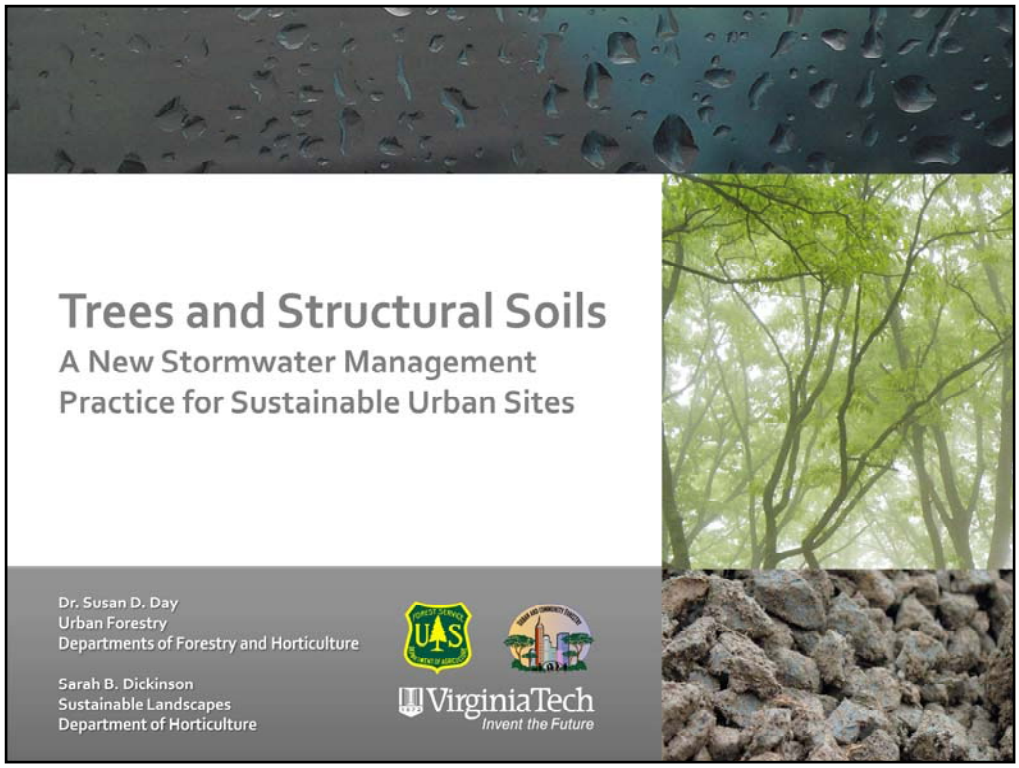

Trees and Structural Soils

A New Stormwater Management Practice for Sustainable Urban Sites

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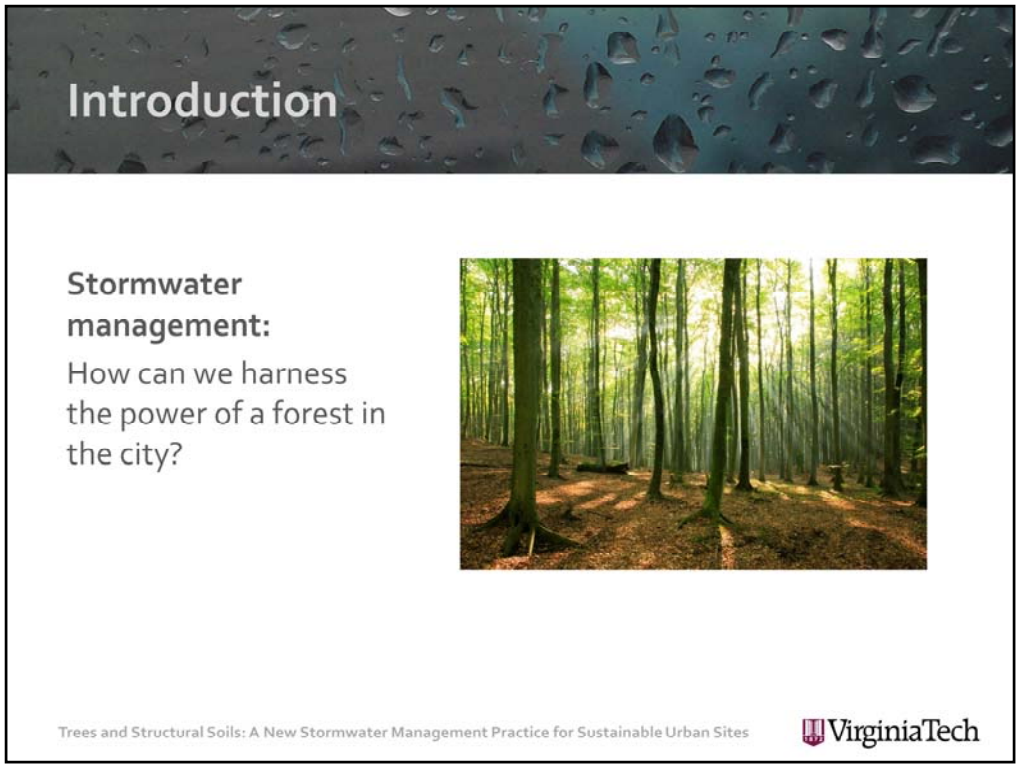
Invent the Future



