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Process Calculation & Design of Sewage Treatment Plant (Sequential Batch Reactor) of Sehore Town Madhya Pradesh

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Abstract: Designing a Sewage Treatment Plant (STP) based on Sequencing Batch Reactor (SBR) technology involves several key considerations. SBR technology is a type of activated sludge process where wastewater is treated in batch mode rather than continuous flow. Screened, de-gritted sewage shall be fed into the Cyclic Activated Sludge Process / SBR Process Basins for biological treatment to remove BOD, COD, Suspended Solids, Biological Nitrogen and Phosphorous. SBR / Cyclic Activated Sludge Process shall work on Cyclic / Batch mode in single step. It shall perform biological organic removal, Nitrification, DE nitrification and Biological Phosphorous removal. It shall be capable of simultaneous sludge stabilization. The oxygen required shall be supplied through fixed type fine bubble diffused aeration system with auto control of oxygen level in tank. The system shall have a SVI < 120 for higher settling rates and should be designed in such a way that growth of filamentous bacteria is restricted. Complete operation of SBR / Cyclic Activated Sludge Process including decanting rate, sludge recirculation and wasting of excess sludge shall be controlled by PLC. Treated Sewage from SBR / Cyclic Activated Sludge Process units shall be collected in Chlorination tank for its disinfection. Treated effluent from this STP will have discharge standards laid down by National Green Tribunal, during Apr 2019, Therefore, the revised standards i.e. **BOD5 < 10 mg/l, TSS < 20 mg/l, pH between 5.5 – 9.0, Nitrogen (Total) Sewerage network and STP of Sehore Town 11 < 10 mg/l, COD < 50 mg/l, Phosphorus Dissolved < 1 mg/l and Faecal Coliforms < 100 MPN / 100 ml (230 Acceptable)** will have to be maintained before reuse or discharge.

Keywords: STP, SBR, Reuse, Population Forecasting, BOD, COD

1 Introduction

Sequencing Batch Reactor (SBR) technology is a type of activated sludge process used in wastewater treatment. Unlike traditional continuous-flow systems, SBR operates in a batch mode, meaning that the treatment process occurs in a series of timed phases within a single reactor vessel.

1.1 Key Features of SBR Technology:

A. **Batch Operation**: The SBR system operates in a batch mode where the reactor undergoes a series of stages, including filling, reacting, settling, and decanting. This approach allows for better control and flexibility in managing different phases of the treatment process.

B. **Flexible Operation**: SBR systems can handle varying inflow and load conditions more efficiently than some continuous systems. They are particularly useful in situations where the influent quality and quantity fluctuate.

1.2 Phases of Treatment:

- **Fill**: Wastewater is introduced into the reactor.
- **React**: Aeration and biological treatment occur during this phase.
- **Settle**: The solids settle to the bottom, separating from the treated effluent.
- **Decant**: The clarified effluent is removed from the top of the reactor.
- **Idle**: The system may have an idle phase to prepare for the next batch or perform maintenance.

2 Population Forecasting

Effective population forecasting is essential for designing an STP that meets current and future needs. By accurately predicting population growth and wastewater generation, planners can ensure that the STP is appropriately sized, designed, and capable of providing reliable service over the long term. Regular updates and flexible design approaches help accommodate changes and uncertainties in population trends.

Table 1 Census Population Data for Sehore Town

Sehore - Population Projection					
S.No.	Year	Population	Increase In Population	Percentage increase in population	Incremental Increase in population

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1	1971	32256			
2	1981	42658	10402	0.32	
3	1991	62589	19931	0.47	9529
4	2001	90586	27997	0.45	8066
5	2011	108909	18323	0.20	-9674
Total			76653	0.014	7921
Average			**19163**	**0.014**	**2640**
		r		**0.342**	

Table 2 Population Projection By differnet Method

S.no.	Name of Methods	Population in the year				
		2022	**2024**	**2025**	**2040**	**2055**
1	Arithmetical increase method	130000	133850	135750	164500	193250
2	Incremental increase method	133050	137800	140200	179450	224600
3	Geometrical increase method	150550	159650	164450	255600	397400
4	Linear Curve Method	37100	38450	39100	49200	59300
5	Exponential Curve method	51500	56650	59400	121100	246950
6	Tehsil Growth rate @ 2.83% per year	38000	39100	41350	62850	95550
Final Population	**Name of Methods**	**Year**				
		2022	**2024**	**2025**	**2040**	**2055**
	Geometrical increase method	150550	159650	164450	255600	397400

