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# UNIT – I

## Water supply Engineering:

**1.1 Introduction:**
Water supply – Salient Features of a Water supply Scheme – Flow chart of a Water supply scheme – Agencies responsible for Protected Water Supply.

### Water Supply:

**General Introduction:**

* Water is essential for our life.
* Without Water we cannot survive in this world.
* 2/3rd of human body is constituted of Water.

Water is essential not only survival of human beings, but also for plants, animals & other living organisms.

* For sufficient good quality of Water, it is essential to plan & build suitable Water supply schemes.

**Water Supply Introduction:**

* Water supply is a Process of supplying water to a particular area. It includes reservoir, tunnels & pipe lines.

**Objective:**

* It is to ensure adequate Water Supply at adequate Water Pressure to all fixtures & equipments.

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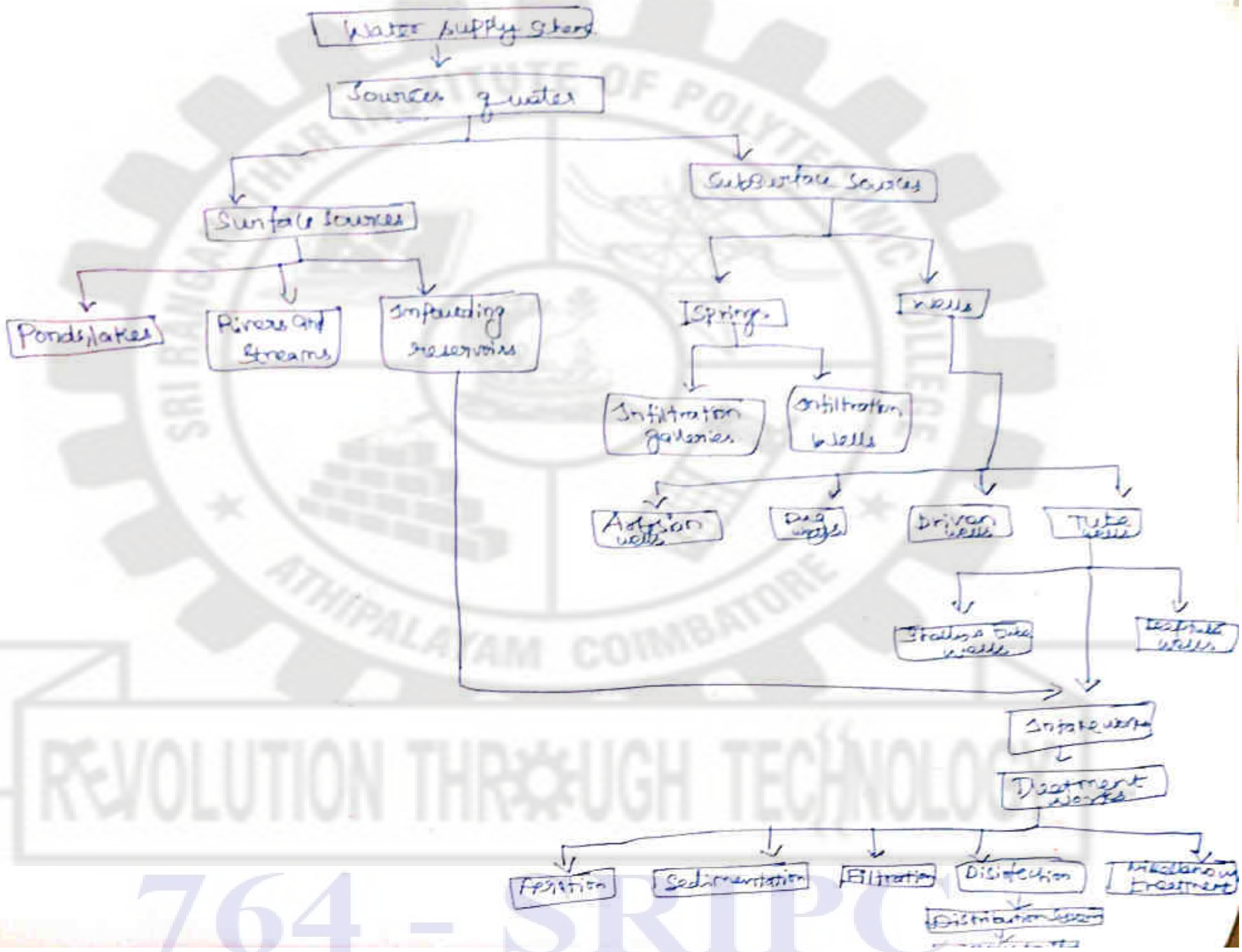
## Salient Features of a Water Supply Scheme:

* The following salient features of a Water Supply Scheme are,

* To supply good quality of Water
* To Supply Safe and Wholesome Water (free from Chemicals or impurities) to the consumers.
* To Supply Water in sufficient Quantities.
* To Supply Water at required Place and time.
* To Supply Water at reasonable, cost to the Consumers/users.

## Flowchart of a Water Supply Scheme:


Water supply scheme
Sources of water
Surface sources
Subsurface sources
Ponds/lakes
Rivers and Streams
Impounding reservoirs
Springs
Wells
Infiltration galleries
Infiltration wells
Artesian wells
Dug wells
Driven wells
Tube wells
Shallow tube wells
Deep tube wells
Intake works
Treatment works
Aeration
Sedimentation
Filtration
Disinfection
Distribution system

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## Agencies responsible for protected Water supply:

* For providing safe drinking water and sanitation facilities for rural areas → under the control of (TWAD) → Tamil water supply and Drainage board → He is the responsible for providing safe drinking water.

  ⇓

  under control of

  ⇓

  Department of Rural development and Panchayat Raj.

* TWAD → Public agency formed by Govt of Tamil Nadu, Under Ministry of Local administration and Water supply on April 14, 1971.

## Role of TWAD Board:

* To implement all water supply and sewerage schemes to state of Tamil nadu except Chennai Metropolitan Area.

## 1.2 Quantity of Water:-

* Water supply
* Need for protected water supply
* Objectives of public water supply system.
* Demand
* Types of demand
* per capita demand.
* Factors affecting per capita demand
* Prediction of population.

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* Methods of prediction population.
* Total quantity of water required for village town

Quantity of Water

Water supply:

* In ancient times no collective effort was taken by the community to arrange water supplies.

* Now the best source of water supply such as springs, shallow wells, cisterns, to meet the demand of the town, people started to collect the water from large source and conveyed it through aqueducts, canals.

* Availability of sufficient quantity of good quality water, water supply scheme should be provided.

Need for Protected Water Supply:

* Water is a good carrier of disease producing germs and water-borne diseases produced.

* Water should be free from pathogens and other toxic substances including micro organisms.

* When untreated water is consumed by living

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organisms there will be large possibilities of water-borne diseases like cholera, typhoid, dysentry.

* Effect of Polluted Water, Water should be pre-treated & consumed.

* Early stages the progress was very little and nowadays people are very aware & need for protected water supply has been increased.

* In 1954, central and state governments have established the "National Water supply and Sanitation Programme" to provide Water Supply & Sanitary facilities.

* In order to provide Protected Water Supplies to the Communities, works are being carried out through five year plan.

* "Tamilnadu Water Supply and Drainage board" was established in Tamilnadu to provide Protected Water supplies & carry out the Sanitary Works.

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## Objectives of public Water Supply System:

* To Supply Safe Wholesome Water to the People, to keep the disease away & Promoting better health.
* To maintain better Sanitation.
* To ensure Safety against fire, by supplying Sufficient quantity of Water.
* To Provide to industrialisation and modernisation of the Society & ensure better living standards.
* To Promote Wealth and Welfare to the entire Community.



Demand:

* When an Engineer has to design water Supply scheme for a Particular Community, first have to evaluate the amount of Water

available and amount of water demanded by the public.

* First study → 1st requirement → To consider the demand.

* 2nd study → 2nd requirement → To find the sources to fulfill that demand.

## Types of demand:

* Domestic water demand.
* Industrial water demand
* Institutional and commercial water demand.
* Demand for public uses.
* Fire demand.
* Demand for compensating various losses.

## * Domestic water demand:-

* It includes water required for drinking, cooking, bathing, lawn sprinkling, sanitary purposes.

(Demand)

* It Varies b/w 135 litres per capita Per day to 225 litres per capita per day.

[135 l - 225 l per capita per day]

* Standard Recommendation:-

* 135 lpcd (Litres per Capita per day)

* Total domestic Water Consumption consumes usually about [50-60%] of total Water Consumption

* Industrial Water demand:-

* Industrial Water demand represents the Industries.

