Seattle Public Utilities

Implementing Green Infrastructure:
Creative Approaches to Reducing Regulatory and Financial Barriers in Seattle

April Mills
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Overview

- **Funding source**
- **Partnering**
- **Interagency coordination**

Funding Source

Establishing a Funding Source

- SPU is rate-payer based.
- Scale the drainage rate by the impact of each parcel on the drainage system.
- Offer rate reductions for those parcels that reduce their environmental impact using green infrastructure (SFCP).

Drainage Rate Structure

Single-family residential and duplex parcels less than 10,000 SF = Flat rate based on parcel size

Small residential	**2011**
Under 3000 SF	$134.06
3000 – 4999 SF	$173.10
5000 – 6999 SF	$234.94
7000 – 9999 SF	$298.32

All other properties rate per 1,000 SF

Undeveloped (0-15% impervious)	**$19.72**
Low impact Undeveloped	$12.35
Light (16-35% impervious)	$29.62
Low impact Light	$23.47
Medium (36-65% impervious)	$42.89
Low impact Medium	$34.43
Heavy (66-85% impervious)	$56.57
Very Heavy (86-100% impervious)	$74.49

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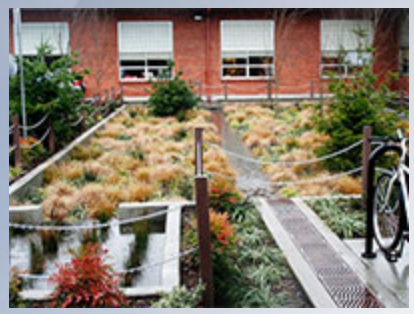
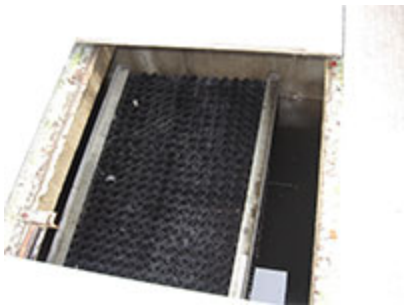
Stormwater Facility Credit Program








Partnering

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Partnering

- Rebates
  - RainWise Program
- City requirements
  - Green Factor
  - Stormwater Code
- Public-private partnerships
  - Capital Hill Water Quality Project
  - Highpoint

Seattle Drainage System

- Pink - Creek/ Separated Sewers
- Green - Partially Separated Sewers
- Yellow - Combined Sewers

SPU CSO System

- **90 permitted CSO outfalls**
  - **37 CSO outfalls do not meet CSO requirements**
- **35 CSO storage facilities (8.1 MG)**
- **100-200 million gallons CSO discharged annually**
- **About 200 CSO discharge events annually**
- **Integration with King County**

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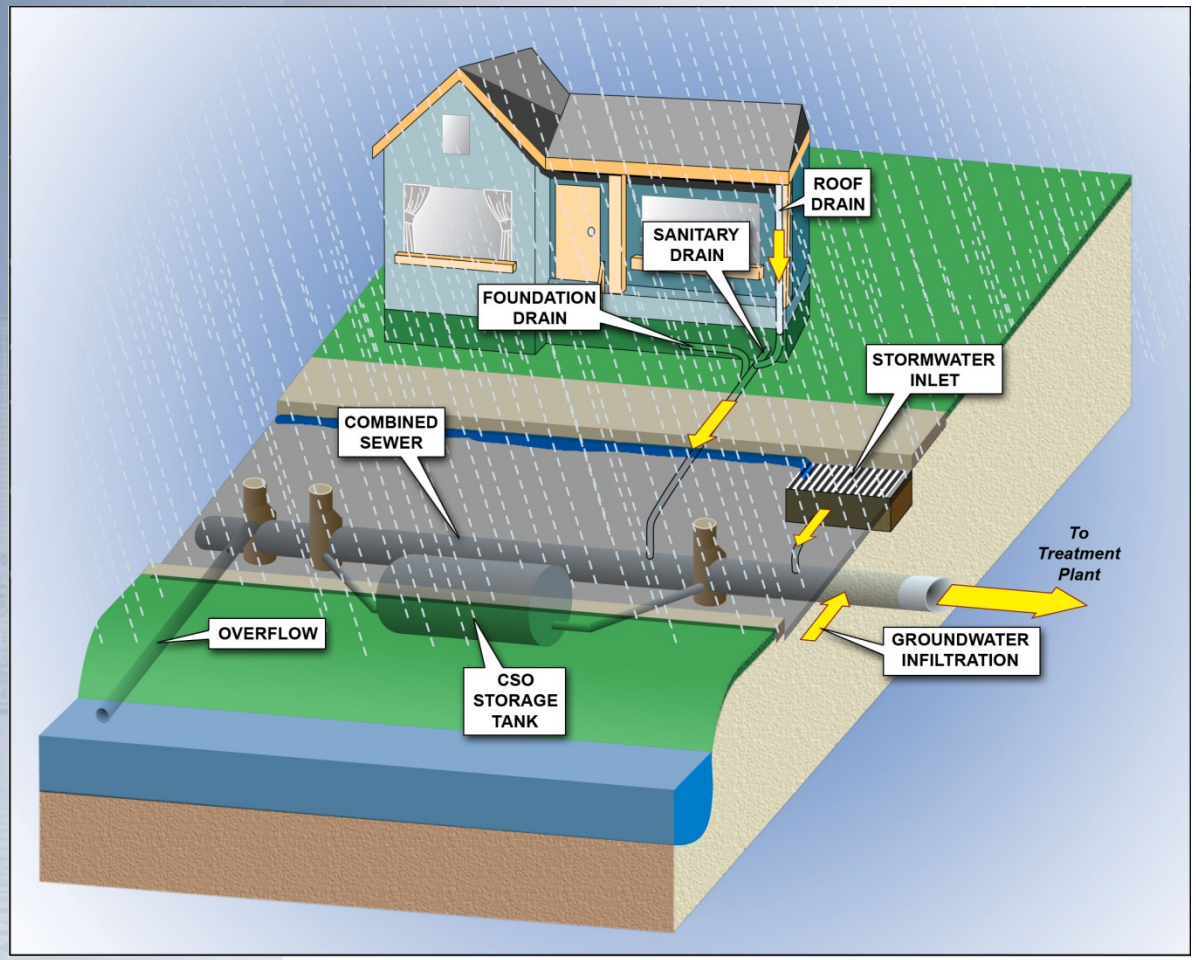
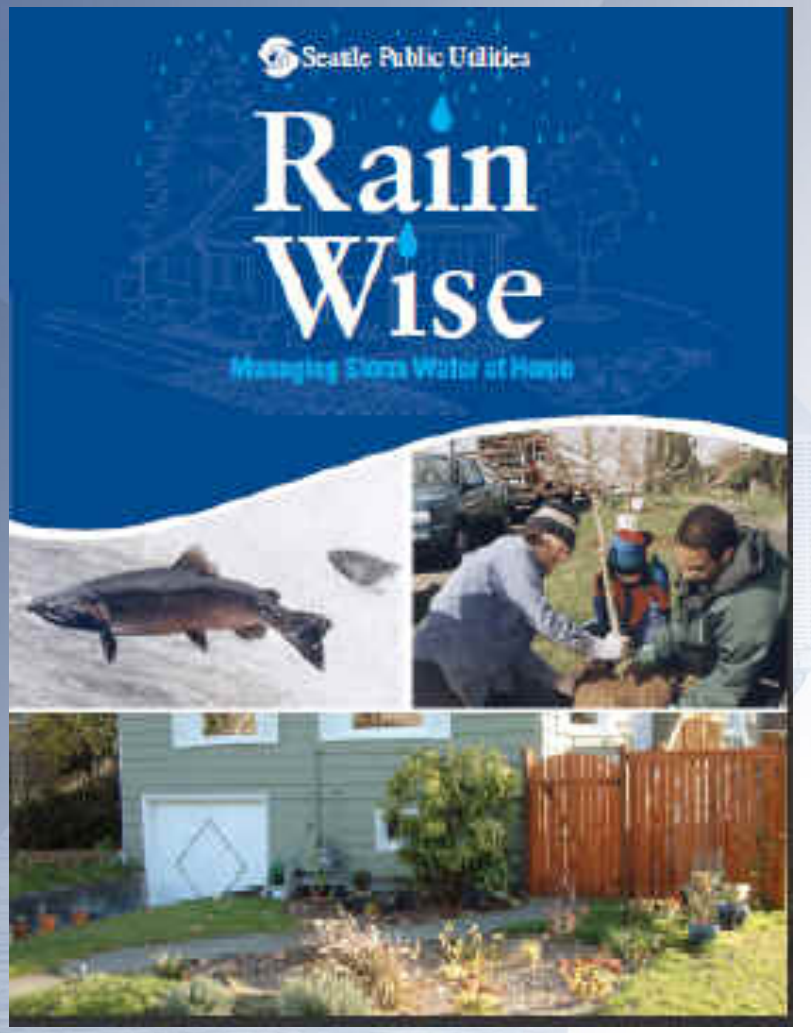
Using Green Infrastructure for CSO Control



