STREAM 101

AN INTRODUCTION TO

STREAM

MORPHOLOGY, FUNCTIONS

And

MANAGEMENT

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Harris Stream Services, LLC

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STREAM 101

Goals:

1. Appreciate stream form and function
2. Understand how streams do work

Objectives: Enable you to

1. Communicate effectively,
2. Evaluate impaired stream conditions, and
3. Identify potential actions to improve stream functions.

PART ONE – FORM AND FUNCTION - TOPICS

- Morphology
- Floodplains
- Bankfull
- Classification
- Natural Functions (what streams do)

PART TWO – MANAGEMENT - TOPICS

- Hydrology
- Hydraulics
- Energy
- Regional Curves
- 8 Controlling Variables
- Equilibrium
- Channel Evolution
- Management Actions

PART ONE

FORM AND FUNCTION

MORPHOLOGY

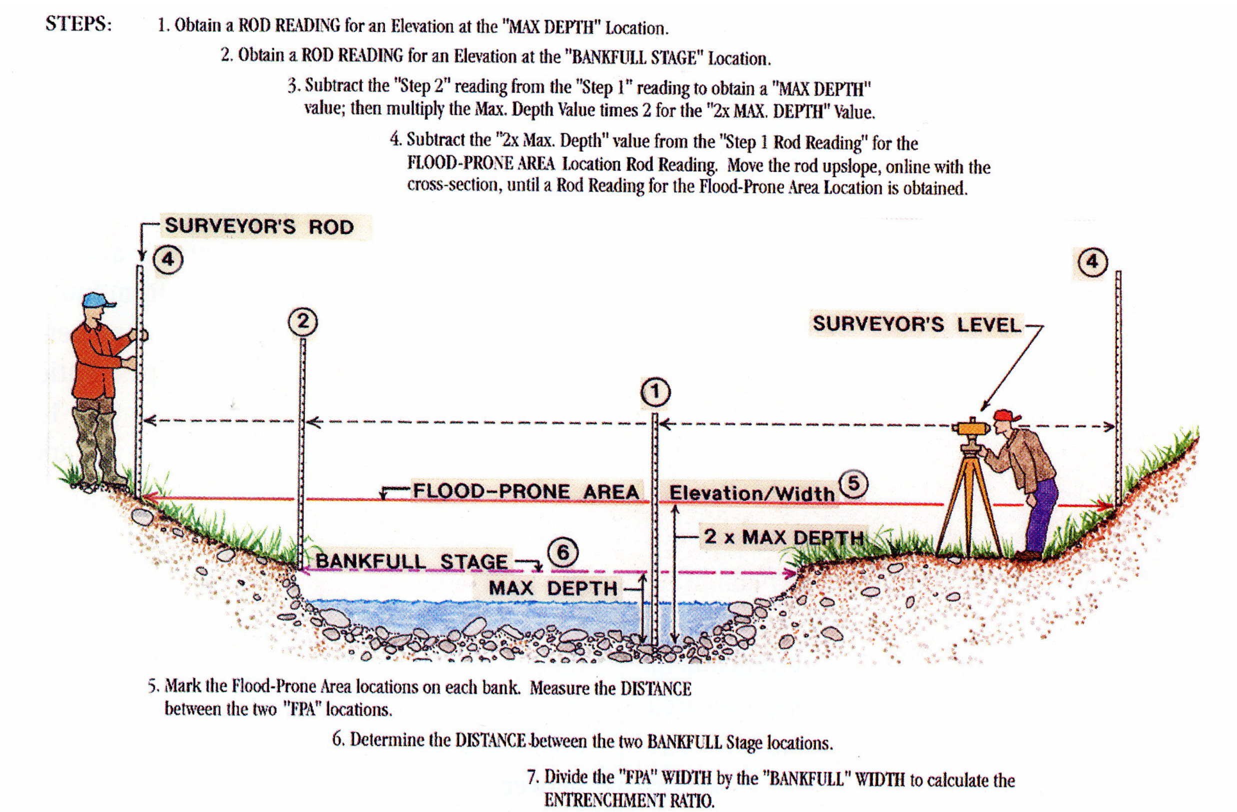
Fluvial morphology is the study of stream forms.

Stream form includes channel *dimension*, *pattern*, *profile*, and *bed materials*.

DIMENSION

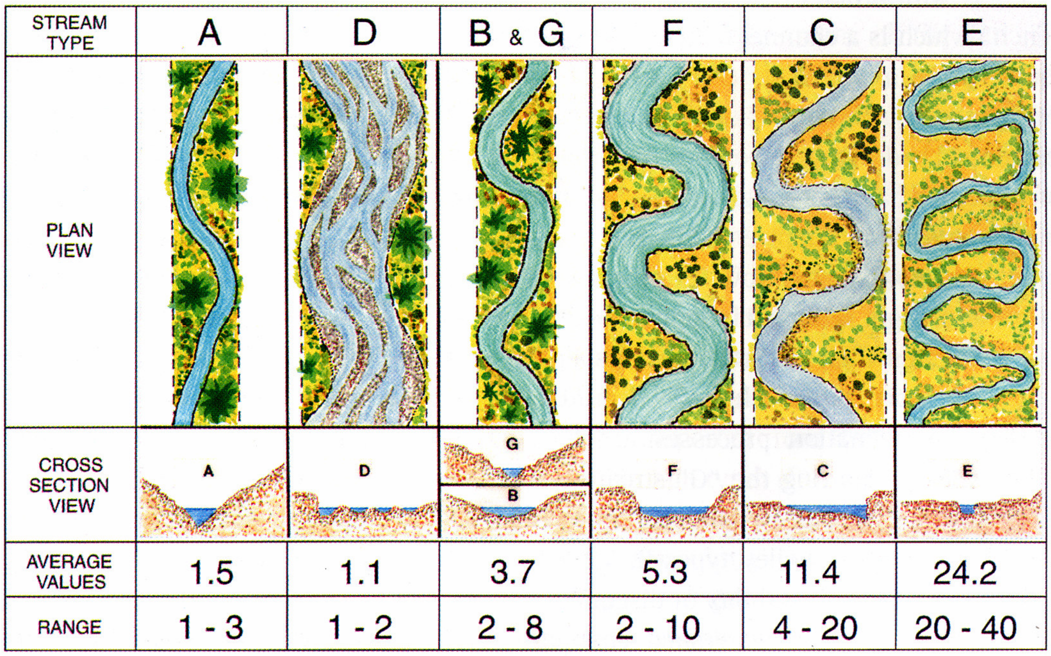
Dimension refers to the width, depth, and cross-sectional area at the bankfull stage.

The thalweg is the deepest (lowest) part of the bed.



