Planning for Rain –
Looking at the Whole Landscape and Assessing the Function of Soil

Soil Health Conference

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Marilyn Mroz, P.E.
Cushetunk Technical Services, Inc.
Clinton, New Jersey

“What will I do differently?”

Photo Source: “Elements”, March 2009, Berks County Conservation District, PA

The Whole Landscape

http://www.wcc.nrcs.usda.gov/factpub/aib326.html

What is Soil?

- A dynamic, natural system
- Weathered geologic parent material
- Ongoing biological, chemical, and physical processes

- Unconsolidated material

Soil Profile

New Jersey State Soil

Downer sandy loam

A

B

C

The Landscape - A Soil Catena

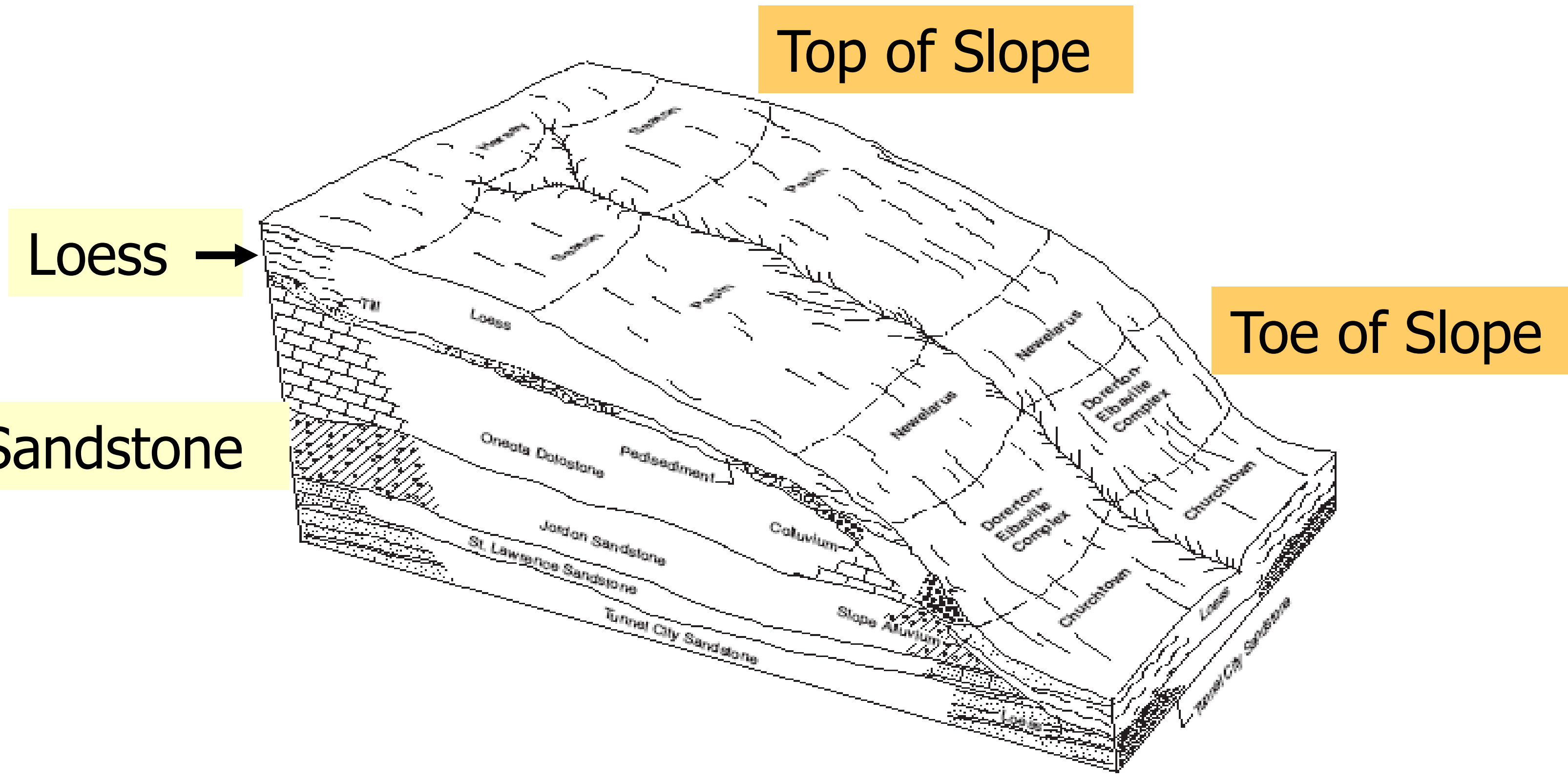

Fig. 1 - Typical pattern of soils and parent material in the Pepin-Churchtown -Dorerton association.

