1ST EDITION

WATER SUPPLY ENGINEERING

(ENVIRONMENT ENGINEERING-1)

THEORY CONTENT

CIVIL ENGINEERING FORUM

- Useful for WBPSC, WBMSC (KMC), KMDA, NS, RRB JE, SSC JE, STATE AE/JE & any other examination of Civil Engineering.
- Colour content with highlighted important points.
- Easy language for understanding with several pictures and table format.

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Chapter 1 — Population Forecasting

- Population Forecasting: Determination of future population.
- Depends on:
  1. Birth rate
  2. Depth rate
  3. Migration rate

Methods for Population Forecasting:

Methods	Suitability	Consideration	Formula
Arithmetic Increase Method (AIM)	Large and old cities, where limited scope of expansion available	Increase in population is constant	$P_n = P_0 + nx$ Where, P_n =Population after n decades P_0 = Initial population n= Number of decades x= Average increase
Geometric Increase Method (GIM)	Young & rapidly growing cities, where large scope of expansion available	Percentage growth rate constant decade to decade	$P_n = P_0 (1 + \frac{r}{100})^n$ $r = (r_1.r_2.r_3....r_n)^{1/n}$ (GM)[GOI] or, $r = \frac{r1 + r2 + \cdots + rn}{n} \times 100$ (AM)
Incremental Increase method (IIM)	Suitable for any cities	Growth rate is progressively increasing or decreasing	$P_n = P_0 + nx' + \frac{n(n+1)}{2} y'$
Decrease Growth Rate Method	Valid when growth rate shows a downward pattern	Growth rate is decreasing and population is reaching towards saturation	$P_n = P_{n-1} (1 + \frac{r - nd'}{100})$
Logistic Curve Method	A logistic curve is an S-shaped curve that is used to model population forecasting	This method is used when the growth rate of population due to births, deaths and migrations takes place under normal situation and it is not subjected to any extraordinary changes like epidemic, war, earth quake or any natural disaster etc.	$P = \frac{Ps}{1 + m \log^{-1} e(nt)}$ $Ps = \frac{2PoP1P2 - P1^2(Po + P2)}{PoP2 + P1^2}$ $n = \frac{1}{t1} \log e[\frac{Po(Ps - P1)}{P1(Ps - Po)}]$ $\log_e(\frac{Ps-P}{P}) - \log_e(\frac{Ps-P0}{P0}) = -K.P_s.t$ $m = \frac{P_S - P_0}{P_0}$

Chapter 2 — Water Demand

Types of Water:

- Raw water: Normally available from natural sources like lakes, rivers etc. (not treated)
- Wholesome water: Not pure but doesn't containing anything harmful to human health.
- Potable water/safe water: Drinking water (IS: 10500-2012)
- Distilled water: Purified water
- Mineral water: Water that comes straight from a place in the ground (a spring), which contains minerals or gases and is thought to be good for your health.

Per Capita Water Demand:

- Per capita water demand = $\frac{\text{Total yearly water requirement of the city in litres}}{365 \times \text{Design population}}$

Units:

- ✓ Litres per person per day
- ✓ Litres per capita per day (Lpcd)
- ✓ Litres per head per day

Factors affecting per capita demand:

1. Climate condition: Hot weather or summer-water demand increase, Cold weather or winter-water demand decrease.
2. Size of city: Size of city α water demand

Population	Consumption (lpcd)
< 20000	110
20000-50000	110-150
50000-2 lakh	150-240
2 lakh-5 lakhs	240-275
5 lakh-10 lakhs	275-335
> 10 lakhs	335-360

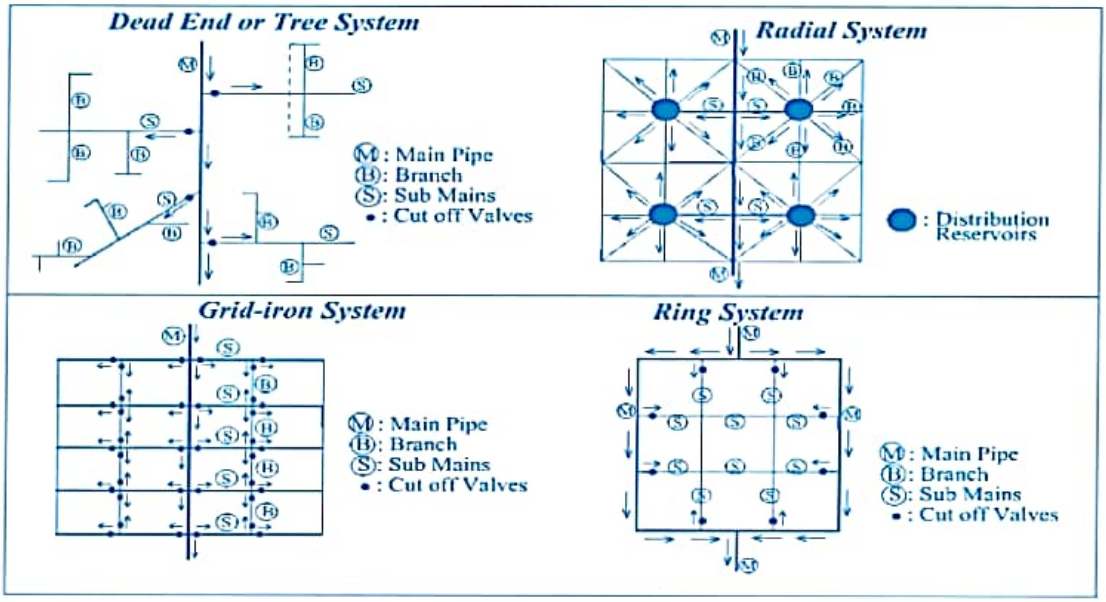
3. Quality of water: Good quality of water increases water demand.
4. Distribution pressure: Higher pressure increases water demand.
5. Living standard (gentry) of people: Higher standard of living increases water demand.
6. Type of sewerage system: Resident in town uses more water for sanitary units.
7. Meter system: Meter system decreases water demand
8. System of water supply: Continuous supply of water increase water demand, intermittent or time to time supply of water decreases water demand
9. Industrialization: Water demand increases with industries build up
10. Wastage of water: Waste of water increases water demand

