International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

DEVELOPING A VERTICAL FLOW CONSTRUCTED WETLAND (VFCW) TO TREAT WASTEWATER

Dr. Mahesh B. Chougule[1], Mr. Bhushan S. Satpute[2], Mr. Deepesh U. Rajmane[3], Mr. Vaibhav N. Patil[4], Mr. Sohan M. Patole[5], , Mr. Shivam C. Kalayani[6.]

[1]. Professor in Civil Engineering, D.K.T.E. Society's Textile and Engineering Institutes, Ichalkaranji, Maharashtra, India

Corresponding author Email: drmbchougule@gmail.com

[2-6] Students, Civil Engineering Department, D.K.T.E. Society's Textile and Engineering Institutes, Ichalkaranji, Maharashtra, India

ABSTRACT :

For the purpose of irrigation, the source of water that is valued highly is water. In this manuscript, an effort is made for evaluated the effluent quality from the industry. This region is located Ichalkaranji. In this research, the samples have been gathered and in order to reduce the very high costs of industrial disposal throughout worldwide, more decentralized purification system need to be established. To attain higher surface water quality, and thereby the acceptance of such system by governmental authorities, good removal rates for organic substances and also for nutrients (N, P) are necessary. This study compares the purification performance of vertical constructed wetland (VCW) in one container remediate sites contaminated with organic and inorganic pollutants. The studies aim at developing and accessing domestic waste water treatment efficiency through a VFCW pilot scale plant for treatment of sewage to test its pollutant sorption capacity. The samples were analysed at treatment in the VCW as bedding media with stone, boulders, and sand. This paper focuses on how the pollutants using Colocasia esculenta plant, Canna Indica, and Mangrass with stone and sand, boulders bed has performed the treatment efficiency and need to notice that how Colocasia esculenta, Canna Indica,and Mangrass.

Keywords: VFCW, Colocasia esculenta plant, Canna Indica, and Mangrass

INTRODUCTION:

Today, water availability is a problem all over the world in terms of both quantity and quality. This problem is getting worsened as the world population and industrialization is increasing and climate change is affecting water resources, mainly in water stressed developing countries. Wastewater discharges are causing eutrophication and water borne diseases. The situation is getting worse with rapid urbanization where adequate sanitation and wastewater treatment facilities are lacking.

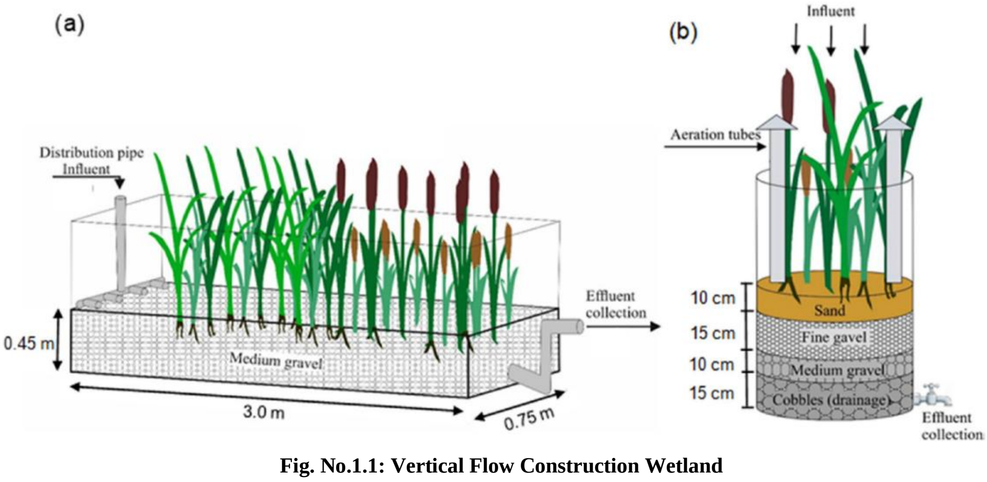


Fig. No.1.1: Vertical Flow Construction Wetland

Source:https://tse2.mm.bing.net/th?id=OIP.7yAWoN_RZLzDsz5lXgdVFQHaDZ&pid=Api&P=0&h=220

The treatment of wastewater using Constructed Wetland (CW) is one of the suitable treatment systems, used in many parts of the world. This system seems to have the potential to be one of the sustainable solutions in treating and then discharging the huge quantity of wastewater and getting access to safe drinking water. Constructed wetlands (CWS) are treatment systems have been designed to accomplish natural processes with wetland substrates, vegetation and the associated microbial assemblages to help in treating wastewaters and take advantage of the processes that occur in natural wetlands within the more controlled environment. The Constructed Wetlands (CW) is designed to mimic natural wetlands with much high degree of treatment for pollution control. Despite recognizing CW as an alternative for conventional wastewater treatment, little has been done in developing countries. Conventional (e.g. biological) and advanced wastewater treatment technologies like activated sludge followed by membrane filtration or chemical treatment are used in many countries for wastewater treatment. However, considering their costs, contaminant removal efficiencies and operational skills required for advanced wastewater treatments, natural treatment systems might be more sustainable and appropriate for developing countries. These natural wastewater treatment systems are used to improve treatment efficiencies by using natural processes. These natural processes of treatment include physical, chemical and biological 1 mechanisms and require less energy, reduce the use of chemicals and have a small carbon footprint in comparison with conventional systems. In terms of contaminant removal efficiency, cost reduction and simplicity, CWs are more suitable. Among the different types of CWs, Vertical Constructed Wetlands (VCW S) are post widely used and became low impact alternatives to more conventional wastewater treatment processes. In a typical VCW, wastewater is maintained at a constant depth and flows horizontally below the surface of the bed. it has been proven to be efficient in removing pollutants, organic matter and pathogens. In VCWs, organic matter is decomposed by both aerobic and anaerobic processes, but an insufficient supply of oxygen in this system greatly reduces the performance of aerobic biological oxidation. Moreover nitrification is the main limiting factor for N removal due to low oxygen availability. Artificial aeration would favour aerobic organic matter oxidation and nitrification in VCW. The main operational problem in CW is progressive clogging of the porous support and growth media, which diminishes the hydraulic performance, and consequently affects the pollutant removal efficiency and life span of the system. The growth of biofilm and microbial activity may depend on oxygen availability in the CW and thus may affect the solid removal efficiency and clogging. The exact mechanisms of granular medium clogging are still unclear. It is believed that accumulation of organic and inorganic solids, growth of biofilm, chemical precipitation and deposition, plant debris and swelling of soil colloids are the main causes of clogging. Biofilm is a collection of micro-organisms surrounded by slime they secrete. Biofilms are mainly comprised of bacteria, fungi, algae and micro-invertebrates. In vertical flow constructed wetlands (VCWS), biofilm (growth of micro-organisms) in substratum pores is regarded as an important factor of causing clogging. Phytoremediation is the use of plants to remediate contamination by the uptake of contaminated water by plants. The phytoremediation technology is uses certain aquatic plants to clean up the water contaminated with metals and organic contaminants. Plants are used to remove or degrade contaminants with an old process that occurs naturally in ecosystems as both in-organic and organic constituent's cycle through these plants. It is an aesthetically pleasing mechanism that can reduce remedial costs, restore habitat and cleanup contamination rather than entombing it or transporting the problem to another site. This study is focused on development of pilot scale Vertical Flow Constructed Wetland for Phytoremediation of Synthetic wastewater using Colocasia esculenta, Canna Indica,and Mangrass with the same treatment mechanism.

