FIRLE SEWERAGE TREATMENT PLANT REPORT

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General Background and History for Firle Treatment Plant

Firle Sewerage Treatment Plant stated off operating in Graniteside before transferring to Firle due to industrialization and housing. Structural construction for Firle started in 1968 and was commissioned in 1970. In 1971 Unit 1 with a design capacity of 18ML was commissioned. From 1971 it took four years till 1975 for another unit, Unit 2, to be constructed and commissioned. Stewart and Scottish Consultancy began to construct the first Biological Nutrient Removal (BNR) which would constitute the third unit on the plant. It was a five stage BNR with a capacity of 18ML/day. Another BNR that would make up Unit 4 was constructed from 1984 to 1988 with its digesters. Unit 4 and 5 which were both 3 stage biological nutrient removers were commissioned in 1988. Today Firle Sewerage Treatment Plant has a total design capacity of 144ML/day. It constitutes of units from one to four that have design capacities of 18ML/day and a fifth unit with a design capacity of 72ML/day. The plant treats both domestic and industrial waste from areas such as Chisipite, Highfield, Mbare, Budiriro, Glen View and Harare's Central Business District.

Departments at Firle Treatment Plant

1. Preliminary Department
   Physical processes, where coarse suspended materials are removed
2. Primary Department
   Organic, sludge and faecal matter removal.
3. Secondary Department
   Treatment refers to chemical and biological processes.
4. Tertiary department
   The effluent that is sent to ponds is pumped to farms for further treatment. (conventional system).

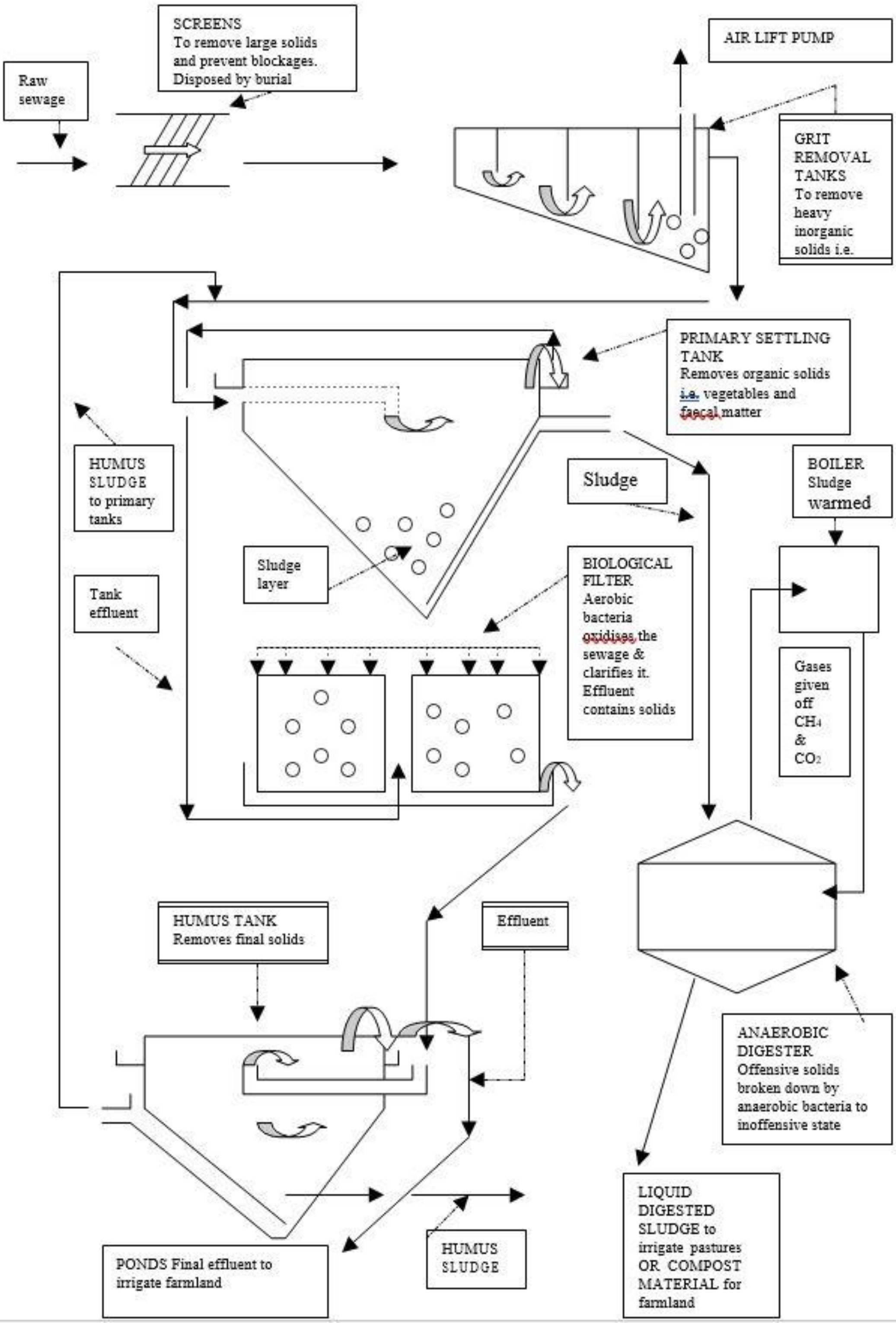
Management at Firle Treatment Plant

At Firle Sewerage Treatment Plant there are a total of 211 human resources.