2.1 Demand Assessment & Sewerage Generation

Water demand is calculated based on the guidelines of CPHEEO Manual. Total quantity of water requirement for the proposed project is estimated to be about 39.45 MLD during the intermediated year 2040 and 61.25 MLD during the ultimate Year 2055. By considering 90% of the water supplied will be converted into sewage i.e. 36 MLD in 2040 and 57 MLD in 2055. Wastewater generated from the proposed project will be treated in an STP of 36 MLD. Detailed design writes up of the STP is in the following section. The sewage generated during the operation phase will be treated up to the tertiary level in Sewage Treatment Plants (STP) The entire (100%) treated sewage from STP of 36 MLD capacity will be recycled/ reused for toilet flushing, car washing and landscaping in the project site excess will be used for avenue plantation/Sewer.

Table 3 Total Sewerage Generation Year wise

Description	Year	2022	2024	2025	2040	2055
Population		130000	159650	164450	255600	397400
Rate of Supply (lpcd)		135	135	135	135	135
Demand (MLD)		17.55	21.55	22.20	34.51	53.65
Floating population	10%	13000	15965	16445	25560	39740
Rate of Supply(lpcd)		45	45	45	45	45
Demand (MLD)		0.585	0.718	0.74	1.15	1.788
ICI (MLD)		0.176	0.177	0.181	0.210	0.244
Fire Demand (MLD)	10%	1.83	2.24	2.31	3.59	5.57
Total demand(MLD)		20.14	24.69	25.43	39.45	61.25
Total demand(MLD)		**20.14**	**24.69**	**25.43**	**39.45**	**61.25**
Interception Factor	0.9	18.127395	22.223525	22.890352	35.50726	55.12391
Sewage Generation (MLD)		**21**	**25**	**25**	**36**	**57**

3 Process Design STP (Sewage Treatment Plant)

Designing a Sequential Batch Reactor (SBR) system for sewage treatment involves several steps to ensure that the system meets capacity requirements and operates efficiently. For a 36 MLD (Million Liters per Day) capacity SBR, the design needs to cover aspects like reactor sizing, operational cycles, and equipment selection. Here's a detailed breakdown of the design computations and considerations.

As per NMCG guideline, shall be select intermediate year population or sewage generation for selection of capacity of STP. The proposed capacity of STP plant shall 36 MLD for Sehore Design Parameter

3.1 SBR Operation

The SBR operates in a batch mode with the following sequential steps:

1. **Filling:** Sewage is pumped into the reactor.
2. **Aeration:** The filled reactor is aerated to promote microbial digestion of contaminants.
3. **Settling:** Aeration stops, allowing solids to settle.
4. **Decanting:** Clear treated water is decanted, and the cycle begins anew.

1	**DESIGN BASIS**				
	Average Flow (Qav)	=	36.000	MLD	
		=	1500.000	m^3/hr	
		=	0.417	m^3/s	
	Peak Flow (Qpk)	=	81.000	MLD	
		=	3375.000	m^3/hr	
		=	0.938	m^3/s	
	Peak Flow Factor = (Qpk / Qav)	=	2.25		
2	**INLET PARAMETERS**				
	BOD_5 @ 20° C	=	225	mg/l	

	COD	=	500	mg/l	
	Total Suspended Solids	=	220	mg/l	
	Total Nitrogen	=	30	mg/l	
	Total Phosphorous	=	5	mg/l	
	pH	=	6.5-8.5		
3	**OUTLET PARAMETERS**				
	BOD_5 @ 20° C	≤	5	mg/l	
	COD	≤	50	mg/l	
	Total Suspended Solids	≤	10	mg/l	
	Total Nitrogen	≤	5	mg/l	
	Total Phosphorous	≤	2	mg/l	
	pH	=	7.0 - 9.0		

4	**RECEIVING CHAMBER:**				
	Unit to be designed for Average Flow	=	36.000	MLD	
		=	1500.000	m^3/hr	
		=	0.417	m^3/s	
	And to be checked for Peak Flow	=	81.000	MLD	
		=	3375.000	m^3/hr	
		=	0.938	m^3/s	
	HRT at Peak Flow	=	60.000	sec	
	Volume required	=	56.250	m^3	
	SWD provided	=	1.000	m	
	Side of square Chamber required	=	7.500	m	
	Length/Width provided	=	7.500	m	
	Volume provided	=	56.250	m^3	
	Free Board provided	=	0.300	m	
5	**COARSE BAR SCREEN CHANNEL (MECHANICAL)**				
	No. of Units to be provided	=	2	Nos.	**1W + 1S**
	Unit to be designed for Average Flow	=	36.000	MLD	
		=	1500.000	m^3/hr	
		=	0.417	m^3/s	
	And to be checked for Peak Flow	=	81.000	MLD	
		=	3375.000	m^3/hr	
		=	0.938	m^3/s	
	As there will be 1 Stream,				
	Design Flow at Average Conditions	=	0.417	m^3/s	
	Design Flow at Peak Conditions	=	0.938	m^3/s	
	Velocity through Screen for :				
	Q av	=	0.600	m/s	
	Q pk	=	1.200	m/s	

