Introduction

Recognizing a growing need to both quickly identify existing channel erosion problem areas and systematically evaluate general stream quality conditions on a watershed-wide scale, the Montgomery County Department of Environmental Protection (DEP) contracted the Metropolitan Washington Council of Governments (COG) to develop a set of rapid stream assessment protocols. In response, the Rapid Stream Assessment Technique (RSAT) was developed for Montgomery County, Maryland by COG in 1992. RSAT has been intentionally designed to provide a simple, rapid reconnaissance-level assessment of stream quality conditions.

The RSAT system represents a synthesis of US Environmental Protection Agency's Rapid Bioassessment Protocols (Plafkin, et.al. 1989), the Izaak Walton League and Save Our Streams stream survey techniques (Kellog, 1992), US Department of Agriculture, Water Quality Indicators Guide: Surface Waters (Terrell and Perfetti, 1989), together with COG staff's many years of local stream survey experience. Presently, the intended use and applicability of RSAT is limited to non-limestone Piedmont streams with drainage areas less than approximately 100-150 square miles. RSAT employs both a reference stream and an integrated numerical scoring and verbal ranking approach.[1] Major abiotic and biotic factors which influence overall stream quality have been streamlined, weighed and placed into the six following general RSAT evaluation categories:

1. Channel Stability;
2. Channel Scouring/Sediment Deposition;
3. Physical Instream Habitat;
4. Water Quality;
5. Riparian Habitat Conditions; and
6. Biological Indicators (macroinvertebrates).

In order to provide a quantitative measurement of the six preceding evaluation factors, the RSAT system employs a rigorous field evaluation protocol in which over 30 physical, chemical and biological parameters are measured at approximately 400 foot intervals along the stream (typically, 12-13 riffle transects per stream mile for smaller streams). Data is first recorded via field survey sheets and later transferred into a spreadsheet data base. Transect locations, the presence of storm drain outfalls, fish barriers, stream channel erosion problem areas and other noteworthy observations are additionally mapped onto topographic maps (preferably 1"=200' horizontal scale or larger). Last, photographic information (35mm color slide format) is catalogued so as to provide a permanent historical reference for stream areas surveyed.

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[1] Upper Rock Creek downstream of Fieldcrest Road was used as the RSAT reference site for stream areas <10 mi^2. Portions of the Gunpowder Falls, Patapsco and Patuxent Rivers were used to help characterize large mainstem reference conditions.

RSAT employs a riffle transect-based assessment approach for two main reasons: 1.) in Piedmont stream systems riffles are the principal macroinvertebrate-producing areas and 2.) riffles are both prominent and relatively permanent geomorphological features of a stream; thereby facilitating repeatable and comparable future stream assessment studies.

I. RSAT Evaluation Factors and Scoring System

An example of the 0-50 point RSAT scoring system, as applied in Montgomery County, Maryland to the Brooke Manor Country Club Branch of Rock Creek has been included as Table 1. As seen in Table 1, the channel stability evaluation category is weighed slightly more heavily than the other five categories. This was intentionally done to reflect the major influence which the stream flow regime exerts on all six evaluation categories.

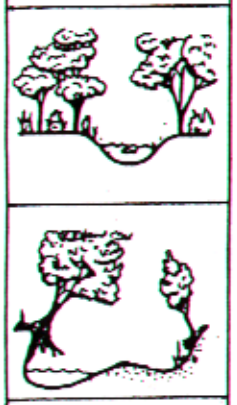
Table 1. Example of RSAT Scoring for Brooke Manor Country Club Branch

RSAT Evaluation Category	General Verbal Rating Categories and Associated Point Range				
	Excellent	Good	Fair	Poor	Points
1. Channel Stability	9-11	6-8	3-5	0-2	7
2. Channel Scouring/Deposition	7-8	5-6	3-4	0-2	4
3. Physical Instream Habitat	7-8	5-6	3-4	0-2	6
4. Water Quality	7-8	5-6	3-4	0-2	6
5. Riparian Habitat Conditions	6-7	4-5	2-3	0-2	5
6. Biological Indicators	7-8	5-6	3-4	0-2	8

