Combining Stormwater Retention with Trees
Experiences with Structural Soils

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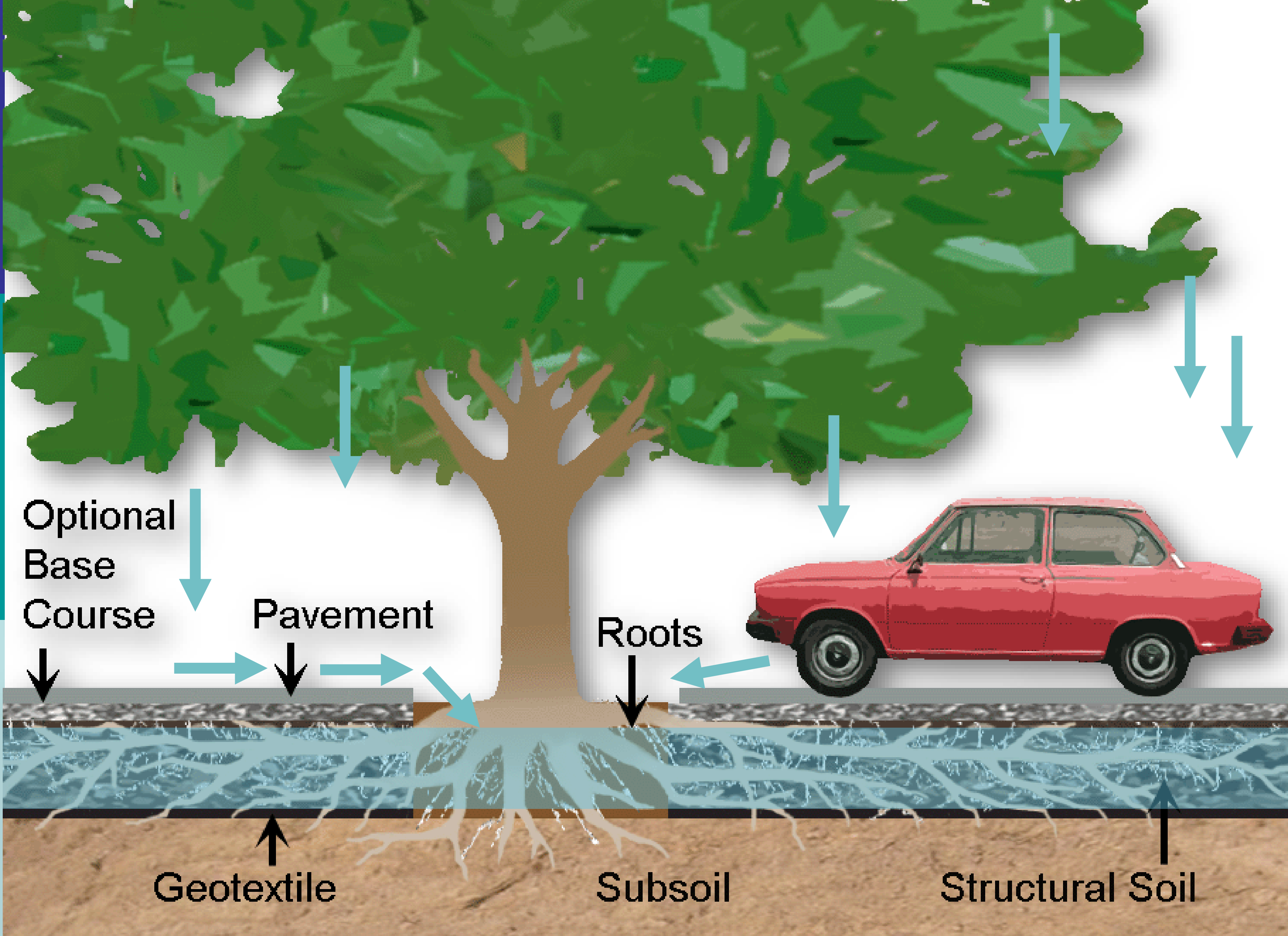
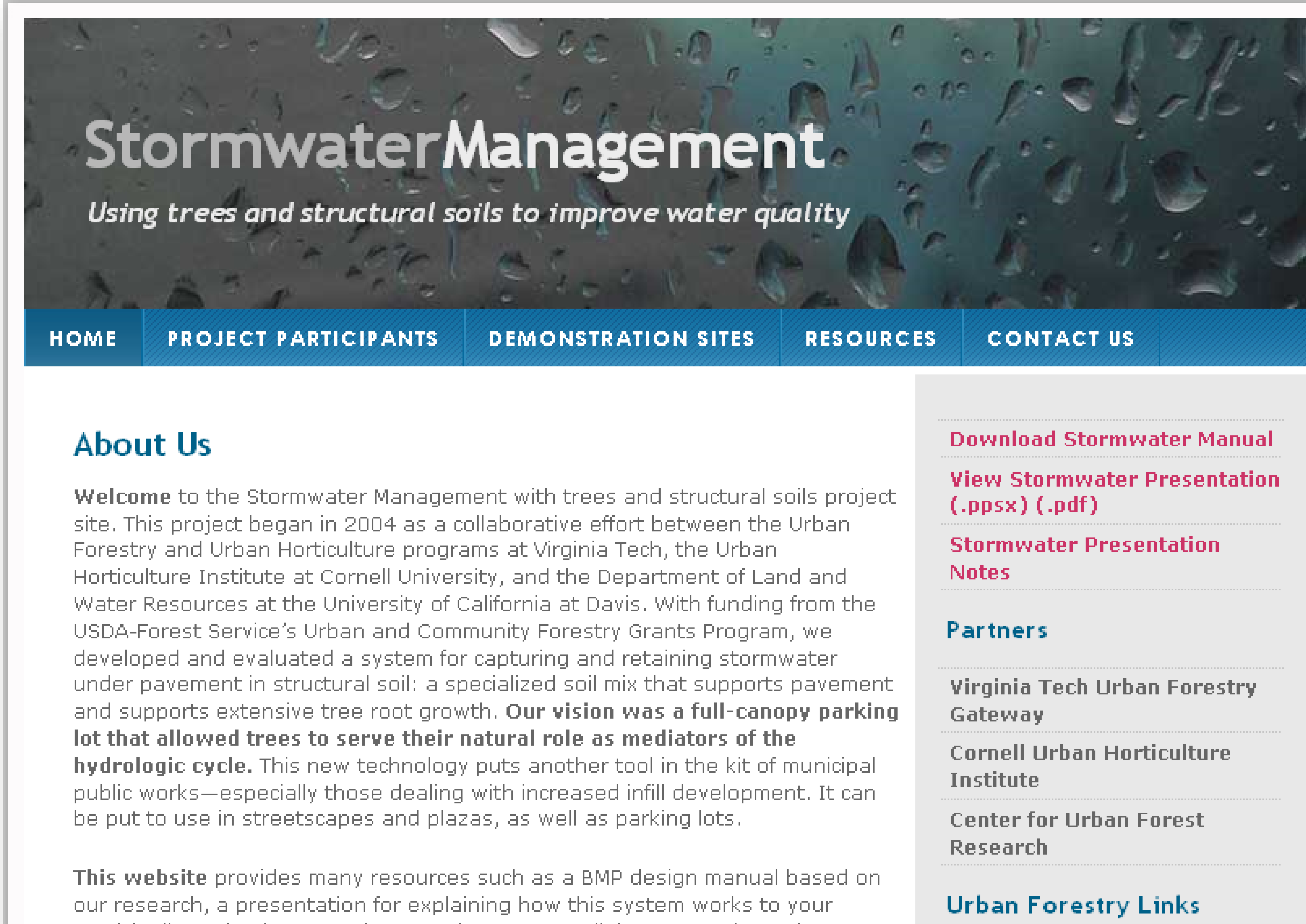
No Trees


