Expansion of design capacity of MAHEWA SEWAGE TREATMENT PLANT

Submitted for partial fulfillment of award
of

BACHELOR OF TECHNOLOGY

Degree In

CIVIL ENGINEERING

By

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PRAYAGRAJ-211002, INDIA

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I declare that this written submission represents my work and ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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CERTIFICATE

This is to certify that the project entitled "**Expansion of design capacity of Mahewa sewage treatment plant**" submitted as partial fulfillment for the award of Bachelor of Technology in Civil engineering, INSTITUTE OF ENGINEERING AND RURAL TECHNOLOGY is a bonafide work done by AKANSHA MISHRA, PREETI TIWARI, CHANDANI MAURYA, KALPANA PRAJAPATI Final year, 8^{th} semester students during the year 2021-2022.

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Finally, the criticisms suggestion and correction towards the improvement of the project and its report are always welcome

ABSTRACT

Allahabad is a city in the Indian state of Uttar Pradesh. It is officially known as Prayagraj, is a metropolis in the Indian state of **Uttar Pradesh.** The holi city of Allahabad is surrounded by river Ganga & Yamuna on three sides. Present population in town is around 15 lakes. Plain terrain with ground level varies between 84m and 92m above the MSL. The steady incremental in the city population results in the increase of domestic sewage generation. But still now there is no full capacity treatment plant. So it is required to construct a Sewage Treatment Plant with sufficient capacity to treat the increased sewage.

Jal Nigam is the prime authority which deals with water supply and sewerage works in Allahabad.

The project deals with the design of the Sewage Treatment plant and its major components such screening chamber, grit chamber, skimming tank, sedimentation tank, secondary clarifier, active sludge tank and sludge drying beds.

The project covers the 1321(Ha) area of Allahabad Municipal Corporation for next 30 years and its increased population. Naini sewage treatment plant within sewerage district A constructed under GAP/ NGRBA. Situated on the right bank of river Yamuna.60 MLD capacity was commissioned in1998 and an additional 20 MLD commissioned in 2013. STP is based on ASP +Chlorination Technique. All the aspect of Allahabad climate and topography, its population growth rate is to be considered while designing the project. By execution of the project the entire sewage of the city can be treated effectively and efficiently.

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ABBREVIATIONS

Qo (m^3 / h)	Influent flow - rate
Qe (m^3 / h)	Effluent flow – rate
Qr (m^3 / h)	Recycled sludge flow – rate
Qw (m^3 / h)	Wasted sludge flow – rate
BOD (mg / L)	Biochemical oxygen demand
BODo (mg / L)	Influent biochemical oxygen Demand
SS (mg / L)	Suspended solids (SS)
SSr , w (mg / L)	Recycled and wasted sludge SS
A (m3 / h)	Air flow – rate
MLSS (mg / L)	Mixed liquor suspended solids
t (h)	Hydraulic retention time
OL (kg BOD / m^3 . day)	Organic loading
F / M (kg BOD / kg MLSS.day)	Food to microorganism ratio
R	R Recycle ratio
SA (day)	Sludge age
ASR (m^3 / kg BOD)	Air supply rate
E (%)	BOD removal efficiency
C_d	Co-efficient of discharge

Chapter 1

INTRODUCTION

1.1 SEWERAGE – GENERAL CONSIDERATIONS

Sewage treatment is the process of removing contaminants from wastewater and household sewage, both runoff (effluents) and domestic. It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants. Its objective is to produce a treated effluent and a solid waste or sludge suitable for discharge or reuse back into the environment. This material is often inadvertently contaminated with many toxic organic and inorganic compounds.

Sewage implies the collecting of wastewaters from occupied areas and conveying them to some point of disposal. The liquid wastes will require treatment before they are discharged into the water body or otherwise disposed of without endangering the public health or causing offensive conditions.

As the cities have grown, the more primitive method of excreta disposal have gain place to the water-carried sewerage system. Even in the small cities the greater safety of sewerage, its convenience, and freedom from nuisance have caused it to be adopted wherever finances permit.

1.2 DEFINITIONS

Sewerage is the art of collecting, treating and finally disposing of the Sewage. Sewageis liquid, consists of any one or a mixture of liquid waste origins from urinals, latrines, bath rooms, kitchens of a dwelling, commercial building or institutional buildings.

Storm sewage is a liquid flowing in sewer during or following a period of rainfall and resulting there from.

A Partially Separate Sewer System is the sewerage system in which the domestic sewage is carried with the storm water in the rain season. Activated sludge is the active biological floc produced in activated sludge plants, largely composed of saprotrophic bacteria, protozoan flora (amoebae) and a range of other filter feeding species.

Mixed Liquor Suspended Solids (MLSS) is the amount of suspended solids in the mixof raw water and activated sludge. Return activated sludge (R.A.S) is the activated sludge extracted from the system and mixed with raw water to form the mixed liquor. Waste activated sludge (W.A.S.) or Surplus Activated Sludge (S.A.S.) is excessactivated sludge that is extracted from the system to be directed to sludge treatment.

Sludge Age is the average residence time of biological solids in the system. It can be defined as the average lifespan of bacteria in the system. Overflow rate / Surface loading is the discharge per unit of plan area. This parameter is the design factor in designing the settling tanks.

Food to Micro-organisms ratio (F/M ratio) is the ratio between daily BOD load applied to Aerator System and total microbial mass in the system.

Chapter 2

TREATMENT OF SEWAGE

The treatment of sewage consists of many complex functions. The degree of treatment depends upon the characteristics of the raw inlet sewage as well as therequired effluent characteristics.
Treatment processes are often classified as:

(i) Preliminary treatment

(ii) Primary treatment

(iii) Secondary treatment

(iv) Tertiary treatment.

2.1 PRELIMINARY TREATMENT

Preliminary treatment consists solely in separating the floating materials

like tree branches, papers, pieces of rags, wood etc. and heavy settable inorganicsolids. It helps in removal of oils and greases and reduces the BOD by 15% to 30%. The processes under this are:

➢ **Screening** – to remove floating papers, rags, clothes.

➢ **Grit chamber** – to remove grit and sand.

➢ **Skimming tank** – to remove oils and greases.

2.2 PRIMARY TREATMENT:

Primary treatment consists in removing large suspended organic solids. It is usually accomplished by sedimentation in settling basins. The liquid effluent fromthe primary treatment often contains a large amount of suspended organic materialand has a high BOD (about 60% of original).

2.3 SECONDARY TREATMENT:

Here the effluent from primary treatment is treated through biological decomposition of organic matter carried out either aerobic or anaerobic conditions.

2.3.1 Aerobic Biological Units:

I) Filters (intermittent sand filters, trickling filters)

II) Activated Sludge Plant (feed of active sludge, secondary settling tank and aeration tank)

III) Oxidation ponds and Aerated lagoon

2.3.2 Anaerobic Biological Units:

I) Anaerobic lagoons

II) Septic tanks

III) Imhoff tanks.

The effluent from the secondary treatment contains a little BOD (5% to 10%of original) and may contain several milligrams per litre of s DO

.

2.4 TERTIARY TREATMENT:

The purpose of tertiary treatment is to provide a final treatment stage to raise the effluent quality before it is discharged to the receiving environment (sea, river, lake, ground, etc.). More than one tertiary treatment process may be used at any treatment plant. If disinfection is practiced, it is always the final process. It is also known as "effluent polishing".

Chapter3

DESIGN PERIOD

A sewerage scheme involves the laying of underground sewer pipes and construction of costly treatment units, which cannot be replaced or increased in their capacities easily or conveniently at a later date. In order to avoid such complications, the future expansions of the city and consequent increase in the sewage quantity should be forecasted to serve the community satisfactorily for a reasonable year. The future period for which the provision is made in designing the capacities of various components of the sewerage is known as design period. This sewage treatment plant is designed for 30 years.

PARAMETERS	RAW SEWAGE OF ALLD Corp.*(outlet)	EFFLUENT
pH	7.3	5.5-9.0
BOD	20	≤ 20 mg/l
COD	40	≤ 250 mg/l
Total Suspended Solids	31	≤ 30 mg/l
Total Coli form	500	≤ 1000 no./ 100ml

* - Raw sewage characteristics, tested in Environmental laboratory with Technical division, Allahabad.

