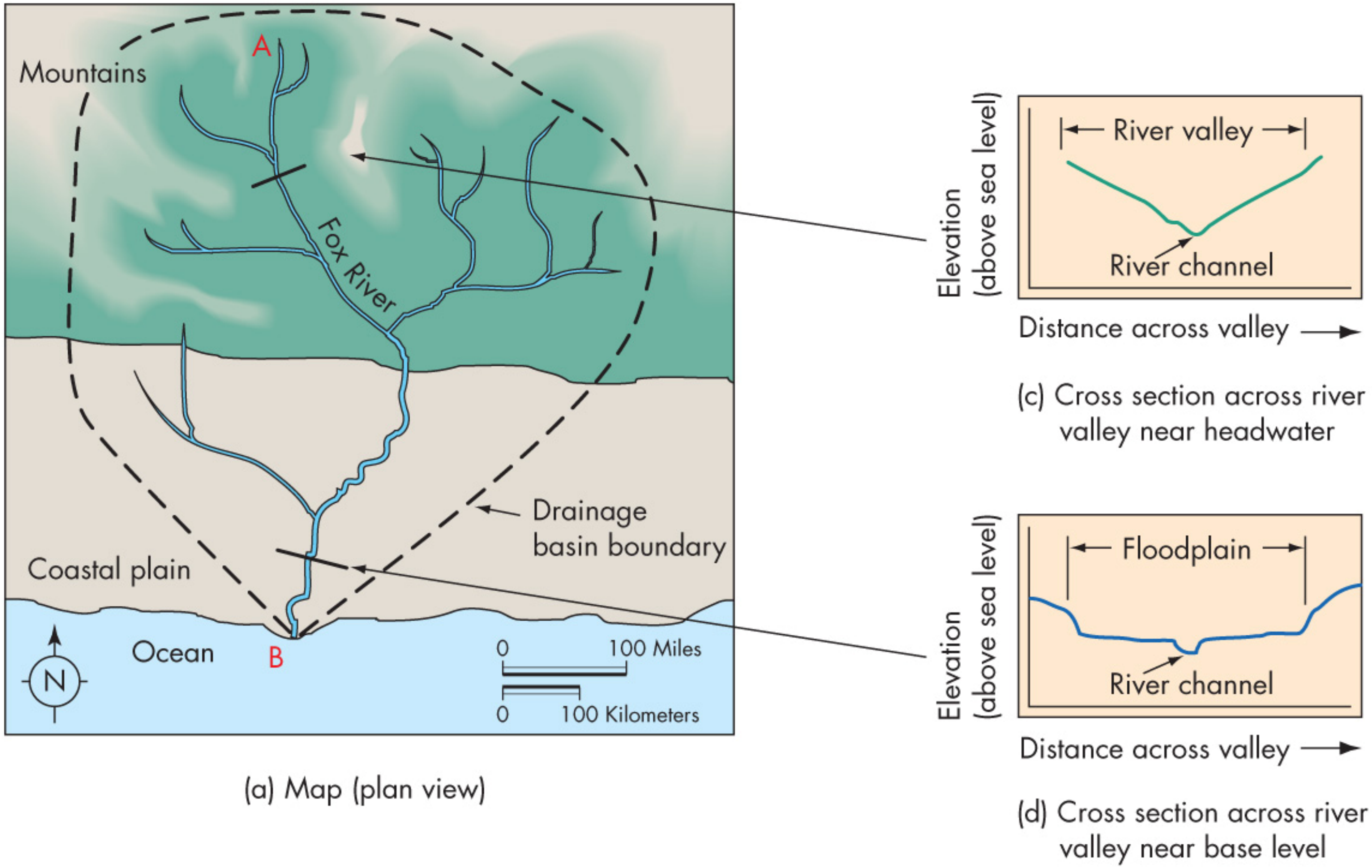
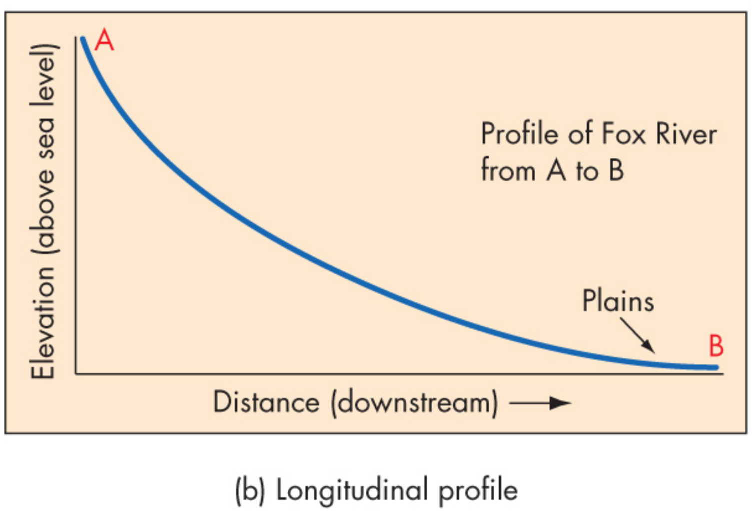
Drainage basins, river discharge, and flooding

