PROJECT# 33589 / 2019

OPERATION & MAINTENANCE MANUAL :

KLAARSTROOM OXIDATION POND SYSTEM

(Pre-Construction Draft)

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1 GENERAL INFORMATION

1.1 Description of the Klaarstroom Oxidation Pond System

The village of Klaarstroom is fairly well serviced in terms of water, sewage, electricity and roads. The village wastewater is collected at a central pump station in the village and then pumped through a 100mm diameter rising main over a distance of 800m to the wastewater treatment plant.

The new wastewater treatment works at Klaarstroom village comprises the following distinct unit processes:

- Inlet works comprising a hand-raked screen, dual grit removal channels and a Parshall flume for flow measurement;
- Dual Anaerobic oxidation ponds with dimensions of 5.5m x 5.5m x 3.5m each;
- A single Facultative Pond with dimensions of 58m x 30m x 1.20m deep;
- Two Secondary aerobic ponds with dimensions of 38m x 15m x 1.00m deep each;
- A single Horizontal Flow Reed Bed;
- A Final Effluent Storage Pond with dimensions of 40m x 20m x 1.50m deep.

This pond system has a hydraulic retention time of 45 days at peak Dry Weather Flow. The Final Effluent will be discharged through a 160mm diameter gravity main to a circular, lined storage dam. The Water will then be abstracted from this dam, chlorinated and then irrigated onto the village sports fields located south of the N12 national road.

1.2 Design Information

Klaarstroom was assessed as having a positive growth potential of 0.5% per annum with the population anticipated to increase from 584 persons (in 2011) to 614 (in 2030). Given that the current run-off amounts to an average of 100 litres per capita per day, an assumption was made that this will be maintained.

When designing a sewage treatment plant, the Inlet Works is designed to accommodate the Peak Wet Weather Flow, but other unit processes are designed to accommodate the average dry weather flow:

Population served	**:**	614
Qty per capita	**:**	100 L per person per day
Calculated Volume	**:**	61 m^3 per day

Average Dry Weather Flow: 61 m^3 per day

Peak Wet Weather Flow	:	126 m^3 per day
Design organic load	:	650mg/l COD measured as O; or 39.65kg COD per day
Ammonia Load:	:	65mg/l NH_4 measured as N; or 4kg NH_4 per day
Plant process	:	Oxidation Pond System with Horizontal Flow Reed Bed final polishing
Design Capacity	:	61 m^3/day (0.71 L/s Average Dry Weather Flow)
Peak Hydraulic Capacity	:	126 m^3/day (1.47 L/s Peak Wet Weather Flow)
Anaerobic Ponds Retention Time	:	5 days
Facultative Pond Retention Time	:	25 days
Aerobic Ponds Retention Time	:	11 days (5.5 days each)
Final Storage Pond Retention Time	:	7 days
Horizontal Flow Reedbed area	:	1 200 m^2
Circular Irrigation Dam volume	:	121 m^3
Irrigation Pump Duty	:	4.5 l/s at 35m head
Irrigation system	:	Rotrix hydraulically driven crawling irrigator
Location	:	S 33° 19' 19" and E 22° 31 44"
Classification of Works	:	Class E
Power Requirement	:	N/A
Elect consumption	:	N/A

2 TREATMENT PLANT SCHEMATIC DIAGRAM AND LAYOUT

Oxidation or stabilization ponds generally consist of a series of ponds which may have several possible configurations. The Klaarstroom pond system is typical of those found throughout South Africa having the following configuration (ref. Fig. 2.1):

Anaerobic → Facultative (aerobic/anaerobic) → Aerobic → HF Reedbed→Final storage

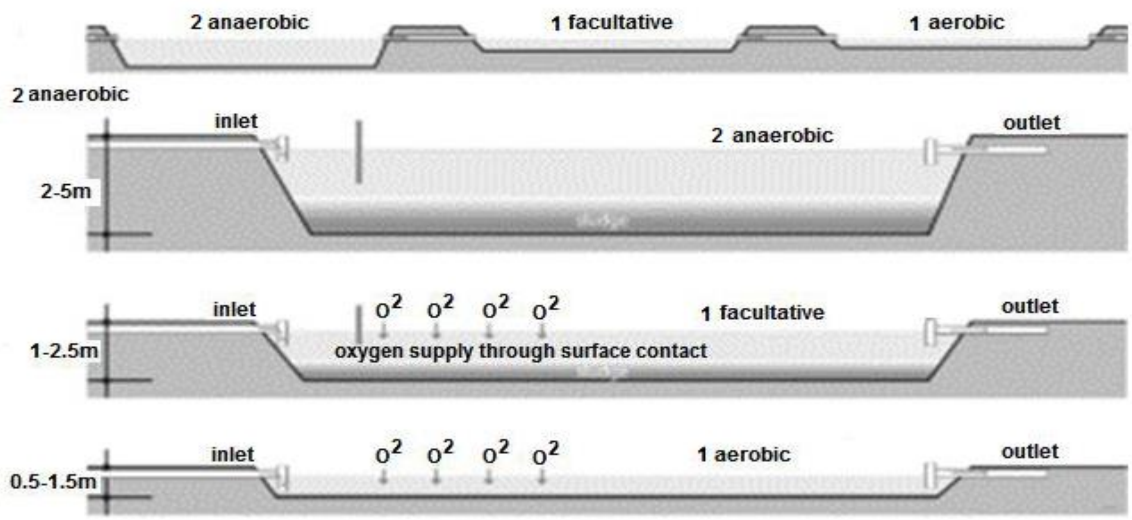

Figure 1: Typical Oxidation Pond Treatment System

This upgraded treatment plant is a ***Combined Oxidation Pond and Horizontal Reed Bed Waste Water Treatment system*** ref. Fig. 2.3. The plant is capable of removing both organic carbonaceous pollutants and nitrogen from the incoming stream.

The plant consists of a common inlet works feeding two(2) Anaerobic ponds operated in parallel.

The single Facultative Pond that follows is operated sequentially in series with the two aerobic ponds under gravity and the effluent is then discharged to the Horizontal Reed Bed where the algae will be filtered out. The horizontal flow reed bed is operated continuously in series under gravity and will discharge the treated effluent to the Final Storage pond.

