



Natural and near natural water solutions:

a review of current decentralised water technologies based on natural processes providing ecosystem services for water resource management, treatment and pollution abatement

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RONWATER

Renewable Organic Nexus

for Water treatment, Adaptation, Transformation, Engagement and Resilience

Why natural and decentral?

- **Current challenges**
with water resource management, water supply, wastewater treatment and flood protection
 - increasing anthropogenic pollution and impacts on the natural water cycle.
 - more demand related to quality as well as quantity
 - changing climatic conditions,
 - stronger rainfall events -> flash runoff and floods, erosion, water quality deterioration
 - longer drought periods -> water scarcity, less groundwater recharge, more storage capacity requirements, drying of former perennial rivers and water bodies
- **Sustainable and resilient solutions**
with decentralised and tailored, situation specific approaches
 - Environmentally friendly as they require less energy and resources
 - Low investment and running costs (energy, spare parts, repair costs)
 - Less dependent operation due to „low tech“ understandable for local stakeholders

Still also decentral, small scale and natural solutions require maintenance, partly even more manpower than fully automatic high tech solutions



Natural and near natural solutions

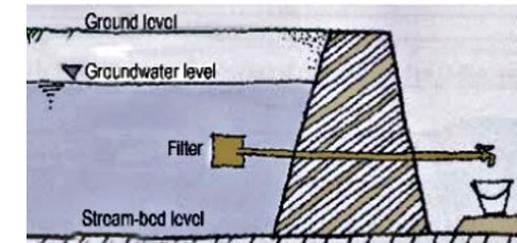
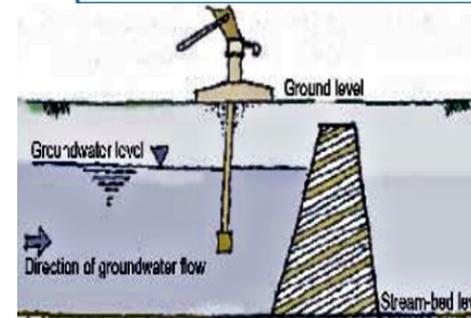
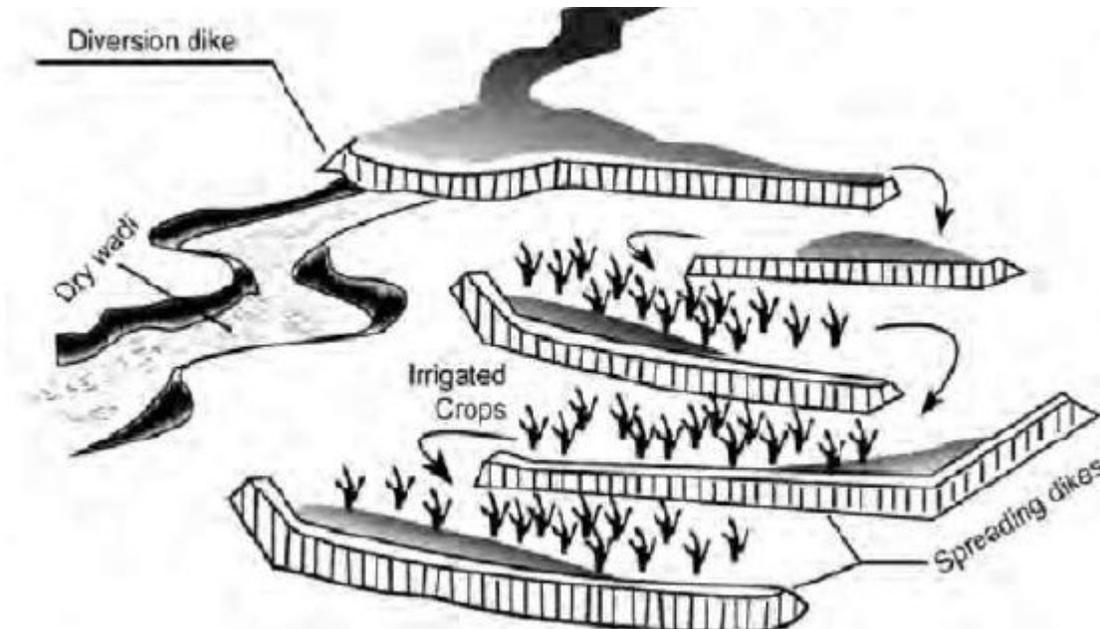
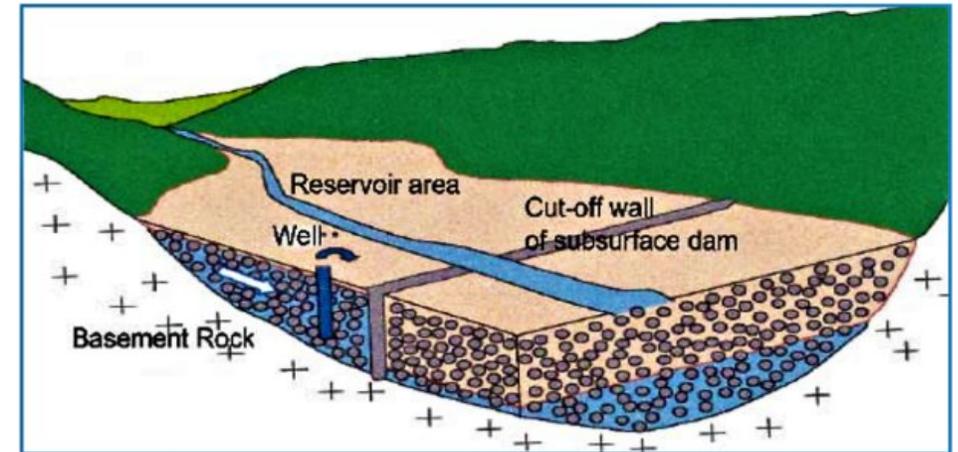
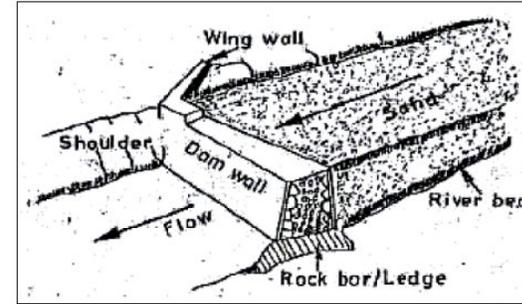
Principles and Characteristics

- **NBS (Nature Based Solutions)**
 - Make use of natural processes / ESS (Eco System Services)
 - Self purification (ponds, streams, rivers)
 - Phytoremediation (constructed wetlands, reedbedfilters)
 - Soil Passage (MAR, soil biotechnology)
- **IWRM (Integrated Water Resources Management)**
 - Environmentally and socio-economically sustainable (eco friendly usage of water protection zones)
 - Benefits for different stakeholders (RBM with checkdams in catchment)
 - Synergies between sectors (MAR for joint usage by farmers and public water supply)
- **DEWATS (Decentralised Wastewater Treatment Systems)**
 - Adapted small scale solutions (in-situ river/drain treatment)
 - Innovative tailored processes (combination with energy/food production, reuse of biogas, treated wastewater)
 - Local ownership (community based operation of oxidation ponds)

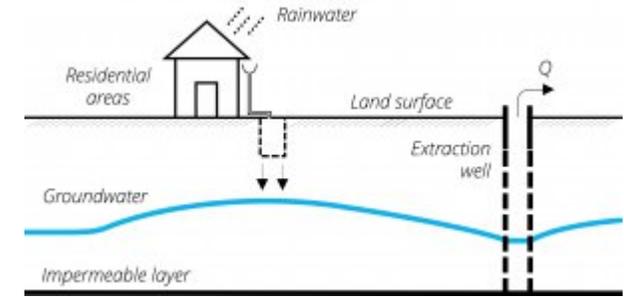
Water Resource Management: Checkdams, sand and subsurface dams

Rainwater Harvesting from surface runoff

- Micro catchment engineering, ponds, lakes
- Contour trenches, keyline design
- Pollution Control: Agroecology, Sanitation

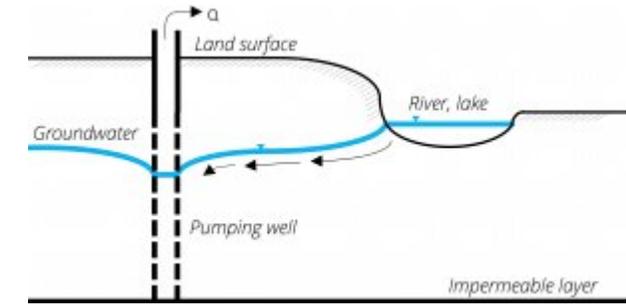
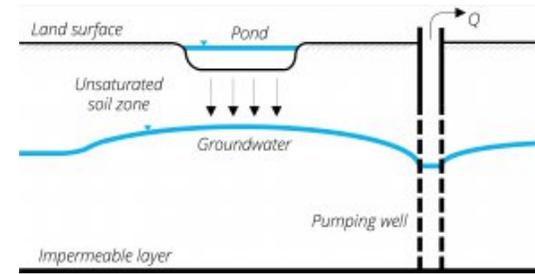


