DEPARTMENT OF CI VIL ENGINEERING

B.Tech 7th semester

WATER SUPPLY AND SANITARY ENGINEERING

Lecture 1

INTRODUCTION

The five most essential elements for the existence of human life are air, water, food, heat and light, of which next to air, water is the most important requirement for the human life to exist. Inspite of apparent abundance of water, less than one percent is available for human use in the form of surface waters as 97 percent is contained in oceans etc. and 2 percent is locked up in ice-caps and glaciers.

DEVELOPMENT OF PUBLIC WATER SUPPLY SYSTEM

Since very early times man has obtained water from the surface sources such as rivers, lakes, etc, as well as from the subsurface or groundwater sources such as springs, wells, etc. Due to relatively less requirement of water in the early times, which was mainly for domestic purposes, these sources were deemed to meet the requirements of the persons residing in the nearby areas. Further water was directly procured from these sources by the persons as per their requirements and there was no public water supply system. However, with the growth of population the demand of water also increased which led to the development of new sources of water, construction of conduits and aqueducts for the conveyance of water from a distance and subsequent storage to be ultimately distributed to the inhabitants through a pipe system.

NEED FOR PROTECTED WATER SUPPLIES

It is necessary that the water which is to supplied to the public must be invariably free from all types of impurities both suspended and/or dissolved in it, any kind of bacteria and any other contamination which may cause serious harm to the health of the public. It is therefore imperative to plan and build such a water supply scheme which would provide potable water free from any kind of contamination.

Therefore care must be taken that a public water supply system should be such that it is able to provide an adequate and reliable supply of water catering to all the public needs and also ensure that the supplies so made are not potable but also fully protected against any infection which might pollute water and cause epidemics resulting in human sufferings and loss.

India's huge and growing population is putting a severe strain on all of the country's natural resources. Most water sources are contaminated by sewage and agricultural runoff. India has made progress in the supply of safe water to its people, but gross disparity in coverage exists across the country. Although access to drinking water has improved, the World Bank estimates that 21% of communicable diseases in India are related to unsafe water. In India, diarrhoea alone causes more than 1,600 deaths daily—the same as if eight 200-person jumbo-jets crashed to the ground each day. Hygiene practices also continue to be a problem in India. Latrine usage is extremely poor in rural areas of the country; only 14% of the rural population has access to a proper sanitation. Hand washing is also very low, increasing the spread of disease. In order to decrease the amount of disease spread through drinking-water, latrine usage and hygiene must be improved simultaneously.

OBJECTIVES OF PUBLIC WATER SUPPLY SYSTEM

The main objectives of any public water supply system are as follows:

(1) To supply safe and wholesome water to the consumers.

(2) To supply water in adequate quantity.

(3) To make water available within easy reach of the consumers so as to encourage the general cleanliness.

PLANNING OF WATER SUPPLY SCHEME FOR A TOWN OR CITY

In planning a water supply scheme for a town or city the following points need to be considered.

(1) Source of water

(2) Quantity of water i.e source selected must provide water in sufficient quantity

(3) Quality of water

(4) Financial aspects

(5) Trends of future development

SOURCES OF WATER

The following are the common sources of water

(i) Surface water *(ii)* Groundwater *(iii)* Water obtained from reclamation.

Surface water is the one which is available as *run -off* from a catchment area, during rainfall or precipitation. This runoff flows either into streams or into undrained lakes. The runoff water flowing into streams can either be *stored* in a reservoir by constructing a dam across it, or be diverted into a water supply channel. Thus depending upon the scheme of collection, we get surface water from the following sources.

(a) Water may be collected directly from the river, without any diversion work

(b) A diversion work is constructed across a perennial river and water is diverted into a canal which leads water to the site of water purification works

(c) *From reservoir storage.* Where supply is not ensured throughout the year. dam may be constructed across the river and water stored in the reservoir

(d) Water may also be obtained through direct intakes from natural lakes which receive surface run-off from the adjoining catchment .

Ground Water

The largest available source of fresh water lies underground. The term *'ground water '* refers to this water, which is stored by nature, under-ground in the water-bearing formation of earth's crust. The total ground water potential is estimated to be one third the capacity o f oceans. The main source of ground water is precipitation. A portion of rain falling on the earth's surface infiltrates into ground, travels down and when checked by impervious layer to travel further down, forms ground water. The *ground water reservoir* consists of water held in voids within a geologic stratum. The ground water can be tapped from the following sources.

(a) From natural *springs*

(b) From *wells* and *bore holes* .

(c) From *infiltration galleries,* basins or cribs .

(d) From wells and galleries with flows augmented from some other sources :
(i) spread on surface of the gathering ground

(u) carried into charging basins or ditches, or
(m) led into diffusion galleries or wells.

Water obtained by redemption

(a) Saline or brackish water may be rendered useful for drinking purposes by installing desalination plants. The common methods used for desalination are: distillation, reverse osmosis, electro dialysis, freezing and solar evaporation.

(b) Effluent or waste water can be treated suitably so that it may be reused .

Or controlled indirect re·use i.e. the intentional artificial recharge of ground water aquifers by adequately treated waste water.

Quantity of Water

Quantity of Water depends on

(i) Design period (ii) Population (iii) Rate of demand

DESIGN PERIOD

Generally, water supply projects are designed for a design period of 20 to 40 years, after their completion. The time period between the design and completion should not be more than 2 years. In some specific components of the project, the design period may be modified. Different segments of water treatment and distribution systems may be approximately designed for differing periods of time using differing capacity criteria , so that expenditure far ahead of utility is avoided. Table gives the design periods for various components of a water supply project. The design period for future population should be such that the design does not become outdated in the near future or overburdens the present population.