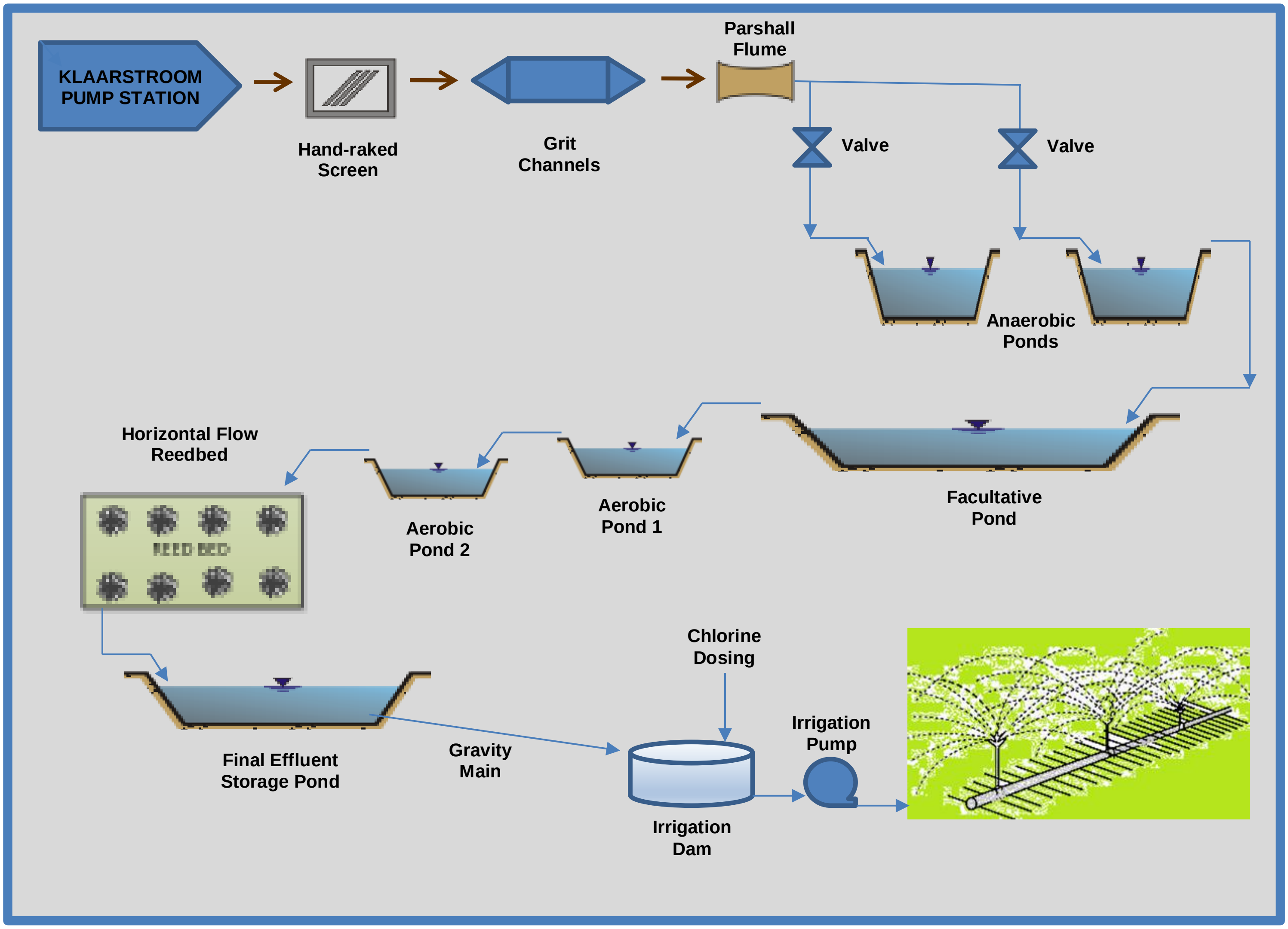

Figure 2: Schematic Diagram: Klaarstroom Oxidation Pond System

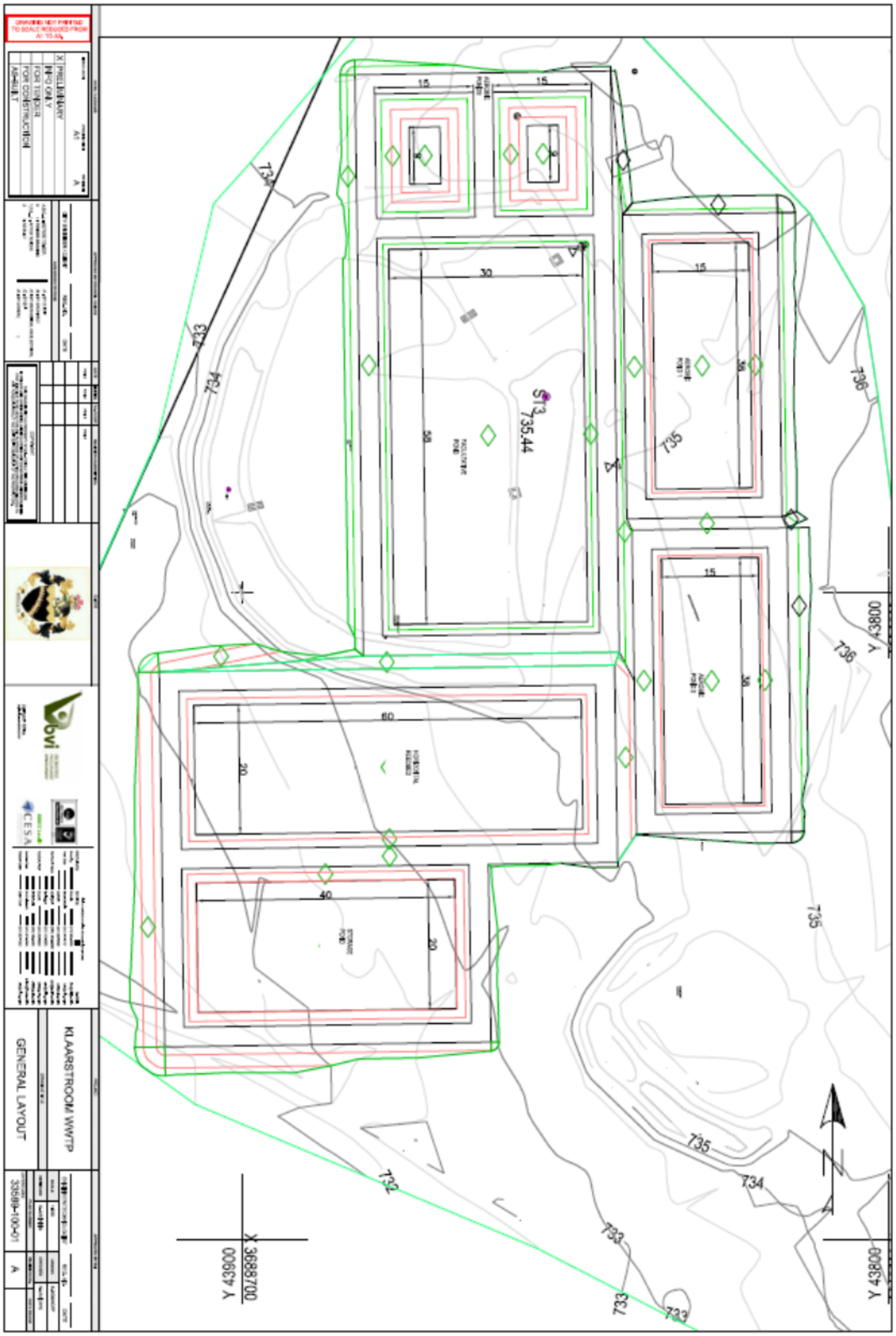

Figure 3: Klaarstroom Oxidation Pond System Site Layout

3 DETAIL DESCRIPTION OF THE TREATMENT PLANT UNIT PROCESSES

For the sake of clarity, each of the above units is described in detail below:

3.1 Inlet works:

The Klaarstroom Oxidation Ponds is equipped with a formal Inlet Works comprising:

- Inlet chamber where the Rising Main from the pump station terminates;
- Hand-raked screen for the removal of rags and solid debris;
- Dual grit removal channels for the removal of sand and grit;
- A 2" (50mm) Parshall flume for the measurement of flow entering the plant;
- A downstream Splitter Box which splits the flow into two equal streams to the two Anaerobic Ponds. The Splitter Box is equipped with aluminium hand stops which allows the either of the anaerobic ponds to be isolated for cleaning purposes.

3.1.1 Hand-raked Screen

The hand-raked screen comprises of inclined bars spaced at 25mm centres placed at a 45° angle from the channel floor. All screenings accumulating behind the screen bars are raked up the screen and deposited on the drainage slab to allow water to drain out of the screenings. The dried screenings can then be shovelled into a bin or wheelbarrow for removal to landfill site or to be buried.

Removal and disposal of screenings must take place on a daily basis.

Figure 4: Hand -raked Screen

3.1.2 Dual Grit Removal Channels

Directly downstream of the mechanical screen, the canal splits into two grit channels. The grit channels are trapezoidal in shape and the flow velocity through them is controlled by two downstream venturi flumes. The shape and length of the grit channels and flumes are designed to maintain a water flow velocity below 0.3 meters per second to allow course debris, grit, sand, glass particles, etc to settle out on the channel floor. Each channel is also fitted with a floor drain and control valve to allow the water to be drained out of the canal to dewater the grit for removal. The two channels are alternated on a daily basis.

Figure 5: Dual Grit Channels

3.1.3 Parshall Flow Measuring Flume

Downstream of the Grit Channels, the flow is measured using a Parshall flume. This flume is equipped with an off-channel stilling chamber where the level of the water passing through the flume is measured. Measurement is done by means of an ultrasonic flow meter. An ultrasonic flow meter bounces ultrasonic sound waves off the surface of the water and then measures the height of water passing through the flume by means of the time-of-flight principle. Said height measurement is converted to a flow reading with an internal computer which is programmed with the Parshall flume's flow formula. In addition to this, a data logger is fitted which records flow data at 1 minute intervals and stores the data complete with a time and date stamp to provide an uninterrupted record of flow coming into the wastewater treatment works.

Figure 6: Parshall flume

3.1.4 Dividing Chamber

Downstream of the flume, the incoming screened raw sewage flows over a flow dividing weir. The weir divides the flow into equal streams inside the dividing chamber and from there each stream flows under gravity to the two(2) anaerobic ponds via 110mm Ø uPVC gravity feed pipes. The feed pipes are installed to ensure that the raw sewage streams are emitted at the bottom of the anaerobic ponds. This prevents entrainment of oxygen into these ponds.

Figure 7 : Dividing Chamber or or Splitter Box

3.2 Oxidation Pond Systems

A pond system processes wastewater in shallow earth basins, referred to as stabilization or oxidation ponds. Pond systems are very popular in small communities due to low construction and operating costs. In rural areas, where large areas of relatively cheap land are available and towns and villages are quite small, this is often the preferred system. Oxidation Ponds are a natural treatment system which means that the wastewater is treated under naturally occurring conditions and that the process cannot be manipulated by external means.

