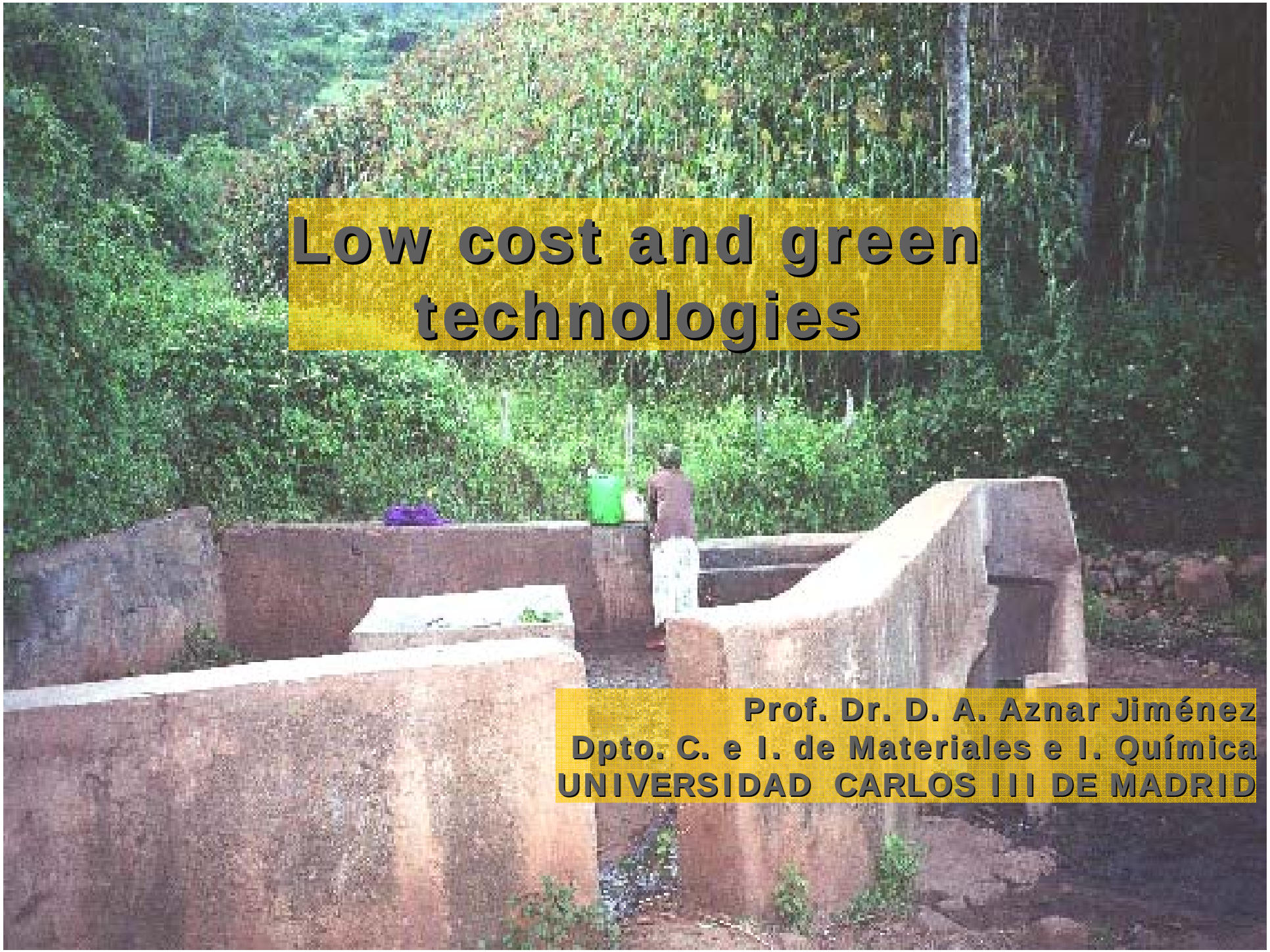

Low cost and green technologies

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NATURAL TREATMENT SYSTEMS

Removal of pollutants of wastewater by natural means, with no chemicals added.

Natural systems can be divided in 6 groups:

- ✓ Primary: stabilization ponds. Lagooning: aerobic, anaerobic, facultative, maturation
- ✓ Sub superficial application : filtering trenches and wells, fast infiltration
- ✓ Surface application: surface runoff, green filter, Macrophytes filter, sand filters , peat beds
- ✓ Biofilm processes: bacterial beds, biodiscs
- ✓ Conventional treatments : extended aeration, active sludge, ...

STABILIZATION TANKS

- Simple systems:
  - cesspits
  - septic tanks
  - digester/decanter tanks
- Very low maintenance cost
- Main biological process: anaerobic
- Advised for small urban areas (< 1000 eq-pop) or isolated settlements.