	Inclined Area of Screen required for Qav	=	0.694	m^2	
	Inclined Area of screen required for Qpk	=	0.781	m^2	
	Considering 20 mm Opening and 10 mm Bar Thickness,				
	Inclined Gross Area	=	**1.172**	m^2	
	Assuming width of Channel as	=	1.000	m	
	Inclined Depth of Screen required	=	1.172	m	
	Angle of Inclination	=	75	0	
	SWD of Channel	=	1.132	m	
	SAY	=	1.200	m	
	Considering Head Loss across Screen	=	0.300	m	
	SWD provided	=	1.500	m	
	Free Board provided	=	0.300	m	
	Length provided	=	5.000	m	
6	**CHECK : MANUAL COARSE BAR SCREEN CHANNEL**				
	Angle of Inclination	=	75	0	
	SWD of Channel provided	=	1.500	m	
	Inclined Length provided	=	1.553	m	
	Submerged Area provided	=	1.553	m^2	
		≥	**1.172**	m^2	**OK**
5	**COARSE BAR SCREEN (MANUAL)**				
	Number of Screens	=	3	Nos.	**2W + 1S**
	Design Flow - Average	=	18.000	MLD	
		=	750.000	m^3/hr	
		=	0.208	m^3/s	
	Design Flow - Peak	=	40.500	MLD	
		=	1687.500	m^3/hr	
		=	0.469	m^3/s	
	Velocity at Average Flow	=	0.300	m/s	
	Area required	=	0.694	m^2	
	Velocity at Peak Flow	=	0.600	m/s	
	Considering Depth of Sewage in Inlet Channel	=	0.600	m	
	Total width of Opening required	=	0.417	m	
	Providing Bar Spacing	=	20.000	mm	
	No. of Opening required	=	21	Nos.	
	Total No. of Bars required	=	20	Nos.	
	Providing Bar Thickness	=	5	mm	
	Total Width of Screen required	=	0.517	m	
	Total Width of Screen provided	=	0.600	m	
	Angle of Inclination	=	75	0	
	Actual submerged Depth of Screen required	=	0.621	m	
	Actual total Depth of Screen provided	=	1.1	m	
	Velocity in Channel at Average Flow	=	0.579	m/s	

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6	**COARSE BAR SCREEN (MECHANICAL)**				
	Number of Screens	=	3	Nos.	**1W + 1S**
	Design Flow : Average	=	18.000	MLD	
		=	750.000	m^3/hr	
		=	0.208	m^3/s	
	Design Flow : Peak	=	40.500	MLD	
		=	1687.500	m^3/hr	
		=	0.469	m^3/s	
	Velocity at Average Flow	=	0.300	m/s	
	Area required	=	0.694	m^2	
	Velocity at Peak Flow	=	0.600	m/s	
	Assuming Depth of Sewage in Inlet Channel as	=	1.000	m	
	Total width of Opening required	=	0.694	m	
	Providing Bar Spacing	=	20.000	mm	
	No. of Opening required	=	35	Nos.	
	Total No. of Bars required	=	34	Nos.	
	Providing Bar Thickness	=	5	mm	
	Total Width of Screen required	=	0.864	m	
	Total Width of Screen provided	=	0.900	m	
	Angle of Inclination	=	75	^{0}	
	Actual submerged Depth of Screen	=	1.035	m	
	Actual total Depth of Screen provided	=	1.6	m	
	Velocity in Channel at Average Flow	=	0.231	m/s	
7	**RAW SEWAGE SUMP**				
	Unit to be designed for Average Flow	=	36.000	MLD	
		=	1500.000	m^3/hr	
		=	0.417	m^3/s	
	And to be checked for Peak Flow	=	81.000	MLD	
		=	3375.000	m^3/hr	
		=	0.938	m^3/s	
	HRT at Peak Flow	=	5.000	minutes	
	Volume required	=	281.250	m^3	
	SWD provided	=	1.000	m	
	Dia of required	=	18.928	m	
	Dia provided	=	19.000	m	
	Volume provided	=	283.385	m^3	
	Free Board provided	=	0.300	m	
8	**RAW SEWAGE TRANSFER PUMPS**				
	Average Flow	=	1500.000	m^3/hr	
	Peak Flow	=	3375.000	m^3/hr	

