ECOSTP®
sewage to gold™

ECOSTP Technology Whitepaper

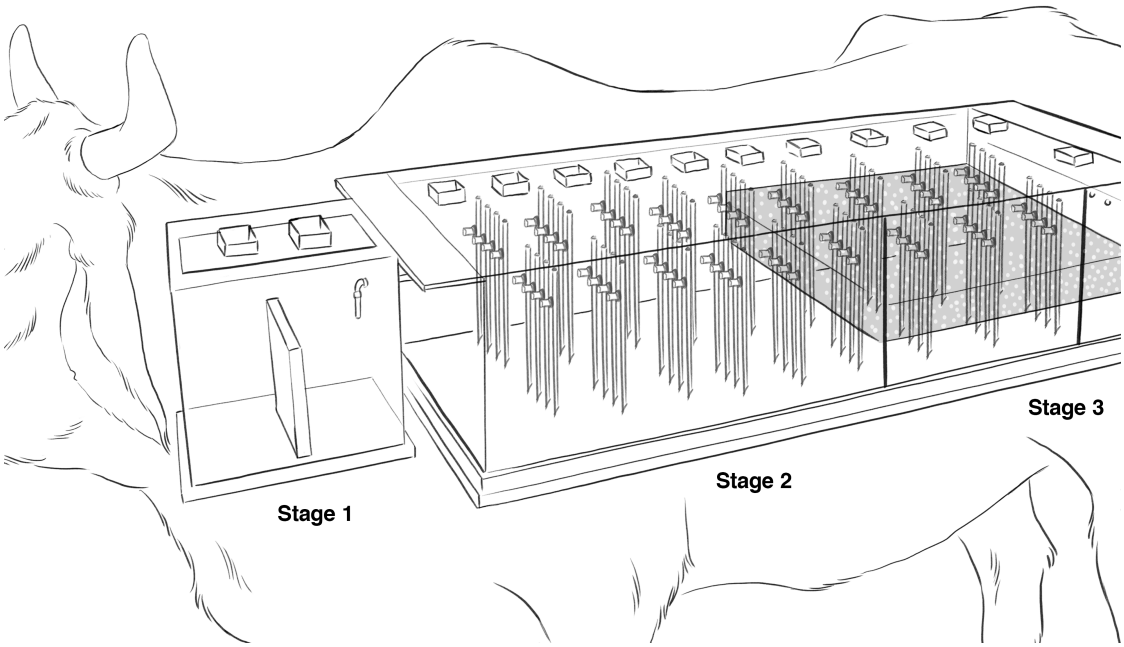

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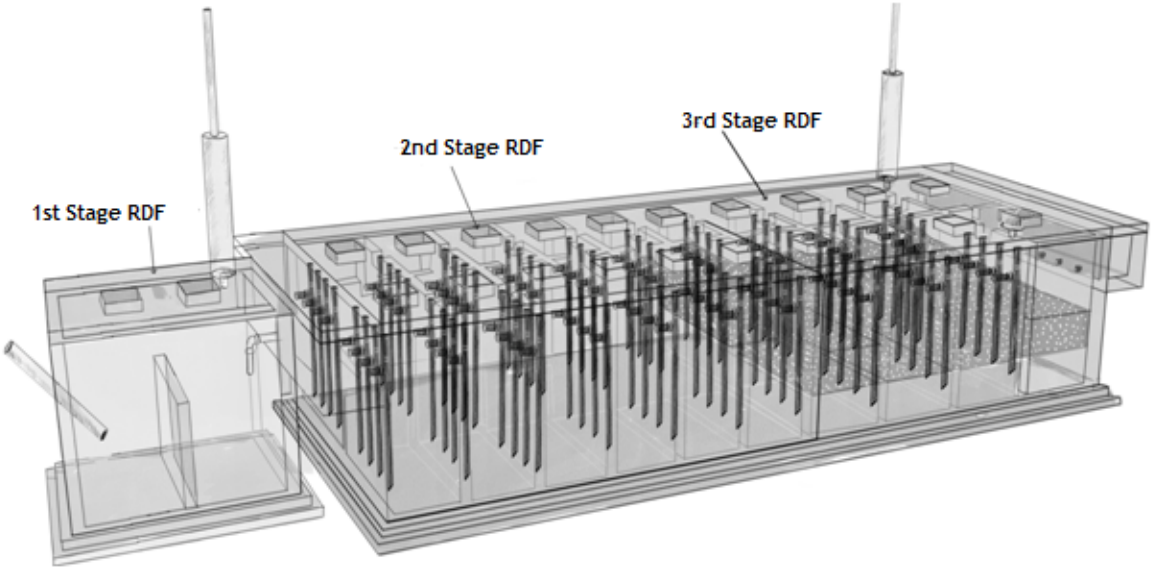
TABLE OF CONTENTS