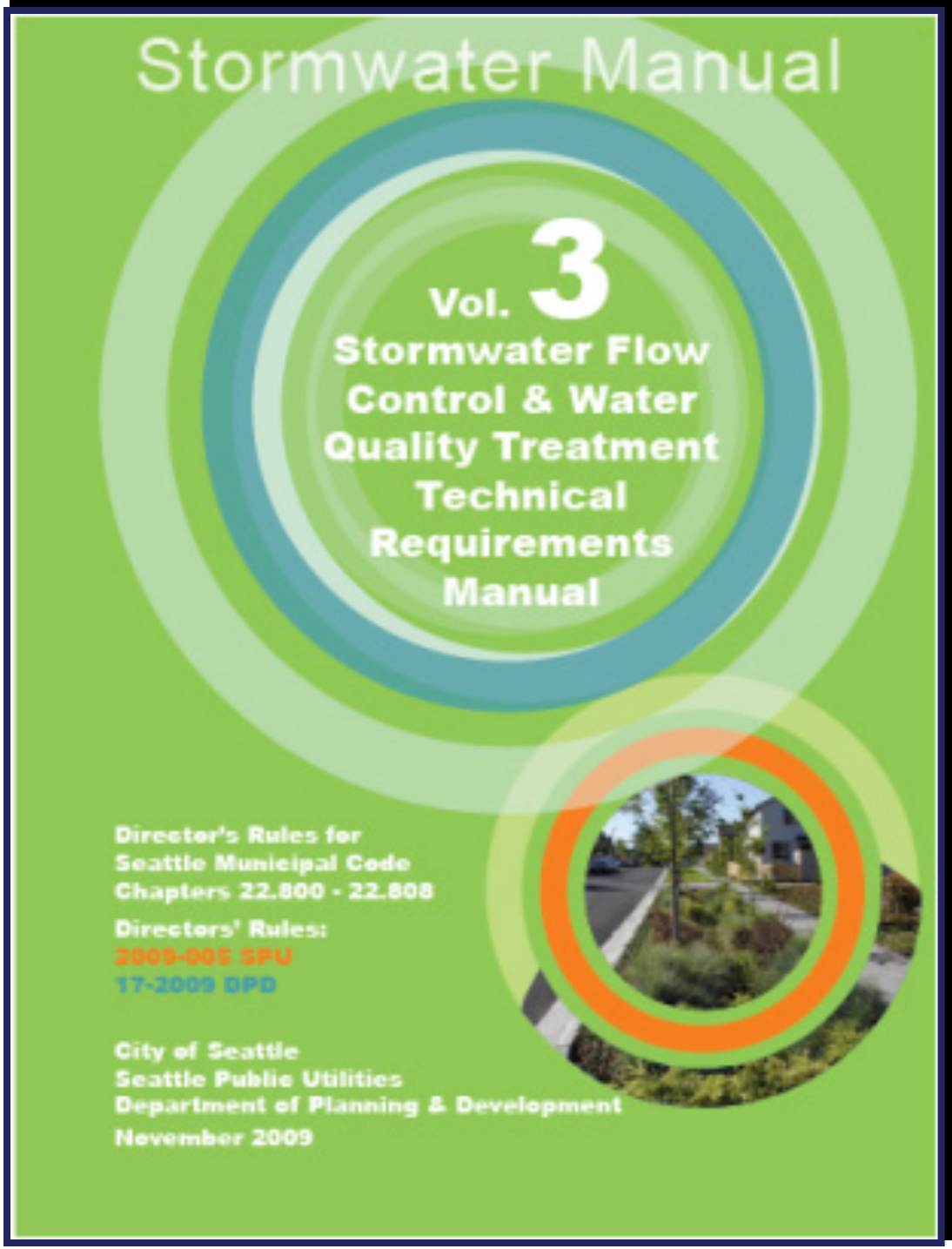
Partnering with the Community: Residential RainWise (2010-2017)



RainWise Tools

Available at

www.rainwise.seattle.gov



Seattle's Stormwater Code Requires GSI to the MEF

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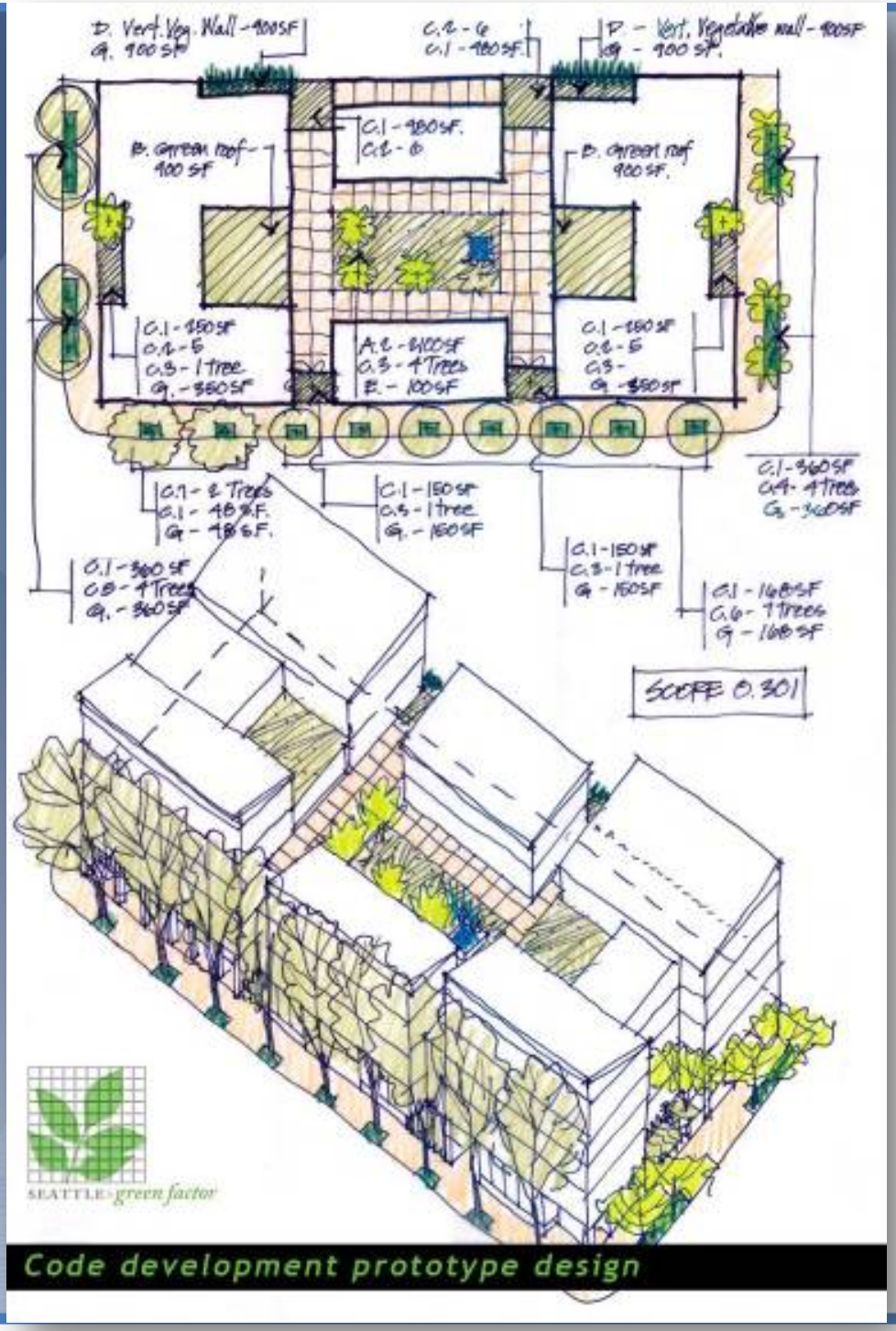
Stormwater Manuals

www.seattle.gov/util/greeninfrastructure
(navigate to Stormwater Code compliance)

- Compost Amended Soil
- Trees
- Bioretention
- Permeable Pavement
- Green Roofs
- Cisterns
- Downspout Dispersion
- Sheet Flow Dispersion


Seattle Green Factor
Improving livability and ecological function through landscaping standards
Phase IV Terry Plaza Looking East



How does the Green Factor work?

- Provides weighted menu, sets minimum score
- Includes green roofs and walls, bioretention, and permeable paving
- Compliance required for permit approval

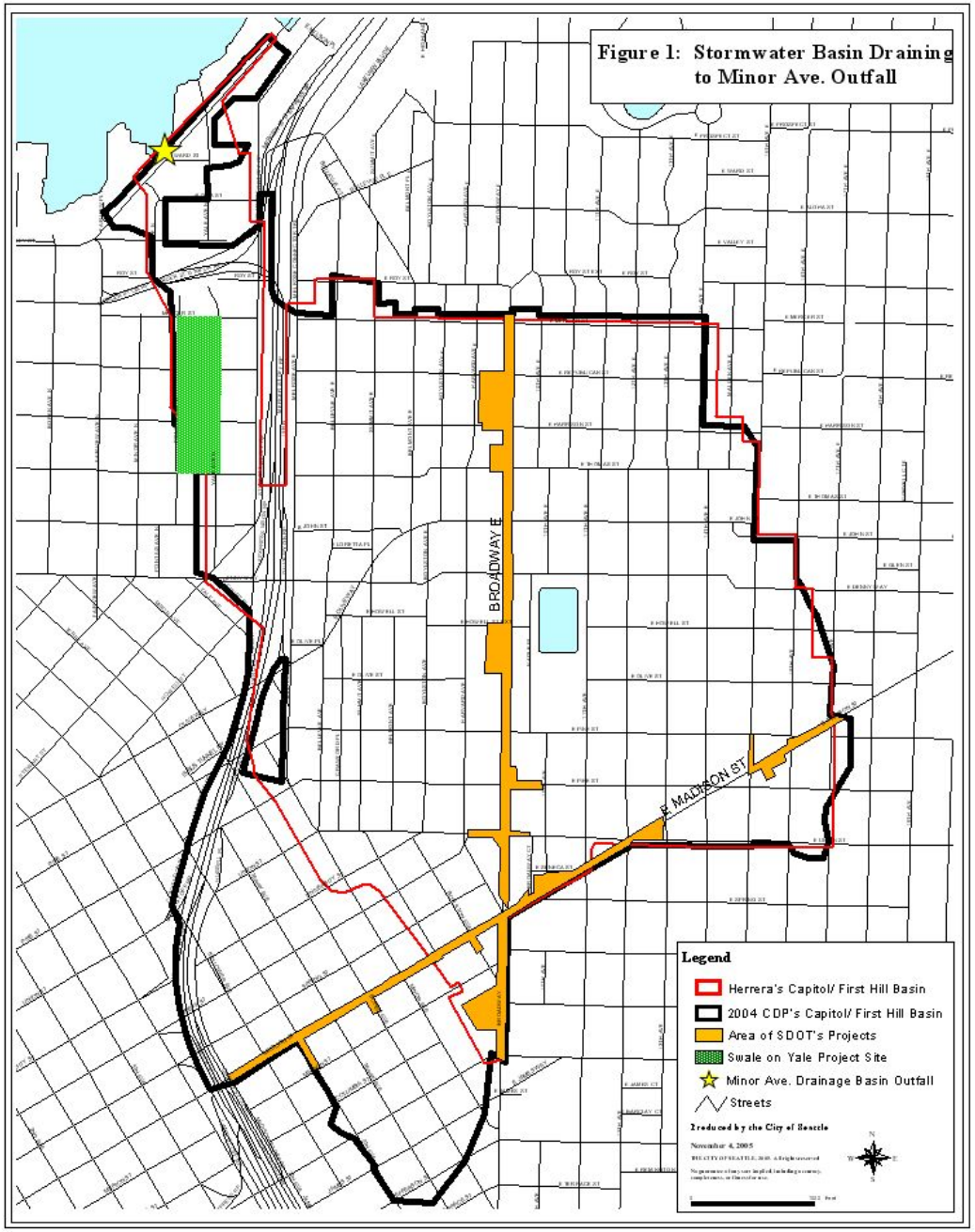
http://www.seattle.gov/dpd/permits/greenfactor/Overview/

