NS481/581 - NSSI

Field Techniques in Fluvial Analysis - Helmick Park Field Trip

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INTRODUCTION

Rivers represent the primary conduits for surface drainage on the earth. Fluvial systems are efficient plumbir mechanisms that transport water and sediment. The kinetic energy of the system is driven by gravity and climate, wi work completed in the form of erosion and transportation.

The amount of water a stream is carrying, or its discharge, is important for a number of reasons. The dischar; may be used for domestic/industrial water supplies, agricultural irrigation, sewage disposal, or transportation. Knowledge of flood history is also vital for appropriate landuse planning and hazards mitigation. The U.S. Geologic Survey has established over 9000 stream gaging stations across the country to collect vital river discharge informatic In addition, many other streams are monitored by agencies such as the Natural Resources Conservation Service, Fore Service, and local water-management organizations.

OBJECTIVES

The objective of this exercise is to make basic field observations at a local stretch of river in the Upper Willamette watershed. We will visit the Luckiamute River, near Helmick State Park, to learn the basic principles of fluvial hydrology and flood analysis. The goals of this exercise are to:

1) Determine a spot discharge for the Luckiamute using basic channel geometry and the continuity equation f rivers.

2) Construct a transverse profile for the Luckiamute channel system where it crosses the iron bridge at Helmi Rd and Helmick State Park.

3) Compare calculated spot discharge and flood discharge values with historical discharge data collected at a USGS gaging station.

4) Classify the Luckiamute according to its channel characteristics, and

5) Make some basic observations with respect to past flood activity at Helmick State Park and long-term evolution of the Upper Willamette watershed.

The field trip will provide an opportunity for data collection. Analysis will be conducted back at the classroom.

FIELD PROCEDURES

Task 1 - Wader-Team (Yes in the water!)

1) Stretch a tape across the active channel of the Luckiamute. Using a jacob's staff, measure the depth of the water at 0.5 - 1.0 m increments across the channel (See Figure 1). Record data, sketch the field layout and note which direction the river is flowing (looking upstream or downstream).

2) At the same stations in (1) above, determine the velocity of surface flow by using the "float" method.

A) Stretch two ropes across the channel at a known down-channel distance (e.g. 5 m between ropes).

B) Drop a fishing bobber or leaf in the stream, measure the time of travel between the two obervation points. Try to make a set of observations at each depth station.

1) Calculate stream velocity V = Distance/time (m/sec)

Record all data in table format. We will later use this data to calculate spot discharge.

Task 2: Roughness and Slope Estimates

Roughness is a measure of the variability of the channel bed. Roughness factors provide resistance in the form of friction and have an influence on velocity and discharge.

3) Using the roughness field guides shown in Table 1, estimate the roughness of the Luckiamute valley botto

A) for the active channel that Team 2 is playing in, and

B) for the total valley bottom beneath the bridge deck.

4) Using the Monmouth-Quad topo sheet, calculate a stream gradient for the Luckiamute in this stretch of the river. Use two contour intervals above and below the bridge to make an average estimate of channel slope.

5) Using the Rosgen River classification guide shown in Figure 2, classify this stretch of the Luckiamute according to channel pattern and slope.

Record all observations and make sketches as necessary.

Task 3: Paleoflood Analysts / Sedimentologists

6) With the instructor's help, identify evidence of flood history in this part of the Luckiamute. Look for:

a) fresh, unvegetated sediment
b) damaged vegetation / scarred bark
c) stunted or deformed vegetation
d) tilted trees
e) floodplain deposits
f) shrubs / disturbed vegetative zones.
g) flotsam / cultural objects

7) Make some observations of the type of sediment that the Luckiamute is transporting. Look in the active channel and cuts in the channel banks. Try to estimate relative percentages of: clay, silt, sand, gravel, woody debris.

A) Collect some channel and channel bank samples for later grain size analysis in the lab.

Record all observations, field sketches will be very helpful later.

