Approach to Innovation in Stormwater Management

July 2013

otak

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What flexibility does Ecology NPDES permits allow for alternative approaches for on-site stormwater management?

Alternate Flow Control (FC) for on-site SWM Allowed by NPDES Permits

1. Retrofitting – FC only for new impervious surfaces, not parking lot areas being repaired or replaced.
2. Vesting – New FC standards do not apply to project "Vested" under older standards.
3. Grand Father Clause – FC to only match existing runoff rates, not historical forested conditions, for areas highly urbanized for a long time (40% impervious for more than 20 years).
4. Large Water Bodies – No FC for site discharging to large water bodies or salt water.

Source: DOE Focus on Stormwater Flows, February 2009.
Note that future permits may further restrict or prohibits some of this FC allowances.

Cost Effective Strategies for On-Site SWM

Integrate LID into Development Plan

Cost Effective Strategies for On-Site SWM

Integrate SWM into Environmental and Multi-use Features

Cost Effective Strategies for On-Site SWM

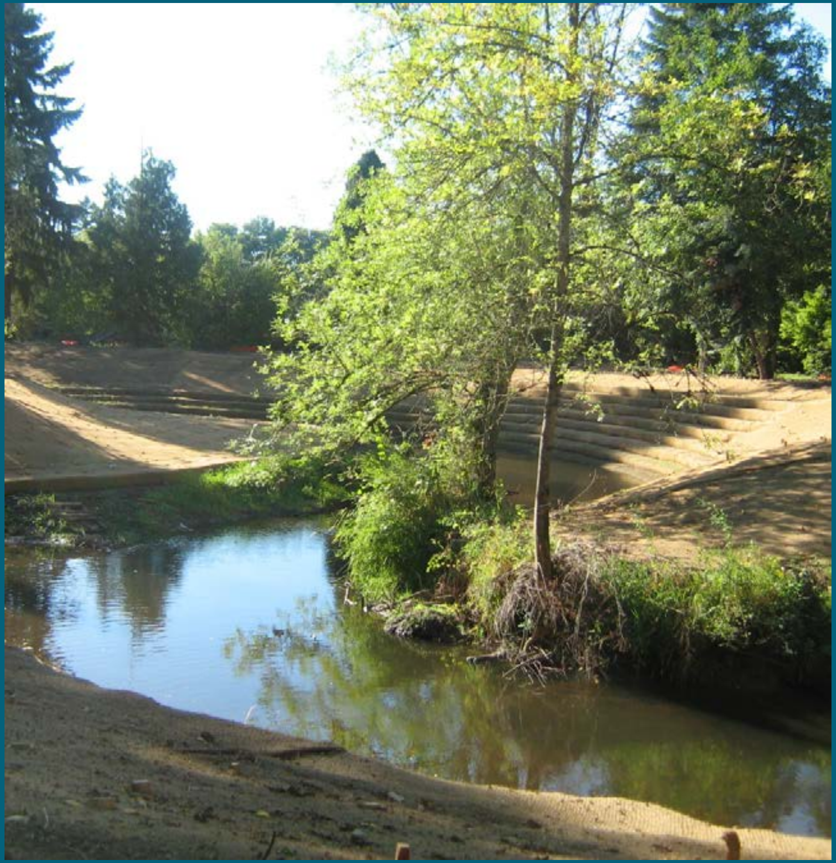
Use Direct Discharge, Where Feasible

- Must convey water to approved large water bodies
- New SW main can be expensive
- May need to combine with minor site FC due to:
  - *Capacity of existing drainage system*
  - *Environmental hydrologic needs*
- WQ treatment required

