FOREST PRACTICES CODE

of

BRITISH COLUMBIA

Channel Assessment Procedure Field Guidebook

December 1996

Authority

Forest Practices Code of British Columbia Act

Operational Planning Regulation

Part 3 (Forest Development Plans)

Canadian Cataloguing in Publication Data
Main entry under title:
Channel assessment procedure field guidebook

(Forest practices code of British Columbia)

Co-published by BC Environment.
Companion vol. to: Channel assessment procedure guidebook.
Includes bibliographical references: p.
ISBN 0-7726-3072-0

1. Logging – Environmental aspects – British Columbia. 2. Rivers – British Columbia – Management. 3. Soil erosion prediction – British Columbia. I. British Columbia. Ministry of Forests. II. BC Environment. III. Series.

SD425.C42 1996 551.48'8 C96-960359-2

Preface

This guidebook has been prepared to help forest resource managers plan, prescribe and implement sound forest practices that comply with the Forest Practices Code.

Guidebooks are one of the four components of the Forest Practices Code. The others are the ***Forest Practices Code of British Columbia Act***, the regulations and the standards. The *Forest Practices Code of British Columbia Act* is the legislative umbrella authorizing the Code's other components. It enables the Code, establishes mandatory requirements for planning and forest practices, sets enforcement and penalty provisions, and specifies administrative arrangements. The **regulations** lay out the forest practices that apply province-wide. **Standards** may be established by the chief forester, where required, to expand on a regulation. Both regulations and standards, where required and established under the Code, must be followed.

Forest Practices Code guidebooks have been developed to support the regulations, but are not part of the legislation. The recommendations in the guidebooks are not mandatory requirements, but once a recommended practice is included in a plan, prescription or contract, it becomes legally enforceable. Guidebooks are not intended to provide a legal interpretation of the *Act* or regulations. In general, they describe procedures, practices and results that are consistent with the legislated requirements of the Code.

The information provided in each guidebook is to help users exercise their professional judgment in developing site-specific management strategies and prescriptions to accommodate resource management objectives. Some guidebook recommendations provide a range of options or outcomes considered acceptable under varying circumstances.

Where ranges are not specified, flexibility in the application of guidebook recommendations may be required to adequately achieve land use and resource management objectives specified in higher-level plans. A recommended practice may also be modified when an alternative could provide better results for forest resource stewardship. The examples provided in many guidebooks are not intended to be definitive and should not be interpreted as the only acceptable options.

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Introduction

The channel assessment procedure (CAP) consists of both office and field work. The following is restricted solely to field assessments. The objective of the field guidebook is to collect the relevant data required to complete the CAP. Only the text and field forms directly relevant to field assessments are included; all supplemental information on methods, definitions and background context is included in the *Channel Assessment Procedure Guidebook.*

Field assessments are conducted in small and intermediate-sized channels; they are not usually required for large channels except to confirm aerial photograph assessments. Field work is done in all reaches along the mainstem where reaches could not be assessed on the aerial photographs (due to riparian vegetation canopies or shadows).

The CAP field assessment is based on determining the type of channel expected (given its location within the watershed and certain channel attributes), a set of field indicators of disturbance, and a series of diagnostic disturbance keys. In general, for those reaches identified on the aerial photographs as requiring field visits, complete the following steps.

1. Walk the stream reach and determine the average channel gradient (s), depth (d), bankfull width (W_b) and largest stone moved by flowing water (D).
2. Determine the appropriate channel type (based on s, d, W_b and D).
3. Refer to the correct series of diagnostic channel keys.
4. Using the field indicators, identify the types and level of stream disturbance present from the series of diagnostic channel keys.
5. Evaluate the overall disturbance level for the stream, using the keys to determine the specific level of disturbance and the survey lengths to calculate the spatial extent of disturbance.

Field procedure overview

The steps to complete a field assessment (Table 1) are as follows (all forms are located in Appendix 1). Details associated with each step can be found in the sections to follow.

1. Proceed to the downstream (or upstream) end of the reach identified on the aerial photograph as requiring field evaluations.
2. Measure bankfull channel width (W_b) at five locations spaced evenly along the reach and record on Field Form 1.
3. Measure channel depth (d), using a stadia rod, at five locations spaced evenly along the reach and record on Field Form 1.
4. Identify the largest sediment particle (D) on the channel bed at five locations spaced evenly along the reach, and measure the b-axis. Record on Field Form 1.
5. Measure the channel gradient (s), over a distance of several channel widths, at five locations spaced evenly along the reach. Record on Field Form 1.
6. Calculate D/W_b.
7. Calculate D/d.
8. Based on s and the ratios D/W_b and D/d, determine channel morphology using the nomogram. Record on Field Form 1.
9. Determine if large woody debris (LWD) is important to channel structure.
10. Refer to appropriate set of seven channel keys corresponding to the determined channel morphology (Appendix 2). For example, if the morphology is identified as a CP_c-w (cascade-pool morphology with predominately cobble bed and functional LWD), then the appropriate set of keys is found on pages 50 to 56.
11. Attach the hip chain thread at the beginning of the reach and begin the channel inventory, using the list of field indicators of disturbance and appropriate diagnostic keys. Walk upstream (or downstream) along the channel thalweg (deepest point along the cross-section if wading is possible) or along the bar tops if the water is too deep or the stream flow velocities are too fast for safe

wading. Record the distance (from the hip chain) corresponding to the channel condition as determined from the list of field indicators of disturbance and appropriate keys. Record data on Field Form 1. For instance, if the reach is a RP_c, the distance corresponding to each level of disturbance is recorded. An example of the field form is as follows:

Distance (m)	Bank type	Channel type and disturbance level	Field indicators S1	S2	S3	...	D3	Photo roll and frame
0–53	A3/4	RP_c: A2	☐	☑	☐		☑	R3:F7, 8
53–109	A3/4	RP_c: D1	☐	☐	☑		☑	R3:F9, 10

12. Refer to the “Field operational rules” section for directions to follow during the survey.
13. At each recording of channel type and disturbance level, determine predominant bank material type and record on Field Form 1 (see Field Form 1 for bank-type codes).
14. Continue the survey, recording all levels of disturbance to the end of the reach. Continue to refer to the “Field operational rules” section.
15. Repeat the procedure in the next reach.
16. Continue to the end of all reaches requiring field inspection.

Table 1. Summary of the field procedure

Task	Refer to figure(s)	Field form
1. Measure:		
W_b	2	1
d	3	1
D	4	1
s	–	1
2. Calculate:		
D/W_b	5 & 6	–
D/d	5 & 6	–
3. Determine:		
Type of morphology	5 & 6	1
Importance of LWD	7	–
4. Inventory:		
Bank material	–	1
Level and extent of disturbance	8 & Appendix 2	1
5. Summarize:		
Level of disturbance associated with each reach	–	2

Disturbance level analysis

The steps to assess the level of disturbance are as follows.

1. Summarize the inventory information collected by completing Field Form 2.
2. Calculate the percentage of the reach in each disturbance class.
3. Sum the percentage of the reach in moderate and severe disturbance classes.
4. Weight the percentage of the reach in both moderate and severe disturbance classes by the total length of the reach.
5. Sum the weighted length of disturbed stream channel for each reach assessed in the field and enter the result on Form 8 of the *Channel Assessment Procedure Guidebook*.

Field operational rules

During any field survey there are always numerous decisions to be made; it is important that these decisions are made in a consistent manner. The following operational rules will make field surveys easier by removing procedural ambiguities.

1. Minimum stream survey length is 1 W_b (no change in *level of disturbance* will be identified and recorded unless the section of channel with a different level of disturbance exceeds 1 W_b).
2. Maximum distance along a channel without an assessment is 10 W_b (even if there is no change in the level of disturbance, an assessment, including the listing of disturbance code, field indicators and photographs looking upstream and downstream, must be made every 10 W_b). This rule is ± 1 W_b ; if a distance of 10 W_b has been reached but it is evident that a change in disturbance level occurs at, or before, the 11 W_b distance, then it is acceptable to miss the 10 W_b and proceed to the 11 W_b.
3. It is acceptable to break reaches, as determined from aerial photographs, into shorter reaches, based on field examinations. Because of the resolution of aerial photographs, it is possible that a reach may need to be divided into two or more shorter segments if field conditions warrant (based on changing s, D, d, W_b). The new reaches should be identified as a subset of the reach that is being subdivided (e.g., Reach B is broken into Reach B.1 and B.2).
4. As in Rule 1, if a different *type* of channel is encountered (e.g., changing from a RP_g to a RP_c, or from a RP_c to a CP_c), it must extend for more than 1 W_b to be included as a distinct type (i.e., if the different channel type is <1 W_b it will not be inventoried).
5. If a different type of channel is encountered (e.g., changing from a RP_g to a RP_c, or from a RP_c to a CP_c), and it extends for more than 3 W_b, then a new reach must be designated.
6. If a channel type not considered in the assessment is encountered (e.g., a bedrock waterfall—drainage network classification code CB3aii), and it is ≤3 W_b in length, it is listed as such on Field Form 1. The total stream length includes these entries (i.e., the total length of the channel used to calculate the percentage of disturbed

channel morphology includes lengths of channel not assessed by this procedure). The level of disturbance assigned to these channels is "none" so they will not influence the overall reach rating.

7. If, as in Rule 5, a channel type not assessed by the CAP (e.g., CB3aii) extends beyond 3 W_b in length, a new reach must be designated and assigned a channel class according to Figure 1.
8. If a survey proceeds from a single channel into zones with multiple channels, the survey is to follow the thalweg (follow the branch with the deepest channel, and usually highest discharge).

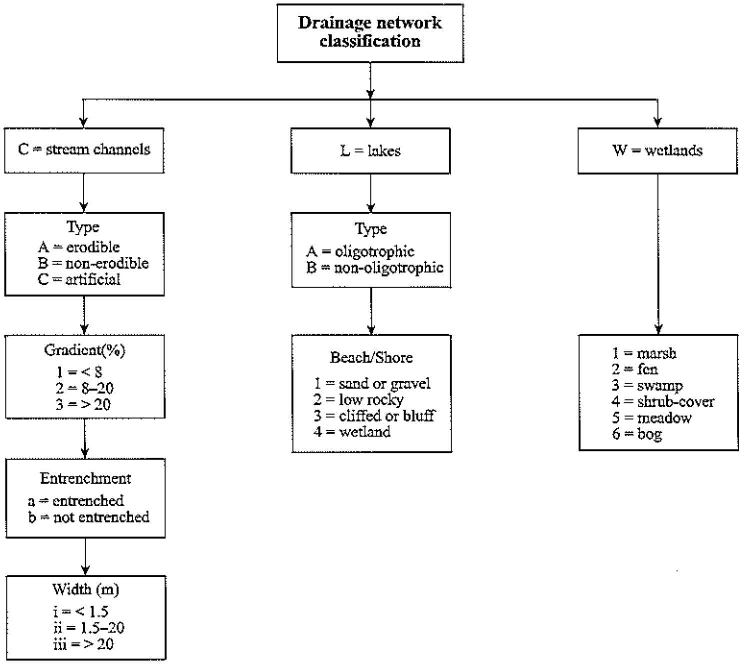


Figure 1. Drainage network classification (details are presented in Appendix 3).

Field measurements and diagrams

The main field measurements required for the CAP are channel gradient, bankfull channel width, and depth and size of the largest stone on the bed that is moved by flowing water. The relative channel size and morphological type are based on these measures. Morphological type is determined by the relative roughness (D/d), relative width (D/W_b), and slope of the channel. Measurements are made at five locations spaced evenly along the reach (i.e., at the begining and end of the reach with three locations between). Fewer measurements may be made if the assessor is an experienced geomorphologist with extensive knowledge of fluvial forms. If competent professional judgement is used to determine the morphological type, the number of field measurements is left up to the assessor.

Channel slope

To measure channel gradient:

- Use a hand-held inclinometer (e.g., Suunto level) and measure the slope (±0.5%) over the longest length of channel possible (greatest distance visible between field workers); a minimum length of several channel widths should be used for each measurement.
- Level shots should be taken between two field workers, each standing at the water's edge and sighting on the point of the other individual, with the same distance to the ground (eye to eye for individuals of same height, eye to chin for individuals 10 cm different in height, etc.).
- The distance between individuals, over which the gradient is being measured, should be approximately the same for each of the five measurements.

Channel width

To determine the channel bankfull width (Figure 2), measure W_b using a fibre tape and measuring to ± 0.1 m.

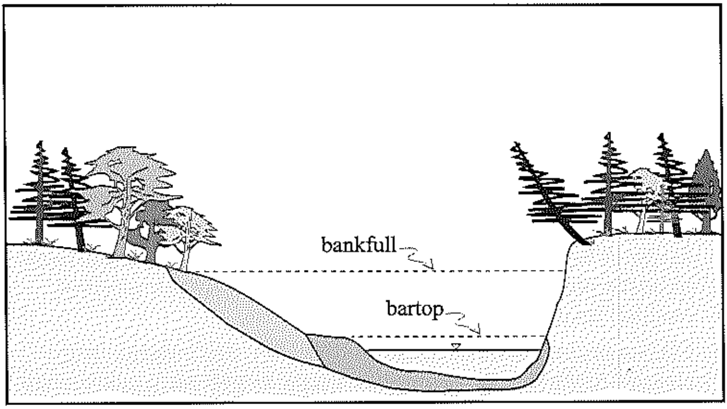


Figure 2. Identifying bankfull width (after Church 1992). In this schematic, the lower limit of perennial terrestrial vegetation is used to define the left banktop while the right banktop is defined by a terrace (old elevated floodplain surface).

A number of standard criteria can be used to determine W_b in the field (after Leopold 1994). Only those relevant to the field site need be used. Look for:

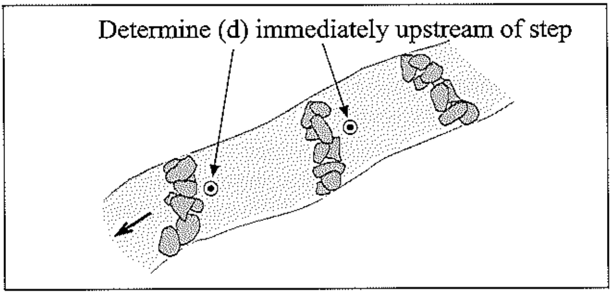
- a change in vegetation from bare ground with no trees to vegetated ground with trees, from no moss to moss-covered ground, or from bare ground to grass-covered ground, particularly in range lands
- a topographic break from vertical bank to flat floodplain
- a topographic break from steep bank to more gentle slope
- the highest elevation below which no fine woody debris (needles, leaves, cones or seeds) occurs
- a change in texture of deposited sediment from clay to sand, or sand to pebbles, or boulders to pebbles.