How the Forest handles stormwater:
15% surface water runoff
35% surface water detained or infiltrated
50% evapotranspiration

In developed conditions:
55-70% surface water runoff
15% surface water detained or infiltrated
15-30% evapotranspiration

(source: Soils for Salmon website: http://www.soilsforsalmon.org/why.htm)

Image from Microsoft clip art

Impermeable surfaces pose substantial challenges in urban areas because they cover such a large proportion of land. Impermeable surfaces are usually in the form of streets, sidewalks, parking lots and buildings. They facilitate runoff and the consequent decrease in water quality. In addition, compacted soils limit plant growth and water infiltration. Impermeable areas disrupt the water cycle because they do not allow rainwater to infiltrate into the ground, affecting the base flow to streams.

Top image: parking lot at a shopping center in Christiansburg, VA, taken by Susan Day
Bottom image from microsoft clip art

Managing stormwater from large paved areas such as this parking lot can be challenging. These large impervious areas contribute to peak flow into rivers and streams which cause erosion and flooding risks. In addition, this water collects any pollutants or contaminants present on the parking lot such as hydrocarbons, silt, salt, and nutrients, and deposits them into surface waters which has a negative effect on water quality and aquatic ecosystems. Impervious surfaces disrupt the water cycle because they do not allow rainwater to infiltrate into the ground. If groundwater is a water source for the city, this can decreases its water supply.

Compacted soils beneath the paved surface of the parking lots are necessary to support the weight of cars and pavement but they cannot store water or provide habitat for trees or other plants which could aid in stormwater management.

Left image: runoff from a parking lot, taken by The Bureau of Land and Water Quality, Maine
Right image: roadsiderunoff during a storm in San Jose, Costa Rica, taken by Susan Day

Infiltration BMPs

- Typical infiltration BMPs **concentrate** stormwater into a small area, increasing the risk of groundwater contamination in some cases

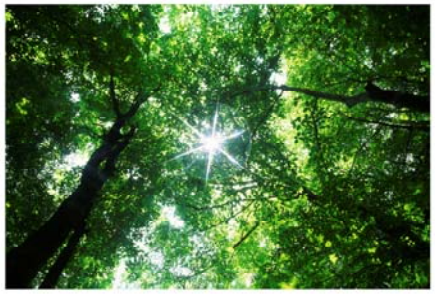
Image of a parking lot bioswale, taken by Nina Bassuk

Top image: a stormwater detention pond on the Virginia Tech campus in Blacksburg, VA, taken by Susan Day

Bottom image: a dry stormwater detention basin at Wong Park in Blacksburg, VA, taken by Susan Day

The Role of Trees

- We cannot mimic pre-development hydrologic cycles **without plants**



Even if runoff, groundwater recharge, and detention are balanced natural hydrologic cycles rely on vegetation to return water to the atmosphere via transpiration

Image from Microsoft clip art

Evapotranspiration

- Trees intercept and store water with their canopies, direct water to the soil with their trunks and roots and transpire water back to the atmosphere.

Image: The Angel Oak in John's Island, South Carolina, Reportedly the oldest thing -- living or man-made -- east of the Rockies (1500 years old), taken by Sarah Dickinson

Trees can transform an urban setting by creating a sense of shelter and beauty.

