Seattle Green Factor: Cascading Benefits for Green Factor and Drainage Code Compliance

Drew Gangnes, P.E.

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Summary

- Buildings that use their landscaping as stormwater management (in lieu of conventional tanks)

or…

- If you've gotta do SGF, get the most out of it.

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Overview

- **Introduction**
  - Why Urban Greening and Civil Engineering?
- **Seattle Green Factor**
- **LEED Site Credits**
- **Natural-Systems Drainage Design**
- **Case Studies**
- **Evolutions**

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Architecturally Focused Civil Engineering

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Project Checklist

Sustainable Sites — 14 Possible Points

Y	Prereq 1	**Erosion & Sedimentation Control**	Required
	Credit 1	**Site Selection**	1
	Credit 2	**Urban Redevelopment**	1
	Credit 3	**Brownfield Redevelopment**	1
	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
	Credit 4.3	**Alternative Transportation**, Alternative Fuel Refueling Stations	1
	Credit 4.4	**Alternative Transportation**, Parking Capacity	1
	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
	Credit 6.1	**Stormwater Management**, Rate or Quantity	1
	Credit 6.2	**Stormwater Management**, Treatment	1
	Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, NonRoof	1
	Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
	Credit 8	**Light Pollution Reduction**	1

Water Efficiency — 5 Possible Points

	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
	Credit 2	**Innovative Wastewater Technologies**	1
	Credit 3.1	**Water Use Reduction**, 20% Reduction	1
	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Energy & Atmosphere — 17 Possible Points

Y	Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y	Prereq 2	**Minimum Energy Performance**	Required
Y	Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
	Credit 1.1	**Optimize Energy Performance**, 20% New / 10% Existing	2
	Credit 1.2	**Optimize Energy Performance**, 30% New / 20% Existing	2
	Credit 1.3	**Optimize Energy Performance**, 40% New / 30% Existing	2
	Credit 1.4	**Optimize Energy Performance**, 50% New / 40% Existing	2
	Credit 1.5	**Optimize Energy Performance**, 60% New / 50% Existing	2
	Credit 2.1	**Renewable Energy**, 5%	1
	Credit 2.2	**Renewable Energy**, 10%	1
	Credit 2.3	**Renewable Energy**, 20%	1
	Credit 3	**Additional Commissioning**	1
	Credit 4	**Ozone Depletion**	1
	Credit 5	**Measurement & Verification**	1
	Credit 6	**Green Power**	1

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Materials & Resources — 13 Possible Points

Y	Prereq 1	**Storage & Collection of Recyclables**	Required
	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
	Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1
	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
	Credit 2.1	**Construction Waste Management**, Divert 50%	1
	Credit 2.2	**Construction Waste Management**, Divert 75%	1
	Credit 3.1	**Resource Reuse**, Specify 5%	1
	Credit 3.2	**Resource Reuse**, Specify 10%	1
	Credit 4.1	**Recycled Content**, Specify 25%	1
	Credit 4.2	**Recycled Content**, Specify 50%	1
	Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
	Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
	Credit 6	**Rapidly Renewable Materials**	1
	Credit 7	**Certified Wood**	1

Indoor Environmental Quality — 15 Possible Points

Y	Prereq 1	**Minimum IAQ Performance**	Required
Y	Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
	Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1
	Credit 2	**Increase Ventilation Effectiveness**	1
	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
	Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
	Credit 4.2	**Low-Emitting Materials**, Paints	1
	Credit 4.3	**Low-Emitting Materials**, Carpet	1
	Credit 4.4	**Low-Emitting Materials**, Composite Wood	1
	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
	Credit 6.1	**Controllability of Systems**, Perimeter	1
	Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
	Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
	Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

Innovation & Design Process — 5 Possible Points

	Credit 1.1	**Innovation in Design**: Specific Title	1
	Credit 1.2	**Innovation in Design**: Specific Title	1
	Credit 1.3	**Innovation in Design**: Specific Title	1
	Credit 1.4	**Innovation in Design**: Specific Title	1
	Credit 2	**LEED™ Accredited Professional**	1

Project Totals — 69 Possible Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points


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PLANT PALETTE

BROAD-LEAVED TREES

ACER CIRCINATUM / VINE MAPLE

ACER MACROPHYLLUM / BIG-LEAF MAPLE

BETULA PAPYRIFERA / PAPER BIRCH

CORNUS NUTTALLII / PACIFIC DOGWOOD

CORYLUS CORNUTA / HAZEL

FRAXINUS LATIFOLIA / OREGON ASH

QUERCUS GARRYANA / GARRY OAK

RHAMNUS PURSHIANA / CASCARA

SORBUS SITCHENSIS / SITKA MOUNTAIN ASH

CONIFEROUS TREES

ABIES GRANDIS / GRAND FIR

PSEUDOTSUGA MENZIESII / DOUGLAS FIR

THUJA PLICATA / WESTERN RED CEDAR

TSUGA HETEROPHYLLA / WESTERN HEMLOCK

EVERGREEN SHRUBS

GAULTHERIA SHALLON / SALAL

LINNAEA BOREALIS / TWINFLOWER

MAHONIA AQUIFOLIUM / TALL OREGON GRAPE

MAHONIA NERVOSA / COMPACT OREGON GRAPE

RHODODENDRON MACROPHYLLUM / PACIFIC RHODODENDRON

RHODODENDRON SPP. / SPECIMEN RHODODENDRON

DECIDUOUS SHRUBS

AMELANCHIER ALNIFOLIA / SERVICEBERRY

HOLODISCUS DISCOLOR / OCEANSPRAY

OEMLERIA CERASIFORMIS / INDIAN PLUM

PHYSOCARPUS CAPITATUS / NINEBARK

RIBES SANGUINEUM / FLOWERING CURRANT

ROSA RUGOSA / NOOTKA ROSE

ROSA GYMNOCARPA / BALD HIP ROSE

SYMPHORICARPOS ALBUS / SNOWBERRY

GROUNDCOVERS

ACHLYS TRIPHYLLA / VANILLA LEAF

ARCTOSTAPHYLOS UVA-URSI / KINNIKINNICK

ASARUM CAUDATUM / WILD GINGER

FRAGARIA VESCA VAR. CRINITA / WOOD STRAWBERRY

CLIMBING VINE

LONICERA CILIOSA / WESTERN TRUMPET HONEYSUCKLE

SEED MIXES

NATIVE UPLAND WILDFLOWER MIX

NATIVE BIOFILTRATION MIX

LANDSCAPE NOTES

1. PLANTS AROUND BUILDING TO BE IRRIGATED WITH DRIP IRRIGATION SYSTEM USING RECLAIMED WATER.
2. PLANTS IN PARKING LOTS AND BUFFERS TO BE HAND-WATERED FOR FIRST TWO GROWING SEASONS.

1 LANDSCAPE PLAN


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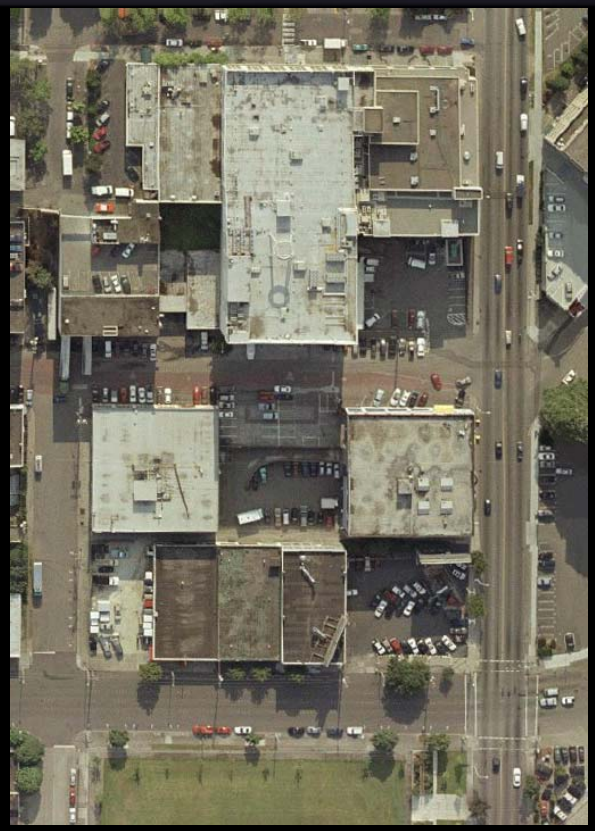
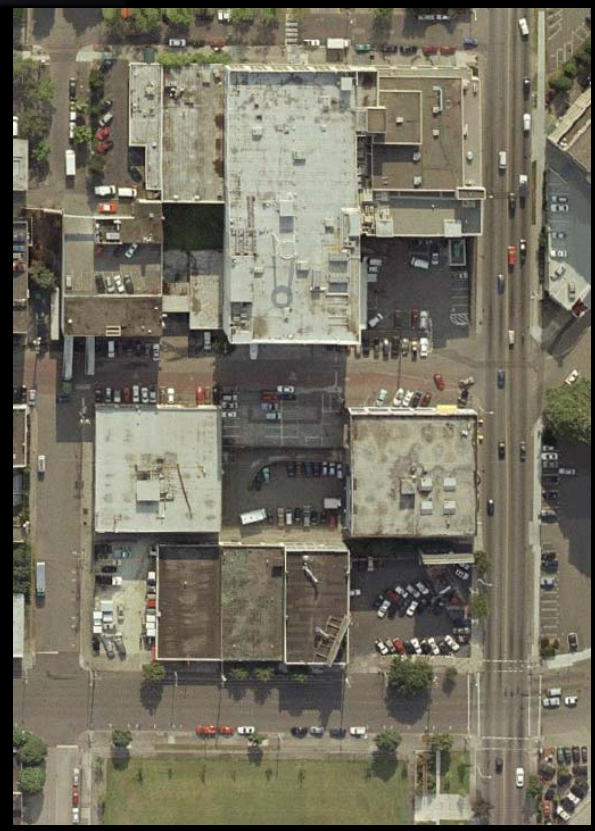
Common Approach to Urban Development

Pre-Settlement Conditions



Historical Urban Development



Common Redevelopment

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"Right building…wrong site…wrong building"

or

"LEED Platinum with no site credits?"

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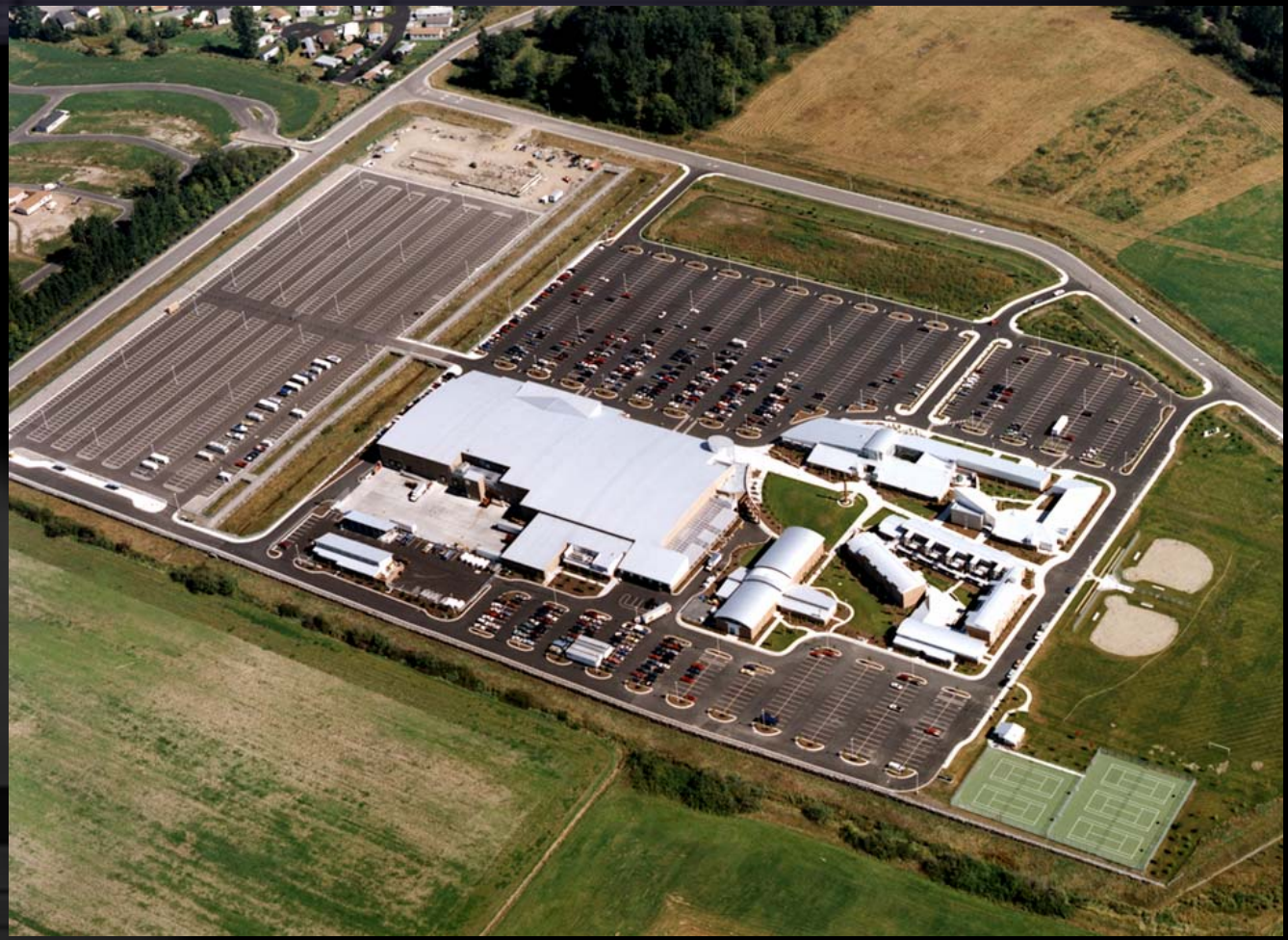
A Joint Obligation



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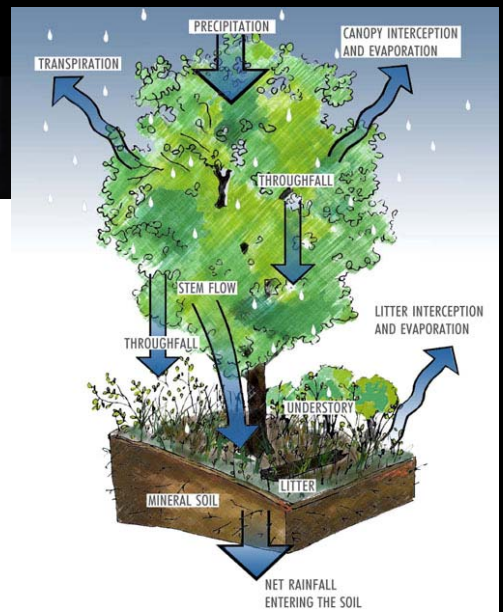
Urban Green



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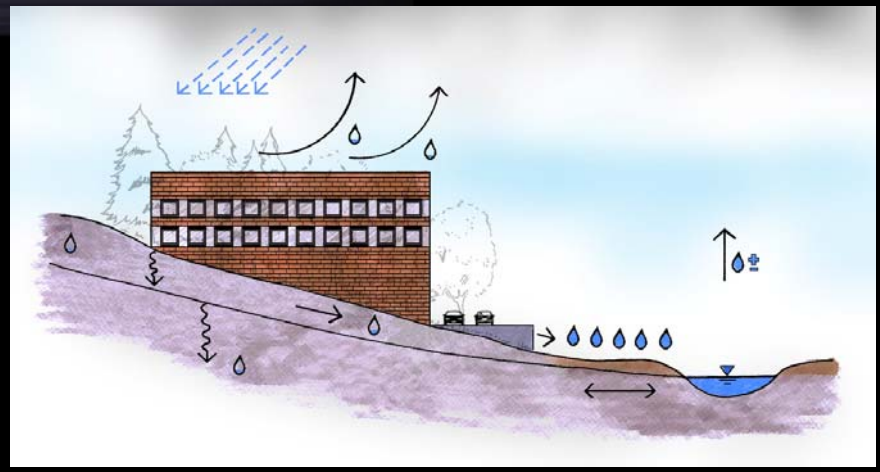
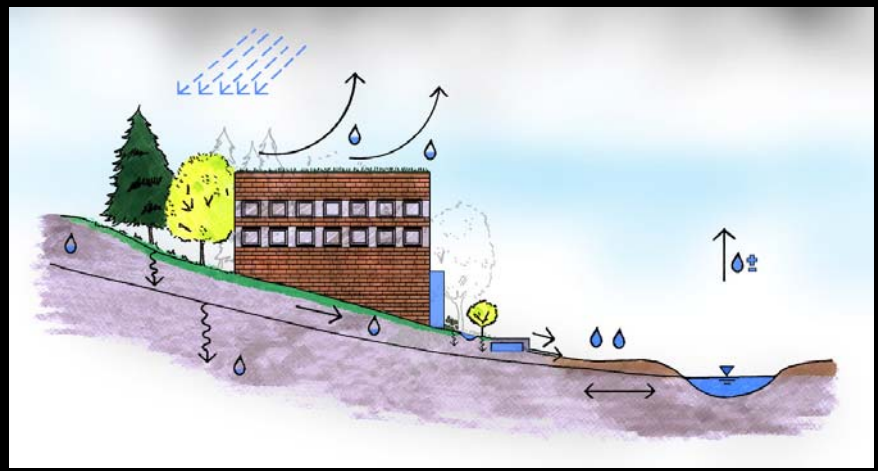
Site Hydrology and Urban Development

Pre-Settlement Conditions



Historical Urban Development



Urban Green

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Combined Sewer Journey

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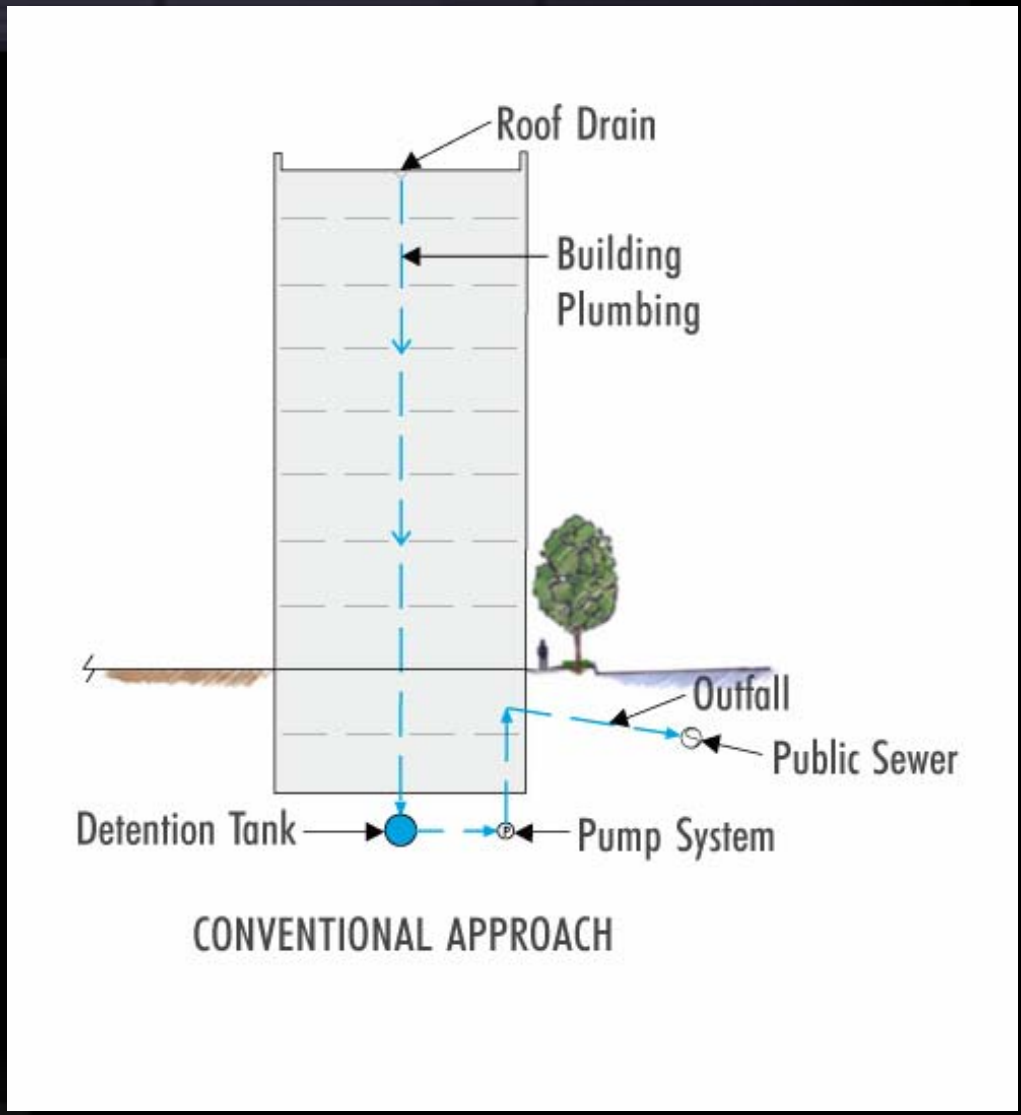
Stormwater Management 101



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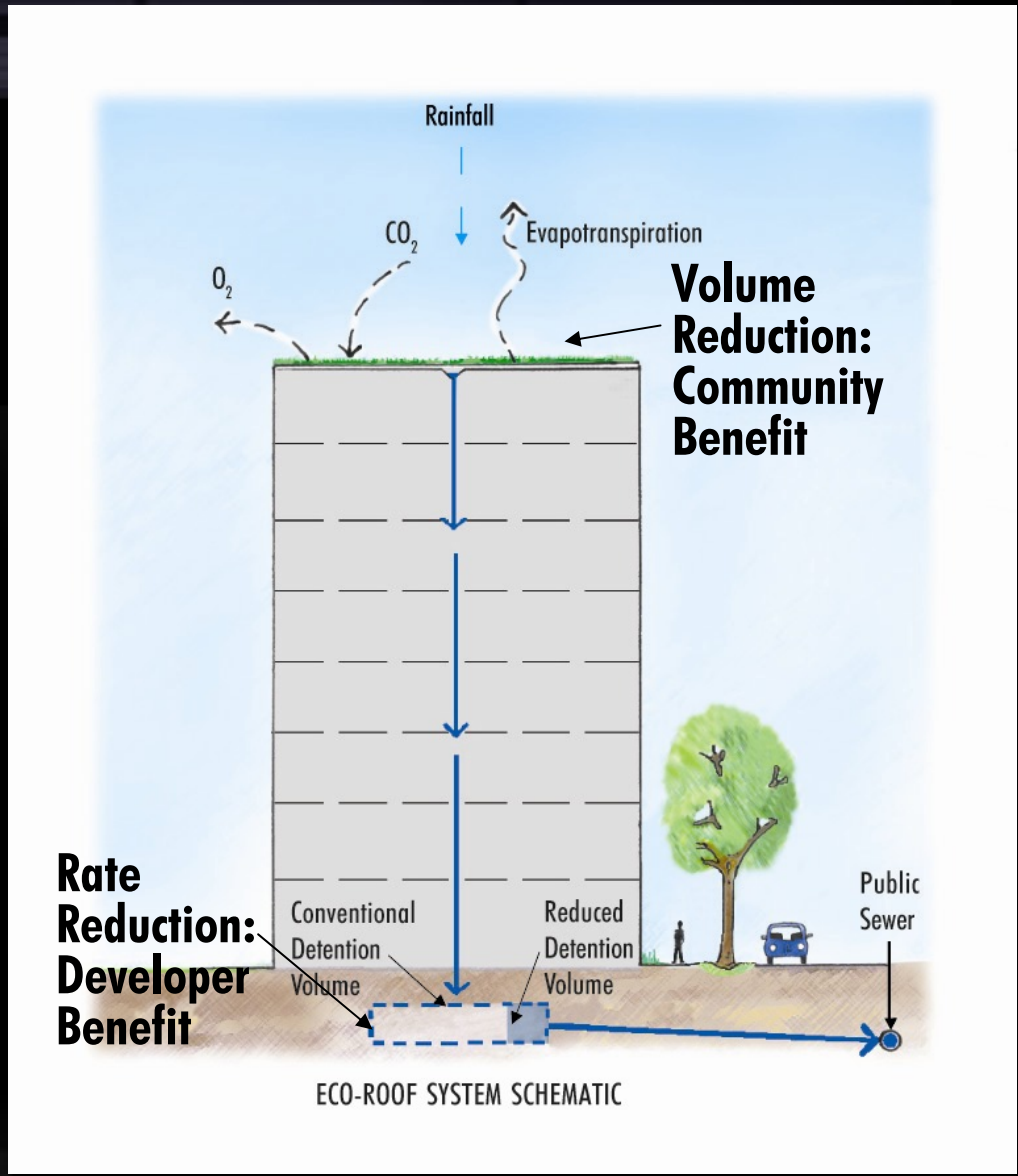
Green Roof Stormwater Benefits



Other:

- Temperature
- Water Quality

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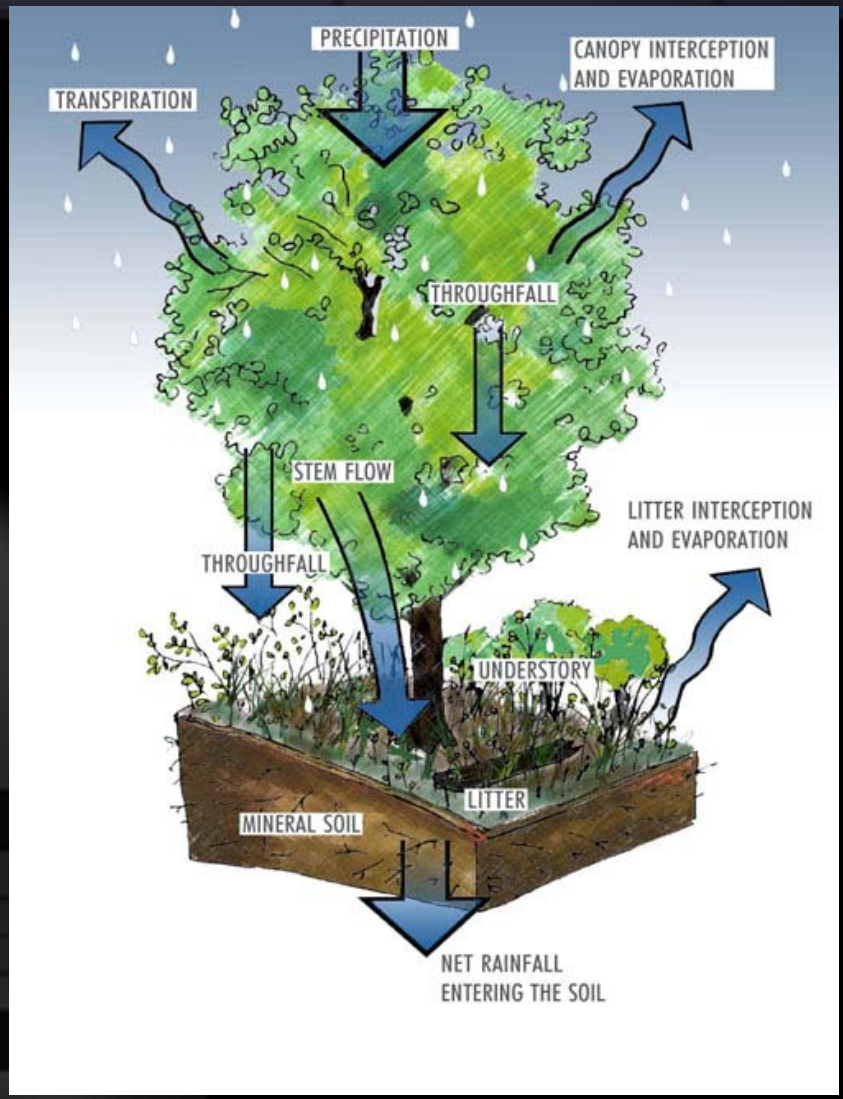
Leveraging "Mother Nature" Management



- Greenery
- Soil
- The Elements

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Forget the Property Lines

- 60% Private/40% Public
- Sidewalks = 30% increase

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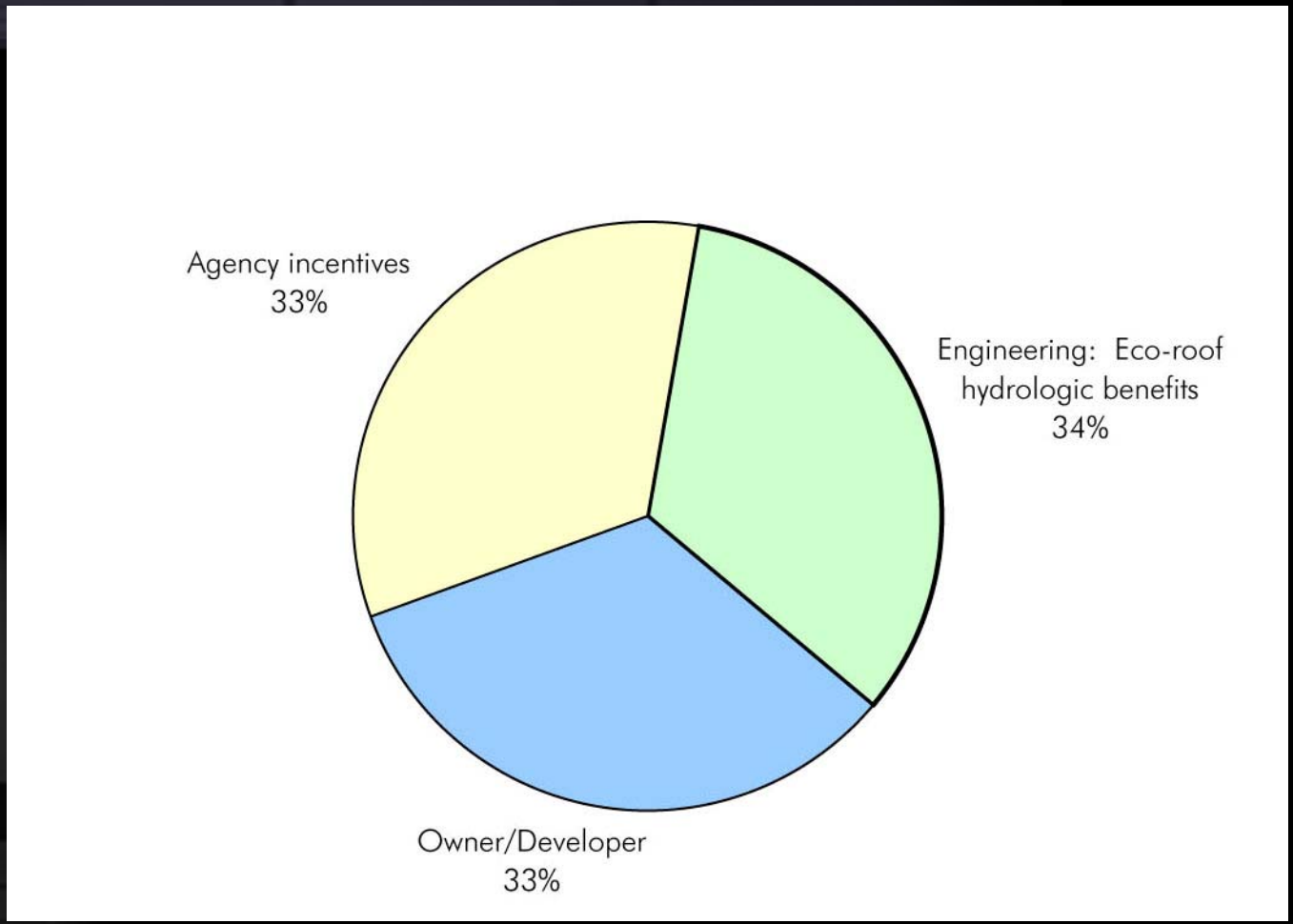
Urban Greening Funding Sources



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Berlin Green Roofs and More

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“Tango” Project in Malmo, Sweden

“Green Space Factor” = 0.50

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Seattle Green Factor

Berlin Biotope Area Factor

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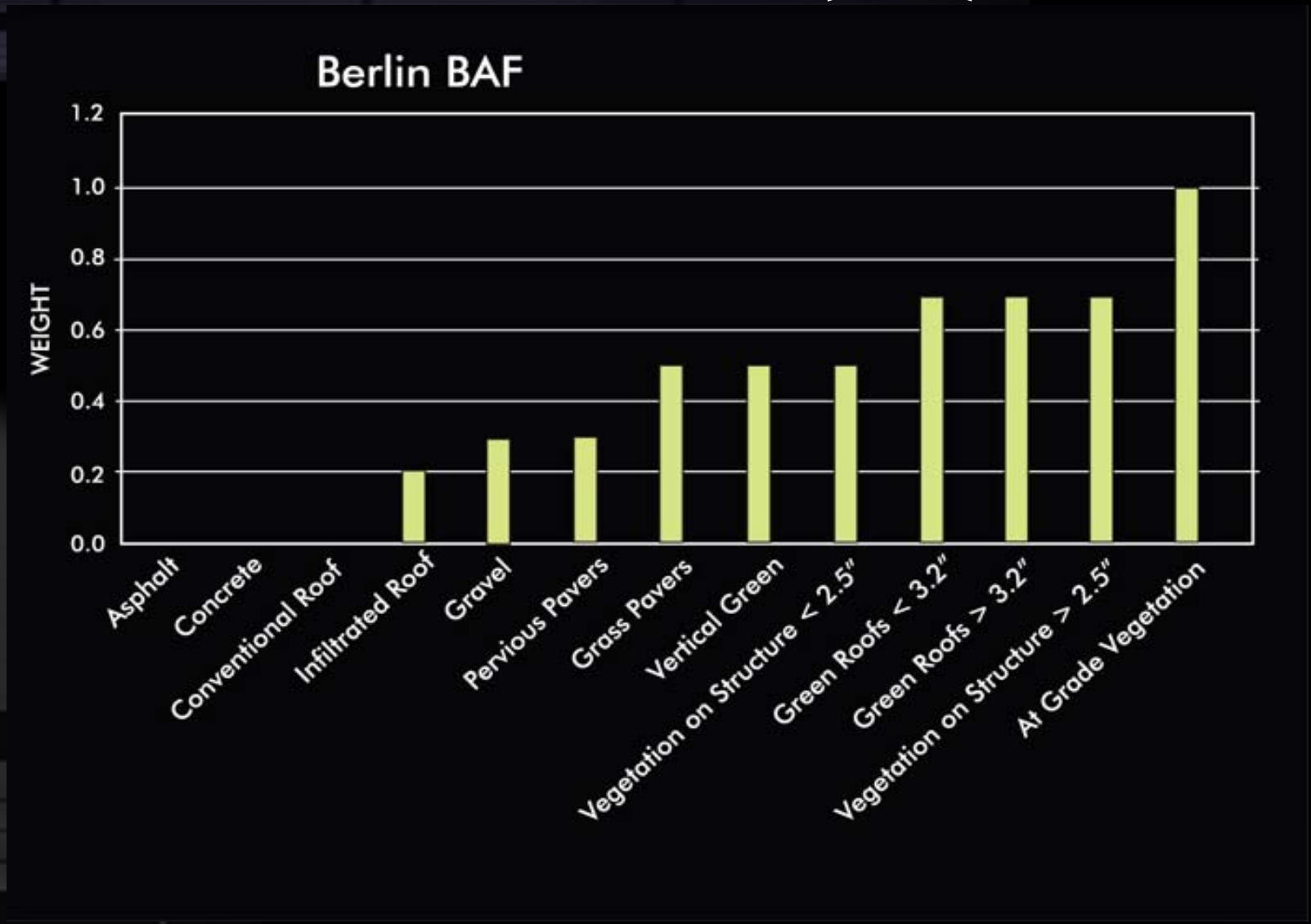
Berlin Biotope Area Factor (BAF)



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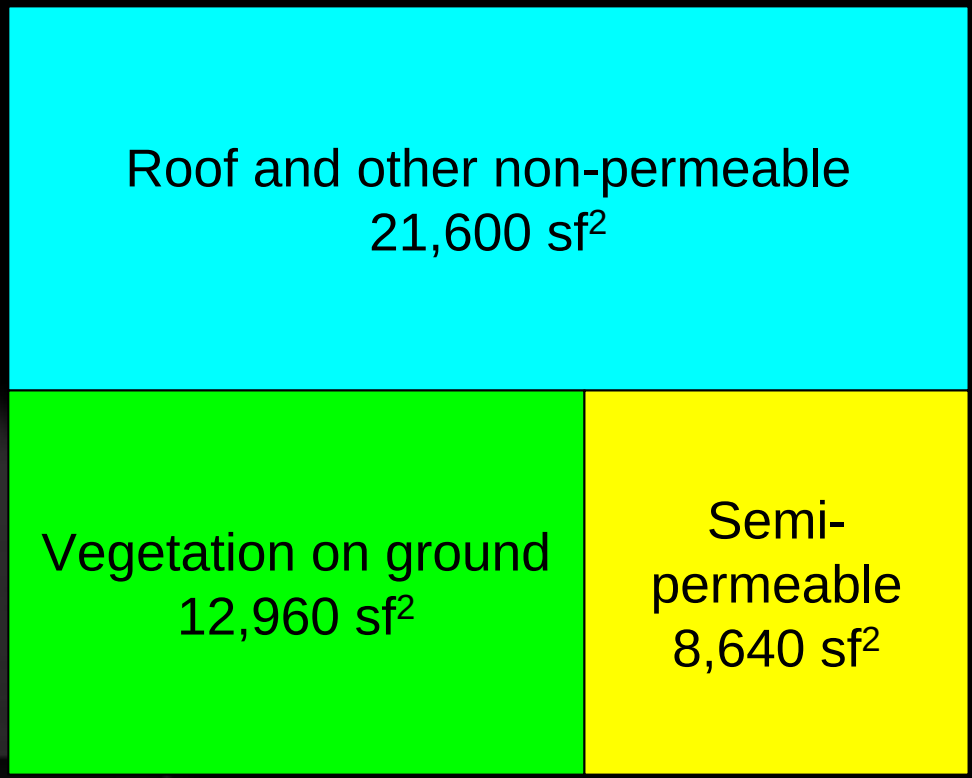
Example BAF Calculation

Sample Project - Total Site Area 43,200 sf^2



Weighting Factors

- Roof, non-permeable: 0
- Vegetation on ground: 1
- Semi-permeable: 0.5

- BAF= (21,600x0 + 12,960x1+ 8640x0.5)/43,200 = 0.40
- Compare to Minimum Target Level (e.g. 0.50)

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Theoretical BAF Result

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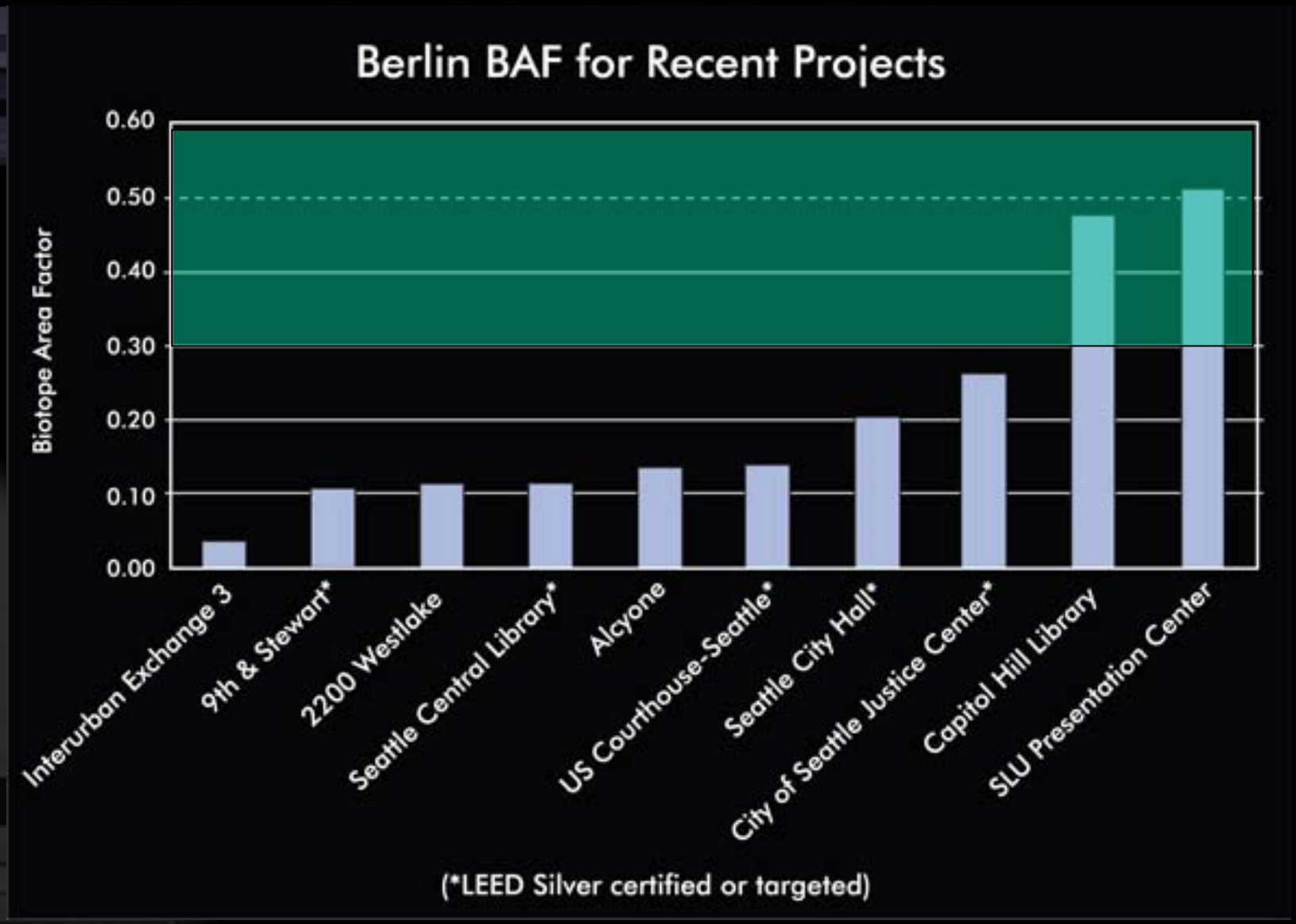

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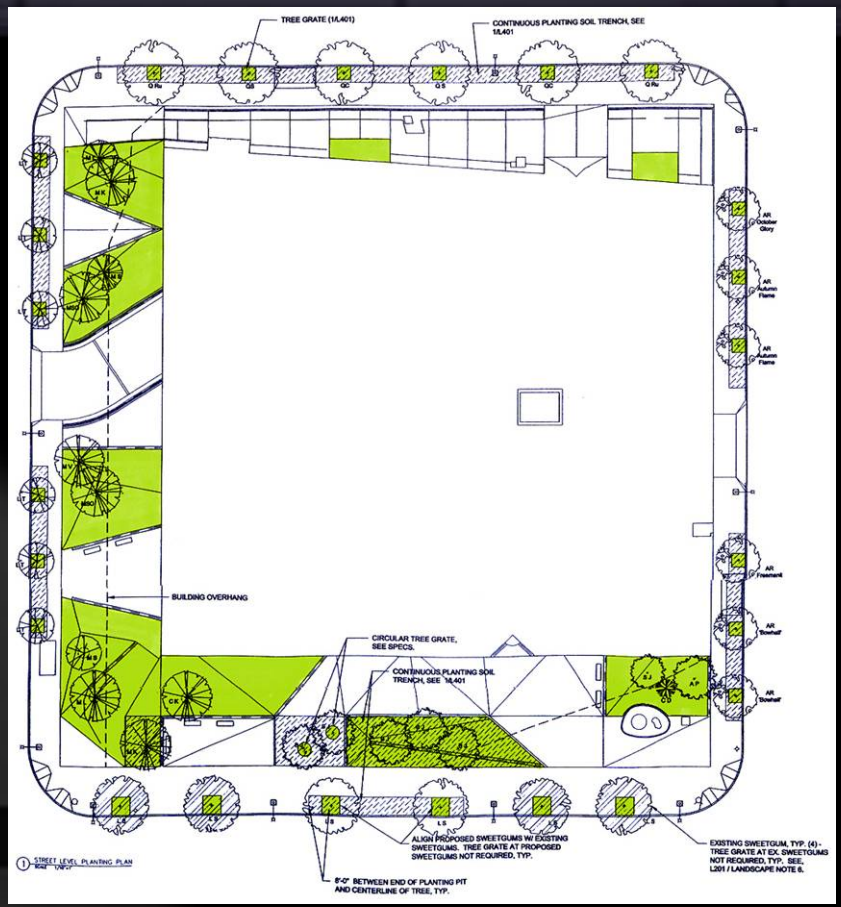
Example Audit – Seattle Central Library



BAF = 0.12

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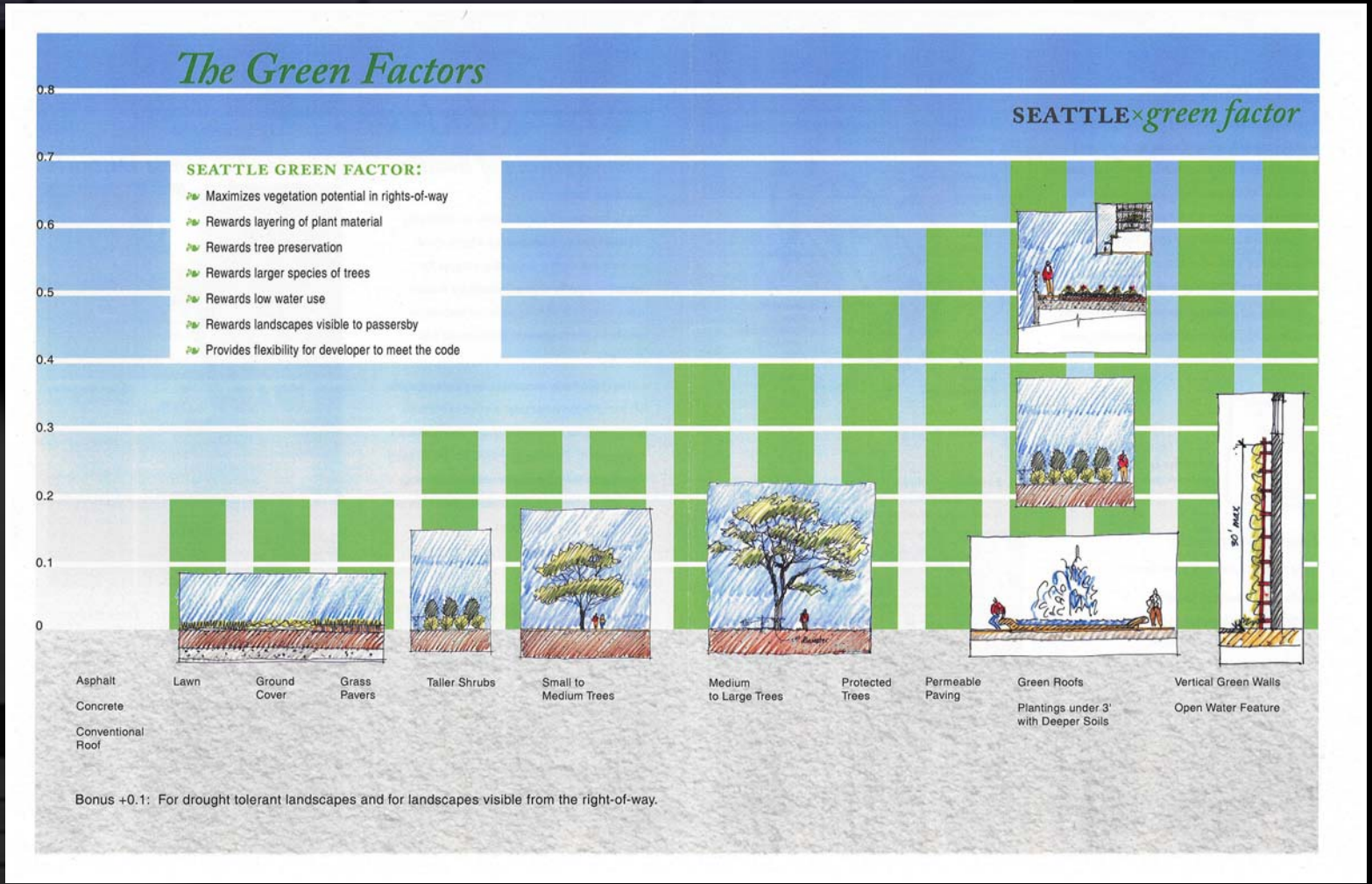
Seattle Green Factor – A Landscaping Requirement