3.2.1 Classification of ponds

Ponds are classified according to the nature of the biological process taking place:

- Aerobic – stabilization in the presence of oxygen
- Anaerobic – stabilization without the presence of oxygen
- Aerobic-anaerobic, or facultative ponds

Ponds can be used singly or in various combinations to treat wastewater. Experience has shown that a combination of various types of ponds in series is best for the treatment of domestic wastewater.

Anaerobic ponds are especially effective in bringing about rapid stabilization of waste that is high in organic content, while aerobic ponds are more suited to stabilising the soluble organic component. Anaerobic ponds are usually used in series with the other types, enabling almost complete stabilization of the effluent.

3.2.2 Limitations of Oxidation Pond Systems

Compared to conventional treatment plants, ponds produce a stable effluent that does not always comply with the General Limit Values as required by law, due to the excessive amount of suspended solids in the final effluent. These suspended solids are primarily due to the nature of oxidation ponds which utilize algae to provide the oxygen required in the process.

Algae are essentially plants that utilize carbon dioxide, nutrients in the waste water and sunlight to produce sugars and oxygen through photosynthesis. The problem with algae is that they have a neutral density. This means that both live and dead algae do not settle to the floor of the pond, nor does it float to the surface, it basically remains in suspension in a uniform concentration through the water profile in the ponds.

Although the algae is essential for the production of dissolved oxygen to nitrify ammonia and break down the organic fraction, they do however create a problem with suspended solids in the final effluent. The General Limit Value for Total Suspended Solids in Final Treated Effluent is 25mg/l. Typically oxidation pond effluent will not comply to this requirement. Hence the requirement for further treatment by passing the effluent through a horizontal reedbed process unit to ensure compliance.

Oxidation Ponds typically have a retention period varying between 40 to 50 days in order to provide sufficient time for natural bacteria to oxidise and stabilize the pollutants in the water. Typically, the metabolism of the active bacteria and algae are temperature dependent. Subsequently, the lowest average ambient temperature dictates the size of ponds and by implication, the retention time needed to fully treat the wastewater. Oxidation Ponds are therefore less active during periods of low temperature, and more active during periods of warm temperature.

3.3 Anaerobic Ponds

Anaerobic ponds are deep ponds that exclude oxygen and encourage the growth of anaerobic bacteria, which break down the organic components of the influent. Anaerobic bacteria are non-motile, which means that they cannot move by themselves. Subsequently, by introducing the incoming raw sewage at the bottom of these ponds, this facilitates mixing of the raw sewage with the bacteria.

These ponds are used as a primary treatment for COD and removal of Suspended Solids. The wastewater that comes in is domestic wastewater. The anaerobic bacteria break down the organic matter in the effluent, which release carbon dioxide, hydrogen sulphide and methane gas as byproduct. The sludge settles to the bottom of the pond by normal sedimentation under gravity. These types of ponds are usually 3 - 5 meters deep.

Anaerobic ponds do not contain algae like other oxidation ponds, although it often contains a scum layer on the surface of the pond. These ponds work extremely well in warm climates.
This treatment process serves to:

- Separate out the solids from dissolved material as solids settle as bottom sludge.
- Breakdown of biodegradable organic material.
- Allow partially treated effluent to pass through to the next treatment process.
- Stores undigested material and non-degradable solids as bottom sludge.
- Dissolves further organic material.

The parameters affecting the organic loading removal and the efficiency in an anaerobic pond are the temperature, volumetric loading, and the retention time. Typical layout and working of anaerobic pond is shown below.

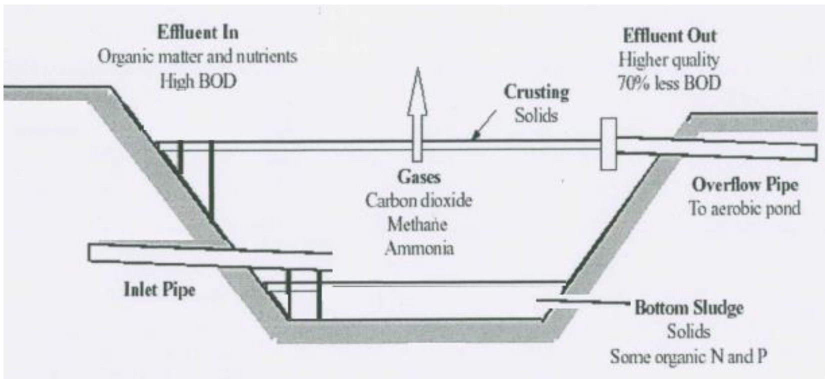

Figure 8: Typical section through Anaerobic Pond

3.4 Facultative Pond (Anaerobic/Aerobic)

Facultative ponds are typically 1.20 to 1.50 m in depth and have both aerobic and anaerobic zones. The unit at Klaarstroom is of 58m x 30m x 1.20m deep.

These ponds rely on photosynthesis during algal growth as well as aeration due to wind and wave action to introduce dissolved oxygen to the upper layers of the water. The bottom of the facultative pond is usually anaerobic and serves to assimilate any settled particles carried over from the anaerobic ponds. Facultative Ponds should have a hydraulic retention time of 20 to 30 days for efficient functioning.

Figure 9: Typical Facultative Pond

3.5 Secondary Aerobic Ponds

Secondary Aerobic Ponds are generally used as a second stage to facultative ponds. Although a degree of COD removal does occur, they are primarily designed for the destruction of pathogens. Faecal bacteria and viruses die off relatively quickly due to the environment in aerobic ponds which is inhospitable to them. Cysts and ova of intestinal parasites have a relative density of about 1.1 which causes them to sink to the bottom of the pond due to the fairly long retention periods where they eventually die off. Two ponds with dimensions of 38m x 15m x 1.00m deep have been provided.

Figure 10: Typical Aerobic Pond

Typically, one would require at least two maturation ponds is series, each with a retention time of at least 5 to 7 days to ensure the removal of the last organic materials (COD) and the complete die-off of bacteria. These ponds are wholly aerobic and seldom deeper than 1.0 to 1.5m.

3.6 Horizontal Flow Reed Bed system (Constructed Wetlands)

The Klaarstroom Horizontal Flow reed beds comprises a single Horizontal Flow Reed Bed of 1,200 m^2 and 1.0m deep in series with the ponds. Wetlands are defined as a contained land area which is saturated by water for various periods of time. Typically constructed wetlands are basins filled with a growth medium such as soil, sand or gravel which has an impervious layer that retains the water and prevents contamination of the natural ground below. Wetlands are provided with distinct plant communities such as reeds, sedges, bulrushes, etc.

Constructed wetlands are designed and built to emulate the natural functions of wetlands. Constructed wetlands have distinct advantages over other means of treating wastewater in that they are not dependant on external energy or chemical inputs and require very little maintenance. Their lifespan can reach anything up to 80 years and in addition they are scenically attractive and provide a habitat for a wide variety of plants, birds, reptiles and invertebrates. They generally provide a final effluent better or similar to that of a conventional treatment system and are especially suited to fluctuating flows. Constructed wetlands can be constructed with unskilled labour and are devoid of high tech equipment and therefore can be considered a low maintenance option.

The water purification function of wetlands is dependent on four principle components: the vegetation, the water column, substrate and the associated microbial populations. The function of the vegetation is to provide an additional environment for the microbial populations. The stems of the plants and the falling leaves in the water column obstruct flow and facilitate sedimentation and increase surface area. Therefore the choice of vegetation is critical as most terrestrial plants cannot survive in waterlogged soils due to the depletion of oxygen which is normally associated with flooding.

Aquatic plants have specialized structures which enable them to conduct atmospheric gases such as oxygen down into their roots. The oxygen is exuded out of their root hairs forming an aerobic rhizosphere around every root hair while the rest of the surface volume remains anaerobic. Within the rhizosphere large populations of common aerobic and anaerobic bacteria thrive and aid the biological breakdown of the organic compounds found in wastewater. Wetland vegetation only take up a fraction of the available nutrients found in the wastewater, their primary role being to increase the amount of aerobic environment for the microbial populations found in the water column and below the water/substrate interface.

Suspended solids in the wastewater are aerobically composted in the above substrate layer of straw and plant debris formed by the dead leaves and stems. By this means, constructed wetlands are able to remove organic compounds (measured as Chemical Oxygen Demand), suspended solids and nitrogen. Pre-treatment by anaerobic reactors is essential to prevent clogging of the substrate surface and also the distribution piping. The **Horizontal Flow System is** usually planted with the common reed *Phragmites Australis.* The wastewater flows horizontally through the substrate surface. The horizontal flow reed bed at Klaarstroom is utilized as a secondary treatment to improve the quality of the Final Effluent.

3.6.1 Horizontal Flow Reed Beds:

For Klaarstroom, a single horizontal flow reed bed unit with dimensions of 60 x 20 x 1.0 m have been constructed. The bed is submerged and fully lined with a HDPE lining. Typically the substrate average depth is 0.85m, with the surrounding embankment at least another 0.35m higher.

