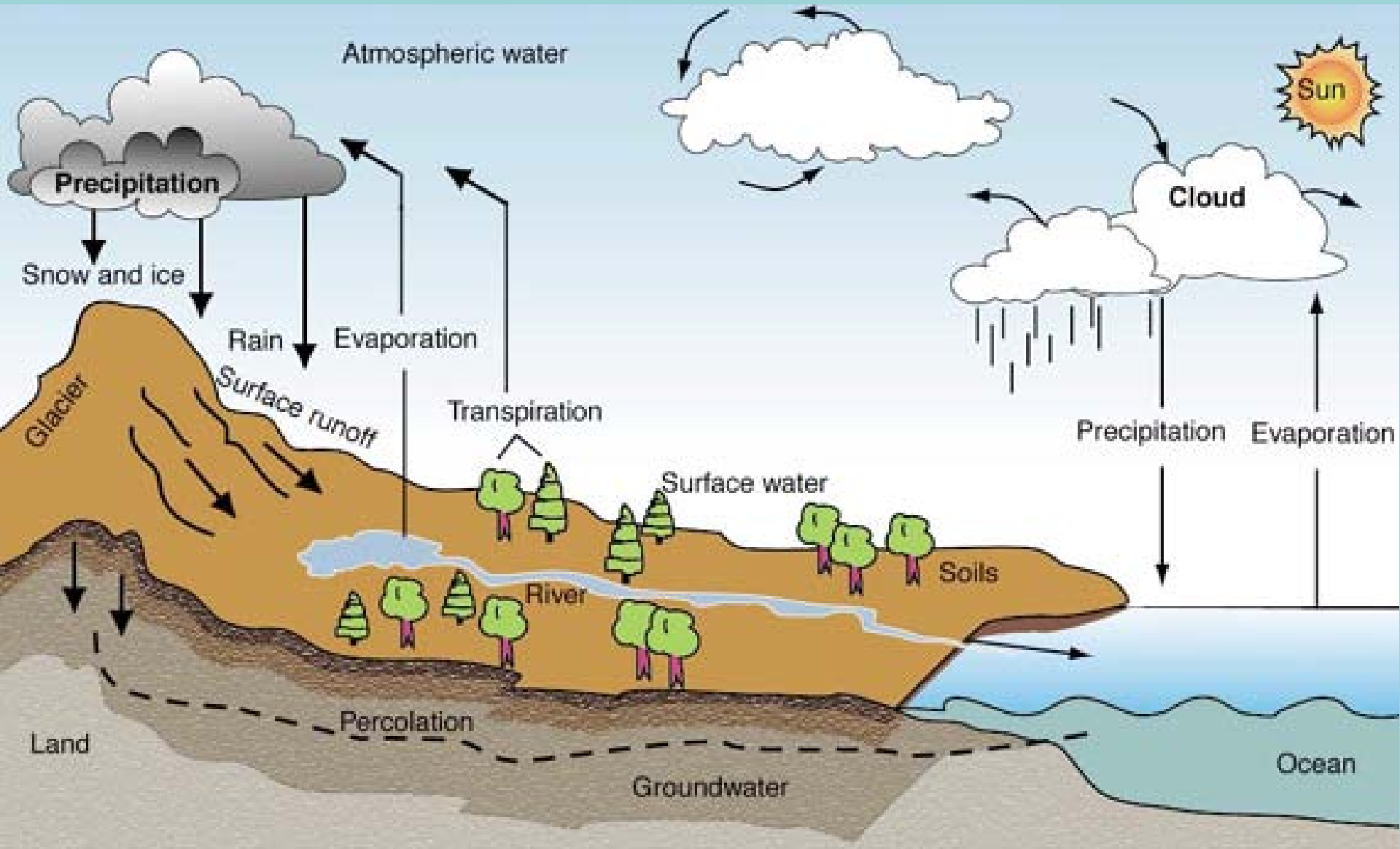
Soils, Landscapes, and Storm Water

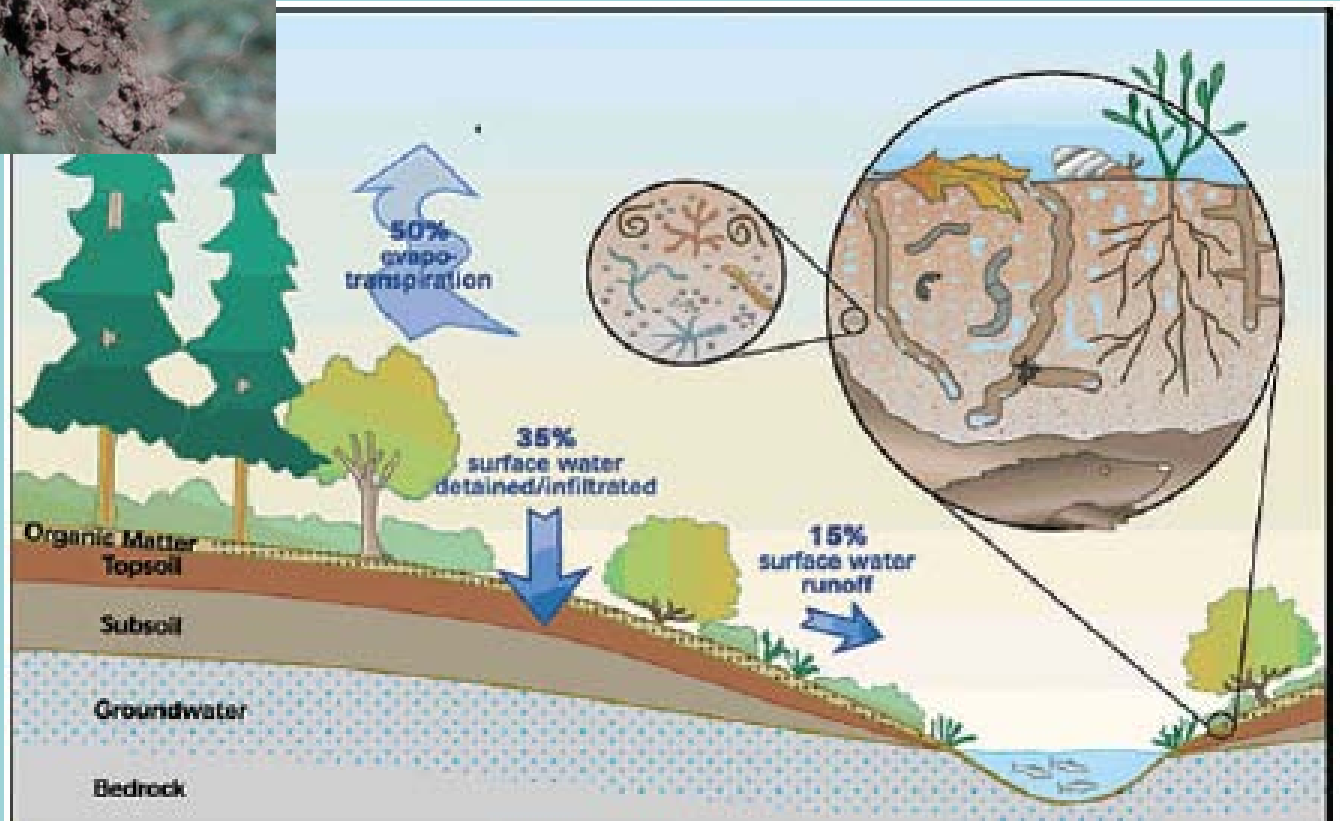
U.S. Department of Agriculture
Natural Resources Conservation Service