Introduction

The unique ECOSTP “Zero Power Zero Maintenance” Sewage Treatment Technology has no moving parts compared to conventional STPs which use energy, hogging motors, exhaust fans, pumps, and blowers. The product is a replica of a cow’s stomach based on biomimicry concepts. This documents outlines the technical details of the patented system.

Overview

The ECOSTP technology offers a state of the art sewage treatment solution taking maximum advantages of natural processes to achieve a reliable and eco-friendly sewage treatment system. The technology works independent from power supply and daily surveillance, treating the wastewater to pollution control board specifications. The ECOSTP product comprises of three separate units as shown in figure below.



Each of the chambers has specific functionalities and components such as filter media and baffle pipes. We introduce custom anaerobic bacteria which works a natural pollutant remover.

The unique technology does not use chemicals or energy to treat the water. Sewage is treated by a combination of microorganisms, plants and gravel to and return clean

water back to mother earth. The treated water can be reused for different purposes like irrigation, flushing of toilets, cooling and heating, washing, groundwater recharge or even potable usage.

ECOSTP technology can be used for community, domestic, hospital as well as for different kinds of wastewater of any volume, complying with the PCB discharge standards. It is a tailored solution taking the specific site conditions and the requirements of the client into consideration to offer the best economical and ecological option for wastewater treatment.