** - Expected effluent characteristics according the design

DATE	FLOW	INLET					MLSS				80(60+20) MLD STP NAINI 1 OUTLET					FECAL COLIFORM	SLUDGE		RESIDUAL CHLORINE-PPM	SIGN			REMARK
	(MLD)	PH	COD (mg/L)	BOD (mg/L)	TSS (mg/L)	DO (mg/L)	TANK 1	TANK 2	TANK 3	TANK 4	PH	COD (mg/L)	BOD (mg/L)	TSS (mg/L)	DO (mg/L)	EFFLUENT WATER	CONCENTRATION	FECAL COLIFORM		CHEMIST	PWPL	UPJN	
01/04/22	102.93	7.28	364	146	306	0.2	2834	–	–	3052	7.34	44	22	30	4.6	500	25.5	1700000	0.3				
02/04/22	103.16	7.31	348	139	304	0.3	2948	–	–	3058	7.39	40	20	32	4.5	600	25.2	1400000	0.2				
03/04/22	103.28	7.33	352	146	307	0.2	2968	–	–	3048	7.37	44	23	35	4.7	400	25.3	1200000	0.3				
04/04/22	104.20	7.32	344	136	309	0.3	3048	–	–	2842	7.36	36	18	33	4.7	600	25.5	1400000	0.2				
05/04/22	97.05	7.29	356	136	308	0.2	3348	–	–	2962	7.28	40	18	31	4.4	400	25.9	1700000	0.3				
06/04/22	97.14	7.31	344	143	312	0.3	2968	–	–	3048	7.39	44	22	29	4.5	500	25.9	1100000	0.2				
07/04/22		Plant Shutdown due to new flow meter installation															25.6	1300000					Due to new flow Installation [illegible] plant taken shutdown on 07.04.2022 [illegible]
08/04/22	102.15	7.28	340	129	306	0.2	2980	–	–	2832	7.35	48	24	32	4.6	700	25.0	1300000	0.3				
09/04/22	118.17	7.33	336	133	302	0.3	2848	–	–	2864	7.39	40	20	34	4.4	500	25.2	1400000	0.2				
10/04/22	118.17	7.33	344	129	306	0.2	2968	–	–	2842	7.37	36	18	32	4.5	400	25.9	1700000	0.3				
11/04/22	117.93	7.31	348	133	308	0.3	2980	–	–	3048	7.38	40	21	35	4.4	600	25.8	1200000	0.2				
12/04/22	111.05	7.33	362	136	302	0.2	2946	–	–	2952	7.39	44	23	33	4.5	400	25.6	1300000	0.3				
13/04/22	108.37	7.28	340	129	305	0.3	2864	–	–	3014	7.36	48	21	30	4.6	500	25.8	1400000	0.2				
14/04/22	113.54	7.33	340	136	307	0.2	2894	–	–	2848	7.38	44	20	32	4.5	700	24.8	1400000	0.3			14/4/22	
15/04/22	117.33	7.31	336	129	303	0.3	3016	–	–	3064	7.35	36	18	31	4.6	500	25.3	1200000	0.2				
16/04/22	118.81	7.33	328	133	298	0.2	2988	–	–	2844	7.38	40	20	33	4.4	600	25.6	1700000	0.3				
17/04/22	116.83	7.28	340	136	301	0.3	2832	–	–	2848	7.35	48	21	35	4.6	400	25.3	1300000	0.2				
18/04/22	118.22	7.33	332	129	306	0.2	3056	–	–	3196	7.44	40	20	32	4.3	700	25.2	1100000	0.3				
19/04/22	116.86	7.35	336	133	302	0.3	2944	–	–	2816	7.39	36	18	34	4.5	600	24.6	1200000	0.2				Thikner outlet consistency
20/04/22	120.39	7.29	340	129	308	0.1	3088	–	–	3226	7.35	44	20	35	4.6	500	25.4	1100000	0.3				
21/04/22	117.34	7.32	352	136	298	0.3	2976	–	–	3032	7.38	40	22	33	4.5	600	25.2	1400000	0.2				
22/04/22	117.58	7.28	348	139	304	0.2	3016	–	–	3064	7.35	44	24	32	4.3	400	25.6	1300000	0.3				
23/04/22	116.33	7.33	362	143	306	0.3	2832	–	–	2988	7.38	48	22	34	4.5	700	25.4	1700000	0.2				
24/04/22	113.80	7.28	348	129	303	0.2	2944	–	–	2864	7.35	40	20	32	4.3	500	25.5	1200000	0.3				
25/04/22	114.68	7.35	328	136	306	0.3	2848	–	–	3048	7.38	36	18	35	4.5	600	24.8	1300000	0.2				
26/04/22	121.22	7.39	340	129	298	0.2	2958	–	–	2848	7.41	44	21	33	4.6	400	25.4	1400000	0.3				
27/04/22	111.24	7.32	328	126	305	0.3	3056	–	–	2968	7.44	48	23	30	4.5	400	25.3	1500000	0.2				
28/04/22	114.72	7.33	348	133	298	0.1	3144	–	–	2892	7.39	40	19	34	4.4	700	25.3	1700000	0.2				
29/04/22	131.97	7.28	336	129	303	0.2	3052	–	–	2948	7.36	44	20	31	4.5	500	25.5	1300000	0.3				
30/04/22	122.77	7.33	344	126	306	0.3	2944	–	–	2852	7.41	36	21	33	4.6	400	25.4	1400000	0.2				

Table 1 : Data collected from site

Chapter 4

FORECASTING METHOD : INCREMENTAL INCREASE METHOD

YEAR	POPULATION	INCREMENTAL	INCREAMENTAL INCREASE
1980	304912	30490	2682
1990	335403	33172	11426
2000	368575	44598	-2867
2010	413173	41731	
2020	454904		

$\bar{x} = 37497$ $\bar{y} = 3747$

PN= Po + N$\bar{x}$ +N((N+1)/2) $\bar{y}$

Base period as 2035,

P2035 =454904+1.5 x37497+ 1.5x2.5x0.5x3747

=5,18,175

Ultimate design period as 2065,

P2065 =454904+ 4.5x37497+ 4.5x5.5x0.5x3747

=6,70,009

AT DESIGN PERIOD OF 30 YEARS THE FORECASTED POPULATION OF THE PRAYAGRAJ CITY(NAINI,MEDICAL CHAURAHA, PHAPHAMAU MAHEWA) IS 6,70,009.

Chapter 5

CACULATION OF SEWAGE GENERATION

ULTIMATE DESIGN PERIOD= 30 YEARS

FORECASTED POPULATION AT 2065= 6,70,009

WATER DEMAND:

>Domestic 135 lpcd

>Institutional 20 lpcd

>Public utility 12 lpcd

>losses and theft 25 lpcd

>total water demand 192 lpcd

Avg. water supply per day = 670009x192

=128.64 MLD

Avg. sewage generation per day =80% of supply water

=0.8x128.64

=102.912MLD

Avg. discharge =1.19cumec

Max. discharge =3xAvg discharge

=3.57cumec

Chapter 6
SEWAGE TREATMENT PROCESS

6.1 GENERAL

Sewage contains various types of impurities and disease bacteria. This sewage is disposed of by dilution or on land after its collection and conveyance. If the sewage is directly disposed of, it will be acted upon the natural forces, which will convert it into harmful substances. The natural forces of purification cannot purify any amount of sewage within specified time. If the quantity of sewage is more, then receiving water willbecome polluted or the land will become sewage sick. Under such circumstances it becomes essential to do some treatment of the sewage, so that it can be accepted by the land or receiving water without any objection. These treatment processes will directly depend on the types of impurities present in the sewage and the standard up to which treatment is required.

6.2 OBJECT OF TREATMENT

The main object of treatment units is to reduce the sewage contents (solids) from the sewage and remove all the nuisance causing elements and change the character of the sewage in such a way that it can be safely discharged in natural water course applied on the land. In other words, the objective of sewage treatment is to produce a disposable effluent without causing harm or trouble to the communities and prevent pollution.

Practically the treatment of sewage is required in big cities only where the volume of the sewage is more as well as the quantity of various types of solid, industrial sewage etc. is more and porous land or large quantity of water bodies is not available for the proper disposal of sewage.

6.3 DEGREE OF TREATMENT

The degree of treatment will mostly be decided by regulatory agencies and the extent to which the final product of treatment are to be utilized.

The regulatory bodies might have laid down standard for the effluent or might specify the condition under which the effluent must be discharged into the natural stream. The method of treatment adopted should not only meet the requirement of the regulatory bodies, but also result in the maximum use of the end product with economy.