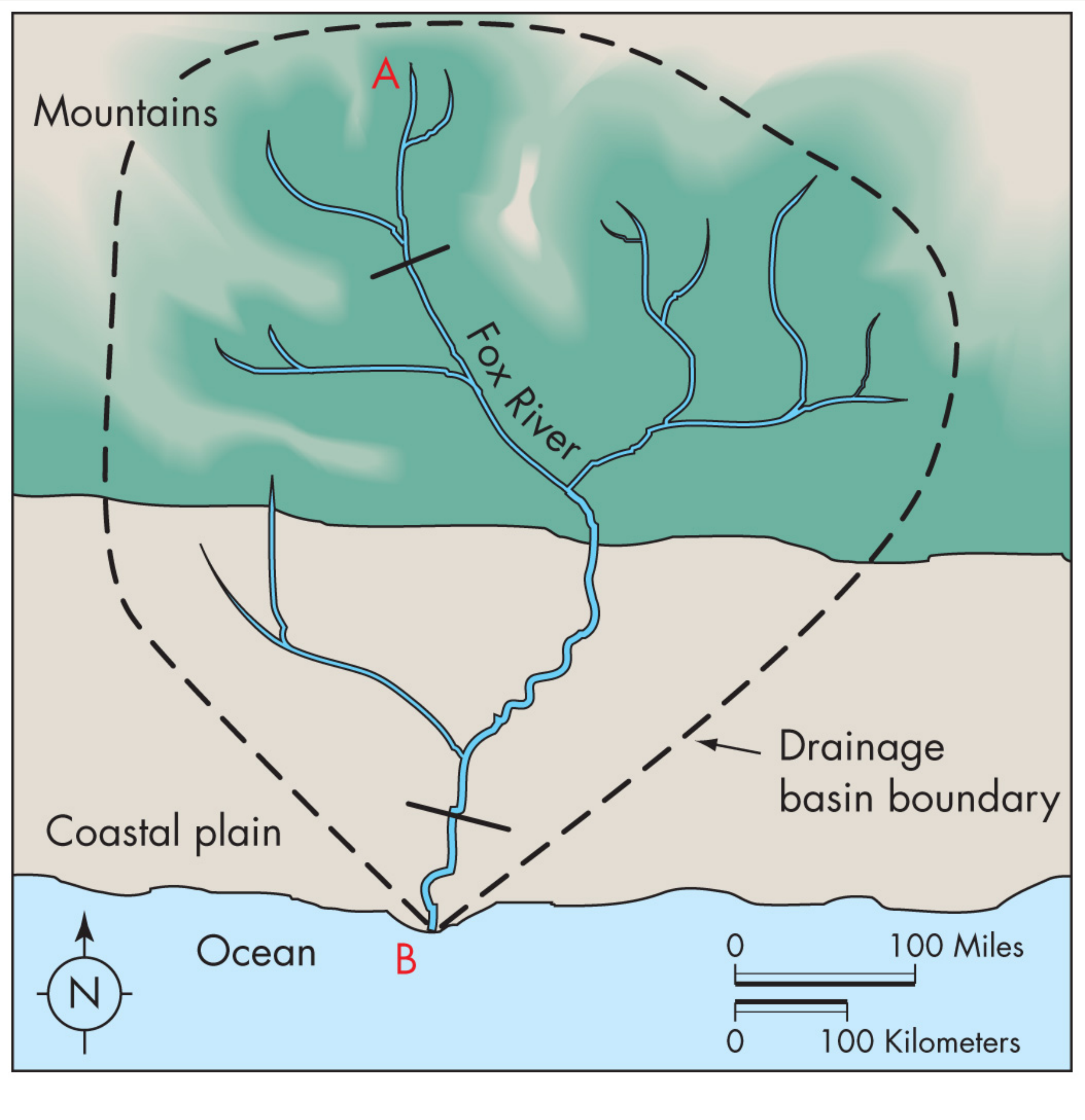




Concept of a drainage basin

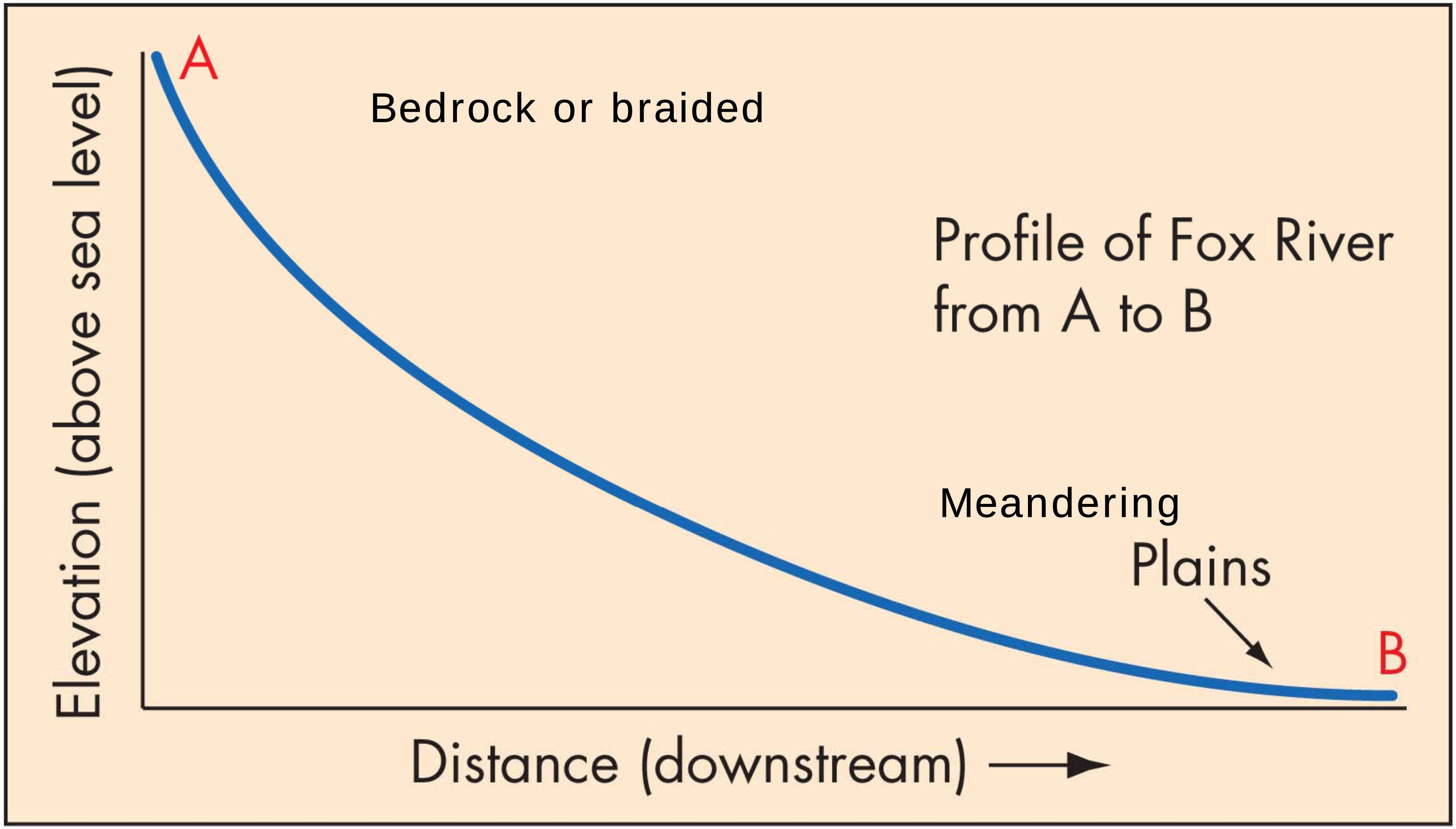
Figure 5.7

Drainage basin: All water flows out B



Also known as a *watershed*

Longitudinal profile down the river

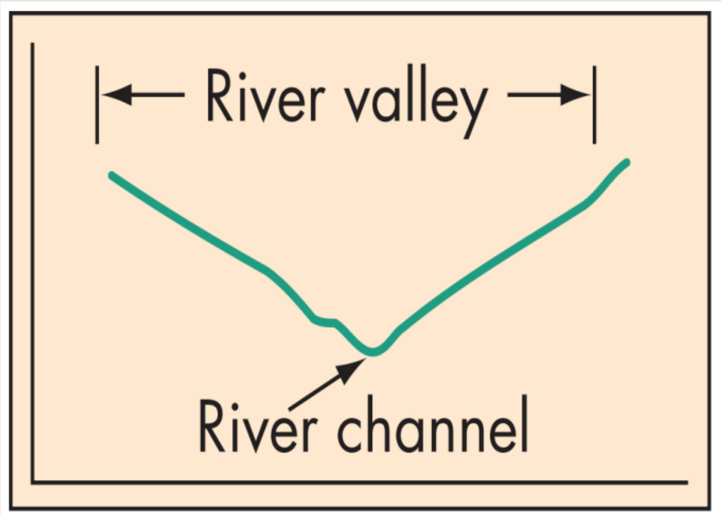


(b) Longitudinal profile

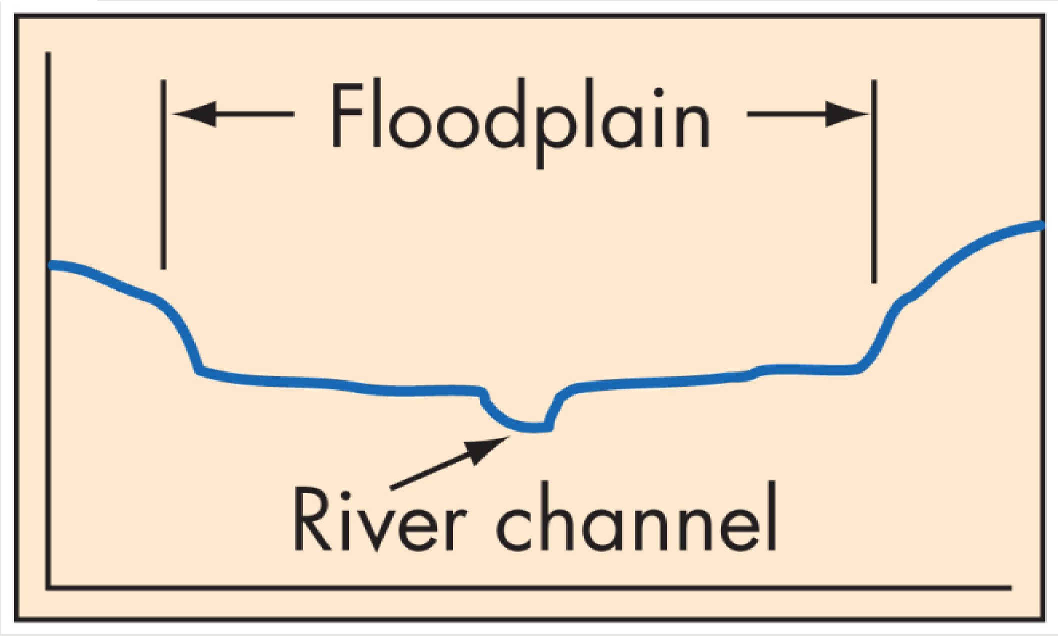
Figure 5.7b

Downstream changes in channel geometry

Upstream

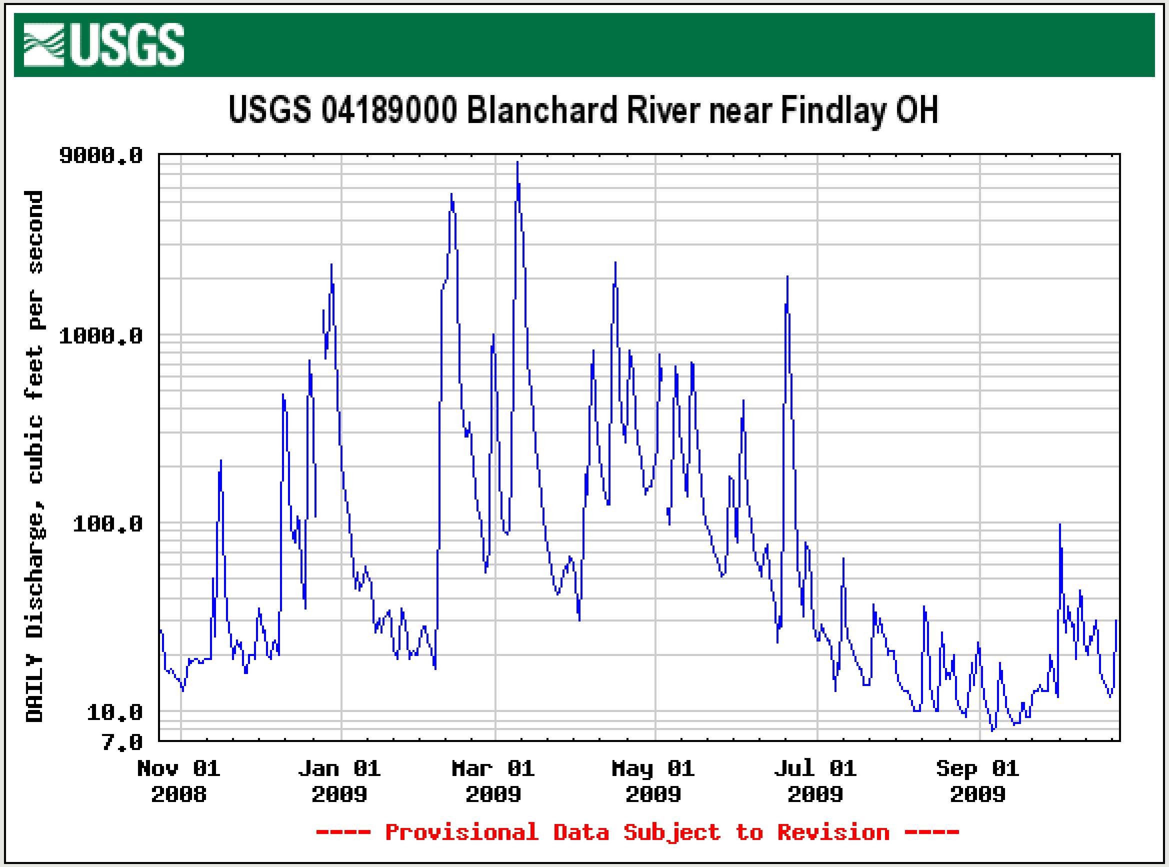


Downstream



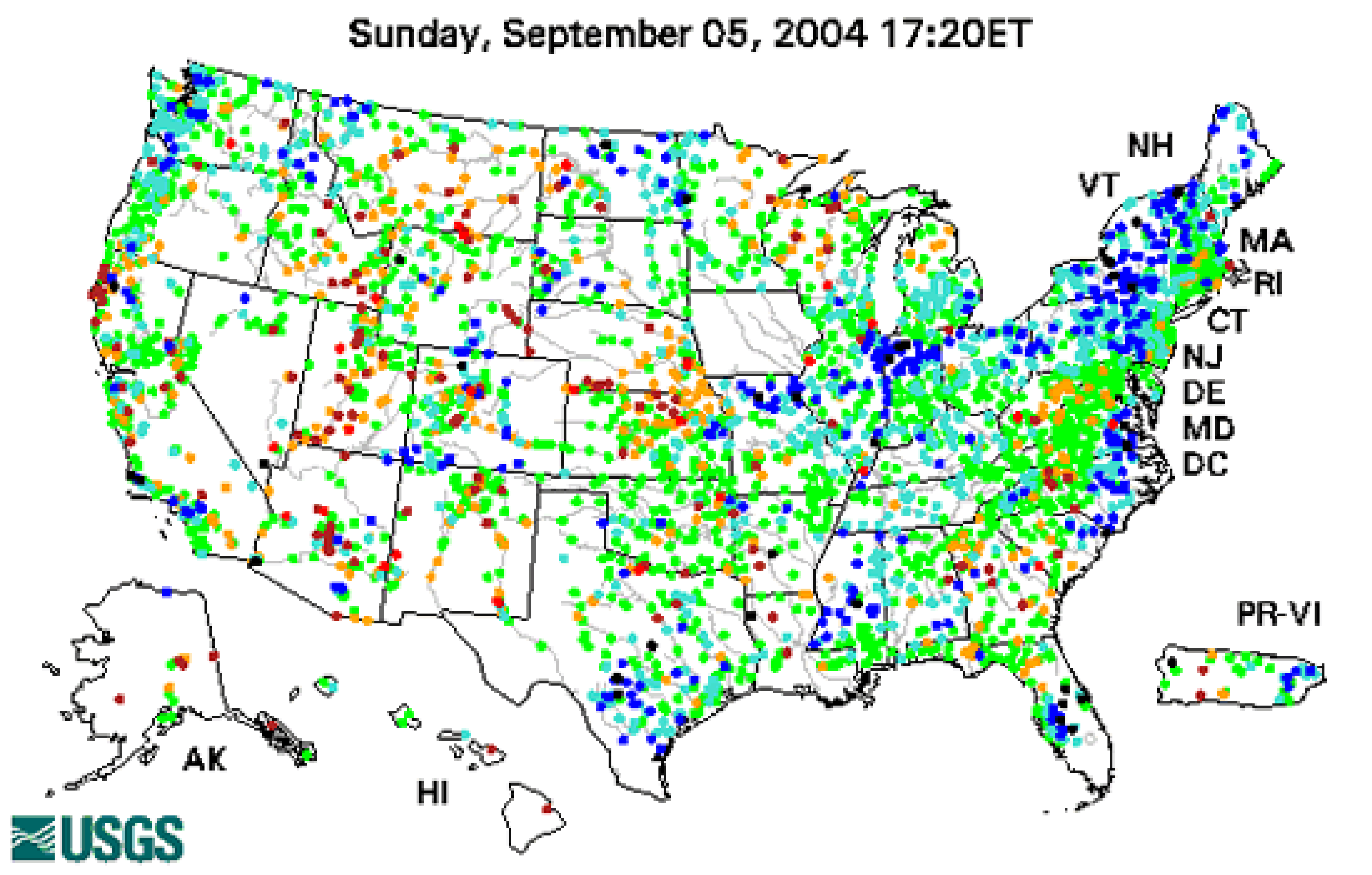
How much water? Measuring discharge

Discharge: The volume of water per unit time
USGS uses cubic feet per second

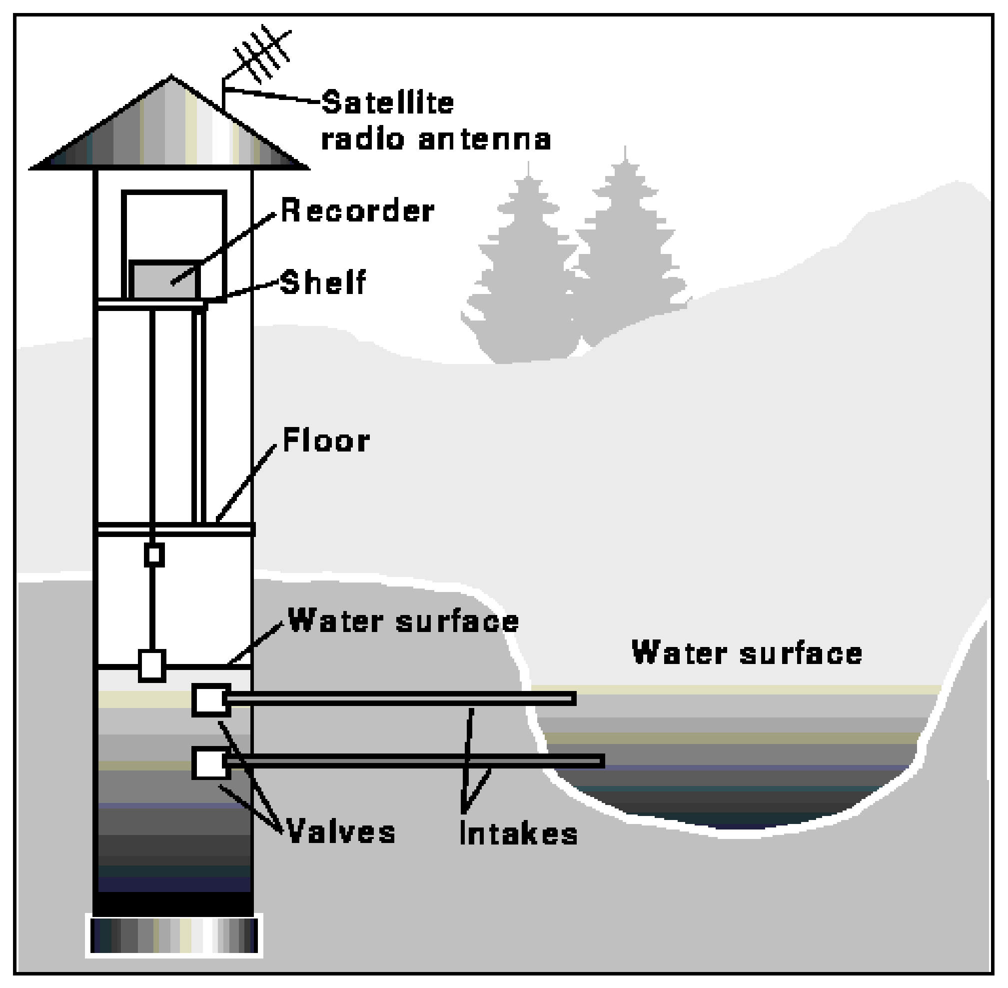


