Perennial Stream Field Identification Protocol
May 2003

This protocol defines procedures for making field determinations between perennial and intermittent streams. The protocol was developed to support fieldwork for the Fairfax County stream-mapping project. Several existing protocols were used to develop this protocol including:

- Virginia Chesapeake Bay Local Assistant Department's (CBLAD) "Very Rough Draft Guidance for Making Perennial vs. Intermittent Stream Determinations." December 2000.
- North Carolina Division of Water Quality's "Perennial Stream Reconnaissance Protocols" January 2000. Version 2.0. (http://h2o.enr.state.nc.us/ncwetlands/strmfrm.html)
- Williamsburg Environmental Group, Inc. "Qualitative Field Procedures for Perennial Stream Determinations." [unpublished manuscript] Corresponding Author: D.A. DeBerry.
- U.S. Corps of Engineers Branch Guidance Letter No 95-01: Identification of Intermittent versus Ephemeral Streams – Not Ditches. October 1994.

The determination between a perennial and intermittent stream is based on the combination of hydrological, physical and biological characteristics of the stream. Field indicators of these characteristics are classed as primary or secondary and ranked using a weighted, four-tiered scoring system similar to the current system developed by the North Carolina Division of Water Quality (NCDWQ). As discussed below, a stream reach is classified as perennial based on the overall score as well as supporting information such as long term flow monitoring, presence of certain aquatic organisms, or historic information.

DEFINITIONS

Perennial Stream – A body of water flowing in a natural or man-made channel year-round, except during periods of drought. The term "water body with perennial flow" includes perennial streams, estuaries, and tidal embayments. Lakes and ponds that form the source of a perennial stream, or through which the perennial stream flows, are a part of the perennial stream. Generally, the water table is located above the streambed for most of the year and groundwater is the primary source for stream flow. In the absence of pollution or other manmade disturbances, a perennial stream is capable of supporting aquatic life.

Intermittent Stream – A body of water flowing in a natural or man-made channel that contains water for only part of the year. During the dry season and periods of drought, these streams will not exhibit flow. Geomorphological characteristics are not well defined and are often inconspicuous. In the absence of external limiting factors (pollution, thermal modifications, etc), biology is scarce and adapted to the wet and dry conditions of the fluctuating water level.

DATA REVIEW

The following information should be reviewed prior to conducting a field reconnaissance.

- Existing Fairfax County GIS data layers for the generation of 1:250 scale field maps showing project area.
- USGS 7.5-minute quadrangle maps and current USDA Fairfax County Soil Survey.
- County aerial photographs.

- Current weather conditions including date of last rainfall and drought condition using the following sources of data:
  - Fairfax County-Department of Public Works and Environmental Services currently maintains 10 rain gauge stations within the County (see Appendix A for relative locations).
  - Dulles airport http://weather.noaa.gov/weather/current/KIAD.html
  - Regan National Airport http://weather.noaa.gov/weather/current/KDCA.html
  - Virginia State Climatology Office http://climate.virginia.edu/
  - Virginia DCR Drought Monitor: http://www.deq.state.va.us/info/drought.html
  - U.S. Drought Monitor http://www.drought.unl.edu/dm/index.html
  - The National Weather Service http://205.156.54.206/er/lwx/index.htm

FIELD RECONNAISSANCE

General Procedures

- The field protocol was developed for use throughout the year, with an expected amount of redundancy to account for seasonal variation. March through May represents the optimum time period to observe key biological species and normal flow conditions. The dry season (July through September) represents the ideal time to observe stream flow. Streams that contain flow during the dry period are likely to be perennial assuming normal precipitation conditions. However, the final determination of perenniality should be based on an evaluation of the hydrological, physical, and biological field indicators defined below.

- Preliminary stream reaches should be identified on the generated maps prior to field observations. The maps should include all pertinent GIS data layers including streams, roads, building footprints, parcels, parking lots, RPAs, topography, stormwater structures, sanitary sewer structures, etc.. By studying the maps before field investigations, more information can be ascertained about land uses and landscape characteristics in contributing drainage areas, as well as access issues and sampling logistics.

- Field reconnaissance should begin within the existing RPA or from the upstream point of flow to confirm the presence of a perennial stream. Proceed to a point where there is a significant change in the hydrological, geomorphological, or biological conditions of the stream. For example, a confluence with a flowing tributary. Document grade controls and headcuts on the 1:250-scale field map and on the field data sheet. Also document on the maps where flow begins and whether it is from a groundwater seep/spring or outfall. These features along with site scores and other reach characteristics will ultimately be used to determine the break point between perennial and intermittent stream reaches. It has been observed that flow may stop at a point and begin again some distance downstream. Therefore, reconnaissance should continue until obvious intermittent or ephemeral stream characteristics are noted (lack of strong evidence of continuous drainage channel, dry channel, etc.). After walking upstream and documenting the aforementioned features, investigators should then have a good idea where individual stream

***Figure 1**: Example of a headcut where perennial stream flow begins.*

reach breaks lie. At this point sampling reaches may be established and subsequent data sheets filled out.

- Complete a data sheet for each catchment. Determinations are made on a representative stream reach by examining at least 200 feet and not a single point. A reach should have similar physical characteristics and may be bounded by an upstream and downstream tributary, grade control, other physical feature (headcut, pipe, etc), or an obvious change in channel characteristic (sinuosity, slope, etc). The upper limits of a reach will define the upper limits of a perennial stream. Document the location of the reach and site ID on the field map and data sheet. See Appendix B for a list of feature and reach codes.

