“EFFICIENCY EVALUATION OF SEWAGE TREATMENT PLANTS IN DELHI"

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF DEGREE OF

MASTER OF TECHNOLOGY
IN
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Submitted by:
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CANDIDATE’S DECLARATION

I **TARUN SIHAG,** Roll no. **2K16/ENE/18** of M.TECH ENVIRONMENTAL ENGINEERING, hereby declare that the project Dissertation title “ **Efficiency evaluation of sewage treatment in Delhi”** which is submitted by me to the Department of **Environmental Engineering,** Delhi technological university, Delhi in partial fulfillment of the requirement for the award of the degree of Master of technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of any Degree, Diploma Associate ship, Fellowship or other similar title or recognition.

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<u>CERTIFICATE</u>

This is to certify that the dissertation entitled **"Efficiency evaluation of sewage treatment plants in Delhi "** has been submitted by **TARUN SIHAG (Roll Number: 2K16/ENE/18),** in partial fulfillment of the requirements for the award of Master of Technology degree in Environmental engineering at **DELHI TECHNOLOGICAL UNIVERSITY, DELHI**. This work is carried out by her under my supervision and has not been submitted earlier for the award of any degree or diploma in any university to the best of my knowledge.

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ABSTRACT

Water is one of the integral natural resources that is essential for the existence of life in all forms on the Earth. Extension of Civil Engineering into the specialization of Environmental Engineering has taken place because of the presence of conventional topics like water supply/shortage, releasing of effluents, sewage which also requires an individual's attention on a regular basis, leading to the introduction of how they can be treated. The dire need to conserve the presently available water resources has also led to the initiation of tertiary treatment of wastewater. Urban drainage system is considered as an important means to remove effluents, treat wastewater and polluted discharge, so as to prevent the city from unhygienic conditions that may take a serious toll on public health in the long run. One of the prime domains of urban drainage system is Sewage treatment plants (STP).

In this thesis, we first analyze the wastewater in major STPs present in Delhi. The verification of presence of these STPs is done by Delhi Jal Board (DJB) . We take the data of nearly 17 major treatment plants out of the 29 plants that we took under consideration. From the data acquired by Delhi Pollution Control Committee (DPCC), we calculate the efficiency of individual treatment plants on the basis of physical and chemical parameters, which will help us to determine the overall performance of the plant.

Once we have the performance measures of the STPs, we compare the different technologies used in their working. Few of the technologies on which these STPs are based are Oxidation pond treatment process, Extended Aeration, Physical Chemical Biological removal treatment, Activated sludge process (ASP) etc. which eventually helps us to draw trends and make inferences related to the most underperforming and most suitable STPs.

Our study shows that the best results for STPs under consideration were majorly obtained from extended aeration process and activated sludge process (ASP) in fewer instances

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In this demanding era of resources, we may not realize but we are slowly, steadily and most definitely pacing towards a “water shock” which will soon be understood by its scarcity even in the obvious of places.
Delhi, being the capital of the India has its own niche of diversification, which in its own ways is becoming an explicit factor contributing in the increase of water pollution. In India, water pollution is primarily caused by the mismanagement of urbanization, expanding population and the poorly managed water drainage systems. This leads to unacceptable and insanitary conditions, opening a gateway to bigger health issues.
The waste generated from the human activities is ineluctable and a major part of this waste ends up being wastewater. It is not only important to find a solution to inadequate treatment measures but also rectify the ones that are already present and in a poor working condition.

Understanding the nature and course of wastewater is an essential part in designing an ideal wastewater treatment plant and accordingly selecting efficient treatment technologies. The treatment plant seeks to safely dispose wastewater without bringing probable harm to the public health. The intention of the treatment plant is to meet and limit itself to the discharge standards as mentioned by CPCB.
The main source of inlet of sewage happens to be from the domestic household, where the wastewater can be originated from the kitchen, washroom, urine, laundry etc.

Domestic wastewater is usually greywater, which is wastewater generated from bathrooms, kitchens, laundries, washrooms, etc. It also contains blackwater which consist of excreta, urine, and flush water generated from toilets. Reason for this increase in pollution is urbanization, rapid industrialization, rising living standards and population growth. If sewage wastewater is left untreated it will cause various water borne diseases like cholera, hepatitis, amoebic dysentery, disease related to gall bladder etc. and this leads to 80 % of health problems and is responsible for one third of deaths annually.

The surface water bodies have been polluted to such an extent that they have been converted to natural effluent channels. In order to protect and preserve the limited water bodies, the formulation of appropriate pollution abatement strategies is essential. One of the steps in this direction is, to develop, a methodology finding integrated efficiency of wastewater treatment plant.

Out of the total waste generated from the developing countries a total of about 90 % of untreated wastewater is discharged directly into rivers, lakes and other coastal water bodies. Therefore to tackle with the poor situation which is caused by the directly discharge of sewage water in the environment and health relating issues arriving from it, we developed proper wastewater treatment methods for the treatment of sewage. Hence by selecting proper wastewater method we can reduce the cost of operation and maintenance of sewage plant and also the effluent coming out will meet desired guidelines in physical, chemical and biological quality.

The main wastewater treatment technologies, which are currently in use in India are Activated Sludge Process (ASP) and Oxidation Pond (OP). But form past few years we have also started using other technologies like membrane bioreactor and biological filtration and oxygen reactor, which are more efficient, more economical, also has less area requirement as compared to old conventional process.

Delhi is facing a number of challenges regarding the acceptability, availability and sustainability of water resource. From past few years high increase in the demand of water is seen which cause decrease in the availability of useable clean water for the population of Delhi resulting in less water is available to meet the daily basic needs of Delhi. In developing countries like India only a fraction of sewage is treated in sewage plants, Delhi itself has only 55 % area which is categorized as sewered area. Regulatory agencies, local authorities and governments of developing countries should come forward and need to understand that waste coming from households and other wastewater going into drains should be treated before discharging directly into drains.

There are total 29 STPs in Delhi as listed by Delhi jal board and the first STP in Delhi was constructed in year 1958 having capacity of 40MGD named as keshopur which works on Activated sludge process, during last few decades various STPs are added to the list and latest constructed STP was in year 2014.

The main thing is to evaluate the efficiency or performance of wastewater treatment plants this can be done by removing different parameters in various treatment units in the plant. By checking the level of pollutants in inflow and outflow of a treatment plant its efficiency can easily be calculated. Physical parameter like total suspended solids and chemical like biochemical oxygen demand helps in determining the general efficiency of the plant.

1.2 OBJECTIVES OF STUDY ARE –

- To evaluate the performance of waste water treatment plants (i.e efficiency of STPs) existing in Delhi. The treated wastewater is discharged into the Yamuna which is polluted day by day by anthropogenic activities.

- To find out the low performing or under performing plants and suggesting the suitable measures for those plants

- To study the seasonal variation of efficiency of different STPs

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

A study conducted by Delhi jal board stated the 55% area of Delhi is sewered and 45% area is unsewered which will be sewered by the year 2031. This unsewered wastewater is around 500 MGD which is directly discharged into river Yamuna.

During mid-seventies, urban per capita solid waste generation in India was 250–350 gm/day1, whereas it has increased to 320–530 gm/day in late eighties; total sewage generated in India was about 30 billion litres/day in 1997 and recent figures indicated additional 50-70 % increase.

Also, a bench of Justices Badar Durrez Ahmed and Siddharth Mridul also expressed concern over the fact that more than 500 million gallons per day (MGD) of sewage was being dumped in river Yamuna as only about 400 MGD of the 900 MGD sewage generated by the city reached sewage treatment plants (STPs) which only have a capacity of 604 MGD as per DJB(Delhi jal board).

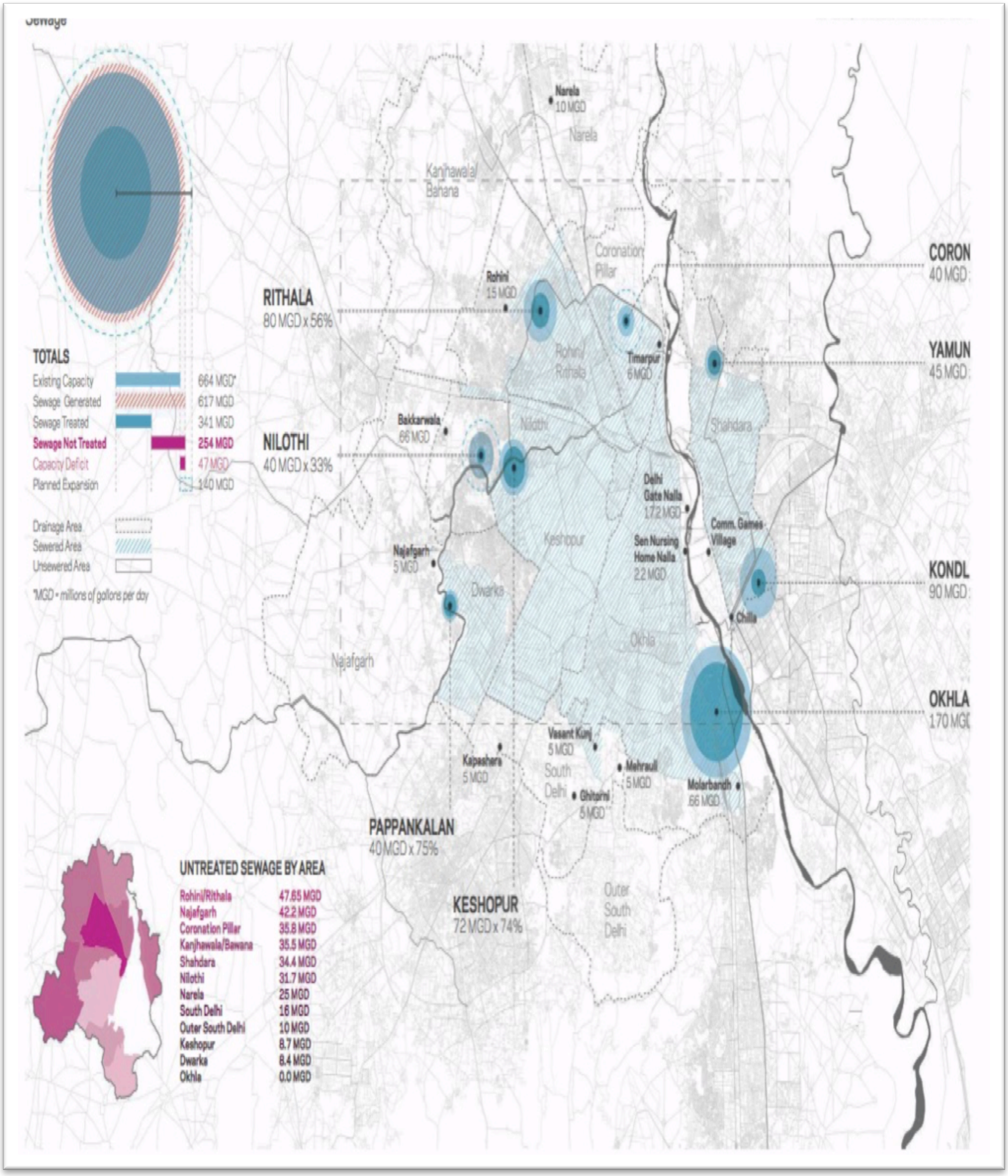
The efficiency of sewage treatment plants can be illustrated by a study on the evaluation of pollutant levels of the influent and the effluent at the treatment plant of sewage treatment plants discharging into the environment Colmenarejo et al. determined the general efficiency indicator to compare overall performances of the different plants in terms of average Total Suspended Solids (TSS), Chemical Oxygen Demand (COD), BOD and ammonia removal efficiencies. The pH directly affects the performance of a secondary treatment process [because the existence of most biological life is dependent upon narrow and critical range of pH. Since, the solids removal is an important measure for the success of a primary treatment unit and the dissolved solids content of the wastewater is of concern as it affects the reuse of wastewater for agricultural purposes Also, BOD removal is indicative of the efficiency of biological treatment processes

River Yamuna, which drains an area of approximately 1483 km^2, is considered a major source of fresh portable water . Of the surface water used to supply water to Delhi, 60% comes from the river Yamuna alone. The river has instigated deterioration in its water quality through the course of time. At Delhi, Yamuna traverse a distance of about 46 Km. Though its stretch between Wazirabad barrage to downstream Okhla barrage is less than 2% of the entire river stretch but it receives around 70% of the total pollution (BOD) load that received by the river causing sever pollution. There are 18 major drains which are responsible for the pollution of river Yamuna. It should be noted that the total installed sewage treatment capacity in Delhi is 2,460 million litres per day (MLD) as against the sewage generation of about 3,800 MLD. Presenting the report to a bench of Justices Swatanter Kumar and S J Mukhopadhaya, CPCB counsel Vijay Panjwani said, "Yamuna is a drain. Fresh water does not flow in the river except during monsoon. The entire flow of fresh water is harnessed at Wazirabad to provide drinking water to residents of Delhi."

Najafgarh drain is the major source of pollution for River Yamuna. Najafgarh drain alone discharges about 2,000 MLD of wastewater into Yamuna. Of this, only 600 MLD (30%) of wastewater is treated through the installed wastewater treatment systems along the Najafgarh drain basin. It clearly indicates that there is huge amount of wastewater (approximately 1,400 MLD) which remains untreated. Further it should be noted that after treatment, the treated sewage from the sewage treatment plants is discharged in the Najafgarh drain. This leads to mixing of the untreated sewage with the treated, thereby defeating the very purpose of wastewater treatment. Due to this fact the stretch of area along the Najafgarh drain has become a concern for environment and health. Therefore most of the STPs are situated along these drains

2.2 LOCATION OF STPS

Fig 2.1 Location of STPs in Delhi



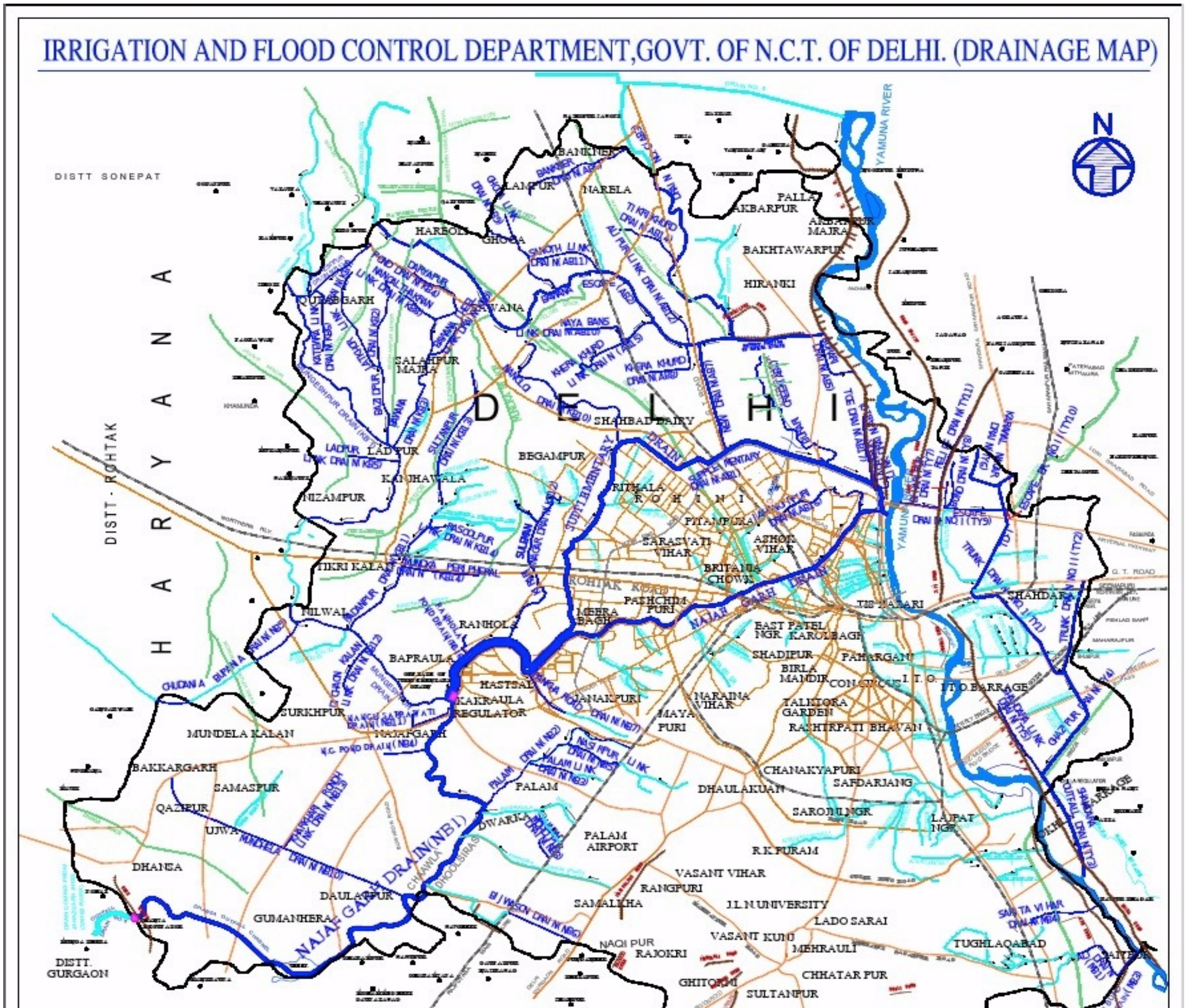
2.3 DRAINAGE SYSTEM OF DELHI

The drainage morphology of Delhi is defined in a large measure by the Aravalli foothills and connected outcrops and, under these influences, a principally easterly storm water movement is indicated from the higher elevations in the West towards Yamuna in the East. In contrast, the region to the east of Yamuna is low-lying and was originally a part of the Yamuna flood plain and, understandably, remained largely un-inhabited until after the partition of 1947. Following large scale migration of people from erstwhile West Pakistan and their re-settlement, this region, also known as the Trans- Yamuna area, is now home to about 30% of the total population of Delhi. Some of the relevant highlights pertaining to the study area are presented in Table 1.

Table 2.1 Details about Delhi

S. No.	Details	Value
1.	Total geographical area of NCT of Delhi	1483 sq km
2.	Last Master plan for storm water drainage prepared in the year	1976
3.	Population of Delhi in the year 1976	60 lacs
4.	Population of Delhi in the year 2011	167 lacs
5.	Projected population as per projection in MPD-2021	250 lacs
6.	Present area urbanized in Delhi	750 sq km
7.	Likely area to be urbanized as per MPD-2021	920 sq km

Figure below shows drainage zone of Delhi as defined by I&FC. Delhi is demarcated into six drainage zones namely (i) North Zone, (ii) West Zone, (iii) Central North West and South East Zone, (iv) Central South and South East Zone, (v) East Zone and (vi) South Zone.



DETAILS OF DRAINS UNDER CONTROL OF I & F.C. DEPARTMENT				
Sl. No.	Name of Drain	Length (in km.)	Catchment Area (in Hect.)	Design Discharge (in Cusecs)
1.	Alipur Block-North Delhi			
	1. Supplementary Drain	34.50	1,26,000	5000
	2. Bawana Escape	19.79	18,231	681
	3. Drain No. 6	14.73	8,807	462
	4. Burari Creek	8.86	1,476	74
	5. Burari Drain	5.79	644	25
	6. Bankner Link Drain	5.50	3,348	118
	7. New Drain	5.40	28,038	1180
	8. Khera Khurd Drain	5.21	1,013	71
	9. Ghoga Link Drain	6.18	1,480	58
	10. Naya Bas Link Drain	3.00	829	32
	11. Sanoth Link Drain	3.00	1,062	41
	12. Alipur Link Drain	0.88	622	31
	13. Jagatpur Link Drain	2.80	250	10
	14. Tikri Khurd Link Drain	1.94	620	11
	15. Khera Kalan Drain (Link)	0.72	440	1.41
	16. Jahangir Puri Outfall	5.47	1619.43	1700
	17. Toe Drain	4.00	150.00	18
2.	Kanjhawala Block-West Delhi			
	1. Mungesh Pur Drain	36.85	47138	1820
	2. Bazidpur Drain	8.05	2202	85
	3. Bawana Drain	11.40	2590	100
	4. Daryapur Pond Drain (Covered Drain)	0.82	259	10
	5. Ladpur Link Drain	2.53	518	20
	6. Katewara Link Drain	1.55	518	8
	7. Jatkhor Link Drain	3.76	453	17.5
	8. Nangal Thakran Link Drain	2.59	155.4	6
	9. Bawana Jheel Link Drain	1.98	155.4	6
	10. Nangloi Drain	8.60	3561	111
	11. Madanpur Drain	8.23	4921	190
	12. Karari SulemanNagarDrain	7.80	2875	168
	13. Sultanpur Drain	9.02	1657.6	60
	14. Rasulpur Link Drain	0.76	129.5	5
	15. Mundka Peripheral Drain	2.50	686.4	104
	16. Ranhola Pond Drain	0.65	259	10
3.	Najafgarh Block-South West Delhi			
	1. Najafgarh Drain	57.40	1093900.00	10000
	2. Palam Drain	8.78	5125.60	3037
	3. Palam Link Drain	1.65	821.00	509
	4. Najaf Garh Pond Drain	1.95	51.80	60
	5. Nasirpur Link Drain	2.90	1038.60	1020
	6. Bijwasan Drain	4.20	2755.80	170
	7. Pankha Road Drain	5.30	818.00	1000
	8. Shahbad Mohammadpur Drain	0.56	2427.00	155
	9. Bhupania Chudania Drain (including Haryana portion)	8.55	370.37	1430
	10. Mudhela Drain	12.50	1554.00	60
	11. Nangli Sakrawati Link Drain	2.34	20.70	24
	12. Dichaon Kalan Link Drain	0.48	12.95	13
	13. Kharkari Rondh Link Drain	1.53	12.95	15
4.	Trans Yamuna Area - North East and East Delhi			
	1. Trunk Drain No.I	13.62	6660.00	3037
	2. Trunk Drain No. II	4.54	2740.00	1766
	3. Shahdara Outfall Drain	5.943	6099.00	5562
	4. Ghazipur Drain	6.241	6741.90	5143
	5. Shahdara Link Drain	4.54	151.70	1159
	6. Karawal Nagar Drain	2.48	12.50	498
	7. Biharipur Drain	1.01	14.56	33
	8. Bund Drain	2.835	170.44	212
	9. Escape Drain No. I	3.00	100.00	283
	10. Escape Drain No. II	0.425	9.06	35
	11. Relief Drain	6.025	500.00	4
5.	Mehrauli Block - South Delhi			
	1. Ali Drain	2.780	3693.00	2500
	2. Asola Drain	2.610	951.05	235
	3. Molar Bund Extension Drain	1.40	48.56	60
	4. Sarita Vihar Drain	1.30	1294.99	2070

ABBREVIATION		
1.	Alipur Block	AB
2.	Kanjhawala Block	KB
3.	Najafgarh Block	NB
4.	Trans Yamuna Area	TY
5.	Mehrauli Block	MB

NOTE -- THIS DRAWING IS INDICATIVE & SHOULD NOT BE USED FOR ANY OTHER PURPOSE

LEGEND	
1.	Drains Under Control Of I & F.C. Department
2.	Drains Under Control Of Other Departments
3.	ROADS
4.	RAILWAYS LINES
5.	INTER STATE BORDER
6.	RIVER COURSE
7.	IRRIGATION CHANNEL
8.	EMBANKMENTS.

Fig 2.2 Drainage map of Delhi

The Sewage network exists in a length of about 6,000 km. consisting of branch sewers/ peripheral sewers and trunk sewers. An action plan to replace the 600km length of peripheral and branch sewers has been prepared by Delhi jal board (DJB) out of which 160km of undersize sewer is already replaced.
Present scenario of Delhi is that around 830 MGD of water for drinking is been supplied by DJB to population of Delhi. Out of that water 80% water is assumed to be generated as sewage water (as per CPHEEO) which is around 680 MGD. At present Delhi has 36 wastewater treatment plants at 21 different locations.

Table 2.2 Capacity of different STPs in Delhi

S.No	Sewage Treatment plants at	Capacity (MGD)
1	Keshopur phase I, II ,III	72 MGD
2	Okhla ph I, II, III, IV, V, VI	170 MGD
3	Kondli ph I, II, III, IV	90 MGD
4	Rithala I, II	80 MGD
5	Yamuna Vihar I, II	20 MGD
6	Vasant kunj I, II	5 MGD
7	Corporation pillar I, II, III	40 MGD
8	Narela	10 MGD
9	Nilothi	40 MGD
10	Najafgarh	5 MGD
11	Pappankalan	20 MGD
12	Dr. Sen Nursing Home Nalla	2.2 MGD
13	Delhi Gate Nalla	2.2 MGD
14	Mehrauli	5 MGD
15	Rohini	15 MGD
16	Ghitorni	5 MGD
17	Kapashera	5 MGD
18	Commonwealth Games villages	1 MGD
19	Bakkarwala	0.66 MGD
20	Akshardham	1 MGD
21	Timarpur Oxidation pond	6 MGD
	Total	604.72

2.4 INSTITUTIONAL JURISDICTIONS

With regard to the management of the storm water drainage system within NCT of Delhi, there is, conspicuously, no single institution that bears an overall responsibility of the total system. To the contrary, the administrative authority of the capital's drainage system is quixotically distributed amongst numerous civic bodies and various constituent departments of Government of NCT of Delhi as well as Government of India. These include (i) Irrigation & Flood Control, Delhi, (ii) Delhi Jal Board, (iii) various Municipal Corporations of Delhi, (iv) Urban Development, Delhi, (v) Ministry of Urban Development, GoI, (vi) New Delhi Municipal Council, (vii) Delhi Development Authority, (viii) Delhi Cantonment Board, (ix) Delhi State Industrial Development Corporation, and (x) Public Works Department, Delhi. Other departments of the Government and civic bodies whose jurisdiction does not entail any direct responsibility pertaining to the state of the capital's drainage system but nevertheless effectiveness is indeed a matter of interest includes (i) Irrigation & Flood Control, Government of Haryana, (ii) Traffic Police, Delhi, (iii) Geo Spatial Delhi Ltd., (iv) Central Water Commission, GoI, (v) Indian Meteorological Department, (vi) Various Resident Welfare Associations (RWAs), (vii) Central Pollution Control Board of Ministry of Environment and Forests, GoI, (viii) National Green Tribunal, (ix) National Highway Authority of India, (x) DIAL and (xi) Civil society activist groups.

