EWCE 331
Water Supply Engineering

Lecture 2

Instructor

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Lecture outline

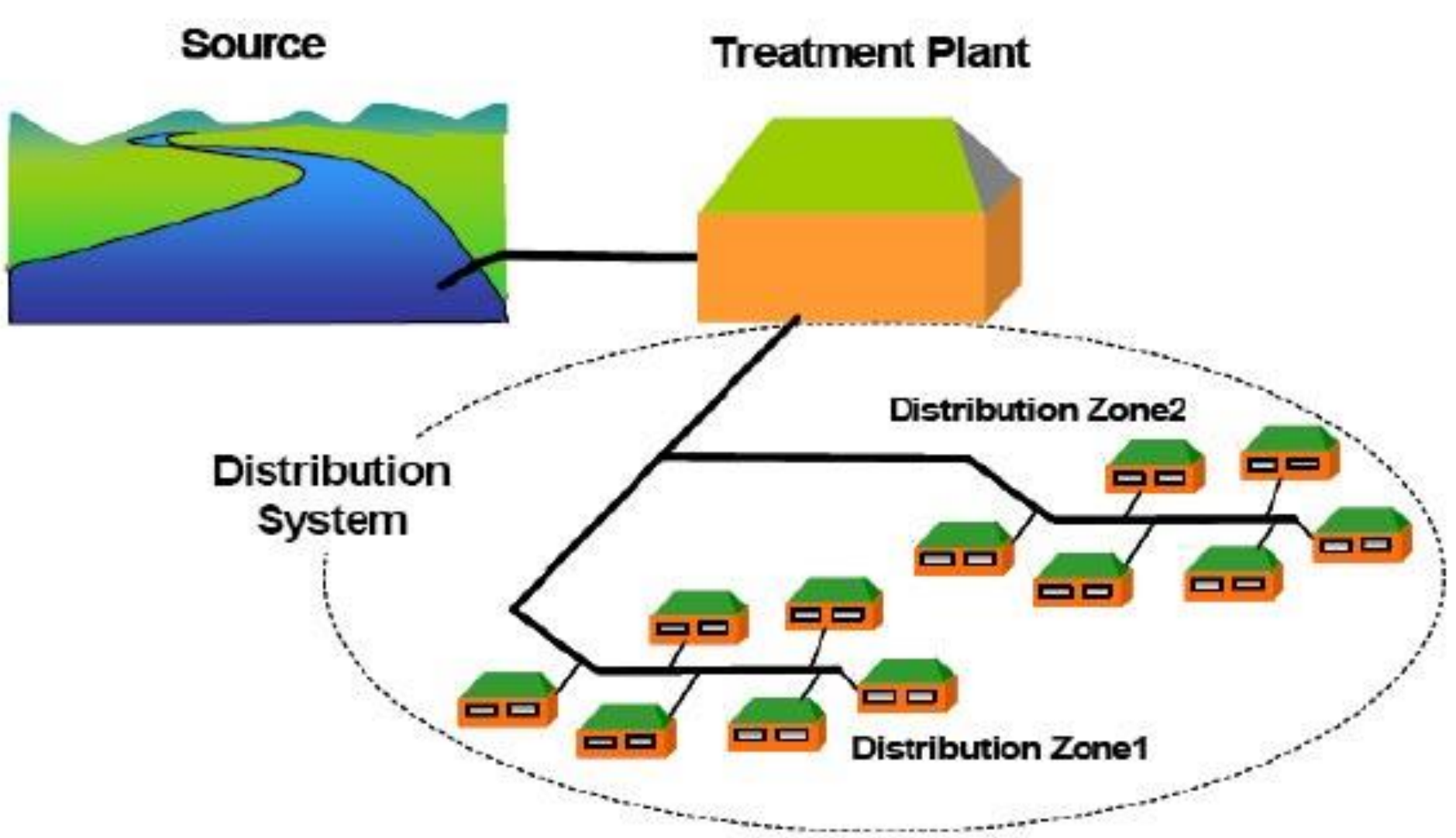
Surface water collection and transmission	
Topics	References
• **Water distribution system** • **Water Distribution methods**	**1. A Text Book of Water Supply Engineering** Authors: M. A. Aziz 1st ed., Hafiz Book Center **3. Water Supply and Sanitation** Authors: M. Feroz Ahmed, Md. Mujibur Rahman 1st ed., ITN-BUET **3. Water and Environmental Engineering** Authors: M. Habibur Rahman, Abdullah Al-Muyeed 1st ed., ITN-BUET

Water Distribution System

- The distribution system is that part of water works which –
  - receives the water from the pumping station of from conduits by the gravity flow and
  - delivers it throughout the district to be served.

- Distribution system comprises a network of pipelines that distribute water to the consumers.

Water Distribution System



Purpose of Water Distribution System

- Water distribution system is designed to adequately satisfy the water requirement for a combination of -
  - o Domestic
  - o Commercial
  - o Industrial
  - o Fire fighting purposes.

Requirement of Good Water Distribution System

A good distribution system should satisfy the followings:

- Adequate water pressure at the consumer's taps for a specific rate of flow (i.e., pressures should be great enough to adequately meet consumer needs).

- Pressures should be great enough to adequately meet fire fighting needs.

- At the same time, pressures should not be excessive because development of the pressure head brings important cost consideration and as pressure increases leakages increases too.

Requirement of Good Water Distribution System

- Note: In tower buildings, it is often necessary to provide booster pumps to elevate the water to upper floors.

- Purity of distributed water should be maintained. This requires distribution system to be completely water-tight.

- Maintenance of the distribution system should be easy and economical.

- The layout should be such that no consumer would be without water supply, during the repair of any section of the system.

Requirement of Good Water Distribution System

- It should be capable of supplying the requisite amount of water during fire fighting.

- It should be fairly water tight as to keep losses due to leakage to the minimum.

- Maintenance of the distribution system should be easy and economical.

Means of Water Distribution/ Supply

- Depending on the topography relationship between the source of supply and the consumer, water can be transported by:

  - ✓ Canals
  - ✓ Tunnels
  - ✓ Pipelines

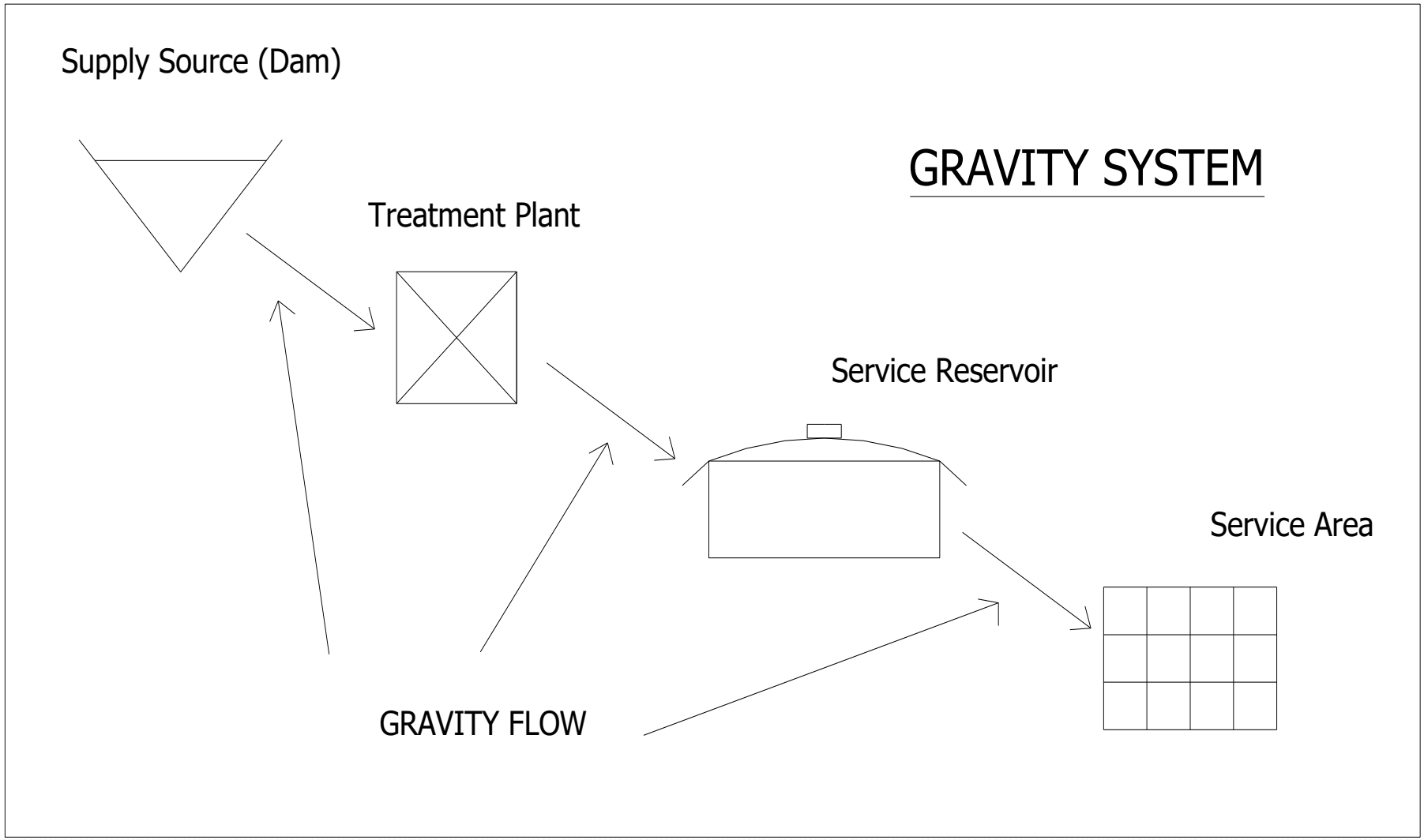
Water Distribution Methods

- For efficient distribution system adequate water pressure required at various points.

