Infiltration

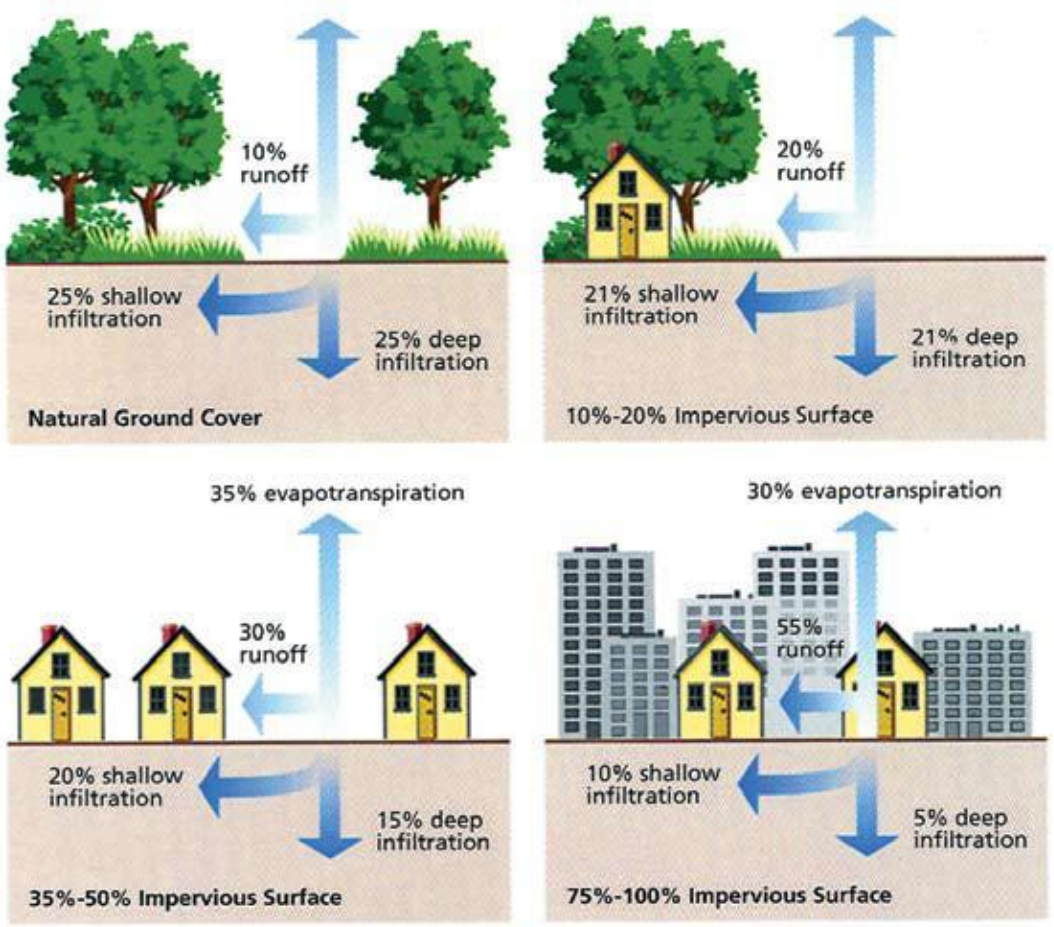
"Keep Water Where it Falls"

Frank Franciosi Novozymes

Infiltration Defined

- **Infiltration** refers to the movement of water into the **soil** layer. The rate of this movement is called the **infiltration rate**. If rainfall intensity is greater than the infiltration rate, water will accumulate on the surface and **runoff** will begin.

