Green Infrastructure Webcast Series

Site Planning and Design Considerations & WERF Cost Tool

Tuesday, May 12, 2009

Guide to Our Webcasts

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Green Infrastructure Webcast Series

Tuesday, June 23, 2009

- Funding & Incentives … Abby Hall, U.S. EPA
- Brownfield Redevelopment …Stacy Swartwood, U.S. EPA

Tuesday, July 28, 2009

- Retrofits: Green Streets … Chris Kloss, LID Center
- Operation & Maintenance … Tracy Tackett, Seattle Public Utilities

Webcasts from this series can be found at the 'Training and Conferences' page, on Green Infrastructure website

Green Infrastructure Website

www.epa.gov/greeninfrastructure

- General Information
- Key Resources
- Case Studies
- Performance Data
- Partnership Contacts
- Statement of Support

Green Infrastructure Workshops

July 1 – 2: Ft. Myers, Florida

July 21 – 22: Charleston, WV

August 27: Kansas City, KS

Agenda and registration available one month prior to workshop: see the 'Training and Conferences' page on Green Infrastructure website

Managing Wet Weather with Green Infrastructure

Design Principles and Considerations

May 12, 2009 Webcast

Daniel P. Christian, P.E., D.WRE
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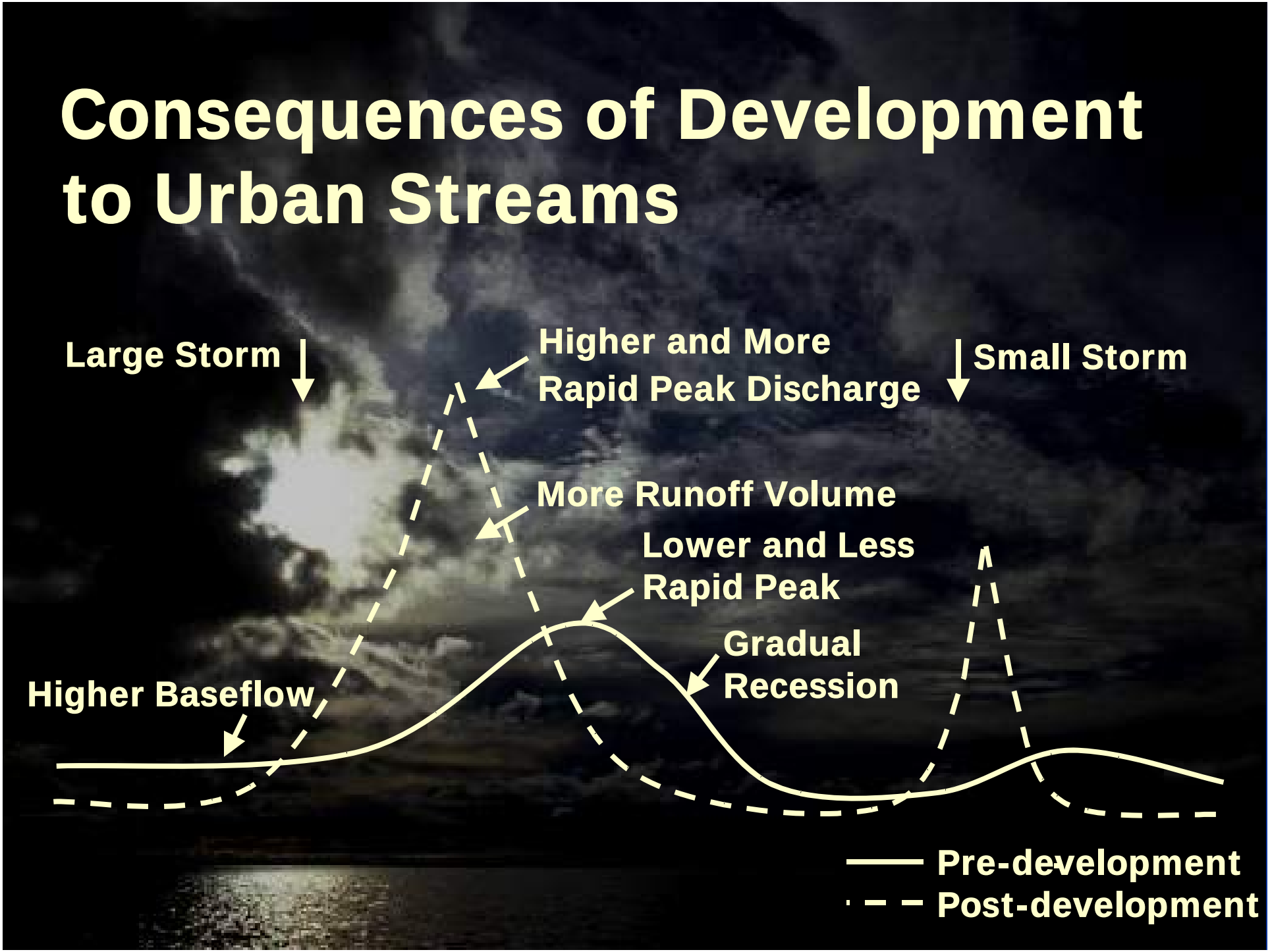
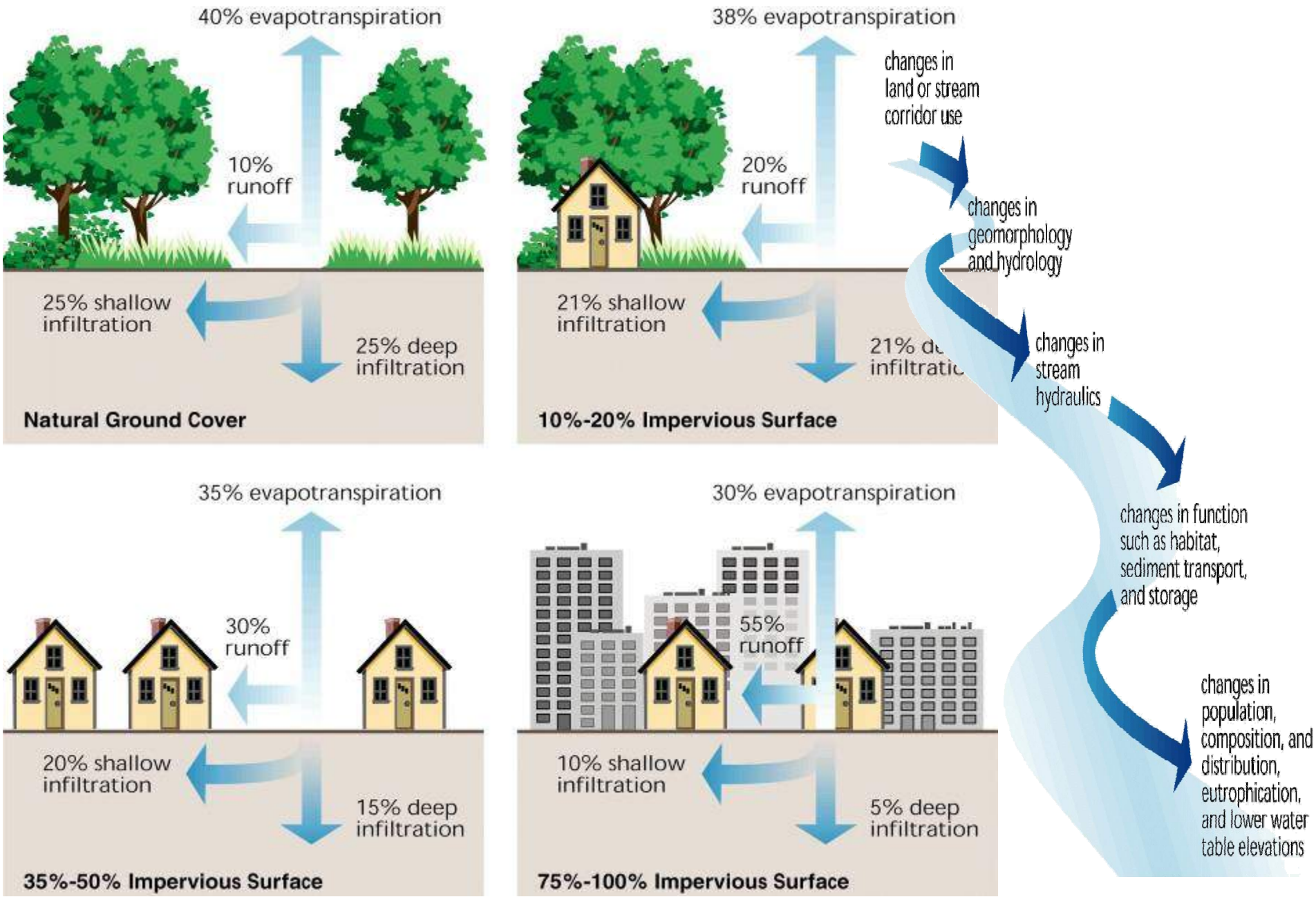
Agenda

- Introduction and Fundamentals
- Types of Practices and What They Do
- Components
- Strategies for Design/Implementation
- Example Surface Runoff Analysis
- Summary

Consequences of Development to Urban Streams





Source: FISRWG 2001

Green Infrastructure

- Green Infrastructure management approaches and technologies infiltrate, evapotranspire, capture and reuse stormwater to maintain or restore natural hydrologies
- Benefits
  - Reduced and delayed stormwater runoff volume
  - Enhanced groundwater recharge
  - Reduced stormwater pollutants
  - Increased carbon sequestration
  - Urban heat island mitigation and reduced energy demands
  - Improved air quality
  - Additional wildlife habitat and recreational space
  - Improved human health
  - Increased land values

Source: USEPA Green Infrastructure website www.epa.gov/greeninfrastructure

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Water Storage - Surface

Bioretention (rain garden)
- Good infiltration
- Poor evaporation
- Good plant uptake and transpiration

Traditional Detention
- No infiltration
- Poor evaporation
- Poor plant uptake and transpiration

Traditional Retention
- Poor infiltration
- Good evaporation
- Poor plant uptake and transpiration

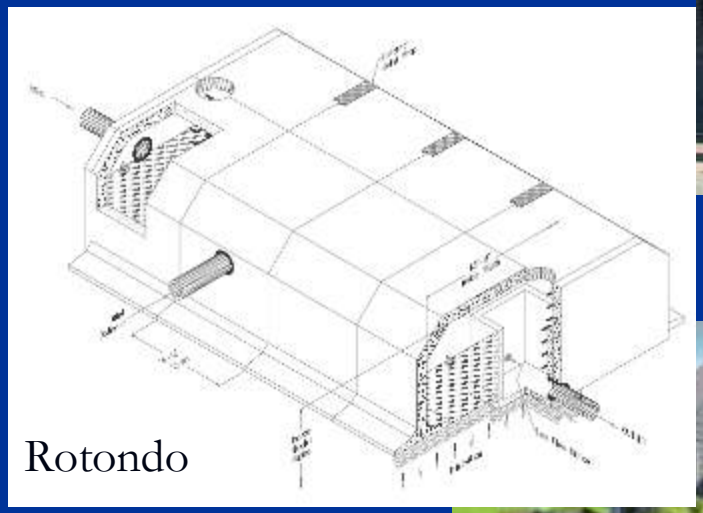
Green Roof
- No infiltration
- Good evaporation
- Good plant uptake and transpiration

Water Storage - Underground

StormChamber

EcoRain

Xerxes


Rotondo

Env21

Cultec

Cultec

Rainwater Harvesting and Conservation

Porous Pavement

Other Stormwater BMPs

- Types
  - Sand filters
  - Hydrodynamic devices
  - Inlet Traps
  - Gross Solids Removal Devices
- Purpose
  - Target floatable trash and suspended solids
  - May be tailored to other pollutants (e.g. hydrocarbons)
- What they don’t do
  - Increase evapotranspiration and infiltration

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Plants

Role

- Water Uptake
- Stabilization
- Impeding Flow
- Filtration
- Infiltration
- Nutrient Uptake
- Toxin Uptake
- Pollutant Breakdown

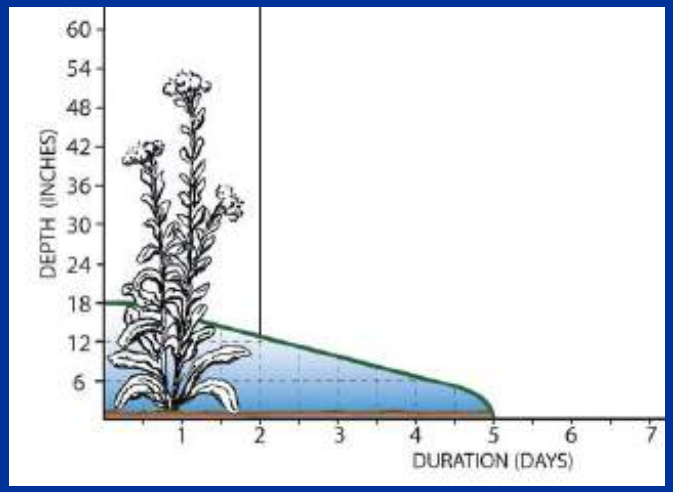
Example Applications

- Nurse crop/cover crop
- Buffer strips
- Vegetated trenches
- Biofiltration/rain gardens
- Vegetated swales and ditches
- Stormwater ponds/wetlands
- Green roofs
- Native plant reconstruction

Plant Selection and Installation Considerations

Site Conditions to Investigate

- Texture, organic content and pH
- Water levels, soil moisture
- Adjacent plant communities
- Slopes
- Amount of sun/shade