(Managed) Aquifer Recharge



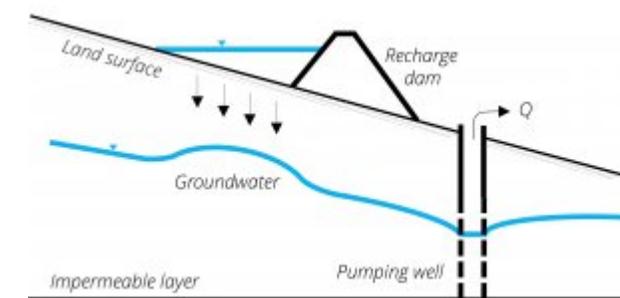
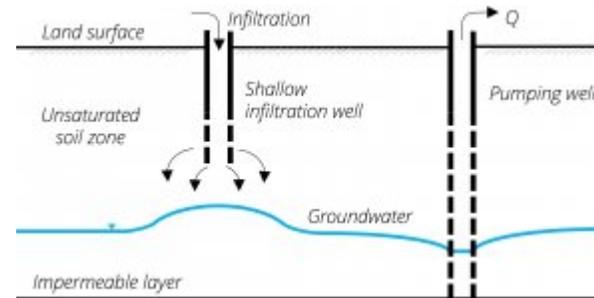
Objectives:

- Maximising natural storage
- Sustainable management of groundwater resources
- Restoration of depleted groundwater levels
- Mitigation of saltwater intrusion



• Technology

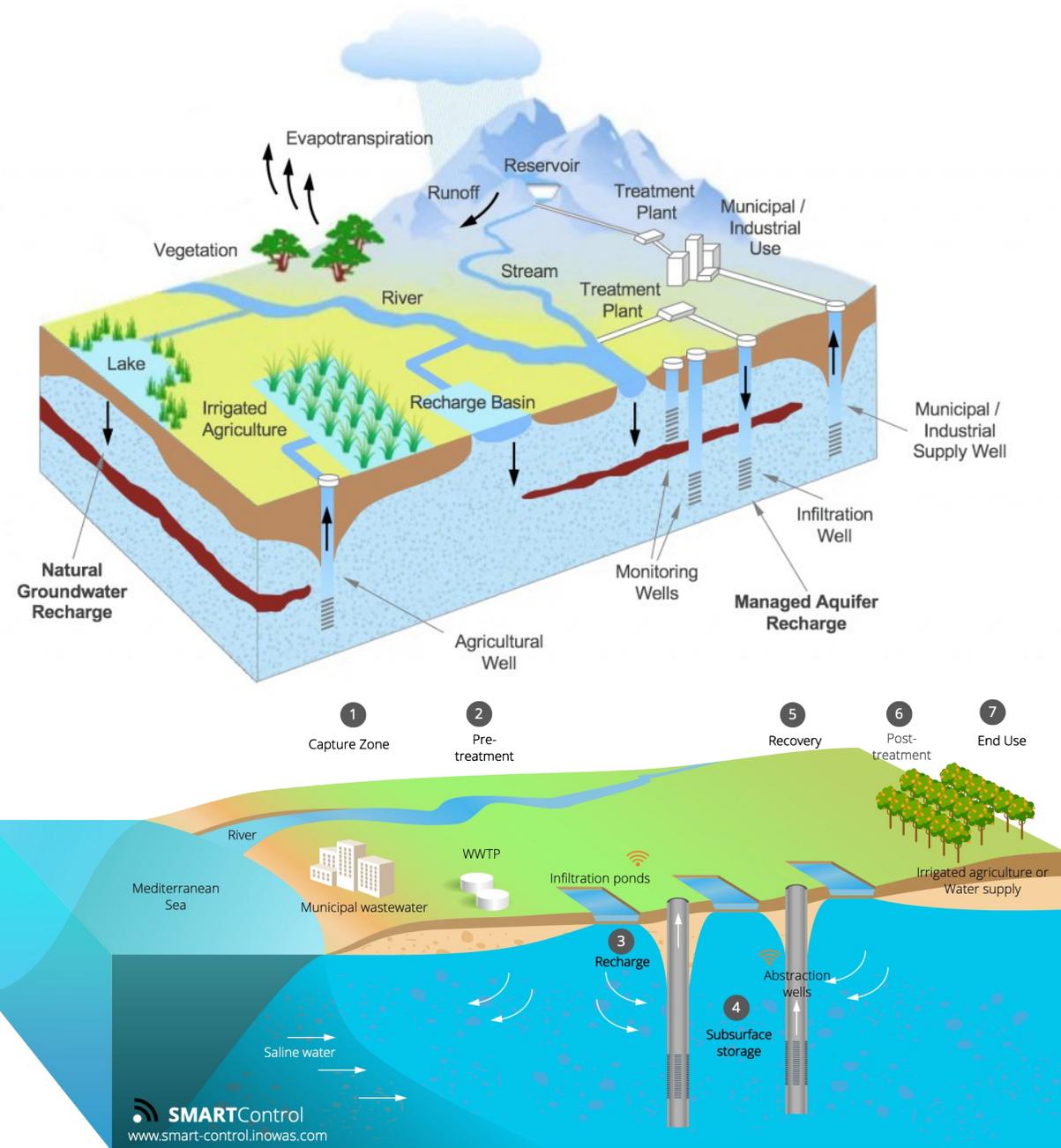
- Runoff/rooftop harvesting with barriers, bunds and trenches
- Infiltration ponds
- Induced Bank filtration
- Well, shaft, borehole recharge
- In-channel modifications: recharge and subsurface dams



