DESIGN OF SEWERAGE SYSTEM AND STP FOR A PROPOSED LOCALITY IN PHAGWARA, PUNJAB

Submitted in partial fulfilment of the Degree of

Bachelor of Technology

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CERTIFICATE

This is to certify that the work titled "DESIGN OF SEWERAGE SYSTEM AND STP FOR A PROPOSED LOCALITY IN PHAGWARA, PUNJAB" submitted by "Sandeep Sharma (101648) and Mayank Lamba (101684)" in partial fulfilment for the award of degree of B. Tech in Civil Engineering of Jaypee University of Information Technology, Waknaghat has been carried out under my supervision. This work has not been submitted partially or wholly to any other University or Institute for the award of this or any other degree or diploma.

Signature of Supervisor

Name of Supervisor: Dr. Veeresh Gali

Date:

Place:

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Our thanks and appreciations also go to our colleague in developing the project and people who have willingly helped us out with their abilities.

ABSTRACT

The main purpose of this project is to design a new Sewerage System including an upgraded Sewage Treatment Plant of capacity 25 MLD (peak) and 15 MLD (Average) using advanced C-Tech Technology in addition to existing 20 MLD Sewage Treatment Plant located in the region Phagwara (Punjab).

The Sewage Treatment involves Preliminary, Primary, Secondary, Tertiary and Advanced Treatment unitswhich include Unit Operations and Unit Processes to remove physical, chemical and biological contaminants. The treated effluent can be discharged into a stream or used in irrigating agricultural farms for growing animal fodder and in landscape irrigation in Phagwara. The stabilized sludge can be used as a soil conditioner. Samples are collected regularly at the plant inlet as well as before and after each treatment process. The raw sewage is characterized by high dissolved solids, medium strength BOD, and low COD/BOD ratio, high concentration of chloride, sulphate and sulfide due to septic sewage. These are typical characteristics of the sewage in this region. The plant is designed, operated and maintained so as to ensure safety and reliability in the treated effluent quality. Any overloading of the treatment processes is handled effectively. The reclaimed water quality meets the international standards and guidelines for landscape irrigation and farming.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

CHAPTERS

CHAPTER 1

INTRODUCTION

Phagwara town is a Tehsil Head Quarter of District Kapurthala. It is situated on main line Northern railway from Jalandhar to Ludhiana at a distance of about 20 Km. from Jalandhar towards Ludhiana. It is an industrial town with major industries of sugar mill, cloth mill, & starch mill etc. The town is divided in two parts by double track main railway line. Area of North side of railway line contains the main population whereas the area of South side of railway line contains new development. The population of the town as per 2001 census was 0.96 Lac persons and population ending 2011 was 116453 persons.

The Main Sewage Pumping Station & Sewage Treatment Plant of 20 MLD has been constructed under Sutlej Action Plan Phase-I at Phagwara North and is functioning since December 2001 and March 2008 respectively. Now due to increase in population, the consumption of water supply has been increased, the industrial outflow has also increased. At present, 20 MLD (average) sewage is being pumped out from Main Pumping Station. Considering flow for year 2043 the calculated discharge for domestic and industrial flow comes out 35 MLD (average). So for the increased 15 MLD raw water sewage treatment, we are designing a new STP of 15 MLD based on C-Tech / SBR technology along with augmentation of existing main pumping station.

1.1 Components

The following categories of works would be taken up under this programme:

- Designing of Sewerage System
    - Collection
    - Treatment and
    - Disposal Facilities
- Process Equipment
- Environmental Impact Assessment Studies

1.1.1 Special Features

- In order to reduce the cost on sewage conveyance and minimizing the energy needs for pumping the sewage, efforts are being made to decentralize the sewage conveyance and treatment facilities.
- For sewage treatment low cost options like use of raw sewage for afforestation, Oxidation pond technology, C-Tech technology are being encouraged.

1.2 Existing Sewerage facilities

At present there exists partly sewerage system about 76.36 Km Lateral and 15.78 Km intercepting sewer. Main Pumping Station on Phagwara North side has been already constructed and commissioned under Sutlej Action Plan. 20 MLD capacity Sewage Treatment Plant on North side is also constructed under SAP & commissioned. Only 0.33 Km 36" internal diameter of main sewer laid on south side of Phagwara& partly branch sewer exists in some colonies and connection with temporary disposal works.

1.2.1 Status of Existing water supply

The water supply of the town is based on underground source. About 24 tubewells have been drilled throughout the town. Depth of the tubewells is about 150 m. About 95% of the population is being served from these tubewells and 19917 number of water supply connections exist.

1.2.2 Existing Sewerage Network and Sewerage Disposal System in the Town

Sewerage network has already been laid in the old city area i.e. Banga Road Wala Bazar and Hoshiarpur Road (North side). The waste water from these areas is being collected on Phagwara (North) and treated in 20 MLD STP Phagwara (North) and then pumped into the nearby drain after treatment. Ultimately it goes to River Sutlej. Major industries also discharge their treated effluent into the River Sutlej.

1.2.3 Domestic & Industrial Flows

Three major industries are discharging at present 11.04 MLD of effluent after treatment into existing sewers. These Industries are, JCT Mills (8.5 MLD), Wahid Sandhar Sugar Mills (1.04 MLD) and Sukhjit Mills (1.50 MLD). It is expected that Phagwara will be a centre of Agro based industries. Industrial effluent shall be of the order of 18 MLD in the year 2043.

1.3 OBJECTIVES

i) Designing of Sewerage System:

- Design and detailing of Coarse Screen Bar rack, Aerated grit chamber, Equalization tank, Aeration tank, Claritube-Settler tank, Chlorination tank.
- Collection
- Treatment and
- Disposal Facilities

ii) Process Equipment

iii) Environmental Impact Assessment Studies

CHAPTER 2

LITERATURE REVIEW

2.1 C TECH System

SBR/Cyclic Activated Sludge Technology is an advanced technology for sewage treatment, which offers high treatment efficiency. The technology derives its process design from the concepts of activated sludge process. It uses deep RCC basins, and very efficient oxygen transfer equipment’s(diffused aeration mechanism) to achieve highest possible treatment in a single tank with 14-20 hours retention only.

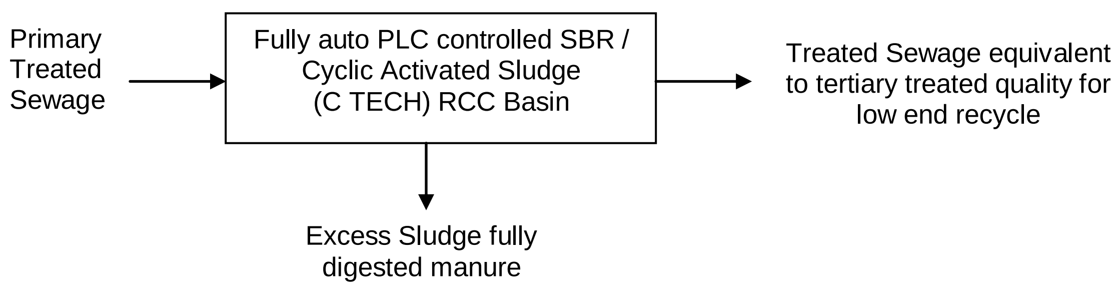

Figure 2.1 Flowchart for Operation Processes of C-TECH System

SBR/Cyclic Activated Sludge Technology operates in a cycle of batches. Two or more modules are provided to ensure continuous treatment of wastewater. The complete process including removal of organics, N and P reduction takes place in a single reactor, within which all biological treatment steps take place sequentially.

One cycle/sequence of operation consists of 3 steps - Filling & Aeration, Settling and Decantation. The settled sludge from the basin shows SVI < 120 and excellent settling characteristics. The excess sludge wasted from the basin is fully digested and can be used as manure directly after dewatering.

SBR/Cyclic Activated Sludge Technology is fully automated using PLC, various transmitters and analysers, VFDs and automated valves. The entire treatment process including incoming flows, cycle duration and regulation between aeration basins, process parameters, Dissolved Oxygen levels, air flow rates to basin, growth of micro-organisms, decanting rates, etc. are controlled, monitored online and are adjusted automatically based on varying incoming flow and organic load conditions. This offers consistent and optimized performance of plant with excellent outlet quality even under varying incoming conditions.

2.2 Up flow Anaerobic Sludge Blanket Process

Raw effluent after screening and grit removal is directly fed into UASB reactors. The reactor maintains a high concentration of anaerobic biomass through formation of highly settleable microbial aggregates. Untreated sewage inside the reactor flows upward through a layer of sludge while getting treated for organics, converting them into methane gas. At top of the reactor, phase separation between gas-solid-liquid takes and treated water is taken out form the reactor. This process is very sensitive to operating conditions like temperature, pH, incoming load and recirculation rate hence treatment efficiency keeps fluctuating. At best operating conditions, the process offer 50 – 70% treatment efficiency, therefore requires second stage biological treatment downstream.

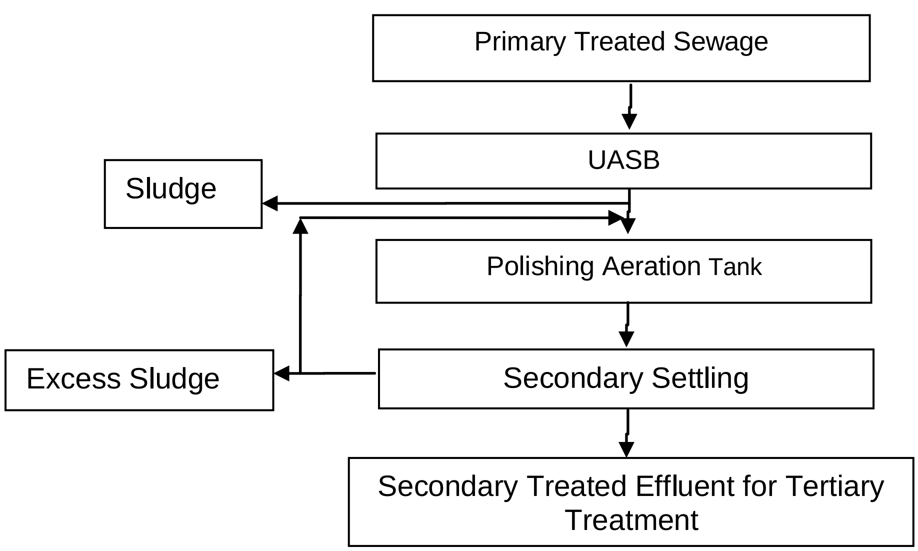

Figure 2.2 Flow-chart for Operating Processes of UASB System

Table 2.1 Comparison between Operation Processes of Cyclic Activated Sludge Technology and Anaerobic Process

SR. NO.	ITEM	C TECH SYSTEM	UASB PROCESS
1	**Treatment efficiency, process performance and odor generation**	C TECH process gives 98 % BOD removal efficiency, Sewage can be treated to recycle quality of turbidity < 10 NTU, COD < 20 ppm, BOD < 5 ppm, TN < 5 ppm, TP < 1 ppm in a single stage of treatment using Batch process. Complete nitrification and de nitrification along with biological removal of phosphorous takes place. There is NO odor problem as complete process is aerobic and generates fully digested sludge, which is excellent manure and can be directly applied as manure to plants.	Anaerobic process has very slow growth rates of microorganism and hence these systems have poor treatment efficiencies of only 50-70%. In order to achieve disposal outlet quality of treated sewage, second stage aerobic biological units are required. Typical outlet quality from anaerobic reactors is suspended solids 50 ppm, COD: 200 ppm, BOD 100-120 ppm. There is no inbuilt provision for removal of Total Nitrogen and Phosphorous. The system generates bad odor, as process releases gases like H_2S and methane.
2	**Process control and simplicity in operation**	C TECH is based on activated sludge process. It is a very simple and sturdy process, which gives consistent outlet results irrespective of feed quality variation by 0-250%. The basic reaction is a single step process, in which organics	Anaerobic process is very difficult to control. It requires consistent feed quality as well as flow rates. The process of degradation is a 3 step fermentation process comprising different sets of bacteria, to generate methane gas and CO_2

		are directly converted into CO_2 and H_2O using aerobic bacteria. The process works between wide ranges of temperature ranging from 5 – 35 degree temperature. No heating is provided during winter months.	Hydrolysis Acidogenisis Methanogenisis It requires constant monitoring of acidogenesis and methano genesis phases in the anaerobic reactor. The process is pH sensitive. Methanogenisi reaction occurs in a pH range of 6-7.5 only, while during acidogenisis phase the ph may drop to 2.0 also due to formation of complex acids. This disturbs the complete equilibrium and further reduces treatment efficiency. Temperature dependent: The process works in the range of 18–38^{o}C. During winter season when ambient temp Drops to 1-2 degree, provision has to be made to heat the entire contents of the reactor or else treatment efficiency drops drastically.
3	**Fully automatic operation**	The complete process is fully automatic PLC controlled and can be monitored and operated from anywhere in the world using internet connectivity. All process parameters are constantly measured and	There is No control on any process parameters. The plants run continuously at all times including low flow/ Nil flow conditions Plant is manually controlled and difficult to monitor. It is susceptible to

		controlled to provide consistent and utmost treatment using lowest power. The plant can automatically shut off during low/nil flow conditions and can automatically adjust power consumption proportional to present flow rate and concentration of pollutant load. This drastically reduces power consumption.	variation in inlet conditions BOD, COD, sulphide levels, pH and temp condition, which directly influences treatment efficiency as well as quantity of gas generation.
4	**Variation in input flow rate as well as quality**	Normally city sewage treatment plants are designed for higher flow rates depending on minimum future 20 years population prediction. In the initial years the plant works at 50-60 % flows only. With C TECH process power consumption is directly proportional to the initial influent load only. Complete operation gets automatically optimized to input condition.	It is a point load design. The design cannot handle sudden peak flow variation, which is expected for any large-scale city sewage system. Normally 0-250% flow variation is present for any sewage treatment plant.
5	**Gas generation and utilization**	As the process is completely aerobic there is NO gas generation, hence does not require extra gas holding tanks, flare system etc.	Gas can be generated; however process is not economical for low strength effluents like sewage where input BOD is less than 300 ppm. Furthermore for financial viability it is important to utilize

			the gas either directly in boilers or households. In case power is to be generated it again requires capital investment by putting duel fuel engines. Also provision has to be made for gas storage facility with flare system installed at site. Gas production is not consistent, and varies in case there is any disruption in the process.
6	**Material of construction and maintenance cost**	In this process pH is always in neutral condition, yet all under water submerged parts are provided in SS304/SS316 to ensure no corrosion problem. Life of all equipments is much longer as no acidic condition prevails.	Due to Process chemistry acids are generated, pH in anaerobic reactors varies from 2-7, which essentially requires SS domes and FRP lining of complete tank internals. Problem of internal corrosion is very high and cost of maintenance is very high.
7	**Space requirement**	C TECH uses deep RCC tanks, with diffused aeration mechanism, which drastically reduces the space requirement. Further there is no need to provide secondary clarifiers, gas storage tanks, flare system or power generation units. This process uses minimum 50 % less space as compared to anaerobic process.	As this process essentially needs second stage aerobic treatment comprising aeration tanks and secondary clarifier, to get good outlet quality, plant area is very high as compared to C TECH process. Also additional space is required to store the generated gas, power generation device, flare towers, diesel holdup tanks etc., which increases the space requirement.

8	**Capital cost**	On a like to like comparison of outlet requirement, land cost, material of construction and automation, this technology has the lowest capital cost.	Initial capital cost is much higher, as it requires many additional units like nitrification and denitrification tanks, post polishing treatment, tertiary treatment, gas storage, and power generation units etc. to achieve the same quality from the system.
9	**Operating cost**	The Cyclic activated sludge technology has a very low power consumption of only 0.7 Rs. per m^3 of raw sewage. Overall operating cost is in the range of 1.2 –1.5 Rs./m^3	Power consumption is low. Typical power consumption are comparable to Cyclic activated sludge process. The 1st stage Anaerobic process does not require any power; however 2nd stage aerobic polishing units require power, which works out to approx. 0.7 Rs per m^3. Other costs like maintenance and manpower are much higher than C TECH process. Overall operating cost range from 1.8 Rs /m^3 to 3 Rs/m^3.

CHAPTER 3

OVERVIEW OF PROCESSES FOR SEWAGE TREATMENT

3.1 Sewage Treatment & Selection Of Treatment Process

Sewage Treatment is the process of removing contaminants from wastewater. It includes Unit Operations and Unit Processes to remove physical, chemical and biological contaminants. Typically, Sewage Treatment involves Preliminary, Primary, Secondary, Tertiary and Advanced Treatment. The final effluent can be discharged into a stream or on land.

3.2 Treatment Stages

3.2.1 Primary Treatment

Primary sewage treatment is a relatively uncomplicated physical process that mainly removes solids. The sewage first passes through screens that filter out large debris such as pieces of wood or cardboard. It then flows to a grit chamber where sand and other heavy particles are removed.

