Water Reuse in Green Buildings

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Introduction

- Increased stress on water usage, sanitation and wastewater disposal

- Availability of water
  - ✓ freshwater
  - ✓ saltwater
  - ✓ grey water and black water

- Alternative water resources
  - ✓ harvested rainwater
  - ✓ reclaimed wastewater

- Concept of green building
  - ✓Reuse and recycling

Green Building and Reuse/Recycling of Water

- Green building
  - ✓environmentally responsible
  - ✓resource-efficient throughout a building's life-cycle
  - ✓ sustainable materials
  - ✓ healthy indoor environments
- Impacts of the built environment

Consumptive impact	Environmental impact	Ultimate impact
• Energy	Waste	Harm to Human Health
• Water	Pollution – Air, Water, Noise	Environment Degradation
• Materials	Heat islands	Loss of Resources
• Natural Resources	Storm water runoff	

Green Building and Reuse/Recycling of Water

- Environmental benefits
  - ✓ Enhance and protect biodiversity and ecosystems
  - ✓ Improve air and water quality
  - ✓ Reduce waste streams
  - ✓ Conserve and restore natural resources sustainable materials
  - ✓ healthy indoor environments
- Recycling
  - ✓reusing treated wastewater for beneficial purposes
  - ✓synonymous with water reclamation and water reuse
  - ✓ unplanned or planned (reusing a recycled water supply)
  - ✓ nonpotable purposes

    toilet flushing, floor cleeaning, irrigation, gardeening, car washing and construction

Green Building and Reuse/Recycling of Water

- Forms of resuable treated wastewater
  - ✓ direct-potable
  - ✓ indirect potable
  - ✓ direct non-potable
  - ✓ indirect non-potable
- Water recycling
  - ✓ to decrease wastewater discharge to sensitive water bodies
  - ✓ to reduce and prevent pollution
  - ✓ effective, successful and reliable water supply for nonpotable reuse
  - ✓ sustainable approach and can be cost-effective in the long term
  - ✓ initially expensive
  - ✓ plays greater role with increase in water and environmental needs

Greywater generation and composition

- Domestic wastewater
  - ✓ Grey water (bathing 50%-60%, cloth washing 25%-30%,kitchen 10
  - ✓ Black water (toilet, urinal)
- Hand washing and bathing
  - ✓ least contaminated
  - ✓ soap, shampoo, hair dye, tooth paste and cleaning products
  - ✓ some faecal contamination
- Cloth washing
  - ✓ varies in quality from wash water to rinse water
  - ✓ faecal contamination
- Kitchen greywater
  - ✓ food particles, oils, fats and other wastes
  - ✓ promotes and supports the growth of microorganisms
  - ✓ chemical pollutants such as detergents and cleaning agents

Typical characteristics of Greywater (NEERI, 2007)

Parameter	Unit	Range
pH	-	6.4-8.1
Suspended solids	mg/L	40-340
Turbidity	NTU	15-270
BOD_5	mg/L	45-330
Nitrite	mg/L	0.1-1.0
Ammonia	mg/L	1.0-2.6
TKN	mg/L	2-23
Total phosphorous	mg/L	0.1-0.8
Sulphate	mg/L	<0.3-12.9
Conductivity	mS/cm	325-1140
Hardness	mg/L	15-50
Sodium	mg/L	60-250
Faecal Coliform	cfu/100mL	10^6-10^8

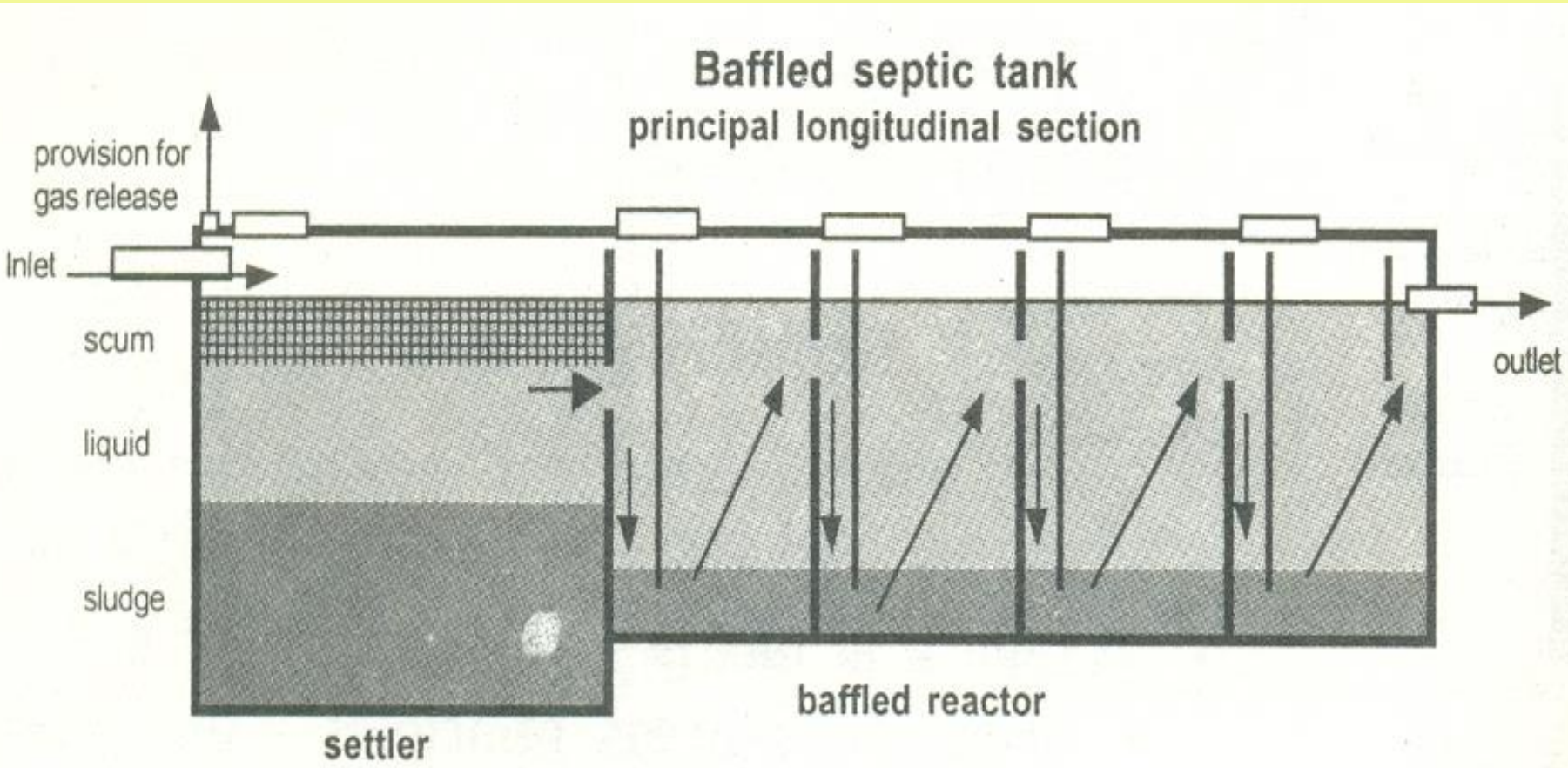
Treatment options for Reuse/Recycling water