Equipment

- Camera
- 16 inch Oakfield probe or Dutch Auger
- Sharpshooter spade
- D-frame dip net/white sorting tray (optional, but may be necessary in Coastal Plains)
- Polarized sunglasses (optional)
- Munsell Soil Color Charts
- GIS-generated site maps (approximately 1 inch = 250 feet)
- Virginia Save Our Streams Benthic Macroinvertebrate Field Sheets: *http://www.sosva.com/download_the_field_sheets_for_th.htm*
- Vegetation Field Guides (Examples):

  Harlow, William M. *Trees of the Eastern and Central United States and Canada*. New York: Dover Publications, Inc., 1942.

  Hurley, Linda M. *Field Guide to the Submerged Aquatic Vegetation of Chesapeake Bay*. U.S. Fish and Wildlife Service, 1992.

  Magee, Dennis W. *Freshwater Wetlands, A Guide to Common Indicator Plants of the Northeast*. Amherst: The University of Massachusetts Press, 1981.

  Newcomb, Lawrence. *Newcomb's Wildflower Guide*. Boston: Little, Brown and Company, 1977.

  Petrides, George A. *Peterson Field Guides Series-A Field Guide to Trees and Shrubs, Northeastern and north-central United States and southeastern and south-central Canada*. Boston: Houghton Mifflin Company, 1958.

  Tiner, Ralph W. *Field Guide to Nontidal Wetland Identification*. Cooperative Publication. Annapolis: Maryland Department of Natural Resources; Newton Corner: U.S. Fish and Wildlife Service, 1998.

FIELD INDICATORS

When assessing the field indicators, in addition to the individual descriptions given below, the amount of time and effort involved in locating and identifying the features described must be factored into each ranking. Use the following time/effort guidelines in conjunction with the detailed ranking parameters for each indicator in assessing the strong, moderate, weak or absent description and assigning the associated scores. *Note*: "strong" does not always mean a strong indication of perenniality. Some indicators, such as leaflitter in streambed, will receive a score of zero for "strong".

Strong - Found easily and consistently throughout the reach.
Moderate - Found with little difficulty but not consistently throughout the reach.
Weak - Takes 10 or more minutes of extensive searching to find.
Absent - Indicator is not present.

Streamflow and Hydrology

1. **Presence or absence of flowing water, >48 hours since last rainfall:** Preferably, flow observations should be taken at least 48 hours after the last rainfall. Local weather data and drought information should be reviewed before evaluating flow conditions. See Data Review section, above, for weather data sources.

   Perennial streams will have water in their channels year-round in the absence of drought conditions. If a stream exhibits flowing water in the height of the dry season (mid-summer through early fall), then it probably conveys water perennially. On the other hand, a stream that does not exhibit flow during periods of increased rainfall would indicate an intermittent or ephemeral flow. Flow is more readily observed in the riffles and very shallow, higher-velocity areas of the stream. Dropping a floating object on the water surface will aid in determining if flow is present.

   Strong - Flow is highly evident throughout the reach. Moving water is easily seen in riffles and runs.
   Moderate - Moving water is easily seen in riffle areas but not as evident throughout the runs.
   Weak - Flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.
   Absent - Water present but there is no flow; dry channel with or without standing pools.

2. **Presence of high groundwater table or seeps and springs:** Groundwater Table: The presence of a high groundwater table or discharge (i.e. seeps or springs) indicates a relatively reliable source of water to a nearby stream. Indicators of a high groundwater table include visual observation of inundation or soil saturation in the floodplain. Indicators of a high water table can be observed by digging a hole in the adjacent floodplain approximately two feet away from the streambed. The presence of water seeping into the hole (usually a slow process) or the presence of hydric soils indicates the presence of a high groundwater table. Use the *Munsell Soil Color Charts* book to determine the chroma of the soil matrix/mottles in the hole. Low chroma soils or mottled soils are good indicators of a high groundwater table*. Hydric soils in the sides of a channel or headcut are also indicators of groundwater discharge. High groundwater tables are commonly found in the Coastal Plain as well as portion of the Triassic Basin within areas with low relief. Seeps: Seeps have water dripping or slowly flowing out from the ground or from the side of a hill or incised stream bank. Springs: Look for "mushy" or very wet, and black decomposing leaf litter nearby in small depressions or natural drainage ways. Springs and seeps often are present at grade controls and headcuts. The presence of this indicator suggests that the stream is continually being recharged by a groundwater source unless during a period of drought. Score this category based on the abundance of these features observed within the reach.

   Strong - Spring, seep or groundwater table is readily observable throughout reach.
   Moderate - Springs, seeps or groundwater table are present, but not abundant throughout reach.
   Weak - Indicators are present, but require considerable time to locate.
   Absent - No springs or seeps present and no indication of a high groundwater table.

*For more information on chroma and redox-morphic features, see following geomorphology section.

