Effects of Treatment on Longevity in American Soil Treatment Systems

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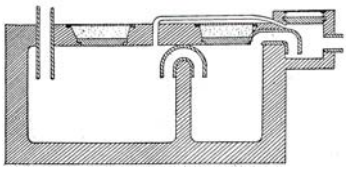
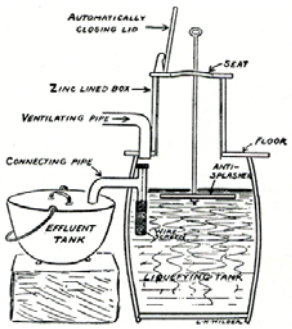
Discussion Topics

- Historical Perspective on Onsite Systems
- Issues With Current Effluent Dispersal Systems
- The Case for Pretreatment
- Utilizing the Soil Mantel More Effectively
- Importance of Holdup Time in Removal of Trace Constituents
- Regulatory Issues
- Research Needs for Sustainability
- What to Expect in the Future

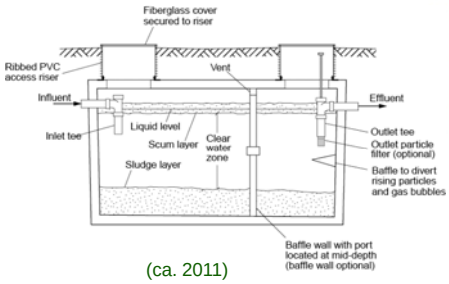
Historical Development of Onsite Systems



Fosse Mouras (ca. 1860)



(ca. 1900-1910)



(ca. 2011)

No new developments in 150 years

Dosing Siphon and Subsurface Dispersal

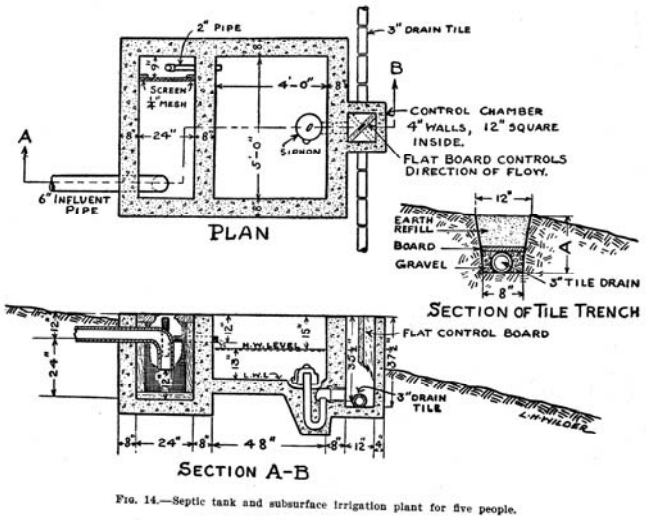
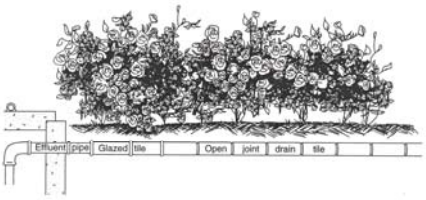


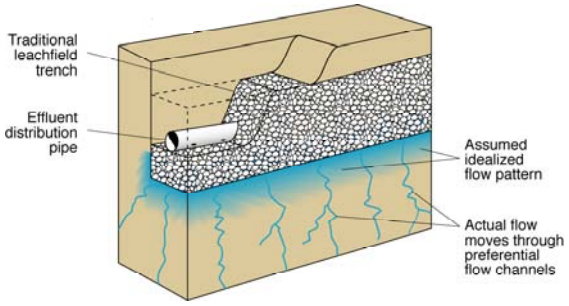
Fig. 14.—Septic tank and subsurface irrigation plant for five people.