Optional
Base
Course
Pavement
Roots
Geotextile
Subsoil
Structural Soil



StormwaterManagement

Using trees and structural soils to improve water quality

HOME | PROJECT PARTICIPANTS | DEMONSTRATION SITES | RESOURCES | CONTACT US

About Us

Welcome to the Stormwater Management with trees and structural soils project site. This project began in 2004 as a collaborative effort between the Urban Forestry and Urban Horticulture programs at Virginia Tech, the Urban Horticulture Institute at Cornell University, and the Department of Land and Water Resources at the University of California at Davis. With funding from the USDA-Forest Service's Urban and Community Forestry Grants Program, we developed and evaluated a system for capturing and retaining stormwater under pavement in structural soil: a specialized soil mix that supports pavement and supports extensive tree root growth. **Our vision was a full-canopy parking lot that allowed trees to serve their natural role as mediators of the hydrologic cycle.** This new technology puts another tool in the kit of municipal public works—especially those dealing with increased infill development. It can be put to use in streetscapes and plazas, as well as parking lots.

This website provides many resources such as a BMP design manual based on our research, a presentation for explaining how this system works to your

Download Stormwater Manual

View Stormwater Presentation (.ppsx) (.pdf)

Stormwater Presentation Notes

Partners

Virginia Tech Urban Forestry Gateway

Cornell Urban Horticulture Institute

Center for Urban Forest Research

Urban Forestry Links

www.urbanforestry.frec.vt.edu/stormwater

Q1—How much stormwater does it hold?