Modeling benefits

UBC study found that Green Factor, applied over a 9-block area, would result in…

- 13% reduction of stormwater runoff
- 9% reduction of energy demand
- 12% GHG reduction

(Roehr et al, 2008)



Capital Hill Water Quality Project

- Biofiltration treatment of road runoff from Capital Hill to South Lake Union
- WQ treatment for 130 – 190M gallons/ yr

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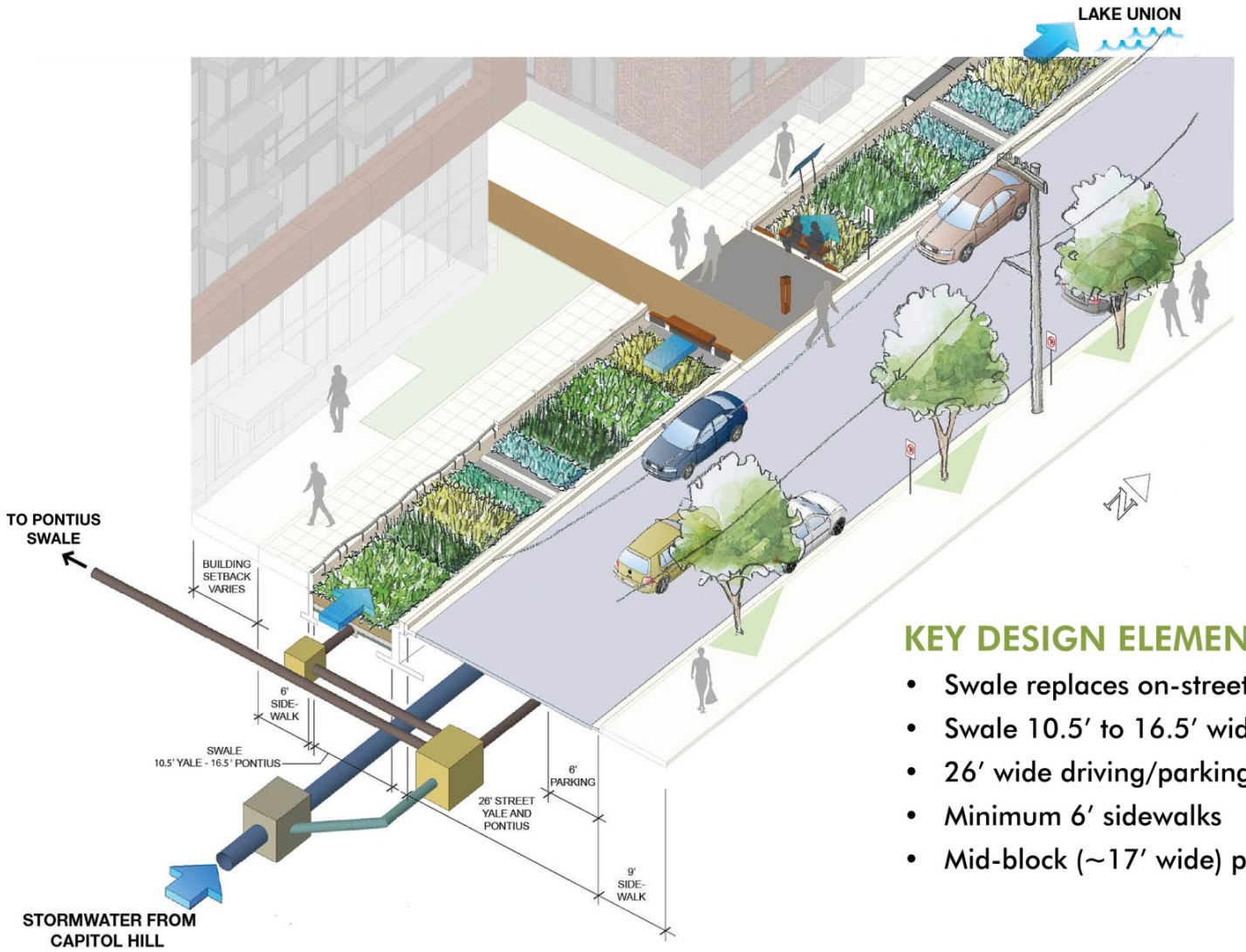
Capitol Hill Water Quality Project

KPG

kpff



KEY DESIGN ELEMENTS

- Swale replaces on-street parking lane
- Swale 10.5′ to 16.5′ wide, 14″ to 23″ deep
- 26′ wide driving/parking roadway
- Minimum 6′ sidewalks
- Mid-block (~17′ wide) pedestrian crossing

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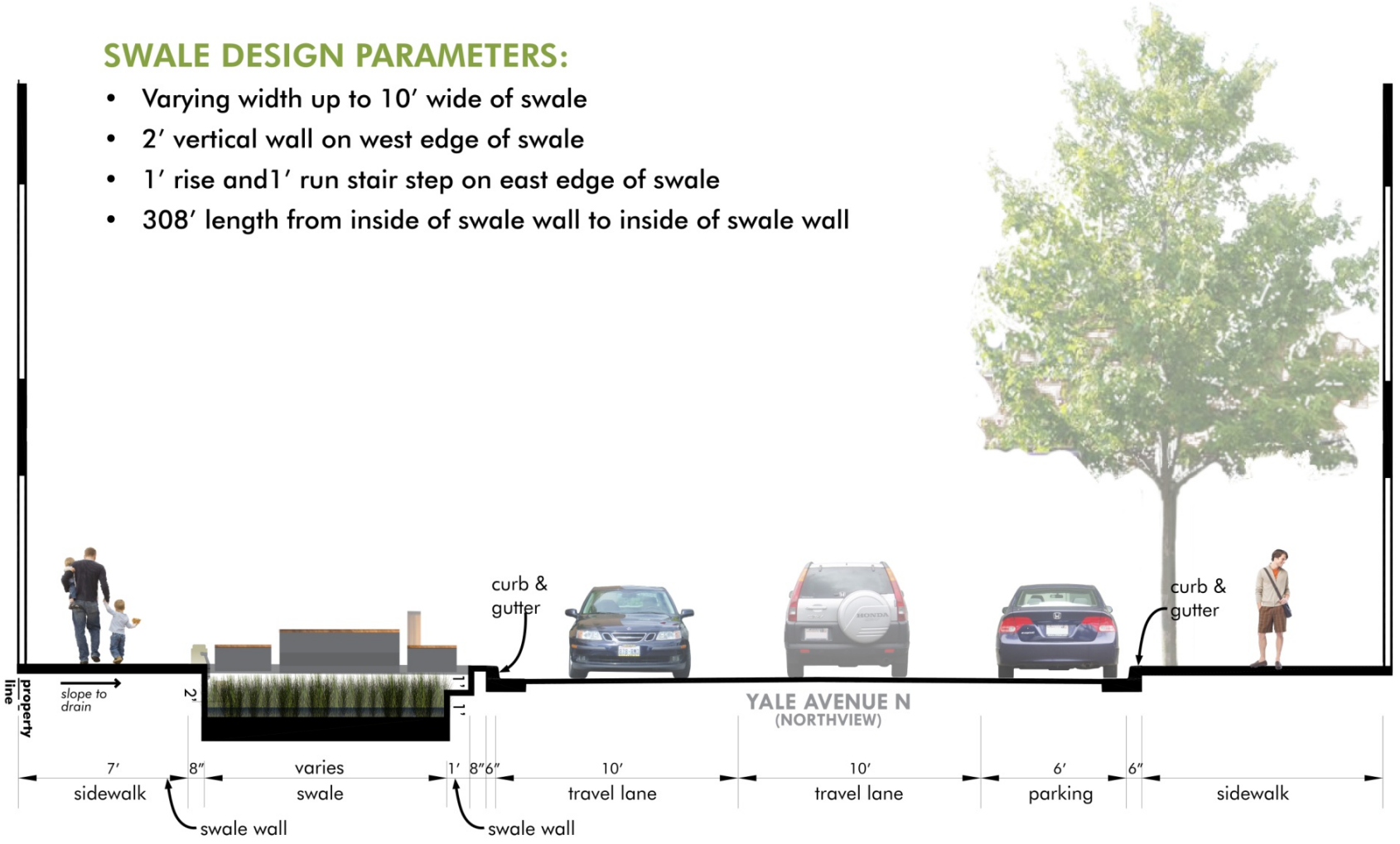
Capitol Hill Water Quality Project

KPG kpff

SWALE DESIGN PARAMETERS:

- Varying width up to 10′ wide of swale
- 2′ vertical wall on west edge of swale
- 1′ rise and1′ run stair step on east edge of swale
- 308′ length from inside of swale wall to inside of swale wall



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Capitol Hill Water Quality Project

