Pilot Project Documentation

HydroHair Barrier System(HBS)

Location: GMDA Stormwater Drain, Gurugram

Submitted by: Kesakambali Foundation

Introduction

The **HydroHair Barrier System (HBS)** is a collaborative project of Moft x Kesakambali featuring a pollutant interception and filtration system that is designed for deployment in drainage systems, and waterways to filter out floating waste, solid particles, hydrocarbons,oils and other pollutants. The system involves modular floating barriers with hair-based filtration arranged in a multi-stage configuration to intercept the contaminants without disrupting the hydraulic flow.

The filtration mechanism uses recycled human hair, a naturally a sorbent material, which attracts and retains oil, pollutants and chemicals due to the fibrous keratin structure, and high - surface area and just the overall nature and properties of hair. Hair can adsorb almost 6 to 9 more times than its own weight, hence making it an effective and reasonable medium.

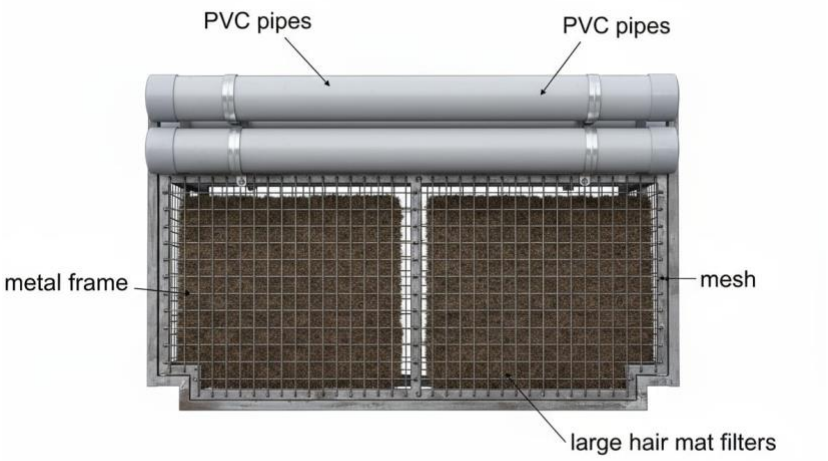
Through a combination of physical interception, absorption, and particulate entrapment, the HydroHair Barrier System assists in reducing pollutant load and improving the downstream water quality in urban drainage systems.

System Configuration

The HydroHair Barrier System (HBS) consists of modular floating barrier units constructed using a combination of metal framing, and buoyant PVC element, along with a hair-based filtration media. Each barrier consists of a metal iron frame supported by approximately four PVC pipes of 4-inch

diameter, sealed with end caps to provide buoyancy and ensure stable floatation within the drainage channel.

The structural frame measures approximately 51 inches in length and 38 inches in height, with an overall unit weight ranging between 20-25 kgs, allowing for both durability and ease of deployment. The PVC pipes are securely fixed to the frame to maintain flotation and structural integrity under varying flow conditions .



Within the metal frame, an internal containment cage is designed to hold the filtration medium. This inner chamber has approximate dimensions of 23.5 inches (length) x 21.5 inches (height) x 1 inch (width) and is fitted with hair-based filtration mats. The hair mats measure approximately 23 inches in length, 21 inches in height, and 0.5-0.7 inches in thickness, with an average weight of 750-850 grams per unit.

The hairmats serve as the primary filtration medium , allowing the absorption of contaminants, debris, hydrocarbons, oil-based pollutants, and fine suspended particles, while the enclosing mesh and frame structure facilitate physical interception of floating debris. The compact and layered configuration ensures effective contact between flowing water and the filtration medium without significantly impacting the hydraulic flow.

Barrier units are deployed at an approximate 45 degree angle relative to the direction of flow and arranged in a mult-stage configuration, allowing progressive interception of pollutants across successive barrier rows . This configuration enhances pollutant capture efficiency while distributing load across the system thereby reducing the risk of clogging and maintaining flow continuity.

