Providence Stormwater Innovation Center

Audubon Society of Rhode Island

PROVIDENCE PARKS + RECREATION play · relax · explore

UNIVERSITY OF NEW HAMPSHIRE STORMWATER CENTER

SAVE THE BAY NARRAGANSETT BAY

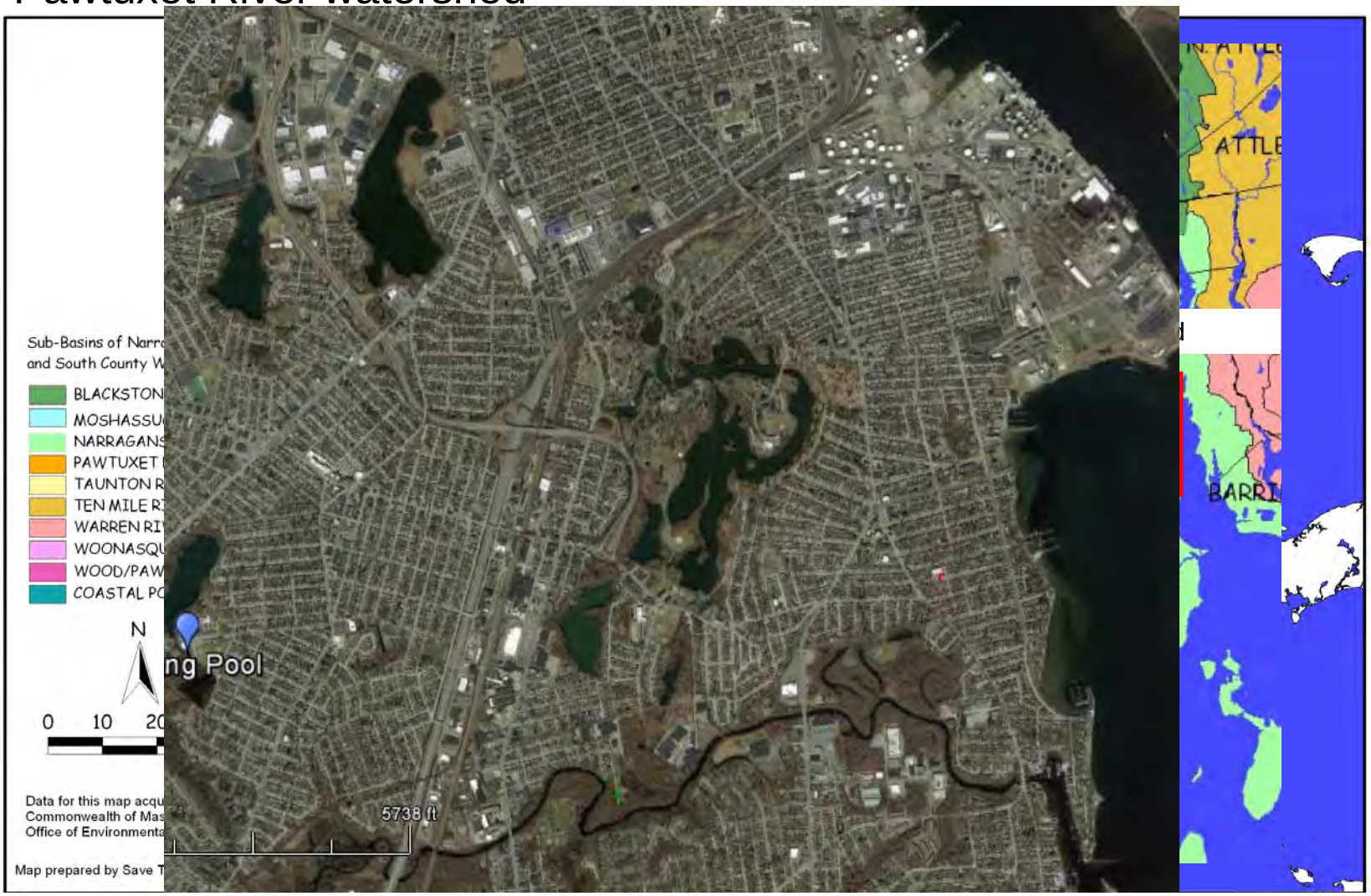
GROUNDWORK Rhode Island

The Nature Conservancy Rhode Island

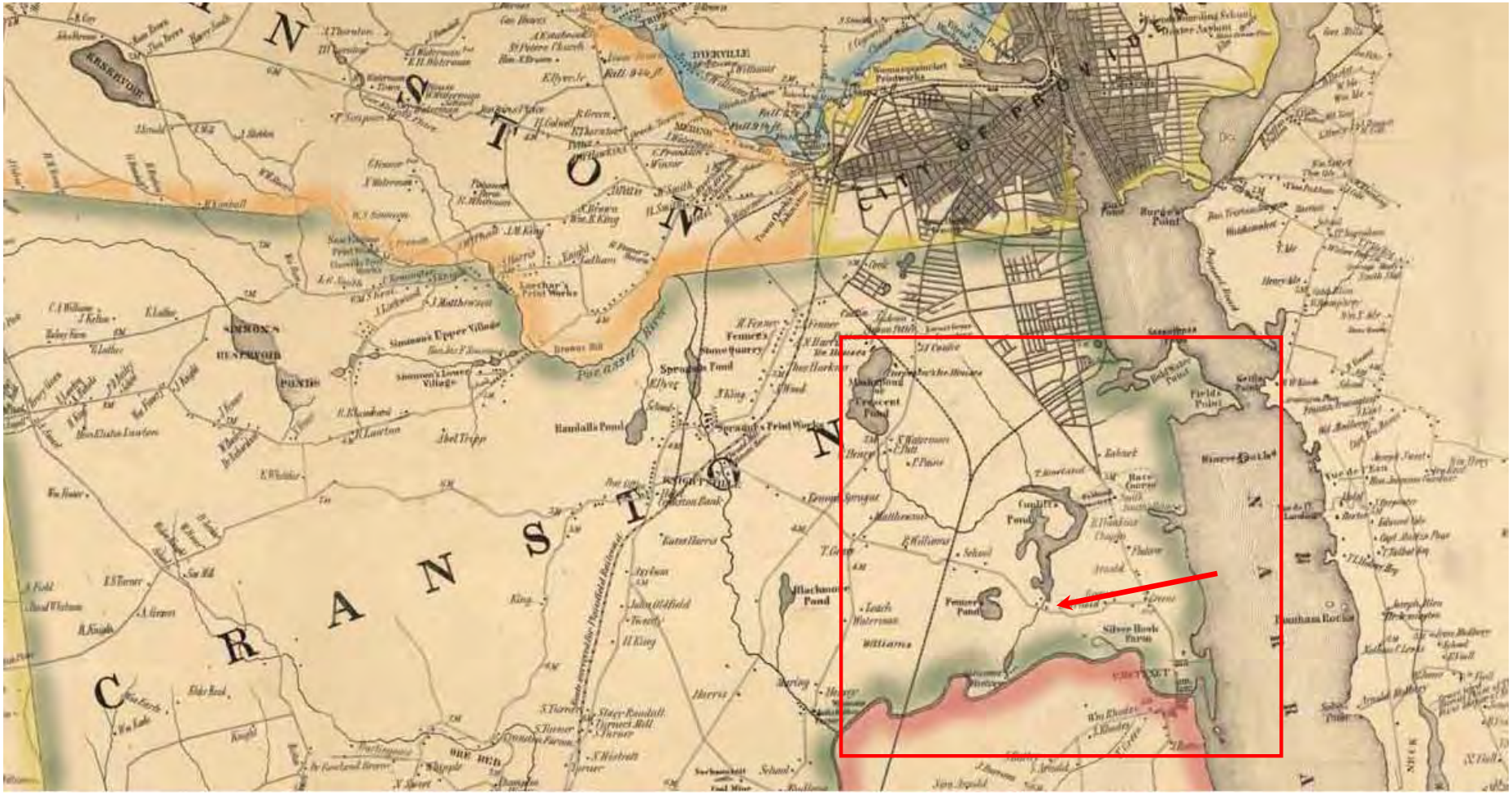
UNIVERSITY OF RHODE ISLAND HOPE 1892

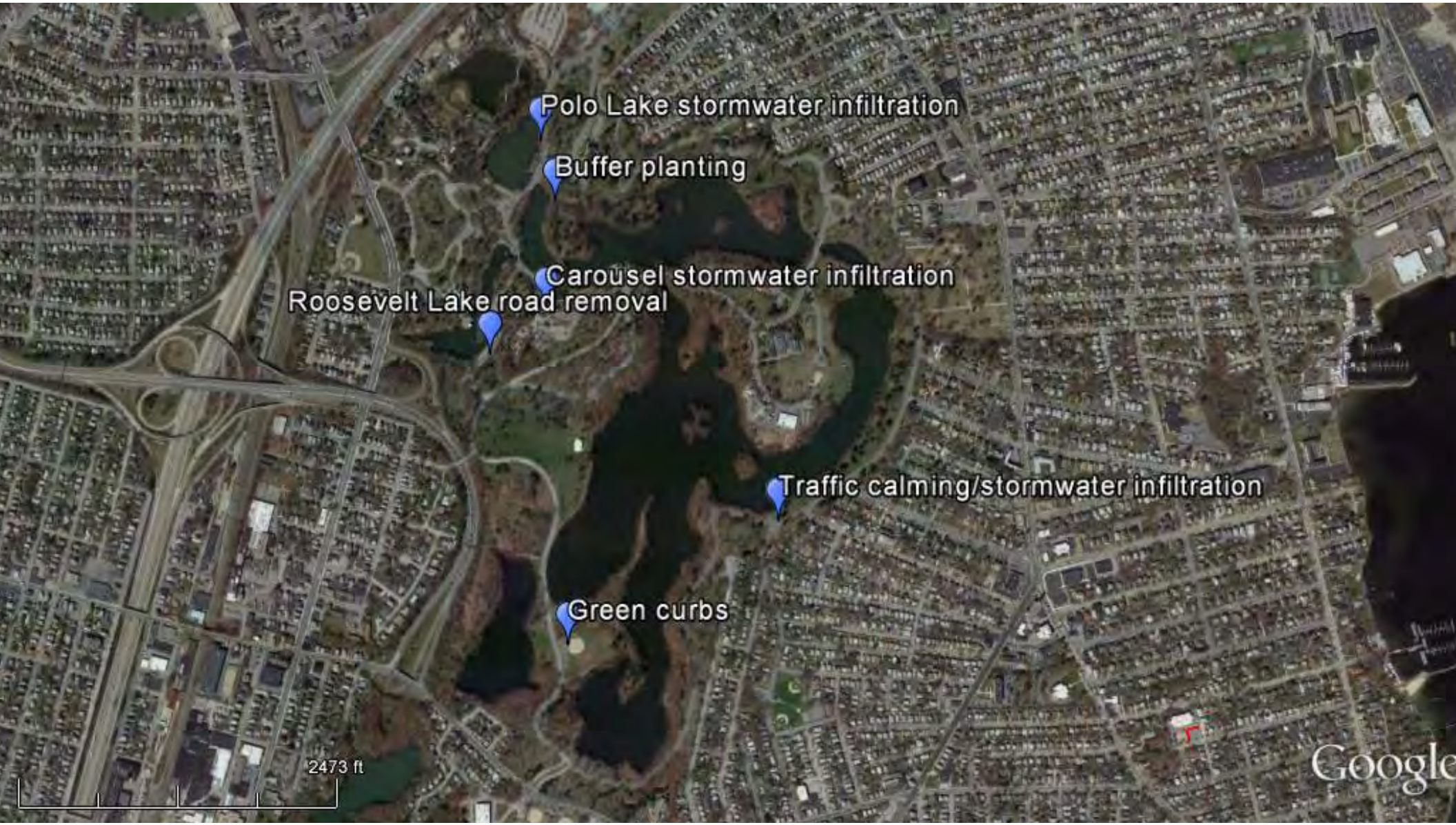
RHODE ISLAND GREEN INFRASTRUCTURE COALITION

Pawtuxet River watershed



Map from 1850: Cunliff Pond formed in 1830s by damming Bellafont Brook




Polo Lake stormwater infiltration
Buffer planting
Carousel stormwater infiltration
Roosevelt Lake road removal
Traffic calming/stormwater infiltration
Green curbs
2473 ft
Google

Roger Williams Park Carousel infiltration area

- installed 2012








Edgewood Ave./F Greene Memorial Blvd stormwater infiltration:

Roger Williams Park stormwater infiltration: green curbs

Polo Lake stormwater infiltration: 2013








Polo Lake wetland/buffer planting: 2013

Roosevelt Lake road removal: 2013


Linden Ave
Gladrash's Ave
F C Greene Memorial Blvd
Gladrash's Ave
Hillside Ave
Maple Ave
393 ft
2012

