CIVIL ENGINEERING

UNACADEMY

Environmental Engineering

Written By-Jaspal Sir

- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

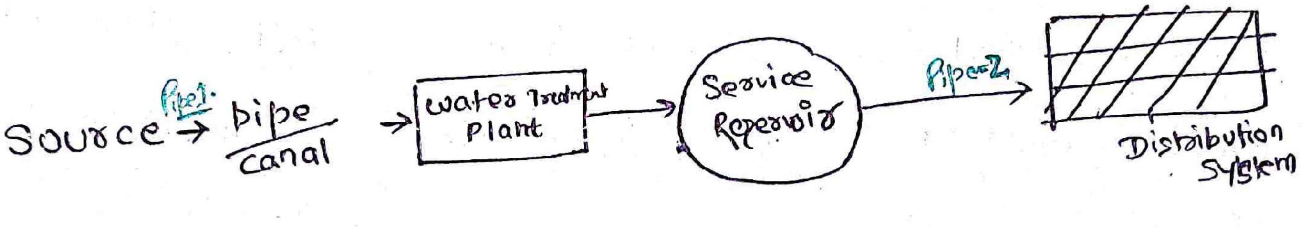
Water Demand

Raw water: The water which is derived from nature.

river-sedimentation.

rain- aeration.

ground water- filtration



(i) Water Demand

(ii) Source of Water

xxx (iii) Quality of Water

xxx (iv) Treatment of Water

(v) Pipes.

(vi) Service reservoir

(vii) Distribution System.

Water Demand/draft:

(i) Annual draft = V

(ii) Annual avg. daily draft = $\frac{V}{365}$

(iii) Annual avg. per capita daily draft = $\frac{V}{365 \cdot P}$ P = present population.

Discharge of water.

Total Demand — l/c/d

(i) Domestic Water demand. = 135 − 225 (200) (50-60)% flushing system.

(ii) Industrial water demand = 50 − 450

(iii) Institution water demand = 20 − 50 l/c/d

(iv) Water for public use = (5 − 6)% of Total demand = (10 − 20)

(v) Fire demand = 1 or emperical. IS code = $100\sqrt{P}$ (Kl) ← (Kl)

thousand — [Volume me aayega − India]

Kuchling method = $Q = 3182\sqrt{P}$ l/min — P = Population in thousand

Freeman method = $Q = 1136\left(\frac{P}{10} + 10\right)$ l/min — P = Pop. in thousand

National Board of fire underwriters method = $Q = 4637\sqrt{P}(1 - 0.01\sqrt{P})$ l/min

Buston = $Q = 5663\sqrt{P}$ l/min

(vi) Losses and theft − (10 − 15)% of total demand.

Total demand = 250 − 350 (335) l/c/d

Factors Influencing demand of water :-

{Demand remain constant but consumption may vary}

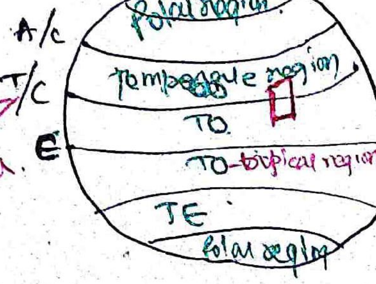
(i) Size of the city.

(ii) Extent of industrialisation.

(iii) Type of sewerage system. (flush system)

(iv) Standard of living / gentry.

(v) Climatic condition. (depend on location of community, latitude
higer latitude − less temp.
lower latitude − high temp.)



(vi) Cost of water :- *

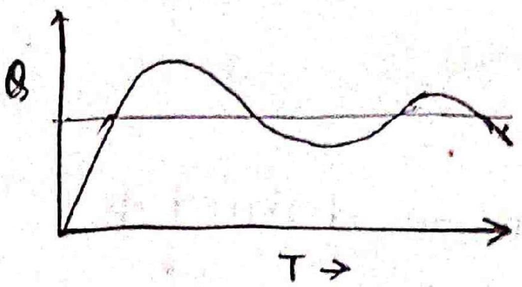
(vii) Quality of water

(ix) Pressure in distribution system.