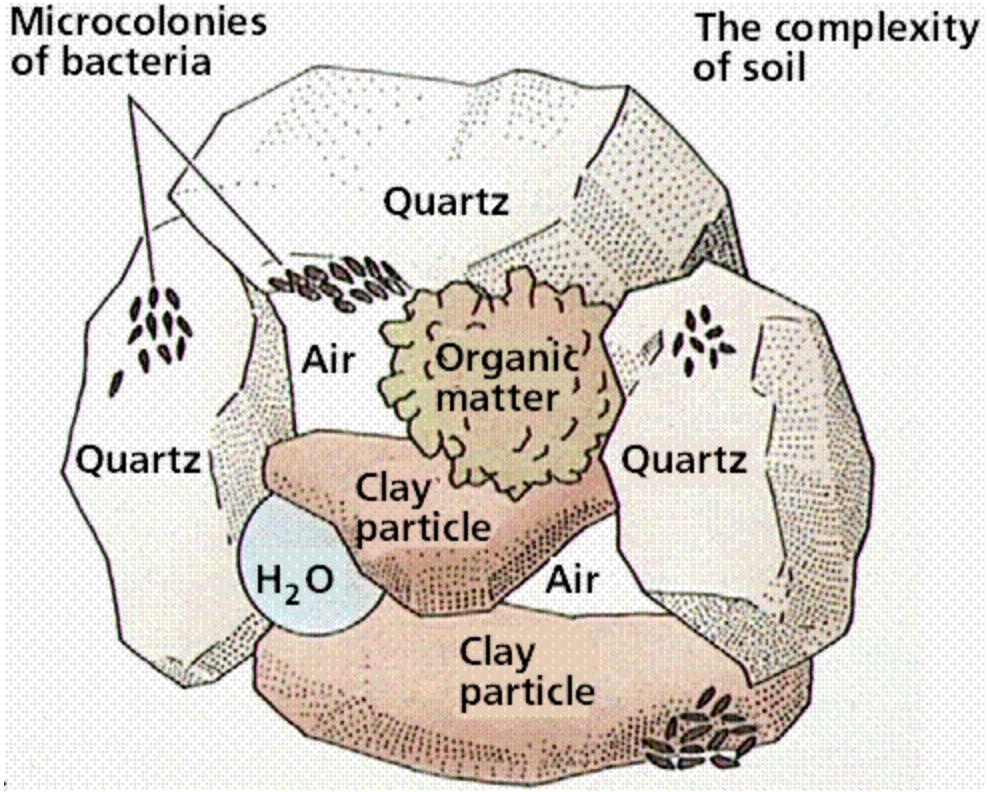
Mimicking Nature



Infiltration

Factors That Influence Soil Water Movement

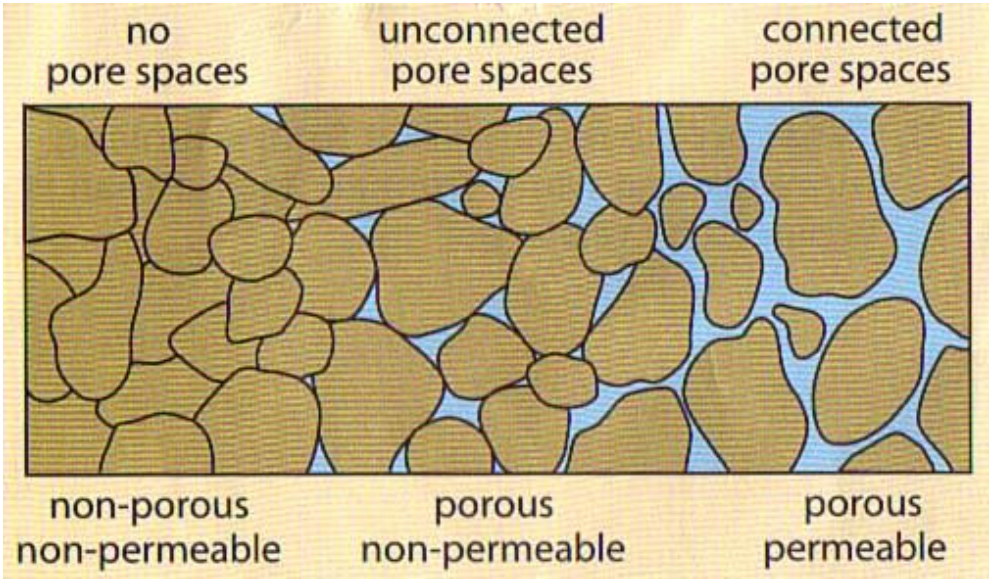
- Gravity
- Capillary action
- Soil porosity & permeability
- Soil layering
- Organic matter
- Deep rooted vegetation



Factors That Influence Soil Water Movement

Soil porosity

- Porosity is a measure of the open space within soil or rock
- Pore spaces represent the reservoir for holding water.



