A to Z
Water Movement in Soils

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Ideal Soil for Dispersal and Treatment of Wastewater

• Deep
• Permeable
• Well Drained (Well Aerated)
• Loamy
• Ample Area
Many Soils Possess Drainage Restrictions

- Redoximorphic Features
- Mottles
- Landscape Position
- Location within the Watershed
Hydrologic Cycle

- Precipitation
  - Saturated flow
  - Unsaturated flow
  - Restrictive layer
  - Regional water table
  - Well
  - ET
Hydrologic Cycle

- Septic System
- Precipitation
- Infiltration
- Evapotranspiration
- Runoff
- Lateral Flow
- Slowly Permeable Layer
- Slowly Moving Stream
- Vertical Separation
- Wastewater Input
- Impermeable Layer
- Ground Water
• The best location for an absorption field on the site is where flow will diverge (note the red flow lines). Areas where water naturally converges (note blue flow lines) should be avoided.
Water Tables

• Apparent: Ground Water Table
• Perched: Laying on top of (“perched”) a horizon or zone which is not saturated. With the lack of vertical movement, there may be a significant lateral flow vector.
Apparent Water Table
Perched Water Table
Slope Considerations

Horizontal Flow

1

2

3

Horizontal Flow
To Better Understand Management of Water One Must Understand how Water Moves in Soils

• Saturated Flow: All pores are filled with water; gravity moves much of the water
• Unsaturated Flow: Movement by capillarity or matric potential; the attraction of water to soil surfaces and pore walls.
• In unsaturated flow that material with the greatest surface area has the largest affinity to water.
In Other Words:

• Sands and Gravels do NOT attract or pull water when surrounded or embedded within soil materials!

• Sands and Gravels do NOT suck
In other words, gravel at the bottom of a vented flower pot will NOT drain the pot!

Therefore, gravel around a drain tile below soil fill will NOT drain the soil!
Unsaturated vs. Saturated flow

Unsaturated

• Pores: Air available

• Slower:
  Next to particles: in small pores

• Aerobic

Saturated

• Pores: Volume filled with water

• Faster:
  In large pores

• Non aerobic
Saturated Conditions

Pores are filled with water
What is Saturation

• A horizon is saturated when the soil water pressure is zero or positive

In layman's terms
• Water flows from the soil into a hole
Auger hole in soil is filled with air just after digging.
Free water is not under a suction, and flows in response to gravity.
Unsaturated Conditions

Pores are filled with air & water along the soil particles
Pore size & unsaturated flow

- Large pores
  Water will be moved predominantly by gravity
- Small pores
  Water will move in all directions better & further
Auger hole in soil is filled with air just after digging.
Water Movement in Soil Movie

- Loamy A Horizon
- Loamy B Horizon
- Coarse Sand B Horizon
- Loamy B Horizon
Initial Wetting Front
Further Movement of the Wetting Front
Initial Wetting Front
Wetting Front Hits Course Sand
Wetting Front Stacks Up Above Boundary
Water Breaks Course Sand Boundary
Trench Flow Examples
1. Effluent flows into pipe

3. Effluent begins to pond and flows across soil interface.

5. Effluent flows into soil

2. Effluent flows out of pipe and into gravel

4. Biomat begins to form
Drip Distribution
Conical Distribution Pattern under Unsaturated Flow
Surface Water Management

Use of Swales, Berms, Surface Diversions, Terraces, etc.
Poor storm water management
Swale for Surface Water Management

Grass-lined swale should be a minimum one foot wide at bottom and one foot deep with a maximum slope of 5 percent.
Diversion berms and swales

- Required?
- Present and effective?
HYDROLOGY OF A SEPTIC SYSTEM

Infiltration from Trenches

Vertical Movement through the Unsaturated Zone

Lateral Movement in the Saturated Zone

Ground Water Mounding and Formation of a Saturated Zone

Slowly Permeable Layer

How does slope influence the hydrology of a septic system?
Flow pattern in sub-surface trench

Least Permeable

Ground Water Mounding and Formation of a Saturated Zone

Slowly Permeable Layer
Capillary Fringe

- Unsaturated zone above the water table
- Water held in this zone by tension (matric potential, adhesive and cohesive forces)
- This zone is generally not important to us, and is difficult to measure
Strip Drain: Note Gravel Completely to the Surface!!!

Place strip drain into 4 inch wide trench and backfill with pea gravel. Slope strip drains to a tightline.
Based on the Principles of Water Movement under Saturated and Unsaturated Conditions: A Curtain Drain Should:

• Be dug into the restrictive layer to serve as a trough.
• Must be diverted around the soil treatment field
• Must have an outlet in which the water does not intrude on the soil treatment field.
• Have trench filled with coarse aggregate material or other suitable material to the SOIL SURFACE!
Remember:

• Sands and Gravels do NOT attract or pull water when surrounded or embedded within soil materials!

• Sands and Gravels do NOT suck
In other words, gravel at the bottom of a vented flower pot will NOT drain the pot!

Therefore, gravel around a drain tile below soil fill will NOT drain the soil!
Based on the Principles of Water Movement under Saturated and Unsaturated Conditions: A Curtain Drain Should: (continued)

• Have a clear path for outlet discharge.
• Have rodent guard or screen over the open pipe.
• Not have soil over the coarse aggregate or similar material so that surface runoff can be collected and the system may breathe.
Potential Curtain Drain Site

- Extend fill 5' past trenches before feathering
- Original grade
- 12" - 18" loamy soil
- 1-1/2" - 3" dia. clean gravel
- Perforated distribution pipe
- 24" min.
- Perched water table
- Restrictive layer
Curtain Drain Placed at Site

- Extend fill 5' past trenches before feathering
- 12" - 18" loamy soil
- 1-1/2" - 3" dia. clean gravel
- Perforated distribution pipe
- Restrictive layer
- Original grade
- Perched water table
- 6" min.
- 12" min.
Curtain Drain
Proper Outlet for Curtain Drain

Curtain drain above trenches diverts water moving laterally and discharges it to the surface.
A proper outlet must.

- be clear and free flowing.
- exit topographically below the bottom of the deepest trench.
Outlet open to drainage

- Clear and free flowing
- Exit topographically below the bottom of the deepest trench
Rodent guard on outlet
A well maintained surface water diversion ditch
System Geometry

- Influences:
- Longer area
  - Smaller loading
- Shorter length
  - Greater down slope impact
Contour Lines

Drainage

Direction of Ground water Flow

Drainfield
Drainage

Direction of Ground water Flow

Drainfield
Slope Considerations

Horizontal Flow

1

2

3
Critical considerations for drainage

• Conductivity of underlying material
• Zone of influence – draw down
• Depth of ditch/outlet
• Outlet for drain
• Long-term maintenance of water lowering system
• Topographic position
Curtain Drain

Limiting Layer