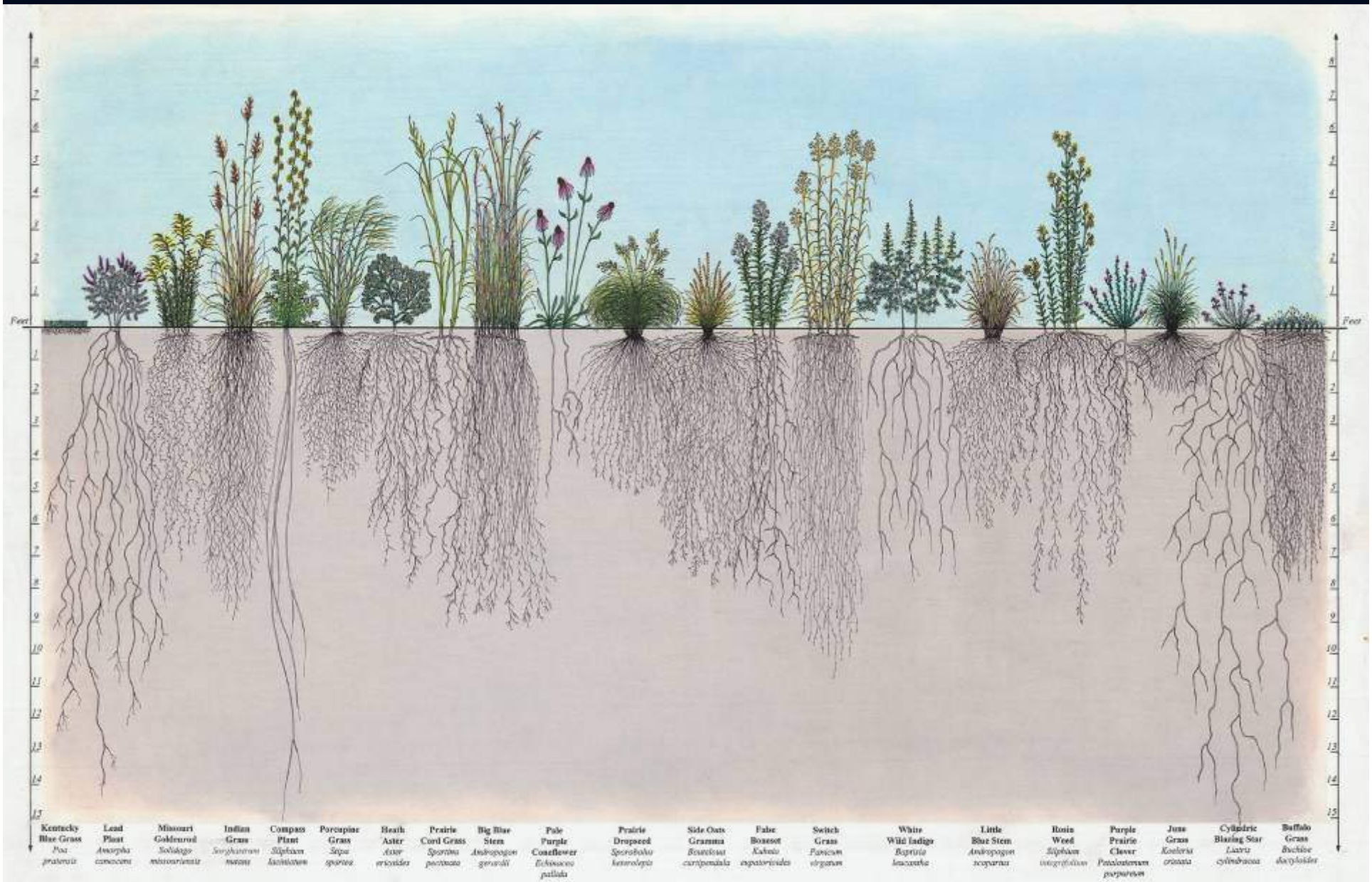
Environmental Threats

- Flood depth, duration and frequency
- Low water levels
- Sediment loads
- Pollutants and toxins
- Nutrients
- Salt
- Turbidity
- Erosion
- Invasive plants
- Herbivores

Transpiration Rates of Various Plants

Plant Name	Plant Type	Transpiration Rate
Perennial rye	Lawn grass	0.27 in/day
Alfalfa	Agriculture crop	0.41 in/day
Common reed	Wetland species	0.44 in/day
Great bulrush	Wetland species	0.86 in/day
Sedge	Wetland/prairie species	1.9 in/day
Prairie cordgrass	Prairie species	0.48 in/day
Cottonwood	Tree (2 year old)	2-3.75 gpd/tree
Hybrid poplar	Tree (5 year old)	20-40 gpd/tree
Cottonwood	Tree (mature)	50-350 gpd/tree
Weeping Willow	Tree (mature)	200-800 gpd/tree

Source: ITRC 2001

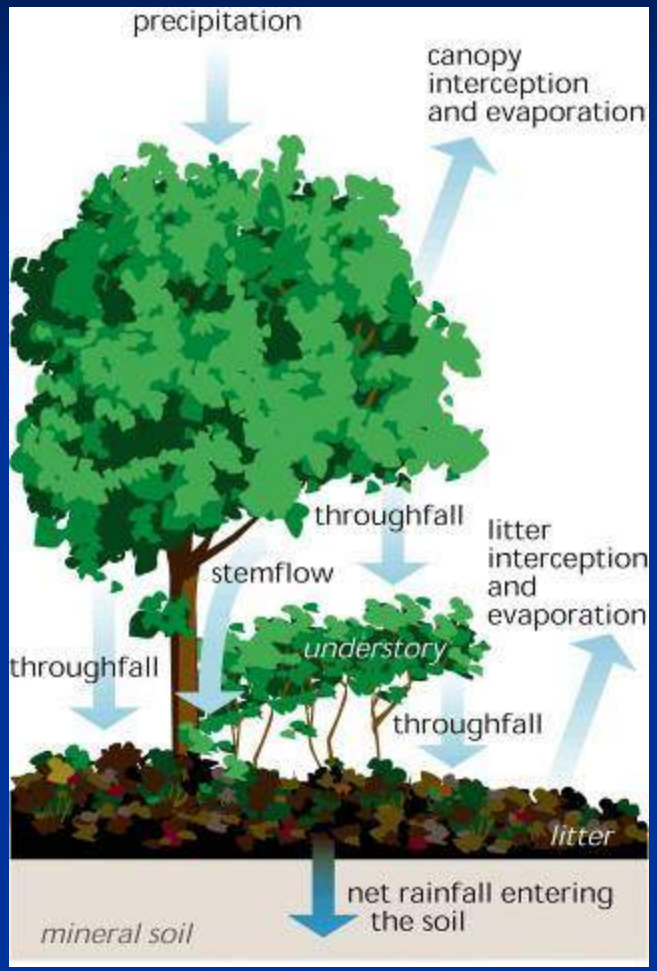


Root Systems of Prairie Plants

Conservation Research Institute

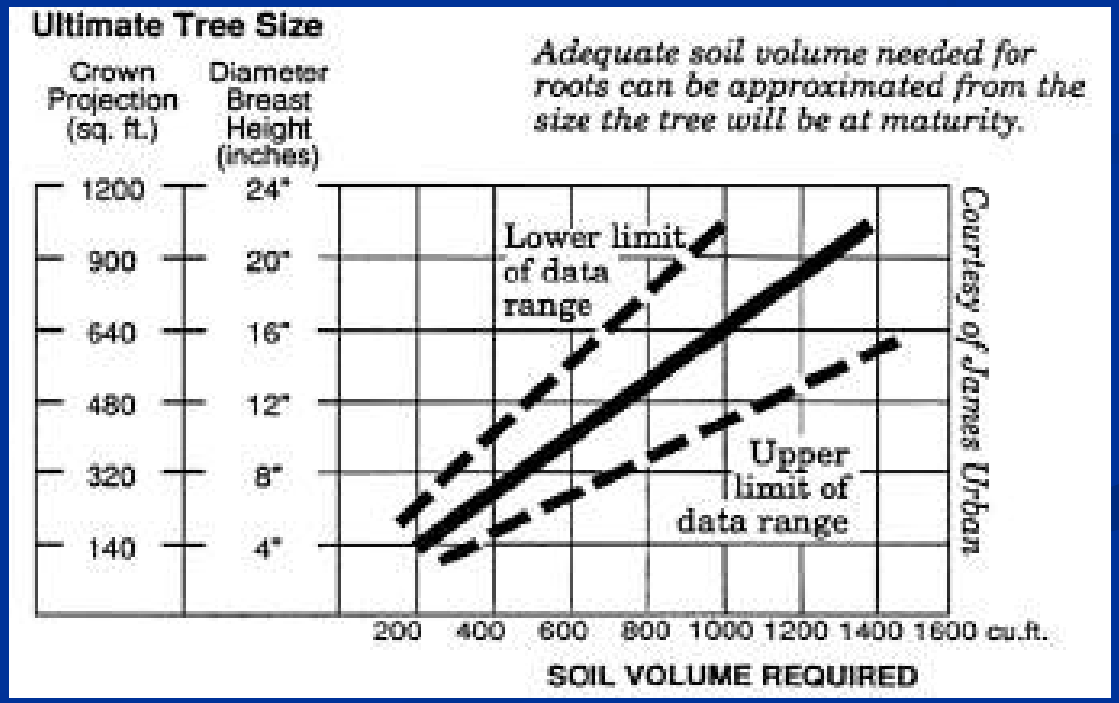
Heidi Natanz 1995

Trees



Source: FISRWG 2001

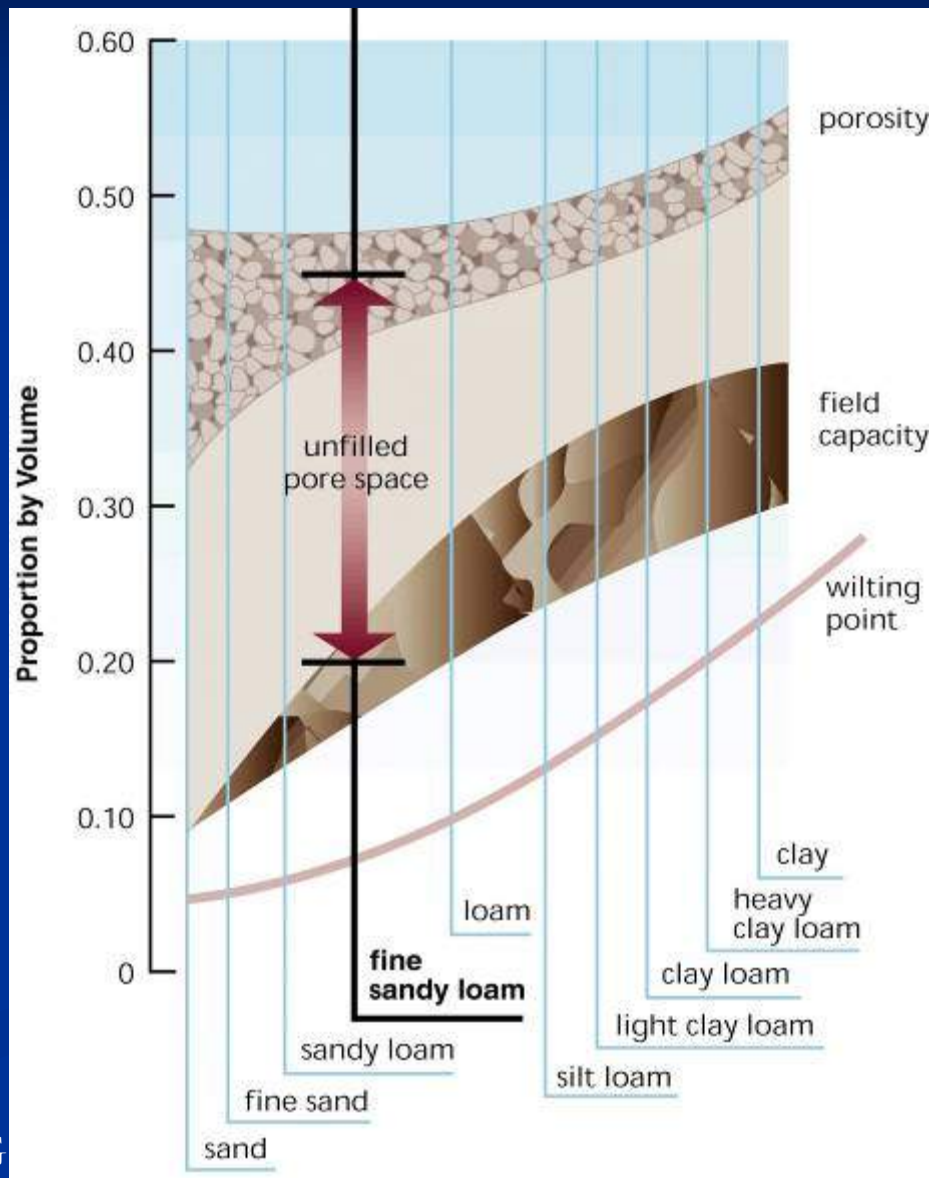
- Enormous potential for stormwater management
- 2 cu. ft. of usable soil for every 1 sq. ft. of mature canopy



Source: CWP 2006

Soil Characteristics

- Porosity: void space of soil (space for water)
- Infiltration: movement of water through soil
- Field Capacity: proportion of void space that stays wet due to surface tension (i.e. after water drains by gravity)
- Wilting Point: point at which plants can no longer withdraw water fast enough to keep up with transpiration



Source: FISRWG

Consider this . . .

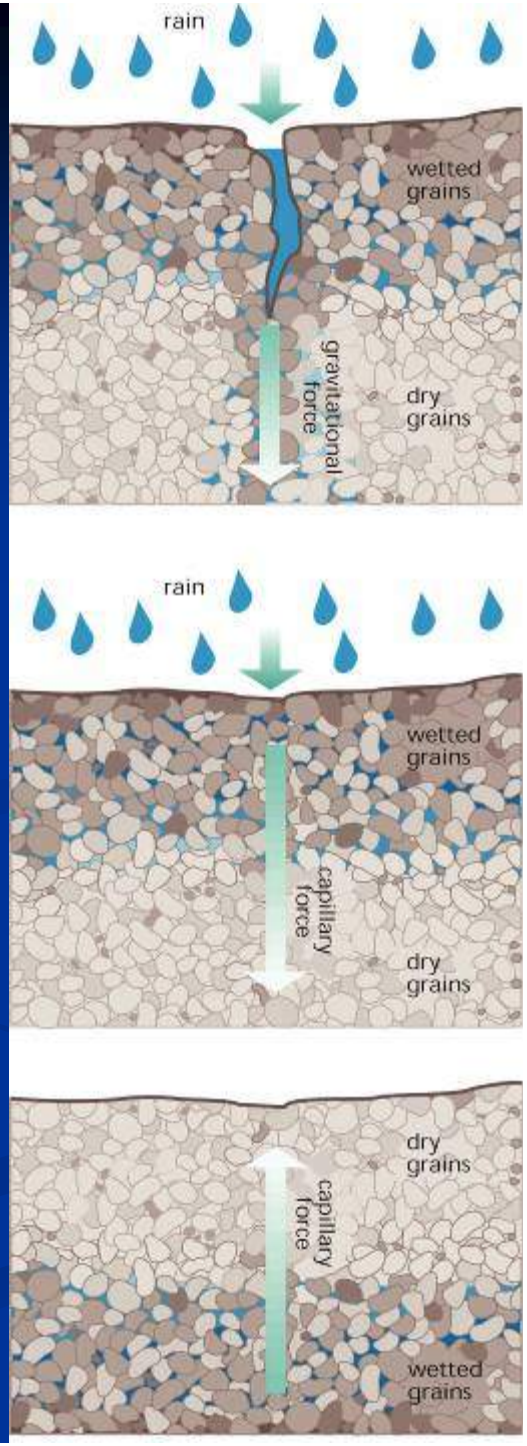
- Consider a tree box sized for a 16” caliper tree, i.e. 1,000 cf of soil
- Fine sandy loam soil with 25% unfilled void space (0.45 porosity – 0.2 field capacity)
- Volume = 250 cf (1000 cf * 0.25)
- Area of impervious surface needed to generate 250 cf of stormwater from a 1-inch of runoff = 3000 sf
- Assuming drainage from ½ a 66-ft ROW equates to one tree box every 91-ft
- *Ignored evaporation, infiltration, water uptake by plants, and depression storage*

What if you combined

- a basin
- water loving trees, and
- an engineered soil mix?