- General approaches
  - ✓ waste minimization
  - ✓ low cost treatment options
- Current practice
  - ✓ Greywater and black water – sewerage systems
  - ✓ black water (effluent from septic tank) and grey water - soak pit
  - ✓ untreated greywater - gardening
- Practice in Green building
  - ✓ appropriate technology – O & M view point
  - ✓ sustainable treatment plant
  - ✓ use of little mechanization, utilization of minimum electric power and reuse for non-domestic purposes
  - ✓acceptable, affordable, and manageable for a long time
  - ✓ based on natural purification mechanisms
- Scope for sharing the responsibility of domestic wastewater treatment

Treatment options for reuse/recycling

- Anaerobic
  - ✓ Baffled Septic tank
  - ✓Anaerobic filter
- Aerobic
  - ✓ Upflow –downflow filter
  - ✓Slow sand filter
  - ✓Horizontal roughening filter
  - ✓ Vermifilter
- Anaerobic and Aerobic
  - ✓ Constructed wetland

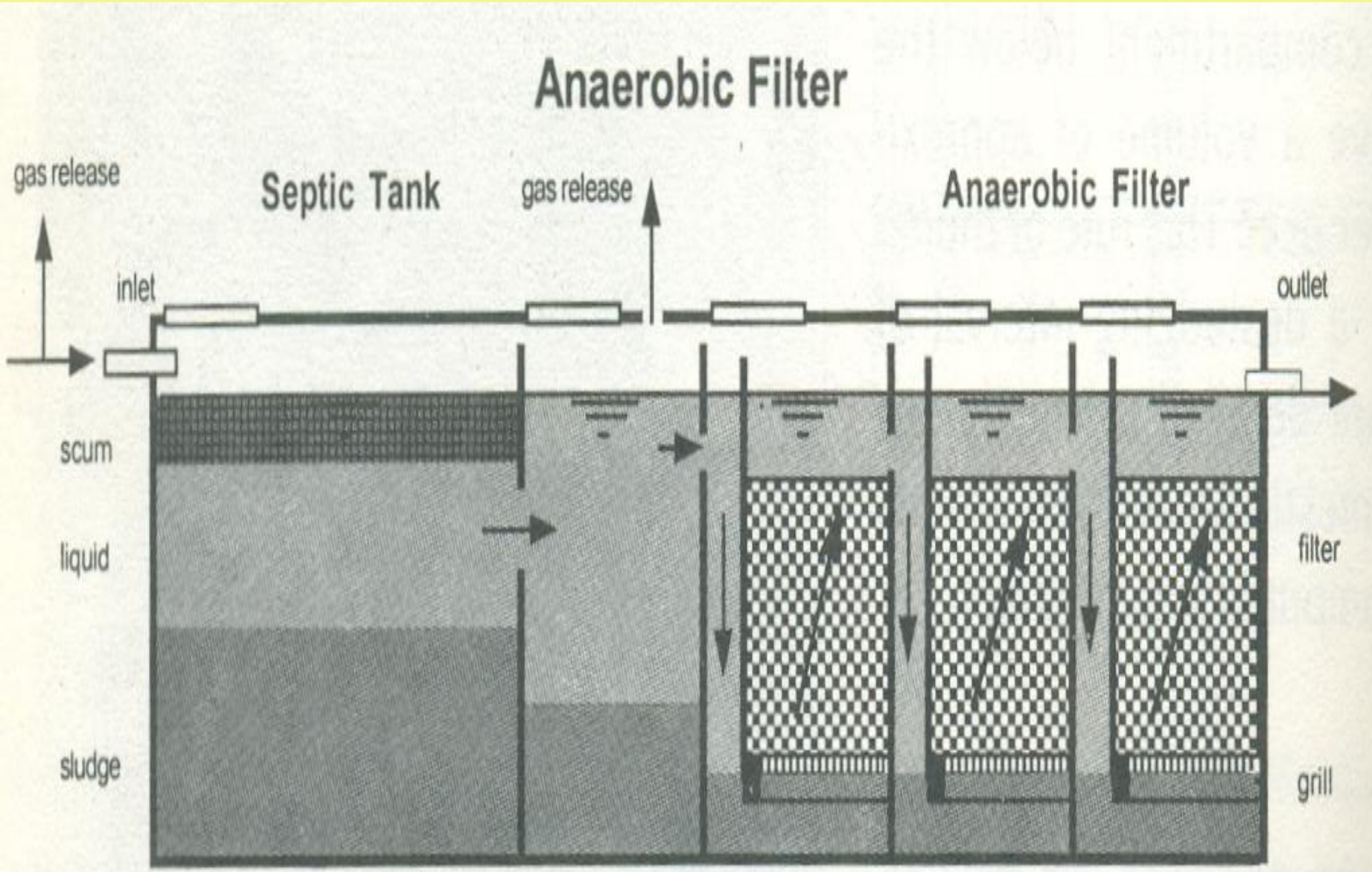
Baffled septic tank



Baffled septic tank

- Combination of septic tank, the fluidized bed reactor and the UASB
- Four chambers in series
- Principle
  - ✓incoming wastewater passes through active bacteria sludge in each compartment
- Process features
  - ✓ equal distribution of inflow
  - ✓ wide spread contact between new and old substrate
- 65% 90% BOD removal
- Pre-treatment in settlers or septic tanks

