Environmental Engineering-I

Lecture 10 - Water Distribution System

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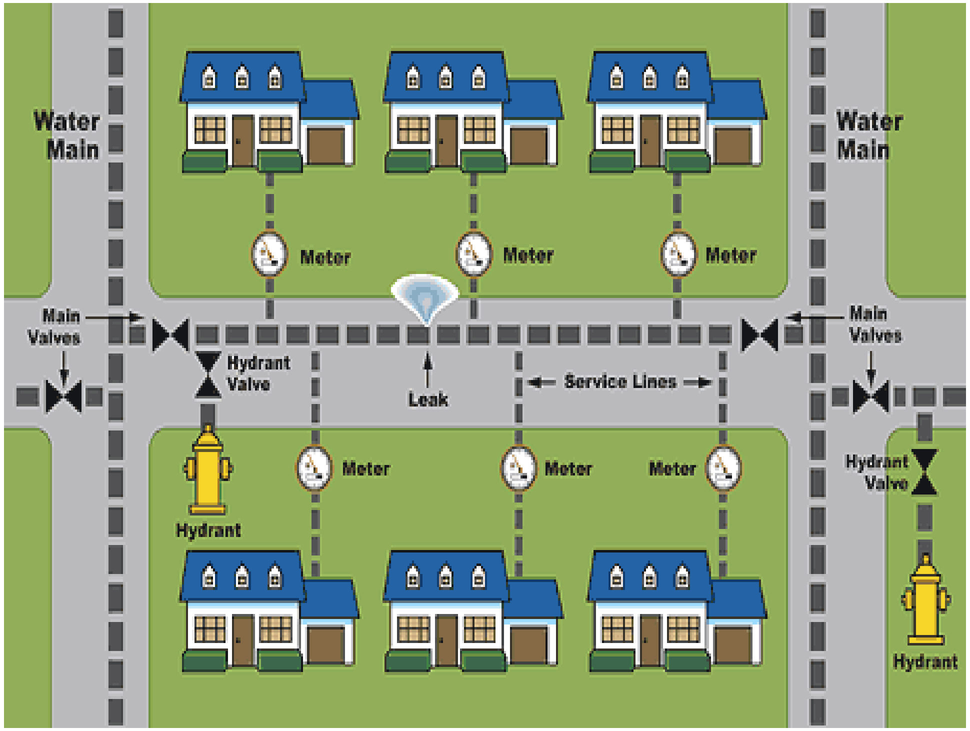
Components

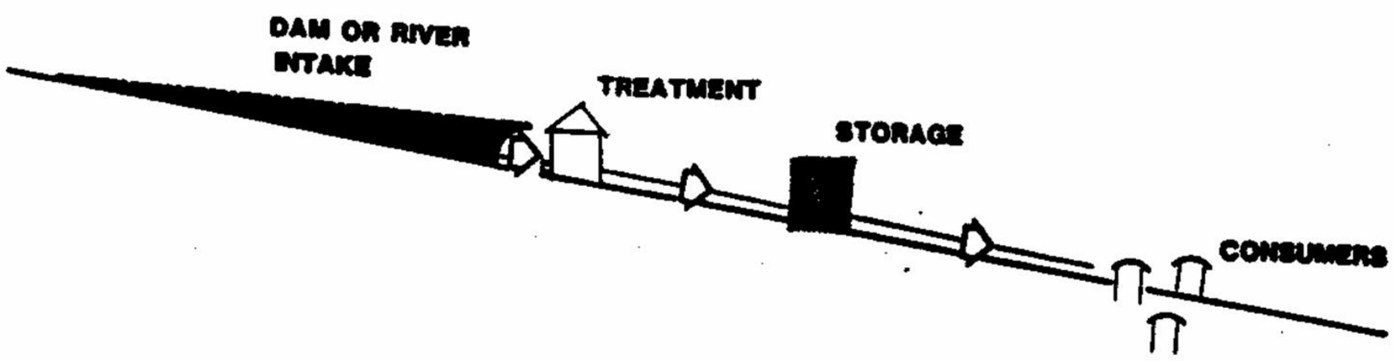
- Pipes
- Fire Hydrants
- Valves
- Service Reservoirs (OHR)



Types of Water Distribution System

1- Gravity distribution

- Natural slope, spring at peak
- Economical & easy to install
- Site specific not applicable in all scenario
- For fire protection we generally install pumps



