A to Z Media Filters

April 2-4, 2019
Mystic Marriott Hotel
Groton, Connecticut

DR. SARA HEGER
SHEGER@UMN.EDU
SEPTIC.UMN.EDU

Media Filter Presentation Overview

- Description
- Definitions
- Operation and types of media filters
- Management

Media Filters: Miniature WWTP

- Biological process is well understood
- Distribute wastewater over media
- Dispersed directly under or collected after the filter and dispersed

Media Filters - Description

- Consist of a watertight structure containing media of particular specifications.
- After being collected in a processing tank, effluent is distributed evenly (pressure, or gravity) over the surface of the media
- The media provides surface area for bacteria and other microorganisms to treat the effluent
- Aerobic treatment zone

Definitions

- **Filter, media -** device that uses materials designed to treat effluent by reducing BOD and/or removing suspended solids in an unsaturated environment; biological treatment is facilitated via microbial growth on the surface of the media.
- **Filter, bottomless media:** media filter that does not incorporate a liner or other physical barrier between the media and the existing soil on which it has been placed; used as a final treatment and dispersal component.

Definitions Cont'd

- **Filter, peat:** media filter that uses appropriate organic fibric material (peat) as the media; typically packaged as pre-fabricated modular units with the media in a container; a type of biofilter.
- **Filter, sand:** media filter which uses sand of particular specifications as the media.

Definitions Cont'd

- **Filter, textile:** type of media filter which uses non-rigid, synthetic material of varying shapes and configurations; typically packaged as pre-fabricated modular units.
- **Recirculating:** design configuration wherein a portion of effluent is returned to a component for further treatment or to facilitate a treatment process.
- **Recirculation ratio:** proportion of effluent returned to the treatment component compared to the amount of forward flow to the next component of the treatment train.

Media Filter - Treatment Process

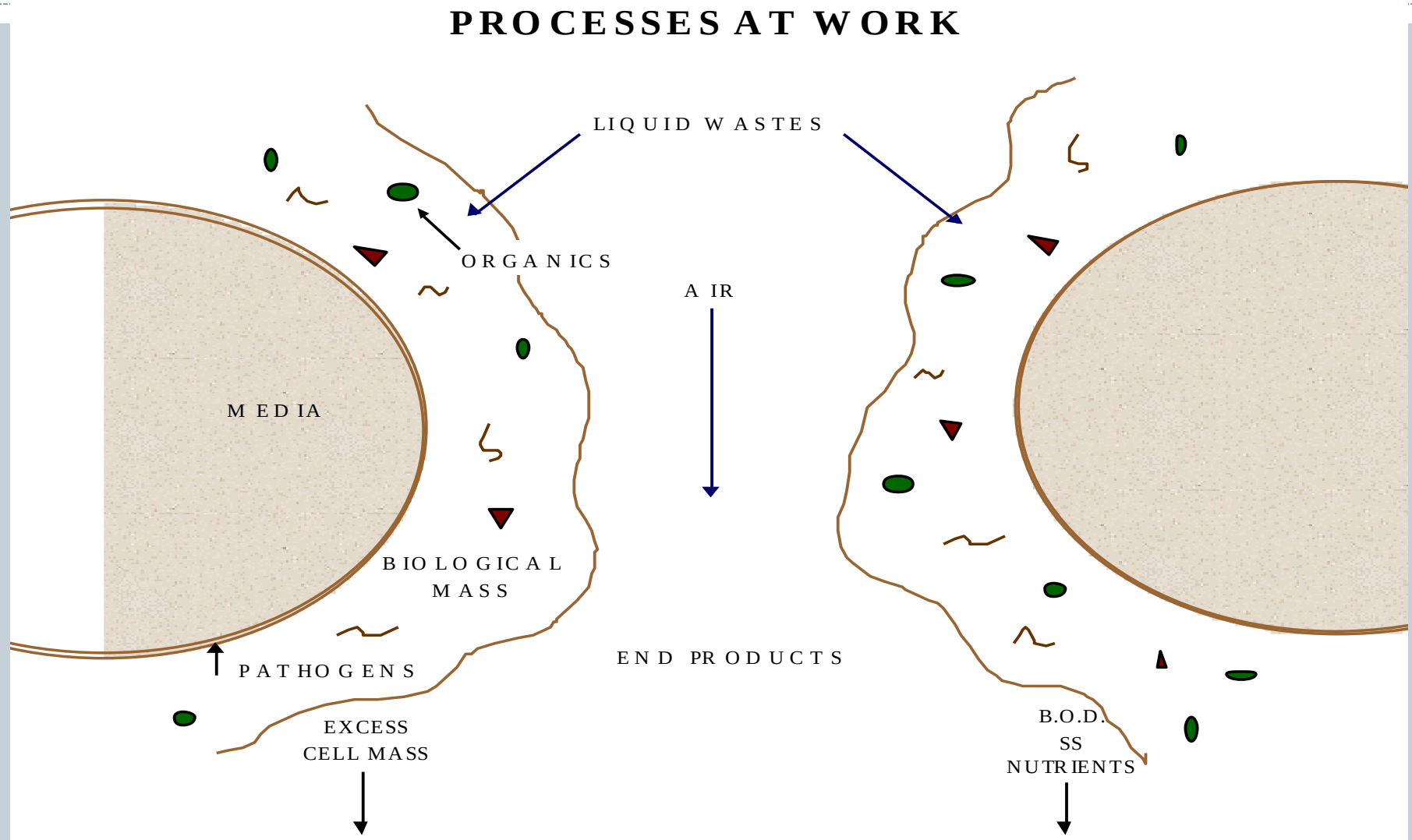
- Wastewater applied in small doses
- Percolates over media in thin film
- Organisms on media contact wastewater
- Air is maintained in media pores
- Oxygen is transferred into the thin film and to organisms
- Aeration may be active or passive

Treatment in media filters

Four main processes:

1. Physical filtration and sedimentation
   - Screens out solids
2. Chemical sorption
   - Adsorption to media surface
   - Biological growth adheres to media
3. Assimilation
   - Microorganisms transform material into another chemical state
4. Decomposition
   - Organic wastes break down into similar compounds