Infiltration Capacity

- Dry Soils, Little or No Vegetation
  - Sandy soils: 5 in/hr
  - Loam soils: 3 in/hr
  - Clay soils: 1 in/hr
- Dry soils with Dense Vegetation
  - **Multiply by 2**
- Saturated Soils
  - Sandy soils: 1 to 4 in/hr
  - Loam soils: 0.25 to 0.50 in/hr
  - Clay soils: 0.01 to 0.06 in/hr



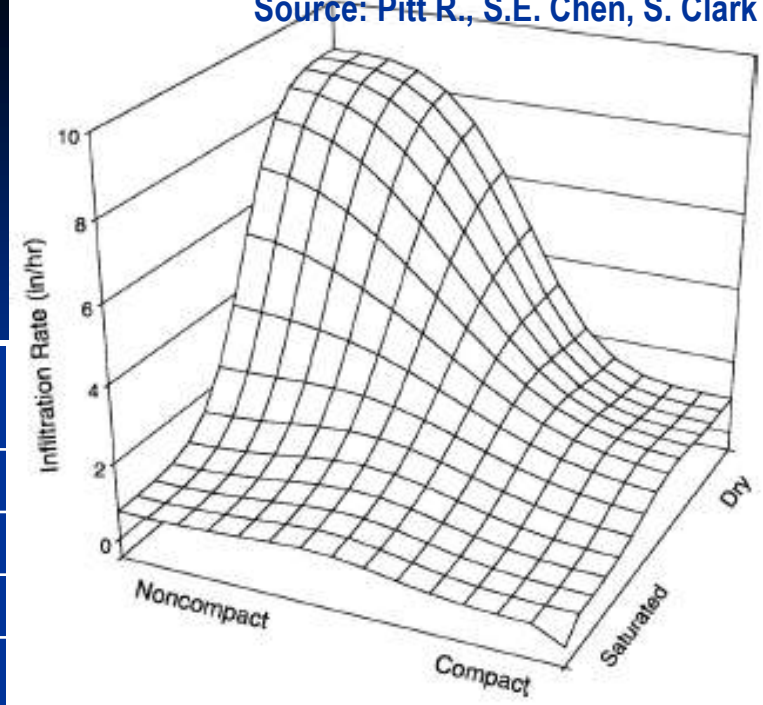
Source: Rawls, W.J., D.L. Brakensiek, and N. Miller, "Green-Ampt Infiltration Parameters from Soil Data" J. Hydr Engr. 109:62, 1983), EPA SWMM 5 Users Manual, and FISRWG

Effects of Compaction on Infiltration Rates

- Decreased infiltration
- Decreased root growth
- Increased runoff

Source: R. Pitt, S.E. Chen, S. Clark	Number of tests	Avg Infil (in/hr)	COV
Noncompacted sandy soils	36	13	0.4
Compacted sandy soils	39	1.4	1.3
Noncompacted and dry clayey soils	18	9.8	1.5
All other clayey soils (compacted and dry, plus all wetter conditions)	60	0.2	2.4

Source: Pitt R., S.E. Chen, S. Clark



Engineered Soil Mix Examples

- Prince Georges Co. MD: 50-60% sand; 20-30% compost; 20-30% topsoil (Minnesota added <5% clay stipulation)
- NCSU: 85% sand; 12% fines; 3-5% organics
- Portland OR: 60-70% sand; 30-40% compost (35-65% organic); particle gradation specified
- Low Impact Development Center: 50% sand; 30% planting soil (50-85% sand, 0-50% silt, 10-20% clay, 1.5 -10% organic); 20% shredded hardwood mulch
- *Typical infiltration rate of soil mixes is 1 to 8 in/hr*

Soil Strategies

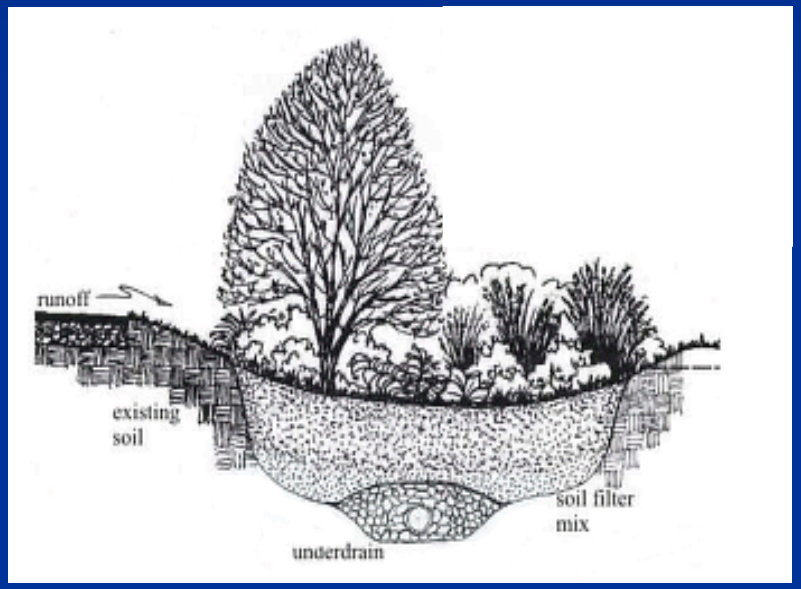
- Test infiltration rate
- Protect native soil during construction by limiting access, grading and clearing
- Increase soil volume by connecting planting areas, thereby sharing rooting space
- Alternative Soil Strategies
  - Soil Trenches
  - Structural Soil (use of stone to provide load bearing integrity while preserving void space)
  - Suspended Pavements and Structural Cells
- Avoid conflicts between rooting and infrastructure subgrade by using soil free aggregate under hardscape surfaces or use of root barriers

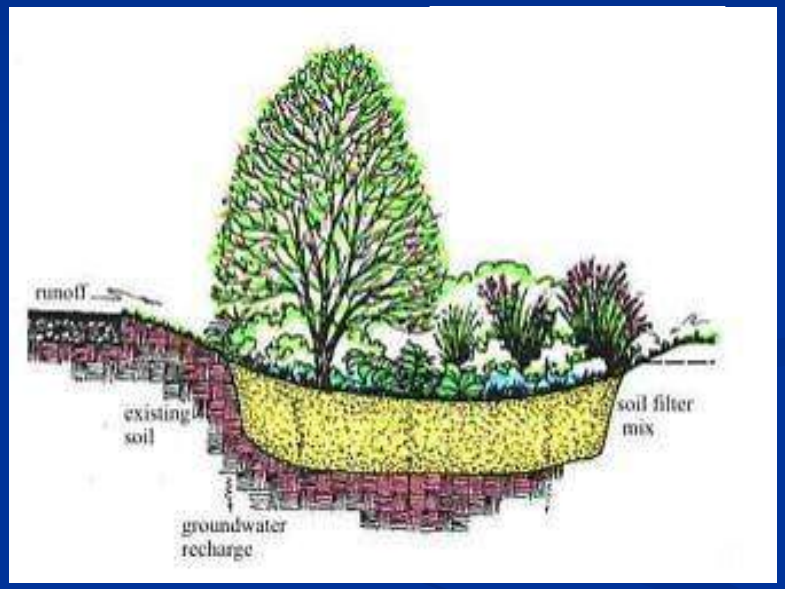
Outlet Controls

- Underdrains
- Liners
- Overflows
- Diversions
- Injection Wells

Outlet Controls

Filtration vs Infiltration





Underdrain Overflow/Diversion

Underdrained systems are flow-through systems, and discharge water from even small ‘design storms’.

Applications for Underdrains and Liners

- Protect surrounding infrastructure
  - Basements
  - Roads/parking
- Isolate contaminated soils
  - Leaky underground storage tanks
- Prevent unwanted flora and fauna
  - Mosquitoes

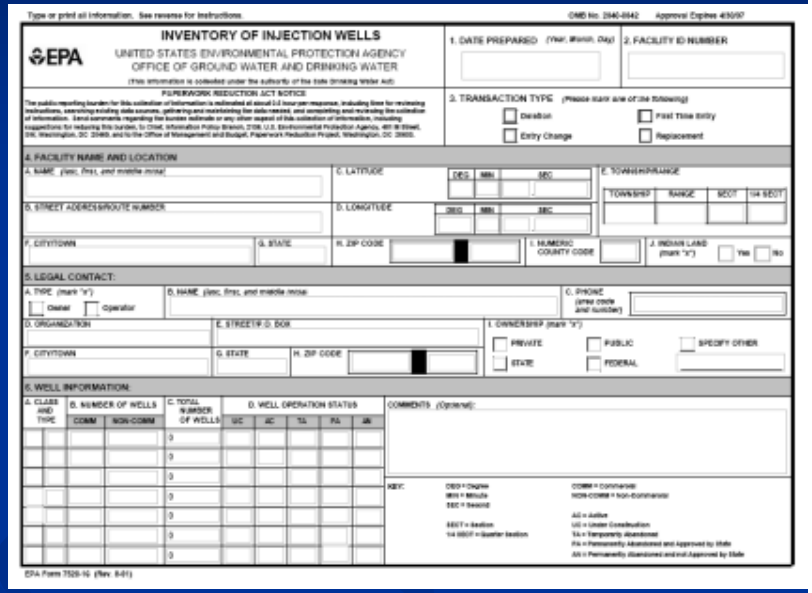
Overflows and Diversions

- Think about big storms
- Inline Systems
  - Water forced to flow through system
- Offline System
  - Water diverted after capacity reached

Class V Injection Well

- Class V wells are shallow wells used to place a variety of fluids directly below the land surface.
- An “injection well” is a “well” into which “fluids” are being injected (40 CFR §144.3).
- Memo & guide issued June 13, 2008 by EPA clarifies which infiltration practices are generally considered class V wells
  - If stormwater directed into hole that is deeper than it’s widest point or
  - has a subsurface distribution system
- Potential examples
  - Infiltration trenches
  - Commercially manufactured stormwater infiltration devices
  - Dry wells and seepage pits
- Reporting requirements

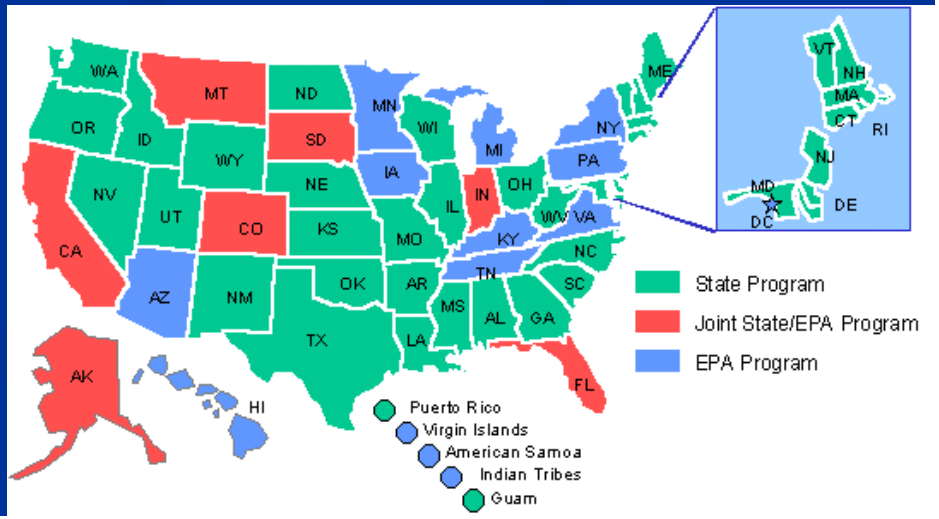
http://cfpub.epa.gov/npdes/greeninfrastructure/information.cfm


EPA

INVENTORY OF INJECTION WELLS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF GROUND WATER AND DRINKING WATER

1. DATE PREPARED
2. FACILITY ID NUMBER
3. TRANSACTION TYPE
4. FACILITY NAME AND LOCATION
5. LEGAL CONTACT
6. WELL INFORMATION



Questions?

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- Components
- **Strategies for Design/Implementation**
- Example Surface Runoff Analysis
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Design Strategies

- Preserve natural systems
- Engineer systems to mimic natural functions
  - Evapotranspiration ↑
    - Plants (water uptake and transpiration)
    - Surface water (evaporation)
  - Infiltration ↓
    - Soils
    - Storage (provides additional time to infiltrate)
  - Surface Runoff →
    - Pipes, gutters, swales, ditches, underdrains
    - Time of concentration (longer is better)
- "Treat" raindrop as close as possible to where it fell
- Lots of little BMPs instead of few regional systems
- BMPs in series not parallel

Design Details

- Test infiltration capacity, don't assume it
- Observation ports for water levels
- Underdrains designed to be cleaned
- Ponding depth in bio-systems approximately 6-12 inch
- Extend time of concentration

Ideas to Consider

- Roto-till pervious surfaces before topsoil/seed
- Amend soils
- Loosen up compacted soils with a ditchwitch/auger and leaf compost
- Valves on underdrains
- Underdrains not at the bottom
- Take every opportunity to educate the public
- Adopt-a-rain garden
- Try something. Anything is better than nothing.

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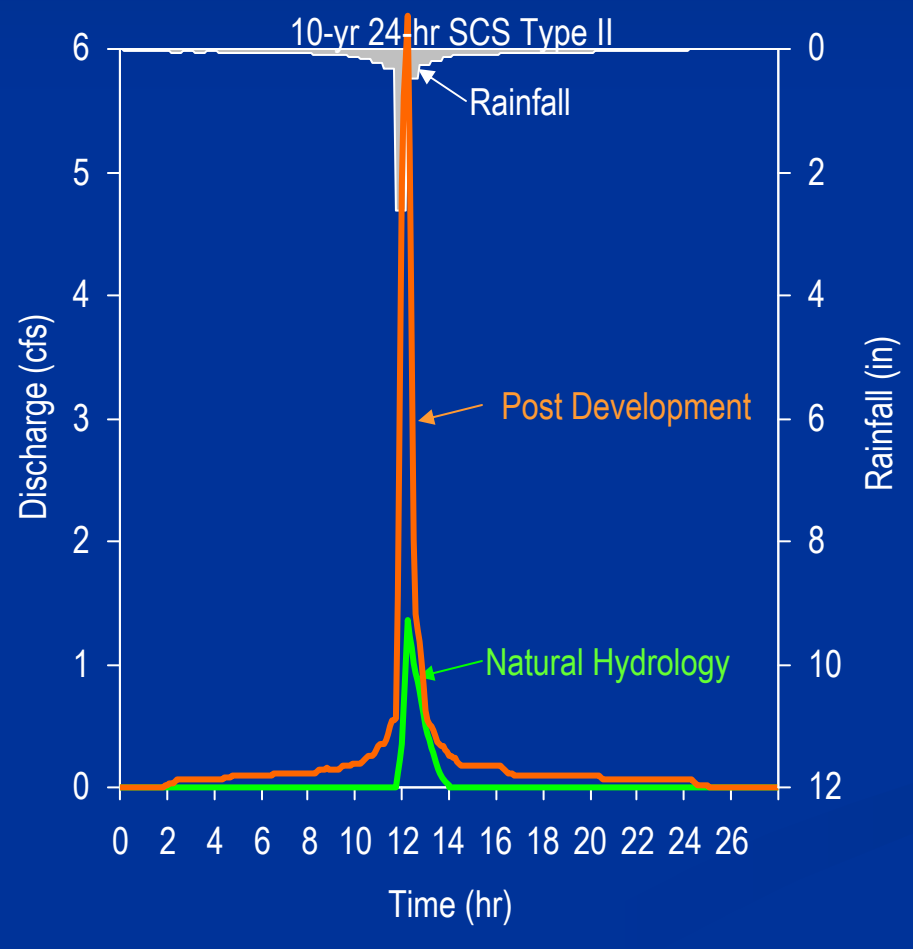
Consider a typical development example

