Soil Mounding Considerations for Septic Systems

Tom Ballestero
University of New Hampshire
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- Overview
- The leach field
- The soil zone
- Analog System
- Groundwater
- Real systems
  - Construction
  - Soils
  - Slopes
  - Sloping groundwater
- Advice

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Overview: What is Mounding?

- The rise in groundwater levels, above normal levels, resulting from infiltration/percolation above.
  - Rainfall is area-wide recharge and thus the entire groundwater system reacts…not really a mound

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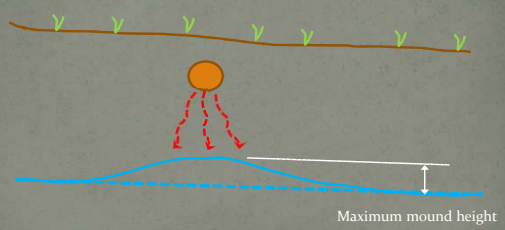
Mounding Results from Localized Recharge



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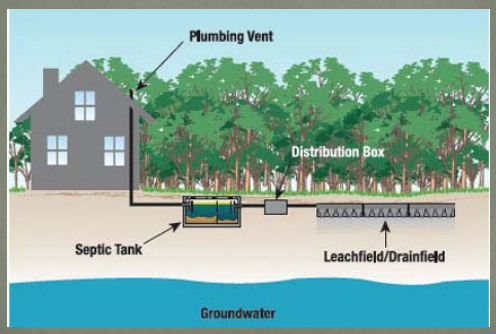
The Leach Field



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The Leach Field

- Design Characteristics
- Materials
- Construction
- Performance

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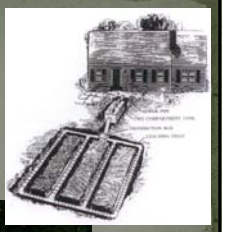
Design Characteristics

- Loading Rate
- Soil permeability
- Setbacks
  - Horizontal
  - Vertical
- Area
- Geometry
  - Trench
  - Field



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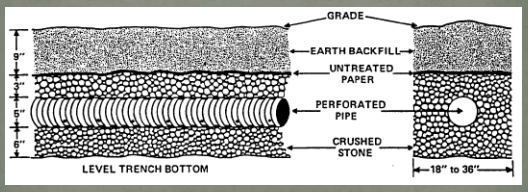
Materials

- Distribution pipe
- Stone/sand



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Construction

- Irregularities at the base of the excavation
- Pipe slope
- Pipe inverts

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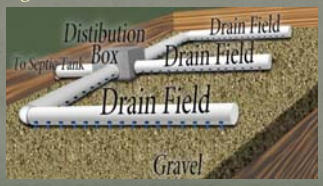
Performance

- Low flow system
  - Tank moderates house flows
  - Distribution to perforated pipe
- Very small deviations
  - Most flow goes to select areas



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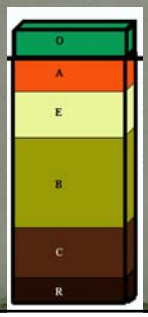
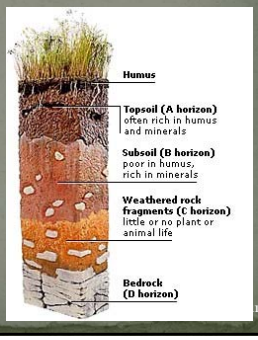
The Soil Zone

- Incredible variability over short distances
- More unknown than known





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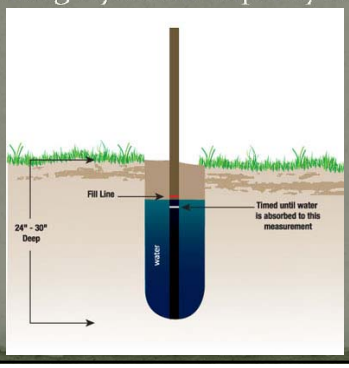
Measuring Hydraulic Capacity of the Soil



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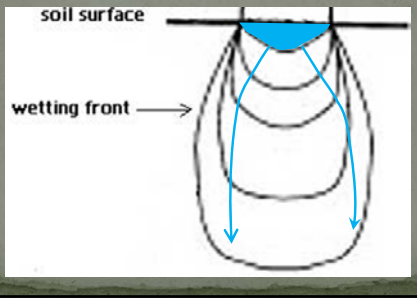
Wetting Front From Perc Test



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Leach Field Subbase Distributes Effluent to Soil