Fixed Film Treatment



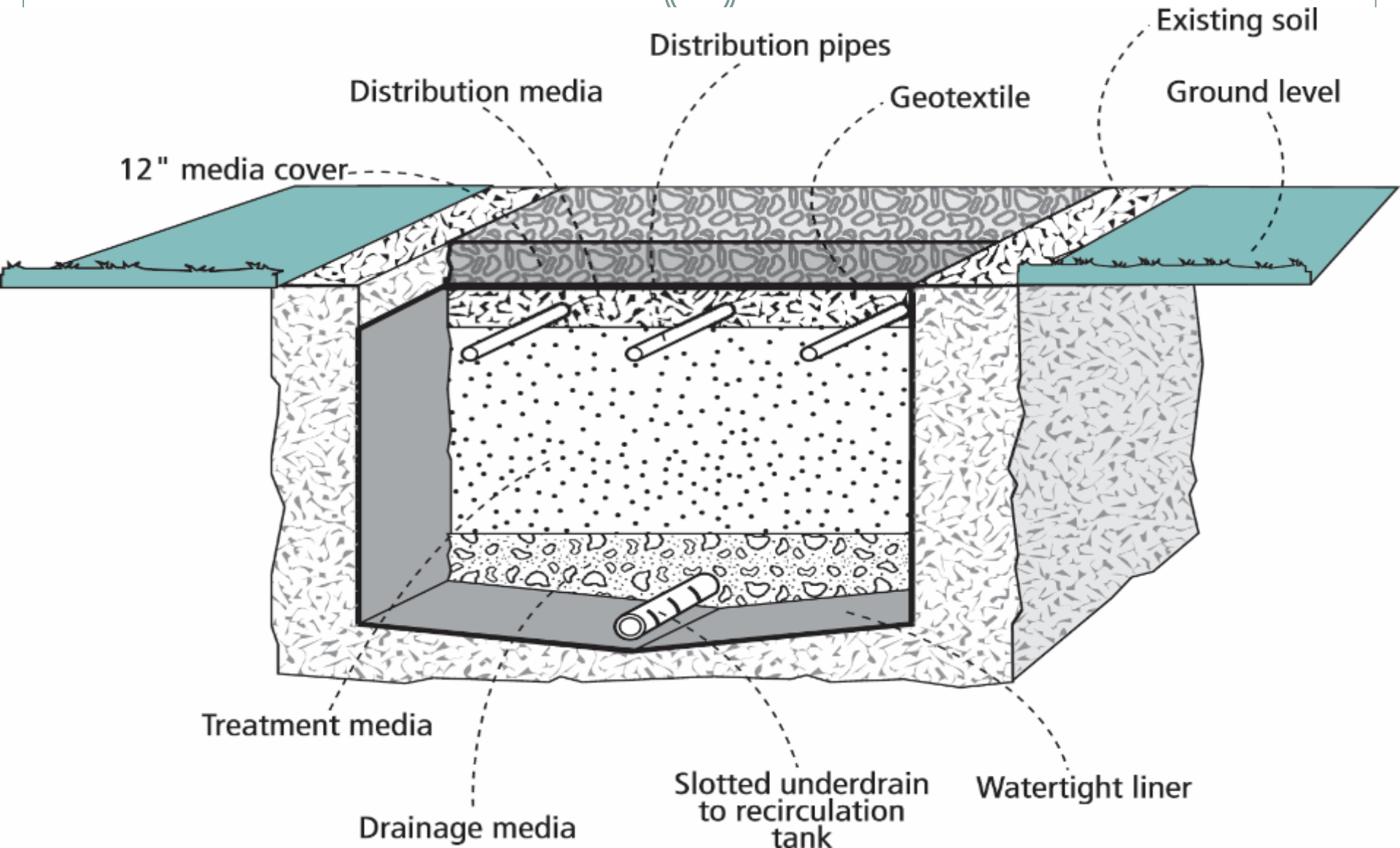
Effluent Quality Before and After Media Filter

	BOD mg/L	TSS mg/L	NO_3-N mg/L	NH_4-N mg/L	DO mg/L	Fecal Coliform Org./100 ml
Septic Tank	**130 - 250**	**30 - 130**	**0 - 2**	**25- 60**	**<2**	**10^5 – 10^7**
Media Filter	**5-25**	**5-30**	**15-30**	**0-4**	**3-5**	**10^2 - 10^4**

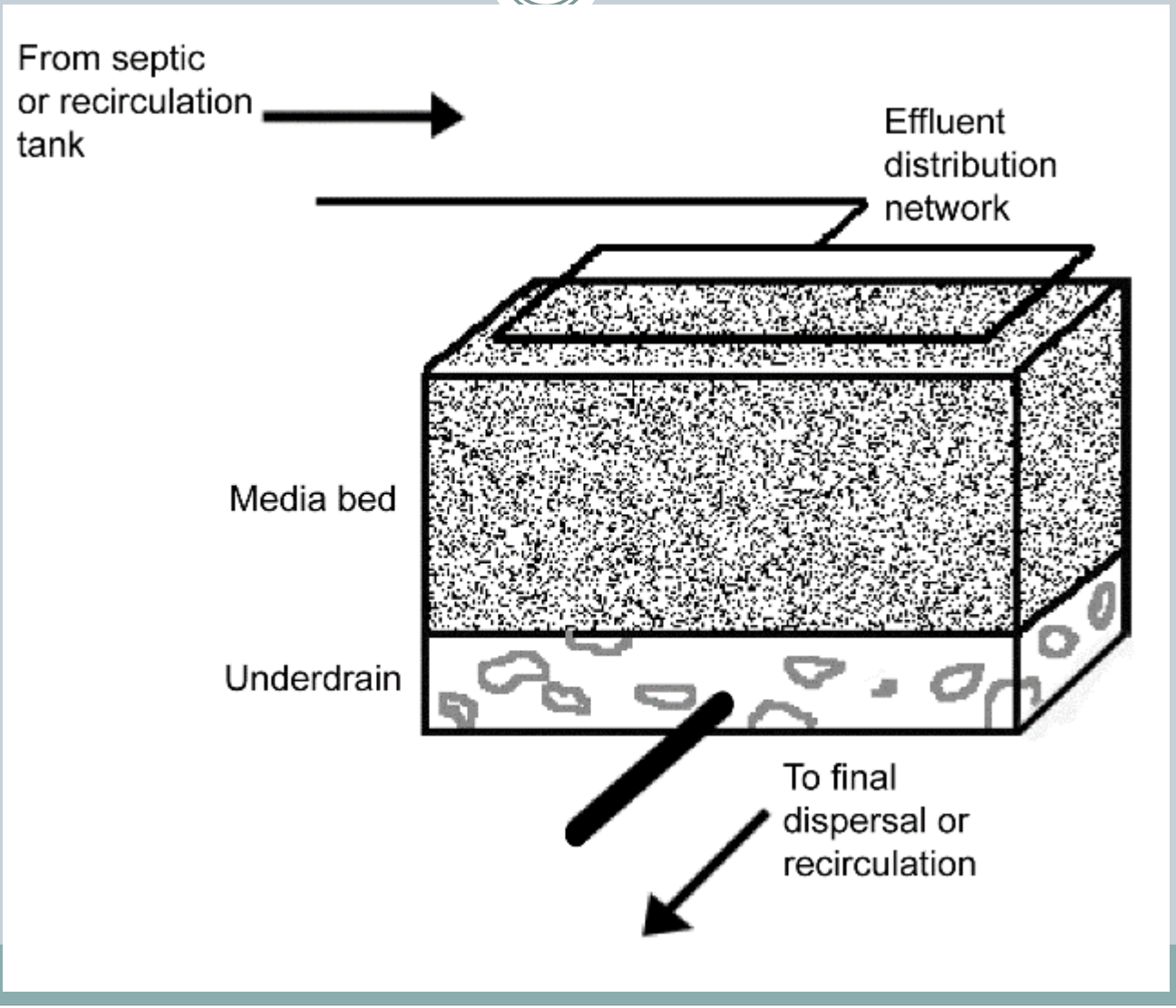
Theory of Operation

- Organisms are “fixed” on the surfaces of media
- Small dose of WW effluent is to the filter
- WW is treated as it moves over media surfaces in contact with organisms

