WASTEWATER MANAGEMENT USING ADVANCED TECHNOLOGIES

Michigan Inland Lakes Convention
Boyne Mountain Resort
May 1, 2014
Think of every wastewater system as . . .

“A series of specifically chosen components assembled in a specific manner so that when properly operated as intended will produce the desired quality of treatment.”
We’ll discuss some details of . . .

Improved soil dispersal methods
Mound Systems
Intermittent sand filters
Recirculating sand filters
Geotextile filters
Foam cube filters
Peat Filters
Aerated Suspended growth processes (ATU’s or “Aeration” Systems)
Improved Soil Dispersal Systems
Systems for Equal Distribution
PUMP CHAMBER DESIGN

WATERPROOF JUNCTION BOX

3' DIA PRECAST RISER

ANCHOR (TYP)

POLYPROPYLENE ROPE FOR PUMP REMOVAL (TYP)

UNION

2" CHECK VALVE

2" GATE VALVE

2" PVC TO DRAINFIELD

(PROVIDE MIN. OF 4' OF COVER – MIN. 5' UNDER ROADS)

ALTERNATE ROUTING OF PVC FORCEMAIN TO GAIN ADDITIONAL COVER, IF NEEDED

2" GALV. OR SCH 80 PVC

TAPE CORD TO PIPE

4" PVC AT 1.5%

4"x16"x16" BLOCKS

PRECAST CONCRETE PUMPING CHAMBER

ED GRADE

BURIED WIRING TO CONTROL BOX

SEAL ALL JOINTS INSIDE AND OUT.
Mound Systems
Mound Systems

- What is it?
  - 1-2 feet of clean sand beneath the stone/media
  - Septic tank, pump tank and system is designed for uniform distribution
  - Clean stone for distribution media – narrow and long is best
  - Mound made of clean, washed sand
Mound Systems

- **Applications**
  - High Seasonal Groundwater
    - Limited Separation
      - Mounds < 4 feet, but > 1 foot
      - Sand provides treatment and separation
  - Heavy textured soil (clay)
    - Treats wastewater before entering soil
Sand Filters
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 limit organisms in lower layers
- Most BOD removal occurs in the top few inches
- Organic matter is consumed by microbes in the biofilm
Single Pass Sand Filter
(Intermittent Sand Filters)

- Geo-Fabric
- Loamy Sand or Decorative Rock
- Stone (2" Over Pipe)
- Filter Sand (See Specifications)
- Pea Gravel
- 30 MIL PVC Liner
- Liner Support (1/2" Plywood)
- Pump Basin Sand Backfill
- Optional Lateral/Flushing Valve Connections
- Sweep
- 2 - 45°
Important Biological Design Parameters

- Choice of media
  - Surface area
  - Void space
- Provision for aeration
  - 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
Sand Filter Effluent compared to septic tank effluent

- Low in Oxygen demand (BOD$_5$) -- $>90\%$ removed
- Low in total solids (TSS) and volatile solids (VSS) -- $>90\%$ removed
- Will not form a significant biological clogging mat in soils
- Greatly reduced in pathogens -- $>99\%$ removed
- Significantly reduced Total Nitrogen -- 40-80$\%$ removed
Uses of Sand 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
  - Where irrigation of effluent is desired
## Effluent Comparisons
### Septic Tanks vs. Associated PBF’s

<table>
<thead>
<tr>
<th></th>
<th>BOD Mg/L</th>
<th>TSS mg/L</th>
<th>Nitrate N mg/L</th>
<th>Ammonia N mg/L</th>
<th>D.O. mg/L</th>
<th>Fecal Coliform Org./100 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Septic Tank</strong></td>
<td>130-250</td>
<td>30-130</td>
<td>0-2</td>
<td>25-60</td>
<td>&lt;2</td>
<td>10⁵ - 10⁷</td>
</tr>
<tr>
<td><strong>PBF</strong></td>
<td>5-25</td>
<td>5-30</td>
<td>15-30</td>
<td>0.4</td>
<td>3-5</td>
<td>10² - 10⁴</td>
</tr>
</tbody>
</table>
Packed Bed Filter Effluent
Sand Filter Maintenance

- Check observation ports for ponding
- Flush distribution system lines
- Check pressure to determine orifice clogging
- Clean orifices as needed
- Check underdrain – open to “breathe” air into filter
- Check pump controls for proper operation and adjustment
- Check pump voltage – off and with pump running
- Check pump amp draw
- Check drainfield observations ports
- Check sludge and scum in all tanks
Recirculating Media Filters
Recirculating Filters