USGS stream gage network

Real-time data: www.USGS.gov



A standard USGS river gage station

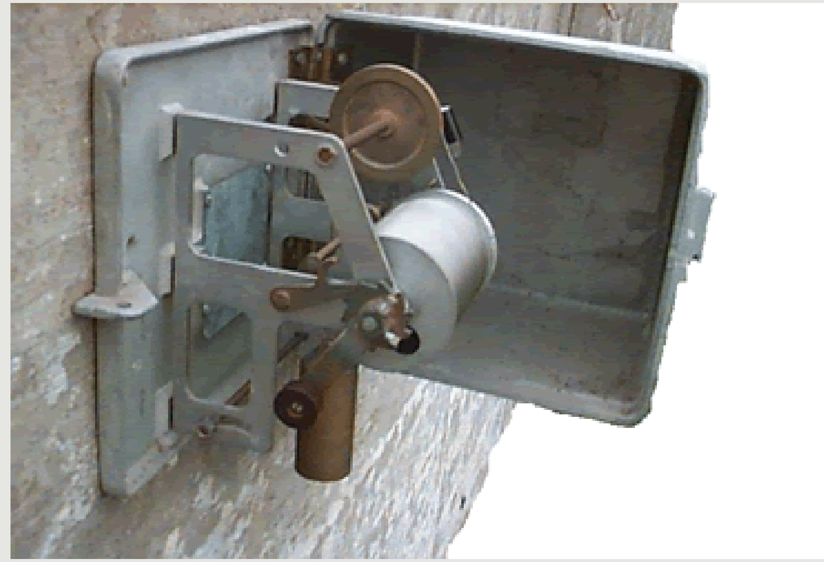


Continuous record
of water height

which is STAGE,
in feet above
a reference
elevation

Gage instruments

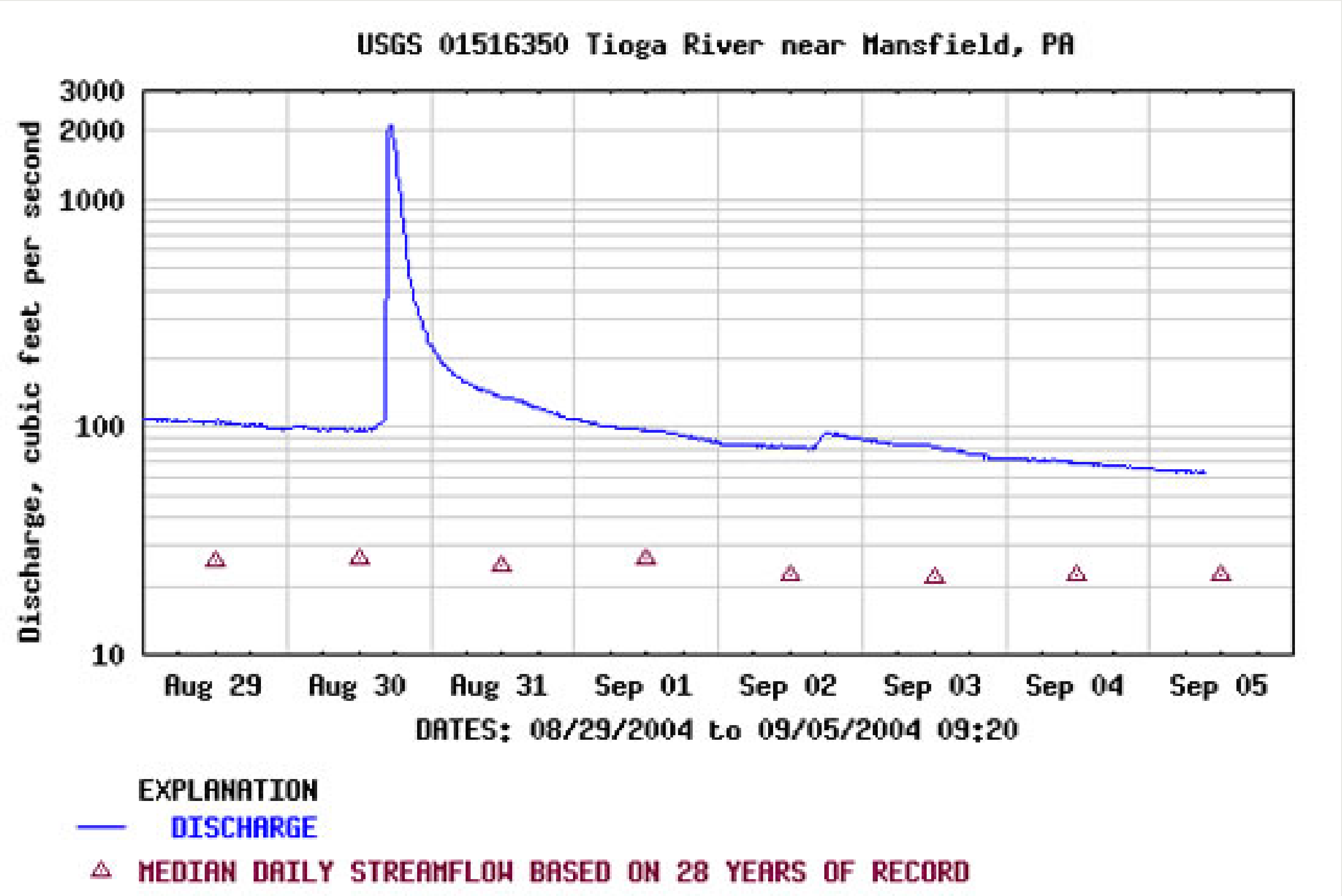
Staff gage



Old school

Modern electronic

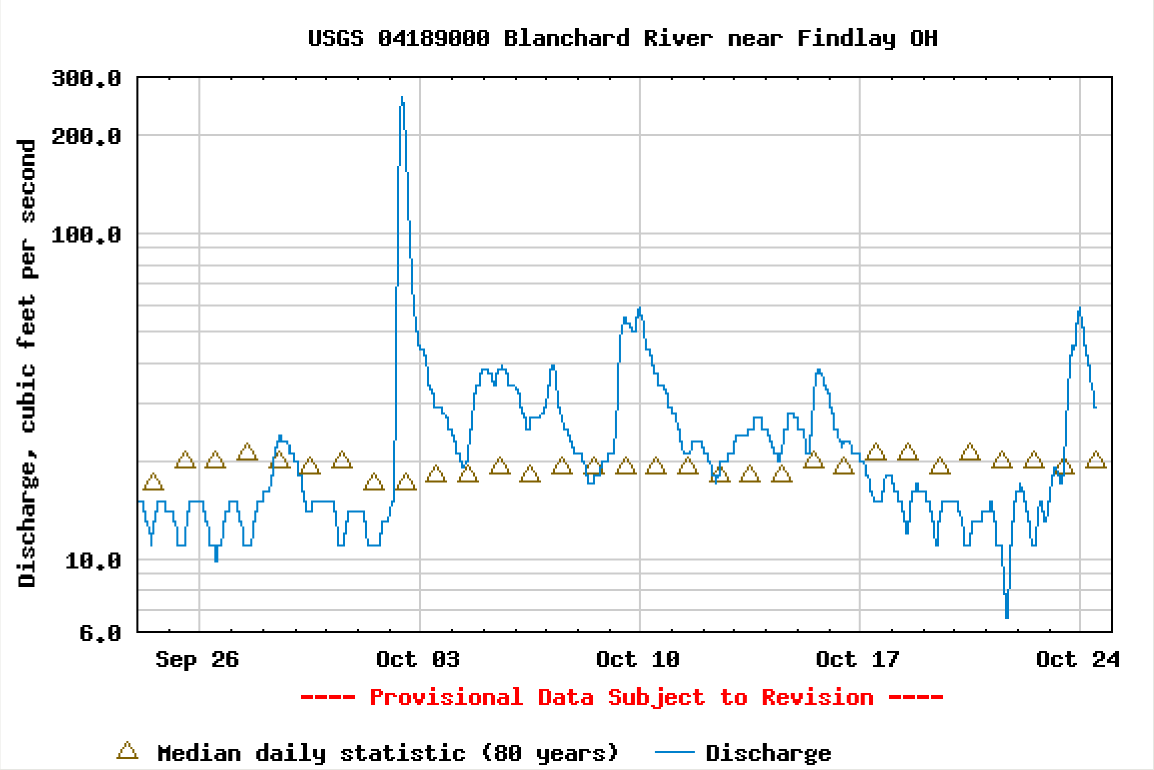
A HYDROGRAPH: Record of a flood event



But note that the X axis is discharge, not stage

Getting from stream height to discharge

A local example:

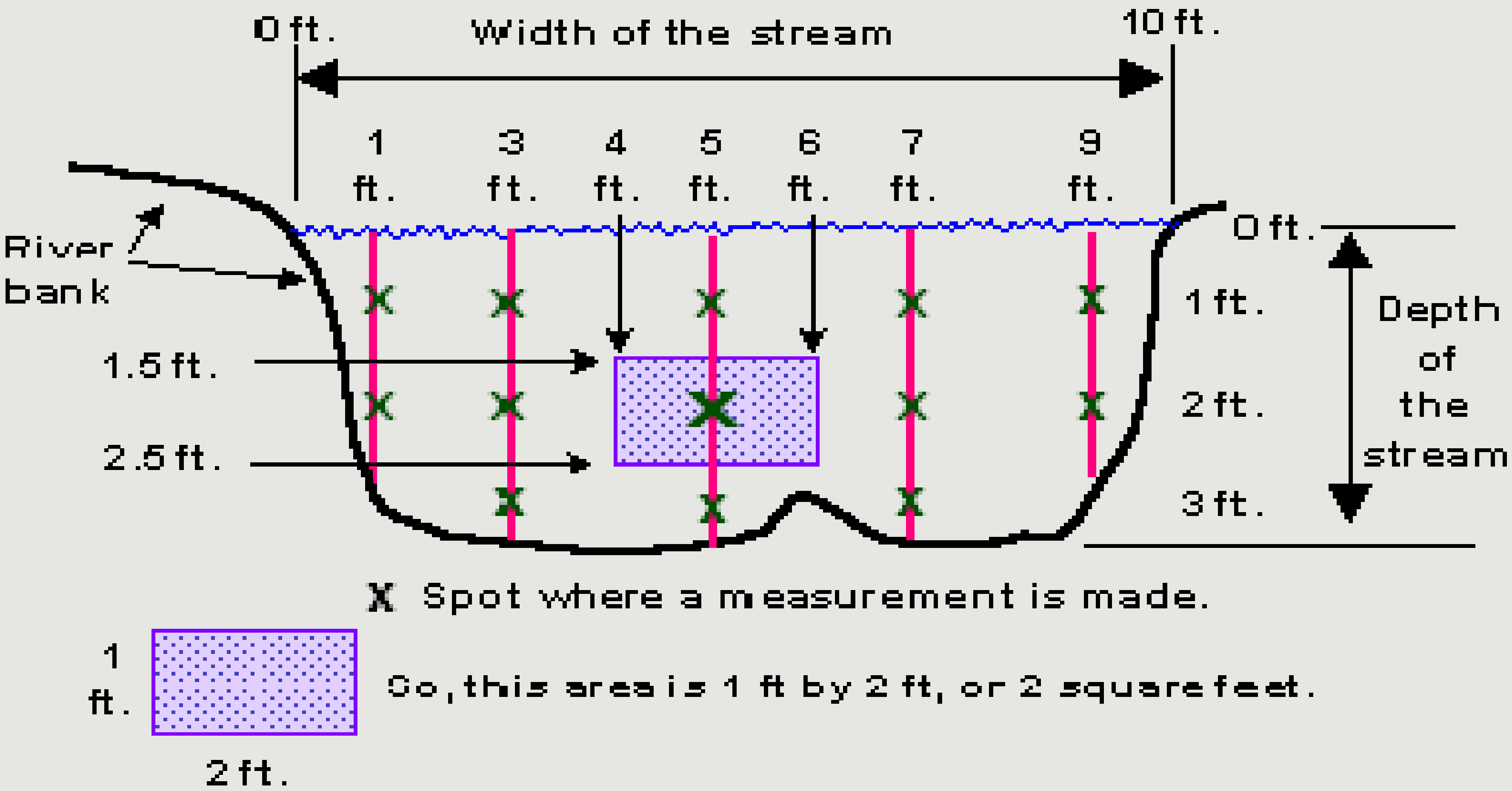


Current meter

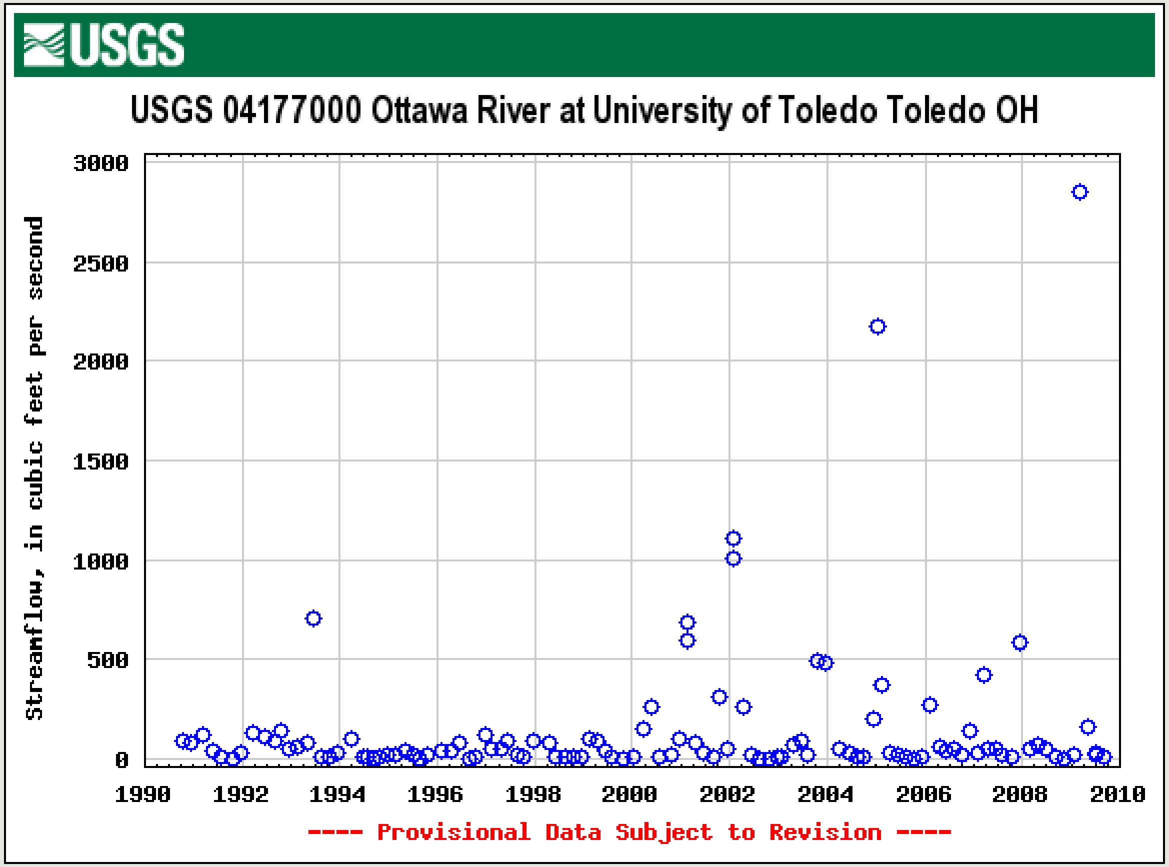
USGS technician makes a series of measurements across the stream