Media Filter Cross Section



General Wastewater Flow



Media Filter Effluent

- Low in Oxygen demand (BOD5) -- >90% removed
- Low in total solids (TSS) and volatile solids (VSS) -- > 90% removed
- Will not form a significant biological clogging mat in soils
- Low in pathogens
- Significantly reduced Total Nitrogen in recirculation mode:
  - Typical removal range is 40-60% removed
  - Up to 80% removal

Uses of Media Filters

- Environmentally sensitive areas
- Soils that are not acceptable for septic tank effluent
  - Hydraulically slow
  - Inadequate vertical separation
- Systems with large flows
  - To mitigate impact of subsurface dispersal
  - Allow a higher application rate to soils
- As a means of meeting secondary treatment levels or TN reduction

Benefits of Media Filters

- Reduce organic matter, pathogens, some nutrients
- Produce an effluent that:
  - Reduce biomat in soil absorption systems when applied at reasonable rates
  - Can be subjected to tertiary treatment, if needed, and surface discharged
    - Further nutrient removal
    - Disinfection
  - Can be applied to a wider range of soils than septic effluent
  - Can be applied to soil at higher loading rates

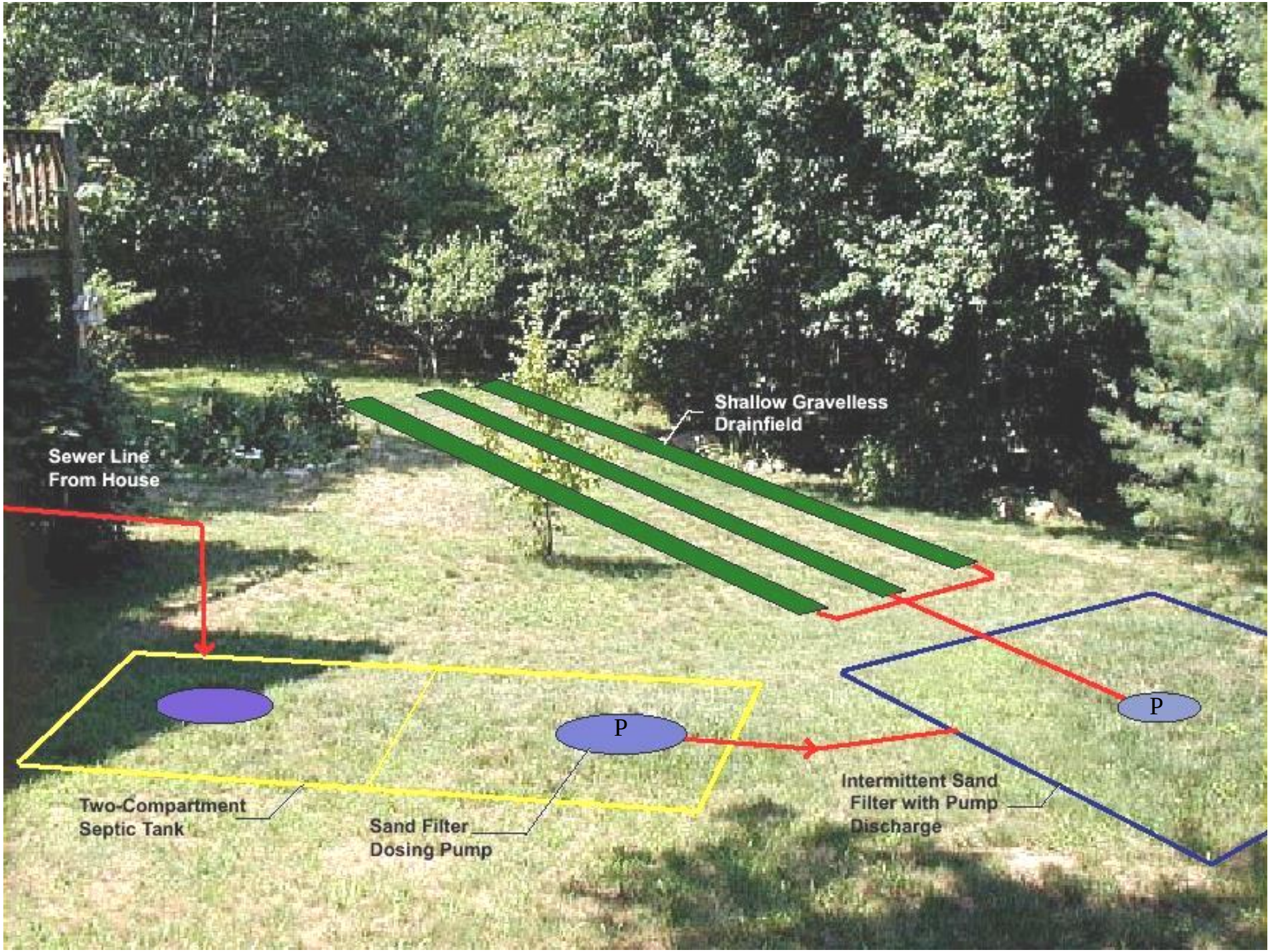
Types of Media Filters

Single-Pass Media Filters

- Granular (sand, glass, etc.)
- Foam (synthetic)
- Peat (organic)