Roosevelt Lake road removal: 2013


2017

Roosevelt Lake wet meadow

April 2013

May 2013

May 2013

April 2015

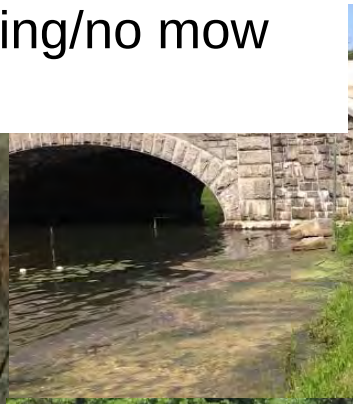
Roosevelt Lake buffer planting

Roger Williams Park stormwater/green infrastructure demonstration site

2013

2015

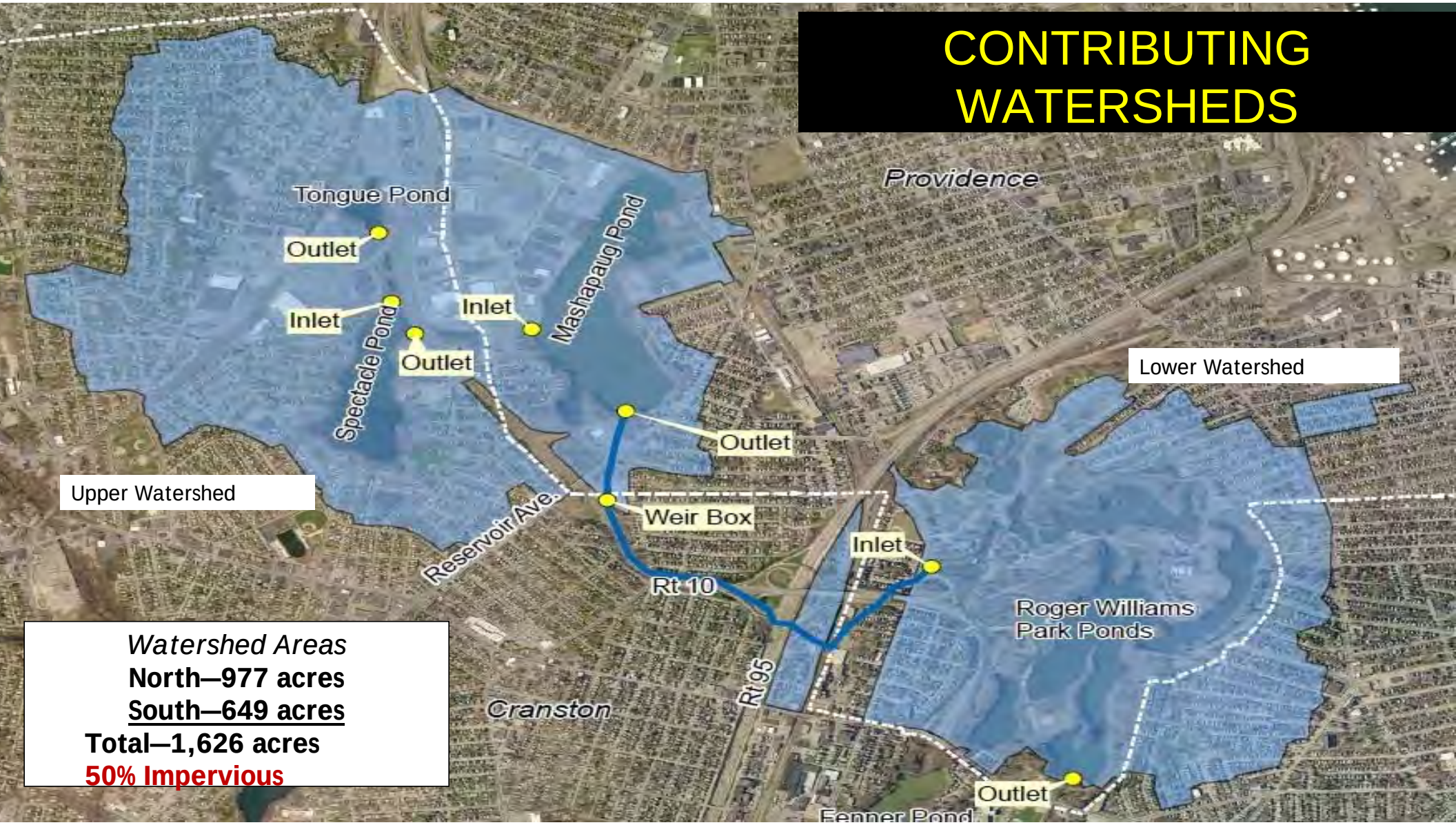
Willow Lake buffer planting/no mow area



ROGER WILLIAMS PARK

- **Designed by Horace Cleveland (1874)**
- **One of Rhode Island's most treasured places**
- **Largest & Most Important Open Space in Providence, RI**
- **435 Acres**
- **1 Million visitors per year**
- **100+ Acres of Ponds**
- **TMDL (Total Maximum Daily Load) for Phosphorus**
- **The ponds are part of the park's historic design and character**
- **Significant Recreational Use & Resources**

CONTRIBUTING WATERSHEDS



Watershed Areas
North—977 acres
South—649 acres
Total—1,626 acres
50% Impervious

City of Providence and RIDEM Execute Consent Agreement

Providence Forced to Invest in Stormwater System
March 09, 2017/ Jo Detz **By ecoRI News staff**
PROVIDENCE — *Mayor Jorge Elorza recently signed an agreement with the Rhode Island Department of Environmental Management (DEM) to bring the city's stormwater management system into compliance with its Municipal Separate Storm Sewer System permit.*

- Signed following a Notice of Violation issued by RIDEM with penalties of $25,000 per day
- City has seven (7) years to come into compliance with the EPAs Clean Water Act
- Items included in the agreement
  - Mapping of all 12,000 catch basins and piping
  - Increased Efforts related to Stormwater Management
  - Increased Public Engagement Around Stormwater Prevention
  - Implementation of Green Infrastructure Projects in Roger Williams Park

Poor Water Quality - Cyanobacteria

Parks Department Capital Projects 2018-2019

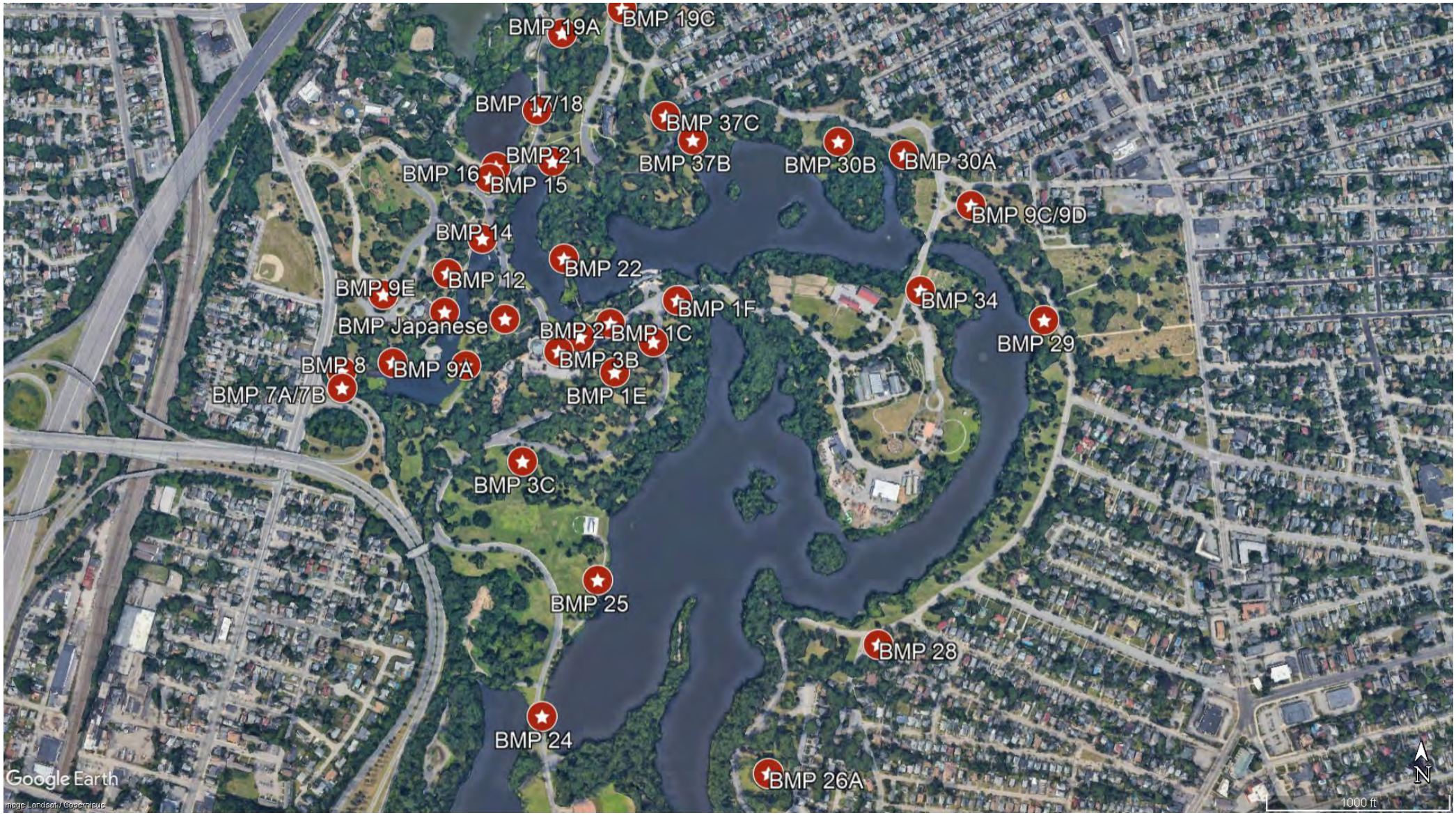
DEM Consent Agreement - 2016 - City of Providence - RIPDES RIR040005					
ATTACHMENT TO: CONSENT AGREEMENT; SECTION (C) AGREEMENT; ITEM (4); SUBSECTION (a); ITEM (iii) 1					
Roger Williams Park Ponds, Water Quality Management Plan (Horsley Witten Group, June 2013)					
Proposed Projects in Roger Williams Park					
SITE I.D.	**LOCATION**	**DESCRIPTION**	**Status / Schedule**	**Budget**	**Current**
RWP-3B	Carousel Parking Lot	Construct bioretention at entrance of parking lot for half of the	Complete	$18,000.00	$18,000.00
		parking lot runoff; overflow into existing closed drainage system			
RWP-17/18	F.C. Greene Memorial Blvd.	Create paved flume/inlet structure direct road runoff to wet swale	Complete	$149,000.00	$149,000.00
		modify box culvert to crewt diversion structure; runoff to			
		bioretention swale			
RWP-24	F.C. Greene Mem. Blvd.	Increase buffer vegetation and reduce road width/impervious	Complete	$162,000.00	$162,000.00
	Between Cunliff and	surface; remove curb, add vegetated swale in buffer to catch			
	Deep Spring Lakes	water before it outfalls through existing spillway			
RWP-28	Intersection of Edgewood,	Remove pavement and add sand filter; install paved flumes and	Complete	$112,000.00	$112,000.00
	Beachmont and F.C. Greene	forebays prior to main sand filter cell, design overflow structure			
	Memorial Blvd.	to connect to existing pipe outfall into the lake			
RWP-6	Roosevelt Lake	Pavement removal; raingardens and buffer restoration	Complete	$300,000.00	$300,000.00
	Across from Monument				
RWP- 1G	Shoreline Near Boathouse	Re-vegetate buffer area with low-growing grasses & shrubs	Complete	$9,000.00	$9,000.00
RWP-26	Ballfield Erosion	Fine grading, stabilization, erosion control and seeding; swale	Complete	$9,500.00	$9,500.00
RWP-10	Casino Hillside Erosion	Buffer Planting & Re-Seeding	Complete	$3,300.00	$3,300.00
RWP-4	F.C. Greene Mem. Blvd -East	Buffer Planting & Re-Seeding	Partially Complete	$5,000.00	$5,000.00
	of Japanese Garden		2018		

