1. INTRODUCTION

Sewage/ waste water is a major carrier of disease (from human wastes) and toxins (from industrial wastes).The safe treatment of sewage is thus crucial to the health of any community. This project focuses on the complex physical and biological treatments used to render sewage both biologically and chemically harmless.

The wastewater discussed in this section is predominantly of domestic origin. Varying amounts of industrial and laboratory wastewaters can be collected and treated with the sanitary sewage. The primary purpose of the treatment of sewage is to prevent the pollution of the receiving waters. Many techniques have been devised to accomplish this aim for both small and large quantities of sewage.

In general, these processes are divided into three stages: preliminary (physical), primary (physical) treatment and secondary (biological) treatment. Figure 2–1 provides a schematic of a typical wastewater treatment plant. Minimally, wastewater should receive primary (physical removal/settling) and secondary (biological) treatment, which can be followed by disinfection before discharge. More advanced processes (advanced or tertiary treatment) may be required for special wastes. When the effluent from secondary treatment is unacceptable, a third level of treatment, tertiary treatment, can be employed. There are many basic types of sewage treatment plants employing both primary and secondary treatment stages that are in use today for treating large quantities of sewage.

Reeds are coarse grasses growing in wet places. Reed bed is one of the natural and cheap methods of treating domestic, industrial and agricultural liquid wastes. Reed bed is considered as an effective and reliable secondary and tertiary treatment method where land area is not a major constraint. Generally reed bed is made in shallow pits, installed with a drain pipe in a bed of pieces of lime stones and filled up with pebbles and graded sand. In this sandy body, reed plants generally with hollow root which bring oxygen into the filter bed are planted.

Reed bed are natural habitats found in floodplains, waterlogged depressions and estuaries. Reed beds are part of a succession from young reed colonising open water or wet ground through a gradation of increasingly dry ground. As reed beds age, they build up a considerable litter layer which eventually rises above the water level, and ultimately provides opportunities for scrub or woodland invasion. Artificial reed beds are used as a method of removing pollutants from grey water. Reeds, Phragmites *australis* is considered to be the best plant because of its roots form horizontal rhizome that guarantee a perfect root zone filter bed.

Application of root zone technology (RZT) is finding wider acceptability in developing and developed countries, as it appears to offer more economical and ecologically acceptable solution to water pollution management problems. The process in a root zone system to treat the sewage is very simple to explain yet complex in nature. Root zone systems whether natural or constructed, constitute an interface between the aquifer system and terrestrial system that is the source of the pollutants. These are reported to be most suitable for schools, hospitals, hotels and for smaller communities.

The country's reportedly first RZT system was designed by NEERI at Sainik School; Bhubaneswar, Orissa. It has reportedly been giving a very good performance of removing 90% BOD and 63% nitrogen (Central Pollution Control Board in 2000). The objective of this case study is to analyze the sewage water/wastewater generated and evaluate the suitability and effectiveness of treating effluents by root zone system and compare the results with conventional methods of treating waste water with STP.

2. HISTORY OF WASTE WATER TREATMENT

Basic sewer systems were used for waste removal in ancient Mesopotamia, where vertical shafts carried the waste away into cesspools. Similar systems existed in the Indus Valley civilization in modern day India and in Ancient Crete and Greece. In the Middle Ages the sewer systems built by the Romans fell into disuse and waste was collected into cesspools that were periodically emptied by workers known as 'rakers' who would often sell it as fertilizer to farmers outside the city.

Modern sewage systems were first built in the mid-nineteenth century as a reaction to the exacerbation of sanitary conditions brought on by heavy industrialization and urbanization. Due to the contaminated water supply, cholera outbreaks occurred in 1832, 1849 and 1855 in London, killing tens of thousands of people. This, combined with the Great Stink of 1858, when the smell of untreated human waste in the River Thames became overpowering, and the report into sanitation reform of the Royal Commissioner Edwin Chadwick, led to the Metropolitan Commission of Sewers appointing Sir Joseph Bazalgette to construct a vast underground sewage system for the safe removal of waste. Contrary to Chadwick's recommendations, Bazalgette's system, and others later built in Continental Europe, did not pump the sewage onto farm land for use as fertilizer; it was simply piped to a natural waterway away from population centres, and pumped back into the environment.

One of the first attempts at diverting sewage for use as a fertilizer in the farm was made by the cotton mill owner James Smith in the 1840s. He experimented with a piped distribution system initially proposed by James Vetch that collected sewage from his factory and pumped it into the outlying farms, and his success was enthusiastically followed by Edwin Chadwick and supported by organic chemist Justus von Liebig.

The idea was officially adopted by the Health of Towns Commission, and various schemes (known as sewage farms) were trialled by different municipalities over the next 50 years. At first, the heavier solids were channelled into ditches on the side of the farm and were covered over when full, but soon flat-bottomed tanks were employed as reservoirs for the sewage; the earliest patent was taken out by William Higgs in 1846 for "tanks or reservoirs in which the contents of sewers and drains from cities, towns and villages are to be collected and the solid animal or vegetable matters therein contained, solidified and dried... Improvements to the design of the tanks included the introduction of the horizontal-flow tank in the 1850s and the radial-flow tank in 1905. These tanks had to be manually de-sludged periodically, until the introduction of automatic mechanical de-sludgers in the early 1900s.

The precursor to the modern septic tank was the cesspool in which the water was sealed off to prevent contamination and the solid waste was slowly liquified due to anaerobic action; it was invented by L.H Mouras in France in the 1860s. Donald Cameron, as City Surveyor for Exeter patented an improved version in 1895, which he called a 'septic tank';

septic having the meaning of 'bacterial'. These are still in worldwide use, especially in rural areas unconnected to large-scale sewage systems.

