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We make technology work

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Specification for Waste Water Treatment Package Plants for the Treatment of Domestic Effluent – Kapama Private Game Reserve

Dear Sirs

Background:

The client had the option to either extend the current dam system or to employ more modern, package plant type effluent treatment systems.

Following is a summarized comparison between the two approaches.

Parameter	Dam System	MBBR Package plant
Pre-treatment required (i.e. grit removal and screening)	Yes	Yes
Capital Cost	More expensive to Comparable if plastic lining is used. Very expensive with concrete lining	Cheaper to Comparable
Energy requirement	Approx 0.8kWh per m3 waste water treated	Approx 1.8 kWh per m3 waste water treated
Operational expertise required	No	No
Specialist technicians	No	No, general electrician

required		and mech/plumber can maintain all equipment
Daily maintenance required	Yes, cleaning of pre-treatment structure	Yes, cleaning of pre-treatment structure
Sludge handling	Every 10-15 year major cleaning by hand, need for additional capacity while cleaning and sludge disposal method acceptable to DWA	Daily automatic desludging onto sand drying beds. Dried sludge can be composted
Can General standards be reached	Sometimes	Always, if inflow water composition is as per design
Footprint	Approx 50m2 per kl	Approx. 1.5m2 per kl
Pumps and blowers	Yes: Recycle pump	Yes: Internal recycle pump and blower
Need for Geological survey at each pond	Yes	No
Monitoring boreholes required and monitoring procedure afterwards	Yes	No
Need for chlorination	Yes, additional tank required	Yes, additional tank required
Need for Sand Filters	Yes, if water is to be re-used for irrigation	Yes, if water is to be re-used for irrigation
Need for Activated Carbon filters	Yes, if organics need to be removed	Yes, if organics need to be removed

Proposal

Design Basis

The client's request was to submit budget prices for Packaged or compact waste water treatment plants for 5 sites in Kapama.

The sites and plant sizes we used for the design are as follows (*Obtained from Eco Elementum Report Ref 18-723-SQ):*

Site	**Average Design Flow**	**Hourly design flow**	**Peak Instantaneous flow**
River Lodge	100 kl/day	4.2 kl/h	25 kl/h max 1 hr
Drakensig	30 kl/day	1.3 kl/h	8 kl/h max 1 hr
Southern Camp	50 kl/day	22.1 kl/h	12 kl/h

Buffalo Camp	24 kl/day	1 kl/h	8 kl/h
Karula	30 kl/day	1.3 kl/h	8 kl/h

The inlet and outlet parameters are as follows:

Parameter	**Feed (mg/l)**	**Product water Target (mg/l)**	**General Standards**
COD	Up to 900 mg/l	< 75	< 75
TSS	200- 250	< 25	< 25
TKN	30-50	< 10	
pH	6-8	6-9	5.5 -9.5
Ammonia	N/A	< 3	< 3
Nitrate	N/A	< 15	< 15
Ortho-phosphate (PO4)	< 20	< 10	<10
FOG	< 50	< 2.5	< 2.5
Total coliforms (MPN/100ml)	N/A	< 500	< 1000

Process offered

Water Skills can offer any type of waste water treatment system, depending on the client's requirement.

For this particular application we offer relatively new technology, so called Moving bio-bed Reactor (MBBR) technology, that encompasses all the advantages of the different technologies.

Based on the remoteness of the site and the need for a simple system, we propose a MBBR system. The advantages of the system are as follows:

- Simple design: The system consists of two reactor tanks with the bacteria required for the process, fixed on carrier media, and a clarifier and is fully automated.

- Reliable: The fixed film principle ensures a stable biological treatment plant. This is in comparison with a suspended growth system where the clarifier has to ensure proper preservation of the bacteria, which is sometimes unreliable in smaller applications like this.

- Compact: The size of the reactor tanks are reduced dramatically by immobilizing the biological biomass necessary for the bio-conversion of the contaminants, on moving bio-carriers. We use the best carrier in the world that is resistant to mechanical scouring and will last 10 years. The reaction tanks are approx. 60% smaller than suspended growth systems.

- Easy to maintain: The media last in excess of 15 years and can be replaced easily. The system has a small submersible pump and a blower for aeration. The control panel is easy to work on as it used standard switch gear.