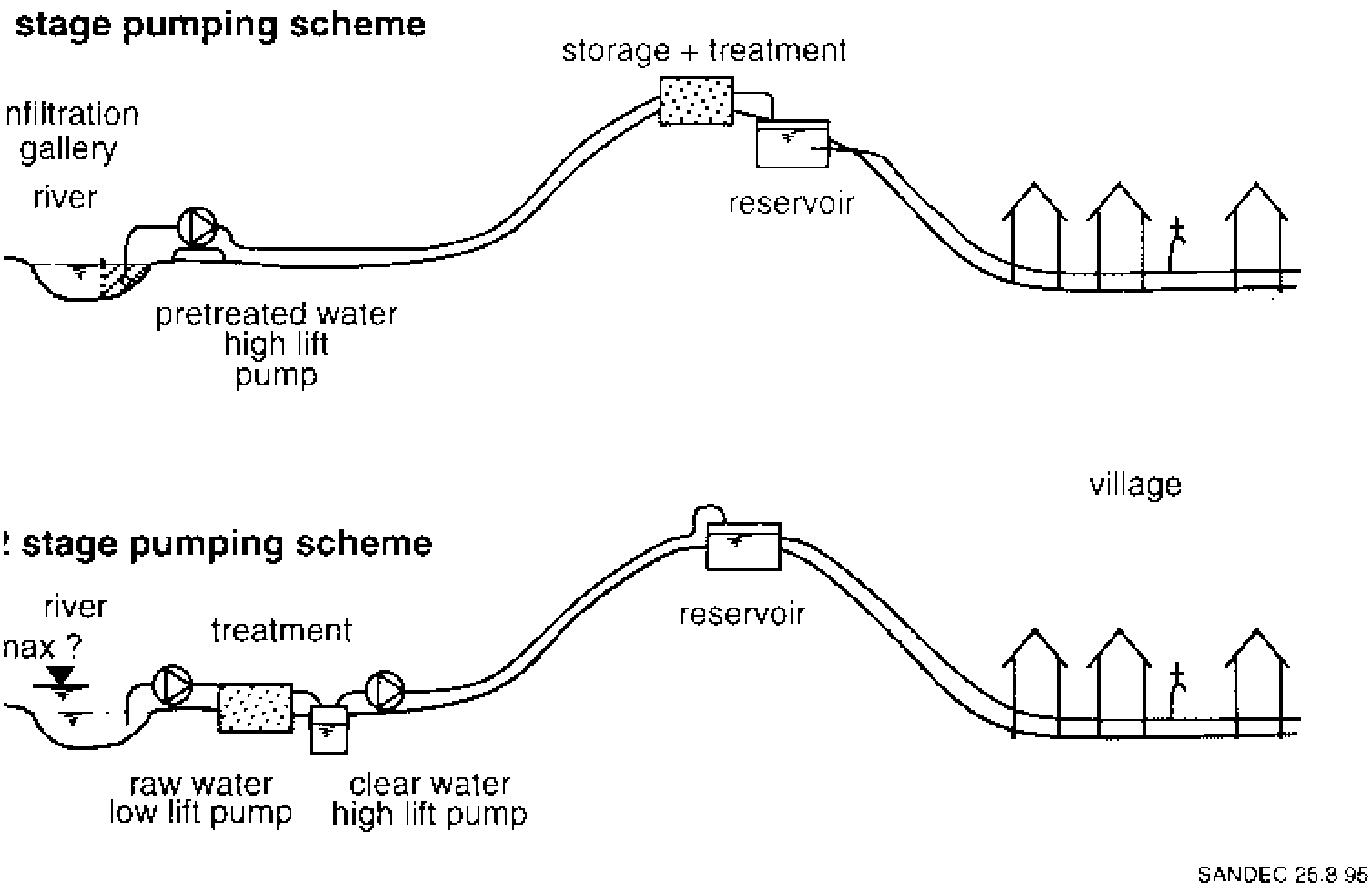
2- Direct Pumping

- High electricity cost
- Operator role important **(Constant attendance)**
- Power /tube well or fire breakdown problem
- Pressure variation
- Pumps are design at peak hourly flow
- Several pumps to deal varying demand
- No storage

3- Pumping with Storage

- Excess water pumped during periods of low consumption stored in OHR
- High consumption periods water drawn out to augment pumped water
- Constant pumping rate
- Economical as pumping rate is set at maximum daily instead of peak hourly flow
- More reliable due to fire fighting reserve

Pumping with storage



• Types of Layout

Dead End or Tree System

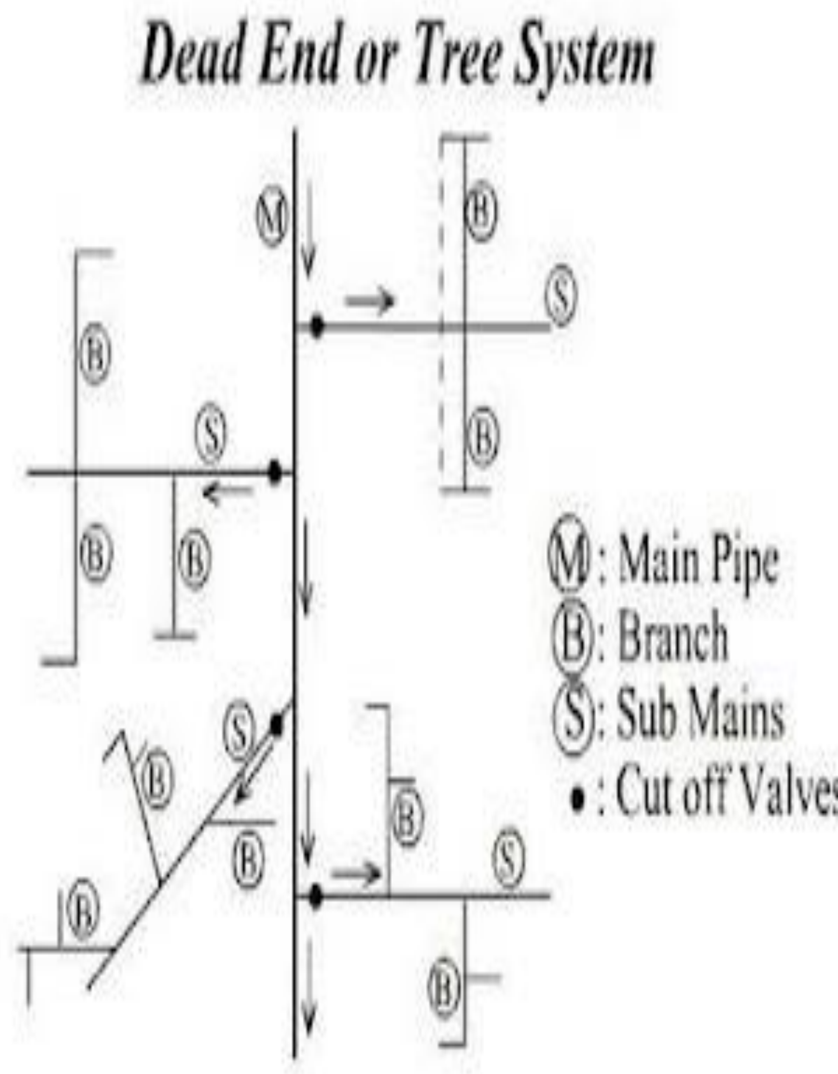
- Irregularly developed cities **(No proper plann**