Infiltration

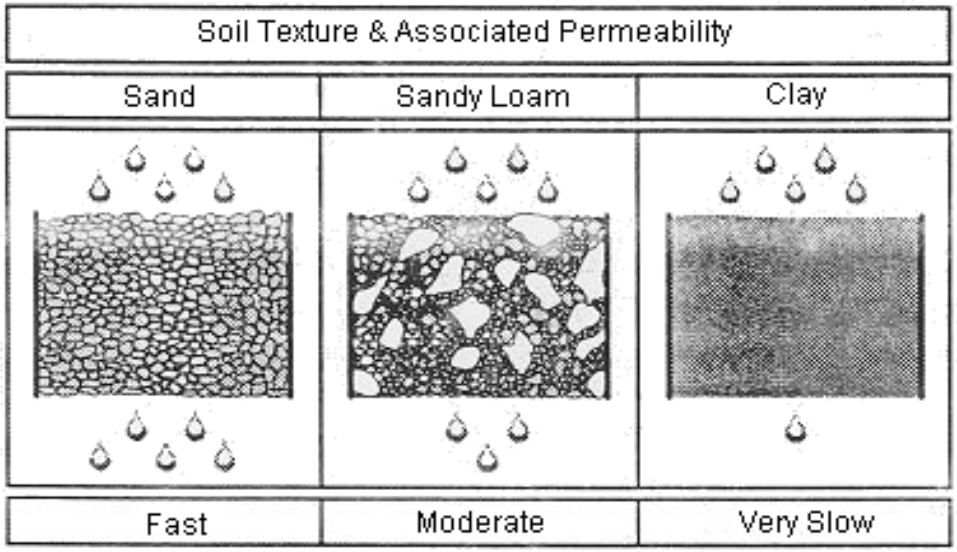
Factors That Influence Soil Water Movement

- Permeability is a function of the sizes of particles, pores, and the way they are arranged.
- Permeability is how quickly water will flow through the soil
- The straighter and larger the pores, the faster the permeability.
- Clays tend to reduce the porosity and permeability of soil material due to the small pores.
- Generally, surface horizons have a larger porosity and subsoils have smaller porosity and reduced permeability

Factors That Influence Soil Water Movement

Soil texture

- Sandy soils will have fast water transmission and low water retention
- Clay soil will have slow water transmission and high water retention



Bulk Density of Soil Types

Table 1. General relationship of soil bulk density to root growth based on soil texture.

Soil Texture	Ideal bulk densities for plant growth (grams/cm^3)	Bulk densities that affect root growth (grams/cm^3)	Bulk densities that restrict root growth (grams/cm^3)
Sands, loamy sands	< 1.60	1.69	> 1.80
Sandy loams, loams	< 1.40	1.63	> 1.80
Sandy clay loams, clay loams	< 1.40	1.60	> 1.75
Silts, silt loams	< 1.40	1.60	> 1.75
Silt loams, silty clay loams	< 1.40	1.55	> 1.65
Sandy clays, silty clays, clay loams	< 1.10	1.49	> 1.58
Clays (> 45% clay)	< 1.10	1.39	> 1.47

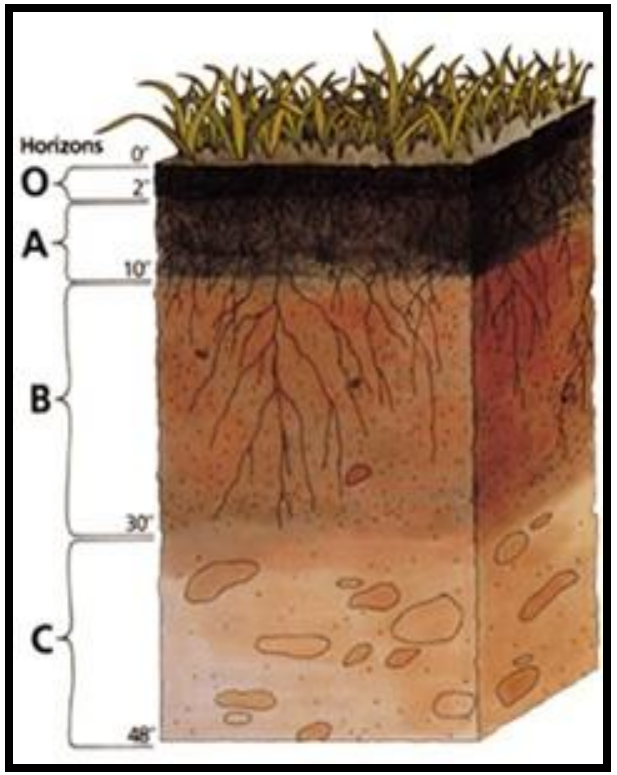
Source: Protecting Urban Soil Quality USDA-NRCS

NC Native Soils

- These soils are called Ultisols.
- They are strongly leached, acid forest soils with low native fertility.
- Most have low percentages of SOM. (1% or less)
- Our nation's most fertile soils have SOM readings in the 5-7% range
- A soil with insufficient organic matter may not hold water adequately or supply an environment for beneficial microbes
- These soils become quickly dependent on high levels of watering and multiple fertilizer applications and pesticides to maintain the appearance that our society expects

