Appendix 6—Information and Data Form for Assessing Stream Geomorphic Characteristics in the Field

This appendix includes the data form and information for collecting the stream geomorphic data. The geomorphic data are collected along the same stream reach as the riparian vegetation and disturbance data. These data are also collected when meadow complexes are sampled.

The geomorphic data are collected using form A.6.1. One form is used for each stream reach or meadow complex. At each sampled stream reach or meadow complex, identifying information is recorded on the data form. This includes the date, observer, watershed name, the watershed code in the Great Basin watershed database, location within the watershed (e.g., high, mid, low), and the reach length of the observations (typically 30 m). A GPS is used to record the UTM coordinates and elevation where the stream cross sectional profile is drawn for the sampled reach.

A complete description of the variables recorded and the specific measurements or scores used to describe each variable are in table A.6.1. The assessment involves collecting information on the current cross-sectional morphology of the valley (including the channel) and the longitudinal profile of the stream channel. Information is collected on the materials comprising the channel bed, banks, and valley fill, and the sediment mobility and availability of bed sediments. In addition, information is obtained on features that are indicative of the magnitude and rate of channel incision (e.g., knickpoints, headcuts, terraces), occurrence and amount of channel avulsion (e.g., filled or unfilled paleochannels), and the extent and mechanisms of bank erosion. Stream cross-section and bed material distribution data may be collected where more detailed data are desired.

A cross-sectional profile is drawn for each sampled reach at a representative location within the reach. An illustration of a cross-sectional profile of a stream channel is in fig. A.6.1. This drawing is used to identify the geomorphic positions used to sample riparian vegetation as described on the riparian vegetation data form A.7.1.

The data collected in the geomorphic assessment are used in the score sheets for assessing watershed sensitivity and resilience in appendix 10 and for rating ecological integrity in appendix 11.

Form A.6.1–GEOMORPHIC DATA	Date: Observer:
Watershed Name:	Database Code:
UTM Zone:	Elevation (m):
UTMs: Northing	Easting
Location in Basin: Low / Mid / High	Reach Length of Observations (m):

Definitions of terms and methods for the variables collected are in appendix A.6.2.
Use consistent units for all measurements.

Channel Character and Form

Flow Type: Perennial Ephemeral

Flow/Water Width (m): _____ **Flow Depth (m):** _____

Bankfull Channel Width (m): _____ **Bankfull Channel Depth (m):** _____

Channel Slope: distance (m): _____ clinometer height (m): _____

stadia height (m): _____ slope: _____

Sediment Size and Mobility

Bed Particle Size: approx. D_{50}: _____ approx. max. (ave. 10 largest) _____

Bank/Valley Fill Sediment Size (%): gravel/boulders mixed gravel/fines fines (<2 mm)

Bed Clast Immobility (% of channel bed): >75% 50-75% 10-50 % <10 %

Pebble Count Taken: yes no

Cross-section Taken: yes no

Sediment Availability

Bar Frequency (# per reach in channel): none few (1-2) common (3-4) many (>4)

Bar Extent (% of channel bed): none to 10% 10-20% 20-30% >30%

Gravel Bars on Valley Floor (# per reach): none few (1-2) common (3-4) many (>4)

Evidence of Incision within the study reach

Fan Steps at the Reach: yes no If yes, range in height(s) (m): _____

Knickpoints (# per reach): none few (1-2) common (3-4) 4 = many (>4)

Knickpoint Height (cm): none 0-25 cm 25-50 cm > 50 cm

Knickpoint Composition: bedrock boulders unconsol. sediment (gravel/silt/clay) roots

Inset Terraces (#): none 1 2 3 >/=4

Incision Depth (m): none 0-1 m 1-2 m >2 m deep

Bedrock Outcrops (% of channel bed): none localized (<25 %) extensive (>25 %)

Headcuts (# per reach): none few (1-2 per reach) common (3-4) many (>4)

Headcut Height (m): no headcuts 0-1 m 1-2 m > 2 m

Evidence of Avulsion and Avulsion Channels within the study reach

Anabranching Channels (# per reach): none few (1-2) common (2-4) many (>4)

Gravel Filled Channels (# per reach): none few (1-2) common (2-4) many (>4)

Gravel Aggradation/Debris Dams (# per reach): none few (1-2) common (2-4) many (>4)

Form A.6.1–GEOMORPHIC DATA	Date:
Watershed Name:	Database Code:
UTM Zone:	Elevation:
UTMs: Northing	Easting
Location in Basin: Low / Mid / High	Reach Length of Observations:

Sketch of Stream Cross-sectional Profile: See fig. A.6.1 for an example sketch of a cross-sectional profile. Include all topographic features as well as bars, bank characteristics, and other features of geomorphic significance. Include the vertical and horizontal scale. Where sampled reaches are near fan steps, headcuts, or other significant geomorphic features, also include a longitudinal sketch. See fig. 14 for an example of a longitudinal profile illustrating a fan step downstream of a meadow.