* Average per capita consumption for Industries → [50 lpcd to 450 lpcd] (litres per capita per day).

* Institutional and Commercial Water Demand:-

* It includes water required for Schools, hospitals, hotels, Railway stations, offices, factories.

* Per capita demand of [20 lpcd].

* Demand for public uses:-

* It includes water reqd for public utility

Purposes Such as Watering of Public parks, gardening, Washing & Sprinkling on roads.

* Average q 20 to 10 lpcd

* Fire demand:-

* It includes the quantity q water reqd for fire-fighting Purposes.

* quantity q water reqd for extinguishing fire. It should be easily available and always Stored in Storage reservoirs.

* quantity q water reqd for fire Prevention → generally taken as 1 lit per capita per day (1 lpcd).

Empirical formulae:-

i) Kuchling's Formula $Q = 3182\sqrt{P}$

ii.) Freeman Formula $Q = 1136\left[\frac{P}{10} + 10\right]$

iii.) National Board Of fire under Writers formula,

$$Q = 4637\sqrt{P}\left[1 - 0.01\sqrt{P}\right]$$

iv.) Buston's Formula

$$Q = 5663\sqrt{P}$$

Where Q = Amt of Water reqd in lit/min

P = Population in thousands.

Per capita demand:

* Annual Average amount of daily Water reqd by one Person.

* It includes domestic, industrial & commercial use & Public use, wastes etc.

* It can be expressed as,

per capita demand (q) in litres per day per head.

$$q = \frac{\text{Total Yearly Water requirement of the city in litres (v)}}{365 \times \text{Design Population}}$$

## Water consumption for Various uses:

| S.NO | Purpose | Consumption in litres per capita per day |
|---|---|---|
| 1. | Domestic | 135 |
| | a) Cooking | 5 |
| | b) Drinking | 5 |
| | c) Washing house | 10 |
| | d) Washing utensils | 10 |
| | e) Washing clothes | 20 |
| | F) Water closets for Flushing | 30 |
| | g) Bathing | 55 |
| | Total | 135 lit per capita per day |

* Same as for Institutional & commercial water consumption.

Eg: Offices, Factories, Hotels, Restaurants, Schools (Day Scholar (or) residential, Nursing home, Railway Stations, Airport, Cinema Halls & Theatres.

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## Factors affecting per capita demand:

* The follows factors affecting per capita demand are,

* Size of the city
* Climatic conditions
* Habits of people
* Industrial & Commercial activities
* Quality of water supplies
* Pressure in distribution system
* Development of sewarage facilities
* System of supply
* cost of water
* policy of metering & method of charging.

i) Size of the City:
* Per capita demand for big cities is large when compared to smaller cities.

ii) Climatic conditions:-
* At hotter and dry place, consumption of water is more, becoz of more bathing, cleaning, airconditioning, lawn sprinkling.

iii) Habits of people:-
* Rich & upper class communities generally consume more water.
* Amt of water consumption directly depends upon the economic status of the consumers.

iv) Industrial & Commercial activities:
* Water consumption increases with increase in industrial & commercial activities.

* It requires huge quantity of water, so the demand is be increased.

v) Quality of Water Supplies

* If the quality & taste of water supplied is good, it will be consumed more.

* Hence, the demand of water increases with increases quality of water.

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i) Size of the City:

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ii) Climatic conditions:-

* At hotter and dry places, Consumption of Water is more, becoz of more bathing, Cleaning, airconditioning, lawn Sprinkling.

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v) Quality of Water Supplies:

* If the quality & taste of Water Supplied is good, it will be consumed more.

* Hence, the demand of Water increases with increases Quality of Water.

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vi) Pressure in the distribution System

* If the Pressure is the distribution Pipe is high, Water consumption is more, if water reaches @ 3rd or 4th Storey, Pressure increases & also it increase the water demand.

vii) Development of Sewerage facilities:-

* If the City is Provided with 'flush System' instead of 'Conservation System', the water Consumption will be more.

viii) System of supply:-

* If the cost of water is high, lesser quantity consumed by the people.

x) policy of metering and method of Charging:-

* When the water supplies are metered, People use required Quantity of water and Consumption is reduced.

Methods of Prediction of population:-

* The water demand reqd for a Community can be estimated from the present Population and Per capita demand.

* For the design of any water Supply Scheme, it is necessary to Calculate the last 2 to 3 decades. The expected Population after the design period can be estimated by the following methods:-

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* Arithmetical increase method
* Geometrical increase method
* Incremental increase method
* Decreasing rate method
* Simple graphical method
* Comparative graphical method
* Master plan method
* Ratio method
* Logistic curve method.

i) Arithmetical increase method:-

* This method is based on the assumption, ie rate of Popula increase in population is assumed to be Constant. So, Avg. increase in population is worked out from the record of past decades.

$$P_n = P_0 + n \cdot \bar{x}$$

Where,

$x$ = population increase per decade.

$P_n$ = Population @ end of 'n' yrs (or) decade.

$P_0$ = present population.

$n$ = No. of decades b/w now & Future.

$\bar{x}$ = Arithmetic mean of population increase in the known decades.

Method (1)

Problem (1) Arithmetic Increase method:

(1) The population of '5' decades from 1930 to 1970 is given below in table. Find out the population after one, two & three decades beyond the last known decades, by using arithmetic increase method.

| Year | 1930 | 1940 | 1950 | 1960 | 1970 |
|---|---|---|---|---|---|
| Population | 25,000 | 28,000 | 34,000 | 42,000 | 47,000 |

| Year | Population | Increase in Population |
|---|---|---|
| 1930 | 25,000 ↕(−) | 3000 |
| 1940 | 28,000 ↕(−) | 6000 |
| 1950 | 34,000 ↕(−) | 8000 |
| 1960 | 42,000 ↕(−) | 5000 |
| 1970 | 47,000 | |
| | Total | 22,000 |
| Arithmetic mean of pop. increase in the known decades ($\bar{x}$) | | $\bar{x} = \frac{22,000}{4} = 5,500$ |

Future Population for 'n' yrs (or) decade,

$$P_n = P_0 + n \cdot \bar{x}$$

(a) Expected Population after '1' decade (i.e 1980):

$P_n = P_0 + n \cdot \bar{x}$  [n = 1]

$P_{1980} = (P_1) = P_{1970} + 1 \times 5,500$

$= 47,000 + 1 \times 5,500$

$= 52,500$

(b) Expected population after '2' decade (i.e 1990):

[n = 2]

$P_{1990} = (P_2) = P_{1970} + 2 \cdot \bar{x}$

$= 47,000 + 2 \times 5,500$

$= 58,000$

c) Expected Population after '3' decade (i.e 2000):

$P_{2000} - (P_3) = P_{1970} + 3 \cdot \bar{x}$

$= 47,000 + 3 \times 5,500$

$= 63,500.$

Result:

Expected Population after '1' decade = 52,500

Expected Population after '2' decade = 58,000

Expected Population after '3' decade = 63,500.

HW: Problem (2):

(1) For the following Census data, compute the probable Population by arithmetic increase method in the year 1996, 2006 & 2016.

| Year | 1956 | 1966 | 1976 | 1986 |
|---|---|---|---|---|
| Population | 18,500 | 26,500 | 36,000 | 46,500. |

Ans: $\bar{x} = 9333$, Exp. population in 1996 = 55,833

" in 2006 = 65,166

" in 2016 = 74,499.

### ③ Geometrical Increase method:-

In this method it is assumed that the percentage increase in population remains constant.

Future Population for 'n' yrs (or) decade,

$$P_n = P_0 \left[ 1 + \frac{i \text{ (or) } r}{100} \right]^n$$

r (or) i = Avg. % increase per decade (ie Assumed growth rate %)

n = No. of decades.

$P_0$ = Present Population (Present Population) (or) Initial Population.

$P_n$ = Future Population after 'n' decades.

