COLLECTION AND DISTRIBUTION OF WATER

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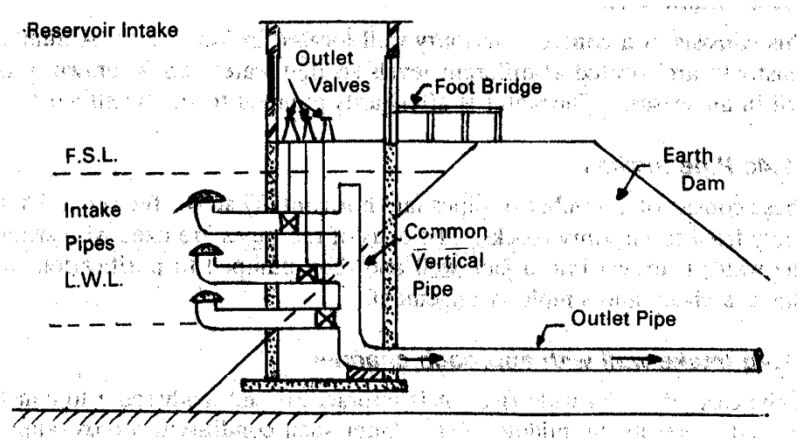
Collection and Distribution of Water

- Deals with the transport of water from the source through the treatment plant to the consumers.
- It requires
  - intake structures,
  - transmission lines,
  - distribution pipe networks and
  - other essential accessories.

Surface water Intakes

- Floating intakes
- Submerged intakes
- Tower intakes
- Shore intakes
- Pier intakes

Reservoir Intake



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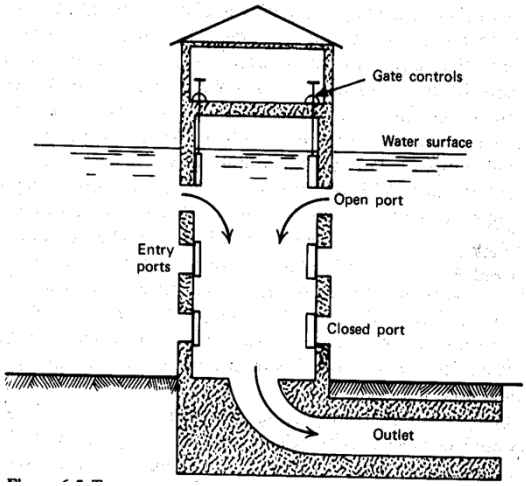
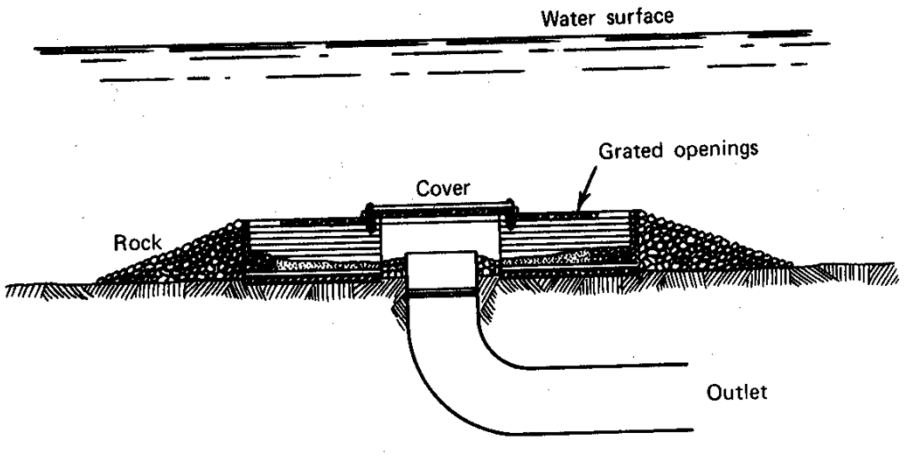
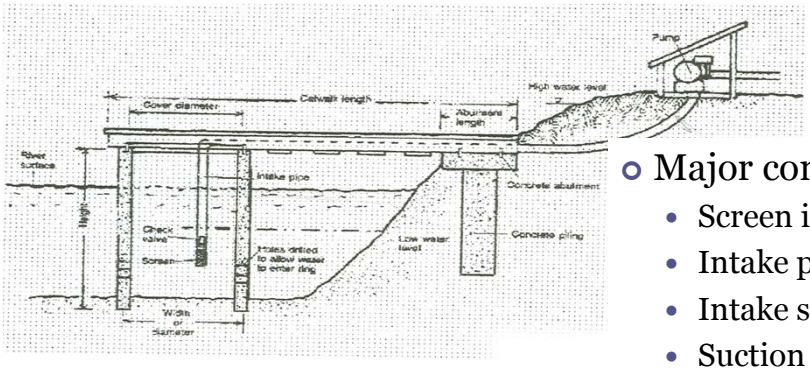
Tower Intake