3. BASIC REED BED DESIGN PARAMETERS

Reed beds should be designed to have a wastewater residence time of 5 to 7 days and can range between 300-1000mm deep. Reed beds should have a length to width ratio between 3:1 and 1:1. If installing a circular reed bed it is advisable to install a central baffle and strongly consider installing inlet and outlet baffles to prevent short-circuiting of wastewater in the reed bed and a possible reduction of treatment performance. Many reed beds contain 10-20mm gravel as a medium for the main body of the reed bed, although some reed beds do have a top layer of sand for planting the reeds in. Clogging due to solids in the influent can be minimized by installing an effluent filter on the outlet of the grey water/septic tank. Current research is indicating that once a reed bed has been established and the reeds have reached maturity that worms enter the reed bed and actually "transport" solids to the surface that would otherwise clog the reed bed. Wastewater enters the reed bed via the inlet pipe positioned at a height greater than the outlet pipe, and disperses the wastewater as evenly as possible into the gravel. Some reed beds use perforated T-junctions made from 100mm PVC sewer grade pipe, whilst others use perforated 300mm capped, perforated storm water pipe. It is important to prevent surfacing of effluent and the escape of odours. Therefore, the inlet pipe should be covered with aggregate. Large 50/100mm diameter rocks must be placed around the inlet and outlet pipes to allow the effluent to disperse easily and quickly, to minimise clogging and make checking for root intrusion easier. Some plumbers use railway ballast. Some reed beds contain baffles that minimise short circuiting of the wastewater flow and direct the wastewater up and down through the aerobic and anaerobic zones in the reed bed, creating unfavourable conditions for pathogens and assisting nutrient removal. The reed bed membrane can be made from ferro-concrete or polyethylene. This every parameter is considered for a large scale of refining of waste water.

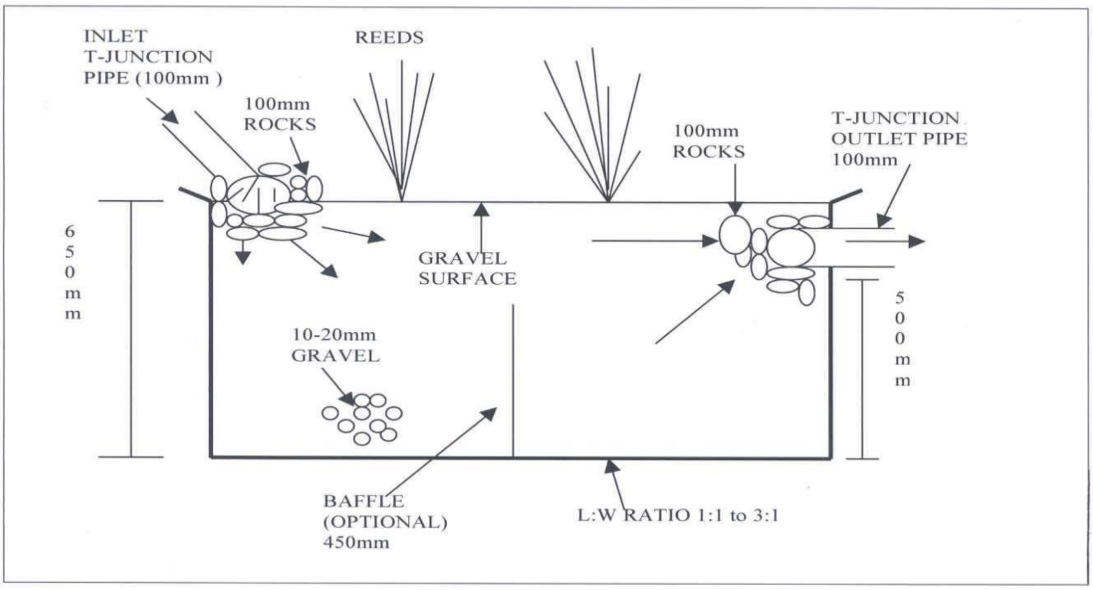


Fig:1 Reed Bed System Arrangement

4. REED BED SYSTEM

4.1 Wastewater parameters:

Wastewater contains a variety of inorganic and organic substances from domestic sources. The wastewater parameters namely BOD, COD, TDS, TSS and pH were analyzed. The procedure followed for calculating the parameters are the standardised methods.

In this wastewater parameters Biochemical oxygen demand or BOD is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period. The term also refers to a chemical procedure for determining this amount. This is not a precise quantitative test, although it is widely used as an indication of the organic quality of water. The BOD value is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days of incubation at 20 °C and is often used as a robust surrogate of the degree of organic pollution of water.

Chemical oxygen demand (COD) commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water (e.g. lakes and rivers), making COD a useful measure of water quality. It is expressed in milligrams per liter (mg/L), which indicates the mass of oxygen consumed per liter of solution. Older references may express the units as parts per million (ppm).

Fig**:2 Wetland Unit Tub**

Fig:3 Sand in Tub

Total dissolved solids (TDS) is a measure of the combined content of all inorganic and organic substances contained in a liquid. Generally the operational definition is that the solids must be small enough to survive filtration through a filter with two-micrometer (nominal size, or smaller) pores.

The principal application of TDS is in the study of water quality for streams, rivers and lakes, although TDS is not generally considered a primary pollutant (e.g. it is not deemed to be associated with health effects) it is used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of the presence of a broad array of chemical contaminants. Primary sources for TDS in receiving waters are agricultural and residential runoff, leaching of soil contamination and point source water pollution discharge from industrial or sewage treatment plants.

Fig:4 Aggregates in Tub

Total suspended solids TSS this parameter was at one time called non-filterable residue (NFR), a term that refers to the identical measurement: the dry-weight of particles trapped by a filter, typically of a specified pore size. In short we can say that TSS is the amount of solid particles floating in a liquid.

4.2 Significance of root zone treatment:

Significance of RZT are it is odorless, there is no frequent maintenance required, it has high treatment efficiency and it does not need any mechanical, electrical or chemical equipment.