Pepin County, Wisconsin

http://soils.usda.gov/education/training/job_aids.html#graphics

The Five Factors of Soil Formation

- Parent Material
  - Red shale, marine sands, glauconite, etc.
- Landscape Position
  - Upslope, midslope, toe of slope

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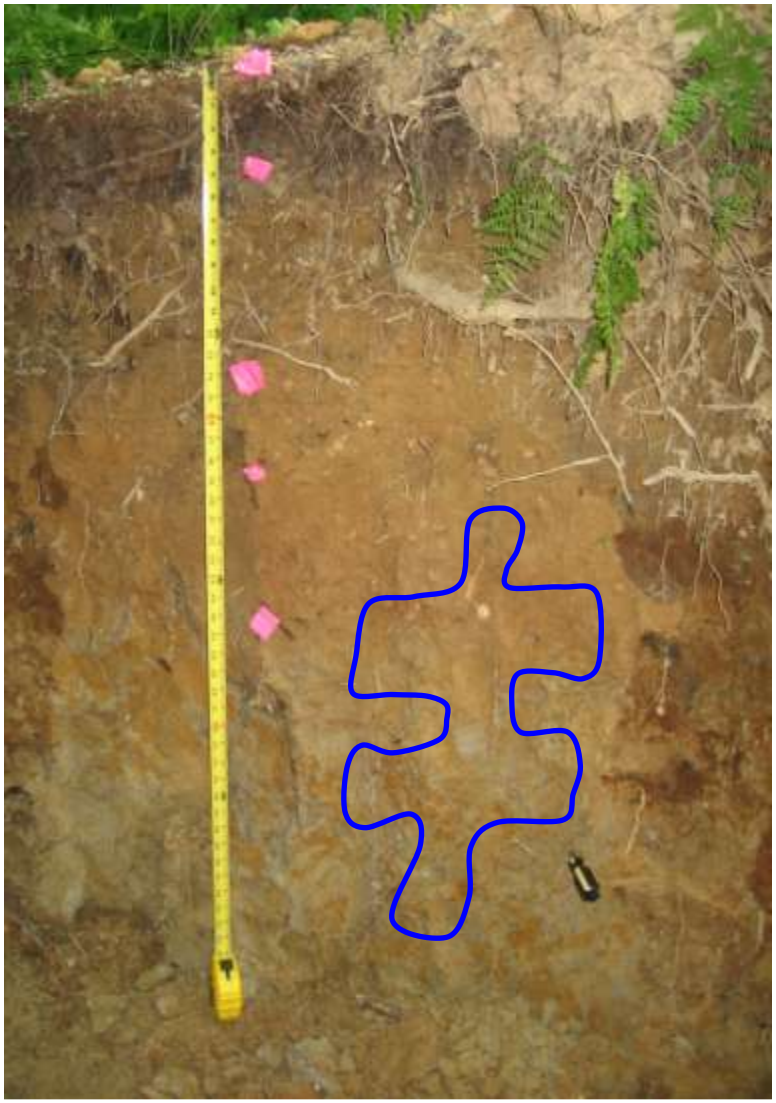
  - Red shale, marine sands, glauconite, etc.
- Landscape Position
  - Upslope, midslope, toe of slope
- Biota
  - Vegetation, microorganisms
- Climate
  - Mesic, arid, tropic, etc.
- Time

M.Mroz

http://www.blm.gov/nstc/soil/bacteria/

What is the Function of Soil?



