M6d: Dynamics of Channel Change and Habitat Issues

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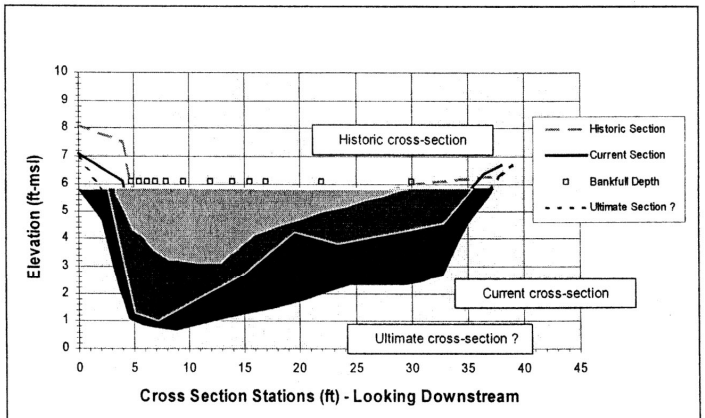


Figure 1: Change in a Stream Cross-Section of Watts Branch Over Time

Schueler, *et al.* 2000)

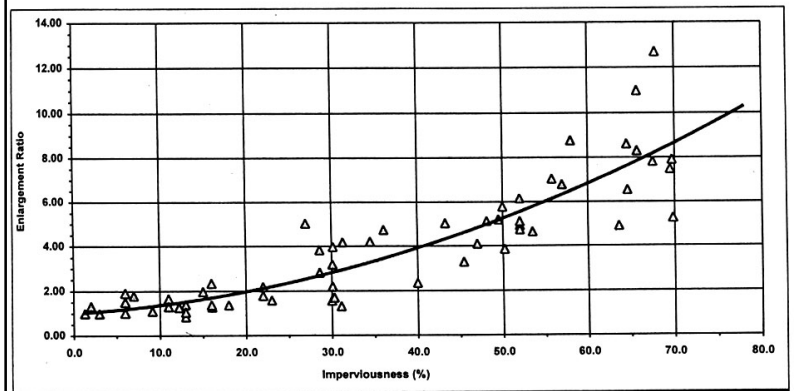


Figure 5: "Ultimate" Channel Enlargement as a Function of Impervious Cover in Alluvial Streams in Maryland, Vermont and Texas (MacRae and DeAndrea, 1999; and Brown and Claytor, 2000)

Schueler, *et al.* 2000)

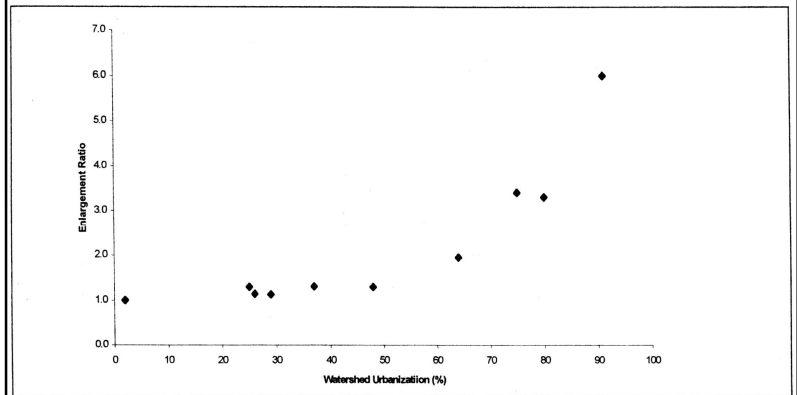


Figure 3: Influence of Urbanization Channel Enlargement in New York and Pennsylvania (Morisawa and LaFlure, 1979)

Schueler, *et al.* 2000)

Recommendations on Dealing with Channel Enlargement Associated with Urbanization (Schueler, *et al.* 2000)

- Channel enlargement will increase with increasing development (generally more with more large amounts of directly connected impervious areas and for more erosive channel banks)
- Increased durations of critical bank-full flows (usually the one or two-year storm), even if the peak flow rates are controlled, cause increased enlargement.
- Usually, a lag time exists between land development and noticeable channel enlargement, although can be very rapid.
- Need to control smaller than bank-full conditions, and reduce durations of critical flows.
- Plan for future channel enlargement, and use appropriate stream buffers.

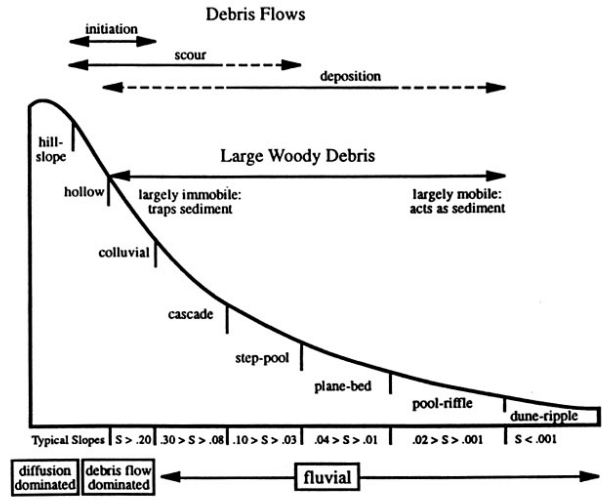


Figure 1. **Characteristics of the channel types of Montgomery and Buffington (1993).**

Booth, *et al.* 1997)

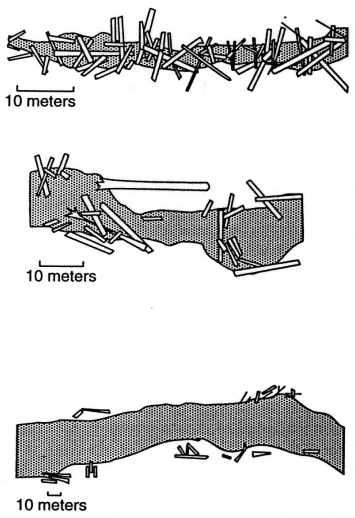


Figure 2. **Position of large woody debris in channels of different sizes (redrawn from Salo and Cundy, 1987).**

Booth, *et al.* 1997)

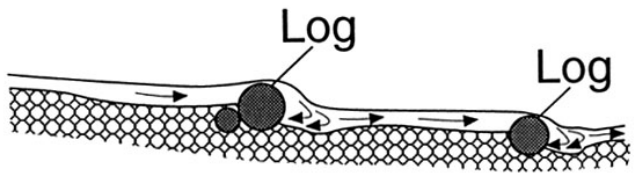


Figure 3. **Cross-sectional view of logs in a step-pool channel.**

Booth, *et al.* 1997)

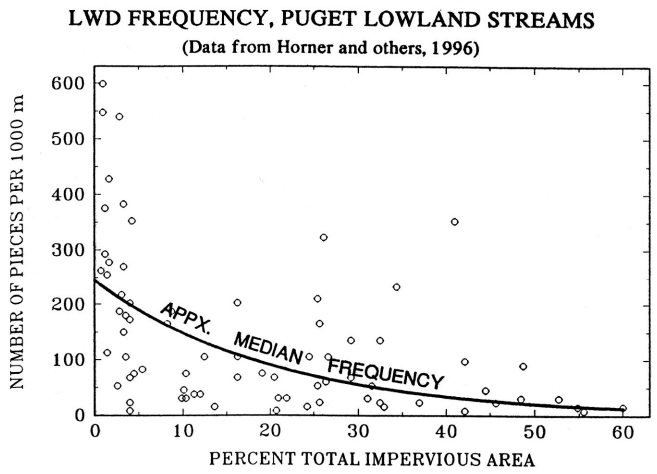


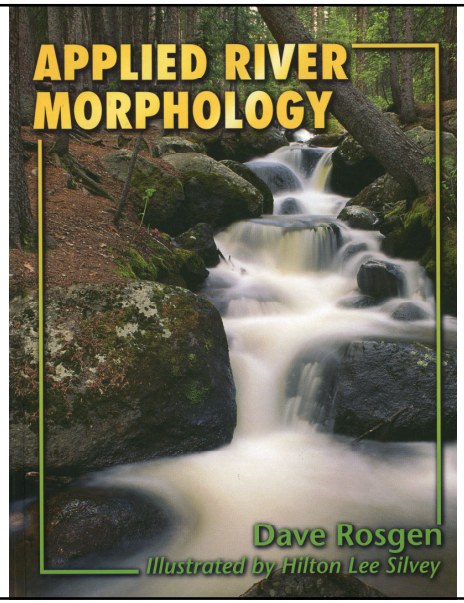
Figure 4. Site-specific measurements and median trend of measured LWD frequency in urban watersheds spanning a range of development intensity.

