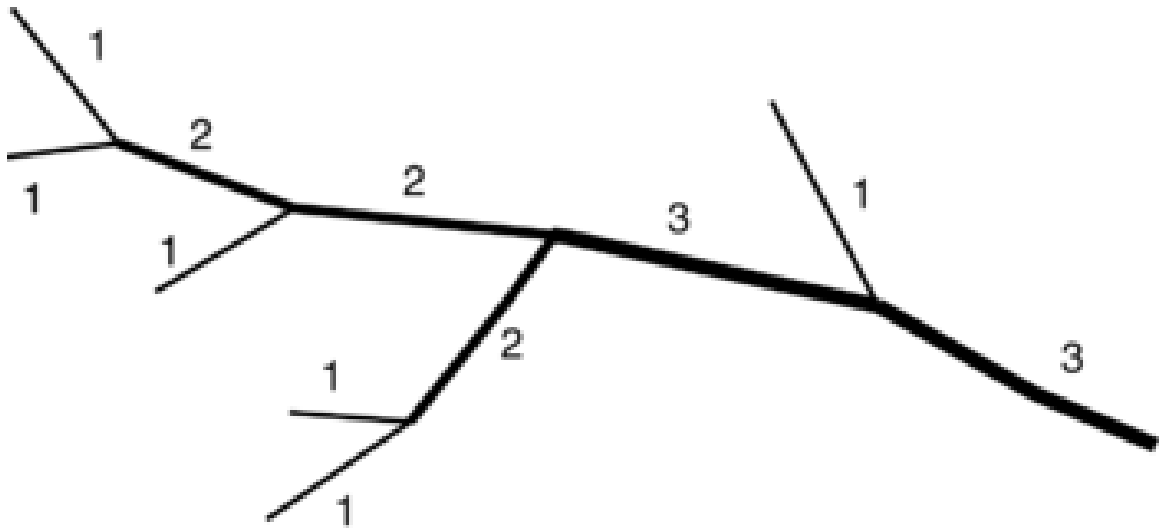
Quantitative Analysis of Stream Network

Stream Order



Stream order is a measure of the position of a stream in the hierarchy of tributaries (branches of stream).

Stream Order

- **Strahler number** or **Horton–Strahler number** of a mathematical tree is a numerical measure of its branching complexity.
- These numbers were first developed by ***Robert E. Horton and Arthur Newell Strahler (1952, 1957).***
- They are referred to as the **Strahler or Horton stream order** and are used to define stream size based on a hierarchy of tributaries.

Stream Order

- Stream sizes range from the smallest, first-order, to the largest, the twelfth-order (the Amazon River).
- Over 80% of the total length of Earth's rivers and streams are headwater streams (first- and second-order).
- As water molecules travel from headwater streams toward the mouth of mighty rivers, streams gradually increase their width and depth. The amount of water they discharge also increases.

Why do we need stream order?