	Number of Pumps provided	=	5	Nos.	
	Pump Capacity provided	=	1500.000	m^3/hr	**1W + 1S**
	And	=	1500.000	m^3/hr	**1W + 1S**
	Head Provided	=	20	m	
9	**STILLING CHAMBER :**				
	Unit to be designed for Average Flow	=	36.000	MLD	
		=	1500.000	m^3/hr	
		=	0.417	m^3/s	
	And to be checked for Peak Flow	=	81.000	MLD	
		=	3375.000	m^3/hr	
		=	0.938	m^3/s	
	HRT at Peak Flow	=	60.000	sec	
	Volume required	=	56.250	m^3	
	SWD provided	=	1.000	m	
	Side of square Chamber required	=	7.500	m	
	Length/Width provided	=	7.500	m	
	Volume provided	=	56.250	m^3	
	Free Board provided	=	0.300	m	
10	**FINE BAR SCREEN CHANNEL (MECHANICAL)**				
	No. of Units to be provided	=	2	Nos.	**1W + 1S**
	Unit to be designed for Average Flow	=	36.000	MLD	
		=	1500.000	m^3/hr	
		=	0.417	m^3/s	
	And to be checked for Peak Flow	=	81.000	MLD	
		=	3375.000	m^3/hr	
		=	0.938	m^3/s	
	As there will be 2 Streams,				
	Design Flow at Average Conditions	=	0.208	m^3/s	
	Design Flow at Peak Conditions	=	0.469	m^3/s	
	Velocity through Screen for :				
	Q av	=	0.600	m/s	
	Q pk	=	1.200	m/s	
	Inclined Area of Screen required for Qav	=	0.347	m^2	
	Inclined Area of screen required for Qpk	=	0.391	m^2	
	Considering 6 mm Opening and 3 mm Bar Thickness,				
	Inclined Gross Area	=	**0.586**	m^2	
	Assuming width of Channel as	=	0.500	m	
	Inclined Depth of Screen required	=	1.172	m	
	Angle of Inclination	=	45	^{0}	
	SWD of Channel	=	0.829	m	

	SAY	=	0.900	m	
	Considering Head Loss across Screen	=	0.300	m	
	SWD provided	=	1.200	m	
	Free Board provided	=	0.200	m	
	Length provided	=	4.000	m	
	CHECK : MANUAL FINE BAR SCREEN CHANNEL				
	Angle of Inclination	=	45	0	
	SWD of Channel provided	=	1.200	m	
	Inclined Length provided	=	1.697	m	
	Submerged Area provided	=	0.849	m^2	
		≥	**0.586**	m^2	**OK**
11	**GRIT CHAMBER**				
	No. of Units to be provided	=	1	No.	
	Unit to be designed for Average Flow	=	36.000	MLD	
		=	1500.000	m^3/hr	
		=	0.417	m^3/s	
	And to be checked for Peak Flow	=	81.000	MLD	
		=	3375.000	m^3/hr	
		=	0.938	m^3/s	
	Flow to each Chamber	=	81.000	MLD	
		=	81000.000	m^3/day	
		=	3375.000	m^3/hr	
		=	0.938	m^3/s	
	According to "Manual on Sewage & Sewage Treatment" published by Central public Health & Environmental Engineering Organization (CPHEEO):				
	For Particle Size of 0.15 mm with Sp. Gr. > 2.65:				
	Surface Overflow Rate	=	1555.000	m^3/m^2/day	
	Considering 75% efficiency and n = 1/8				
	Design Overflow Rate	=	959.000	m^3/m^2/day	
	Area required	=	84.463	m^2	
	Length/Width required (square)	=	9.190	m	
	Length/Width provided (square)	=	9.500	m	
	HRT in Grit Chamber	=	60.000	sec	
	Volume required	=	56.25	m^3	
	SWD required	=	0.623	m	
	SAY	=	0.700	m	
	Grit Storage Space provided	=	0.200	m	
	SWD provided	=	0.700	m	
	Free Board provided	=	0.300	m	