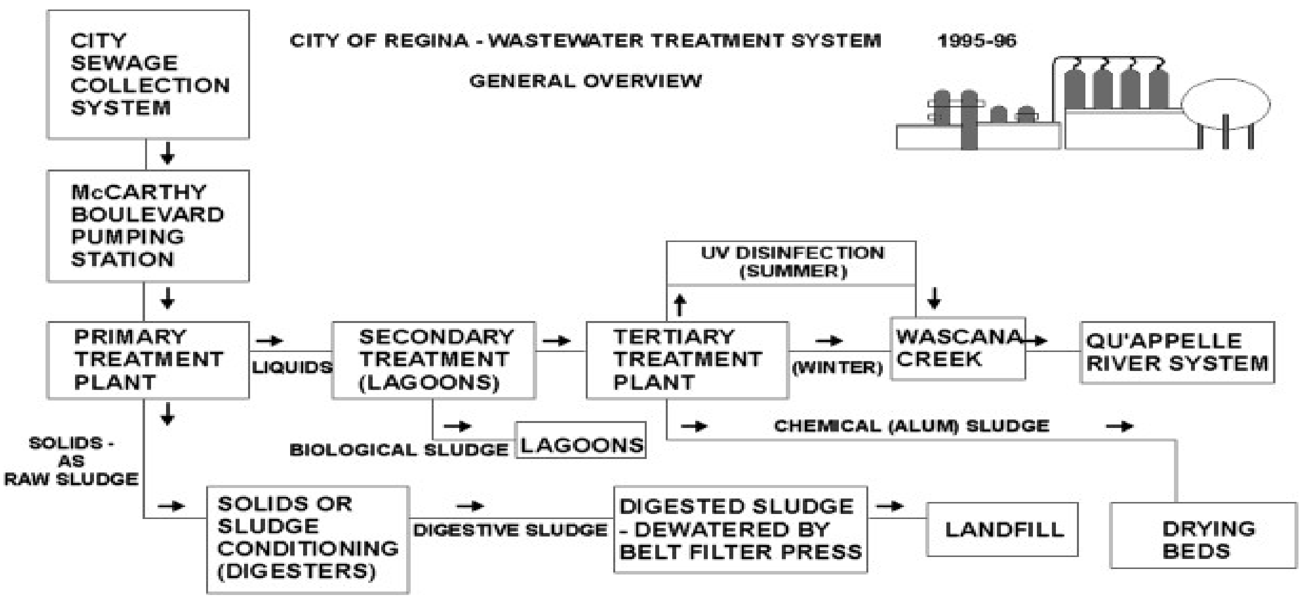

Figure1.waste water treatment system

6.4 LOCATION OF TREATMENT PLANT

The treatment plant should be located as near to the point of disposal as possible. If the sewage has to be disposed finally in to the river, the plant should be located near the river bank. Care should be taken while locating the site that it should be on the downstream side of the city and sufficiently away from water intake works. If finally the sewage has to be applied on land, the treatment plant should be located near the land at such a place from where the treated sewage can directly flow under

gravitational forces toward the disposal point. The plant should not be much far away from the town to reduce the length of the sewer line.
On the other hand the site should not be close to the town, that it may cause difficulties in the expansion of town and may pollute the general atmosphere by smell and fly nuisance.

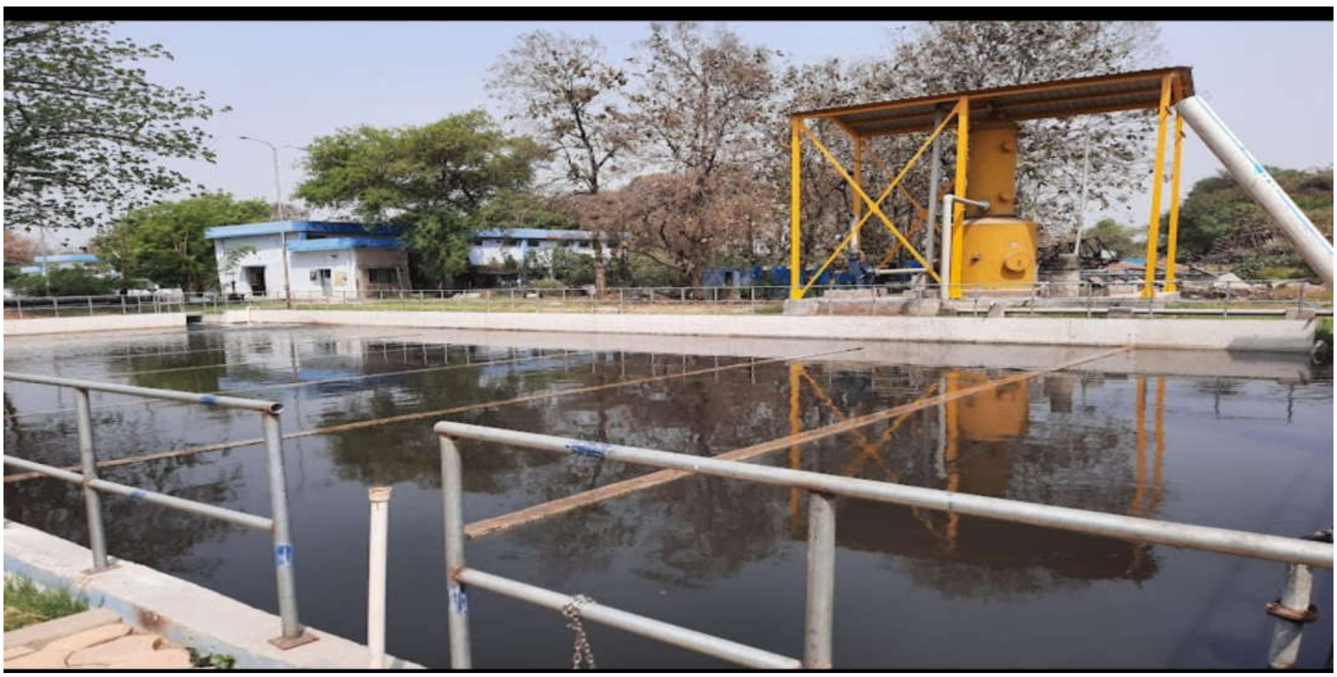

Figure 2.Ttreatment plant

6.5 LAYOUT OF TREATMENT PLANT

The following point should be kept in mind while giving layout of any sewage treatment plant:

1. All the plant should be located in the order of sequence, so that sewage from oneprocess should directly go to other process.

2. If possible all the plant should be located at such elevation that sewage can flow from one plant into next under its force of gravity only.

3. All the treatment units should be arranged in such a way that minimum area isrequired it will also ensure economy in its cost.

4. Sufficient area should be occupied for future extension.

5. Staff quarter and office also should be provided near the treatment plant, so thatoperators can watch the plant easily.