Advantages

1. Easy to design
2. Less valve to cut off supplies

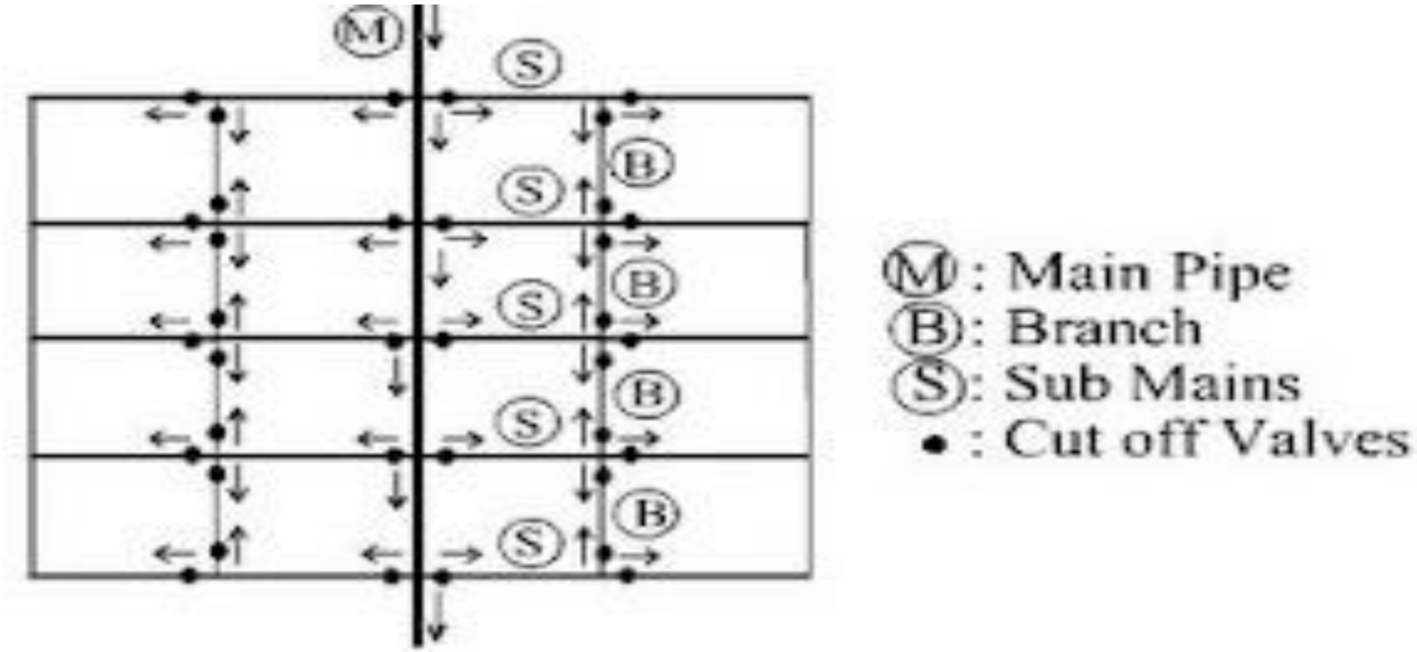
Disadvantages

1. Stagnation of water at dead ends
2. Large portions of cities for repairs to be cu



Grid –Iron System

- No stagnation
- More valves(costly)
- Difficult to design
- Expensive option but more reliable
- More common in developed countries