Submerged Lake Intake



River Intake



- Major components
  - Screen inlet
  - Intake pipe
  - Intake sump
  - Suction pipe
  - Pumps
  - Gate and foot valves
  - access

Intake Structures

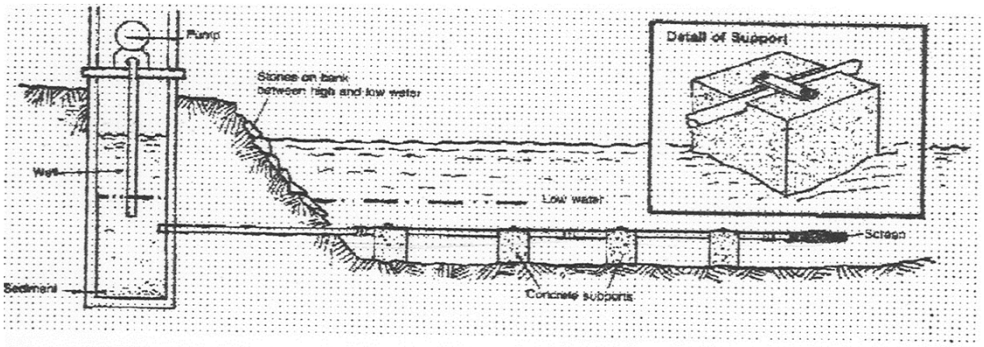


Figure: an example of a lake intake

locating the positions of intakes

- Avoid wastewater discharge points and pollution hazard
- enable withdrawal of water from a range of levels
- Magnitude and direction of stream or current velocities should not affect the function and stability of the intake structure.
- Reliable access roads and power sources should be available
- should be near to treatment plant
- Should not interfere with navigation requirements,
- major environmental impacts should be avoided

Design Criteria for intake structures

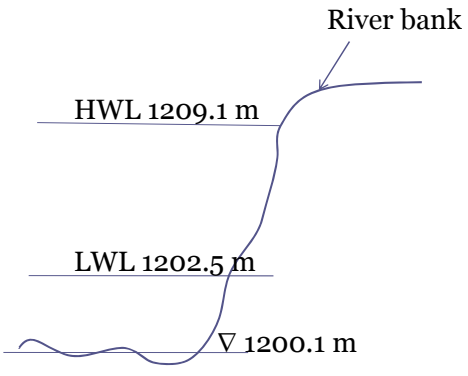
- Design capacity = Q max-day
- Intake velocity should be $\leq$ 8 cm/s
- vertical positions intake ports should be such that good quality water is withdrawn.
- Locate the top intake port at a distance not less than 2 m from the normal water level and the bottom port at least 1 m above the bottom.

Intake design

- **Volume of sump** →detention time. A detention time of at least 20min is recommended.
- At least two sumps - to avoid interruption of service.
- **Height** (with a freeboard about 0.5m)
- Location of the bottom of the sump should be > 1.5m below the lowest stream level or > 1m below stream bed.

Example 1: River Intake design

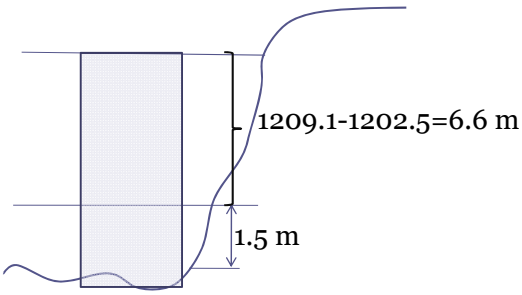
- Given the following information proportion a suitable river intake.
  - Daily demand 5000 m^3
  - Pump capacity: 50 l/s (working 8 hr/day)



Example 1 Solution

- Capacity of each pump daily = 8x3600x50/1000=1440 m^3
- Number of pumps = 5000/1440 = 3.47 ≅ 4
- Hourly flow of each pump = 5000/(4x8)=156.24 m^3/h
- Take detention time, T_d = 20 min
- ➔ capacity = T_d x Q = (20/60)x 156.24 = 52.08 m^3