Task 4: Farm Fields Just South of Helmick State Park

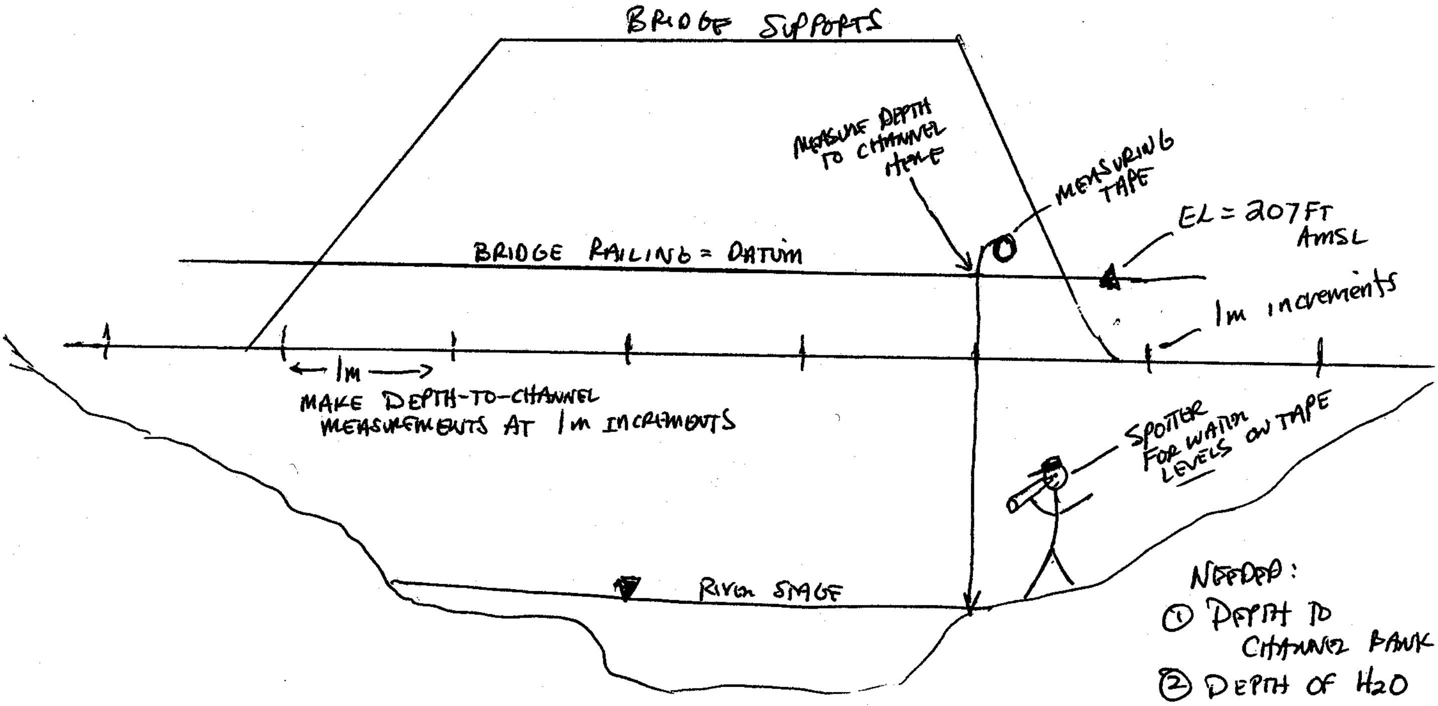
8) Make observations regarding variation in surface topography, slope, and land elevations. Record your observations.

9) Collect soil samples using the buck auger at various topographic positions. Using the grain size and geotechnical charts, determine the type of material that comprises the deposits.

10) Make some general hypotheses regarding geomorphic surfaces adjacent to the Luckiamute River. Think terms of landform, process, and age of surfaces.