- **Types of water supply**

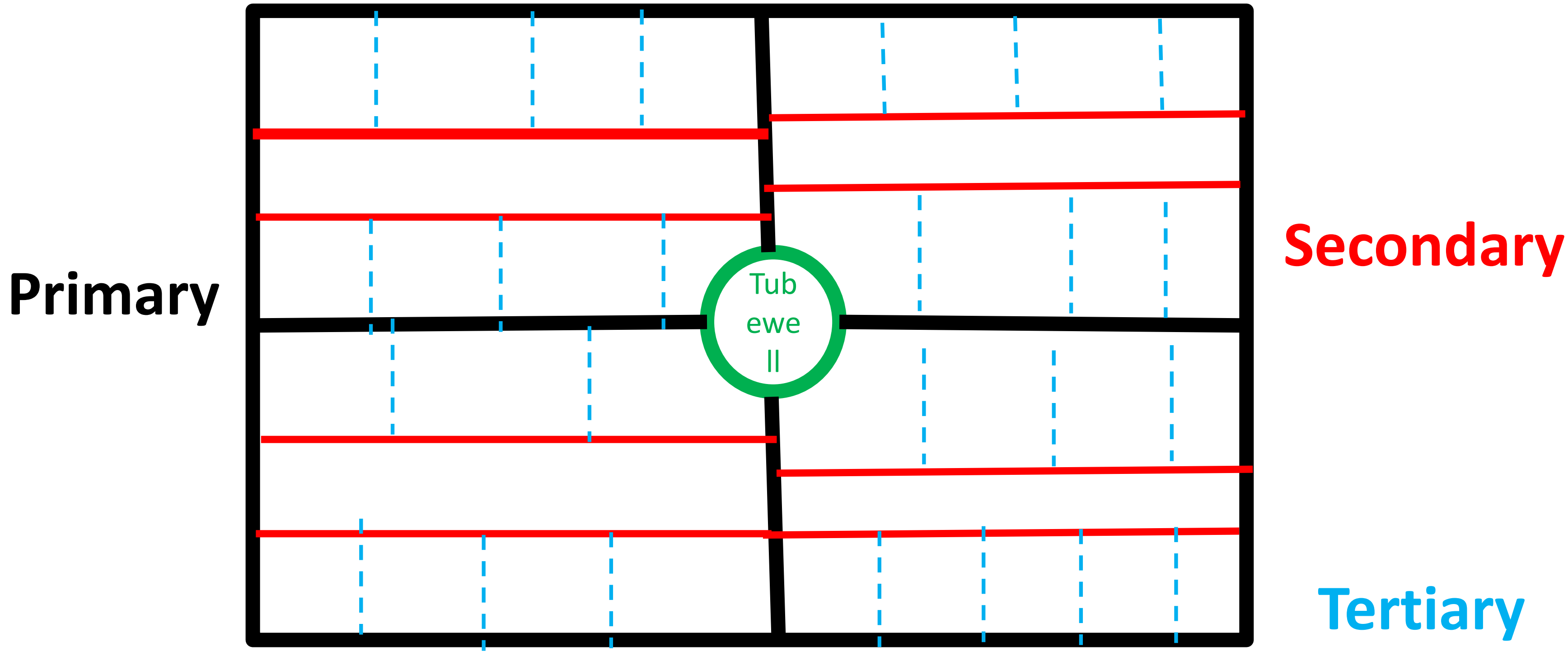
Continuous

- No infiltration
- More water use

Intermittent

- Infiltration/Seepage (more chance of contamination)
- Storing water in dirty containers
- Taps carelessly kept open
- Consumers waste stored water to get fresh water

Pipe Distribution System



Primary Feeders

- Main skeleton
- Water pumping to OHR and various parts of city
- In cities form loops, about 1 km apart.
- Looping allows continuous flow and adequate fire flows.
- Provided with air relief valve & blow off valve
- Size >300mm ϕ

Secondary feeder

- Carry water from Primary feeder to cater for normal supplies +firefighting(12”- Lahore)
- Smaller loops within loops of primary feeder
- In cities these are few blocks apart
- Sizes are 200mm, 250, 300mm ϕ

Small distribution mains/Tertiary Feeder

- Form grid over areas and supply water to fire hydrant and domestic supply lines (150 mm ϕ)

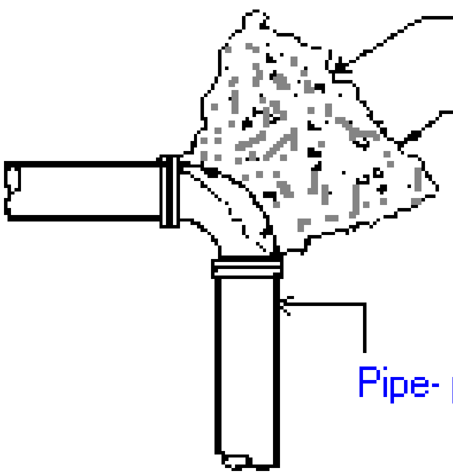
Domestic supply lines

- Generally the sizes are <100-150 mm ϕ normal size is 75mm

Consideration Pipe Layout

1. Right of way: Should not intersect private property
2. Not on mines/ military remains
3. Not to damage existing infrastructure(telephone lines, sewerage pipes.
4. For high points use air release valves and low points blow off valve
5. Avoid point of inflection "Concrete blocks at point of inflection(Thrust blocks)"
6. When crossing river/stream better to attach with bridge or if passing through stream keep narrowest section when in need to bury pipes

Water Distribution System



TYPICAL THRUST BLOCK

Excavation

- Min depth : **1 m** to protect the pipe against traffic load
- Trench width: Sufficient width be provided for proper laying & jointing of pipes.

Pipe	Trench width
2"	1.5'
3"	2'
4"	2'
6"	2'

Laying of Distribution System

Laying & Jointing

- This include removal of pipes from vehicle, conveying it to the storage in a yard or at street , placing it in a trench and making proper joints.

Thrust blocks

- PCC blocks are provided at all tees, bends & dead ends to nullify water thrust

Back Filling

- Back filling material should be free from large stones.

Over Head Reservoir (OHT)

Yield

The portion of precipitation on the watershed that can be collected for use.

Safe Yield

It is the minimum yield recorded for given past period.

Draft

It is the intended or actually quantity of water drawn for use.

Capacity of Overhead Reservoir

Objective of Storage

1. Uniform or desired pumping rate of water over a given time

2. Equalize demand over a period of high use or when pumping discontinued

3. Emergency Services

- *Fire Demand*
- *Tube well changes*
- *Electrical breakdown*

Capacity of Overhead Reservoir

- **Storage capacity**= Equalizing storage(15-30% Max daily demand) + Fire Fighting (2-10hrs) + Emergency (Variable)