- Area = 2.98 ac
  - Building Footprint = 20.9%
  - Parking/sidewalk = 36.5%
  - Turf grass = 42.6%
- B/C soil
- Flat
- 50-year continuous simulation
- EPA-SWMM V5 model (note, limited abilities to model water uptake by plants)

No Stormwater Controls

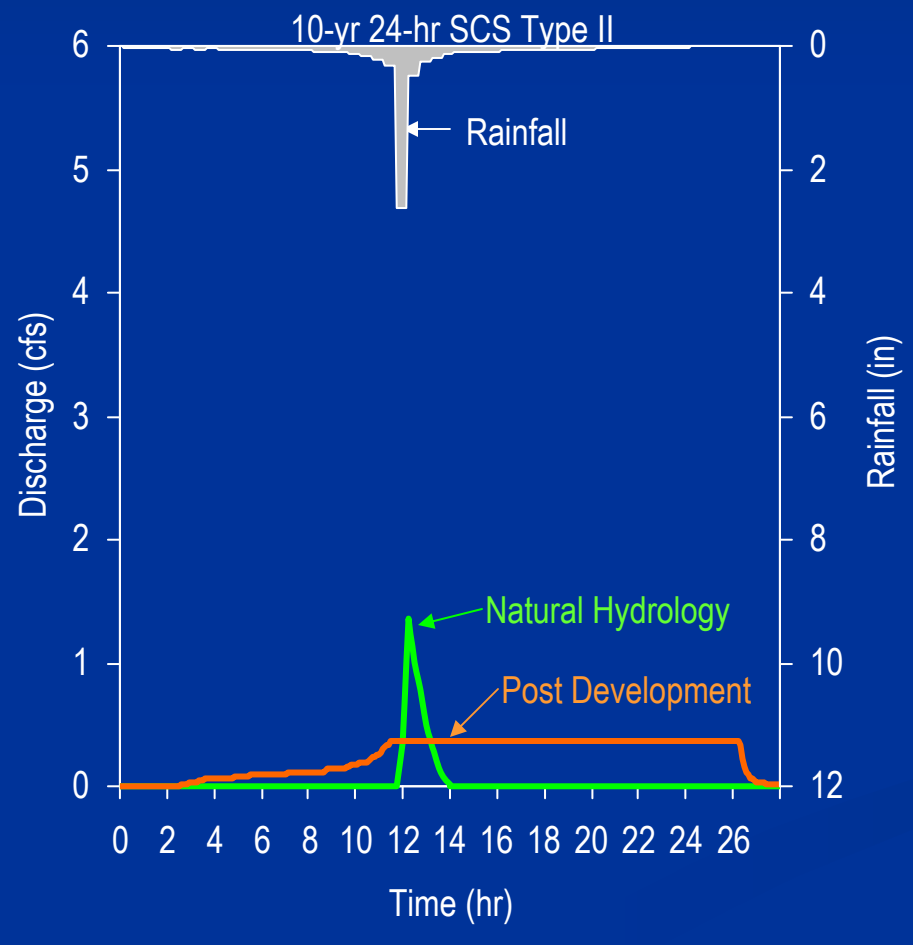
- Traditional development with no stormwater controls



Average Annual (from 50-years)	Natural Hydrology	Post Development
Evaporation	10%	19%
Infiltration	90%	38%
Surface Runoff	**<1%**	**43%**

Traditional Detention

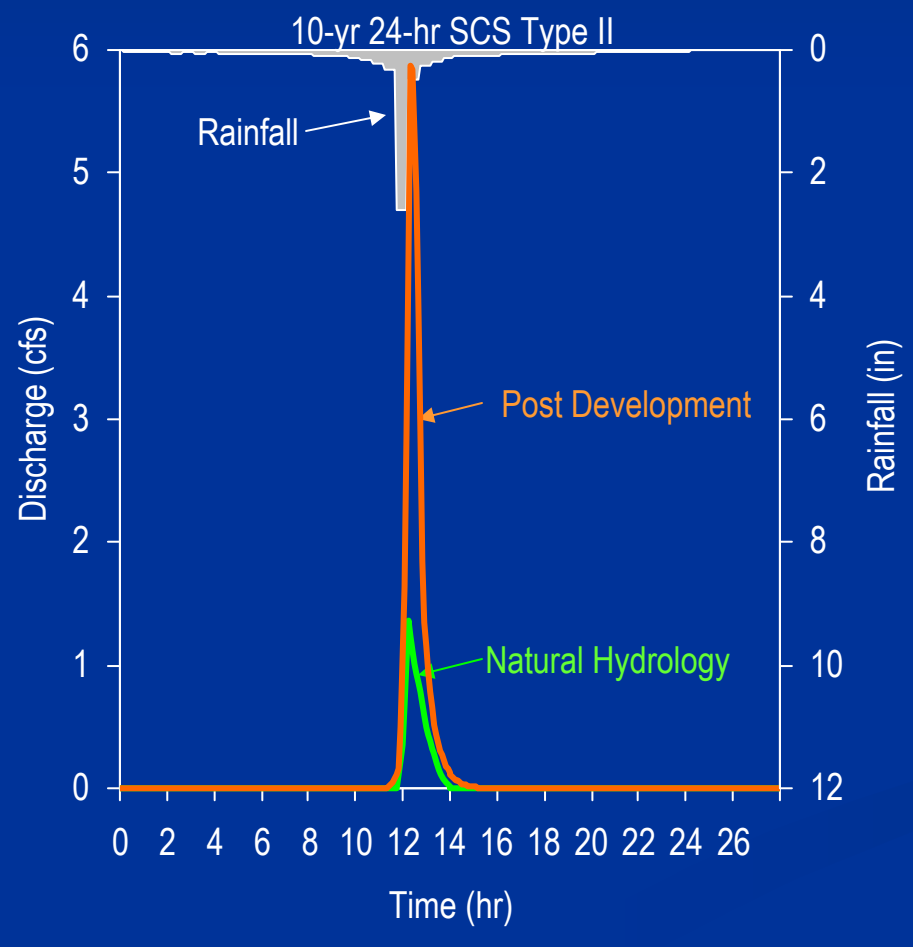
- Traditional drainage system
- Detention sized with 0.15 cfs/acre maximum release rate
- No change in average annual surface runoff

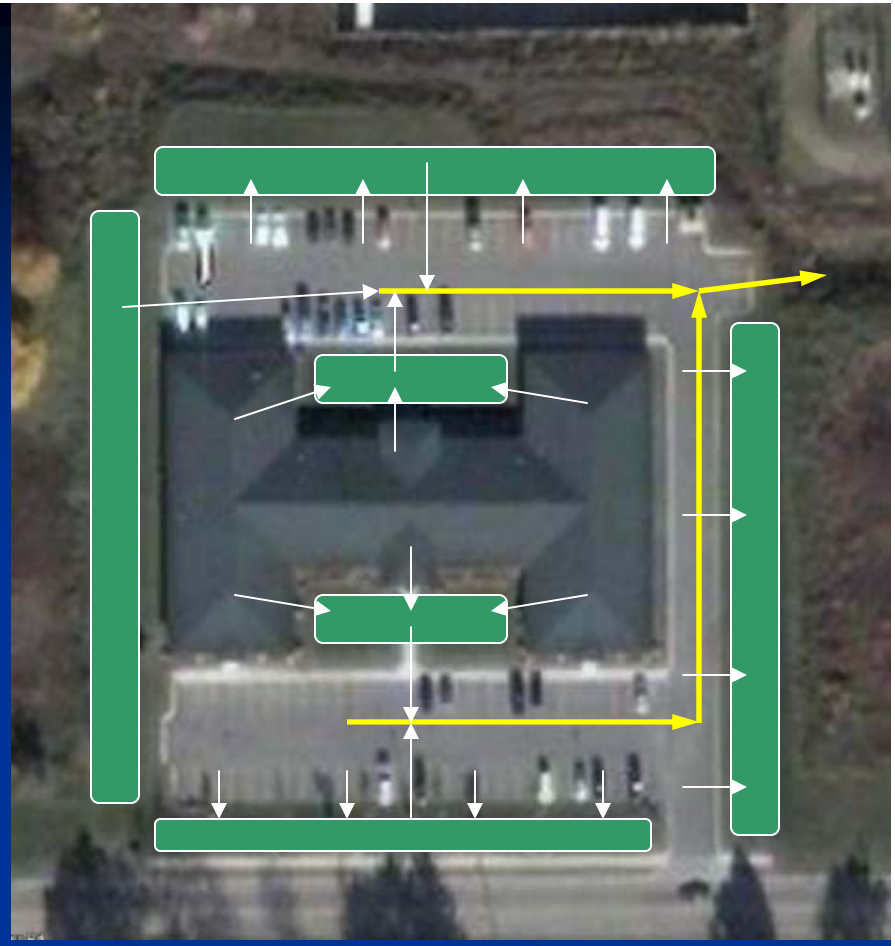


Average Annual (from 50-years)	Natural Hydrology	Post Development
Evaporation	10%	19%
Infiltration	90%	38%
Surface Runoff	**<1%**	**43%**

Impervious → Pervious

- Impervious surfaces discharge to green areas
- Green areas discharge to drainage system
- Decreased average annual surface runoff from 43% to 9%

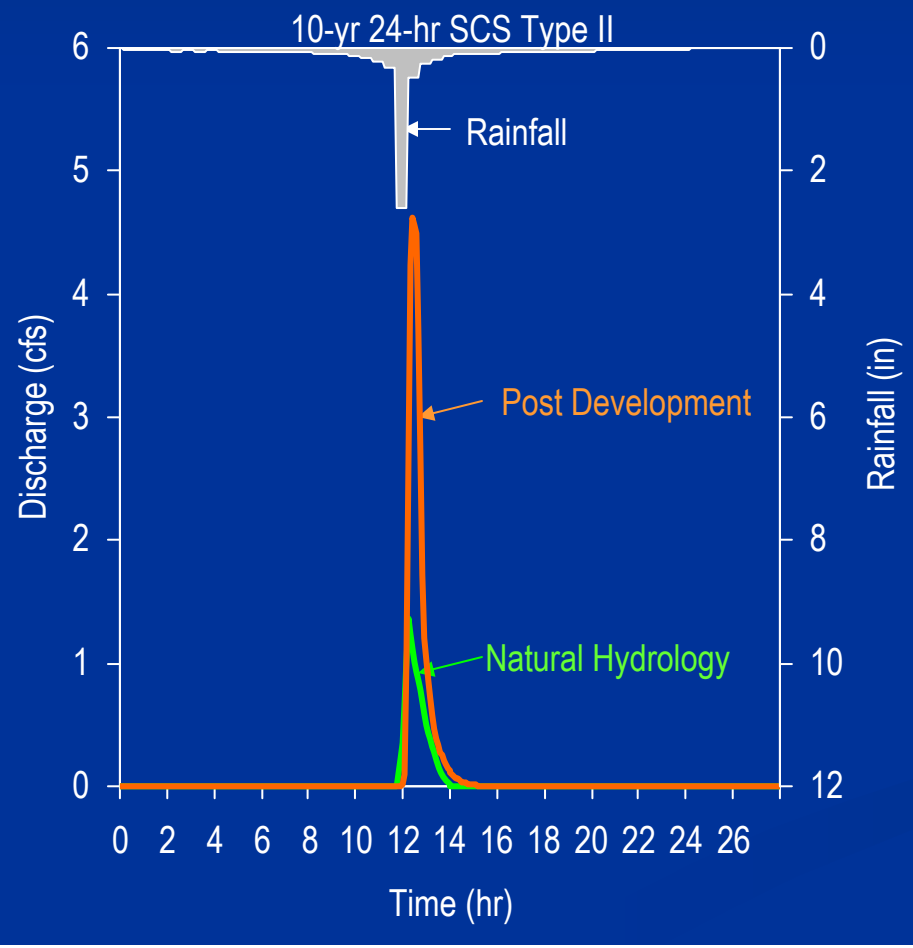


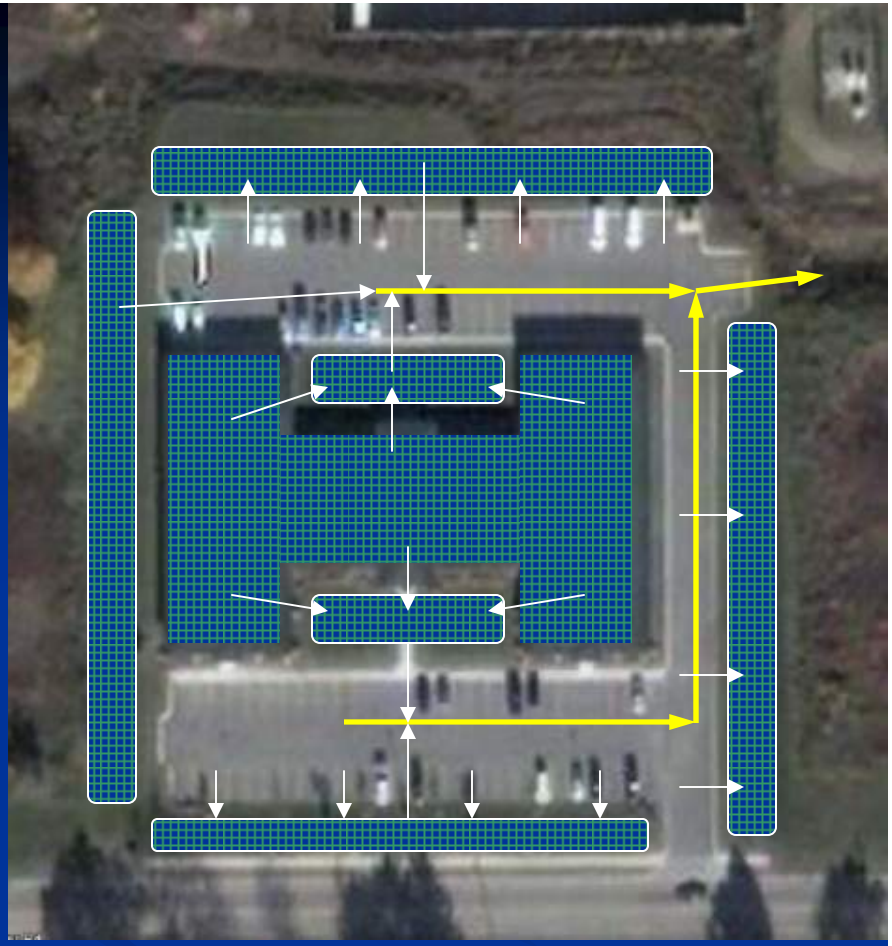


Average Annual (from 50-years)	Natural Hydrology	Post Development
Evaporation	10%	20%
Infiltration	90%	72%
Surface Runoff	**<1%**	**9%**