- Depending upon the level of source, topography of the area and other local conditions, the water may be forced into distribution system by following ways –

  - ❑ Gravity Flow System (Free-flow Conduit)
  - ❑ Direct Pumping System (Pressurized pipelines)
  - ❑ Combined gravity and pumping system

Water Distribution Methods – Gravity Flow

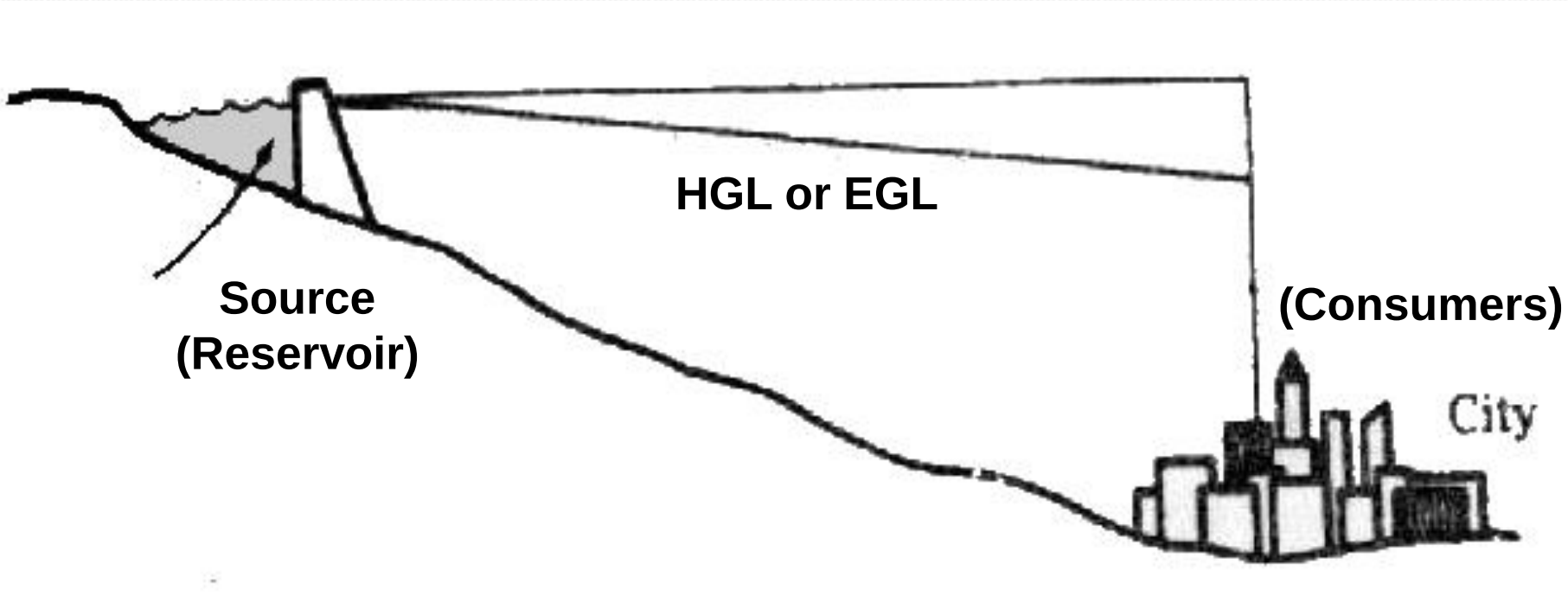


- Suitable when source of supply is at sufficient height.

Water Distribution Methods – Gravity Flow

- Free-flow conduits (canals, aqueducts and tunnels) are preferred in hilly areas or in areas where the required slope of the conduit more or less coincides with the slope of the terrain.
- Most reliable and economical distribution system.
- The water head available at the consumer is just minimum required.
- The remaining head is consumed in the frictional and other losses.
- Pump is not used.

Water Distribution Methods – Gravity Flow



Water Distribution Methods – Gravity Flow

Advantages

- Requires no energy to operate as water is conveyed by gravity.
- No pump is required and there are very few moving parts.
- Construction, operation and maintenance are simple.

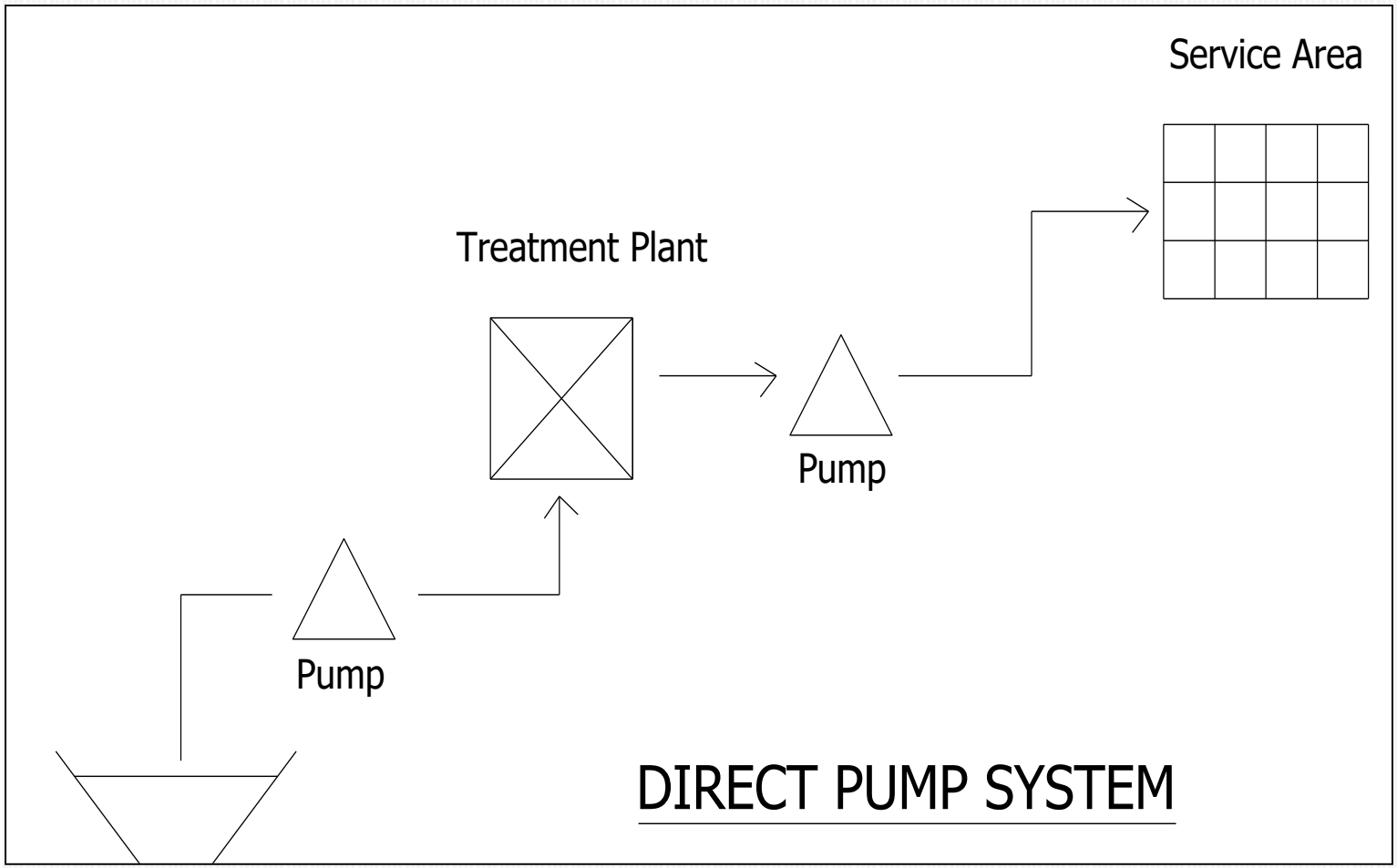
Water Distribution Methods – Gravity Flow

