



Sanitary Engineering Project

Group 1

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"Abstract"

In This project we will focus on three Categories

- Water treatment plant
- Water distribution network
- Waste water collection work

> Project Definition

This project involves the construction of a water treatment plant and the design of both the water distribution network and the sewage network.

> The Problem

The challenge at hand is to create a water treatment plant capable of supplying water to a city in both 2040 and 2060. This entails determining the appropriate number and sizes of pipes for the water distribution network to ensure efficient delivery to households, as well as identifying the optimal number and diameters of pipes for the sewage network.

> Study Objectives

The primary objectives of this study are as follows:

- Designing a water treatment plant
- Planning the water distribution network
- Establishing the wastewater network design

Existing Solutions

For the water treatment plant, the existing solutions involve the use of pumping mechanisms, filters, and tanks to treat the water and produce clean, potable water suitable for human consumption. Regarding the distribution network, pipes, pumps, and elevated tanks are utilized to transport water to residential areas.

In the case of the wastewater network, the design revolves around determining pipe slopes, utilizing gravity, and selecting appropriate diameters to convey the Lift Station

> Design Constraints

There are no specific design constraints or limitations identified for this project

Customer Needs And Background

The customer's needs revolve around water treatment, extraction of drinking water, ensuring water delivery to the highest level in the distribution network, maintaining suitable water pressure during peak consumption hours, and efficient collection of wastewater from households for transport to sewage stations. These requirements should be met while ensuring economic viability and maintaining water quality.

> Generated Ideas Water Treatment Plant:

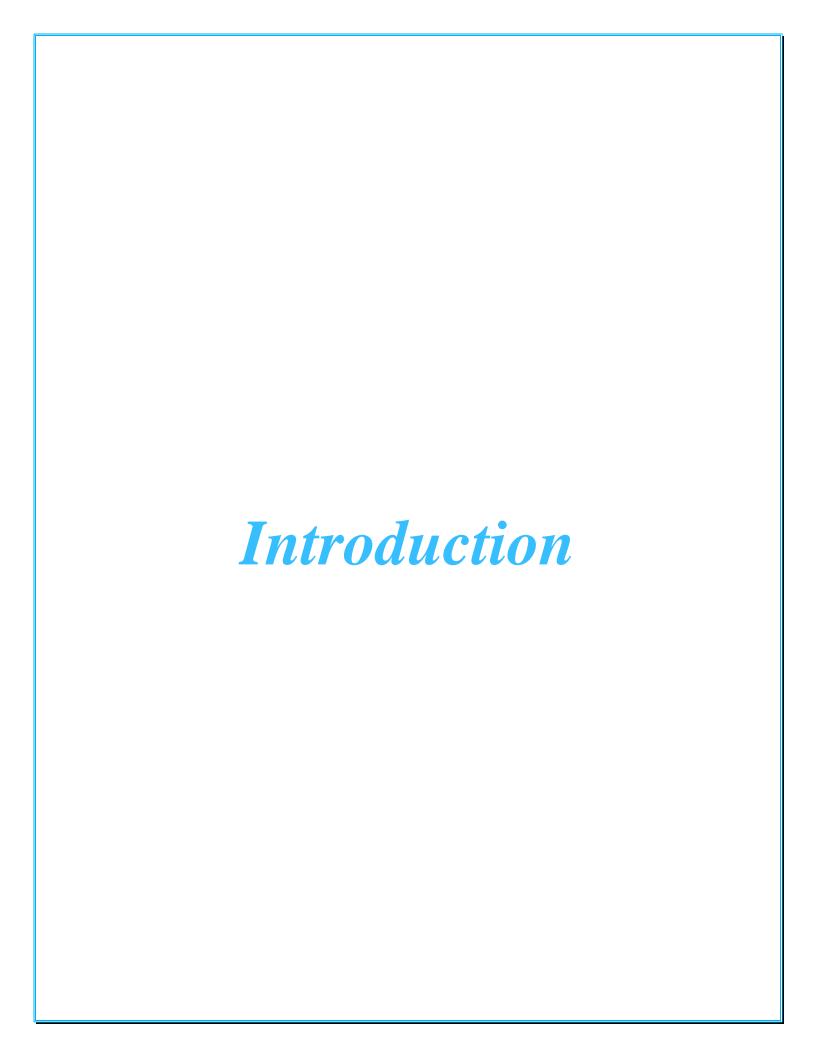
The water treatment process involves treating water obtained from the source and disinfecting it by adding chlorine (CL2). Water distribution network: The design of the distribution network includes determining the appropriate pipe diameters to withstand pressure and ensure water reaches all areas of the city, even the farthest points. Wastewater network: The wastewater network is responsible for transporting wastewater from the city to the wastewater treatment plant.

> Final Design

Water treatment plant: The final concept includes the utilization of pumps, filters, and tanks to treat water and produce purified water suitable for human consumption.

Water distribution network: The distribution network involves the use of pipes, pumps, and overhead tanks to deliver water to residential areas.

Sewage pipe network: The design of the sewage pipe network considers factors such as pipe slope and gravity, along with the selection of suitable pipe diameters for transporting wastewate lift station



"Introduction"

Sanitary engineering, also known as public health engineering or wastewater engineering, is the application of engineering methods to improve sanitation of human communities, primarily by providing the removal and disposal of human waste, and in addition to the supply of safe potable water. Traditionally a branch of civil engineering and now a subset of environmental engineering, in the mid-19th century, the discipline concentrated on the reduction of disease, then thought to be caused by miasma. This was accomplished mainly by the collection and segregation of sewerage flow in London specifically, and Great Britain generally.

These and later regulatory improvements were reported in the United States as early as 1865.

It is also concerned with environmental factors that do not have an immediate and clearly understood effect on public health. Areas outside the purview of sanitary engineering include aesthetic concerns such as landscaping, and environmental conservation as it pertains to plants and animals.

Skills within this field are usually employed for the primary goal of disease prevention within human beings by assuring a supply of healthy drinking water, treatment of waste water, and removal of garbage from inhabited areas.

Compared to (for example) electrical engineering or mechanical engineering which are concerned primarily with closed systems, sanitary engineering is a very interdisciplinary field which may involve such elements as plumbing, fire protection, hydraulics, life safety, constructive modelling, information technology, project design, microbiology, pathology and the many divisions within environmental science and environmental technology. In some cases, considerations that fall within the field of social sciences and urban planning must be factored in as well.

Although sanitary engineering may be most associated with the design of sewers, sewage treatment and wastewater treatment facilities, recycling centers, public landfills and other things which are constructed, the term applies equally to a plan of action to reverse the effects of water pollution or soil contamination in a specific area.

Job description and typical tasks:-

Important job types working in sanitary engineering include sanitation workers, waste collectors and wastewater engineers.[citation needed]

Wastewater engineers use a variety of skills and must have knowledge of mechanical and environmental engineering. They are required to perform tasks and demonstrate knowledge in design, mathematics, English, construction, physics, chemistry, biology, management, and personnel. Wastewater engineers must have skills in complex problem solving, critical thinking, mathematics, active listening, judgement, reading comprehension, speaking, writing, science, and system analysis.

Typical work activities include problem solving, communication with management and staff, gathering information, analyzing data, evaluating standards and complying with them, and communicating with others in the field.[citation needed]

Wastewater engineers perform these activities by combining their knowledge and skills to perform tasks. These tasks are to understand computer-aided design programs, and to conduct studies for the construction of facilities, water supply systems and collection systems. They may design systems for wastewater collection machinery, as well as system components.

They may perform water flow analysis, then select designs and equipment based on government and industry standards. Some are involved with a specific area of concern such as waste collection or the maintenance of waste water facilities and stormwater drainage systems within an area. Others cover a broader scope of activities that might include maintenance of the public water supply, collection of residential yard waste program, disposal of hazardous waste, recycling strategies and even community programs where individuals or businesses "adopt" an area and either maintain it themselves or donate funds for doing so.[citation needed]

Wastewater engineers may also map out topographical and geographical features of Earth to determine the best means of collection, design pipe and pumped collection systems, and design treatment processes for collected wastewater.[citation needed]

Modern challenges:

Water scarcity Water managers confront new challenges and the need for new technology as water levels decrease due to increasingly frequent and extended droughts.