CUSoil~30% porosity

24-inch deep bed holds about a 5-inch rain event

Carolina Stalite mix~34% porosity

24-inch deep bed holds a 6- to 7-inch rain event

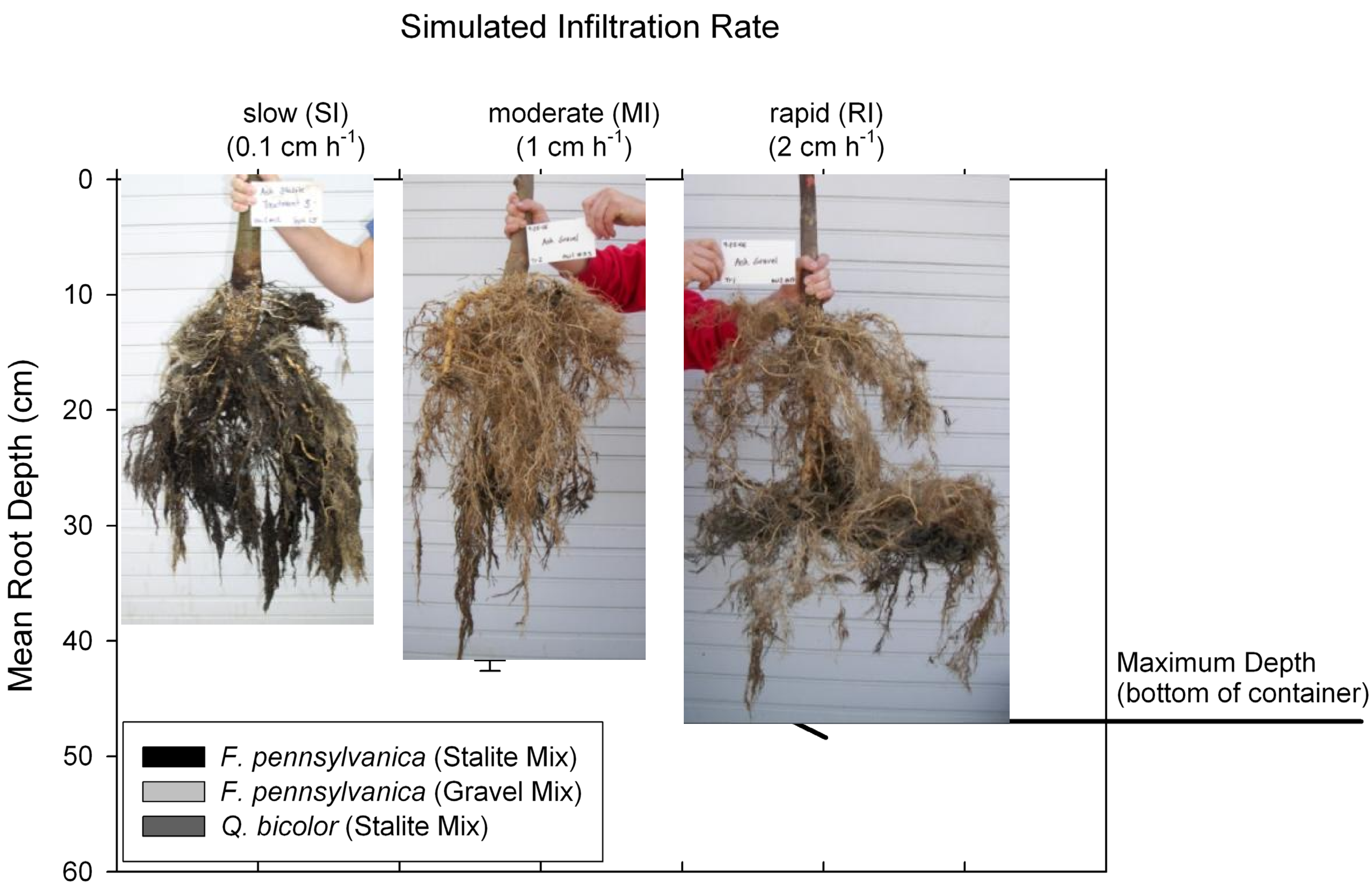
Q2—Will roots grow in it if it is holding stormwater?

Root Distribution Under Different Drainage Regimes

- Four bottomland, pH tolerant species
- Three Drainage Regimes:
  - Rapid drainage (1 day)
  - Moderate Drainage (4 day)
  - Slow drainage (25 day)
- Imposed during establishment—how will root distribution be affected?
- Water uptake determined via water level drop, sap flow gauge, and porometer.




Reservoir should drain in 2 days



~9 weeks of root growth moderate drainage regime-ash


Ash Stalite
Treatment 3
row 2 #12
Sept 15

Q3—Will tree continue to transpire at normal rates under these conditions?