WHAT ARE WETLANDS?

Wetlands are transitional areas between land and water. The boundaries between wetlands and uplands or deep water are therefore not always distinct. The term "wetlands" encompasses a broad range of wet environments, including marshes, bogs, swamps, wet meadows, tidal wetlands, floodplains, and ribbon (riparian) wetlands along stream channels. All wetlands - natural or constructed, freshwater or salt - have one characteristic in common: the presence of surface or near-surface water, at least periodically. In most wetlands, hydrologic conditions are such that the substrate is saturated long enough during the growing season to create oxygen-poor conditions in the substrate. The lack of oxygen creates reducing. (oxygen-poor) conditions within the substrate and limits the vegetation to those species that are adapted to low-oxygen environments. The hydrology of wetlands is generally one of slow flows and either shallow waters or saturated substrates. The slow flows and shallow water depths allow sediments to settle as the water passes through the wetland. The slow flows also provide prolonged contact times between the water and the surfaces within the wetland.

OBJECTIVES

1) To treat wastewater using VFCW.
2) To determine the overall efficiency of plants.
3) To compare the performance of planted and unplanted units of vertical flow constructed wetlands for treatment.

NEED OF Study

1. To give the simple and easy way to treat waste water/gray water.
2. To know the efficiency of construction wetland.
3. The study of plants to treat waste water.
4. Suggesting plants for treating waste water.

Advantages of Constructed Wetlands

1. Estimated cost of wetland construction is comparatively less than other treatment methods.
2. Construction does not need expensive materials.
3. Operation and maintenance of the system is easy.
4. Once established process is consistent.
5. Process does not require fossil fuels and chemicals for treatment.

6. Able to meet the target effluent quality.

Limitations of Constructed Wetlands

1. For construction needs large area.
2. Land availability and affordability is a constraint.
3. Knowledge of wetland ecology and native wetland species is a pre-requisite.
4. Optimizations of parameters become difficult when different wastewater get mixed together.
5. Periodic harvesting of the biomass is essential to maintain consistent performance.
6. Design criteria still in development for different kind of wastewater in different climatic Conditions.

concept OF Treatment of waste water using vertical flow construction wetland.

Fig.1.2: Vertical Flow Construction Wetland Prepared Model

A constructed wetland is an engineered sequence of water bodies designed to treat wastewater or storm water runoff.
Vegetation in a wetland provides a substrate (roots, stems, and leaves) upon which microorganisms can grow as they break down organic materials. This community of microorganisms is known as the periphyton. The periphyton and natural chemical processes are responsible for approximately 90 per cent of pollutant removal and waste breakdown.[5] The plants remove about seven to ten per cent of pollutants, and act as a carbon source for the microbes when they decay. Different species of aquatic plants have different rates of heavy metal uptake, a consideration for plant selection in a constructed wetland used for water treatment. Constructed wetlands are of two basic types: subsurface flow and surface flow wetlands.
Constructed wetlands are one example of nature-based solutions and of phytoremediation.
Constructed wetland systems are highly controlled environments that intend to mimic the occurrences of soil, flora, and microorganisms in natural wetlands to aid in treating wastewater. They are constructed with flow regimes, micro-biotic composition, and suitable plants in order to produce the most efficient treatment process.

Literature review

1. Kinetics of pollutants removal in vertical and horizontal flow constructed wetlands in temperate climate

Author:- 1) Magdalena Gajewska, 2)Katarzyna Skrzypiec, 3)Krzysztof Jóźwiakowski, 4) Zbigniew Mucha, 5) Włodzimierz Wójcik, 6) Agnieszka Karczmarczyk, 7) Piotr Bugajski.
Published Year:-2020

This paper reports a comparative study on kinetics of organic matter expressed as BOD and nitrogen removal in constructed wetlands operated in Poland. Analyzed data were collected at eight wetland systems, composed of subsurface flow beds: horizontal flow (HF) and vertical flow (VF), in different number and sequences. Analysis involved particularly Mass Removal Rates (MRR) and first-order removal rate coefficients of BOD5.They observed that the higher the load of pollutants applied to the beds, the higher MRR values were obtained.
The research was carried out in eight hybrid constructed wetlands (HCWs) situated in different localities in Poland. These systems consist of beds with subsurface horizontal (HF) and vertical (VF) flow with different configuration. The BOD5/COD ratio is an indicator of organic matter biodegradability.

Its value above 0.5 indicates that the organic matter is easily biodegradable, whereas, a ratio lowers than 0.3 signifies that the organic matter is difficult to degrade in wastewater treatment process.

Much bigger differences of efficacy kinetics have been were observed for both VF and HF beds working in different analyzed HCWs.

2. **Quality Testing of Raw and Filtered Grey-water Emerging from Kitchen Sink: A Case Study**

Author: Deepak N. Paithankar.

Published: 2022

This paper reports a comparative study on Quality Testing of Raw and Filtered Grey-water The limited freshwater supplies in arid regions have created alternative water management strategies. Data indicates that grey-water generation varies from 39-85% in various countries. Grey-water treatment and reuse can be a helpful no potable water source for toilet draining, watering gardens, car and floor washing, etc. Treated grey-water should be clean, hygienic, environment-friendly and cost-effective. The goal of this research is :

(I) To test the parameters of raw grey-water.

(ii) Create a filter bed.

(iii) Test parameters of treated grey-water.

(iv) Compare the parameters of raw and treated grey-water.

(v) Describe the area of use.

The limited freshwater supplies in arid regions have created alternative water management strategies. Nearly 97 percent of the total water supplies on Earth are found in the oceans, although only 3 percent are eligible for direct use. There are high concentrations of fecal indicator species in domestic waste-water, ranging from 106 to 108 CFU/100 mL. Grey-water treatment and reuse can be a helpful non-potable water source for toilet draining, watering garden, car and floor washing, etc. It is found that a simple filtration technique helps improve BOD and COD rate by 57.57 and 46.98%, respectively. Filtered waste-water can be used for watering household plants as the BOD and COD levels are better than raw grey-water

Variation of the feeding/resting period in modified vertical treatment wetlands (depth, zeolite as medium) employed for treating rural domestic wastewater in tourist areas

Author: Christian Correa

Published:2023

This work aimed to evaluate the performance of modified vertical flow treatment wetlands (VF-TWs) in terms of depth and medium to assess the effect of the feeding/resting periods and footprint (FP). Vacation centres and dwellings in rural tourist areas increase the population during vacation periods. This implies a seasonal increase in wastewater flow that must be treated. Therefore, the design of wastewater treatment systems must be robust to cope with flow variations. Treatment wetlands (TWs), a type of nature-based solution (NBS), have the potential to be an effective solution for wastewater treatment in rural tourist facilities precisely for their capacity to support flow changes, maintaining treated water of good quality throughout the year. In addition, TWs provide a wide range of ecological benefits and eco-systemic services that include water quality improvement, climate regulation, nutrient processing, and carbon sequestration, as well as recreation and habitat improvement.