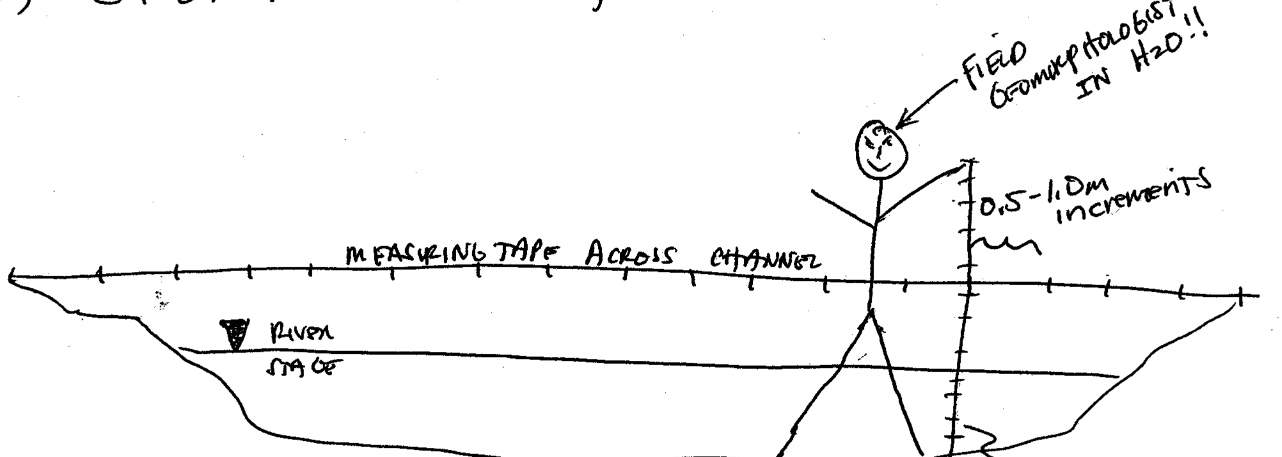
FIGURE 1

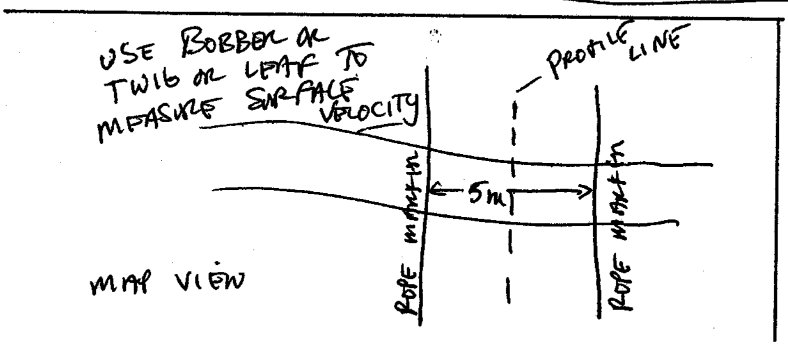
1) SKETCH OF VALLEY PROFILE TECHNIQUE



NEEDED:
① DEPTH TO CHANNEL BANK
② DEPTH OF H_2O

2) SKETCH OF VELOCITY-DISCHARGE TECHNIQUE





NEEDED:
① WATER DEPTH
② SURFACE VELOCITY

D.L. Rosgen / Catena 22 (1994) 169-199

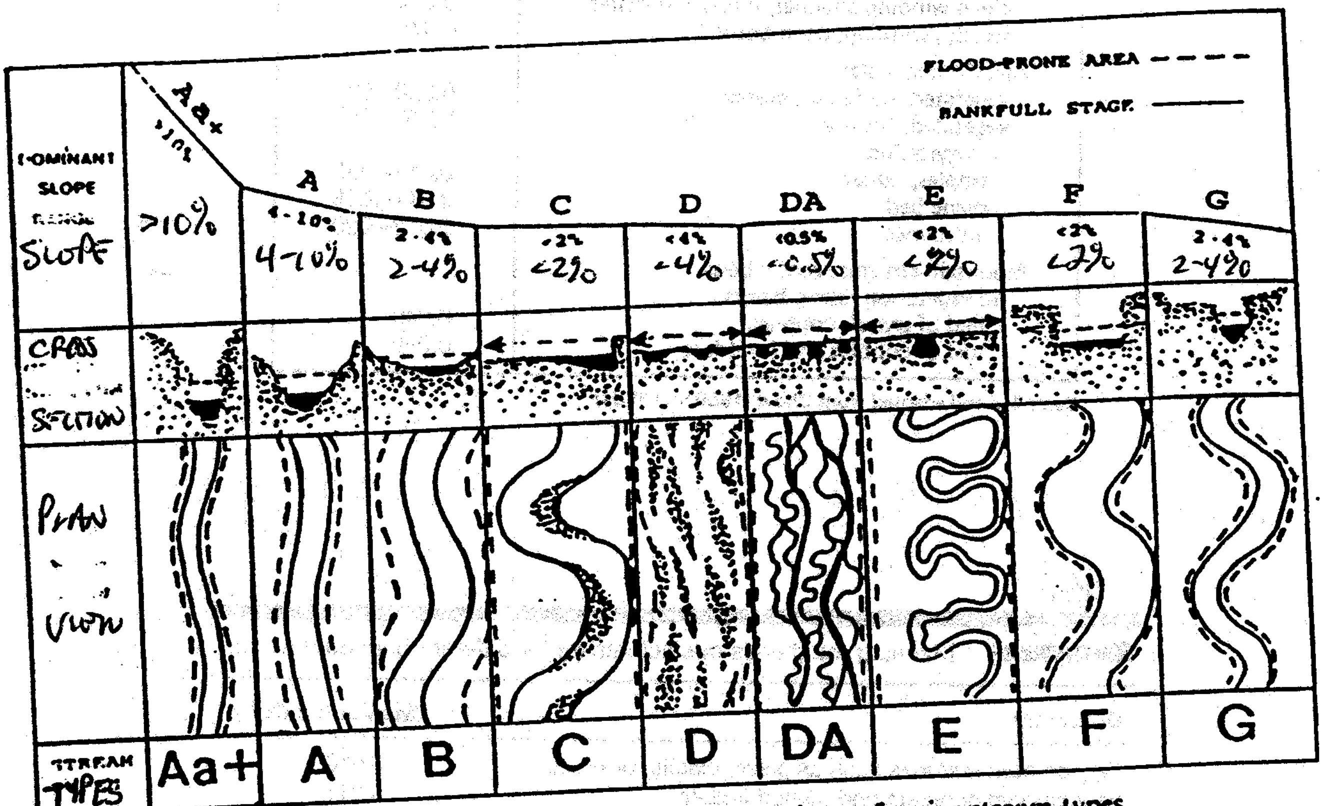


FIG. 2 ~~Fig. 1~~. Longitudinal, cross-sectional and plan views of major stream types.

TABLE 1 — ROUGHNESS

A. [redacted] **Values of Roughness, n**

River Description	*Roughness, n*
Ordinary rivers:	
clean, straight channel, no riffles or pools	0.030
straight, weedy, boulders	0.035
clean winding channel, pools and riffles	0.040
weedy, winding, deep pools	0.070
Alluvial channels:	
vegetated, no brush, grassy	0.030–.035
vegetated, brushy	0.050–.10
no vegetation	
ripples, dunes	0.017–.035
plane bed	0.011–.015
antidunes	0.012–.020
Mountain streams: rocky beds	
no vegetation, steep banks	
bed of gravel, cobbles,	0.040
bed of cobbles and boulders	0.050

Compiled and adapted from Chow (1959 and 1964)

B.

[redacted] Manning roughness coefficients (n) for different boundary types.

Boundary	Manning n ($ft^{1/6}$)
Very smooth surfaces such as glass, plastic, or brass	0.010
Very smooth concrete and planed timber	0.011
Smooth concrete	0.012
Ordinary concrete lining	0.013
Good wood	0.014
Vitrified clay	0.015
Shot concrete, untroweled, and earth channels in best condition	0.017
Straight unlined earth canals in good condition	0.020
Rivers and earth canals in fair condition; some growth	0.025
Winding natural streams and canals in poor condition; considerable moss growth	0.035
Mountain streams with rocky beds and rivers with variable sections and some vegetation along banks	0.041–0.050

Source: *Handbook of Applied Hydrology*, ed. by Ven T. Chow, copyright 1964 McGraw-Hill Publishing Co., Inc.