6. The site of treatment plant should be very neat and give very good appearance.

7. Bypass and overflow weir should be provided to cut out of operation any unitwhen required.

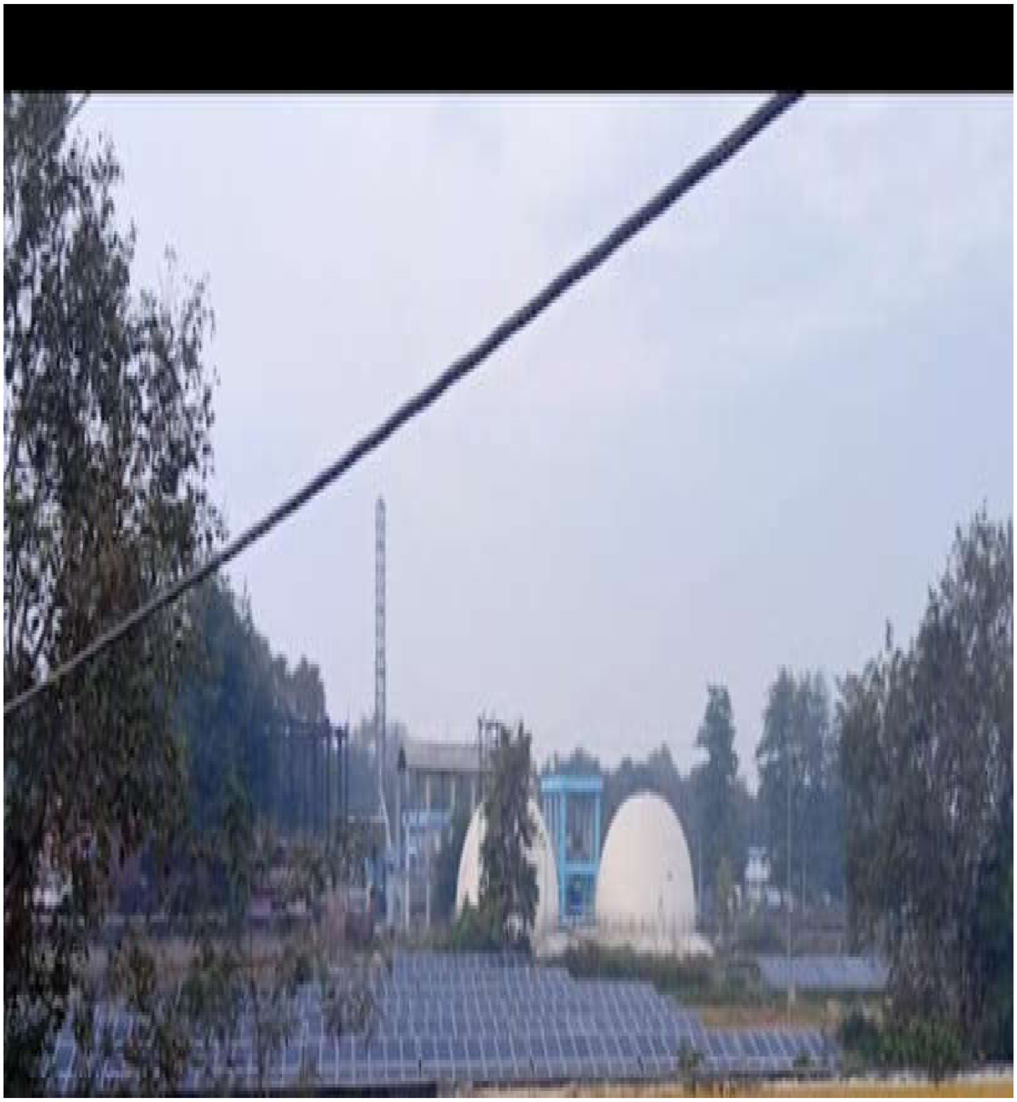

Figure 3. Naini STP

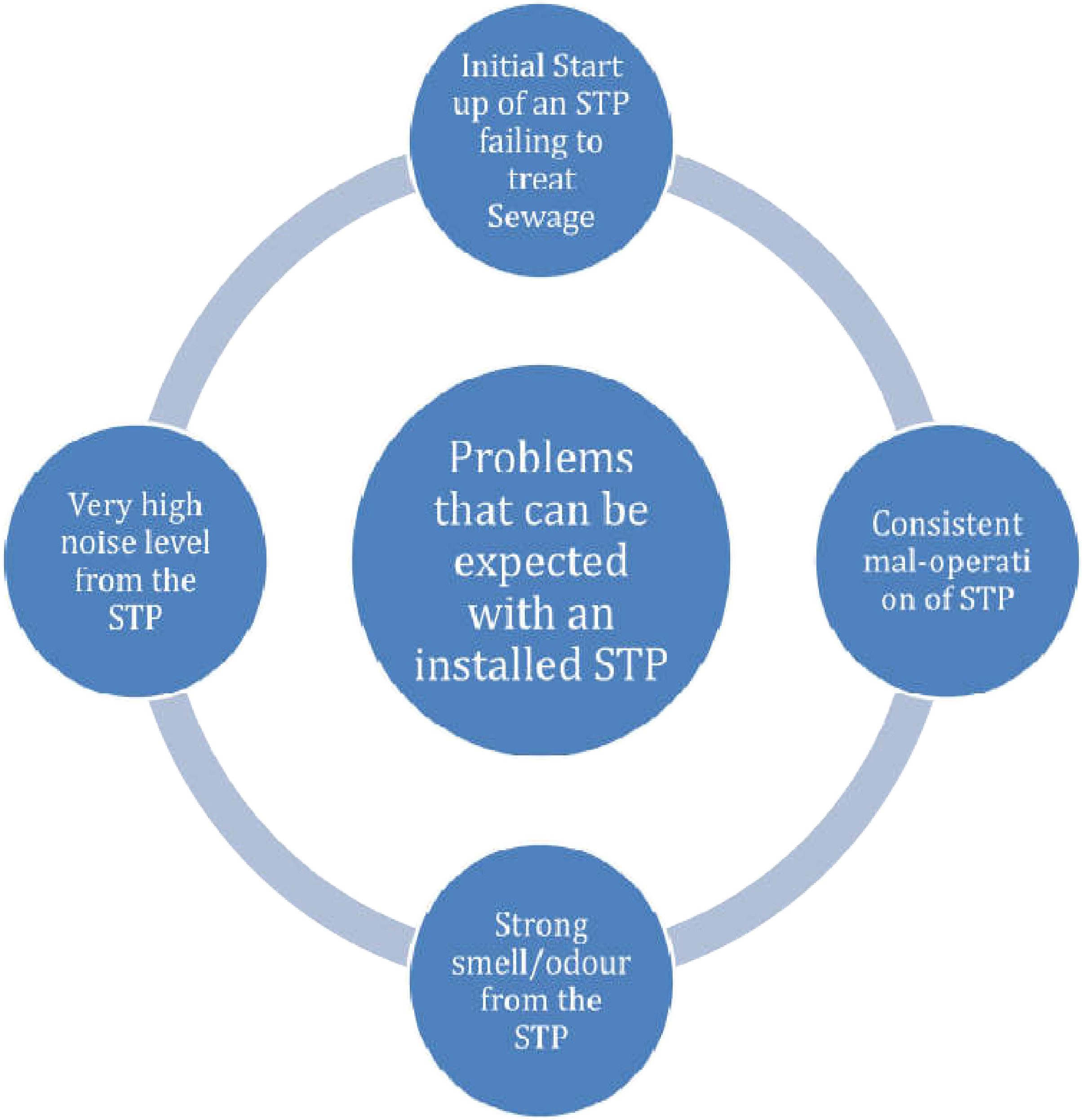

Figure 4: Problems due to STP

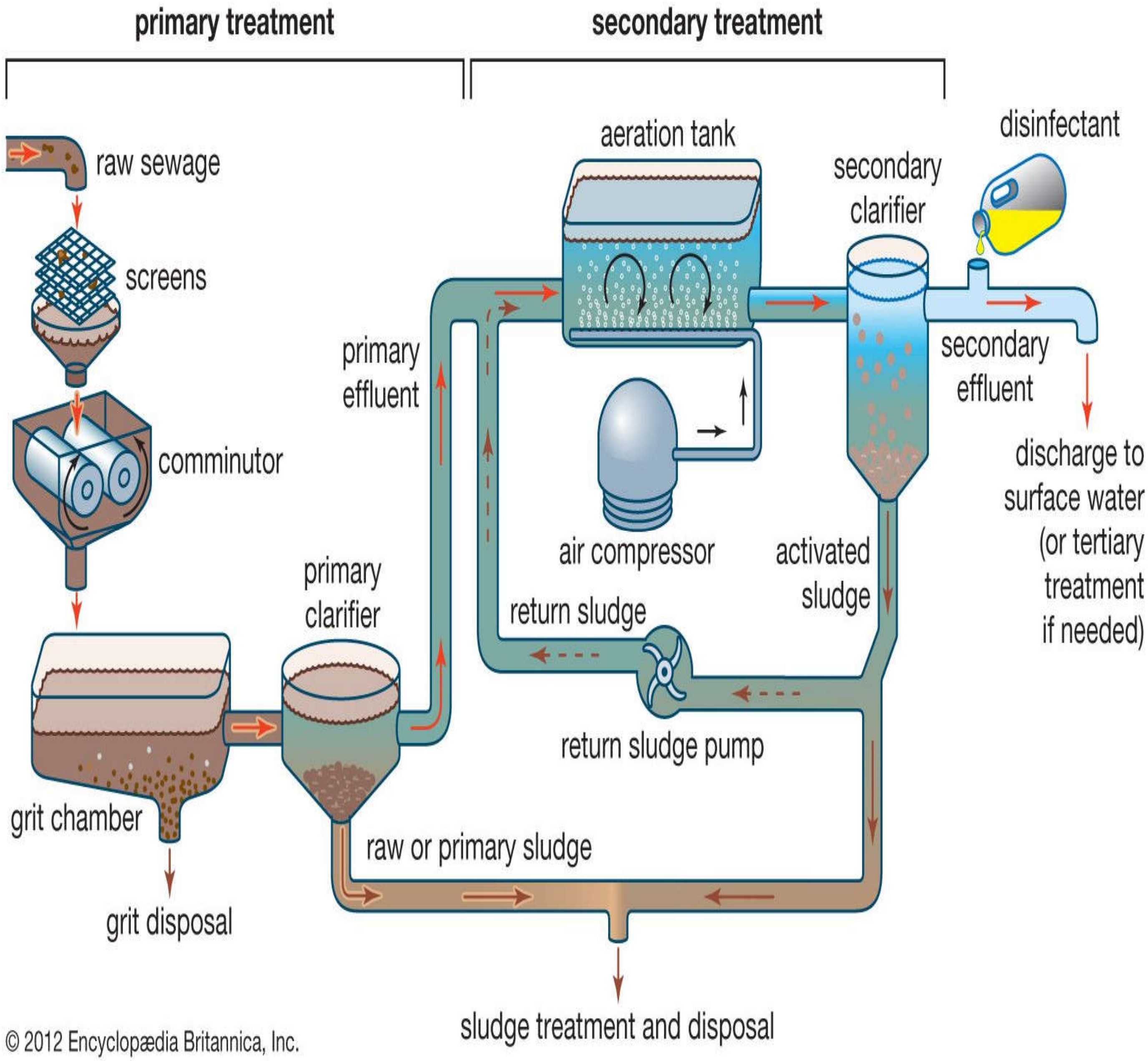

Figure 5 : Block diagram of process of STP

6.6 POINT CONSIDERED IN DESIGN:

Following points are considered during the design of sewage treatment unit:

1. The design period should be taken between 25 to 30 years.

2. The design should not be done on the hourly sewage flow basis, bu the average domestic flow plus the maximum industrial flow on the yearly record basis.

1. Instead of providing one big unit for each treatment more than two numbers smallunits should provided, which will provide in operation as well as no stoppage during maintenance and repair of the plant.