Added Storage

- Impervious → Pervious
- 1-inch roof storage (or equiv)
- 1-inch storage on pervious areas

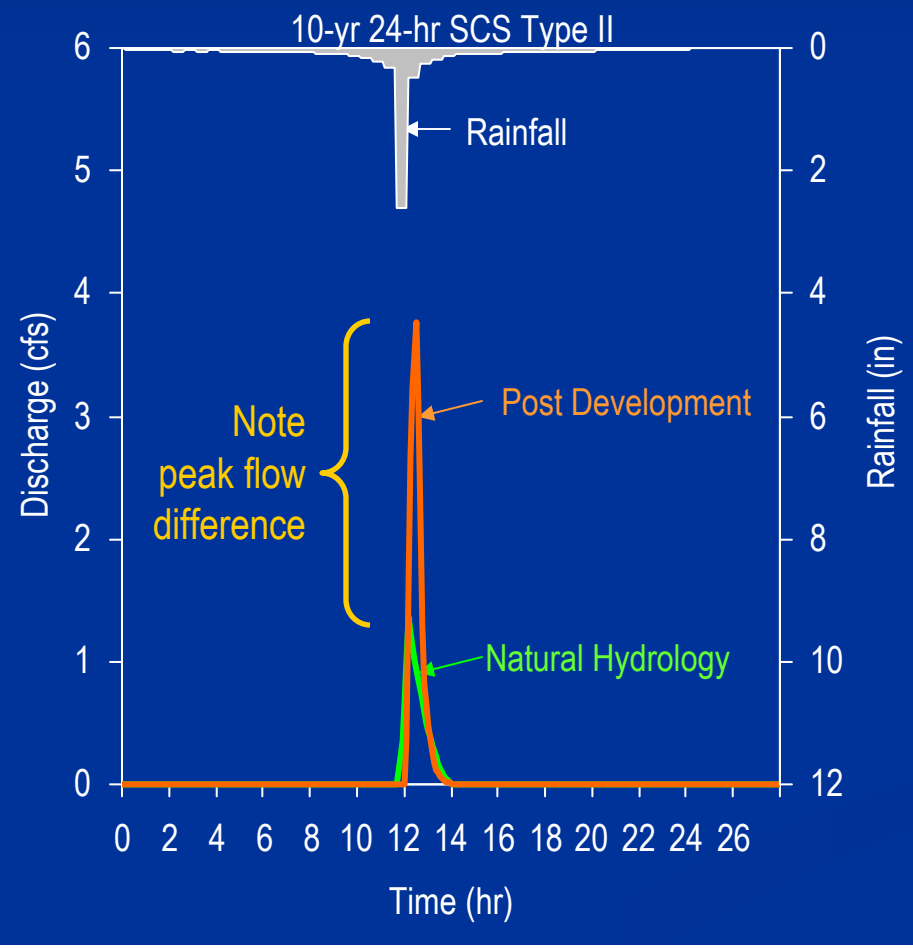


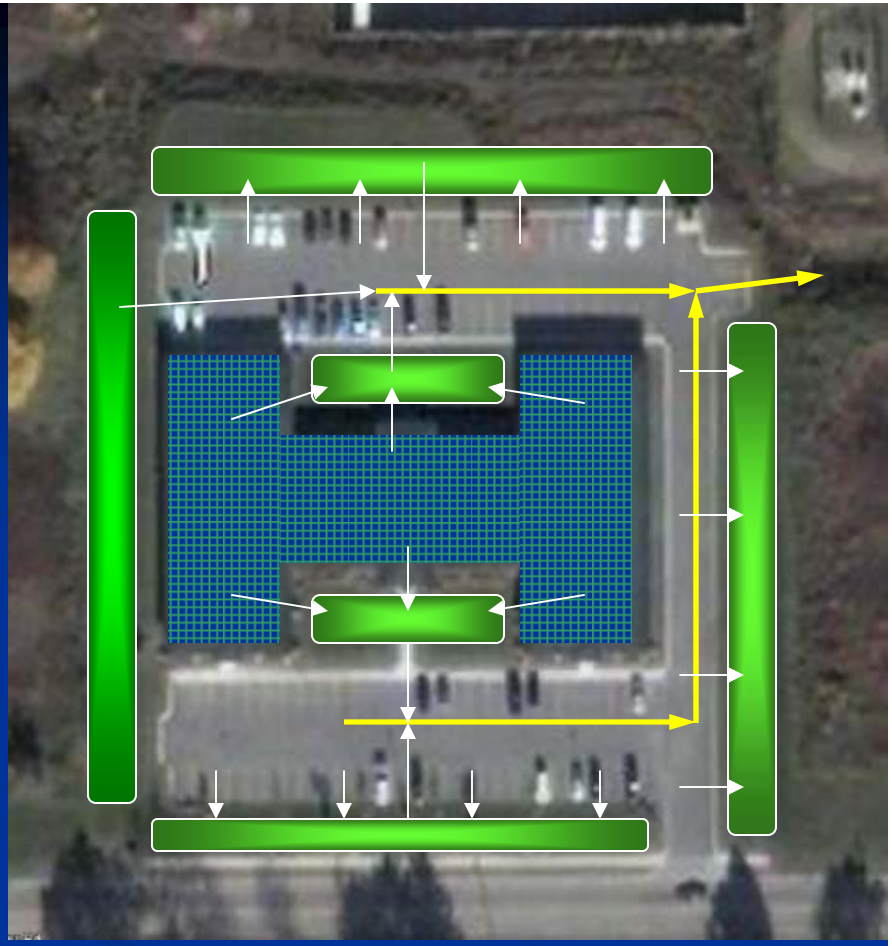


Average Annual (from 50-years)	Natural Hydrology	Post Development
Evaporation	10%	32%
Infiltration	90%	66%
Surface Runoff	**<1%**	**3%**

Enhanced Infiltration and Evapotranspiration

- Impervious → Pervious
- 1-inch roof storage (or equivalent)
- 1-inch storage on pervious areas with enhanced rates





Average Annual (from 50-years)	Natural Hydrology	Post Development
Evaporation	10%	32%
Infiltration	90%	67%
Surface Runoff	**<1%**	**1%**

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Putting it All Together . . . Recreating Natural Hydrology

- Protect natural features
- Let pervious be pervious
- Minimize impervious surfaces
- Route grey to green
- Promote vigorous plant growth
- Slow the water down
- Design for stormwater as an asset and amenity

Think outside the pipe!

Questions?

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Green Infrastructure Costs

An Introduction to the Whole-Life Costing Tool for Green Stormwater Management Practices

Overview

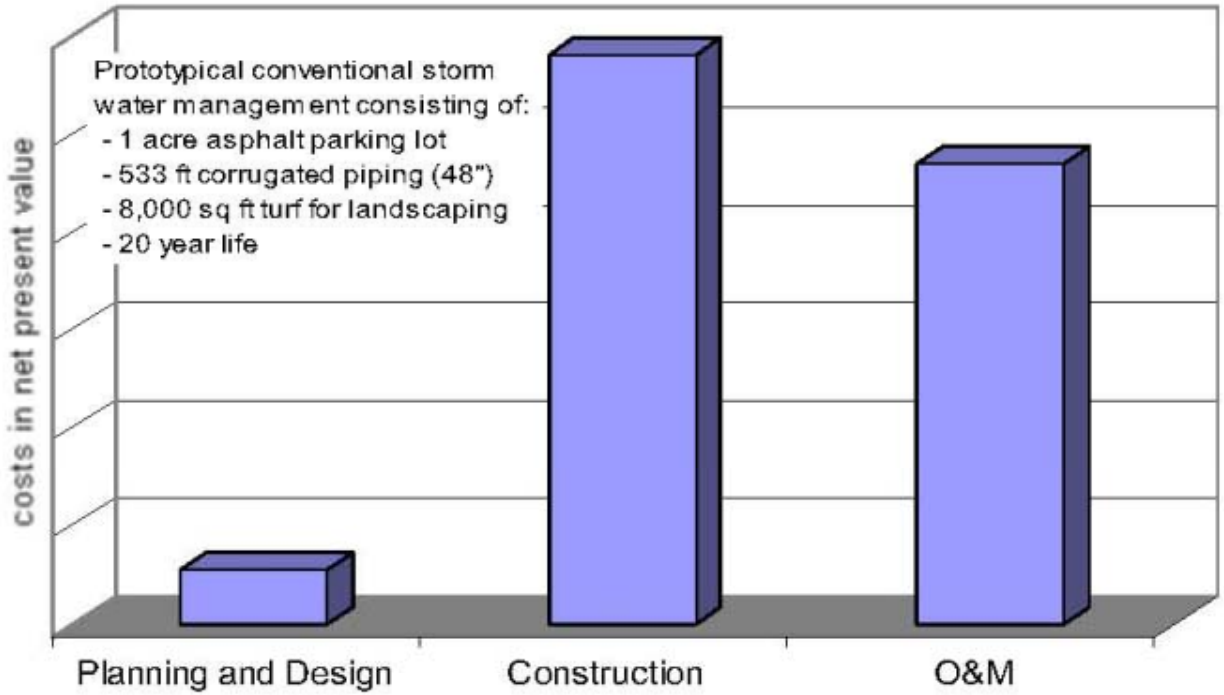
- Defining "Green Infrastructure" context
- The importance of using life-cycle cost analysis in alternative evaluations
- The Business Case: Importance of Cost Savings in Green Infrastructure Practices
- The value non-quantifiable benefits
- Tools – WERF Cost tool

Defining "Green Infrastructure"

- Stormwater management practices that restore natural hydrology, rainwater infiltrates into soils and groundwater
- Infiltration, evapotranspiration, reuse
- Recharges groundwater, provides base stream flows in dry weather

Deciding Between Investments: Initial Cost vs. Life-cycle Cost

Costs Over 20-yrs of a Conventional SWM:



Source: Department of Energy, Federal Energy Management Program, *The Business Case for Sustainable Design in Federal Facilities*, 2003.

Deciding Between Investments: Initial Cost vs. LCC

Whole-life cost approach useful because:

- Design, permitting, and construction are significantly different for green infrastructure
- Operation and maintenance costs are very project-specific
- Drawbacks: Long-lived alternatives make future cost projections difficult; comprehensive analysis requires professional expertise; future forecasts can be highly variable and inaccurate.

How Green Infrastructure Can Provide Value - Examples

- Single building: green roofs extend roof life
  - *Green Save Calculator* at www.greenroofs.org; and *Cost Benefit Evaluation of Ecoroofs, 2008* at PortlandOnLine.com
- Subdivisions: eliminate pipe system costs
  - *Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices, EPA 841-F-07-006, Dec 2007*
- Municipalities: Reduce CSO tunnel costs
  - *"Sustainable Raindrops: Cleaning New York Harbor by Greening the Urban Landscape", by Mike Plumb, Riverkeeper, 2006*
- Regional: Recharge Groundwater, Save Transfer Costs
  - 10 billion gals/day runs off in a Los Angeles storm, capturing could relieve strain on the water supply, much of which is imported. dpw.lacounty.gov

The "Triple Bottom Line"

GI may be perceived to be more costly because long-term cost saving or benefits are not considered in the comparisons analysis. Benefits include:

- Social: Enhanced quality of life
- Environmental: Ecological value
- Economic: Whole-life cost advantage, considering economic effect on large scale

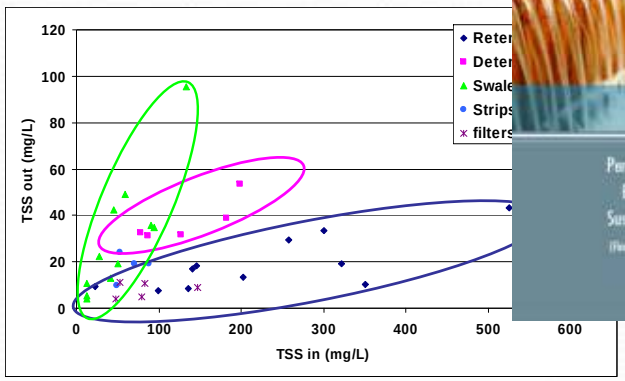
Cost Estimating Tools for LID BMPs

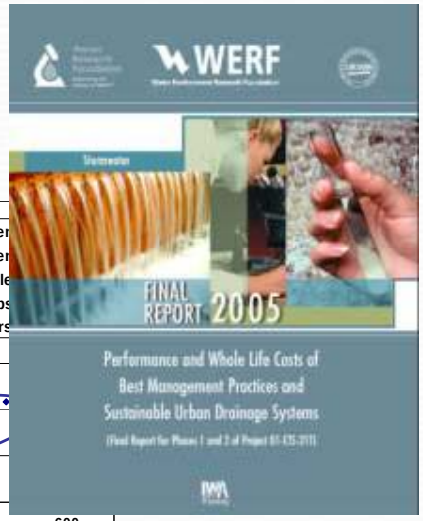
- Provide framework to facilitate cost estimation for capital costs, O&M costs, and life-cycle net present value
- Serve as a format for cost reporting (past, current and future projects)
- Provide users with planning-level cost estimates.

- Bioretention
- Green Roofs
- Commercial Cisterns

Previous Work

- *"Performance and Whole Life Costs of Best Management Practices and Sustainable Urban Drainage Systems"*
- Spreadsheet cost estimation tool designed to estimate whole life costs of several BMPs
  - Extended detention ponds
  - Retention ponds
  - Swales
  - Permeable pavement





Project Approach

- Literature Review
  - Capital costs and maintenance costs
- Collect and review manufacturer's data
- Collect data on cost and construction elements for existing systems
- Review by professional cost-estimator (RS Means costs)
- Review by environmental economist
- Peer review

Bioretention

- Residential rain gardens
- Curb-contained bioretention
- In-curb planter vaults

Green Roofs

- Extensive roofs: those with shallow soil and low plant cover
- Divided green roofs into two roof installation types.
  - Modular
  - Layered or custom

Extensive green roof cross-section
Copied from EPA LID Center
Source: American Wick Drain Corp.

Cisterns

- Large commercial buildings
- Indoor or outdoor water reuse options
- Components include tank, installation and redistribution pump
- Irrigation system costs and cost for additional plumbing needed for indoor use not included in the model
- Treatment costs not included

Model Overview

1. Design and Maintenance Options
2. Capital Costs
3. Maintenance Costs
4. Cost Summary
5. Whole Life Costs
6. Present Value Graphs
7. Design and Cost Information
8. References

Considerations

- Accuracy of the cost data is limited to referenced sources.
- Users are encouraged to modify the tool to meet their own project needs.
- Results of the cost tool should be viewed in light of the cost of conventional development, and not be interpreted as a separate, additional development cost.
- Tools do not attempt to quantify the benefits provided by various BMP or LID techniques which decision-makers should consider in evaluating various stormwater control alternatives.

Questions?