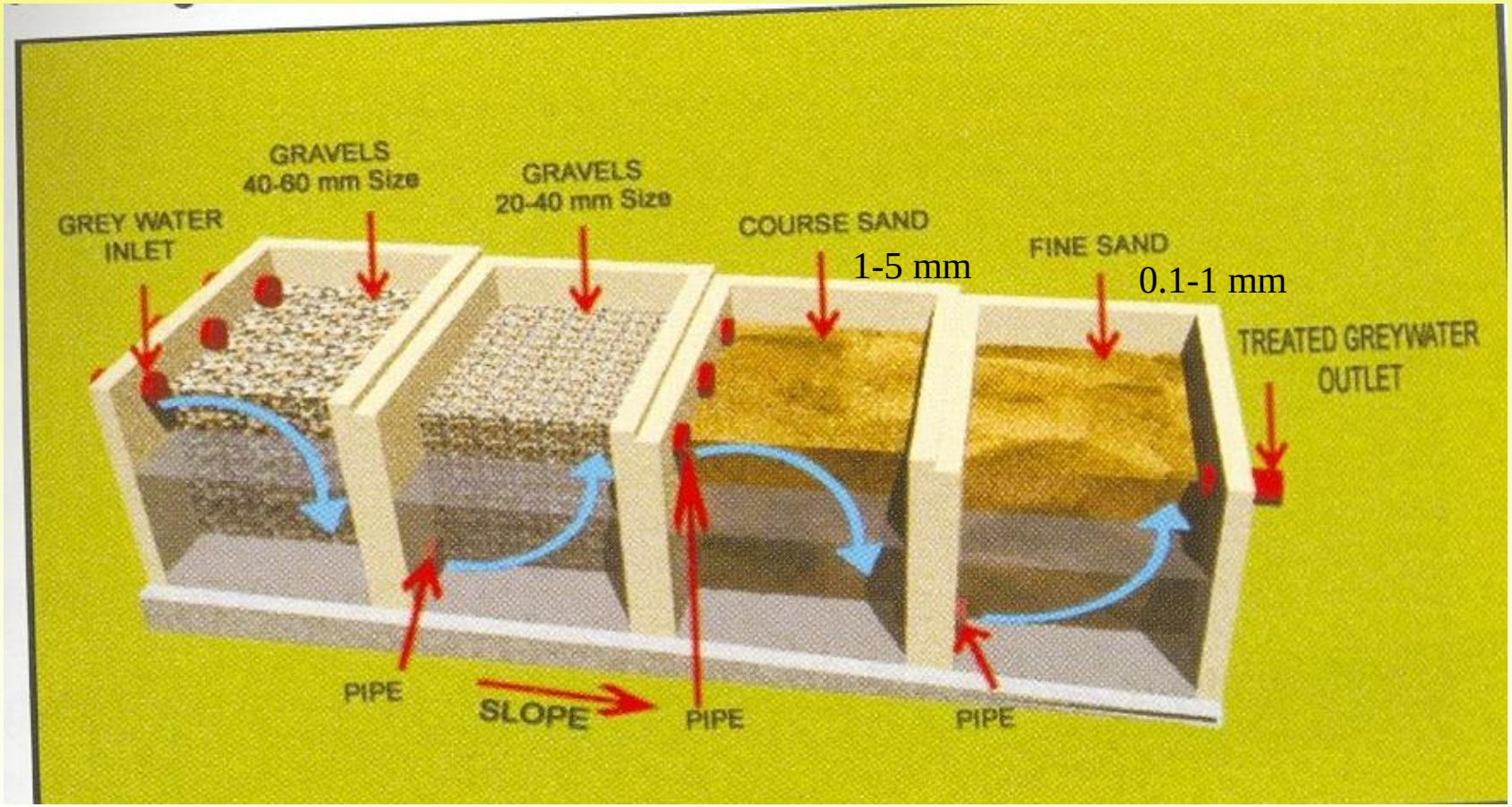
Anaerobic filter



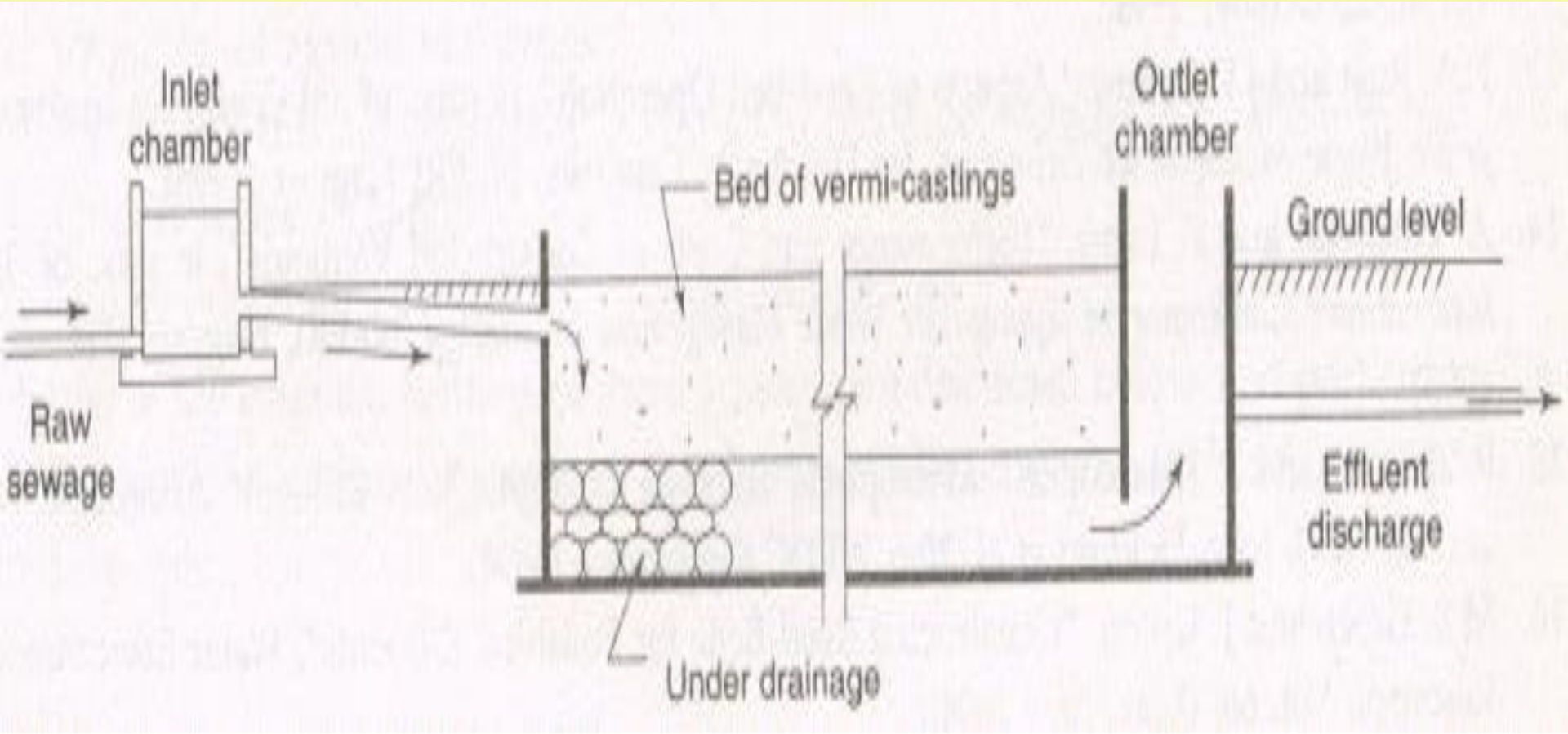
Anaerobic filter

- Anaerobic filter - a column filled with various types of solid media
- Upflow through the column
- Treats both the non-settleable and dissolved solids
- Bacteria are immobile
- Surface area
- Lawn or film that grows on the filter
- Cleaning by backflash of wastewater
- 70% 90% BOD removal
- Pre-treatment in settlers or septic tanks