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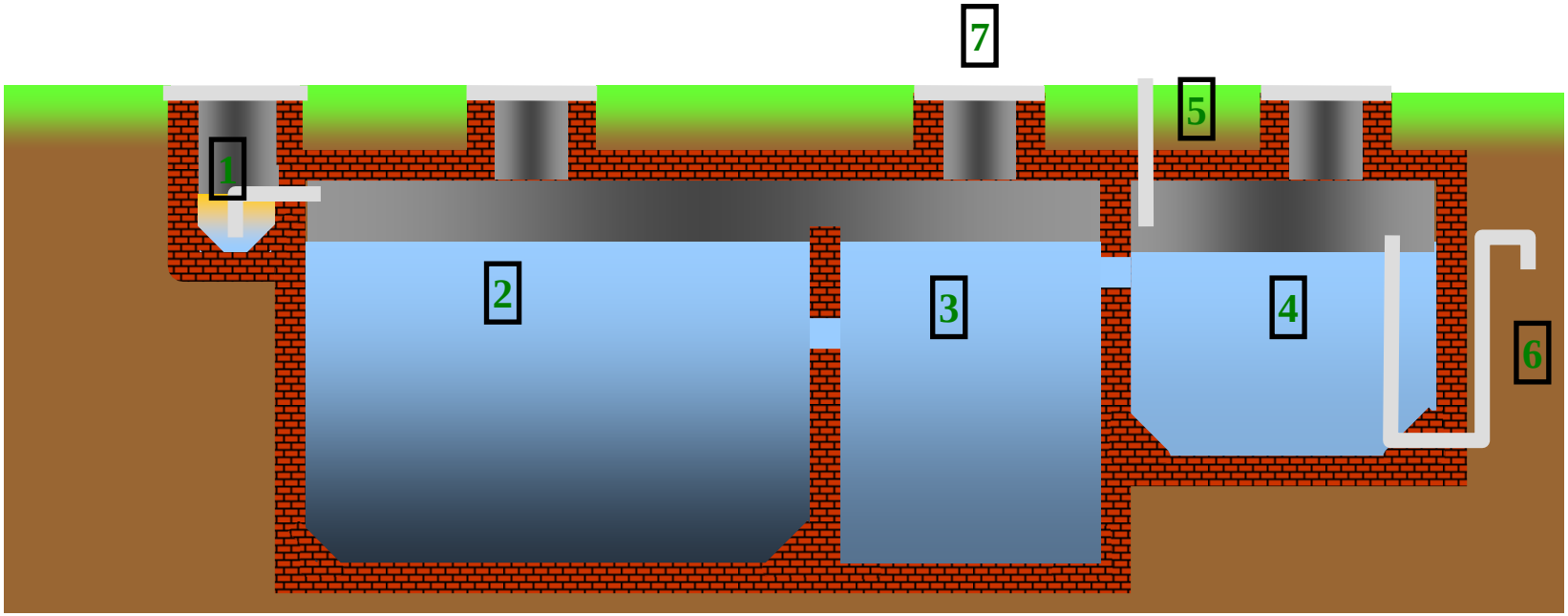
SEPTIC TANKS



1 degreaser

2 anaerobic decantation/digestion chamber

3 anaerobic digestion chamber

4 aeration chamber

5 ventilation

6 Discharge

7 Man hole

DESIGN OF SEPTIC TANKS

$V = 1{,}5 \cdot Q \quad \Rightarrow \quad Q < 6\ m^3/day$

$V = 4{,}5 + 0{,}75 \cdot Q \quad \Rightarrow \quad 6{,}0\ m^3/day < Q < 40{,}0\ m^3/day$

