Decentralized Wastewater Treatment: A Paradigm Shift

विकेन्द्रीकरण दृष्टि जल उपचार संयंत्रः 
एक प्रतिमान विस्थापन

Online Training on ‘Offsite and Onsite Management of Sewage for Citywide Sanitation,
15 December- 16 December 2020
• Concept, Principle and Scale of Intervention of the alternative approach in Urban Setting (शहरों की स्थापना में दुसरे विकल्पो की संकल्पना, सिद्धांत, हस्ताक्षर के पैमाने)

• Importance of Decentralized Wastewater Treatment in Citywide Water and Sanitation (विकेन्द्रीकरण दूषित जल उपचार संयंत्र का महत्व)

• Showcasing Best Practices of various DWWTs (विभिन्न विकेन्द्रिकरण दूषित जल उपचार संयंत्र की सर्वोत्तम प्रथाएं)
Urban Wastewater Management: How we conventionally plan our cities?

शहरी दृष्टि जल उपचार संयंत्र: कैसे प्रथानुसार शहरों की योजना बनायें?
Cities plan for water, forget waste

80% water leaves homes as sewage

More water = more waste

Water = Waste

Cities have no accounts for sewage

Cities have no clue how they will convey waste

No idea, how to clean rivers

Cities are clueless, how to treat it

Most of our cities do not have underground sewerage

Where there is pipeline; broken; sewage does not reach treatment plants

Most treatment plants are under-utilized

We lose rivers

Cities plan for water, forget waste (शहरों में जल की योजना बनायी जाती है, अपशिष्ट की नहीं)
Current Approach of Water and Wastewater Management

- **Infrastructure-intensive (गहन आधारिक संरचना)**
- **Energy intensive -** extraction, storage, distribution, collection and conveyance systems (गहन उजा)
- **Average leakage loss ratio in developing countries:** 40–50% in large metropolitan cities, and 50–60% in smaller cities. (औसत रिसाव की कमी अनुपात, विकासशील देश – 40-50% महानगरो में, 50-60% छोटे शहर)
- **Most of the transmission and distribution pipelines are very old, and many of them are corroded and leaking, resulting in increased water losses and inadequate water quality.** (पुरानी पार ेषण पाइपलाइन की पानी का रिसाव होना)
- **Carbon Emissions (कार्बन उत्सर्जन)**
Decentralised wastewater management (DWWM) is defined as the collection, treatment and disposal / reuse of wastewater at or near the point of waste generation.

It includes systems that treat wastewater from individual homes, cluster of homes, isolated communities, industries or institutional facilities as well as portion of existing communities.

Decentralised wastewater treatment (DWWT) is based on the important principle – devolving level of the application so that wastewater can be treated at affordable costs, cutting the cost of pumping long distances and promoting local reuse of treated wastewater.
Scales of Decentralized Wastewater Management

(विके‌न्द्रिकरण दूषित जल उपचार संयंत्र के स्तर)

- Residential and institutional land uses have high potential at all the scales.
- Informal settlements have a high potential of simplified sewerage networks and decentralized projects at lower scales.
- Commercial areas, industrial estates and transportation hubs have potential at lower scales.
- Recreation areas and natural areas have high potential for projects of higher scales.

Density (gph)

- Centralized sewerage systems are not recommended for low density areas as they are expensive.
- On-site sanitation systems are not recommended for high density areas as it may lead to saturation of soil with pathogenic bacteria.

General % land use distribution in Indian cities

(Average % distribution for towns of various sizes as per UDRIFF guidelines)

- Residential and institutional land uses make up approx. 50%. These areas have favourable built-to-open ratio which allows locating of the system.
- Balance 2:1
- Scope of reuse for domestic purposes.
- Informal areas can be served through simplified sewer networks, which can connect to a decentralised in the vicinity system or trunk sewer.
## Scales of Decentralized Wastewater Management