KPG

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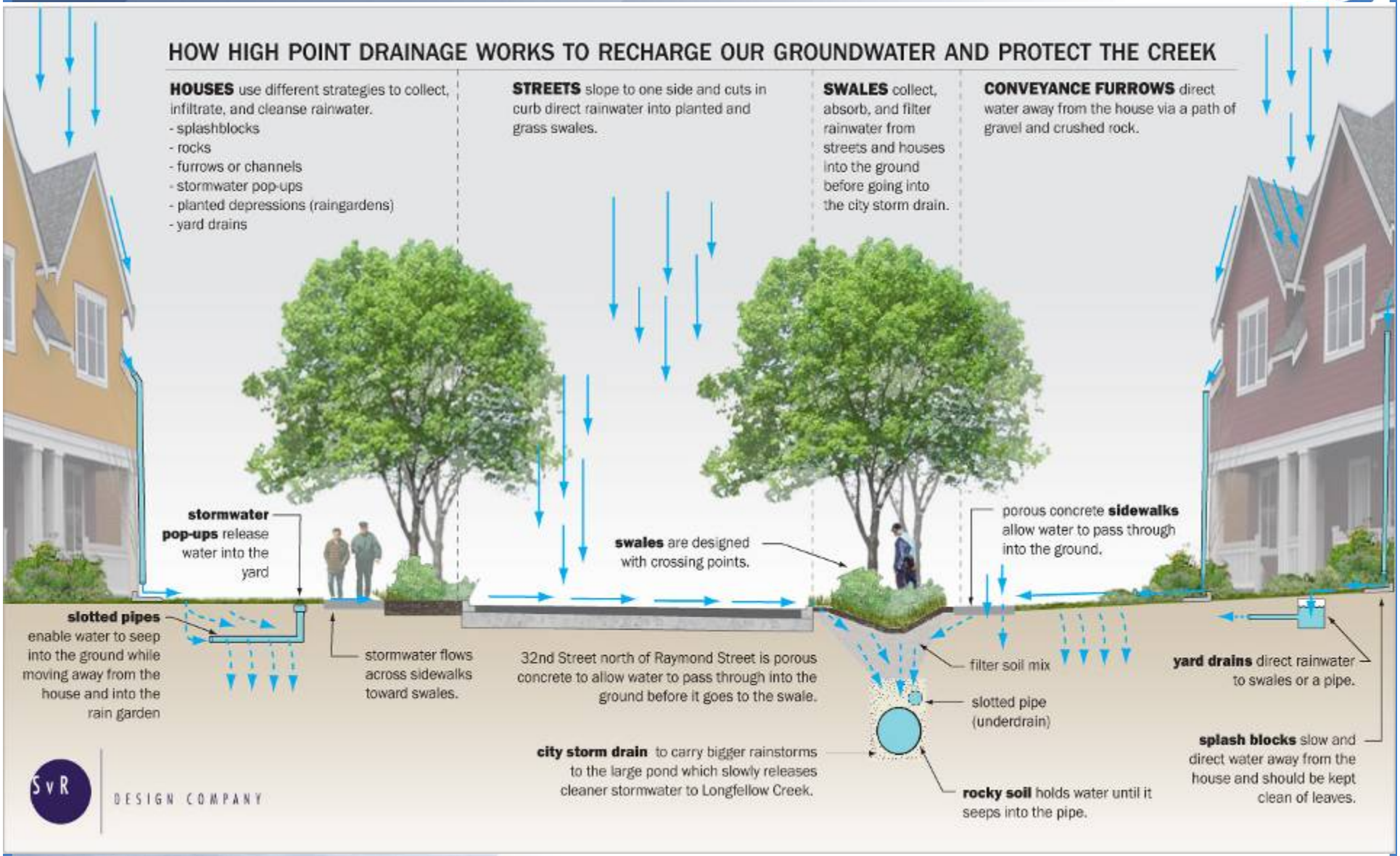
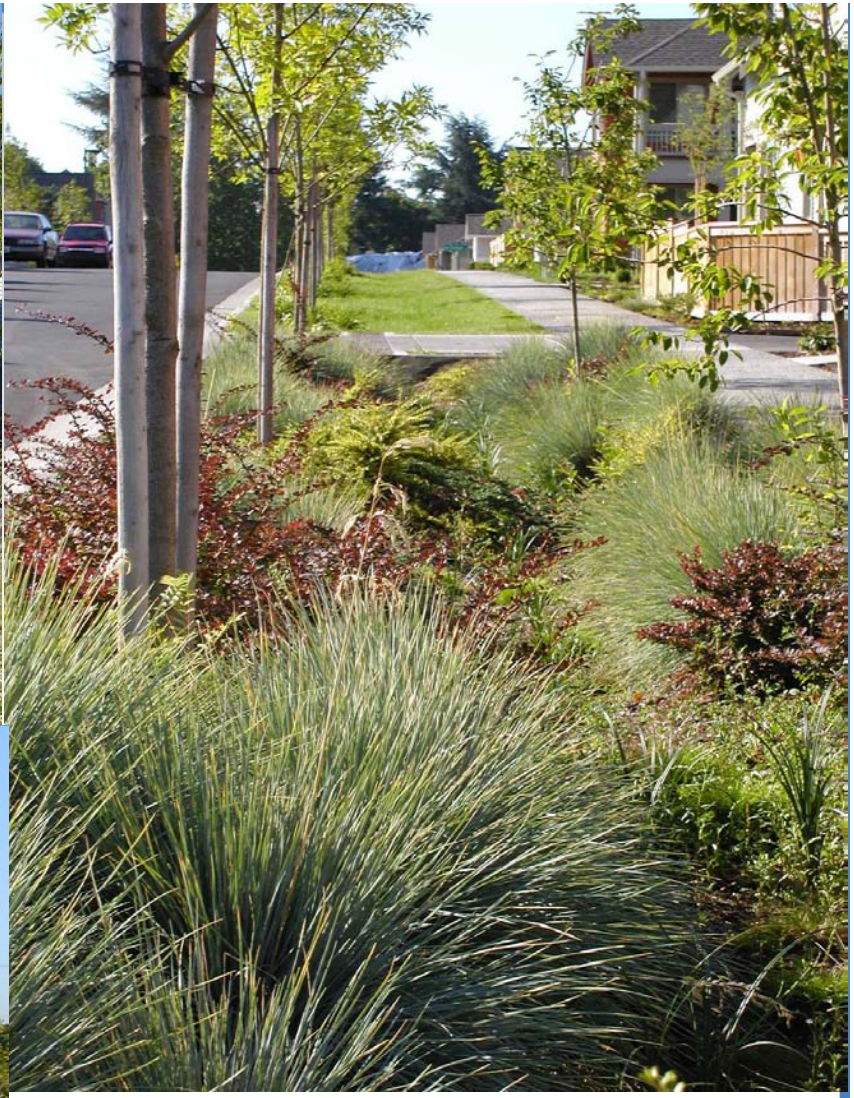
High Point Project

High Point Natural Drainage System

- Housing Authority Project
- 129 acre drainage (8% of Longfellow Creek drainage basin)
- Engineering Diligence
  - Evaluated full SW toolbox
  - Pond plus green infrastructure


HOW HIGH POINT DRAINAGE WORKS TO RECHARGE OUR GROUNDWATER AND PROTECT THE CREEK
HOUSES use different strategies to collect, infiltrate, and cleanse rainwater.
- splashblocks
- rocks
- furrows or channels
- stormwater pop-ups
- planted depressions (raingardens)
- yard drains
STREETS slope to one side and cuts in curb direct rainwater into planted and grass swales.
SWALES collect, absorb, and filter rainwater from streets and houses into the ground before going into the city storm drain.
CONVEYANCE FURROWS direct water away from the house via a path of gravel and crushed rock.
stormwater pop-ups release water into the yard
swales are designed with crossing points.
porous concrete sidewalks allow water to pass through into the ground.
slotted pipes enable water to seep into the ground while moving away from the house and into the rain garden
stormwater flows across sidewalks toward swales.
32nd Street north of Raymond Street is porous concrete to allow water to pass through into the ground before it goes to the swale.
filter soil mix
slotted pipe (underdrain)
yard drains direct rainwater to swales or a pipe.
city storm drain to carry bigger rainstorms to the large pond which slowly releases cleaner stormwater to Longfellow Creek.
rocky soil holds water until it seeps into the pipe.
splash blocks slow and direct water away from the house and should be kept clean of leaves.
SvR
DESIGN COMPANY



Porous Pavement

High Point Project

Interagency Coordination

Interagency Coordination

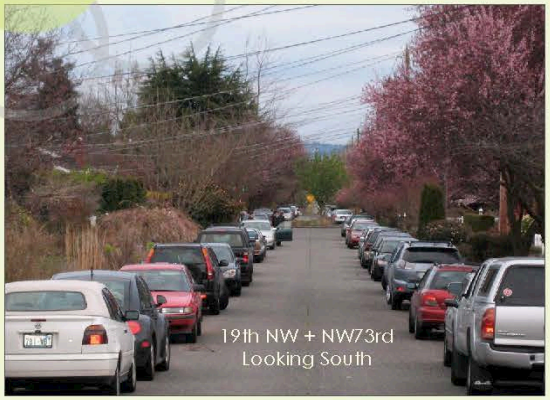
- Cost savings for City if multiple objectives (from multiple departments) achieved in one project
  - Walk/Bike/Ride + CSO mitigation
- Partnering dollars with other agencies set aside to integrate elements from partner agency into lead agency's project
  - A work in progress with Dept. of Transportation

GSI Siting Considerations

In addition to soil infiltration tests and other technical feasiblity variables such as grade and proximity to steep slopes, social/use variables are also critical. For exmple, siting roadside GSI on streets with less-congested parking, on wider streets, in areas with patches of unnecessary paving, on residential arterials or side streets where traffic calming or Neighborhood Greenways are desired, or adjacent to neighborhood destinations will help achieve multiple benefits and foster support.

Neighborhood Destinations

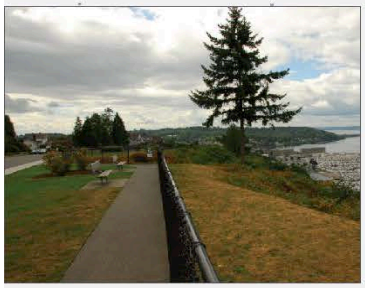
Streets with Less Parking Congestion



Extra-Wide Streets

Traffic-calming Desired

Oblique Intersections


Sunset Hill Park


Salmon Bay Park


Larsens' Corner Bakery


Loyal Heights Elementary

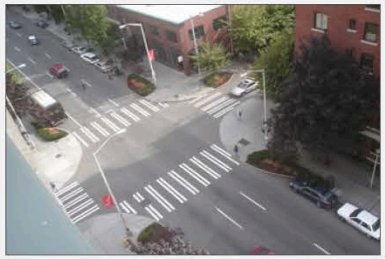

Loyal Heights Play Fields

Slide by Pam Emerson

walk. bike. ride.