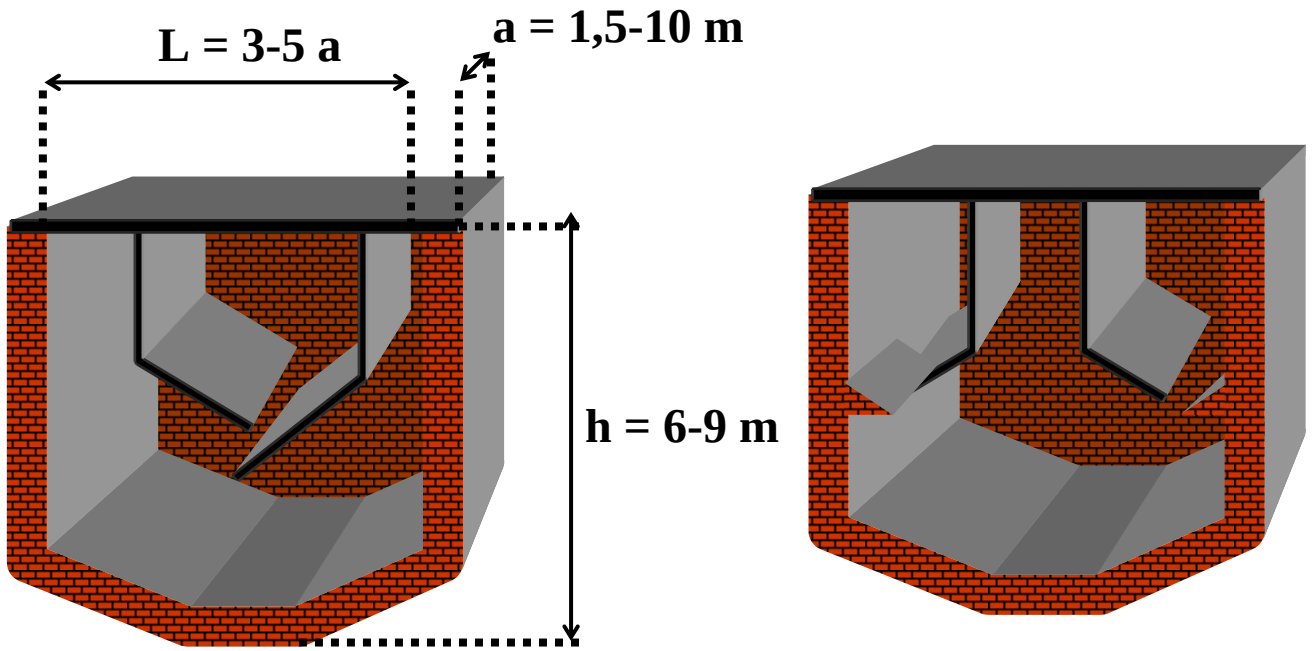
- length = 2-3 width
- $1{,}2\ m < h_{effective} < 1{,}7\ m$
- guard > 0,3 m
- 2 compartments 60/40 3 compartments 50/25/25
- Discharge pipe 7,5 cm < Ø < 15,0 cm

DIGESTER / DECANTER TANKS

t_d (medium flow) = 2,5 h

t_d (maximum flow) = 1,0 h

t_d (sludge digestion) = 4 months



Type of discharge	Decanter volume (L/eq.h.)	Digester volume (L/he)
Small plants (< 5.000 eq.h)	40	100
Plants with industrial discharges	40	50
Plants with industrial discharges and high SS	50	75

eq.pop. 60 g BOD_5

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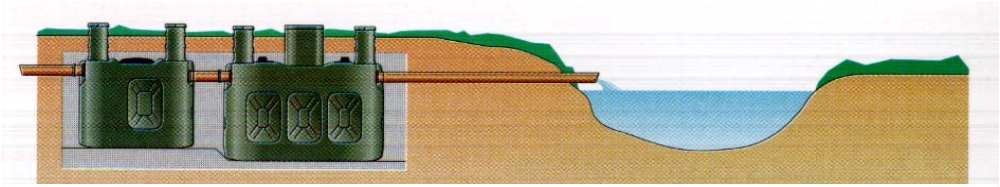
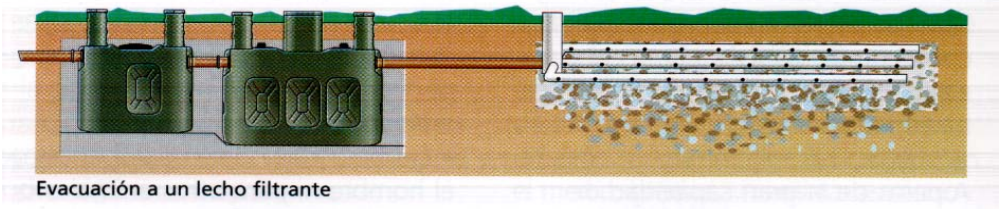
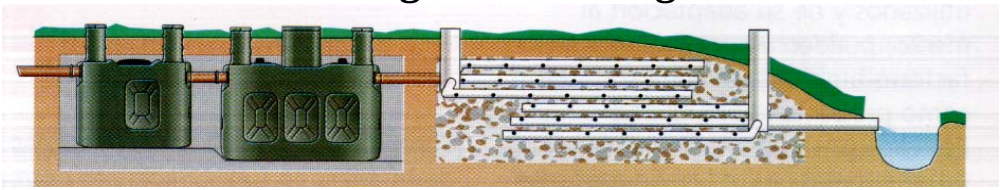
DISCHARGE OF THE TREATED WATER



