Growing Trees in Gravel Retention Systems to Reduce Stormwater Runoff

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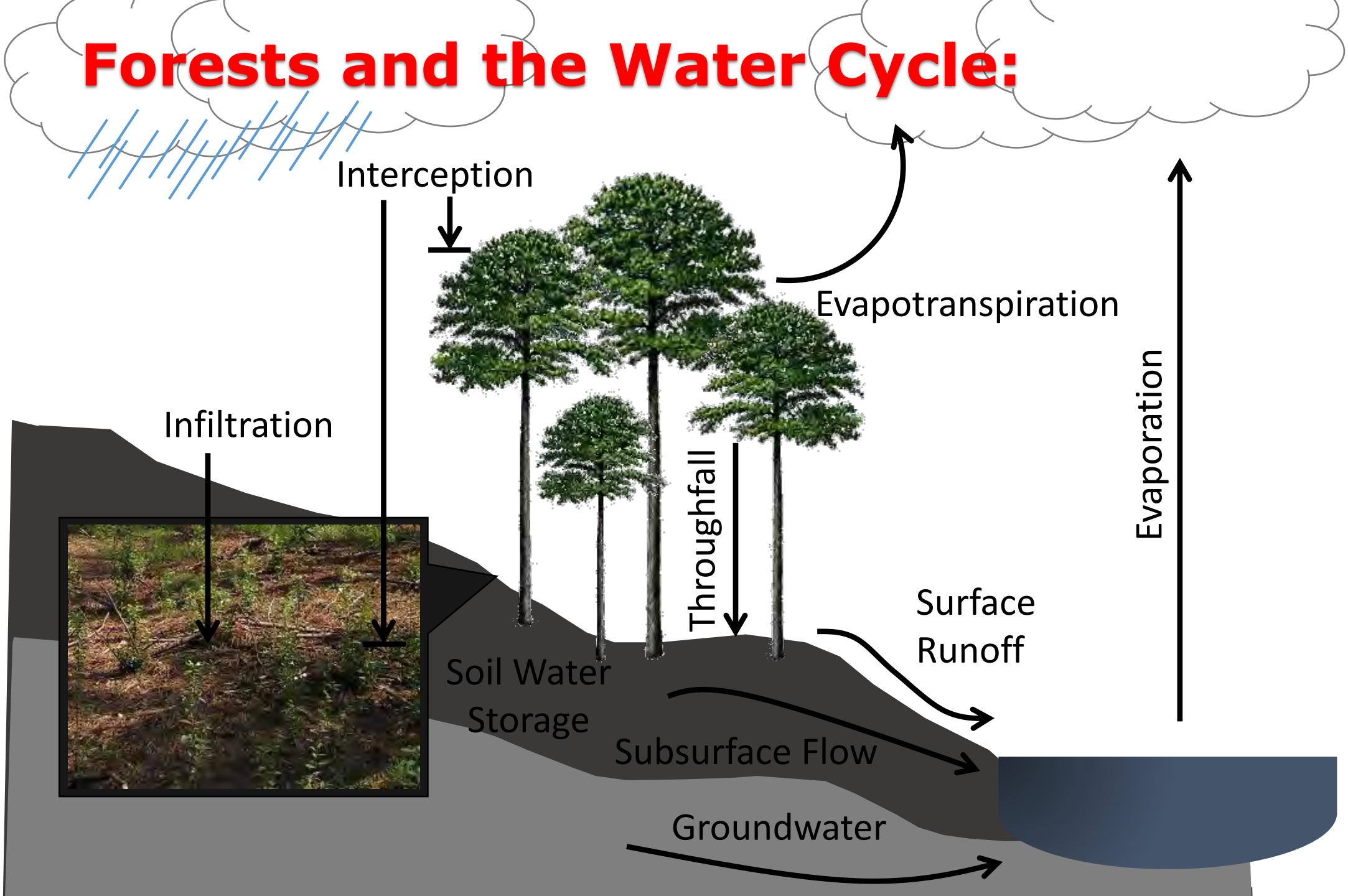
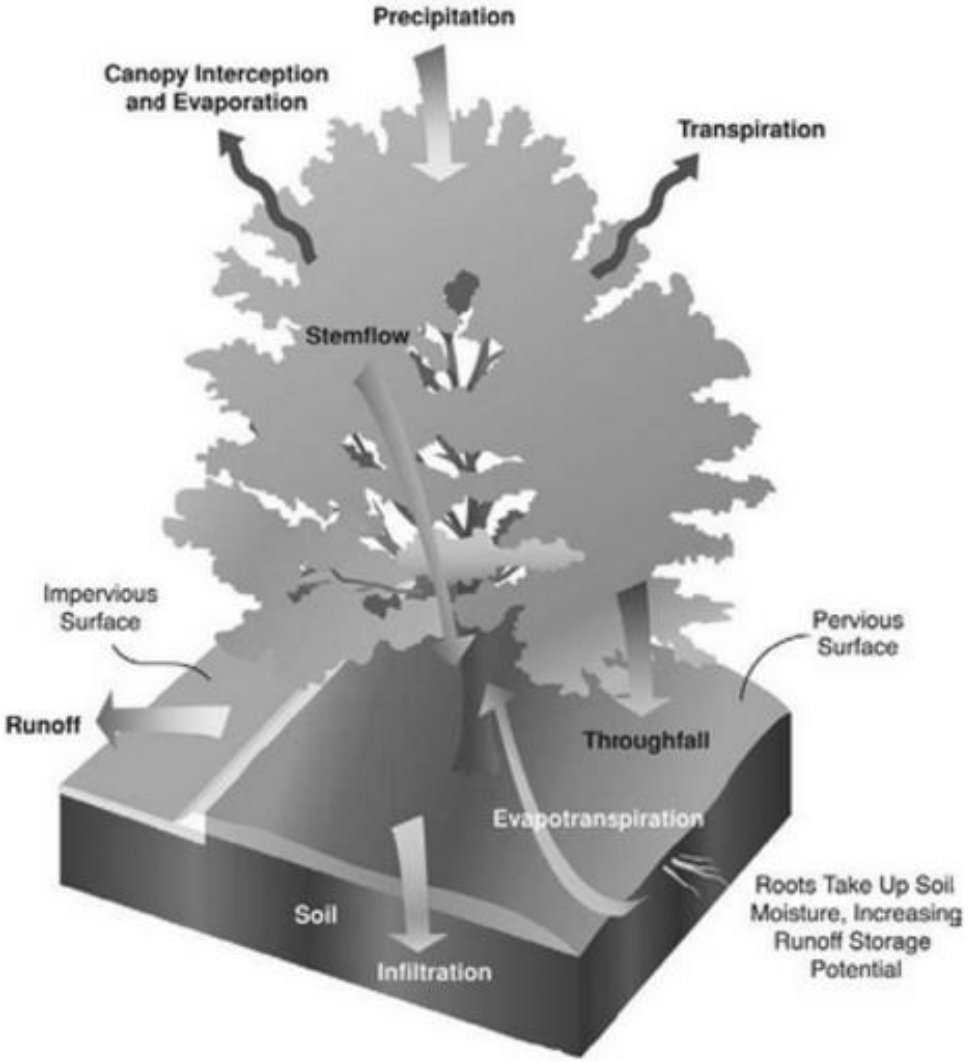
Forests and the Water Cycle:

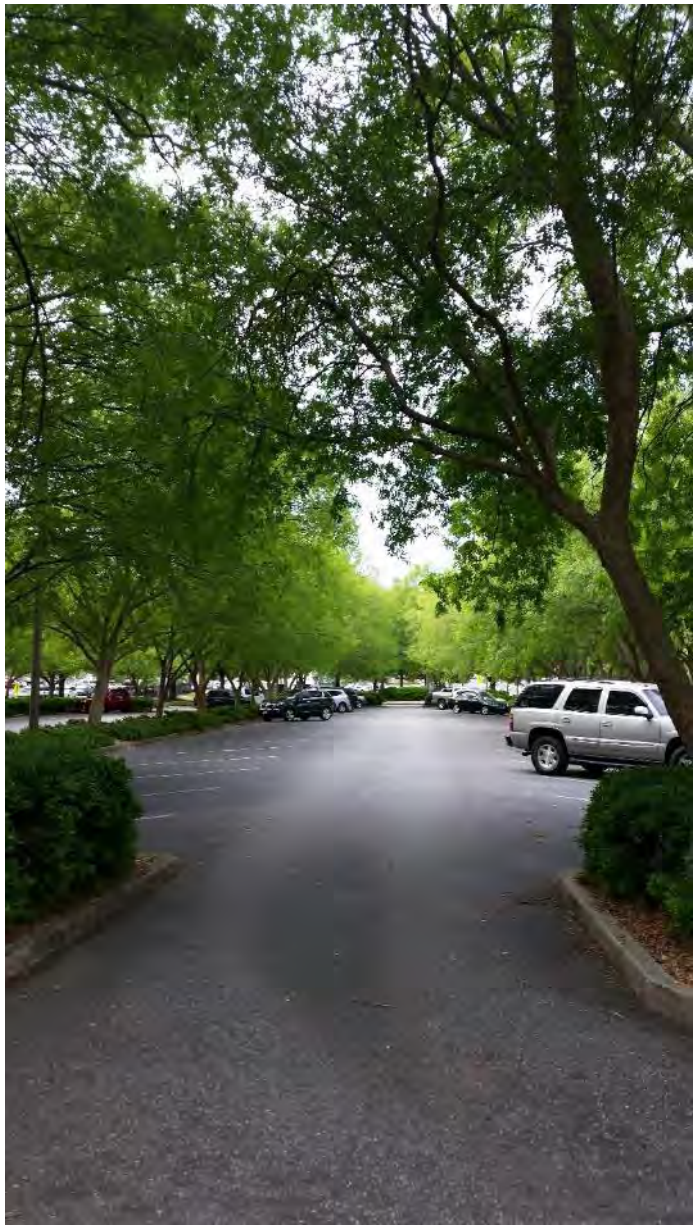


Co-Benefits of Tree Canopy Cover

- Stormwater
  - Retention/detention
  - Rainfall intensity reduction
  - Transpiration
- Energy Conservation
  - Reduce UHI effects
- Improve ambient air quality
  - Dry deposition of pollutants
- Increase business revenue
  - 9-12% (Wolf, 2007)



Can forested systems be incorporated into our ultra-urban settings?



What Do Trees Need?

Belowground Water Storage

- Store water under pavement
  - Parking lots
  - Plazas
- Allows water to be used as resource
  - Irrigation
  - Non-potable uses
- May be expensive for some municipal budgets
- Gravel?