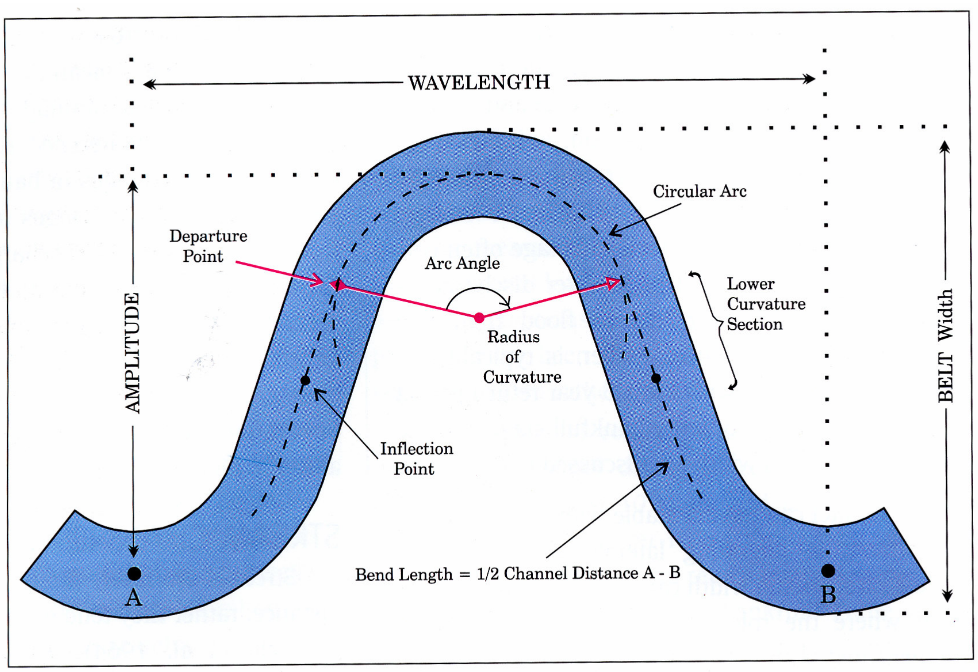
PATTERN

Pattern refers to the shape or form of the stream viewed from above. Channel patterns include be *straight*, *braided*, or *meandering*.



Meanders are described in terms of *wavelength*, *belt width*, *wavelength*, and *radius of curvature*.

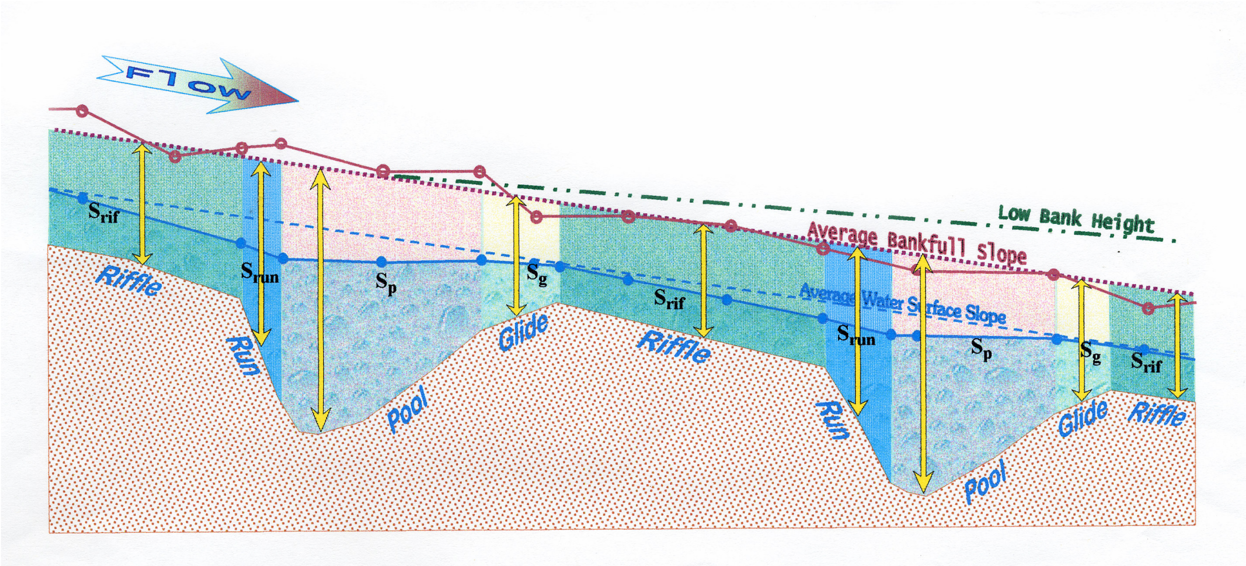
Channels of all sizes have a remarkable similar relationship between bankfull width, wavelength, and radius of curvature. Meander wavelengths average 11 times bankfull width. Radius of curvature averages 2.3 times bankfull width.



Sinuosity is an index of channel pattern determined from the ratio of stream length to valley length or the ration of valley slope to channel slope.

PROFILE

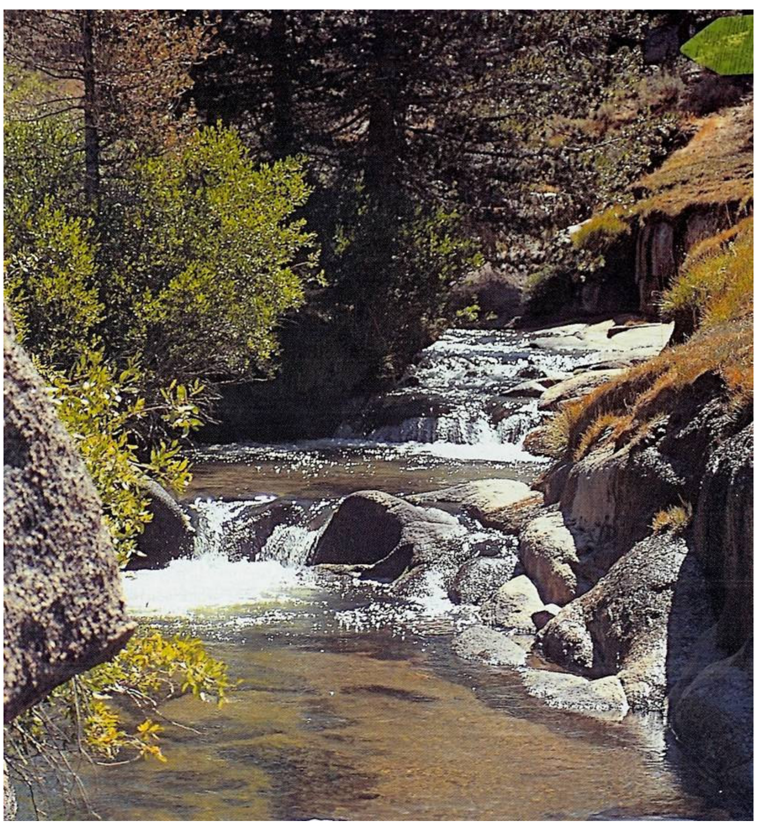
The **Longitudinal Profile** shows top of banks, average bankfull slope, thalweg, water surface slope, and bed features (riffles, runs, pools, and, glides.