Example 1 Solution



- Effective height of sump = 6.6 + 1.5 = 8.1
- Free board = 0.5
- Total sump height = 8.6 m
- If we use circular sump diameter = 2.86 m

Pipelines and appurtenances

The selection of pipe materials is based on

- carrying capacity
- strength
- ease of transportation and handling
- availability
- quality of water
- cost (initial and maintenance)

Pipelines and appurtenances

- *Cast iron pipes*:
  - highly resistant to corrosion, strong but brittle,
  - easy jointing, withstanding high internal pressure, long life
  - very heavy and difficult to transport

Pipelines and appurtenances

- *Steel pipe:*
  - strong, very light weight and can withstand higher pressure than cast iron pipes.
  - cheap, easy to construct and can be easily transported
  - cannot withstand external loads, affected by corrosion and are costly to maintain.

Pipelines and appurtenances

- *Cement-lined cast iron pipes*:
  - cement protect against corrosion.
  - very small coefficient of friction than unlined cast iron pipes.

Pipelines and appurtenances

- *Plastic pipes*:
  - corrosion resistant , light weight and economical.
  - Rigid (unplasticized) uPVC is stronger and can withstand much higher pressure for a given wall thickness.

Pipelines and Appurtenances

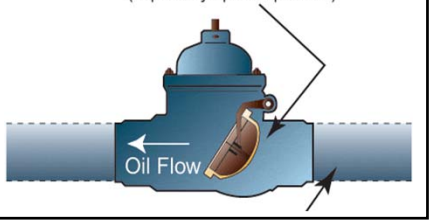
- *Valves:*
  - to isolate segments of a pipeline, to regulate rate of flow, to control pressure, and to allow release or entry of air from pipe system.
- *Factors considered in the selection of valves:*
  - include purpose and operation,
  - capacity required,
  - head loss and rate of flow,
  - cost,
  - availability, etc.

Pipelines and Appurtenances

- *Shutoff valves:*
  - to stop the flow of water through a pipeline
  - spacing from 150 to 370m
  - a minimum of three of the four pipes connected at a junction are valved.
  - fire hydrant, in inlet, outlet, and by-pass lines
  - Gate valves and butterfly valves

Pipelines and appurtenances

- *Check valves:*
  - semiautomatic device and permits water flow only in one direction.
  - in the discharge pipes of centrifugal pumps→ prevent backflow
  - in conjunction with altitude valves



Pipelines and appurtenances

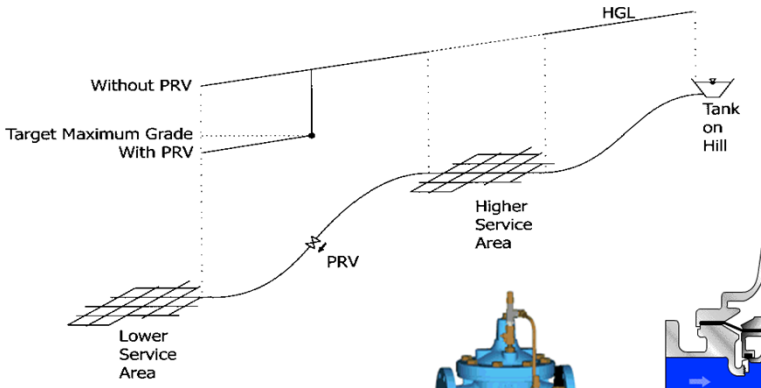
- *Altitude valves :*
  - to automatically control the flow into and out of an elevated storage tank or standpipe to maintain desired water level elevations.
  - include double-acting sequence valve, single-acting type, or differential altitude valve

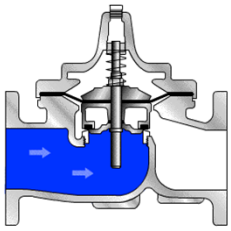
Pipelines and appurtenances

- *Air-release and vacuum valves :*
  - Air-release valves installed at high points of distribution piping, in valve domes, and fittings, and in discharge lines from pump to discharge the trapped air.
  - Vacuum valves are used to protect pipelines from collapse as they are emptied, by allowing air to enter the pipes.