Primary sewage treatment removes 40%-60% of suspended solids and about 30% of organic matter. In plants that provide no further level of treatment, the water is chlorinated to kill any remaining pathogens and returned to the environment at this point. Primary sewage treatment alone is no longer considered sufficient.

3.2.2 Secondary Treatment

Secondary treatment is designed to substantially degrade the biological content of the sewage such as are derived from human waste, food waste, soaps and detergent. The majority of municipal and industrial plants treat the settled sewage liquor using aerobic biological processes. For this to be effective, the biota requires both oxygen and a substrate on which to live. There are number of ways in which this is done. In all these methods, the bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, organic short-chain carbon molecules, etc.) and bind much of the less soluble fractions into flocs. Secondary treatment systems are classified as fixed film or suspended growth. Fixed-film treatment process including trickling filter and rotating biological contactors where the biomass grows on media and the sewage passes over its surface. In suspended growth systems—such as activated sludge—the biomass is well mixed with the sewage and can be operated in a smaller space than fixed-film systems that treat the same amount of water. However, fixed-film systems are more able to cope with drastic changes in the amount of biological material and can provide higher removal rates for organic material and suspended solids than suspended growth systems.

Roughing filters are intended to treat particularly strong or variable organic loads, typically industrial, to allow them to then be treated by conventional secondary treatment processes. Characteristics include typically tall, circular filters filled with open synthetic filter media to which wastewater is applied at a relatively high rate. They are designed to allow high hydraulic loading and a high flow-through of air. On larger installations, air is forced through the media using blowers. The resultant wastewater is usually within the normal range for conventional treatment processes.

The result of effective primary plus secondary treatment is removal of about 90% of the organic matter, virtually all pathogens, and most solids. Between 10% and 20% of the nitrogen is also automatically removed because the decomposer bacteria require this much for their own growth.

3.2.2.1 Selection of Secondary Treatment Process

The selection of a particular type of treatment will depend upon the techno-economic feasibility of the process selected for the treatment. The techno-economical feasibility can be attributed to the following parameters:

1. Degree of treatment required
2. Capital and Operation & Maintenance cost
3. Mechanical equipment requirement
4. Power requirement
5. Land requirement

The various treatment options considered for the treatment are considered to find out the techno-economically best suitable treatment scheme to suit wastewater characteristics, climate and land available for the STP.

The various treatment options considered for techno-economic evaluation are us under:-

1. UASB
2. Activated sludge process
3. Cyclic Activated Sludge Technology System
4. Waste stabilization pond
5. Fluidized Aerobic Bioreactor Process (FAB Technology)

3.3 Treatment Options

3.3.1 UASB Technology

The development of the Up Flow Anaerobic Sludge Blanket (UASB) reactor dates back from early 1970's. Pre-sedimentation, anaerobic wastewater treatment and final sedimentation including sludge stabilisation are essentially combined in one reactor making it most attractive high-rate wastewater treatment option. It produces high value by products viz.

- Treated wastewater usable for gardening purpose or for pisci-culture after a simple post treatment.
- Methane enriched biogas having high calorific value is converted into a usable energy resource like heat energy, electricity etc., and
- Mineralized excess sludge produced in UASB reactor for its usage as manure for agricultural purpose.

UASB initially was developed for the anaerobic treatment of industrial wastewater with a moderate to high COD and BOD concentrations. The basic idea is flocculent or granular sludge developed in the reactor depending on the wastewater characteristics and operational parameters will tend to settle under gravity when applying moderate upward velocities in the reactor. In this way no separate sedimentation basin is necessary. Anaerobic bacteria are developed in the reactor and are kept in the biological reaction compartment for sufficient time. Organic compounds present in the wastewater are absorbed or adsorbed on the sludge particles in the reaction zone during its passage through the sludge bed. Organic compounds there after get anaerobically biodegraded converting it into methane-enriched biogas and a small part into the new bacterial mass. Biogas consists of Methane CH_4, Carbon dioxide CO_2, Hydrogen H_2, Hydrogen Sulphide H_2S and traces of Ammonia NH_3 and Nitrogen N_2.

A Gas, liquid and solids separator (GLSS) is provided below the gas collectors in order to provide an opportunity to the sludge particles to which biogas bubbles are attached to lose biogas and settle back into the reaction compartment. In between two gas collectors as settling zone is provided where virtually no gas bubbles are present in the liquid. The sludge particles carried along with the wastewater flow are settled in the settling zone and slide down into the biological reaction zone. Wastewater enters the UASB reactor from the bottom and travels through the reactor in the upward direction. In order to ensure sufficient contact between the incoming wastewater and the anaerobic bacterial mass present in the reactor, the wastewater is fed uniformly all over the bottom of the reactor. Further mixing in the reaction zone is achieved by the production of the biogas travelling in the upward direction, settling velocity of the sludge particles and the density currents in the sludge mass.

With proper seed material available at the time of start-up of the UASB reactor, the microbial population is developed within three months period. Proper care is taken while designing the UASB reactor to absorb estimated shock loads in terms of hydraulic and organic contents in the wastewater. The reactor is having the following zones:

- Gas Collection Zone
- Clarification Zone
- Sludge blanket Zone

Advantages:

- Minimal power consumption
- Large numbers of plants have been constructed on this process in India.
- Less land requirement as compared to Waste Stabilisation Ponds.

Disadvantages:

- Requires second stage aerobic treatment

3.3.2 Activated Sludge Process

An Activated sludge process (ASP) is a type of Aerobic Suspended Growth system. The ASP plant essentially consists of the following:

- Aeration Tank containing micro-organisms in suspension in which the reaction takes place,
- Activated sludge recirculation system to maintain the sufficient micro-organisms in aeration tank,
- Excess sludge washing and disposal facilities,
- Aeration system to transfer oxygen,
- Secondary settling tank to separate and thicken activated sludge.
- Gas Digester for gas production and Gasholder for gas storage

This option consists of the following treatment units:-

- Inlet chamber
- Fine Screen Channel,
- Detritor Tank/Grit Channel,
- Primary Clarifier,
- Aeration Tank,
- Secondary Clarifier,
- Sludge Pumping Station,
- Filtrate Pumping Station,
- Digester
- Centrifuge

Raw sewage will be received in the inlet chamber and then passed to the screen channel and subsequently to the detritor tank. In screen channel floating matters are trapped and removed whereas in detritor tank, grit is removed. After screening and grit removal the wastewater is taken into a primary clarifier. This is provided for the removal of suspended solids before taking wastewater for further biological treatment. The sludge generated as a result of primary settling is taken for digestion. A sludge digester and pumps are provided for this purpose.

After primary settlement of the suspended solids, the wastewater is taken to aeration tank containing micro-organisms in suspension in which the biological degradation takes place. Further, a secondary clarifier is provided to separate the activated sludge. 60% of the incoming

flow is re-circulated upstream of the aeration tank. A tapping is provided on this line to lead the excess sludge to the primary sludge sump. Form here the sludge is pumped up to the digester.
A digester is provided for sludge degradation. The detention time in the digester is 32-38 days. Mixers are provided to operate a completely mixed regime in the digester. It is proposed to use Centrifuge for sludge dewatering prior to sludge disposal.

Advantages:

- Land requirement lesser than Waste Stabilisation Ponds.

Disadvantages:

- High Capital Cost
- High Maintenance Cost

3.3.3 Cyclic Activated Sludge Technology System / Sequential Batch Reactor (SBR)

Sequential Batch Reactor (SBR) / Cyclic Activated Sludge Technology is an advanced technology for sewage treatment, which offers high treatment efficiency. The technology derives its process design from the concepts of activated sludge process. It uses deep RCC basins, and very efficient oxygen transfer equipments (diffused aeration mechanism) to achieve highest possible treatment in a single tank with 14 – 20 hrs.retention only.

Sequential Batch Reactor (SBR) / Cyclic Activated Sludge Technology operates in a cycle of batches. Two or more modules are provided to ensure continuous treatment of wastewater. The complete process including removal of organics, N and P reduction takes place in a single reactor, within which all biological treatment steps take place sequentially.

One cycle / sequence of operation consists of 3 steps – Filling & Aeration, settling and Decantation. The settled sludge from the basin shows SVI < 120 and excellent settling characteristics. The excess sludge wasted from the basin is fully digested and can be used as manure directly after dewatering.

Sequential Batch Reactor (SBR) / Cyclic Activated Sludge Technology is fully automated using PLC, various transmitters and analysers, VFDs and automated valves. The entire treatment process including incoming flows, cycle duration and regulation between aeration basins, process parameters, Dissolved Oxygen levels, air flow rates to basin, growth of micro – organisms, decanting rates, etc. are controlled, monitored online and are adjusted automatically based on varying incoming flow and organic load conditions. It offers consistent and optimized performance of plant with excellent outlet quality even under varying incoming conditions.

Disadvantages:

- The technology is quite new. It was introduced in India 2 years back. Since then, one large 28 MLD STP is working at Goa and some other plants are in currently under installation stage (HPCL, Vizag and Pharamacity).
- Requirement of Skilled Operational staff
- Higher power consumption
- Lack of reputed Indian Suppliers
- High cost of import of technology
- Lack of reference Sewage Treatment Plants in India.

Conclusion:

Keeping in view above parameters and comparisons, various alternatives are feasible for construction of STPs at Phagwara (North). However, because of following reasons SBR is the best alternative for proposed STPs at Phagwara (North):-

(1.) Land requirement is very less in SBR as comparative to other technology.

(2.) SBR offers high treatment efficiency

(3.) SBR uses deep RCC basins, and very efficient oxygen transfer equipments (diffused aeration mechanism) to achieve highest possible treatment in a single tank with 14 – 20 hrs. retention only as comparative to other technology.

Thus, proposed Sewage Treatment Plant of capacity 15 MLD shall be based on SBR/ C-Tech.

CHAPTER 4

DESIGN OF SEWAGE TREATMENT PLANT

4.1 Population Projection

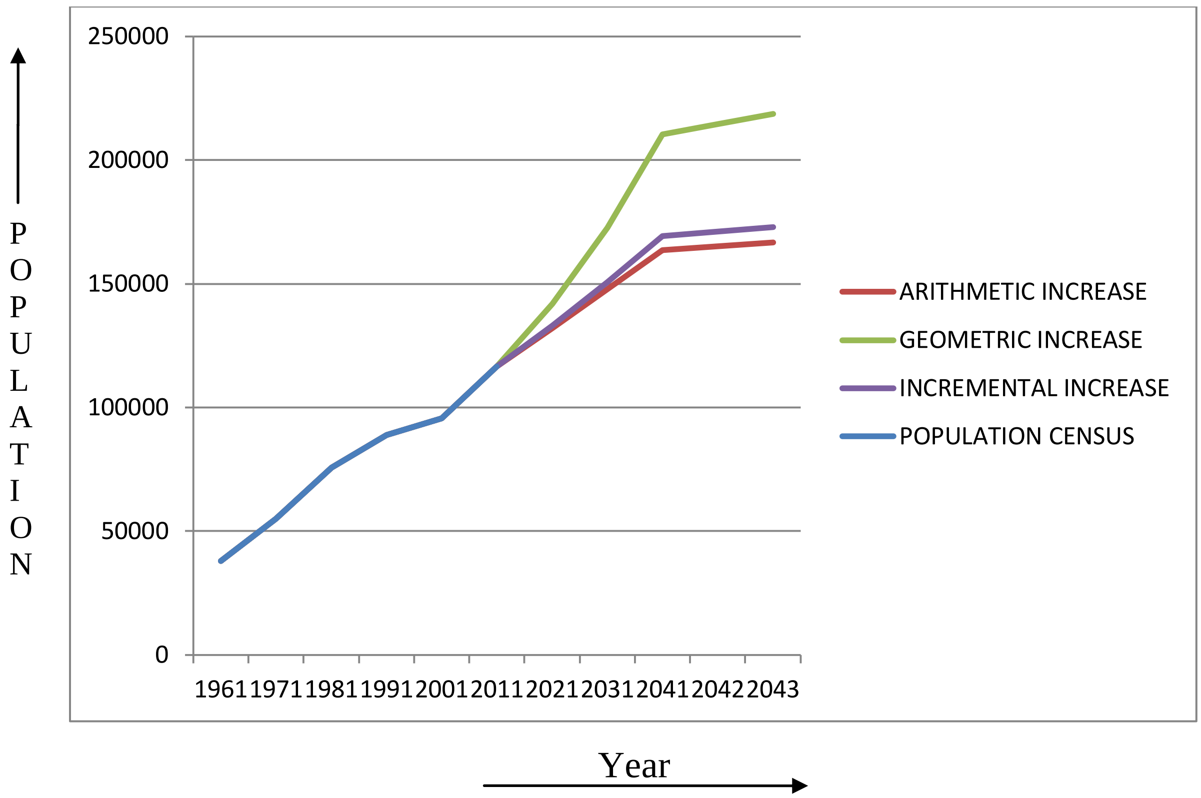

Figure 4.1 Graph for Prediction of future Population

4.2 Design of Coarse Screen Bar

Inputs			***Adjusted Values***	
Bar Size				
Length =	50	mm		
Width =	10	mm		
Depth =	50	mm		
Height of Channel excluding freeboard, **h** =	0.4	m	0.39	m
Clear Space Between openings, **s** =	25	mm		
Slope from Horizontal =	60	degree		
Approach Velocity, **v** =	0.7	m/s		
Avg. volume flow per day =	15	MLD		

Output Parameter				
Approach Volume Max., Q_{max} =	0.313	m3/s		
Approach Area, **A** =	0.45	m2		
Approch Width, **W** =	1.12	m	1.15	m
Total Number of Bars, **N** =	32.1		32.0	
Total Width of screen chamber, W_t =	1.15	m	1.15	m
Effective width of Channel, W_e =	0.83	m		
Effective Cross-Secional Area of Screen, A_e =	0.332	m2		
Approach velocity Through Screen, **V** =	0.94	m/s		
Head Loss through Bar Screen, h_L =	0.03	m		

Equations used for Calculations:

$h_L = 0.0729 (V^2 - v^2)$

$V = Q_{max} / A_e$

$N = (W*1000 - s) / (s + \text{width of bar})$

$W_t = N*\text{width of bar} + (N + 1)*s$

$W_e = W_t - \text{width of bar}*N$

$A_e = W_e * h$

Table 4.1 Design Criteria For Mechanically Cleaned Bar Screens

Parameter	Design Criteria
Bar width	5 - 15 mm
Bar depth	25 - 40 mm
Clear spacing between bars	15 - 75 mm
Slope from vertical	0 - 30 degrees
Approach velocity	0.6 - 1.0 m/s
Allowable Headloss	150 - 600 mm

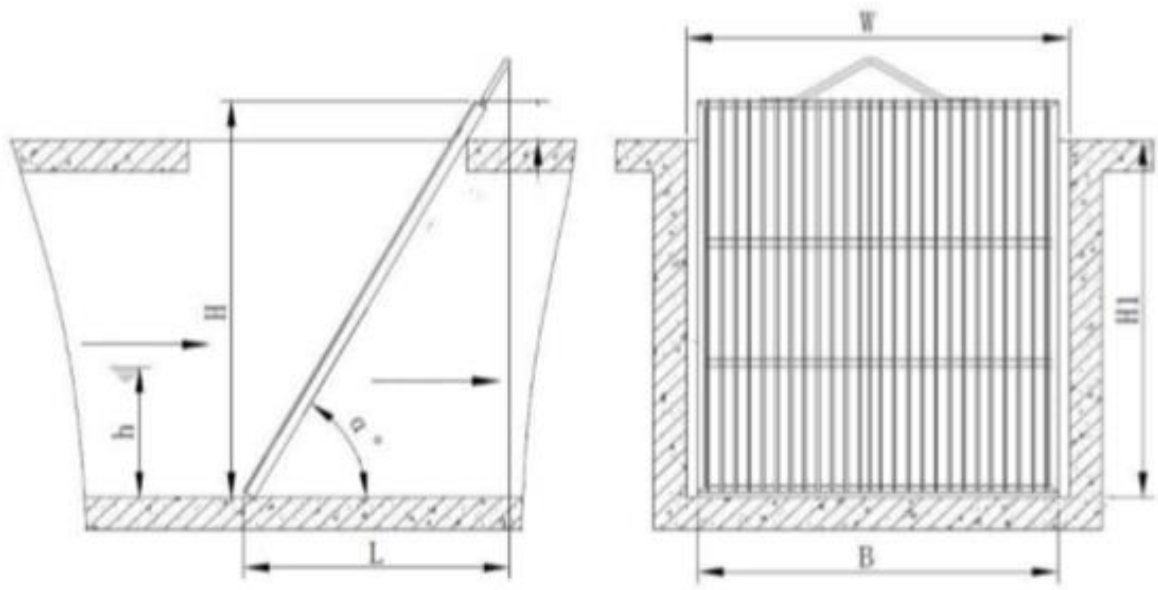

Figure 4.2 Cross – Section and Front View of Coarse Bar Screen

4.2.1 Quantity of Screening

Inputs

Screening Production for Clear Space Opening =	0.004	m^3/ML

Calculations

Quantity of Screening Production per day =	0.06	m^3/day
Quantity of Screening Production per day =	60	L/day
Quantity of Screening Production for 3 day =	0.18	m^3/day
Design of Perforated Plate:		
Length of perforated plate =	0.7	m
Width of perforated plate =	1.1	m
Depth of Perforated plate =	0.2	m
Volume of perforated plate =	0.17	m^3
Inclined Length of Bars =	0.46	m
Projected Length =	0.23	m
Length of Outlet Zone =	0.9	m
Inlet Zone =	0.5	m
Total Length of Screen Channel =	1.67	m

