

Integrating Urban Trees & Stormwater Management

or

A Reason for Public Works Engineers to Hug Trees

Who am I? Why Stormwater and Trees?

Randy Neprash, P.E.

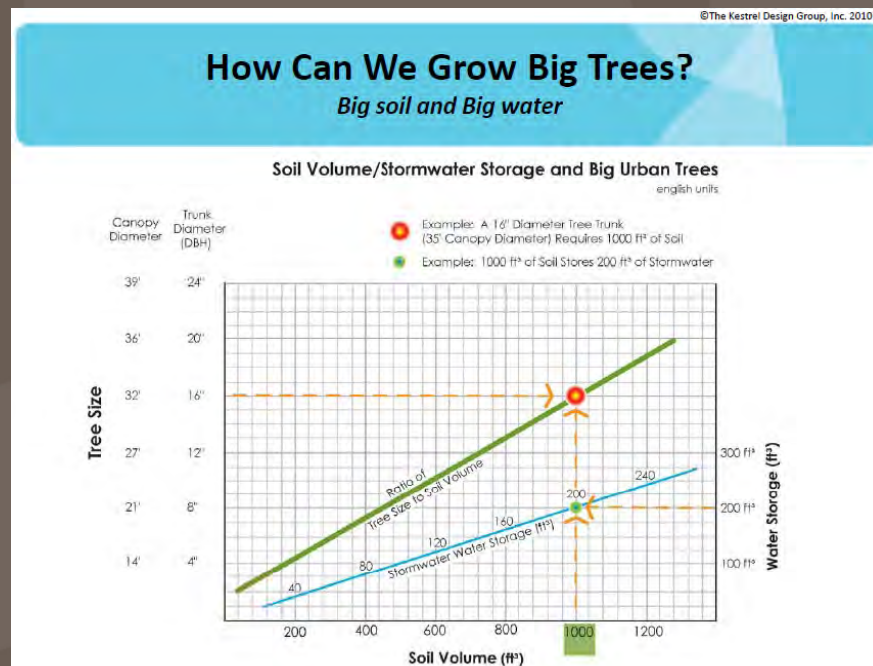


- Some challenges of urban stormwater management
 - Densely-developed urban areas – MS4 stormwater permits
 - TMDLs, nondeg, volume reduction regs
 - Controlling dissolved phosphorus runoff & other contaminants

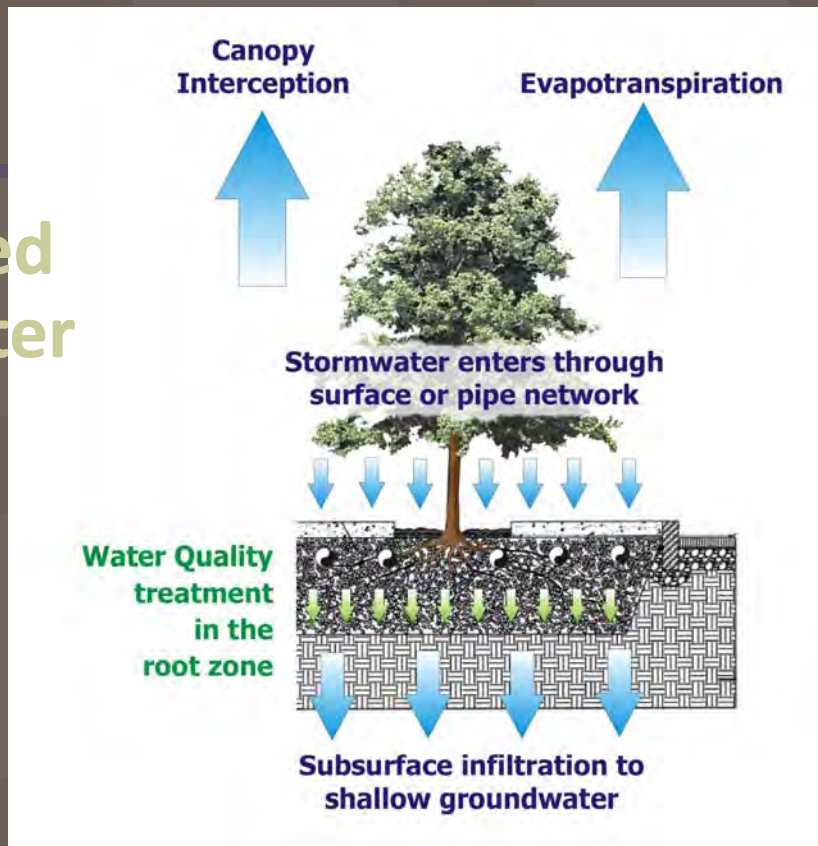
Basic Questions

- Why are we growing short-lived, stunted urban trees instead of long-lived, large trees
- Why aren't we using the biomass of trees?
- Why aren't we using the proven volume reduction capacity of our tree canopy?
- Can we redesign streets, parking lots, and streetscapes around trees and stormwater?
- Is there an existing model for integrating trees into stormwater management?