Biomimicry - Nature inspired design

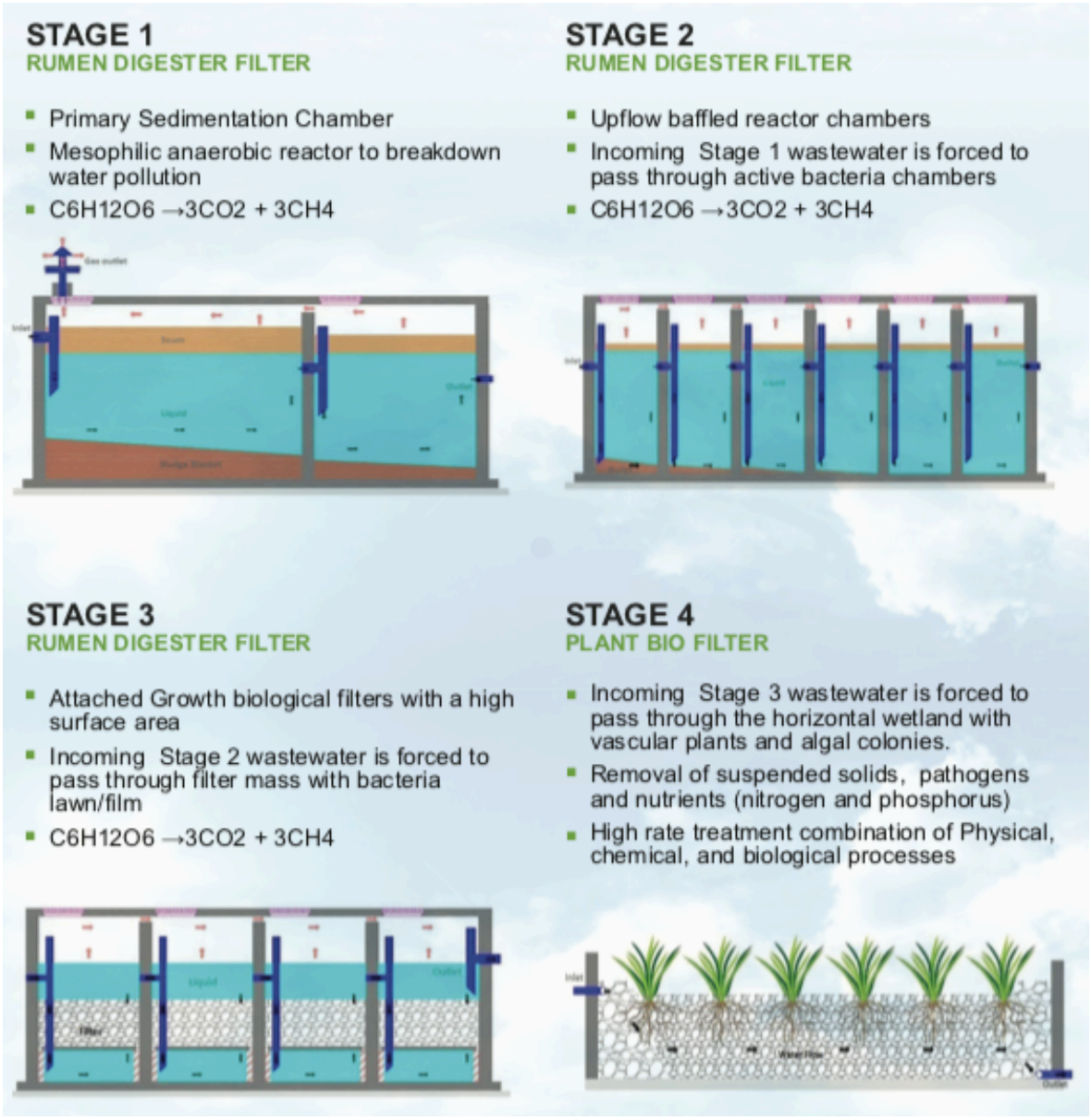
Our biological strategy was to look at how a cow's stomach implements anaerobic digestion in detail. As we all know, the ruminant stomach in a cow turns grass into milk, meat, and wool. We biologized the same method to convert "bad" water to "good" water using exactly the same ruminant stomach process.

Our natural digester model based on the biology of a cow's stomach is used to break down organic fecal content into treated water. We add anaerobic bacteria catalyst seed (one time addition) from a cow dung substrate and the end result is that sewage you put in is converted to water, some gas, and very little sludge (digester). We also added two more natural layers as Stage 2 and 3 to help in disinfection (E. coli) of the treated water. In other words, the three stages work cohesively as a living system.

This is classic biomimicry—mimicking the self-healing processes of nature — AND the use of an organism to perform a function, in this case the anaerobic bacteria.

ECOSTP Functional Units

ECOSTP is a combination of different wastewater treatment technologies cascaded in modules to a full-blown system, to achieve the required effluent quality for the reuse purpose.



The first part of the cascade always consists of three specific anaerobic modules, performing extensive wastewater stabilization in terms of organic pollution. Different options of additional modules can be added for further polishing of the water in accordance with the targeted effluent quality.

The four stages of ECOSTP Technology are highlighted in the figure above.

Modules of ECOSTP

The anaerobic core modules are:

- 1st Stage Rumen Digester Filter (RDF)
- 2nd Stage Rumen Digester Filter (RDF)