CHAPTER 3

TECHNOLOGIES USED FOR THE TREATMENT OF SEWAGE

3.1 UNIT OPERATION AND UNIT PROCESS IN SEWAGE TREATMENT SYSTEM-

After reviewing the objectives of treatment and applicable regulations a particular degree of treatment can be selected after comparing the characteristics of influent sewage with the effluent wastewater sewage.

Various physical, chemical and biological methods are adopted to remove contaminants from the wastewater. These methods are classified as physical unit operations, chemical unit processes, and biological unit processes. These processes have same working principle and a variety of combinations is available in treatment system and it is beneficial to study their scientific basis separately.

3.1.1 Physical Unit Operations

It involves contaminant removal by physical forces. The major treatment methods falling under this category are screening, mixing, coagulation flocculation, sedimentation, grit chamber, filtration etc.

3.1.2 Chemical Unit Processes

Treatment methods in which chemical reactions or addition of chemicals are used for the conversion or removal of contaminants from the wastewater is called chemical unit process. The most examples used in wastewater treatment are adsorption and precipitation. In chemical precipitation a settleable chemical precipitate is produced which help in completing the treatment. This settled precipitate will contain both the constituents that were removed out of water as settled precipitate and the constituents which may have reacted with the externally added chemicals, this happen in most of the cases.

Adsorption works on the principle of force of attraction between bodies that is compounds get adsorbed on the surface of solids which helps in removal of desired compound from the wastewater.

3.1.3 Biological Unit Processes

In this process biological forces are used for the removal of contaminants from the wastewater. Biological treatment units are used for the removal of biodegradable organic matter present in wastewater. The working process involved in these units is that organic matter present is converted into gases which can easily escape into atmosphere and can be easily removed by settling in biological cell tissue. Nutrients like phosphorous and nitrogen can easily be removed from wastewater in these units.

3.2 CLASSIFICATION OF SEWAGE TREATMENT UNITS IS AS FOLLOWS-

1. Preliminary treatment
2. Primary treatment
3. Biological or secondary treatment
4. Final or tertiary treatment

3.2.1 Preliminary Wastewater Treatment

Preliminary treatment is used for removal of floating bodies like dead animals, plants, papers, trees, wood etc. and also for the removal of heavy settlebale inorganic solids. This method is also helpful in removal of oil and grease from the wastewater. Preliminary treatment also satisfies 15 to 30% BOD of the wastewater.

Units involved in this treatment are –

- Screening – helps in removal of animal dead, wood, papers, leaves, plastic etc.
- Detritus tanks or grit chambers – helps in removal of sand from the system
- Skimming tanks – helps in the removal of oil and grease

3.2.2 Primary wastewater treatment

Only a part of organic matter and suspended solids is removed from the wastewater in primary treatment. Physical operations like sedimentation occurring in settling basin helps in removal of suspended solids and organic matter. The effluent coming out from the primary treatment is rich in suspended organic compounds and also has a high value of BOD which is about 60% of the original value. Sedimentation tank separates the organic solids from the wastewater which can be decomposed or stabilized in digestion tank or in incinerators anaerobically. The residue from these tanks are used as a soil conditioner or can be used as a landfill.

Biochemical oxygen demand (BOD)-

BOD is defined as the amount of oxygen required for the decomposition or oxidization of biodegradable organic matter. Oxygen demand of wastewater is exerted by these types of material –

1. carbonaceous organic materials.
2. Oxidisable nitrogen derived from nitrite, ammonia, and other organic nitrogen compounds which serves as food for specific bacteria (nitrosomous and nitrobacter)
3. Chemical reducing compounds , example- sulfides ,sulfites, which are oxidized by dissolved oxygen.

For domestic sewage, carbonaceous organic material is responsible for all oxygen demand and its value is determined by BOD test. The useful aerobic bacteria will work properly if the amount of oxygen present is sufficient for their working and will cause biological decomposition of wastewater and this process keep on going till all the biodegradable matter is aerobically decomposed. The amount of oxygen consumed in this aerobic process is called BOD.

Standard value of BOD is taken at 20 C during period of 5 days and its value is about 68% of ultimate demand

BOD is calculated as-

BOD = (D.O. consumed in the test by the diluted sample) X (volume of diluted sample/ volume of raw or undiluted sample)

Chemical oxygen demand (COD)-

COD test used to measure the amount of organic matter in wastewater, both biodegradable and non-biodegradable.

A strong oxidizing agent is used in an acidic medium (here potassium dichromate is used as a strong oxidizing agent) which helps in measuring the oxidized oxygen equivalent of organic matter. This test is also called dichromate oxygen demand test.

3.2.3 Secondary Wastewater Treatment

Effluent from primary sedimentation tank is further treated in secondary treatment tanks which aims for the removal of suspended solids and biodegradable organic matter through the process of decomposition of organic matter which can occur either in anaerobic or aerobic condition. A clearer effluent is produced in these biological units by bacteria which help in decomposition of fine organic matter present in it.

Aerobic biological units are the treatment reactors in which aerobic bacteria helps in decomposition or oxidization of organic matter present in sewage. It may consist of-

- Filters which include periodical sand filters as well as trickling filters,
- Aeration tanks, in which activated recycled sludge is fed into (i.e. the sludge settling in secondary sedimentation tank, receiving effluents from the aeration tank),
- Aerated lagoons and oxidation ponds. These aerobic units are classified as secondary units because they make use of primary settled sludge. And anaerobic biological units are the treatment reactors in which decomposition and stabilization of organic matter occur by anaerobic bacteria. These units may consist of-

  - Anaerobic lagoons
  - Imhoff tanks
  - Septic tanks, etc

  Imhoff and septic tanks are not classified as secondary units because they make use of raw sewage while anaerobic lagoons are classified as secondary biological treatment units as they uses primary settled sludge.

  The value of BOD in effluent coming from secondary treatment is usually very less which is about 5-10% of the original value of BOD and it may also contain few milligrams per litre of dissolved oxygen (DO). In sludge digestion tank the organic sludge which is obtained from primary and secondary treatment is disposed off by stabilizing it under anaerobic conditions.

3.3 TECHNOLOGY USED IN VARIOUS SEWAGE TREATMENT PLANT IN DELHI

Various technologies are available for the treatment of sewage which are Activated sludge process (ASP), Rotating biological contractor, Trickling filter, Extended aeration, Membrane bioreactor, Oxidation pond, Biological Filtration and Oxygenated Reactor (BIOFOR), Upflow anaerobic sludge blanket reactor (UASB), Imhoff tank etc.

Out of these technologies only few are used in sewage treatment in Delhi which are – Activated sludge process (ASP), Extended aeration, Trickling filter, Membrane bioreactor, Biological filtration and oxygenated reactor, sequencing batch reactor (SBR).

Table 3.1 Different technologies used for various STPs in Delhi

Sl. No	City/town	Commissioned in (Year)	Status	Technology
1	Akshardham	2014	Operational	MBR
2	Kondli	1987	Operational	ASP
3	Papankalla	2000	Operational	ASP
4	Nazafgarh	2002	Operational	Extended aeration
5	Yamuna Vihar	1999	Operational	ASP
6	Rithala	1989	Operational	ASP
7	Rohini	2002	Operational	ASP
8	Okhla	1937	Operational	ASP
9	Keshopur	1958	Operational	ASP
10	Coronation	1957	Operational	Trickling Filtration
11	Narela	2001	Operational	ASP
12	Vasant Kunj	1982	Operational	Extended aeration
13	Dr. Sen Nursing Home Nalla	1998	Operational	BIOFOR
14	Delhi Gate Nalla	1998	Operational	BIOFOR
15	Mehrauli	2003	Operational	ASP
16	Ghitorni	2014	Non Operational	ASP
17	Timarpur	2014	Operational	OP
18	Chilla	2014	Operational	SBR

3.3.1 TRICKLING FILTER

It works as a aerobic attached growth system. As the wastewater trickles through the filter medium, biomass grows over the medium particle normally within 2-3 weeks making filter ready for operation.
During the operation, micro organisms present in the biomass layer comes in contact with organic matter present in wastewater leading to their stabalisation (i.e decomposition) which further results in the formation of biomass attach to medium particles.

Over the period of time as the thickness of this layer increases, penetration of food and oxygen is limited only in upper layers of the slime which results in the endogenous respiration at the bottom layers of this slime, that weakens the bond between slime and medium particles which is further sheared off from the medium particles due to the turbulence created by the continuous flow of wastewater through the filter medium. This process of removal of slime over the medium particle is termed as sloughing.

The sloughed off biomass is then further taken to SST for its removal where it settles and leads to the formation of biological sludge.

These filters are generally constructed above the ground with honey comb walls in order to ensure the availability of oxygen throughout the filter medium.

Distribution of the wastewater over the filter medium can be done by any of these methods-

a. Rotatory distribution method
b. Spray nozzle method

Distribution is more uniform in the case of rotatory distribution unlike spray nozzle method where it is intermittent.

Due to intermittent distribution of wastewater over filter medium, it does not remain fresh all the time due to which odour problem persists in this case.

Tricking filter is further of two types -

a. Standard rate tricking filter (SRTF)
b. High rate tricking filter (HRTF)

Design data for trickling filter is as follows-

a. Hydraulic loading rate (m^3/m^2/day) –
    - SRTF - 1 to4
    - HRTF - 10 to 40 (including recirculation)
    - Super HRTF - 40 to 200 (including recirculation)

b. Organic loading rate (kg/m^3/day)-
    - SRTF - 0.08 to 0.32
    - HRTF - 0.32 to 1.0 (excluding recirculation)
    - Super HRTF - 0.6 to 0.8 (excluding recirculation)

c. Depth in meter-
    - SRTF - 0.8 to 2.5 m
    - HRTF - 0.9 to 3.0 m

- Super HRTF – 4.5 to 12 m

d. Recirculation ratio
   - SRTF - 0
   - HRTF - 0.5 to 3
   - Super HRTF – 1 to 4

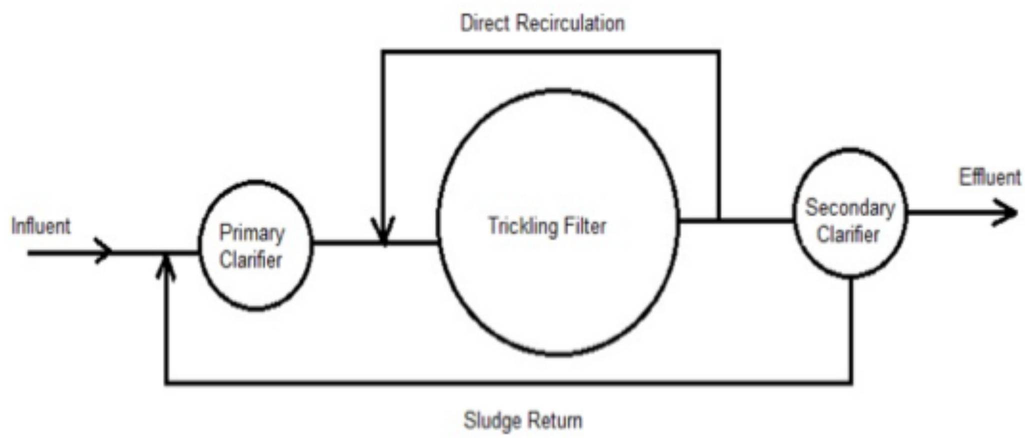


Fig 3.1 Single stage trickling filter

3.3.2 ROTATING BIOLOGICAL CONTRACTORS

This works as the aerobic attached growth system. In this case closely spaced rotating disc are used as a medium for the growth of biomass layer.

Unlike trickling filter in which wastewater passes through the biomass layer, it is the biomass layer in this case which passes through the wastewater.

These disc are kept immersed in the wastewater upto 40% of their size and are exposed alternatively to the atmosphere and wastewater.

Micro organisms present in biomass layer comes in contact with organic matter when disc are immersed in wastewater and utilizes the oxygen from the atmosphere for its decomposition.
Biomass formed during the decomposition again gets attached over the rotating disc as a result of which its thickness increases over the period of time. A stage comes during the operation when the biomass layer is sheared off from the rotating disc due to the turbulence created by the movement of the disc through the wastewater.
This sheared off biomass is then taken to SST for its removal where it leads to the formation of biological sludge.

This method offers high degree of treatment including the decomposition of organic matter upto the nitrate level. In real term rotating biological contractors take the advantage of both attached and suspended growth system.

These disc are rotated at about 3-6 rpm. An increase in speed of rotation of disc causes increase in DO in the tank but minimum DO should be around 1-2 mg/l. The largest rotating disc system in situated in orlando, US having capacity of 93000 m^3/day is designed for the removal of BOD, nitrogen and phosphorous.

Power requirement for mechanically operated disc units of smaller sizes have been reported to vary widely from 6 to 12 kWh/person year for about 80 per cent efficiency and upwards of 16 kWh/ person year for higher efficiencies coupled for nitrification.

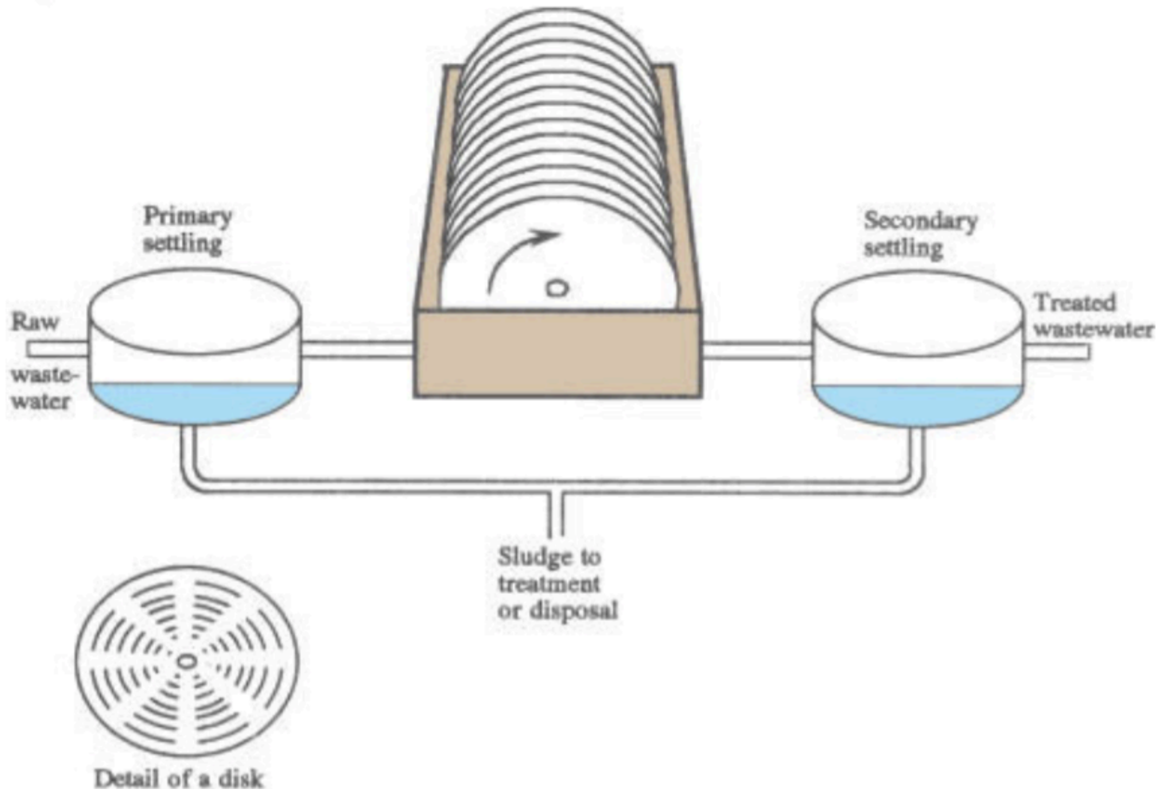


Fig 3.2 Rotating biological reactor

3.3.3 ACTIVATED SLUDGE PROCESS (ASP)

Sludge generated from secondary sedimentation tank mostly consists of living or active micro organism which is re-circulated back into the system to carry out the decomposition of organic matter. Hence the process is named as activated sludge process.

It can also be defined as-it is a sewage treatment process a biological soup is developed by the smashing the solids present in raw or unsettled sewage. This smashing is done by blowing the air or oxygen into raw sewage. This soup helps in digestion of pollutants and organic contents present in the sewage.
The term “activated” in ASP means that the particles are combining with the useful sewage digesting protozoa and bacteria, which eases the process of digestion.

ASP based plants do not have primary settlement tank, which needs emptying by tanker on a regular basis with most three stage sewage.

ASP is a suspended growth system in which flow pattern may be any of the following-

i. Complete mix
ii. Plug flow

i. Complete mix-

This process is used for the small plants of capacity less than 25MLD.
In this process complete mixing of the incoming activated sludge with wastewater is done mechanically in order to increase the opportunity of contact between organic matter and micro organisms that in turn increases the rate of removal of organic matter.
Square or circular tanks fitted with mechanical aerators are used in this case.
Operational stability of this system w.r.t shock loading is comparatively more as complete homogeneous environment is created by mixing.

F/M ration and oxygen demand remains constant throughout the tank in this case.
As F/M ratio increases that means F increases and M decreases which leads to decrease in efficiency.
As F/M ratio decreases that means more M and less F that in increase in efficiency.

ii. Plug flow

It is a conventional process which is used for the plants of capacity greater than 300 MLD.

Plug flow implies that wastewater moves progressively along the length of the tank remaining essentially unmixed throughout the volume of the tank.
In this case long aeration channels are used in which activated sludge and wastewater is fed at the inlet and the treated wastewater is collected from the outlet.
Operational stability of the system w.r.t shock loading is comparatively less as there is no provision of mixing in this case.

F/M ratio and oxygen demand reduces along the length.

Parameters which are included in the design of ASP are- hydraulic retention time, organic loading rate, specific food or substrate utilization rate, sludge age, F/M ratio and sludge volume index (SVI).

Hydraulic retention rate- is defined as the ratio of volume of the aeration tank to the rate of flow of wastewater into the system.

Organic loading rate- is defined as the ratio of flow of organic matter into the system to the volume of the aeration tank.

Specific food- is defined as the ratio of the amount of BOD removal in the system to the mass of biomass (i.e volume X biomass) in the aeration tank.

Sludge age- it represents the time for which biomass remains in the system. It is defined as the ratio of mass of biomass in the aeration tank to the mass of biomass leaving the system per day.
Sludge age controls the tendency of nitrification in ASP hence if nitrification is to be avoided than sludge age is reduced by increasing the wasted sludge discharge.

F/M ratio- is defined as the amount of organic matter entering into the system to the biomass in the aeration tank.

Sludge volume index (SVI)- it represents the concentration of the sludge in the system that decides the rate of return of sludge which is required to maintain desired MLSS concentration in the aeration taken corresponding to a particular F/M ratio to achieve the design degree of treatment.

SVI is also defined as the volume occupied in milli-litre by 1 gram of solids in the mixed liquor when allowed to settle for 30min.

Design data for ASP –

1. For conventional process-
    - Flow regime – plug flow
    - MLSS (mg/l) – 1500 to 3000
    - F/M (day^{-1}) – 0.3 to 0.4
    - HRT (hours) – 4 to 6
    - Sludge age (days) – 5 to 8
    - Recirculation ratio – 0.25 to 0.50
    - Efficiency – 85 to 92 %
    - Volume of O_2 required / Volume of BOD $_{removal}$ - 0.8 to 1.0
2. For complete mix process –
    - Flow regime – Complete mix
    - MLSS (mg/l) –3000 to 4000
    - F/M (day^{-1}) – 0.3 to 0.5

- HRT (hours) – 4 to 5
- Sludge age (days) – 5 to 8
- Recirculation ratio – 0.25 to 0.80
- Efficiency – 85 to 92 %
- Volume of O_2 required / Volume of BOD $_{removal}$ - 0.8 to 1.0

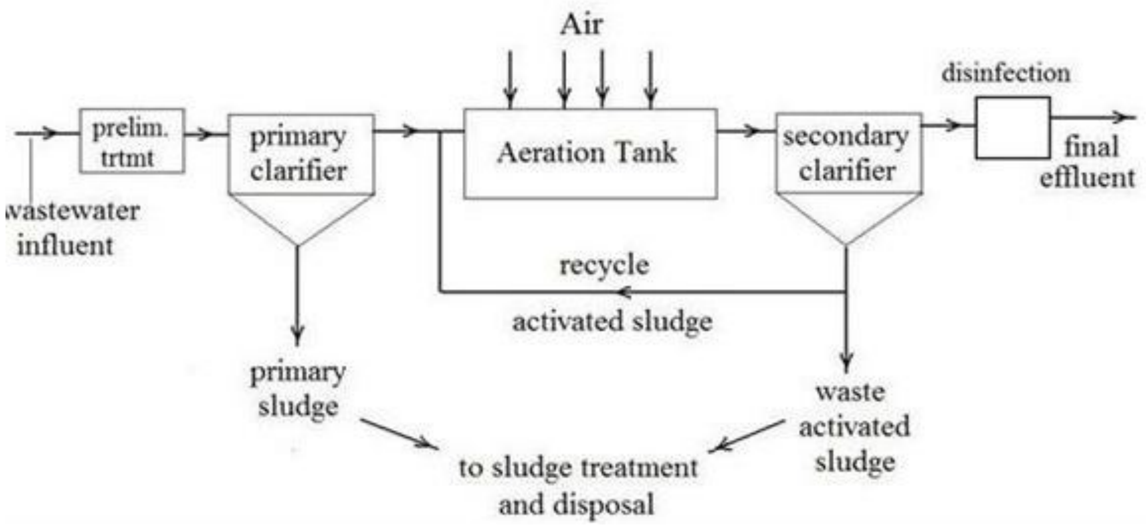


Fig 3.3 Flow chart of ASP

3.3.4 EXTENDED AERATION

Extended aeration process is the hybrid process of both plug flow and complete mix. Flow regime in extended aeration is essentially completely mixed.
Primary sedimentation tank is avoided in this case and it utilizes the long aeration channels, low organic loading rate, high MLSS concentration, which results in low F/M ratio thereby, provides high degree of treatment.

Unlike the normal ASP process which is maintained in log phase, extended aeration is maintained in endogenous phase as a result of which concentration of dead cell mass increases in the sludge formed which avoids the requirement of further treatment of sludge.

Extended aeration is an aerobic process. In extended aeration, aeration tank directly receives the raw sewage for its treatment. As from the name it can easily be decoded that this process has longer aeration time. The efficiency of extended aeration to remove BOD is much higher than that of activated sludge, which makes it especially desirable to use where it is to be followed by tertiary treatment for reuse.

Design data for extended aeration process-

- Flow regime – complete mix
- MLSS (mg/l) – 3000 to 5000
- F/M (day^{-1}) – 0.1 to 0.18
- HRT (hours) – 12 to 24
- Sludge age (days) – 10 to 15
- Recirculation ratio – 0.8 to 1.0
- Efficiency – 95 to 98 %
- Volume of O_2 required / Volume of $BOD_{removal}$ - 1.0 to 1.2

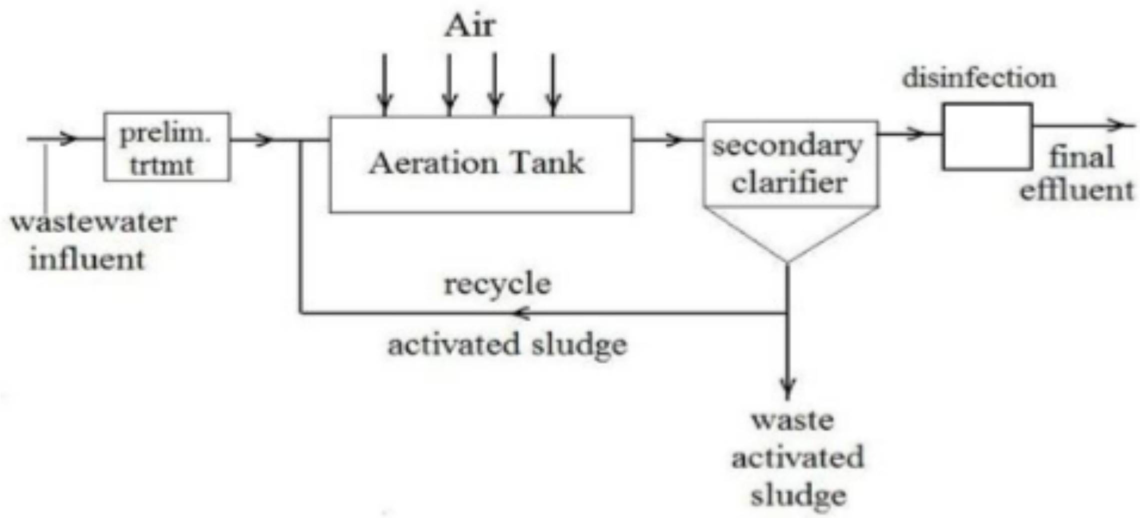


Fig 3.4 Flow diagram of extended aeration

3.3.5 UPFLOW ANAEROBIC SLUDGE BLANKET REACTOR (UASB)-

It is an anaerobic process. In this process wastewater is passed through layer of activated sludge in vertically upward direction as a result of which organic matter present in the wastewater get stabilized by the action of micro organisms present in activated sludge. As no mixing is done during the treatment, three phase separation of the constituents take place in it. This method is suitable for both treatment of soluble wastewater and wastewater having particulate matter.