Large, long-lived trees



Tree-based stormwater BMP



Basic Principles

- Volume reduction and WQ treatment
- What works for trees can work for stormwater
 - Uncompacted soil for roots
 - Sufficient depth and volume for roots
 - Support large, long-lived urban trees
- Kill two birds with one stone
 - Use budget and land for both stormwater management and urban forestry
 - Meet the goals of both public works and urban forestry

Real Budget Results

City of Vancouver, WA

City of Vancouver **URBAN FORESTRY PROGRAM**

**ANNUAL REPORT
2009**

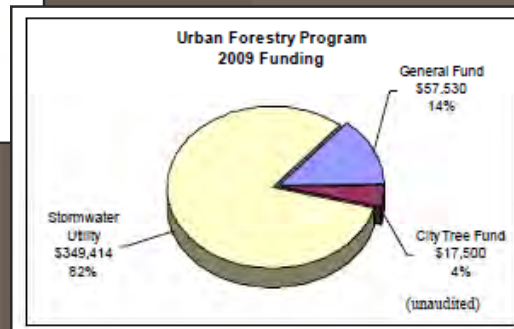
\$349,414 of a
\$424,444 budget



SW utility – 82%

General Fund – 14%

City Tree Fund – 4%



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Green Infrastructure – Trees and Rain Gardens

■ Similarities – bioretention BMPs

- Deep root systems
- Significant biomass – active microbial communities
- Infiltration and filtration capacity
- Evapotranspiration is a factor
- Habitat value
- Aesthetic value



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Green Infrastructure – Trees and Rain Gardens

■ Advantages of trees

- Greater evapotranspiration
- Unique relationship to ground
- We already have lots of them
- We know how to manage them
- Everyone likes them
- Extra benefits – see the list



Benefits of Trees

■ Improve water quality

- Stormwater rate control
- Facilitate stormwater infiltration/treatment
- Rainfall interception
- Pollution removal – through phytoremediation

■ Improve air quality

- Mitigate global warming by reducing green house gases
- Carbon dioxide storage and sequestration

More Benefits of Trees

■ Energy and temperature

- Increase energy savings (shade and windbreaks) – reduced energy use
- Reduce urban heat island effect
- Reduce asphalt temperature

Still More Benefits of Trees

■ Economic benefits

- Increased property values
- Longer life for shaded asphalt paved areas
- Attractiveness of retail settings – greater sales

■ Social and psychological benefits

- Crime reduction
- Increased aesthetics
- Human health benefits
- Wildlife habitat

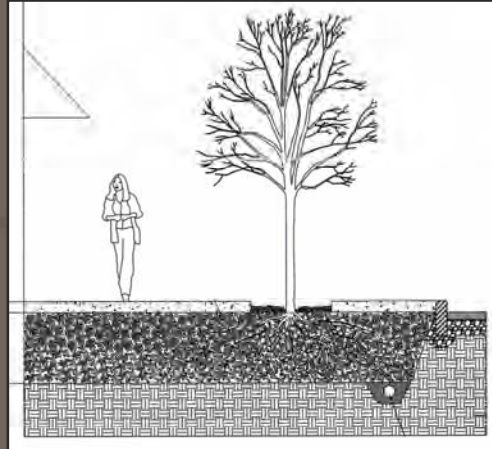
University of Illinois at Urbana-Champaign
Landscape and Human Health
Laboratory

Frances E. Kuo, Director

<http://lhhl.illinois.edu/index.htm>

Interesting Planting Systems

We can build sidewalks and parking lots over tree roots



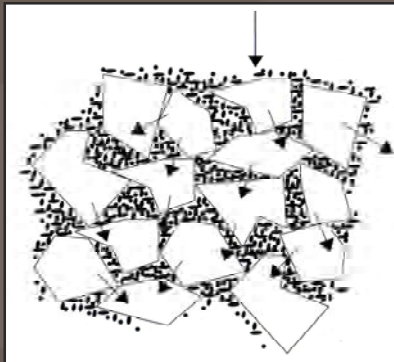
>15 years of
successful
installations

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Interesting Planting Systems