Effluent Dispersal Trenches

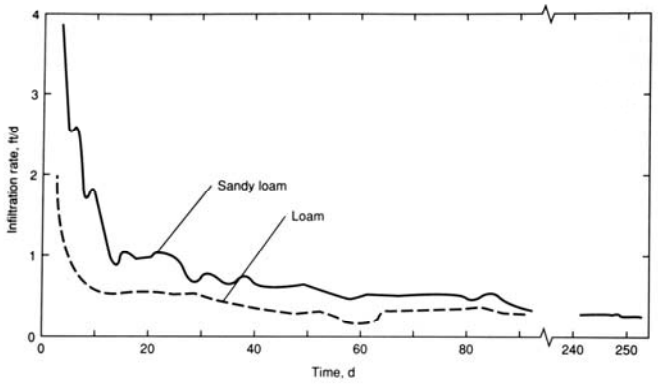


Recommended shallow (30 mm) dispersal trench for maximum utilization of nutrients in septic tank effluent circa 1900.

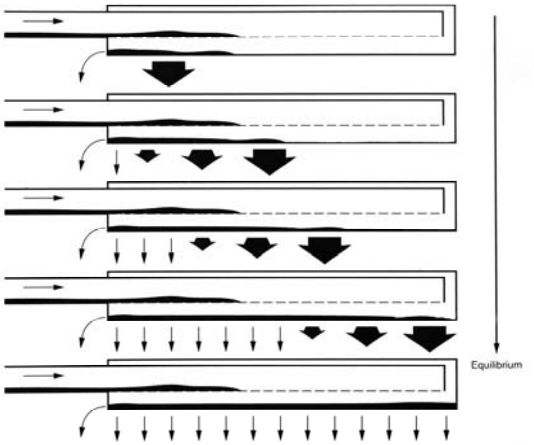
Conventional dispersal trench utilizing mechanical excavation techniques. Effluent discharged below active soil horizon, often leading to groundwater contamination.



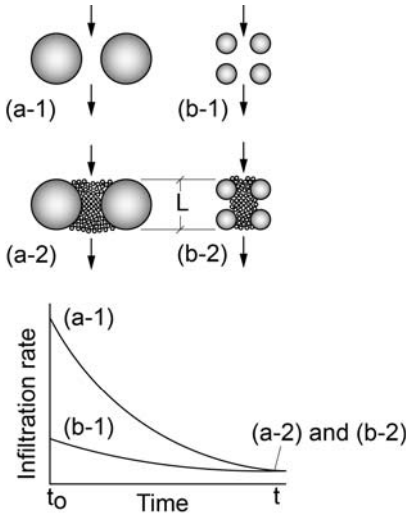
Affects of Continuous Application of Effluent on Soils with Varying Initial Permeabilities
(Orlob and Butler, 1955)



Progressive Development of Biomat (Kreissl, 1982)



Infiltration Rate is Controlled by the d_{10} Size:



Issues with Current Effluent Dispersal Systems

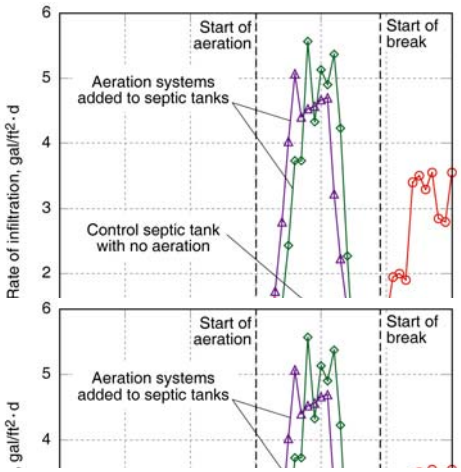
- Inappropriate estimate of dispersal area assimilative capacity (both trench or area)
- Solids and grease carryover from septic tank
- Loss of permeability due to the sodium in septic tank effluent
- Discharge of nitrogen and phosphorus (issue: insufficient alkalinity and organic matter)
- Discharge of trace organics
- Actual and presumed groundwater contamination (e.g., use of deep trenches below active region)

The Case For Pretreatment

- The percolation (perc) test is hopeless
- Soil variability is beyond description
- All soil absorption systems will eventually reach an equilibrium acceptance rate
- Use of equilibrium rate (e.g., 0.125 gal/ft^2•d) is acceptable, but may not be practicable in many situations