4. Overflow weirs and the bypasses should be provided to cut the particular operationif desired.

5. Self cleaning velocity should develop at every place and stage.

6. The design of the treatment units should be economical; easy in maintenance should offer flexibility in operation.

Chapter 7
DESIGN OF UNITS

7.1 RECEIVING CHAMBER

Receiving chamber is the structure to receive the raw sewage collected through Under Ground Sewage System from the city. It is a rectangular shape tank constructed at the entrance of the sewage treatment plant. The main sewer pipe is directly connected with this tank.

7.1.1 DESIGN

Design flow =
3.57 m3/s
Detention time
= 60 sec
Volume required = flow X detention time
= 3.57 x 60
Vol.
rqd = 225 m^3
Provide, depth
= 3m
Area = 75m^2
Length: Breadth = 2:1
L x B = 2B x B = 75

B = 6.13mL

= 12.3m

:
CHEC
K

Volume designed = 12.3x6.13x3
V_{des} = 225.5 m^2
V_{rqd} = 225 m^3
$V_{des} > V_{rqd}$
Receiving chamber is designed for the size of

12.3m X 6.13m X 3m (SWD) + 0.5 (FB)

7.2 SCREENING

7.2.1 GENERAL:

Screening is the very first operation carried out at a sewage treatment plant and consists of passing the raw sewage through different types of screens so as to trap and remove the floating matter such as tree leaves, paper, gravel, timber pieces, rags, fiber, tampons, cans, and kitchen refuse etc.

7.2.2 PURPOSE OF SCREENING:

Screening is essential in sewage treatment for removal of materials which would otherwise damage the plant, interfere with the satisfactory operation of treatment unit or equipment.

- To protect the pumps and other equipments from the possible damages due to floating matter.
- To remove the major floating matters from the raw sewage in a simple manner before it reaches into the complex high energy required process.

7.2.3 COARSE SCREENS

The coarse screens essentially consist of steel bars or flat placed 30° to 60°inclination to the horizontal. The opening between bars are 50mm or above. These racks are placed inthe screen chamber provided in the way of sewer line. The width of the rack channel should be sufficient so that self cleaning velocity should be available and a bypass channel should be provided to prevent the overtopping. The bypass channel is provided with vertical bar screen. A well drained trough is provided to store the impurities while cleaning the rack. Theseracks are cleaned mechanically.

Figure 6: Screening chamber

7.2.4 DESIGN OF COARSE SCREEN:

Peak discharge of sewage = $3.57 m^3/s$

Assume the velocity at average flow is not allowed to exceed 0.8 m/s.

The net area screen opening required = 3.57/0.8

= $2.85 m^2$

Using rectangular steel bars, in the screens having 1 cm with and placed at5cm clear spacing.

Clear opening between bars = 30 mm = .03 m

Size of the bars = 75mm*10mm

Assume width of the channel = 1 m

Assuming that the screens bars are placed at 60 to the horizontal, velocity through screen at peak flow = 1.6 m/s

= $2.85*\sin 60 \ m^2$

No. of openings= 2.47/.03

=83 Nos.

Assume 2 course screen ,

= 83/2

= 42

Width of Channel = (42x30) + (43x10)

= 1.69 m

Coarse screen channel is designed for the size

<u>1.69 m X 0.7m (SWD) + 0.5 m (FB)</u>

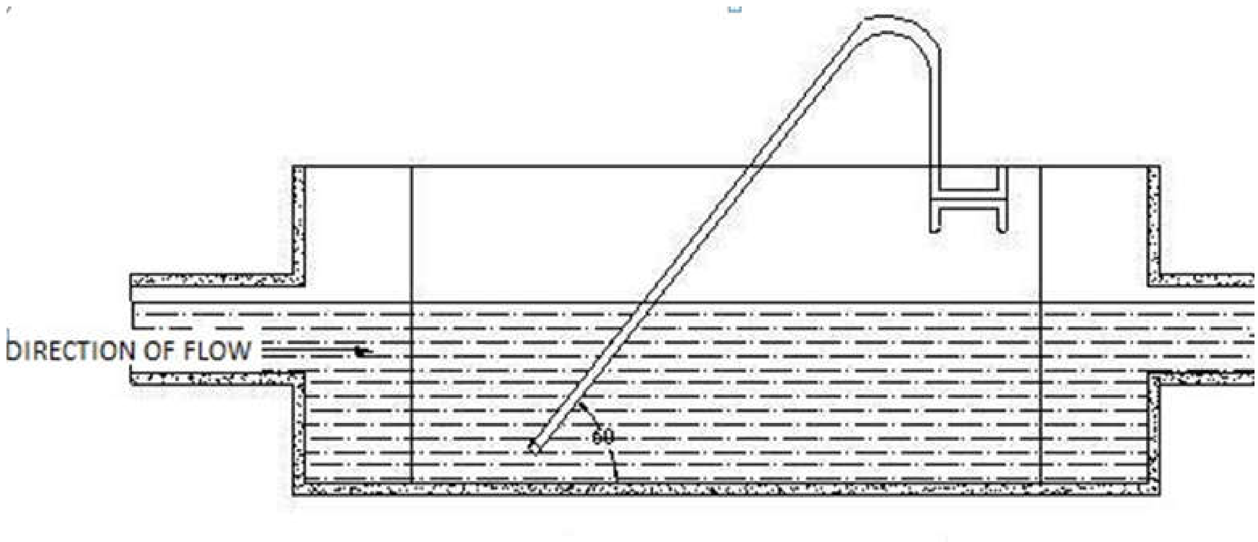

Figure 7: Coarse Screen

7.3. GRIT CHAMBER

Grit removal basins are the sedimentation basins placed in front of the fine screen to remove the inorganic particles having specific gravity of 2.65 such as sand, gravel, grit, egg shells and other non-putrescible materials that may clog channels or damage pumps due to abrasion and to prevent their accumulation in sludge digesters. The grit chamber is designed to scour the lighter organic particles while the heavier grit particles remain settled. Here the horizontal flow type grit chamber is designed to give a horizontal straight line flow velocity, which is kept constant over varying discharge.

7.3.1 DESIGN

Peak flow of sewage = 3.57 m^3/s

Assume average detention period = 180 s

Aerated volume = 3.57 x 180

= 642.6 m^3/s

In order to drain the channel periodically for routine cleaning and maintenance twochambers are used.

Therefore volume of one aerated chamber = 642.6/2 m^3

= 321.3 m^3

Assume depth of 3.5m and Width to depth ratio 2:1

Width of the channel = 2 x 3

= 6 m

Area = (321.3/18) m^2

Length of the channel = 17.85m.