BED FEATURES

Riffle – Pool Morphology includes Riffles, runs, pools, and glides

Step – Pool Morphology (Steps replace riffles and runs)



BED FEATURES

Bed Materials refer to the materials found in the bed of the stream channel.

Boulders	(>256 mm)	basketball (241 mm)
Cobble	(64 – 256 mm)	tennis ball (67 mm)
Gravel	(2 – 64 mm)	BB (4.4 mm)
Sand	(.062 – 2)	<BB size
Silt/clay	(<0.062 mm)	smooth/not gritty

Pebbles Count

The pebble count characterizes the channel and bed materials in a given reach. A minimum 100 pebbles are systematically collected. The intermediate axis of each particle is measured with a mm ruler. The sample is analyzed to determine the particle size distribution.

D50	The particle that is equal in size to 50% of the particles sampled.
D100	The largest particle size sampled.

This data is used for hydraulic calculations to estimate velocity and sediment competence.

FLOODPLAINS

The floodplain is defined as the *relatively flat depositional surface* immediately adjacent to the channel that is formed and reformed under *current climatic and hydrologic conditions*.

TERRACES

Terraces are abandoned floodplains.

BANKFULL STAGE

Bankfull stage is where water just starts to flow over the floodplain.

It may also be referred to as the Ordinary High Water (OHW) elevation.

Bankfull is the most significant feature to recognize.

If you don't know "bankfull" you don't know a thing.

BANKFULL DISCHARGE

"The bankfull stage corresponds to the discharge at which channel maintenance is most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels." Dunne and Leopold (1978).

Bankfull stage is a surrogate that can be used to describe the full range of flows that shape a channel.

BANKFULL INDICATORS

When it comes to bankfull determination in the field, the most critical words to keep in mind are "flat *depositional surface immediately adjacent to the channel*"; and "*current hydrologic conditions*.

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In doing so, it is critical to be able to differentiate the active floodplain from terraces that typically occur along stream channels in many locations.

1. Floodplains
2. Highest active depositional feature like the elevation on top of a point bar or center bar.
3. Changes in particle size from coarse to fine (sand) on the flat surface
4. Evidence of a depositional feature such as a small bench.
5. Staining of rocks

There is more to a river than just the stream channel.

What dis the stream say to the floodplain?	You complete me.
What did the floodplain say to the stream?	You had me at bankfull.

CLASSIFICATION

The Rosgen stream classification provides one way to classify rivers based on descriptive and measurable morphological features.

It provides a basis for thinking and enables you to

- Communicate effectively about stream morphology and conditions,
- Predict behavior from appearance
- Develop relationships by stream type, and
- Extrapolate data from similar stream types.

The Rosgen system of natural channel classification is the U.S. Forest Service standard for stream classification at the reach level.

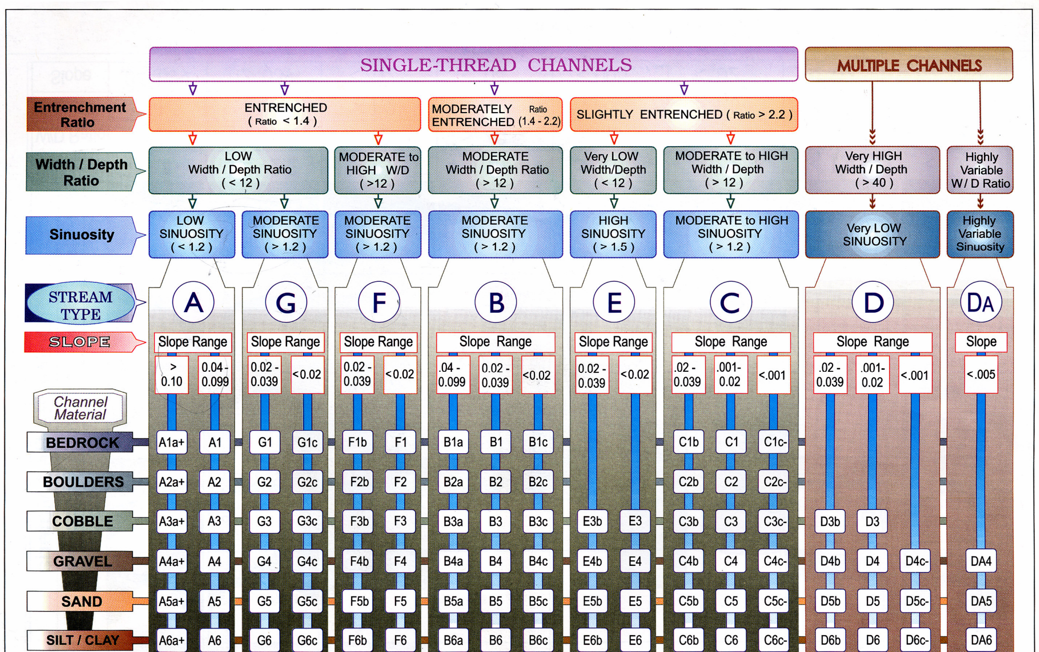
ROSGEN STREAM TYPES

The system uses a set of four primary criteria to classify streams.

1. Entrenchment Ratio
2. The width / depth ratio
3. Sinuosity
4. Slope of the water

Streams are assigned an alphabetic designation of A, B, C, D, DA, E, F or G.

A numerical designation describes the median particle size diameter (D50).



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.

Crooked River, OR

NATURAL FUNCTIONS

Properly functioning streams provide *physical*, *chemical*, *and* *biological* *integrity.*

Physical (hydrologic)
1. *Self-maintaining stable stream morphology*
2. *Flow conveyance*
3. *Sediment transport*
4. *Flood storage*
5. *Flow attenuation*
6. *Riparian hydrology*
7. *Streambank stabilization by plants*
8. *Groundwater exchange*
9. *Pollutant filtration by plants*

Chemical
10. *Nutrient cycling by plants*
11. *Pollution retention by plants*
12. *Thermoregulation (shading)*

Biological
13. *Habitat (for fish, macroinvertebrates, and wildlife)*
14. *Passage (for fish, macroinvertebrates, and wildlife)*
15. *Riparian plant production (shade, food, cover, buffer, and large woody)*
16. *Human stewardship*

The term "*natural functions*" describes the work done by natural areas such as stream systems, wetlands, and uplands. They work together to filter stormwater, cool streams and protect stream banks from erosion.