(i) Methods to determine assumed growth rate (r).

$$r = \sqrt[t]{\frac{P_2}{P_1}} - 1$$

where, $P_1$ = Initial Known population

$P_2$ = Final Known Population

t = no. of decades b/w $P_1$ & $P_2$

$$r = \frac{r_1 + r_2 + r_3 + r_4 \dots r_n}{n}$$

Problem ①: Method ② ✓

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Geometrical Increase population:-

| Year | 1930 | 1940 | 1950 | 1960 | 1970 |
|---|---|---|---|---|---|
| Population | 25,000 | 28,000 | 34,000 | 42,000 | 47,000 |

| Year ① | Population ② | Increase in population in per decade ③ | % increase in Population per decade (ie growth rate (r)) |
|---|---|---|---|
| 1930 | 25,000 | | |
| | ↕ (−) | 3000 | $\frac{3000}{25,000} \times 100 = 12\%$ |
| 1940 | 28,000 | | |
| | ↕ (−) | 6000 | $\frac{6000}{28,000} \times 100 = 21.4\%$ |
| 1950 | 34,000 | | |
| | ↕ (−) | 8000 | $\frac{8000}{34,000} \times 100 = 23.5\%$ |
| 1960 | 42,000 | | |
| | ↕ (−) | 5000 | $\frac{5000}{42,000} \times 100 = 11.9\%$ |
| 1970 | 47,000 | | |

col $\frac{③}{①} \times 100$

% increase in population ×100 / increase in population

geometric mean of growth rate (r)

$r = \sqrt[n]{\%\ \text{increase in population}}$

$r = \sqrt[4]{12 \times 21.4 \times 23.5 \times 11.9}$

$r = 16.37\ \%$ per decade

[illegible] that the future population increases [illegible] at constant rate of [illegible]%

Then $P_n = P_0 \left[1 + \frac{r}{100}\right]^n$

[illegible]

[illegible]

Using [illegible] decade, we have

(i) Expected population after 1 decade (i.e. [illegible])

$P_1 = $ [illegible] $= $ [illegible]

(ii) Expected population after 2 decade (i.e. [illegible])

$P_2 = $ [illegible] $= $ [illegible]

(iii) Expected population after 3 decade (i.e. [illegible])

$P_3 = $ [illegible] $= $ [illegible]

Result

Expected population after 1 decade $P_1 = $ [illegible]

" after 2 decade $P_2 = $ [illegible]

" after 3 decade $P_3 = $ [illegible]

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Now Assuming that the future Population Increases @ constant rate of 16.37%.

Then, $P_n = P_o\left[1 + \frac{r}{100}\right]$

$$P_n = P_o\left[1 + \frac{16.37}{100}\right]^n$$

$$= P_o\left[1 + 0.1637\right]^n$$

$$\boxed{P_n = P_o(1.1637)^n}$$

Using $n = 1, 2, 3$ decades, we have

(i) Expected Population after '1' decade (ie 1980)

$P_{1980} = P_1 = 47{,}000[1.1637]^1 = 54{,}694.$

(ii) Expected Population after '2' decade (ie 1990)

$P_{1990} = P_2 = 47{,}000[1.1637]^2 = 63{,}647$

(iii) Expected Population after '3' decades (ie 2000)

$P_{2000} = P_3 = [47{,}000][1.1637]^3 = 74{,}066.$

Result:

Expected Population after '1' decade $P_1 = 54{,}694$
" after '2' decade $P_2 = 63{,}647$
" after '3' decade $P_3 = 74{,}066.$

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Problem (2):

Compute the population of the year 2000 & 2006 for a city whose population in the year 1930 was 25,000 and in the year 1970 was 47,000. Make use of Geometric increase method.

given data:

Population $P_2 = 47{,}000$

$P_1 = 25{,}000$

$$r = \sqrt[t]{\frac{P_2}{P_1}} - 1$$

$$r = \sqrt[4]{\frac{47000}{25000}} - 1$$

$r = 0.17095 = 17.095\%$ per decade

$\boxed{r = 17.095\% \text{ per decade}}$

W.K.T,

$$P_n = P_0\left[1 + \frac{r}{100}\right]^n, \quad \boxed{n = 3} \text{ decade}$$

Expected population after 3 decades. (from 1970) (i.e. 1970 to 2000 3 decade)

Hence, $P_{2000} = P_3 = P_{1970}\left[1 + \frac{r}{100}\right]^3$

$$P_3 = 47{,}000\left[1 + \frac{17.095}{100}\right]^3$$

$$P_3 = 47{,}000\left[1 + 0.17095\right]^3$$

$$P_3 = 47{,}000\left[1.17095\right]^3 = 75{,}459$$

$\boxed{P_3 = 75{,}459}$

Expected population after 36 yrs (or) decades (ie 3.6 decades)

$P_{2006} = P_{3.6} = P_{1970}\left[1+\frac{r}{100}\right]^{3.6}$ $n = 3.6$ decades

(from 1970 to 2006) ie 36 yrs = 3.6 decades. ie (36/10)

$P_{2006} = P_{3.6} = P_{1970}(1+0.17095)^{3.6}$

$P_{2006} = P_{3.6} = 47,000\left[1+0.17095\right]^{3.6}$

$P_{2006} = P_{3.6} = 47,000\left[1.17095\right]^{3.6}$

$P_{3.6} = 82,954$

Result:

Expected population after '3' decades $P_3 = 75,457$

" after 3.6 decades $P_{3.6} = 82,954$

Method (3)

(3) Incremental Increase method:

* This method is also known as Method of Varying increment.

* In this method, the % increase in population is not assumed to be constant.

Formula:

Future Population @ end of 'n' decade,

$$P_n = P_0 + n\bar{x} + \frac{n(n+1)}{2}\cdot\bar{y}$$

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Expected population after 36 yrs (or) decades (ie 3.6 decades)

$n = 3.6$ decades (from 1970 to 2006) ie 36 yrs = 3.6 decades. ie $(36/10)$

$$P_{2006} = P_{3.6} = P_{1970}\left[1 + \frac{r}{100}\right]^{3.6}$$

$$P_{2006} = P_{3.6} = P_{1970}\left(1 + 0.17095\right)^{3.6}$$

$$P_{2006} = P_{3.6} = 47,000\left[1 + 0.17095\right]^{3.6}$$

$$P_{2006} = P_{3.6} = 47,000\left[1.17095\right]^{3.6}$$

$$\boxed{P_{3.6} = 82,954}$$

**Result:**

Expected population after '3' decades $P_3 = 75,459$

" after '3.6' decades $P_{3.6} = 82,954$.

Method ③ ✓

## ③ Incremental Increase method:

* This method is also known as Method of Varying increment.

* In this method, the % increase in population is not assumed to be constant.

Formula:

Future Population @ end of 'n' decade,

$$\boxed{P_n = P_0 + n\bar{x} + \frac{n(n+1)}{2}\cdot\bar{y}}$$

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Where, $P_n$ = population @ end of 'n' decades (or) yrs.

$\bar{x}$ = Avg. mean of Population increase in the known decades.

$\bar{y}$ = Avg. mean of population incremental increase in the known decades.

Problem ①: Incremental Increase Population

Solve by Incremental increase method.

| Year | Population | Increase in Population | Incremental increase in Population |
|---|---|---|---|
| 1930 | 25,000 | | |
| | | 3000 | |
| 1940 | 28,000 | | (+) 3000 |
| | | 6000 | |
| 1950 | 34,000 | | (+) 2000 |
| | | 8000 | |
| 1960 | 42,000 | | (−) 3000 |
| | | 5000 | |
| 1970 | 47,000 | | |
| Total | | 22,000 | (+) 2000 |
| | | $\bar{x} = \frac{22,000}{4} = 5,500$ | $\bar{y} = \frac{2200}{3} =$ (+) 667. |

Future Population ($P_n$) @ end of 'n' decades,

$$P_n = P_0 + n.\bar{x} + \frac{n.(n+1)}{2}.\bar{y}$$

Expected population after '1' decade,

$$P_{1980} = P_{1970} + 1 \times 5500 + \frac{1.(1+1)}{2}.667$$

$$= 47,000 + 5500 + \frac{1 \times 2}{2} \times 667$$

$P_{1980} = P_1 = 53,167$

Expected population after '2' decade,

$$P_{1990} = P_{1970} + 2 \times 5500 + \frac{2.(2+1)}{2} \times 667$$

$$= 47,000 + 2 \times 5,500 + 2 \times 3/2 \times 667$$

$$= 47,000 + 2 \times 5,500 + 3 \times 667$$

$P_{1990} = P_2 = 69,001$

Expected population after '3' decade,

$$P_{2000} = P_{1970} + 3 \times 5500 + \frac{3.(3+1)}{2} \times 667$$

$$= 47,000 + 3 \times 5500 + 3 \times 4/2 \times 667$$

$$= 47,000 + 3 \times 5500 + 6 \times 667$$

$P_{2000} = P_3 = 67,502$

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Result:

Expected Population after '1' decade = $P_1$ = 53,167.

