Natural waste water treatment systems

Natural low-rate biological treatment systems tend to be lower in cost and less sophisticated in maintenance although they require the use of relatively large land areas

1.- Upland natural wastewater treatment systems

2.- Wastewater stabilization ponds

3.- Wetland treatment systems (Macrophyte treatment)

Wetland wastewater treatment systems

Natural wetlands are usually unmanaged, whereas artificial systems are specially designed to maximize performance by providing the optimum conditions for emergent macrophyte growth. The key features of this treatment are:

1.- Rhizomes and roots of the vegetation grow vertically and horizontally in the soil or gravel bed, opening up 'hydraulic pathways'.

2.- Wastewater BOD and nitrogen are removed by bacterial activity; aerobic treatment takes place in the rhizosphere, with anoxic and anaerobic treatment taking place in the surrounding soil.

3.- Oxygen passes from the atmosphere to the rhizosphere via the leaves and stems through the hollow rhizomes and out through the roots.

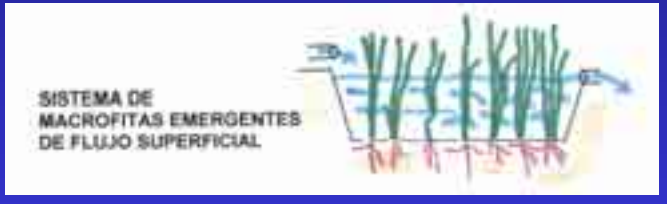
4.- Suspended solids in the sewage are aerobically composted in the above-ground layer of vegetation formed from dead leaves and stems.

5.- Nutrients and heavy metals are removed by plant uptake.

Emergent Macrophyte Treatment Systems

1- System of emergent superficial-flow macrophytes

In superficial-flow systems, contaminants are eliminated through reactions that take place in water and upper zone of contact. Little wastewater circulates through the roots, which limits their water treatment capacity.



Emergent Macrophyte Treatment Systems

2- System of emergent subsuperficial-flow macrophytes

As in the previous system, a layer of gravel or soil is used, through which water circulates by gravity. Its most important drawback it the rapid clogging up of the terrain with time by roots, rhizomes, and sedimented solids.

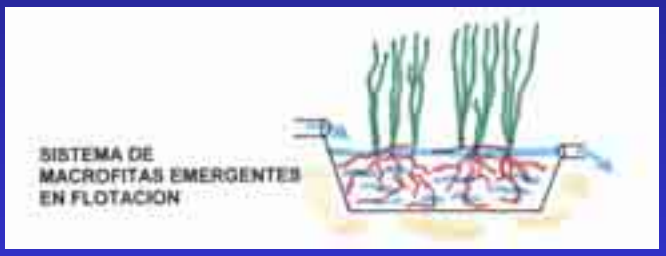
Emergent Macrophyte Treatment Systems

Pilot system of emergent subsuperficial-flow macrophytes. Ciudad Real (Spain)
Universidad de Castilla-La Mancha

Emergent Macrophyte Treatment Systems

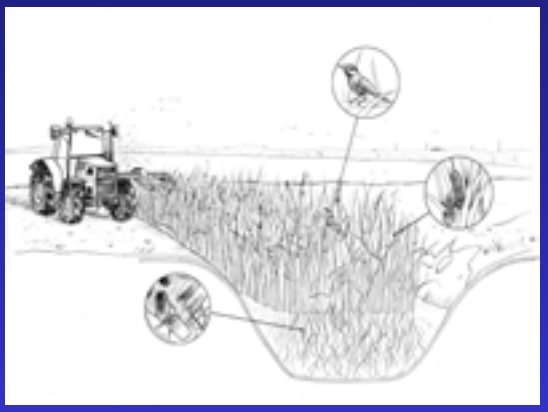
3- A new method: artificially floating macrophyte filters

This wastewater treatment system, developed by the School of Agricultural Engineering of Madrid, is based on emergent macrophytes that naturally root to the soil, but in this case are converted into artificially floating macrophytes.