4.3 Design of Aerated Grit Chamber

Inputs

Average Flow per day =	15	MLD
Peak Flow =	0.313	m^3/s
Avg. Detention Time =	5	min
Number of Chambers =	2	
Width to Depth Ratio =	1.5	
Depth =	2	m
Air Supply Provided =	0.4	$m^3/min*m$
Quantity of Grit per 1000m^3 =	0.015	m^3

Calculations

For 1 Chamber:

Aerated Chamber Volume =	46.88	m^3
Width =	3	m
Length =	7.81	m
Adjusted Length =	8.98	m
Air Required length basis =	3.59	m^3/min
Volume of Grit =	0.405	m^3/day

Table 4.2 Typical Design Information for Aerated grit chamber

Particulars	Range	Typical
Detention time (mins) at max. flow	2 - 5	3
Dimensions		
Depth (m)	2 - 5	
Length (m)	7.5 - 20	
Width (m)	2.5 - 7	
Width -depth ratio	1:1 - 5:1	1.5:1
Length-width ratio	3:1 - 5:1	4:1
Air supply (m^3/min/m of length)	0.2 - 0.5	
Grit quantities (m^3/1000 m^3)	0.004 - 0.20	0.015

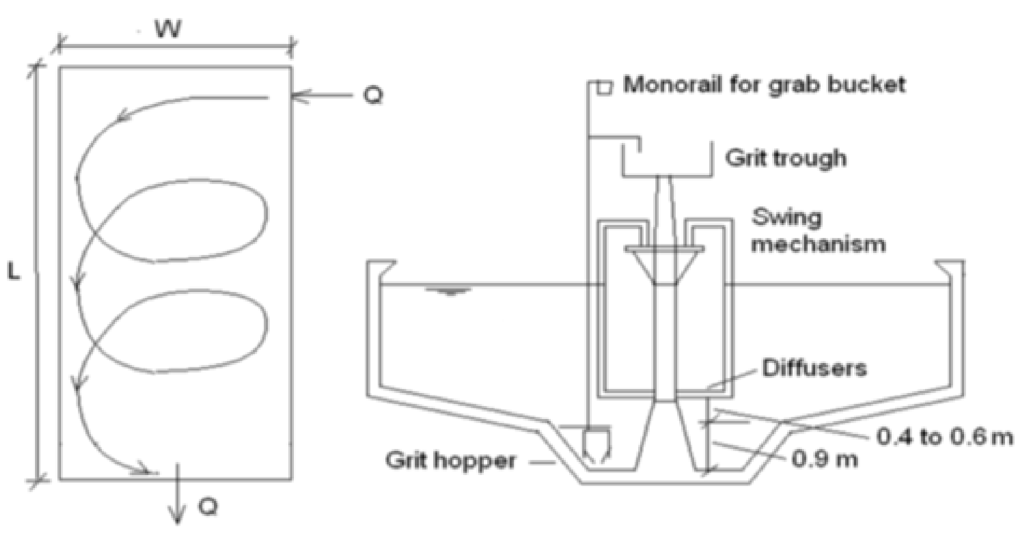

Figure 4.3 Aerated grit chamber (first figure showing the helical flow pattern of the wastewater in grit chamber and second showing cross section of grit chamber)

4.4 Equalization tank

Determination of Volume of Equalization Tank

Average Flow for day =	15	MLD
Average Flow per sec =	0.174	m^3/s
Average Flow per hour =	625.00	m^3/hr

Table 4.3 Determination of Volume of Equalization Tank

Hours of day	%age of Avg. flow for the day	Average flowrate during time period (m^3/s)	Volume of flow at end of time period (m^3)	Cumulative volume of flow at end of time period (m^3)	Average Cumulative volume of flow at end of time period (m^3)	Tangent line	Equalization Tank Volume
M - 0	50	0.087	312.50	312.50	625.00		
M - 1	45	0.078	281.25	593.75	1250.00		
M - 2	40	0.069	250.00	843.75	1875.00		
M - 3	50	0.087	312.50	1156.25	2500.00	812.50	
M - 4	65	0.113	406.25	1562.50	3125.00	1437.50	
M - 5	80	0.139	500.00	2062.50	3750.00	2062.50	1687.50
M - 6	100	0.174	625.00	2687.50	4375.00	2687.50	
M - 7	135	0.234	843.75	3531.25	5000.00	3312.50	
M - 8	160	0.278	1000.00	4531.25	5625.00	3937.50	
M - 9	175	0.304	1093.75	5625.00	6250.00		
M - 10	180	0.313	1125.00	6750.00	6875.00		
M - 11	170	0.295	1062.50	7812.50	7500.00		
N - 12	160	0.278	1000.00	8812.50	8125.00		
N - 1	145	0.252	906.25	9718.75	8750.00	10000.00	
N - 2	130	0.226	812.50	10531.25	9375.00	10625.00	
N - 3	115	0.200	718.75	11250.00	10000.00	11250.00	
N - 4	100	0.174	625.00	11875.00	10625.00	11875.00	1250.00
N - 5	95	0.165	593.75	12468.75	11250.00	12500.00	
N - 6	80	0.139	500.00	12968.75	11875.00	13125.00	
N - 7	75	0.130	468.75	13437.50	12500.00		
N - 8	70	0.122	437.50	13875.00	13125.00		
N - 9	65	0.113	406.25	14281.25	13750.00		
N - 10	60	0.104	375.00	14656.25	14375.00		
N - 11	55	0.095	343.75	15000.00	15000.00		**2937.50**

Volume Of Equalization Tank =	3500	m^3
Height of Tank =	8	m
Diameter of Tank =	23.6	m

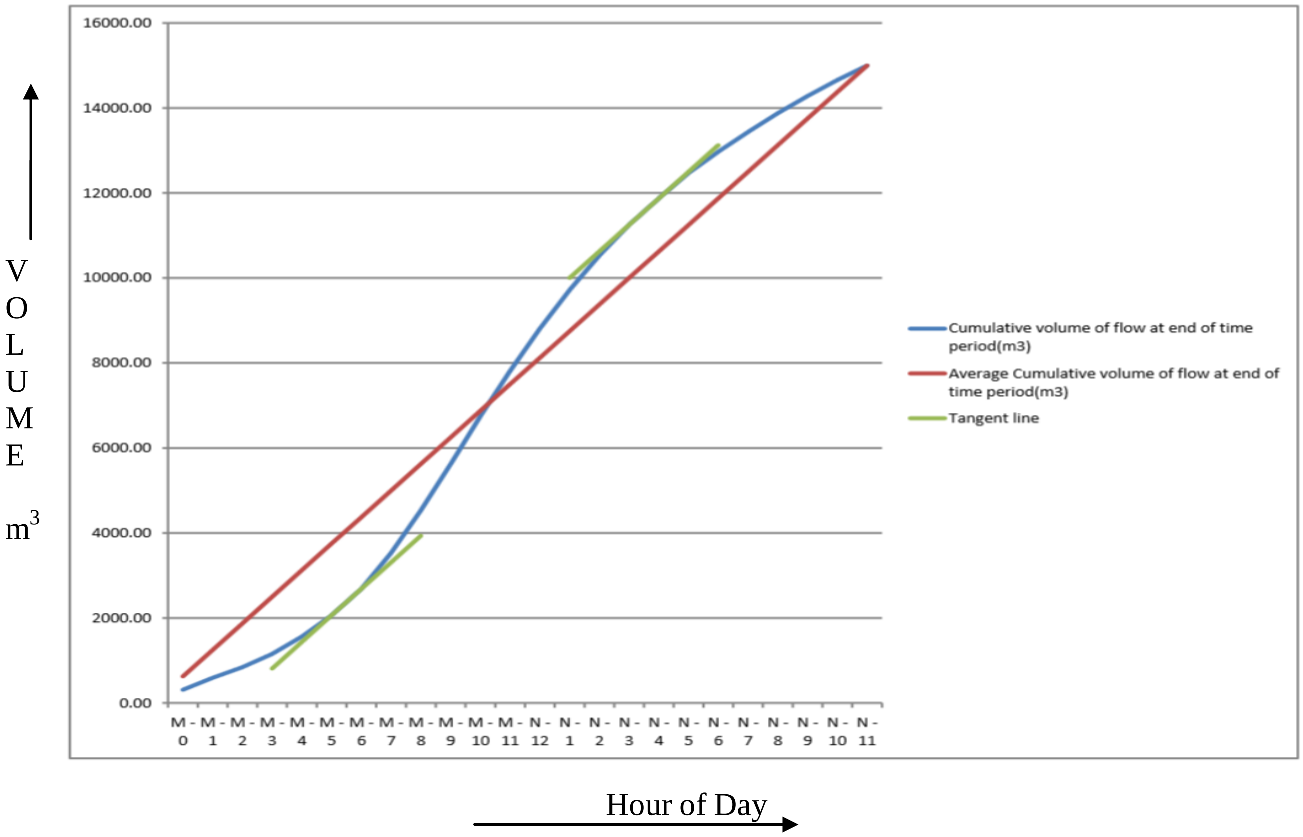

Figure 4.4 Determination of Volume of Equalization tank

4.5 Design of Aeration tank

Cyclic Activated Sludge wastewater Treatment Calculations

Inputs

Prim. Effl. Flow Rate, $\mathbf{Q_o}$ =	15,000	m^3/d
Prim. Effl. BOD, $\mathbf{S_o}$ =	250	g/m^3
Aeration tank MLSS, **X** =	2000	g/m^3
Design Vol. Loading, $\mathbf{V_L}$ = (kg BOD/day/m^3)	1	
% volatile MLSS, **%Vol** =	75%	

Calculations

(Design Based on Volumetric Loading)

Aeration tank volume, **V** =	3,750	m^3

Check on other design parameters:

Aeration tank **HRT** =	6.0	hr
Aeration tank **F:M** = (kg BOD/day/kg MLVSS)	0.67	

Equations used for Calculations:

$$V = (S_o * Q_{o/1000})/V_L$$

$$HRT = 24 * V_{MG}/Q_o$$

$$F:M = (S_o * Q_o)/(\%Vol * X * V_{MG})$$

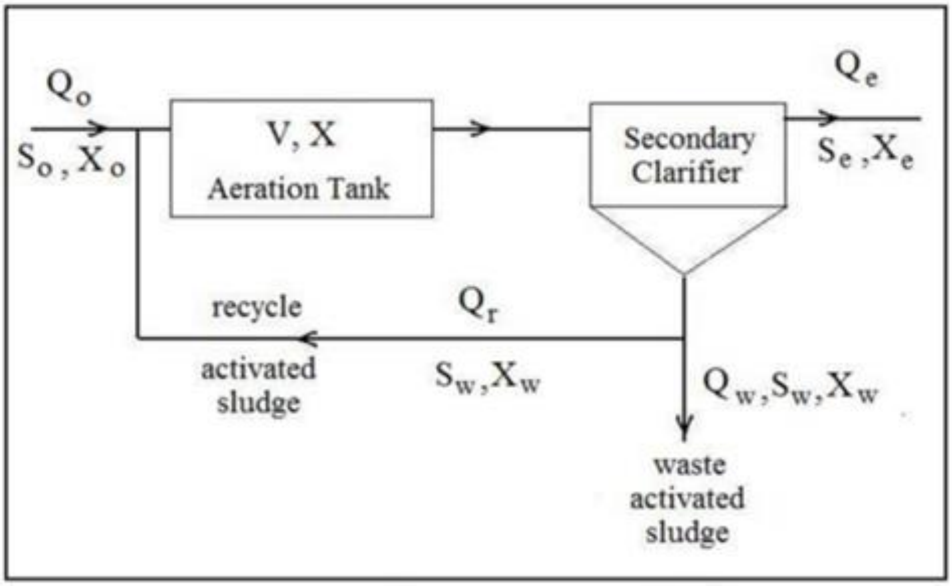

Figure 4.5 Activated Sludge Flow Diagram and Parameters

Table 4.4 Activated Sludge Design Parameters – Typical Ranges

Activated Sludge Process	Volumetric Loading		F:M	HRT
	lb BOD/day / 1000 ft^3	kg BOD/day / m^3	kg BOD/day / kg MLVSS	hours
Conventional Plug Flow	20 -40	0.3 - 0.7	0.2 - 0.4	4 - 8
Complete Mix	20 - 100	0.3 - 1.6	0.2 - 0.6	3 - 5
Extended Aeration	5 - 15	0.1 - 0.3	0.04 - 0.1	20 - 30

4.5.1 Dimensions Calculation for Circular tank

Inputs

Maximum height for Reactor upto water level =	6	m
Maximum height for Reactor with freeboard =	7	m

Calculations

For 2 Tanks:

Average Flow for 3 hours =	1.875	MLD
Reactor Radius =	9.97	m
Area Required for 1 Reactor =	312.50	m^2
Area Required for both Reactors =	625.00	m^2

For 1 Tank:

Average Flow for 6 hours =	3.75	MLD
Reactor Radius =	14.10	m
Area Required for Reactor =	625.00	m^2

Equation used:

Average Flow (**Q** m^3/s) = Cross Sectional Area (**A** m^2) * Height of Circular tank **(H** m)

4.6 Claritube Settler Operation

Inputs

Prim. Effl. Flow Rate, $\mathbf{Q_o}$ = 15,000 m^3/d

Prim. Effl. BOD, $\mathbf{S_o}$ = 250 g/m^3

Prim. Effl. TSS, $\mathbf{X_o}$ = 400 g/m^3

Waste/recycle activated sludge SS conc., $\mathbf{X_w}$ = 400 g/m^3

Aeration tank vol., **V** = 3,750 m^3

Aeration tank MLSS, **X** = 2000 g/m^3

% volatile MLSS, **%Vol** = 75%

Sludge ret. time, **SRT** = 12 days

Calculations

Recycle Activated Sludge Flow Rate, $\mathbf{Q_r}$ = (15,000) m^3/d

Waste Activated Sludge Flow Rate, $\mathbf{Q_w}$ = 1563 m^3/d

Aeration tank **F:M** = 0.67

(kg BOD/day/kg MLVSS)

Equations used for Calculations:

$$Q_r = Q_o(X - X_o)/(X_w - X)$$

$$Q_w = (V*X)/(SRT*X_w)$$

$$F:M = (S_o*Q_o)/(\%Vol*X*V_{MG})$$

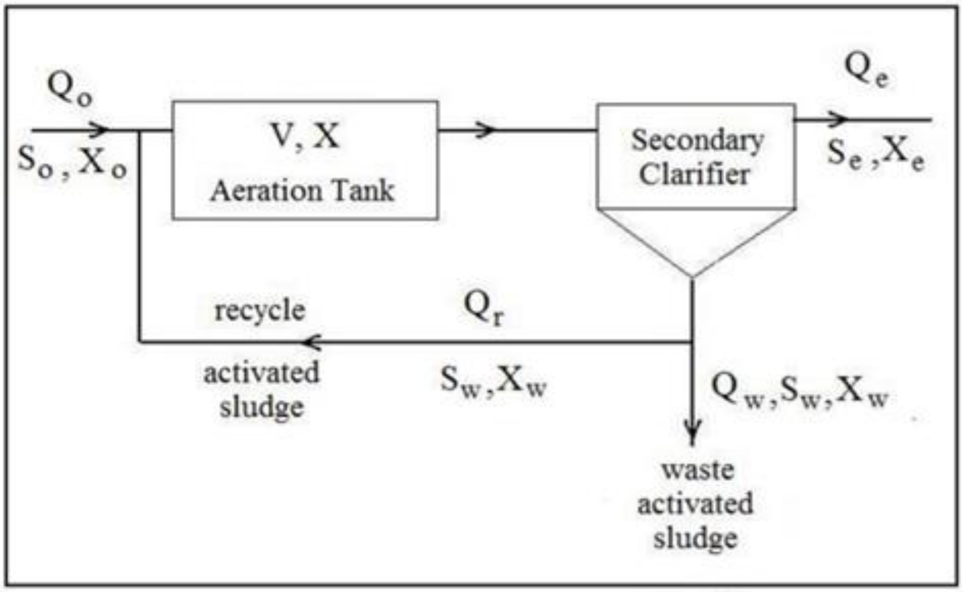

Figure 4.6 Activated Sludge Flow Diagram and Parameters

Table 4.5 Activated Sludge Operational Parameters – Typical Ranges

Activated Sludge Process	SRT days	MLSS g/m^3	F:M $\frac{kg\ BOD/day}{kg\ MLVSS}$	Q_r / Q_o %
Conventional Plug Flow	3 - 15	1000 - 3000	0.2 - 0.4	25 - 75
Complete Mix	3 - 15	1500 - 4000	0.2 - 0.6	25 - 100
Extended Aeration	20 - 40	2000 - 5000	0.04 - 0.1	50 - 150