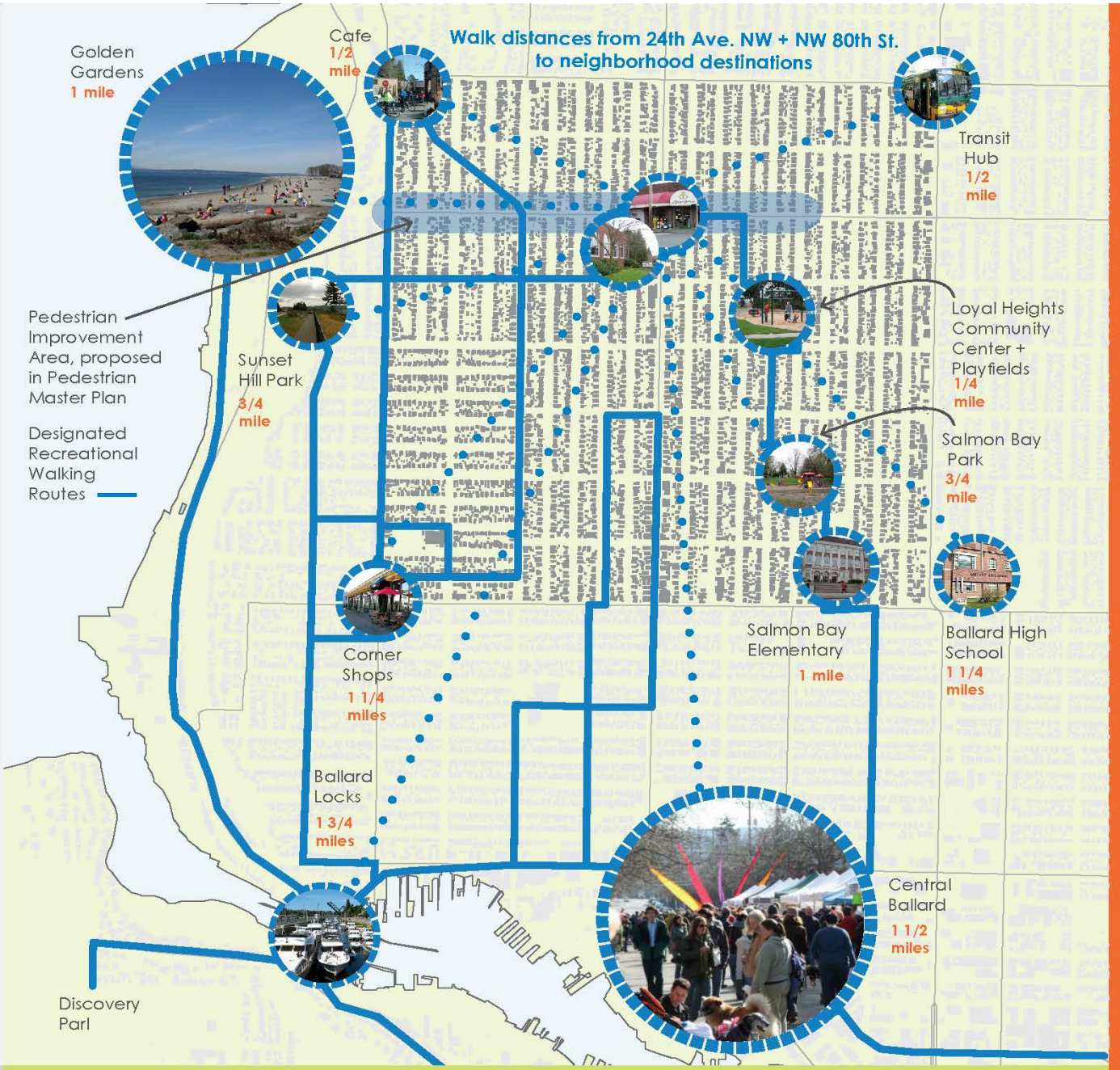
Pedestrian Master Plan Goals Conducive to GSI Overlay

Chicanes calm sidestreet traffic speeds



Curb bulbs shorten crossing distances + improve sightlines for pedestrians

Extended planting strips narrow drive lanes to provide traffic calming



walk. bike. ride.

Major Opportunities:

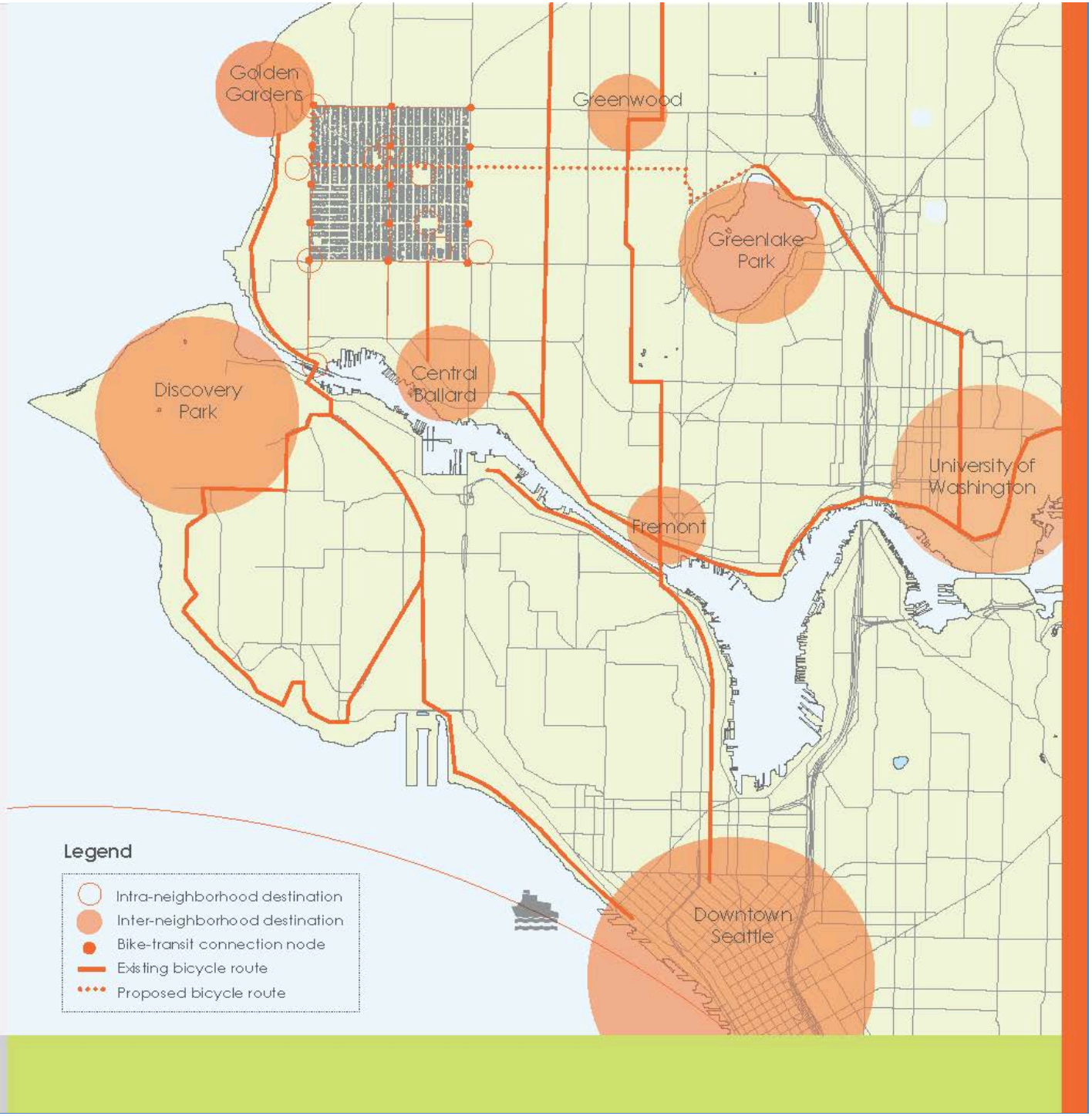
- Inter-neighborhood bicycle connections, especially E-W
- Improved Burke-Gilman Access
- Improved Ballard Bridge Crossing
- Transit Hub Facilities for bike/bus commuters along 15th Ave. NW
- Non-arterial, family-friendly bike routes, intra-neighborhood and inter-neighborhood

Neighborhood Greenway

To meet its Bicycle Master Plan targets, Seattle must invite more intra-neighborhood and inter-neighborhood family-friendly, everyday riding.

NW 77th St. has been identified in the Bicycle Master Plan as a critical East-West connector between the Ballard plateau, Greenlake and the UW. Adding bicycle-friendly features, traffic calming strategies and green stormwater infrastructure along this route would create Ballard's first Neighborhood Greenway.

Neighborhood Greenways may include design elements that reduce vehicle access and speeds, such as this pilot stratgy in NW Portland, Oregon



walk. bike. ride.

Bus Rapid Transit Planned
15th Ave. NW, 2012

RAPID RIDE

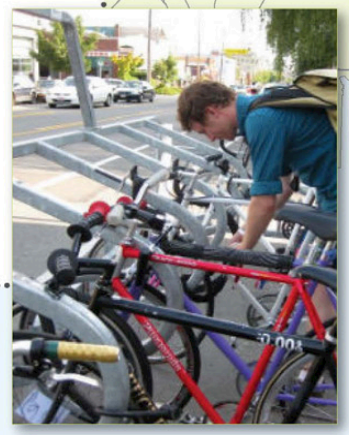
D Line

- -Buses every 10 minutes
- -Easy, fast boarding
- -Pay in advance
- -Traffic redesigns
- -Lights will favor buses
- -Sheltered, lit stations
- -Real-time bus info
- -Stop request signals
- -New, low-emission buses

LEGEND

- RapidRide - D Line
- Other Metro transit service
- Station
- Stop

King County METRO
We'll Get You There



Major Opportunity:
Bicycle Park + Ride facilities along 15th Ave. NW

Additional Opportunities for Complete Streets Integration

Near-term Transit Improvements

Improved bike-transit integration: Bike + ride facility at major Rapid Ride stations might include bike lockers or dedicated, covered, lit bicycle parking and could also incorporate attractive rain garden demonstrations and/or permeable paving.

Family-Friendly Biking

Improved major connection routes to Burke-Gilman trail. Major entry points to trail could also incorporate GSI demonstrations such as attractive, linear bio-filtration swales to cleanse stormwater (lower basin is a separated system).