Among the different types of TWs, vertical subsurface flow (VF) is one of the alternatives to traditional horizontal subsur-face flow (HF), which is the most commonly used TW worldwide (Moreira & Dias 2020). VF-TWs are becoming more common than HF-TWs because of their potential to cope with higher organic loadings (.6 g 5-day Biological Oxygen Demand (BOD5)/m2-d) capacity to nitrify (ammonium removal above 90%; and smaller footprint demand (VF-TWs, 2–4m2/PE (person-equivalent); HF-TWs, 5 m2/PE).In addition, VF-TW shave more design and operational options (surface area, bed depth, filter medium, loading mode, and plant species; Vera-Puerto et al. 2021a) than HF-TWs; therefore, their adaptability to operational conditions makes VF-TWs more suitable as a sustainable sanitation system for rural areas.

Elevated Vertical-Flow Constructed Wetlands for Light Grey water Treatment Author: Carlo Morand Published: 2021

Integrated planning of urban blue–green infrastructures is crucial to strengthen urban environmental quality and mitigate negative climate change-associated effects. It implies, however, increased water demand for irrigation, wherefore greywater (wastewater excluding wastewater from toilets and urinals) can be used, yet it requires handling for safe reuse. One treatment option is the use of constructed wetlands (CW), which have thus far not been broadly applied in inner-city districts due to large area requirements. This work investigates a novel bipartite container-based vertical-flow constructed wetland (VFCW) for the treatment of light greywater (from showers and hand wash basins) and its use as irrigation water for urban facade greenery. The VFCW consists of two compartments with 2.5 m^2 filter area each, filled with 75 cm zeolite-containing lava sand (0–4 mm) and 75 cm Rhine sand (0–2 mm), respectively. In short, screening has proven to be well suitable for coarse solids removal, so there is no further need to settle light grey water, which reduces overall treatment area and benefits urban application. Treated grey water complied with irrigation standards at all times, yet mixing with rainwater can help reduce salt contents, if applicable. The modular/elevated lava sand VFCW exhibited extensive nitrification, even at extremely low water temperatures, as well as mean effluent concentrations of 6.3 mg/L COD and <0.05 mg/L, which makes it a very promising treatment option for grey water. All in all, the modular/elevated design promotes urban application of VFCW as a multifunctional blue–green system that can help increase urban resilience

CONSTRUCTED WETLANDS A COMPREHENSIVE REVIEW

Author: Luna Al Hadidi

Published: 2021

Constructed wetlands are wastewater treatment systems composed of one or more treatment cells in a building designed and constructed to provide wastewater treatment. Constructed wetlands are classified into two types: free water surface (FWS) wetlands (also known as surface flow wetlands) closely resemble natural wetlands in appearance because they contain aquatic plants that are rooted in a soil layer on the bottom of the wetland and water flows through the leaves and stems of plants. Subsurface flow wetlands (SSF) or known as a vegetated submerged bed (VSB) systems do not resemble natural wetlands because they have no standing water. They contain a bed of media (such as crushed rock, small stones, gravel, sand, or soil) that has been planted with aquatic plants. When properly designed and operated, wastewater stays beneath the surface of the media, flows in contact with the roots and rhizomes of the plants, and is not visible or available to wildlife. Constructed wetlands are an appropriate technology for areas where inexpensive land is generally available and skilled labor is less available. In this paper, a comprehensive review covered types, characteristics, design variation and considerations, limitations, and the advantages and disadvantages of constructed wetlands.

Constructed wetlands are a natural and cost-efficient treatment process to enhance and improve water quality and decrease overall Constructed wetlands being in use since the '50s and provide better treatment for different kinds of wastewater such as (urban runoff, municipal wastewater, industrial wastewater, agricultural waste, and acid mine drainage by mimic biological, physical, and chemical processes that happen in natural wetland systems. The use of constructed wetlands for wastewater treatment has drastically increased over the last 40 years. Constructed wetlands are fast gaining ground and became a practical water resource management strategy in many developing countries Constructed wetlands for wastewater treatment substituted conventional wastewater treatment processes and targets to create a sustainable and Wetland as an unconventional treatment technology for wastewater has great potential in developing countries which provides a comparative advantage over conventional, mechanized treatment processes.

Methodology

METHODOLOGY

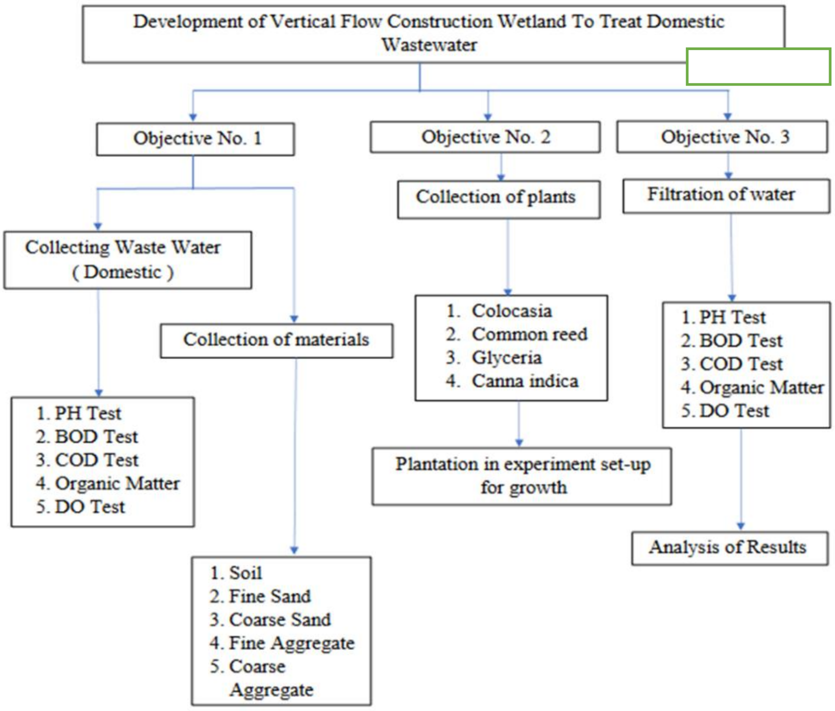


Fig.3.1: This Methodology for this project

2) OPERATION, MAINTENANCE, AND MONITORING.

1) Operation and maintenance

Wetlands must be managed if they are to perform well. Wetland management should focus on the most important factors in treatment performance:
Providing ample opportunity for contact of the water with the microbial community and with the litter and sediment.
Assuring that flows reach all parts of the wetland.
Maintaining a healthy environment for microbes maintaining a vigorous growth of vegetation.

2) Operation and maintenance plan

Operation and maintenance (O&M) should be described in an O&M plan written during the design of the constructed wetland system. The plan can be updated to reflect specific system characteristics learned during actual operation. The plan should provide a schedule for routine cleaning of distribution systems and weirs, dike mowing and inspection, and system monitoring. The plan should specify those individuals responsible for performing and paying for maintenance. The plan should address:

Setting of water depth control structures.

Schedule for cleaning and maintaining inlet and outlet structures, valving, and monitoring devices.

Schedule for inspecting embankments and structures for damage.

Depth of sediment accumulation before removal is required.

Operating range of water levels, including acceptable ranges of fluctuation.

The supplemental water source to be used to ensure adequate water levels during establishment and operation wastewater application schedule, if this is part of the system design.

An application schedule should be selected that is both convenient and relatively continuous. Short, high-flow discharges to a wetland are more likely to erode or damage established vegetation than lower velocity, more continuous flows.

Scheduling discharges to or from the wetland, recycling/redirecting flows, or rotating between cells, if such are part of the design.