Position	Number
Senior Superintended	1
Superintended Admin	1
Senior Operators	2
Senior Assistant Workers	8
Operators	102
Attendants	14
Boiler Makers	1
Plumbers	1
Day Workers/Operaters	74
Welders	1
Clerical	1
Clerical Senior Officer	1
General Labourers	2

Firle Treatment Plant Services

Firle Sewerage Treatment Plant Technologies and processes



STAGES INVOLVED IN THE TREATMENT PROCESS AT FIRLE TREATMENT PLANT:

- PRELIMINARY STAGE
- PRIMARY STAGE
- SECONDARY STAGE
- TERTIARY STAGE

PRELIMINARY TREATMENT

The main inlet box and the screens make up the initial stage of the wastewater treatment process. The main inlet box is where the wastewater calms down before splitting into smaller channels as it enters the facility with the force of gravity. Metal plates are used in these pipes to quantify the influent using electronic sensors or the channel's side walls. Every second, the metal plates measure in litres. The screens are slanted to make it easier to remove waste by using a rake. It catches strings by pulling them down with gravity. The dirty water goes through three screens namely - course, medium and fine ones. We take samples of wastewater at the main entrance to check how much organic matter is in it, and to measure the pH. After checking the water, it goes through chambers that filter out small particles called grit which are horizontal and vertical grit removal chambers.

Horizontal grit removal

The horizontal system has three parts: the grit chamber, detritor, and elevator. Influent from the screens is regulated at a velocity of 0.3m/s to allow settlement partial flumes. The detritor scoops deposits on the chamber floor and directs the deposits to an elevator. The elevator goes up at an angle and drops the waste onto trailers.

Vertical grit removal

The vertical grit system uses an airlift system which has six units. It has a machine called a compressor that pulls grit from the bottom of a deep chamber called the grit chamber. The grit is then moved to the loading bay.

PRIMARY TREATMENT

This treatment stage comprises of two forms with distinctive structures which are primary sedimentation tanks and primary digesters.

Primary sedimentation tanks processes

Utilizing Dortmund tanks, this stage aims to separate the liquid from the solids. Dortmund tanks are cylindrical and cone shaped downwards. For the solids to settle, the retention time is 1/2 to 2 hours. The settled particles can be deposited as a layer of raw sludge at the bottom of the tank. Raw sludge, the solids that settle to the bottom of the tank from the sewage, shouldn't stay there long enough to start fermenting, which will make the sludge rise (belch). The outlet pipe is used to push the sludge at the bottom of the tank out. In-order to de-sludge the tank, a valve is opened and hydrostatic pressure pushes out the sludge and is collected in a sump with the scum collected at the top of the tank. Both the scum and raw sludge are go to the raw sludge pump then eventually get pumped to primary digesters.

Primary digesters processes

The purpose of the anaerobic process is to convert sludge to end products of liquid and gases while producing as little biomass as possible. The process is much more economical than aerobic digestion. The stability of the anaerobic process is very fragile. The balance between several microbial populations must be maintained. Temperature is also a critical element. Sudden changes in temperature adversely affect the methane producers. Anaerobic digestion produces two valuable outputs: biogas and digestate. In the primary digester the sludge is mixed and heated in-order to provide the best condition for bacteria to act. Detention time in the primary digesters is 15 to 21 days.

SECONDARY TREATMENT

Aeration and filtration are used in secondary treatment to get rid of suspended solids and biodegradable organic matter (BOD). Secondary treatment makes use of biological trickling filters.

Biological filters

They are cylindrical shaped concrete structures with a bed filled with stone media and a distribution

systems for applying settled sewage to the media and under drains to remove the filter effluent. The primary sewage flushes downward via a perforated rotary distributor, which evenly distribute the sewage over the filter matrix. The filter bed is packed with constituents like rock and gravel that acts as a media for the attachment of the microorganisms. Trickling filter is the best example of an attached growth system, in which biomass is directly associated with the media. The filter media is chiefly composed of porous media that increases the surface area for the decomposition of the organic matter by the microorganisms. The above surface containing aerobic microbes is considered as the rapid growth phase region, as the microorganisms harness direct sunlight and maximum amount of oxygen to degrade the organic waste. In contrast, the lower surface containing anaerobic microorganisms is considered as the oxygen-deficient region, in which the microbes enter the endogenous phase to utilize their own cell for the growth. The treated wastewater from the trickling filter bed goes down the drainage system and further undergoes tertiary stage, secondary sedimentation. A humus tank is a sedimentation unit, which separates the small colloids, suspended particles etc. at the bottom out of waste fluid.