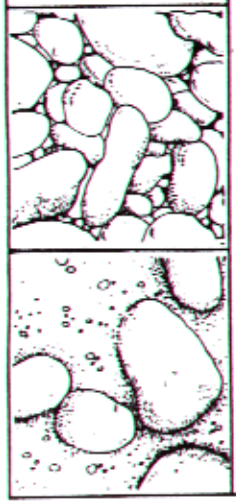
Total Points		Verbal Ranking	Good	Total Score	36
42-50	Excellent				
30-41	Good				
16-29	Fair				
<16	Poor				

A brief description of representative stream characteristics for each of the six preceding evaluation categories has been provided in Table 2. As seen in Table 2, necessary reference condition descriptor adjustments have been made in an attempt to account for differences associated with increased stream/catchment area size. While considerable variation often exists, large mainstem-type stream conditions generally become self-evident when drainage basin size approaches 10-15 square miles. These changes include but are not limited to the following: increased baseflow discharge, lower average stream gradient, wider channel widths and wetted perimeters, taller bank

Table 2. RSAT Evaluation Method - Representative Stream Characteristics[1]

Evaluation Category	Relative Significance	Excellent	Good	Fair	Poor
1. Channel Stability 	• Indicative of hydrologic/ flow regime alteration and general condition of physical aquatic habitat. • Provides insight into past, present and possible future changes in channel morphometry.	• > 80% of bank network stable. no evidence of bank sloughing, slumping or failure;	• 71-80% of bank network stable. infrequent signs of bank sloughing, slumping or failure;	• 50-70% of bank network stable. recent signs of bank sloughing, slumping or failure fairly common;	• <50% of bank network stable. recent bank sloughing, slumping or failure frequently observed ;
		• stream bend areas are very stable. outerbank height <2 ft. above stream (**<4 ft. above stream for large mainstem areas**). bank overhang < 2 ft.;	• stream bend areas stable. outer bank height 2-3 ft. above stream bank (**4-5 ft. above stream bank for large mainstem areas**). overhang 2-2.5 ft.;	• stream bend areas unstable. outer bank height 3-4 ft. above stream (**5-7 ft. above stream for large mainstem areas**). bank overhang 2.5-3 ft.;	• stream bend areas highly unstable. outer bank height >4 ft. above stream. (**>7 ft. above stream for large mainstem areas**). overhang >3 ft.;
		• exposed tree roots old, large, and woody. generally 0-1 recent (large) tree falls/stream mile;	• exposed tree roots predominantly old and large, smaller young roots scarce. 2-3 recent (large) tree falls/ stream mile;	• young exposed tree roots common. 4-5 recent (large) tree falls/stream mile;	• young exposed tree roots abundant. ≥6 recent large tree falls/stream mile.;
		• bottom 1/3 of bank is generally highly resistant plant/soil matrix or material;	• bottom 1/3 of bank is generally highly resistant plant/soil matrix or material;	• bottom 1/3 of bank is generally highly erodible material; plant/soil matrix compromised;	• bottom 1/3 of bank is highly erodible material; plant/soil matrix severely compromised;

Evaluation Category	Relative Significance	Excellent	Good	Fair	Poor
1. Channel Stability (cont'd.)		*channel x-sect. is generally V or U-shaped.	*channel x-sect. is generally V or U-shaped.	*channel x-sect. is generally trapezoidally-shaped.	*channel x-sect. is generally trapezoidally-shaped.
Point Range		9-11	6-8	3-5	0-2

2. Channel Scouring/ Sediment Deposition 	• Relates to level of uncontrolled stormwater runoff, sediment load and transport and degradation of instream habitat.	• riffle embeddness <25% sand/silt **(<35% for large mainstem areas);**	• 25-49% embedded **(35-59% embedded for large mainstem areas);**	• 50-75% embedded **(60-85% embedded for large mainstem areas);**	• > 75% embedded **(>85% embedded for large mainstem areas);**
		• high number of deep pools ≥24" **(≥48" for large mainstem areas).** pool substrate <30% composed of sand/silt;	• moderate number of deep pools. pool substrate 30-59% sand/ silt;	• low-moderate number of deep pools. pool substrate 60-80% sand/silt;	• few, if any, deep pools. pool substrate >81% sand/silt;
		• streambed streak marks and/or banana-shaped sediment deposits absent;	• streak marks and/or "banana" deposits uncommon;	• streak marks and/or "banana" deposits common;	• streak marks and/or "banana" deposits common;