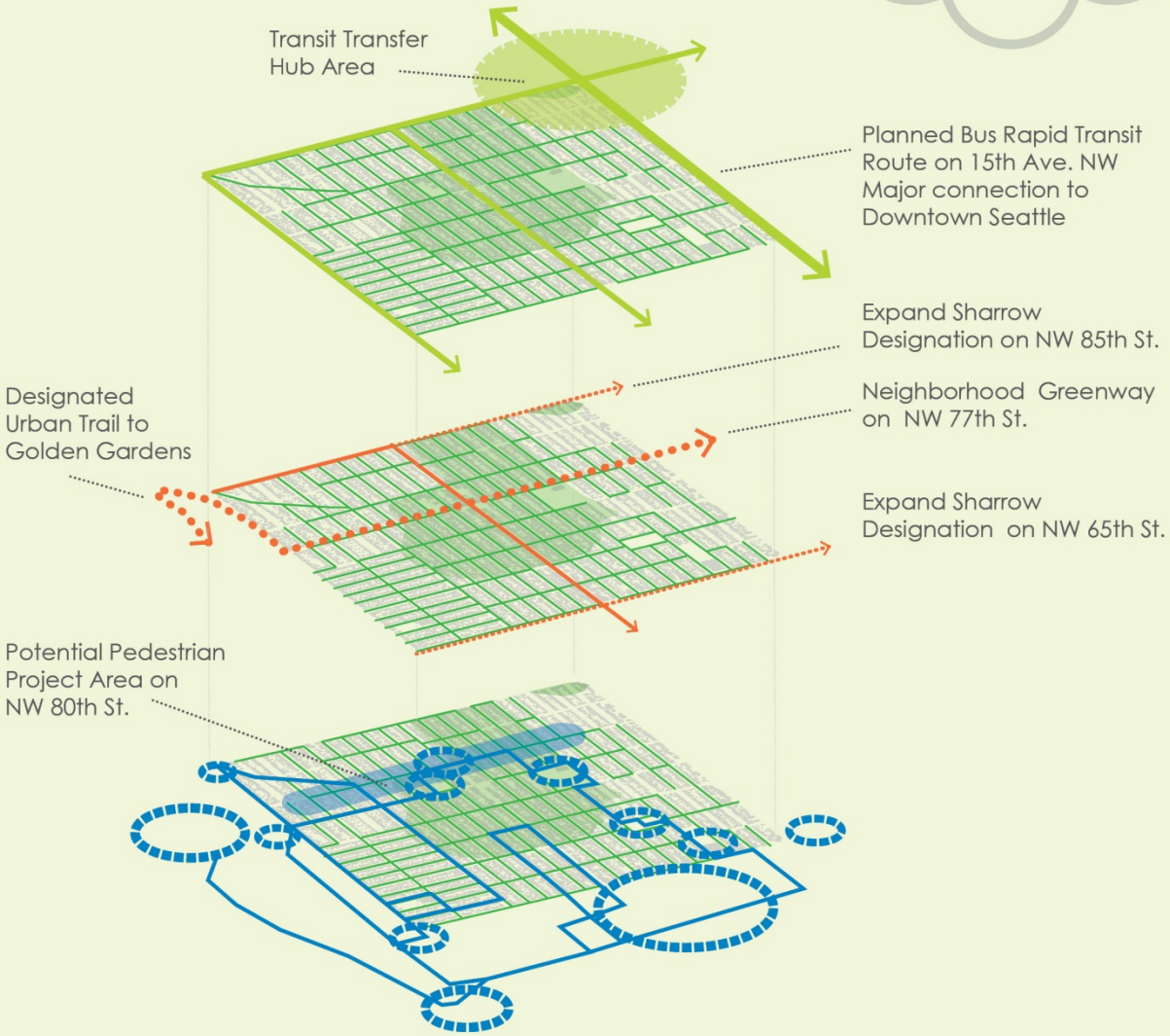
Improved major arterial crossings at NW 85th St., NW 80th St., NW65th St., 15th Ave. NW, and 24th Ave. NW could include curb bulb extensions with attractive GSI treatments.

Pedestrian Safety + Amenities

Safe Routes to School programs at Salmon Bay Elementary, Loyal Heights Elementary and Ballard HS could include GSI demonstration sites at or adjacent to each learning institution and/or along walking routes. Pedestrian counts could help identify most heavily-traveled routes. Similar approach could be taken with neighborhood churches and senior housing facilities.

walk. bike. ride.

Summary of Existing Aspirations within the Ballard CSO Basins



Bulb Extension 60' ROW

- 6" ponding
- 3:1 side slopes
- 1.5' flat buffer at sidewalk
- 190 square foot bottom area
- 38' linear feet, including including side slopes

6 additional linear feet would allow for 20' curb to curb

Stormwater/CSO Considerations

- Mitigates whole block to 95% GSI standard

Walk. Bike. Ride. Considerations

- Shortens ped. crossing by 7'
- Narrows street/traffic calming
- Improves aesthetic quality and safety of streetscape for pedestrians and bike riders along proposed Neighborhood Greenway route
- Extends existing no-parking zone at intersection by an additional 10', improving sightlines
- In total, 40' no parking zone
- Enhances a Safe Routes to School route and a designated recreational walking route

Other Considerations

- Provides "outdoor classroom" opportunity for adjacent elementary school
- Existing code prohibits parking within 30' of intersection

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Achieving Multiple Benefits- Integrating with Transportation

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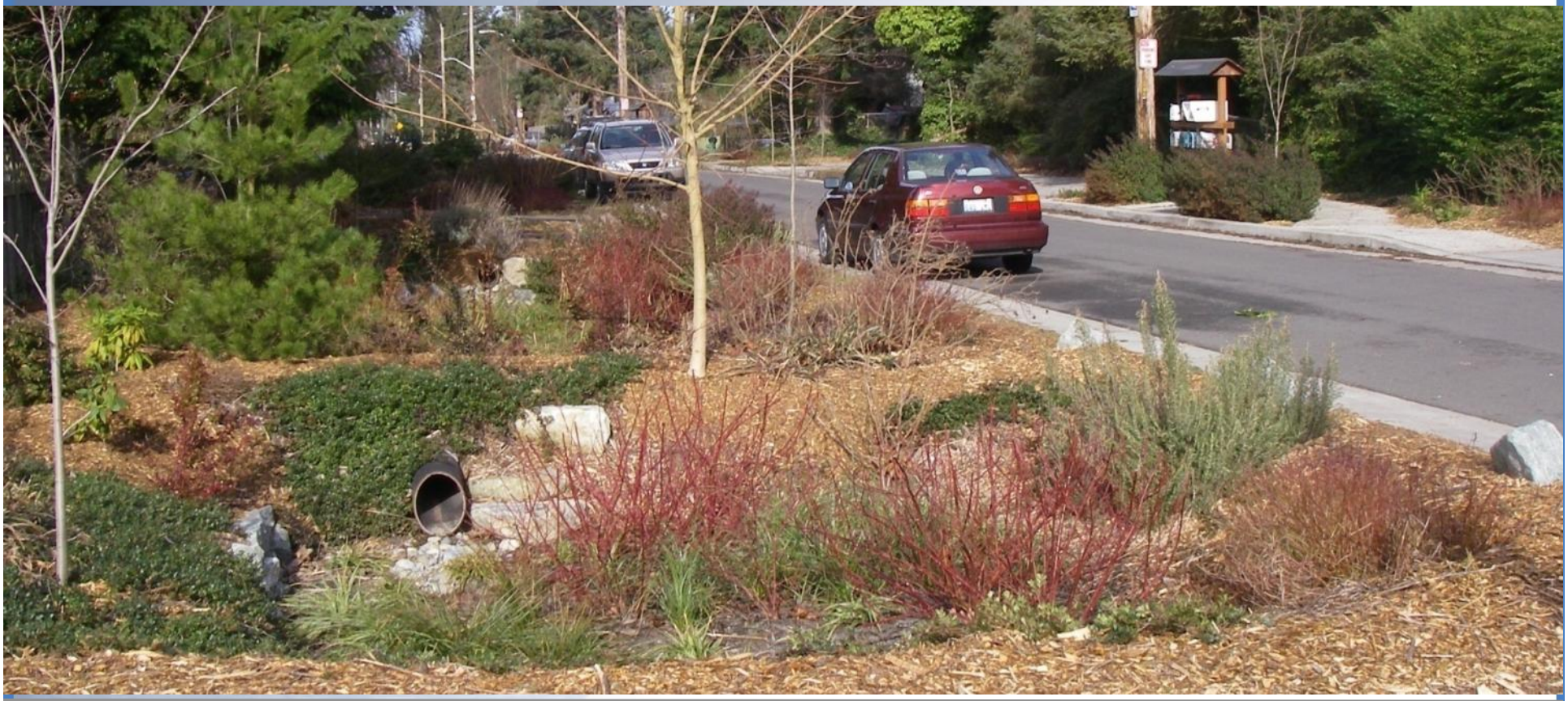
GSI Senior Planner
Seattle.gov/util/greeninfrastructure



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Stormwater Code Revision Project
Flow Control Standards

