

# Water and power consumption: analysis of sewage treatment plant



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## **1. INTRODUCTION:**

Water's unique Characteristics and its essential Role for all life have inspired myths and influenced cultures, religions, art, and literature through all times.

The process involved for the RBC Biological Treatment method is named as FIXED FILM ROTATING BIOLOGICAL CONTACTOR BIOWHEELS. In this process by means of rotation of the bio wheels micro - organisms are expected to growth in the RBC and the overflow from the Lamella clarifier will be the first stage of the treated water. The micro organisms will develop on the surface of the disk and the colonization of the organisms will take place because of the inlet load into the system. The thick film like formation in the surface of the disk is the indication of the growth. In Sewage water the main constituents of Pollutants being organic in nature these can be digested easily in the RBC.

Sewage is created by institutions, residences, and hospitals and commercial and industrial establishments. Raw influent of sewage wastewater includes household waste liquid from the toilets, sinks, showers, kitchens, baths, and so forth that is disposed of sewage waste water.

### **1.1 Aim:**

The aim of the project is to Analysis of water consumption and power consumption of sewage treatment plant.

### **1.2 Objective:**

\* To Analysis the water and power consumption of the sewage treatment plant

- \* To vary the parameters of water source, power source.
- \* To Analyze the Rotating Biological contactor Biowheels. Lamella clarifier
- \* Analyzing 2D design of the Sewage Treatment Plant.
- \* To analyze the results and propose appropriate solution.

## **2. BACKGROUND RESEARCH:**

Waste water collected from domestic and industrial communities must be returned to receiving waters or to the land. Although the collecting of storm water and drainage dates from ancient times the collection of waste water can be traced only to the early 1800s. The systematic treatment of wastewater followed in the late 1800s and early 1900s.

There are many methods and processes to treat wastewater. The most common approach uses primary treatment (screening and clarification) to remove solids; aerobic, suspended growth, activated sludge secondary treatment to reduce organic pollutants; and chlorine disinfection to reduce pathogens. Secondary treatment is the largest energy consumer (30 to 60% of total plant usage), followed by pumping and sludge processing. Although suspended growth, activated sludge is the most common wastewater treatment process, it is not the most energy efficient.

Aerated lagoons, trickling filters and rotating biological contactors are significantly more efficient. They are not as widely used because aerated lagoons require a large land area, and trickling filters and rotating biological contactors are better suited for smaller capacity applications. Many wastewater treatment plants are shifting from chlorine-based disinfection to <https://assignbuster.com/water-and-power-consumption-analysis-of-sewage-treatment-plant/>

UV disinfection to eliminate the risk of storage and handling of toxic chemicals. Although UV disinfection is energy intensive, it adds no chemical residue to the effluent. This feature is particularly important for discharge to sensitive aquatic environments or for wastewater reuse. In general, low pressure UV systems are substantially more efficient than medium pressure systems.

Energy efficiency opportunities in wastewater treatment include the use of fine bubble diffusers, dissolved oxygen control of aeration, high efficiency blowers, variable frequency drives on pumps and blowers, premium efficiency motors, and the reduction of the head against which pumps and blowers operate. Sewage is generally a mixture of domestic of waste water from bath, sinks and washing machines and toilets, waste water from all industry and rainwater runoff from roads and other surfaced areas.

Every day in the UK about 347, 000 Kilometers of sewers collect over 11 Billion liters of waste water. This is treated about 9000 sewage treatment works before the treated effluent is discharged to inland waters, estuaries and the sea.

Without suitable treatment, the waste water we produce every day would damage the water environmental and creates to affect the public health problems. Untreated sewage contains organic matter carbohydrates, fats and proteins, bacteria and chemicals. Bacteria naturally present in environmental waters do break these substances down, but in doing so they use the oxygen dissolved in this water. If there were large or continuous untreated discharges of urban waste water the result could be too little

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oxygen for fish and other aquatic life to survive. So the purpose of waste water treatment is to remove organic substances to protect the environment from these effects. Sewage works therefore reproduce what would be occurring in the environmental. Settling out much of the solid matter is called Primary Treatment, and using Bacteria that digest and break down the organic substances is called Secondary Treatment.