FLUVIAL FIELD TRIP
EQUATION LIST

FROUDE NO. – DESCRIBES FLOW TYPE

$$Fr = \frac{V}{\sqrt{dg}}$$

V = velocity m/sec
d = depth m
g = gravity acc. = 9.8 m/sec^2

F < 1 = TRANQUIL FLOW
F = 1 = CRITICAL FLOW
F > 1 = SUPER CRITICAL FLOW

MANNING'S EQUATION – TO CALCULATE STREAM VELOCITY

$$V = \frac{R^{2/3} S^{1/2}}{n}$$

V = VELOCITY m/sec
R = HYDRAULIC RADIUS = $\frac{A}{P}$ — A = CHANNEL AREA m^2 — P = WETTED PERIMETER m
S = SLOPE
n = ROUGHNESS

$T_c = \gamma RS$ = CRITICAL STREAM FORCE FOR EROSION

γ = SPECIFIC WT. OF H_2O = 9800 N/m^3
R = HYDRAULIC RADIUS = $\frac{A}{P}$
S = SLOPE

STREAM POWER = KINETIC ENERGY AVAILABLE FOR WORK

TOTAL POWER $\Omega = \gamma QS$ (WATTS)

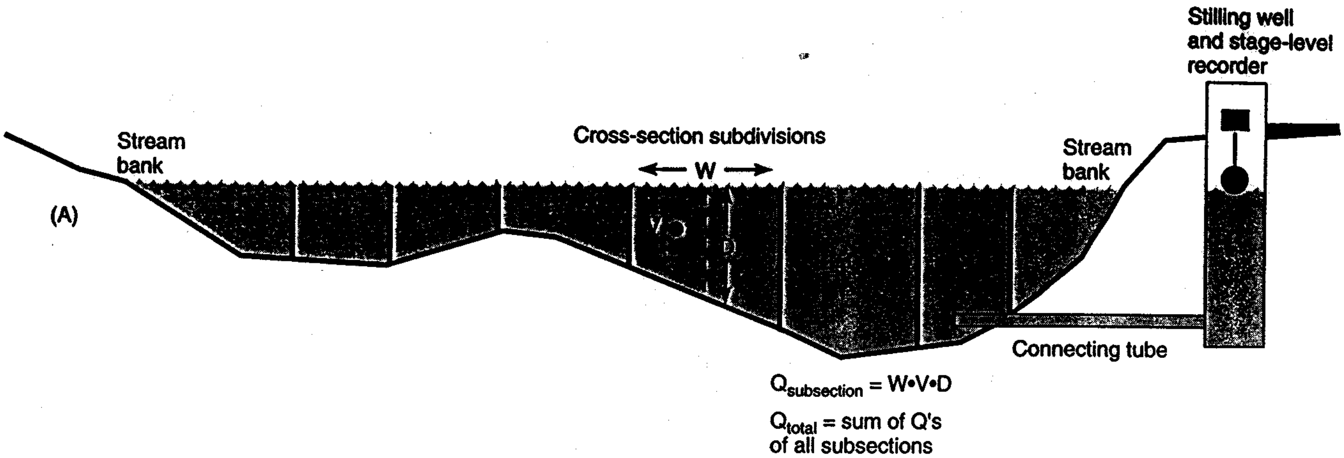
UNIT POWER $\omega = \frac{\gamma QS}{w}$ (WATTS/m)