Four flow control performance standards

- Wetland Protection Standard

  Protect functions and values

- Pre-developed Forest Standard

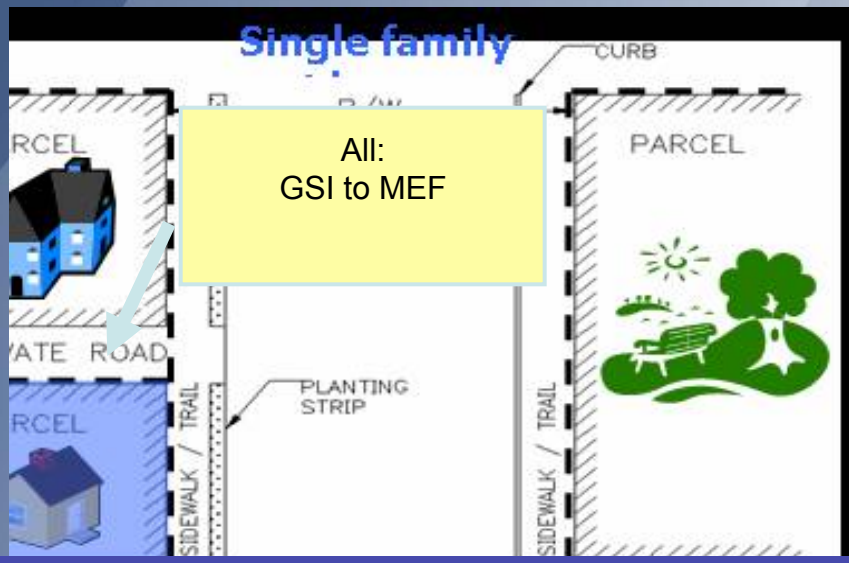
  Listed creeks

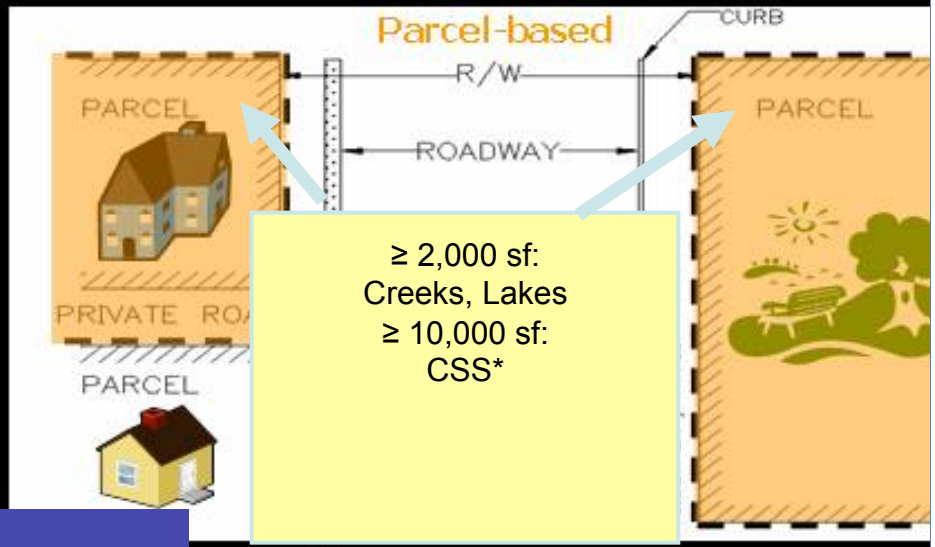
- Pre-developed Pasture Standard

  All other creeks

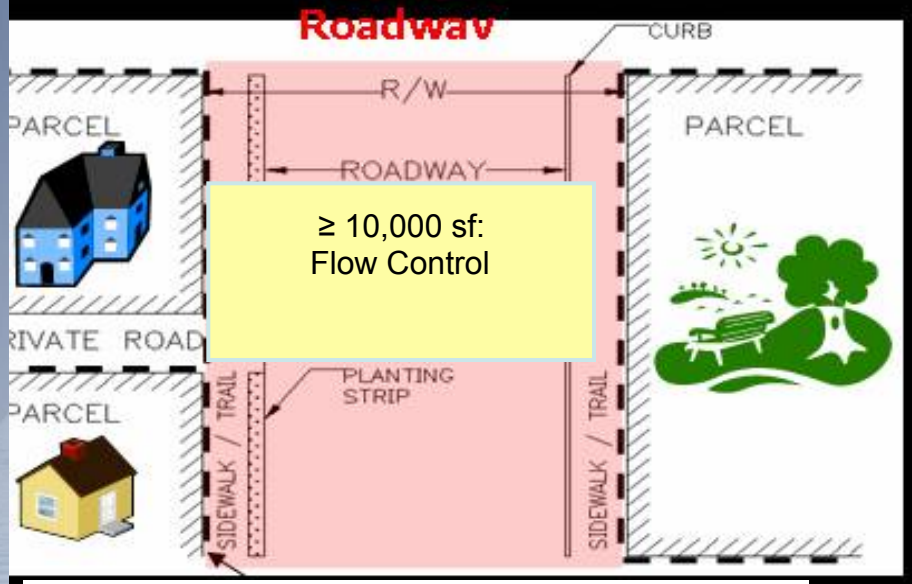
- Peak Flow Control Standard

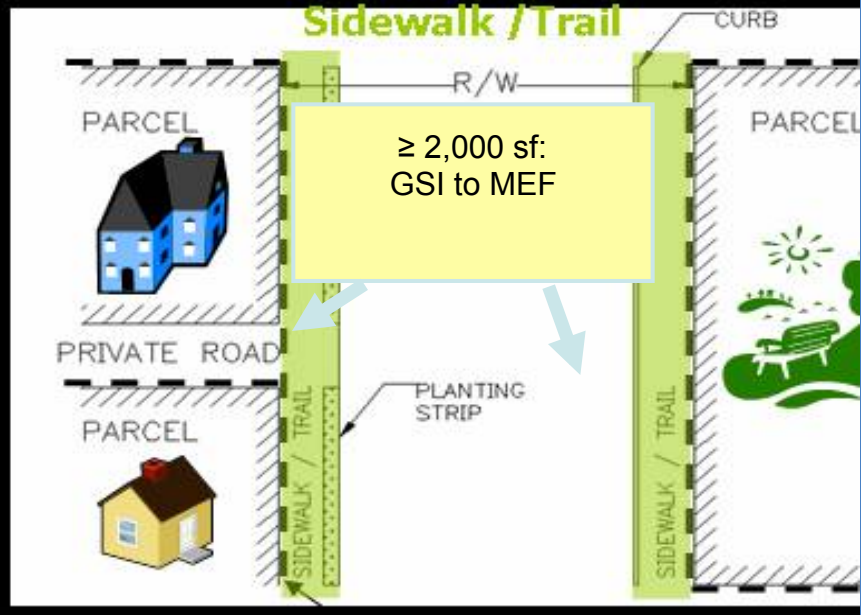
  Public combined sewer, Capacity-constrained systems , Small Lake Basins





Minimum Requirements for Flow Control



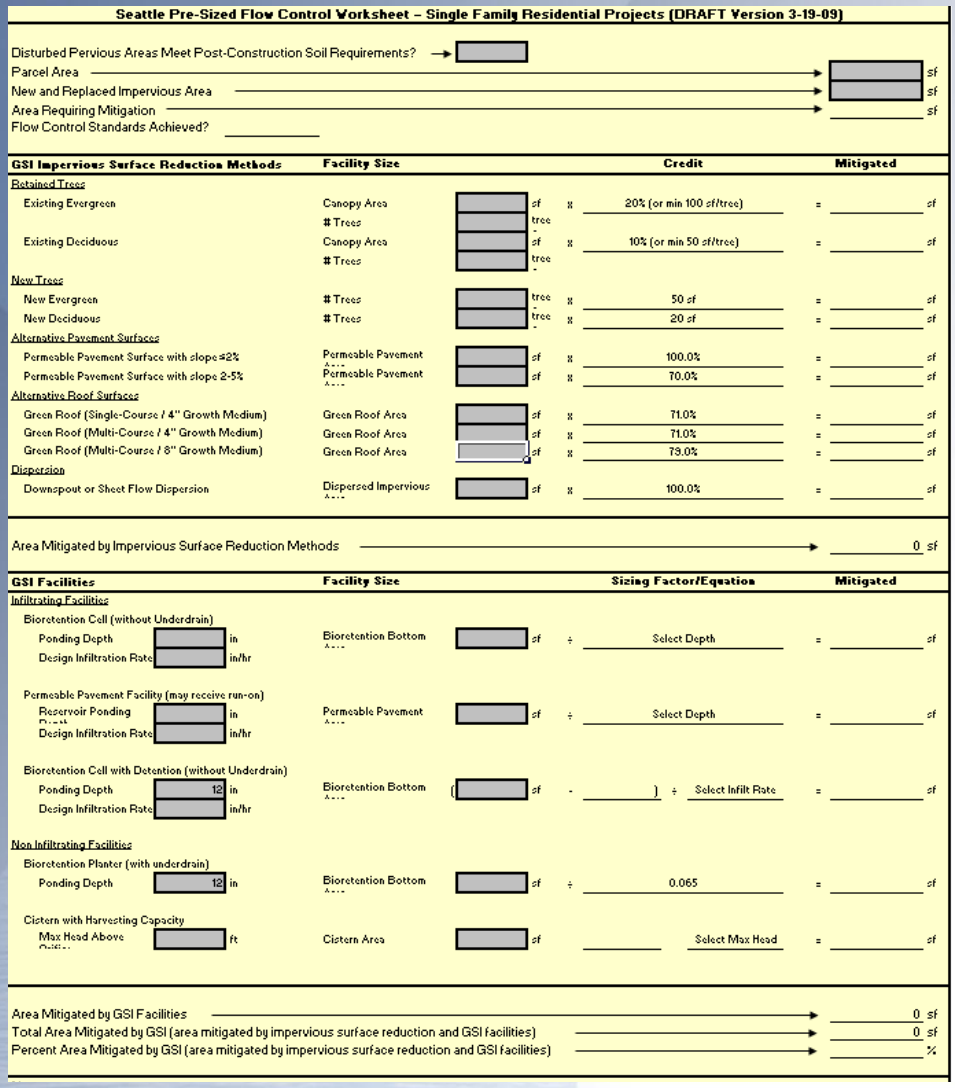


* = Combined Sewer System

Maximum Extent Feasible

"the requirement is to be fully implemented, constrained only by the physical limitations of the site, practical considerations of engineering design, and reasonable considerations of financial costs and environmental impacts."

GSI to MEF Target



Seattle Pre-Sized Flow Control Worksheet – Single Family Residential Projects (DRAFT Version 3-19-09)

Disturbed Pervious Areas Meet Post-Construction Soil Requirements? →
Parcel Area → sf
New and Replaced Impervious Area → sf
Area Requiring Mitigation → sf
Flow Control Standards Achieved?

