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TREATMENT OF COMMUNITY WATER SUPPLY: CONSTRUCTED WETLANDS
A SASOL CONCEPT PAPER

1. INTRODUCTION

Kitui District is mainly a semi-arid area and the lack of water is a perennial problem. The perpetual lack of water limits development. Insufficient water provided the impetus of establishing SASOL, an NGO whose major effort is to bring water within 2 km of every home in Central Kitui. This is achieved using community-based construction of a large number of sand dams to conserve water in sandy rivers. Towards this end over 140 dams have now been constructed in Kiindu, Musya, Nduni, and Mwewe and Kisiiyo rivers.

SASOL's efforts to maximise provision of clean water to the community is currently hampered by the pollution of Kalundu and Nzeeu rivers, the major river systems in the project area. Due to lack of proper treatment of the sewage and urban effluents, the two rivers receive substantial pollution as they pass through Kitui Town. Water from these sources therefore presents a health risk to the communities downstream. Hence the two rivers are not at present included in the SASOL's dam programme.

A major challenge of the community water development programme in this area is to clean Kalundu and Nzeeu river water at the immediate downstream of Kitui Town to a level acceptable for human consumption and other domestic uses. Due to meagre funds available and the high input of resources required in constructing treatment facilities, conventional waste water treatment will not be feasible in the cleaning of waste water associated with the two rivers. Constructed wetlands, however, offer an alternative to the conventional treatment of the contaminated waters. Constructed wetlands provide relatively simple and inexpensive solution to a wide variety of water pollution problems. This facility has great potential for utilisation in the treatment of the two polluted rivers.

2. CONSTRUCTED WETLANDS

Wetland ecosystems have the ability to remove aquatic pollutants through a variety of physical, chemical and biological processes occurring in the substrate-water matrix and plant rhizosphere. There is now convincing evidence that wetland ecosystems can be used as alternative treatment works for a variety of wastewater effluents. However, natural wetlands are usually unavailable at the sites where treatment of wastewater is required. Hence a need for the establishment of constructed wetlands at appropriate sites where treatment of wastewater is required.

Constructed wetlands are systems that are designed to simulate processes that occur in natural wetlands. They have five major components including substrates, macrophytes, water, microbes and fauna.

2.1. Substrate

Physical substrates in constructed wetlands have various rates of hydraulic conductivity. These include various soils, sand and gravel which provide support for plants, provide surface areas for complexing ions and anions and other mineral components and attachment surfaces for microbial population.

2.2. Macrophytes

Wetland plants provide surface area for the attachment of microbial populations. The aquatic plants have the ability to transport atmospheric gases including oxygen down into the roots to enable the roots and plants survive in anaerobic environment. Transport of O2 to the roots produces a thin film of aerobic region called rhizosphere surrounding the root hair, which supports a large microbial population involved in pollutant transformations. The plants conduct uptake of nutrients and other minerals and subsequent incorporation into biomass.

2.3. Water Column

Surface and subsurface water transports substances and gases to microbial populations, carries off by-products and provides the environment and waste for biochemical processes of plants, fauna and microbes.

2.4. Microbes

These include bacteria, fungi, algae and protozoa. They alter the contaminants substances to obtain nutrients or energy to carry out their life cycles and in so doing break up pollutants. The effectiveness of the constructed wetlands is dependent on developing and maintaining optimal environments for desirable microbial populations. Fortunately the microbes are ubiquitous, naturally occurring in most waters and are likely to have populations in the wetlands and contaminated waters. In addition many naturally occurring microbial groups are predatory and will forage on pathogenic organisms. Wetland microbial populations that conduct critical processing of pollutants have short generation times, high reproductive rates and considerable genetic plasticity, all which permit these organisms to rapidly adapt to and exploit new nutrient or energy sources.

3. OPERATION AND PERFORMANCE.

Operational experience and research results reported in the available literature suggest that a growing interest in the use of constructed wetlands as part of water treatment offers considerable opportunity for realising sizeable future savings in waste water costs especially for small communities. Constructed wetlands help small communities to meet wastewater treatment requirements of the future. They provide treatment systems that are not only effective and reliable but also simple and inexpensive to build and operate.

Constructed wetlands offer a promising alternative to conventional treatment plants. They have the following qualities:

- relatively inexpensive to construct and operate
- easy to maintain
- provide effective and reliable waste water treatment
- relatively tolerant of fluctuating hydrological and contaminant loading rates
- provide green space, wildlife habitats and recreational and educational areas.

4. LOCALAND REGIONAL EXPERIENCES

Use of constructed wetlands for the treatment of wastewater is rare in East Africa. Nevertheless, Carnivore Restaurant has demonstrated the efficacy of constructed wetland facility in the treatment of the hotel in-house wastewater. Local communities have, however, utilised natural wetlands especially papyrus swamps for dumping sewage effluents from primary treatment works. Recent studies in East Africa have shown that papyrus swamps can remove large amounts of nutrients from waters flowing through them.

The removal of nutrients and pollutants by papyrus swamp from Kampala sewage effluent while it passes through Nakivibo Swamp to Lake Victoria demonstrates the role of wetlands in waste treatment under local conditions. In Lake Naivasha, a large percentage of mineral input is retained by papyrus swamp. The percentage removal of elements from the inflowing Malewa River was of the following order: phosphorous (57%), sulphur (59%), iron (83%) and manganese (94%). The efficacy of Kahawa Swamp (near Nairobi) in wastewater purification has also been reported. This is a small swamp (3.2 ha) situated on Sukari Ranch, opposite Kenyatta University. The swamp receives inflow consisting mainly of sewage effluent from Kahawa barracks. Studies show that the Kahawa Swamp efficiently treats sewage, thus reducing over 76% ammonia and 80% phosphate contained in the sewage effluent.

Evidently wetlands whether natural or constructed have considerable water purification properties. This potential can be utilised in cleaning the Kalundu River with subsequent reduction of pollution downstream of Kitui Town. This will pave the way for SASOL to establish sand dams and provide clean water to the community.