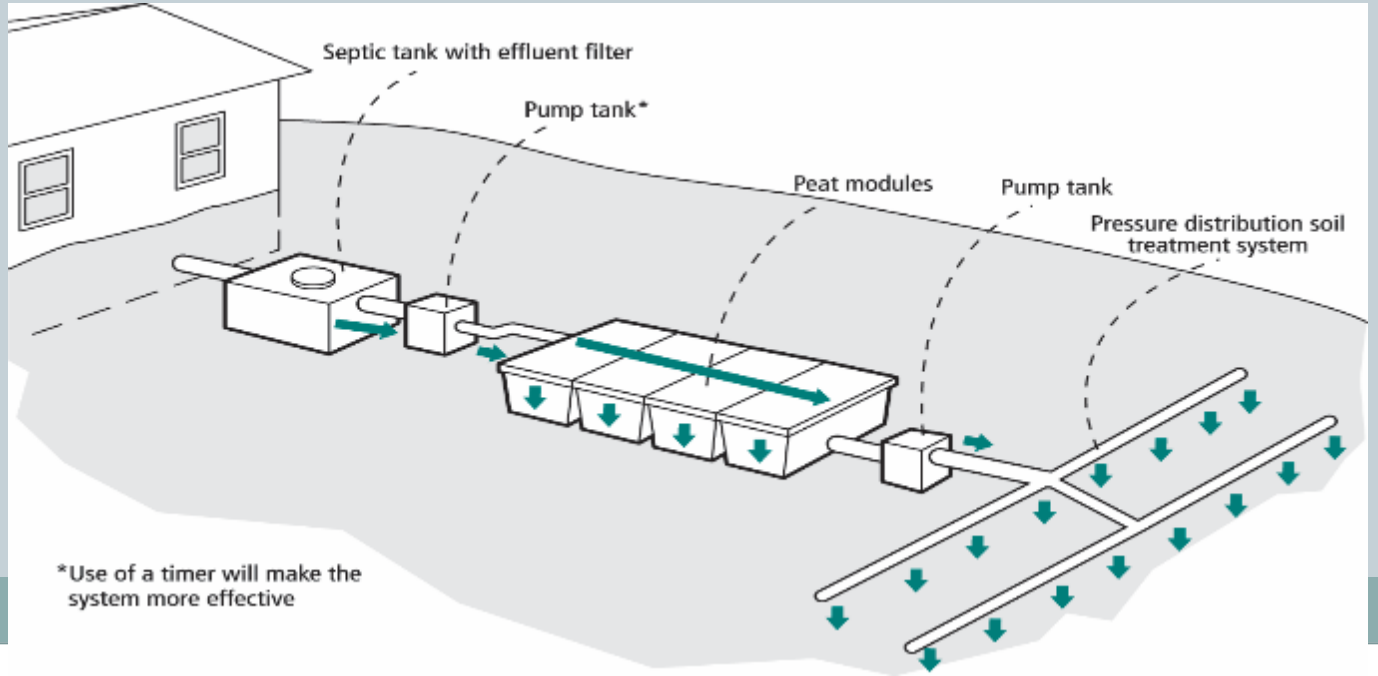
Recirculating / Trickling Filters (multipass)

- Granular (sand, gravel, bottom ash, etc.)
- Foam or plastic
- Textile


Shallow Gravelless
Drainfield
Sewer Line
From House
P
P
Two-Compartment
Septic Tank
Sand Filter
Dosing Pump
Intermittent Sand
Filter with Pump
Discharge

Single Pass Media Filters

- Septic tank effluent is dosed to the media filter
- Wastewater pass over media once then is discharged to the soil
- Single pass filters are effective in reducing BOD, TSS



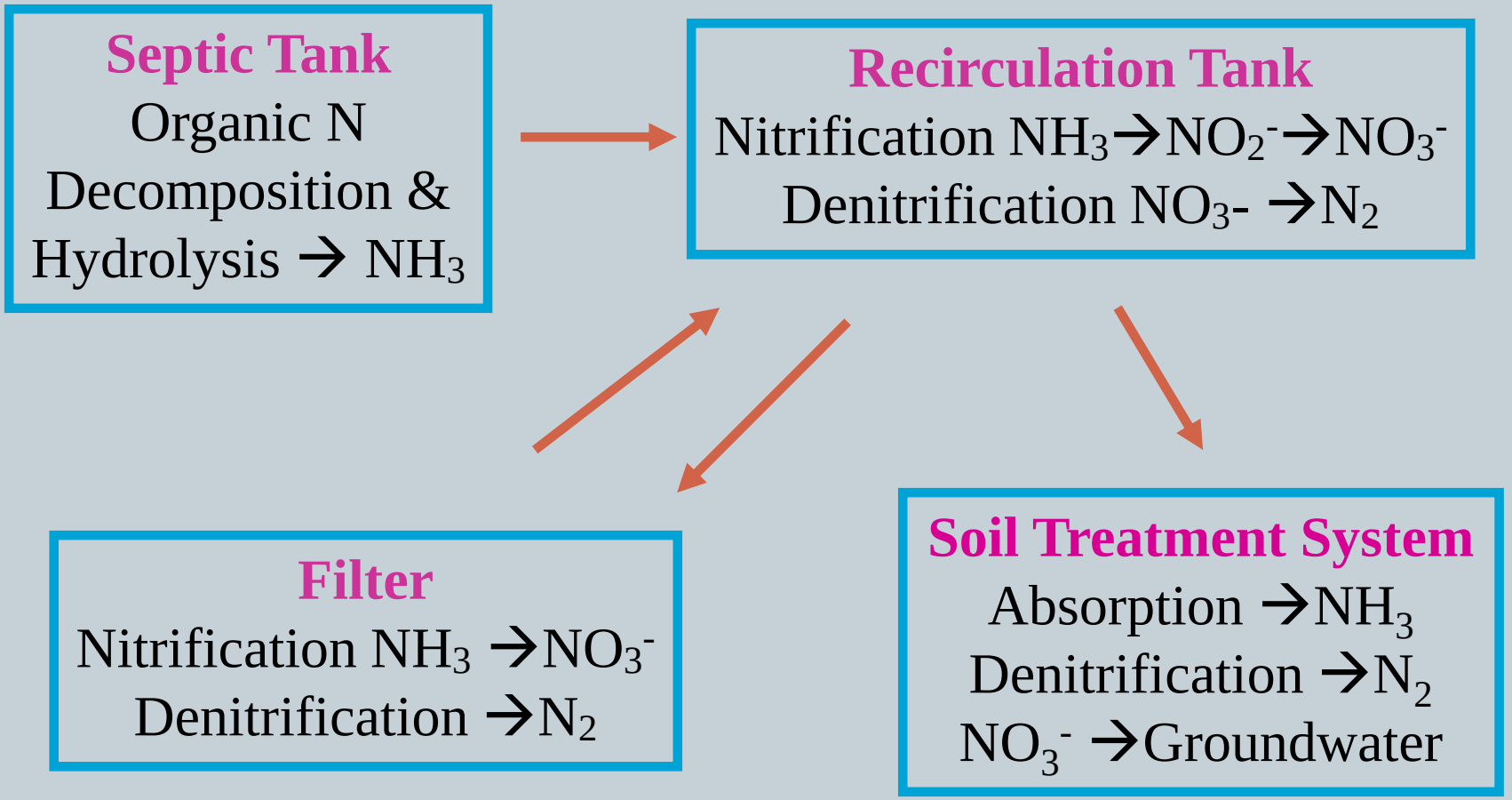
Recirculating Media Filters

- Wastewater is treated by mixing effluent that has passed through the media bed with raw septic tank effluent.
- Filtrate from the media filter is split so that a portion returns back to the recirculation tank, and a portion goes out for final dispersal.
- Recirculating media filters are effective in reducing BOD, TSS and 40-60% total nitrogen.