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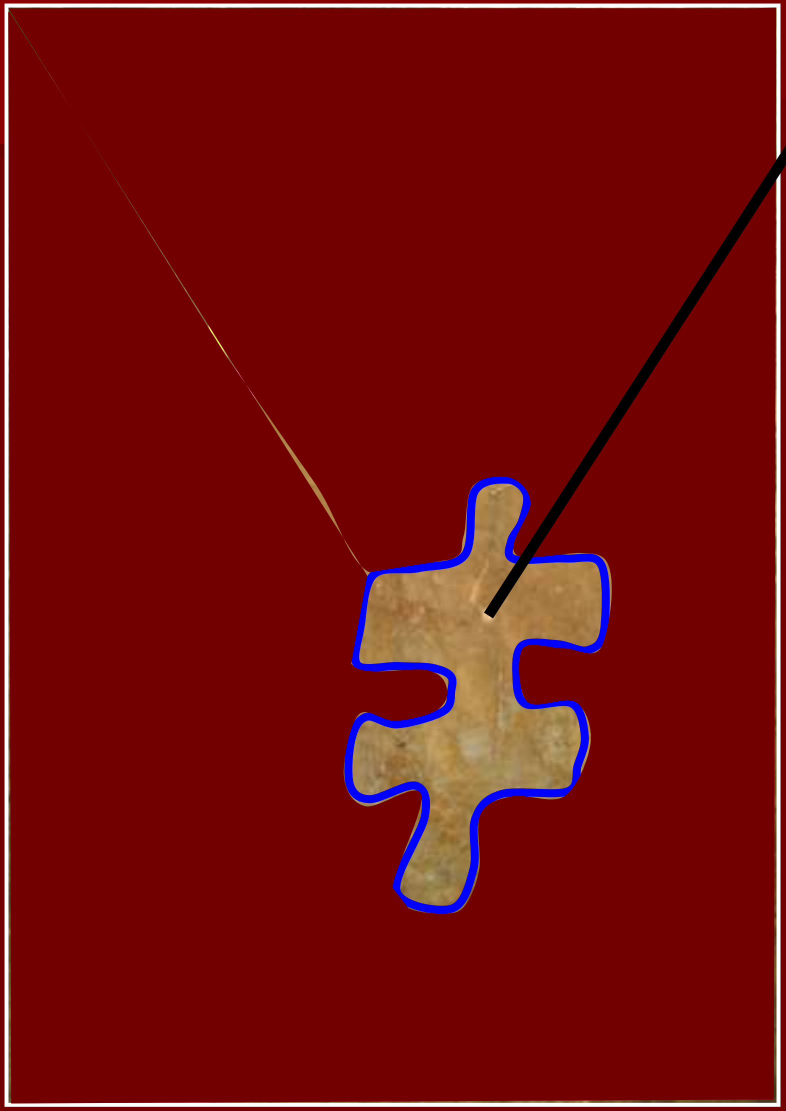
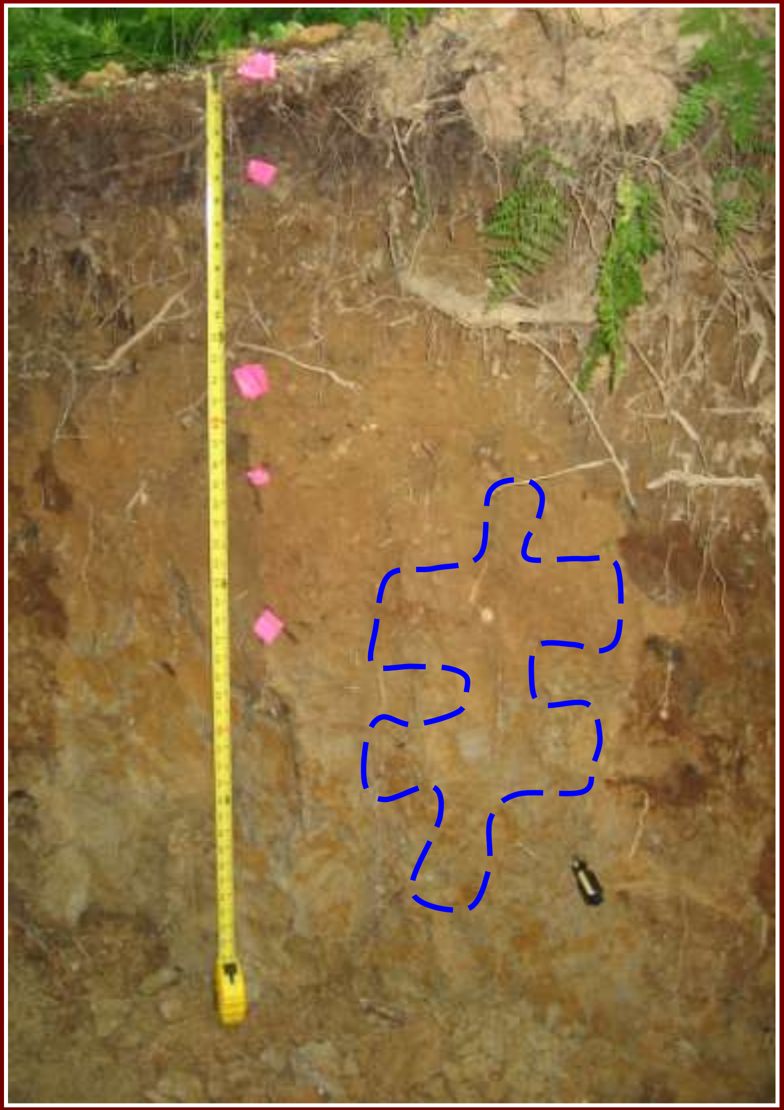


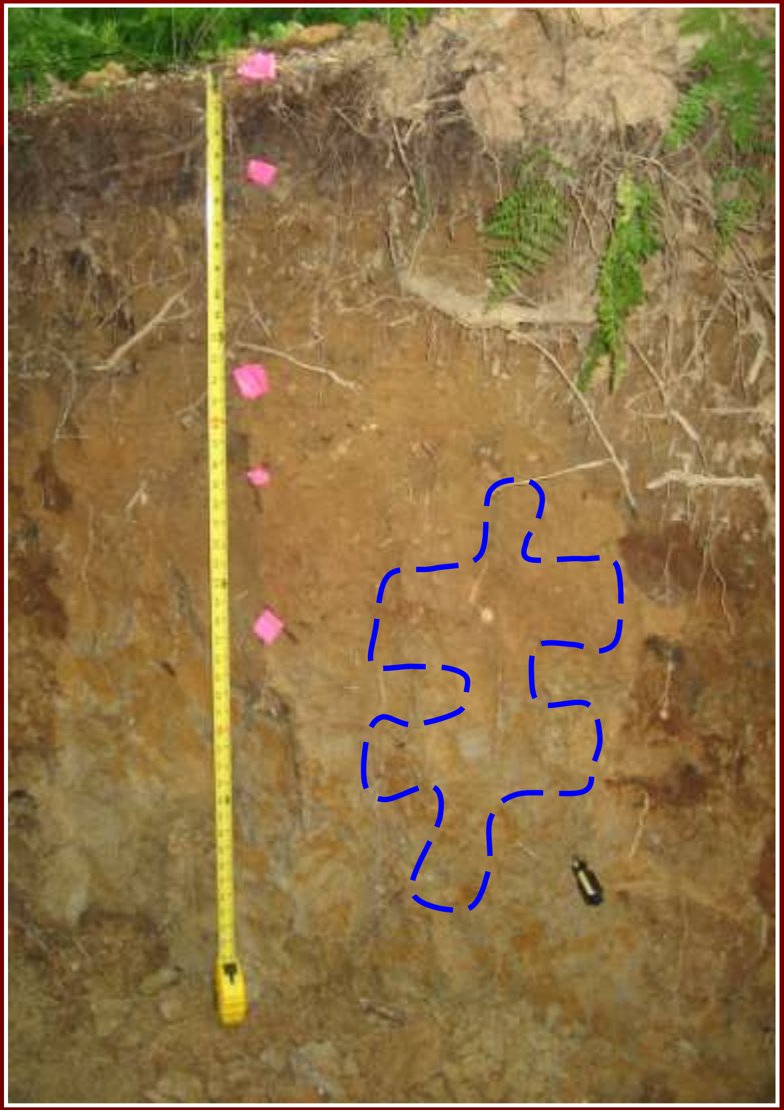
- Building foundations
  - Bearing strength
  - Absence of water
- Road subgrade
  - Frost-heave potential
  - Well-drained
- Drainage medium
  - Gradation analysis
- Earth embankments

What is the Function of Soil?