3. **Leaflitter in streambed:** Are leaves (freshly fallen or older leaves that may be "blackish" in color and/or partially decomposed) accumulating in the streambed? Perennial streams (with deciduous riparian vegetation) should continuously transport plant material through the channel. Leaves and lighter debris will predominate throughout the length of non-perennial stream channels, whereas there will be little to no leaves present in the stronger flowing areas (riffles) with small accumulations on the upstream side of obstructions. This indicator may be hindered during autumn sampling in

between rain events. This is a secondary hydrologic indicator. *Note the reversal of score on the data sheet.*

Strong - Abundant amount of leaf litter is present throughout the length of the stream.
Moderate - Leaf litter is present throughout most of the stream's reach with some accumulation beginning on the upstream side of obstructions and in pools.
Weak - Leaf litter is present and is mostly located in small packs along the upstream side of obstructions and accumulated in pools.
Absent - Leaf litter is not present in the fast moving areas of the reach but there may be some present in the pools.

4. **Drift lines or wrack lines:** Twigs, sticks, logs, leaves, trash, plastics, and any other floating materials piled up on the upstream side of obstructions in the stream, on the streambank, in overhanging branches, and/or in the floodplain indicate high stream flows. Unless downstream of a stormdrain, non-perennial streams usually exhibit fewer or no drift lines within their channels. This is a secondary hydrologic indicator of perenniality.

   Strong - Large drift lines are prevalent along the upstream side of obstructions within the channel and the floodplain.
   Moderate - Large drift lines are dispersed mostly within the stream channel.
   Weak - Small drift lines are present within the stream channel.
   Absent - No drift lines are present.

5. **Sediment on debris or plants:** Are plants in the stream, on the streambank, or in the floodplain stained white, gray, red, or brown, with sediment? Look for silt/sand accumulating in thin layers on debris or rooted aquatic vegetation in the runs and pools. Be aware of upstream land-disturbing construction activities, which may contribute greater amounts of sediments to the stream channel, and can confound this indicator. Note these activities on the data sheet. This is a secondary hydrologic indicator.

   Strong - Sediment found readily on plants and debris within the stream channel, on the streambank, and within the floodplain throughout the length of the stream.
   Moderate - Sediment found on plants or debris within the stream channel although not prevalent along the stream. Mostly accumulating in pools.
   Weak - Sediment is isolated in small amounts along the stream.
   Absent - No sediment is present on plants or debris.

<u>Geomorphology</u>

1. **Riffle-Pool sequence**: A repeating sequence of riffle/pool (or riffle/run in lower-gradient streams) can be observed readily in perennial streams. This morphological feature is always present to some degree in higher gradient streams such as the piedmont streams that predominate much of Fairfax County. This is a result of sediment transport and the work of channel-shaping hydrologic forces. <u>Riffle</u>-Shallow, turbulent areas along narrower portions of a stream where the water has a tendency to churn and flow rapidly. In smaller streams, riffles are defined as areas of a distinct change in gradient where flowing water can be observed. <u>Pool</u>-Areas of slow moving water, where the stream widens and deepens. Along the stream reach, take notice of the frequency between the riffles and pools. Keep in mind that because of higher gradients, riffles are more frequent in the Piedmont physiographic province than in the Coastal Plains and many parts of the Triassic Basin.

   Strong - Demonstrated by an even and frequent number of riffles followed by pools along the entire reach. There is an obvious transition between riffles and pools.
   Moderate - Represented by a less frequent number of riffles and pools. Distinguishing the transition between riffles and pools is difficult.
   Weak - Streams show some flow but mostly have areas of pools or mostly areas of riffles.
   Absent - There is no sequence exhibited, or there is no flow in the channel.

2. **USDA Texture in stream bed/Substrate Sorting:** Observe the substrate comprising the bottom of the streambed. In pristine stream environments with a normal flow regime, substrate movement is highly dependent upon particle size; heavier substrate material (sands, gravel and cobbles) tends to remain in place while the finer silts and clays are transported quickly downstream. In urban and suburban areas, however, storm outfalls often drain runoff directly to the channel, and the highly erosive flash flows associated with heavy storm events remove all sized particles, and the channel quickly becomes incised. Although the distinction between the two situations should be kept in mind, the manner in which the remaining particles settle out will be consistent, and the question becomes, "is there an <u>even</u> distribution of various sized substrates throughout the reach or does partitioning occur (See Appendix C)?" The occurrence of depositional features will be infrequent in intermittent streams. Perennial streams, on the other hand, tend to exhibit correspondingly larger depositional features, with cobble/gravel/boulders being localized in riffles and runs, and with accumulations of fine sediments settling out in pools.

   Strong - There is a clear distribution of various sized substrates. Depositional features are present, finer particles are absent or accumulate in pools, and larger particles are located in the riffles/runs.
   Moderate - Various sized substrates are present but represented by a higher ratio of larger particles (cobble/gravel/rock). Small depositional features are present; small pools are accumulating some sediment.
   Weak - Substrate sorting is not readily observed. There may be some small depositional features present on the downstream side of obstructions (large rocks, etc…).
   Absent – Substrate sorting is absent. There are few depositional features.

3. **Natural levees**: Levees develop when sand or silt is deposited relatively parallel to the top of the bank. These aid in the concentration of water to the channel during periods of high flow. They are represented as large "mounds", "hills", or broad low "ridges" that may be covered by vegetation or remain as bare areas. Scoring is based on the presence and length of the levee through the stream reach.