Media Filter

- Recirculating systems have increased nitrogen removal
- Why?
  - Ammonia converted to nitrate in media filter (aerobic)
  - Effluent goes to recirculating tank
    - Nitrate converted to nitrogen gas via denitrification

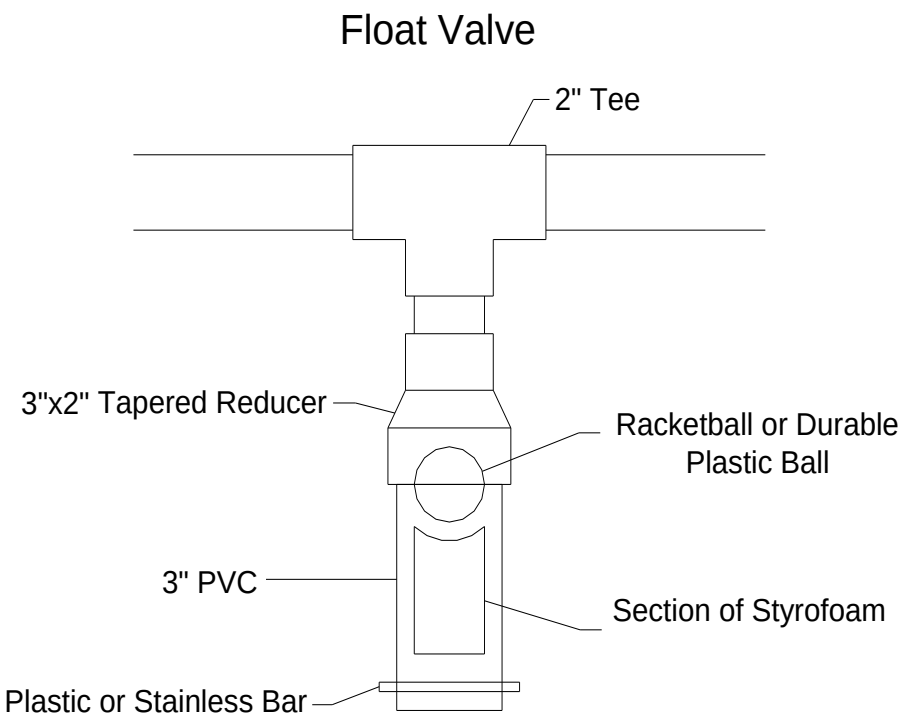
Forms and Fate of Nitrogen



Benefits of Recirculation

- Filter receives diluted effluent
  - Can apply effluent at a greater loading rate
  - Less odor
- Smaller filter surface area needed for given flow
- Can withstand somewhat higher strength incoming wastewater
- Can cope with flow variations, including peak flows
- Can adjust for variations in flow and strength through varying recirculation ratios

Flow Splitter
Simple Float Valve



- Valve mounted in recirc. tank on filter drain return line
- When valve is closed
  - All flow goes to final dispersal
- When valve is open
  - All flow drops into tank
- Set timer for correct total daily flow to filter for proper recirculation ratio.

Media Characteristics

- Home for microbes
- Solid material
- Surface area
- Porosity
- Biomass return
- Clogging potential
- Cleaning/replacement

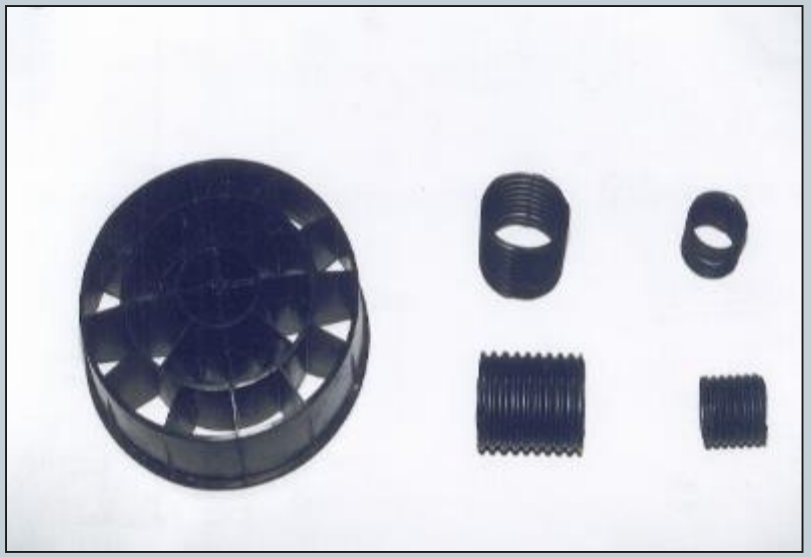
Natural Media Types

- Sand and gravel
- Expanded shale
- Cinders
- Limestone
- Activated carbon
- Peat or peat fiber
- Coconut husks

Most common in single pass filters

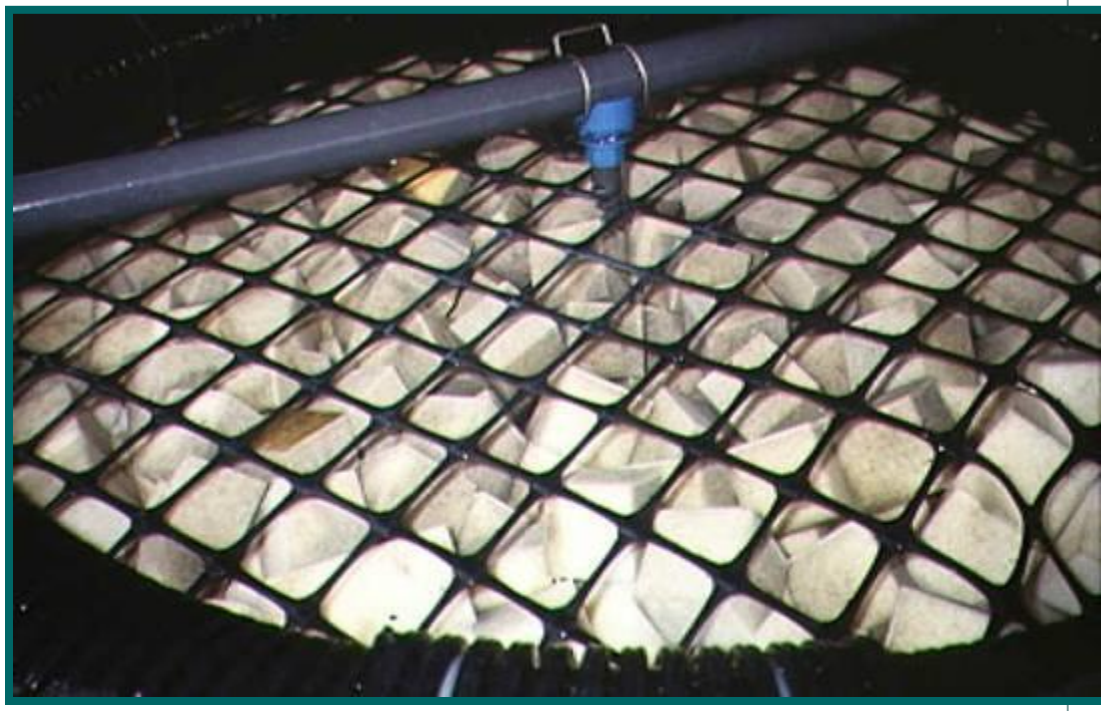
Manufactured Media Types

- Textile fabric
- Open cell foam cubes
- Hard plastic
- Crushed recycled glass
- Chipped recycled tires
- Processed slag