Cost Effective Strategies for On-Site SWM

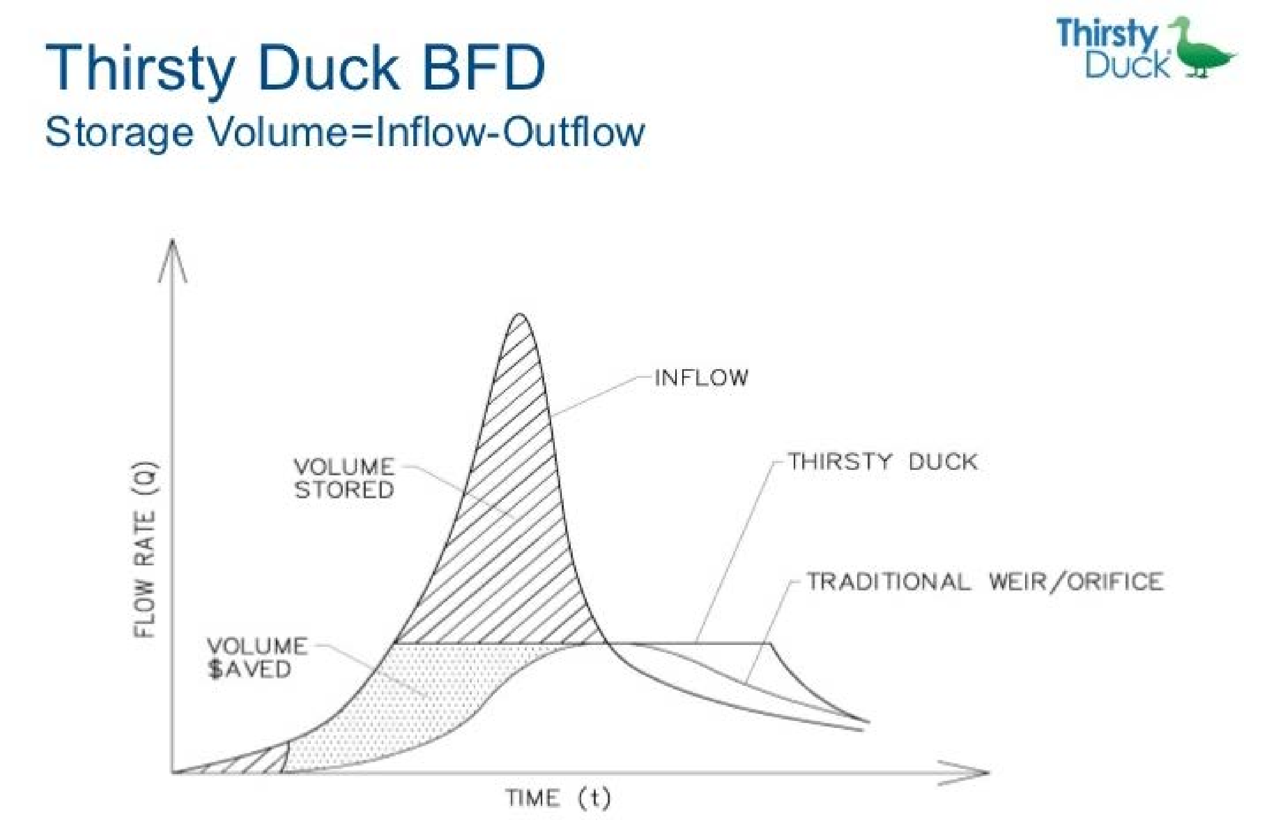
Use Infiltration or Detention Facilities

- Infiltration pond ($10K /SA), where soils are appropriate
- Detention pond ($44K /SA), , where land is available and affordable
  Next cheapest facilities:
  - Infiltration chambers ($25/SA)
  - Infiltration vaults ($35K/SA)
  - Detention vaults($150K/SA)
- WQ treatment required



Cost Effective Strategies for On-Site SWM

Use constant FC devices to maximize discharge below half of two-year runoff threshold



What can cities do to help developers of infill projects meet NPDES permit requirements in a cost-effective manner?

Note Developer Challenges with SWM of Urban Infill Projects

- Easy sites already developed, infill typically harder on sites with risky SWM and lengthy permitting
- Developers are less willing to invest in studies for sites likely to have a poor ROE
- Developers often do not use specialized water resource engineers to develop optimal solutions

City Strategies to Promote Cost-effective SWM of Urban Infill Projects

- Educate/partner with developers and home owners
- Develop financial incentives for infill development
- Provide watershed planning/developer guidance
- Partner on public/private projects

City Strategies for Cost Effective SWM

Educate Developers

- *Rain Garden Handbook for Home Owner Associations*
- *Outreach to developers*

GETTING WATER TO THE RAIN GARDEN

Water can be delivered to the rain garden across a landscaped area, through an open swale lined with plants or decorative rock, or through a pipe. Whatever technique is used, consider the slope and protect against erosion. If the slope is gentle (about 2% or less) and the swale or landscaped area is well protected with vegetation or rock, then no special design is needed. If the slope is more than 2% and water is directed through a swale, consider adding small rock check dams every 5 to 10 feet to slow the water. Where water enters the rain garden from a swale or pipe place a pad of rock to slow the water and guard against erosion.

TIP

Before burying the inlet pipe check that water flows easily to the rain garden from the source.

Rock lined inlet. Rock should be free of sediment, so order "washed."

OVERFLOW

During much of the winter all the water that flows into the rain garden will soak into the ground. Occasionally, when the ground is wet and a big storm delivers a lot of rain the garden can fill up and overflow. So, design the garden with an overflow lined with rock to protect from erosion. Extend the rock about 4 feet outside the rain garden to slow the water as it exits. Direct water safely to the storm drain or disperse into the landscape.