Gravel

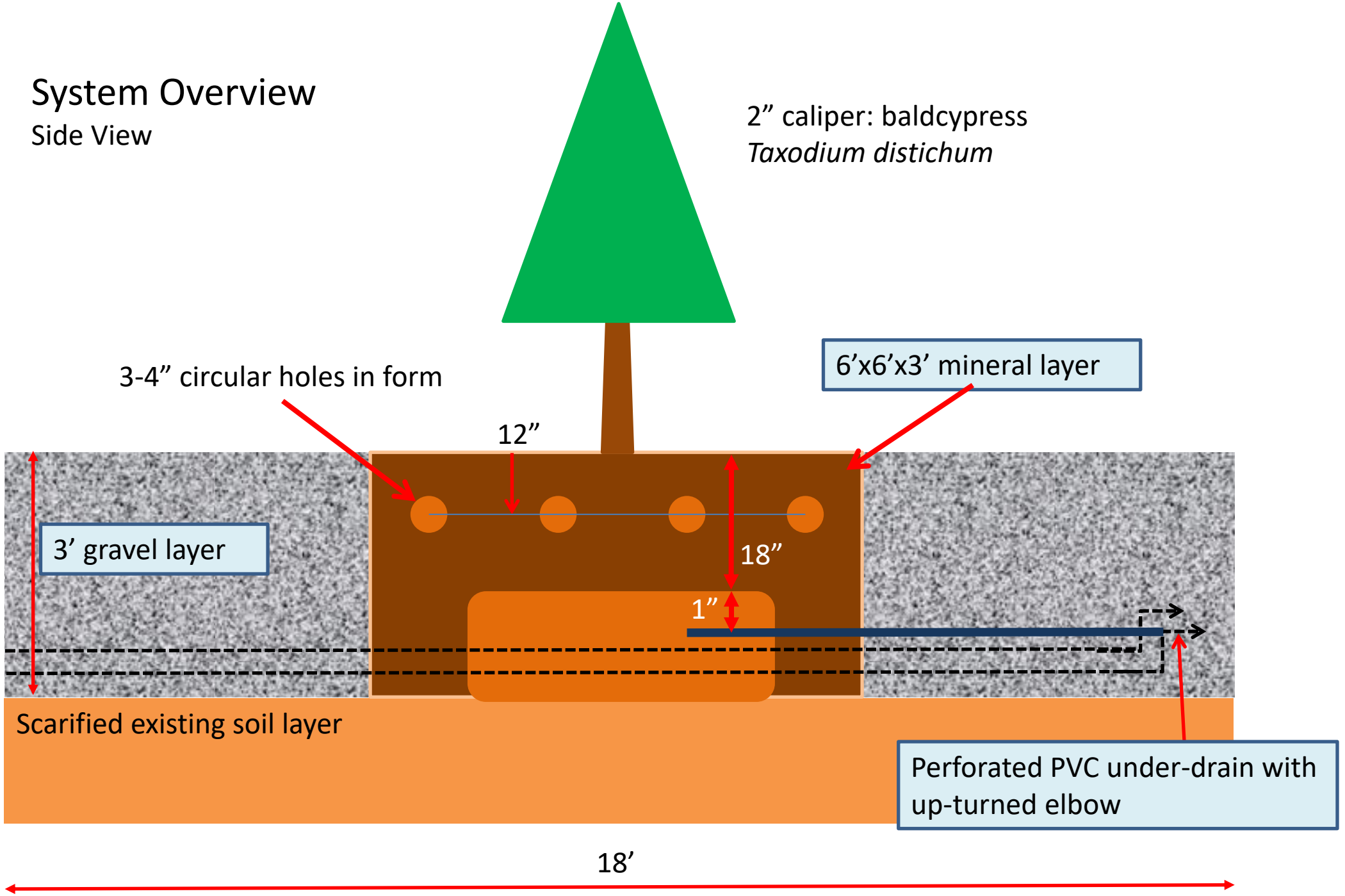
- Provides structural support
- Stores stormwater
  - ~40% storage capacity
    - DeepRoot-Pros and Cons of Using Aggregate to Store Stormwater
- Provides rooting space
  - With adequate moisture
- Athens/Clarke County gravel bed
  - Growing trees in gravel since 2011
  - Mainly for out-planting

Combining Trees and Gravel in Extra-urban Environment

- Plant trees in minimal soil bed
  - To maximize growth potential
  - Trees need mineral soil for adequate nutrient availability
- Allow tree roots to penetrate gravel stormwater storage layer
- Transpiration reduces water level
  - Allowing for more runoff storage
- Stored water augments tree's needs