CONNECTICUT

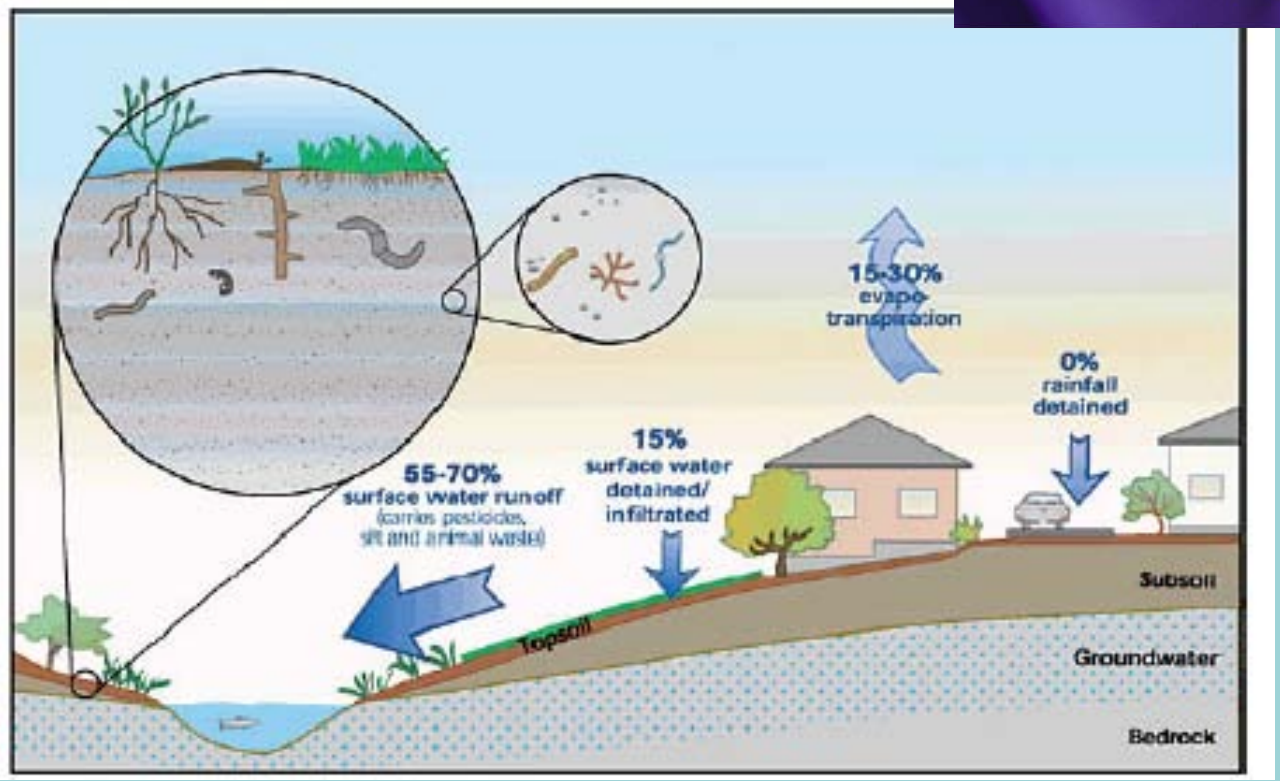
Hydrologic Cycle



Soil Quality: Pre-Development



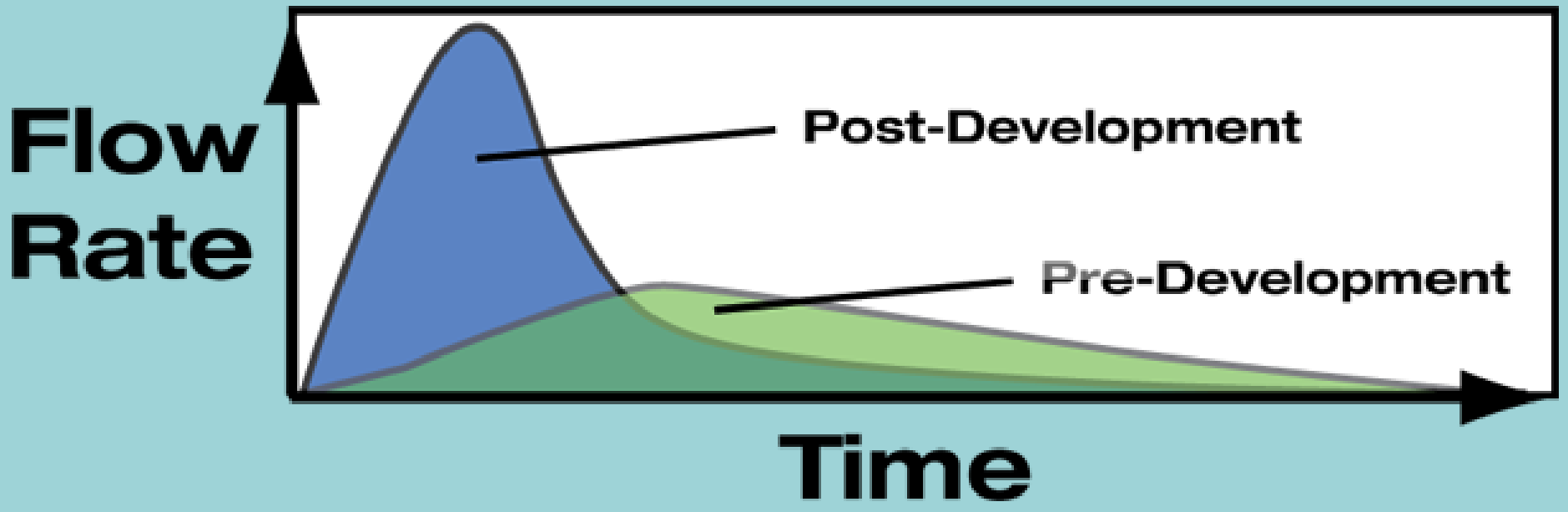
Reduced Function: Post-Development



Impacts of Development on Water Quantity

- Changes to surface flow patterns
- Changes to flooding regimes
- Compaction
- Construction disturbances
- Changes to recharge and base flow
- Changes in vegetation

Peak flow pre and post development



Conventional

- “end of pipe” technology
- Large structural practices
- Low end of site
- On “leftover” land

Low Impact Development (LID)

- Uses site design
- Many small scale treatment practices close to source
- Planning phase first optimizes conservation of natural hydrologic functions

LID Principals

- Minimize site disturbance
- Work with site hydrology (and native soils)
- Minimize and disconnect impervious surface
- Apply small scale controls at the source

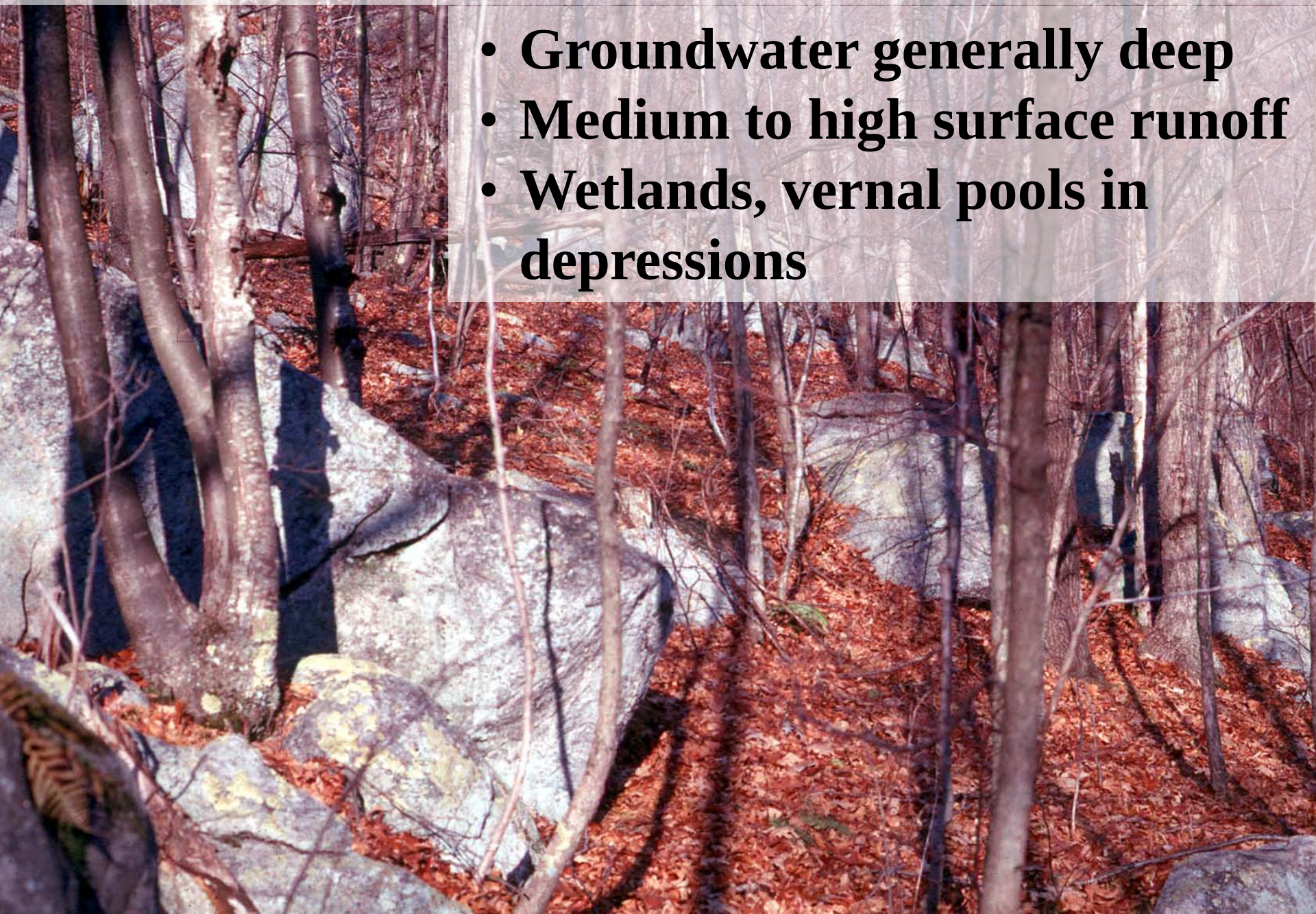
It's easy to put the right practice in the wrong place!

Understand the soil properties before selecting practice types.

Soil properties that influence Infiltration and runoff

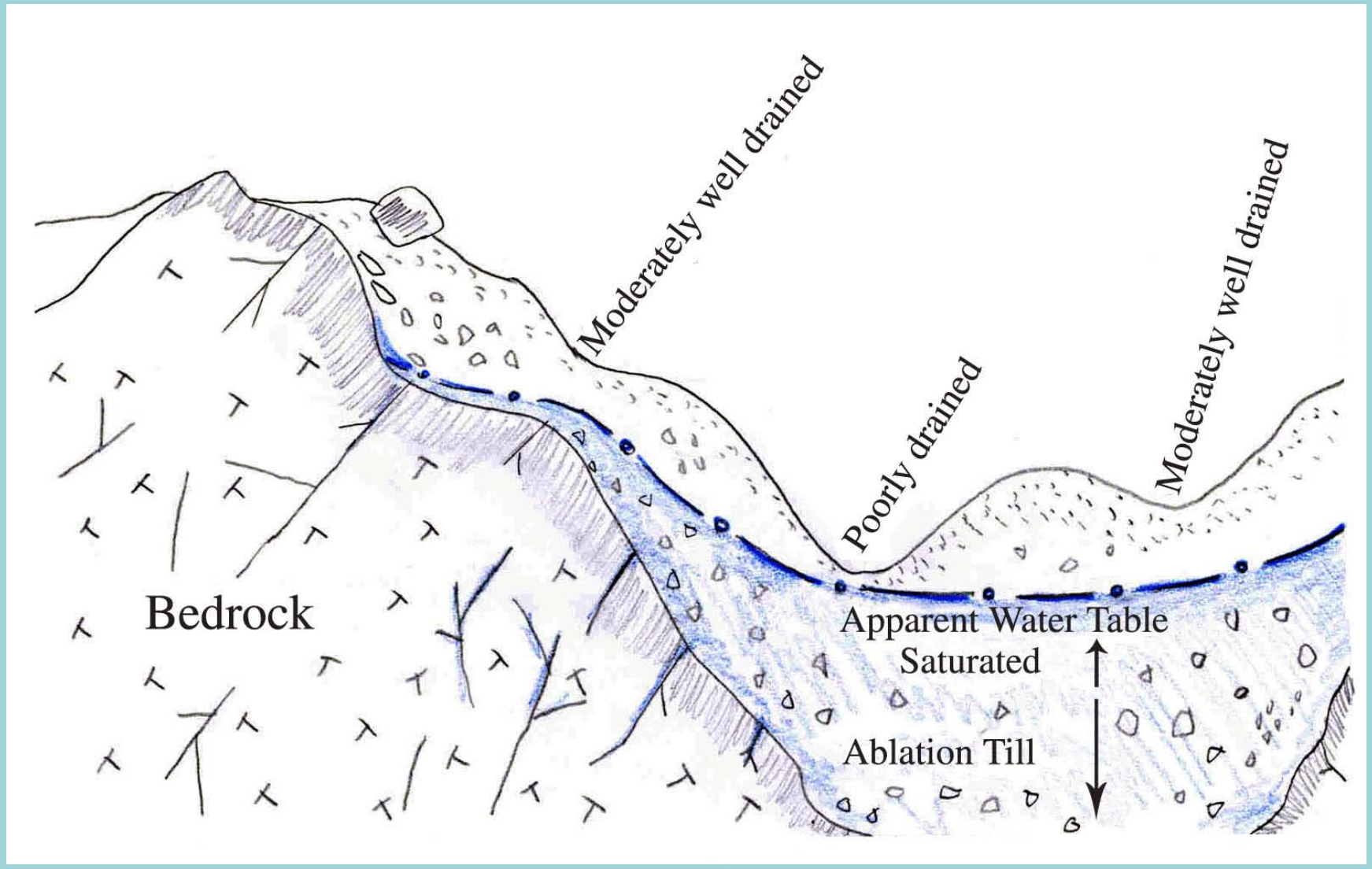
- Infiltration and Saturated hydraulic conductivity (Ksat)
- Slope
- Depth
  - to water table
  - Bedrock
  - Hardpan