- Plant growth
- Water movement
- Nutrient supply
- Phytoremediation
- Erosion control

What do we consider?



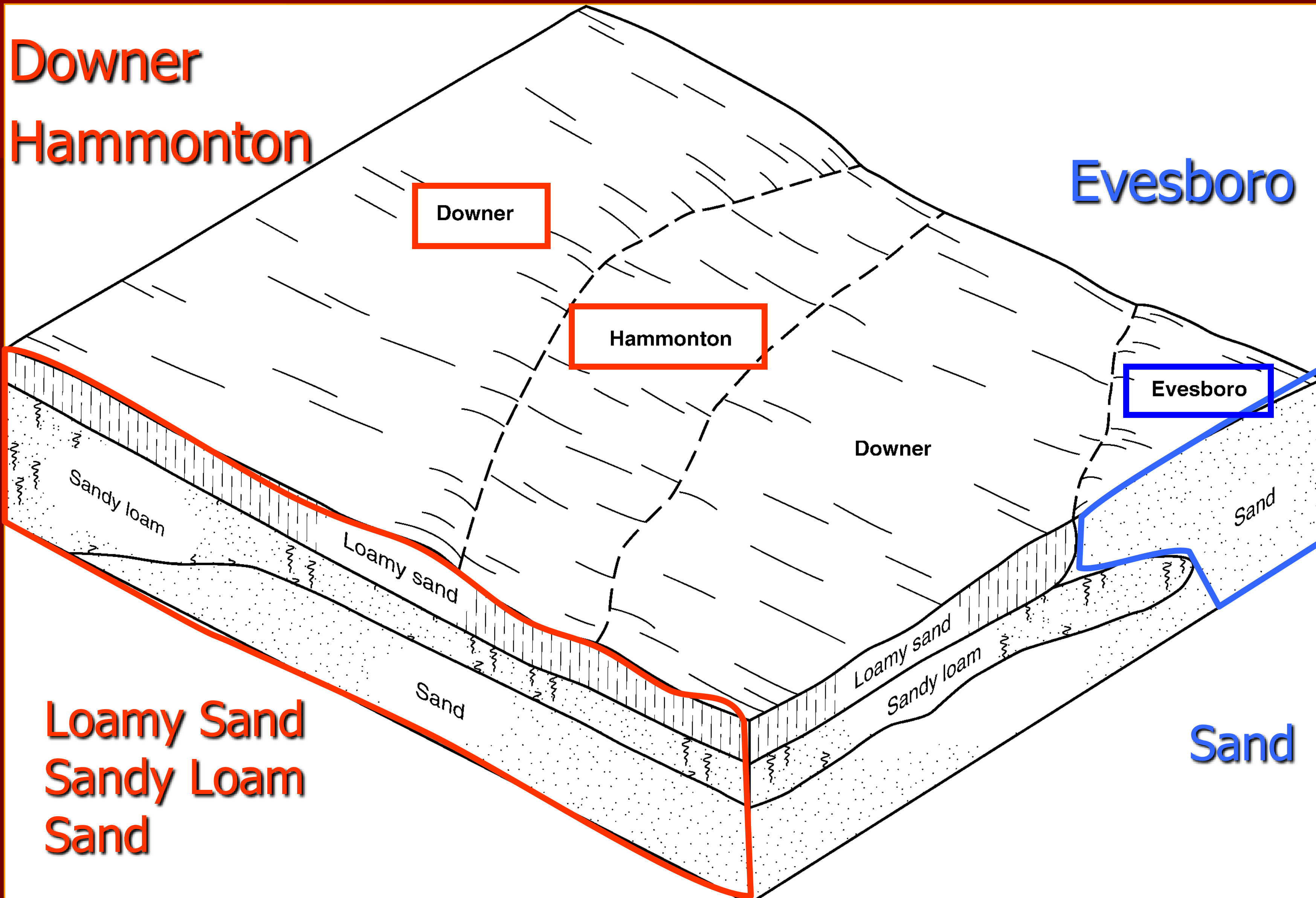
- Soil Physical Properties
  - Texture, structure, etc.
- Soil Chemical Properties
  - pH, type of clay, fertility
- Soil-forming Processes
  - Transformation
  - Translocation
  - Additions
  - losses
- Macropores, Micropores
- Capillarity, Gravity