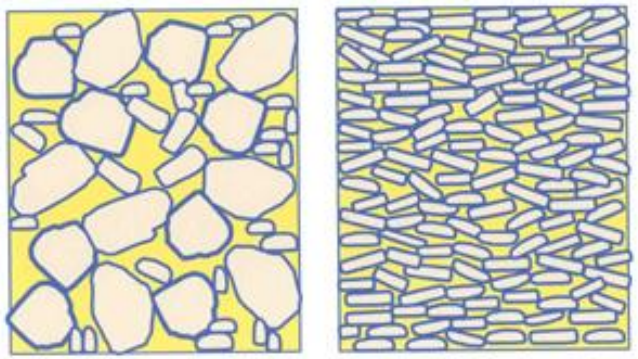
The Soil Profile

- Topsoil- "O"& "A" Horizons
  - Major zone of root development for plants
- Subsoil-"B" Horizon
  - Harder for plant roots to penetrate
  - Less reservoir of nutrients and moisture
  - Often less drainage



Disturbed Soils

- Heavy equipment compaction



Disturbed Soils

- Developer's removing and selling topsoil and leaving compacted subsoil

Disturbed Soils

Sod installed on disturbed soils

- No “O” or “A” soil horizon
- Poor root development
- Increases the need to water more
- Increase need for chemical inputs

Disturbed Soils

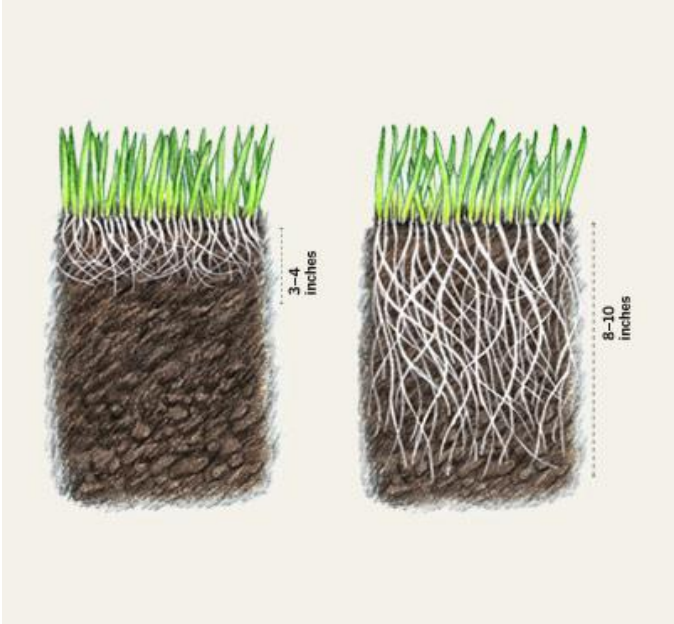
Tree installed on disturbed soils

- Poor root development

Promoting Deep Rooted Vegetation

Improving soil health to encourage deep rooting by providing:

- Good soil tilth
- Sufficient depth
- Sufficient, but not excessive, nutrient supply
- Good soil drainage
- Large population of beneficial organisms



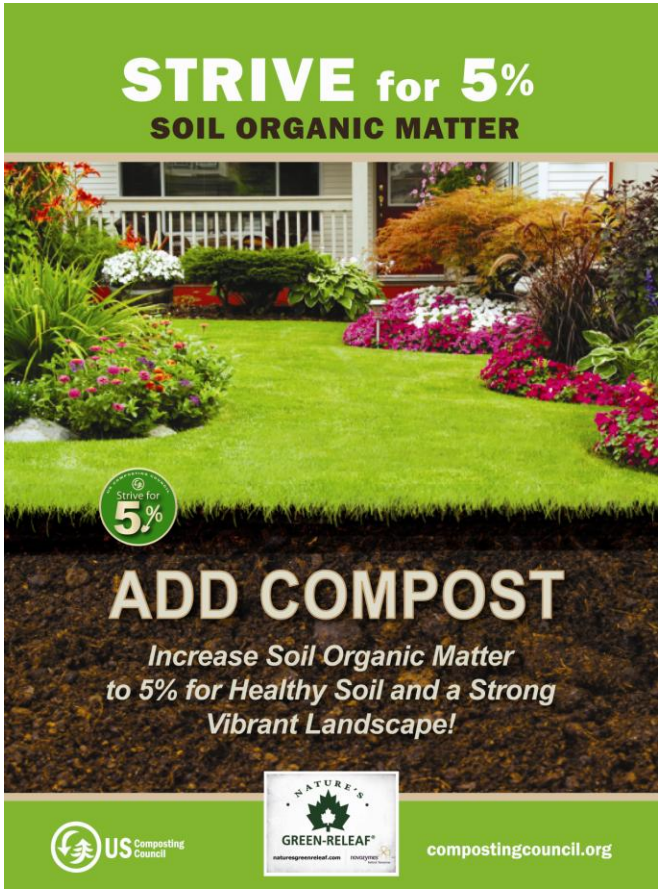
Soil Restoration

Strategies

- Evaluate current conditions
- Physical soil loosening, ripping, tilling or subsoiling
- Adding organic matter by amending with compost and incorporating

