Field Geology Services

Standard Operating Procedure
Methods for Collecting Geomorphological Field Data

Version 2 (May 20, 2020)

1. **Applicability.** This standard operating procedure (SOP) is used by staff of Field Geology Services or other persons who have received training from Field Geology Services to collect from wadeable rivers and streams the following types of data:

   A. morphological data (e.g., substrate particle size);
   B. habitat and geomorphic data (e.g., epifaunal substrate and available cover, embeddedness, channel degradation/aggradation);
   C. physical stream data (e.g., bank height, stability and composition, woody material);
   D. cross-sectional and longitudinal channel dimension data (e.g., flow velocity, entrenchment ratio, planform parameters); and
   E. Rosgen Level 2 data (e.g., width:depth ratios, bankfull channel depth, entrenchment ratios).

2. **Purpose**. This procedure is used to standardize collection procedures of a wide range of data to enable a comprehensive geomorphological assessment of wadeable rivers and streams.

3. **Responsibilities**

   A. Training. It is the responsibility of Field Geology Services to ensure that all persons collecting data included in this SOP have received sufficient training. Some of the work done under this SOP requires specialized training or experience. Persons currently authorized to collect data described in *Section 4 Guidelines and Procedures* below are Dr. John Field, President of Field Geology Services and Mr. Nicolas Miller, Senior fluvial geomorphologist with Field Geology Services.
   B. Data recording. It is the responsibility of a designated team leader or the individual collecting the data to ensure that all data, and additional qualifying information, are collected and recorded accurately and completely on standard data recording forms obtained from Field Geology Services.
   C. Data submission. If no staff from Field Geology Services is present at a data collection event, it is the responsibility of a designated team leader to return the completed data recording forms to Field Geology Services.

4. **Guidelines and Procedures**

   A. Data Collection Period. In general, data collection can take place between April and November although it most commonly occurs between June and September.
   B. Data Types.
      (1) Basic geomorphological data

Data are collected along stream reaches that have been delineated by Dr. John Field using topographic maps, aerial photographs, and surficial geology maps. Distinct reaches will be identified based on differences in channel slope, valley confinement, and geological material. The existing morphology of each reach will be characterized with measurements and descriptions of one or more of the following parameters:

(a) cross sectional dimensions – the bankfull width will be surveyed with a Sokkia Set 5 Electronic Total Station by measuring, perpendicular to flow, a point of bankfull elevation on one bank to the bankfull elevation on the opposite bank. All bankfull measurements will be taken across riffles at all locations to ensure consistency and comparability. The maximum bankfull depth is the height difference between the channel thalweg (i.e., deepest portion of the channel) and the bankfull elevation. All surveys will be extended until the height of the ground is at least two times the maximum bankfull depth; the flood prone-width will be taken as the flow width at this stage. For flood-prone widths greater than 50 m, the flood-prone width will be recorded as greater than 50 m. The width:depth ratio of the channel in each reach will be taken as the bankfull width divided by the maximum bankfull depth.

(b) entrenchment ratio – the entrenchment ratio is taken as the flood-prone width divided by the bankfull width, both described in the section above on cross sectional dimensions.

(c) channel gradient – the gradient of the stream channel in each reach will be taken as the difference in ground elevation between two points on the channel thalweg (surveyed with the electronic total station) divided by the total length between the upstream and downstream points. To ensure accuracy and comparability between reaches, the upstream and downstream endpoints need to be separated by more than 10 m and placed in the same position of a similar bed feature (e.g., the head of a riffle).

(d) substrate size and embeddedness – the average particle size (D_{50}) and the embeddedness (percentage of the bed covered with sand or finer particles) will be visually estimated for channel features mapping and measured at the three survey locations using the pebble count methods of Wolman (1954). The pebble count recording form is attached to the end of this document.

(e) wood – all wood in the channel greater than 15 cm diameter will be GPS located on a hand-held Trimble Yuma tablet computer with an embedded GPS device.

(f) bar features – the location and type of bar (e.g., mid-channel, point, delta) will be recorded on the handheld computer during the channel features mapping.