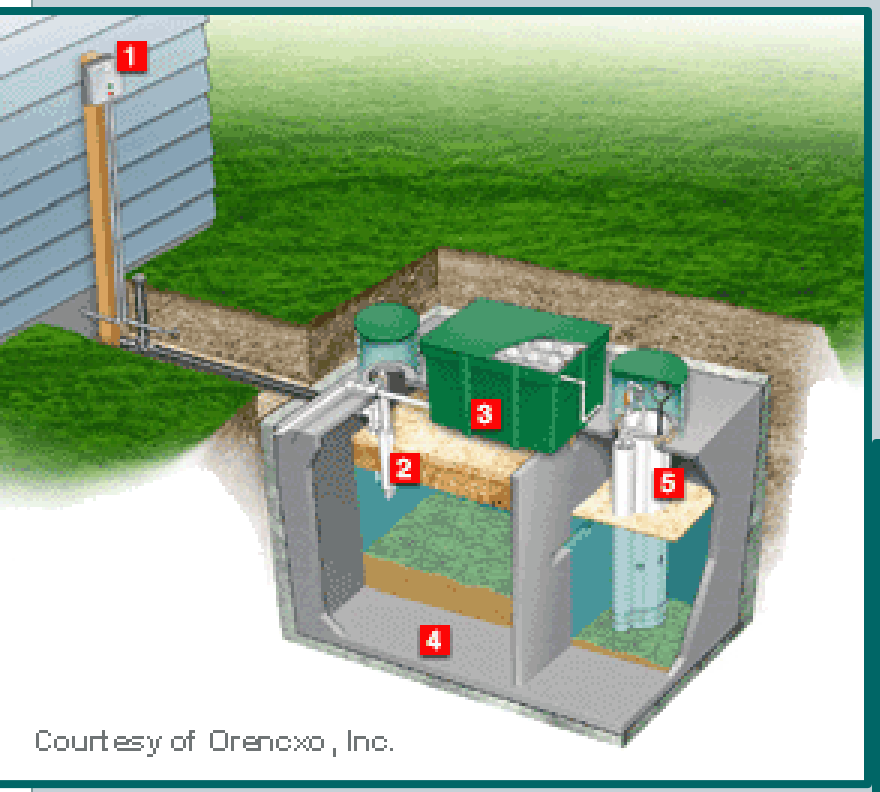


- Usually used in recirculating modes

Foam Filters



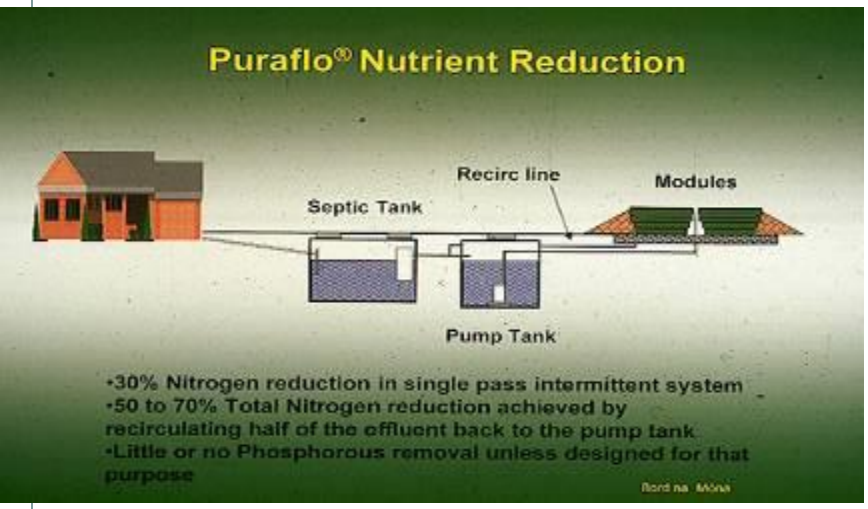
Textile-Based Filter



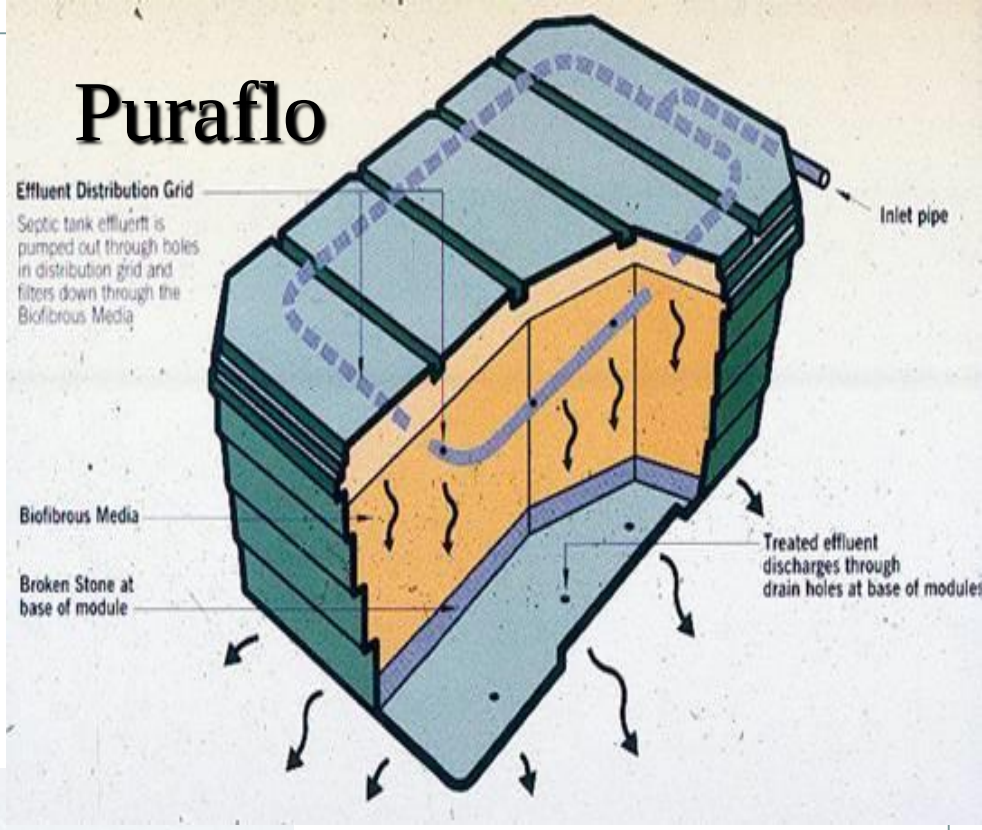
Courtesy of Orencxo, Inc.