Repeated visits at different stages

Measurements of flow rate across the stream



Ottawa River at the University of Toledo



Big rivers and high flow

This can get dangerous

The Stage – Discharge Relationship

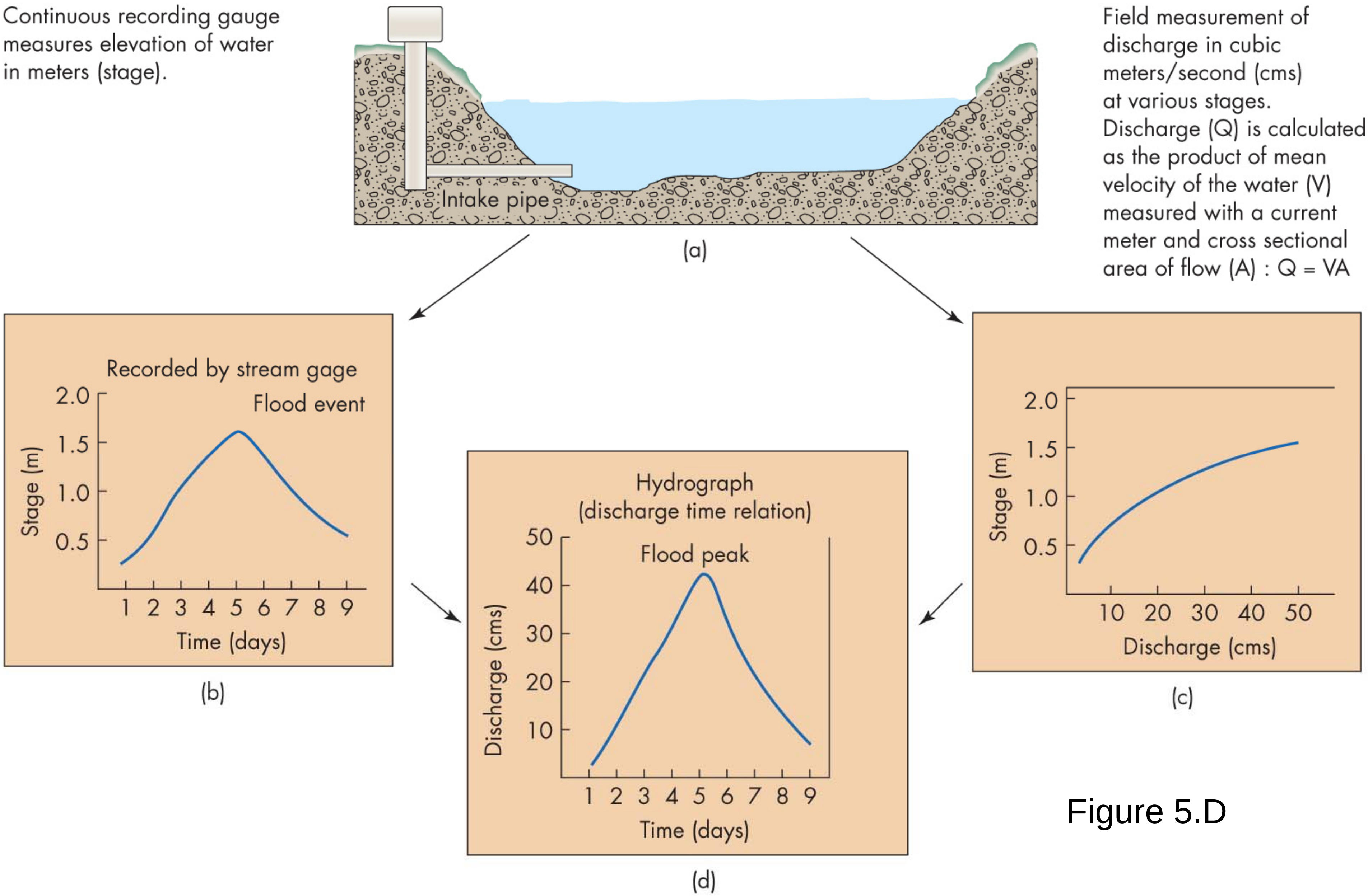
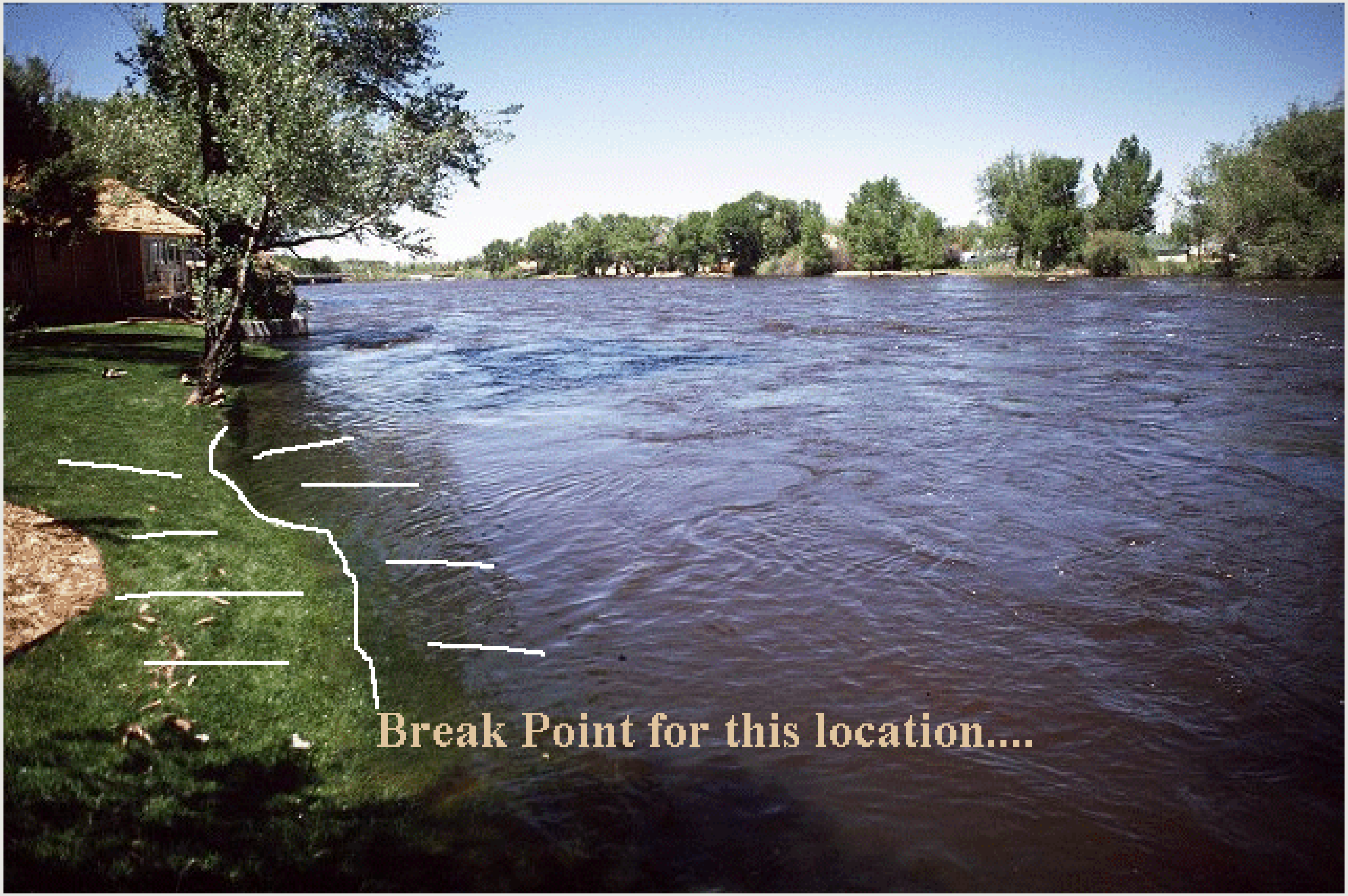


Figure 5.D

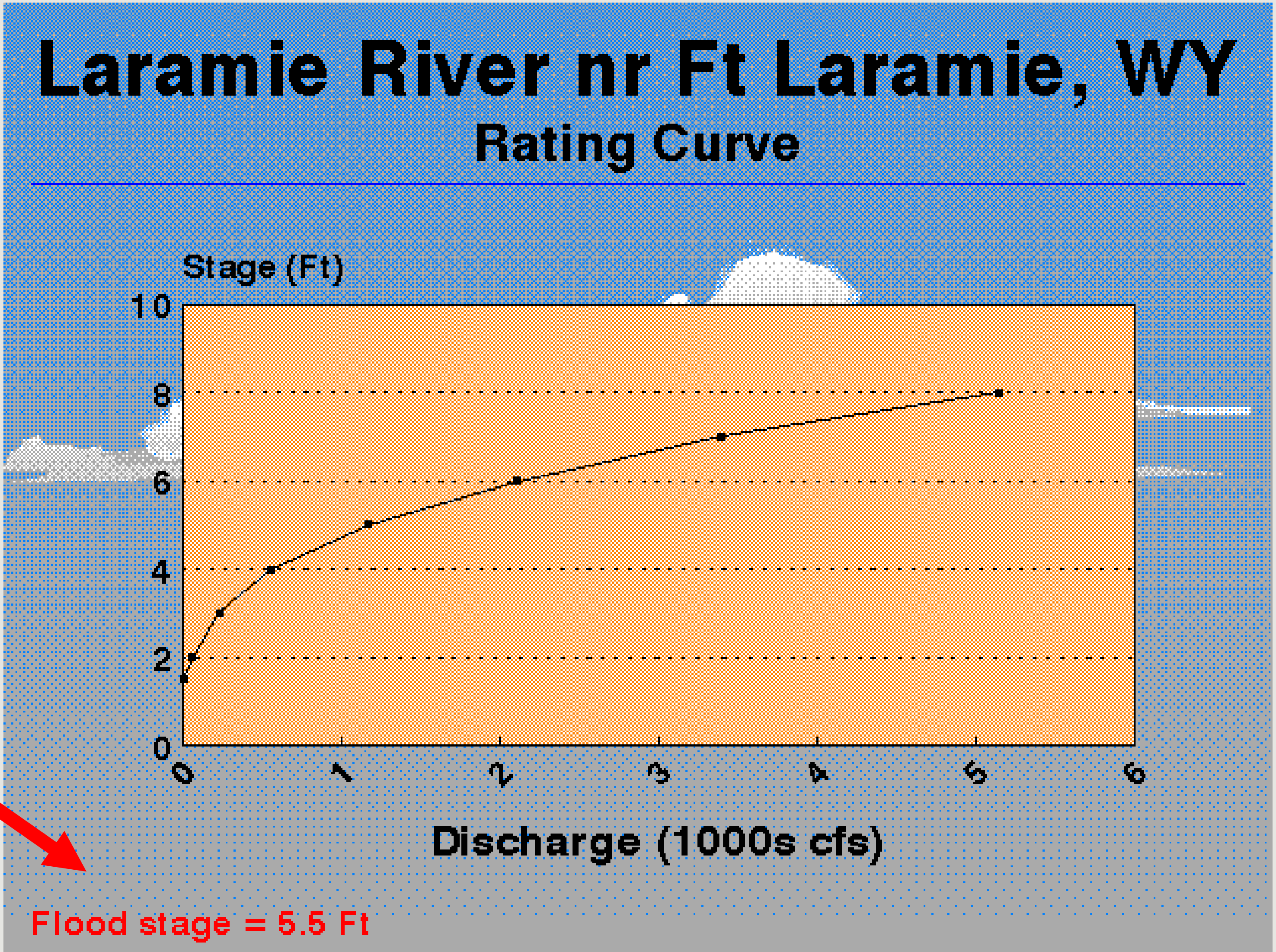
Break point for discharge measurements

Flood spills out of the channel



A discharge rating curve

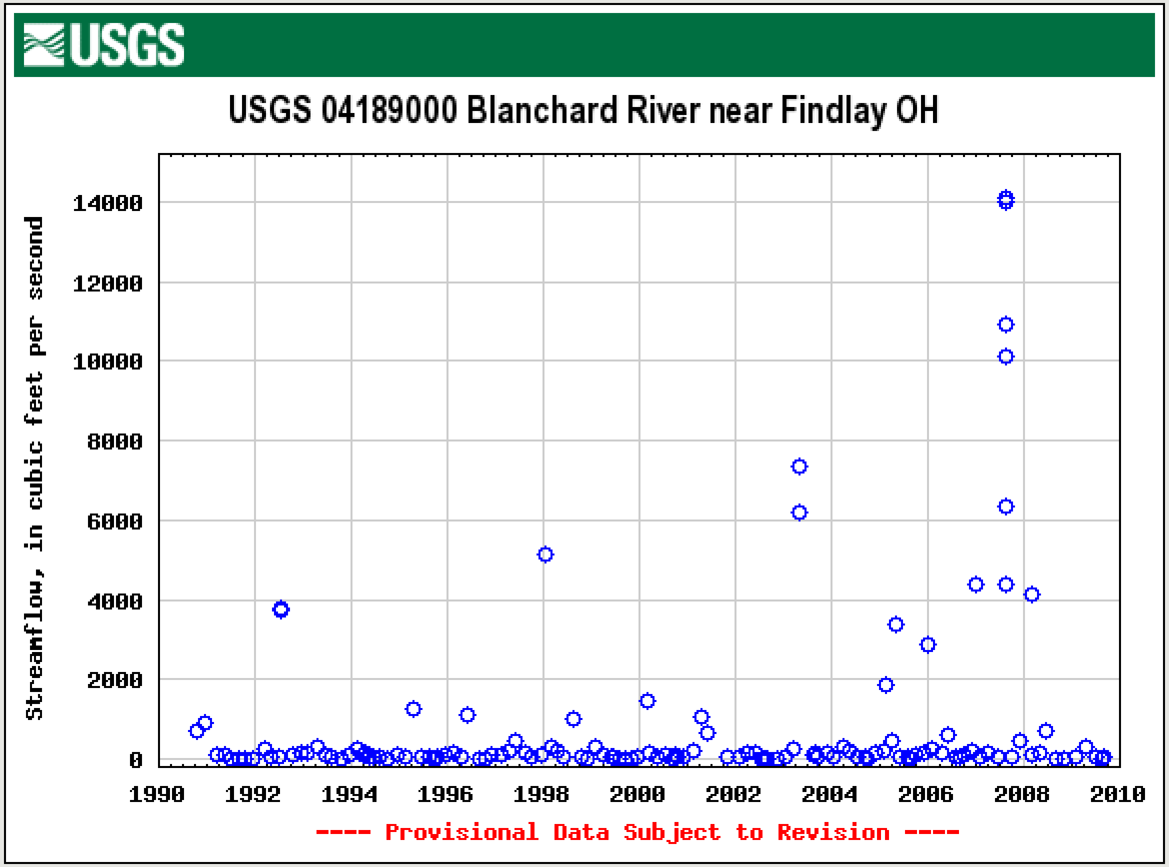
Compiled from LOTS of individual measurements