Figure A.6.1—Example sketch of a cross-sectional profile of a stream channel.

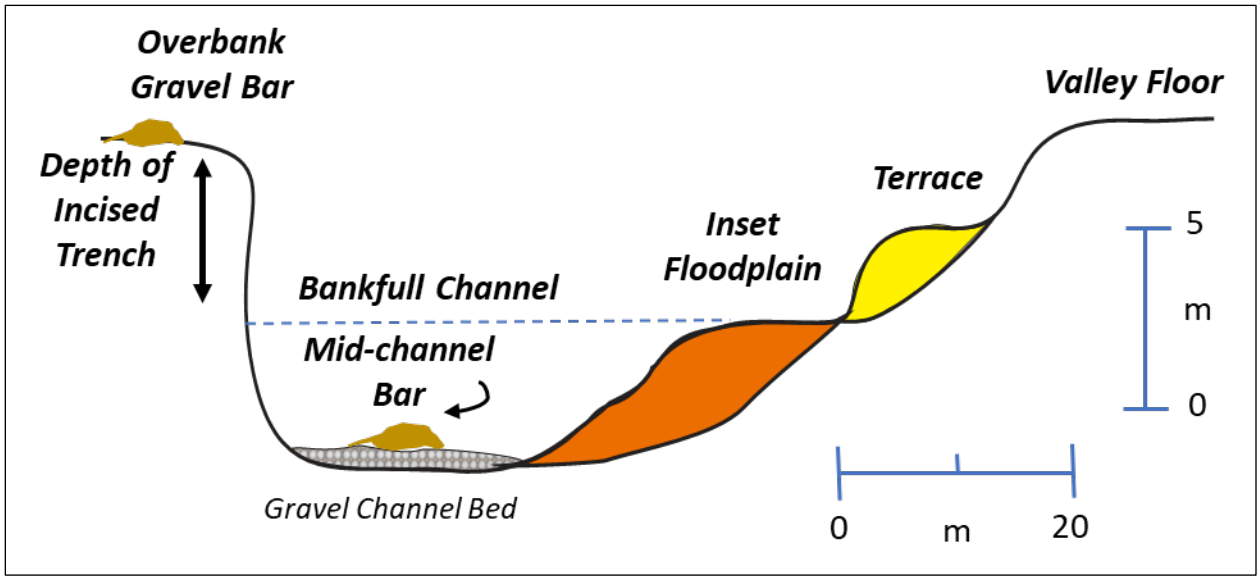

Table A.6.1—Descriptions of the variables used to assess stream reach geomorphic characteristics in the field.

- **Reach Length of Observations:** A stream reach is defined as a segment of the drainage network with homogenous channel and valley floor characteristics, including landforms (e.g., terraces, floodplains), channel bed features (pools and riffles, step and pools, bars, knickpoints, etc.), and sediment sizes. In the field, sample reaches are selected from the dominant watershed segments in the lower, middle, and higher portions of the watershed, which are predetermined in the office. The sample reach should be representative of the most common reach type within the dominant watershed segment. It should be long enough to include all valley, channel, and channel bed features that exist within the reach type. A typical study reach length is 30 m.
- **Channel Character and Form**
  - **Flow Type:** Describes the temporal variations in flow within the channel. Perennial flow – flow is present within the reach throughout the year; ephemeral flow – distinct periods of flow and dry conditions within the stream reach during the year.
  - **Flow /Water Width and Flow Depth:** The width of the water at the water's surface, and the maximum depth of the water in the channel.
  - **Bankfull:** The water level at which water is at the top of the stream bank and any further increase in water level would cause the water to "spill over" and inundate the adjacent terrace or floodplain. The bankfull channel is defined based on several parameters including: (1) the break in slope between the channel banks and the floodplain, defined as the first flat-lying, low-relief surface above the channel bed whose sediments are deposited by the modern channel; (2) the elevation of the highest depositional feature within the channel (e.g., point bar, alternate bar, or central bar), where well-defined floodplains are absent; and (3) changes in the particle-size distribution and vegetation along the channel perimeter resulting from a change in the frequency of inundation and depositional processes.