■ Cornell Structure Soil

- CU Structural Soil™
- Address soil compaction in urban settings



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Suspended Pavement

- Silva Cells®
- Supports paving to H-20 standard
 - Truck loading
- Promotes large trees

www.deeproot.com



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Suspended Pavement



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Suspended Pavement

- 25-year old installation – ≈ 170 trees
- Charlotte, NC – Tryon St. & Trade St.
- Precast concrete pavement supported by piers
- 700 cubic feet of soil per tree
- Avg DBH 16"
- Avg height 44'



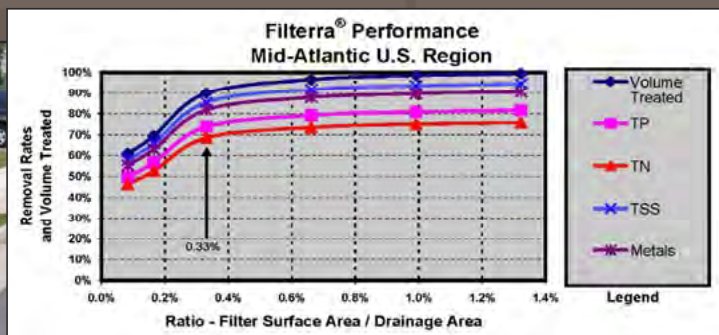
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Interesting Planting Systems

- Filterra[®]
 - Engineered bioretention system
 - Route stormwater to root system



The use of plants enhances pollutant removal and aesthetics, making Filterra ideal for residential areas.



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NURP Ponds – A Precedent

- National Urban Runoff Program
- Study by the USEPA
 - 1977 to 1983
- One result was the wide-spread use of stormwater ponds
 - Public and private projects

NURP Ponds – A Precedent

- Essential elements of NURP
 - **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**
- Result
 - estimated **20,000** SW ponds in the Twin Cities metro area

Regulatory Goals

- **Integrate tree BMPs into the stormwater regulatory framework**
 - Credits for tree BMP implementation
 - Clear design standards for engineers and designers
 - Not just instructions and good intentions
 - All levels and programs
 - MS4 cities, TMDLs, nondeg, watersheds, city ordinances, Mn/DOT
- **Build the framework right – implementation will follow**
 - the stormwater pond lesson

Applications

- **Response to TMDL load allocation**
 - **Increase tree canopy**
 - Reduce runoff volume
 - Improve water quality
 - Regional or city-wide
 - Reduce Combined Sewer Overflow



Applications

- Corporate offices and public spaces should be covered with trees



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Applications

- **Tree riparian buffers**

- Stream bank stability
- Filtering runoff
- Stream temperature



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Applications

■ New development projects

- Save existing stands of trees
- Give credit for their stormwater functions
- Expand & strengthen city ordinances

Subdivision with no open space



Open-space design



Graphic courtesy of
Renaissance
Planning Group

Applications

■ Brownfield sites

- Using trees, it may be possible to achieve stormwater volume reduction on sites where infiltration is impossible



Applications

■ Departments of Transportation

- Under pressure to improve water quality
- Ponds have limited value
- Trees can break down hydrocarbons



Applications

■ Replace stormwater ponds with tree basins

- Improved water quality
- Other benefits of trees



Applications

Streetscapes

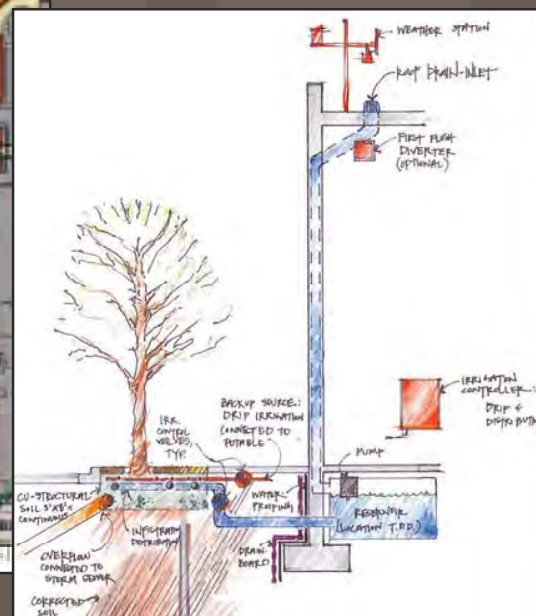
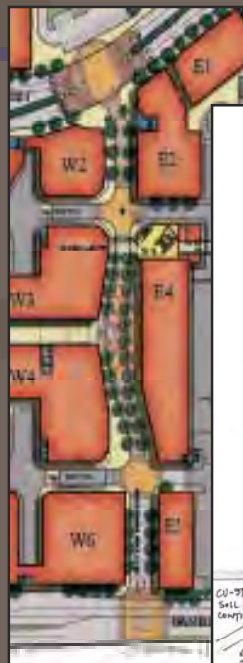