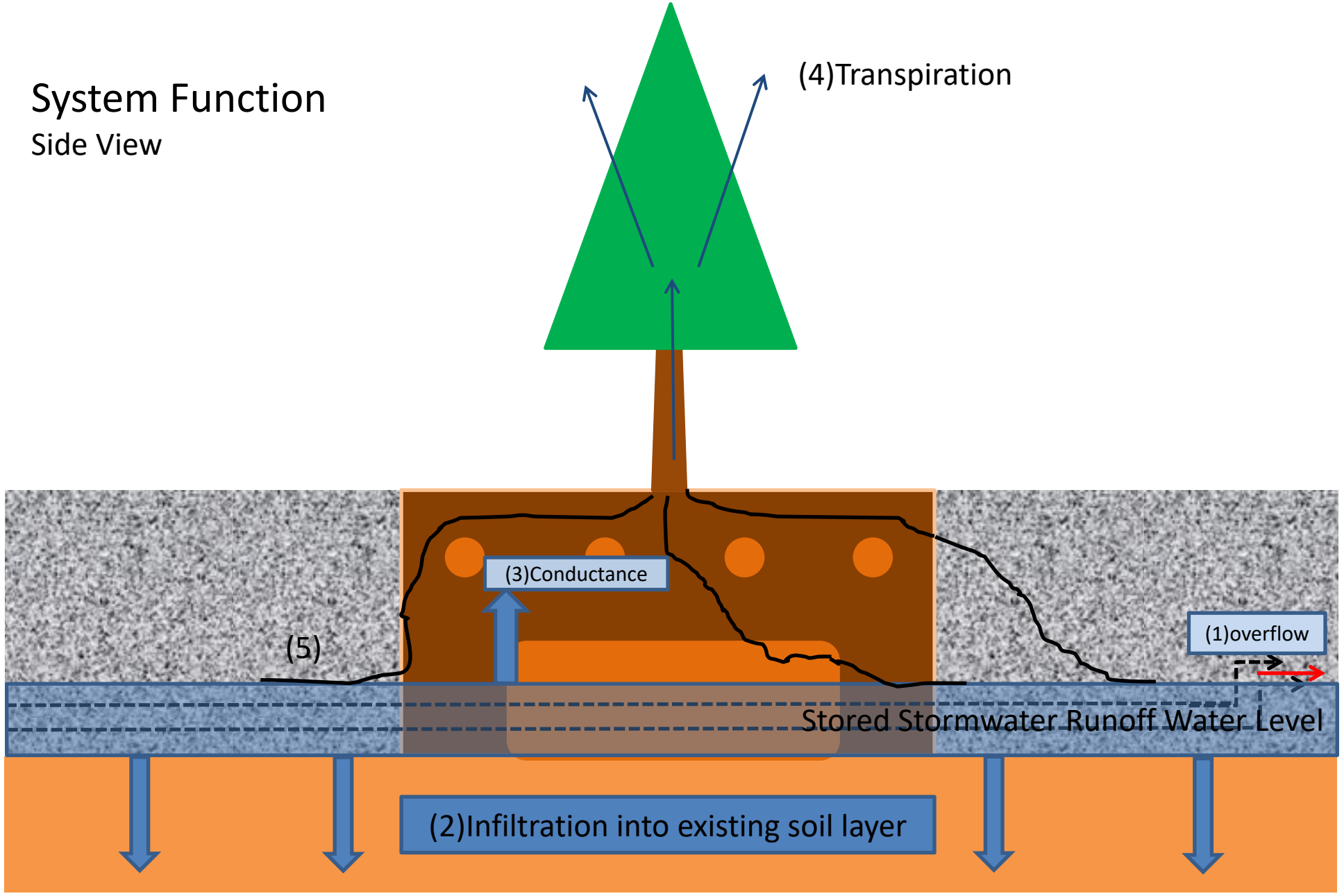
System Overview

Side View



System Function

Side View



Mineral Bed Form

1/2” Oriented Strand Board with holes for root growth
8 oz. non-woven geotextile fabric covering

Gravel Bed and Material

Quartzitic Sandstone – 0.75” Crushed Stone
4 ply, 6 mil clear plastic sheeting to hold water in system

Under-drain System

4” perforated PVC sewer drain pipe with up-turned elbow
Under-drain in place with black drain sleeve