1) Hydrology

In SF wetlands, water should reach all parts of the wetland surface. The wetland should be periodically checked to ensure that water is moving through all parts of the wetland, that buildup of debris. Has not blocked flow paths, and those stagnant areas have not developed. The importance of assuring adequate water depth and movement cannot be over-emphasized. Stagnant water decreases removal and increases the likelihood of mosquitoes and unsightly conditions. Flows and water levels should be checked regularly. SSF wetlands should be checked to see that surface flow is not developing.

2) Structures

Dikes, spillways, and water control structures should be inspected on a regular basis and immediately after any unusual flow event. Wetlands should be checked after high flows or after rapid ice break-up; both can scour substrates, particularly at outlets. Any damage, erosion, or blockage should be corrected as soon as possible to prevent catastrophic failure and expensive repairs.

3) Vegetation

Water level management is the key to determining the success of vegetation. While wetland plants can tolerate temporary changes in water depth, care should be taken not to exceed the tolerance limits of desired species for extended periods of time. Water depth can be increased during the cold months to increase retention time and to protect against freezing. Alternating flows and drawdown may help to oxidize organic matter and to encourage the recruitment of new plants into the wetland. Vegetative cover on dikes should be maintained by mowing, and fertilizing or liming, as needed. Frequent mowing encourages grasses to develop a good ground cover with extensive root systems that resist erosion, and prevents shrubs and trees from becoming established. The roots of shrubs and trees can create channels and subsequent leakage through the berm. Vegetation should be inspected regularly and. invasive species should be removed. Herbicides should not be used except in extreme circumstances, and then only with extreme care, since they can severely damage emergent vegetation.

4) Mosquitoes

Mosquitoes are common in natural wetlands and can be expected in constructed wetlands. However mosquitoes are usually not a major problem in constructed wetlands. The best approach to avoiding mosquito problems in constructed wetlands is to create conditions in the wetland that are not attractive to mosquitoes or are not conducive to larval development. Open, stagnant water creates excellent mosquito breeding habitat, and stagnant, high nutrient water is ideal for larval development. Flowing water and a covered water surface minimize mosquito development. Control methods include unblocking flows to eliminate stagnant backwaters, shading the water surface (females avoid shaded water for egg laying). and dispersing floating mats of duckweed or other floating plants. Purple martins, swallows, and bats can eat thousands of adult mosquitoes every day, so providing purple martin houses, swallow perches, and bat boxes will reduce the number of mosquitoes. Mosquito fish (Gambia) can be introduced to prey on mosquito larvae. The green sunfish (Leporine cyanoles), a native. hardy, and aggressive mosquito-eating fish, can be used in areas that are too cold for mosquito fish. Some control is provided by the larvae of insects. such as dragon-. flies, which prey on mosquito larvae. The control of mosquitoes with insecticides, oils, and bacterial agents such as Bti (Bacillus thuringiensis insolences) is often difficult in constructed wetlands. The use of insecticides in constructed wetlands with large amounts of organic matter is ineffective because the insecticides adsorb onto the organic matter and because they are rapidly diluted or degraded by the water traveling through the wetland. Chemical treatment should be used with caution because it is poorly understood and runs the risk of contaminating both the wetland and the receiving stream. Before beginning any involved control procedures, every aspect of the wetland system and the surrounding area should be carefully inspected, perhaps with the aid of a good vector control specialist. The inspection should include such minor components as old cans, discarded tires, un drainable depressions in wooded areas, hollow stumps, water control structures, open piping, and anywhere else that standing water can accumulate. Mosquito problems often originate from some small and frequently overlooked pocket of standing water rather than from the wetland as a whole.

3) Monitoring

Monitoring is an important operational tool that:

Provides data for improving treatment performance.

Identifies problems.

Documents the accumulation of potentially toxic substances before they bio accumulate.

Determines compliance with regulatory requirements.

Monitoring is needed to measure whether the wetland is meeting the objectives of the wetland system and to indicate its biological integrity. Monitoring the wetland can identify problems early on, when intervention is most effective. Photographs can be invaluable in documenting conditions. Photographs should be taken each time at the same locations and viewing angles.

The level of detail of the monitoring will depend on the size and complexity of the wetland system and may change as the system matures and its performance becomes more well known. As a minimum. lightly-loaded systems that have been operating satisfactorily may only need to be checked every month and after every major storm. Those that are heavily loaded will require more frequent and detailed monitoring.

4) Monitoring plan

A written monitoring plan is essential if continuity is to be maintained throughout the life of the project, which may span many decades. The monitoring plan should include:

Clearly and precisely stated goals of the project.

The specific objectives of monitoring organizational.

Technical responsibilities tasks.

Methods data analysis.

Quality assurance procedures schedules.

Reporting requirements

Resource requirements

Budget.

5) Monitoring for discharge compliance

Monitoring for compliance with the limitations of the discharge permit represents the minimum of sampling and analysis a requirement. A fixed weir at the outlet provides a simple means of measuring flow and collecting water samples. The parameters to be monitored and the frequency of data collection will be set by the terms of the permit.

6) Monitoring for system performance

Wetland system performance is usually assessed by determining:

Hydraulic loading rates.

Inflow and outflow volumes.

Water quality changes between inflow and outflow.

Excursions from normal operating conditions.

The effectiveness of contaminant removal can be determined from the difference between influent loads (inflow volume x contaminant concentration) and effluent loads (discharge volume x contaminant concentration). The parameters of concern may include:

Domestic wastewater: BOD, nitrogen, phosphorus, total suspended solids, heavy metals, bacteria (total or fecal coliform).

Agricultural wastewater: BOD, nitrogen, phosphorus, total suspended solids, pesticides, bacteria (total or fecal coliform).

Mine drainage: pH, iron, manganese, aluminum, total suspended solids, sulfate.

Storm water: total suspended solids, nitrogen, phosphorus. heavy metals, vehicle emission residues.

Surface water sampling stations should be located at accessible points at the inlet and outlet, and, depending on the size and complexity of the system, at points along the flow path within the wetland. Surface water quality stations should be permanently marked. Boardwalks can be installed to avoid disturbing sediment and vegetation while sampling. If the wastewater could contain toxic pollutants, such as pesticides or heavy metals, sediments should be sampled once or twice a year to monitor the potential buildup of contaminants in the wetland sediments. The effluent should be sampled during high storms and high spring runoff flows to assure that sediments are being retained in the wetland. Groundwater should also be monitored once or twice a year to ensure that the wetland is not contaminating groundwater.

7) Monitoring for wetland health

The wetland should be checked periodically to observe general site conditions and to detect major adverse changes, such as erosion or growth of undesirable vegetation. Vegetation should be monitored periodically to assess its health and abundance. For wetlands that are not heavily loaded, vegetation monitoring need not be quantitative and qualitative observations of the site will usually suffice. Large systems and those that are heavily loaded will require more frequent, quantitative monitoring. In general, more frequent monitoring also is required during the first five years after the wetland is installed. Species composition and plant density are easily determined, by inspecting quadrats (square plots, usually 3 ft. x 3 ft.) within the wetland at selected locations. A lightweight, open frame of wood or PVC pipe is laid on the wetland and the number of stems of each species present within the frame is counted. Changes of concern include an increase in the numbers of aggressive nuisance species, a decrease in the density of the vegetative cover, or signs of disease. The vegetation in constructed wetlands is subject to gradual year-to-year change, just as in natural wetlands. There may be tendency for some species to die out and be replaced by others. Temporary changes, such as the appearance of duckweed or algae, can occur in response to random or seasonal climatic changes. Because vegetative changes are often slow, they may not be obvious in the short-term, and good recordkeeping becomes essential. The buildup of accumulated sediment and litter decreases the available water storage capacity, affecting the depth of the water in the wetland and possibly altering flow paths. Sediment, litter, and water depths should be checked occasionally.