Bedrock Controlled Supraglacial Till



- Groundwater generally deep
- Medium to high surface runoff
- Wetlands, vernal pools in depressions

Hydrology in Bedrock Controlled Till



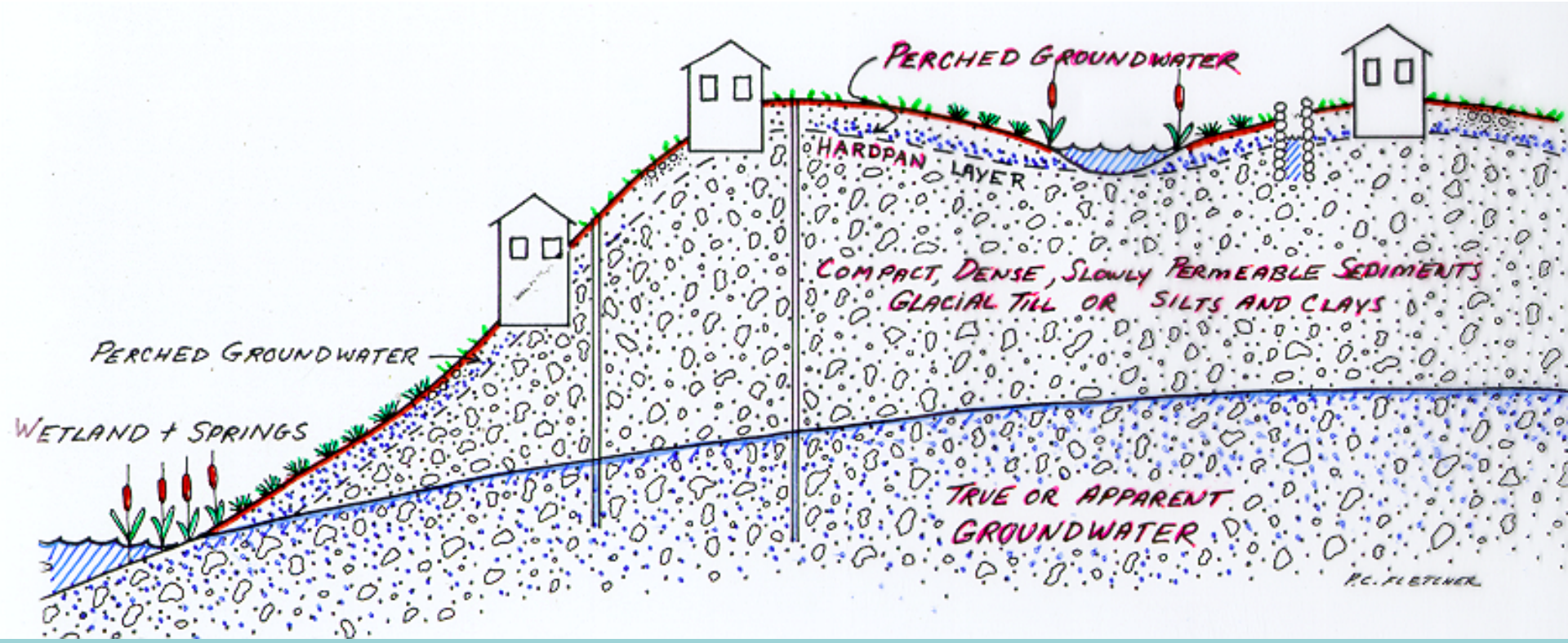
Development Impacts

- Increased runoff
- Reduced ground water recharge and base flow to wetlands and watercourses

Deep Subglacial Till

- Medium surface runoff from side slopes
- Shallow, perched groundwater flow follows contours of dense till
- Wetlands in depressions and seeps

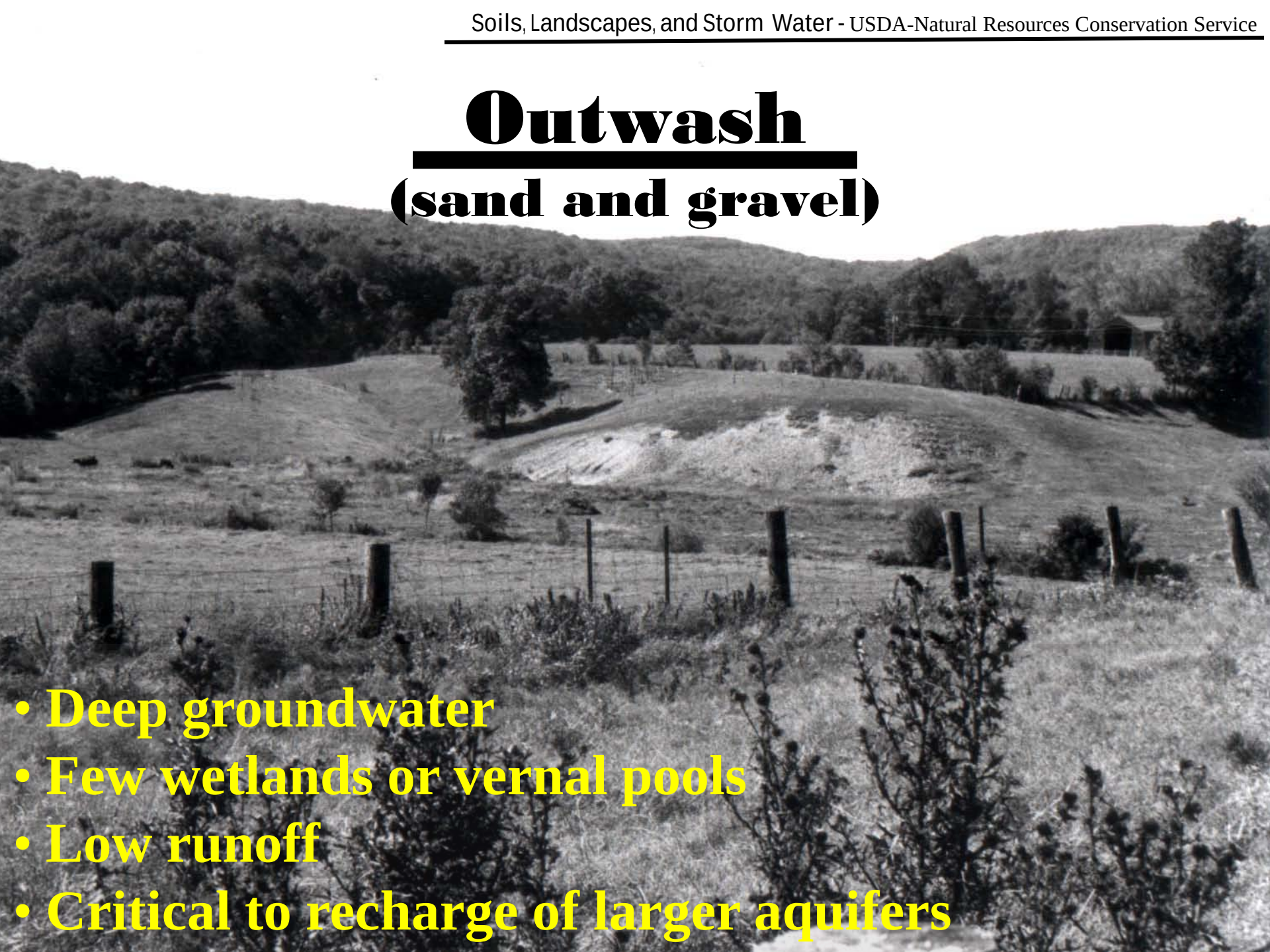
Hydrology in Tills



Development Impacts

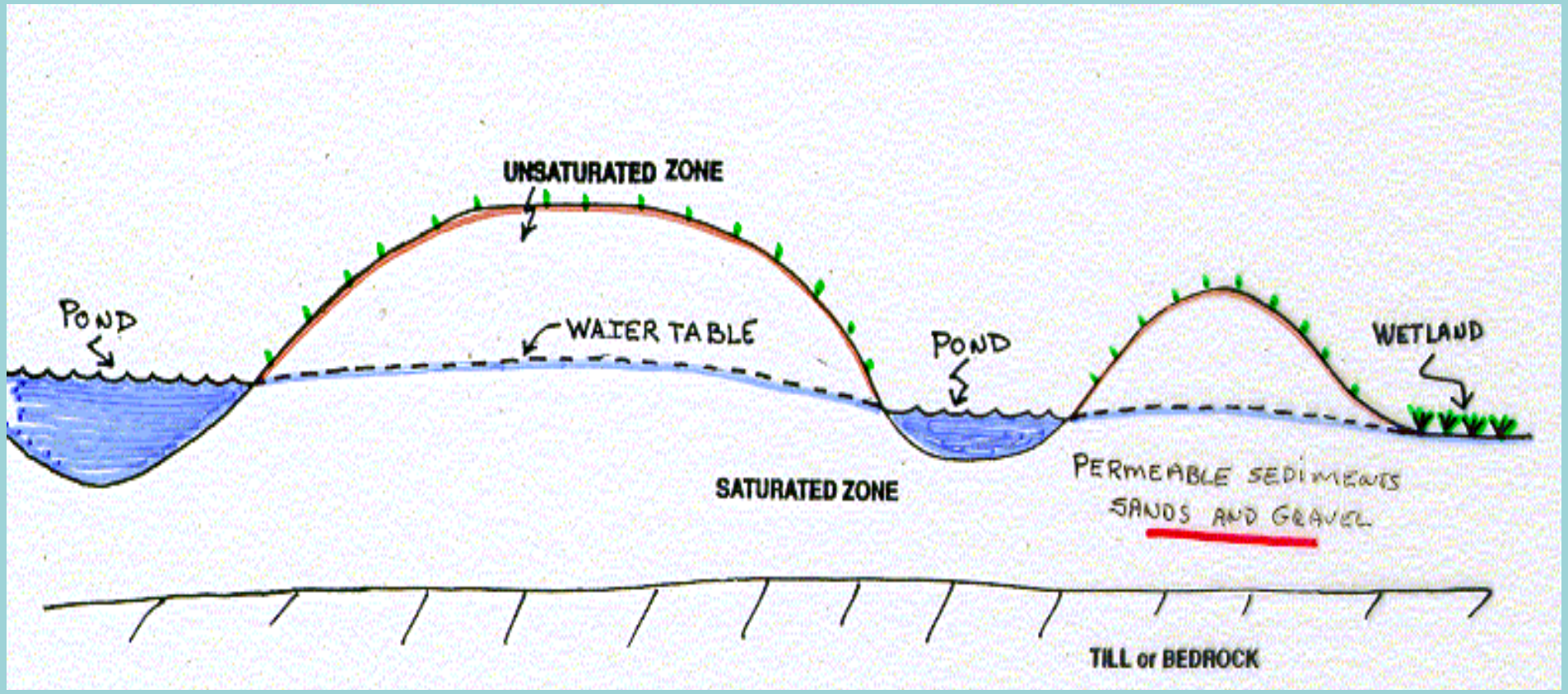
- Subsurface drainage
- Increased runoff
- Decreased base flow to wetlands and watercourses

Outwash
(sand and gravel)