The overall system is designed as a free-flow, non-obstructive intervention, ensuring that stormwater movement is not hindered. The combination of structural stability, buoyancy, and absorptive filtration enables the HydroHair Barrier System to function effectively under real-world drainage conditions.

Monitoring Methodology

The performance of the HydroHair Barrier System was evaluated through a structured water quality monitoring system under real-time flow conditions within a stormwater drain in Gurugram, specifically at Drain-Lag3, Ramprastha, Sector 37-D.

To assess the effectiveness of the system in pollutant interception and reduction, water samples were collected from two defined sampling locations within the drainage channel. Sampling was carried out at the inlet point, located upstream of the barrier system prior to filtration, and at the outlet point, located downstream after water had passed through the installed barrier units . This comparative sampling framework enabled a direct evaluation of changes in water quality attributable to the system

Collected Samples were analyzed by key physico-chemical and microbiological parameters relevant to urban stormwater pollution. The parameters assessed included Lead, Chromium, Copper, pH at 25 degree celsius , Biological Oxygen Demand for three days at 27 degree Celcius, Chemical Oxygen Demand at 150 degree Celsius, Total Suspended Solids at 105 degree Celsius, Oil and Grease, and Faecal Coliform levels,

These indicators were selected to evaluate the system's performance in reducing organic pollution load, suspended particulate matter, hydrocarbon contamination, and microbial presence associated with organic waste. Sampling and analysis were conducted under representative flow conditions to ensure that the results accurately reflect the operational performance of the HydroHair Barrier System within an active urban drainage environment.

Quantitative Results

Water quality analysis was conducted to evaluate the performance of the HydroHair Barrier System installed at Drain-Lag 3, Ramprashta, Sector 37-D, Gurugram. Competitive assessment was carried out between inlet(before) and outlet (after) conditions based on the laboratory-tested parameters.

Inlet-Outlet Water Quality Comparison

Parameter	Unit	Inlet Value	Outlet Value
pH	-	7.12	7.30
BOD	mg/L	140.00	83.00
COD	mg/L	279.00	160.00
TSS	mg/L	386.90	263.00
Oil and Grease	mg/L	BLQ (<4.0)	BLQ (<4.0)
Faecal Coliform	MPN/100ml	540	70
Lead	mg/L	BLQ (<0.002)	BLQ (<0.002)
Chromium	mg/L	BLQ (<0.002)	BLQ (<0.002)
Copper	mg/L	BLQ (<0.002)	BLQ (<0.002)

The observed results showed a reduction in the Biochemical Oxygen Demand (BOD) from 140.00 mg/L to 83.00mg/L was observed, indicating a decrease of 40.7% in organic pollution load. Chemical Oxygen Demand (COD) decreased from 279.00mg/L to 160.00 mg/l, reflecting the removal of oxidizable contaminants down to 42.6%.

Total Suspended Solids (TSS) reduced from 386.90 mg/L to 263.00mg/L, demonstrating effective interception of 32.0% of suspended particulate matter and floating debris.

The concentration of oil and grease remained below the limit of quantification (BLQ) at both inlet and outlet stages, indicating lower detectable levels and effective control of hydrocarbon contamination within the system.

A significant reduction in faecal coliform levels was recorded, decreasing from 540MPN/100ml to 70 MPN/100ml, suggesting removal of microbial load associated with suspended organic matter.

The pH levels remained stable, shifting from 7.12 at the inlet to 7.30 at the outlet, indicating no adverse impact on the chemical balance of the water.

Heavy metals including lead, chromium, and copper were observed to be below the limit of the quantification at both inlet and outlet stages.

Technical Interpretation of Results

The observed reductions in the k water quality parameters indicate that the HydroHair Barrier System (HBS) functions effectively as a combined physical interception and absorption- based filtration system under real drainage conditions.