These are the units in which sludge granules themselves and act as a media and stay in suspension form. Hence no special media have to be used. UASB system is not yet patented by anyone.

The worlds first full scale UASB was built in Kanpur in 1989.

Units involved in a typical UASB type wastewater treatment plant are-

1. Pumping
2. Screening
3. UASB reactor
4. Gas conversion or collection or conveyance
5. Sludge drying bed
6. Post treatment

Design data for UASB-

UASBs are considered where temperature in the reactors will be above 20^0c. between 20 to 26 a solid retention time of around 30 to 38 days in India gives a stabalised sludge for disposal on open sand beds.

- Configuration in plan – rectangular or circular
- Depth – 4.5 to 5 m for sewage
- Sludge blanket depth – 2 to 2.5 m for sewage.
- Solid retention time – 30 to 50 days or more
- Hydraulic retention time – 8 to 10 hours at average flow
- BOD/COD removal efficiency – 75 to 85 % for BOD, 74 to 78 % for COD
- Sludge production – 0.15 to 0.25 kg TS per m^3 sewage treated.
- Nutrients removal - only 5 to 10%

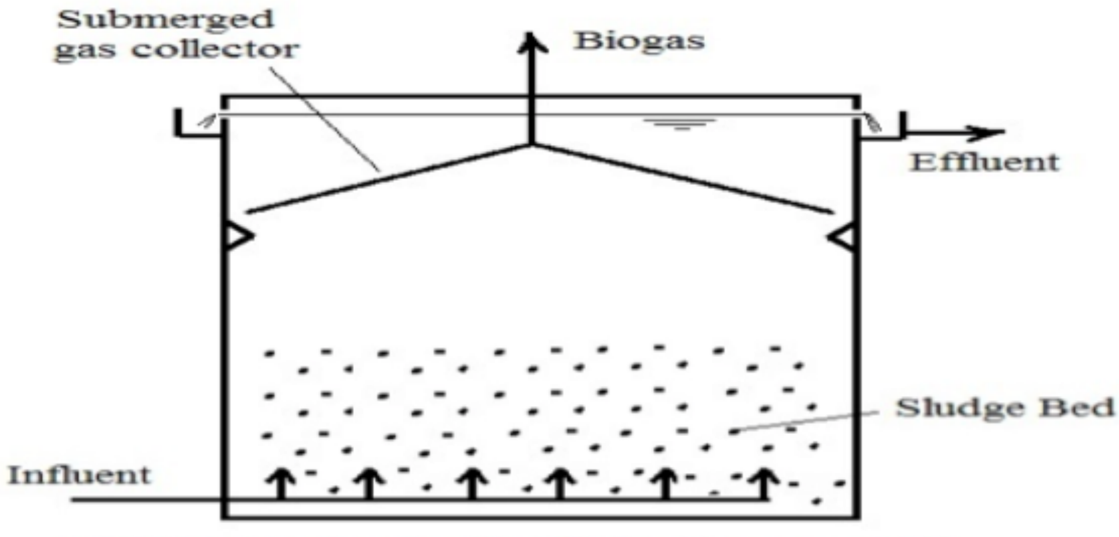


Fig 3.5 Upflow anaerobic sludge blanket reactor

3.3.6 BIOLOGICAL FILTRATION AND OXYGENATED REACTOR (BIOFOR)

Biological aerated filtration technique has been developed to provide small compact plants and to give better treatment reliability and efficiency. Degremont has patent for BIOFOR technology which includes intensified aerobic treatment with BIOFOR and dense-Deg. BIOFOR is a new technology as compared to other technologies like ASP, SBR, extended aeration etc., still it has been installed over 100 locations across the world and the installing capacity ranging from 0.1 to 110MGD, which shows its increased usability over a very short span of time . The first BIOFOR municipal wastewater plant was installed in the year 1997 having capacity of 1.7MGD at woodstream-Evesham wastewater plant in Marlton, New jersey.

This technology can be applied for nitrification and denitrification and also for the removal of aerobic carbonaceous BOD5. Solids retention and Biological degradation of biodegradable soluble matter i.e aerated biological filtration both combines in a single step by mechanical filtration of suspended solids. In up flow filters which are loaded with suitably sized granular particles which supports the media helps in achieving the biological filtration which ultimately gives rises to an efficient filtration effect. This filter media provides proper support for mechanical filtration capability and for biomass attachment.

The processes which works with air and water concurrently are advantageous and more superior to process which works on counter current with regard to the nitrification capacity. The biological filtration process is three phase process which are-

a. Solid phase – filter material with attached biomass

b. Gas phase – sufficient oxygen to carry oxidation process or the gaseous nitrogen at the time of denitrification
c. Liquid phase – wastewater passing through the filter material

Details about BIOFOR media –

That filter material is selected which possibly has a high attached biomass concentration and can retain high amount of solids. BIOLITE filter material having rough and porous surface are mostly used in BIOFOR for the treatment of waste. BIOLITE is manufactured from natural silicate at very high temperatures. Its stable chemical concentration accord with the primitive living environment where microorganisms live in. this space structure is the best for the growth and colonization of microorganisms. This multi porous structure provides us more area as compared to other bio- media which is around 6 to 8 times more than other. This highly penetrative porous structure enables the anaerobic bacteria's denitrification process and aerobic bacteris's nitrification process. A schematic diagram of BIOFOR tank and a picture showing BIOLITE is shown below-

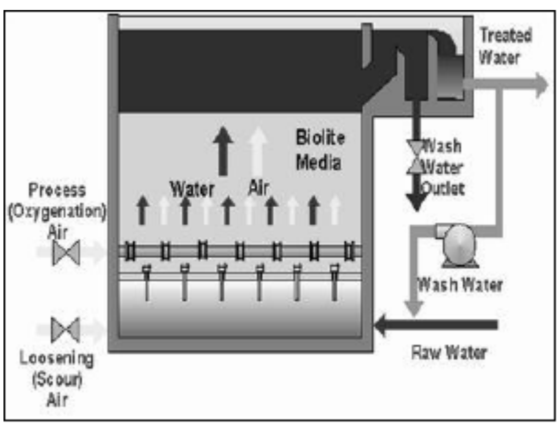


Fig 3.6 Schematic Diagram of BIOFOR and BIOLITE

Advantages of BIOFOR are- it easily adapts to variable pollution loads and flows, expansion of plant is easy in future as modular construction is used in it and the elimination of secondary clarifier helps in reducing the costs related to it and the operation problems related to it.

Disadvantages related to BIOFOR are- high energy is required in it, high and continuous dosing of chemicals in primary clarification tank and the sludge coming from primary clarification is undigested sludge which require post treatment.

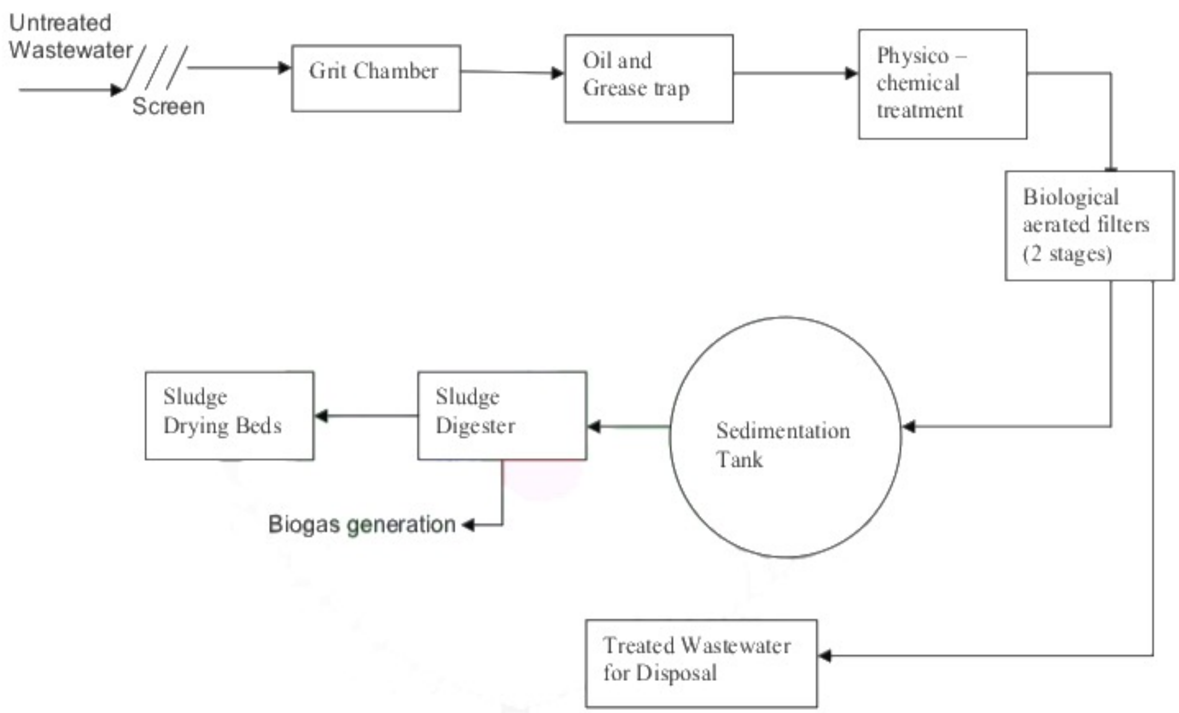


Fig 3.7 Flow diagram of BIOFOR technology

3.3.7 OTHER AEROBIC TREATMENT UNITS

1. Stabilization ponds:

   The stabilization ponds are specially designed and constructed for the treatment of sewage and biodegradable industrial waste. These are basically open flow through basins which provide long detention periods extending from a few days to several days.

2. Aerated lagoons:

   Aerated lagoons are ponds in which mechanical method are used for aeration instead of algal photosynthesis.

3. Oxidation ditch:

   It consists of a long continuous channel having oval shape consisting of two surface rotors, which are placed across the channel. It is a modified form of extended aeration of activated sludge process.

Oxidation pond/ symbiotic pond/ lagoons these above mentioned aerobic units works as aerobic suspended growth system. Oxidation pond is an open flow through an earthen channel which provides comparatively long retention time of 2 to 6 weeks during which organic matter present in the waste water gets stabalised by the action of micro organisms.

In these tanks special type of relationship exist between algae and aerobic micro organisms in which algae produces oxygen during the photosynthesis that is utilized by aerobic micro organisms to carry out the decomposition of organic matter resulting in the formation of biomass, which is further utilized by algae as a nutrient. Such mutual relationship is termed as symbiotic relationship.

This type of relationship also exist between aerobic and anaerobic micro organisms in which gases formed during anaerobic decomposition rises to the surface to get utilized as the source of energy by aerobic micro organisms and biomass formed during aerobic decomposition settles to get utilized as nutrient by anaerobic micro organisms.

Organic loading rate depends upon the temperature of the location of the pond, which in turn depends on the latitude of that location.

BOD removal efficiency of the pond is approximately 95%. Pathogenic removal efficiency is approximately 98-99%.

Effluents of oxidation pond are sufficiently clarified hence are now wasted by disposing it into the river but instead are reused as manure in sewage farming.

Oxidation pond is generally provide in small villages and communities having no source of electricity. Overdosing of the pond may result in odour problem, which is avoided by adding sodium nitrate that acts as both oxidizing agent and nutrient for the algae. Effluents of oxidation pond are generally reused as manure in sewage farming.

Design data for oxidation pond is as follows –

- Depth of the pond – 1 to 1.8m
- Detention time – 2 to 6 weeks
- Length to width ratio – 2
- Area of each unit should be in the range of – 0.5 to 1 hectare
- Organic loading rate depends on the temperature of the location of the pond which in turn depends on the latitude of that location

3.3.8 SEPTIC TANK

It works as anaerobic suspended growth system. It is similar to that of sedimentation tank with the only difference that detention time in this case is comparatively more and it is around 12 to 36 hours.

Raw sewage is directly fed into the tank and is kept for sufficient duration during which suspended organic matter get settled down and result in the formation of sludge that is further being acted upon by anaerobic micro organisms over the period of 6 to 12 months.

Additional volume is provided at the bottom of this tank for the accumulation of sludge. Gases formed during the digestion are collected from the top and are further reutilized for their fuel value.

Oil and grease present in sewage rises to the surface and leads to the formation of scum layer, which acts as a thermal insulator and avoid the escape of odourous gases out from the system.

Effluents of septic tank are disposed over land either in soak pits or in dispersion trenches. Permeability of soak pits and dispersion trench should be sufficient to allow the easy percolation of the effluent into the ground.

Percolation rate is defined as the time required in minutes by the sewage effluent to seep into ground by the distance of 1cm.

Soak pit is used when percolation rate is less than 30 minutes whereas dispersion trench is used if percolation rate is in the range of 30 to 60 min.

Design parameters –

- Rate of flow of sewage is taken in the range of – 40 to 70 l/c/day
- If sludge is also considered it is taken in the range of – 90 to 150 l/c/day
- Rate of accumulation of sludge is – 30 to 70 l/c/year
- Detention time – 12 to 36 hours
- Cleaning period – 6 to 12 months
- Depth – 1 to 1.8m
- Length to width ratio – 2 to 3
- Width should not be less than 0.9m

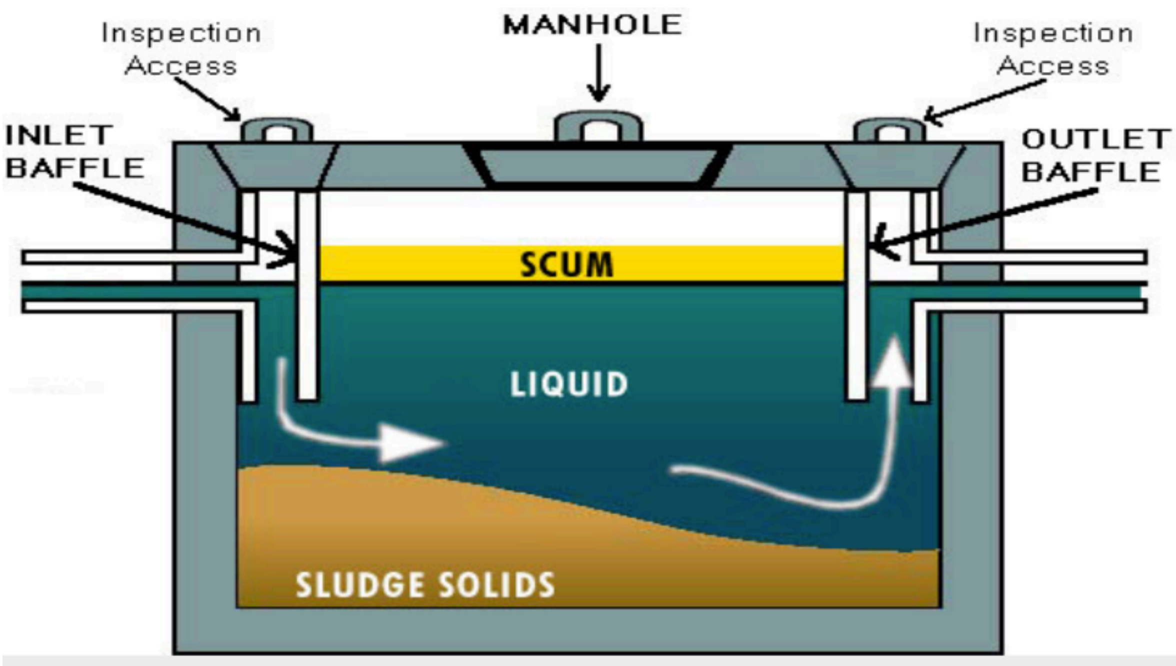


Fig 3.8 Diagram of septic tank

3.3.9 IMHOFF TANK

Imhoff tank works as anaerobic suspended growth system.

It is a modification over septic tank in which incoming sewage is not allowed to get mixed with sludge produced and the outgoing effluent is not allowed to carry undigested sludge solids along with it.

It is a two storied tank in which sedimentation is carried out in upper sedimentation chamber and the digestion is carried out in lower digestion chamber.

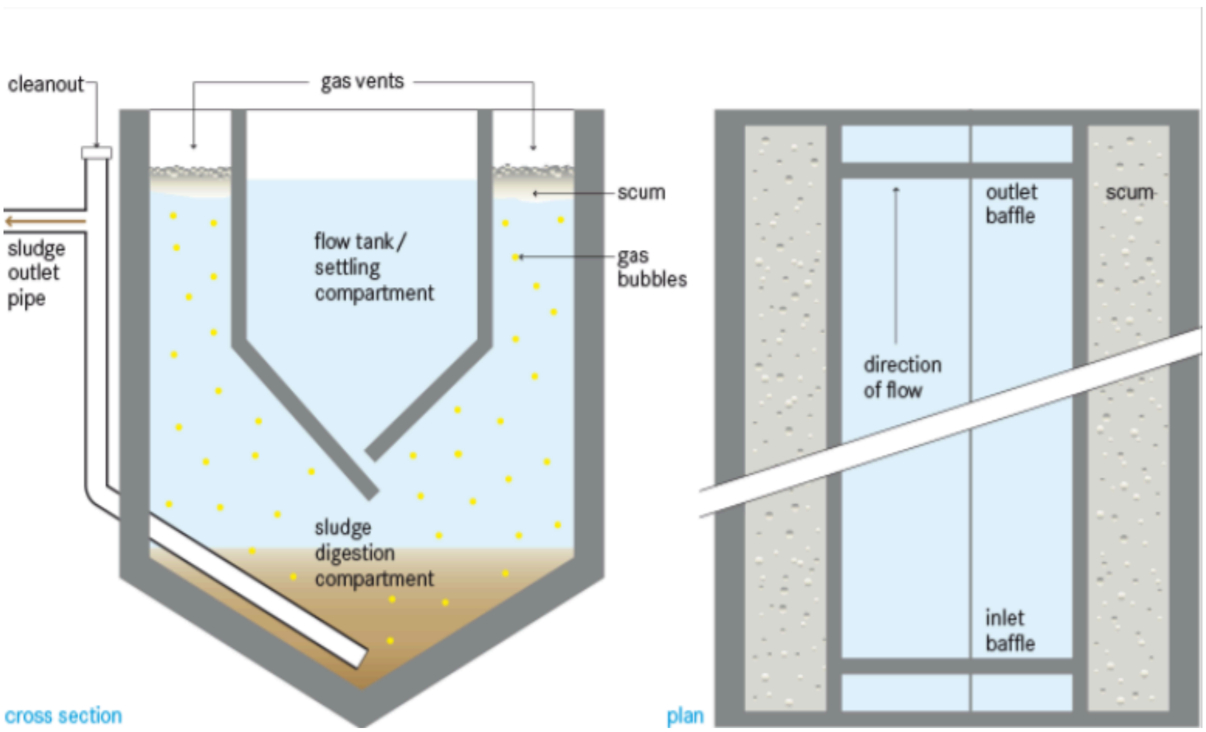


Fig 3.9 Imhoff tank

3.3.10 MEMBRANE BIOREACTOR (MBR)

The membrane bioreactor (MBR) is as an efficient compact technology for the treatment of industrial and municipal wastewater. People has started opting for the membrane reactor technology as compared to activated sludge sludge process, which was the conventional technology for the treatment of wastewater over the last century. This technology overcomes the drawback of activated sludge process which are issues related to separation of liquid- solid, large area requirement for secondary tanks, formation of excess sludge.
This technology is the hybrid combination of conventional biological treatment system and physical separation of liquid-solid with the help of membrane filters.

Advantages of using membrane bioreactor over ASP are-

- Shorter hydraulic retention time,
- High quality of effluents,
- Long retention time for solids,
- High volumetric loading rates,
- Less amount of sludge, and
- Potential for simulation for nitrification in long solid retention times.
- Therefore elimination of secondary clarifier is the reason for the reduction in the area of treatment plant.

Disadvantages of using MBR technology are-

- Higher energy costs,
- Periodic replacement of membranes is an expensive process, and the need to control membrane fouling problem.
- Each vendor gives his own designed criteria for membranes which makes it difficult to have a common design criteria.
- Therefore, IITs, NEERI or CPCB should perform detailed evaluation these plants

This membrane fouling reduces the lifespan and performance of membranes which causes increase in operating and maintenance costs. Membrane fouling feature to colloids, sludge flocs, suspended particles and solutes. These mentioned particles deposit on the surface of membrane and some into the pores of membrane which ultimately leads to the reduction of permeability of the membrane.

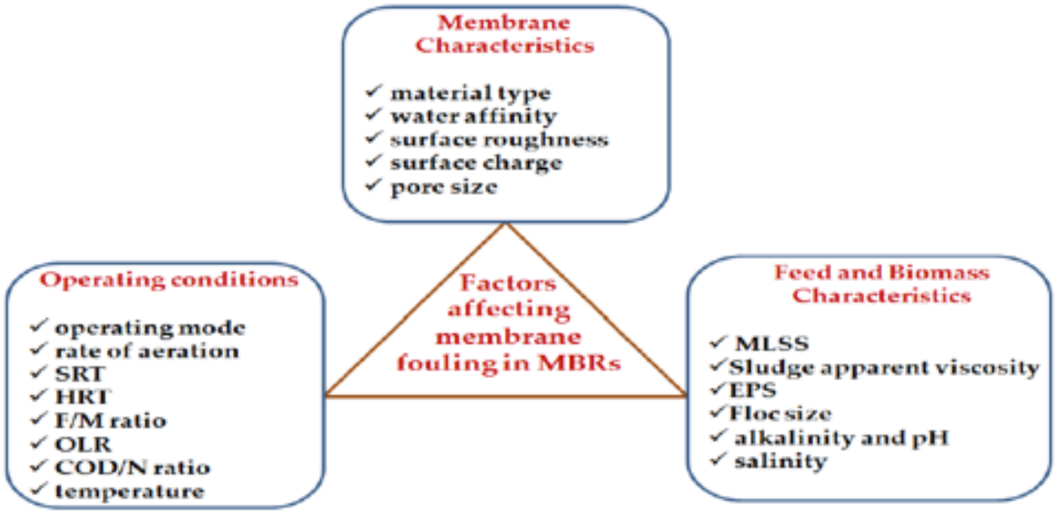


Fig 3.10 Factors affecting membrane fouling in MBR

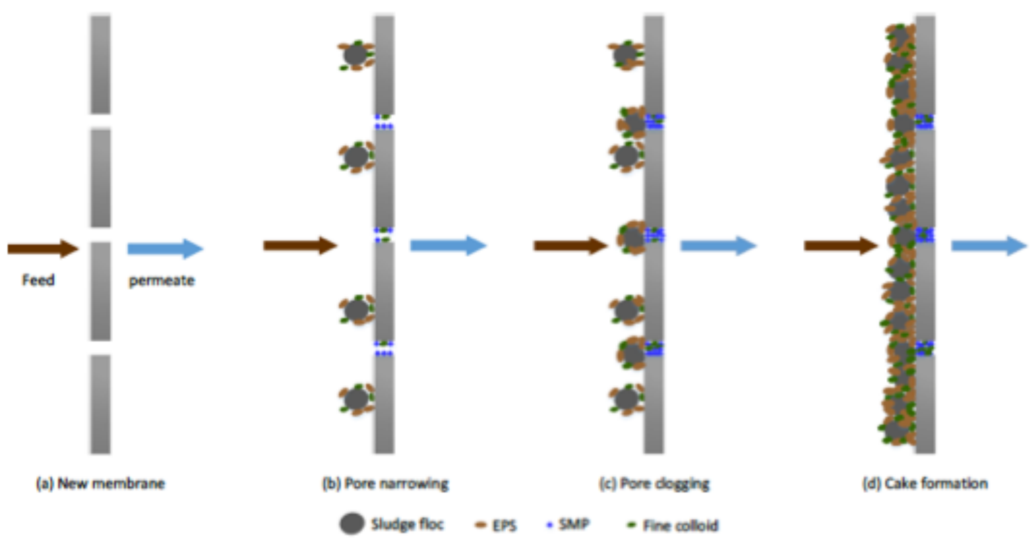


Fig 3.11 Mechanism of membrane fouling in MBR

3.3.11 SEQUENCING BATCH REACTOR

Sequencing batch reactors (SBR) or sequential batch reactors are used for cleaning of wastewater coming from industries.
SBR treats wastewater such as output coming from anaerobic digesters or sewage or from mechanical biological treatment facilities in batches.
To make discharge suitable into sewers or to be used on land, the value of BOD (biochemical oxygen demand) and COD (chemical oxygen demand)
Is reduced by oxygen through wastewater. There are several configurations available for SBRs but they all have same basic working process.

The installation setup consists of at least two identically equipped tanks with a common inlet, which can be switched between them. These tanks have a "flow through system", that is the raw wastewater which is called influent enters from one end and the treated wastewater (which is effluent) flowing out from the other end. Out of these two tanks one tank is in aerating and filling mode while the other is on settle or decant mode.
Bio-selector is a section at the inlet of the tank. This consists of a series of walls or baffles which direct the flow either from side to side of the tank or under and over consecutive baffles. These walls or baffles helps in mixing the influent and the returned activated sludge, which initiates the biological digestion process before the liquor enters the main part of the tank.