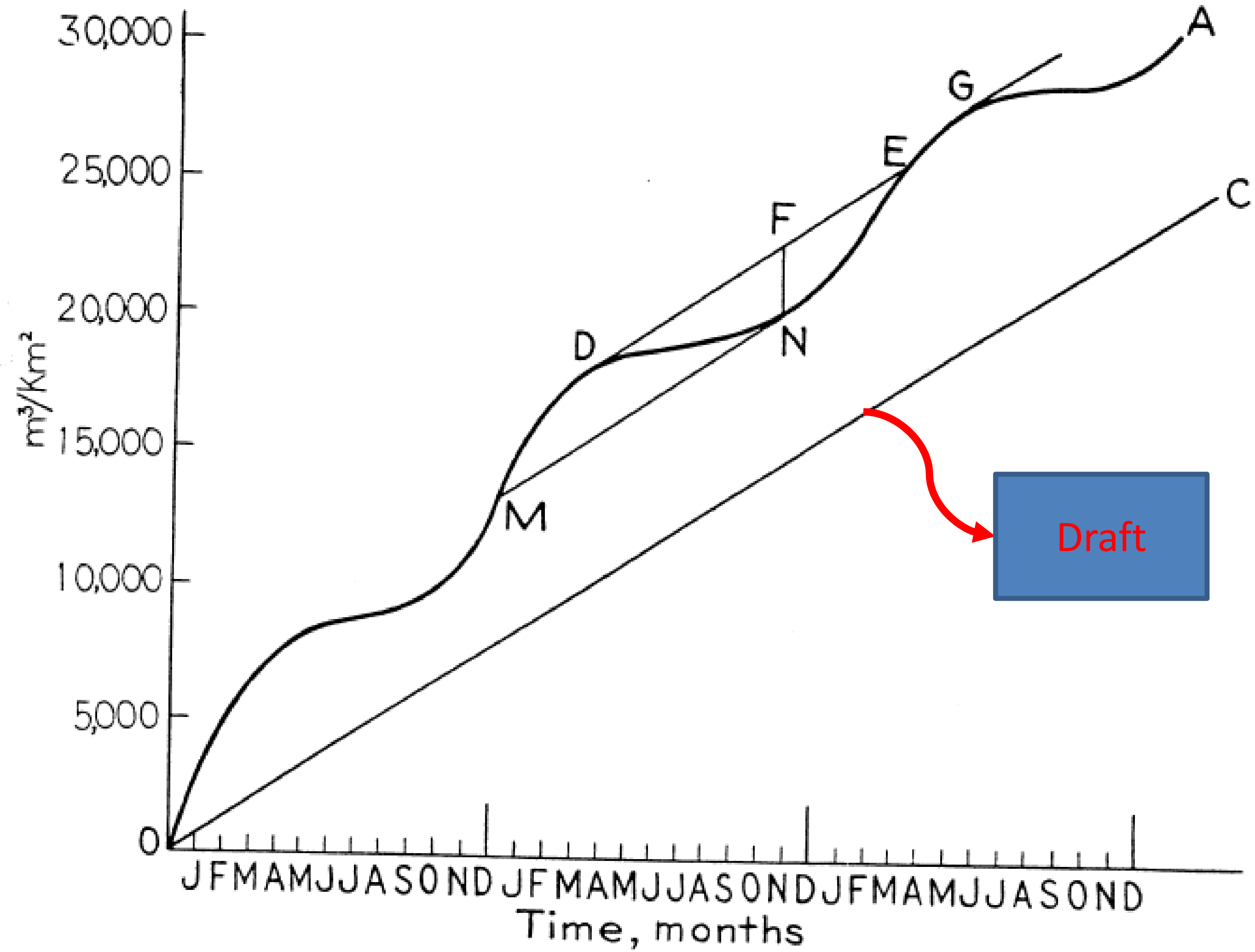
- Public Health engineering Department (PHED) recommended storage capacities for

1. ***Electric pumps – 1/6 th of avg. daily consumption***
2. ***Diesel Pumps – ¼ th of avg. daily consumption***

Mass Diagram

- Graphical representation for finding the storage in reservoir.
- Also called **Ripple diagram**
- Mass diagram present the accumulated total discharge as a function of time.
- For mass diagram records of stream flow for substantial period of time is required generally more than **30 years**.

Determination of Required Storage



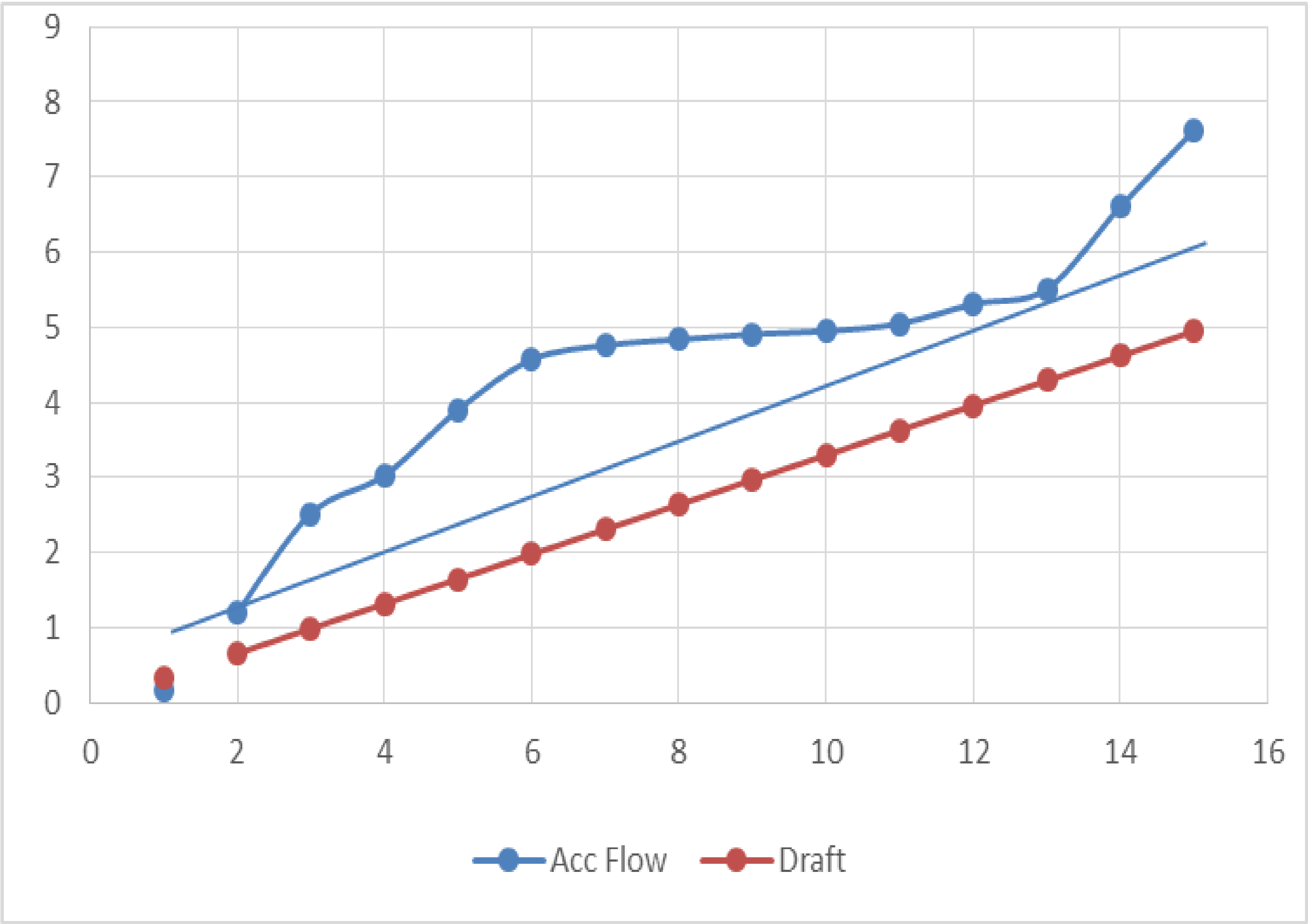
Determination of Required Storage

Problem 1: From the following record of average monthly stream flows:

Month	Flow(m^3X 10^6)	Month	Flow(m^3X 10^6)	Month	Flow (m^3X 10^6)
1	0.18	8	0.08	15	1.01
2	1.02	9	0.07		
3	1.32	10	0.04		
4	0.51	11	0.1		
5	0.87	12	0.26		
6	0.67	13	0.2		
7	0.19	14	1.10		

Determine the require reservoir size to provide a uniform flow(draft) of 11000 m^3 /day

Determination of Required Storage



Determination of Required Storage

Design the storage reservoir for a constant outflow rate of 8055 gallons for the following data:

Sr.No.	Time (hr)	Flow (gal/min)
1	8	50
2	9	92
3	10	230
4	11	310
5	12	270
6	1	140
7	2	90
8	3	110
9	4	80
10	5	150
11	6	230
12	7	305
13	8	380

Sr.No.	Time (hr)	Flow (gal/min)
14	9	200
15	10	80
16	11	60
17	12	70
18	1	55
19	2	40
20	3	70
21	4	75
22	5	45
23	6	55
24	7	35

Types of Water Supply Pipes

Water Supply Pipes

- Various types of pipes are available for the construction of water supply network.
- The following points should be considered for selection;

- Carrying capacity
- Durability
- First cost
- Maintenance cost
- Type of water to be conveyed

1. Cast Iron Pipes:

- Most widely used for city water supply
- Average life of pipes 100 years
- Corrosion (tuberculation)may reduce its capacity by 70%,must be lined with cement or bitumen
- Roughness coefficient (C)for new pipe is 130
- Roughness coefficient (C) for old pipe is 100

2. Steel Pipes:

- Contains less carbon than cast iron pipe
- Average life is **25-50** years
- Frequently used for trunk mains
- Difficult to make connections, hence seldom used for water distribution
- Much stronger and lighter than cast iron pipes
- Cheaper than cast iron pipes
- Cannot withstand vacuum, hence collapse
- Highly susceptible to corrosion, hence high maintenance charges required.

3. Ductile Pipes:

- Similar to **C.I** pipes except their increased ductility*(it is the property of a metal of being capable to be drawn out into wire)*
- Ductile iron is produced by adding a controlled amount of Mg into molten iron of low sulphur and phosphorus content
- Stronger, tougher and more elastic than **C.I**
- More expensive than **C.I**

Water Supply Pipes

4. Galvanized Iron Pipes:

- Produced by dipping **C.I** pipes in molten zinc
- Resistant to corrosion
- Mainly used for plumbing
- Maximum diameter 6 inches

5. Concrete Pipes:

- Usual size of RCC pipes 400 mm and above
- Not subjected to corrosion
- Manufactured at or near site
- Average life of pipe is 75 years
- Roughness coefficient is between 138 to 15

Water Supply Pipes

6. Asbestos Cement Pipes:

- Sizes available between 100mm-600 mm
- Average life – 30 years
- Immune to actions of acids, salts, soil, corrosion
- Less pumping cost due to less friction
- Roughness coefficient is equal to 140

7. Poly vinyl chloride Pipes:

- Mainly used for domestic plumbing
- Easy to install , easy to handle
- Cheaper in material cost
- Weak to sustain load
- Only available up to 350mm diameter size
- Expected life – 25 years
- PVC becomes brittle when placed in sunlight

8. POLYPROPYLENE RANDOM COPOLYMER (PPRC)

- Exceptional corrosion & erosion resistance
- Anti-Fungal & Non-toxic
- Inherited characteristic of high impact strength
- Wide Temperature range: **-4^{0}C to $+95^{0}$C** (suitable for both hot & cold applications)
- Long Service life, above **50 years** over a wide temperature range.
- Highly economical as compared to **G. I , C. I, M.S, PVC**
- Superior Impact, Fracture Resistance & Minimum Crack Transmission due to Co-polymer with random assortment.
- PPR-C being an Eco-Friendly product does not catches fire straightforwardly, indeed in case of fire it

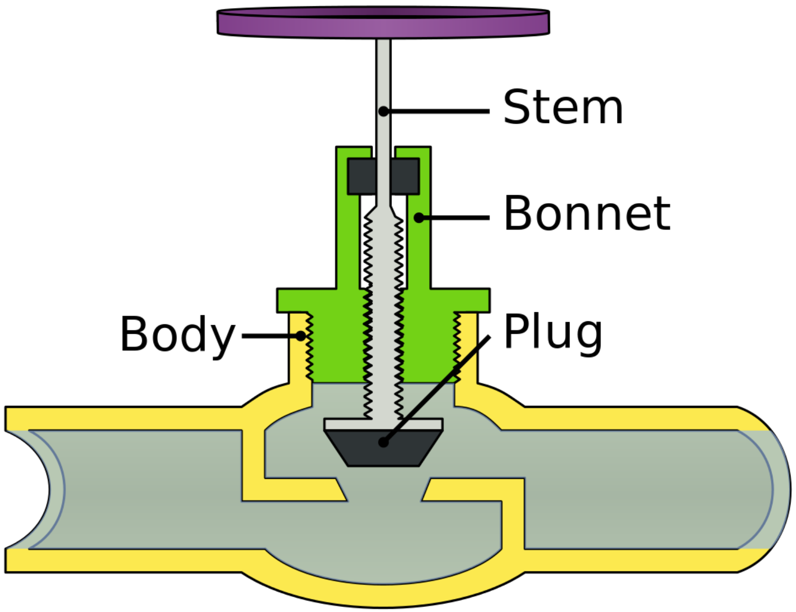
Types of Valves

1.Gate Valve(sluice valve)

- Used to shut off water supply mains for repair
- Generally placed at street corners where lines intersect.