Expected Population after '2' decade = $P_2$ = 60,001

Expected Population after '3' decade = $P_3$ = 67,502

UNIT - 1 & 2 Assignment questions: (1).

1) i) List out the various pipe materials used in conveyance of water.
ii) Explain about any three joint in pipe lines.

2) i) Explain step by step procedure should be followed while laying of pipes with sketches.
ii) Write short notes on testing of pipe lines.

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14M Question Problem:

(1) Population after one, two, three decades by using three methods:

Present Population = 97500
Before One decade = 85000
Before two decade = 72000
Before three decade = 60000

Method - 1 (Arithmetic Increase method).

| Population | Increase in Population |
|---|---|
| 60,000 | |
| 72,000 (−) | 12000 |
| 85,000 (−) | 13000 |
| 97,500 (−) | 12500 |
| Total | $\bar{x} = \frac{37500}{3} = 12500$ |

Given:-
Present Population ($P_0$) = 97500

97,500

Where $\bar{x}$ = Arithmetic mean of population increase in the known decade.

Future Population for 'n' yrs decade,

$$P_n = P_0 + n \cdot \bar{x}$$

a) Expected population after '1' decade: ($P_1$):

$n = 1$ & $P_0 = 97500$

$P_1 = 97500 + 1 \times 12500$

$P_1 = 97500 + 12500 = 1,10,000.$

$$P_1 = 1,10,000$$

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ii) Expected population after '2' decade ($P_2$):

$P_2 = 97500 + 2 \times 12500$ [n = 2]

$P_2 = 97500 + 25,000$

$P_2 = 122,500 \Rightarrow 1,22,500$

$P_2 = 1,22,500$

iii) Expected Population after '3' decade ($P_3$):

$P_3 = 97500 + 3 \times 12500$

$P_3 = 1,35,000$

Result:-

Expected Population after '1' decade = 1,10,000

Expected Population after '2' decade = 1,22,500

Expected Population after '3' decade = 1,35,000.

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# Method – ②

## Geometric Increase Method

| Population ① | Increase in population in per decade ② | % increase in population per decade (i.e. growth rate (r)) |
|---|---|---|
| 12000 | | $\frac{1000}{12000} \times 100 = 8.33\%$ |
| (−) | 1000 | |
| 13000 | | $\frac{(-)500}{13000} \times 100 = (-)3.85\%$ |
| (−) | (−)500 | |
| 12500 | | |

Col $\frac{②}{①} \times 100$

$\%$ increase in population $= \frac{\text{Increase in population}}{\text{population}} \times 100$

Geometric mean of growth rate (r).

$r = \sqrt[r]{\%\text{ increase in population}}$

$r = \sqrt[2]{8.33\% \times (-)3.85\%}$

$r = \sqrt[2]{30.506}$

$\boxed{r = 5.66\%}$

## Method – ②

### Geometric Increase Method.

| Population ① | Increase in Population per decade ② | % Increase in Population per decade (ie growth rate (r)) |
|---|---|---|
| 12000 | | |
| ↕ (−) | 1000 | $\frac{1000}{12000} \times 100 = 8.33\%$ |
| 13000 | | |
| ↕ (−) | (−)500 | $\frac{(-)500}{13000} \times 100 = (-)3.85\%$ |
| 12500 | | |

Col $\frac{②}{①} \times 100$

$\%$ Increase in population $= \frac{\text{Increase in population}}{\text{population}} \times 100$

Geometric mean of growth rate (r).

$$r = \sqrt[n]{\%\ \text{increase in population}}$$

$$r = \sqrt[2]{8.33\% \; (-)3.85\%}$$

$$r = \sqrt[2]{30.586}$$

$$\boxed{r = 5.53\%}$$

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# UNIT-II

## Water supply Engineering

### Quality of Water:

The water treated to remove impurities, it may not be harmful to the public health. Its called as Wholesome water (or) potable water.

### Impurities in water:

* Physical
* Chemical
* Bacteriological

} impurities.

### Forms of Impurities:

* Suspended
* Colloidal
* Dissolved

} impurities.

### Testing of water:

* Physical
* Chemical
* Bacteriological

} Test of water.

### Physical Test:

* Temperature
* Colour
* Turbidity
* Taste and odour

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## Chemical Test:-

* Total Solids
* Hardness
* Chlorides
* Residual Chlorine
* Iron and Manganese
* pH Value.

## Bacteriological Test.

* Total Count (or) Agar plate count Test.
* B-coli test.

a) * presumptive test.
b) * Confirmed Test
c) * Completed Test.

## Water Borne diseases:-

* Diseases caused by bacterial infections
* Diseases caused by viral infections
* Diseases caused by protozoal infections

## Primary Treatment of Water:-

* The main object of the treatment process is to remove the impurities of raw water.

* To remove the dissolved gases, colour of water.

* To remove the unpleasant & tastes & colours from the Water.

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* To kill all the Pathogenic germs, which are harmful to the human health.

## Sedimentation:

The purpose of sedimentation is to remove the heavier suspended Particles in Water.

## Types of Sedimentation tanks:-

* Classification according to the flow.

* Draw & fill type tanks
* Continuous flow type of Sedimentation tank.

* Classification according to the Shape.
* Rectangular tank- Horizontal flow type
* Circular tank - Radial flow type.
* Hopper bottom type - Vertical flow.

## Coagulation:

Very fine suspended clay Particles are not removed by Plain Sedimentation. Silt Particle of 0.06 mm Size requires 10 hours to settle in 3m deep plain Sedimentation tank and 0.02 mm Particle will require about 4 days for Settling.

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## Filtration of Water:

* Screening & sedimentation removes a large percentage of the suspended solids and organic matter.

## Theory of Filtration:-

* The colloidal impurities & some of bacteria are removed.

a) Mechanical straining.
b) Sedimentation.
c) Biological Action.
d) Electrolytic Action.

## Classification of Filters:

a) Slow sand
b) Rapid sand } Filters.
c) Pressure

## Disinfection of Water:

* The process of killing the infective bacteria from the water and making it safe to the people is called disinfection. The chemicals used for killing the bacterias are known as

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disinfectants and Process of Killing the bacteria is Known as disinfection of Water.

Necessity of disinfections:

* After filtration, Water is found to carry some Pathogenic bacteria which are responsible for Waterborne diseases. Disinfection is necessary to destroy all such bacteria.

* Disinfection is necessary to protect the citizens from health hazard and to assure a healthy atmosphere.

Methods of disinfection:

* Boiling
* Using Iodine and Bromine.
* Using Ozone
* Using Potassium Permanganate
* Using silver
* By chlorination.

Methods of Chlorination:

* Plain chlorination
* Pre chlorination
* Double chlorination
* Break Point chlorination
* Super chlorination
* De chlorination.

## Forms of Chlorination

* In the form of liquid chlorine.
* In the form of bleaching Powder
* In the form of chloramines.
* In the form of chlorine dioxide

## Water softening:

* Water softening may be defined as the removal or reduction of hardness from water.

## Necessity of Water softening:

* To improve taste of food.
* To reduce the consumption of soap in washing of clothes.
* To reduce the formation of scales in boilers
* To increase the life of fabrics
* To neutralize the effect on colour in dying system
* To reduce the corrosive effect on pipes.

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## Hardness

Hardness of water is defined as the quality of water which is due to the presence of bicarbonates of calcium & magnesium, sulphates, chlorides & nitrates of calcium & magnesium. Such water is termed as hard water.

## Effects of hardness:

* It makes the food tasteless.
* The vegetables, meat, boiled properly.
* It increase the fuel cost of cooking.
* It consumes more soap & uneconomical in washing of clothes.

## Miscellaneous Water treatment:

* Removal of Iron and Manganese.
* Removal of Colour, Odour & taste.
* Fluoridation * De fluoridation * Desalination

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Requirements:

* It should be sparkling clear & fresh.
* It should be cool and tasty.
* It should be reasonably soft.
* It should be free from diseases producing bacterias.

Reverse Osmosis (RO):

* osmosis is a process in which the difference in the chemical potential b/w two solutions separated by a semi-permeable membrane, forces flow from low to high concentration solution.

Treatment Scheme:

* Passing through sand bed filter.
* Passing through Activated carbon filter.
* Reverse osmosis membrane.

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## UNIT- II

### Distribution System:

* Distribution systems are designed to satisfy the Water requirements for a Combination of domestic, Commercial, Industrial & fire fighting purposes.

