Green Infrastructure for Clean Water  
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Stormwater Credits for Trees

Janna Kieffer  
Barr Engineering Company

Randy Neprash  
Bonestroo, now Stantec
Why credits for trees?

- Protect existing trees
- Promote planting new trees
- Use the known stormwater & water quality benefits of trees
- Use the largest biomass we have
- Because it’s worked in the past
It worked in the past?

- The lesson of stormwater ponds
- We built a solid, quantified foundation of science and design standards
- We ended up with 20,000 stormwater ponds in the Twin Cities Metro area
National Urban Runoff Program

- USEPA – 1977 to 1983
  - Good research – conclusions supported by science and study
  - Specific design standards for stormwater ponds – suitable for any engineer or designer
  - Quantification of benefits – build according to the design and you get specific reduction credit
  - Complete integration into every level of stormwater regulation

- Build a good foundation and the landscape will be changed
- A “calculation methodology”
What should receive credit?

Tree-based Stormwater BMP

Four Functions

1. Canopy Interception
2. Evapotranspiration
3. Subsurface infiltration
4. Water quality treatment in root zone
What should receive credit?

- Volume reduction
  - Canopy interception
  - Evapotranspiration
  - Infiltration – surface & subsurface
- Water quality improvement
  - Chemical changes as it moves through the root zone
  - Uptake of pollutants
Interception by Tree Canopy Reduces Stormwater Runoff

- Rainfall intercepted by tree leaves & branches
- Dependent on canopy surface storage
- Varies by species, size
- Full-leaf canopy interception 0.09 - 0.17 inch (Link, et al. 2004, Xiao, et al. 2000)
Interception Varies by Tree Species

- **Conifer Stands**
  - Interception 20% - 40%
  - Annual Precipitation

- **Hardwood Stands**
  - Interception 10% - 20%
  - Annual Precipitation
  - (Zinke, 1967)
Interception varies by Tree Size and Structure
Interception varies by Tree Size and Structure

VS.
Rainfall Characteristics affect Tree Interception

- Small, frequent storms result in more interception
- Example: with monthly rainfall = 3 inches, and 0.1 inch of rainfall interception per event

**Small, frequent storms:**
Monthly Interception = 1.75 inches

**Large, infrequent storms:**
Monthly Interception = 0.6 inches
Interception Losses vary by Region and Tree Characteristics

- Davis, CA study- interception losses account for about 15% precipitation for a pear tree (leaf off) and 27% for an oak tree (Xiao, et. al. 1999)

- Vancouver, BC study- interception losses account for about 76% precipitation for coniferous and 56% for deciduous urban trees (Asadian, 2010)
Estimated Interception Losses in Minnesota

- In Twin Cities, during leaf-on months (May – October), average precipitation = 20 inches*

- If up to 0.1 inches of interception loss occurs on every day with measurable precipitation, 4.6 inches of interception can be expected per year (May – October)

- This represents 23% of average precipitation (May – Oct.)

* Based on MSP rainfall data, 1949 - 2009
Other Variables Affecting Runoff Reduction Credits

- Does the tree canopy reduce runoff from impervious surfaces?
Tree Roots Improve Infiltration, Reduce Runoff

- Root growth increases the rate of infiltration
- Root decomposition increases the infiltration capacity
- Roots can help penetrate compacted or tight soils
Trees Reduce Runoff through Evapotranspiration

- Water from soil is consumed by trees and transpired into atmosphere
- Water is also lost directly from soil
Trees Incorporated into BMPs to improve function
Tree Systems as BMPs

- Runoff is captured and stored in underground trench systems
  - Trench filled with rock, soil, or structural soil
- Runoff temporarily stored for transpiration by tree(s)
- Water not consumed by trees will infiltrate or be released slowly
Tree Systems as BMPs

- Boulevard Tree Systems
Tree Systems as BMPs
Credits for Tree Systems

- Volume reduction can be quantified by storage volume in trench

- Volume “Credit” = Trench Area * Depth * Porosity
Developing a Credit System

- We are just getting started on developing a credit system for trees and stormwater
- MPCA’s Minimal Impact Design Standards (MIDS) project will incorporate runoff reduction credits for trees
What is MIDS?

- Effort by MPCA in response to 2009 legislation to promote low impact development
  - Stormwater management should mimic a site’s natural hydrology
- Three main components
  - Performance standards for runoff rate and volume
  - Development of “credit” system and calculator for wide range of BMPs (including trees!)
  - Ordinance package
Credit System

- MIDS small workgroup considering stormwater credits for trees
- Modeled on work done for raingardens
  - *Burnsville rain garden study project*
- We are looking at other approaches around the U.S. and the world
- We are collecting quantitative information from multiple sources
Credit Systems

- **Seattle**
  - Trees are given credit for “area mitigated”
  - Square feet per tree
  - Existing & new
- **Virginia Runoff Reduction Method**
  - Site reforestation is considered to be a Site Planning & Design Practice
- **Ventura County, CA**
  - Planter boxes are considered to be a Biofiltration BMP – minimal volume reduction
- **New Hampshire**
  - Tree box filter included – but no accepted values for TSS, TN, or TP reduction
Challenges

- Multiple scales – project, city, region
  - MIDS Project focuses on the project scale
- Differences between types of trees
  - Deciduous & conifer
  - Species
- Seasonality – function in the winter
- Credits while the trees are young & small
- Permanence
- Phosphorus from leaf drop
- Lack of quantitative data for the benefits
Questions?

JKieffer@barr.com

randy.neprash@stantec.com