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Reality of Nonhomogeneity

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The Soil Zone

- Three phase system
- Unsaturated flow
- Thesis modeling
  - Guest (1989)
  - Ordway (1997)

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Analog System – Container in the Sink

- No outflow
- Single Outflow
- Multiple Outflow
- Relation between stable water level and flow
- Relation between stable water level and hole size
- Multiple holes and slope
- Breakout

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No Outlet

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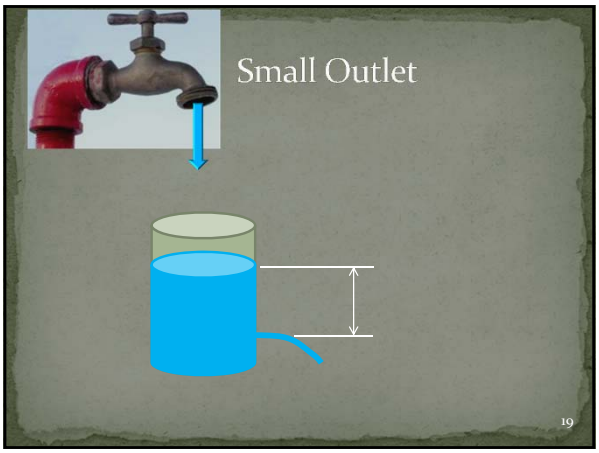
Small Outlet
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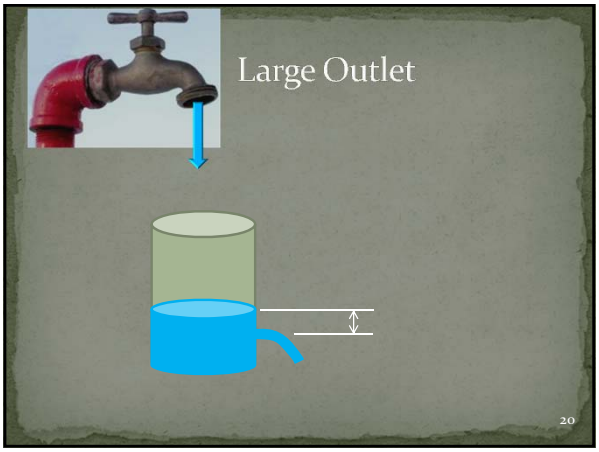
Large Outlet
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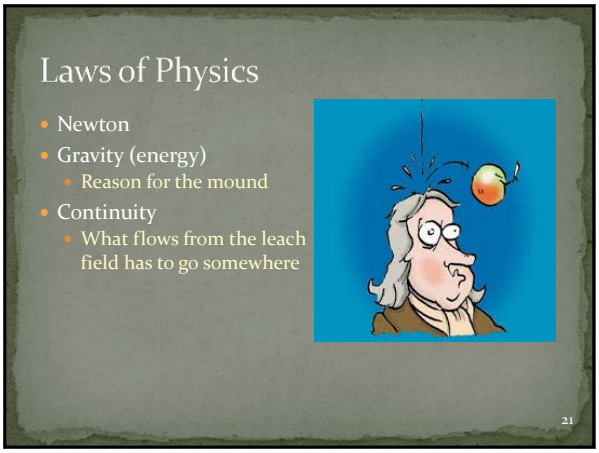
Laws of Physics
Newton
Gravity (energy)
Reason for the mound
Continuity
What flows from the leach field has to go somewhere
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Groundwater

- Two-phase system
- Darcy's Law (energy)
- Mounding
- Relationship between mounding and analogs and soil hydraulic characteristics

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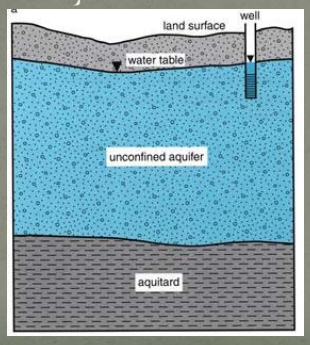
Two-Phase System



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Energy-Darcy's Law-Flow

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Yes, water does flow uphill

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More Common Example

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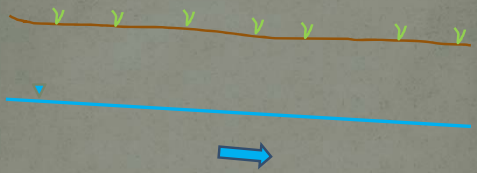
Groundwater Flow



- Rate of flow (velocity)
  - Slope
  - Permeability
- Amount of flow (discharge)
  - Velocity
  - Depth of saturation
  - Width

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So Why the Mound?