Tour of Bioretention Tool

Bioretention Scenario:

- Retrofit 1 acre impervious parking lot
- Corporate maintenance policy:
  - Labor crew responsible for inspection and reporting
  - Min. 2 person crew
  - $25/hr labor rate including equipment
- City Ordinance: any trees that are planted to be fruit trees, and the owner must clean up fruit and trim trees every fall.
- $ 5,000 local grading permit fee

Tour of Bioretention Tool

Curb-Contained Bioretention Reference Sheet

Curb-Contained Bioretention are defined as a series of smaller, depressed vegetated collection basins that retain stormwater runoff from parking lots, residential streets or large impervious commercial areas. These depressions are often surrounded by curbing to maximize storage during large events, and often include an over-flow outlet or underdrains to conventional stormwater systems. Inflow is often dispersed via a gravel diaphragm or level spreader to disperse flow evenly into the facility.

Design Assumptions for Default Cost

-- Size: 7% of impervious area. Default assumes 1 acre DA, garden total is 3,050 ft2. It is assumed that this will be broken into at least 4 separate planters, 875 sf each (Wossink, 2003).

-- Depth: Default assumed 5 ft media depth (EPA 2000).

-- Commercial and municipal Landscaping maintenance costs established on per-hour basis.

-- Cost of retrofitting commercial parking lot is 16% higher than new construction (Clar et al 2004)

4.Cost Summary | 5.Whole Life Costs | 6.Present Value Graph | **7.Design and Cost Information** | 8.Reference

Model Setup: User-Selected Options

	A	B	C	D	E
1	**Curb-Contained Bioretention**				
2	**Please refer to the user's guide for instructions on the proper use of the spreadsheets**				
3	**Site Name: Webinar Demp**				
4	**Site Location: National**				
5	**Date: May, 2009**				
6					
7	**Design & Maintenance Options**				
8					
9	**WATERSHED CHARACTERISTICS**	**Unit**	**Model Default**	**User**	**Chosen Option**
10	Drainage Area (DA)	ac	1.00		1.00
11	Drainage Area Impervious Cover (IC)*	pct	80%	93%	93%
12	Underdrain to Conventional Storm Drain? (Y = yes, N=no)		n	N	N
13	* Included since this is frequently used to calculate facility sizing.				
14					
15	**DESIGN & MAINTENANCE OPTIONS**	**Unit**	**Model Default**	**User**	**Chosen Option**
16	Choose Level of Maintenance *("H"=high; "M"=medium; "L"=low)*	-	M		M
17	Retrofit vs. New Construction (R for "Retrofit", "N" for New Construction"	-	N	R	R
18					
19	**WHOLE LIFE COST OPTIONS**	**Unit**	**Model Default**	**User**	**Chosen Option**
20	Discount Rate	%	5.50		5.5
21					

Note: All worksheets, other than User Entered information, are locked to prevent unintentional changes to default values or formulas. To unlock, right-click on the tab of the worksheet you wish to unlock and select "unprotect".

1.Design & Maintenance Options | 2.Capital Costs | 3.Maintenance Costs | 4.Cost Summary | 5.Whole Li

Ready

Cisterns Model Setup: User-Selected Options

16	SYSTEM CHARACTERISTICS	Unit	Model Default	User	Chosen Option
17	Type of Tank Desired (*P=Plastic, M=Metal, F=Fiberglass, C=Concrete. See sizing cost chart below*)	-	C		C
18	Primary Use (*I = Indoor*, Non-potable; O = Outdoor Irrigation.*)	-	O		O
19	Height of Building (Used to calculate 'Indoor' Use costs)	story	3		3
20	Number of Fixtures per Floor (toilets, used to calculate 'Indoor' Use costs)	ea	10		10

21 * Local health codes strictly control indoor water use. Before installing any indoor rainwater use system, check with local regulations to insure it is permitted. Regulations may require rainwater be treated before indoor use; this model does not estimate costs associated with treatment as systems may vary significantly. If the cost of the treatment system is know, the user may enter this cost in the "other" row in either Capital Cost Method A or B

22	DESIGN & MAINTENANCE OPTIONS	Unit	Model Default	User	Chosen Option
23	Choose Level of Maintenance, Irrigation (*"H"=high; "M"=medium; "L"=low*)	-	M		M

24
25
26

27	WHOLE LIFE COST OPTIONS	Unit	Model Default	User	Chosen Option
28	Discount Rate	%	5.50		5.5

29

30 **Note: Except for user entered cells, all Worksheets are Locked. If you wish to unlock any worksheet, right-click on that sheet's tab at the bottom of the sheet and select "unprotect".**
31
32

Tank Type Cost Chart ($/gallon, installation not included)			
Fiberglass	Steel	Plastic	Concrete
10,000 gal and up	500-15,000 gal	50-1,500 gal	2,000 gal and up
$ 1.33	$ 2.51	$ 1.43	$ 1.66

33

1.Design & Maintenance Options / 2.Capital Costs / 3.Maintenance Costs / 4.Cost Summary / 5.Wh

Capital Costs: Method A

	A	B	C	D	E
1	**Curb-Contained Bioretention**				
2	**CAPITAL COSTS**		**Choose Capital Costing Option**		
3	**Site Name: Webinar Demp**		**A**	**Total Facility Cost**	**$ 60,413**
4	**Site Location: National**		**"A"** - Simple Cost based on Drainage Area		
5	**Date: May, 2009**		**"B"** - User-Entered Engineer's Estimate		
6					
7	**Method A: Simple Cost Based on Drainage Area**				
8	**Cost Based on Drainage Area**		**Model Default**	**User**	**Chosen Option**
9					
10	Effective Drainage Area (DA) (acres)		0.80		0.93
11	Suggested Garden Size (SF)		2,500		2,900
12	Base Facility Cost ($/acre effective DA)		$ 42,254		$ 42,254
13	**Base Facility Cost**		**$ 33,900**		**$ 39,300**
14	Engineering & Planning (default = 25% of Base Cost)		$ 8,475		$ 9,825
15	Cost Adjustment for Retrofit		$ 0		$ 6,288
16	Land Cost		$ 0		$ 0
17	Other Costs		$ 0	$ 5,000	$ 5,000
18	**Total Associated Capital Costs (e.g., Engineering, Land, etc.)**		**$ 8,475**		**$ 21,113**
19	**Total Facility Cost**		**$ 42,375**		**$ 60,413**
20					

1.Design & Maintenance Options | **2.Capital Costs** | 3.Maintenance Costs | 4.Cost Summary | 5.Whole Life Cost

Capital Costs: Method B

Method B: User-Entered Engineer's Estimate

Select from the following list, as applicable to the project or facility type; add items where necessary.

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Mobilization	LS			$ -
Clearing & Grubbing	AC			$ -
Excavation/Grading	CY			$ -
Dewatering	LS			$ -
Haul/Dispose of Excavated Material	CY			$ -
Sedimentation Pretreatment Structure	SY			$ -
Basin Liner	SY			$ -
Underdrains to Conventional Storm Drain	CY			$ -
Soil Amendment or Engineered Substrate Backfill	LS			$ -
Inflow Structure(s)	LS			$ -
Energy Dissipation Apron	CY			$ -
Overflow Structure (concrete or rock riprap)	LF			$ -
Topsoil				$ -
Curbing Around Facility				$ -
Vegetation				$ -
Bark Mulch				$ -
Irrigation				$ -
Traffic Control				$ -
Signage, Public Education Materials, etc.				$ -
Other				$ -
Other				$ -
Other				$ -
Total Facility Base Cost				**$ -**
Associated Capital Costs			Quantity	Cost
Project Management	LS			$

Insert...
Delete
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Move or Copy...
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Unprotect Sheet...
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Hide
Unhide...
Select All Sheets

1.Design & Maintenance Options | 2.Capital Costs | 3.Maintenance Costs | 4.Cost Summary | 5.Whole Life Cost

Ready

Capital Costs: Method B

Added Lines

Remove Existing Curbing	LF	$ 328.00	6.5	$ 2,132
Sawcutting	LS	$ 1.00	500	$ 500
Vegetation (Anuals)	EA	$ 1.95	350	$ 683
Vegittion (Ornamental Grasses)	EA	$ 15.65	153	$ 2,394
Vegetation (Shrubs)	EA	$ 100.00	35	$ 3,500
Vegetation (Wetland Plants)	EA	$ 0.89	152	$ 135
Total Facility Base Cost				**=SUM(E24:E48)**
Associated Capital Costs		Unit Cost	Quantity	

Capital Costs: Method B

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Mobilization	LS	$ 300.00	1	$ 300
Clearing & Grubbing	SF	$ 0.59	3050	$ 1,800
Excavation/Grading	SF	$ 0.50	3050	$ 1,525
Dewatering	LS			$ -
Haul/Dispose of Excavated Material	CY	$ 0.89	3050	$ 2,715
Sedimentation Pretreatment Structure	SY			$ -
Basin Liner	SF	$ 0.45	3050	$ 1,373
Underdrains to Conventional Storm Drain	LF	$ 15.68	505	$ 7,918
Soil Amendment or Engineered Substrate Backfill	CY	$ 30.00	150	$ 4,500
Inflow Structure(s)	LS			$ -
Energy Dissipation Apron	EA	$ 650.00	1	$ 650
Overflow Structure (concrete or rock riprap)	LF	$ 650.00	1	$ 650
Topsoil	CY	$ 22.00	113	$ 2,486
Curbing Around Facility	SY	$ 19.68	480	$ 9,446
Vegetation (Trees)	CY	$ 300.00	10	$ 3,000
Bark Mulch	SF	$ 0.75	3050	$ 2,288
Irrigation	LS			$ -
Traffic Control	LS	$ 1.00	450	$ 450
Signage, Public Education Materials, etc.	LS			$ -
Remove Existing Curbing	LF	$ 328.00	6.5	$ 2,132
Sawcutting	LS	$ 1.00	500	$ 500
Vegetation (Anuals)	EA	$ 1.95	350	$ 683
Vegittion (Ornamental Grasses)	EA	$ 15.65	153	$ 2,394
Vegetation (Shrubs)	EA	$ 100.00	35	$ 3,500
Vegetation (Wetland Plants)	EA	$ 0.89	152	$ 135
Total Facility Base Cost				**$ 48,444**

Capital Costs: Method B

49	**Total Facility Base Cost**				**$ 48,444**
50	**Associated Capital Costs**		**Unit Cost**	**Quantity**	**Cost**
51	Project Management	LS			$ -
52	Engineering: Preliminary	LS			$ -
53	Engineering: Final Design	LS			$ -
54	Topographic Survey	LS			$ -
55	Geotechnical	LS			$ -
56	Landscape Design	LS			$ -
57	Land Acquisition (site, easements, etc.)	AC			$ -
58	Utility Relocation	LS			$ -
59	Legal Services	LS			$ -
60	Permitting Fees	LS			$ 5,000
61	Construction Inspection	LS			$ -
62	Sales Tax	LS			$ -
63	Contingency (e.g., 30%)	LS			$ -
64	Other				$ -
65	Other				$ -
66	**Estimated Associated Costs (25% of capital)**				$ 12,111
67	**Total Associated Capital Costs**				**$ 5,000**
68	**Total Facility Cost**				**$ 53,444**

Green Roofs Capital Costs: Method A

10	**Method A: Simple Cost Based on Modular Green Roof Assembly Package for a Flat Roof and Roof Area**			
11	**Cost based on Roof Area**	**Model Default**	**User**	**Chosen Option**
12	Roof Area (SF)	10,000		10,000
13	Estimated Basic Modular Roof Components Cost per SF	$ 19.50		$ 19.50
14	**Base Facility Cost (rounded up to nearest $100)**	**$ 195,000**		**$ 195,000**
15	Cost Adjustment for Smaller Projects	$ 0		$ 0
16	Cost Adjustment for Heights Above 5 Stories	$ 0		$ 0
17	Delivery Costs, Total	$ 8,500		$ 8,500
18	Resulting Base Cost per SF	$ 20.35		$ 20.35
19	**Basic Roof Installation Cost**	**$ 203,500**		**$ 203,500**
20	**Roof Design Options**			
21	Note: All landscape upgrades apply additional weight. It is critical to insure that your roof can support this added weight. Structural inspection or reinforcement costs are not shown here.			
22	Irrigation ($/SF)	$ 0.00		$ 0.00
23	Ornate or Designer Plants ($/SF)	$ 0.00		$ 0.00
24	Walking Surface (SF)	0		0
25	Walking Surface ($ per SF)	$ 8.50		$ 8.50
26	Leveling Jacks for Walkways (per SF of walkway)	$ 20.00		$ 20.00
27	Total Cost of Walkways	$ -		$ -
28	**Total Landscaping Options Costs**	**$ 0**		**$ 0**
29	**Total Facility Cost**	**$ 203,500**		**$ 203,500**
30				

Green Roofs Capital Costs: Method B

31	**Method B: Simple Cost Based on Basic Non-Modular Custom Installations for a Flat Roof**			
32	**Cost based on Roof Area**	**Model Default**	**User**	**Chosen Option**
33	Roof Area (SF)	10,000		10,000
34	Estimated Cost of Gravel Drain Layer	$ 0.00		$ 0.00
35	Estimated Cost of Root Barrier ($ per SF)	$ 2.25		$ 2.25
36	Estimated Cost of Basic Plant Selection ($ per SF)	$ 2.50		$ 2.50
37	Labor Costs ($ per SF)	$ 4.00		$ 4.00
38	Resulting Base ($ per SF)	$ 8.75		$ 8.75
39	**Base Facility Cost (rounded up to nearest $100)**	**$ 87,500**		**$ 87,500**
40	Default Cost Adjustment for Smaller Projects	$ 0		$ 0
41	Cost for Heights Above 5 Stories	$ 0		$ 0
42	Design Costs	$ 4,375		$ 4,375
43	**Basic Roof Installation Cost**	**$ 91,875**		**$ 91,875**
44	**Roof Design Options**			
45	Note: All landscape upgrades apply additional weight. It is critical to insure that your roof can support this added weight. Structural inspection or reinforcement costs are not shown here.			
46	Irrigation ($/SF)	$ 0.00		$ 0.00
47	Ornate or Designer Plants ($/SF)	$ 0.00		$ 0.00
48	Estimated Cost of Growth Medium ($ per SF)	$ 2.00		$ 2.00
49	Walking Surface (SF)	0		0
50	Walking Surface ($ per SF)	$ 8.50		$ 8.50
51	Leveling Jacks for Walkways (per SF of walkway)	$ 20.00		$ 20.00
52	Total Cost of Walkways	$ -		$ -
53	**Total Landscaping Options Costs**	**$ 10,000**		**$ 10,000**
54	**Total Facility Cost**	**$ 101,875**		**$ 101,875**

Maintenance Options

Curb-Contained Bioretention

Site Name: Webinar Demp

M User entered 'MEDIUM' maintenance level in Sheet 1.