4.7 Process Equipment's

4.7.1 Design Basis

Average Flow (Qav)	=	15.00	MLD
	=	625.00	m^3/hr
	=	0.17	m^3/s
Peak Flow Factor = (Qpk / Qav)	=	1.80	
Peak Flow (Qpk)	=	27.00	MLD
	=	1125.00	m^3/hr
	=	0.31	m^3/s

4.7.2 Inlet Parameters

BOD_5 @ 20^o C	=	250.00	mg/l
COD	=	675.00	mg/l
Total Suspended Solids	=	400.00	mg/l

4.7.3 Outlet Parameters

BOD_5 @ 20^o C	$\leq$	5.00	mg/l
COD	$\leq$	25.00	mg/l
Total Suspended Solids	$\leq$	10.00	mg/l

4.7.4 Stilling Chamber

Unit to be designed for Average Flow	=	15.00	MLD
	=	625.00	m^3/hr
	=	0.17	m^3/s
And to be checked for Peak Flow	=	27.00	MLD
	=	1125.00	m^3/hr
	=	0.31	m^3/s
HRT at Peak Flow	=	60.00	sec
Volume required	=	18.75	m^3
SWD provided	=	2.50	m

	Side of Square Chamber required	=	2.74	m
	Length/Width provided	=	3.00	m
	Volume provided	=	22.50	m
	Freeboard provided	=	0.50	m

4.7.5 Basin Sizing

A	Volume of Sewage treated	=	15000.00	m^3/d
B	BOD removed (Inlet BOD – Outlet BOD)	=	245.00	mg/l
C	MLSS	=	2000.00	mg/l
D	MLVSS	=	1475.00	mg/l
E	F/M	=	0.67	
F	Total Volume of C-Tech Basins = (A x B) / (D x E)	=	3718.69	m^3
G	No. of Basins Provided	=	2.00	Nos.
H	Volume per Basin = F / G	=	1859.35	m^3
I	Side Water Depth (SWD) of C-Tech Basins	=	6.00	m
J	Radius of C-Tech Basins	=	9.93	m
K	Volume provided per C-Tech Basin = $Pi*J^2*I$	=	1859.35	m^3
L	Total Volume offered = L x G	=	3718.69	m^3
M	Freeboard provided	=	1.00	m
N	Total Depth of C-Tech Basin = I + N	=	7.00	m
O	Providing Recirculation Ratio	=	**0.03**	
P	Feed Flow to each Basin	=	625.00	m^3/hr
Q	Recirculation Flow	=	15.63	m^3/hr
R	Recirculation Pump flow provided	=	20.00	m^3/hr

4.7.6 Oxygen Calculation at Peak Flow Conditions

A	Volume of Sewage treated	=	15000.00	m^3/d
B	O_2 required as per Sewage Manual	=	1.20	kg/kg BOD
C	Safety Factor considered	=	0.00	%
D	O_2 required	=	1.20	kg/kg BOD
E	Inlet BOD_5 @ 20^0 C	=	250.00	mg/l

F	Outlet BOD_5 @ 20^0 C	=	5.00	mg/l
G	BOD_5 removed	=	245.00	mg/l
H	BOD removed in a day = A x G	=	3675.00	kg/d
I	O_2 required for above BOD Load = D x H	=	4410.00	kg/d
J	Inlet Total Kjeldhal Nitrogen assumed	=	135.00	mg/l
K	Outlet Ammonical Nitrogen	=	2.00	mg/l
L	Outlet Nitrate Nitrogen	=	86.00	mg/l
M	NH_3-N removed in a day = J – K	=	133.00	mg/l
N	Kg O_2 required per Kg of NH_3-N	=	4.60	kg/ kg NH_3-N
O	NH_3-N removed in a day = A x M	=	1995.00	kg/d
P	O_2 required for NH_3-N removal = O x N	=	9177.00	kg/d
Q	Kg O_2 released per Kg of Nitrate-Nitrogen during de-nitrification	=	2.86	kg/NO_3-N
R	Kg of Nitrate-Nitrogen generated = A x J x 75%	=	1518.75	kg/d
S	Kg of Nitrate Nitrogen in the Treated Sewage = A x L	=	1290.00	kg/d
T	Quantity of Nitrate Nitrogen that is denitrified = R – S	=	228.75	kg/d
U	O_2 released during De-nitrification = T x Q	=	654.23	kg/d
V	Total O_2 required/day = I + P – U	=	12932.78	kg/d
W	Consider Safety Factor for Aeration	=	0.00	%
X	Total O_2 required per day considering Safety Factor = V x (1 + W)	=	12932.78	kg/d

4.7.6.1 Air Requirement at Peak Flow Conditions

A	Total Theoretical O_2 required per day	=	12932.78	kg/d
B	Alpha	=	0.65	
C	Beta	=	0.90	
D	Standard O_2 required at field conditions = A / (B x C)	=	22107.31	kg/d
E	No. of Basins	=	2.00	Nos.
F	Standard O_2 required at field conditions per Basin = D /E	=	11053.65	kg/d/Basin
G	Standard Oxygen Transfer Efficiency (SOTE) of Diffuser per m Depth of Submergence	=	6.00	% / m

H	Liquid Level in C-Tech Basin during Average Flow	=	6.00	m
I	Height at which Diffusers are kept	=	0.20	m
J	Effective Aeration Depth = H - I	=	5.80	m
K	SOTE for the above effective aeration depth = G x J	=	34.80	%
L	Fraction of O_2 in Air	=	23.20	%
M	Specific Gravity of Air	=	1.29	
N	Air required at field condition per basin = F / (K x L x M)	=	105804.55	Nm^3/d/Basin
O	Aeration Time per Basin per day	=	3.00	hrs/d/Basin
P	Air required per hour per Basin = N / O	=	35268.18	Nm^3/hr/Basin
Q	Number of Operating Air Blowers per Basin	=	2.00	Nos.
R	Capacity of Air Blowers required = P / Q	=	17634.09	Nm^3/hr
S	Safety Factor considered	=	7.00	%
T	Capacity of Air Blowers with Safety Factor = R x (1 + S)	=	18868.48	Nm^3/hr
U	Capacity of Air Blowers offered	=	18900.00	Nm^3/hr
V	No. of Basins aerating at any given time	=	2.00	Nos.
W	No. of Operating Blowers = Q x V	=	4.00	Nos.
X	No. of Standby Blowers per set of Operating Blowers	=	1.00	Nos./Set
Y	Number of Standby Blowers = V x X	=	2.00	Nos.

4.7.7 Sludge Wasting

A	Excess sludge generated	=	1.26	kg/kg BOD
B	BOD	=	3750.00	kg/d
C	Excess Sludge generated per day = A x B	=	4706.25	kg/d
D	No. of Basins	=	1.00	Nos.
E	Sludge Wasted/Basin = C / D	=	4706.25	kg/d/Basin
F	No.of Cycles per day per Basin	=	4.00	Cycles/d/ Basin
G	Sludge Wasted per cycle per basin = E / F	=	1176.56	kg/d
H	Sludge Solids Consistency	=	0.01	
I	Volume of Sludge Wasted per cycle per Basin = G / (H x 1000)	=	150.84	m^3/Cycle
J	Pump Running Time / Cycle	=	30.00	minutes

K	Pump Capacity required= (I x 60) / J	=	301.68	m^3/hr
I	Pump Capacity provided	=	305.00	m^3/hr

4.7.8 Chlorination Tank

Volume of Sewage treated	=	15000.00	m^3/d
Treated Sewage Flow Rate	=	1250.00	m^3/hr
HRT in Chlorination Tank	=	20.00	minutes
Volume required	=	416.67	m^3
SWD provided	=	3.50	m
Width provided	=	5.00	m
Length provided	=	24.00	m
Volume provided	=	420.00	m^3
Freeboard provided	=	0.50	m

4.7.9 Chlorinator

Volume of Sewage treated	=	15000.00	m^3/d
Treated Sewage Flow Rate	=	1250.00	m^3/hr
Design Chlorine Dosage	=	3.00	ppm
Chlorine Dosage Rate	=	3.75	kg/hr
Chlorinator Capacity provided	=	2.00	kg/hr
No. of Working Chlorinators provided	=	1.00	No.
No. of Standby Chlorinators provided	=	1.00	No.

4.7.10 Sludge Sump

Volume of Sludge generated in a day	=	603.37	m^3/d
Sludge Flow Rate	=	25.14	m^3/hr
HRT of Sludge Sump	=	6	hrs
Volume required	=	150.84	m^3
SWD provided	=	3.00	m
Length provided	=	6.00	m
Width provided	=	6.00	m

Volume provided	=	108.00	m^3
Freeboard provided	=	0.50	m

4.7.11 Sludge Sump Air Blower

Volume of Sludge Sump	=	108.00	m^3
Design Air Agitation requirement in Sludge Sump	=	**1.20**	$m^3/hr/m^3$
Capacity of Air Blower required	=	129.60	m^3/hr
Capacity of Air Blower offered	=	130.00	m^3/hr
No. of Working Air Blowers offered	=	1.00	No.
No. of Standby Air Blowers offered	=	1.00	No.
Side Water Depth of Sludge Sump	=	3.00	m
Head of Air Blowers offered	=	0.35	kg/cm^2

4.7.12 Centrifuge

Volume of Sludge generated in a day	=	603.37	m^3/d
Maximum Running hours considered	=	21.00	hrs/day
Sludge Flow Rate	=	28.73	m^3/hr
No. of Working Centrifuges considered	=	1.00	Nos.
Capacity required for each Centrifuge	=	28.73	m^3/hr
Capacity of Centrifuge offered	=	30.00	m^3/hr
Hours of Operation	=	20.11	hrs/day
No. of Standby Centrifuge offered	=	1.00	No.

4.7.13 Centrifuge Feed Pumps

Volume of Sludge generated in a day	=	603.37	m^3/d
Sludge Flow Rate	=	28.73	m^3/hr
No. of Working Centrifuge Feed Pumps considered	=	1.00	Nos.
Capacity required for each Pump	=	28.73	m^3/hr
Capacity offered	=	30.00	m^3/hr
Hours of Operation	=	20.11	hrs/day
No. of Standby Pump offered	=	1.00	No.

4.7.14 Dwpe Dosing System

Quantity of Sludge generated	=	4.71	Ton/day
DWPE Dosing Rate	=	1.20	kg/Ton of day Solids
DWPE required	=	5.65	kg/day
Hours of Operation	=	20.11	hrs/day
DWPE Dosing Rate	=	0.28	kg/hr
Solution Strength	=	0.00	
DWPE Dosing Rate	=	280.80	LPH
No. of Working DWPE Dosing Pumps offered	=	1.00	Nos.
Capacity of DWPE Dosing Pumps offered	=	300.00	LPH
No. of Standby Pump offered	=	1.00	No.
Volume of DWPE Dosing Tank required assuming 6 hours RT	=	1.68	m^3
SWD offered	=	1.50	m
Length/Width required	=	1.06	m
Length/Width offered	=	1.50	m
Free Board provided	=	0.50	m
Volume of DWPE Dosing Tank offered	=	3.38	m^3
No. of DWPE Dosing Tank offered	=	2.00	Nos.
Capacity of Agitator provided	=	1.00	HP
No. of Agitators provided	=	2.00	No.

4.8 Co-current Nitrification and Denitrification

C Tech process allows co-current Nitrification and Denitrification (N/DN) to occur in the same basin simultaneously.

Biological Reactions:

1. Biodegradation (aerobic):
   Organics (BOD) + O2 + Nutrients + Bacteria = New Bacteria + C02 + H20
2. Nitrification (aerobic):
   NH3-N + O2 + Nitrosomonas = NO2 + O2 + Nitrobacter = NO3
3. De nitrification (anoxic):
   NO3 + organic substrate + Heterotrophic = N2 + CO2 + H2O + New cells
4. Phosphorous removal (anoxic/anaerobic/aerobic):
   VFA (organics) + Acinetobactor = release O-P   O-P + Bacteria + O2= new cells + cell maintenance

In the C-tech basin, excess oxygen is provided to oxidize ammonical nitrogen into nitrates. This is an aerobic process. The biological process is regulated in such a way that the biofloc profile allows for nitrification at the peripheral sections and denitrification at the inner parts of the flocs. Ammonical nitrogen (NH4-N) is converted into nitrates (NO3-N) during the aeration process. Aeration is then stopped to allow for settling of the biomass. During this time, anoxic conditions set in which allow for denitrification of the nitrates (NO3N) into nitrogen (N2) and carbon di oxide (CO2) gas. Also at the start of each cycle, part of the settled biomass is recycled into the selector zone using the RAS pumps, where in raw effluent is also fed. The raw effluent acts as a substrate for the denitrification bacteria and under the influence of, anoxic conditions denitrification occurs. Elemental oxygen is release during this phase. This process of co Nitrification and Denitrifictaion result in complete removal of Nitrogen from the effluent.

4.9 Proposed Location for STP

The location for the proposed C-Tech Based STP of capacity 15 MLD has been taken along the existing UASB based STP of capacity 20 MLD. It is the low lying area in the phagwara region hence it is adopted for existing STP and we are considering the surrounding area for our Proposed STP.