Upflow-downflow Filter



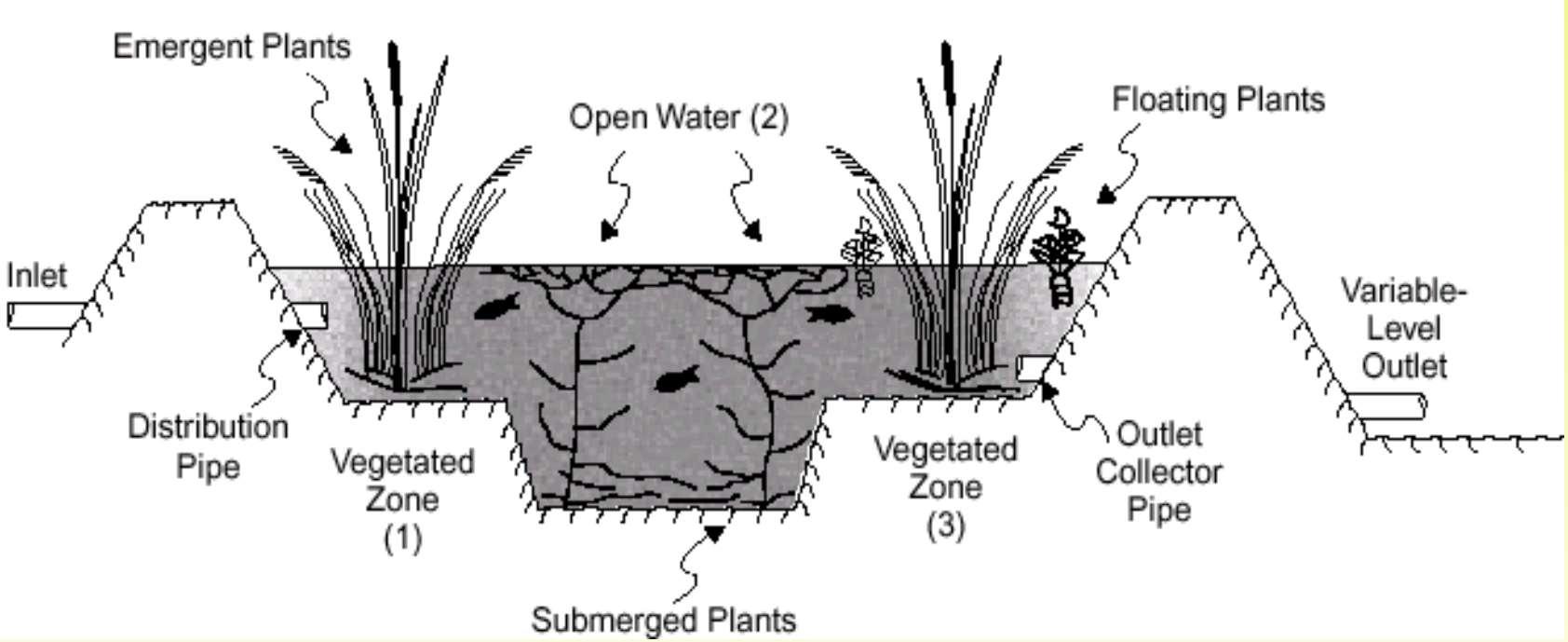
Vermifilter



Vermifilter

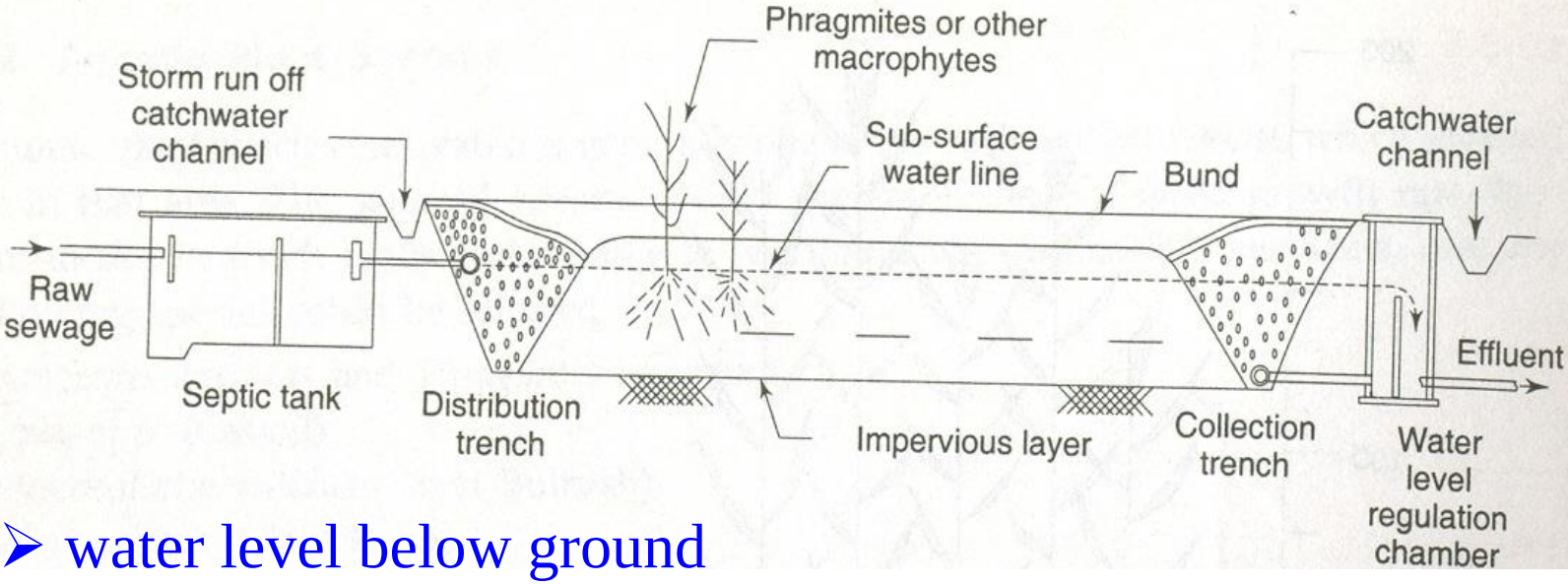
- Improved soil filter with earthworms, bacteria and active root zone bed of selected plants
- Work forces
  - ✓ soil
    - suitable environment for earthworms and microorganisms
  - ✓ earthworm
    - graze only on the surplus bacterial crop
    - aids soil aeration
    - produce vermicastings
  - ✓ bacteria
  - ✓ plant root
    - reduce the organics, total solids etc
  - ✓ biofilm
- Efficiency 80 % – 90 %

