CE-441- ENVIRONMENTAL ENGINEERING II

Lecture 5- Design of Storm Sewer

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Storm Sewer

- To design a storm sewer system, it is necessary to determine the **flow** which each segment must carry.
- Main Source = **Rainfall**

Rational Method

- Simplest method used for estimating the quantity of flow
- This procedure relates:

❑ Storm flow to the rainfall intensity

$$Q \infty I$$

❑ Storm flow to the tributary (flowing area)

$$Q \infty A$$

❑ A co-efficient C which represents the combined effects of surface storage, infiltration, and evaporation

Hence,

$$Q \propto IA$$

$$Q = CIA$$

Where,

Q=Actual amount of rainfall that appears as runoff (m^3/hr)

A=Area drained (m^2)

I=Intensity of rainfall ($m^3/m^2/hr$)

C=Co-efficient of runoff

Run-off coefficient "C"

- C for an area is variant i.e. tends to increase as the rainfall continues.
- Determine by using following formula

$$C = \frac{t}{8 + t}$$ Impervious surface

$$C = \frac{0.3t}{20 + t}$$ Pervious surface

Runoff coefficient for Various surfaces

Type of surfaces	C
Watertight roofs	0.70-0.85
Asphaltic cement streets	0.85-0.90
Portland cement streets	0.80-0.95
Paved driveways and walks	0.75-0.85
Gravel driveways and walks	0.15-0.30
Lawns, sandy soil 2%slope 2-7% slope >7 % slope	 0.05-0.10 0.10-0.15 0.15-0.20
Lawns, heavy soil 2%slope 2-7% slope >7 % slope	 0.13-0.17 0.18-0.32 0.25-0.35

Rainfall intensity(I)

- Defined as the precipitation rate expressed in mm/hr or in/hr
- Depends upon two factors

1 .Frequency of storm occurrence

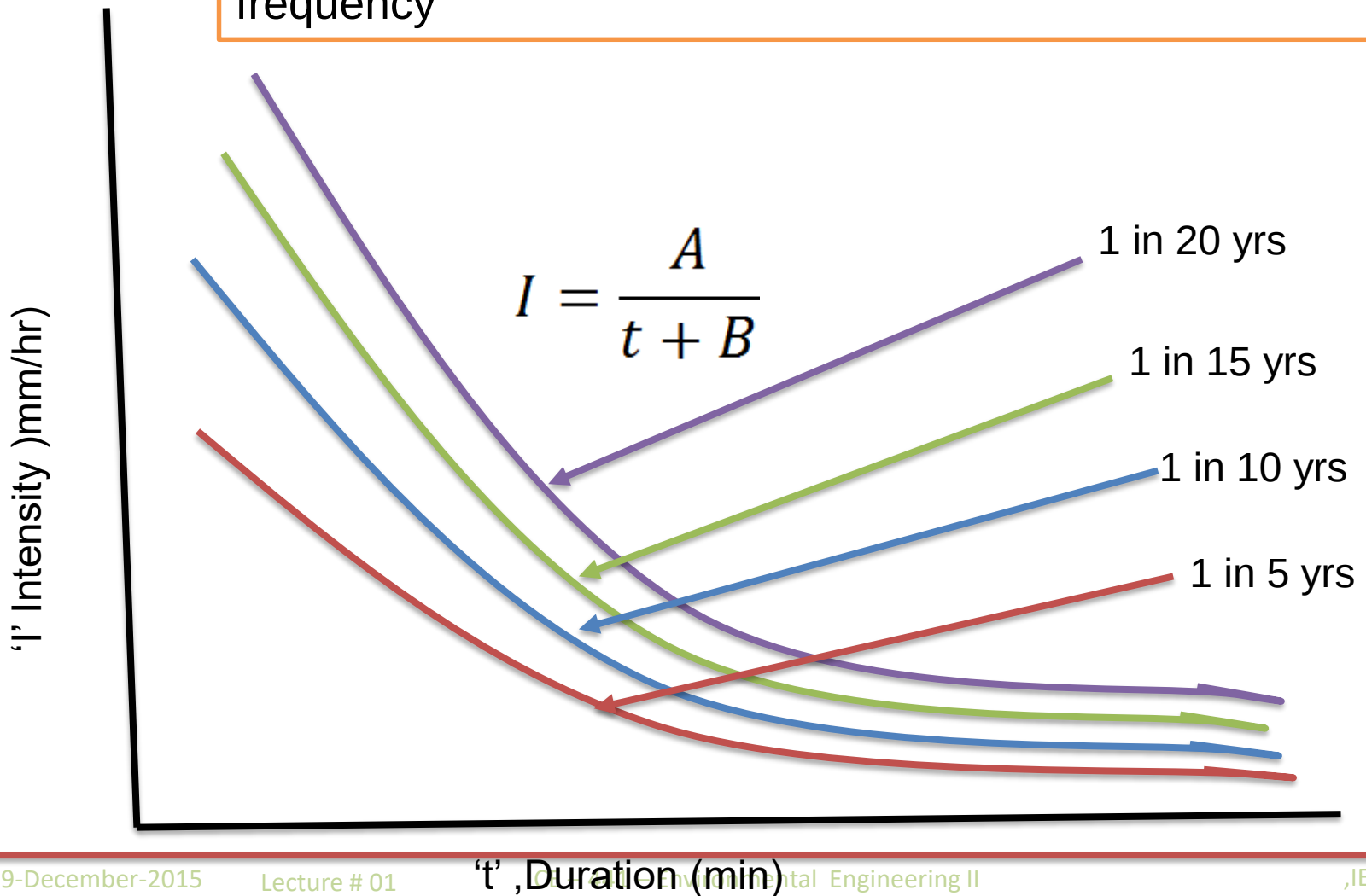
- ❑5 years for residential areas
- ❑10-15 years for commercial areas