- Localized recharge flow moves vertically to the groundwater table
- At groundwater, the recharge water needs to move away and or build up
- In either case, the growth of the mound is both build-up, and the creation of a slope
- Equilibrium (stable mound height) occurs when the recharge equals the flow away from the mound
- Mound will grow until equillibrium is achieved

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Real Systems

- Non-uniform construction
- Non-uniform pipe slopes
- Non-constant flows
- Spatially-variable loading
- Non-uniform soils
- Restrictive layer

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Estimating the Mound Under a Simple System based on NH Codes

- Assume a 4-bedroom home with total flow of 600 gpd
- Various perc rates
- Assume saturated thickness of soil above impermeable layer of 2 feet.
- Square dimension to leach field

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Relation Between Perc Rate and Soil Hydraulic Conductivity

Table C1: Approximate relationships between hydraulic conductivity, percolation time and infiltration rate

Hydraulic Conductivity, K_{fs} (centimetres/second)	Percolation Time, T (minutes/centimetre)	Infiltration Rate, 1/T (millimetres/hour)
0.1	2	300
0.01	4	150
0.001	8	75
0.0001	12	50
0.00001	20	30
0.000001	50	12

Source: Ontario Ministry of Municipal Affairs and Housing (OMMAH). 1997. Supplementary Guidelines to the Ontario Building Code 1997. SG-6 Percolation Time and Soil Descriptions. Toronto, Ontario.

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Allen, 1980

Perc Rate (ft/day) = 6.03 (hydraulic conductivity in ft/day)^0.844

$$1/P = 6.03\,K^{0.844}$$

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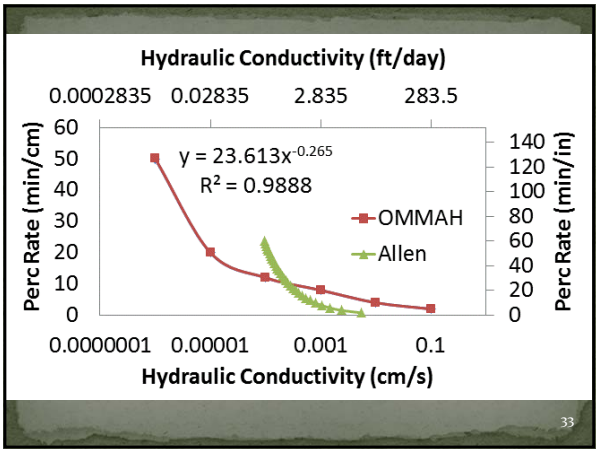

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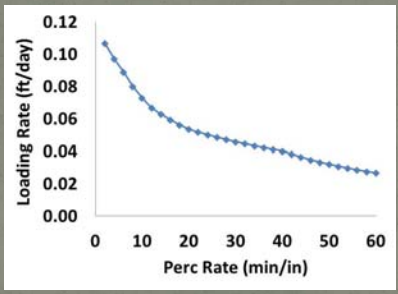
Loading Rates vs. Perc Rate



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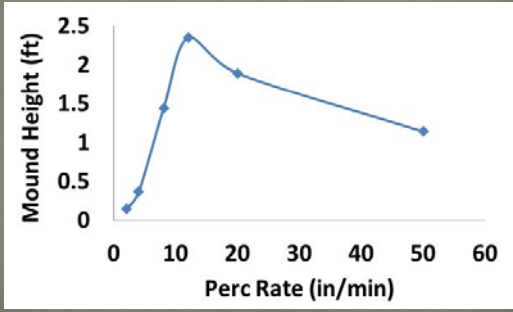
Mound Height



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Modeling Community Leach Field

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3-D Flow

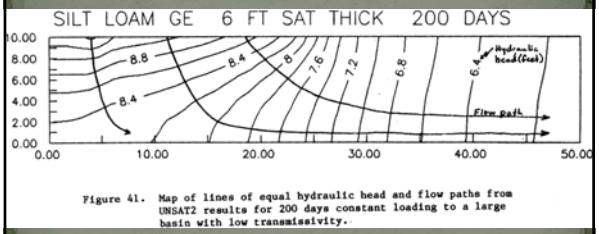

Figure 41. Map of lines of equal hydraulic head and flow paths from UNSAT2 results for 200 days constant loading to a large basin with low transmissivity.