Advantages of SBR-

- It is economical plant as it has no separate settling tank and no recycling pump.
- It has simple construction and hence it is more stable.
- As settling tank becomes settling tank, it has large surface area and comfortably accommodate peak flows.
- It also eliminates the danger of overflowing.
- These have better responding for shock loading.
- It can easily remove N and P parallel to BOD.
- Absence of corrosive gases and odourous gases.
- A stabilized is generated from this system

Disadvantages are-

- There is no provision for management of sludge.
- High input of energy is required if it is used with bio-methanation
- Semi skilled manpower is required at work site.
- It is a patented technology and decanters defying local cannibalization

The overall BOD removal efficiency is in the range of around 95 %

Design data-

Goronszy describes an installation of the SBR serving 4000 persons in Australia as-

- Design flow – 2 * average dry weather flow
- BOD – 70 g/ person –day
- Loading – 0.05 kg BOD_5/kg MLSS
- MLSS at low water level – 5000mg/l
- Volume of settled sludge – 70% of depth (after 1 hour)
- Excess sludge – 0.4g/g BOD removed
- Oxygenation rate for effective 12 hour aeration – 2.4 kg O_2/kg BOD_5 applied

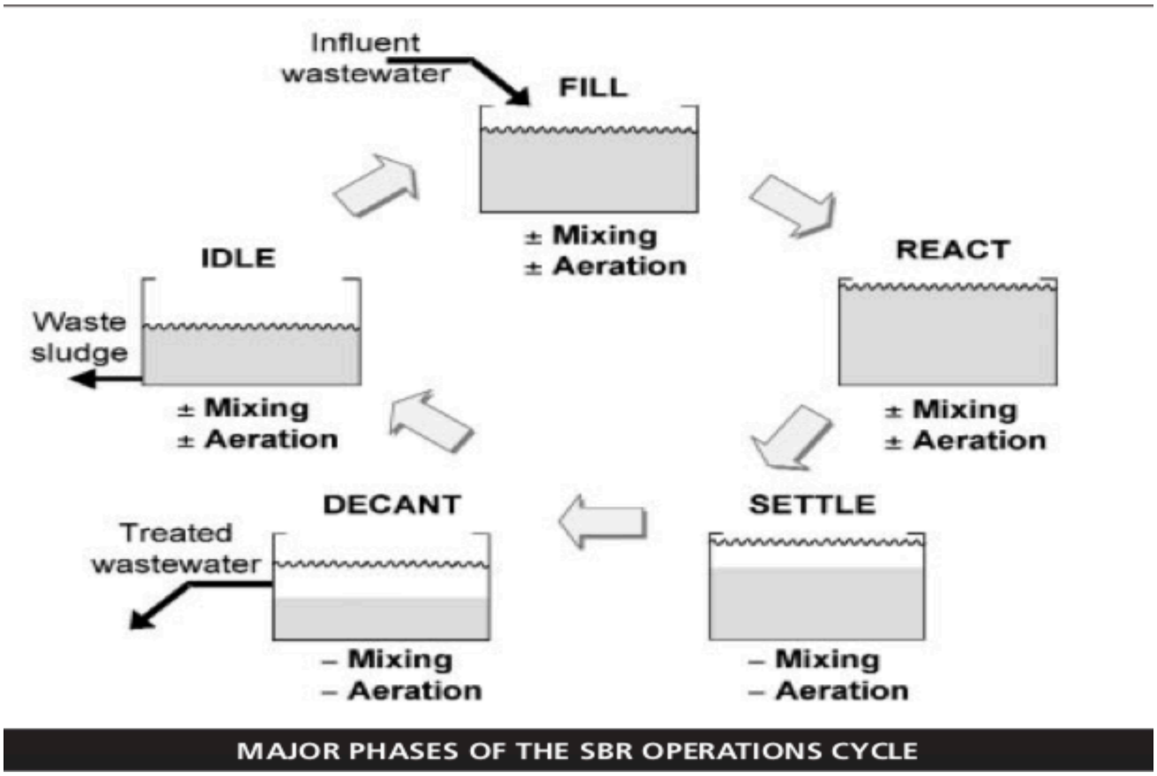


Fig 3.12 Phases of SBR operation cycle

Chapter 4

STATUS OF VARIOUS TREATMENT PLANTS IN DELHI

4.1 CURRENT STATUS

At present there are 29 sewage treatment plants in as per the record of Delhi jal board. Most of them are working on activated sludge process technology and extended aeration technology, only few of them are working on biological filtration and oxygen reactor technology, which comes out to be the most efficient as compared to other technologies. These treatment plants have a capacity of 607 MGD as per today, and a proposal has been laid to increase the capacity of these plants by the end of year 2021.

4.2 EFFICIENCY OF SEWAGE TREATMENT PLANTS IN DELHI

We have calculated the efficiency of sewage treatment plants of Delhi on the basis of three parameters. First two parameters are physical and chemical parameter, physical includes total suspended solids and chemical includes biochemical oxygen demand and the third parameter helps us in finding the overall efficiency of these sewage plants which is by taking the average of total suspended solids and biochemical oxygen demand.

We have collected the data from the DPCC , which shows us the parameters like pH, Total suspended solids (TSS), BOD , COD, Oil and grease and ammonical nitrogen all these have unit mg/l except pH which is a unitless parameter. The data collected shows the concentration of above mentioned parameters in sewage which is entering into the sewage plant that is influent and effluent which is discharged out of the treatment plant. By analyzing the inflow and outflow data of sewage water we have calculated the efficiency of sewage treatment plants of Delhi, we have analysed two parameters which are total suspended solids which is a physical parameter and biochemical oxygen demand which is a chemical parameter.We have also shown the discharge standard for the discharged water for each parameter in given tables. Collected data of sewage treatment plants of above mentioned parameter is as shown below-

1. NAJAFGARH STP (installed capacity 5MGD)

Table 4.1 Different parameters for Najafgarh STP

Year	Month	Parameters											
		pH (Discharge standard) 5.5-9		TSS (mg/l) 50		BOD (27 c, 3days) (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
2018	April	7.2	7.4	240	40	110	28	324	80	19.2	2	30.6	5.2
	March	7.3	7.8	256	38	120	26	364	80	20.4	1.6	33.4	3.8
	Feb	7.3	7.8	250	39	120	27	360	80	20.1	1.2	30.6	3.5
	Jan	7.1	7.6	244	40	115	30	364	90	16.4	2.0	24.5	5.5
2017	Dec	7.2	7.3	244	54	130	36	396	124	19.6	1.2	30.6	6.1
	Nov	7.4	7.8	272	28	135	19	400	56	15.6	1.2	20.2	4.8
	Oct	7.8	7.2	260	26	120	22	348	64	18.4	2.0	24.6	7.83
	Sept	7.5	7.6	232	30	145	24	432	72	18.0	1.6	4.6	2.6
	Aug	7.4	7.8	208	16	130	12	388	48	16.8	1.2	22.7	4.3
	July	7.4	7.5	110	25	85	17	286	59	14.4	1.6	22.7	4.5
	June	7.4	7.8	272	28	135	19	400	56	15.6	1.2	20.2	4.8
	May	7.8	7.2	260	26	120	22	348	64	18.4	2.0	24.6	7.83
	April	7.4	7.5	100	20	80	16	288	60	14.4	1.6	22.7	4.5
	March	7.4	7.8	272	28	135	19	400	56	15.6	1.2	20.2	4.8
	Feb	7.8	7.2	260	26	120	22	348	64	18.4	2.0	24.6	7.83
	Jan	6.9	7.7	244	40	115	32	364	92	16.4	2.0	24.5	5.5
2016	Dec 16	7.4	7.5	110	25	85	17	286	59	14.4	1.6	22.7	4.5
	Nov	7.4	7.8	278	25	139	20	420	55	15.6	1.2	20.2	4.8
	Oct	7.8	7.2	260	26	120	22	348	64	18.4	2.0	24.6	7.83
	Sept	7.4	7.5	100	20	80	16	288	60	14.4	1.6	22.7	4.5
	Aug	7.4	7.8	272	28	135	19	400	56	15.6	1.2	20.2	4.8
	July	7.8	7.2	260	26	120	22	348	64	18.4	2.0	24.6	7.83
	June	7.4	7.8	272	28	135	19	400	56	15.6	1.2	20.2	4.8
	May	7.3	7.5	268	24	110	21	344	60	18	3	22.8	6.2
	April	7.8	7.2	260	26	120	22	348	64	18.4	2.0	24.6	7.83
	March	7.4	7.5	200	20	165	21	484	60	18	3.0	19.4	4.8
	Feb	8.1	8.4	176	30	135	26	356	68	16	3	20.6	6
	Jan	7.11	7.13	192	24	155	21	416	72	15	2	22.4	8.2
	Dec	6.7	7.7	240	22	145	26	440	80	18	2	20.8	9.3
	Nov	7	7.9	90	15	80	26	244	80	13	3	0.1	0.11
	Oct	7.9	8	108	22	145	24	596	104	14	2	2.28	0.42
	Sept	7.4	7.8	272	28	135	19	400	56	15.6	1.2	20.2	3.2

2015	Aug	7.4	7.5	100	20	80	16	288	60	14.4	1.6	22.7	4.5
	July	7.8	7.2	260	26	120	22	348	64	18.4	2.0	24.6	7.83
	June	8.7	8.4	324	28	130	24	460	96	28	2	2	0.22
	May	7.3	7.5	268	24	110	21	344	60	18	3	22.8	6.2
	April	7	7.9	90	15	80	26	244	80	13	3	1	0.1
	March	7.4	7.5	200	20	165	21	484	60	18	3.0	19.4	4.8
	Feb	8.1	8.4	176	30	135	26	356	68	16	3	20.6	6
	Jan	7.9	8	109	21	150	25	596	104	14	2	2.28	0.42
2014	Dec	7.4	7.8	272	28	135	19	400	56	15.6	1.2	20.2	4.8
	Nov	7.8	7.2	260	26	120	22	348	64	18.4	2.0	24.6	7.83
	Oct	7.9	8	108	22	145	24	596	104	14	2	2.28	0.42
	Sept	7.11	7.13	192	24	155	21	416	72	15	2	22.4	8.2
	Aug	6.7	7.7	240	22	145	26	440	80	18	2	20.8	9.3
	July	7	7.9	90	15	80	26	244	80	13	3	0.1	0.11
	June	7.9	8	108	22	145	24	596	104	14	2	2.28	0.42
	May	7.7	7.8	80	10	90	18	288	60	14	2	1.9	.3
	April	8.7	8.4	324	28	130	24	460	96	28	2	2	0.22
	March	6.8	6.8	184	56	130	32	372	92	20	3	3.2	1.8
	Feb	7.7	7.6	132	22	110	28	412	156	26	2	1.34	0.52
	Jan	8.1	8.2	280	40	160	26	480	84	28	3	0.82	0.2
2013	Dec	7.7	7.6	132	22	110	28	412	156	26	2	1.34	0.52
	Nov	8.7	8.4	324	28	130	24	460	96	28	2	2	0.22
	Oct	7.9	7.5	296	32	145	28	448	100	26	4	1.59	0.14
	Sept	7.7	7.6	368	30	140	22	520	64	32	3	1.4	1.1
	Aug	7.9	7.8	224	28	165	30	564	92	28	3	0.23	0.04
	July	7.7	7.6	132	22	110	28	412	156	26	2	1.34	0.52
	June	7.4	7.3	156	30	85	26	368	88	23	2	1.19	.2
	May	7.8	7.7	192	22	145	24	356	72	28	2	3.23	0.53
	April	7.7	7.6	132	22	110	28	412	156	26	2	1.34	0.52
	March	7.4	7.3	156	30	85	26	368	88	23	2	1.19	.2
	Feb	7.7	7.6	124	18	120	20	364	68	14	1	2.1	1.53
	Jan	7.8	7.7	192	22	145	24	356	72	28	2	3.23	0.53

Tables 4.2 Efficiency on the basis of TSS and BOD and seasonal efficiency for Najafgarh STP

Year	Efficiency	
	TSS	BOD
2018	84.14	80.19
2017	86.3	83.06
2016	87.5	84.5
2015	87.3	82.3
2014	86.7	83.3
2013	87.3	81.3

Year	Efficiency			
	Winter (Dec-Feb)	Summer (March-May)	Monsoon (June- Sept)	Post monsoon (Oct-Nov)
2018	84.4	84.2	-	-
2017	83.9	88.2	87.5	89.7
2016	83.4	90.3	88.7	90.5
2015	86.1	89.4	90.1	82.3
2014	86.8	84.1	86.8	86.9
2013	86.1	84.5	87.5	90.3

2. MEHRAULI STP (15MGD)

Table 4.3 Different parameters for Mehrauli STP

Year	Month	Parameters											
		pH (Discharge standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
2018	April	7.2	7.4	236	58	105	34	320	96	15.2	2.4	25.4	3.9
	March	6.9	7.1	208	50	90	34	260	112	13.2	2.4	32.4	6.8
	Feb	7.1	7.4	205	45	85	30	220	71	19.6	2.4	20.4	4.9
	Jan	6.8	7	212	52	95	36	271	116	14.4	2	26.4	7.4
2017	Dec	7.1	7.3	316	22	190	18	548	64	19.6	1.6	28.6	3.4
	Nov	7.1	7.4	200	44	80	28	220	71	19.6	2.4	20.4	4.9
	Oct	6.9	7.3	180	22	70	16	216	56	18.4	2.4	17.5	5.1
	Sept	6.7	7.1	364	64	130	32	300	84	19.6	3.6	32.7	8.6
	Aug	7.1	7.4	200	44	80	28	220	71	19.6	2.4	20.4	4.9
	July	7.4	7.5	184	58	115	36	344	108	16.4	3.2	22.6	6.8
	June	7.9	7.4	124	12	95	10	308	36	2.8	0.8	20	4
	May	6.9	7.5	136	18	105	12	320	32	12.4	1.3	18.4	4.6
	April	7.9	7.4	124	12	95	10	308	36	2.8	0.8	20	4
	March	7.1	7.4	200	44	80	28	220	71	19.6	2.4	20.4	4.9
	Feb	7.9	7.4	124	12	95	10	308	36	2.8	0.8	20	4
	Jan	6.2	6.4	276	18	144	13	433	44	17.7	0.8	24.3	4.4
2016	Dec	7.4	7.6	500	13	170	12	528	40	18.8	12.2	34.5	6
	Nov	7.3	7.6	320	20	135	16	404	52	18	1.1	24	5
	Oct	7.8	7.7	328	18	150	15	476	48	18.8	0.8	30.3	5
	Sept	7.4	7.6	500	13	170	12	528	40	18.8	12.2	34.5	6
	Aug	7.3	7.6	320	20	135	16	404	52	18	1.1	24	5
	July	7.8	7.7	328	18	150	15	476	48	18.8	0.8	30.3	5
	June	7.2	7.3	240	20	110	14	311	40	12	1.2	27.3	5.5
	May	6.9	7.2	233	20	170	22	432	67	18	1.2	24	5.1
	April	7.2	7.3	240	20	110	14	311	40	12	1.2	27.3	5.5
	March	7.8	7.7	328	18	150	15	476	48	18.8	0.8	30.3	5
	Feb	6.9	7.2	233	20	170	22	432	67	18	1.2	24	5.1
	Jan	7.8	7.7	328	18	150	15	476	48	18.8	0.8	30.3	5
	Dec	6.9	7	236	20	150	22	432	68	18	1	24	5.1
	Nov	7.2	7.9	148	26	110	20	304	56	17	2	26.2	6
	Oct	7.4	7.5	222	21	120	14	332	64	19.6	1.2	26	6
	Sept	7.2	7.9	148	26	110	20	304	56	17	2	26.2	6

2015	Aug	7.4	7.5	222	22	120	14	332	64	19.6	1.2	26	5
	July	6.9	7	236	20	150	22	432	68	18	1	24	5.1
	June	7.4	7.5	222	20	120	14	332	64	19.6	1.2	26	6
	May	6.9	7	236	20	150	22	432	68	18	1	24	5.1
	April	7.2	7.9	148	26	110	20	304	56	17	2	26.2	6
	March	6.9	7	230	20	160	22	432	68	18	1	24	5.1
	Feb	6.9	7	236	20	150	22	432	68	18	1	24	5.1
	Jan	7.2	7.9	148	26	110	20	304	56	17	2	26.2	6
2014	Dec	7.4	7.5	182	20	140	16	384	72	40	12	21.2	2.3
	Nov	7.1	7.3	132	24	130	21	432	68	18	2.8	20.6	5.0
	Oct	7.3	7.6	124	26	145	29	536	64	19.6	3	26	3.9
	Sept	7.4	7.5	182	20	140	16	384	72	40	12	22.2	2
	Aug	7	7.1	168	18	90	18	312	76	17	1	3	1.1
	July	6.9	7	688	50	80	20	292	71	21	3	2.9	1.6
	June	7.3	7.6	124	26	145	29	536	64	19.6	3	26	3.9
	May	7.4	7.5	182	20	140	16	384	72	40	12	1.2	27.3
	April	7	7.1	168	18	90	18	312	76	17	1	3	1
	March	6.9	7	170	50	80	20	292	71	21	3	2.9	1.6
	Feb	7.4	7.5	180	20	144	16	385	75	40	12	1.2	27.3
	Jan	7	7.1	166	18	90	18	312	76	17	1	3	1.5

Tables 4.4 Efficiency on the basis of TSS and BOD and seasonal efficiency for Mehrauli STP

Year	Efficiency	
	TSS	BOD
2018	76.27	70
2017	84.7	81.2
2016	94.9	89.5
2015	89.4	85.27
2014	87.4	83.2
2013	90.1	82.6

Year	Efficiency			
	Winter (Dec-Feb)	Summer (March-May)	Monsoon (June- Sept)	Post monsoon (Oct-Nov)
2018	76.7	75.8	-	-
2017	92.7	83.9	80.1	82.6
2016	95.3	92.8	94.8	94.2
2015	89.3	89.2	89.3	87.2
2014	89	83.1	90.1	81.1
2013	93.2	90.1	88.2	89.1

3. PAPPANKALA STP II (20MGD)

Table 4.5 Different parameters for Pappankala II STP

Year	Month	Parameters											
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
2018	April	7.1	7.3	196	8	98	6	288	24	12.8	0.8	18.6	2.7
	March	7.3	7.2	156	10	75	8	224	32	14.4	0.4	16.8	2.4
	Feb	6.8	7.1	164	8	85	6	244	24	11	1	20.2	5.6
	Jan	7.2	7.3	180	10	95	8	272	32	12	1.6	24.8	3.6
2017	Dec	7.3	7.4	216	42	95	32	276	104	12.4	2	22.8	3.4
	Nov	7.3	7.6	212	8	105	6	320	24	13.6	0.8	23.4	2.4
	Oct	7.3	7.4	240	10	130	8	396	32	14.4	1.6	23.5	2
	Sept	7.1	7.4	276	18	155	15	464	44	16	2.1	24.8	3.6
	Aug	7.4	7.5	132	28	105	20	320	60	12.1	1.6	20.5	1.9
	July	7.3	7.6	220	10	105	8	320	28	12.4	0.8	24.8	3.6
	June	7.2	7.3	392	14	145	12	432	36	18.8	1.8	22.4	3.3
	May	7.2	7.4	308	10	130	8	380	48	17.6	1.2	21.3	3.8
	April	7.3	7.5	312	6	145	4.6	424	16	17.2	0.8	25.2	2.8
	March	6.7	7.1	212	10	125	9	360	32	15.6	2.4	22.6	6.3
	Feb	7.1	7.3	212	8	105	6	320	24	13.6	0.8	23.4	2.4
	Jan	7.3	7.2	204	24	120	16	364	52	15.6	1.2	23.5	6.7
2016	Dec	6.8	7.1	168	9	130	8	412	40	14	0.8	23.4	6
	Nov	7.2	7.3	232	8	145	6	436	24	19.6	.4	28.9	4.1
	Oct	7.6	7.9	128	10	105	10	320	28	16	1.2	26.2	4
	Sept	7.1	7.3	164	10	125	8	348	56	18.8	1.8	20.5	1.9
	Aug	7.3	7.2	116	10	90	10	300	40	17.6	0.4	25.3	.3
	July	6.8	7.1	168	9	130	8	412	40	14	0.8	23.4	6

Tables 4.6 Efficiency on the basis of TSS and BOD and seasonal efficiency for Pappankala II STP

Year	Efficiency	
	TSS	BOD
2018	94.6	92.06
2017	93.8	81.1
2016	94.2	93.1

Year	Efficiency			
	Winter (Dec-Feb)	Summer (March-May)	Monsoon (June-Sept)	Post monsoon (Oct-Nov)
2018	94.6	94.8	-	-
2017	88.3	96.8	93.1	96.0
2016	94.6	-	93.5	95.0

4. KAPASHERA STP (23 MGD)

Table 4.7 Various parameters for Kapashera STP

Year	Month	Parameters											
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
2018	April	7.4	7.6	212	10	105	5	320	20	18.4	1.3	26.5	3.3
	March	7.4	7.1	156	6	90	4	256	12	13.6	0.8	19.1	1.2
	Feb	7.3	7.2	172	8	105	6	308	28	14.8	0.4	17.5	1.6
	Jan	7.4	7.1	248	10	120	8	336	32	18.4	0.4	27	2
2017	Dec	7.3	7.2	272	10	150	9	430	32	19.6	2	21.9	2
	Nov	7.3	7.5	208	34	120	24	348	76	14.8	2.8	19.1	1.2
	Oct	7.2	7.1	288	32	145	25	456	72	15.2	2	21.9	7.2
	Sept	6.8	7.2	172	30	105	16	316	48	10.2	2.8	12.4	6.3
	Aug	7.3	7.2	272	8	150	6	436	24	19.6	0.4	29	2
	July	7.6	7.2	116	10	90	9	268	28	12.4	0.8	9	5.1
	June	7.3	7.2	172	8	105	6	308	28	14.8	0.4	17.5	1.6
	May	7.4	7.1	248	10	120	8	336	32	18.4	0.4	27	2
	April	7.5	7.3	440	10	170	8	512	32	19.2	1.6	27.1	1.6
	March	7.2	7.1	288	32	145	25	456	72	15.2	2	21.9	7.2
	Feb	7.3	7.2	272	8	150	6	436	24	19.6	0.4	29	2
	Jan	7.2	7.1	288	32	145	25	456	72	15.2	2	21.9	7.2
2016	Dec	7.3	7.2	172	8	105	6	308	28	14.8	0.4	17.5	1.6
	Nov	7.9	8.1	280	16	135	11	420	40	17.6	0.4	20.3	2
	Oct	7.3	7.2	172	10	110	8	310	30	14.8	1.6	17	1.6
	Sept	7.3	7.2	176	16	115	14	352	52	17.2	0.8	29	2
	Aug	7.3	7.4	181	10	130	16	352	28	17.8	1.6	27	1.6
	July	7.2	7.3	152	8	105	6.6	324	20	10	0.4	23.2	3.2

Tables 4.8 Efficiency on the basis of TSS and BOD and seasonal efficiency for Kapashera

Year	Efficiency	
	TSS	BOD
2018	95.6	94.5
2017	92.6	89.1
2016	94.5	91.4

Year	Efficiency			
	Winter (Dec-Feb)	Summer (March-May)	Monsoon (June- Sept)	Post monsoon (Oct-Nov)
2018	95.9	95.6	-	-
2017	93.5	94.6	92.3	88.6
2016	95.3	-	93.3	94.2

5. **AKSHARDHAM STP (1MGD)**

Table 4.9 Different parameters for Akshardham STP

Year	Month	Parameters											
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
2018	April	6.7	7.5	164	3	80	2	248	12	12.4	2	19.7	1.3
	March	7.1	7.3	152	4	85	2	264	8	13.6	1.9	20.4	1.5
	Feb	7.2	7.3	140	2	85	3	248	12	12.4	1.3	13.4	1.1
	Jan	7.5	7.6	212	8	105	4	308	16	14.4	0.8	21	1.1
2017	Dec 17	7.1	7.3	76	2	48	1.6	152	12	2	0.5	25.6	1.8
	Nov 17	7.2	7.3	256	6	120	3	344	12	17.6	0.4	23	5
	Oct 17	7.2	7.3	200	4	95	2	300	12	14.4	1.9	27.8	1.0
	Sept	7.4	7.5	216	2	105	1.8	316	6	15.6	1.5	20.4	1.5
	Aug	7.0	7.5	380	4	140	2.2	420	8	17.7	0.4	13	1.8
	July	7.1	7.3	960	9	165	3.6	492	8	24.8	0.4	13.4	1.1
	June	7.2	7.3	160	4	110	3	332	12	15.5	1.3	21	1.1
	May	6.9	7.5	728	2	165	2.4	484	8	21.6	0.8	25	1.5
	April	7.5	7.8	108	2	95	2.2	280	12	10	0.5	27.9	1.0
	March	7	7.4	200	2	140	2.4	444	12	15.6	0.4	20.4	1.5
	Feb 17	7.1	7.9	636	4	195	3.6	524	16	20.4	0.4	13.4	1.1
	Jan 17	6.1	7.0	884	2	175	2.4	508	8	22.4	1.9	21	1.1
2016	Dec 16	7.1	7.3	164	1	125	2	396	16	12	1.5	25.6	1.8
	Nov	7.2	7.3	208	2	110	3.8	344	20	17.2	0.4	27.9	1.0
	Oct	7.2	7.3	228	4	125	3	372	20	17.2	0.4	28.64	4
	Sept	7.4	7.5	112	10	75	8.8	252	32	12.4	.4	25	1.5
	Aug	7.0	7.5	164	4	105	3.6	320	20	12.4	0.4	28	3.4
	July	7.1	7.3	112	8	75	6.2	276	28	11.6	0.4	24	2.8
	June	7.2	7.3	344	8	145	5.6	428	16	17.6	0.4	20.9	4.9
	May	6.9	7.5	164	1	125	2	396	16	12	1.5	25.6	1.8
	April	7.5	7.8	208	2	110	3.8	344	20	17.2	0.4	27.9	1.0
	March	7.1	7.3	230	5	130	5	372	20	17.2	0.4	28.64	4
	Feb	7.2	7.3	115	11	75	8.8	252	32	12.4	.4	25	1.5
	Jan16	6.9	7.5	164	4	105	3.6	320	20	12.4	0.4	28	3.4
2015	Dec 15	7.5	7.8	112	4	80	7	276	29	12.1	0.8	23	2.6
	Nov	7	7.4	344	8	145	5.6	428	16	17.6	0.4	20.9	4.9
	Oct	7.1	7.9	200	2	140	2.4	444	12	15.6	0.4	20.4	1.5
	Sept	6.9	7.4	144	12	105	10.6	308	32	18	0.4	13.2	0.2