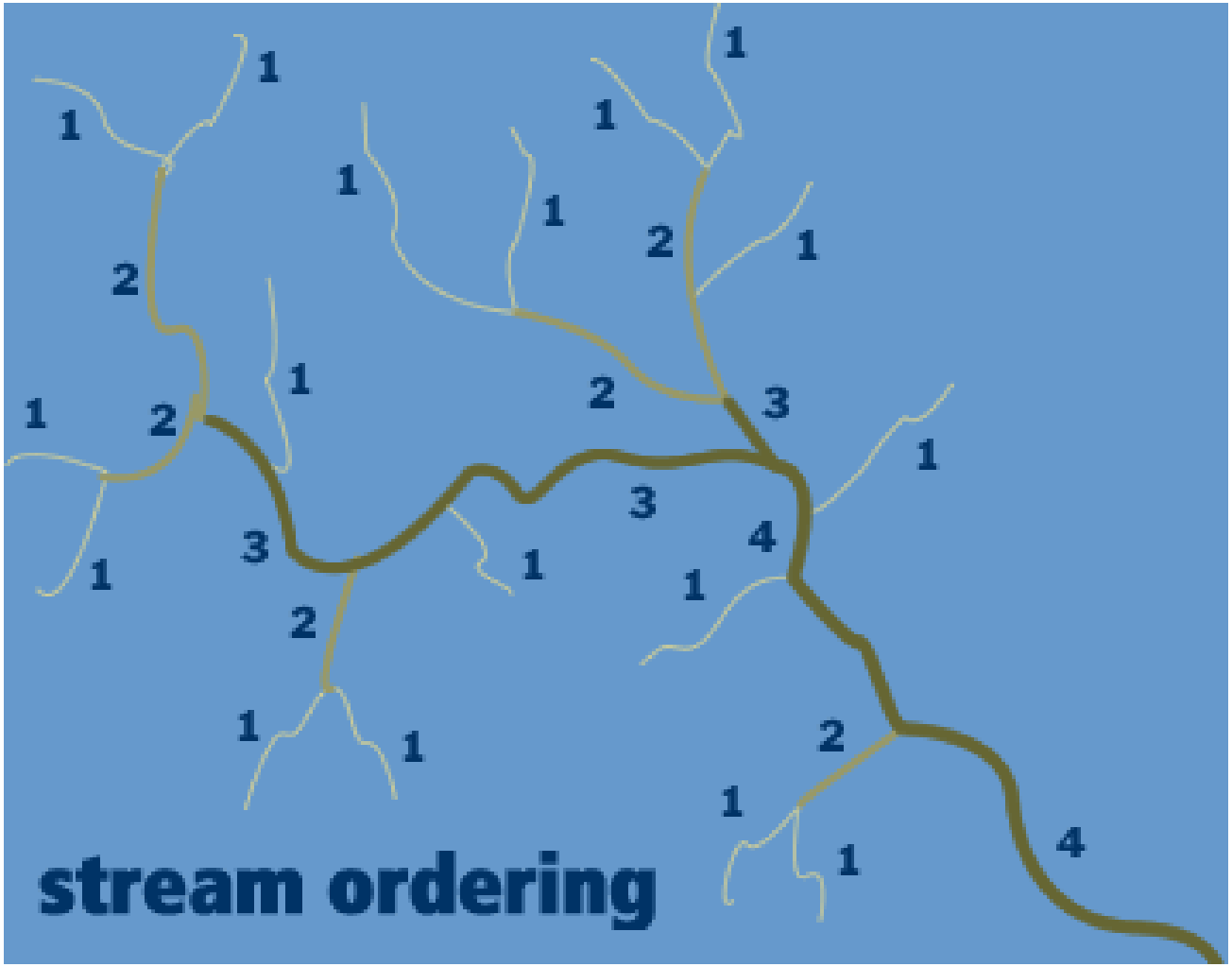
- Gives them an idea of the ***size and strength of specific waterways within stream networks*** - an important component to water management.
- Allows more easily ***study the amount of sediment*** in an area.
- Allows the ***use of waterways as natural resources*** more effectively.