Healthy uplands in the watershed work to intercept rainfall, allowing it to soak slowly into the ground instead of running off. As storm water runoff passes through layers of plant debris on the forest floor, pollutants are filtered out. Cool spring water, released slowly, feeds streams and keeps them cool in the dry part of the year. The roots of trees and shrubs hold stream banks, helping them to resist erosion. Streamside forests shade streams, keeping them cool, and provide woody debris, which helps create habitats for fish and wildlife. Vegetation in the stream-side area helps to slow water down during flood events, and in doing so, allows sediments to settle out. Streamside plants also take up pollutants from overland and overbank flows.

Healthy streams work efficiently to carry runoff and transport sediment provided by watershed.

Healthy streams have a remarkable ability to filter pollutants, recycle nutrients, hold pollution in plant tissue, cool stream flow, prevent channel erosion, transport runoff and sediment, provide flood storage, reduce flow velocity, provide soil moisture for riparian vegetation, exchange cool clean groundwater, create habitat for fish and wildlife in pools, glides, riffles, and runs, and most significantly, maintain dynamically stable stream morphology.

PART TWO

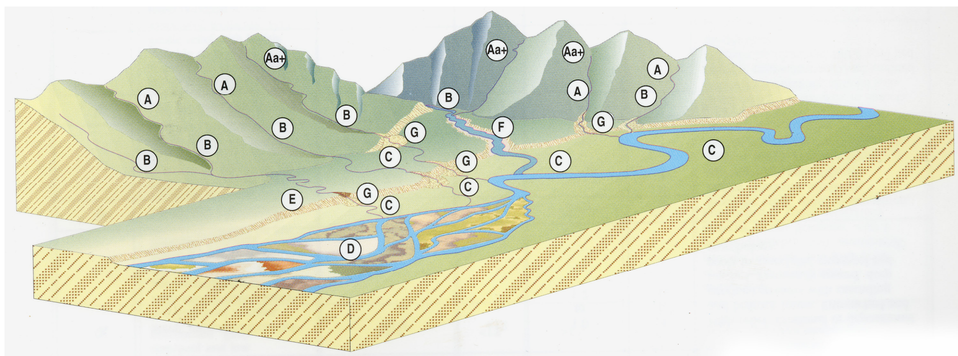
MANGAGEMENT

HYDROLOGY

Applied hydrology utilizes scientific findings to predict rates and amounts of runoff.

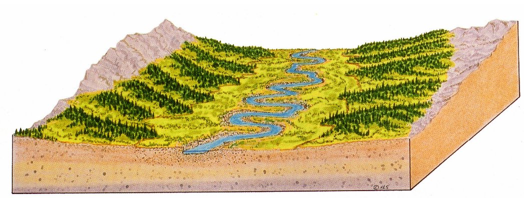
RIVER SYSTEMS

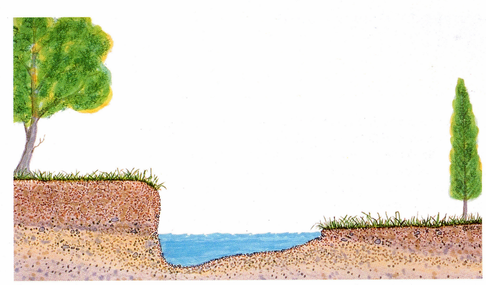
Rivers are a high organized system that convey flows and transport the products of weathering and erosion.



VALLEYS

Stream types correspond to the valley type they are in. Controlling factors include valley width, longitudinal slope, geology, and soil materials.





HYDRAULICS

Applied hydraulics uses scientific findings to estimate dynamic behavior of fluids including flow velocity, sediment transport competence, stream power, and shear stress.

ENERGY

River form and actions are determined by two physical laws.

1. The tendency to do minimal work and
2. The uniform distribution of work.

MOST PROBABLE STATE

These two conditions cannot be met simultaneously.
Therefore, rivers tend to achieve an intermediate position in channel form and action known as the "most probable state".

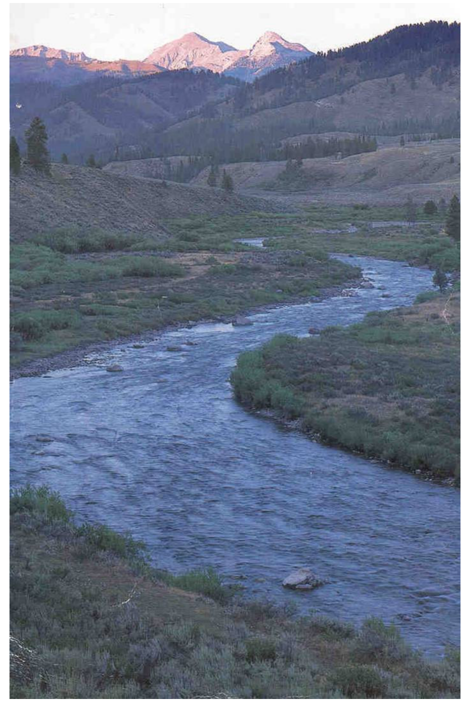
CENTRAL TENDENCY

"Rivers of all sizes have a natural tendency to respond to changing climate and conditions in the watershed by adjusting or evolving channel morphology toward the most probable state." Luna Leopold

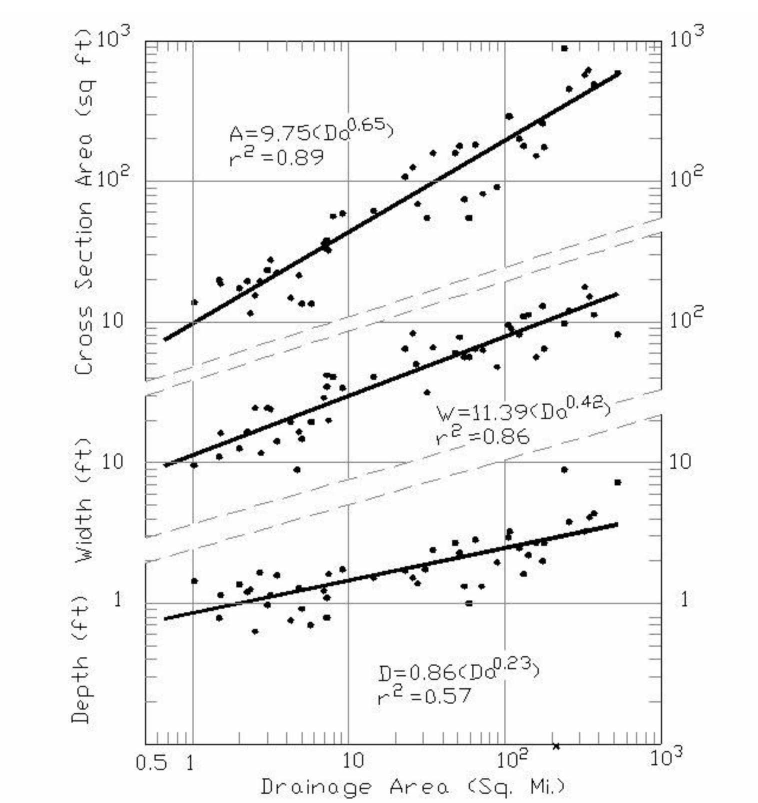
Walla Walla River through Milton-Freewater after the 1964 floods.