Channel depth

To determine the channel depth:

- Measure the depth (using a stadia rod) at five locations along the reach (measurements are made at a riffle-pool or step-pool break; see Figures 3a and 3b).
- Place the stadia rod on the channel bed at the break (between either riffle or step) and, holding the stadia rod vertical, estimate the height of bankfull stage using the hand level to sight off the bank (read the stadia rod at the point that corresponds to level from bankfull height).
- Measurement should be to the nearest 10%. For instance, if the channel depth is 1 m, then measurement to ±10 cm is appropriate. If the depth is only 10 cm, then the measurement should be ±10 mm.
- Channel depth should be measured at the thalweg (generally, the deepest portion of the channel).

(a) Step-pool morphology



(b) Riffle-pool morphology

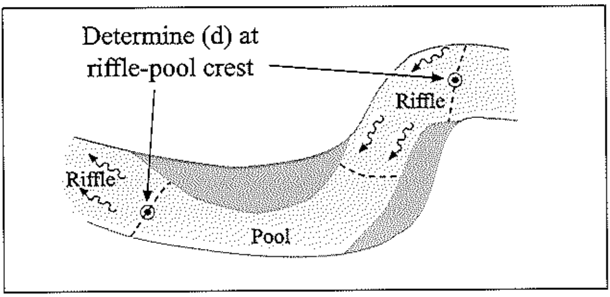


Figure 3. Locations used to determine channel depth. (a) Illustration of step-pool morphology and location to determine channel depth (d). Depth is estimated at the step-pool break from the thalweg to the height of bankfull conditions. Note that D/W_b in this schematic is approximately equal to 0.3.
(b) Illustration of riffle-pool morphology and location to determine channel depth (d). Depth is estimated at the riffle-pool break from the thalweg to the height of bankfull conditions. Note that D/W_b in this schematic is <0.01.

Largest stone moved by flowing water

To determine the size of the largest sediment particle on the channel bed:

- Locate the five largest stones at a cross-section and measure the b-axis (intermediate length) diameter of each (see Figure 4). Select the median value for analysis.
- Measurements need be to the nearest 10%. For instance, if the largest stone is 1 m in b-diameter, measurement to ±10 cm is appropriate. If the largest stone is 10 cm, the measurement should be ±10 mm.
- The largest stone does not include large lag boulders deposited during periods with very different streamflow regimes (e.g., immediately post-glacial) or those that have fallen into the channel from surrounding glacial moraines or colluvial fans/cones.
- The largest stone should not be covered in old moss and organic stains and should be rounded or sub-rounded but not angular. It should have evidence of movement by flowing water during the past decade, that is, it should be incorporated into the channel bed (other sediment knitted around the larger stones) and not be an isolated stone distinctly different than all others in the near vicinity (within several bankfull widths, upstream and downstream). Note, however, that in extremely stable CP or SP morphologies (i.e., the channel has not reformed in the last century), the entire bed may be covered in moss.

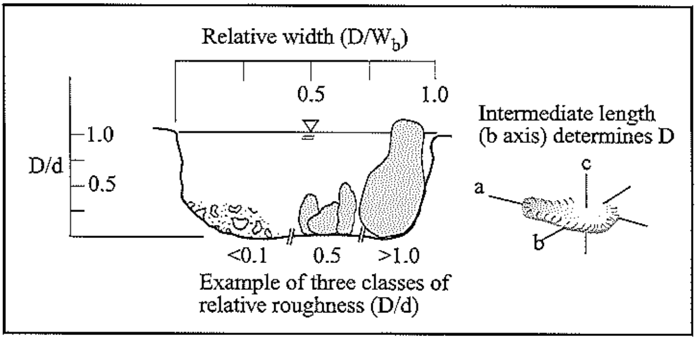


Figure 4. Illustration of the largest stone moved by flowing water, relative width, and relative roughness used to determine channel size.

Determining the type of channel morphology

The seven channel types used in the CAP are summarized in Table 2. The type of morphology is determined by using the field measures, nomogram (Figure 5), and by referring to Figure 6. First, the relative width is calculated by entering the measured values of D and W_b on Graph 1 of Figure 5. Second, the relative roughness is determined by entering the measured values of D and d on Graph 2. Third, the respective D/W_b and D/d values are transferred onto Graph 3, which calculates their product. Finally, the product of D/W_b and D/d is transferred onto Graph 4, with the intersection of this value and s giving the type of channel morphology. If the point of intersection between s and $(D/W_b)(D/d)$ does not lie on the diagonal line, follow the shortest line distance back to the shaded band.

Table 2. Channel types and associated characteristics

Code	Morphology	Sub-code	Bed material	LWD
RP	riffle-pool	RP_g-w	gravel	functioning
RP	riffle-pool	RP_c-w	cobble	functioning
CP	cascade-pool	CP_c-w	cobble	present, minor function
CP	cascade-pool	CP_b	boulder	absent
SP	step-pool	SP_b-w	boulder	present, minimal function
SP	step-pool	SP_b	boulder	absent
SP	step-pool	SP_r	boulder-block	absent

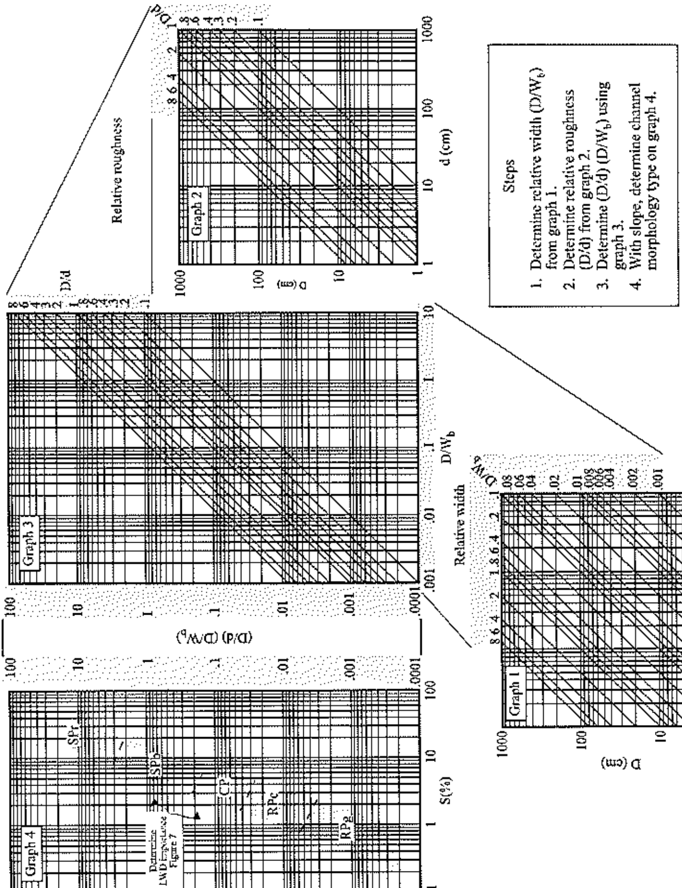


Figure 5. Nomogram used to determine channel morphology.

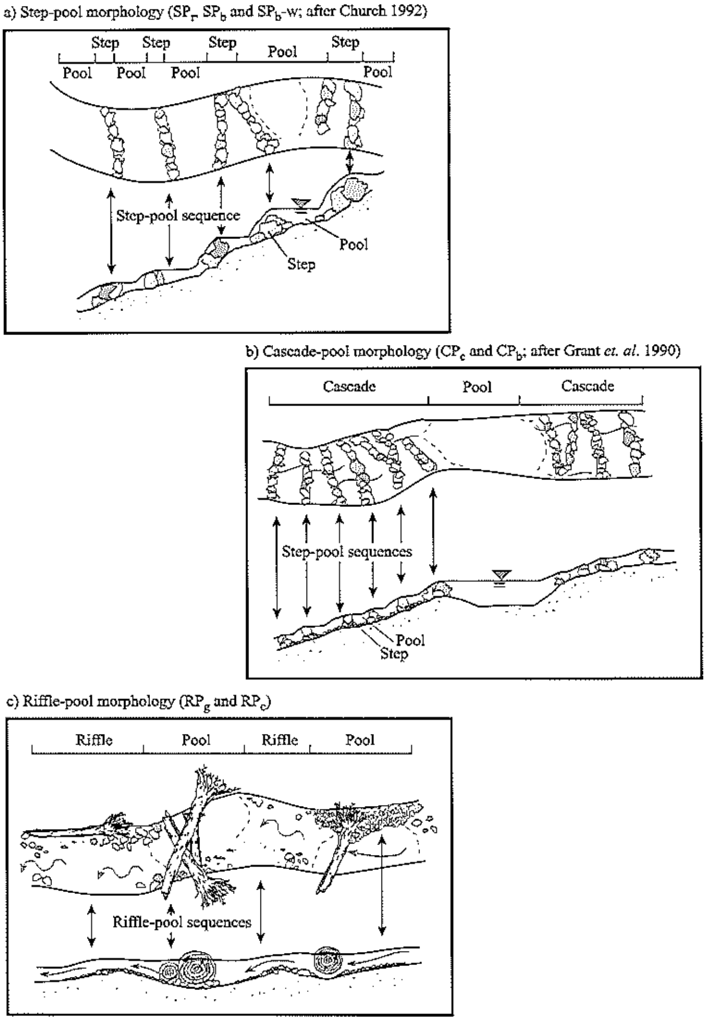


Figure 6. Channel morphologies of small- and intermediate-sized channels.

As an example of the use of Figure 5, use:

D	=	10 cm
d	=	120 cm
W_b	=	20 m
s	=	1.5%

Following the lines in the nomogram produces a riffle-pool morphology with predominately gravel-textured materials (RP_g). Large woody debris (LWD) is important in these channel types (see Figure 7).

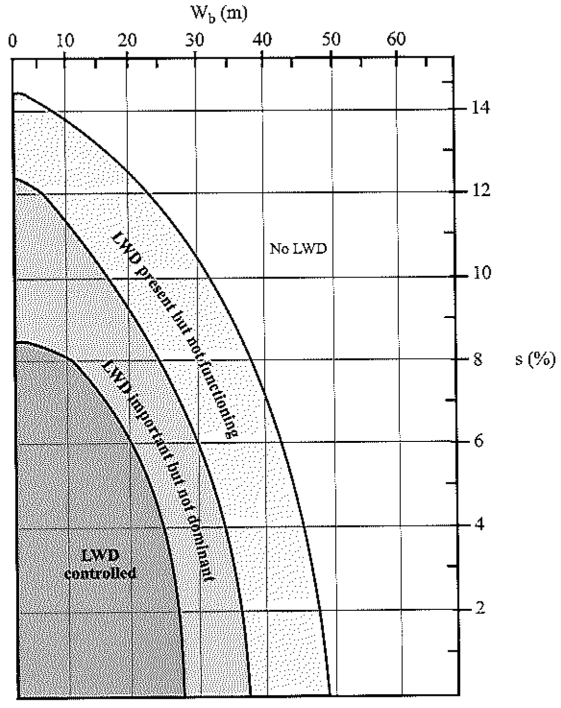


Figure 7. Determining the influence of LWD on channel morphology.

If either the CP or SP morphologies are determined from Figure 5, it is necessary to determine if LWD is expected in the particular channel. The importance of LWD to channel functions depends on the width of the channel (also stream power, but this is considered implicitly in Figure 5). The functional role of LWD is given in Figure 7. For instance, if a channel is determined to be cascade-pool morphology, from Figure 7 it is apparent that when the channel is less than 30 m wide, LWD should be present. When the channel is wider than 30 m, LWD is present but not functioning. (Note that since LWD characteristics are to be used as field indicators of disturbance, it is necessary to know when LWD should, or should not, be present in channel.)

The nomogram is a tool to assist in determining the type of channel morphology. If, in the field, the nomogram indicates a type of morphology that appears incorrect, the field measures should be re-taken. For instance, if a step-pool morphology is determined from Figure 5, but the channel is clearly a riffle-pool morphology, the field values used (with emphasis on channel slope) should be checked.

Evaluating channel disturbance

Each of the three main channel morphologies assessed in the field (step-pool, cascade-pool, riffle-pool) respond differently to disturbances caused by changes in streamflow discharge and sediment/debris loads. In general, the nature of the morphological disturbance expected is associated with channel degradation and aggradation (Figure 8 and Appendix 2).

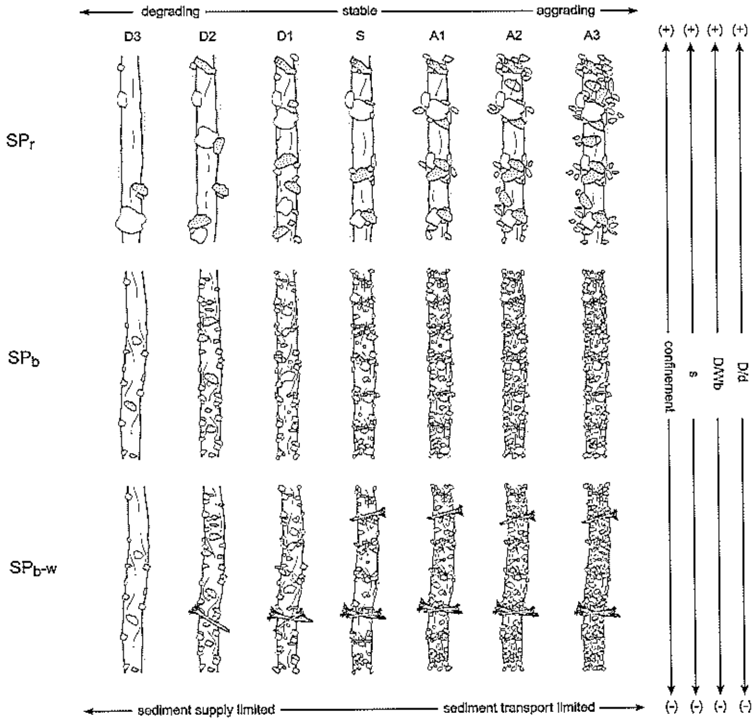


Figure 8a. Small-sized channel morphology matrix showing levels of disturbance (degradation and aggradation).