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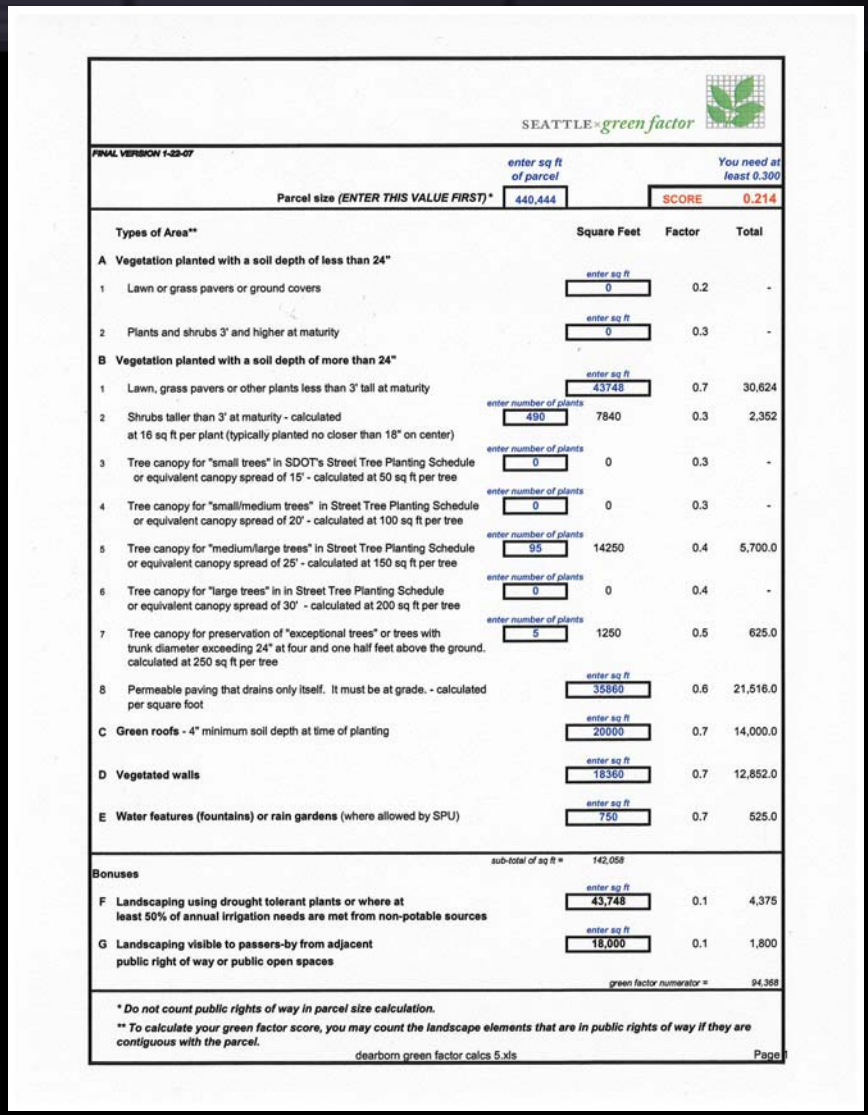
Seattle Green Factor



SEATTLE green factor

FINAL VERSION 1-22-07

	enter sq ft of parcel	You need at least 0.300
Parcel size (ENTER THIS VALUE FIRST) *	440,444	SCORE 0.214

	Types of Area**	Square Feet	Factor	Total
A	**Vegetation planted with a soil depth of less than 24"**			
1	Lawn or grass pavers or ground covers	enter sq ft: 0	0.2	-
2	Plants and shrubs 3' and higher at maturity	enter sq ft: 0	0.3	-
B	**Vegetation planted with a soil depth of more than 24"**			
1	Lawn, grass pavers or other plants less than 3' tall at maturity	enter sq ft: 43748	0.7	30,624
2	Shrubs taller than 3' at maturity - calculated at 16 sq ft per plant (typically planted no closer than 18" on center)	enter number of plants: 490 — 7840	0.3	2,352
3	Tree canopy for "small trees" in SDOT's Street Tree Planting Schedule or equivalent canopy spread of 15' - calculated at 50 sq ft per tree	enter number of plants: 0 — 0	0.3	-
4	Tree canopy for "small/medium trees" in Street Tree Planting Schedule or equivalent canopy spread of 20' - calculated at 100 sq ft per tree	enter number of plants: 0 — 0	0.3	-
5	Tree canopy for "medium/large trees" in Street Tree Planting Schedule or equivalent canopy spread of 25' - calculated at 150 sq ft per tree	enter number of plants: 95 — 14250	0.4	5,700.0
6	Tree canopy for "large trees" in in Street Tree Planting Schedule or equivalent canopy spread of 30' - calculated at 200 sq ft per tree	enter number of plants: 0 — 0	0.4	-
7	Tree canopy for preservation of "exceptional trees" or trees with trunk diameter exceeding 24" at four and one half feet above the ground. calculated at 250 sq ft per tree	enter number of plants: 5 — 1250	0.5	625.0
8	Permeable paving that drains only itself. It must be at grade. - calculated per square foot	enter sq ft: 35860	0.6	21,516.0
C	**Green roofs** - 4" minimum soil depth at time of planting	enter sq ft: 20000	0.7	14,000.0
D	**Vegetated walls**	enter sq ft: 18360	0.7	12,852.0
E	**Water features (fountains) or rain gardens** (where allowed by SPU)	enter sq ft: 750	0.7	525.0
		sub-total of sq ft = 142,058		
	Bonuses			
F	**Landscaping using drought tolerant plants or where at least 50% of annual irrigation needs are met from non-potable sources**	enter sq ft: 43,748	0.1	4,375
G	**Landscaping visible to passers-by from adjacent public right of way or public open spaces**	enter sq ft: 18,000	0.1	1,800
		green factor numerator =		94,368

** Do not count public rights of way in parcel size calculation.*

*** To calculate your green factor score, you may count the landscape elements that are in public rights of way if they are contiguous with the parcel.*

dearborn green factor calcs 5.xls Page 1

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Example of Layering Factors

	SGF Factor	
	Component	Cumulative
Base	0.70	0.70
Irrigation Bonus	0.10	0.80
Visibility Bonus	0.10	0.90
Trees	0.22	1.12
Shrubs	0.48	1.60

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Comparison of Factors and ROM Costs

	SGF Factor			
	Base	Max	$/sf	$/point
Stormwater Planter	0.70	1.00	20	20.00
Green Roofs	0.70	0.70	10	14.29
Green Walls	0.70	0.80	11	13.75
Permeable Pavers	0.60	0.60	5	8.33
Green on Ground	0.70	1.12	5	4.46
Green on Ground	0.70	1.60	7.5	4.69

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Seattle Green Factors

0.17 – Seattle Central Library

0.07 – Interurban Exchange 3

0.12 – Alcyone Apartments

0.47 - SLU Discovery Center

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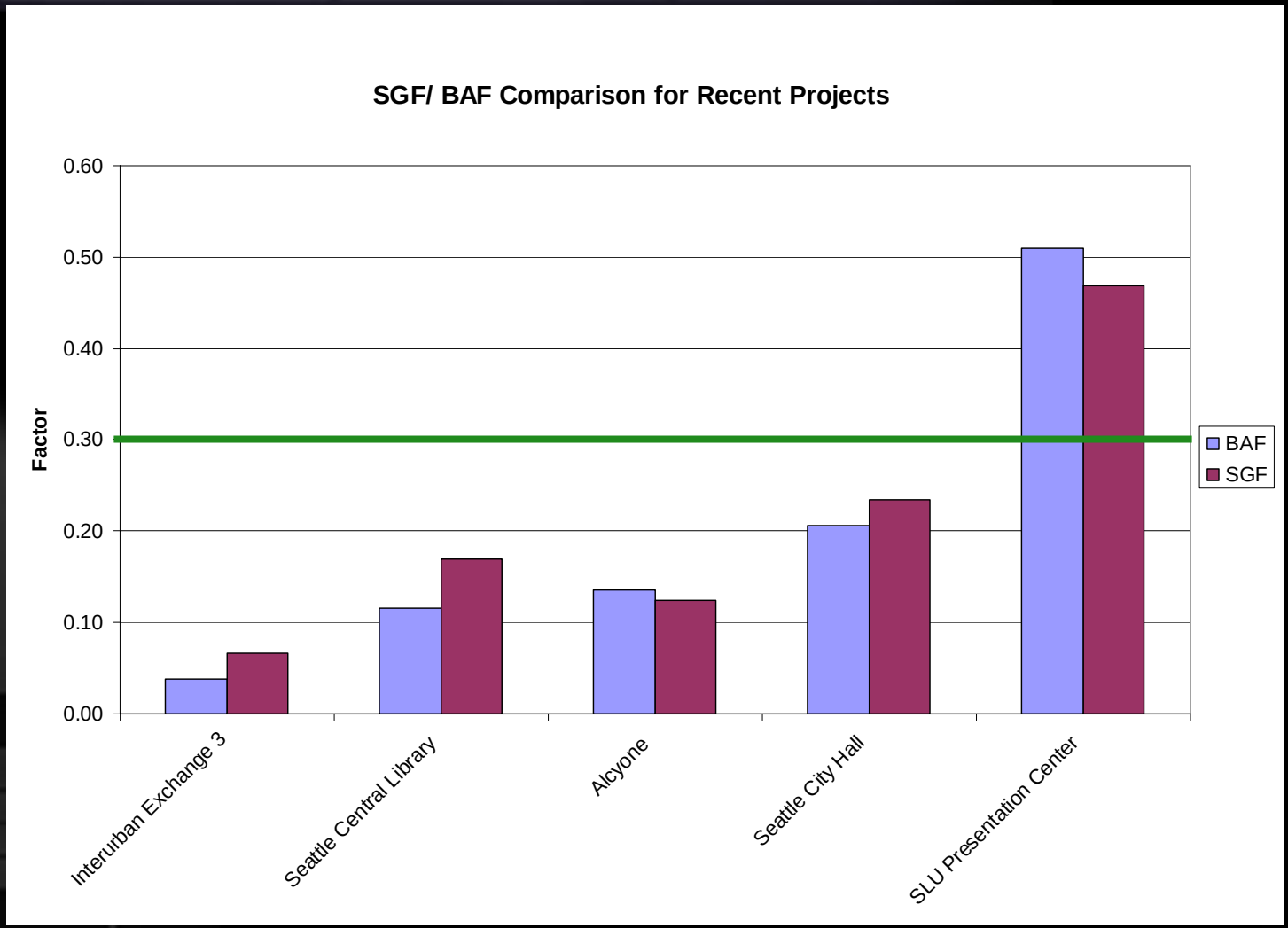
SGF/BAF Comparison



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Getting to 0.30

	Shortfall	Green on Ground		Green Roof	
	"numerator"	sf	$	sf	$
Interurban Exchange 3	10,128	6,330	47,475	14,469	144,686
Seattle Central Library	7,735	4,834	36,258	11,050	110,500
Alcyone	6,233	3,896	29,217	8,904	89,043
Seattle City Hall	3,921	2,451	18,380	5,601	56,014

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LEED Site Credits

Sustainable Site Credits

- SSp1: Construction Activity and Pollution Prevention
- SSc1: Site Selection
- SSc2: Development Density and Community Connectivity
- SSc3: Brownfield Redevelopment
- SSc4: Alternative Transportation
- SSc5: Site Development
- SSc6: Stormwater Management
- SSc7: Heat Island Effect
- SSc8: Light Pollution Reduction

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SSc5: Site Development

- Formerly known as “Reduced Site Disturbance”
- 5.1: Habitat
- 5.2: Open Space
- Only LEED credits directly related to site greening
- Green roofs count now (if getting SSc2)
- Ped hardscape = openspace (if getting SSc2)
- First of several credits demanding a site definition
- Suburban/Urban tension

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Glossary

- LEED: "Site Area" = "synonymous with property area"
- LEED: "Property Area" = "The total area within the legal property boundaries of a site and encompassing all areas of the site, including constructed areas and non-constructed areas."
- Clear? Not necessarily!

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Suburban Sites

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Urban Sites

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SSc5: Site Development Summary

- Hard to inturpret for urban projects
- Easy to give up on
- Contributes to the problem of high performance buildings on low performance sites
- Needs improvement!

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SSc7.1: Heat Island Effect: Non-roof

- Urban site definition…sidewalks

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Pavement Culture

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SSc7.2: Heat Island Effect: Roof

- Green roofs still count
- But so do certain non-green roofs

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SSc6: Stormwater Management

- 6.1: "Quantity Control" (rate *and* volume)
- 6.2: Quality Control

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The Volume Conundrum or the Infiltration Fallacy

- 6.1 is not a gimme due to its volume requirement
- Rate is almost always regulated; Volume is almost never regulated
- LEED is infiltration-centric
- Good infiltration is hard to come by

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Tumwater Office Building

Tumwater Office Building

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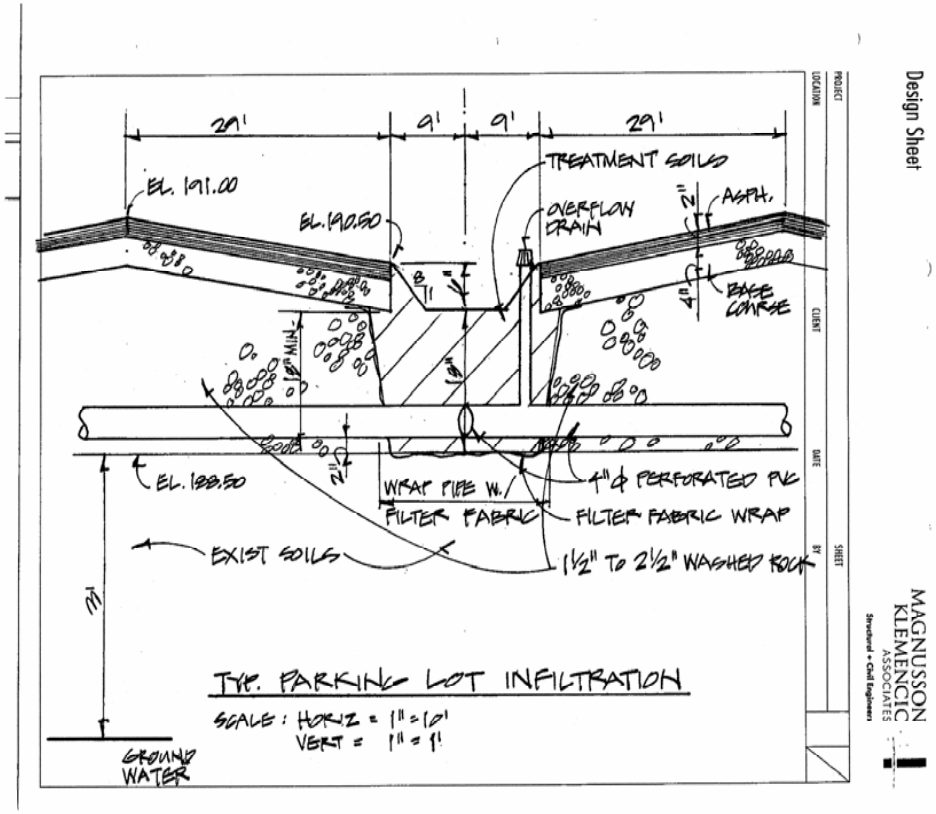
Tumwater Office Building



Tumwater Office Building

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Tumwater Office Building

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Other Infiltration Projects

- Hmm…

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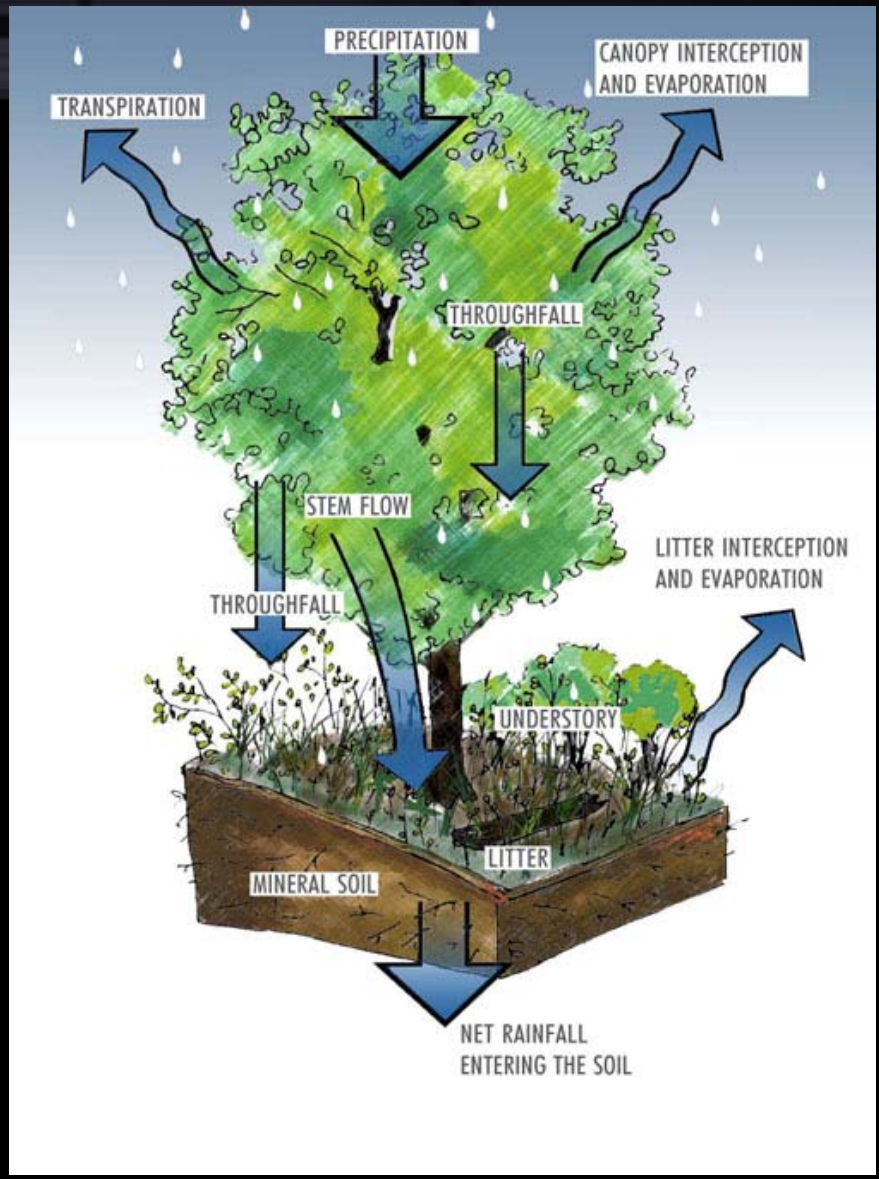
Hydrologic Processes



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SSc6.1: Quantity Control Summary

- Reducing Volume is a good thing
- Infiltration is not always available
- Other volume reduction strategies also heal the hydrologic cycle
- These need to be rewarded; if not they will not be implemented

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SSc6.2: Quality Control

- Code compliance gets this credit
- Combined sewer doesn't count
- This credit can be yours for $20,000!

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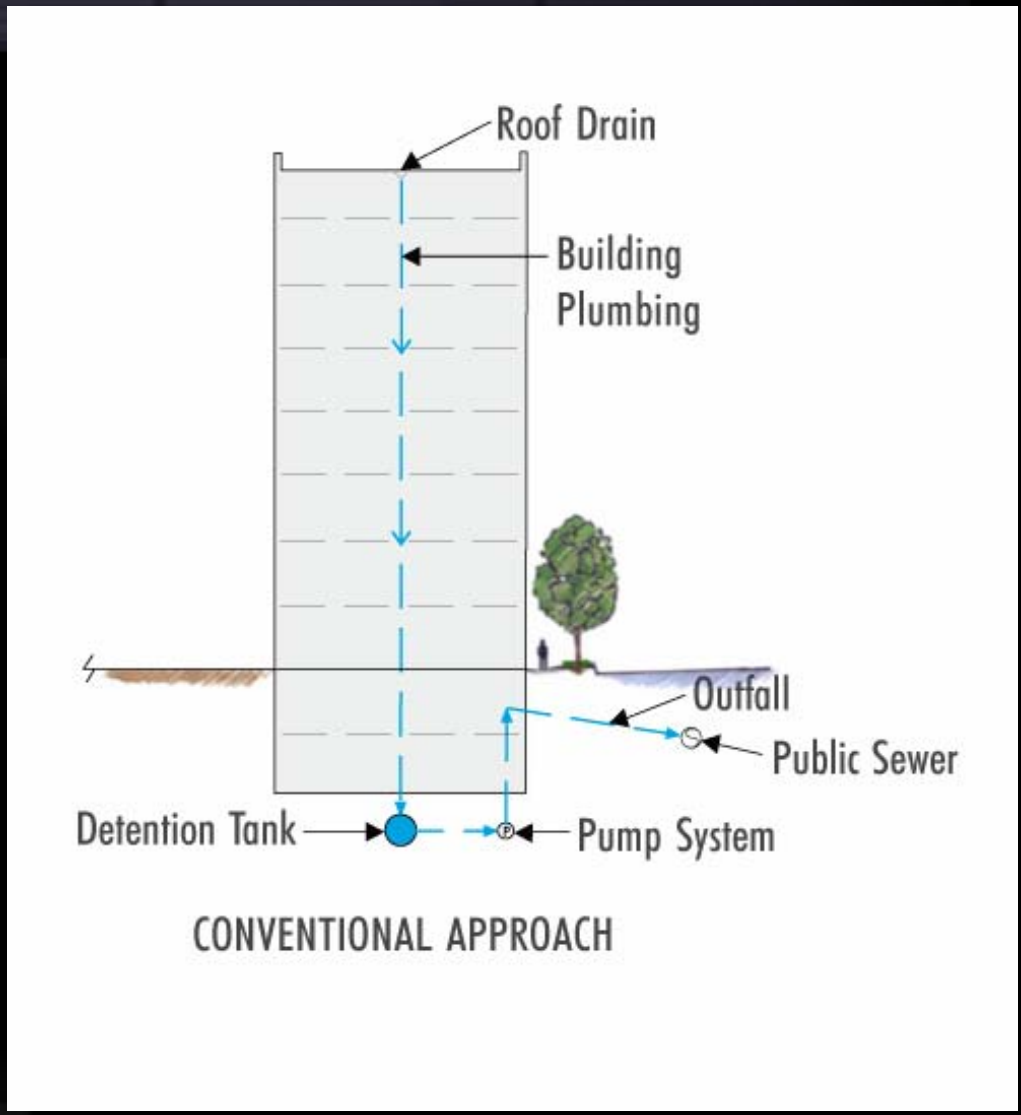
Natural Drainage Systems

Stormwater Management 101



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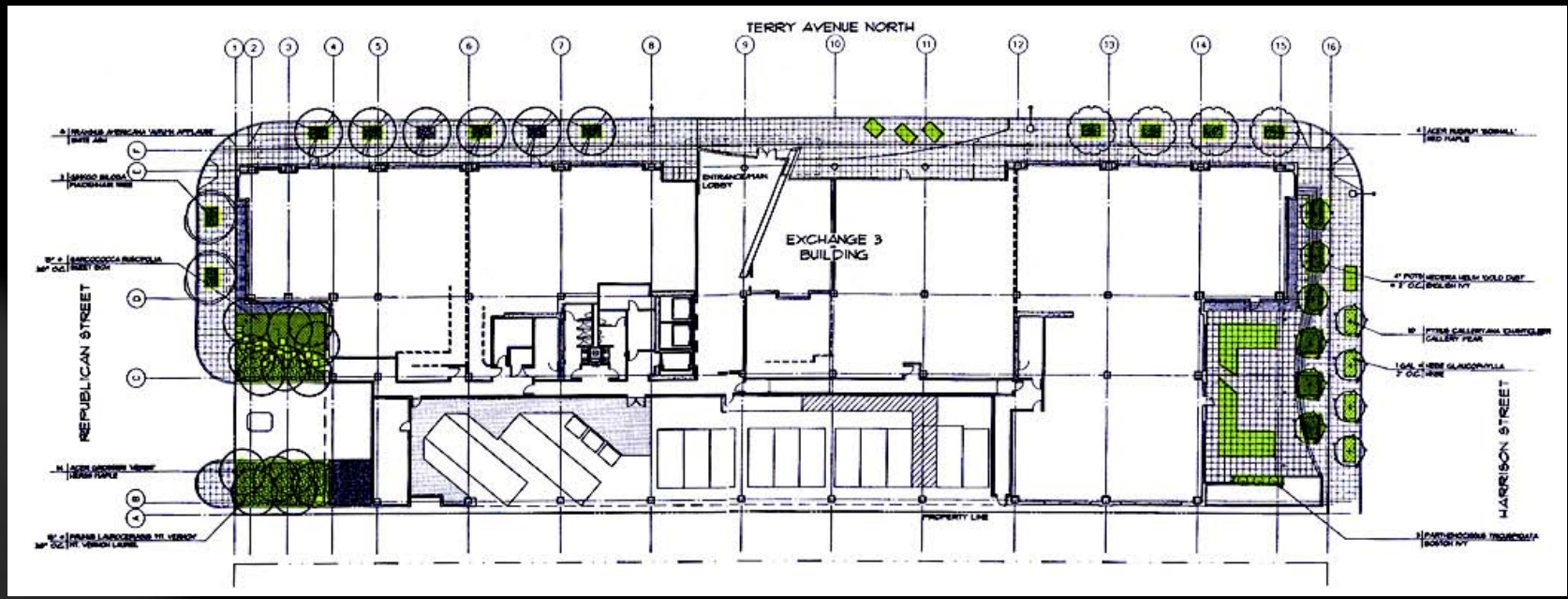
Drainage Code Site Definition