REGIOANAL CURVES

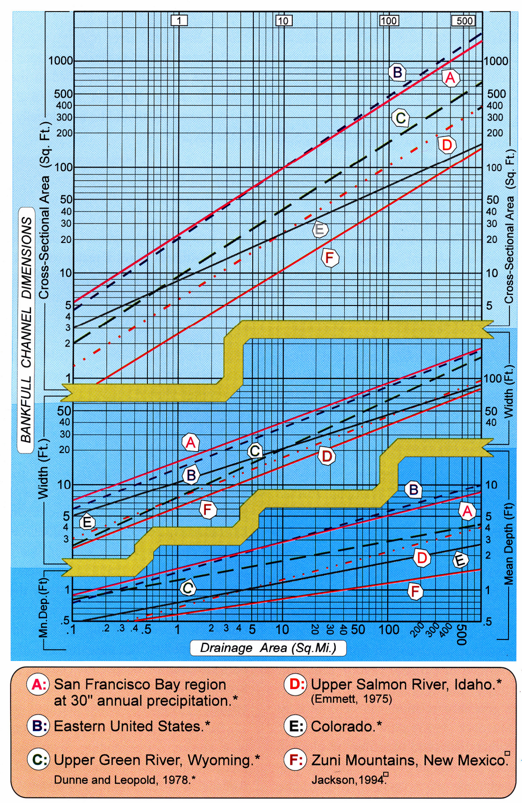
River of all sizes consistently maintain a morphology that is proportional to the drainage area.



REGIONAL CURVES



Willamette Valley Regional Curves



Other Regional Curves

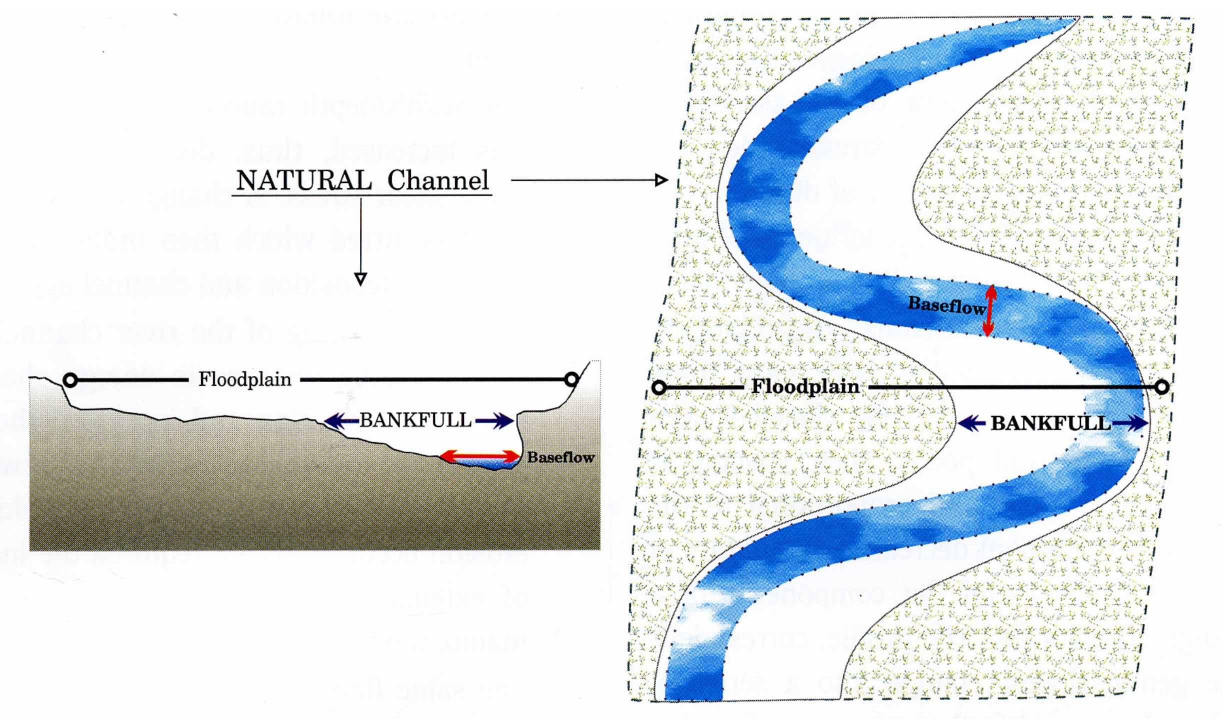
8 CHANNEL CONTROLLING VARIABLES

These controlling factors are the "eight (8) interrelated variables involved in downstream changes to river slope and channel form". (Miller, pp 268) They are all related to the bankfull channel.

1. Discharge (Q)
2. Sediment Size
3. Sediment Load
4. Width (w)
5. Depth (d)
6. Slope (s)
7. *Hydraulic Roughness (n)
8. Velocity (u)

- The first three (3) are provided by upstream conditions.
- The last five (5) are channel adjustments made in response to upstream conditions.

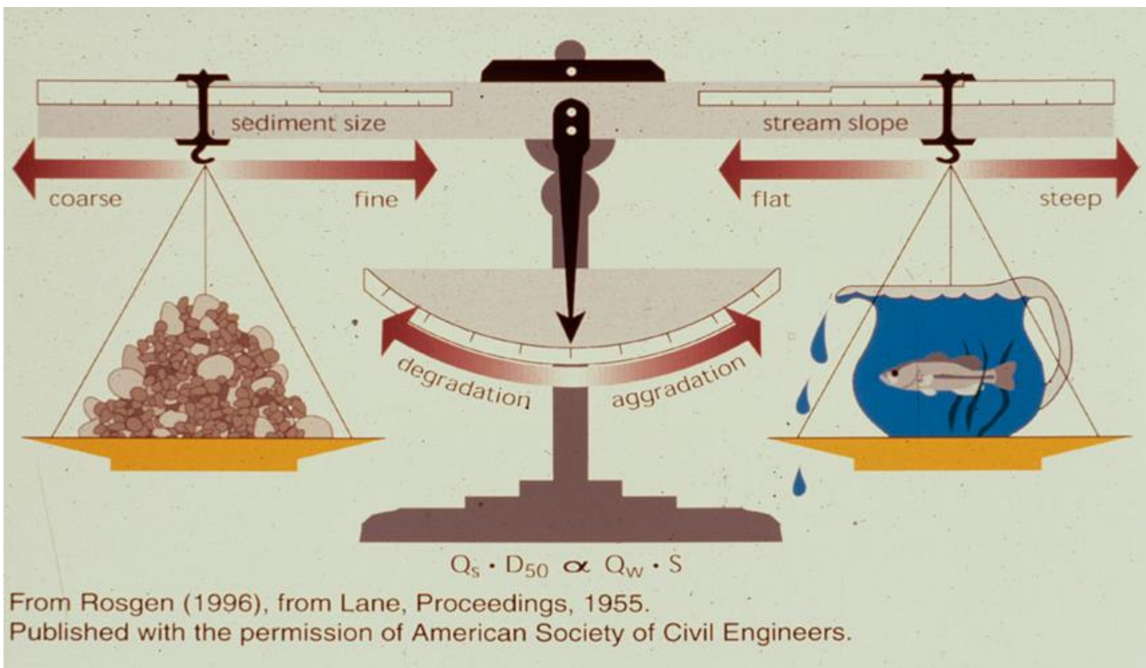
*Hydraulic roughness is flow resistance from plants, particle size, channel form (meanders), and bed form (riffles, pool, steps, and bars). (Miller, page 247 & 251)