<table>
<thead>
<tr>
<th>Scales</th>
<th>City/zonal scale</th>
<th>Neighbourhood / Institutional scale</th>
<th>Individual scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Areas (sq. m)</td>
<td>10,000-15,000</td>
<td>4,000-5,000</td>
<td>1,000-4,000</td>
</tr>
<tr>
<td>Users/population</td>
<td>5,000 (maximum)</td>
<td>200-5,000</td>
<td>5-200</td>
</tr>
<tr>
<td>Wastewater generation capacity (kilolitre per day—KLD)</td>
<td>500 (maximum)</td>
<td>20-500</td>
<td>0.5-20</td>
</tr>
<tr>
<td>Land uses/activities</td>
<td>Medium density: 200-400 persons per hectare (pph), commercial areas, neighbourhoods, institutional and peri-urban areas</td>
<td>Institutional/commercial buildings</td>
<td>Residential buildings (plotted/four-five storied)</td>
</tr>
</tbody>
</table>

Approach depends on (दृष्टिकोण निर्भर करता है)

- Area (छेत्र)
- Size and density of the population (जनसंख्या घनत्व)
- Level of economic development (आर्थिक विकास का स्तर)
- Technical capacity and system of governance in place (सरकार की तकनीकी क्षमता)
- Quality required for end users or that required for safe disposal
**DWWT Characteristics and Advantages**

(विकेन्द्रिकरण दूषित जल उपचार संयंत्र की विशेषताएँ और लाभ)

- **Cut / Reduce the length of pipeline** (पाइपलाइन की लंबाई कम)
  Wastewater can be treated on site, no need of conveying to far distances. Sewer networks are shorter in length and smaller in diameter since there are several disposal points.

- **Required basic skills to operate and maintain** (बुनयादी कौशल की जरूरत)
  Semi skilled/ unskilled labour required for operation and maintenance.

- **Reduces carbon footprint** (कार्बन फुंड ट्रॉप कम होता है)
  Generally less or no energy required. Also no addition of expensive chemicals or additives.

- **Safe reuse of treated wastewater** (उपचारित दूषित जल का सुरक्षित पुनःउपयोग)
  Especially for non potable end uses.

- **Cost efficient** (लागत कुशल)
  Doesn’t require sophisticated or costly maintenance.

- **Promotes a kind of ‘public-private partnership’** (सरकारी और निजी भागीदारी की प्रोत्साहन)
  ULBs / local authorities have to provide lesser capital outlay including low O&M that is taken care by public.

- **Adaptability in nature** (स्थानिक में अनुकूलता)
  Adaptable to varying organic load and climatic condition.

- **Suitable for Organic wastewater flow** (जैविक दूषित जल के बहाव के लिए उपयुक्त)
  1-1,000 m³ per day.

- **Meets the wastewater standards** (दूषित जल के मानक को पूरा करता है)
  Treated wastewater meets the discharge standards and environmental laws.

- **Follows circular economy** (परिपर्य-अर्थव्यवस्था की पालन करता है)
  Treat and reuse of wastewater locally and promotes resource recovery.

- **Doesn’t cause any nuisance** (बाधाहीन)
  Such as noise pollution, bad odour to the surrounding, problems of mosquito breeding etc.

- **Site specific and flexible in nature** (साईट विशिष्ट)
  To be designed according to the characteristics of wastewater.
Benefits of DWWTs

Social
- Improved Livelihood: Improve quality of life
- Public health safeguard: By reducing level of pollution

Economic
- Cost efficient
- Informed choice: Stakeholders involvement
- Time efficient: Less than 12 months for plan and implement

Environmental

Source: Adapted from Policy Guidance Manual on Wastewater Management with a Special Emphasis on Decentralized Wastewater Treatment Systems. Bangkok, Thailand
Decentralized approach bridges the gap between OSS and conventional off-site sanitation approaches.

• The decentralized approach is also applicable to address the issue of environmental pollution caused by effluent from the on-site sanitation systems.
• The concept of septage management that sets out interlinked steps that are vital to manage septage and effluent from generation to disposal to end-use also recognize DWWM as one of the solution for effluent management.
DWWM approach talks beyond Toilets
विकेन्द्रिकरण दृष्टि जल उपचार संयंत्र दृष्टिकोण शौचालय से आगे की बात करता है

ODF+ and ODF++ are aimed towards proper maintenance of toilet facilities and safe collection, conveyance, treatment/disposal of all faecal sludge and sewage

• ODF+ focuses on toilets with water, maintenance and hygiene (ODF+ शौचालय, जल की व议案 और स्वच्छता पर जोर देता है)

• ODF++ focuses on toilets with sludge and septage management hygiene (ODF++ में शौचालय और फेकल स्लेज और स्पेटेज प्रबंधन पर जोर है)
Why Wastewater Treatment?