Transpiration rates are within the normal range

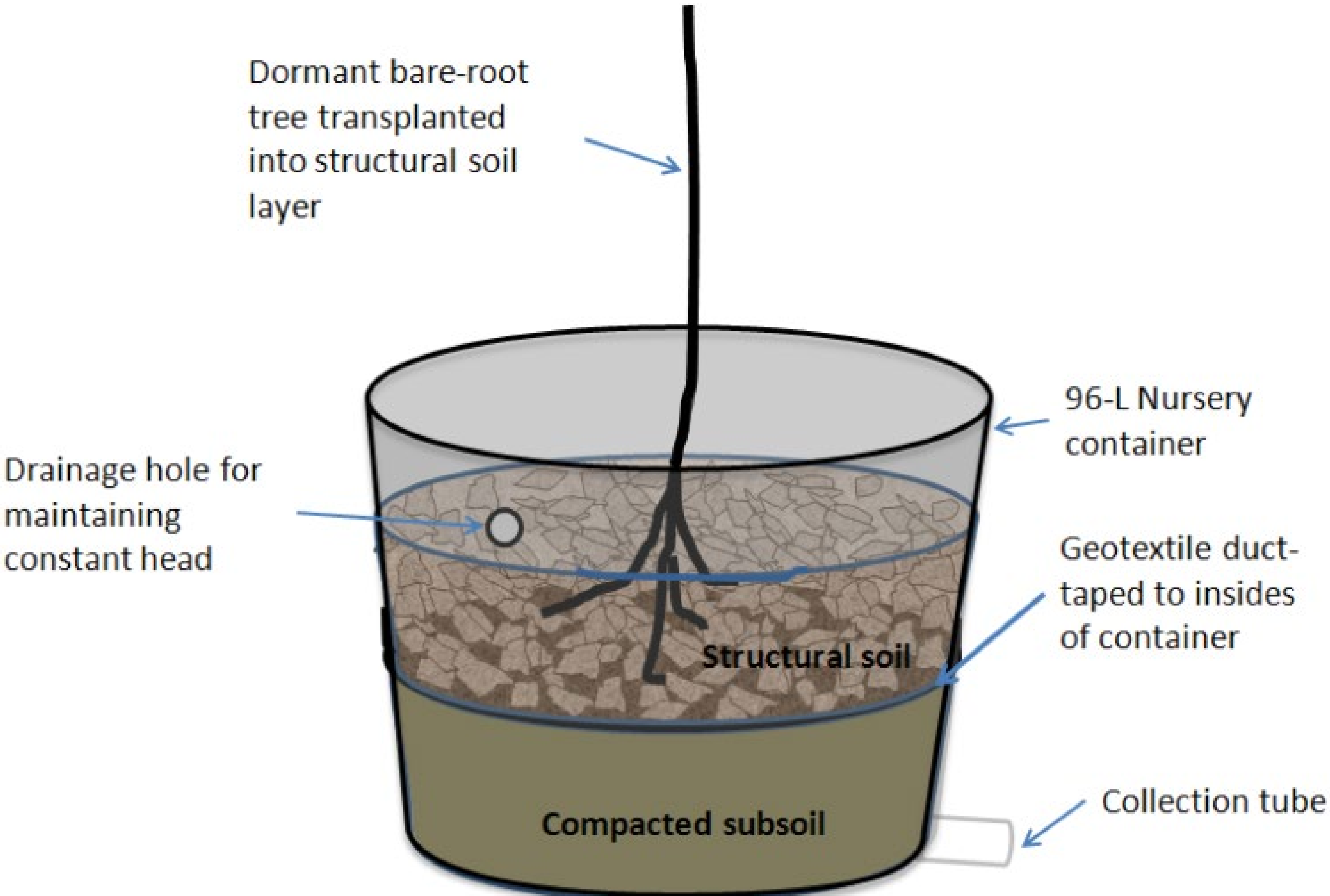
Q4—Will roots penetrate compacted soil beneath the reservoir and could they improve drainage?

- Green ash (*Fraxinus pennsylvanica*)
- Red maple (*Acer rubrum*)
- Black oak (*Quercus velutina*)

fibrous roots (ash, maple) ■coarse roots (black oak)