EQUILIBRIUM

All streams have a natural tendency to adjust move to a state of dynamic equilibrium with conditions in the watershed. Dynamic equilibrium is synonymous with the term "graded" (Mackin, 1948). The concept of a graded river is a fundamental principle in the study of river morphology.

When conditions change in the watershed (e.g. due to urbanization), the result is a change in the flow and sediment load from the watershed. This in turn causes the natural river system to undergo a succession of physical changes in channel width, depth, slope, and pattern through a process of erosion and incision until the stream re-establishes a state of dynamic equilibrium with changed conditions in the watershed. This process can take many years.



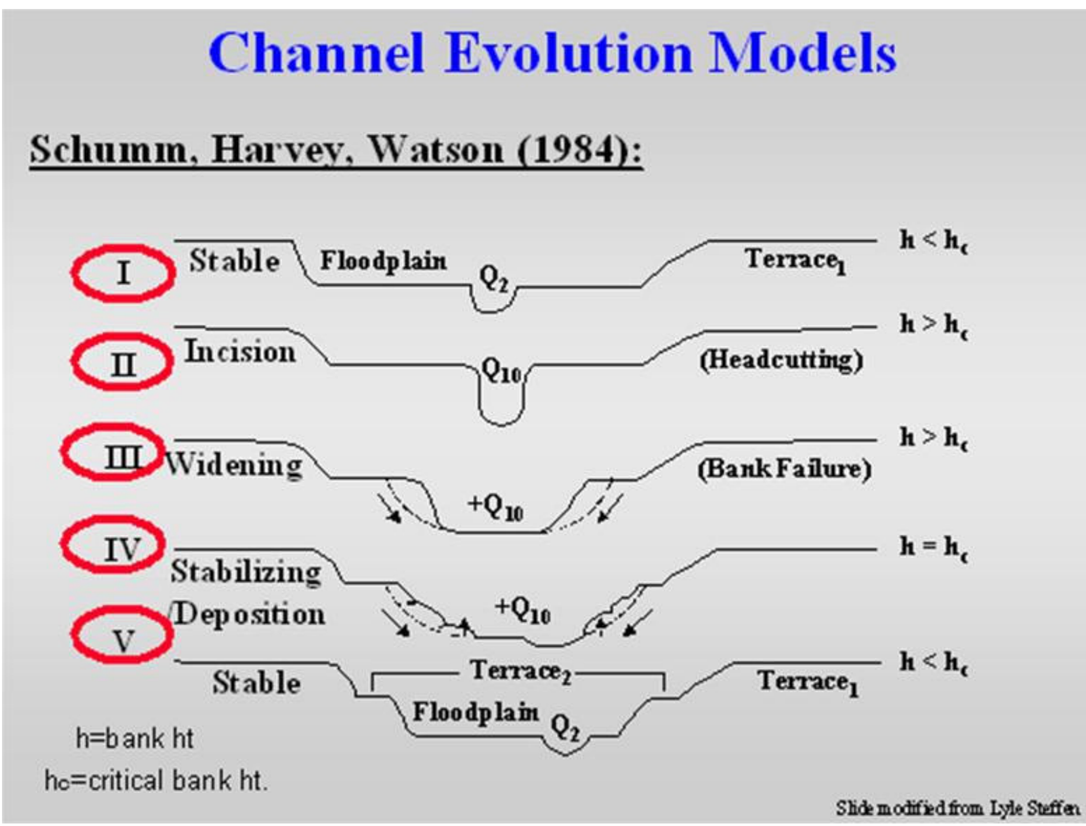
CHANNEL EVOLUTION MODEL

Stanley Schumm, the internationally recognized geomorphologist states: "*Once incision has commenced, it is unlikely that erosion will cease naturally until the channel has progressed through the several stages of the incised channel evolution model. Incised channels, after initial incision, follow an evolutionary sequence that results in relative stability after a number of years.*" *(***Schumm, 2005, p.22).**

This general pattern of headcutting and channel response was described in the channel evolution model (Schumm, 1977). The model breaks the process down into five stages:

- Stage I: stable channel
- Stage II: incision
- Stage III: widening
- Stage IV: Stabilizing
- Stage V: Stable.

Scientists have found that stream channel adjustments following the Schumm channel evolution model is predictable and quantifiable. Stream restoration using a geomorphic approach is an effective design tool to predict what the stable stream channel will look like and to restore the state of dynamic equilibrium between a stream and its watershed conditions. This approach enables stream stewards to stabilize stream banks from erosion, reduce water pollution, and restore proper stream functions in a way that is sustainable and self-maintaining.



MANAGEMENT ACTIONS

1. Observe impaired conditions.
2. Consider the corresponding impaired natural functions.
3. Consider the hydraulic factors at play.
4. Consider the channel evolution process.
5. Consult with fluvial geomorphologist and professional engineer.
6. Consult with the Oregon Department of Fish and Wildlife.
7. Apply for local, state, and federal permits.

IMPAIRED CONDISION

BANK EROSION

INCISION

A RESTORATION OF NATURAL FUNCTIONS

RECOMMENDED REFERENCES

PUBLICATIONS

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Leopold, L.B, Wolman, M. G., and Miller, J.P. (1995). *Fluvial Processes in Geomorphology*. Dover Publications, Inc. New York.

Rosgen, D.L. (1996). *Applied River Morphology*. Wildland Hydrology, 11210 County Rd 19, Fort Collins, Colo.

VIDEOS

Leopold, Luna, W. W, Emmett, L. Silvey, and D. L. Rosgen. (1995). *A Guide to Field Identification of Bankfull Stage in the Western United States*. (DVD Video, 31 minutes). SDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, Stream System Technology Center, Fort Collins, CO.