Humus separating tanks

The primary task is to separate biofilter effluent from humus sludge. The slugde in humus tanks ought to be very

dark as an indication of productive treatment. Biofilter effluent is conventionally treated, and this humus sludge is returned to the head in primary sedimentation tanks that feed bio filters in order to return the beneficial microbes.

BIOLOGICAL NUTRIENTS REMOVAL

The three stages of biological nutrient removal are

- fermentation,
- the anoxic zone
- aeration zone.

Anaerobic fermentation

Takes place in the fermentation zone. When we place bacteria in anaerobic conditions, they are starved of oxygen and cannot survive. Phosphate discharge is occurs during this stage. Stirrers agitate the contents calmly. Ammonia and acetic acids are formed here.

Anoxic zone

Anaerobic conditions still exist in this zone. Denitrification occurs whereby nitrates are switched over completely to nitrogen and oxygen.

Aeration zone

Aerobic condition prevail in this zone. This zone utilizes surface aerators. In order to let air flow through, two adjacent aerators rotate in opposite directions, one in a clockwise direction and the other in an anticlockwise direction. In this region, ammonia is transformed into nitrates during nitrification. The wastewater should be brown (mixed liquor) if it has been properly treated. Effluent from the aeration basin goes through a splitter box where it is divided it into three clarifiers.

Clarifier

Similar to a primary settling tank. In a clarifier a telescopic valve collects activated sludge. Sludge collected in the tank is piped to a sump that has two compartments for sludge to be returned and sludge to be wasted. Return activated sludge is pumped back into the fermentation basin. The final effluent from the clarifiers ought to be clear of suspended solids. The effluent from the Biological Nutrient Removal process should be able to meet dissolved matter standards before it cascades towards a river.

Work responsibilities, skills learnt and experience at the plant

I have appreciated all departments at the plant from preliminary, primary, secondary and tertiary. Screens at the preliminary stage are regularly manually racked to remove material that would have collected on them overtime. Upkeep: Upkeep of facilities includes all the work required to maintain equipment, civil works, buildings and the remainder of facilities in an adequate state (painting, leaks, carpentry, welding, grass cutting). Currently Health and Safety at the plant isn't up to standards with little to no employees having the adequate protective equipment on the plant. At the plant how a treating process is not only complex but highly diverse. The final effluent be it from conventional or modified processes goes through numerous stages that remove quite a significant amount of dissolved and suspended matter.

Budgeting processes and its importance for the plant

1. The plant moved from a five to a three stage biological removal system that makes use of less mechanical aerators to conserve power, reducing power costs on the plant.
2. The effluent produced in the conventional is used to fertilize pastures for cattle instead of it being wasted away.
3. Methane gas produced by fermenting sludge is used in boilers to heat the sludge.

Challenges and critical observations experienced on the plant

1. Energy Consumption

Energy consumption is one of the largest expenses at the plant. The treatment equipment like mechanical aerators consume a lot of power during operation. In municipal wastewater treatment, the largest proportion of energy is used in biological treatment, generally in the range of 50 - 60% of plant usage.

What is the solution?
Changes in biological treatment processes have the potential to significantly reduce the energy demand at a treatment plant. Some examples of solutions include use of fine screens in primary treatment, use of membrane diffusers in the aeration process.

2.Staff

Operators of wastewater treatment facilities must be adequately trained and certified individuals. They are on call 24 hours a day and are responsible for overseeing everything from pipe leaks and valves to electrical and instrumentation equipment. This work becomes especially demanding during changes in influent and seasonal changes.

What is the solution?

While there will always be a need for the physical presence of staff to be responsible for the overseeing of activities at treatment facilities, operator management can account for up to 30% of the operational costs of a wastewater treatment plant. Emerging technologies utilising the benefits of automation which reduces the requirement of operator engagement.

3. Sludge Production

Sludge is the residue generated during physical, chemical and biological treatment. A major environmental challenge for wastewater treatment is the disposal of excess sludge produced during the process.

What is the solution?

Safe and long term solutions for the destination of sludge produced by wastewater treatment plants are a vital element of a sustainable functioning facility. The recycling of sludge, containing useful organic matter and nutrients in agriculture is considered as the best solution. Some more modern treatment technologies are even able to reduce the burden of sludge by lowering its production.

Conclusion

At the end the day the amount of wastewater handled by the plant is extremely commendable. With proper maintenance of equipment, detritors, digesters and other equipment with moving parts, the plant can keep operating for a long longer in the future. Morden strategies need also to be implemented to improve the plant’s overall efficiency.