Technologies such as sonar mapping are being used in wells to determine the volume of water that they can hold. For example, the United States Geological Survey and the State of New York worked together to map underground aquifers since the 1980s.

Today they have thorough maps of these aquifers to assist in water management.

Desalination plants may be required in the future for those regions hardest hit by water scarcity.

Desalination is a process of cleaning water by means of evaporation. Water is evaporated and it passes through membranes. The water is then cooled and condenses allowing it to flow either back into the main water line or out to sea.

Smart Sanitation:

Smart Sanitation: Advances in sensor technology, data analytics, and automation are enabling the development of smart sanitation systems that can monitor water quality, detect leaks, optimize treatment processes, and improve overall efficiency.

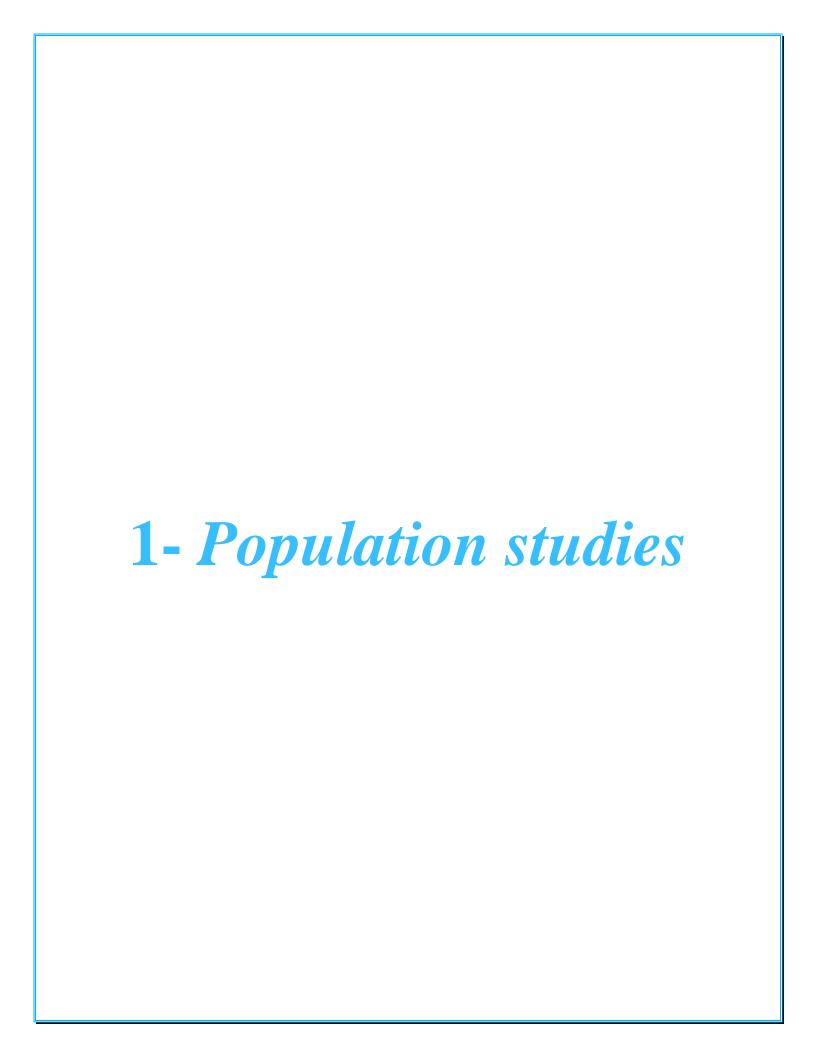
Sanitary engineers need to leverage these technologies to enhance the performance and reliability of sanitation infrastructure.

Project aims

- Designing a water treatment plant
- Planning the water distribution network
- Establishing the wastewater network design

Standards

- 1. The Egyptian Code for Drinking Water and Sewage Networks, 2010.
- 2. The Egyptian Code for Sewage Treatment Plants.
- 3. The Egyptian Code for Water Treatment Plants.



" Population studies "

♣ Arithmetic method:- table (1-1)

Year	Pop	ΔΡ	Δt	k _a
1996	50200			
2006	62000	11800	10	1180
2016	77400	15400	10	1540
Average				1360

$$P_n = P_o + ka_{av.}(t)$$

$$P_{2040} = 77400 + 1360 (24)$$

$$P_{2040} = 110040$$
 Capita

$$P_{2060} = 77400 + 1360 (44)$$

$$P_{2060} = 137240$$
 Capita

4 Geometric method: - table (1-2)

Year	Pop	Ln P	ΔLn P	Δt	$\mathbf{k_g}$
1996	50200	10.824			
2006	62000	11.035	0.211	10	0.0211
2016	77400	11.257	0.222	10	0.0222
Average					0.02165

$$ln p_n = ln P_o + kg_{av.}(t)$$

$$ln \ P_{2040} \ = ln \ 77400 + 0.02165 \ (24)$$

$$ln P_{2040} = 11.776$$

$$\therefore P_{2040} = 130093$$
 Capita

$$ln\ P_{2060}\ = ln\ 77400 + 0.02165\ (44)$$

$$\ln P_{2060} = 12.21$$

$$P_{2060} = 200788$$
 Capita

Annual growth method:- table (1-3)

Year	Pop	Δt	m
1996	50200		
2006	62000	10	0.021
2016	77400	10	0.022
Average			0.0215

$$P_n = P_{o^{\times}} (1 + m)^t$$

$$P_{2040} = 77400 * (1 + 0.0215)^{24}$$

$$\therefore P_{2040} = 128963 \text{ Capita}$$

$$P_{2060} = 77400 * (1 + 0.0215)^{44}$$

$$P_{2060} = 197347$$
 Capita

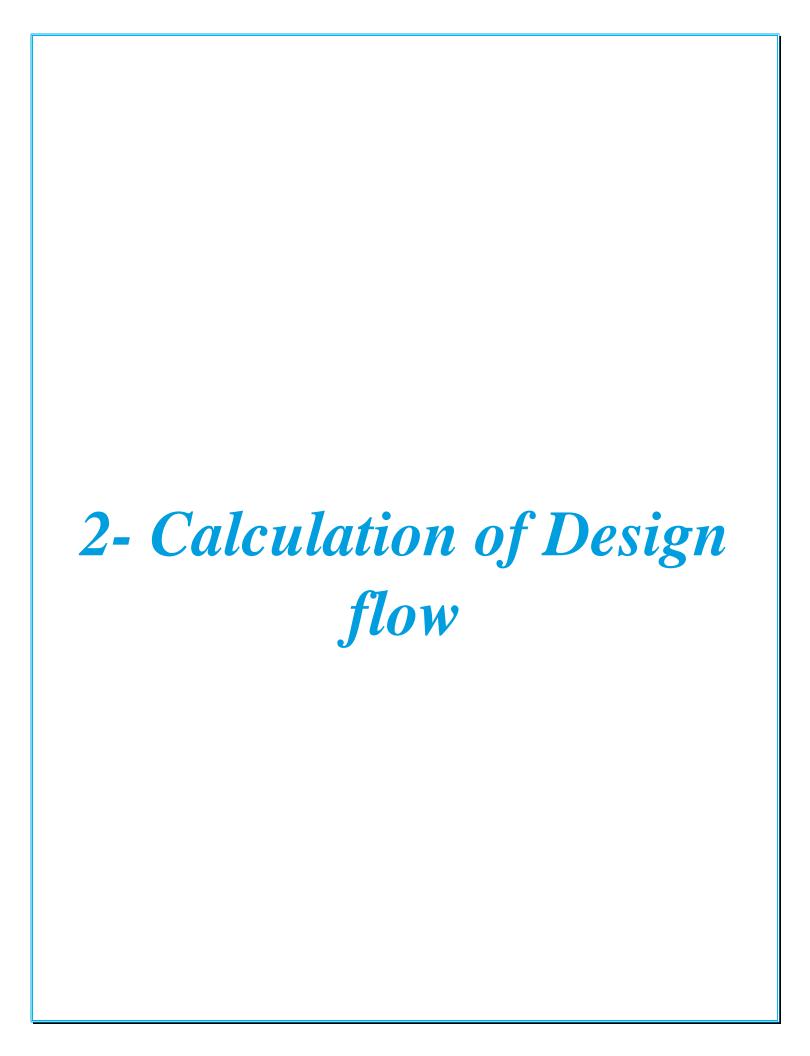
> (The average population)

$$P_{2040} \ = (110040 + 130093 + 128963) \, / 3$$

$$P_{2040} = 123032$$
 Capita

$$P_{2060} \ = (137240 + 200788 + 197347) \ / 3$$

$$P_{2060} = 178458$$
 Capita



"Design flow"