γ = SP. WT. H_2O = 9800 N/m^3
Q = DISCHARGE = m^3/sec
S = SLOPE
w = width m

CONTINUITY EQUATION

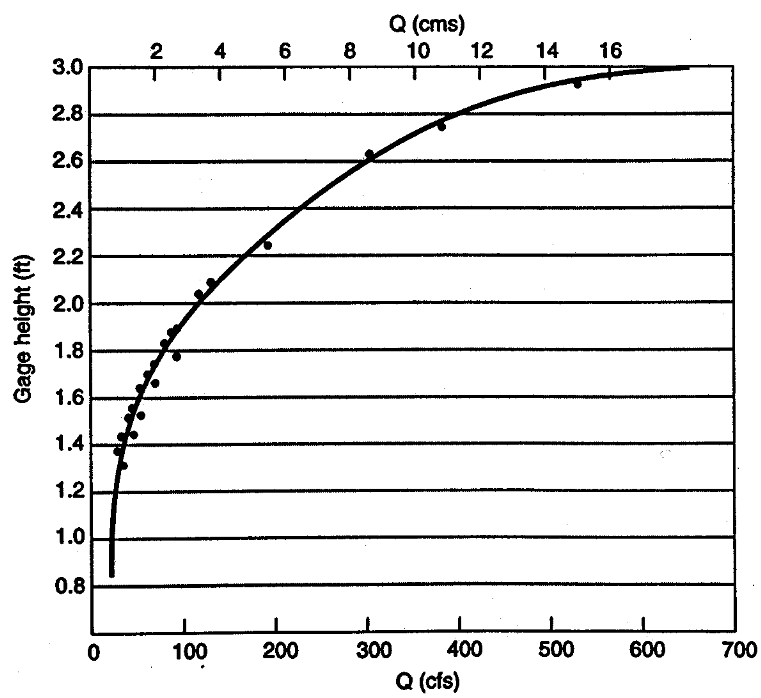
$$Q = VA$$

Q = DISCHARGE m^3/sec
V = VELOCITY m/sec
A = AREA OF CHANNEL m^2



(D)

FIGURE 5.33
Rating curve for low flow. Rock Creek near Red Lodge, Mont.



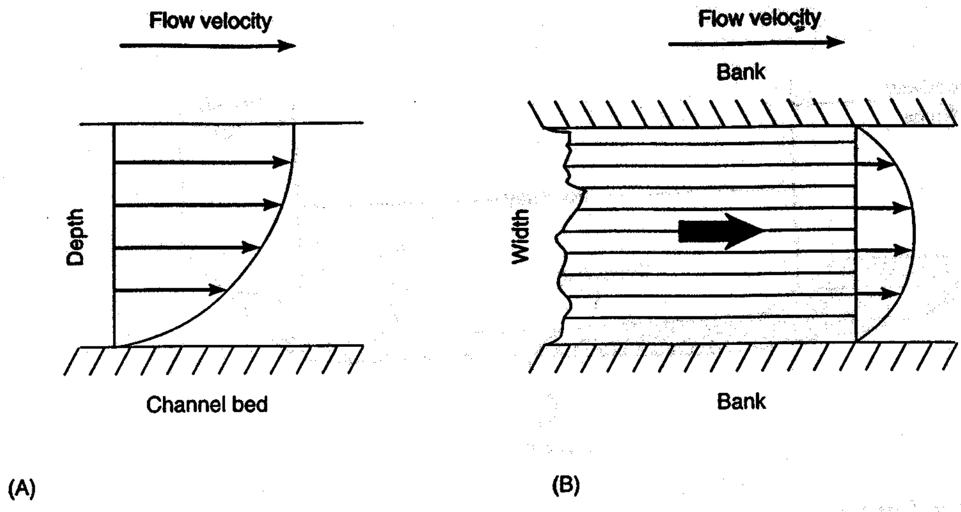
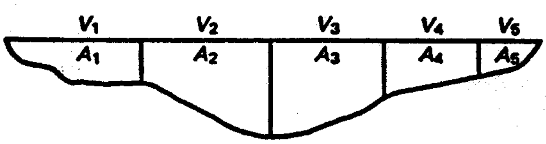


FIGURE 6.1
Diagram showing the changes in flow velocity with (A) flow depth and (B) flow width. Resistance to flow along the bed and banks allows the greatest velocities to occur toward the center of the channel near the water surface.



subareas of velocity domains.

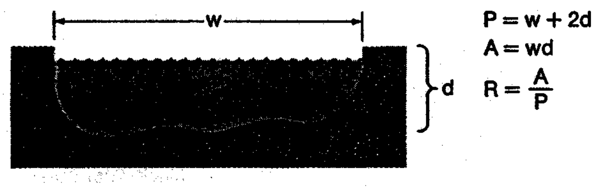


FIGURE 6.2
Cross-sectional measurements of a stream channel: w = width, d = depth, A = area, R = hydraulic radius, P = distance along wetted perimeter.

