

PLANNING AND IMPLEMENTING GREEN STORMWATER INFRASTRUCTURE

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Meliora Design*

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APA-PA Conference (Allentown, PA)
October 16, 2016

MELIORA DESIGN

Civil, Water Resources, and Structural Engineering



OUTLINE

- Water Cycle
- CSOs
- Philadelphia
 - Green City, Clean Waters
 - Planning process
 - GSI Examples
- What's happening in other cities
- New Municipal Stormwater Regulations
- Regulatory Tools for GSI
- GSI Implementation in Small Municipalities
- Incentive Program for GSI

Meliora Design

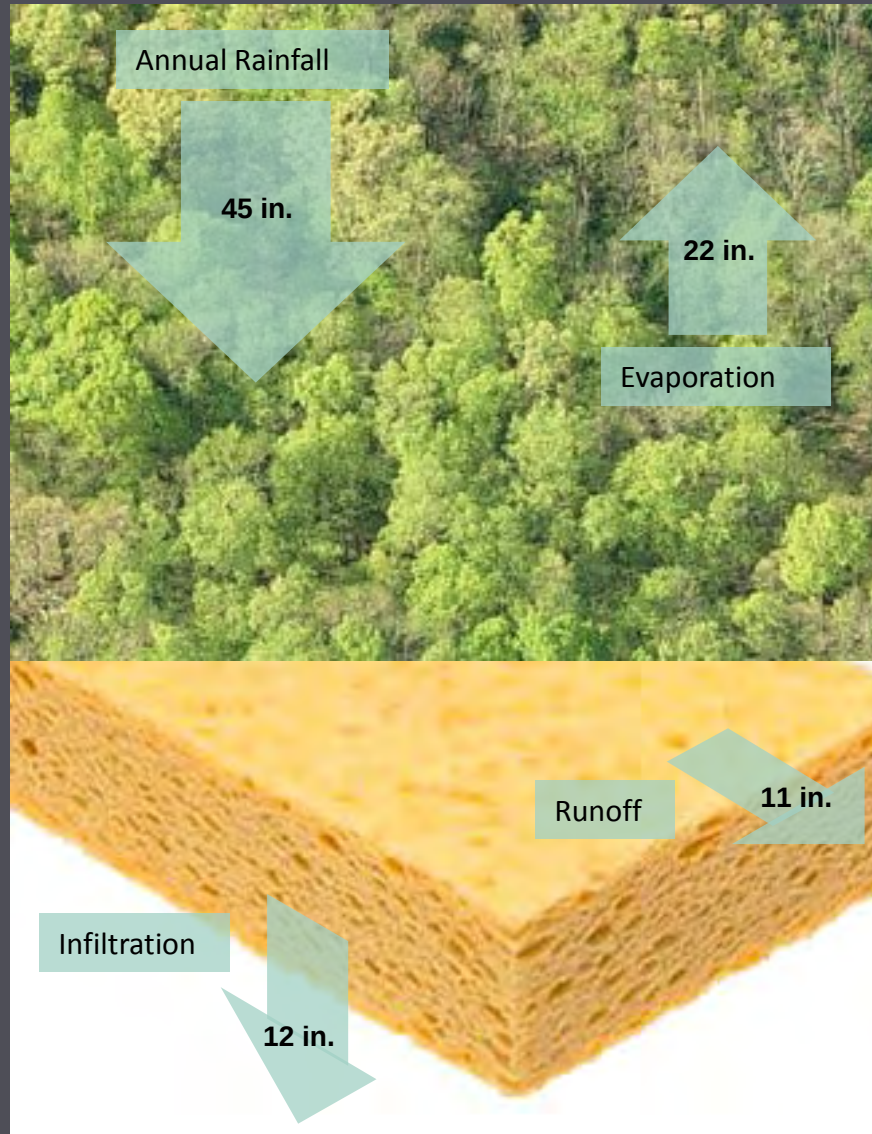
WHO WE ARE

- Civil engineering
- Specialize in Sustainable Site Design and Stormwater Management
- Planning
- Advocacy
- Certified Women-owned Business Enterprise (WBE)



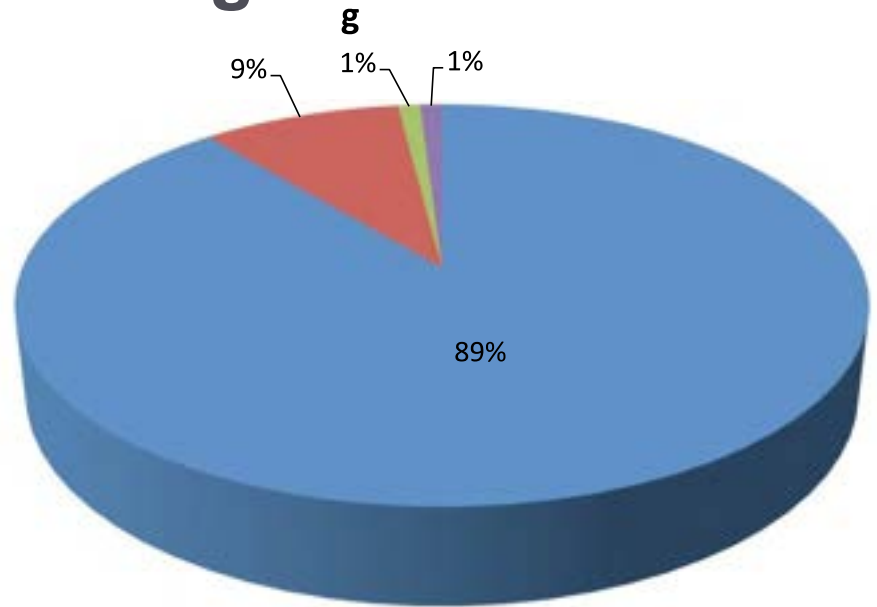
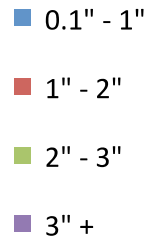
Natural Water Balance

Philadelphia, PA

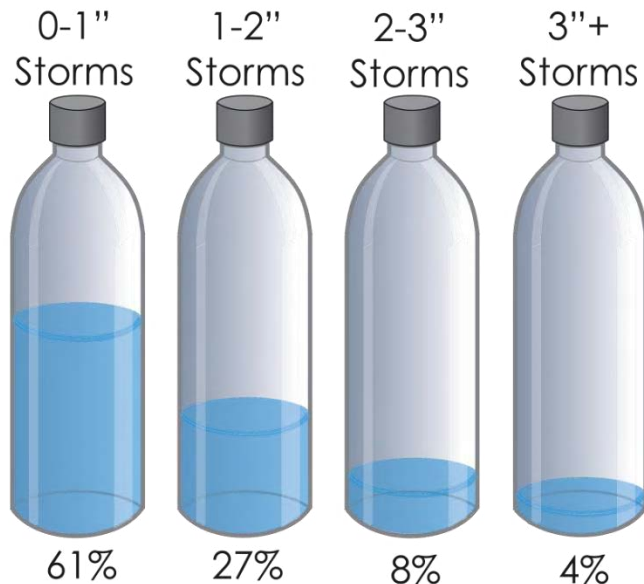


RAINFALL: 45" per year on average

Frequency: Most of the time,
it rains 1 inch or less



Annual Percentages of Volume from Storms



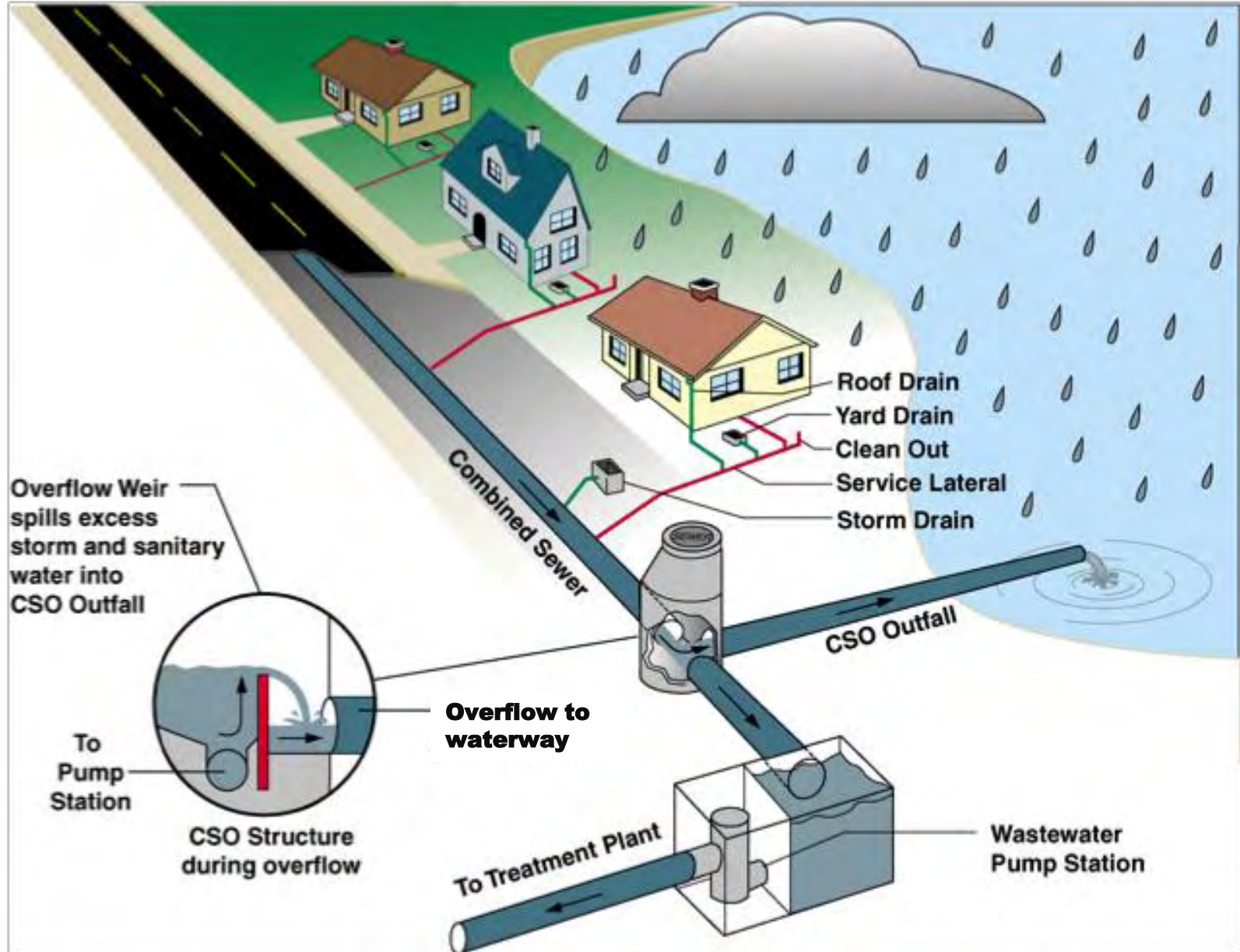
Small storms comprise
most of the annual Volume
of rainfall.

Philadelphia

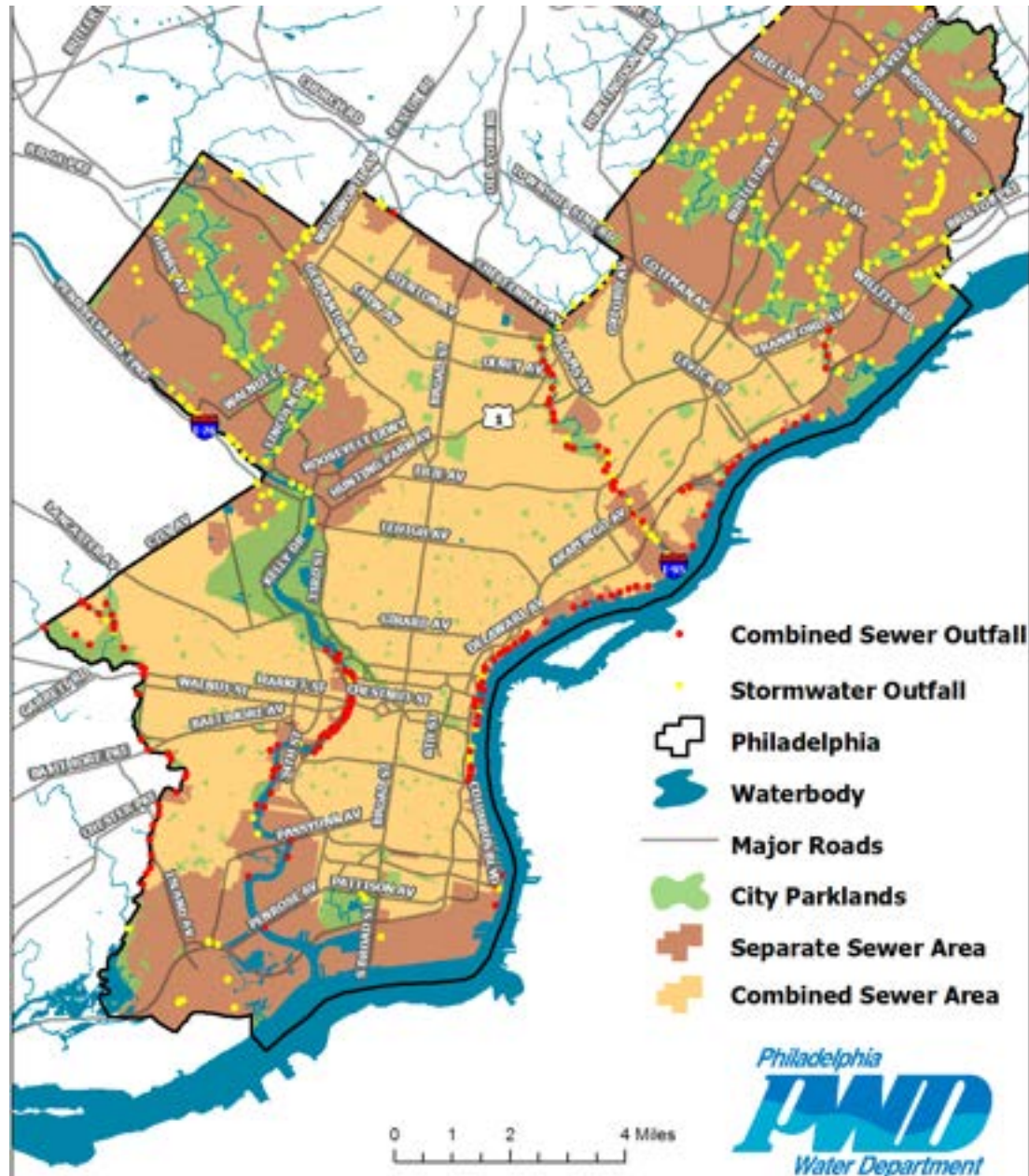


Image Source: Google Earth

Combined Sewer Systems (CSS)



Combined Sewer Overflows (CSO)



Green City Clean Waters

The City of Philadelphia's Program for Combined Sewer Overflow Control
A Long Term Control Plan Update

- Public Green Stormwater Infrastructure Projects
- Incentivized Stormwater Infrastructure Projects
- (Re)Development Green Stormwater Infrastructure

5 Down, 20 to Go: Celebrating 5 Years Neighborhoods

As of June 1, 2016 the Green City, Clean Waters program has established 837.7 Greened Acres, exceeding the five-year regulatory target and reducing pollution from stormwater runoff and combined sewer overflows by more than 1.5 billion gallons annually.





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Planning for Success

- Mapping
- Site Analysis
- Capital Projects are an opportunity for GI:
 - Sidewalk improvements
 - Intersection improvements
 - Water and sewer line work
- All municipal and public projects maximize GI (schools, parks, streets, etc.) are opportunities
- Public involvement early on
- Project tracking
- Maintenance Plans & Training

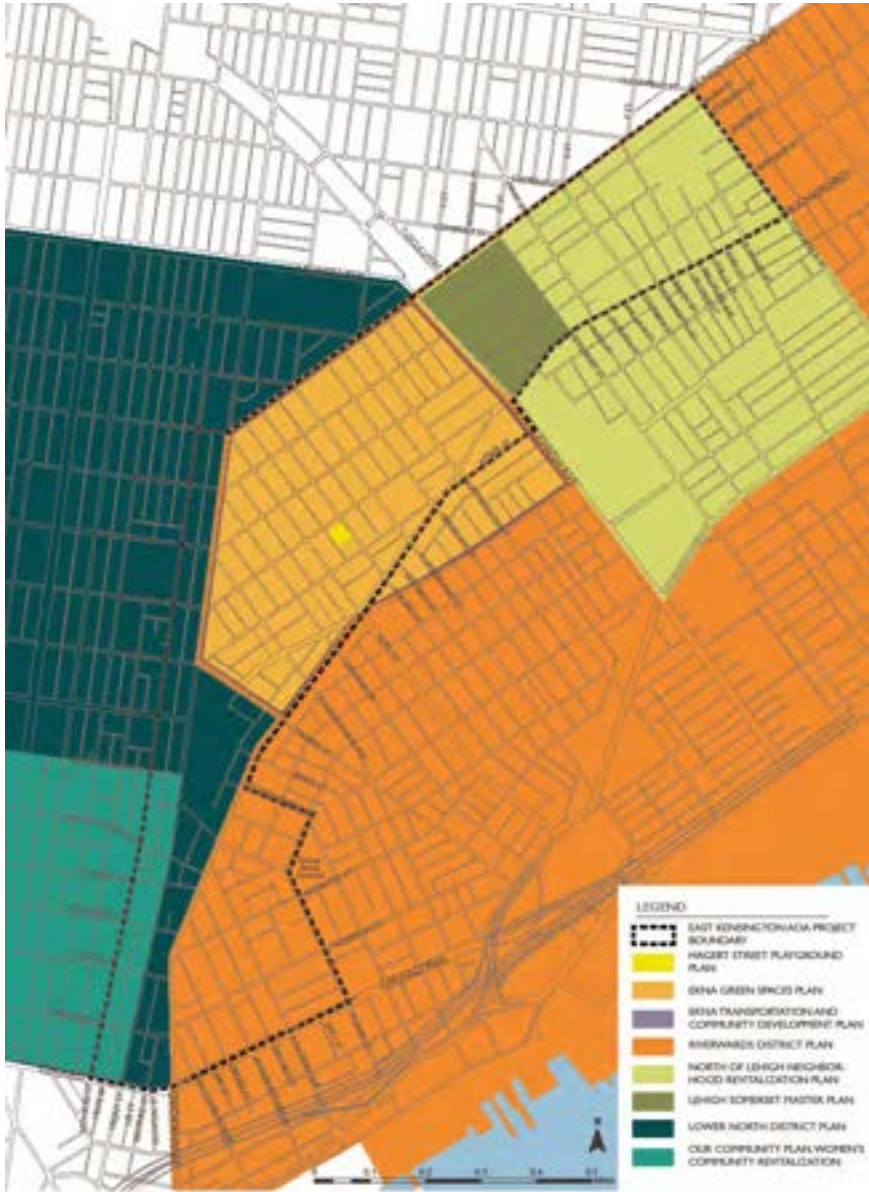
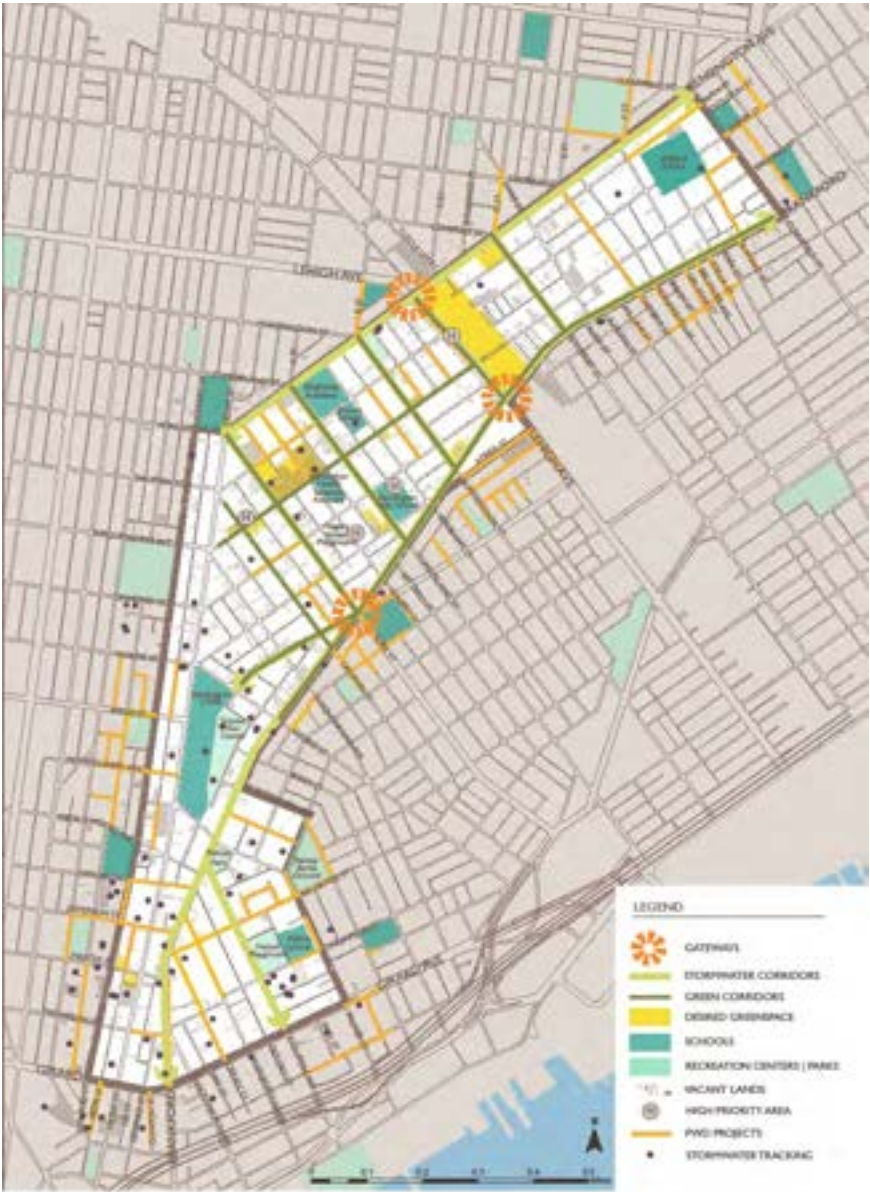
GIS BASEMAP LAYERS

- ❑ Conceptual Work
 - GSI SMP Footprint Concept
 - GSI Drainage Area Concept
- ❑ Planning Group Layers
 - Project Opportunity Parcels in CSO
 - Planning Study Areas
- ❑ Existing Projects
 - CAPIT Projects
 - SW Permit Tracking
 - GSI Project Areas
 - Green Stormwater Infrastructure
 - Green Stormwater Infrastructure Drainage Area
- ❑ PWD Infrastructure
 - Sewer
 - Combined System (CSO)
 - Inlet
 - Manhole
 - Sewer Inlet Pipe
 - Sewer
 - Waste Water Vent Pipes
 - Separate & Green System (SS)
 - Stormwater Manholes
 - Stormwater Inlets
 - Stormwater
 - Stormwater Inlet Pipes
 - Stormwater Vent Pipes
 - Water
 - Fire Hydrant
 - Water Valves
 - Water
 - Water Service Line Pipes
 - Water Hydrant Line Pipes
- ❑ Environmental
 - Flow Network
 - Ridges
 - Nodes
 - Valleys
 - Streets
 - Impervious and Sewersheds
 - Philadelphia Major Watersheds
 - Sewersheds
 - Modelsheds
- ❑ Reference
 - Neighborhoods
 - Council Districts 2016
 - Land Use
 - Philadelphia Planning Districts
 - Philadelphia Parks & Recreation
 - Philadelphia City Limits
- ❑ Base Layers
 - Streets
 - PWD Parcels
 - Topographic 2' Contours
 - Curbs
 - Hydrology Centerline
 - Hydrology Polygon
 - Aerial Imagery 2012

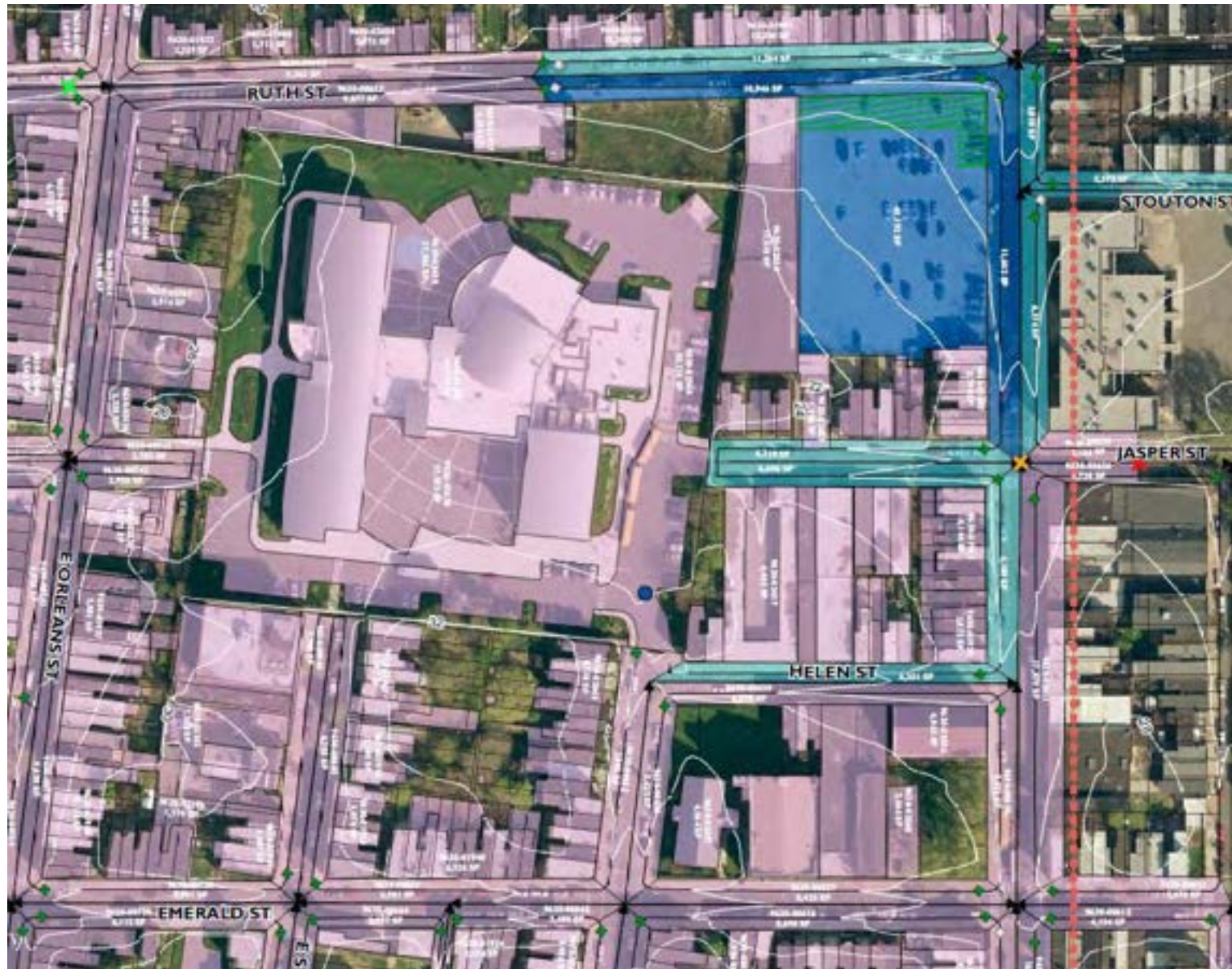
PREVIOUS STUDIES



PREVIOUS STUDIES



DRAINAGE AREA MAPPING



UTILITY MAPPING



GSI SIZING

- DRAINAGE AREA > 5,000 SF
- DOWNSTREAM OF EXISTING INLET
- 3' BUFFER FROM ROW LINE
- 5' BUFFER FROM ADJACENT PROPOERTY LINE
- 4' MINIMUM TREE TRENCH WIDTH
- 3' BUFFER FROM UTILITIES
- 20' MINIMUM STREET WIDTH FOR BUMPOUTS



GSI OPPORTUNITIES

- UTILITIES
- SUFFICIENT SPACE FOR SMP FOOTPRINT
- MATURE TREES
- STEEP TOPOGRAPHY
- PREFER: SCHOOLS, PARKS, VACANT LOTS, TAX DELINQUENT PARCELS



GIS LAYER – CONSTRAINTS

Drainage Area ID	
PlanIT ID	<Null>
Drainage Area Feasibility	<Null>
Constraints 1	<Null>
Constraints 2	<Null>
Constraints 3	<Null>
Obscuring Utilities 1	<Null>
Obscuring Utilities 2	<Null>
Obscuring Utilities 3	<Null>
Notes	<Null>
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Edited By	<Null>
Consultant	<Null>
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OR_Drawnby	<Null>
OR_Drawndate	<Null>
Shape.STArea()	30,900
Shape.STLength()	1875.136371

TRACKING DATA

Data Tracking (Recommended): Study Area

GRI Project Number (if recommended potential)	Segment or Parcel ID (ID of Street Centerline Layer or PARCELOID of Parcel Layer)	Site Name ("Parcel Address" and Facility Name if applicable) or "X St from Y St to Z St"	Primary Poop	Ownership	Owner Name	Site Evaluating Result	# Recommended or Potential, Drainage Area Map Number, Managed (SLP, IL)	Estimated Drainage Area (C)	Max Potential Drainage Area (C)	Difference Between Max Potential & Estimated (select multiple)	Recent Improvements On Site?	# Yes, Type? (select multiple)	Are There Physical Constraints?	Have Utilities Been Evaluated? (select multiple)
FC00	518464	2101E VENANGO ST	FACILITIES	PRIVATE	NEWELL MARTIN P JR	RECOMMENDED	P405, P192, S707	27,221	47,041	ROOFTOP	NO		NO	GS, GAS
FC01	357255	3501 JANNEY ST	FACILITIES	PRIVATE	SMAGACH JOHN P	RECOMMENDED	P444, S076	7,391	7,391		NO		NO	GS, GAS
FC02	357255	3501 JANNEY ST	FACILITIES	PRIVATE	SMAGACH JOHN P	RECOMMENDED	P471	7,292	7,292		NO		YES	GS, GAS
FC03	262650	2275 E TODA ST	FACILITIES	PRIVATE	2275 E TODA STREET LLC	RECOMMENDED	P443	3,608	3,608		NO		NO	GS, GAS
FC04	306330	3515 LAMBER ST	FACILITIES	PRIVATE	WORTHMAN RICHARD LLP	RECOMMENDED	P382, S374, S371	25,638	30,043	STREET CROSSING	NO		NO	GS, GAS
FC05	500001	3737-371 FRANKFORD AVE	FACILITIES	PRIVATE	SCYPER LEN	RECOMMENDED	P186, S323, S324	26,897	26,897		NO		NO	GS, GAS
FC06	344852	2045-SHE GLENWOOD AVE	FACILITIES	PRIVATE	SPIN MC	RECOMMENDED	P101, P177, S117	6,246	22,325	ROOFTOP	NO		NO	GS, GAS
FC07	248649	2035 E GLENWOOD AVE	FACILITIES	PRIVATE	HUMMEL ANDREW JV	RECOMMENDED	P180	3,931	3,931		NO		NO	GS, GAS
FC12	525000	5215 TULIP ST	FACILITIES	PRIVATE	EAST COAST RECYCLING INC	RECOMMENDED	P493, S420	16,030	16,030		NO		NO	GS, GAS
FC14	262363	2005-10 E ALLEGHENY AVE	FACILITIES	PRIVATE	ONP PROPERTIES LLC	RECOMMENDED	P285, R195, S197, S196	34,509	42,588	ROOFTOP	NO		NO	GS, GAS
FC15	205349	3740 FRANKFORD AVE	FACILITIES	PRIVATE	WALNUT STREET THEATRE COR	RECOMMENDED	P164, S438, S437	45,692	48,771	STREET CROSSING	NO		NO	GS, GAS
FC16	530804	2270 E BUTLER ST	FACILITIES	PRIVATE	LIPOFF MARTIN	RECOMMENDED	P181, R60, S774, S776, S785	9,081	34,287	ROOFTOP	NO		NO	GS, GAS
FC18	453776	3251 EMERALD ST	FACILITIES	PRIVATE	STRAUS MICHAEL S	RECOMMENDED	P195, R708, S299	3,702	20,528	ROOFTOP	NO		NO	GS, GAS
FC19	97504	3405 COLLINS ST	FACILITIES	PRIVATE	VALUE STORAGE	RECOMMENDED	P248, S623, S626	58,326	58,326		NO		NO	GS, GAS
FC20	226227	2230 CASTOR AVE	FACILITIES	PRIVATE	CASTOR AVENUE PROPERTIES	RECOMMENDED	P146, S736, S63	35,070	35,070		NO		NO	GS, GAS
FC22	529530	3355-45 KENNINGTON AVE	FACILITIES	PRIVATE	7-ELEVEN INC	RECOMMENDED	P386, S631	10,617	10,617		NO		NO	GS, GAS
FC23	535607	3630-32 FRANKFORD AVE	FACILITIES	PRIVATE	HUGHES GREGORY K	RECOMMENDED	P456, S632	12,224	12,224		NO		NO	GS, GAS
FC25	149372	2005-15 E GLENWOOD AVE	FACILITIES	PRIVATE	HUMMEL ANDREW JV	RECOMMENDED	P48, S162, S718	40,907	40,907		NO		NO	GS, GAS
FC26	527229	2239-43 E ONTARIO ST	FACILITIES	PRIVATE	W-D AQUATION CORP INC	RECOMMENDED	P483, R226	8,846	41,196	ROOFTOP	NO		NO	GS, GAS
FC29	663457	2275 E WESTMORELAND ST	FACILITIES	PRIVATE	MARIANO DOMINIC	RECOMMENDED	P339	71,467	71,467		NO		NO	GS, GAS
FC30	73108	2220 E ONTARIO ST	FACILITIES	PRIVATE	ONTARIO ASSOCIATES LLC	RECOMMENDED	P479, S593	17,825	17,825		NO		NO	GS, GAS
FC31	515767	3434 KENSINGTON AVE	FACILITIES	PUBLIC	CITY OF PHILADELPHIA	RECOMMENDED	SEE PARCELOID 530842	-	-		NO		NO	GS, GAS

SITE VISITS

1. Confirm parcel name (if applicable)
2. Inlet locations - identify type and current condition
3. Tree locations - identify location and note condition.
4. Access points - identify locations of gates, doors, curb cuts and driveways
5. Utility mark-outs- identify type and distance from front of curb
6. Valves and manholes - identify type (gas, sewer, water, unknown)
7. Handicap ramp locations and condition
8. Bus stops and other public transit
9. Sidewalk widths
10. Sidewalk condition
11. Curb reveal- identify material and reveal
12. Parking-identify no parking zones and the type and location of parking spaces
13. Bike lanes - note location
14. Overhead wires - identify location and clearance
15. Runoff flow directions (i.e. surface flow directions)
16. Misc. features such as fire hydrants, bollards, traffic lights, and poles



PROJECT SHEETS

901 EAST WESTMORELAND STREET

VL1



GS#	Site Name	Ownership	Drainage Area Numbers Managed	Estimated Drainage Area (SF)	Max Potential Drainage Area (SF)	SMP Footprint (SF)	SMP Location	SMP Type
VL1	901 E WESTMORELAND ST	CITY OF PHILADELPHIA	S781, S825, S844	7,506	25,401	2,430	On-Site	RAIN GARDEN

Utility Crossings For Drainage Areas

H STREET

- 6" Gas Line, 3'-0" Cover (Source: PGW)
- 30" RCP Sewer Line, Cover Unknown (Source: PWD)
- 6" Abandoned Water Line, Cover Unknown (Source: PWD)
- 8" DI Water Line, Cover Unknown (Source: PWD)

Existing Site Photos



Relevant Site Notes

- Middle parcel - Tax Delinquent 12 Years
- Other two parcels are Project Opportunity Parcels
- Young existing tree in southwest corner

Relevant Site Constraints

- Existing laterals - assumed to be abandoned
- Steep topography
- Fire hydrant on east side of H street
- Low wooden fence

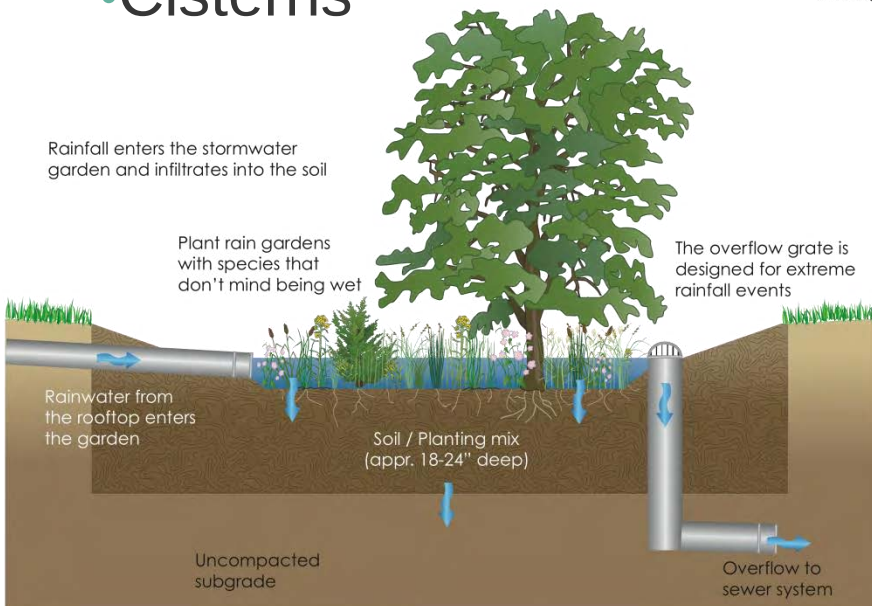
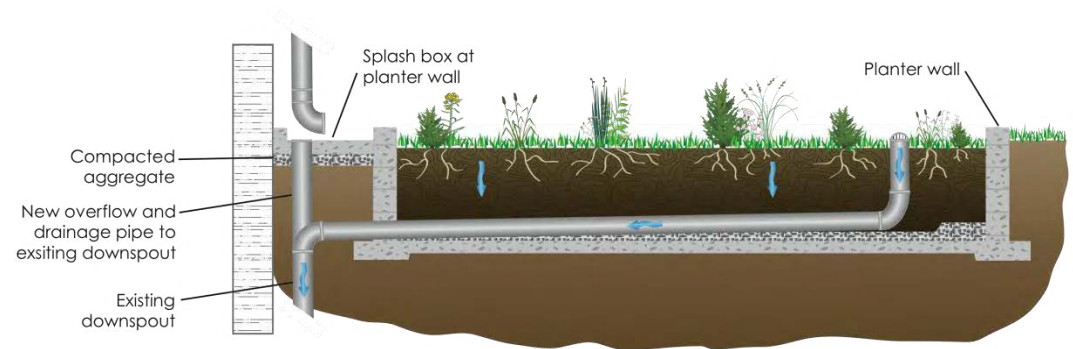


VICINITY MAP

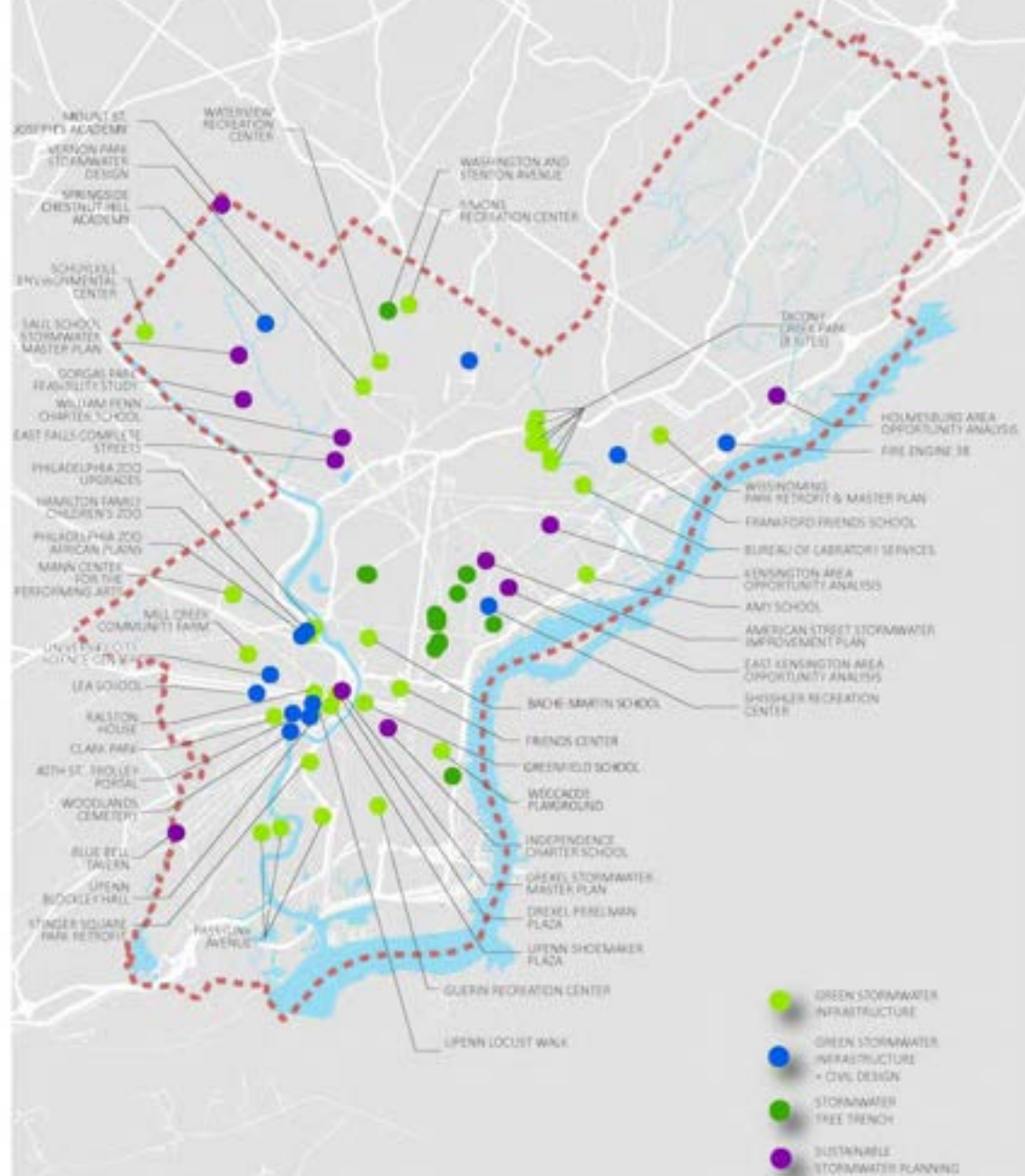
STORMWATER BMP EXAMPLES

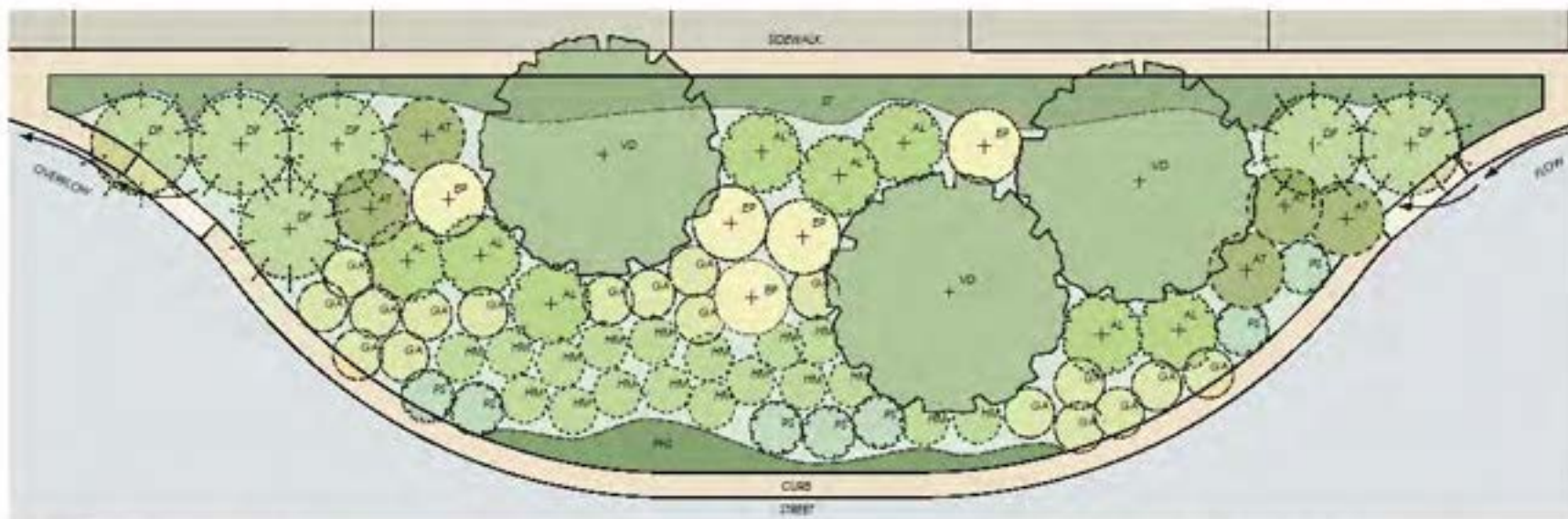
- Rain Gardens
- Porous Pavements
- Planter Boxes
- Tree Trenches
- Curb Bump-outs
- Cisterns

Green infrastructure provides stormwater filtration, storage, and infiltration, enhances aesthetics, and reduces flooding and burdens on storm sewer systems.



MELIORA DESIGN | PHILADELPHIA EXPERIENCE





PLANT PALETTE

Key

AT	<i>Asclepias tuberosa</i>
AL	<i>Aster laevis</i>
DP	<i>Deschampsia flexuosa</i>
BP	<i>Echinacea purpurea</i>
GA	<i>Gallardia arvensis</i>
HM	<i>Hieracium micrantha</i>
PS	<i>Penstemon smallii</i>
PLS	<i>Phlox subulata</i>
ST	<i>Sedum arifolium</i>
VD	<i>Viburnum dentatum</i>
	'Blue Muffin'

Common Name

Butterfly Milkweed
Snowish Blue Aster
Common Hair Grass
Purple Coneflower
Blanket Flower
Smallflower Alumroot
Small's Penstemon
Mountain Phlox
Woodland Stonecrop
'Blue Muffin' Anemone
Viburnum



Asclepias tuberosa
Butterfly Milkweed



Aster laevis
Snowish Blue Aster



Deschampsia flexuosa
Common Hair Grass



Echinacea purpurea
Purple Coneflower



Gallardia arvensis
Blanket Flower



Hieracium micrantha
Smallflower Alumroot



Penstemon smallii
Small's Penstemon



Phlox subulata
Mountain Phlox



Sedum arifolium
Woodland Stonecrop



Viburnum dentatum 'Blue Muffin'
'Blue Muffin' Anemone

NATIVE SPLENDOR

DESIGNER

Christopher Darby, Stewardship Assistant, Pennypack Ecological Restoration Trust
Darby was the Urban and Community Forestry Intern at the Meritt Arboretum of the University of Pennsylvania after graduating with a B.S. in Horticulture from Temple University. At the Pennypack Ecological Restoration Trust, he manages water meadow native grasslands, acts as nursery manager, and assists with forest restoration and invasive plant control.

DESCRIPTION

Darby's design features prairie-oriented and late successional plants. These plants thrive best in partial sun to full sun, and could complement particular urban settings.

DETAILS AND MAINTENANCE NOTES

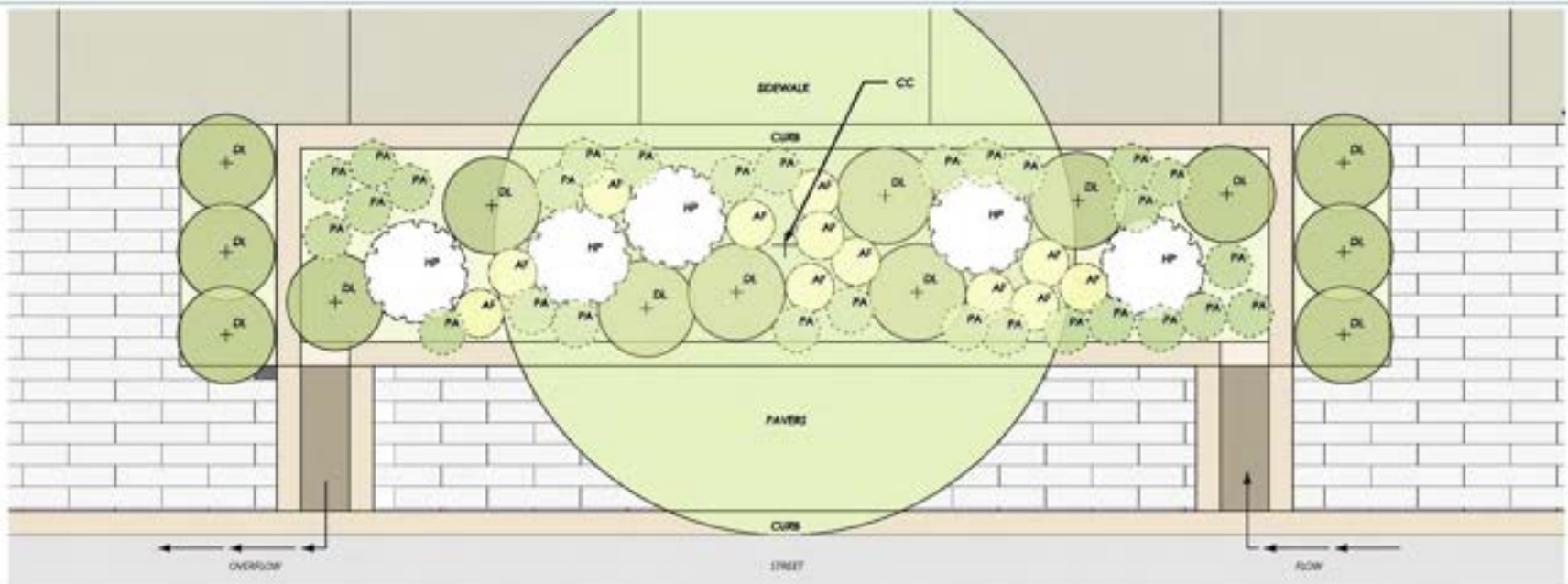
- This is a low maintenance planter. Pruning of shrubs and cutting back of perennials and grasses are needed once a year in the late spring.
- Leaving the foliage on the plants provides habitat and for wildlife through the winter.

STORMWATER PLANTER DESIGN SHOWCASE



Recommended Plants for Urban Stormwater Management Publication

Image Source: PHS



PLANT PALETTE

Sym	Botanical Name	Common Name
AF	<i>Athyrium filix-femina</i>	Lady Fern
CC	<i>Corylus americana</i>	Hickories
DL	<i>Diervilla lonicera</i>	Southern-bush Honeysuckle
HP	<i>Hypericum polypleurum</i>	Steadily St. John's Wort
PA	<i>Polypodium acrostichoides</i>	Christmas Fern



Athyrium filix-femina
Lady Fern



Corylus americana
Hickories



Diervilla lonicera
Southern-bush Honeysuckle



Hypericum polypleurum
Steadily St. John's Wort



Polypodium acrostichoides
Christmas Fern

STREETSMARTS

DESIGNER

John Munn, Certified Ecologist, Munn Ecological Services, Haverhill, PA

Munn has worked in applied ecology since the 1970s and has earned professional certifications in Wetlands and Ecology. He has designed ecological restoration plans for forests, grasslands, shorelines, waterways, and wetlands in northeast North America.

DESCRIPTION

This planter design starts with native plants expected to relieve most of the limiting factors of a city environment on the street. Shape, size, adaptability, and ornamental characteristics were also considered. Designed as a true demonstration planter, monitoring will be crucial, taking particular note of the individual set of stresses present at the installation site. The recommended plants are a mix of woody and herbaceous FACW plants that will thrive in partial shade or sun.

DETAILS AND MAINTENANCE NOTES

- Annual pruning.
- Weeding necessary only in the first growing season.

STORMWATER PLANTER DESIGN SHOWCASE



Recommended Plants for Urban Stormwater Management Publication

Image Source: PHS



Before

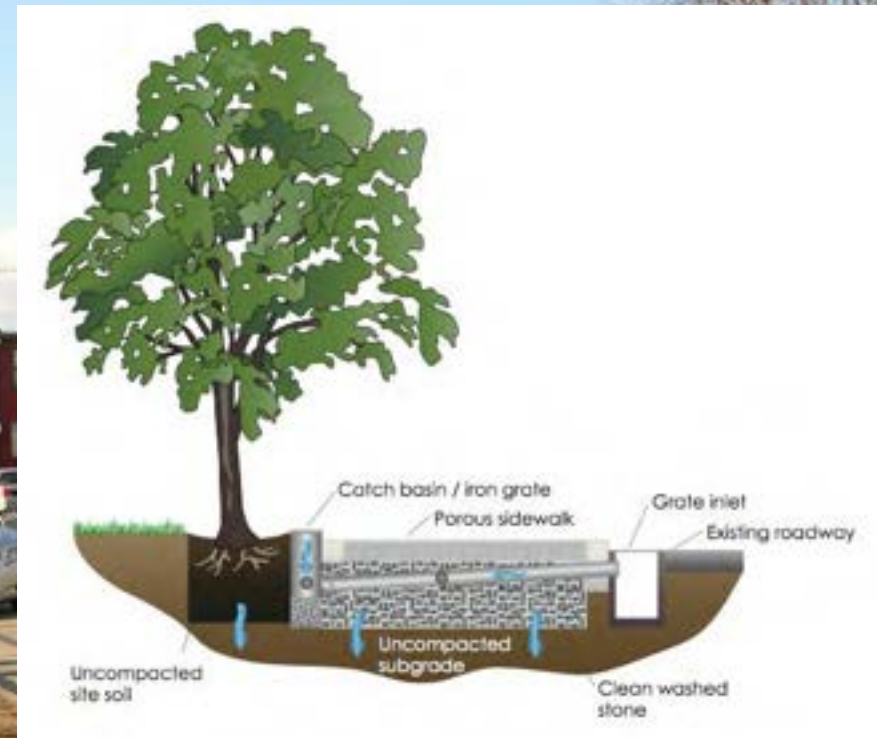
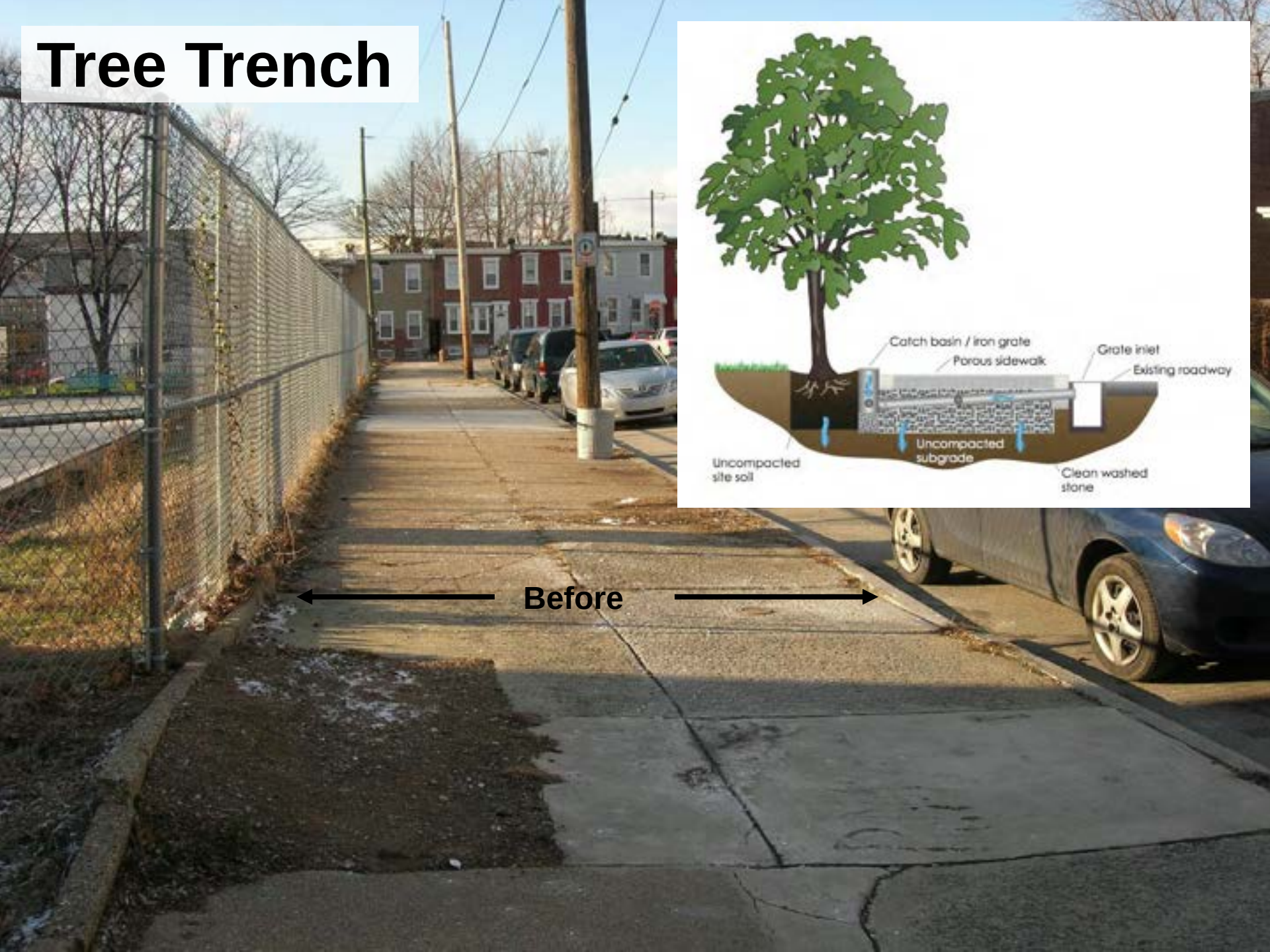


After

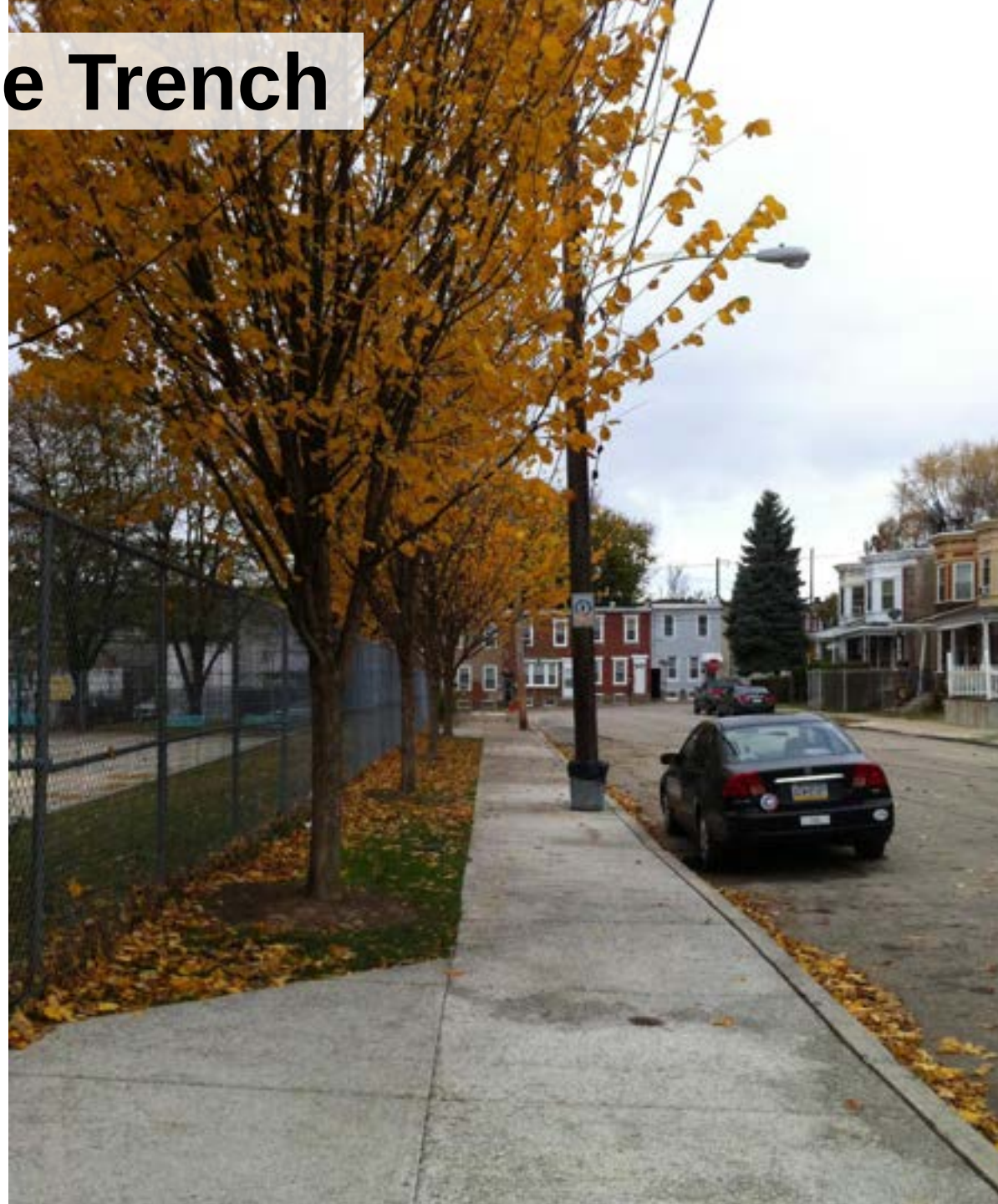




Tree Trench



Tree Trench



Traffic Island

Overflow water exits to an inlet

Bio-retention

Water from the street enters through a trench drain

63RD STREET (S.R. 3004)

PASSYUNK AVENUE (S.R. 3019)

Traffic Island

Overflow water exits to an inlet

Bio-retention

Water from the street enters through a trench drain

63RD STREET
(S.R. 3004)

PASSYUNK AVENUE (S.R. 3019)

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Porous Asphalt – Independence Charter School



Greenfield School

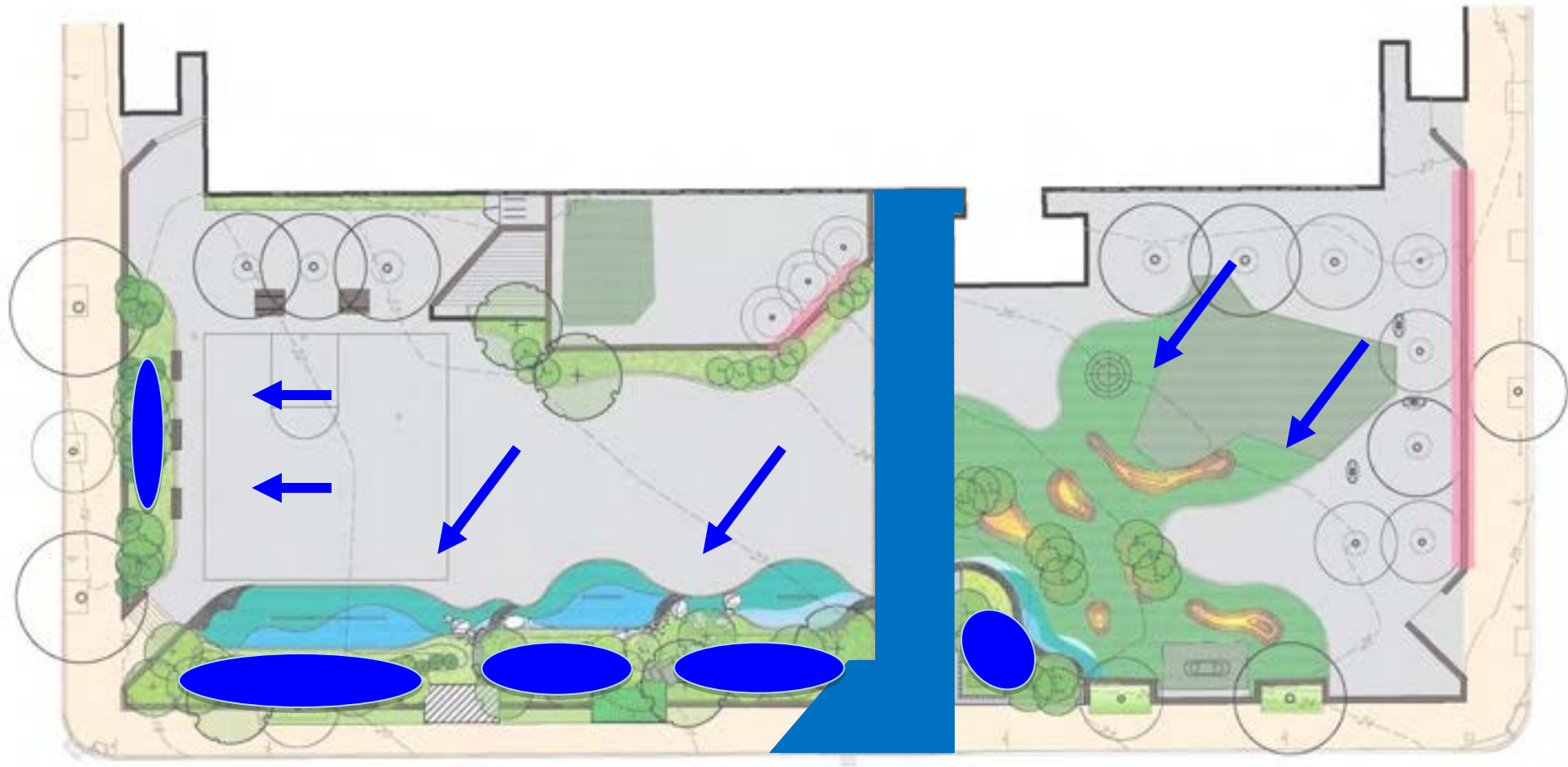
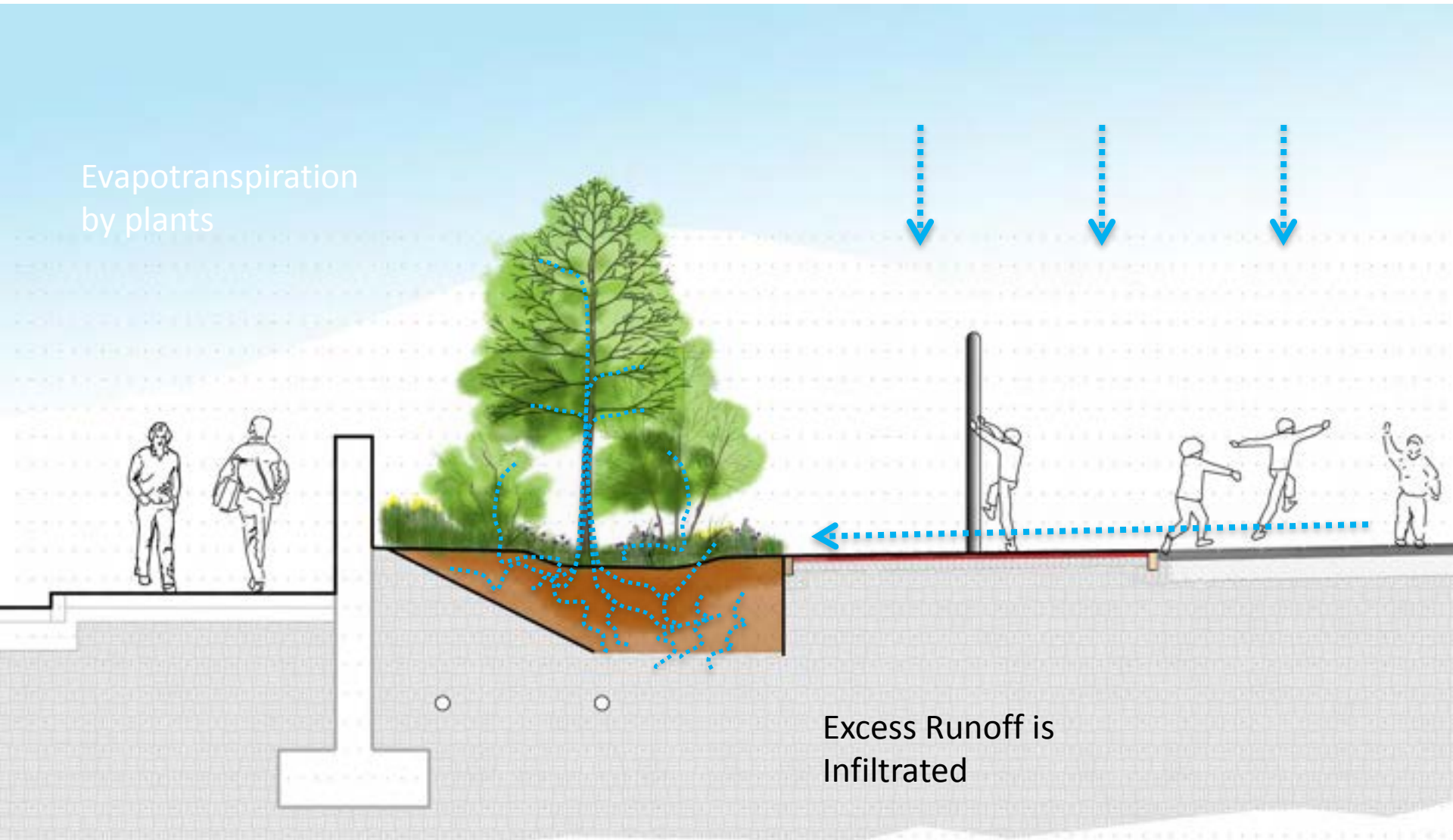


Image Source: Viridian Landscape Studio

Greenfield School









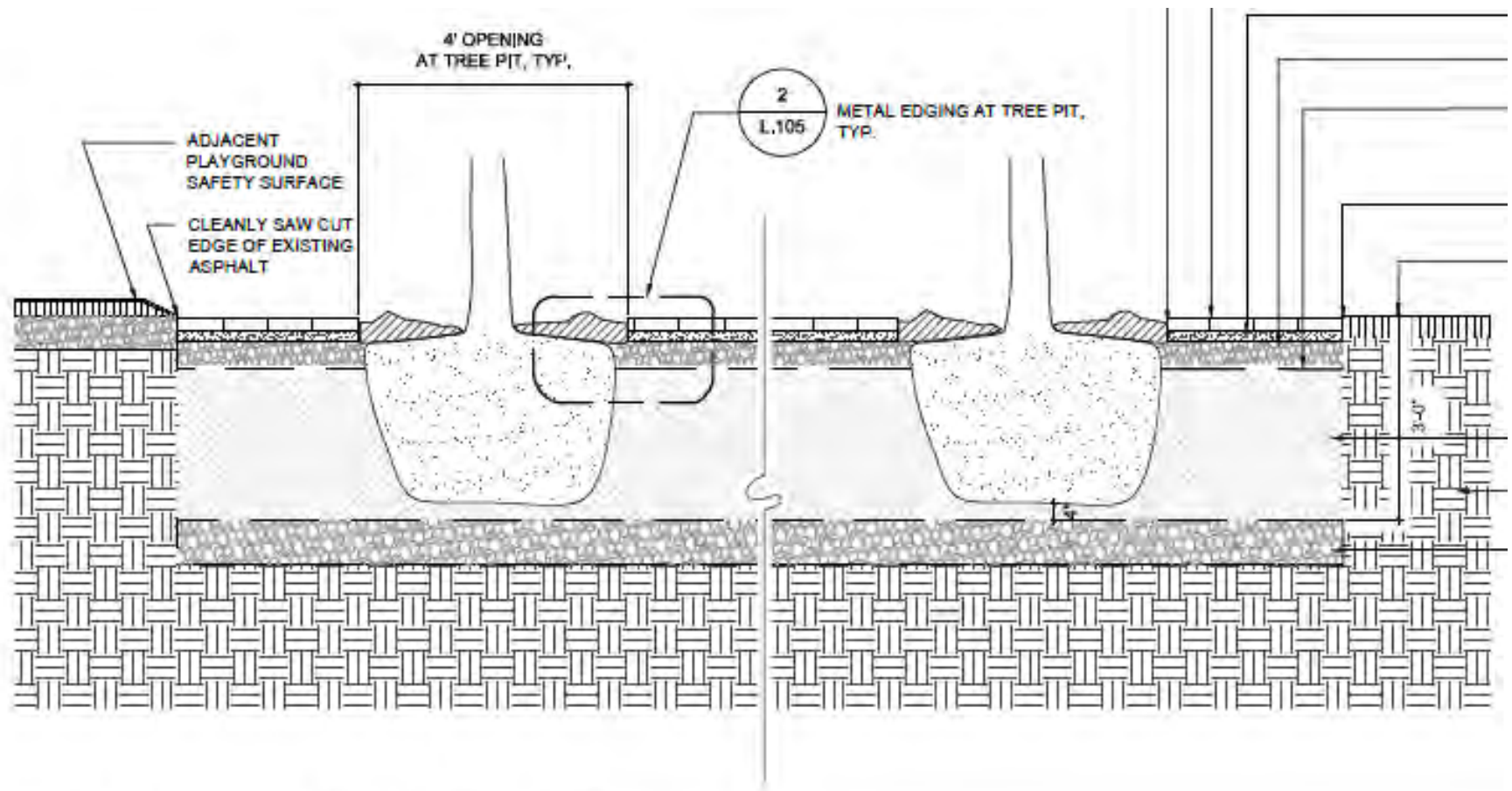
Lea School

Excellence in GSI Awards Ceremony: Celebrating the Triple Bottom Line



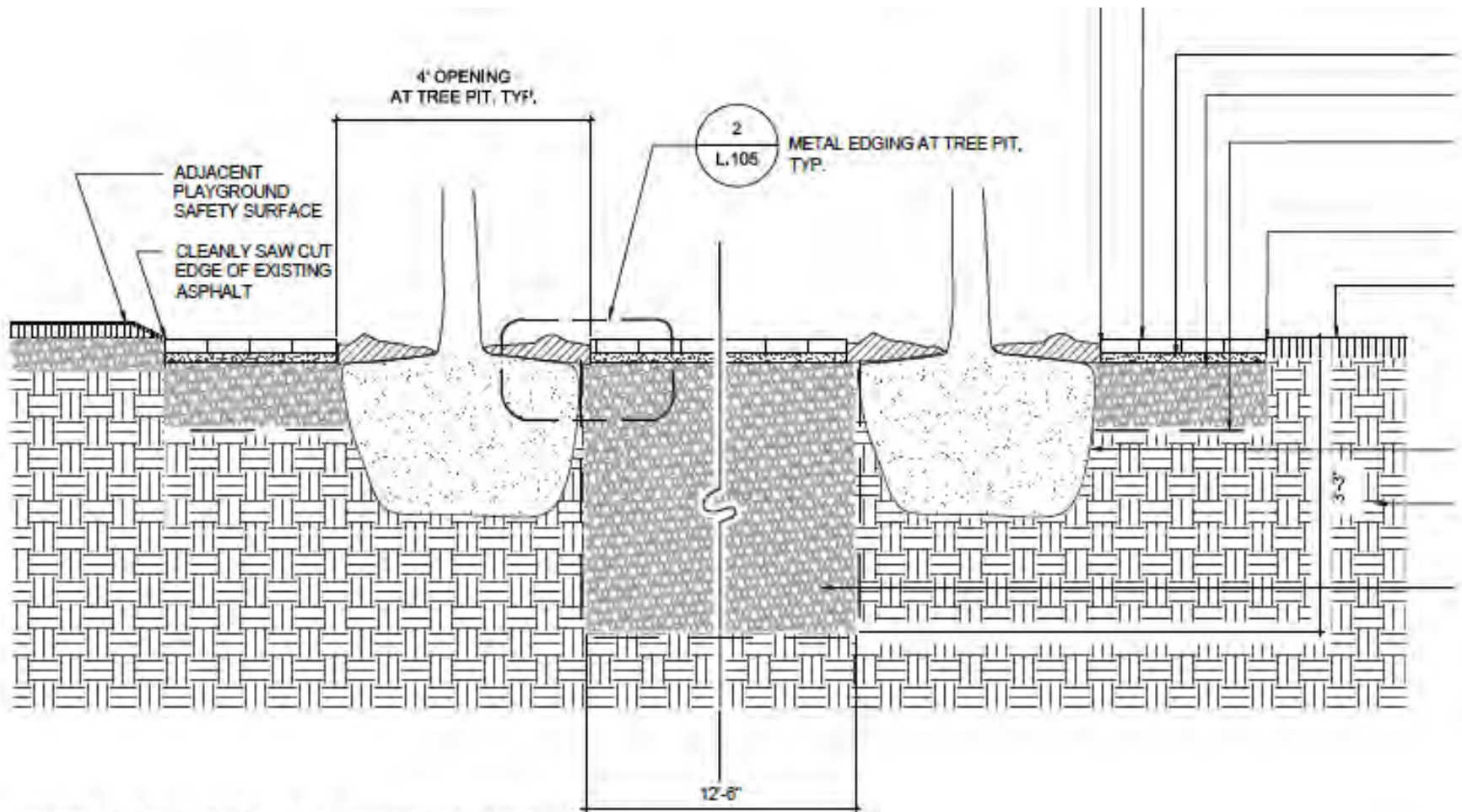






1

TREE IN BOSQUE PLANTING DETAIL



1

TREE IN BOSQUE PLANTING DETAIL

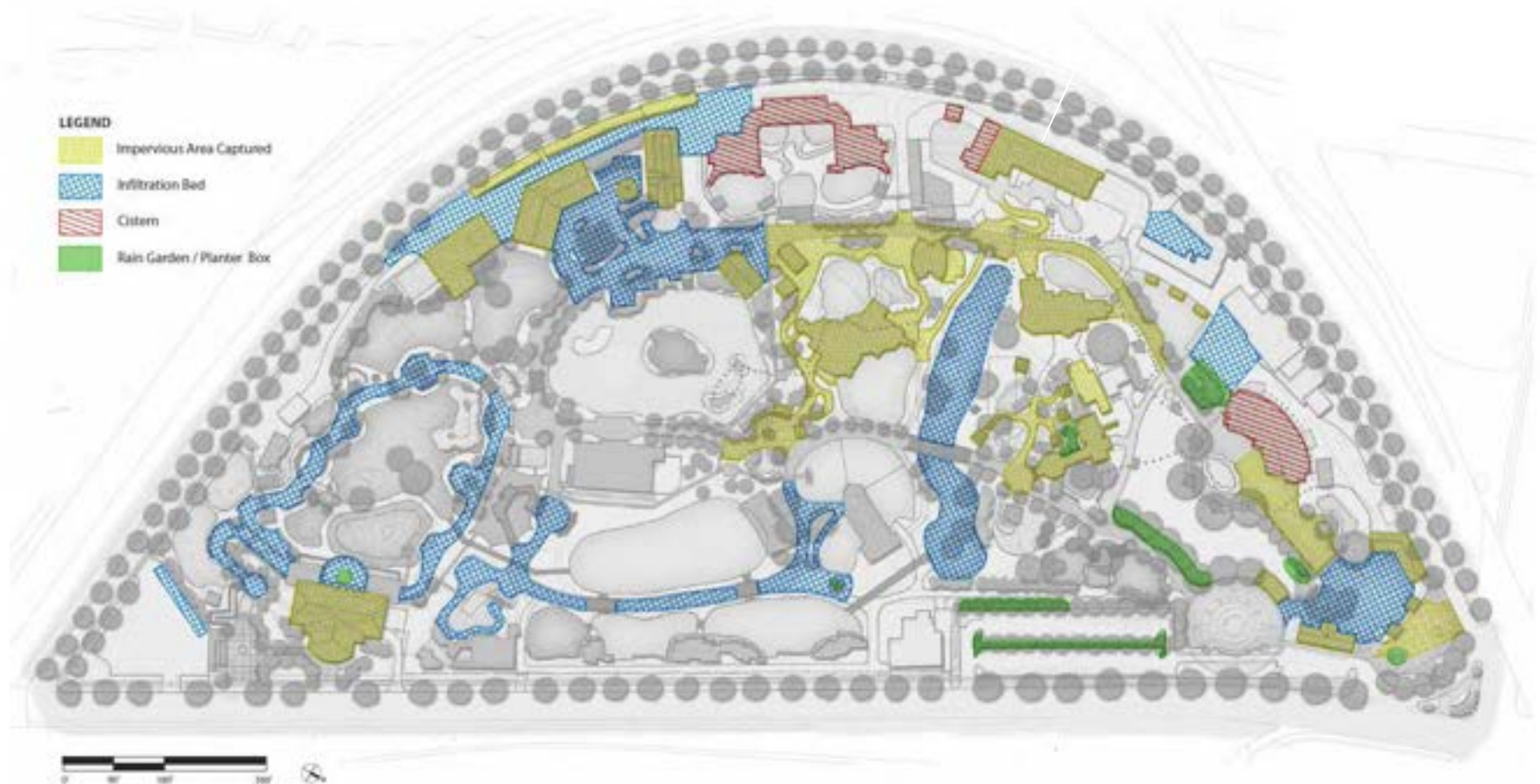
EXECUTIVE SUMMARY

LEGEND

-
- Legend:**
- Small Animals Raceway / Play Nodes
 - Medium Animals Raceway / Flex Habitats
 - Large Animals Raceway / Flex Habitats
 - Medium Animals Raceway
 - Not in Preliminary Test Budget
 - Large Animals Raceway
 - Not in Preliminary Test Budget
- Labels:**
- POTENTIAL FUTURE LARGE ANIMAL RACEWAY
 - ELEPHANT HOLDING
 - ELEPHANT YARD
 - ELEPHANT EXHIBIT 1
 - ELEPHANT EXHIBIT 2
 - FLEX / ELEPHANT EXHIBIT
 - FLEX / CHEETAH EXHIBIT
 - EXISTING BARBOON
 - EXISTING CONDOIR
 - EXISTING WILD DOG
 - FLEX / ELEPHANT ACTIVITY YARD
 - EXISTING CHEETAH
 - PARKING
 - CARNIVORE KINGDOM
 - PRIMATE ISLANDS
 - PRIMATE RESERVE
 - GORILLA
 - BEAR COUNTRY
 - AFRICAN PLAINS
 - HIPPO
 - GIRAFFE
 - ZEBRA / RANG
 - ADMIN
 - PARKING
 - POTENTIAL FUTURE MEDIUM & LARGE ANIMAL RACEWAYS
 - EXIT EXHIBITS
 - SMALL ANIMAL PLAY NODE TVF
 - SMALL MAMMAL HOUSE
 - RAVEN MAMMAL HOUSE
 - MONKEY JUNCTION
 - LAWN
 - DAIRY PLANT
 - FUTURE HIPPO SWIM RACEWAY
 - BIG CAT FALLS
 - ORANG
 - GORILLA
 - BEAR COUNTRY
 - AFRICAN PLAINS
 - HIPPO
 - GIRAFFE
 - ZEBRA / RANG
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 - RAVEN MAMMAL HOUSE
 - MONKEY JUNCTION
 - LAWN
 - DAIRY PLANT

Stormwater Management Plan

STORMWATER MANAGEMENT RECOMMENDATIONS



Parking Lot Retrofit



Tiger Lot



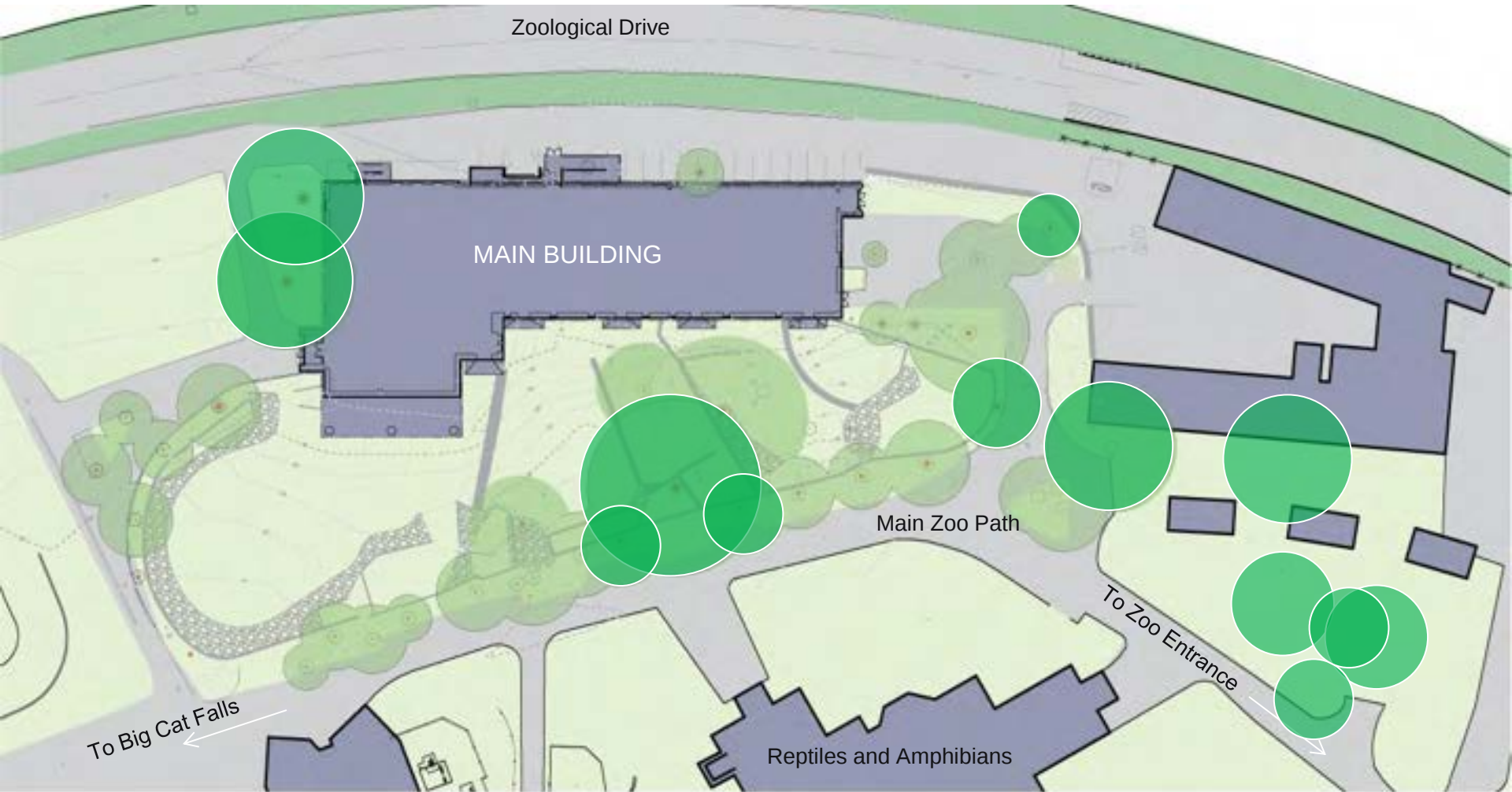
Tiger Lot: Before & After



Philadelphia Zoo – KidZooU



KidZooU: Trees



Rendering by Viridian Landscape
Studio

0' 20' 40' 80'
SCALE 1" = 40'

KidZooU: Trees

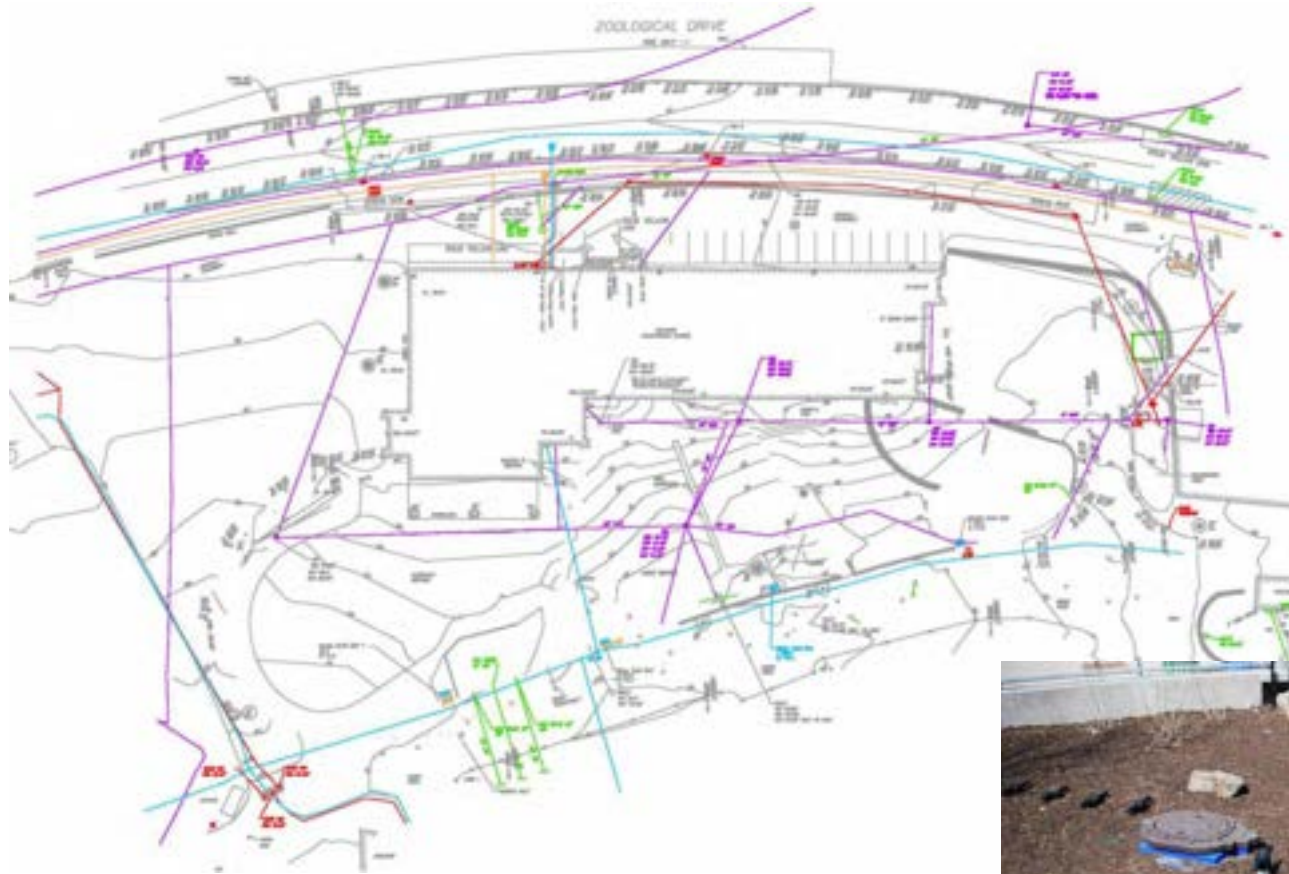


KidZooU: Trees

Photos by Arborilogical Services, Inc.



KidZooU: Utility Coordination



KidZooU: Stormwater Infiltration Beds



Saving Water Saves Animals

Start with Rainwater



KidZooU: Rain Gardens



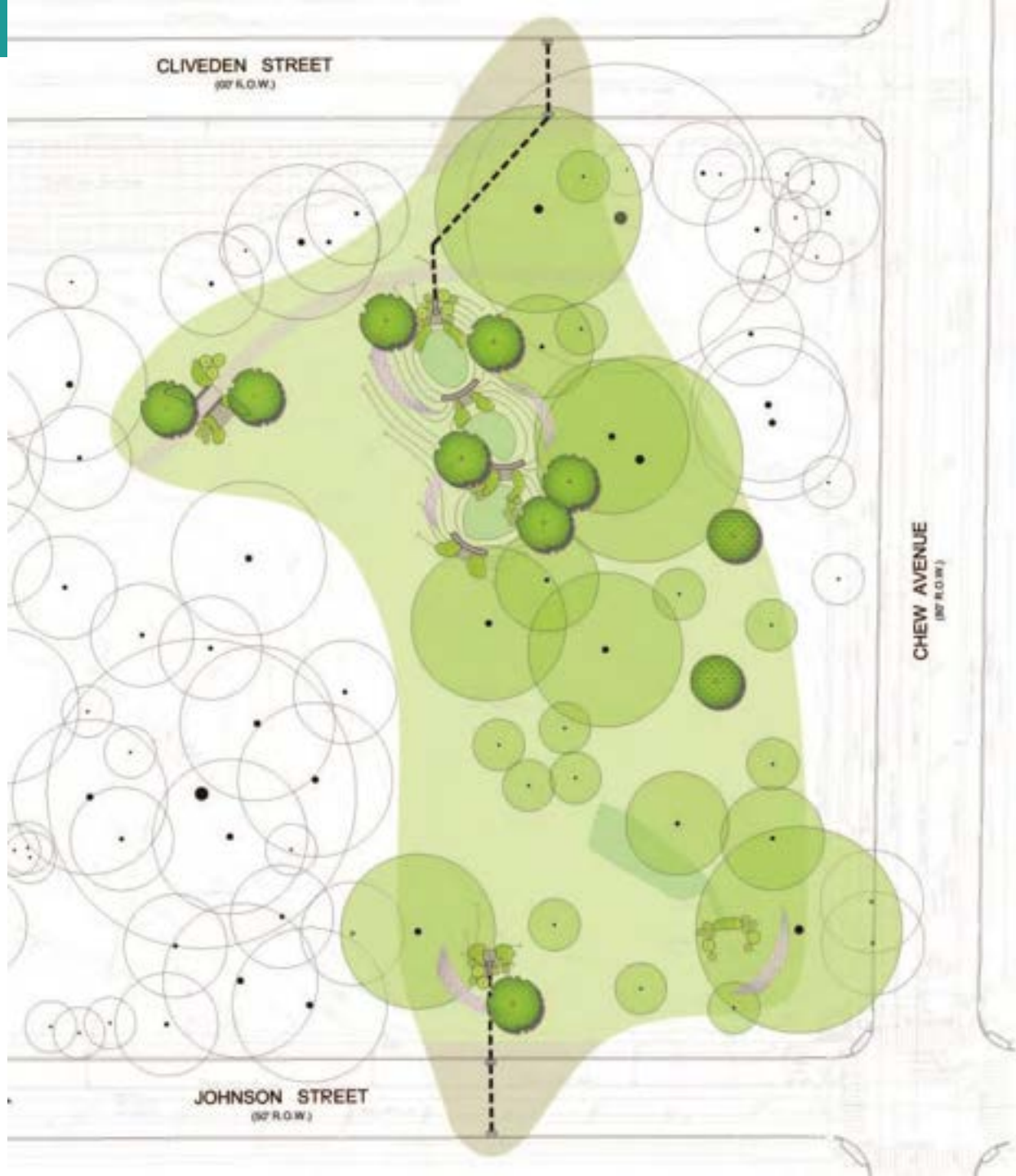




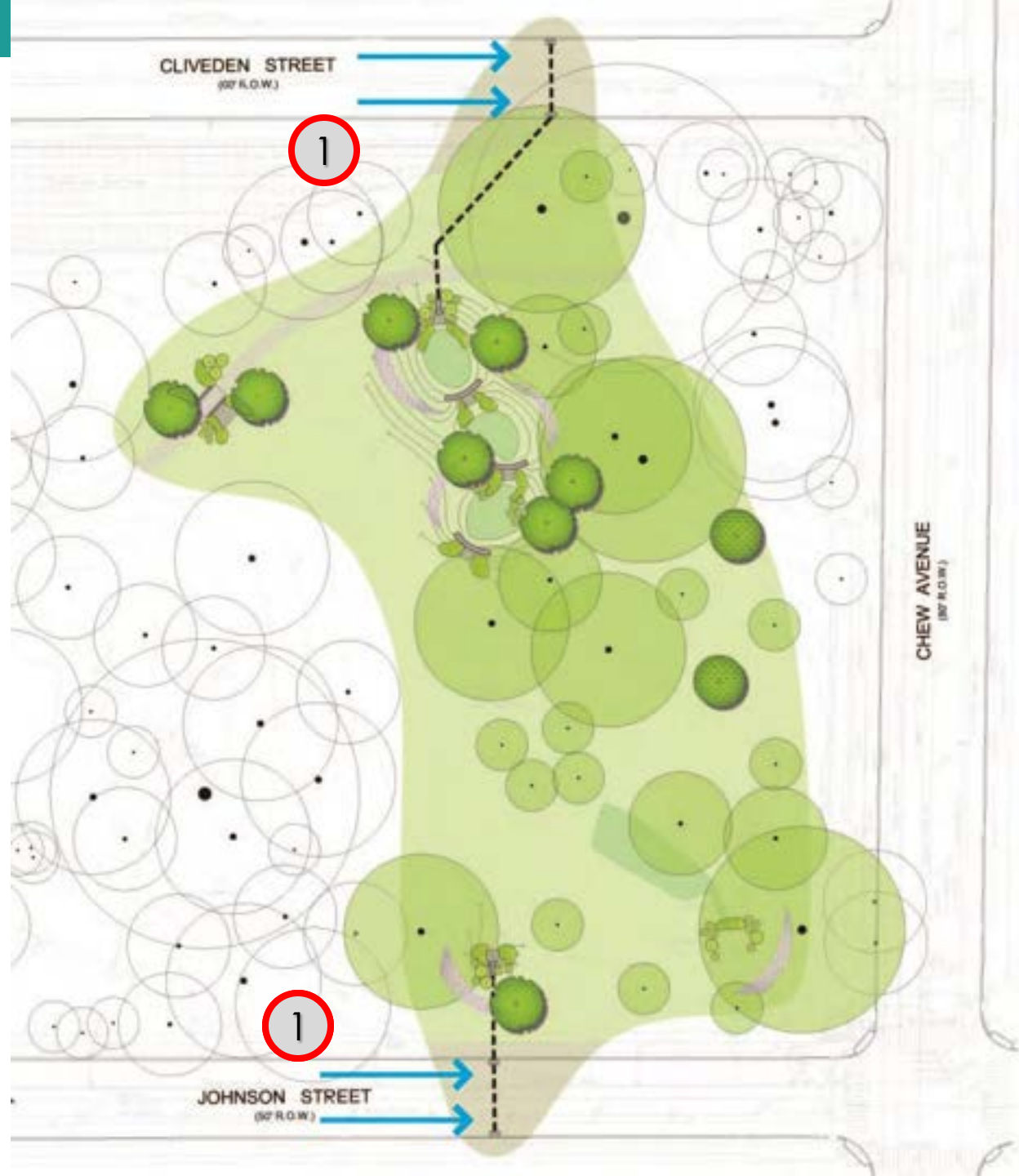
Cliveden



Cliveden



Cliveden

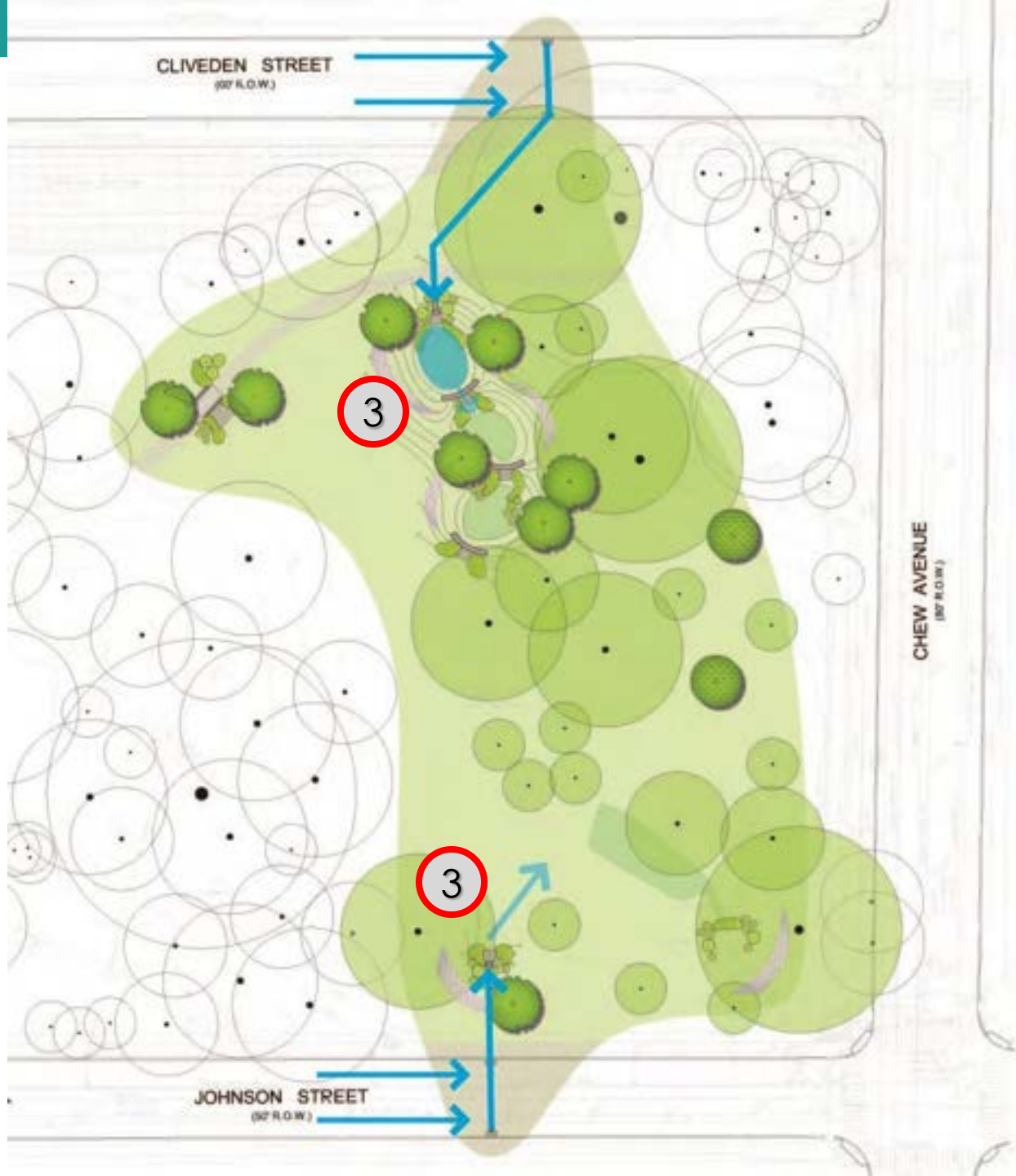


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Image Source: PHS

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Image Source: PHS

Detention Basin Retrofit



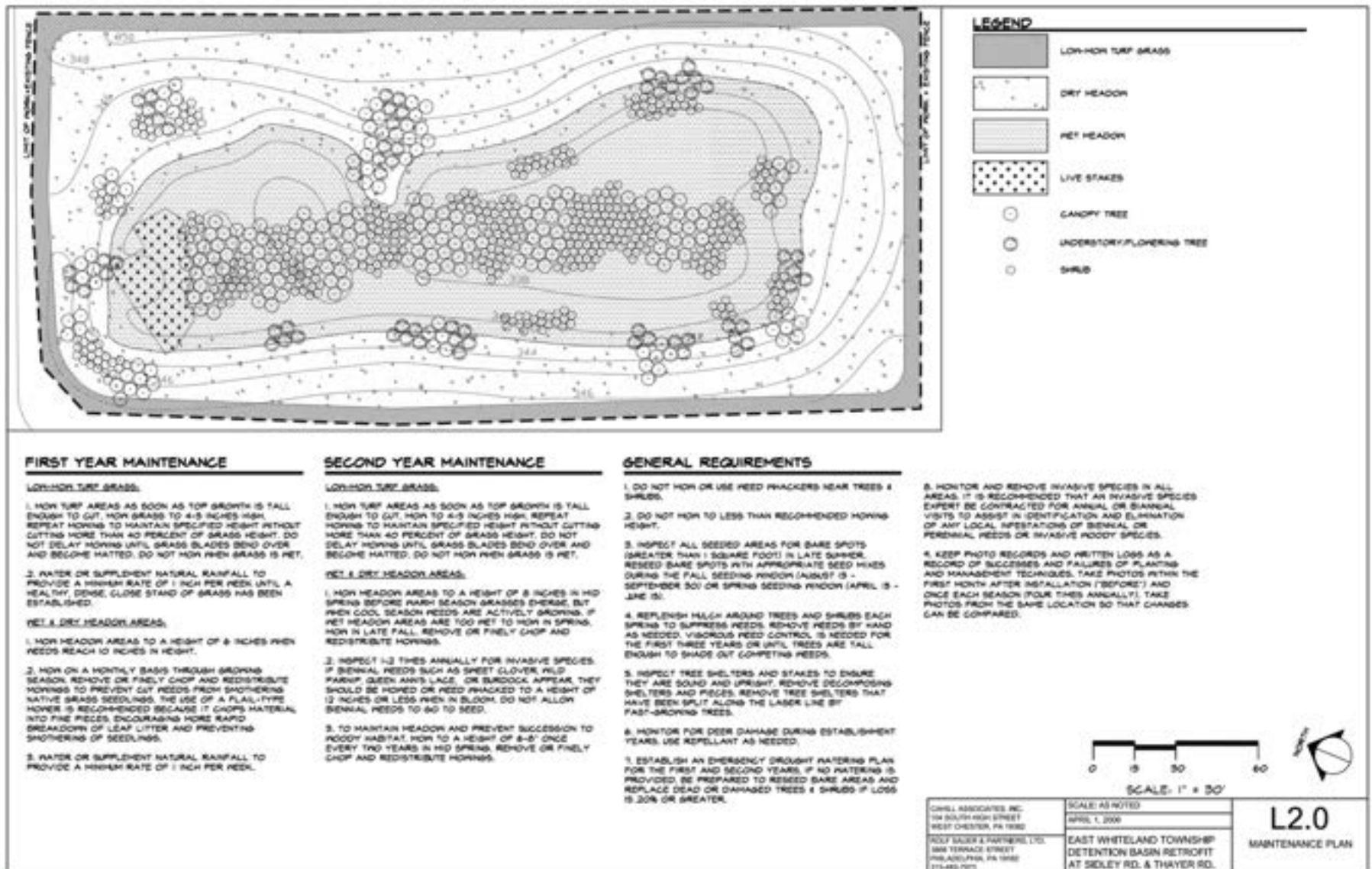
Detention Basin Retrofit



Detention Basin Retrofit



Provide a simple maintenance plan



Pittsburgh GSI – Panther Hollow Park

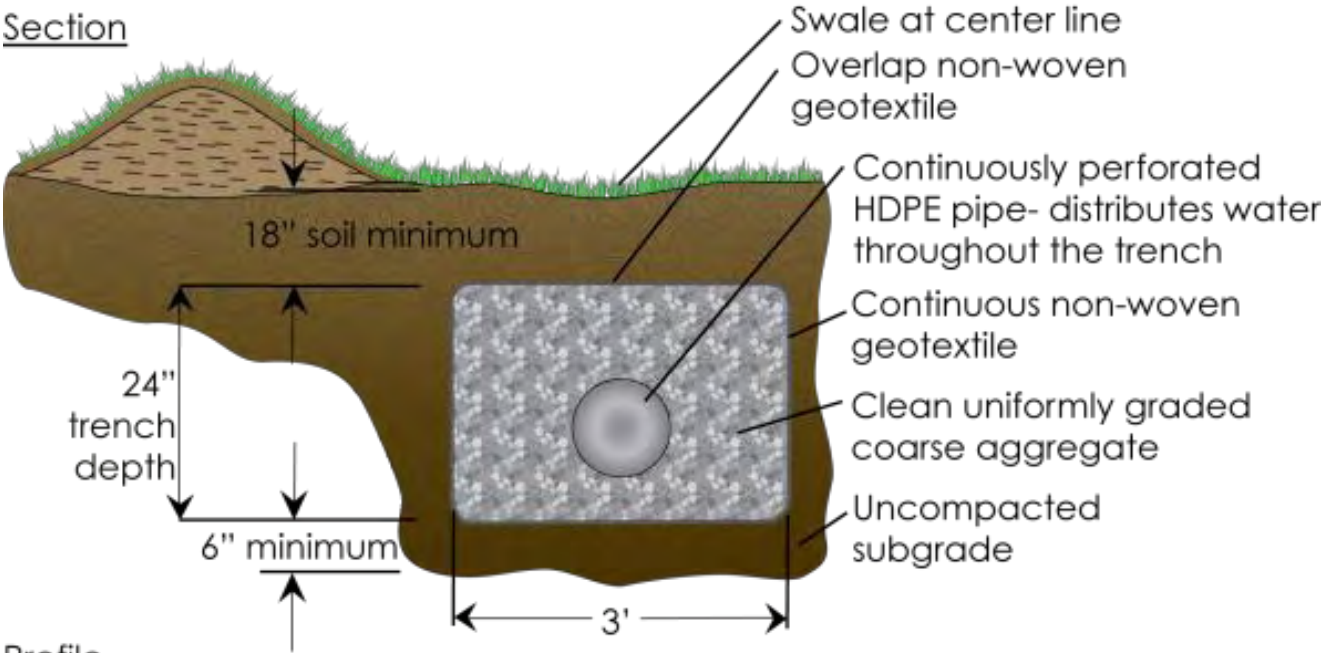


hill

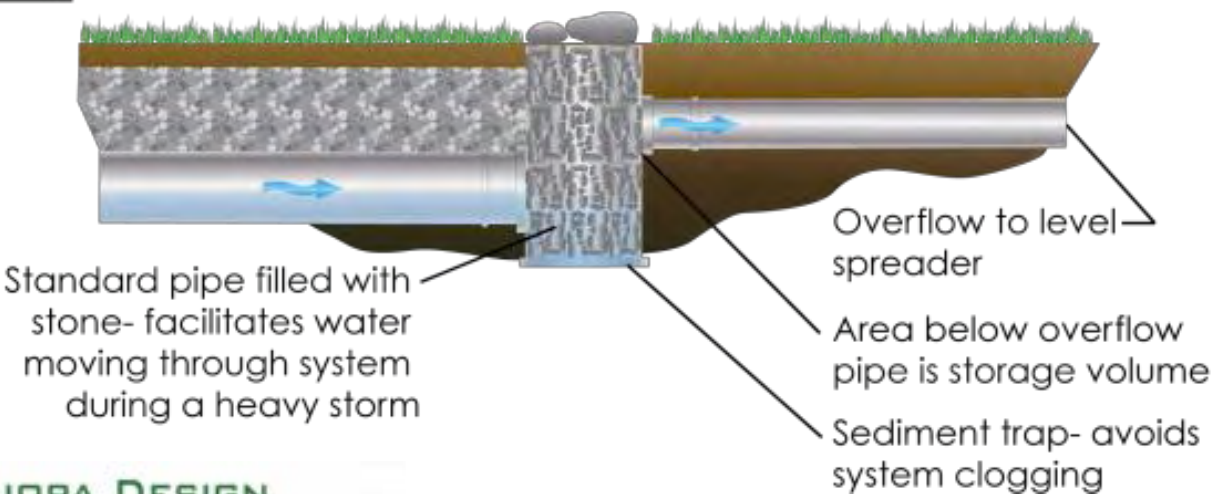


Infiltration Trench

Section



Profile

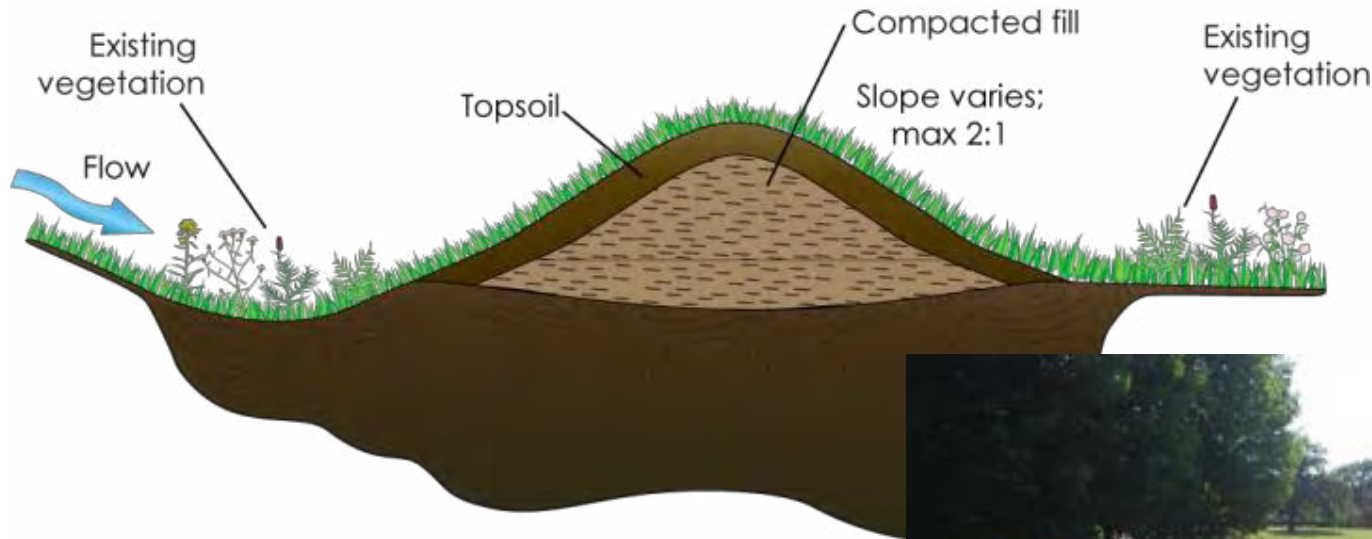


Infiltration Trench



Golf Course – Infiltration Berms

- Infiltration Berm – Reduces Runoff, Promotes Recharge
 - Allows runoff to naturally pond along the contour and infiltrate into the soil.



Washington D.C.

What's happening in Bartholdi Park?

Originally created in 1932, when the U.S. Botanic Garden (USBG) was moved to its current location, Bartholdi Park has served as a two-acre home demonstration garden for 84 years, but has not undergone a renovation since its construction.

The USBG and the Architect of the Capitol are renovating the park to include accessible pathways, improved access to the American Veterans Disabled for Life Memorial, increased safety via new lighting, improved stormwater collection, updated irrigation, new plantings, and restoration of the small fountain at the northwest corner.

Bartholdi Park will continue to have demonstration and educational gardens, featuring additional seating, native American plants, patio gardens, rain gardens, an edible garden, and accessible gardening areas. Many of the larger woody plants are being saved in place and much of the plant material will be used elsewhere at the USBG and on the grounds of the Library of Congress, the Supreme Court of the United States, and D.C. public schools.

Follow the progress of the renovation through construction fence windows and from across the street on the canopy walkway in The Tropics room of the Conservatory. We look forward to welcoming you to the renovated Bartholdi Park in 2016!

www.usbg.gov/bartholdi



Construction of Bartholdi Park 1932



UNITED STATES
BOTANIC GARDEN



Washington D.C. – USBG Bartholdi Park

- 95th Percentile = 1.7"
- Stormwater Credits
- SITES



Lancaster, PA



The U.S. Environmental Protection Agency enforces strict regulations on polluted stormwater. The City faces potential fines of up to \$37,500 per day if we cannot show progress towards eliminating at least 750 million gallons of polluted water discharged into the Conestoga River. To recover the costs of services the City is mandated to provide, the City has adopted a stormwater management fee—an equitable, fair and low-cost solution.

Revenue raised through the fee would be specifically dedicated to important infrastructure repairs and improvements that will not only help avoid Federal fines, but also make Lancaster a healthier and greener place to live.

Newly renovated Brandon Park Basketball courts and Parking lot



There are over 100,000 sq. feet of green roofs in Lancaster City.



Planning for Success

- Mapping
- Site Analysis
- Capital Projects are an opportunity for GI:
 - Sidewalk improvements
 - Intersection improvements
 - Water and sewer line work
- All municipal and public projects maximize GI (schools, parks, streets, etc.) are opportunities
- Public involvement early on
- Project tracking
- Maintenance Plans & Training



BRANDYWINE
CONSERVANCY

MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) REQUIREMENTS



BRANDYWINE
CONSERVANCY

Municipal Stormwater Regulations

- National Pollutant Discharge Elimination System (NPDES)
 - 1990 - “Phase I” MS4 municipalities (medium and large, as defined by federal regulations) required to get NPDES permits
 - 1999 - “Phase II” MS4 municipalities (small municipalities in urbanized areas and other municipalities designated by the permitting authority) required to get NPDES permits

NPDES Requirements for Small MS4s

- The NPDES requires operators of Small MS4s to:
 - Apply for NPDES permit coverage (individual or general)
 - Develop a stormwater management program which includes the 6 minimum control measures
 - Implement the stormwater management program using appropriate stormwater management controls, or best management practices (BMPs)
 - Develop measurable goals for the program
 - Evaluate the effectiveness of the program.

Six Minimum Control Measures (MCMs)

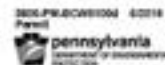
Operators of regulated small MS4s are required to include these 6 minimum control measures in their stormwater management programs:

- 1) Public Education and Outreach
- 2) Public Participation/Involvement
- 3) Illicit Discharge Detection and Elimination
- 4) Construction Site Runoff Control
- 5) Post-Construction Runoff Control
- 6) Pollution Prevention/Good Housekeeping

NEW MS4 REGULATIONS FOR PA MUNICIPALITIES



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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF CLEAN WATER

PAG-13

**AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
GENERAL PERMIT FOR STORMWATER DISCHARGES FROM
SMALL MUNICIPAL SEPARATE STORM SEWER SYSTEMS (MS4s)
APPROVAL OF COVERAGE**

NPDES PERMIT NO.

in compliance with the provisions of the Clean Water Act, 33 U.S.C. Section 1251 et seq. ("CWA") and Pennsylvania's Clean Streams Law, as amended, 35 P.S. Section 691.1 et seq.,

is authorized to discharge from a regulated small municipal separate storm sewer system (MS4) located in _____
County to _____ in watersheds(s) _____ in accordance with effluent limitations, monitoring requirements and
other conditions set forth herein.

**APPROVAL OF COVERAGE UNDER THIS GENERAL NPDES PERMIT IS AUTHORIZED
BEGINNING ON _____ WHEN THE GENERAL PERMIT IS RENEWED, REISSUED OR MODIFIED, THE
FACILITY OR ACTIVITY COVERED BY THIS APPROVAL FOR COVERAGE MUST COMPLY WITH THE FINAL
RENEWED, REISSUED OR MODIFIED GENERAL PERMIT.**

The authority granted by coverage under this General Permit is subject to the following further qualifications:

1. The permittee shall comply with the effluent limitations and reporting requirements contained in this General Permit.
2. Following initial coverage under this General Permit, the submission of Annual MS4 Status Reports in accordance with Part A (I.D) of the General Permit shall constitute the permittee's Notice of Intent (NOI) for continued coverage under the General Permit. The permittee shall be responsible for complying with the final renewed, reissued or amended General Permit. If the permittee is unable to comply with the renewed or amended General Permit, the permittee must submit an application for an individual NPDES permit within 90 days of publication of the final General Permit.
3. The NOI and its supporting documents are incorporated into this approval of coverage. If there is a conflict between the NOI or its supporting documents and the terms and conditions of this General Permit, the terms and conditions of this General Permit shall apply.
4. Failure to comply with the terms, conditions, or effluent limitations of this General Permit is grounds for enforcement action, permit termination or revocation.
5. (IF APPLICABLE) The permittee shall implement Pollutant Control Measures as specified in Appendix (A, B and/or C).
6. (IF APPLICABLE) The permittee shall achieve pollutant loading reductions for (sediment, Total Phosphorus and/or Total Nitrogen) as specified in Appendix (D or E) by (DATE) 3 Years from Effective Date of Coverage).

This approval of coverage is authorized by:

Clean Water Program Manager
Regional Office
Department of Environmental Protection

PA DEP MS4 Requirements Table

MS4 Name	NPDES ID	Individual Permit Required?	Reason	Impaired Downstream Waters or Applicable TMDL Name	Requirement(s)	Other Cause(s) of Impairment
Chester County						
DOWNTOWN BORO	PAG130140	No		Beaver Creek		Cause Unknown (4a), Other Habitat Alterations, WaterFlow Variability (4c)
				East Branch Brandywine Creek		Cause Unknown (4a), Other Habitat Alterations, WaterFlow Variability (4c)
EAST BRADFORD TWP	PAI130523	Yes	TMDL Plan, SP, IP	Plum Run		WaterFlow Variability (4c)
				Valley Creek	Appendix C-PCB (4a), Appendix B-Pathogens (5), Appendix E-Siltation (5)	Cause Unknown (5), Other Habitat Alterations, WaterFlow Variability (4c)
				Blackhorse Run		Other Habitat Alterations, WaterFlow Variability (4c)
				Broad Run		WaterFlow Variability (4c)
				Christina River Basin Sediment	TMDL Plan-Siltation, Suspended Solids (4a)	
				Taylor Run		Other Habitat Alterations (4c)
				Unnamed Tributaries to East Branch Brandywine Creek		Other Habitat Alterations (4c)
				East Branch Brandywine Creek		Cause Unknown (4a), WaterFlow Variability (4c)
EAST BRANDYWINE TWP	PAI130524	Yes	SP, IP	Unnamed Tributaries to Beaver Creek	Appendix E-Siltation (4a)	
				Beaver Creek		Cause Unknown (4a), Other Habitat Alterations, WaterFlow Variability (4c)
				Culbertson Run	Appendix E-Siltation (4a)	Other Habitat Alterations (4c)
				East Branch Brandywine Creek		Cause Unknown (4a), Other Habitat Alterations, WaterFlow Variability (4c)

PA DEP MS4 Requirements Table

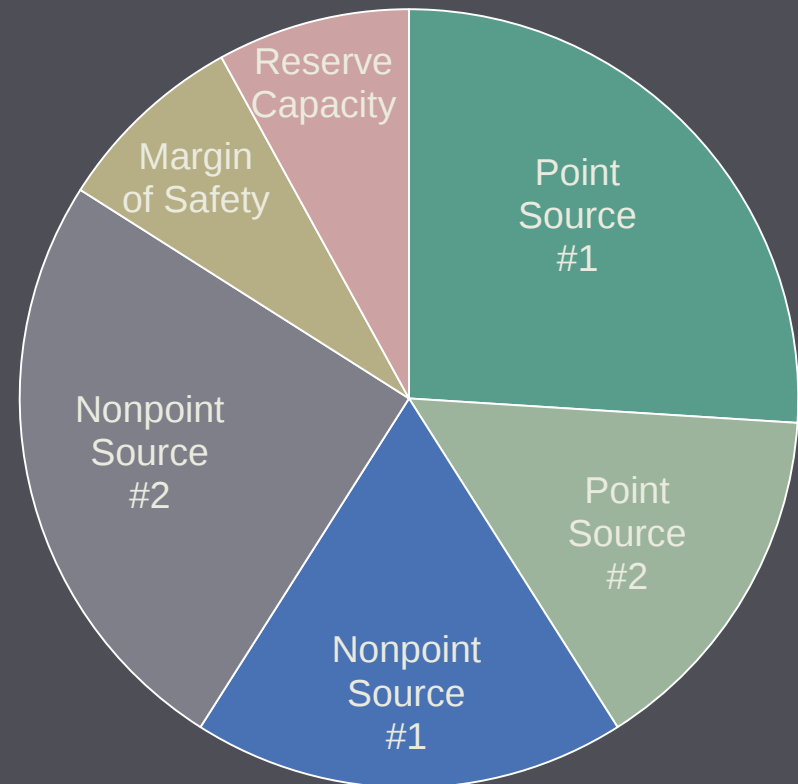
MS4 Name	NPDES ID	Individual Permit Required?	Reason	Impaired Downstream Waters or Applicable TMDL Name	Requirement(s)	Other Cause(s) of Impairment
NEW GARDEN TWP	PA1130516	Yes	TMDL Plan, SP, IP	East Branch White Clay Creek	Appendix B-Pathogens (5)	
				Egypt Run	Appendix B-Pathogens (5)	
				Bucktoe Creek	Appendix C-PCB (4a)	
				Christina River Basin Sediment	TMDL Plan-Siltation, Suspended Solids (4a)	
				Christina River Basin Nutrients	TMDL Plan-Nutrients, Organic Enrichment/Low D.O. (4a)	
				White Clay Creek	Appendix B-Pathogens (5)	
				Trout Run	Appendix C-Pesticides (4a)	
				Broad Run	Appendix B-Pathogens (5)	WaterFlow Variability (4c)
				West Branch Red Clay Creek	Appendix C-PCB (4a)	
				Walnut Run	Appendix B-Pathogens (5)	WaterFlow Variability (4c)
				Unnamed Tributaries to East Branch White Clay Creek		Other Habitat Alterations (4c)
				Red Clay Creek	Appendix C-PCB (4a)	
NEW LONDON TWP	PA1130526	Yes	TMDL Plan, SP, IP	White Clay Creek	Appendix B-Pathogens (5)	
				West Branch White Clay Creek	Appendix B-Pathogens (5)	
				Middle Branch White Clay Creek	Appendix B-Pathogens (5)	
				East Branch Big Elk Creek	Appendix E-Organic Enrichment/Low D.O. (5)	
				Christina River Basin Nutrients	TMDL Plan-Nutrients, Organic Enrichment/Low D.O. (4a)	
				Chesapeake Bay Nutrients/Sediment	Appendix D-Nutrients, Siltation (4a)	
				Christina River Basin Sediment	TMDL Plan-Siltation, Suspended Solids (4a)	



What is a TMDL?

- Total Maximum Daily Load
- EPA - “a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards”
- Pollution diet
- TMDLs provide EPA and states with a mechanism to address pollution from both point and nonpoint sources.

TMDL Components



Example Allocations for the Christina Basin Sediment TMDL

Subbasin	Total Baseline Load (ton/day)	Total TMDL Allocation (ton/day)	Percent Reduction (%)	% of TMDL Allocated to MS4s
Brandywine Creek	23.19	12.16	47.6%	78.8%
White Clay Creek	105.95	46.93	55.7%	88.0%
Red Clay Creek	60.16	30.17	49.9%	91.4%
Total	189.31	89.26	52.9%	87.9%

TMDL Plans

- Explains how the municipality plans to reduce stormwater pollution consistent with WLA requirements
- For the current permit cycle, it may be submitted in two parts:
 - TMDL Strategy (due at time of application – already submitted)
 - TMDL Design Details (due one year after permit application is approved)
- Next permit cycle (2017 application), TMDL Plans are expected to be submitted in a single step with the permit application.

Pollutant Reduction Plans (PRPs)

- PRP is a planning document that is designed to guide BMP selection in a manner that will reduce pollutant loading to impaired waters.
- Describe expected municipal upgrades and look for opportunities to implement BMPs that will reduce sediment and nutrient pollution to affected water body by 10% and 5% over the 5-year permit term.
- For next permit cycle, DEP proposes that the following municipalities will be required to submit PRPs:
 - Municipalities that discharge to waters impaired by nutrients and/or sediment without a TMDL
 - Municipalities that discharge to Special Protection Waters (HQ/EV)

Multi-Municipal Collaboration for MS4s

- PA DEP allows for municipalities to work together on meeting pollution reductions
- Drivers
 - NPDES/PA DEP Municipal Stormwater Requirements
 - Challenges to addressing impaired streams
 - Local economic/resource limitations
 - Existing multi-municipal planning initiatives and collaboration
 - Local champion/coordinating organization
 - Public pressure
- Examples – York County, Wissahickon Watershed, Christina Watersheds Partnership, Oxford Region

The Brandywine Conservancy

*Our Mission is:
To conserve the
natural and cultural
resources of the
Brandywine
watershed and other
selected areas with a
primary emphasis on
water quality and
quantity of the
Brandywine
watershed.*



BRANDYWINE
CONSERVANCY

Photo by Chuck Bowers

Protected Lands
of
Southeastern Pennsylvania
&
Northern Delaware

LEGEND

- Brandywine Conservancy
- Municipal boundaries
- City and Borough boundaries
- Roads
- Railroads
- Protected Lands
 - Brandywine Conservancy owned lands
 - Lands owned or leased by other land owner
 - Other public-specified lands
 - Private land
 - Public land
 - Other protected lands

Scale: 0 1 2 3 4 miles

Source: Brandywine Conservancy and other sources. All boundaries are approximate and not guaranteed to be accurate.

Brandywine Conservancy



**BRANDYWINE
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Resource Protection Tools

Comprehensive Plan

Zoning Ordinance

- Ag. Preservation
- Conservation Design
- Natural Resource Protection
- Timber Harvesting
- Transferable Development Rights
- Renewable Energy

Subdivision & Land Development Ordinance

- Existing Resources and Site Analysis
- Sketch Plan
- Site Visit
- Erosion & Sedimentation
- Low Impact Development Standards
- Public Land Dedication or Fee In-Lieu

Stormwater Ordinance

- Site Design
- Best Management Practices

Official Map

- Right of first refusal





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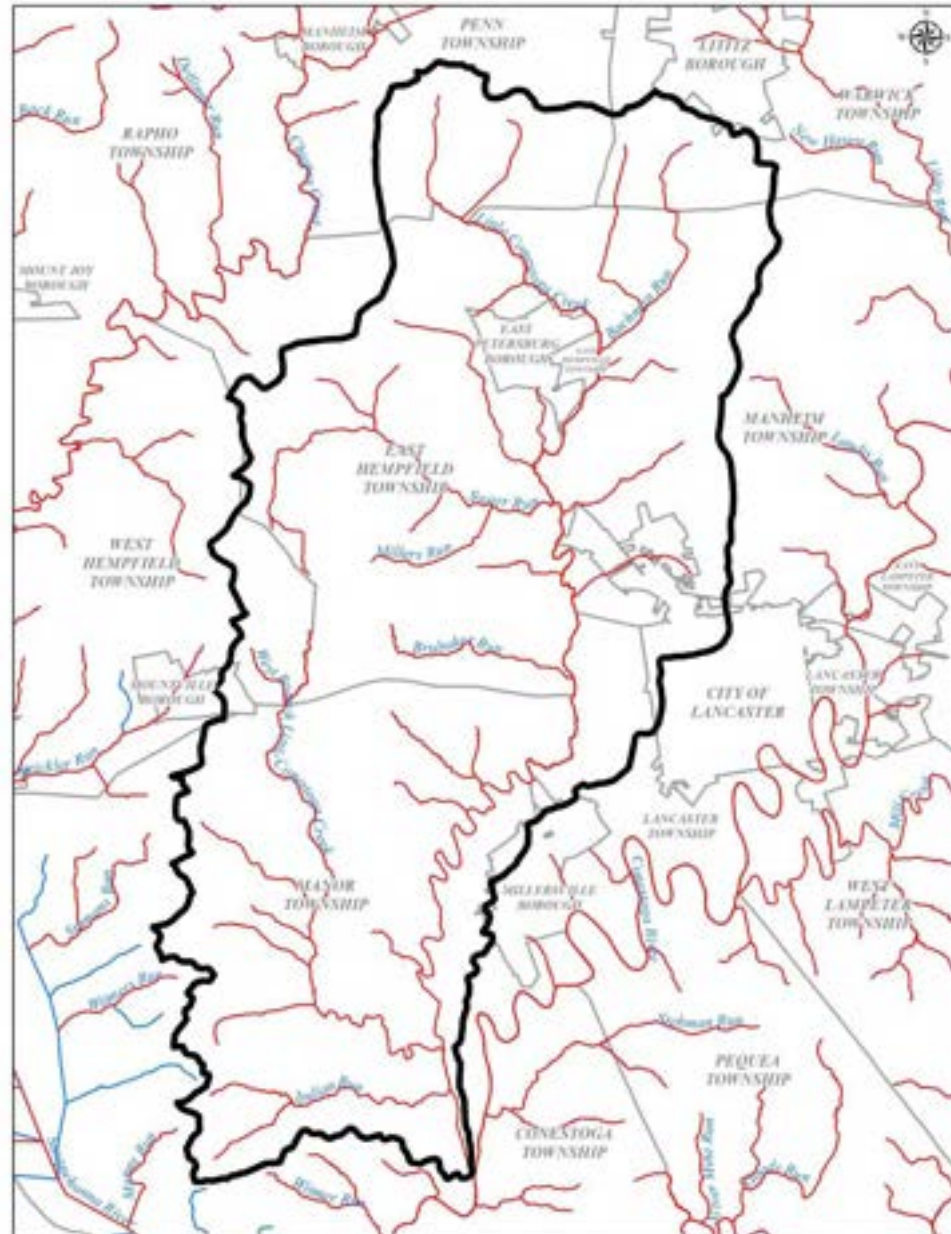
LITTLE CONESTOGA WATERSHED (LANCASTER COUNTY, PA)

Municipal Ordinances to Address Stormwater and Promote GSI



BRANDYWINE
CONSERVANCY

Little Conestoga Watershed



BRANDYWINE
CONSERVANCY

Little Conestoga Watershed – Community Watershed Approach

- Local Partnership Efforts
 - Little Conestoga Watershed Alliance formed (2000)
 - Watershed Assessment and Restoration Plan (2003)
 - Lancaster County Clean Water Consortium (2010)
- NFWF Grant Awarded in 2012 to Conservation Foundation of Lancaster County
 - Work proceeded 2012-2015
- Little Conestoga Partnership:
 - Alliance of the Chesapeake Bay, Brandywine Conservancy, Chesapeake Bay Foundation, Habitat MT, Lancaster Area Sewer Authority, Lancaster Clean Water Consortium, Lancaster County Conservancy, Lancaster County Conservation District, Lancaster county Planning Commission, Little Conestoga Watershed Alliance, Penn State University, PA Landscape and Nursery Association, PADEP, PA DCNR

Little Conestoga Partnership

Municipal Assistance

- Municipal Team – worked with interested municipalities to demonstrate municipal tools to address stormwater from future development
- Tools to Address Stormwater from New Development
 - Aligning SALDO, zoning ordinance provisions (site planning process)
 - More stringent stormwater ordinance provisions
 - Assessments for 4 municipalities (Manor, Mannheim, **Penn**, and **West Hempfield** Townships)
 - Toolboxes developed for 2 Little Conestoga municipalities
- Challenges include “ordinance fatigue”



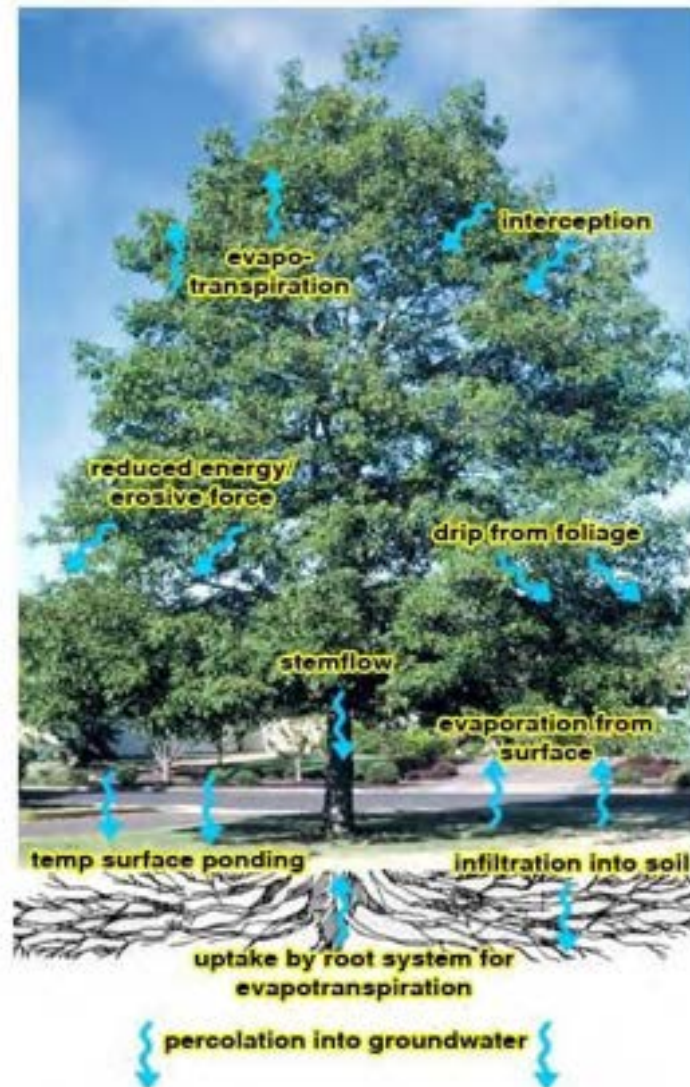
BRANDYWINE
CONSERVANCY

RIPARIAN BUFFER PROTECTION THROUGH ORDINANCES



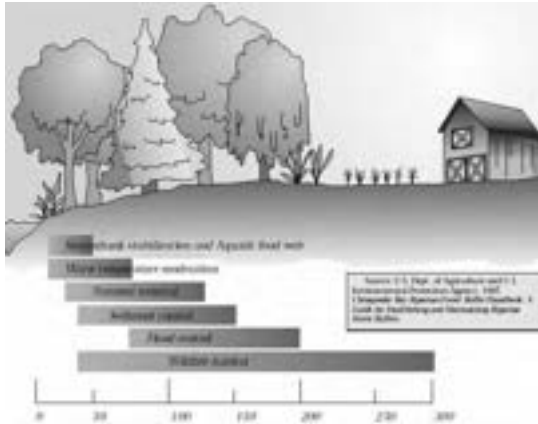
BRANDYWINE
CONSERVANCY

Trees as THE Best Management Practice



Buffer Width

*Riparian Buffer Zones:
Functions and
Recommended Widths
(Ellen Hawes and
Markelle Smith, Yale
School of Forestry, April
2005)*



- Lots of data showing lots of things, depending on study structure....
- Erosion control 30 to 98 feet
- Water quality
- Nutrients 49 to 164 feet
- Pesticides 49 to 328 feet
- Biocontaminants (fecal, etc.) 30 feet or more
- Aquatic habitat
- Wildlife 33 to 164 feet
- Litter/debris 50 to 100 feet
- Temperature 30 to 230 feet
- Terrestrial habitat 15 to 330 feet

So....municipalities can get tough on protection!

- Within a Zoning Ordinance
 - Overlay district
 - Protection standards
- Within a SALDO
 - Design standards
- Within a Stormwater Ordinance
 - Riparian buffer requirements

Model Riparian Buffer Protection Overlay District

Second Edition
(with annotations)

BOARD OF SUPERVISORS

_____ TOWNSHIP

_____ COUNTY, PENNSYLVANIA

ORDINANCE NO. _____

AN ORDINANCE TO AMEND THE _____ TOWNSHIP ZONING ORDINANCE IN ORDER TO PROVIDE FOR PROTECTIONS TO STREAMS AND OTHER WATERCOURSES BY ESTABLISHING RIPARIAN BUFFER AREAS ADJACENT THERETO; STATING THE PURPOSES AND INTENTS OF SUCH PROTECTIVE PROVISIONS; DEFINING CERTAIN TERMS IN CONNECTION WITH SUCH REGULATIONS; PROVIDING FOR THE SCOPE OF APPLICABILITY OF THE REGULATIONS; DELINEATING THE SCOPE OF RIPARIAN BUFFERS; ESTABLISHING PERMITTED USES WITHIN RIPARIAN BUFFER AREAS; PROVIDING FOR THE RESTORATION OF BUFFER AREAS AND PLANTING REQUIREMENTS, IN ORDER TO CREATE EFFECTIVE FORESTED RIPARIAN BUFFER AREAS; PROVIDING FOR MODIFICATIONS TO RIPARIAN BUFFER STANDARDS AND PROCEDURES FOR SAME.

UNDER AND BY VIRTUE OF THE AUTHORITY SET FORTH IN ARTICLE I, SECTION 27 OF THE CONSTITUTION OF THE COMMONWEALTH OF PENNSYLVANIA, THE PENNSYLVANIA CLEAN STREAMS LAW (35 P.S. §6911, ET. SEQ.) AND ARTICLE VI OF THE PENNSYLVANIA MUNICIPALITIES PLANNING CODE (53 P.S. §3601 ET. SEQ.), THE BOARD OF SUPERVISORS OF _____ TOWNSHIP DOES HEREBY ENACT AND ORDAIN THE FOLLOWING AMENDMENTS TO THE _____ TOWNSHIP ZONING ORDINANCE.

Section 100. **Purpose and Intent.** The specific purposes and intent of this article are to:

- A. Conserve, protect, and restore natural riparian resources through scientifically supported processes.

Find the latest edition at ConservationToolbox.org

3

Guidance for Pennsylvania's Municipalities



A Scientific Foundation for Shaping Riparian Buffer Protection Regulations



Extensive scientific research documents that vegetated strips of land along water bodies provide numerous water quality and other public benefits. The science shows that development should be kept away from the water's edge, buffer protected strips provide greater benefits, forested buffers are more effective than grassy ones, and forested buffers in headwaters provide the greatest benefits of all.

Overview 1

- Summary 1
- Conservation Impact 1
- Riparian Buffer Defined 1
- Consent of Guide 2

The Science 2

- Point 1. Do Not Allow Development to Encroach into Riparian Buffers 2
- Point 2. The Wider the Buffer, the Greater the Benefit 3
- Point 3. Riparian Buffers Need to Be Forested 3
- Point 4. Protect Forested Riparian Buffers into Headwaters 4

Related Resources at ConservationTools.org 5

Overview

Summary

Scientific research has strongly established the harm to water quality, the increased flooding, and the damage to the ecosystem that results from failure to protect riparian buffers. This guide identifies the key scientifically grounded principles that municipalities should follow when developing riparian buffer protection regulations.

Pennsylvania's streams, rivers, wetlands, and other natural water bodies are a major part of our state's "life blood" and at one time, virtually all were in a naturally forested landscape that contributed to their high quality. Riparian buffers, particularly when forested, effectively prevent non-point pollutants from degrading these resources. Extensive scientific research documents that undisturbed, vegetated buffers provide extensive water quality and other environmental benefits. New research shows an even higher ecological value of riparian buffers in headwaters, or first-order streams that should be protected from disturbance or degradation. As explained in later sections, headwater streams are primary food/habitat production areas

and have been found to be essential to the health of the entire aquatic system.

Conservation Impact

- Riparian buffers, particularly forested buffers, have been documented to provide the following conservation benefits: prevent stream bank erosion, protect fish and stream morphology (i.e., broad meanders with maximum stream bottom habitat, remove excess nitrogen, phosphorus and sediment from surface water runoff), reduce downstream flooding, provide thermal protection to adjoining streams, wetlands, and water bodies, provide food and habitat for wildlife, provide food and habitat for fish and amphibians, help contribute to habitat conservation and greenways, and protect associated wetlands.

- Forested riparian buffers in headwaters that order streams generate high levels of organic inputs directly from land to water, which in turn maximize in-stream processing functions that provide the "fuel" needed for downstream energy and nutrient processing.

Riparian Buffer Defined

Riparian buffers are vegetated lands, ideally forested, that border streams, rivers, reservoirs, ponds, lakes, and wetlands. Riparian buffers provide an array of valuable ecological functions (often termed "ecoservices") and are critical natural resources worthy of both public and private landowner protection efforts. Riparian buffers effectively intercept non-point source pollutants carried by surface water runoff or groundwater from adjoining land uses, preventing these pollutants from reaching water bodies. Forested buffers, in particular, maintain erosion of stream or river banks, help to control stream temperature fluctuations and elevated temperatures harmful to aquatic life, provide food and habitat for wildlife, fish and amphibians, allow for wildlife movement within, stream or river corridor.

Last updated on May 31, 2014

Pennsylvania Land Trust Association (PALTA) and the Brandywine Conservancy – www.ConservationTools.org.



Contents

- *Purpose and Intent*
- *Definitions*
- *Applicability*
- *Riparian Buffer Delineation*
- *Uses Permitted*
- *Buffer Restoration and Planting Requirements*
- *Modifications to Riparian Buffer Standards*



Model Riparian Buffer Protection Overlay District

Proposed Regulations for Use in a
Municipal Zoning Ordinance

Second Edition

Prepared by the
Brandywine Conservancy and
Pennsylvania Land Trust Association

in consultation with the
Stroud Water Research Center, Natural Lands Trust, and Fronfield Crawford, Jr., Esq.

and financially supported by the
William Penn Foundation, Colcom Foundation, and Community Conservation Partnerships
Program, Environmental Stewardship Fund, under the administration of the Pennsylvania
Department of Conservation and Natural Resources, Bureau of Recreation and Conservation

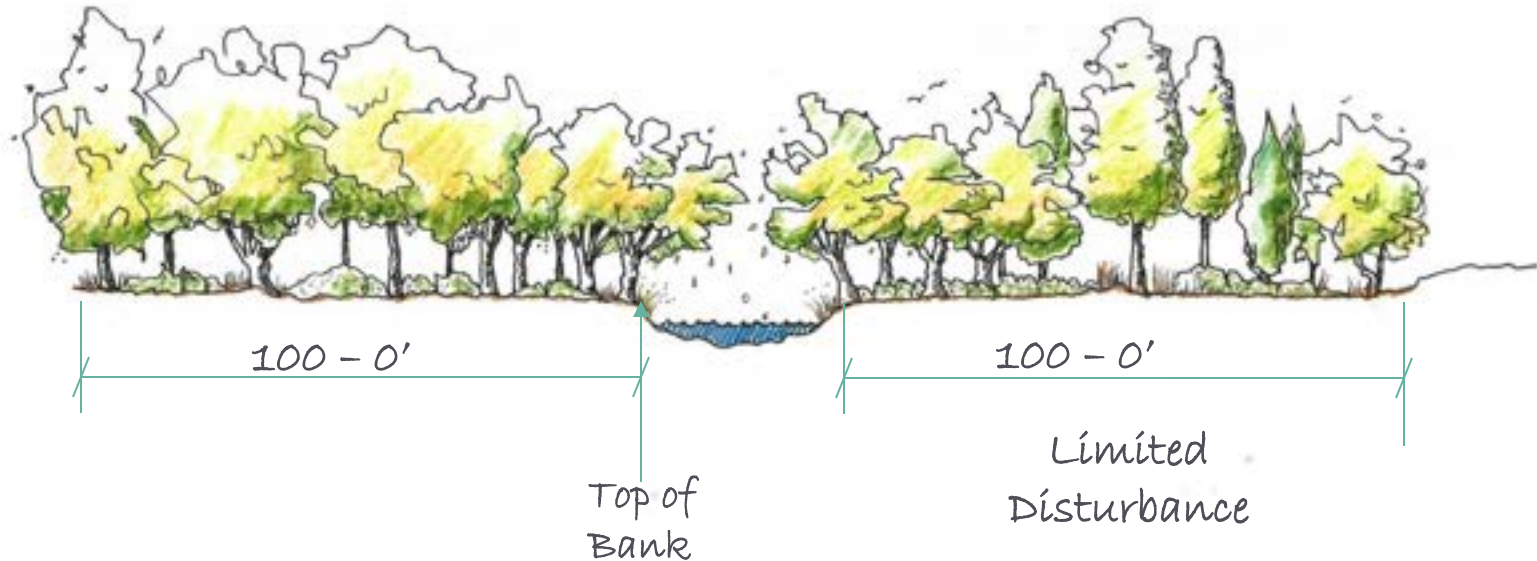
Find the most recent edition at
ConservationTools.org

3/11/2016



Preserves existing riparian buffers

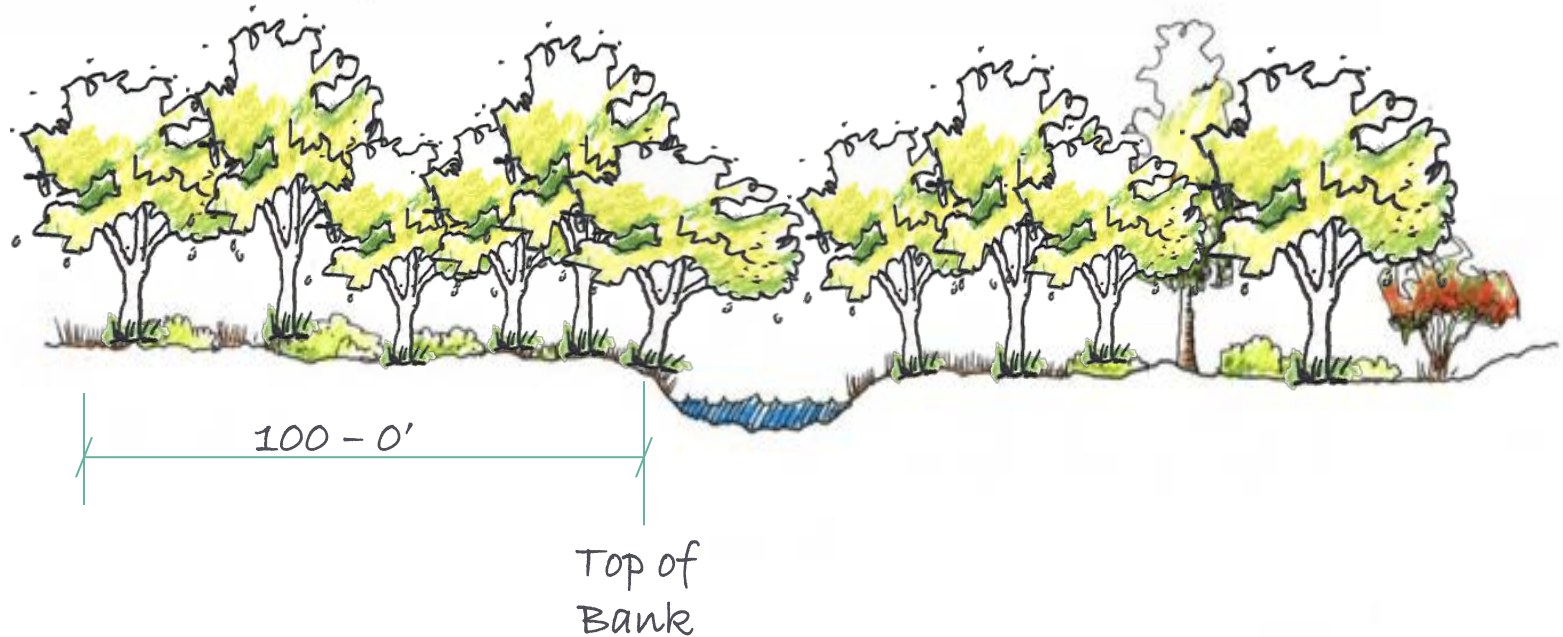
Forested Riparian Buffers (existing)



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Minimum of 60% native tree
canopy in riparian buffer

Impacted Riparian Buffer (Existing)



BRANDYWINE
CONSERVANCY

Restoration to minimum 60% native tree canopy
in riparian buffer

Restores impacted riparian buffers

CONSERVANCY MODEL APPLIES TO WETLANDS



AND CAN BE MODIFIED FOR WIDE
FLOODPLAINS AND STEEP
SLOPES.



Modifications to Buffer Requirements

- Municipalities can get tough on protection provided...
 - A “safety valve” exists for unique/unforeseen circumstances
- Simpler modification process proposed
 - Requested at the time of conditional use, special exception, or variance approval, or subdivision or land development approval
 - Limited to minimum adjustment necessary to allow relief while adhering to riparian buffer purposes



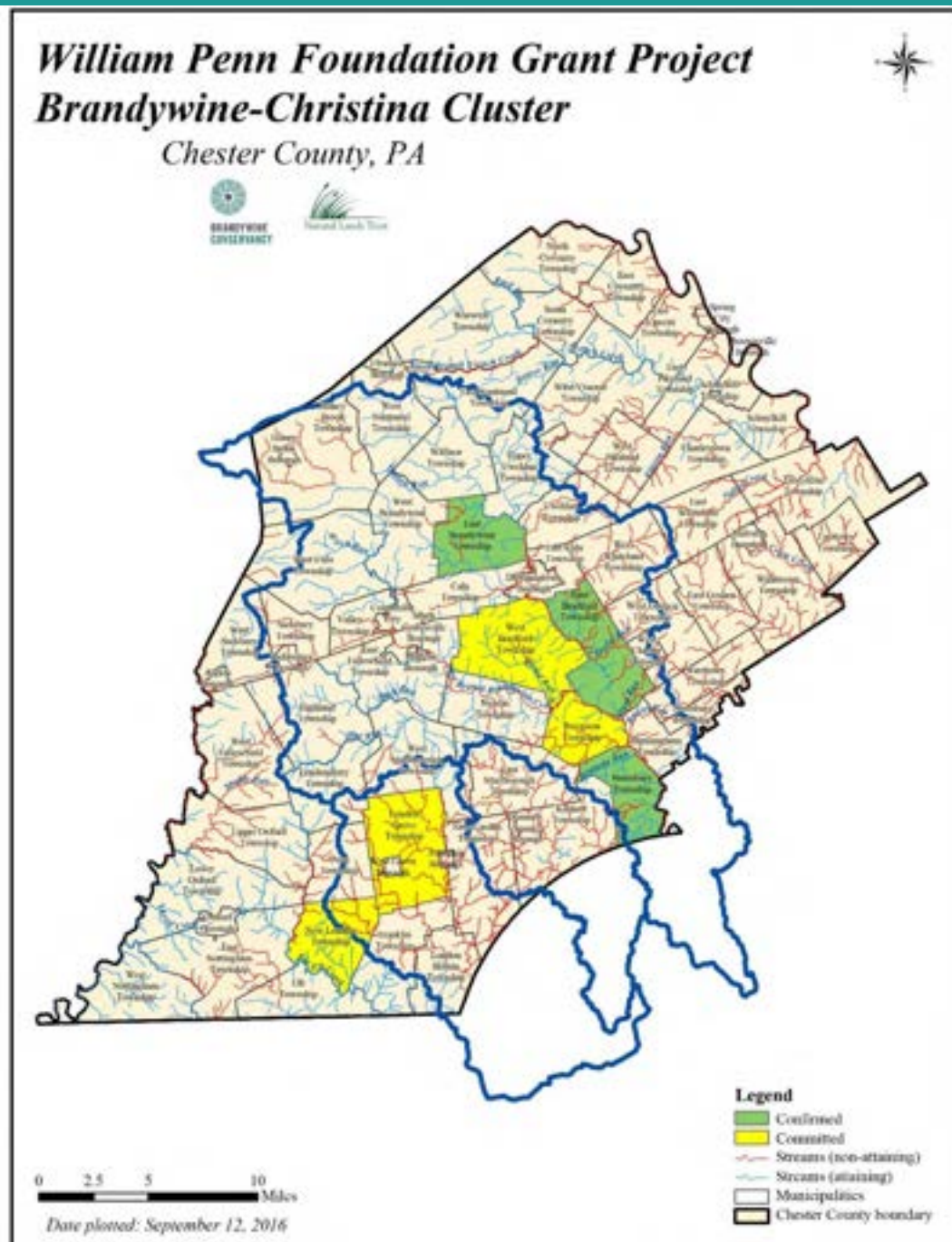
Riparian Buffer Ordinance Adoption

3 Confirmed

- East Bradford
- East Brandywine
- Pennsbury

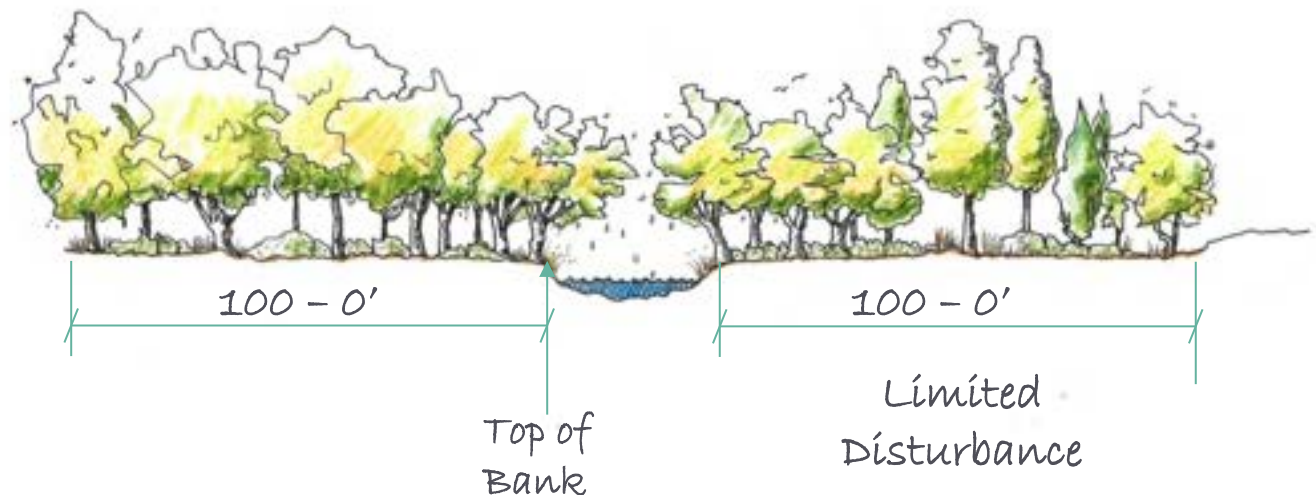
4 In Process

- London Grove
- Pocopson
- West Bradford
- New London

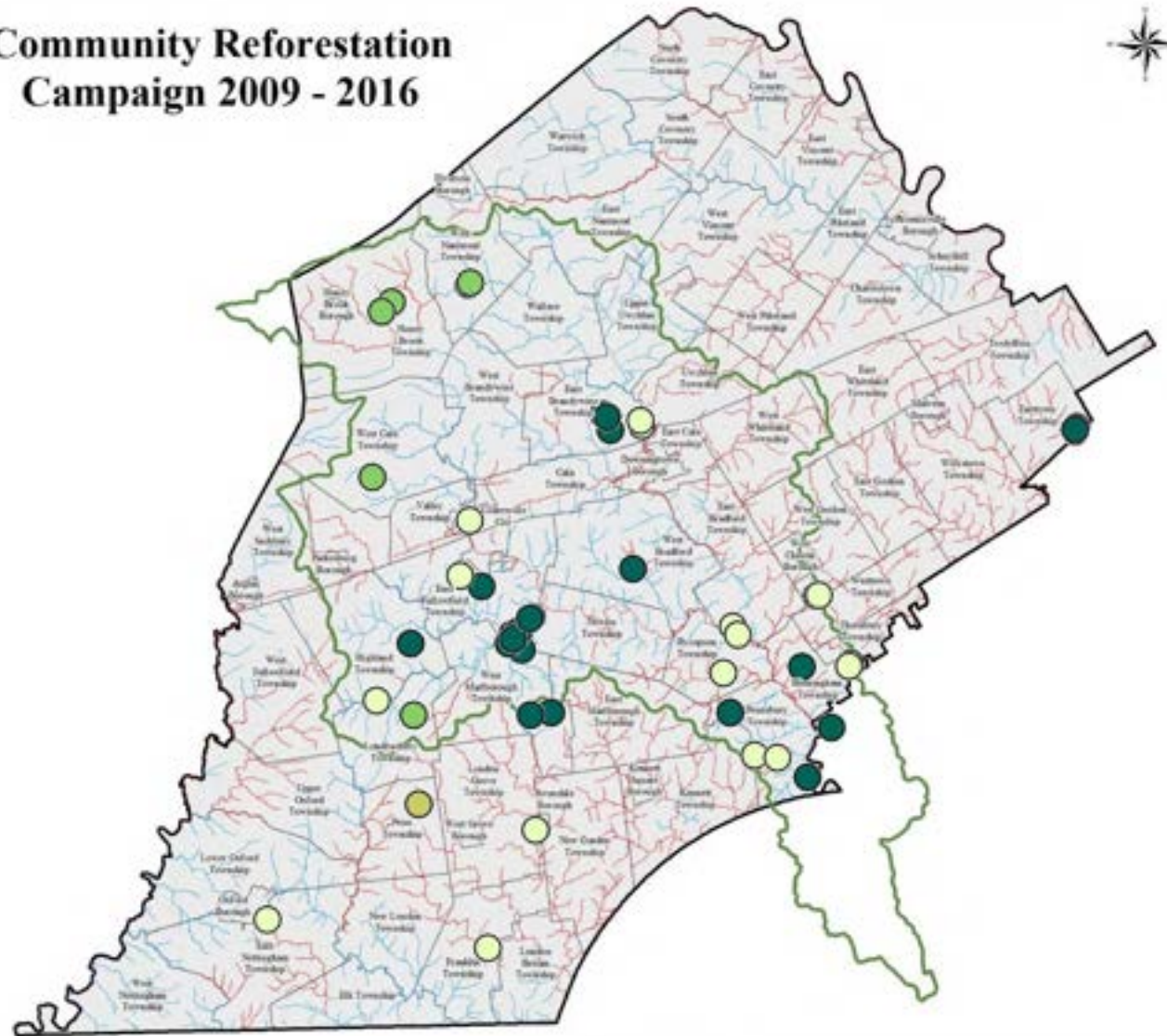


A Few Observations

- The minimum forested buffer width could be larger (or smaller)
- Should avoid terms such as “special protection waters” or “impaired streams” in ordinance
- Regulation of agricultural uses is very difficult from practical, political, and pre-emption perspectives
- Requiring restoration is a legitimate use of regulatory powers
- Seek MS4/TMDL credit for ordinance implementation



Community Reforestation Campaign 2009 - 2016



**BRANDYWINE
CONSERVANCY**

- Brandywine Conservancy Owned and Eased Land
- Agricultural Easement
- Public Open Space and Institutional Lands
- Private Property
- Brandywine Creek watershed
- Streams (non-attaining)
- Streams (attaining)

0 2.5 5 10
Miles

Data source: Base data from Chester County GIS Department,
2016. Attaining and non-attaining streams from PADEP, 2013.
Date plotted: September 23, 2016

Riparian Buffer Restoration

*Best Management
Practices on
Farmland*



East Brandywine Township

2013

- 1200 trees planted

2014

- 650 trees planted



East Fallowfield Township Park

2015

- *265 trees planted*



Oxford Area School District

*Nottingham
Elementary
School,
East Nottingham
Township
2014*

- *1200 trees
planted*



Upper Oxford Township Park – Rain Garden



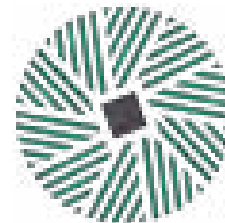
Upper Oxford Rain Garden – After Installation





Catch the Rain

Green Stormwater Rebate Program



**BRANDYWINE
CONSERVANCY**



CATCH THE RAIN IN THE WHITE CLAY CREEK WATERSHED



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BEFORE...



EXISTING STORMWATER FLOW
GOES TO THE STREET, UNFILTERED



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AFTER...



LAWN
AREA IS
REDUCED

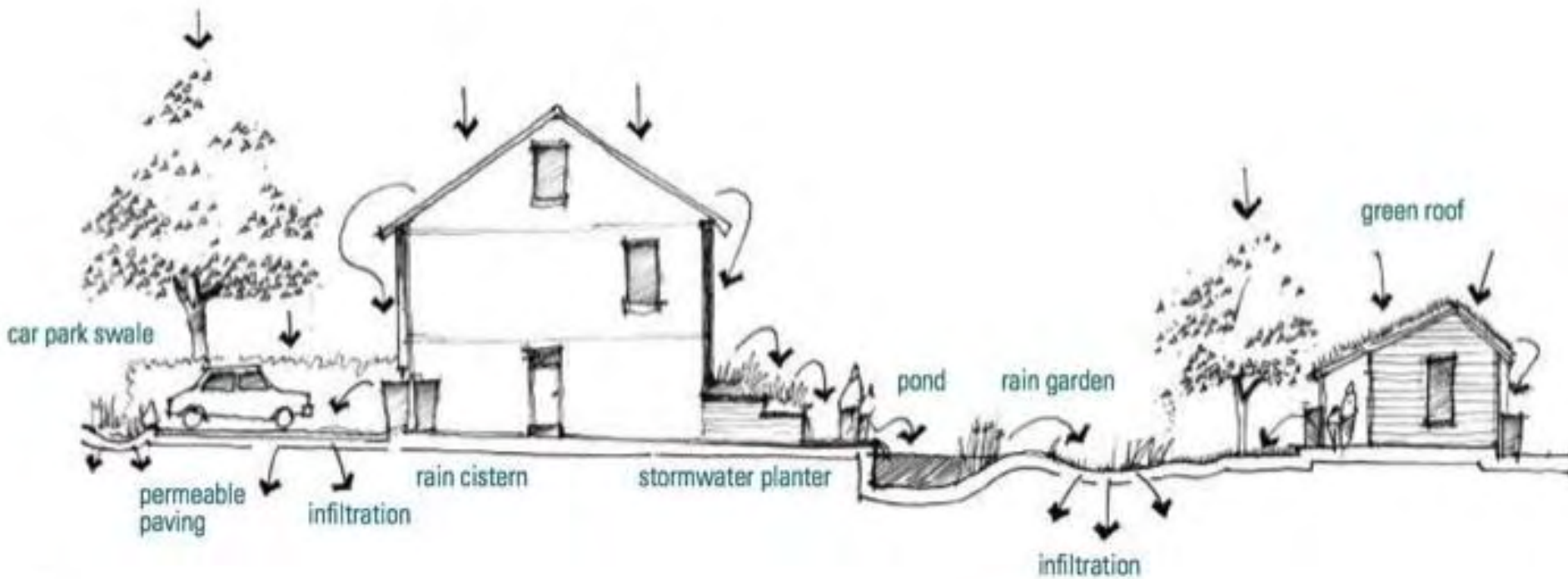
RAIN GARDENS
CATCH ROOF
RUNOFF

PERVIOUS PAVERS ABSORB RAIN

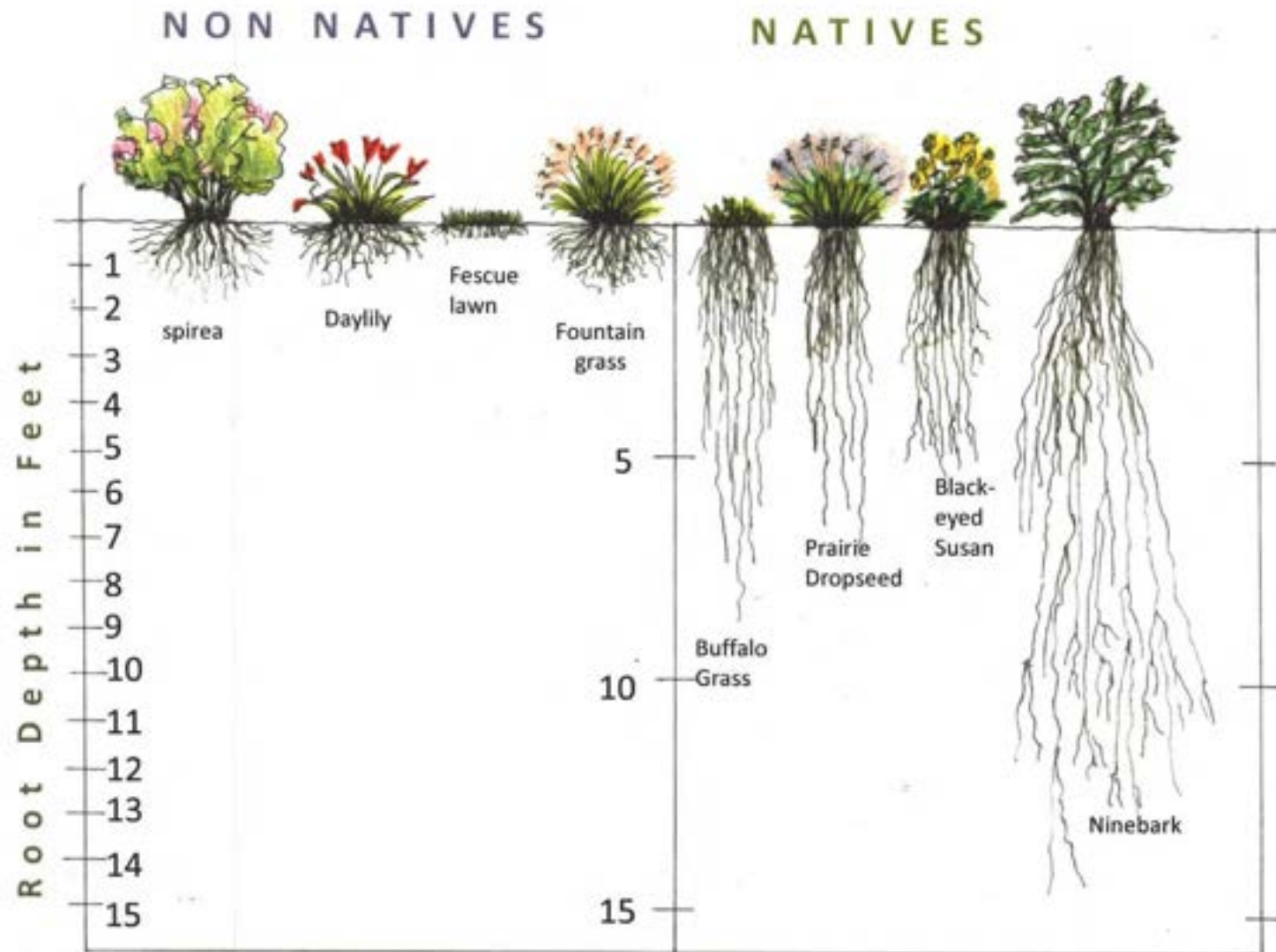


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Treatment Train Approach



Why Native Plants?



Catch the Rain Practice	Residential Rebate Amount Total Maximum Rebate = \$2500/parcel	Practice Requirements
Rain Gardens	Typical cost: \$4–25/sq. ft. Rebate: \$10/sq. ft., \$2000 max.	Minimum sizes: 120 sq. ft. Rain capture: min. 1", max. 2.7" Location must pass percolation test
Conservation Landscapes	Typical cost: \$4–10/sq. ft. Rebate: \$3/sq. ft., \$1200 max.	Minimum sizes: 250 sq. ft. Rain capture: must receive drainage from impervious surface and must have a microberm around the downhill perimeter to help slow and infiltrate water.
Permeable Paving Retrofit	Typical cost: \$16–25/sq. ft. Rebate: \$4/ sq. ft., \$1200 max.	Minimum sizes: 150 sq. ft. of existing impervious surface must be replaced. Must be installed by a certified ICPI contractor with an additional certification in PICP.
Pavement Removal	Typical cost: \$3–5/sq. ft. Rebate: \$5/sq. ft. for conversion to conservation landscape; \$2/sq. ft. for conversion to turf (grass), \$2000 max.	Minimum sizes: 100 sq. ft.
Rain Barrels	Typical cost: \$100 Rebate: \$50/barrel, first rain barrel free if combined with another approved practice, \$250 max.	Minimum sizes: 60 gallon barrel
Canopy Trees	Typical installed cost: \$75–250/tree Rebate: \$100/tree, \$1000 max.	Minimum sizes: #7 pot or larger, 8' tall or 1" caliper. Tree must be planted 10–25' from permanent buildings. Planting shall occur between Sept. 15 and April 30. Tree must be mulched and have protection from deer.



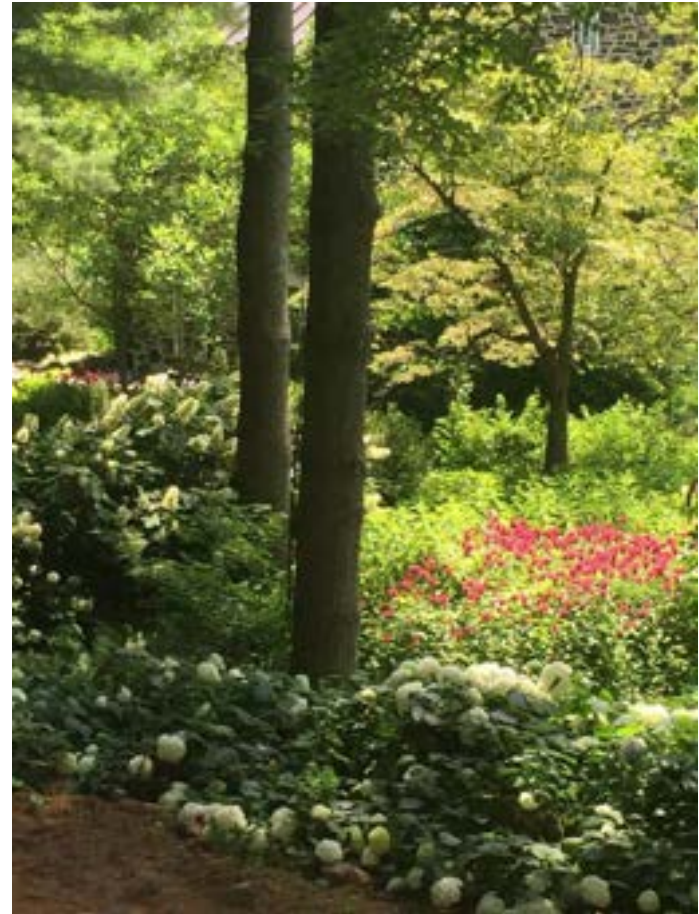
Rain Gardens

- Cost: \$4-25/ sq. ft.
- Rebate: \$10/sq. ft. (\$2000 maximum)
- 120 square feet or more
- Minimum 1" rain capture
- Successful percolation test



Conservation Landscapes

- Cost: \$4-10/ sq. ft.
- Rebate: \$3/sq. ft. (\$1200 maximum)
- At least 250 sq. ft.
- Must receive drainage from impervious surface
- Must have a micro-berm (12" high or so) on the downhill edge to help slow and infiltrate water.



Catch the Rain - Canopy Trees



CATCH THE RAIN IN THE WHITE CLAY CREEK WATERSHED

Canopy Trees

- *Cost: \$75-250/tree*
- *Rebate: \$100/tree*
 - *(\$1000 max.)*
- *Minimum size: #7 pot, 8' tall or 1" caliper*
- *At least 10-25' from buildings*
- *Shade to pavement/buildings*
- *Mulch AND deer Protection.*



Tree protection is required!



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© Mark
Raycroft

Rain Barrels

- Typical cost: \$100
- Rebate: \$50/barrel
- First rain barrel free if combined with another approved practice
- \$250 max rebate
- Minimum size: 60 gallon
- <http://www.camels-hump.com/>



Catch the Rain – Paving Removal



CATCH THE RAIN IN THE WHITE CLAY CREEK WATERSHED

Options for Paving Removal

- Remove existing and install pavers (requires certified professional installer)
- Remove existing and plant
 - Lawn, Conservation Landscaping, or Rain Garden.



Permeable Paver Retrofit



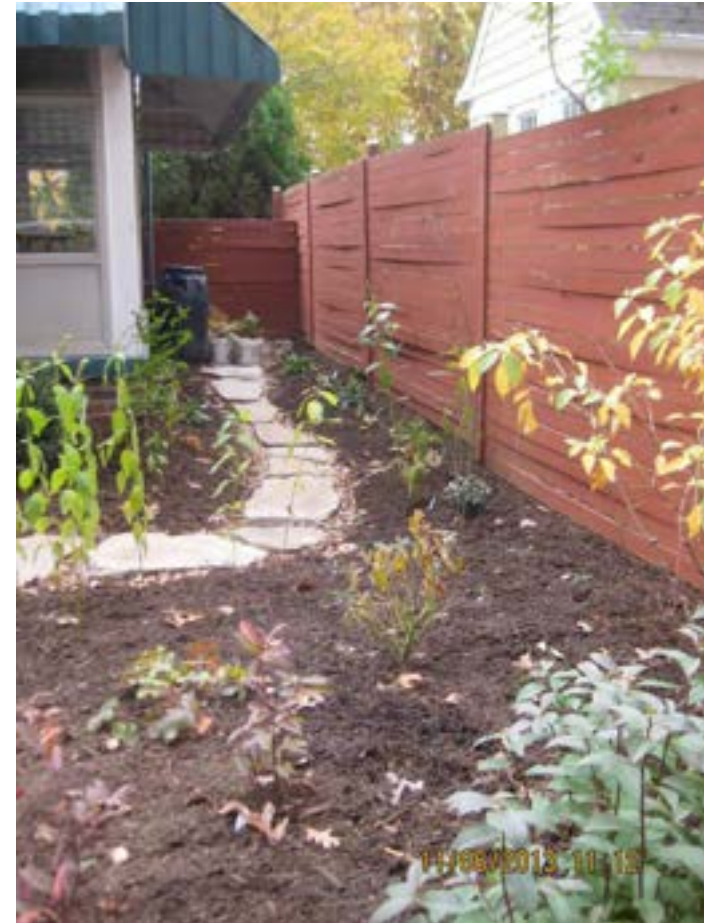
- Cost: \$16-25/ sq. ft.
- Rebate: \$4/ sq. ft.
 - \$1200 maximum
- At least 150 sq. ft. of existing impervious surface must be replaced
- Must be installed by a certified ICPI contractor with an additional certification in Permeable Interlocking Concrete Paving.



Pavement Removal and Revegetation



- Cost:\$3-5 sq. ft.
- Rebate: \$5/sq. ft. for conversion to conservation landscape
- \$2/ sq. ft. for conversion to turf (grass)
- \$2000 max rebate
- Minimum size: 100 sq. ft.



Monitoring and Management

- Catch the Rain provides maintenance plan.
- Homeowner must agree to weed, water, and carefully monitor all plantings.
- Maintenance is more intensive at first and becomes easier as the plants mature.



MELIORA DESIGN

Civil, Water Resources, and Structural Engineering



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Thank you! Questions?

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