Increase the length by about 20% to account for inlet and outlet

Provide length = 17.85 x 1.2 m

= 21.42m

Grit chamber is designed for the size of

<u>21.42m X 6m X 3m</u>

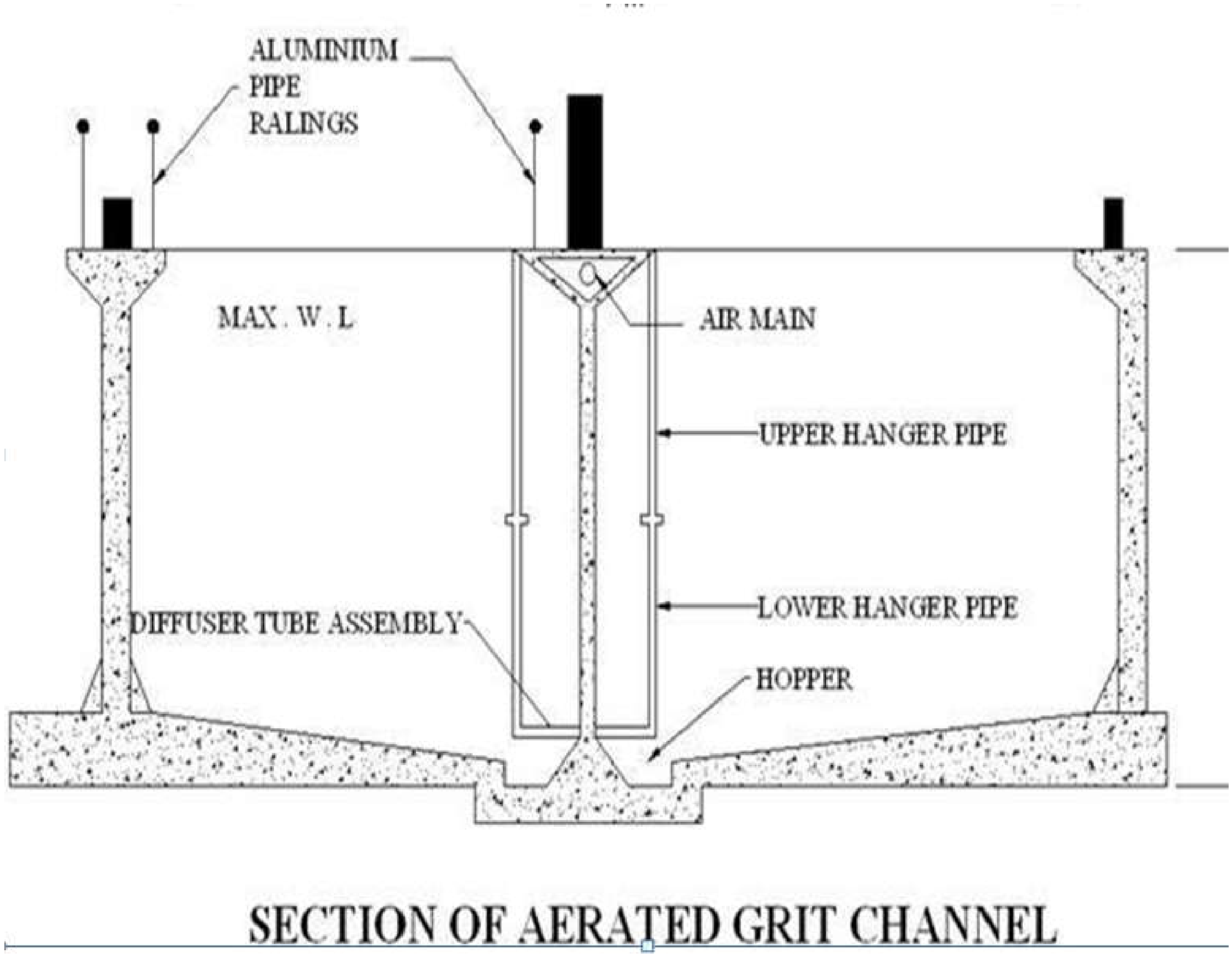

Figure 8:Section of aerated grit channel

7.4. SKIMMING TANK

Skimming tanks are the tanks removing oils and grease from the sewage constructed before the sedimentation tanks. Municipal raw sewage contains oils, fats, waxes, soaps, fatty acids etc. The greasy and oily matter may form unsightly and odorous scum on the surface of settling tanks or may interfere with the activated sludge process.

In skimming tank air is blown along with chlorine gas by air diffuser
placed at the bottom of the tank. The rising air tends to coagulate and solidify the grease and cause it to rise to the top of the tank whereas chlorine destroys the protective colloidal effect of protein, which holds the grease in emulsified form. The greasy materials are collected from the top of the tank and the collected are skimmed of specially designed mechanical equipments.

Figure 9 : Skimming Tank

7.4.1 DESIGN:

The surface area required for the tank $A = 6.22 \text{ X } 10\text{-}3 \text{ X } q/V_R \ m^2$

Where q = rate of flow sewage in m^3/day

V_R = minimum rising velocity of the oily materialto be removed in

m/min

= 0.25 m/min
= 0.25 x 60 x 24
= 360 m/day

q = 3.57 x 60 x 60 x24

=

308448.0

m^3/day

The surface area Ar. = 6.22 x 308448 / (1000 x 360)

$\approx 5.3 \ m^2$

Provide the depth of the skimming tank is

3.5m The length breadth ratio is 1.5: 1

Therefore L = 1.5B
$5.3 = 1.5B^2$

Therefore B= 1.87m
L = 2.81 m

Skimming tank is designed for the size of

2.8m X 1.8m X 3.5m + 0.5m (FB)

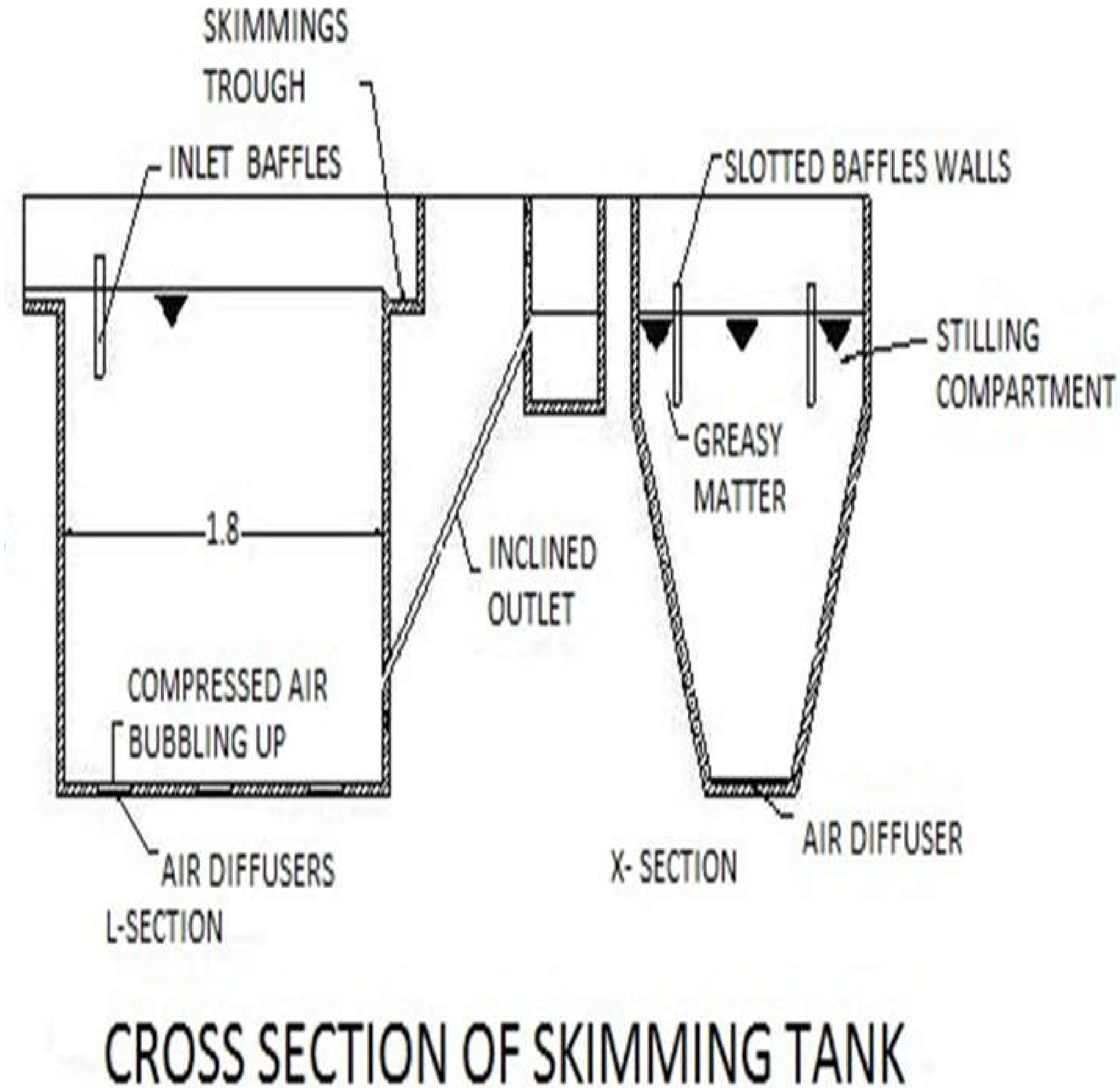

Figure 10 : Cross section of Skimming Tank

Chapter 8

PRIMARY SEDIMENTATION TANK

Primary sedimentation tank is the settling tank constructed next to
skimming tank to remove the organic solids which are too heavy to be removed i.e. the particles having lesser size of 0.2 mm and specific gravity of 2.65. The designed tank is circular type which makes settling by allowing radial flow. These are fabricated using carbon steel with epoxy lining on the inside and epoxy coating on the outside. Built on the concept of inclined plate clarification, these clarifiers use gravity in conjunction with the projected settling area so as to effect a fairly high percentage of removal of suspended solids as 60 to 65% of the suspended solids and 30 to 35% of the BOD from the sewage.

8.1 DESIGN:

Max. quantity sewage = 103 MLD

Surface loading = 60

cum/sqm/day

Detention period = 2

hrs

Volume of sewage = 103x10^6x10^(-3)x2/ 24

= 8583 m^3

Provide effective depth = 3 m

Surface area = 8583/3

= 2861 m^2

Surface area from total flow surface loading = 103x10^3/60

= 1716.7 m2

Use greater of area of these two,

Therefore surface area of the tank = 2861

Diameter of the tank = $\sqrt{(2861 \times 4/\pi)}$

=

60.35 m

Primary sedimentation tank is designed for the dimension of

<u>60.35m (dia) X 3 m (depth) + 0.5 (FB)</u>

Figure 11: P.S.T

Chapter 9
ACTIVATED SLUDGE PROCES

The activated sludge process is an aerobic, biological sewage treatment system to treat the settled sewage consist a variety of mechanisms and processes that use dissolved oxygen to promote the growth of biological floc that substantially removes organic material. The essential units of the process are an aeration tank, a secondary settling tank,a sludge return line from the secondary settling tank to the aeration tank and an excess sludge waste line.