Stage (I):-

$$P_{2040} \, = 123032 \; capita. \hspace{1.5cm} q = \; 250 \; \; L/c/d$$

$$\mathbf{Q_{av}}$$
 = $\mathbf{P_{2040}}$ * $\mathbf{q} = 123032 * 250 = 30758 \text{ m}^3/\text{d} = 0.36 \text{ m}^3/\text{sec}$.

$$Q_{max \ monthly} = 1.4 * Q_{av} = 1.4 * 0.36 = 0.504 \ m^3/sec.$$

$$Q_{\text{max daily}} = 1.8 * Q_{\text{av}} = 1.8 * 0.36 = 0.648 \text{ m}^3/\text{sec.}$$

$$Q_{\text{max hourly}} = 2.5 * Q_{\text{av}} = 2.5 * 0.36 = 0.90 \text{ m}^3/\text{sec.}$$

Stage(II):-

$$P_{2060} = 178458$$
capita. , $q = 270 \text{ L/c/d}$

$$\mathbf{Q_{av}}$$
 = $\mathbf{P_{2060}} * \mathbf{q} = 178458 * 270 = 48183.66 \text{ m}^3/\text{d} = 0.56 \text{ m}^3/\text{sec}$

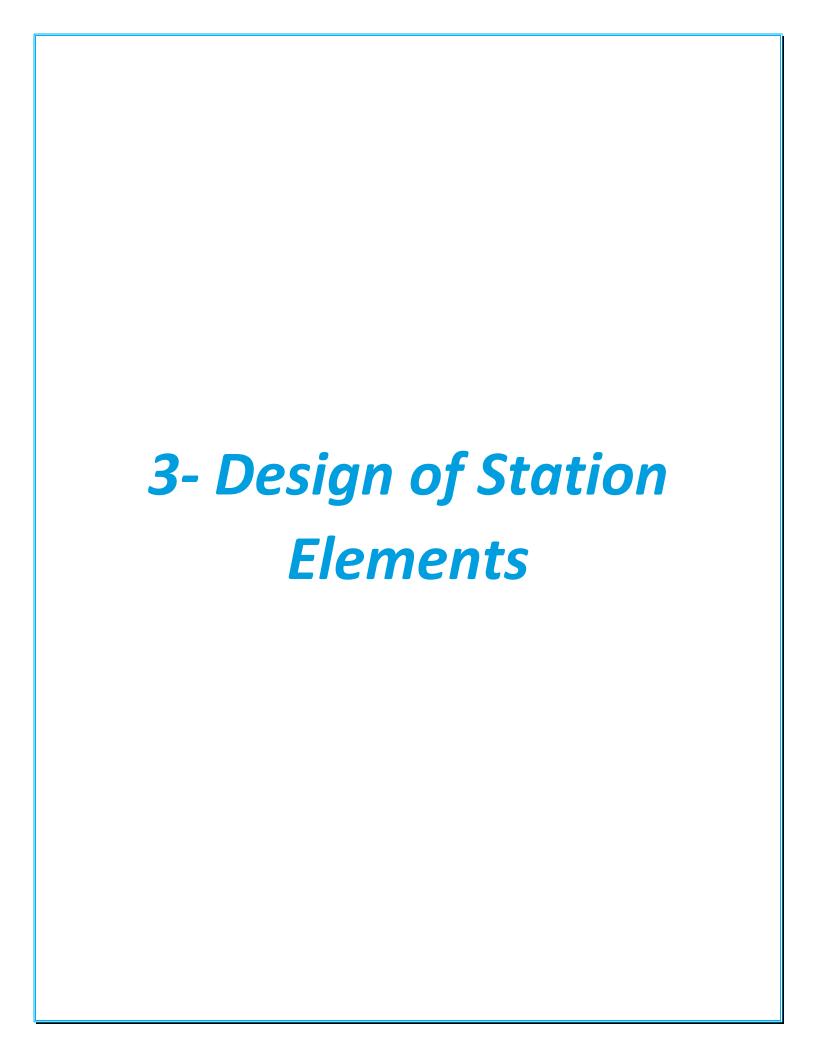
$$Q_{max\ monthly} = 1.4 * Q_{av} = 1.4 * 0.56 = 0.784 \ m^3/sec.$$

$$Q_{\text{max daily}} = 1.8 * Q_{\text{av}} = 1.8 * 0.56 = 1.01 \text{ m}^3/\text{sec.}$$

$$Q_{max\;hourly} \ = \ 2.5 \; * \; Q_{av} \; = 2.52 \; * 0.56 \; = \; 1.40 \quad m^3/sec.$$

table (2-1)

	Stage (I)	Stage(II)
P (capita)	123032	178458
$Q_{av.}$ $(m^3/sec.)$	0.36	0.56
Q _{max monthly} (m ³ /sec.)	0.504	0.784
Q _{max daily} (m ³ /sec.)	0.648	1.01
Q _{max hourly} (m ³ /sec.)	0.90	1.40



Lesson Collection works :-

Stage (**I**) :-

$$Q_{des} = Q_{max (monthly)} * 1.1 = 0.504* 1.1 = 0.55 m^3 / sec$$

Stage (II) :-

$$Q_{des} = Q_{max \, (monthly)} * 1.1 = 0.784 * 1.1 = 0.86 m^3/sec$$

table (3-1)

	Stage (I)	Stage(II)
Q _{des} (m ³ /sec)	0.55	0.86

> Design of conduit pipe:

Stage (II)

$$Q_{des} = 0.86 \text{ m}^3/\text{sec}$$

Assume:
$$V = 1 \text{ m/s}$$

$$A = \frac{Q}{V}$$

$$\therefore$$
 A pipe = $0.86/1 = 0.86 \text{m}^2$

Take No. of pipes = 3 pipes

$$0.86 = 3 * \frac{\pi \phi^2}{4}$$
 $\therefore \phi = 0.604 \text{ m}$

$$\therefore \phi = 0.604 \text{ m}$$

$\rightarrow Use: (3 conduit pipes \phi 600 mm)$

$$V_{act} = \frac{Q_{des}}{Apipe} = 0.86 / \left(\frac{\Pi * (0.6)^2}{4}\right) * 3 = 1.014 \text{ m/s}$$

$$H_f = F*L*V^2/2g\phi$$

$$V_{act}\ = 1.014\ m/s$$

Take: -
$$F = 0.04$$

$$Take: \textbf{-} \quad F = 0.04 \qquad \quad , \qquad L = 100 \; m \qquad , \quad \varphi = 0.600 \; m$$

$$\therefore H_f = \frac{(1.014)^2}{2*9.81} \left[\frac{0.04*100}{0.6} \right] = 0.35 \text{ m}$$

Stage (I):

$$Q_{des} = 0.55 \text{ m}^3/\text{s}$$

$$A_{pipe} = \frac{\Pi (0.6)^2}{4} * 2 = 0.57 \text{ m}^2$$

$$V_{act} = \frac{Q_{des}}{Apipe} = \frac{0.55}{0.57} = 0.97 \text{ m/s} > 0.6$$
 (safe)

$$H_f = F*L*V^2/2g\phi$$

$$V_{act} = 0.97 \text{ m/s}$$

Take: F = 0.04 , take: L = 100 m

 \rightarrow Use: (2 conduit pipes ϕ 600 mm)

$$\therefore \ H_{\rm f} = \frac{(0.97)^2}{2^*9.81} \left[\frac{0.04^*100}{0.6} \right] = 0.32 \ m$$