### Methods of distribution:-

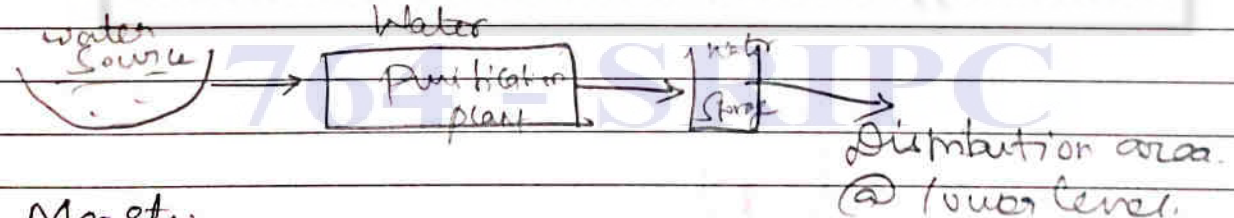
* It depends upon the topography of the area.

The Systems of distribution:-

a) Gravity system b) Pumping System.

c) Combined Pumping & gravity System.

### Gravity System:

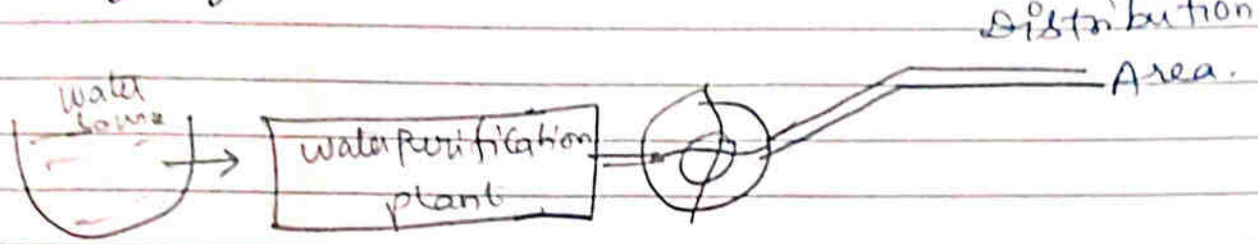



Merits:

* No pumping is reqd.

Demerits: * source of Water Supply Should be higher than area to be Served

Pumping system:



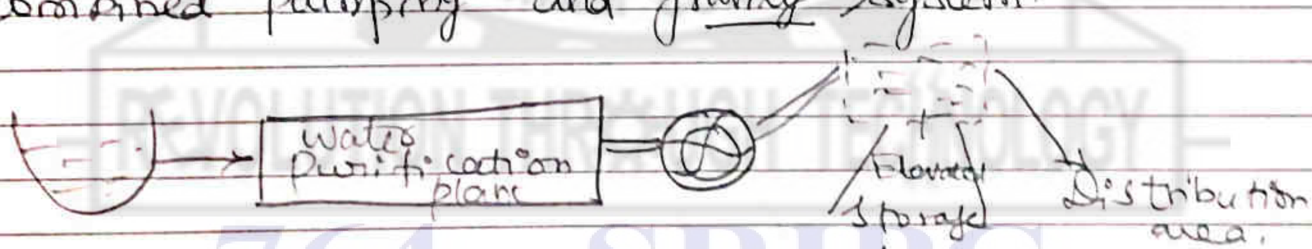

* In direct, Pumping, water is pumped from the Source to treatment plant & from treatment plant to distribution area.

Demerits:

a) Pumping is costly.

b) Water supply fails when Power supply fails.

Combined pumping and gravity System:




Merits:

* This is the most common system.
* Stored water can be used during emergencies like fire fighting.

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## Systems of Water Supply:-

- Continuous Supply System
- Intermittent supply System.

| Intermittent supply system | Continuous Supply system |
| --- | --- |
| This System is suitable when water available is limited quantities | This System is suitable when water available in large quantities. |
| Pipes of bigger size is laid. | pipes of smaller size is laid. |
| Storage tanks reqd. | No necessity to Store water |

## Different layout of Distribution System.

- Dead end System
- Grid Iron System
- Circular system
- Radial System.

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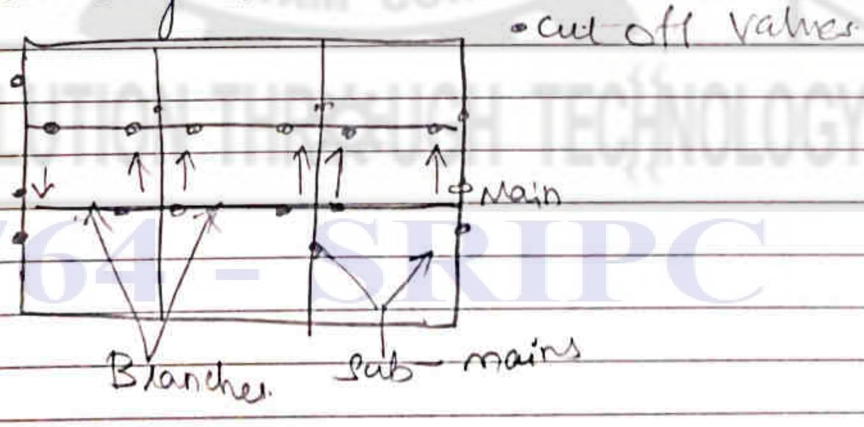
## Dead end System :

* The ends of the Sub-mains & branch lines are stopped by Scour Valves are known as dead ends.
* The entire distribution area is covered by pipe lines like tree.
* This System is suitable for irregular developing town or city.

## Grid Iron System:

It is also known as Interlaced System (or) reticulation System.



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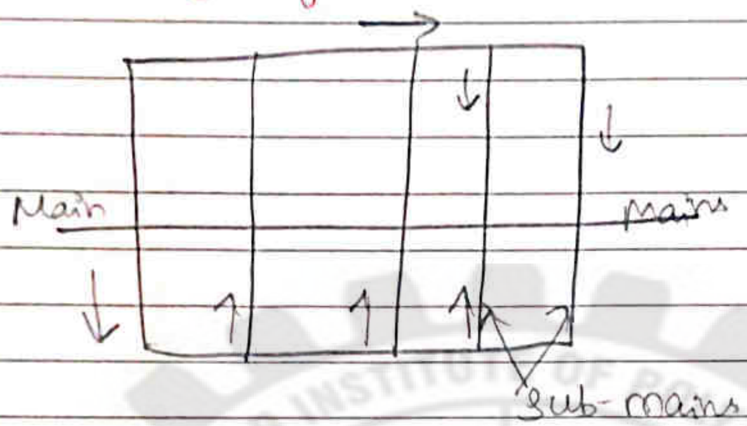
## Circular or Ring System:




* Left & Right water mains travel in Opposite direction along the Periphery of the area and they meet again on the outlet side. This System is also known as ring System.

## Radial System:

It is just the reverse of the Circular System.

## Service Reservoirs: (Distribution Reservoir)

Service Reservoir Provide Service Storage to meet the fluctuating demands in distribution System

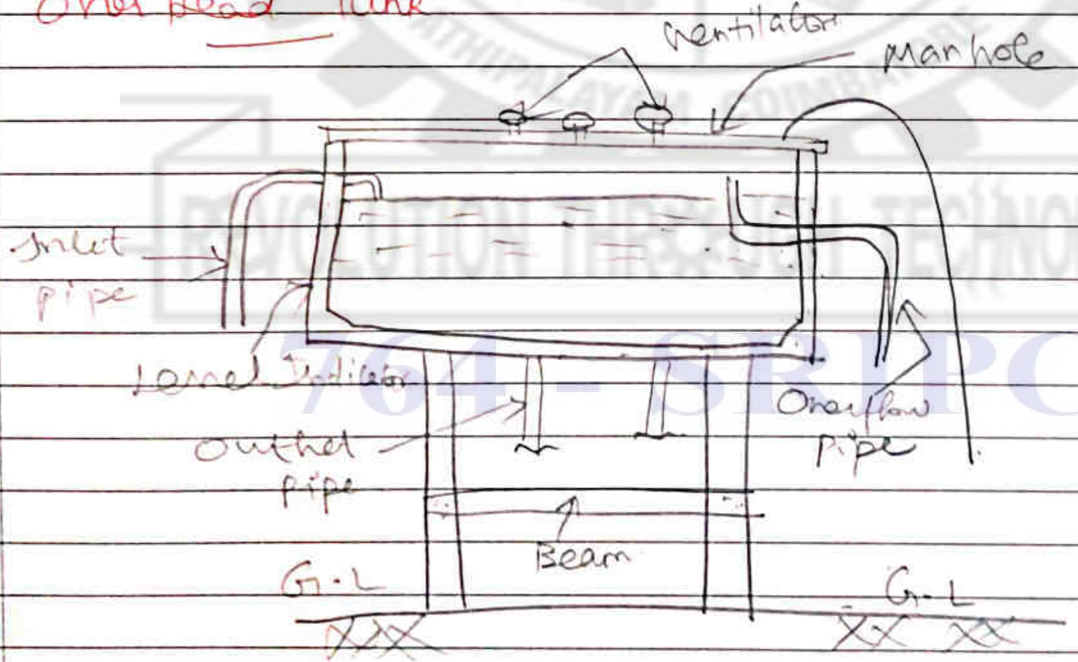
Types of Service reservoirs:

* Surface reservoirs
* Elevated reservoirs.