Guest, D., 1989

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Real–Time Vs. Constant Loading

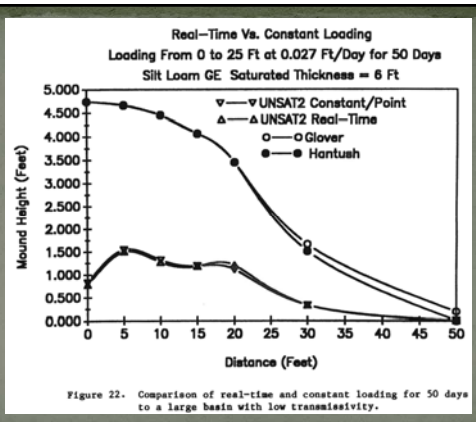

Figure 22. Comparison of real-time and constant loading for 50 days to a large basin with low transmissivity.

Guest, D., 1989

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Silt Loam G.E. 10 Days at 0.025 Ft/Day

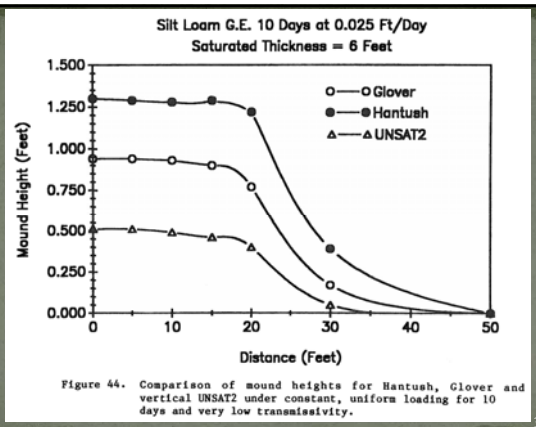

Figure 44. Comparison of mound heights for Hantush, Glover and vertical UNSAT2 under constant, uniform loading for 10 days and very low transmissivity.

Guest, D., 1989

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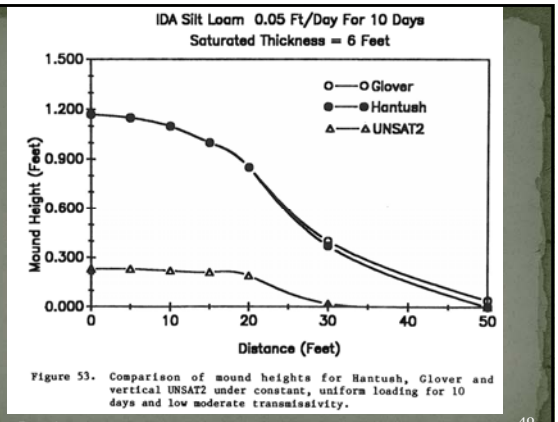

Figure 53. Comparison of mound heights for Hantush, Glover and vertical UNSAT2 under constant, uniform loading for 10 days and low moderate transmissivity.

Guest, D., 1989

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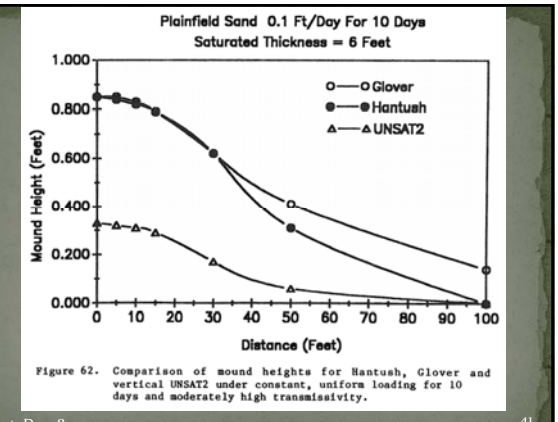

Figure 62. Comparison of mound heights for Hantush, Glover and vertical UNSAT2 under constant, uniform loading for 10 days and moderately high transmissivity.

Guest, D., 1989

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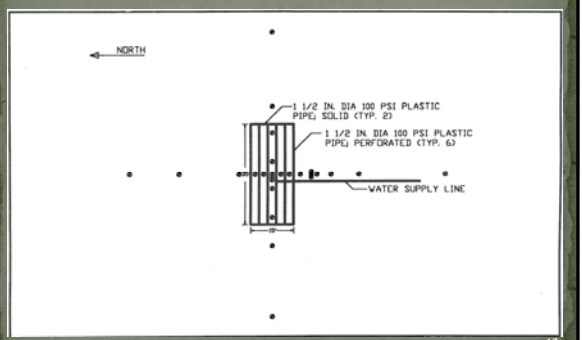
Comparing Field Data to Model Estimates



Ordway, 1997

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Table 11: Comparison of the predicted duration of recharge required to reach steady state and the duration at which steady state conditions were observed in the field.