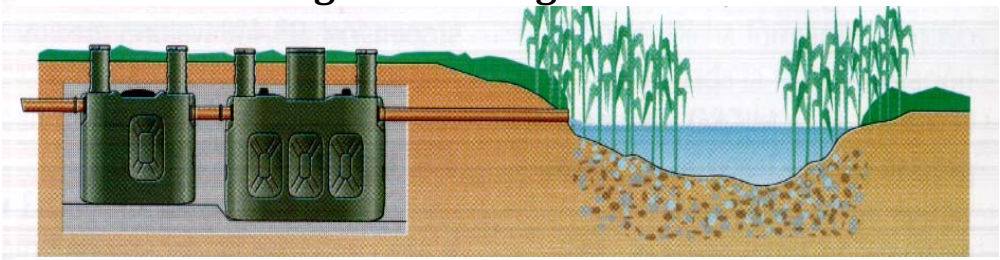
Direct discharge to a river bed



discharge to a filtering bed



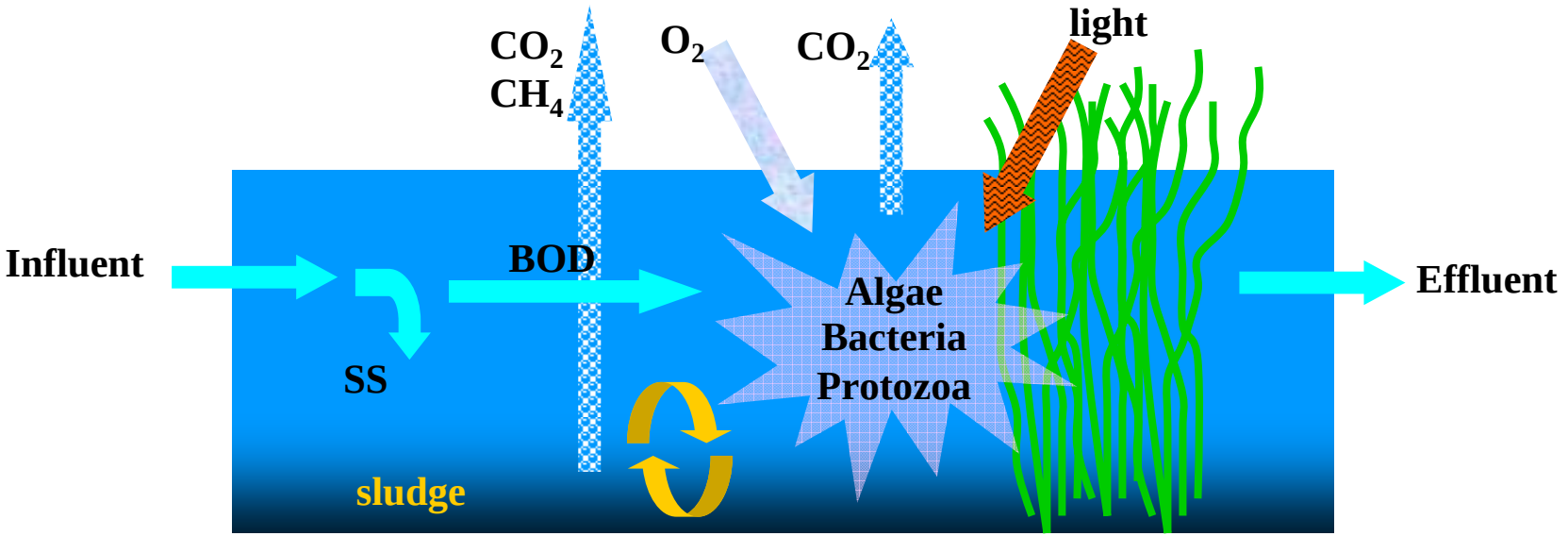
Drainage + discharge to a river bed



Discharge to a pond

LAGOONS

- Natural or aerated
- Tanks of large surface and small relative depth
- Aerobic process, occasionally anaerobic (deep areas)
- Low installation and maintenance costs
- Small urban nuclei (< 2000 eq. pop.) where cost of land is low.