Disadvantages

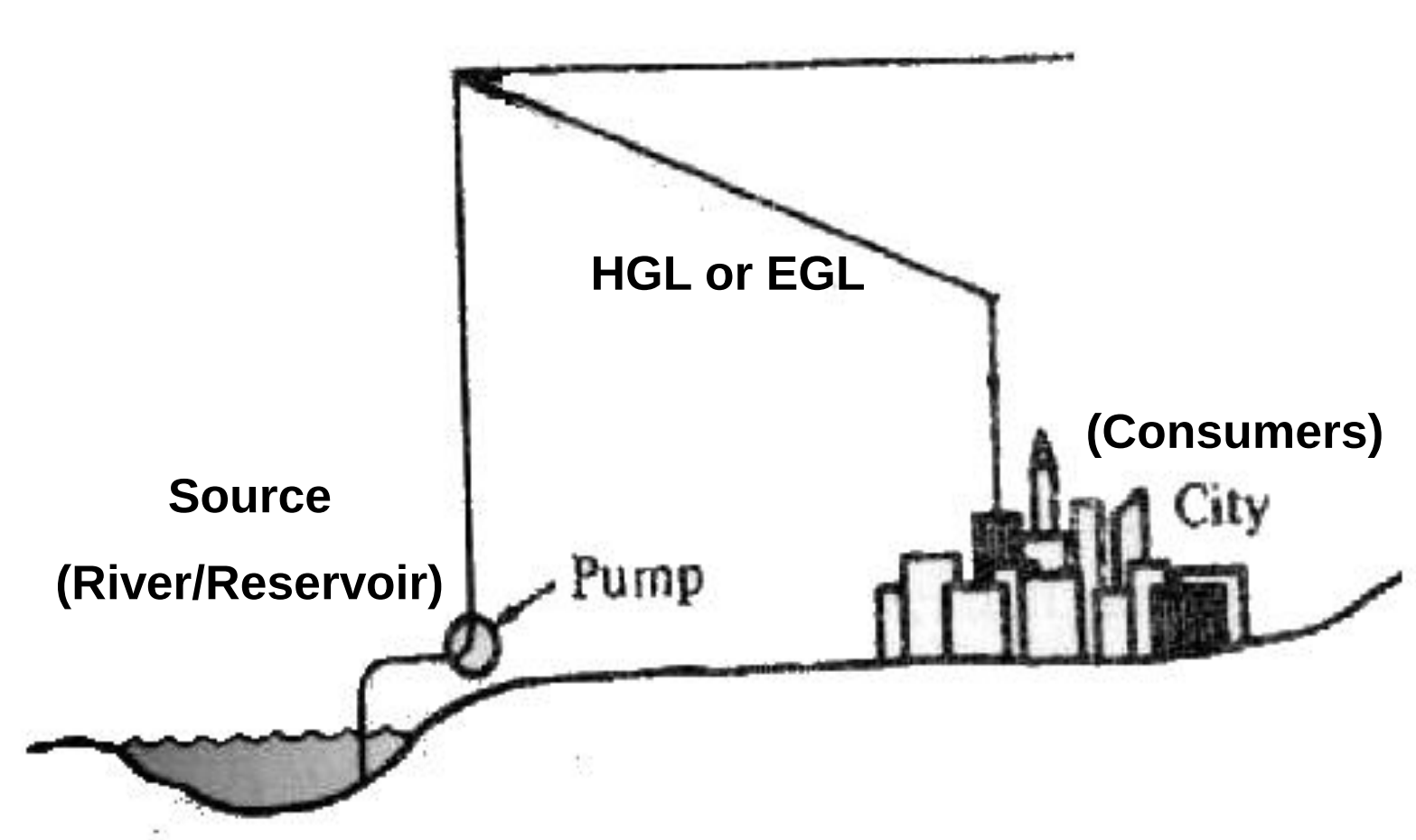
- Not applicable in those countries where an elevated source of water supply is not available.
- Water loss by leakage and wastage is comparatively higher as the system remains under constant pressure.

Water Distribution Methods – Direct Pumping System

- For small community water supplies through pressurized pipelined (direct pumping) are most common, since they are not very limited by the topography of the area to be traversed.



Water Distribution Methods – Direct Pumping System



Water Distribution Methods – Direct Pumping System

- Level of water sources is at the same height or lower from the service areas
- Treated water is directly pumped into the distribution main.
- Also called pumping without storage system.

Water Distribution Methods – Direct Pumping System

- High lifts pumps are required.
- If power supply fails, complete stoppage of water supply.
- The method is not generally used, since this system is expensive as well as less effective.

Water Distribution Methods – Direct Pumping System

Advantages

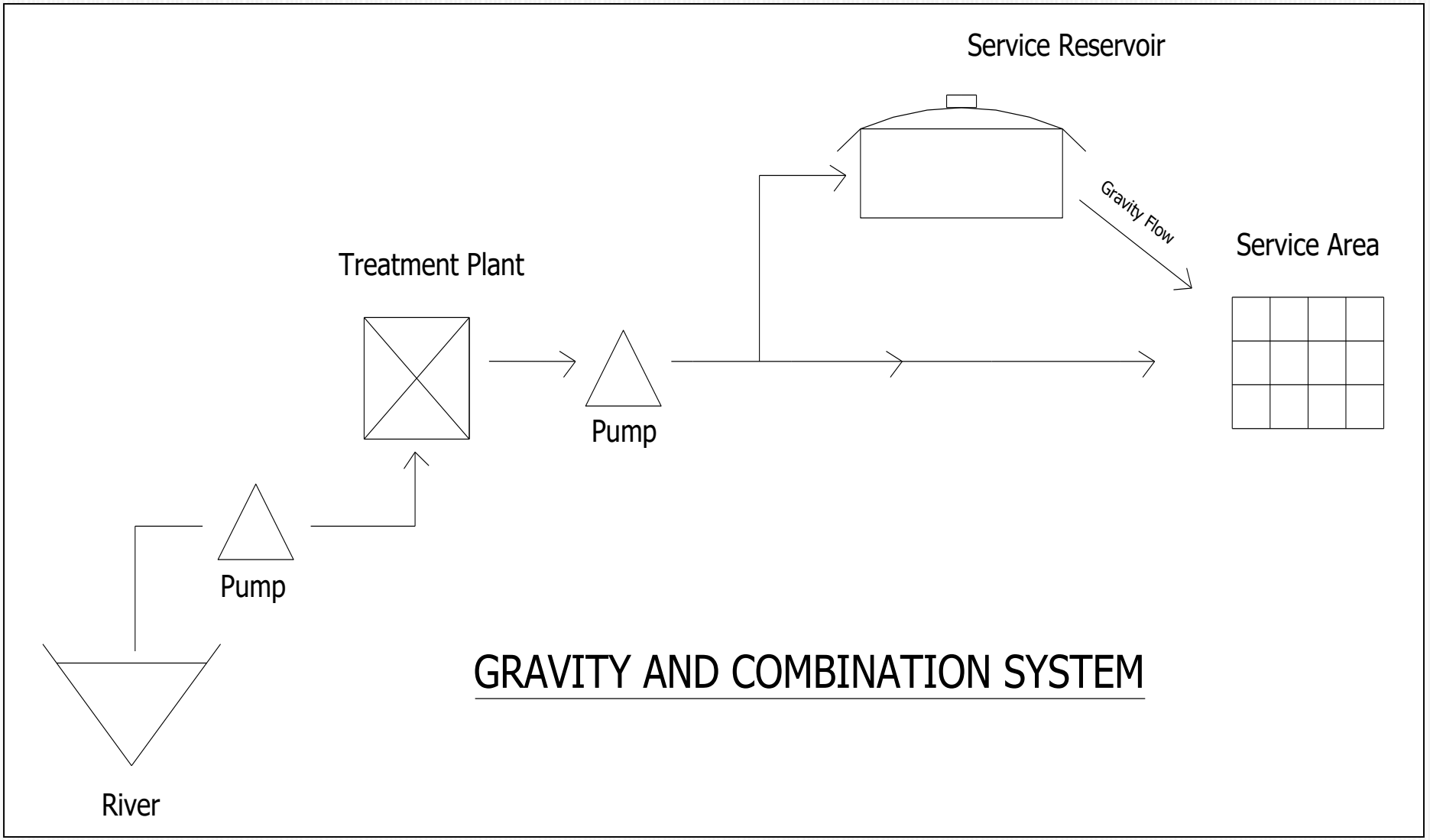
- Water can be pumped when required.
- Low water loss due to system leakage.

Water Distribution Methods – Direct Pumping System

Disadvantages

- Direct pumping at a uniform rate is not able to meet varying water demand and maintain required pressure under varying rates of consumption.
- A power failure means breakdown of the system.
- Maintenance and operation costs are high
- Inflow of water through leaks may cause water contamination during non-pumping hours.

