Fairfax County Stream Physical Assessment Protocols

Prepared for

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Introduction

Fairfax County is currently undertaking a number of studies and projects related to watershed protection and restoration. These include the Stream Protection Strategy (SPS) program, a wetlands assessment and monitoring program, a perennial streams mapping project, and the development of comprehensive management plans for the County's watersheds. The SPS program is an ongoing biological monitoring effort with the overall goal of identifying and assessing trends in stream conditions countywide. The baseline SPS study, completed in January 2001, documented current conditions throughout the county's streams based on biological indicators, and provided a foundation for prioritizing and implementing sound watershed management strategies (Fairfax County 2001).

The data collection effort will continue with the initiation of this countywide physical and habitat assessment of streams. As the data are compiled, the County will have a thorough understanding of each stream and watershed and will be able to integrate the data to anticipate, prevent, mitigate, and correct stormwater impacts in coordination with the County's land use goals. The addition of habitat information to the Stream Evaluation program will allow a more comprehensive assessment of the stream conditions. Stream aquatic integrity in urban settings is directly affected by physical changes in the watershed, some of which result in the degradation of the chemical and/or physical condition of the stream. Habitat information is extremely important for discriminating between physical and chemical effects. The habitat information can be integrated with the historic and ongoing biological and chemical data collected by Fairfax County to develop comprehensive tools that predict the effects of watershed changes on stream features and integrity.

This document includes the protocols for the following:

- Characterizing stream and riparian zone habitat conditions
- Identifying erosion and pollution problems associated with infrastructure and other factors
- Making visual observations about general water quality conditions
- Classifying stream shape using techniques based on geomorphic conditions
- Collecting the data in uniform and standard process so they are accurate and reproducible

Purpose of this Document

The purpose of this document is to provide a practical, technical reference for conducting stream assessments. This document is designed to be dynamic and periodically reviewed and updated through the course of the project. The document is designed to describe operating procedures for collecting and recording stream assessment data. Essential to this project, this document establishes procedures for maintaining uniform operational and quality control guidance. Compliance with these procedures is essential to produce accurate and reliable data. This document is intended for use as a training resource as well as a technical manual for experienced personnel. Deviation from the operating procedures presented, must be documented and cleared by Fairfax County.

Purpose for a Stream Physical Assessment

The protocols presented in this document will be used for the stream physical assessment. It will provide information on the habitat conditions (habitat assessment), impacts on the stream from specific infrastructure and problem areas (infrastructure inventory), general stream characteristics, and a geomorphic classification of stream type. A baseline assessment will be conducted on approximately 900 miles of stream throughout the county. The assessment results will be incorporated into the watershed planning process to determine appropriate management strategies.

Protocol Development

Habitat Assessment

The habitat assessment protocols and metrics presented here were used on several watershed management projects for documenting the stream physical conditions. The protocols were developed from existing sources, tested and documented in the scientific literature, and recommended by the U.S. Environmental Protection Agency (USEPA). The following discussion summarizes how "visual based" stream habitat assessment protocols were selected and adapted for the watershed wide management programs.

Several techniques have been developed for assessing the habitat quality of streams. Historically, many of these focused on developing habitats for maintaining certain fish species for commercial and recreation activities, rather than measuring overall system aquatic integrity for the purpose of meeting Clean Water Act goals. Table 1 describes habitat assessment protocols developed by Rankin (1995).

TABLE 1
Selected Listing of Habitat Indices Used in North America Over Past 30 Years

Index/Methodology	Purpose	Reference
Habitat Evaluation Procedures/Habitat Suitability Index (HEP/HSI)	Relate habitat quality to single species carrying capacity	Terrell (1984)!
Habitat Quality Index (HQI)	Assess habitat as predictor of trout standing crop	Layher and Maughan (1985)!, Binns and Eiserman (1979)1
Biological Stream Classification (BSC)	Use habitat quality with IBI to determine biotic potential of a stream reach	Bertrand et al. (1996)! Hite (1988)!
Transect Method	Assess various aspects of stream habitat by taking measurements along transects in a reach	Dunham and Collotzi (1975)!, Platts et al. (1983), Armour et al. (1983)!, Duff et al. (1989)!
Habitat Diversity/complexity	Calculate Shannon index using substrate, depth, and velocity	Gorman and Karr (1978)!, Schlosser (1982)!
Habitat Index (HI)	Compare present status to pristine conditions (Missouri's habitat	Fajen and Wehness (1981)!

TABLE 1
Selected Listing of Habitat Indices Used in North America Over Past 30 Years

Index/Methodology	Purpose	Reference
	quality index)	
Habitat Condition Indicator (HCI)	Indicate habitat condition for stream bank and instream components	Duff et al. (1989)!
Biological Condition Index (BCI/DAT)	Assess species diversity using habitat, species dominance, and taxa	Winget and Mangum (1979)!, Mangum (1986)!
IFIM	Determine flow needs of stream fish species	Bovee (1982, 1986)!
Rosgen	Classify stream channel and riparian characteristics based on fluvial geomorphology and stream conditions.	Rosgen (1985)!
Ohio EPA QHEI	Perform visual habitat assessment correlated with fish community conditions (e.g., IBI)	Rankin (1989, 1991) Ohio EPA (1989)
RBP	Perform habitat evaluation based on stream classification guidelines for Wisconsin	Barbour and Stribling (1991, 1994); Ball (1982); Platts et al. (1983)

Source: Modified from Rankin (1995)

In the early 1980s, states began developing habitat assessment protocols to measure overall stream integrity and to demonstrate if streams were in compliance with their designated use requirements in order to meet the goals of the Clean Water Act. Ohio was one of the first states to implement a habitat assessment program to determine compliance with a designated use. As other states began developing their own habitat assessment protocols, it became more difficult to compare results between investigations and between states and regions. To facilitate the transfer of data and information between states, the USEPA developed the first Rapid Bioassessment Protocols (RBP) (Plafkin et al., 1989), which included a standardized "visual based" habitat assessment procedure. Barbour and Stribling have revised the original USEPA RBP in the past decade (Barbour et al., 1997).

In the past 20 to 25 years, the North Carolina Mecklenburg County Department of Environmental Protection (MCDEP) has conducted comprehensive efforts to assess the quality of streams within the county by monitoring biological and water quality indicators. However, one component that was not previously addressed by the MCDEP's biological and water quality program was the evaluation of the physical stream conditions through a stream habitat assessment program on a watershed scale. In order to select the most effective and appropriate method for characterizing stream and surrounding habitat conditions, the MCDEP conducted a watershed-scale pilot study to evaluate the usefulness of three standardized "visual based" habitat assessment protocols. The protocols were selected through exclusionary and discretionary screening of many standardized stream habitat assessment forms prior to conducting the field work.

The exclusionary screening process was used to eliminate habitat assessment protocols focused on developing management strategies for fisheries programs. Protocols brought forward into the discretionary screening included those that were designed to be used for aquatic integrity assessments. A list of these protocols is shown in Table 2, listed by the reference and/or states in which they are used.

TABLE 2
Habitat Assessment Protocols Brought Forward for Phase 2 Screening

Document/Use by	Source	Comments *
Draft EPA RBP 1987	Plafkin et al. (1987)	• 15 habitat assessment parameters:4 in the primary, 3 in the secondary, and 8 in the tertiary categories • Score ranges are variable parameters are weighted • Low scores indicate better habitat integrity • One form was developed that is applicable to various stream types
Final EPA RBP 1989	Plafkin et al. (1989)	• 9 habitat assessment parameters: 3 in the primary, 3 in the secondary, and 3 in the tertiary categories • Score ranges are variable; thus, parameters are weighted • One form was developed that is applicable to various stream types
Alabama RBP	Plafkin et al. (1989)	• 9 habitat assessment parameters: 3 in the primary, 3 in the secondary, and 3 in the tertiary categories • Score ranges are variable; thus, parameters are weighted • One form was developed that is applicable to various stream types
Florida	Florida Department of Environmental Protection (1996)	• 7 habitat assessment parameters: 3 in the primary, 1 in the secondary and 3 in the tertiary categories • Scores range from 0 to 20 and all parameters are weighted equally • One form was developed that is applicable to various stream types
Revised Protocols Barbour and Stribling (1991)	Barbour and Stribling (1991)	• 9 habitat assessment parameters: 3 in each of the three (primary, secondary, and tertiary) physical stream habitat categories • Scores range from 0 to 20 and all parameters are weighted equally • Dual assessment system using two forms based on stream energy: one form for riffle/run and the other for glide/pool
USEPA 1997 Revised RBP	Barbour et al. (1997)	• 10 habitat assessment parameters: 3 in the primary, 4 in the secondary, and 3 in the tertiary categories (Barbour et al., 1997) • Scores range from 0 to 20 and all parameters are weighted equally • Dual assessment system using two forms based on stream energy, one form for riffle/run the other for glide/pool
Revised Protocols Barbour and Stribling (1994)	Barbour and Stribling (1994)	• 12 habitat assessment parameters: 4 in each of the three (primary, secondary, and tertiary) physical stream habitat categories • Scores range from 0 to 20 and all parameters are weighted equally • Dual assessment system using two forms based on stream energy: one form for riffle/run and the other for glide/pool
Georgia RBP	Modified by Barbour and Stribling (1991)	• 10 habitat assessment parameters: 3 in the primary, 4 in the secondary, and 3 in the tertiary categories • Scores range from 0 to 20 and all parameters are weighted equally • A dichotomous key is followed that minimizes variability between observes scoring a site; however, the key is cumbersome and time consuming to use • Dual assessment system using two forms based on stream energy: one form for riffle/run and the other for glide/pool

TABLE 2
Habitat Assessment Protocols Brought Forward for Phase 2 Screening

Document/Use by	Source	Comments *
Tennessee RBP	Barbour (1994)	• 10 habitat assessment parameters: 3 in the primary, 4 in the secondary, and 3 in the tertiary categories • Scores range from 0 to 20 and all parameters are weighted equally • Dual assessment system using two forms based on stream energy: one form for riffle/run and the other for glide/pool
Ohio EPA QHEI	Rankin (1989)	• 7 habitat assessment parameters: 4 in the primary, 1 in the secondary, and 2 in the tertiary categories • Score ranges are variable; thus, parameters are weighted • One form was developed that is applicable to various stream types
North Carolina	North Carolina Department of Environment and Natural Resources (1997)	• 8 habitat assessment parameters: 2 in the primary, 3 in the secondary, and 3 in the tertiary categories; having more than one choice in the decision process increases the precision with which habitats can be described • Score ranges are variable; thus, parameters are weighted • One form was developed that is applicable to various stream types
Field and Laboratory Methods for Macroinvertebrate and Habitat Assessment of Low-Gradient, Nontidal Streams	Mid-Atlantic Coastal Stream Workgroup (1997)	• 7 habitat assessment parameters: 3 in the primary, 1 in the secondary and 3 in the tertiary categories • Scores range from 0 to 20 and all parameters are weighted equally • One form was developed that is applicable to various stream types

* Primary category = Instream habitat conditions for biota
Secondary category = Channel shape
Tertiary category = Bank and riparian zone conditions

The final three habitat protocols selected for evaluation in the field pilot study were the modified Barbour and Stribling method developed by the Georgia Department of Natural Resources (GADNR); the North Carolina Department of Environment and Natural Resources (NCDENR) protocol (NCDWQ 1997); and the Ohio EPA's Qualitative Habitat Evaluation Index (QHEI).

The pilot study involved walking most of the lengths of two representative streams and documenting the physical habitat conditions of the stream and riparian zones by using the prescribed field forms, taking photographs, and recording general physical conditions. Three to five observers provided independent evaluations of the three different protocols that were used to document their understating and interpretation of the data collection and to show variability, if any, in the results. The representative streams used for the pilot study (McMullen Creek, located in an urban portion of the county, and Gar Creek, located in a rural setting) are characterized by a range of different land uses. The observers evaluated the mainstems, tributaries, and headwaters that constitute the hydrologic components of these two watersheds.

The results of the pilot study, using the three protocols and independent observes are shown in Figures 1 and 2. In order to compare the results among the three different protocols, the scores were normalized by dividing the total assigned score assessed in the field by the total possible score per field sheet. Thus the points in the scatter graphs are the normalized values represented as a percentage of the total possible score for each individual data sheet.

FIGURE 1
McMullen Creek, Mecklenburg County Summary

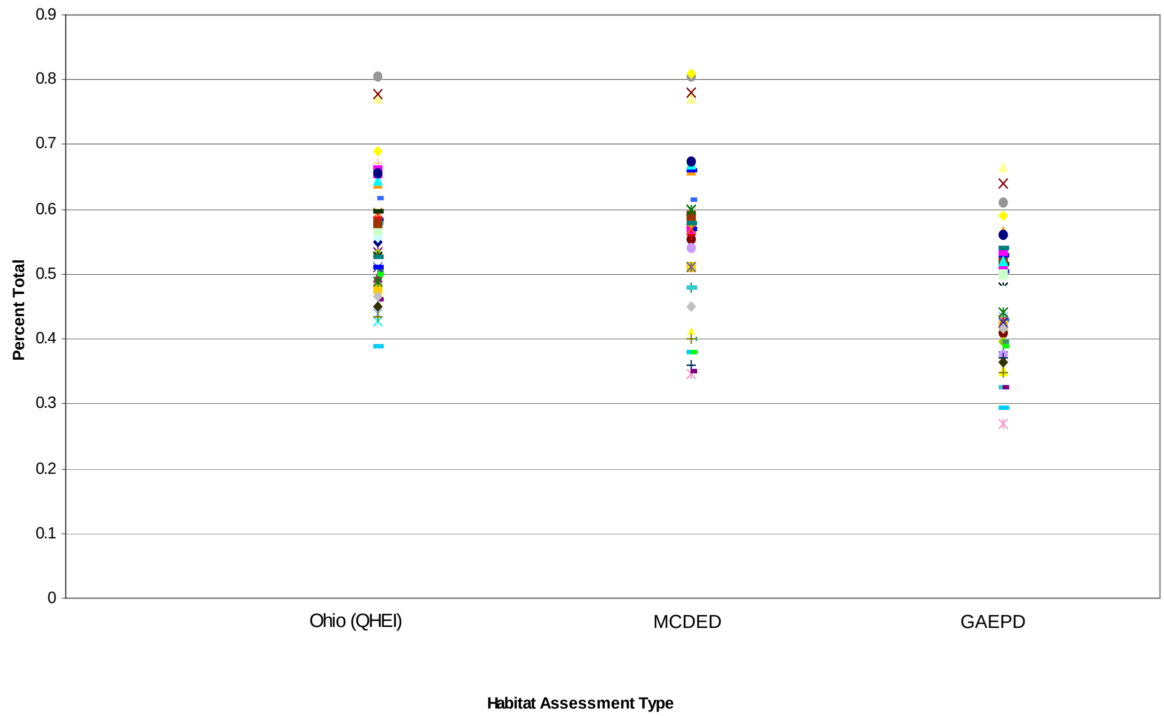
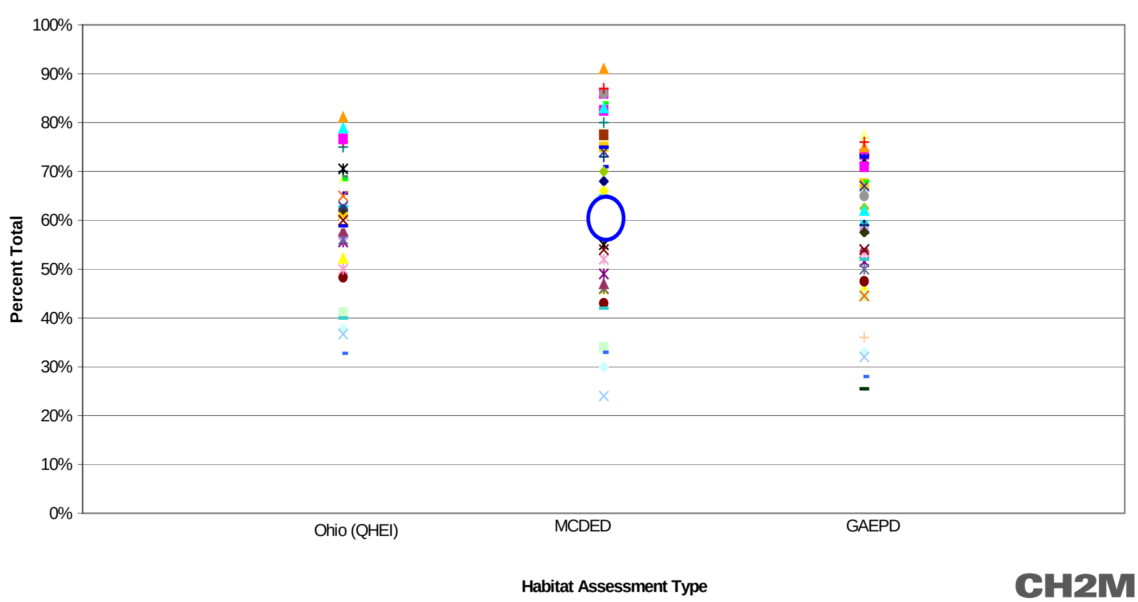


FIGURE 2
Gar Creek, Mecklenburg County Summary



Several trends and conclusions can be inferred from Figures 1 and 2:

- The QHEI and modified GADNR Barbour and Stribling protocols produced more similar scores at individual stations as compared to the NCDENR protocol.
- For streams that had relatively good infaunal and riparian habitats but poor bank conditions, the QHEI form resulted in slightly higher scores than the GADNR protocols. This was due to the weighting factor associated with bank stability.
- Scores using the NCDENR protocols for streams with relatively undisturbed habitats were generally higher than those obtained using the QHEI or modified GADNR Barbour and Stribling protocols. However, for streams with more disturbed habitats, the NCDENR protocols scored slightly lower. This resulted in a bimodal distribution of the data, as shown in the NCDENR column in Figure 2. This bimodal distribution, compared to the more uniform spread of the data points using the modified GADNR Barbour and Stribling and QHEI forms, indicates that the response of the NCDENR form may be less sensitive for the range of stream habitats evaluated in this pilot study.
- In areas where stream channels have been modified due to livestock activities or increased flow resulting from changes in land use and impervious areas, channel alteration may be underestimated using the modified GADNR Barbour and Stribling form because instructions are not clearly stated for this metric.

The field observers also commented on the general uses of the forms and instructions under field conditions as follows:

- Habitat assessment forms are inherently equally subjective.
- Results between reviewers are variable but variability is reduced considerably with experience.
- Internal field quality assurance/quality control (QA/QC) review and independent assessment by field team members is critical and reduces variability.

The habitat assessment protocols were screened using the criteria listed in Table 3. This screening evaluation showed that each of the forms has redeeming features that give it certain advantages over the others. However, when all the favorable/unfavorable designations for all eight criteria are compiled (Table 3), the GADNR modified Barbour and Stribling protocol was more suitable for Mecklenburg County's purposes than the other protocols, since it was rated favorably for six criteria as opposed to four for the other two. The GADNR Barbour and Stribling habitat assessment protocol was adopted for the countywide program with minor modifications.

Since the Mecklenburg County project, numerous habitat assessment stream walks have been conducted for watershed wide programs in Piedmont and Coastal Zone physiographic provinces, including over 400 miles in Virginia, about 200 miles in North Carolina, and 200 miles in Georgia. For these projects, the habitat assessment protocols and metrics have been adjusted slightly for purposes of clarification and to further minimize subjectivity during use and variability of the results.

TABLE 3
Favorability Ratings of the Three Habitat Assessment Protocols with Regard to the Screening Criteria

	Habitat Assessment Protocol		
Screening Criteria	**GADNR Modified Barbour and Stribling**	**NCDENR**	**QHEI**
1. Parameters clearly defined	X	X	X
2. Parameters characterize a range of conditions	X		X
3. Parameter attributes minimize subjectivity	X		
4. Parameters suitable for SE region, flexible	X	X	X
5. Methodology reflects local limiting factors	X	X	
6. Methodology enables assessment of biodiversity	X		
7. Easy to use		X	X
8. Requires little experience/training			
Totals:	6	4	4

Note: An ‘X’ indicates that this protocol was considered favorable with regard to the given screening criterion

Habitat Assessment Metrics

An evaluation of habitat quality is critical to any assessment of ecological integrity (U.S. EPA 1995). The habitat quality evaluation is accomplished by characterizing selected physical parameters that represent stream conditions. Metrics for the visual based approach depend on several conditions to accurately assess the quality of the physical habitat structure:

- The metrics selected to represent the various features of habitat structure need to be relevant and clearly defined.
- The metrics must be sensitive to a continuum of conditions from the optimum to the poorest.
- The judgement criteria for the attributes of each parameter should minimize subjectivity through quantitative measurements or specific categorical choices.

Table 4 is a list of metrics cited in the literature and adopted by many states and environmental groups, including the USEPA, to conduct “visual based” stream and riparian zone assessments for their biological and aquatic quality monitoring programs. Several of these metrics were tested and evaluated in the development of watershed-wide assessment protocols for several municipalities in Virginia and the southeast. The table lists a description of each metric and its relevance to instream aquatic integrity.

TABLE 4
Habitat Assessment Metrics

Metric	Description	Comment
Epifaunal Substrate/Available Cover	Include the relative quantity and variety of natural structures in streams such as cobble, large rocks, fallen trees, logs and branches, feeding, or sites for spawning and nursery functions of aquatic macrofauna.	High and low gradient streams. Variability occurs percent area coverage is misinterpreted.
Embeddedness	Refers to the extent to which rocks (gravel, cobbles, and boulders) are sunk into the silt, sand, or mud of the stream bottom.	High gradient streams. It may also be useful to lift a few rocks in riffle areas and observe the extent of the dark area on their underside. Observations should be taken in the upstream and central portions of riffles (i.e., run).
Pool Substrate Characterization	Evaluates the type and condition of bottom substrates found in pools. Firmer sediments and rooted aquatic plants support a wider variety of organisms than a pool substrate dominated by mud or bedrock and no plants.	Low gradient streams. Observations require visual inspection of pool substrate.
Velocity depth combinations	Patterns of velocity and depth combinations: 1 Slow – Deep, 2 Slow – Shallow, 3 Fast –Deep, 4 Fast – Shallow.	High gradient streams. Guidelines are 0.5 m depth to separate shallow from deep and 0.3 m to separate fast from slow. Guidelines may not be sensitive to discriminate between large and small stream systems.
Pool variability	Rates overall mixture of pool types according to size and depth. In rivers with low sinuosity (few bends) and monotonous pool characteristics, very little instream habitat variety exists to support a diverse community. The four basic types of pools are large-shallow, large-deep, small-shallow, and small-deep.	Low gradient streams. Any pool dimension (e.g., length, width) greater than half the cross-section of the stream is a large pool. Small pools have length and width dimensions less than half the width of the stream. Pools with depths greater than 1.0 m are deep. Shallow pools are less than 1.0 m deep. Guidelines may not be sensitive to discriminate between large and small stream systems.
Sediment Deposition	Relates to the amount of sediment that has accumulated and the changes that have occurred to the stream bottom as a result of deposition. 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 pools.	High and low gradient streams. Estimation of growth of point bars requires observers visually determine if they are stable (e.g., presence of vegetation).
Channel Flow status	Is the degree to which the channel is filled with water during normal flow periods. Flow status changes as channel enlarges. Useful for interpreting biological condition during abnormal or lowered flow conditions.	High and low gradient streams. This is a seasonal parameter. A decrease in water will wet smaller portions of the streambed, thus decreasing available habitat for aquatic organisms. Observers use the toe of slope and vegetation line on the lower bank as reference point to estimate channel flow status. Variability occurs if stream is a “C” type or if “C” in forming in an “F” channel.
Channel alteration	Measurement of large-scale alteration of instream habitat, which affects stream biotic integrity and causes scouring. Channel alteration is present when: artificial embankments, rip rap, and other forms of artificial bank stabilization or structures are present; when dredging has altered bank stability; when dams and bridges are present; when banks and channels have been disturbed by livestock, other agricultural practices; or hydrology; and when other changes have occurred.	High and low gradient streams. Variability occurs when discriminating between natural conditions and induced by development or other human use.

TABLE 4
Habitat Assessment Metrics

Metric	Description	Comment
Frequency of riffles	Measure of sequence of riffles and the heterogeneity occurring in a stream. A riffle/run (i.e., distanced between riffle divided by width of stream) ratio is use to as a measure of heterogeneity.	High gradient streams. Observers must estimate distance between riffles. For high gradient streams were riffles are uncommon, a run/bend rations is used.
Channel sinuosity	Evaluates the meandering or sinuosity of the stream.	Low gradient streams. Run/bend ration may not necessarily provide an accurate measurement. Stream length divided by valley length requires map measurements.
Bank stability	Measures the existence of or the potential for detachment of soil from the upper and lower stream banks and its movement into the stream. 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. Reinforcement of banks via rocks, artificial or natural, provides stability.	High and low gradient streams. Observers must evaluate bank soil condition, slope, shape, root mat density, etc.
Bank vegetative protection	Measures the amount of the stream bank that is covered by vegetation. This parameter supplies information on the ability of the bank to resist erosion. Banks that have full, natural plant growth are better for fish and macroinvertebrates than those without vegetation protection and those shored up with concrete or riprap.	High and low gradient streams. Observers must consider when scoring vegetative protection: (1) is the vegetation native or natural or planted and introduced (2) is the upper story, under story, and ground cover vegetation well balanced; (3) what is the standing crop biomass; and (4) during which season are you conducting this assessment.
Vegetation buffer zone width	Measures the width and conditions of the vegetation or land use from the edge of the upper stream bank out through, and in some cases, beyond the flood plain and riparian zone Gregory et al. 1991). The vegetative zone serves as a buffer to pollutants entering a stream from runoff, and minimizes erosion.	High and low gradient streams. Observers must walk around in the buffer area, paying close attention to the amount of natural vegetation present and how deep it extends from the bank, and disturbances that may effect the transport of pollutants through the zone. Vegetated buffer zone assessment involves documenting three condition factors: 1) vegetation cover type, 2) breaks, and 3) vegetated zone width.
Canopy cover	Measures the amount of cover overhead that provides shading and cooling of the water.	High and low gradient streams. Assessment involves vegetation cover type, and density of leaf material. Metric is sensitive to season and size of stream.
Aesthetics	Measures the perception of what constitutes desirable surface water and aquatic integrity.	High and low gradient streams. Highly subjective and does not necessarily relate to the ability of a stream to support aquatic life.
Riffle/run depth	Measures habitat conditions for fish habitat and refuge.	High and low gradient streams. Established pool or riffle depths may not be sensitive to discriminate between large and small stream systems.

In Table 5, habitat assessment metrics were evaluated for their sensitivity to accurately measure and document the conditions and represent the stream and riparian features. Overall, the metrics evaluated would respond to the expected field conditions and support watershed management decisions. Those with mostly high probability ratings are most useful for collecting reliable and reproducible data and describing the systems being evaluated. No one metric could be eliminated based on the criteria established; however, some metrics are redundant and some are highly subjective such as aesthetics.

TABLE 5
Efficacy of Habitat Assessment Metrics with Regard to the Screening Criteria

Metric	Feature Expected for Different Ecoregion	Differentiate Between Good and Bad Streams	Reproducible	Works in Small and Large Streams	Level of Subjectivity	Supports Watershed Management Decisions
Instream Cover	Medium	High	Low	Medium	Medium	High
Epifaunal/Bottom Substrate	Low	High	High	Medium	Medium	High
Embeddedness	Low	High	Medium	High	Medium	Medium
Channel/Bank Alteration	High	High	Medium	High	Medium	High
Sediment Deposition	Low	High	High	High	Medium	Medium
Frequency of Riffles	Low	High	Medium	High	Medium	Medium
Channel Flow Status	High	Low	High	High	Medium	Medium
Bank Vegetation Protection	High	Medium	Medium	Medium	Medium	Medium
Bank Stability	High	Medium	Medium	High	Medium	High
Vegetative Buffer Zone Width	High	High	High	High	High	High
Pool Substrate Characterization	Medium	Medium	High	Low	Medium	Medium
Pool Variability	Medium	Medium	Medium	Low	Medium	Medium
Channel Sinuosity	Medium	Medium	Medium	High	Medium	Medium
Velocity/Depth Regimes	Low	High	High	Low	Medium	Medium
Aesthetics	Medium	Medium	Medium	High	Low	Low
Canopy cover	Medium	Medium	Medium	Low	Medium	Medium
Development of Riffle/Run	Low	High	High	Medium	Medium	Medium
Riffle/Run Depth	Low	High	High	Medium	Medium	Medium

Infrastructure Inventory

The infrastructure inventory was developed as part of the Henrico County Stream Assessment Project to:

- Identify potential sources of contamination
- Identify bank erosion and degraded aquatic integrity
- Identify locations for potential spot improvements
- Inventory county infrastructure in and around the stream channel

The protocols are primarily focused on sources of bank and bed erosion. The inventory includes protocols for evaluating pipes, ditches, obstructions, dump sites, head cuts, public utility lines, erosion problem areas, road and other stream crossings, and areas of deficient buffer vegetation. The protocols capture information that is readily available from visual observations of each inventory point.

Based on the inventory results, management decisions can be made to prioritize improvement projects in critical areas.

Stream Characteristics

The stream characteristics form was developed as part of the Henrico County Stream Assessment Project to record general stream information and to capture visual information on stream quality. This form is also a single location to capture notes and comments about the reach that may not be well represented in the other forms, such as specific restrictions to stream restoration or conversations with local residents. Information captured in this form includes general stream information such as stream name, watershed, and reach length, as well as instream quality indicators such as observations of water appearance, odors, and organisms.

Geomorphological Assessment

A geomorphological assessment will be performed based on the conceptual incised Channel Evolution Model (CEM) developed by Schumm et al. (1984). The CEM, when applied on a watershed scale can be of great value in developing an understanding of channel dynamics and characterizing stable reaches within these channels. More recently, Watson et al. (2002) have presented an approach that allows use of the CEM, in conjunction with additional information on channel stability to better understand and provide guidance in the selection of rehabilitation alternatives.

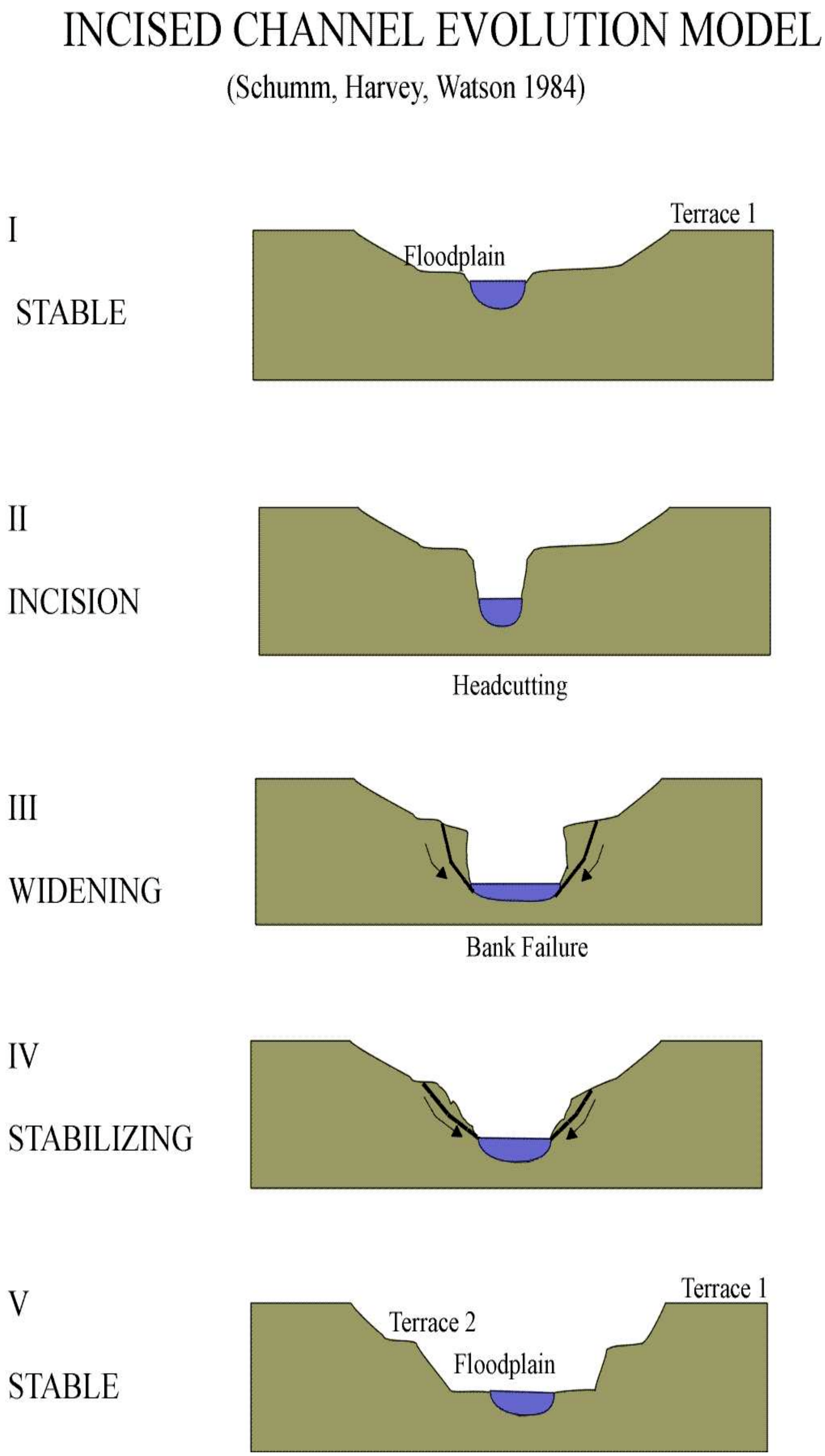
Schumm et al. (1984), based on an intensive study of channels in the Gulf Coastal Plain (upper Yazoo basin in Mississippi) developed the CEM to describe the sequence of changes a channel undergoes after disturbances due to anthropogenic activity. The basic approach employed in the study assumed that the evolutionary stages of a channel's response to disturbance could be identified morphologically. Schumm et al. (1984) then selected a series of landforms (represented by channel cross-sections) that they had observed for their evolution model. By invoking the ergodicity[1] assumption, which allows a space for time substitution to assist in conceptualizing landform evolution model, they were able to hypothesize that the landform series they had selected would occur at a <u>given location over time</u> in the future.

The channel-reach types proposed in the CEM are shown in Figure 3. The channel types are labeled I through V and in the CEM, are assumed to occur at a given location as the channel evolves. A Type I channel represents a pre-disturbance condition, in which the channel has well vegetated banks and interacts frequently with its floodplain. Following disturbance, the reach starts to incise or downcut and is called a Type II channel. Bed degradation is the dominant process in this stage.

[1] The use of ergodicity in geomorphology is conceptual rather than mathematical and departs from the formal concept originally developed in physics. Thus, the phrases "location-for-time" or "space-for-time" substitution are used to describe the assumption in geomorphology.

As bed degradation continues, the banks eventually oversteepen and when some critical bank height is exceeded, bank failures and mass wasting begin to occur. This marks the transition to a Type III channel. This transitional stage generally represents the most unstable phase of the CEM. Overall, the dominant process in the Type III phase is channel widening.

FIGURE 3
Stages in the Conceptual Incised Channel Evolution Model



As the channel continues to widen, the reduced sediment transport capacity and increased sediment supply result in the initiation of sediment deposition on the bed. This is representative of a Type IV channel in which streambank aggradation is the dominant process. The Type IV channel can be regarded as the first sign that the originally disturbed, incised channel is stabilizing and returning to a new state of equilibrium.

The final, quasi-equilibrium channel reach is Type V. In this channel type, bank heights are less than the critical bank height and a balance between sediment transport capacity and sediment supply is approached. Eventually, a channel with dimensions and capacity similar to the predisturbance channel forms within the deposited alluvium The new channel is lower than the predisturbance channel, and the original floodplain of the Type I channel becomes discernable as a terrace.

Stream Assessment Protocols

Habitat Assessment

Each of the two members of a team should conduct habitat assessments separately, without collaboration. After each team member fills out the form separately, the two compare their scores. If the scores for any parameter differ by more than six points out of 20 (or three out of 10), then the two team members should discuss that parameter and, based on the conclusion of the discussion, adjust their scores before averaging them. The habitat assessment protocols for each metric are provided below. The field forms are provided in Attachment A1.

Habitat Assessment - Riffle/Run Prevalent Streams

I. Instream Cover

Measures substrates that are available as refuge for aquatic organisms. A wide variety and/or abundance of submerged structures in the stream provides macroinvertebrates with a large number of niches, thus increasing the potential diversity. As the variety and abundance of cover decreases, habitat structure becomes monotonous, diversity decreases, and the potential for recovery following disturbance decreases.

Circle habitat types which occur at this site: fallen trees/large woody debris, deep pools, shallow pools, overhanging shrubbery in water, large rocks, cobble, undercut banks, thick root mats, dense macrophyte beds, or deep riffles with lots of turbulence (habitat type found in cold-water, mountain streams)

A. Habitat(s) expected for stream type make up >70% of reach

1. 7 habitats common	20
2. 6 habitat types common, additional habitat types rare	19
3. 5 habitat types common, additional habitat types rare	18
4. 4 habitat types common, additional habitat types rare	17
5. Less than 4 habitat types present	16

B. Habitat(s) expected for stream type make up >50% of reach

1. 7 habitats common	15
2. 6 habitat types common, additional habitat types rare	14
3. 5 habitat types common, additional habitat types rare	13
4. 4 habitat types common, additional habitat types rare	12
5. Less than 4 habitat types present	11

C. Habitat(s) expected for stream type makes up <50% of reach

a. 7-3 habitats common

1. 7 habitats common	10
2. 6 habitat types common, additional habitat types rare	9
3. 5 habitat types common, additional habitat types rare	8
4. 4 habitat types common, additional habitat types rare	7
5. 3 habitat types common, additional habitat types rare	6

b. 2-0 habitats common

1. 2 habitat types present, additional habitat types rare	5
2. 2 habitat types only and common	4
3. 1 habitat type common, additional habitat types rare	3
4. 1 habitat type only and common	2
5. 1 habitat type rare	1
6. 0 habitat types present	0

II. Epifaunal Substrate

Measures the availability of benthic habitat for macroinvertebrate (insects and snails) colonization. Riffle areas are critical for maintaining a healthy variety of insects in most riffle prevalent streams.

A. Well developed riffle-run complex. Riffle is as wide as the stream and its length extends twice the stream width. Substrate dominated by:

1. Softball size cobble stones	20
2. Cobble and boulder stones (>10 in.)	19
3. Boulder stones only	18
4. Mixture of cobble and gravel stones and/or stable woody debris	17
5. Mixture of gravel stones and boulders/bedrock and/or stable woody debris	16

B. Riffle is as wide as the stream and its length does not extend twice the stream width. Substrate dominated by:

1. Softball size cobble stones	15
2. Cobble and boulder stones (>10 in.)	14
3. Boulder stones only	13
4. Mixture of cobble and gravel stones and/or stable woody debris	12
5. Mixture of gravel stones and boulders/bedrock and/or stable woody debris	11

C. Riffle is not as wide as the stream and its length does not extend twice the stream width. Substrate dominated by:

1. Softball size cobble stones	10
2. Cobble and boulder stones (> 10 in.)	9
3. Boulder stones only	8
4. Mixture of boulders/bedrock and gravel stones and/or stable woody debris	7
5. Mixture of bedrock and/or gravel stones and/or stable woody debris	6

D. Riffles or runs virtually nonexistent, no cobble substrate. Substrate dominated by:

1. Large boulders, short runs	5
2. Mixture of boulders and bedrock	4
3. Rock and sand with long runs, no riffles	3
4. Rock and sand with short runs, no riffles	2
5. Rock and sand, no runs or riffles	1
6. Sand with no riffles or runs	0

III. Embeddedness In Run Areas

Measures the degree to which cobble, boulders, and other rock substrate are surrounded by fine sediment and silt (including all sand plus silt). Embeddedness relates directly to the suitability of the stream substrate as habitat for macroinvertebrates and for fish spawning and egg incubation.

Fine sediments/sands range from 0.062 mm to 2 mm in size. Silt particles measure less than 0.062 mm. Sediment and silt particles smaller than 2 mm can be distinguished using "texture by feel techniques" employed in soil surveys.

A. Little or no embeddedness present by fine sediment and silt surrounding and covering rocks

1.	<10% embeddedness	20
2.	10% embeddedness by sediment	19
3.	10% embeddedness by sediment and silt	18
4.	20% embeddedness by sediment	17
5.	20% embeddedness by sediment and silt	16

B. Fine sediment and silt surrounds and fills 25-50% of the living spaces around and in between gravel, cobble, and boulders

1.	30% embeddedness by sediment	15
2.	30% embeddedness by sediment and silt	14
3.	40% embeddedness by sediment	13
4.	40% embeddedness by sediment and silt	12
5.	50% embeddedness by sediment	11

C. Fine sediment and silt surrounds and fills 50-75% of the living spaces around and in between gravel, cobble, and boulders

1.	50% embeddedness by sediment and silt	10
2.	60% embeddedness by sediment	9
3.	60% embeddedness by sediment and silt	8
4.	70% embeddedness by sediment	7
5.	70% embeddedness by sediment and silt	6

D. Fine sediment and silt surrounds and fills more than 75% of the living spaces around and in between gravel, cobble, and boulders

1.	80% embeddedness by sediment	5
2.	80% embeddedness by sediment and silt	4
3.	90% embeddedness by sediment	3
4.	90% embeddedness by sediment and silt	2
5.	100% embeddedness by sediment	1
6.	100% embeddedness by sediment with a thick layer of silt on its surface	0

IV. Channel/Bank Alteration

Measurement of large-scale alteration of instream habitat, which affects stream biotic integrity and causes scouring. Channel alteration is present (circle or identify conditions) when: artificial embankments, rip rap, and other forms of artificial bank stabilization or structures are present; when dredging has altered bank stability; when dams and bridges are present; when banks and channels have been disturbed by livestock, other agricultural practices; or hydrology; and when other changes have occurred (list).