Sometimes further treatment Tertiary is required to protect sensitive water environments; Tertiary treatment can involve disinfecting the treated effluent to protect the bathing and shellfish waters. It can also involve the removal of phosphorous or nitrates nutrients present in sewage. To protect the waters that is threatened by eutrophication. (ref sewage treatment in the UK defray department for environment food & Rural affairs, PB 6655 March 2002.).

### **3. LITERATURE REVIEW:**

Municipal water use is generally divided into four categories,

1. Domestic water normally used for sanitary and general purposes
2. Industrial water used for nondomestic purposes,
3. The Public service water normally used for fir fighting, and system maintenance and also municipal landscape irrigation.
4. Unaccounted for system losses and leakage

The following data are typical municipal water use in the United States Report.

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( (George Tchobanoglous and Franklin L. Burton, 1991)

Table 1 Municipalities water use

### **3. 1 Domestic water use:**

Domestic water use encompasses the water supplied to residential areas , and commercial districts, institutional facilities, and recreational facilities as a measured by individual water meters . The uses to which this water is put include drinking, washing, bathing, culinary, and waste removal, and yard watering these kind of water collected from household sewage. Using the average flow values reported in above table of the water used in a municipal water supply system is for domestic purposes.

### **3. 2 Residential areas:**

The water normally used by residential households consists of water for interior use such as showers and toilets and water for exterior use such as lawn watering and car washing, the household wastewater mostly used in sewage treatment plant. Typical data for interior water use are presented in below table.

How much amount of water used in residential areas water use for exterior applications varies widely depending upon the geographic location, climate and time of year and mainly consists of landscape irrigation.

The Residential areas 100% of water normally used by typical distribution of residential interior water use the following table given details

Table 2 Typical distribution interior water use

(George Tchobanoglous and Franklin L. Burton, 1991)

### **3. 3 Commercial facilities:**

The water used by commercial facilities for sanitary purposes will vary widely depending on the type of activity means example of offices and compared to a restaurant. Typical water use values for various types of commercial facilities are reported in following table also for large commercial water using facilities such as laundries and car washes, careful estimates of actual water use should be made.

Table 3 Typical rates of water use for commercial facilities

(George Tchobanoglous and Franklin L. Burton, 1991)

### **3. 4 Institutional facilities:**

Water used by facilities such as hospitals, schools and rest home is usually based on some measure of the size of the facility and the type of housing function provided example of per student or per bed, and water normally use for schools will vary significantly depending on whether the students are housed on campus or are day students. The representative water use values for institutional facilities are reported following table.

Table 4 Typical water-use values for institutional facilities

(George Tchobanoglous and Franklin L. Burton, 1991)

### **3. 5 Recreational Facilities:**

The recreational facilities mostly water used in such as swimming pools, bowling alleys, and camps, resorts, then country clubs perform a wide range

of functions involving water use. The following table typical water use values are reported.

Table: Typical water-use values for recreational facilities

(George Tchobanoglous and Franklin L. Burton, 1991)

#### **4. SEWAGE TREATMENT PLANT:**

##### **4.1 PRINCIPLE:**

Sewage treatment plant there are two main types of biological reaction, depending upon the presence or absence of free oxygen, the aerobic reaction takes place only in the presence of free oxygen and produces stable, relatively inert end products. Anaerobic reaction are more complex, being two stage, proceeding relatively slowly and leading to end products which are unstable and which still contain considerable amounts of energy. In any biological reaction the energy in the organic matter, used as food by the microorganisms, is split three ways; some is used in creating new microorganisms, some is incorporated in the end products of the reaction, the proportions of energy in the three areas depend upon the nature of the reaction, the type of organic matter, the type of microorganisms, and environmental conditions. The organic matter in wastewater thus provides the well as providing the energy for the oxidation reactions which releases the end products of biological treatment. (THY Tebbutt, 1990).

Domestic sewage satisfies all these requirements but some industrial wastewaters may be lacking in nutrients or other factors, which could result in inhibition of biological activity, Toxic substances present in the wastewater can also mean that biological treatment of an organic wastewater is

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ineffective, although it is sometimes possible for microorganisms to become acclimated to substances which initially appear to be toxic. The aim of conventional biological treatment processes is to achieve almost complete removal of the organic matter in the feed. The activated sludge system is a common form of dispersed growth reactor, and both systems require a settling facility to remove the excess biological solids produced in the process. In the case of fixed film systems the solids are essentially dead cells, but with the dispersed growth activated sludge systems the bulk of the cells are living and are returned to the reactor for re use, only the excess solids being removed. (THY Tebbutt, 1990).