Water Distribution Methods – Combined System

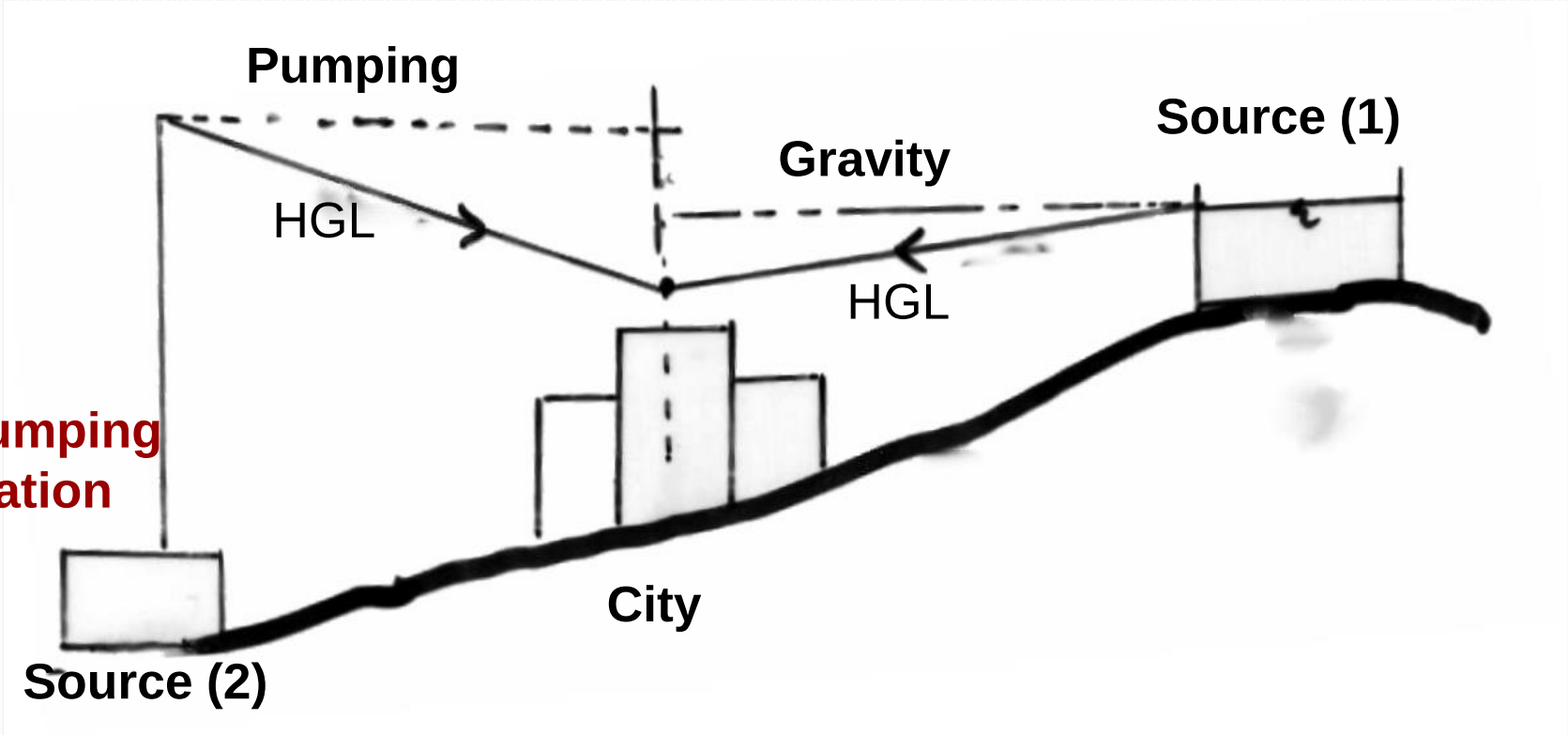


Water Distribution Methods – Combined System

- Most common system
- Treated water is pumped and stored in an elevated distribution reservoir.
- Then supplies to consumer by action of gravity.
- The excess water during low demand periods get stored in reservoir and get supplied during high demand period.
- Economical, efficient and reliable system.

Water Distribution Methods – Combined System

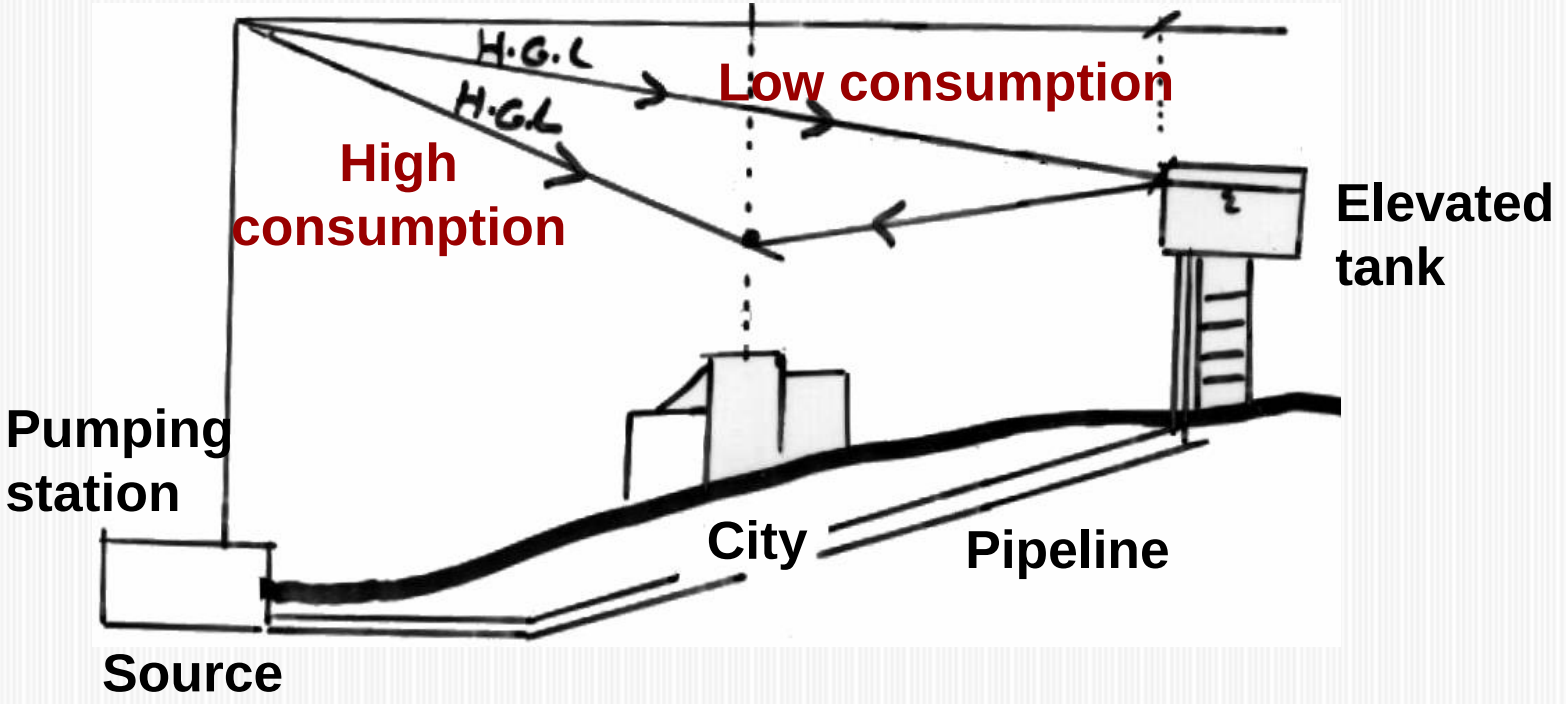
Case 1: When two sources of water are used to supply water



Water Distribution Methods – Combined System

Case 2: In the pumped system sometimes a storage (elevated) tank is connected to the system

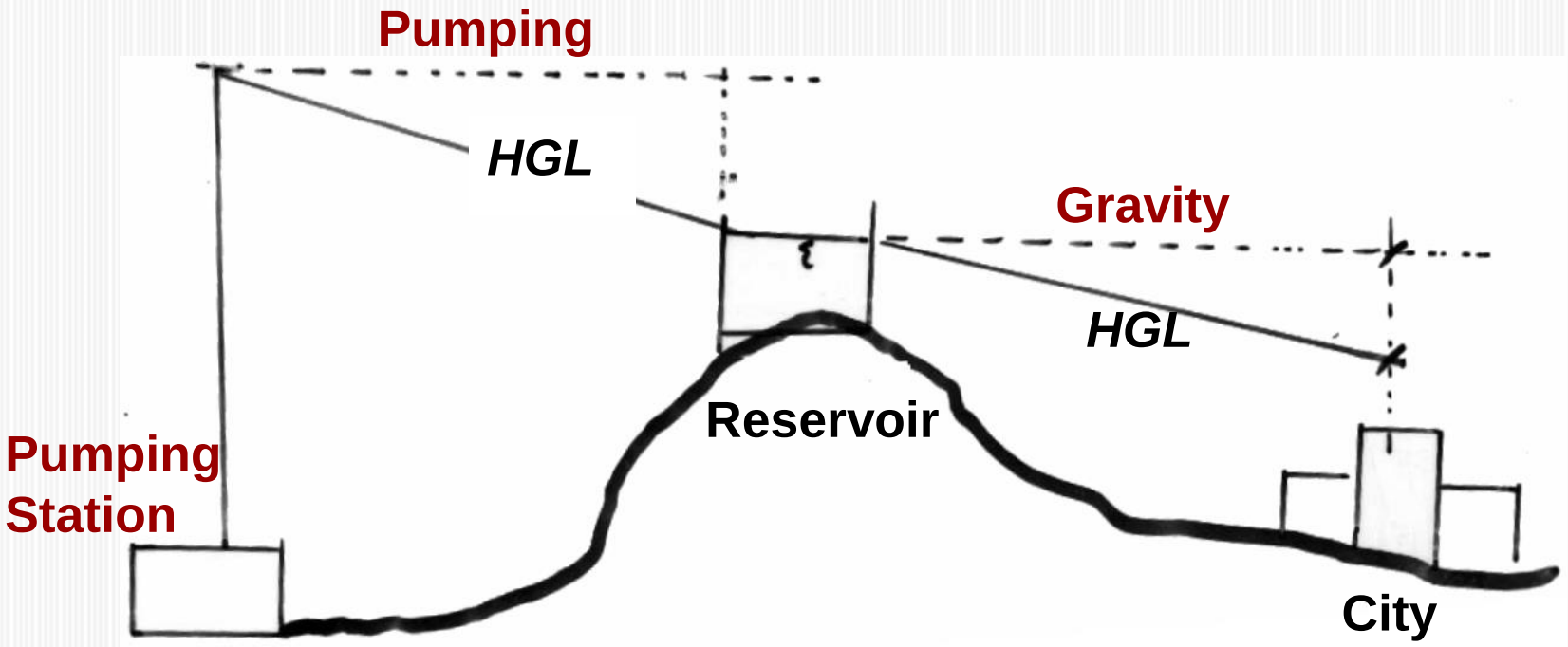
- When the water consumption is low, the residual water is pumped to the tank.
- When the consumption is high the water flows back to the consumer area by gravity.