4. **Sinuosity**: How much does the stream bend and curve? Is the channel meandering? Has the stream been straightened by human influence (i.e. piping, ditching, stormdrains, farming, roads, etc…). If so, is the stream beginning to meander around deposited sediments *within* its channelized banks? Sinuosity is the ratio of the stream channel length (SL) to the down-valley length (VL). The higher the ratio (SL/VL), the more sinuous the stream. Sinuosity is the result of the stream naturally dissipating its flow forces. Intermittent streams don't have a constant flow regime, and as a result exhibit a significantly less sinuous channel morphology. While ranking, take into consideration the size of the stream, which may also influence the stream wavelength. Sinuosity may be visually estimated, or approximated using a map and a map-wheel.

   Strong - Ratio > 1.4. Stream has numerous, closely-spaced bends, very few straight sections.
   Moderate - Ratio $\leq$ 1.4. Stream has good sinuosity with some straight sections.
   Weak - Ratio $\leq$ 1.2. Stream has very few bends and mostly straight sections.
   Absent - Ratio = 1.0. Stream is completely straight with no bends.

5. **Active (or Relic) Floodplain**: Floodplains are relatively flat areas usually located outside of or adjacent to the stream bank that accumulate organic matter and alluvium deposited during flooding. An active floodplain shows characteristics such as drift lines, sediment deposited on the banks or surrounding plants, which may also be flattened by flowing water. In cases of severe channel incision (down-cutting) the stream's new floodplain may be restricted to within the channel itself, and its disconnected (relic) floodplain will be harder to see (outside of channel). In these instances, look for

indicators along the sides and within the incised channel. In either case, there should be evidence of a floodplain if the stream has perennial flow.

Strong - The area displays all of the aforementioned characteristics.
Moderate - Most of the characteristics are apparent.
Weak - The floodplain is not obvious, however some of the indicators are present.
Absent - The characteristics are not present.

6. **Braided Channel**: Occurs in shallow, low gradient areas where abundant sediment has a tendency to build up, crosscutting the stream creating a braided pattern.
   Strong - The stream displays a braided appearance with many crossings creating many "islands".
   Moderate - The stream displays a braided pattern however, it does not cross many times and only has a few "islands".
   Weak - The braided pattern is present but the stream only crosses one or two times creating only one or two "islands".
   Absent - The gradient is too high such that the water is flowing too quickly in order to create a braided channel.

7. **Recent Alluvial Deposits:** Alluvium may be deposited as sand, silt, various sized cobble, and gravel. Observe whether or not there is any recent deposition or accumulation of these substrates within the stream channel (sand and point bars) or floodplain. The amount of alluvium deposited will indicate whether water is constantly pushing substrate downstream and will also determine ranking. Keep in mind that eroding stream channels influenced by stormwater drains/outfalls will likely score higher than natural channels for this indicator.
   Strong - Large amounts of sand, silt, cobble, and/or gravel alluvium present in the channel and in the floodplain.
   Moderate - Large to moderate amount of sand, silt, cobble, and/or gravel mostly present in the stream channel.
   Weak - Small amounts of sand, silt, and/or small cobble present within the channel.
   Absent - There is no sand or point bars present within the stream channel and no indication of overbank deposition within the floodplain.

8. **Bank-full Bench present:** When a stream channel conveys perennial flow, the forces of channel scouring and deposition create certain distinct physical features, which can be readily observed. One of these features includes scoured areas along the bank above which the stream banks are much less eroded. Another feature is accumulations sand or silt creating a bar or "bench" which may or may not be covered with vegetation. The former should be fairly continuous along the length of the stream's banks and should be seen at roughly the same elevation as the top of any sediment bars (where the stream bank slope begins to increase dramatically). Please see Figure 2 below.

Figure 2: *Examples of bank-full elevation (bench) in a second order, perennial stream.*

Bank-full indicators imply that the channel experiences a relatively continuous hydrologic regime and is in dynamic equilibrium with the shaping forces of its water/sediment load. The flow regime, soils and grade determine the bank-full width and morphology of the conveyance channel. The more obvious and continuous the bank-full features are throughout the reach, the higher the score should be.

Strong - Bank-full indicators are obvious throughout the sample reach.
Moderate - Indicators are present throughout most of the reach.
Weak - Indicators are infrequent along sampling reach.
Absent - Indications of a bank-full bench are completely lacking.

9. **Continuous bed and bank:** Throughout the length of the stream, is the channel well defined by having a clearly discernable bank and streambed? The clarity of this indicator lessens upstream as the stream becomes ephemeral.
Strong - There is a continuous bed and bank throughout the length of the stream channel.
Moderate - The majority of the stream has a continuous bed and bank. However, there are obvious interruptions.
Weak - The majority of the stream has obvious interruptions in the continuity of bed and bank. However, there is still some representation of the bed and bank sequence.
Absent - There is little or no ability to distinguish between the bed and bank.

10. **Second order or greater *channel*:** The higher the channel order the more likely the stream is to be perennial. Stream order should be based on available information and evaluated in the field. The primary map sources to be use include the Fairfax County Soil Survey and the most recent Fairfax County GIS hydrography data layer. Second order flowing streams are almost always perennial, while second order channels are usually in the intermittent/perennial zone. It is often difficult to evaluate stream order on channels starting at a stormwater outfall. Based on field observations, these channels are considered 1st order. However, a review of historic data such as the County Soil Survey may indicate that the order is greater.
YES - One or more first order channels are draining into the stream above sampling reach.
NO – There are no first order inputs above sampling reach.