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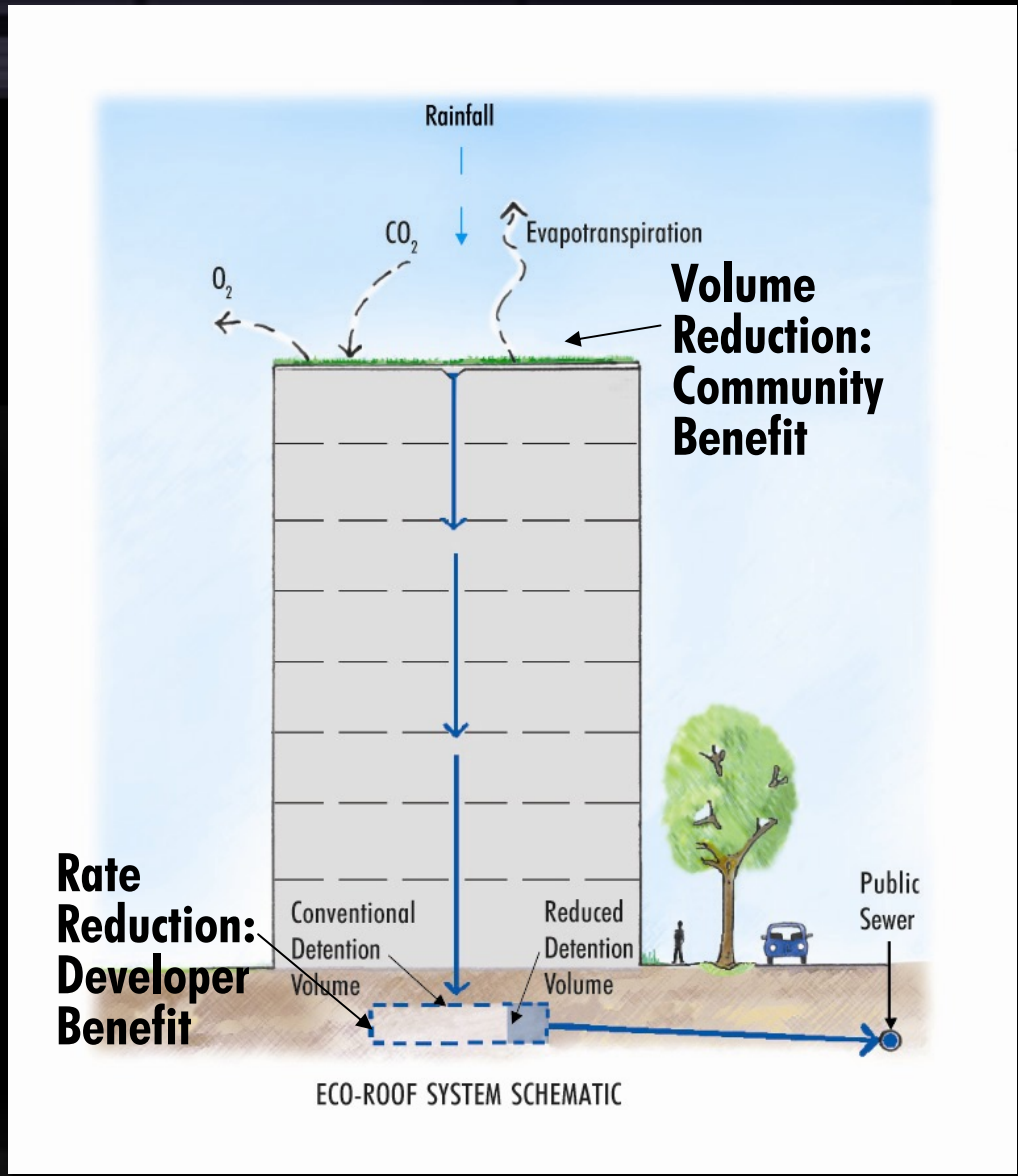
Green Roof Stormwater Benefits



Other:

- Temperature
- Water Quality

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Seattle Flow Control Manual

Flow Control Technical Requirements Manual

Issued November 2000

City of Seattle

Title 22.800 Stormwater, Grading & Drainage Control Code

Volume 1: Source Control Technical Requirements Manual
Volume 2: Construction Stormwater Control Technical Requirements Manual
Volume 3: Flow Control Technical Requirements Manual
Volume 4: Stormwater Treatment Technical Requirements Manual

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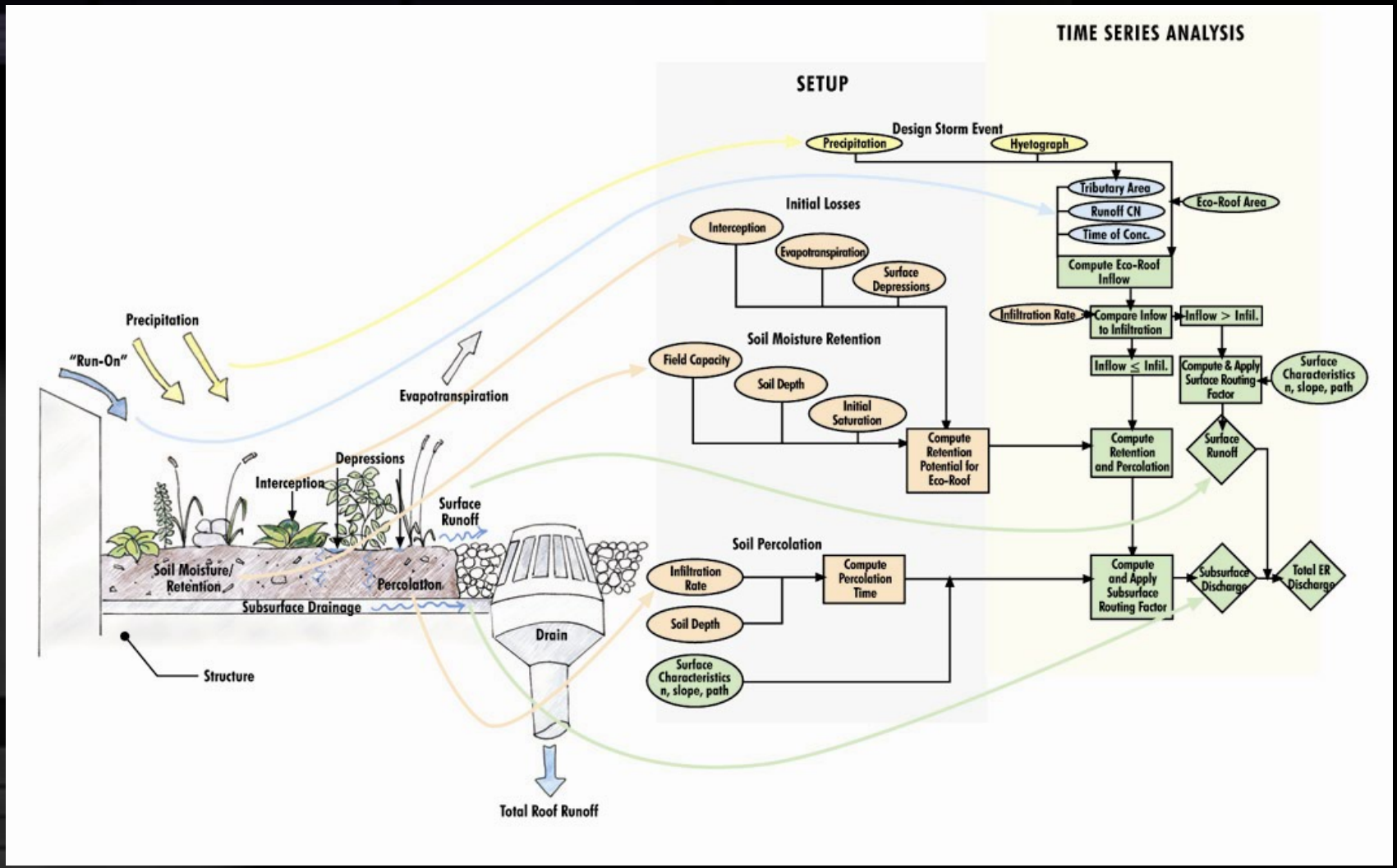
Green Roof Modeling Tool



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Scandinavian Green Roof Institute

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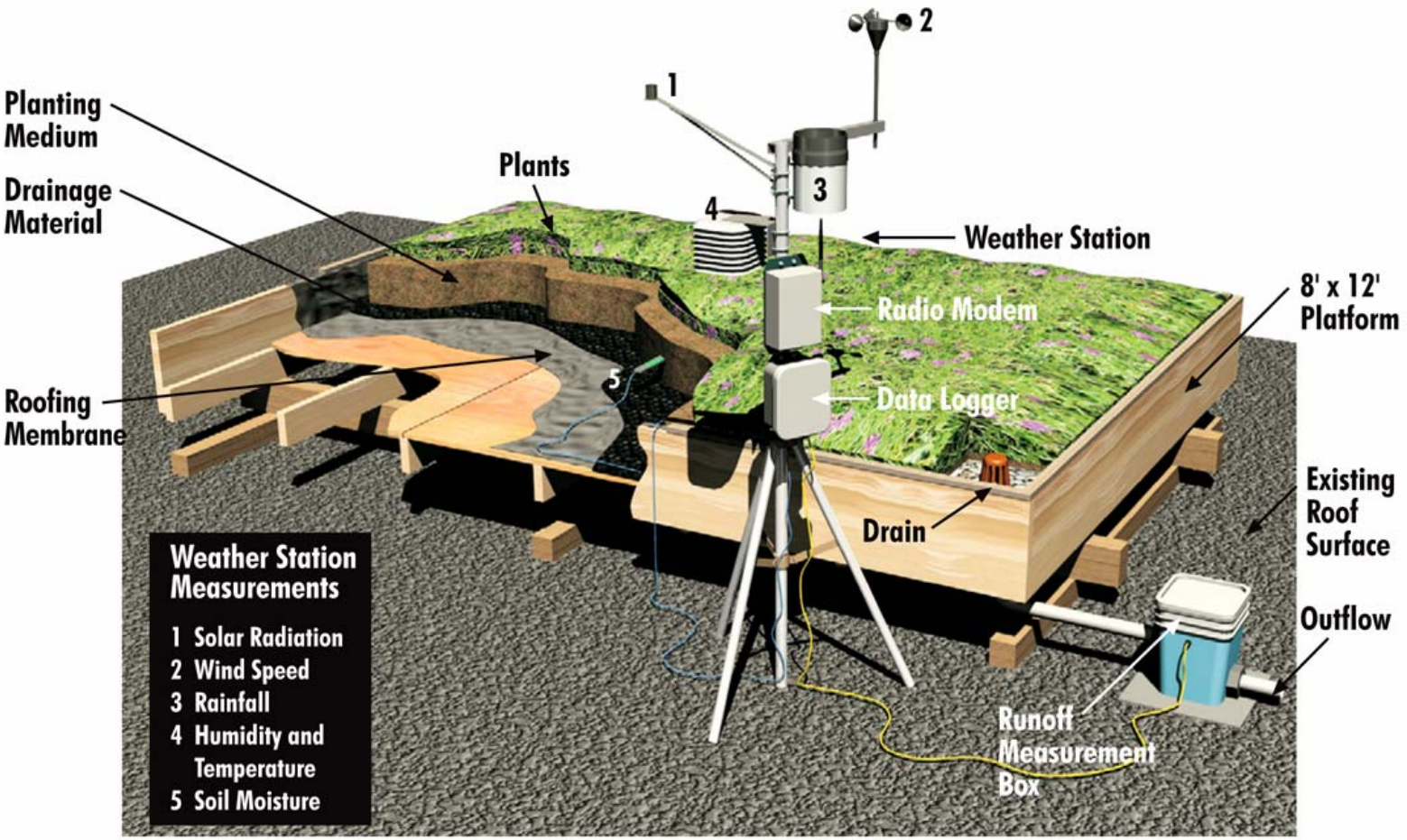
Test Plot Configuration



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Evaluation Plot

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Diverse Locations in Downtown Seattle

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Installation Day – February 2005

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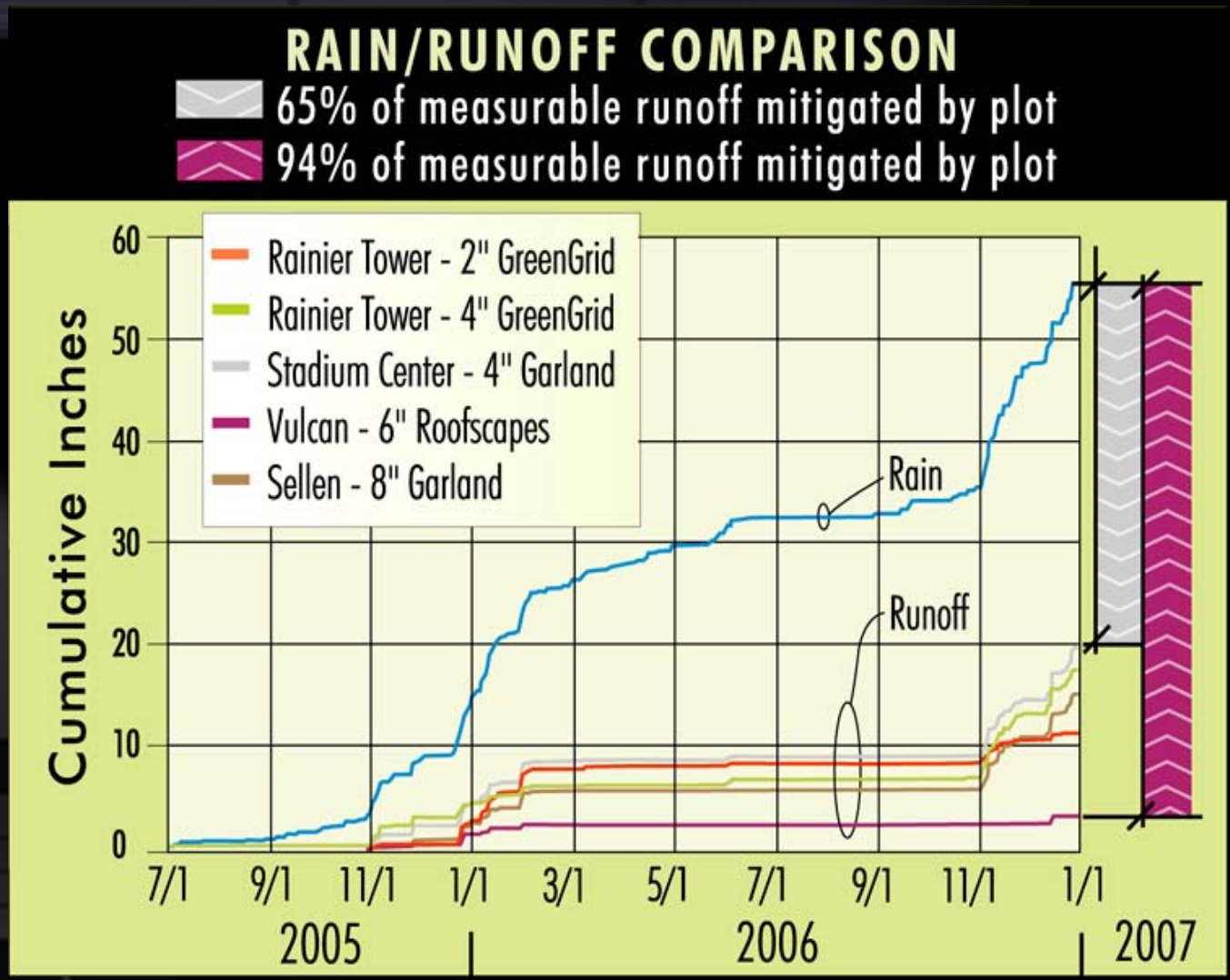
Volume Reduction



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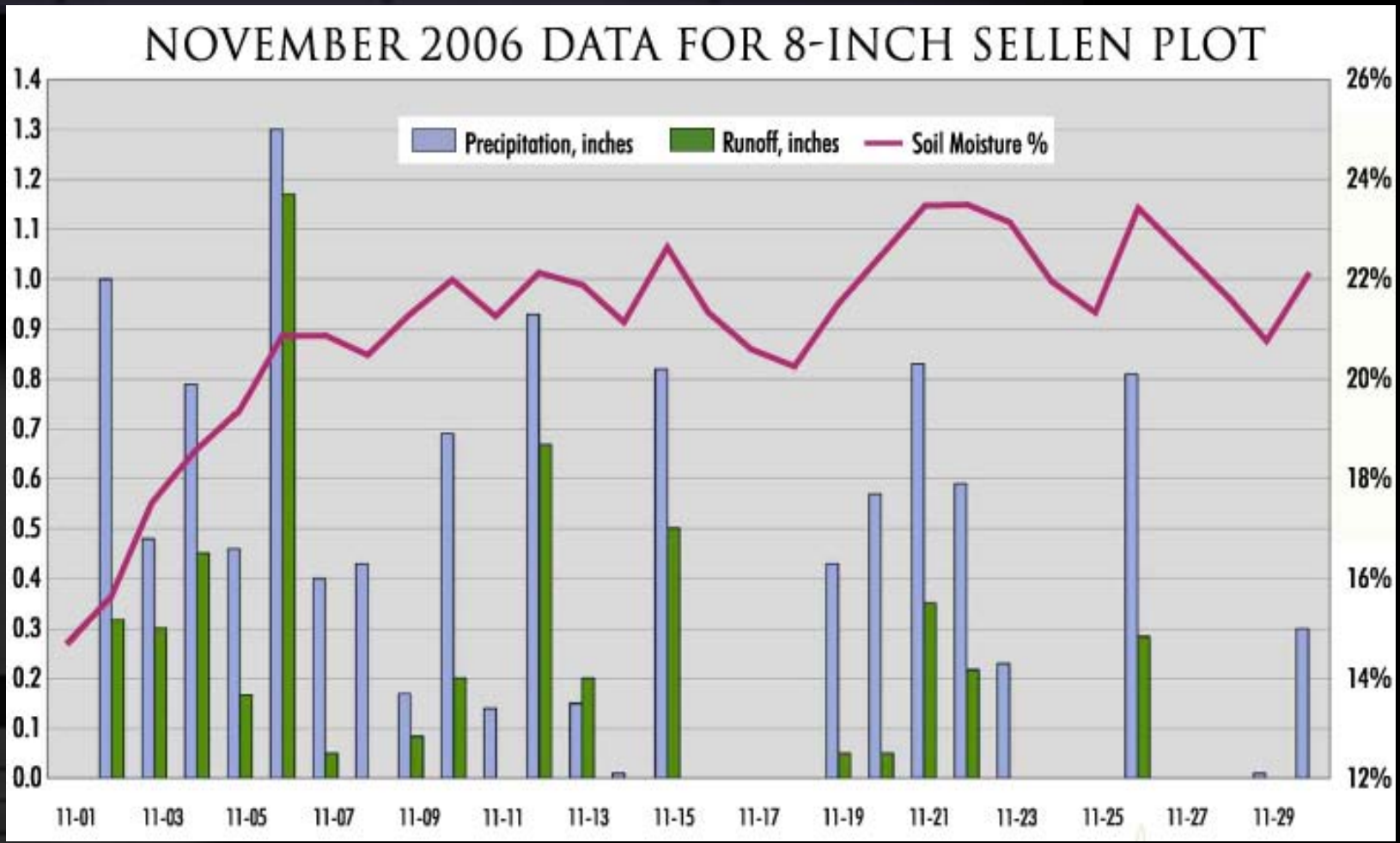
Runoff Reduction Rebound



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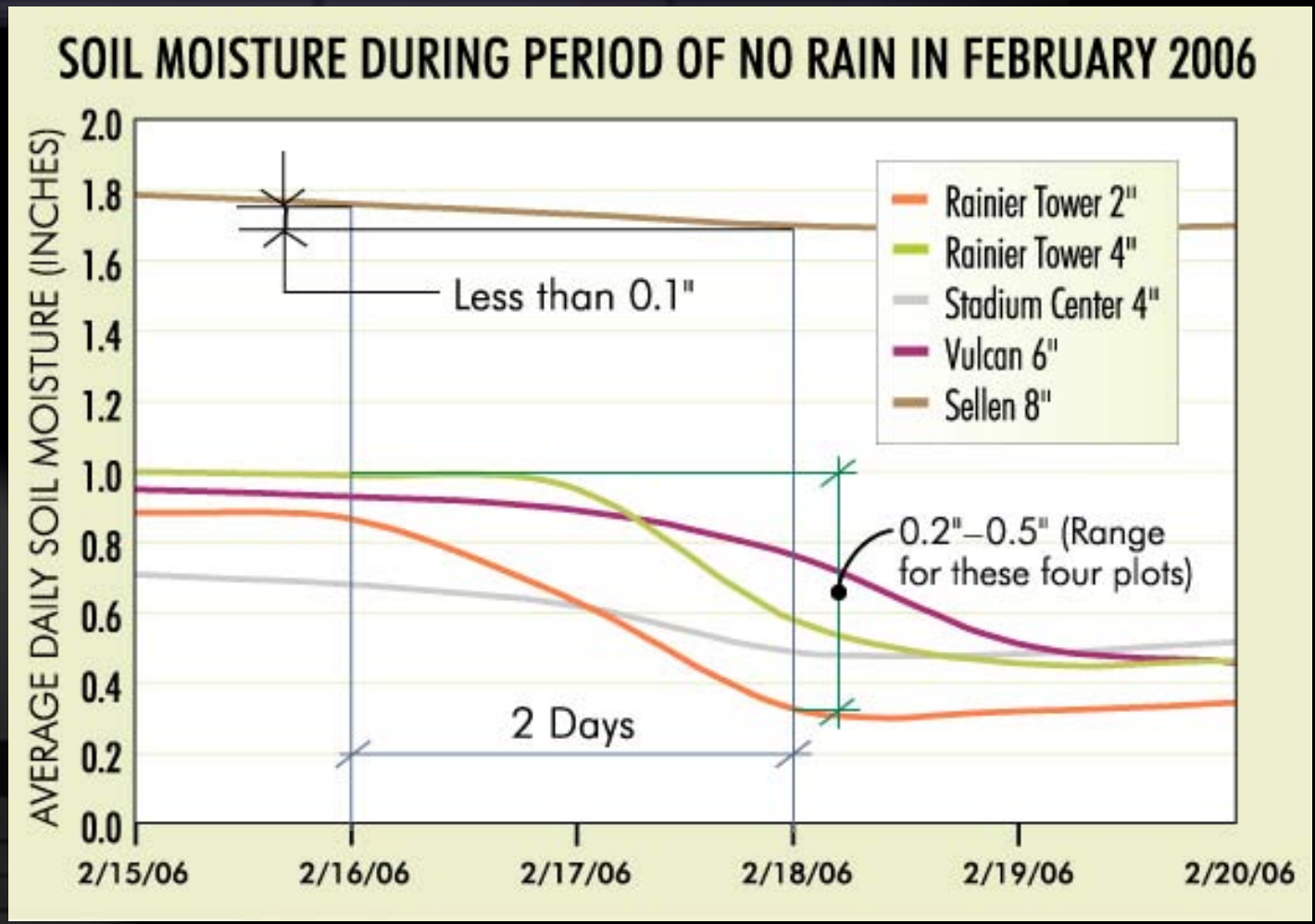
Soil Moisture Shedding



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Stormwater Detention Reduction

Green Roof	Detention Reduction	
	GR Only	Total Project
Roofscapes 6"	53%	20%
Optimal 6"	100%	45%

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Green Roof Evaluation Summary

- Volume reduction exceeded expectations
- Detention reduction smaller than hoped
- Permitting ready
- Lacking applicants
- We're still not building green roofs in Seattle!

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Top 10 Green Roof Cities for 2006

1. Chicago, IL
2. Washington D.C.
3. Wildwood Crest, NJ
4. Dulles, VA
5. Kansas City, MO
6. Phoenix, AZ
7. Milwaukee, WI
8. New York, NY
9. Portland, OR
10. Columbus, OH

Based on square footage installed in 2006. Source: Green Roofs for Healthy Cities

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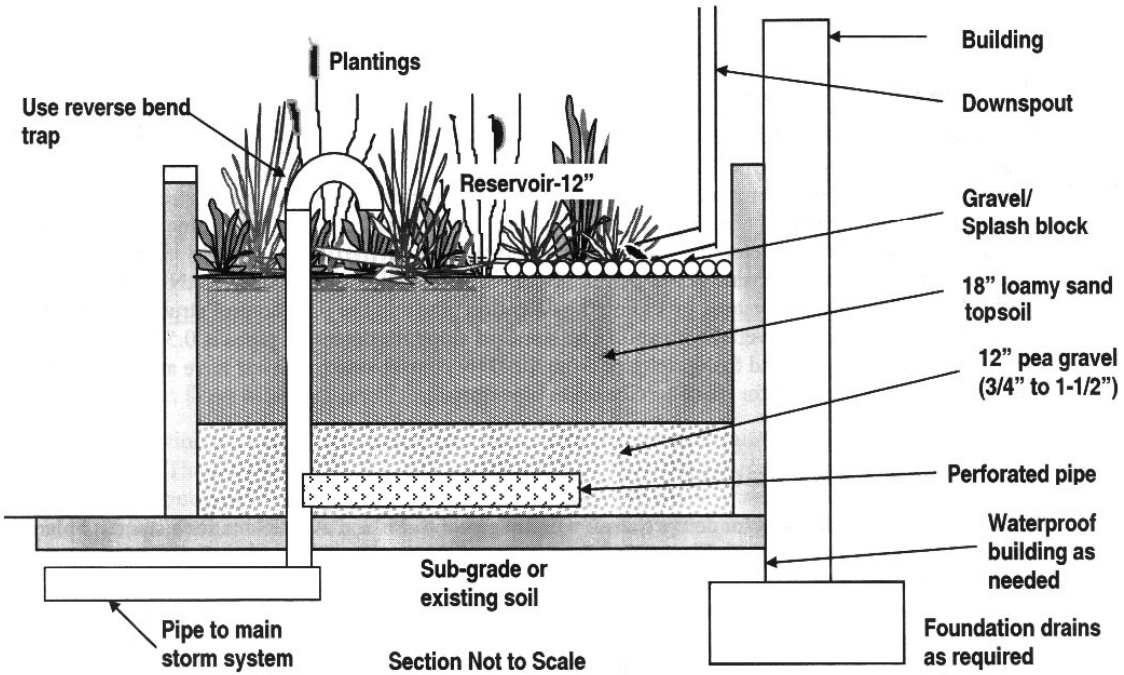
Storm Water Planters

2.3 Stormwater Planter

Figure 2. Stormwater Planter



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Storm Water Planters

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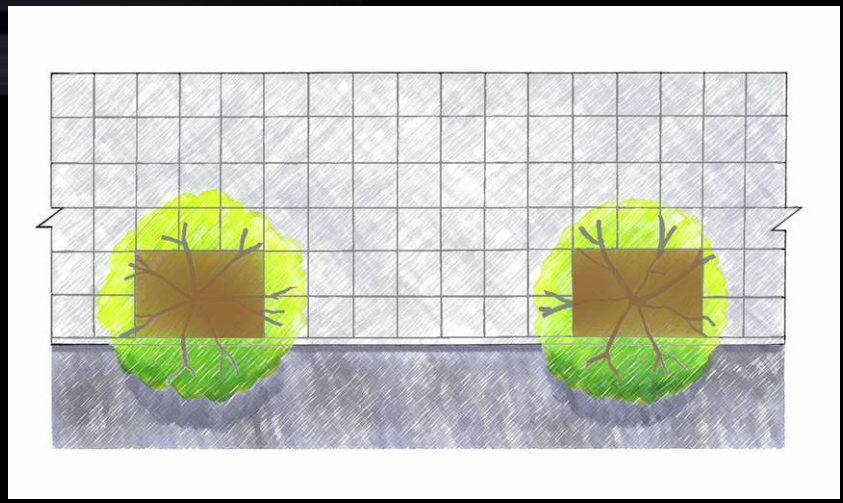
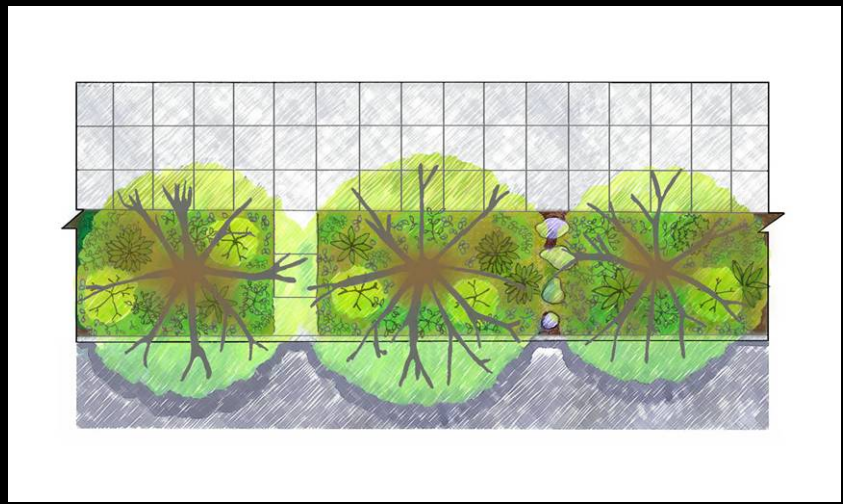
Self Mitigating Sidewalks





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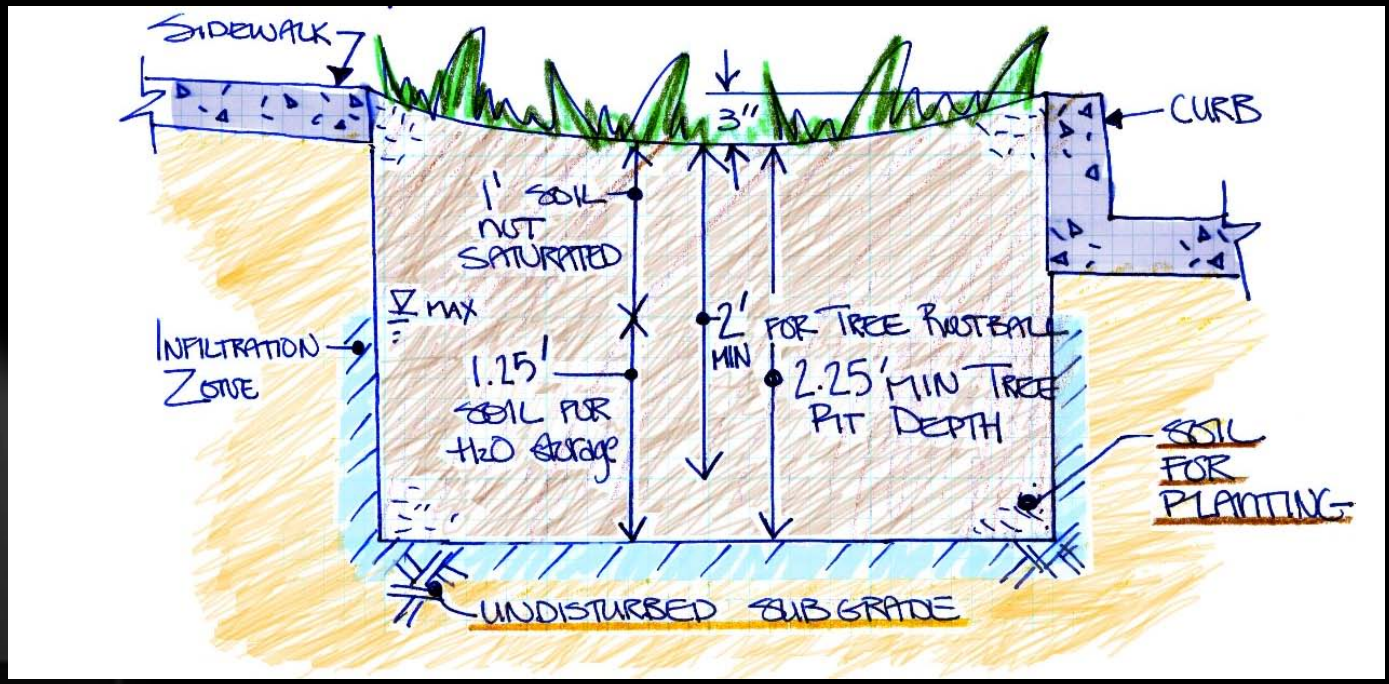
Self Mitigating Sidewalks



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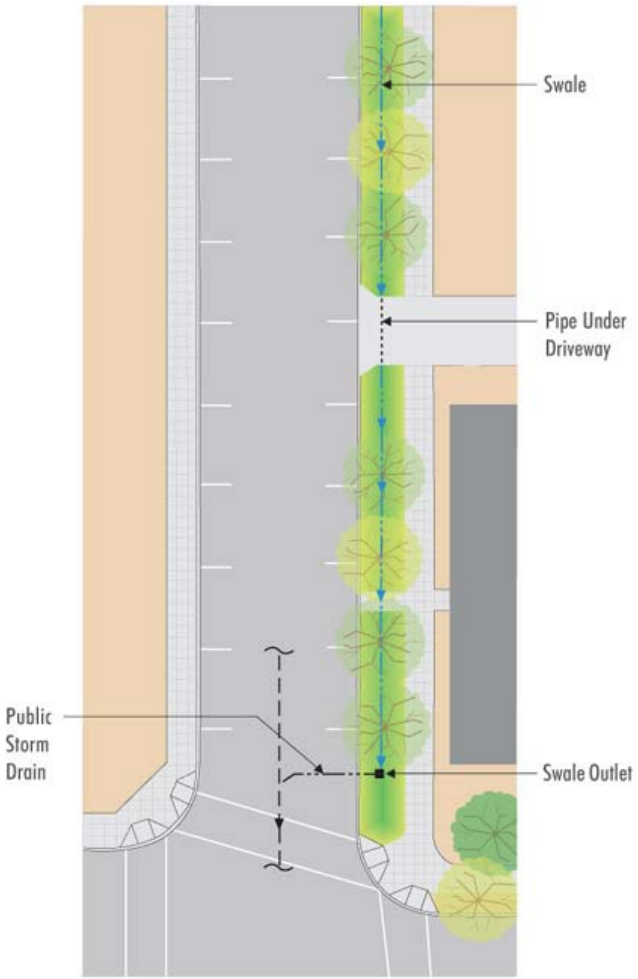
From Green Streets to Eco-Streets



SIMPLE ECO-STREET PLAN

SIDEWALK SECTION

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SEA Streets

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SEA Streets

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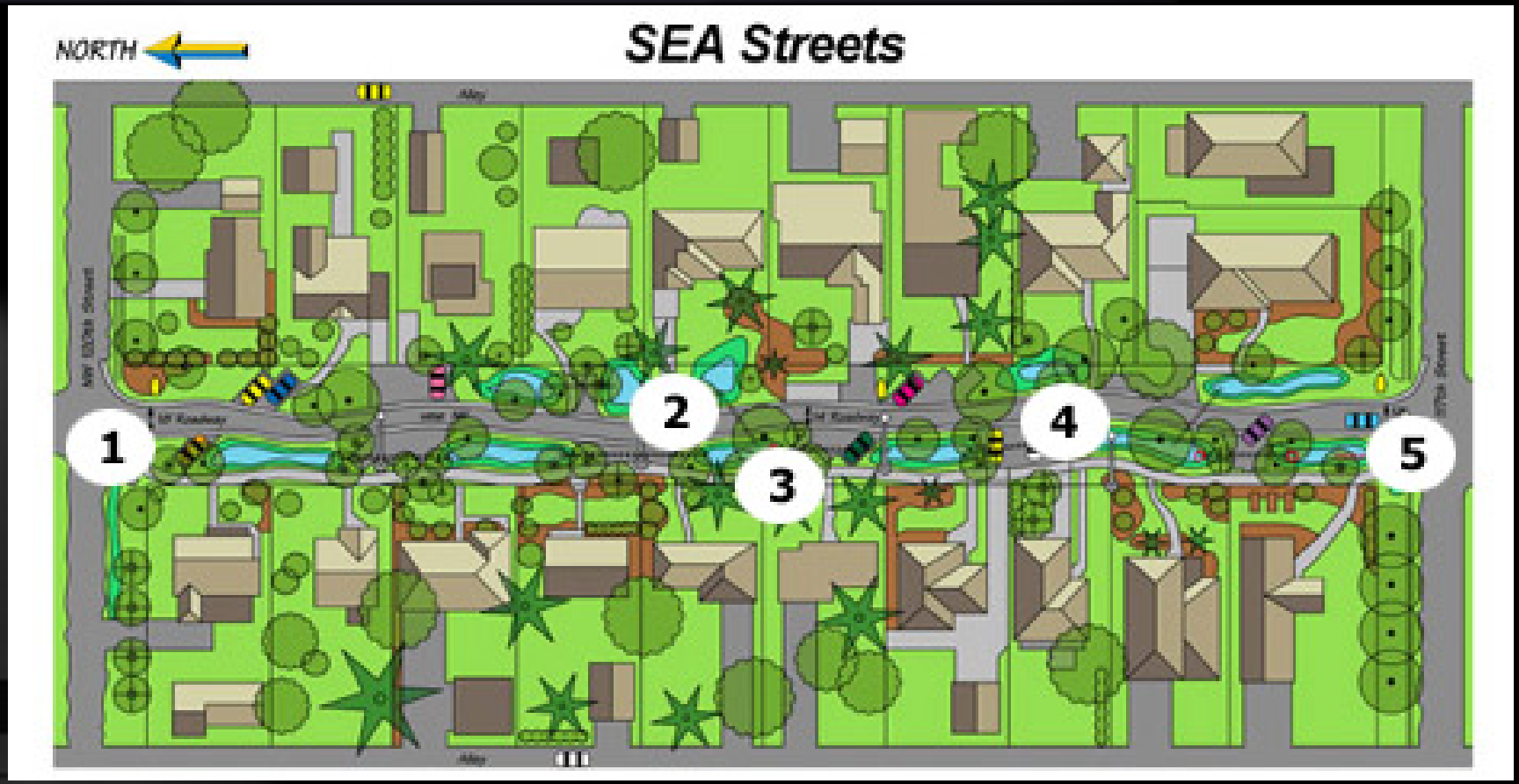
SEA Streets



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SEA Streets

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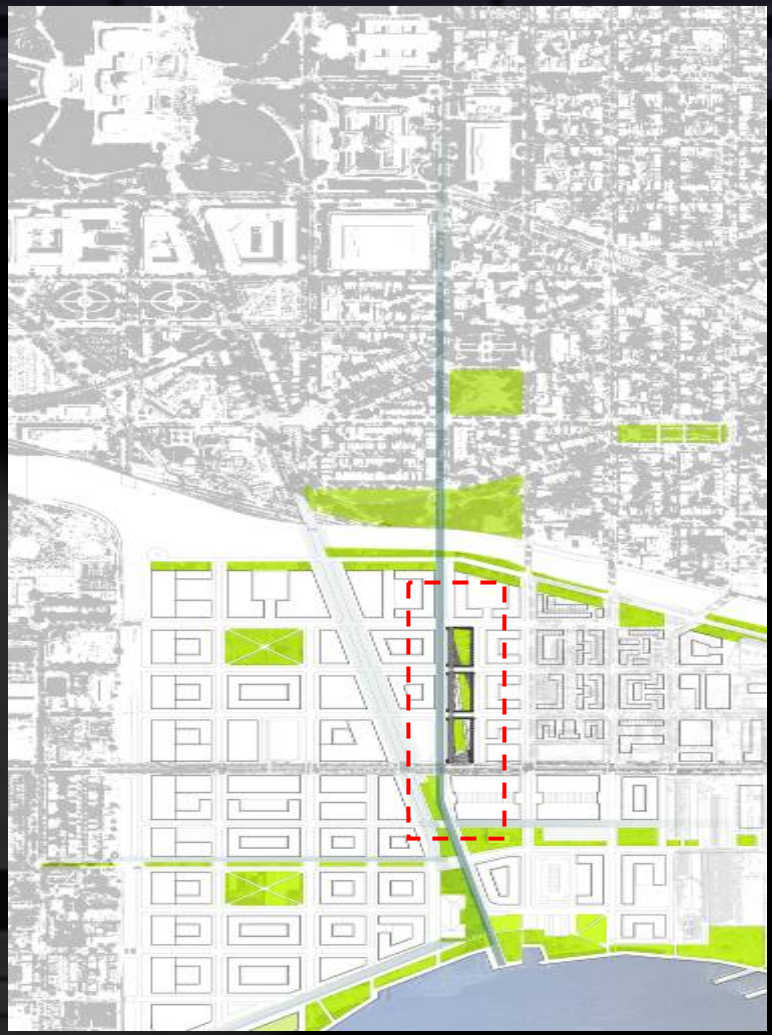
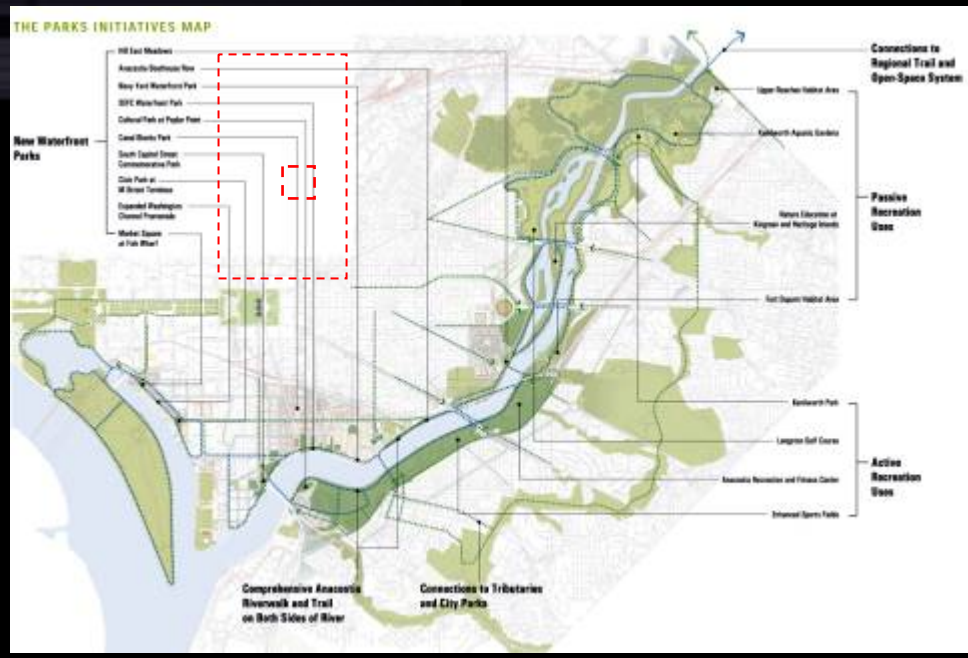
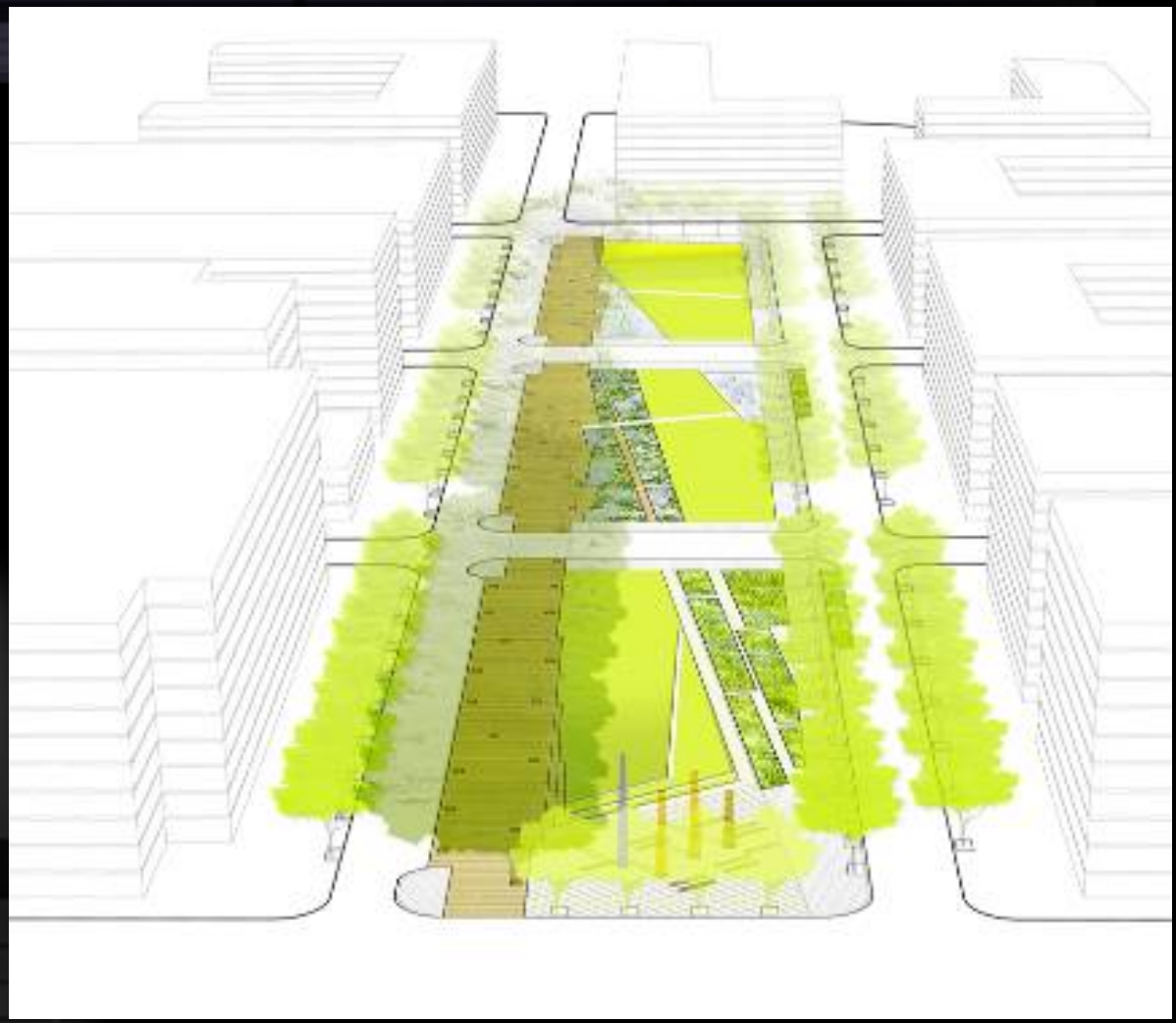
Washington D.C. Canal Park





Washington D.C. Canal Park



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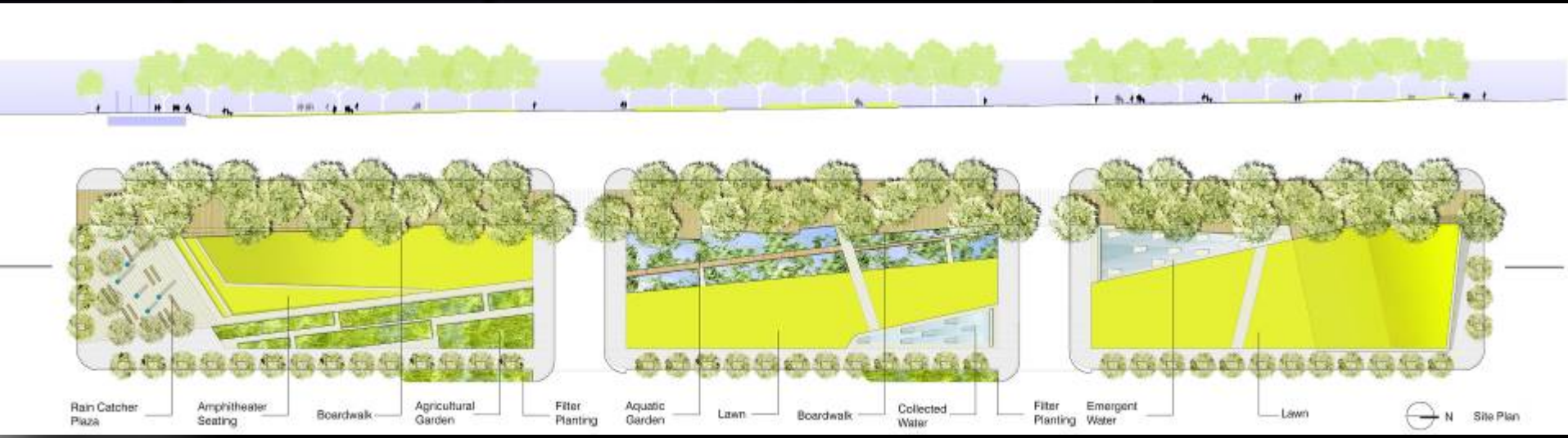
Washington D.C. Canal Park



[collect] [celebrate] [convey]

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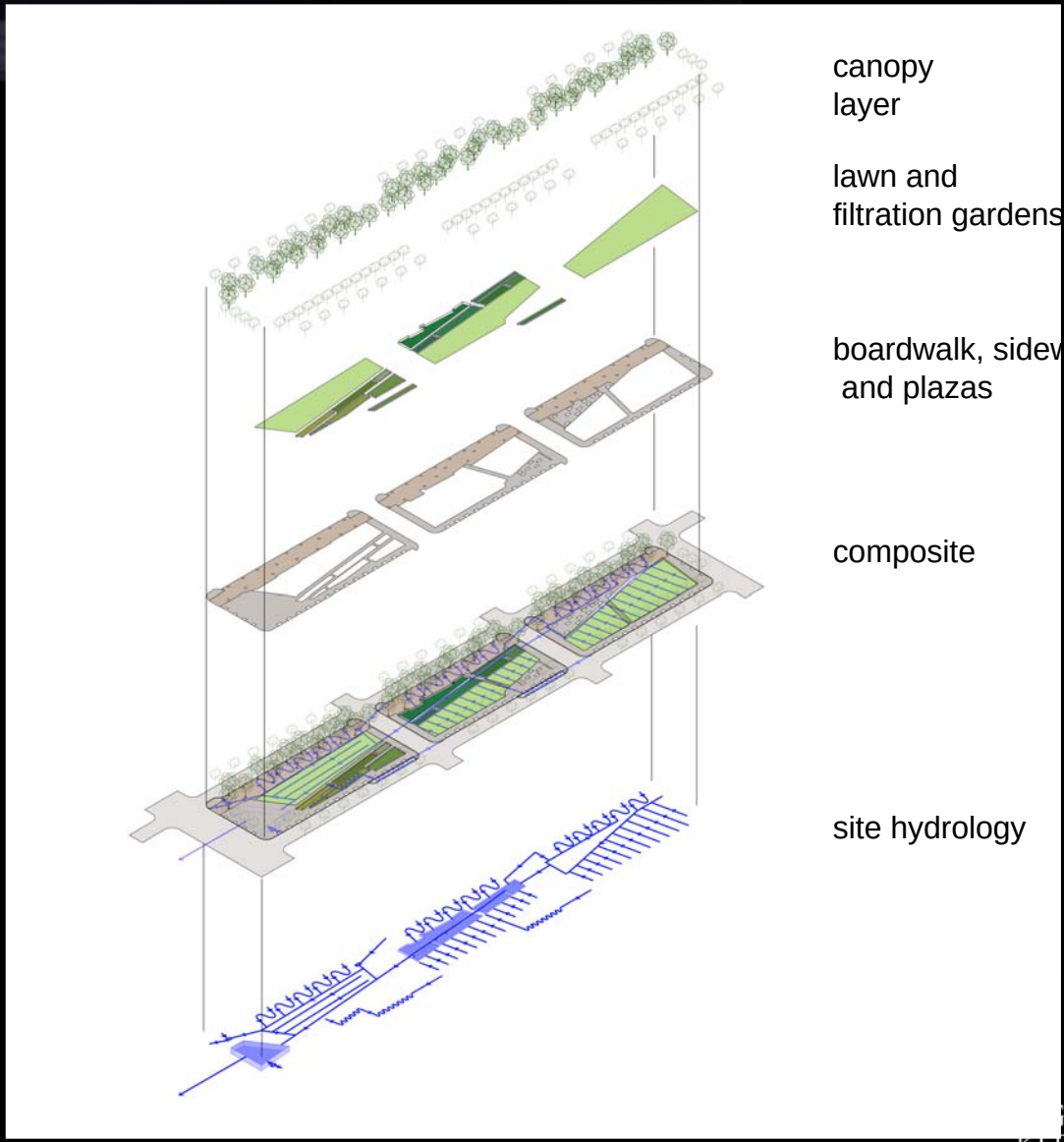
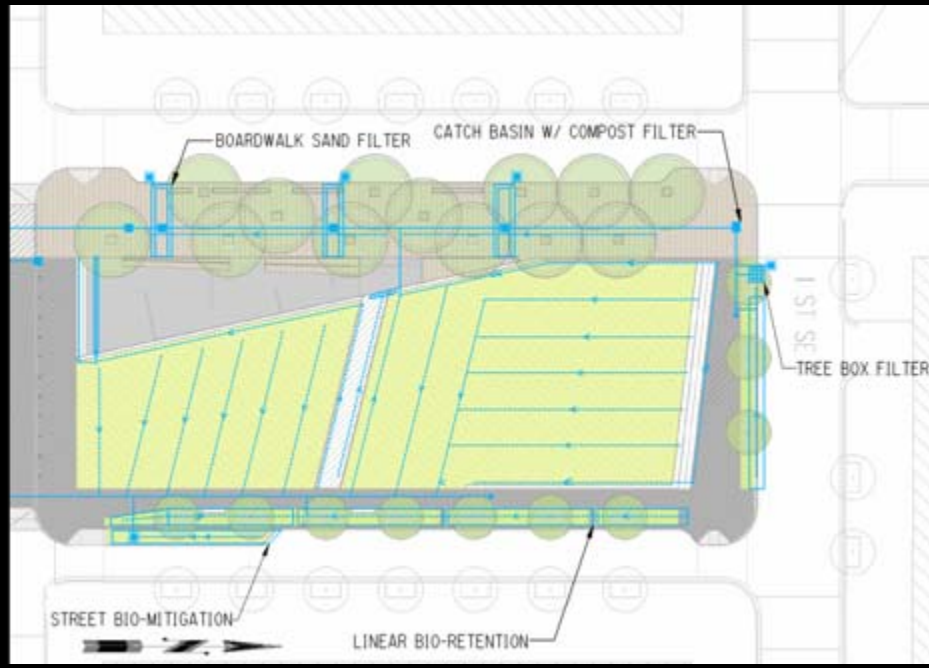
Washington D.C. Canal Park





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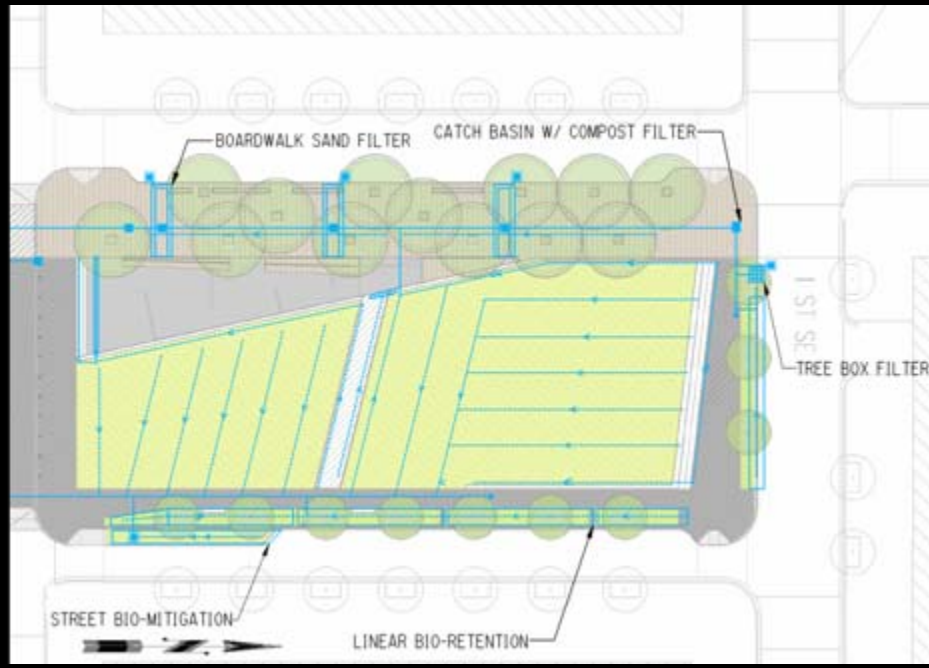

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Project Case Studies

South Lake Union Discovery Center

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South Lake Union Discovery Center

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Cascade Park

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MINOR AVE N
PONTIUS AVE N
THOMAS ST
HARRISON ST
110
100
120
1214
307
301
305
310
325
R=15

Minor Ave N
Thomas St
Cascade Creek
Harrison St
Pontius Ave N

South Lake Union Discovery Center

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Discovery Center Summary

SGF	-	0.468
LEED 6.1	-	Yes
LEED 6.2	-	Maybe
Detention	-	All Natural for New Development

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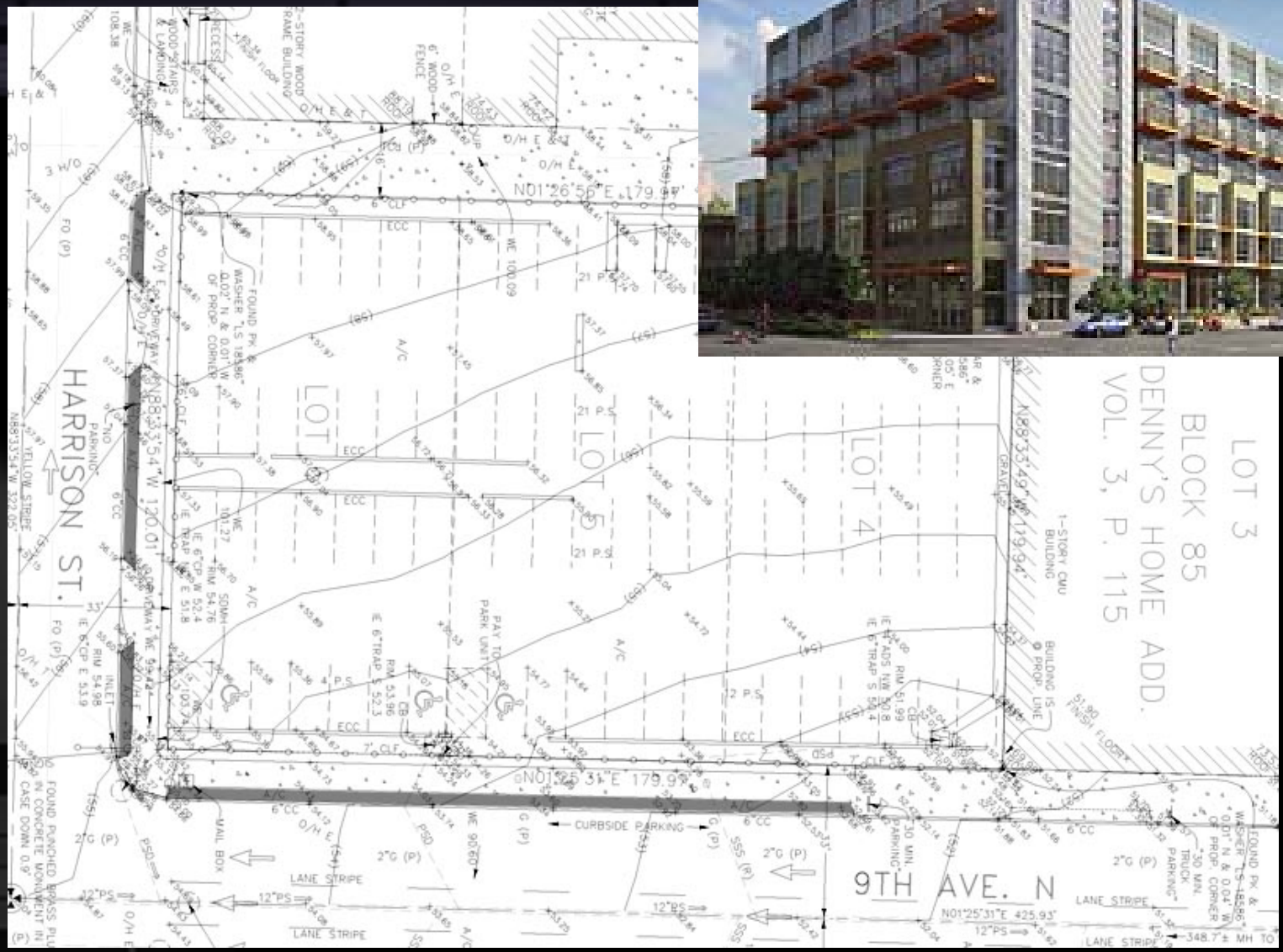
Veer Lofts



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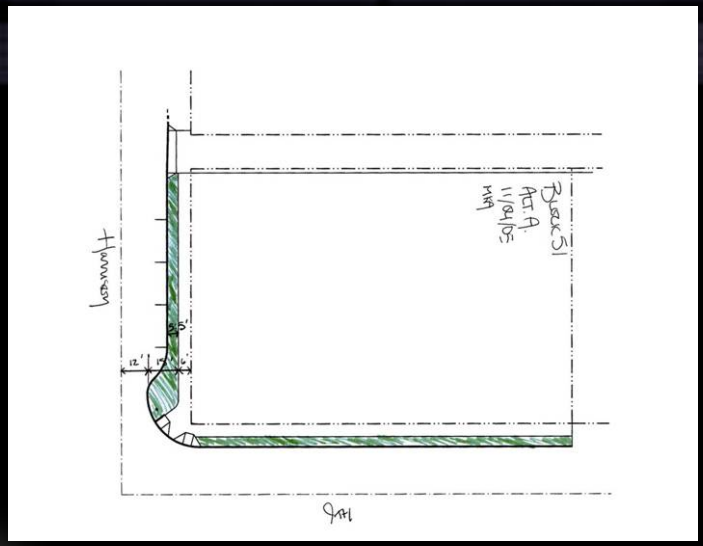
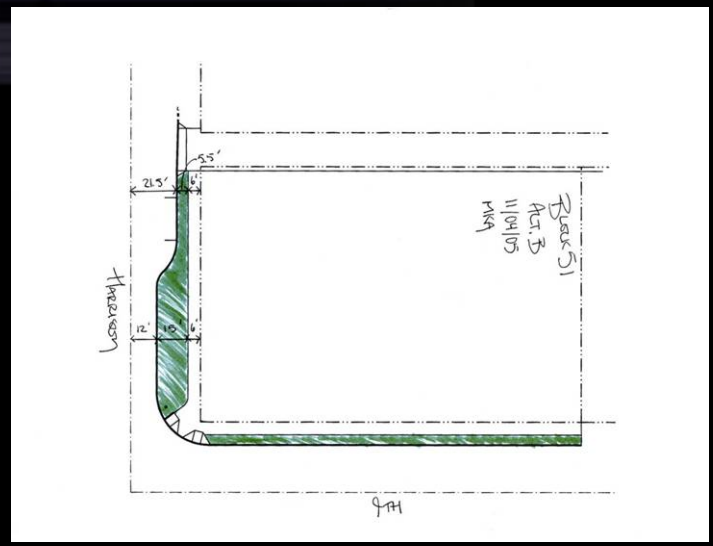
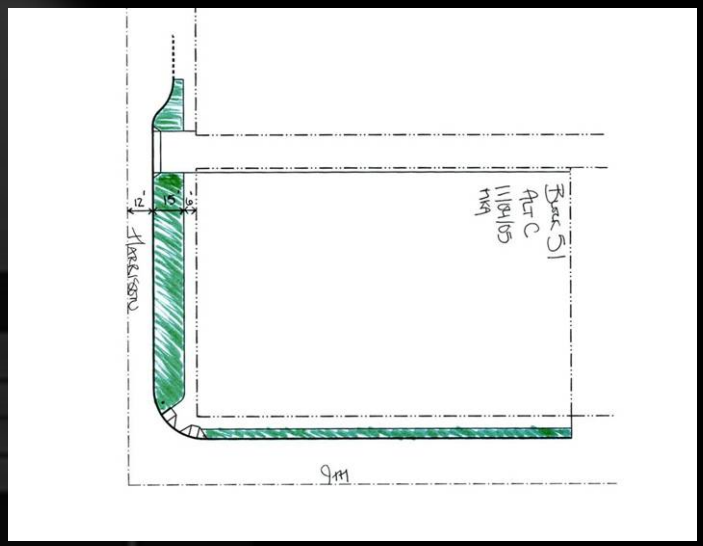
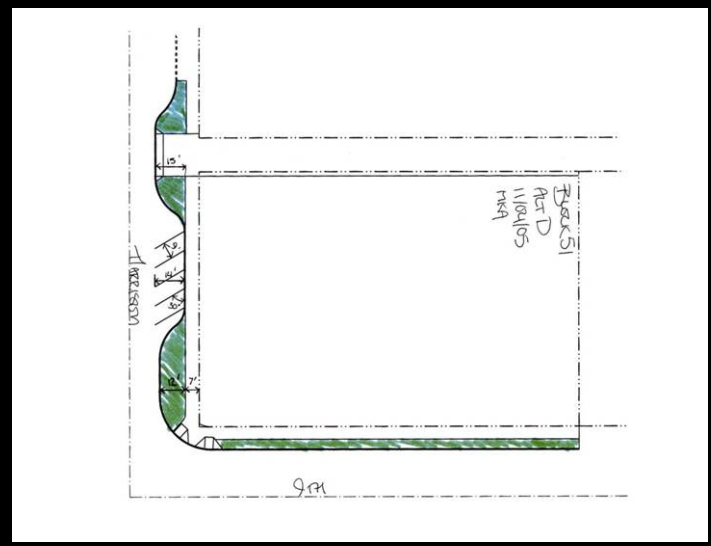
Streetscape Studies









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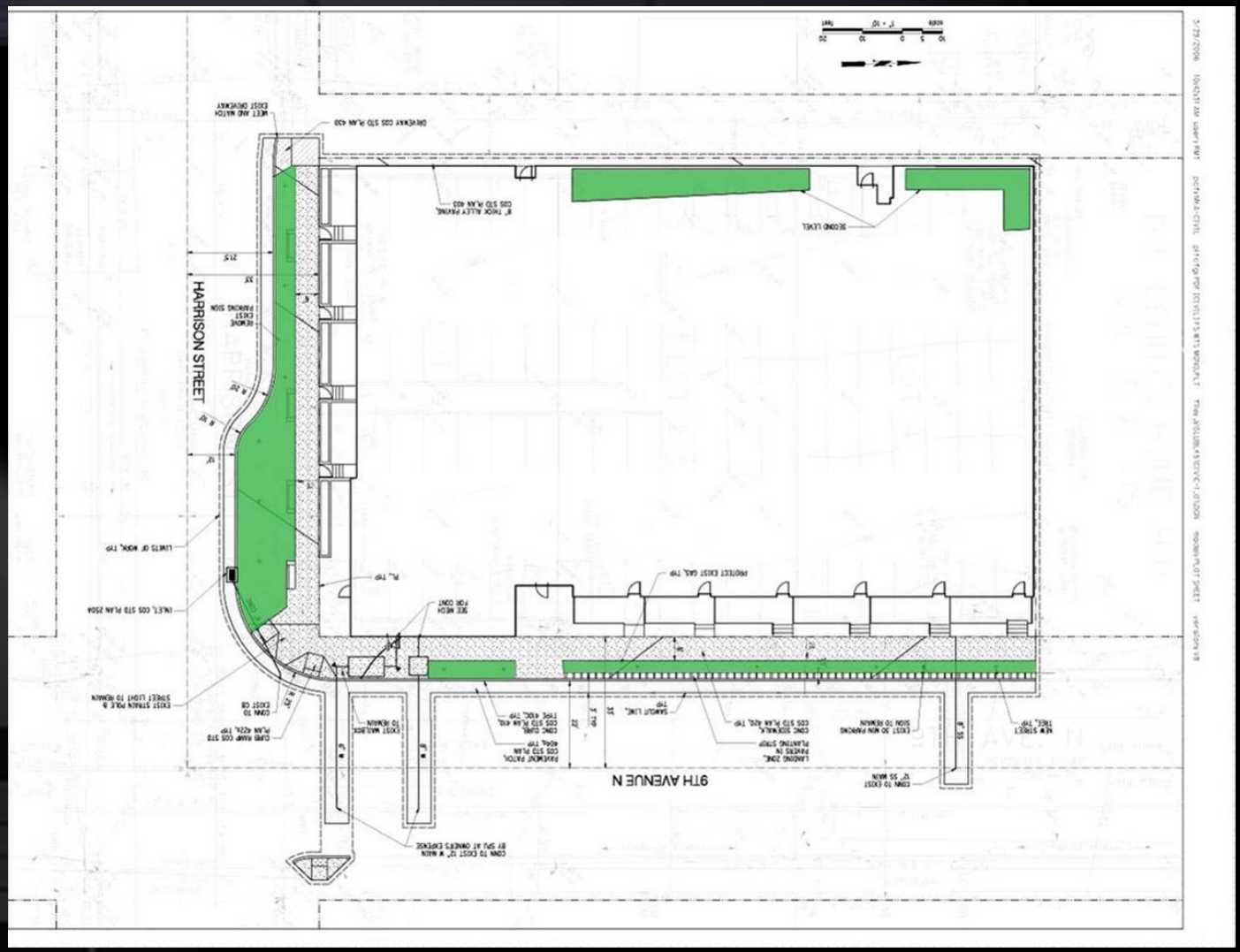
Final "Site" Plan: Self Mitigating Building



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Veer Lofts Summary

SGF	-	0.161
LEED 6.1	-	No
LEED 6.2	-	No
Detention	-	All Natural

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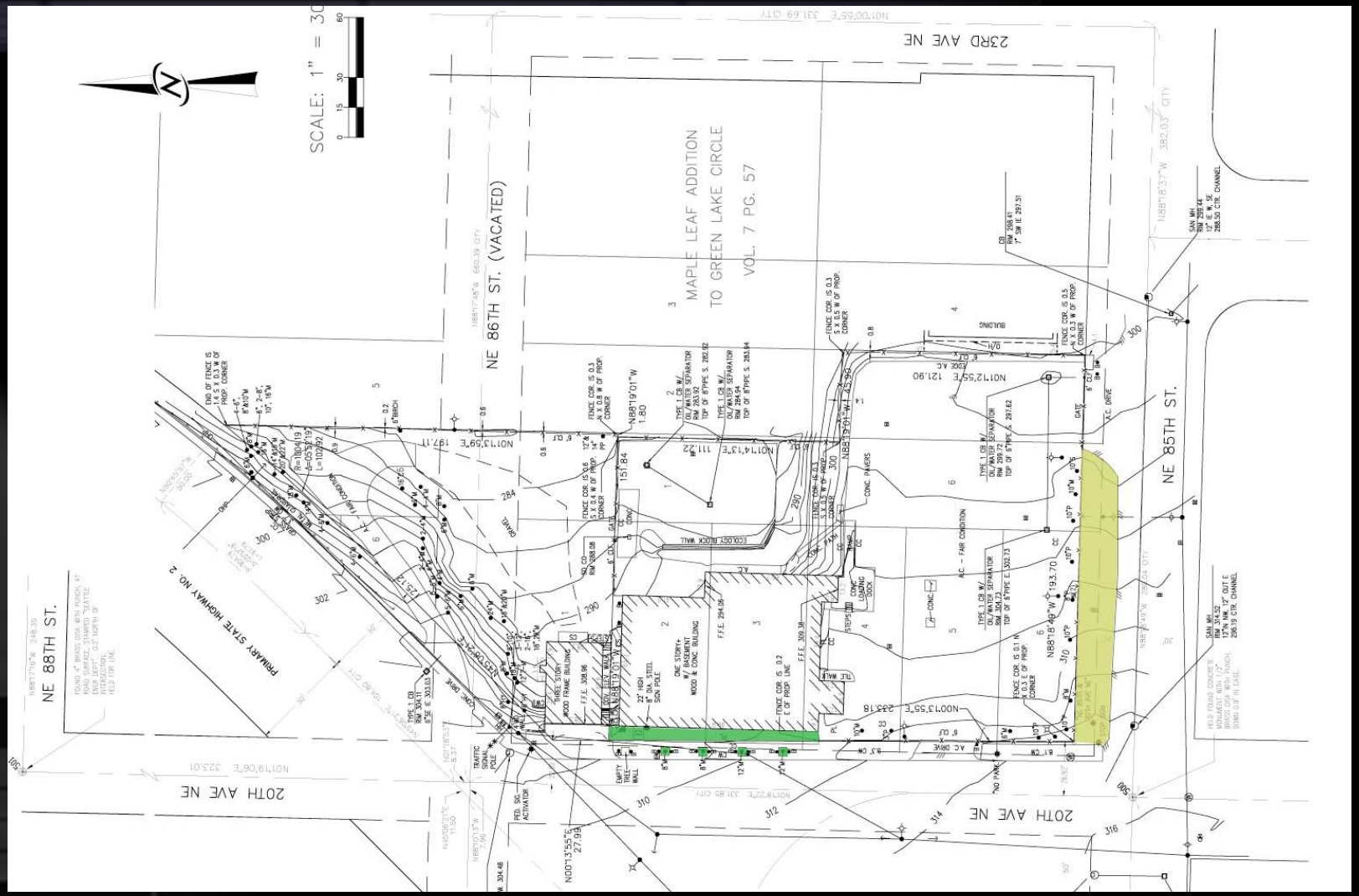
The Sedona



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Two Distinct Streetscape Languages

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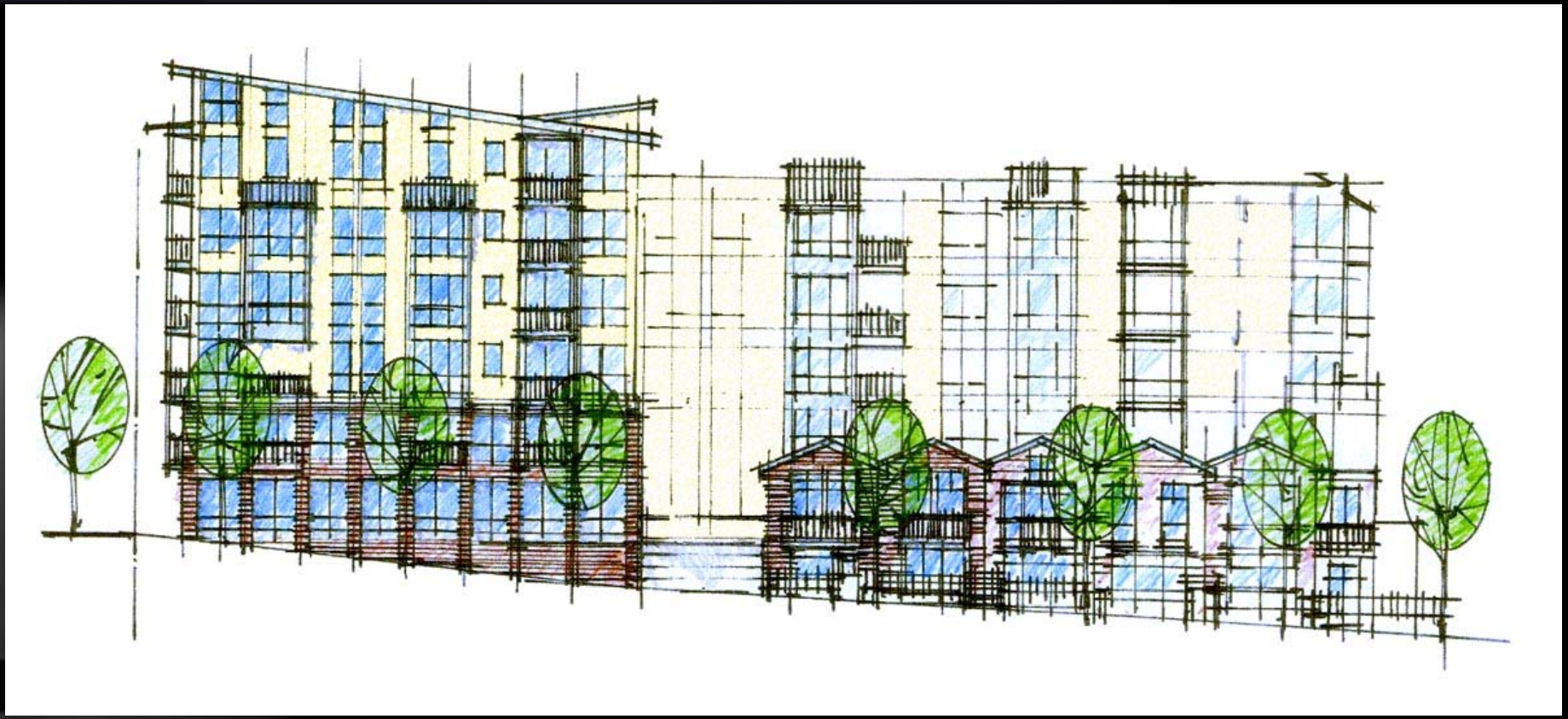

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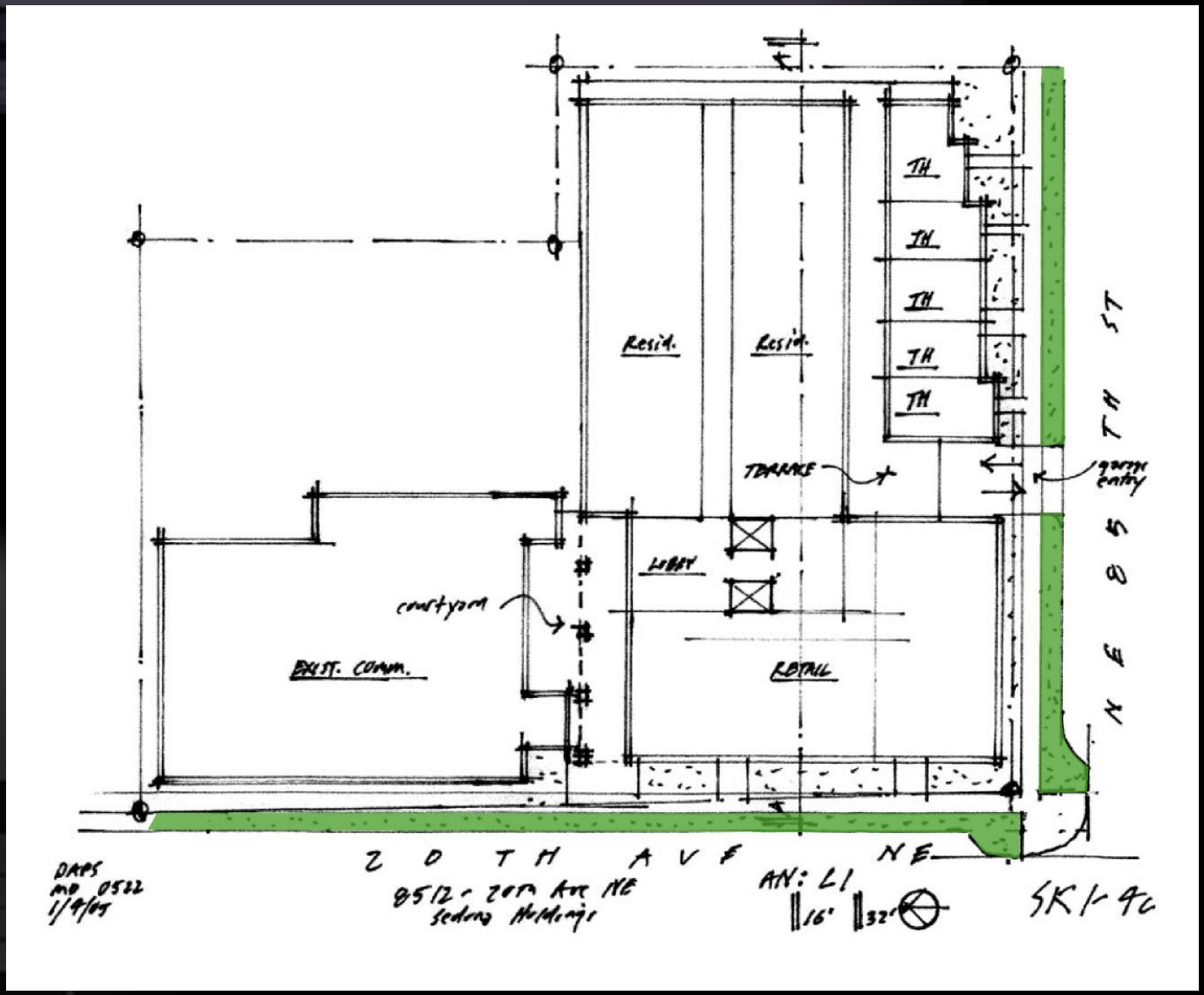

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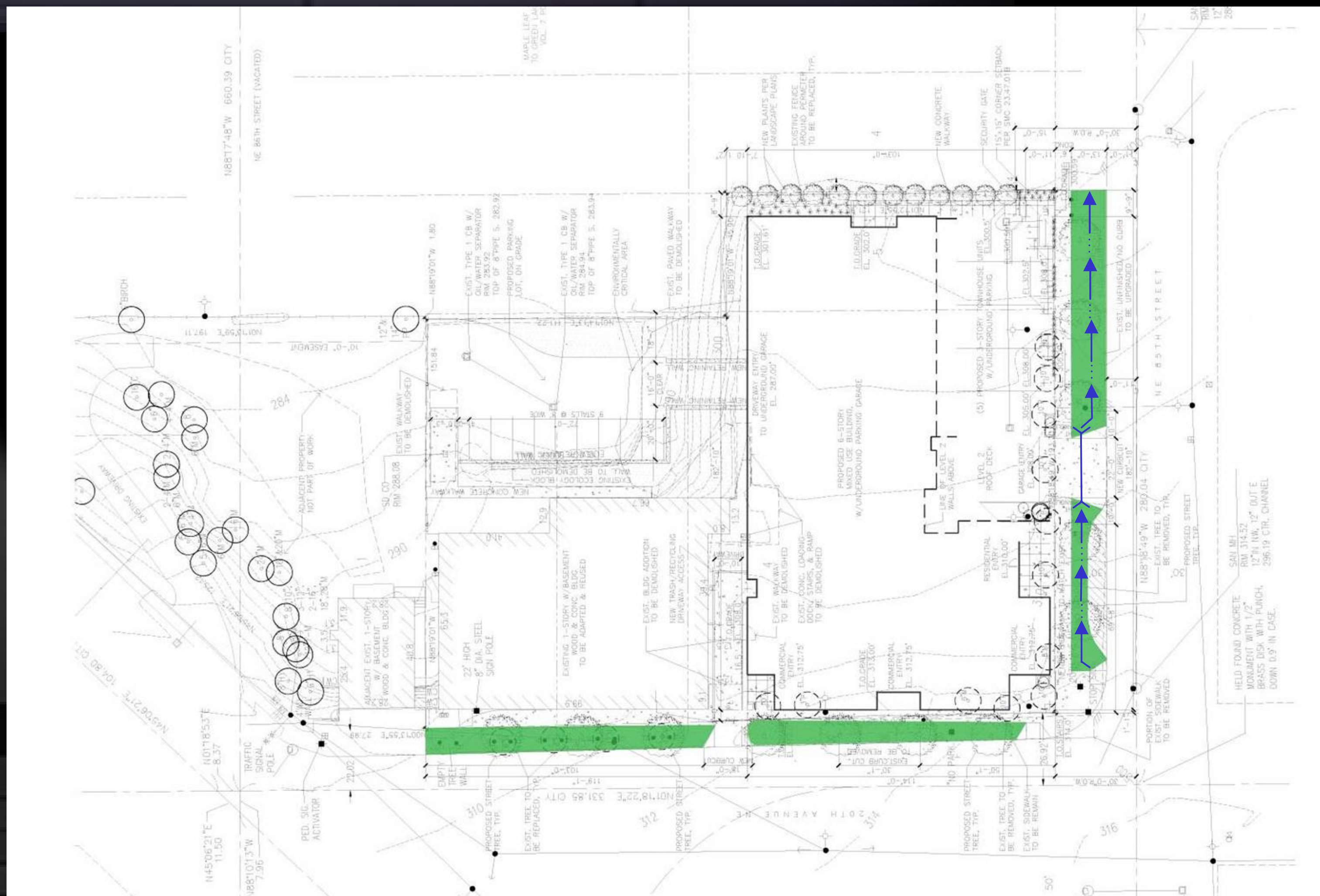

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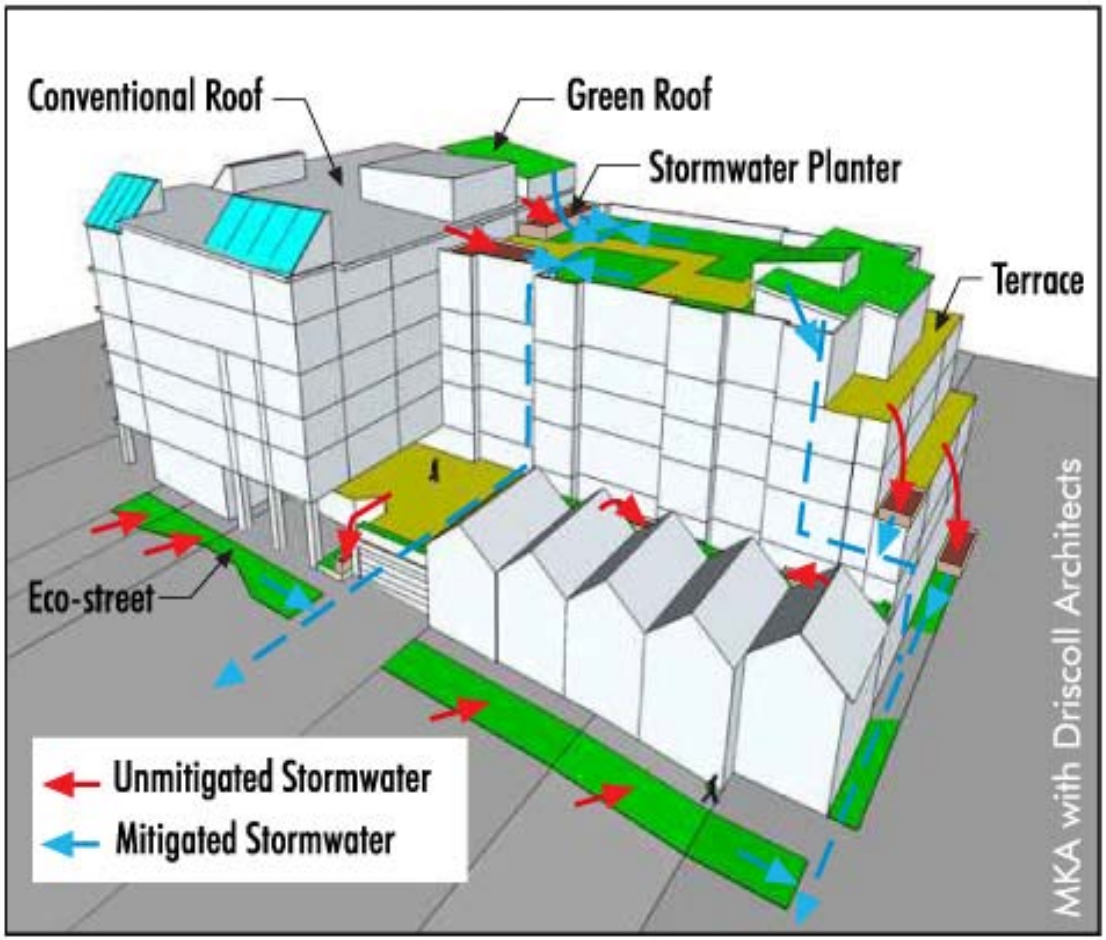
Self Mitigating Building with Eco-street



The Sedona project's storm water design is self-mitigating, with no need for a detention tank.

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The Sedona Summary

SGF	-	0.49
LEED 6.1	-	Yes
LEED 6.2	-	Maybe
Detention	-	All Natural

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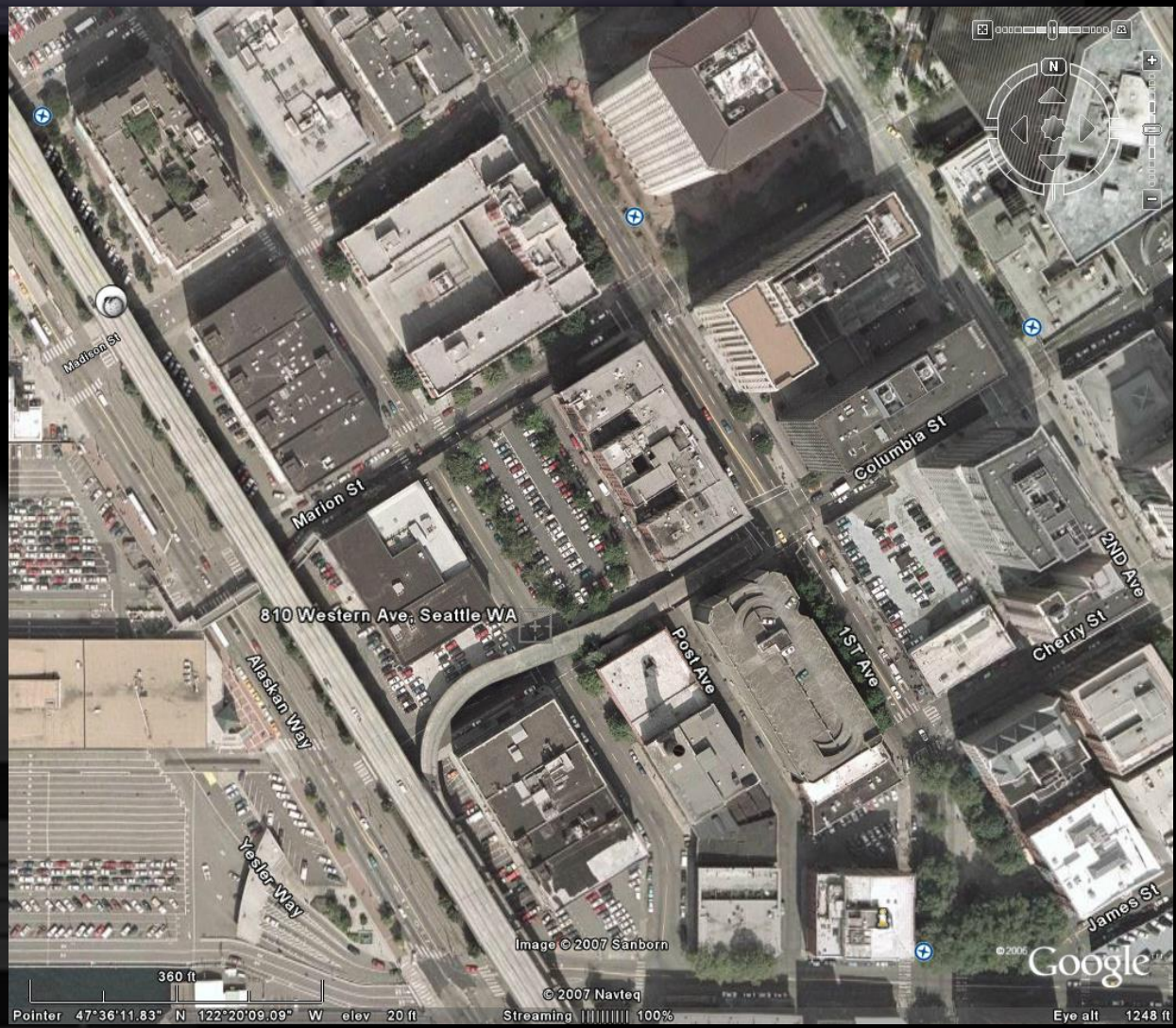
Colman Center



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Colman Center

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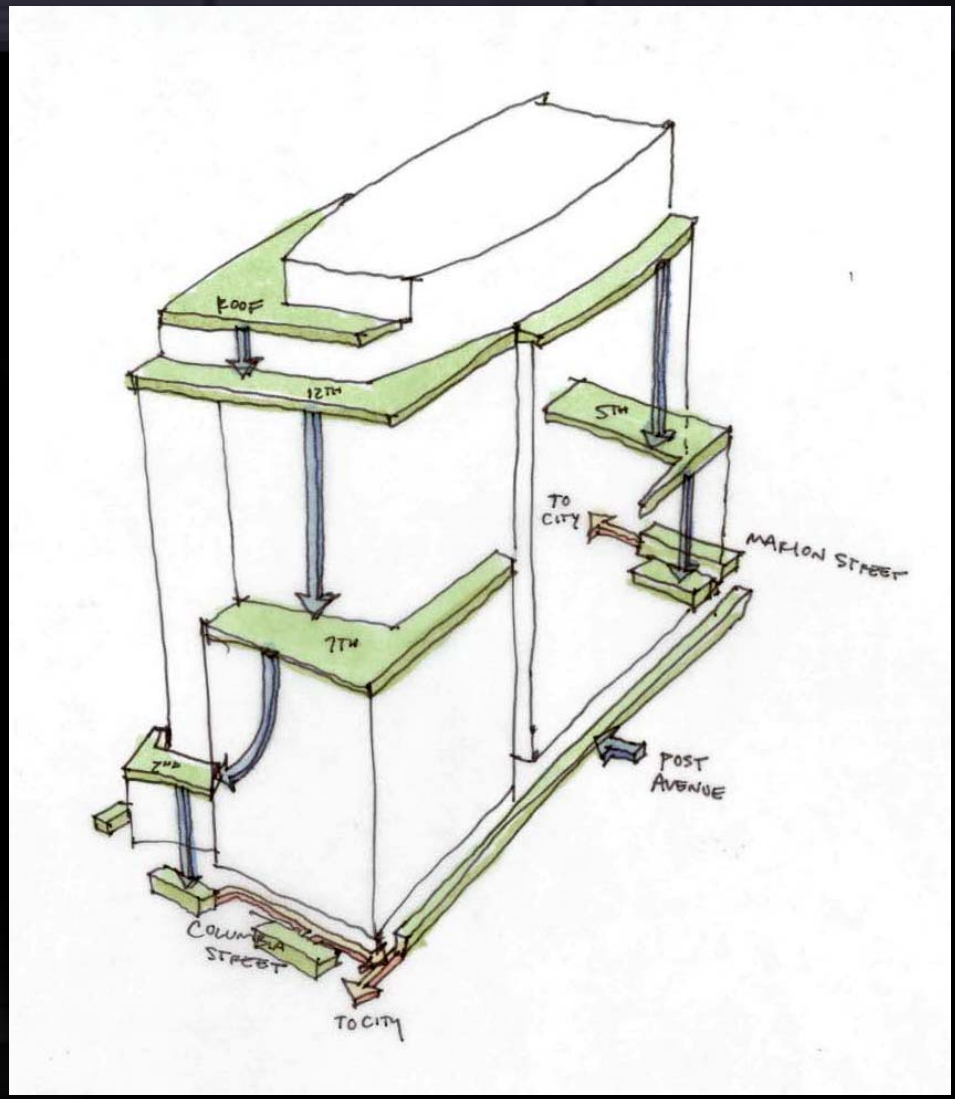
Original Landscape Vision



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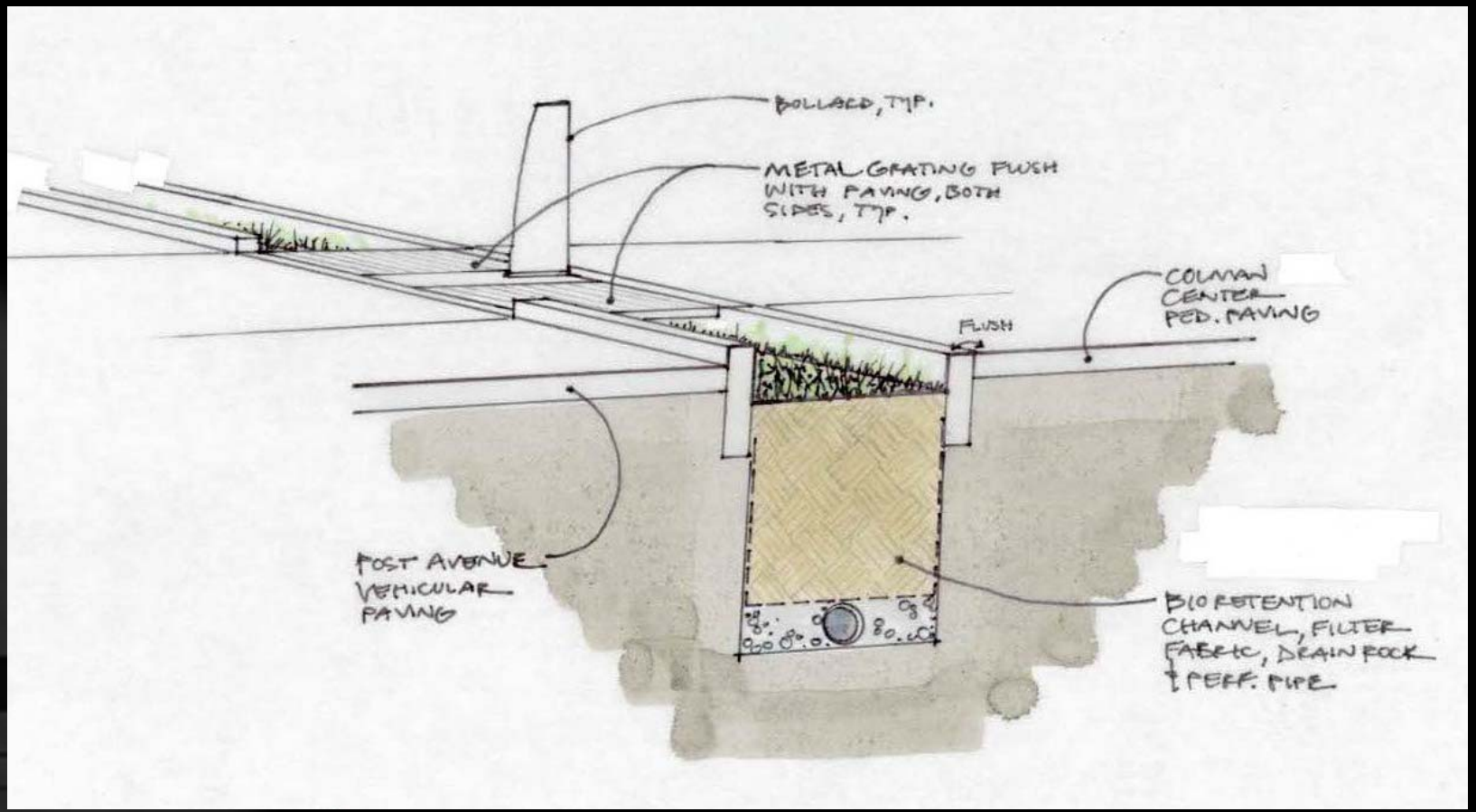
SMB with Urban Eco-Street



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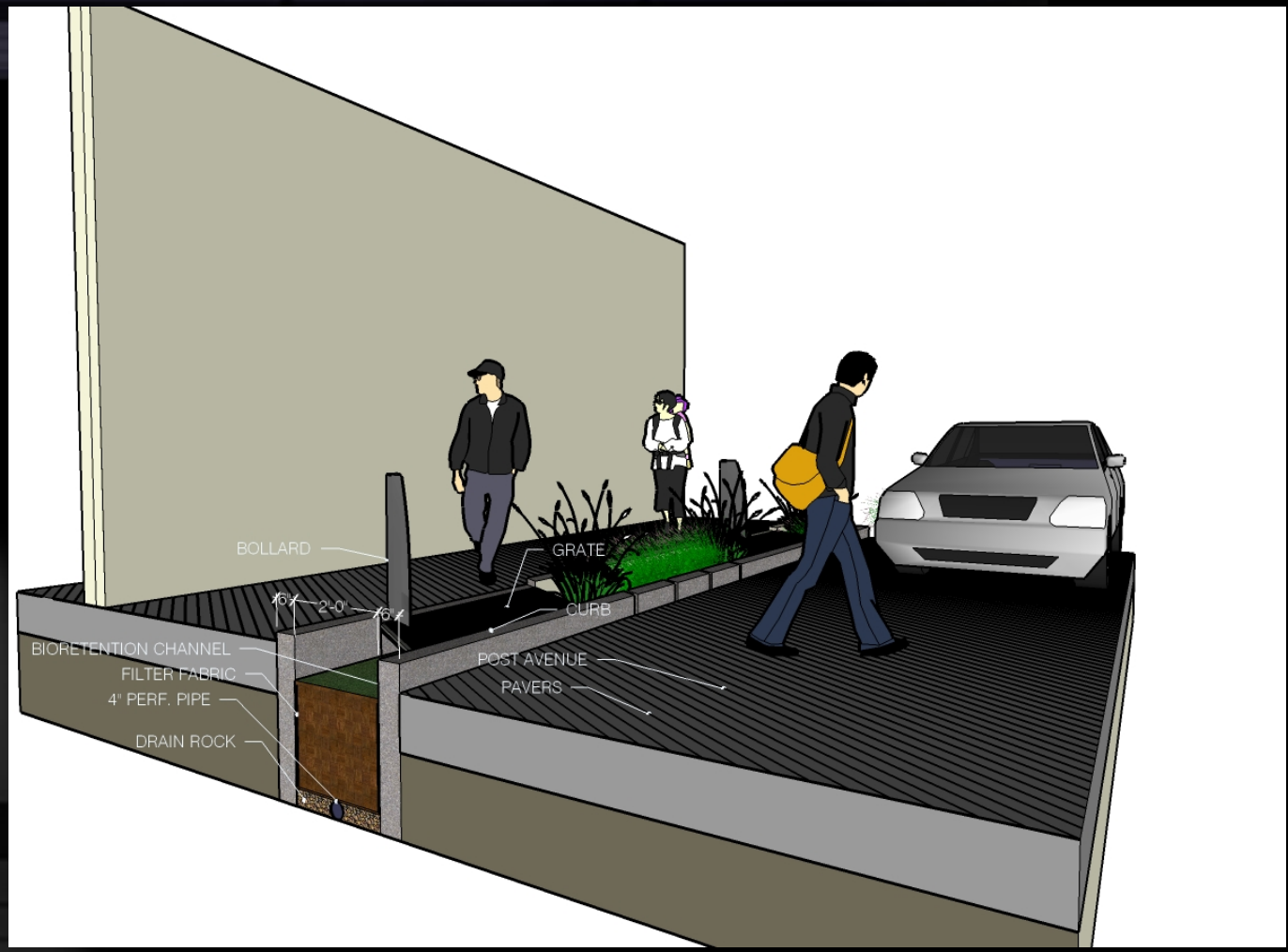

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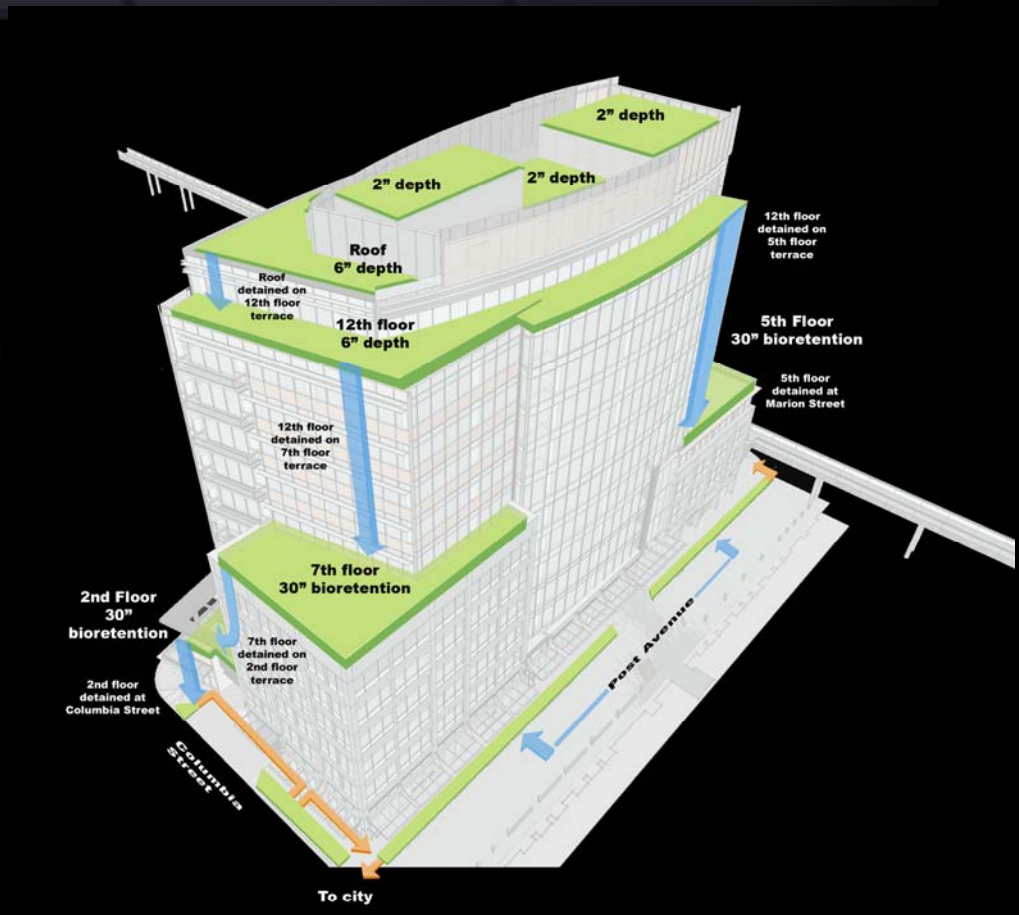

COLEMAN CENTER
BIORETENTION DIAGRAM

The Berger Partnership PS
Landscape Architecture

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Colman Center Summary

SGF	-	0.322
LEED 6.1	-	Yes
LEED 6.2	-	Maybe
Detention	-	All Natural

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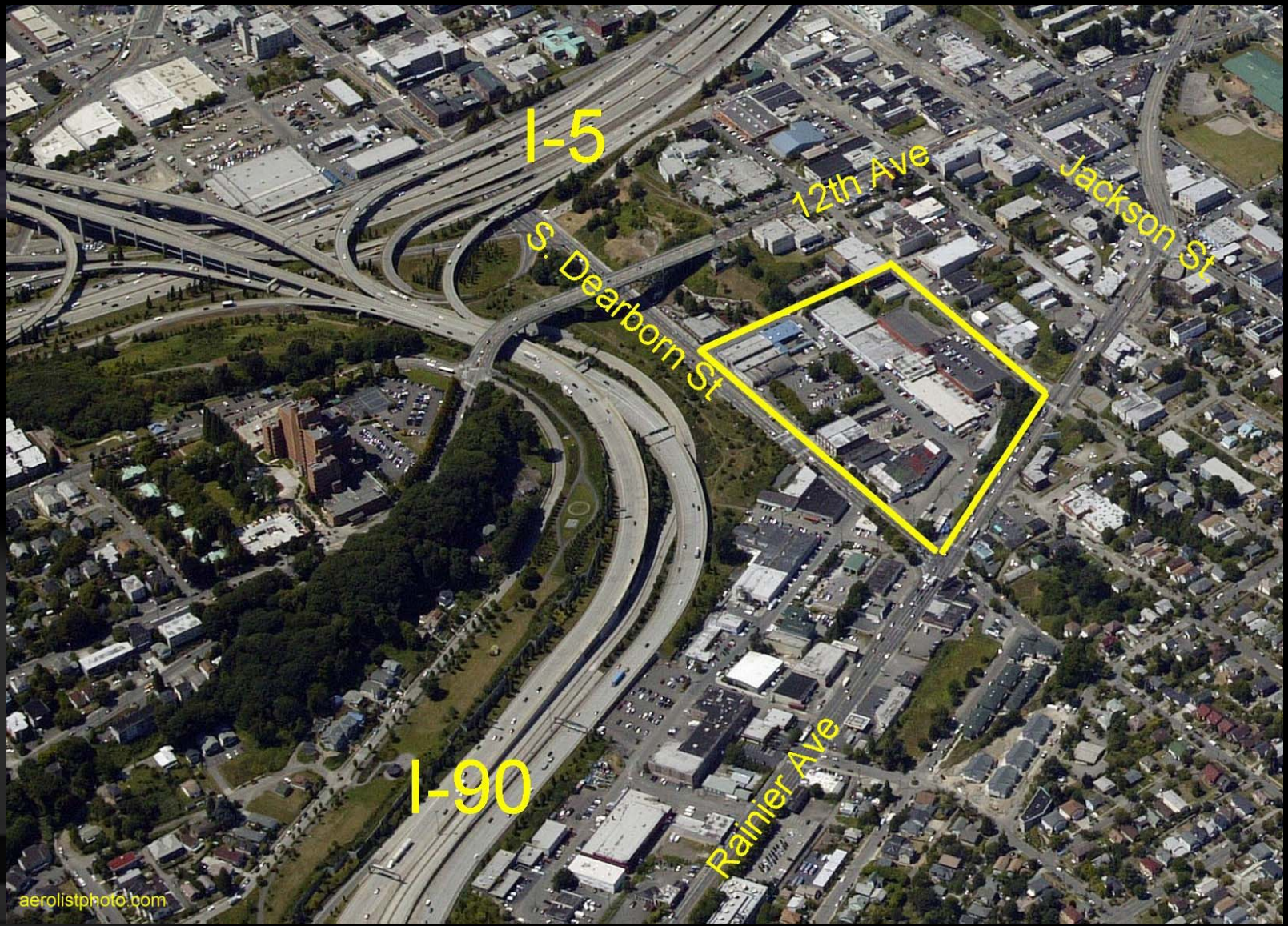

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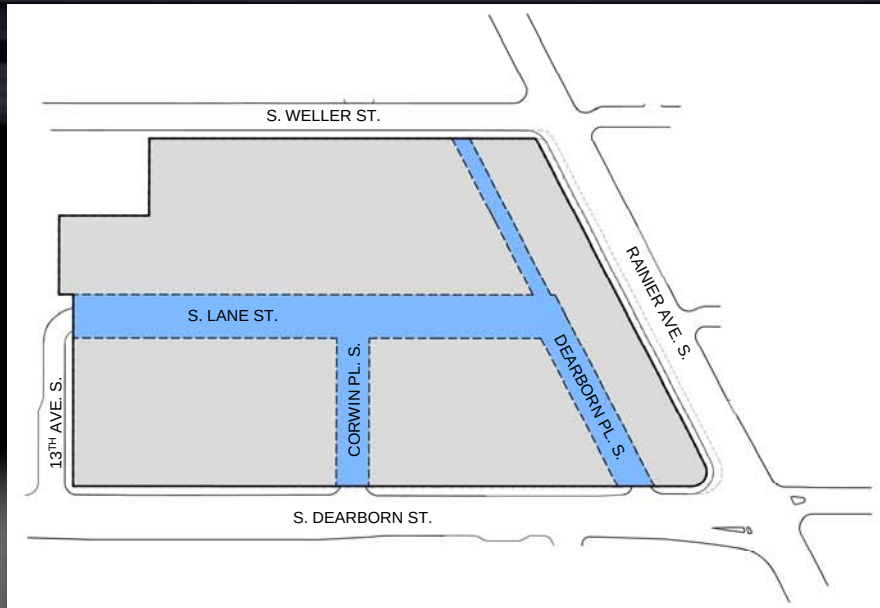
RIGHT-OF-WAY TO BE VA

MAGNUSSON KLEMENCIC ASSOCIATES



EXISTING S

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Tree Box Filter (Root Canal)

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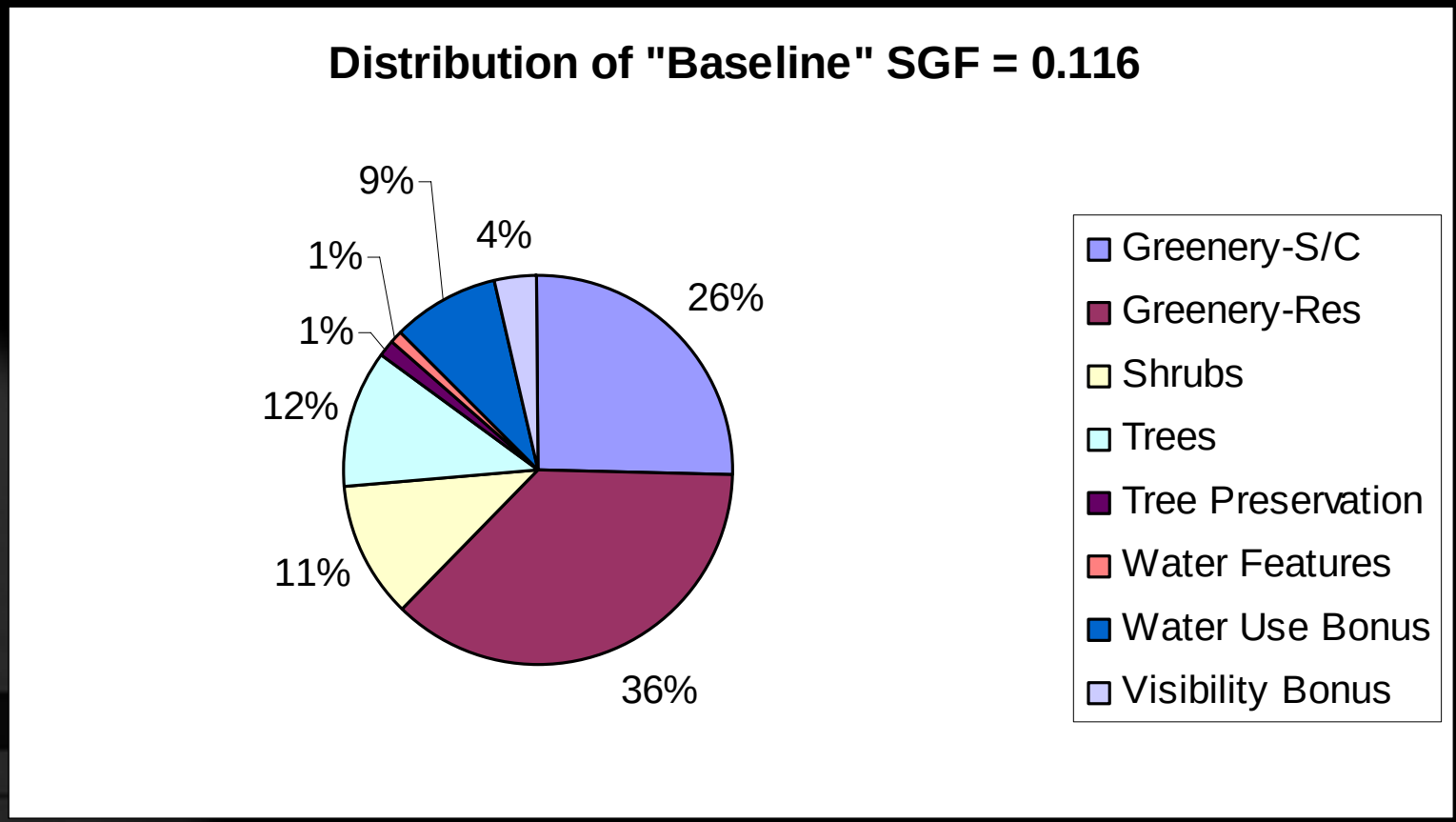
Baseline SGF



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Distribution of 0.30 SGF

Item	SGF		Portion
	Component	Cumulative	
Baseline	0.116	0.116	39%
Permeable Paving (35,860 sf)	0.049	0.165	16%
Green Walls (18,908 sf)	0.030	0.195	10%
Additional Visibility Bonus	0.004	0.199	1%
Green Roof (65,000 sf)	0.101	0.300	34%

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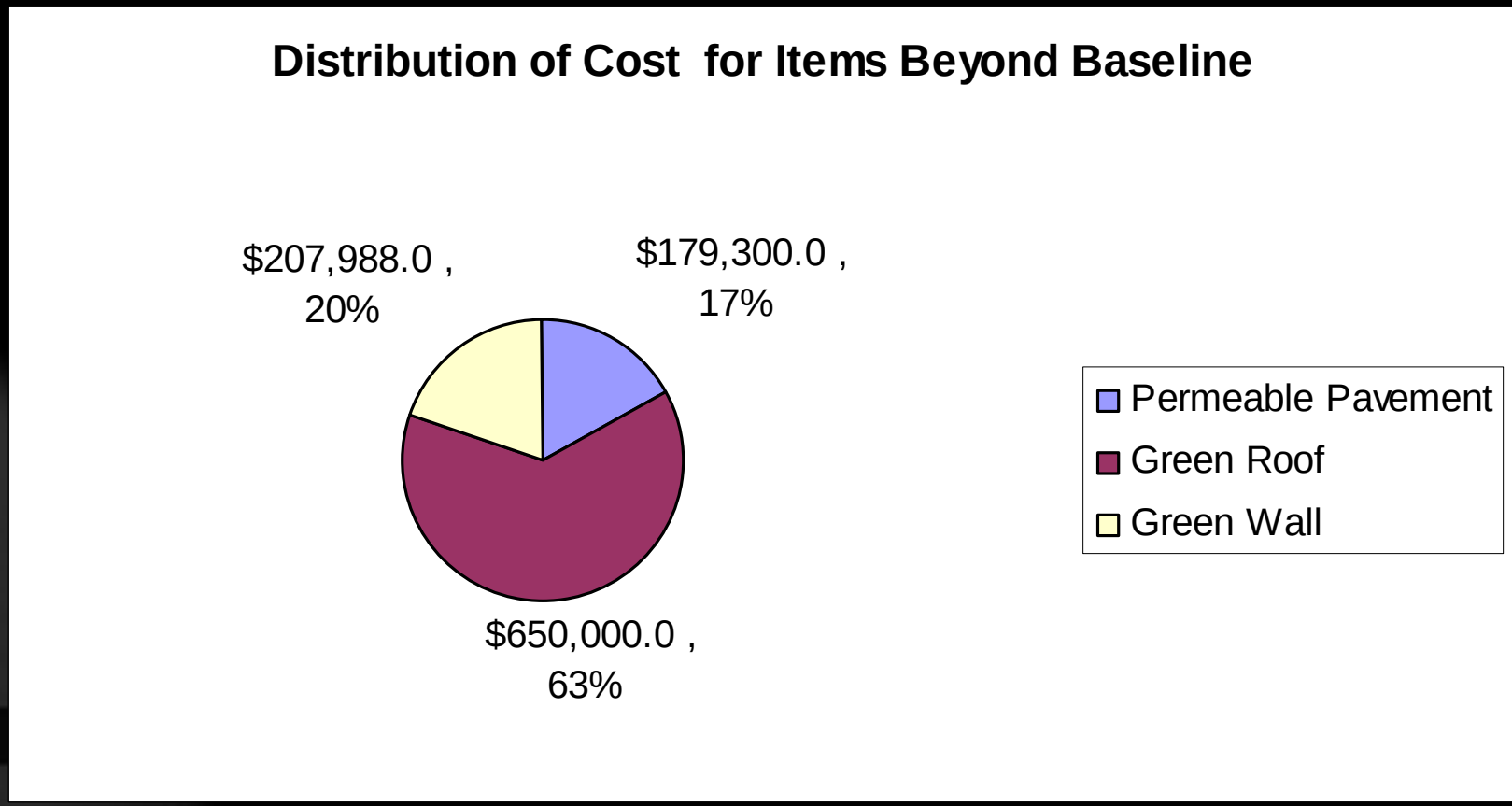
Distribution of 0.30 SGF



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Adding Neighborhood Streets

Item	SGF		Portion
	Component	Cumulative	
Baseline	0.116	0.116	39%
Permeable Paving (35,860 sf)	0.049	0.165	16%
Green Walls (18,908 sf)	0.030	0.195	10%
Additional Visibility Bonus	0.004	0.199	1%
Green Roof (20,000 sf)	0.032	0.231	11%
Neighborhood Streets (20,000 sf)	0.069	0.300	23%

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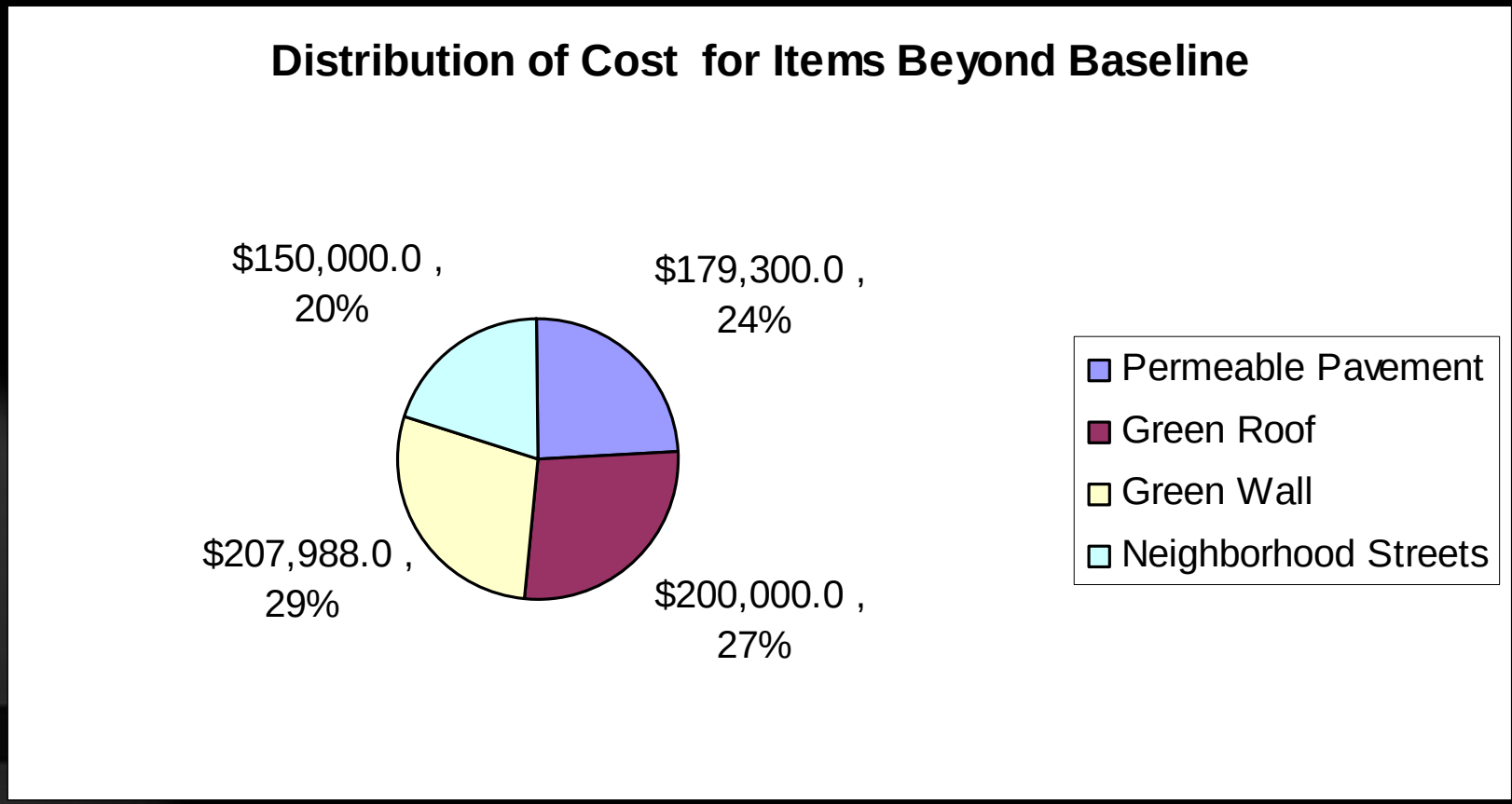
Revised Distribution



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Dearborn Street Summary

SGF	-	0.3
LEED 6.1	-	Yes
LEED 6.2	-	Yes
Detention	-	Some Natural/Some Conventional

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Evolutions

- Serving the building and the street (40% of the land is being ignored)
- City Street Retrofits
- Incentives for Distributed Infrastructure
- SGF Improvements
  - Permeable paving
  - Rain garden bonus
  - Mid-sized shrubs
- Coming to Other Zones
- More High Performance SGF Projects

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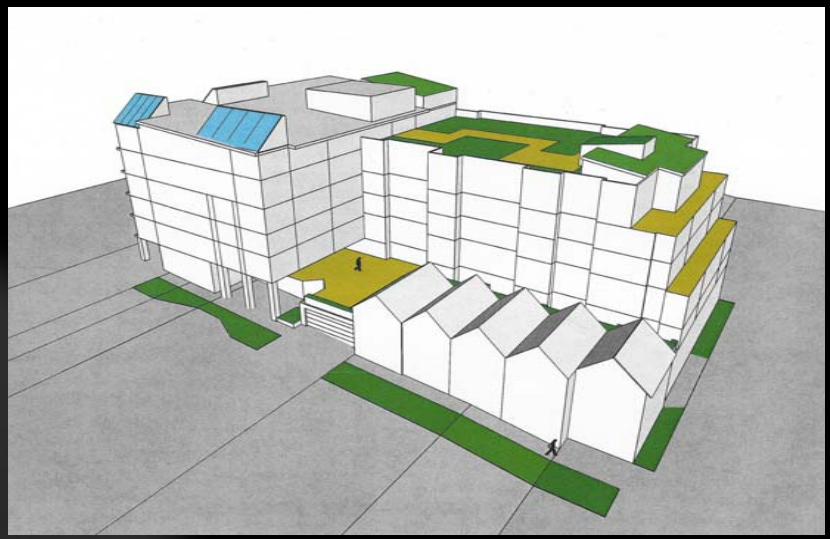
Back to Basics



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