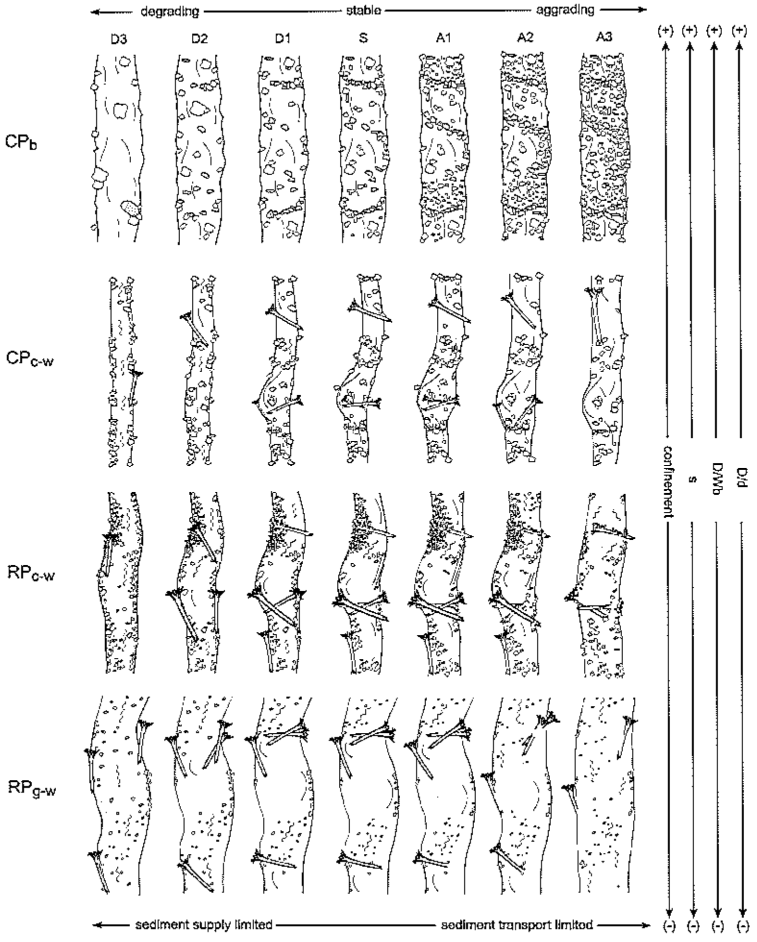


Figure 8b. Intermediate-sized channel morphology matrix showing levels of disturbance (degradation and aggradation).

Field indicators

Field evidence of channel degradation and aggradation is summarized in Figure 9. The changes in sedimentological characteristics are related to both sediment supply and transport limitations. Bank impacts are related to recent erosion as evidenced by collapsing or freshly removed materials. Morphological features considered are primarily the relative abundance of pools and steps or riffles.

Disturbances associated with LWD are assessed by considering the functional role of debris in controlling the morphology (see Hogan *et al.*, in press, for additional details concerning LWD functions). In certain channels, LWD controls the patterns of sediment erosion and deposition within the channel zone. The channel will adjust to any change if LWD is altered in its dimensions, orientation, or storage patterns. LWD plays an insignificant stream-forming role in other channel types (Figure 7).

Field code	Description	Typical photograph
Field indicators: sedimentation		
S1	Homogeneous bed texture. The channel bed and bars exhibit minimal sediment textural variability. (Sediment sorting is influenced by changes in LWD characteristics—low variability means that sediment is all similarly sized, regardless of actual texture.) Occurs in both aggrading and degrading channels (typical of RP morphologies).	
S2	Sediment fingers. Long linear fingers or stripes of fine-textured sediment (commonly coarse sand in cobble-gravel bed streams) extend longitudinally along the channel bed. Typical of aggrading intermediate and large channel morphologies.	
S3	Sediment wedges. The channel develops extensive wedges of sediment. In extreme cases, the channel can be completely de-watered. Occurs in all morphologies in aggrading channels (associated with channel bends, bedrock outcrops, LWD jams, or large pieces of LWD or root wads). Sediment wedges may occur in degrading channels when a supply-limited channel begins to erode an old wedge surface.	
S4	Extensive bars. Areas of bar extend throughout the entire channel reach and consist primarily of bed material with minimal flowing water during low flows (the extreme is a de-watered channel and may develop in association with individual sediment wedges). Usually occurs in aggrading channels and is typical of all morphologies.	
S5	Extensively scoured zones. The majority of bed and bar material is absent due to scouring flows, typical of degrading channel beds. Occurs in all morphologies.	

Figure 9a. Field indicators of channel disturbance—sedimentological features.

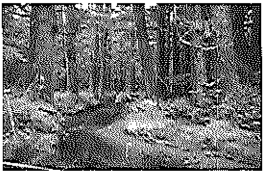
Field code	Description	Typical photograph
Field indicators: banks		
B1	Abandoned channels. Abandoned and/or isolated back or side channels that show signs of colonization by riparian vegetation and have accumulated some forest litter. Typical of degrading channels with an RP morphology (although may occasionally occur in CP morphology).	
B2	Eroding banks. Recently exposed bank material or lack of undercut associated with the bank. Typical of aggrading RP and CP morphologies.	
B3	Avulsions. Similar to B1 although mainstem channels are abandoned and/or isolated when the channel shifts laterally. Typical of aggrading RP and CP morphologies.	

Figure 9b. Field indicators of channel disturbance—bank features.

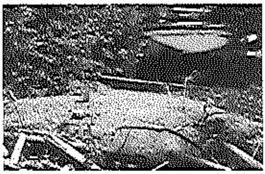
Field code	Description	Typical photograph
Field indicators: morphology		
C1	Extensive riffles or cascades. In intermediate and large channel morphologies, the channel is dominated by riffles and relatively shallow pools or glides. In small channel morphologies, extensive riffles are replaced with extensive cascades. Occurs in all morphologies and both aggrading and degrading channels.	
C2	Minimal pool area. Pools are limited in frequency and extent and are often only associated with individual pieces of LWD. Occurs in all morphologies and both aggrading and degrading channels.	
C3	Elevated mid-channel bars. Channel bars have aggraded with bar-tops at equal elevations or higher than adjacent bank-tops. Typically, such bars have relatively steep downstream faces. Occurs in aggrading CP and RP morphologies.	
C4	Multiple channels or braids. Multiple channels develop as the channel aggrades and shifts from past single thread to recent multiple channels. Typical of CP and RP morphologies, and occurs in aggrading channels.	
C5	Disturbed stone lines. Steps associated with step-pool morphologies are disturbed (stone lines are no longer intact and water flows around individual stones, rather than cascading over actual stone lines). Occurs in SP and CP morphologies, typically in degrading channels (although may occasionally be present in aggrading channels).	

Figure 9c. Field indicators of channel disturbance—morphological features.

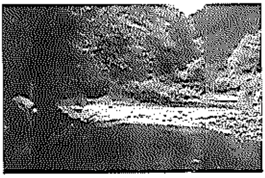
Field code	Description	Typical photograph
Field indicators: large woody debris		
D1	Small woody debris. Abundant small-sized woody debris pieces (commonly logs with saw-cut ends and detached root wads and branches). Typical of aggrading channels.	
D2	Function of LWD. The majority of LWD does not span the channel width as the orientation of individual LWD pieces shifts from perpendicular to parallel (relative to the channel banks). Typical of both aggrading and degrading channels in RP and CP morphologies.	
D3	Recently formed LWD jams. Typical of aggrading channels (but can occur in degrading channels) in RP and CP morphologies.	

Figure 9d. Field indicators of channel disturbance—LWD features.

Channel keys

The field indicators of disturbance described in Figure 9 are used together with the diagnostic keys (Appendix 2) to determine the level of disturbance present along a reach of a particular channel type. The keys integrate all the individual properties of disturbance and incorporate the field indicator evidence to show the overall disturbance pattern. Without the keys it would be necessary to physically measure the attributes of disturbance (many of which are problematic due to streamflow stage dependency), and then compile these in some statistically rigorous way to determine the overall level of channel disturbance.

Several points should be noted concerning the channel keys. First, the keys are organized so that the undisturbed channel is located in the middle of each set of channel types. Three levels of aggraded channels are found in front of the undisturbed channel and three levels of degraded channels are located after the undisturbed channel. This series shows the progression of channel changes that occur if sediment and/or water quantity are increased (aggrading, for example, downstream of a landslide entry point to the channel) or decreased (degrading, for example, downstream of a barrier to sediment transport, such as a landslide-dammed channel). This series is given in Appendix 2. The three levels represent degrees of disturbance severity.

Second, the text associated with each channel disturbance level often indicates that a feature is becoming "more," "less," "coarser," "finer," etc. These terms refer to the progression of changes away from the undisturbed state (e.g., see title page of each channel type in Appendix 2). They indicate the sequence of changes that make up the disturbance.

Third, the keys provide generalized, typical examples of channel conditions along a reach. They are not intended to be exact duplicates of the conditions encountered (do not expect your field situation to be exactly the same as conditions shown in the keys). Finally, the "typical field indicators" listed in the keys do not have to be found in every case for that particular level of disturbance to be assigned. The indicators are included to show which indicators should, but not must, be present for the level of disturbance.

In the field, the morphology of each reach is determined according to the channel attributes measured in the field and with Figure 5. The level of disturbance is then assessed by inventorying the field indicators of channel disturbance and reviewing the deviation from the stable state, as shown in Appendix 2. All data are recorded on Field Form 1, and the proportion of each reach with disturbed morphology is calculated on Field Form 2. Finally, the information summarized on Field Form 2 is transferred to Form 8 of the *Channel Assessment Procedure Guidebook.*

Field equipment

Recommended field equipment for conducting the CAP include:

- map and aerial photographs showing channel reaches to be evaluated in the field
- field guidebook and notebook
- chest waders
- 50 m fibre tape measure
- pocket tape measure
- surveyor's hip chain
- hand-held level (e.g., Suunto clinometer)
- stadia rod
- 35 mm camera and 400 ASA (or faster) film
- channel "types" and "keys" (Figure 8 and Appendix 2).

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Appendix 1. Field forms

The blank field forms that follow are to be used to make copies for field use. These should be copied onto water-proof paper with enough copies to complete the assessment.

Sub-basin:	Date:
Reach:	Crew:
	Weather:

Station	W_b (m)	d (cm)	s (%)	D (cm)	Morphology from nomogram (Figure 5)
				Modal morphological type	

Distance (m)	Bank type†	Channel type and disturbance level	Check any field indicators present S1 S2 S3 S4 S5 C1 C2 C3 C4 C5 B1 B2 B3 D1 D2 D3	Photo roll & frame
			❑❑❑❑❑ ❑❑❑❑❑ ❑❑❑ ❑❑❑	
			❑❑❑❑❑ ❑❑❑❑❑ ❑❑❑ ❑❑❑	
			❑❑❑❑❑ ❑❑❑❑❑ ❑❑❑ ❑❑❑	
			❑❑❑❑❑ ❑❑❑❑❑ ❑❑❑ ❑❑❑	
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			❑❑❑❑❑ ❑❑❑❑❑ ❑❑❑ ❑❑❑	
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			❑❑❑❑❑ ❑❑❑❑❑ ❑❑❑ ❑❑❑	

S1 Homogeneous bed texture
S2 Sediment fingers
S3 Sediment wedges
S4 Extensive bars
S5 Extensively scoured zones

C1 Extensive riffles or cascades
C2 Minimal pool area
C3 Elevated mid-channel bars
C4 Multiple channels or braids
C5 Disturbed stone lines

B1 Abandoned channels
B2 Eroding banks
B3 Avulsions
D1 Small woody debris
D2 LWD function
D3 Recently formed LWD jams

†A (Erodible): 1 = silt, 2 = sand, 3 = gravel, 4 = cobble, 5 = boulder (A4/5 = Alluvial, gravel over boulder)
N (Non-erodible): 1 = Till, 2 = colluvium, 3 = bedrock (see WAP Appendix 11 for bedrock types)

Field Form 1. Field data.

Sub-basin:	Reach:
	Morphology:

Survey distance (m)	Disturbance level	Stream length in each class (m)			
		None (S or other)	Low (A1, D1)	Moderate (A2, D2)	Severe (A3, D3)
Σ =				Σ =	Σ =

Sum moderate and severe = ____________________ (m)
Sum % moderate and severe = ____________________ %

Field Form 2. Disturbance summary.

Appendix 2. Diagnostic channel keys

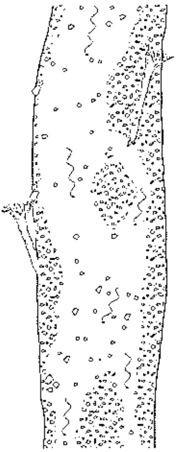
Riffle-pool: RP_g-w

Degraded	Stable	Aggraded
Morphology:		
Extensive riffles and runs	Repeating riffle-bar-pool sequences	Extensive riffles, runs and bars
Small shallow pools (due to erosion of riffle crests)	Diverse pool size, shape, and depth	Small, shallow pools (due to depositional infilling)
Pools represent approximately 15% of the channel	Pools represent 50–70% of the channel	Pools represent approximately 15% of the channel
One main channel	One or two main channels	Multiple channels on braided bed surface
Simple, uniform riffle and run shapes	Diverse riffle shapes	Simple, uniform riffle and run shapes (minimal depth variability)
Limited side-channel bars	Mainly diagonal and point bars	Mainly mid-channel bars elevated above surrounding bank tops
Bed sediment:		
Mainly cobbles and coarser textures	Gravel and cobble	Mainly gravel and finer textures
Banks:		
Mainly cobbles and gravel	Mainly cobbles, gravel, and sand	Mainly gravels, sand, and cobbles
Banks primarily sloping and/or overhanging	Large proportion of vegetated undercut or overhanging banks	Extensive bank erosion (commonly complete absence of undercut banks)
LWD:		
Limited. Any LWD present is small, oriented parallel to the banks, and elevated above the channel	Abundant. Most LWD is incorporated into the channel and oriented perpendicular to the banks	Absent or buried. Any LWD present is small and oriented parallel to the banks

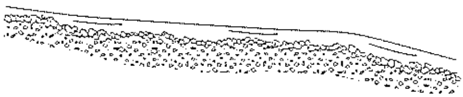
Morphology:	**Riffle-pool**	**RP_g-w A3**
Disturbance level:	**Severely aggraded**	
Code:	**RP_g-w: A3**	

Typically:
s ~ 0.5–1.5%
D/d ~ 0.1–0.3
D/W_b ~ 0.002–0.01

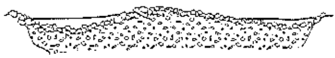
Plan view



Long profile



Cross section



Relevant field indicators: S1, S2, S3, S4, C2, C3, C4, B2, B3, D1, D2, D3

Generally:

Channel widened over entire reach length.

No undercut banks.

Pools are infrequent (≤15% of channel length) and shallow (≤ one-third of a metre deep).

Riffles are extensive (>80% of channel).

Elevated mid-channel bars (bar tops higher than bank tops) with steep and easily disturbed downstream faces.

LWD is clumped into jams.