In fact there is literature that found links between exposure to green landscapes and health improvements such as lower body weight, less stress and improves self-reported health. In children, this has even been linked to improved brain functioning and fewer symptoms of attention deficit hyperactivity disorder. (Reuters Nov 11, 2008 By Megan Rauscher)

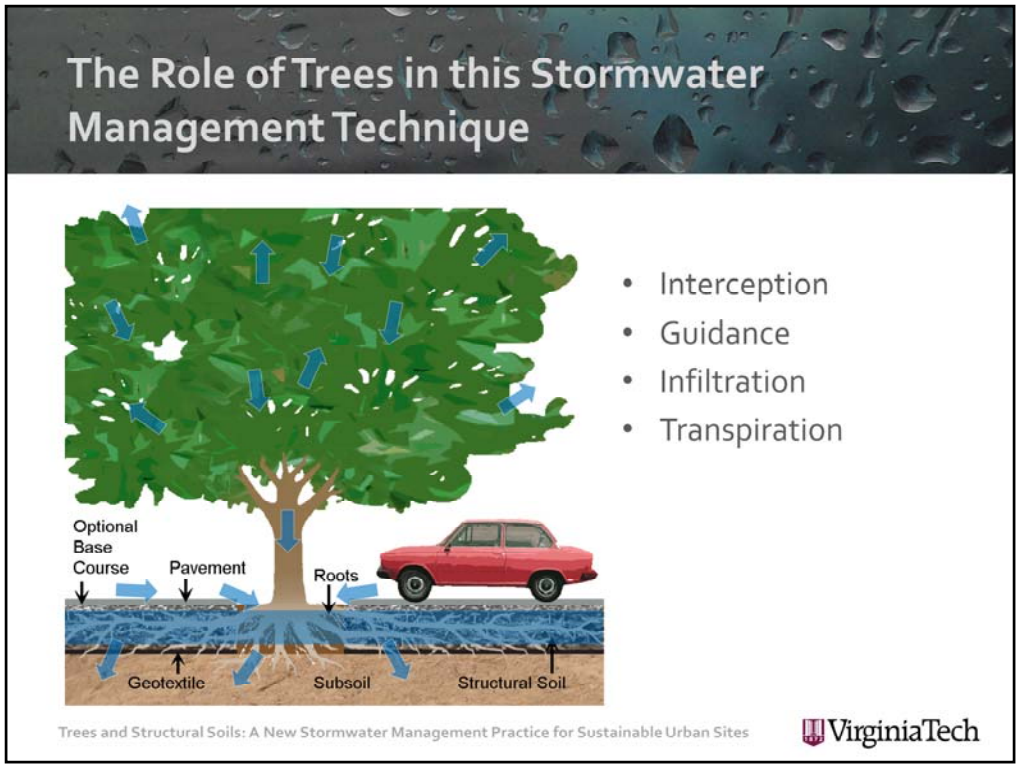
Trees can help transform crowded cities into greener more livable sites. It is important to look for opportunities to transform our living spaces with trees.

In the next few slides, we will discuss additional benefits to trees related to stormwater and other environmental services

Left-top image: full canopy street, Fort Collins, Colorado taken by: Lisa Richardson-Calfee

Left-bottom image: Cayuga lake trail head parking lot (Ithaca, NY), one of the sites demonstrating this stormwater technique, taken by Nina Bassuk