### **Characterstics of waste water sewage treatment plant:**

- Bio chemical oxygen demand
  
- Total dissolved solids
  
- Chemical oxygen demand
  
- Total suspended solids
  
- PH

#### **· Bio chemical oxygen demand:**

It is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions.

#### **· Total dissolved solids:**

It comprises inorganic salts and small amounts of organic matter that are dissolved in water. The principle constituents are usually the captions ,

calcium, magnesium, sodium, and potassium and the anions carbonate, bicarbonate, chloride, sulphate and particularly in groundwater nitrate.

• **Chemical oxygen demand:**

It is a measure of the total quantity of oxygen required to oxidize all organic material into carbon dioxide and water.

\* **Total suspended solids:**

It is a measure of the suspended solids in waste water, effluent, or water bodies determined by tests for “ Total suspended non-filterable solids”.

• **PH:**

It is a measure of the acidity or alkalinity of a solution numerically equal to 7 for neutral solutions increasing with increasing alkalinity and decreasing with increasing acidity. The PH scale commonly in use ranges from 0 to 14.

( [www. answers. com](http://www.answers.com) )

### **Classification of Waste Water Treatment Methods**

The wastewater treatment is contaminants are removed by physical, chemical and also biological methods. Sewage Treatment Plant individual methods usually are classified as a physical unit operations, chemical unit operations and also Biological unit operations and processes. Although these operations and processes occur in a variety of combinations in Treatment Systems. (George Tchobanoglous, Franklin L. Burton, 1991, 1979, 1972)

#### **4. 2 Physical operations unit:**

The Treatment methods in which the application of physical forces to predominate are known as physical operation unit. Because most of these

methods involved directly from the first observations of a nature, and they were the first to be used for wastewater . treatment.

These are the Screening, Mixing, Flocculation, Flotation, sedimentation, Filtration, and Gas transfer are typical unit operations. (George Tchobanoglous, Franklin L. Burton, 1991, 1979, 1972).

### **Screening:**

The first off all unit operation entered in wastewater treatment plants is screening . a screen is a device with openings , generally of uniform a size, that is using to retain the coarse solids found in wastewater.

### **Description:**

The screening elements may consists of parallel bars, wires or , grating, rods, mesh, or perforated plate , a screen composed of parallel bars or rods is called a bar rack sometimes called a bar screen).

The term screen is used for screening devices consisting of perforated plates wedges wire elements and wire cloth. The materials removed by these devices are known as screenings.

### **Bar Racks:**

In Wastewater treatment, bar racks are used to protect the Pumps pipelines valves and other appurtenances from the damaged or clogging by a rags and large objects.

### **Screens:**

Sewage treatment plant is widely used to Barscreening, early screens were of the inclined disk or drum type, whose screening media consisted of bronze

or copper plates with milled slots , and were installed in place of sedimentation tanks for primary treatment . since the early 1970s, there has been resurgence of interest in the field of wastewater treatment in the use of screens of all types , the application range from primary treatment to the removal of the residual suspended solids from biological treatment processes. (George Tchobanoglous, Franklin L. Burton, 1991, 1979, 1972)

**Mixing:**

Mixing is an important unit operation in many phases of wastewater treatment including (1)the mixing of one substances completely with another, (2)the mixing of liquid suspensions,(3)the blending of miscible liquids,(4)floculation and (5)heat transfer . chemicals are also mixed with sludge to improve tidal watering characteristics. In anaerobic digestion, mixing is used accelerate the biological conversion process and to heat the contents of the digester uniformly .

**Description Apparatus:**

Most mixing operations in wastewater can be classified as continuous rapid or continuous. Continuous -rapid mixing is used most often where one substance is to be mixed with another. Continuous mixing is used where the contents of reactor or holding tank or basin must be kept in suspension.

**Energy dissipation mixing:**

The power input per unit volume of liquid can be used as a rough measure of mixing effectiveness, based on the reasoning that more input power creates greater turbulence, and greater turbulence leads to better mixing.