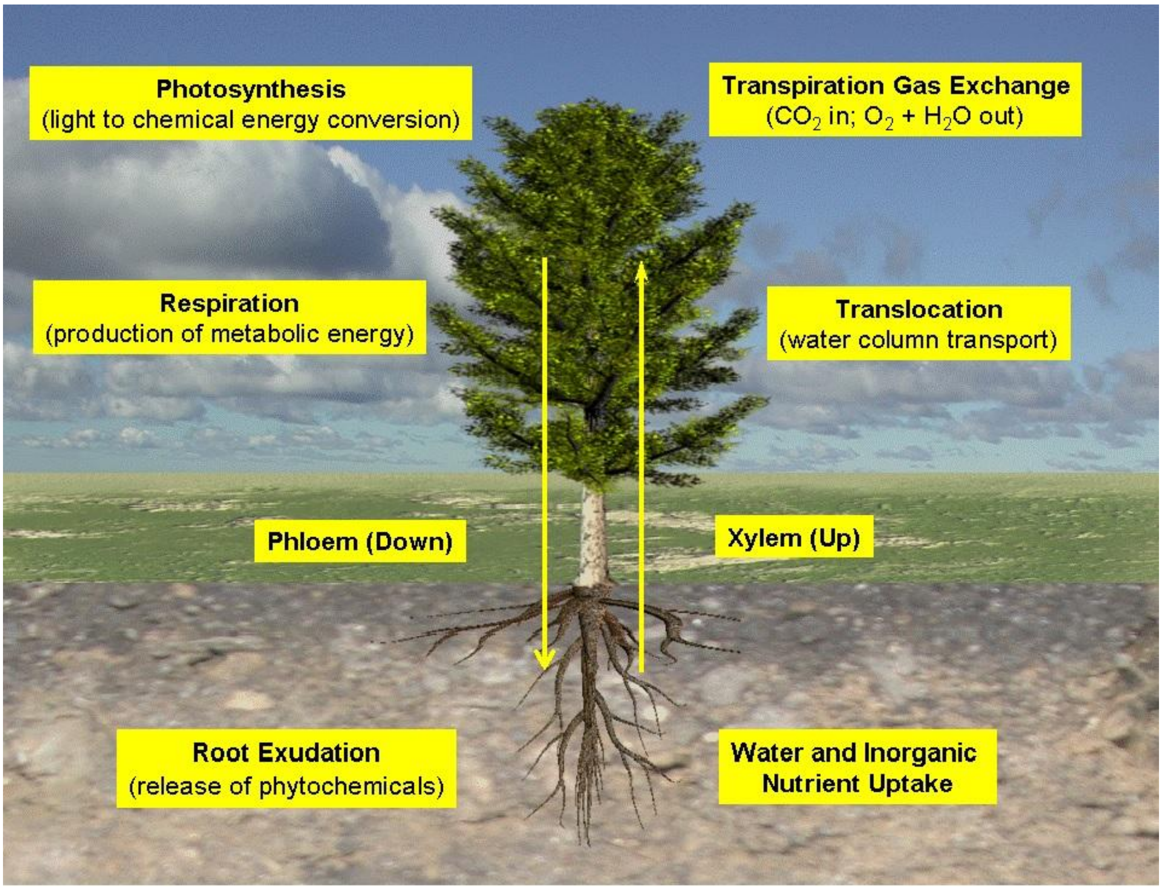


Fig:4 Process involved in root zone treatment.

4.3 Mechanism of root zone Treatment:

1. Extraction of contaminants from soil or groundwater.
2. Degradation of contaminants by various biotic or abiotic processes.
3. Breakdown action carried out by microorganisms dwelling at the root zone degrade / breakdown pollutants.
4. Filtration process / biofilm formed at surface of pebble / gravel / coarse sand bed.
5. Processes like adsorption / absorption in soil strata or their combination.
6. Vertical and horizontal flow patterns & another possible mechanism for contaminant degradation is metabolism within the plant.

4.4 Phragmites Australis:

Phragmites, the common reed, is a large perennial grass found in wetlands throughout temperate and tropical regions of the world. Phragmites australis is sometimes regarded as the sole species of the genus Phragmites, though some botanists divide Phragmites australis into three or four species. Waste water from lavatories and greywater from kitchens is routed to an underground septic tank-like compartment where the solid waste is allowed to settle out. The water then trickles through a constructed wetland or artificial reed bed, where bioremediation bacterial action on the surface of roots and leaf litter removes some of the nutrients in biotransformation. This species has hole from the leaves throughout the stem to the root zone. It takes the oxygen from the atmosphere and supplies to the root zone. So the oxygen supply in the root zone is sufficient to support the growth of aerobic bacteria. These bacteria consume the oxygen and break the organic compounds. The existing conditions favor the growth of the bacteria and they multiply easily. As the anoxic zone in the system is comparatively low the nuisance due to the anaerobic decomposition is also low. The plant which is grown for the treatment is also useful for manufacturing papers. Therefore the disposal of the plants is not at all a problem. The water is then suitable for irrigation, groundwater recharge, or release to natural watercourses.

Fig:5 Typical figure of Phragmites australis

4.5 Functions of Phragmites australis:

First, the very existence of root zone system creates channels for the water to pass through. Secondly, the roots introduce oxygen down into the body of soil and provide an environment where aerobic bacteria can thrive. These organisms are necessary for the breakdown of many types of compounds in particular in the oxidation of ammonia to nitrate; this is the first step in the biological breakdown of nitro compound. Thirdly, the process of nitrification takes place i.e. the plants themselves take up a certain amount of nutrient from the wastewater. In the spring and summer about 15% of the treatment capacity for sewage effluent occurs through this root zone treatment. Most degradation of nutrients is however undertaken by the microbes. The plants are also capable of accumulating certain heavy metals, an area where there is currently a great deal of research. In essence Reed beds can help to achieve a better standard of water quality through

1. High level of bacterial and viral removal
2. Decreased biological oxygen demand and reduction of suspended solids
3. Reduction of nitrogen concentrations and removal of metals

4.6 Principles of reed beds:

1. Common reed (Phragmites australis) has the ability to transfer oxygen to root zone.
2. Large population of microorganism found in root zone.
3. Pollutants digested and rendered innocuous by a range of organisms similar to conventional sewage works.