Infiltration in Ponded Sand Filters

Sand Filter Response To Aerobic Influent



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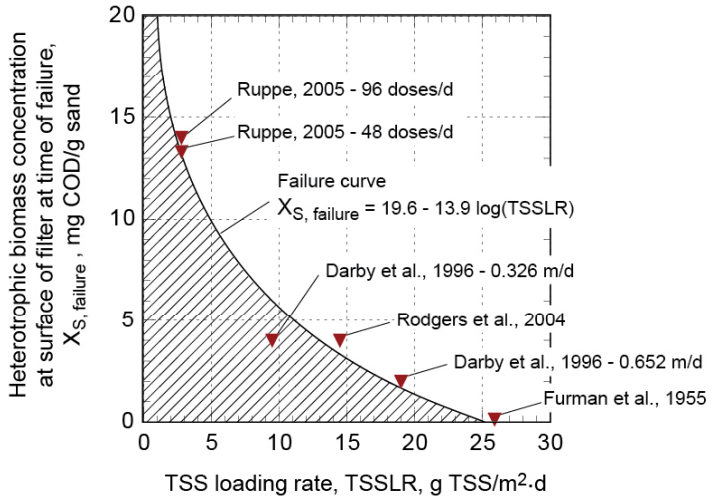
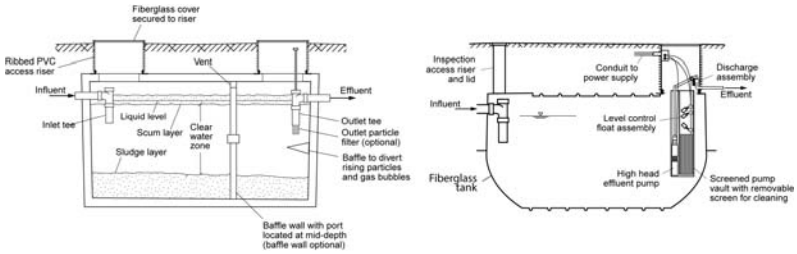
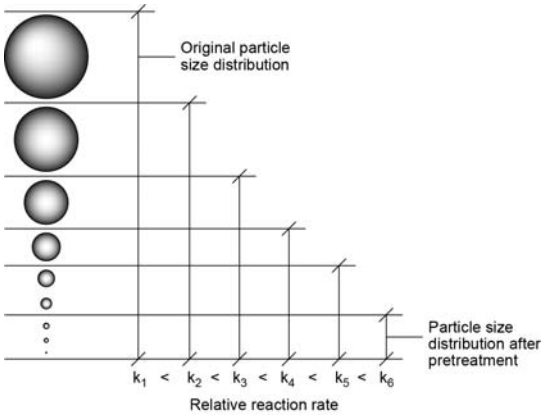


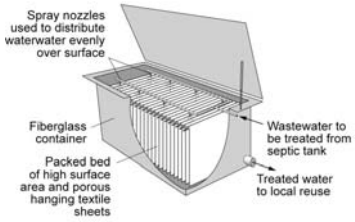
Conventional Pretreatment



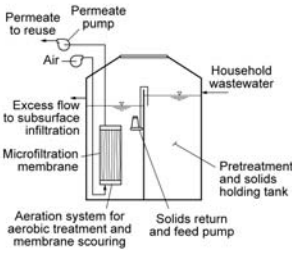
Impact of Particle Size on Biological Reactions in Reactors and Soil- Consider Grinding Wastewater Solids



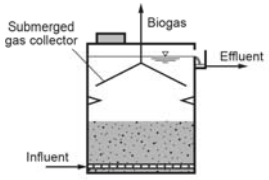
Aerobic/Anaerobic Biological Treatment



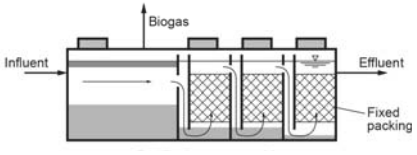
Textile Filter
(O_2 in air ~275 mg/L)