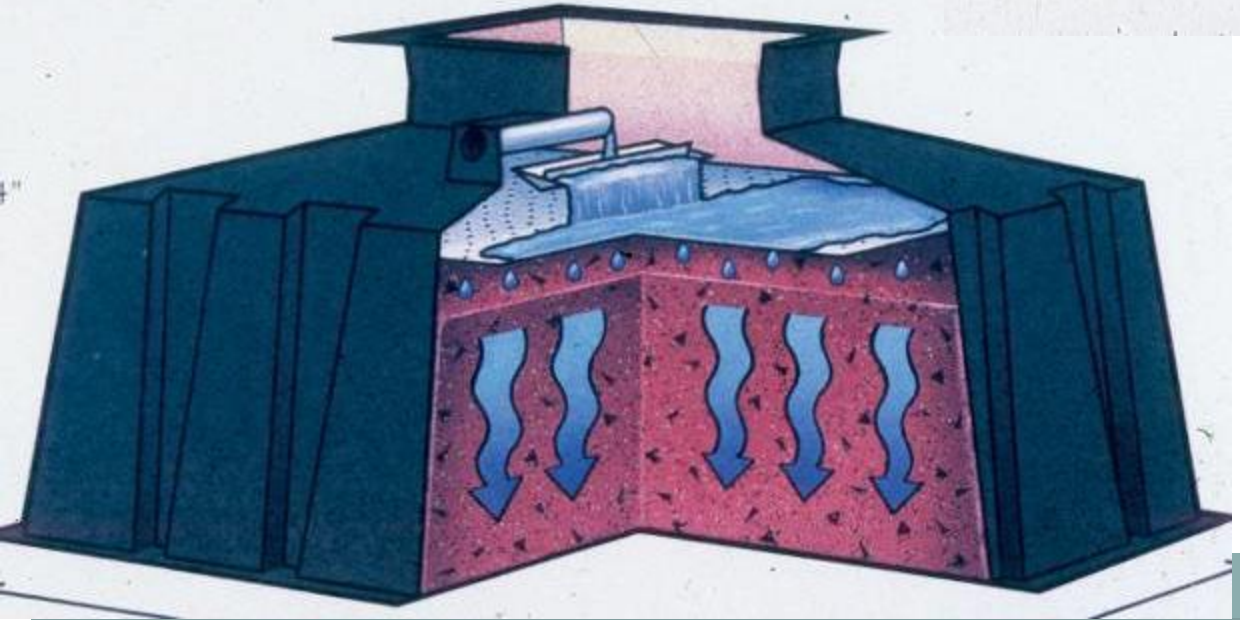

Courtesy of Orenco, Inc.

Peat Filters



Puraflo





Holes in bottom can be plugged to divert effluent to a pc or distant dispersal area.

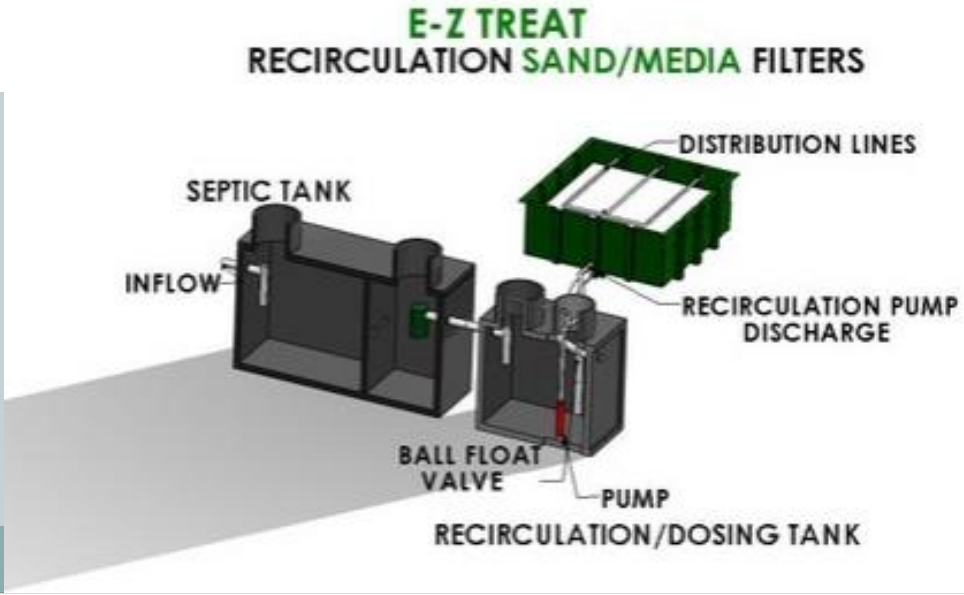
Ecoflo Biofilter

Other Media


Other media such as
“whiffle balls” – Some
call these trickling filters

Plastic Media Filters

Other Mediums



Sand and Gravel Filters

- May be designed and constructed to operate in either single pass or recirculating mode
- Sand/Gravel media must meet a specific specification
- Must (generally) be processed to provide the right gradation
  - Sometimes crushed
  - Screened for proper gradation
  - Washed
- Must be handled carefully after processing to maintain the specification and remain free of fines

Biological Processes

- Biofilm forms on sand grains
- Oxygen around the film promotes aerobic activity
- Many species are present at all times
- Most are in the upper 12 inches
- Insufficient food and oxygen limit aerobic organisms in lower layers
- Most BOD removal occurs in the top few inches
- Organic matter is consumed by microbes in the biofilm