Pipelines and appurtenances

- *Pressure reducing valves (PRV). :*





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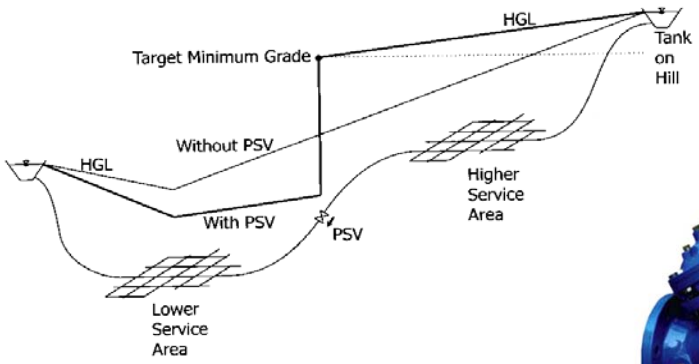
Pipelines and appurtenances

- *Pressure sustaining valves (PSV) :*



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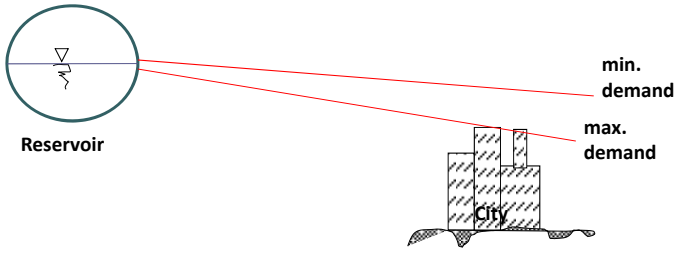
Distribution systems

- Depending upon the level of the source of water and the city, topography of the area, and other local considerations,
  - Gravitational system,
  - Pumping without storage, and
  - Pumping with storage.

Distribution systems

- ***Gravitational system***:
  - action of gravity without any pumping
  - most economical and reliable
  - for cities situated at foothills

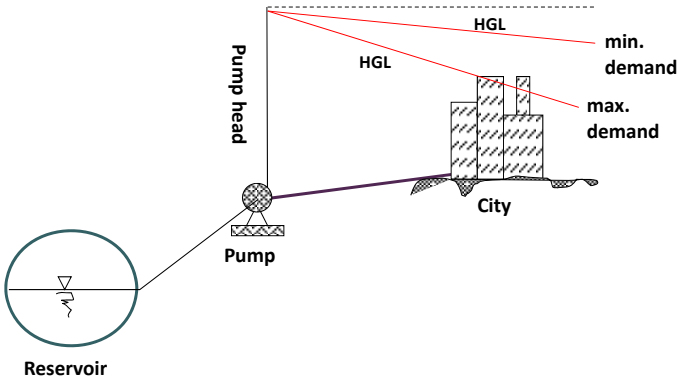


Distribution systems

- ***Pumping without storage:***
  - treated water is directly pumped into the distribution mains without storing
  - High lift pumps →operate at variable speeds → to match variable water demand
  - Disadvantageous (power failure) ← no reserve flow

Distribution systems

- ***Pumping without storage:***

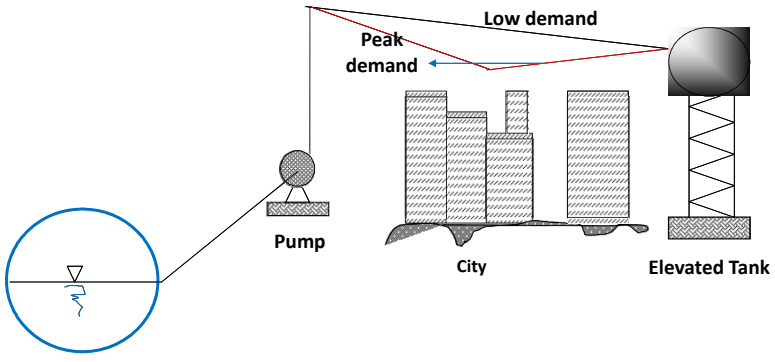


Distribution systems

- ***Pumping with storage:***
  - treated water is pumped at a constant rate → stored in elevated distribution reservoir →distributed to the consumers by the action of gravity
  - excess water during low demand period gets stored in the reservoir → supplied during high demand periods.
  - pumps work at uniform rate →high efficiency
  - quite reliable (even during power failure)

Distribution systems

- ***Pumping with storage:***



Layout of distribution systems

- **Pipe networks :**
  - *Primary or arterial mains*
    - from the pumping stations and from storage facilities to the various districts of the city.
    - valved at intervals of not ≤ 1.5 km
  - *Secondary lines or Sub-mains*
    - run from one primary main to another
    - located at spacings of 2-4 blocks
  - *Small distribution mains or branches*
    - Supply water to every consumer and to the fire hydrants