Artificially floating macrophyte filters

Since they float, these species form a dense mat of roots and rhizomes that occupy the entire volume of the collector (pond or canal), thus forcing all the water to circulate through the matted vegetation, which supports microorganisms that degrade organic material.



Artificially floating macrophyte filters

- Easy installation and minimum energy demand
- Greater effectiveness: the entire volume if wastewater circulates through the treatment mesh (annual absorption rate 180 g N/ m^2 and 27 g P/ m^2) (*Typha latifolia*)
- Harvesting does not destroy the system
- Production of a large amount of biomass. 13 kg/m^2 year of dry matter (*Typha latifolia*)
- It absorbs hydraulic peaks. The filter volume acts as a laminator
- Little noise and low visual impact

Artificially floating macrophyte filters

At present, a Floating Macrophyte Filter is being used experimentally in Spain at Madrid, Reus, Zaragoza, Fuerteventura and Alicante airports. The first one for 500 inhabitant-equivalents.

Artificially floating macrophyte filters

Fundación Global Nature has managed a LIFE-Environment project financed by the European Commission and the municipality of Lorca to demonstrate the effectiveness of a wastewater treatment system using floating macrophyte filters (FMF)

3 filters in 3 isolated population centers located more than 20 km from the central urban area of Lorca: (150-500 inhabitants)

Three filters in three single family homes or Education Centres

One filter in a pig farm as a prototype for purine treatment

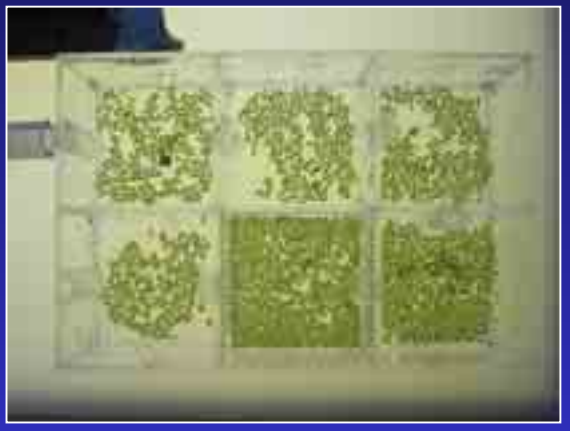
Floating Aquatic Macrophyte Systems

4- Floating Aquatic Macrophyte Systems

Several genera are used, including *Salvinia, Spirodella, Lemna* and *Eichornia* (water hyacinth) In tropical regions, water hyacinth can produce more than 250 kg/ha d (dry weight). Floating macrophyte species can be easily collected. In colder regions, these floating species do not reach a large size, and their production of biomass is limited, which reduces their absolute water treatment value.

Floating Aquatic Macrophyte Systems

Duckweed *(Lemna*)



Lemna can stand lower temperatures and reaches lower crop levels than water hyacinth

Floating Aquatic Macrophyte Systems

Water hyacinth (Eichhornia crassipes)

In tropical regions, water hyacinth doubles in mass about 6-14 days. Nitrogen and phosphorus reductions up to 80% and 50% have been achieved. Water hyacinth was found to reach a standing crop level of 30 tonnes (dry weight)/ha in Florida, resulting in a maximum storage of 900 kg N/ha and 180 kg P/ha (Reddy and Debusk 1987)

- Being a floating plant it is easily harvested with nets.
- The fresh plant contains prickly crystals which make it unpalatable. The fresh leaves are sometimes eaten when other feeds are scarce, but normally more than 25% fresh water hyacinth in the feed reduces intake.
- The high water content of the plant imposes a limitation on the amount of dry matter an animal is capable of ingesting, and the danger of spreading the weed through seeds in the faeces is great.
- Usually 2:4-D is used to control the plant. The feeding of sprayed plants should be avoided. Although 2:4-d is not toxic to livestock, sprayed plants may accumulate lethal doses of nitrates.
- Boiled water hyacinth is used in Southeast Asia as a feed for pigs. Chopped and mixed with other vegetable wastes, such as banana stems, rice bran and sometimes maize and salt are added.
- The physical structure of the plant makes it unsuitable for the normal methods of making hay and silage.
- The nutritive value of dry matter is too low to warrant the cost of artificial drying.