4.7 Advantages of reed bed:

- Operation does not require electricity or fuel supply.
- No mechanical systems are involved.
- Reed beds do not breakdown.
- Set up is visually unobtrusive (aesthetical good) and provides growth of microorganisms.
- The plants, especially the species that grow naturally and under harsh environment conditions, offer a simple and economic method of wastewater treatment.

4.8 Type of reed beds:

There are two types of reed beds/root zone filters:-

4.8.1 ROOTZONE HORIZONTAL FILTERS:

Horizontal subsurface filters (HSF) are able to remove a wide range of contaminants from waste water. The progress of development from a haphazard natural phenomenon to a designed engineering process has continued for around 40 years now and the system enjoys worldwide recognition for its ability to offer low capital cost, environmentally safe reduction of pollutants to low levels.

Fig:6 Horizontal Filter Arrangement

In particular wastewater from households, industries and other sources in remote areas can be treated at low cost in this way. The system is also applicable on a much larger scale. Under construction at this moment (2004) is a Rootzone facility treating municipal sewage to the highest standards for reuse as irrigation water for public parklands. The capacity of this system is planned to be 260kl/day and will cover an area of 2500sqm.

Rootzone Filters have been constructed all over the world for such diverse purposes as wastewater from

1	Oil exploration	2	Chemical laboratories
3	Soap and pharmaceutical production	4	Mining
5	Metal plating industries	6	Hospitals
7	Hotels & motels	8	Boarding schools
9	Private houses	10	Plus many more

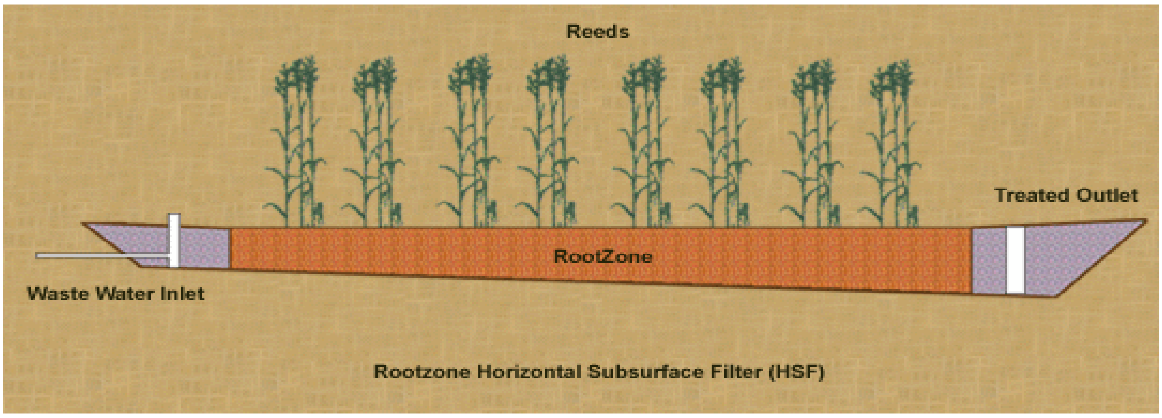


Fig:7 Root Zone Horizontal Sub-surface Filter

Note;Each design is made to the specific requirements of the project, but standard designs have been developed for more common applications such as domestic waste water.

Through the design the aim is to optimize the conditions for hydraulics and desired microbial activities, hence through an integrated process of biological and chemical activity, mechanical filtration and sorption processes to remove the desired contaminant compounds.

The same processes as those applied in conventional biological, chemical and mechanical treatment plants are also used in HSFs. The difference is that the processes are integrated in a nature based design, which at the same time delivers buffer capacity in the soil volume, allowing the purification performance to remain constant even in heavy rainfall situations.

4.8.2 ROOTZONE VERTICAL FILTERS:

Vertical reed bed filters have been developed over the past 40 years in Europe as a means of mineralising industrial sludges from many types of industry, in particular oil sector wastes and municipal sewage sludge. Many of these beds have been constructed worldwide. The advantages of this method over others are the low capital cost, low operating cost and the considerable reduction in volume and hence handling costs. In sludge mineralisation beds the dry matter is dewatered and mineralised so that the sludge is reduced to 2-5% of the original amount.

The residue is removed at intervals of 10-20 years. Sludge mineralisation beds utilize the evaporative and aerating capabilities of the wetland species Phragmitis Australis. The design layout is dependent on the dry matter content and volume of the applied sludge.

The bed is built over a polyethylene liner to protect the ground water. In the bottom of the bed a drainage system removes excess and returns it to the waste water treatment plant which may be a rootzone filter or another type of wastewater treatment plant.It is important that the applications are adjusted to the biological activity of the plants in order to obtain maximum volume reduction.

When mineralising organic matter 60-70% of the dry matter is converted to carbon dioxide, oxygen, free nitrogen and partly dewatered soil particles. Part of the released carbon dioxide is assimilated into plants and microbes through photosynthesis.