Constructed wetland: *Surface flow*



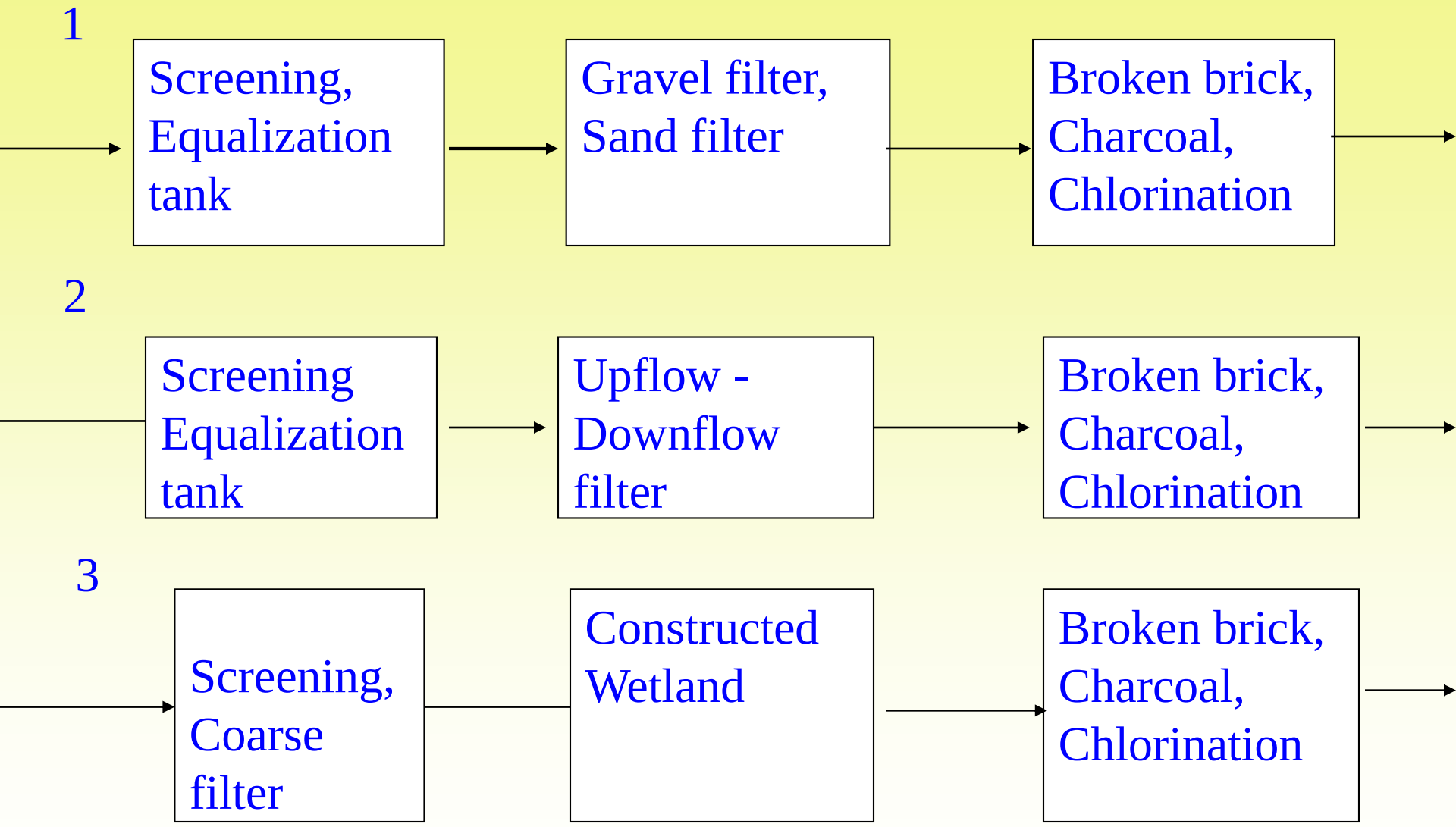
- shallow basin, soil or other medium to support the roots of vegetation
- water level above surface of medium
- near-surface layer is aerobic
- deeper waters and substrate are usually anaerobic

Constructed wetland: *Subsurface flow*



- water level below ground
- water flow through a sand or gravel
- roots penetrate the bed
- porous medium provides greater surface area for treatment

Treatment alternatives for Grey water



Treatment alternatives for Grey water

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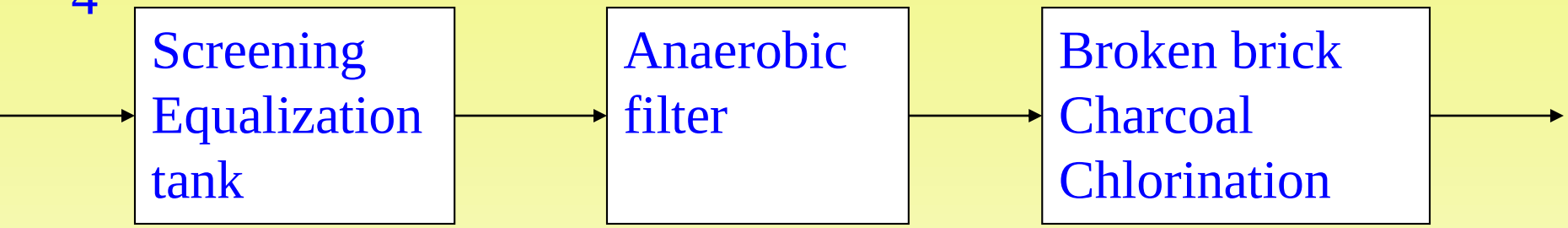