Monitoring Equipment

PVC place-holders for clear plastic mini-rhizotrons to observe root growth

Perforated observation well with HOBO water level data logger

Finished Project

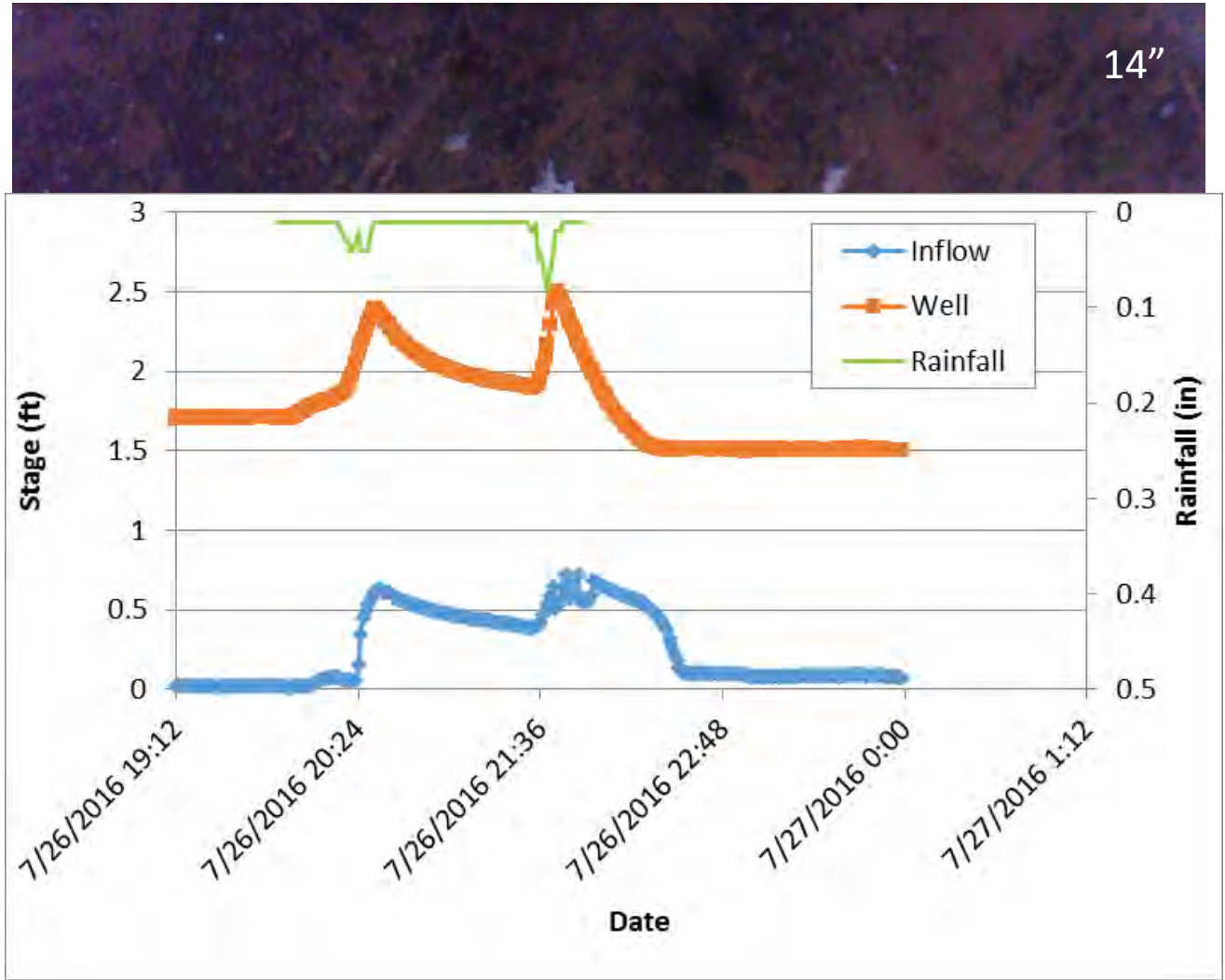
Large, decorative river stone to discourage parking.
Water drains from parking lot into system.

Material Costs

Item	Sub-Total	Total $
Mineral Bed Form • 7/16” OSB Sheathing (4’x8’) • #2 Kiln-dried whitewood (2”x4”x12’) • #8 x 1.25” wood screw (100 count) • 3” bi-metal Arbored Hole Saw • 8 oz. non-woven geotextile fabric	$79.64	
Under-Drain System • 4” x 10’ PVC sewer drain pipe (perforated and solid) • 4” PVC sewer drain elbows and Tee • PVC fittings, primer, cement • 100’ 4” Drain sleeve • 20’x100’ 6 mil clear sheeting	$225.26	
Gravel • 46 cu yd Quartzitic Sandstone – 0.75” crushed stone @ $30/ cu yd.	$1380.00	
Trees • 15# Baldcypress	$180.00	
Total		**$1864.90**