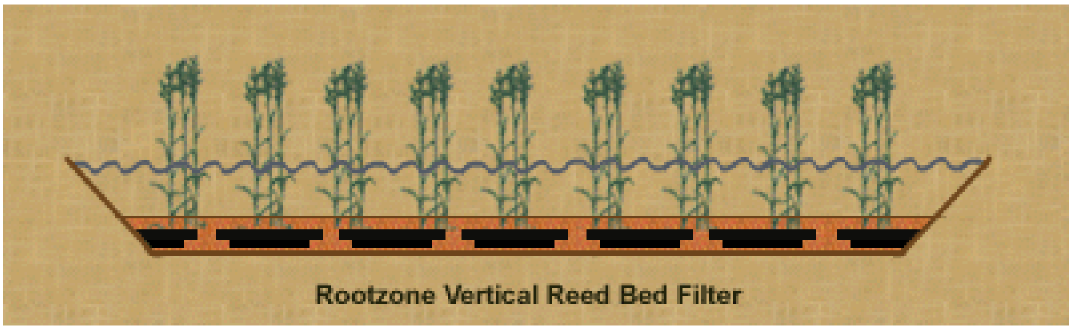


Fig:8 Root zone Vertical Reed Bed Filter

The drains remove moisture from the sludge and the reeds remove moisture from the sludge. The sludge layer composts naturally at higher dry matter levels thus converting organic matter into water and carbon dioxide.

4.9 Benefit of this treatment:

1. Low Capital Costs
2. Low Operating and maintenance costs
3. No Technical expertise needed to operate
4. Environmentally safe and friendly
5. Wide range of applications including some that are difficult to treat by any other means

4.10 Applications include:

1	Oil Exploration	2	Fish Processing
3	Lubricant Manufacturing	4	Abattoirs
5	Petroleum & Oil Distribution	6	Piggeries
7	Steel Making	8	Agricultural Run Off
9	Plastics Production	10	Resorts and Caravan Parks
11	Chemical Manufacturing	12	Mine Water Drainage
13	Car and Train Wash Facilities	14	Heavy Metals Removal
15	Municipal Sewage and Sludge	16	Airport Run Off
17	Industrial Sludges	18	Printing and Paper Industry
19	Dairy Production	20	Stormwater Treatment
21	Meat and Poultry Processing		

4.11 Sewage flow:

The sewage from the collection tank is passed continuously to the filter. It filters through the graded stone layer and enters the prepared bed where the treatment takes place. After passing through the bed the treated sewage is allowed to filter through the down end filter. It rises up to the initial level maintained. It is collected in a tank by using a pump and discarded to the farmlands. The particles present above the stone layers are scraped and disposed. The reed grows quickly; it produces large clumps of thick rhizomes, oxygen transfers through the roots may be sufficient. Due to thick and sturdy rhizomes it is planted to help control soil.

5. SEWAGE TREATMENT PLANT

Sewage treatment is the process of removing contaminants from wastewater, including household sewage and runoff (effluents). It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants. Its objective is to produce an environmentally safe fluid waste stream (or treated effluent) and a solid waste (or treated sludge) suitable for disposal or reuse (usually as farm fertilizer). With suitable technology, it is possible to re-use sewage effluent for drinking water, although this is usually only done in places with limited water supplies.

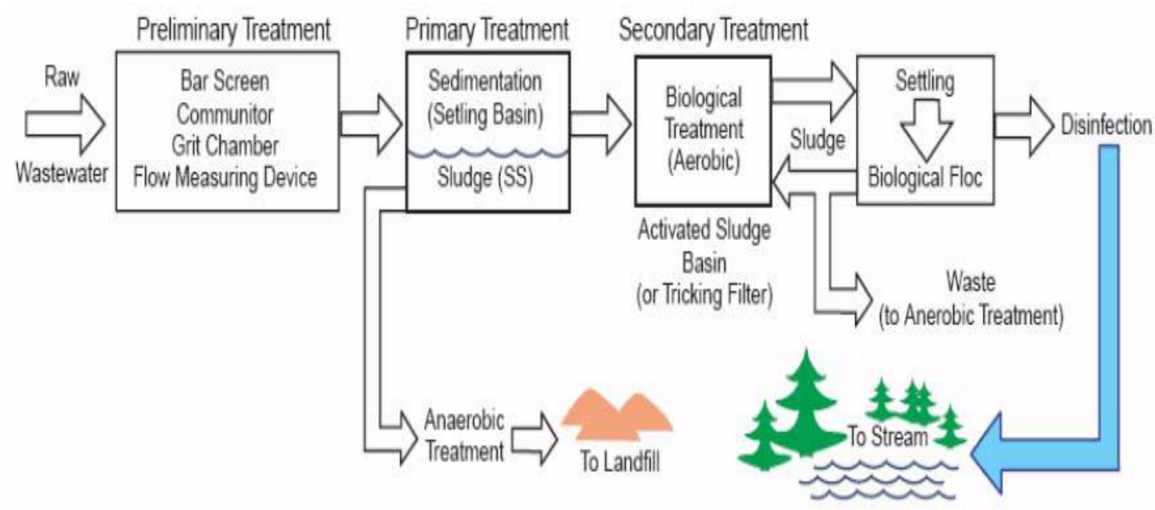


Fig:9 Process of treating waste water in a sewage treatment plant.

Sewage is a mixture of domestic and industrial wastes. It is more than 99% water, but the remainder contains some ions, suspended solids and harmful bacteria that must be removed before the water is released into the sea. Primary treatment removes most of the solids from the effluent, but doesn't remove or degrade the dissolved organic matter. Secondary treatment uses microorganisms to convert these organics to simple compounds, and uses the energy of the sun to destroy pathogens.

The treatment of wastewater is divided into three phases: pre-treatment, primary treatment and secondary treatment.

5.1 Pre-treatment:

Pre-treatment removes the large solids (such as rags and sticks) that are carried in with the wastewater. Large solids (i.e. those with a diameter of more than 2cm) and grit (heavy solids) are removed by screening. These are disposed of in landfills.

5.2 Primary treatment:

5.2.1 PREAERATION:

Firstly the wastewater is aerated by air pumped through perforated pipes near the floor of the tanks. This aeration makes the water less dense, causing the grit to settle out. As the air jets are positioned such that the water is swirling as it moves down the tanks the suspended solids are prevented from settling out. The air also provides dissolved oxygen for the bacteria to use later in the process, but the wastewater is not in these tanks long enough for bacterial action to occur here. The grit is collected in hoppers and washed, after which it is used for on site land reclamation and landscaping.