Booth, *et al.* 1997)

Creek Name	Year Constructed	Length of Channel Treated (m)	Total # of Woody Pieces	Pieces / 100 Meters	# of Logs w/o Rootwads	# of Logs w/ Rootwads	# of Rootwads	Method of Construction
Madsen	1993	210	51	24	32	9	10	helicopter
Boise	1994	500	93	19	20	51	22	helicopter
Soosette	1994	1600	278	17	278	0	0	helicopter
Laughing Jacobs	1995	300	68	23	22	15	31	crane
Hollywood Hills	1995	80	53	66	17	4	32	crane

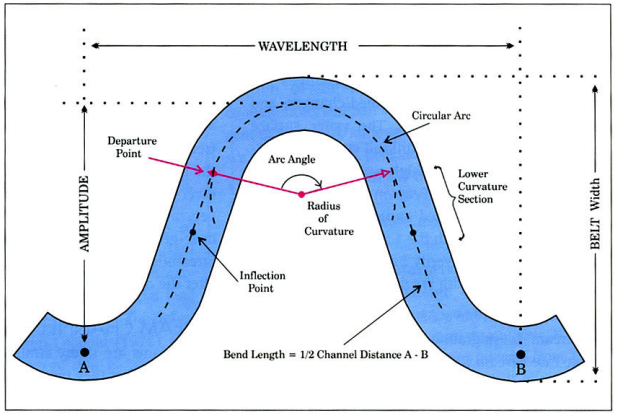
Table 1. **Summary of LWD Placement Projects**

Booth, *et al.* 1997)



Rosgen 1996)

FIGURE 2-3.
Schematic Meander Geometry Descriptions.
(After Williams, 1986)



Rosgen 1996)

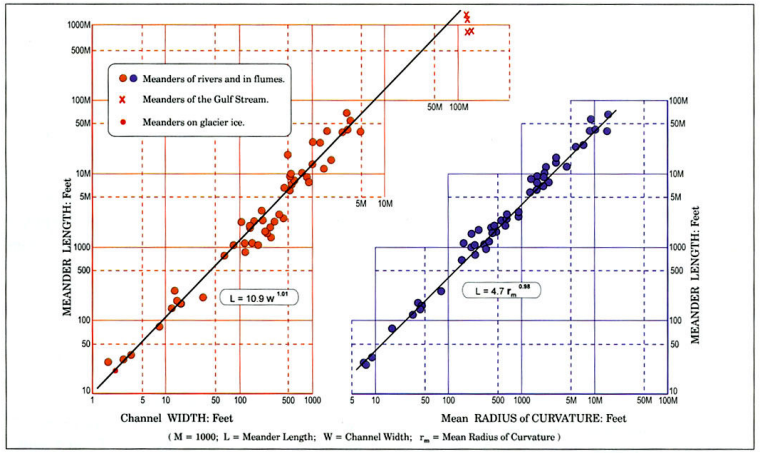


FIGURE 2-4. Relations between meander length and channel width, and meander length and mean radius of curvature. *(After Leopold, et al. 1964)*

Rosgen 1996)

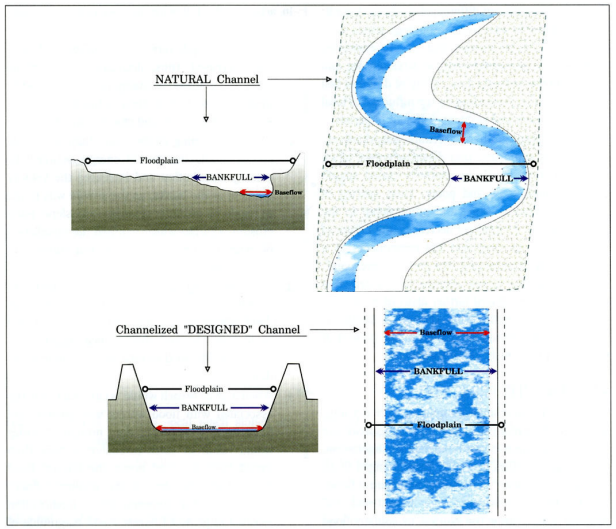


FIGURE 2-7. Comparison of "designed" channel dimensions and pattern with a natural channel. *(Rosgen 1993b)*

Rosgen 1996)

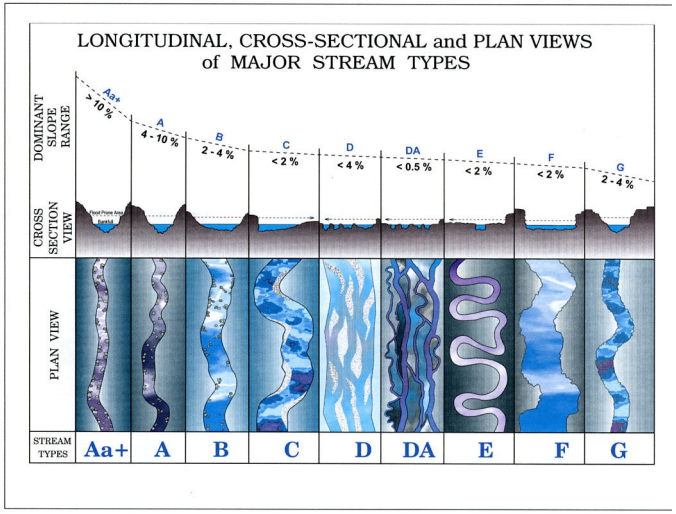


FIGURE 4-2. Broad level stream classification delineation showing longitudinal, cross-sectional, and plan-views of major stream types *(from Rosgen, 1994)*

Rosgen 1996)

FIGURE 4-4. Meander width ratio (belt width/bankfull width) by stream type categories.

STREAM TYPE	A	D	B & G	F	C	E
PLAN VIEW						
CROSS SECTION VIEW						
AVERAGE VALUES	1.5	1.1	3.7	5.3	11.4	24.2
RANGE	1 - 3	1 - 2	2 - 8	2 - 10	4 - 20	20 - 40

Rosgen 1996)

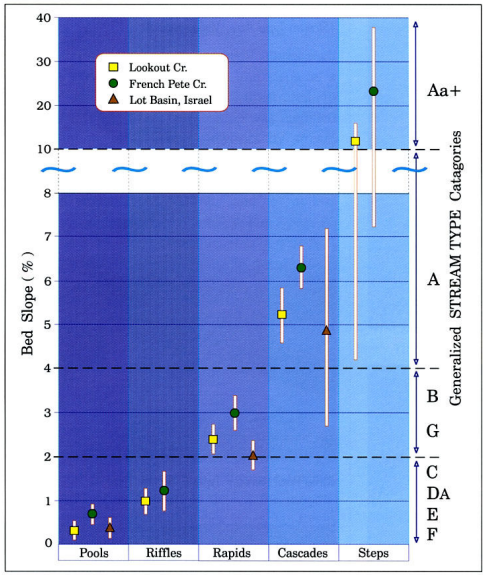


FIGURE 4-21 Relationship of bed slope to bed forms (*from Grant et al., 1990*) for various stream types.(*Rosgen, 1994*).

Rosgen 1996)

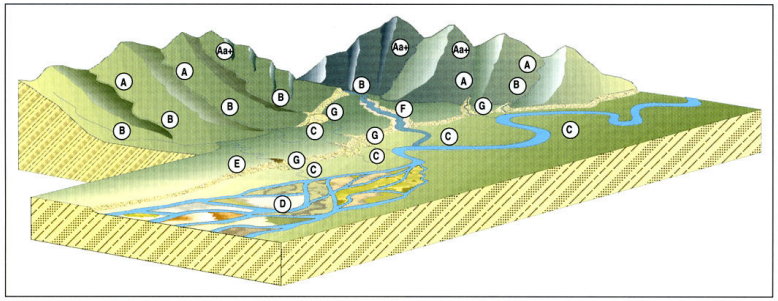


FIGURE 4-22. Example of broad level delineation of stream types at Level I.

Rosgen 1996)

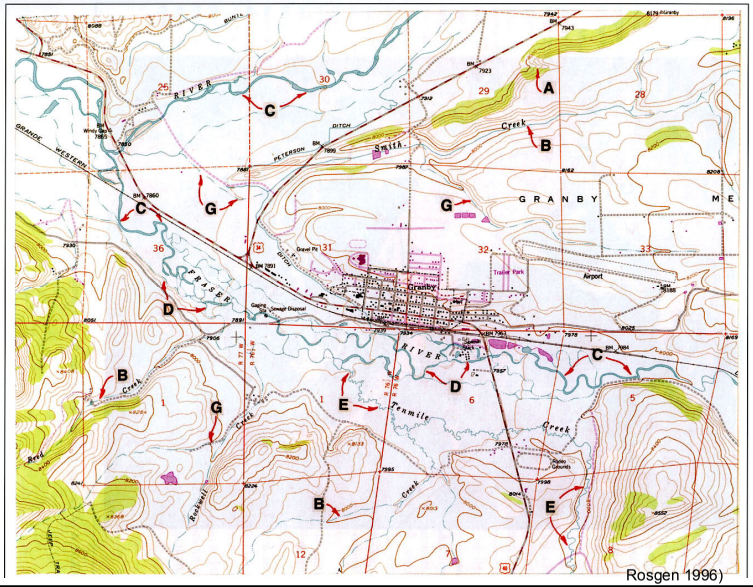


FIGURE 4-23. Example of stream type delineation (Level I) on 7½' quadrangle topographic maps on the upper reaches of the Colorado and Fraser Rivers - Colorado.