Healthy root zone volume,
stormwater treatment,
evapotranspiration,
and infiltration

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Applications

- Streetscape
- Roof rainwater
- Storage cistern
- Tree root system
- Volume reduction
- WQ treatment

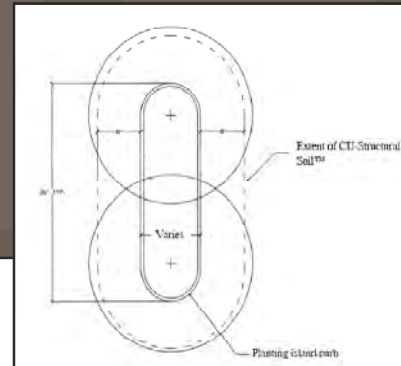
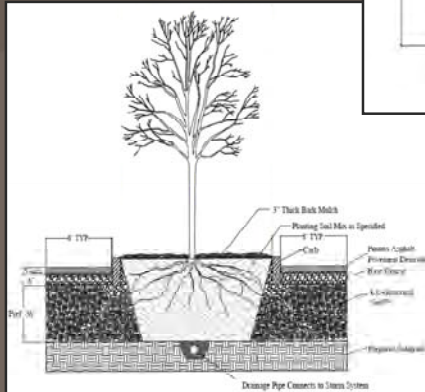


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Applications

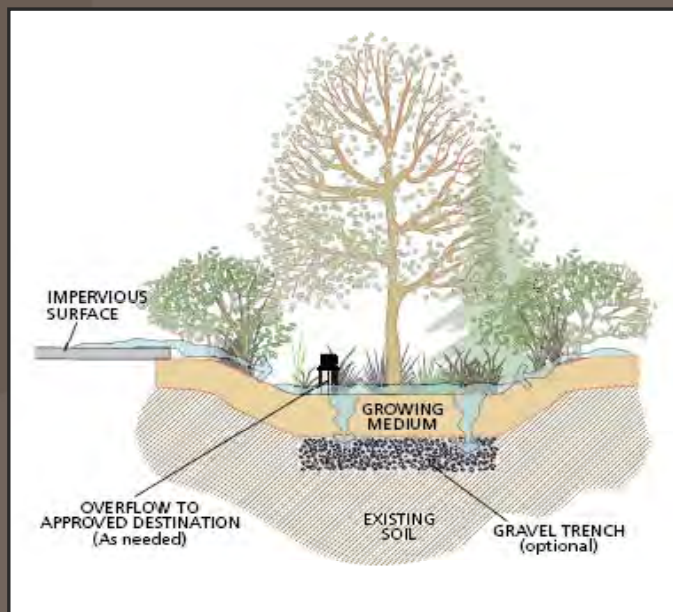
■ Parking lots

- Larger planting volume without losing spaces



Applications

Portland, OR



Applications



Portland, OR



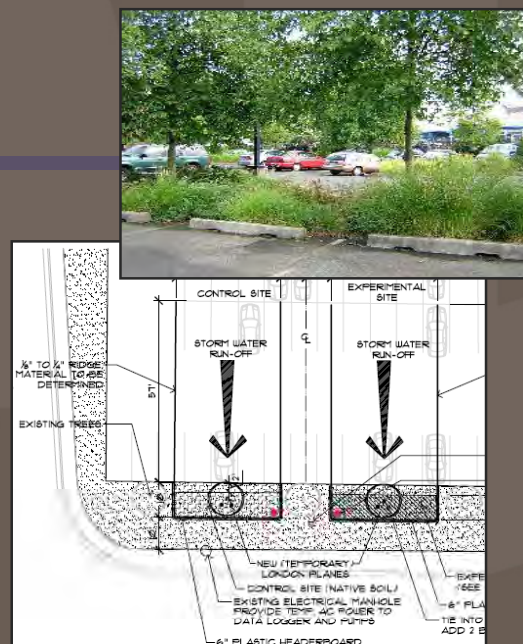
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Applications