Surface Reservoirs:

* It's rectangular tank constructed with brick masonry or R.C.C.
* The storage capacity depends on the water requirement of the scheme. The water from the treatment plant is stored in this tank.

Over Head Tank:



* The height of the reservoir depends on the pressure head to be developed to supply water to all points of the distribution zone.
* So, such types of reservoirs are essential in dual system of water supply.
* They are provided with top cover, ladder and man holes for inspection and cleaning purposes.

## Location of Service Reservoirs:

* Service reservoirs should be located centrally or at least as near as possible to the zone that they serve.

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## UNIT – IV
## SANITARY ENGINEERING

### Sanitation:

* Sanitation is the preservation of health of the individual and community, by preventing communicable diseases.

### Definition of Terms:

* Refuse:

* Rejected materials which are collected in dustbins and foul discharges which are carried by underground drains are termed as refuse.

Sullage:

* Discharge from the bathrooms and kitchens is termed as sullage.

Sewer:-

* Underground conduits (or) drains which carry sewage are known as sewers.

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Sewerage:

Network of Collecting and conveying sewage by water Carriage System through the underground Sewers is Known as Sewerage.

Manhole:

Opening (or) hole through which a man can enter the sewer line (or) closed Structure for inspection & cleaning is termed as Manhole.

Systems of Sanitation:

* Dry (or) conservancy System
* Water Carriage System.

Quantity of Sewage:

* Domestic (Or) Sanitary Sewage.
* Storm water.

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Estimation of Storm water:

× Quantity of Storm water, which is known as WWF (Wet weather flow).

× Rational method.

× Empirical formulas.

Rational Method:-

$$Q = \frac{KiA}{360} \text{ Cumecs}$$

Q = Storm water in cumec

K = Run-off coefficient

i - Intensity of rainfall in mm/hr.

A - Catchment area in hectares.

Shapes of Sewers:-

× Circular
× Non-circular } Sections.

Materials used for Sewers:

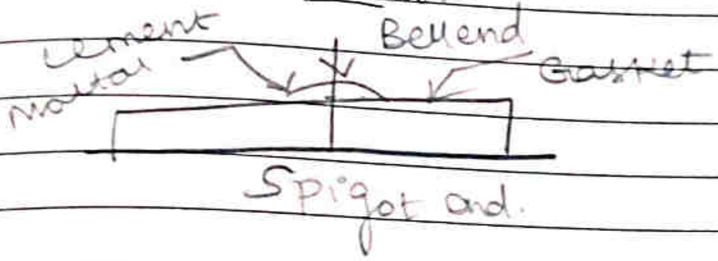
* Asbestos Cement
* Brick
* Cast Iron
* Cement Concrete Sewers
* plastic * Stoneware * Steel

Joints in Sewer lines

Types of Joints:

* Cement Mortar Joint.
* Collar Joint
* Flexible or Bitumen Joint
* Mechanical Joint.
* Open Joint.

## Cement Mortar Joint:




Cement mortar Joints are widely used in the construction of sewers & found to be satisfactory.

## Collar Joint:-

* Ends of the sewer are plain they are placed near each other and collar of slightly bigger diameter is placed over the ends of the sewer.

## Flexible Joints:

* Bitumen is used instead of cement mortar. These joints are flexible & suitable where chances of sewer settlement.

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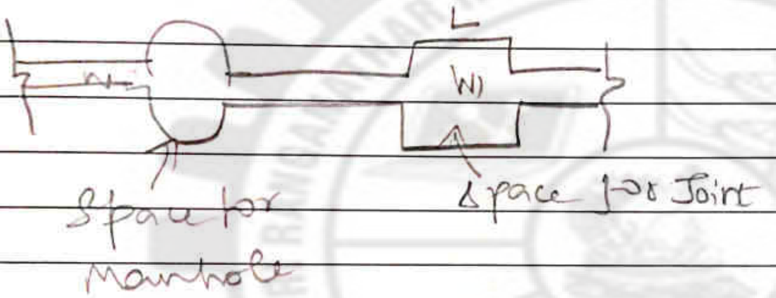
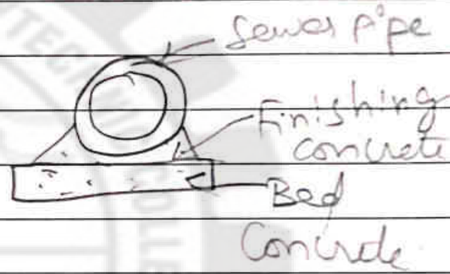
Mechanical Joints:

* Dresser coupling.
* Victaulic joint.

## Laying of Sewer lines




Concrete Bed.

Smaller size pipes can be laid by the pipe layers directly by hand only but heavier & larger size pipes are lowered in the trenches by passing ropes around them & supporting through a hook.

Testing of Sewer lines:

* By Water Test
* By Air Test
* Obstructions & Straightness

Ventilation of Sewers:

* Use of Manhole with chemicals
* use of Manhole with gratings
* proper construction
* Proper design
* Proper house drainage System
* Ventilating columns (or) Shafts

Cleaning of Sewers:

* Small sewers are cleaned by rodding from the manholes.
* The cleaning may be done by discharging water from a fire-hose under high pressure

through Small nozzles

* For medium Sewers, Scrapers are used to remove obstructions.

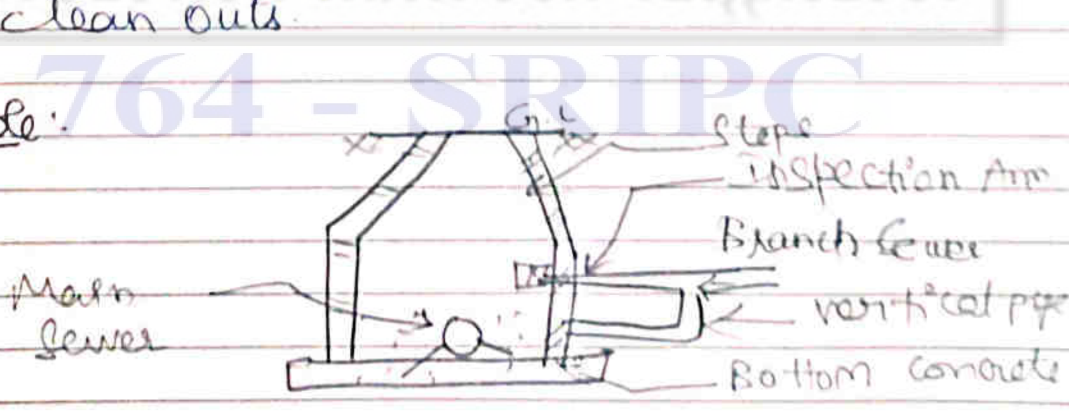
* Large Sewers may be cleaned by manual labour, removing materials on barges

## Sewer Appurtenances:

* Man holes
* Lamp holes
* Drop manholes
* Catch basins
* Inlets
* Traps
* Flushing tanks
* Regulators
* Inverted Siphons
* clean outs



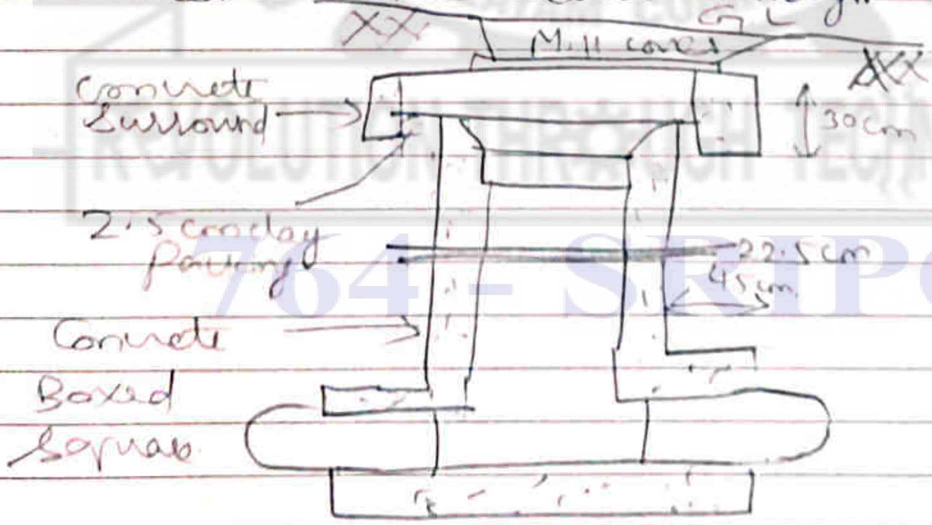
## Man hole:



* A man hole is a structure constructed to provide access to the Sewer for facilitating inspection, cleaning (or) usual maintenance operations.