Study Of Plants

1) STUDY OF PLANTS USED IN CONSTRUCTION WETLAND

2) Colocasia (elephant ear)

General info:-It is a genus of flowering plants in the family Araceae .

It is found In Africa, southeastern Asia and the Indian subcontinents.

This is also known as elephant ear because of its shape and size of leaves.

Environment required:- Colocasia is a wetland plant that prefers mild climates and lots of humidity.

Cultivation period:- Colocasia needs 5 to 6 weeks for there, growth.

Importance of plant:- Colocasia, exhibits robust root development and possesses unique characteristics suitable for wastewater treatment, including high porosity and a large surface area that facilitates the removal of pollutants.

Fig 4.1: Colacosia

3) Common reed:

General information: Vertical reed beds are designed to provice secondary treatment by removing the pollutants. A layered sand and gravel bed is known as common reed.

Identification of plants:

Apperance Phregmites australis is a tall, perennial grass that can grow to heights of 15 feet or more.

Foliage leaves are 6-23.6 inches long 0.4-2.4 inches wide flat and glabrous.

Environmental required: Common reed grows in sunny, wetland habitats. It is found in fresh and alkaline marshes, pond margins, swamps and ditches.

Cultivation period: 60 to 90 days.

Importance of plant: The plants can be utilized for the removal of heavy metallic ions from the water by expending least cost.

Fig 4.2 :Common Reed

Environmental benefits: Among those are morphological adaptations to develop in water saturated soils, an extensive lacunar system facilitating substantial oxygen transport to the well-developed roots of the plant and rhizosphere, high growth rate, and the ability to incorporate biomass.

Common reed properties: 1. Grow in the low land. **2.**transfer the oxygen from their shoot zone to root zone. **3.**utilized to remove heavy metallic ions.

How they clear water:

A reed bed is a natural filtration system that can be used to treat and improve water quality prior to discharging into ability of a reed to transport oxygen to the soil.

Hence encouraging micro- organisms to digest the contaminants in the effluent.

4) Glyceria (mangrass)

General Info:-Glyceria is a widespread genus of grass family.

It is found in Australia, North Africa , India , & Americas.

Glyceria is commonly known as mangrass in the United States, or, in the UK, sweet-grass.

Environment required:= Glyceria is a wetland obligate species (plant that has occurred in wetland habitat 99% of the time it was sampled), which typically grows in rivers, streams, dams, and ponds.

Cultivation period:= Glyceria needs 4 to 5 weeks for there, growth.

Importance of plant:-This Glyceria is recommended for use in storm water management, including detention ponds and bio filtration swales that are wet year round.

Environmental benefits:

The species rapid growth, underground stems, and floating leaves helps in reducing erosion along the edges of streams and lakes where it naturally occurs.

Glyceria properties:- 1. rapid growth

2. underground stems.

3. floating leaves

How they clear water ?:-

Mangrass is recognized for its ability to absorb excess nutrients, chemicals, and pollutants from the water. Its roots act as filters, effectively purifying the water and improving its quality.

The extensive root system of Mangrass helps stabilize the soil and prevent erosion along pond banks or shorelines.

Fig 4.3: Glyceria (Mangrass)

5) Canna indica:

General information: Canna indica is effective for the removal of high organic load, color and other waste particle and phosphates present due to the use of surfactants. Canna indica have a fibrous roots structure that produces high aerobic conditions throughout the CW.

Environmental required:

1)To cultivate Canna indica, the substrate should be rich, humiferous, and light.

2)The optimal substrate consists of a deep, rich and well-drained soil in a sunny place with a pH between 5.5–7.5.

Cultivation period: 50 to 60 days.

Importance of plant:

Canna indica root system has much more root development, root number, root biomass, and root surface area than the other plant species.

The review demonstrated the potentials of Canna indica in removal of organic pollutants, nutrients and heavy metals in aquatic environments.

How they clear the water:

- Canna indica have a fibrous roots structure that produces high aerobic conditions throughout the CW, allowing for more removal
- Its root system has much more root development, root number, root biomass, and root surface area than the other plant species.

Environmental benefits: As storm water flows through a constructed wetland, wetland microbes, plants, and soil help filter pollutants and treat the water through natural ecological processes. And also to removal of high organic load, color and other waste particle and phosphates present due to the use of surfactants.

Properties: 1. Fibrous roots structure. 2. High aerobic conditions.
3. Allowing for more removal.

Fig 4.4: Canna Indica

1) feasibility

Vertical Flow constructed wetlands (VFCWs) are environmentally feasible engineered systems that mimic the functions of natural wetlands. They are alternative engineering systems that are economical, and simple in structure with reduced land area compared to Horizontal Flow Constructed Wetlands (HFCW).

Thus provides a sustainable solution for greywater treatment to a considerable extent. However, VFCWs feasibility and plant performance were not tested in the context of Sri Lanka for the greywater treatment. Therefore, the purpose of this study is to evaluate the potential of household greywater treatment using a pilot-scale VFCW and examine the performance characteristics of different types of plants.

2) Planning and designing

1) Components of constructed wetlands

A constructed wetland consists of a properly designed basin that contains water, a substrate, and, most commonly, vascular plants. These components can be manipulated in constructing a wetland. Other important components of wetlands, such as the communities of microbes and aquatic invertebrates, develop naturally.

2) Water

Wetlands are likely to form where landforms direct surface water to shallow basins and where a relatively impermeable subsurface layer prevents the surface water from seeping into the ground. These conditions can be created to construct a wetland. A wetland can be built almost anywhere in the landscape by shaping the land surface to collect surface water and by sealing the basin to retain the water. Hydrology is the most important design factor in constructed wetlands because it links all of the functions in a wetland and because it is often the primary factor in the success or failure of a constructed wetland. While the hydrology of constructed wetlands is not greatly different than that of other surface and near-surface waters, it does differ in several important respects: small changes in hydrology can have fairly significant effects on a wetland and its treatment effectiveness l because of the large surface area of the water and its shallow depth, a wetland system interacts strongly with the atmosphere through rainfall and evapotranspiration (the combined loss of water by evaporation from the water surface and loss through transpiration by plants) l the density of vegetation of a wetland strongly affects its hydrology, first, by obstructing flow paths as the water finds its sinuous way through the network of stems, leaves, roots, and rhizomes and, second, by blocking exposure to wind and sun.

Waste water

- Grey water refers to domestic wastewater generated in households or office buildings from streams without fecal contamination, i.e., all streams except for the wastewater from toilets.
- Sources of grey water include sinks, showers, baths, washing machines or dishwashers.

Fig 4.5 : Waste Water Collected For Tests

Fig.4.6:Waste Water Stored In Tank

3) Substrates, sediments, and litter.