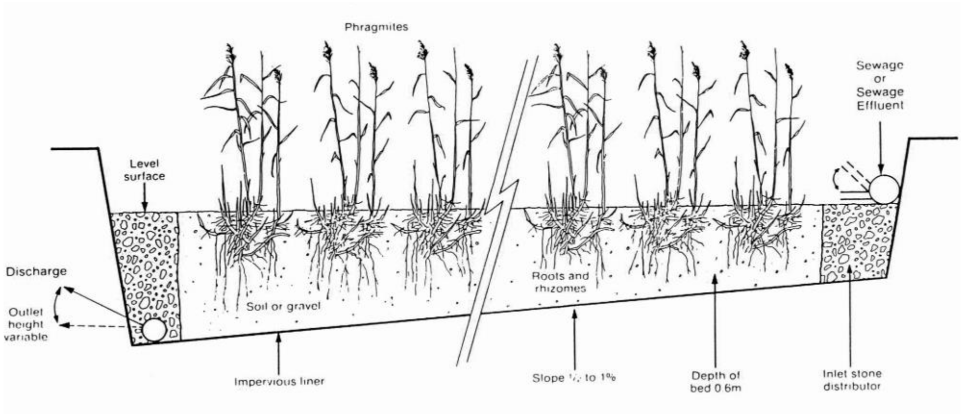

Figure 11: Typical horizontal flow reed bed cross section

The surface of the substrate is perfectly level with no slope while the floor of the basin has 0.5% slope to facilitate flow towards the outlet. The substrate for this type of reed bed comprises of gravely sand typically 5mm to 8mm in diameter to facilitate subsurface flow.

The inlet of the horizontal flow reed bed comprises a wire cage gabion filled with large stones for the full width of the basin. A distribution manifold is positioned on top of the stone gabion and designed so that equal distribution of the water takes place over the full width of the basin. The water flows easily to below the surface of the substrate and the level of the water in the substrate is controlled by a weir or riser pipe at the downstream end of the basin. Similarly, the downstream collection system comprises a slotted pipe installed in a wire mesh gabion.

Figure 12: Newly established vegetation on horizontal flow reed bed

Typically the water level is controlled to be no lower than 80mm to 100mm below the top level of the substrate. The surface of the substrate is planted with vegetation at a density of 3 to 5 plants per square meter. The vegetation selected for this reed bed is *Phragmites Australis*. The horizontal flow reed bed is operated in series with the ponds and receives flow continuously by means of a 110mm dia gravity feed Class 4 uPVC pipe.

3.5 Final Storage Pond

Provision is made for storage of 7 days effluent from the treatment facility. The storage pond will act as a maturation pond and in addition assist with evaporation as it has a large surface area. This pond has dimensions of 40 x 20 x 1.5m deep with a total volume of 1,200 m^3.

Figure 13: Final Storage Pond

The water from this pond shall be utilized for the irrigation of the municipal sports fields located south of the N12 national road. Water will be transferred to a circular holding dam at the Klaarstroom Sports fields by means of a gravity main pipeline where the water will be chlorinated and used for irrigation.

3.7 Irrigation Water Holding Dam

At the Klaarstroom sports fields, a circular holding dam is provided with dimensions of 10m diameter x 1.55m high. The dam is constructed of galvanized metal sheeting and has a PVC liner to avoid corrosion of the metal sheeting. The dam has a capacity of 121m^3. This dam merely serves as an abstraction sump for the irrigation pump, allowing it to draw water continuously for irrigation purposes.

Figure 14: Irrigation water holding dam at sports fields

3.8 Irrigation Pump Station

At the Irrigation Holding Dam, a small pump is installed to provide pressure and flow for a Rotrix hydraulically powered crawling irrigator. The Pump withdraws water from the dam and then provides 4.5 l/s at 3.5 bar pressure for operation of the irrigator. The pump is provided with an electrical switchgear panel from where the pump is started manually when irrigation of the field is needed.

Figure 15: Irrigation Pump Station

3.9 Chlorination system

The Klaarstroom irrigation water will be disinfected using a Calcium Hypochlorite chip doser. Calcium Hypochlorite will be provided in “chip” form and a “chip doser” is utilized to dose the chlorine solution into the irrigation water.

A chip doser consists of a plastic basin filled with Calcium Hypochlorite chips. A stream of water is directed to the base of the basin at a controlled flow rate, where the water serves to dissolve the calcium hypochlorite chips. The solution then flows through the perforated base of the basin into the dam to disinfect the water within.

Figure 16: Chlorine "chip" doser

The system is semi-automated in that the water for dissolving the chips is sourced from the irrigation pump outlet as a side stream. This means that as soon as the irrigation pump is started, chlorine solution will be dosed into the dam contents.

The chip doser provided at Klaarstroom can accommodate 35kg of HTH chips and dose chlorine at a rate of 0.2kg to 35kg per day of chlorine to disinfect the irrigation water. A free chlorine concentration of at least 1mg/l must be maintained.

4 STANDARD OPERATING PROCEDURES FOR UNIT PROCESSES

This section provides a detailed instruction of HOW each and every unit process is to be operated.

The following contents present a step-by-step operating procedure for all operational unit processes that need to be operational to successfully operate the treatment plant:

4.1 Hand-raked Screen

4.2 Degritting Channels

4.3 Open Channel Flow Meter

4.4 Oxidation Pond System

4.5 Horizontal Flow Reedbed

4.6 Irrigation Pump Station

4.7 Irrigation Chlorine dosing

STANDARD OPERATING PROCEDURES FOR:

4.1 Hand-raked Screen

Purpose:

- Preliminary treatment is done to protect downstream equipment from damage and to prevent nuisances such as blockages of pumps and pipes.
- Screening of raw incoming waste water to remove non-biodegradable floating objects.

Procedure:

1. Process Controller changes from private clothes to Personal Protective Clothing (PPC) at beginning of shift.
2. Process Controller collects the correct tools and equipment.
3. Process Controller rakes the hand-raked screen with the specially designed rake that fits snugly between the bars to remove all the screening material.
4. Screenings must be removed at least once every 30 minutes. This frequency will change depending on flow patterns. During storms or heavy rainfall it is advised that the screen is raked continuously because large volumes of water and solid matter infiltrate the waste water collection system.
5. Process Controller put the screenings on the platform with draining holes to dry out.
6. Process Controller sprinkles lime on the drying screenings to discourage flies.
7. Process Controller disposes of the dried screenings in an excavated trench and covers the disposed screenings with at least 100mm thick soil.
8. Screenings must be disposed and covered on a daily basis. The reason is to prevent odors, rodents, flies and prevent the dried screenings being blown all over the area.
9. Screenings can either be buried or burned (incineration usually smokeless) if the smoke poses no health or nuisance problem to surrounding areas.
10. When the trench is full, the process controller covers the trench with at least 300mm of soil.
11. Process Controller is responsible for the general upkeep around the inlet works.
12. Any foreign substance or liquid entering the inlet works must be reported immediately to the supervisor e.g. blood, oil, grease, fat, colored liquid, sour beer etc. These substances could have a very detrimental effect on the WWTW and it can take up to 3 months for a WWTW to recover.

Important:

- Wastewater and Screenings are a potential health risk.
- Do not work in private clothes or go home in work clothes.
- Do not work without gloves.
- Be careful of the incoming water stream when working at the screen.
- Do not wash screenings off with a water jet; it forces the residue through the bars into the downstream units.
- Do not allow screenable material to build up in inlet chamber. This will result in pipe blockages, waste water being forced back through pipes into manholes in the community, flies and unpleasant odors, possible health problems, screens overflowing, scum formation and screenable material will occupy process volume in downstream units.
- Wash hands with water and soap regularly and before eating.
- Do not eat or drink near inlet works, eat in designated area.
- Do not dump screenings in undesignated area.

STANDARD OPERATING PROCEDURES FOR:

4.2 Degritting Channels

Purpose:

- Preliminary treatment is done to protect mechanical equipment from abnormal wear and to prevent loss of volume in subsequent processes due to sand accumulating in ponds and sumps.
- Screening of raw incoming waste water to remove sand, silt, stones, glass and metal particles.

Procedure:

1. Process Controller changes from private clothes to Personal Protective Equipment (PPE) at beginning of shift.
2. Process Controller collects the correct tools and equipment.
3. Process Controller diverts the inflow from the channel to be cleaned by closing hand stops, allowing wastewater to pass through a clean channel.
4. Process Controller opens the drain valve slowly to drain the water out of the isolated channel. If the valve is opened too quickly, the grit will be washed out.
5. Process Controller drains and cleans alternative channels daily.
6. After the channel has been drained, the Process Controller removes the settled grit from the bottom of the channel with a spade/ shovel.
7. The Process Controller places the grit on the area adjacent to the channel, to allow the grit to dry, and the water to drain back into the channel.
8. Process Controller sprinkles lime on the drying grit to discourage flies.
9. Process Controller disposes of the dried grit in an excavated trench and covers the disposed grit with at least 100mm thick soil.
10. When the trench is full, the process controller covers the trench with at least 300mm of soil.
11. Wash down grit removal area with a hose pipe/high pressure washer
12. Process Controller is responsible for the general upkeep around the Degritting Channels.