Recharge Rate (ft/day)	Observed (hours)	Predicted (hours)	Predicted (days)
1.0	33	100	4.2
3.0	81	299	12.5
4.6	53	458	19.1

Ordway, 1997

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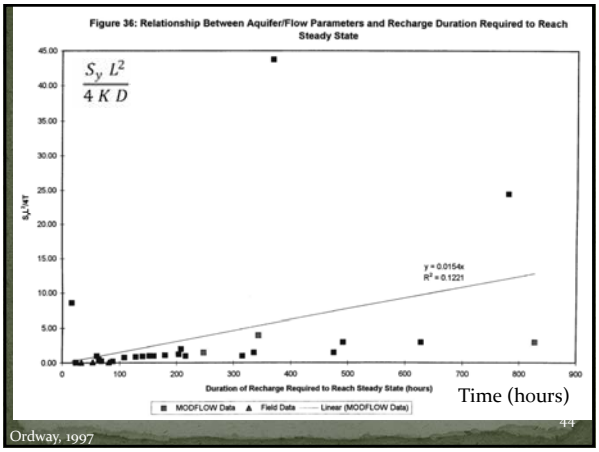

Time (hours)

Ordway, 1997

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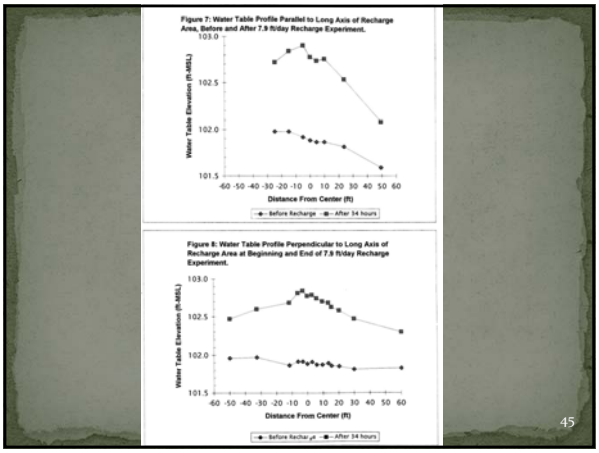

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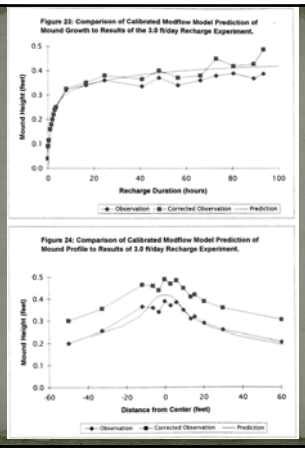

Ordway, 1997

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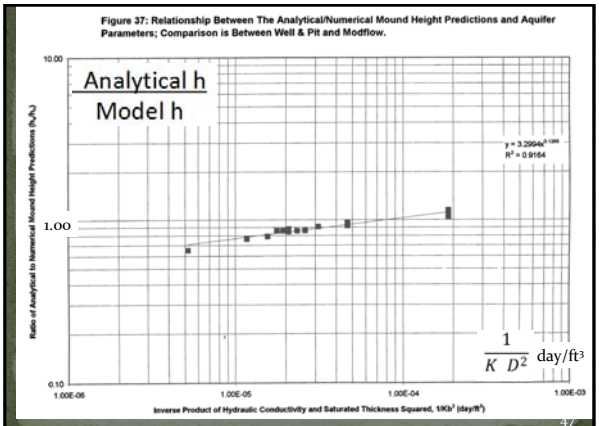

Ordway, 1997

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Discussion of Research

- Typical designs should not create mounding "issues"
- Modeling approaches vary, unsaturated flow models yield the lowest because recharge is dispersed laterally in the soil before reaching the groundwater table.
- Analytical models predict lower mound height than saturated flow model in the short term, higher in the long term
- Fairly good prediction between field and modeled mound predictions when sufficient field information exists
- Mound growth should reach steady state within one month

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Analog System – Container in the Sink

- No outflow
- Single Outflow
- Multiple Outflow
- Relation between stable water level and flow
- Relation between stable water level and hole size
- Multiple holes and slope
- Breakout

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Advice

- System layout to minimize mounding
  - Long dimension parallel to slope
- Beware of high variability
  - Large boulders
  - Few deep soil pockets
  - Roots
- Pay attention during construction

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Thanks

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