Substrates used to construct wetlands include soil, sand, gravel, rock, and organic materials such as compost. Sediments and litter then accumulate in the wetland because of the low water velocities and high productivity typical of wetlands. The substrates, sediments, and litter are important for several reasons: 1)They support many of the living organisms in wetlands

2)substrate permeability affects the movement of water through the wetland

3) many chemical and biological (especially microbial) transformations take place within the substrates.

4) substrates provide storage for many contaminants.

5) The accumulation of litter increases the amount of organic matter in the wetland.

Organic matter provides sites for material exchange and microbial attachment, and is a source of carbon, the energy source that drives some of the important biological reactions in wetlands. The physical and chemical characteristics of soils and other substrates are altered when they are flooded. In a saturated substrate, water replaces the atmospheric gases in the pore spaces and microbial metabolism consumes the available oxygen. Since oxygen is consumed more rapidly than it. can be replaced by diffusion from the atmosphere, substrates become anoxic (without oxygen). This reducing environment is important in the removal of pollutants such as nitrogen and metals.

4) Material Used

Following are the materials used in VFCW setup :

Soil (2 micro meter, size)

Fine Sand (300 micro meter, size)

Coarse Sand (600 micro meter, size)

Fine Aggregate Crushed stones (5 mm, size)

Coarse Aggregate (20 mm, size)

River Pebble (30-50 mm, size)

Drums (50 litter capacity, 5 drums)

Pipes (1 & 2 inch)

Tub (70-80 cm height, 5treys)

Tap (2 units)

layers of support bed in constructed wetland will be prepared with Soil, Fine Sand , Coarse Sand ,Fine Aggregate, Coarse Aggregate and River Pebble in Tub.

River pebble used for bottom layer.(7.5cm depth)
Then Coarse aggregate layer is placed.(7.5cm depth)
After that fine aggregate layer is placed.(15cm depth)
Coarse Sand layer.(15cm depth)
Fine Sand layer.(7.5cm depth)
Soil layer.(7.5cm depth)

5) Vegetation

Both vascular plants (the higher plants) and non-vascular plants (algae) are important in constructed wetlands. Photosynthesis by algae increases the dissolved oxygen content of the water which in turn affects nutrient and metal Constructed wetlands attract waterfowl and wading birds, including mallards, green-winged teal, wood ducks, moorhens, green and great blue herons, and bitterns. Snipe, red-winged blackbirds, marsh wrens, bank swallows, red-tailed hawks, and Northern harriers feed and/or nest in wetlands.

The species used in wetland

1)Colocasia

Effective in removing pollutants like nitrogen, phosphorus, heavy metals, and organic compounds.

Fig 4.7:Tubular roots of Colocasia used for plantation

Fig 4.8:Colacosia

Location : Takavdi

2) Glyceria

Glycerin was used as an external carbon source to remove nitrogen

Location : Near Panchganga river.Ichalkaranji

3) Canna indica:

General information: Canna indica is effective for the removal of high organic load, color and other waste particle and phosphates present due to the use of surfactants. Canna indica have a fibrous roots structure that produces high aerobic conditions throughout the CW.

Environmental required:

- To cultivate Canna indica, the substrate should be rich, humiferous, and light.
- The optimal substrate consists of a deep, rich and well-drained soil in a sunny place with a pH between 5.5–7.5.

Cultivation period: 50 to 60 days.

Importance of plant:

- Canna indica root system has much more root development, root number, root biomass, and root surface area than the other plant species.
- The review demonstrated the potentials of Canna indica in removal of organic pollutants, nutrients and heavy metals in aquatic environments.

Fig No. 4.10:Canna Indica

Location :Takavdi Nala

6) Water Distribution

Inlet Distribution system

Perforated PVC pipe was used as inlet distribution system to distribute wastewater evenly over a bed.

Fig 4.11:Inflow Cock

Flow adjusting valve was provided to control rate of flow

Wastewater is distributed to plants through provided pipes having 2mm hole at 15cm c/c

Fig 4.12 : Equally Distributed Water

4) Aesthetics and landscape enhancement

While wetlands are primarily treatment systems, they provide intangible benefits by increasing the aesthetics of the site and enhancing the landscape. Visually, wetlands are unusually rich environments. By introducing the element of water to the landscape, constructed wetlands, as much as natural wetlands. add diversity to the landscape. The complexity of shape, color, size, and interspersion of plants, and the variety in the sweep and curve of the edges of landforms all add to the aesthetic quality of the wetlands. Constructed wetlands can be built with curving shapes that follow the natural contours of the site, and some wetlands for water treatment are' indistinguishable, at first glance, from natural wetlands.

5) Climate and weather

Because wetlands are shallow water bodies open to the atmosphere, they are strongly influenced by climate and weather. Rainfall, snowmelt, spring runoff, drought, freeze, and temperature can all affect wetland treatment. The high flows caused by heavy rains and rapid snowmelt shorten residence times. The efficiency of a wetland may therefore decrease during rainfall and snowmelt because of increased flow velocities and shortened contact times. High flows may dilute some dissolved pollutants while increasing the amount of suspended material as sediments in the wetland are resuspended and additional sediments are carried into the wetland by runoff. The first flush of runoff from a storm, often carries much higher pollutant concentrations than flows later in the storm. Taylor et al. (1993) found that intense storms during summer, when conditions were generally dry, often had greater impacts on treatment than storms during other times of the year, when conditions were generally wetter. Snowmelt and spring runoff can suspend and export stored pollutants. Jacobson (1994) found that runoff during spring may carry more than half the annual nitrate and phosphorus exported during the year and suggests that wetland management should focus on this time of the year. Runoff in excess of maximum design flows should be diverted around the wetland to avoid excessive flows through the wetland. Minimum temperatures limit the ability of wetlands to treat some, but not all, pollutants.. Wetlands continue to treat water during cold weather. However, freezing temperatures in winter and early spring can reduce treatment if the wetland either freezes solid or a cover of ice prevents the water from entering the wetland. If under-ice water becomes confined, water velocities may increase, thereby reducing contact times.

6) Hydraulic loading rate

Hydraulic loading rate (HLR) refers to the loading on a water volume per unit area basis. [loading = (parameter concentration)(water volume/area)].

7) Groundwater exchange

The movement of water between a 'wetland add groundwater will affect the hydrology of the wetland. Constructed wetlands for domestic wastewater, agricultural wastewater, and mine drainage are usually lined to avoid-possible contamination of groundwater. If the wetland is properly sealed, infiltration can be considered negligible. Many storm water wetlands are sealed so that that water needed to support the wetland will be retained between storms. Other storm water wetlands are designed to intercept groundwater to ensure sufficient base flow. In this case, the wetland will receive groundwater when the water table is high and may discharge to groundwater when the water table is low.

8) Evapotranspiration

Evapotranspiration (ET) is the combined water loss through plant transpiration and evaporation from the water surface. In wetlands, the amount of surface area is large relative to the volume of water and ET is an important factor. Also, many wetland plants do not conserve water during hot, dry weather as most terrestrial plants do, and can transfer considerable amounts of water from a wetland to the atmosphere in summer. If ET losses exceed water inflows, supplemental water will be required to keep the wetland wet and to avoid concentrating pollutants to toxic levels. Estimates of ET values vary widely. The Water Pollution Control Federation (1990) suggests that, for wetlands that are continuously flooded, ET can generally be estimated as being equal to lake evaporation, or approximately 70% to 80% of pan evaporation values. (Rainfall and pan evaporation data can be obtained from National Oceanic and Atmospheric Administration in Asheville, NC, or from local weather stations.) Kadlec (1993) found that dense stands of emergent vegetation reduced the total water loss from prairie potholes and concluded that the vegetation removed less water through transpiration than would have evaporated from open surface water. Other data indicate that most wetlands show ET to be equal to or slightly less than pan evaporation and that experiments that show higher ET rates have been conducted on too small a scale to compensate for edge effects.