Plate 4.1 Satellite image showing proposed location for this project

4.10 Layout of Sewerage Network

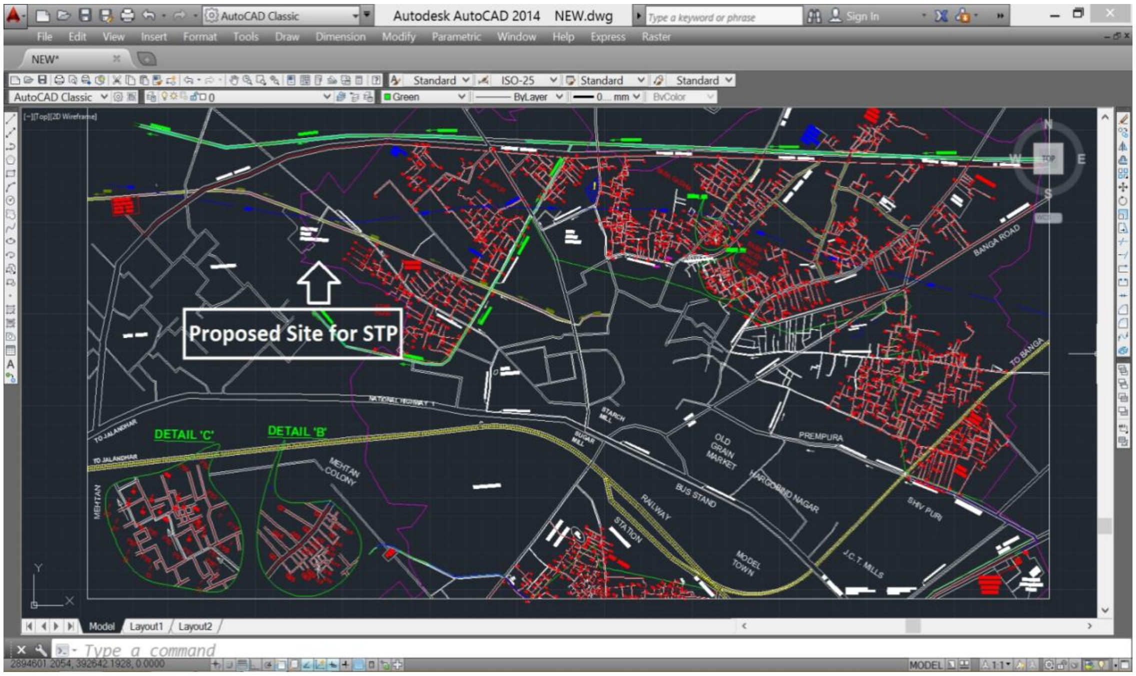

Plate 4.2 AutoCAD drawing for laying of proposed sewer

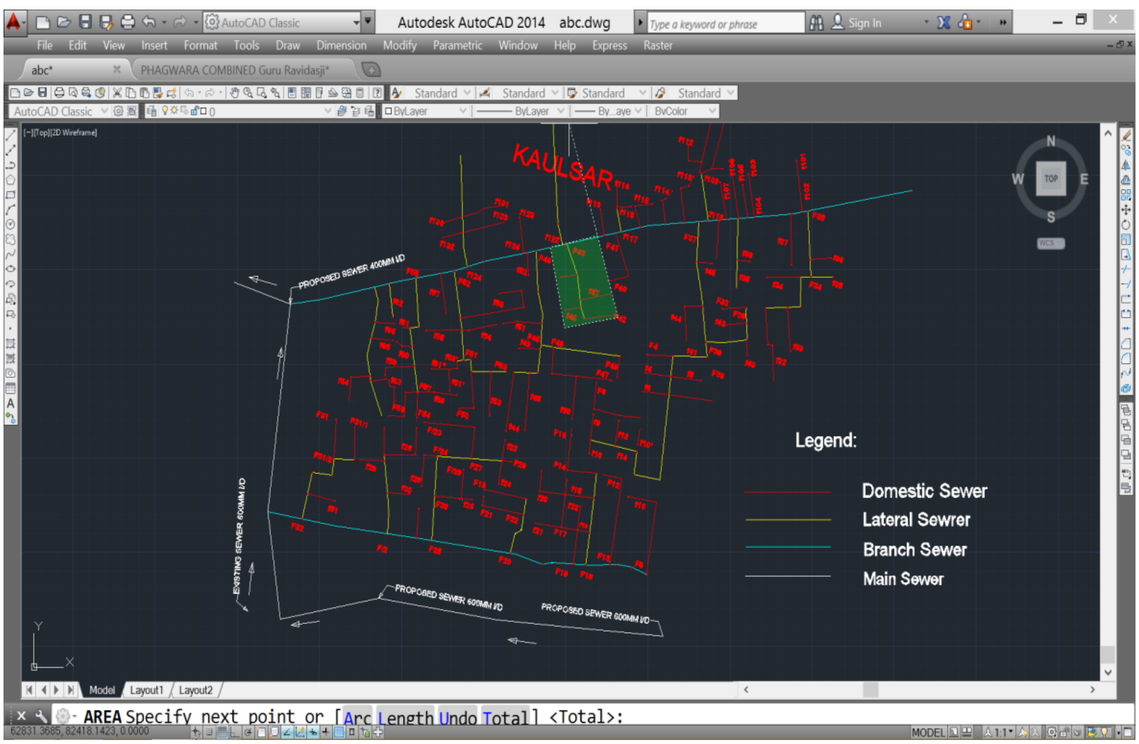

Plate 4.3 Zoomed Section of an area from the above CAD drawing

4.11AutoCAD Drawing of Proposed STP

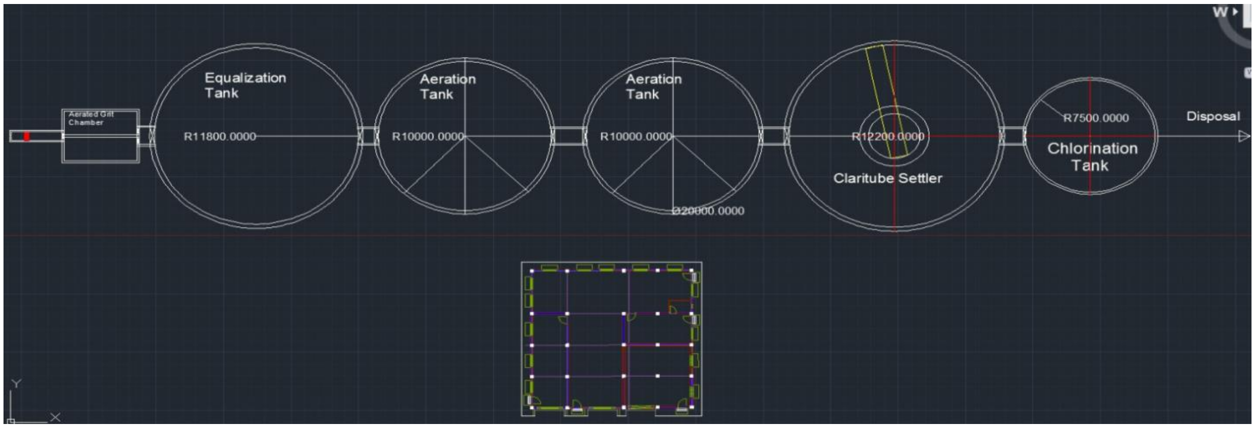

Plate 4.4 AutoCAD Drawing/ Layout for Proposed STP

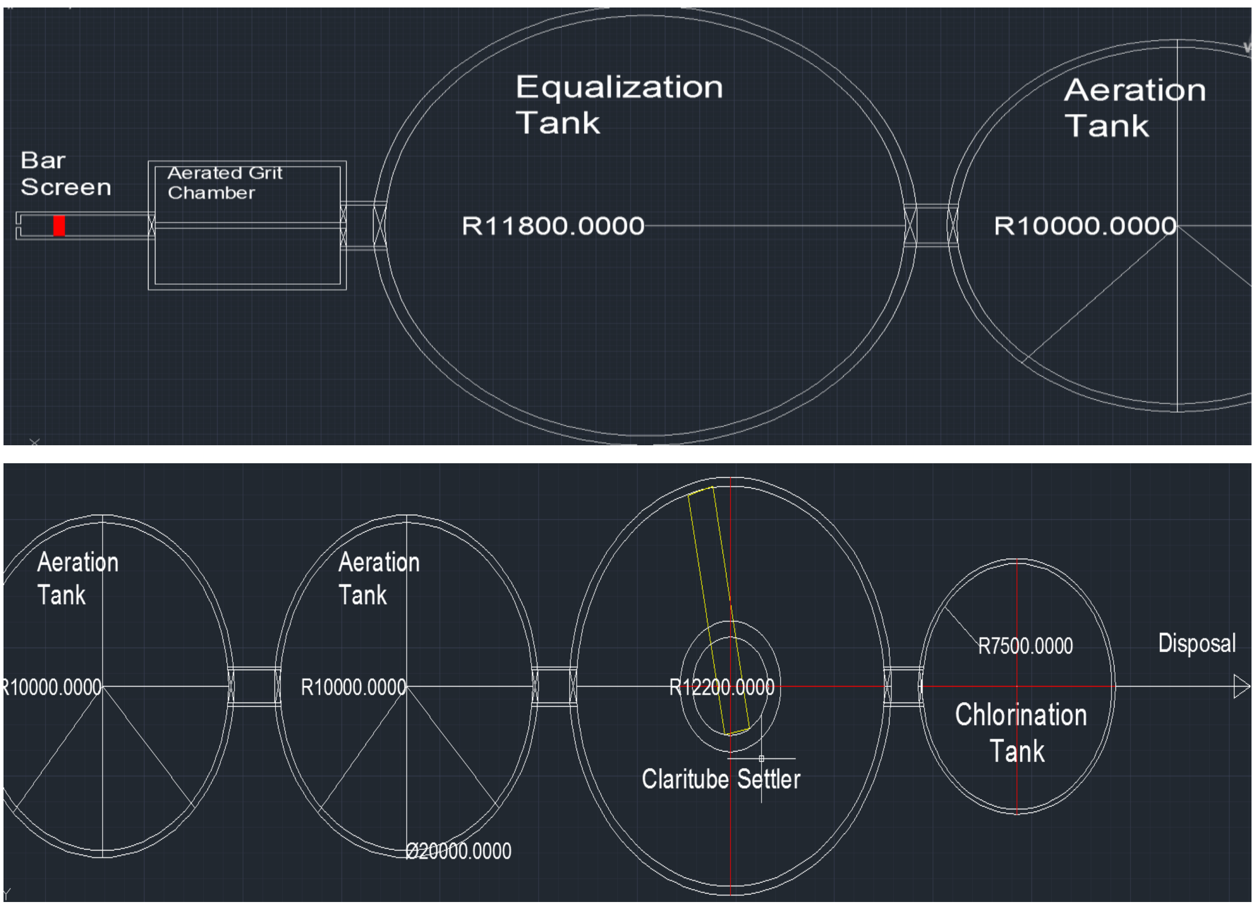

Plate 4.5 and Plate 4.6 Zoomed in look at the Section of Proposed STP

4.12Structural Detailing of Aeration Tank

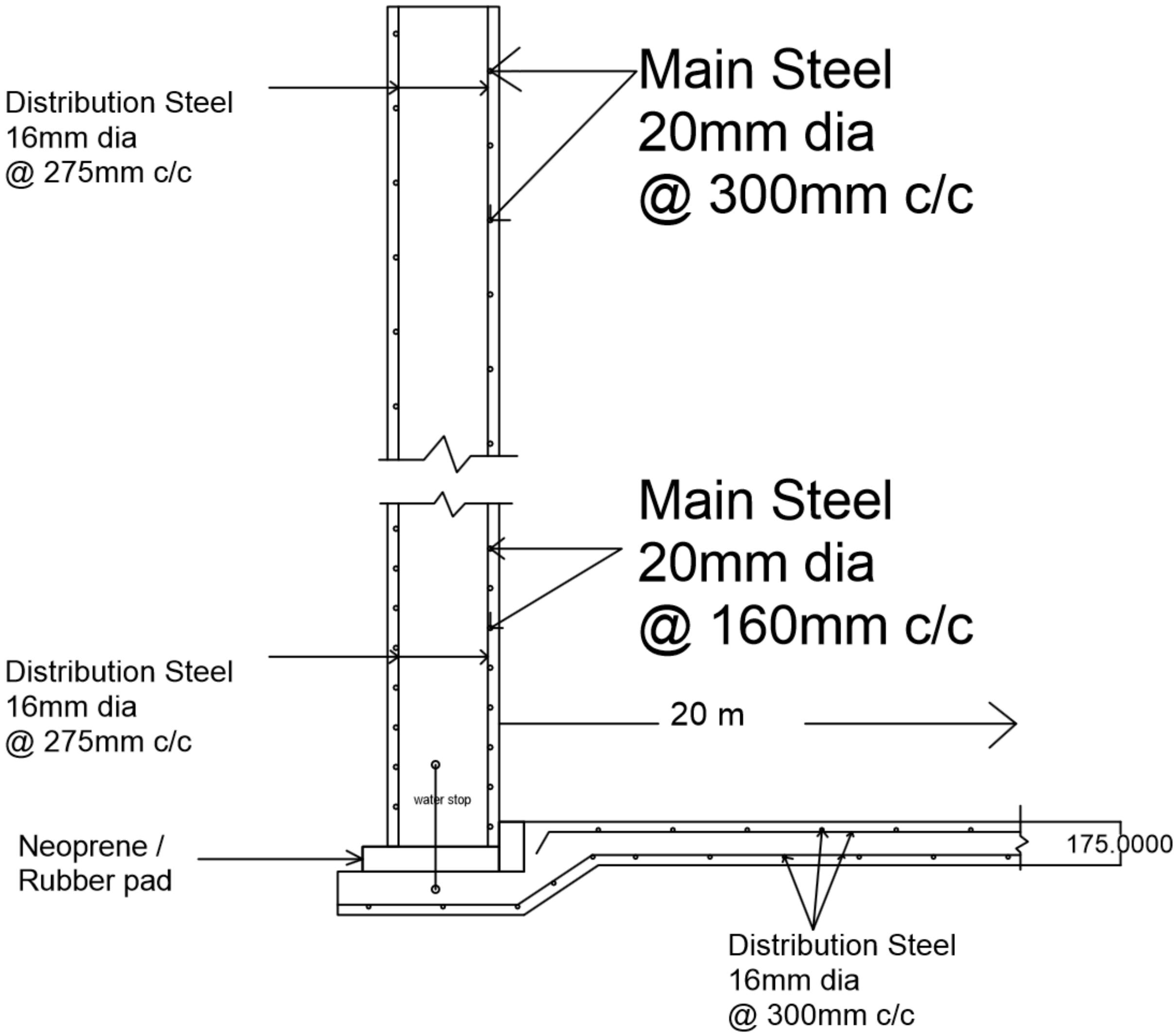

Figure 4.6 Structural Detailing of Circular Aeration tank

4.13Equation used for Designing Sewer Network

Manning's Formula has been used in designing of sewerage network

- $v = (1/n)^* R^{2/3} S^{1/2}$
- $Q = A^* v$

Where, v = Velocity of flow (m/s)

Q = Discharge (cumec)

R = Hydraulic mean depth (m)

S = Slope (m/m)

Note: Self Cleansing Velocity of 0.6 m/s should be obtained atleast once in a day.

CHAPTER 5

DESIGN OF SEWER

5.1 Design Statement of Main Sewer

Table 5.1 Design of Main Sewer

S.No	Name of Sewer line	RESIDENTIAL AREA WITH DENSITY IN ACRES & POPULATION IN PERSONS				Total Population in persons	Discharge Cumec.	Discharge Cumec. @ 2.5 times	Total Discharge Cumec.
		@150/P/Ac	@100/P/Ac	@60/P/Ac	@40/P/Ac				
1	2	3	4	5	6	7	8	9	10
1	D - E	---	---	95.50 = 5730	443.50 = 17740	23470	0.0367	0.092	0.0917
2	E - F	---	---	372.50 = 22350	443.50 = 17740	40090	0.0626	0.157	0.2483
3	F - G/1	---	---	550.30 = 33018	443.50 = 17740	50758	0.0793	0.20	0.3549
4	G/1 - G	---	---	700.30 = 42018	443.50 = 17740	59758	0.0934	0.23	0.4317
5	G - H	---	---	770.30 = 46218	443.50 = 17740	63958	0.0999	0.25	0.4833
6	H - J	128 = 19200	---	911.30 = 54678	443.50 = 17740	91618	0.1432	0.36	0.6077
7	J - STP	128= 19200	58 = 5800	1393.90 = 83634	443.50 = 17740	126374	0.1975	0.49	0.8515

Table 5.1 Design of main Sewer

Ground Level		**Fall in m**	**Length of Sewer in ft**	**Length of Sewer in m**	**Gradient**	**Dia of Sewer in mm**	**Running of Sewer**	**Maximum Velocity**	**Average Velocity**	**Minimum Velocity**
U.E.	**L.E**							**m/s**	**m/s**	**m/s**
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
243.76	243.16	0.6	1494	455.4	1 in 750	450.00	4/5	0.73	0.33	0.22
243.16	242.63	0.53	1707	520.3	1 in 1000	600.00	4/5	0.75	0.34	0.23
242.63	242.06	0.57	1707	520.3	1 in 900	600.00	4/5	0.82	0.37	0.25
242.06	241.42	0.64	1932	588.9	1 in 900	700.00	4/5	0.86	0.39	0.26
241.42	241.17	0.25	619	188.7	1 in 750	700.00	4/5	0.93	0.42	0.29
241.17	240.87	0.30	730	222.6	1 in 750	800.00	4/5	1.02	0.46	0.31
240.87	240.34	0.56	1852	565	1 in 1000	900.00	4/5	0.99	0.45	0.30

5.2 Design Statement for Branch Sewer

Table 5.2 Design of Branch Sewer

S.No	**Identification of Sewer line**	**RESIDENTIAL AREA WITH DENSITY IN ACRES & POPULATION IN PERSONS**			**Total Population in persons**	**Discharge Cumec.**	**Discharge Cumec. @ 3 times**	**Total Discharge Cumec.**
		@150/P/Ac	**@60/P/Ac**	**@40/P/Ac**				
1	**2**	**3**	**5**	**6**	**7**	**8**	**9**	**10**
1	Longer Blue Line	---	206.92 = 5730	---	12415	0.0194	0.058	0.0582
2	Smaller Blue Line	---	70.08 = 22350	---	4205	0.0066	0.020	0.0197

Ground Level		**Fall in m**	**Length of Sewer in ft**	**Length of Sewer in m**	**Gradient**	**Dia of Sewer in mm**	**Running of Sewer**	**Maximum Velocity**	**Average Velocity**	**Minimum Velocity**
U.E.	**L.E**							**m/s**	**m/s**	**m/s**
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
243.16	242.91	0.53	620	189	1 in 750	400.00	4/5	0.65	0.26	0.18
243.16	242.87	0.295	387	118	1 in 400	250.00	3/4	0.63	0.24	0.17

5.3 Design Statement of Lateral Sewer

Table 5.3 Design of Lateral Sewer

S.No	Identification of Sewer line	RESIDENTIAL AREA WITH DENSITY IN ACRES & POPULATION IN PERSONS			Total Population in persons	Disch in Cumec.	Disch. In Cumec. @ 5 times	Total Discharge in Cumec.
		@150/P/Ac	@60/P/Ac	@40/P/Ac				
1	**2**	**3**	**5**	**6**	**7**	**8**	**9**	**10**
1	1	---	.84 = 5730	---	50	0.0001	0.00039	0.0004

Ground Level		Fall in m	Length of Sewer in ft	Length of Sewer in m	Gradient	Dia of Sewer in mm	Running of Sewer	Maximum Velocity	Average Velocity	Minimum Velocity
U.E.	L.E							m/s	m/s	m/s
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
243.71	243.00	0.53	115	35	1 in 25	100.00	2/3	0.69	0.17	0.12