- Deep groundwater
- Few wetlands or vernal pools
- Low runoff
- Critical to recharge of larger aquifers

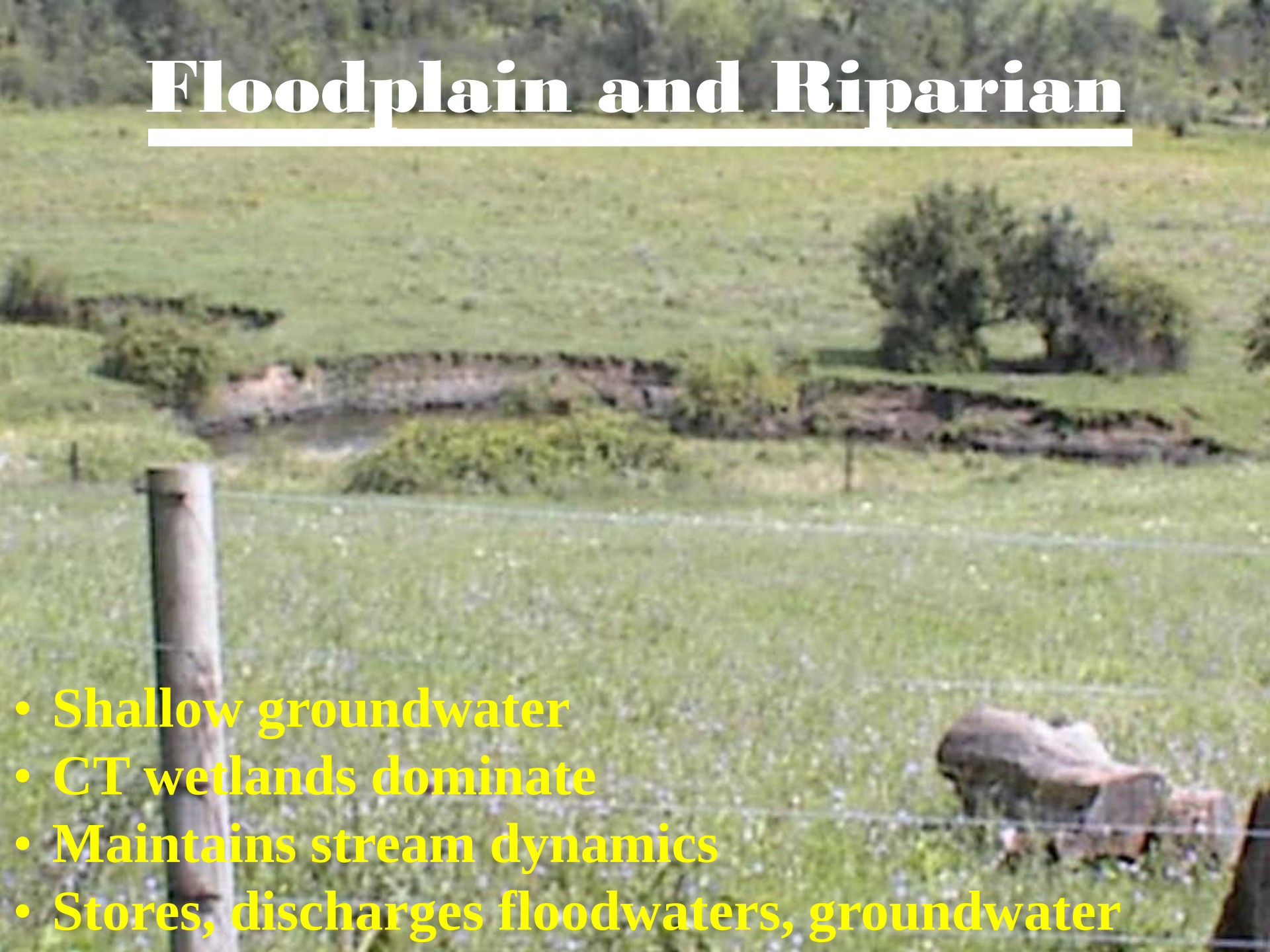
Outwash Hydrology



Development Impacts

- Highest increase in runoff
- Loss of groundwater recharge
- Decreased water levels in wetlands

Floodplain and Riparian



- Shallow groundwater
- CT wetlands dominate
- Maintains stream dynamics
- Stores, discharges floodwaters, groundwater

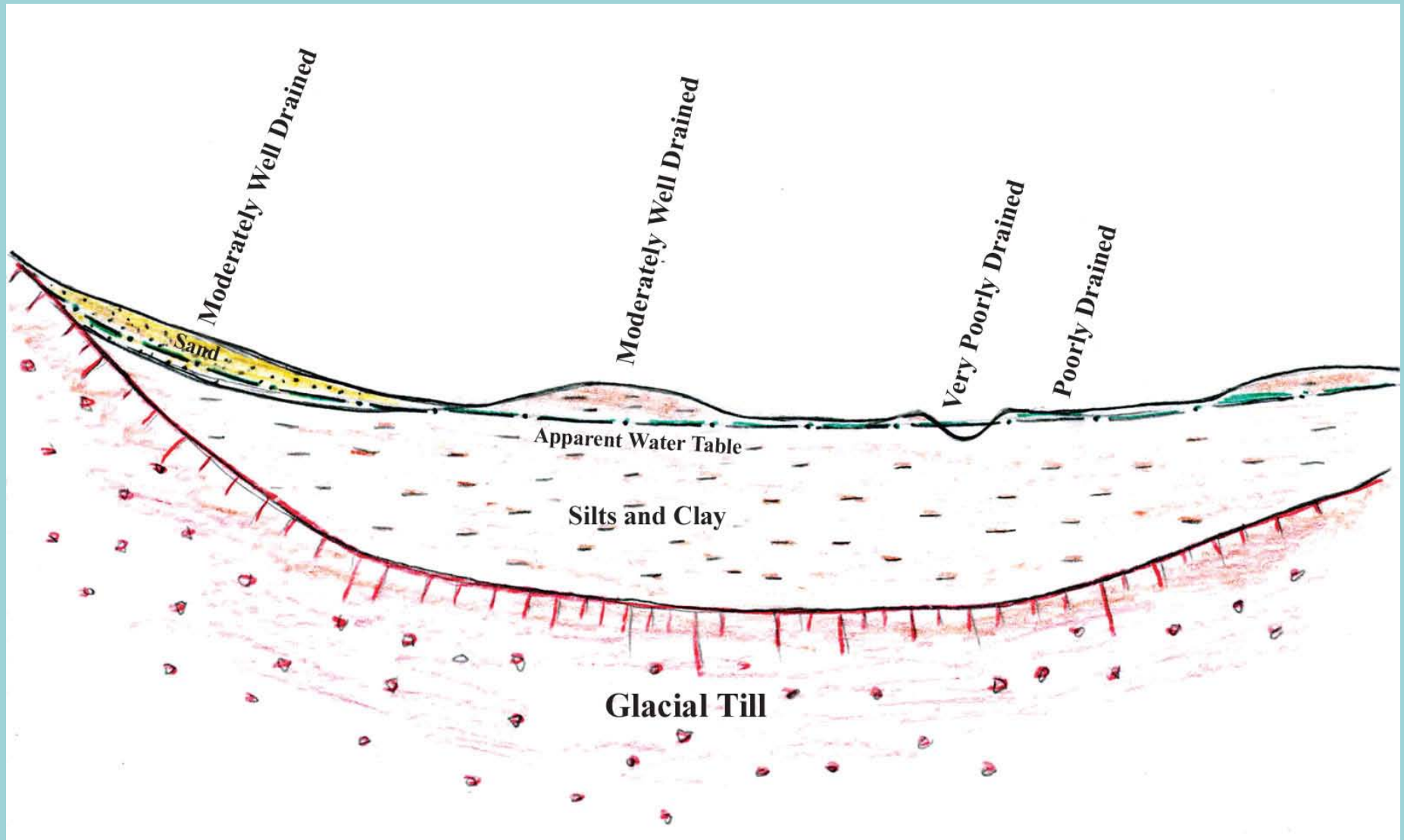
Development Impacts

- Decreased storage for flood events
- Increased flooding frequency
- Wider area impacts

Lacustrine
(silt and clay)

- High surface runoff
- Extensive wetlands and many vernal pools, supported by runoff
- Groundwater both shallow and deep