**Sedimentation::**

It is one of the most widely used in waste water treatment, sedimentation is the separation from the water, by gravitational settling, of suspended solids that are heavier than water, it is one of the most widely used unit operations in wastewater treatment . A Sedimentation basin may also be referred to as a sedimentation tank, settling basin , or settling tank,

Sedimentation is used for grit removal, particularly floating matter removal in the primary settling basin, biological float removal in the activated sludge and settling basin and chemical flog removal. Whenever' the chemical coagulation processes is used.

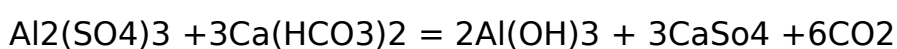
**4. 3 Chemical unit processes:**

Sewage treatment plant is widely used to chemical unit processes , This Treatment Methods in which the removal or conversion of the contaminants is brought about by the chemicals or by other chemical reactions are known as a chemical processes unit. There are three different types chemical processes used in the wastewater treatment. Precipitation, and disinfection and adsorption, which the process mostly used in the wastewater treatment. In the chemical precipitation , treatment is also accomplished by producing a chemical precipitate that will settle. In most cases the settled precipitate will contain the both constituents that may have reacted with the adding to chemicals and the substance that were swept of wastewater as the predicated settled in the water. (George Tchobanoglous, Franklin L. Burton, 1991, 1979, 1972)

#### 4. 4 Chemical coagulation:

The settlement of fine colloidal and suspended solids can be assisted by the use of flocculation as but with dilute suspensions, such as lowland river waters, the opportunities for collisions and agglomeration are limited. In such circumstances flocculation does not significantly improve the settling characteristics of the suspension. the addition of a chemical coagulant, which precipitates flocculent solids in the water, followed by flocculation and sedimentation, can provide a high degree of clarification. the processes of chemical coagulation is thus carried out in a sequence of operations, the first of which involves rapid to permit enmeshment of the colloidal solids in the rapidly precipitating flock. (THY Tebbutt, 1990)

Following the initial stage precipitation stage, the suspension is passed to flocculation and sedimentation units, which may be separate or combined. the most popular coagulant for potable water treatment is aluminum sulphate, often referred to as alum. When it is added to water in small doses of around 20-50mg/l, a reaction takes place with the natural alkalinity present, and insoluble aluminum hydroxide is formed. this responds well to controlled flocculation. The chemical reactions which occur are complex but may be simplified as



When using the commercial alum which has 16-18 molecules of water of crystallization, and expressing alkalinity in terms of calcium carbonate, each mg/l of alum reacts with 0. 5mg/l of alkalinity. By using a range of coagulant

does and PH values , it is possible to determine the optimum conditions to achieve the required water quality. (THY Tebbutt, 1990)

### **Chemical precipitation:**

In essence , chemical precipitation depends upon the use of an added reagent which combines with the impurity to be removed to give an insoluble product which can then be removed by sedimentation, preceded by flocculation if necessary.

$A(\text{impurity}) + B(\text{reagent}) = C(\text{precipitate}) + D(\text{by product})$

It is clearly essential that any byproduct of the reaction does not itself have undesirable properties in relation to the eventual use of the water or wastewater. It is also important to remember that chemical precipitation processes produce sludge's containing the impurities and that the cost of handling and disposing of these sludge's in a safe manner can be significant. (THY Tebbutt, 1990)

### **Disinfection:**

Disinfection refers to the selective destroy of disease causing organism . all the organisms are not destroyed of during the process; this differentiates disinfection from sterilization, which is the destruction of all organisms. In the field of waste water treatment, there are three categories of human enteric organisms of the greatest consequence in producing disease are viruses, bacteria, and amoebic cysts.

Disinfection is widely used to wastewater sewage treatment plant; there are well -established links between the contamination of drinking water with

facial matter and the incidence of such water related diseases as cholera, typhoid and many gastrointestinal infections. Thus the removal of the pathogenic microorganisms from water supplies is a very valuable measure for the improvement of public health. Disinfection means the destruction of pathogenic microorganisms and does not necessarily mean that the water is sterile, since a small number of harmless microorganisms are usually present in tap water and poses no hazard.