9) Photosynthesis

Photosynthesis is performed by wetland plants and algae, with the process adding carbon and oxygen to the wetland. Both carbon and oxygen drive the nitrification process. Plants transfer arygen to their roots, where it passes to the root zones (rhizosphere). Respiration is the oxidation of organic carbon, and is performed by all living organisms, leading to the formation of carbon dioxide and water. The common microorganisms in the CW are bacteria, fungi, algae and protozoa Fermentation The maintenance of optimal conditions in the system is required for the proper functioning of wetland organisms

10) Working Mechanism of Vertical Constructed Wetland

a) Physical processes

Sedimentation and filtration are the main physical processes leading to the removal of wastewater pollutants. The effectiveness of all processes (biological, chemical, physical) varies with the water residence time (i.e., the length of time the water stays in the wetland). Longer retention times accelerate the remove of more contaminants, although too long retention times can have detrimental effects.

1) Sedimentation, Absorption and Adsorption

The floating matter is removed due to mechanical action of straining. Sedimentation is mainly used for removal of suspended solids in influent wastewater. Besides suspended solids, sedimentation is a major mechanism for elimination of microbial pathogens which mainly includes coliforms and other bacteria. Partial removal of organic matter also occurs by sedimentation process. Sedimentation process is driven by gravity which in turn depends upon shape size and gravity of particles along with consistency of fluid medium. Sedimentation or settling can be categorized into discrete and flocculent settling in view of no contact with other particles and interaction with other particles respectively. Solids settle down to bottom of the constructed wetland and become part of the deposited material.

2) Absorption

Absorption is a chemical process used to depict adsorption and absorption, which may be physical (using weak atomic and molecular interactions) or chemical (using stronger ionic-type bonds). Adsorption refers to retention of gas/ liquid/ dissolved substances on the surface of solids. Adsorption is an important mechanism for phosphorous removal. Soluble inorganic phosphate becomes adsorbed to soil particles. Phosphorous adsorption is enhanced with increase clay content in soil owing to high cation exchange capacity in comparison to sandy soil. Apart from phosphorous heavy metals are also removed by adsorption organic matter present in soil and water. Ammonium cation due to charged property also gets adsorbed to filter media. Size and chemical composition of filter media influence the adsorption of ammonium ion and can be enhanced by using specific media like zeolite.

Another mechanism of pollutant removal in CW is absorption by plants and microbial population. Phosphorous in its inorganic form i.e. orthophosphate is absorbed by macrophytes present in constructed wetland. Most of the phosphorous removal in constructed wetland occurs by absorption of plant roots. Absorption of P by other parts of plant (ice. stems and leaves) is not significant. Microbial absorption of phosphorous occurs rapidly due to high multiplication rate however low storage capacity due to small size limits the amount of uptake. The mechanism responsible for each of the pollutant removal from the wastewater is summa razed.

b) Biological processes

The following major biological reactions are involved in the removal of contaminants from constructed wetlands including photosynthesis, fermentation, microbial removal, ammonification, nitrification, de-nitrification. Ammonification Ammonia fixation is the primary step of nitrogen transformation in organic nitrogen rich wastewater received in CW systems. In ammonification process conversion of organic N to NH4+N occurs by extracellular enzymes secreted by microbes. It is energy yielding process where oxidative domination of amino acids to NH3 takes place.

c) Ammonification

Is fast in upper layer of water due prevalence of aerobic condition whereas it occurs slowly in lower layers due to change in environment from facultative anaerobic to obligate anaerobic. The rate of ammonification process also depends on pH (optimum pH-6.5-6.8) and temperature (ammonification doubles with temp. increase of 10C).

d) Nitrification

Followed by ammonification, nitrification takes place in nitrogen transformation in which oxidation of ammonium (NH4+) to nitrate (NO3-) is carried out by autotrophic bacteria with nitrite (NO2) as a key intermediate product. Instead of organic nitrogen if NH4+N predominates in water, the nitrification process starts directly without the need of ammonification. Nitrification takes place in two steps, in first stage conversion of NH4-N to NO2-N take place in presence of oxygen by chemolithotrophic microbes (e.g. Nitrosamines, Nitrosococcus and Nitrosospira). In the second step NO2-N is converted to NO3-N by facultative chemolithotrophic bacteria (Nitrospira, and Nitrobacter) Nitrification process requires presence of desired microbes. 02. Alkaline conditions and mi14 cro nutrients in the wastewater. Besides these requirements optimum temperature should be between 25-400 . Most of the Nitrification is carried out by autotrophic microbes (Ni trosomonas and Nitro bacter). Apart from autotrophic bacteria heterotrophic bacteria are also involved in nitrification, however nitrification rate performed by heterotrophs are comparatively lower than autotrophic bacteria.

e) Fermentation

Fermentation is the decomposition of organic carbon in the absence of oxygen, producing energy-rich compounds (e.g.. methane, alcohol, volatile fatty acids). This process is often undertaken by microbial activity.

f) Microbial Degradation

Microbial Degradation and Plant Uptake 15 Microbial degradation takes place to generate new cells by degrading soluble organic matter. The process involved in organic matter degradation may be aerobic and anaerobic but principally occurs by aerobic way. Attached to biofilm, which further decompose attached organic matter. The microbial population involved in organic matter decomposition includes bacteria, actinomycetes, and fungi Along with organic matter, organic forms of phosphorous such as phospholipids, nucleic acids (DNA, RNA) and phosphorylated sugars (easily decomposable organic phosphorus), and phytin (slowly decomposable organic phosphorus) are converted into inorganic phosphorous by micro-bial action .Plant uptake is another important process for pollutants removal in constructed wetland. Plants can uptake and store inorganic nitrogen in the range of 0.2 to 0.8 g N/m2.d which depends upon the plant species and be harvested (above ground biomass) intermittently. Along with above ground part nitrogen also remains stored in below ground parts of the macrophyte. Nitrogen absorbed by plant uptake is utilized in protein synthesis and thus increase plant biomass.

Metals are also eliminated by plant uptake. The metal uptake limit is governed by the type of macrophyte and type of heavy metal. Metal accumulates in plant biomass and in the roots of plants. Some plants accumulate metals significantly for e.g. duckweed which can store a huge amount of metals such as Cu, Cd and Se. According to some researchers plant can uptake only 1-2% of amount of metals present in constructed wetland, rest is removed by adsorption oxidation and sedimentation processes.

g) Chemical process

Chemical process Metals can precipitate from the water column as insoluble compounds. Exposure to light and atmospheric gases can break down organic pesticides, or kill disease- producing organisms. The pH of water and soils in wetlands exerts a strong influence on the direction of many reactions and processes, including biological transformation partitioning of ionized and un- ionized forms of acids and bases, cation exchange, solid and gases solubility.