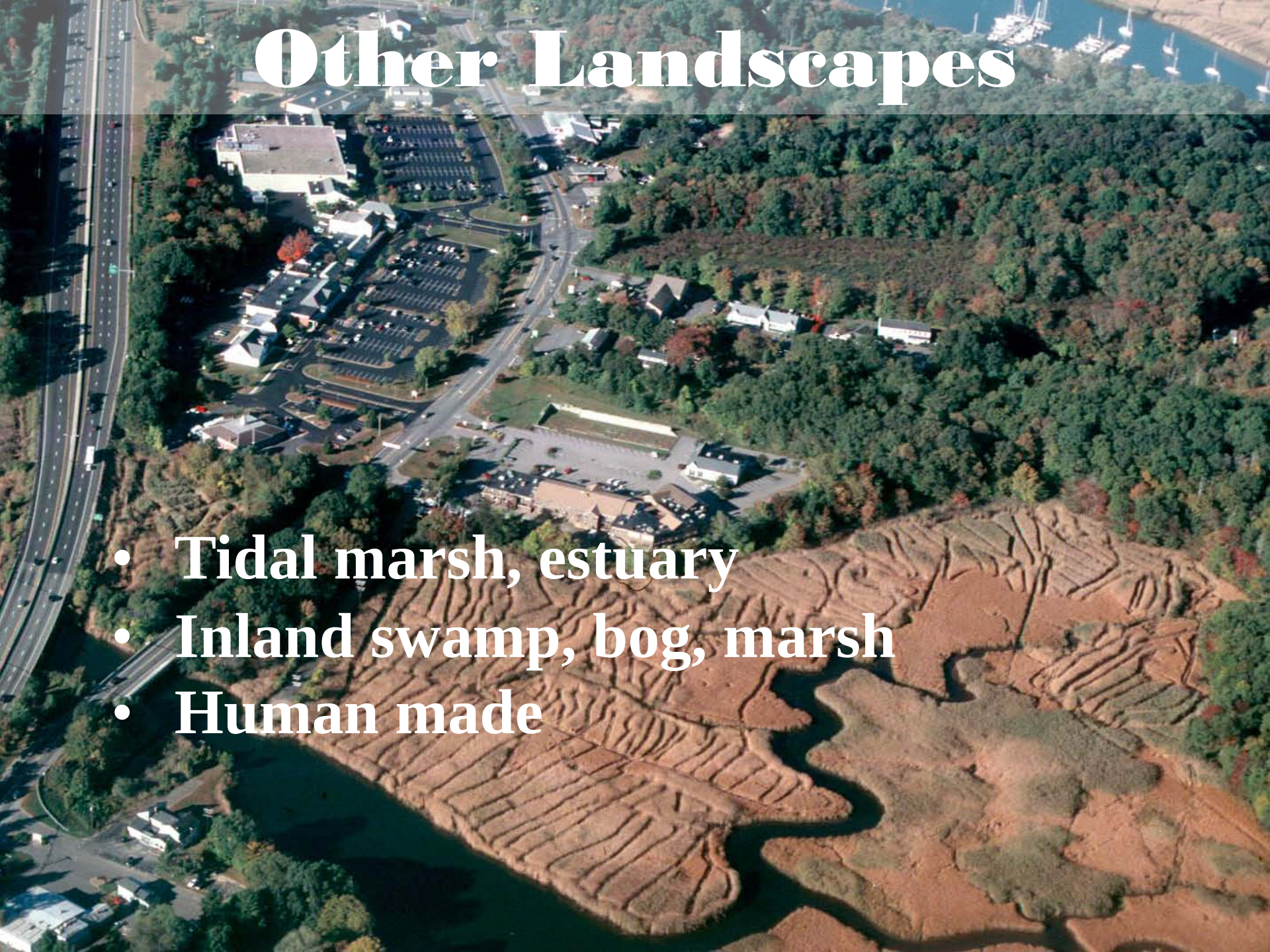
Lacustrine Landscape



Development Impacts

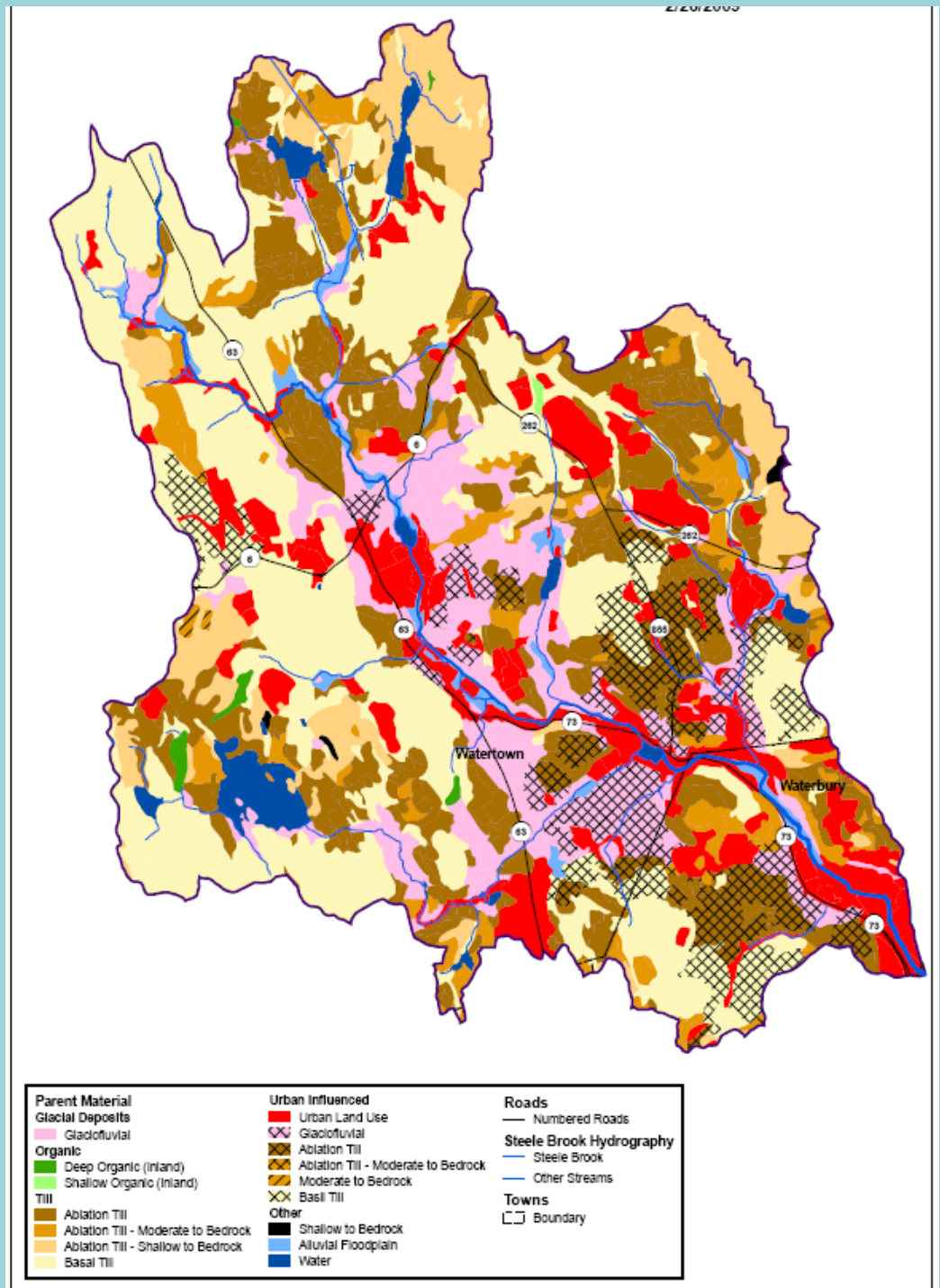
- Increased runoff
- Subsurface drainage for homes and roads diverts groundwater
- Surface runoff captured and diverted

Other Landscapes



- Tidal marsh, estuary
- Inland swamp, bog, marsh
- Human made

Soil landscape functions in a watershed



LID Principals

- Minimize site disturbance
- Work with site hydrology
  - Existing drainage patterns
  - Native soils
- Minimize and disconnect impervious surface
- Apply small scale controls at the source

Soil properties that influence Infiltration and runoff

- Infiltration and Saturated hydraulic conductivity (Ksat)
- Slope
- Depth to
  - water table
  - Bedrock
  - Hardpan

Infiltration

Entry of water into the soil

Permeability *Quality* of soil that enables water to move through it (cm/hr)

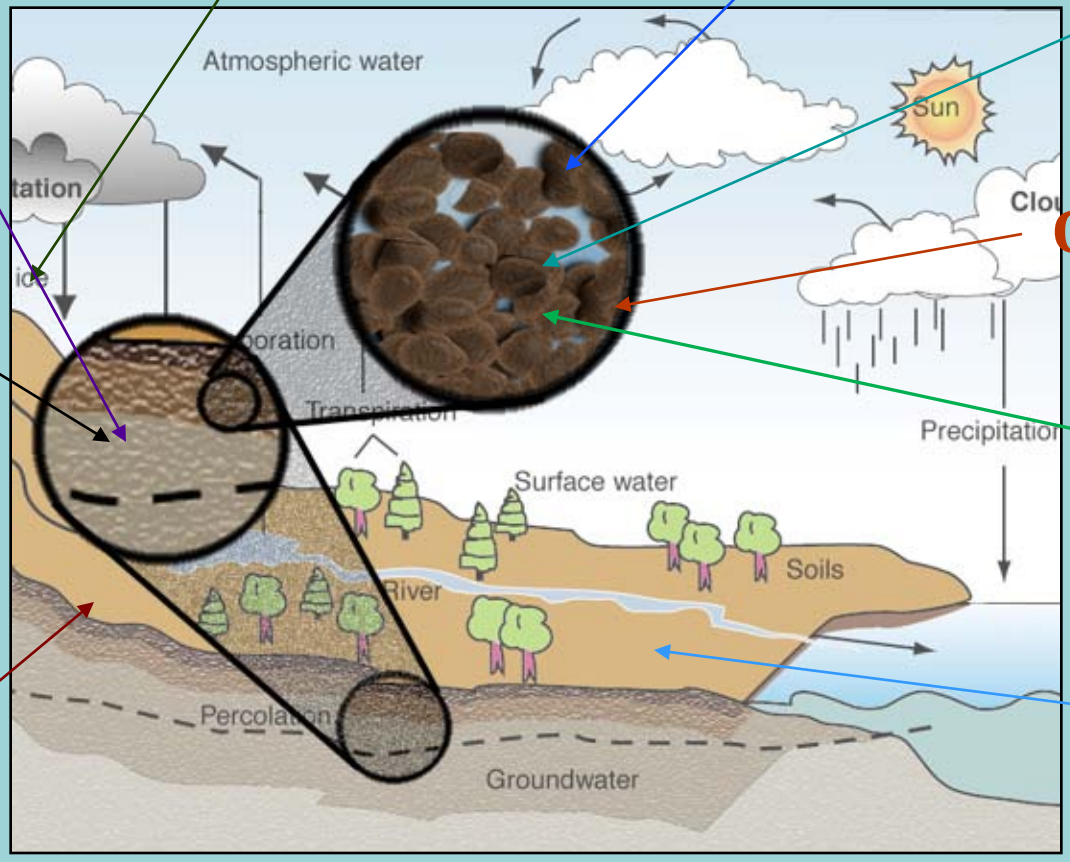
Hydraulic Conductivity

Quantifies ability of soil to transmit water

$Q = KAi$ (cm^3/hr)

Saturated Hydraulic Conductivity (Ksat) With Amoozemeter

Soil Properties That Affect Infiltration and Saturated Hydraulic Conductivity



Pore Space

Slope

Texture

Dense Soil Material

Organic Matter

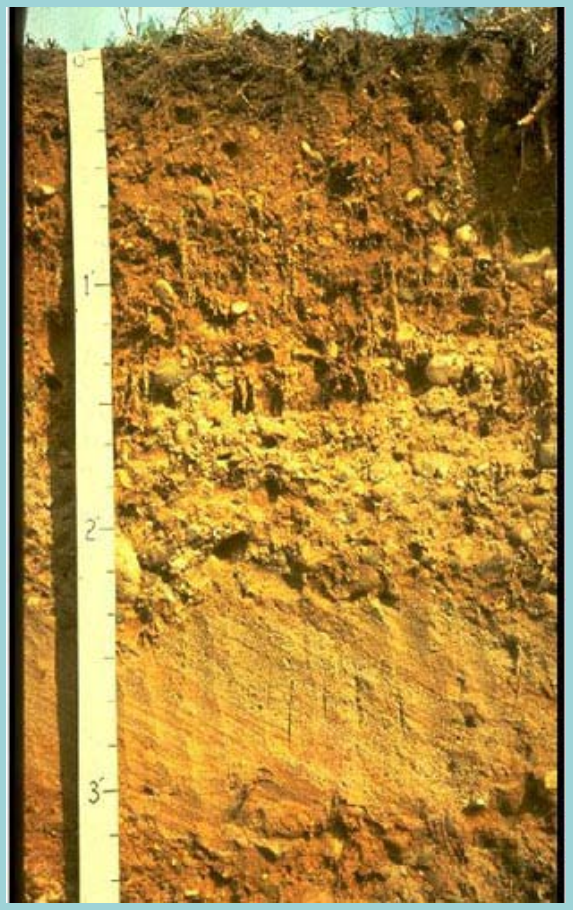
Horizon Depths

Structure

Bedrock and Water Table Depths

Flooding

High Infiltration and permeability



Course textures and loose soil material

Low Infiltration and permeability

Compact till restricts water, movement

Infiltration and Saturated Hydraulic Conductivity Information

- Data
  - Practice specifications
    - Pervious pavement: >.5 inches per hour best
  - Design considerations:
    - A rain garden on soils with low Ksat may need to be larger
  - May need converting to use
- Rating class
- Interpretations