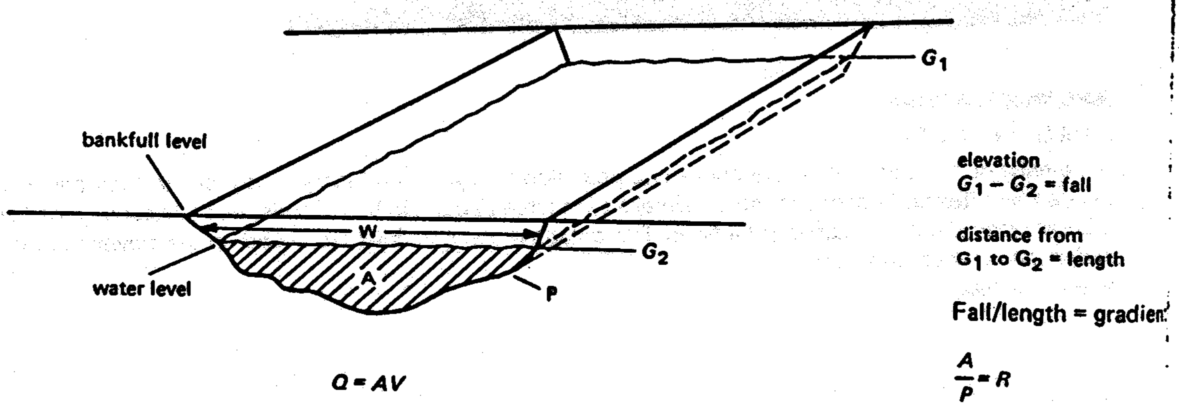


Figure 9.2. Nomenclature of channel morphology.

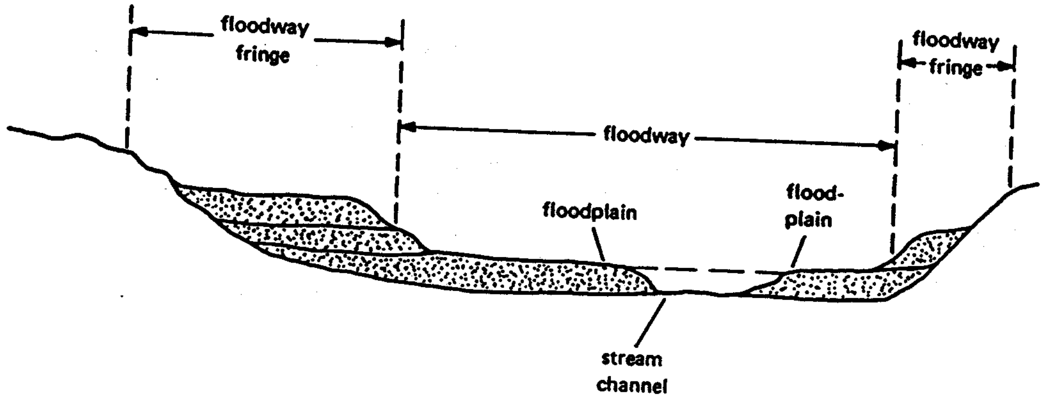


Figure 11.1. View across a river. The floodway is the area along the river which is frequently flooded, an area over which the flood discharge moves with great velocity. The floodway fringe includes areas which are further from the actual channel and which are infrequently flooded by rare events. The floodway fringe is that area flooded by the "100-year" flood.

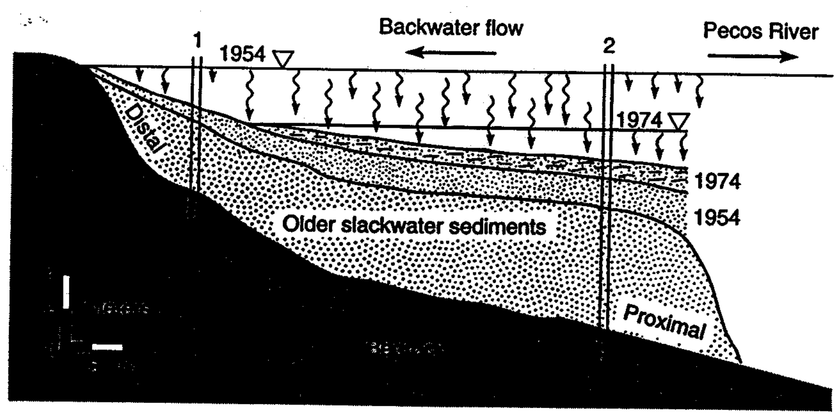


FIGURE 5.37

Schematic of on- and off-lap sequences and peak flood stage in a tributary valley for the 1954 and 1974 floods on the Pecos River, Texas. Sections in the proximal region (area 2) contain both floods, while distal regions (area 1) farther up the tributary record only the larger 1954 flood. Paleostage reconstructions are based on the elevation of the most distal sediments of each flood unit.