Rosgen 1996)

LEVEL I: GEOMORPHIC CHARACTERIZATION

Stream Type	General Description	Entrenchment Ratio	W/D Ratio	Sinuosity	Slope	Landform/ Soils/Features
Aa+	Very steep, deeply entrenched, debris transport, torrent streams.	<1.4	<12	1.0 to 1.1	≥10	Very high relief. Erosional, bedrock or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with deep scour pools; waterfalls.
A	Steep, entrenched, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.	<1.4	<12	1.0 to 1.2	.04 to .10	High relief. Erosional or depositional and bedrock forms. Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in associated step/pool bed morphology.
B	Moderately entrenched, moderate gradient, riffle dominated channel, with infrequently spaced pools. Very stable plan and profile. Stable banks.	1.4 to 2.2	>12	>1.2	.02 to .039	Moderate relief, colluvial deposition, and/or structural. Moderate entrenchment and W/D ratio. Narrow, gently sloping valleys. Rapids predominate w/scour pools.
C	Low gradient, meandering, point-bar, riffle/pool, alluvial channels with broad, well defined floodplains.	>2.2	>12	>1.4	<.02	Broad valleys w/terraces, in association with floodplains, alluvial soils. Slightly entrenched with well-defined meandering channels. Riffle/pool bed morphology.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks.	n/a	>40	n/a	<.04	Broad valleys with alluvium, steeper fans. Glacial debris and depositional features. Active lateral adjustment, w/abundance of sediment supply. Convergence/divergence bed features, aggradational processes, high bedload and bank erosion.
DA	Anastomosing (multiple channels) narrow and deep with extensive, well vegetated floodplains and associated wetlands. Very gentle relief with highly variable sinuosities and width/depth ratios. Very stable streambanks.	>2.2	Highly variable	Highly variable	<.005	Broad, low-gradient valleys with fine alluvium and/or lacustrine soils. Anastomosed (multiple channel) geologic control creating fine deposition w/well-vegetated bars that are laterally stable with broad wetland floodplains. Very low bedload, high wash load sediment.
E	Low gradient, meandering riffle/pool stream with low width/depth ratio and little deposition. Very efficient and stable. High meander width ratio.	>2.2	<12	>1.5	<.02	Broad valley/meadows. Alluvial materials with floodplains. Highly sinuous with stable, well-vegetated banks. Riffle/pool morphology with very low width/depth ratios.
F	Entrenched meandering riffle/pool channel on low gradients with high width/depth ratio.	<1.4	>12	>1.4	<.02	Entrenched in highly weathered material. Gentle gradients, with a high width/depth ratio. Meandering, laterally unstable with high bank erosion rates. Riffle/pool morphology.
G	Entrenched "gully" step/pool and low width/depth ratio on moderate gradients.	<1.4	<12	>1.2	.02 to .039	Gullies, step/pool morphology w/moderate slopes and low width/depth ratio. Narrow valleys, or deeply incised in alluvial or colluvial materials, i.e., fans or deltas. Unstable, with grade control problems and high bank erosion rates.

TABLE 4-1 General stream type descriptions and delineative criteria for broad-level classification (Level I).

Rosgen 1996)

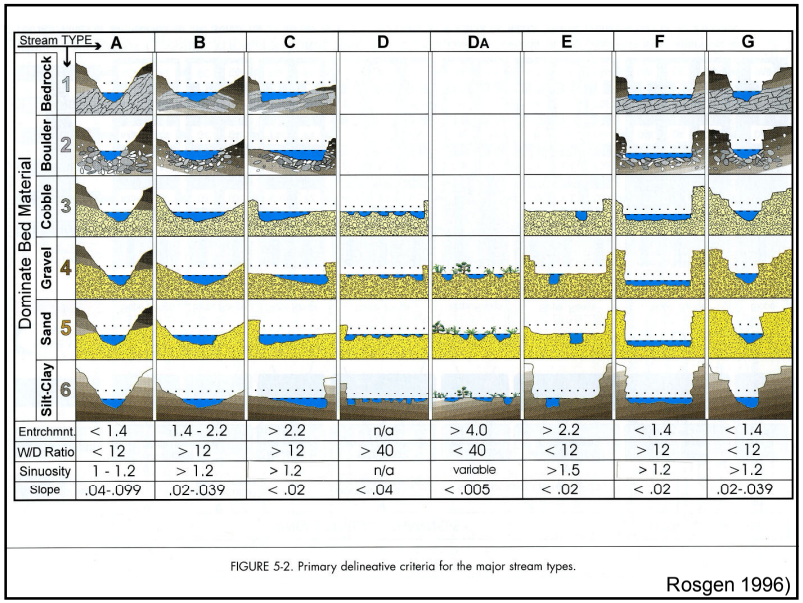
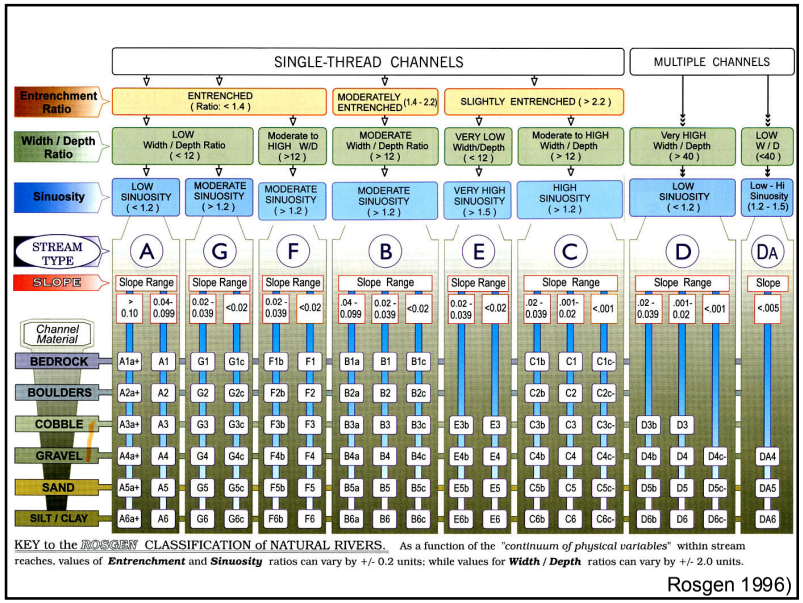


FIGURE 5-2. Primary delineative criteria for the major stream types.

Rosgen 1996)



KEY to the ROSGEN CLASSIFICATION of NATURAL RIVERS. As a function of the *"continuum of physical variables"* within stream reaches, values of ***Entrenchment*** and ***Sinuosity*** ratios can vary by +/- 0.2 units; while values for ***Width / Depth*** ratios can vary by +/- 2.0 units.

Rosgen 1996)

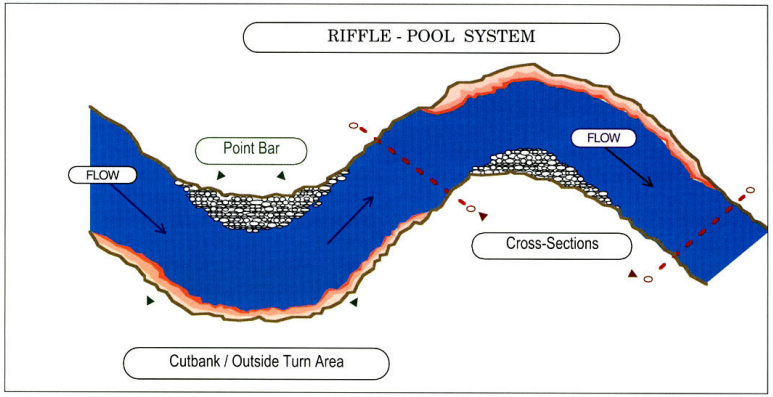


FIGURE 5-4. Recommended cross-section locations for bankfull stage measurements in "riffle/pool" systems.

Rosgen 1996)

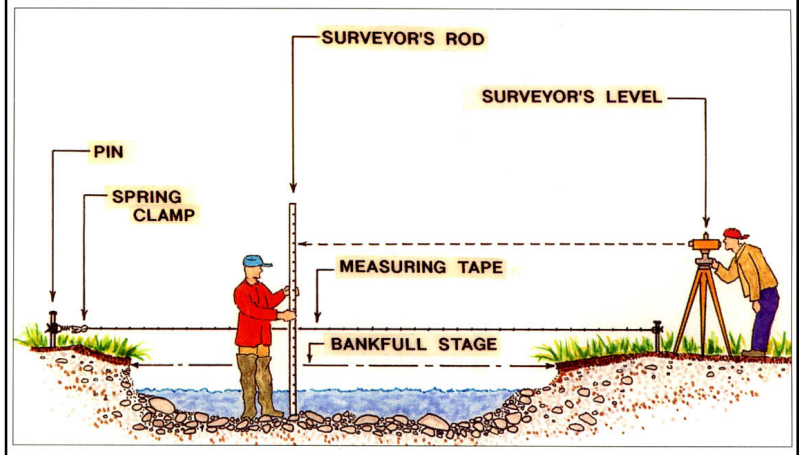


FIGURE 27. Measuring a stream channel cross-section.