Parks Department Capital Projects 2018-2019 (2)

RWP-23	F.C. Greene Memorial Blvd.	Curb Removal only and areas of no-mow meadows	Curbing Complete	$19,500.00	$19,500.00
	by Temple of Music		Plantings Pending		
RWP-12	Ornamental Bridge	Diversion structure into a terraced bioretention under the bridge	Complete 2017	$159,000.00	$159,000.00
	North of Casino				
RWP-19A	Outfall at Polo Lake-Museum	Terraced Bioswale	FY2018	$103,000.00	
RWP-2	Road by Carousel	Plant native material;augment soils and convert low area at yard	FY2018	$18,600.00	
		drain to rain garden; shoreline buffer planting			
RWP-8	Island @ Elmwood Entrance	Fine grading,stabilization, erosion control and seeding; raingarden	FY2018	$21,000.00	
RWP-9A	Hillside Erosion South	Fine grading,stabilization, erosion control and seeding; pathway	FY2018	$17,000.00	
	of Casino	removal			
RWP-22	Path Intersection by	Fine grading,stabilization, erosion control and seeding; knotweed	FY2018	$15,000.00	
	Willow & Pleasure Lakes	removal			
RWP-1A	Pine Hill Ave	Bioretention Area	Complete	$14,000.00	$14,000.00
RWP-1B	Pine Hill & Maple	Bioretention Area	FY2018	$16,000.00	
RWP 1E	Maple Ave	Dryswale	FY2018	$21,500.00	
RWP-26A	F.C. Greene Mem. Blvd	WVTS	Complete	$6,500.00	$6,500.00
	Ballfield				
RWP-26B	F.C. Greene Mem. Blvd	WVTS	FY2018	$9,500.00	
	Ballfield				
RWP-37A	History Museum Lot	Dry Swale	FY2018	$7,000.00	
RWP-37B	History Museum	Terraced Bioswale	FY2018	$60,000.00	
	Memorial Blvd.				
RWP-37C	History Museum	Bioretention Area	FY2018	$50,000.00	
	Babcock Street				
RWP-16	Hillside Near Polo Lake	Plant with native, low growing grasses and shrubs to stabilize and	FY2019	$19,000.00	

Parks Department Capital Projects 2018-2019 (3)

RWP-25	Temple of Music Access Rd	Bank clearing; fine grading; stabilization, erosion control; planting & re-seeding	FY2019	$87,000.00	
RWP-11	Hillside Erosion East of Casino	Fine grading, stabilization, erosion control and seeding; Buffer Planting	FY2019	$12,000.00	
RWP-21	Hillside Erosion Near Pleasure Lake	Fine grading, stabilization, erosion control and seeding; planting	FY2019	$25,000.00	
RWP-3C	Carousel Parking Lot	Bioretention Area	FY2019	$23,500.00	
RWP-9C/9D	Casino Parking Lot	Bioretention Area	FY2019	$22,500.00	
RWP-9E	Casino Entrance	Bioretention Area	FY2019	$9,000.00	
RWP-19B	Outfall at Polo Lake-Tennis	Dry Swale	Complete	$92,000.00	$92,000.00
RWP-34	Botanical Center/Stables	Bioretention Area	FY2019	$130,000.00	
RWP-22	Path Intersection by Willow & Pleasure Lakes	Re-vegetate erosion rear stairs; replant area of recent storm damage / tree removal; remove area of Japanese knotweed	Duplicate	$18,500.00	$18,500.00
RWP-16	Hillside South of Polo Lake	Fine grading, stabilization, erosion control and seeding; buffer planting	Duplicate	$19,000.00	$19,000.00
RWP-1F	Cladrastis Ave Intersection	Bioretention Area	FY2020	$8,500.00	
RWP-7A	R:10 Off-Ramp	Infiltration Basin / Dry Swale	Ongoing - RIDOT	$14,000.00	$14,000.00
RWP-7B	Outfall at Roosevelt Lake	From Route 10 - WVTS	Ongoing - RIDOT	$11,000.00	$11,000.00
RWP-19C	Miller Ave	Bioretention Area	FY2020	$115,000.00	
RWP-29	Oakland Cemetery and Wentworth Ave.	Terraced/Shallow Bioretention	FY2020	$85,000.00	
RWP-30A	Marion Ave & F.C. Greene	Terraced Bioswale	FY2020	$203,000.00	
RWP-1C	Cladrastis Ave - Boathouse	Dryswale	FY2021	$18,500.00	
RWP-20	Willow Lake - Near Bridge	Buffer Planting & Re-Seeding	Complete	$3,900.00	$3,900.00
RWP-14	North of Roosevelt Lake	Shallow Bioretention	FY2021	$17,700.00	
RWP-15	Polo Lake Near Rotary	Terraced Bioswale	FY2021	$67,500.00	
RWP-30B	Marion Ave & F.C. Greene	WVTS	FY2021	$215,000.00	
not reflect actual project costs - construction costs will vary				Budget	Completed
e revisions and are working with consultants to formalize pricing			Totals:	$2,818,400.00	$1,121,600.00
f P-N from RWPP Report Page E-7; Table E.5			Balance to Complete:		$1,196,800.00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BMP 9E
BMP 1F
BMP 34
BMP Japanese
BMP 2
BMP 1C
BMP 29
BMP 8
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BMP 1E
BMP 3C
BMP 25
BMP 28
BMP 24
BMP 26A
Google Earth
Image Landsat / Copernicus
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1000 ft