- **Bankfull Channel Width and Depth:** Bankfull channel width is the width of the channel at the bankfull water stage. Bankfull depth is the maximum depth of the channel measured from the bankfull stage to the thalweg (deepest part of the channel).
- **Channel Slope:** Gradient (rise/run) of the channel measured along the thalweg of the stream. To calculate the percent slope, divide the elevation change (stadia or level height - clinometer height) by the distance measured. Multiply the resulting number by 100 to obtain the percentage slope.

- **Sediment Size and Mobility:** Particle size and mobility influences the ease with which the channel bed can be eroded and incised by flood flows. The variables used to evaluate sediment size and mobility can be estimated. Alternatively, pebble counts can be taken. Methods for collecting and analyzing particle size are in Bunte and Abt (2001).
  - **Bed Particle Size:** Particle size D_{50} is defined based on the intermediate diameters of at least 50 particles (clasts) randomly collected from the channel bed. The approximate maximum particle size is the average intermediate diameter of the 10 largest particles (clasts) in the sample reach.
  - **Bank/Valley Fill Sediment Size (%):** Describes the percent of the bank deposits consisting of gravel/boulders, mixed gravels/fines, and fines (<2 mm). In many cases, the channel banks will be composed of multiple alluvial stratigraphic units possessing sediments of varying size. Where multiple units are present, the percent of each particle-size range should be assessed by considering all of the units collectively.
  - **Bed Clast Immobility (% of channel bed):** Describes the approximate percentage of clasts on the channel bed that have not been transported by floods occurring at least once every 5 to 10 years. Indicators of immobility include the degree to which clasts are coated by biofilms (algae), particle imbrication (the "stacking of clasts at an oblique angle in the channel bed), and sediment sources (e.g., glacial moraines, talus cones).
- **Sediment Availability:** Describes the amount of mobile sediment that is stored within the channel and that can be entrained and transported during low to moderate flood events. Large amounts of sediment are required for channel avulsions, whereas limited sediment relative to the available discharge leads to channel incision. Sediment availability is determined from three parameters.
  - **Bar Frequency (# per reach):** Bars represent accumulations of sediment within the channel. The number of bars describes the occurrence of in-channel bars composed of mobile bed materials within the channel in the sample reach. Bar number per reach is recorded as none, few (1-2), common (3-4), or many (>4).
  - **Bar Extent (% of channel bed):** Describes the percentage of the channel bed comprised of in-channel bars in the sample reach (e.g., point bars, alternate bars, glides, etc.). Bar extent within the channel bed is recorded as 0-10 %, 10-20 %, 20-30 %, or >30%.
  - **Gravel Bars on Valley Floor (# per reach):** Gravel accumulations on the valley floor are an indicator of the movement of large amounts of sediment during overbank floods. In some cases, these deposits are associated with channel aggradation (filling), which may or may not be associated with channel avulsion initiated by a localized aggradational event. Number of gravel bars per reach is recorded as none, few (1-2), common (3-4), or many (>4).
- **Evidence of Channel Incision:** The degree and rate to which the channel has or is currently incising provides insights into its future response.
  - **Fan Steps:** Large side-valley alluvial fans that traverse the majority of the valley floor often produce "steps" or abrupt changes in the longitudinal profile of the channel bed (fig. 14). Where these occur, they should be noted, and the approximate height of the elevation change across the fan should be estimated using a clinometer.