Parking lots

- Can we change how parking lots are built?
- Benefits for pavement, shopping, stormwater

Dr. Greg McPherson
U.S.F.S.
Univ. of California – Davis



Parameter	Nutrients	Metals	Organic Carbon	Solids
Load Reduction	95.3%	86.7%	95.5%	95.5%



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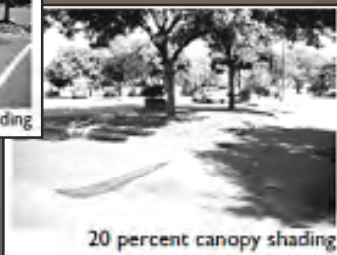
Applications

■ Tree canopy requirements for parking lots

- 30%, 40%, 50%
- Route runoff to the root zones
- Volume reduction & water quality improvement



5 percent canopy shading



20 percent canopy shading



Parking lot having 50 percent tree canopy cover

Kathleen Wolf, Ph.D.
Univ. of Washington



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Applications

■ Public plaza

- Large area, large root zone volume



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Stockholm, Sweden



Applications

Boulevard trees

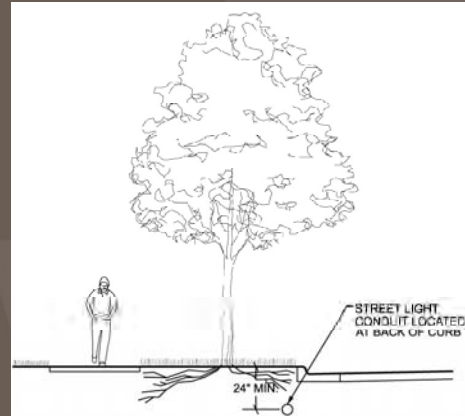
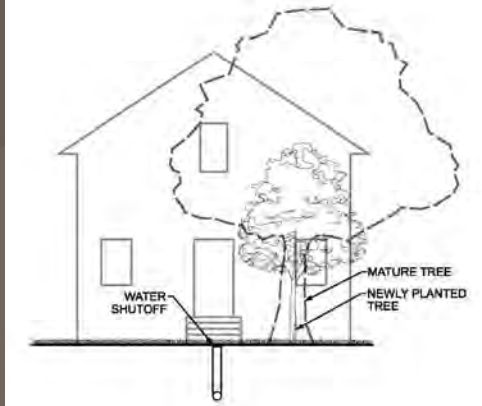


Portland, OR

Minneapolis is a leader

■ City street tree standards – draft completed

- “The primary use of the planted boulevard in Minneapolis is for trees and tree roots.”



Minneapolis is a leader

■ Swedish soil

- Washington Ave. – North Loop
- Trees thrive in rock with void space
- 40” growth in one year



Minneapolis is a leader

■ W 54th St. – between Penn & Upton

- Rock infiltration cells under street



Significant Questions and Issues

- Selection of best tree species
- Phosphorus management – street cleaning
 - Bannerman's work shows increased P runoff to streets with greater tree canopy
- Viability of routing stormwater to tree roots
 - Water regime
 - Chemicals – road pollution, deicers (salt)
- Demonstrate and quantify benefits
- Long-term infiltration capacity and tree health
- Traffic safety
- Understand phytoremediation

Summary Themes

- Develop tree BMP systems based on canopy and root zones
- Develop approaches that are site-specific, city-wide, and regional – multiple scales
- Support tree BMP systems in a manner similar to NURP ponds – integrate with regs
- Simultaneously meet the goals and regulatory needs of public works engineers and urban foresters
- Harness the power of enlightened self-interest

Any questions?

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[http://www.bonestroo.com/client_files/
Bonestroo/Publications/City_Trees.pdf](http://www.bonestroo.com/client_files/Bonestroo/Publications/City_Trees.pdf)

http://www.bonestroo.com/trees_and_stormwater_symposium/



Tree-based Stormwater BMP

Four Functions

1. Canopy Interception
2. Evapotranspiration
3. Subsurface infiltration
4. Water quality treatment in root zone