STANDARD OPERATING PROCEDURES FOR:

4.3 Open Channel Flow Meter

Purpose:

- Flow measurement is usually carried out at the intake works just after screening and grit removal, to eliminate artificial fluctuations in the water level caused by grit and solid waste increasing volumes
- Legislation enforces flow measurement – 'to measure is to know'
- Regular measuring of the flow is required to determine the hydraulic and organic load of a WWTW.
- Regular flow recordings can provide warnings on blockages or pump failures in sewer reticulation and also indicate peaks due to rainfall or other occurrences.
- To determine average dry weather flow (ADWF) and peak wet weather flow (PWWF)
- In open channels, with the liquid surface exposed to the atmosphere, flow is measured with a flume or weir where flow is a function of water depth.
- In closed systems, where the waste water is in a pipe and the pipe is always full, flow depends on cross sectional area of the pipe and the velocity of the liquid in the pipe.
- Weirs and flumes measure flow in conjunction with a calibration equation and the height of water passing through the flume or over a weir, can be measured with an ultrasonic level sensor which electronically converts the height to a flow.

Procedure:

1. The Process Controller takes flow meter readings (current and total in l/s and m^3) every day at the same time (beginning of every shift).
2. The flow meter provides 2 readings. An instantaneous flow in liters per second and a totalizer which counts the total volume in m^3. The latter reading is taken once every 24 hours to calculate the daily average flow coming into the plant.
3. The Process Controller gives these readings to the supervisor for inclusion in the works operating records.
4. The Process Controller reports immediately if any suspicious readings are recorded or if the meter is not working properly or at all.
5. When the process controller maintains the correct working procedures, the correct flow meter readings will be recorded.
6. If there is no power supply, the Process Controller must report to the supervisor immediately. A manual reading can also be taken by measuring the depth/height of the water passing through the flume with a gauge plate fixed to the inside wall of the flume.
7. The flow meter must be cleaned with a duster to remove spider webs and dust on a weekly basis as part of good housekeeping.

Important:

- The Average Daily Flow is calculated as follows:

Today's Totalizer Reading – Yesterdays Totalizer Reading = Volume received in 24 hours

Record this figure in the log sheet

Calculate the following:

Average Daily Flow in liters per second:

Total Volume ÷ 24 hours ÷ 3.6 = Flow in liters per second

Record this figure in the log sheet.

The Klaarstroom WWTP is fitted with a Parshall Flume for measuring open channel flow. The flow through the flume is measured by measuring the height of the water flowing through the flume at a specific point up stream of the flume throat. The calibration formula for a typical 2" (50mm) Parshall flume is:

$$Q = ch_a{}^{n1}$$

where $c =$ **0.1207 for a 2" flume**

and $n1 =$ **1.55**

$ha =$ **height of water flowing through the throat in mm**

for the Klaarstroom WWTP flume, the calibration formula therefore is:

$$Q = 0.1207.ha^{1.55}$$

Example:

If water flows through the flume throat at a height of 100mm, then the flow can be calculated as follows:

$$Q = 0.1207(0.100)^{1.522}$$

$$= 0.0034\ m^3/s$$

= 3.40 liters per second

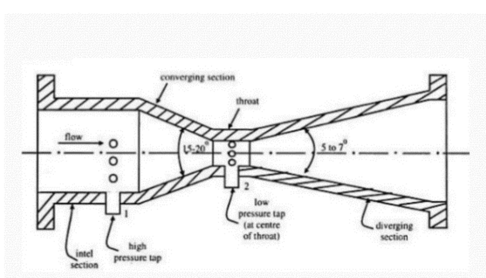

Figure 17: Typical layout of a Parshall flume

STANDARD OPERATING PROCEDURES FOR:

4.4 Oxidation Pond System

Purpose:

- A pond system processes wastewater in shallow earth dams, referred to as stabilization or oxidation ponds.
- Ponds are classified according to the nature of the biological process taking place (Anaerobic, Aerobic or Aerobic-anaerobic / Facultative Ponds).

Procedure:

1. Process Controller changes from private clothes to Personal Protective Equipment (PPE) at beginning of shift.
2. Process Controller collects the correct tools and equipment.

Primary Ponds / Anaerobic Ponds:

1. Check inlet hand stops operation. Close and open completely.
2. Check pond water level. Increase in level indicates an outlet blockage.
3. Check for different smell of the pond.
4. Check for colour changes in the pond contents.

Secondary Ponds / Facultative Ponds:

1. Check pond water level. Increase in level indicates an outlet blockage.
2. Check for different smell of the pond.
3. Check for colour changes in the pond contents.

Final Ponds:

1. Check available storage capacity
2. If pond is full, operate outlet valve.
3. Discharge the effluent to the Irrigation Holding Dam at sports fields.

Connector Piping:

1. Ensure pipes are open and flowing freely.

Process Controller is responsible for the general upkeep around the Oxidation Pond System.

4.5 Horizontal Flow Reedbed

Purpose:

- Monitoring is the most important factor in successful operation of a reed bed treatment system. Operating a reed bed treatment system is likened to guiding a large ship in a confined space with a tugboat. This implies that changing the direction takes considerable time and energy. Once something has gone wrong, the natural processes occurring within the system take a long time to rectify. This means that incorrect operational control decisions can cause long periods of poor operational performance.

- Early detection of changes in the effluent quality are the best defence to prevent this. To ensure this it is required that adequate data is collected and reviewed to pick up these subtle changes and to implement corrective measures timeously.

4.5.1 Daily Procedure:

1. Check that Horizontal flow reed bed inlet distribution manifold is open.
2. Each horizontal flow reed bed must receive water so that flow takes place 80-100mm below filter media top surface level. This can be adjusted by shortening the standpipe at the reedbed outlet pipe.
3. Remove any non-biodegradable debris from the horizontal reed bed media surface for disposal.
4. Ensure that the horizontal flow reed bed outlet valves are open and water is flowing freely.
5. Monitor water levels in horizontal flow reed beds. No surface water must be visible above the media. If water is visible, lower the outlet standpipe.

4.5.2 Weekly procedures:

1. Execute daily procedures as described above.
2. Trim back overgrowth of reed runners that are outside the lining area.
3. Keep all areas of the treatment plant neat and tidy by removing windblown litter and debris.
4. Inspect all manhole chambers and clean out debris, sand, etc.

4.5.3 Monthly Procedure:

1. Execute daily and weekly procedures as described in 3.1 and 3.2.

2. Take water samples of the effluent at the following points on the plant:

(a) Raw sewage at the Inlet works.
(b) Anaerobic Pond effluent sample at the pond outlet weirs
(c) Facultative Pond effluent at the pond outlet weir
(d) Aerobic Pond effluent at the pond outlet weir
(e) Effluent from each Horizontal flow reed bed outlet.
(f) Effluent from Final Storage Pond outlet.
(g) Chlorine treated final effluent from Irrigation Pump station.
(h) Each sample to be a minimum of two (2) litres in volume.
(i) Samples to reach a laboratory for analysis within 24 hours. Alternatively samples to be kept cool (± 4º C) until they reach the laboratory. This is required to inhibit bacterial activity and to ensure representative samples.
(j) Take one biological sample of 250ml in volume of the Final effluent. Bacteriological samples must be taken in a sterilized glass bottle and properly sealed. Care must be taken not to touch the mouth of the bottle during sampling.
(k) All chemical and bacteriological analysis results are to be kept on record by the operator.

4.5.4 Annual Procedure:

1. Execute Daily, Weekly and Monthly procedures as described.
2. Once a year in September with the onset of the growing season, the vegetation on the reed bed must be harvested. This is typically done by cutting off the plants at a height of 100mm above the media surface using either powered brush cutters or by hand using sickles.
3. All cut off vegetation is to be removed from the media surface and disposed of. This action removes dead plants, leaves and debris and stimulates plant growth for the new season.
4. The screening and flow measuring equipment must be serviced and inspected by the agents as follows:
   (a) The complete unit must be drained and thoroughly cleaned using a high pressure water cleaner.
   (b) Screen bars must be inspected for wear and play and may need to be replaced.
   (c) Check electrical equipment for functionality and tighten all terminations.
5. Check operation and condition of all valves on the plant. Repair and replace if necessary.
6. Inspect earth-fill embankments for signs of stormwater erosion and repair if required.
7. Try to establish plants on steep embankments as soil erosion protection measure.
8. Inspect visible sections of HDPE linings for deterioration due to UV exposure and repair bad spots.