12	**FEED CHANNEL TO SPLITTER BOX**				
	No. of Channel to be provided	=	1	No.	
	Unit to be designed for Average Flow	=	36.000	MLD	
		=	1500.000	m^3/hr	
		=	0.417	m^3/s	
	And to be checked for Peak Flow	=	81.000	MLD	
		=	3375.000	m^3/hr	
		=	0.938	m^3/s	
	Design Flow at Average Conditions	=	0.417	m^3/s	
	Design Flow at Peak Conditions	=	0.938	m^3/s	
	Velocity through Screen for :				
	Q av	=	0.600	m/s	
	Q pk	=	1.200	m/s	
	Area of Channel required for Qav	=	0.694	m^2	
	Area of Channel required for Qpk	=	0.781	m^2	
	Assuming Width of Channel	=	1.000	m	
	SWD of Channel required	=	0.938	m	
	SWD of Channel provided	=	1.000	m	
	Free Board	=	0.300	m	
13	**SPLITTER BOX**				
	Unit to be designed for Peak Flow	=	81.000	MLD	
		=	3375.000	m^3/hr	
		=	0.938	m^3/s	
	HRT at Inlet	=	60.000	sec	
	Volume required	=	56.250	m^3	
	SWD provided	=	1.000	m	
	Width provided	=	1.500	m	
	Length required	=	37.500	m	
	Length provided	=	37.500	m	
	Volume provided	=	56.250	m^3	
		>	56.250	m^3	**OK**
	No. of downstream Streams (2 Basins will receive flow at any time)	=	2	Nos.	
	Flow to each Stream	=	0.469	m^3/s	
	Velocity in Channel for Qpk	=	1.000	m/s	
	Area of Channel required	=	0.469	m^2	
	Width of Channel assumed	=	0.800	m	
	Depth of Channel required	=	0.586	m	
	Depth of Channel provided	=	0.600	m	
	Discharge over a Sharp Crested Rectangular Weir (with end contractions suppressed) is given by the following equation.				

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	Q = (2/3)*Cd*L*(2g)^0.5*h^1.5				
	Rearranging h = ((3/2)*Q/(Cd*L*(2g)^0.5*))^(1/1.5) where				
	Q = Flow	=	0.469	m^3/s	
	Cd = Coefficient of Discharge	=	0.620		
	L = Length of Weir (Considering flow from each side of 2.5 m length))	=	6.000	m	
	h = Head over Weir	=	0.122	m	
	SAY	=	0.200	m	
12	**BASINS**				
A	Volume of Sewage treated in a day	=	36000.000	m^3/d	
B	Filling & Aeration Phase	=	1.50	hrs	
C	Settling Phase	=	0.75	hrs	
D	Decanting Phase	=	0.75	hrs	
E	Total Cycle Time = B + C + D	=	3.00	hrs	
F	No. of Cycles per day/basin = 24 / E	=	8	Nos.	
G	Aeration Time/day/basin = B x F	=	12.00	hrs	
H	No. of Basins receiving flow simultaneously	=	2	Nos.	
I	No. of Basins Aerating simultaneously	=	1	Nos.	
J	No. of basins Decanting simultaneously	=	1	Nos.	
K	Flow Rate = A / 24	=	1500.000	m^3/hr	
L	Flow rate to each Basin = K / H	=	750.000	m^3/hr	
	Basin Sizing				
A	Volume of Sewage treated	=	36000.000	m^3/d	
B	BOD removed (Inlet BOD – Outlet BOD)	=	220	ppm	
C	MLSS	=	4500	ppm	
D	MLVSS	=	3600	ppm	
E	F/M	=	0.150	0.1-0.18 as per CPHEEO Manual	
F	Total Volume of Basins = (A x B) / (D x E)	=	14666.667	m^3	
G	No. of Basins Provided	=	2	Nos.	
H	Volume per Basin = F / G	=	7333.333	m^3	
I	Side Water Depth (SWD) of Basins	=	3.000	m	
J	Width of Basins	=	10.000	m	
K	Length of Basins	=	10.000	m	
L	Volume provided per Basin = I x J x K	=	300.000	m^3	
M	Total Volume offered = L x G	=	600.000	m^3	
N	Freeboard provided	=	0.300	m	
O	Total Depth of Basin = I + N	=	3.300	m	
P	Providing Recirculation Ratio (14.0% of Feed Flow)	=	**14.00%**		
Q	Feed Flow to each Basin	=	750.000	m^3/hr	
R	Recirculation Flow	=	105.000	m^3/hr	
S	SAY	=	105.000	m^3/hr	
T	Hydraulic Retention Time, HRT		0.40	12-24 hrs as per CPHEEO Manual	
13	**Selector (Anoxic) Zone**				
A	Flow Rate through each Basin	=	855.000	m^3/hr	