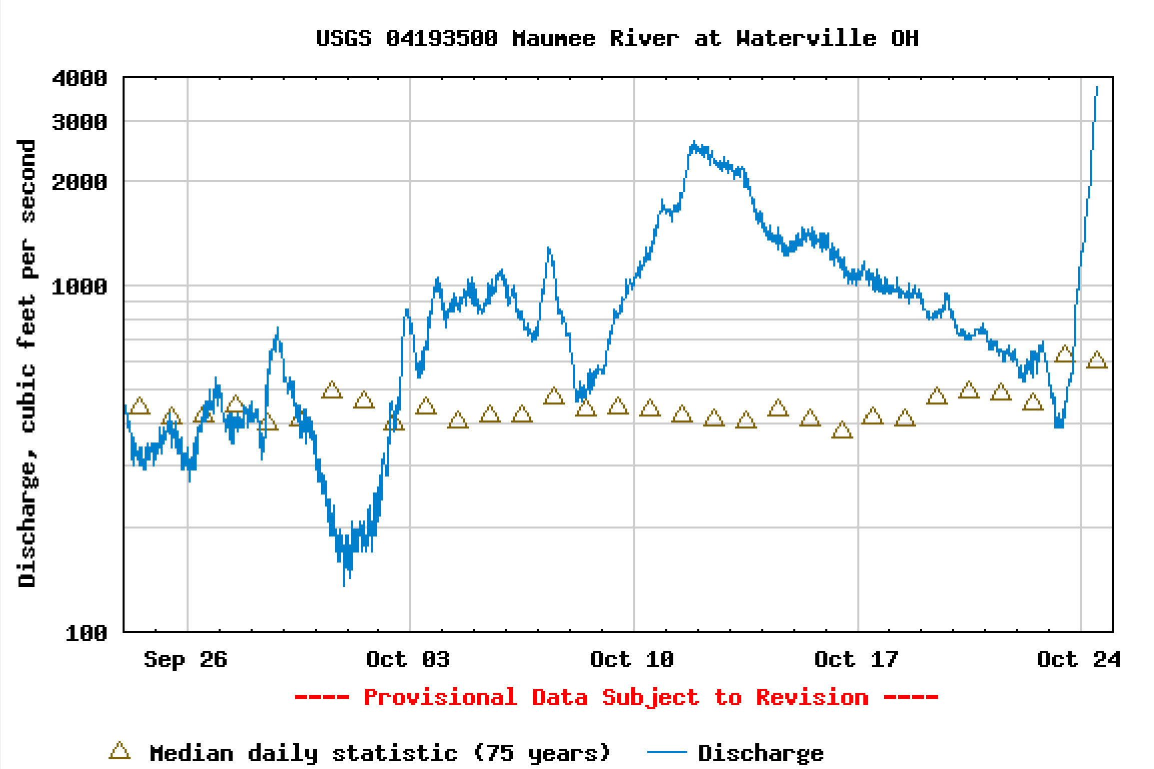
NOTE

Stage-discharge measurements

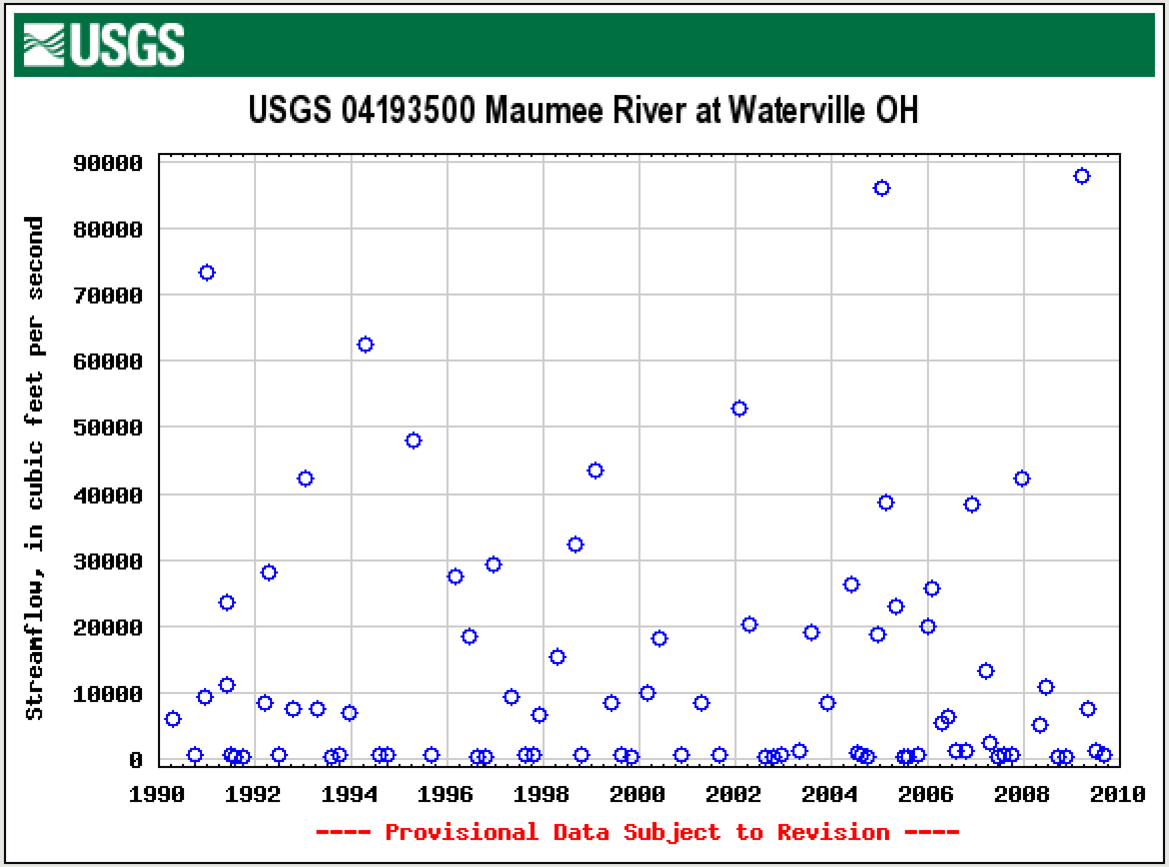
The Blanchard River near Findlay



Maumee River at Waterville



Maumee River at Waterville



Determining flood recurrence intervals

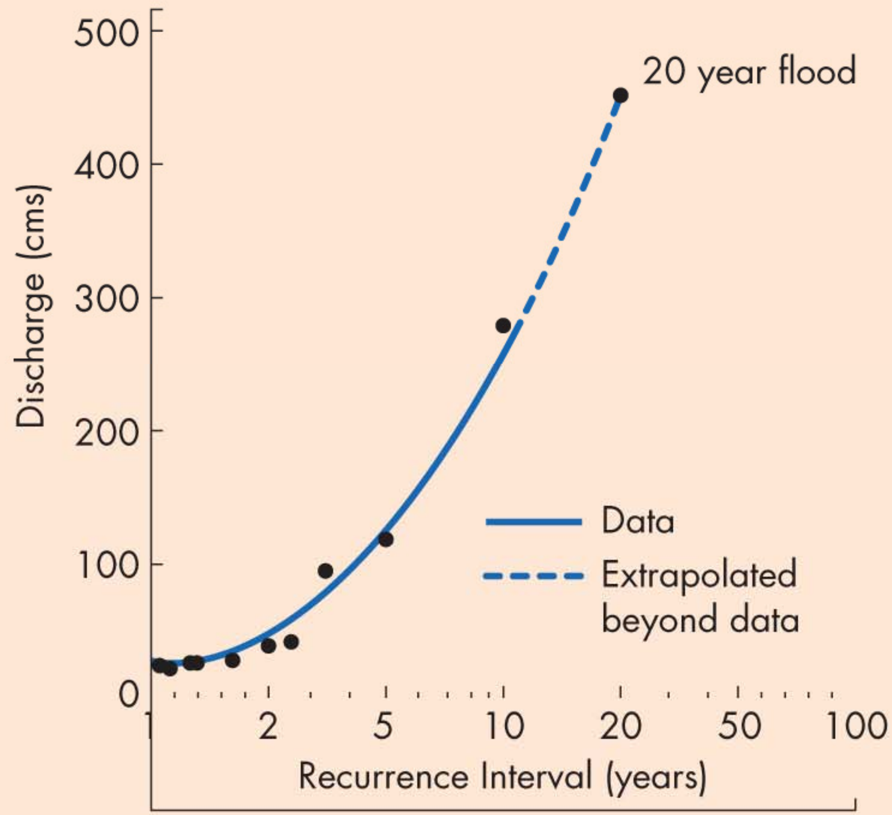
Figure 5.E

Patrick River
Stream Gauge Data
Peak Annual Flow

Year	Discharge (cms)	M	R (yrs)
1995	30	5	2
1996	280	1	10
1997	45	4	2.5
1998	28	6	1.7
1999	120	2	5
2000	26	7	1.4
2001	100	3	3.3
2002	23	8	1.3
2003	20	9	1.1

M = Magnitude where M = 1 is the highest flow on record

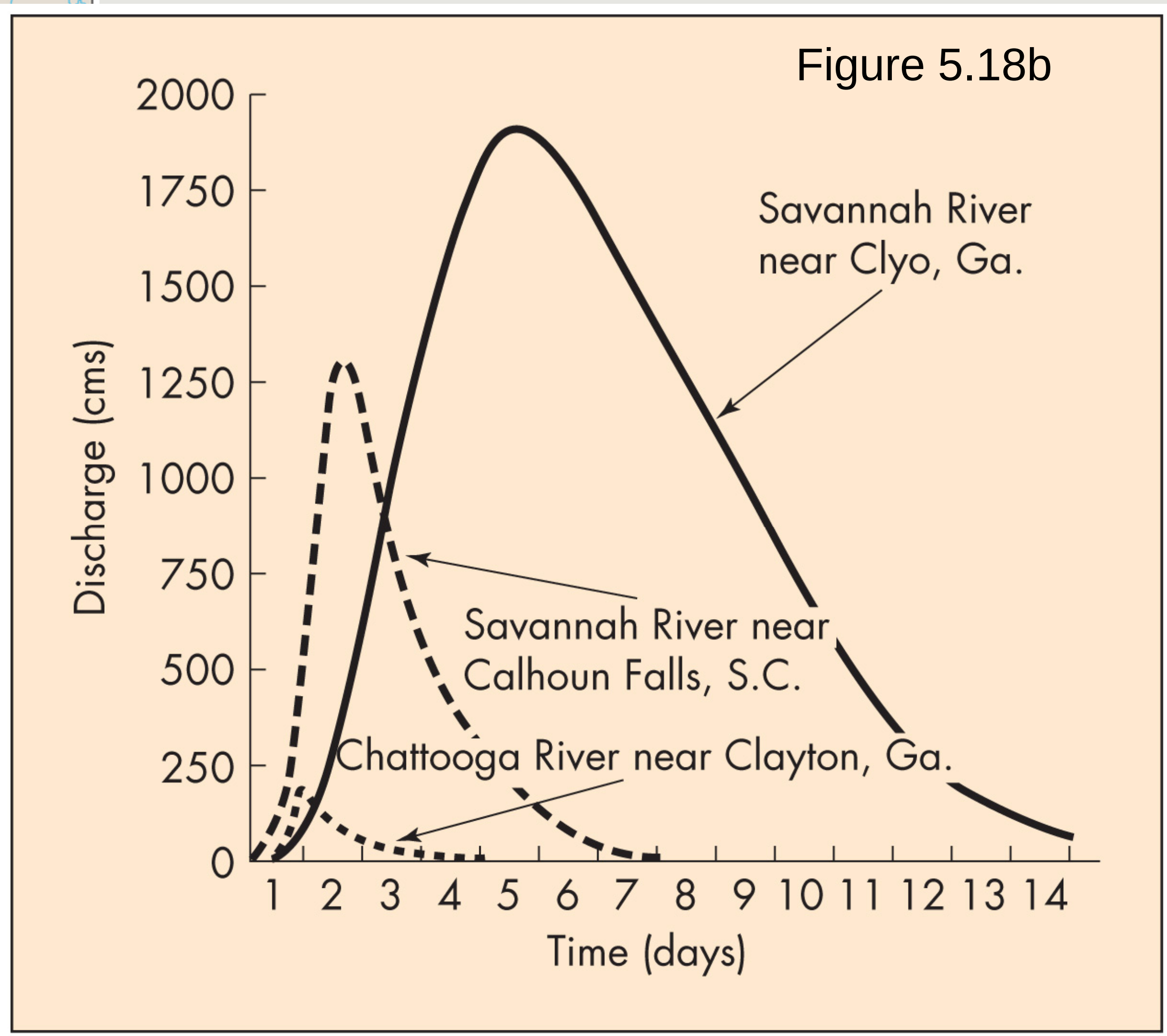
R = Recurrence Interval in years; calculated by $R = \frac{N \quad 1}{M}$; for Patrick River N = 9