Morphology: Riffle-pool RP_g-w

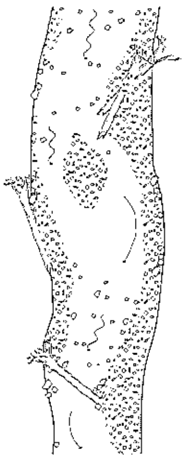
Disturbance level: Moderately aggraded — A2

Code: RP_g-w: A2

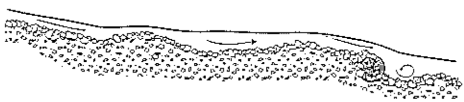
Typically:

s ~ 0.5–1.5%
D/d ~ 0.1–0.3
D/W_b ~ 0.002–0.01

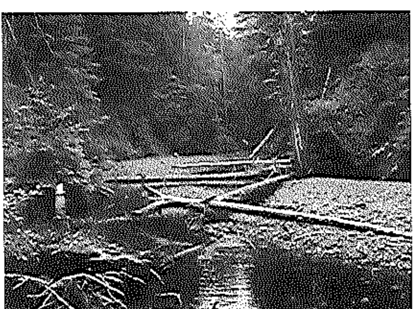
Plan view



Long profile



Cross section



Relevant field indicators: S2, S3, S4, C2, C3, C4, B2, D2, D3

Generally:

Channel widening is evident over much of the channel length (≥ one-half reach length).

Pools are less frequent and shallow (<0.5 m deep).

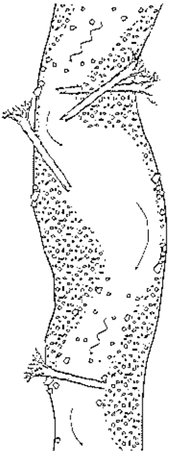
Riffles make up over 50% of the channel length.

Side and mid-channel bars are more extensive and relatively high, with bar tops as high as bank tops.

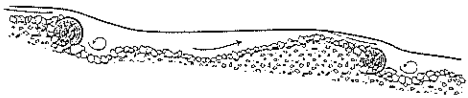
The distribution of LWD is uneven, oriented parallel to the banks, and often clumped into jams.

Morphology:	**Riffle-pool**	**RP_g-w**
Disturbance level:	**Partially aggraded**	**A1**
Code:	**RP_g-w: A1**	

Plan view



Long profile



Typically:

s ~ 0.5–1.5%
D/d ~ 0.1–0.3
D/W_b ~ 0.002–0.01

Cross section

Relevant field indicators: S1, S2, S4, C1, C3, B2, D1, D2

Generally:

Channel widening is evident (bank erosion).

Pools are less pronounced, making up one-half to one-third of the channel length.

Pool depth is reduced; deep pools (≥0.5 m) typically associated with LWD.

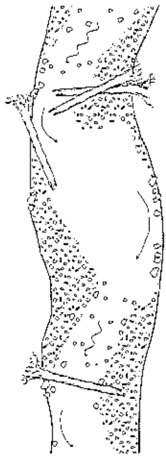
Side channel bars are larger (due to a wider channel), and bars begin to form in the middle of the channel.

Morphology:	**Riffle-pool**	**RP_g-w**
Disturbance level:	**Stable**	**S**
Code:	**RP_g-w: S**	

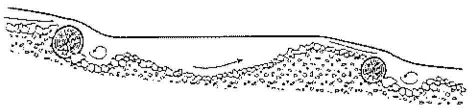
Typically:

s ~ 0.5–1.5%
D/d ~ 0.1–0.3
D/W_b ~ 0.002–0.01

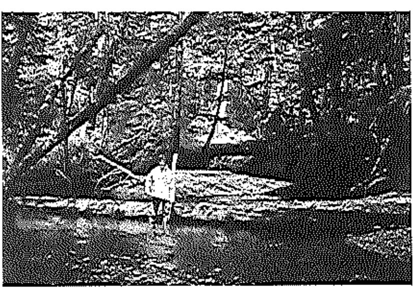
Plan view



Long profile



Cross section



Generally:

Very complex channel morphology with diverse range of pool and riffle sizes, shapes and types, undercut banks, and highly variable widths and sediment textures.

Pools comprise 75% of the channel and have wide range of depths; many pools can be over 1 m deep at low flow.

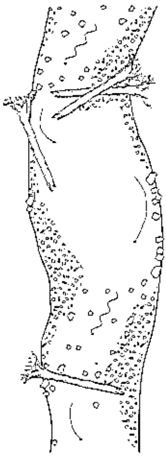
Wide range of sediment size (fine sand to cobbles).

LWD is present and plays a critical role in controlling channel morphology (influences deposition and the scour pattern of channel bed and banks).

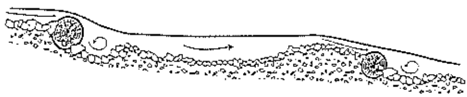
Morphology:	**Riffle-pool**	**RP_g-w D1**
Disturbance level:	**Partially degraded**	
Code:	**RP_g-w: D1**	

Typically:
$s \sim 0.5$–1.5%
$D/d \sim 0.1$–0.3
$D/W_b \sim 0.002$–0.01

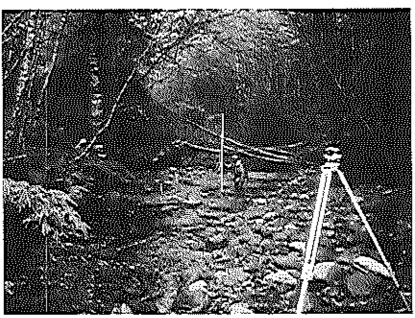
Plan view



Long profile



Cross section



Relevant field indicators: S5, C1, D2

Generally:

Channel is complex with diverse pool and riffle shapes, undercut banks, and LWD functions (LWD interacts with flow of water and sedimentation).

Pools make up one-half to one-third of channel length.

Pool depth is reduced by degradation of riffle crests (pool depth approximately 0.25 to 1 m).

Riffle texture is coarse as sediment is eroded.

LWD influences bed and bank conditions.

Morphology:	**Riffle-pool**	**RP_g-w**
Disturbance level:	**Moderately degraded**	**D2**
Code:	**RP_g-w: D2**	

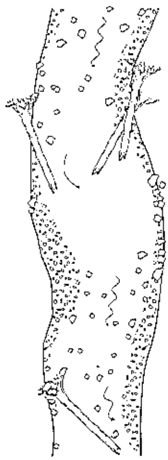
Typically:

s ~ 0.5–1.5%

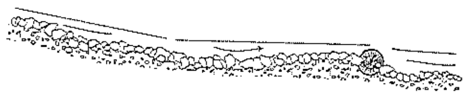
D/d ~ 0.1–0.3

D/W_b ~ 0.002–0.01

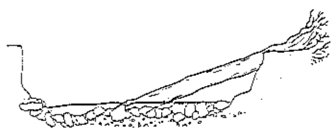
Plan view

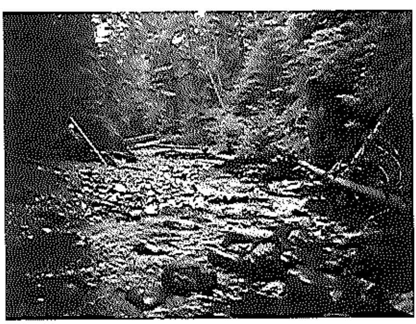


Long profile



Cross section





Relevant field indicators: S5, C1, C2, B1, D2, D3

Generally:

Channel complexity is reduced by continuous down-cutting of riffle surface.

Channel bed is uniformly coarser.

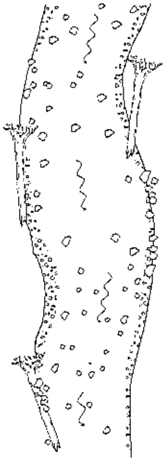
Pools represent approximately one-quarter of the channel length.

Pools are uniformly shallow with only rare pools exceeding 0.5 to 0.75 m in depth.

LWD pieces are less numerous and oriented primarily parallel to the channel banks. Log jams are common.

Morphology:	**Riffle-pool**	**RP_g-w D3**
Disturbance level:	**Severely degraded**	
Code:	**RP_g-w: D3**	

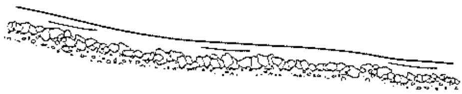
Plan view



Typically:

s ~ 0.5–1.5%
D/d ~ 0.1–0.3
D/W_b ~ 0.002–0.01

Long profile



Cross section

Relevant field indicators: S1, S5, C1, C2, B1, D2, D3

Generally:

Channel complexity reduced by continuous down-cutting of riffle surface.

Bed uniformly coarser.

Pools represent approximately one-quarter of the channel length and are uniformly shallow, rarely exceeding one-half metre in depth.

Channel bed has exposed bedrock over significant lengths of the reach.

Riffle-pool: RP_c-w

Degraded	Stable	Aggraded
Morphology:		
Extensive riffles and runs	Repeating riffle-bar-pool sequences	Extensive riffles, runs and bars
Small shallow pools (due to erosion of riffle crests)	Diverse pool size, shape, and depth	Small, shallow pools (due to depositional infilling)
Pools represent approximately 15% of the channel	Pools represent 50–70% of the channel	Pools represent approximately 15% of the channel
One main channel	One or two main channels	Multiple channels on braided bed surface
Simple, uniform riffle and run shapes	Diverse riffle shapes	Simple, uniform riffle and run shapes (minimal depth variability)
Limited side-channel bars	Mainly diagonal and point bars	Mainly mid-channel bars elevated above surrounding bank tops
Bed sediment:		
Mainly cobbles and coarser textures	Cobble and gravels	Mainly gravel and finer textures
Banks:		
Mainly cobbles and gravel	Mainly cobbles, gravel, and sand	Mainly gravels, sand, and cobbles
Banks primarily sloping and/or overhanging	Large proportion of vegetated undercut or overhanging banks	Extensive bank erosion (commonly complete absence of undercut banks)
LWD:		
Limited. Any LWD present is small, oriented parallel to the banks, and elevated above the channel	Abundant. Most LWD is incorporated into the channel and oriented perpendicular to the banks	Absent or buried. Any LWD present is small and oriented parallel to the banks

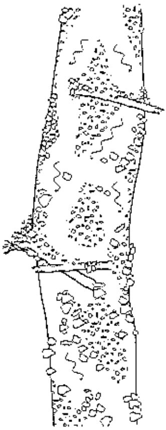
Morphology: Riffle-pool — RP_c-w A3

Disturbance level: Severely aggraded

Code: RP_c-w: A3

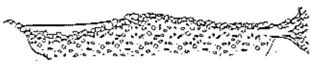
Typically:
s ~ 1.5–3.0%
D/d ~ 0.3–0.6
D/W_b ~ 0.01–0.05

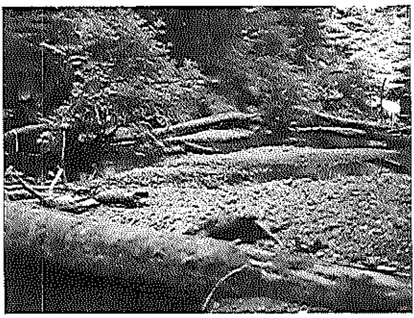
Plan view



Long profile

Cross section





Relevant field indicators: S1, S2, S3, S4, C2, C3, C4, B2, B3, D1, D2, D3

Generally:

Channel widened over entire reach length. Undercut banks are absent.

Pools are infrequent (≤15% of channel length) and shallow (≤ one-third metre deep).

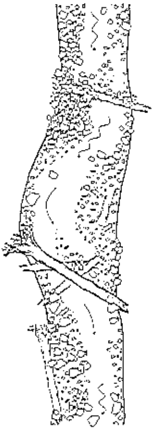
Riffles are extensive (>80% of channel).

Elevated mid-channel bars (bar tops higher than bank tops) are present and have steep and easily disturbed downstream faces.

LWD is clumped into jams.

Morphology:	**Riffle-pool**	**RP_c-w**
Disturbance level:	**Moderately aggraded**	**A2**
Code:	**RP_c-w: A2**	

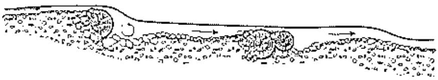
Plan view



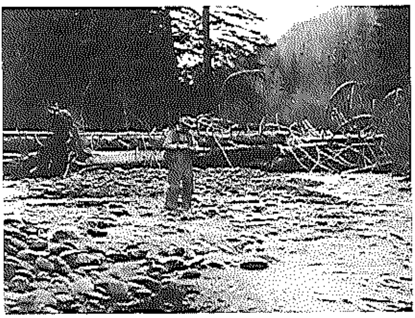
Typically:

s ~ 1.5–3.0%
D/d ~ 0.3–0.6
D/W_b ~ 0.01–0.05

Long profile



Cross section



Relevant field indicators: S2, S3, C2, C3, C4, B2, D2, D3

Generally:

Channel widening is evident over much of the channel length (≥ one-half reach length).

Pools are less frequent and shallow (<0.5 m in depth). Riffles make up over 50% of the channel length.

Side and mid-channel bars are more extensive.

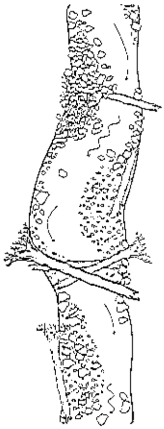
Mid-channel bars are relatively high, with bar tops as high as banks.

LWD is less evenly distributed, often clumped into jams. Individual pieces are oriented parallel to the banks.

Morphology:	**Riffle-pool**	**RP_c-w**
Disturbance level:	**Partially aggraded**	**A1**
Code:	**RP_c-w: A1**	

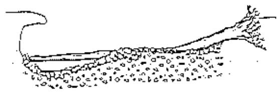
Typically:
s ~ 1.5–3.0%
D/d ~ 0.3–0.6
D/W_b ~ 0.01–0.05

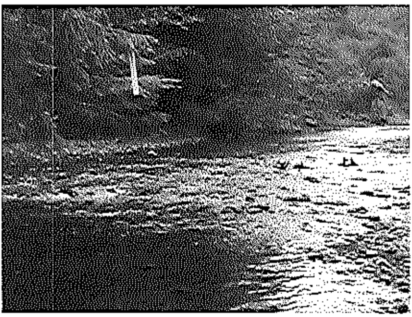
Plan view



Long profile

Cross section





Relevant field indicators: S1, S2, S4, C1, C3, B2, D1, D2

Generally:

Channel widening is evident (bank erosion).

Pools are less pronounced, making up one-half to one-third of the channel length.

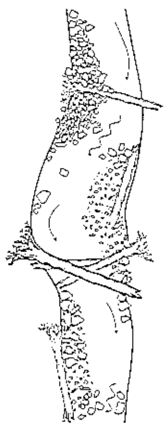
Pools are less deep, few deep pools (≥ one-half metre); those that are deep are associated with LWD.

Side channel bars are larger (due to wider channel), and bars are beginning to form in the middle of the channel.

Mid-channel bars are relatively high, with bar-top surface at the same elevation as the bank tops.

Morphology:	**Riffle-pool**	**RP_c-w**
Disturbance level:	**Stable**	**S**
Code:	**RP_c-w: S**	

Plan view



Typically:
s ~ 1.5–3.0%
D/d ~ 0.3–0.6
D/W_b ~ 0.01–0.05

Long profile

Cross section

Generally:

Very complex channel morphology with diverse range of pool and riffle sizes, shapes and types, undercut banks, and highly variable widths and sediment textures.