A. Stream follows a normal and natural meandering pattern. Alteration is absent.

1.	No evidence of disturbance with bends and riffle/runs frequent; bend angles average > 60°	20
2.	No evidence of disturbance with bends combination of riffle/runs and glide/pool habitats frequent; bend angles average between 60°- 40°	18
3.	No evidence of disturbance with bends and glide pools prevalent; bend angles average < 40°	16

B. Some minor alterations, dredging, artificial embankments, or dams present but NO evidence of recent alteration activities; mostly recovered and somewhat stable. .

1.	5% of reach has channel disturbance	15
2.	10% of reach or less has channel disturbance	14
3.	20% of reach has channel disturbance	13
4.	30% of reach has channel disturbance	12
5.	40% of reach has channel disturbance	11

C. Somewhat channelized; 40-80% of the area has been straightened, dredged, or otherwise altered.

1.	40% of reach has channel disturbance	10
2.	50% of reach has channel disturbance	9
3.	60% of reach has channel disturbance	8
4.	70% of reach has channel disturbance	7
5.	80% of reach has channel disturbance	6

D. More than 80% of the stream site has been dredged, or otherwise altered; banks most likely box-cut (Including natural U-shaped) or rip-rap or no longer have native vegetation; instream habitat highly altered.

1.	90% of reach has channel disturbance	5
2.	Channel reach 100% disturbed; with no artificial embankments	3
3.	Channel reach 100% disturbed; with artificial embankments	2
4	Channel reach 100% disturbed; with natural and manmade artificial embankments	1
5.	Channel 100% shored by gabion and/or cement	0

V. Sediment Deposition

Relates to the amount of sediment that has accumulated and the changes that have occurred to the stream bottom as a result of deposition. Sediment deposition may correlate with embededness. 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 pools. Depositional material comes from the watershed and bank erosion (Barbour and Stribling, 1995). The growth, or appearance of bars/islands where they did not previously exist is an indication of upstream erosion. Sediment bars/islands tend to grow in depth and length with continued watershed disturbance because increased sedimentation results in increased deposition. High levels of sediment deposition create an unstable and continually changing environment that becomes unsuitable for many organisms (FL DEP, 1996)!.

A. No enlargements of islands/point bars present or less than 20% bottom affected by sand or silt accumulation.

1.	No sediment deposition detected; especially in pools	20
2.	Less than 20% sediment deposition with accumulation in pools only	18
3.	Less than 20% sediment deposition with accumulation in runs and pools	17
4.	Less than 20% sediment deposition with few, old, small point bars or islands made up of coarse gravel in stream channel	16

B. 20-50% bottom affected by sand or silt accumulation; slight deposition in pools; some new increase in bar and island formation.

1.	20-30% sediment deposition with gravel and/or sand	15
2.	20-30% sediment deposition with sand and/or silt	14
3.	40-50% sediment deposition with gravel and/or sand	12
4.	40-50% sediment deposition with sand and/or silt	11

C. 50-80% bottom affected with moderate deposition in pools. Number of shallow pools increases. Habitats smothered by sand, silt, and possibly coarse gravel. Deposits of fresh, fine, gravel, sand, and silt observed on old and new point bars, islands, and behind obstructions. Formation of few new bars/islands is evident and old bars are deep and wide; deposition at bends obvious.

1.	50-60% sediment deposition with gravel and/or sand	10
2.	50-60% sediment deposition with sand and/or silt	9
3	70-80% sediment deposition with gravel and/or sand	7
4	70-80% sediment deposition with sand and/or silt	6

D. More than 80% bottom affected with heavy deposition from coarse and fine gravel and sand at stream bends, constrictions, and/or pools. Extensive deposits of fine sand and/or silt on old and new bars, islands, and along banks in straight channels. Few pools are present due to siltation. Only larger rocks in riffle areas remain exposed.

1.	80-90% sediment deposition; pools almost absent due to substantial deposition; bottom silt may move with almost any flow above normal	4
2.	90-100% sediment deposition; pools almost absent	2
3.	100% sediment deposition; pools absent due to substantial deposition; bottom silt moves with almost any flow above normal	0

VI. Frequency of Riffles

Estimates the frequency of occurrence of riffles. 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. Divide the average distance between riffles by the average width of the stream to estimate run-to-riffle ratio.

A. Occurrence of riffles relatively frequent. Deep pools may be present and riffles are deep enough to allow passage of fish.

1.	Riffles are continuous: run-to-riffle ratio = 1-2	20
2.	Run-to-riffle ratio = 3-4	19
3.	Run-to-riffle ratio = 5	18
4.	Run-to-riffle ratio = 6	17
5.	Run-to-riffle ratio = 7	16

B. Occurrence of riffles moderately frequent; adequate depth in pools and riffles.

1.	Run-to-riffle ratio = 8	15
2.	Run-to-riffle ratio = 10	14
3.	Run-to-riffle ratio = 11	13
4.	Run-to-riffle ratio = 13	12
5.	Run-to-riffle ratio = 15	11

C. Infrequent riffles or bends variable bottom contours may provide some habitat.

1.	Run-to-riffle ratio = 16	10
2.	Run-to-riffle ratio = 18	9
3.	Run-to-riffle ratio = 20	8
4.	Run-to-riffle ratio = 22	7
5.	Run-to-riffle ratio = 24	6

D. Generally all flat water or shallow riffles; essentially a straight and uniform depth stream; riffles are not deep enough to provide free passage for fish.

1.	Run-to-riffle ratio = 25	4
2.	Run-to-riffle ratio > 30 with some shallow riffles	2
3.	Run-to-riffle ratio >30 with no shallow riffles	0

VII. Channel Flow Status

Is the degree to which the channel is filled with water during normal flow periods. The flow status will change as the channel enlarges or as flow decreases as a result of dams and other obstructions, diversions for irrigation, drought, or aggrading stream bottoms with actively widening channels. This is a seasonal parameter. A decrease in water will wet smaller portions of the streambed, thus decreasing available habitat for aquatic organisms. Use the toe of slope and possibly the vegetation line on the lower bank as your reference point to estimate channel flow status.

A. Water reaches the base of both lower banks and minimal amount of channel substrate is exposed (100% channel full)	20
1. > 95% channel is full	18
2. 90-95% channel is full	16
B. Water fills > 75% of the available channel (or <25% of channel substrate is exposed)	
1. 90% of channel is full	15
2. 85% of channel is full	13
3. 80% of channel is full	11
C. Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed	
1. 75% of channel is full	10
2. 60-65% of channel is full	9
3. 50% of channel is full	8
4. 35-40% of channel is full	7
5. 25% of channel is full	6
D. Very little water in the channel and mostly present as standing pools	
1. 20% of channel is full	5
2. 10% of channel is full	4
3. < 10% of channel is full	3
4. Water present as isolated standing pools	1
5. Channel is dry	0

VIII. Bank Vegetative Protection

Measures the amount of the stream bank that is covered by vegetation. 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 those without vegetation protection and those shored up with concrete or riprap.

Four factors to consider when scoring bank vegetative protection: (1) is the vegetation native or natural or planted and introduced? (2) Is the upper story, under story, and ground cover vegetation well balanced?; (3) What is the standing crop biomass?; and (4) During which season are you conducting this assessment?

Determine left or right bank by facing downstream. Score left and right banks separately.

A. Left Bank or Right Bank

1. More than 90% stream bank surfaces is covered by native/natural vegetation. A variety of vegetation present (e.g., trees, shrubs, understory, or nonwoody macrophytes). Any bare or sparsely vegetated areas are small and evenly dispersed.

a.	100% plant cover on stream bank	10
b.	> 90% plant cover on stream bank	9

2. A variety of vegetation is present and covers 70-90% of stream bank surface, but one class of plants is not well represented. Some open areas with unstable vegetation are present. Disruption evident but not affecting full plant growth potential.

a.	90% plant cover but one class of plants is not well represented	8
b.	80% plant cover with a few barren or thin areas present	7
c.	70% plant cover with a few barren or thin areas present with fewer plant species	6

3. 50-70% of stream bank surface covered by vegetation; typically composed of scattered shrubs, grasses, and forbes. Thin or bare spots visible and/or closely cropped vegetation with less that ½ plant stubble height remaining.

a.	70% vegetation cover; typically of shrubs, grasses, and forbes	5
b.	60% vegetation cover; typically of shrubs, grasses, and forbes	4
c.	50% vegetation cover; typically of shrubs, grasses, and forbes	3

4. Less than 50% stream bank surface covered by vegetation; 2 inches or less in average stubble height remaining. Any shrubs or trees on bank exist as individuals or widely scattered clumps.

a.	40% vegetation cover with many bare spots/rock	2
b.	20% vegetation cover with many bare spots/rock	1
c.	No vegetation cover on stream bank	0

IX. Bank Stability

Measures the existence of or the potential for detachment of soil from the upper and lower stream banks and its movement into the stream. 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. Reinforcement of banks via rocks, artificial or natural, provides stability.

Determine left or right bank by facing downstream. Score left and right banks separately.

A. Left Bank or Right Bank

1. Bank stable; erosion absent or minimal. Side slopes are generally less than 30% and are stable. Bank may be reinforced by rock thus increasing slope >30% while providing stability.

a.	No evidence of erosion or bank failure	10
b.	Less than 5% bank affected by erosion	9

2. Moderately stable bank; small areas of erosion or bank slumping visible. Most areas are stable with only slight potential for erosion at flood stages. Side slopes up to 40% on one bank. Bank may be reinforced by rock thus increasing slope > 40% while providing stability.

a.	5% bank has erosional areas	8
b.	15% bank has erosional areas	7
c.	30% bank has erosional areas	6

3. Moderately unstable bank; frequency and size of raw areas are such that high water events have eroded some areas of the bank. Medium size areas of erosion or bank slumping visible. Side slopes up to 60% on some of the bank. High erosion potential during floods.

a.	40% - 50% bank has erosional areas	5
b.	50% - 60% bank has erosional areas	4
c.	60% - 70% bank has erosional areas	3

4. Unstable bank; mass erosion and bank failure is evident; erosion and pronounced undercutting present at bends and along some straight channel areas. Side slopes > 60% are common. Many raw areas present and 60-100% bank has erosional scars.

a.	70%- 80% bank has erosional areas	2
b.	80%-90% bank has erosional areas	1
c.	> 90% stream bank has eroded	0

X. Vegetation Buffer Zone Width

Measures the width and conditions of the vegetation or land use from the edge of the upper stream bank out through, and in some cases, beyond the flood plain and riparian zone. The vegetative zone serves as a buffer to pollutants entering a stream from runoff, and minimizes erosion. Far less useful buffer zones occur when roads, parking lots, fields, heavily used paths, lawns, bare soil, rocks, or buildings are near the bank. .

Determine left or right bank by facing downstream. Score left and right banks separately.

When evaluating this parameter, walk around in the buffer area paying close attention to the amount of natural vegetation present and how deep it extends from the bank, and disturbances that may effect the transport of pollutants through the zone. Vegetated buffer zone assessment involves documenting three condition factors: 1) Vegetation Cover Type, 2) Breaks, and 3) Vegetated Zone Width. A break in the buffer zone is an area, which allows sediment or other pollutants to enter directly into the stream. Breaks refer only to the near stream portion of the buffer zone and may or may not extend into the entire buffer zone. Breaks include storm drains, culverts etc. If breaks occur, subtract 1 if moderated and 2 if substantial.

Identify Left and Right Bank Cover Conditions (circle appropriate value)

1 Width of forested vegetated buffer zone >100 feet wide and no man-made activities.

- a. Forest – generally a later successional stage or climax community with a diversity of growth forms including ground cover, vines, and shrubs. 10
- b Man-made activities include paths, utility lines (pipes, power etc) and other minor disturbances parallel to the creek. 9

2 Width of forested vegetated buffer zone –50-100 feet wide. Impacts beyond 100 feet are <50% impervious and predominantly:

- a. Shrub: An earlier successional growth stage on disturbed land, mostly consisting of shrubs & a few trees. 8
- b. Old Field: Any stage of old field succession with herbaceous or shrub species (few if any trees). 7
- c. Planted lawn grass: Includes yards and other landscaped surfaces consisting of mostly lawn grass vegetation such as parks and cemeteries. 6
- d. Pasture/Agricultural: Active pasture consisting of planted grasses and forbes and land for row crops. 5
- e. Forested vegetated buffer zone 50-100 feet & impacts beyond 100 feet are >50% Impervious: 4

3 Width of forested vegetated buffer zone 25-50 feet wide. Impacts beyond 50 feet are < 25% impervious and predominantly:

- a. Shrub: An earlier successional growth stage on disturbed land, mostly consisting of shrubs & a few trees. 7
- b. Old Field: Any stage of old field succession with herbaceous or shrub species (few if any trees). 6
- c. Planted lawn grass: Includes yards and other landscaped surfaces consisting of mostly lawn grass vegetation such as parks and cemeteries. 5
- d. Pasture/Agricultural: Active pasture consisting of planted grasses and forbes and land for row crops. 4
- e. Forested vegetated buffer zone 25-50 feet & impacts beyond 50 feet are >25% Impervious: 3

4 Width of forested vegetated buffer zone 5 – 25 feet wide. Impacts beyond 25 feet are <20% impervious and predominantly:

- a. Shrub: An earlier successional growth stage on disturbed land, mostly consisting of shrubs & a few trees. 5
- b. Old Field: Any stage of old field succession with herbaceous or shrub species (few if any trees). 4
- c. Planted lawn grass: Includes yards and other landscaped surfaces consisting of mostly lawn grass vegetation such as parks and cemeteries. 3
- d. Pasture/Agricultural: Active pasture consisting of planted grasses and forbes and land for row crops. 2
- e. Forested vegetated buffer zone 5-25 feet & impacts beyond 25 feet are >20% Impervious: 1

5 No forested vegetated buffer zone

- a. Shrub: An earlier successional growth stage on disturbed land, mostly consisting of shrubs and a few trees. 4
- b. Old Field: Any stage of old field succession with herbaceous or shrub species (few if any trees). 3
- c. Planted lawn grass: Includes yards and other landscaped surfaces consisting of mostly lawn grass vegetation such as parks and cemeteries. 2
- d. Pasture/Agricultural: Active pasture consisting of planted grasses and forbes and land for row crops. 1
- e. >75% Impervious along creek: Includes parking lots, road, structures etc. 0

Habitat Assessment - Glide/Pool Prevalent Streams

I. Bottom Substrate / Available Cover

Measures substrates that are available as refuge for aquatic organisms. A wide variety and/or abundance of submerged structures in the stream provides macroinvertebrates with a large number of niches, thus increasing the potential diversity. As the variety and abundance of cover decreases, habitat structure becomes monotonous, diversity decreases, and the potential for recovery following disturbance decreases.

Circle habitat types which occur at this site: fallen trees/large woody debris, deep pools, shallow pools, overhanging shrubbery in water, large rocks, undercut banks, thick root mats, dense macrophyte beds, or deep riffles with lots of turbulence (habitat type found in cold-water, mountain streams)

A. Habitat(s) expected for stream type make up >70% of reach

1. 7 habitats common	20
2. 6 habitat types common, additional habitat types rare	19
3. 5 habitat types common, additional habitat types rare	18
4. 4 habitat types common, additional habitat types rare	17
5. Less than 4 habitat types present	16

B. Habitat(s) expected for stream type make up >50% of reach

1. 7 habitats common	15
2. 6 habitat types common, additional habitat types rare	14
3. 5 habitat types common, additional habitat types rare	13
4. 4 habitat types common, additional habitat types rare	12
5. Less than 4 habitat types present	11

C. Habitat(s) expected for stream type make up <50% of reach

a. 7-3 habitats common

1. 7 habitats common	10
2. 6 habitat types common, additional habitat types rare	9
3. 5 habitat types common, additional habitat types rare	8
4. 4 habitat types common, additional habitat types rare	7
5. 3 habitat types common, additional habitat types rare	6

b. 2-0 habitats common

1. 2 habitat types present, additional habitat types rare	5
2. 2 habitat types only and common	4
3. 1 habitat type common, additional habitat types rare	3
4. 1 habitat type only and common	2
5. 1 habitat type rare	1
6. 0 habitat types present	0

II. Pool Substrate Characterization

Evaluates the type and condition of bottom substrates found in pools. Firmer sediments, and material that provides “habitat structure” such as rooted aquatic plants and other organic debris (e.g., snags, leaf packs, sticks, root mats) that support a wider variety of organisms than a pool substrate dominated by mud or bedrock and no plants or no other material (snags, rocks etc.).

A. Mixture of substrate materials, with gravel and firm sand prevalent; habitat structure consists of root mats, organic debris (e.g., snags, leaf packs) or submerged vegetation common.

1. Gravel, and firm sand, >10% habitat structure	20
2. Gravel,>10% habitat structure	19
3. Gravel, <10% habitat structure	18
4. Firm sand, >10% habitat structure	17
5. Firm sand, <10% habitat structure	16

B. Mixture of soft sand, mud, or clay; mud may be dominant; some habitat structure consisting of organic debris, root mats or submerged vegetation present.

1. Firm and soft sand, >10% habitat structure	15
2. Firm and soft sand, <10% habitat structure	14
3. Soft sand, mud, clay, >10% habitat structure	13
4. Soft sand, mud, clay, <10% habitat structure	12
5. Soft sand/mud, soft sand/clay, or clay/mud, <10% habitat structure	11

C. All mud or clay or sand bottom; little or no root mat; no submerged vegetation. Substrate consists of:

1. All sand bottom with > 10% habitat structure	10
2. All mud bottom with >10% habitat structure	9
3. All clay bottom with >10% habitat structure	8
4. All sand bottom with <10% habitat structure	7
5. All mud or clay bottom with <10% habitat structure	6

D. Hard pan clay or bedrock; with/no appreciable habitat structure

1. All hard pan clay with >10% habitat structure	4
2. All bedrock with >10% habitat structure	3
3. All hard pan clay with <10% habitat structure	1
4. All bedrock with <10% habitat structure	0

III. Pool Variability

Rates overall mixture of pool types according to size and depth thus accommodating a diverse aquatic community consisting of a variety of species and age classes. In rivers with low sinuosity (few bends) and monotonous pool characteristics, very little instream habitat variety exists to support a diverse community. The four basic types of pools are large-shallow, large-deep, small-shallow, and small-deep.

Any pool dimension (e.g., length, width) greater than half the cross-section of the stream is a large pool. Small pools have length and width dimensions less than half the width of the stream. Pool depth is relative to the size of the stream/watershed. The dimensions of deep and small pools are proportional to the size of the stream and the average depth of stream. Generally deep pools would be at least 2 times the average depth of the streams. “Reaeration” is defined as the oxygen transfer from the atmosphere to the stream. Reaeration points are any areas where the stream surface is disturbed (e.g., dams, water falling over snags or logs or other debris, riffles),

A. All pool sizes (area and depth) present and mixed.

1. All sizes evenly mixed and below areas of reaeration 20
2. All sizes evenly mixed but can be found below and above reaeration areas 18
3. All sizes evenly mixed not below areas of reaeration 16

B. Majority of pools are large-deep; very few shallow.

1. Large and small deep pools evenly mixed and all below areas of reaeration 15
2. Majority of pools are large-deep and below areas of reaeration 14
3. Large and small deep pools evenly mixed and above and below areas of reaeration 13
4. Majority of pools are large-deep and found above and below areas of reaeration 12
5. Majority of pools are large-deep and not below areas of reaeration 11

C. Shallow pools are much more prevalent than deep pools.

1. Large and small shallow pools evenly mixed and all below areas of reaeration 10
2. Majority of pools are large-shallow and below areas of reaeration 9
3. Large and small shallow pools evenly mixed and above and below areas of reaeration 8
4. Majority of pools are large-shallow and found above and below areas of reaeration 7
5. Majority of pools are large-shallow and not below areas of reaeration 6

D. Majority of pools small-shallow or pools absent

1. Majority of pools are small-shallow and all below areas of reaeration 5
2. Majority of pools are small-shallow and above and below reaeration areas 3
3. Majority of pools are small-shallow and all above areas of reaeration 2
4. Pools absent 0

IV. Channel/Bank Alteration

Measurement of large-scale alteration of instream habitat, which affects stream biotic integrity and causes scouring. Channel alteration is present (circle or identify conditions) when: artificial embankments, rip rap, and other forms of artificial bank stabilization or structures are present; when dredging has altered bank stability ; when dams and bridges are present; when banks and channels have been disturbed by livestock, other agricultural practices; or hydrology; and when other changes have occurred (list).

A. Stream follows a normal and natural meandering pattern. Alteration is absent.

1.	No evidence of disturbance with bends and riffle/runs frequent; bend angles average > 60°	20
2.	No evidence of disturbance with bends combination of riffle/runs and glide/pool habitats frequent; bend angles average between 60°- 40°	18
3.	No evidence of disturbance with bends and glide pools prevalent; bend angles average < 40°	16

B. Some minor alterations, dredging, artificial embankments, or dams present but NO evidence of recent alteration activities; mostly recovered and somewhat stable. .

1.	5% of reach has channel disturbance	15
2.	10% of reach or less has channel disturbance	14
3.	20% of reach has channel disturbance	13
4.	30% of reach has channel disturbance	12
5.	40% of reach has channel disturbance	11

C. Somewhat channelized; 40-80% of the area has been straightened, dredged, or otherwise altered.

1.	40% of reach has channel disturbance	10
2.	50% of reach has channel disturbance	9
3.	60% of reach has channel disturbance	8
4.	70% of reach has channel disturbance	7
5.	80% of reach has channel disturbance	6

D. More than 80% of the stream site has been dredged, or otherwise altered; banks most likely box-cut (including natural U-shaped) or rip-rap or no longer have native vegetation; instream habitat highly altered.

1.	90% of reach has channel disturbance	5
2.	Channel reach 100% disturbed; with no artificial embankments	3
3.	Channel reach 100% disturbed; with artificial embankments	2
4.	Channel reach 100% disturbed; with natural and manmade artificial embankments	1
5.	Channel 100% shored by gabion and/or cement	0

V. Sediment Deposition

Relates to the amount of sediment that has accumulated and the changes that have occurred to the stream bottom as a result of deposition. 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 pools. Depositional material comes from the watershed and bank erosion (Barbour and Stribling, 1995). The growth, or appearance of bars/islands where they did not previously exist is an indication of upstream erosion. Sediment bars/islands tend to grow in depth and length with continued watershed disturbance because increased sedimentation results in increased deposition. High levels of sediment deposition create an unstable and continually changing environment that becomes unsuitable for many organisms (FL DEP, 1996)!.

A. No enlargements of islands/point bars present or less than 20% bottom affected by sand or silt accumulation.

1. No sediment deposition detected; especially in pools 20
2. Less than 20% sediment deposition with accumulation in pools only 18
3. Less than 20% sediment deposition with accumulation in runs and pools 17
4. Less than 20% sediment deposition with few, old, small point bars or islands made up of coarse gravel in stream channel 16

B. 5-50% bottom affected by sand or silt accumulation; slight deposition in pools; some new increase in bar and island formation.

1. 20-30% sediment deposition with gravel and/or sand 15
2. 20-30% sediment deposition with sand and/or silt 14
3. 40-50% sediment deposition with gravel and/or sand 12
4. 40-50% sediment deposition with sand and/or silt 11

C. 50-80% bottom affected with moderate deposition in pools. Number of shallow pools increases. Habitats smothered by sand, silt, and possibly coarse gravel. Deposits of fresh, fine, gravel, sand, and silt observed on old and new point bars, islands, and behind obstructions. Formation of few new bars/islands is evident and old bars are deep and wide; deposition at bends obvious.

1. 50-60% sediment deposition with gravel and/or sand 10
2. 50-60% sediment deposition with sand and/or silt 9
3. 70-80% sediment deposition with gravel and/or sand 7
5. 70-80% sediment deposition with sand and/or silt 6

D. More than 80% bottom affected with heavy deposition from coarse and fine gravel and sand at stream bends, constrictions, and /or pools. Extensive deposits of fine sand and/or silt on old and new bars, islands, and along banks in straight channels. Few pools are present due to siltation. Only larger rocks in riffle areas remain exposed.

1. 80-90% sediment deposition; pools almost absent due to substantial deposition; bottom silt may move with almost any flow above normal 4
2. 90-100% sediment deposition; pools almost absent 2
3. 100% sediment deposition; pools absent due to substantial deposition; bottom silt moves with almost any flow above normal 0

VI. Channel Sinuosity

Measure of meandering or sinuosity. 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.

Divide the stream length (SL) by the valley length (VL) to estimate sinuosity ratio. In general, low sinuosity ratio suggests steeper channel gradient, fairly uniform cross section shapes, limited bank cutting, and limited pools. High sinuosity ratio is associated with lower gradients, asymmetrical cross sections, overhanging banks, and bank pools on the outside curves.

Sinuosity can be emitted in the filed and measured using aerial photography.

A. Occurrence of bends relatively frequent.

1. SL/VL ratio > 1.6	20
2. SL/VL ratio = 1.57	19
3. SL/VL ratio = 1.54	18
4. SL/VL ratio = 1.51	17
5. SL/VL ratio = 1.48	16

B. Occurrence of bends moderately frequent.

1. SL/VL ratio = 1.54	15
2. SL/VL ratio = 1.420	14
3. SL/VL ratio = 1.39	13
4. SL/VL ratio = 1.36	12
5. SL/VL ratio = 1.33	11

C. Infrequent bends; variable bottom contours may provide some habitat.

1. SL/VL ratio = 1.30	10
2. SL/VL ratio = 1.27	9
3. SL/VL ratio = 1.24	8
4. SL/VL ratio = 1.21	7
5. SL/VL ratio = 1.18	6

D. Essentially a straight and uniform depth stream.

1. SL/VL ratio = 1.15	5
2. SL/VL ratio = 1.12	4
3. SL/VL ratio =1.09	3
4. SL/VL ratio = 1.06	2
5. SL/VL ratio = 1.03	1
6. SL/VL ratio = 1.0	0

VII. Channel Flow Status

Is the degree to which the channel is filled with water during normal flow periods. The flow status will change as the channel enlarges or as flow decreases as a result of dams and other obstructions, diversions for irrigation, drought, or aggrading stream bottoms with actively widening channels. This is a seasonal parameter. A decrease in water will wet smaller portions of the streambed, thus decreasing available habitat for aquatic organisms. Use the vegetation line on the lower bank as your reference point to estimate channel flow status.

Stretch a tape very tight across the channel. Level and secure tape at the base of both lower banks. This channel cross-section may help the investigator(s) estimate what percentage of the available channel is full.

A. Water reaches the base of both lower banks and minimal amount of channel substrate is exposed (100% channel full) 20
   1. > 95% channel is full 18
   2. 90-95% channel is full 16

B. Water fills > 75% of the available channel (or <25% of channel substrate is exposed)
   1. 90% of channel is full 15
   2. 85% of channel is full 13
   3. 80% of channel is full 11

C. Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed
   1. 75% of channel is full 10
   2. 60-65% of channel is full 9
   3. 50% of channel is full 8
   4. 35-40% of channel is full 7
   5. 25% of channel is full 6

D. Very little water in the channel and mostly present as standing pools
   1. 20% of channel is full 5
   2. 10% of channel is full 4
   3. < 10% of channel is full 3
   4. Water present as isolated standing pools 1
   5. Channel is dry 0

VIII. Bank Vegetative Protection

Measures the amount of the stream bank that is covered by vegetation. 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 those without vegetation protection and those shored up with concrete or riprap.

Four factors to consider when scoring bank vegetative protection: (1) Is the vegetation native or natural or planted and introduced ?; (2) Is the upper story, under story, and ground cover vegetation well balanced?; (3) What is the standing crop biomass?; and (4) During which season are you conducting this assessment?

Determine left or right bank by facing downstream. Score left and right banks separately.

A. Left Bank or Right Bank

1. More than 90% stream bank surfaces is covered by native/natural vegetation. A variety of vegetation present (e.g., trees, shrubs, understory, or nonwoody macrophytes). Any bare or sparsely vegetated areas are small and evenly dispersed.

a.	100% plant cover on stream bank	10
b.	> 90% plant cover on stream bank	9

2. A variety of vegetation is present and covers 70-90% of stream bank surface, but one class of plants is not well represented. Some open areas with unstable vegetation are present. Disruption evident but not affecting full plant growth potential.

a.	90% plant cover but one class of plants is not well represented	8
b.	80% plant cover with a few barren or thin areas present	7
c.	70% plant cover with a few barren or thin areas present with fewer plant species	6

3. 50-70% of stream bank surface covered by vegetation; typically composed of scattered shrubs, grasses, and forbes. Thin or bare spots visible and/or closely cropped vegetation with less that ½ plant stubble height remaining.

a.	70% vegetation cover; typically of shrubs, grasses, and	5
b.	60% vegetation cover; typically of shrubs, grasses, and forbes	4
c.	50% vegetation cover; typically of shrubs, grasses, and forbes	3

4. Less than 50% stream bank surface covered by vegetation; 2 inches or less in average stubble height remaining. Any shrubs or trees on bank exist as individuals or widely scattered clumps.

a.	40% vegetation cover with many bare spots/rock	2
b.	20% vegetation cover with m. any bare spots/rock	1
c.	No vegetation cover on stream bank	0

IX. Bank Stability

Measures the existence of, or the potential for detachment of soil from the upper and lower stream banks and its movement into the stream. 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. Reinforcement of banks via rocks, artificial or natural, provides stability.

Determine left or right bank by facing downstream. Score left and right banks separately.

A. Left Bank or Right Bank

1. Bank stable; erosion absent or minimal. Side slopes are generally less than 30% and are stable. Bank may be reinforced by rock thus increasing slope >30% while providing stability.

   a. No evidence of erosion or bank failure 10
   b. Less than 5% bank affected by erosion 9

2. Moderately stable bank; small areas of erosion or bank slumping visible. Most areas are stable with only slight potential for erosion at flood stages. Side slopes up to 40% on one bank. Bank may be reinforced by rock thus increasing slope > 40% while providing stability.

   a. 5% bank has erosional areas 8
   b. 15% bank has erosional areas 7
   c. 30% bank has erosional areas 6

3. Moderately unstable bank; frequency and size of raw areas are such that high water events have eroded some areas of the bank. Medium size areas of erosion or bank slumping visible. Side slopes up to 60% on some of the bank. High erosion potential during floods.

   a. 40% - 50% bank has erosional areas 5
   b. 50% - 60% bank has erosional areas 4
   c. 60% - 70% bank has erosional areas 3

4. Unstable bank; mass erosion and bank failure is evident; erosion and pronounced undercutting present at bends and along some straight channel areas. Side slopes > 60% are common. Many raw areas present and 60-100% bank has erosional scars.

   a. 70% - 80% bank has erosional areas. 2
   b. 80% - 90% bank has erosional areas 1
   c. > 90% stream bank has eroded 0

X. Vegetation Buffer Zone Width

Measures the width and conditions of the vegetation or land use from the edge of the upper stream bank out through, and in some cases, beyond the flood plain and riparian zone. The vegetative zone serves as a buffer to pollutants entering a stream from runoff, and minimizes erosion. Far less useful buffer zones occur when roads, parking lots, fields, heavily used paths, lawns, bare soil, rocks, or buildings are near the bank. .

Determine left or right bank by facing downstream. Score left and right banks separately.

When evaluating this parameter, walk around in the buffer area paying close attention to the amount of natural vegetation present and how deep it extends from the bank, and disturbances that may effect the transport of pollutants through the zone. Vegetated buffer zone assessment involves documenting three condition factors: 1) Vegetation Cover Type, 2) Breaks, and 3) Vegetated Zone Width. A break in the buffer zone is an area, which allows sediment or other pollutants to enter directly into the stream. Breaks refer only to the near stream portion of the buffer zone and may or may not extend into the entire buffer zone. Breaks include storm drains, culverts etc. If breaks occur, subtract 1 if moderated and 2 if substantial.

Identify Left and Right Bank Cover Conditions (circle appropriate value)

1 Width of forested vegetated buffer zone >100 feet wide and no man-made activities.

a.	Forest – generally a later successional stage or climax community with a diversity of growth forms including ground cover, vines, and shrubs.	10
b	Man-made activities include paths, utility lines (pipes, power etc) and other minor disturbances parallel to the creek.	9

2 Width of forested vegetated buffer zone –50-100 feet wide. Impacts beyond 100 feet are <50% impervious and predominantly:

a.	Shrub: An earlier successional growth stage on disturbed land, mostly consisting of shrubs & a few trees.	8
b.	Old Field: Any stage of old field succession with herbaceous or shrub species (few if any trees).	7
c.	Planted lawn grass: Includes yards and other landscaped surfaces consisting of mostly lawn grass vegetation such as parks and cemeteries.	6
d.	Pasture/Agricultural: Active pasture consisting of planted grasses and forbes and land for row crops.	5
e.	Forested vegetated buffer zone 50-100 feet & impacts beyond 100 feet are >50% Impervious:	4

3 Width of forested vegetated buffer zone 25-50 feet wide. Impacts beyond 50 feet are < 25% impervious and predominantly:

a.	Shrub: An earlier successional growth stage on disturbed land, mostly consisting of shrubs & a few trees.	7
b.	Old Field: Any stage of old field succession with herbaceous or shrub species (few if any trees).	6
c.	Planted lawn grass: Includes yards and other landscaped surfaces consisting of mostly lawn grass vegetation such as parks and cemeteries.	5
d.	Pasture/Agricultural: Active pasture consisting of planted grasses and forbes and land for row crops.	4
e.	Forested vegetated buffer zone 25-50 feet & impacts beyond 50 feet are >25% Impervious:	3

4 Width of forested vegetated buffer zone 5 – 25 feet wide. Impacts beyond 25 feet are <20% impervious and predominantly:

a.	Shrub: An earlier successional growth stage on disturbed land, mostly consisting of shrubs & a few trees.	5
b.	Old Field: Any stage of old field succession with herbaceous or shrub species (few if any trees).	4
c.	Planted lawn grass: Includes yards and other landscaped surfaces consisting of mostly lawn grass vegetation such as parks and cemeteries.	3
d.	Pasture/Agricultural: Active pasture consisting of planted grasses and forbes and land for row crops.	2
e.	Forested vegetated buffer zone 5-25 feet & impacts beyond 25 feet are >20% Impervious:	1

5 No forested vegetated buffer zone

a.	Shrub: An earlier successional growth stage on disturbed land, mostly consisting of shrubs and a few trees.	4
b.	Old Field: Any stage of old field succession with herbaceous or shrub species (few if any trees).	3
c.	Planted lawn grass: Includes yards and other landscaped surfaces consisting of mostly lawn grass vegetation such as parks and cemeteries.	2
d.	Pasture/Agricultural: Active pasture consisting of planted grasses and forbes and land for row crops.	1
e.	>75% Impervious along creek: Includes parking lots, road, structures etc.	0

Infrastructure Inventory

The infrastructure inventory is identifying and characterizing the following items: pipes, ditches, dump sites, head cuts, utility lines, obstructions, deficient buffer vegetation, erosional areas, and road and other stream crossings.

When an inventory item is identified, note it on the appropriate inventory form, with the requested information, mark it on the map with the Inventory ID (see below), and if appropriate, take a photo, and log the photo on the inventory form and the photo log. All lengths and measurements are visual estimates unless specified otherwise.

Assign impact scores to each inventory item according to the criteria listed on the bottom of each inventory form. The field forms are provided in Attachment A2.

Naming Conventions for Inventory Lists – use same number for GIS Maps

(Stream code)(Reach ##).(inventory initial)(list number)

Example of Stream Codes:	Deep Run	DRC
	Fourmile Creek	FMC
Inventory initial:	Pipe	P
	Ditch	D
	Dump	M
	Head Cut	H
	Utility	U
	Obstruction	T
	Buffer	B
	Erosion	E
	Crossing	C

Example: ACBB02.D04 is Accotink Creek watershed, Bear Branch, Reach #2, 4th ditch
(or the 4th ditch in the second reach of Fourmile Creek)

Pipes and Ditches

Pipes and ditches are recorded on the same form. They are differentiated by the inventory ID (P for pipes or D for ditches). If a pipe discharges into a ditch some distance from the channel, record it as a pipe and record the ditch width and distance from the channel in addition to the pipe characteristics. Record all pipes or ditches, and take photos of those that are causing an impact. Record the following information.

Pipe or Ditch ID	According to naming convention.
Bank	Record bank from which pipe or ditch discharges. If the pipe is at the top of a channel, circle both.
Photo #	
Average Ditch Width	(Ditches Only) in feet
Pipe Diameter	(Pipes Only) in inches.
Distance from Channel	(Pipes Only) Distance from end of pipe to water surface in feet.

Type of Pipe	(Pipes Only) Pipe material Polyvinyl chloride (PVC) (heavy plastic), Reinforced Concrete (RCP), Corrugated metal (CMP), High Density Polyethylene (HDPE) (thin black plastic), Iron, Clay, or Other.
Type of Discharge	If no discharge is present record if the pipe appears to be a stormwater pipe or roof drain. If discharge is present record if it appears to be sewage or some other type of illicit discharge. If the pipe or ditch is an intake pipe, record as Intake.
Discharge Quality	If there is evidence of significant sediments from erosion in the watershed record silty stormwater runoff. Otherwise if discharge is present, record as Clear, Oil Slick, Oil Sheen, or Iron Flocculent.
Source of Discharge	If discharge quality is poor and source is evident, record source.
Erosion	(Ditches Only) None, Minor, Moderate or Major. An indication of erosion within the ditch
Impact Score	0-10. An indication of impacts the pipe or ditch has on the channel. See form for scoring details.

Obstruction

Record all obstructions that are causing erosion problems or are causing flooding of manmade structures. Also record all beaver dams (impact score = 0 unless significant bank damage is evident). Record the following information.

Obstruction ID	According to naming convention.
Photo #	
Type	Material Causing Obstruction.
Impact Score	0-10. An indication of impacts the obstruction has on the channel. See form for scoring details.

Dump Sites

Record all areas where inappropriate materials have been disposed. Record the presence of cows or other domestic animals in the stream as a dump site. Record grass clippings, leaf piles, or other organic debris piles as a dump site only if it is in the stream. Record the following information.

Dump Site ID	According to naming convention.
Bank	Record bank on which materials have been dumped. If the dump site is in the stream or on both banks circle both.
Photo #	
Location	In the stream, on the banks, or in the floodplain
Description of Materials	
Impact Score	0-10. An indication of impacts the dump site has on the channel. See form for scoring details.

Head Cuts

Record only those head cuts that appear to be active. Do not record sites where bed rock or other grade control points have arrested the head cut. Record the following information.

Head Cut ID	According to naming convention.
Photo #	
Height	In feet.
Impact Score	0-10. An indication of impacts the head cut has on the channel. See form for scoring details.

Utility

Record all utility lines that are exposed. Record all manholes within the channel and take photos if they are impacting the channel. Record the following information.

Utility ID	According to naming convention.
Bank	Record bank along which utility line runs. If the utility line crosses the stream circle both.
Photo #	
Size	In inches. Approximate diameter of pipe. MH if manhole.
Type	Identify type of utility if known.
Description	Location of utility line, with respect to the channel.
Impact Score	0-10. An indication of impacts the utility line has on the channel. See form for scoring details.

Deficient Buffer Areas (within 100 feet of Streambank)

Record all buffer areas that are not forested. Record the following information.

Buffer ID	According to naming convention.
Bank	Record bank along which buffer is deficient. If deficient buffer runs along both banks record them separately.
Photo #	
Linear Feet	Length along the stream of deficient buffer, in feet.
Buffer Type	Identify type of land use buffering the stream. Forbes are thick non-woody vegetation.
Impact Score	0-10. An indication of impacts the deficient buffer has on the channel. See form for scoring details.
Buffer Restoration Candidate	Identify buffer restoration potential based on the following criteria: • Apparent property ownership (e.g. public property has good potential) • Relative location of structures • Ease of access

Erosion

Record all active erosion problems rated as moderate (2 to 3 feet high) or worse. Record the following information.

Bank Erosion ID	According to naming convention.
Bank	Record bank which is eroded. If erosion runs along both banks record them separately.
Photo #	
Eroded Bank Height	Height, in feet, of erosional area above water surface.
Linear Feet	Length of erosion along the stream, in feet.

Impact Score	0-10. An indication of impacts the erosion has on the channel. See form for scoring details.
Restoration Potential	Identify the restoration potential associated with the erosional area based on the following criteria: • Ease of access • Benefit of restoration project • Minimizing number of property easements necessary.

Road and Other Crossing

Record all stream crossings, including foot and vehicle bridges and man made fords. Record structural integrity and upstream and downstream conditions. Record the following information.

Crossing ID	According to naming convention.
Photo #	
Crossing Type	Type of culvert or bridge.
Conveyance Material	Material at invert (concrete, natural channel).
Number of Barrels	Number of culvert barrels or number of openings under a bridge.
Width or Diameter of Barrel	In feet. Width or diameter of individual barrel or opening.
Height of Barrel	In feet. Blank if round.
Conveyance Length	In feet.
Upstream and Downstream Conditions	Indication of impacts at the upstream and downstream end of the culvert. Rated None, Low, Medium, High.
Debris	Debris obstructing the openings.
Sediment	Sediment in the culvert or creating islands and bars around the openings.
Bank Erosion	
Bed Erosion	Erosion cutting below the culvert invert. Estimate depth of erosion from the invert where present.
Structure Condition	Indication of cracking, rusting, or otherwise deteriorating structural integrity.
Impact Score	0-10. An indication of impacts the erosion has on the channel. See form for scoring details.

