1 ft DS of staff plate
0164425950	Horsepen Run	LEW approx. 30 ft DS of upstream flag before large leaning tree
01652789	Indian Run	REW approx. 1 ft DS of red-painted reference mark U-channel
01645745	Little Difficult Run	REW approx. 1 ft DS of staff plate
01654500	Long Branch	Gage Site - No HOBO
01645844	Old Courthouse Spring Branch	REW approx. 20 ft DS of staff plate in a pool just behind a very large boulder (can't see the HOBO logger from the staff plate)
01653717	Paul Spring Branch	LEW approx. 10 ft DS of staff plate. There is also a HOBO located here on a large, ivy-covered tree that is in a straight line from the staff plate to the street. The tree is practically on the curb but is currently shielded from the street by bamboo. The HOBO logger is situated on the tree facing away from the stream (towards the street) and is about 1-2 ft above the ground.
01657322	Popes Head Creek	LEW in pool just DS of large overhanging tree. HOBO logger located just off the bank at the red flag marker located roughly 150 feet downstream of the old location(US of red-painted reference mark U-channel)
01655305	Rabbit Branch	LEW approx. 5 ft US of staff plate under undercut bank with exposed roots
01645762	SF Little Difficult Run	Gage Site - No HOBO
01644343	Sugarland Run	REW beside staff plate
01652860	Turkeycock Run	LEW approx. At base of staff plate (staff plate faces the bank)
01657100	Willow Springs Branch	Next to staff plate

Figure IX.14: HOBO Location Descriptions

USGS Monthly Sample Log Sheet – Run 4B

Site ID	Name	Sample Date	Sample Time	Comment
01653844	Dogue Creek tributary at Woodley Drive at Mount Vernon, Va	4/9/2017	0915	
01653717	Paul Spring Br Ab North Branch Nr Gum Springs,	4/9/2017	0945	
01652789	Indian Run At Bren Mar Drive At Alexandria, VA	4/9/2017	1030	
01652860	Turkeycock Run At Edsall Road At Alexandria, VA	4/9/2017	1045	
01654500	Long Branch at Route 620 near Annandale, Va	4/9/2017	1130	
01655305	Rabbit Branch tributary above Lake Royal near Burke, Va	4/9/2017	1145	
01657322	Popes Head Creek Trib Near Fairfax Station, VA	4/9/2017	1215	
01657394	Castle Creek At Newman Road At Clifton, VA	4/9/2017	1230	
01657100	Willow Springs Branch at Route 29 near Centreville, Va	4/9/2017	1245	
0165694286	Big Rocky Run At Stringfellow Rd Nr Chantilly, VA	4/9/2017	1315	
QA 2 - 01653844	Replicate (Dogue Creek tributary at Woodley Drive at Mount Vernon, Va)	4/9/2017	0930	

Samples Delivered By: Fairfax Crew
Samples Received By: LaWanda Posey

Date and Time of Delivery: 5 4/9/2017 - 1415
Date and Time of Receipt: 5/9/17 1415

Figure IX.15: Monthly Sample Log Sheet Example

Sampling route: 1B
Sampling sequence no.: 1

science for a changing world

NWIS RECORD NO ___
NWIS QA REC # (DB 2) ___

STATION NO: 01644343 SAMPLE DATE: 9/12/2017 PURPOSE OF SITE VISIT (50280): 1001

STATION NAME : Sugarland Run trib below Crayton Road nr Herndon, VA MEAN SAMPLE TIME (CLOCK) 0900 TIME DATUM: EST EDT

PROJECT NO.: GC17LM009RO3500 PROJECT NAME: FAIRFAX MONITORING HYDRO EVENT 9 HYDRO COND 9

SAMPLING TEAM : 0 TEAM LEAD SIGNATURE [signature] DATE 9,12,17

Time: Label Fairfax replicates 15 minutes past regular samples and blanks 5 minutes before regular samples.
Sample Type: A regular sample is Sample Type 9. If a replicate is collected, label both regular and replicate 7. If a blank is collected, label the blank Sample Type 2 and the regular sample Sample Type 9.