If you design a rain garden that is shared between homes, make sure everyone is in agreement about where excess water can be directed. The depth from the bottom of the overflow to the bottom of the rain garden determines the maximum depth that the water will pond.

City Strategies for Cost Effective SWM

Developer Financial Incentives for SWM of Urban Infill Projects

- *Higher density development*
- *Lower surface water fees*
- *Increased property values*
- *Lower permitting costs and risks*

City Strategies for Cost Effective SWM

Watershed planning FC strategies allowed by NPDES Permits

- *Alternate FC standard allowed for approved basin plans* (difficult and costly to get approved)
- *Regional stormwater FC facilities*

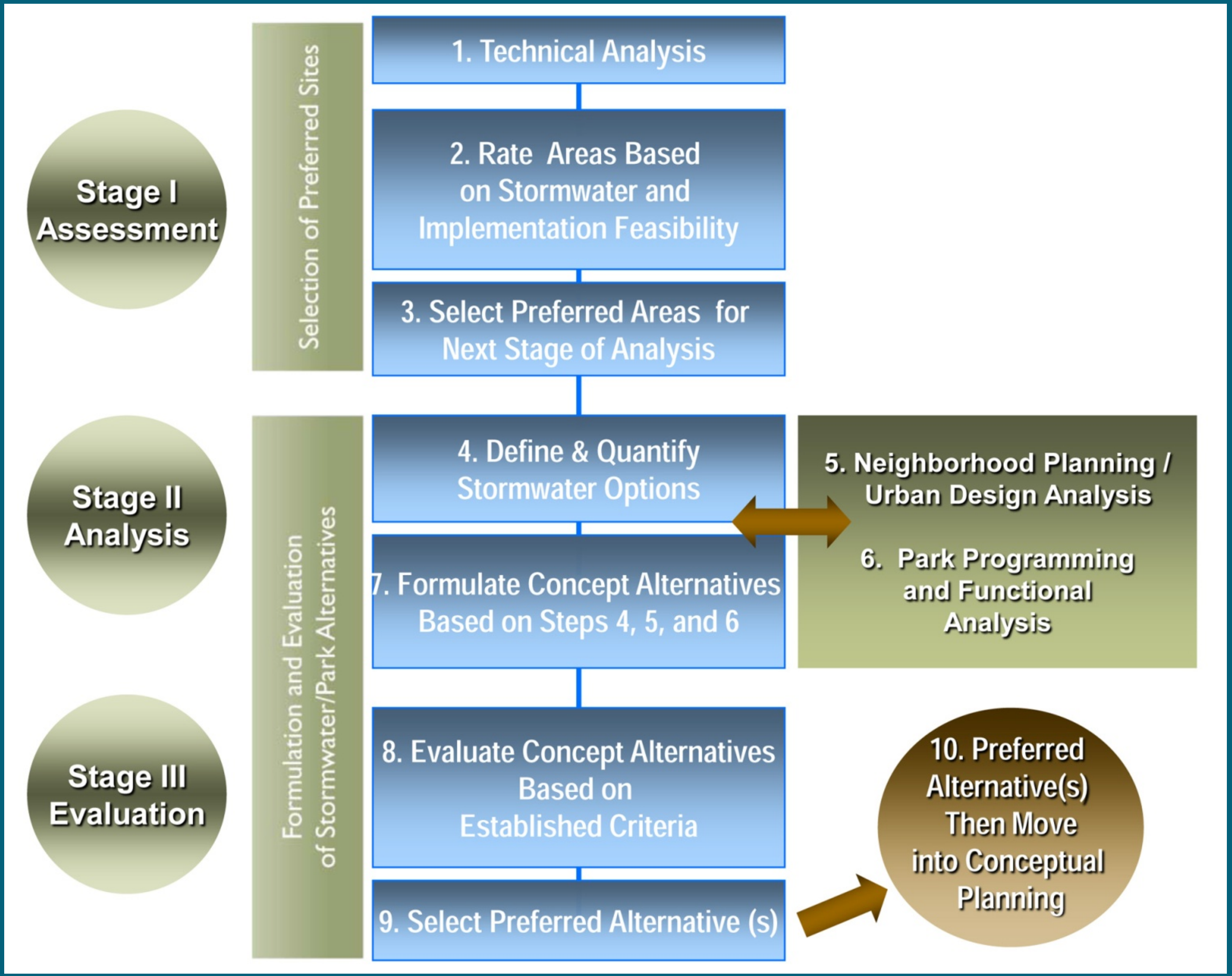
Source: DOE Focus on Stormwater Flows, February 2009.