Tables 4.10 Efficiency on the basis of TSS and BOD and seasonal efficiency for Akshardham STP

Year	Efficiency	
	TSS	BOD
2018	97.4	96.9
2017	98.5	97.9
2016	97.2	95.6
2015	96.7	94.5

Year	Efficiency			
	Winter (Dec-feb)	Summer (march-may)	Monsoon (june- sept)	Post monsoon (oct-nov)
2018	96.2	97.7		
2017	99.1	99.2	99.0	97.4
2016	96.3	98.6	95.9	98.6
2015	96.4	-	91.6	98.1

6. YAMUNA VIHAR (20MGD)

Table 4.11 Different parameters for Yamuna vihar STP

Year	Month	Parameters											
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
2018	April	6.9	7.1	232	34	120	22	352	72	17.6	2.4	24.8	4
	March	7.5	7.3	244	46	135	25	396	72	17.6	2.4	31.9	4.7
	Feb	7.3	7.6	280	40	120	28	348	76	18.4	2.8	29	6.1
	Jan	6.7	7.3	236	42	110	26	324	88	18.4	5.6	26	5.1
2017	Dec	7.3	7.4	192	48	80	26	248	84	14.4	2.4	21.6	5.5
	Nov	7.5	7.3	256	44	105	28	300	76	14.4	2.8	28	6.4
	Oct	7.3	7.6	280	40	120	26	364	84	16.4	2.4	27	11.2
	Sept	6.8	7.3	300	38	165	28	492	84	18.4	2.0	27	9.2
	Aug	7.3	7.4	248	34	125	26	376	76	16.4	1.6	29	6.1
	July	6.5	6.7	368	56	110	38	332	116	15.6	2.0	24.9	8.2
	June	6.5	7.1	180	40	105	36	316	108	12	2	18.4	5.3
	May	7.5	7.3	280	98	130	44	380	132	13.2	4	27	9
	April	7.5	7.6	364	82	175	36	520	108	19.2	4.4	27.4	8.2
	March	6.8	7.3	300	38	165	28	492	84	18.4	2.0	27	9.2
	Feb	6.9	7.1	480	42	160	29	480	84	20.4	2.8	23.4	10.8
	Jan	6.5	6.7	364	40	165	28	372	92	18	2	24.5	6.3
2016	Dec	6.9	7.1	124	32	100	24	324	68	11.2	1.6	16.3	5.9
	Nov	7.5	7.3	364	42	135	28	408	92	18.8	2.4	26.2	9.1
	Oct	7.3	7.6	252	40	150	28	464	76	20.8	2.4	24	7.3
	Sept	6.7	7.3	120	20	95	17	300	52	16	1.2	27	9.2
	Aug	7.3	7.4	144	24	115	18	360	56	18	0.8	28.7	5.8
	July	7.5	7.3	360	32	140	29	400	90	18.8	2.4	25.2	9.1
	June	7.3	7.6	252	40	150	28	464	76	20.8	2.4	24	7.3
	May	6.7	7.3	120	20	95	17	300	52	16	1.2	27	9.2
	April	7.3	7.4	140	25	118	19	365	58	19	1.2	28.7	5.8
	March	7.5	7.6	252	40	150	28	464	76	20.8	2.4	24	7.3
	Feb	6.8	7.3	256	24	140	28	400	84	17	3	20.8	5.6
	Jan	6.9	7.1	364	42	135	28	408	92	18.8	2.4	26.2	9.1
2015	Dec	6.5	6.7	172	22	125	18	320	56	16	2	17.8	5.4
	Nov	6.9	7.1	232	20	115	17	344	56	16	0.8	17	4.5
	Oct	7.5	7.6	208	14	110	15	336	68	16.8	0.8	20	5.3
	Sept	6.8	7.3	160	26	130	17	332	56	14	3	29	5.2
	Aug	7.5	7.6	210	15	115	18	338	52	16.8	2	22	5.1
	July	7.4	7.3	310	25	125	24	368	65	17	2	29	6.2

2 0 1 5	June	6.9	7.1	232	20	115	17	344	56	16	0.8	17	4.5
	May	7	7.7	256	24	140	28	400	84	17	3	20.8	5.6
	April	7.4	7.3	308	28	130	24	368	68	18	2	29.2	6.2
	March	7.9	8	172	22	125	18	320	56	16	2	17.8	5.4
	Feb	7.4	7.3	308	28	130	24	368	68	18	2	29.2	6.2
	Jan	7.1	7.3	160	26	130	17	332	56	14	3	18	4.1
2 0 1 4	Dec	7	7.2	170	38	130	24	400	120	22	2	23.8	11
	Nov	7.1	7.6	180	30	160	27	380	80	17	3.2	16	2.8
	Oct	7	7.2	170	38	130	24	400	120	22	2	23.8	11
	Sept	7.3	8.3	76	12	120	22	344	72	22	2	17.4	7
	Aug	7	7.2	168	38	130	27	400	120	24	2	23.8	12.3
	July	6.2	7.1	205	24	130	20	412	52	20	1	2.2	1.2
	June	7.9	8	172	22	125	18	320	56	16	2	17.8	5.4
	May	7.3	8.2	80	12	125	23	350	73	21	2	17.4	6.2
	April	7	7.2	170	38	130	24	400	120	22	2	23.8	11
	March	6.2	7.1	200	24	130	20	412	52	20	1	2.2	1.2
	Feb	7.9	8	172	22	125	18	320	56	16	2	17.8	5.4
	Jan	7.9	8	260	26	130	16	420	80	20	3	0.84	0.1
2 0 1 3	Dec	7.4	7.3	310	25	125	24	368	65	17	2	29	6.2
	Nov	8.3	8.4	312	20	150	20	444	64	20	3	1.05	0.2
	Oct	7.6	7.9	284	28	145	11	460	36	22	4	2.95	0.23
	Sept	7.8	7.7	124	28	80	22	296	76	16	3	3.8	0.3
	Aug	7.4	7.3	108	18	115	26	360	72	11	2	2.11	1.3
	July	7.7	7.6	124	24	128	16	420	60	20	4	2.5	1
	June	6.2	7.1	200	22	130	16	400	52	20	2	2.2	1
	May	7.6	7.5	312	28	95	23	276	68	32	4	1	0.18
	April	7.8	7.9	328	18	85	24	248	88	34	2	3.7	2.64
	March	6.2	7.1	210	24	130	20	412	52	20	1	2.2	1.3
	Feb	7.5	7.4	132	20	55	24	148	76	26	3	2.9	.15
	Jan	7.7	7.6	124	24	128	16	420	60	20	4	2.5	1

Tables 4.12 Efficiency on the basis of TSS and BOD and seasonal efficiency for Yamuna vihar STP

Year	Efficiency	
	TSS	BOD
2018	83.6	79.1
2017	82.5	77.8
2016	86.1	81.8
2015	88.1	83.9
2014	84.9	83.1
2013	88.1	82.2

Year	Efficiency			
	Winter (Dec-Feb)	Summer (March-May)	Monsoon (June- Sept)	Post monsoon (Oct-Nov)
2018	84.1	83.2	-	-
2017	87.4	76.9	83.6	84.3
2016	86.8	83.4	86.5	86.8
2015	88.1	89.4	90.5	92.2
2014	85.7	83.6	84.5	83.6
2013	87.8	91.7	83.4	91.9

7. NILOTHI STP (40 MGD)

Table 4.13 Different parameters for Nilothi STP

Year	Month	Parameters											
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
2018	April	6.8	7.4	196	30	95	22	296	72	14.4	1.6	22	4
	March	7.1	7.3	216	26	95	18	292	60	14.4	1.2	32.3	3.3
	Feb	6.9	7.2	236	38	105	28	324	92	15.2	1.6	21	4
	Jan	7.1	7.4	324	42	165	34	472	104	15.6	2	29.1	3.8
2017	Dec	6.8	7.4	120	48	65	36	184	128	12	2	32.3	3.6
	Nov	7.1	7.3	136	26	85	16	256	52	14.4	1.2	32.3	3.3
	Oct	6.9	7.2	144	36	80	24	244	76	15.2	1.6	21	4
	Sept	7.1	7.4	136	26	85	16	256	52	15.6	2	29.1	3.8
	Aug	6.8	7.4	216	64	115	36	348	108	14.4	1.2	32.3	3.3
	July	7.1	7.3	292	42	140	30	424	92	20	2	32.3	3.3
	June	6.9	7.2	184	12	125	10	372	32	16	1.2	21	4
	May	7.1	7.4	116	42	95	36	280	108	14.4	1.2	29.1	3.8
	April	6.8	7.4	136	26	85	16	256	52	20	2	32.3	3.4
	March	7.1	7.3	164	28	115	25	312	80	16	1.2	32.3	3.3
	Feb	6.9	7.2	228	38	135	24	412	80	14.4	1.2	21	4
	Jan	7.1	7.4	676	116	160	50	492	140	20	2	29.1	3.8
2016	Dec	6.8	7.4	228	38	135	24	412	80	16	1.2	32.3	3.3
	Nov	7.1	7.3	248	40	45	32	432	104	18	2.8	32.3	3.3
	Oct	6.9	7.2	212	46	125	32	384	92	20	2	21	4
	Sept	7.1	7.3	152	16	115	14	344	32	16.8	1.2	29.1	3.8
	Aug	6.8	7.2	176	16	135	12	444	44	14.4	1.2	32.3	3.3
	July	7.1	7.7	164	28	115	25	312	80	16	1.2	32.3	3.3
	June	7.0	7.4	228	38	135	24	412	80	14.4	1.2	21	4
	may	7.1	7.3	225	35	140	24	420	32	20	1.2	32.3	3.3
	April	6.9	7.2	250	38	125	32	444	104	18	2.8	32.3	3.3
	March	7.1	7.4	212	46	125	32	384	92	20	2	21	4
	Feb	6.8	7.4	152	16	118	16	350	32	20	2	21	3.4
	Jan	7.1	7.3	176	26	135	12	444	40	16	1.2	32.3	3.8
2015	Dec	7.8	7.7	248	30	105	22	308	64	29	2	2.3	1.5
	Nov	7.0	7.4	228	38	135	24	412	80	14.8	1.2	23	4
	Oct	7.1	7.3	225	35	140	24	420	32	20	1.2	32.3	3.3
	Sept	7.1	7.4	256	40	110	22	324	68	14.4	1.2	29.1	3.8
	Aug	7.1	7.7	164	28	115	25	312	80	16	1.2	32.3	3.3
	July	7.5	7.2	220	28	115	24	340	68	17	1.2	22	8.6

	June	7.8	7.7	248	30	105	22	308	64	29	2	2.3	1.5
	May	7.0	7.4	228	38	135	24	412	80	14.4	1.2	21	4
	April	7.1	7.3	225	35	140	24	420	32	20	1.2	32.3	3.3
	March	7.8	7.8	236	36	125	28	464	96	20	3	2.3	1.8
	Feb	6.9	7	212	28	130	25	296	60	18	3	25.6	5
	Jan	7.7	8	92	16	115	22	352	84	11	1	.4	.34
2013	Dec	7.8	7.7	248	30	105	22	308	64	29	2	2.3	1.5
	Nov	8.6	8.6	220	26	105	22	380	92	24	3	1.3	0.23
	Oct	8.3	7.6	260	30	130	28	400	112	26	6	1.37	0.17
	Sept	7.4	7.3	164	34	120	26	444	104	18	4	2.8	1.4
	Aug	7.6	7.4	96	12	105	24	340	72	10	1	2.64	.84
	July	7.1	7.7	164	28	115	25	312	80	16	1.2	32.3	3.3
	June	7.8	7.7	248	30	105	22	308	64	29	2	2.3	1.5
	May	7.8	7.7	240	32	115	22	340	32	17	2	21	1.5
	April	7.1	7.3	225	35	140	24	420	32	20	1.2	30.3	3
	March	7.8	7.7	244	32	100	24	304	88	22	2	1.15	0.8
	Feb	7.8	7.7	248	30	105	22	308	64	29	2	2.3	1.5
	Jan	7.6	7.5	256	24	165	24	484	112	32	4.4	0.1	0.06

Tables 4.14 Efficiency on the basis of TSS and BOD and seasonal efficiency for Nilothi STP

Year	Efficiency	
	TSS	BOD
2018	85.8	78.2
2017	81.0	76.1
2016	84.2	80.7
2015	85.2	80.6
2013	86.9	80.8

Year	Efficiency			
	Winter (Dec-Feb)	Summer (March-May)	Monsoon (June- Sept)	Post monsoon (Oct-Nov)
2018	85.7	86.4	-	-
2017	80.2	77.0	82.6	77.8
2016	85.6	82.6	86.3	83.8
2015	86.5	84.1	85.8	83.8
2013	88.8	86.1	84.5	88.3

8. Narela STP (10 MGD)

Table 4.15 Different parameters for Narela STP

Year	Month	Parameters											
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
2018	April	7.1	7.2	120	30	65	18	204	60	11.6	1.6	20.6	4.4
	March	7.6	7.8	188	28	80	20	224	64	16.4	1.6	26	4.6
	Feb	6.8	7.4	176	30	85	18	268	34	14	2	20.4	3
	Jan	7.1	7.3	196	26	85	20	232	72	16.4	1.6	19.7	9
2017	Dec 17	6.9	7.2	108	40	95	32	284	96	16	2.8	25	7.3
	Nov 17	7.1	7.4	216	22	85	18	220	48	20.4	1.6	21.3	3.4
	Oct 17	6.8	7.4	160	22	115	19	300	52	14	1	24.2	6
	Sept	7.1	7.3	288	26	120	21	332	60	14	1.2	29	4.1
	Aug	6.9	7.2	108	40	95	32	284	96	16	2.8	17.1	9.9
	July	7.1	7.4	148	56	110	35	332	108	14.4	2	19.7	9
	June	6.8	7.4	756	44	165	29	496	88	21	2.8	25	7.3
	May	7.1	7.3	136	18	100	18	316	56	16.8	1.2	32.4	6.4
	April	6.9	7.2	176	28	125	24	360	84	15	1.2	18.8	5.9
	March	7.1	7.4	190	30	90	20	225	60	16	1.6	26	4
	Feb 17	6.8	7.4	206	30	110	18	316	34	14	1.8	20.4	3
	Jan 17	7.1	7.3	200	26	100	20	232	72	16.4	1.6	19.7	9
2016	Dec 16	6.9	7.2	108	40	95	32	284	96	16	2.8	25	7.3
	Nov	7.1	7.4	112	30	100	24	340	68	16.4	1.6	25.7	4.7
	Oct	6.8	7.4	136	18	100	18	316	56	16.8	1.2	32.4	6.4
	Sept	7.1	7.3	132	20	105	16	344	56	14	0.8	26.9	5.2
	Aug	6.9	7.2	160	22	115	19	300	52	14	1	24.2	6
	July	7.2	7.8	288	26	120	21	332	60	14	1.2	29	4.1
	June	6.9	7.2	312	20	170	22	540	72	20	2	4	2.8
	May	7.1	7.3	196	26	85	20	232	72	16.4	1.6	19.7	9
	April	7.1	7.4	226	23	95	18	220	48	20.4	1.6	21.3	3.4
	March	6.8	7.4	170	22	115	19	300	52	14	1	24.2	6
	Feb	7.1	7.3	298	26	120	21	332	60	14	1.2	29	4.1
	Jan	6.9	7.2	312	20	170	22	540	72	20	2	4	2.8
	Dec	7.1	7.4	220	22	85	18	220	48	20.4	1.6	21.3	3.4
	Nov	6.8	7.4	160	22	115	19	300	52	14	1	24.2	6
	Oct	7.1	7.2	136	18	100	18	316	56	16.8	1.2	32.4	6.4
	Sept	7.1	7.4	206	21	105	16	230	48	20.4	1.6	21.3	3.4
	Aug	7.1	7.4	206	21	106	17	240	52	20	1.2	21	3.4

2015	July	6.8	7.4	196	22	110	20	336	60	18	2.8	30.2	11.6
	June	7.1	7.3	208	34	110	24	320	72	18	3	19.8	7.2
	May	6.9	7.2	166	23	105	16	306	52	14	1.2	24.2	7
	April	7.1	7.4	136	18	100	18	316	56	16.8	1.2	32.4	6.4
	March	6.8	7.4	160	22	115	19	300	52	14	1	24.2	6
	Feb	7.1	7.3	146	17	95	17	220	56	20	1.2	24	6.4
	Jan	6.9	7.2	160	22	115	19	300	52	14	1	24.2	6
2014	Dec	7.1	7.4	206	21	105	16	230	48	20.4	1.6	21.3	3.4
	Nov	6.8	7.4	160	22	115	19	300	52	14	1	24.2	6
	Oct	7.1	7.3	132	20	125	16	300	60	18	1.4	12	3.2
	Sept	7.1	7.3	196	25	86	19	232	75	19	1.6	19.7	9
	Aug	7.1	7.4	136	20	100	19	336	60	18	2.8	30.2	11.6
	July	7.1	7.2	86	28	80	29	320	72	18	3	19.8	7.2
	June	7.1	7.3	196	26	85	20	232	72	16.4	1.6	19.7	9
	May	6.8	7.4	116	18	120	21	336	60	18	2.8	30.2	11.6
	April	7.1	7.3	284	32	155	22	510	80	19	3	19.7	5.4
	March	6.9	7.2	312	20	170	22	540	72	20	2	4	2.8
	Feb	7.1	7.3	208	34	110	24	320	72	18	3	11	3.4
	Jan	7.9	8.3	352	26	110	20	412	88	26	2	0.9	0.8
2013	Dec	7.1	7.4	206	21	105	16	230	48	20.4	1.6	21.3	3.4
	Nov	7.5	8.7	296	24	165	20	420	80	24	2	2.9	0.7
	Oct	7.6	7.9	316	28	150	23	460	92	28	4	2.3	1.8
	Sept	7.9	7.8	188	32	155	30	692	96	17	4	1.2	1.1
	Aug	7.8	7.7	232	22	175	30	580	88	17	3	2.6	1
	june	7.1	7.3	196	26	85	20	232	72	16.4	1.6	19.7	9
	May	7.7	7.6	464	30	135	24	340	116	36	3	5.4	3.2
	April	7.1	7.4	136	20	100	19	336	60	18	2.8	30.2	11.6
	Feb	7.8	7.7	312	24	145	28	352	84	32	3	2.6	0.1
	Jan	7.9	7.8	392	30	180	20	672	88	32	5.6	2.2	0.6

Tables 4.16 Efficiency on the basis of TSS and BOD and seasonal efficiency for Narela STP

Year	Efficiency	
	TSS	BOD
2018	83.2	77.2
2017	85.1	79.1
2016	88.7	81.8
2015	86.7	82.5
2014	87.7	82.7
2013	89.1	84.1

Year	Efficiency			
	Winter (Dec-Feb)	Summer (March-May)	Monsoon (June- Sept)	Post monsoon (Oct-Nov)
2018	84.9	81.1	-	-
2017	81.3	84.8	87.2	88.2
2016	88.0	88.1	90.1	81.6
2015	88.4	86.3	87.9	86.4
2014	89.4	90.2	83.8	85.6
2013	88.8	91.4	87.2	87.4

9. RITHALA STP (80MGD)

Table 4.17 Different parameters for Rithala STP

Year	Month	Parameter											
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
2018	April	7.1	7.5	304	34	145	20	428	68	22	2.4	30	7
	March	7.6	7.5	300	28	145	20	424	68	21.6	1.6	29.6	4.7
	Feb	6.8	7.4	280	30	130	18	384	64	20.4	2	24.8	4.9
	Jan	7.1	7.3	376	38	190	26	544	84	16.8	1.6	28.8	3.6
2017	Dec	6.9	7.2	256	40	120	34	352	112	16.4	1.6	29.4	6.8
	Nov	7.1	7.4	296	38	140	32	396	76	20.4	2	28.4	5.2
	Oct	6.8	7.4	292	34	105	18	320	60	16.4	1.6	27.8	3.6
	Sept	7.1	7.3	252	32	95	20	288	64	15.6	2	26.6	7.3
	Aug	6.9	7.2	268	56	110	38	336	116	17.7	2.4	24.5	9.2
	July	7.1	7.4	224	40	224	16	424	68	15.6	2	21.6	6.4
	June	6.8	7.4	216	20	110	16	384	64	12.4	1.6	20.2	4.9
	May	6.8	7.3	332	56	140	38	416	116	14.4	3.6	28	7.4
	April	6.9	7.2	232	20	130	12	380	48	16.4	1.2	22	6.5
	March	7.1	7.4	272	64	140	36	396	76	15.6	2	26.6	7.3
	Feb	7.8	7.7	384	44	155	28	472	88	18.8	1.6	23.8	7.2
	Jan	6.2	6.7	376	40	125	25	396	84	18	2.4	24.3	7.7
2016	Dec	7.1	6.6	156	24	135	22	420	68	12	2	25.7	5.3
	Nov	6.2	7.7	292	74	135	45	412	104	17.6	1.6	22.9	6.5
	Oct	7.4	7.8	188	16	145	13	420	40	18	0.8	28.9	3.2
	Sept	7.9	8	248	24	130	20	400	64	18	1.6	24.6	6.2
	Aug	7.5	7.7	192	28	125	21	372	68	16	1.2	31	6
	July	6.7	6.8	276	34	120	17	372	64	16.8	1.6	20.8	5.9
	June	6.9	7.4	208	32	150	28	456	80	17	1.6	24	5.1
	May	7.5	7.7	148	16	120	13	348	44	18	0.8	28.6	5.6
	April	6.9	7.4	176	22	110	18	328	60	15.6	1.2	24	6.4
	March	7.1	6.6	156	24	135	22	420	68	12	2	25.7	5.3
	Feb	6.9	7.7	290	74	135	44	410	104	17.6	1.6	22.9	6.5
	Jan	6.9	7.5	352	24	155	17	452	60	17.6	0.8	27.9	6
	Dec	7.1	7.4	168	12	130	10	256	36	18	0.8	21.9	5.7
	Nov	7	7.4	144	18	105	19	316	60	16	1.2	15	6.3
	Oct	7.5	7.8	124	14	110	12	332	40	18	1.2	26.8	6.8
	Sept	7.1	7.4	220	20	135	19	420	68	12	2	25.7	5.3
	Aug	7.4	7.2	216	22	125	24	364	64	16.8	1.6	25.8	8.6

2015	July	7.5	7.3	288	96	125	35	396	112	17.2	1.2	23.6	6.4
	June	6.9	7.4	276	24	115	20	376	60	18	1.6	28.6	6.4
	May	7.4	7.8	228	22	145	22	364	76	15	3	22.8	8
	April	7.1	7.4	168	12	130	10	256	36	18	1.4	21.9	5.7
	March	7.1	7.2	128	26	120	20	392	64	16	2	22.4	7.4
	Feb	7	7.6	164	24	125	25	300	60	18	3	18.6	5.8
	Jan	7.6	8	192	24	115	20	292	64	16	3	26	7
2014	Dec	7.5	7.3	280	96	125	35	396	112	17.2	1.2	23.6	6.4
	Nov	7.5	7.8	156	14	135	9	316	32	16	4	23.2	4.2
	Oct	7.2	8	104	24	90	12	284	60	23	2	19	5.2
	Sept	7.9	8.3	100	16	95	20	224	56	20	3	16.2	5
	Aug	6.9	7.2	144	20	125	19	380	60	22	3	27.4	11.4
	July	6.9	7.6	96	14	95	17	284	68	22	2	3	0.4
	June	7.1	7.4	160	12	130	10	250	36	18	1.6	21	5.7
	May	7.5	7.6	148	12	95	15	268	60	16	2	2.1	1.8
	April	7.5	7.7	268	28	85	14	292	64	22	2	3.2	0.6
	March	7.7	7.9	332	32	145	30	460	120	27	2	1.9	0.5
	Feb	7.5	7.3	298	96	135	30	396	112	17.2	1.2	23.6	6.4
	Jan	7.5	7.9	156	20	130	24	420	76	16	2	0.9	0.16

Tables 4.18 Efficiency on the basis of TSS and BOD and seasonal efficiency for Rithala STP

Year	Efficiency	
	TSS	BOD
2018	89.5	86.2
2017	84.9	80.3
2016	85.3	82.4
2015	86.4	84.1
2014	82.8	80.2