9.1 CONCEPT:

Atmospheric air is bubbled through primary treated sewage combined with organisms to develop a biological flocculant which reduces the organic content of the sewage. The Mixed Liquor, the combination of raw sewage and biological mass is formed. In activated sludge plant, once the effluent from the primary clarifier get sufficient treatment, the excess mixed liquor is discharged into settling tanks and the treated supernatant is run off toundergo further treatment. Part of the settled sludge called *Return Activated Sludge (R.A.S.)* is returned to the head of the aeration system to re-seed the new sewage entering the tank. Excess sludge which eventually accumulates beyond R.A.S known *Waste Activated Sludge (W.A.S.)* is removed from the treatment process to keep the ratio of biomass to food supplied *(F:M) ratio*. W.A.S is further treated by digestion underanaerobic conditions.

9.2 METHOD: CONTACT STABILIZATION METHOD

- Microorganisms consume organics in the contact tank.
- Effluent from primary clarifier flows into the contact tank where it is aerated and mixed with bacteria.

- Soluble materials pass through bacterial cell walls, while insoluble materials stick to the outside.

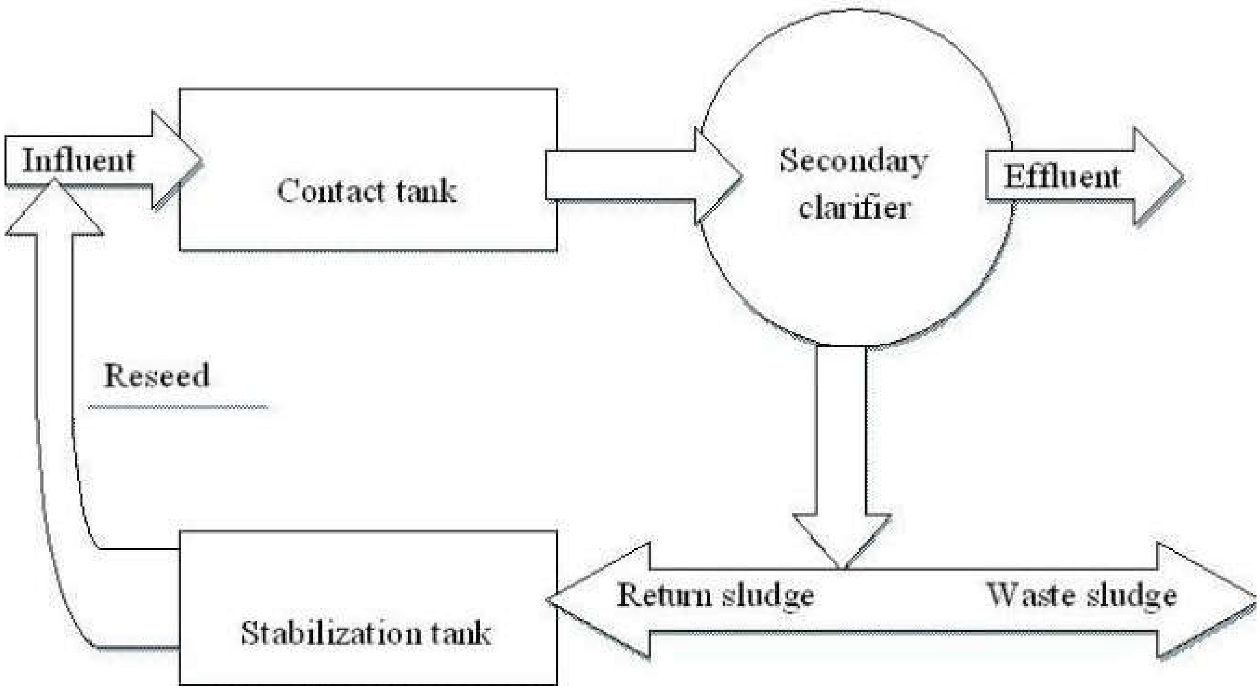

Figure 12 : Flow diagram of Activated Sludge Process

FLOW CHART OF CONTACT STABILIZATION ACTIVATED SLUDGE PROCESS

- Solids settle out later and are wasted from the system or returned to a stabilization tank.
- Microbes digest organics in the stabilization tank, and are then recycled back tothe contact tank, because they need more food.
- Waste Activated Sludge is removed and sent to further treatment

9.3 PROCESS

The activated sludge functions in the above mentioned concept by following he Contact stabilization method. The effluent from primary clarifier is mixed with 40 to 50% of own volume of activated sludge (R.A.S). Then it is mixed for 4 to 8 hours in the aeration tank by the combined aerator which does compressed air diffusion and mechanical mixing. The moving organisms oxidize the organic matter and make it to settle in the secondary clarifier.

The settled sludge known as activated sludge is then recycled to head of aeration tank and mixed with the new entering sewage. New activated sludge is produced continuously and W.A.S is disposed along with primary treated sludge after proper digestion.

The activated sludge plant results 80 to 95% of BOD removal and 90 to 95% bacteria removal by making the necessary set up such as:

(i) Ample supply of oxygen to plant

(ii) Intimate and continuous mixing sewage with activated sludge.

(iii) Constant rate of return sludge is made to be kept through out the process.

Chapter 10
AERATION TANK

Aeration tank is the mixing and diffusing structure in the activated sludge plant. These are rectangular in shape having the dimensions ranging 3 to 4.5m deep, 4 to 6m wide and 20 to 200m length. Air is introduced continuously to the tank.

Combined Aeration type aerators having the diffused air aeration as well as mechanical aeration together in a single unit are used in the project. The *Dorroco* model is designed as it gives higher efficiency and occupies less space. This results in higher efficiency and lesser detention period and lesser amount of compressed air.

10.1DESIGN

No. of Aeration tank = 6

Design flow = 103 MLD

Average flow of each tank =103000/6

= 17167 m^3

BOD at inlet = 0.8 x 300

(20 % of BOD removed at Grit chamber)

Y_o = 240 mg/l

BOD at outlet Y_E = 20 mg/l

BOD Removed in Activated Plant = 240-20

= 220 mg/l

Minimum efficiency required in the activated plant

= 220 / 240

= 91.7 %

Since the adopted extended aeration process can remove 85-92. %

Hence it is OK

MLSS (Xt) = 4000 mg/l

F/M ratio = 0.3

$$F/M \text{ ratio} = (Q \times Y_o) / (V \times X_t)$$

Volume the tank required V = (17167 x 240) / (0.3 x 4000)
= 3433.4 m^3

Assume the liquid depth of the tank as

4.5 mThe Width to Depth ratio as 2.5

B=2.5x

DB = 11.25m

L = 3433.4/ (B x D)
= 67.8m

L = 67.8 m; B = 11.25 m; D = 4.5 m

Volume provided = 67.8x
11.25 x 4.5
= 3569.7 m^3

(i)CHECK FOR AERATION PERIOD / HRT:

Hydraulic Retention Time (HRT) = t = V x 24 / Q
= 3569.7 x 24 /17167
= 4.99 hrs

Since it lies between 3-6 hrs it is OK.

(ii) CHECK FOR VOLUMETRIC LOADING:

Volumetric loading = Q x Y_o / V
= 17167x 240 / 3569.7
=

1.154g/m^3

Since it lies between 1.0 – 1.2 it

is OK

(iii) CHECK FOR RETURN SUDGE RATIO:
(for SVI ranging between 50-150 ml/gm)

Adopt SVI (Sludge Volume Index) = 100 ml/gm

Return Sludge Ratio = Q_R/Q

$= X_t/\{(10^6/SVI)- X_t\}$

$=4000/\{(10^6/100)-4000\}$

$= .67$

Since it lies between 0.25 – 1.00 it is OK.

(iv) CHECK FOR SRT (□C):

$V.X_t = \{\alpha y.Q (Y_o-Y_E) □c\}/(1+K_E.□c)$

Where, αy (Max. Yield Co-efficient) = 1.0 constant with respect to MLSSKe

= 0.06 d^{-1} constant for municipal sewage

$□_C$ = Solids Retention Time

(SRT)Y_o = 240 mg/l

Y_E = 20 mg/l

V = 3569.7 m^3

X_t = 4000 mg/l

Q = 17167 m^3/day

3569.7 x 4000 = {1x 17167 x(240-20) □c}/(1+0.06 x □c)

1+ 0.06 □c = 0.264 □c

□c = 4.9 ≈ 5 days

It lies between 5-8 days. The deign is OK

Provide the Aeration tank as

67.8 m x 11.25 m x 4.5 m + 0.5 m (FB)

Chapter 11
SECONDARY SEDIMENTATION TANK

A sedimentation tank constructed next to the aeration tank is the secondary sedimentation. This tank will be as the primary sedimentation tank with certain modifications as no floating materials are here, provisions for the removal of scum, float age are not needed.

The surface area for the secondary sedimentation tank is designed for both overflow rate basis and solids loading rate basis. The larger value is adopted.