Horton's System of Stream Ordering

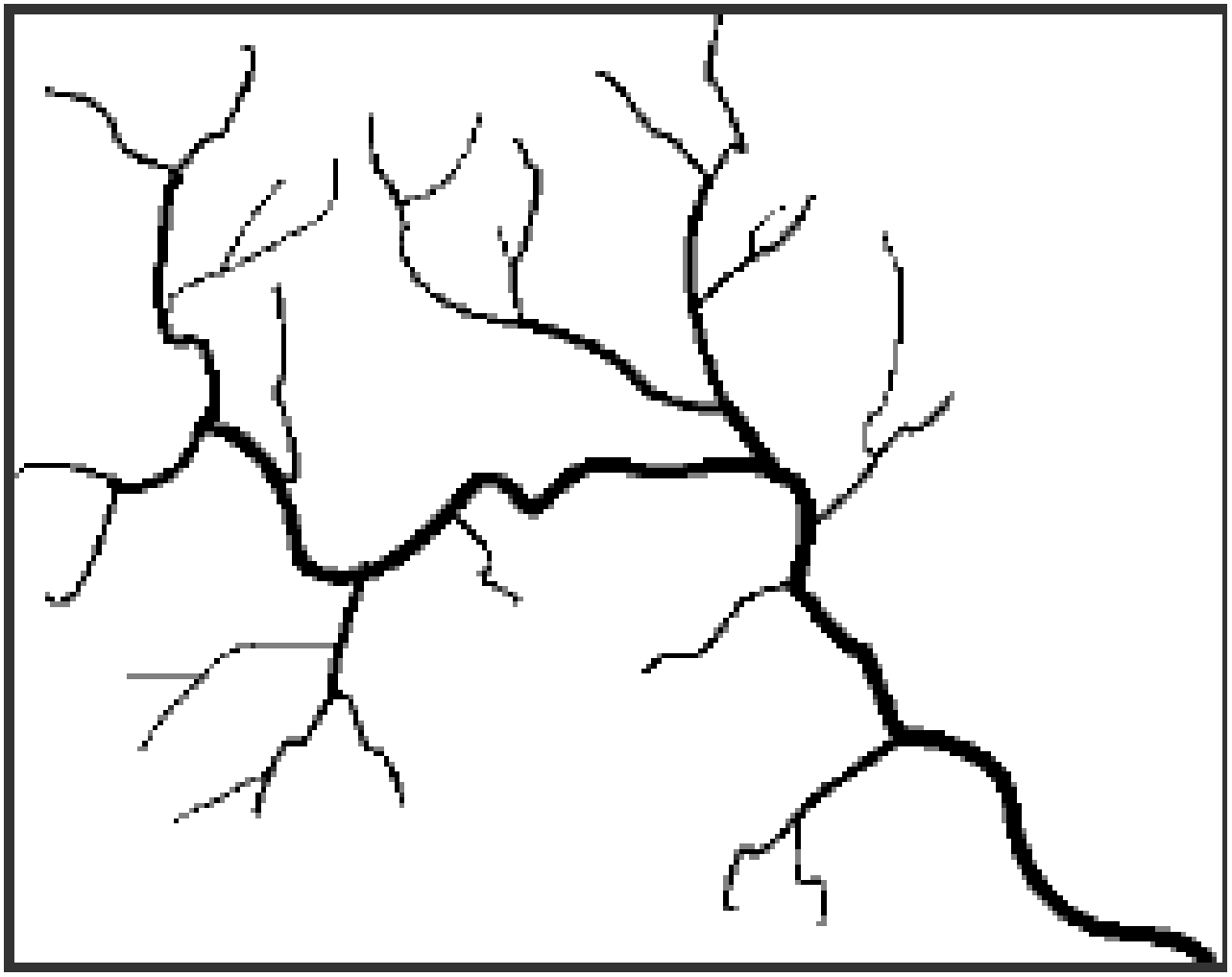


- A stream which has no tributaries is a stream of *1st order*.
- A stream which has tributaries of Order 1, is a *2nd order* stream.
- A stream which has 1st and 2nd order tributaries, is a stream of *3rd order* and so on.

Horton's System of Stream Ordering



Exercise on Stream Order



Bifurcation Ratio