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FACULTATIVE LAGOONS

Aerobic/anaerobic systems

✓**load ratio**

$\lambda_5 = 20\ T - 60$ λ_5 = kg BOD_5/Ha·day

(56 < λ_5 < 200)

T = average temperature (ºC)

variable surface as a function of flow (0,8-4 m)

$A = (10 \cdot Li \cdot Q)/ \lambda_5$ A = lagoon area (m^2)

Li = Influent concentration (mg BOD_5/L)

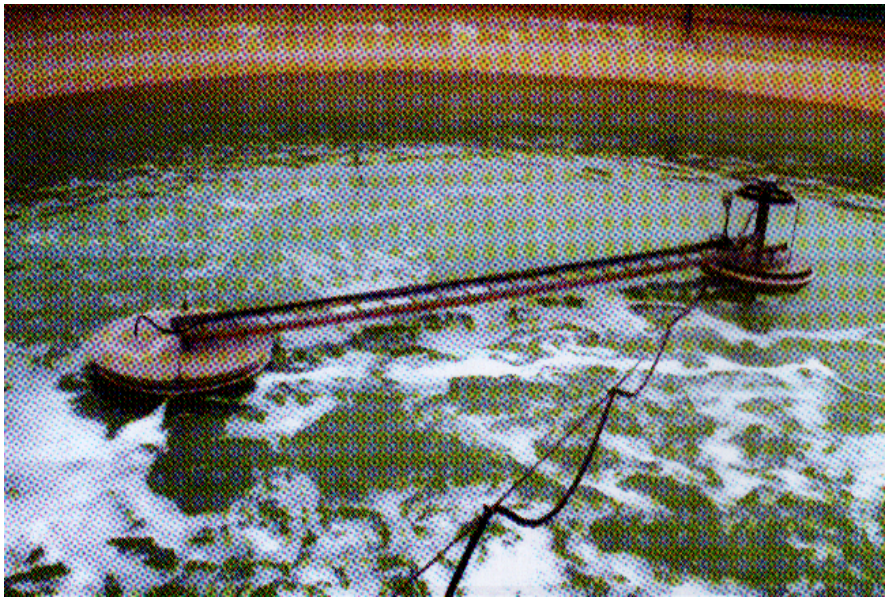
Q = Influent flow (m^3/day)

depth: 1-2,5 m
td = 5-30 days

AERATED LAGOONS

Aerobic systems

- ✓Mechanical aeration (1-2 kW/1.000 m^3)
- ✓Perfect mixing (≈3 kW/1.000 m^3)
- ✓depth: 1,8-6 m
- ✓td = 2-10 days
- ✓load ratio (80 - 95 kg DOB_5/Ha·day)
- ✓variable surface as a function of flow (0,8-4 m)



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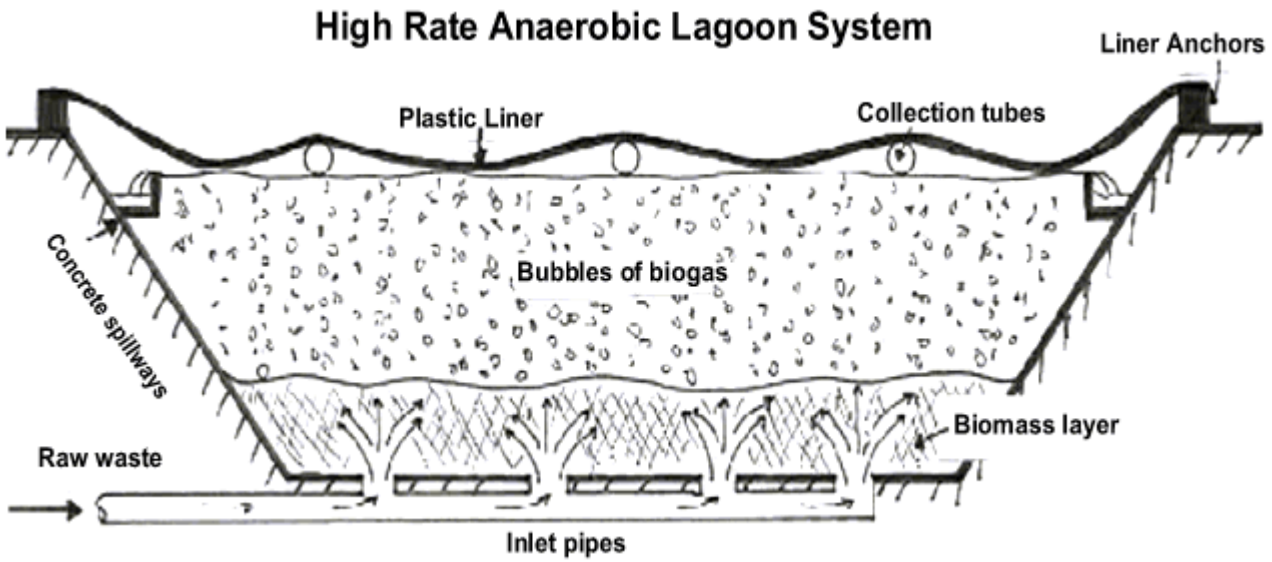
ANAEROBIC LAGOONS

Anaerobic systems

- ✓depth: >3 m
- ✓t_d = 20-50 days
- ✓load ratio: 100-500 g $BOD_5/m^3/day$
- ✓mineralization of sludge, removal 5-10 years

ANAEROBIC LAGOON

- Sedimentation
- Hydrolysis.
- Formation of acids.
- Formation of methane.