Tree vs. No Tree

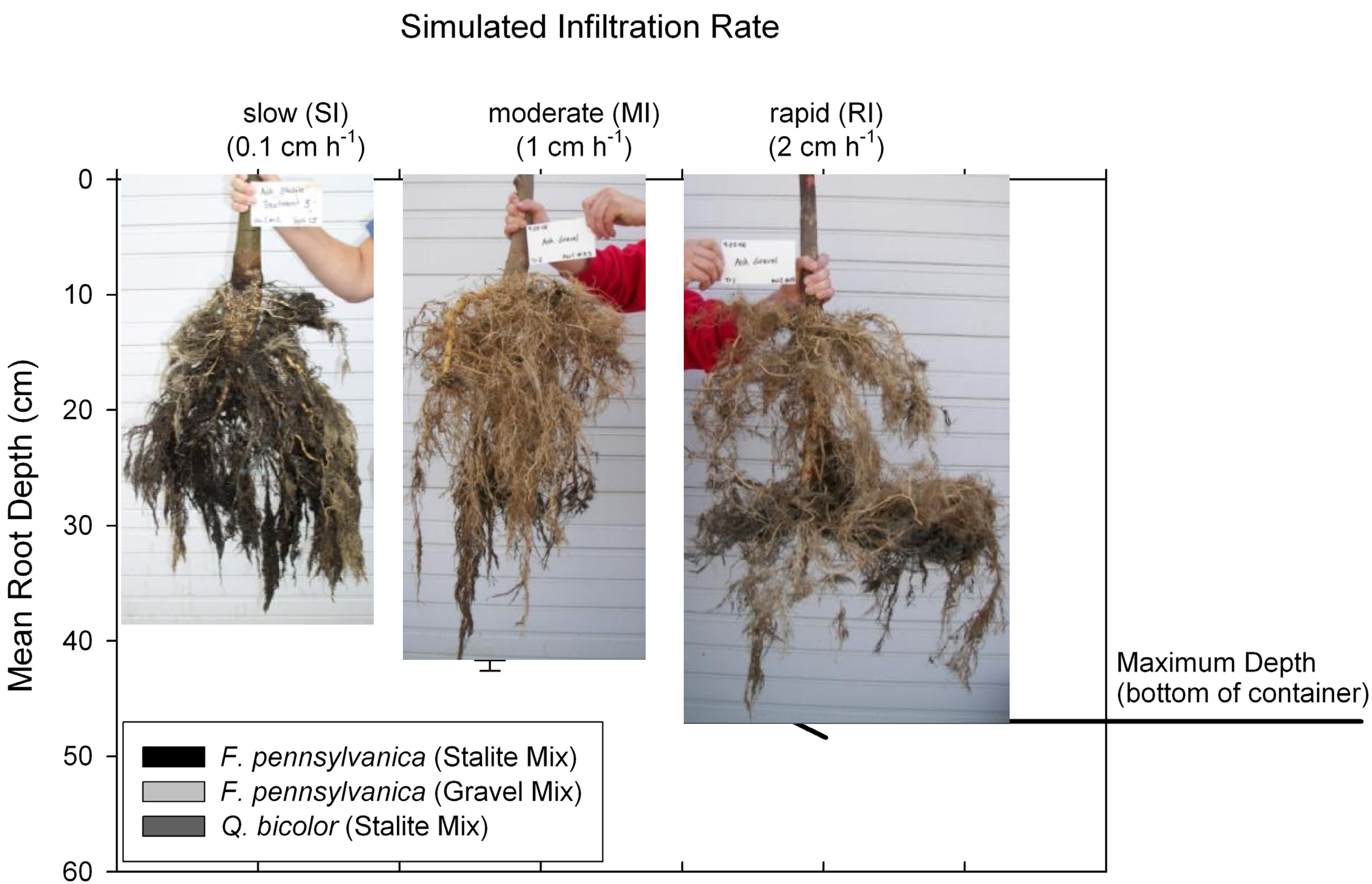
K_{sat} increased by a factor of 1.5 on average