SITE 3-BIORETENTION


SITE 12
08.24.2016 10:07


SITE 12
08 24 2016 09:05

Breach in System Boulder Wall

Construction Practice

- Boulder Walls Need to be Set Higher in Terrace

- Mortar or Fill Voids in Boulder Walls

- Confirm Overflow is Lower Than Boulder Wall


SITE 17/18-WET SWALE
Stormwater
Pretreatment
Buffer Restoration

LESSONS LEARNED


Diversion Structure Problems


Retrofit Existing Structure


Scenic Overlook Added

The Sidewalk Returns

LESSONS LEARNED


Clogged Inlet By-pass


Clogged Inlet swale

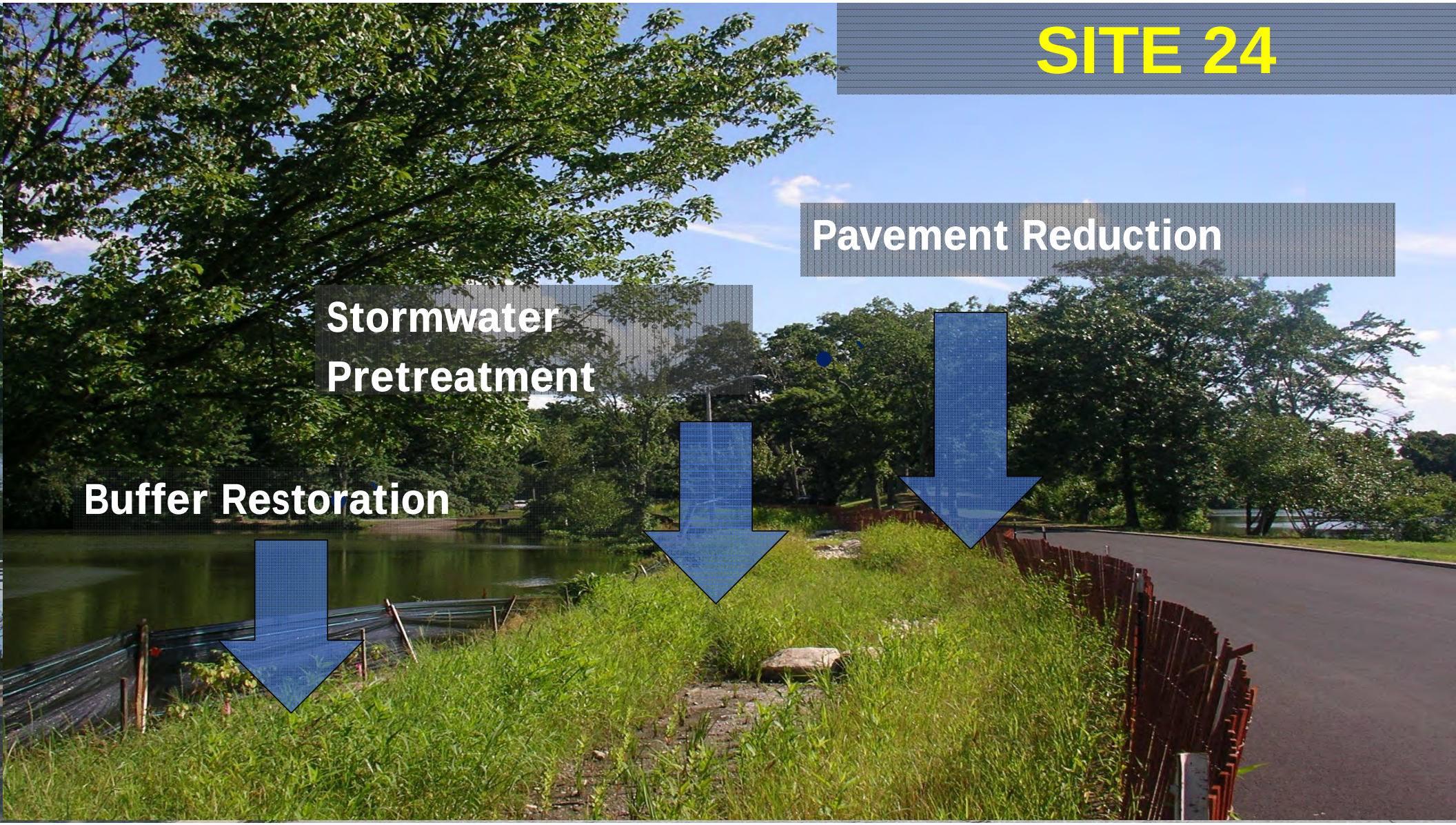

Overtopped berm


Box culvert cleaning

SITE 24


bioswale
24' of pavement
to remain
8' of pavement removal


8' of pavement removal
bioswale
Roger Williams Park
Frederick C Green Memorial Blvd


SITE 24
Pavement Reduction
Stormwater
Pretreatment
Buffer Restoration

LESSONS LEARNED

System Malfunction – Berm Elevation

Over Compaction

- Control Access
- Review Materials
- Repair
- Re-establish Proper Elevation for Water Direction

Additional Stormwater Elements

- Geese Control – Egg Addling – US Fish & Wildlife
- Downspout Disconnection Program - Pavers
- Lawn Signs for ‘Stormwater Heroes”
- Rain Barrel Sale / Giveaway (DPW)
- Algae Water Treatments - $18k Per Year
- Street Sweeping & Catch Basin Cleaning
- Street Scuppers on Roadway Projects

Design Challenges at Roger Williams Park - Visitors

Creating Places People Can Enjoy and Still Make Room for Green Infrastructure

- Lessons Learned – Temple to Music
  - Impact of Installation on Events
  - Difficult to Control Behavior
  - Result – Element not Functioning
  - Victims of Our Own Success
    - Increased Activity Day and Night

Design Options - Economics

Re-Purposing Materials

- Element of Value Engineering
  - Creating Weir Structures
    - Used Granite or Pre-Cast Curbing
  - Base Materials
    - Recycled asphalt
  - Fire Wood (Forestry Operations)
    - Water Bars
    - Retaining Structures
  - Used Brick and Cobblestones
    - Swales
  - What is the Next Great Idea?
    - Tires, Trash or Mattresses

Perception and Impact on Activities

Element/Benefit	Perception/Impact
Shoreline Plantings	**Shoreline Plantings**
Discourages Geese	Aggravates Fisherman
Selective Mowing on Hillsides	**Selective Mowing on Hillsides**
Filters Water & Prevents Erosion	Not Doing Our Job - Unkempt
Rain Gardens	**Rain Gardens**
Water Filtration	Love the Flowers – but Tics and Rodents
Aerating Fountains	**Aerating Fountains**
Water Movement & Oxygen	Activates Park (Lit at Night) - Leak
Pavement Removal	**Pavement Removal**
Decreases Impermeable Area	Less Parking Spots

Maintenance Challenges

- **Funding**
  - Staffing to Maintain (42) Stormwater Sites with Budgets Cuts Etc.
  - Huge Task for the Parks Department
  - Outsourcing Needs Commitment – Funding
- **Education**
  - Schools
  - Adult Education Classes
  - Adult Job Training

Design With Maintenance In Mind

- Use native plants that will not only flourish but will be easily identified by maintenance personnel
- Cost effective designs.
- Landscape material free systems that so not require purchasing yearly materials.
- Create forebays that have easy access to be cleaned out.
- Design GI systems based on what funding you will have for future maintenance.
- Always design the structure for who will be maintaining it.

Maintenance Issues - Accessibility

- Proximity to Roadway
  - Sediment Removal
    - Large Basin
  - Slopes
  - Access To All Areas
  - 'In Water' Access
  - Equipment Capabilities
  - Design for Staff and Machinery