B	Retention Time in Selector Zone	=	**30.00**	minutes	
C	Volume Required = (A x B) / 60	=	**427.500**	m^3	
D	No. of Selector Compartments / Basin	=	1	No.	
E	SWD of Selector Compartment provided	=	3.000	m	
F	Length of Selector Compartment provided	=	10.000	m	
G	Width of Selector Compartment required	=	14.250	m	
H	Width of Selector Compartment provided	=	14.500	m	
I	Volume offered in Selector Zone = E x F x H	=	435.000	m^3	
14	**Oxygen Calculation at Peak Flow Conditions**				
A	Volume of Sewage treated	=	36000.000	m^3/d	
B	O_2 required as per Sewage Manual	=	1.200	kg/kg BOD	
C	Safety Factor considered	=	20	%	
D	O_2 required	=	1.440	kg/kg BOD	
E	Inlet BOD_5 @ 20^0 C	=	225	ppm	
F	Outlet BOD_5 @ 20^0 C	=	5	ppm	
G	BOD_5 removed	=	220	ppm	
H	BOD removed in a day = A x G	=	7920.000	kg/d	
I	O_2 required for above BOD Load = D x H	=	11404.800	kg/d	
J	Inlet Total Kjeldhal Nitrogen assumed	=	45	ppm	
K	Outlet Ammoniacal Nitrogen	=	2	ppm	
L	Outlet Nitrate Nitrogen	=	3	ppm	
M	NH_3-N removed in a day = J – K	=	43	ppm	
N	Kg O_2 required per Kg of NH_3-N	=	4.600	kg/ kg NH_3-N	
O	NH_3-N removed in a day = A x M	=	1548.000	kg/d	
P	O_2 required for NH_3-N removal = O x N	=	7120.800	kg/d	
Q	Kg O_2 released per Kg of Nitrate-Nitrogen during denitrification	=	2.860	kg/NO_3-N	
R	Kg of Nitrate-Nitrogen generated = A x J x 75%	=	1215.000	kg/d	
S	Kg of Nitrate Nitrogen in the Treated Sewage = A x L	=	108.000	kg/d	
T	Quantity of Nitrate Nitrogen that is denitrified = R – S	=	1107.000	kg/d	
U	O_2 released during Denitrification = T x Q	=	3166.020	kg/d	
V	Total O_2 required/day = I + P – U	=	15359.580	kg/d	
W	Consider Safety Factor for Aeration	=	20	%	
X	Total O_2 required per day considering Safety Factor = V x (1 + W)	=	18431.496	kg/d	
15	**Air Requirementat at Peak Flow Conditions**				
A	Total Theoretical O_2 required per day	=	18431.496	kg/d	
B	Alpha	=	0.65		
C	Beta	=	0.95		
D	Standard O_2 required at field conditions = A / (B x C)	=	29848.577	kg/d	
E	No. of Basins	=	2	Nos.	
F	Standard O_2 required at field conditions per Basin = D / E	=	14924.288	kg/d/Basin	