The ratio between (mean ratio) the number of streams of one order to the number of streams of next higher order is a constant and is called bifurcation ratio.

- Bifurcation Ratio (BR) is denoted by –

$$BR = \frac{n_i}{n_{i+1}}$$

where,

i is the order of a stream

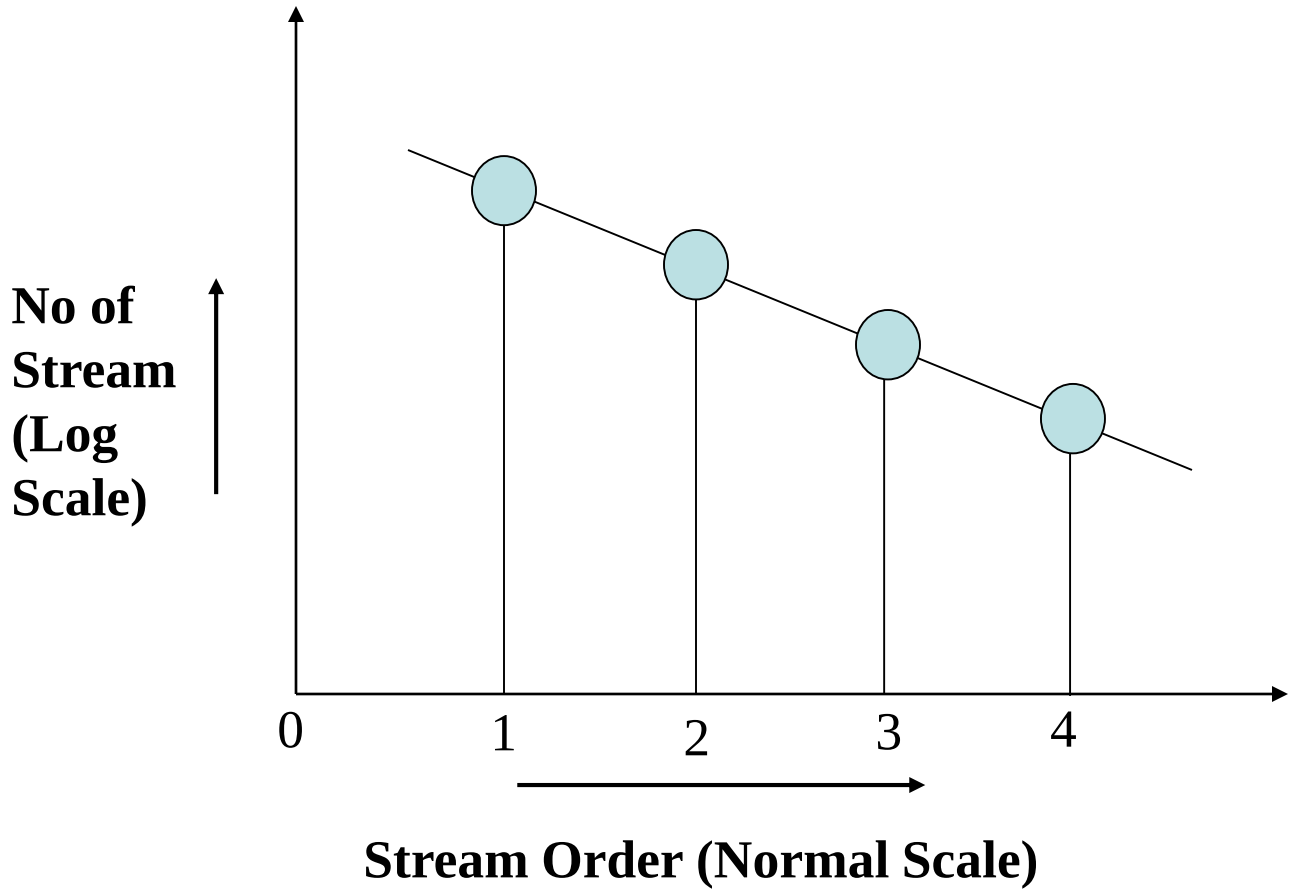
and ***n*** is the number of streams of the corresponding order.