5.2.2 SEDIMENTATION:

The water then flows slowly and smoothly through the sedimentation tanks, where the suspended solids fall to the bottom and scum rises to the surface, while clarified effluent passes on. The solids are removed from the bottom of the tanks by scrapers, and scum is washed off with water jets. The scum and solids are brought to a common collection point where they are combined to form 'sludge' and sent off for secondary treatment.

5.3 Secondary treatment:

The sludge is further treated in 'sludge digesters': large heated tanks in which its chemical decomposition is catalysed by microorganisms. The sludge is largely converted to 'biogas', a mixture of CH_4 and CO_2, which is used to generate electricity for the plant.

The liquid is treated by bacteria which break down the organic matter remaining in solution. It is then sent to oxidation ponds where heterotrophic bacteria continue the breakdown of the organics and solar UV light destroys the harmful bacteria.

After secondary treatment all effluent, both solid and liquid, is sufficiently safe to be released into the environment. The treatment of solids and liquids are covered separately below.

5.3.1 SOLIDS:

Sludge from the sedimentation tanks is digested anaerobically in large tanks, and then further digested in lagoons before being dried in dewatering beds. In the sludge digesters the sludge is kept at $37^{o}C$ and mechanically mixed to ensure optimum operation. During this time the organic compounds within the sludge are converted to carboxylic acids and then finally to methane and carbon dioxide. This gaseous mix is known as "biogas", and is a valuable source of fuel. At Mangere it is used to generate electricity, which is primarily used to drive the plant machinery, with any excess electricity being sold to Mercury Energy. The exhaust created by burning the biogas is used to heat the sludge in the digesters.

When the sludge leaves the digesters it has undergone a 50% volume reduction. It is then sent to lagoons for about a year, and finally to dewatering beds. During this time all pathogens are killed by the sunlight.

A small proportion of the sludge is currently mechanically dewatered instead of being treated in the lagoons and dewatering beds. Polyelectrolytes are added to the sludge, and the attraction of opposite charges causes a floc (loose aggregation of particles) to form. Most of the water is then removed by rollers squeezing the mixture. After this the sludge has become concentrated from 4 to 30% solids, and could potentially be used as a soil conditioner, although currently it is simply landfilled.

5.3.2 LIQUIDS:

The liquids are either sent directly to open-air oxidation ponds, or sent to 'fixed growth reactors' to reduce their BOD before pond oxidation. The fixed growth reactors (FGR's) are tall, circular tanks covered with fibreglass. Each one is filled with approximately 36 million 10 cm diameter PVC 'wheels'. Microorganisms live on the wheels, and these reduce the BOD of the sewage by a further 75%. The wastewater is sprayed on the top of the wheels and percolates down, with the organics being reduced to CO_2, CH_4 and a small amount of foul-smelling H_2S. From the bottom of the FGR the effluent is piped to one of the secondary sedimentation tanks where sludge (consisting mainly of dead microorganisms from the FGR's) is removed. This sludge is piped back to join the incoming wastewater and complete the cycle again.

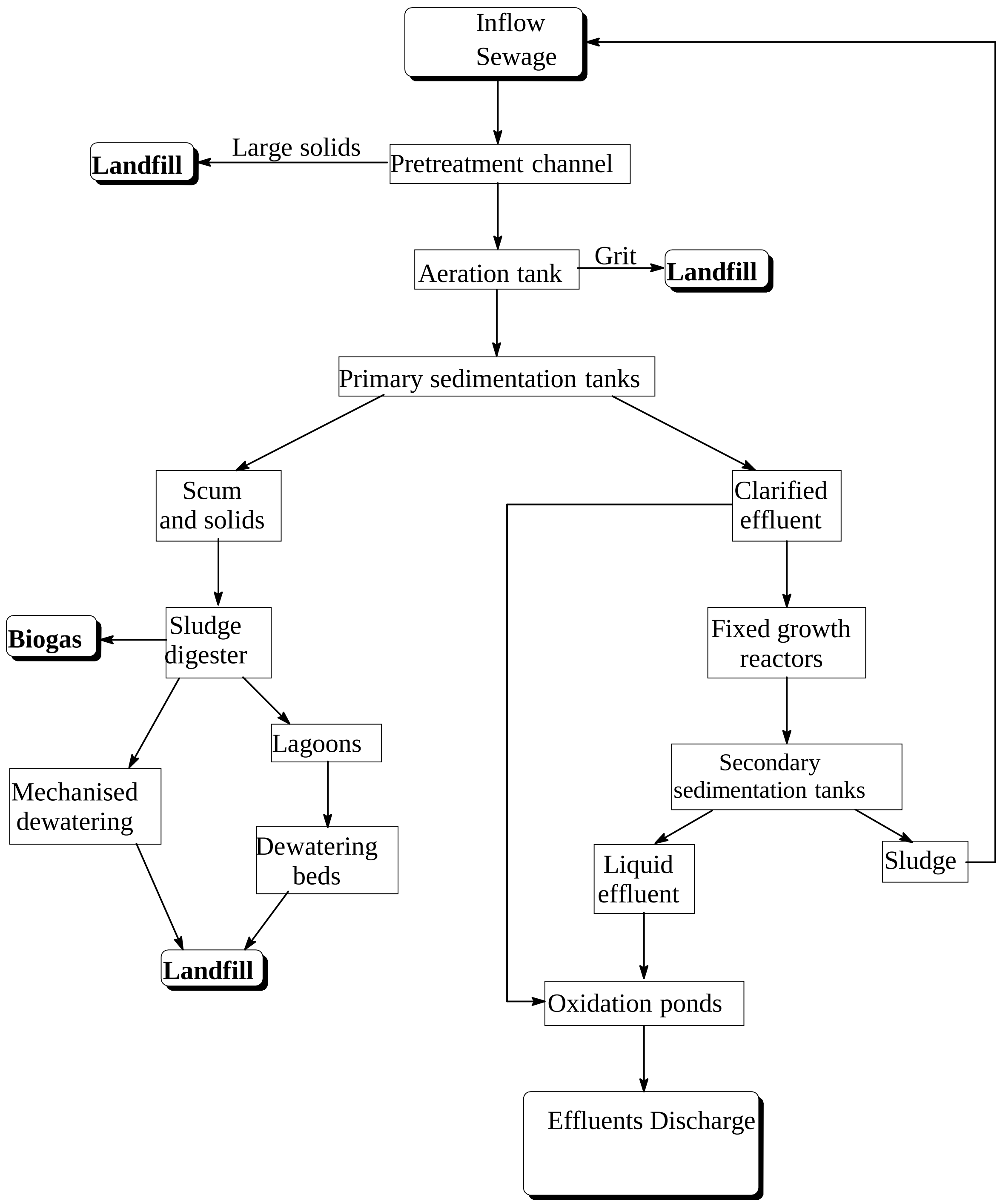
The wastewater then joins the liquid that was sent straight to the ponds for oxidation, where an influent mix of primary and secondary treated wastewater and some recycled pondwater is received. The mix is precisely calculated to ensure that the amount of organics entering the pond is the optimum amount for the bacteria to process given the amount of oxygen available at that time.