Streambed Soils

The soils indicators described here were taken from the wetland delineation procedures set forth in the 1987 US Army COE Manual:

Environmental Laboratory. (1987). “Corps of Engineers Wetlands Delineation Manual,” Technical Report Y-87-1, U.S. Army Engineer Waterways Experimentation Station, Vicksburg, Miss.

Figure 3: *Iron oxidized mottling of a gleyed soil matrix.*

1. **Redox-morphic features:** Iron found in the matrix of soil continuously inundated with water cannot come in contact with the oxygen in the air and thus stays in the reduced ferrous (Fe^{2+}) valence state. This is seen as a grayish soil matrix. If the soil goes through a wetting/drying phase (as with intermittent or ephemeral streambeds), the iron will oxidize once in contact with atmospheric O_2 to form the ferric (Fe^{3+}) valence state. This is seen as the classic iron oxide or “rust” red color mottling within the matrix (see Figure 3). This is a redox-morphic feature. Use a Dutch auger or Oakfield probe to obtain a 12 to 14-inch deep core of the streambed soil. This may be impossible in some very rocky bottom streams. In this case try to bore in at an angle where the stream bank meets the substrate. If this fails, the soils indicators are not applicable (N/A) and should not be scored. Be sure to split the soil pedon apart in many places to look for these small pockets of oxidized soil iron. Sometimes "oxidized rhizospheres" or higher colored mottles surrounding root cavities in the soil will be easily observed. Tiny (<2 mm), hard manganese or iron concretions in the matrix are also redox-morphic features. In inundated soils and wetlands, redox-morphic features are absent. Redox-morphic features are usually absent, or very difficult to observe in high chroma soils. However, the absence of redox features in these soils is not an indicator of inundation. Caution must be used when scoring this indicator in non-gleyed soils. In sandy soils, redox-morphic features are uncommon or very difficult to identify. In these instances look for organic matter distributed evenly throughout the matrix. Organic matter is moved downward through sandy soils as the water table fluctuates. As a result, dark organic streaks can be seen in most ephemeral and intermittent stream soils, which contain substantial amounts of organic materials. When soil from a darker area is rubbed between the fingers, the organic matter will leave a stain.

Scoring is ranked purely on the presence or absence of these features.

2. **Chroma:** Mineral soils which are exposed to atmospheric oxygen in the soil profile will have some degree of oxidation occurring and as a result will have bright red, orange, or yellow matrix colors (See Figure 4). Saturated soils, such as those found in the streambeds of perennial streams, have limited or no contact with O_2, will remain reduced and subsequently have a very dull color chroma or may be gleyed completely (dull gray hues or chroma throughout soil ped). See Figure 5. The soil sample should be representative of the major stream bed/bank soil type observed throughout the sample reach. Use the Munsell Color Charts book to determine the chroma of the soil matrix. The soil matrix is defined as the dominant soil constituent (>50%). Low chroma values (<2) or gleyed soils indicate continual saturation, while brightly colored soils or mottles (>2) indicate only short periods of wetting, typical of intermittent or ephemeral streambed soils or upland soils.

Figure 4: *A high chroma soil matrix*

Figure 5: *Completely gleyed, low-chroma soil matrix.*

Strong - Gleyed soils
Moderate - Matrix chroma of 1.
Weak - Matrix chroma of 2.
Absent - Matrix chroma of 2 or greater.

Vegetation

When ranking the presence of rooted aquatic plants in channel, periphython/green algae and iron oxidizing bacteria/fungus use the following:

Strong - Found easily and consistently throughout the reach.
Moderate - Found with little difficulty but not consistently throughout the reach.
Weak - Takes 10 or more minutes of extensive searching to find.
Absent - Indicator is not present.

1. **Rooted AQUATIC plants in channel:** Aquatic plants rooted in the substrate can be described as SAV and floating leaved plants. Some of the most common found are Water Lilies (*Nymphaeaceae*). Use wetland plant/aquatic plants field identification guides for appropriate designations.

2. **Presence of Periphyton/Green Algae:** These forms of algae and aquatic mosses are attached to the substrate, and are visible as a pigmented mass or film, or sometimes hairlike growths on submerged surfaces of rocks, logs, plants and any other structure within the stream channel. These life forms require an aquatic environment to persist. Periphyton growth is influenced by chemical disturbances such as increased nutrient (N and P) inputs and physical disturbances such as increased sunlight to the stream from riparian zone disturbances.

3. **Iron Oxidizing Bacteria/Fungus:** Iron oxidizing bacteria/fungus in streams derives energy by oxidizing iron, originating from groundwater, in the ferrous form (Fe^{2+}) to the ferric form (Fe^{3+}). In large amounts, iron-oxidizing bacteria/fungus discolors the stream substrate giving it a red appearance. In small amounts, it can be observed as an oily sheen on the water's surface. This indicates that the stream is being recharged from a groundwater source, and these features are most commonly seen at seeps or springs.