For most disinfection the rate of kill is given by

$$dN/dt = -KN$$

where  $k$  = rate constant

$N$  = number of living microorganisms

The rate constant varies with the particular disinfectant, its concentration, the organism being killed, PH, Temperature, and other environmental factors. (THY Tebbutt, 1990)

### **5. Biological unit processes:**

Sewage Treatment plant is widely used to Biological unit processes , this is processes is remove the microorganism of the water, In this Treatment methods in which the removal of contaminants is bring about by biological activity are known as a biological unit processes. Biological treatment is used primary to remove the biodegradable organic substances matter (means colloidal or dissolved )in wastewater. Basically, these substances matter are converted into the gases that can be escaped to the atmosphere and into the biological cell tissue unit that can be removed by settling. At the same <https://assignbuster.com/water-and-power-consumption-analysis-of-sewage-treatment-plant/>



time this treatment is also used to remove the nutrients (means nitrogen and phosphorous) in wastewater. (George Tchobanoglous, Franklin L. Burton, 1991, 1979, 1972)

### **5. 1 Components of wastewater Flows**

The components of the wastewater flows that make up the wastewater flow from a community depend on the type of collection system used and may include the following:

There are four types of wastewater flows available in the wastewater treatment.

1. Domestic (is also called sanitary) wastewater. This is kind of wastewater discharged from residences and from commercial, institutional, and household sewage toilet waste water, bath, sinks, and canteen wastewater and similar facilities.
2. Industrial wastewater. This kind of wastewater in which industrial wastes predominate.
3. Infiltration/inflow. Water that enters the sewer system through the indirect and direct means. The infiltration is extraneous water that enters the sewer system through the leaking joints.
4. Storm water. Runoff resulting from rainfall and snowmelt. This kind of components of wastewater flows essentially used in the sewage treatment plant.

## **5. 2 Waste water treatment:**

There are four different types of wastewater processing in available in sewage treatment plant. Primary treatment referred to physical unit operations. Secondary treatment referred to chemical and Biological unit process, and also Advanced or tertiary referred to combinations of all four other processing.

### **• Preliminary wastewater treatment:**

Preliminary wastewater treatment is defined as the removal of wastewater constituents that may causes to maintenance of the operational problems with the treatment of the operations. Examples of preliminary operations are screening and commutation for the removal of debris (J. Staudenmann, A. Schonborn, C. Etnier, 1996). primary wastewater treatment:

In primary wastewater treatment, a portion of the suspended solids and organic material is removing from the waste water. This removal is usually accomplished with physical operations such as screening and sedimentation. The effluent from primary treatment will ordinarily contain considerable organic matter and will have relatively high BOD. treatment plants using only primary treatment will be phased out in the future as implementation of the EPA secondary treatment requirements is completed. Rare instances (for those communities having a secondary treatment waiver)will primary treatment be used as the sole method of treatment . the principal function of primary treatment will continue to be as a precursor to secondary treatment .

**\* Conventional secondary wastewater treatment:**

The secondary treatment is directed principally toward the removal of bio degradable organics and suspended. Disinfection is included frequently in the definition of conventional secondary treatment is defined as the combination of processes customarily used for the removal of these constituents and includes biological treatment by activated sludge fixed film reactors, or lagoon systems and sedimentation.

**• Advanced wastewater treatment/wastewater reclamation:**

Advanced wastewater treatment is defined as the level of treatment required beyond conventional secondary treatment to removing constituents of concern including toxic, nutrients, compounds, and larger amounts of organic material and suspended solids . In addition to the nutrient removal processes, unit operations or processes frequently employed in advanced wastewater treatment are chemical coagulation, flocculation, and sedimentation followed by filtration and multi grade filter and also activated carbon filter. (George Tchobanoglous, Franklin L. Burton, 1991, 1979, 1972).

**6. STP BASED ROTATING BIOLOGICAL CONTACTORS:****6. 2 Principle:**

A Rotating biological contactor (RBC) is constructed of bundles of plastic packing attached radially to a shaft, forming a cylinder of media . the shaft is placed contour bottomed tank so that the media are submerged approximately 40 percent. the contactor surfaces are spaced so that during submergence in wastewater can enter the voids in the packing . when rotated out of the tank , the liquid trickles out of the voids in the packing. when rotated out of the tank the liquid trickles out of the voids between

surfaces and is replaced by air. A fixed film biological growth, similar to that on a trickling filter packing, adheres to the media surfaces. Alternating exposure to organics in the wastewater and oxygen in the air during rotation distributor. Excess the biomass sloughs from the media and is carried out in the processes effluent for gravity separation.