Year	Efficiency			
	Winter (Dec-Feb)	Summer (March-May)	Monsoon (June- Sept)	Post monsoon (Oct-Nov)
2018	89.6	89.4	-	-
2017	87.7	83.2	84.5	87.7
2016	84.7	89.1	87.2	81.3
2015	88.5	88.5	83.8	88.0
2014	71.1	90.3	87.6	85.3

10. CORONATION PILLAR STP (30MGD)

Table 4.19 Different parameters for Coronation pillar STP

Year	Month	Parameter									
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10	
		In	Out	In	Out	In	Out	In	Out	In	Out
2018	April	7.6	7.5	228	32	95	24	292	80	12.4	2.8
	March	6.8	7.4	184	44	95	32	296	104	13.6	1.2
	Feb	7.1	7.3	240	30	120	22	348	56	17	2
	Jan	6.9	7.2	176	42	85	32	244	84	12.4	0.8
2017	Dec	7.1	7.4	208	46	105	34	312	108	14.8	2
	Nov	6.8	7.4	216	48	115	38	324	124	12.4	0.8
	Oct	7.1	7.3	176	42	85	32	244	84	14.8	2
	Sept	6.9	7.2	168	38	90	28	268	84	12	2.8
	Aug	7.1	7.4	208	46	105	34	312	108	12.4	2.8
	July	6.8	7.4	232	34	110	26	336	76	13.6	1.2
	June	7.1	7.3	183	48	96	31	296	104	17	2
	May	6.9	7.2	240	30	120	22	348	56	12.4	0.8
	April	7.1	7.4	240	48	130	36	380	72	14.8	2
	March	7.1	7.3	212	46	125	31	388	100	12.4	0.8
	Feb	7.0	7.2	160	46	130	34	372	104	14.8	2
	Jan	7.6	7.5	187	45	98	33	296	104	12	2.8
2016	Dec	6.8	7.4	240	30	120	22	348	56	12.4	2.8
	Nov	7.1	7.3	212	46	125	31	388	100	13.6	1.2
	Oct	6.9	7.2	160	46	130	34	372	104	17	2
	Sept	7.1	7.4	212	46	125	31	388	100	12.4	0.8
	Aug	6.8	7.4	280	20	120	17	368	60	14.8	2
	July	7.1	7.3	160	46	130	34	372	104	14.8	2
	June	6.9	7.2	187	45	98	33	296	104	12	2.8
	May	7.1	7.4	242	35	120	22	348	56	12.4	2.8
	April	6.8	7.4	215	46	125	31	388	100	13.6	1.2
	March	7.1	7.3	160	30	129	34	372	104	17	2
	Feb	6.9	7.2	216	46	125	31	388	100	12.4	0.8
	Jan	7.1	7.4	280	20	120	17	368	60	14.8	2
	Dec	7.6	7.5	380	22	120	20	372	68	17.2	1.6
	Nov	7.1	7.3	160	46	130	34	372	104	14.8	2
	Oct	7.1	7.3	164	18	140	16	436	48	19.2	1.2
	Sept	6.9	7.2	132	18	120	16	316	52	17	2
	Aug	7.4	7.8	212	22	115	20	380	64	17.6	1.6
	July	7.9	7.5	224	20	115	22	348	68	18	1.6

2 0 1 5	June	7.1	7.3	160	46	130	34	372	104	14.8	2
	May	7.2	7.6	220	20	100	25	312	60	17	3
	April	7.1	7.3	160	46	130	34	372	104	14.8	2
	March	7.1	7.3	187	45	98	33	296	104	12	2.8
	Feb	6.9	7.4	124	20	105	20	256	64	17	2.4
	Jan	7.3	7.9	132	18	120	16	316	52	17	2

Tables 4.20 Efficiency on the basis of TSS and BOD and seasonal efficiency for Coronation pillar STP

Year	Efficiency	
	TSS	BOD
2018	82.1	72.2
2017	79.2	71.1
2016	81.8	77.1
2015	84.8	79.6

Year	Efficiency			
	Winter (Dec-Feb)	Summer (March-May)	Monsoon (June- Sept)	Post monsoon (Oct-Nov)
2018	82.7	81.6	-	-
2017	75.3	82.1	81.3	78.1
2016	86.5	82.0	81.2	75.6
2015	90.5	80.4	85.4	80.2

11. DELHI GATE STP (2.2 MGD)

Table 4.21 Different parameters for Delhi gate STP

`Year	Month	Parameters											
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
2018	April	7.1	7.3	144	12	75	7	232	28	14	1.2	16.5	2.4
	March	6.9	7.4	124	10	65	8	184	32	13.6	0.8	17.6	0.8
	Feb	7.4	7.1	172	12	115	10	388	32	16.4	1.2	19.4	6.8
	Jan	7.4	7.1	144	4	80	2.2	220	8	11.	2	17.4	3.4
2017	Dec	7.4	7.2	132	10	105	8	308	28	12.4	0.8	18.4	3
	Nov	7.3	7.1	240	18	120	14	312	36	19.2	1.6	24.8	2.8
	Oct	7.4	7.1	172	12	115	10	388	32	16.4	1.2	19.4	6.8
	Sept	7.2	7.1	188	12	105	8	316	28	18	2	25.6	4.5
	Aug	6.8	6.6	160	8	95	6.2	284	20	16	0.8	18.4	5.8
	July	7.1	6.9	208	10	125	9	327	28	17.6	0.8	18.4	4.3
	June	7.4	7.1	172	12	115	10	388	32	16.4	1.2	19.4	6.8
	May	6.8	7.1	160	6	105	4.6	324	28	15.6	0.8	19.2	2.8
	April	7.7	7.1	232	4	135	4.4	380	16	17.6	0.4	20.3	2.4
	March	7.5	7.1	168	28	110	14	360	48	16	1.6	18.4	5.5
	Feb	7.3	7.2	176	6	120	5.6	384	24	15.6	0.4	17	3
	Jan	6.9	7.2	144	8	110	7.6	360	32	13.2	0.4	18.8	2.8
2016	Dec	6.3	7.2	136	12	95	8.2	328	36	12	0.4	21.3	5.5
	Nov	7.1	7.4	240	10	130	6.6	400	36	18	0.4	16.6	1.2
	Oct	7.7	7.4	152	6	110	5.2	360	36	14.4	0.4	20.8	4.8
	Sept	6.8	7.1	188	6	120	5.2	392	24	12.8	0.4	25.6	2.3
	Aug	7.1	7.3	184	10	135	6.8	420	32	12.4	0.4	24	2
	July	6.8	7.1	432	6	145	4.6	568	16	17.6	0.4	23.1	4.4
	June	6.7	7.5	176	4	100	3.6	276	16	11.6	0.4	21.6	3.7
	May	7.4	7.2	288	14	130	8.4	388	28	16.8	0.4	25.3	2.4
	April	7.1	7.3	240	10	120	6.6	410	32	18	0.4	20.8	3.2
	March	7.1	7.4	260	14	125	8.6	356	28	16	0.8	23.5	4.5
	Feb	7.2	7.1	188	10	120	4.2	324	16	12.8	0.4	19.2	2.8
	Jan	6.9	7.1	240	10	115	7.6	352	28	16	0.4	14.1	3.7
20	Dec	7.4	7.1	172	12	115	10	388	32	16.4	1.2	19.4	6.8
	Nov	6.9	7	112	8	80	6.2	260	24	9.6	.4	15.4	1.5
	Oct	7.1	7.5	136	8	100	6.6	296	36	16	.4	20.3	2.4
	Sept	7.4	7.3	168	12	90	7.2	272	20	14	.8	18.4	5.5
	Aug	7.6	7.5	480	14	130	8	368	32	16	.8	17	3
	July	7.7	7.1	512	14	125	10	368	40	16	1.2	18.8	2.8

15	June	6.7	6.8	440	12	120	10	352	48	16.8	.8	21.3	5.5
	May	7.3	7.1	200	14	125	10	348	52	15	1	16.6	1.2
	April	7.5	7.9	120	14	105	10	292	44	22	2	20.8	4.8
	March	7.4	7.2	280	14	130	8.6	388	25	16	0.4	24.2	2.3
	Feb	7.1	7.6	120	14	100	10	280	40	16	2	24	2
	Jan	6.9	7.3	124	14	115	10	252	36	12	1	23.1	4.4
2014	Dec	7.4	7.2	288	14	130	8.4	388	28	16.8	0.4	21.6	3.7
	Nov	7.2	7.8	156	14	150	10	276	40	18	2.4	18.6	5.9
	Oct	7.1	7.4	104	14	115	10	280	44	14	2	18.4	4.3
	Sept	7.5	7.2	100	12	105	9	288	44	18	3	19.4	6.8
	Aug	7	7.1	132	14	100	10	320	40	19	2	19.2	2.4
	July	7.6	7.4	112	12	90	10	296	40	25	1	20.3	2.4
	June	7.1	7.3	240	10	120	6.6	410	32	18	0.4	20.8	3.2
	May	7.3	7.1	200	14	125	10	348	52	15	1	16.6	1.2
	April	7.6	7.5	620	14	160	8	464	28	25	1	19.4	6.8
	March	6	7.1	304	10	180	10	500	56	30	1	17.4	3.4
	Feb	6.9	7.1	240	10	115	7.6	352	28	16	0.4	14.1	3.7
	Jan	7.1	7.4	312	14	190	9	520	48	26	1	0.37	0.1
2013	Dec	7.3	7.1	200	14	125	10	348	52	15	1	16.6	1.2
	Nov	7.7	7.6	296	14	180	9	524	44	24	1	2.7	0.8
	Oct	7.5	7.4	348	16	210	10	584	48	28	1	2.9	0.7
	Sept	7.5	7.4	320	16	140	10	580	48	24	2	1.1	0.07
	Aug	7.5	7.4	148	14	115	10	356	32	17	1	0.35	0.20
	July	6	7.1	304	10	180	10	500	56	30	1	17.4	3.4
	June	7.4	7.2	288	14	130	8.4	388	28	16.8	0.4	25.6	2.3
	May	7.5	7.4	372	15	125	10	396	56	33	1	2.86	0.7
	April	7.5	7.4	364	16	90	10	396	36	36	1	2.9	1.78
	March	7.4	7.3	252	14	180	10	560	40	28	2	1	0.2
	Feb	7.4	7.4	396	14	135	9	436	36	30	2	2.8	2.6
	Jan	7.6	7.7	120	14	130	10	400	44	22	1	0.7	0.02

Tables 4.22 Efficiency on the basis of TSS and BOD and seasonal efficiency for Delhi gate STP

Year	Efficiency	
	TSS	BOD
2018	93.4	91.8
2017	93.7	92.5
2016	95.5	94.7
2015	91.9	91.4
2014	94.4	93.1
2013	94.0	92.3

Year	Efficiency			
	Winter (Dec-Feb)	Summer (March-May)	Monsoon (June- Sept)	Post monsoon (Oct-Nov)
2018	94.7	91.7	-	-
2017	94.5	93.2	94.2	92.7
2016	94.3	95.1	96.3	95.9
2015	90.3	93.0	94.5	92.2
2014	95.4	96.3	91.7	89.2
2013	93.1	94.4	94.9	95.3

12. OKHLA (170 MGD)

Table 4.23 Different parameters for Okhla STP

Year	Month	Parameters											
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	In	In	Out	In	Out	In	Out
2018	April	7.4	7.6	232	24	95	18	296	60	13.6	1.2	26.8	6.3
	March	7.2	7.4	244	18	105	12	324	40	14.8	1.6	22	3.4
	Feb	6.8	7.4	320	24	150	16	436	56	19.6	1.2	29.8	2.7
	Jan	7.3	7.5	224	20	125	12	368	40	16.4	0.8	26.5	2
2017	Dec	7.4	7.3	294	20	145	16	428	52	24.4	1.6	23.6	3.8
	Nov	7.5	7.4	288	16	120	12	376	48	23.2	0.4	22.6	.2
	Oct	7.1	7.4	224	10	115	8	316	24	22.4	1.8	19.6	4
	Sept	6.9	7.1	172	20	85	15	256	48	20.4	2.4	17	5.2
	Aug	7.2	7.6	300	16	130	13	388	48	17.6	1.6	28	4.6
	July	7.1	7.4	268	24	140	18	424	56	17.6	1.6	20.2	4.9
	June	7.6	8.0	200	24	120	21	360	60	16.8	1.2	21	5.1
	May	7.6	7.8	260	34	130	24	408	72	18.4	2.8	22	8.6
	April	7.2	7.6	300	18	135	15	396	48	14.8	1.6	24.9	7.3
	March	7.4	7.6	284	26	140	18	428	56	19.6	1.2	21.7	4.5
	Feb	7.2	7.4	224	14	135	11	412	56	16.4	0.8	19.4	4.2
	Jan	6.8	7.4	216	28	120	21	388	64	17.6	1.2	21	5
2016	Dec	7.3	7.5	140	24	125	20	388	52	23.2	0.4	22.9	6.5
	Nov	7.4	7.3	316	14	145	12	420	48	18.8	0.8	28.9	6.1
	Oct	7.5	7.4	356	28	145	23	444	68	20.4	2.4	28	6.2
	Sept	8.1	8	224	36	140	27	436	84	18	2	25.6	6
	Aug	6.7	7.6	320	28	140	25	444	80	18.4	1.6	28.6	5.9
	July	6.8	6.9	460	34	150	21	432	68	15.6	1.2	24	6
	June	7.2	7.3	196	24	105	18	340	64	16.4	1.2	28.6	5.6
	May	7.3	7.4	156	36	115	24	340	76	17	2	31	6.4
	April	7.3	7.5	280	22	145	23	323	48	19.6	1.2	25.7	5.3
	March	7.4	7.3	224	36	140	19	404	56	17.6	0.8	24.2	4.6
	Feb	7.5	7.4	320	28	140	21	390	40	24.4	1.6	27.9	6
	Jan	7.4	7.6	200	28	110	22	344	68	16.8	2.8	28	5.5
2015	Dec	7.2	7.4	172	20	120	16	324	64	18	0.8	28.5	5.5
	Nov	6.8	7.4	168	38	100	26	240	72	12.8	1.6	22	5
	Oct	6.9	7.5	172	22	120	22	392	68	19.2	1.6	23.7	6
	Sept	7.0	7.1	324	22	130	21	328	64	18	1.6	25.8	5.6
	Aug	7.4	7.3	156	36	115	16	380	56	24.4	1.6	23.6	6.4

	July	7.5	8	292	24	125	22	364	64	17	2	32	9.8
	June	7.4	7.6	168	40	100	26	369	40	24.4	1.6	28.6	6.4
	May	7.3	7.4	188	28	130	24	392	60	18	2	33	9.6
	April	7.2	7.6	224	20	145	18	260	56	18	2	21.9	7.4
	March	7.4	7.6	169	38	110	26	315	24	20.4	2.4	22.4	7.4
	Feb	7.6	8.0	192	24	115	20	340	64	17.6	3	21.6	5.8
	Jan	7.6	7.8	220	18	140	18	380	48	17.6	1.6	26	7
	Dec	7.3	7.5	192	24	115	20	424	56	16.8	1.2	23.6	6.4
	Nov	7.7	7.9	208	20	185	17	300	52	16.4	2.8	21.6	7.8
	Oct	7.2	7.4	220	20	155	20	340	52	17	3	20	5.2
2	Sept	7.1	7.4	220	26	150	19	432	52	15	3	20	9.8
0	Aug	7.2	7.6	220	36	150	29	528	84	15	1	20	15.3
1	July	7.3	7.5	168	38	100	26	408	72	24.4	1.6	3	0.4
4	June	7.4	7.3	172	22	120	22	396	48	18.4	2.8	21	5.7
	May	7.6	7.8	172	20	95	20	396	72	18	1.6	2.1	0.8
	April	7.3	7.4	240	16	105	15	340	68	18	1	2.4	1.7
	March	7.2	7.2	106	16	95	14	320	52	16	1	1.9	0.5
	Feb	7.1	7.6	208	20	185	18	425	52	23.2	0.4	23.6	6.4
	Jan	7.6	8.3	140	20	105	18	376	48	15	1	0.9	0.16
	Dec	7.0	7.1	324	22	130	21	328	64	18	1.6	25.8	5.6
	Nov	8.4	8.5	168	34	135	26	340	92	15	2	3.12	0.6
	Oct	7.7	7.6	136	28	110	22	364	88	14	4	3.11	2.2
2	Sept	7.4	7.3	176	16	120	20	448	64	22	1	1.6	1.1
0	Aug	7.4	7.3	136	10	140	20	476	68	14	2	2.7	0.9
1	July	7.3	7.5	220	36	150	29	528	84	15	1	20	15.3
3	June	7.4	7.3	168	38	100	26	408	72	24.4	1.6	3	0.4
	May	7.4	7.3	132	12	100	18	296	60	24	2	3.4	1.2
	April	7.6	7.5	120	16	125	26	568	100	16	2	2.8	0.1
	March	7.7	7.5	124	24	110	20	364	72	20	3	1.4	0.5
	Feb	7.4	7.3	156	24	105	24	320	68	22	4	4	0.1
	Jan	7.4	7.4	112	28	139	22	412	88	24	3.2	2.1	1.5

Tables 4.24 Efficiency on the basis of TSS and BOD and seasonal efficiency for Okhla STP

Year	Efficiency	
	TSS	BOD
2018	91.5	87.8
2017	91.1	87.3
2016	88.9	84
2015	86.7	82.4
2014	87.8	84.7
2013	85.3	81.2

Year	Efficiency			
	Winter (Dec-Feb)	Summer (March-May)	Monsoon (June- Sept)	Post monsoon (Oct-Nov)
2018	91.8	91.2	-	-
2017	91.4	90.5	91.0	93.2
2016	87.8	85.7	89.2	92.1
2015	89.3	85.1	87.0	83
2014	88.1	89.9	84.3	90.1
2013	87.5	86.1	85.7	79.6

13. ROHINI STP (15 MGD)

Table 4.25 Different parameters for Rohini STP

Year	Month	Parameters											
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
2018	April	6.9	7.6	284	48	130	32	384	32	19.2	2.4	20.6	4.4
	March	7.9	7.7	168	48	70	38	220	120	13.2	2.4	26	4.6
	Feb	7.1	7.7	240	52	105	36	308	116	19.6	2.4	20.4	3
	Jan	7.1	7.3	236	56	110	38	324	124	18.4	1.9	19.7	9
2017	Dec	7.1	7.5	192	52	110	36	328	128	13.6	1.2	25	7.3
	Nov	7.1	7.4	212	46	105	38	324	108	16.4	1.6	21.3	3.4
	Oct	7.2	7.1	200	44	80	36	248	128	13.6	1.2	24.2	6
	Sept	6.7	7.2	156	22	75	18	228	56	14	1	29	4.1
	Aug	7.5	7.6	280	30	120	24	360	72	18	2	17.1	9.9
	July	7.5	7.2	116	44	95	34	280	112	13.2	1.6	19.7	9
	June	7.1	7.3	236	56	110	38	324	124	18.4	1.9	25	7.3
	May	8.3	7.5	276	44	120	29	360	88	13.6	1.6	32.4	6.4
	April	7.2	6.8	460	84	165	36	480	108	19.2	3.2	18.8	5.9
	March	7.5	7.6	268	40	145	32	424	92	18	2	26	4
	Feb	7.9	7.7	632	54	225	34	636	108	30	2	20.4	3
	Jan	6.9	7.3	672	40	160	34	480	92	21.6	2.4	19.7	9
2016	Dec	7.5	7.6	280	30	120	24	360	72	18	2	25	7.3
	Nov	7.5	7.2	116	44	95	34	280	112	13.2	1.6	25.7	4.7
	Oct	6.8	8	248	32	145	28	416	96	17.2	2.4	32.4	6.4
	Sept	7.5	7.7	188	40	140	21	400	60	17.2	2.4	26.9	5.2
	Aug	6.8	7.3	204	40	135	34	408	108	17.2	1.6	24.2	6
	July	6.3	7.3	244	64	125	32	388	88	16.8	2	29	4.1
	June	7.4	7.5	352	64	150	31	460	84	18	2	4	2.8
	May	7.4	7.7	160	42	125	33	376	88	17.6	2	19.7	9
	April	7.9	7.7	632	54	225	34	636	108	30	2	21.3	3.4
	March	6.9	7.3	672	40	160	34	480	92	21.6	2.4	24.2	6
	Feb	7.5	7.6	280	30	120	24	360	72	18	2	29	4.1
	Jan	7.3	7.4	372	38	145	30	428	88	16.8	1.2	4	2.8
201	Dec	7.5	7.6	268	40	145	32	424	92	18	2	21.3	3.4
	Nov	7.5	7.6	268	40	145	32	424	92	18	2	24.2	6
	Oct	7.5	7.4	224	54	155	36	456	108	20	2.4	32.4	6.4
	Sept	7.5	7.7	180	40	140	21	400	60	17.2	2.4	21.3	3.4
	Aug	7.4	7.7	160	42	125	33	376	88	17.6	2	21.3	3.4

5	July	7.9	7.7	632	54	225	34	636	108	30	2	30.2	11.6

Year	Efficiency	
	TSS	BOD
2018	78	66
2017	84.1	75.2
2016	86.1	78.7
2015	84.4	79.8

Year	Efficiency			
	Winter (Dec-feb)	Summer (march-may)	Monsoon (june- sept)	Post monsoon (oct-nov)
2018	77.3	78.7	-	-
2017	89.2	83.2	80.7	79.1
2016	89.4	90.7	78.9	79.2
2015	85.0	-	86.0	80.9

Tables 4.26 Efficiency on the basis of TSS and BOD and seasonal efficiency for Rohini STP

14. VASANT KUNJ STP (5.2 MGD)

Table 4.27 Different parameters for Vasant kunj STP

Year	Month	Parameters											
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	In	In	Out	In	Out	In	Out
2	April	6.9	7.6	332	44	160	32	472	96	20.4	2.0	34.7	8.4
0	March	7.2	7.6	276	60	155	48	448	152	18	2	12.6	6.3
1	Feb	7.2	7.6	112	48	65	32	184	108	10.4	2	29.8	2.7
8	Jan	7.3	7.5	152	68	95	52	272	136	13.2	2.8	18.4	4.1
	Dec	7.6	7.2	276	60	155	48	448	152	18	2	22.6	.2
	Nov	7.5	7.8	212	46	105	38	324	108	16.4	1.6	19.6	4
	Oct	7.5	7.8	200	44	80	36	248	128	13.6	1.2	17	5.2
2	Sept	7.6	7.9	156	22	75	18	228	56	14	1	28	4.6
0	Aug	7.8	7.6	256	32	130	24	384	72	17.2	2.4	20.2	4.9
1	July	7.4	7.5	236	16	125	13	376	44	16.8	.8	21	5.1
7	June	7.6	7.8	260	34	130	24	408	72	18.4	2.8	22	8.6
	May	7.6	7.2	276	60	155	48	448	152	18	2	24.9	7.3
	April	7.3	7.7	268	28	145	24	436	72	17.2	2	21.7	4.5
	March	7.2	7.6	460	84	165	36	480	108	13.5	1.2	19.4	4.2
	Feb	7.6	7.2	276	60	155	48	448	152	18	2	21	5
	Jan	7.5	7.9	384	28	145	25	440	76	18.4	1.6	22.9	6.5
	Dec	6.5	6.8	368	64	150	34	440	100	18.4	2.4	28.9	6.1
	Nov	7.5	7.8	340	24	150	20	444	68	14.8	1.6	28	6.2
	Oct	7.1	7.8	348	34	150	25	460	76	19.6	2.4	25.6	6
2	Sept	7.6	7.9	260	24	140	19	468	60	18.8	1.2	28.6	5.9
0	Aug	7.1	7.8	424	44	160	34	460	108	19.6	2.4	30	5
1	July	7.6	7.9	204	40	135	34	408	108	18.4	1	28.6	5.6
6	June	7.2	7.6	212	28	125	22	360	68	12	1.2	31	6.4
	May	7.3	7.6	288	28	130	22	340	60	22	1.2	25.7	5.3
	April	7.3	7.6	200	24	110	20	340	60	17	2	24.2	4.6
	March	7.5	7.8	212	46	105	38	324	108	16.4	1.6	27.9	6
	Feb	7.5	7.8	200	44	80	36	248	128	13.6	1.2	28	5.5
	Jan	7.6	7.9	156	22	75	18	228	56	14	1	28.5	5.5
	Dec	7.3	7.8	372	38	145	30	436	152	17	2	22	5
	Nov	7.6	7.2	276	60	155	48	448	152	18	2	23.7	6
	Oct	7.5	7.9	268	40	145	32	424	92	13.6	1.2	25.8	5.6
	Sept	6.5	6.8	224	54	155	36	456	108	14	1	23.6	6.4
	Aug	7.1	7.2	164	4	105	3.6	320	20	12.4	0.4	28	3.4
	July	7.8	7.6	256	32	130	24	384	72	17.2	2.4	28.6	6.4

2015	June	7.2	7.6	288	28	130	22	340	60	22	1.2	34.2	6
	May	7.3	7.6	200	24	110	20	340	60	17	2	20	6
	April	7.3	7.6	200	24	120	20	430	60	16	1.2	28	7
	March	7.3	7.6	200	24	110	20	430	60	17	2	22.4	7.4
	Feb	7.1	7.2	156	24	130	20	396	60	18	2	22	6.4
	Jan	8	8.3	160	22	130	17	304	38	12	2	25	5.8

Tables 4.28 Efficiency on the basis of TSS and BOD and seasonal efficiency for Vasant Kunj STP

Year	Efficiency	
	TSS	BOD
2018	74.2	66.8
2017	84.2	76.5
2016	86.6	78.9
2015	84.4	79.8