Thailand, Institute of Scientific and Technological Research (TISTR), Research:

- Decaying water hyacinth was found to be the perfect medium to cultivate valuable straw mushrooms
- Water-hyacinth-based fiber board for construction.
- It rots in 15 days: it is an ideal component in fertilizer. Weed harvested from the Bangkok area is used in a new fertilizer factory to provide low cost organic fertilizer for farms.
- Wicker items made from the stems have proved extremely popula. The success of wickerwork sales has in fact caused a shortage of water hyacinth and, incredibly, the weed must be brought in from other areas to maintain production levels. In Chaninat Province, water hyacinth is actually being cultivated to produce the long stems that are best for wickerwork.
- They are now testing fermenting water hyacinth for butane gas production.

An hectare of well-grown plants will weigh approximately 230 tons. A given area will at least double itself in one month.

Cropping the same rate as reproduction, one hectare will yield a maximum of 16 tons and a minimum of 11 tons of dry matter per month, or 192 and 132 tons per hectare per year.

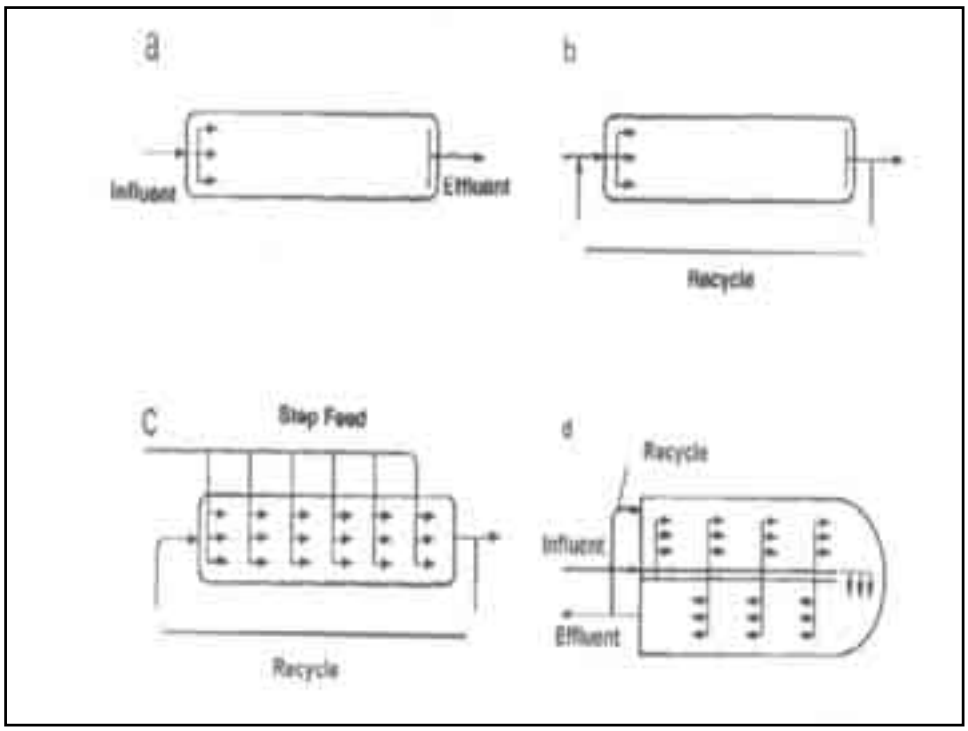
0.017 kg of nitrogen are lost in urine per person per day. Taking this yield of nitrogen 200,000 people would require approximately 364 cropping hectares.