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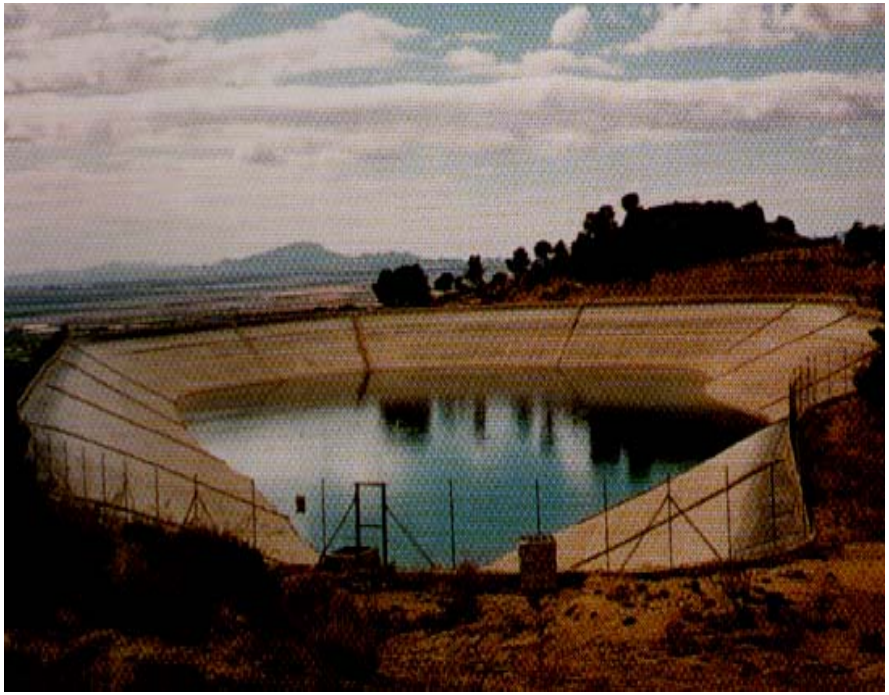
MATURATION LAGOONS

Aerobic systems

✓< 1 m

✓td > 10 days

✓Disinfect and remove minor contaminants



FACTORS INFLUENCING PERFORMANCE

- **Climatic: temperature, solar radiation, wind, rainfall, evaporation.**
- **Physical: stratification, flow lines, depth.**
- **Chemical: pollutant load, peak values, presence of toxics and inhibitors, greases, nutrients, pH.**
- **Biological: macrophytes, microphytes, bacteria, algae, protozoa, fungi, insects.**

ADVANTAGES	DISADVANTAGES
Low maintenance cost	Large extension of land
Small energetic needs	Extraction and removal of sludge
Does not require qualified personnel	Odor problems
Acceptable removal of BOD and SS	Production of insects
Flow variation	Eutrophication of discharges
It is a natural process	Water lost by evaporation

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LAGOONING SYSTEM

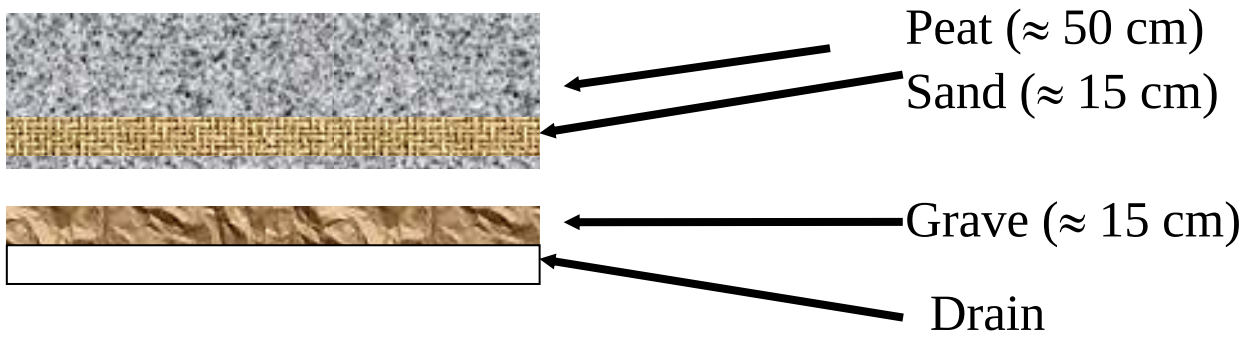
Aerial view of a lagooning system.