Year	Efficiency			
	Winter (Dec-Feb)	Summer (March-May)	Monsoon (June- Sept)	Post monsoon (Oct-Nov)
2018	65.6	82.7	-	-
2017	84.1	82.8	88.5	79.2
2016	82.1	86.0	87.6	90.4
2015	87.7	87.9	87.3	81.1

15 SEN NURSING HOME (2.2 MGD)

Table 4.29 Different parameters for Sen nursing home STP

Year	Month	Parameters											
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil and grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	In	In	Out	In	Out	In	Out
2018	April	6.9	7.1	156	8	75	5	232	20	15.2	.4	19.7	2.7
	March	7.5	7.1	148	10	70	8	220	28	14.8	.8	23.7	2.7
	Feb	7.1	7.6	144	12	80	8	224	36	11.2	.4	20	2.9
	Jan	7.2	7.5	160	8	75	6	236	28	12.2	.8	22.4	2.6
2017	Dec	7.4	7.2	144	10	105	6	320	28	13.2	.8	21.6	3
	Nov	7.4	7.3	216	8	105	6	17.3	24	14.8	.8	25.4	3.4
	Oct	7.2	7.6	192	12	105	5.5	312	16	16.4	1.2	22	2.7
	Sept	7.5	7.2	348	46	155	24	460	76	18.8	2.4	24.8	3.8
	Aug	6.9	6.7	200	6	110	4.4	332	16	17.2	.4	27	9.2
	July	7.4	7.5	180	14	110	9	332	28	15.2	1.6	29	6.1
	June	6.8	7.7	208	10	125	8	376	24	17.2	1.2	24.9	8.2
	May	6.9	7.2	172	8	120	4.4	36	24	16.4	.4	18.4	5.3
	April	7.7	7.4	180	8	120	5.6	296	20	16	.4	27	6
	March	7.5	7.3	280	10	145	8	440	28	17.2	.8	27.4	8.2
	Feb	7.5	7.2	348	46	155	24	460	76	18.8	2.4	27	4.2
	Jan	6.8	7.6	240	14	130	10	376	36	14	.8	23.4	6.8
2016	Dec	7.5	7.4	204	4	130	4.6	412	32	13.6	.4	24.5	6.3
	Nov	7.1	7.4	176	14	105	7.6	364	7.6	16.8	.8	16.3	5.9
	Oct	7.6	8	212	8	135	5.8	396	28	16.4	.4	26.2	3.1
	Sept	7.1	7	148	6	105	5.6	352	28	14.4	.4	24	4.3
	Aug	7.2	7.1	192	8	110	7	376	36	14.4	.8	27	2.2
	July	7.2	7	356	12	135	6.6	408	32	17.2	.4	28.7	5.8
	June	7.3	6.9	192	8	140	7.4	400	28	16	.4	25.2	9.1
	May	7.3	7.8	168	12	135	7.6	332	28	15.2	1.6	24	7.3
	April	7.1	7.2	160	10	100	7.6	376	24	17.2	1.2	27	9.2
	March	7.2	7.3	268	12	135	8	36	24	16.4	.4	28.7	5.8
	Feb	7.1	7.4	176	14	105	7.6	364	7.6	16.8	.8	24	7.3
	Jan	6.8	7.1	220	10	105	7.8	440	28	17.2	.8	20.8	5.0
20	Dec	7.1	7.4	196	14	110	7.6	364	7.6	16.8	.8	26.2	9.1
	Nov	6.9	7	232	8	110	7.6	376	36	14	.8	17.8	5.4
	Oct	7.5	7.7	176	10	125	6	412	32	13.6	.4	17	4.5
	Sept	7.2	7.1	136	10	115	8	376	36	14.4	.8	20	5.3
	Aug	6.9	7.2	512	12	140	7.8	408	32	17.2	.4	29	5.2
	July	7.5	7.2	136	12	100	10	420	26	17.2	.4	22	5.1
	June	7.2	7.1	136	10	115	8	332	28	15.2	1.6	29	6.2

15	May	7.2	7.4	124	14	110	8	370	24	17.2	1.2	17	4.5
	April	7.5	7.8	140	12	115	10	36	24	16.4	.4	20.8	5.6
	March	6.9	7.2	156	20	120	8	384	40	15	2	29.2	6.2
	Feb	8	8.3	144	14	105	10	240	56	15	2	17.8	5.4
	Jan	7.1	7.9	136	16	125	10	276	32	22.8	3.8	20	2.4
2014	Dec	7.1	6.9	180	12	150	9	396	56	12	1	21	5
	Nov	7.5	7.8	156	14	135	9	316	32	16	4	23.2	4.1
	Oct	7.1	7.6	148	12	135	9	240	44	12	1	21	4.2
	Sept	7.1	6.9	180	12	150	9	396	56	12	1	21	5
	Aug	7.4	7.5	176	14	130	10	400	40	22	1	21.3	5.2
	July	7.6	7.7	140	14	110	8	324	44	13	2	3.2	0.2
	June	7.4	7.6	88	12	120	13	468	64	12	1	2.3	0.4
	May	7.5	7.7	280	12	95	10	396	32	18	1	0.5	0.3
	April	7.6	7.4	160	12	120	8	248	40	22	1	3.7	0.9
	March	7	7.2	320	14	165	9	620	52	30	2	1.7	0.5
	Feb	7.1	6.9	180	12	150	9	396	56	12	1	21	5
	Jan	7.7	7.6	300	12	150	8	500	48	25	1	1.5	1.2

Tables 4.30 Efficiency on the basis of TSS and BOD and seasonal efficiency for Sen nursing home STP

Year	Efficiency	
	TSS	BOD
2018	93.7	91
2017	92.9	92.1
2016	95.2	94.25
2015	91.5	92.7
2014	92.4	92.8

Year	Efficiency			
	Winter (Dec-feb)	Summer (march-may)	Monsoon (june- sept)	Post monsoon (oct-nov)
2018	93.4	94.0	-	-
2017	90.4	94.5	91.8	93.8
2016	95.3	93.1	96.1	94.3
2015	90.4	89.0	93.2	94.1

16 KONDLI STP (45 MGD)

Table 4.31 Different parameters for Kondli STP

Year	Month	Parameters											
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
2018	April	7.2	7.1	296	54	135	34	408	92	20.4	3.6	29.8	5.6
	March	6.9	7.1	264	42	120	26	372	84	18.4	3.2	28.6	6.9
	Feb	6.7	7.3	288	44	125	30	364	96	19.6	2.4	24.6	6.4
	Jan	7.2	74	268	48	115	32	336	104	17.2	3.6	25.5	6
2017	Dec	7.4	7.3	340	52	190	34	568	112	21.6	2	29.2	6.2
	Nov	7.1	7.3	284	56	120	38	324	104	18.4	2.8	28.6	6.4
	Oct	7.2	7.6	212	44	105	26	320	84	13.6	.8	28.4	4.4
	Sept	6.8	7.3	292	54	155	32	460	96	18.4	1.6	32.6	8.1
	Aug	7.1	7.4	124	44	105	28	316	84	14.4	2	20.2	10.6
	July	7.2	7.4	300	68	120	36	360	108	16.8	2.8	22.5	7.1
	June	7.3	7.6	188	48	105	38	288	112	15.2	2.4	16.6	4.8
	May	7.5	7.8	244	40	120	36	364	104	12.8	2.4	17.2	4.3
	April	7.5	7.6	208	24	115	20	336	64	16.4	1.6	26	6.2
	March	7.3	7.6	328	60	165	34	480	124	18.4	2.0	26.3	9.2
	Feb	7.1	7.4	288	44	145	25	448	80	18	2.4	22.3	6.4
	Jan	6.5	6.9	280	28	135	24	400	76	18.8	1.6	20.8	7.4
2016	Dec	7.4	7.6	164	32	120	26	364	88	12.4	.8	21	5.9
	Nov	7.5	7.7	288	34	130	19	404	60	18	1.6	23	7
	Oct	6.5	7.6	136	30	115	22	320	68	16.4	1.6	21.5	5
	Sept	6.7	7.6	172	20	135	18	428	56	18	1.6	27.7	5.5
	Aug	7.3	7.4	212	18	145	15	444	48	16	1.2	28.7	5.8
	July	6.7	7.3	304	30	140	22	420	60	16	1.6	25.2	6.8
	June	6.9	7.6	272	14	110	12	308	44	16	.8	27	5.7
	May	7.3	6.7	196	44	115	27	360	72	18	2	27	5
	April	6.8	7.4	240	24	130	20	396	64	16	1.6	28.3	6.6
	March	6.9	7.4	188	26	120	18	388	56	16	1.2	20	5.9
	Feb	6.8	7.3	272	28	145	23	424	64	18.4	1.6	22.8	6.2
	Jan	7.3	7.4	212	18	145	15	444	48	16	1.2	28.7	5.8
	Dec	6.7	7.3	304	30	140	22	420	60	16	1.6	25.2	6.8
	Nov	7.2	7.3	228	24	130	23	392	72	20	1.2	17.3	5
	Oct	6.9	7	220	32	120	22	388	62	18	1.6	20	5.3
	Sept	7.1	7.3	228	36	125	29	368	76	17.6	1.2	20	5
	Aug	7.5	7.2	288	34	130	26	404	72	18.8	2	22	6.2
	july	8	7.9	292	36	135	24	396	72	17	1.6	34	9.8

2015	June	6.9	7.1	312	30	130	23	356	64	18.8	0.8	30	8.6
	May	7	7.7	240	22	120	23	348	64	17	3	27	5.6
	April	7.4	7.3	236	28	140	20	480	60	15	2	23.8	6.2
	March	7.1	8	136	28	110	23	312	80	16	2	19.6	5.4
	Feb	7.4	7.6	168	24	115	23	288	60	14	2	22.2	6.2
	Jan	7.1	7.3	120	20	105	15	300	44	11	3	24	4.1
2014	Dec	7.5	7.9	228	28	150	20	528	74	16	3	11.5	2.6
	Nov	7	7.8	176	30	155	24	312	60	16.8	3.2	19	5.2
	Oct	7.5	7.4	188	30	150	26	544	92	15	1	3.5	1.8
	Sept	7.3	8.3	112	36	145	19	304	96	20	2	17	7.8
	Aug	7	7.2	136	36	100	27	320	100	18	2	24	9.2
	July	7.5	7.9	228	28	150	20	528	74	16	3	1.5	.36
	June	6.2	6.8	140	48	160	28	640	136	15	4	1.5	.8
	May	7.6	7.6	328	18	140	16	428	64	24	1	1.26	.4
	April	7.8	7.5	188	30	150	26	544	92	15	1	3.5	1.8
	March	7	7.7	456	18	160	30	740	136	32	2	3.3	1.2
	Feb	6.7	7.3	304	30	140	22	420	60	16	1.6	25.2	6.8
	Jan	7.5	7.1	400	28	140	28	420	84	28	2	1.5	0.4
2013	Dec	7.6	7.6	244	26	125	18	486	72	16	2	1.1	0.6
	Nov	7.6	7.5	244	32	125	20	496	76	18	2	1.2	0.7
	Oct	8.1	7.3	424	24	160	30	496	120	32	4	1.6	1.5
	Sept	7.7	7.6	236	34	85	28	424	80	18	4	1.3	0.5
	Aug	7.8	7.7	184	34	155	30	544	88	23	4	0.9	0.4
	July	7.1	7.3	380	24	160	32	496	120	32	4	1.6	1.5
	June	7.8	7.8	360	28	140	25	436	84	33	3	2.8	0.2
	May	7.8	7.7	364	24	140	22	436	76	33	2	2.9	0.2
	April	7.8	7.7	324	26	110	24	404	88	35	2	4.7	3.5
	March	7.6	7.5	328	24	145	24	468	100	32	2	2	0.5
	Feb	7.6	7.5	284	28	115	26	300	96	24	3	5.19	3.5
	Jan	7.0	7.5	184	34	90	28	296	108	20	4.4	1.7	1.1

Year	Efficiency	
	TSS	BOD
2018	83.1	75.75
2017	81.8	76.5
2016	88.1	83.2
2015	87.6	81.8
2014	83.6	82.9
2013	89.5	81.1

Year	Efficiency			
	Winter (Dec-Feb)	Summer (March-May)	Monsoon (June-Sept)	Post monsoon (Oct-Nov)
2018	83.4	82.8	-	-
2017	86.3	84.1	76.9	80.1
2016	87.9	84.9	91.4	84.8
2015	87.5	87.2	87.8	87.5
2014	90.7	93.2	76.1	83.5

Tables 4.32 Efficiency on the basis of TSS and BOD and seasonal efficiency for Kondli STP

17. Keshopur STP (60 MGD)

Table 4.33 Different parameters for Keshopur STP

Year	Month	Parameters											
		pH (STP standard) 5.5-9		TSS (mg/l) 50		BOD (mg/l) 30		COD (mg/l) 250		Oil & grease (mg/l) 10		Ammonical N (mg/l) 50	
		In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
2018	April	7.1	7.2	264	46	95	33	292	104	18.8	2	31	5.6
	March	6.9	7.1	252	56	110	40	324	136	18.4	1.6	34	5.1
	Feb	6.7	7.3	336	42	130	30	372	96	19.6	1.6	29	6.4
	Jan	6.8	7.2	356	56	180	42	524	116	21	1.6	31	7.6
2017	Dec	7.4	7.5	340	62	195	42	568	112	21.6	6.4	32.4	8.1
	Nov	7.1	7.3	284	56	120	38	324	104	18.4	2.8	28.6	6.4
	Oct	7.2	7.2	328	56	125	36	384	128	18.4	5.6	28.4	6.4
	Sept	6.8	7.3	344	66	140	24	420	76	20.4	6.8	32.6	7
	Aug	6.6	6.8	200	140	105	58	316	176	18	1.4	27	11
	July	7.2	7.2	212	90	125	46	376	136	16.8	2.8	26.2	7.1
	June	7.3	7.6	188	48	105	38	288	112	15.2	2.4	16.6	4.8
	May	7.1	7.1	372	102	165	48	496	144	20.4	4.8	17.2	9.2
	April	7.1	6.9	428	90	160	38	396	116	18.4	1.6	26	8.7
	March	7.3	7.6	328	60	165	34	480	124	18.4	2.0	26.3	9.2
	Feb	7.1	7.4	288	44	145	25	448	80	18	2.4	22.3	6.4
	Jan	6.7	6.9	300	60	135	31	412	92	18.8	2	27.4	6.7
2016	Dec	7.4	7.6	288	24	140	18	432	60	18	2	25	4.2
	Nov	7.1	7.7	292	14	10	11	440	36	20	1.6	27.9	7
	Oct	7.3	7.6	128	36	100	28	320	84	18	1.6	21.5	5
	Sept	7.9	7.6	192	38	110	35	428	56	18	1.6	27.7	5.5
	Aug	7.3	7.4	332	80	155	33	444	84	20	2	35	8.6
	July	6.7	7.3	304	30	140	22	420	60	16	1.6	25.2	6.8
	June	6.9	7.6	272	14	110	12	308	44	16	.8	27	5.7
	May	7.3	6.7	196	44	115	27	360	72	18	2	27	5
	April	6.8	7.4	240	24	130	20	396	64	16	1.6	28.3	6.6
	March	6.9	7.4	188	26	120	18	388	56	16	1.2	20	5.9
	Feb	6.8	7.3	272	28	145	23	424	64	18.4	1.6	22.8	6.2
	Jan	7.3	7.4	212	18	145	15	444	48	16	1.2	28.7	5.8
	Dec	6.7	7.3	304	30	140	22	420	60	16	1.6	25.2	6.8
	Nov	7.2	7.3	228	24	130	23	392	72	20	1.2	17.3	5
	Oct	6.9	7	220	32	120	22	388	62	18	1.6	20	5.3
	Sept	7.1	7.3	292	26	125	21	368	64	18.4	1.2	21.2	5
	Aug	7.5	7.2	288	34	130	26	404	72	18.8	2	22	6.2
	July	7.9	7.5	248	26	155	24	464	64	18	1.6	34	11

2015	June	6.9	7.1	312	30	130	23	356	64	18.8	0.8	30	8.6
	May	7	7.7	240	22	120	23	348	64	17	3	27	5.6
	April	7.4	7.3	236	28	140	20	480	60	15	2	23.8	6.2
	March	7.1	8	136	28	110	23	312	80	16	2	19.6	5.4
	Feb	6.9	7.9	228	28	150	24	420	96	20	3	20.2	6.2
	Jan	7.1	7.3	120	20	105	15	300	44	11	3	24	4.1
2014	Dec	7.5	7.9	228	28	150	20	528	74	16	3	11.5	2.6
	Nov	7	7.8	176	30	155	24	312	60	16.8	3.2	19	5.2
	Oct	7.5	7.6	188	30	150	26	544	92	15	1	3.5	1.8
	Sept	7.3	8.3	112	36	145	19	304	96	20	2	17	7.8
	Aug	7	7.2	124	24	100	23	300	80	12	1	28.2	14
	July	6.8	7.5	124	34	90	20	296	64	31	1	2.04	1
	June	7.7	8.1	340	12	180	10	640	36	31	1	1.5	.8
	May	7.6	7.6	328	18	140	16	428	64	24	1	1.26	.4
	April	7.1	7.9	540	38	135	23	420	92	26	2	1.36	.3
	March	7	7.2	552	30	145	20	520	72	22	3	2.5	1.2
	Feb	6.7	7.3	304	30	140	22	420	60	16	1.6	25.2	6.8
	Jan	7.8	7.9	312	20	185	12	500	56	24	2	1.5	0.4
2013	Dec	8.5	8.7	224	22	130	16	420	72	28	1	1.14	0.1
	Nov	8.4	8.2	220	26	105	22	380	92	24	3	1.3	0.3
	Oct	8.2	8.1	224	22	110	20	360	88	24	4	1.03	0.3
	Sept	7.5	7.4	296	30	115	18	392	80	23	4	3.1	0.1
	Aug	7.7	7.6	140	14	130	22	404	68	17	2	1.3	0.4
	July	7.5	7.4	135	16	135	24	416	72	16	2	0.24	0.1
	June	7.5	7.5	132	20	135	26	416	72	16	3	0.3	0.1
	May	7.7	7.6	404	24	205	18	564	68	35	2	0.8	0.2
	April	7.7	7.6	296	44	215	20	860	124	24	1	1.5	0.7
	March	7.6	7.5	312	34	195	23	788	80	24	1	1.5	0.9
	Feb	7.8	7.7	236	28	130	24	444	64	22	3	3.15	2.9
	Jan	7.6	7.6	360	24	135	20	452	72	24	4	2.7	1.8

Tables 4.34 Efficiency on the basis of TSS and BOD and seasonal efficiency for Keshopur STP

Year	Efficiency	
	TSS	BOD
2018	83.8	72.4
2017	76.8	72.8
2016	87.1	81.6
2015	88.5	82.8
2014	89.9	86.2
2013	89.8	87.2

Year	Efficiency			
	Winter (Dec-Feb)	Summer (March-May)	Monsoon (June-Sept)	Post monsoon (Oct-Nov)
2018	85.4	80.2	-	-
2017	82.1	77.8	66.1	81.6
2016	90.3	84.8	85.2	88.0
2015	88.0	87.5	89.4	87.4
2014	87.8	93.1	84.8	83.5
2013	86.8	92.4	86.6	82.9

CHAPTER 5

RESULT AND DISCUSSION

The analysis of our study has been depicted in the form of graphs. The graphs are made on the basis of three different parameters that we have considered to eventually conclude the result for the two inferences: best performing and worst performing STPs. Taken into consideration are 17 STPs from in and around the city, whose individual efficiency is calculated on the basis of the incoming and outgoing effluents. This also shows the trend of the plant in the given time in the past few years. Further, contemplating this trend, we come to vis-a-vis with the technologies used in these treatment plants. From the many technologies that exist, we take into account TSS and BOD as the two parameters for further evaluation, and their overall efficiency as the third one, to draw up the concluded graphs.

5.1 RESULT

Table 5.1 Average value of efficiency for the removal of TSS

	STP	2018	2017	2016	2015	2014	2013	Average efficiency	Technology
1	Najafgarh	84.14	86.3	87.5	87.25	86.7	87.3	86.53166667	Extended aeration
2	Mehrauli	76.27	84.7	94.9	89.4	87.4	90.1	87.12833333	Extended aeration
3	Pappankala	94.8	93.8	94.2				94.26666667	ASP
4	Kapashera	95.6	92.6	94.5				94.23333333	ASP
5	Akshardham	97.4	98.5	97.2	96.7			97.45	MBR
6	Yamuna vihar	83.6	82.5	86.1	88.1	84.9	88.1	85.55	ASP
7	Nilothi	85.8	81	84.2	85.2		86.9	84.62	ASP
8	Narela	83.2	85.1	88.7	86.7	87.7	89.1	86.75	ASP
9	Rithala	89.4	84.9	85.3	86.4	82.8		85.76	ASP
10	Coronation pillar	82.1	79.2	81.8	84.8			81.975	ASP
11	Delhi gate	93.4	93.7	95.5	91.9	94.4	93.9	93.8	BIOFOR
12	Okhla	91.5	90.7	89.4	86.7	87.7	85.3	88.55	ASP
13	Rohini	78	84.1	86.1	84.4			83.15	ASP
14	Vasant kunj	74.7	84.2	86.6	84.4	85.1		83	Extended aeration
15	Sen nursing home	93.7	92.9	95.2	93.1	92.4	92.8	93.35	BIOFOR
16	Kondli	83.1	81.8	88.1	87.6	83.6	89.5	85.61666667	ASP
17	Keshopur	83.8	76.8	87.1	88.5	89.9	89.8	85.98333333	ASP

Table 5.2 Average value of efficiency for the removal of BOD

		2018	2017	2016	2015	2014	2013		Average Efficien	Technology
1	Najafgarh	80.19	83.06	84.5	82.3	83.3	81.3		82.44166667	Extended aeration
2	Mehrauli	70	81.2	89.5	85.27	83.2	82.6		81.96166667	Extended aeration
3	Pappankala	92.06	81.1	93.1					88.75333333	ASP
4	Kapashera	94.5	89.1	91.4					91.66666667	ASP
5	Akshardham	96.9	97.9	95.6	94.5				96.225	MBR
6	Yamuna vihar	79.1	77.8	81.8	83.9	83.1	82.2		81.31666667	ASP
7	Nilothi	78.2	76.1	80.7	80.6		80.8		79.28	ASP
8	Narela	77.2	79.1	81.8	82.5	82.7	84.1		81.23333333	ASP
9	Rithala	86.2	80.3	82.4	84.1	80.2			82.64	ASP
10	Coronation pilla	72.2	71.1	77.1	79.6				75	ASP
11	Delhi gate	91.8	92.5	94.7	91.4	93.1	92.3		92.63333333	BIOFOR
12	Okhla	87.8	87.3	84	82.4	84.7	81.2		84.56666667	ASP
13	Rohini	66	75.2	78.7	79.8				74.925	ASP
14	Vasant kunj	66.8	76.5	78.9	79.8				75.5	Extended aeration
15	Sen nursing hom	91	92.1	94.25	92.7	92.8			92.57	BIOFOR
16	Kondli	75.75	76.5	83.2	81.8	82.9	81.1		80.20833333	ASP
17	Keshopur	72.4	72.8	81.6	82.8	86.2	87.2		80.5	ASP

Table 5.3 Average value of overall efficiency for sewage plants of Delhi

	STP	TSS	BOD	Overall efficiency	Technology
1	Najafgarh	86.5316667	82.4416667	84.48666667	Extended aeration
2	Mehrauli	87.1283333	81.9616667	84.545	Extended aeration
3	Pappankala	94.2666667	88.7533333	91.51	ASP
4	Kapashera	94.2333333	91.6666667	92.95	ASP
5	Akshardham	97.45	96.225	94.89375	MBR
6	Yamuna vihar	85.55	81.3166667	83.43333333	ASP
7	Nilothi	84.62	79.28	81.95	ASP
8	Narela	86.75	81.2333333	83.99166667	ASP
9	Rithala	85.76	82.64	84.2	ASP
10	Coronation pillar	81.975	75	78.4875	ASP
11	Delhi gate	93.8	92.6333333	93.21666667	BIOFOR
12	Okhla	88.55	84.5666667	86.55833333	ASP
13	Rohini	83.15	74.925	79.0375	ASP
14	Vasant kunj	83	75.5	79.25	Extended aeration
15	Sen nursing home	93.46	92.57	93.015	BIOFOR
16	Kondli	85.6166667	80.2083333	82.9125	ASP
17	Keshopur	85.9833333	80.5	83.24166667	ASP

Table 5.4 Average annual seasonal data for sewage plants of Delhi -

		Winter	Summer	Monsoon	Post monsoon
1	Najafgarh	85.1	86.7	88.12	87.94
2	Mehrauli	88.6	84.96	88.575	86.2525
3	Pappankala	92.5	95.8	93.3	95.5
4	Kapashera	94.9	95.1	92.8	91.4
5	Akshardham	97	98.5	95.5	98
6	Yamuna vihar	86.65	84.7	85.7	87.76
7	Nilothi	85.36	83.24	84.8	83.425
8	Narela	86.4	86.1	87.25	85.45
9	Rithala	84.32	88.1	85.775	85.575
10	Coronation pillar	83.75	81.525	82.6	78
11	Delhi gate	93.7	93.95	94.32	93.06
12	Okhla	89.3	88.1	87.44	87.6
13	Rohini	85.225	84.2	81.8	79.7
14	Vasant kunj	79.875	84.85	87.8	85.6
15	Sen nursing home	92.375	92.65	93.7	94.2
16	Kondli	87.16	86.44	83.05	83.975
17	Keshopur	86.72	84.68	81.375	85.125

5.1.1 AVERAGE EFFICIENCY ON THE BASIS OF TSS FOR SEWAGE PLANTS OF DELHI

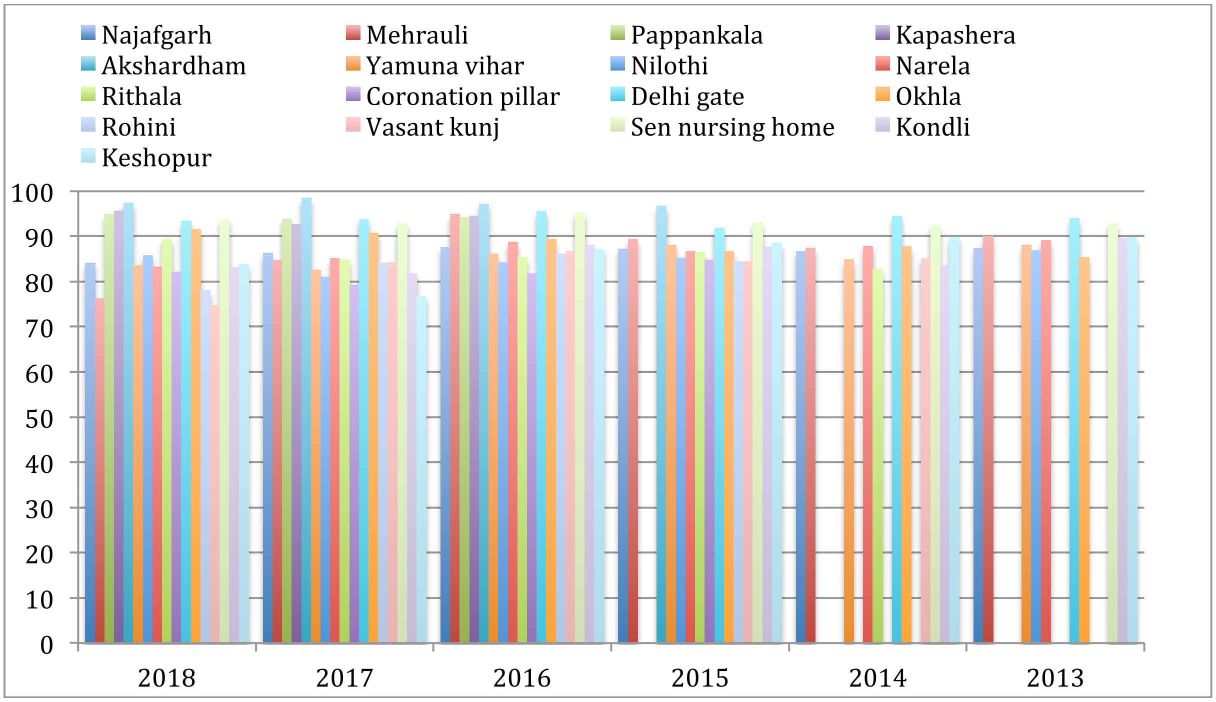


Fig 5.1 TSS removal efficiency of STPs of Delhi

As per fig 5.1, it can be seen that most of the plants in Delhi works on activated sludge process (ASP) technology and they have removal efficiency varying from 81 to 94% which is a huge range gap but as compared to BIOFOR technology and MBR technology which comes out to be the most efficient technology in the removal of total suspended solids (TSS) which is around 94% removal, plants working on BIOFOR technology are Delhi gate and Sen nursing home STP and these sewage plants have almost the same value of efficiency over past 5years and there is only one sewage plant which uses MBR technology which is Akshardham STP and it has efficiency of 97% .