- **Knickpoints (# per reach):** Knickpoints, defined as abrupt, vertical or near vertical breaks in channel slope over a distance of a few meters are a direct indicator of ongoing channel incision. Number of knickpoints is recorded as none, few (1-2 per reach), common (3-4), or many (>4).
- **Knickpoint Height (cm):** Knickpoint height is measured as the maximum distance from the top of the knickpoint to the channel bed at the foot of the knickpoint. Knickpoint height is dependent, in part, on the composition of the materials in which the knickpoint is formed. Cohesive and/or resistant materials tend to form higher knickpoints. However, the type of channel materials is also an indicator of the magnitude to which channel incision is likely to occur. Knickpoint height is recorded as the average height of the knickpoints at the sample reach, and ranges from no knickpoints, 0-25 cm, 25-50 cm high, or > 50 cm high.
- **Knickpoint Composition:** Refers to the predominant type of material(s) with which the knickpoint is constructed. Common materials include bedrock, boulders, unconsolidated sediments (gravel, silt/clay), and roots.
- **Inset Terraces (#):** Terraces are formed during channel incision. The number of terraces within a valley is an indicator of the number of incision events that have occurred and may help approximate the length of time over which incision has occurred and the rate and timing of incision. Inset terraces indicate a period of lateral erosion and deposition (of an inset floodplain) prior to subsequent incision. Multiple incision events may occur prior to the development of an inset floodplain, precluding the presence of an indicative inset terrace. Additionally, lateral erosion after an incision event may remove evidence of one or more inset terraces. In the Great Basin, inset terraces of differing age often correspond to high magnitude flood events that are capable of eroding channel bed sediments and are occupied by differing vegetation communities. Evidence of a given inset terrace may exist on one or both sides of a channel. Surfaces of similar height above the thalweg on both sides of a channel should be considered parts of the same inset terrace. The number of inset terraces is recorded as none, few (1), common (2-3 per reach), or many (>4).
- **Incision Depth (m):** The depth of incision, or depth of the incised trench, is a measure of depth of channel incision below the valley floor. Incision depth is measured as the distance from the valley floor to the top of the inset floodplain, if a floodplain is present. If no floodplain is present, then it is the distance from the valley floor to the highest point on the channel bed. Deep, highly incised channels are typically associated with fine-grained channel bed and bank materials, and large-scale headcuts or knickpoints. Incision depth is recorded as none, 0-1 m, 1-2 m, or >2 m.
- **Bedrock Outcrops/Exposures (% of channel bed):** Describes the presence of bedrock within the channel bed and/or banks. The rate and depth of incision can be reduced along some reaches by the occurrence of resistant bedrock outcrops. Where present, the percent of the channel bed consisting of bedrock should be recorded. Bedrock is recorded as none, localized (<25 % of channel bed), or extensive (>25 % of channel bed).
- **Headcuts (# per reach):** Headcuts are similar to knickpoints but are commonly associated with gully systems that are developed in previously unincised alluvial valleys devoid of an existing channel (see figs. 15, 21). They often represent a significant potential change in valley conditions by means of channel incision. Number of headcuts is recorded as none, few (1-2 per reach), common (3-4), or many (>4).
- **Headcut Height (m):** Headcut height is the maximum height of the headcut as measured from the incised channel bed to the valley floor. Headcut height is recorded as none, 0-1 m, 1-2 m, or >2 m.

- **Evidence of Avulsions and Avulsion Channels:** Avulsions indicate the abrupt change in channel position from one location to another on the valley floor. Several indicators of occurrence and frequency of avulsion are used to rate geomorphic sensitivity to this process.
    - **Anabranching Channels (# per reach):** Anabranching channels are typically formed by channel avulsion and are usually associated with relatively unstable channels characterized by local channel aggradation. The number of anabranching channels per reach is recorded as none, few (1-2 per reach), common (2-4), or many (>4).
    - **Gravel Filled Channels (# per reach):** Gravel-filled channels are segments of 'old' channel reaches that have been filled with gravel and no longer transmit water. The gravel fill found in most paleo-channels are found near the surface of the valley floor. While not all gravel-filled channels are associated with channel avulsions, they are the primary evidence of avulsions, and can be found at most sites where avulsion has occurred in the Great Basin. The number of gravel filled channels in the reach are recorded as none, few (1-2), common (2-4), or many (>4).
    - **Gravel Aggradation/Debris Dams (# per reach):** Accumulation (aggradation) of gravel behind piles of wood debris or woody riparian species is common in many Type A_1 basins. Avulsions are often associated with these gravel accumulations, and they result in partial blockage of the channel, particularly during the input of sediment from debris flows, landslides, and/or upstream valley incision. The number of gravel aggradation or debris dams per reach is recorded as none, few (1), common (2-4), or many (>4).

Reference

Bunte, K.; Abt, S.R. 2001. Sampling surface and subsurface particle-size distributions in wadable gravel-and cobble-bed streams for analyses in sediment transport, hydraulics and streambed monitoring. Gen. Tech. Rep. RMRS-GTR-74. Fort Collins: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 428 p.