Safe disposal into the environment (वातावरण में जल का सुरक्षित निपटान)

Improving current sanitation situation - impacting public health (वर्तमान के सैंटिटेशन परिस्थिति में बेहतरी)

Replenishing/ Restoration of a lake/ water body (झील या जल श्रोत को पुनः स्थापित करना)

Bulk or domestic reuse of treated wastewater (उपचारीक दूषित जल का घरेलू उपयोग)

Why Wastewater Treatment?

दूषित जल का उपचार क्यूं?
Process flow for setting up DWWTs

1. **Need of the Treatment**
   - Abatement of pollution
   - Water sensitive planning – reducing water demand by reuse/recycle
   - Lake revival

2. **Data Collection**
   - Volume of wastewater (depends upon population, per capita water consumption)
   - Quality of wastewater (depends upon type of water consumption pattern)

3. **Site Feasibility**
   - Terrain
   - Area availability
   - Environmental conditions (Temperature, Sunlight)
   - Building codes and by-laws - Distance from underground water tank, building foundation etc.

4. **Technology Selection**
   - What is the required treated water quality? – Types of re-use/discharge
Data Collection

Flow of wastewater
dूषित जल का बहाव

• Population
• Per capita water consumption
• Volume of wastewater generation

Quality of wastewater
dूषित जल की गुणवत्ता

• Type of water consumption pattern
• Quality analysis report
• Physical appearance of wastewater

Volume of wastewater generated /day (cum)

**Thumb rule:** 80% of the total water consumption goes out as waste

Example:
Population (P) = 130,
Water use = 100 litres / capita / day
Volume of water consumed
= 130 x 100 = 13000 litres / day or 13cum/ day

Hence average volume of wastewater generated
= 13000 x 0.8 = 10,400 litres /day or approx. 10 cum/ day.
Site Feasibility

Soil भूमि
Ground water भूजल
Topography तलरुप

High ground water level
- Construction of DWWT is challenging
- Scope of possible leakage of untreated sewage into ground water
- DWWT system should be strictly waterproof

Topography – high altitude, steep terrain
- High pumping requirements for water
- Sewer can be gravity driven
Site Feasibility
साईट की व्यवहार्यता

Things to keep in mind while planning a DWWTs:

- Land ownership? Is there any land dispute? भूमि का स्वामित्व? कोई जमीनी मतभेद?
- What are the constraints? बाकी बाधाएं?
- Is there any service and utility infrastructure that could get affected? किसी सर्विस या आधारिक सरंचना में प्रभाव पड़ना?
- How much surface area available कितना सतह छेत्र उपलब्ध है?
- Are there any opportunity areas – available open spaces? खुली सतह उपलब्ध है?
- Try to utilize set-back area
- Incorporation as a landscape feature परिदृश्य जैसा सम्मलित करना
The objective of wastewater treatment is to extract pollutants, remove toxicants & coarse particles, reduce organic & nutrient load, kill pathogens so that quality of effluent is improved to reach the permissible level of water to be reused.
Stages of Wastewater Treatment

Primary Treatment
(Screen, Grit chamber and Primary sedimentation tank (PST))

Secondary Treatment
(Biological treatment process)

Tertiary Treatment
(Disinfection Process)