Sample Type	Time	Medium	Sample Type	Dupl. Type 99105	
Regular	0900	WS	7		
Replicate	0915	WSQ	7	30 (split)	
Lab Split		WSQ	7	200 (lab-split)	
Blank		OAQ	2		
Reference		OAQ	6		
Other					

Analysis Source 3
Collecting Agency VA-FCSPD

SAMPLES COLLECTED
SUSP. SED. X
NUTRIENTS X
OTHER: _____

FIELD MEASUREMENTS

GAGE HT (00065) 0.52 ft
COND (00095) 398 µS/cm@25 °C
DIS. OXYGEN (00300) 8.05 mg/L
TEMP, AIR (00020) 17 °C
BAROMETRIC PRES. (00025) 755.7 mm Hg
TEMP, WATER (00010) 18.16 °C
TURBIDITY (63680) 0.2 FNU
pH (00400) 6.83 UNITS

GAGE HEIGHT READINGS:
___ @ ___
___ @ ___
SOURCE: (STAFF PLATE) REFERENCE MARK
REF. MK. ELEVATION: ___.___
DISTANCE TO WATER: - ___.___
GAGE HEIGHT: = ___.___

SAMPLING INFORMATION

Sampler Type (84164) 3070 Sampler ID GRAB

Sampler Bottle/Bag Material: PLASTIC TEFLON OTHER ___ Nozzle Material: PLASTIC TEFLON OTHER ___ Nozzle Size: 3/16" 1/8" 5/16"

Stream Width: ___ ft mi Left Bank ___ Right Bank ___ Mean Depth: ___ ft Ice Cover ___ % Ave. Ice Thickness ___ in.

Sampling Points: centroid

Sampling Location: WADING BRIDGE UPSTREAM DOWNSTREAM SIDE OF BRIDGE ___ ft mi above below (at gage)

Sampling Site: POOL (RIFFLE) OPEN CHANNEL BRAIDED BACKWATER Bottom: BEDROCK ROCK (COBBLE) GRAVEL SAND SILT CONCRETE OTHER ___

Stream Color: BROWN GREEN BLUE GRAY (CLEAR) OTHER ___ Stream Mixing: (WELL-MIXED) STRATIFIED POORLY-MIXED UNKNOWN OTHER ___

Weather: SKY- CLEAR PARTLY CLOUDY (CLOUDY) PRECIP- LIGHT MEDIUM HEAVY SNOW RAIN MIST WIND- (CALM) LIGHT BREEZE GUSTY WINDY EST. WIND SPEED ___

TEMP- VERY COLD (COOL) WARM HOT Stage: (STABLE, NORMAL) STABLE, HIGH RISING FALLING PEAK

Sampling Method (82398): EWI [10] GRAB [70] SINGLE VERTICAL [30] MULT VERTICAL [40]

COMPILED BY: ___ CHECKED BY: ___ DATE: ___

Figure IX.16: Example Field Form (Page 1)

SITE NO.: 01644343

Multiparameter Meter

Sonde Make/Model: YSI 6920 **Serial Number** _____ **Meter Make/Model:** YSI 650 **Meter SN:** _____

Calibrated at SUGARLAND RUN **(site name) today**

SC Calibration

Std. Value	1000	250	50
Temp	22.51	22.55	22.50
Initial	997	251	53
Adjusted	1000	———	———
Lot #	2703D66	2601A93	2606B13
Exp Date	3/19	1/18	6/18

In standard ≥ 167 µS/cm, calibrate if probe reads ± 3% from expected value.
In standard < 167 µS/cm, calibrate if probe reads ± 5 µS/cm from expected value.

Turbidity Calibration

Std. Value	0	100	
Temp	22.27		
Initial	0.0		
Adjusted	0.0		
Lot #	–	A6022	
Exp Date	–	1/18	

In standard ≥ 40 NTU, calibrate if probe reads ± 5% from expected value.
In standard < 40 NTU, calibrate if probe reads ± 2 NTU from expected value.

pH Calibration

	pH 7	pH 10	pH4
Theo. pH	7.01	10.02	4.00
Temp	22.39	22.34	22.33
Initial	7.02	10.02	4.01
Adjusted	7.01	10.02	4.00
Lot #	168343	164223	166544
Exp Date	1/19	7/18	10/18

Calibrate if probe reads ± 0.1 units from expected value.