And sewage plants using ASP technology also have constant value of efficiency over the periodexcept Narela, Okhla and Keshopur STP. Efficiency of Narela and Keshopur is decreasing constantly due to increase in amount of total suspended solids in influent going into sewage plant and incrcrease in amount of TSS in effluent discharge while the efficiency of Okhla STP is seen increasing this is due to its more removal efficiency that is as very less amount of TSS is seen in effluent discharge.

5.1.2 AVERAGE ANNUAL SEASONAL EFFICINCY FOR SEWAGE PLANTS OF DELHI

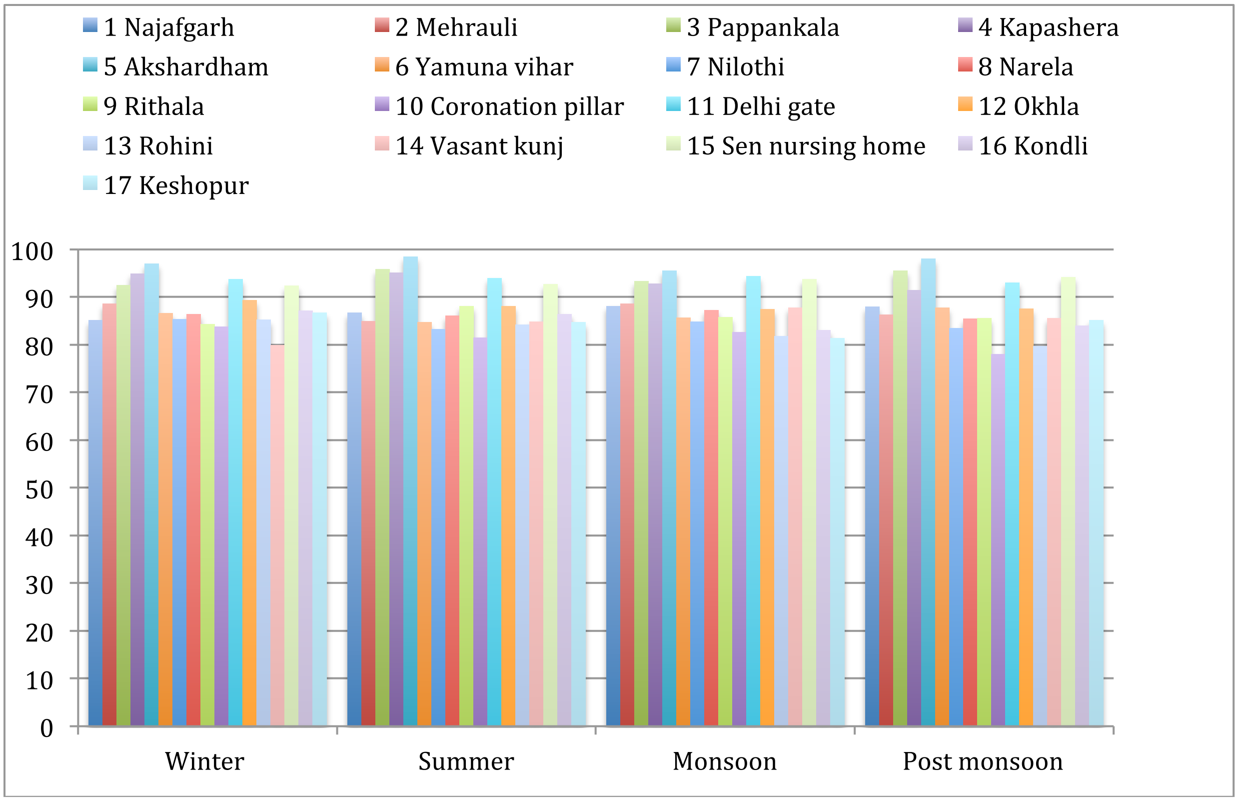


Fig 5.2 Average annual seasonal efficieny of STPs of Delhi

As per fig 5.2, which is taken for average "annual-seasonal" duration and between STPs, it can be seen that the value of efficiency in between seasons (winter, summer , monsoon, post monsoon as per IMD) is in the range of 80-90% . Most of the STPs have same working efficiency in different seasons except the STPs which are located at Coronation pillar and Rohini, they have a low value of efficiency in post monsoon season which is 78% and 79% respectively. Post season is the season from the month of October and upto November. It so happens to have a low efficiency during that time because of the occurrence of various events that happen during that time. Festivals like Diwali, Durga Puja and Ganesh Visarjan. The source of water pollution due to Diwali are the crackers and the fireworks which have no proper disposal after they have been used, and they tend to be the effluents which cause great harm to aquatic life as well because of the release of lead and other harmful elements. The latter two festivals require mass immersion ceremonies, and the permitted area for that is restricted. The water bodies approved for this purpose happen to lie near the Coronation Pillar and Rohini STPs which is why we tend to have a degraded efficiency in these two cases.

5.1.3 AVERAGE EFFICIENCY IN TERMS OF BOD FOR SEWAGE PLANTS OF DELHI

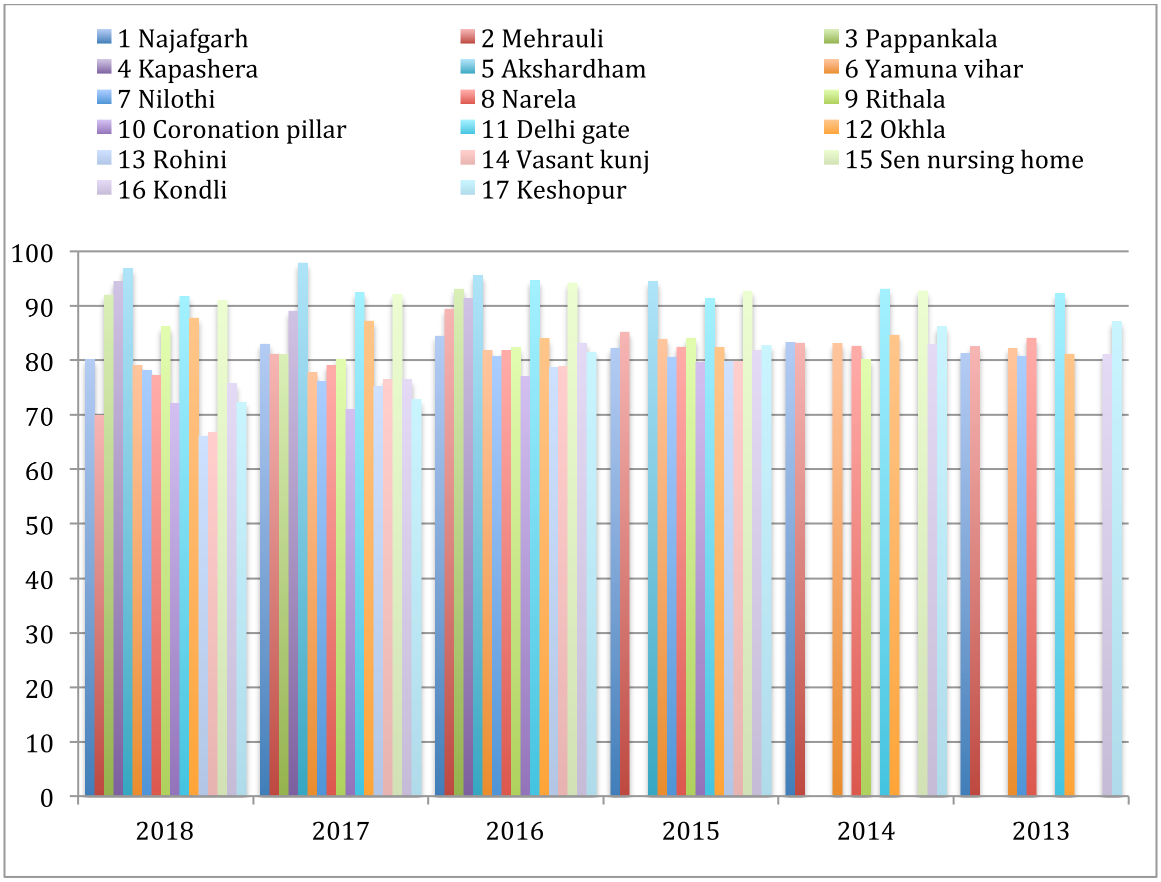


Fig 5.3 BOD removal efficiency of STPs of Delhi

As per fig 5.3, which is in between BOD removal and STPs for the years of 5 years, it can be seen that sewage plants are less efficient in BOD removal as compared to TSS. Among these plants Rohini, Coronation pilar and Vasant kunj STP are worst efficient plants, these have efficiency of 74.9%, 75% and 75% respectively while Delhi gate and Sen nursing STP are the most efficient in BOD removal, these have value of 93% each. These areas are the only areas which are permitted for the immersion of idols during various festivals in Delhi , and there is no particular check on whether a particular idol is biodegradable or non biodegradable. Rohini, Coronation pillar and Vasant kunj works on ASP, trickling filter and extended aeration technology (which is the advanced form of activated sludge process technology) respectively , rest of the plants have the efficiency in the range of 80 to 90%. While the plants Sen nursing home and Delhi gate both works on BIOFOR technology. Here is the another result which shows BOD removal efficiency of BIOFOR based plants is better as compared to plants using ASP or extended aeration technology.

5.1.4 OVERALL EFFICIENCY OF SEWAGE PLANTS OF DELHI

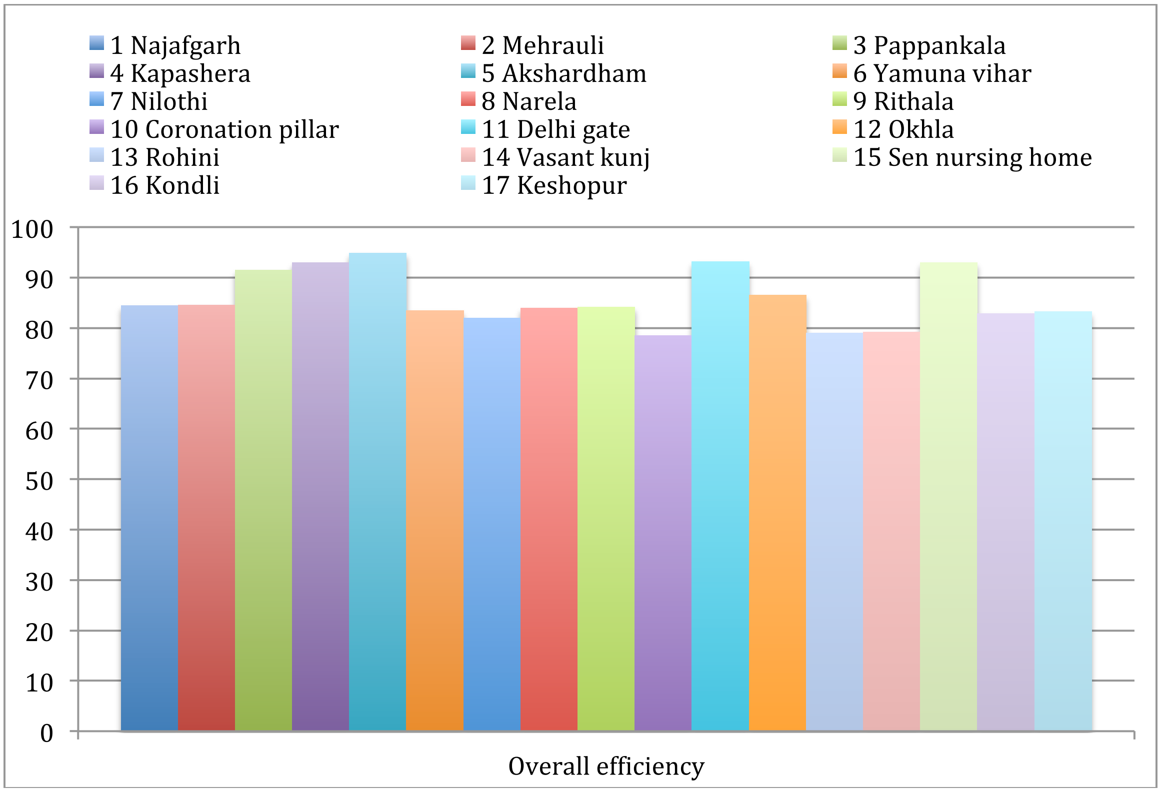


Fig 5.4 Overall efficiency of STPs of Delhi

As per fig 5.4, which is about the overall efficiency of the plant we can easily find out which one is the best efficient and which is worst. Here it can be seen that plants working on old conventional process like activated sludge process, extended aeration or oxidation pond process are comparatively less efficient as compared to plants working on technology like biological filtration and oxygenated reactor and membrane bioreactor (MBR). These technologies are comparatively new and are more economical and are more efficient as compared to old technologies. Though there are not any specific standards for these technologies but still they are better as compared to old ones. Here, Delhi gate and Sen nursing home both uses BIOFOR technology and have value of 93% while Akshardham is the only STP which uses MBR technology and it is 94% efficient in removal of TSS and BOD. Plants like Rohini , Coronation pillar and Vasant kunj they all works on old conventional technology which is activated sludge process and extended aeration (Vasant kunj works on this technology), these treatment plants have the lowest value of overall efiiciency and which is around 78 to 79 %.

CHAPTER 6

CONCLUSION

- By analyzing the data for various sewage treatments plants of Delhi, we have calculated the efficiency of these plants on the basis of TSS , BOD and overall efficiency for the period of past few years .

- Most of these plants works on the old conventional technology like activated sludge technology and extended aeration, only two plants Yamuna vihar and Vasant kunj works on extended aeration process which is the hybrid of activated sludge process. Sen nursing home and Delhi gate uses BIOFOR technology, this is the latest as compared to ASP and oxidation pond and also has better efficiency as compared to others. Chilla is the only sewage plant which works on SBR technology.

- Old conventional process like activated sludge and extended aeration are not efficient as compared to BIOFOR and MBR, these technology also uses more area and are not very economical in terms of operation and maintenance while BIOFOR and MBR are more economical in terms of operation and maintenance. BIOFOR and MBR doesn't have secondary clarifiers therefore their cost of construction is less as compared to activated sludge process

- By above calculations we can easily say that BIOFOR is the best among others, plants using this technology has efficiency in the range of 90 to 95%. Secondly in BIOFOR technology cost on installation and operation is also and it also requires very less area for its working. While sewage treatment plants working on old conventional technology like activated sludge process have efficiency in the range of 80 to 90% , also these plants require more area as compared to BIOFOR.

- Akshardham is the only plant which uses MBR technology and its efficiency comes out to be 92%, which is also better than activated sludge process though it is also new as compare to ASP but it is also economical in comparison to ASP though its expensive to change the membranes of MBR and it also requires semi skilled labour but still it comes out to be more economical as compared to activated sludge process and extended aeration.

- By analyzing the average seasonal efficiency it can be easily said that sewage treatment plants have almost same efficiency over these seasons , in some cases it can be seen that the value of efficiency decreases slightly in the season of monsoon and which is obvious as in this season high load can be seen entering into the sewage treatment plants.

- Over the period of five years these sewage plants have almost the same efficiency as no particular trend like increase or decrease can be seen.

- Proper detailed evaluation of plants working on latest technologies like MBR and BIOFOR should be performed by NEERI or CPCB or by IITs so that we have a standard uniform data for the design of sewage plants using this technology as these plants comes out to be better as the effluent coming out from these sewage plants have very less concentration of solids particles and these have better efficiency in removal of organic matter from sewage water. As the water going out as effluent from sewage plants is more treated therefore its contribution in the pollution of environment will also be less.

- At last we can sum up saying that new technologies like biological filtration and oxygenated reactor and membrane bioreactor are better than old conventional process and proper measures should be taken so that these technologies can be implemented in our system. BIOFOR and MBR comes out to be more economical and more efficient in terms of removal of suspended solids and in the removal of biological oxygen demand.

REFERENCES

American public health association (APHA) (1998). Standard methods for the examination of waters and wastewaters (20th edn). Washington, DC, USA.

Andreadakis, A., Mamais, D., Gavalaki, E., & Panagiotopoulou, V. (2003). Evaluation of treatment schemes appropriate for wastewater reuse in Greece. Environmental Science and Technology, 5, 1–8.

Bradley B.R., Daigger G.T., Rubin R. and Tchobanoglous, G. "Evaluation of onsite wastewater treatment technologies using sustainable development criteria". J. of Clean Technol. and Envt. vol. 4, pp. 87-99, 2001.

Colmenarejo, M. F., Rubio, A., Sanchez, E., Vicente, J., Gracia, M. G., & Bojra, R. (2006). Evaluaton of municipal wastewater treatment plants with different technologies at Las-Rozas, Madrid (Spain). Journal of Environmental Management, 81, 399–404.

CPHEEO, Central Public Health and Environmental Engineering Organization (1993). Manual on sewerage and sewage treatment (2nd ed.). New Delhi: Ministry of Urban Development.

Degremont Ltd. http://www.degremont-technologies.com/dgtech.php?article463

Dr. Andreas Rudiger "Experiences with biological filtration in waste water treatment", AQUABIOTEC GmbH, Germany, Unpublished.

Dr. P.N Modi, Sewage treatment and Disposal and wastewater engineering

Foundation for Greentech Environmental Systems (2004). Case study on sewage treatment plants and low-cost sanitation under river action plans. New Delhi.

Garcia-Amrisen, T., & Servais, P. (2006). Respective contribution of point and non- point sources of E.coli and Enterococci in large urbanized watershed (the seine river, France). Journal of Environment Management, 82, 512–518.

Gray, N. F. (1983). Ponding of random plastic filter medium due to fungus Subbaromcyes splendens Hesseltine in the treatment of sewage. Water Research, 17, 1295–1302.

Gijzen, H.J. “Aerobes, anaerobes and photographs: a winning team for wastewater management”. Water Sci. and Technol. vol. 44(8), pp. 123-132, 2001.

Jamrah, A.I., 1999. Assessment of Characteristics and Biological Treatment Technologies of Jordanian Wastewater, *Bioprocess Engineering*, 21, 331-34

Khan, A., Khan P., Wiegant, W., Schaapman, J. E., & Sikka, B. (2001). Implementation of UASB technology in river conservation projects in India – Policy development for wastewater treatment. Paper presented in 9th International Conference on Anaerobic Digestion, Belgium.

Koivunen, J., Siitonen, A., & Heinonen-Tanski, H. (2003). Elimination of enteric bacteria in biological-chemical wastewater treatment and tertiary filtration units. Water Research, 37, 690–698.

Kimura, K.; Yamato, N.; Yamamura, H.;Watanabe, Y. Membrane Fouling in pilot-scale Membrane Bioreactors (MBRs) treating municipal wastewater. Environ. Sci. Tech. 2005, 39, 6293–6299.

Leslie Grady, P. C., Daigger, T. G., & Lim, C. H. (1999). Fundamentals of biochemical operations. Biological wastewater treatment (pp. 26–28). New York: Marcel Dekker.

Maeng, S. K., Ahn, K. H., Kim, K. P., Song, K. G., & Park, K. Y. (2006). Compressible synthetic dual-medium filtration of wastewater effluents for water reuse. Water Practice Technology, 1.

Meng, F.; Chae, S.-R.; Drews, A.; Kraume, M.; Shin, H.-S.; Yang, F. Recent advances in membrane bioreactors (MBRs): Membrane fouling and membrane material. Water Res. 2009, 43, 1489–1512.

Metcalf & Eddy, 1991 & 2003. Wastewater Engineering: Treatment Disposal Reuse, third ed. McGraw-Hill, Singapore.

Mohammed A. I., Hayder T.H., 2013. Stabilization pond for wastewater treatment. *European Scientific Journal*, 9 (14), 278

Mutamim, N.S.A.; Noor, Z.Z.; Hassan, M.A.A.; Yuniarto, A.; Olsson, G. Membrane bioreactor: Applications and limitations in treating high strength industrial wastewater. Chem. Eng. J. 2013, 225, 109–119

NRCD (2005). Ministry of Environment and Forest Annual Report 2001–2002. Retrieved from http://envfor.nic.in/report/0102/chap06.html.

Ognier, S.;Wisniewski, C.; Grasmick, A. Membrane bioreactor fouling in sub-critical filtration conditions:A local critical flux concept. J. Membr. Sci. 2004, 229, 171–177

Pommepuy, M., Guillaud, J. F., Dupray, E., Guyader, F. L., & Cormier, M. (1992). Enteric bacteria survival factors. Water Science and Technology, 25, 93–103.

Prachi N.W., Sameer, U.S., 2014. Performance Evaluation of 25MLD Sewage Treatment Plant (STP) at Kalyan, *American Journal of Engineering Research* 3 (3), 310-316.

Sato,N., Okubo, T.,Onodera, T., Ohashi, A.,&Harada, H. (2006). Prospects for a self-sustainable sewage treatment system: A case study on full-scale UASB system in India's Yamuna River Basin. Journal of Environmental Management, 80, 198–207.

Sharma C. ,Singh S.K (2013). Performance Evaluation Of Sewage Treatment Plant Based On Advanced Aerobic Biological Filtration And Oxygenated Reactor (BIOFOR) Technology- A Case Study Of Capital City -Delhi, India, IJESIT

Shyam R Asolekar, Soli J Arceivala, Wastewater treatment for Pollution control and reuse , Third edition ,Tata McGraw-Hill Professional

Vrijenhoek, E.M.; Hong, S.; Elimelech, M. Influence of membrane surface properties on initial rate of colloidal fouling of reverse osmosis and nanofiltration membranes. J. Membr. Sci. 2001, 188, 115–128.

Von Sperling M, "Biological principles of used water treatment- Introduction to water quality and sewage treatment". Minas Gerais, ABES, Brazil, 1995.

Vandeweerd, V., Cheatle, M., Henricksen, B., Schomaker, M., Seki, M. and Zahedi, K., 1997. *Global Environment Outlook (GEO)*, UNEP Global State of Environment Report, 121-132

YAP Yamuna action plan (2006a). Retrieved November 9, 2007 from http://yap.nic.in/yamuna-in-delhi.asp