(x) Type of distribution system. − (Continuous and intermittent)

$$FI = \frac{Max. P}{Avg\ P} = \frac{Avg\ P}{Min\ P}$$

fluctuation



Maximum daily demand = 1.8 Annual average daily demand $= \frac{V}{365}$

$\frac{x+y}{365}$ 15 Jul.

Maximum hourly demand of max^m day = 1.5 Avg. hourly demand of max^m day.

$= 1.5 \times \frac{Max^m\ daily\ demand}{24}$

$= 1.5 \times 1.8\ \frac{Annual\ average\ daily\ demand}{24}$

Max^m hourly demand of max^m day = 2.7 Annual average hourly demand

Goodrich eq^n:-

percentage fluctuation, $P = \frac{Max^m\ demand}{Avg\ demand}$ (in percentage)

$= 180\, t^{-0.1}$ (t = days)

t = time (days) ≥ 1 days and less than 1 year.

Time		Fluctuation
hourly	-	2.7
daily	=	1.8
weekly	=	1.48
Monthly	=	1.28
Yearly	=	1

peak factor

[Bigger the sample lesser the standard deviation]

Population	Peak factor
< 50,000	3
50,000 – 2,00,000	2.5
> 2,00,000	2

} Avg 2.7

We know that, raw water scheme designed for maximum hourly design.

(i) Q_{MH} – maxm hourly
(ii) $Q_{MH} + Q_{FD}$ fire demand (on including fire demand cost increased)
(iii) $Q_{MD} + Q_{FD}$ [coincident demand/draft]

* Design should be done.
(i) Q_{MH}
(ii) $Q_{MD} + Q_{FD}$ } Maxm

Design Life and design discharge:-

Component	Designlife (yrs)	Design Discharge.
Source (life is greater because all things depend on it)	50	Q_{MD}
Pipe-I	30	Q_{MD}
Pump Canal	15	Q_{MD}*
WTP	15	Q_{MD}
Service Reservoir	15	Volume
Pipe-II	30	Q_{MH}, $Q_{MD} + Q_{FD}$ } maxm
Distribution System	30	Q_{MH}, $Q_{MD} + Q_{FD}$ } maxm

life is less because mechanical component technology changes time to time (Pump Canal, WTP, Service Reservoir)

Pump & Canal - is not used for 24hrs.

Q $P = 2\times10^5$, AA POD = 300 L/c/d.

(i) find Important type of demand.
(ii) design capacity of all components of RWS.

Q_{MD} : Maximum daily demand = 1.8 AAdD = $1.8\times300\times2\times10^5\times10^{-6}$ = 108 MLD

~~Q_{MH} = Max^m hourly demand =~~

~~Q_{FD} fire demand =~~

Q_{MH} = Max^m hourly demand = $2.7\left(\frac{q}{24}\right)$

$= 2.7\times300\times10^{-5}\times\frac{10^{-6}}{24}$

$= 6.75$ MLH

$= 6.75\times24$ MLD = 162 MLD

or, $Q_{MH} = 1.5\,Q_{MD} = 1.5\times108 = 162$ MLD

Fire demand

As per NBFUM.

$Q_{FD} = 4637\sqrt{P}\,(1-0.01\sqrt{P})$

$= 4637\sqrt{200}\,(1-0.01\sqrt{200})$

$= 56303$ l/min

$= 56303\times10^{-6}\times60\times24$ MLD

$= 81.07$ MLD

Coincident demand.