> Design of screen:-

Assume:

$$L=1.5~\phi$$
 , $S=3cm=0.03m$, $a=1.5~cm$

$$L = N*S + a(N-1)$$

$$1.5* 0.6 = 0.03N + 0.015*(N-1)$$
 $\rightarrow N = 20.33 \approx 21$ no. of bars $21-1=20$

Take $H_f = 20 \text{ cm}$

> Sump of Low Lift Pump :-

Assume:
$$(T = 5 min)$$

, W = 3 m)

Volume of sump $\forall = Q * T$

Stage (II)

$$\forall$$
 = Q * T = 0.86*5*60 = 258 m³

High
$$_{level} = 23.50 - h_{pipe} - h_{screen} = 22.95 m$$

Low
$$_{level} = 20.00 - (100/100) - 1 = 18.00 \text{ m}$$

$$d = 22.95 - 18.00 = 4.95 \text{ m}$$

$$\therefore$$
 L = volume / w * d

$$\therefore$$
 L = 258 / (3×4.95) = 18.00 m

\rightarrow Sump dim. (L= 18.00 m, W = 3.00 m, d = 4.95 m)

Stage (I)

$$\Psi = Q * T = 0.55*5*60 = 165 \text{ m}^3$$

High level =
$$23.50 - h_{pipe} - h_{screen} = 22.98 m$$

Low
$$_{level} = 20.00 - (100/100) - 1 = 18.00 \text{ m}$$

$$d = 22.98 - 18.00 = 4.98 \text{ m}$$

$$\therefore$$
 L = volume / w * d

$$\therefore$$
 L = 165 / (3×4.98) = 12.00 m

→ Sump dim. (
$$L=12.00 \text{ m}$$
, $W=3 \text{ m}$, $d=4.98 \text{ m}$)

♣ Design of raising main :-

L = 100 m

V = 1.5 m/s

A = Q/v

Stage (II)

 $A = 0.86/1.5 = 0.573 \text{ m}^2$

 \rightarrow Use: (1 raising main ϕ 900 mm)

 $V_{act} = 1.35$ m/sec

 $\mathbf{H_f} = \begin{bmatrix} \frac{\mathrm{FLV}^2}{\omega 2\mathrm{g}} \end{bmatrix}$, Assume: $\mathbf{L} = 100 \, \mathrm{m}$

 $\therefore H_f = \frac{(1.35)^2}{2*9.81} \left[\frac{0.04*100}{0.9} \right] = 0.41 \text{ m}$

Stage (I)

$$A = 0.55 / 1.5 = 0.37 \text{ m}^2$$

 \rightarrow Use: (1 raising main ϕ 700 mm)

 $V_{act} = 1.43$ m/sec

$$\mathbf{H_f} = \left[\frac{\mathrm{FLV}^2}{\boldsymbol{\varphi} 2\mathrm{g}}\right]$$

, Assume: L = 100 m

$$\therefore \ H_f \ = \frac{(1.43)^2}{2*9.81} \bigg[\, \frac{0.04*100}{0.7} \bigg] \ = 0.60 \ m$$

♣ Design of low lift pump:-

Stage (II)

$$L = N * S$$
 take: $S = 2.5 \text{ m}$

$$18 = N * 2.5$$
 $\rightarrow N = 8 \text{ Pump}$ (5 work, 3 Stand by)

$$Q_{\text{pump}} = Q_d / N_{\text{work}}$$

$$Q_{pump} = 0.86 / 5 = 0.172 \text{ m}^3/\text{s}$$

$$H_T = H_{st} + H_{fr} + 0.2H_{fr}$$

$$H_{st} = W.L_{in RMT} - L.W.L_{in Sump} = (29.76 - 21.98) = 7.78 \text{ m}$$

$$H_T = 7.78 + 0.41 + 0.2 * 0.41 = 8.30 \text{ m}$$

$$H_P = \frac{\gamma * Qpump*Ht}{75 \times \mu \mu} = \frac{1000 \times 0.172 \times 8.30}{75 \times (0.63)} = 30.90 \text{ Hp/pump}$$

Stage (I)

$$L = N * S$$
 take: $S = 2.5 \text{ m}$

$$12.00 = N * 2.5$$
 \rightarrow N = 5 Pump (3 work, 2 Stand by)

$$Q_{pump} = Q_d / N_{work}$$

$$Q_{pump} = 0.55 \ / \ 3 = 0.183 \ m^3/s$$

$$H_T \! = H_{st} + H_{fr} + 0.2 H_{fr}$$

$$H_{st} = W.L_{in RMT} - L.W.L_{in Sump} = (29.76 - 21.98) = 7.78 \text{ m}$$

$$H_T = 7.78 + 0.6 + 0.2 * 0.6 = 8.50 \text{ m}$$

$$H_P = \frac{\gamma * Qpump * Ht}{75 \times \mu \mu} = \frac{1000 \times 0.183 \times 8.50}{75 \times (0.63)} = 32.90 \text{ Hp /pump}$$

A Rapid mixing tank :-

Stage (II)

assume: (circular section), T = 45 sec, depth = 2 m, $G_{value} = 700 \text{ sec}^{-1}$

$$T = V/Q$$

$$45 = V / 0.86$$
 $\therefore V = 38.7 \text{ m}^3$

$$\therefore$$
 V = 38.7 m³

$$A = V / d$$

$$\therefore A = 19.35 \text{ m}^2$$

$$A=\frac{\pi\varphi^2}{4}$$

$$19.35 = \frac{\pi \varphi^2}{4}$$

$$\therefore \varphi = 5 \text{ m}$$

$$\therefore \varphi = 5 \text{ m}$$

$$\textbf{\textit{P}} = \textbf{\textit{G}}^2 * \textbf{\textit{V}} * \mu$$

$$P = 700^{2} * 38.7 * 1.002 * 10^{-3} = 19000.93 \text{ watt} = 19.001 \text{ KW}$$

Stage (I)

assume: (circular section), T = 45 sec, depth = 1.5 m, $G_{value} = 700 \text{ sec}^{-1}$

$$T \ = \ V \ / \ Q$$

$$45 = V / 0.55$$

$$45 = V / 0.55$$
 $\therefore V = 24.75 \text{ m}^3$

$$A = V / d$$

$$A = V / d \qquad \qquad \therefore A = 16.50 \text{ m}^2$$

$$A=\frac{\pi\varphi^2}{4}$$

$$16.50 = \frac{\pi \varphi^2}{4}$$
 $\therefore \varphi = 4.6 \text{ m}$

$$\therefore \varphi = 4.6 \text{ m}$$

$$P = G^2 * V * \mu$$

$$P = 700^{2} * 24.75 * 1.002 * 10^{-3} = 12151.8 \text{ watt} = 12.152 \text{ KW}$$

♣ <u>Clariflculator tank :-</u>

Stage (II)

> Sedemintation zone :

time = 3 hr , depth = 4 m , $\varphi = 30$ m Take

Volume = $Q_d * T = 0.86 * 3 * 60 * 60 = 9288 \text{ m}^3$

Area = $V / d = 9288 / 4 = 2322 \text{ m}^2$

 $A=N*(\pi \phi^2) / 4$ \\ 2322 = N * (\pi 30^2) / 4 \: N = 3.28 = 4 tanks

 $A=N*(\pi \varphi^2) / 4$ \\ $\varphi_{act} = 27.20 \text{ m}$

(use 4 tanks with $\varphi = 27.20 \text{ m}$)

> flocculation zone :

time = 0.5 hr , depth = 3.5 mTake

Volume = $Q_d * T = 0.86 * 0.5 * 60 * 60 = 1548 \text{ m}^3$

Area = $V / d = 1548 / 3.5 = 442.30 \text{ m}^2$

 $A_{tank} = 442.30 / 4 = 110.575 \text{ m}^2$

 $A = (\pi \phi^2) / 4$ \\ 110.575 = $(\pi \phi^2) / 4$ \: $\phi_{act} = 11.90 \text{ m}$