GSI Impervious Surface Reduction Methods	Facility Size			Credit	Mitigated
Retained Trees					
Existing Evergreen	Canopy Area	sf	x	20% (or min 100 sf/tree)	= sf
	# Trees	tree			
Existing Deciduous	Canopy Area	sf	x	10% (or min 50 sf/tree)	= sf
	# Trees	tree			
New Trees					
New Evergreen	# Trees	tree	x	50 sf	= sf
New Deciduous	# Trees	tree	x	20 sf	= sf
Alternative Pavement Surfaces					
Permeable Pavement Surface with slope ≤2%	Permeable Pavement Area	sf	x	100.0%	= sf
Permeable Pavement Surface with slope 2-5%	Permeable Pavement Area	sf	x	70.0%	= sf
Alternative Roof Surfaces					
Green Roof (Single-Course / 4" Growth Medium)	Green Roof Area	sf	x	71.0%	= sf
Green Roof (Multi-Course / 4" Growth Medium)	Green Roof Area	sf	x	71.0%	= sf
Green Roof (Multi-Course / 8" Growth Medium)	Green Roof Area	sf	x	73.0%	= sf
Dispersion					
Downspout or Sheet Flow Dispersion	Dispersed Impervious Area	sf	x	100.0%	= sf

Area Mitigated by Impervious Surface Reduction Methods → 0 sf

GSI Facilities	Facility Size			Sizing Factor/Equation	Mitigated
Infiltrating Facilities					
Bioretention Cell (without Underdrain)					
Ponding Depth	in	Bioretention Bottom Area	sf	÷ Select Depth	= sf
Design Infiltration Rate	in/hr				
Permeable Pavement Facility (may receive run-on)					
Reservoir Ponding Depth	in	Permeable Pavement Area	sf	÷ Select Depth	= sf
Design Infiltration Rate	in/hr				
Bioretention Cell with Detention (without Underdrain)					
Ponding Depth	12 in	Bioretention Bottom Area	(sf	-) ÷ Select Infilt Rate	= sf
Design Infiltration Rate	in/hr				
Non Infiltrating Facilities					
Bioretention Planter (with underdrain)					
Ponding Depth	12 in	Bioretention Bottom Area	sf	÷ 0.065	= sf
Cistern with Harvesting Capacity					
Max Head Above Orifice	ft	Cistern Area	sf	Select Max Head	= sf

Area Mitigated by GSI Facilities → 0 sf
Total Area Mitigated by GSI (area mitigated by impervious surface reduction and GSI facilities) → 0 sf
Percent Area Mitigated by GSI (area mitigated by impervious surface reduction and GSI facilities) → %

- Single Family Residential – all but 1500 SF new plus replaced impervious surface
- Other – 100% new plus replaced impervious surface
- Incentive – sites with performance standard if achieve 75% control with GSI, done

Feasibility: Practical Considerations of Engineering Design

- Specify: Minimum Requirements– "may be feasible" (Stormwater Manual)
- Specify: Technical Limitations – "not feasible" (Stormwater Manual)
- Eg. Infiltration facilities – steep slopes, contaminated soils, etc
- Specify: Sizing requirments

All information compiled into "GSI to MEF Directors Rule"

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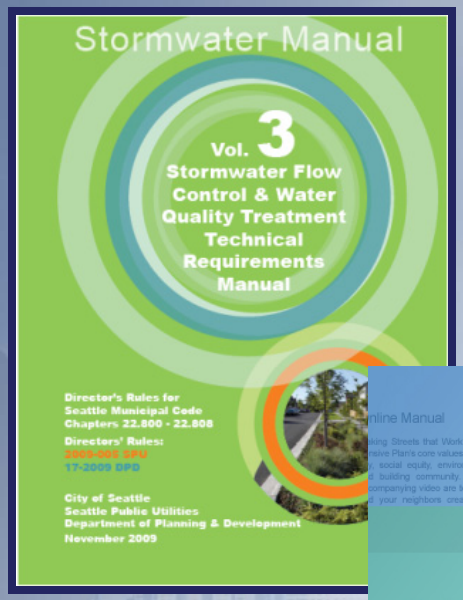
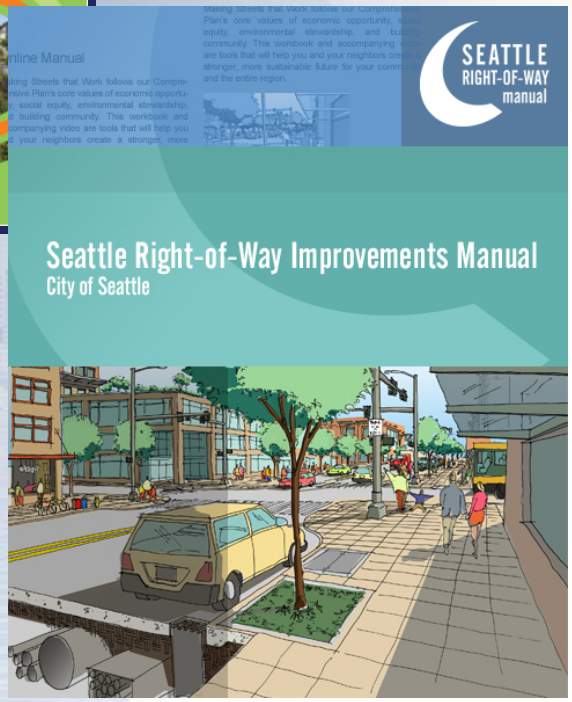
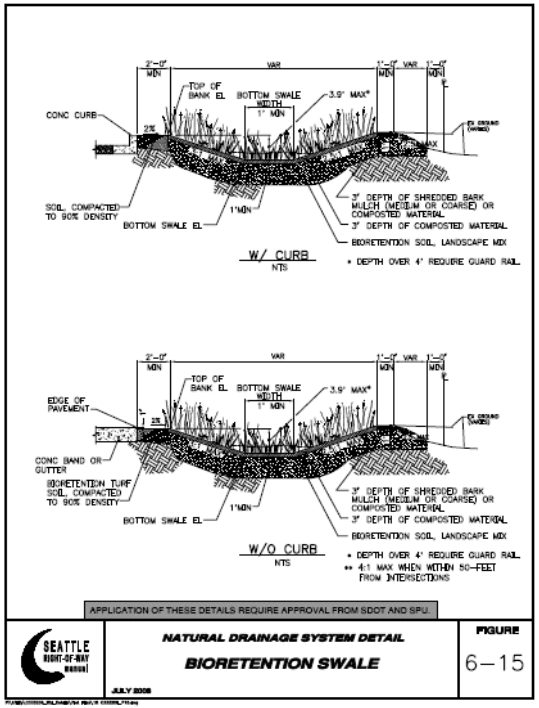
Feasibility: Physical Limitations of the Site





- Reflects the multiple demands on public space: historical designation, vehicular and pedestrian access, intended use of the right-of-way, urban design elements, etc



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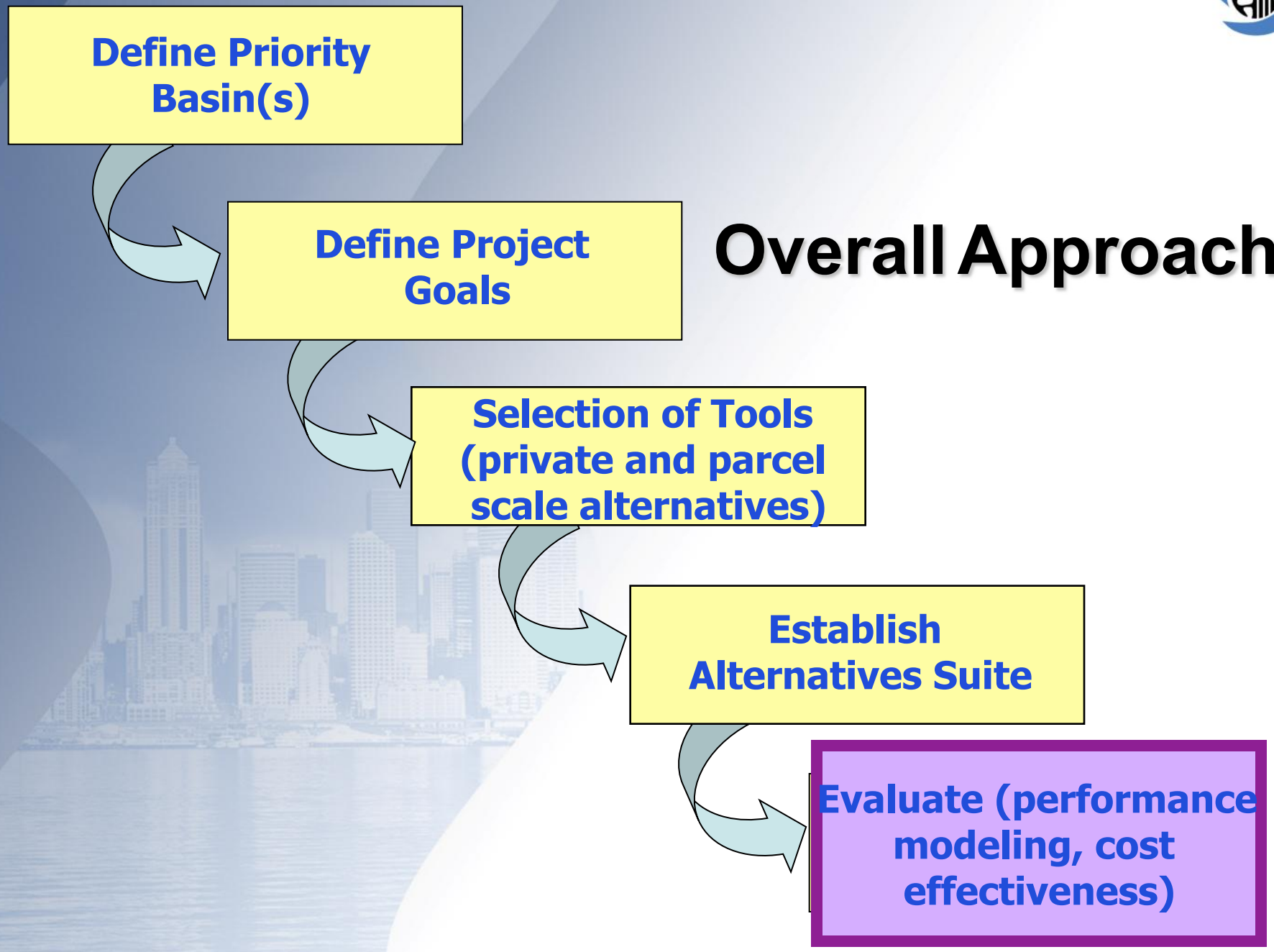
CSO Control Approaches

CSO Control	Cost Range per Gallon
1. System Retrofits	$1 to $2
2. Green Stormwater Infrastructure	$3 to $22
3. Infiltration/Inflow	$30 to $32
4. Flow Transfer	Site Specific
5. Wet Weather Storage	$12 to $40
6. Wet Weather Treatment	$8 to $25

Overall Approach



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The Beginning of GI in Seattle: SEA Street Project

- Achieved 99% reduction in runoff
- Treated local runoff only
- Added formal drainage system and sidewalk

Pre-project

2001

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SEA Street Project

Pre-project

Post construction 2001

Ten years later

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Green Stormwater Infrastructure Projects

12 years of Building GSI Experience and Knowledge

Project	Project Drainage Area
SEA Street #1	2 acres
NW 110th Cascade	28 acres
Broadview Green Grid	32 acres
Pinehurst Green Grid	49 acres
High Point	129 acres
	240- acres

SEA Street #1, Seattle