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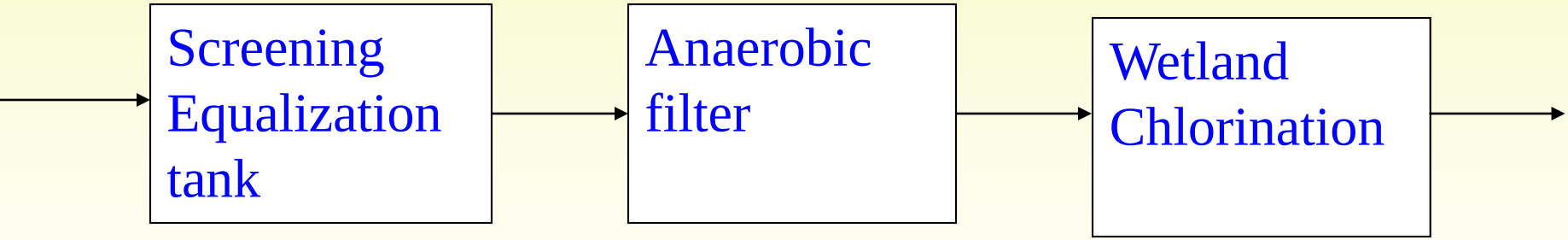
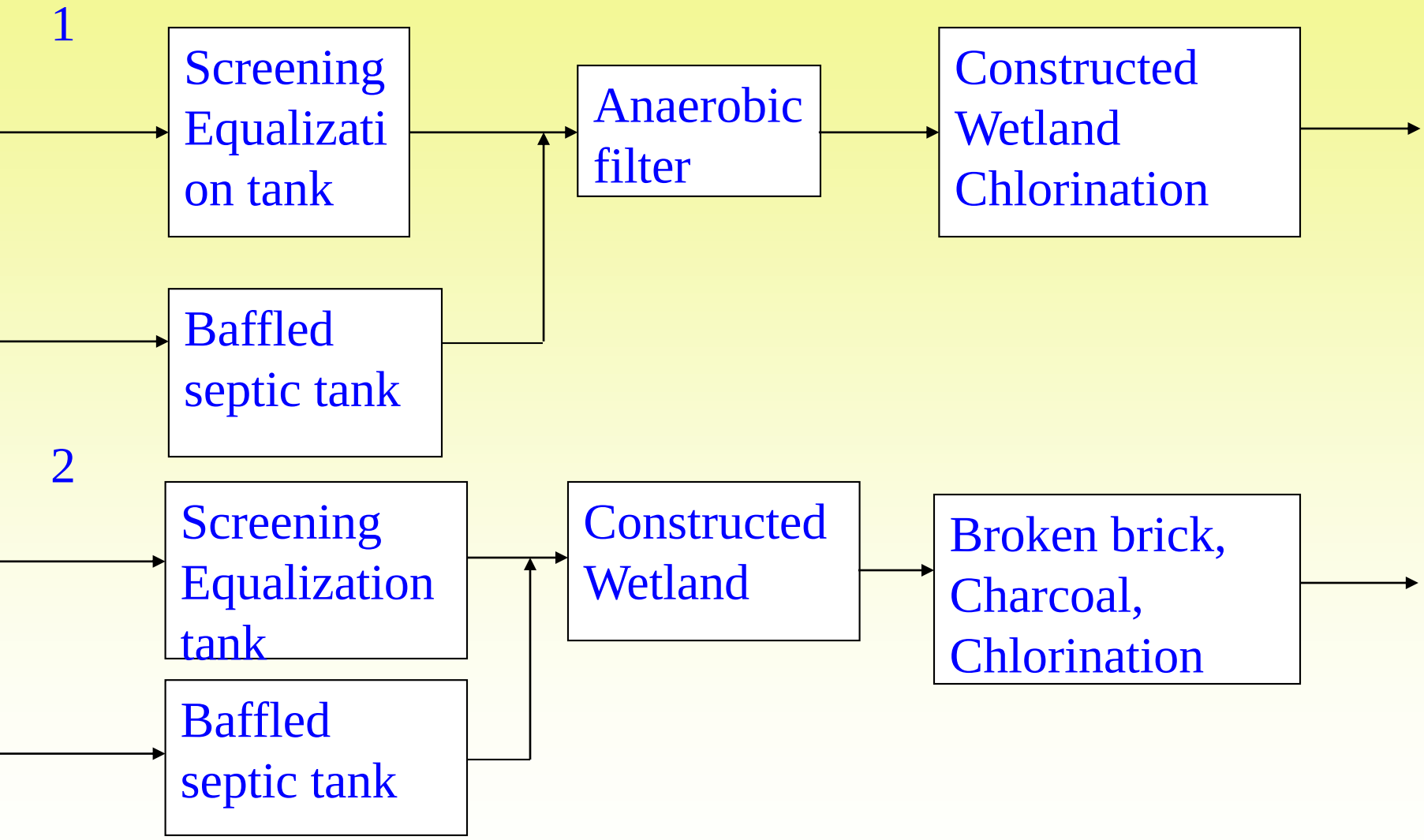