Case Studies MAR

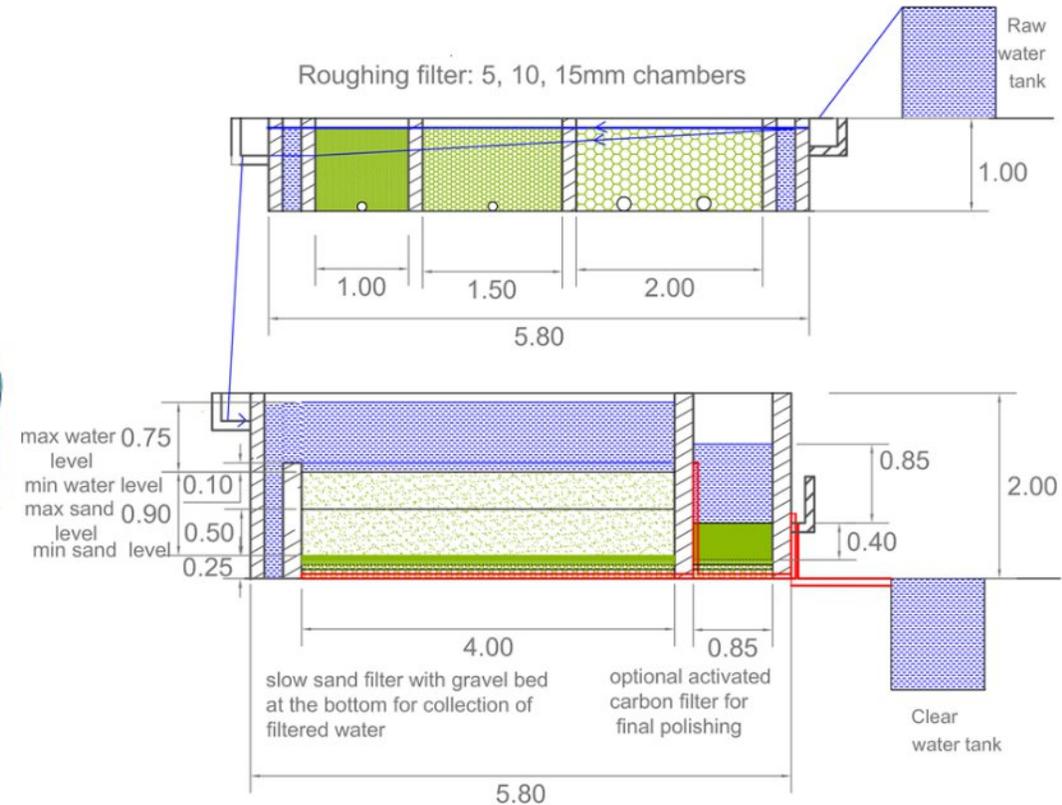
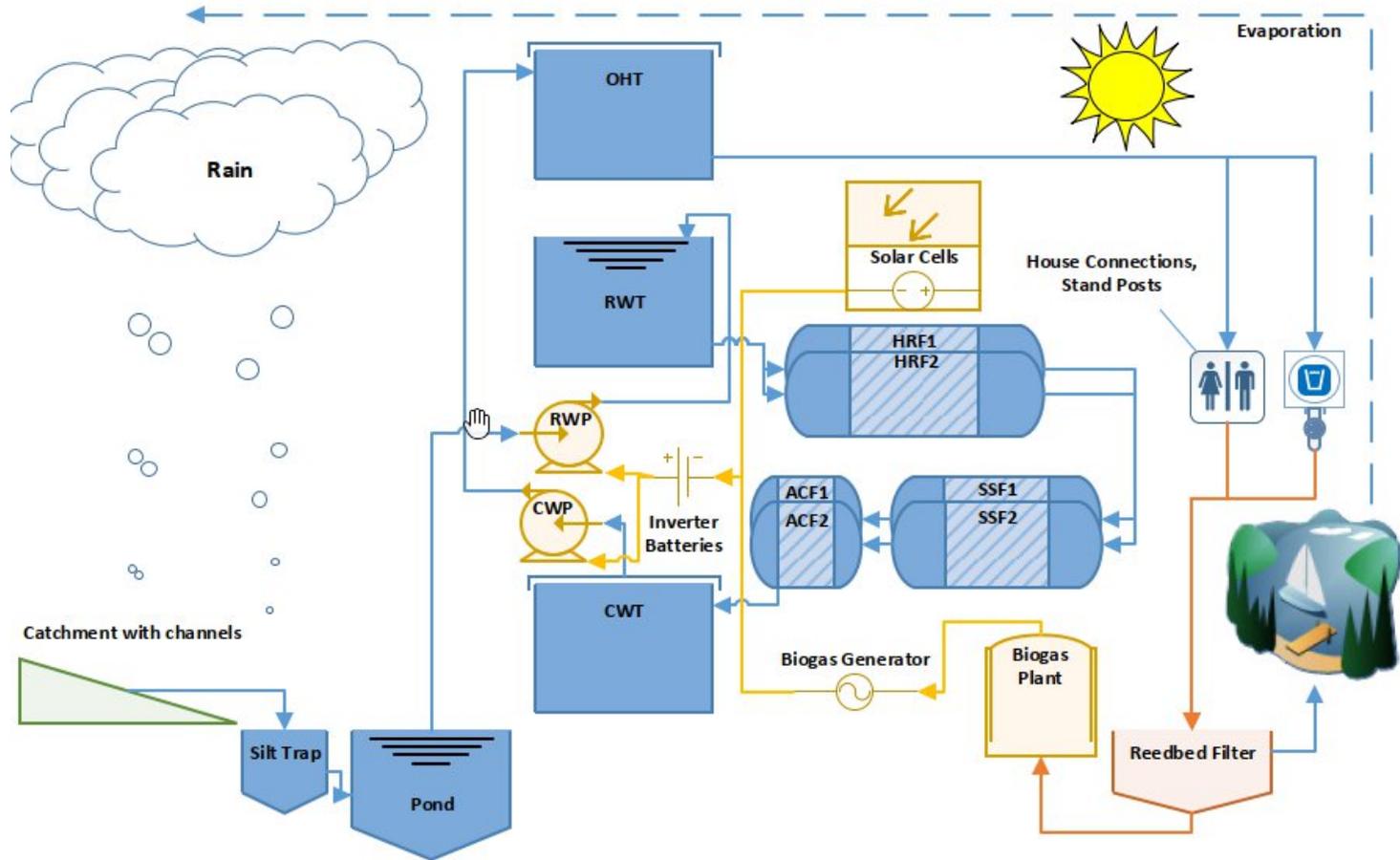
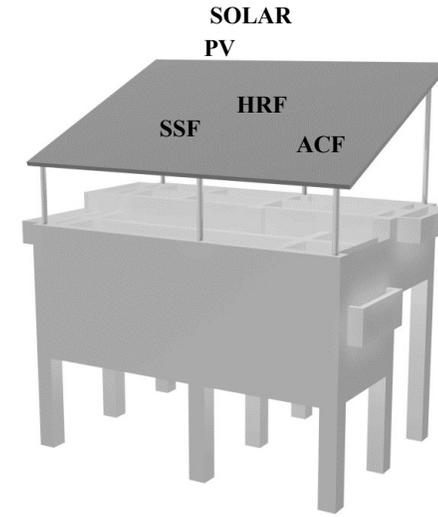
- Temporary water scarcity
 - Various recharge technologies
 - Usage of fresh water and treated waste water
 - Natural infiltration with lake, recharge basin
 - Managed with infiltration well
 - Aquifer Storage (Transfer) and Recovery (AS(T)R)
 - Soil Aquifer Treatment (SAT)

- Seawater intrusion
 - Managed with infiltration ponds
 - Protection of abstraction wells
 - Supporting municipal water supply and agriculture





Horizontal Roughing - , Slow Sand - and Activated Carbon Filtration



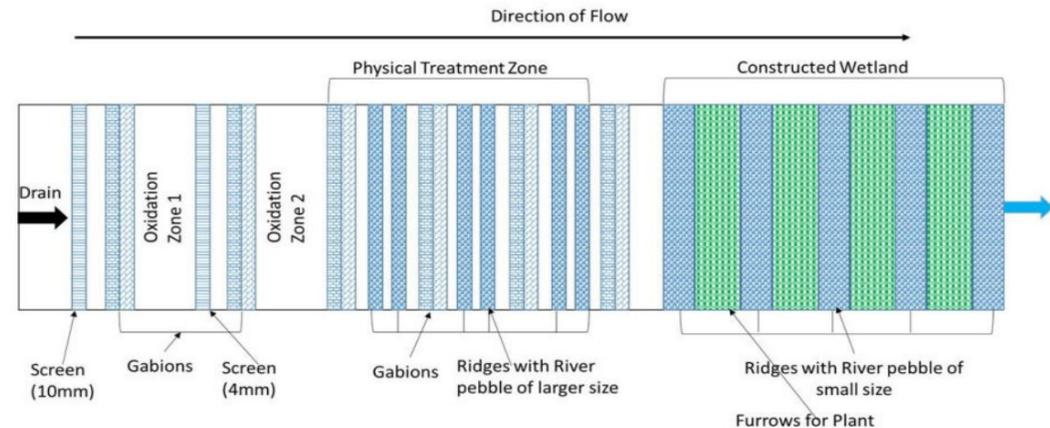
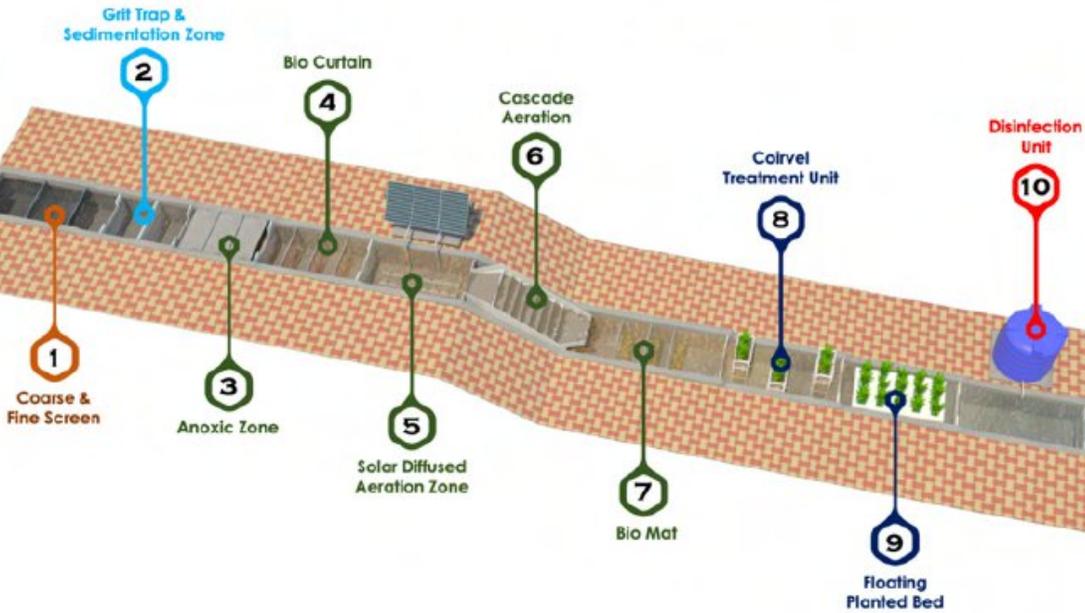
source: Analysis of near natural community based surface water supply



Waste Water In-Situ Drain Treatment

Series of treatment steps inside a drain /canal:
physical, anaerobic, aerobic, phytoremediation, filtration, etc.