Site Location: National

** Change on Sheet 1 if desired/applicable **

Date: May, 2009

Maintenance Costs

User May Enter Lump Sum Here:

ROUTINE MAINTENANCE ACTIVITIES (Frequent, scheduled events)

Lookup ID	Cost Item	Frequency (months betw. maint. events)			Hours per Event			Average Labor Crew Size			Avg. (Pro-Rated) Labor Rate/Hr. ($)			Machinery Cost/Hour ($)			Materials & Inciden-tals Cost/Event ($)			Total Cost per Visit ($)		
		Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input
1.1	Inspection, Reporting & Information Management	24		24.00	4		4.00	1	1	1.0	65	25.00	25.00	0		0.00	0		0.00	260		100
1.2	Vegetation Management with Trash & Minor Debris Removal	6		6.00	4		4.00	2	2	2.0	31	25.00	25.00	0		0.00	0		0.00	248		200
1.4	*Pick up fruit and prune tree*	0	12.00	12.00	0	2.00	2.00	0	2	2.0	0	25.00	25.00	0		0.00	0		0.00	0		100
1.5	*add additional activities if necessary*	0		0.00	0		0.00	0		0.0	0		0.00	0		0.00	0		0.00	0		0

CORRECTIVE AND INFREQUENT MAINTENANCE ACTIVITIES (Unplanned and/or > 2 yrs. betw. events)

Lookup ID	Cost Item	Frequency (months betw. maint. events)			Hours per Event			Average Labor Crew Size			Avg. (Pro-Rated) Labor Rate/Hr. ($)			Machinery Cost/Hour ($)			Materials & Inciden-tals Cost/Event ($)			Total Cost per Visit ($)		
		Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input
2.1	Till Soil	48		48.00	4		4.00	2	2	2.0	31	25.00	25.00	50		50.00	0		0.00	448		400
2.2	Unclog Drain	24		24.00	2		2.00	1	2	2.0	30	25.00	25.00	0		0.00	100		100.00	160	0	0
2.3	Replace Mulch	24		24.00	4		4.00	2	2	2.0	31	25.00	25.00	0		0.00	1,875		1,875.00	2,123		2,075
2.4	*add additional activities if necessary*	0		0.00	0		0.00	0		0.0	0		0.00	0		0.00	0		0.00	0		0
2.5	*add additional activities if necessary*	0		0.00	0		0.00	0		0.0	0		0.00	0		0.00	0		0.00	0		0

Note: For facilities judged to require larger or smaller amounts of maintenance (due to land area, etc.), consider multiplying the Model output in Column U by a multiplier (e.g., 120%) in Column V.
Another quick means of adjustment would be to multiply the number of Hours per Event by a multiplier in the User Input field.

Lookup Table Value

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

HIGH, MEDIUM, AND LOW (MINIMUM) MAINTENANCE COST TABLES

Lookup ID	Cost Item	Frequency (months betw. maint. events)			Hours per Event			Average Labor Crew Size			Avg. (Pro-Rated) Labor Rate/Hr. ($)			Machinery Cost/Hour ($)			Materials & Inciden-tals Cost/Event ($)			Total Cost per Visit ($)		
		Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High
1.0	ROUTINE MAINTENANCE ACTIVITIES (Frequent, scheduled)																					
1.1	Inspection, Reporting & Information Management	36	24	12	4	4	6	1.0	1.0	2.0	30.00	65.00	95.00	0	0	0	0	0	0	120	260	1,140
1.2	Vegetation Management with Trash & Minor Debris Removal	12	6	1	4	4	6	2.0	2.0	2.0	15.00	31.00	45.00	0	0	0	0	0	0	120	248	540
1.4	*Pick up fruit and prune tree*																			0	0	0
1.5	*add additional activities if necessary*																			0	0	0
2.0	CORRECTIVE AND INFREQUENT MAINTENANCE ACTIVITIES (Unplanned and/or > 2 yrs. betw. events)																					
2.1	Till Soil	60	48	24	4	4	4	2.0	2.0	2.0	15.00	31.00	45.00	50	50	50	0	0	0	320	448	560
2.2	Unclog Drain	60	24	12	4	2	2	1.0	1.0	1.0	15.00	30.00	45.00	0	0	0	100	100	100	160	160	190
2.3	Replace Mulch	48	24	12	4	4	6	2.0	2.0	2.0	15.00	31.00	45.00	0	0	0	2,175	1,875	1,875	2,295	2,123	2,415
2.4	*add additional activities if necessary*																			0	0	0
2.5	*add additional activities if necessary*																			0	0	0

1.Design & Maintenance Options | 2.Capital Costs | 3.Maintenance Costs | 4.Cost Summary | 5.Whole Life Costs | 6.Present Value Graph | 7.Design and Cost Information | 8.Refer

Maintenance Options

25		Lookup Table Value			
26	1	2	3	4	5
27	Lookup ID	HIGH, MEDIUM, AND LOW (MINIMUM) MAINTEN			
28		Cost Item	Frequency (months betw. maint. events)		
29			Low	Med	High
30	1.0	ROUTINE MAINTENANCE ACTIVITIES (Frequent, scheduled)			
31	1.1	Inspection, Reporting & Information Management	36	24	12
32	1.2	Vegetation Management with Trash & Minor Debris Removal	12	6	1
33	1.4	*Pick up fruit and prune tree*			
34	1.5	*add additional activities if necessary*			
35	2.0	CORRECTIVE AND INFREQUENT MAINTENANCE ACTIVITIES (Unplann			
36	2.1	Till Soil	60	48	24
37	2.2	Unclog Drain	60	24	12
38	2.3	Replace Mulch	48	24	12
39	2.4	*add additional activities if necessary*			
40	2.5	*add additional activities if necessary*			

1.Design & Maintenance Options | 2.Capital Costs | 3.

Maintenance Options:

Curb-Contained Bioretention

Site Name: Webinar Demp

Site Location: National

Date: May, 2009

M User entered 'MEDIUM' maintenance level in Sheet 1.

** Change on Sheet ** esired/applicable **

Maintenance Costs

User May Enter Lump Sum Here:

ROUTINE MAINTENANCE ACTIVITIES (Frequent, scheduled events)

Lookup ID	Cost Item	Frequency (months betw. maint. events)			Hours per Event			Average Labor Crew Size			Avg. (Pro-Rated) Labor Rate/Hr. ($)			Machinery Cost/Hour ($)			Materials & Inciden-tals Cost/Event ($)			Total Cost per Visit ($)		
		Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input
1.1	Inspection, Reporting & Information Management	24		24.00	4		4.00	1	1	1.0	65	25.00	25.00	0		0.00	0		0.00	260		100
1.2	Vegetation Management with Trash & Minor Debris Removal	6		6.00	4		4.00	2	2	2.0	31	25.00	25.00	0		0.00	0		0.00	248		200
1.4	*Pick up fruit and prune tree*	0	12.00	12.00	0	2.00	2.00	0	2	2.0	0	25.00	25.00	0		0.00	0		0.00	0		100
1.5	*add additional activities if necessary*	0		0.00	0		0.00	0		0.0	0		0.00	0		0.00	0		0.00	0		0

CORRECTIVE AND INFREQUENT MAINTENANCE ACTIVITIES (Unplanned and/or > 2 yrs. betw. events)

Lookup ID	Cost Item	Frequency (months betw. maint. events)			Hours per Event			Average Labor Crew Size			Avg. (Pro-Rated) Labor Rate/Hr. ($)			Machinery Cost/Hour ($)			Materials & Inciden-tals Cost/Event ($)			Total Cost per Visit ($)		
		Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input
2.1	Till Soil	48		48.00	4		4.00	2	2	2.0	31	25.00	25.00	50		50.00	0		0.00	448		400
2.2	Unclog Drain	24		24.00	2		2.00	1	2	2.0	30	25.00	25.00	0		0.00	100		100.00	160	0	0
2.3	Replace Mulch	24		24.00	4		4.00	2	2	2.0	31	25.00	25.00	0		0.00	1,875		1,875.00	2,123		2,075
2.4	*add additional activities if necessary*	0		0.00	0		0.00	0		0.0	0		0.00	0		0.00	0		0.00	0		0
2.5	*add additional activities if necessary*	0		0.00	0		0.00	0		0.0	0		0.00	0		0.00	0		0.00	0		0

Note: For facilities judged to require larger or smaller amounts of maintenance (due to land area, etc.), consider multiplying the Model output in Column U by a multiplier (e.g., 120%) in Column V.
Another quick means of adjustment would be to multiply the number of Hours per Event by a multiplier in the User Input field.

Lookup Table Value

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

HIGH, MEDIUM, AND LOW (MINIMUM) MAINTENANCE COST TABLES

Lookup ID	Cost Item	Frequency (months betw. maint. events)			Hours per Event			Average Labor Crew Size			Avg. (Pro-Rated) Labor Rate/Hr. ($)			Machinery Cost/Hour ($)			Materials & Inciden-tals Cost/Event ($)			Total Cost per Visit ($)		
		Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High
1.0	ROUTINE MAINTENANCE ACTIVITIES (Frequent, scheduled)																					
1.1	Inspection, Reporting & Information Management	36	24	12	4	4	6	1.0	1.0	2.0	30.00	65.00	95.00	0	0	0	0	0	0	120	260	1,140
1.2	Vegetation Management with Trash & Minor Debris Removal	12	6	1	4	4	6	2.0	2.0	2.0	15.00	31.00	45.00	0	0	0	0	0	0	120	248	540
1.4	*Pick up fruit and prune tree*																			0	0	0
1.5	*add additional activities if necessary*																			0	0	0
2.0	CORRECTIVE AND INFREQUENT MAINTENANCE ACTIVITIES (Unplanned and/or > 2 yrs. betw. events)																					
2.1	Till Soil	60	48	24	4	4	4	2.0	2.0	2.0	15.00	31.00	45.00	50	50	50	0	0	0	320	448	560
2.2	Unclog Drain	60	24	12	4	2	2	1.0	1.0	1.0	15.00	30.00	45.00	0	0	0	100	100	100	160	160	190
2.3	Replace Mulch	48	24	12	4	4	6	2.0	2.0	2.0	15.00	31.00	45.00	0	0	0	2,175	1,875	1,875	2,295	2,123	2,415
2.4	*add additional activities if necessary*																			0	0	0
2.5	*add additional activities if necessary*																			0	0	0

1.Design & Maintenance Options | 2.Capital Costs | 3.Maintenance Costs | 4.Cost Summary | 5.Whole Life Costs | 6.Present Value Graph | 7.Design and Cost Information | 8.Refere

Maintenance Options:

Maintenance Costs

ROUTINE MAINTENANCE ACTIVITIES (Frequent, scheduled events)

	Cost Item	Frequency (months betw. maint. events)			Hours per Event			Average Labor Crew Size		
		Model	User	Input	Model	User	Input	Model	User	Input
1	Inspection, Reporting & Information Management	24		24.00	4		4.00	1	1	1.0
2	Vegetation Management with Trash & Minor Debris Removal	6		6.00	4		4.00	2	2	2.0
4	*Pick up fruit and prune tree*	0	12.00	12.00	0	2.00	2.00	0	2	2.0
5	*add additional activities if necessary*	0		0.00	0		0.00	0		0.0

CORRECTIVE AND INFREQUENT MAINTENANCE ACTIVITIES (Unplanned and

	Cost Item	Frequency (months betw. maint. events)			Hours per Event			Average Labor Crew Size		
		Model	User	Input	Model	User	Input	Model	User	Input
1	Till Soil	48		48.00	4		4.00	2	2	2.0
2	Unclog Drain	24		24.00	2		2.00	1	2	2.0
3	Replace Mulch	24		24.00	4		4.00	2	2	2.0
4	*add additional activities if necessary*	0		0.00	0		0.00	0		0.0
5	*add additional activities if necessary*	0		0.00	0		0.00	0		0.0

Corrective and Infrequent Maintenance:

24														
25		Lookup Table Value												
26	1	2	3	4	5	6	7	8	9	10	11	12	13	14
27	Lookup ID	HIGH, MEDIUM, AND LOW (MINIMUM) MAINTENANCE COST TABLES												
28		Cost Item	Frequency (months betw. maint. events)			Hours per Event			Average Labor Crew Size			Avg. (Pro-Rated) Labor Rate/Hr. ($)		
29			Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High
30	1.0	ROUTINE MAINTENANCE ACTIVITIES (F												
31	1.1	Inspection, Reporting & Information Management	36	24	12	4	4	6	1.0	1.0	2.0	30.00	65.00	95.00
32	1.2	Vegetation Management with Trash & Minor Debris Removal	12	6	1	4	4	6	2.0	2.0	2.0	15.00	31.00	45.00
33	1.4	*Pick up fruit and prune tree*												
34	1.5	*add additional activities if necessary*												
35	2.0	CORRECTIVE AND INFREQUENT MAINTENANCE ACTIVITIES (Unplanned and/or > 2 yrs. betw. events)												
36	2.1	Till Soil	60	48	24	4	4	4	2.0	2.0	2.0	15.00	31.00	45.00
37	2.2	Unclog Drain	60	24	12	4	2	2	1.0	1.0	1.0	15.00	30.00	45.00
38	2.3	Replace Mulch	48	24	12	4	4	6	2.0	2.0	2.0	15.00	31.00	45.00
39	2.4	*add additional activities if necessary*												
40	2.5	*add additional activities if necessary*												
41														

1.Design & Maintenance Options | 2.Capital Costs | 3.Maintenance Costs | 4.Cost Summary | 5.Whole Life Costs | 6.Present Value Gra

Ready

WLC Summary

Curbed Bioretention

M	User entered 'MEDIUM' maintenance level in Sheet 1.

Site Name: Webinar Demp
Site Location: National
Date: May, 2009

Cost Summary

CAPITAL COSTS	Included in WLC Calculation			Total Cost
	Model	User	Chosen option	
Total Facility Base Cost	$39,300		$ 39,300	$ 39,300
Total Associated Capital Costs (e.g., Engineering, Land, etc.)	$21,113		$ 21,113	$ 21,113
Capital Costs				**$60,413**

REGULAR MAINTENANCE ACTIVITIES	Months Between Events	Cost per Event	Total Cost per Year	Included in WLC Calculation		
				Model	User	Chosen option
Inspection, Reporting & Information Management	24	$100	$50	$ 50.00		$ 50.00
Vegetation Management with Trash & Minor Debris Removal	6	$200	$400	$ 400.00		$ 400.00
Pick up fruit and prune tree	12	$100	100	$ 100.00		$ 100.00
add additional activities if necessary	0	$0	0	$ -		$ -
Annual Totals, Regular Maintenance Activities				**$550**		**$550**

CORRECTIVE AND INFREQUENT MAINTENANCE ACTIVITIES (Unplanned and/or >3yrs. betw. events)	Years between Events	Cost per Event	Total Cost per Year	Included in WLC		
				Model	User	Chosen option
Till Soil	4	$400	$100	$ 100.00		$ 100.00
Unclog Drain	2	$0	$0	$ -		$ -
Replace Mulch	2	$2,075	$1,038	$ 1,037.50		$ 1,037.50
add additional activities if necessary	0	$0	$0	$ -		$ -
add additional activities if necessary	0	$0	$0	$ -		$ -
Corrective and Infrequebt MaintenanceActivities (Unplanned and/or >3yrs. betw. events)				**$1,138**		**$1,138**
Maintenance Costs as a percent of Capital Cost:						**3%**

Note: Annual maintenance costs should be expected to be between 5% and 10% of total capitol Costs (Kang, et al (2008)).