Photo credit

Soil Restoration



US COMPOSTING COUNCIL
Strive for 5%

Compost Quality

US Composting Council
Seal of Testing Assurance

What is good compost?

- Stable – low biological activity level
- Mature – aged for optimum plant growth
- Nutrient content – 0.5-2.5% N, 0.2-2.0% P and 0.3-1.5% K
- Organic matter content – 50-60%
- Moisture content – 40-50%
- Water holding capacity - > 100%
- pH – 6.0-7.5
- Soluble Salts - < 6 mmhos/cm
- Bulk density – 800-1,000 lbs/cy
- C:N Ratio 13:1

US Composting Council
Seal of Testing Assurance

Benefits of Compost Use

Physical:
Improved structure
Moisture management

Chemical:
Modifies and stabilizes pH
Increases CEC
Provides nutrients

Biological:
Provides soil microorganisms
Suppresses plant diseases

Other:
Binds/degrades contaminants
Binds nutrients
Sequesters air-borne carbon

Soil Organic Matter

- The percentage of organic content directly relates to water holding capacity
- Each 1% of Organic Matter adds about 1.5% to available water capacity
- For every 1% of Organic Matter content, the soil can hold 16,500 gallons of plant available water per acre of soil down to one foot in depth

Source: National Sustainable Agriculture Information Service-(ATTRA)

Water Savings

- A 10,000 square foot lawn would hold 18,800 gallons of plant available water that would otherwise not be held and made available
- A town of 5,000 residences each with 10,000 square feet of lawn could potentially save 94 million gallons of water a year as a result of increased organic matter content in the soil by 5%

Source: National Sustainable Agriculture Information Service-(ATTRA)

Model Ordinances

Greeley Colorado

- "Because soil amended with compost requires less water (as much as 30% less), the city of Greeley is requiring proof of compost to obtain a variance to water your new lawn."
- Minimum rate of 4 cubic yards per 1,000 square feet of area tilled into a depth of 6-8 inches

Model Ordinances

City of Leander Texas

- All new Landscapes (non-residential and residential) are required to have a minimum of six inches of soil depth in areas planted with turfgrass.
- The 6" minimum soil depth will consist of 75% soil blended with 25% compost. The soil/compost blend shall be incorporated into the top two inches of the native soil

Soil BMP Requirements

Washington

DOE Stormwater Manual BMP t 5.13 --Soil Quality and Depth

- Building permit requires achieving a post-construction soil standard to preserve and restore soil quality and meet new code requirements
- Four options
  - Leave native soil undisturbed and protect from compaction
  - Amend existing soil in place (pre-approved amendment rate of 2.5 " to a depth of 8 inches
  - Import topsoil mix with 8-13% organic matter content
  - Stockpile site duff and topsoil and reapply after grading and construction 8" minimum depth

Soil BMP Requirements

Delaware

14.0 Soil Amendments

Definition:

Soil Amendment (also called soil restoration) is a technique applied after construction to till compacted soils and restore their porosity by amending them with compost. These soil amendments can reduce the generation of runoff from compacted urban lawns and may also be used to enhance the performance of impervious cover disconnections and grass channels.

14.1 Soil Amendment Stormwater Credit Calculations

Soil Amendment does not receive a retention allowance. However, the use of soil amendments in accordance with this specification allows disturbed areas to receive a reduction credit for the annual runoff. The adjustment varies depending on the soil's Hydrologic Soil Group. Pollutant loads are assumed to be reduced by the equivalent reduction in runoff. **Table 14.1** summarizes the runoff and pollutant reduction credits for this practice. Soil amendments can also enhance the performance of other runoff reduction practices that rely on surface infiltration. Runoff and pollutant reduction credits for these types of applications are discussed in the respective specifications for those practices.