RENEU (RESTORATION OF NALLAH WITH ECOLOGICAL UNITS)



sources: URMP Aurangabad / CPCB report /MOHUA advisory

Oxidation Ponds

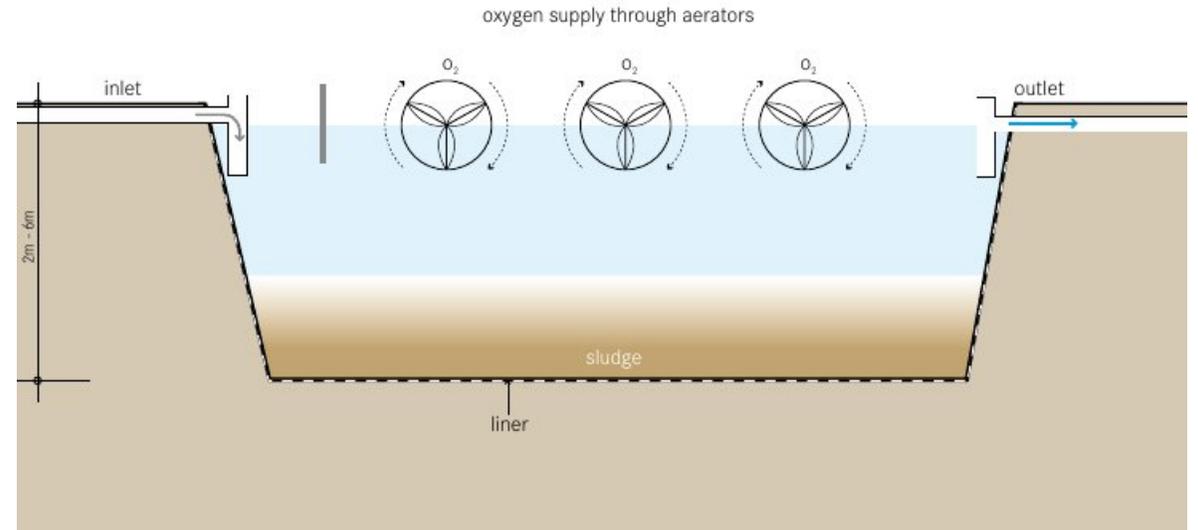
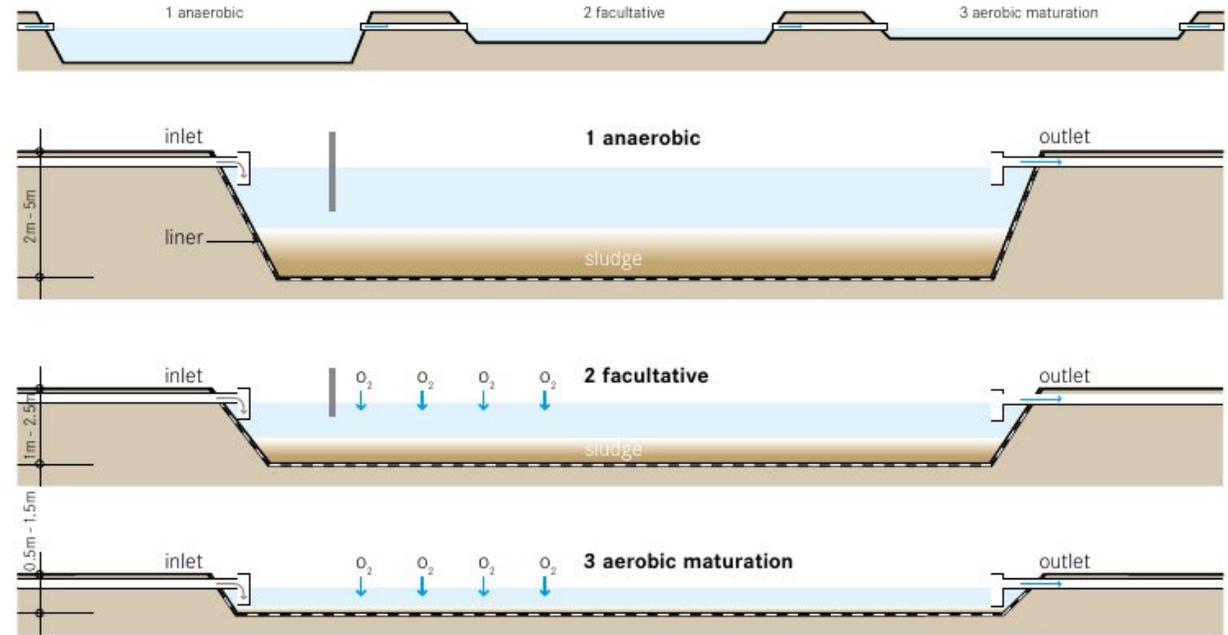
• Waste Stabilisation Ponds(WSP)

Application Level:	Management Level:	Inputs:
<input type="checkbox"/> Household <input checked="" type="checkbox"/> Neighbourhood <input checked="" type="checkbox"/> City	<input type="checkbox"/> Household <input checked="" type="checkbox"/> Shared <input checked="" type="checkbox"/> Public	<input checked="" type="checkbox"/> Blackwater <input checked="" type="checkbox"/> Brownwater <input checked="" type="checkbox"/> Greywater <input checked="" type="checkbox"/> Sludge
		Outputs:
		<input checked="" type="checkbox"/> Effluent <input checked="" type="checkbox"/> Sludge

• Aerated pond

Application Level:	Management Level:	Inputs:
<input type="checkbox"/> Household <input checked="" type="checkbox"/> Neighbourhood <input checked="" type="checkbox"/> City	<input type="checkbox"/> Household <input checked="" type="checkbox"/> Shared <input checked="" type="checkbox"/> Public	<input checked="" type="checkbox"/> Effluent <input checked="" type="checkbox"/> Blackwater <input checked="" type="checkbox"/> Brownwater <input checked="" type="checkbox"/> Greywater
		Outputs:
		<input checked="" type="checkbox"/> Effluent <input checked="" type="checkbox"/> Sludge

can also be used as final polishing step



Constructed Wetland

• Free-Water Surface Constructed Wetland

Application Level:	Management Level:	Inputs: Effluent Stormwater
<input type="checkbox"/> Household	<input type="checkbox"/> Household	Outputs: Effluent Biomass
<input checked="" type="checkbox"/> Neighbourhood	<input checked="" type="checkbox"/> Shared	
<input checked="" type="checkbox"/> City	<input checked="" type="checkbox"/> Public	

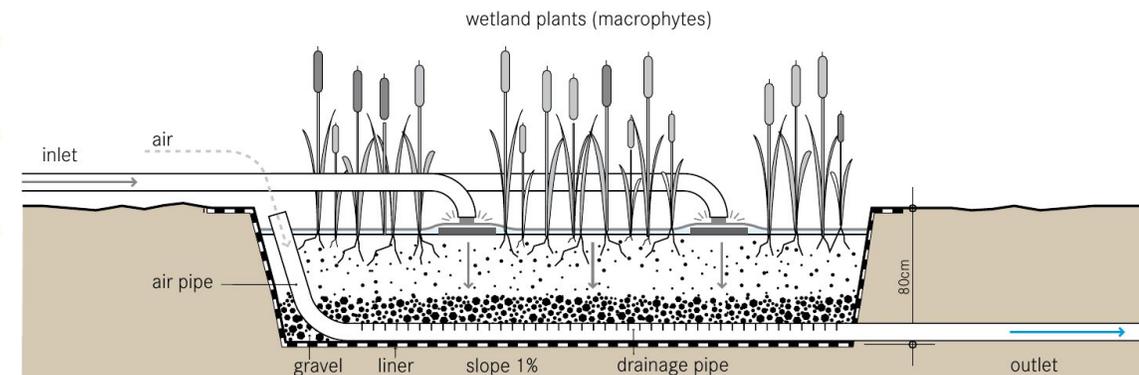
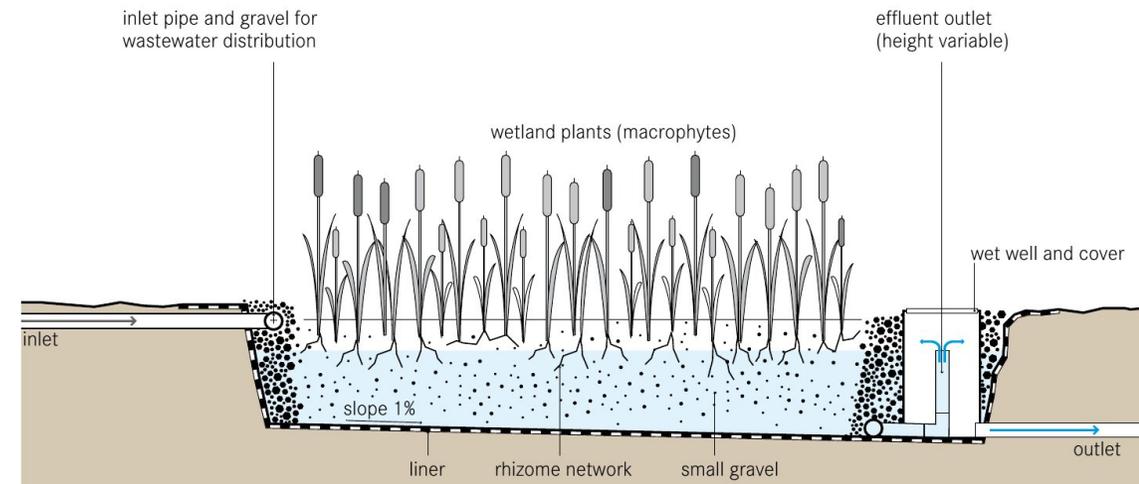
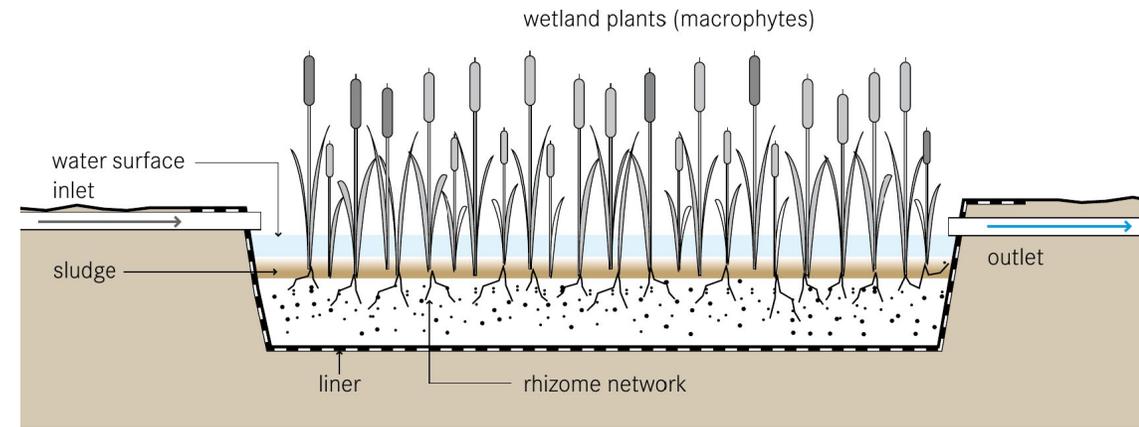
• Horizontal Subsurface Flow Constructed Wetland