G	Standard Oxygen Transfer Efficiency (SOTE) of Diffuser per m Depth of Submergence	=	6	% / m	
H	Liquid Level in Basin during Peak Flow	=	3.000	m	
I	Height at which Diffusers are kept	=	0.300	m	
J	Effective Aeration Depth = H - I	=	2.700	m	
K	SOTE for the above effective aeration depth = G x J	=	16	%	
L	Fraction of O_2 in Air	=	23.18	%	
M	Specific Gravity of Air	=	1.293		
N	Air required at field condition per basin = F / (K x L x M)	=	307373.667	Nm^3/d/ Basin	
O	Aeration Time per Basin per day	=	12.00	hrs/d/Basin	
P	Air required per hour per Basin = N / O	=	25614.472	Nm^3/hr/ Basin	
Q	Number of Operating Air Blowers per Basin	=	2	Nos.	
R	Capacity of Air Blowers required = P / Q	=	12807.236	Nm^3/hr	
S	Safety Factor considered	=	15	%	
T	Capacity of Air Blowers with Safety Factor = R x (1 + S)	=	14728.322	Nm^3/hr	
U	Capacity of Air Blowers offered	=	14730.000	Nm^3/hr	
V	No. of Basins aerating at any given time	=	1	Nos.	
W	No. of Operating Blowers = Q x V	=	2	Nos.	
X	No. of Standby Blowers per set of Operating Blowers	=	1	Nos./Set	
Y	Number of Standby Blowers = V x X	=	1	Nos.	
16	**Sludge Wasting**				
A	Excess sludge generated	=	0.900	kg/kg BOD	
B	BOD removed in a day	=	7920.000	kg/d	
C	Excess Sludge generated per day = A x B	=	7128.000	kg/d	
D	No. of Basins	=	2	Nos.	
E	Sludge Wasted/Basin = C / D	=	3564.000	kg/d/Basin	
F	No.of Cycles per day per Basin	=	8	Cycles/ d/ Basin	
G	Sludge Wasted per cycle per basin = E / F	=	445.500	kg/d	
H	Sludge Solids Consistency	=	0.8%	%	
I	Volume of Sludge Wasted per cycle per Basin = G / (H x 1000)	=	55.688	m^3/Cycle	
J	Pump Running Time / Cycle	=	30.00	minutes	
K	Pump Capacity required= (I x 60) / J	=	111.375	m^3/hr	
I	Pump Capacity provided	=	115.000	m^3/hr	
17	**CHLORINATION TANK**				
A	Volume of Sewage treated	=	36000.000	m^3/d	
B	Treated Sewage Flow Rate = A / 24	=	**1500.000**	m^3/hr	
C	HRT in Chlorination Tank	=	20.000	minutes	
D	Volume required = (B x C) / 60	=	500.000	m^3	
E	SWD provided	=	1.500	m	
F	Width provided	=	3.000	m	
G	Length provided	=	5.000	m	

H	Volume provided = E x F x G	=	22.500	m^3	
G	Freeboard provided	=	0.300	m	
18	**CHLORINATOR**				
A	Volume of Sewage treated	=	36000.000	m^3/d	
B	Treated Sewage Flow Rate = A / 24	=	**1500.000**	m^3/hr	
C	Design Chlorine Dosage	=	2.000	ppm	
D	Chlorine Dosage Rate = (B x C) / (D X 1000)	=	3.000	kg/hr	
E	Chlorinator Capacity offered	=	3	kg/hr	
F	No. of Chlorinators offered	=	2	Nos.	**1W + 1S**
19	**NaOCl DOSING SYSTEM:**				
A	Volume of sewage treated	=	36000.000	m^3/d	
B	Treated sewage flow rate = A / 24	=	**1500.000**	m^3/hr	
C	Design Chlorine dosage	=	3	ppm	
D	Chlorine dosage rate	=	4.500	Kg/hr	
E	Capacity of NaOCl Dosing Pumps reqd	=	75.000	LPH	
F	Capacity of NaOCl Dosing Pumps offered	=	75.000	LPH	
G	No. of NaOCl Dosing Pumps offered	=	1	Nos.	
H	Capacity of NaOCl Dosing Tank reqd assuming 12 hours holding capacity	=	900.000	Litres	
I	No. of NaOCl Dosing Tank offered	=	1	Nos.	
J	Capacity of NaOCl Dosing Tank offered	=	900.000	Litres	
20	**SLUDGE SUMP**				
A	Volume of Sludge generated in a day	=	891.000	m^3/d	
B	Sludge Flow Rate = A / 24	=	37.125	m^3/hr	
C	HRT of Sludge Sump	=	2.500	hrs	
D	Volume of required = B x C	=	92.813	m^3	
E	SWD provided	=	1.000	m	
F	Length provided	=	2.000	m	
G	Width provided	=	2.000	m	
H	Volume provided = E x F x G	=	4.000	m^3	
I	Freeboard provided	=	0.300	m	
21	**SLUDGE SUMP AIR BLOWER**				
A	Volume of Sludge Sump	=	4.000	m^3	
B	Design Air Agitation requirement in Sludge Sump	=	1.000	m^3/hr/m^3	
D	Capacity of Air Blower required = (A X B)	=	4.000	m^3/hr	
E	Capacity of Air Blower offered	=	10.000	m^3/hr	
F	No. of Air Blowers offered	=	2	Nos.	**1W + 1S**
H	Side Water Depth of Sludge Sump	=	1.000	m	
H	Head of Air Blowers offered	=	0.150	kg/cm^2	
22	**CENTRIFUGE**				