5.4 Tertiary treatment:

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

Thus, these are steps carried out in the treatment process of the sewage treatment plant. The following process diagram gives a clear pictorial representation about how the process starts right from the waste water and upto when it is treated and discharged into the sea or many a times reused.

Flow diagram of the process involved in STP



6. DESCRIPTION OF THE STP SITE

The following things need to be kept in mind before laying out any STP.

6.1 Important factors:

6.1.1 Ecology - Almost all the area within and around the proposed site comprises dry agricultural land. The majority of the crops grown consist of cereals, with a few fields being used to grow ornamental flowers. There is also one field with a small vineyard, with another planted with onions and peas. There are no protected areas in close proximity to the proposed site.

6.1.2 Agricultural Land Quality - The study area is predominantly agricultural land with a good soil cover, and a small proportion of non-productive wasteland used for bird-trapping. The natural topography is complex, with slopes in excess of 10°. In general, the fields are all wellcontained within rubble walls. There are a few sparsely located trees on marginal land and as wind shelter at field boundaries. The soils within the area are of two main types.

6.1.3 Geology, Palaeontology and Geomorphology - The geology in the area comprises mostly Globigerina Limestone with a layer of Blue Clay Formation in the north. The Globigerina Limestone overlies the Lower Coralline Limestone Formation. There are also a number of fault systems affecting the general area around the site.

6.1.4 Landscape and Visual Setting - In landscape terms, the site is relatively exposed, and consists of a steep, terraced slope predominantly used for agriculture. The condition of the landscape is generally of a high scenic quality, with potentially high sensitivity to large scale, inappropriate development. Despite the open nature of the site and its coastal location, the visual influence of the site is relatively restricted.

6.1.5 Hydrology and Hydrogeology - The geological formation to the south of Ghajnsielem gives rise to two water bearing rock strate. Surface runoff in the area is expected to be higher than the 6% average for Malta. The fields are well terraced and the majority have rubble boundarywalls, and this tends to reduce surface runoff and soil erosion and enhances infiltration.

6.1.6 Archaeology and Cultural Heritage - It can be assumed that this area has supported continual human activity, although the site identified for construction of the proposed sewage treatment plant at Ras Il-Hobz, and its immediate environs, do not appear to preserve any cultural remains of any significance.

6.1.7 Land Use - The predominant land use within the site identified for development of the proposed sewage treatment plant, and the surrounding area, is agriculture.

6.1.8 Public Rights of Way - There are no public rights of way which traverse the site identified for the proposed sewage treatment plant. The site itself comprises agricultural land under private ownership, and the public therefore have no rights as such to gain access to the land.

6.1.9 Air Quality and Micro-Climate – Wind, rainfall and temperature data has been obtained for Luqa, on the Island of Malta, for the five-year period 1995 to 1999. Luqa is located
approximately 25 km to the south-east of the proposed plant and this station is the nearest that has data appropriate for characterising the climate at the proposed development site.

6.1.10 Noise and Vibration - Noise monitoring locations utilised were agreed in discussion with the Planning Authority and are considered as being representative of the closest noise receptors to the proposed development.

6.1.11 Marine Environment - A review of the existing marine environment within the coastal area adjacent to Gozo has been undertaken by reference to information published in the State of the Environment Report for 1998, and an extract is included in the main text of this report. It is clear that this development will improve the quality of the coastal waters once the discharge of untreated sewage going to the open sea is topped.

6.1.12 Highways and Traffic - The site of the proposed sewage treatment plant is somewhat remote from the main highway network. The closest road to the site which can be described as being easily accessed by car is Triq Ta' Brieghen some 500 metres or so to the north. There is an existing track which connects with Triq Ta' Brieghen and runs in a southerly direction close to the eastern boundary of the proposed site. It is this track that will be upgraded so as to provide access to the proposed sewage treatment works site.

6.2 Assessment of impacts and risks of the proposed development:

6.2.1 Primary Impacts - A summary of the impacts associated with the proposed development is provided in the table A overleaf.

6.2.2 Secondary Impacts - There will be a number of secondary impacts associated with development of the proposed sewage treatment plant. The principal issues that have the potential to give rise to secondary impacts are as follows:
• Installation of the access road to the sewage treatment plant
• Sourcing of construction materials (building stone, aggregates and concrete)
• Installation of services to the sewage treatment plant (power supply, water supply, telecommunications, foul water sewer)
• Re-use of treated effluent
• Management and disposal of wastes from the plant
• Construction of ancillary structures.