Bifurcation Ratio



Stream Order	No of Streams	B.R.	Avg B.R.
1st	7	7/4 = 1.75	1.875
2nd	4		
3rd	2	4/2 = 2	

Law of Stream Number



Length Ratio

The ratio between the mean length of stream of an order to the mean length of streams of the next lower order is a constant and is called length ratio.

- Length Ratio (LR) is denoted by –

$$LR = \frac{l_{i+1}}{l_i}$$

where,

i is the order of a stream

and ***l*** is the mean length of streams of the corresponding order.

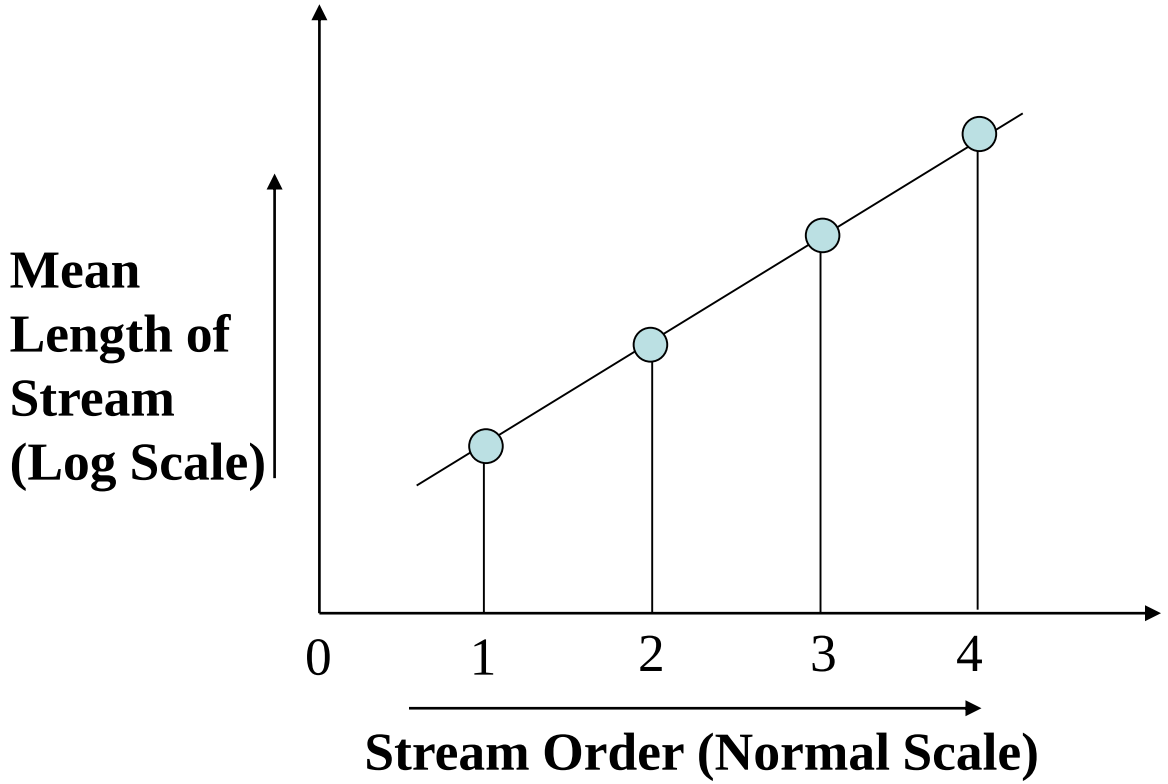
Length Ratio

The length of each stream of order 'n' has length 10^n Km



Stream Order	Mean Length	L.R.	Avg L.R.
1^{st}	10^1	100/10 = 10	10
2^{nd}	10^2		
3^{rd}	10^3	1000/100 = 10	

Law of Stream Length



Constant of Channel Maintenance

- This is the drainage area required to be sustained by unit length of the channel.
- Length of the channel is given by the empirical formula:

$$L = 1.4\ A_d^{0.6}$$

Where,

L = Mean length of the channel in miles.

A_d = Area of the drainage basin in sq – mile.

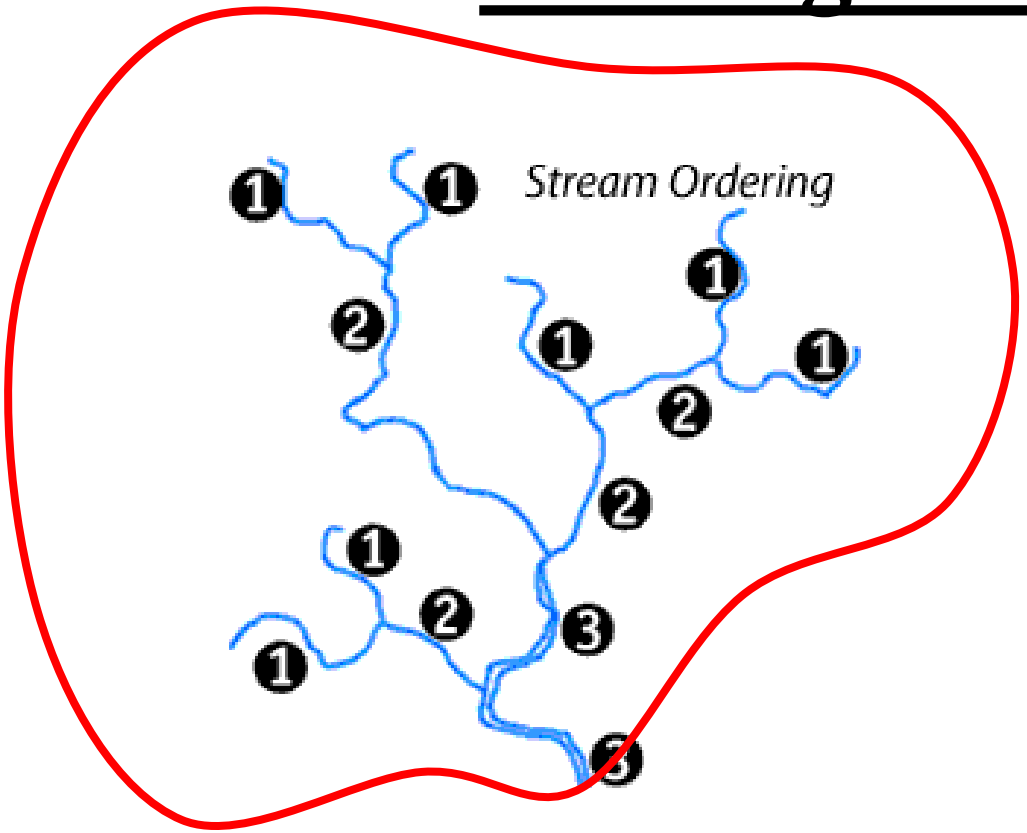
- The value of A_d for $L = 1$, is the constant of channel maintenance.