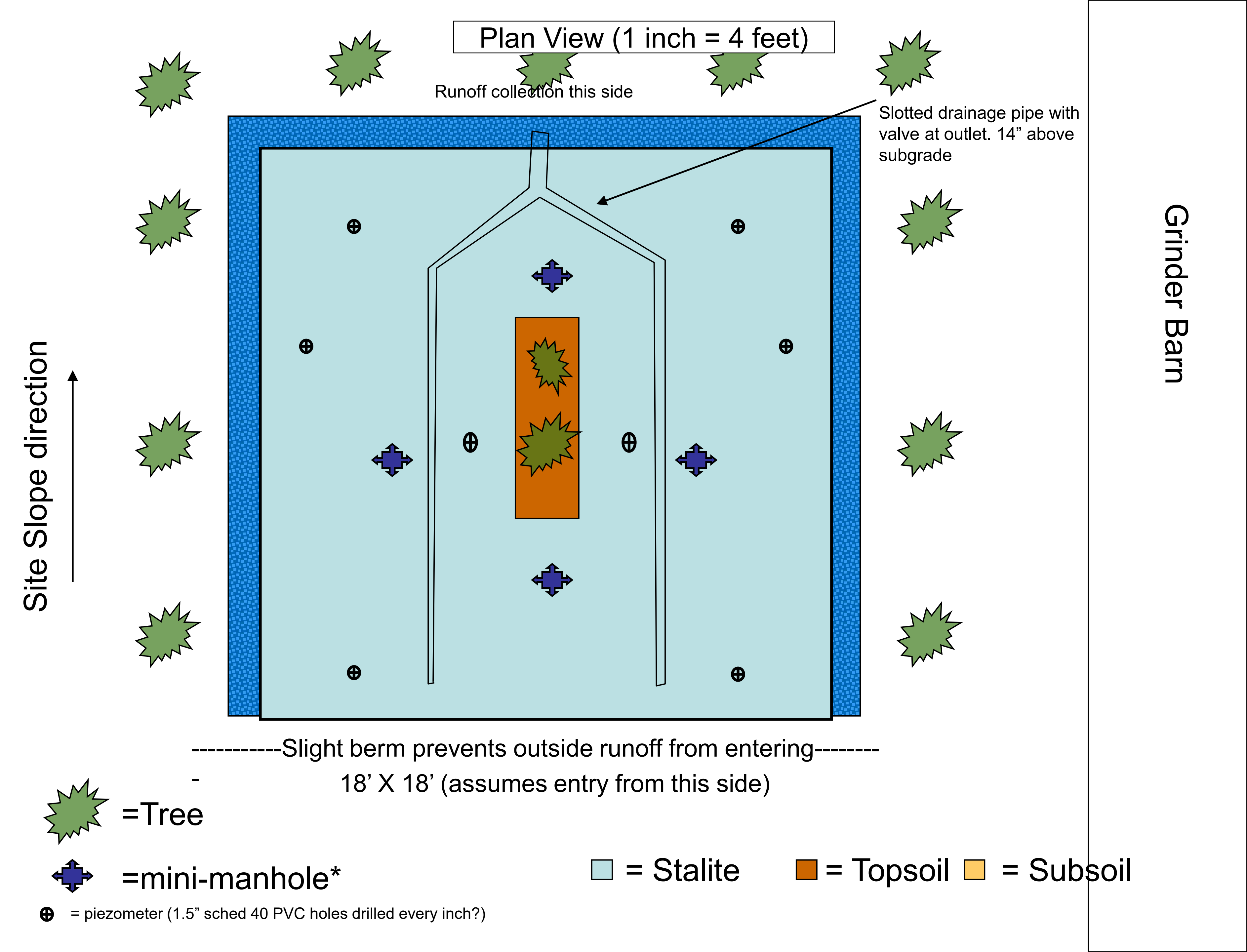

Dormant bare-root tree transplanted into structural soil layer
96-L Nursery container
Drainage hole for maintaining constant head
Geotextile duct-taped to insides of container
Structural soil
Collection tube
Compacted subsoil


K_{sat} increased by a factor of 27 on average

Q5—How fast does the reservoir need to drain?

Reservoir should drain in 2 days




Plan View (1 inch = 4 feet)
Runoff collection this side
Slotted drainage pipe with valve at outlet. 14” above subgrade
Grinder Barn
Site Slope direction
-----------Slight berm prevents outside runoff from entering---------
18’ X 18’ (assumes entry from this side)
=Tree
=mini-manhole*
= Stalite
= Topsoil
= Subsoil
= piezometer (1.5” sched 40 PVC holes drilled every inch?)

Excavated corner showing soil horizons

Immediately after a rain event

Water drained out very quickly—this photo was taken minutes after rain had ceased. Wooden box around island was removed progressively as structural soil was added.

Q6—How fast will water move laterally?