Treatment alternatives for Grey water and blackwater



Treatment alternatives for Grey water and blackwater

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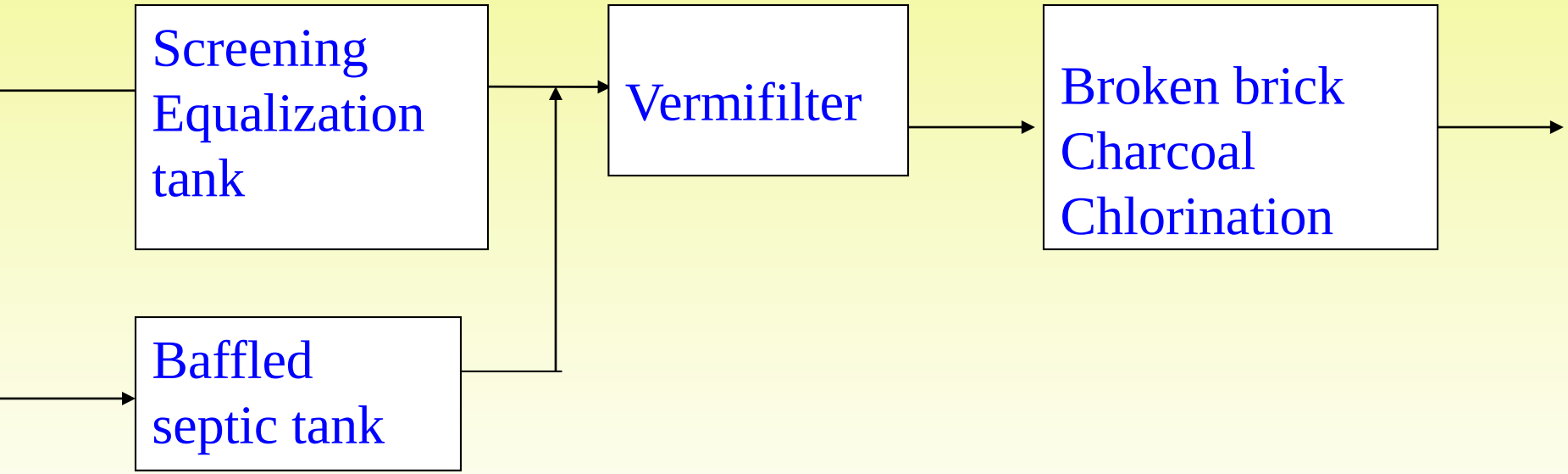
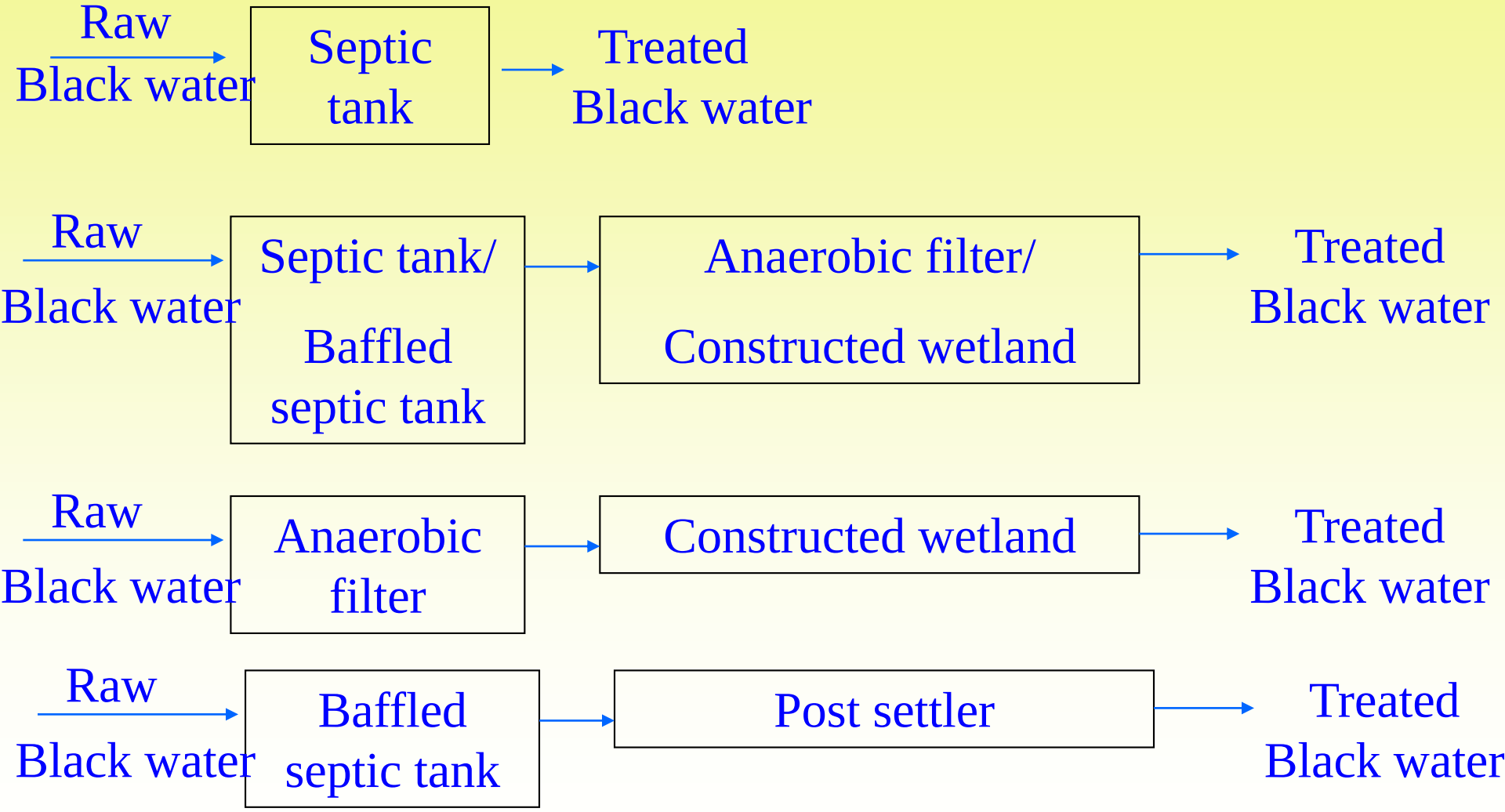


Treatment alternatives for Black water



Maintenance of treatment systems

Treatment Unit	Activity	Frequency of cleaning	Purpose
Equalization tank	De-sludging	Week	Maintain the volume
Horizontal filter	Cleaning	10 days	Maintain efficiency
Coarse filter	Cleaning	Weekly	Maintain efficiency
Sand filter	Refill upper layer	Weekly	Overcome choking
	Cleaning	10 days	Maintain effective filtration
Filter broken bricks	Cleaning	10 days	Colour removal
Wetland	Removal of grass and plants	2 months	Maintain efficiency
Chlorination	Proper dose	Daily	Disinfection