- Virtually operator free, except for cleaning of the inlet screens and grit channel

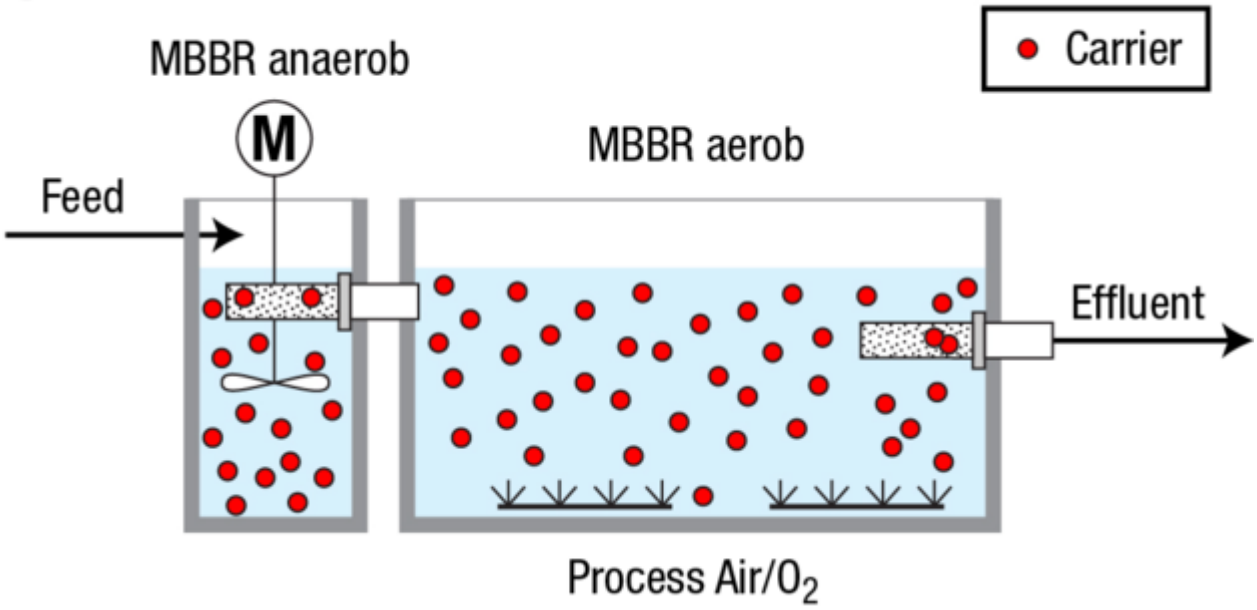
- Option to add an automated media filter to enable re-use of the treated sewage for irrigation purposes – this has been included.

How MBBR Works:

The MBBR process utilizes floating plastic carriers (media) within the aeration tank to increase the amount of microorganisms available to treat the wastewater.

The Figure below shows a basic process configuration:

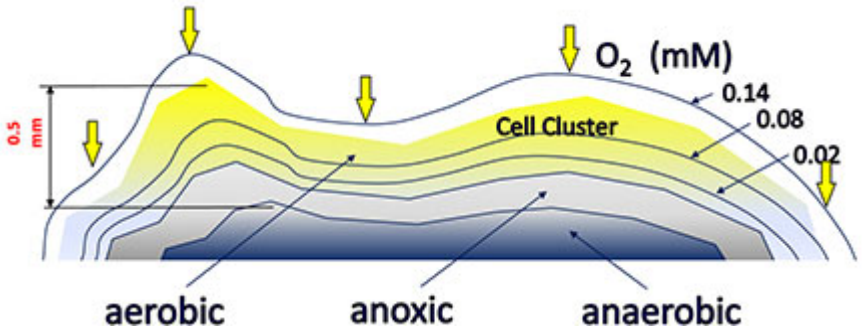
Figure 1: MBBR Schematic




MBBR Media

The microorganisms consume organic material. The media provides increased surface area for the biological microorganisms to attach to and grow in the aeration tanks. The increased surface area reduces the footprint of the tanks required to treat the wastewater. The media is continuously agitated by bubbles from the aeration system that adds oxygen at the bottom of the first compartment of the aeration tank. The microorganisms consume organic material. When compared to conventional secondary treatment it provides superior efficiency and value.

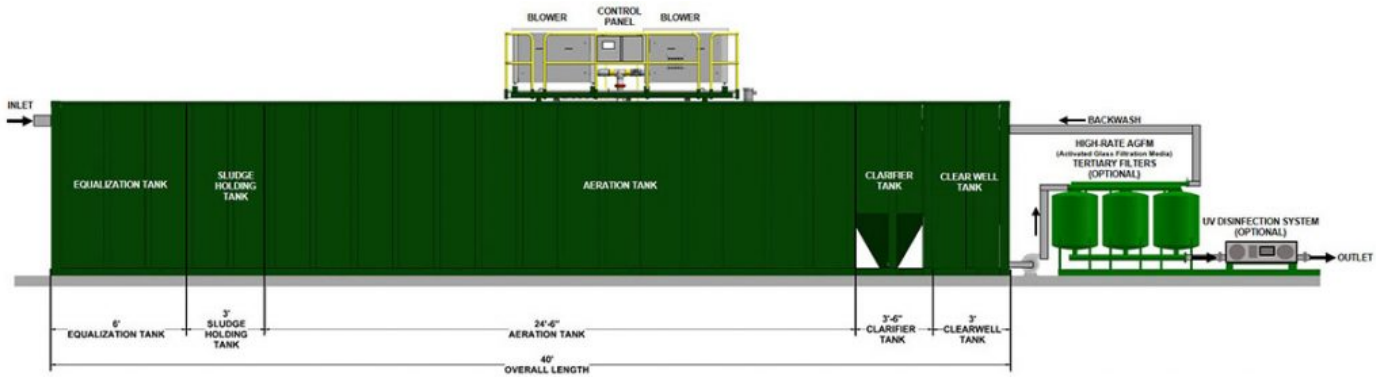
In fact the MBBR media or biochips utilized exclusively by Water Skills have an active surface area > 4000 m2/m3 which is up to six (6) times greater than any competing media available on the market today.