Offline Wetland Potential

Offline wetlands are a potential management practice that can be used to improve stormwater quality. Water would be diverted out of the stream channel into the floodplain where a treatment wetland would be constructed. The opportunity occasionally exists near stream crossings where access is good and flows can more easily be diverted. Record locations near crossings where the buffer area could be converted to a wetland without significant impact and where stream banks are relatively low, allowing flows to be diverted easily. Record the following information if a site is identified:

Crossing ID	Crossing to which the wetland would be connected.
Photo #	
Bank Height	In feet.
Bank Slope	Slope of the stream bank, in ft/ft.

Length	Length of potential wetland area, in feet.
Width	Width of potential wetland area, in feet.

Stream Characteristics

Stream characteristics protocols capture general reach information and visual observations. The field forms are provided in Attachment A3. The form is self explanatory, with the following exceptions.

- **Stream Restoration Candidate**
  - **N/A—**Stream is in good condition OR is still stabilizing and is not currently threatening other land uses/properties.
  - **Major—**Good candidate for stream restoration pilot project.
  - **Minor—**Minor bank stabilization would be appropriate to protect adjacent properties from future problems.
- **Stream Assessment—**Identify if the habitat assessment was conducted. A site may be eliminated from assessment for the following reasons:
  - **Wetland—**The forms are not responsive to wetlands.
  - **No access—**Property owner will not allow access on their property.
  - **Dangerous conditions—**Safety is always first.
  - **Pond/lake—**The forms are not responsive to impounded water.
  - **No flow—**Flow must be present for the habitat assessment.
  - **Too deep—**The majority of the steam must be wadable.
- **Infrastructure Assessment—**Identify if the infrastructure inventory was conducted. A site may be eliminated from assessment for the following reasons:
  - **Wetland—**Only if foot travel is significantly hindered.
  - **No Access—**Property owner would not allow access on their property.
  - **Dangerous conditions—**Safety is always first.
  - **Pond/Lake—**Only if foot travel is significantly hindered.
  - **Too Deep—**Only if foot travel along the banks is hindered.
- **Water Appearance**—Can be a physical indicator of water pollution. Be sure you are checking the water color and not picking up an apparent water color due to the underlying sediments.
- **Water Odor**—Can be a physical indicator of water pollution.
  - **Sewage—**May indicate the release of human waste material.
  - **Chlorine—**May indicate over chlorinated sewage treatment/water treatment plant or swimming pool discharges.
  - **Fishy—**May indicate the presence of excessive algal growth or dead fish.
  - **Rotten eggs—**May indicate sewage pollution (or the presence of a natural gas).

- **Sediment Odors**—Same categories as water.
- **Fish—**Are fish present in the stream? Fish can indicate that the stream is of sufficient quality for other organisms. Macroinvertebrates will also generally be found somewhere in a stream with fish.
- **Aquatic Plants—**Aquatic plants vary greatly. They may be floating, submerged, emergent, or rooted and have true leaves, stems, and roots. Aquatic plants can help to stabilize the bottom sediments of a stream and provide food and habitat for aquatic organisms.
- **Algae—**Algae are simple plants that do not grow true roots, stems, or leaves and that mainly live in water, providing food for the food chain. Algae may also be seen growing on the surface of substrate material. Algae naturally occurs in green and brown colors. Excessive algal growth may indicate excessive nutrients (organic matter or a pollutant such as lawn fertilizer).

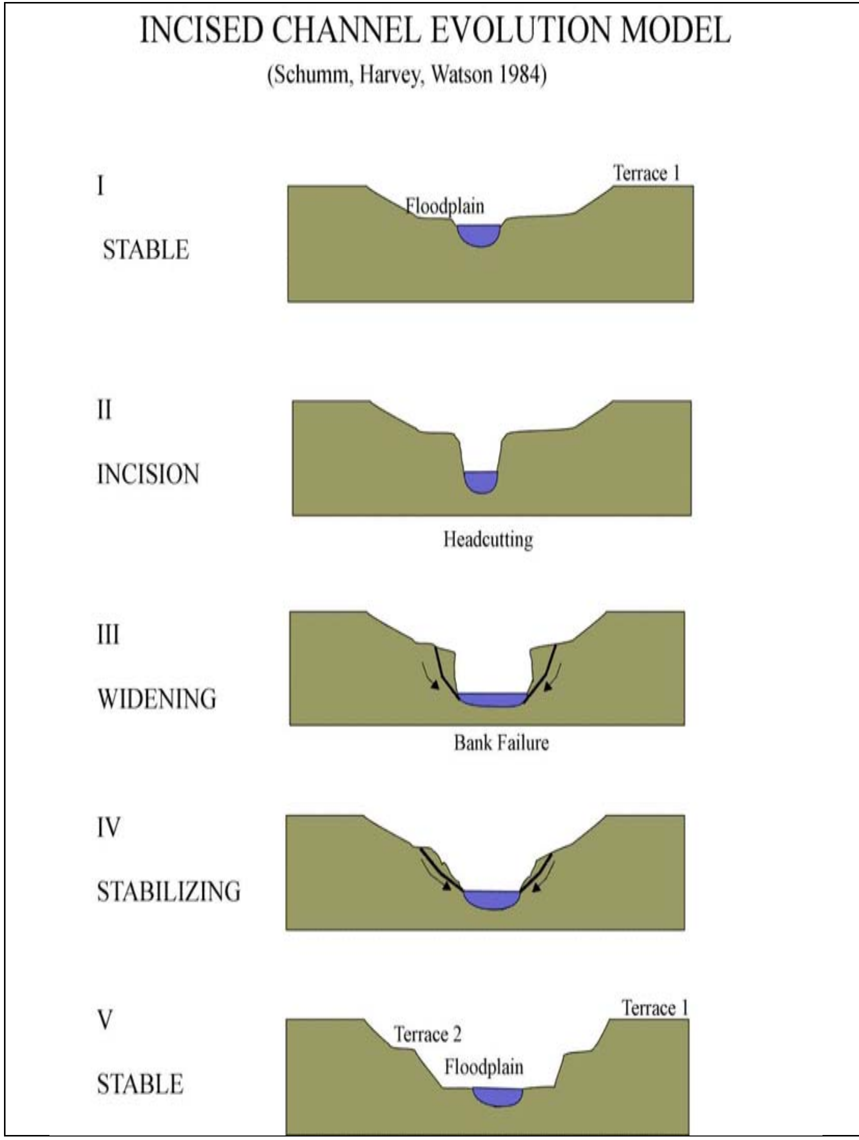
Channel Evolution Model Assessment

The CEM-based geomorphic assessment will entail assigning one or more CEM channel type or stage to each assessment reach and the % of the assessment reach represented by each assignment, based primarily on visual observations of the channel cross-section and as well as other morphological observations within the assessment reach. The various visual indicators utilized are summarized in Figure 4.

In addition to assigning CEM channel type(s), cross-sectional measurements will be taken at one or more representative points (depending on the number of CEM types assigned) over the assessment reach. The major factors to consider when establishing locations to take cross-sectional measurements are: (i) locations should preferably be in relatively straight, thalweg cross-over points located between two meander bends, and (ii) the channel section at the selected point should be representative of the entire CEM channel type. The measurements will focus on characterizing the cross-section as accurately as possible by taking sufficient vertical measurements to capture major breakpoints and features in the cross-section profile.

Self-explanatory field forms for performing the CEM-based assessment are provided in Attachment A4.

FIGURE 4 Indicators for Assigning Channel Type in the Incised Channel Evolution Model



Type I: Well developed base flow and bankfull channel; consistent floodplain features easily identified; one terrace apparent above active floodplain; predictable channel morphology; floodplain covered by diverse vegetation; stream banks ≤ 45°.

Type II: Head cuts; exposed cultural features (along channel bottom); sediment deposits absent or sparse; exposed bedrock (parts of reach); streambank slopes > 45°.

Type III: Stream bank sloughing, sloughed material eroding; streambank slopes > 60° or vertical/undercut; erosion on inside of bends; accelerated bend migration; exposed cultural features (along channel banks); exposed bedrock (majority of reach)

Type IV: Streambank aggrading; sloughed material not eroded; sloughed material colonized by vegetation; base flow, bankfull and floodplain channel developing; predictable channel morphology developing; streambank slopes ≤ 45 °.

Type V: Well developed base flow and bankfull channel; consistent floodplain features easily identified; two terraces apparent above active floodplain; predictable channel morphology; streambanks ≤ 45°.

Data Collection

Identifying a Reach

A habitat assessment form and a stream characteristic form are filled out for each stream reach. Inventory items are also assigned to a specific reach through use of the inventory naming convention.

To identify and assess a reach boundary, start at downstream end. As you walk upstream, do the following:

1. Identify reach number
2. Fill out inventory forms
3. Mark-up maps with inventory IDs
4. Identify a representative cross section and take measurements
5. Take photos as required and log them on the photo log
6. Take notes on habitat information, as needed
7. Walk upstream until one of the following occurs. Note, the following suggestions would apply for both riffle/run (Piedmont and Triassic) and glide/pool (Coastal Plain):[2]
   - Stream characteristics change significantly (e.g., downcut channel vs. naturally shaped channel)
   - Change in geomorphic stream type (e.g., narrow G channel to a widened F channel)
   - Encounter a confluences with a major tributary
   - Stream bank stability changes substantially (e.g., from vegetation cover, natural hard substrate i.e. rock, or improved hard substrate i.e. rip-rap) over a length of greater than 200 feet. Note: Rip-rap and cement channels would be treated as an anomaly and would not be evaluated using the habitat assessment.
   - Stream bank vegetation cover changes substantially (e.g., from >50% to <%50 percent) over a length of greater than 200 feet.
   - Buffer land use changes dramatically (e.g., forested to mostly residential or residential to commercial etc.). This change would have to be greater than 200 feet. This may be identified on aerial maps prior to field survey.
   - A change in channel flow status from greater than 75% to less than 75% over a length of greater than 200 feet.
   - Frequency of Riffles changes dramatically (e.g., a change from frequent or infrequent to occasional or flat) over a length of greater than 200 feet.

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[2] It should be noted that the County has adopted the convention that only one set of protocols should be applied in each major physiographic region, i.e. the glide-pool (low-energy system) habitat assessment metrics should consistently be used in the Coastal Plain region and the riffle-run (high-energy system) metrics should consistently be used for the Piedmont region (including the Triassic basin). Therefore, changes from glide-pool to riffle run systems will not be used to distinguish reaches within a physiographic region, as is sometimes done in assessments elsewhere.

- A change in sediment deposition from greater than 50% to less than 50% over a length of greater than 200 feet.
- Change from a relatively natural sinuous unaltered stream channel stream to channelized system over a length of greater than 200 feet. This can be identified on maps prior to field work.
- Change in habitat coverage from >50% to <50% over a length of greater than 200 feet.
- Change in slope from less than 2% to greater than 2% over a length of greater than 1000 feet.

8. At that point, stop, mark the end of the reach and fill out stream characteristics and habitat forms for the reach.

While reach lengths are expected to vary substantially based on the parameters above, in general field teams are encouraged to not have reaches greater than one mile in length. If an arbitrary reach break is created, field teams are encouraged to locate the breaks at distinct locations, such as road crossings or other inventory points, and to take photos and habitat forms for each reach.

Marking the Reach

Locate the reaches being evaluated as accurately as possible on the GIS base maps. Use the planimetric information on the GIS maps to help identify the location.

Forms to be Filled out for Each Reach

The following forms need to be filled out for each reach. Each form is discussed further in later sections.

- Inventory Forms as needed—Pipe/Drainage Ditch; Obstructions; Dump Sites/Head Cuts; Utility Lines; Deficient Buffers; Erosion Problems, Road Crossings
- Channel Cross Section Form
- Stream Characteristics Form
- Habitat Form (Glide-Pool or Riffle-Run)
- Channel Evolution Model Form
- Photo log
- Markup of GIS Maps

Photo Log

All photos should be logged on this form. Photos should be taken of the following:

- Downstream end of reach looking upstream
- Upstream end of reach looking downstream

Each **problem** area that is entered on the inventory sheets, **not** all inventory items – the inventory sheets identify which ones to photograph.

Mark-up of GIS Maps

Each team will have a set of GIS maps. Note ends of reaches and all inventory items on this map. Points will be digitized off this map, so mark the points and the ID numbers as clearly as possible.

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Attachment A1
Habitat Assessment Field Forms

Attachment A2

Infrastructure Inventory Field Forms

Attachment A3
Stream Characteristics Field Forms

Attachment A4

Geomorphic Classification Field Forms

Attachment A1

Habitat Assessment Field Forms

Fairfax County Habitat Assessment Worksheet

Riffle/Run Prevalent Stream [High Gradient]

Stream______________________________ Date__________________

Reach ID____

Watershed____

Assessor:______________ Assessor:______________ Assessor:______________

Habitat Parameter	Score	Habitat Parameter	Score	Habitat Parameter	Score	AVG.
1. Instream Cover (fish)		1. Instream Cover (fish)		1. Instream Cover (fish)		
2. Epifaunal Substrate (benthic)		2. Epifaunal Substrate (benthic)		2. Epifaunal Substrate (benthic)		
3. Embeddedness		3. Embeddedness		3. Embeddedness		
4. Channel Alteration		4. Channel Alteration		4. Channel Alteration		
5. Sediment Deposition		5. Sediment Deposition		5. Sediment Deposition		
6. Frequency of Riffles		6. Frequency of Riffles		6. Frequency of Riffles		
~~7a. Channel Flow Status drought~~	X	~~7a. Channel Flow Status drought~~	X	~~7a. Channel Flow Status drought~~	X	X
7b. Channel Flow Status normal flow		7b. Channel Flow Status normal flow		7b. Channel Flow Status normal flow		
8. Bank Vegetative Protection LB		8. Bank Vegetative Protection LB		8. Bank Vegetative Protection LB		
RB		RB		RB		
9. Bank Stability LB		9. Bank Stability LB		9. Bank Stability LB		
RB		RB		RB		
10. Vegetated Buffer Zone Width LB		10. Vegetated Buffer Zone Width LB		10. Vegetated Buffer Zone With LB		
RB		RB		RB		
Total Score:		Total Score:		Total Score:		

Fairfax County Habitat Assessment Worksheet

Glide/Pool Prevalent Stream [Low Gradient]

Stream________________________ Date________________

Reach ID____

Watershed_______________________________________

Assessor:____________ Assessor:______________ Assessor:___________

Habitat Parameter	Score	Habitat Parameter	Score	Habitat Parameter	Score	AVG.
1. Bottom Substrate/Available Cover		1. Bottom Substrate/Available Cover		1. Bottom Substrate/Available Cover		
2. Pool Substrate Characterization		2. Pool Substrate Characterization		2. Pool Substrate Characterization		
3. Pool Variability		3. Pool Variability		3. Pool Variability		
4. Channel Alteration		4. Channel Alteration		4. Channel Alteration		
5. Sediment Deposition		5. Sediment Deposition		5. Sediment Deposition		
6. Channel Sinuosity		6. Channel Sinuosity		6. Channel Sinuosity		
~~7a. Channel Flow Status drought~~	~~X~~	~~7a. Channel Flow Status drought~~	~~X~~	~~7a. Channel Flow Status drought~~	~~X~~	~~X~~
7b. Channel Flow Status normal flow		7b. Channel Flow Status normal flow		7b. Channel Flow Status normal flow		
8. Bank Vegetative Protection LB		8. Bank Vegetative Protection LB		8. Bank Vegetative Protection LB		
RB		RB		RB		
9. Bank Stability LB		9. Bank Stability LB		9. Bank Stability LB		
RB		RB		RB		
10. Vegetated Buffer Zone Width LB		10. Vegetated Buffer Zone Width LB		10 Vegetated Buffer Zone Width LB		
RB		RB		RB		
Total Score:		Total Score:		Total Score:		

Attachment A2

Infrastructure Inventory Field Forms

PHOTO LOG

Watershed: ________________________ Date: ________________

Stream(s): ________________________ Investigators: ________________

Camera ID: ________________________ (If using non-digital camera, note each new roll of film on this form)

Digital Photo #	Disposable Photo #	Inventory ID	Direction (u/s,d/s,RB,LB)	Notes (Required)
X 0 0 1		ABCD001.BOT	u/s	John on LB.
X 0 0 2	X 0 0 1	ABCD001.E001	LB	John in foreground of 10 ft bank erosion. (Score > 5)
X 0 0 3		ABCD001.TOP	d/s	House in background.

u/s = upstream; d/s = downstream; RB, LB = right bank and left bank (when looking d/s)

Use Disposbale Cameras for Inventory Points with a Score >= 5.

Don't Use Disposable Camera for Top or Bottom of Reach.

Use Digital Camera for Top and Bottom of Reach and all Inventory Points that Require a Photo.

 Photolog

DEFICIENT BUFFER AREAS (within 100 feet of Streambank)

Reach ID: _______________________________ Date: _______________

Watershed: _______________________________ Investigators: _______________

Stream(s): _______________________________

Buffer ID		Bank looking d/s (circle one)	Photo #	Linear Feet with Forest Buffer Less than 100' width	Buffer Type of Non-Forest Area	Impact Score (See Below)	Buffer Restoration Candidate (Circle one)
Ex. ABCD001.	B###				1. Forbs 5. Cultivated Crop 2. Lawn 6. Meadow 3. Pavement 99. Other (specify) 4. Pasture		
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No
		Left / Right					High / Mod / Low / No

Impact Scoring:

Extreme – impervious/commercial area in close proximity to stream; banks may be modified or engineered. Stream character (bank/bed stability; sediment deposition, and/or light penetration) is obviously degraded by adjacent use. 10

Severe -- some impervious and/or just turf up to bank and water; very little vegetation aside from turf within 25’ zone; may be home site very close to stream; stream character probably degraded by adjacent use. 7

Moderate -- encroachment mostly from residential uses and yard; some vegetation within 25’ zone, but very little aside from turf within remainder of 100’ zone; stream character may be changed slightly by adjacent use. 5

Minor - Vegetated buffer primarily consists of native meadow. (Not Grazed) 2

None – Vegetated buffer primarily intact within 100’ [**DO NOT RECORD NOR TAKE PICTURES**] 0

Notes:

1. Record only scores of 2 or greater.

2. Photograph all recorded buffer areas.

Restoration Potential

High -- Potential project is of good size (more than one or a couple of residential yards), would not involve easements in residential yards, involves one or a few properties, appears to have good access, and would provide good benefit to stream.

Moderate -- Potential project is of good or fair size, involves just a few properties, may include but is not confined to small residential yards, appears to have access, and would benefit stream.

Low -- Potential project is small OR is confined to small residential yards, appears to have access issues OR is not critical for character of stream.

EROSION PROBLEMS

Reach ID: ______________________ Date: _______________

Watershed: _______________________ Investigators: _______________

Stream(s): _______________________

Bank Erosion ID Ex. ABCD001.	E###	Bank looking d/s (circle one)	Photo #	Eroded Bank Height (decimal feet)	Linear Feet	Impact Score (See Below)	Restoration Potential (Circle one)
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No
		Left / Right / Outer Bends					High / Mod / Low / No

Impact Scoring:

Extreme – impending threat to structures or infrastructure	10
Severe – large area of erosion that is damaging property and causing obvious instream degradation. Eroding bank is generally 5' or greater in height.	7
Moderate -- moderate area of erosion that may be damaging property and causing some instream degradation. Eroding bank is generally 2-3' or greater in height.	5
Minor – minor area of erosion, low threat to property, no noticable instream degradation. **[DO NOT RECORD NOR TAKE PICTURES]**	0

Notes:

1. Record only moderate, severe, and extreme erosion problems.

2. Photograph all recorded erosion problems with a score of 5 or greater.

Restoration Potential

High -- Potential project is of good size (more than one or a couple of residential yards), would not involve easements in residential yards, involves one or a few properties, appears to have good access, and would provide good benefit to stream.

Moderate -- Potential project is of good or fair size, involves just a few properties, may include but is not confined to small residential yards, appears to have access, and would benefit stream.

Low -- Potential project is small OR is confined to small residential yards, appears to have access issues OR is not critical for character of stream.

OBSTRUCTIONS

Reach ID(s): ______________________ Date: ______________

Watershed: ______________________ Investigators: ______________

Stream(s): ______________________

Obstruction ID		Photo #	Type	Fish Passage Restriction	Impact Score
Ex. ABCD001.	T###		1. Trees 5. Riprap 2. Debris 6. Beaver Dam 3. Sediment 7. Utility Line 4. Concrete 99. Other (Specify)		(See Below)
				Yes / No	
				Yes / No	
				Yes / No	
				Yes / No	
				Yes / No	
				Yes / No	
				Yes / No	
				Yes / No	
				Yes / No	
				Yes / No	
				Yes / No	
				Yes / No	

Scoring:

Severe:	Blockage causing significant erosion problem and/or potential for flooding that can cause damage to infrastructure. Stream usually almost totally blocked (>75%).	10
Moderate:	Blockage is causing moderate erosion and could cause flooding. Stream partially blocked, but obstruction should probably be removed, because problem could worsen.	5
Minor:	Blockage is causing some erosion problems but does have potential to worsen and probably should be looked at/or monitored.	3
None	Beaver dam exists, but is not causing any erosion.	0

Notes:

1. **Obstructions that partially block stream but are not causing erosion problems or that may even be beneficial to instream habitat should not be identified with the exception of beaver dams. All beaver dams should be recorded.**
2. **Photograph all recorded obstructions.**

DUMP SITES / HEAD CUTS

Reach ID(s): ______________________ Date: ______________________

Watershed: ______________________ Investigators: ______________________

Stream(s): ______________________

Dump Site ID		Bank looking d/s	Photo #	Location	Description of Materials		Impact Score
Ex. ABCD001.	M###	(circle one or both)		1. Instream 2. Bank 3. Floodplain 99. Other (Specify)	1. Appliances 2. Trash 3. Petroleum 4. Tires 5. 55-gal Drums (Closed)	6. 55-gal Drums (Leaking) 7. 55-gal Drums (Empty) 8. Domestic Animals in Stream 9. Lawn waste (leaves, grass) 99. Other (Specify)	(See Below)
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					

Scoring:

Active and/or Threatening: Material may be considered toxic or threatening to environment (concrete, petroleum, empty 55 gal. Drums etc.) or site is large (>2,500 s.f. (50'x50')) and appears active.	10
Dumpsite (<2,500 s.f. (50'x50')) non-toxic material, does not appear to be used often, however clean-up would definitely be a benefit.	5
Dumpsite appears small (<1,000 s.f.) and material stable (will not likely be transported downstream by high water). Not high priority.	1

Note:
Photograph all recorded dump sites.

Head Cut ID		Photo #	Height	Impact Score
Ex. ABCD001	H###		Decimal Feet	(See Below)

Scoring:

Height < 0.5' or Inactive (Do not Record)	1
Height = 1'	3
Height = 2'	5
Height >2'	10

Note : Photograph all recorded head cuts.

PIPES/DRAINAGE DITCHES

Reach ID(s): ____________________ Date: ____________________

Watershed: ____________________ Investigators: ____________________

Stream(s): ____________________

Pipe/Ditch ID		Bank looking d/s	Photo #	Present in County GIS	County GIS Size Incorrect	Avg Ditch Width	Pipe Diameter	Distance from Channel	Type of Pipe	Type of Discharge	Discharge Quality (if any)	Discharge Source	Erosion	Impact Score
Ex. ABCD001. OR Ex. ABCD001.	D### P###	(circle one or both)		(circle one)	(circle one)	feet	inches	ft (Pipes Only)	1. PVC 2. RCP 3. CMP 4. HDPE 5. Iron 6. Clay 99. Other (Specify)	1. None 2. Stormwater 3. Roof drain (dry) 4. Sewage 5. Other Non-stormwater or possible illicit discharge 6. Intake/diversion 99. Other (Specify)	1. Clear 2. Oil Slick 3. Oil Sheen 4. Iron Flocculent 5. Significant Algae 6. Silty stormwater runoff 99. Other (Specify)	1. Unknown 2. Construction Site 3. Overburdened Outlet 4. Agriculture 5. Washing Machine 6. Parking Lot/Driveway 7. Stormwater Pond 99. Other (Specify)	1. None 2. Minor 3. Moderate 4. Major	(See Below)
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									
		Left / Right		Yes / No	Yes / No									

Scoring:

Ditch or Pipe is causing a significant erosion problem to stream bank or stream and/or discharge is coming from pipe that may not be stormwater.	10
Ditch or Pipe is causing moderate erosion problem and should be fixed, it may get worse if left unattended. OR Discharge may be coming from pipe, probably stormwater - unsure without further investigation.	5
Ditch or Pipe is not causing erosion problem and no discharge is occurring. **[no picture needed]**	0

Notes:

1. Please document all pipes and drainage ditches, with scores greater than 2

2. Photographs scores greater than 2.

PUBLIC UTILITY LINES

Reach ID(s): ______________________ Date: ______________________

Watershed: ______________________ Investigators: ______________________

Stream(s): ______________________

Utility ID		Bank looking d/s	Photo #	Size	Type	Description	Impact Score
Ex. ABCD001.	U###	(circle one or both)		(Inches) MH for Manhole	1. Sanitary 2. Water 3. Gas 4. Cable 99. Other (Specify)	1. Within Stream banks 2. Within Buffer 3. Crossing Stream partially buried 4. Crossing Stream above base flow 5. Crossing Stream above high water 99. Other (Specify)	(See Below)
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					
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		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					
		Left / Right					

Scoring:

Line is leaking. 20

Exposed line causing a significant erosion problem &/or obstruction (blockage) OR sanitary line potential to burst/leak appears high. 10

Half exposed line causing moderate erosion problem. 7

Line is partially visible however mostly buried in stream bed little if any erosion. 5

Line is exposed but stabilized with concrete lining and stable anchoring into the bank 3

Note:
Photograph scores greater than 2.
Log manholes only if they are surcharging or impacting the stream.

Utility

ROAD AND OTHER CROSSINGS

Reach ID(s): ______________________

Watershed: ______________________

Stream(s): ______________________

Date: _______________

Investigators: _______________

Note: Also record on head cut sheet if crossing is part of head cut.

Crossing ID Ex. ABCD001.	C###	Photo #	Crossing Type	Conveyance Material	Number of Barrels	Comments (If multi pipe sizes)	Width or Diameter of Barrel (ft)	Height of Barrel (ft)	Conveyance Length (ft)	Downstream Conditions Debris	Sediment	Bank Erosion	Bed Erosion (Specify Height, ft)	Structural Damage *	Upstream Conditions Debris	Sediment	Bank Erosion	Bed Erosion (Specify Height, ft)	Structural Damage *	Impact Score
			Box Elliptical Circular Bridge Ft. Bridge Ford Dam	Concrete CMP Plastic Wood Natural Other ____	(If Multiple) Equal Sizes? Yes / No					none low medium high	none low medium high	none low medium high	none low medium high Height _____	none low medium high	none low medium high	none low medium high	none low medium high	none low medium high Height _____	none low medium high	
			Box Elliptical Circular Bridge Ft. Bridge Ford Dam	Concrete CMP Plastic Wood Natural Other ____	(If Multiple) Equal Sizes? Yes / No					none low medium high	none low medium high	none low medium high	none low medium high Height _____	none low medium high	none low medium high	none low medium high	none low medium high	none low medium high Height _____	none low medium high	
			Box Elliptical Circular Bridge Ft. Bridge Ford Dam	Concrete CMP Plastic Wood Natural Other ____	(If Multiple) Equal Sizes? Yes / No					none low medium high	none low medium high	none low medium high	none low medium high Height _____	none low medium high	none low medium high	none low medium high	none low medium high	none low medium high Height _____	none low medium high	
			Box Elliptical Circular Bridge Ft. Bridge Ford Dam	Concrete CMP Plastic Wood Natural Other ____	(If Multiple) Equal Sizes? Yes / No					none low medium high	none low medium high	none low medium high	none low medium high Height _____	none low medium high	none low medium high	none low medium high	none low medium high	none low medium high Height _____	none low medium high	
			Box Elliptical Circular Bridge Ft. Bridge Ford Dam	Concrete CMP Plastic Wood Natural Other ____	(If Multiple) Equal Sizes? Yes / No					none low medium high	none low medium high	none low medium high	none low medium high Height _____	none low medium high	none low medium high	none low medium high	none low medium high	none low medium high Height _____	none low medium high	

Offline Wetland Potential

Crossing ID (use for GIS/map ID)		Photo #	Bank Height, ft	Bank Slope, ft/ft	Length, ft	Width, ft

Impact Score

Extreme – Condition of debris, sediment, or erosion poses immediate threat to structural stability of road or other structure. Major repair will be needed if problem is not addressed.	10
Severe – Condition probably poses threat to road or other structure. Problem should be addressed to avoid bigger problem in the future.	7
Moderate – Condition does not appear to pose threat to road or other structure, but should be addressed to enhance stream integrity and future stability of structure.	5
Minor – Condition is noticeable, but may not warrant repair.	2

*Does not affect score.

Note:
1. Photograph all recorded crossings.

End of Flow

Reach ID(s): ______________________ Date: ________________

Watershed: _______________________ Investigators: ________________

Stream(s): _______________________

End of Flow ID		
Ex. ABCD001.	F###	Photo # (not required)

Attachment A3

Stream Characteristics Field Forms

CF:_______
IFR:_______ IFQ:_______

STREAM CHARACTERISTICS FORM

Reach ID:

Map Grid Number:

Stream:

Watershed

Estimated Length of Reach:

Investigators:

Date:

Time:

Weather in past 24 hours
- ☐ 1. Storm (heavy rain)
- ☐ 2. Rain (steady rain)
- ☐ 3. Showers (intermittent rain)
- ☐ 4. Overcast
- ☐ 5. Clear/Sunny

Weather now:
- ☐ 1. Storm (heavy rain)
- ☐ 2. Rain (steady rain)
- ☐ 3. Showers (intermittent rain)
- ☐ 4. Overcast
- ☐ 5. Clear/Sunny

Flow present ☐ Yes ☐ No

Sketch the following on GIS map

outfalls (ditches, pipes); obstructions (dams, debris), wetlands, unmapped tributaries, dumping, stream crossings (unmapped road crossings), utility crossings.

erosion problems

Comments on Reach:

Hydro Layer Error Comment:
- ☐ Tributary is gray line
- ☐ Gap in blue line
- ☐ Blue line needs to be extended
- ☐ Whole reach is grey line
- ☐ Other ____________________________

Stream Restoration Candidate: N/A Major Minor

	circle one	If No Provide Reason
Stream Assessment	Yes / No	Reason:__________
Stream Walked	Yes / No	
Infrastructure Inventory	Yes / No	Reason:

Reasons for not performing assessments/inventory:

1. Wetland
2. No Access
3. Dangerous Conditions
4. Pond/Lake
5. Stormwater pond
6. Other ________________

Reach ID __________

Other Influences	
In-stream Characteristics A **Water appearance:** ☐ 1. clear ☐ 5. light brown ☐ 7. oily sheen ☐ 2. milky (other than tannin) ☐ 8. reddish ☐ 3. foamy ☐ 6. dark brown ☐ 9. greenish ☐ 4. turbid (other than tannin) ☐ 99. other _______ B **Water odor:** ☐ 1. sewage ☐ 3. fishy ☐ 5. none ☐ 2. chlorine ☐ 4. rotten eggs ☐ 6. other _______ C **Sediment odor:** ☐ 1. sewage ☐ 3. petroleum ☐ 5. none ☐ 2. chlorine ☐ 4. rotten eggs ☐ 6. other ________ D **Fish:** ☐ 1. none ☐ 3. medium (3-6 in.) ☐ 2. small (1-2 in.) ☐ 4. large (7 in. & above) E **Aquatic Plants:** Percent area: ☐ 1. (0%) ☐ 3. (10-30%) ☐ 5. (>50%) ☐ 2. (1-10%) ☐ 4. (30-50%) If present, are they: ☐ attached ☐ free-floating Where are they located? ☐ stream margin ☐ pools ☐ near riffles	F **Algae:** **Algae "slime" coating:** (on submerged stones, twigs or other material in the stream) ☐ 1. none ☐ 3. heavy ☐ 2. light **Algae color:** ☐ 1. brown ☐ 2. green ☐ 99. other _____________ **Filamentous (stringlike) algae:** ☐ 1. none ☐ 3. green ☐ 99. other _____________ ☐ 2. brown ☐ 4. orange **Floating Algae:** (detached "clumps" or "mats" on the water's surface) ☐ 1. none ☐ 3. green ☐ 2. brown ☐ 99. other _____________ Comments: add additional observations that may affect water quality or watershed integrity including effects from livestock and other agricultural practices and new development near streambanks:

Attachment A4

Geomorphic Classification Field Forms

Channel Evolution Model Data Sheet

Reach ID:________________	Investigators:________________
Date:________________	Watershed:_______________Stream(s):______________

TYPE 1

- [ ] well developed baseflow and bankfull channel
- [ ] consistent floodplain features easily identified
- [ ] one terrace apparent above active floodplain
- [ ] predictable channel morphology
- [ ] floodplain covered by diverse vegetation
- [ ] streambanks $\leq 45^o$

TYPE 2

- [ ] headcuts
- [ ] exposed cultural features (channel bottom)
- [ ] sediment deposits absent or sparse
- [ ] exposed bedrock (part of reach)
- [ ] streambank slopes > 45^o

TYPE 3

- [ ] streambank sloughing
- [ ] sloughed material eroding
- [ ] streambank slopes > 60^o or vertical/undercut
- [ ] erosion on inside of bends
- [ ] accelerated bend migration
- [ ] exposed cultural features (channel banks)
- [ ] exposed bedrock (majority of reach)

TYPE 4

- [ ] streambank aggrading
- [ ] sloughed material not eroded
- [ ] sloughed material colonized by vegetation
- [ ] baseflow, bankfull and floodplain channel developing
- [ ] predictable channel morphology developing
- [ ] streambank slopes $\leq 45^o$

TYPE 5

- [ ] well developed baseflow and bankfull channel
- [ ] consistent floodplain features easily identified
- [ ] two terraces apparent above active floodplain
- [ ] predictable channel morphology
- [ ] streambanks $\leq 45^o$

Assigned CEM Type [ ]

Representative of _____% of total reach length

Dominant substrate ________

1. Clay 2. Silt 3. Sand 4. Gravel 5. Cobble 6. Boulder 7. Bedrock

8. Other (specify)

Comments

Cross Section Data

Reach ID:________________ Investigators:________________
Date:________________ Watershed:________________Stream(s):_____________

X-section ID	Distance from Left Bank (decimal feet)	Depth (decimal feet)	Feature abbreviation

Notes:

Distances are measured from left bank looking downstream.

Use feature abbreviations from the following list, as shown in figure (WS refers to baseflow water surface):

TOLB - Top of left bank

BKP - Breakpoint

LCB - Left channel Bottom

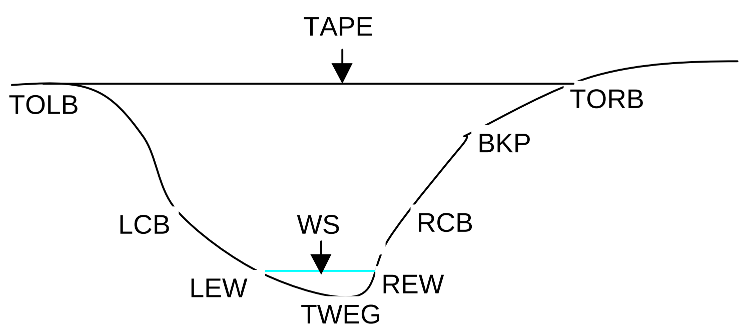
LEW - Left edge of water

TWEG - Thalweg

REW - Right edge of water

RCB - Right channel bottom

TORB - Top of right bank



Watershed and Reach Naming Convention

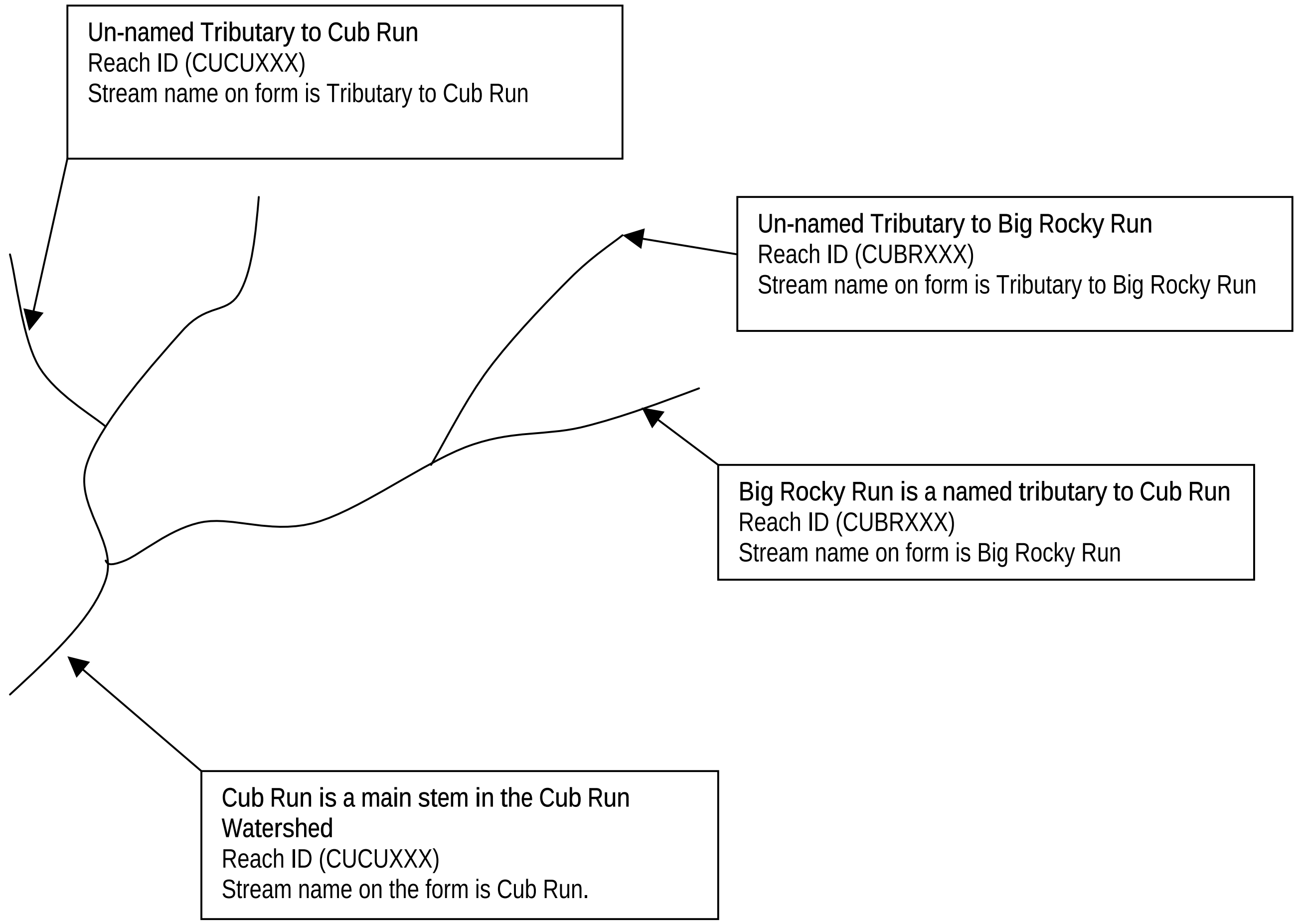
The attached site code list and sketch explain the tributary naming conventions. The list is a comprehensive list of site codes. However, unnamed tributaries to any named stream will use the same stream code, as shown in the sketch and explained below.

The code list was developed directly from Fairfax County's naming convention with a few additions such as the Potomac River. Any additions or modifications to the original list are noted in the comments field of the attached list. As was discussed during the training session for field staff and County personnel, there is no distinction between different unnamed tributaries except that all reaches are unique based on reach IDs. For example, the unnamed tributaries to Cub Run will all have a stream name of Tributary to Cub Run, and the IDs will be CUCU004, CUCU005, CUCU006 ...). To summarize the information for a specific tributary, the reach IDs should be determined by looking at the GIS data and then the database can be used to retrieve the corresponding data.

Please note that the names within the County's GIS coverage of stream names were not modified to be consistent with the stream assessment database naming convention.

Note: Multiple watersheds contain small unnamed tributaries to Bull Run, Potomac River and Occoquan River. These segments would have the watershed code for the watershed and the stream code of the river. For instance an unnamed tributary that drains directly to Bull Run that falls within Cub Run Watershed boundaries would have the Reach ID: CUBUXXX and Stream Name: Tributary to Bull Run

NAMING CONVENTION EXAMPLE FOR CUB RUN WATERSHED



Site Codes by Watershed by Tributary

05/14/2003

ACCOTINK CREEK (AC)

Tributary:	Site Code:	Comment:
ACCOTINK CREEK (AC)	ACAC	
BEAR BRANCH (BB)	ACBB	
CALAMO RUN (CA)	ACCA	added 11/5
COON BRANCH (CO)	ACCO	
CROOK BRANCH (CR) DANIELS	ACCR	
RUN (DR) FIELDLARK BRANCH	ACDR	
(FL) FLAG RUN (FR)	ACFL	
HUNTERS BRANCH (HB)	ACFR	
KERNAN RUN (KR)	ACHB	
LONG BRANCH (CENTRAL) (LB)	ACKR	added 11/5
LONG BRANCH (NORTH) (LC)	ACLB	Drains to Lake Accotink
LONG BRANCH (SOUTH) (LA)	ACLC	East of Bear Branch
MASON RUN (MR)	ACLA	Parallel to and east of I-95
POTOMAC RIVER (PO) TURKEY	ACMR	
RUN (TR)	ACPO	
	ACTR	added 11/5

BELLE HAVEN (BE)

Tributary:	Site Code:	Comment:
CAMERON RUN (CR)	BECR	
HUNTING CREEK (BE)	BEBE	Even though the main stem is called Hunting Creek, the code needs to be BEBE.
POTOMAC RIVER (PO)	BEPO	

BULL RUN (BL)

Tributary:	Site Code:	Comment:
BULL RUN (BU)	BLBU	For Bull Run watershed the code is BL, for the Bull Run river the code is BU.