DO Calibration

Temp. 22.10 **BP** 751.4

	Initial	Adjusted
DO %	98.1	99.0
DO mg/L	8.56	8.63
DO charge		
Chart DO	8.63	

Changed Membrane? YES NO **Value in zero D.O. sol'n:** 0.1

Calibrate if probe reads ± 0.3 mg/L from expected value.

NOTES:

Reference point elevations:
Indian Run: Red corner of U-channel on REW ~50 ft US of concrete dam = 25.08 ft
Popes Head Cr Trib: Red corner of HOBO U-channel post = 22.68 ft
Castle Cr: Top of threaded bolt near the bottom of the CSG that the stick rests on inside the pipe at gage = 24.98 ft

84164 SAMPLER TYPE

3001	US DH-48
3044	US DH-81
3045	US DH-81 With Teflon Cap And Nozzle
3051	US DH-95 Teflon Bottle
3052	US DH-95 Plastic Bottle
3053	US D-95 Teflon Bottle
3054	US D-95 Plastic Bottle
3055	US D-96 Bag Sampler
3060	Weighted-Bottle Sampler
3061	US WBH-96 Weighted-Bottle Sampler
3070	Grab Sample
8000	None
8010	Other

HYROLOGIC CONDITION

A	Not determined
4	Stable, low stage
5	Falling stage
6	Stable high stage
7	Peak stage
8	Rising stage
9	Stable normal stage

HYDROLOGIC EVENT

J	Storm
9	Routine

50280 PURPOSE OF SITE VISIT

1001	Fixed frequency, surface-water
1002	Storm hydrograph, surface-water
1003	Extreme high flow, surface-water
1004	Extreme low flow, surface-water
1005	Diurnal, surface-water
1006	Synoptic, surface-water
1099	Other, surface-water
5052	Event-based (runoff or recharge conditions), any media

Figure IX.17: Field Form (Page 2)

USGS Kentucky Sediment Laboratory
Sediment Lab Analysis Request (SLAR v.5.1)

FBMS billing No.	GC17LM009ROXA00	Project Chief:	jdjarra @usgs.gov	Shipped by and ship date:	Joseph.Sanchirico@fairfaxcounty.gov

Special Instructions:
Fedex #150838967; VA Water Science Center, 1730 E. Parham Rd Richmond, VA 23228

Station Number:	01653844	Station Name:	Dogue Creek trib at Woodley Drive at Mount Vernon, VA
NWIS User Code:	VA	Parameter Family: *(check one)*	☑ Suspended ☐ Bed Material ☐ Bed Load ☐ Lab conductivity

Individual Bottle Information – 1 line for each bottle included in shipment

	Sample ID *(Lab use only)*	Sample Date (mm-dd-yy)	Sample Time (24hr)	Sample End Date (mm-dd-yy)	Sample End Time (24hr)	Bottle ID	Sample Type	Medium Code	Sampling Method	Lab Analysis Requested *(See Code Key)*	Collector Initials	Remarks
1		05-09-17	0915			1	9 7	WS	70	C		
2		05-09-17	0930			2	7	WSQ	70	C		
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												

Code Keys: (for any codes not listed, please contact laboratory)
Sample Type: Regular (9) Replicate (7) Blank (2)
Medium Codes: Surface Water (WS) Surface Water QC (WSQ) Artificial QC (OAQ) Bottom Material (SB) Bottom Material QC (SBQ)
Sampling Method: EWI (10) EWI, non-isokinetic (15) IBI (20) Single-Vertical (40) Multiple-Vertical (45) Point (50) Grab (70) Pump (900) FSV-Box (930)
Lab Analysis Request Code: Concentration (C) Sand/Fine (SF) Composite-Concentration (CC) Composite-Sand/Fine (CSF) Size (Z) Loss-on-Ignition (LOI)
Note: SH and ISH both include concentration; no need to add on analysis request copy for concentration (ex. C,H is not correct to request a sand/fine split, just use SF.)

Figure IX.18: Sediment Shipping Form