11.1 DESIGN

No. of Secondary clarifier = 5

Average flow = 103000/5

= 20600 m^3/day

Recalculated flow = 53%

= 20600 x .53

=10918 m^3/day

Total inflow = 20600+10918

=

31518 m^3/dayProvide hydraulic detention period = 2 hrs

Volume the tank (exclusive of hopper portion)

= 31518 x 2 /24

= 2626.5 m^3

Assume depth =3.5

Area = 2626.5 / 3.5

= 750.5 m^2

Surface loading rate of average flow = 25 m3/m2/day

Surface area provided = 103000/(25x5)

= 824 m2

Therefore surface area = 824 m2

Diameter $=\sqrt{(824 \times 4/\pi)}$

=32.39 m

≈

32.4 m

Provide diameter of 32m

(i) CHECK FOR WEIR LOADING:

Average flow = 17167

m^3/day Weir loading =

17167/ (25 x π)

= 218.6 m^3/day/m

It is lesser than (100 -225)m^3/day/m. Hence it is OK.

(ii) CHECK FOR SOLIDS LOADING:

Recirculated flow =10918m^3/day

Average flow = 17167 m^3/day

MLSS in the tank = 4000 mg/l

T Total solids in flow = (17167+10918) x 5

= 140425 kg/day

Solids loading = 140425 / 824

= 170kg/day/m2

It lies between 100-225 kg/m^2/day

Hence it is OK

Provide secondary sedimentation as

32m (dia) x 3.5 m (depth) + 0.5 m (FB)

Chapter 12

STABILIZATION TANK

Total return flow = 54590 m^3/day
= 37.9 m^3/min

Detention time = 15 min
Volume of wet well = 37.9 x 15
= 568.5 m^3

Provide depth as 4m,

width as 5 mTherefore

length is = 28.42 m
≈ 28.4 m

Wet well dimension **as <u>28.4m x 5m x 4m + 0.5m (FB)</u>**

2 No. of pump house each of 16 MLD capacity in the dry well are provided.

Chapter 13
SEWAGE DISPOSAL

The disposal of treated effluent into land or water body is sewage disposal.This can be of two methods,

(i) Dilution – disposal in water bodies.

(ii) Effluent irrigation – disposal on land

13.1 DILUTION

The disposal of effluent by discharging it into water courses such as streams, rivers or large body of water such as lake, sea is called dilution.

13.2 EFFULENT IRRIGATION:

The effluent to be disposed in Land Effluent Irrigation method and it is done by constructing Ridge and Furrow in the disposal land. Here the land is first ploughed up to 45cm, then leveled and divided into plots and sub-plots. Then each sub-plot is enclosed by small dykes. Now ridges and furrows are formed in each sub-plot. The sewage is allowed to flow in furrows, whereas crops are grown on ridges. After an interval of 8-10 days the sewage can be again applied depending on the crops requirement and the nature of the soil.

	PARAMETERS	**Tolerance limit as per IS:3307-1986**	**EFFLUENT From the Plant**
	pH	5.5-9.0	5.5-9.0
	BOD	100mg/l	≤ 20 mg/l

	Oil & Grease	200mg/l	≤ 5 mg/l
	Suspended Solids	10mg/l	≤ 30 mg/l
	Chlorides	600mg/l	≤400 mg/l
	Sulphat	1000mg/l	≤ 250 mg/l

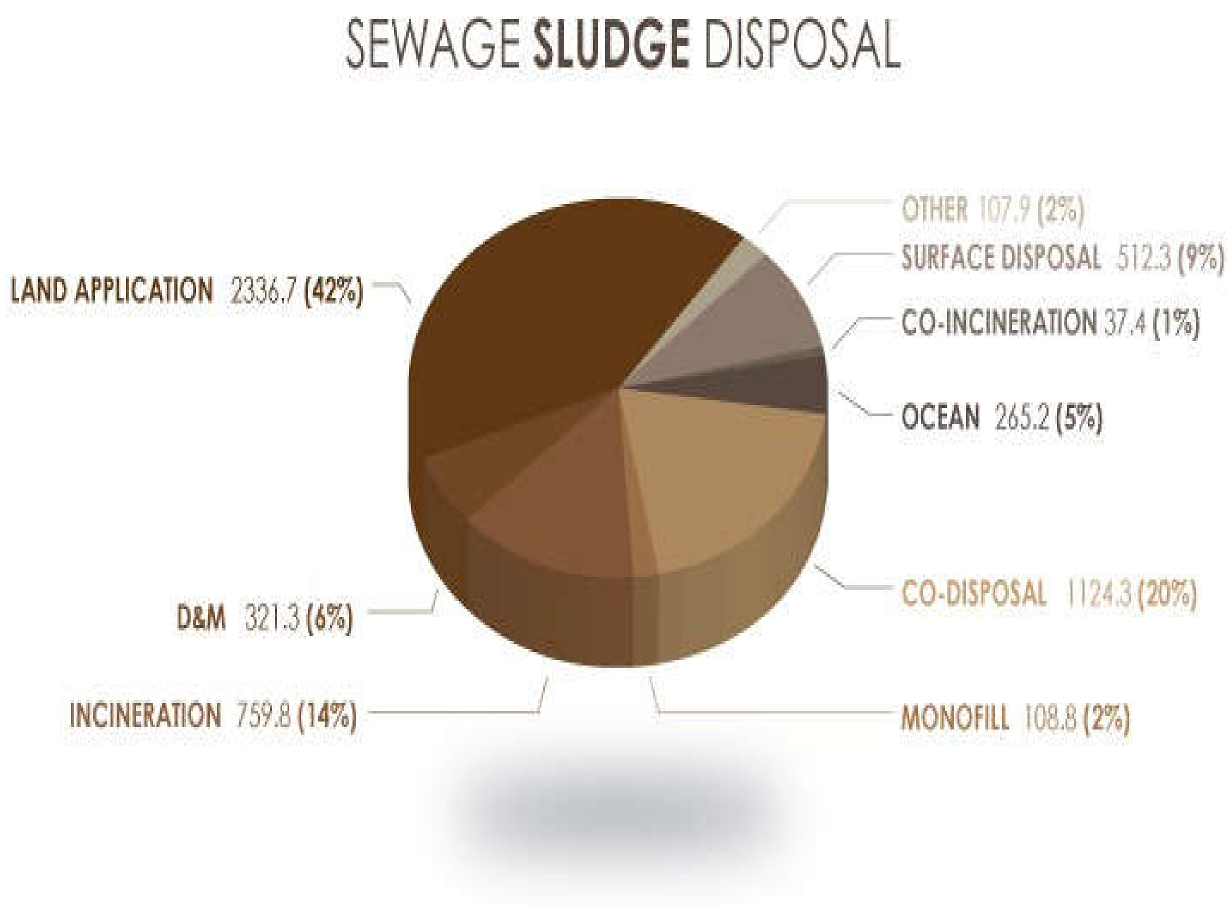

Figure 13 :Sewage Sludge Disposal

Chapter 14

FUTURE SCOPE

Some possible future related experiments might be:

1. I could attempt to measure how fast the waste water moves throughthe system. For example, if I found that it takes four hours to move through the system, I could take the downstream samples four hourslater than the upstream samples. That way, I would be testing the same water before and after it passed through the system.

2. I could study which plants are effective at absorbing phosphates and nitrates. It is possible that the plants currently in the system are better at absorbing nitrates than phosphates. I could find plant typesthat could absorb phosphates and recommend that they are added tothe system.

Chapter 15

CONCLUSION

A successful technical project involves integration of various fields. This is an attempt to combine several aspects of environmental, biological and chemicaland civil engineering. Since, in Allahabad city in naini region there is no proper treatment plant for sewage, it is necessary to construct a Sewage Treatment Plant. The plant is designed perfectly to meet the future expansion for the next 30 years in accordance with Indian Codal provisions. This project consists the design of the complete components of a Sewage Treatment Plant from receiving chamber, screening chamber, grit chamber, skimming tank, sedimentation tank, secondary clarifier, active sludge tank and sludge drying beds for sewage.

Following results were obtained from the population forecasting studies :

1. From base period 2035 population increases 5,18,175 to 6,70,009 in the year 2065 as ultimate design period.
2. Average sewage generation per day from 6,70,009 population as forecasted in the year 2065 is 102.912 MLD and Max. discharge 3.57 cumec.
3. For proper functioning of STP various unit should have following dimensions :

- Receiving chamber : 12.3m x 6.13m x 3m +0.5m(FB)
- Grit chamber : 21.42m x 6m x 3m
- Skimming tank : 2.8m x 1.8m x 3.5m +0.5m(FB)
- PST : 60.35m(dia) x 3m(depth) + 0.5m(FB)
- Aeration tank : 67.8m x 11.25m x 4.5m +0.5m(FB)
- SST: 32m(dia) x 3.5m(depth) + 0.5m(FB)
- Stabilization tank : 28.4m x 5m x 4m + 0.5m(FB)

Chapter 16

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