A treatment system consists of primary sedimentation preceding and final sedimentation following the rotating biological contactors. Since the recirculation through RBC units is not normally practiced, only sufficient underflow from the final clarifier is returned to allow removal of excess of the biological solids in primary sedimentation and waste sludge similar to the character to the from trickling filter plant , in withdrawn from the primary clarifiers disposal of waste. In large type of plants, a common shaft is placed over a contoured tank with the wastewater flow parallel to the shaft. A series of four stages are normally installed in the treatment of domestic wastewater for BOD reduction. additional stages may be added to initiate nitrification . Each stage acts as a completely mixed chamber and the movement of the wastewater through the series of tanks simulates plug flow. Biological solids washed off of the media are transported hydraulically under the baffles to be carried out with the effluent. RBC units are protected by installation either in a building with adequate ventilation or under separate plastic covers lined with insulation.

The efficiency of BOD removal of in the processing domestic wastewater is based on empirical data from operating RBC plants. the Mathematical equations also have been developed , but their prediction of the

performance is not consistently reliable. the typically recommendations for <https://assignbuster.com/water-and-power-consumption-analysis-of-sewage-treatment-plant/>

secondary treatment of domestic wastewater to produce an effluent of less than 30 mg/l of BOD and also 30mg/l of suspended solids. (Mark J. Hammer Mark J. Hammer, Jr, 1996)

### **TECHNICAL DETAILS OF RBC:**

#### **DESCRIPTION MOC / MAK**

1. Polymer sheet die 2m x 2 thk – special polymer from Germany
2. RBC Trough – poly propylene /FRP
3. RBC Support – MS Resin Coated
4. Geared Motor (0. 75HP) – FLENDER
5. Input Coupling – Love Joy
6. Drive Support – Mild Steel
7. Bush – Nylon
8. Shaft – SS304

#### **TANK SCHEDULE OF RBC :**

The following tanks used in sewage treatment plant based Rotating Biological contactor Processes.

1. Bar screen
2. Collection Tank
3. PIT 1, 2, 3

4. Flow divider
5. Sludge drying bed
6. Semi Treated water tank
7. Multi grade sand filter
8. Activated carbon filter
9. Treated water tank

### **EQUIPMENT SCHEDULE**

The following equipments used in sewage treatment plant based Rotating Biological contactor processes.

### **DESCRIPTION MODEL/HP QTY**

RBC 0. 75 hp 1

Submersible Pump 1 Hp 2

Submersible Pump (Lamella) 1 Hp 1

Filter feed submersible pump 3 Hp 2

### **7. ROTATING BIOLOGICAL CONTACTOR PROCESS(60 KILO LITRE PER DAY): 2D**

### **8. WATER CONSUMPTION ANALYSIS OF SEWAGE TREATMENT PLANT:**

#### **Raw sewage characteristics:**

#### **Domestic waste water:**

The volume of a wastewater from a community varies from 50 to 250 gal capital per day depending on the sewer system uses. A common values for <https://assignbuster.com/water-and-power-consumption-analysis-of-sewage-treatment-plant/>

domestic wastewater flow is 120 gpcd means 450 liter person per day use, which assumes that the residential waste water have modern water using appliances, such as automatic washing machines. the organic substances matter contributed per person per day in domestic wastewater is approximately 0. 24 lb to 110gram of suspended solids and 0. 20lb and 90 gram of BOD in communities where a substantial portion of the household kitchen wastes is designed is discharged to the sewer system through garbage grinders. In selection of data for design, the quantity of and organic strength of wastewater should be based on actual measurements taken through the year to account for variations resulting from seasonal climatic changes and other factors. the average values during the peak month may be used for design , excluding un usual infiltration and inflow, the average daily sanitary wastewater flow during the maximum month of the year is commonly 20 to 30 percent greater than the average annual daily flow, excluding seasonal industrial wastes, the average daily BOD load from sanitary wastewater during the maximum month is greater than the annual ave