Rosgen 1996)

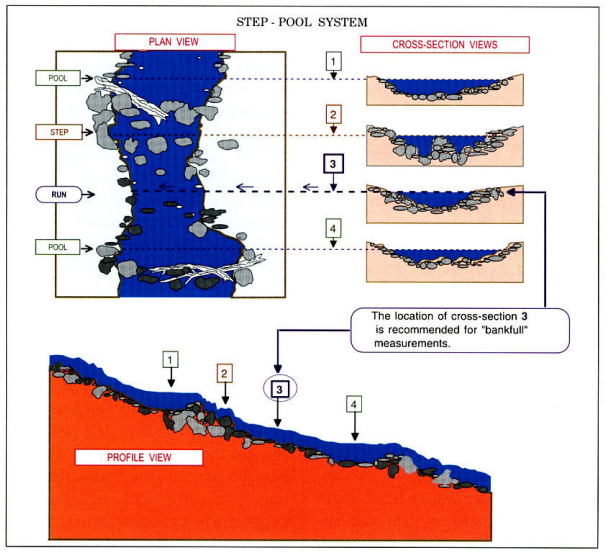
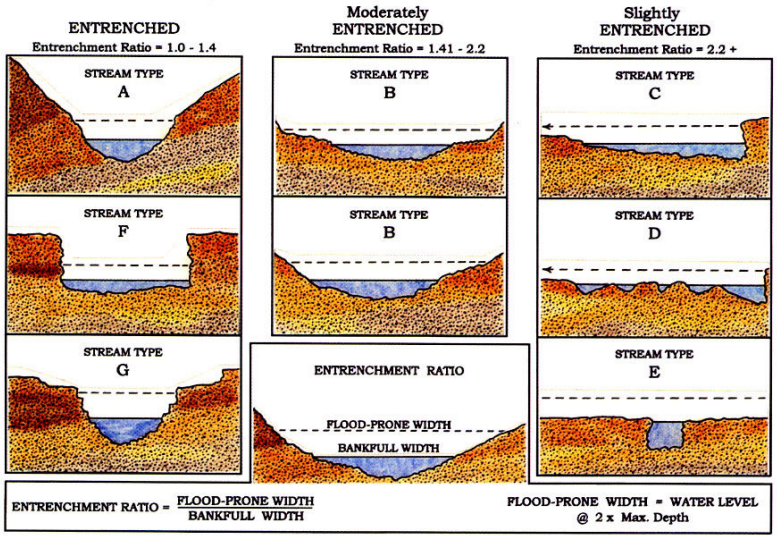


FIGURE 5-5. Recommended location for measurement of bankfull stage in "step/pool" systems. Rosgen 1996)

Rosgen 1996)

FIGURE 5-6a. Jefferson Creek, Oregon - @ gaging station (27.8 sq. mi.) Entr. ratio: 2.2, W_{bkf}: 32.5', d_{bkf}: 2.2', W/D: 14.8, Sinuosity: 1.25, Channel materials: D-15,12mm, D-34,28mm, D-50,48mm, D-84,94mm, Stream Type C4.

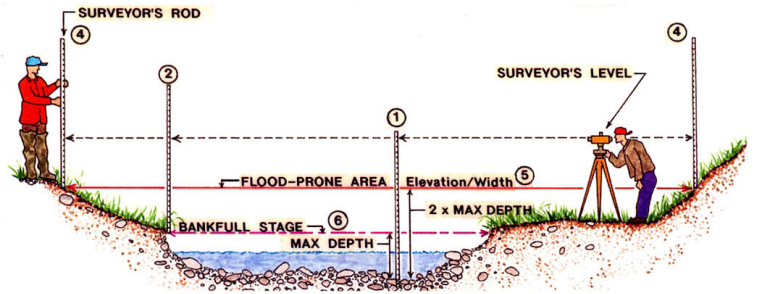


Rosgen 1996)

FIGURE 5-10. Representative entrenchment ratios for cross-sections of various stream types.

STEPS:

1. Obtain a ROD READING for an Elevation at the "MAX DEPTH" Location.
2. Obtain a ROD READING for an Elevation at the "BANKFULL STAGE" Location.
3. Subtract the "Step 2" reading from the "Step 1" reading to obtain a "MAX DEPTH" value; then multiply the Max. Depth Value times 2 for the "2x MAX. DEPTH" Value.
4. Subtract the "2x Max. Depth" value from the "Step 1 Rod Reading" for the FLOOD-PRONE AREA Location Rod Reading. Move the rod upslope, online with the cross-section, until a Rod Reading for the Flood-Prone Area Location is obtained.



5. Mark the Flood-Prone Area locations on each bank. Measure the DISTANCE between the two "FPA" locations.
6. Determine the DISTANCE between the two BANKFULL Stage locations.
7. Divide the "FPA" WIDTH by the "BANKFULL" WIDTH to calculate the ENTRENCHMENT RATIO.

FIGURE 26. Determining a Flood-Prone Area elevation/width for calculation of Entrenchment Ratio.

Rosgen 1996)

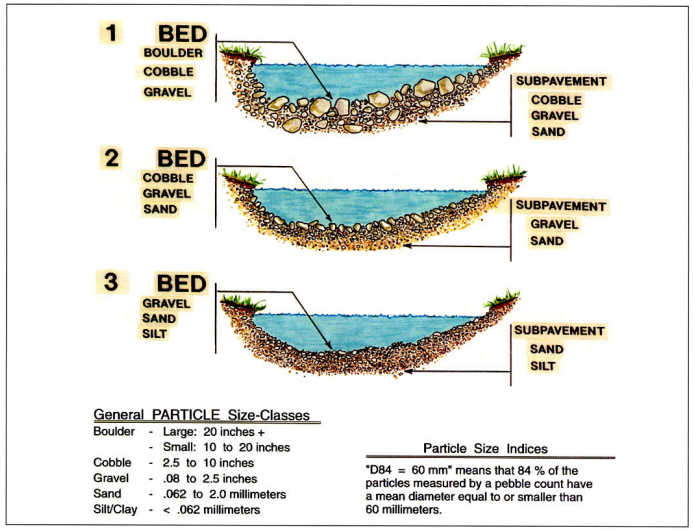


FIGURE 5-17. General categories of channel bed and sub-pavement materials.

Rosgen 1996)

LEVEL III: ASSESSMENT OF STREAM CONDITION AND DEPARTURE

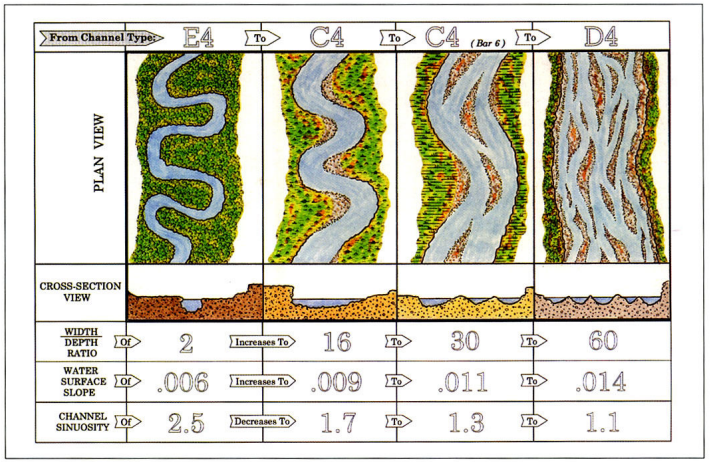


FIGURE 6-4. Example of progressive stages of channel adjustment due to an imposed change in stream bank stability.

Rosgen 1996)

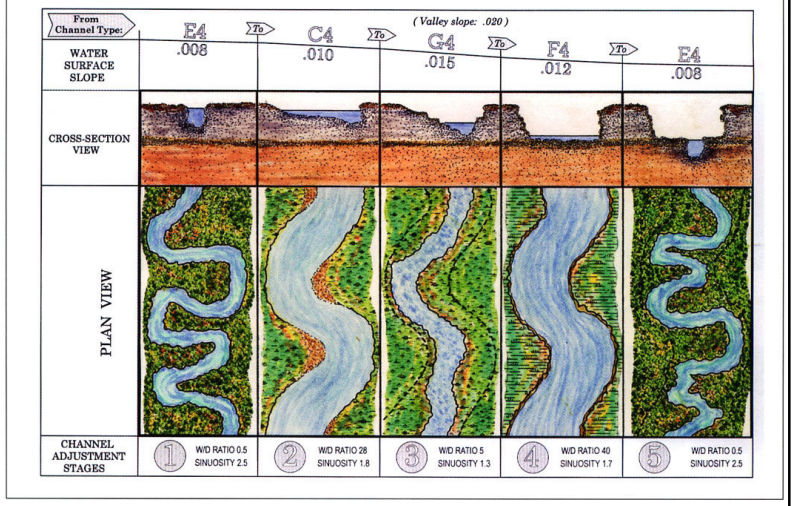


FIGURE 6-5. Adjustment of stream types in five progressive stages.

