


## On-site Wastewater Management Training Course


### Secondary Treatment

### Sand Filters, Media Filters and Mound Systems

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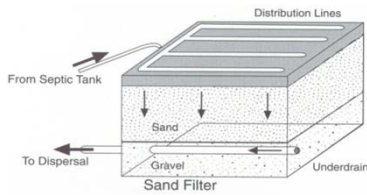
### Sand Filter

- Aerobic treatment provided by trickling primary treated effluent through 600mm - 900mm sand bed (packed bed)
- Biofilm develops on media surface
- In contact with air in pore spaces in media
- Media contained within an impermeable liner
- May be above, partially above, or below ground
- Filter surface may be open or covered

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### Sand Filter

- Historically gravity fed with intermittent dosing
- Results in uneven distribution and may lead to creeping failure and clogging of media




Source: NSFC

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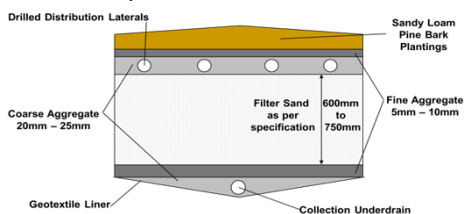
### Treatment

- Acquired in a single pass through media
- Effectiveness dependent on hydraulic and organic load
- Hydraulic conductivity determined by media characteristics (particle size distribution)
- Hydraulic load 50L/m<sup>2</sup>/d
- BOD<sub>5</sub> load 25g/m<sup>2</sup>/d
- Typically achieves BOD<sub>5</sub>/TSS: 20/30mg/L or better

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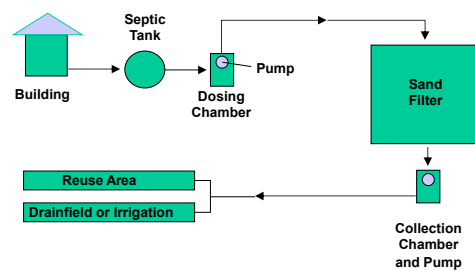
### Improved Efficiency

- Pressure dosing for more even distribution
- Small and frequent timed doses



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### Typical System Configuration



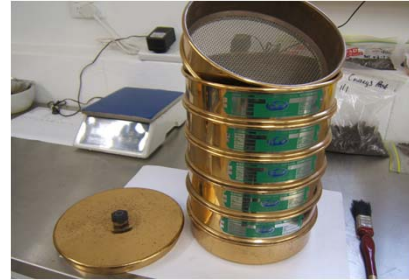
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## Filter Sand Considerations

- Sand sieved for particle size analysis (PSA)
- Plot histogram and cumulative frequency curve
- Filter sand <3% clay and fine silt (<0.006mm)
- Effective size (ES) ( $d_{10}$  - smallest 10% diameter) between 0.25mm and 1.00mm
- Uniformity coefficient (UC) ( $d_{60}/d_{10}$ ) <4

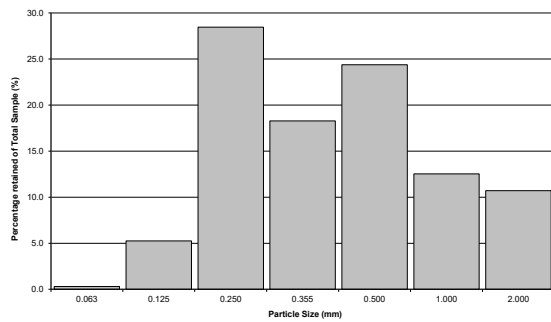
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## Sieve Analysis



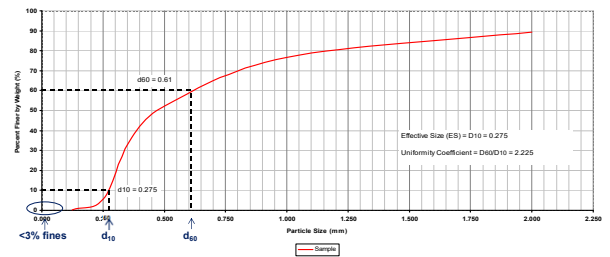
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## Histogram



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## Cumulative Frequency Curve



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## Bottomless Sand Filter

- Treatment and land application in single footprint

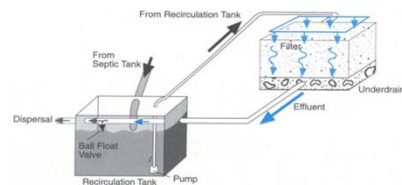


Source: W Cromer

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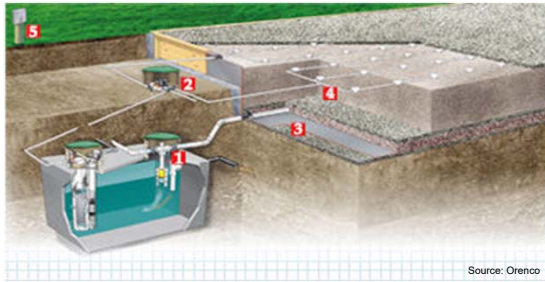
## Recirculating Media Filter

- Acquires treatment in several passes
- Higher hydraulic conductivity media – gravel
- Permits higher aerial loading rate



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### Recirculating Sand Filter