1.Design & Maintenance Options | 2.Capital Costs | 3.Maintenance Costs | **4.Cost Summary** | 5.Whole Life Costs | 6.Present Value Graph | 7.De

Whole Life Cost Calculator

Year	Discount Factor	Capital & Assoc. Costs	Regular Maint. Costs	Corrective Maint.	Total Costs	Present Value of Costs	Cumulative Costs		
							Cash	Present Value	Discounted Cost per Year
Cash Sum ($)					$ 146,763	$ 89,822			
0	1.000	$ 60,413			$ 60,413	$ 60,413	$ 60,413	$ 60,413	$ 89,822
1	0.948	$ -	$ 550	$ -	$ 550	$ 521	$ 60,963	$ 60,934	$ 29,409
2	0.898	$ -	$ 550	$ 2,275	$ 2,825	$ 2,538	$ 63,788	$ 63,472	$ 28,888
3	0.852	$ -	$ 550	$ -	$ 550	$ 468	$ 64,338	$ 63,941	$ 26,349
4	0.807	$ -	$ 550	$ 2,675	$ 3,225	$ 2,603	$ 67,563	$ 66,544	$ 25,881
5	0.765	$ -	$ 550	$ -	$ 550	$ 421	$ 68,113	$ 66,965	$ 23,278
6	0.725	$ -	$ 550	$ 2,275	$ 2,825	$ 2,049	$ 70,938	$ 69,014	$ 22,857
7	0.687	$ -	$ 550	$ -	$ 550	$ 378	$ 71,488	$ 69,392	$ 20,808
8	0.652	$ -	$ 550	$ 2,675	$ 3,225	$ 2,101	$ 74,713	$ 71,493	$ 20,430
9	0.618	$ -	$ 550	$ -	$ 550	$ 340	$ 75,263	$ 71,833	$ 18,329
10	0.585	$ -	$ 550	$ 2,275	$ 2,825	$ 1,654	$ 78,088	$ 73,487	$ 17,989
11	0.555	$ -	$ 550	$ -	$ 550	$ 305	$ 78,638	$ 73,792	$ 16,335
12	0.526	$ -	$ 550	$ 2,675	$ 3,225	$ 1,696	$ 81,863	$ 75,488	$ 16,030
13	0.499	$ -	$ 550	$ -	$ 550	$ 274	$ 82,413	$ 75,762	$ 14,334
14	0.473	$ -	$ 550	$ 2,275	$ 2,825	$ 1,335	$ 85,238	$ 77,098	$ 14,059
15	0.448	$ -	$ 550	$ -	$ 550	$ 246	$ 85,788	$ 77,344	$ 12,724
16	0.425	$ -	$ 550	$ 2,675	$ 3,225	$ 1,369	$ 89,013	$ 78,713	$ 12,478

1.Design & Maintenance Options / 2.Capital Costs / 3.Maintenance Costs / 4.Cost Summary / **5.Whole Life Costs**

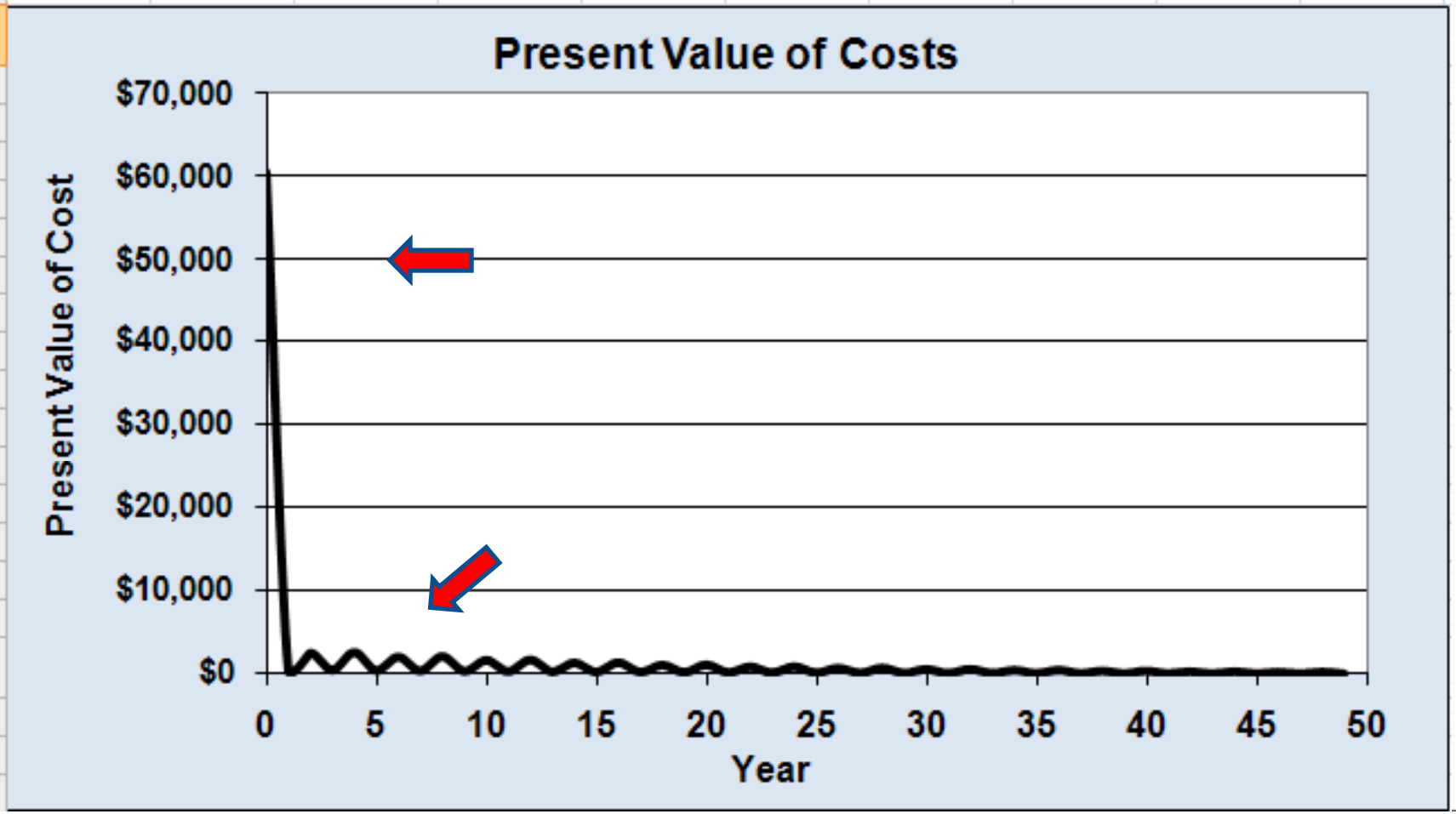
Curbed Bioretention

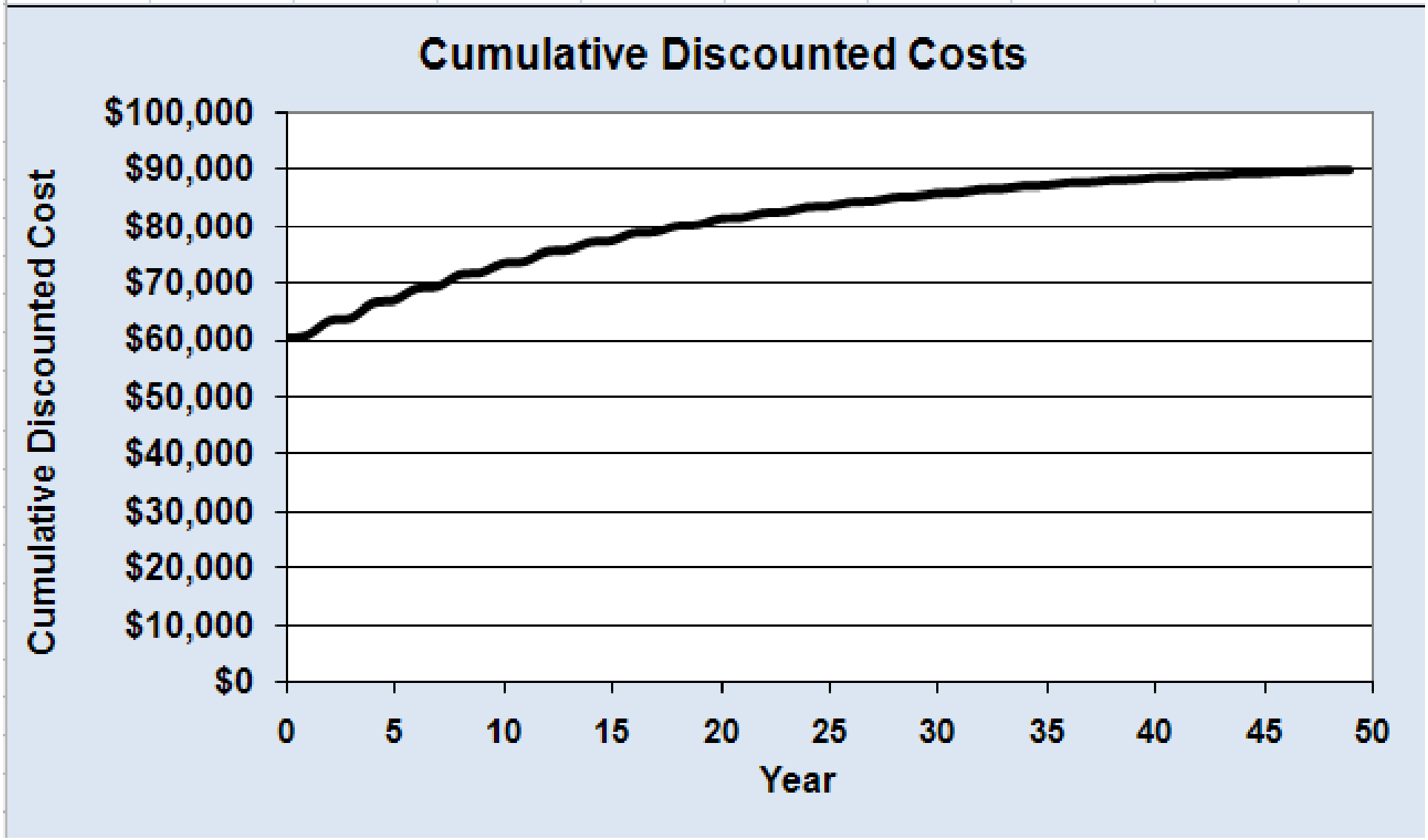
M User entered 'MEDIUM' maintenance level in Sheet 1.

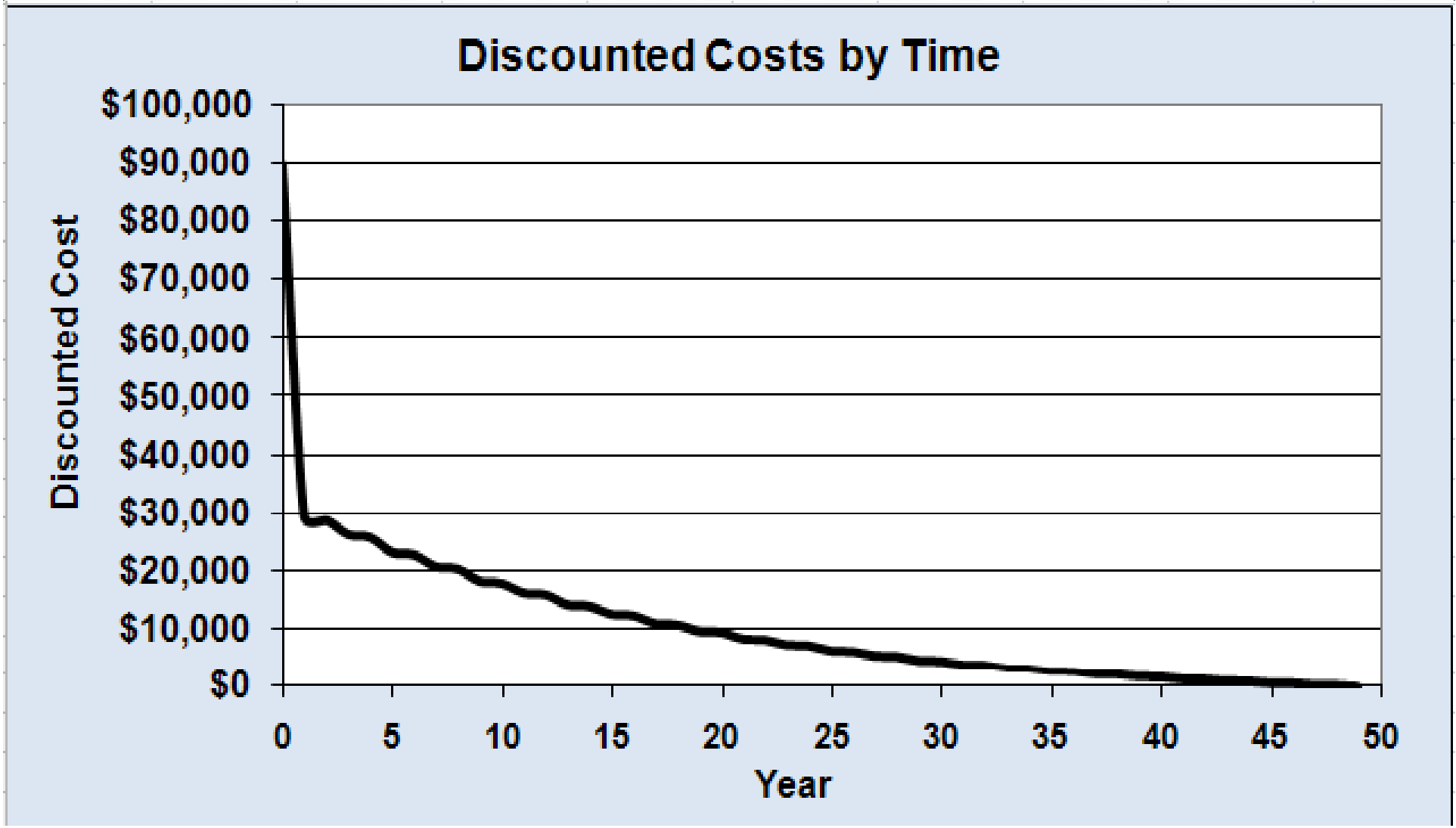
Site Name: Webinar Demp

Site Location: National

Date: May, 2009




Cumulative Discounted Costs
Cumulative Discounted Cost
$100,000
$90,000
$80,000
$70,000
$60,000
$50,000
$40,000
$30,000
$20,000
$10,000
$0
0
5
10
15
20
25
30
35
40
45
50
Year


Discounted Costs by Time
Discounted Cost
$100,000
$90,000
$80,000
$70,000
$60,000
$50,000
$40,000
$30,000
$20,000
$10,000
$0
0
5
10
15
20
25
30
35
40
45
50
Year

Future Improvements

- Create regional cost multipliers based on climate or economic region
- Allow user to determine lifetime of facility
- Consider land costs for smaller-scale BMP's
- Updating the original models prepared in 2005 including permeable pavement, swales, retention and extended detention

Questions?

You may download these cost tools from:
http://www.werf.org/bmpcost

Please feel free to contact us with further questions:

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Participation Certificate

- If you would like to obtain participation certificates for multiple attendees, click the link below
- You can type each of the attendees names in and print the certificates

www.epa.gov/npdes/webcasts/certificate/gi_siteplanning.pdf