Ksat Class (in/hr)
Very High ≥ 14.7
High 1.4 – 14.7
Moderately High .14 – 1.40
Moderately Low 0.014 – 0.14
Low 0.0014 - 0.014
Very Low < 0.0014

Ksat data is used to develop Hydrologic Soil Group and Runoff class

Sizing a Rain Garden

Step 2: Examine the Soils in Your Proposed Rain Garden

Indicator	Unfavorable Condition	Favorable Condition	Comments/Modifications
Bedrock (ledge)	Exposed bedrock at the proposed site or within one foot of the surface	Can dig a hole at least 2 feet deep without hitting solid bedrock	Consider another location for the rain garden if bedrock is near the surface. Some types of bedrock may allow water to infiltrate through cracks and into groundwater. Other types will not allow infiltration at all and cause overflow.
Soil compaction	Wire flag or probe cannot be inserted into the soil at all	Loose soil at least 2 feet deep	If the soil is compacted, follow attached instructions on how to loosen it OR replace with a mix of 50-60% sand
Soil texture	Clay, sand		

http://www.ct.nrcs.usda.gov/eln-site_assessment.html

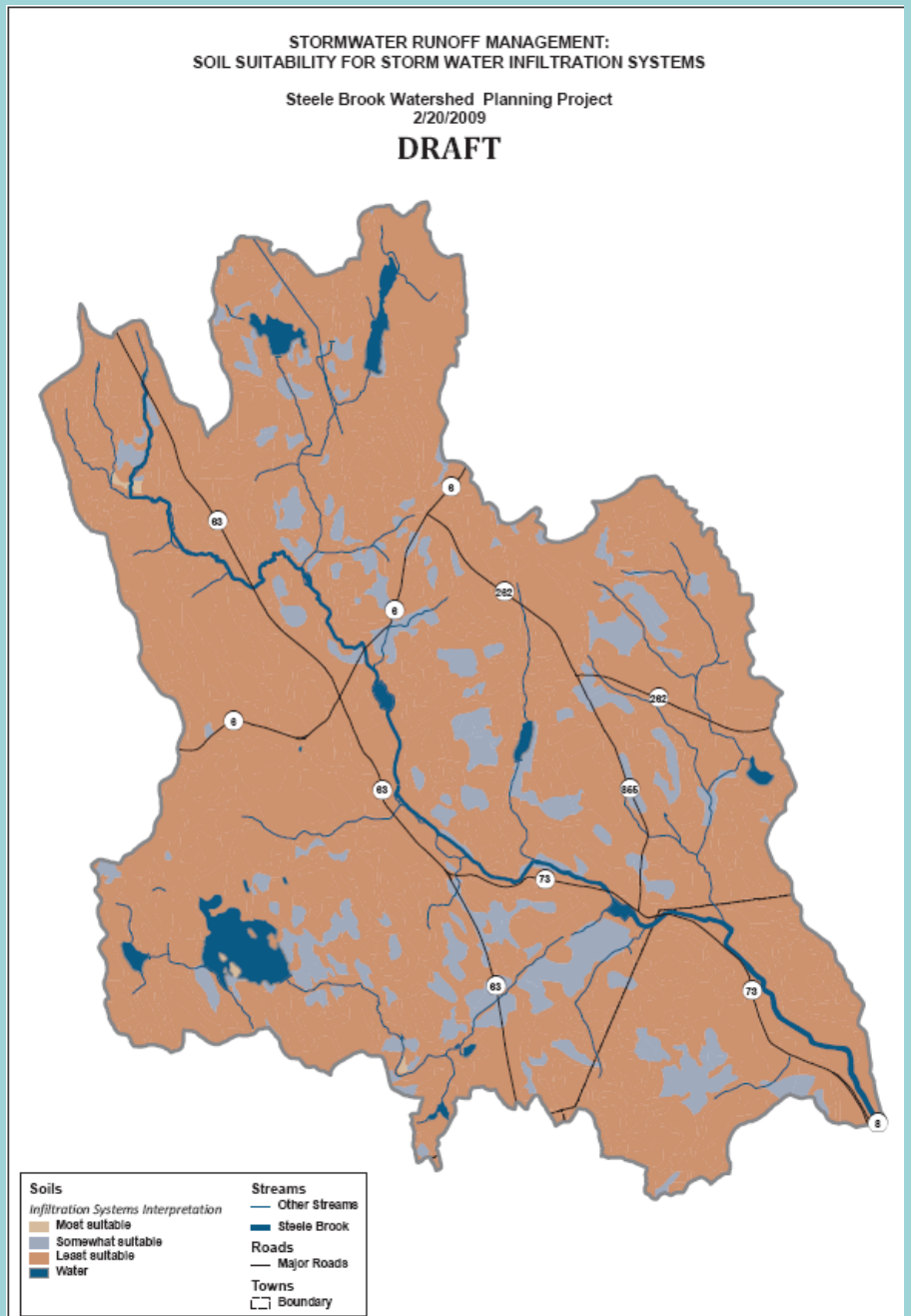
Soil suitability for LID Practices

- Infiltration
- Retention
- Combo / Detention

Soil Survey: Soil Interpretations

Background Information

- **A soil interpretation refers to the behavior of soils in response to human activities. Interpretations are a guide to use and management of soils in a survey area. Soils with similar responses to a particular use or treatment often are grouped together.**
- **These interpretations are designed to be used with the National Cooperative Soil Survey of Connecticut. The mapping was done at the 1:12000 scale. The minimum delineation is about 3 acres.**
- **Maps generated from these ratings are for planning purposes and do not replace an on-site evaluation for siting and design.**

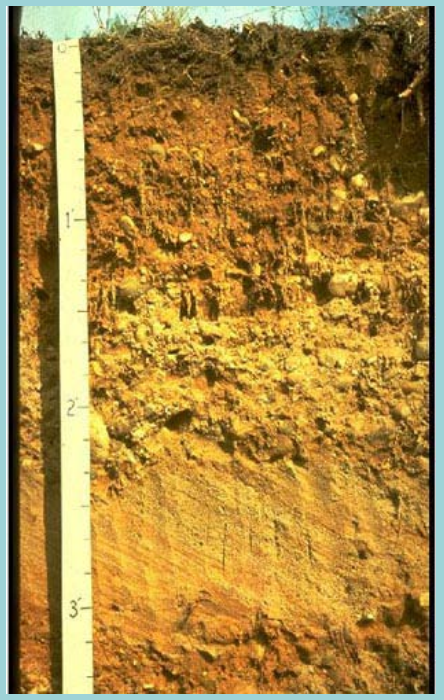


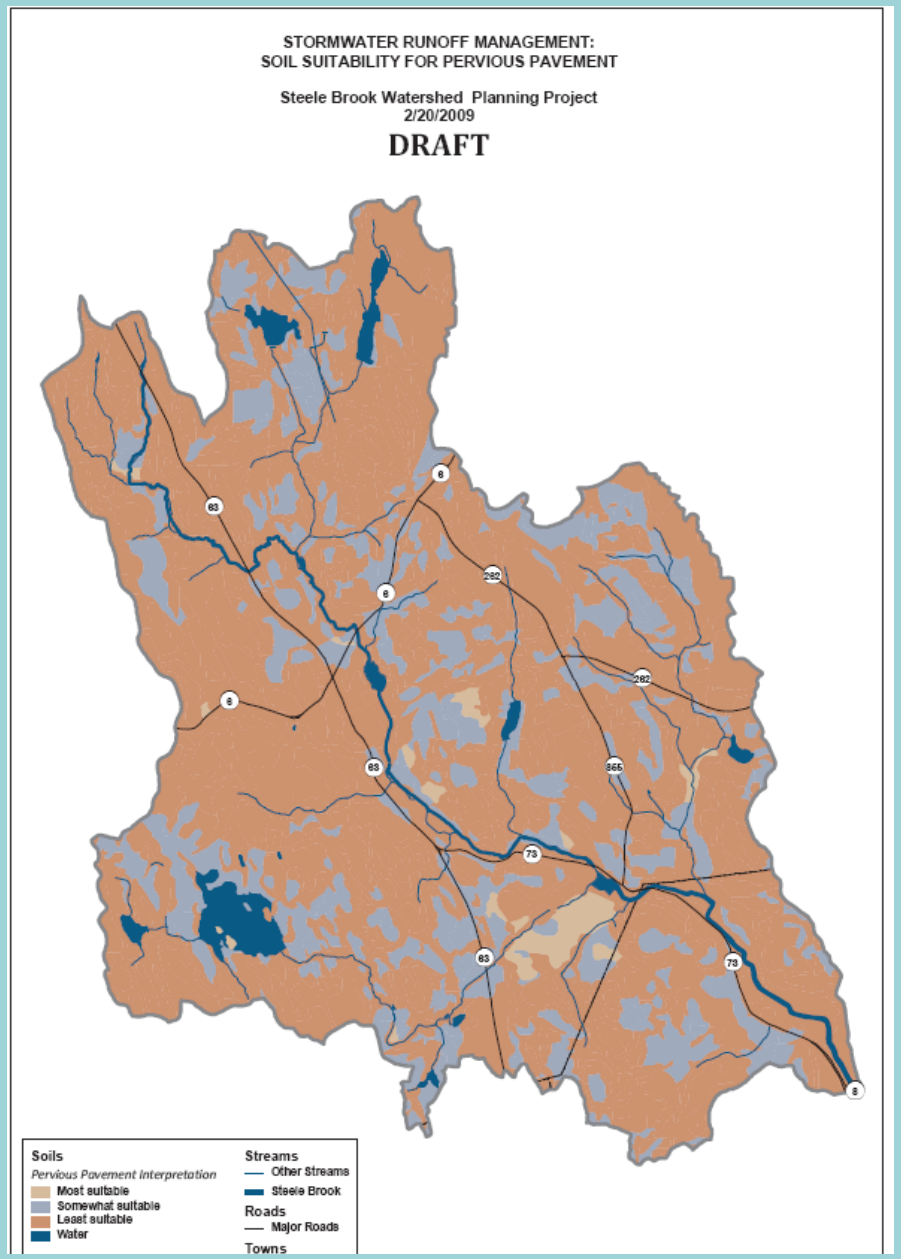
Infiltration Systems

Soils: Very deep, well drained, permeable

Hydrologic Soil Group A

Practices: Large engineered underground infiltration systems, large bioretention practices , dry wells