5 STANDARD OPERATING PROCEDURES FOR OPERATIONAL MONITORING

Monitoring is the most important factor in successful operation of a wastewater treatment system.

This means that incorrect operational control decisions can cause long periods of poor operational performance. Early detection of changes in the effluent quality is the best defence to prevent this from occurring. To ensure this, it is required that adequate data of the required operational parameters are collected and reviewed to pick up these subtle changes and to implement corrective measures timeously.

The following pages represent step-by-step operating procedures required for all operational monitoring that needs to take place to successfully operate the treatment plant:

5.1 Wastewater parameters to be analyzed for Compliance Monitoring

5.2 Wastewater parameters to be analyzed for Operational Monitoring

5.3 Chemical Compliance Sampling Procedure

5.4 Typical Chemical Sample organization schematic for laboratory

5.5 Biological Compliance Sampling Procedure

5.6 Typical Biological Sample organization schematic for laboratory

5.7 Measuring pH

5.8 Flow Measurement

5.9 Measuring Nitrates

5.10 Measuring Conductivity

STANDARD OPERATING PROCEDURES FOR:

5.1 Parameters to be analyzed for Compliance Monitoring:

Purpose:

- It is a legal requirement of either the General Authorization or the Water Use License that the operator of a wastewater treatment plant should monitor the quality of the wastewater received at the treatment plant and report it to the regulating authority.
- Parameters to be analyzed by a SANAS accredited laboratory

Raw Sewage parameters at the plant Inlet (monthly basis):

1. Total dissolved solids (TDS)
2. Suspended Solids (SS)
3. Conductivity mS/m
4. 4 Hours Oxygen Absorbed / Permanganate value (PV)
5. Chemical oxygen demand (COD)
6. Free and saline ammonia as N
7. Nitrate – NO_3 as N
8. Nitrite – NO_2 as N
9. Ortho-phosphate – PO_4 as P
10. Chlorides as Cl
11. Total Alkalinity as $CaCO_3$
12. pH – value
13. Sodium as Na
14. Potassium as K
15. Sulphate as SO_4
16. Kjeldahl Nitrogen as N (TKN)

Final Effluent at the plant Outlet (monthly basis)

1. Total dissolved solids (TDS)
2. Suspended Solids (SS)
3. Conductivity mS/m
4. 4 Hours Oxygen Absorbed / Permanganate value (PV)
5. Chemical Oxygen Demand (COD)
6. Free and saline ammonia as N
7. Nitrate – NO_3 as N
8. Nitrite – NO_2 as N
9. Ortho-phosphate – PO_4 as P
10. Chlorides as Cl
11. Total Alkalinity as $CaCO_3$
12. pH – value
13. Sodium as Na
14. Potassium as K
15. Sulphate as SO_4
16. Fecal Coliforms

MINIMUM LIMITS FOR SPORTS FIELD IRRIGATION

The Klaarstroom WWTW is designed for irrigation and the capacity of the plant does not exceed 2000m³/d. Therefore the irrigation limits listed in Table 1.1 from the General Authorisation will be assumed to be the minimum performance benchmark for this WWTW. pH between 5.5 - 9.5

- Electrical Conductivity max of 150 mS/m not to exceed 70 mS/m above intake
- Suspended Solids ≤ 25 mg/l
- Chlorine as Free Chlorine ≤ 0.25 mg/l
- Fluoride ≤ 1 mg/l
- Soap, oil and grease ≤ 2.5 mg/l
- Chemical Oxygen Demand ≤ 75 mg/l
- Faecal coliforms 1000 cfu/100 ml
- Total ammonia as N ≤ 3 mg/l
- Nitrate as N ≤ 15 mg/l
- Ortho –phosphate as Phosphorus ≤ 10 mg/l

This assumption of this regulatory requirement is used throughout this manual as a performance benchmark.

STANDARD OPERATING PROCEDURES FOR:

5.2 Parameters to be analyzed for Operational Monitoring:

Purpose:

- Operational Monitoring is required on a continuous basis to allow monitoring of the process parameters in order to make adjustments to ensure that the Final Effluent meets the required legal quality standard.
- Parameters to be analyzed on site by the Process Controllers
- Parameter results to be recorded and monitored by the Plant Supervisor in order to take decisions based on the data recorded to ensure the best possible quality of effluent is constantly produced.

Process Control Tests (daily)- Inlet

1. pH
2. Conductivity mS/m
3. Free and saline ammonia as N

Process Control Tests (daily)- Final Effluent

1. pH
2. Conductivity mS/m
3. Nitrates
4. Nitrites
5. Free and saline ammonia as N

STANDARD OPERATING PROCEDURES FOR:

5.3 Chemical compliance sampling procedures

Requirements:

1. The sample should be representative.
2. Its results should be reproducible.
3. It should be dependable in terms of systematic procedures and documentation followed.
4. The recommended sampling procedure must be followed.
5. Grab sample – “snap shot”- of what is the status quo of the sample at that specific time.
6. Composite sample – “video/dvd” - the average of what is the happening over a 24h flow period. Take 50-100ml every hour over a 24 hour period in one sample bottle.
7. pH (acid or base) Hydrogen ion concentration in sample.
8. Conductivity (electrical current is conducted because of salts that are negatively/positively charged present in water, conductivity multiplied by 6.5 gives an estimate of total dissolved salts in sample).
9. Chemical oxygen demand –COD- (strength or concentration of the sewage measured in the amount of oxygen in mg/l needed to break down the organic matter in the sewage)
10. Ammonia in urine reacts with water and forms urea, bacteria breaks it down to nitrates (NO_3) – form that plants use- and nitrites (NO_2) and Nitrogen gas (N). This process is called de-nitrification and takes place in anoxic conditions (without any free available oxygen. Total ammonia is the sum of the above mentioned.
11. Phosphates – building blocks that plants need to grow.
12. Suspended solids - solids that are suspended in water that can settle out at later stage
13. Temperature - very important if industries discharge directly into river. Hot water can influence breeding patterns of fish and other aquatic life. Sewage water usually higher temperature due to hot tap water being added.

Sampling procedure:

1. A minimum sample of 2 liter is needed.
2. Use gloves when taking sample for own protection and to protect the integrity of the sample.
3. No need for a sterilized bottle but bottle must be thoroughly cleaned.
4. Rinse bottle 3 times with sample before taking sample (borosilicate glass-stopper bottles, polyethylene containers with screw caps, soft glass containers).
5. Fill sample bottle to brim and keep refrigerated, but do not freeze.
6. Mark sample with permanent marker, specify sample location, date and time, inlet or outlet sample, type of sample and sampler name.
7. Send sample to Laboratory the same day. Ensure that sampling takes place and sample can be delivered to the Laboratory during office hours to limit transport time and ensure that the cold chain is not broken.
8. Give Laboratory full details e.g. municipality's name, contact person, telephone and fax, address, location of sample and any other info to be able to contact you if there is a problem.
9. For chemical analysis the following time limits are suggested:

- Unpolluted waters – 72 hours
- Slightly polluted waters – 48 hour
- Polluted waters – 12 hours

10. Use of preservatives is permitted – remember to measure pH on site if preserving with an acid.

5.4 Typical Chemical Sample Organization Chart for Laboratory

Domestic Effluent

Sample (A)	Sample (B)	Sample(C)
Wash container (glass/plastic ± 750ml). Rinse and dry. Label marked **for COD** and **Oil H2SO$_4$ Preserved**	Wash container (glass/plastic ± 2 liter). Rinse and dry. Label marked for **general / unpreserved**	Wash container (glass/plastic ± 750ml). Rinse and dry. Label marked for Trace/ **metals HNO$_3$ Preserved**
↓	↓	↓

Dispatch sample bottles to sampling systems/clients or keep for own use

Sampling

Preserving: H2SO$_4$ ± 2ml conc. is added to container. Fill container completely with sample make sure not to trap air in container.	Fill container with water, if pH is not determined immediately get sample to laboratory as soon as possible.	Take sample and add HNO3 to lower pH <2
↓	↓	↓

Laboratory Procedure

Check sample into system. Fill in sample information sheet and give registration No.	Check sample in to system. Fill in sample information sheet and give registration No.	Check sample in to system. Fill in sample information sheet and give registration No.
↓	↓	↓
Standardize apparatus for analysis, QC. Check and log results	Standardize all relevant apparatus. QC. Analysis on all standards. Logging.	If samples are to be analyzed, self-prepare instrument. Standardize, QC. Analyze. Log.
↓	↓	↓
Analyze Samples using methods described in QC. Manual	Analyze Samples using methods described in QC. Manual	Analyze Samples using methods described in Q.C. Manual
↓	↓	↓
Do all result calculations and keep for future reference	Do all result calculations and keep for future reference	Do all result calculations and keep for future reference

↓

Generate report. Distribute report and all relevant documents to the client as per mutual agreement

5.5 Bacteriological Compliance sampling procedure:

Procedure:

1. Laboratory supply sterilized bottle with blue cap and autoclave tape indicating it has been sterilized. Sterile disposable bottles can also be used.
2. Mark bottles the same as for chemical samples but indicating it is a bacteriological sample for E.coli or Fecal coliforms.
3. Do not open bottle beforehand - if opened it is not sterile anymore.
4. Use gloves when taking the sample to protect yourself and the integrity of the sample.
5. Open bottle as close as possible to sample point.
6. Turn bottle upside down before entering water, turn horizontal when 25cm submerge, fill and close quickly.
7. Do not touch inside of bottle or cap, or put cap down on any surface.
8. Send sample within 6 hours to lab, on ice, for longer times put sample in fridge not freezer, until sent to lab on ice.
9. Give lab full details e.g. municipality, contact person, telephone and fax, address, location of sample and any other info if there is a problem.
10. Holding time for samples should not exceed 24 hours.