Evaluation Category	Relative Significance	Excellent	Good	Fair	Poor
2. Channel Scouring/ Sediment Deposition (cont'd.)		• fresh, large sand deposits in channel rare-absent. no evidence of fresh sediment deposition on overbank;	• fresh, large sand deposits in channel uncommon. small localized areas of fresh sand deposits along top of low banks;	• fresh, large sand deposits in channel common. small localized areas of fresh sand deposits along top of low banks;	• fresh, large sand deposits v. common in channel. moderate-heavy sand deposition along major portion of over-bank area v. common;
		• point bars few, small and stable, well vegetated and/ or armored with little or no fresh sand.	• point bars small and stable, well vegetated and/or armored with little or no fresh sand.	• point bars moderate-large and unstable with high amount of fresh sand common.	• point bars moderate-large and unstable with high amount of fresh sand present at most stream bends.
	Point Range	7-8	5-6	3-4	0-2

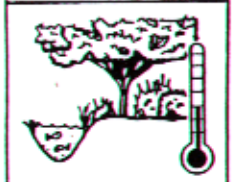
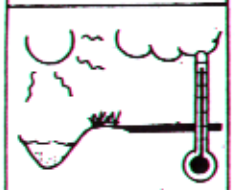
RSAT Evaluation Method - Representative Stream Characteristics (cont'd.)

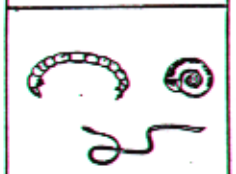
Evaluation Category	Relative Significance	Excellent	Good	Fair	Poor
3. Physical Instream Habitat  	• Relates to the ability of a stream to meet basic physical requirements necessary for the support of a well-balanced aquatic community (e.g. depth of flow, water-velocity, water temperature, substrate type and quality, etc.)	• wetted perimeter >85% of bottom channel width **(>90% for large mainstem areas);**	• wetted perimeter 61-85% of bottom width **(66-90% for large mainstem areas);**	• wetted perimeter 40-60% of bottom width **(45-65% for large mainstem areas);**	• wetted perimeter <40% of bottom width **(<45% for large mainstem areas);**
		• riffles, runs, and pool habitat present, diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water);	• good mix between riffles, runs and pools, relatively diverse velocity/ depth of flow;	• few pools present, riffles and runs dominant, velocity/ depth generally slow-shallow **(for large mainstem areas runs and pools dominant, velocity/depth diversity intermediate);**	• dominated by one habitat type (usually runs) and by one velocity/ depth condition (slow-shallow) **(for large mainstem areas few riffles present, runs and pools dominant, velocity/depth diversity low);**
		• riffle substrate composition - cobble, gravel, rubble, boulder mix with little sand, • (≥50% cobble);	• riffle substrate composition has good mix of gravel, cobble and rubble material • (25-49% cobble);	• riffle substrate composition predominantly small cobble, gravel and sand • (5-24% cobble);	• riffle substrate composition predominantly gravel with high percentage of sand • (<5% cobble);
		• riffle depth ≥ 8" for large mainstem areas;	**• riffle depth 6-7.9" for large mainstem area;**	**• riffle depth 4-5.9" for large mainstem area;**	**• riffle depth <4" for large mainstem area;**

RSAT Evaluation Method - Representative Stream Characteristics (cont'd.)

Evaluation Category	Relative Significance	Excellent	Good	Fair	Poor
3. Physical Instream Habitat (cont'd.)		• large pools generally >24 in. deep **(>48 in. for large mainstem areas)** with good overhead cover/ structure;	• large pools generally 18-24 in. deep **(36-48 in. for large mainstem areas)** with some cover/structure;	• large pools generally 12-18 in. deep **(24-36 in. for large mainstem areas)** with little or no cover/structure;	• large pools generally <12 in. deep **(< 24 in. for large mainstem areas)** and devoid of cover/structure;
		• no channel alteration or significant point bar formation or enlargement;	• slight increase in point bar formation/ enlargement or slight amount of channel modification;	• moderate increase in points bars and/or in amount of channel modification;	• extensive channel alteration or point bar formation/ enlargement;
		* riffle/pool ratio- 0.9-1.1:1	* riffle/pool ratio- 0.7-0.89:1; 1.11-1.3:1	* riffle/pool ratio- 0.5-0.69:1; 1.31-1.5:1	* riffle/pool ratio- 0.49:1 ≤; ≥ 1.51:1
		* summer afternoon H_2O temp <68°F.	* summer afternoon H_2O temp 68-75°F.	* summer afternoon H_2O temp 75-80°F.	* summer afternoon H_2O temp >80°F.
Point Range		7-8	5-6	3-4	0-2