2.Duration of storm

- ❑Up to 2 hours
- ❑Average intensity of storm decreases as the duration increases.

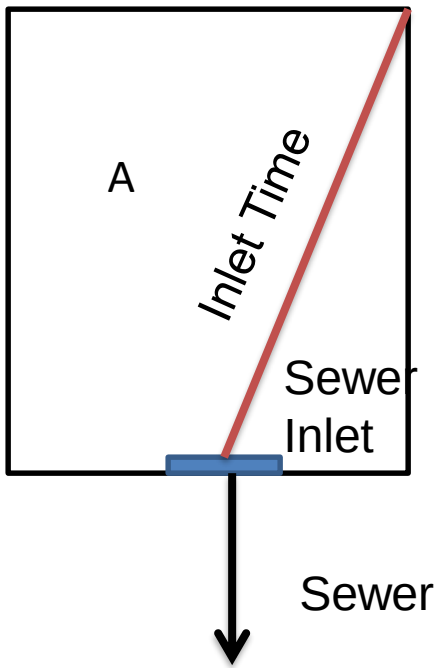
Relationship between I, t and frequency

A,B=Constants and vary for different area and cities.
For Lahore A=7190 , B=103 (for once in 5 year frequency based on 27 yrs rainfall record) now these values varies with frequency



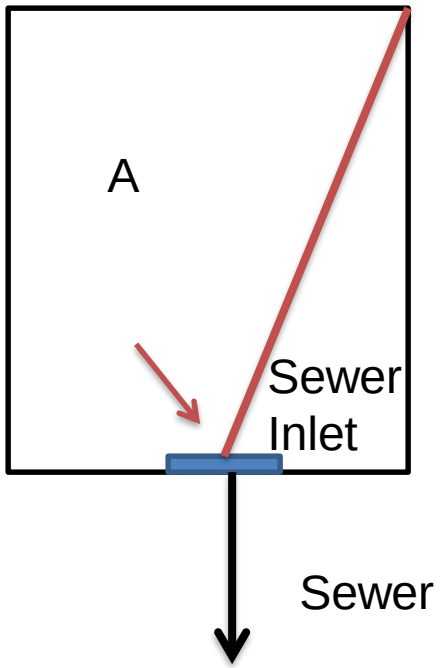
Inlet time

"Time required for the rain water to flow from the farthest point over the surface of the ground to the sewer inlet."



Inlet Time

Case 1



-Sewer should be designed based on duration of rainfall
-Which should be equal or greater than the time of travel of storm water from the farthest point to the sewer inlet

CASE 2

•Maximum runoff at M1 will be developed when rainfall duration is equal or greater then the inlet time.