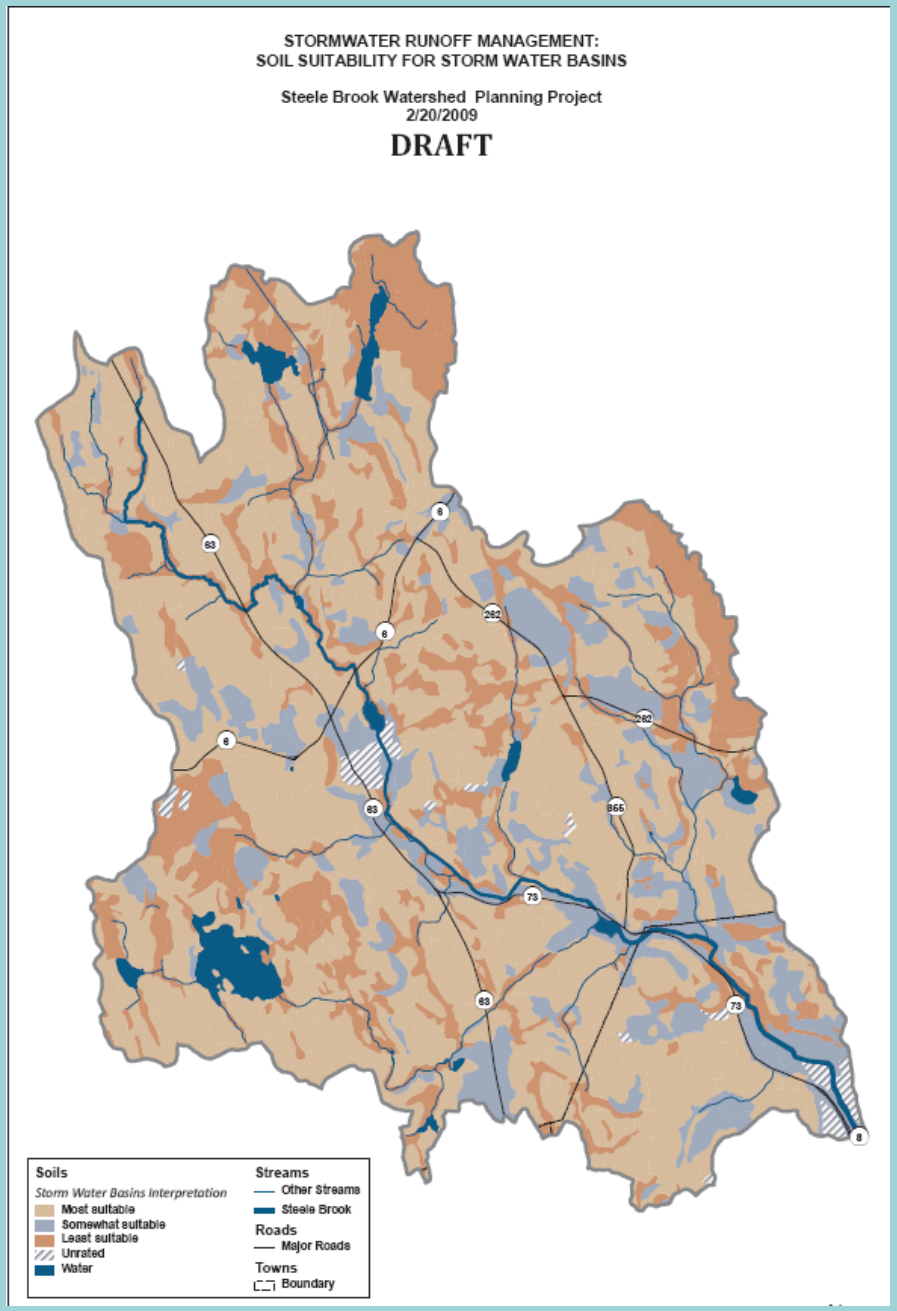


Pervious Pavement

Soils: Nearly level, moderate to rapid permeability, adequate depth to water table and bedrock.

Hydrologic soil groups A and B

Practices:
Porous asphalt or concrete
Reinforced vegetation
Other materials like gravel, cobbles, brick, etc.
Also OK for dry wells

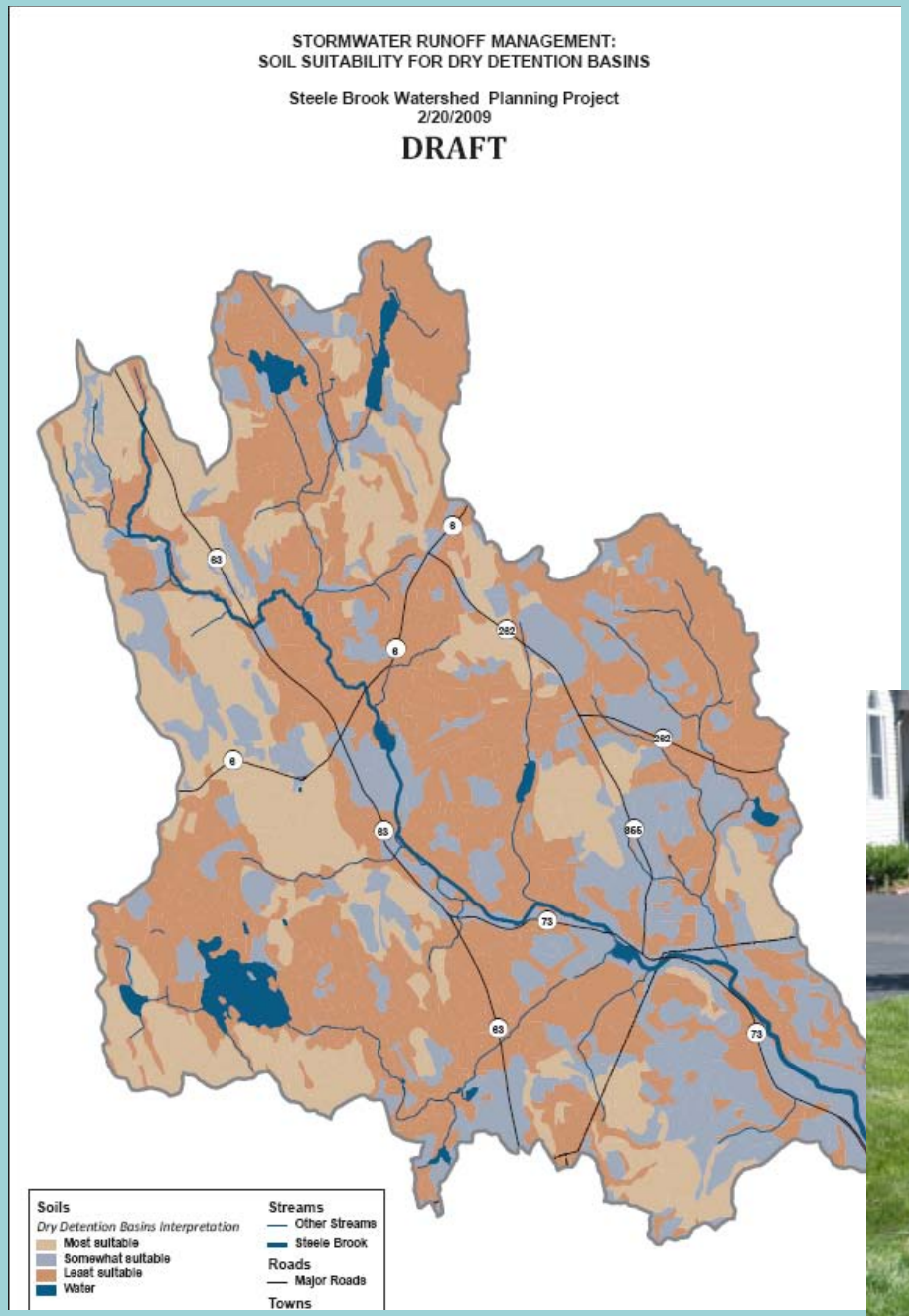


Storm water Basins:

Soils: Excludes very shallow soils, wetland soils, very steep areas.

Hydrologic soil groups A, B, C

Practices: Wide range of practices, especially small scale, rain gardens, swales, buffers, filter strips



Dry Detention Basins

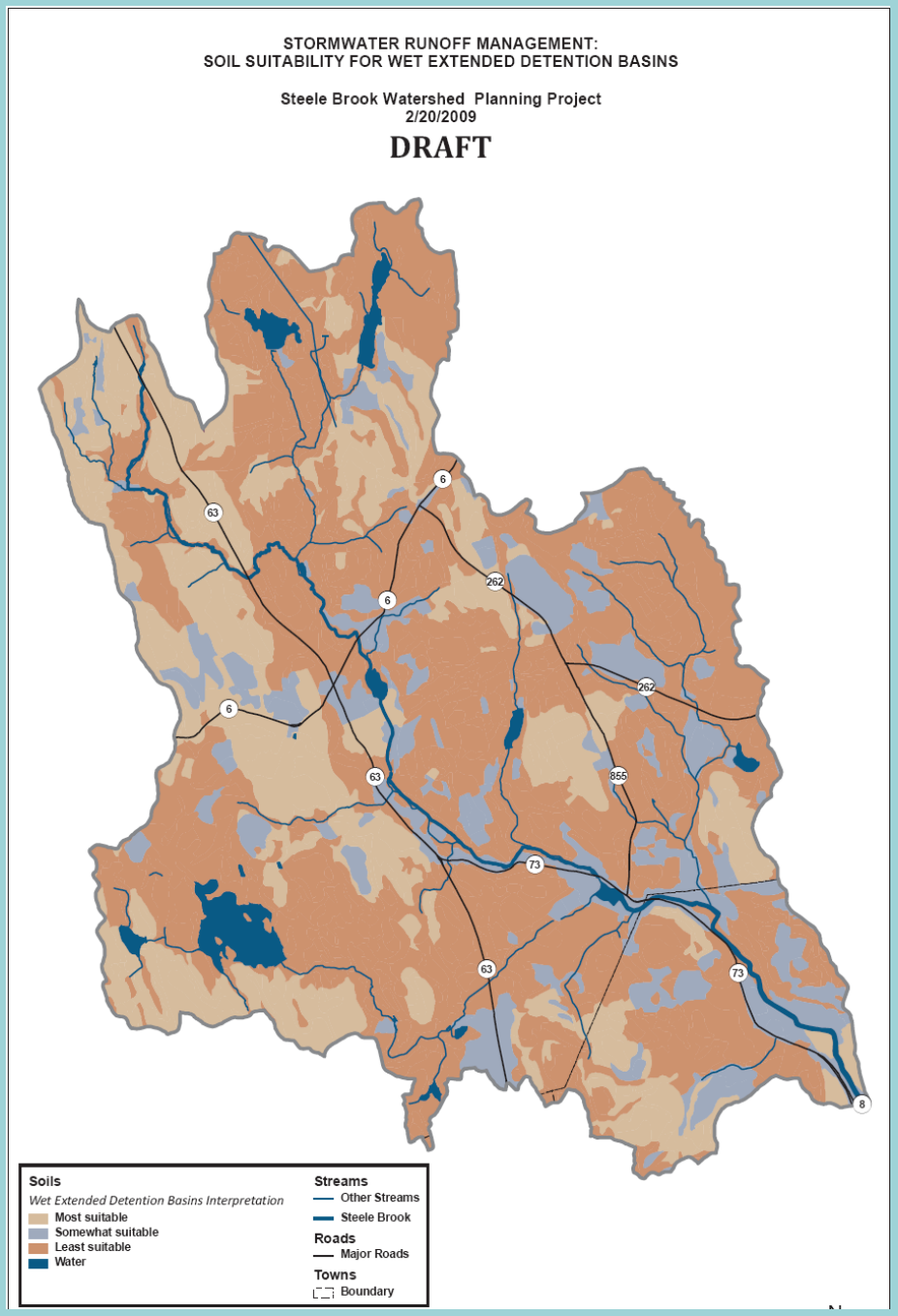
A subset of stormwater basins

Moderate or low permeability, deep, well drained.