RESULT

Test on Gray Water:

Sr.No.	Parameters	Unit	Values
1	pH		7.30
2	E. Conductivity	mm.hos/cm	7.54
3	Chemical Oxygen Demand (COD)	mg/lit	3220
4	Biological Oxygen Demand (BOD)	Mg/lit	1730
5	Chlorides	Mg/lit	428
6	Total Dissolved Solid (TDS)	Mg/lit	3770
7	Total Suspended Solids (TSS)	Mg/lit	27
8	Total Solids	Mg/lit	3797
9	Oil and Grease	mg/lit	06

Table No .5.1: Test on Gray Water

Fig 5.1: Waste Water For Test

Fig 5.2:Waste Water Collected For Test

Test on Collected Water From Waste Water Wetland Basin After 7 Days on Colacosia plant.

Sr.No.	Parameters	Unit	Values
1	pH		6.70
2	E. Conductivity	mm.hos/cm	5.00
3	Chemical Oxygen Demand (COD)	mg/lit	760
4	Biological Oxygen Demand (BOD)	mg/lit	253
5	Chlorides	mg/lit	227
6	Total Dissolved Solid (TDS)	mg/lit	2500
7	Total Suspended Solids (TSS)	mg/lit	08
8	Total Solids	mg/lit	2508
9	Oil and Grease	mg/lit	01

Table No.5.2: Test on Collected Water From Waste Water Wetland Basin After 7 Days on Colacosia plant.

Test on Collected Water From Waste Water Wetland Basin After 7 Days on Canna Indica plant.

Sr.No.	Parameters	Unit	Values
1	pH		6.00
2	E. Conductivity	mm.hos/cm	4.70
3	Chemical Oxygen Demand (COD)	mg/lit	780
4	Biological Oxygen Demand (BOD)	mg/lit	312
5	Chlorides	mg/lit	197
6	Total Dissolved Solid (TDS)	mg/lit	2498
7	Total Suspended Solids (TSS)	mg/lit	09
8	Total Solids	mg/lit	2507

9	Oil and Grease	mg/lit	01

Table No. 5.3: Test on Collected Water From Waste Water Wetland Basin After 7 Days on Canna Indica plant.

Test on Collected Water From Waste Water Wetland Basin After 7 Days on Man Grass plant.

Sr.No.	Parameters	Unit	Values
1	pH		6.40
2	E. Conductivity	mm.hos/cm	5.90
3	Chemical Oxygen Demand (COD)	mg/lit	905
4	Biological Oxygen Demand (BOD)	mg/lit	416
5	Chlorides	mg/lit	268
6	Total Dissolved Solid (TDS)	mg/lit	2456
7	Total Suspended Solids (TSS)	mg/lit	07
8	Total Solids	mg/lit	2463
9	Oil and Grease	mg/lit	01

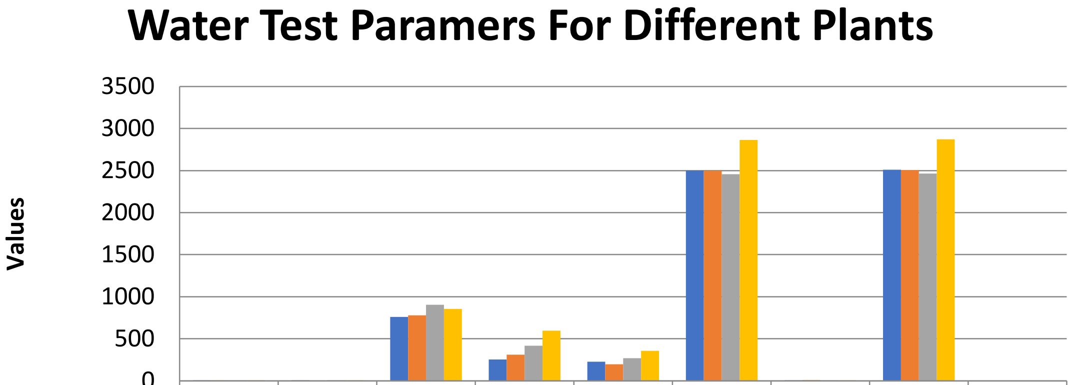
Table No.5.4: Test on Collected Water From Waste Water Wetland Basin After 7 Days on Man Grass plant.

Test on Collected Water From Waste Water Wetland Basin After 7 Days on Mixture plant.

Sr.No.	Parameters	Unit	Values
1	pH		7.4
2	E. Conductivity	mm.hos/cm	6.40
3	Chemical Oxygen Demand (COD)	mg/lit	854
4	Biological Oxygen Demand (BOD)	mg/lit	598
5	Chlorides	mg/lit	357
6	Total Dissolved Solid (TDS)	mg/lit	2864
7	Total Suspended Solids (TSS)	mg/lit	08
8	Total Solids	mg/lit	2872
9	Oil and Grease	mg/lit	01

Table No.5.5: Test on Collected Water From Waste Water Wetland Basin After 7 Days on Mixture plant.

Graph No.5.1:Graph Shows Different Parameters for Different Plants



	pH	E.Conductivity	COD	BOD	Chlorides	TDS	TSS	TSS	Oil and Greass
Colcosia	6.7	5	760	253	227	2500	8	2508	1
Cann Indica	6	4.7	780	312	197	2498	9	2507	1
Man Grass	6.4	5.9	905	416	268	2456	7	2463	1
Mix	7.4	6.4	854	598	357	2864	8	2872	1

Conclusion

1. The optimum Hydraulic loading Rate (HLR) was **0.11m^3 /m^2 /hr**.
2. The plants used in this study are Colcosia, Canna Indica, Man grass and Mixture of these. The removal efficiency of systems in a decreasing order :Canna Indica , combination Mix Plants of all species and Colocasia esculenta,Glyceria (Mangrass).
3. The tropical plant Colocasia esculenta is very efficient in treating wastewater due to its hairy roots.
4. VFCW consisting filter media and Canna Indica and Colcosia eluctanta can be effective method to treat domestic wastewater if designed and planned properly.

Future Scope

1. The efficiency of VFCW can be checked by substrate alteration.
2. The efficiency of system can be checked by using various Industrial wastes as a substrate.
3. The VFCW system can also be evaluated by using other locally available plants.
4. The efficiency of VFCW system can be checked by adding artificial aeration. 5.The system performance can also be checked for longer period.

REFERENCES :

1. Al Hadidi, L. (2021). Constructed Wetlands a Comprehensive Review.
2. Dąbrowski, W., Karolinczak, B., Gajewska, M., & Wojciechowska, E. (2017). Application of subsurface vertical flow constructed wetlands to reject water treatment in wastewater treatment plant. Environmental technology, 38(2), 175-182.
3. García-Ávila, F., Patiño-Chávez, J., Zhinín-Chimbo, F., Donoso-Moscoso, S., del Pino, A. (2019). Performance of Phragmites Australis and Cyperus Papyrus in the treatment of municipal wastewater by vertical flow subsurface constructed wetlands. *International Soil and Water Conservation Research*, *7*(3), 286-296.
4. Galve, J. C. A., Sundo, M. B., Camus, D. R. D., De Padua, V. M. N., & Morales, R. D. F. (2021). Series type vertical subsurface flow constructed wetlands for dairy farm wastewater treatment. *Civil Engineering Journal*, *7*(2), 292-303.
5. Gajewska, M., Skrzypiec, K., Mucha, A., & Bugajski, P. (2020).
6. Kinetics of pollutants removal in vertical and horizontal flow constructed wetlands in temperate climate. Science of the Total Environment, 718.