Soil BMP Requirements

Delaware

Table 14.3. Short-Cut Method to Determine Compost and Incorporation Depths

	Contributing Impervious Cover to Soil Amendment Area Ratio [1]			
	IC/SA = 0 [2]	IC/SA = 0.5	IC/SA = 0.75	IC/SA = 1.0 [3]
Compost (in) [4]	2 to 4 [5]	3 to 6 [5]	4 to 8 [5]	6 to 10 [5]
Incorporation Depth (in)	6 to 10 [5]	8 to 12 [5]	15 to 18 [5]	18 to 24 [5]
Incorporation Method	Tiller	Tiller	Excavation + Mixing	Excavation + Mixing

Notes:
[1] IC = contrib. impervious cover (sq. ft.) and SA = surface area of compost amendment (sq. ft.)
[2] For amendment of areas that do not receive off-site impervious cover runoff
[3] In general, IC/SA ratios greater than 1 should be avoided
[4] Average depth of compost added
[5] Lower end for A/B soils, higher end for C/D soils

Soil BMP Requirements

Pennsylvania

BMP 6.7.3: Soil Amendment & Restoration

Soil amendment and restoration is the process of improving disturbed soils and low organic soils by restoring soil porosity and/or adding a soil amendment, such as compost, for the purpose of re-establishing the soil's long-term capacity for infiltration and pollution removal.

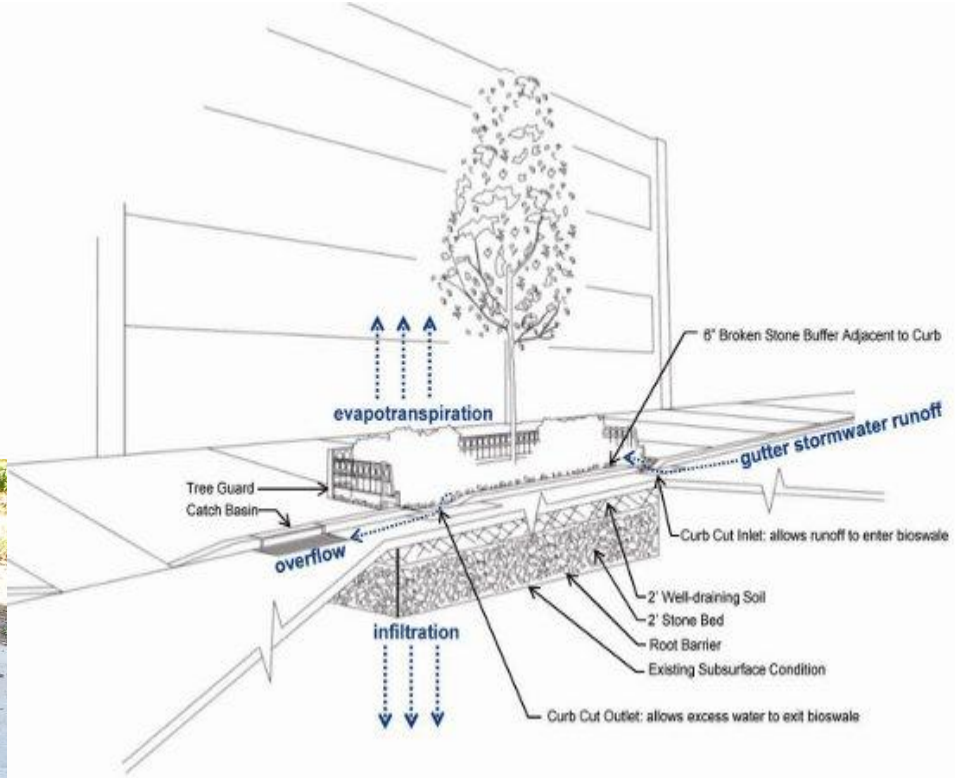
Plan Philadelphia

Engineered Soils

- Soils designed with compost and mineral aggregates in a measurable way so as to meet specific soil quality and depth requirements
- Soils designed to perform to a standard of permeability, stability and fertility