Drainage Density

$$Drainage\ density = \frac{\sum Length}{\sum Area_d}$$

$$= \frac{\sum L}{\sum A_d}, \ unit\ is\ 1\ per\ mile.$$

Drainage Density



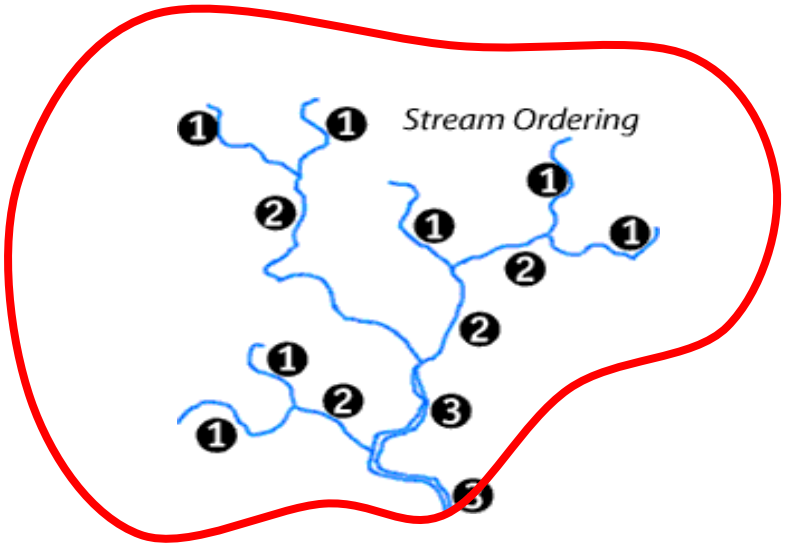
$$Drainage\ \ density = \frac{\sum L}{\sum A_d}\ per\ \ mile.$$

Length of Overland Flow

$$Length\ of\ \ Overland\ Flow = \frac{1}{2} \times \frac{1}{Drainage\ density}$$

$$= \frac{\sum A_d}{2\sum L},\ unit\ is\ mile.$$

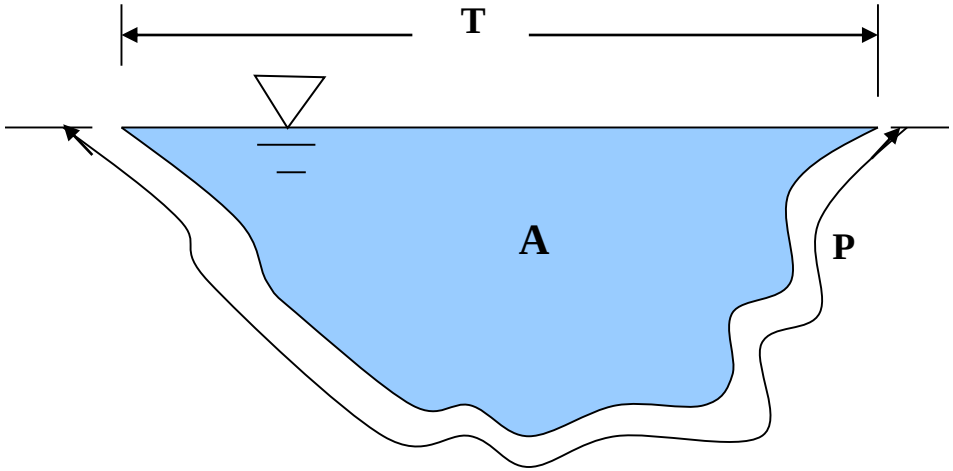
Stream Frequency



$$Stream\ frequency = \frac{No\ of\ streams\ in\ a\ network}{Total\ area\ of\ drainage\ basin}$$