Bacteriological - E.coli (indicator of fecal pollution from human or animal origin)

5.6 Typical Biological Sample organization schematic for laboratory

Wastewater

Wash blue cap sample bottle, dry and sterilise in autoclave with autoclave tape. Label bottle. Dispatch sample bottles to sampling points

↓

Sampling

When sampling is not done by Laboratory Staff, samplers get educated/trained in sampling procedures

↓

Laboratory Procedure

Samples get taken into the lab system. Sample information sheet gets filled in and sample receives registration number.

↓

Sample sorting

< 6hours old – no refrigeration reqd.
> 6 hours < 12 hours - 1°C to 10° C
> 24 hours – do only Faecal Coliforms
> 48 hours no tests done.

↓

Samples and testing equipment are prepared for analyses

↓

Samples are analysed using the methods described in QC Manual. Turnaround time of 4 working days.

↓

After incubation period results are included in the report and results and relevant documents are distributed to the clients as per mutual agreement

STANDARD OPERATING PROCEDURES FOR:

5.7 Measure pH using Crison pH meter

- pH is the measurement of the degree of acidity or alkalinity of an aqueous solution.
- **The pH Meter should be calibrated once a day.**

Procedure:

1. Fill the calibration tubes with the standard solutions pH4; pH7 and pH10.
2. Wash the electrode with distilled water.
3. Press power button.
4. Meter will show auto-test; presentation of model and measuring pH.
5. Screw the electrode onto the tube containing the first buffer, pH4.
6. Press CAL. P1 will show; press CAL again. Wait to stabilize and P2 will show.
7. Rinse electrode with distilled water.
8. Insert electrode into buffer pH 7 and press CAL again for reading. Wait until stabilized. P3 will show.
9. Rinse electrode with distilled water.
10. Insert electrode into buffer pH10 and press CAL. Wait until stabilized.
11. Rinse electrode with distilled water.
12. To check meter against Quality Control (QC) put probe into pH7 (P2) and wait for reading to stabilize.
13. Rinse electrode with distilled water.
14. Put probe into sample and wait to stabilize, take reading.
15. Rinse electrode with distilled water.
16. Repeat with other samples.
17. Rinse electrode with distilled water.
18. Switch meter off and replace probe in protector filled with KCL. If the electrode is not used, it must be stored in its protector with a buffer solution pH4 or pH7 and KCL.
19. Do not re-use buffers. Discard and clean tubes.

<u>The pH of waste water</u>

pH of incoming raw waste water and final effluent:

- pH should be measured with a pH probe with automatic temperature compensation at least once a day.
- A pH meter should be calibrated with buffer solutions (pH 4, pH 7, and pH 10) as standards against which the accurate measurement of the pH meter is checked before use.
- A 150 ml sample in a glass beaker is needed to test pH.
- The pH of domestic wastewater is fairly constant (6.5 – 8). Any sharp deviations from the long-term average readings are a sure indication that something has been discharged into the stream that may cause a process problem.
- pH values below 7 affect the removal of nitrates and phosphates.
- pH values higher than 8.5 indicate that nitrate formation is incomplete and nitrites may appear in the final effluent.
- At pH values above 9 the process will fail.

5.8 Flow Measurement

Purpose:

- Flow measurement is usually carried out at the intake works just after screening and grit removal, to eliminate artificial fluctuations in the water level caused by grit and solid waste increasing volume
- Legislation enforces flow meter readings – 'to measure is to know'
- Regular measuring of the flow is required to determine the hydraulic and organic load of a WWTW.
- Regular flow recordings can provide warnings on blockages or pump failures in sewer reticulation.
- To determine average dry weather flow (ADWF) and peak wet weather flow (PWWF)
- In open channels, with the liquid surface exposed to the atmosphere, flow is measured with a flume or weir where flow is a function of water depth.

Procedure:

1. The Process Controller takes flow meter readings (current and total in l/s and m3) every day at the same time (beginning of every shift).
2. The flow meter provides 2 readings. An instantaneous flow in liters per second and a totalizer which counts the total volume in m^3. The latter reading is taken once every 24 hours to calculate the daily average flow entering the plant.
3. The Process Controller gives these readings to the supervisor for inclusion in the works operating records.
4. The Process Controller reports immediately if any suspicious readings are recorded or if the meter is not working properly or at all.
5. If there is no power supply, the Process Controller must report to the supervisor immediately.
6. The flow instrument must be cleaned with a duster to remove spider webs and dust on a weekly basis as part of good housekeeping.

Important:

- The Average Daily Flow is calculated as follows:

Today's Totalizer Reading – Yesterdays Totalizer Reading = Volume received in 24 hours

Record this figure in the log sheet

5.9 Measure NITRATE using Lovibond MD 600 photometer

Procedure:

1. Turn the instrument ON with the ON/OFF power switch.
2. The meter will perform an auto diagnostic test. During this test, the Hanna Instrument logo will appear on the LCD. After 5 seconds, if the test was successful, the last method used will appear on the display.
3. In order to select the desired method press the METHOD key and a screen with the available methods will appear.
4. Press the UP or DOWN arrow to highlight the desired method. Press select after NITRATE displays on the screen.
5. Fill the cuvette with 6ml of sample using a pipette, replace the cap.
6. Place the cuvette into the holder and close the lid.
7. Press the ZERO key. The display will show "-0.0-"when the meter is zeroed and ready for measurement.
8. Remove the cuvette and add the content of one packet of HI 93728-0 reagent.
9. Replace the cap and immediately shake vigorously up and down for exactly 10 seconds. Continue to mix by inverting the cuvette gently for 50 seconds, while taking care not to induce air bubbles. Powder will not completely dissolve. Time and way of shaking could sensitively affect the measurement.
10. Reinsert the cuvette into the instrument, taking care not to shake it.
11. Press TIMER and the display will show the countdown prior to the measurement or, alternatively, wait for 4 minutes and 30 seconds and press READ. When the TIMER ends the meter will perform the reading. The instrument displays the results in mg/L of nitrate-nitrogen.

STANDARD OPERATING PROCEDURES FOR:

5.10 Measure CONDUCTIVITY using Jenway 4510

Procedure:

1. Turn the instrument ON with the ON/OFF power switch.
2. The meter will perform an auto diagnostic test. During this test, the Hanna Instrument logo will appear on the LCD. After 5 seconds, if the test was successful, the last method used will appear on the display.
3. In order to select the desired method press the METHOD key and a screen with the available methods will appear.
4. Press the UP or DOWN arrow to highlight the desired method. Press select after NITRATE displays on the screen.
5. Fill the cuvette with 6ml of sample using a pipette, replace the cap.
6. Place the cuvette into the holder and close the lid.
7. Press the ZERO key. The display will show "-0.0-"when the meter is zeroed and ready for measurement.
8. Remove the cuvette and add the content of one packet of HI 93728-0 reagent.
9. Replace the cap and immediately shake vigorously up and down for exactly 10 seconds. Continue to mix by inverting the cuvette gently for 50 seconds, while taking care not to induce air bubbles. Powder will not completely dissolve. Time and way of shaking could sensitively affect the measurement.
10. Reinsert the cuvette into the instrument, taking care not to shake it.

6 STANDARD MAINTENANCE PROCEDURES FOR MECHANICAL EQUIPMENT

Maintenance on a wastewater treatment plant entails the work involved to keep all mechanical equipment operational in order to constantly be able to treat the incoming wastewater to the required standard.

Typically, first –line maintenance is a function of the Operational staff while preventative maintenance is either outsourced to specialists or conducted in-house by the municipal mechanical staff.