Designed to detain runoff briefly.

Hydrologic soil group B and C

Could be used for a swale or rain garden where short term detention is desired



Wet Extended Detention Basins

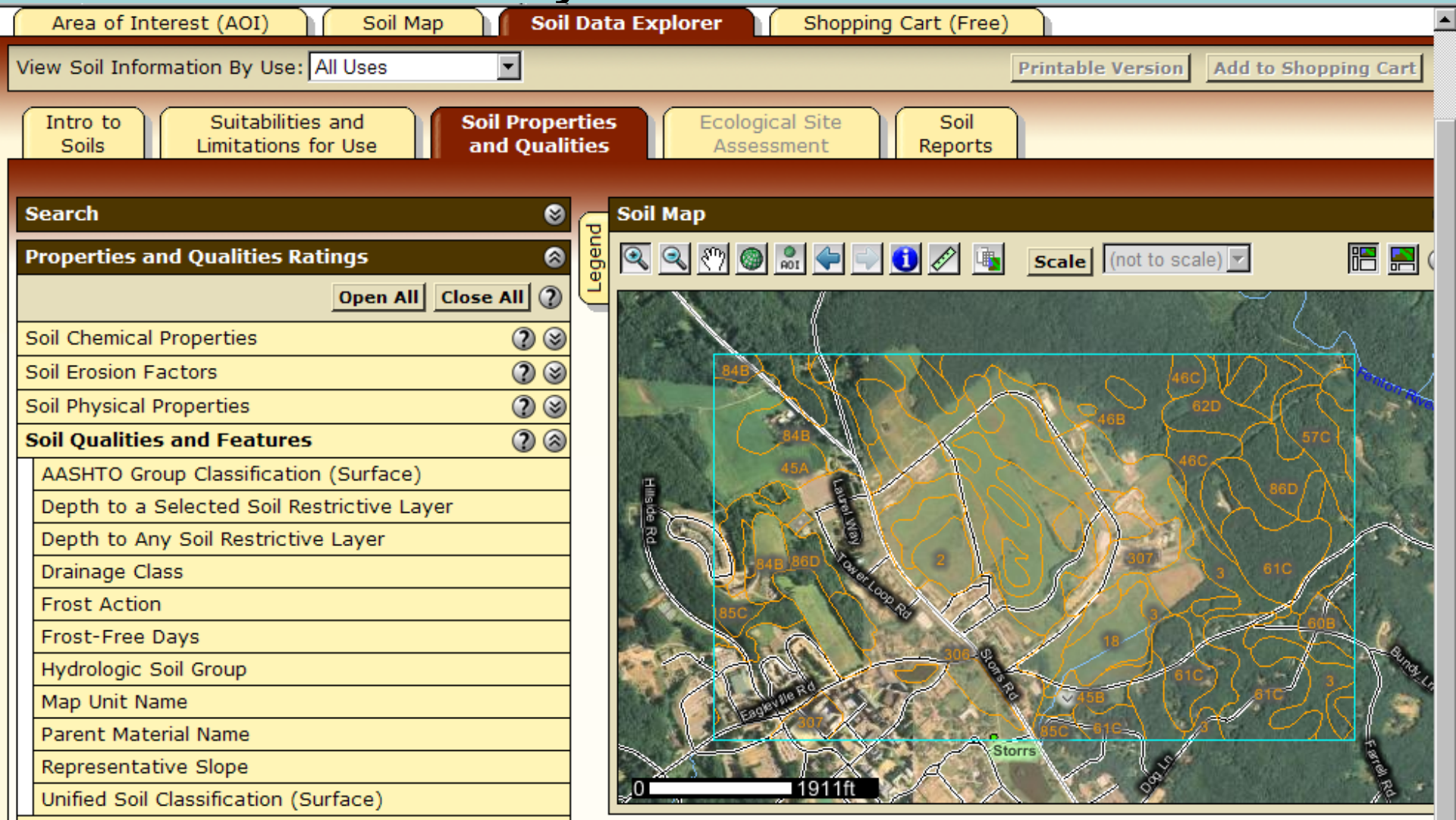
A subset of storm water basins

Low permeability for longest detention (without using wetlands)

Hydrologic soil group C
Practices: Storm water basins with longer detention times.
Could be used for a swale or rain garden where extended detention is desired

Putting it all together / getting info

- Web soil survey



Bookmarks

United States Department of Agriculture
Natural Resources Conservation Service
In cooperation with The Connecticut Agricultural Experiment Station, The Storrs Agricultural Experiment Station, and Connecticut Department of Environmental Protection

Soil Survey of the State of Connecticut

Putting it all together / getting info

A	B	C	D	E	F	G	H	I	J	K	L
Map Unit S	Series	Infiltration Systems	Limitations	Porous Pavement	Limitations	Stormwater Basins	Limitations	Wet edended Detention Basins	Limitations	Dry Detention Basins	Limitations
2	Ridgebury	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
3	Ridgebury	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
3	Leicester	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
3	Whitman	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
4	Leicester	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
5	Wilbraham	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
6	Wilbraham	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
6	Menlo	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
7	Mudgepond	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
8	Mudgepond	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
8	Alden	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
9	Scitico	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
9	Shaker	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
9	Maybid	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
10	Raynham	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
12	Raypol	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
13	Walpole	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
14	Fredon	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
15	Scarboro	water table	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
16	Halsey	water table	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table	Least suitable	water table
17	Timakwa	Least suitable	flooding, water table	Least suitable	flooding, water table	Least suitable	flooding, water table	Least suitable	flooding, water table	Least suitable	flooding, water table
17	Natchaug	Least suitable	flooding, water table	Least suitable	flooding, water table	Least suitable	flooding, water table	Least suitable	flooding, water table	Least suitable	flooding, water table
18	Catden	Least suitable	flooding, water table	Least suitable	flooding, water table	Least suitable	flooding, water table	Least suitable	flooding, water table	Least suitable	flooding, water table
18	Freetown	Least suitable	flooding, water table	Least suitable	flooding, water table	Least suitable	flooding, water table	Least suitable	flooding, water table	Least suitable	flooding, water table
20A	Ellington	Least suitable	water table	Least suitable	water table	Most suitable		Least suitable	too permeable	Least suitable	too permeable
21A	Ninigret	Least suitable	water table	Least suitable	water table	Most suitable		Least suitable	too permeable	Least suitable	too permeable
21A	Tisbury	Least suitable	water table	Least suitable	water table	Most suitable		Least suitable	too permeable	Least suitable	too permeable
22A	Hero	Least suitable	water table	Least suitable	water table	Most suitable		Least suitable	too permeable	Least suitable	too permeable
22B	Hero	Least suitable	water table	Least suitable	water table	Most suitable		Least suitable	too permeable	Least suitable	too permeable
23A	Sudbury	Least suitable	water table	Least suitable	water table	Most suitable		Least suitable	too permeable	Least suitable	too permeable
24A	Deerfield	Least suitable	water table	Least suitable	water table	Most suitable		Least suitable	too permeable	Least suitable	too permeable
25A	Brancroft	Least suitable	water table / low permeability	Least suitable	water table / low permeability	Most suitable		Most suitable		Most suitable	
25B	Brancroft	Least suitable	water table / low permeability	Least suitable	water table / low permeability	Most suitable		Most suitable		Most suitable	
25C	Brancroft	Least suitable	water table / low permeability	Least suitable	water table / low permeability	Most suitable		Most suitable		Most suitable	
26A	Berlin	Least suitable	water table / low permeability	Least suitable	water table / low permeability	Most suitable		Most suitable		Most suitable	
26B	Berlin	Least suitable	water table / low permeability	Least suitable	water table / low permeability	Most suitable		Most suitable		Most suitable	
27A	Belgrade	Least suitable	water table / low permeability	Least suitable	water table	Most suitable		Somewhat suitable	too permeable	Most suitable	
28A	Elmridge	Least suitable	water table / low permeability	Least suitable	water table	Most suitable		Most suitable		Most suitable	
28B	Elmridge	Least suitable	water table / low permeability	Least suitable	water table	Most suitable		Most suitable		Most suitable	
29A	Agawam	Most suitable		Most suitable		Most suitable		Least suitable	too permeable	Least suitable	too permeable
29B	Agawam	Somewhat suitable	slope	Somewhat suitable	slope	Most suitable		Least suitable	too permeable	Least suitable	too permeable
29C	Agawam	Least suitable	slope	Least suitable	slope	Most suitable		Least suitable	too permeable	Least suitable	too permeable
30A	Branford	Most suitable		Most suitable		Most suitable		Least suitable	too permeable	Least suitable	too permeable
30B	Branford	Somewhat suitable	slope	Most suitable		Most suitable		Least suitable	too permeable	Least suitable	too permeable
30C	Branford	Least suitable	slope	Least suitable	slope	Most suitable		Least suitable	too permeable	Least suitable	too permeable
31A	Copake	Most suitable		Most suitable		Most suitable		Least suitable	too permeable	Least suitable	too permeable
31B	Copake	Somewhat suitable	slope	Somewhat suitable	slope	Most suitable		Least suitable	too permeable	Least suitable	too permeable
31C	Copake	Least suitable	slope	Least suitable	slope	Most suitable		Least suitable	too permeable	Least suitable	too permeable
32A	Haven	Most suitable		Most suitable		Most suitable		Least suitable	too permeable	Least suitable	too permeable
32A	Enfield	Most suitable		Most suitable		Most suitable		Least suitable	too permeable	Least suitable	too permeable
32B	Haven	Somewhat suitable	slope	Somewhat suitable	slope	Most suitable		Least suitable	too permeable	Least suitable	too permeable
32B	Enfield	Somewhat suitable	slope	Somewhat suitable	slope	Most suitable		Least suitable	too permeable	Least suitable	too permeable
32C	Haven	Least suitable	slope	Least suitable	slope	Most suitable		Least suitable	too permeable	Least suitable	too permeable
32C	Enfield	Least suitable	slope	Least suitable	slope	Most suitable		Least suitable	too permeable	Least suitable	too permeable
33A	Hartford	Most suitable		Most suitable		Most suitable		Least suitable	too permeable	Least suitable	too permeable
33B	Hartford	Somewhat suitable	slope	Somewhat suitable	slope	Most suitable		Least suitable	too permeable	Least suitable	too permeable
34A	Merrimac	Most suitable		Most suitable		Most suitable		Least suitable	too permeable	Least suitable	too permeable


On-site investigation!
20
40
60
80
1


Questions?