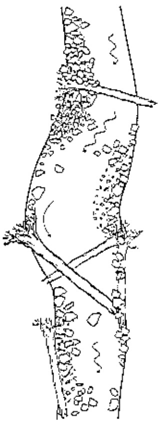
Pools comprise 75% of the channel and have a wide range of depths; many pools can be 0.5 to 1 m deep at low flow.

Wide range of sediment size (coarse sand to cobbles).

LWD is present and plays a critical role in controlling channel morphology (influences deposition and the scour pattern of channel bed and banks).

Morphology:	**Riffle-pool**	**RP_c-w**
Disturbance level:	**Partially degraded**	**D1**
Code:	**RP_c-w: D1**	

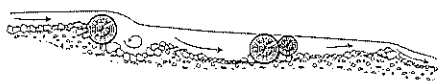
Plan view



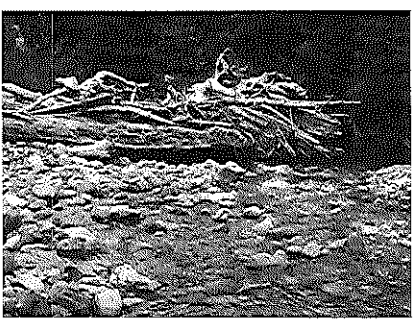
Typically:

s ~ 1.5–3.0%
D/d ~ 0.3–0.6
D/W_b ~ 0.01–0.05

Long profile



Cross section



Relevant field indicators: S5, C1, D2

Generally:

Channel is complex with diverse pool and riffle shapes; undercut banks and LWD functions (LWD interacts with flow of water and sedimentation).

Pools make up between one-half and one-third of channel length.

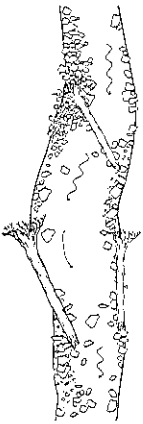
Pools becoming shallower by degradation of riffle crests. Pools have depths between 0.5 to 0.75 m.

Riffles are coarser as coarse sediment is eroded.

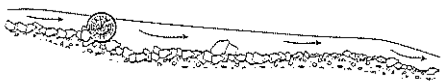
LWD influences bed and bank conditions.

Morphology:	**Riffle-pool**	**RP_c-w**
Disturbance level:	**Moderately degraded**	**D2**
Code:	**RP_c-w: D2**	

Plan view

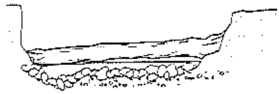


Long profile



Typically:
s ~ 1.5–3.0%
D/d ~ 0.3–0.6
D/W_b ~ 0.01–0.05

Cross section



Relevant field indicators: S5, C1, C2, D2, B1, D2, D3

Generally:

Channel complexity reduced by continuous down-cutting of riffle surface.

Bed uniformly coarser.

Pools make up approximately one-quarter of the channel length.

Pools are uniformly shallow with only rare pools exceeding 0.5 m in depth.

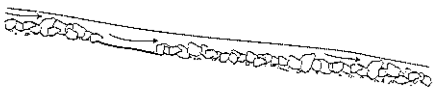
LWD pieces are less numerous and oriented primarily parallel to the channel banks. Log jams are common.

Morphology:	**Riffle-pool**	**RP_c-w**
Disturbance level:	**Severely degraded**	**D3**
Code:	**RP_c-w: D3**	

Typically:
s ~ 1.5–3.0%
D/d ~ 0.3–0.6
D/W_b ~ 0.01–0.05

Plan view

Long profile



Cross section

Relevant field indicators: S1, S5, C1, C2, B1, D2, D3

Generally:

Channel complexity reduced by continuous down-cutting of riffle surface.

Bed uniformly coarser.

Pools make up < one-quarter of the channel length.

Pools are uniformly shallow with only rare pools exceeding 0.25 m in depth.

Channel bed has exposed bedrock over significant lengths of the reach.

Cascade-pool: CP_c-w

Degraded	Stable	Aggraded
Morphology:		
Stone line series disorganized (no recognizable pattern due to displacement)	Series of repeating stone lines forming overall steep zone connecting lower gradient pools (pools typically ≥1 W_b in length)	Few distinct pools (deeps are infilled with stones originally in lines and finer materials transported by the channel)
Bed sediment:		
Only the largest stones remain (strewn over beds) and are devoid of moss	Moss-covered stone steps	All sediment along the bed devoid of moss or vegetative cover
Banks:		
Boulder and cobble	Boulder and cobble	Boulder and cobble, localized bank erosion
LWD:		
LWD (if present) has a minimal functional role	LWD is present and functioning to a limited extent (forms steps, traps/scours sediment and protects banks)	LWD is present but not functional (does not trap/ scour sediment in any substantial way)

Morphology: Cascade-pool — CP_c-w A3

Disturbance level: Severely aggraded

Code: CP_c-w: A3

Plan view

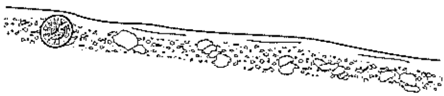
Typically:

$s \sim 3–5\%$

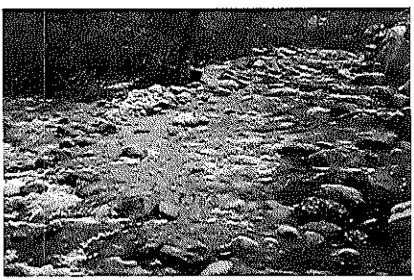
$D/d \sim 0.6–1.0$

$D/W_b \sim 0.05–0.15$

Long profile



Cross section



Relevant field indicators: S1, S2, S3, S4, C1, C2, C3, C4, B2, D2, D3

Generally:

Step-pool morphology is absent due to infilling of pools and expansion of bars.

Bars are present along entire reach; both side and mid-channel bars have elevated surfaces—bars are as high as surrounding bank tops.

Stream flow is shallow and rapid, and channel widening is evident.

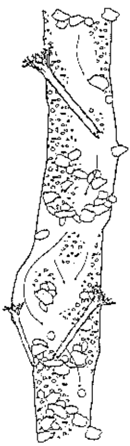
LWD oriented primarily parallel to channel.

Channel bed often de-waters during low flow periods.

Morphology:	**Cascade-pool**	**CP_c-w**
Disturbance level:	**Moderately aggraded**	**A2**
Code:	**CP_c-w: A2**	

Typically:
s ~ 3–5%
D/d ~ 0.6–1.0
D/W_b ~ 0.05–0.15

Plan view



Long profile

Cross section

Relevant field indicators: S3, S4, C1, C2, C3, C4, D2

Generally:

Step-pool structure is difficult to distinguish.

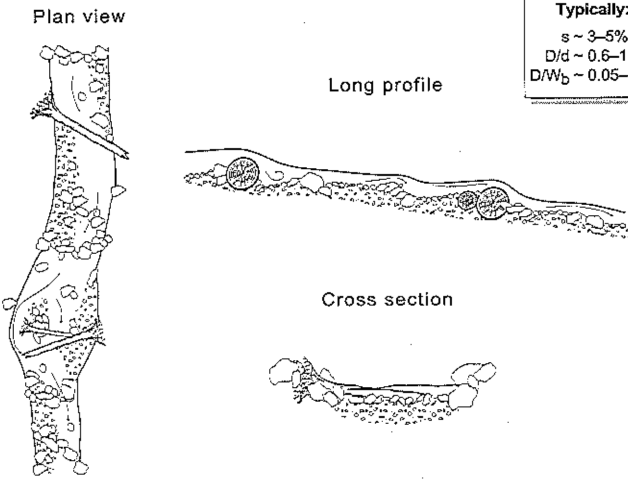
Channel has been widened by bank erosion.

Pools are short (≤ one-third channel length) and shallow with little difference in depth between pool and step zones.

Bars (gravel, cobble, and sand) are at same height as bank tops and occur both along margins and in mid-channel.

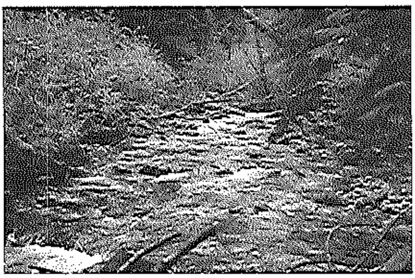
LWD spans portion of the channel and is oriented parallel to the banks.

Morphology:	**Cascade-pool**	**CP_c-w**
Disturbance level:	**Partially aggraded**	**A1**
Code:	**CP_c-w: A1**	



Typically:

s ~ 3–5%
D/d ~ 0.6–1.0
D/W_b ~ 0.05–0.15



Relevant field indicators: S2, S4, C3, D2

Generally:

Interlocking cobbles and LWD form steps along the channel.

Bars are relatively large and extend from the channel margins into pool zones.

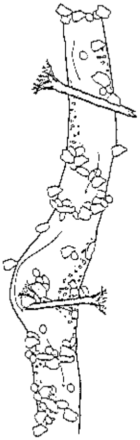
Pools are less deep, due to infilling, and cover one-half to one-third of the channel.

Channel sediments include a wide range of textures, but overall texture is relatively fine.

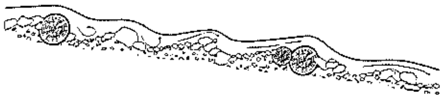
Channel widening is evident.

Morphology:	**Cascade-pool**	**CP_c-w**
Disturbance level:	**Stable**	**S**
Code:	**CP_c-w: S**	

Plan view

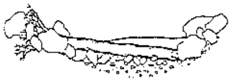


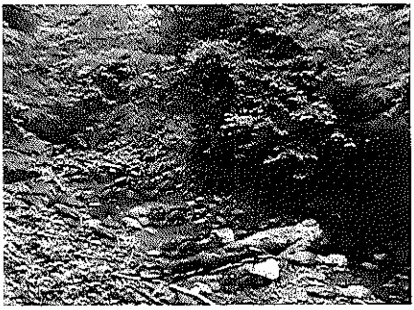
Long profile



Typically:
s ~ 3–5%
D/d ~ 0.6–1.0
D/W_b ~ 0.05–0.15

Cross section





Generally:

Series of repeating stone lines forming overall steep zones connecting lower gradient pools $\geq 1 W_b$ in length.

Boulder and cobble stone steps are partially covered by moss.

LWD is present and functioning to a limited extent by forming steps, trapping sediment, initiating scour, and protecting the banks.

Morphology:	**Cascade-pool**	**CP_c-w**
Disturbance level:	**Partially degraded**	**D1**
Code:	**CP_c-w: D1**	

Typically:

$s \sim 3\text{–}5\%$

$D/d \sim 0.6\text{–}1.0$

$D/W_b \sim 0.05\text{–}0.15$

Plan view

Long profile

Cross section

Generally:

Cobble steps are intact with minor breaks in line.

Pools are deep with cobble-textured bed.

Channel bed becoming coarser overall, as gravels and finer-textured sediments entrained and transported downstream.

Bars less extensive, and margins near banks have recently established vegetation (channel is beginning to recover).

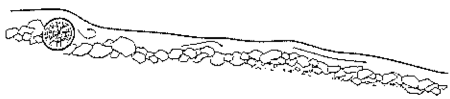
Deepest pools associated with LWD.

Relevant field indicators: S5, C1, D2

Morphology:	**Cascade-pool**	**CP_c-w**
Disturbance level:	**Moderately degraded**	**D2**
Code:	**CP_c-w: D2**	

Plan view

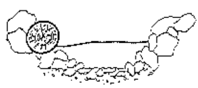
Long profile



Typically:

s ~ 3–5%
D/d ~ 0.6–1.0
D/W_b ~ 0.05–0.15

Cross section



Relevant field indicators: S5, C1, C2, C5, D2

Generally:

Cobble steps remain evident but they are usually not continuous across the channel.

Pools are shallow due to downcutting of steps.

Channel is coarse-textured overall (only minor amounts of gravel or finer sediments).

Bars are not extensive, existing only along channel margins; commonly bar surfaces are vegetated (e.g., moss, alder).

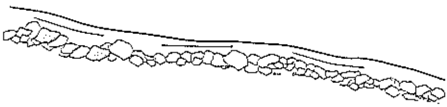
Morphology:	**Cascade-pool**	**CP_c-w**
Disturbance level:	**Severely degraded**	**D3**
Code:	**CP_c-w: D3**	

Typically:

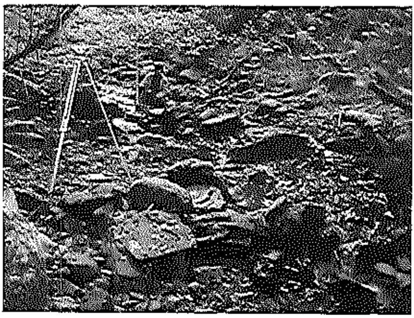
s ~ 3–5%
D/d ~ 0.6–1.0
D/W_b ~ 0.05–0.15

Plan view

Long profile



Cross section



Relevant field indicators: S5, C1, C2, C5, B1, B3, D1, D2, D3

Generally:

Severely degraded channels have no steps present; steps have been eroded, and stream flow is rapid along entire channel with no pools.

Bed is coarse-textured, mainly cobbles, with localized exposure of bedrock.

Bars are absent, sediment remaining along channel margin has become vegetated.

LWD present only along channel banks.

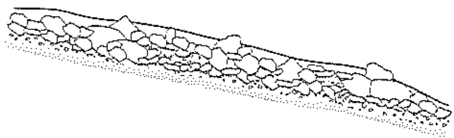
Cascade-pool: CP_b

Degraded	Stable	Aggraded
Morphology:		
Stone line series disorganized (no recognizable pattern due to displacement)	Series of repeating stone lines forming overall steep zone connecting lower gradient pools (pools typically ≥1 W_b in length)	Few distinct pools (deeps are infilled with stones originally in lines and finer materials transported by the channel)
Bed sediment:		
Only the largest stones remain (strewn over bed) and are devoid of moss	Moss-covered stone steps	All sediment along the bed devoid of moss or vegetative cover
Banks:		
Boulder and cobble	Boulder and cobble	Boulder and cobble, localized bank erosion
LWD:		
LWD (if present) has a minimal functional role	LWD is present and functioning to a limited extent (forms steps, traps/scours sediment and protects banks)	LWD is present but not functional (does not trap/ scour sediment in any substantial way)

Morphology:	**Cascade-pool**	**CP_b**
Disturbance level:	**Severely aggraded**	**A3**
Code:	**CP_b: A3**	

Plan form

Long profile



Typically:

$s \sim 3$–5%

$D/d \sim 0.6$–1.0

$D/W_b \sim 0.05$–0.15

Cross section

Relevant field indicators: S1, S2, S3, S4, C1, C2, C3, C4, B2

Generally:

Channel filled with sediment of all sizes (coarse layer at surface of channel).