BULL NECK RUN (BN)

Tributary:	Site Code:	Comment:
BULL NECK RUN (BN)	BNBN	
POTOMAC RIVER (PO)	BNPO	

CAMERON RUN (CA)

Tributary:	Site Code:	Comment:
BACKLICK RUN (BA)	CABA	
CAMERON RUN (CA)	CACA	
COW BRANCH (CW)	CACW	added 11/5
HOLMES RUN (HR)	CAHR	
HOOFF RUN (HO)	CAHO	
INDIAN RUN (IR)	CAIR	
PIKE BRANCH (PK)	CAPK	

CAMERON RUN (CA)

Tributary:	Site Code:	Comment:
POPLAR RUN (PR)	CAPR	added 11/5
TAYLOR RUN (TA)	CATA	
TRIPPS RUN (TR)	CATR	
TURKEYCOCK RUN (TK)	CATK	

CUB RUN (CU)

Tributary:	Site Code:	Comment:
BIG ROCKY RUN	CUBR	
(BR) BULL RUN (BU)	CUBU	For Bull Run watershed the code is BL, for the Bull Run river the code is BU.
CAIN BRANCH (CB)	CUCB	
CUB RUN (CU)	CUCU	
DEAD RUN (DE)	CUDE	
ELKLICK RUN (ER)	CUER	
FLATLICK BRANCH (FL)	CUFL	
FROG BRANCH (FR)	CUFR	
OXLICK BRANCH (OX)	CUOX	
ROUND LICK BRANCH (RL)	CURL	
SAND BRANCH (SN)	CUSN	
SCHNEIDER BRANCH (SB)	CUSB	

DEAD RUN (DE)

Tributary:	Site Code:	Comment:
DEAD RUN (DE)	DEDE	
POTOMAC RIVER (PO)	DEPO	

DIFFICULT RUN (DF)

Tributary:	Site Code:	Comment:
ANGELICO BRANCH (AB)	DFAB	
BRIDGE BRANCH (BC)	DFBC	
BROWNS BRANCH (BW)	DFBW	
CAPTAIN HICKORY RUN (CH)	DFCH	
COLVIN MILL RUN (CM)	DFCM	
COLVIN RUN (CR) DIFFICULT	DFCR	
RUN (DF)	DFDF	
DOG RUN (DG)	DFDG	
FORD (FD)	DFFD	
LITTLE DIFFICULT RUN (LD)	DFLD	
MOONAC CREEK (MN)	DFMN	
OLD COURTHOUSE SPRING BRANCH (OR)	DFOR	
PINEY BRANCH (PB)	DFPB	
PINEY RUN (PR)	DFPR	
POTOMAC RIVER (PO)	DFPO	

DIFFICULT RUN (DF)

Tributary:	Site Code:	Comment:
ROCKY BRANCH (RB)	DFRB	
ROCKY RUN (RR)	DFRR	
SHARPERS RUN (SP)	DFSP	
SNAKEDEN BRANCH (SB)	DFSB	
SOUTH FORK RUN (SF)	DFSF	
THE GLADE (GL)	DFGL	
WOLFTRAP CREEK (WC)	DFWC	

DOGUE CREEK (DC)

Tributary:	Site Code:	Comment:
ACCOTINK BAY (AY)	DCAY	
BARNYARD RUN (BY)	DCBY	
DOGUE CREEK (DC)	DCDC	
NORTH FORK OF DOGUE CREEK (NF)	DCNF	
PINEY RUN (PY)	DCPY	
POTOMAC RIVER (PO)	DCPO	

DOUGE CREEK (DC)

Tributary:	Site Code:	Comment:
ACCOTINK BAY (AB)	DCAB	

FOUR MILE RUN (FM)

Tributary:	Site Code:	Comment:
DONALDSON RUN	FMDL	
(DL) FOUR MILE RUN	FMFM	
(FM) GULF BRANCH (GB)	FMGB	
LONG BRANCH (LO)	FMLO	
POTOMAC RIVER (PO)	FMPO	

HIGH POINT (HP)

Tributary:	Site Code:	Comment:
POTOMAC RIVER (PO)	HPPO	

HORSEPEN CREEK (HC)

Tributary:	Site Code:	Comment:
CEDAR RUN (CR) FRYING	HCCR	
PAN BRANCH (FP)	HCFP	
HORSEPEN RUN (HC)	HCHC	Although the tributary is named Horsepen Run, the code is HC.
MERRYBROOK RUN (MR)	HCMR	added 11/5

JOHNNY MORE CREEK (JM)

Tributary:	Site Code:	Comment:
BULL RUN (BU)	JMBU	For Bull Run watershed the code is BL, for the Bull Run river the code is BU.
JOHNNY MOORE CREEK (JM)	JMJM	
POLECAT BRANCH (PC)	JMPC	

KANE CREEK (KC)

Tributary:	Site Code:	Comment:
KANES CREEK (KC)	KCKC	
OCCOQUAN RIVER (OC)	KCOC	
THOMPSON CREEK (TC)	KCTC	added 11/5

LITTLE HUNTING CREEK (LH)

Tributary:	Site Code:	Comment:
LITTLE HUNTING CREEK (LH)	LHLH	
NORTH BRANCH (NB)	LHNB	
PAUL SPRING BRANCH (PS)	LHPS	
POTOMAC RIVER (PO)	LHPO	
SOUTH BRANCH (SB)	LHSB	

LITTLE ROCKY RUN (LR)

Tributary:	Site Code:	Comment:
BULL RUN (BU)	LRBU	For Bull Run watershed the code is BL, for the Bull Run river the code is BU.
LITTLE ROCKY RUN (LR)	LRLR	
WILLOW SPRINGS BRANCH (WS)	LRWS	

MILL BRANCH (MB)

Tributary:	Site Code:	Comment:
GILES RUN (GR)	MBGR	
MILLS BRANCH (MB)	MBMB	
OCCOQUAN RIVER (OC)	MBOC	
SOUTH BRANCH (SB)	MBSB	

NICHOL RUN (NI)

Tributary:	Site Code:	Comment:
HARKNEY BRANCH (HB)	NIHB	
JEFFERSON BRANCH (JB)	NIJB	
NICHOLS RUN (NI)	NINI	
OCCOQUAN RIVER (OC)	NIOC	

OCCOQUAN (OC)

Tributary:	Site Code:	Comment:
ELK HORN RUN (EH)	OCEH	
LITTLE OCCOQUAN CREEK (LQ)	OCLQ	
OCCOQUAN RIVER (OR)	OCOR	

OLD MILL BRANCH (OM)

Tributary:	Site Code:	Comment:
BULL RUN (BU)	OMBU	For Bull Run watershed the code is BL, for the Bull Run river the code is BU.
OCCOQUAN RIVER (OR)	OMOR	
OLD MILL BRANCH (OM)	OMOM	

PIMMIT RUN (PM)

Tributary:	Site Code:	Comment:
BRYAN BRANCH (BH) BURKES	PMBH	
SPRING BRANCH (BK) GULF	PMBK	
BRANCH (GB)	PMGB	
LITTLE PIMMIT RUN (LP)	PMLP	
PIMMIT RUN (PM)	PMPM	
POTOMAC RIVER (PO)	PMPO	

POHICK CREEK (PC)

Tributary:	Site Code:	Comment:
CHERRY RUN (CY)	PCCY	
CROOKED BRANCH (CK)	PCCK	
MIDDLE RUN (MR)	PCMR	added 1/16/03
OPPOSSUM BRANCH	PCOS	
(OS) PEYTON RUN (PR)	PCPR	added 11/5
POHICK CREEK (PC)	PCPC	
POTOMAC RIVER (PO)	PCPO	
RABBIT BRANCH (RA)	PCRA	
ROCKY BRANCH (RY)	PCRY	
SANGSTER BRANCH (SB)	PCSB	
SIDEBURN BRANCH (SI)	PCSI	
SILVER BROOK (SL)	PCSL	
SOUTH RUN (SR)	PCSR	

POND BRANCH (PN)

Tributary:	Site Code:	Comment:
CLARKS BRANCH (CL)	PNCL	
MINE RUN BRANCH (MR)	PNMR	
POND BRANCH (PN)	PNPN	added 11/5
POTOMAC RIVER (PO)	PNPO	

POPES HEAD CREEK (PH)

Tributary:	Site Code:	Comment:
BULL RUN (BU)	PHBU	added 11/5
CASTLE CREEK (CC)	PHCC	
EAST FORK (EF)	PHEF	
PINEY BRANCH (PI)	PHPI	
POPES HEAD CREEK (PH)	PHPH	

RYANS DAM (RD)

Tributary:	Site Code:	Comment:
OCCOQUAN RIVER (OR)	RDOR	
SANDY RUN (SY)	RDSY	
STILLWELL RUN (SW)	RDSW	

SANDY RUN (SA)

Tributary:	Site Code:	Comment:
OCCOQUAN RIVER (OR)	SAOR	
SANDY RUN (SA)	SASA	

SCOTTS RUN (SC)

Tributary:	Site Code:	Comment:
BRADLEY BRANCH	SCBB	added 11/5
(BB) POTOMAC RIVER	SCPO	
(PO) SCOTT RUN (SC)	SCSC	

SUGARLAND RUN (SU)

Tributary:	Site Code:	Comment:
FOLLY LICK BRANCH	SUFL	
(FL) FORD (FD)	SUFD	
HUGHES BRANCH (HB)	SUHB	added 11/5
MUDDY BRANCH (MB)	SUMB	added 11/5
OFFUTS BRANCH (FF)	SUFF	
ROSIERS BRANCH (RI)	SURI	
SUGARLAND RUN (SU)	SUSU	

TURKEY RUN (TU)

Tributary:	Site Code:	Comment:
POTOMAC RIVER (PO)	TUPO	
TURKEY RUN (TU)	TUTU	

WOLF RUN (WR)

Tributary:	Site Code:	Comment:
MAPLE BRANCH (MB)	WRMB	

WOLF RUN (WR)

Tributary:	Site Code:	Comment:
OCCOQUAN RIVER (OR)	WROR	
SWIFT RUN (SR) WOLF	WRSR	
RUN (WR)	WRWR	

Accuracy and Precision Evaluation, Stream Physical Assessment

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COPIES: Cheri Edwards/CH2MHILL

DATE: November 1, 2002

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Background and Purpose

Accuracy and precision were evaluated for stream physical assessment metrics according to the procedures presented in the *Quality Assurance Project Plan* (CH2MHILL, October 2002). Seven teams participated in the assessment, consisting of 2- or 3- person teams that are now continuing with the stream walks. The evaluations were conducted by having the teams assess two sites previously identified by the County, and previously assessed as part of the County Stream Protection Strategy (SPS):

- Dogue Creek (DCDC01), a site located in the Coastal Plain physiographic region, in the Dogue Creek watershed
- Elk Horn Run (OCEH01), a site located in the Piedmont physiographic region, in the Occoquan watershed not far from the Occoquan River

Attachments A and B contain site location maps and upstream and downstream photographs from reaches identified by the field teams, for Dogue Creek and Elk Horn Run, respectively.

Challenges Assessing Elk Horn Run

Assessments for Elk Horn Run were not carried out consistently by the field teams because the lower segment was located in a wetland area (see photos in Attachment B). Table 1 and the accompanying schematic illustrates the issue and areas that were assessed.

While we considered dropping the site from the data analysis presented in this memorandum, we found that the data do contain some valuable information and therefore have completed the analysis of the available data.

TABLE 1
Team approaches to Elk Horn Site (OCEH)

TEAM	Assessed lower wetland channel A to B	Assessed upper wetland channel B to C	Assessed stream above wetland C to D	Assessed combined stream and wetland B to D
1	N	N	N	YES
2	N	YES	YES	N
3	N	N	N	N
4	N	N	N	YES
5	N	N	N	N
6	N	N	YES	N
7	N	N	YES	N

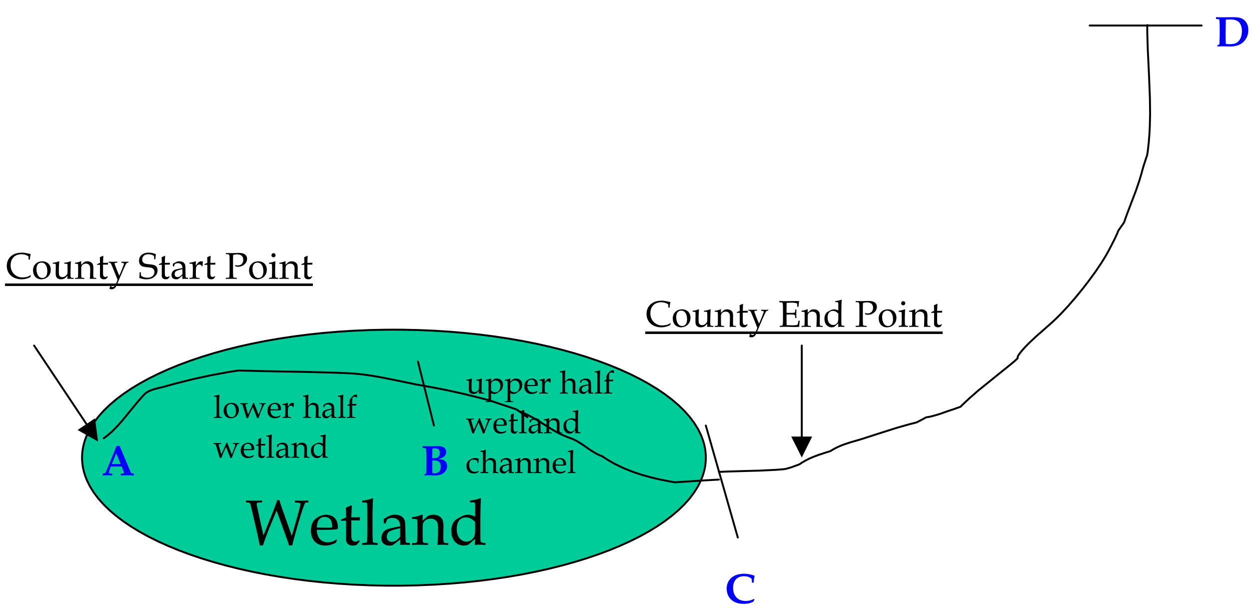
Teams 1 and 4 assessed the representative channel observed in the upper half of the wetland combined with the lower portion of the stream reach (B to D).

Team 2 assessed the representative channel observed in the upper half of the wetland (B to C). Also, Team 2 evaluated the stream reach between points C and D.

Teams 3 and 5 did not evaluate the reach (points A to C) based on the assumption wetland would not be accessible under normal flow.

Teams 6 and 7 did not evaluate the wetland portion of the reach (points A to C) based on the assumption wetland would not be accessible under normal flow. Also, Teams 6 and 7 evaluated the stream reach between points C and D.

NOTE: County end points are approximate.



Raw Data and Team Averages

Raw data from the assessments conducted by each field team member are tabulated in Attachment C. Tables 2 and 3 contain the team averages for the individual metrics and for the total habitat score for Dogue Creek and Elk Horn Run, respectively.

TABLE 2
Team Averages for Dogue Creek

Glide/Pool Metrics	TEAM 1	TEAM 2	TEAM 3	TEAM 4	TEAM 5	TEAM 6	TEAM 7
Bottom Substrate/ Available Cover	11.0	8.0	15.5	11.5	14.0	12.5	13.5
Pool Substrate Characterization	8.5	9.3	16.5	7.0	9.5	12.0	12.0
Pool Variability	11.0	11.7	16.0	11.0	13.5	12.0	11.5
Channel/Bank Alteration	11.5	5.7	14.0	16.0	16.5	10.5	15.0
Sediment Deposition	11.5	5.7	11.5	7.5	8.5	8.5	9.0
Channel Sinuosity	11.0	1.0	14.5	6.0	9.0	2.0	7.0
Channel Flow Status-drought	9.0	7.7	11.0	5.5	8.5	8.5	14.5
Channel Flow Status-normal	14.0	12.7	14.5	8.5	12.0	11.5	16.0
Bank Vegetative Protection							
LB	2.5	2.3	5.5	2.0	3.0	4.5	4.0
RB	2.5	2.3	6.5	2.0	3.5	4.5	4.0
Bank Stability							
LB	6.5	2.7	5.5	2.0	3.5	5.0	4.0
RB	5.5	2.7	6.5	2.5	4.0	5.0	3.5
Vegetation Buffer Zone Width							
LB	9.5	8.0	9.5	9.5	9.0	8.5	10.0
RB	6.0	6.3	9.5	8.5	8.5	4.0	10.0
Total	120.0	86.0	156.5	99.5	123.0	109.0	134.0
Total without Drought Channel Flow Status	111.0	78.3	145.5	94.0	114.5	100.5	119.5

TABLE 3
Team Averages for Elk Horn Run(Reach B to D)

Riffle/Run Metrics	TEAM 1	TEAM 2	TEAM 4	TEAM 6	TEAM 7
Instream Cover	7.5	12.0	12.0	8.0	12.5
Epifaunal Substrate	2.5	0.7	7.0	11.5	3.5
Embeddedness	17.5	5.0	9.5	12.0	5.0
Channel/Bank Alteration	17.0	17.0	16.0	13.0	15.0
Sediment Deposition	14.5	17.0	11.0	14.5	11.5
Frequency of Riffles	3.0	2.3	8.0	8.0	7.0
Channel Flow Status-drought	1.0	0	1.0	1.0	4.5
Channel Flow Status-normal	9.0	18.0	3.5	7.5	11.5
Bank Vegetative Protection					
LB	7.0	8.7	7.5	5.5	8.5
RB	7.0	8.7	7.5	5.5	9.0
Bank Stability					
LB	7.5	8.7	7.5	7.5	7.5
RB	7.5	8.7	7.0	7.5	8.5
Vegetation Buffer Zone Width					
LB	5.5	8.0	5.0	6.0	5.0
RB	4.5	8.0	6.5	9.0	7.0
Total	111.0	122.7	109.0	116.5	116.0
Total without Drought Channel Flow Status	110.0	122.7	108.0	115.5	111.5

Precision Evaluation

Tables 4 and 5 present the standard deviation, mean and coefficient of variation of the Dogue Creek and the Elk Horn Run sites for the individual habitat metrics and the total habitat scores. The statistics are presented based on the individual scores of each team member, and based on the average score of each team.

TABLE 4
Standard Deviation, Mean and Coefficient of Variation for Dogue Creek, by Individual Score, and by Average Team Score

Glide/Pool Metrics	Statistics on Individual Basis				Statistics on Team Basis			
	Standard Deviation	Mean	Coefficient of Variation (%)	Sample Size	Standard Deviation	Mean	Coefficient of Variation (%)	Sample Size
Bottom Substrate/ Available Cover	2.9	11.9	25%	16	2.4	12.3	20%	7
Pool Substrate Characterization	3.4	10.4	33%	16	3.1	10.7	29%	7
Pool Variability	2.1	12.4	17%	16	1.8	12.4	15%	7
Channel/Bank Alteration	4.1	12.4	33%	16	3.8	12.7	30%	7
Sediment Deposition	2.5	8.6	29%	16	2.1	8.9	24%	7
Channel Sinuosity	4.6	6.8	68%	16	4.8	7.2	66%	7
Channel Flow Status-drought	2.8	9.1	31%	16	2.8	9.2	31%	7
Channel Flow Status-normal	2.7	12.6	21%	16	2.4	12.7	19%	7
Bank Vegetative Protection								
LB	1.5	3.3	47%	16	1.3	3.4	38%	7
RB	1.7	3.5	49%	16	1.6	3.6	43%	7
Bank Stability								
LB	1.8	3.9	47%	16	0.7	9.1	38%	7
RB	1.7	4.1	41%	16	2.2	7.5	35%	7
Vegetation Buffer Zone Width								
LB	0.9	9.1	10%	16	23.1	118.3	8%	7
RB	2.0	7.6	27%	16	21.3	109.0	29%	7
Total without Drought Channel Flow Status	22.2	106.5	21%	16	21.27	109.0	20%	7

TABLE 5
Standard Deviation, Mean and Coefficient of Variation for Elk Horn Run, by Individual Score, and by Average Team Score

Riffle/Run Metrics	Statistics on Individual Basis				Statistics on Team Basis			
	Standard Deviation	Mean	Coefficient of Variation (%)	Sample Size	Standard Deviation	Mean	Coefficient of Variation (%)	Sample Size
Instream Cover	3.0	10.5	29%	11	2.4	10.4	23%	5
Epifaunal Substrate	4.1	4.6	89%	11	4.3	5.0	85%	5
Embeddedness	5.0	9.4	54%	11	5.3	9.8	54%	5
Channel/Bank Alteration	1.9	15.7	12%	11	1.7	15.6	11%	5
Sediment Deposition	2.5	14.0	18%	11	2.5	13.7	18%	5
Frequency of Riffles	3.1	5.4	59%	11	2.8	5.7	49%	5
Channel Flow Status-drought	1.6	1.4	119%	11	1.7	1.5	115%	5
Channel Flow Status-normal	5.6	10.6	53%	11	5.4	9.9	54%	5
Bank Vegetative Protection								
LB	1.3	7.5	17%	11	1.3	7.4	17%	5
RB	1.4	7.6	18%	11	1.4	7.5	19%	5
Bank Stability								
LB	1.0	7.8	13%	11	0.5	7.7	7%	5
RB	1.0	7.9	13%	11	0.7	7.8	9%	5
Vegetation Buffer Zone Width								
LB	1.6	6.1	26%	11	1.2	5.9	21%	5
RB	1.6	7.1	23%	11	1.7	7.0	24%	5
Total without Drought Channel Flow Status	7.3	114.4	6%	11	5.8	113.5	5%	5

According to the QAPP no set goals were established for the precision evaluation, however a reasonable target was suggested that the COV for the overall habitat score should not exceed 15%, while the COV for any one metric should not exceed 25%. The results shown in Tables 4 and 5 indicate that, in general, these targets have not been met for the glide-pool system, but they were more frequently met for the riffle run system. However, the overall COV for the glide pool system of 20% is not unreasonable, and the overall COV for the riffle-run system of 5% is excellent (the latter for fewer teams, because of the problems assessing the wetlands area at the riffle-run site).

The glide-pool metrics with the most inconsistent results, based on the COV, are as follows, in declining order:

- Channel Sinuosity – the discrepancies with sinuosity are a result of map wheel measurements of GIS coverage and observations of internal channel meandering through point bars.
- Bank Vegetative Protection – bank vegetative protection differences are a result of misunderstanding among some field teams between actual bank vegetation (that vegetative cover that occurs between the bank toe of slope and the top of bank) and riparian vegetative cover.
- Bank stability – the condition of the Dogue Creek system was such that bank stability could be easily misinterpreted. The creek did not have any active erosion with slumping, however, it was scoured and had little vegetative stability.
- Channel Flow Status – given the drought conditions occurring at the time of evaluation, normal channel flow status was difficult to ascertain. The internal meandering within the larger established stream bed made accurate determination of normal flow status difficult.
- Pool substrate characterization – assessing the productivity of pools within a system experiencing drought can be quite difficult. Pool substrate is easily determined by the dominant bed material, however, determining the “quality” of the pool in relation to habitat for fish and aquatic macroinvertebrates can vary depending on experience of the assessor(s).
- Sediment deposition – determining sediment deposition is a subjective estimation of the amount of point bars and unstable sediment within a stream. This evaluation is also hindered by drought conditions in which more sediment is exposed and might skew the results of some field teams.

The conflicting riffle-run metrics are a direct result of the wetland system of Elk Horn Run. Applying stream protocols to a system with braided and overgrown wetland channels can produce a wide range of differing results. The metrics with the most inconsistent results, based on the COV, are as follows, in declining order:

- Channel Flow Status – drought
- Epifaunal substrate
- Embeddedness
- Frequency of riffles
- Vegetation buffer zone width
- Instream cover

Accuracy Evaluation

Table 6 presents the total habitat assessment score and condition rating for the 2 sites and the 7 teams. Figure 1 shows the spread in the total habitat scores. For Dogue Creek and Elk Horn Run, respectively, Attachments D and E contain graphs illustrating the scatter in the raw data and the average data by team, for each of the individual habitat metrics.

Team 2 was assumed to be made up of the most experienced team. No County assessment information for these sites was provided. All the habitat assessment scores fell within one category of the Team 2 category for the Elk Horn Run site, and all but one total habitat assessment score (Team 3) fell within one category of the Team 2 category for the Dogue Creek site. Note that the Team 2 score was the only one to rate Dogue Creek as "Poor" (by just 3 points), while all others rated it fair or good.

Figure 1 Total Habitat Scores, by Team, by Site

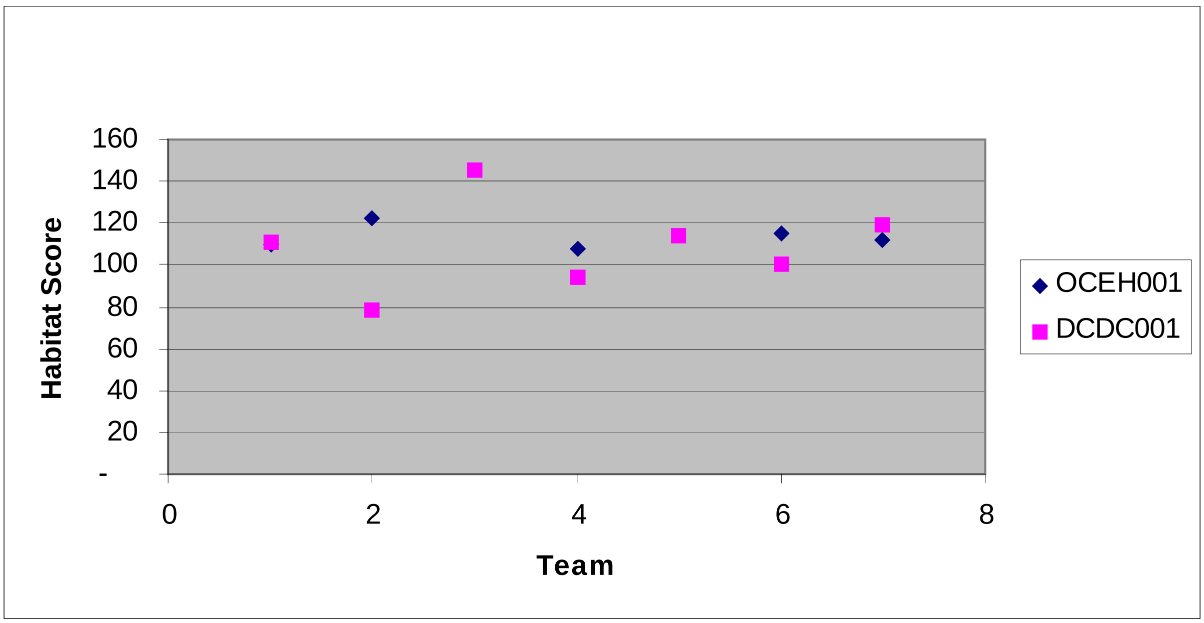


TABLE 6
Total Habitat Assessment Score and Condition Rating for Elk Horn Run and Dogue Creek by Team

TEAM	OCEH001		DCDC001	
	Score	Condition	Score	Condition
1	110	Fair	111	Fair
2	123	Good	78	Poor
3	DNA	DNA	146	Good
4	108	Fair	94	Fair
5	DNA	DNA	115	Fair
6	116	Fair	101	Fair
7	112	Fair	120	Fair

Notes:
1. Condition categories are as follows:

0 – 40	Very Poor
41 – 80	Poor
81 – 120	Fair
121 – 160	Good
161 - 200	Excellent

2. OCEH001 data for Team 2 are obtained by combining the 2 Elk Horn Reaches.
3. DNA = Did Not Assess

Accuracy and Precision for Reach Demarcation

Accuracy and precision for the reach demarcation were evaluated following the procedure outlined in the QAPP. Habitat reaches were demarcated (end points identified) in the stream segment previously assessed by the County that encompasses the two sites used in the SPS baseline study. Here again, Team 2 was assumed to provide the “true value” of the end of the reaches, that is their independent assessment of the location of reach breaks was used for comparison purposes.

Figures 2 and 3 show the locations of start and stop of the reaches for Dogue Creek and Elk Horn Run, respectively, for all 7 teams, overlaid on the County’s digital orthophotographs. The team number is embedded in the identification label for the reach break. For example, DCDC201.TOP is the top of reach 1 in Dogue Creek, for Team number 2; and DCDC202.TOP is the top of reach 2, for Team 2.

Table 7 summarizes the distance along the stream from the reach demarcation identified by Team 2, and the reach demarcation by all other teams, for Dogue Creek and Elk Horn Run.

TABLE 7
Distance along stream from reach demarcation identified by Team 2 for Dogue Creek and Elk Horn Run

INV_ID	TEAM_NO	DISTANCE ALONG STREAM FROM TEAM 2 REACH DEMARCATION
	Dogue Creek	
DCDC101.TOP	1	0.0
DCDC201.TOP	2	0.0
DCDC301.TOP	3	-24.0
DCDC401.TOP	4	0.0
DCDC501.TOP	5	0.0
DCDC601.TOP	6	549.1
	Elk Horn Run	
OCEH101.TOP	1	58.2
OCEH201.TOP	2	0.0
OCEH301.TOP	3	0.0
OCEH401.TOP	4	107.2
OCEH501.TOP	5	32.0
OCEH601.TOP	6	-34.6
OCEH701.TOP	7	-34.6

Notes:

Team 7 did not locate the top of reach 1 in Dogue Creek.

Positive distance is upstream, negative distance is downstream.

As an initial target, it is assumed that an acceptable level of accuracy for the evaluation is for subsequent teams to fall within ± 50 ft of the independently established reach break. Table 7 indicates that in Dogue Creek all but one team fell within that target, whereas in Elk Horn Run two teams missed the threshold.

Precision could be estimated as the COV computed as the standard deviation of the distance from the reach break divided by the mean distance from the reach break for all observers. Table 8 summarizes the average, standard deviation, and coefficient of variation.

TABLE 8
Average, Standard Deviation, and Coefficient of Variation of distance along stream from reach demarcation identified by Team 2 for Dogue Creek and Elk Horn Run

Average (ft)	Standard Deviation (ft)	Coefficient of Variation (%)
Dogue Creek		
88	226	259%
Elk Horn Run		
18	52	282%

Channel Evolution Model Evaluation

Table 9 presents the channel evolution model rating for each team and assessment site. The Dogue Creek data shows good consistency, with 5 out of 7 teams rating the site a 3, and the other two rating it a 3.5 or 4.

TABLE 9
Channel Evolution Model (CEM) Rating for Elk Horn Run and Dogue Creek by Team

TEAM	OCEH001 (Points B to C)	OCEH002 (Points C to D)	DCDC001
	Wetland	**Transitional Channel**	**Defined Channel**
1	4.5 – sand	DNA	4 – sand
2	1 – sand	1.5 - gravel	3 – sand
3	*DNA*	*DNA*	3 – sand
4	4.5 – sand	DNA	3.5 – sand
5	*DNA*	*DNA*	3 – sand
6	*DNA*	3.5 - gravel	3 – sand
7	*DNA*	2.5 - sand	3 – sand

DNA = Did Not Assess

Inventory Impact Score Evaluation

Table 10 summarizes inventory points that were observed and impact scores assessed by the seven teams in Dogue Creek and Elk Horn Run. In general, three inventory points were assessed in Dogue Creek and 5 in Elk Horn Run, of the types shown in Table 10. Each inventory point is discussed below.

TABLE 10
Inventory Impact Scores in Dogue Creek and Elk Horn Run.

Inventory ID	Type	Team 1	Team 2	Team 3	Team 4	Team 5	Team 6	Team 7
				Dogue Creek				
D001 (R)	Pipes/ Drainage Ditches [1]	~~0~~	x	3	~~2~~	5	4	3
E001 (L)	Erosion [2]	~~3~~	x	x	~~4~~	~~2~~	x	5
E002 (R)	Erosion [2]	~~3~~	x	x	~~3~~	~~2~~	x	5
				Elk Horn Run				
B001 (L)	Deficient Buffer	x	2	3	x	2	x	2
B002 (R)	Deficient Buffer	x	2	3	x	2	x	2
T001	Obstruction	4	x	x	1	x	x	2
M001	Dump Site	x	x	5	x	x	x	1
E001 (L)	Erosion	x	x	x	~~5~~ [3]	x	x	x

Notes:

1. Ditch scores of 2 or less are crossed out because based on the protocols they should not be recorded.
2. Erosion scores of less than 5 are crossed out because based on the protocols they should not be recorded.
3. Erosion point was recorded in the stream reach above the wetland.

Dogue Creek Inventory Discrepancies

Ditch

Six teams logged a ditch. Of these, 2 should not have recorded them since their impact scores were less than 2 (a convention established by Fairfax County). The remaining teams scored a 3, 3, 4, and 5, respectively. The ditch had no major impact on the reach. The ditch itself had eroded significantly to interface with the downcut creek channel; however, an impact to the creek would have been minimal.

Erosion

Four teams logged erosion along the reach. Of these, 3 teams should not have recorded them since their impact scores were less than 5 (a convention established by Fairfax County). The remaining team scored a 5.

Elk Horn Run Inventory Discrepancies

Deficient Buffer

Four of the seven teams scored deficient buffers for both sides of the reach. Of these, 3 teams scored this area an impact of '2' and the fourth team scored an impact of '3'. Given that the reach went through an unforested wetland, some teams were unclear as how to approach assessing the wetland portion of the designated reach.

Obstruction

Three of the seven teams scored an obstruction through the reach. Of these, 2 teams scored the obstruction very low (impacts of 1 and 2). The remaining team elevated the score to a '4'. This obstruction was a log jam through the main channel of the wetland. Again, the dry wetland condition made an accurate assessment of an obstruction difficult.

Dump

Two of the seven teams recorded a dump along the reach. This dump was a 55 gallon drum on the bank. One of the teams scored it extremely low (1), while the other gave it an elevated score because they were unsure of its contents (5). The other teams felt that a single drum did not constitute a dump.

Erosion

One team scored erosion along the reach with an impact of '5'. However, since this was in the stream area above the wetland, it should not be included or compared to the other teams assessment, which encompassed the wetland portion and did not contain any erosional areas.

Action Items

- Establish a convention with sinuosity measurements (use the GIS map only or estimate relative sinuosity based on field observations). Discussions with Fairfax County indicate that we will proceed with measurements of sinuosity based only on available GIS mapping.
- Reiterate to teams the difference between bank vegetative protection and vegetation buffer zone width.
- Make sure teams understand that bank stability is a direct result of bank vegetative protection, hydrology, and scouring in addition to merely erosional slumping.
- Flow status should be judged for normal flow conditions based on visible signs of normal water levels (i.e. wrack lines, water stains, etc.).
- Sediment deposition should portray the accumulation of unstable sediment in a stream. Point bars and unstable sandy/silty substrate is the direct result of this deposition, however, be aware that drought conditions might expose more sediment than normal.
- Do not apply stream protocols to a wetland system. Even an established braid may not accurately project the area. These reaches should be written off as wetland and the assessment begins when the assessors first discover an established stream that is not being adversely influenced by the wetland (i.e. standing backwater stream).
- Reiterate to teams the low-end threshold for the inventory points, below which inventory points should not be idenfitied and scores should not be recorded (e.g. Ditch scores of 2 or less and Erosion scores of less than 5) following the convention established by Fairfax County in the stream physical assessment protocols.