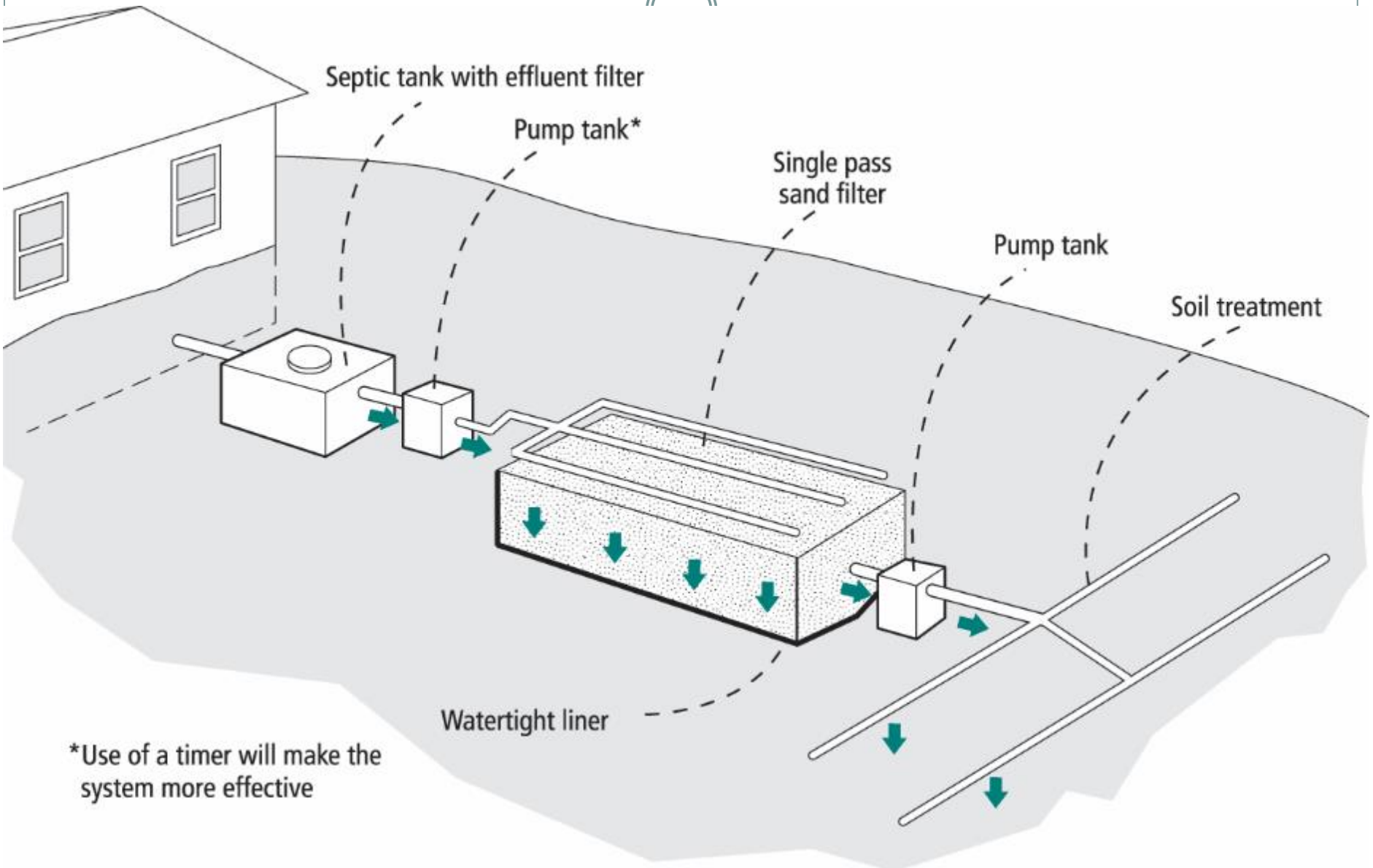
Important Biological Design Parameters

- Choice of media
  - Surface area
  - Void space
- Provision for aeration
  - Active
  - Passive
- Small doses of wastewater applied uniformly
  - Keeps flow in the biofilm – i.e. unsaturated flow
  - Provides residence time in thin films on surfaces
  - Prevents displacing air from voids

More on Biological Processes

- Nitrogen removal is a biological process
- Nitrifying bacteria convert ammonium-N (NH_4)and organic-N to nitrate-N (NO_3)
- Most conversion to NO_3 occurs in the top 12 inches
- In small pores and lower in the filter, oxygen concentrations are reduced and some Denitrification can occur in smaller saturated pores, releasing nitrogen gas (N_2)

Single Pass Filter Layout



Importance of Media Specification

- Correct media is an important factor in determining the useful life of a sand filter
- Media availability is an issue is some areas
- If material that fits the media spec is not available, consult an engineer.
  - If media is too fine – filter will clog with biomat
  - If media is too coarse – effluent quality may be reduced, but only slightly
- Smaller, more frequent doses can partially compensate for somewhat coarser media

Liner Installation

Orifice Orientation

- Upward directed orifices
  - Required to have oriface shields
  - Less prone to clogging
  - Less flow as the network fills and pressurizes
  - A few orifices must point downward to drain pipe
  - Require special provision for drainage
    - Network set to drain back to pump chamber – no check valve
- Downward directed orifices
  - More prone to clogging
  - A few orifices up are required to allow air back into pipe

Flow Equalization

- In order to maintain a non-saturated environment flow distribution dosing is important
- Enough to keep the media wet to keep microbes alive
- Not too much so system does not get overloaded or cause bypass issues…ie bridging

Design for Maintenance

- Inspection ports – 3 recommended
  - To infiltrative surface-
  - At the bottom of the media
  - Just above the liner /container
- Cleanouts - provide for flushing of distribution laterals
  - Access to dead end laterals
  - Continuous, low rate flushing
  - Alternating flow direction
- Provide for aeration
  - Regular, continuous
  - Catastrophic rejuvenation
- Prevent storm water infiltration

Access to Components Is Critical

- Risers to grade
- Easy-to-reach quick disconnects for pump removal
- Floats on separate mount that is easy to remove
- Control boxes within sight of pump chamber riser
- Convenient sampling locations

Media Filter Start-UP

- Information needed:
- Forward flow through system in gallons
  - Water use records or assumed
- Pump delivery rate (PDR) in gpm
  - Run draw down test
- Pump ON time in minutes
  - From design, manufacturer

Start-Up Measurement of Pressure at the End of Laterals

- Minimum Head is 5 ft
- Clear tube that can be screwed in or attached to laterals allows easy determination of head
- Head increase over time may mean clogging of orifices

Pressure Distribution Network

Maintenance on Filters

- Maintenance should be performed at least annually, preferably more often (as required by operating permit)
- Owners should hire knowledgeable service provider
- First visit should be within the first few weeks/months of use
  - To catch construction damage or errors
  - To be sure controls/alarms are set correctly for the use pattern
  - To check for leaks, including leaky tanks
  - To advise owner/resident on filter use
  - To be sure landscaping does not add depth, compact or cause other damage

Routine Maintenance for Filters

- The septic tank(s) should be inspected periodically and pumped as needed
- Flush pressure pipe network
- Check pressure at end of laterals: compare with previous
- Check filter surface for ponding
- Check pump controls for proper operation
- Read pump run-time meter and event counter
- Check pump voltage (off and while pumping) and amp draw while pumping
- Pull and observe the final effluent in a clear sample bottle checking for clarity and odor.

Management Plans

- Developed for Proprietary treatment systems:
  - Bord na Mona Puraflo
  - Premier Tec Ecopod
  - Orenco Advantex
- Public domain
  - Single pass sand filters
  - Reciruclating sand filters

Aerobic Treatment Can Help Solve Problems!

- May be a solution if:
  - Not enough vertical separation or if soil is coarse
    - Effluent has fewer pathogens
  - Site is too small
    - Reduced BOD/TSS may allow for less square footage
  - Waste is high strength
    - Reduce BOD/TSS
  - System is near or failing
    - May recover due to reduced BOD/TSS
  - Nitrogen is a problem
    - Some systems reduce nitrogen

Summary

- ATUs and Media Filters can provide reliable, long term service and excellent effluent quality if they are:
  - Properly sited
  - Properly designed
  - Properly used by the owner/occupant
  - Properly maintained on a regular basis

Questions