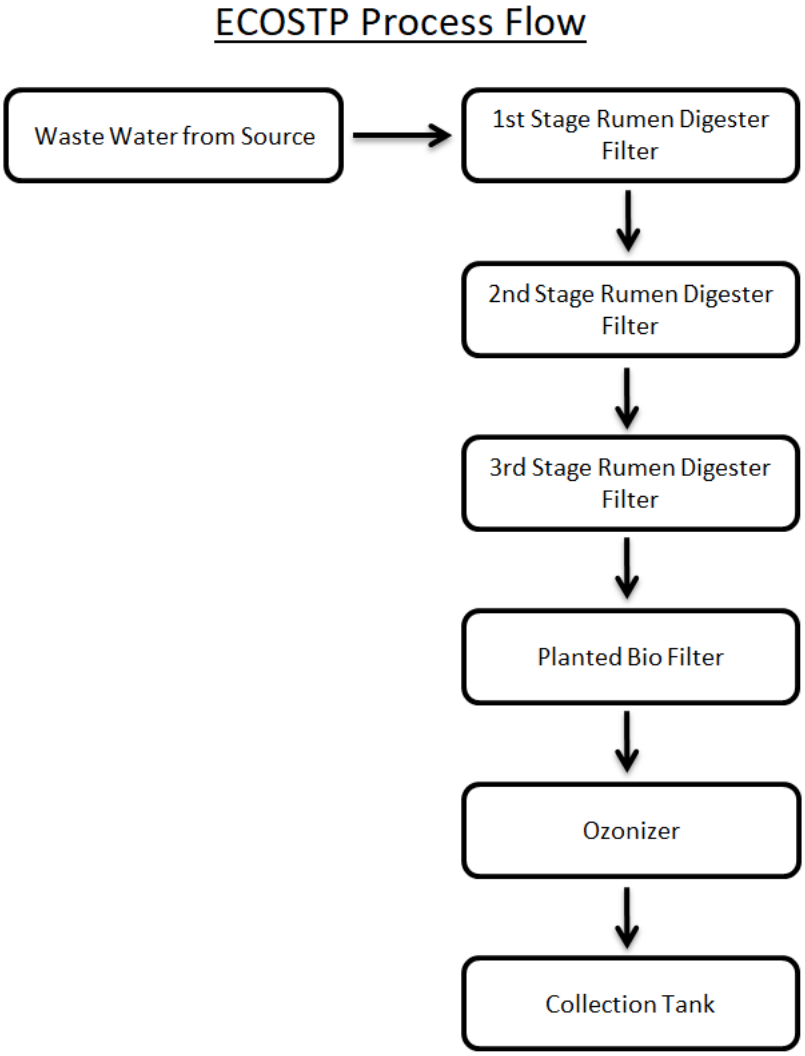
- 3rd Stage Rumen Digester Filter (RDF)

Plus (+) 4th Stage tertiary treatment modules are:

- Planted Bio Filter (PBF) OR Activated Charcoal Filter+ Pressure Sand Filter
- Sand filter (SF) (slow, rapid, aerated)
- Disinfection : Ozoniser /Chlorine Dozer/ UV Lamp

ECOSTP Treatment Process Flow

The design concept is as per the flowchart below:



The wastewater from all the sources is combined and is applied with a treatment appropriate to it. The waste water passes through various stages as shown above to achieve 'flushing quality' water. Additional modules can be added to achieve 'potable quality' water.

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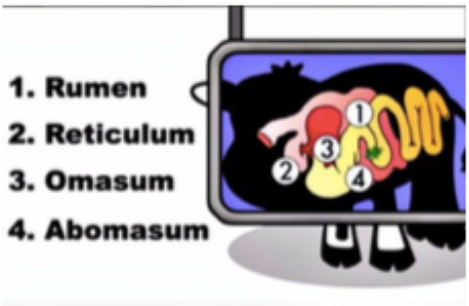
ECOSTP Anaerobic Digestion Design

ECOSTP is a very sophisticated 20 step 3 stage anaerobic treatment system which is modelled around the Cow's stomach.

We took inspiration from the cow's stomach, replicating its chambers and coming up with a civil engineering design which can be used for natural treatment of sewage.



There are two biological strategies at play here.

1. We formed a STP structure mimicking the cow's stomach. There are 3 chambers interconnected with multiple pipes, with roughness added to the chamber walls to increase the surface area.
2. The second component is the bugs that clean up the sewage.