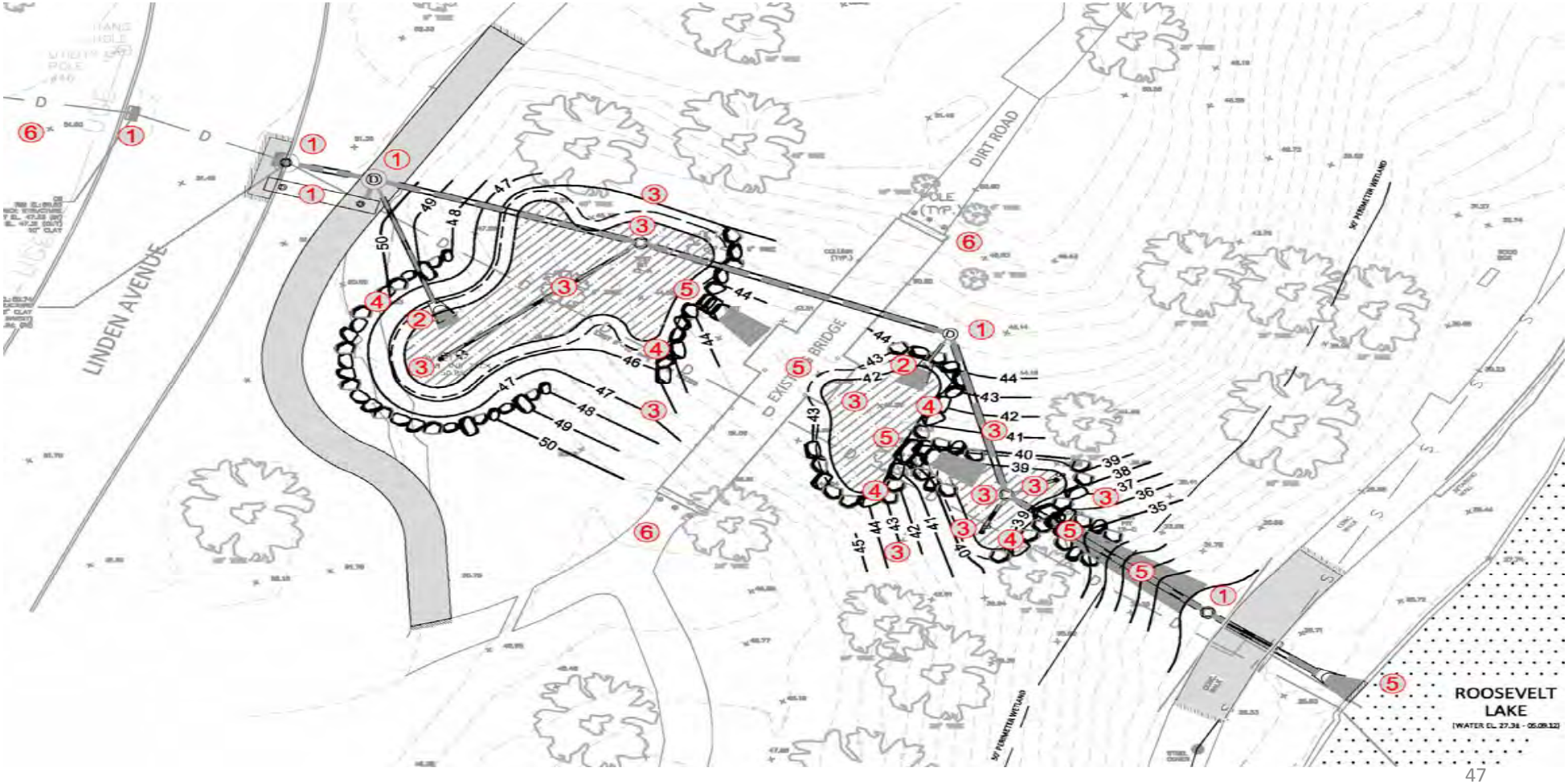
Maintenance Issues - Training

- Experience of Crews
  - Equipment Operation
  - Training
  - Plant Identification
- Experience of Management
  - Landscape Architect
  - Botanical Center Manager
  - Training
- Willingness to Adapt

Maintenance Issues - Funding

- Much More Expensive Than Catch Basins
- Labor Intensive = More Staff
- Commitment from City to Make Clean Water a Priority
- Clean Water Act

Maintenance – Training - Plans



Roger Williams Park - Providence, RI

Site 12 – Terraced Bioretention

Operation and Maintenance Checklist

Date:

Time:

Inspector:

Maintenance Item	Description	Maintenance Required? (Y/N)
1. Drainage Structures: **Includes: Manholes/Diversion Structures/Water Quality Units and Outlets** **Inspect annually and after major storm events (2" of rain or greater)**		
Debris	Remove all trash, leaf litter and debris.	
Manholes/Diversion Structures/Outlets	Check for sediment accumulation that impacts inflow. If sediment accumulation. Schedule cleaning. Check for leaf litter and inlet clogging and clear.	
ADS Water Quality Unit	Per manufacturers recommendations. See Appendix D of O&M manual.	
Drainage Network	Check contributing and asscocaited catch basins, manholes and pipes for sedimentation/clogging	
2. Bioretention Inlet **Inspect annually and after major storm events (2" of rain or greater)**		
Debris	Remove all trash and debris from the swale and forebay.	
Sediment/Organic Debris Removal	Check for sediment accumulation. Remove sediment as necessary	
Vegetation Maintenance	Check to ensure vegetation is not blocking the inlet. Prune/thin vegetation as necessary. Remove undesirable woody vegetation and weeds.	
3. Bioretention System **Inspect at least bi-annually and after major storm events the first year; then annually and after major storm events (2" of rain or greater)**		
Debris	Remove all trash and debris from the surface of the bioretention system.	
Side Slopes	Check for signs of erosion gullies, animal burrowing, or slumping. Repair as necessary.	
Sediment	Check for sediment accumulation that impacts infiltration. Remove any sediment accumulation and properly dispose.	

Maintenance Item	Description	Maintenance Required? (Y/N)
Vegetation Maintenance / Replacement	Check for erosion and signs of scouring. Remove and replace Ill-established, dead or severely diseased plants annually. Remove undesirable woody vegetation and weeds. See Sheet LA-1 of Construction Plans for appropriate species. Grasses should be cut back annually in the spring.	
Overflow Structure	Check for sediment accumulation that impacts inflow. If sediment accumulation. Schedule cleaning. Check for leaf litter and inlet clogging.	
Water Draining properly	If standing water is observed in the bioretention area 48 hours after a storm event: Check cleanouts for underdrain clogging. See plans Aerate/Rototill the bottom 6 inches to breakup any hard-packed sediment, and replenished with mulch	
4. Boulder Walls **Inspect annually and after major storm events (2" rain or greater)**		
Boulder Walls	Check for wall settlement, areas of erosion or water seepage. Repair as necessary.	
5. Emergency Spillways **Inspect annually and after major storm events (2" rain or greater)**		
Emergency Spillways	Check for settling gullying, erosion damage or settling. Repair as necessary and return to design grades.	
Overflow	Look for areas of erosion in the overflow swale between bioretention areas. Repair as necessary.	
6. Routine Grounds Maintenance **Inspect annually or as needed.**		
Debris	Remove trash from perimeter areas.	
Pavement Sweeping	Sweep roads minimum once a year after spring thaw.	
Contributing drainage area	Check for erosion/sediment sources from the surrounding area	

*Sediment shall be disposed of offsite in a pre-approved location.

Comments:

Action to be Taken:

Trees/shrubs

Cottonwood
Populus sp.


Pussy willow
Salix discolor



Willow
Salix sp.


Plants to be removed

Tulip Tree
Liriodendron tulipifera


Maple
Acer sp.


Staghorn Sumac
Rhus typhina



Plants to be removed

Grassy

Common Reed
Phragmites australis



Herbaceous

Eastern Daisy Fleabane
Erigeron annuus



Pokeweed
Phytolacca Americana


Plants to be removed

Smartweed
Polygonum persicaria



Mugwort
Artemisia vulgaris



Perennial sowthistle
Sonchus arvensis




Plants to be removed

Vines

Bittersweet Nightshade
Solanum dulcamara



Oriental Bittersweet
Celastrus orbiculatus



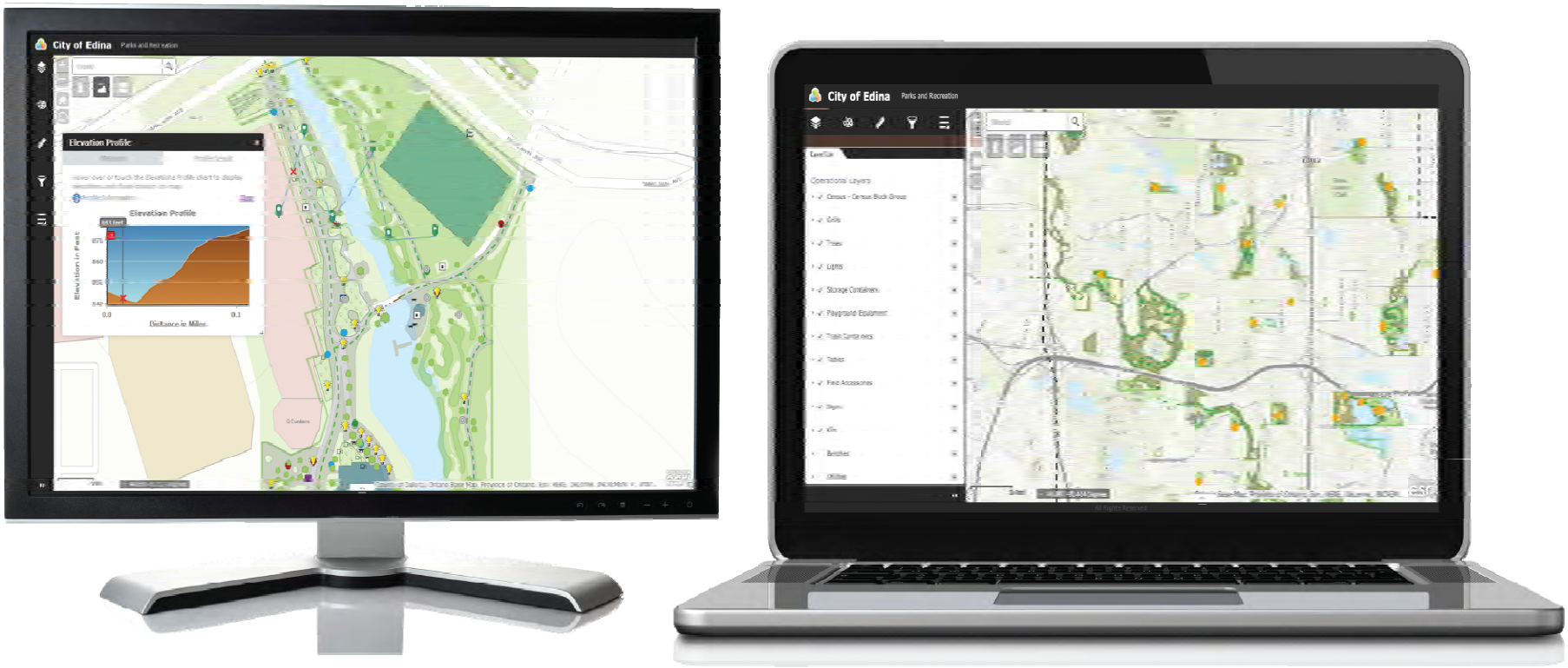
Japanese beach rose
Rosa multiflora


Sources:

Photos for

Maintenance Documentation

Greencities – Work Force



Education


Nature at Work
8
Nature is at work here!
We're creating a healthy community! This site uses nature to clean dirty stormwater and reduce flooding.
www.greeninfrastructureri.org
What's happening here?
Clean
Uses plants and soilsto filter out pollution.
Protect
Absorbs rain and reduces flooding.
Economy
Reduces utility bills and creates local jobs.
Cool
Replaces hard surfaces that hold heat.
Wellness
Cleans our air and creates welcoming spaces.
Habitat
Attracts animals like butterflies, turtles and frogs.
William D'Abate Elementary Rain Garden
5th Graders here helped plant this rain garden to hold and clean rain water coming off of the school roof. Plants native to RI beautify the school while making food for butterflies. This garden will also help reduce flooding in the Woonasquatucket River at Riverside Park.
riverzedge arts
TREMCO
GROUNDWORK Rhode Island
H

Awareness

ROGER WILLIAMS PARK

Willow Lake
Stormwater Treatment

PONDS RESTORATION GOALS;

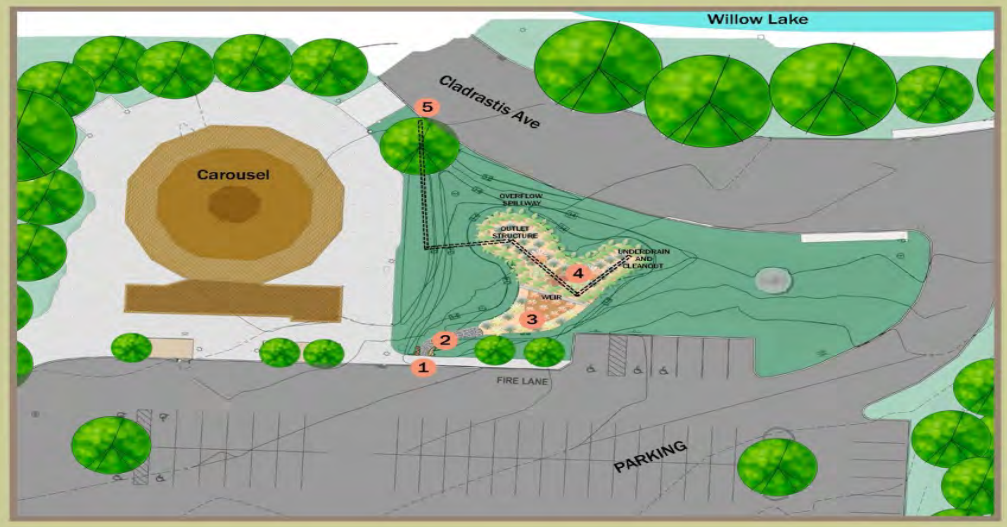
Improve water quality, habitat and biodiversity within the ponds.

Improve the overall quality and user experiance of the Park.

Identify health risk associated with fish consumption; increase public awareness as warranted.

Foster watershed awareness and environmental stewardship among Park user and surrounding residents through a public out reach campaign.

1. INLET DRAINAGE
2. STONE LINE SWALE
3. SEDIMENT FOREBAY
4. BIORENTENTION
5. PIPE INTO EXISTING CATCH BASIN



Eastern half of the parking lot drainage areas 1.4 acres, 38% impervious is to create a biorentention in the open grasses area between Carousel Village parking lot and Cladrastis Avenue. The overflow runoff outlet exit into closed drainage system. Stromwater feature design estimate 30% total Phosphorus removal.

Clean

Uses plants and bio-engineered soil to filter out pollution before entering Willow Lake.

Habitat

Attracts beneficial insects to help improve floral diversity.

Protect

Stores runoff from parking area to prevent flooding

Signage


LAGO CUNLIFF
Jardín Biológico de Zanjas


LAGO CUNLIFF
Jardín Biológico de Zanjas
ROGER WILLIAMS PARK
¿Sabías?
Ayudemos a mantener nuestras fuentes de agua más limpias al reducir la cantidad de contaminantes que ingresan a nuestros lagos, arroyos y cursos de agua.
¿Qué está pasando aquí?
Este valle natural en la carretera se conoce como una zanja biológica o una zanja con vegetación.
Es un corredor poco profundo para colectar la corriente de aguas pluviales que han sido sembradas con hierbas nativas y césped.
Cada vez que llueve, la suciedad y las toxinas de la carretera amenazan nuestros lagos. Las plantas que ves aquí ayudan a filtrar estos contaminantes del agua de lluvia.
Limpio
Utiliza plantas nativas para filtrar los contaminantes antes de que entren en nuestros lagos y arroyos.
Hábitat
Crea un hábitat seguro para aves, mariposas, libélulas y muchos otros insectos.
Proteger
Ayuda a prevenir problemas de inundación y drenaje.
Plantas al trabajo
Formando las Conexiónes: ¿Conoces todas las partes del jardín biológico de zanjas?

‘Park’nerships That Work

MAYOR JORGE O. ELORZA
CITY OF PROVIDENCE

Horsley Witten Group
Sustainable Environmental Solutions

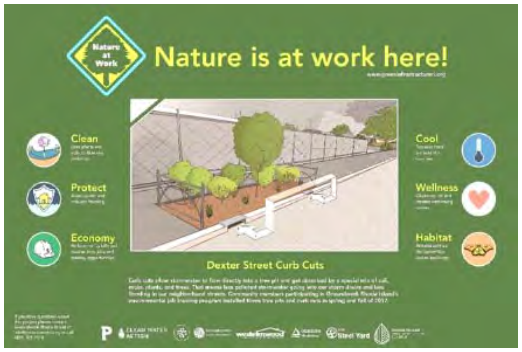
GROUNDWORK
CHANGING PLACES
CHANGING LIVES
GROUNDWORK
Rhode Island

RHODE ISLAND
GREEN INFRASTRUCTURE
COALITION

RI dot

PROVIDENCE
PARKS + RECREATION
play · relax · explore

ROGER
WILLIAMS
PARK



Water Quality Monitoring and Analysis

Training and Curriculum Development

Natural Infrastructure Design Innovation

Providence Stormwater Innovation Center

Training and Curriculum Development

Providence Stormwater Innovation Center

Natural Infrastructure Design Innovation

Providence Stormwater Innovation Center

Monitoring Plan

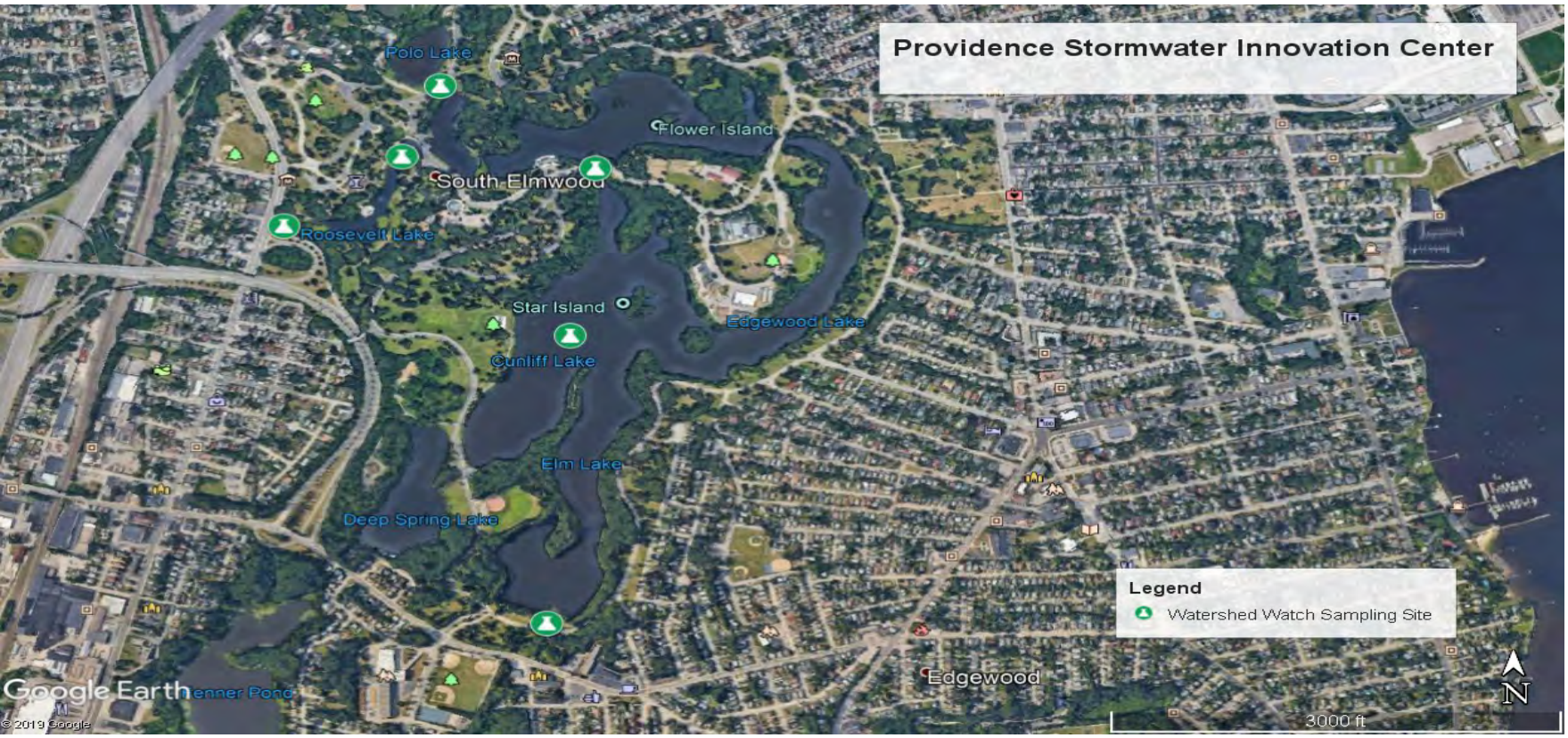
Providence Stormwater Innovation Center

Types of monitoring:

- Water Quality
- Water Quantity
- Picture Posts
- Cyanobacteria
- Visual Inspection of BMPs

Providence Stormwater Innovation Center

Water Quality
URI Watershed Watch Volunteer Monitoring Program



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URI Watershed Watch
Volunteer Monitoring Program

PARAMETERS	FREQUENCY
Dissolved Oxygen, Temperature	Weekly
Chlorophyll-a	Bi-Weekly
Nutrients, bacteria, alkalinity, pH	3 times per year

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Continuous Water Quality Monitoring

- **Data logged every 5 minutes (Inflow and Outflow)**
- **Nitrogen and Phosphorous (Spectro::Lyser)**
- **Temperature, Specific Conductance, pH, Dissolved Oxygen, Fluorescent dissolved organic matter (YSI-EXO2)**

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Water Quantity Monitoring

- **Continuous Water Level and Streamflow Monitoring (Inflow and Outflow)**
- **Precipitation Monitoring**

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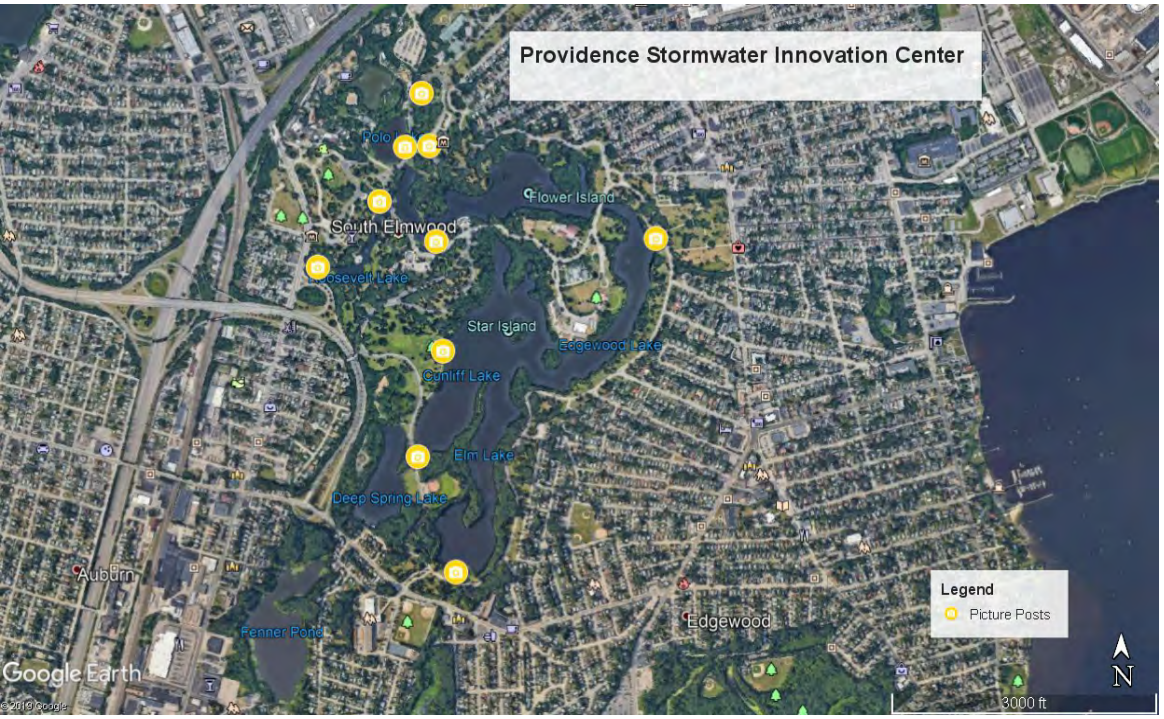
Picture Post Monitoring

- **Community Involvement**
- **Document changes of BMPs over time**
- **Visually document timing of algal blooms**



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Cyanobacteria Monitoring

- **Organize Volunteers to participate in Cyanobacteria Monitoring Collaborative**
- **Bloomwatch App**
- **Cyanoscope Training**

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Visual Inspections of BMPs

- **Inlet and outlet are functioning**
- **Invasive plants**
- **Trash, debris, leaves**
- **Excessive sediment in forebay**
- **Water draining properly**

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DISCUSSION:

How could the Stormwater Innovation Center support your work?

www.stormwaterinnovation.org

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