## Lamp hole:

A lamp hole is a small opening in sewer constructed for lowering a lamp inside it. The lamp hole consists of a Stoneware (Or) Cast Iron Pipe of 20 to 30cm dia Connected to the Sewer through a T-junction.



Sewage pumps:

Sewage flows by gravitational force pumping is not necessary.

Necessity of Pump Sewage:-

* When the water course is at higher level than Outfall.

* to lift Sewage from outfall Sewer to treatment plant.

* Pumping may also be essential for transferring Sludge from Settling tank to Sludge digestion tank.

Types of Sewage Pumps:

* Centrifugal Pumps
* Reciprocating pumps
* Pneumatic ejectors
* Air lift pumps.

UNIT-V

# Primary Treatment of Sewage

Object:

* To protect public health.
* To save land from sickness.
* To get fertilizer & food from poultry farm
* To get grease & combustible gas

## Primary Treatment:

* Screens
* grit chambers
* Skimming tanks
* Sedimentation tanks with (or) without chemicals

## Necessity of Screening:

* To prevent formation of screens in settling and aeration tanks.
* To protect pumping wells, siphons from damage.

Types of Screens:

* According to size of the openings screens may be
* Coarse Screen * Medium Screen.
* Fine screen.

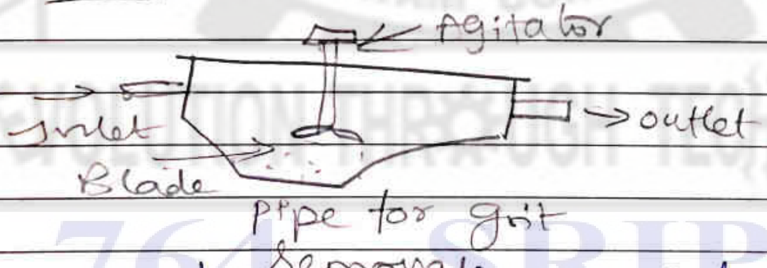
* According to the condition of movement screens may be,

a) Fixed b) movable c) Moving Screens.

According method of cleaning screens may be,

a) Hand Cleaned b) Mechanically Cleaned.

Grit chambers:




A grit chamber is an enlarged channel (or) long basin in which the cross section is increased to reduce the velocity the flowing sewage sufficiently to cause heavy organic matter

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such as Grit, Sand & gravel of size 0.2mm & larger to settle & higher Organic matter remaining in suspension. Dry grit weighs about 1300 kg/m³ while wet grit weighs about 1600 kg/m³ grit has 40% voids. Grit has particles larger than 0.2 m diameter.

## Secondary Treatment of Sewage:

* The treatment reaction in which the Organic matter is destroyed & stabilized by aerobic bacterias are known as anaerobic biological units.
  * Anaerobic lagoons
  * Septic tanks.
  * Imhoff tanks

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## Secondary Sedimentation (or) Secondary clarifiers tanks

* Secondary clarifiers are:
* Capacity of tank * Sludge Removal.
* Recirculation device.

### Sludge Removal:

* Hand cleaning
* Hydraulic cleaning
* Mechanical cleaning.

### Filters:

* Source or formation of bacterial colonies.

These bacteria decompose the organic matters for their survival.

Types of Filters:

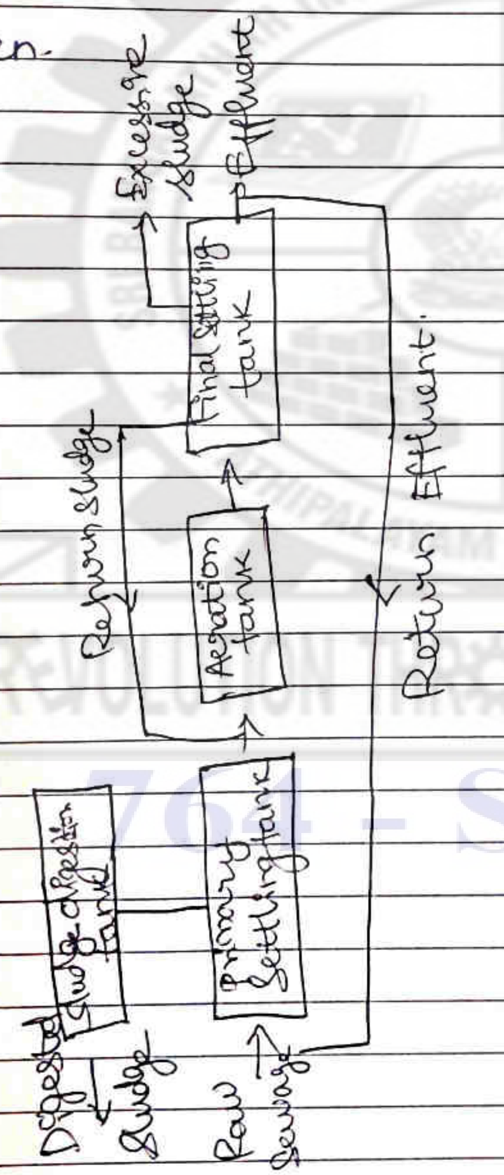
* Trickling Filter is the one type of treatment method in Secondary treatment. It is used to complete treatment of moderately strong waste.

* Standard rate (or) low rate trickling filters.

* High rate trickling filters

## Activated Sludge Process:

* Activated sludge is defined as the sludge settled out of sewage in the presence of abundant oxygen.




Activated Sludge Process.

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## Septic tank for Isolated Buildings:

* Septic tank is like a plain sedimentation tank but in septic tank the bio chemical reaction by anaerobic bacteria.

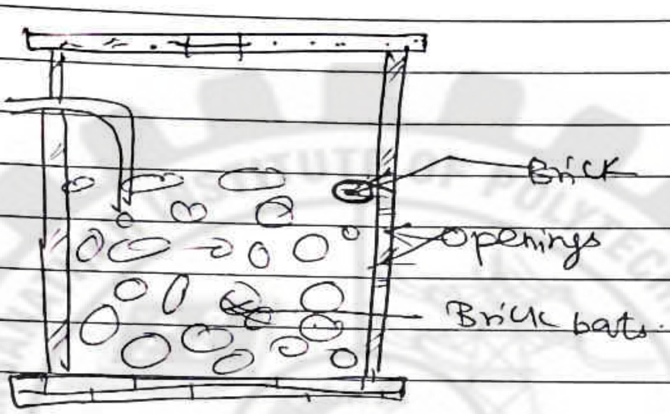
## Isolated buildings:-

* A septic tank for a building, should not contain less than 2300 litres of sewage. Accumulation should be about 100 litres. In a two-compartment tank the first compartment should hold not less than 2300 litres. The first compartment is 2/3 to 1/2 of the entire tank.

## Soak pit:

* Soak pit is also called seepage pit. Where space is restricted as in towns. Soak pits may be used particularly in areas where rainfall is not heavy underground drinking water

supply line should be situated in a radius of atleast 60m from a disposal site (or) Soak pit.




Dispersion trenches:

* Trenches should be 50 to 100 cm deep and 30 to 100 cm wide excavated to slight gradient.
* It should be provided with 15 to 25cm of washed gravel (or) crushed stone.
* It should be made of unglazed earthenware (or) Concrete.
* It should have a minimum internal diameter of 7.5 cm to 10 cm.

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## Environmental Pollution and Solid Waste disposal:

Types of Pollution:

* Water Pollution:
* Soil Pollution
* Air Pollution
* Noise Pollution

Environmental Pollution:-

* Pollution is generally defined as the addition of the constitutents of water, air (or) land, which adversely after the natural quality of the environment.