Diffusion of O2 into the Cell Cluster

The MBBR is a complete mix, continuous flow through process which is based on the biofilms principle that combines the benefits of both the activated sludge process and conventional fixed film systems without their disadvantages.

Below is containerised system we built for the export market (100kl/day).



Process Description and Battery limits Specifically for Kapama Lodges

The Package plants we offer can be in various containerized systems. For the purpose of this costing exercise, we will use sun resistant Heavy Duty (SG1.6)

LDPE tanks. Reason being that is cost effective and the whole plant is then above ground for ease of maintenance.

Note that the system can also be built into containers or into concrete structures.

1. **Supply of Raw effluent to the plants:**

Existing pumps will pump the sewage from various sources to the new treatment plant sites.

2. **Pre-treatment**

For each of the pumped lines there is already a grit and solids removal structure in place. Grit is removed on regular basis and disposed as per regulation as solid waste. The other organic solids accumulate in the septic tanks where it biodegrades and the semi-stabilised sludge is pumped from time to time by Honey Sucker and disposed on the existing drying beds. Dry sludge is raked together and mixed with grass cuttings to make compost which is then used in gardens. Since the sludge originates from domestic effluent only, it is rated as safe sludge for composting used in non-edible applications like gardens.

3. **Balancing tank**

It can be seen from the design figures that high instantaneous peaks are prevalent, typical of lodges. These peaks have to be attenuated so that the actual process can be designed on the average flow.

There will be a balancing tank at each plant, big enough to take a full one horu of a sustained peak of 6x ADWF.

4. **Treatment Process**

An ultrasonic inlet flow meter provides flow records and is used to automatically adjust the chemical dosing rates according to flow.

The process is based on the widely accepted 3-stage Bardenpho Biological process used very widely in South Africa. The big difference here is that the activated sludge is immobilized on the bio-carrier material, making the process much more efficient and requiring smaller process tanks

The first treatment stage is the anaerobic section. This is necessary for the removal of phosphates. The second stage is the anoxic reactor. In this reactor, nitrified effluent (nitrate) is converted to Nitrogen gas that escapes, while the

bacteria utilizes the organics in the effluent simultaneously. This reactor is mixed with a small electrical mixer.

The third stage is an aerated tank, where the organic material and ammonia is converted. Aeration is done with a blower.

All the reactors contain the special bio-carrier media.

There is a recycling pump that recycle process water from the 3rd to the 2nd stage to enhance nitrogen removal.

The addition of the denitrification step has two added advantages

- It makes the system more energy efficient as it recovers Oxygen
- It makes the system more stable as alkalinity recovered

5. **Clarification**

The last stage consists of a high rate clarifier with inclined media. In this stage the fine biomass is separated and settles to the bottom the conical clarifier. The water overflowing here is very close to general standards, except that the TSS might still be high. Sludge is withdrawn periodically by an automatic sludge valve and is discarded to the sludge drying bed.

6. **Ferric chloride dosing**

We have allowed for ferric dosing in case that additional phosphate removal is required or if the TSS must be reduced. The system is automatic and will self-adjust with the flow.

NOTES:

a) *If the water is to be used for irrigation, it is not necessary to remove phosphate to the general standard, as the phosphate remaining in the treated water will eliminate the need to add phosphate fertilizer to lawns.*

7. **Sludge handling:**

   We propose that sludge drying beds be constructed by client – we will issue dwgs for this. The dried sludge is then raked off and can be mixed with a bulking agent like cut grass to make compost.

8. **Sand Filters**

At Southern Camp and River Camp there are existing slow sand filters. These will be used as is and treated effluent from the plant will be filtered here for additional polishing.

At sites where there are no such facilities, pressure filters will be installed to reduce the TSS in the effluent.

9. **Final Chlorination**

The clarified water is chlorinated and gravitates to a treated water tank that acts as chlorine contact tank. The minimum contact time is 20 minutes. The overflow of this tank will then irrigated.

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Program (per site)

Detail Design and Dwgs: 2-3 weeks
Manufacturing and procurement: 8 weeks
Civil preparation work: By client, roughly 4-6 weeks
Installation: 2 weeks
Commissioning and training: One week (but process takes about a month to stabilize)

Operating personnel

The plant can easily be operated by one operator only, that needs to be there for a maximum of 1-2 hours to check everything.

Yours Sincerely,

Water Skills (Pty) Ltd

Herman van der Westhuizen
MANAGING DIRECTOR