Note that future permits may further restrict or prohibits some of this FC allowances.

Watershed Planning – 4 legs of stool

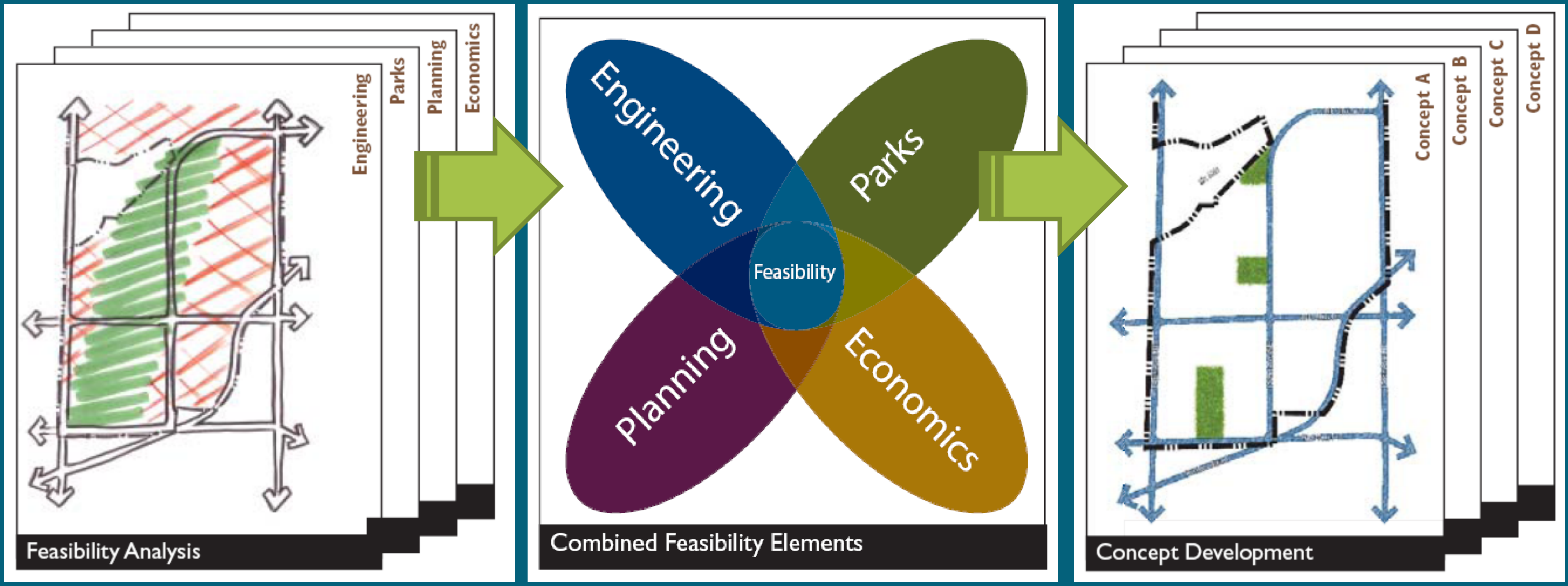
- Policy Implementation
- Parks & Trails
- Project Elements
- Stormwater Quality
- Stormwater Quantity

Watershed Planning
Basic Flow of Analysis



Watershed Planning

How it Comes Together



Cost Effective Watershed/ Basin Strategies

Build SW mains for direct discharge to large bodies of water

- *Must be able to safely convey to approved larger body of water*
- *Can be piped or ditched to backwater from OH*
- *May want to combine with regional FC to minimize new conveyance size*
- *WQ treatment required*

Cost Effective Watershed/Basin Strategies

Use Regional SW Facilities

- *Must safely convey water to POC*
- *Can use area substitution within basin*
- *Results in a better triple bottom line (economic, social, environmental)*