Application Level:	Management Level:	Inputs: Effluent Blackwater
<input type="checkbox"/> Household	<input type="checkbox"/> Household	Brownwater Greywater
<input checked="" type="checkbox"/> Neighbourhood	<input checked="" type="checkbox"/> Shared	Outputs: Effluent Biomass
<input type="checkbox"/> City	<input checked="" type="checkbox"/> Public	

• Vertical Flow Constructed Wetland

Application Level:	Management Level:	Inputs: Effluent Blackwater
<input type="checkbox"/> Household	<input type="checkbox"/> Household	Brownwater Greywater
<input checked="" type="checkbox"/> Neighbourhood	<input checked="" type="checkbox"/> Shared	Outputs: Effluent Biomass
<input checked="" type="checkbox"/> City	<input checked="" type="checkbox"/> Public	

can also be used as final polishing step



Primary Treatment

• Preatreatment Technologies

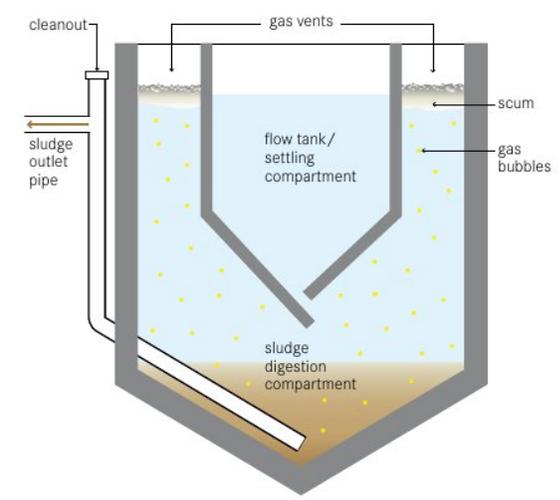
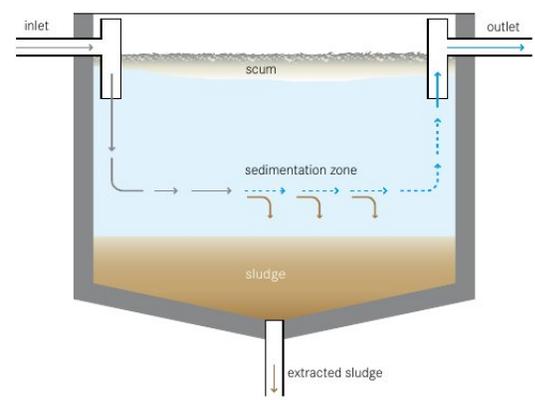
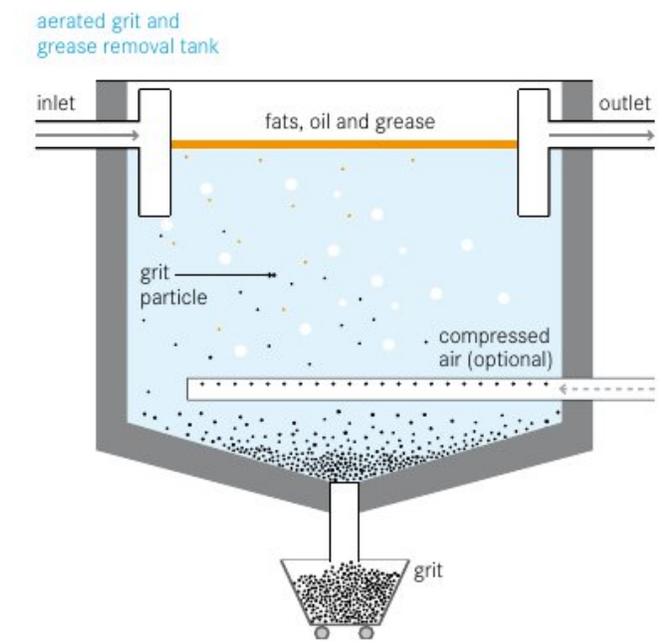
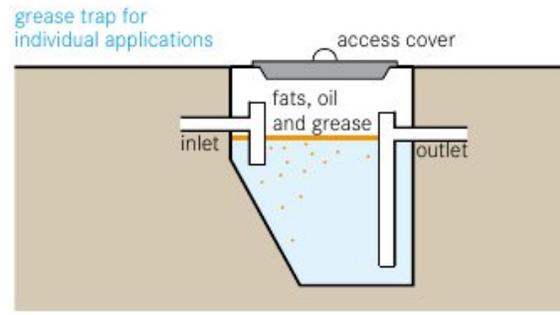
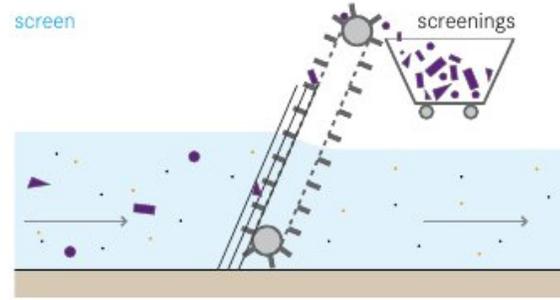
Application Level:	Management Level:	Inputs:
<input type="checkbox"/> Household <input checked="" type="checkbox"/> Neighbourhood <input checked="" type="checkbox"/> City	<input checked="" type="checkbox"/> Household <input type="checkbox"/> Shared <input checked="" type="checkbox"/> Public	<input checked="" type="checkbox"/> Blackwater <input type="checkbox"/> Brownwater <input type="checkbox"/> Greywater <input type="checkbox"/> Sludge
		Outputs:
		<input type="checkbox"/> Blackwater <input type="checkbox"/> Brownwater <input type="checkbox"/> Greywater <input type="checkbox"/> Sludge <input checked="" type="checkbox"/> Pre-Treatment Products

• Settler

Application Level:	Management Level:	Inputs:
<input type="checkbox"/> Household <input checked="" type="checkbox"/> Neighbourhood <input checked="" type="checkbox"/> City	<input type="checkbox"/> Household <input checked="" type="checkbox"/> Shared <input checked="" type="checkbox"/> Public	<input checked="" type="checkbox"/> Blackwater <input type="checkbox"/> Brownwater <input type="checkbox"/> Greywater
		Outputs:
		<input checked="" type="checkbox"/> Effluent <input type="checkbox"/> Sludge