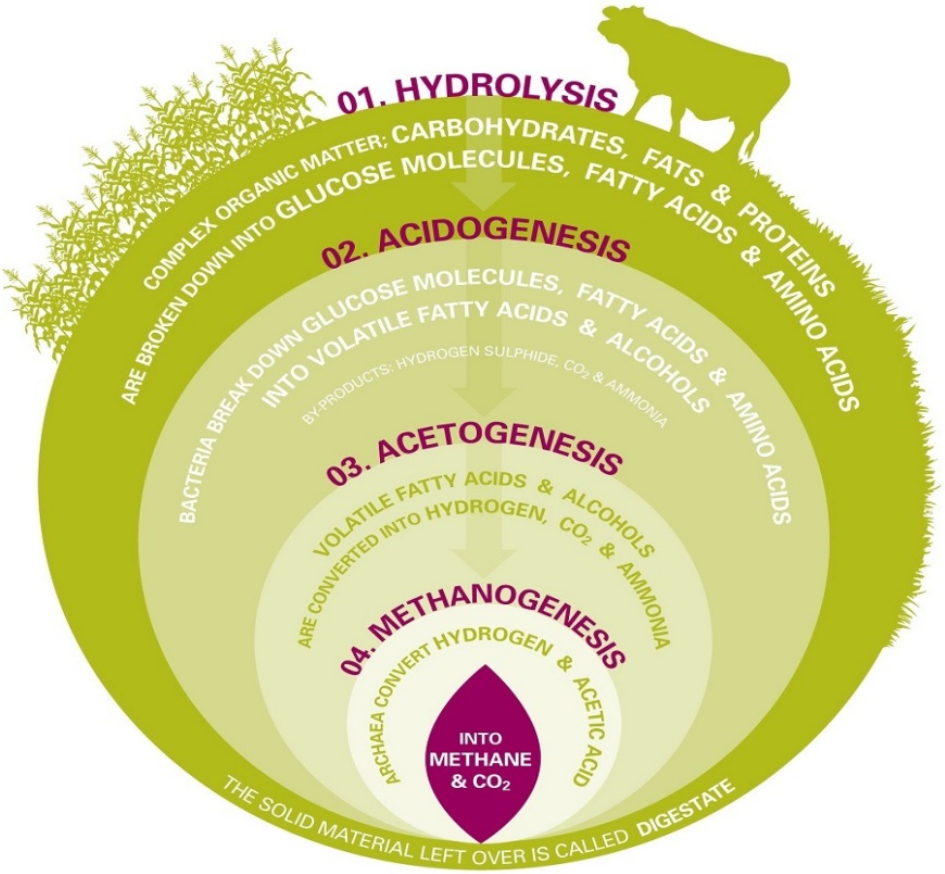
Let's understand the bugs in detail.

Life began on earth when there was no oxygen (primordial atmosphere). The earliest organisms used to get energy from methane, carbon dioxide, and sulphur compounds. Archea anaerobic bacteria and facultative anaerobic fungi (*Neocallimastigomycotorigin*) are all examples of such an environment. These bugs convert and clean the sewage in ECOSTP.

At micro level, the anaerobic sludge digestion process is carried out by microbes under anaerobic conditions (i.e., oxygen is not used in the degradation process reactions). This makes it different from aerobic digestion wherein oxygen is used. Anerobic digestion can also be more economical than aerobic treatment / aerobic septic system as aeration process is not required for the anaerobic digestion.

In anaerobic digestion, organic matter is degraded by a microbial population consisting of bacteria in the absence of oxygen.Further, anaerobic digestion processes can be one-phase (also called single-phase) or two-phase or three phase. In one-phase anaerobic digestion, the complete digestion is taking place in one unit or digester. In two-phase and three phase fermentation, the first hydrolysis and acidification phase and the subsequent methanogenic phase are run in separate tanks.

The process of anaerobic digestion takes place in four steps in a cow's stomach: Rumen, Reticulum, Omasum, and Abomasum. ECOSTP is a replica of the same. The process is as follows.



Phase 1 - Hydrolysis: During this phase, the long-chain organic compounds (e.g. proteins, fats, carbohydrates) are split into more simple organic compounds (e.g. amino acids, fatty acids, sugars) through bacterial action.