Attachment A: Dogue Creek Site Map and Reach Photographs

ACCURACY/PRECISION EVALUATION SITE: DOGUE CREEK (SPS SITE: DCDC01, MAP GRID 92-3)

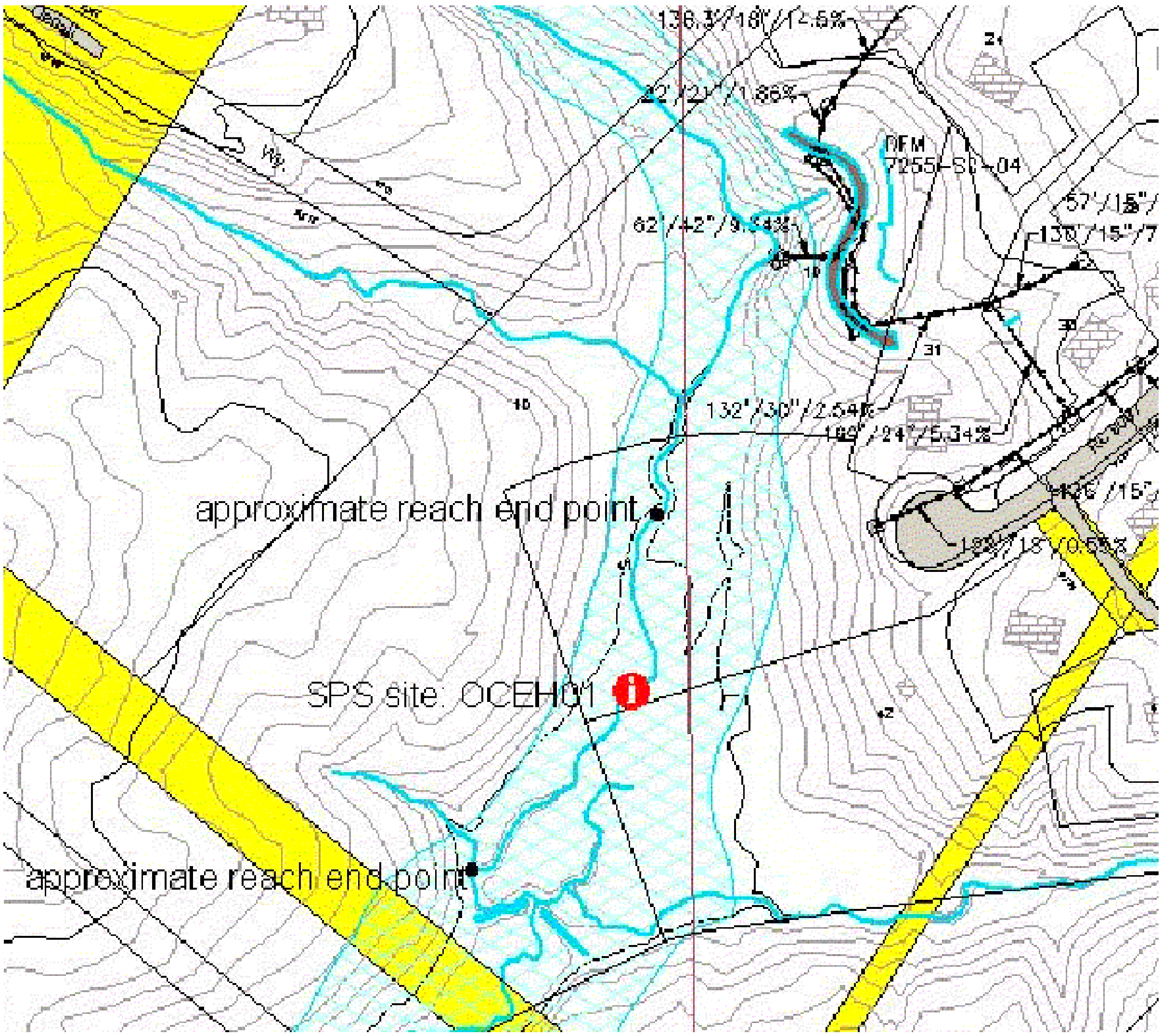
Dogue Creek, Reach 1 View Upstream (Inventory Photo ID: DCDC001.BOT, Team 2)

Dogue Creek, Reach 1 View Downstream (Inventory Photo ID: DCDC001.TOP, Team 2)

Dogue Creek, Reach 1 View Upstream (Inventory Photo ID: DCDC001.BOT, Team 6)

Dogue Creek, Reach 1 View Downstream (Inventory Photo ID: DCDC001.TOP, Team 6)

Attachment B: Elk Horn Run Site Map and Reach Photographs



ACCURACY/PRECISION EVALUATION SITE: ELK HORN RUN (SPS SITE: OCEH01, MAP GRID 106-3)

Elk Horn Run, Channel Through Wetland, Reach 1 View Upstream (Inventory Photo ID: OCEH001.BOT, Team 2)

Elk Horn Run, Wetland Channel, Reach 1, View Downstream (Inventory Photo ID: OCEH001.TOP, Team 2)

Elk Horn Run, Bottom Reach 2, View Upstream (Inventory Photo ID: OCEH002.BOT, Team 2)

Elk Horn Run, Top Reach 2, View Downstream (Inventory Photo ID: OCEH002.TOP, Team 2)

Attachment C

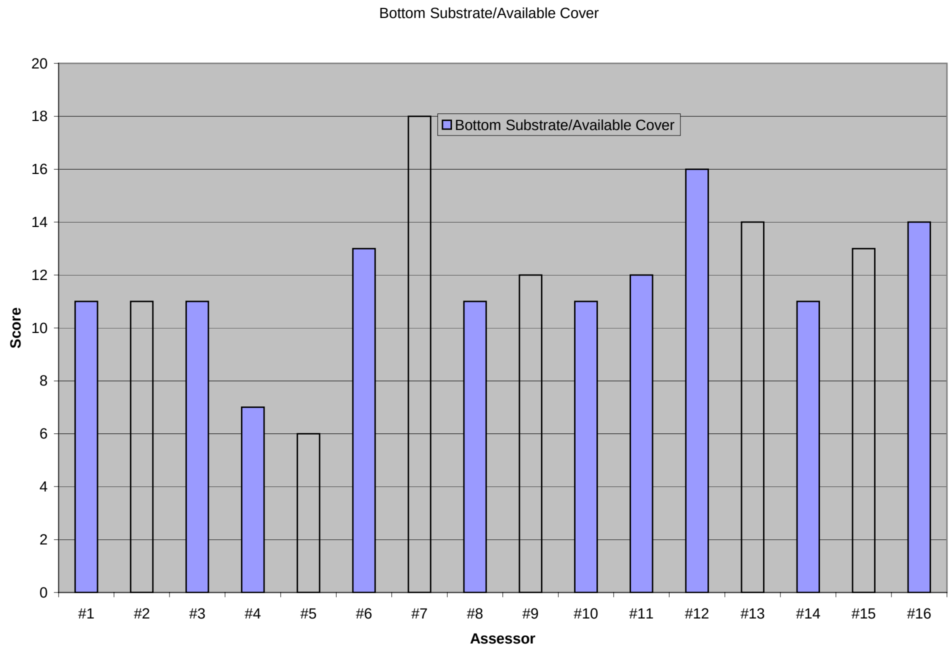
Fairfax County QA/QC- Habitat Assessments

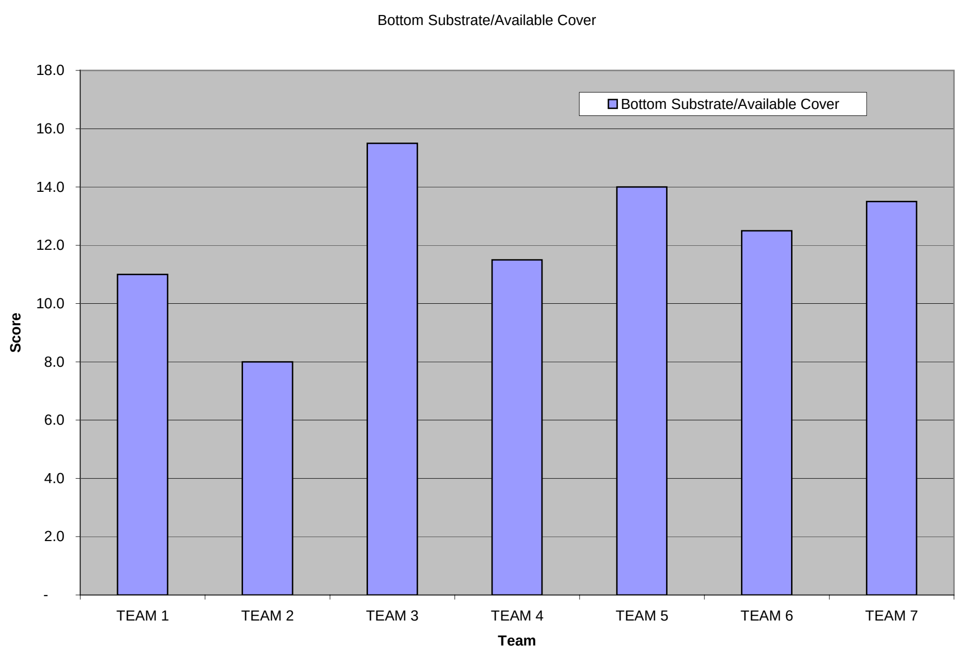
Potential Score	Riffle/Run	Glide/Pool	OCEH001		DCDC001		OCEH001			OCEH002			DCDC001		
		TEAM	TEAM 1		TEAM 1		TEAM 2			TEAM 2			TEAM 2		
		ASSESSOR	#1	#2	#1	#2	#3	#4	#5	#3	#4	#5	#3	#4	#5
20	Instream Cover	Bottom Substrate/Available Cover	3	12	11	11	12	12	12	13	17	14	11	7	6
20	Epifaunal Substrate	Pool Substrate Characterization	2	3	10	7	1	1	0	14	17	15	7	11	10
20	Embeddedness	Pool Variability	19	16	11	11	5	5	5	9	11	14	10	10	15
20	Channel/Bank Alteration	Channel/Bank Alteration	18	16	11	12	16	19	16	10	13	11	6	3	8
20	Sediment Deposition	Sediment Deposition	14	15	11	12	17	16	18	9	12	15	6	4	7
20	Frequency of Riffles	Channel Sinuosity	2	4	11	11	0	1	6	12	16	14	1	1	1
20	Channel Flow Status- drought	Channel Flow Status- drought	1	1	9	9	0	0	0	1	0	6	9	6	8
20	Channel Flow Status- normal	Channel Flow Status- normal	10	8	13	15	18	19	17	13	16	13	12	10	16
	Bank Vegetative Protection	Bank Vegetative Protection													
10	LB	LB	7	7	2	3	8	9	9	6	5	3	2	2	3
10	RB	RB	7	7	3	2	8	9	9	5	4	2	2	2	3
10	LB	LB	6	9	7	6	9	8	9	6	4	5	2	2	4
10	RB	RB	6	9	5	6	9	8	9	6	4	3	2	2	4
	Vegetation Buffer Zone Width	Vegetation Buffer Zone Width													
10	LB	LB	4	7	10	9	7	9	8	5	5	4	8	7	9
10	RB	RB	4	5	6	6	7	9	8	9	7	8	6	6	7
220		Total	103	119	120	120	117	125	126	118	131	127	84	73	101
Total without Drought Channel Flow Status			**102**	**118**	**111**	**111**	**117**	**125**	**126**	**117**	**131**	**121**	**75**	**67**	**93**

Potential Score	Riffle/Run	Glide/Pool	DCDC001		OCEH001		DCDC001		DCDC001			OCEH002		DCDC001		OCEH001		DCDC001	
		TEAM	TEAM 3		TEAM 4		TEAM 4		TEAM 5			TEAM 6		TEAM 6		TEAM 7		TEAM 7	
		ASSESSOR	#6	#7	#8	#9	#8	#9	#10	#11	#12	#13	#14	#13	#14	#15	#16	#15	#16
20	Instream Cover	Bottom Substrate/Available Cover	13	18	12	12	11	12	11	12	16	8	8	14	11	13	12	13	14
20	Epifaunal Substrate	Pool Substrate Characterization	14	19	7	7	7	7	7	12	7	11	12	11	13	2	5	11	13
20	Embeddedness	Pool Variability	14	18	10	9	11	11	13	14	13	10	14	11	13	5	5	12	11
20	Channel/Bank Alteration	Channel/Bank Alteration	12	16	16	16	16	16	15	15	18	14	12	10	11	16	14	16	14
20	Sediment Deposition	Sediment Deposition	12	11	12	10	6	9	7	10	7	15	14	10	7	12	11	7	11
20	Frequency of Riffles	Channel Sinuosity	15	14	7	9	6	6	7	11	7	8	8	2	2	8	6	6	8
20	Channel Flow Status- drought	Channel Flow Status- drought	9	13	1	1	5	6	8	8	9	1	1	8	9	4	5	13	16
20	Channel Flow Status- normal	Channel Flow Status- normal	13	16	3	4	9	8	11	11	13	6	9	10	13	9	14	15	17
	Bank Vegetative Protection	Bank Vegetative Protection																	
10	LB	LB	4	7	8	7	1	3	2	4	2	6	5	5	4	9	8	3	5
10	RB	RB	6	7	8	7	1	3	3	4	3	6	5	5	4	9	9	2	6
10	LB	LB	4	7	8	7	2	2	2	5	2	7	8	5	5	7	8	3	5
10	RB	RB	6	7	7	7	2	3	3	5	3	7	8	5	5	8	9	2	5
	Vegetation Buffer Zone Width	Vegetation Buffer Zone Width																	
10	LB	LB	9	10	4	6	9	10	9	8	10	6	6	9	8	5	5	10	10
10	RB	RB	9	10	6	7	8	9	9	8	9	9	9	4	4	7	7	10	10
220		Total	140	173	109	109	94	105	107	127	119	114	119	109	109	114	118	123	145
Total without Drought Channel Flow Status			**131**	**160**	**108**	**108**	**89**	**99**	**99**	**119**	**110**	**113**	**118**	**101**	**100**	**110**	**113**	**110**	**129**

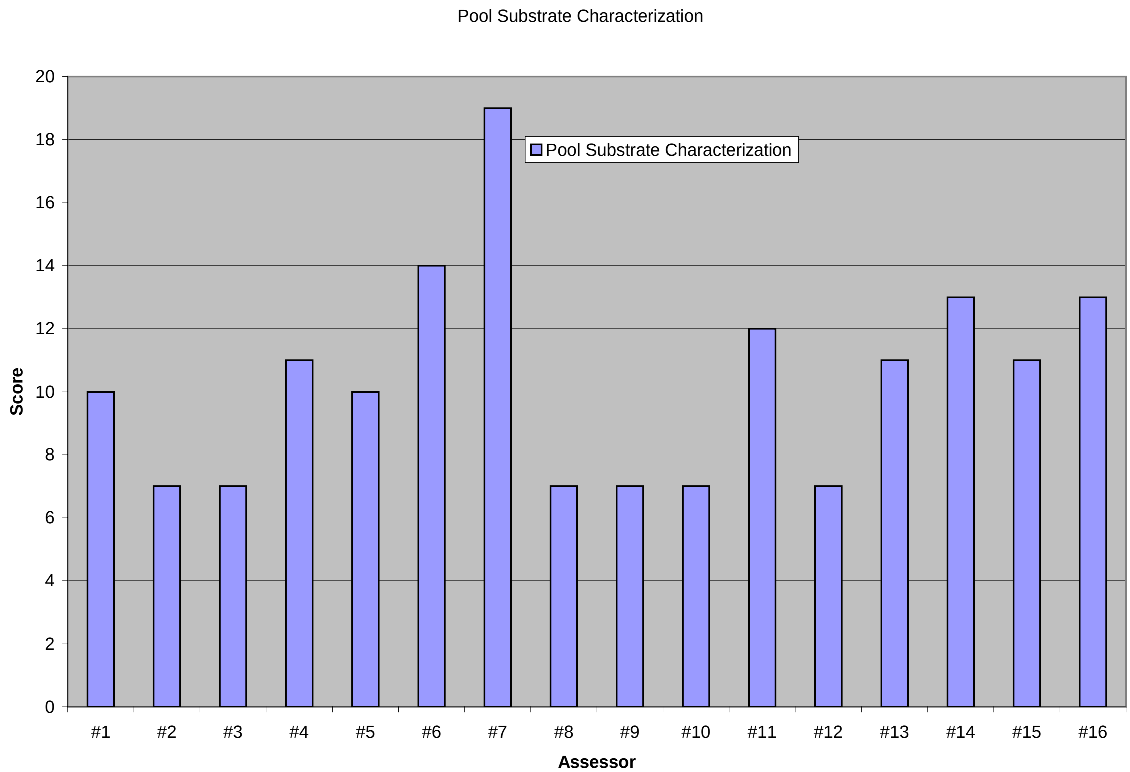
Attachment D: Plots of Habitat Metrics Scores by Individual and by Team, at Dogue Creek