• Imhoff Tank

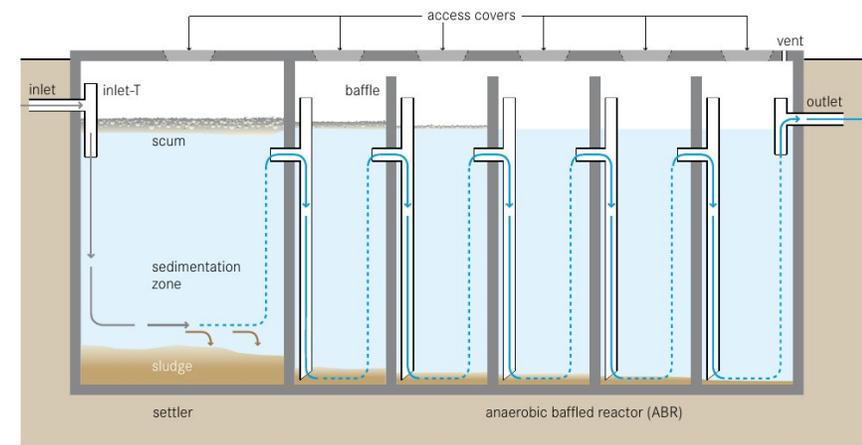
Application Level:	Management Level:	Inputs:
<input type="checkbox"/> Household <input checked="" type="checkbox"/> Neighbourhood <input checked="" type="checkbox"/> City	<input type="checkbox"/> Household <input type="checkbox"/> Shared <input checked="" type="checkbox"/> Public	<input checked="" type="checkbox"/> Blackwater <input type="checkbox"/> Brownwater <input type="checkbox"/> Greywater
		Outputs:
		<input checked="" type="checkbox"/> Effluent <input type="checkbox"/> Sludge



Secondary Treatment

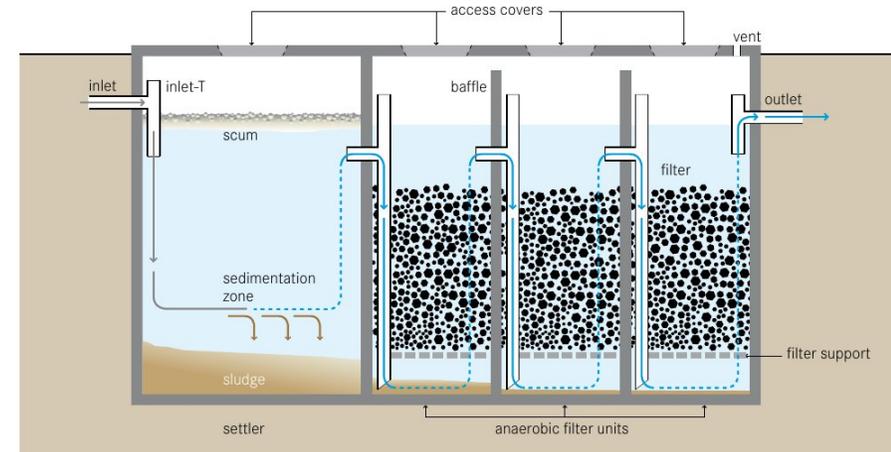
• Anaerobic Baffled Reactor (ABR)

Application Level:	Management Level:	Inputs: <input type="checkbox"/> Effluent <input type="checkbox"/> Blackwater <input type="checkbox"/> Brownwater <input type="checkbox"/> Greywater
<input type="checkbox"/> Household <input checked="" type="checkbox"/> Neighbourhood <input type="checkbox"/> City	<input type="checkbox"/> Household <input checked="" type="checkbox"/> Shared <input checked="" type="checkbox"/> Public	Outputs: <input type="checkbox"/> Effluent <input type="checkbox"/> Sludge



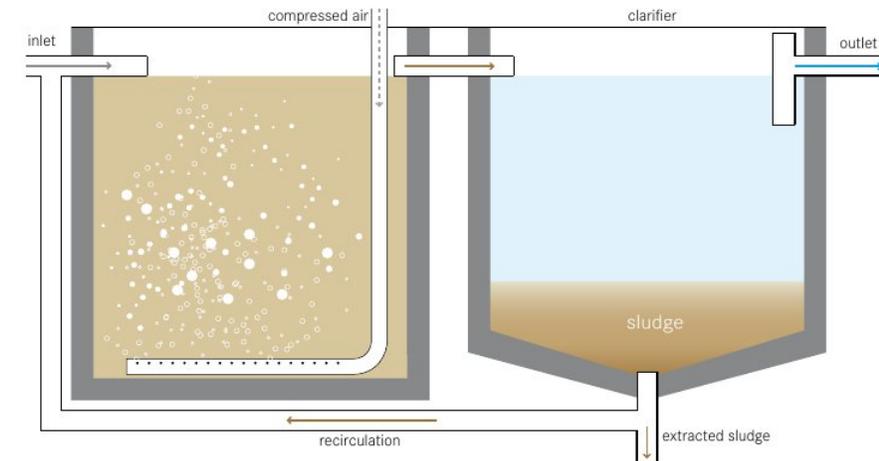
• Anaerobic Filter

Application Level:	Management Level:	Inputs: <input type="checkbox"/> Effluent <input type="checkbox"/> Blackwater <input type="checkbox"/> Brownwater <input type="checkbox"/> Greywater
<input type="checkbox"/> Household <input checked="" type="checkbox"/> Neighbourhood <input type="checkbox"/> City	<input type="checkbox"/> Household <input checked="" type="checkbox"/> Shared <input checked="" type="checkbox"/> Public	Outputs: <input type="checkbox"/> Effluent <input type="checkbox"/> Sludge



• Activated Sludge

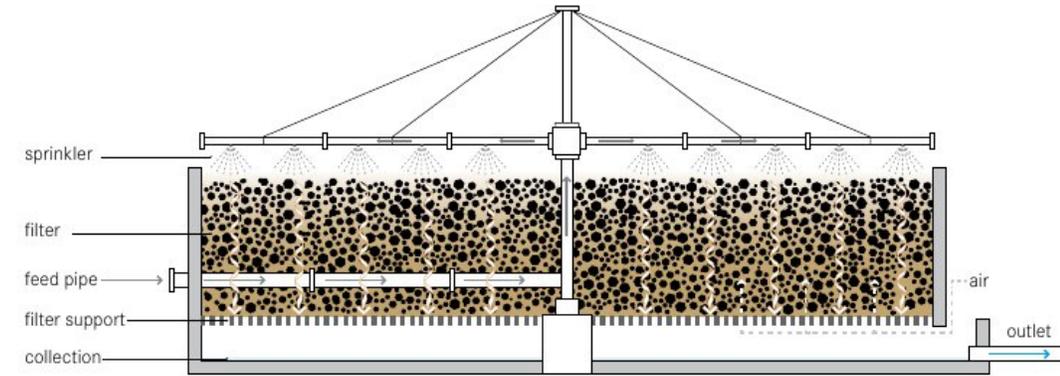
Application Level:	Management Level:	Inputs: <input type="checkbox"/> Effluent <input type="checkbox"/> Blackwater <input type="checkbox"/> Brownwater <input type="checkbox"/> Greywater
<input type="checkbox"/> Household <input checked="" type="checkbox"/> Neighbourhood <input checked="" type="checkbox"/> City	<input type="checkbox"/> Household <input type="checkbox"/> Shared <input checked="" type="checkbox"/> Public	Outputs: <input type="checkbox"/> Effluent <input type="checkbox"/> Sludge



Further Polishing Treatment

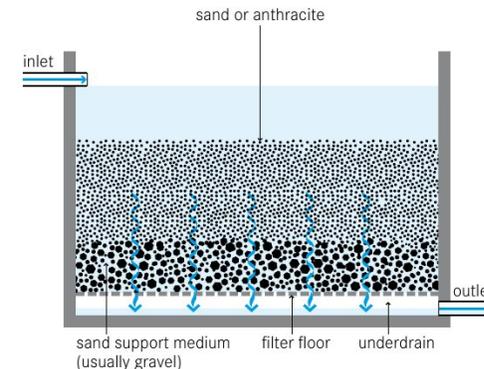
• Trickling Filter

Application Level:	Management Level:	Inputs:
<input type="checkbox"/> Household <input checked="" type="checkbox"/> Neighbourhood <input checked="" type="checkbox"/> City	<input type="checkbox"/> Household <input type="checkbox"/> Shared <input checked="" type="checkbox"/> Public	<input checked="" type="checkbox"/> Effluent <input checked="" type="checkbox"/> Blackwater <input checked="" type="checkbox"/> Brownwater <input type="checkbox"/> Greywater
		Outputs:
		<input checked="" type="checkbox"/> Effluent <input checked="" type="checkbox"/> Sludge