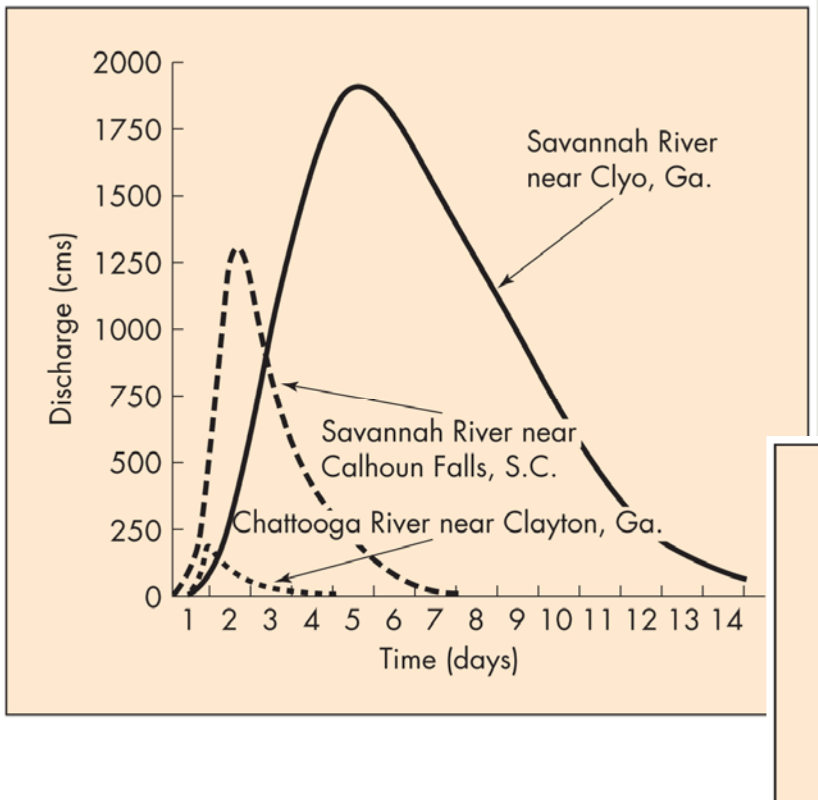
As a flood moves downstream

Figure 5.18a

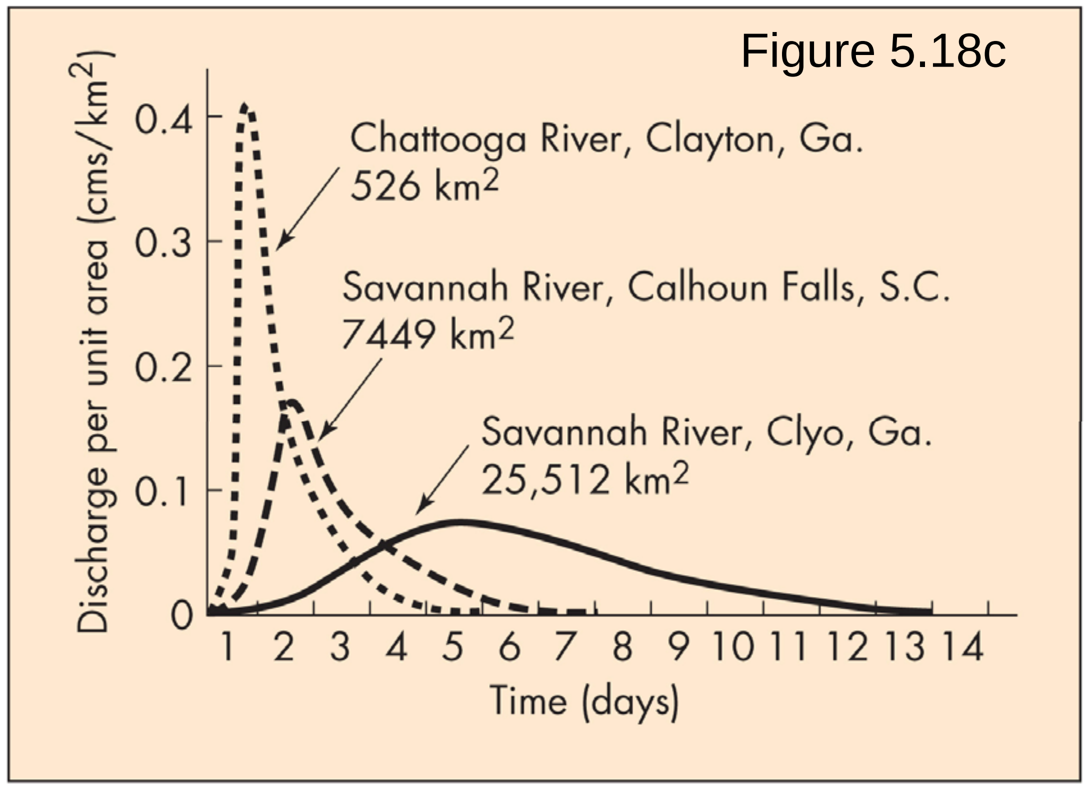
As a flood moves downstream



A different way of looking at the same data

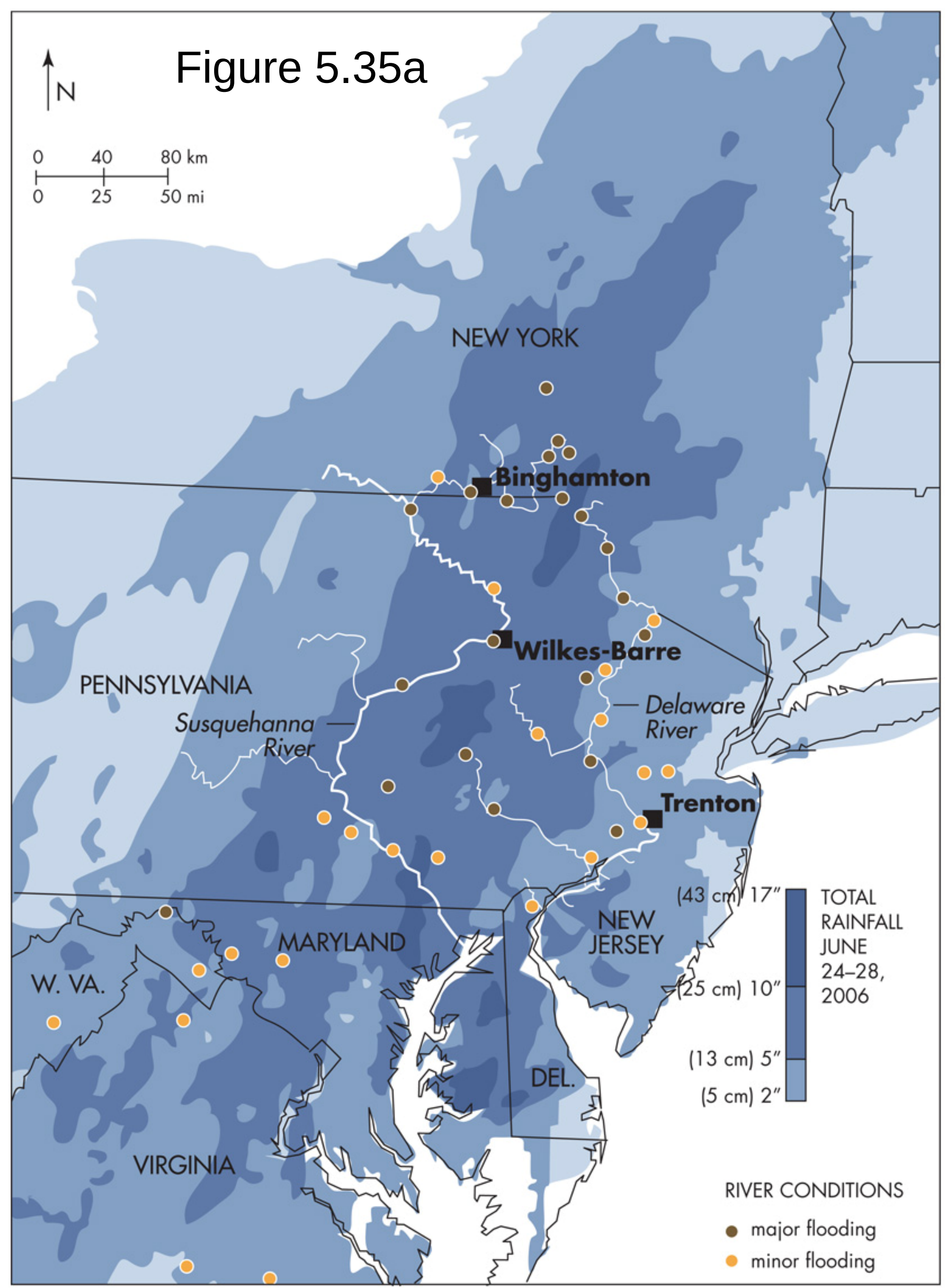


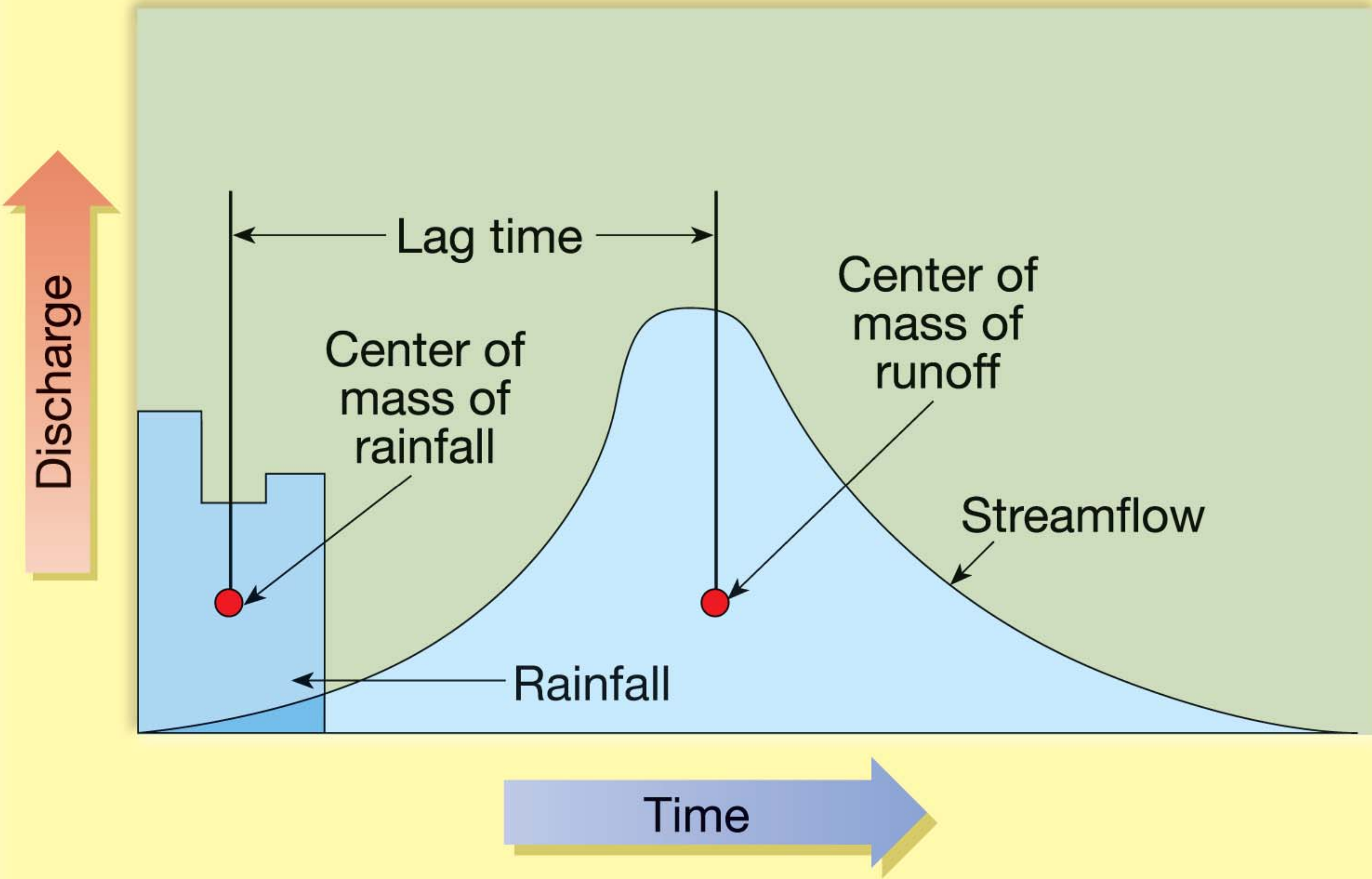
Discharge per unit area of the drainage basin



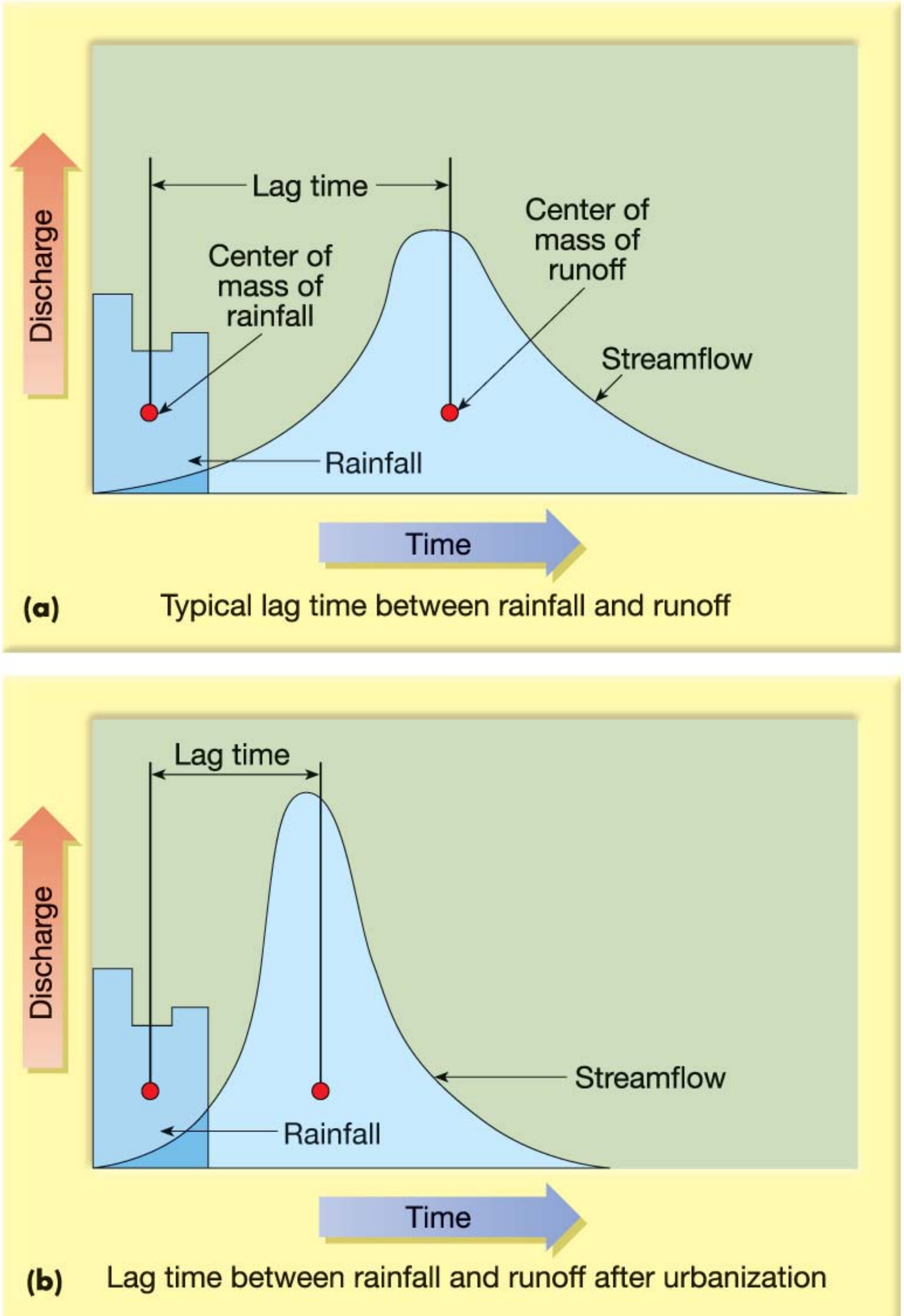
(c)