4. **Wetland plants in streambed:**
The U.S. Army Corp of Engineers wetland delineation procedure utilizes a plant species classification system upon which soil moisture regimes can be inferred. This same system can be used to determine the duration of soil saturation in streams. All wetland designations are defined by *1988 National List of Vascular Plant Species That Occur in Wetlands*, U.S. Fish and Wildlife Service.** Perennial indicator scores (0 through 3) corresponding to each class of vegetation are listed on field data sheet

SAV - (Submerged Aquatic Vegetation) grows completely underwater.
Example: Coontail (*Ceratophyllum demersum*)
Mostly OBL - Obligate wetland plants are almost always found in a wetland (estimated probability is greater than 99 percent) and any EAV (Emergent Aquatic Vegetation)
Examples: Skunk Cabbage (*Symplocarpus foetidus*), Cattail (*Typha spp.*)
Mostly FACW - Facultative wetland plants are mostly found in wetlands (estimated probability is 67 to 99 percent).
Example: Cardinal flower (*Lobelia cardinalis*)
Mostly FAC - Facultative plants are equally likely to occur in wetlands or non-wetlands (estimated probability is 34 to 66 percent).
Example: Southern Lady Fern (*Athryium felix-femina*)
Mostly FACU (1 to 33% probability), UPL (0 – 1% probability), or no plants in streambed.

**Reed, Jr., Porter B. 1988. National List of Plant Species That Occur in Wetlands: National Summary. U.S. Fish & Wildlife Service. Biol. Rep. 88 (24). 244 pp.

Has been updated to 1996 National Listing (1998 revision still pending approval). Available at http://www.nwi.fws.gov/bha

USDA/NRCS 1994 synonymized checklist - PLANTS database:
Available at http://plants.usda.gov/index.html

Benthic Macroinvertebrates

When checking for the presence or absence of Benthic Macroinvertebrates, clams and crayfish, follow these procedures based on physiographic province.

Turn over the rocks and other large substrate found in areas of visible flowing water, (i.e. riffles) and scan the undersides for benthic macroinvertebrates. Also observe the newly disturbed area where the rock once was for signs of movement. This method may be more suitable for the Piedmont and Triassic Basin provinces where riffles predominate. For the lower gradient Coastal Plain and other areas of slow moving water, benthic macroinvertebrates may be located in a variety of habitats including root wads, undercut banks, pools, leaf-packs, and submerged aquatic vegetation (SAV). Note that some benthic macroinvertebrates will make small debris/sand cases, which can be covered with periphyton and easily confused for excess debris picked up from the substrate.

All macroinvertebrates should be identified to order, using the Virginia Isaac Walton League Save Our Streams Bug ID Charts, available at http://www.sosva.com/download_the_field_sheets_for_th.htm. For Ephemeroptera, Plecoptera, and Trichoptera (EPT), samples should be identified to the lowest taxonomic level possible and noted on the back of the field data sheet. Samples can be retained for further analysis in the laboratory. If clams, crayfish or amphibians are found in the sample then also fill out the respective lines on the datasheet. Several samples should be taken to accurately assess the reach's benthic community.

When ranking the presence of benthic macroinvertebrates and bivalves, use the following:

Strong - Indicator is easily found in all samples.
Moderate - Only takes a few samples to locate indicator.
Weak - Sampling takes 10 minutes or more to locate indicator.
Absent - Indicator is not present.

1. **Benthic Macroinvertebrates:** The larval stages of most aquatic insects are good indicators that the stream is perennial because they require a continuous aquatic habitat until maturity. Crayfish and other crustaceans, as well as aquatic worms and snails are also included under this indicator. The existence of crayfish can also be detected by the presence of "crayfish chimneys" (an extruded tunnel of clay) seen on the stream banks. Follow the sampling/identification procedures detailed above. When scoring, take note of the quantity as well as the diversity of your macroinvertebrate sample. Because some of the species observed are not strict indicators of a constant aquatic regime, this is a secondary indicator of perenniality.

2. **Bivalves:** Clams require a constant aquatic environment in order to survive. Incorporate the search for bivalves while looking for other benthic macroinvertebrates. This indicator also includes any empty shells found on stream banks and within the channel.

3. **Ephemeroptera, Plecoptera, and Tricoptera (EPT) taxa:** The larval stages of many species of these three orders require a period of at least a year, submerged in a constantly flowing aquatic environment before reaching maturity and therefore are commonly associated with perennial streams. Studies conducted by North Carolina State University have found that benthic samples collected in intermittent streams frequently display crustaceans (crayfish, isopods, and amphipods) as the dominant order. Downstream, where the stream has perennial characteristics, EPT taxa were collected. In highly urbanized areas, these indicators may be absent due to the degraded nature of the stream and, therefore, cannot be used to evaluate perennial or intermittent flow conditions. North Carolina State University is continuing to work on a list of specific genus that exhibit aquatic larval stages requiring a year before maturity. West Virginia's Department of Environmental Protection also maintains a list of macroinvertebrate species that have an extended aquatic life stage. These lists

should be consulted (family or genus level ID) before applying points to the reach score, because some genus, such as the baetis mayflies for example, are very ephemeral in their aquatic life stages.

Presence/Absence

Vertebrates

When ranking the presence of all vertebrates, use the following:

Strong - Indicator is readily visible in all prime habitats.
Moderate - Indicator is evident in smaller numbers. Some prime habitat is not occupied.
Weak - Indicator is not readily visible, requires 10 or more minutes to locate. Very sparse.
Absent - Indicator is not found.