Channel bed approximately as high as surrounding banks.

Flow consists of rapids between largest stones and sediment accumulations.

Flow is often in branches of braided pattern.

No moss-covered sediment; bed is regularly reworked.

Morphology:	**Cascade-pool**	**CP_b**
Disturbance level:	**Moderately aggraded**	**A2**
Code:	**CP_b: A2**	

Plan form

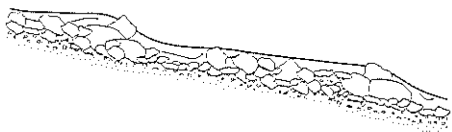
Typically:

s ~ 3–5%

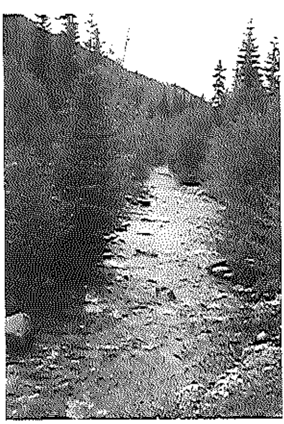
D/d ~ 0.6–1.0

D/W_b ~ 0.05–0.15

Long profile



Cross section



Generally:

Stone lines intact with flow over the steps and around large boulders.

Pools infilled; flow is rapid with minor areas of slower moving water.

Channel is filled with sediment; top of sediment accumulation is almost as high as surrounding boulders.

No moss-covered sediment.

Minimal localized channel widening.

Relevant field indicators: S3, S4, C1, C2, C3, C4

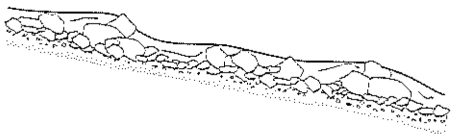
Morphology:	**Cascade-pool**	**CP_b**
Disturbance level:	**Partially aggraded**	**A1**
Code:	**CP_b: A1**	

Plan form

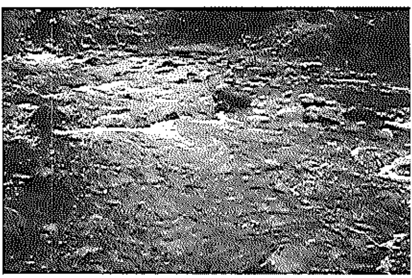
Typically:

s ~ 3–5%
D/d ~ 0.6–1.0
D/W_b ~ 0.05–0.15

Long profile



Cross section



Relevant field indicators: S2, S4, C3

Generally:

Stone lines are intact, and flow tumbles over the step.

Pools beginning to fill with finer-textured sediment (small boulders and cobbles).

Pools are about 50% of the channel extent; flow is rapid through pool (even during low flow conditions) because of reduced depth.

Tops of large boulders covered in moss (sides and base not covered).

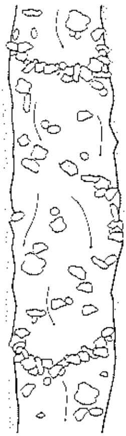
LWD is insignificant.

Morphology: Cascade-pool CP_b

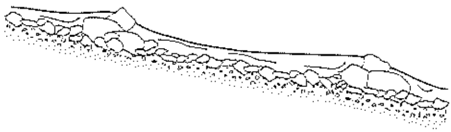
Disturbance level: Stable S

Code: CP_b: S

Plan form



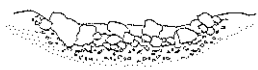
Long profile

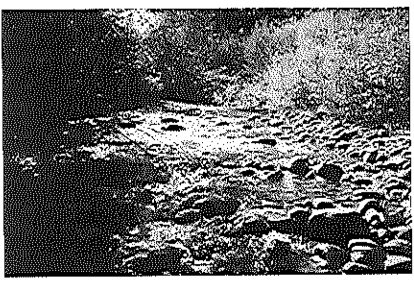


Typically:

s ~ 3–5%
D/d ~ 0.6–1.0
D/W_b ~ 0.05–0.15

Cross section





Generally:

Stone lines largely intact, forming steps. Water flows over steps and around individual boulders.

Stone lines cross the channel in a diagonal pattern, often forming diamond or "net" shapes.

Pools between steps often make up over two-thirds of the channel (steps ≤ one-third).

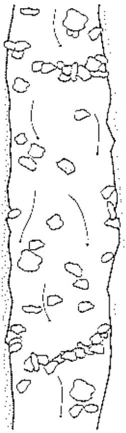
LWD plays an insignificant role in controlling channel pattern (LWD is present but not important functionally; it does not significantly influence sediment storage or scour).

Morphology:	**Cascade-pool**	**CP_b**
Disturbance level:	**Partially degraded**	**D1**
Code:	**CP_b: D1**	

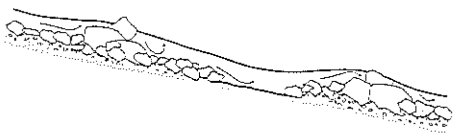
Typically:

$s \sim 3–5\%$
$D/d \sim 0.6–1.0$
$D/W_b \sim 0.05–0.15$

Plan form



Long profile



Cross section

Generally:

Stone lines becoming less continuous; diamond and “net” shapes not obvious.

Bed is becoming coarser-textured as fine sediments are excavated from the reach.

Minor sections of channel bed consist of exposed bedrock.

Pools represent <50% of the channel; flow is rapid through pools.

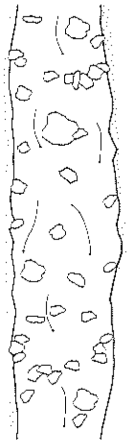
Most stones not moss-covered.

LWD plays an insignificant role in controlling channel pattern.

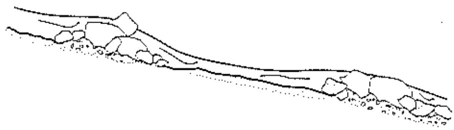
Relevant field indicators: S5, C1

Morphology:	**Cascade-pool**	**CP_b**
Disturbance level:	**Moderately degraded**	**D2**
Code:	**CP_b: D2**	

Plan form



Long profile



Typically:

s ~ 3–5%

D/d ~ 0.6–1.0

D/W_b ~ 0.05–0.15

Cross section

Generally:

Stone lines almost completely absent.

Stream flow is rapid with only minor, slow-moving pool water during low flow conditions.

No moss covering sediment within the active channel.

Minimal localized channel narrowing.

Relevant field indicators: S5, C1, C2, C5

Morphology:	**Cascade-pool**	**CP_b**
Disturbance level:	**Severely degraded**	**D3**
Code:	**CP_b: D3**	

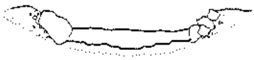
Plan form

Long profile

Typically:

$s \sim 3–5\%$
$D/d \sim 0.6–1.0$
$D/W_b \sim 0.05–0.15$

Cross section



Relevant field indicators: S5, C1, C2, C5, B1

Generally:

Stone lines and diamonds absent.

Stream flow is rapid, with no ponding or slow-moving sections of water.

Channel bed consists primarily of bedrock.

No sediment present along channel.

Pools present <50% of the channel; flow is rapid through pools.

Most stones not moss-covered.

Minimal localized channel narrowing.

Step-pool: SP_b-w

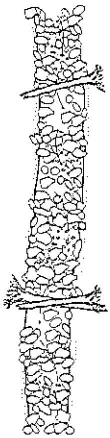
Degraded	Stable	Aggraded
Morphology:		
No organized stone lines (due to erosional displacement)	Intact stone lines (clast steps with intervening pools)	No organized stone lines (due to depositional infilling)
Bed sediment:		
Largely bedrock	Largely moss-covered bedrock	Largely bedrock
Banks:		
Not eroded	Boulder, bedrock, turf, or roots	Banks cleaned of moss but not eroded (due to bedrock)
LWD:		
Absent	Occasionally present with minimal influence on morphology	Absent

Morphology:	**Step-pool**	**SP_b-w**
Disturbance level:	**Severely aggraded**	**A3**
Code:	**SP_b-w: A3**	

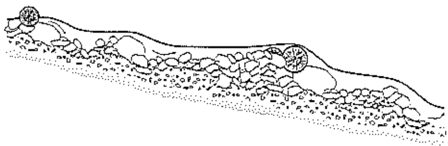
Typically:

s ~ 5–13%
D/d ~ 1.0–2.6
D/W_b ~ 0.2–1.0

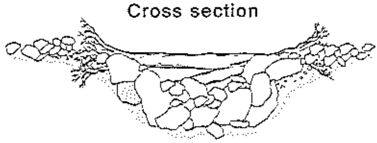
Plan view



Long profile



Cross section



Relevant field indicators: S3, S4, C3, D2, D3

Generally:

Step-pool morphology not evident due to complete infilling of pools.

Stream flow is rapid and appears as chutes separated by higher sediment deposits.

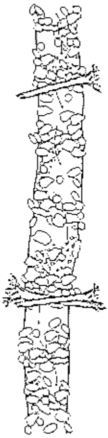
Large sediment wedges can be associated with log jams or large root wads.

All sediment is devoid of moss.

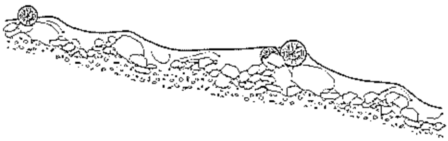
Morphology:	**Step-pool**	**SP_b-w**
Disturbance level:	**Moderately aggraded**	**A2**
Code:	**SP_b-w: A2**	

Typically:
s ~ 5–13%
D/d ~ 1.0–2.6
D/W_b ~ 0.2–1.0

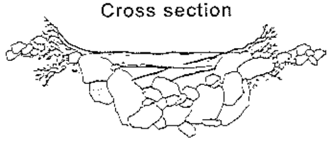
Plan view

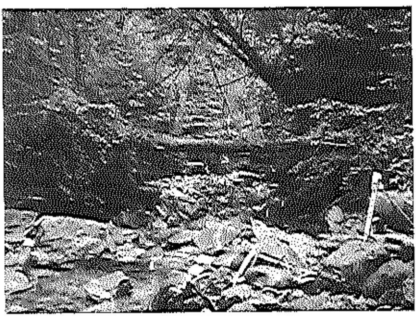


Long profile



Cross section





Relevant field indicators: S3, S4, D2

Generally:

Step-pool morphology exists but is less distinct because pool extent is greatly reduced by sediment accumulation.

Stream flow alternates between rapid chutes and occasional slow-moving pools.

Large sediment wedges are present, but not dominant; associated with log jams or large root wads.

Very little, if any, moss covering on bed sediments.

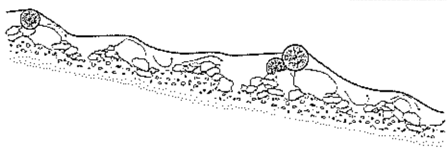
Morphology: Step-pool — SP_b-w A1

Disturbance level: Partially aggraded

Code: SP_b-w: A1

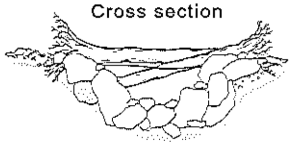
Plan view

Long profile



Typically:
s ~ 5–13%
D/d ~ 1.0–2.6
D/W_b ~ 0.2–1.0

Cross section



Relevant field indicators: S4

Generally:

Boulders and cobbles continue to interlock, forming step-pool morphology.

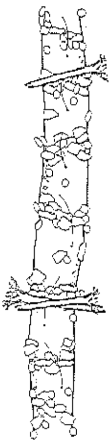
Intervening pools are less extensive due to sediment accumulation.

Sediment accumulation also occurs around LWD.

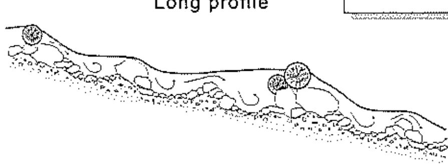
Sediment covered by moss in isolated locations (e.g., in lee of bedrock outcrops, large boulders, or root wads).

Morphology:	**Step-pool**	**SP_b-w**
Disturbance level:	**Stable**	**S**
Code:	**SP_b-w: S**	

Plan view

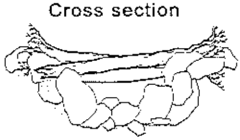


Long profile



Typically:
s ~ 5–13%
D/d ~ 1.0–2.6
D/W_b ~ 0.2–1.0

Cross section



Generally:

Boulders and cobbles interlock to form complete lines that cross the channel from bank to bank.

Lines oriented perpendicular or diagonal to the banks.

LWD is present but flow is commonly beneath (LWD is supported by banks above the bed so is of minor overall importance).

Stream flow is over the boulder/ cobble step and through intervening pool.

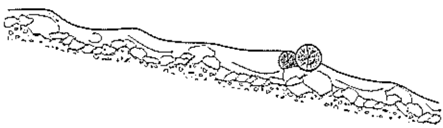
Boulders are commonly moss-covered.

Morphology:	**Step-pool**	**SP_b-w**
Disturbance level:	**Partially degraded**	**D1**
Code:	**SP_b-w: D1**	

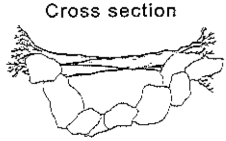
Typically:
s ~ 5–13%
D/d ~ 1.0–2.6
D/W_b ~ 0.2–1.0

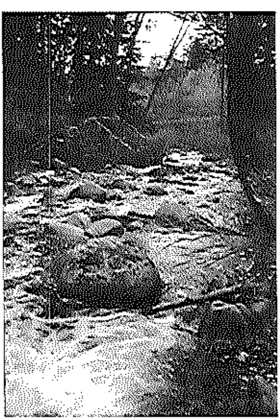
Plan view

Long profile



Cross section





Generally:

Boulder and cobble lines do not always interlock (breaks in line)—flow is around individual stones in addition to over steps.

Lines have less obvious orientation.

LWD is present but plays a secondary role to boulders and cobble clusters.

Bank erosion occurs in small, isolated spots (only in sections of alluvial bank).

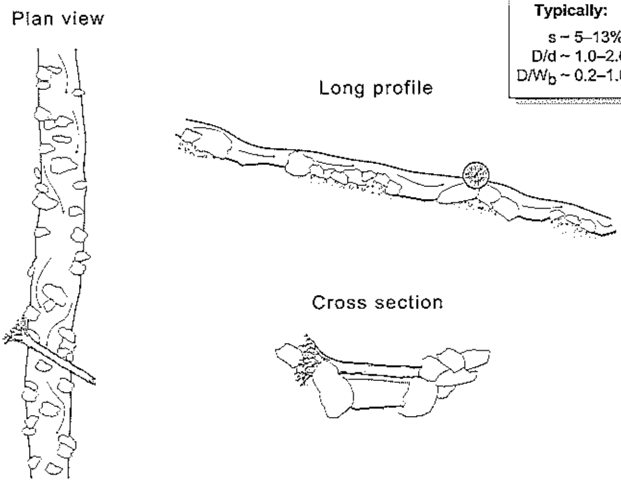
Boulders are not always covered in moss (some are moss covered, but others have been moved recently).