BIOLOGICAL FILTERS

- **Systems based in:**
  - **depurating capacity of the soil**
  - **other types of beds (peat, sand,...).**
- **Possible use/benefits of water y its nutrients**
  - **Make use of nutrients (Green filter)**
  - **No use of nutrients (infiltration).**
- **Systems have a very low cost.**

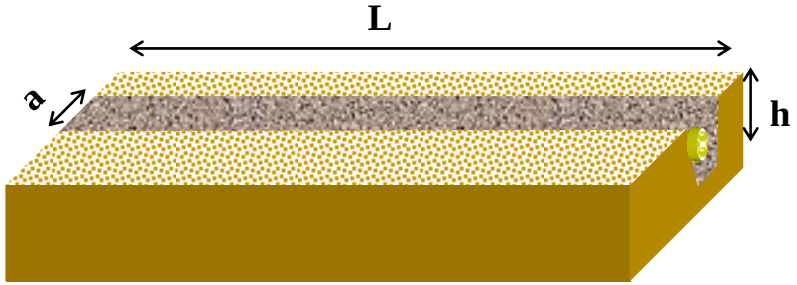
PEAT BEDS

Act as filtering and adsorption elements

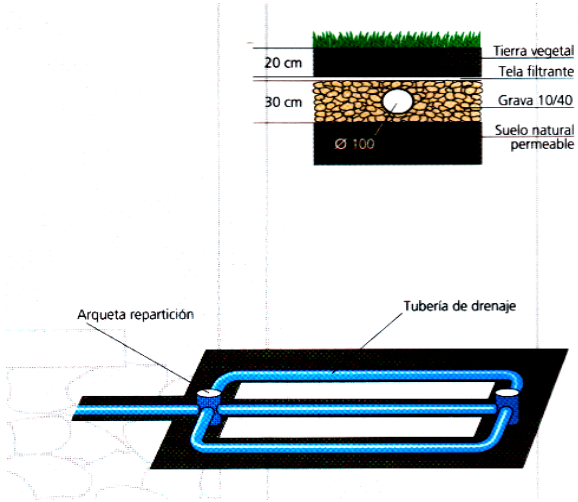


FILTERING TRENCHES

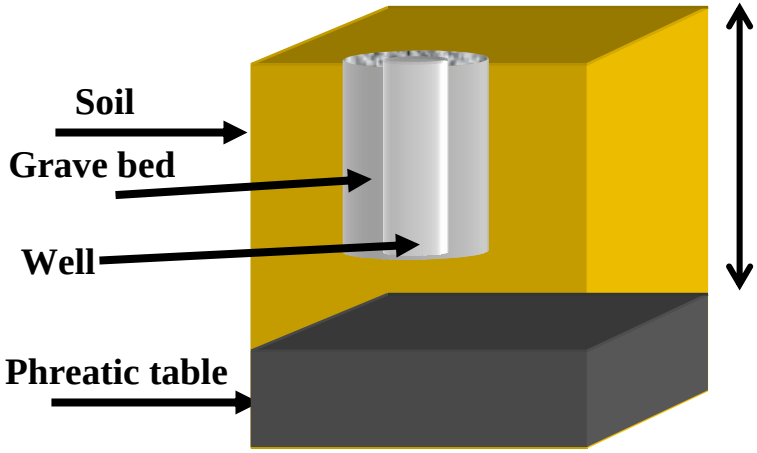
Depurating capacity of soil (edaphodepuration)



