Wastewater Stabilization Pond Technology: Effectiveness and Efficiency at the Ratjomose Sewage Treatment Plant, Maseru, Lesotho

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Abstract: The study was carried out to determine performance and efficiency of stabilization ponds at Ratjomose sewage treatment plant in removal of Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS) and total phosphorus from wastewater. Factors that may affect the plant's efficiency and effectiveness were also determined. Grab samples of wastewater from the influents and effluents of facultative ponds (F1 and F2) and maturation ponds (M1 and M2), were analysed according to standard analytical procedures for water analysis. Facultative pond 1 showed 40%, 93.3% and 85.1% efficiency in removal of BOD, TSS and Total phosphorus respectively. Facultative pond 2 showed -233.5%, -255% and -14.2% removal efficiency for BOD, TSS and total phosphorus respectively. Maturation pond 1 showed 55%, -427%, and 87.5% removal efficiency for BOD, TSS and Total phosphorus; whereas maturation pond 2 showed 6.4%, -10.6% and -26.7% removal efficiency for BOD, TSS and Total phosphorus respectively. Temperature was measured at sampling point, and temperatures ranged from 20 to 28 ºC. Removal efficiencies of these ponds were thought to be affected by inadequate maintenance and introduction of detergents into the ponds by people living around the treatment plant. The plant thus needs better management and an upgrading, to ensure the protection of the environment and public health..

Keywords: Wastewater, Wastewater stabilization ponds, Efficiency, Upgrading.

1. Introduction

Lesotho is a mountain kingdom in the Sub-Saharan Africa, surrounded by its only neighbouring country, South Africa. It has a surface area of just over 30,000km², with a population of about 2 million inhabitants. Maseru is the capital city, directly on the Lesotho-South Africa border. The population of Maseru is about 227, 880, with a size of approximately 138km².
Wastewater (as blackwater) emanating from parts of Maseru is treated at the Ratjomose wastewater treatment plant. The main reasons for the treatment are to prevent environmental pollution of soil, surface water and groundwater, to protect the receiving water (the fluvial environment of the Caledon River in this case), by enabling acceptable discharge. Other reasons are to prevent eutrophication, and to protect public health, together with ensuring environmental aesthetics.

The Ratjomose wastewater treatment plant (RWTP):

At the Ratjomose wastewater treatment plant, the Water and Sewerage Company (WASCO) is the service provider. The plant is the largest sewage treatment facility in Lesotho, making use of conventional treatment technologies, waste stabilization ponds being quite prominent. It is found South West of Maseru on the banks of the Mohokare (Caledon) River.
Sewage sources are industries, hospitals and homes in and around Maseru. The sewage is brought by a sewerage network. The contents of the sewage include plastics, twigs, human wastes, etc (blackwater). The sewage flows through two main sewers of 1.5m diameter, handling up to 20 m^3/day. Figure 1 shows the treatment flow scheme.

Raw sewage ⇒ Screens ⇒ PST ⇒
TF ⇒ SST ⇒ FP ⇒ MP ⇒
Caledon River.

Figure 1. Treatment flow scheme at the Ratjomose wastewater treatment plant

The main stages of the treatment scheme are depicted in Plates (A-E) in figure 2. The plant serves a catchment area of about 20 km^2. The topography of Maseru has enabled installation of eleven pumping