The foregoing estimates are based on an average urine effluent from 200,000 persons and take no account of the values present in the solids. Such values are additional.

The only criticism against its use in practice is its bulk and high percentage of water. Thus an hectare will produce 2.700 tons of plants per hectare per annum, representing only 163 tons of dry matter. This condition is, however, largely balanced by the ease of cropping.

Examples of water treatment with water hyacinth and duckweed in USA:

	Flow m^3/d	Type	BOD_5 (mg/l) Inlet	Outlet	% red.	$m^3/ha\ d$
Orlando, FL	30.280	Eichhornia	4,9	3,1	37	2.525
San Diego, CA	378	Eichhornia	160,0	15,0	91	590
NSTL, MS	8	Lemna	35,0	5,3	85	504
Austin, TX	1.700	Eichhornia	42,0	12,0	73	140
Biloxi, MS	49	Lemna	30,0	15,0	50	700
Disney World, FL	30	Eichhornia	200,0	26,0	87	300



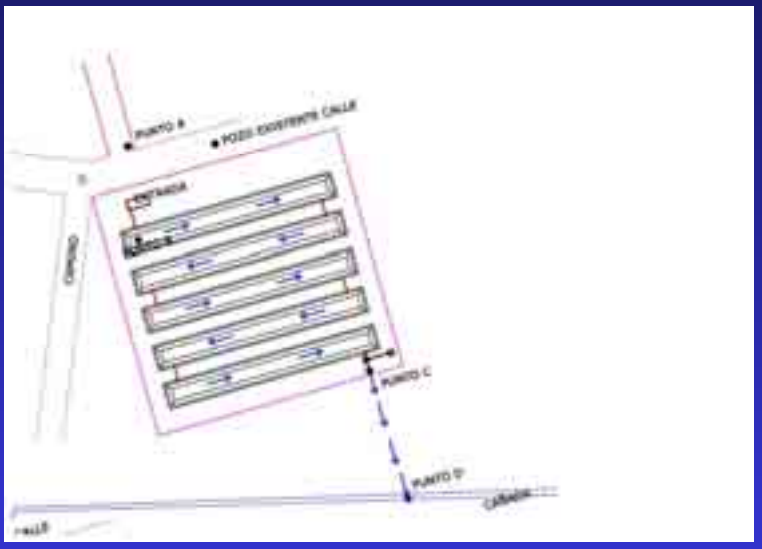
Wastewater Treatment in the Dominican Republic, Chirino and San José de Los Llanos

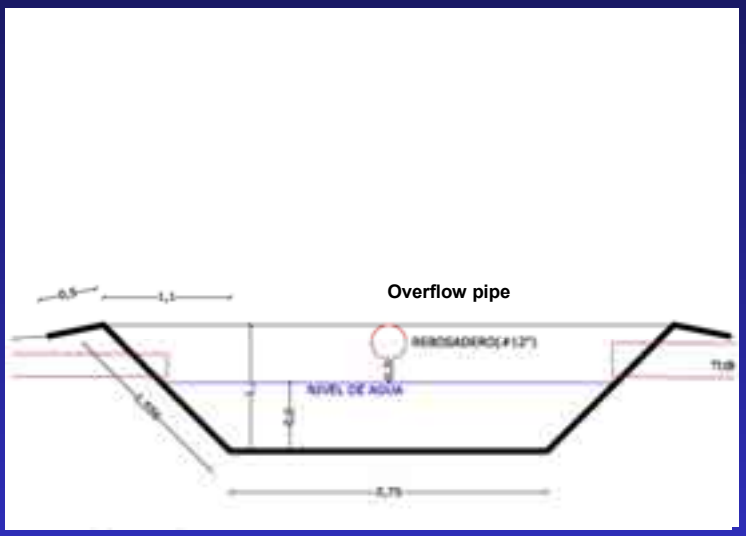
The spanish NGO Arquitectos sin Fronteras (Architects without Borders) and Fundación Global Nature build sewage treatment canals for new and old settlements. They use water hyacinth (*Eichhornia crassipes)*