Rosgen 1996)

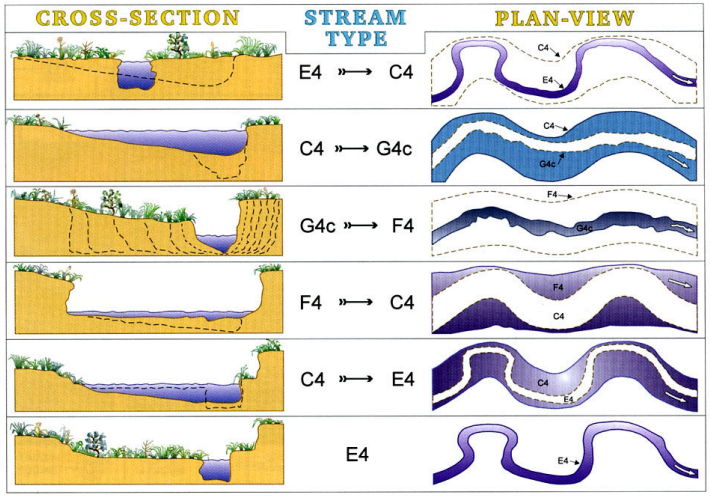


FIGURE 6-6. Adjustments of channel cross-section and plan-view patterns, as stream types change or shift through an evolutionary cycle.

Rosgen 1996)

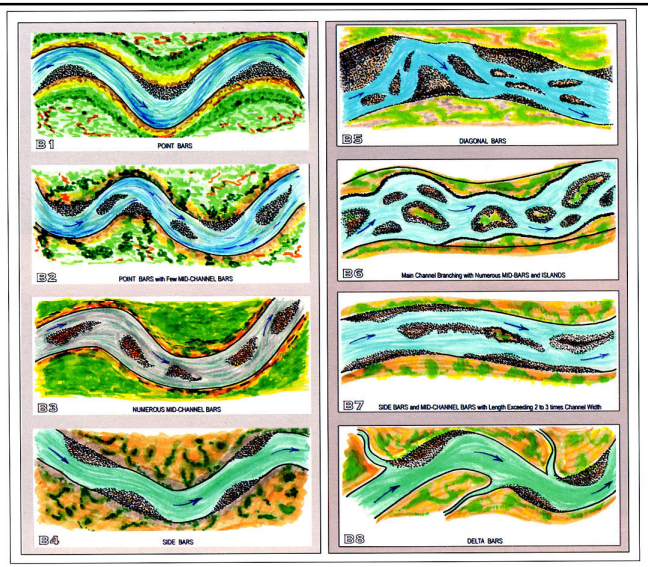


FIGURE 6-10. Illustrations of various depositional features as modified from Galay et al. (1973).

Rosgen 1996)

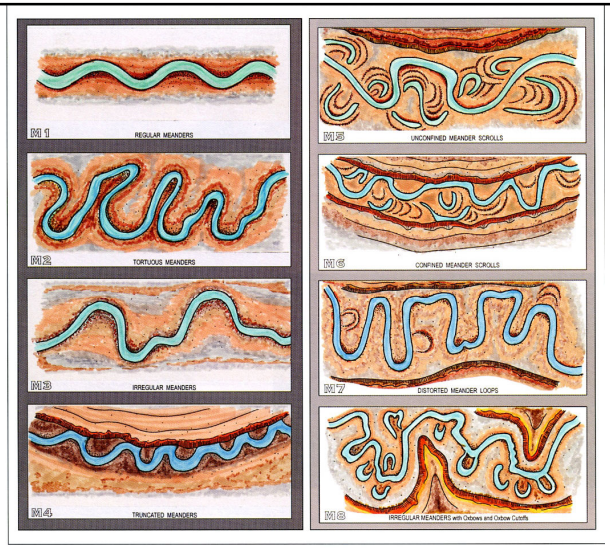


FIGURE 6-12. Illustrations of various meander pattern descriptions as modified from Galay et al. (1973)

Rosgen 1996)

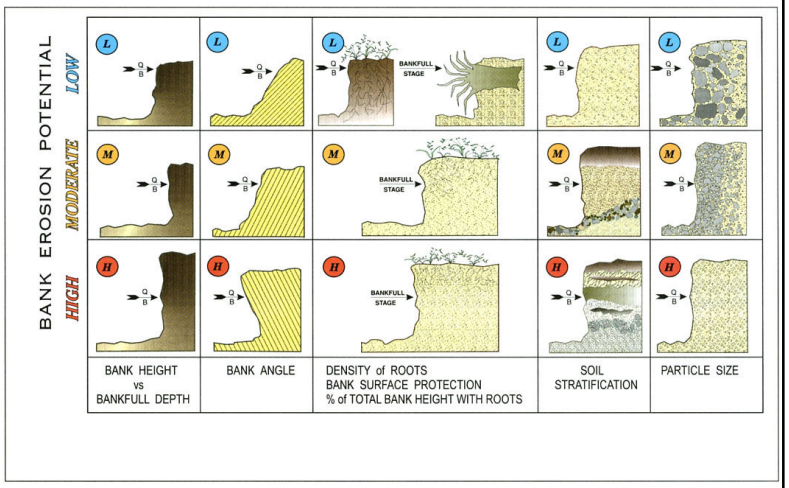


FIGURE 6-25. Stream bank erodibility factors. (*Rosgen, 1993a*)

Rosgen 1996)

TABLE 6-1. Riparian vegetation inventory/condition survey.

RIPARIAN VEGETATION

Existing Vegetation:

Composition: _____

Vigor, Density: _____

Potential: _____

Summary Categories (Identify individually and/or in combination)

1.	Bare		RV 1
2.	Forbs only -	Low density	2a
		Moderate density	2b
3.	Annual grass with forbs -	Low density	3a
		Mod. density	3b
		High density	3c
4.	Perennial grass -	Low density	4a
		Mod. density	4b
		High density	4c
5.	Rhizomatous grasses (bluegrass, grasslike plants, sedges, rushes)	Low density	5a
		Mod. density	5b
		High density	5c
6.	Low brush	Low density	6a
		Mod. density	6b
		High density	6c
7.	High brush -	Low density	7a
		Mod. density	7b
		High density	7c
8.	Combination grass/brush -	Low density	8a
		Mod. density	8b
		High density	8c
9.	Deciduous overstory -	Low density	9a
		Mod. density	9b
		High density	9c
10.	Deciduous with brush/ grass understory	Low density	10a
		Mod. density	10b
		High density	10c
11.	Perennial overstory -	Low density	11a
		Mod. density	11b
		High density	11c
12.	Wetland vegetation community		12a
		Bog	12b
		Fen	12c
		Marsh	RV 12d

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FLOW REGIME

General Category

E. Ephemeral stream channels - flows only in response to precipitation. Often used in conjunction with intermittent (USDA SCS, 1982).

S. Subterranean stream channel - flows parallel to and near the surface for various seasons - a subsurface flow which follows the stream bed.

I. Intermittent stream channel - one which flows only seasonally, or sporadically. Surface sources involve springs, snow melt, artificial controls, etc. Often this term is associated with flows that reappear along various locations of a reach, then run subterranean.

P. Perennial stream channels. Surface water persists year long.

Specific Category

1. Seasonal variation in streamflow dominated primarily by snowmelt runoff.
2. Seasonal variation in streamflow dominated primarily by stormflow runoff.
3. Uniform stage and associated streamflow due to spring fed condition, backwater etc.
4. Stream flow regulated by glacial melt.
5. Ice flows, ice torrents from ice dam breaches
6. Alternating flow/backwater due to tidal influence
7. Regulated stream flow due to diversions, dam release, dewatering, etc.
8. Altered due to development, such as urban streams, cut-over watersheds, vegetation conversions (forested to grassland) that changes flow response to precipitation events.

TABLE 6-2. Categories of flow regime for specification in level III inventories.

Rosgen 1996)

STREAM CHANNEL DEBRIS/BLOCKAGES

DESCRIPTION/EXTENT		Materials, which upon placement into the active channel or floodprone area may cause an adjustment in channel dimensions or conditions, due to influences on the existing flow regime.
D1	NONE	Minor amounts of small, floatable material.
D2	INFREQUENT	Debris consists of small, easily moved, floatable material; i.e. leaves, needles, small limbs, twigs, etc.
D3	MODERATE	Increasing frequency of small to medium sized material, such as large limbs, branches and small logs that when accumulated effect 10% or less of the active channel cross-sectional area.
D4	NUMEROUS	Significant build-up of medium to large sized materials, i.e. large limbs, branches, small logs or portions of trees that may occupy 10 to 30% of the active channel cross-section area.
D5	EXTENSIVE	Debris "dams" of predominantly larger materials, i.e. branches, logs, trees, etc., occupying 30 to 50% of the active channel cross-section; often extending across the width of the active channel.
D6	DOMINATING	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section. Such accumulations may divert water into the floodprone areas and form fish migration barriers, even when flows are at less than bankfull.
D7	BEAVER DAMS - FEW	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.
D8	BEAVER DAMS - FREQUENT	Frequency of dams is such that backwater conditions exist for channel reaches between structures; where streamflow velocities are reduced and channel dimensions or conditions are influenced.
D9	BEAVER DAMS - ABANDONED	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments such as bank erosion, lateral migration, evulsion, aggradation and degradation.
D10	HUMAN INFLUENCES	Structures, facilities, or materials related to land uses or development located within the floodprone area, such as diversions or low-head dams, controlled by-pass channels, velocity control structures, and various transportation encroachments that have an influence on the existing flow regime, such that significant channel adjustments occur.