- Recirculation is used in many wastewater treatment processes.
- Recirculating involves mixing a portion of the filtered effluent with incoming septic tank effluent.
- This blended effluent can be applied to filter media at higher loading rates.
Typical RSF Media

- Fine gravel media with effective size of 2.5 – 3 mm
- No fines on the media
Home Size RSF
Training Center Demonstration
Combination – Single Pass & Recirculating Sand Filters
Media Characteristics

- Home for microbes
- Solid material
- Surface area
- Porosity
- Biomass return
- Clogging potential
- Cleaning/replacement
Synthetic Media
Geotextile Sheets
Geotextile Packed-bed Filters
Synthetic Media

Open Cell Foam Cubes
Open Cell Foam Filters

- Developed for use in Ontario as the “Waterloo Biofilter™”
- The foam material is a polyurethane foam
  - Large surface area, large void volume percentage
  - Not decomposed by organisms in wastewater
- Foam is in 2-inch cubes
- Wastewater is sprayed over the top
- Long retention time provides good treatment
- Sometimes requires forced aeration
Single-Family Home Open Cell Foam Filter
SCAT™ System

Foam Coir

Quanics, Inc.
Open Cell Foam Filters
Open Cell Foam Filters
Peat Filters
Peat Biofilter

Biofilter Modules
(1 per bedroom)

Septic Tank

Pump Tank

Effluent Filter

Panel

Bord na Móna
Peat Filters for a Cluster System
Aerobic Treatment Units
(ATAU's)
Or
(Aeration Systems)
Common Types of ATU’s

- Suspended growth – open chamber
- Submerged attached growth/fixed film – media in aeration
- Combination suspended/attached growth – both media and open area
- Sequential batch reactor – all-in-one with panel to control pumps
- Adaptive mechanical aerator – aerator in septic tank with/without bioaugmentation
- Membrane Bioreactor
Increasing the potential for oxygen to go into solution
  - Bubble create air-water surfaces

Air injection should be near bottom of tank
  - More time for oxygen to go into solution
  - More hydrostatic pressure on bubble

Air Provided 24 Hrs. a Day
Positioned after primary tank (septic tank)
- minimizes the solids that enter an ATU
- provides some flow equalization
ATUs versus Media Filters

- ATUs Provide Air to Wastewater
  - Continuous mechanical aeration
  - Bugs are moved to the food by agitation

- Pack-Bed Media Filters Move Wastewater to Bugs Living in Media
  - Attached growth
  - Active aeration
Typical Suspended Growth Reactor

- Influent (from Primary Tank)
- Maintenance Access
- Baffle
- Aeration Device
- Suspended-Growth Chamber
- Sludge Return
- Effluent
- Settling Chamber (clarifier)
Combination of Suspended Growth and Attached Growth Reactor
Blowers

- Regenerative Blowers
  - provide aeration and agitation
  - mounted in an accessible location
  - maintenance item
  - constant source of noise
Problems with Flow Variations

- Variations in flow seriously complicate treatment process
  - need stable flow and stable substrate supply to maintain stable microbial population
  - single family home can have extreme variations from vacations (no flow) to laundry (high flow)
Examples of ATUs
Suspended and attached-growth
- bubbles trickle up through honeycombed surfaces
- common application is aboard ships
Package Plants

- Includes additional unit processes
  - uses recycle through anaerobic zone to promote denitrification
  - adds disinfection
  - sludge recycling
Aerodiffuser
Zabel’s HOOT Plant

1. Pretreatment tank where influent enters.
2. Aeration chamber where oxygen is pumped into the waste water.
3. Clarifier chamber where the clear, odorless effluent rises.
4. Chlorinator the clear effluent passes through for disinfection.
5. Holding tank for disinfected* effluent ready for discharge.
6. Extremely quiet, efficient aerator and pump.
7. Unique solid-state HOOT Control Center monitors and controls the system.
ATUs Require Maintenance

- **Biomass Removal**
  - biomass removal may be required every six to nine months

- **Aeration System Maintenance**
  - blowers and motors are operating in a corrosive environment

- **Long-Term Costs**
  - energy, inspection, and maintenance
Integrated Wastewater Management

Cluster System

River/Ocean
Questions?

Larry Stephens, P.E.
Stephens Consulting Services, P.C.
(517) 339-8692
scscons@yahoo.com