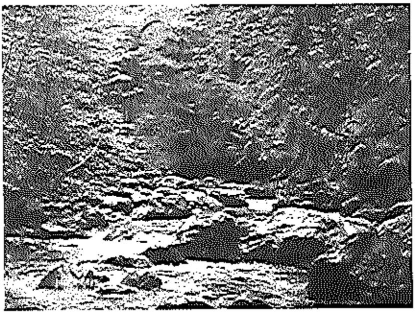
Relevant field indicators: C5, D2

Morphology:	**Step-pool**	**SP_b-w**
Disturbance level:	**Moderately degraded**	**D2**
Code:	**SP_b-w: D2**	

Typically:

s ~ 5–13%
D/d ~ 1.0–2.6
D/W_b ~ 0.2–1.0





Generally:

Boulder and cobble lines completely disorganized.

Flow is around boulders.

LWD not common but occasionally present.

Bank erosion occurs in small localized areas (only in alluvial bank sections).

Boulders are not covered in moss.

Relevant field indicators: S5, C2, C5, D2

Morphology:	**Step-pool**	**SP_b-w**
Disturbance level:	**Severely degraded**	**D3**
Code:	**SP_b-w: D3**	

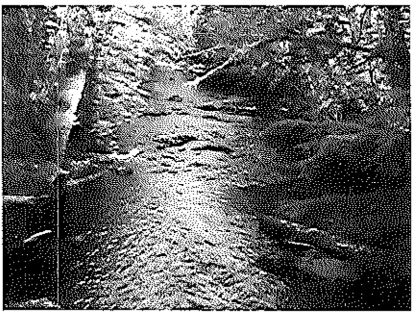
Typically:

s ~ 5–13%
D/d ~ 1.0–2.6
D/W_b ~ 0.2–1.0

Plan view

Long profile

Cross section



Relevant field indicators: S5, C2, C5, D2

Generally:

Very few boulders, cobbles, or loose sediments along channel bed.

Bed consists mainly of bedrock.

Localized bank erosion.

Remaining boulders are not covered in moss.

Erosion trim lines are evident along channel walls.

Step-pool: SP_b

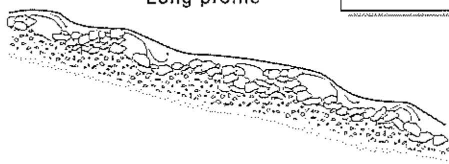
Degraded	Stable	Aggraded
Morphology:		
No organized stone lines (due to erosional displacement)	Intact stone lines (clast steps with intervening pools)	No organized stone lines (due to depositional infilling)
Bed sediment:		
Largely bedrock	Largely moss-covered bedrock	Largely bedrock
Banks:		
Not eroded	Boulder, bedrock, turf, or roots	Banks cleaned of moss but not eroded (due to bedrock)
LWD:		
Absent	Occasionally present with minimal influence on morphology	Absent

Morphology:	**Step-pool**	**SP_b**
Disturbance level:	**Severely aggraded**	**A3**
Code:	**SP_b: A3**	

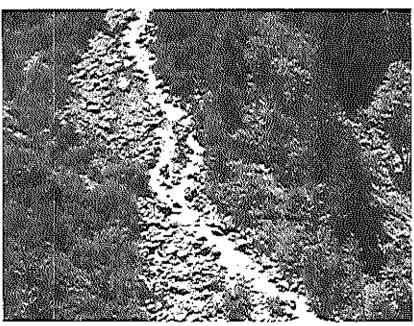
Plan view

Typically:
s ~ 5–13%
D/d ~ 1.0–2.6
D/W_b ~ 0.2–1.0

Long profile



Cross section



Generally:

Step-pool morphology not evident due to complete infilling of pools. Channel pattern is braided.

Stream flow is along multiple branches (braids).

LWD is not commonly present, although accumulations of LWD can form log jams.

No moss-covered bed sediments.

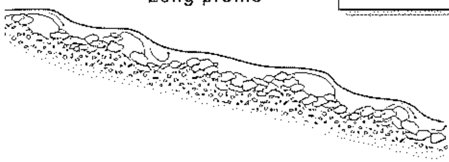
Relevant field indicators: S3, S4, C3

Morphology:	**Step-pool**	**SP_b**
Disturbance level:	**Moderately aggraded**	**A2**
Code:	**SP_b: A2**	

Typically:
s ~ 5–13%
D/d ~ 1.0–2.6
D/W_b ~ 0.2–1.0

Plan view

Long profile



Cross section

Generally:

Step-pool morphology exists but is less distinct because pool extent is reduced by sediment accumulation.

Stream flow is along multiple branches (braided pattern).

Moss-covered bed sediment is not uncommon.

Relevant field indicators: S3, S4

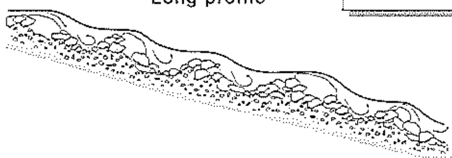
Morphology:	**Step-pool**	**SP_b**
Disturbance level:	**Partially aggraded**	**A1**
Code:	**SP_b: A1**	

Typically:

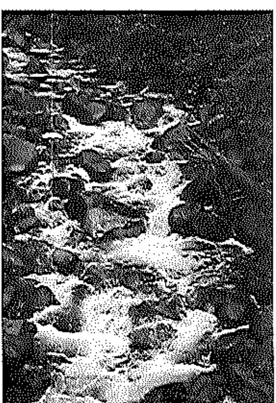
s ~ 5–13%
D/d ~ 1.0–2.6
D/W_b ~ 0.2–1.0

Plan view

Long profile



Cross section



Generally:

Boulders continue to interlock forming step-pool morphology.

Intervening pools are less extensive (one-half to two-thirds of total length) due to sediment accumulation between steps.

Sediment is covered by moss in isolated locations (e.g., in lee of bedrock outcrops, large boulders, and root wads).

LWD is present but is not an important structural element.

Relevant field indicators: S4

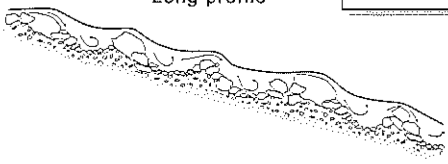
Morphology:	**Step-pool**	**SP_b**
Disturbance level:	**Stable**	**S**
Code:	**SP_b: S**	

Typically:

$s \sim 5–13\%$
$D/d \sim 1.0–2.6$
$D/W_b \sim 0.2–1.0$

Plan view

Long profile



Cross section

Generally:

Boulders interlock to form complete lines that cross the channel.

Lines are oriented perpendicular or diagonal to the channel banks.

LWD may be present but main structural feature are the stone lines.

Boulders usually covered with moss.

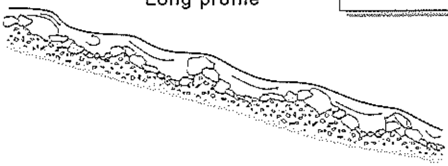
Steps usually < one-third of total step-pool feature (pool ≥ two-thirds).

Banks consist of alluvial and non-alluvial materials.

Morphology:	**Step-pool**	**SP_b**
Disturbance level:	**Partially degraded**	**D1**
Code:	**SP_b: D1**	

Plan form

Long profile



Typically:

s ~ 5–13%
D/d ~ 1.0–2.6
D/W_b ~ 0.2–1.0

Cross section

Relevant field indicators: C5

Generally:

Boulder lines becoming less continuous (breaks in line) so the flow is around and over individual boulders.

Lines oriented more parallel to banks (less distinct diagonal crossing of lines).

Pool proportion is reduced to one-half to one-third of channel length.

Minimal bank erosion due to non-alluvial banks (bedrock).

Apparent movement of boulders (many without moss covering).

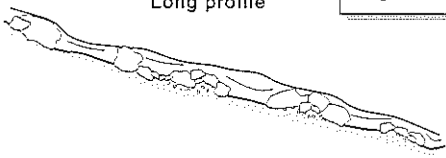
Morphology:	**Step-pool**	**SP_b**
Disturbance level:	**Moderately degraded**	**D2**
Code:	**SP_b: D2**	

Typically:

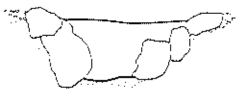
s ~ 5–13%
D/d ~ 1.0–2.6
D/W_b ~ 0.2–1.0

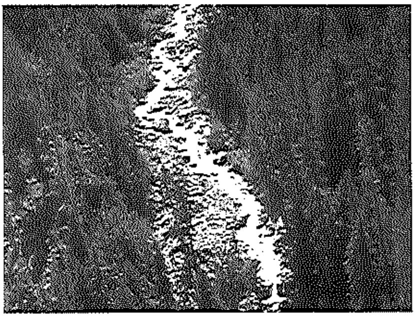
Plan form

Long profile



Cross section





Relevant field indicators: S5, C2, C5

Generally:

Boulder lines almost completely destroyed—boulders scattered with no apparent pattern over channel bed.

Step-pool structure absent.

Streamflow lines predominantly around individual boulders rather than over boulder steps.

Remaining boulders have only minor covering of moss (if any).

Minimal bank erosion due to bedrock.

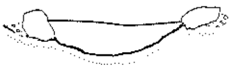
Morphology:	**Step-pool**	**SP_b**
Disturbance level:	**Severely degraded**	**D3**
Code:	**SP_b: D3**	

Plan view

Typically:
$s \sim 5\text{–}13\%$
$D/d \sim 1.0\text{–}2.6$
$D/W_b \sim 0.2\text{–}1.0$

Long profile

Cross section



Generally:

Boulder lines not present.

Step-pool morphology not present.

Channel bed consists of bedrock; minor, isolated deposits of sediment (usually large boulders).

Remaining boulders are devoid of moss covering.

Minimal bank erosion due to bedrock.

Relevant field indicators: S5, C1, C2, C5

Step-pool: SP_r

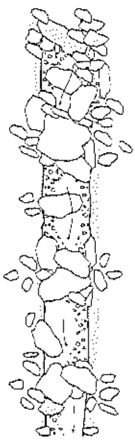
Degraded	Stable	Aggraded
Morphology:		
No organized stone lines (due to erosional displacement)	Intact stone lines (clast steps with intervening pools)	No organized stone lines (due to depositional infilling)
Bed sediment:		
Largely bedrock	Largely moss-covered bedrock	Largely bedrock
Banks:		
Not eroded	Boulder, bedrock, turf, or roots	Banks cleaned of moss but not eroded (due to bedrock)
LWD:		
Absent	Occasionally present with minimal influence on morphology	Absent

Morphology: Step-pool — SP_r A3

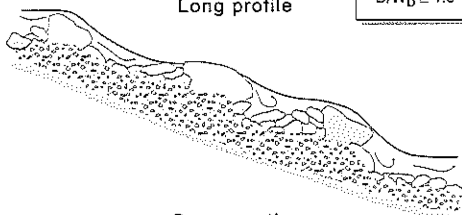
Disturbance level: Severely aggraded

Code: SP_r: A3

Plan view



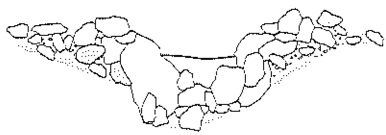
Long profile

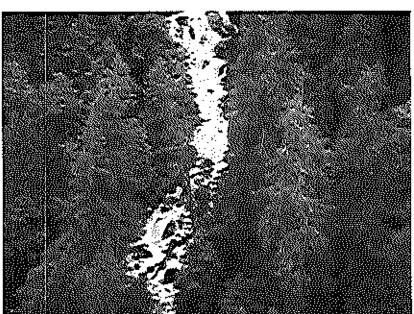


Typically:

s > 13%
D/d > 2.6
$D/W_b \geq 1.0$

Cross section





Generally:

Boulder lines present but partially "drowned-out" because of reduced pool depth due to sediment infilling.

Large sediment wedge may be present.

Stream sediments are present along channel bank top and surrounding areas.

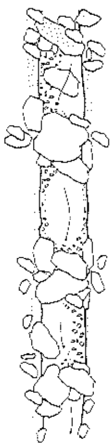
Relevant field indicators: S4

Morphology:	**Step-pool**	**SP_r**
Disturbance level:	**Moderately aggraded**	**A2**
Code:	**SP_r: A2**	

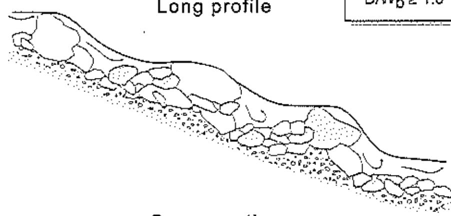
Typically:

s > 13%
D/d > 2.6
$D/W_b \geq 1.0$

Plan view



Long profile



Cross section

Relevant field indicators: S3, S4

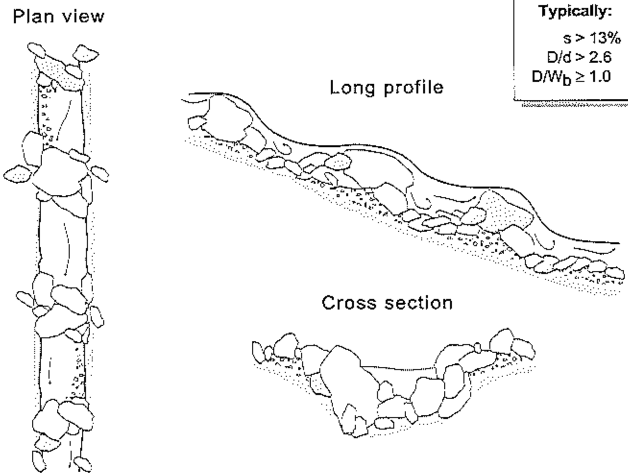
Generally:

Boulder lines are less distinct due to progressive infilling of intervening pools.

Sediment filling pools is moved regularly (several times per year) and is loosely packed and devoid of moss.

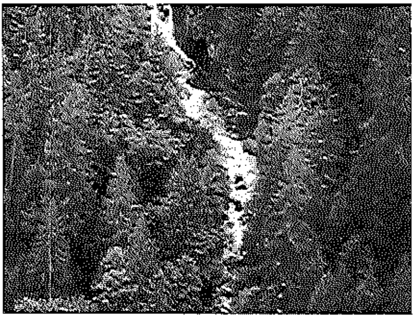
Stream sediments are present along channel bank tops and surrounding near-bank environments.