Layout of distribution systems

- layout of distribution pipes generally follows the road pattern
- four types of pipe network layouts –
  - *dead end system or branch system,*
  - *gridiron system,*
  - *ring system, and*
  - *radial system.*

Layout of distribution systems

- ***Dead end system***
  - solved easily
  - Lesser number of shut-off valves
  - Shorter pipe lengths and the easy to lay pipes
  - cheap and simple and expanded easily
  - dead ends →prevent circulation of water
  - Problematic if a pipe is damaged

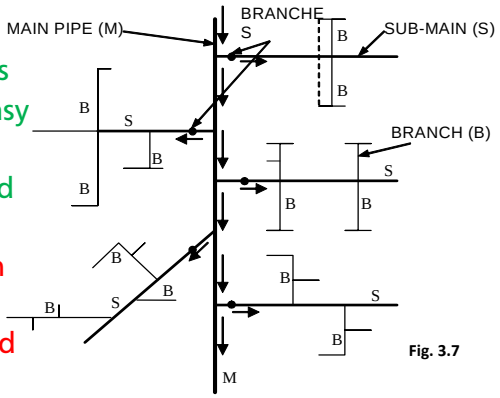


Fig. 3.7

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Layout of distribution systems

- ***Gridiron systems***
  - Discharge, friction loss and pipe size is less
  - Not problematic if a pipe is damaged
  - No dead ends →allows circulation of water
  - Good for fire fighting
  - more pipelines and shut-off valves
  - high cost of construction
  - design is difficult and expensive

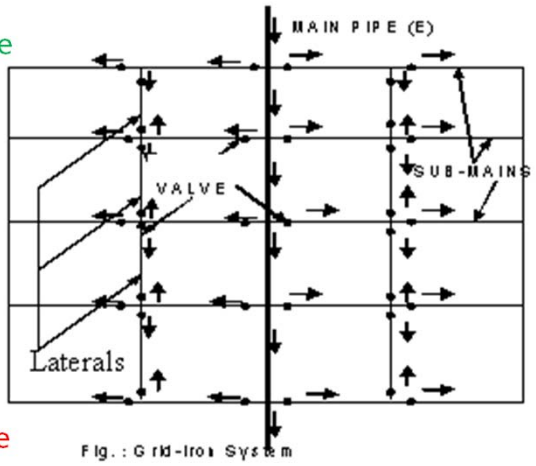

Fig. : Grid-iron System

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Layout of distribution systems

- ***Ring systems:***
  - closed ring, circular or rectangular
  - suitable for well-planned towns and cities
  - Generally at high demand areas
  - Not problematic if a pipe is damaged
  - No dead ends →allows circulation of water
  - Good for fire fighting
  - more pipelines and shut-off valves
  - high cost of construction
  - design is difficult and expensive

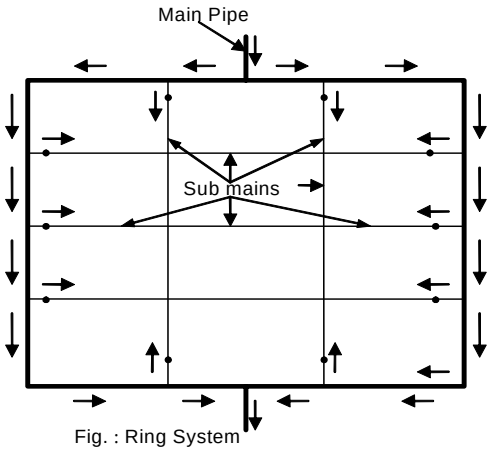

Fig. : Ring System

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Layout of distribution systems

- ***Radial systems***
  - For city or a town having a system of radial roads emerging from different centers
  - distribution reservoirs at these centers
  - From mains → pumped into the DRs placed at different centers and then to the service areas.
  - ensures high pressure and efficient water distribution

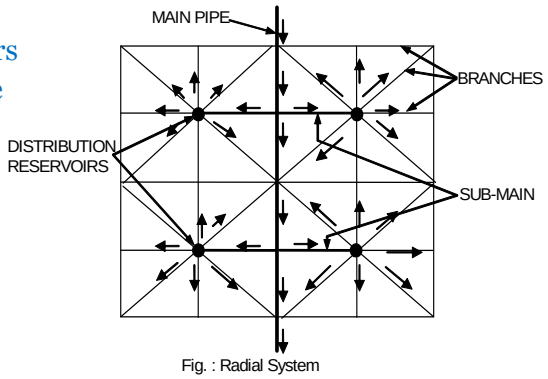

Fig. : Radial System

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