The decrease in Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand(COD) suggests that the system is successful in removing organic pollutants primarily associated with suspended solids and floating debris. Since a significant portion of organic load in stormwater is attached to particulate matter, the interception of these particles directly contributes to the reduction in both BOD and COD levels.

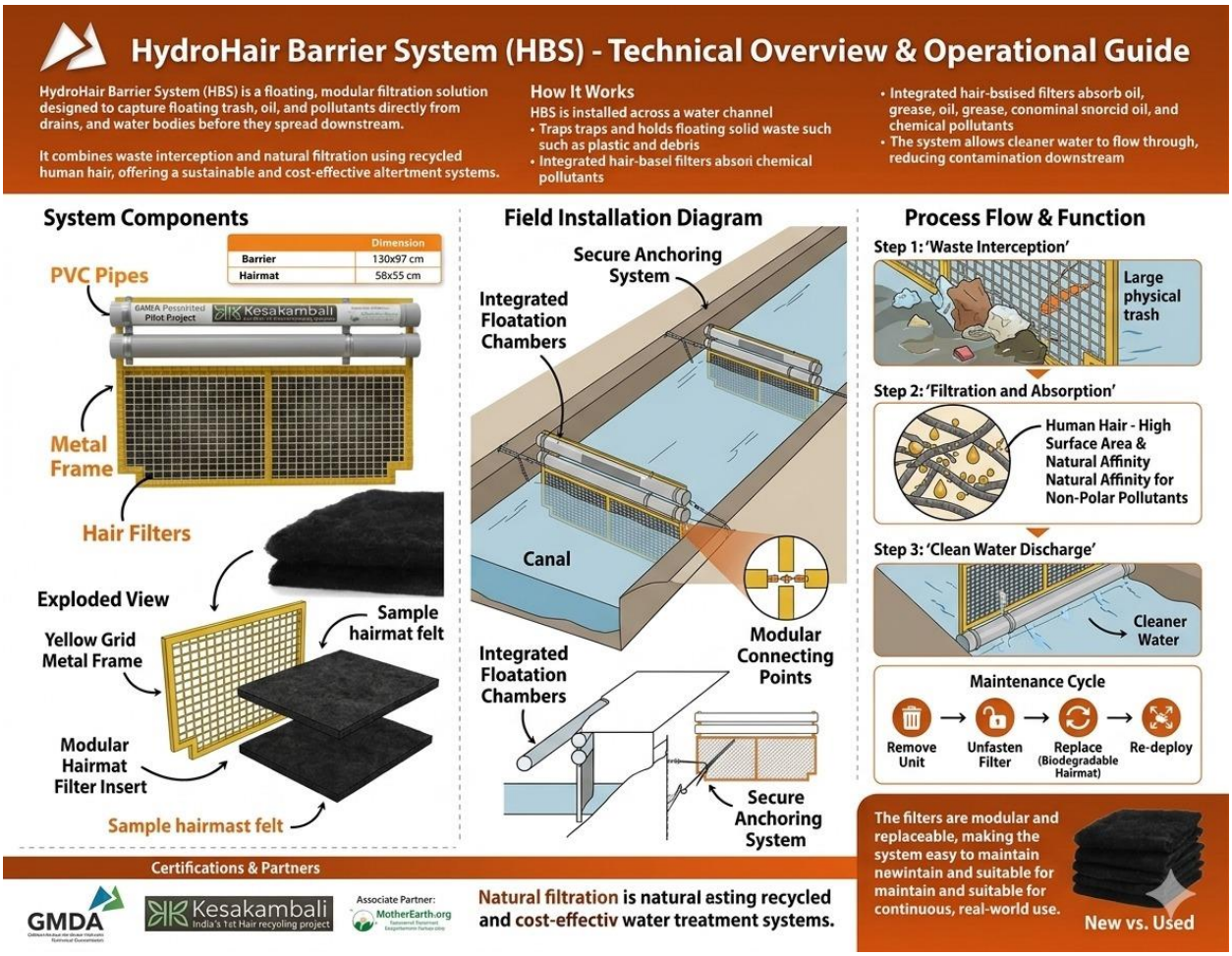
The reduction in Total Suspended Solids (TSS) confirms the system's ability to physically trap particulate matter through the hair-based filtration medium. The multi-stage configuration further enhances this effect by allowing progressive removal of finer particles across successive barrier rows. The consistently low levels of oil and grease, remaining below the limit of quantification at the outlet, indicate the effective absorption capacity of the hair-based filtration media. Human hair, being naturally oleophilic, facilitates the binding and retention of hydrocarbon-based contaminants, preventing their downstream transport.