6.2.3Cumulative Effects - There will be times during either the construction or operational
phases of the development when one or more impact will be experienced over the same

period of time. This will be most noticeable during the construction phase of the project. This will not be the case for the full 24 month construction period, but during discrete stages of the project (excavation works and concreting works for example when traffic, noise and air quality impacts will be at their most significant). During the operational phase of the development there does not appear to be any potential for cumulative effects to increase the overall impact of the scheme. There is significant positive impact to be gained through elimination of discharges of untreated sewage to the sea, and this (assuming suitable mitigation measures are incorporated) far outweighs any other negative impacts associated with the proposed development.

6.3 Sewage treatment in developing countries:

Few reliable figures exist on the share of the wastewater collected in sewers that is being treated in the world. In many developing countries the bulk of domestic and industrial wastewater is discharged without any treatment or after primary treatment only. In Latin America about 15 percent of collected wastewater passes through treatment plants (with varying levels of actual treatment). In Venezuela, a below average country in South America with respect to wastewater treatment, 97 percent of the country’s sewage is discharged raw into the environment. In a relatively developed Middle Eastern country such as Iran, the majority of Tehran's population has totally untreated sewage injected to the city’s groundwater. However, the construction of major parts of the sewage system, collection and treatment, in Tehran is almost complete, and under development, due to be fully completed by the end of 2012. In Isfahan, Iran's third largest city, sewage treatment was started more than 100 years ago.

In Israel, about 50 percent of agricultural water usage (total use was 1 billion cubic metres in 2008) is provided through reclaimed sewer water. Future plans call for increased use of treated sewer water as well as more desalination plants.Most of sub-Saharan Africa is without wastewater treatment.

7. RESULTS AND SCOPE OF STUDY

Following are the results and the discussion on the bases of the obtained values of pH, TDS, TSS, BOD and COD

7.1 Results and observation tables:

Table 1: General characteristics of Sewage Wastewater

Parameter	High	Medium	Low
pH	8.0	7.2	7.0
BOD at 20 ^{o}C in mg/L	350	200	50
COD in mg/L	1000	500	250
Total Solids in mg/L	1300	700	200
Dissolved in mg/L	100	500	250
Suspended in mg/L	350	200	50

Table 2: Concentration of various parameters collected (Before Treatment)

S.No	Parameter	Date 13-05-14	Date 20-05-14	Date 27-05-14	Date 04-06-14	Date 07-06-14
	Samples	1	2	3	4	5
1	pH	7.27	7.35	7.15	7.22	7.44
2	TSS in mg/L	134	560	468	162	197
3	TDS in mg/L	972	734	820	835	760
4	BOD in mg/L	130	396	619	140	101
5	COD in mg/L	392	895	1250	515	336

Table 3: Concentration of various parameters collected (After Treatment)

Parameter	Date 13-05-14	Date 20-05-14	Date 27-05-14	Date 04-06-14	Date 07-06-14
Samples	1	2	3	4	5
pH	6.90	7.00	6.86	6.89	7.09
TSS in mg/L	85	110	102	92	94
TDS in mg/L	680	580	640	655	605
BOD in mg/L	25	30	28	27	28
COD in mg/L	248	250	240	245	246

Table 4: Comparison of treated sewage from STP and RZT

S.No	Parameter	Before Treatment	Treated by STP	Treated by RZT	Treated without plants
1	pH	7.53	6.71	6.965	7.27
2	Total Suspended Solids	310	107.7	85.7	138.0
3	Total Dissolved Solids	990	739	650	750
4	BOD	210	69.8	29.6	42.0
5	COD	930	392	247.5	303.5

Table 1 describes the general characteristics of the sewage water which we generally come across before treating it.

Table 2 describes various types of water sample on various dates used for the experiment to be treated through the reed bed system

Table 3 describes the same water in table 2 which the values indicate the parameter after treating through the reed bed system

Table 4 describes the sewage water which is to be compared treating with STP and RZT method and without plants.

7.2 Scope of study:

The results show the concentrations of five parameters for wastewater treated by conventional treatment plant, root zone system and simple filter bed system. It is clear that the use of Reed bed system is best for the treatment of all parameters when compared to the other two. There is a remarkable reduction in pH, B.O.D,C.O.D,T.S.S,T.D.S by Reed bed treatment and the treated water has become fit enough to be let out directly into a receiving water body as the concentrations are below allowable limits.

Thus the root zone treatment can be used independently or as an addition to conventional treatment so as to make the final output fit enough for discharge into a natural water body. A sudden change in values of TSS and BOD on May 20th and 27th are noted. This is due the fact those two days shows peak activity combined with some amount of rainfall on 20th morning. A sudden Rise in values of COD on May 27th may be due to the discharge of chemicals.

1. There is a remarkable reduction in pH, B.O.D, C.O.D by Reed bed treatment and the treated water has become fit enough to be let out directly into a receiving water body as the concentrations are below allowable limits. Whereas, for the water treated by conventional plant, some more treatment is needed before it can be discharged.
2. Thus the root zone treatment can be used independently or as an addition to conventional treatment so as to make the final output fit enough for discharge into a natural water body.
3. Root zone system achieves standards for tertiary treatment with no operating cost or any hidden cost included in its operation. For Example: there is no consumption of electricity.

For the STP we need to be care full regarding the environmental impact assessment.

CONCLUSION

1) The wastewater from different places shows variation in concentration according to its strength. TSS,TDS , BOD, pH and COD particularly show a large temporal variation.
2) The root zone method was employed on a lab scale to treat the waste water. The results were compared with the conventional treatment. It is seen that the root zone treatment can be utilized independently for a small scale unit or as an additional unit to conventional treatment system for complete treatment of waste water.
3) The STP construction also need to have be assessed through environmental impact assessment.

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