Cost Effective Watershed/Basin Strategies

Use natural surface water features to attenuate peak surface water flows

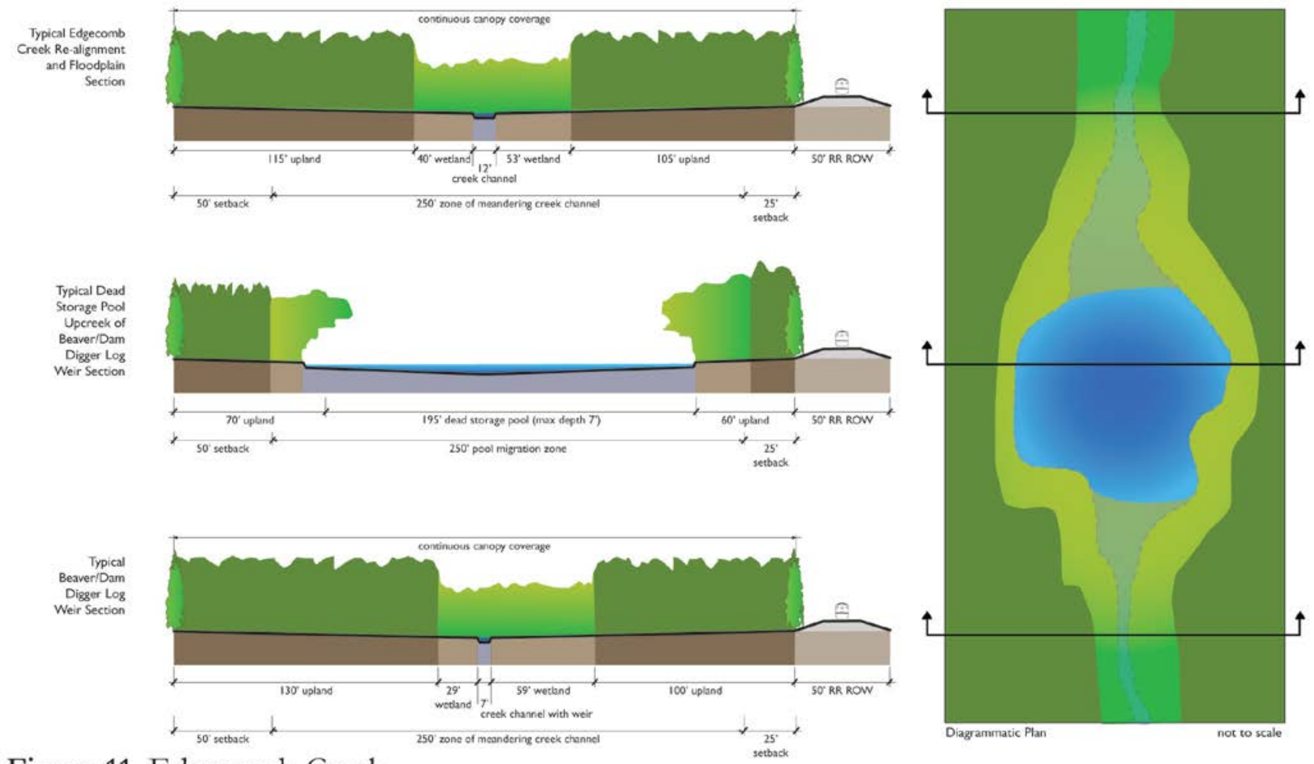


Figure 11 Edgecomb Creek
Schematic Re-alignment Sections

City Strategies for Cost Effective SWM

Develop public/private partnerships

- *City planning/design/permitting*
- *Developer provides property for regional SW facility*
- *City or developer obtains seed money—SW facilities for public projects are oversized to accommodate private development*
- *City seeks SW grants for public retrofit projects*
- *Developer pays connection charges for proportional share of design and construction of region SW facility*
- *Developer pays surface water utility fee for O&M*

What types of LID stormwater management treatments are appropriate for urban infill development and what are the relative costs?

LID Green Infrastructure Effective in Mixed-Use Development in Urban Infill

- *Rain gardens*
- *Bioretention*
- *Porous pavement*
- *Infiltration ponds*
- *Gravel trenches*
- *Planter boxes*
- *Rain barrels*
- *Green roofs*