TABLE 6-6. Debris and channel blockages categorized by size and extent.

Rosgen 1996)

CHANNEL STABILITY (PFANKUCH) EVALUATION AND STREAM CLASSIFICATION SUMMARY (LEVEL III)

Reach Location_____ Date_____ Observers_____

Stream Type _____

		Category	EXCELLENT	
UPPER BANKS	1	Landform Slope	Bank Slope Gradient <30%.	2
	2	Mass Wasting	No evidence of past or future mass wasting.	3
	3	Debris Jam Potential	Essentially absent from immediate channel area.	2
	4	Vegetative Bank Protection	90%+ plant density. Vigor and variety suggest a deep dense soil binding root mass.	3
LOWER BANKS	5	Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	1
	6	Bank Rock Content	65%+ with large angular boulders. 12"+ common.	2
	7	Obstructions to Flow	Rocks and logs firmly imbedded. Flow pattern without cutting or deposition. Stable bed.	2
	8	Cutting	Little or none. Infreq. raw banks less than 6".	4
	9	Deposition	Little or no enlargement of channel or pt. bars.	4
BOTTOM	10	Rock Angularity	Sharp edges and corners. Plane surfaces rough.	1
	11	Brightness	Surfaces dull, dark or stained. Gen. not bright.	1
	12	Consolidation of Particles	Assorted sizes tightly packed or overlapping.	2
	13	Bottom Size Distribution	No size change evident. Stable mater. 80-100%.	4
	14	Scouring and Deposition	<5% of bottom affected by scour or deposition.	6
	15	Aquatic Vegetation	Abundant Growth moss-like, dark green perennial. In swift water too.	1
			TOTAL	

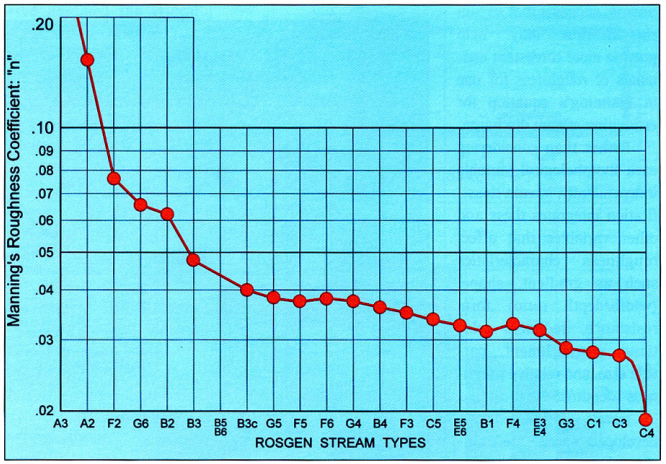
		Category	GOOD	
UPPER BANKS	1	Landform Slope	Bank Slope Gradient 30-40%.	4
	2	Mass Wasting	Infrequent. Mostly healed over. Low future potential.	6
	3	Debris Jam Potential	Present, but mostly small twigs and limbs.	4
	4	Vegetative Bank Protection	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	6
LOWER BANKS	5	Channel Capacity	Adequate. Bank overflows rare. W/D ratio 8-15.	2
	6	Bank Rock Content	40-65%. Mostly small boulders to cobbles 6-12"	4
	7	Obstructions to Flow	Some present causing erosive cross currents and minor pool. filling. Obstructions newer and less firm.	4
	8	Cutting	Some, intermittently at outcurves and constrictions. Raw banks may be up to 12"	6
	9	Deposition	Some new bar increase, mostly from coarse gravel.	8
BOTTOM	10	Rock Angularity	Rounded corners and edges, surfaces smooth, flat.	2
	11	Brightness	Mostly dull, but may have <50% bright surfaces.	2
	12	Consolidation of Particles	Moderately packed with some overlapping.	4
	13	Bottom Size Distribution	Distribution shift light. Stable material 50-80%.	8
	14	Scouring and Deposition	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	12
	15	Aquatic Vegetation	Common. Algae forms in low velocity and pool areas. Moss here too.	2
			TOTAL	

		Category	FAIR	
UPPER BANKS	1	Landform Slope	Bank slope gradient 40-60%.	6
	2	Mass Wasting	Frequent or large, causing sediment nearly year long.	9
	3	Debris Jam Potential	Moderate to heavy amounts, mostly larger sizes.	6
	4	Vegetative Bank Protection	50-70% density. Lower vigor and fewer species from a shallow, discontinuous root mass.	9
LOWER BANKS	5	Channel Capacity	Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25.	3
	6	Bank Rock Content	20-40% with most in the 3-6" diameter class.	6
	7	Obstructions to Flow	Moder. frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	6
	8	Cutting	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident	12
	9	Deposition	Moder. deposition of new gravel and course sand on old and some new bars.	12
BOTTOM	10	Rock Angularity	Corners and edges well rounded in two dimensions.	3
	11	Brightness	Mixture dull and bright, ie 35-65% mixture range.	3
	12	Consolidation of Particles	Mostly loose assortment with no apparent overlap.	6
	13	Bottom Size Distribution	Moder. change in sizes. Stable materials 20-50%	12
	14	Scouring and Deposition	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	18
	15	Aquatic Vegetation	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	3
			TOTAL	

TABLE 6-7. Channel stability evaluation (Pfankuch, 1975) with a conversion of the channel stability rating to a reach condition by stream type.

Rosgen 1996)

FIGURE 8-2. Manning's "n" value computed at bankfull stage for selected stream types.



Rosgen 1996)

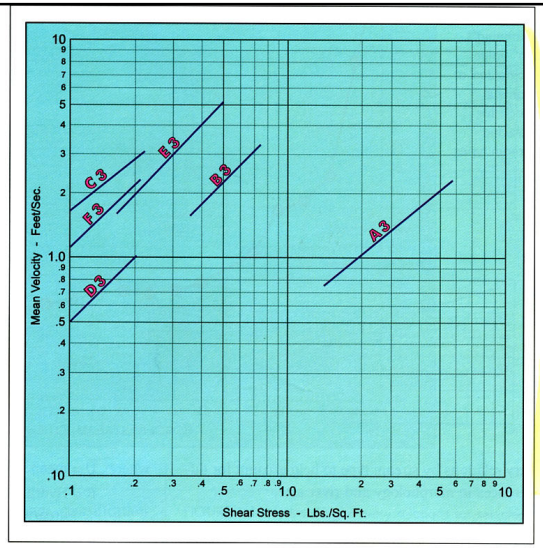


FIGURE 8-3. Relationship of mean velocity v.s. shear stress for six stream types, from base flow (3-4 cfs.) to bankfull discharge (40-41 cfs.). (*Rosgen, 1994*)

Rosgen 1996)

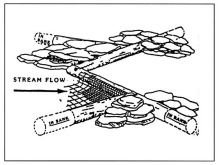


FIGURE 8-10. Low Stage check dam. (*Seehorn, 1985*)

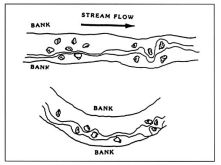


FIGURE 8-11. Boulder Placement. (*USDT, 1979*)

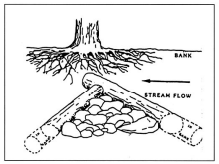


FIGURE 8-12. Single-wing deflector. (*Seehorn, 1985*)

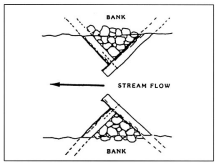


FIGURE 8-13. Double-wing deflector. (*Seehorn, 1985*)

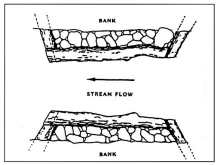


FIGURE 8-14. Channel constrictor. (*Seehorn, 1985*)

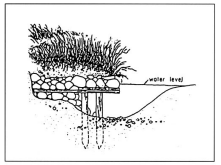


FIGURE 8-15. Bank cover. (*White and Brynildson, 1967*)

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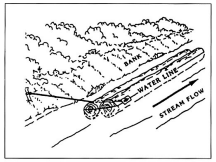

FIGURE 8-16. Floating log cover.