Consider a Sample Landscape

Downner

Hammonton

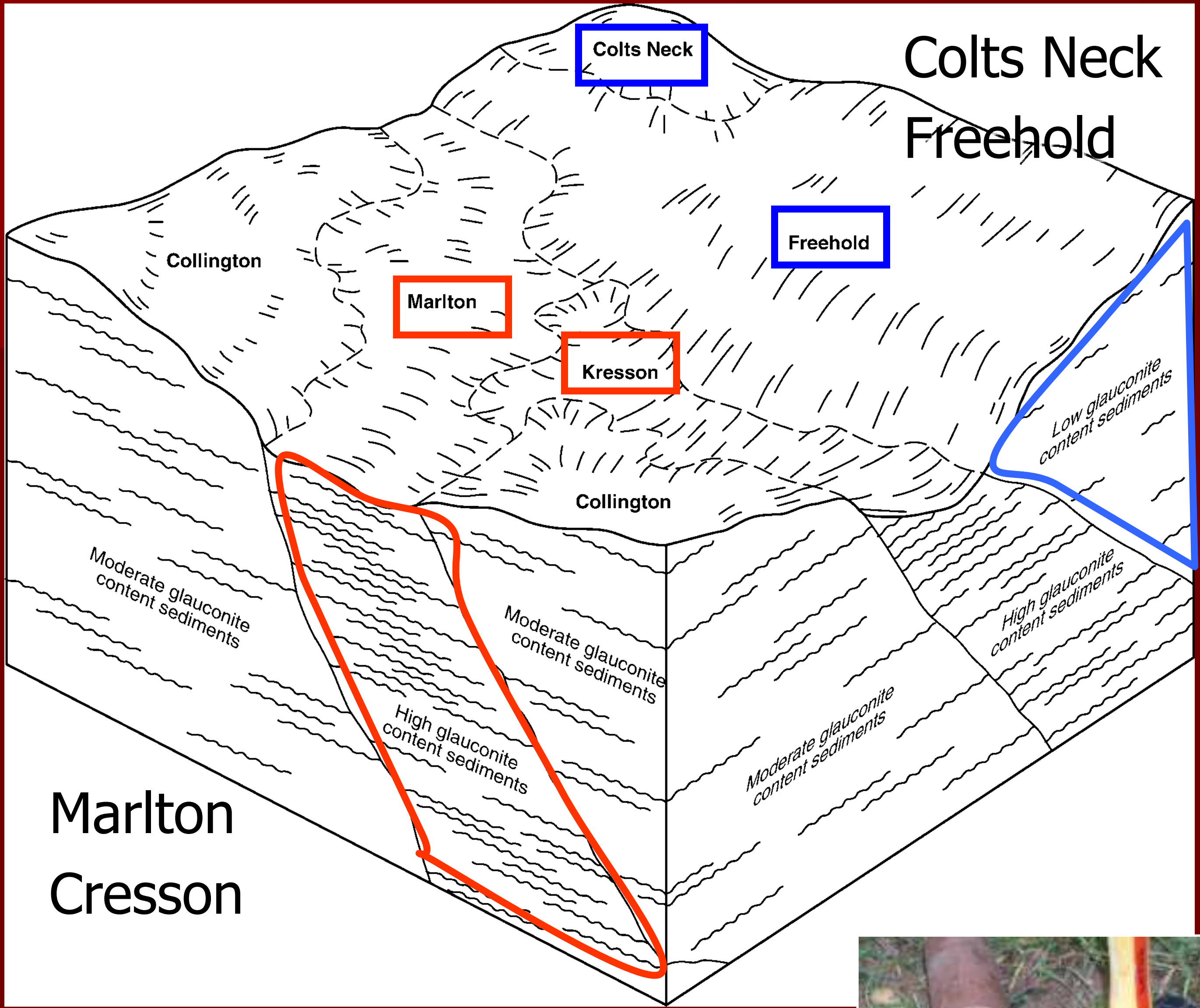
Evesboro



Loamy Sand
Sandy Loam
Sand

Sand

http://soils.usda.gov/education/training/job_aids.html#graphics



Colts Neck

Freehold

Marlton

Cresson

Example

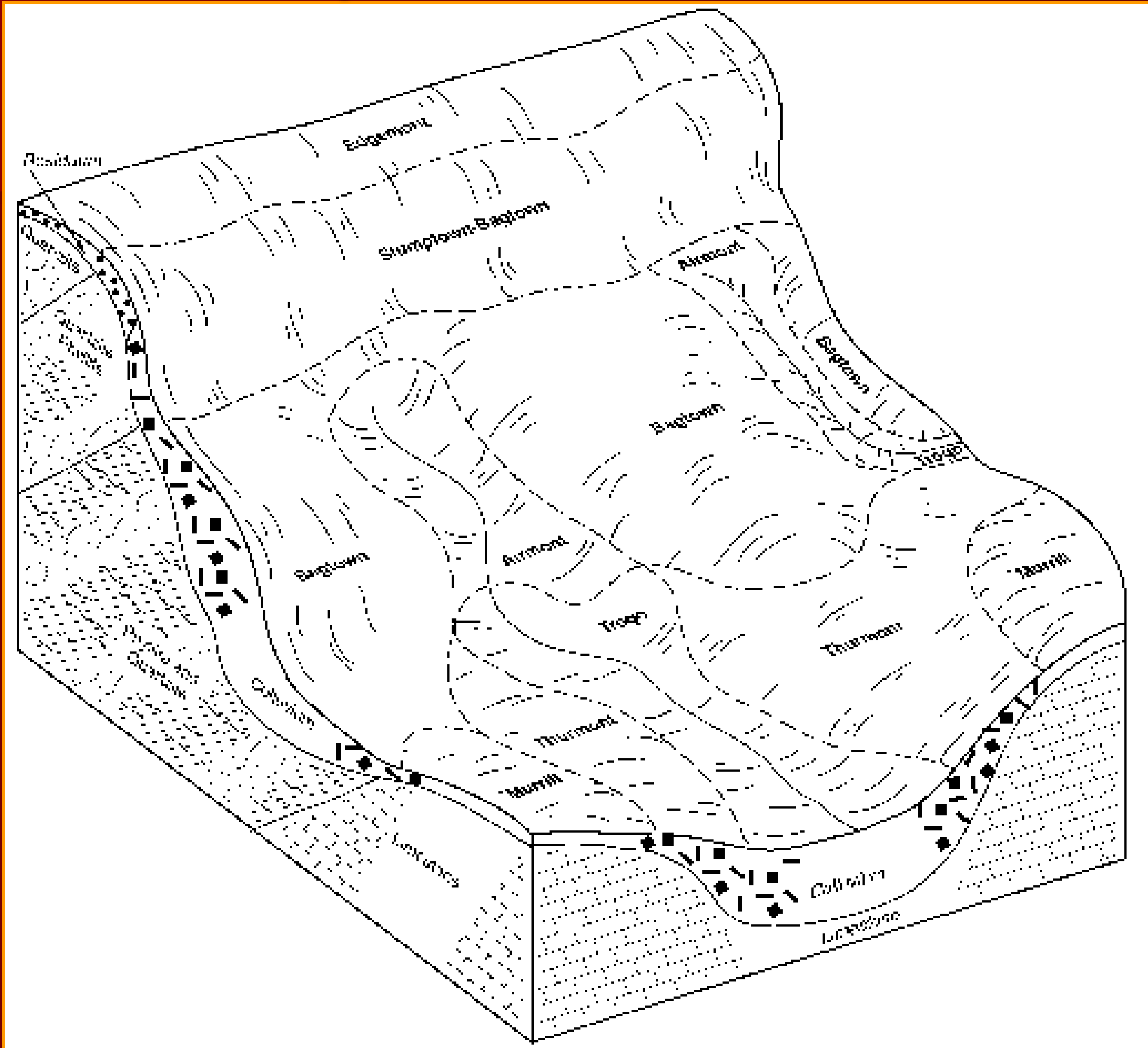
Low-glauconite-content sediments

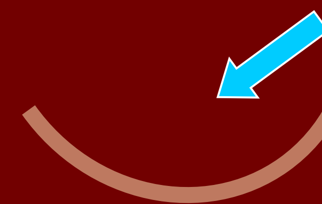
Tube Permeameter Test

High-glauconite-content sediments