Massive rainfall in the entire drainage basin





(a) Typical lag time between rainfall and runoff



Important Concept: Reservoir volume and retention time

Figure 5.26

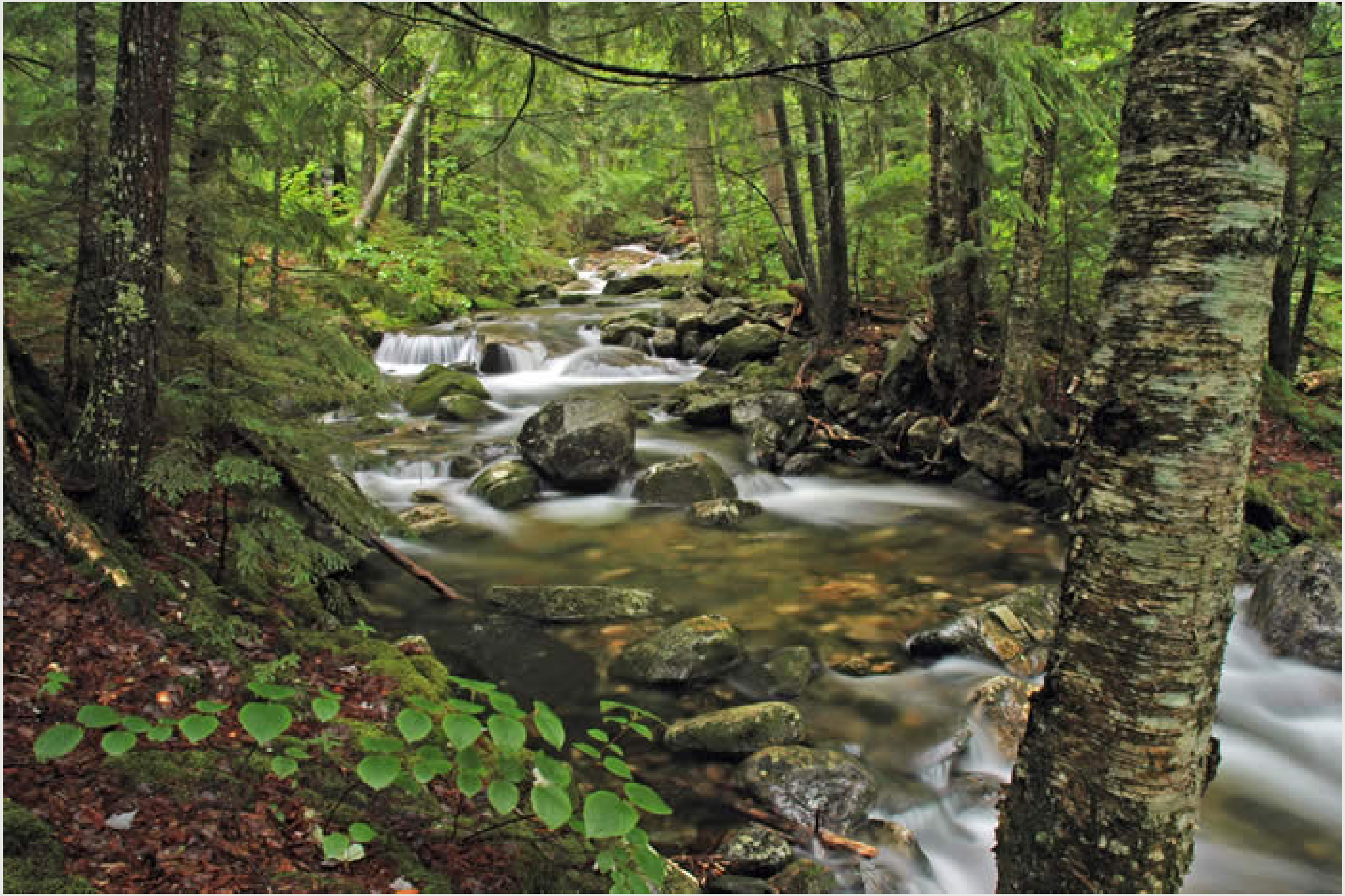
Watershed land use and discharge

Hardwood forest


Tallgrass prairie

Mixed prairie with wooded riparian zone

Mixed forest riparian zone

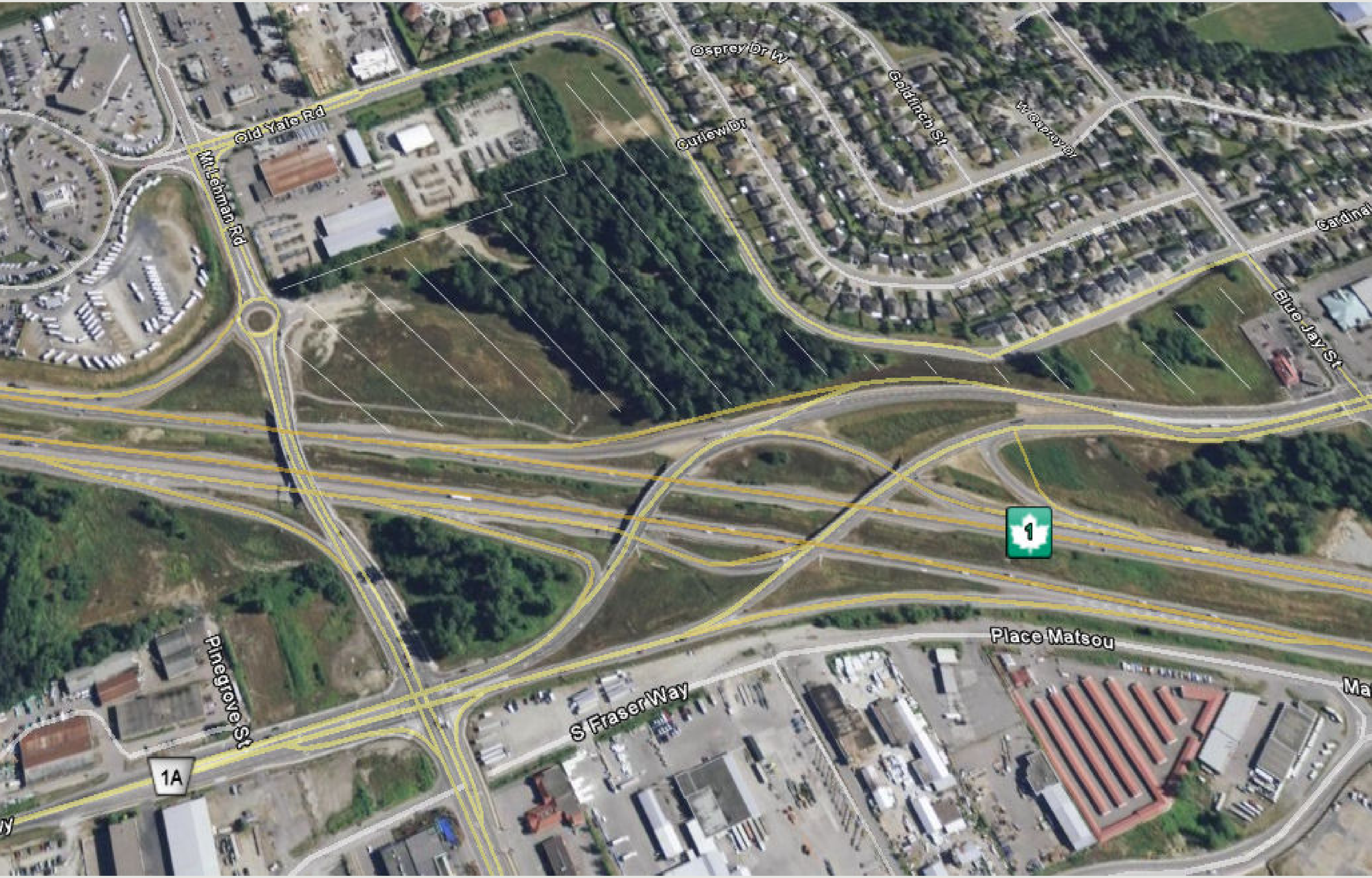


Hardwood swamp on a floodplain

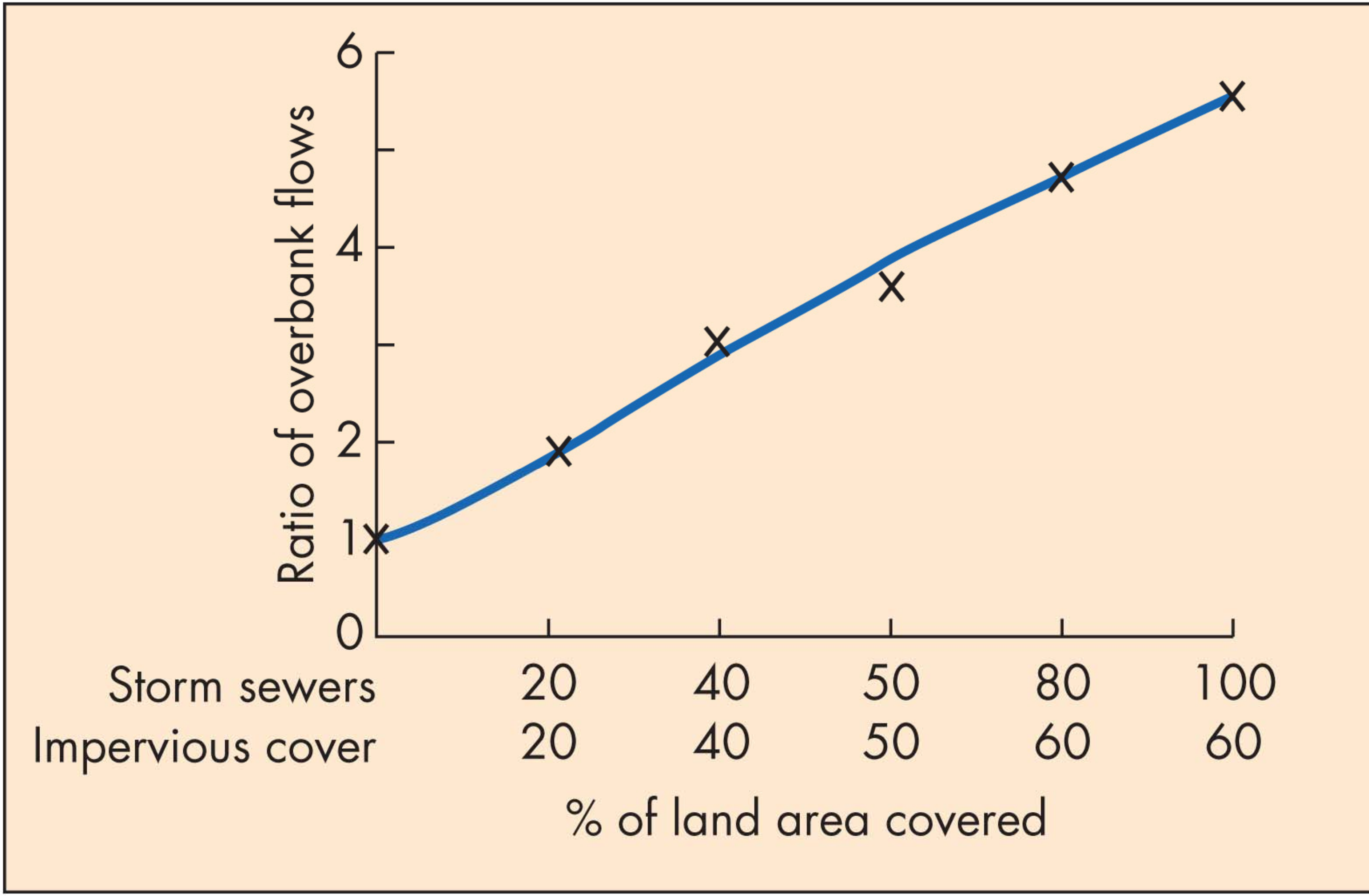

Agricultural fields
Does season matter?
Does soil type matter?

Important point: It’s not just about water run-off

Impervious surfaces and engineered drainage




Where does the water go?
How fast does it get there?