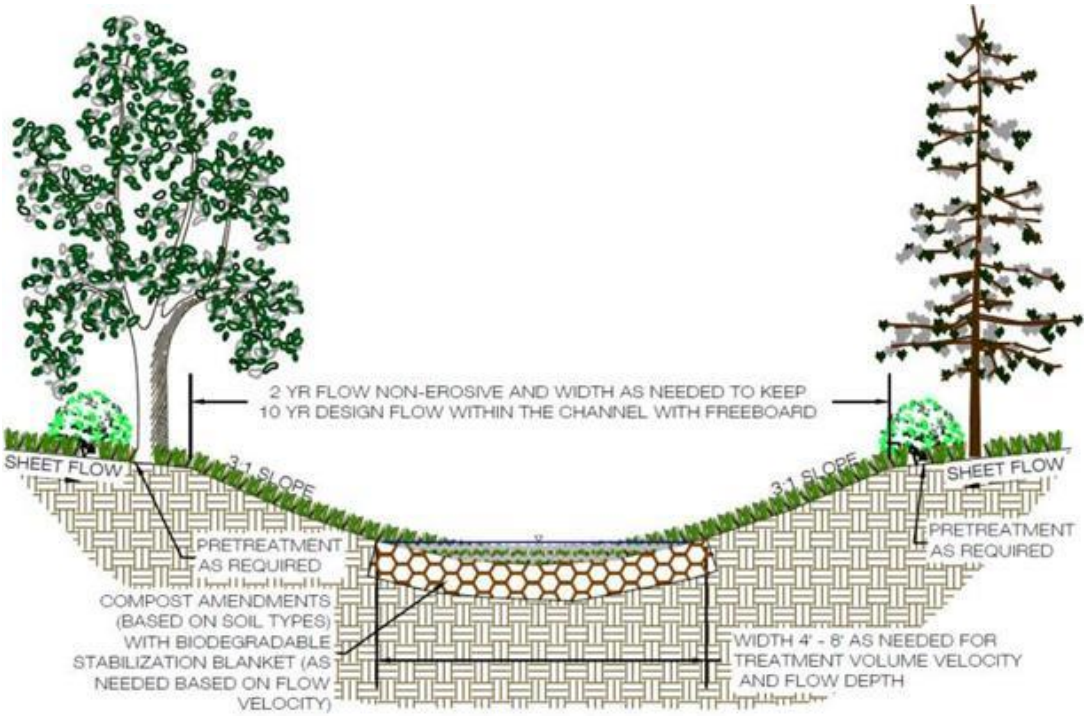
Tree Scape Soils

- 70-80% aggregate based and 30-20% soil amendments

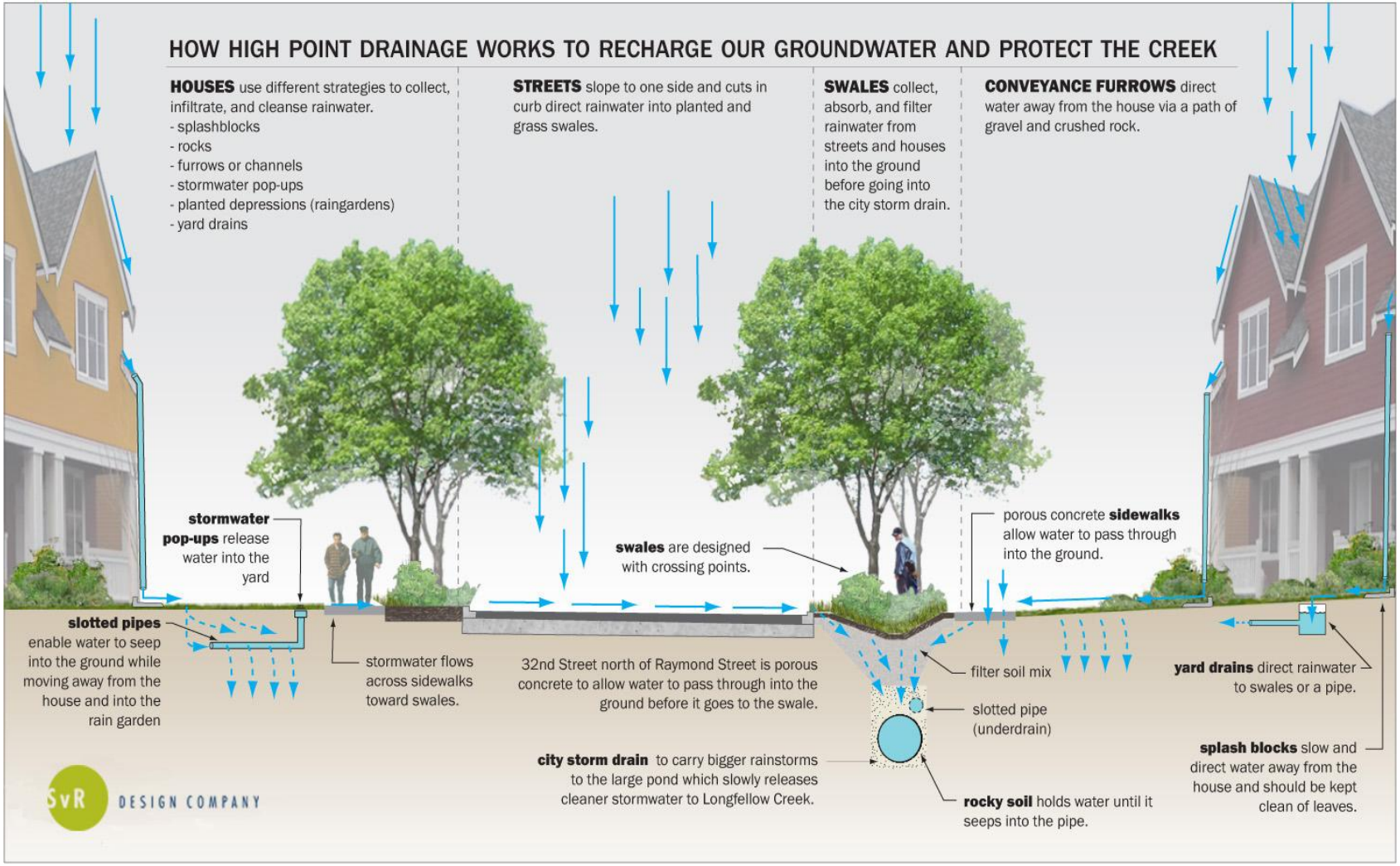


Grass Swales

- Compost amended soil or engineered soils



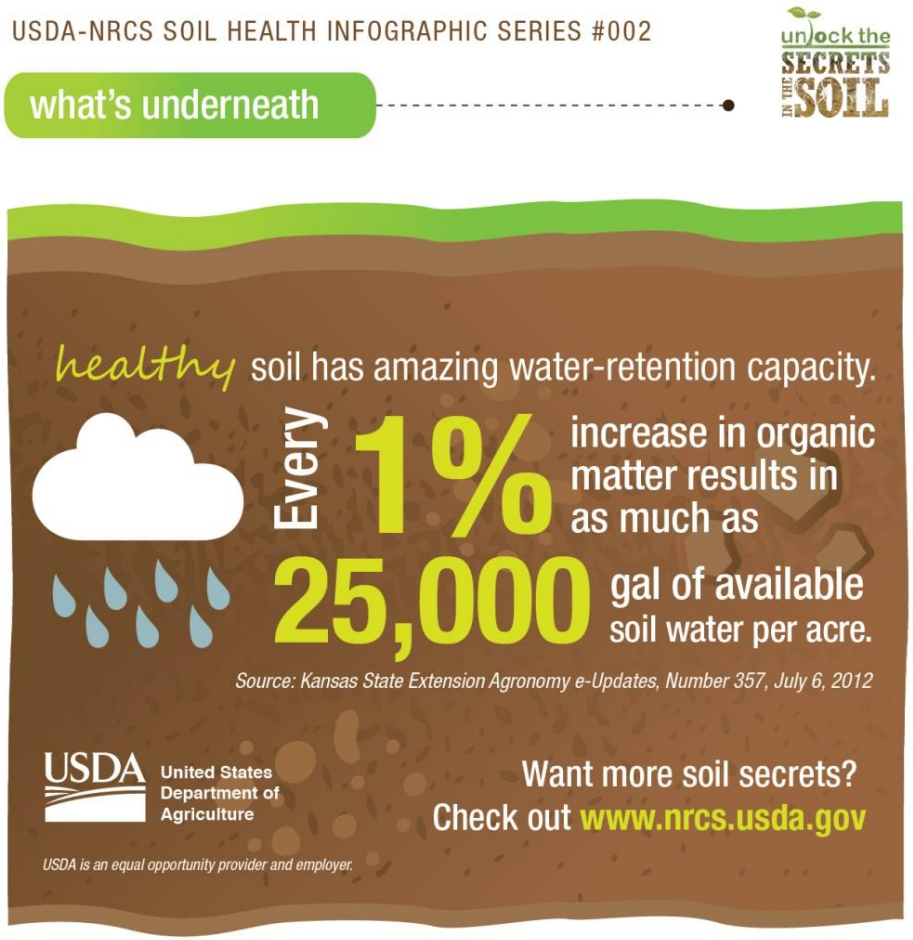
Infiltration



Closing Comments

- We must rethink how can we mimic nature in our designs for both new and established landscapes
- Choices made during construction and landscaping projects can impact soil and water functions for decades
- The continued practice of installing poorly-performing landscapes and hardscapes which contribute to impervious surfaces when properly functioning soil and vegetated systems are practical and cost-effective should be viewed as a lost opportunity

Infiltration



Infiltration

" A nation that destroys it's soils, destroys itself"
- *Franklin D. Roosevelt*