The morphological parameters described above will be recorded during the channel features mapping and detailed surveying. The measurement techniques are in part adopted from Vermont's Phase 2 Geomorphic

Assessment Protocols (Web citation 1). Those portions of the protocols used will be followed as detailed but certain portions of the protocols are not always relevant to Maine or the given project to be completed (e.g., rapid habitat assessment).

(2) Rapid Geomorphic Assessment data
The basic geomorphological data described above can be useful for completing a Rapid Geomorphic Assessment for a given reach. A form for completing a Rapid Geomorphic Assessment has been developed by the Maine Inland Fisheries and Wildlife and is attached to the end of this document.

(3) Visual Assessment Data
A visual assessment of a stream is achieved by continuously mapping channel features along stream using a modified version of the USDA Natural Resources Conservation Service's "Stream Visual Assessment Protocol". The protocol rates 14 stream features with a 1 – 10 scoring system. In order to map stream bank and channel features continuously along the streams the protocol is modified to include 8 stream features outlined and described below. The modification of the protocol's scoring system is necessary to produce a continuous GIS compatible map of features rather than discontinuous study reaches selected at various points along the river. Data collection without modifying the protocol would be too time consuming and would not permit for a GIS compatible data set for the entire stream length. The stream features to be mapped are:

(a) bank heights (to assess degree of channel incision or aggradation);
(b) bank stability (eroding vs. stable);
(c) bank composition (alluvial, non-alluvial, or bedrock – a measure of channel responsiveness);
(d) grade controls (dams, waterfalls, etc. – to determine upstream and downstream extent of morphological impacts);
(e) wood (isolated trees and log jams – a measure of channel roughness and habitat quality);
(f) channel reach morphology (pool-riffle, step-pool, etc. as defined by Montgomery and Buffington, 1997 – a proxy for habitat conditions and to compare existing conditions with expected reference conditions);
(g) substrate size/embeddedness (visual estimate of percentage of boulders, cobbles, fines, etc. to establish impact of erosion on habitat quality and sediment transport dynamics); and
(h) past channel management activities (location of previously straightened reaches)

The visual assessment (i.e., channel features mapping) is completed by using a hand-held Trimble Yuma tablet computer with an embedded GPS device and loaded with the most recent digital orthophotos as a base map. The location of beginning and end points of mapped features (e.g., an eroding bank) will be recorded, so GIS shapefiles of the mapped features can be created and analyzed. Stream features can be displayed with a variety of symbols, letters, and color-coded lines. For example, highly eroding alluvial channel banks could be highlighted using a brown line running along the river bank over the length of the eroding portion of the bank.

(4) Channel Dimension and Sediment Data

(a) Data on cross sectional and longitudinal channel dimensions are collected during a detailed survey of a stream reach using a Sokkia Set 5 Electronic Total Station and following standard survey procedures. Procedures for using the Set 5 as detailed in the owner's manual are followed in the operation of the electronic total station. Following completion of a survey, the data from the Electronic Total Station are downloaded onto the office computer of Field Geology Services.

(b) Substrate particle size information is collected for a stream reach using standard pebble count procedures (Wolman, 1954) for reaches where detailed surveying is undertaken. Data will be recorded on the Data Recording Form provided by Rosgen (1996) and included below. One pebble count will be undertaken at each reach where detailed surveying is occurring.

(5) Rosgen Level 2 Data

A Rosgen Level 2 analysis is completed from the survey data collected in detailed study reaches. The Rosgen Level 2 procedures outlined in Rosgen (1996) are followed to ensure consistency among projects. Characterization of a stream channel using cross-sections and longitudinal profiles helps to evaluate the physical character of a stream reach. Parameters measured in the Rosgen Level 2 analysis include width:depth ratios, bankfull channel depth, channel substrate size, pool-riffle spacing, pool depth, channel sinuosity, and channel gradient.

(6) Schumm Channel Evolutionary Model Assessment

Stream reaches that undergo detailed surveying may also be classified using the Schumm channel evolutionary model, which is a qualitative schematic/ pictorial model of the evolutionary stages that a channel progresses through as it restabilizes following an incision event. As such, it is an assessment based on expertise and professional judgment rather than precise measurements. In this assessment, a stream reach is designated to be in one of the five stages of channel evolution (Schumm, 1984) - the stage chosen matching most closely the character of the reach in question.