Membrane Bioreactor
(O_2 in water ~9 mg/L)



Upflow Anaerobic Sludge Blanket (UASB)

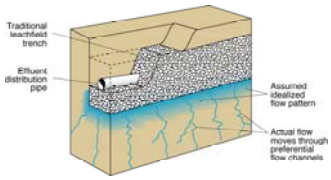


Baffled Reactor with Fixed Packing

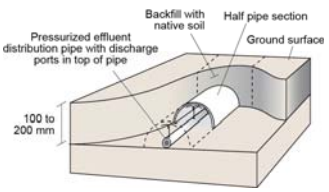
A Strategy for Utilizing the Soil Mantle More Effectively

- Develop a policy for the use of the soil mantle for the treatment of constituents of concern in the 21st century (e.g. pathogens, trace organics, and unknowns), and not BOD, TSS, and/or nutrients
- Eliminate the need for soil characterization for the dispersal of treated effluent
- Develop more effective distribution and dispersal systems

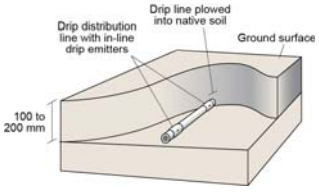
Typical Dispersal Systems



Conventional trench
Circa late 1800s to present



Schematic of shallow trench



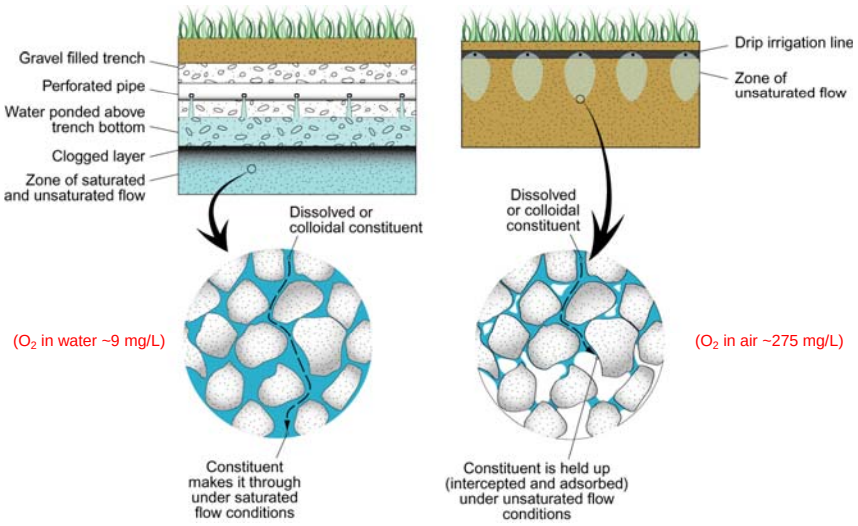
Schematic of drip application

Six Way Distribution Valve

Removal of Trace Organics in Soil Treatment: What's Needed

- Wastewater reduced in organic content and total suspended solids
- Aerobic conditions
- Reduced hydraulic loading rates to achieve adequate hold-up times to allow soil microorganisms to use carbon from trace organics

Importance of Holdup Time in Removal of Trace Organics in Soil Treatment



Groundwater Accretion Issue

(750 L/home•d)(365 d/yr) = 273,750 L/home•yr

(273,750 L/yr)/(450 m^2) = 608 L/m^2•yr

= 0.608 m/m^2•yr

= 1.67 mm/m^2•d

Rainfall = 0.33 m/m^2•yr

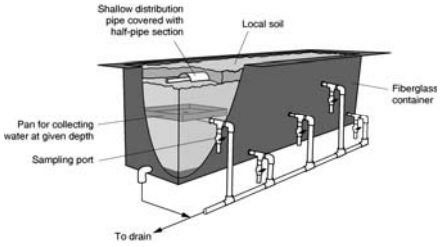
Evapotranspiration = 1.6 m/m^2•yr

Field capacity = 25 % by volume

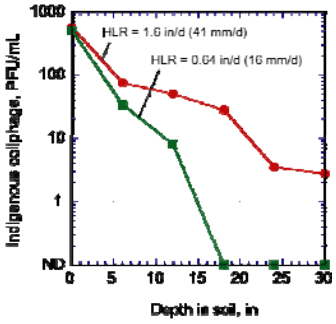
Conclusion: little or no groundwater accretion