(Kochel et al. 1982)

(in/sec)(2834.65) = "/DAY

APPENDIX 9.A.
Conversion Tables

Length

Unit	Equivalent[1,2]					
	millimeters	inches	feet	meters	kilometers	miles
millimeters	1	3.937×10^{-2}	3.281×10^{-3}	1×10^{-3}	1×10^{-6}	6.214×10^{-7}
inches	25.4	1	8.33×10^{-2}	2.54×10^{-2}	2.54×10^{-5}	1.578×10^{-5}
feet	304.8	12	1	0.3048	3.048×10^{-4}	1.894×10^{-4}
meters	1,000	39.37	3.281	1	1×10^{-3}	6.214×10^{-4}
kilometers	1×10^{6}	3.937×10^{4}	3,281	1,000	1	0.6214
miles	1.609×10^{6}	6.336×10^{4}	5,280	1,609	1.609	1

Area

Unit	Equivalent[1,2]						
	square inches	square feet	square meters	acres	hectares	square kilometers	square miles
square inches	1	6.944×10^{-3}	6.452×10^{-4}	1.594×10^{-8}	6.452×10^{-8}	6.452×10^{-10}	2.491×10^{-10}
square feet	144	1	9.29×10^{-2}	2.296×10^{-5}	9.29×10^{-9}	9.29×10^{-8}	3.587×10^{-8}
square meters	1,550	10.76	1	2.471×10^{-4}	1×10^{-4}	1×10^{-6}	3.861×10^{-7}
acres	6.273×10^{6}	4.356×10^{4}	4,047	1	0.4047	4.047×10^{-3}	1.563×10^{-3}
hectares	1.55×10^{7}	1.076×10^{5}	1×10^{4}	2.471	1	0.01	3.861×10^{-3}
square kilometers	1.55×10^{9}	1.076×10^{7}	1×10^{6}	247.1	100	1	0.3861
square miles	4.014×10^{9}	2.788×10^{7}	2.59×10^{6}	640	259	2.59	1

Volume

Unit	Equivalent[1,2]						
	cubic inches	liters	gallons	cubic feet	cubic yards	cubic meters	acre-ft
cubic inches	1	1.639×10^{-2}	4.329×10^{-3}	5.787×10^{-4}	2.143×10^{-5}	1.639×10^{-5}	1.329×10^{-8}
liters	61.02	1	0.2642	3.531×10^{-2}	1.308×10^{-3}	0.001	8.106×10^{-7}
gallons	231.0	3.785	1	0.1337	4.951×10^{-3}	3.785×10^{-3}	3.068×10^{-6}
cubic feet	1,728	28.32	7.481	1	3.704×10^{-2}	2.832×10^{-3}	2.296×10^{-5}
cubic yards	4.666×10^{4}	764.6	202.0	27	1	0.7646	6.198×10^{-4}
cubic meters	6.102×10^{4}	1,000	264.2	35.31	1.308	1	8.106×10^{-4}
acre-ft	7.527×10^{7}	1.233×10^{6}	3.259×10^{5}	4.356×10^{4}	1,613	1,233	1

Discharge (flow rate, volume/time)

Unit	Equivalent[1,2]				
	gallons per minute	liters per second	acre-feet per day	cubic feet per second	cubic meters per day
gallons per minute	1	6.309×10^{-2}	4.419×10^{-3}	2.228×10^{-3}	5.45
liters per second	15.85	1	7.005×10^{-2}	3.531×10^{-2}	86.4
acre-feet per day	226.3	14.28	1	0.5042	1,234
cubic feet per second	448.8	28.32	1.983	1	2,447
cubic meters per day	1.369×10^{9}	8.64×10^{7}	6.051×10^{6}	3.051×10^{6}	1