LID Green Infrastructure

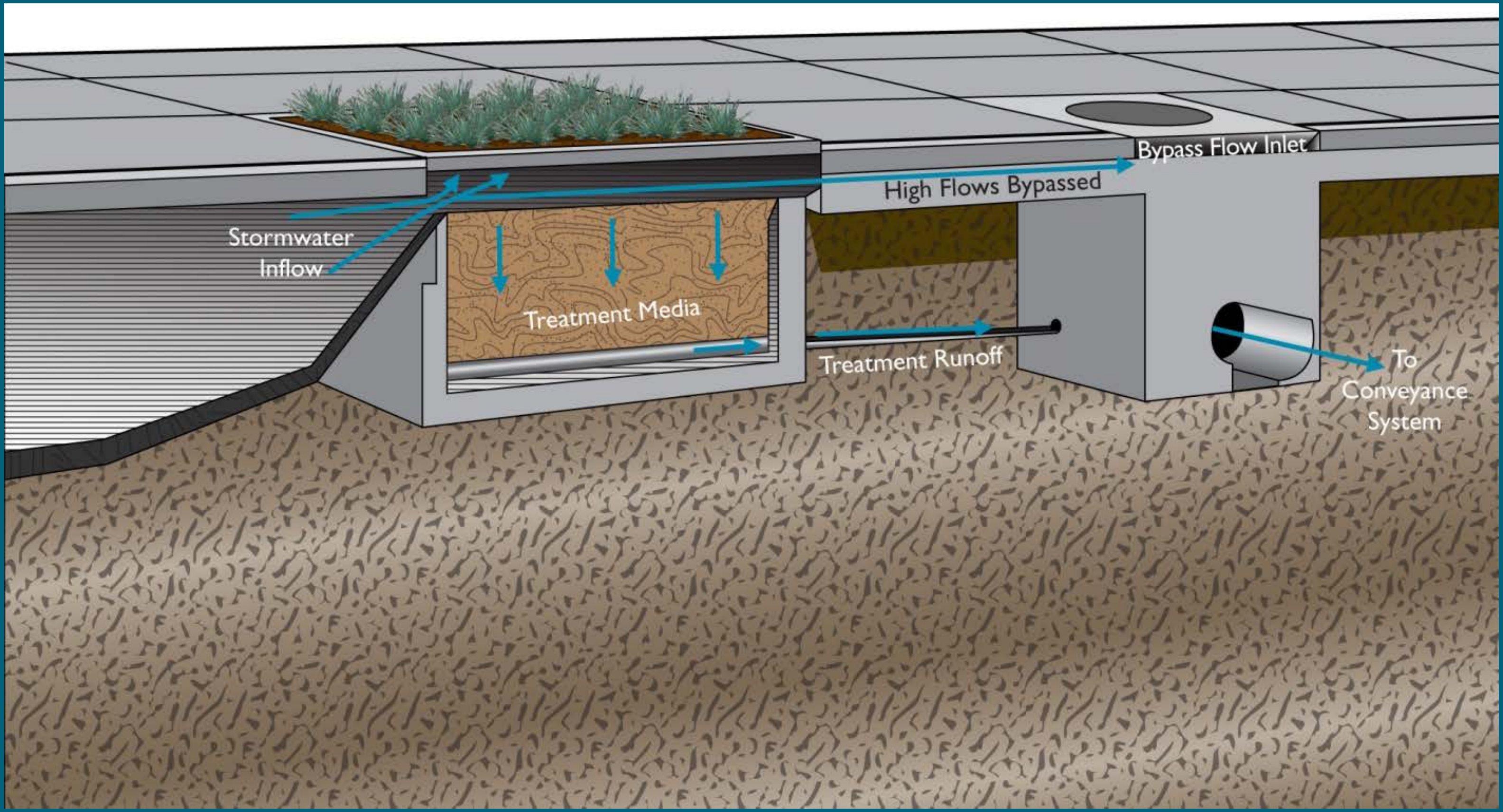
Rain garden/bioretention facility

Green Infrastructure LID Effective for Streets in Urban Infill

- *Rain gardens*
- *Porous pavement*
- *Infiltration chambers*
- *Gravel trenches*
- *Planter boxes*

LID Green Infrastructure

Planter box/storm filter



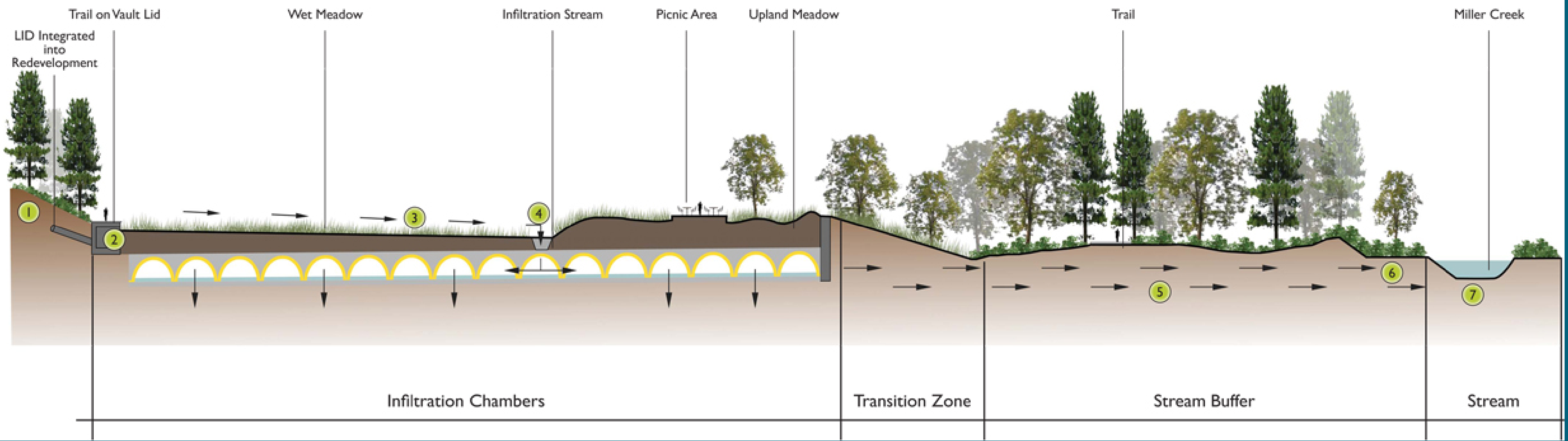
LID Natural Drainage System Effective for Open Spaces in Urban Infill