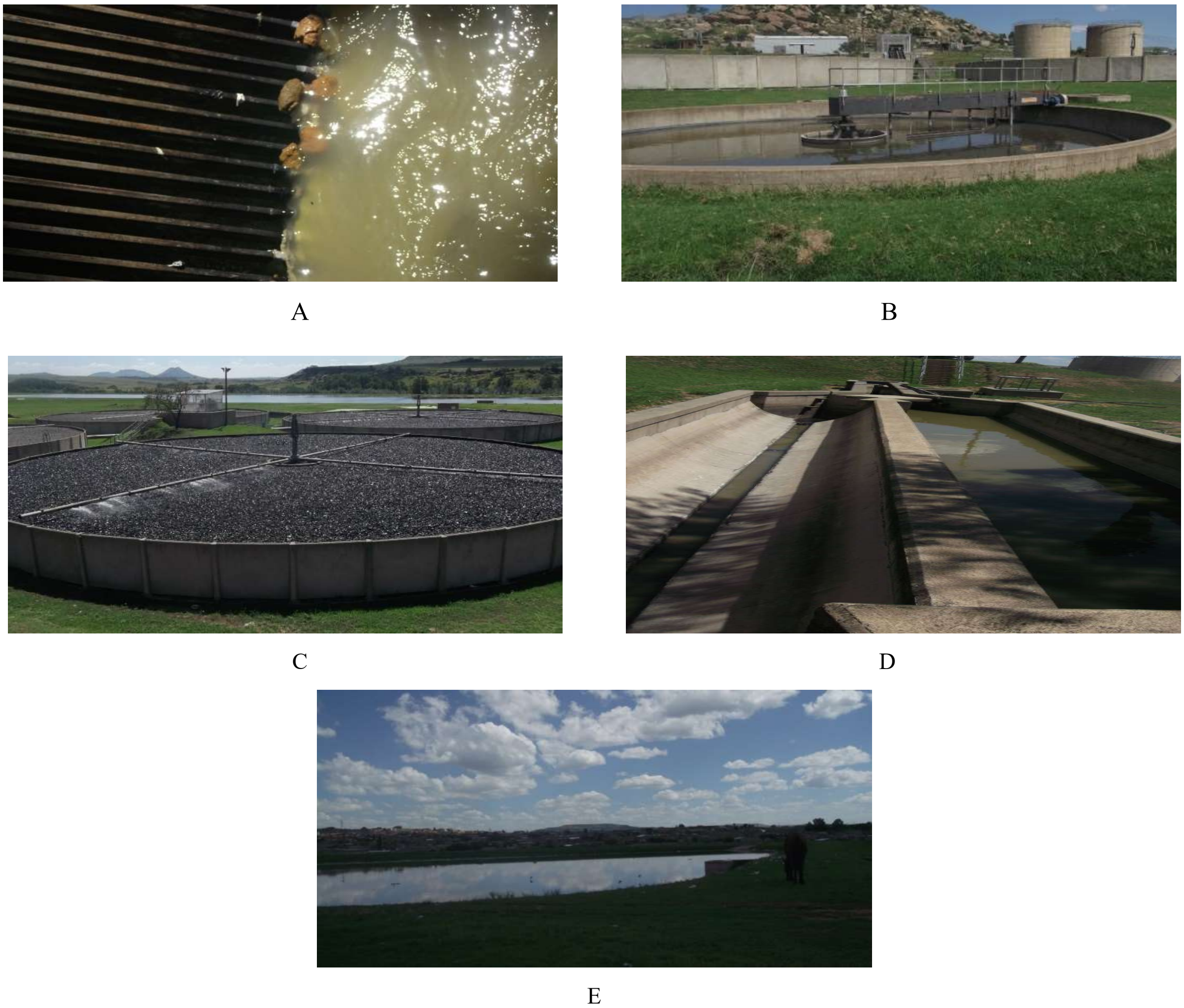

Figure 2. Plates of the treatment scheme: A-Screens; B- PST; C- TF; D- SST; E- Pond system.

stations to assist in transporting sewage to the treatment plant under gravity. The population served is estimated to be over 12 000.

The treatment plant treats the blackwater through the following four stages: preliminary treatment (with the screens), primary treatment (through sedimentation), secondary treatment by four trickling filters, two facultative and four maturation ponds. Due to the use of the trickling filters, the pond system has no anaerobic ponds. The trickling filters remove about 60% of Biochemical Oxygen Demand (BOD) and the effluent goes straight into the first facultative pond. Tertiary treatment is with the maturation or aerobic ponds.