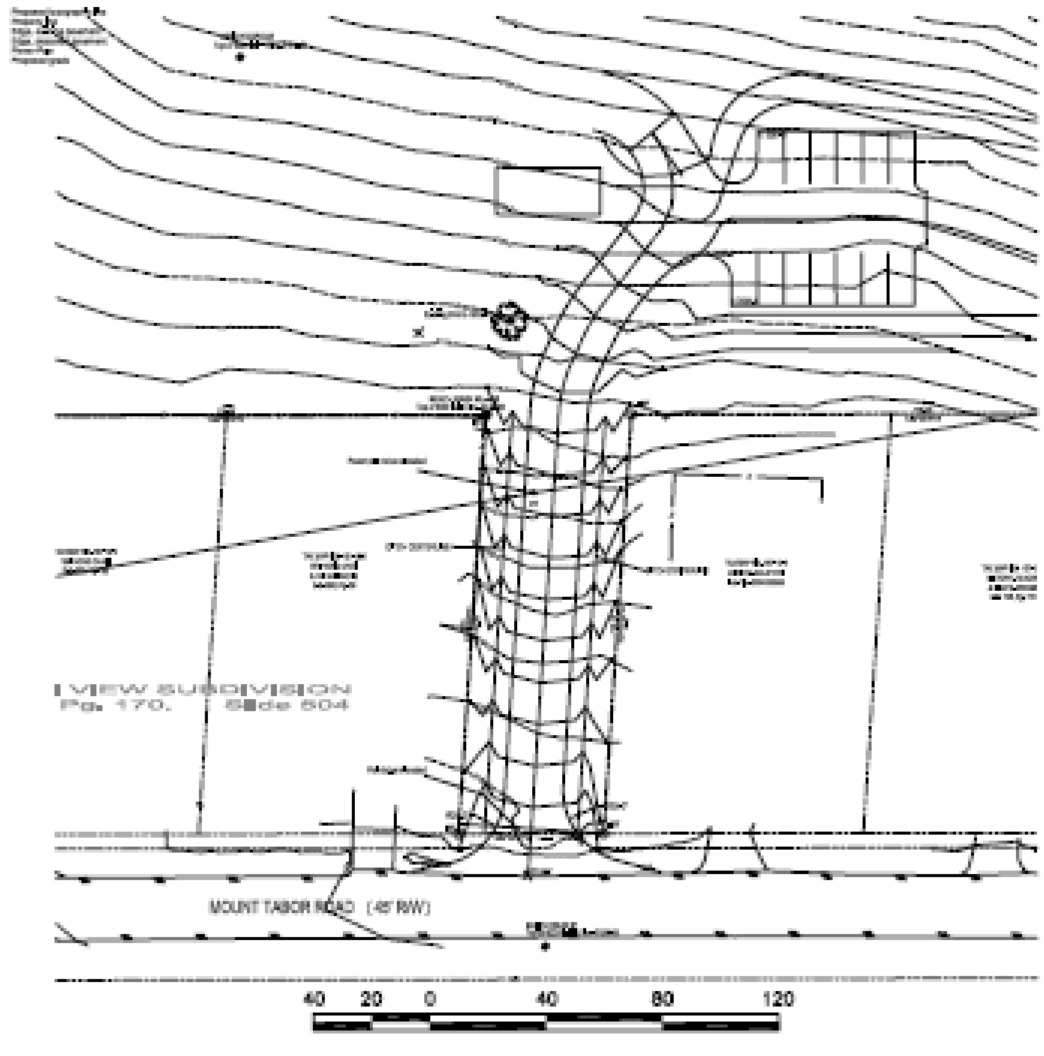
Minirhizotron Manhole

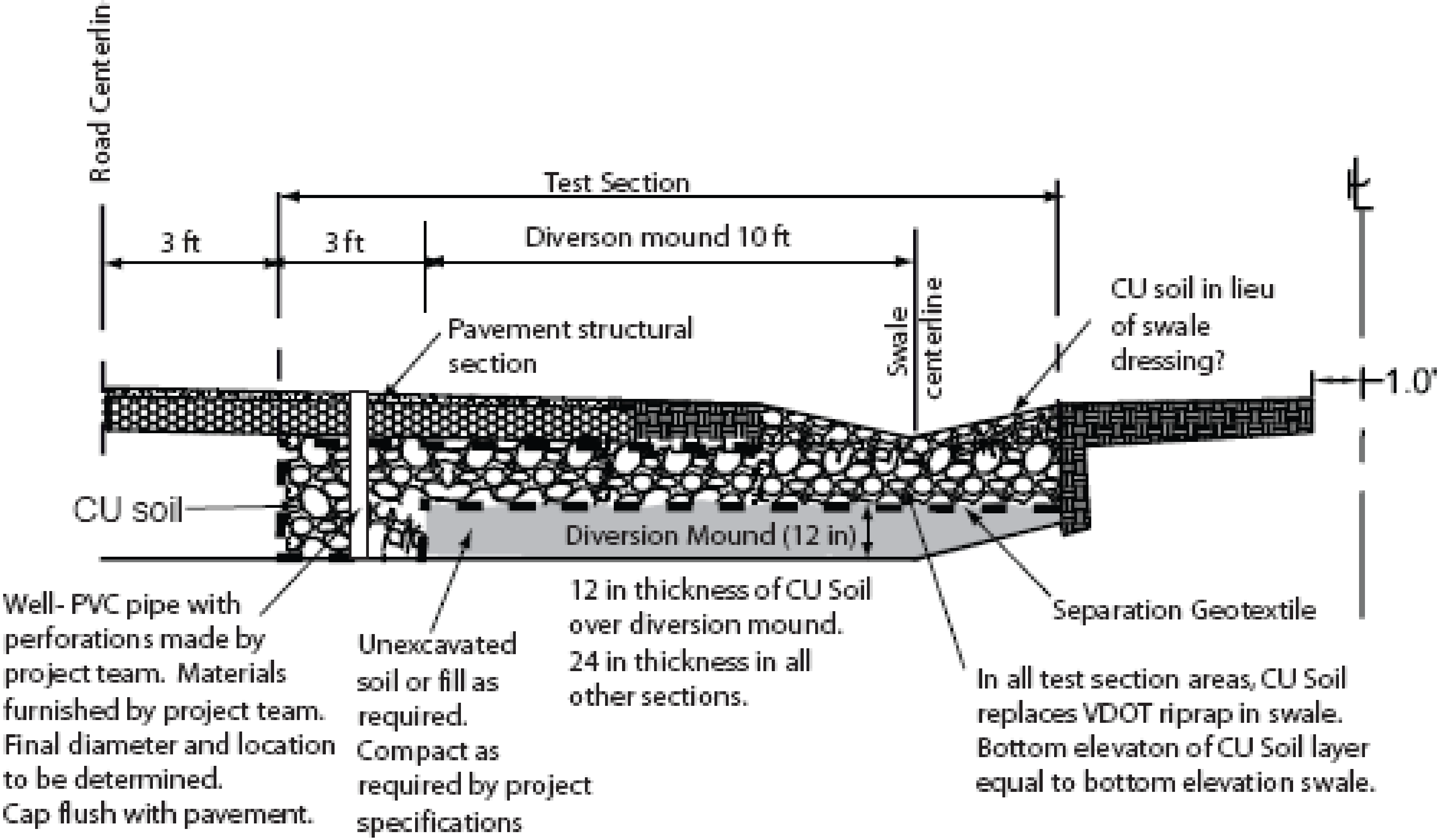
4 minirhizotron tubes extend outwards and downwards to the bottom of the structural soil.

Acer rubrum ‘Red Sunset’