M. Gordon Wolman, W. W, Emmett, Verry, and Kappesser.. (1995). *Identifying Bankfull Stage in Forested Streams in the Eastern United States*.(DCD Video, 46 minutes). Stream System Technology Center, Fort Collins, CO.

*USFS. (2005) *Guide to Identification of Bankfull Stage in the Northeastern United States*. (4 DVD Videos). General Technical Report RMRS-GTR-133-CD. Stream System Technology Center, Fort Collins, CO.

WEB SITES

USFS. Stream Systems Technology Center, *Stream Notes and Videos* http://www.stream.fs.fed.us/

Wildland Hydrology, Inc., 1481 Stevens Lake Road, Pagosa Springs, CO. 81147; (970)264-7120 www.wildlandhydrology.com

* FIRST CHOICES

Aggradation

A rising of local base level due to a sediment depositional process.

Alluvium

Material deposited by rivers.

Bank Height Ratio

It is determined by calculating the ratio of the lowest bank height to the maximum bankfull depth. It is a quantitative measure of vertical containment or degree of channel incision.

Bankfull Discharge

Bankfull discharge is the stream flow rate measured at the bankfull stage elevation. It is often associated with a return period of 1-2 years, with an average of 1.5 years. It is expressed as the momentary maximum of instantaneous peak flows rather than the mean daily discharge.

Bankfull Indicators

When it comes to bankfull determination in the field, the most critical words to keep in mind are "flat depositional surface immediately adjacent to the channel"; and "current hydrologic conditions

.

In doing so, it is critical to be able to differentiate the active floodplain from terraces that typically occur along stream channels in many locations.

It is the depositional floodplain flats immediately adjacent to the channel that define the bankfull elevation and these flat depositional features are the most reliable indicators of the bankfull stage in the vast majority of streams.

6. Floodplains
7. Highest active depositional feature like the elevation on top of a point bar or center bar.
8. Slope breaks or changes in particle size distribution. Breaks in slope on the banks. Changes in particle size from coarse to fine (sand).
9. Evidence of an inundation feature such as a small bench.
10. Staining of rocks

Bankfull Maximum Depth

The bankfull maximum depth is the determined by measuring the depth from the bankfull stage elevation to the thalweg.

Channel maximum depth is measured from the bankfull stage elevation to the deepest part of the channel or thalweg.

Bankfull Mean Depth

The bankfull mean depth is the determined dividing the bankfull cross-sectional area (sum of products of unit width times depth) by the bankfull width.

Bankfull Stage

Bankfull stage is where water just starts to flow over the floodplain.

It is generally defined as that stage of flow at which water has filled the principle channel and "just begins" to flow onto the floodplain.

Bankfull stage is the elevation of the stream water surface at the incipient (just beginning) point of flooding.

Bankfull stage is a surrogate that can be used to describe the full range of flows that shape a channel.

"The bankfull stage corresponds to the discharge at which channel maintenance is most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels." Dunne and Leopold (1978).

Bankfull Width (W_{bkf})

Bankfull width is the surface width of the stream measured at the bankfull stage elevation. Channel width is measured from the edge of the channel bank at the bankfull stage.

Bankfull Width/Depth Ratio (W/D)

The width/depth ratio of the stream is determined by measuring the bankfull surface width by the bankfull mean depth.

Bed Features (Riffle, Run, Pool, Glide, and Step)

Riffle: Riffles have the shallowest depths of flow and steep bed and water surface slopes. Flows are turbulent. They typically occur at the cross over location in a meander and have a poorly defined thalweg.

Runs: Runs typically have greater depths of flow and steeper bed and water surface slopes than that of riffles. Runs will often have a well defined thalweg. Water "runs" into the pool

Pool: Pools have the deepest depths of the reach. Water surface slope of pools is near zero. Pools are often located at the outside of meander bends.

Glides: The slope of the bed through a glide is negative while the slope of the water surface is positive. Glides are located immediately downstream of pools. The head of the glide can be difficult t identify. Use the following characteristics to help you locate the head of the slide:

- The location of increased flow velocity coming out of the pool,
- The location at which the steeply sloped bed rising out of the pool decreases to a lesser gradient,
- The location at which the thalweg coming out of the pool becomes less will defined and essentially fades completely,
- The location which is approximately the sane elevation as the tail of the run.

Bed Materials

The material found in the bed of the channel. Particle sizes are described as bedrock, boulders, cobble, gravel, sand, and silt/clay.

Boulders	(>256 mm)	basketball	(241 mm)
Cobble	(64 – 256 mm)	tennis ball	(67 mm)
Gravel	(2 – 64 mm)	BB	(4.4 mm)
Sand	(.062 – 2)	<BB size	
Silt/clay	(<0.062 mm)	smooth/not gritty	

D50	The particle that is equal in size to 50% of the particles sampled.
D100	The largest particle size sampled.

Classification (Rosgen Stream Classification System)

The Rosgen stream classification provides one way to classify rivers based on descriptive and measurable morphological features.

It provides a basis for thinking and enables you to

- Communicate effectively about stream morphology and conditions,
- Predict behavior from appearance
- Develop relationships by stream type, and
- Extrapolate data from similar stream types.

The Rosgen system of natural channel classification is the U.S. Forest Service standard for stream classification at the reach level.

The system uses a set of four primary criteria to classify streams.

5. Entrenchment Ratio, a computed index used to describe the degree of vertical containment of the river channel. Entrenchment ratio is calculated using this formula, where flood-prone width equals water level at two times the maximum bankfull depth.

6. The width / depth ratio of the channel is another primary classification criterion. It is an index value which indicates the shape of the channel cross section, calculated using the formula shown where mean bankfull depth equals cross-sectional area divided by bankfull width.

7. Sinuosity is another delineative criterion, which describes the "plan-form" pattern of the channel measured over at least two meander wave lengths. It is calculated as stream length divided by valley length.

8. The fourth delineative criteria is the slope of the water surface which is measured over a distance of 20 to 30 channel widths, or from the top of one riffle to the top of another riffle and calculated using the formula shown.

In this system, streams are assigned an alphabetic designation of A, B, C, D, DA, E, F or G, based on the slope and how the valley and the stream handle the energy of flowing water and sediment.

Channels are also assigned a numerical designation which describes the median particle size diameter (d50), or dominant particle size of material found on the bed of the stream over a channel reach representing both pools and riffles. As shown, numerical designation ranges from a value of one for bedrock to six for silt or clay.

Colluvium

Soil and debris that accumulate at the base of a slope by mass wasting or sheet erosion.

Competence

The ability of the river to move the largest particle made available from the immediate upstream supply.

Cross-sectional area

The sum of products of unit width and depth at the bankfull stage elevation in a riffle.

Entrenchment Ratio:

The entrenchment ratio is determined by dividing the flood prone area width by the bankfull width. The entrenchment ratio is the quantitative defined as the ratio of flood-prone area divided by the bankfull width.

Flood Plain.