5.4 Trench Excavation

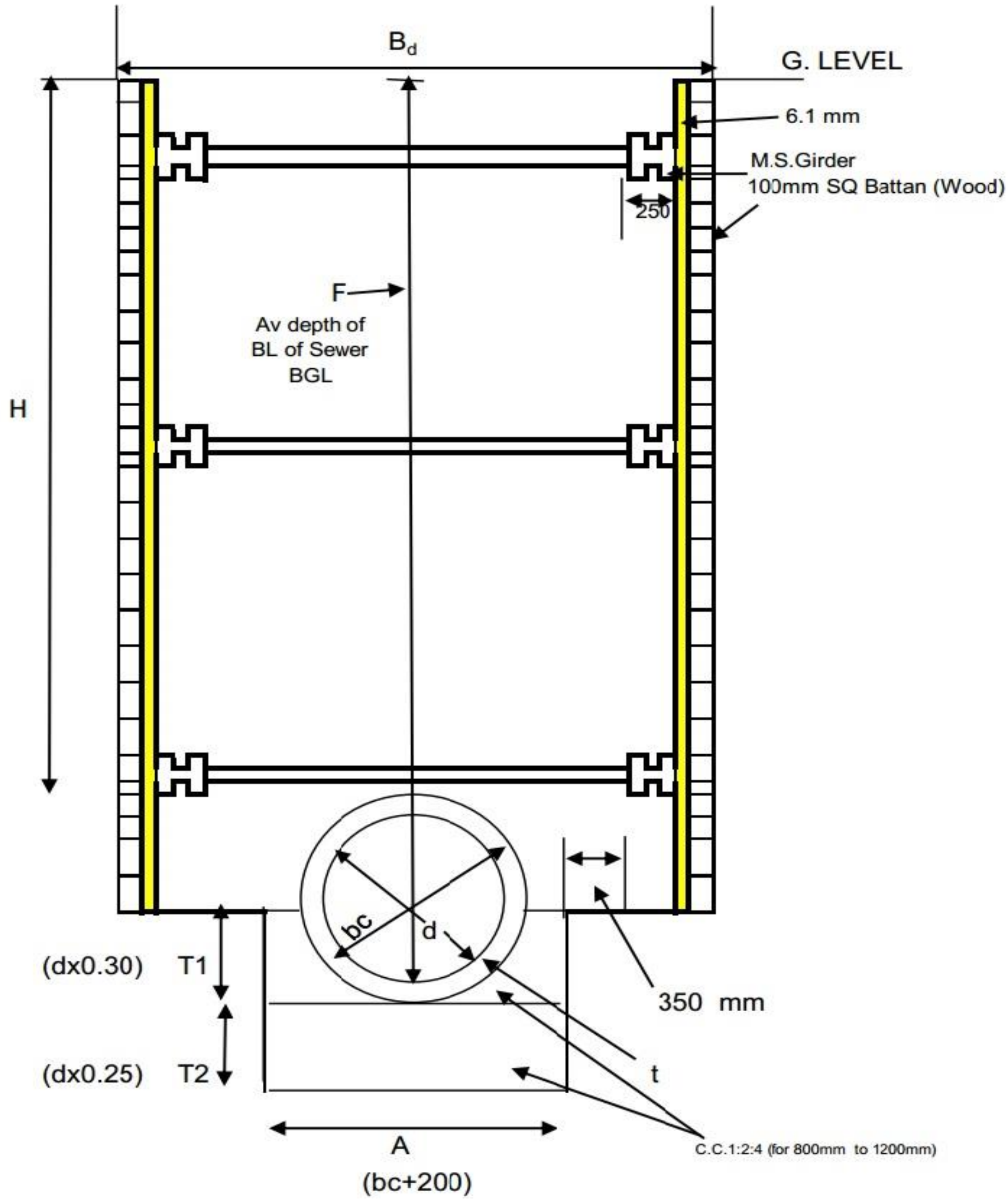

Figure 5.1 Typical Cross Section for Laying R.C.C. Pipe with Confined Cut Excavation

5.4.1 Standard Values for Trench Excavation

Table 5.4 Dimension Values for excavating a trench

SIZE IN MM (d)	DIMENSIONS IN MM							
	t	bc	T1	T2	A	F	E	B_d
450	75	600	135	112.5	800	3000	2940	2212
600	85	770	180	150	970	3540	3445	2382
700	85	870	210	175	1070	3930	3805	1782
800	95	990	240	200	1190	4200	4055	2602
900	100	1100	270	225	1300	4530	4360	2712
1000	115	1230	300	250	1430	4870	4685	2842
1100	115	1330	330	275	1530	5030	4815	2942
1200	120	1440	360	300	1640	5290	5050	3052

5.4.2 Quantity of Cement Concrete Required per m for Bedding of RCC NP pipes

Table 5.5 Volume of Concrete Required in bedding for particular RCC NP Pipe

Size/ Dia in mm	**All Dimensions in m**								C.C cum / m	C.C. cum / ft
	A	B	C	d Outer dia	d1	D	T	h		
400	0.750	0.100	0.238	0.550	0.454	0.400	0.075	0.120	0.142	0.043
450	0.800	0.113	0.263	0.600	0.501	0.450	0.075	0.135	0.165	0.050
500	0.850	0.125	0.288	0.650	0.548	0.500	0.075	0.150	0.190	0.058
600	0.970	0.150	0.343	0.770	0.652	0.600	0.085	0.180	0.254	0.077
700	1.070	0.175	0.393	0.870	0.745	0.700	0.085	0.210	0.316	0.096
800	1.190	0.200	0.448	0.990	0.849	0.800	0.095	0.240	0.397	0.121
900	1.300	0.225	0.500	1.100	0.947	0.900	0.100	0.270	0.480	0.146
1000	1.430	0.250	0.558	1.230	1.056	1.000	0.115	0.300	0.587	0.179
1100	1.530	0.275	0.608	1.330	1.149	1.100	0.115	0.330	0.677	0.206
1200	1.640	0.300	0.660	1.440	1.247	1.200	0.120	0.360	0.783	0.239

A = Outer dia + .2

B = DX0.25 /1000

h = D X 0.30 / 1000

D = internal dia of pipe

d = outer dia of pipe

Qty of C.C. 1:4:8 (under bed of R.C.C. Pipe / m) = A X C - (2/3 X d1 X h)

To evaluate d1 i.e. upto top of Base concrete.

$$(od/2)^2 - (od/2 - h)^2 = (d_1/2)^2$$

od = outer Diameter of pipe

Table 5.6 Calculation of d_1

Size/ Dia in mm	od/2	(od/2 -h)	$(od/2)^2$	$(od/2 -h)^2$	$d_1^2/2$	d_1
400	0.275	0.155	0.02	0.08	0.05	0.45
450	0.3	0.165	0.03	0.09	0.06	0.50
500	0.325	0.175	0.03	0.11	0.08	0.55
600	0.385	0.205	0.04	0.15	0.11	0.65
700	0.435	0.225	0.05	0.19	0.14	0.74
800	0.495	0.255	0.07	0.25	0.18	0.85
900	0.55	0.280	0.08	0.30	0.22	0.95
1000	0.615	0.315	0.10	0.38	0.28	1.06
1100	0.665	0.335	0.11	0.44	0.33	1.15
1200	0.72	0.360	0.13	0.52	0.39	1.25

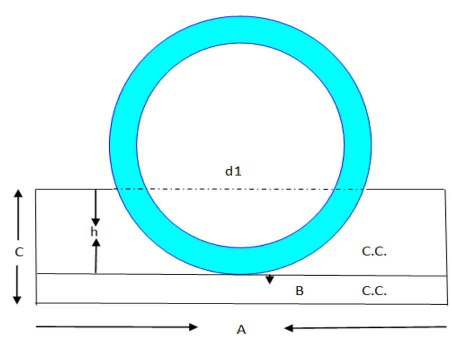

Figure 5.2 Cross – Section of bedding

5.5 Computation of Loads

5.5.1 Loads on Conduit Due to backfill

$$W_c = C_d * w * B_d^2$$

where, Wc = load on the pipe in Kg per linear meter

w = Unit weight of backfill soil in kg/m^3

B_d = Width of trench at the top of the pipe in m

C_d = Load coefficient which is a function of a ratio of height of fill to width of trench (H/B_d) and of the friction coefficient between the backfill and the sides of the trench.

5.5.2 Loads on Conduit Due to Superimposed Loads

$$W_{sc} = C_s(PF/L)$$

W_{sc} = Load on the conduit in kg/m

P = Concentrated load in kg acting on the surface

F = Impact factor (1.0 for air field runways, 1.5 for highway traffic , 1.75 for railway traffic) and

C_s = Load coefficient which is a function of

$\frac{B_c}{2H}$ and $\frac{L}{2H}$

where,

H = Height of the top of the conduit to ground surface in m

B_c = Outside width of conduit in m, and

L = Effective length of the conduit to which the load is transmitted (m)

5.6 Type of Bedding for RCC NP-3 Pipe

5.6.1 For Pipe Diameter 400 mm

Table 5.7 Calculation of total load on conduit for pipe diameter 400 mm

Size in mm(d)	Dimensions in mm					
	t	bc	T1	T2	A	B_d
400	75	550	120	100	750	2250

H (mm)	H/B_d	C_d	Loading on Pipe due to backfill (kg/m)	C_s	Loading on Pipe due to Superimposed load (kg/m)	Bedding Factor	Type of Bedding
1000	0.44	0.46	4322.16	0.21	3535.43	4.02	Class Ad
1200	0.53	0.49	4545.72	0.15	2616.30	3.67	Class Ad
1400	0.62	0.56	5216.40	0.12	2000.70	3.70	Class Ad
1600	0.71	0.63	5887.08	0.09	1573.20	3.82	Class Ad
1800	0.80	0.70	6557.76	0.07	1265.40	4.01	Class Ad
2000	0.89	0.78	7228.44	0.06	1043.10	4.24	Class Ad

5.6.2 For Pipe Diameter 600 mm

Table 5.8 Calculation of total load on conduit for pipe diameter 600 mm

Size in mm(d)	Dimensions in mm					
	t	bc	T1	T2	A	B_d
600	85	770	180	150	970	2350

H (mm)	H/B_d	C_d	Loading on Pipe due to backfill (kg/m)	C_s	Loading on Pipe due to Superimposed load (kg/m)	Bedding Factor	Type of Bedding
1000	0.43	0.46	4714.89	0.28	4702.50	4.82	Class Ad
1200	0.51	0.47	4796.18	0.21	3532.86	4.26	Class Ad
1400	0.60	0.54	5527.80	0.16	2718.90	4.22	Class Ad
1600	0.68	0.61	6178.13	0.13	2151.18	4.26	Class Ad
1800	0.77	0.68	6909.75	0.10	1744.20	4.43	Class Ad
2000	0.85	0.74	7560.08	0.08	1441.53	4.61	Class Ad

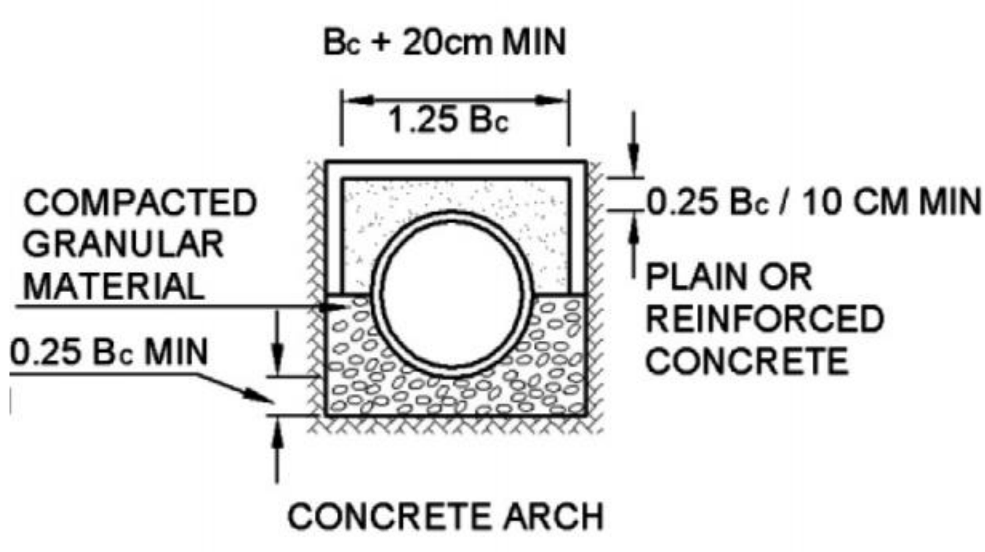

Figure 5.3 Bedding Type Ad Concrete arch

5.7 Sewer Appurtenances

5.7.1 Manholes

- Provide manholes at all breaks in the horizontal and vertical plane for 600mm and smaller sewer mains.
- Provide manholes on 700mm and larger sewers at all breaks in the horizontal and vertical planes, except when the horizontal alignment is in a curve or when the use of bends has been approved.

Pipe Size	Maximum Manhole Spacing
200 mm – 600 mm	120 m
700 mm – 1100 mm	180 m
1100 mm – 1500 mm	250 m

Circular Manholes: The circular manholes can be provided for all depths starting from 0·9 m. Circular manholes are straight down in lower portion and slanting in top portion so as to narrow down the top opening equal to internal diameter of manhole cover. Depending upon the depth of manhole, the diameter of manhole changes. The internal diameter of circular manholes may be kept as following for varying depths:

a)	For depths above 0·90 m and up to 1·65 m	900 mm diameter
b)	For depths above 1.65 m and up to 2.30 m	1200 mm diameter
c)	For depths above 2.30 m and up to 9.0 m	1500 mm diameter
d)	For depths above 9.0 m and up to 14.0 m	1800 mm diameter

Circular manholes are much stronger than rectangular and arch type manholes and thus these are preferred over rectangular (ordinary) as well as arch type of manholes.

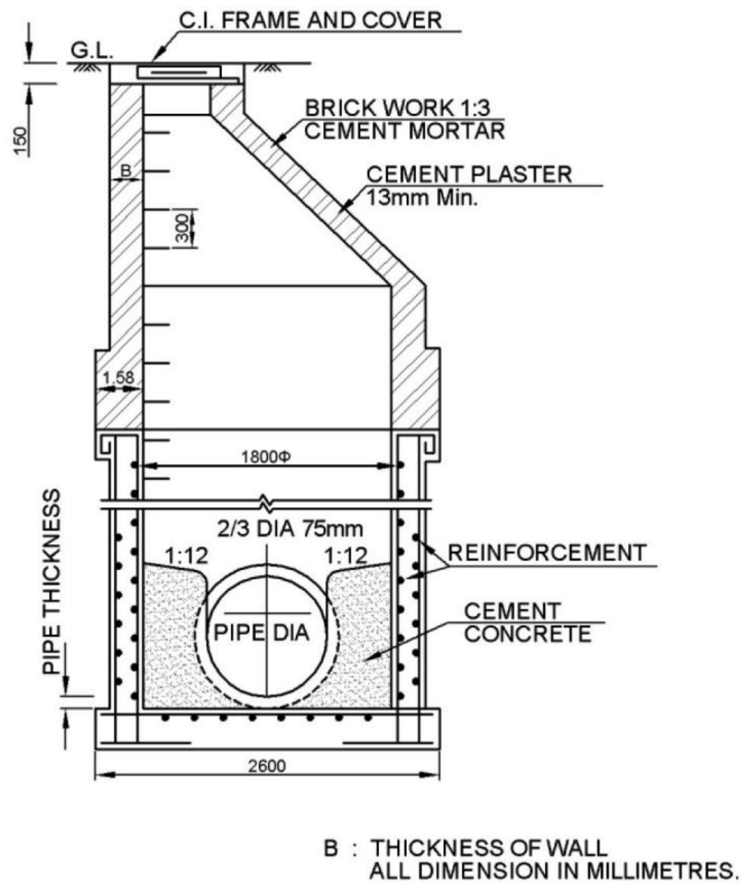

Figure 5.4 Cross Section View of Manhole

5.7.2 Catch Basin

A catch basin is a part of a storm drain or sewer system that is designed to trap debris so that it cannot enter the drainage pipes. These basins are a large scale version of the traps used in home drains to accomplish a similar function. Most municipal sewer and storm drainage systems use them, and the design is basically the same all over the world, with a few small variations.

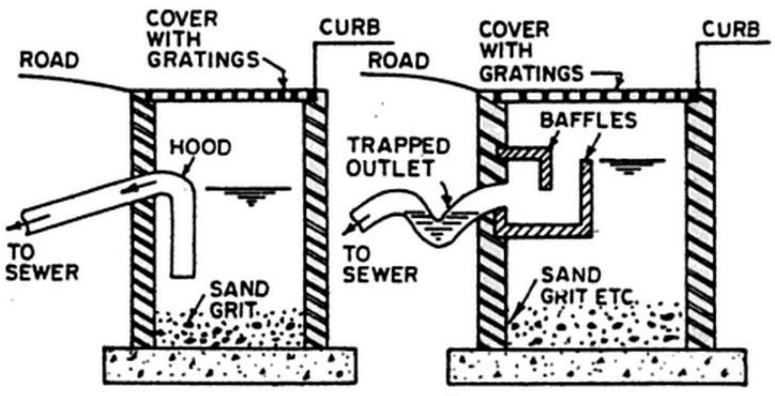

Figure 5.5 Cross – Section view of Catch Basin

CHAPTER 6

ENVIRONMENTAL IMPACT ASSESSMENT

6.1 Need For The Project

With the rapid growth of the population in Phagwara, the lack of proper drainage system and sewage treatment facility has become an ever larger problem for public and from environmental point of view.

In order to assess the impact of the proposed STP on the environment, we have studied the environmental scenario of the existing situation and the probable impacts that could arise from the proposed sewage treatment plant at Phagwara. Suitable mitigation measures have also been suggested based on the impact assessment.