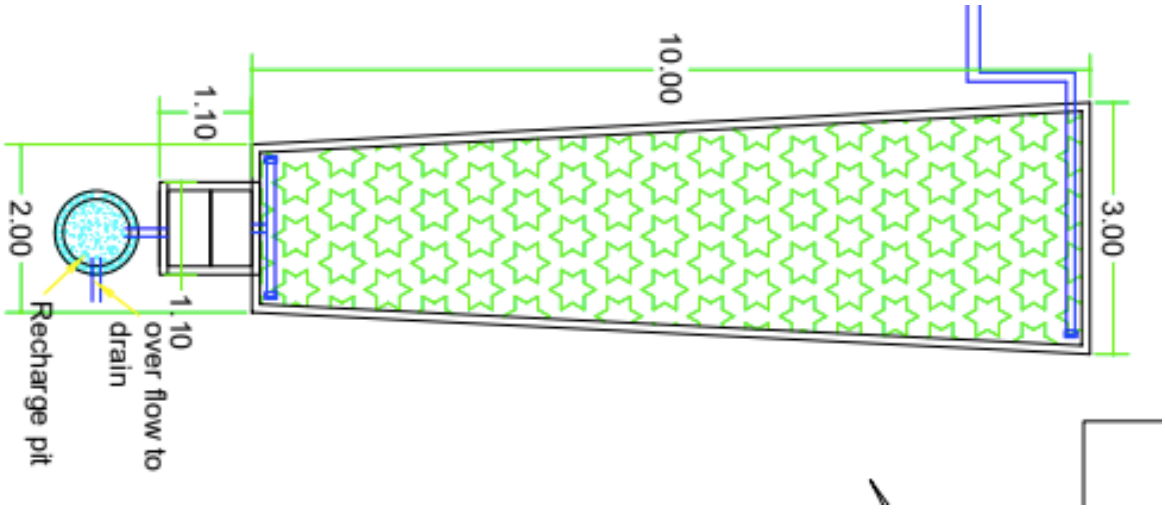
Phase 2 - Acidogenesis: The products of hydrolysis are subsequently metabolized in the acidogenesis phase by acidogenic bacteria and broken down into short-chain fatty acids (e.g. acetic acid, propionic acid, butyric acid, valeric acid) and alcohol. They belong to diverse genera such as Escherichia, Flavobacterium, Alcaligenes, Aerobacter, Psuedomonas, etc., and can function in a large pH range.

Phase 3 - Acetogenesis: The organic acids and alcohols are broken down from acetogenic bacteria into acetic acid, hydrogen, and carbon dioxide.

Phase 4 - Methanogenesis: The products from the previous phases are converted into methane and carbon dioxide. Microbes involved in this process are also anaerobic and belong to the Methanococcus, Methanobacterium, and Methanoscarcinagenera.