The significant decrease in faecal coliform levels can be attributed to the removal of suspended organic carriers and particulate clusters that support microbial presence in flowing water. As these carriers are intercepted, the associated microbial load is reduced.

The stability in pH levels indicate the system does not introduce a chemical alteration to the water, conforming that the process is primarily physical and adsorptive rather than reactive.

The absence of detectable concentration of heavy metals such as lead, chromium, and copper suggests that these were either not present in significant quantities in the influent or remained unaffected by the filtration process, as the system is not specifically designed for dissolved metal removal.Overall, the results demonstrate that the HydroHair Barrier System is particularly effective in targeting particulate-bound pollutants, hydrocarbons, and associated microbial contaminants, while maintaining hydraulic efficiency and the overall chemical neutrality.

Visual Documentation



Scalability Potential

The HydroHair Barrier System (HBS) demonstrates strong potential for scalable deployment across urban drainage networks and water bodies, particularly in environments characterized by high loads of floating pollutants, suspended solids, and hydrocarbon contamination.

The modular design of the system allows for flexible installation across varying drain widths, flow conditions, and pollution intensities, making it adaptable to diverse urban and semi-urban contexts. Barrier units can be deployed individually or in multi-stage configurations depending on site-specific requirements, enabling both localized intervention and large-scale implementation.

The use of readily available and low-cost materials, including recycled human hair, metal framing, and PVC floatation elements, enhances the economic feasibility of scaling the system. Additionally, the reliance on passive filtration mechanisms reduces the need for energy input and complex infrastructure, making it suitable for decentralized pollution control strategies.

Operational observations indicate that the system requires minimal maintenance and can be managed through periodic cleaning and replacement cycles, which can be integrated into existing municipal maintenance frameworks. The localized accumulation of pollutants further simplifies waste removal and handling processes.

The system can be effectively deployed in a range of applications, including stormwater drains, urban canals, lake inlets, industrial discharge channels, and tributaries feeding into larger water bodies. Its ability to reduce pollutant loads at source points make it particularly valuable as a pre-treatment intervention within broader water management stems.

Overall, the HydroHair Barrier System offers a cost-effective, adaptable,and environmentally sustainable solution for scaling pollution mitigation efforts across urban water infrastructure.

Conclusion

The pilot implementation of the HydroHair Barrier System (HBS) at Drain-Lag 3, Ramprastha, Sector 37-D, Gurugram demonstrates the effectiveness of a low-cost, modular intervention for pollution control in urban stormwater drainage systems.

The system achieved measurable reductions in key water quality parameters , including Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), and faecal coliform levels, indicating successful removal of organic load, suspended particulates, and associated microbial contaminants. The consistent control of oil and grease levels further validates the absorption capability of the hair-based filtration medium.

Operational performance under real flow conditions confirmed that the system maintenance and structural stability further support its practical applicability in urban environments.

As a physical and absorption-based filtration system, the HydroHair Barrier System provides a targeted solution for capturing particulate-bound pollutants and hydrocarbons at source points within the drainage networks. Its use of recycled materials and passive operation enhances its sustainability and cost-effectiveness.

Overall, the pilots demonstrates that the HydroHair Barrier System is a viable, scalable, and environmentally sustainable intervention for improving water quality in urban drainage infrastructure and supporting broader pollution mitigation efforts,