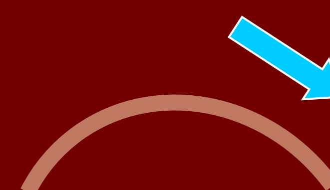
http://soils.usda.gov/education/training/job_aids.html#graphics

Slope: Concave or Convex?





collects water



sheds water

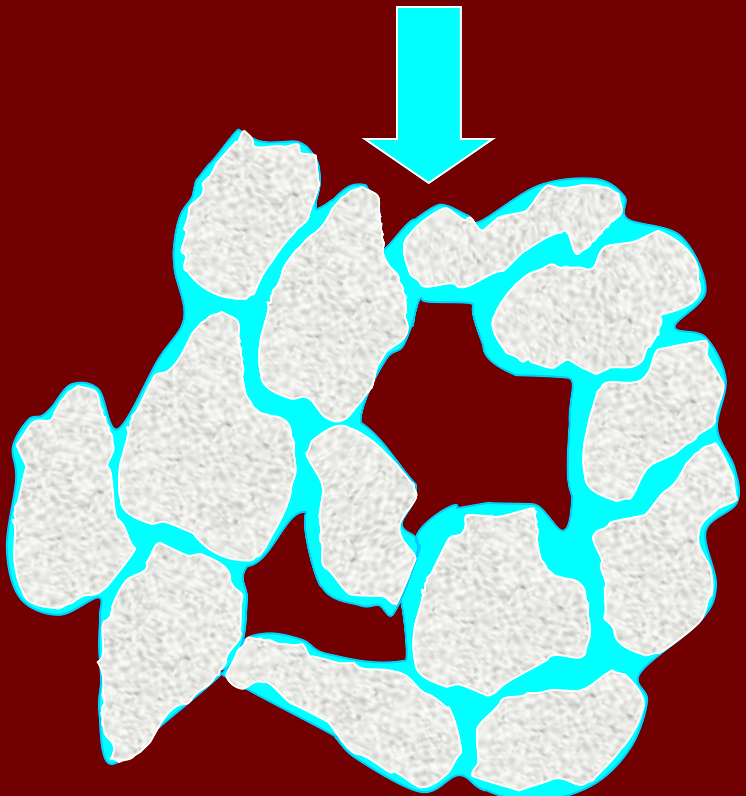
Applications

- Stormwater Management
- Hydrologic Soil Group
- Numerical Modeling
- Groundwater Recharge
- Construction

Stormwater Management

The success of infiltration is directly related to the macropores in the surface soil.