Water pollution:-

Water pollution Occurs when chemicals (or) nutrients (or) wastes enter water faster than they can be removed by natural processes.

Types of water Pollution:

* Physical
* Chemical
* Biological
* Physiological

} Pollution of water.

Sources of Water Pollution:

* Washing clothes of persons suffering from diseases like dysentery, cholera, typhoid.
* Bathing of persons suffering from skin diseases.
* Discharge from nuclear research centre.
* Discharge from nuclear power plant.
* Discharge of sewage of a town or city, into the river without any treatment.

Effects of Water Pollution

* Water Contaminated by fibres causes fatal diseases like lung cancer.
* Organic Pollutants present on an aesthetic scene and disturb recreational uses of water.
* Sulphate present in water causes intestinal problems.
* Acid Pollution in water causes damage to concrete structures & water pipes due to their corrosive reaction.

Soil Pollution:

Soil Pollution is defined can be the contamination of soil of a particular region. Soil Pollution mainly is a result penetration of harmful pesticides & insecticides.

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## Noise Pollution:

* Due to increase in Population, no. of vehicles & other sound articles, noise is increasing day by day in the cities.

**Sources of Noise Pollution:**

* Domestic
* Public
* Traffic
* Construction
* Industrial

} Noise.

**Effects of Noise Pollution:**

* It may cause loss of sleep.
* It may increase blood pressure.
* It may cause irritation of mind.
* It may cause digestive disorder.
* It may develop hypertension.

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Control of Noise Pollution:

* Reduction in Sources of noise.
* Use of Sound absorbing matter.
* Through law.

Air Pollution:-

* Air Pollution may be defined as the presence of one (or) more contaminants like dust, Smoke & odour in the atmosphere which are injurious to human beings, plants & animals.

Sources of Air Pollution:-

* Natural Sources * Man made Sources.

a) Atmospheric reaction e Radioactive minerals
b) Dust and aerosols.
c) Micro-organisms.
d) Pollens.

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Effects of Air Pollution on Human beings:

* Effects on Human health.
* Effects of Air Pollution on Animals.
* Effects on materials.
* Effects on Plants.

Air Pollution control equipments:

* Settling chambers
* Cyclone Filters
* Scrubbers
* Electrostatic Precipitators.

Environmental degradation:

* Ozone layer depletion.
* Green house effect.

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Ozone layer deflection:

* upper layer of the atmosphere envelped by ozone is commonly known as ozonosphere, ozone layer, Stratospheric ozone layer, protective layer (or) ozone umbrella.

* Ozone depleting substances,

* Chloroflouro carbon.

* Emitting home products.

* Effects on Human beings:

* Ultra violet causes leukemia and breast cancer.

* UV radiations make the skin hot, swollen or red causing sun burns.

* Ozone at low concentration is also known to cause accumulation of inflammatory cells at the site of lung injury causing severe damage to lung.

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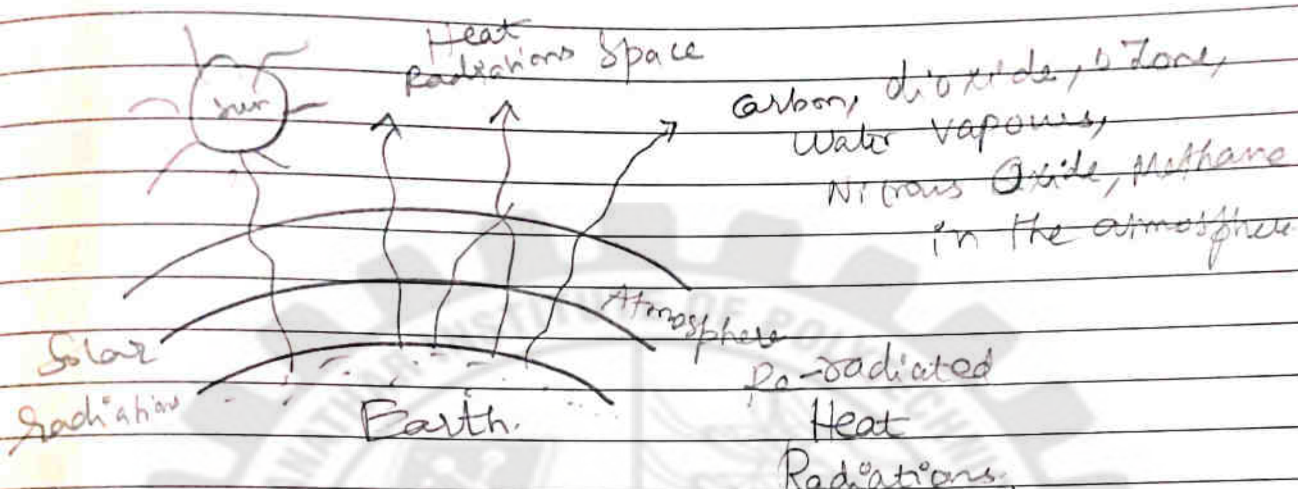
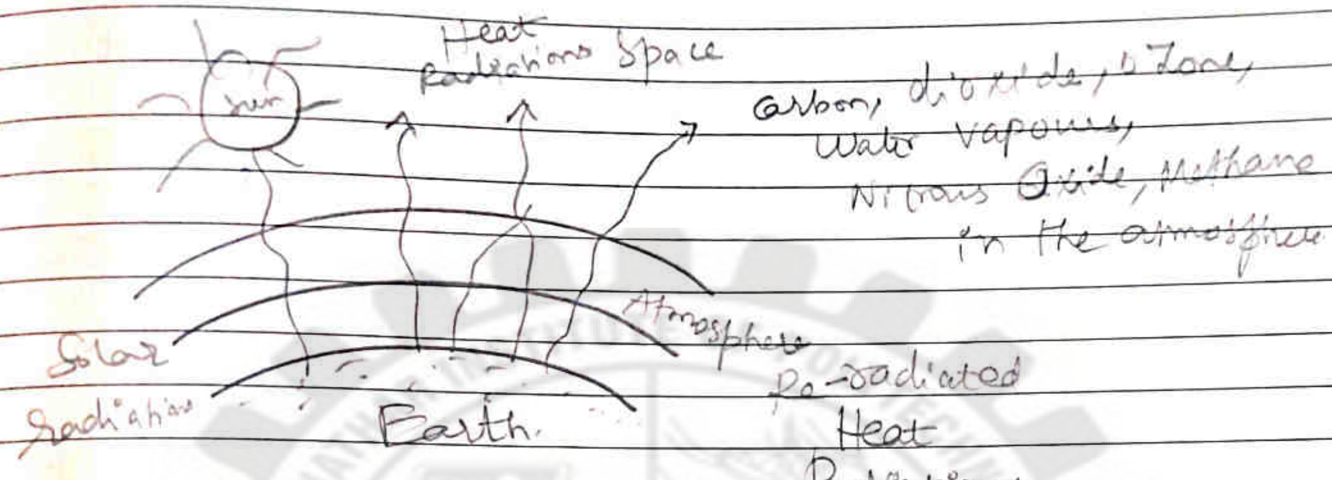
## Green house effect:-




As a result of air pollution (or) human activities, more energy radiated back and Consequantly temperature of the earth increases. This phenomenon is known as green house effect (or) global warming.

* An aerosol is particle of solid (or) liquid matter of minute size that it can remain suspended in the atmosphere for a long period of time.

## Green house effect:-

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Impacts of Greenhouse effect:

* Global temperature increases.
* Rise in Sea level.
* Effects of human heath.
* Effects of Agriculture.

Solid waste disposal:

* To avoid the bad smell from the Solid waste
* To avoid Pollution of the Environment.
* To Prevent environment.
* To avoid flying nuisance.
* To neutralize the Solid waste.

Methods of Solid waste disposal:-

* Dumping disposal into sea.
* Disposal by Sanitary land filling.
* Disposal by incineration
* Disposal by composting.

## EIA (Environmental Impact assessment):

* Environmental Impact Assessment (EIA) is a study of the Probable changes in Socio-economic and bio physical characteristics of the environment.

## Preparation of Environmental Impact Statement (EIS):

* EIS is the conclusion of the EIA as the results of the assessment are reported through it.

a) Description of the site (or) environment where the proposed project is to take place.

b) The environmental Impact of the Proposed Project.

* The unavoidable adverse effects resulting from the activity.
* Alternatives of the activity.
* Relationship between the local short term uses and long term productivity of the resources involved.