Water Distribution Methods – Combined System

Case 3: When the source is lower than the consumer area

- A tank is constructed above the highest point in the area.
- Then the water is pumped from the source to the storage tank (reservoir).
- And hence the water is distributed from the reservoir by gravity.



Water Distribution Methods – Combined System

Advantages

- The system is more reliable and cope with fluctuation of water demand.
- The pumps can be operated at rated capacity, resulting in higher efficiency and economy of operation.
- Reasonable pressure can be maintained with varying water demand and there is no possibility of inflow of polluted water in the system.

Water Distribution Methods – Combined System

Disadvantages

- Relatively higher initial cost.
- Comparatively higher loss due to leakage and wastage.

Water Distribution Pipe System

Pipe system comprises of the following four units:

- Supply main
- Sub-main
- Minor distributors
- Valves

Water Distribution Pipe System

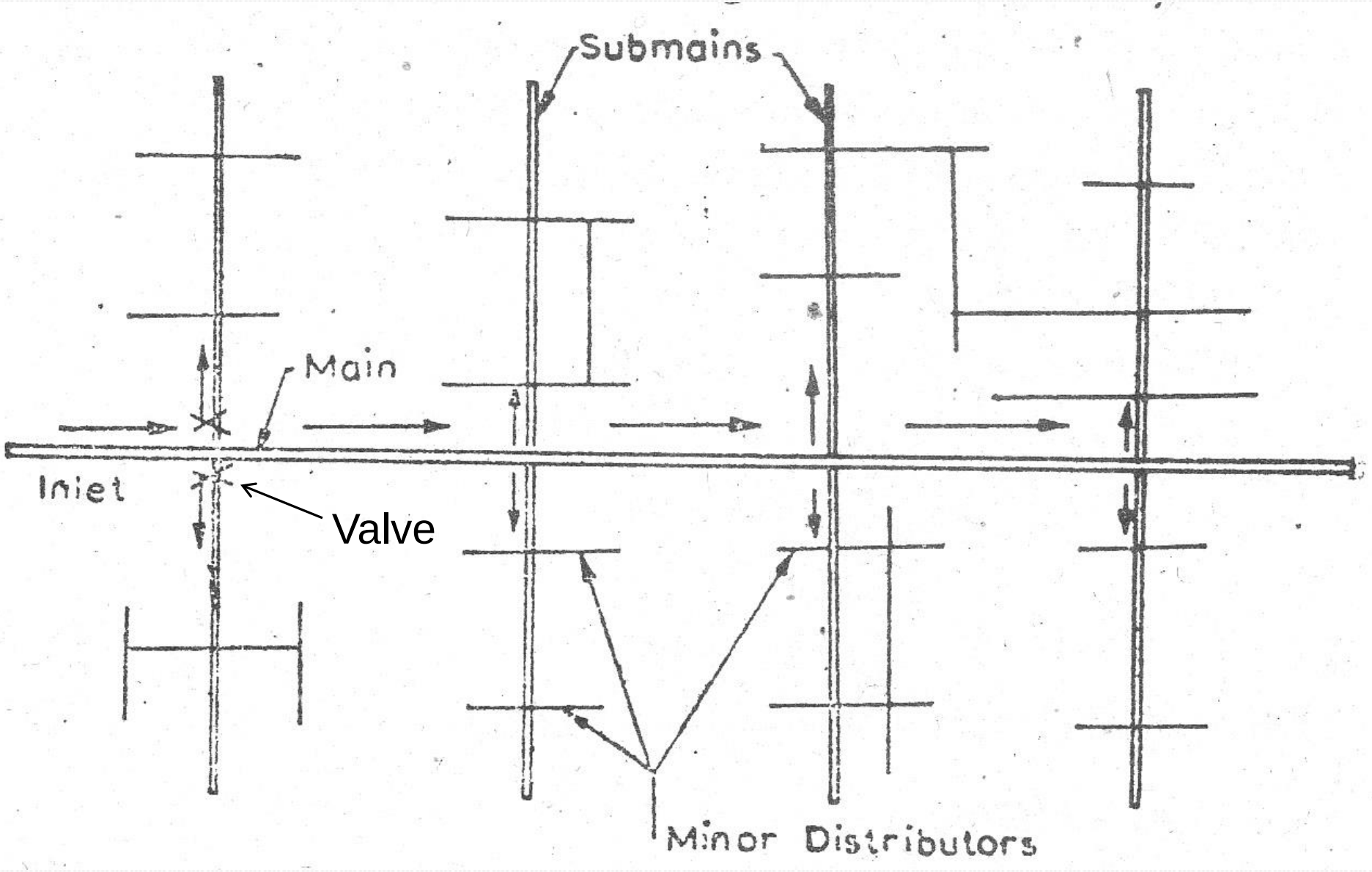
Supply main / Main

- Direct conveyor of water from the pumping plant or the gravity conduit.
- It should be of different size to carry the flow.

Sub-main

- Secondary feeders connected to either side
- May be placed at about 1000 ft apart
- Should be of sufficient size to discharge domestic supply and fire flow.

Water Distribution Pipe System



Water Distribution Pipe System

Minor Distributor/ Branches

- Make up the grid iron of pipes
- Supply water to the fire hydrants and service pipes of the residences and other buildings.
- For fire service, minimum diameter of pipe should be 6 inch and for domestic service alone, 4 inch or less.

Water Distribution Pipe System

Valves

- Needed to operate and control the pipe system.

- These should be sufficient in number and suitably located.

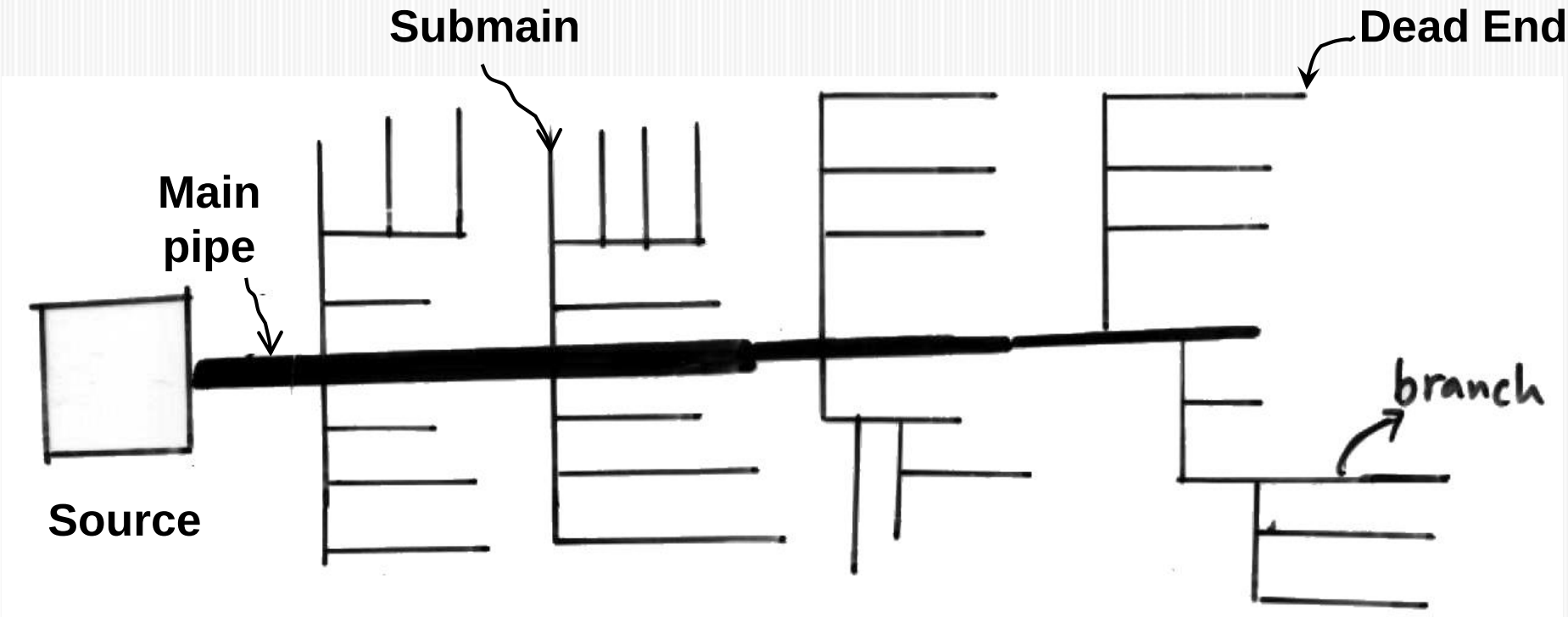
Layout of Water Distribution Network

- The distribution pipes are generally laid below the road pavements, and as such their layouts generally follow the layouts of roads.