Macropores → particle size and/or humus



Good Soil Structure

Infiltration Basins

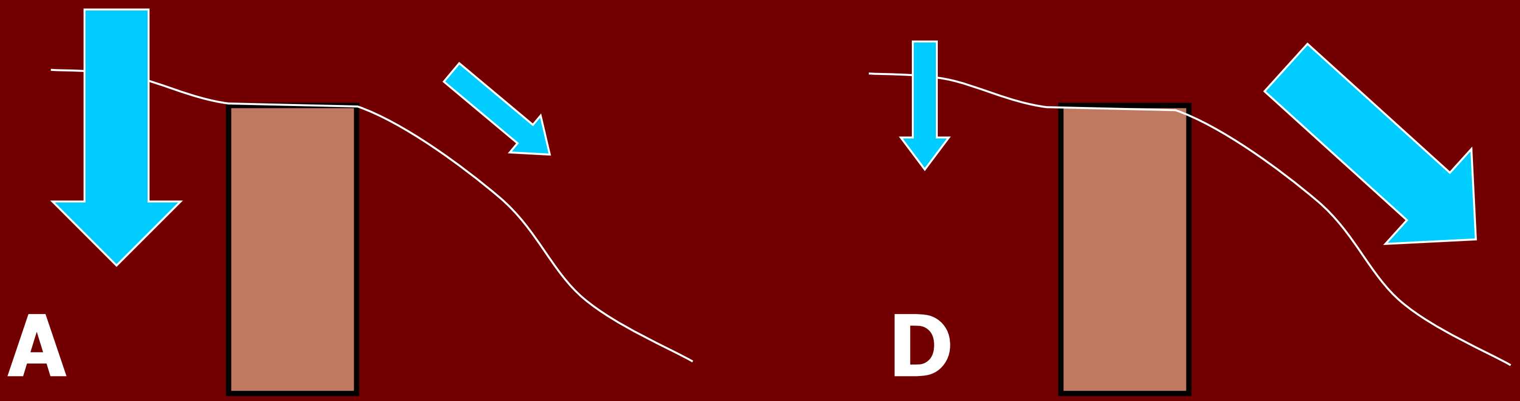
Causes of Failure

- Clogging by sediments
- Inadequate Maintenance
- High Groundwater
- Hydraulic Overloading
- Compaction

Photo Source: “Elements”, March 2009, Berks County Conservation District, PA

Hydrologic Soil Groups – A, B, C, and D

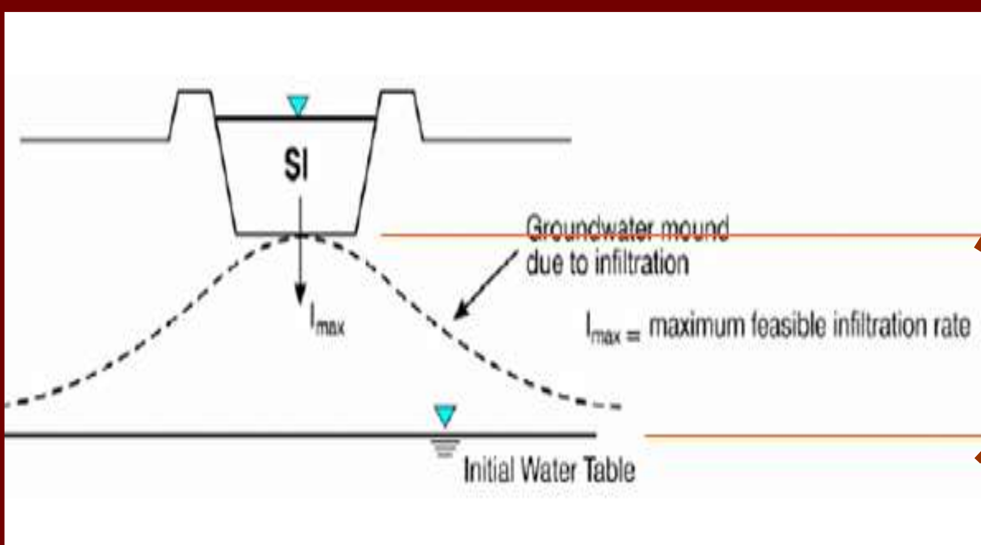
- "A"- low runoff potential, typically >90% sand
- Originally based on measured rainfall, runoff, and infiltrometer data (Musgrave, 1955)
- Sat. hydr. Cond. >5.6 iph
- Depth to impermeable layer, 20 to 40 in.
- Depth to high water table, 24 to 40 in.



Ref.: NRCS, National Engineering Handbook, Part 630, Chapter 7

Numerical Modeling

- Trying to put numbers to Nature
- Soil horizons
- On-site permeability test data
- Water table – where is capillary fringe?



2 ft

Groundwater Recharge

"Default" Soil Series: Fort Mott (A), Nixon (B), Venango (C), Any (D)

New Jersey Groundwater Recharge Spreadsheet Version 2.0 November 2003

Annual Groundwater Recharge Analysis (based on GSR-32)

Select Township	Average Annual P (in)	Climatic Factor
MIDDLESEX CO., PERTH AMBOY	47.0	1.53

Project Name:	Sample Project
Description:	This is a test application
Analysis Date:	05/01/03

Pre-Developed Conditions

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	1.4	Open space	Woodstown	12.9	65,490
2	0.3	Gravel, dirt	Woodstown	6.9	7,536
3	3.5	Woods-grass combination	Woodstown	13.5	171,255
4	1.4	Open space	Keyport	13.4	68,146
5	0.5	Gravel, dirt	Keyport	7.5	13,657
6	3.3	Woods-grass combination	Keyport	13.9	165,963
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				
Total =	10.4			Total Annual Recharge (in)	Total Annual Recharge (cu-ft)
				13.0	492,054

Post-Developed Conditions

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	1.5	Impervious areas	Keyport	0.0	-
2	1.6	Gravel, dirt	Woodstown	6.9	40,191
3	3.65	Open space	Keyport	13.4	177,667
4	3.65	Open space	Woodstown	12.9	170,762
5	0				
6	0				
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				
Total =	10.4			Total Annual Recharge (in)	Total Annual Recharge (cu.ft)
				10.3	388,620

Annual Recharge Requirements Calculation ↓

% of Pre-Developed Annual Recharge to Preserve =	100%	Total Impervious Area (sq.ft)	65,340
Post-Development Annual Recharge Deficit=	*103,435*	(cubic feet)	

Recharge Efficiency Parameters Calculations (area averages)

RWC=	3.94	(in)	DRWC=	3.94	(in)
ERWC =	0.93	(in)	EDRWC=	0.93	(in)

Procedure to fill the Pre-Development and Post-Development Conditions Tables

For each land segment, first enter the area, then select TR-55 Land Cover, then select Soil. Start from the top of the table and proceed downward. Don't leave blank rows (with A=0) in between your segment entries. Rows with A=0 will not be displayed or used in calculations. For impervious areas outside of standard lots select "Impervious Areas" as the Land Cover. Soil type for impervious areas are only required if an infiltration facility will be built within these areas.