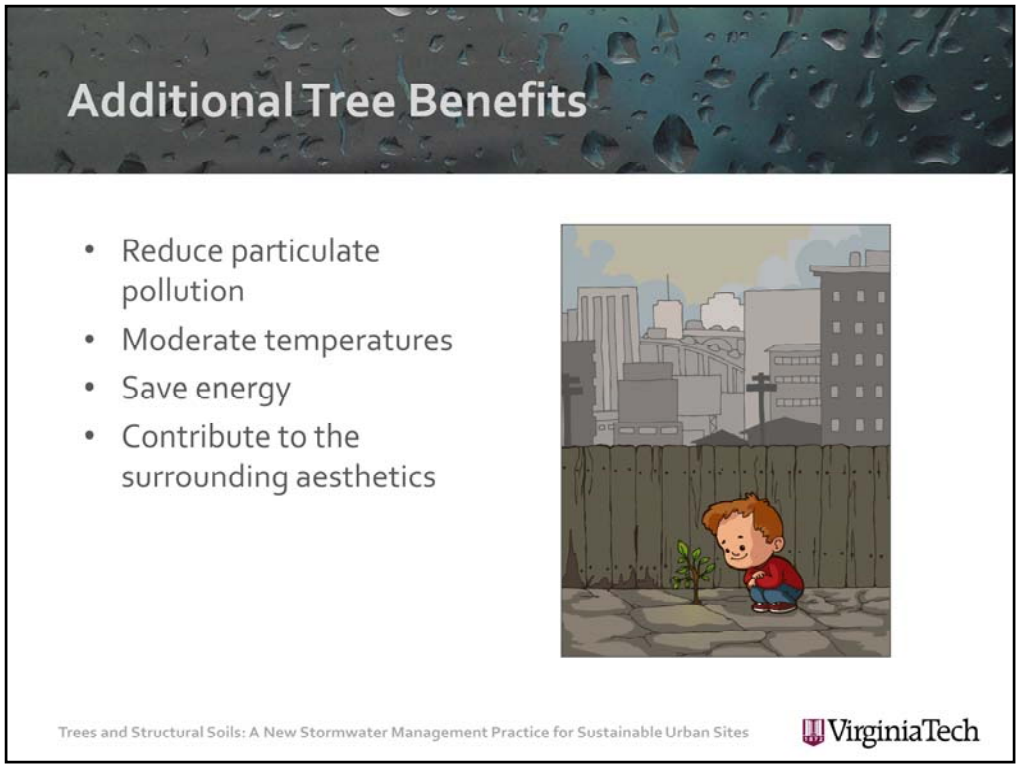
Right image: Honeylocust trees planted in structural soil, taken by Nina Bassuk



THIS IS AN ANIMATED SLIDE: reservoir automatically fills when you arrive to the slide and 1 additional click empties the reservoir and additional text appears.

Trees affect stormwater on many levels, they aid in infiltration by intercepting and guiding water to the ground and their roots also absorb water via transpiration.
Interception: Precipitation is intercepted by the tree canopy. Some water is stored on the leaves and branches and eventually evaporates.
Guidance: Other water is guided to the reservoir below via the tree trunk
Infiltration: the tree roots facilitate water to infiltrate into the ground below
Transpiration: Water may also be taken up and transpired by the trees themselves

Illustration by Sarah Dickinson



In addition to stormwater management, trees provide cities with many important services. Their leaves hold large amounts of air particulates, improving air quality. Air temperatures beneath trees can be 25% cooler
The magnitude of all of these ecosystem services (including stormwater management) increases with tree size.