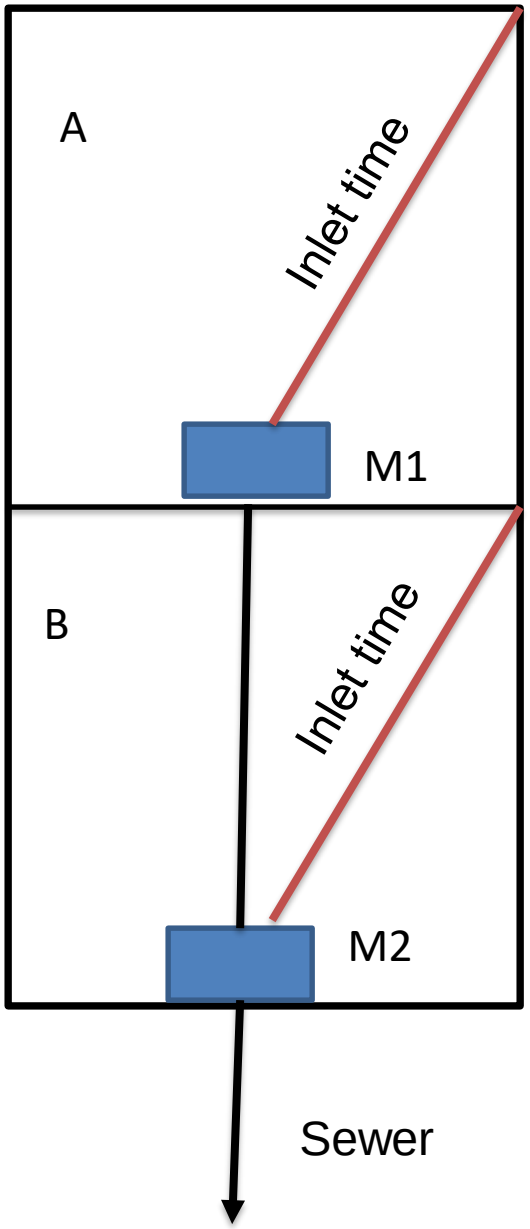
•So sewer line between M1 and M2 should be designed for that run off.

•Maximum runoff at M2 will be developed when rainfall duration is equal or greater then inlet time (up to M1) plus time of runoff travel in sewer from M1 to M2

Or

Inlet time of area B to M2

•So sewer line between M2 and M3 should be designed for that runoff.

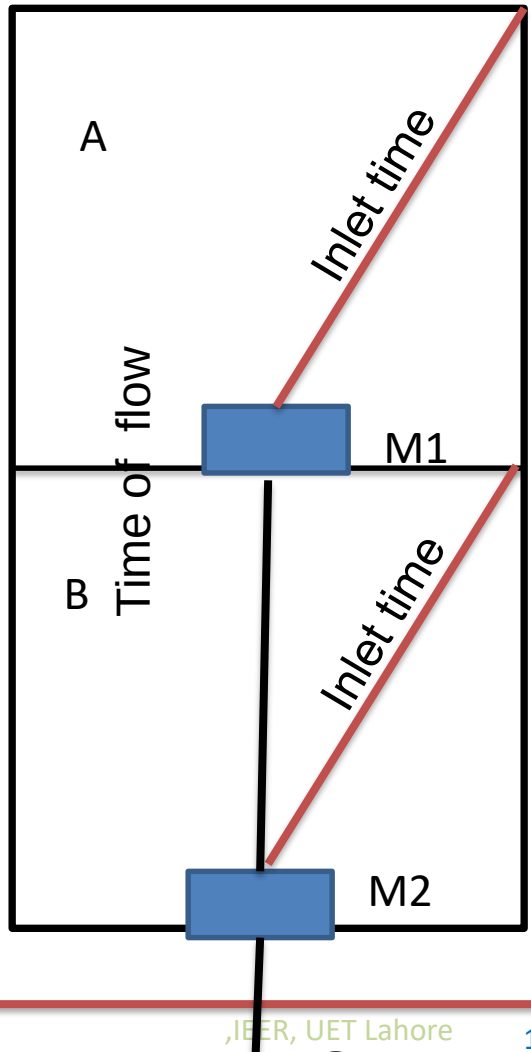


Time of Concentration

- Defined as *the time required for the maximum runoff rate to develop or it is the time required for storm water to run from the farthest point of the area to reach the point for which the maximum runoff is to be estimated*.