- ***Types/ Configuration of distribution network:***
  (a) Branched distribution with dead end/ Tree system
  (b) Looped distribution network
    - ✓ Grid system
    - ✓ Ring system
    - ✓ Radial system
  (c) Combination of dead end and loop network

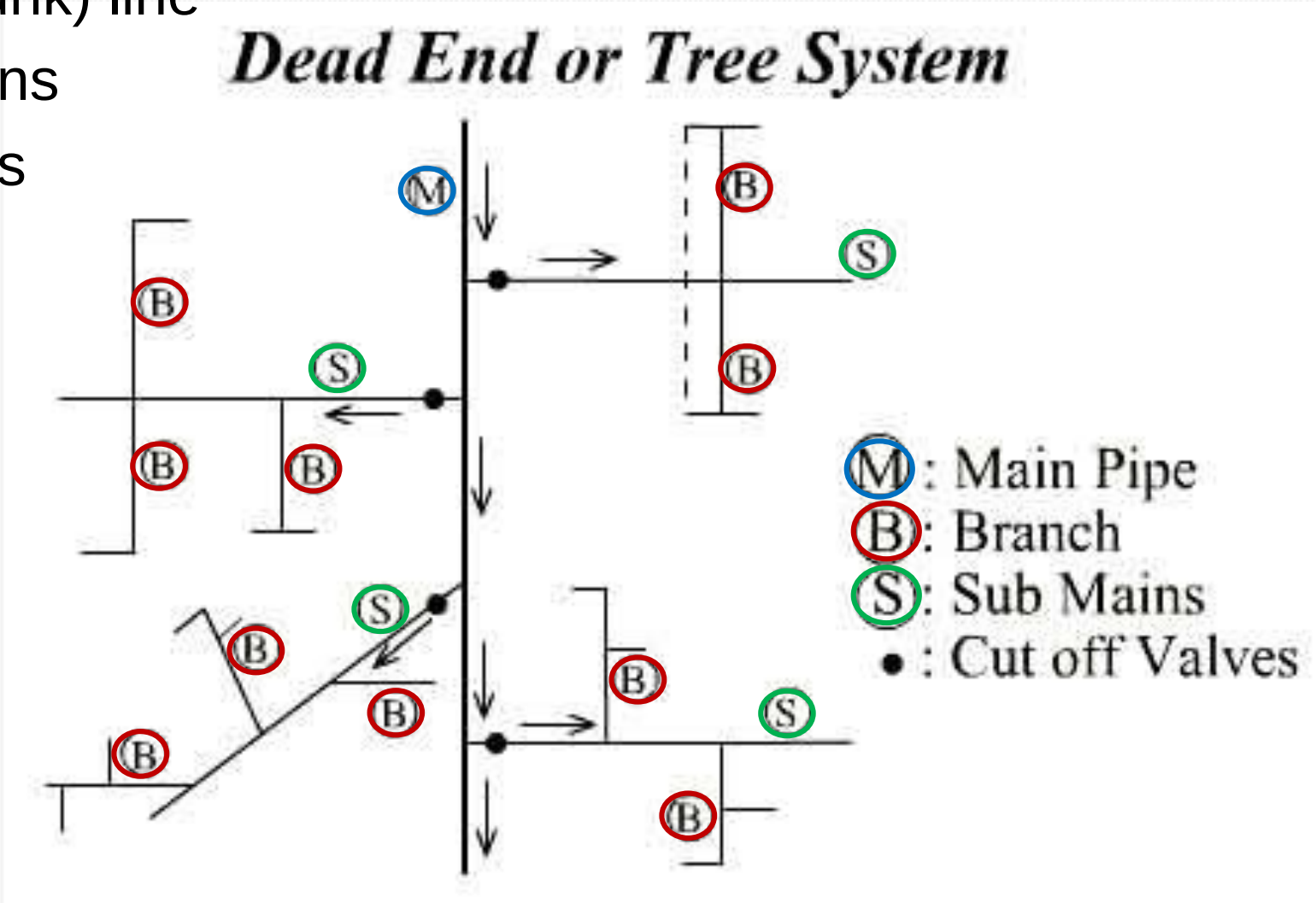
- Any one of the above mentioned systems either singly or in combinations, can be used for a particular place.

Branched Distribution Network / Dead End System



Branched Distribution Network / Dead End System

- It consists of
  - ✓ Main (trunk) line
  - ✓ Sub-mains
  - ✓ Branches



Branched Distribution Network / Dead End System

- Main line is the main source of water supply. There is no water distribution to consumers from trunk line.
- Sub-mains are connected to the main line and they are along the main roads.
- Branches are connected to the sub-mains and they are along the streets.
- Lastly service connections are given to the consumers from branches.

Dead End Distribution System

Advantages:

- It is a very simple method of water distribution and comparatively cheaper.
- Calculations for discharge and pressure are easy and simple to do.
- The required dimensions of the pipes are economical.
- This method requires comparatively less number of cut-off valves.
- It is suitable for old towns and cities having no definite pattern of roads.

Dead End Distribution System

Disadvantages:

- The area receiving water from a pipe under repair is without water until the work is completed.
- In this system, there are large number of dead ends where water does not circulate but remains static.
- Sediments accumulate due to stagnation of the dead end and bacterial growth may occur at these points.

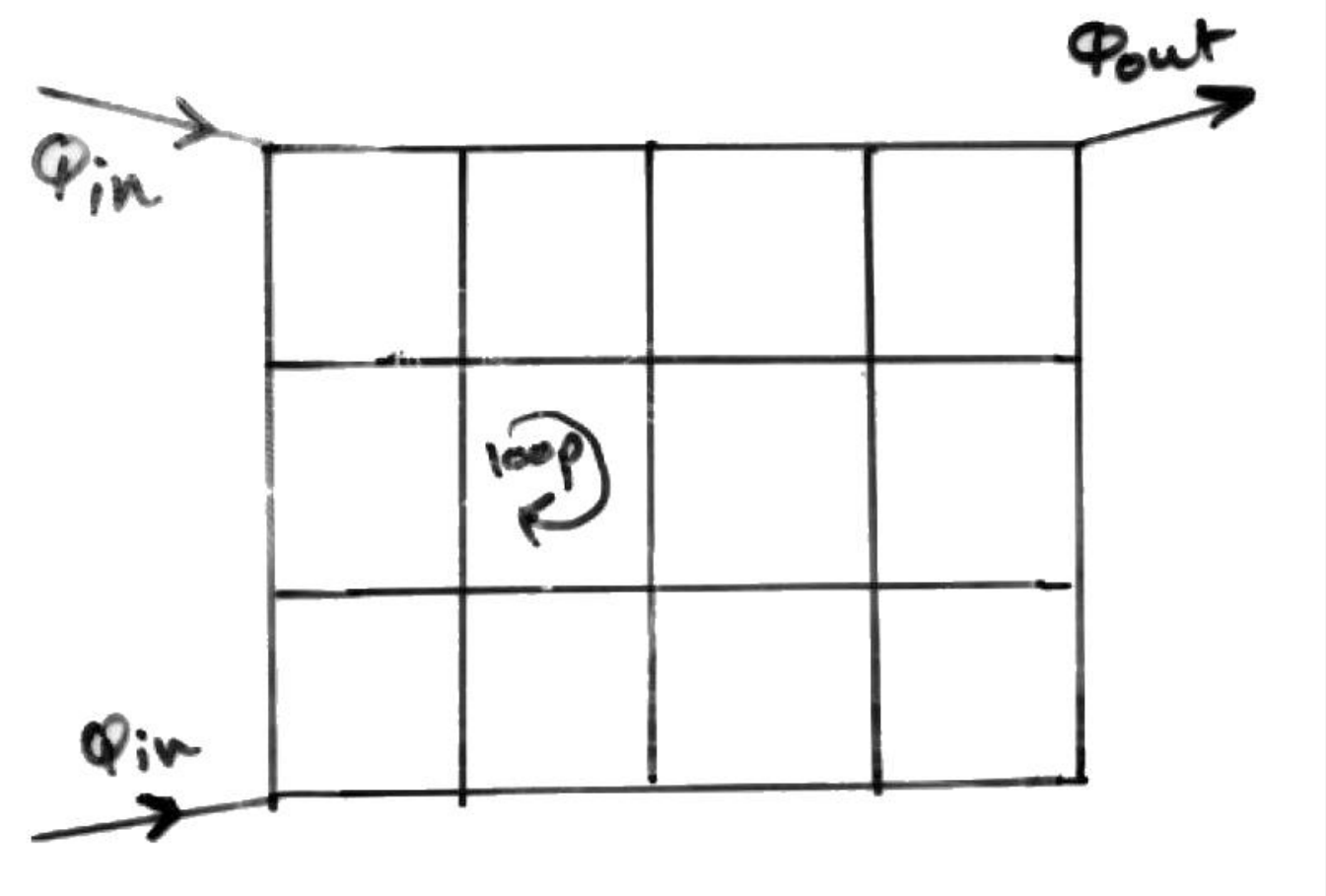
Dead End Distribution System

Disadvantages:

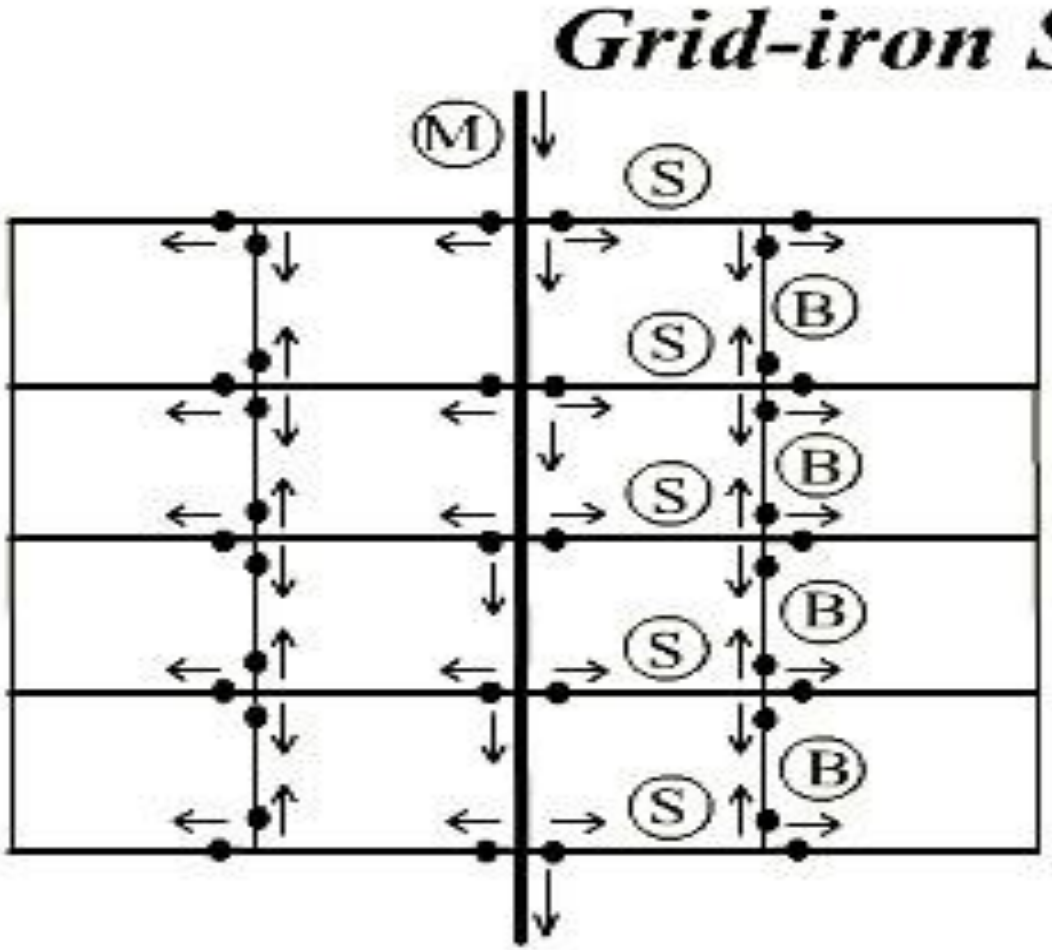
- To overcome the problem of standing water, drain valves are provided at dead ends and stagnant water is drained out by periodically opening these valves but a large amount of water is wasted.
- It is difficult to maintain chlorine residual at the dead ends of the pipe.
- Water available for fire-fighting will be limited since it is being supplied by only one water main.
- The pressure at the end of the line may become undesirably low as additional areas are connected to the water supply system.

Looped/ Grid System

The grid system overcomes all of the difficulties of the branching system discussed before.



Grid System



M : Main Pipe
B : Branch
S : Sub Mains
• : Cut off Valves

Grid System

- In grid pattern, all the pipes are interconnected with no dead-ends.
- In such a system, water can reach any point from more than one direction.
- It is suitable for cities with rectangular layout, where the water mains and branches are laid in rectangles.

Grid System

Advantages

- Since water in the supply system is free to flow in more than one direction, stagnation does not occur as readily as in the branching pattern.
- In case of repair or break down in a pipe, the area connected to that pipe will continue to receive water, as water will flow to that area from the other side.
- Water reaches all points with minimum head loss.
- At the time of fires, by manipulating the cut-off valves, plenty of water supply may be diverted and concentrated for fire-fight.

Grid System

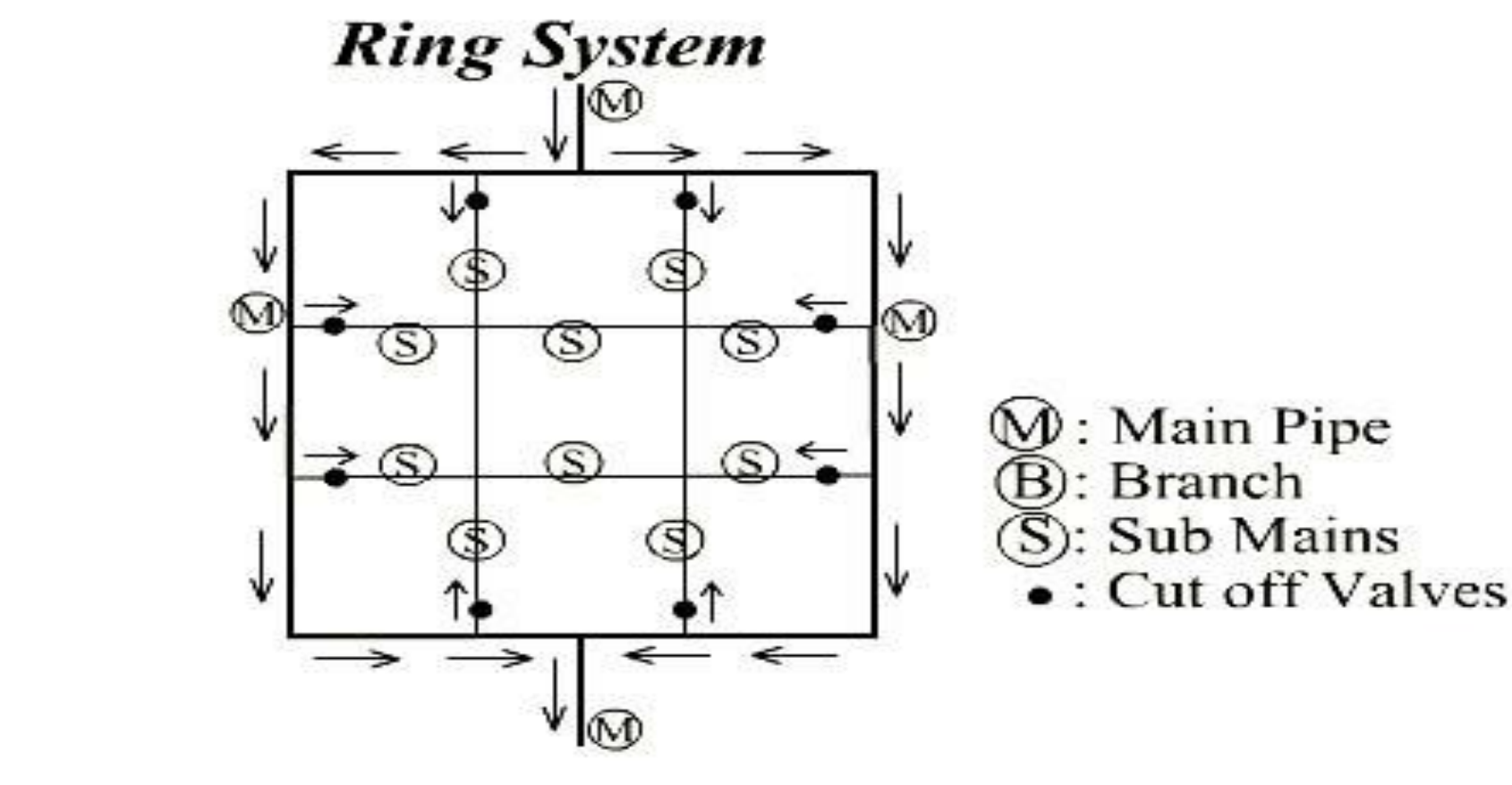
Disadvantages

- Cost of pipe laying is more because relatively more length of pipes is required.
- More number of valves are required.
- The calculation of pipe sizes are more complicated.

Ring System

- The supply main is laid all along the peripheral roads and sub mains branch out from the mains.
- This system also follows the grid iron system with the flow pattern similar in character to that of dead end system.
- Therefore, determination of the size of pipes is easy.

Ring System

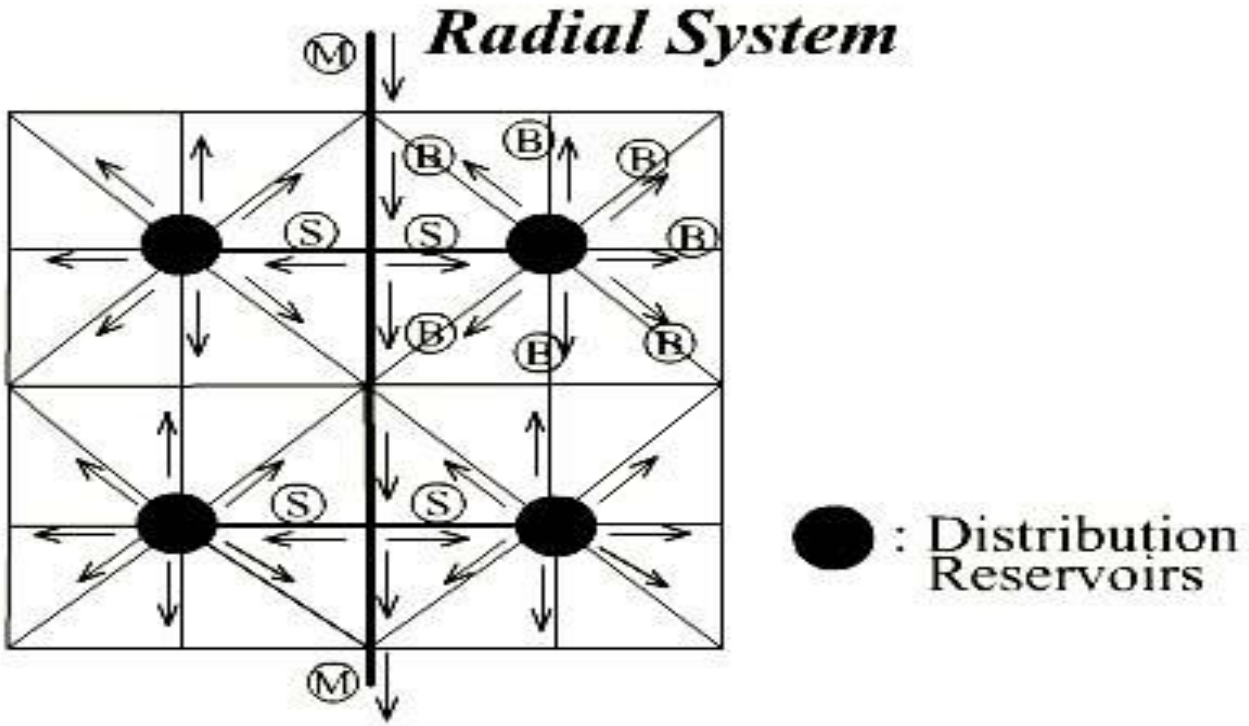


Advantages

- Water can be supplied to any point from at least two directions.