The floodplain is defined as the relatively flat depositional surface immediately adjacent to the channel that is formed and reformed under current climatic and hydrologic conditions.

It is available to the river to accommodate flows greater than the bankfull discharge (see bankfull stage). There is not a constant frequency of occurrence of flood discharge associated with the floodplain as the depth of flow over the floodplain is a function of the width of the floodplain and the magnitude of the flood peak.

Flood-Prone Area Width.

The flood prone area width is the width associated with a value of twice the maximum bankfull depth. It is the area including the floodplain of the river and often the low terrace of alluvial streams.

Grade Control Structure:

A structure designed to maintain the local base level of a stream and/or to influence the grade of the stream either upstream and/or downstream. It can be concrete from a variety of materials including logs, boulders, and loose rock.

Hydraulics

Hydraulics is the physical science and technology of the static and dynamic behavior of fluids.

Hydrology

Hydrology is the scientific study of the waters of the earth, especially with relation to the effects of precipitation and evaporation upon the occurrence and character of water in streams, lakes, and on or below the land surface. In terms of the hydrologic cycle, the scope of hydrology may be defined as that portion of the cycle from precipitation to re-evaporation or return to the water of the seas. Applied hydrology utilizes scientific findings to predict rates and amounts of runoff (river-forecasting), estimate required spillway and reservoir capacities, study soil-water-plant relationships in agriculture, estimate available water supply, and for other applications necessary to the management of water resources.

Incision

Incision is the process of lowering the local base level of the stream channel.

Meander

A meander is a sinuous channel form usually found on streams with flatter gradients (less than 2%). Meanders typically form with a pool or pools on the outside of the meander bend and a point bar or bars on the inside of the bend. Riffles generally form on the straight section of the meander where flows cross over from one side of the bend to the other side.

Meander Belt Width (BW):

The belt width is the width of the full lateral extent of the bankfull channel measured perpendicular to the fall of the valley. It is also the meander amplitude.

Meander Wavelenth

The meander wavelength is the distance parallel with the fall line of the valley between the apex of two sequential meanders.

Meander Width Ratio (MWR)

The meander width ratio is the quantitative morphological measure of confinement (lateral containment of rivers). It is the ratio of meander belt width to bankfull width.

Most Probable State:

"River form and action are determined by physical laws that do not dictate one and only one solution to the reaction of the channel as changes are imposed on it when seasons go from dry to wet and back to dry." Luna Leopold

"A steady state in an open system is one which both **minimum total work** and **uniform rate of energy expenditure** are tendencies. These two conditions cannot be simultaneously satisfied, so the result is a compromise. Rivers tend toward both minimum work and uniform work rate in many aspects of channel form and action." Luna Leopold

One of the characteristics of compromise is minimization of variance, a condition statistically known as the most probable state.

Natural Channel Stability:

"The ability of the stream, over time, to transport the flow and sediment of its watershed without aggrading or degrading while maintaining its dimension, pattern, and profile."

Regional Curves (of hydraulic geometry)

Leopold and his colleagues also discovered that bankfull dimensions for most channels could be roughly correlated with drainage areas for those channels. Based on this finding, they developed *regional curves of hydraulic geometry* which provide rough estimates of bankfull dimensions as a function of drainage area.

To obtain maximum utility, curves should be developed for local geographic areas. This can be a useful practice that can be of value in consistently identifying bankfull stage at specific locations in different regions.

Restoration:

Stream restoration is the creation of a stable dimension, pattern, and profile for a stream type and channel morphology appropriate to its landform and valley, designed such that over time, is self-maintaining, Native materials common to the river are used to obtain natural stability including the stream bank and stream beds.

Riparian Areas:

Riparian areas are transition areas between permanently saturated wetlands or stream banks and upland areas. These areas exhibit vegetation or physical characteristics that reflect the permanent influence of surface or subsurface water. Typical riparian areas are lands along, adjacent to or contiguous with perennially

Riparian hydrology

The hydrology of a river system is a critical physical factor affecting aquatic life. In streams where groundwater is the principal water source, stable flow patterns occur, characterized by low seasonal and daily fluctuations in discharge. Stable flows promote stable habitat for aquatic life in the form of diverse bottom substrates, secure in-stream cover and moderate water velocities and temperatures. Unstable flows erode river bottoms and may cause excessive sedimentation, which in turn may cover up critical in-stream habitats.

Sinuosity

Sinuosity is an index of channel pattern determined from the ratio of stream length to valley length or the ration of valley slope to channel slope.

Stabilization:

Stream stabilization is the hardening the bed and banks of a river in place using a variety of materials and methods including: bio-engineering, check dams, concrete lined channels, gabions, rip rap, bin-walls, log crib walls, weirs, willow post plantings, and many other techniques.

Stream:

A body of water flowing in a natural channel. Streams are defined as follows (Meinzer, 1923):

Perennial - A stream that flows continuously. Perennial streams are generally associated with a water table in the localities through which they flow.

Intermittent or seasonal - A stream that flows only at certain times of the year when it receives water from springs or from some surface source such as melting snow in mountainous or upland areas.

Ephemeral - A stream that flows only in direct response to precipitation and whose channel is at all times above the water table.

Stream Assessment:

The analysis of sediment production, transport, and deposition, hydrology and hydraulics associated with a particular stream reach.

Stream Integrity:

Chemical integrity includes anything that influences the water quality of runoff including phosphorous, nutrients, bacteria, and temperature. Please see comment 18.

Physical integrity is the healthy condition of stream morphology and dynamics including channel dimensions, pattern, profile, topography, bed materials, flow regime, flow types and presence of a functioning floodplain, where appropriate.

Biological integrity means that the fish, macroinvertebrates and wildlife that by nature would be associated with a healthy stream are, in fact, present and thriving.

Stream Morphology:

Stream morphology describes stream form and structure in terms of channel dimensions (width, depth, and cross-sectional area), pattern (meanders), longitudinal profile (gradient), and bed materials. Primary components include channel width, active flood-prone areas, pools, riffles, glides, runs, steps, large woody debris, protective cover, stream bed materials, and riparian vegetation.

Stream Potential:

Self-formed natural streams are said to be operating at their full potential when they are stable, self-maintaining, and in quasi-equilibrium with the flow and sediment provided by the watershed. A full potential, physical and biological functions are at an optimum based on quantifiable morphological characteristics for each stream type.

Terrace.

A terrace is an abandoned floodplain. It is located at a higher elevation than the current active floodplain.

Thalweg (T)

The line connecting the lowest or deepest points along a stream bed, valley, or reservoir, whether underwater or not.

Water Surface Slope:

The water surface slope is the slope of the stream measured at the water surface rather than the bed surface.

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Watershed

A watershed is the area of land where all of the water that is under it or drains off of it goes into the same place.

John Wesley Powell, scientist geographer, put it best when he said that a watershed is:

"that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community."