Typical first-line maintenance comprises the following actions:

- Cleaning of pump stations
- Wiping off of electrical panel enclosures
- Washing off accumulated sludge and debris from sump and structure walls
- Removal and safe disposal of screenings and floating rags from the screen and all other unit processes.
- Upkeep and maintenance of the plant grounds such as keeping the plant neat and tidy, mowing the lawns, etc.

In addition to the above, regular maintenance should be conducted on mechanical equipment such as pumps, gearboxes, electrical motors and electrical control panels.

<u>Typical maintenance on the mechanical equipment includes the following:</u>

- Check for undue temperature and vibration on rotating equipment
- Listen for irregular noises on all rotating equipment
- Check the oil levels on pumps and gearboxes on a weekly basis and top up with the correct grade of oil.
- Check condition and state of pumps, valves and crawling irrigator at sport field reservoir.
- Apply grease with a grease gun at all equipment fitted with grease nipples and gate hinges on a weekly basis.
- Read the operation and maintenance manuals on special equipment and ensure that specialist services are conducted as scheduled.

Maintenance on a weekly basis consists of basic inspections, checks and care to lubricating fluids such as oil and grease which are critical to the smooth operation of mechanical and electrical equipment.

Maintenance **MUST** be conducted on a weekly, monthly and annual basis as per the recommendations of the equipment manufacturer to ensure that the equipment reaches its expected life cycle and also to enable constant and consistent treatment of the wastewater coming into the plant.

Lack of consistent maintenance will very quickly result in plant equipment failure and then poorly treated water quality which will impact negatively on both the environment and public health.

It is recommended that mechanical maintenance be conducted by an experienced maintenance artisan who has either qualified as a Mechanical Fitter, a Pump Fitter, a Fitter and Turner or as a Millwright.

This person should have qualified with a trade test conducted at an accredited technical training institution and have a minimum of 5 years maintenance experience on mechanical equipment.

Work conducted by unqualified or inexperienced staff may lead to both damage of municipal equipment and or loss of life or limbs of the artisan.

7 STANDARD MAINTENANCE PROCEDURES FOR ELECTRICAL EQUIPMENT

Maintenance on a wastewater treatment plant entails the work involved to keep all electrical equipment operational in order to constantly be able to treat the incoming wastewater to the required standard.

Typically, first –line maintenance is a function of the Operational staff while preventative maintenance is either outsourced to specialists or conducted in-house by the municipal mechanical and electrical staff.

<u>Typical first-line maintenance comprises the following actions:</u>

- Wiping off of electrical panel enclosures.
- Monitoring incoming Line Voltages to ensure that sufficient supply is available.
- Cleaning of instruments such as level sensors, flow meters, etc.
- Reporting of equipment that trips the circuit breakers or overload switches on a regular basis.
- Reporting of non-working grounds equipment such as site lighting, plugs, domestic outlet sockets, etc.

In addition to the above, regular maintenance should be conducted on electrical equipment such as switchgear panels, instrumentation, data loggers and electrical drive motors on the treatment plant.

Read the operation and maintenance manuals on special equipment and ensure that specialist services are conducted as scheduled.

<u>Typical electrical maintenance on switchgear and instrumentation includes the following basic actions:</u>

- Check operation of all soft starters and DOL starters.
- Check protective equipment settings such as the overload, over- and under-voltage settings.
- Start the equipment and check the operating current and instruments such as the Ammeters and Voltmeters on the panel.
- Check that all indication lamps on the panel are functioning.
- Check whether instruments such as ultrasonic level sensors are operating at the correct levels and that correct switching of equipment takes place.

Maintenance on a weekly basis consists of basic inspections and checks on electrical equipment which are critical to the smooth operation of mechanical equipment.

Maintenance **MUST** be conducted on a weekly, monthly and annual basis as per the recommendations of the equipment manufacturer to ensure that the equipment reaches its expected life cycle and also to enable constant and consistent treatment of the wastewater coming into the plant.

Lack of consistent maintenance will very quickly result in plant equipment failure and then poorly treated water quality which will impact negatively on both the environment and public health.

It is recommended that electrical maintenance be conducted by an experienced maintenance artisan who has either qualified as an Electrician, as a Millwright or an Electrical Engineering Technician. Such an Artisan/Technician should preferably have a Wireman's License and be qualified for working on Low to Medium Voltage installations.

This person should have qualified with a diploma or trade test conducted at an accredited technical training institution and have a minimum of 5 years maintenance experience on electrical equipment.

Electrical power is dangerous. Work conducted by unqualified or inexperienced staff may lead to both damage of municipal equipment and or loss of life or limbs of the artisan.

STANDARD MAINTENANCE PROCEDURES FOR:

7.1 Irrigation Pump Station Electrical Switchgear Panel

Equipment description:

- Mains incomer kiosk.
- Domestic supply switchgear kiosk.
- DOL Starter
- Level sensors in Irrigation Holding Dam.

Weekly Procedures for Switchgear:

1. Start and stop each of the equipment items to ensure that they are operating correctly as required.
2. Check functioning of DOL contactors and overload/under load trip mechanisms.
3. Check over/under voltage protection relay operation and settings
4. Check phase imbalance settings on starters and Newelec motor protection relays.
5. Check phase rotation settings on soft starters and Newelec motor protection relays.
6. Start each of the equipment items manually and check the operation of all panel instruments such as ammeters and voltmeters.
7. Check that all panel indication lamps and site lights are working
8. Blow out all dust and cobwebs inside the electrical panels using an electric air blower.
9. Wipe down the outside of the electrical enclosure with a damp rag.

General Quarterly Maintenance Procedures:

1. Clean all enclosures thoroughly by washing down with a wet cloth on the outside and blowing out all dust, cobwebs and insects on the inside with an electrical industrial air blower.
2. Remove and clean contactors with a special solvent used specifically for electrical components.
3. Check and tighten all cable entry glands.
4. Check and ensure that all cables are properly secured on cable racks and in conduits.
5. Check ALL terminations in the panel for tightness, integrity and signs of corrosion. Clean off corrosion with electrical solvent and allow to dry thoroughly.
6. Check all electrical motor termination boxes for the integrity of the water seal and tighten terminations to avoid “hot” connections.
7. Monitor all electrical motor bearings for wear by listening at the bearing housing with a screwdriver pressed to the ear. If bearings are running coarsely, this should be noted and scheduled for replacement.
8. Check all earthing systems, lightning arrestors and surge arrestors for correct functioning and replace if faulty.
9. Record all maintenance actions in the plant item log sheet.

Weekly Procedures for Instrumentation:

1. Clean ultrasonic level sensors by wiping off the active face of the sensor with a clean damp cloth to remove dirt and moisture droplets.
2. Check level / flow settings on the ultrasonic transmitter unit and correct if necessary.
3. Check flow setting and digital display on electro-magnetic flow meter is in working condition.
4. Check that analogue and digital signals are transferred correctly to the data logger.

Annual Procedure for instrumentation:

1. Electronic instruments are sensitive equipment which should be repaired and worked on by specialists in a clean environment.
2. It is advisable to procure the services of a specialist technician from the instrumentation equipment supplier at least once a year to service and re-calibrate all instruments at the wastewater treatment plant.
3. **Municipal electrical staff should avoid making repairs or tampering with specialized instruments. This may cause undue damage to the instrument.**
4. Record all maintenance actions in the plant item log sheet.

STANDARD MAINTENANCE PROCEDURES FOR:

7.2 Wastewater Plant Instrumentation

Equipment description:

- Ultrasonic level sensors
- Data Loggers

Weekly Procedures for Instrumentation:

1. Clean ultrasonic level sensors by wiping off the active face of the sensor with a clean damp cloth to remove dirt and moisture droplets.
2. Check level / flow settings on the ultrasonic transmitter unit and correct if necessary.
3. Check calibration on Parshall flume ultrasonic by comparing the instantaneous reading with the flow tables by taking a manual water depth reading.
4. Check that analogue and digital signals are transferred correctly to the data logger.

Annual Procedure for instrumentation:

1. Electronic instruments are sensitive equipment which should be repaired and worked on by specialists in a clean environment.
2. It is advisable to procure the services of a specialist technician from the instrumentation equipment supplier at least once a year to service and re-calibrate all instruments at the wastewater treatment plant.
3. **Municipal electrical staff should avoid making repairs or tampering with specialized instruments. This may cause undue damage to the instrument.**
4. Record all maintenance actions in the plant item log sheet.

8 TREATMENT PLANT DRAWINGS

The drawings inserted into this manual are the basic plant drawings in reduced A4 size for ease of insertion into this document.

Full scale A1 drawings are kept in the plant archive at the Municipal building. When drawings are required for work purposes, this manual will serve to find the correct drawing number of which a full scale copy can then be sourced from the archives to work with.

Each of the engineering disciplines applied on the Brandvlei Wastewater Treatment Plant has a set of drawings.

8.1 List of Drawings

DRAWING NO.	SHORT DESCRIPTION