Collection tank	Reuse of water	2 days	Maintain quality of greywater

Cost of Existing Greywater reuse systems (NEERI, 2007)

Greywater generation (L/d)	Treatment units	Size LxBxH (m)	Cost (USD)
1000	Equalization Gravel(30-50mm) Gravel(10-30mm) Coarse sand(1-2mm) Fine sand(0.5- 0.8mm) Broken brick (20-40 mm)	3x2x0.5 0.4x2x0.5 0.35x2x0.5 0.5x2x0.5 0.35x2x0.5 0.35x2x0.5	600
2500	Equalization Gravel(15-25mm) Gravel(8-15mm) Coarse sand(1-1.4mm) Fine sand(0.5- 0.8mm) Charcoal Chlorination	1.7x1.2x0.6 0.5x2.3x0.6 0.5x1.5x0.6 0.7x1.2x0.6 0.3x1.2x0.6 0.25x1.2x0.6	870
4500	Equalization Gravel(15-25mm) Gravel(8-15mm) Coarse sand(1-1.4mm) Wetland Charcoal(0.5- 0.8mm) Chlorination	3.9x1.5x0.6 0.8x1.5x0.6 0.8x1.5x0.6 1.0x1.5x0.6 2.0x7x0.6 0.5x1.5x0.6 0.5x1.5x0.6	1200

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