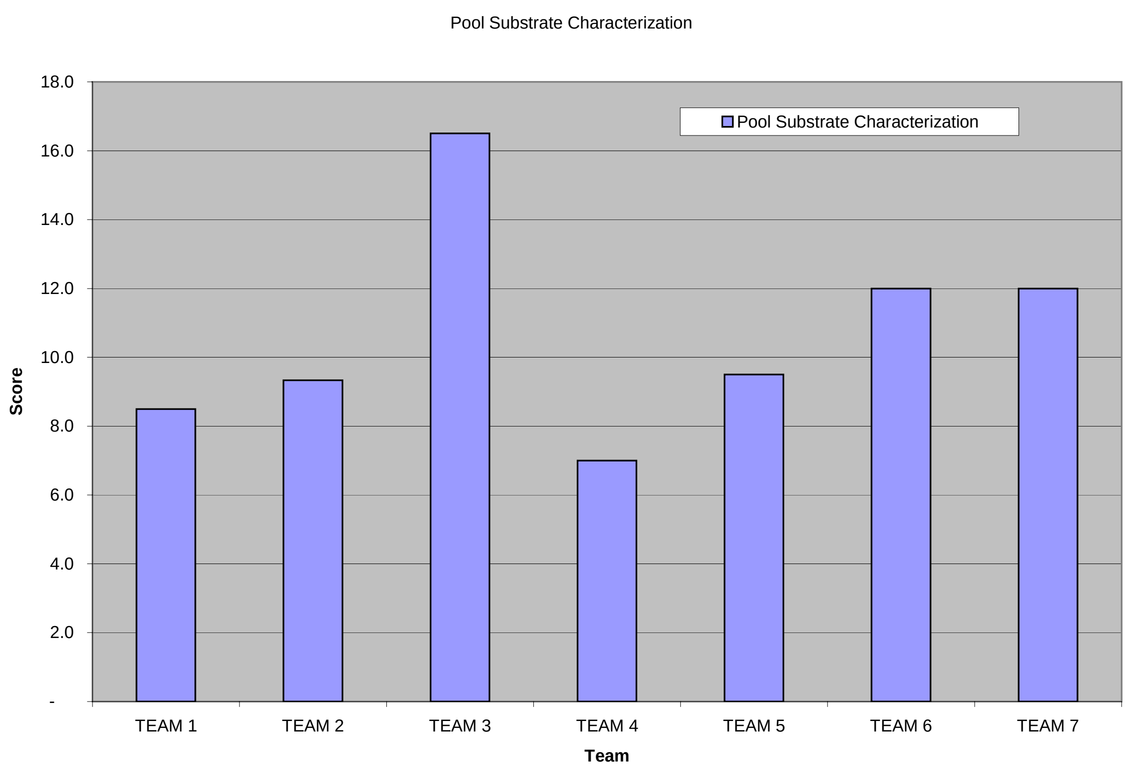
Bottom Substrate/ Available Cover



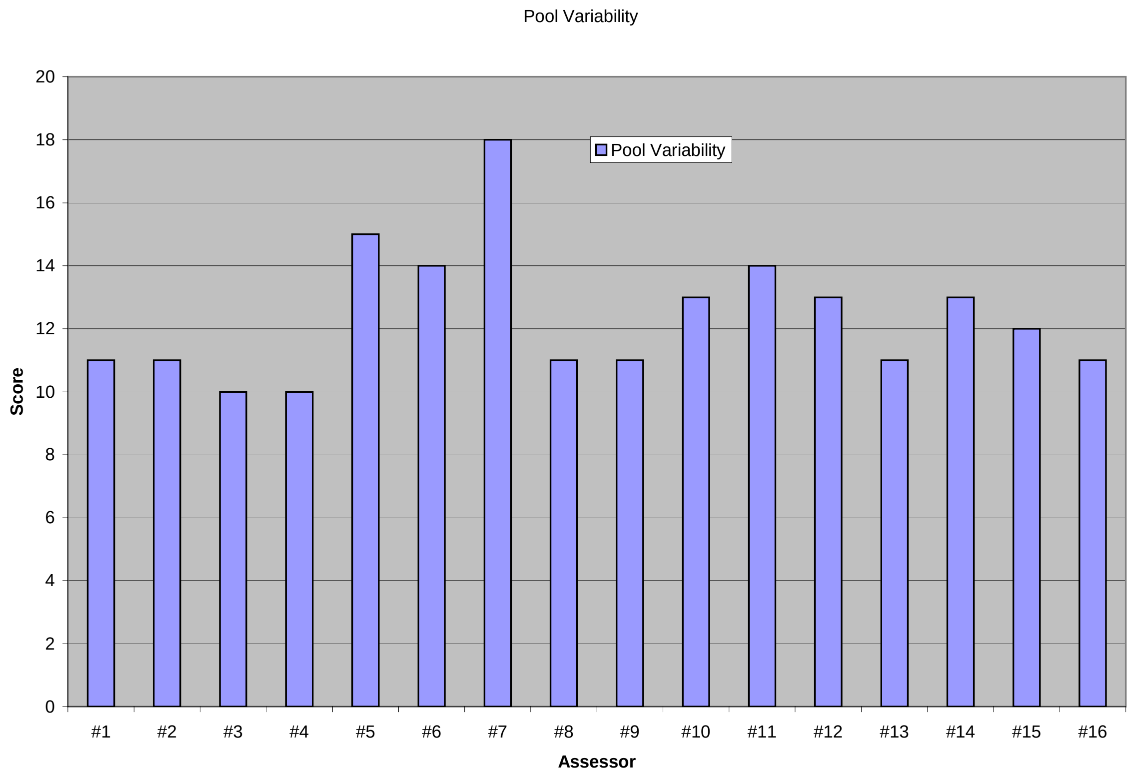


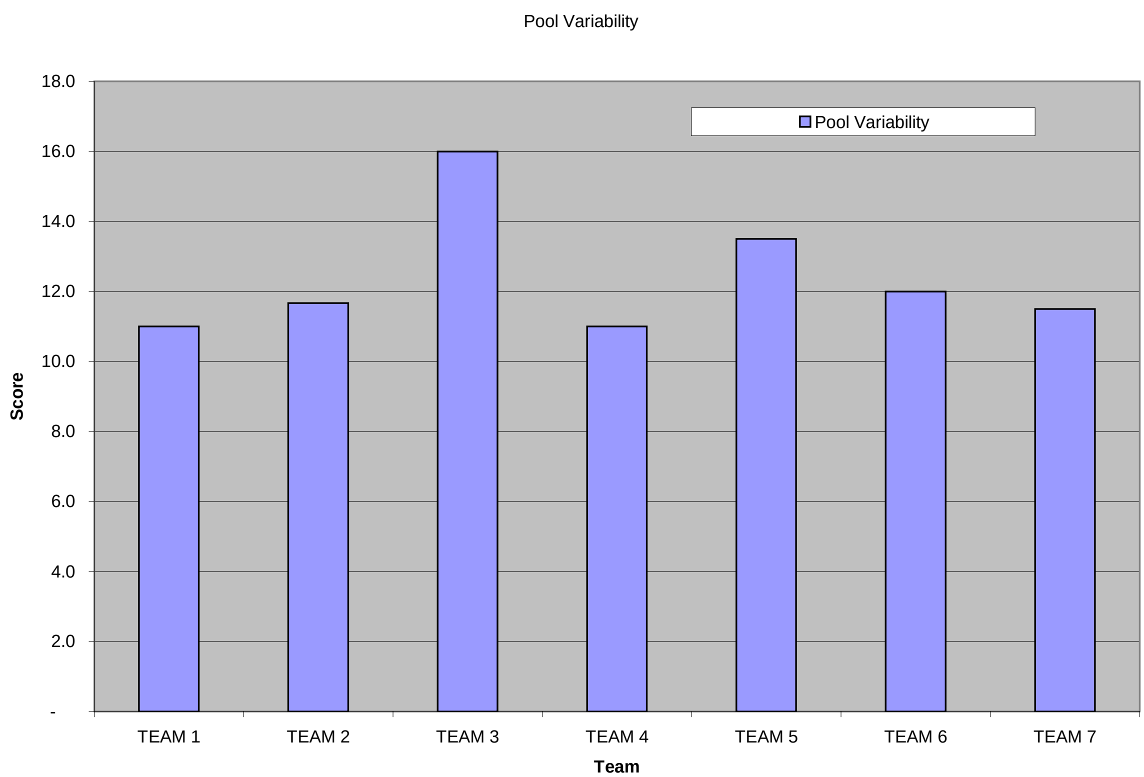
Pool Substrate Characterization



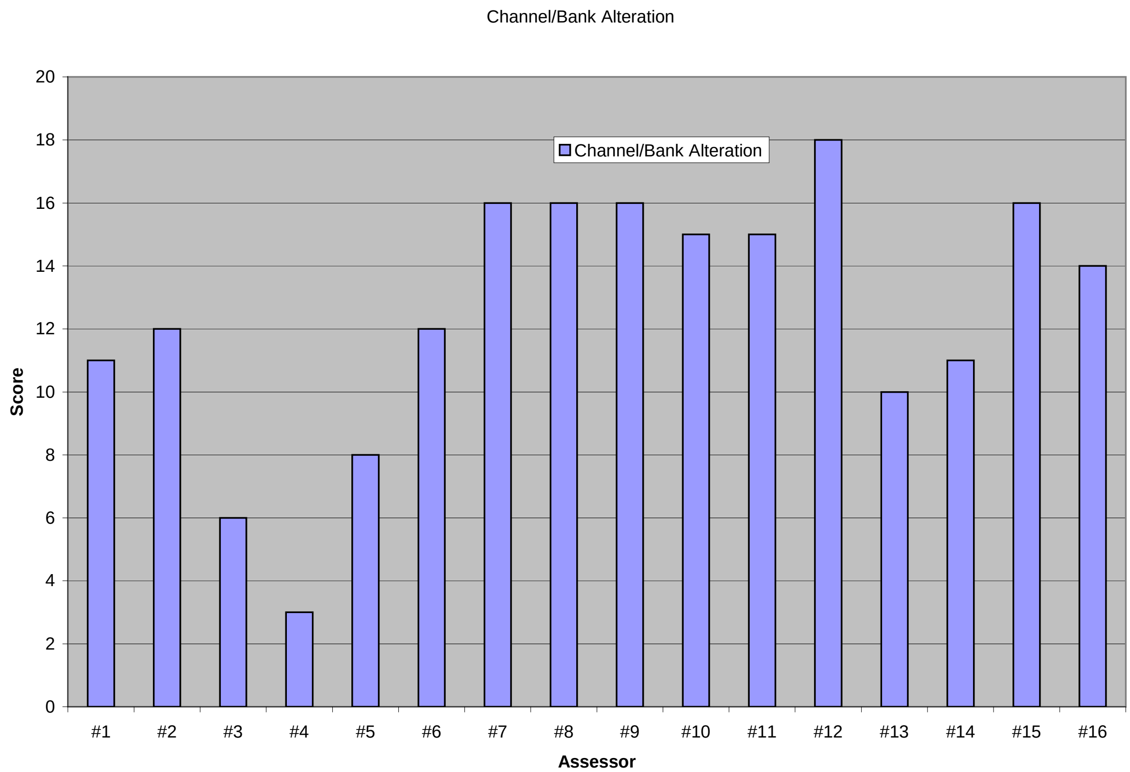


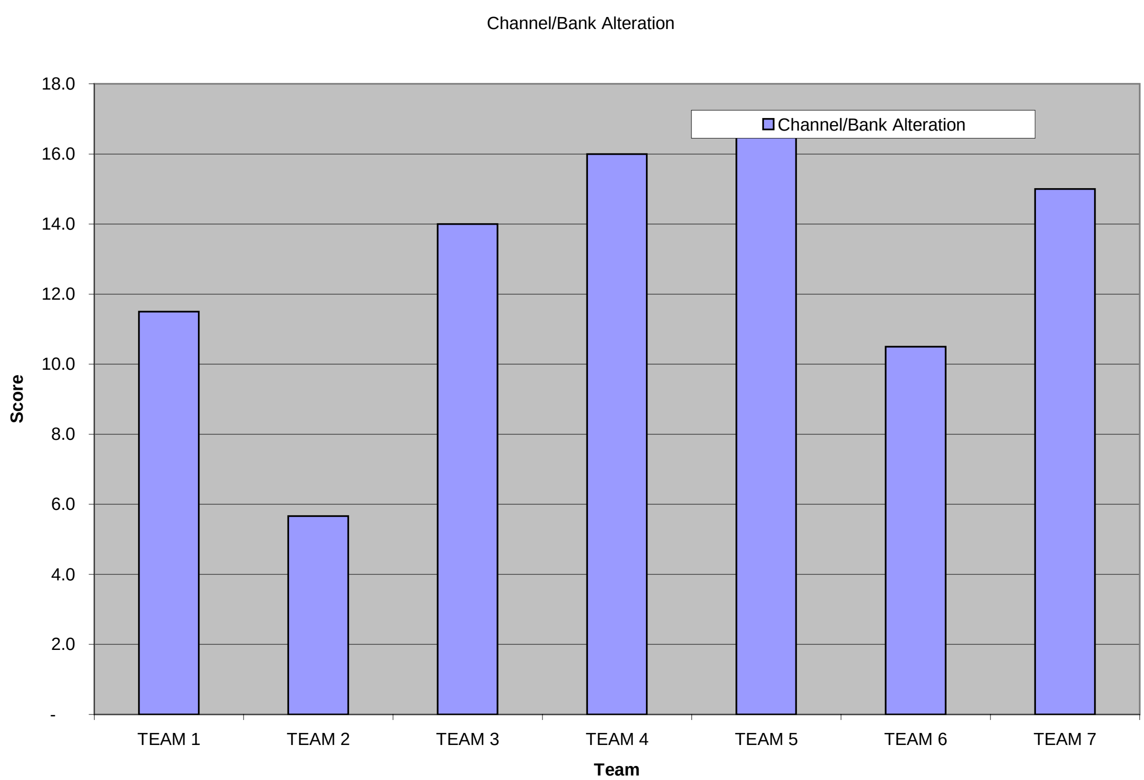
Pool Variability



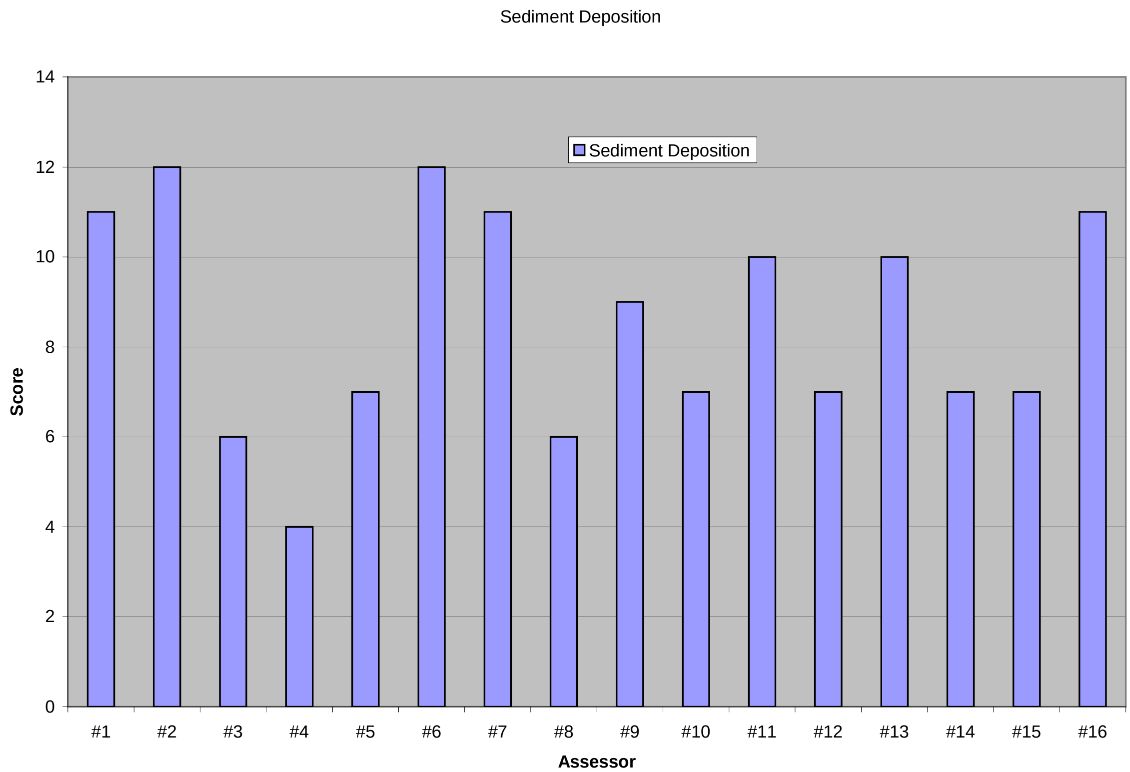


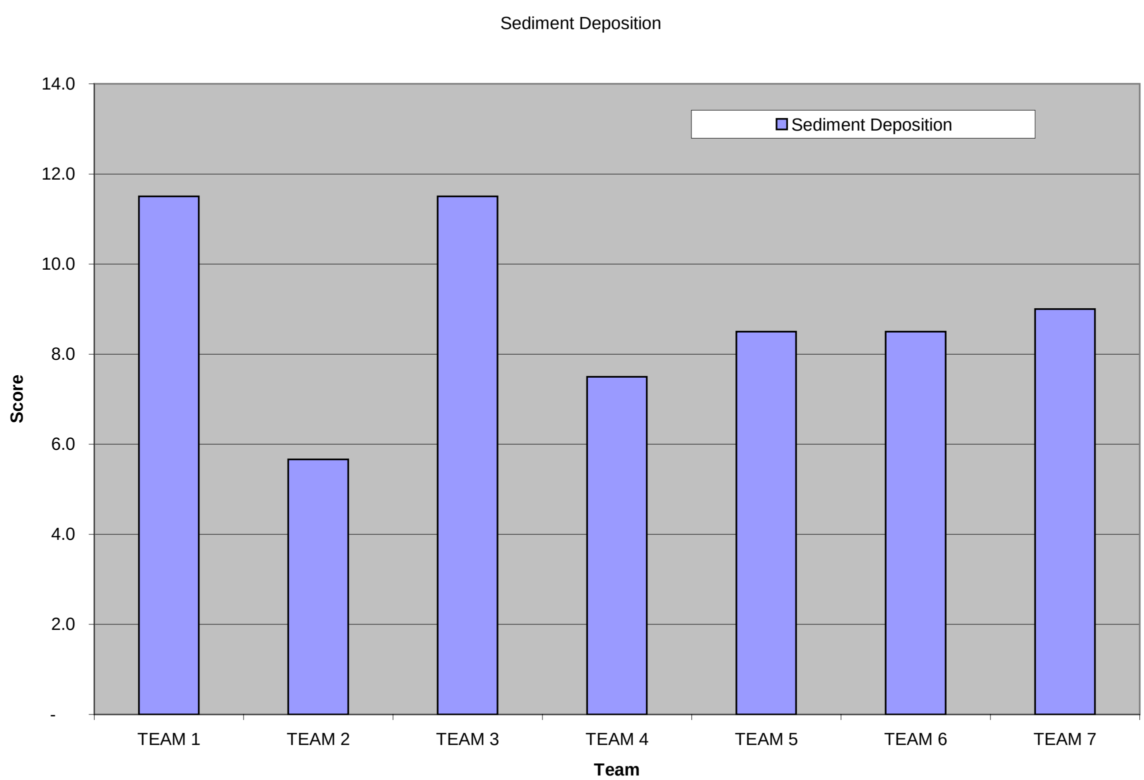
Channel/Bank Alteration



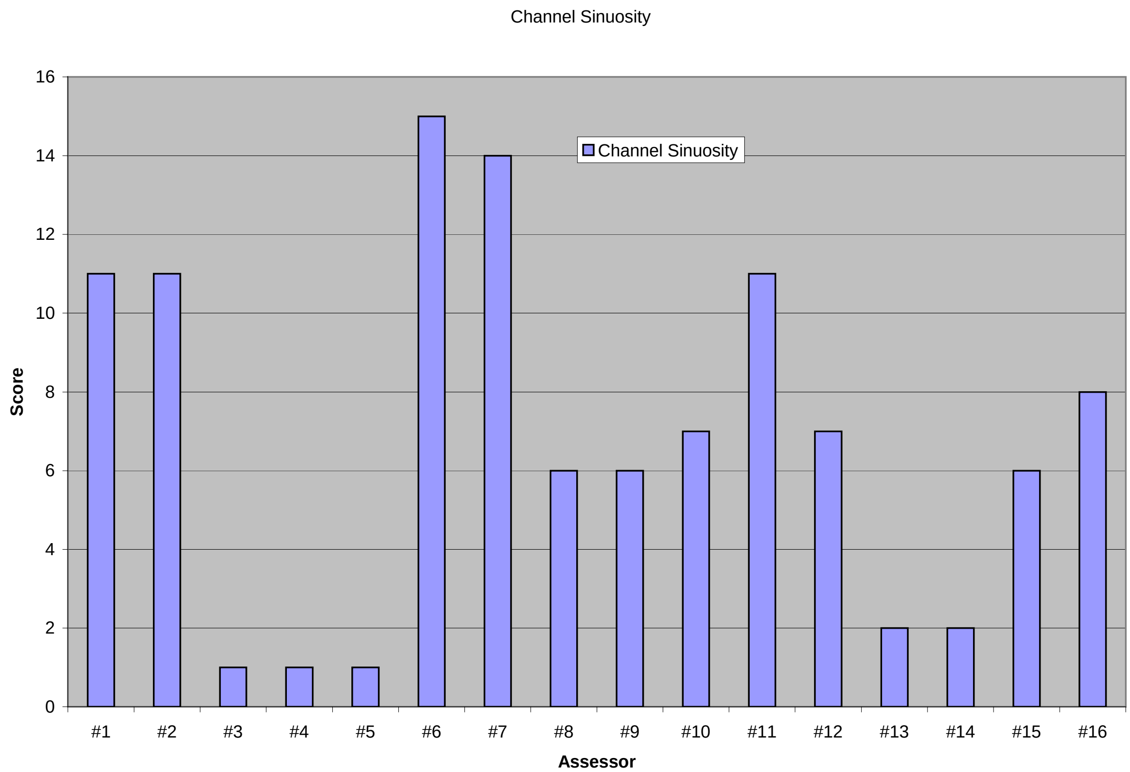


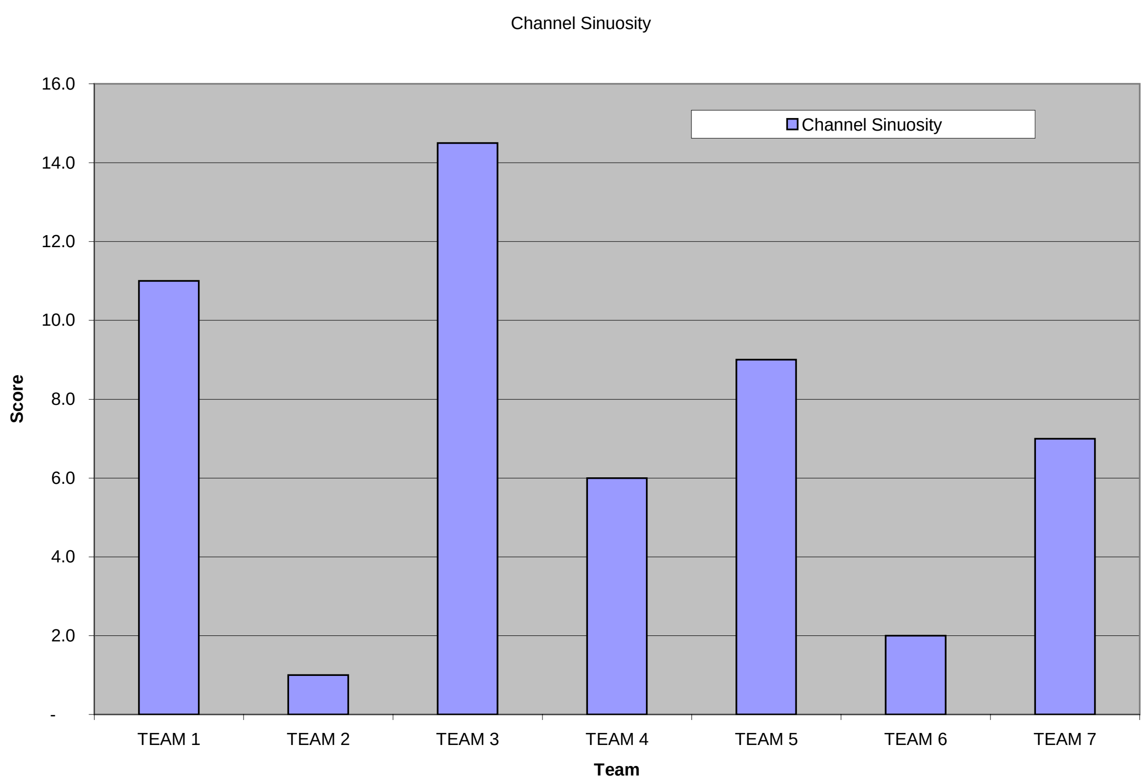
Sediment Deposition



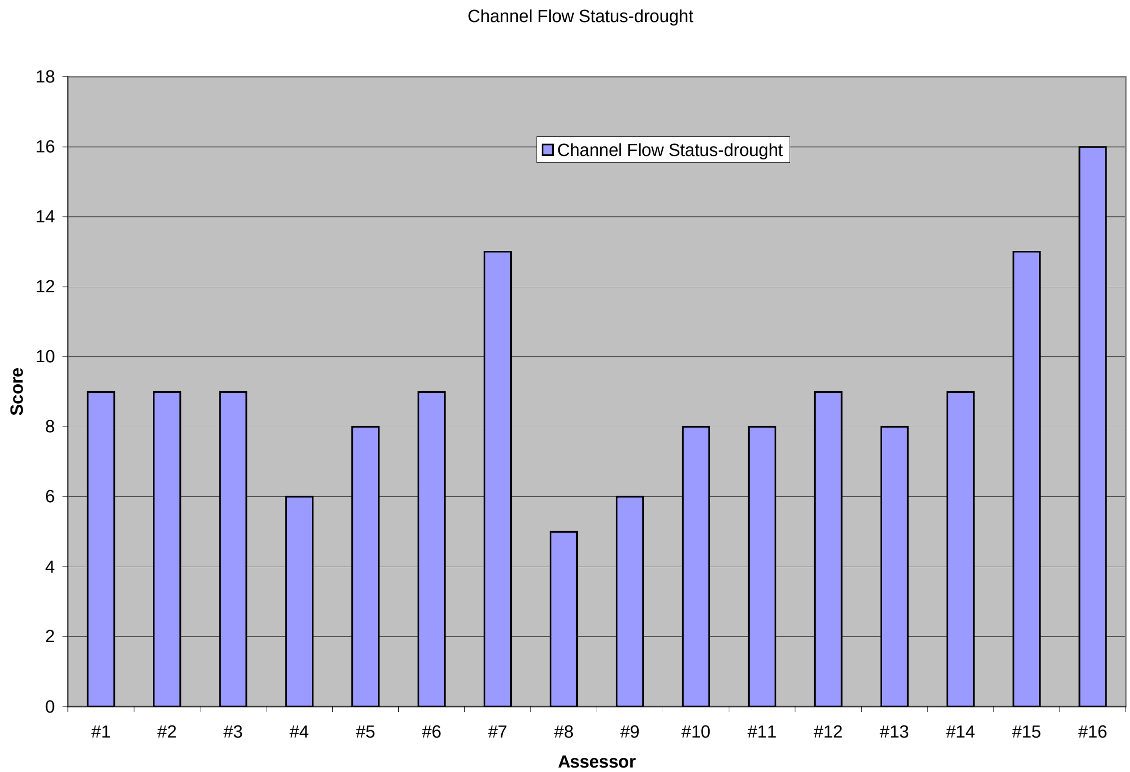


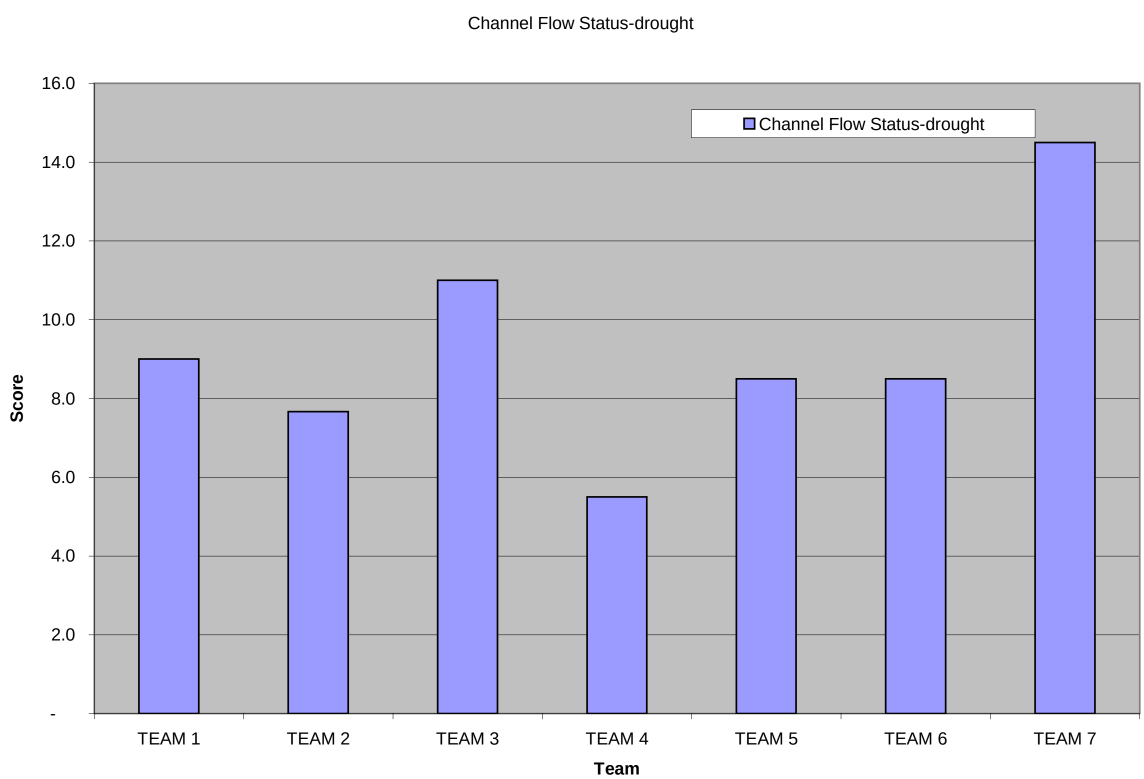
Channel Sinuosity



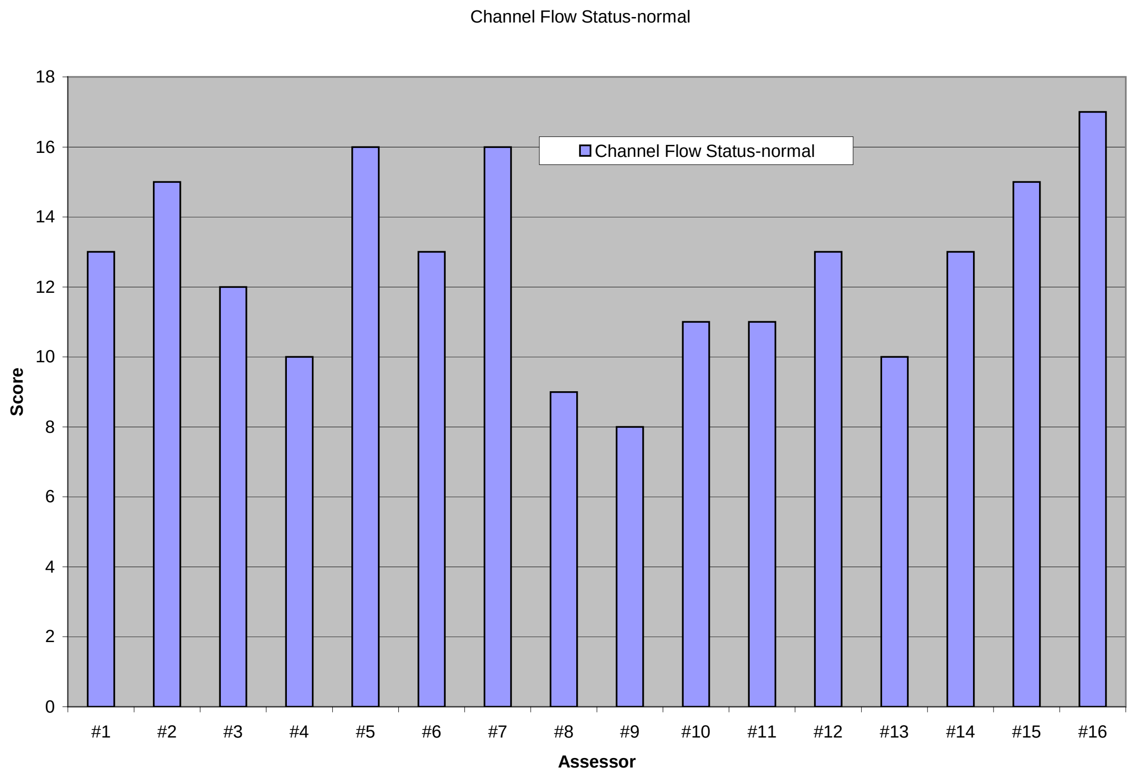


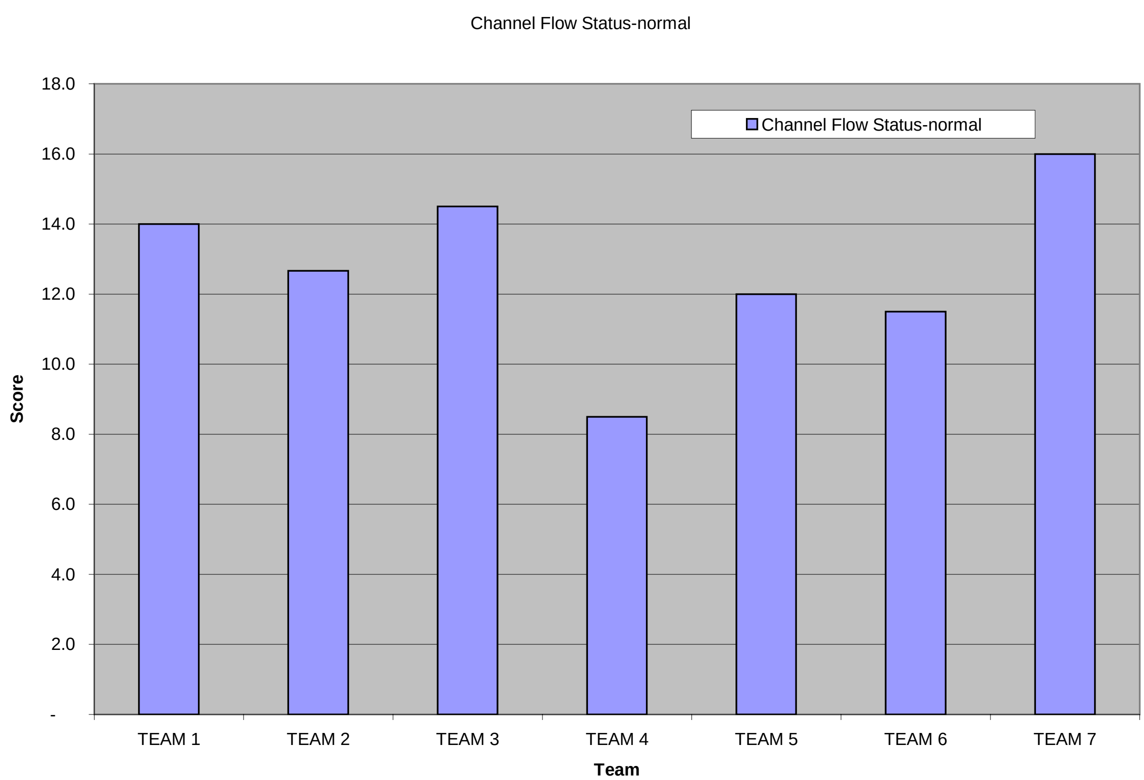
Channel Flow Status-drought



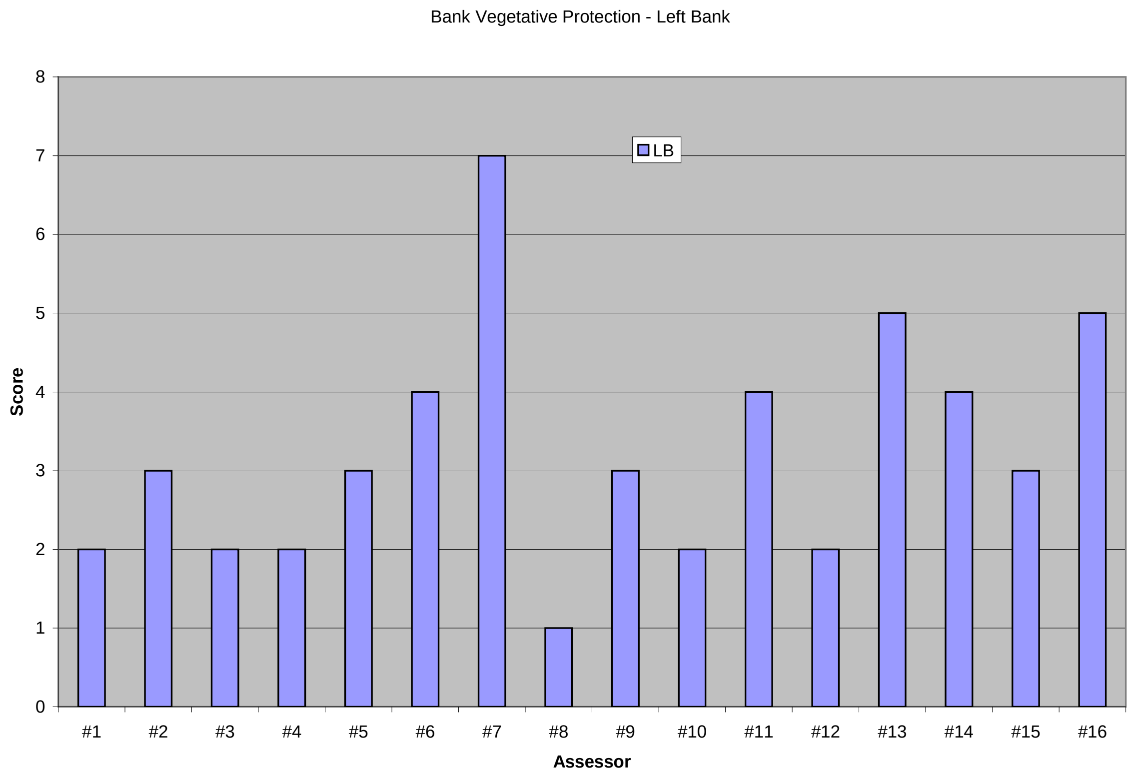


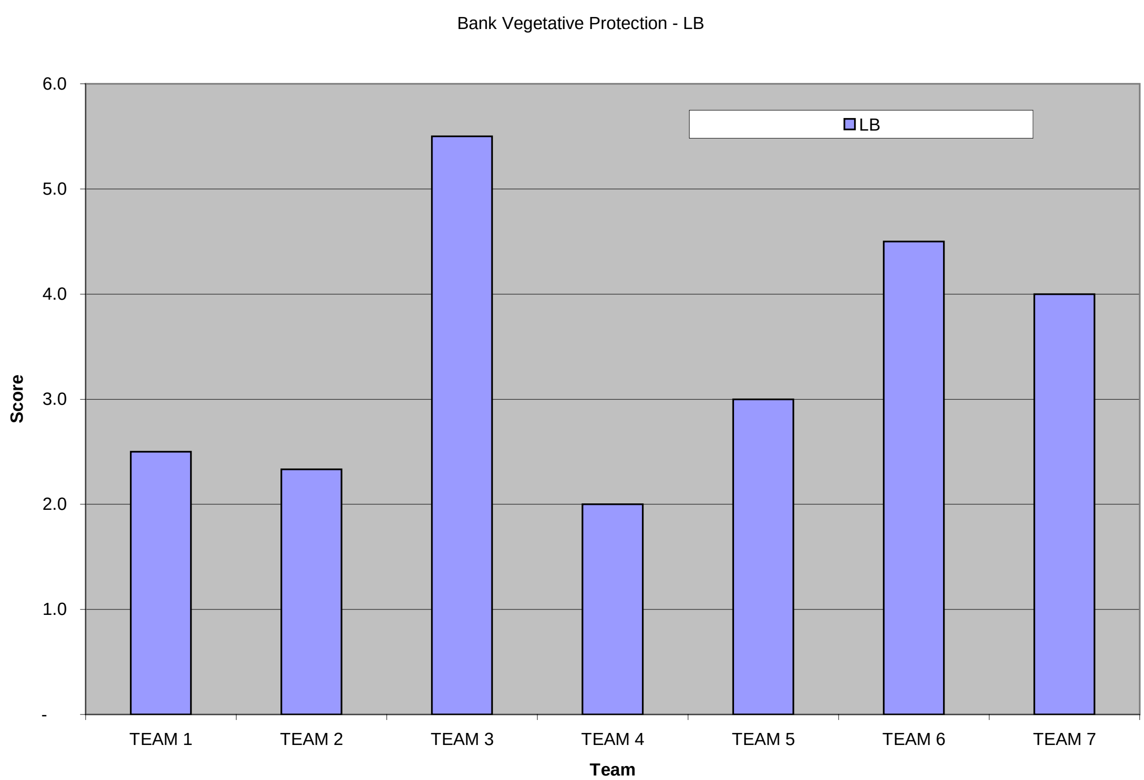
Channel Flow Status-normal



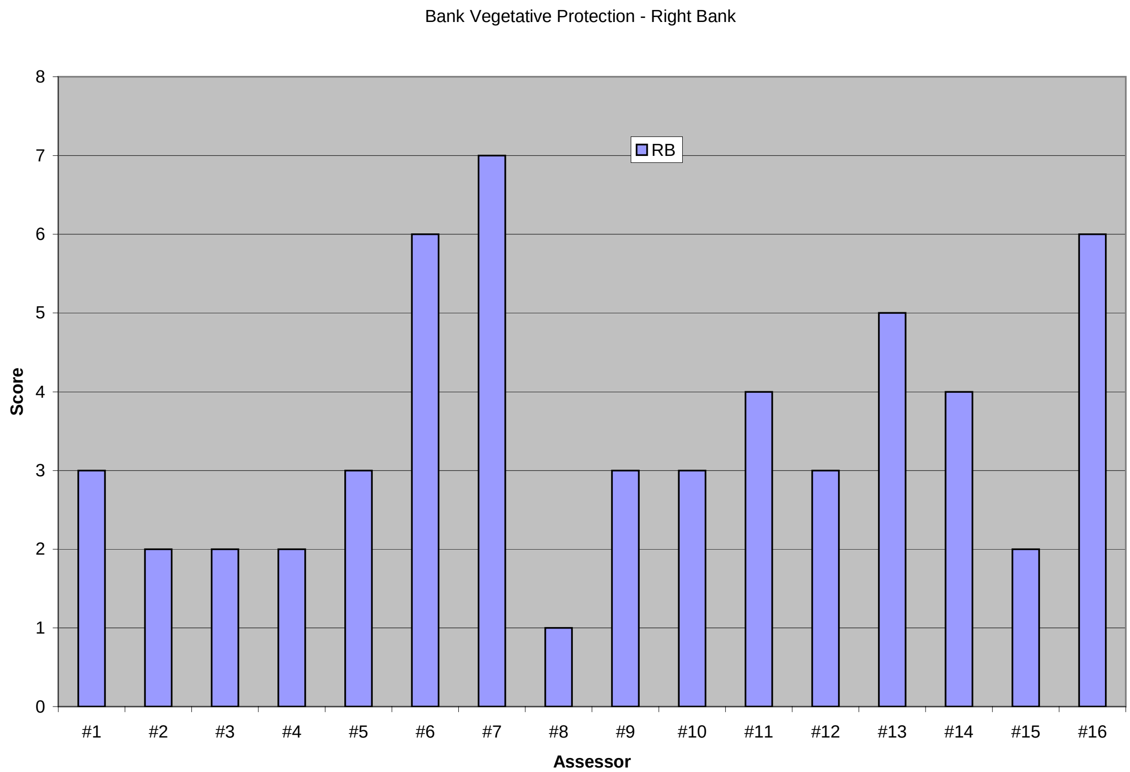


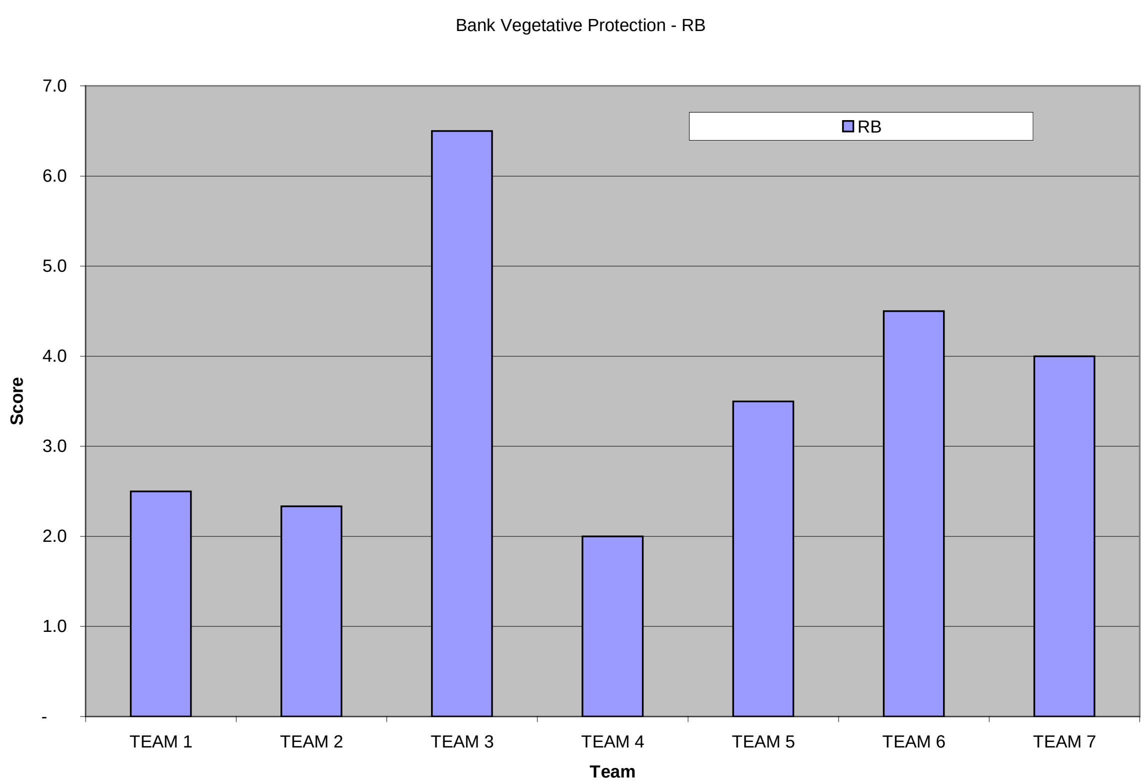
Bank Vegetative Protection – Left Bank



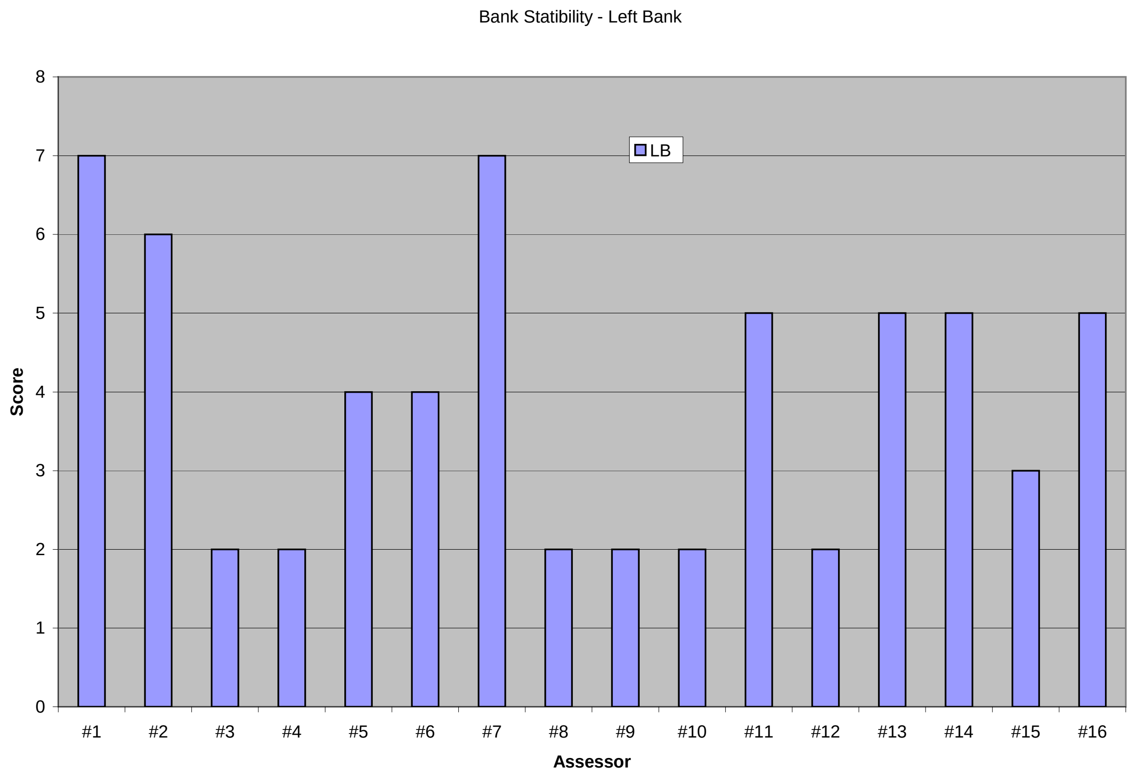


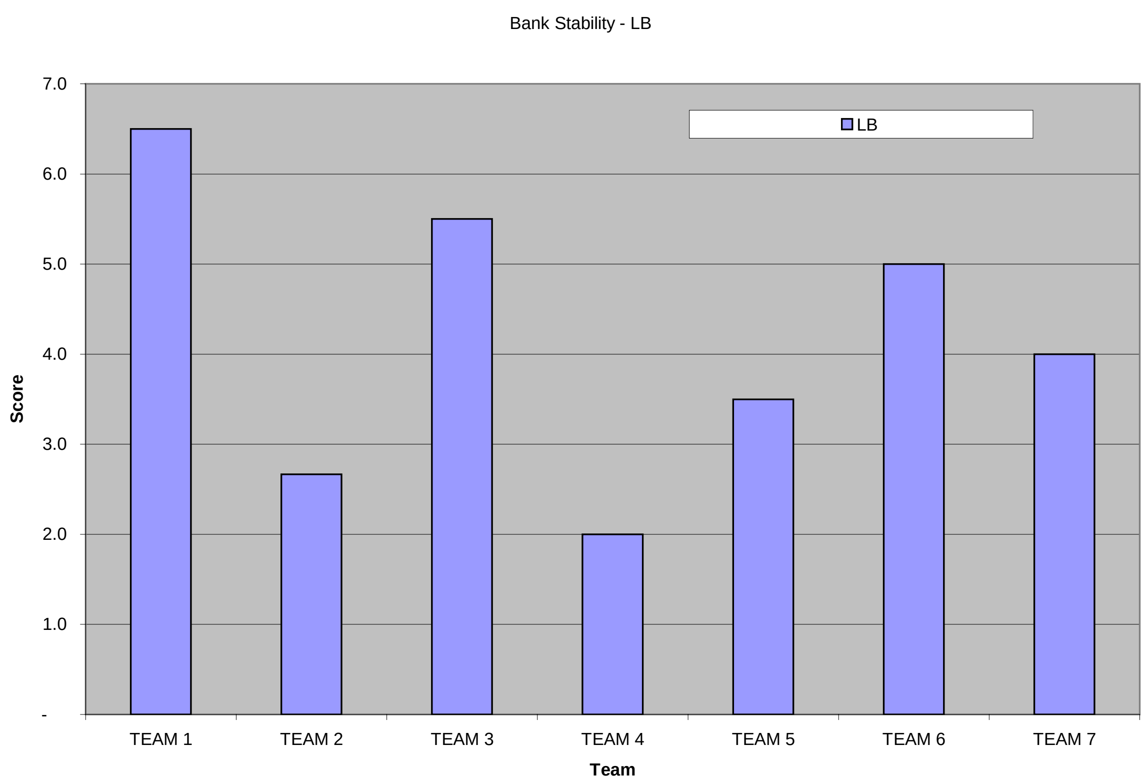
Bank Vegetative Protection – Right Bank



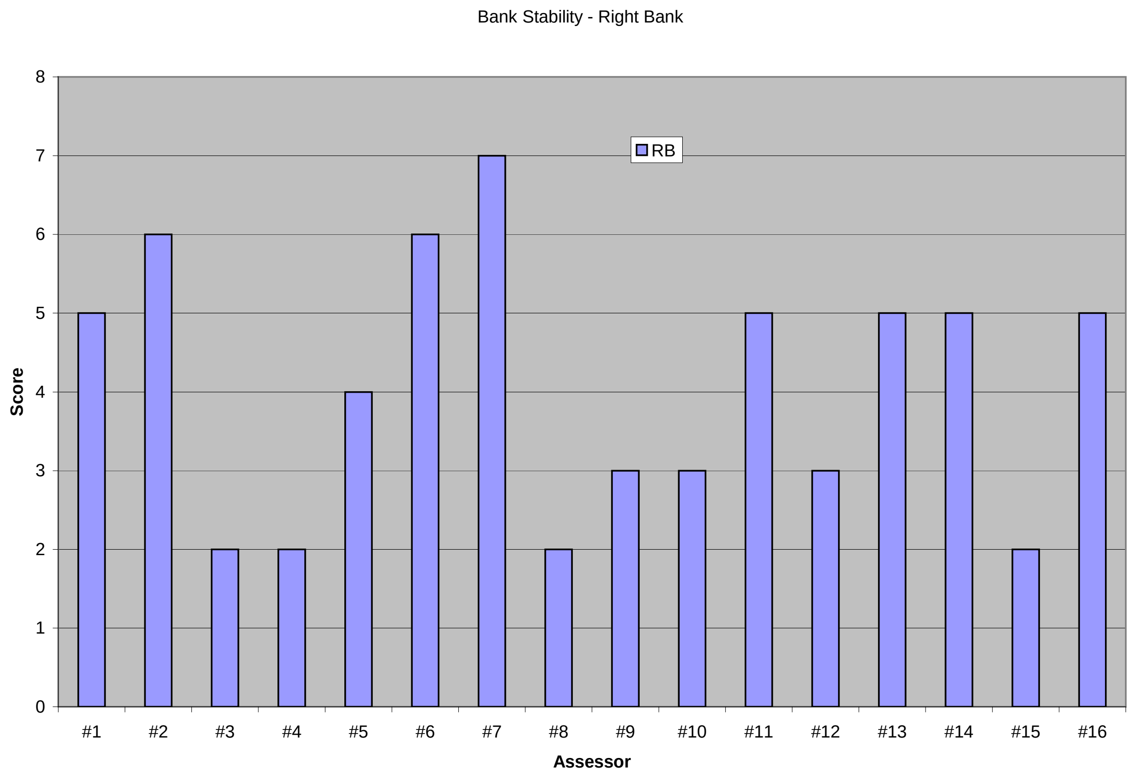


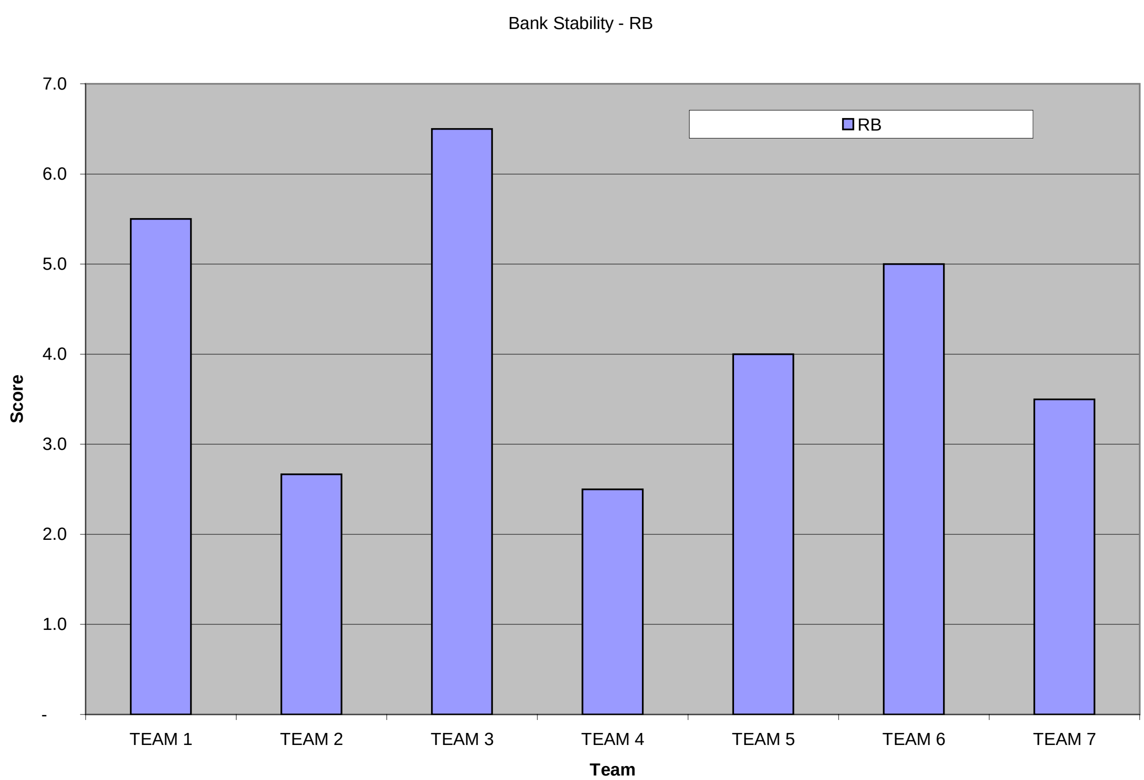
Bank Stability – Left Bank



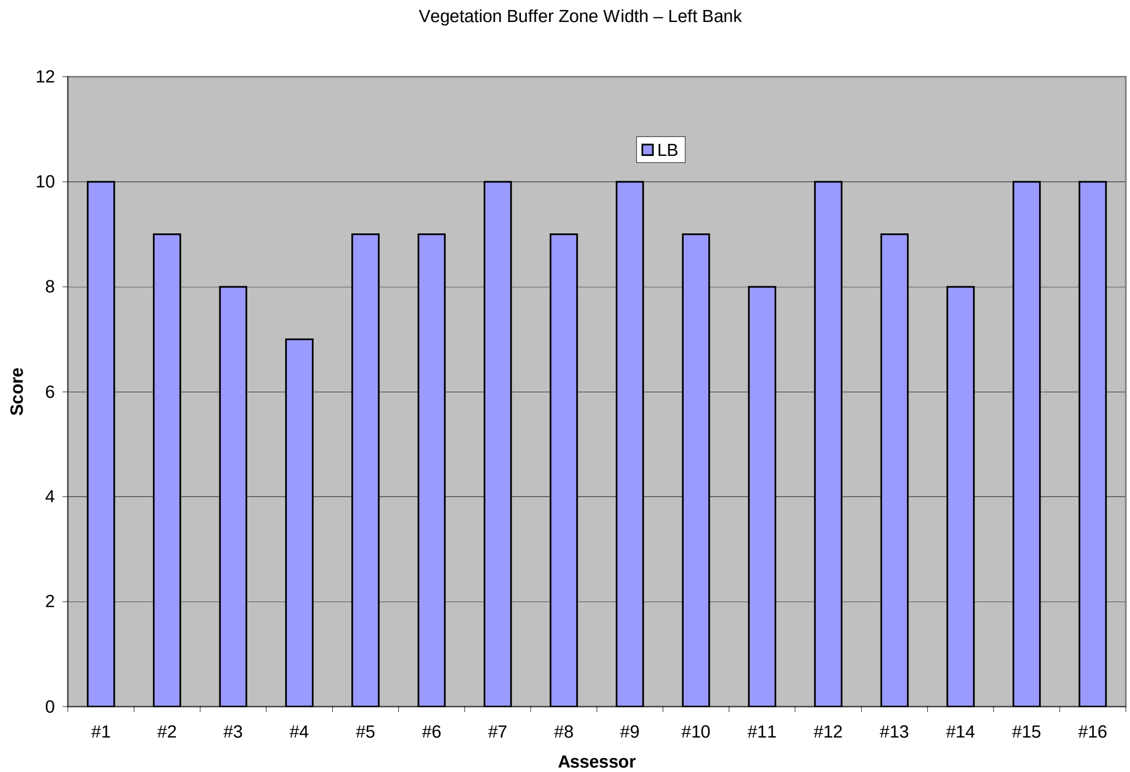


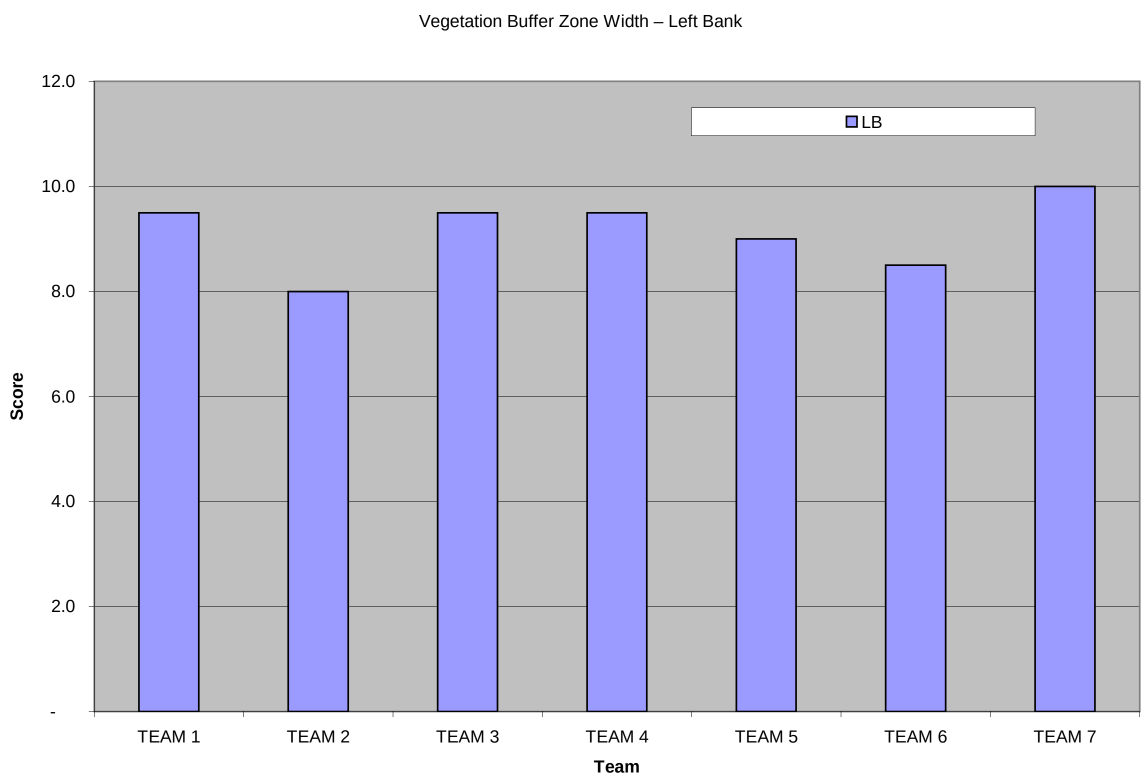
Bank Stability – Right Bank



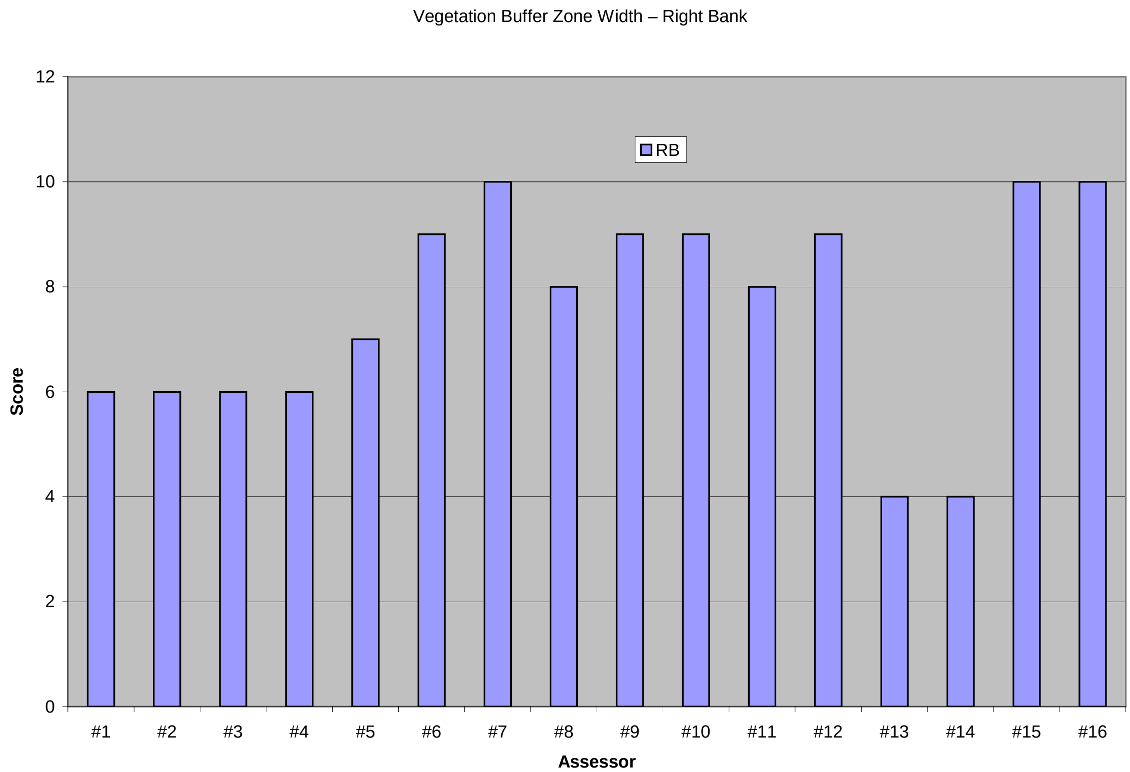


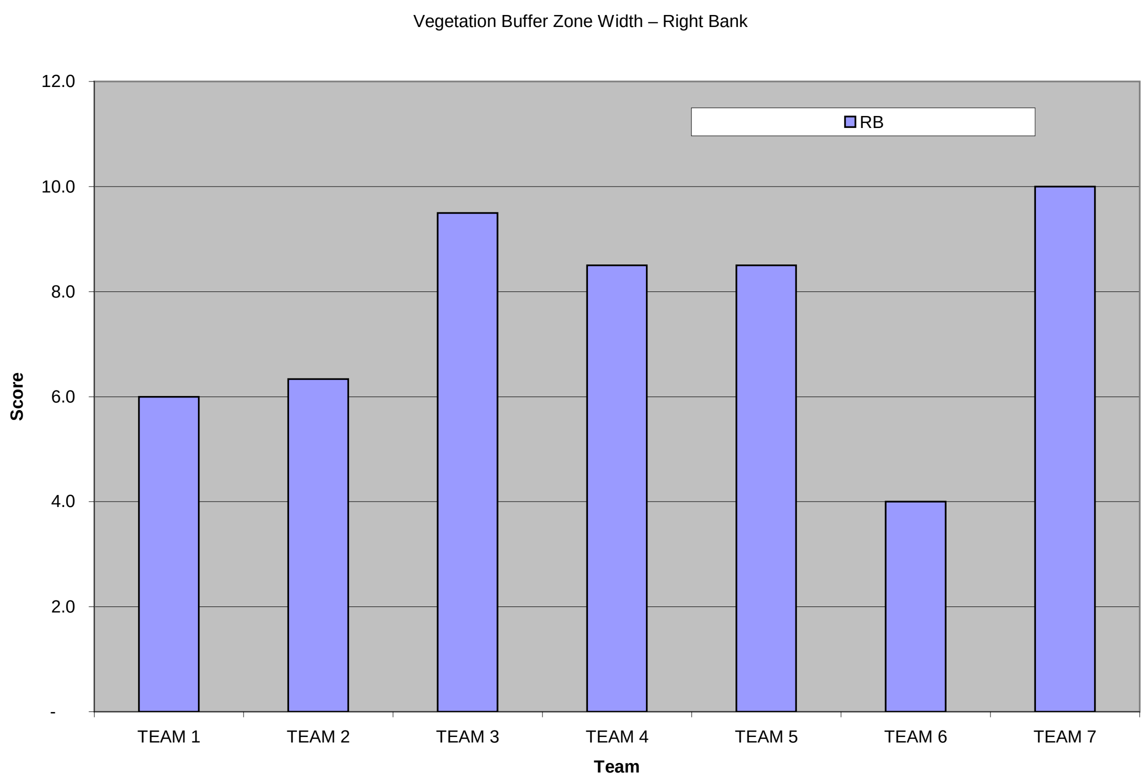
Vegetation Buffer Zone Width – Left Bank





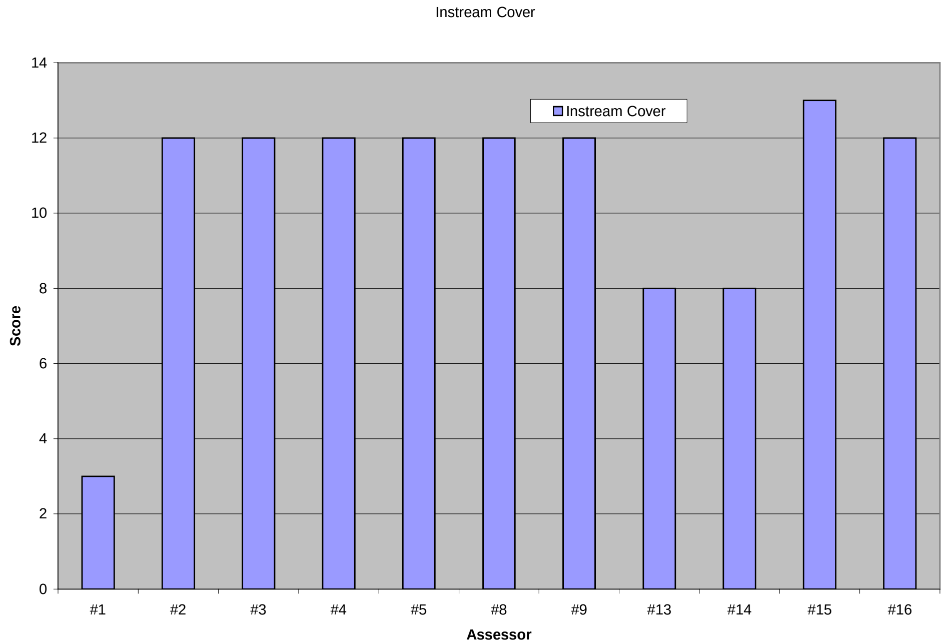
Vegetation Buffer Zone Width – Right Bank