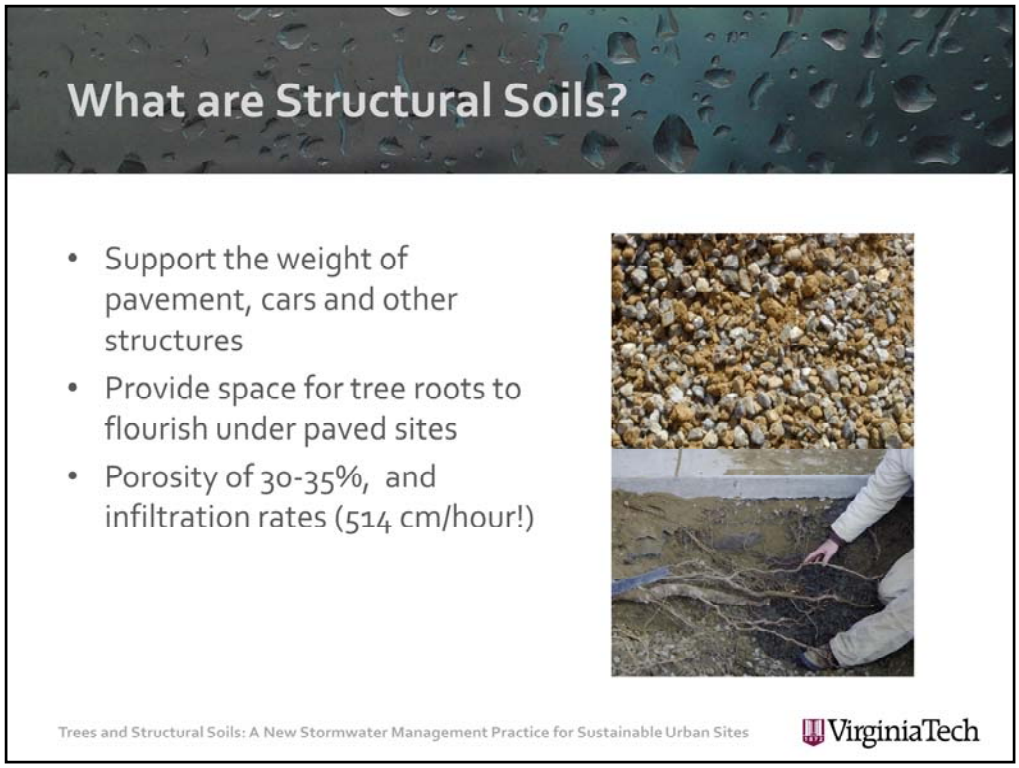
Image from Microsoft clip art

Soil in pits is often low quality and compacted soil under surrounding pavement often cannot be penetrated by roots.
Urban tree pits are often too small for trees to reach their full potential size and health
This tree pit is 4’ by 5’ and probably only a few feet deep

Image: B&B tree about to be planted into a tree pit that is too small, taken by Nina Bassuk

For example, this image shows willow oak trees that were planted at the same time on Pennsylvania Ave in Washington, DC. The trees on the left have a limited soil volume- they have been planted into small tree pits and the surrounding soil beneath the sidewalk and street is severely compacted limiting root growth. The trees on the right have access to larger volumes of uncompacted soil (beneath the turf).
A solution to this stunted growth is to make room for roots beneath the pavement.

Image taken by Nina Bassuk



This is a picture of tree roots which were growing in Cornell Structural soil. The soil provided enough support for the sidewalk and at the same time, allowed roots to grow beneath the pavement. Regular, compacted soil beneath pavement would not have allowed these roots to grow so easily.

Top image: Stalite structural soil mix, taken by Susan Day
Bottom image: excavated tree roots that were growing in structural soil, taken by Nina Bassuk

How does the System Work?

- Water enters the structural soil reservoir through pavement swales and tree pits (or through porous pavement)
- Water filters through the structural soil and recharges the groundwater below or is transpired by the tree

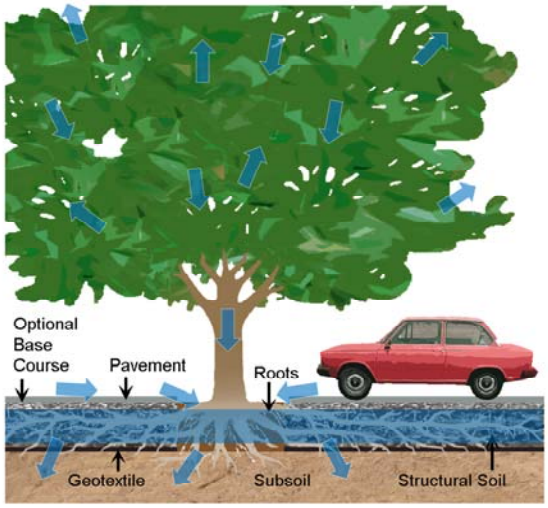


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Illustration by Sarah Dickinson

Benefits

- Tree canopy is increased—so runoff is of lower intensity over a longer period
- Water storage occurs under pavement and out of the way
- Infiltration is enhanced, improving watershed hydrology
- Water quality is improved compared to direct runoff

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Top image: parking lot at a shopping center in Christiansburg, VA, taken by Susan Day
Bottom image: Cayuga lake trail head parking lot (Ithaca, NY), one of the sites demonstrating this stormwater technique, taken by Nina Bassuk

Resources

- This presentation is based on:

  Day, S.D., and S.B. Dickinson (Eds.) 2008. Managing Stormwater for Urban Sustainability using Trees and Structural Soils. Virginia Polytechnic Institute and State University, Blacksburg, VA. (http://www.cnr.vt.edu/urbanforestry/stormwater/Resources/TreesAndStructuralSoilsManual.pdf)

- Stormwater Management with Trees and Structural Soils

  http://www.cnr.vt.edu/urbanforestry/stormwater/

- Virginia Tech Urban Forestry Gateway

  http://www.cnr.vt.edu/urbanforestry/

- US Forest Service (Center for Urban Forest Research)

  http://www.fs.fed.us/psw/programs/cufr/

- Urban Horticulture Institute

  http://www.hort.cornell.edu/UHI/

Leaf image from Microsoft clip art

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