$$Time\ of\ conc = Inlet\ time + Time\ of\ flow$$

$$Time\ of\ flow = Tf = \frac{length\ of\ sewer}{velocity\ of\ flow}$$

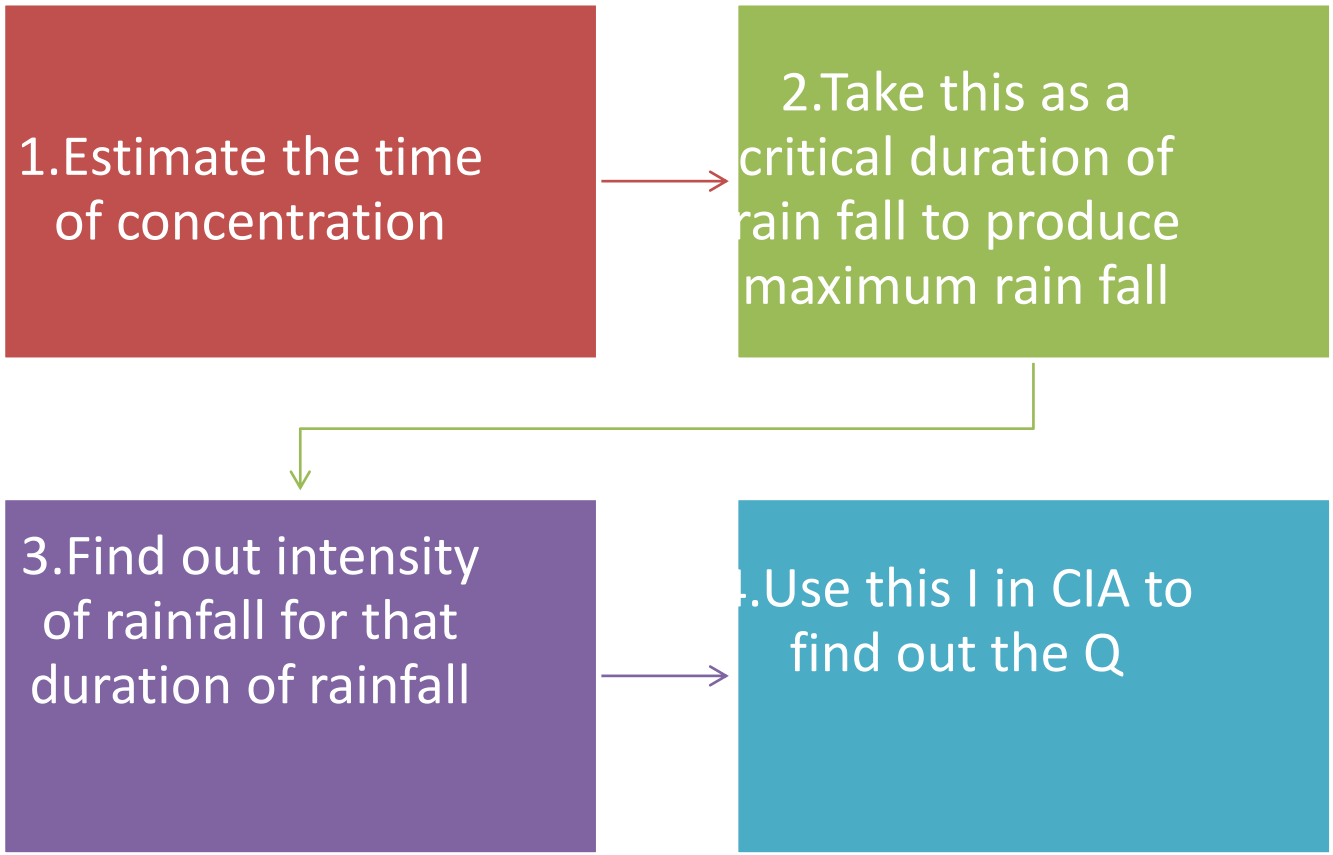


So storm water sewers must be designed taking into consideration the time of concentration at various manholes

Critical duration of rainfall

It is the duration of rainfall which will produce maximum runoff and so it is equal to the time of concentration

Steps for the design of storm sewer



Hydraulic Computations for Storm water Flow

HYDRAULIC COMPUTATIONS FOR STORMWATER FLOW

Sr. No.	Location (Street)	From MH	To MH	Increment Area ΔA	C	ΔAC	ΣAC	Time of Conc. t (min)	I = A/(t+B)	Q = CIA	Velocity m/s	Dia of Sewer (mm)	Sewer Slope	Length of Sewer (m)	Time of Flow (min)	Sewer Capacity m^3/sec.	Ground Elevation		Invert Level	
																	U/S	D/S	U/S	D/S
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Problem 1