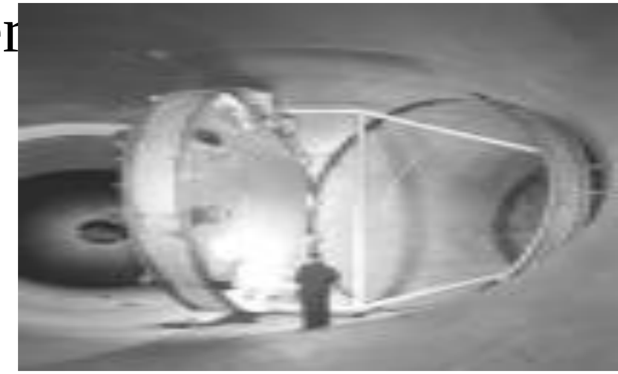
2.Global Valve

- Used in the plumbing system on smaller pipes.
- They create lot of head loss



3.Check Valve

- Uni-directional flow
- Discharge side of pump to reduce water hammer effect (pumping stations)



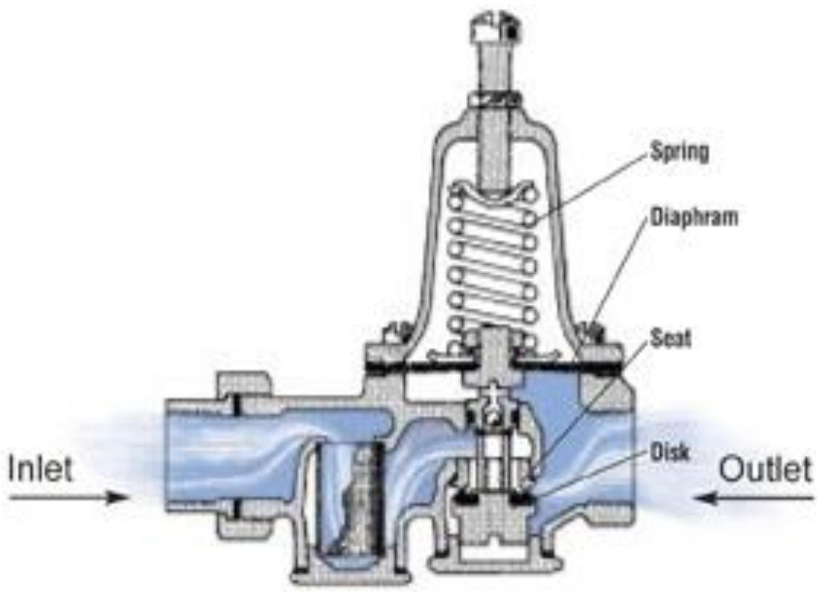
4.Butterfly Valve

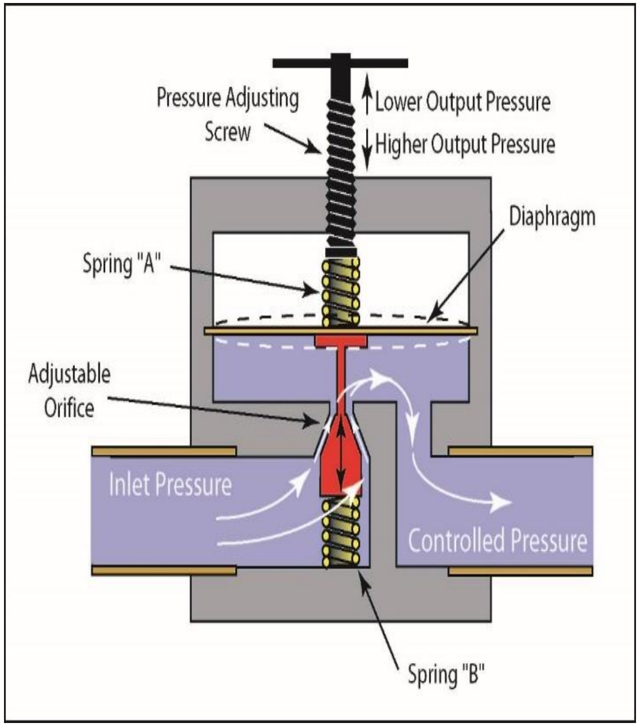
- Used in filter plants and high pressure distribution systems.
- Shut off very slowly to avoid water hammer.