a =0,5-1,3 m
h = 0,5-1,3 m
L = 25-30 m

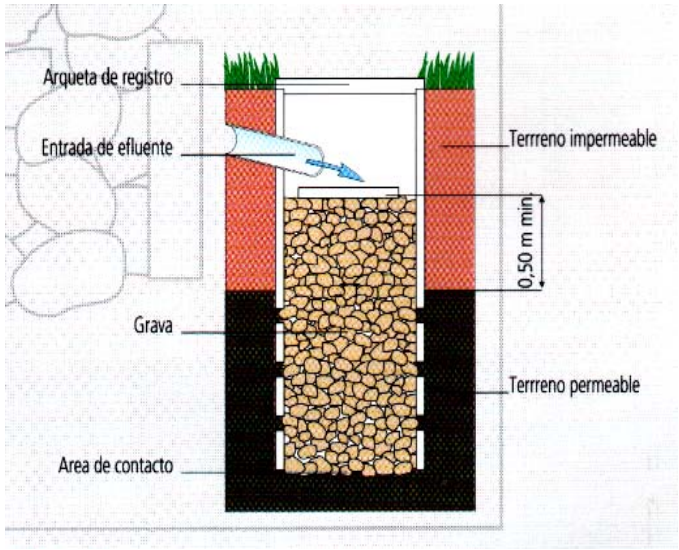


FILTERING WELLS



> 4 m

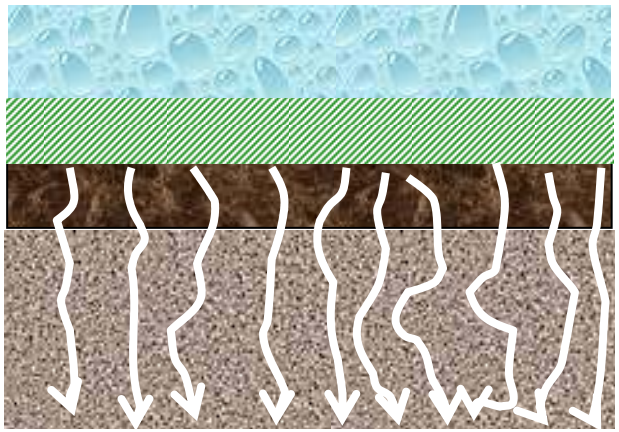
Ø =1,5-3 m
h = 1,5-2,7 m



FAST INFILTRATION

GREEN FILTERS

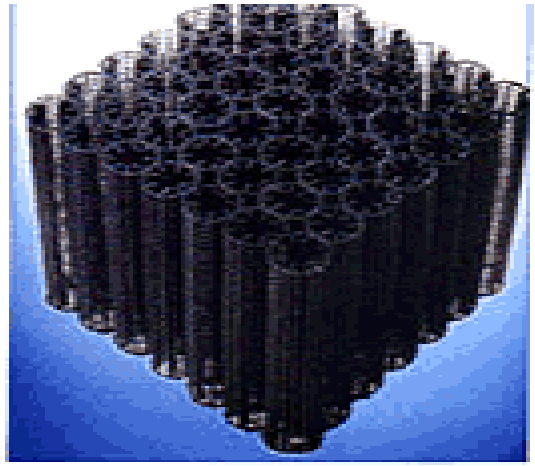
Addition of water to wetlands covered by vegetation (macrophytodepuration), using the natural capacity to decontaminate (edaphodepuration).



- **Vegetal species**
  - ✓**Evapotranspiration**
  - ✓**nutrient assimilation**
  - ✓**tolerance to the humidity conditions of the soil**
  - ✓**potential productivity,**
- **Soil**
  - ✓ **availability (5 ha/1000 eq.pop)**
  - ✓ **permeability (intermediate)**
  - ✓**Far from wells and sources of drinking water**
  - ✓**Slope between 2 and 6%**
- **Discharge**
  - ✓**presence of toxics**
  - ✓ **flow/rainfall**

PERCOLATING FILTERS

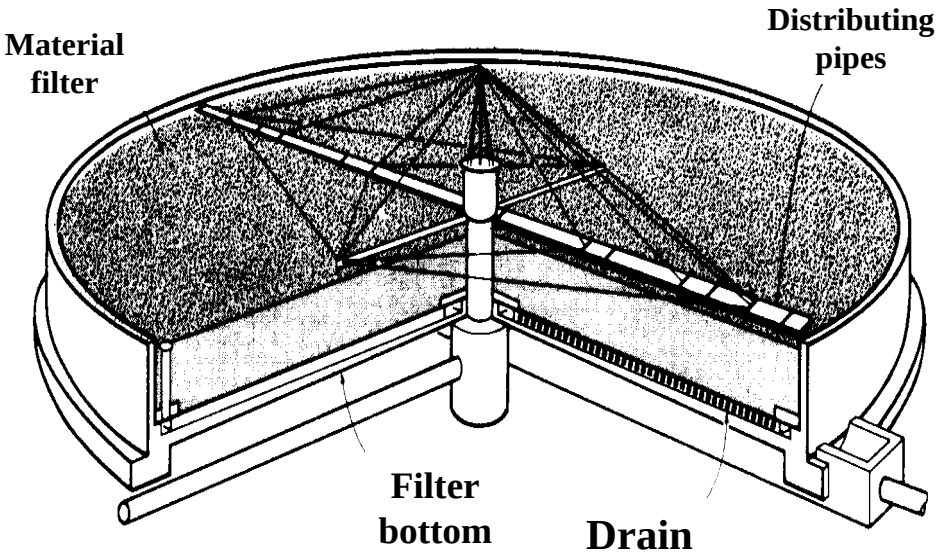
- **Filtering bed (peat, volcanic, polymers, …)**



- **Contact with attached microorganisms**

PERCOLATING FILTERS

- **Aerobic/anaerobic system**



- **Recycling of the effluent (≈50-90%)**
- **Biomass carried over**