- A sewer line is to serve 7.2 hectors, the imperviousness of area is 35%.Time of concentration is 30 minutes .The rainfall intensity
- formula adopted is I=3330/(t+19).
- Calculate the capacity of storm sewer.
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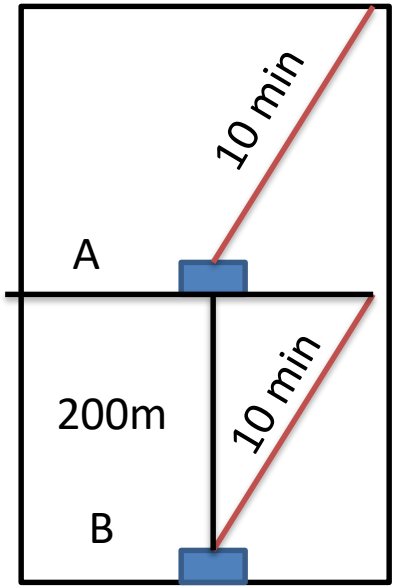
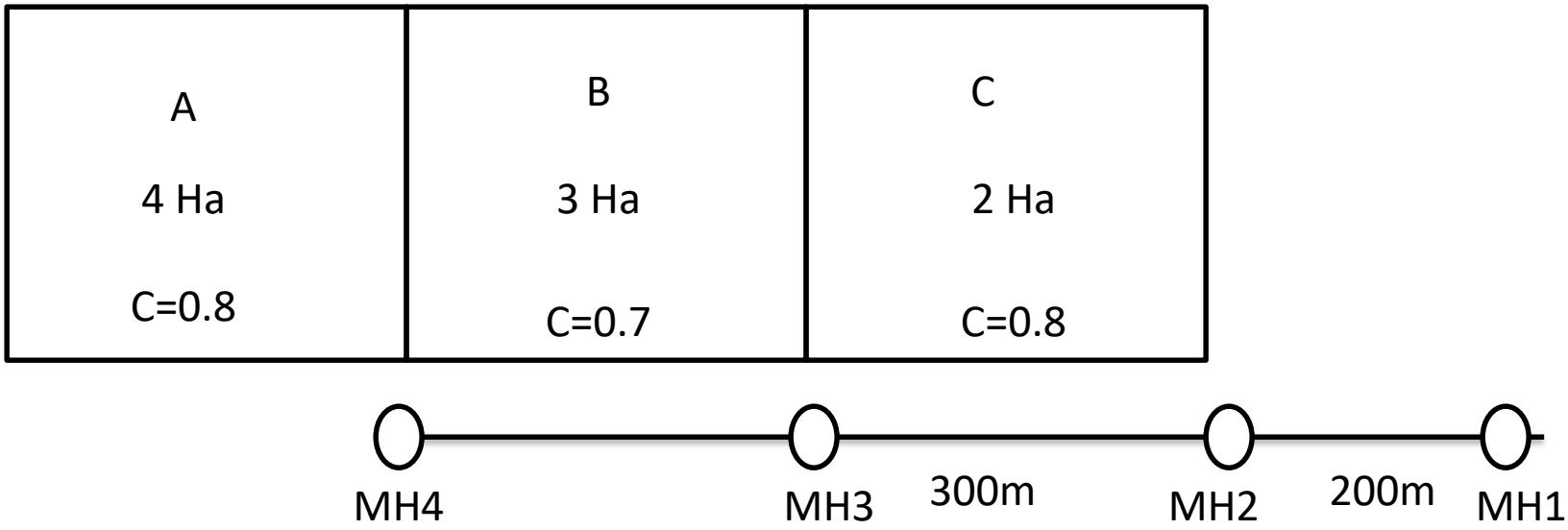
Problem 2

- Calculate the maximum storm water runoff at point A and B of the area which is divided into two equal parts of 4 hectors each .The intensity of rainfall is given by I=719/(t+103),C=0.4 and inlet time for each part of area is 10 minutes. Velocity of flow is equal to 1 m/s.



Problem 3 (Design of Storm Sewer)



Inlet time for each area=8 min

Velocity of sewer =1m/sec

Compute maximum rate of flow in storm sewer, diameter of sewer and sewer slope.

$$I = 2670/t+15$$