Evaluation Category	Relative Significance	Excellent	Good	Fair	Poor
4. Water Quality  	• Indicative of: watershed perturbations/ general level of human activity, point and nonpoint source loads, and aquatic habitat conditions.	• substrate fouling[2] level 0-10% (rock underside).	• substrate fouling level - very light-light (11-20%).	• substrate fouling level - moderate (21-50%).	• substrate fouling level - high (>50%).
		•TDS[3]: <50 mg/L;	• TDS: 50-100 mg/L;	• TDS: 101-150 mg/L;	• TDS: >150 mg/L;
		• clear water - objects >3 ft. deep visible;	• objects visible down 1.5-3.0 ft.;	• objects visible down 0.5-1.5 ft.;	• objects visible to depth <0.5 ft.;
		• no odor;	• slight organic odor;	• slight-moderate odor;	• moderate-strong organic odor;
Point Range		7-8	5-6	3-4	0-2

5. Riparian Habitat Conditions  	• Provides insight into change(s) in stream energetics, temperature regime, and both aquatic and terrestrial habitat conditions.	• wide (>200') mature forested buffer along both banks;	• forested buffer generally more than 100 ft. wide along major portion of both banks;	• riparian area predominantly wooded but with major localized gaps;	• riparian area mostly non-woody vegetation, narrow-width riparian area;
		• canopy coverage; ≥80% shading **(≥60% for large mainstem areas).**	• canopy coverage; 60-79% shading **(45-59% for large mainstem areas).**	• canopy coverage; 50-60% shading **(30-44% for large mainstem areas).**	• canopy coverage; <50% shading **(<30% for large mainstem areas).**
Point Range		6-7	4-5	2-3	0-1

Evaluation Category	Relative Significance	Excellent	Good	Fair	Poor
6. Biological Indicators 	• Best overall indication of stream health and level of watershed perturbation.	• diverse macroinvertebrate community present, dominated by flat-head mayflies, stoneflies and cased caddisflies, very few snails, and/or leeches present;	• mayflies and caddisflies present (stoneflies absent), good overall diversity;	• pollution-tolerant caddisflies, snails, midgeflies, aquatic worms dominant;	• poor diversity generally dominated by midgeflies, aquatic worms and snails;
		• moderate-high number individuals.	• moderate-high number individuals.	• low-moderate number individuals.	• depauperate population - low number individuals.
Point Range		7-8	5-6	3-4	0-2

Score	Verbal Stream Quality Ranking
42-50	**Excellent Condition**
30-41	**Good Condition**
16-30	**Fair Condition**
< 16	**Poor Condition**

TOTAL SCORE: _____

[1] Bolded characteristics pertain to drainage areas generally ≥ approx. 10-15 mi².

[2] Substrate fouling = percentage of underside surface area of a cobble-sized stone (or larger), lying free on the streambed, which is coated with a biological film or growth.

[3] TDS = total dissolved solids. Note, natural background TDS level may sometimes be >50 mg/L due to geologic composition of water bearing strata.

heights, deeper riffles and pools, a general increase in instream large woody debris, a gradual reduction in canopy coverage, increased numbers of macroinvertebrate filter feeders such as clams, increased fish diversity, etc.

Under the RSAT system, the stream, including its channel network, is surveyed in its entirety in an upstream-downstream fashion. As implied by its name, RSAT is designed to provide a quick yet accurate assessment of stream conditions. For example, an experienced two-person monitoring team can under normal field conditions, generally survey 1.0 - 1.25 stream miles per day (roughly equivalent to 12-15 transects). Although a two-person team approach is strongly recommended, the RSAT survey can be performed satisfactorily by a single investigator.