Ratio of overbank flows
6
4
2
1
0
Storm sewers
20
40
50
80
100
Impervious cover
20
40
50
60
60
% of land area covered

Mixed land use

Mixed land use

Suburban lawns

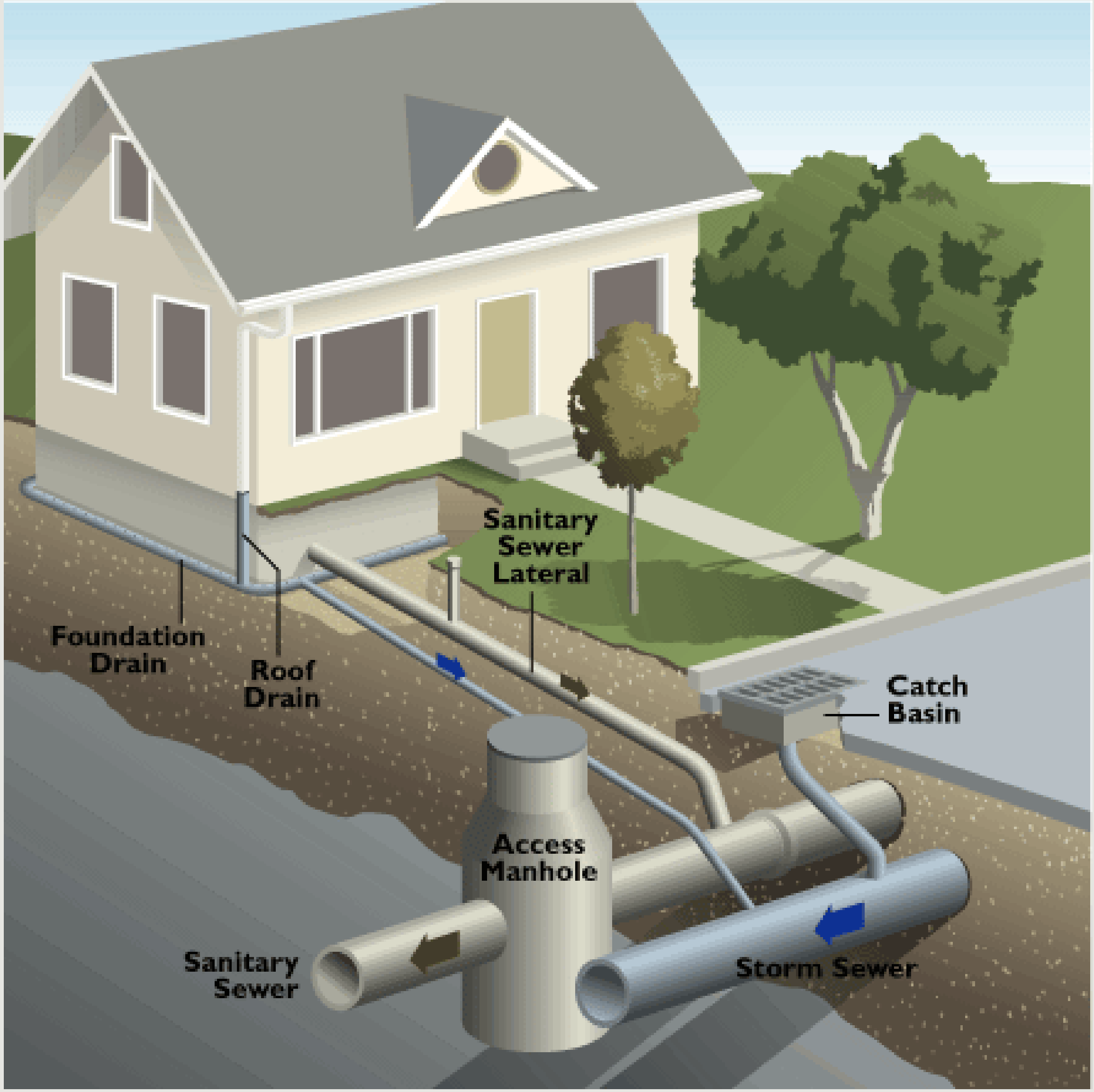
Storm drains

Storm drains / storm sewers

Commonly have direct outflow into a waterway

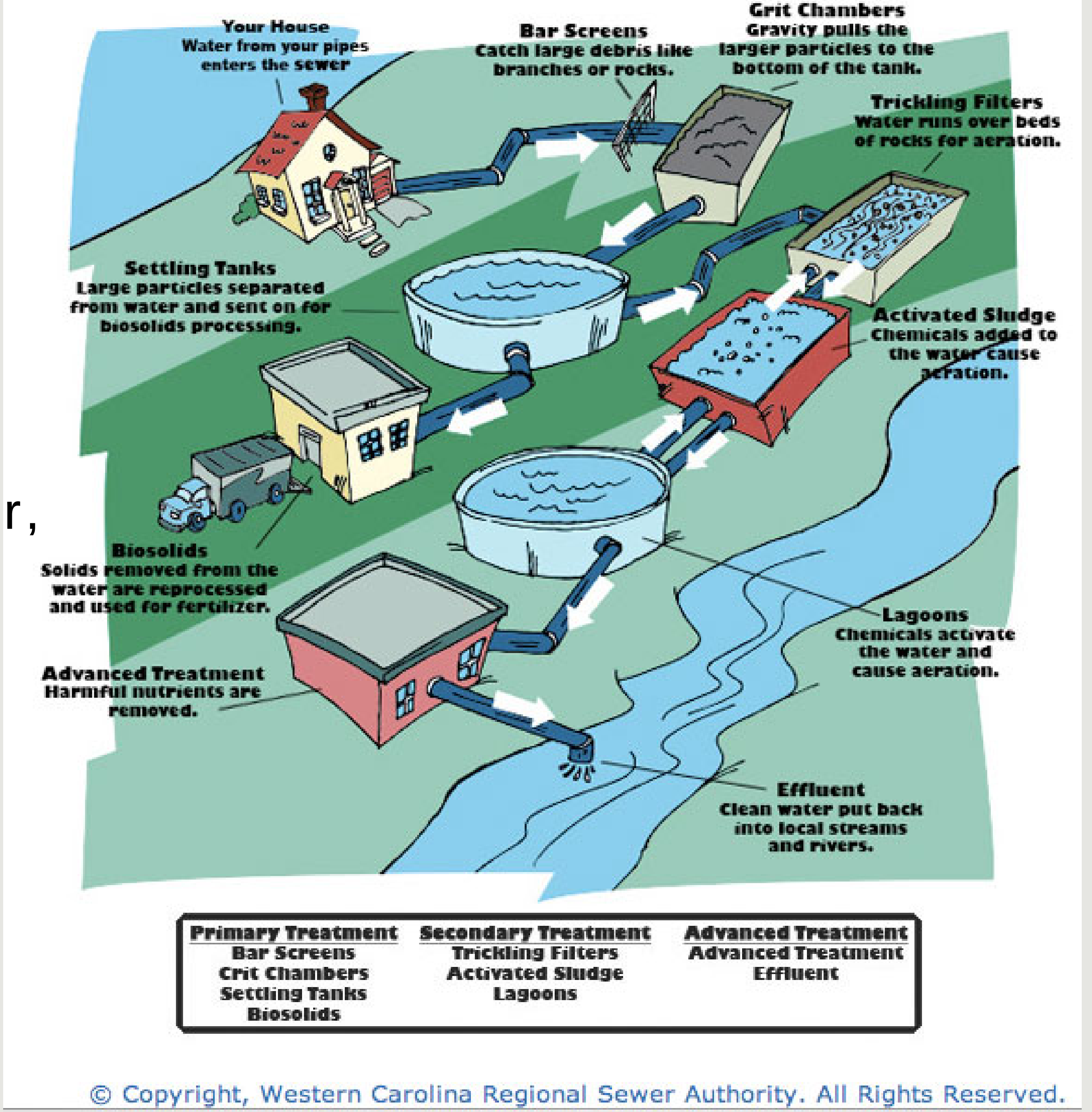
Comment: Surface runoff from Seattle metro area into Puget Sound

Separated sewer system



Municipal sewage treatment

Removes debris, sediments, organic matter, chemicals, nutrients

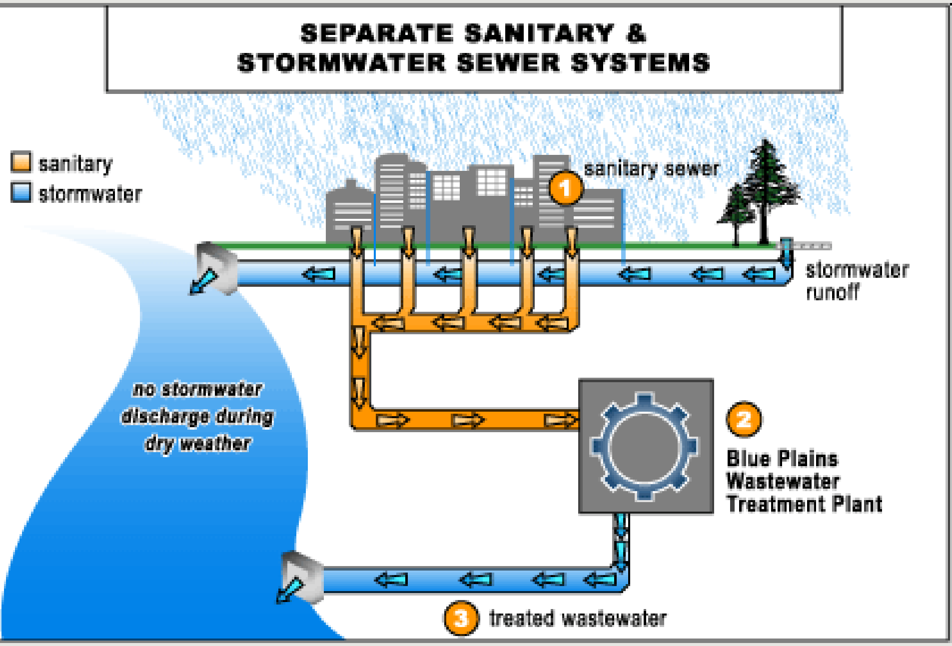


Combined sewer overflow

CSO

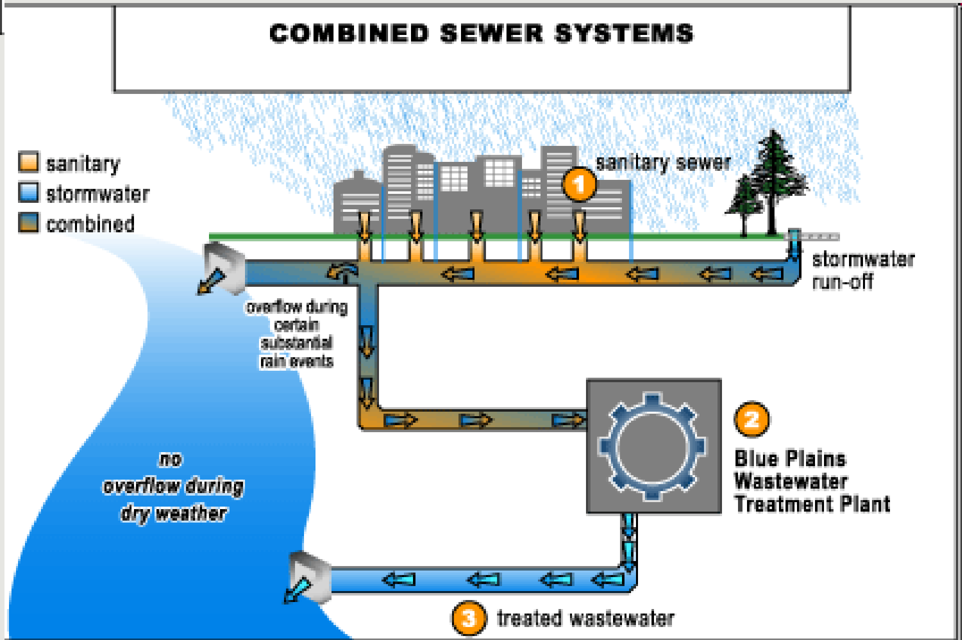

L127

Combined vs separate sewer systems



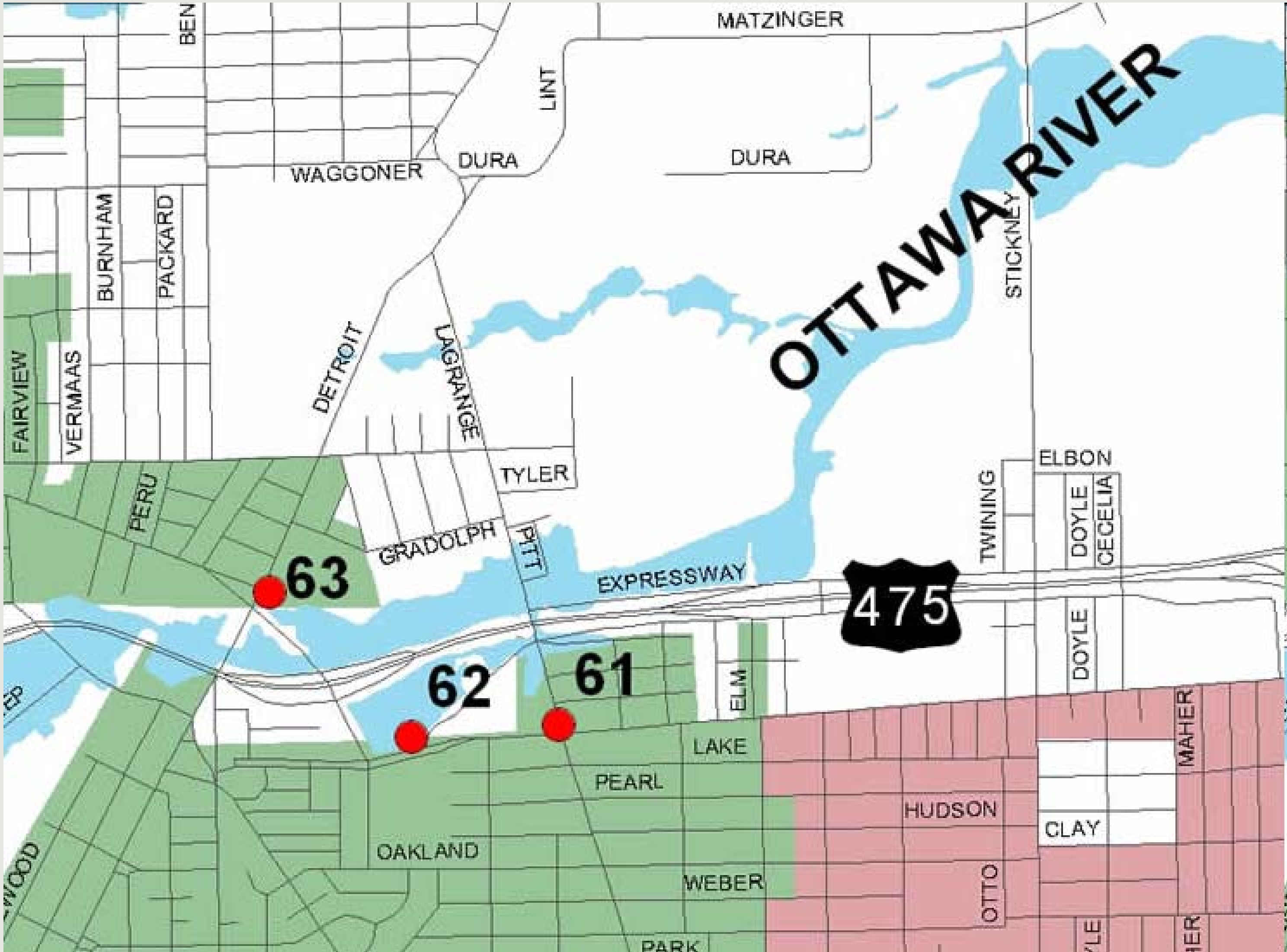
Separate

Combined



CSO's in Toledo

http://www.toledowaterwaysinitiative.com/



CSO's in Toledo

The 15-year series of improvements to upgrade the City's aging sewer system is expected to cost more than $450 million. Funding for the program will come from an incremental increase of sanitary sewer rates over the next 15 years.