Types of Demand: (As per IS: 1172)

1. **Domestic water demand:**
   - Uses for domestic purpose like drinking, cooking, bathing, washing cloth etc.

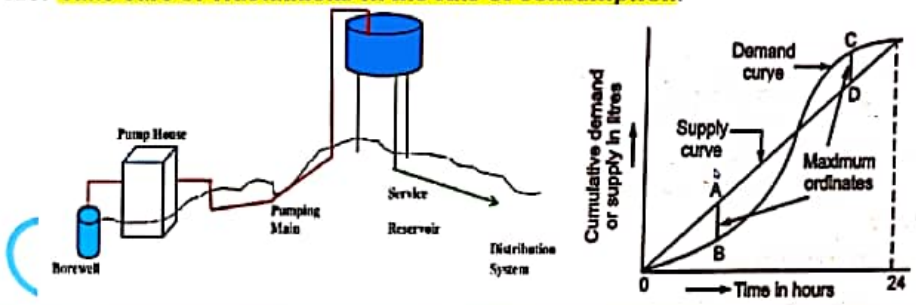
Disadvantages:

- Costlier.
- The requirement for cut-off valves is more.
- This system requires skilled laborers for laying pipelines.



Service Reservoir:

- Service reservoirs are designed for balancing storage or equalizing storage, Breakdown or emergency storage and fire demand.
- Design of balancing reservoir is done using Mass Curve Method.
- Balancing storage is the variation between rate of supply and rate of demand.
- Purpose: Take care of fluctuations in the rate of consumption.



Types of Pipes:

1. **Metal Pipes:**

a) Cast Iron Pipes:

- Used for distribution mains because they are less expensive, corrosion resistant and long lasting.
- Takes heavy load but not bear heavy pressure.
- More durable than wrought iron pipes (can last up to 100 years).

b) Steel Pipes:

Chapter 4

Water Quality Parameters

Classification of Water Quality Parameters:

Water Quality Parameters

Physical	Chemical	Biological
✓ Suspended solids	✓ TDS	➢ Pathogenic Bacteria, Micro-organism
✓ Turbidity	✓ pH	✓ Bacteria
✓ Colour	✓ Alkalinity	✓ Virus
✓ Taste & Odour	✓ Hardness	✓ Protozoa
✓ Temperature	✓ DO	✓ Helminthes
✓ Specific Conductivity	✓ Fluoride	
	✓ Chloride	➢ Non Pathogenic or Coliform
	✓ Nitrates	
	✓ Sulphate	
	✓ Metals	

1. Physical Parameters:

A. Suspended Solids:

- Suspended Solids in water comes from inorganic particle like silt, clay etc., organic particles like plant fibers, algae etc.
- Measurement is done by graviometric technique i.e. weighing.
- Total Solids (TS) = SS + DS are calculated by evaporating the sample at 104°C and measuring the residue.
- SS is obtained by filtration and heating the residue on filter at 104°C.
- TDS = TS – TSS
- Suspended Solids are also called as Non-Filterable Solids.
- Dissolved Solids are also called as Filterable Solids.
- Organic solids both in total and suspended form can be determined by firing the test sample and residue in muffle furnace at 600-650°C.
- At this temperature organic solids will be vaporized leaving behind inorganic solids.
- Organic fraction @600°C gives Carbon dioxide + water + gases
- Organics solids are also called as volatile solids and Inorganic solids are also called as fixed solids.
- There must not be any suspended solids in the drinking water.
- Acceptance Limit: 30 mg/l (As per EPA).

B. Turbidity:

- Resistance offered by the passage of light.
- Due to fine suspended matter presence in water.
- If turbidity is more than 5 mg/l ⟶ Naked eye.
- Turbidity is measured on Standard Silica Scale.
- Units: NTU, JTU or TU.
- Measured based on two principles: 1) Light absorption principle 2) Light scattering principle.
- Permissible limit: 5-10 ppm