Information. Public participation

Chirino Project

La Guázara suburb





La Guázara Suburb Project

Los Cocos Suburb Project

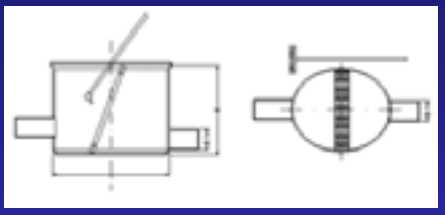
Equipment

Screening equ… the total pollution reduc… on biodegradable… pieces of wood and metallic it…

Screening ren… ontribute a significant soli… chanical equipment by…

- Inclined …
- Curved …
- Radial b…
- Manual … ows and require …

Manual bar screens:

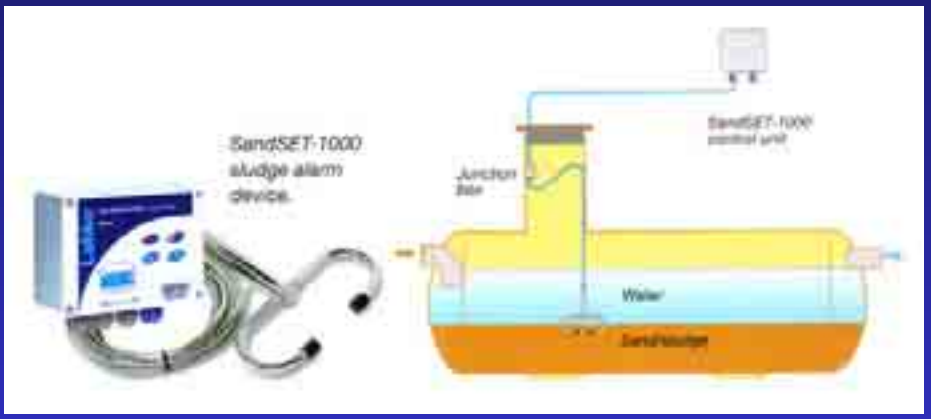


Grit Removal

Wastewater contains solid particles that fall into the classification of grit. Grit is nonputrescible, and frequently of a hardness that is abrasive to metals. The main objective is to separate it by a sedimentation process.

Gravity Channels: sized to produce a certain optimum maximum flow velocity through the channel. Up to this velocity the majority of grits will fall out of solution and be collected in a bottom dump pit in the channel.
Aerated Grit Channels: velocity through the channel combined with the rolling motion produced by the aeration, ensures entrained grit being separated from the liquid flow.
Vortex grit traps remove the grit from sewage inflow in a mechanised vortex flow container.

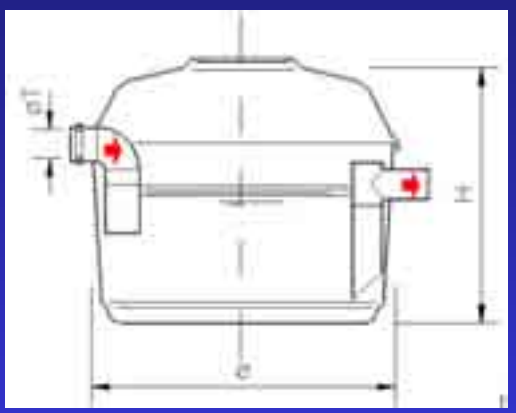
Grit Removal



Clarification

Clarification is the process of separating solids from the liquid stream. In wastewater treatment the terms clarifier and sedimentation tank are synonymous. Clarification tanks may contain a scraper mechanism mounted inside it.

Grease removal tanks



http://www.fundacionglobalnature.org