(use 4 tanks with $\varphi = 11.90 \text{ m}$)

Stage (I)

> Sedemintation zone :

time = 3 hr , depth = 4 m , $\varphi = 27.20 \text{ m}$ Take

Volume = $Q_d * T = 0.55 * 3 * 60 * 60 = 5940 \text{ m}^3$

Area = $V / d = 5940 / 4 = 1485 \text{ m}^2$

$$A=N*(\pi\phi^2) / 4$$
 \\ 1485 = N * (\pi 27.20^2) / 4 \therefore N = 3 tanks

$$A{=}N^*(\pi\phi^2) \: / \: 4 \qquad \backslash \backslash \qquad \phi_{act}{=}\: 27.20 \ m$$

(use 3 tanks with $\varphi = 27.20 \text{ m}$)

> flocculation zone :

Take
$$time = 0.5 hr$$
, $depth = 3.5 m$

Volume =
$$Q_d * T = 0.55 * 0.5 * 60 * 60 = 990 \text{ m}^3$$

Area =
$$V / d = 990 / 3.5 = 282.86 \text{ m}^2$$

$$A_{tank} = 282.86 / 3 = 94.30 \text{ m}^2$$

$$A = \left(\pi \phi^2\right) / \, 4 \qquad \backslash \qquad \qquad 94.30 = \left(\pi \phi^2\right) / \, 4 \qquad \qquad \therefore \quad \phi_{act} = 11.00 \; m$$

(use 3 tanks with $\varphi = 11.00 \text{ m}$)

+ rapid sand filter :-

Stage (II)

$$Q_d = 1.07 * 1.4 * p * q = 1.07 * Q_{max monthly}$$

$$Q_d = 1.07 * 0.784 * 24 * 60 * 60 = 72479.2 m^3 / d$$

Take :-
$$R.O.F = 140 \text{ m} / d$$

$$Area = \frac{Qd}{R.O.F} = \frac{72479.2}{140} = 517.71 \text{ m}^2$$

Take :- Area one filter =
$$52 \text{ m}^2 = (6.5 * 8)$$

Number of filter (N) =
$$\frac{Area\ total}{Area\ one} = \frac{517.71}{52} = 9.95 = 10\ filter + 2\ B.W$$

$$R.O.F_{act} = \frac{Qd}{N * Area one} = \frac{72479.2}{10 * 52} = 139.38 \text{ m/d}$$
 (OK).

Take :- R.O.B.W =
$$5 * R.O.F = 5 * 140 = 700 \text{ m}^3/\text{ d}$$
 , $T = 10 \text{ min}$

Amount of (B.W) =
$$52 * 700 * 10 = 364000 / 24 * 60 = 252.78 \text{ m}^3$$

Amount of waste =
$$52 * 140 * 10 = 72800 / 24 * 60 = 50.56 \text{ m}^3$$

Stage (I)

$$Q_d = 1.07 * 1.4 * p * q = 1.07 * Q_{max monthly}$$

$$Q_d = 1.07 * 0.504 * 24 * 60 * 60 = 46593.8 m^3 / d$$

Take :-
$$R.O.F = 140 \text{ m} / d$$

$$Area = \frac{Qd}{R.O.F} = \frac{46593.8}{140} = 332.8 \text{ m}^2$$

Take :- Area one filter =
$$52 \text{ m}^2 = (6.5 * 8)$$

Number of filter (N) =
$$\frac{Area\ total}{Area\ one} = \frac{332.8}{52} = 6.4 = 6$$
 filter + 2 B.W

$$R.O.F_{act} = \frac{Qd}{N * Area one} = \frac{46593.8}{6 * 52} = 149.34 \text{ m/d}$$
 (OK).

Take :- R.O.B.W =
$$5 * R.O.F = 5 * 140 = 700 \text{ m}^3 / \text{d}$$
, $T = 10 \text{ min}$

Amount of (B.W) =
$$52 * 700 * 10 = 364000 / 24 * 60 = 252.78 \text{ m}^3$$

Amount of waste =
$$52 * 140 * 10 = 72800 / 24 * 60 = 50.56 \text{ m}^3$$

♣ Ground tank :-

Stage (II)

$$Q_{max \ daily} = 1.01 * 24 * 60 * 60 = 87264 \ m^3 / d$$

$$Q_{max \ monthly} = 0.784 * 24 * 60 * 60 = 67737.6 m^3 / d$$

$$C_{fire} = \frac{\textit{population*}120}{10000} = \frac{178458*120}{10000} = 2141.5 \text{ m}^3$$

$$C_1 = \frac{0.5}{24} * Q_{\text{max monthly}} = \frac{0.5}{24} * 67737.6 = 1411.2 \text{ m}^3$$

$$C_2 = Q_{max \ daily} - Q_{max \ monthly} = 87264 - 67737.6 = 19526.4 \ m^3$$

$$C_3 = \frac{8}{24} * Q_{\text{max monthly}} = \frac{8}{24} * 67737.6 = 22579.2 \text{ m}^3$$

Volume =
$$C_3 + (\frac{4}{5} C_{\text{fire}}) = 24292.4 \text{ m}^3$$

$$Volume = N * L * W * d$$

\\ take :- L =
$$50 \text{ m}$$
, W = 40 m , d = 5 m

$N = 3 \text{ tanks} \quad (50 * 40 * 4.05) \text{ m}$

Stage (I)

$$Q_{max \ daily} = 0.648 * 24 * 60 * 60 = 55987.2 \ m^3 / d$$

$$Q_{max\ monthly} = 0.504\ *\ 24\ *\ 60\ *\ 60 = 43545.6\ m^3\ /\ d$$

$$C_{fire} = \frac{population*120}{10000} = \frac{123032*120}{10000} = 1476.4 \text{ m}^3$$

$$C_1 = \frac{0.5}{24} * Q_{max monthly} = \frac{0.5}{24} * 43545.6 = 907.2 \text{ m}^3$$

$$C_2 = Q_{max \ daily} \text{ - } Q_{max \ monthly} = 55987.2 - 43545.6 = \!\! 12441.6 \ m^3$$

$$C_3 = \frac{8}{24} * Q_{\text{max monthly}} = \frac{8}{24} * 43545.6 = 14515.2 \text{ m}^3$$

Volume =
$$C_3 + (\frac{4}{5} C_{fire}) = 15696.32 \text{ m}^3$$

$$Volume = N * L * W * d$$

\\ take :- L =
$$50 \text{ m}$$
, W = 40 m , d = 5 m

 $N = 2 \text{ tanks} \quad (50 * 40 * 3.92) \text{ m}$

♣ Design of sludge tank:-

Assume: Ret. time = 15 min , S.S = 150 mg/L , removal ratio = 90 %

Assume: wash 2 filters at the same time

$$V_{B.W} = B.W * A_f * T = 700 * 2 * 52 * \frac{15}{24*60*60} = 758.00 \text{ m}^3$$

Assume: 4 clariflocculator tanks disludging at the same time

$$V_{clari} = \frac{Q*s.s*R}{(1-WC)*10^6} = \frac{74304*150*0.90}{(1-0.97)*10^6} = 334.40 \text{ m}^3$$

$$V_{total} = V_{B.W} + V_{clari} = 758 + 335 = 1093 \text{ m}^3$$

Take depth of Tank = 8 m

$$\therefore$$
 Area = 1093 / 8 = 136.625 m²

$$\therefore$$
 L = (136.625) ^ 0.5 = 11.70 m

:. Take one tanks (11.70 * 11.70 * 8.00)

table (3-2) parts of plant:-

Parts of plant	Stage (II)	Stage (I)	
Conduit pipe	3 conduit pipes $\phi = 600 \text{ mm}$ $Losess = 0.35 \text{ m}$	2 conduit pipes $\phi = 600 \text{ mm}$ Losess = 0.32 m	
sump	L=18.00 m $W=3 m$ $d=4.95 m$	L=12.00 m $W=3 m$ $d=4.98 m$	
pump	5 pump work 3 Stand by $H_p = 30.90 H_p / pump$	3 pump work 2 Stand by $H_p = 32.90 H_p / pump$	
Raising main	one pipe $\phi = 900 \text{ mm}$ $Losess = 0.41 \text{ m}$		
Rapid mixing Tank	One Tank $\phi = 5.00 m$ $d = 2.00 m$		
	•		
Flocculation	•		
	$d = 2$ 4 Tanks $\phi = 11.90 \text{ m}$	$2.00 m$ $3 Tanks$ $\phi = 11.90 m$	
Flocculation	$d = 2$ 4 Tanks $\phi = 11.90 \text{ m}$ $d = 4.00 \text{ m}$ 4 Tanks $\phi = 27.20 \text{ m}$	2.00 m $3 Tanks$ $\phi = 11.90 m$ $d = 3.50 m$ $3 Tanks$ $\phi = 27.20 m$	