- *Reforestation*
- *Lateral flow dispersion*
- *Rain gardens*
- *Infiltration facilities*
- *Floodplain restoration*

LID Natural Drainage System

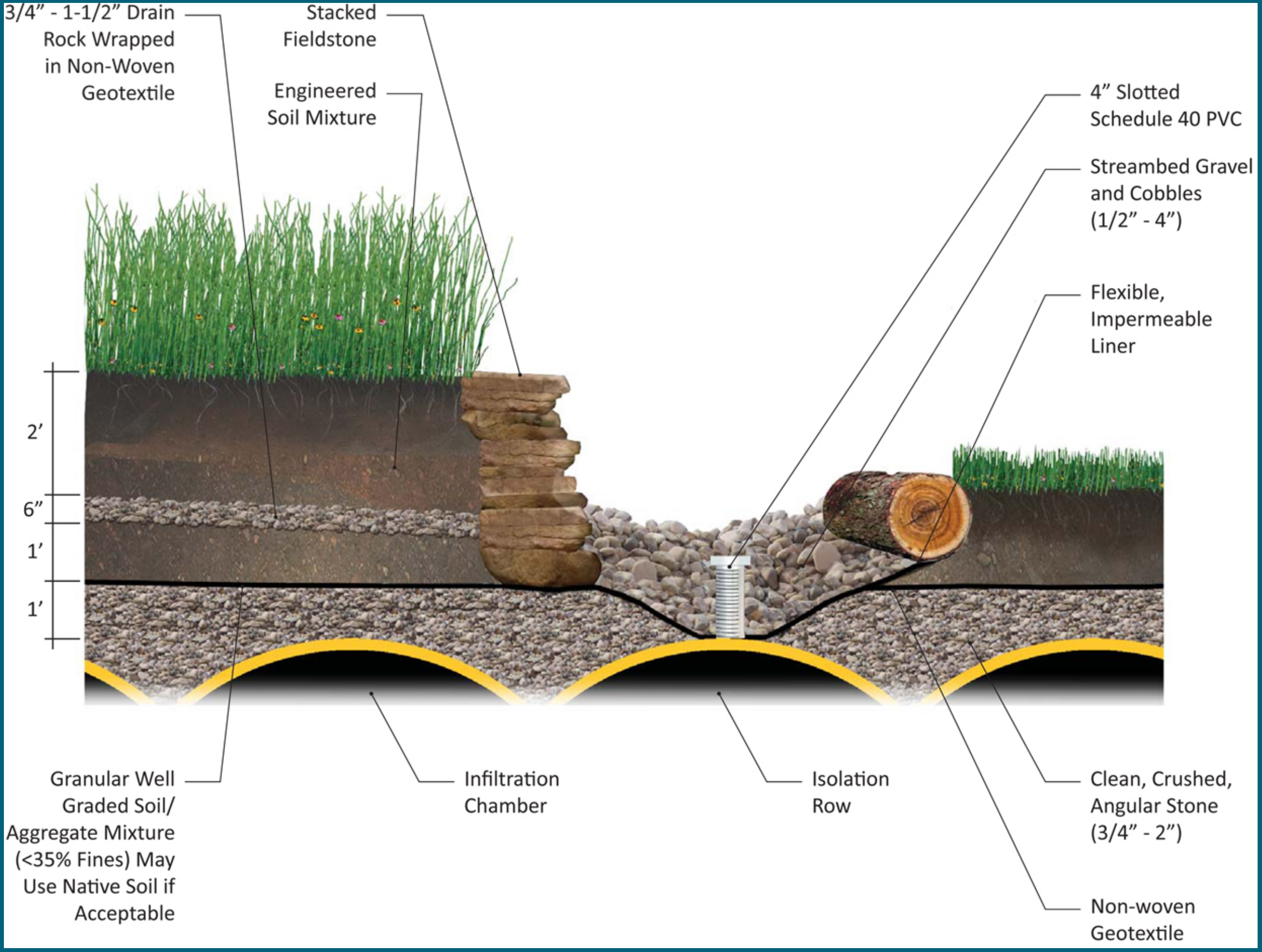
Restoring Natural Hydrologic Functions

	1	2	3	4	5	6	7
Natural Hydrologic Processes	**Forested Upland**	**Hillside Seeps**	**Wet Meadow in Terraced Floodplain**	**Losing (Infiltrating) Stream Tributary in Terraced Floodplain**	**Floodplain Hyporheic Zone**	**Floodplain Wetland**	**Miller Creek In-Channel Habitat**
Design Approach to Emulate Natural Processes	Upland raingardens infiltrate all stormwater from 25% of redevelopment area	Stormwater vault is an energy dissipator, sediment catchment, and flow spreader to wet meadow	Raingarden/Bio-Swale provides water quality treatment	Intake and maintenance isolation chamber to infiltration gallery	Underground chambers infiltrate all runoff through the 100-year event to enhance base flow to Miller Creek	Regraded floodplain wetland removes channel incision and reconnects stream to floodplain wetland	Large wood, invasive species removal and live vegetation restored within and along Miller Creek



LID Natural Drainage System

Close up of an Infiltration Floodplain Stream Inlet



Relative Costs

Table 8—Cost Evaluations of IMP Elements						
	IMP Element	*Element Footprint Area (acres)*	*Element Cost per Footprint Area ($/acre(s))*	*Stormwater Volume Detained by Element (ft³)*	*Cost per Detention Volume($/ft³)*
IMP Elements	Bioretention (with plantings assumed incidental)	1	$720,000	191,700	$3.76
	Bioretention (including planting costs)	1	$1,030,000	191,700	$5.37
	Permeable Pavers with Reservoir (with credit for sidewalk)	1	$1,400,000	266,700	$5.25
	Permeable Pavers with Chambers (no credit for sidewalk)	1	$1,700,000	266,700	$6.38