$$= \frac{\sum N}{\sum A_d}$$

Channel Sectional Properties

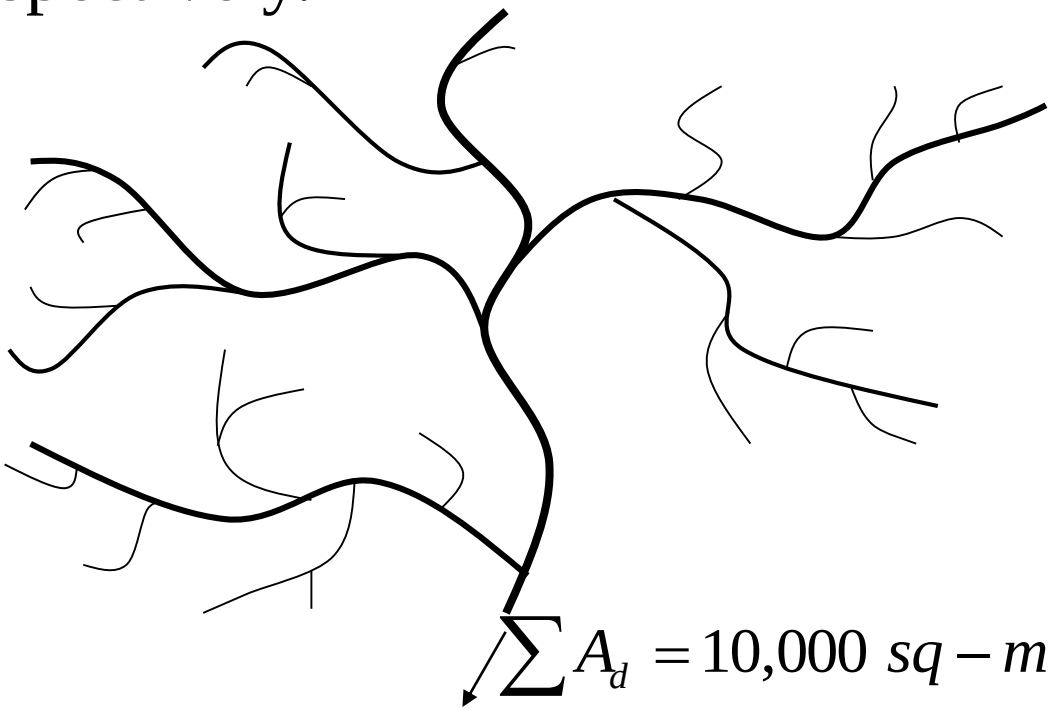


$$Hydraulic\ radius\ (R) = \frac{Wetted\ area\ (A)}{Wetted\ \ perimeter\ (P)}$$

$$Hydraulic\ depth\ (D) = \frac{Wetted\ \ Area\ \ (A)}{Top\ \ width\ \ (T)}$$

Worked Out Example - 1

A drainage area of rectangular shape with its drainage network is as shown below. The mean length of 1st, 2nd, 3rd and 4th order streams are 5.3, 24.8, 70.2 and 200.5 miles respectively.