Radial System

- The area is divided into different zones.
- The water is pumped into the distribution reservoir kept in the middle of each zone.
- The supply pipes are laid radially ending towards the periphery.



Radial System

Advantages:

- It gives quick service.
- Calculation of pipe sizes is easy.

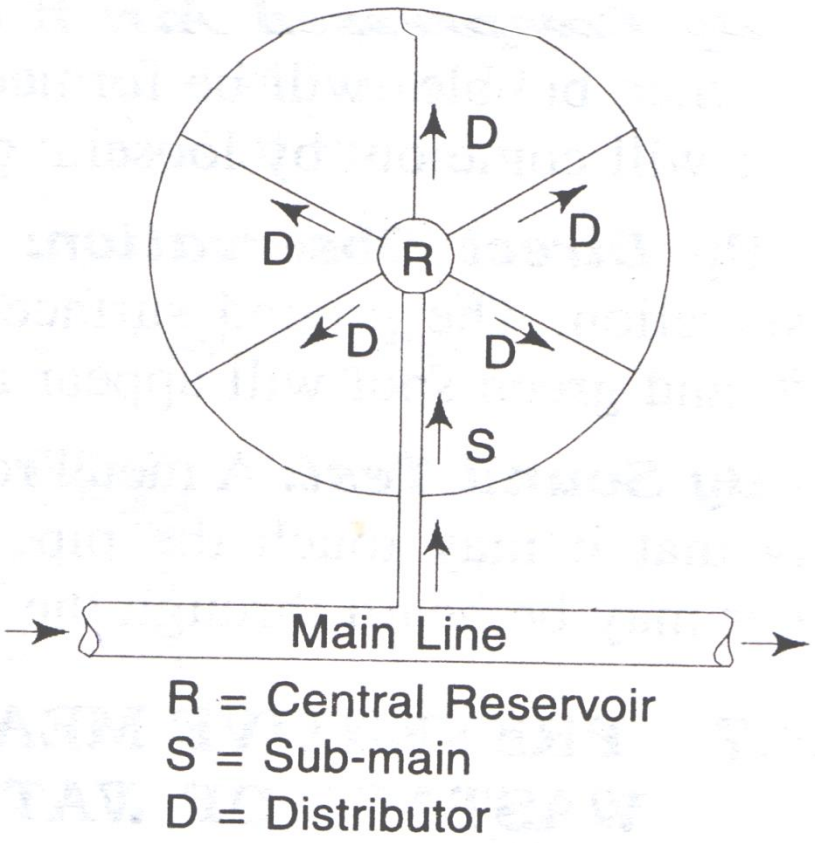
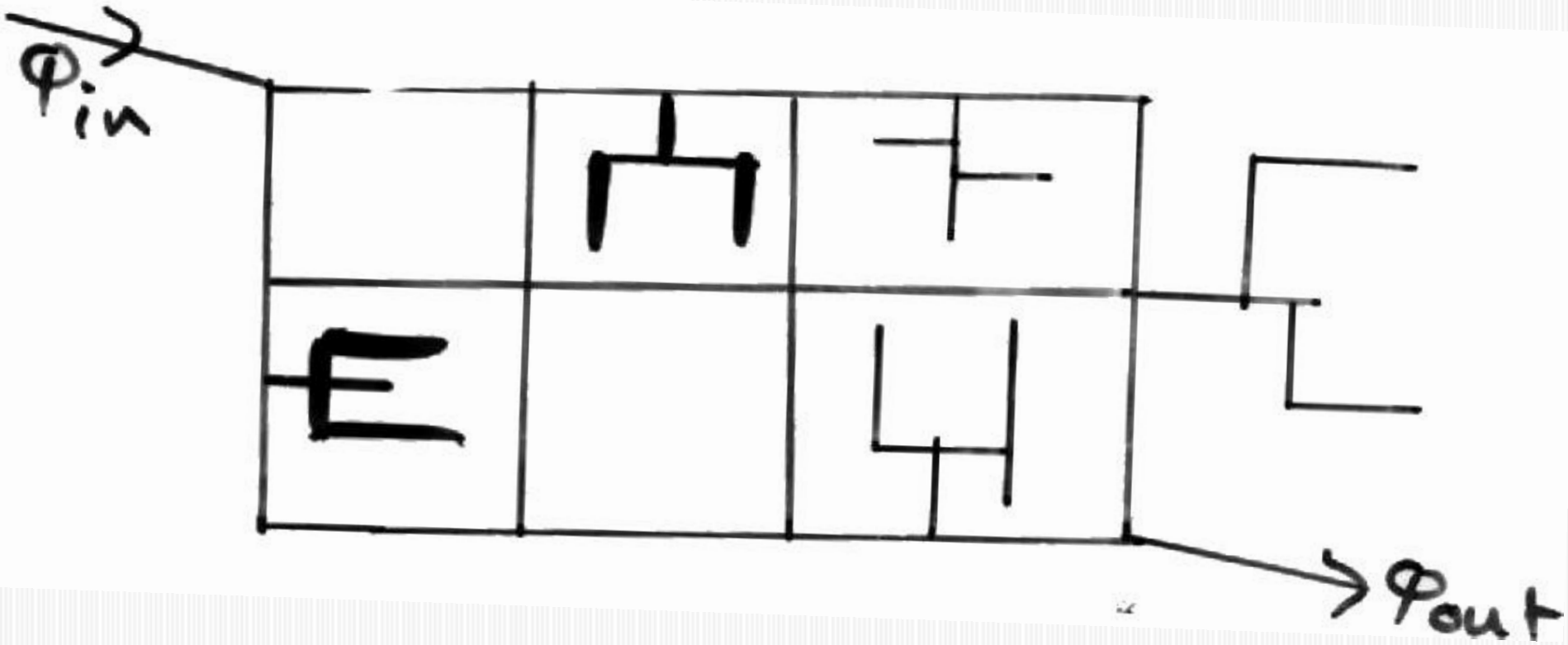


Fig. 13.7 *Radial method*

Combination of Dead End and Loop Network System



- It is a combination of both Grid and Branching systems
- This type is widely used all over the world.

Fire Hydrant



- **Main function :** provide water for firefighting
- **Spacing and location :** Depends on fire protection and insurance needs
- **Other function :**

i. Flush the distribution system lines to remove sediments and bio-growth accumulation

ii. Supply water to construction projects

iii. Provide water to water trucks and street sweepers

Distribution Reservoirs

- Distribution reservoirs, also called **service reservoirs**, are the **storage reservoirs**.
- Store the treated water for supplying water during emergencies (such as during fires, repairs, etc.)
- Also help in absorbing the hourly fluctuations in the normal water demand.

Distribution Reservoirs

- Such a reservoir can be filled by pumping water at a certain rate.
- Can be used to supply water even at rate higher than inflow rate during period of maximum demands called critical periods of demand.
- Such reservoirs are helpful in permitting the pumps or the water treatment plants to work at a uniform rate, and
- They store water during the hours of no demand or less demand, and supply water from their storage during the critical periods of maximum demand

Functions/ Purpose of Distribution Reservoirs

- To absorb the hourly variations in demand.
- To maintain constant pressure in the distribution main.
- Water stored can be supplied during emergencies.

Design Criteria of Distribution Reservoirs

- Should be located as close as possible to the centre of demand.
- Water level in the reservoir must be at sufficient elevation to permit gravity flow at an adequate pressure.

Types of Reservoirs

Depending upon the elevation with respect to ground, it may be classified into the following types:

- **Surface reservoirs**
- **Elevated/ Overhead reservoirs**





Surface Reservoirs

- These also called ground reservoir.
- Mostly circular or rectangular tanks.
- Underground reservoir are preferred especially when the size is large.
- These reservoirs are constructed on high natural grounds and are usually made of stones, brick, plain or reinforced concrete cement.
- The side walls are designed to take up the pressure of the water, when the reservoir is full and the earth pressure, when it is empty.

Elevated/ Overhead Reservoirs

- It is also referred to as overhead tanks.
- Are required at distribution areas which are not governed and controlled by the gravity system of distribution.
- These are rectangular, circular or elliptical in shape.
- If the topography of the town not suitable for under gravity, the elevated tank or reservoir are used.
- They are constructed where combine gravity and pumping system of water distribution is adopted.
- These tanks may be steel or RCC.