Types of Valves

5.Pressure Regulating Valve

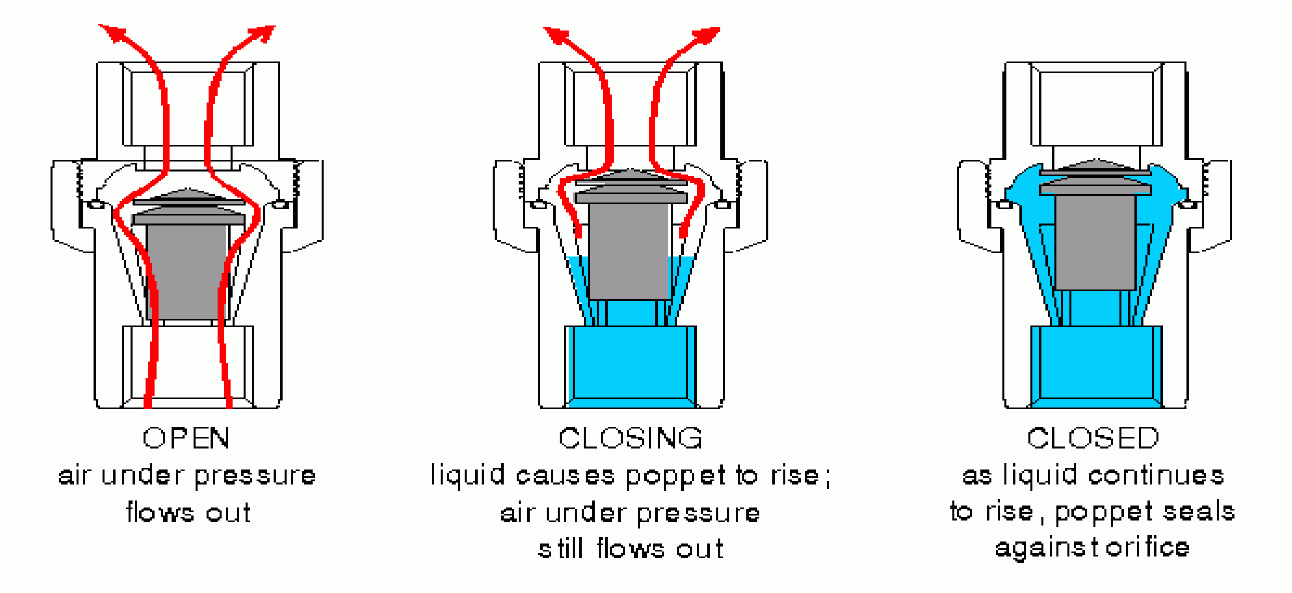
- Reduce pressure downstream side to any desired magnitude(60 PSI)
- Spring and adjustable diaphragm in order to increase or decrease the water pressure within the water supply service

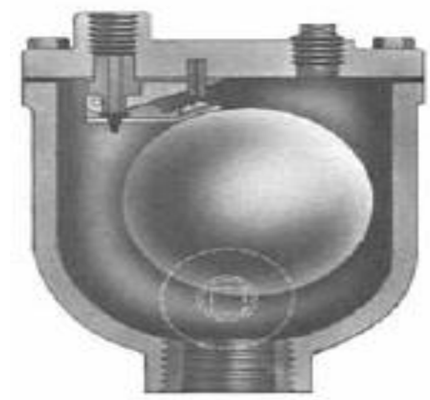




6. Air Relief Valve

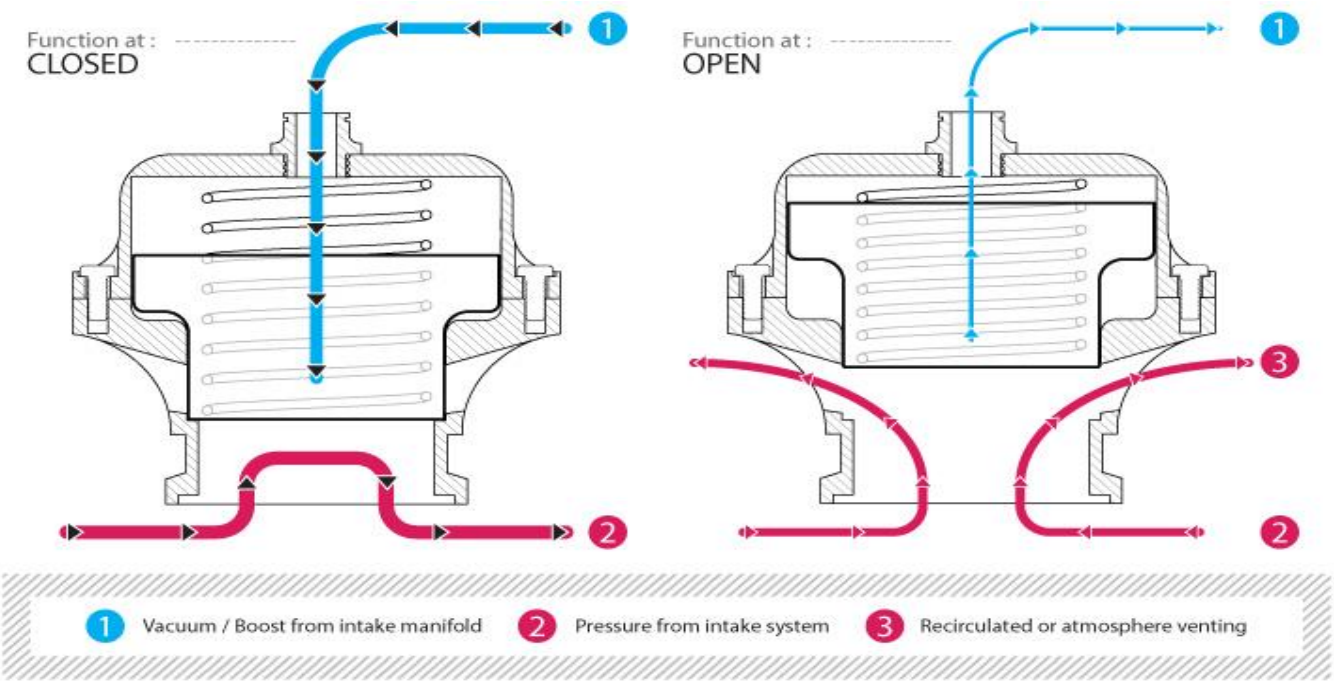
- It allows the accumulated air in the pipe to escape
- It also allows the external air to enter the pipe to break the vacuum.
- Placed at high points of the line





7. Blow off Valve

- Used to drain a line, or to remove accumulated sediments
- Located at low points.



8. Altitude Valve

- Close automatically a supply line to an elevated tank when full
- Differential in forces between a spring load and the water level in the reservoir.
- When the force of the spring is overcome by the force of the reservoir head, the pilot closes the main valve
- **Desired** high water level set by adjusting the spring force

Fire hydrants

- At least 2 hose outlets and larger pumper outlet
- Located at street intersection 1-2 m from the edge of road