♣ Calculation of Pizometric line :-

> Ground Tank :-

Water level = ground level = (24.50) m

> Rapid Sand Filter :-

Filter ground level = (24.50) m

- \therefore losses + thickness of filter layers = 4 m
- \therefore water level in filter = (28.50) m

> Clariflculator tank :-

Take :- length pipe from CFT to RSF = 200 m , Velocity = 0.65 m/s

Losses = 1.2 *
$$(\frac{(0.65)^2}{2*9.81} \left[\frac{0.04*200}{1.3} \right]) = 0.16 \text{ m}$$

Level
$$(4) = (28.50) + 0.16 = (28.66) \text{ m}$$

Level (3) =
$$(28.66) + 0.01* \pi \frac{\varphi}{2} = (29.09) \text{ m}$$

Level (2) = Level (3) +
$$0.10 = (29.19)$$
 m

V- notch weir:-

Weir length = $\pi \varphi$ = 85.45 m

No. of weir =
$$\pi \frac{\varphi}{0.30}$$
 = 285 weirs

$$Q_{Tank} = 18576 \text{ m}^3/\text{d}$$

$$q = \frac{QTank}{No.of weir} = \frac{18576}{285} = 65.18 \text{ m}^3/\text{d/weir}$$

$$\therefore$$
 q = 1.367 h^{5/2} \therefore h = 0.05 m

Level
$$(1) = 29.19 + 0.05 = (29.24) \text{ m}$$

Flocculation level = 29.24 + 0.05 = (29.29)

➤ Rapid Mixed Tank :-

Take :- length pipe from RMT to CFT = 40 m , Velocity = 0.905 m/s

Losses =
$$1.2 * \frac{(0.905)^2}{2*9.81} \left[\frac{0.04*40}{0.55} \right] = 0.12 \text{ m}$$

Level water in hadar = 29.29 + 0.12 = (29.41) m

Level water in crest = 29.41 + 0.10 = (29.51) m

Francis wier:-

$$Q = 1.84 * (L - 0.1 n h) * h^{3/2}$$

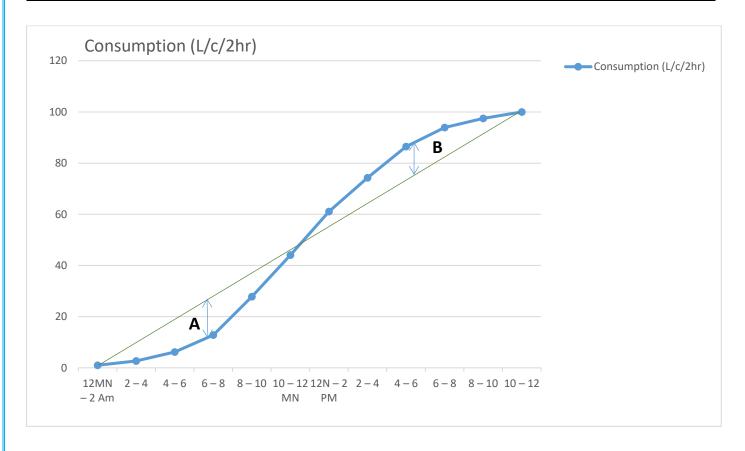
$$0.86 = 1.84 * (\pi \frac{5}{4} - 0.1*(2)*h)* h^{3/2}$$

$$\therefore$$
 h = 0.25 m

Level water in center tank = 29.51 + 0.25 = (29.76) m

♣ <u>Elevated tank</u> :- table (3-3)

Time	Consumption lit/capita/2hrs	Accumulative
12 MN - 2Am	1	1
2-4	1.7	2.7
4-6	3.5	6.2
6-8	6.6	12.8
8-10	15.1	27.9
10-12N	16.2	44.1
10N-2PM	17	61.1
2-4	13.2	74.3
4-6	12.2	86.5
6-8	7.4	93.9
8-10	3.6	97.5
10-12Mn	2.5	100



$$A = 30-12 = 18$$

 $B = 90-75 = 15$

Capacity =
$$\frac{1.8 * (A + B) * P}{1000} + \frac{1}{5}$$
 Cfire

$$C = \frac{1.8 * (18 + 15)P}{1000} + \frac{120 * P}{5 * 10000}$$

stage (II) :-

Capacitiy Of tanke :-

$$C = \frac{1.8 (18+15)178458}{1000} + \frac{120*178458}{5*10000} = 11028.70 \text{ m}^3$$

Assume NO. of tanks = 6 tanks

Volume =
$$\frac{11028.70}{6}$$
 = 1838.12 m³ Assume d = $\frac{3 \varphi}{4}$

$$V = \frac{3\pi\phi^3}{16}$$
 \to $\phi = 14.80 \text{ m}$ Take $d = 11.00 \text{ m}$

Rate Of pumps:-

$$R = \frac{1.8 * p q}{T * 1000}$$

$$R = \frac{1.8*178458*100}{24*1000} = 1338.44 \text{ m}^3/\text{ hr}$$

stage (I) :-

Capacitiy Of tanke :-

$$C = \frac{1.8 (18+15)123032}{1000} + \frac{120*123032}{5*10000} = 7603.40 \text{ m}^3$$

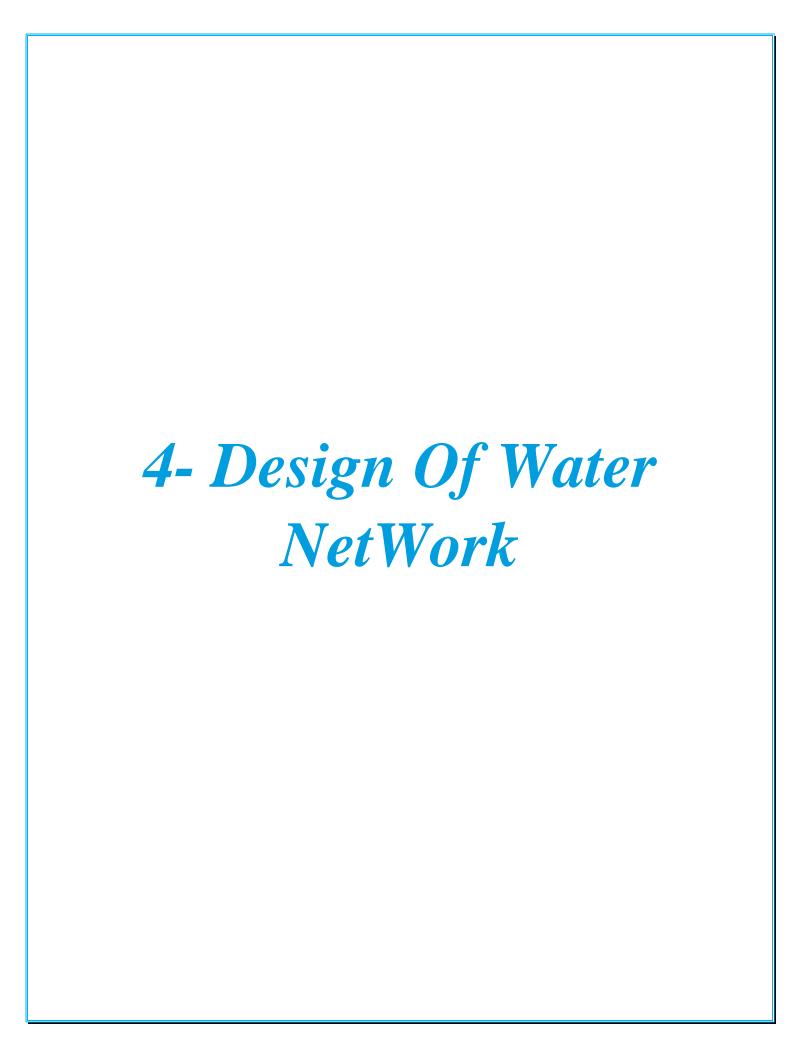
Assume NO. of tanks = 4 tanks

Volume =
$$\frac{7603.40}{4}$$
 = 1900.85 m³ Assume d = $\frac{3 \phi}{4}$
V = $\frac{3\pi\phi^3}{16}$ \rightarrow ϕ = 14.80 m Take d = 11.00 m