1. **Fish:** The drastically fluctuating water levels of intermittent streams provide unstable and stressful habitat conditions for fish communities. Only a small number of species will opportunistically inhabit available areas within intermittent streams. Therefore, the presence of fish is used as a secondary indicator of perenniality. When looking for fish, all available habitats should be observed, including pools, riffles, root clumps, and other obstructions (to greatly reduce surface glare, the use of polarized sunglasses is recommended). In small streams, the majority of species usually inhabit pools and runs. Fish should be easily observed within a minute or two. Also, fish will seek cover once alerted to your presence, so be sure to look for them slightly ahead of where you are walking along the stream. Again, check several areas along stream sampling reach.

2. **Amphibians:** Newts, frogs, salamanders and tadpoles can be found under rocks, on streambanks and on the bottom of the stream channel. They may also appear in the benthic sample. Frogs will alert you of their presence by jumping into the water for cover, usually following an audible “squeak”. Frogs and tadpoles typically inhabit the shallow, slower moving waters of the pools and near the sides of the bank. Amphibian eggs, also included as a minor indicator, can be located on the bottom of rocks and in or on other submerged debris. They are usually observed in gelatinous clumps or strings of eggs. Frog eggs will be much more prevalent in the springtime. Identify the species of amphibian or describe in detail the characteristics observed. A persistent water regime is not an exclusive requirement for all amphibious species, therefore this is a secondary indicator of perenniality.

Overall Score Interpretation

The final determination of whether a stream reach is perennial is based on a preponderance of information including the total score, supporting information and professional judgment. Based on the results of the pilot survey conducted in the Fall of 2001 and Spring 2002, a minimum total score of 25 was set as a guideline for classifying a stream as perennial. Higher scores indicate that a channel has more perennial characteristics. Streams with lower scores can be classified as perennial; however, other supporting information such as biological indicators should be used in making the final determination.

The total score can be affected by seasonal or hydrologic conditions as well as man-made impacts associated with activities in the watershed. For example, a reach may score less in drought conditions due to the lack of biological and/or certain hydrologic indicators. However, a reach may score higher on certain indicators, such as drift lines and alluvial deposits, if directly below a stormwater outfall. The final determination of perenniality must take these factors into account. If a stream is recognized as borderline, reaches upstream and downstream should be assessed to better evaluate the changes in stream classifications along a channel. Additional supporting information can be used with the total score to make the final determination. This supporting information includes:

Observation of flow: Observation of flow under certain seasonal or hydrologic conditions can directly support classifying a stream reach as intermittent or perennial.

Conditions supporting a perennial stream classification include:

- Stream reaches with flow during the dry season (July through September) or periods of drought are likely perennial. The longer the period from the last rainfall the stronger the presence of flow supports the perennial stream determination. Although the presence of flow during a drought indicates perennial conditions, care must be taken in evaluating the upper limits of perenniality because some perennial streams may only contain isolated pools of water or be dry during periods of drought.

Key biological indicators: As discussed under the biological criteria, the presence of aquatic organisms whose life cycle requires residency in flowing water for extended periods (especially those one year or greater) is a strong indication that a stream reach is perennial. A qualified aquatic biologist/environmental scientist should evaluate the presence and abundance of such macroinvertebrates and vertebrates species before determining the final stream classification.

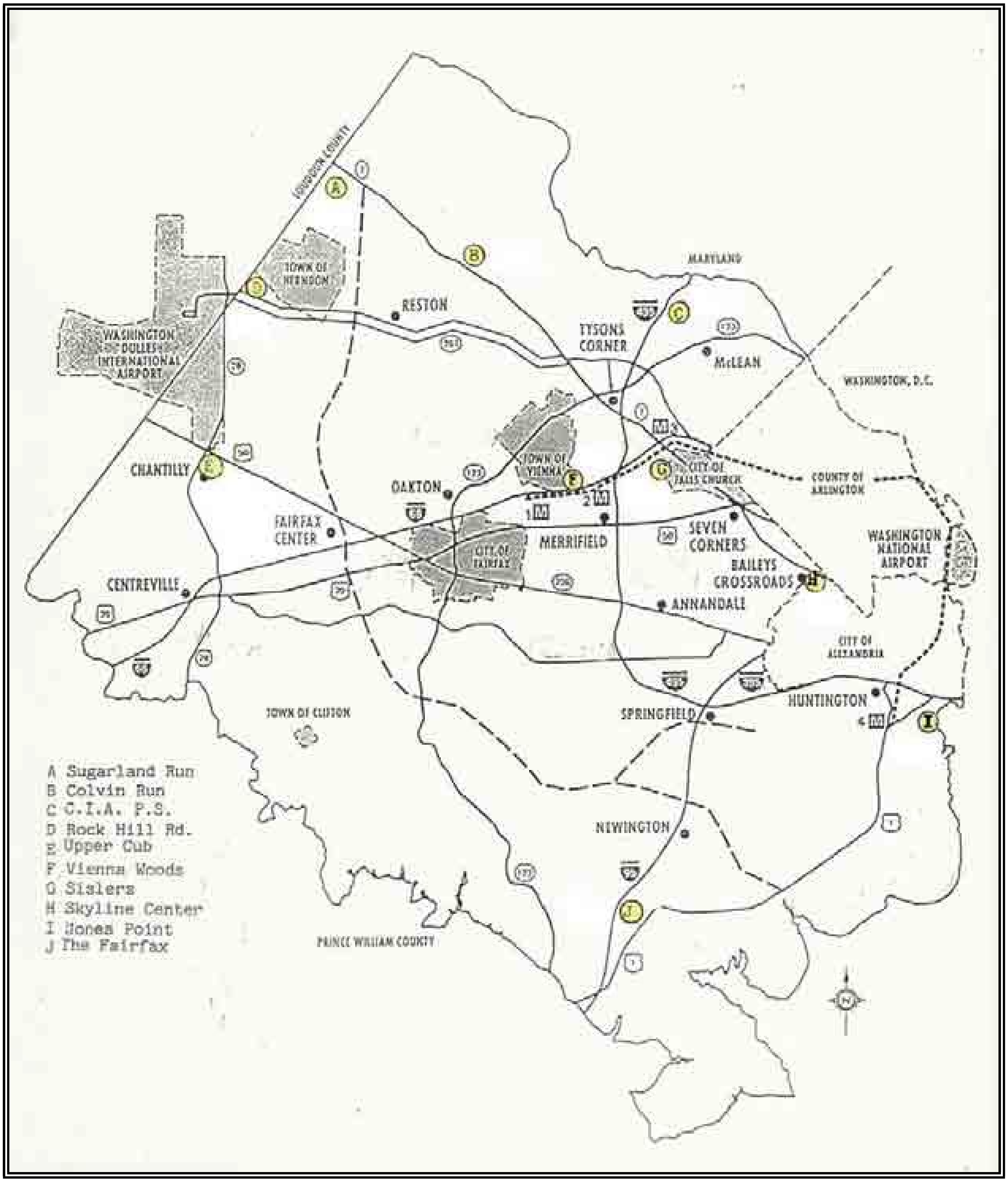
Other supporting information: Other data to be considered in determining the final stream classification includes:

- Information provided by a long-term resident and/or local professional who has observed the stream during the various seasons and hydrologic conditions.
- Review of historic information such as aerial photography or the Fairfax County Soil Survey. Based on the pilot field surveys and initial countywide surveys, many of the streams shown as perennial (solid lines) on the County Soil Survey have been determined to be perennial using the field protocol.

Professional judgment should be used in conjunctions with the total score and supporting information in making the final determination.

APPENDIX A.

FAIRFAX COUNTY-DEPARTMENT OF PUBLIC WORKS AND ENVIRONMENTAL SERVICES, WASTEWATER MANAGEMENT DIVISION'S RAIN GAUGE STATION LOCATIONS



APPENDIX B.

FEATURE/REACH CODES

FEATURES WITHIN REACH

TYPE	***CODE***
Beaver Dam	BDM
Concrete Ditch (trickle ditch)	CCD
Construction Activity	CON
Damaged Structure or Utility	DAM
Does Not Exist	DNE
Dry Pond Here	DPD
Dry Pond Intake	DPI
Dry Pond Outfall	DPO
Fish Present	FSH
Flow stops (point of drying)	POD
Grade Control (natural or artificial)	GRC
Grassy Drainage Swale	GSW
Groundwater Seep or Spring	GSP
Headcut	HCT
Non-Perennial Channel (Eph/Int) + date	NPC
Other (make comments)	OTH
Picture taken here + date	PIC
Point of Flow	POF
Rip-Rap Channel	RRC
Road Culvert	RCU
Roadside Ditch	RSD
Standing Pools Only (no connecting flow)	POL
Stormwater Drain (Inlet)	SDI
Stormwater Drain (Outfall)	SDO
Stream No longer Exists (gone or piped)	NLE
Unsurveyed Area	UNS
Utility Easement (state type if necessary)	ESM
Utility or Path Crossing	XNG
Wetland or Marshy Area	WTL
Wet Pond Here	WPD
Wet Pond Intake	WPI
Wet Pond Outfall	WPO

REACH END POINTS

TYPE	***CODE***
Arbitrary Point Chosen	ARB
Beaver Dam	BDM
Channel Changes	CCH
Dry Pond Intake	DPI
Dry Pond Outfall	DPO
Grade Control (natural or artificial)	GRC
Groundwater, Spring or Seep	GSP
Headcut	HCT
Other (make comments)	OTH
Point of Flow	POF
Property Boundary (public or private)	PBY
Resource Protection Area	RPA
Road Culvert	RCU
Stormwater Drain (Inlet)	SDI
Stormwater Drain (Outfall)	SDO
Tributary (or Confluence)	TRB
Utility Easement (state type if necessary)	ESM
Utility or Path Crossing	XNG
Wetland or Marshy Area	WTL
Wet Pond Intake	WPI
Wet Pond Outfall	WPO

APPENDIX C.

PARTICLE SIZE CLASSIFICATION AND DESCRIPTION

Adapted from *Stream Hydrology-An Introduction for Ecologists*
Nancy D. Gordon, Thomas A. McMahon, Brian L. Finlayson

Classification	Description
Silt/Clay	Size range is less than 0.06 mm
Sand	Size range is 0.06 - 2 mm
Gravel	Size range is 2-4 mm
Pebble	Size range is 4-64 mm
Cobble	Size range is 64-256 mm
Boulder	Size range is greater than 256 mm
Bedrock	