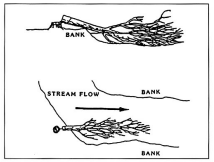

FIGURE 8-17. Submerged shelters. (*Seehorn, 1985*)

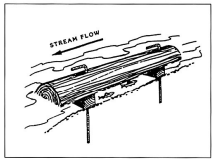

FIGURE 8-18. Half-log cover. (*Hunt, 1977*)

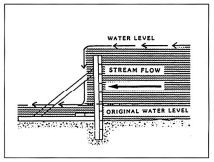

FIGURE 8-19. Migration barrier. (*Culver, 1985*)

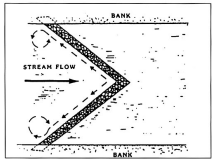

FIGURE 8-20. V-shaped gravel trap. (*Reeves & Roelofs, 1982*)

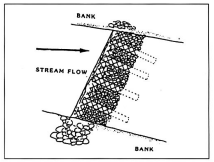

FIGURE 8-21. Log-sill gravel trap. (*Reeves & Roelofs, 1982*)

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Stream type	Sensitivity to disturbance[a]	Recovery potential[b]	Sediment supply[c]	Streambank erosion potential	Vegetation controlling influence[d]
A1	very low	excellent	very low	very low	negligible
A2	very low	excellent	very low	very low	negligible
A3	very high	very poor	very high	very high	negligible
A4	extreme	very poor	very high	very high	negligible
A5	extreme	very poor	very high	very high	negligible
A6	high	poor	high	high	negligible
B1	very low	excellent	very low	very low	negligible
B2	very low	excellent	very low	very low	negligible
B3	low	excellent	low	low	moderate
B4	moderate	excellent	moderate	low	moderate
B5	moderate	excellent	moderate	moderate	moderate
B6	moderate	excellent	moderate	low	moderate
C1	low	very good	very low	low	moderate
C2	low	very good	low	low	moderate
C3	moderate	good	moderate	moderate	very high
C4	very high	good	high	very high	very high
C5	very high	fair	very high	very high	very high
C6	very high	good	high	high	very high
D3	very high	poor	very high	very high	moderate
D4	very high	poor	very high	very high	moderate
D5	very high	poor	very high	very high	moderate
D6	high	poor	high	high	moderate
DA4	moderate	good	very low	low	very high
DA5	moderate	good	low	low	very high
DA6	moderate	good	very low	very low	very high
E3	high	good	low	moderate	very high
E4	very high	good	moderate	high	very high
E5	very high	good	moderate	high	very high
E6	very high	good	low	moderate	very high
F1	low	fair	low	moderate	low
F2	low	fair	moderate	moderate	low
F3	moderate	poor	very high	very high	moderate
F4	extreme	poor	very high	very high	moderate
F5	very high	poor	very high	very high	moderate
F6	very high	fair	high	very high	moderate
G1	low	good	low	low	low
G2	moderate	fair	moderate	moderate	low
G3	very high	poor	very high	very high	high
G4	extreme	very poor	very high	very high	high
G5	extreme	very poor	very high	very high	high
G6	very high	poor	high	high	high

a Includes increases in streamflow magnitude and timing and/or sediment increases.
b Assumes natural recovery once cause of instability is corrected.
c Includes suspended and bedload from channel derived sources and/or from stream adjacent slopes.
d Vegetation that influences width/depth ratio-stability.

TABLE 8-1. Management interpretations of various stream types (*Rosgen, 1994*)

Rosgen 1996)

Previous Types 1985	Channel Type 1994	Low St. Ch. Dams	Med. St. Ch. Dams	Random Boulder Placement	Bank Placed Boulder	Single Wing Deflector	Double Wing Deflector	Channel Constrictor	Bank Cover	Half Log Cover	Floating Log Cover
A1	A1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
A2	A2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
A3	A3	FAIR	POOR	POOR	GOOD	POOR	FAIR	N/A	POOR	POOR	FAIR
A3	A4	FAIR	POOR	POOR	GOOD	POOR	FAIR	N/A	POOR	POOR	FAIR
A4	A5	FAIR	POOR	POOR	GOOD	POOR	FAIR	N/A	POOR	POOR	FAIR
A5	A6	FAIR	FAIR	POOR	GOOD	POOR	FAIR	N/A	POOR	FAIR	FAIR
B1-1	B1	POOR	POOR	POOR	EXC	POOR	POOR	POOR	EXC	GOOD	GOOD
B1	B2	EXC	EXC	N/A	N/A	EXC	EXC	EXC	EXC	N/A	N/A
B2	B3	EXC	GOOD	EXC	EXC	EXC	EXC	EXC	EXC	EXC	EXC
	B4	EXC	GOOD	EXC	EXC	EXC	EXC	EXC	EXC	EXC	EXC
	B5	GOOD	FAIR	FAIR	EXC	GOOD	GOOD	GOOD	EXC	GOOD	EXC
	B6	GOOD	FAIR	FAIR	EXC	GOOD	GOOD	GOOD	EC	EXC	EXC
C1-1	C1	POOR	POOR	POOR	EXC	POOR	POOR	POOR	EXC	EXC	EXC
C2	C2	GOOD	FAIR	N/A	N/A	GOOD	GOOD	GOOD	GOOD	N/A	GOOD
C2	C3	GOOD	FAIR	GOOD	EXC	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD
C3	C4	FAIR	POOR	POOR	GOOD	FAIR	FAIR	FAIR	GOOD	FAIR	GOOD
C4	C5	FAIR	POOR	POOR	GOOD	POOR	POOR	POOR	FAIR	POOR	GOOD
C5	C6	FAIR	POOR	POOR	GOOD	POOR	POOR	FAIR	GOOD	FAIR	GOOD
D1	D3	POOR	POOR	POOR	FAIR	FAIR	FAIR	FAIR	POOR	POOR	POOR
D1	D4	POOR	POOR	POOR	FAIR	FAIR	FAIR	FAIR	POOR	POOR	POOR
D2	D5	POOR	POOR	POOR	FAIR	FAIR	FAIR	FAIR	POOR	POOR	POOR
B6	E3	N/A	POOR	POOR	GOOD	POOR	FAIR	N/A	N/A	N/A	N/A
C6	E4	N/A	POOR	POOR	GOOD	POOR	FAIR	N/A	N/A	N/A	N/A
C6	E5	N/A	POOR	POOR	GOOD	POOR	FAIR	N/A	N/A	N/A	N/A
C6	E6	N/A	POOR	POOR	GOOD	POOR	FAIR	N/A	N/A	N/A	N/A
F1	F1	POOR	POOR	POOR	GOOD	FAIR	POOR	POOR	FAIR	FAIR	FAIR
F2	F2	FAIR	POOR	N/A	N/A	FAIR	FAIR	FAIR	FAIR	FAIR	FAIR
F3	F3	FAIR	POOR	FAIR	GOOD	GOOD	GOOD	FAIR	FAIR	FAIR	FAIR
F3	F4	FAIR	POOR	POOR	POOR	GOOD	FAIR	FAIR	FAIR	FAIR	FAIR
F4	F5	FAIR	POOR	POOR	GOOD	FAIR	FAIR	FAIR	FAIR	FAIR	FAIR
F5	F6	FAIR	POOR	FAIR	GOOD	FAIR	FAIR	FAIR	FAIR	FAIR	FAIR
	G1	N/A	N/A	POOR	N/A	N/A	N/A	N/A	POOR	FAIR	FAIR
	G2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	POOR	FAIR	N/A
	G3	FAIR	POOR	POOR	GOOD	POOR	FAIR	N/A	POOR	POOR	FAIR
B3	G4	FAIR	POOR	POOR	GOOD	POOR	FAIR	N/A	POOR	POOR	FAIR
B4	G5	FAIR	POOR	POOR	GOOD	POOR	FAIR	N/A	POOR	POOR	FAIR
B5	G6	FAIR	POOR	POOR	GOOD	POOR	FAIR	N/A	POOR	POOR	FAIR

TABLE 8-2a. Fish habitat improvement structures - suitability to stream types.

Rosgen 1996)

REARING HABITAT ENHANCEMENT					
LOW STAGE CHECK DAM			MEDIUM STAGE CHECK DAMS		
Rating	Channel Types	Limitation/Discussion	Rating	Channel Types	Limitation/Discussion
Exc	B2,B3,B4	No limitations	Exc	B2	No limitations
Good	B5,B6 C2,C3	Bank erosion due to lateral migration will occur unless bank stabilization is utilized	Good	B3, B4	Stage increase will result in floodplain encroachment. Limit dam height to less than 75% of bankfull stage and select sites with high stable banks
Fair	A3 A6 C4 C6 F2 F6 G3 G6	Low dams must be constructed in conjunction with bank stabilization in these channel types. Use in conjunction with confinement measures and bank stabilization to reduce lateral migration	Fair	A6, B5, B6, C2, C3	Banks must be adequately protected both up and downstream of structure
Poor	B1,C1	Bedrock streambed limits the development of pools	Poor	A3 A5 C4 C5 D3 D6 F2 F6 G3 G6	Increased stream aggradation accelerated bank erosion, slope rejuvenation and floodplain encroachment can result. Extensive bank stabilization measures must accompany installation. Exceptions are on headwater streams in ephemeral channels to stop gully headcuts, which rate fair.
	D3 D6	High width/depth ratio and high sediment yields makes ineffective. Increases bank erosion.		B1, C1, F1	Bedrock streambed limits pool scour depth, anchoring difficult.
N/A	A1,A2,F1E3 E6 F1,G1,G2	Pools not limiting in these stream types	N/A	A1,A2,G1,G3 E3-E6	Pools not limiting factor in these channel types. These stream types provide excellent fish habitat and generally do not require modification.