Rate Of pumps :-

$$R = \frac{1.8 * p q}{T * 1000}$$

$$R = \frac{1.8*123032*100}{24*1000} = 922.74 \text{ m}^3/\text{ hr}$$



"Design Of Water NetWork"

Hazen William's Eqution :- table (4-1)

 $Q = 0.278 C D^{2.63} S^{0.54}$

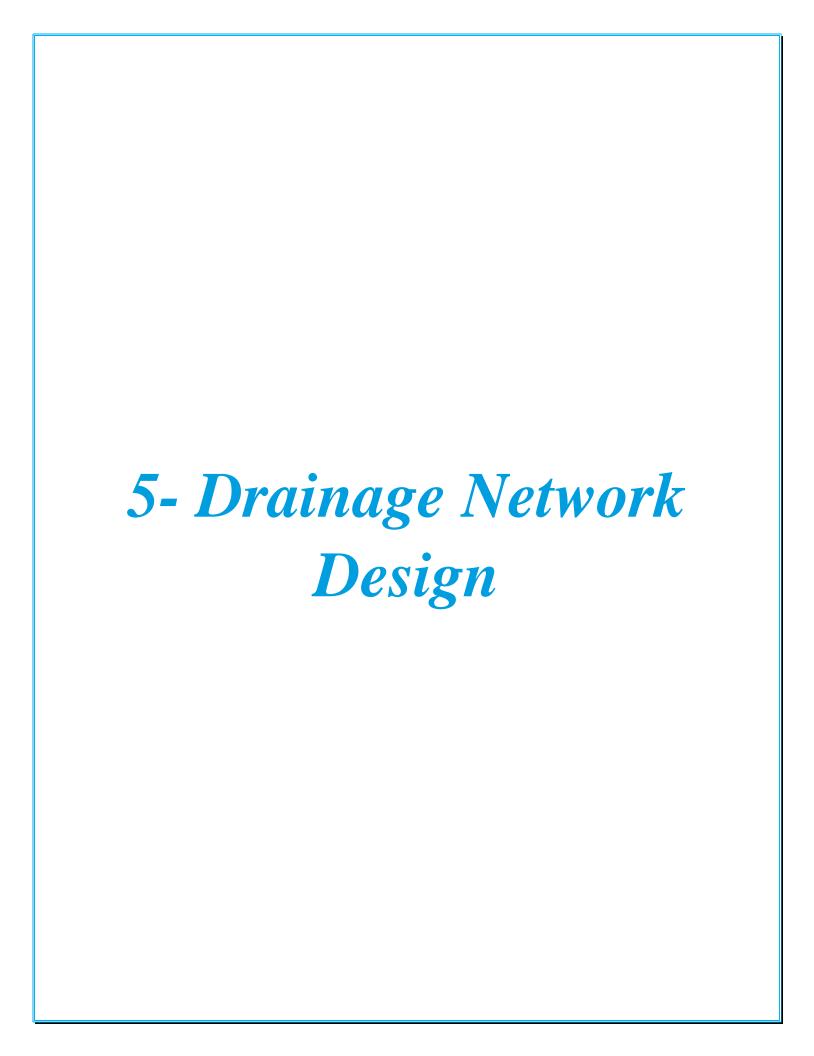
Ø, mm	S = 2 %o		S =	3 %0
	Q, l/sec	V, m/sec	Q, l/sec	V, m/sec
200	17	0.54	21	0.67
250	30	0.61	38	0.77
300	49	0.69	61	0.86
350	74	0.77	92	0.96
400	105	0.84	130	1.03
450	142	0.89	177	1.11
500	188	0.96	234	1.19
600	304	1.08	378	1.34
700	455	1.18	567	1.47
800	647	1.29	805	1.6
900	882	1.39	1098	1.73
1000	1164	1.48	1448	1.84

table (4-2)

Population	Q fire (L/sec)
Up To 10000	20
10000 - 25000	25
25000 - 50000	30
50000 - 100000	40
100000 – 250000	50
250000 - 500000	60

Method Of Section :- table (4-3)

Sec	P	QFIRE	$\mathbf{Q}_{\mathrm{av}} = \mathbf{p} \mathbf{q}$	1.8Q _{av} + Q _{fire}	2.5Q _{av}	$\mathbf{Q}_{\mathrm{MAX}}$	$\Phi_{ m pipe}$	%
1-1	178458	50	560	1058	1400	1058	1Ф1000	100
2-2	178458	50	560	1058	1400	1400	3Ф 700	100
3-3	142766.4	50	448	856.4	1120	1120	5Ф 600	80
4-4	115997.7	50	364	705.2	910	910	4Ф 500	65
5-5	71383.2	40	224	443.2	560	560	3Ф 500	40
6-6	35691.6	30	112	231.6	280	280	2Ф 450	20
`7-7	17845.8	25	56	125.8	140	140	2Ф 250	10



" Drainage Network Design "

↓ Waste Water Flow Rate :- Stage (II)

In summer:

$$Q_{av(sewage)} = 0.8*Q_{av} = 0.8*560 = 448 \text{ lit/sec}$$
 $`p = 178458 \text{ capita}$ $Q = P.F.*Q_{av} = (1 + \frac{14}{4 + \sqrt{178.458}}) * 448 = 809.3 \text{ } L/s$ $Q_{max} = 1.8* \ 448 = 806.4 \ \text{lit/sec} = 0.806 \ \text{m}^3/\text{sec}$

Qmax = 1.0 440 = 000.4 nt/sec = 0.000

In winter:

M.F =
$$0.2 p^{0.167} = 0.2 * (178.458)^{0.167} = 0.48$$

Q_{min} = $0.8*0.48*448 = 172.3$ lit/sec

Stage (I)

In summer:

In winter:

M.F =
$$0.2 p^{0.167} = 0.2 * (123.032)^{0.167} = 0.44$$

Q_{min} = $0.8*0.44*288 = 101.37$ lit/sec

Lt = 18538 m

Factor =
$$\frac{Qmax}{Lt} = \frac{806}{18538} = 0.043$$

$$\mathbf{L}_{\text{served}} = (\mathbf{Q}_{0.9\text{fall}} / \mathbf{Factor})$$

table (5-1)

Ø mm	Slope %	$V_{\it full} \ (m/s)$	Q _{full} (L/S)	$\frac{d_{max}}{\emptyset}$	$\frac{Q_{max}}{Q_{full}}$	$Q_{max}(L/sec)$ For each pipe	L served (m)
200	5	0.71	22			20	465
250	4	0.74	36			32	755
300	3.33	0.76	54			49	1130
350	2.8	0.78	75			68	1570
400	2.5	0.80	100	0.75	0.90	90	2095
450	2	0.77	122			110	2555
500	1.8	0.79	155			140	3245
600	1.4	0.79	223			200	4670
700	1.3	0.84	323			291	6760
800	1.0	0.81	407			431	8520
900	0.8	0.78	496	0.90	1.06	526	10385
1000	0.8	0.84	660			700	13815