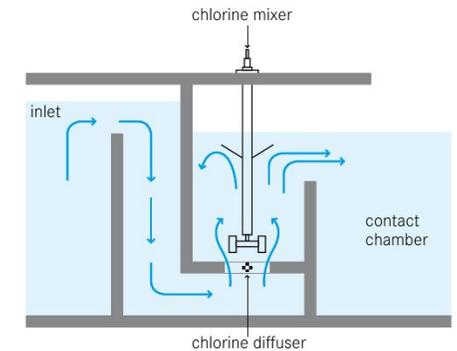


• Tertiary Filtration and Disinfection

Application Level:	Management Level:	Inputs:
<input type="checkbox"/> Household <input checked="" type="checkbox"/> Neighbourhood <input checked="" type="checkbox"/> City	<input type="checkbox"/> Household <input checked="" type="checkbox"/> Shared <input checked="" type="checkbox"/> Public	<input checked="" type="checkbox"/> Effluent
		Outputs:
		<input checked="" type="checkbox"/> Effluent



tertiary filtration (e.g., depth filtration)



disinfection (e.g., chlorination)

Energy Recovery

• Upflow Anaerobic Sludge Blanke Reactor (AUSB)

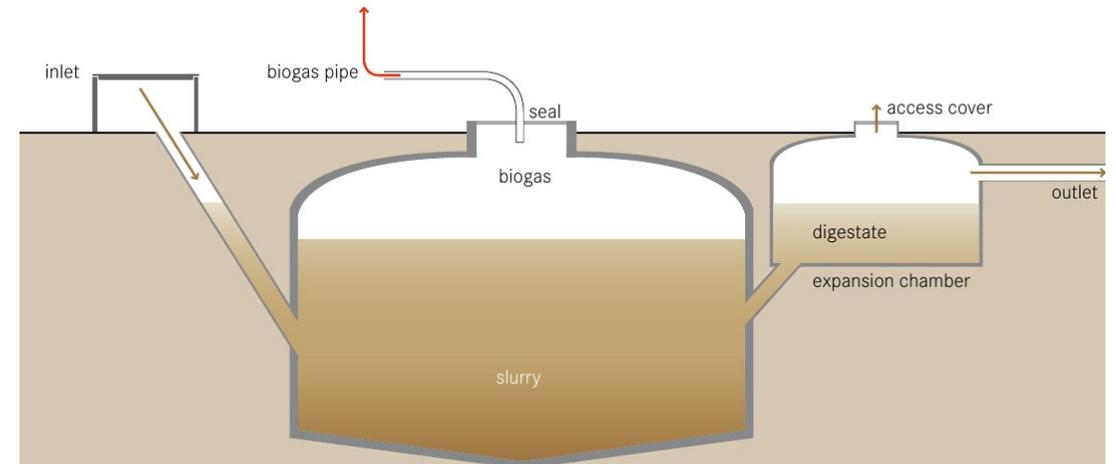
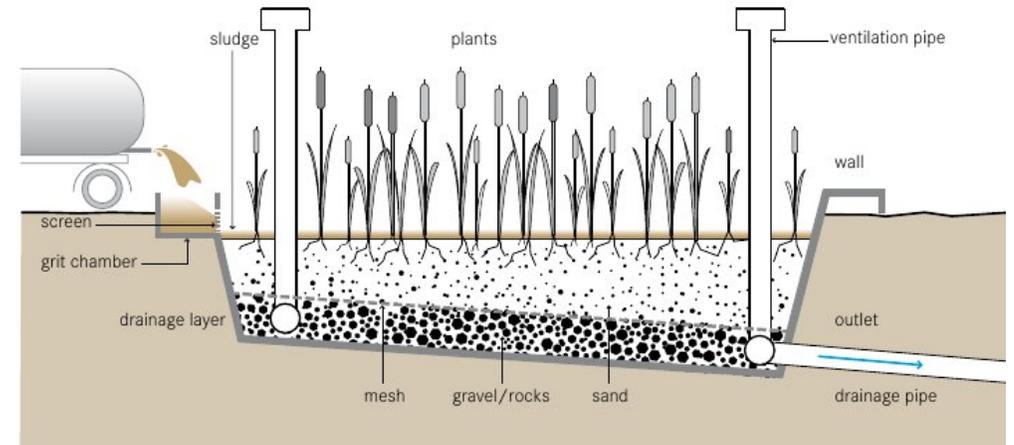
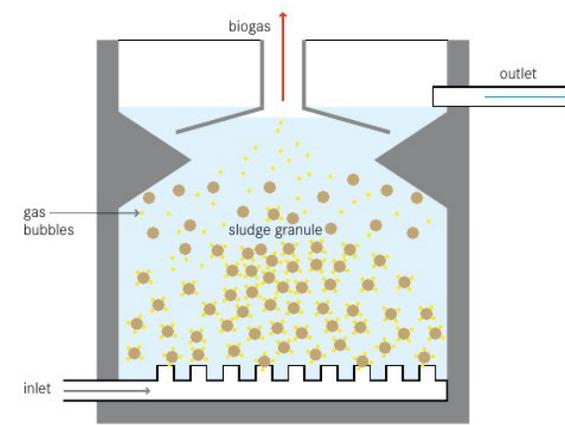
Application Level:	Management Level:	Inputs: Blackwater Brownwater (+ Greywater)
<input type="checkbox"/> Household	<input type="checkbox"/> Household	Outputs: Effluent Sludge Biogas
<input checked="" type="checkbox"/> Neighbourhood	<input type="checkbox"/> Shared	
<input checked="" type="checkbox"/> City	<input checked="" type="checkbox"/> Public	

• Planted Drying Beds

Application Level:	Management Level:	Inputs: Sludge
<input type="checkbox"/> Household	<input type="checkbox"/> Household	Outputs: Sludge Effluent Biomass
<input checked="" type="checkbox"/> Neighbourhood	<input type="checkbox"/> Shared	
<input checked="" type="checkbox"/> City	<input checked="" type="checkbox"/> Public	

• Biogas Reactor

Application Level:	Management Level:	Inputs: Sludge Blackwater Brownwater Organics
<input checked="" type="checkbox"/> Household	<input checked="" type="checkbox"/> Household	Outputs: Sludge Biogas
<input checked="" type="checkbox"/> Neighbourhood	<input checked="" type="checkbox"/> Shared	
<input checked="" type="checkbox"/> City	<input checked="" type="checkbox"/> Public	



Resource Recovery

• Fishpond

Application Level:	Management Level:	Inputs: Effluent
<input type="checkbox"/> Household	<input type="checkbox"/> Household	Outputs: Biomass
<input checked="" type="checkbox"/> Neighbourhood	<input checked="" type="checkbox"/> Shared	
<input checked="" type="checkbox"/> City	<input checked="" type="checkbox"/> Public	

• Floating Plant Pond

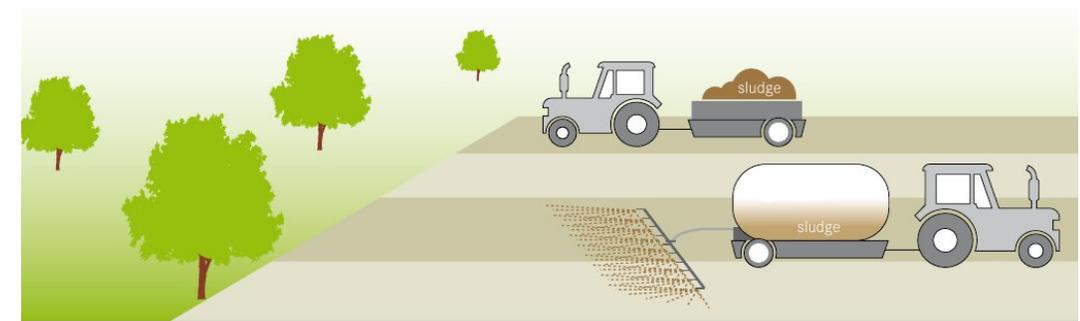
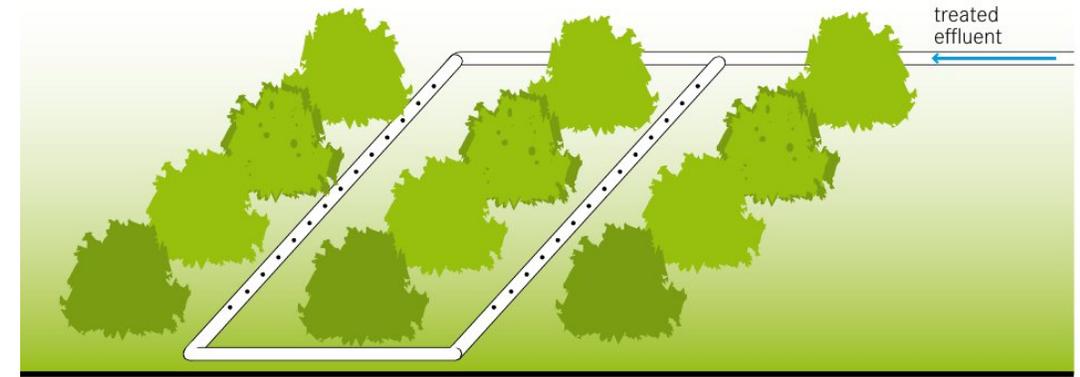
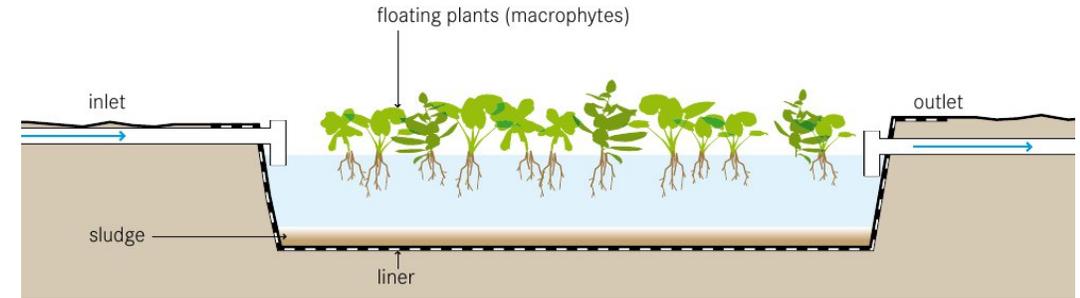
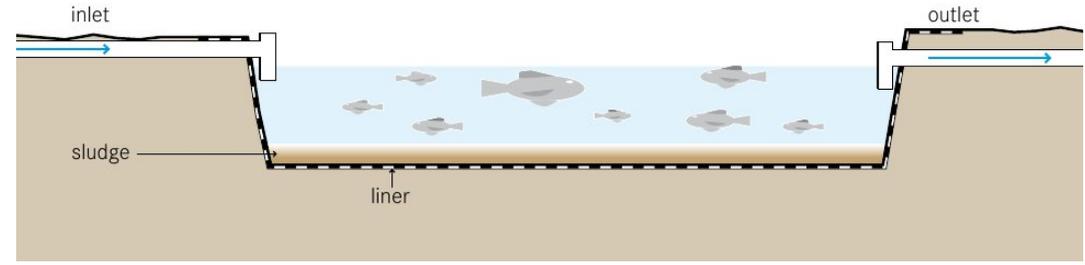
Application Level:	Management Level:	Inputs: Effluent
<input type="checkbox"/> Household	<input type="checkbox"/> Household	Outputs: Biomass
<input checked="" type="checkbox"/> Neighbourhood	<input checked="" type="checkbox"/> Shared	
<input checked="" type="checkbox"/> City	<input checked="" type="checkbox"/> Public	