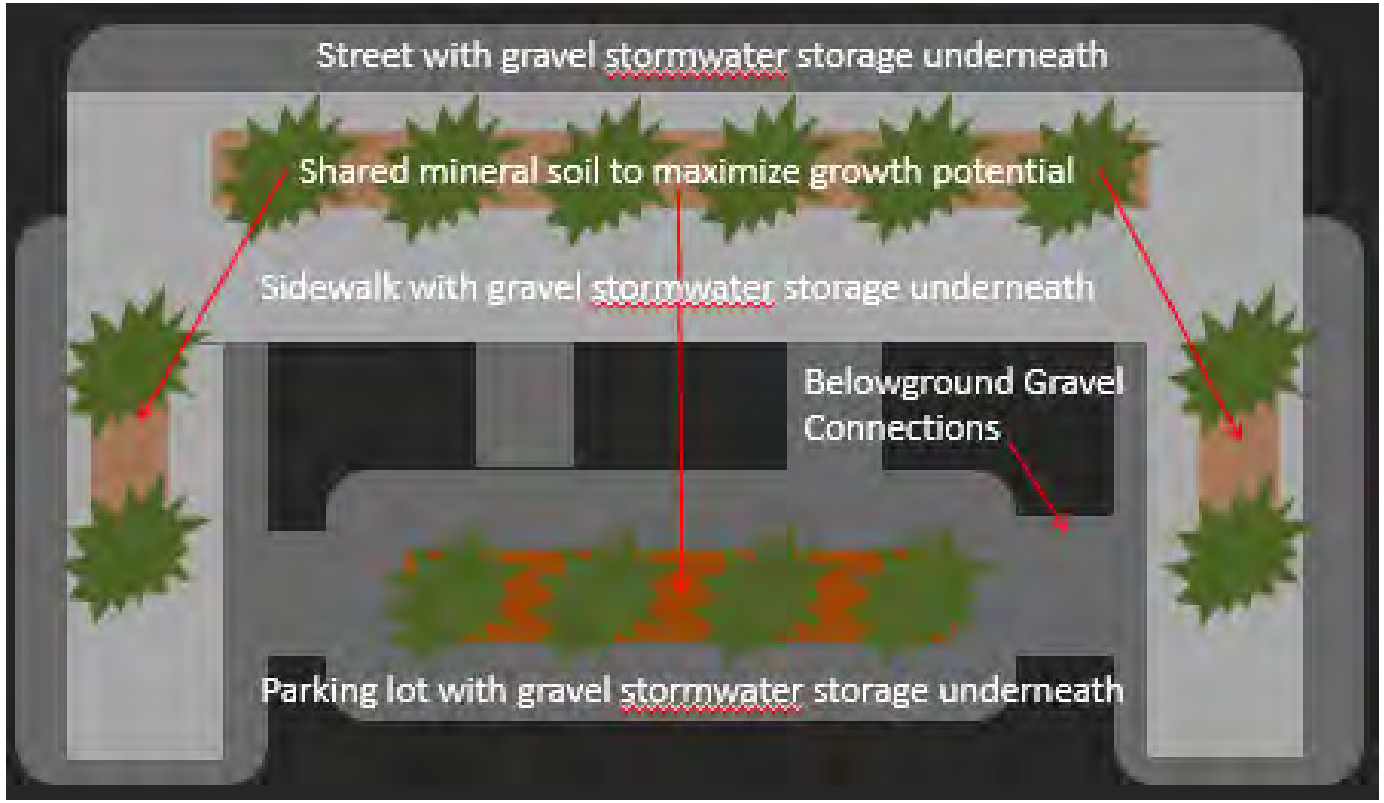
Preliminary Results

- Two trees planted Apr. 5
  - One inside / one outside system
  - To compare growth rates
  - By July 1 outside tree stressed
- Root growth observed Sept. 12
  - In mineral soil
  - And in gravel layer
- Hydrologic function
  - Volume attenuation at outfall?



Next Steps

- Gain knowledge/gather data
  - Root growth within profile
  - Tree growth/health over time
  - Transpiration rates
  - Stormwater benefits
    - Volume control
    - Water quality
- Grant funding
  - WERF / EPA 319 grants ?
- Replication
  - Athens/Clarke County, GA
- Design expansion
  - Multiple trees in parking lot



Conclusion

- Urban trees improve quality of life
- Trees have quantifiable stormwater benefits
- Growing trees in dense urban areas is difficult
- Belowground tree systems can be expensive
- Use gravel to store water belowground
- Allow tree roots to access stored water
- Retrofit impervious areas with tree canopy
- Increases property value and retail business

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