6.1.1 The river sutlej – over view

The river Sutlej has its source in Mansrover lake area in the Tibet region. After meandering about 320 Kilometers, it enters India at Shipkila pass on the Himachal – Tibet border. There after it flows in Himachal territory for another 320 Kilometers, augmenting its flow en-route upto Bhakra Dam. Beyond this, it enters Punjab and runs entirely in the Punjab Territory up to Harike where there is confluence of this river with river Beas. The river downstream of Harike is still called Sutlej and it continues to flow within Punjab upto Hussainiwala head works. From there onward of it flows almost along the Indo-Pak border up to Sulemanki where it enters Pakistan.

Table 6.1 Punjab towns falls on or along the banks of the river Sutlej

Sr. No.	Town	Population (1991)	Tributory/River
1	Nangal Township	32,008	Sutlej
2	NayaNagal	12,027	Sutlej
3	Anandpur Sahib	10,797	Sutlej
4	Ropar	37,830	Sutlej
5	Phillaur	20,877	Sutlej
6	Ludhiana	10,12,062	BudhaNallah/Sutlej

7	Jalandhar	5,79,530	East Bein/Sutlej
8	Nawanshahar	29,796	East Bein/Sutlej
9	Phagwara	88,855	East Bein/Sutlej
10	Hoshiarpur	1,22,528	East Bein/Sutlej
11	Kapurthala	63,083	West Bein/Sutlej
12	SultanpurLodhi	13,580	Sutlej

The domestic and industrial waste of these towns ultimately reaches river Sutlej either through drains or directly. This waste water requires proper treatment at source before it is discharged into the water body. The drains which contaminate the river water with domestic and industrial effluents are mainly BudhaNallah, East Bein and West Bein, BudhaNallah joins river Sutlej downstream of Ludhiana, East Bein joins River Sutlej near Village Yousfpur, and West Bein joins the river Harike head works, on the upstream side.

6.2 Proposed Project Site

Phagwara town is a Tehsil Head Quarter of District Kapurthala. It is situated on main line Northern railway from Jalandhar to Ludhiana at a distance of about 20 Kms from Jalandhar towards Ludhiana. It is an industrial town. The major industries are sugar mill, cloth mill, & starch mill etc. The town is divided in two parts by double track main railway line. Area of North side of railway line contains the main population whereas the area of South side of railway line contains new development. The population of the town as per 2001 census is 0.96 Lac persons and at present population ending 2011 is 111953.

The satellite image of the project site is shown before. With the rapid expansion and urbanization of Phagwara, an underground sewerage scheme has been formulated for the town.

The Main Sewage Pumping Station & Sewage Treatment Plant of 20 MLD has been constructed under Sutlej Action Plan Phase-I at Phagwara North and is functioning since December 2001 and March 2008 respectively. Now due to increase in population, the consumption of water supply has been increased. The industrial outflow has been also increased. At present, 20 MLD (average) sewage is been pump out from Main Pumping Station. The present population in 2011 is 1,11,953 persons. Considering flow for year 2043 the calculated discharge for domestic comes out 35 MLD. So for the increased 15 MLD raw water sewage treatment, new STP of 15 MLD based on C-Tech/SBR technology has been proposed along with augmentation of existing main pumping station.

6.3 Need for EIA

Environmental Impact Assessment (EIA) is a study of the possible impacts that a proposed project may have on the environment, which may affect natural, social and economic aspects in and around the project area. The purpose of the assessment is to make the project proponent to enhance the environmental quality of the project site during planning and execution of the project. The International Association for Impact Assessment (IAIA) defines an Environmental Impact Assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made."

This Present report elucidates the existing environmental scenario of the project site and the predicted impacts due to installation of the proposed Sewage Treatment Plant. It evaluates the impacts during the preconstruction, construction and operation phases of the project. Both positive and negative impacts are being considered and reported. The Environmental Management Plan (EMP) is also aimed at mitigating the possible adverse impact of the project and ensuring the existing environmental quality gets enhanced.

6.4 Objectives of this Report

The objectives of the report are:

- To identify and assess any potential negative environmental and social impacts and to facilitate the planning of preventive and remedial measures.
- To identify possible environmental enhancements in the project setting and lay down the action plans.
- To develop a set of environmental monitoring and management plans compliant with the relevant codes, statutes and social norms.

6.5 Scope of the Report

- To assess the baseline of air, water, land, soil and noise environment around the proposed site in relation to the town by collecting the samples of air, water, soil and noise in the project setting and analyzing for the recognized parameters as per local statutory regulations and prepare the baseline document and to predict the potential impacts.
- To identify the potential impact by the STP on related environmental issues like wildlife, bird sanctuaries, flora & fauna, public health, social uplift, archeological monuments, heritage structures and bring up the appropriate preventive & remedial procedures without compromising the objective of STP.
- To develop a set of practices to be followed during preconstruction, construction and post construction periods in order to avoid the foreseeable negative impacts.
- In keeping with the operational policy of the World Bank 4.01, go through a process of public consultation and transparently appraising the public of the foregoing and securing their concerns, evolving mutually agreeable measures to all the concerns, document the same and ensuring a periodic and continual follow up with project persons and the public.

6.6 Environmental Legislations

Salient features of some of the major laws that are applicable are given below:

6.6.1 Water (Prevention and Control of Pollution) Act, 1974

The basic objective of this Act is to maintain and restore the wholesomeness of the country's aquatic resources by prevention and control of pollution. Consequently, the Water Act, a Central law, was enacted under Article 252(1) of the Constitution, which empowers the Union Government to legislate in a field reserved for the States. All the States have approved implementation of the Water Act. As during operation, it is likely that the ground water quality and surface water quality may be altered. Therefore this act is applicable to the proposed project.

6.6.2 Air (Prevention and Control of Pollution) Act, 1981

The Union Government under Article 253 of the Constitution passed this Statute. This Act provides for the prevention, control and abatement of air pollution and confers powers to the

Central and State Pollution Control Board with a view to carry out the aforesaid purposes. This act is applicable to the proposed project.

6.6.3 Environment (Protection) Act, 1986

The Union Government under Article 253 of the Constitution passed this Statute. The Environment (Protection) Act, 1986 seeks to achieve the objective of protection and improvement of environment and for matters connected therewith. This legislation enables the co-ordination of activities of the various regulatory agencies; setting up of an authority or authorities with advocate powers for environmental protection etc., This Act is applicable to the proposed project.

Objective of this Act is to provide the protection and improvement of environment (which includes water, air, land, human being, other living creatures, plants, microorganism and properties) and for matters connected therewith.

6.6.4 Municipal Solid Waste (Management & Handling) Rules, 2000

This notification by Ministry of Environment & Forest lay down the methods of handling Municipal Solid Waste (MSW) and its scientific disposal. It bans incineration of MSW. Municipal Solid Waste (Management & Handling) Rules, 2000 are applicable to every municipal authority responsible for collection, segregation, storage, transportation, processing and disposal of Municipal Solid Waste. The Rules contains four Schedules namely;

Schedule	**Activity**
I	Relates to implementation schedule
II	Specifications relating to collection, segregation, storage, transport, processing and disposal of Municipal Solid Waste
III	Specifications for land filling, indicating site selection, facilities at site, specifications for and filling, Pollution prevention, water quality monitoring, ambient air quality monitoring, Plantation at landfill site, closure of landfill site and post care
IV	Indicate waste processing options including; standards for composting, treated lactates and incinerations

6.7World Bank Policies

Following are the Operation Policy & Directorate of the World Bank.

6.7.1 Environmental Assessment OP/BP 4.01

This requires the borrower to screen projects upstream in the project cycle for potential impacts. Thereafter, an appropriate EA approach to assess, minimize / enhance and mitigate potentially adverse impacts is selected depending on nature and scale of project. The EA needs to be integrated in the project development process such that timely measures can be applied to address identified impacts. The policy requires consultation with affected groups and NGOs to recognize community concerns and the need to address the same as part of EA.

6.7.2 Cultural Property - OP 11.03

Requirements - World Bank's Operational Policy Note11.03 which aims at preserving and avoiding the elimination of structures having archaeological (prehistoric), paleontological, historical, religious and unique natural values. Projects that could significantly damage non-replicable cultural properties are declined for funding and the Bank will in turn assist protection and enhancement of cultural properties encountered in the project rather than leaving that protection to chance.

6.7.3 Natural Habitats – OP/BP 4.04

This policy sets out the World Bank's policy on supporting and emphasizing the precautionary approach to natural resource management and ensuring opportunities for environmentally sustainable development. As per this policy, projects that involve significant conversion or degradation of critical natural habitats are not supported by the Bank.

6.7.4 Forests – OP/BP 4.36

This sets out specific policy on protection of forests through consideration of forest related impacts of all investment operations, ensuring restrictions for operations affecting critical forest conservation areas, and improving commercial forest practice through use of modern certification systems. The policy requires consultation with local people, the private sector and other stakeholders in forest area.

6.8 Matrix of Impacts

Table 6.2 Predicted Impacts to Physical Components of Environment

			PHASE I			PHASE II		
			Pre Construction			Construction/ Establishment		
1	2	3	4	5	6	7	8	9
ENVIRONMENT	COMPONENT	Project Activity Parameter/ Factor	Land Acquirement	Site Clearing/Leveling	Burning of wastes, refuse and cleared vegetation	Civil works such as earth moving and building of structures including temporary structures	Heavy Equipment operations	Laying of pipeline for collection of wastewater as well as disposal of treated wastewaters
PHYSICAL	Soil	Erosion Risks						
		Soil Quality /Contamination		*				
	Resources	Fuels/ Electricity		*			*	
		Construction material- stone, aggregates				*		
		Land especially undeveloped or agricultural land		*				
	Water	Interpretation or alteration of river beds						
		Alteration of aquifers						
		Water quality/ Contamination						
	Air	Air quality			*	*	*	

Table 6.2 Predicted Impacts to Physical Components of Environment

PHASE III															
Operation and Maintenance															
10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Wastewaters collection					Treatment						Disposal				
Tanker		Pipeline													
Traffic related	Spills / leaks	Unauthorized disposal	Leak, corrosion, break	Maintenance/pump flow status/power supply	Adequacy of treatment units including holding tank capacity	Better operating practicing and management system	Stormwater network	Temporary storage and handling of sludge	Laboratory operations	Safety and health protection measures	Reuse/recycle	Surface water bodies	Land applications	Marine	Sewer
												*			
	*	*	*	*	*			*					*		
*															
												*			
	*	*	*	*	*	*	*		*			*		*	*
		*				*									*

Table 6.3 Predicted Impacts to Social and Biological Components of Environment

			PHASE I			**PHASE II**		
			Pre Construction			**Construction/ Establishment**		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
		Noise		*		*	*	
BIOLOGICAL	Terrestrial fauna	Effect on grass & flowers		*				
		Effect on trees & shrubs		*				
		Effect on farmland		*				
		Endangered species		*				
		Fragmentation of terrestrial habitats		*				
		Disturbance of habitats by noise or vibration		*				
		Reduction of Biodiversity		*				
	Aquatic biota	Habitat removal						
		Contamination of habitats						
		Reduction of aquatic biota						
SOCIAL	Economy	Creation of new economic activities	*					
		Commercial value of properties	*					*
		Conflict due to negotiation and/ compensation payments	*					*
		Generation of temporary and permanent jobs				*		
		Effect on crops		*				
		Reduction of farmland productivity		*				

Table 6.3 Predicted Impacts to Social and Biological Components of Environment

PHASE III															
Operation and Maintenance															
10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
	*	*	*										*		
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	*	*	*	*		*									
											*				
		*	*				*					*			
		*													

Table 6.4 Predicted Impacts to Social Components of Environment

			PHASE I			**PHASE II**		
			Pre Construction			**Construction/ Establishment**		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
		Income for the state and private sector	*					
		Savings for consumers & private consumers				*		
		Savings in foreign currency for the state						
	Education	Training in new technologies						
	Public order	Political Conflicts	*					*
		Unrest, Demonstrations & Social conflicts	*					*
	Infrastructure and services	Conflicts with projects of urban, commercial or Industrial development	*				*	*
	Health	Accidents caused by					*	
		Temporary				*	*	*
		Chronic						
		Acute						
	Cultural	Land use	*	*		*		*
		Recreation		*	*	*		
		Aesthetics and human interest		*	*	*		*

Table 6.4 Predicted Impacts to Social Components of Environment

PHASE III															
Operation and Maintenance															
10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
						*			*						
										*					
	*	*	*	*	*	*	*					*	*	*	*
		*													
		*		*						*		*			
			*										*		
		*					*								
	*	*	*	*								*	*	*	

6.9 Predicted Impacts and Mitigation Measures

When identifying the potential impacts of a new project on the existing environment, such as the proposed Sewage Treatment Plant in Phagwara, it is necessary that it should be measured against the existing baseline conditions. Construction of sewer line with sewage treatment plant and there after operation of this system, if undertaken without a proper understanding of the relationships inherent in environmental function, can be accompanied by disruptions to the environment, from which it may take a long time to regain equilibrium. In human terms, this may mean that generations must function in a debilitated environment and suffer many possible associated socio-economic hardships and financial losses.

Some of the major environmental impacts of sewerage system include damage to local ecosystems, loss of productive agricultural lands, demographic change, accelerated urbanization, and introduction of disease. The need of development and growth in the area must be matched with the conservation of the existing natural resources.

In general, construction of a new sewage treatment plant will have a positive environmental impact on the town. It is expected to produce a long term improvement in public health of the residents of Phagwara as well as to significantly reduce a source of chronic water pollution of an ecologically valuable portion if the water body where the sewage drains.

6.9.1 IMPACT EVALUATION

6.9.1.1 Air Quality

This section presents an assessment of air quality impacts associated with the construction and operation of the proposed STP activity at Phagwara, Punjab. Major sources of air pollution have been identified namely construction dust emission and road traffic emissions. The sources of air pollutants at the different phases of the development are categorized as follows:

• Construction Phase: Construction works include site clearance, site formation, STP units & administration building works. The major temporary air pollution is dust generated as a result of these construction works. Cutting and welding operation, loading-unloading, operation is mainly responsible for the release of SPM, SO2, NO_x, etc. However the overall impact may be rated as direct, short-term, adverse, and reversible.

• Operational Phase: The primary emission sources during the operations phase would include compressor and pumping station operations, vehicular traffic, carbon dioxide and a small quantity of Hydrogen sulphide may be produced in Aerobic Tank.

6.9.1.2 Water Quality

• Construction Phase: The construction of the proposed sewage treatment plant will facilitate improvement of water quality in and around the site by avoiding the unhygienic disposal of the raw sewage in the vicinity.

• Operational Phase: There will not be any adverse impact on the ground water quality since the treated effluent will be within the standards prescribed by the CPCB / PPCB.

6.9.1.3 Soil Quality

• Construction Phase: Topsoil shall be stripped to a depth of 200 mm from areas proposed to be occupied by buildings, roads, paved areas and external services.

6.9.1.4 Solid Waste Handling

• Construction Phase: Solid waste generated during site preparation and construction work would include cut vegetation and typical construction waste (e.g. wasted concrete, steel, wooden scaffolding and forms, bags, waste earth materials, etc.). This waste would negatively impact the site and surrounding environment if not properly managed and disposed of at an approved dumpsite.

• Operation Phase: Grit, screenings and the sludge generated from the treatment plant will be the major source of solid waste generation.

6.9.1.5 Cultural and Socio-Economic Impacts

• The construction of proposed sewage treatment plant is a mark beneficial socio-economic aspect since it leads to safe and hygienic disposal of the treated effluent.

• It enhances the existing environment as the untreated raw sewage disposal will be ceased.

• Also, the project will provide employment to the people during the constructional and operational phase hence creating a positive impact due to this project.

6.9.2 PROPOSED MITIGATION MEASURES

6.9.2.1Air Quality

• The fugitive emissions and dust from the proposed site during construction phase can be reduced by sprinkling of water.

• The release of volatile organic compound, Carbon di oxide and H2S may take place during the operational phase which will be mitigated by implementing Environmental Management Plan.

• DG sets are operated only during power failures and the D.G sets are proposed to provide 200 KVA as required suitable power back up to run the plant. The emissions from the D.G sets will have marginal impact on the existing air quality, however adequate Stack height of 10 m is provided as per the CPCB norms to combat the effect on the air quality and also to facilitate proper dispersion.

6.9.2.2 Water Quality

• Adequate care will be taken to the leakages in the plant and leak proof joints are already proposed for the construction.

• The treated and chlorinated sewage will disposed off to the disposal site by closed RCC pipe or DI pipe.

• All underground-buried mild steel piping will be protected by the application of hot coal tar enamel and fiberglass wrapping. The coating will consist of one coal tar primer one coat, wrapping of fiber glass one more coat of enamel and the final wrap of enamel impregnated fiber glass.

6.9.2.3 Soil Quality

• Top soils shall be stockpiled to a height of 400 mm in pre-designated areas for preservation and shall be reapplied to site during plantation of the proposed vegetation.

• Top soil shall be separated from sub-soil debris and stones larger than 50 mm diameter. So that, the soil erosion can be prevented and proper construction procedure will be done.

6.9.2.4 Solid Waste Handling

• Grit and screenings will be immediately removed and taken to municipal solid waste dump site in consultation with the municipality.