Reuse/Disposal
# Nature based Decentralized Wastewater Treatment Technologies

<table>
<thead>
<tr>
<th>Name of the technology</th>
<th>Reuse of treated water</th>
<th>Capital cost (INR/KLD)</th>
<th>O&amp;M cost (INR/KLD/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructed Wetland</td>
<td>Horticulture</td>
<td>10000</td>
<td>1500-2000</td>
</tr>
<tr>
<td>DWWTs</td>
<td>Horticulture</td>
<td>50000</td>
<td>8500</td>
</tr>
<tr>
<td>Green bridge</td>
<td>In situ treatment of water bodies</td>
<td>200-500</td>
<td>20-50</td>
</tr>
<tr>
<td>Biosanitizer/ Eco chip</td>
<td>In situ treatment of water bodies, Horticulture</td>
<td>10000 per chip excluding construction cost</td>
<td>-</td>
</tr>
<tr>
<td>Nualgi</td>
<td>In situ treatment of lakes/ ponds, Increase in fish yield</td>
<td>0.35</td>
<td>9-10</td>
</tr>
<tr>
<td>Bioremediation</td>
<td>In situ treatment of lakes/ ponds</td>
<td>225 – 300</td>
<td>200 – 225</td>
</tr>
<tr>
<td>Soil scape filter</td>
<td>Horticulture</td>
<td>20000-30000</td>
<td>1800 – 2000</td>
</tr>
<tr>
<td>Fixed film biofilter Technology (FFBT)</td>
<td>Horticulture/ Car washing</td>
<td>25,000-35,000</td>
<td>1,000-2,000</td>
</tr>
<tr>
<td>Phytorid</td>
<td>Horticulture</td>
<td>14,000-35,000</td>
<td>1,000-2,000</td>
</tr>
</tbody>
</table>
# Electro-mechanical Decentralized Wastewater Treatment Technologies

<table>
<thead>
<tr>
<th>Name of the technology</th>
<th>Treatment capacity</th>
<th>Reuse of treated water</th>
<th>Capital cost (INR/KLD)</th>
<th>O&amp;M cost (INR/KLD/ year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Bio technology (SBT)</td>
<td>5KLD – tens of MLD</td>
<td>Horticulture, Cooling systems</td>
<td>10,000-15,000</td>
<td>1000-1500</td>
</tr>
<tr>
<td>Trans Biofilter</td>
<td>5 KLD-3 MLD</td>
<td>Gardening, landscaping, farming &amp; other non-potable purposes</td>
<td>50-70</td>
<td>5-7</td>
</tr>
</tbody>
</table>
### Criteria: Selection of Technology

<table>
<thead>
<tr>
<th>Parameter Consideration</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated effluent quality</td>
<td>The technology must meet the standards as required</td>
</tr>
<tr>
<td>Energy requirement</td>
<td>The process choice should consider minimizing energy requirements</td>
</tr>
<tr>
<td>Land requirement</td>
<td>Minimize land requirement</td>
</tr>
<tr>
<td>Capital Cost of Plant</td>
<td>Process should allow optimum utilization of capital</td>
</tr>
<tr>
<td>Operational and Maintenance costs</td>
<td>Process design should be conducive to attaining lower running cost</td>
</tr>
<tr>
<td>Operation and Maintenance requirement</td>
<td>Simple and reliable</td>
</tr>
<tr>
<td>Reliability of System</td>
<td>Deliver the desired quality on a consistent basis</td>
</tr>
<tr>
<td>Reuse and Resource Recovery</td>
<td>Ability to maximize reuse of end products</td>
</tr>
<tr>
<td>Load Fluctuations</td>
<td>System should be able to withstand organic and hydraulic load fluctuations</td>
</tr>
</tbody>
</table>

Source: Guidelines for Decentralized Wastewater Management by IIT Madras
MOUNT is an aggregator platform for various sustainable technologies, encouraging and disseminating knowledge and good practices for wastewater management. MOUNT divides treatment process in 4 Categories

https://www.cseindia.org/mount/home

Menu on Un-networked Technologies
A constructed wetland is an organic wastewater treatment system that mimics and improves the effectiveness of the processes that help to purify water similar to naturally occurring wetlands. The system uses water, aquatic plants (i.e. reeds, duckweed), naturally occurring microorganisms and a filter bed (usually of sand, soils and/or gravel).

The general concept is that the plants, microorganisms and substrates together act as a filter and purification system. First, water is slowed as it enters the wetland, allowing for the sedimentation of solids. Through the process of water flow through the constructed wetland, plant roots and the substrate remove the larger particles present in the wastewater.

Pollutants and nutrients present in the wastewater are then naturally broken down and taken up by the bacteria and plants, thereby removing them from the water. The retention time in the wetland, which varies depending on the design and desired quality level. After treatment in a constructed wetland, water can be safely released into surface waters or used various purposes.