	4" Extensive Green Roof	1	$1,300,000	3,550	$366.20
	12" Intensive Green Roof	1	$1,660,000	5,560	$298.56
Regional Detention	Detention Vault (without land cost)	2.75	$7,110,000	1,733,000	$4.10
	Detention Vault (with land cost)	2.75	$16,100,000	1,733,000	$9.29

Source: Overlake Village Low Impact Development Feasibility Analysis (Otak, 2010)

Relative Costs

Table 2
LID installation and O&M costs from a variety of sources in 2006 dollars

LID technology	Installation cost (US$ 2006)	O&M costs	Source
Rain gardens	US$ 107–129 m^{-2} (US$ 13–15 ft^{-2})		Bannerman (2003)
Stormwater planters	US$ 426 m^{-2} (US$ 39.60 ft^{-2})	2–8% of installation cost	PBES (2006b), Flinker (2005)
Porous concrete	US$ 28–90 m^{-2} (US$ 2.50–8.30 ft^{-2})	1–2% of installation cost	USEPA (1999a), CRI (2005), NCGBT (2003)
Grass/gravel pavers	US$ 22–86 m^{-2} (US$ 2.10–8.00 ft^{-2})	1–2% of installation cost	USEPA (1999a)
Interlocking concrete paving blocks	US$ 75–150 m^{-2} (US$ 7.00–13.90 ft^{-2})	1–2% of installation cost	USEPA (1999a)
Porous asphalt	US$ 67–85 m^{-2} (US$ 6.30–7.90 ft^{-2})	Not available	PADEP (2005)
New green roofs	US$ 69–165 m^{-2} (US$ 6.40–15.30 ft^{-2})	10–16% of installation cost	Peck and Kuhn (2003)
Retrofit green roofs	US$ 95–276 m^{-2} (US$ 9.00–25.50 ft^{-2})	6–11% of installation cost	Peck and Kuhn (2003)
Cisterns	US$ 0.14–1.17 l^{-1} (US$ 0.50–4.00 gal^{-1})	Not available	TWDB (2005)
Constructed treatment wetlands	US$ 14,200–60,700 ha^{-1} (US$ 35,000–150,000 $acre^{-1}$)	Low	BNL (2007)
Stormwater wetland	US$ 26,100–36,200 ha^{-1} (US$ 64,700–89,200 $acre^{-1}$)	2–4% of installation cost	SFBF (2001)

Source: Rapid Assessment of the Cost-Effectiveness of Low Impact Development for CSO Control, Landscape and Urban Planning Volume 82, Issue 3 (Monalto, et al, 2007)

Questions?

Thank You!