Morphology:	Step-pool	SP_r
Disturbance level:	Partially aggraded	A1
Code:	SP_r: A1	



Typically:

s > 13%
D/d > 2.6
$D/W_b \geq 1.0$



Relevant field indicators: S4

Generally:

Interlocking boulders are intact but intervening pools have evidence of infilling (recently deposited cobbles, boulders, and fine-textured sediments—all loosely packed and devoid of mosses or algaes).

Stream flow continues to drop over steps and decelerate through pools during low flow.

Banks do not erode due to non-alluvial materials.

Recently deposited sediments are located along the bank tops.

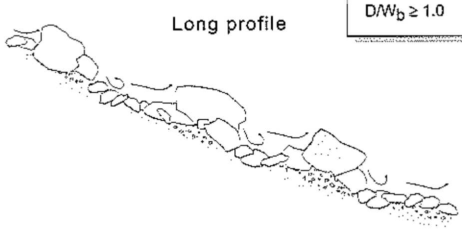
Morphology:	**Step-pool**	**SP_r**
Disturbance level:	**Stable**	**S**
Code:	**SP_r: S**	

Typically:

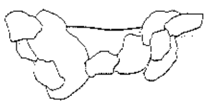
s > 13%
D/d > 2.6
$D/W_b \geq 1.0$

Plan view

Long profile



Cross section



Generally:

Steps formed primarily by individual large boulders or "blocks."

Blocks are either relict features or colluvial, too large to be moved by stream flows (may be moved by debris flows.)

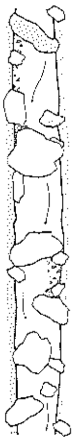
Blocks interlock to form complete steps that span the channel perpendicular to banks (stream flow tumbles over steps).

Pool depth determined by boulder size.

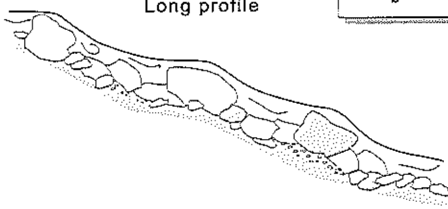
Fine-textured sediment can be stored behind or between blocks.

Morphology:	**Step-pool**	**SP_r**
Disturbance level:	**Partially degraded**	**D1**
Code:	**SP_r: D1**	

Plan view



Long profile



Typically:

s > 13%
D/d > 2.6
$D/W_b \geq 1.0$

Cross section

Relevant field indicators: S5, C5

Generally:

Step morphology (formed around very large boulders that are not transported by stream flow) is largely intact but gaps are present so water flows around boulders in addition to flowing over steps.

Finer-textured sediments remain stored upstream and downstream of boulders.

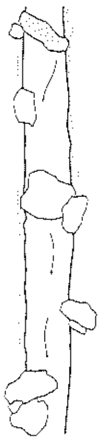
Pool depth determined by boulder size.

Banks consist of non-alluvial material, so channel width does not change, even in disturbed channels.

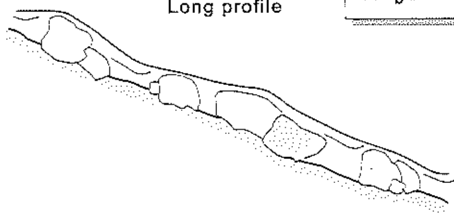
Morphology: **Step-pool** **SP_r**
Disturbance level: **Moderately degraded** **D2**
Code: **SP_r: D2**

Typically:
$s > 13\%$
$D/d > 2.6$
$D/W_b \geq 1.0$

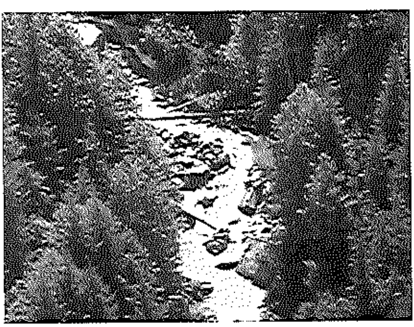
Plan view



Long profile



Cross section



Relevant field indicators: S5, C5

Generally:

Step-pool morphology continues to exist because boulders are not moved by stream flow.

Large gaps exist adjacent to many large boulders so stream flow moves around stones.

Finer-textured sediment removed from upstream of boulders.

Channel consists of series of large boulders separated by bedrock chutes.

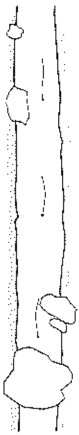
Banks consist primarily of non-alluvial materials and are not eroded (pools are not evident along channel banks).

Morphology:	**Step-pool**	**SP_r**
Disturbance level:	**Severely degraded**	**D3**
Code:	**SP_r: D3**	

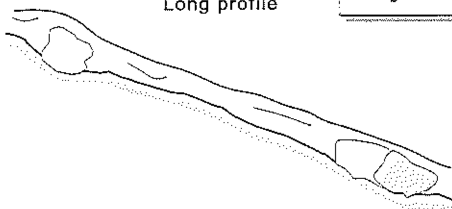
Typically:

$s > 13\%$
$D/d > 2.6$
$D/W_b \geq 1.0$

Plan view



Long profile



Cross section

Relevant field indicators: S5, C5

Generally:

Largest boulders remain (unless removed by debris flow), so steps occur where boulders span the entire channel.

Finer-textured sediment completely removed.

Channel consists of bedrock chute with occasional large boulders (pools are absent).

Banks are not eroded because they consist primarily of non-alluvial materials.

Appendix 3. Drainage network classification

This appendix includes a modified version of Appendix 11 in the fifth report of the Scientific Panel for Sustainable Forest Practices in Clayoquot Sound, *Sustainable Ecosystem Management in Clayoquot Sound: Planning and Practices* (Anon, 1995). Several physical dimensions have been altered to be consistent with other Forest Practices Code documents. The classification units changed here are intended to avoid some of the operational difficulties encountered in the field. Wherever possible, the original definitions used in the Clayoquot Sound report are retained.

Bases for classification (from the Clayoquot Sound report 5)

The hydroriparian classification in the Clayoquot Sound report 5 has been modified for use with the CAP and is referred to here as the drainage network classification (Figure 1).

The most basic division is defined by the nature of the water body, because this fundamentally determines the nature of the associated ecosystems. Lotic (streams), lentic (standing fresh water), and marine are the basic units; the latter is not considered here.

Within stream channels, the most basic division is between erodible and non-erodible channels. Erodible channels flow through either their own alluvium deposits or materials erodible by flowing water, such as lacustrine, marine and certain colluvium deposits. Non-erodible channels are non-alluvial channels—those flowing on bedrock or on sediments not normally eroded by the contemporary stream flow. This corresponds with the criterion of confinement, because an unconfined channel always flows with at least one erodible (alluvial) bank. The next most important criterion is stream gradient, because this determines important aspects of fluvial processes and morphology. A third criterion is entrenchment; entrenched channels are confined within fluvially eroded gullies or valleys of some depth. A final criterion is stream size, which influences some of the physical and biological processes.

Within the class of erodible stream channels, the definition of a "floodplain" presents some difficulty. The generic definition—the surface of a body of sediment deposited by the stream—ignores whether a change of stream regime has led to degradation and consequent development of a terrace (which is not subject to inundation). The difference is ecologically significant. A definition based on the possibility of inundation occurring needs some qualification about the frequency of inundation, but it is not practically applicable in terrain analysis procedures. The best discriminators probably are the presence of indicator plant species in the understorey and immature cumulic soils, which can be decided definitively at the stage of field checking. Adopting such discriminators requires local guidelines.

Lentic freshwater environments are divided according to whether the environment is permanently open water more than 1 m deep (a lake) or is a wetland. A second distinction is the nature of the lacustrine ecosystem: oligotrophic lakes have relatively poor nutrient status. Wetlands are further classified as fen, marsh, swamp, or bog. Another criterion is water body size. As in streams, this determines some of the physical and biological processes between the water body and adjacent land.

Classification

Stream (lotic environment)

C – Stream channels

A Erodible channels

An erodible channel has a flanking floodplain, including estuarine channels in deltas, and alluvial fans (also called fluvial fans):

1. gradient less than 8 per cent
   - (i) channel width less than 1.5 m
   - (ii) channel width between 1.5 m and 20 m
   - (iii) channel width greater than 20 m

Notes: Channels with gradient less than 8 per cent (4.6°) have primary morphological units consisting of pools separated by riffles or extended rapids. Anadromous salmonids are found in these channels. Channels with gradients greater than 8 per cent, up to 20 per cent (5–11.3°), have step-pool morphology. Resident fish may be present.

2. gradient greater than 8 oer cent

   (i)–(iii) width criteria as in Al.

Operational rules:

1. A channel with one erodible bank and one non-erodible bank is classified as erodible. The bed need not be erodible, but a non-erodible bed with contemporaneously active erodible bank will be rare.
2. A channel with non-erodible banks but erodible bed is classified as erodible. The intent is to identify channels that can be disturbed by forestry activities. Channels that clearly cannot be disturbed are non-erodible. Those that clearly can or could undergo changes (step-pool sequences) are erodible.
3. If a reach is classified as erodible, but a non-erodible segment is encountered along the reach, the reach class will not change if the non-erodible segment is $\leq 1W_b$. If the non-erodible channel extends for between 1 and 3 bankfull widths, the segment is noted, but the reach class remains erodible. If the segment extends for ≥3Wb, then the reach class is changed to non-erodible for the extent of the segment.
4. In Type 1 (C1), many channels less than 1.5 m wide will be secondary channels on floodplains, which will be incorporated into the unit defined by the main channel. Type 2 (C2) will usually be alluvial fans; in Type 2 (C2), width criterion (iii) is rare.

B Non-erodible channels

1. gradient less than 8 per cent
   a) not entrenched
      (i)–(iii) width criteria as in Al.

b) entrenched

(i)–(iii) width criteria as in A1.

Notes: These may include fairly large channels that have degraded and now flow between terraced banks on lag armour (unconsolidated material—typically cobbles or boulders—that the stream cannot move and that is not alluvial in the current regime). An entrenched channel, as the result of fluvial erosion, is continuously confined within banks sufficiently high that overflow may not occur. Gullies, ravines, and bedrock gorges are typical entrenchment landforms.

2. gradient in the range 8–20 per cent

   a) not entrenched

      (i)–(iii) width criteria as in A1.

   b) entrenched

      (i)–(iii) width criteria as in A1.

Notes: Class (a) streams will principally have steep alluvial fans. In this gradient range, width class (iii) streams probably are non-existent. Most debris flows stop in this gradient range.

3. gradient greater than 20 per cent

   a) not entrenched

      (i) seasonal or perennial

      (ii) ephemeral

   b) entrenched

Notes: Although streams in class (3) are steep, they maintain water quality downstream and serve as animal travel routes and the site of riparian herbs and shrubs—including some with otherwise limited distribution. Fish are not normally present. Gradient is usually bedrock-controlled. In (a), one will classify mainly seasonal to ephemeral rills on hillsides. In (b), one will classify mainly gullies but could include sizable rivers cascading down bedrock-controlled channels from hanging valleys. Stream width is usually less than 1.5 m. Gully floor width is more significant than channel width, but usually will not be critical for processes. Debris flows may start and will be maintained on these gradients. An upper limit for stream channel gradients (other than cascades and waterfalls on bedrock) is 60 per cent.

Operational rules:

1. Both channel banks and the bed must be non-erodible for the stream to be classed as such. If one bank is erodible (alluvial) and one bank non-erodible, or the banks are non-erodible but the bed is erodible, then the reach is classified as erodible.
2. If a reach is classified as non-erodible, but an erodible segment is encountered along the reach, it will not change the reach class if the erodible segment is $\leq 1W_b$. If the erodible channel extends for between 1 and 3 bankfull widths, the segment will be noted but the reach class remains non-erodible. If the segment extends for $\geq 3W_b$, then the reach class is changed to erodible for its extent.

C Artificial channels

Artificial channels have been modified by engineering works. This commonly involves channelization, rip-rap bank protection, long culverts or other human activity.

Operational rules:

1. The artificial channel must extend for $\geq 3W_b$ to be classed as such. If a reach is classified as either erodible or non-erodible, but an artificial channel segment is encountered along the reach, it will not change the reach class if the non-artificial segment is $\leq 1W_b$. If the artificial channel extends for between 1 and 3 bankfull widths, the segment will be noted but the reach class remains unchanged. If the segment extends for $\geq 3W_b$, then the reach class is changed to artificial for its extent.

Standing waterbodies and wetlands (lentic environment)

L – Lakes

A. Oligotrophic

(i) sand or gravel beach

(ii) low, rocky shore

(iii) cliffed or bluffs

(iv) wetland shore

B. Non-oligotrophic

W – Wetlands

(i) shallow open

(ii) marsh

(iii) fen

(iv) swamp

(v) shrub-carr

(vi) wet meadow

Notes: Shallow open water denotes ponds and sloughs with submerged aquatic plants, and water less than 2 m deep in midsummer.

A marsh has free-standing water with emergent vegetation or remains waterlogged throughout the growing season.

A fen (minerotrophic mire) is a wetland with limited peat accumulation, maintained by groundwater and runoff. Fens often occur as shoreline wetlands peripheral to lakes, ponds, and low-gradient streams.

A swamp is a forest or high shrub mineral wetland or peat land that is periodically flooded. Swamps include sparse, open-canopy to closed-canopy forests of mixes of western redcedar, red alder, and shore pine (the latter is more commonly associated with bogs). Most of the surface is usually submerged, but there are periods when the soil may be dry and aerated.

Very poorly drained, sparsely forested swamps are characterized by western redcedar, yellow-cedar (increasingly at higher montane to subalpine elevations), red alder, crabapple, salmonberry, stink currant, skunk cabbage, and giant horsetail, all of which are culturally important. The poorly drained, closed-canopy forested swamps vary less, with predominant western redcedar and an understorey of western hemlock, both growing on raised microsites of accumulated rotting wood.

Minor vegetation includes skunk cabbage growing in wet, mucky organic materials in depressions between the drier hummocks. On the minor hummocks grow minor vegetation similar to that of mesic sites—*Vaccinium* spp., *Comus canadensis*, *Hylocomium spiendens*, *Rhytidiadelphus loreus*, etc. This latter type is properly classified as a western redcedar swamp forest, but is not generally recognized as such.

Shrub-carr is a shrub-dominated wetland, developed on mineral soils, that is periodically saturated, but rarely inundated.

A wet meadow is a herbaceous wetland that is rarely inundated. The latter two types are not waterlogged in the growing season. All foregoing types (i) to (vi) are fed by inflowing surface or groundwater.

A bog (ombrotrophic mire) is a peat accumulation that has grown above the local water table, so that the water in the upper peat is sustained by precipitation.

These definitions are consistent with the *Proposed Wetland Classification System for British Columbia* (Kistritz and Porter 1993).