Lift Station Design :-

Assume: b = 2 m, h/D = 0.40, $\theta = 15 \text{ min}$

Volume =
$$\frac{\theta * q}{4}$$

$$V = \frac{15*0.806*60}{4} = 181.35 \text{ m}^3$$

Area of Segment $=\frac{V}{b} = \frac{181.35}{2} = 90.675 \text{ m}^2$

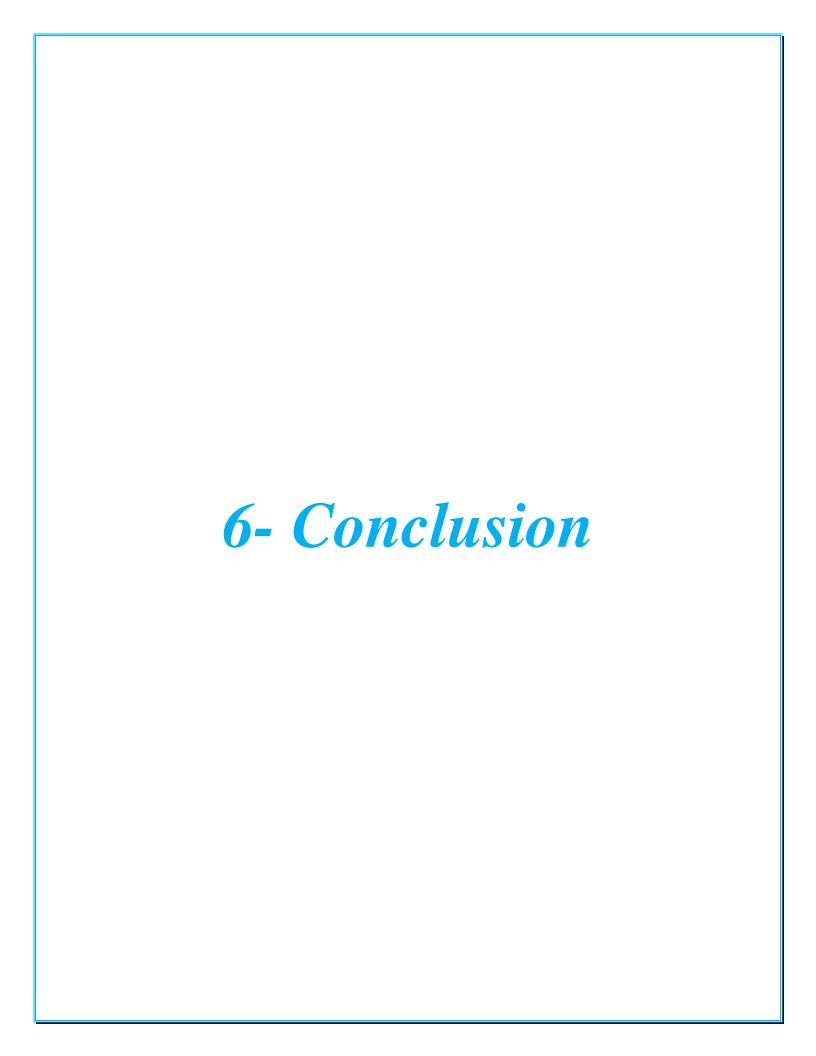
$$\frac{\text{Area of Segment}}{D^2} = 0.2934$$

$$D^2 = 306.05 \text{ m}^2$$
 $\therefore D = 17.60 \text{ m}$

$$\therefore$$
 D = 17.60 m

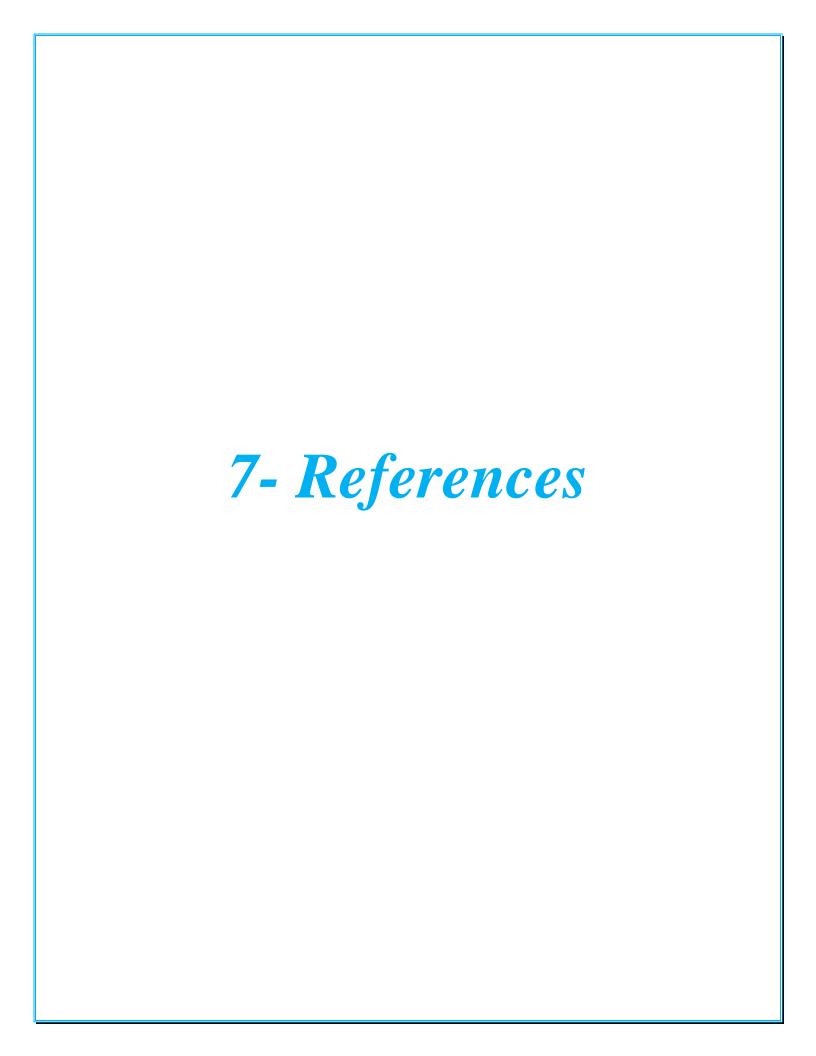
$$\frac{h}{D} = 0.40$$

∴
$$h = 7.10 \text{ m}$$



"Conclusion"

Recognizing the importance of enhancing sanitation practices is more effective than simply introducing technological advancements. This approach is considered advantageous for the community as it emphasizes collaboration between suppliers and beneficiaries through dialogue and information sharing. Ultimately, individual users have the ultimate authority in deciding whether to adopt or reject new technologies. The success of the project lies in the hands of these users, as the value of the investment relies not only on community support but also on the acceptance of families and individuals. It is crucial to convince individuals about the benefits of improved hygiene and the advantages that come with adopting new technologies, outweighing any associated risks. Providers must also take into account the social context and limitations that influence personal decisions. By understanding the community's perspectives, providers can identify positive attributes that may elicit negative responses and utilize the community's values, beliefs, and practices to drive positive change.



"References"

- 1. Sanitary Engineering. Prof. Dr. Kamal Radwan.
- 2. Reynolds, T.D. and Richards, P.A. "Unit operations and Processes in Environmental Engineering", Second Edition, PWS Publishing Company, 1996.
- 3. Gray, N.F., "Water Technology", Arnold Publishers, 1999.
- 4. Clark, J.W., Niessman, W. and Hammer, M.J. "Water Supply and pollution control", Third Edition, Harper & Row publishers, 1977.
- 5. Laws of The Minister of Health and Population No. 458 of 2007 regarding the standards and specifications for potable water.
- 6. Laws of The Minister of Irrigation and Water Resources: Law No. 48 of 1982 regarding the protection of the Nile River and waterways.

STANDARDS

- 4. The Egyptian Code for Drinking Water and Sewage Networks, 2010.
- 5. The Egyptian Code for Sewage Treatment Plants.
- 6. The Egyptian Code for Water Treatment Plants.