**Salient Features:**
- Cost efficient in terms of construction, operations and maintenance
- Effectively treats wastewater from human waste, agricultural runoff, storm water and some metals or pollutants from mining and industry
- Uses technology that is simple to understand and manage
- Low energy consumption required for operations
- Assists in maintaining groundwater and surface water levels
- Contributes to environmental protection by providing a habitat for plants and animals
- Pleasing natural aesthetics
Case Example: Institutional Building
Constructed wetland at Indian Agriculture Research Institute, Pusa, New Delhi

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Building</td>
<td>Institution</td>
</tr>
<tr>
<td>Source of Wastewater</td>
<td>Drain coming from 2 colonies</td>
</tr>
<tr>
<td>Capacity of the system</td>
<td>2.2 MLD</td>
</tr>
<tr>
<td>Re-use</td>
<td>Agricultural Purpose</td>
</tr>
<tr>
<td>Capital Cost</td>
<td>Rs. 1.2 Crores</td>
</tr>
<tr>
<td>O&amp;M Cost (per annum)</td>
<td>Rs. 1335/-</td>
</tr>
<tr>
<td>Year of Implementation</td>
<td>2012</td>
</tr>
</tbody>
</table>

The treatment plant comprises of 3-treatment cells (each of 80 meter by 40 meter), where organic, nutrient and metal pollutant reductions (i.e. secondary and tertiary treatments) take place; besides 2-sewage wells and 1-grit chamber, where preliminary/primary treatment takes place.

Each treatment cell is stratified with a bed of gravels of varying sizes/grades, onto which Typha latifolia – a hyper-accumulating emergent vegetation is planted.
Decentralized Wastewater Treatment System (DWWTs)

DWWTs is an easy and sustainable solution to treat wastewater with the combination of settler, anaerobic baffled reactor, anaerobic filter, planted gravel filter and polishing pond.

<table>
<thead>
<tr>
<th>Area Requirements Sq-m per Cum (As per Thumb Rules)</th>
<th>Settler</th>
<th>ABR + AF</th>
<th>PGF</th>
<th>Polishing Pond</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.5</td>
<td>1.0</td>
<td>4.0</td>
<td>1.2</td>
</tr>
</tbody>
</table>

**Removal**

- **Underground anaerobic process**
  - 25%-30% BOD removal – Settler
  - 70%-90% BOD removal – Baffled reactor
- **Above ground level aerobic + anaerobic process**
  - 40%-60% BOD removal
- **Removal of suspended solids**
- **Reduction of Organic contaminants**
- **Nutrients removal**
  - (Aeration through roots, adsorption on filter material)
Costing of DWWTs Project

(As per Thumb Rules)

<table>
<thead>
<tr>
<th>Capacity of DWWTs</th>
<th>CAPEX per Cum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 8 KLD</td>
<td>1.2 – 1.5 Lac</td>
</tr>
<tr>
<td>10 – 25 KLD</td>
<td>70,000 – 80,000</td>
</tr>
<tr>
<td>Beyond 30 KLD</td>
<td>40,000 – 60,000</td>
</tr>
</tbody>
</table>

Operation & Maintenance Cost = 3 to 5% of CAPEX
Case example: Institutional Building
Decentralized Wastewater Treatment System at CSE HQ

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Building</td>
<td>Office Building</td>
</tr>
<tr>
<td>Source of Wastewater</td>
<td>Kitchen and Toilets</td>
</tr>
<tr>
<td>Capacity of the system</td>
<td>8KLD (Approx 150 Users)</td>
</tr>
<tr>
<td>Re-use</td>
<td>For maintaining greenery</td>
</tr>
<tr>
<td>Capital Cost (2005)</td>
<td>Rs. 2,25,000/-</td>
</tr>
<tr>
<td>O&amp;M Cost (per annum)</td>
<td>Rs. 30,000/-</td>
</tr>
<tr>
<td>Year of Implementation</td>
<td>2005</td>
</tr>
</tbody>
</table>

Benefit –
Freshwater (groundwater and municipal supply) not used in low end usage.
Monthly saving – Rs. 400 municipal supply and Rs. 2,500 if recycled water is purchase from tankers
Ten chambers with two chambers of anaerobic filters
## DWWT at Institutional level