What is important is holdup time

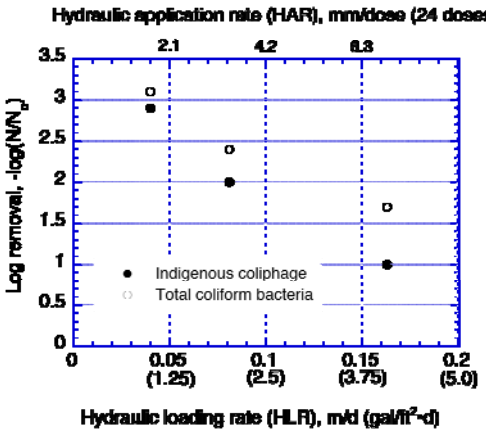
Removal of Coliphage in Soil Filter



- Effluent applied uniformly at 24 dose/d
- Soil filter constructed with Yolo Loam soil
- At low HLRs, no coliphage detected below 12 in



Impacts of Hydraulic Loading Rate on Removal of Virus



Surface Application

Australia

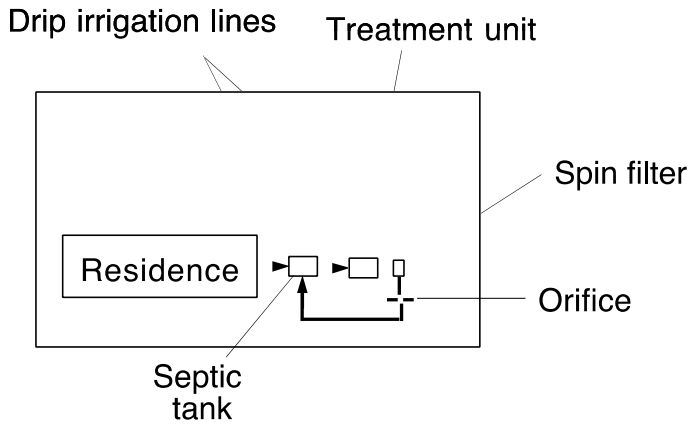
Canada

Appropriate Spacing for Drip Irrigation Lines

Potential Impacts of Urine Separation On Biological Wastewater Treatment Consider Partial Urine Separation

Constituent	With US, mg/L	After primary, mg/L	Cell yield, mg/L
BOD_5	~450	292	190
COD	~1050	525	-
TSS	~500	150	-
NH_4-N	3	~3	Req. N for cell growth 23.5
Organic N	13	~9	
TKN	16	~12	
P (biogenic)	3.3	2.3	Req. P 4.7
P (other)	2.6	1.8	

New Design Concept: Self Cleaning and Flushing Drip Irrigation Reuse System



Regulatory Issues

- Existing standards based on limited and, in many cases, poor older science (e.g., the perc test)
- Serious disconnects now exist between research (applied) and regulations
- Relationship between many water quality indicators and public health are unclear or inconsistent
- Must develop uniform standards based on scientific findings and proven field performance

Research Needs For Sustainability

- Need to assess impact of wastewater modification on biological treatment in reactors and the
- Need to understand how to optimize the application of a high quality effluent to the soil to:
  - Control nutrients
  - Reduce pathogens (primarily viruses)
  - Reduce anthropogenic compounds
  - Enhance reuse (e.g., irrigation, recharge)
- Hydraulic model to predict holdup times and actual groundwater accretion

What to Expect in the Future

- Enhanced performance and longevity of dispersal areas through effective pretreatment and pressure application of effluent
- Enhanced utilization of the soil for treatment of viruses and trace organics
- New and improved dispersal systems for source separated waste streams
- Revision of legacy regulations and thinking regarding treatment and effluent reuse or dispersal

THANK YOU

FOR LISTENING