• Irrigation

Application Level:	Management Level:	Inputs: Effluent Stormwater (+ Stored Urine)
<input checked="" type="checkbox"/> Household	<input checked="" type="checkbox"/> Household	Outputs: Biomass
<input checked="" type="checkbox"/> Neighbourhood	<input checked="" type="checkbox"/> Shared	
<input checked="" type="checkbox"/> City	<input checked="" type="checkbox"/> Public	

• Application of sludge

Application Level:	Management Level:	Inputs: Sludge
<input type="checkbox"/> Household	<input checked="" type="checkbox"/> Household	Outputs: Biomass
<input checked="" type="checkbox"/> Neighbourhood	<input checked="" type="checkbox"/> Shared	
<input checked="" type="checkbox"/> City	<input checked="" type="checkbox"/> Public	

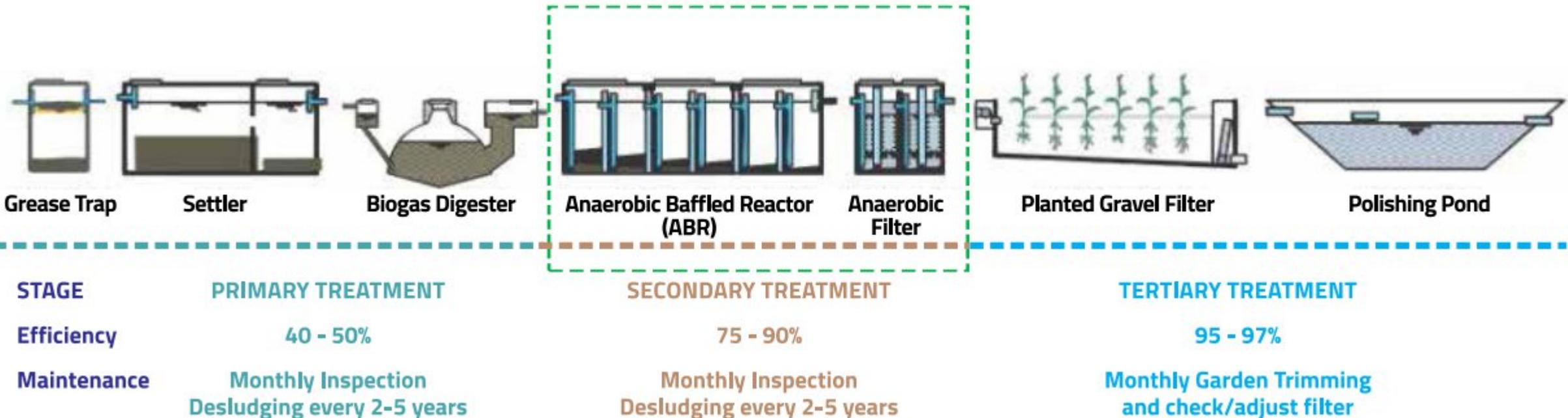




DEWATS combination

Mahadeva Pura Lake in Bengaluru:

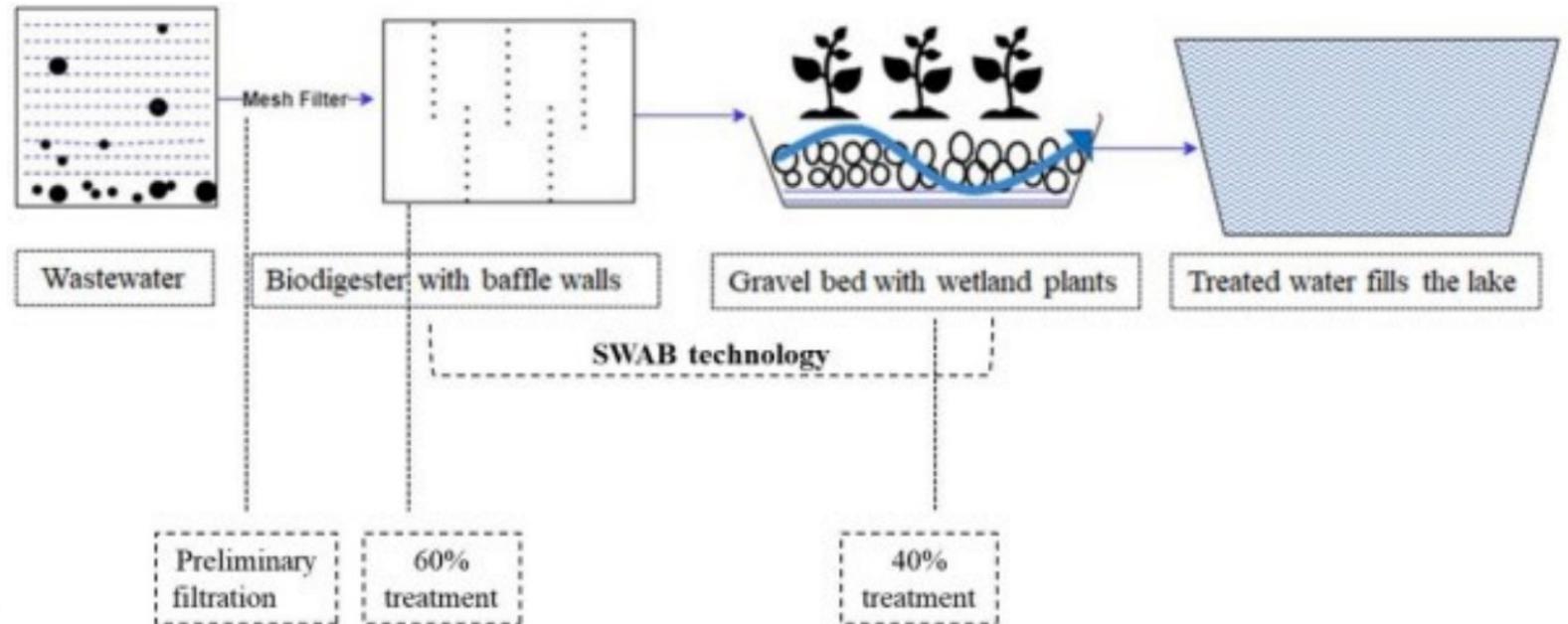
- Lake rejuvenation with natural solutions



DEWATS combination

Rajokri lake, Delhi

- Scientific Wetland System with Active Bio - Digester (SWAB) of 0.6 MLD treatment capacity
- Plantation of Bioremediation grasses
- Installation of 40 floating wetlands in lake.





Thank You for your attention

Any Questions, Comments, Remarks?

Sources used:

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