Source: Orenco

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### Sand Filter Construction



Liner

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### Sand Filter Construction



Underdrain and gravel bed

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### Sand Filter Construction



Filter sand and distribution bed

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### Sand Filter Construction



Drilling orifices

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### Sand Filter Construction



Distribution manifold

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## Testing Distribution System



Uniform squirt height

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## Completed Sand Filter



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## Completed Sand Filter



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## Media Filters

- Variety of alternative filter media used
- Some modify or enhance performance of traditional sands and gravels
- Others are economically viable alternatives
  - Peat
  - Foam
  - Fabric
  - Amended soils

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## Peat Filter



Bioflow modules, Bord na Mona, USA

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## Peat Filter



Peat Biofilter installation, VIC

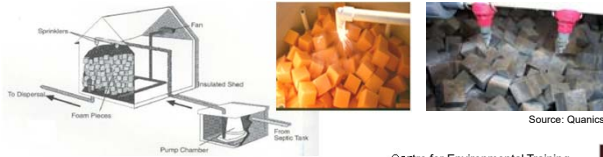
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## Foam Filter

- Foam filters
- Provide some physical filtration
- Combine porosity and high surface area
- Main function as surface for biofilm growth



Source: Quonics

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## Foam Filter



Waterloo Biofilter, Canada

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## Fabric Filter

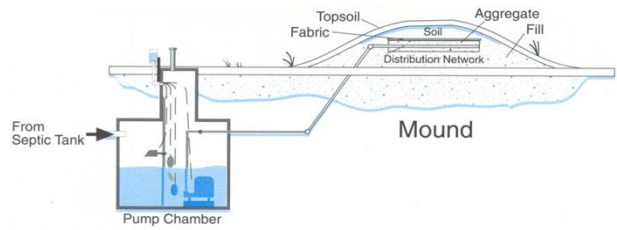


Orenco Advantex fabric filter

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## Mound Systems

- Mound Systems are in effect bottomless intermittent sand filters



Source: NSFC

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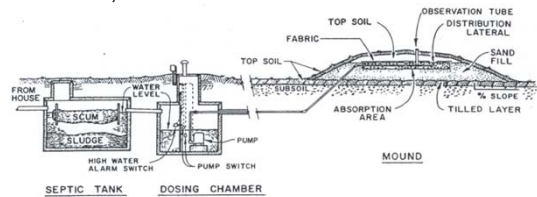
## Mound Systems

- Soil absorption systems
- Elevated above natural soil surface
- Uses suitable fill such as quality sand media
- Pretreated effluent is dosed to the mound
- Overcome site restrictions such as:
  - slowly permeable soils
  - shallow permeable soils over porous bedrock
  - permeable soils with high water table

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## Mound Systems

- Developed in 1970s
- Incorporated in Wisconsin Code in 1980s
- Over 30,000 Wisconsin mounds in Wisconsin




Source: Converse 2000

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## Wisconsin Mound Systems




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## Wisconsin Mound Systems

Design considerations:


- Aligned on contour
- Ground suitably prepared
- Appropriate materials and construction
- Sand loading rate – at distribution manifold
- Linear loading rate – across slope
- Basal loading rate – on soil at base of mound

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## Completed Wisconsin Mound




Source: B. Banens

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## Completed Wisconsin Mound



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## Completed Wisconsin Mound



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## Alternative Vegetation Cover



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## Treatment Performance of Sand Filters and Mound Systems

|                                  | BOD <sub>5</sub><br>(% removal) | TSS<br>(% removal) | TN<br>(% removal) | FC<br>(% removal) |
|----------------------------------|---------------------------------|--------------------|-------------------|-------------------|
| Intermittent sand filter / Mound | 90-98                           | 90-95              | 14-50             | 97-99             |
| Recirculating sand filter        | 95-99                           | 81-95              | 45-82             | 97-99             |

Source: Crites and Tchobanoglous (1998)

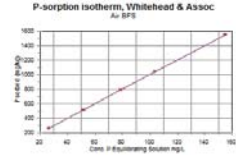
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## Amended Soil Systems

Use soil or alternative media for nutrient reduction

- P-sorption
  - Gypsum amended red mud (by-product of bauxite refining for aluminium)
  - Air-dried Blast Furnace Slag
- N reduction
  - Zeolite



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## Ecomax System, WA



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## Ecomax System, WA



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## Ecomax System, NSW



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## Ecomax System, NSW




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## Ecomax Mound at School, NSW




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## Amended Ecomax Design




Source: Ecomax NSW

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## Ecomax Hydraulic Overload




Flat bed limits rainfall runoff and evapotranspiration

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## References

- Converse, JC & Tyler EJ (2000). Wisconsin Mound Soil Absorption System: Siting, Design and Construction Manual, #15.24, University of Wisconsin-Madison, Small Scale Waste Management Project.

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## References

- Cromer, WC (2013). Bottomless sand filters: Notes for designers, installers and regulators July 2013. Land application systems for domestic wastewater management. Unpublished report by William C Cromer Pty Ltd, 1 December 2013.
- Whitehead, J & Geary P (2009). Sand Mounds for Effective Domestic Effluent Management, *Water* 36, 1 (pp 27-32).

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## References

- A guide to installing a sand mound to manage onsite wastewater, WaterNSW, <https://vimeo.com/72859822>



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