• The sludge from the Treatment Plant shall be collected in a sludge sump where it is aerated continuously for mixing. The aerated sludge shall be treated through mechanical dewatering system by aeration, digestion and thickening.

• Before dewatering, the sludge shall be aerated and polyelectrolyte is to be added for best settlement of sludge.

6.10 ENVIRONMENTAL MANAGEMENT PLAN

Environmental Management Plan (EMP) is aimed at mitigating the possible adverse impact of a project and ensuring the existing environmental quality. The EMP converse all aspects of planning, construction and operation of the project relevant to environment. It is essential to implement the EMP right from the planning stage continuing throughout the construction and operation stage. Therefore the main purpose of the Environmental Management Plan (EMP) is to identify the project specific activities that would have to be considered for the significant adverse impacts and the mitigation measure required.

6.10.1EMP during Construction Phase

The environmental impact during the construction phase will be of short term and reversible nature and will gradually eliminate after the construction activity is over. Further the area of the unit is small in size. Still the following measures will be considered on priority basis to minimize the impacts.

6.10.1.1 Mitigation for Modification of Drainage Pattern

• Rainwater harvesting prevents the flooding of low-lying areas in the project premises.

• A basic surface drainage system can be provided for the site to avoid water runoff on to the surrounding properties and roads, especially during the monsoon months.

• If during excavation, water accumulates in the excavated areas, then it should be pumped out and disposed off either in the municipal storm water drain or into recharge soak pits of drybore wells.

6.10.1.2 Air and Noise Environment

a) Site clearance, excavation and earthmoving

• The working area for the uprooting of shrubs or vegetation or for the removal of boulders or temporary or permanent structures shall be sprayed with water or a dust suppression chemical immediately before, during and immediately after the operation so as to maintain the entire surface wet.

b) Construction equipment’s

• All machineries to be used for construction purpose will be of highest standard of reputed make and compliance of noise pollution control norms by these equipment’s will be emphasized by company.

• Transport vehicles and construction equipment’s / machineries will be properly maintained to reduce air emissions.

• Equipment’s will be periodically checked for pollutant emissions against stipulated norms.

• Exhaust vent of DG set will be kept at proper height to ensure quick dispersal of gaseous emissions.

c) Excavation and earth moving

• The working area of any excavation or earth moving operation should be sprayed with water or a dusty suppression chemical immediately before, during and immediately after the operation so as to maintain the entire surface wet.

6.10.1.3 Mitigation Measures for Water Environment

• Excavation can be avoided during monsoon season

• Check dams shall be provided to prevent construction runoff from the site to the surrounding water bodies.

• Pit latrines and community toilets with temporary soak pits and septic tanks shall be constructed on the site during construction phase to prevent wastewater from entering the ground water or surrounding water bodies.

• To prevent surface and ground water contamination by oil/grease, leak proof containers shall be used for storage and transportation of oil/grease.

6.10.1.4 Mitigation Measures for Biological Environment

• The dust emissions will be suppressed by spraying water and then the activities will be carried out.

• Emissions from D.G sets and vehicles will be minimized by proper maintenance and by avoiding use of adulterant fuel sand will be maintained below the standard limits prescribed by competent authority.

• Important species of trees will be identified and marked and will be merged with landscape plan.

6.10.1.5 Construction Waste Disposal

• A site waste management plan should be prepared by the contractor prior to commencement of construction work. This should include the designation of appropriate waste storage areas, collection and removal schedule, identification of approved disposal site, and a system for supervision and monitoring. Preparation and implementation of the plan must be made the responsibility of the building contractor with the system being monitored independently.

• Special attention should be given to minimizing and reducing the quantities of solid waste produced during site preparation and construction. To reduce organic waste, softer vegetation may be composted onsite and used for soil amendment during landscaping.

• Most of the construction materials like soil, bricks, concrete will be reused in the backfilling, road construction and sub-grade reparation etc. works. Metals, word scraps & bitumen junks will be recycled either within site or outside with help of the local authority. The measures like reusing materials on-site and /or donating /selling salvaged items reduces waste, virgin material use and disposal cost.

• Vegetation and combustible waste must not be burnt on the site.

• Reusable inorganic waste (e.g. excavated sand) should be stockpiled away from drainage features and used for in filling where necessary.

• Unusable construction waste, such as damaged pipes, formwork and other construction material, must be disposed of at an approved dumpsite.

6.10.2 EMP during Operation Phase

During the operation phase, the plant will contribute to environmental pollution in the following manner:

• Atmospheric emission
• Noise Pollution
• Solid Waste Disposal

6.10.2.1 Management of Atmospheric Emissions and Noise Pollution

There is no source of air or noise pollution except the DG sets to be used as standby only. In addition there may be release of volatile compounds from the aeration tank. The emissions from the D.G sets will have marginal impact on the existing air quality, however adequate Stack height of 10 m is provided as per the CPCB / PPCB norms to combat the effect on the air quality and also to facilitate proper dispersion. Proper acoustic enclosure will be provided so that there will not be any vibrations and incremental noise in significant level.

6.10.2.2 Solid Waste Disposal

The main source of solid waste is sludge generated during operational activity.

• The sludge from the Treatment Plant shall be collected in a sludge sump where it is aerated continuously for mixing. The aerated sludge shall be treated through mechanical dewatering system by aeration, digestion and thickening.

• Before dewatering, the sludge shall be aerated and polyelectrolyte is to be added for best settlement of sludge.

• The sludge cake from the centrifuge pump will be moved to the composting yard through trucks.

• During transportation sludge will be covered in tarpaulin sheets.

• The sludge will be removed at frequent intervals in order to avoid accumulation inside the site.

6.11 Environmental Monitoring Program

Regular monitoring of all significant environmental parameters is essential to check the compliance status as per the environmental laws and regulation.

The objectives of the monitoring will be as follows:

• To verify the results of the impact assessment study with respect to the proposed project.

• To study the trend of concentration values of the parameters, which have been, identified as critical.

• To check and assess the efficacy of pollution control equipment.

• To ensure that any additional parameters, other than those identified in the impact, do not become critical.

To implement the EMP, a structured Environmental Management Cell (EMC) interwoven with the existing management system will be created. EMC will undertake regular monitoring of the proposed pollution control system and conduct yearly audit of the environmental performance of the system. It will also check that the stipulated measures are being satisfactorily implemented and operated. To monitor the extent of environmental impact of the proposed project, the contractor will periodically monitor the environmental quality along the proposed project area.

Apart from the mentioned monitoring requirements, any major accidents /spillage during bulk transport of hazardous materials, depending on the type of spillages / accidents the parameters will be monitored and is decided by the engineer and will be carried out by the contractor through approved monitoring agencies and supervised by the Implementing agency.

6.11.1 Air Pollution Monitoring

The Stack emissions from the DG Set shall be monitored on monthly basis for PM, NOx& SO2. The ambient air at the plant site shall be monitored at regular intervals for PM10, PM 2.5, NOx, SO2, CO &odour.

6.11.2 Treated Wastewater Monitoring

The quantity of waste generated from STP will be regularly measured using flow meters. Wastewater samples will be collected and analyzed for critical parameters like pH, BOD, COD, Solids, Oil and Grease. The frequency of monitoring will be at regular intervals.

CHAPTER 7

RESULTS AND DISCUSSIONS

- For the treated wastewater, SBR showed lesser values as compared to UASB technology. So by analyzing the values we can conclude that SBR is better technology as compared to UASB.
- Also land required for installing SBR is less as compared to UASB.
- Since up-gradation of the existing UASB based STP is not economical, so we are designing a new STP based on C-Tech/SBR Technology considering the discharge which will be generated by future population as projected earlier.

7.1 Water Disposal

Since Phagwara region is mainly agricultural area and the treatment efficiency of the C-tech based STP is high, the wastewater after treatment can be reused for irrigation purposes.

7.2 Collar Joints for RCC Np-3 Pipes

Collar joint is the vertical longitudinal space between wythes of masonry or between an outer masonry wythe and another backup system. This space is specified to be filled solid with mortar or grout.

Cracks and voids in collar joints filled with mortar are common and can be expected for a number of reasons. Separation cracks sometimes develop between the interface of the masonry units and the collar joint. This can be due to the different absorption rates of each masonry wythe and the fact that mortar-filled collar joints aren't compacted.

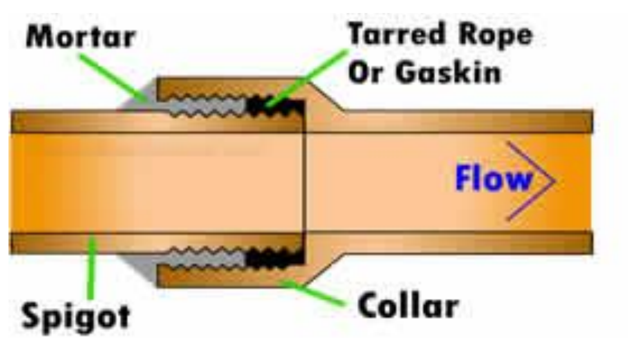

Figure 7.1 Cross – Section view of collar joint

APPENDIX

A.1 Parameters used in design of STP

Month				After UASB reactors		After PAT		After FPU		Overall	Remarks if any
	Parameters	Units	Raw Water	Effluent	% age removal	Effluent	% age removal	Effluent	% age removal	% age removal	
Dec-12	BOD	Mg/l	188	62	67.02%	47	24.19%	31	34.04%	83.51%	Ok
	TSS	Mg/l	240	163	32.08%	135	17.18%	55	59.26%	77.08%	Ok
	F. Coliform	MPN/100ml	480000					2500		99.48%	Ok
	pH		7.5	7.2		7.1		7.3			Within Limit
	Temp	°C	19.2	18.3		18.4		15.8			Within Limit
Jan-13	BOD	Mg/l	198	89	55.05%	54	39.33%	28	48.15%	85.86%	Ok
	TSS	Mg/l	250	135	46.00%	88	34.81%	53	39.77%	78.80%	Ok
	F. Coliform	MPN/100ml	110000					7200		93.45%	Ok
	pH		7.5	7.2		7.2		7.3			Within Limit
	Temp	°C	18	17		16		15			Within Limit
Feb-13	BOD	Mg/l	234	80	65.81%	58	27.50%	29	50.00%	87.61%	Ok
	TSS	Mg/l	132	95	28.03%	78	17.89%	45	42.31%	65.91%	Ok
	F. Coliform	MPN/100ml	170000					7500		95.59%	Ok
	pH		7.6	7.4		7.4		7.5			Within Limit
	Temp	°C	17	16		15		14			Within Limit
Mar-13	BOD	Mg/l	210	82	60.95%	55	32.93%	30	45.45%	85.71%	Ok
	TSS	Mg/l	234	136	41.88%	78	42.65%	50	35.90%	78.63%	Ok
	F. Coliform	MPN/100ml	130000					8500		93.46%	Ok
	pH		7.6	7.3		7.2		7.2			Within Limit
	Temp	°C	20	19		18		18			Within Limit

A.2 Population Projection

Year	Population	Increase in Population	Incremental Increase	Percentage Decade Increase(%)
1961	37929	---	---	---
1971	55012	17083	---	45.04
1981	75618	20606	3523	37.46
1991	88855	13237	-7369	17.51
2001	95626	6771	-6466	7.62
2011	116453	20827	14056	21.78
	Total:	78524	3744	129.40
	Average:	15705	936	25.88
	Rg:	0.217802576		

A.2.1 Arithmetic Increase

P-1961					37929	Persons
P-1971					55012	Persons
P-1981					75618	Persons
P-1991					88855	Persons
P-2001					95626	Persons
P-2011	116453				116453	Persons
P-2021	116453	+(15705)	1	15705	132158	Persons
P-2031	116453	+(15705)	2	31410	147863	Persons
P-2041	116453	+(15705)	3	47115	163568	Persons
P-2042	116453	+(15705)	3.1	48685.5	165139	Persons
P-2043	116453	+(15705)	3.2	50256	166709	Persons

A.2.2 Geometric Increase

P-1961					37929	Persons
P-1971					55012	Persons
P-1981					75618	Persons
P-1991					88855	Persons
P-2001					95626	Persons
P-2011	116453				116453	Persons
P-2021	116453	(1+.2178)	1	1.2178	141816	Persons
P-2031	116453	(1+.2178)	2	1.48303684	172704	Persons
P-2041	116453	(1+.2178)	3	1.806042264	210319	Persons
P-2042	116453	(1+.2178)	3.1	1.841982527	214504	Persons
P-2043	116453	(1+.2178)	3.2	1.878638002	218773	Persons

A.2.3 Incremental Increase

P-1961						37929	Persons
P-1971						55012	Persons
P-1981						75618	Persons
P-1991						88855	Persons
P-2001						95626	Persons
P-2011	116453					116453	Persons
P-2021	116453	+(15705)	1	+	936	133094	Persons
P-2031	116453	+(15705)	2	+	2808	150671	Persons
P-2041	116453	+(15705)	3	+	5616	169184	Persons
P-2042	116453	+(15705)	3.1	+	5948.28	171087	Persons
P-2043	116453	+(15705)	3.2	+	6289.92	172999	Persons

A.3 Values of C_d for calculating loads on pipes in trenches

Ratio H/B_d	Safe working Values of C_d				
	Minimum possible without cohesion**	Maximum for Ordinary Sand***	Completely Top Soil	Ordinary maximum for clay****	Extreme maximum for clay*****
0.5	0.455	0.461	0.464	0.469	0.474
1.0	0.830	0.852	0.864	0.881	0.898
1.5	1.140	1.183	1.208	1.242	1.278
2.0	1.395	1.464	1.504	1.560	1.618
2.5	1.606	1.702	1.764	1.838	1.923
3.0	1.780	1.904	1.978	2.083	2.196
3.5	1.923	2.075	2.167	2.298	2.441
4.0	2.041	2.221	2.329	2.487	2.660
4.5	2.136	2.344	2.469	2.650	2.856
5.0	2.219	2.448	2.590	2.798	3.032
5.5	2.286	2.537	2.693	2.926	3.190
6.0	2.340	2.612	2.782	3.038	3.331
6.5	2.386	2.675	2.859	3.137	3.458
7.0	2.423	2.729	2.925	3.223	3.571
7.5	2.454	2.775	2.982	3.299	3.673
8.0	2.479	2.814	3.031	3.366	3.764
8.5	2.500	2.847	3.073	3.424	3.845
9.0	2.518	2.875	3.109	3.476	3.918
9.5	2.532	2.898	3.141	3.521	3.983
10.0	2.543	2.918	3.167	3.560	4.042
11.0	2.561	2.950	3.210	3.626	4.141
12.0	2.573	2.972	3.242	3.676	4.221
13.0	2.581	2.989	3.266	3.715	4.285
14.0	2.587	3.000	3.283	3.745	4.336
15.0	2.591	3.009	3.296	3.768	4.378
Very Great	2.599	3.030	3.333	3.846	4.548

A.4 Values of load coefficients, C_s for concentrated and distributed superimposed loads vertically centered over conduits

$\frac{D}{2H}$ or $\frac{B_c}{2H}$	$\frac{M}{2H}$ or $\frac{L}{2H}$													
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.5	2.0	5.0
0.1	0.019	0.037	0.053	0.067	0.079	0.089	0.097	0.103	0.108	0.112	0.117	0.121	0.124	0.128
0.2	0.037	0.072	0.103	0.131	0.155	0.174	0.189	0.202	0.211	0.219	0.229	0.238	0.244	0.248
0.3	0.053	0.103	0.149	0.190	0.224	0.252	0.274	0.292	0.306	0.318	0.333	0.345	0.355	0.360
0.4	0.067	0.131	0.190	0.241	0.284	0.320	0.349	0.373	0.391	0.405	0.425	0.440	0.454	0.460
0.5	0.079	0.155	0.224	0.284	0.336	0.379	0.414	0.441	0.463	0.481	0.505	0.525	0.540	0.548
0.6	0.089	0.174	0.252	0.320	0.379	0.428	0.467	0.499	0.524	0.544	0.572	0.596	0.613	0.624
0.7	0.097	0.189	0.274	0.349	0.414	0.467	0.511	0.546	0.584	0.597	0.628	0.650	0.674	0.688
0.8	0.103	0.202	0.292	0.373	0.441	0.499	0.546	0.584	0.615	0.639	0.674	0.703	0.725	0.740
0.9	0.108	0.211	0.306	0.391	0.463	0.524	0.574	0.615	0.647	0.673	0.711	0.742	0.766	0.784
1.0	0.112	0.219	0.318	0.405	0.481	0.544	0.597	0.639	0.673	0.701	0.740	0.774	0.800	0.816
1.2	0.117	0.229	0.333	0.425	0.505	0.572	0.628	0.674	0.711	0.740	0.783	0.820	0.849	0.868
1.5	0.121	0.238	0.345	0.440	0.525	0.596	0.650	0.703	0.742	0.774	0.820	0.861	0.894	0.916
2.0	0.124	0.244	0.355	0.454	0.540	0.613	0.674	0.725	0.766	0.800	0.849	0.894	0.930	0.956

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