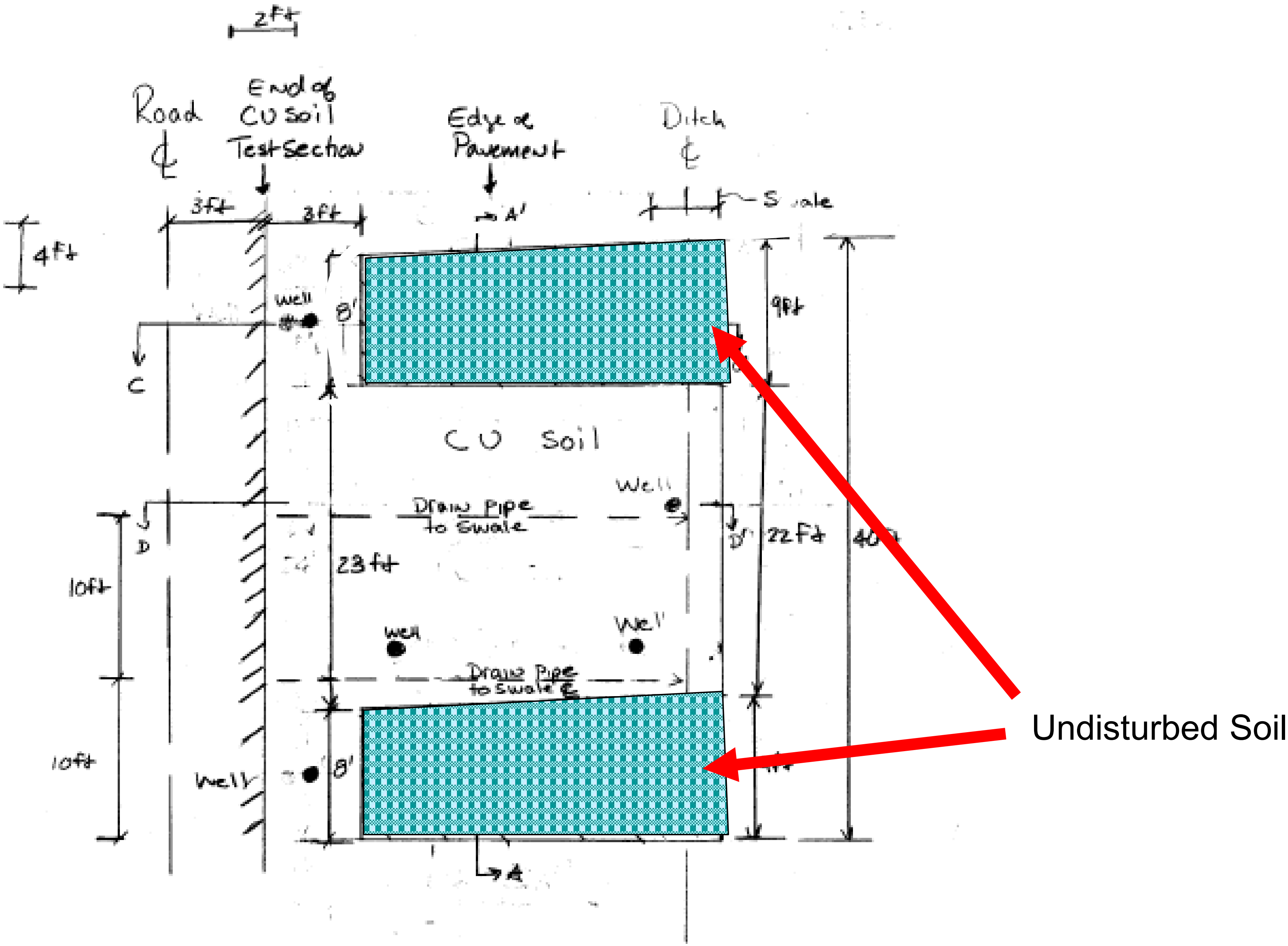
Q7—Can this be used on a slope? What about hydrostatic pressure?

Access Road on Slope





Section c-c' with Diversion Mound



Diversion Mound Test Section Plan


06.15.2012
Photo: Nina L. Bassuk

Q8—Does this system remove pollutants?

Pollutant Removal Study by Dr. Qingfu Xiao, UC Davis


UNITED

	Pollutant reduction (percent)														
	Max			Min			Mean			STD			[1]No		
	CS	CU	DS	CS	CU	DS	CS	CU	DS	CS	CU	DS	CS	CU	DS
TKN	67	39	85	8	20	12	42	29	46	21	8	19	17	4	23
NH4-N	100	99	100	36	7	42	84	54	83	18	31	16	15	13	17
NO3-N	95	88	95	58	58	58	77	73	77	26	21	26	2	2	2
[2]P_S	96		95	13		11	62		59	26		25	16	0	19
P	82		78	0		0	58		52	23		25	16	0	19
[2]K_S	78		73	25		34	59		56	16		13	9	0	9
K			64			37			50			19	0	0	2
Zn	100	100	100	50	50	50	80	75	80	21	21	21	15	15	14
Cr	100	100	100	0	0	50	78	88	92	36	35	20	9	8	6

[1]: Number of samples.

[2]: S stands for soluble.

Table 3. Pollutant removal of single storm event. CU= CU Soil, CS= Carolina Stalite, and DS= Davis Soil.

Table by Qingfu Xiao.

Research Team

- Virginia Tech
  - Dr. Susan D. Day—Forestry
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  - Dr. Joseph Dove, P.E.—Civil and Environmental Engineering
  - Julia Bartens, Graduate Student
- Cornell University
  - Dr. Nina L. Bassuk, Urban Horticulture Institute
  - Dr. Peter Trowbridge, Landscape Architecture
  - Ted Haffner, Graduate Student
- University of California at Davis
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