Tertiary Treatment - Plant Gravel Filter

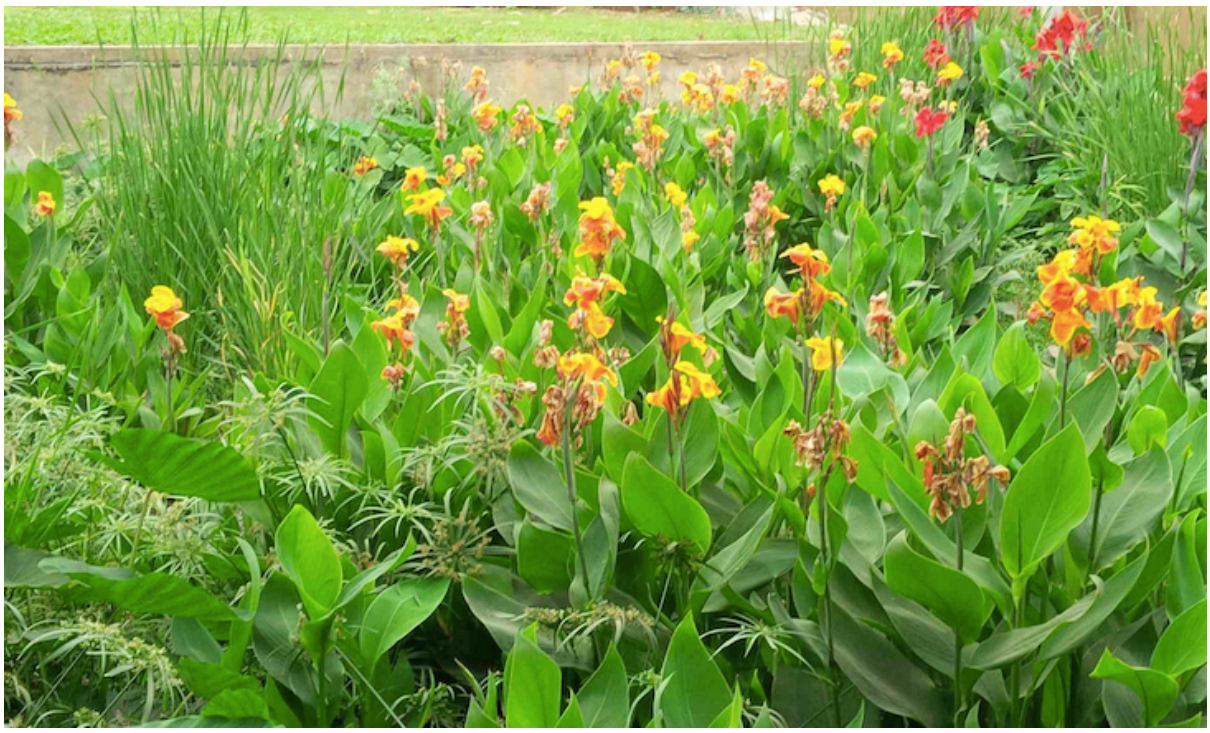
Plant Gravel Filter (Modified Constructed wetlands) are shallow-water ecosystems that mimic natural wetlands. The wetland ecosystem—water, plants,



microorganisms, sunlight, substrate, sand and air—filters and treats wastewater. Water quality is improved through physical, biological, and chemical processes.

Though many plants like bulrushes (Scirpus), spikerush (Efeocharis), other sedges (Cyperus). rushes (Juncus), common reed (Phragrnites), and cattails (Typha) can be used in the indian context we find Canna (canna lily) ,Colocasia (Araceae) and papyrus (Cyperus papyrus) as the sturdy ones with little maintenance.

Treatment through Plant Gravel Filter removes pollutants, organic matter, metals, hydrocarbons, nitrogen, phosphorus. A variety of pathogens is also removed. Plant Gravel Filter consists of soil, water, plants and micro organisms and there are many interactions between them. Treatment occurs as wastewater flows through the substrate and the rhizosphere. The slow flow allows longer periods of contact between wastewater and wetland surfaces. A diverse community of aerobic and



anaerobic microorganisms is attracted to the organic/inorganic materials and the opportunities for gas/water interchanges. Microorganisms attach to roots and rhizomes, forming a biofilm that breaks down pollutants and organic matter. Nutrients–carbon, nitrogen, and phosphorus–provided by plant litter and

decomposing plants feed the microbial process. In the substrate, suspended solids are filtered out of the wastewater and pathogens are removed by filtration and adsorption. The saturated substrate creates an oxygen-deprived environment in which oxygen is consumed more rapidly than it is replaced.

This low-oxygen environment prevents the growth of plants unfit for a wetland environment.The low-oxygen environment is also essential to the elimination of pollutants. Nitrogen is broken down and nitrogen gas is released harmlessly into the atmosphere. Phosphorus is collected and stored within a wetland system by binding phosphorus in organic matter or by coprecipitation with iron, aluminum, and calcium. Likewise, heavy metals are sequestered in the substrate or absorbed by plants.

Lastly the Plant Gravel Filter has a sand filter integrated completing the unique design.

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