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A	Volume of Sludge generated in a day	=	891.000	m^3/d	
B	Sludge Flow Rate = A / 24	=	37.125	m^3/hr	
D	No. of Working Centrifuges considered	=	1	Nos.	
E	Capacity required for each Centrifuge = B / D	=	37.125	m^3/h	
F	Capacity of Centrifuge offered	=	37.500	m^3/h	
G	Hours of Operation	=	23.760	hrs/day	
H	No. of Standby Centrifuge offered	=	1	No.	
23	**CENTRIFUGE FEED PUMPS**				
	Volume of Sludge generated in a day	=	891.000	m^3/d	
	Sludge Flow Rate = A / 24	=	37.125	m^3/hr	
	No. of Working Centrifuge Feed Pumps considered	=	1	Nos.	
	Capacity required for each Pump	=	37.125	m^3/hr	
	Capacity offered	=	37.500	m^3/hr	
	Hours of Operation	=	23.760	hrs/day	
	No. of Standby Pump offered	=	1	No.	

4 Civil Unit (STP Dimension)

CIVIL UNITS(STP-1)						
Sl. No.	Description	Qty	Length m	Width m	SWD m	FB m
1	Receiving Chamber	1	7.50	7.50	1.00	0.30
2	Coarse Screen Channel - Manual	1	5.00	1.00	1.50	0.30
3	Coarse Screen Channel - Mechanical	1	5.00	1.00	1.50	0.30
4	Raw Sewage Sump	1	19.00	**Dia.**	1.00	0.30
5	Stilling Chamber	1	7.50	7.50	1.00	0.30
6	Fine Screen Channel - Manual	1	5.00	0.50	1.20	0.20
7	Fine Screen Channel - Mechanical	1	5.00	0.50	1.20	0.20
8	Grit Chambers	1	9.50	9.50	0.70	0.30
9	Basins	4	10.00	10.00	3.00	0.30
10	Chlorination Tank	1	5.00	3.00	1.50	0.30
11	Sludge Sump	1	2.00	2.00	1.00	0.30
12	DWPE Dosing Tanks	2	0.60	0.60	1.00	0.30

5 Result

The suggested SBR calculations can be used to construct the ideal sewage treatment facility with a 36 MLD capacity. The four-stage SBR system is a batch-operated treatment process.

24	**DWPE DOSING SYSTEM**				
A	Volume of Sludge generated in a day	=	891.000	kg/d	
B	DWPE reqd @ 1.1 Kg/MT of Dry Sludge	=	0.980	kg/d	
C	Capacity of DWPE Dosing Pumps reqd	=	41.250	LPH	
D	Capacity of DWPE Dosing Pumps offered	=	41.500	LPH	
E	No. of DWPE Dosing Pumps offered	=	2	Nos.	1W + 1S
F	Volume of DWPE Dosing Tank reqd assuming 8 hours RT	=	0.330	m^3	
G	SWD offered	=	1.000	m	
H	Length/Width required	=	0.574	m	
I	Length/Width offered	=	0.600	m	
J	Free Board provided	=	0.300	m	
K	Volume of DWPE Dosing Tank offered	=	0.360	m^3	
L	No. of DWPE Dosing Tank offered	=	2	Nos.	1W + 1S

The four steps filling, aeration, settling, and decanting are carried out in three batches of eight hours each. Sequential batch reactor is the finest technology for our communities and corporations in our burgeoning population, since it is a batch process with a suspended growth treatment. SBR systems have minimal operating and maintenance costs, can withstand shock loads, and reduce odour using aerobic microorganisms. The best possible aeration and digestion of organic matter also makes it possible to significantly reduce BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), TSS (Total Suspended Solids), Oil and Grease. The treated water would adhere to the discharge regulations and be suitable for use in gardening or for safe disposal. Treated effluent from this STP will have discharge standards laid down by National Green Tribunal, during Apr 2019, Therefore, the revised standards i.e. **BOD5 < 10 mg/l, TSS < 20 mg/l, pH between 5.5 – 9.0, Nitrogen (Total) Sewerage network and STP of Seohore Town 11 < 10 mg/l, COD < 50 mg/l, Phosphorus Dissolved < 1 mg/l and Faecal Coliforms < 100 MPN / 100 ml (230 Acceptable)** will have to be maintained before reuse or discharge.

Since there is no proper treatment plant for sewage in Sehore Town, it is necessary to construct a Sewage Treatment plant. The plant is designed perfectly to meet the future expansion for the next 30 years (upto the year 2055) in accordance with Indian Codal provisions. The plant is designed perfectly to meet the needs and demands of appropriate 397400 population with a very large time. The treated sewage water is further used for the irrigation, fire protection, and toilet flushing in public, commercial and industrial buildings and if it is sufficiently clean, it can be used for ground water recharge.

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