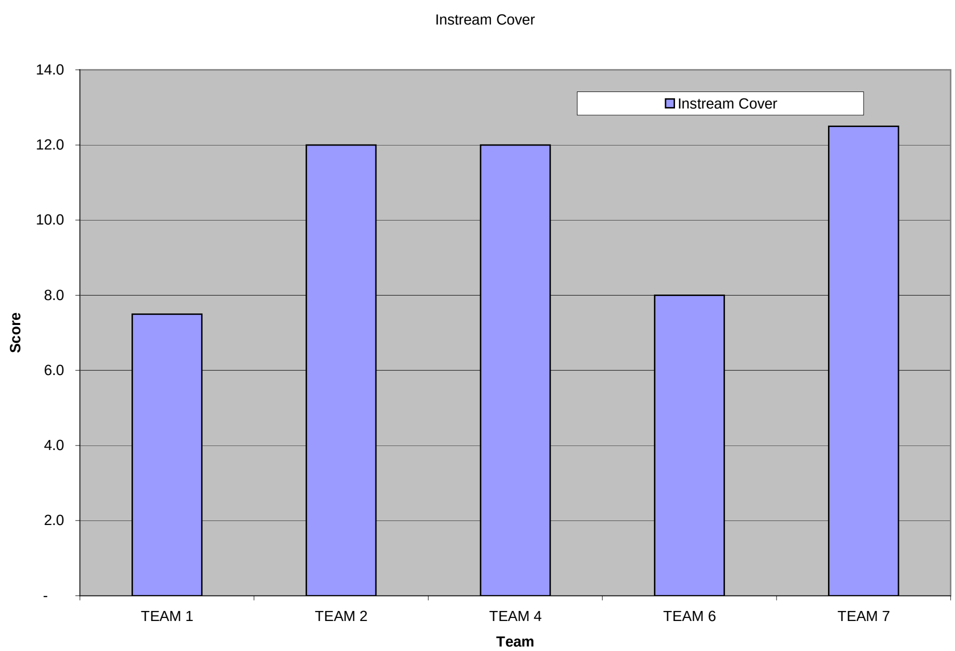




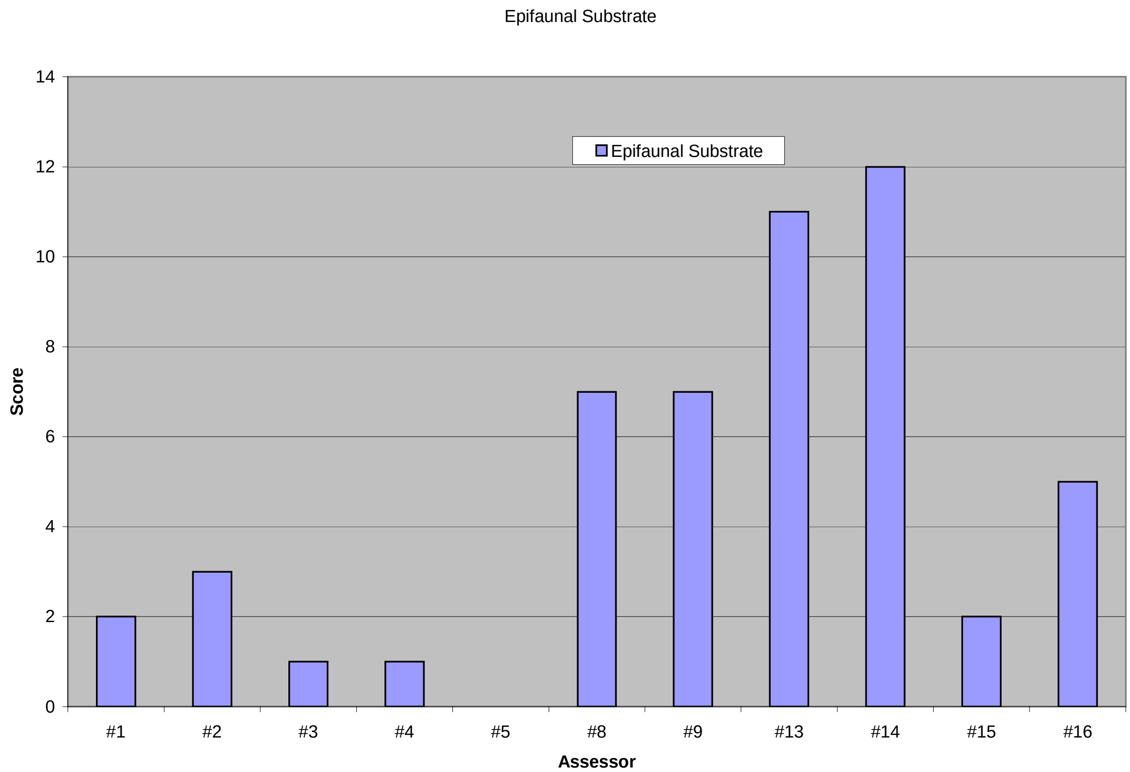
Attachment E: Plots of Habitat Metrics Scores by Individual and by Team, at Elk Horn Run