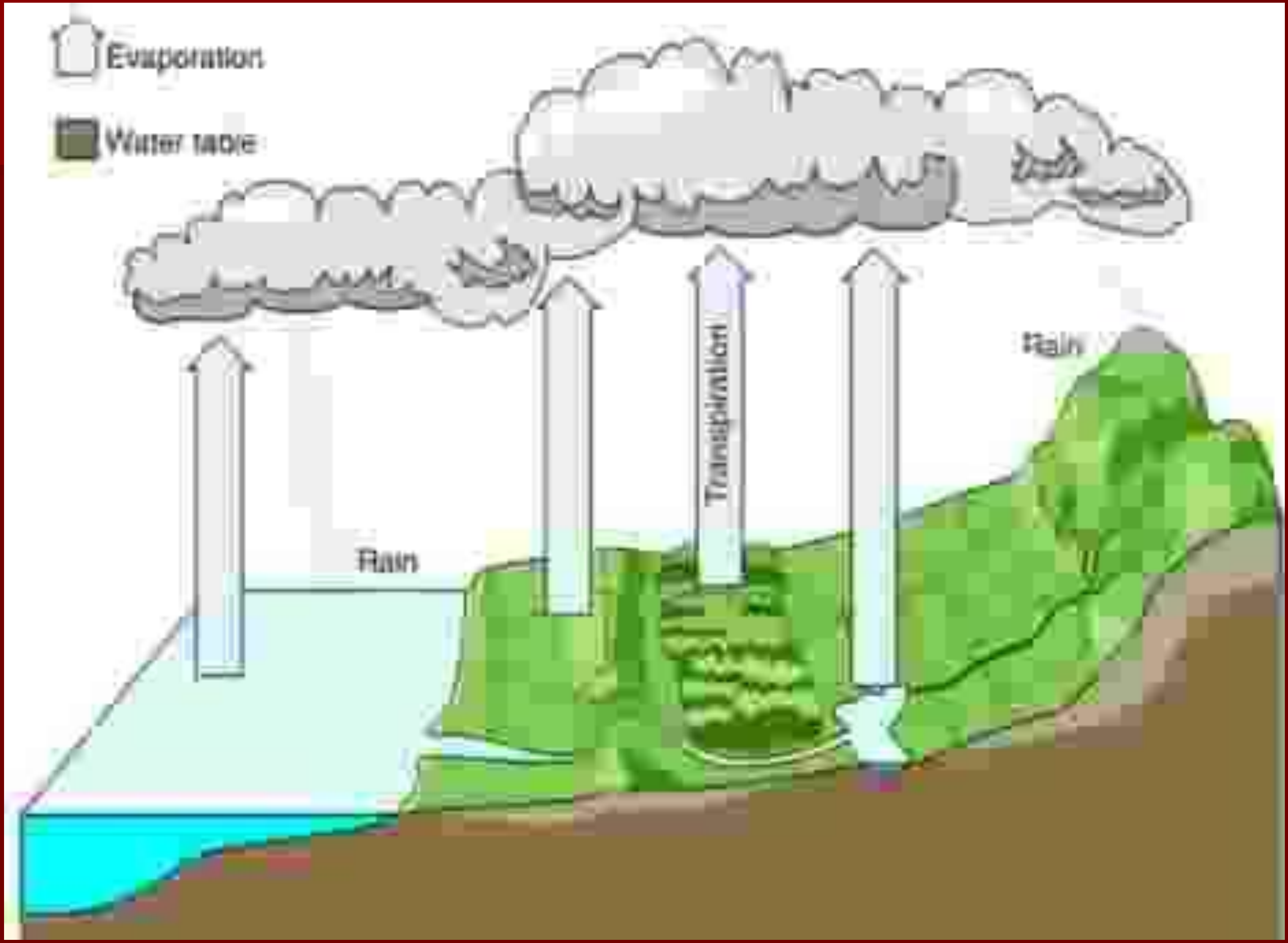
Construction

- "Don't work the soil when it's wet."
- Proctor density curve – moisture matters
- Counteract smearing by scarifying when soil is drier
- Minimize compaction

What will you do differently?...

- Check soil characteristics - Web Soil Survey
- On-site testing
  - Re-consider which soil permeability test to use
  - Re-consider the number of permeability tests
- Construction and installation
  - Timing: "Don't work the soil when it's wet"
  - Avoid compaction
  - Scarify
- Soil amendments: organic matter

Thank you.



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/www.treehugger.com/clean-technology/an-explanation-of-the-water-cycle-with-pictures-ar


solar radiation +
condensation +
action of wind
evaporation
evaporation
precipitation +
+ precipitation
+ ice
transpiration
+ surface runoff
infiltration
+ ocean
underground flow