RANDOM BOULDER PLACEMENT			BANK PLACED BOULDER		
Rating	Channel Types	Limitation/Discussion	Rating	Channel Types	Limitation/Discussion
Exc	B3,B4	No limitations	Exc	B1,B3 B6 C1,C3	No limitations
Good	C3	Lower gradient provides more opportunity for bar development up and downstream of rock - unless placed on meander points (See Bank placed rock). Use in conjunction with deflectors to increase velocity sufficient to create pools	Good	A3 A6 C4 C6 E3 E6 F1,F3 F6 G3 G6	Boulders must be keyed into the bank.
Fair	B5,B6 F3	Potential bar deposition and lateral migration can be offset by stabilizing the banks and by strategic placement. Due to bed armor and flatter gradients, it is advantageous to create deep pools with a combination of deflectors, boulders and/or rock clusters	Fair	D3 D6	Difficult to locate thalweg channel and where the banks will be inundated from one year to another
			Poor		
Poor	B1,C1,F1, G1 A3 A6 C4 C6 D3 D6 E3 E6 F4,F5,F6 G3-G6	Bedrock limits bed scour, difficult to stabilize in place with high flows. The high sediment supply and highly unstable banks limit the effectiveness of boulders placed in the channel (other than along banks). Bar deposition up and downstream of boulder and excessive bank erosion often occur. Deflectors can reduce sediment deposition, but stress banks.	N/A	B2,C2,F2,G1 G2, A1,A2	Bank rock and streamside boulders naturally occur and banks are naturally stable. Cover and pools not limiting in this channel type
N/A	A1,A2, B2,C2 F2,G2	Large boulder and/or pools are not a limiting factor in these channel types			

TABLE 8-3a. Limitations and discussions of various fish habitat improvement structures by stream types.

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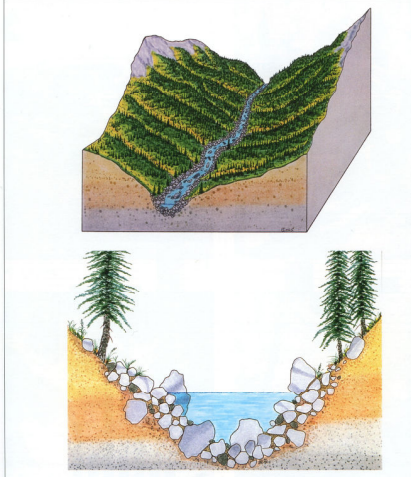
A2 Stream Type

Rosgen 1996)



DELINEATIVE CRITERIA (A2)

Landform/soils: Steep, structural controlled slopes with colluvial deposition in narrow and confined valleys.

Channel materials: Predominantly boulders, with lesser amounts of cobble, gravel and sand. Some bedrock sporadically spaced.

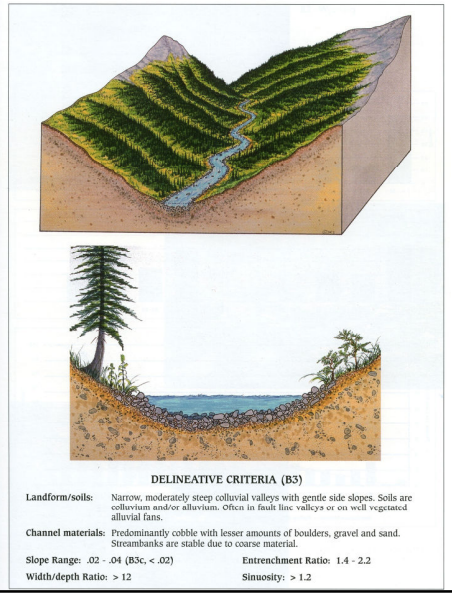
Slope Range: .04 - .10 (A2a+ > .10) **Entrenchment Ratio:** < 1.4

Width/depth Ratio: < 12 **Sinuosity:** < 1.2

Rosgen 1996)

B3 Stream Type

Rosgen 1996)



DELINEATIVE CRITERIA (B3)

Landform/soils: Narrow, moderately steep colluvial valleys with gentle side slopes. Soils are colluvium and/or alluvium. Often in fault line valleys or on well vegetated alluvial fans.

Channel materials: Predominantly cobble with lesser amounts of boulders, gravel and sand. Streambanks are stable due to coarse material.

Slope Range: .02 - .04 (B3c, < .02) **Entrenchment Ratio:** 1.4 - 2.2

Width/depth Ratio: > 12 **Sinuosity:** > 1.2

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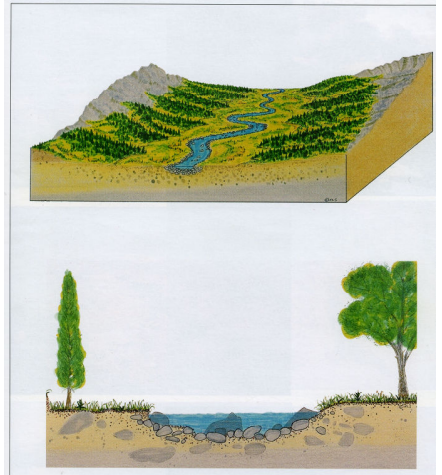
C2 Stream Type

Rosgen 1996)



DELINEATIVE CRITERIA (C2)

Landform/soils: Broad, gentle gradient, alluvial valleys associated with lag deposits. Can also be associated with glaciated and/or structural controlled valleys.

Channel materials: Predominantly boulders with lesser amounts of cobble, gravel and sand.

Slope Range: < .02 (C2c- .001) **Entrenchment Ratio:** > 2.2

Width/depth Ratio: >12 **Sinuosity:** >1.2

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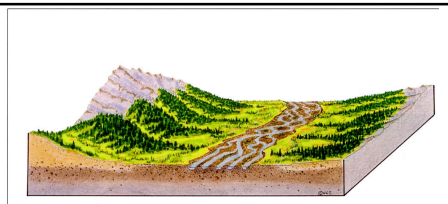
D6 Stream Type

Rosgen 1996)



DELINEATIVE CRITERIA (D6)

Landform/soils: Gentle, wide alluvial valleys, Lacustrine deposits, and deltas. Cohesive depositional soils. Organic lenses and peat common in deltas and some lacustrine features.

Channel materials: Silts and/or clays dominate the D6 stream type. Organic contributions are common such as peat.

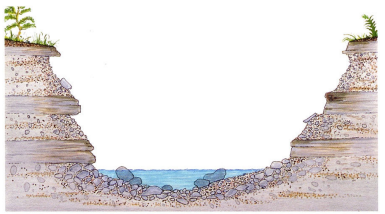
Slope Range: < .02 (generally less than .0001) **Entrenchment Ratio:** N/A (not incised)

Width/depth Ratio: > 40 **Sinuosity:** Low, channel slope = valley slope

Rosgen 1996)

F2 Stream Type

Rosgen 1996)



DELINEATIVE CRITERIA (F2)

Landform/soils: The F2 stream type is associated with deeply entrenched, structurally controlled, gentle gradient valleys and gorges. The F2 stream type is associated with highly weathered bedrock in a combination of river downcutting and uplift of valley walls.

Channel materials: Boulder dominated channel with accumulations of cobble and gravel. Some sand deposits in pools and backwater eddies.

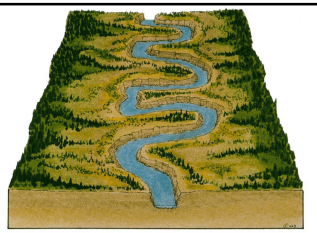
Slope Range: < .02 **Entrenchment Ratio:** < 1.4

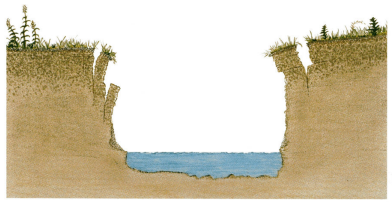
Width/depth Ratio: > 12 **Sinuosity:** > 1.2

Rosgen 1996)

F6 Stream Type

Rosgen 1996)





DELINEATIVE CRITERIA (F6)

Landform/soils: The F6 stream type is associated with deeply entrenched channels in alluvium or in structurally controlled, gentle gradient valleys and gorges. The F6 stream type is associated with highly weathered rock or depositional soils involving a combination of river downcutting and/or uplift of the valley walls. Cohesive soils with occasional mass-wasting slump blocks.

Channel materials: Silt and or clay

Slope Range: < .02 **Entrenchment Ratio:** < 1.4

Width/depth Ratio: > 12 **Sinuosity:** > 1.2

Rosgen 1996)