Table 1 shows the pond characteristics. F1 indicates the first facultative pond, F2 the second facultative pond, M1 the first maturation pond and M6 the fourth maturation pond (6^{th} pond).

The principal objectives of the research were to:

- Determine the levels to which waste stabilization ponds (WSPs) at Ratjomose sewage treatment plant remove Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS) and Total Phosphorus (P), to determine their treatment efficiencies.
- Determine factors that affect the efficiency & effectiveness of the WSPs.

2. Materials and Methods

Grab samples of wastewater from the influents and effluents of facultative ponds (F1 and F2) and maturation ponds (M1 and M6), were analyzed twice according to standard analytical procedures for water analysis [1]. Temperature (T) was taken at sampling point with a thermometer. the samples were transported in an ice box to the laboratory and stored at 3°C. Phosphorus (P) samples were preserved with conc. sulphuric acid. BOD was analysed using the Winkler Azide Titrimetric method. Totao suspended solids

Table 1. Pond characteristics with sampling points (F1, F2, M1, M6)

STABILIZATION POND	LENGTH (m)	WIDTH (m)	DEPTH (m)
F1	650	166	1.8
F2	333	171	1.8
M1	228	68	1.5
M6	171	114	1.5

(TSS) was determined by gravimetry, following heating at 105°C overnight. P was determined by Digestion and Ascorbic Acid Spectrophotometry.
Treatment Efficiency was measured as:

(output/input)×100%, where:

Output= influent concentration – effluent concentration and Input= influent concentration

3. Results and Discussion

Table 2 shows the removal efficiencies for the 3 parameters- BOD, TSS and P for trial 1. Results for trial 2 were similar and are not shown.
Removals for all 3 parameters were good for F1 (entry into the pond system). At other levels of the pond system there was hardly any removal, pointing to low maintenance as one reason. But the presence of the parameters in influents was also low.
The ponds need to be disludged, as there are surely dead spaces (sludge occupied), causing reduction in hydraulic retention time [2]. This was confirmed by a worker at the plant, who talked of no pond disludging since he started working there. However, such results are not far from similar systems in other developing countries. See, for example, [3].
The results showed good removal efficiency of BOD, TSS and total phosphorus at F1 and poor in the other WSP stages, both in trials 1 and 2. Temperature was measured at sampling point, and the temperatures ranged from 20 to 28°C. The removal efficiencies of these ponds were affected by inadequate maintenance and introduction of detergents into the ponds by people living around the treatment plant. Indeed, generally,

Table 2. Removal efficiencies

Pond's Name	Parameter	Influent (mg/l)	Effluent (mg/l)	Removal Efficiency (%)
F1	BOD_5	1.572	0.943	40
	TSS	148.4	10	93.3
	Total phosphorus	18.8	2.8	85.1
F2	BOD_5	0.943	3.145	-233.5
	TSS	10.0	35.5	-255
	Total phosphorus	2.8	3.2	-14.2
M1	BOD_5	3.145	1.415	55
	TSS	35.5	187.1	-427
	Total phosphorus	3.2	0.4	87.5
M6	BOD_5	2.67	2.5	6.4
	TSS	75.13	83.12	-10.6
	Total phosphorus	6.0	7.6	-26.7

stabilization ponds are said to be of low cost, low maintenance and highly efficient in removal of nutrients, biochemical oxygen demand (BOD) and pathogens, but may fail, due to lack of technical knowledge, and failure to consider all relevant local factors at the pre- design stage. So, the ponds have been well designed [4], but their operation and maintenance are not optimal.

4. Conclusion and recommendations

The facultative and maturation ponds are found to be well designed. However, from poor operation and low maintenance, results are not good, especially for sections after F1.
Rock filters may be installed to further polish the maturation pond effluent. Retrofitting of baffles into the ponds may also help. Again, the public should be kept away, as people interfere with the pond functions, e.g. by introducing detergents (P) that lead to eutrophication.

5. References

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