TABLE

DESIGN PERIODS FOR PROJ ECT COMPONENTS

Component	Design. period (in years)
Storage by dams	50
Pump house	30
Electric motor and pumps	15
Water treatment units	15
Raw water conveying units	30
Service reservoirs	15
Distribution system	30

Future Population:

POPULATION FORECAST

The data about the present population of a city for which a water treatment system is to be designed can always be obtained from the records of the municipality or civic body. However, a water supply project is designed to cater the needs of the community upto the end the design period which may extend upto 2 to 4 decades, before the project is abandoned or enlarged by reason of inadequacy. There are several methods for population forecast, but the judgment must be exercised by the engineer as to which method is most applicable for a particular location. The increase in population of city depends upon several factors such the living conditions of the city and its environs, industrial potential, state of development, location with respect to road and rail links, climatic conditions etc. The entire population o f a city may not be evenly distributed , due to variations in the land use pattern and available facilities etc. The *population density,* indicating the number of persons per unit area, and the distribution of population should also be studied for efficient design of the distribution system.

Various methods for estimation of future population are listed below.

1. Arithmetical increase method .
2. Geometrical increase method.
3. Incremental increase method.
4. Decreased rate of growth method .
5. Graphical extension method.
6. Graphical comparison method.
7. Zoning method or master plan method.

1) Arithmetical Increase Method:

Here we assume that the actual increase per decade is constant. The average increase in population per decade is added for each successive future decade to obtain the prospective population of the future decade.

Where the prospective population P_n after n decades from the year corresponding to latest known population P_0 is given by expression

$P_n = P + n \times c$

This method is suitable for old towns and for a rapidly growing town it gives a lower figure.

2) Geometrical Increase Method:

Here we assume that the percentage increase from decade to decade is constant. An average percentage increase (r) in last decades is taken and added to present population.

$P_n = P_0(1 + r/100)^n$

The value of r is taken as either the arithmetic mean or the geometric mean of these percentage increase in population for each decade.

Thus if r_1 ,r_2 , r_3 ,… ……. r_t are the percentage increase in population for each of the past t successive decades then the value of r is taken as either the arithmetic mean i.e

$$r = \frac{r_1 + r_2 + r_3 + \ldots\ldots\ldots + r_t}{t}$$

or the geometric mean 1.e

$$r = (r_1 \times r_2 \times r_3 \times \ldots \ldots\ldots \times r_t)^{1/t}$$

The value of arithmetic mean is slightly higher than that obtained by geometric mean.

Govt. of India Manual on Water and Water Treatment recommends the use of geometric mean for determining the value of r.

3) Incremental Increase Method:

To overcome the deficit of the first method, the incremental increase is also taken into account. This is more suited for a town which is rapidly but steadily growing. Population: (Present population) + (Average increase per decade)*n + (Incremental increase per decade)*n

4) Decreased rate of growth method /Changing rate of increase method:

This method is similar to the geometrical increase method except that instead of a constant value of the percentage increase in population per decade a decreasing value of the percentage increase in population per decade is adopted for each future decade. For determining the decreasing value of the percentage increase in population per decade for each future decade, the average decrease in the percentage increase in population per decade is worked out and it is subtracted from the latest percentage increase in population per decade for each successive future decade.

Here we have an example of a small village and we are trying to predict its population
In the year 2045 using first four methods.

Sr No.	Year	Population	Increase	% Increase	Incremental Increase
1	1975	8000			
2	1985	12000	4000	$\frac{4000}{8000} \times 100$ = 50	
3	1995	17000	5000	$\frac{5000}{12000} \times 100$ = 41.7	1000
4	2005	22500	5500	$\frac{5000}{12000} \times 100$ = 32.4	500
Total		Total	14500	124.1	1500
		Average	c = 4833	r = 41.37	m = 750

Expected population in 2045 i.e. almost 3 decades from now and 4 decades from the year 2005 as calculated using various methods.

1) Using Arithmetical Increase Method where n= 4, P_0 = 22500

P_4=22500 +
4x4833 = 41832

2) Using Geometrical Increase Method where percentage increase in population per decade is taken as the arithematic mean.

$P_4 = 22500\ (1+0.4137)^4 = 89870$

3) Using Incremental Increase Method:

$$P_n = P_0 + nc + \frac{n(n+1)}{2} m$$

$$P_4 = 22500 + 4\text{x}\ 4833 + \frac{3\ (3+1)}{2}\ 750 = 46332$$

4)Using Decreased rate of growth method /Changing rate of increase method:

Sr	Year	Population	Increase	% Increase	Change in rate of increase

No.					
1	1975	8000			
2	1985	12000	4000	$\frac{4000}{8000} \times 100 = 50$	
3	1995	17000	5000	$\frac{5000}{12000} \times 100 = 41.7$	+8.3* (* it can also have a negative value if value in row 3 is greater than at 2)
4	2005	22500	5500	$\frac{5000}{12000} \times 100 = 32.4$	+9.3
Total		Total	14500	124.1	17.6
		Average	c = 4833	r = 41.37	r' =8.8

$$P_n = P_0 \left(1 + \frac{r_t - r'}{100}\right)\left(1 + \frac{r_t - 2r'}{100}\right) \ldots\ldots\ldots\ldots\ldots\left(1 + \frac{r_t - n r'}{100}\right)$$

$$P_4 = 22500 \left(1 + \frac{32.4 - 8.8}{100}\right)\left(1 + \frac{32.4 - 2 \times 8.8}{100}\right)\left(1 + \frac{32.4 - 3 \times 8.8'}{100}\right)\left(1 + \frac{32.4 - 4 \times 8.8'}{100}\right)$$

$$= 32894$$