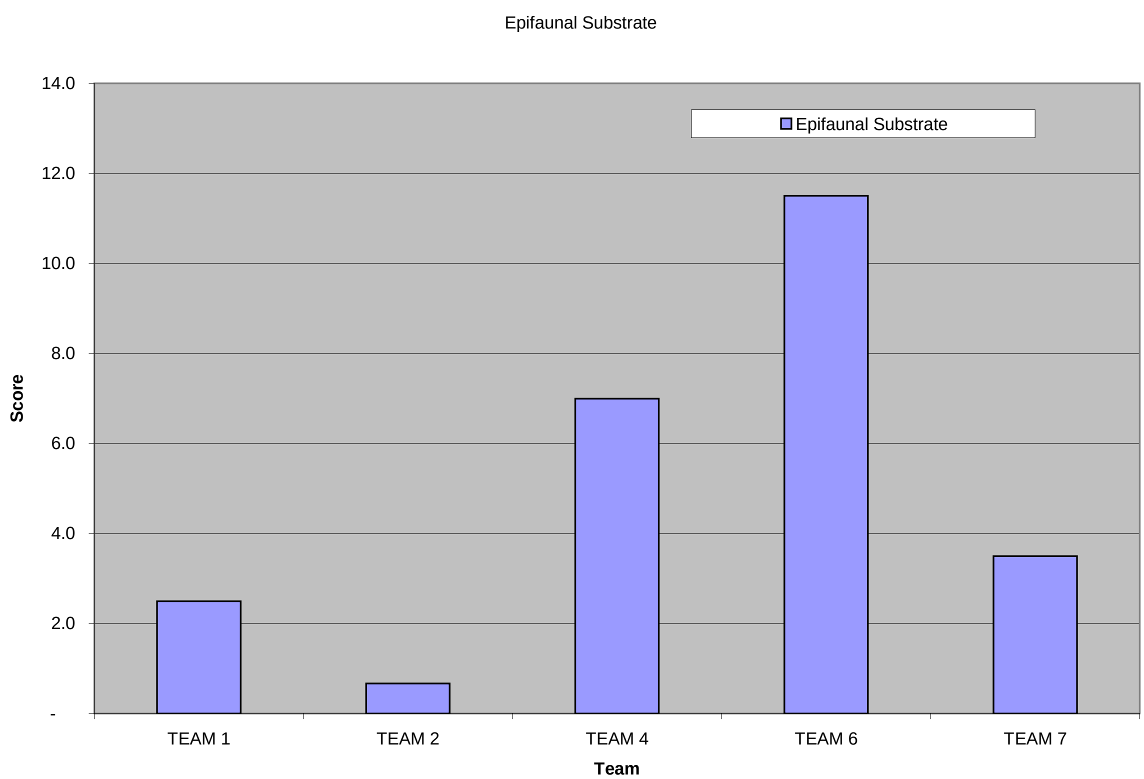
Instream Cover



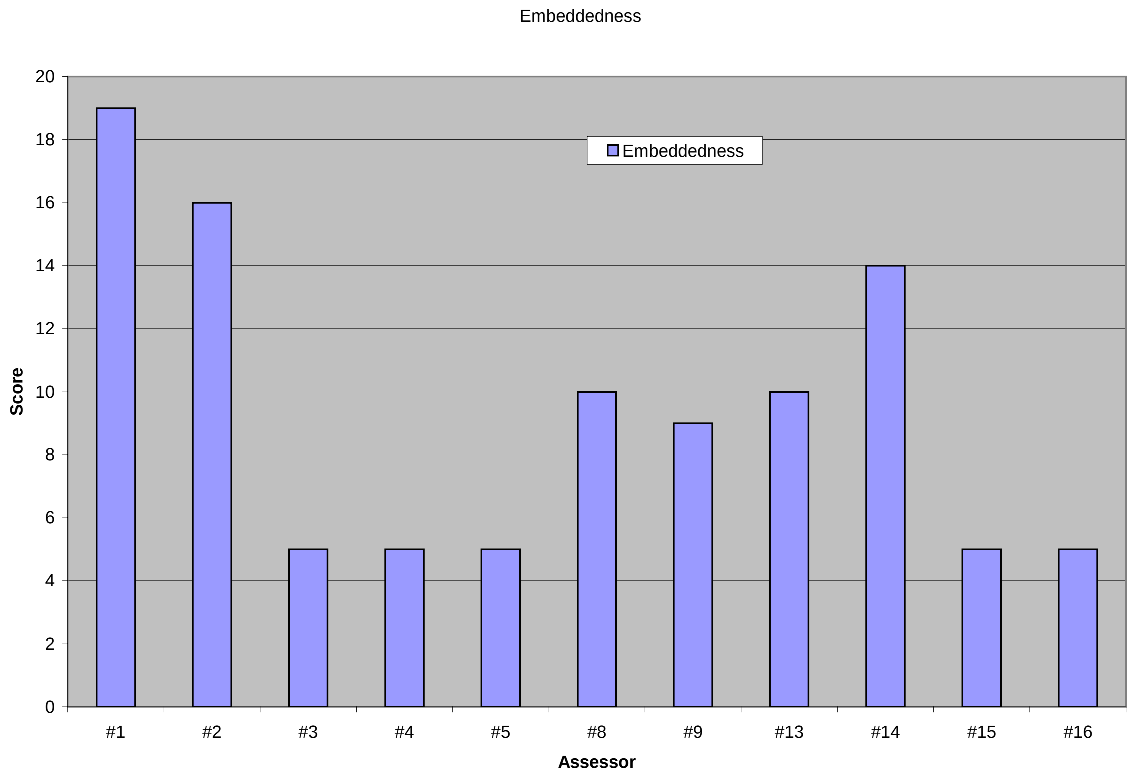


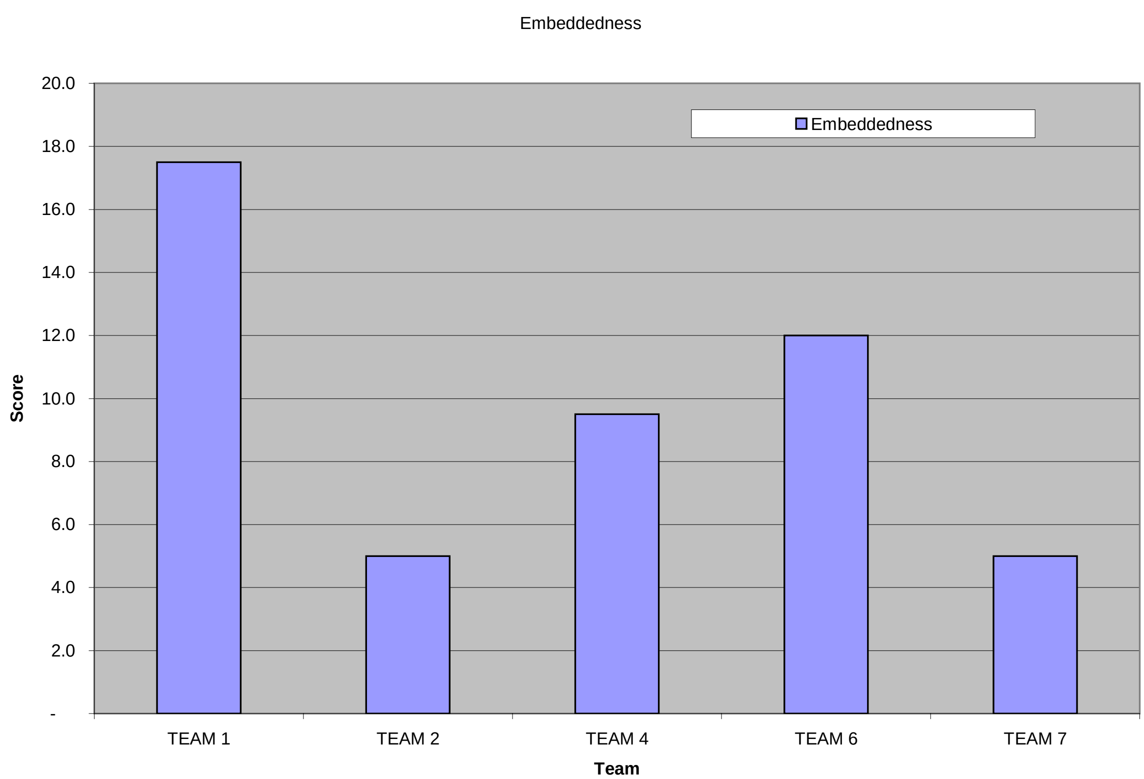
Epifaunal Substrate



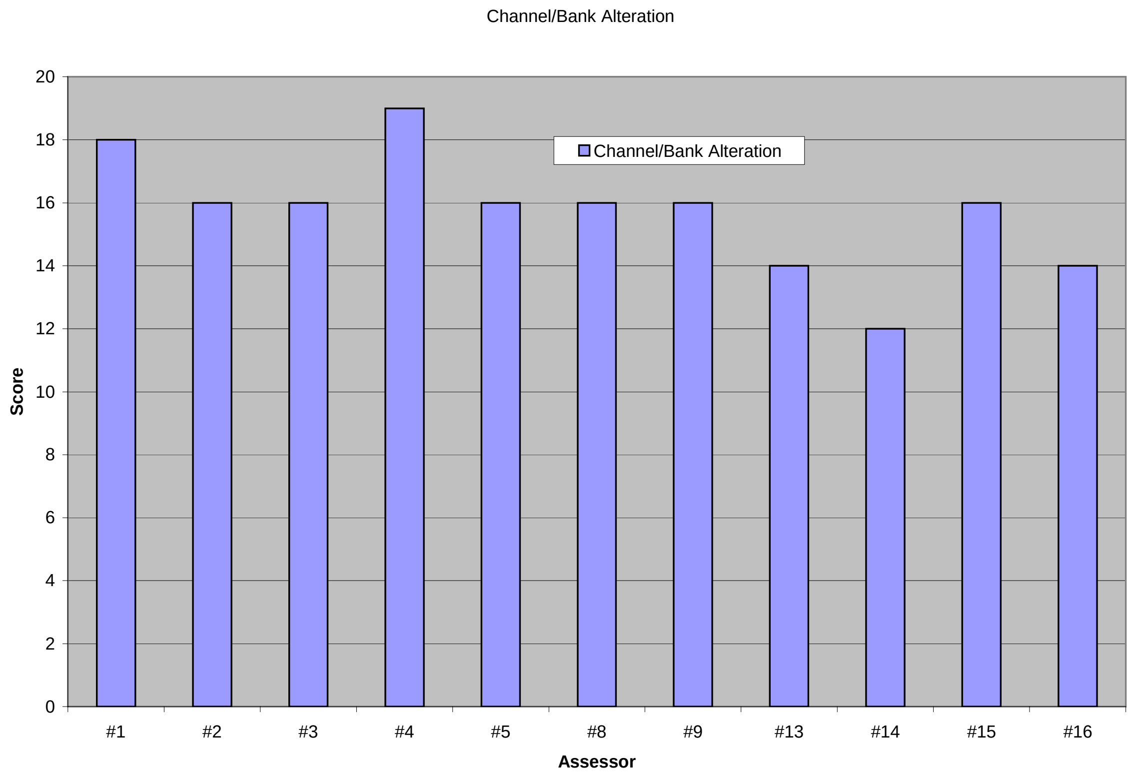


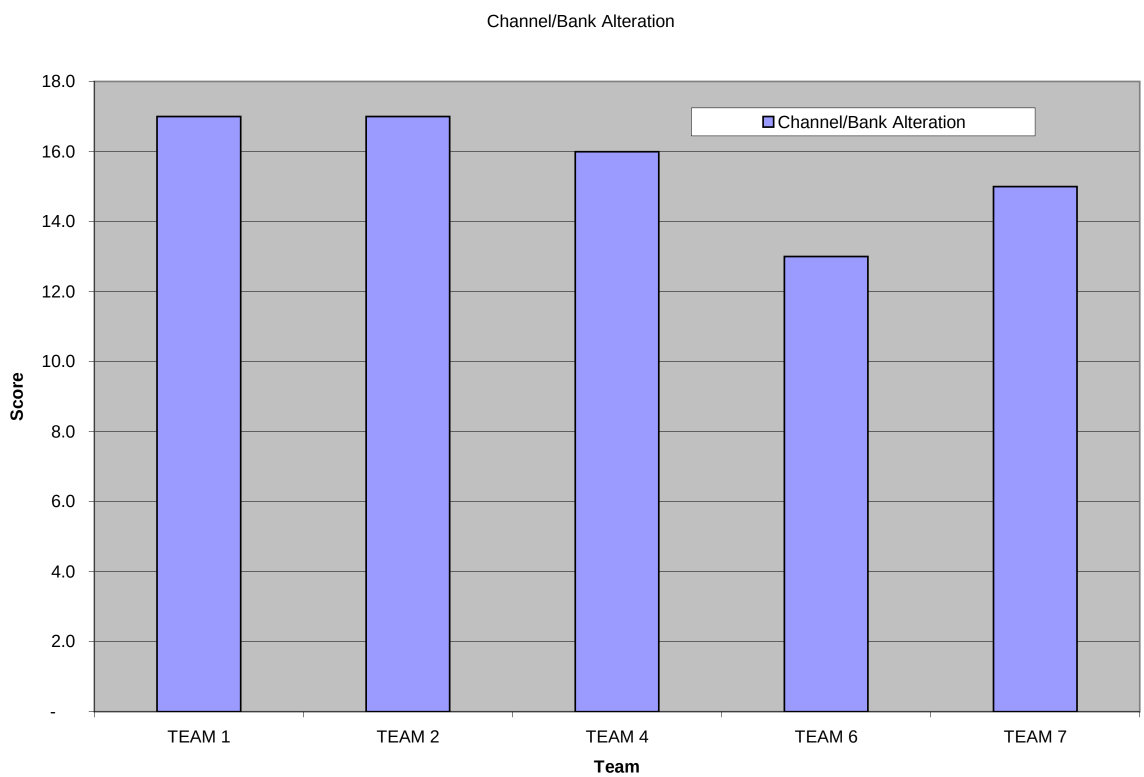
Embeddedness



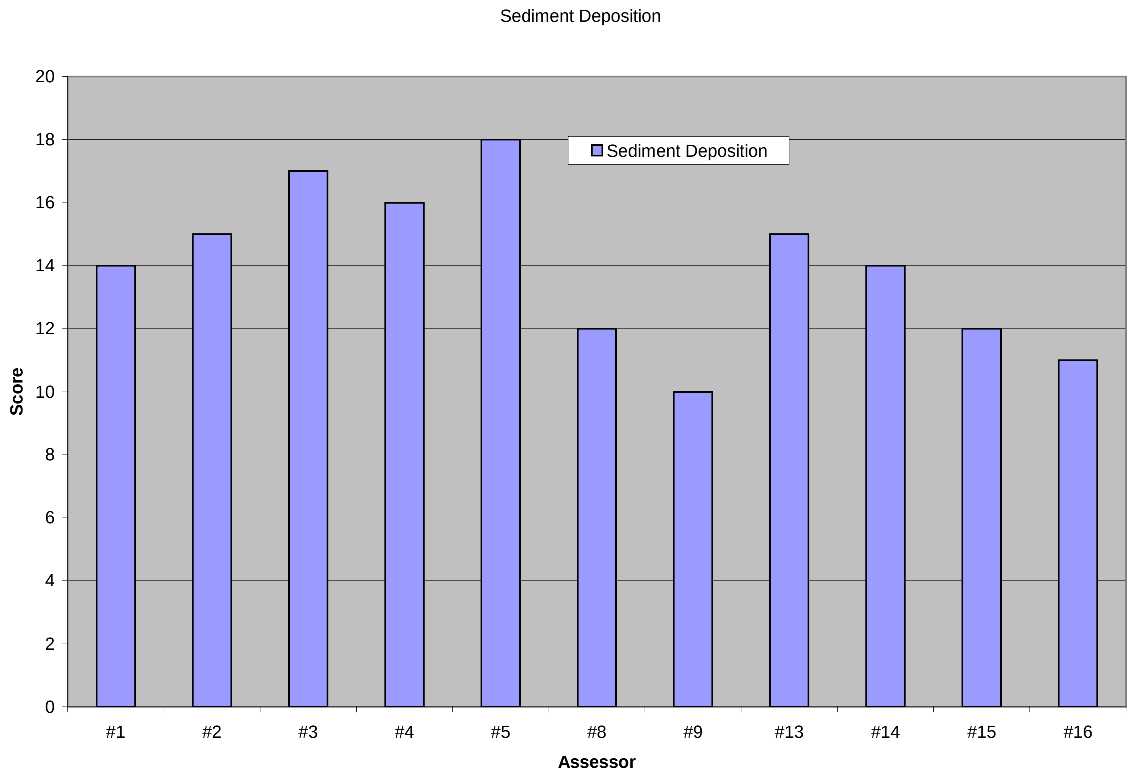


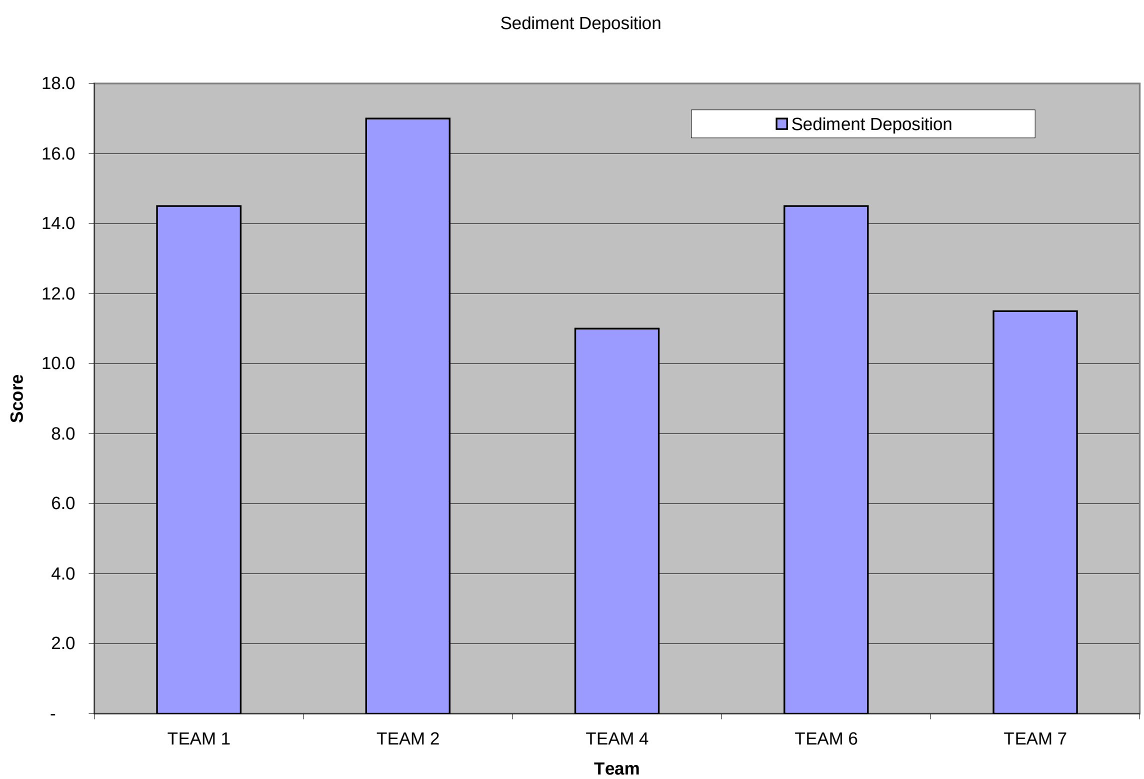
Channel/Bank Alteration



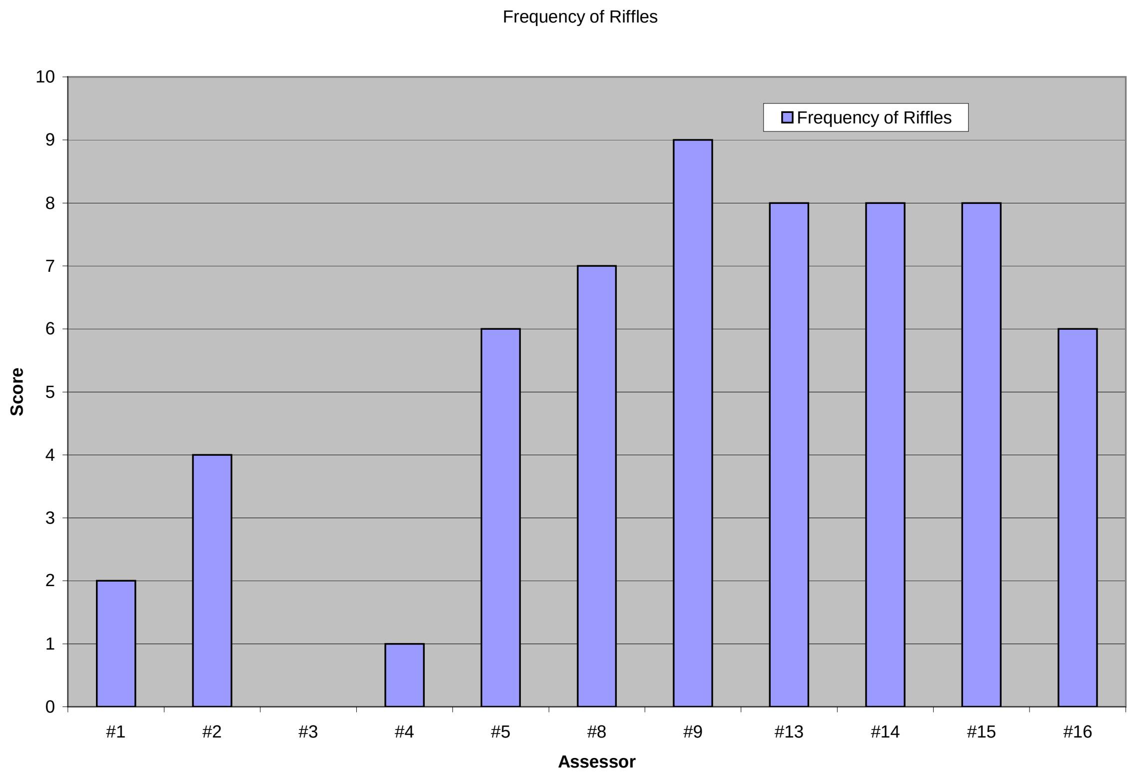


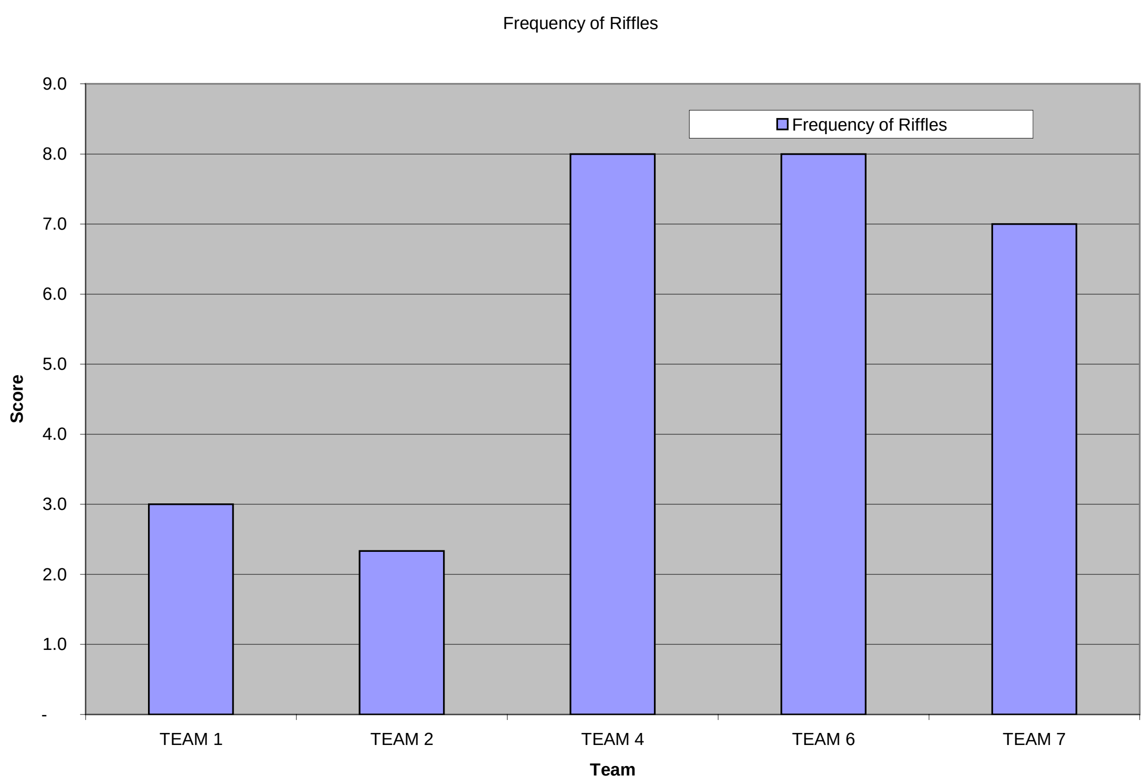
Sediment Deposition



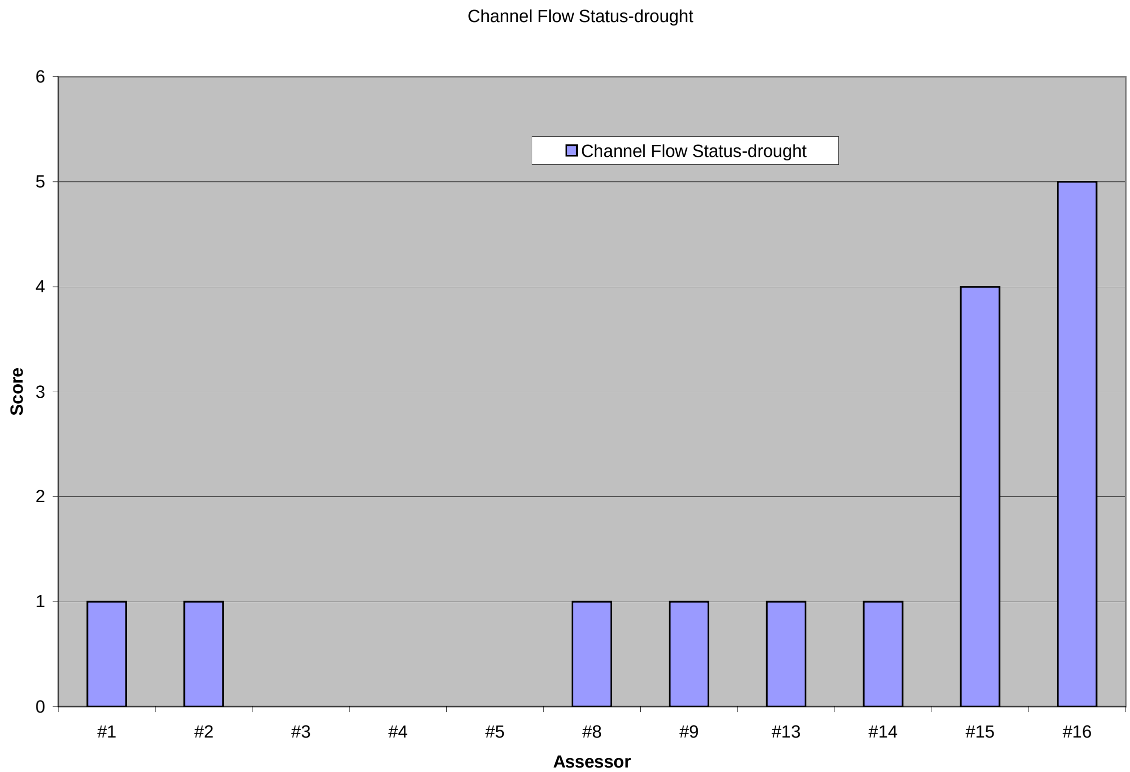


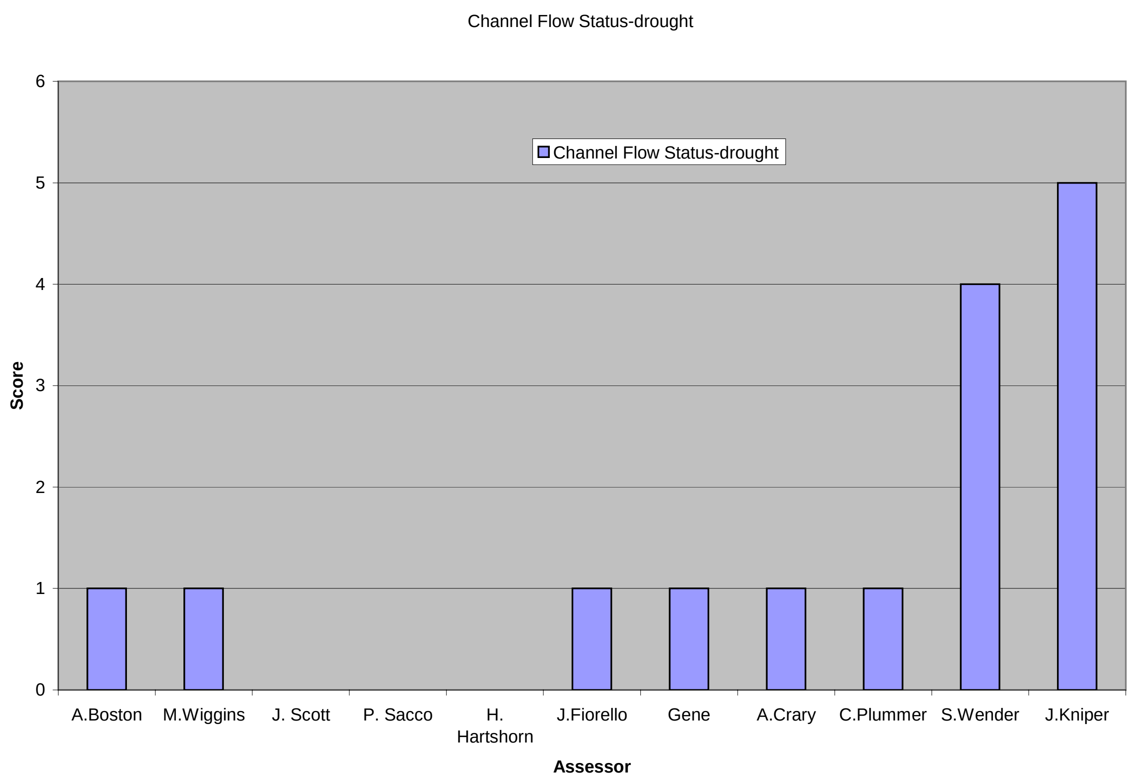
Frequency of Riffles



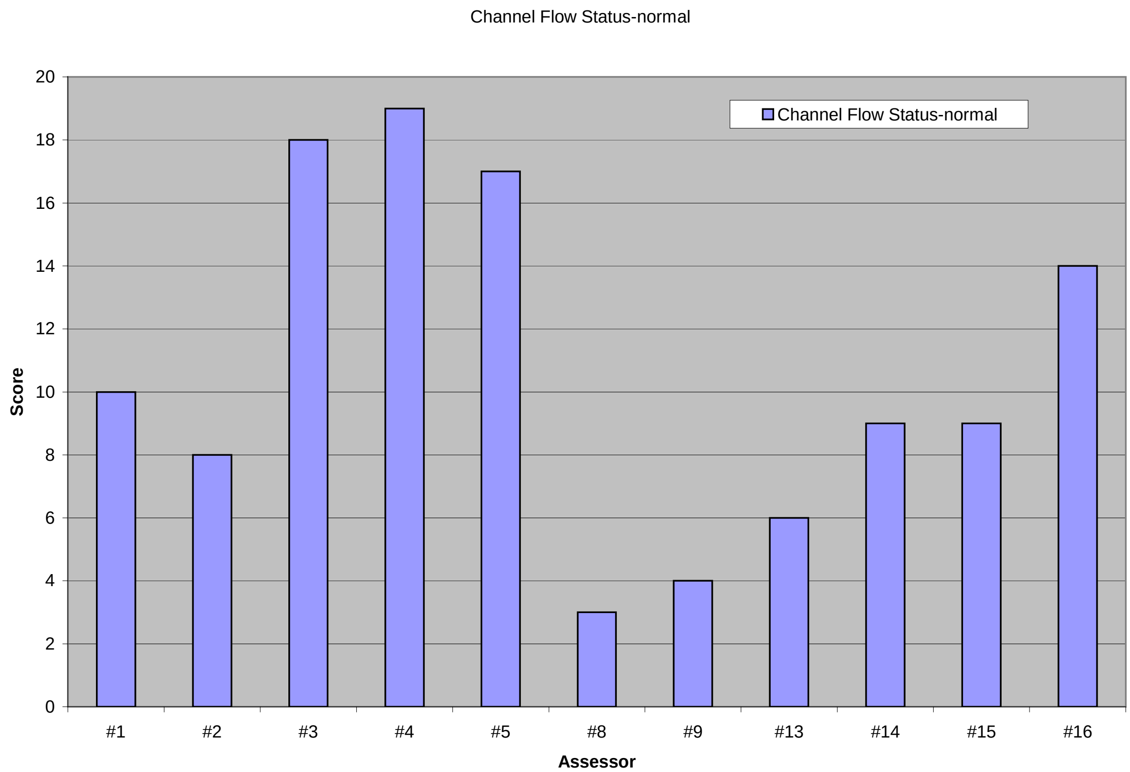


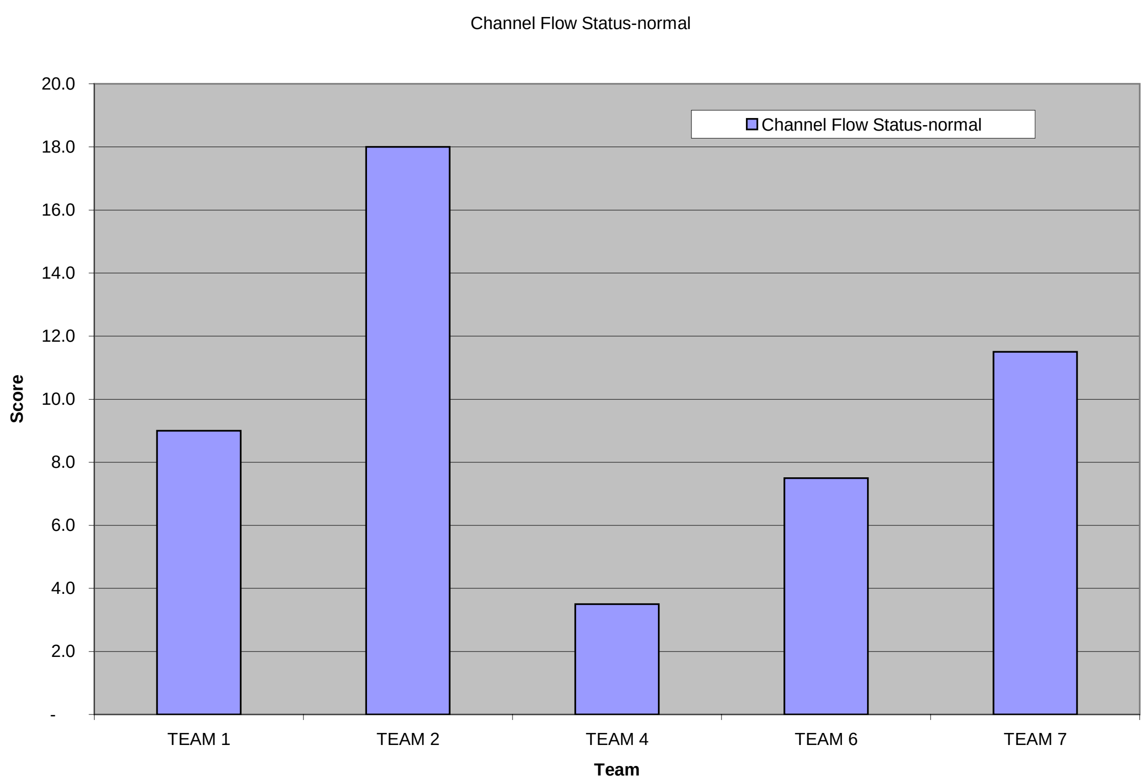
Channel Flow Status-drought



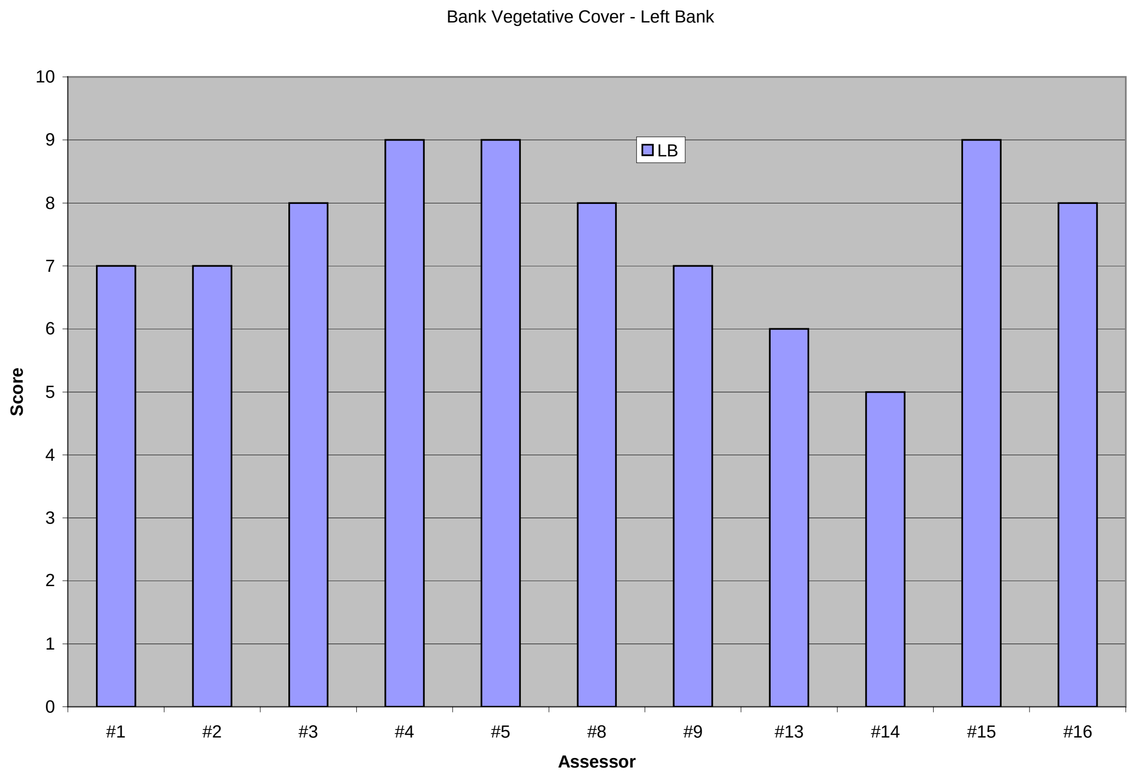


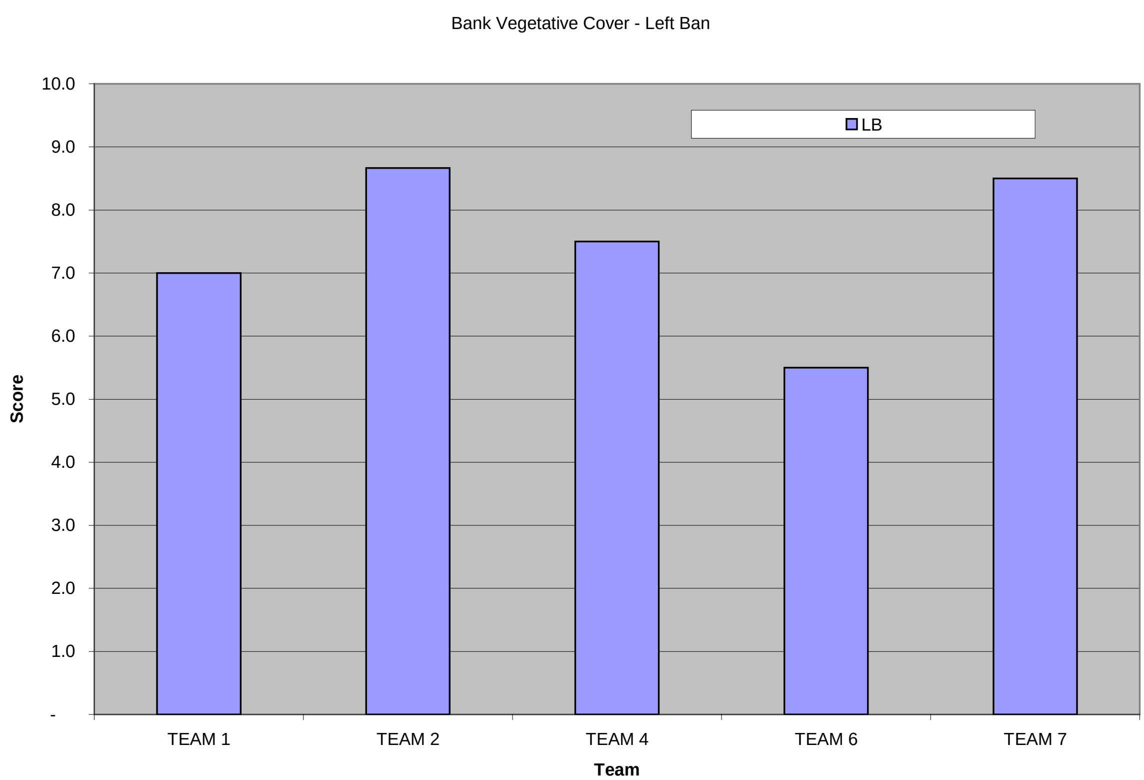
Channel Flow Status-normal



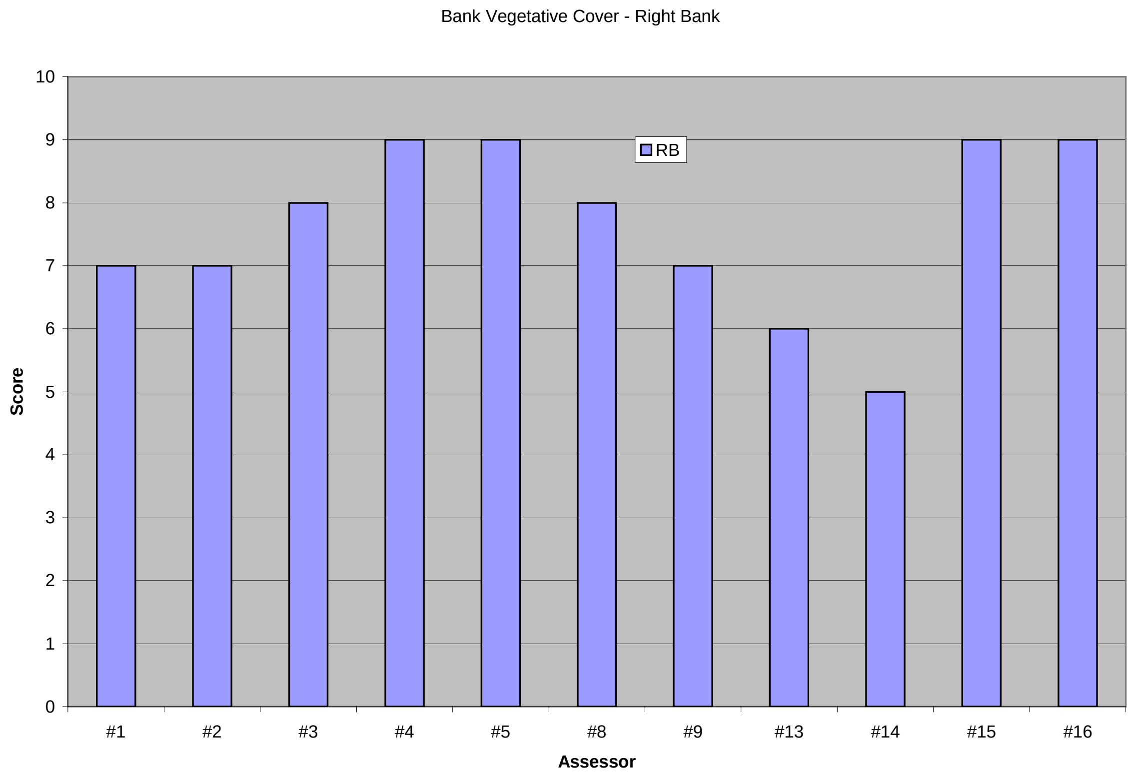


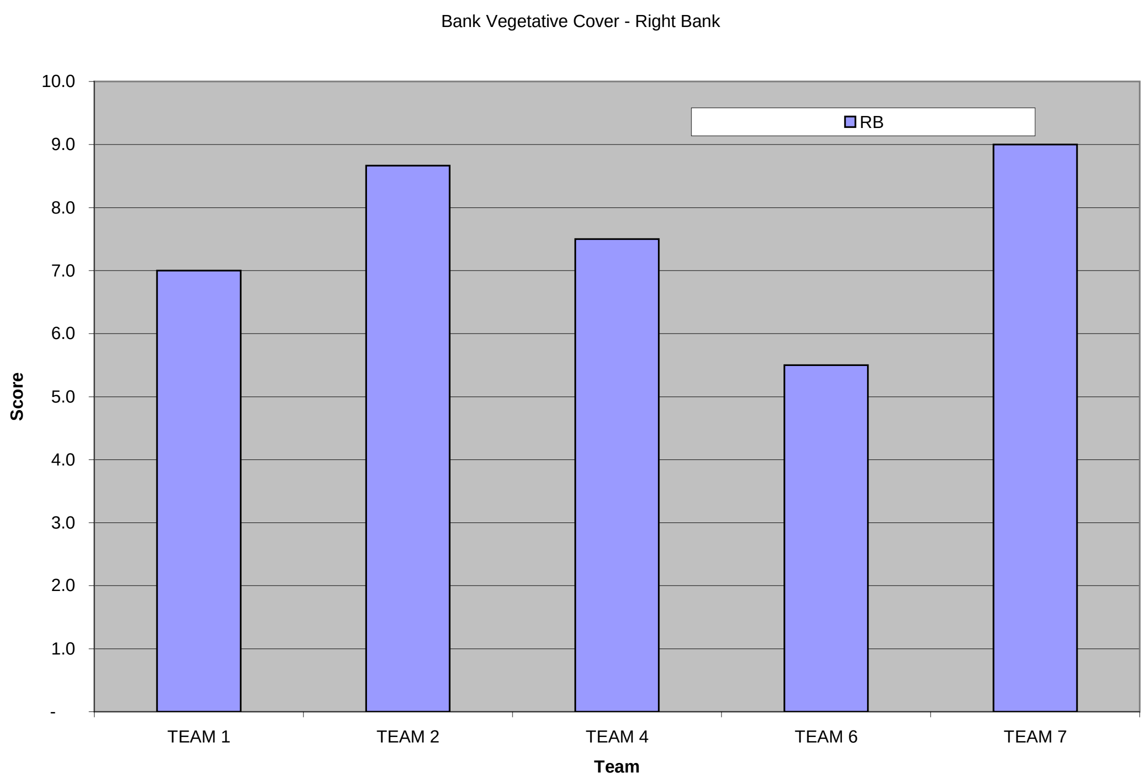
Bank Vegetative Protection – Left Bank



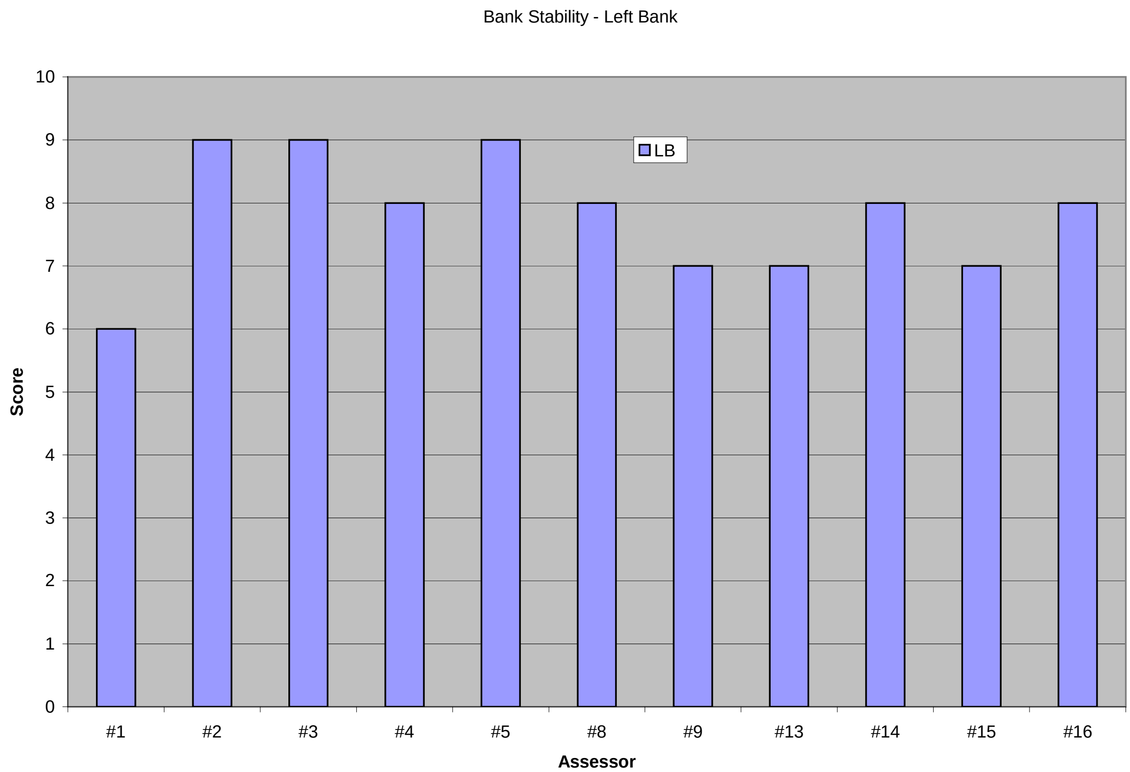


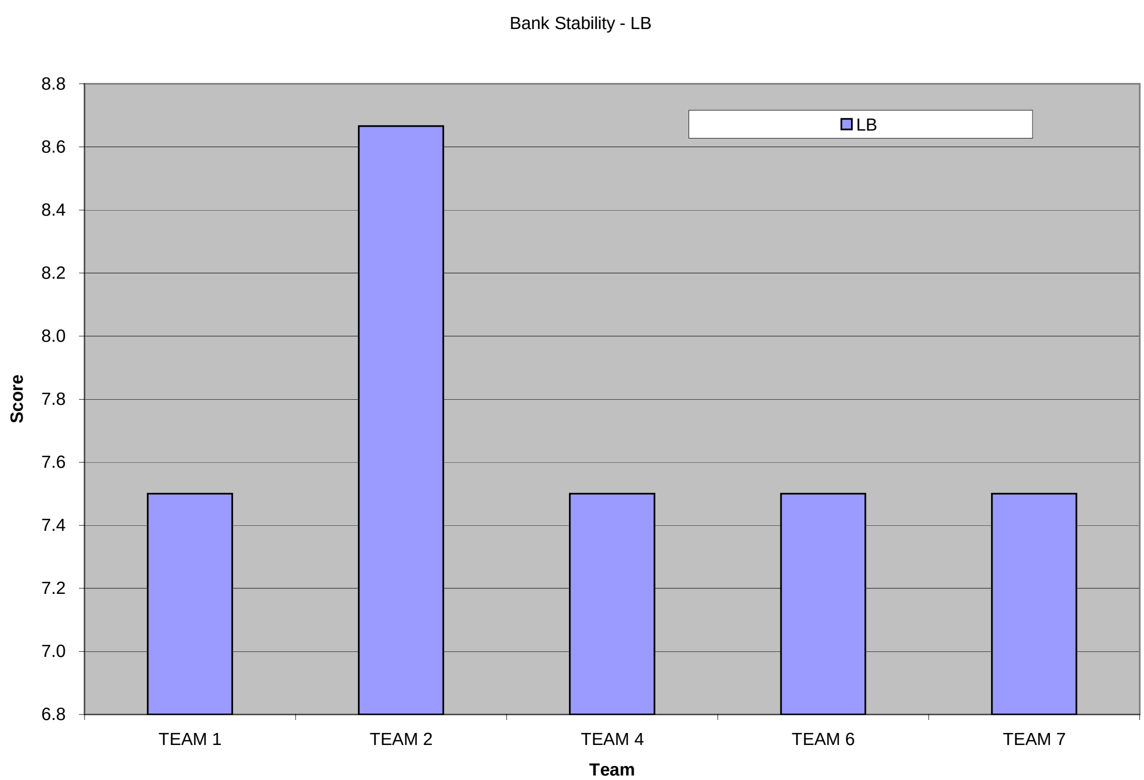
Bank Vegetative Protection – Right Bank



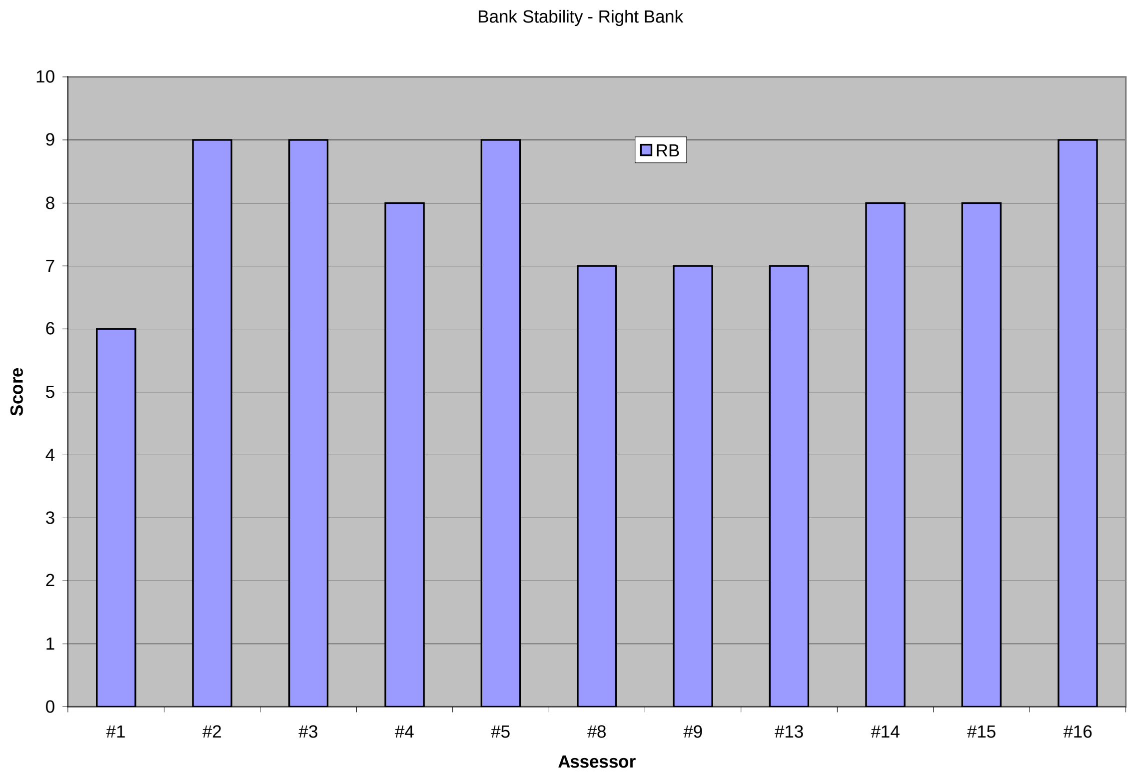


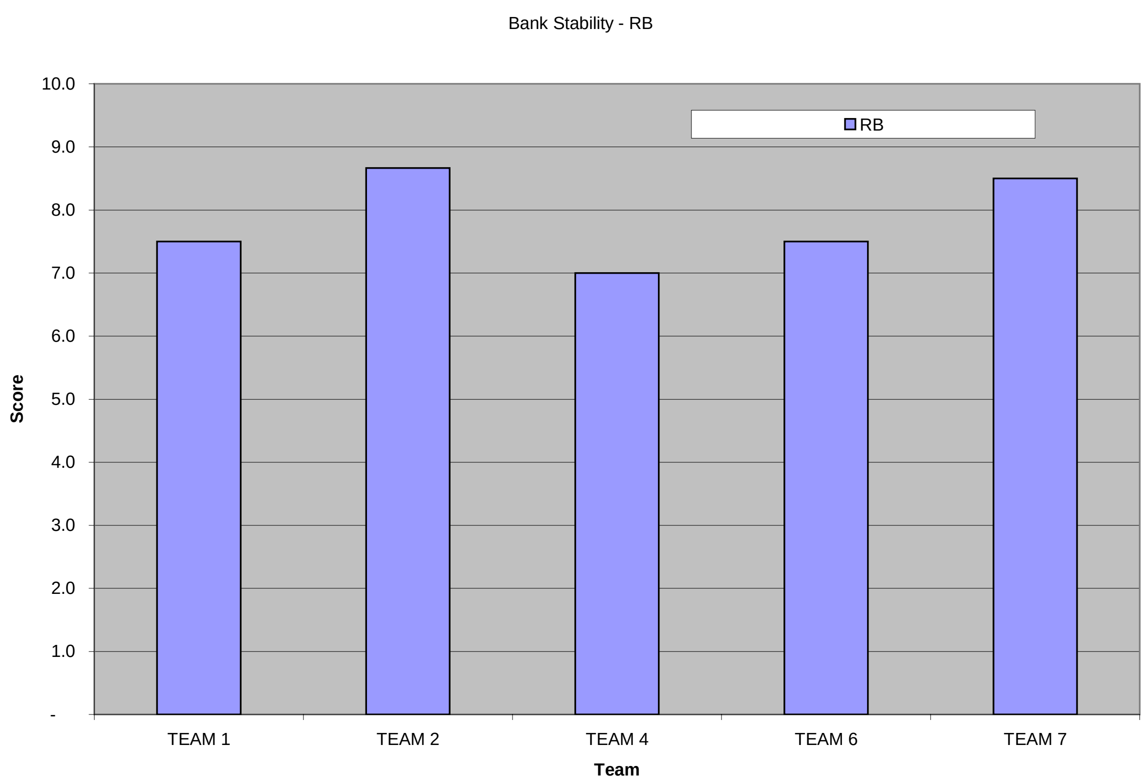
Bank Stability – Left Bank



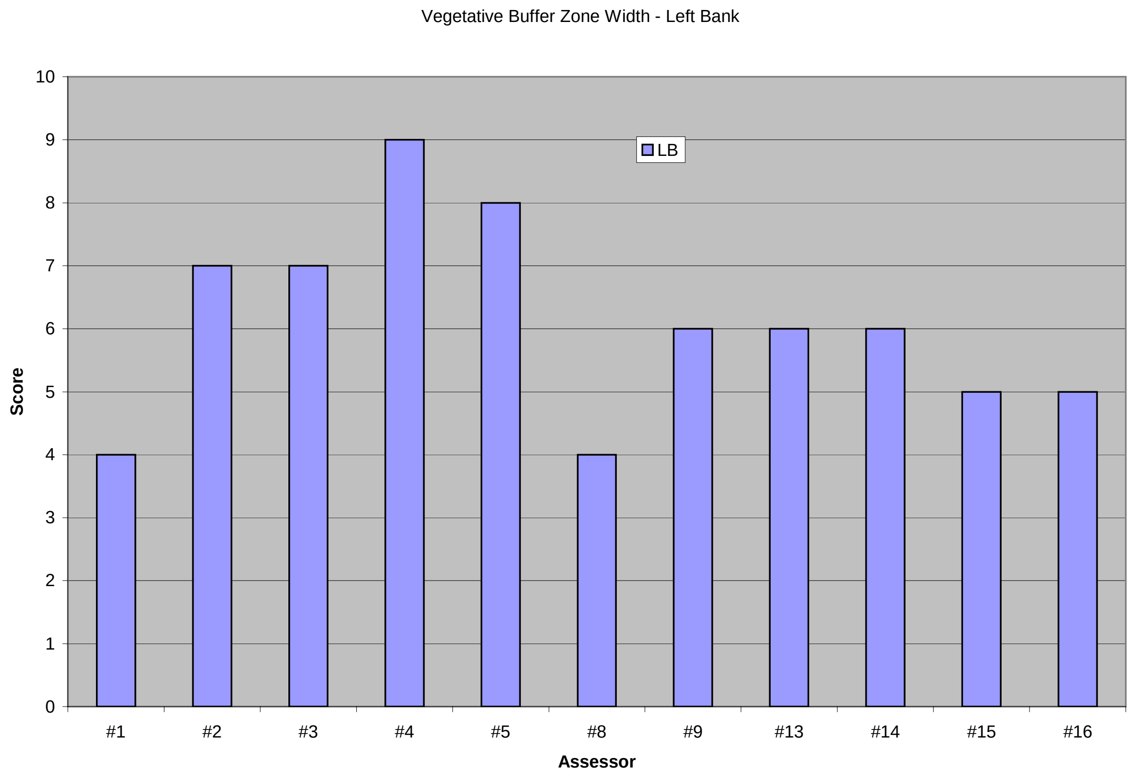


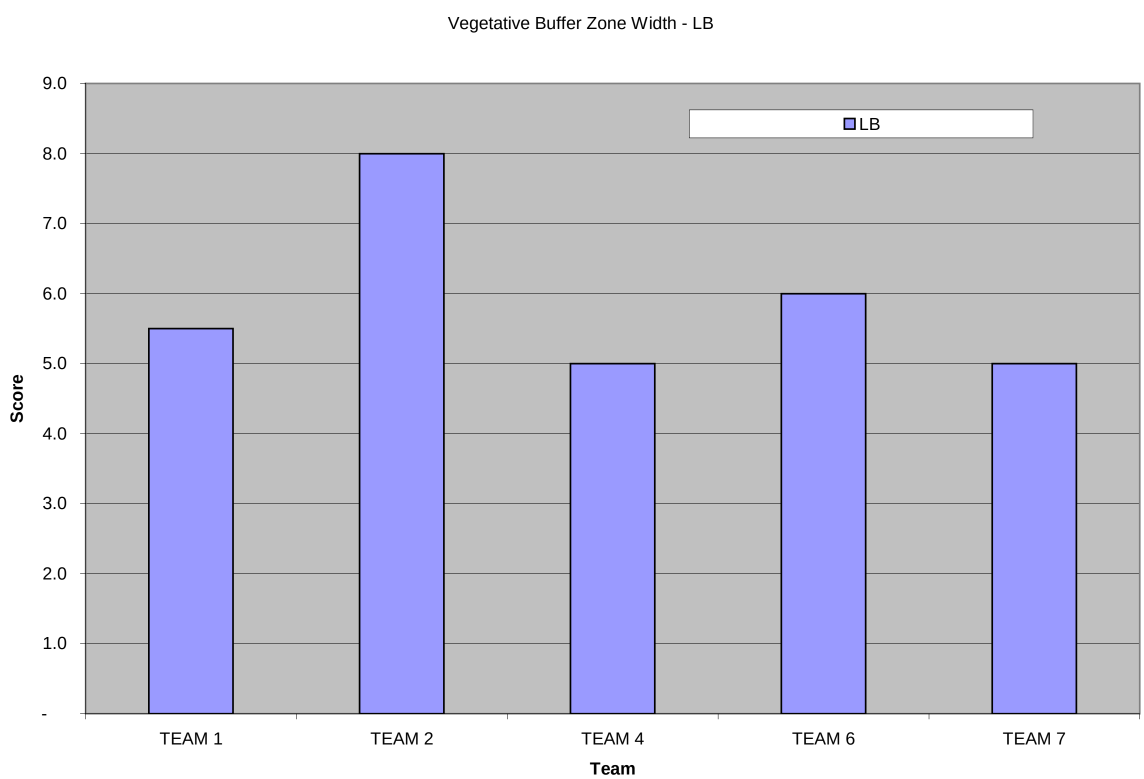
Bank Stability – Right Bank



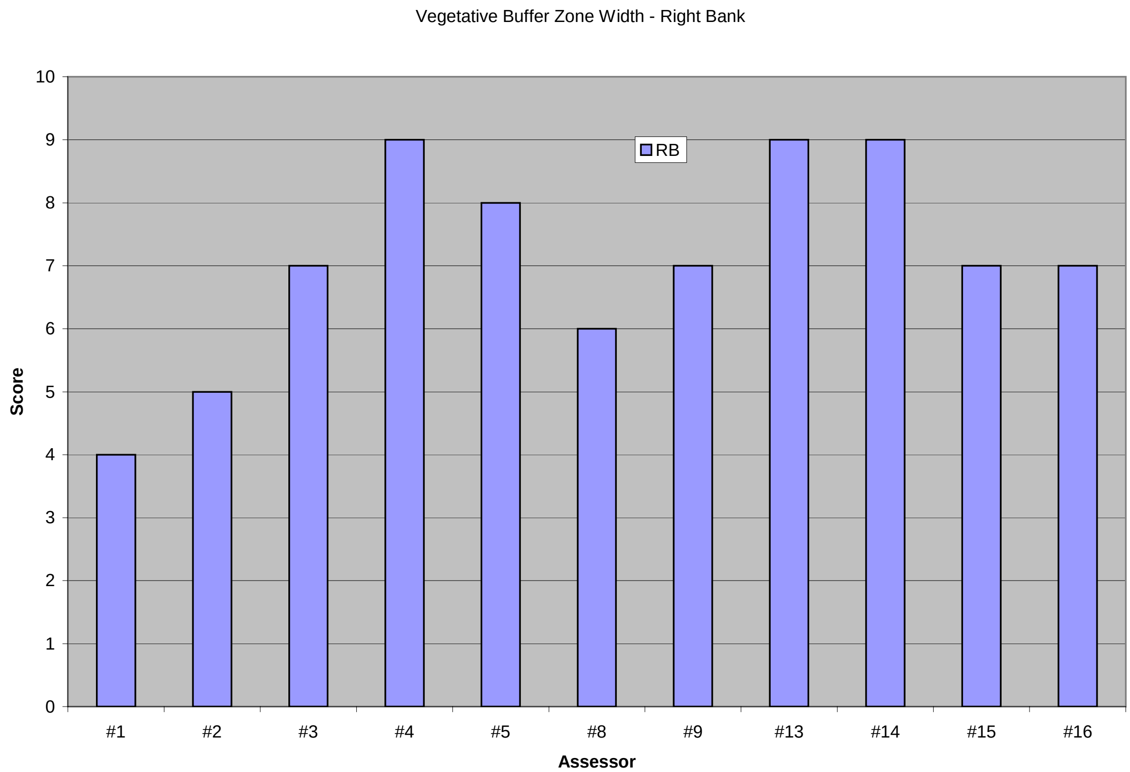


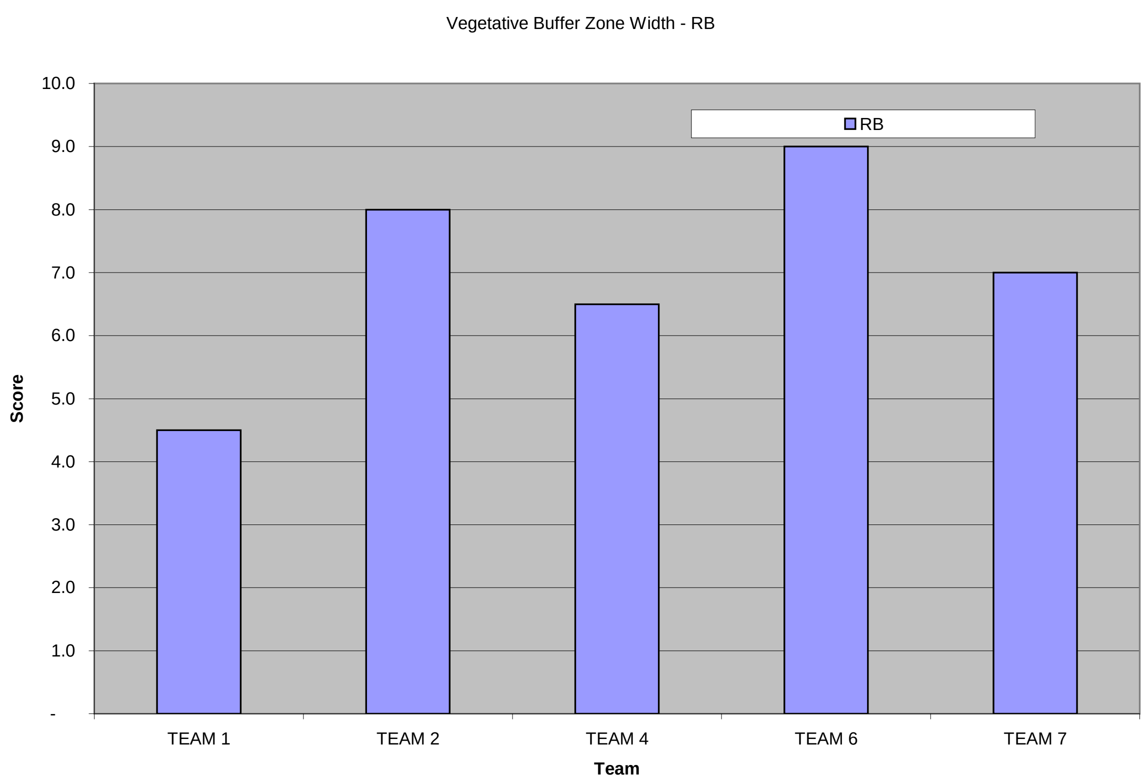
Vegetation Buffer Zone Width – Left Bank





Vegetation Buffer Zone Width – Right Bank





Reason Not Assessed	Number of Reaches	Length (ft)	% Length
	3	2907.8	0.6%
NO WATER	1	357	0.1%
PIPED	1	620	0.1%
~ 200' OF STREAM ; REST IS PIPED	1	621.2	0.1%
6. PIPED	1	1305.2	0.2%
6. SUBSURFACE	1	1032.1	0.2%
6. TOO DEEP AND WIDE	1	5178.2	1.0%
AIRPORT PROPERTY	1	3744.5	0.7%
BMP	2	1180.3	0.2%
BMP, CEMENT CHANNEL	1	1019.5	0.2%
BVR INFLUENCED / ICED	1	775.7	0.1%
CEMENT DITCH	1	1312.1	0.2%
CEMENT DITCH, STORMWATER POND AND PIPES	1	1253.6	0.2%
CHANNELIZED	6	10841.2	2.1%
COMMENTS	1	898.8	0.2%
CONCRETE	2	1714.9	0.3%
CONCRETE AND GRASS DITCH	5	4843.9	0.9%
CONCRETE CHANNEL	21	28149.4	5.3%
CONCRETE CHANNEL,WETLANDS	1	571.6	0.1%
CONCRETE DITCHES (6)	1	696.2	0.1%
CONCRETE, TRAPEZOIDAL CHANNEL	1	2343.6	0.4%
CONCRETE/ RIP RAP CHANNEL	1	280.2	0.1%
CONSTRUCTION	1	898	0.2%
CONTAINED	1	113.1	0.0%
CULVERT UNDER HYWAY, CONCRETE CHANNEL & STORMDRAIN SYSTEM.	1	1065.5	0.2%
CURB/GUTTER/CULVERT INLET TO POND DEVELOPED	1	938.9	0.2%
Dangerous conditions	3	12495.1	2.4%
DANGEROUS CONDITIONS , STREAM UNWADABLE DUE TO DEEP WATERS & HIGH FLOWS.	1	4257.7	0.8%
DANGEROUS CONDITIONS, POND/LAKE	1	2540.8	0.5%
DANGEROUS CONDITIONS, DEEP WATERS	1	3755.7	0.7%
DANGEROUS CONDITONS, SEE COMMENTS	1	6006.3	1.1%
DEVELOPED STREAM NOT EXISTING	1	1464.1	0.3%
DITCH	2	3277.3	0.6%
DRAINAGE DITCH CONCRETE & RIP RAP	1	1066.8	0.2%
FLOW PRESENT BUT IN PIPE	1	555.4	0.1%
GABION	1	705.6	0.1%
GRASS DITCH / RIP RAP CHANNEL	1	635.1	0.1%
GRASS-LINED CHANNEL, PIPE, & STORMWATER POND	1	1683.9	0.3%
GRASS-LINED DRAINAGE	1	508	0.1%
IS CHANNELIZED CONCRETE CHANNEL	1	694.7	0.1%
LAKES	1	5605.3	1.1%
LESS THAN 300'	1	221.3	0.0%
MAJORITY OF STREAM FLOWS THROUGH PIPES	1	2791.2	0.5%
MAN MADE, RIP RAP & CONCRETE PIPE CHANNEL UNDER ROAD	1	844.3	0.2%
No access	6	13443.7	2.6%
NO CHANNEL , FLOOD PLAIN W/ MULTIPLE CHANNEL	1	787.3	0.1%
NO FLOW	1	936.3	0.2%
NO FLOW & CHANNEL COVERED IN SNOW.	1	762.3	0.1%
NO REASON GIVEN	1	479	0.1%
NO STREAM CHANNEL	1	351	0.1%
NO WATER	1	509.9	0.1%
NONE GIVEN	1	1222.1	0.2%
NOT LISTED	7	7163.1	1.4%
NOT ON POND	1	897.6	0.2%
OLD BEAVER POND SYSTEM	1	2108.1	0.4%
PIPE	6	4193.7	0.8%
PIPED	38	43698.9	8.3%
PIPED REACH	1	441	0.1%
PIPED THROUGH GOLF COURSE	1	2688.3	0.5%
PIPED/ CONCRETE CHANNEL	1	3305.7	0.6%
PIPES/DITCHES	1	586.3	0.1%

Reason Not Assessed	Number of Reaches	Length (ft)	% Length
POND	2	948.8	0.2%
POND COVERED W/ ICE	1	1022.9	0.2%
POND LAKE, PIPED	1	5184.3	1.0%
Pond/Lake	60	81734.5	15.5%
POND/LAKE, BEAVER ACTIVITY	1	1081.3	0.2%
POND/LAKE, BEAVER INFLUENCE	1	2405.3	0.5%
POND/LAKE, NO ACCESS	1	3917.9	0.7%
POND/LAKE, PIPED	1	811	0.2%
POND/LAKE, RIP RAP CHANNEL	1	883.6	0.2%
POND/LAKE, STORMWATER POND	2	3206.6	0.6%
POND/LAKE, TRAP CHANNEL FOR MAJORITY	1	1552	0.3%
POND/LAKE, WETLAND	2	2419.3	0.5%
REACH IS PIPED	1	933.1	0.2%
REACH PONDED, RIPRAPPED, AND PIPED THROUGHOUT REACH.	1	1928.5	0.4%
RIP RAP	1	488.9	0.1%
RIP RAP / CONC. CHANNEL	1	1745.2	0.3%
RIP RAP CHANNEL	3	2946.3	0.6%
RIP RAP CHANNEL (NO HABITAT)	1	805.1	0.2%
RIP RAP CHANNEL & BANKS ALONG I-495.	1	1654.8	0.3%
RIP RAP CHANNEL WITH NO VISIBLE WATER, ONLY SAW WATER AT X-ING.	1	438.9	0.1%
RIP RAP 'D STORM DRAIN	1	2167.8	0.4%
RIP-RAP CHANNEL	1	949.9	0.2%
SEE COMMENTS	20	30316	5.8%
STORMDRAIN SYSTEM	1	1062.9	0.2%
STORMWATER DRAIN, PONDLAKE, STORMDRAIN S	1	1438.3	0.3%
Stormwater pond	29	23615.6	4.5%
STORMWATER POND, CEMENT DITCH & PIPES	1	3504.2	0.7%
STORMWATER POND, CONCRETE DITCH	1	773	0.1%
STORMWATER POND, NO ACCESS, WETLAND	1	342.5	0.1%
STORMWATER POND, POND/LAKE	1	832.5	0.2%
STORMWATER POND, WETLAND, 100 % ALTERED, BRAIDED CHANNELS	1	1852.6	0.4%
STORMWATER POND, WETLAND, SEE COMMENTS	1	764.1	0.1%
STREAM IS PIPED THROUGH FENCED HORSE PASTURE	1	826.8	0.2%
STREAM PIPED	1	251.5	0.0%
TOO BIG	1	5982	1.1%
TOO SMALL	1	113	0.0%
TRAP CHANNEL	2	1403.1	0.3%
TRAP./ CONCRETE CHANNEL	1	267.4	0.1%
TRAPEZOIDAL & GRASS-LINED CHANNEL	1	1348.6	0.3%
TRAPEZOIDAL CHANNEL	1	690.2	0.1%
UNDERGROUND REACH	1	339.3	0.1%
UNKNOWN	6	10473.3	2.0%
Wetland	60	80516.8	15.3%
WETLAND , BEAVER POND	1	692.6	0.1%
WETLAND AND BEAVER DAM	1	156.9	0.0%
WETLAND AND POND/LAKE	1	819	0.2%
WETLAND, STORM WATER POND	1	222.6	0.0%
WETLAND, BEAVER DAM & ACTIVITY	1	996.6	0.2%
WETLAND, CONCRETE CHANNEL	1	548.9	0.1%
WETLAND, FILLED BY FILL SOIL PILES	1	186.4	0.0%
WETLAND, FORESTED	1	1326.9	0.3%
WETLAND, MULTIPLE CHANNEL	1	860.2	0.2%
WETLAND, NO ACCESS, DANGEROUS CONDITIONS	2	9490.7	1.8%
WETLAND, PIPED	1	1618.3	0.3%
WETLAND, POND LAKE, GOLF COURSE	1	1337.8	0.3%
WETLAND, POND/ LAKE, STORMWATER POND	1	377.7	0.1%
WETLAND, POND/LAKE	3	5356	1.0%
WETLAND, POND/LAKE, BEAVER PONDS	1	1621.4	0.3%
WETLAND, PONDLAKE	1	726.2	0.1%
WETLAND, STORMWATER POND	2	1895.8	0.4%
WETLAND, STORMWATER POND, CHANNELIZED	1	397.4	0.1%

Reason Not Assessed	Number of Reaches	Length (ft)	% Length
WETLAND, STORMWATER POND, NO DEFINED CHANNEL BELOW STORMWATER POND.	1	388.6	0.1%
WETLANDS, STORMWATER POND	1	1217.5	0.2%
WHOLE REACH IS PIPED	1	2780.8	0.5%
Grand Total	394	526303.4	100%