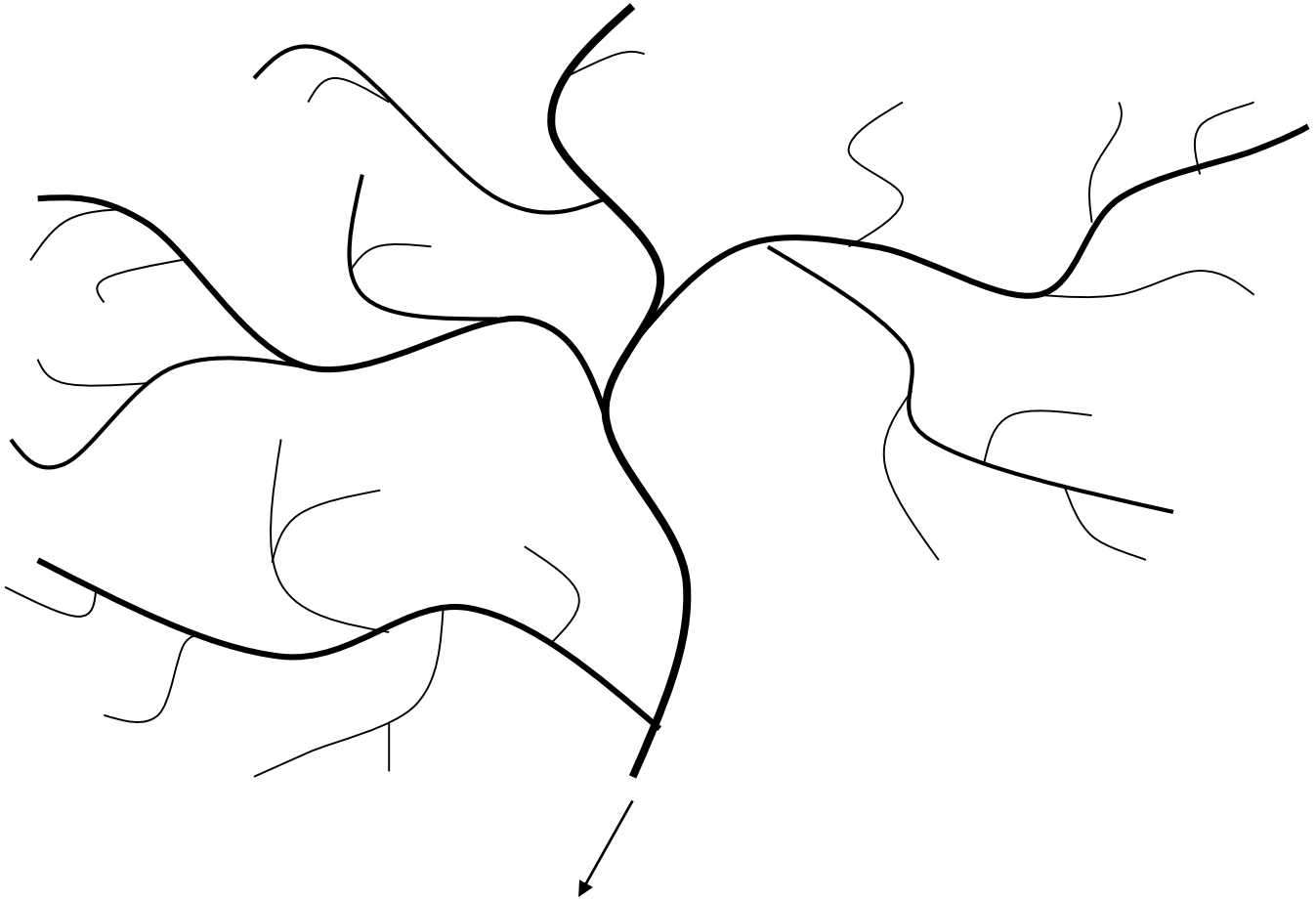


Worked Out Example - 1

Find –

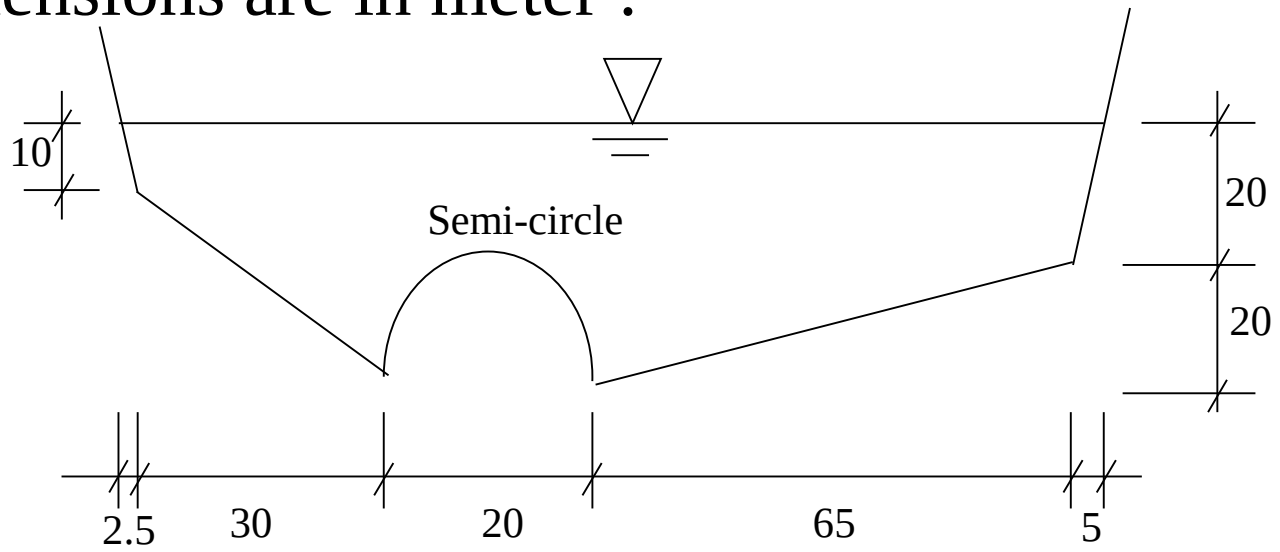
a. Bifurcation ratio.
b. Length ratio.
c. Drainage density.
d. Length of overland flow.
e. Stream frequency.
f. Graphically prove that the stream network closely meets the law of stream length and law of stream number.

Worked Out Example - 1



Worked Out Example - 2

- Determine the top width, wetted area, wetted perimeter, hydraulic radius and hydraulic depth for the channel section of the following Figure where all the dimensions are in meter .



Worked Out Example - 2