संस्थागत विकेन्द्रिकरण दृष्टि जल उपचार संयंत्र

Aravind Eye Hospital, Abhishekapakkam, Pondicherry, India

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of Implementation</td>
<td>2003</td>
</tr>
<tr>
<td>Type of Building</td>
<td>Hospital and Residential Buildings together</td>
</tr>
<tr>
<td>System’s area</td>
<td>2690 sq m</td>
</tr>
<tr>
<td>Capacity of the system</td>
<td>320 KLD</td>
</tr>
<tr>
<td>Re-use</td>
<td>Horticulture of 15 acres of area within the hospital premises</td>
</tr>
<tr>
<td>Capital Cost (2003)</td>
<td>INR 11.2 Million</td>
</tr>
<tr>
<td>O&amp;M Cost (per annum)</td>
<td>INR 250,000-500,000</td>
</tr>
</tbody>
</table>

Settler and Anaerobic baffled reactors
Institutional Complex:
संस्थागत कॉम्प्लेक्स
Aravind Eye Hospital and Residential Buildings, Puducherry

Planted filter bed with Canna indica
Polishing pond
Treated wastewater reuse for horticulture
Case Example: Public space
DWWTs at Nehru Garden, Alwar

Implementing Agency: UTI, Alwar
Year of Implementation: 2016
Knowledge Partner and Design: Centre for Science and Environment (CSE), New Delhi
Proposed use of treated water: Horticulture
Treatment Capacity: 100 KLD
Capital Cost: Rs. 32 Lakhs (2013)
O&M Cost: Rs. 1.1 -1.5 Lakhs/annum
Total Area: 730 m²
Phytorid is a sub-surface flow type treatment system, it treats wastewater with the help of porous media such as crushed bricks, gravels and wetland plants. The system is divided broadly into the three zones viz. inlet zone, treatment zone and outlet zone.

Processes
- Sedimentation
- Bacterial action
- Filtration
- Adsorption
- Precipitation
- Decomposition
- Nutrient uptake
- Vegetation system

Treated water can be utilized in irrigation, fountains etc.
Case example: Housing Society
Phytorid Technology based treatment plant at Rainbow Drive Society, Bangalore

Rainbow Drive is a 36 acre neighborhood with 430 plots located in south east Bangalore.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of Implementation</td>
<td>2014</td>
</tr>
<tr>
<td>Type of Building</td>
<td>Community level</td>
</tr>
<tr>
<td>Capacity of the system</td>
<td>250 KLD</td>
</tr>
<tr>
<td>Re-use</td>
<td>For maintaining green landscapes</td>
</tr>
<tr>
<td>Capital Cost</td>
<td>INR. 55 Lakhs</td>
</tr>
<tr>
<td>O&amp;M Cost (per annum)</td>
<td>INR. 10,000</td>
</tr>
</tbody>
</table>
Soil Bio-technology is a terrestrial system for wastewater treatment with the combination of physical and biochemical processes. It is based on the principle of trickling filter. Suitable mineral constitution, culture containing native microflora and bio-indicator plants are the key components of the system.

**Salient Features:**
- The process can be run on batch or continuous mode.
- The overall time of operation is 6-7 hours per day.
- No sludge production
- Mechanical aeration is not required.

Case Example: Public Place
Soil Bio-Technology at Lodhi Gardens, New Delhi
सोइल बायोटेक्नोलॉजी (एस बी टी), लोधी गार्डन, नयी दिल्ली

PPP contract between NDMC (owners of the gardens) and Vision Earth (technology providers) is based on the Hybrid Annuity Model. Under this contract, the payments made to Vision Earth are subject to performance of the treatment system.

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<tbody>
<tr>
<td>Year: 2017</td>
<td>O&amp;M</td>
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</table>

The organic content of the sewage is removed as it passes through bioreactor bed. The bioreactor bed can be customized depending upon local conditions.

The treatment within the bed takes place via adsorption by the layers of soil followed by biological aerobic degradation. This creates acidic conditions which is regulated by the chemical weathering of mineral additives that are added in the bioreactor bed. In addition, photosynthesis of natural flora serves as a bio-indicator of the micro-habitat. Rates of mineral weathering and photosynthesis are slow and a majority of the treatment can be attributed to the sedimentation, infiltration and bio-degradation processes.

Lucknow Airport
For more details visit https://www.cseindia.org/page/water-and-wastewater-management
THANK YOU

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