5. References Cited

Montgomery, D.R., and Buffington, J.M., 1997, Channel-reach morphology in mountain drainage basins: Geological Society of America Bulletin, v. 109, p. 596-611.

Rosgen, D.L., 1996, Applied River Morphology: Wildland Hydrology: Pagosa Springs, CO.

Schumm, S.A., 1984, Incised Channels: Morphology, Dynamics, and Control. Water Resources Publications: Littleton, CO.

Wolman, M.G., 1954, A method of sampling coarse river-bed material: Transactions of American Geophysical Union, v. 35, p. 951-956.

Web citations:

Web citation 1:
https://dec.vermont.gov/sites/dec/files/wsm/rivers/docs/rv_SGA_Phase2_Protocol.pdf
(Accessed May 20, 2020)

Pebble Count Data Recording Form

PEBBLE COUNT

Site:					Date:		
Party:					Reach:		
INCHES	PARTICLE	MILLIMETER		Particle Count	TOT #	ITEM %	% CUM
	Silt/Clay	< .062	S/C				
	Very Fine	.062 - .125	S				
	Fine	.125 - .25	A				
	Medium	.25 - .50	N				
	Coarse	.50 - 1.0	D				
.04 - .08	Very Coarse	1.0 - 2	S				
.08 - .16	Very Fine	2 - 4					
.16 - .24	Fine	4 - 6	G				
.24 - .31	Fine	6 - 8	R				
.31 - .47	Medium	8 - 12	A				
.47 - .63	Medium	12 -16	V				
.63 - .94	Coarse	16 - 24	E				
.94 - 1.26	Coarse	24 - 32	L				
1.26 - 1.9	Very Coarse	32 - 48	S				
1.9 - 2.5	Very Coarse	48 - 64					
2.5 - 3.8	Small	64 - 96	C				
3.8 - 5.0	Small	96 - 128	O				
5.0 - 7.6	Large	128 - 192	B				
7.6 - 10	Large	192 - 256	L				
10 - 15	Small	256 - 384	B				
15 - 20	Small	384 - 512	L				
20 - 40	Medium	512 - 1024	D				
40 - 160	Lrg-Very Lrg	1024 - 4096	R				
	BEDROCK		BDRK				
				TOTALS			

Rapid Geomorphic Assessment (RGA)

Date: *Site:* *Crew:*
Location: *Recorder:*

Form/ Process	*Geomorphic Indicator*		*Present*		*Score**
	Num	Description	No	Yes	
Evidence of Aggradation (AI)	1	Lateral bars			
	2	Coarse materials in riffles embedded			
	3	Siltation in pools			
	4	Mid-channel bars			
	5	Deposition on point bars			
	6	Poor longitudinal sorting of bed materials			
	7	Soft, unconsolidated bed			
	8	Evidence of deposition in/around structures			
	9	Deposition in the overbank zone			
		Sum of Indices:			

Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock			
	2	Elevated tree roots/root fan above channel bed			
	3	Bank height increases			
	4	Absence of depositional features (no bars)			
	5	Cut face on bar forms			
	6	Head cutting due to knick point migration			
	7	Suspended armour layer visible in bank			
		Sum of Indices:			

Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc			
	2	Occurrence of large organic debris			
	3	Exposed tree roots			
	4	Basal scour on inside meander bends			
	5	Toe erosion on both sides of channel through riffle			
	6	Steep bank angles through most of reach			
	7	Length of bank scour >50% through subject reach			
	8	Fracture lines along top of bank			
		Sum of Indices:			

Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes			
	2	Single thread channel to multiple channel			
	3	Evolution of pool-riffle form to low bed relief form			
	4	Cut-off channel(s)			
	5	Formation of island(s)			
	6	Thalweg alignment out of phase meander form			
	7	Bar forms poorly formed / reworked / removed			
		Sum of Indices:			

Stability Index:

Condition: