

DECENTRALIZED WASTE WATER TREATMENT

Gevod V.S.
Ukraine State Chemical Technology University
Dnepro
Pr.Gagarina,8
aquilegya@ua.fm

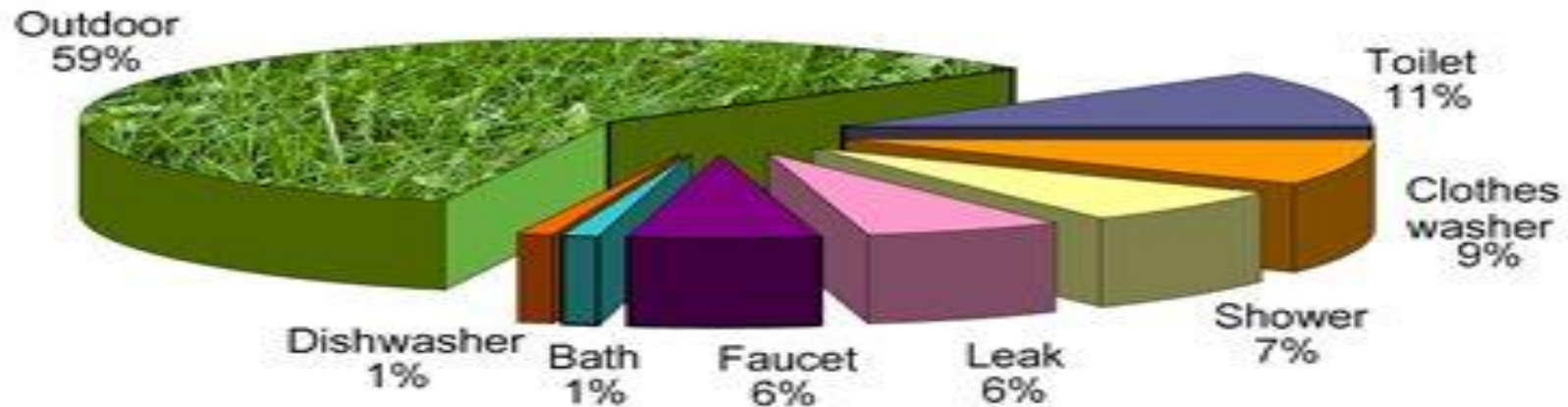
WE SHALL CONSIDER NEXT QUESTIONS

- **What requirements should to satisfy of good local sewage system ?**
- **What processes occurs at treatment of sewage water inside of local sewer?**
- **The role of microorganisms at sewage water purification.**
- **Drain systems, the processes inside of their and some important notes.**
- **How does long the septic system can run?**
- **Requirements for its proper operation.**
- **Source separation systems.**
- **Membrane bioreactors.**
- **Small waste water treatment plants.**
- **Wetlands.**

DECENTRALIZED WASTEWATER TREATMENT

We all prefer to live with a certain of comfort, despite the place of residence, whether it is a cottage, apartment or country house. We consume a certain quantities of fresh water for different purposes and we produce about the same amount of domestic wastewater.

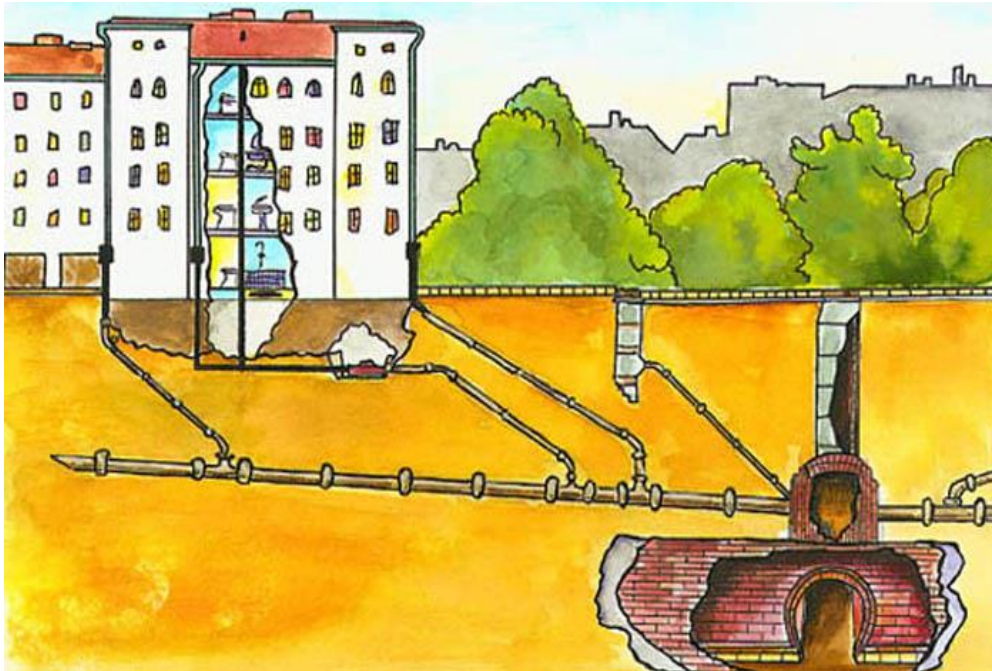
Residential Average Water Use



Source: American Water Works Association Research Foundation, End Uses of Water

MUNICIPAL SEWAGE SYSTEMS

Within the territory of cities all amenities are usually provided by the centralized systems of water supply and sewerage.



<http://santehexp.ru/wp-content/uploads/2014/04/image001.jpg>



http://tekil.ru/wp-content/uploads/2011/09/kanal_014.jpg

WHERE IS NO CENTRAL SEWAGE SYSTEM THE PROBLEM OF HOUSEHOLD EFFLUENTS IS RESOLVED IN A SPECIAL WAY.

In this case homeowner is required the local sewage. For safe disposal of the sewage water which is generated in the house, it is necessary the adequate treatment of this water.



<http://nua.in.ua/wp-content/uploads/2016/01/stroitelstvo-kottedzhey-2.jpg>

WHAT CONDITIONS SHOULD TO SATISFY OF GOOD LOCAL SEWAGE SYSTEM?

- 1 . Local sewage should not pollute the drinking water sources, either surface or ground water, or water bodies that are used for bathing or recreational purposes.**
- 2. The untreated sewage water should not be exposed so as to have access to human beings or animals.**
- 3. Local sewage should not to give unpleasant smell, and should not become a place for breeding flies.**
- 4. Local sewage should not cause harm to public health and adversely affect the receiving environment.**

THE SIMPLEST KIND OF LOCAL SEWER IS CREATED USE OF A CESSPOOL.

The maintenance of cesspools is reduced to regular pumping of accumulated effluents by means of special sanitary cars and of delivering these effluents onto sewage treatment plants.



BUT THE USE OF CESSPOOLS IS LEGAL ONLY WHERE THE QUANTITY OF EFFLUENTS FOR ONE DAY DISCHARGE NOT EXCEED ONE CUBIC METER.

So either anyone will use a cesspool and live in uncomfortable conditions, or anyone will enjoy all the amenities of modern appliances, when there are local waste water treatment facilities.



<http://decorate.panaromalife.com/wp-content/uploads/2016/02/Put-On-Top-Of-Kitchen-Cabinets.jpg>



<http://design-ideas.dressesdesignsdecors.com/design-ideas/bathroom/bathroomrenovationsjohannesburg2.jpg>

WHAT COMPOSITION OF HOUSEHOLD EFFLUENTS IS?

WHAT KIND OF EQUIPMENT FOR LOCAL SEWAGE IS REQUIRED?

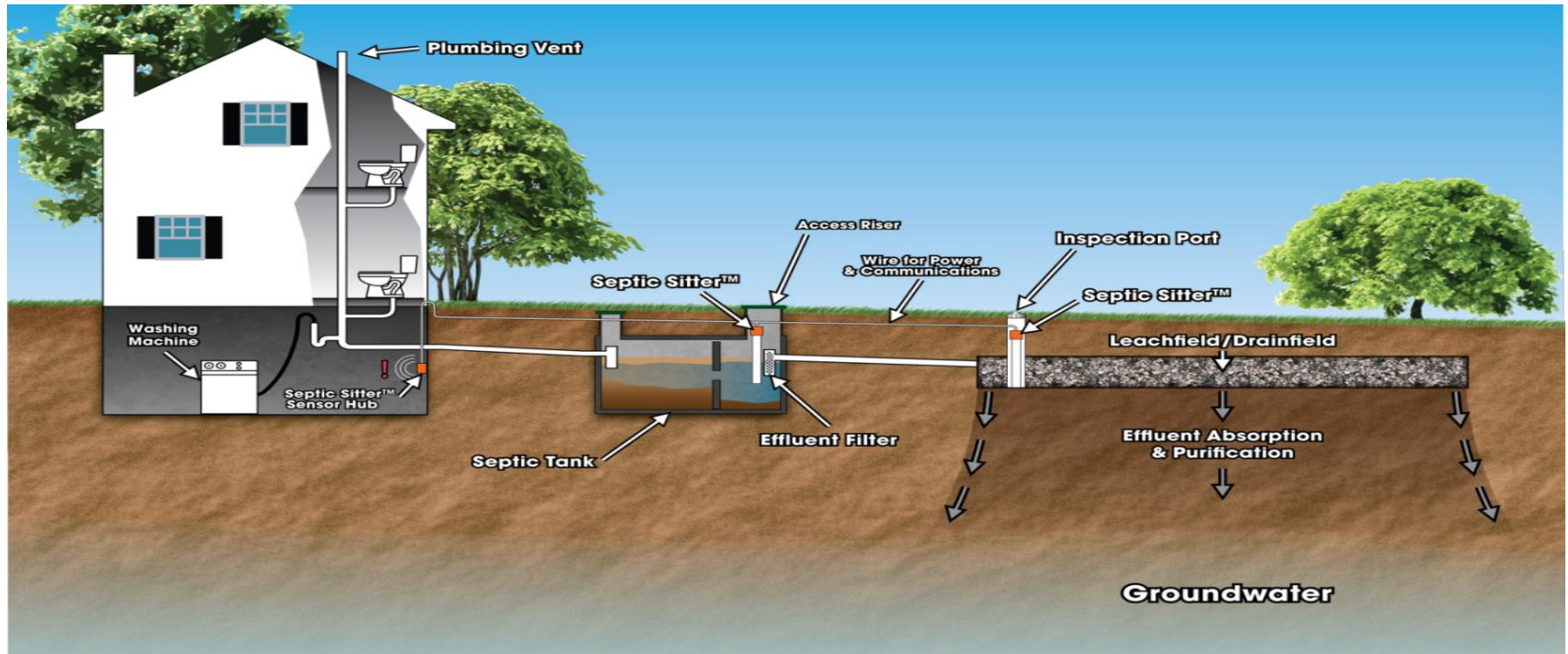
HOW DOES THIS EQUIPMENT WORKS?

Table Average composition of domestic sewage

Parameter	Concentration (mg/l)	Parameter	Concentration (mg/l)
Carbohydrates	95	Magnesium	15
Fats	100	Zinc	0.2
Proteins	115	Manganese	0.15
Detergents	43	Copper	0.15
Phosphorus	10	Lead	0.1
Sulphur	46	Nickel	0.04
Chloride	50	Chromium	0.03
Boron	2	Tin	0.015
Sodium	80	Silver	0.01
Potassium	19	Cadmium	<1
Calcium	70	Mercury	<0.1

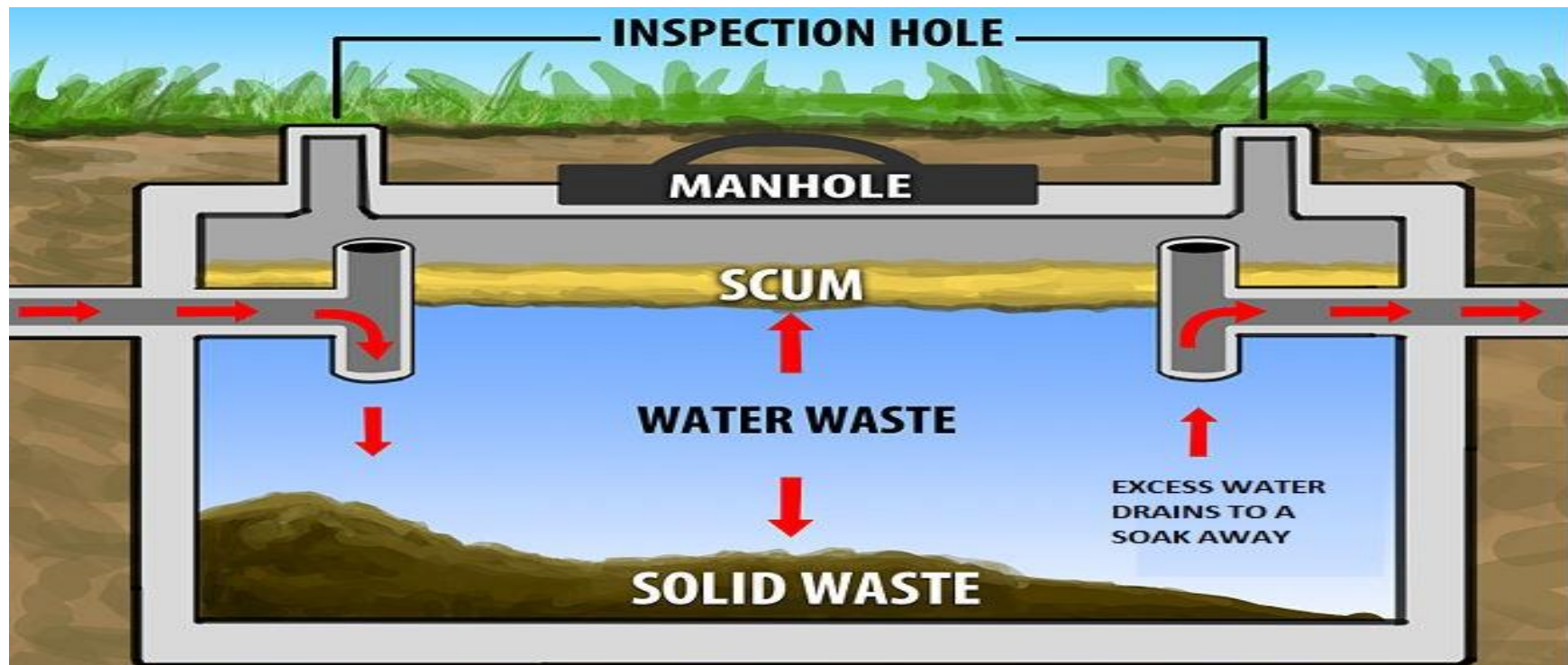
THE DESIGN OF LOCAL SEWAGE

Local sewage consist of plumbing devices in the house, of sewer pipes, of septic tank and drainage network for discharging of treated wastewater into the ground.



THE MAIN PART OF LOCAL SEWAGE IS A SEPTIC TANK.

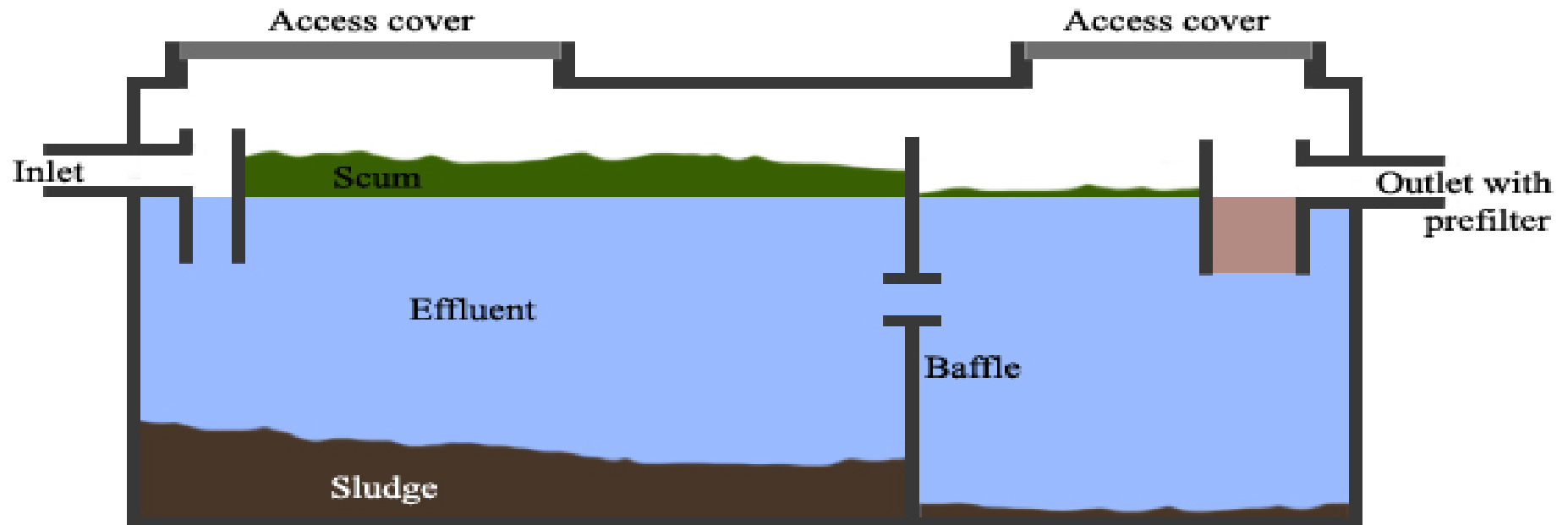
Here bacteria start to decompose human waste products into environmentally acceptable substances.



TYPICALLY THE SEPTIC TANK CONSIST OF TWO UNITS.

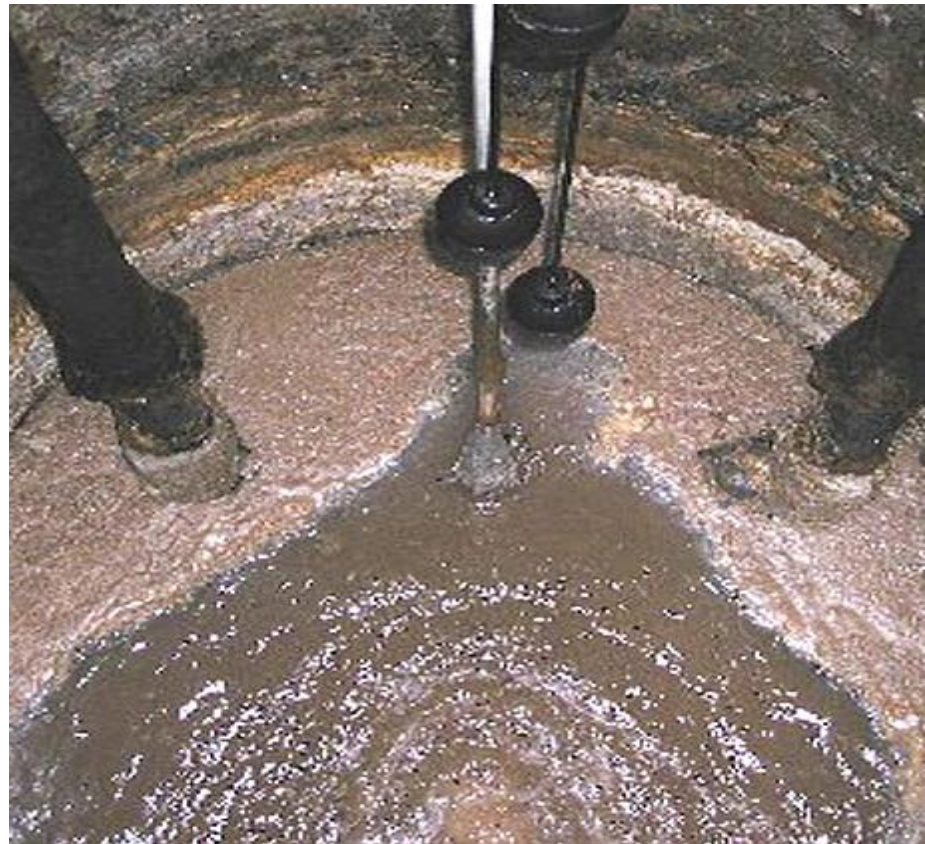
The first unit is a settling compartment.

Inside of it the sewage water is accumulated and undergoes of initial segregation.



THE PROCESSES INSIDE OF SETTLING COMPARTMENT

- Inside the settling compartment the heavy impurities settle the bottom, forming a sludge and light impurities float to the surface of water, forming a scum. The scum is seen on the photo at right.
- In such a way, the bulk of water becomes freed from impurities which have a specific density difference from the specific density of water.



<http://septick.ru/articles/images/max/zailivanie-septika.jpg>

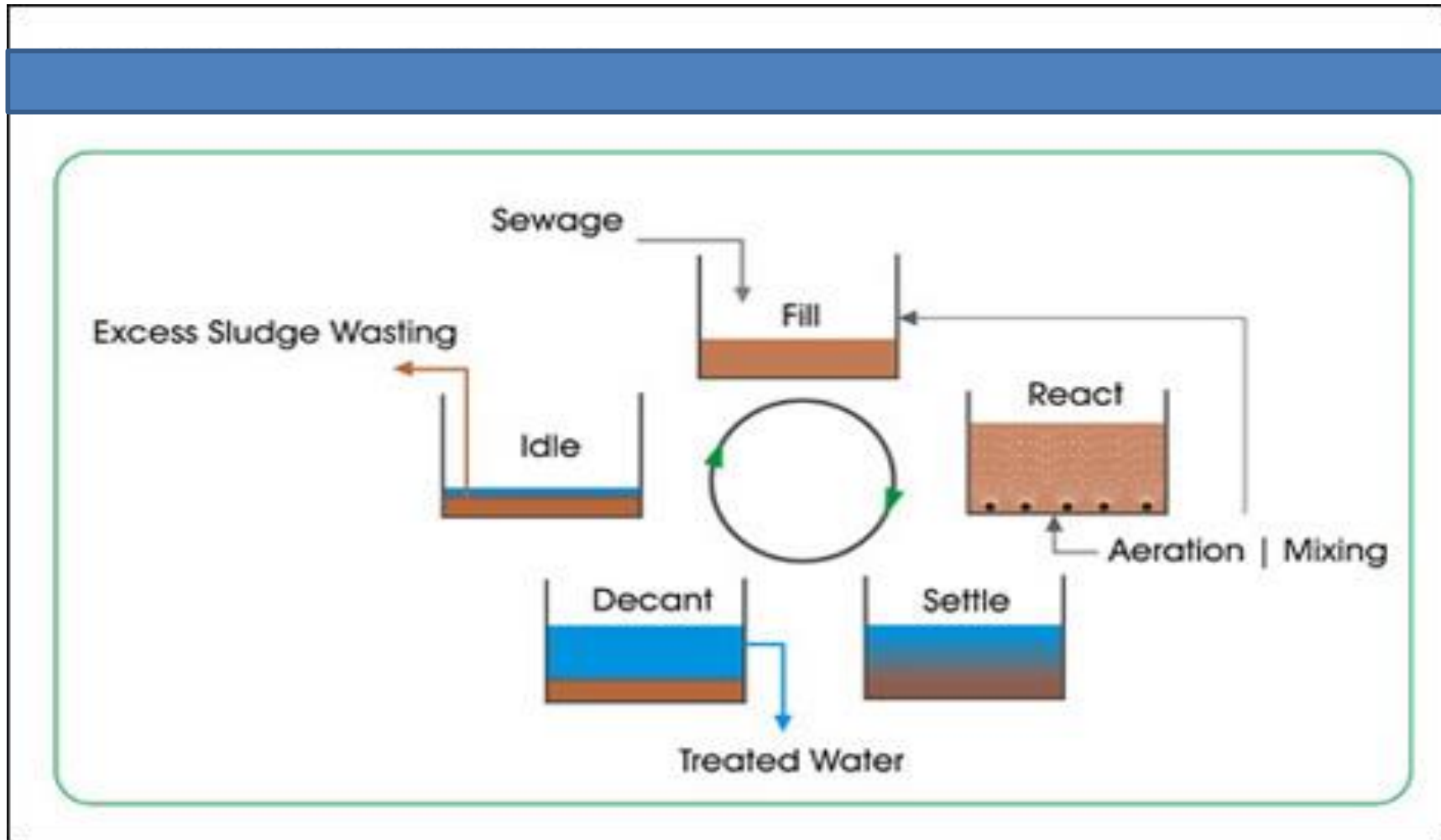
THE PROCESSES INSIDE OF SECOND COMPARTMENT

In this compartment the wastewater treatment is continuing under action of heterotrophic bacteria.

- **The sludge, generated inside of second compartment as result of bacteria action is gradually deposited on the bottom and as result the waste water becomes cleaner and cleaner.**
- **After a stay in the second compartment of certain time the waste water becomes so pure that it can be pumped into the drainage pit, trench, etc.**

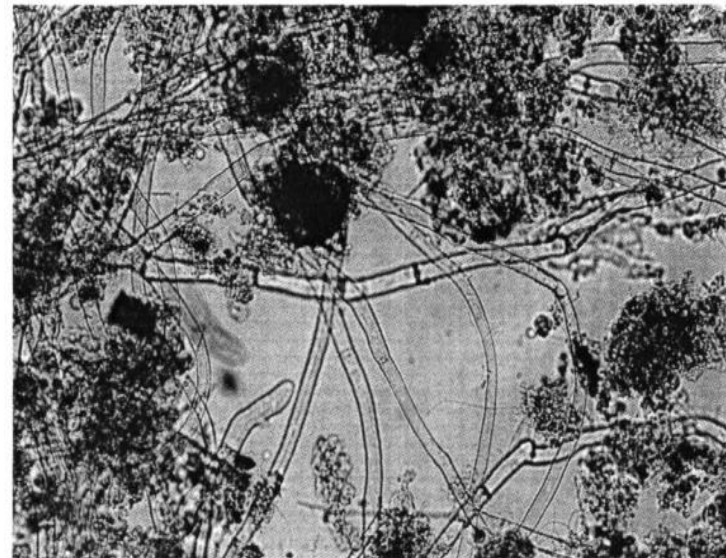
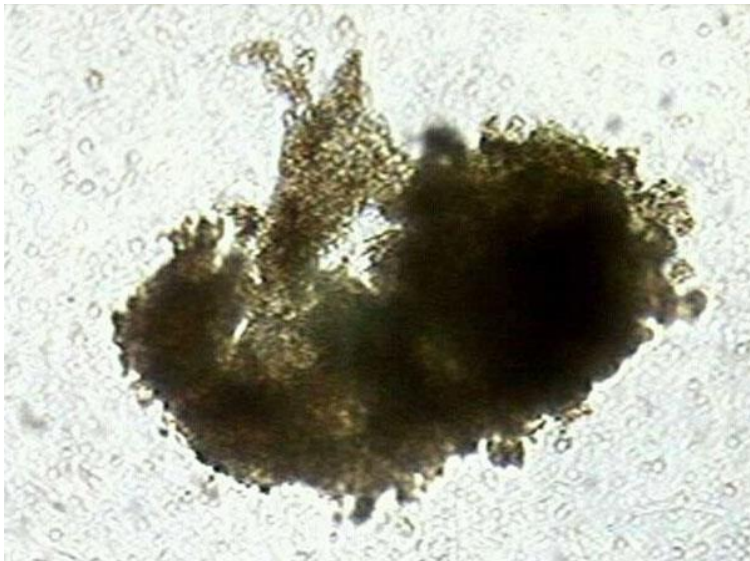


LAYOUT OF PROCESSES INSIDE OF SEPTIC TANK

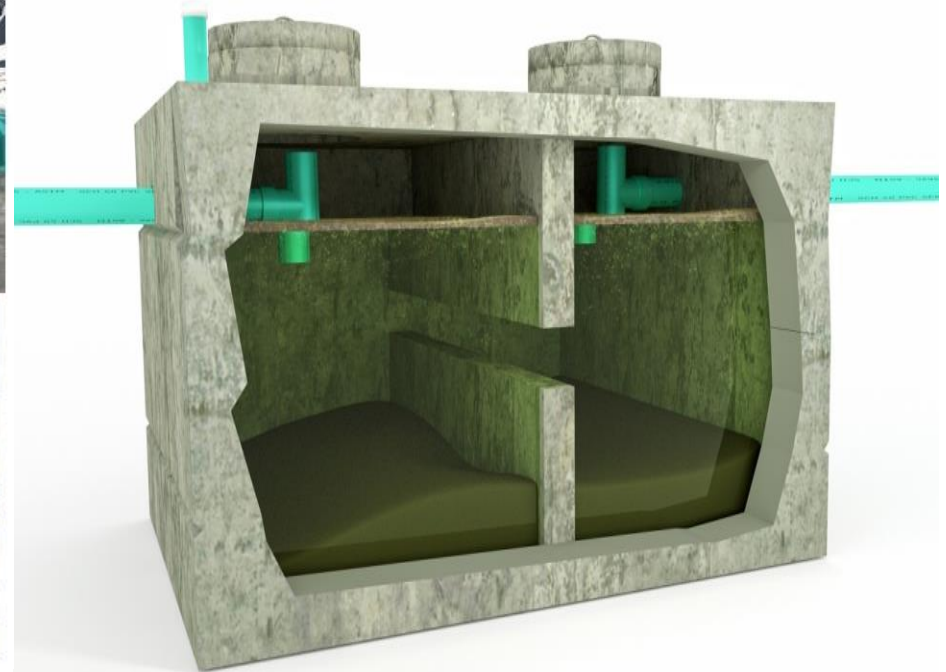


THE MECHANISMS OF MICROBIOLOGICAL TREATMENT.

The microorganisms of active sludge when contacting with organic substances of sewage water are consume some part of these substances, releasing into water carbon dioxide, nitrate ions, sulfide ions etc. Other part of organic matter is transformed into the biomass of bacterium cells forming additional sludge.

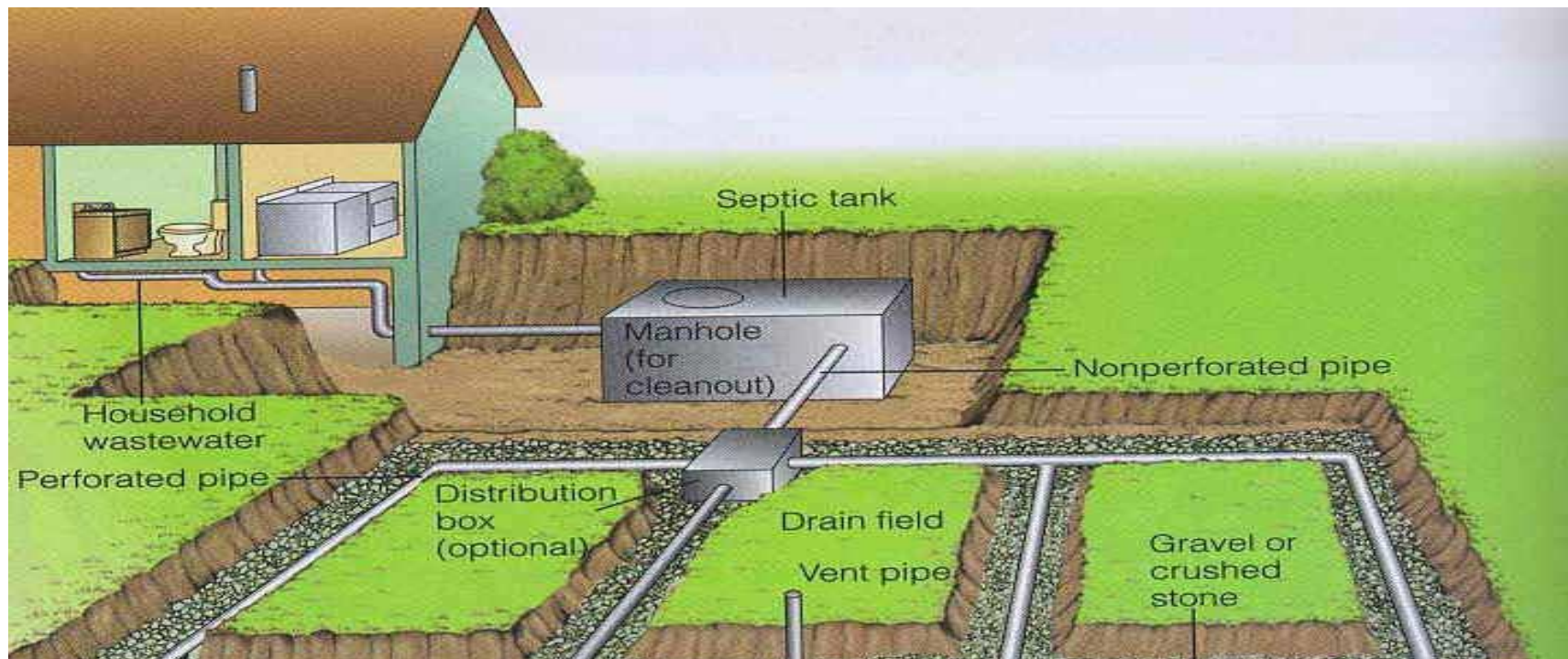


DESIGN OF SEPTIC TANKS MADE OF PLASTIC AND CONCRETE



DISCHARGING OF TREATED EFFLUENT INTO THE SOIL

From septic tank the end products of digestion sewage water are discharged into the drainage field that uses microorganisms to final destruction these products naturally in the soil.



TECHNICAL DETAILS

Discharging occurs through the perforated pipes of appropriate diameter disposed on the washed gravel. The gravel bed perform the function of initial filtration layer of septic field.



ESSEMBLING OF DRAINAGE SYSTEM

This is the picture of drain field made of perforated pipes on the gravel bed.



CONSTRUCTION OF DISTRIBUTION BOX

From the septic tank to the laterals of drain field the treated effluent is directed through a distribution box



DISPOSITION OF SEPTIC

When creating of local sewage system the septic is displaced at certain distance from the house. Minimal distance is about 2-3 meters.

- In the case of small volumes of sewage water discharge one can use the septic unit in conjunction with the drain well.



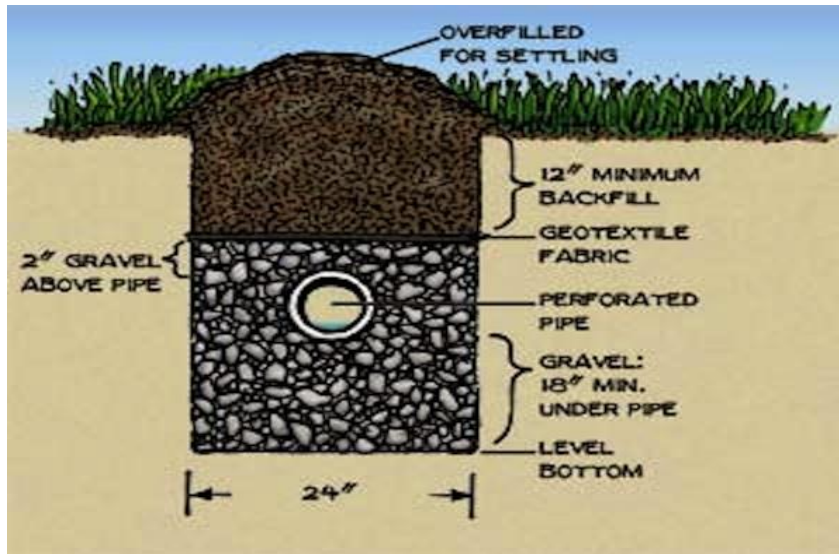
USING OF DRAIN WELL IS JUSTIFIED ONLY AT HIGH WATER ABSORPTION CAPACITIES OF SOILS.

In other cases it is required to use more complicated drainage systems containing many drainage pipes or special drainage units like shown here.



DESIGN OF DRAINAGE TRENCHES AND OF INSPECTION NODES

**Above the soil filter is top soil in which grass is planted.
The drain field is normally 0,3-0,6 meter below the surface.**



<http://1landscapedesign.ru/wp-content/uploads/2014/02/razrez-drenazh.jpg>



<http://krasnodarskiy.xyz/wp-content/uploads/st-d100z-1.jpg>

DAMAGE IN THE SEPTIC

If the effluent cannot soak into the soil surrounding the drain field, sewage may back up, overflow into the house or puddle on the surface of the ground.



<http://www.davidzuidema.com/images/Homeimage.jpg>



<http://www.cpssepticandsewer.com/images/stories/failedleachline.jpg>

POSSIBLE CAUSES OF PROBLEMS WITH A SEPTIC SYSTEM.

- 1. Faulty design of the septic system.**
- 2. The drain field system placed in unsuitable soil.**
- 3. The septic system is too small for the house it serves.**
- 4. The septic system is improperly constructed.**
- 5. High water table.**
- 6. Physical damage.**

DAMAGE IN THE UNITS OF SEPTIC SYSTEM



http://www.classicdrainage.com/assets/Clogged_pipe.jpg



<http://cdn.balkanplumbing.com/wp-content/uploads/Tree-Roots-Inside-Sewer-Pipe.jpg>

HOW LONG SHOULD A SEPTIC SYSTEM LAST?

How big should a septic tank be for a proper operation of local sewage system?

# Bedrooms	Home Square Footage, M ²	Tank Capacity, M ³
1 or 2	Less than 150	3,3
3	Less than 150	4,5
4	Less than 350	5,6
5	Less than 450	5,6
6	Less than 550	5,9

HOW BIG SHOULD A DRAIN FIELDS BE FOR A PROPER OPERATION OF LOCAL SEWAGE SYSTEM?

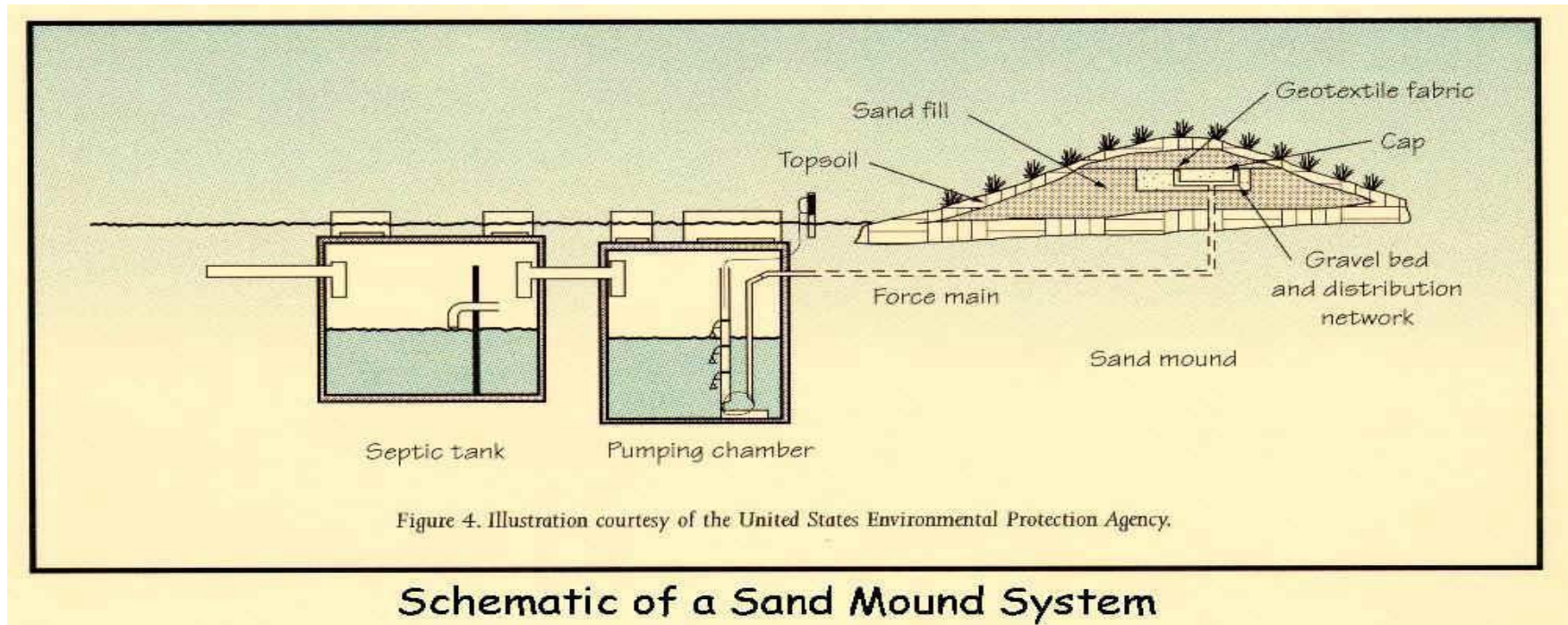
- **Determining the required size of a drain field is more complicated.**
- **The first thing to consider is the nature of the soil in which the drain fields is to be constructed.**
- **Because water has to be absorbed in the soil, one must to know how fast it can be absorbed.**
- **This is called the percolation rate and is expressed as the time it takes for water in a test hole to decrease in level by one centimeter (minutes/cm).**

CHOOSING OF DRAIN FIELD SIZE DEPENDING OF PERCOLATION RATE

Soil Percola tion Rate in Minutes / Inch	Required Septic Absorption Trench Length in Feet versus Soil Percolation Rate & Wastewater Flow Rate														
	2 Bedrooms				3 Bdrms		4 Bdrms			5 Bdrms			6 Bdrms		
	Septic Wastewater Effluent Input Flow Rate (Gallons per Day)[1]														
	220 gpd	260 gpd	300 gpd	330 gpd	390 gpd	450 gpd	440 gpd	520 gpd	600 gpd	550 gpd	650 gpd	750 gpd	660 gpd	780 gpd	900 gpd
1 - 5	92	108	125	138	162	187	184	216	250	230	270	312	275	325	374
6 - 7	110	130	150	165	195	225	220	260	300	275	325	375	330	390	450
8 - 10	123	145	167	184	217	250	245	290	333	306	360	417	367	433	500
11 - 15	138	162	188	207	244	281	275	325	375	344	406	469	413	488	563
16 - 20	158	186	214	236	279	321	315	372	429	393	464	536	472	557	643
21 - 30	184	217	250	275	325	375	367	433	500	459	542	625	550	650	750
31 - 45	220	260	300	330	390	450	440	520	600	550	650	750	660	780	900
46 - 60	245	290	333	333	433	500	489	578	667	612	722	833	734	867	1000[2]
Dosing not required (but recommended)							Dosing system or alternative design is required if the total drainfield (soakbed / leachfield) trench length is 500 feet or more in length.								

THE MOUND SYSTEM

If ground water or percolation rate are unsuitable, it may be possible to install a “mound” system. In a mound system, a suitable soil is placed above the unsuitable soil. A conventional system is then installed in the mound.

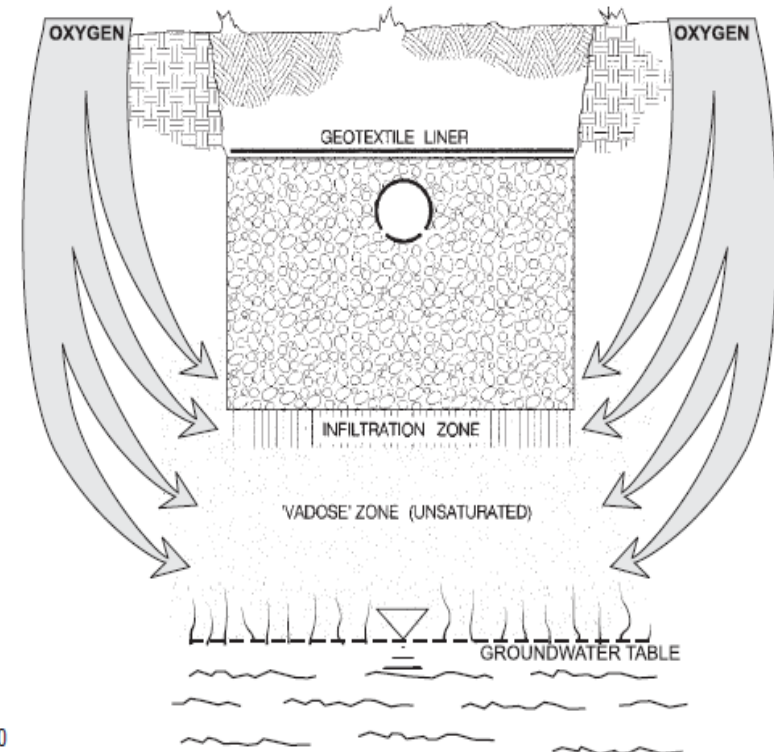
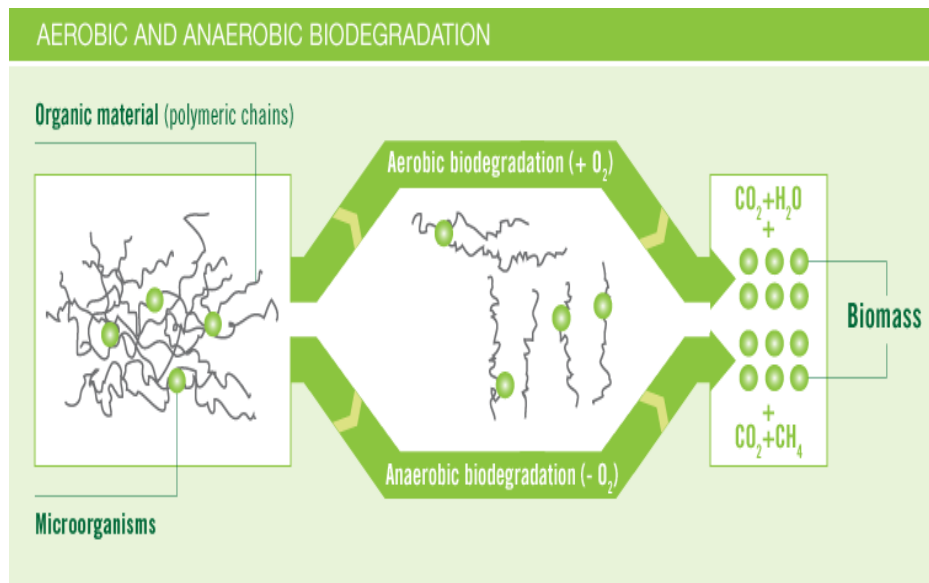


A MOUND LEACH FIELD IN A LOCAL SEWAGE SYSTEM



AEROBIC AND ANAEROBIC BIODEGRADATION

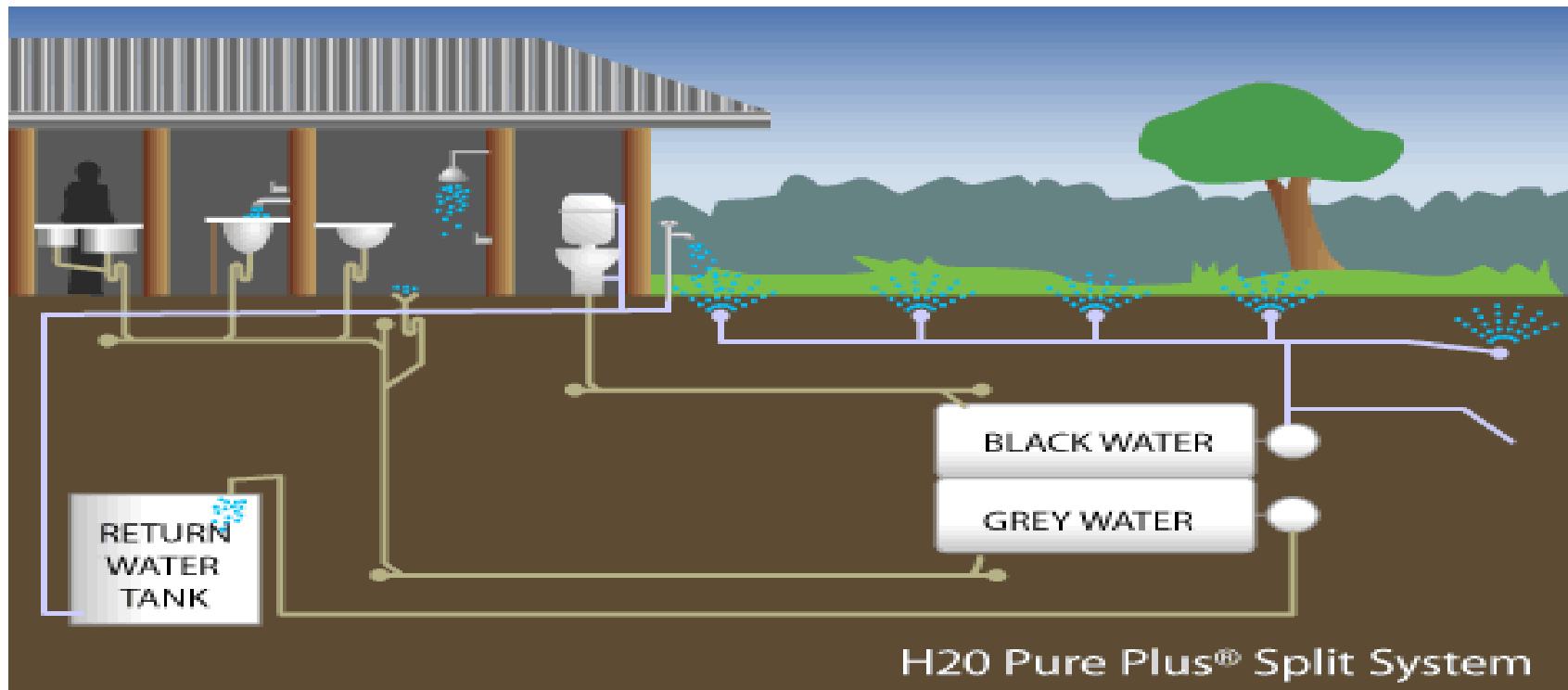
At present time the popular becomes the hybrid system that uses a combination of anaerobic and aerobic sections.



Source: Ayres Associates, 2000

SOURCE SEPARATION SYSTEMS

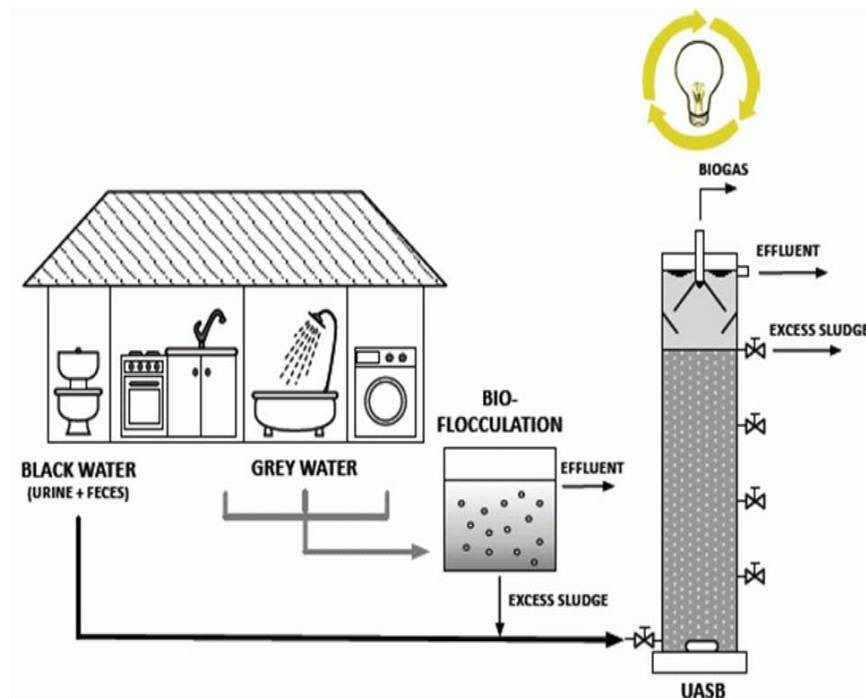
This systems offers the possibility of recover nutrients, reducing release of micro pollutants to the environment, and increase degree of the water recycling.



<http://h2opureplus.com/images/blackgrey.gif>

SOURCE SEPARATION IS DRIVING INNOVATION IN DECENTRALIZED WASTEWATER TREATMENT

Novel approach allow also to reduce the discharge of water into soil and get an additional energy source as shown in picture below.



DECENTRALIZED WASTE WATER TREATMENT



<http://i.ytimg.com/vi/Y7SuiMDymBA/mqdefault.jpg>

BENEFITS OF SOURCE SEPARATION

Gray water is the largest contributor to total volume of sewage water in the household.

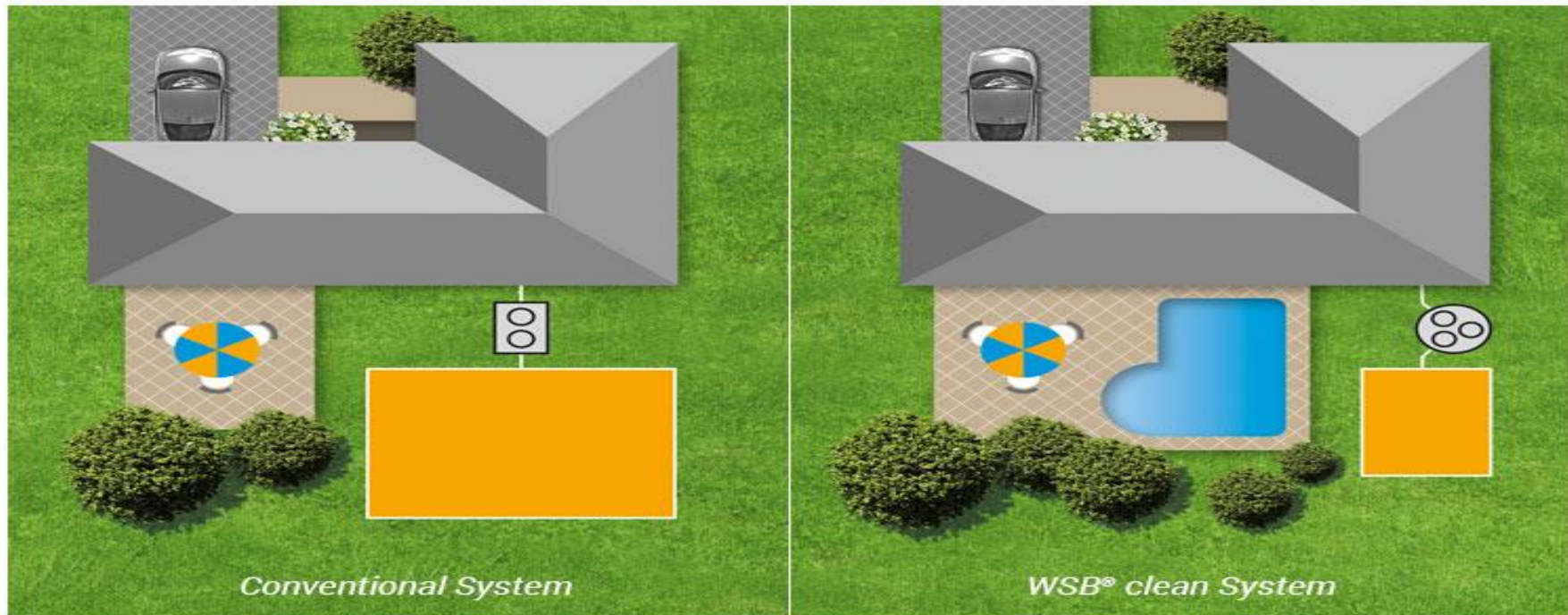
At the same time gray water is the least contaminated

In the absence of kitchen wastewater, gray water is low in organic content.

Novel approach allow one to reduce the discharge of water into soil and get an additional energy source

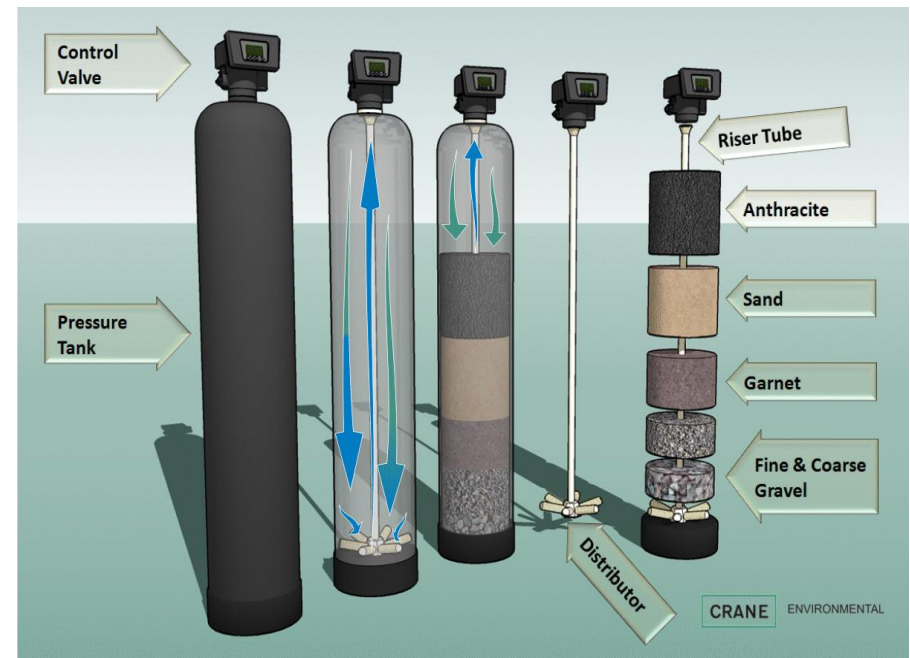
ADDITIONAL PROFIT

The useful free area around the house is extended due to reducing of required area for the drain field.



INSTRUMENTATION

Purification of grey water up to required quality can be attained by different devices



<http://www.avloppscenter.se/shop/11994/art94/h6182/15086182-origpic-173141.jpg>

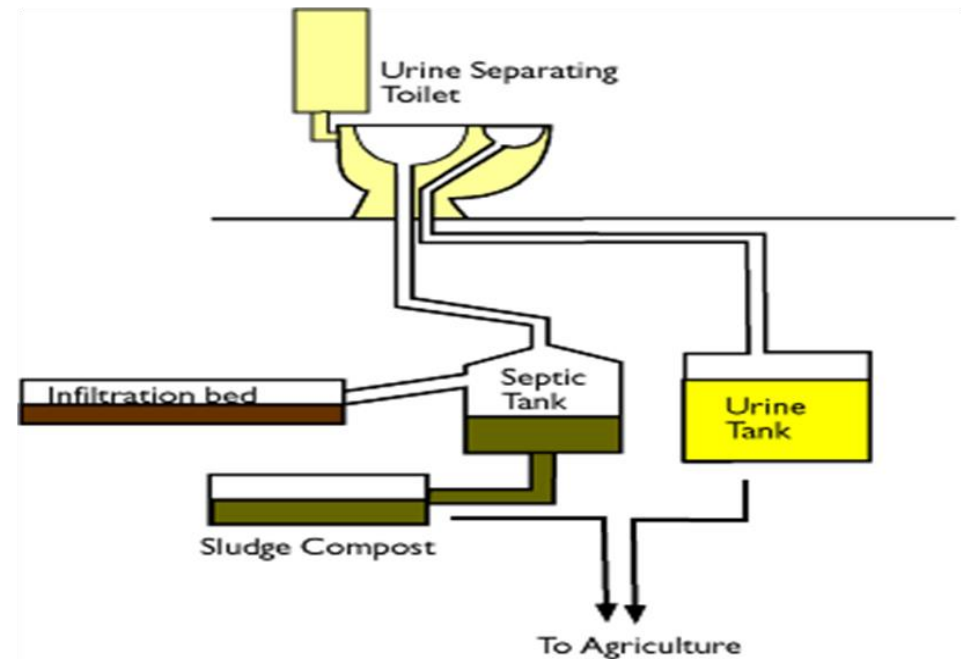
http://www.omegagroup.gr/omega/portals/0/Images/Επεξεργασία_νερου/Multimedia-filter.png

NEXT BREAKTHROUGH

It is the use of range of toilets with very low dilution



https://grist.files.wordpress.com/2010/03/toilet_463.jpg



http://www.fujitaresearch.com/reports/_img/023-WW-Tileot.gif

The toilets of low dilution was approbated in several projects where was shown how from the human rests to get addition sources of energy and fertilizes .



<http://nursingcrib.com/wp-content/uploads/urine.jpg>

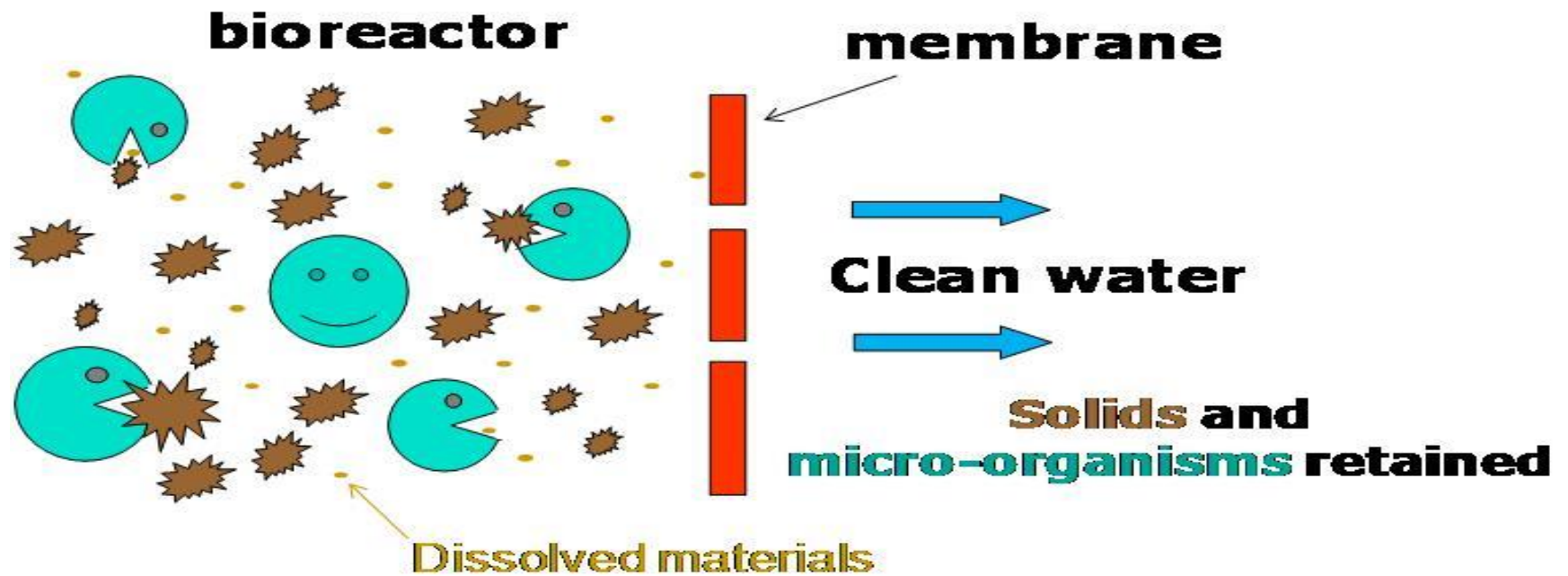
Processed feces



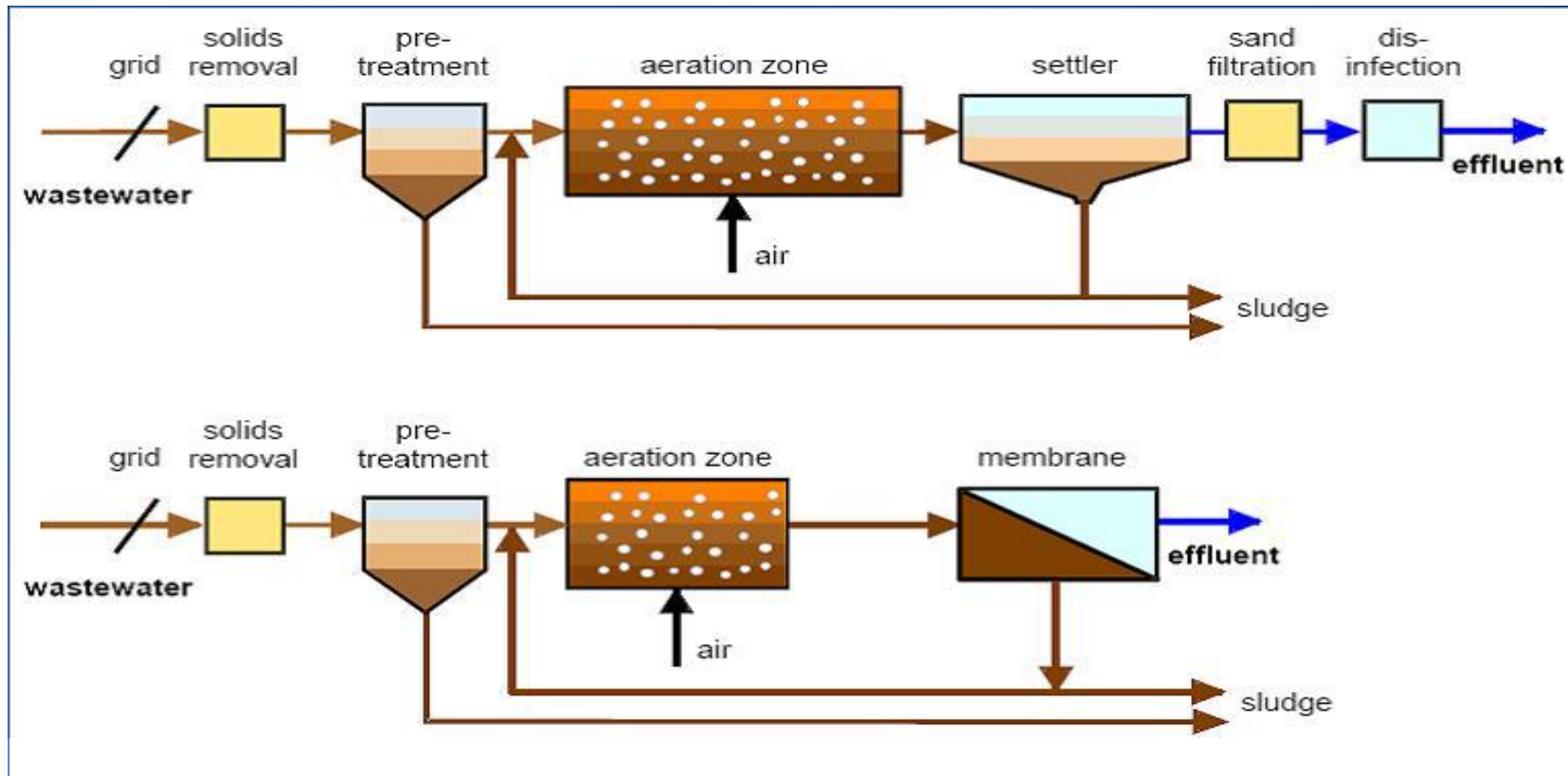
<http://www.myessentia.com/blog/wp-content/uploads/2010/05/biosolids.jpg>

MEMBRANE BIOREACTORS

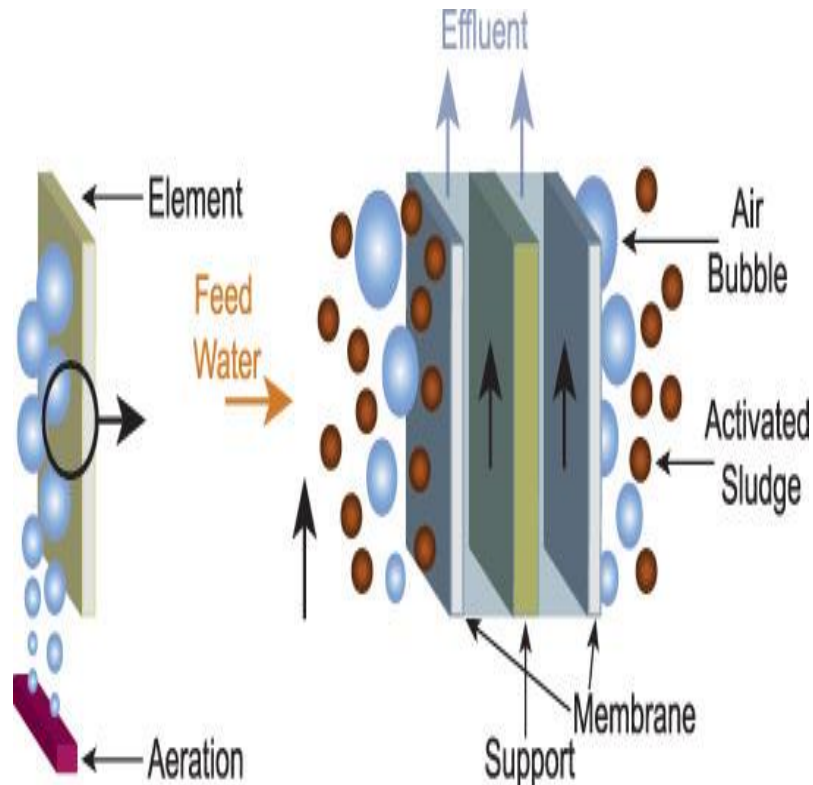
Last innovation within the range of decentralized systems for wastewater treatment include the using of membrane bioreactors.



THE BASIC DIFFERENCE BETWEEN ORDINARY WASTE WATER TREATMENT SYSTEM AND OF MEMBRANE BIOREACTOR



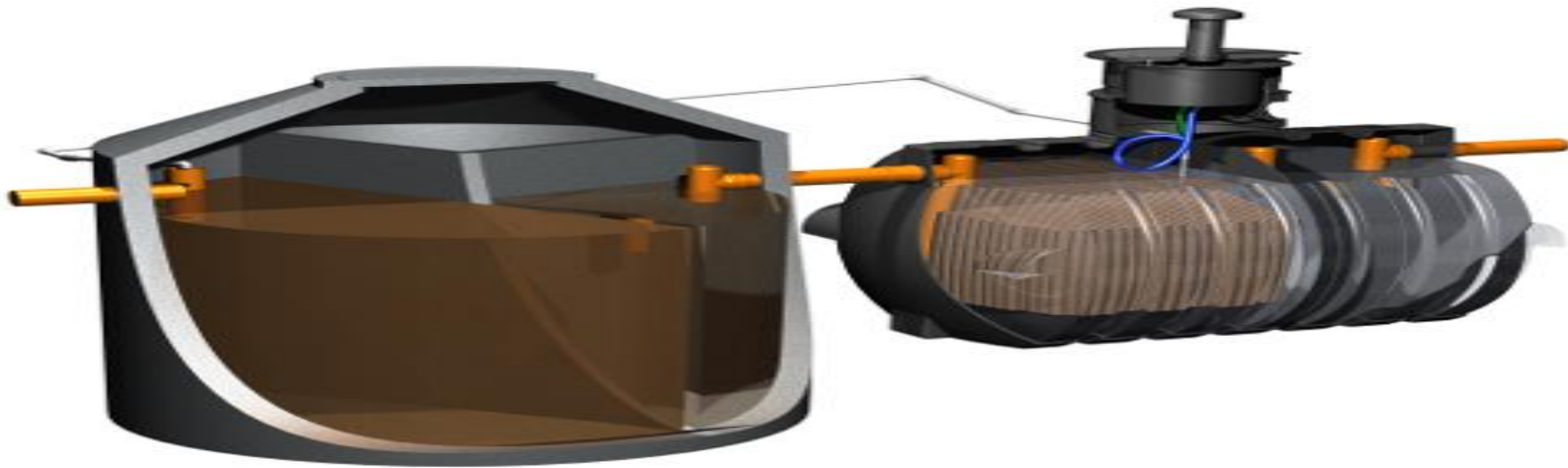
SCHEMATIC OF ELEMENTARY UNIT OF MBR AND THE PICTURE OF MBR MODULE



<http://sc02.alicdn.com/kf/HTB1qTO6HFXXXXc5XVXXq6xXFX5X5/MBR-Plant-Membrane-Bioreactor-Membrane-Bio-reactor.jpg>

SMALL WASTE WATER TREATMENT PLANTS

Septic tanks, biological reactors, membrane bioreactors, soil-box planters, natural and artificial soil filters, as well as multimedia filters and other functional devices being connected in a certain sequence forms a small waste water treatment plants

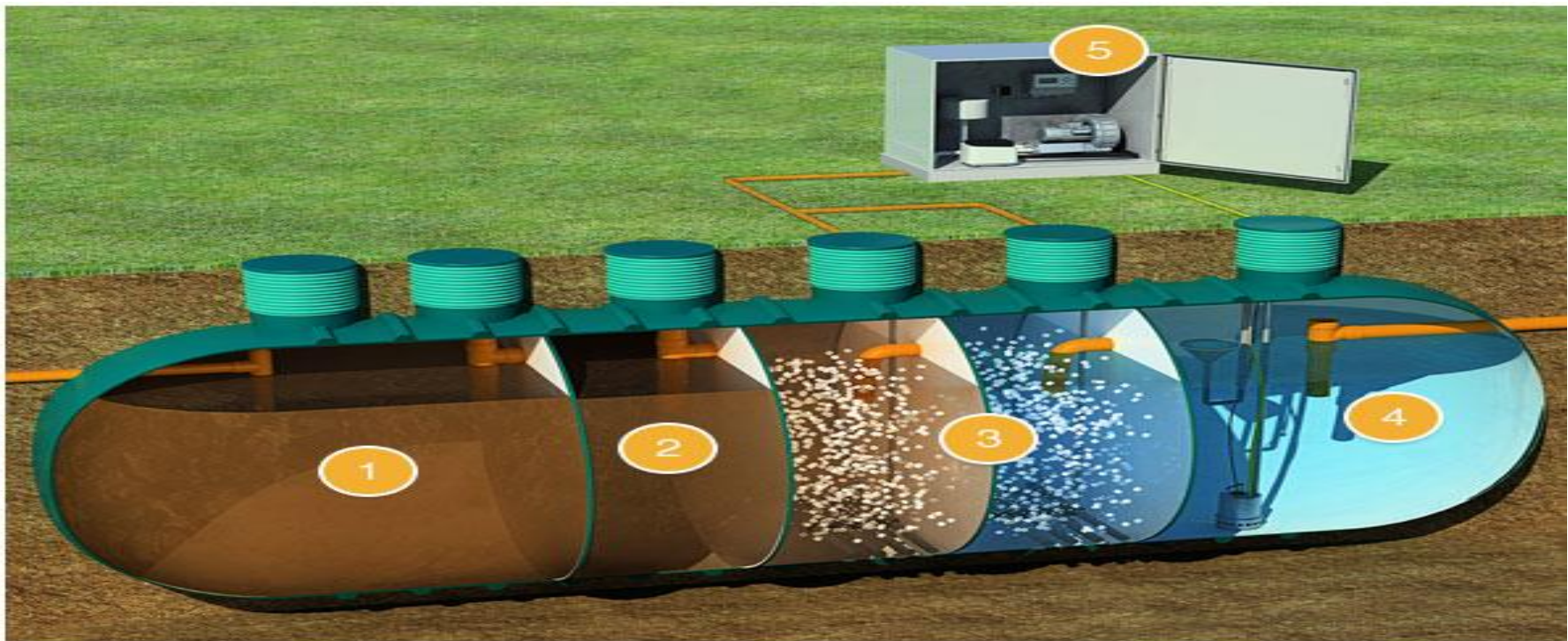


This is example of WWTP designed of septic tank and membrane bioreactor

http://www.delphinws.de/uploads/pics/Kleinklaieranlage_DELPHIN_classic_plus_S_M_Schnitt_03.png

THIS IS THE SMALL WWTP CONSISTING OF:

sludge storage unit (1), pre-treatment unit (2), biological compartments (3), final clarification unit (4) and control system (5).



<http://www.rh2o.com/sites/all/themes/rh2o/css/images/commercial-howitworks.jpg>

SMALL WASTEWATER TREATMENT PLANTS CAN SERVE FEW HOUSES WITHIN THE COMMUNITY AREA.



DISPOSAL OF LARGE QUANTITIES OF TREATED WATER INTO GROUND OCCURS THROUGH A LARGE DRAINAGE SYSTEM



WETLANDS ARE USED ALSO

Wetlands is a permanently waterlogged areas populated by hydrophytic plants such as reeds, comprise a variety of sub-surface micro-habitats of differing oxygenation and red-ox potential.



SCHEMA OF ADVANCED SMALL WASTE WATER TREATMENT PLANT