$Q_{CD} = \left.\begin{matrix} Q_{MD}+Q_{FD} \\ = Q_{MH} \end{matrix}\right\}$ max^m

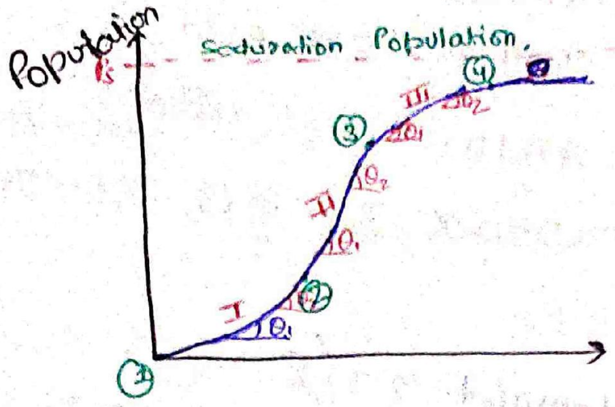
$\left.\begin{matrix} Q_{MD}+Q_{FD} = 108+81 = 189 \text{ MLD} \\ Q_{MH} = 162 \text{ MLD} \end{matrix}\right\}$ max^m

$Q_{CD} = 189$ MLD

Pipe-II and distribution system design for $Q_{CD} = 189$ MD.

Source, Pipes, Pump, WTP, Q_{MD} = 108 MLD

✳ Population forecasting.



[logistic / Auto catylyt curve.]

$y = f(x)$

$P = f(t)$

(I) $\frac{dy}{dx} = \frac{dP}{dt}$ (↑) In a yong city rate of growth of population increase

$(\theta_2 > \theta_1)$

(II) In old city rate of development stabilises $\frac{dP}{dt} \simeq C$

$\theta_2 \sim \theta_1$

III Very old City - Population is increasing but its rate is decreasing.

$\theta_2 < \theta_1$

$\frac{dP}{dt}$ (↓) $\propto (P_s - P\uparrow)\downarrow$

Part-III

Population of any community depend upon:-

(a) Growth rate. } depend upon ^develo city development
(b) Death rate
(c) Migration rate ~(+, -)
(d) Increase due to annexation - [forcefully taking land of other country] eg. china taking land of Honkgong.

DO YOU KNOW?

Panedimic - ^Covid when it is in every place of world.
Epidimic - When it was only in Wuhan (local area)

Methods of Population forecasting:-

(i) Arithmetic Increase Method.

→ In arithmetic I. Method we considered rate of growth of population is constant. $\frac{dP}{dt} = \text{constant}$

→ In this method, we consider the average increasing of population over the present population.

eg.

Year	1970	1980	1990	2000	2010	2020	2030
Pop^n -	25	50	100	175	200	200+43.75 = 243.75	243.75+43.75 = 287.5 ~288
increase, x =		25	50	75	25		

$$\text{average}, \bar{x} = \frac{25+50+75+25}{4} = 43.75/\text{decade.}$$

$t = t_0 \qquad P = P_0$

$t = t_1 \qquad P_1 = P_0 + \bar{x}$

$t = t_2 \qquad P_2 = P_1 + \bar{x} = P_0 + 2\bar{x}$

$- - - - -$

$t = t_n \qquad P_n = P_{n-1} + \bar{x} = P_0 + (n-1)\bar{x} + \bar{x}$

$\qquad\qquad = P_0 + n\bar{x}$

(ii) Geometric Increase Method./compounding/Uniform Incre... method

→ In this method, percentage rate of growth is constant.

Year →	1970	1980	1990	2000	2010	2020	2030
Population →	25	50	100	175	200	$= P_0(1+r)^1$ = 314.4	$= 200 \times (1+0.572)^2$ = 494.23 ~495

$\frac{50-25}{25} \times 100 = 100\%$

$\frac{100-50}{50} \times 100 = 100\%$

$\frac{175-100}{100} \times 100 = 75\%$

$\frac{200-175}{175} \times 100 = 14.28\%$

$$r\% = \frac{dP}{dt} \times \frac{1}{P} \times 100 = \text{const.}$$

Using Arithmetic mean method, $= \frac{100+100+75+14.28}{4}$ %/decade

$= 72.32\%/\text{decade}$

By using Geometry mean method $= \sqrt[4]{100 \times 100 \times 75 \times 14.28}$

$= 57.2\%/\text{decade.}$