



DESIGNING “MAINTAINABLE” GREEN INFRASTRUCTURE



Proper maintenance of stormwater retrofits follows smart and well thought out design and construction.

Providence Parks Department

Brian F. Byrnes – Deputy Superintendent

Providence Parks Department

- ▣ BS in Urban Planning & Resource Development – URI
- ▣ Over 30 Years of Construction Experience
- ▣ Constructed over 200 Stormwater Retrofits
- ▣ National Storm Water Center - Certified Stormwater Inspector
- ▣ Project Manager for Projects in (116) Providence Parks
- ▣ Supervisor of (100) Parks Department Maintenance Personnel

Groundwork Rhode Island

Steven Ricci Director Of Field Operations – Groundwork Rhode Island

- ▣ Degrees in Landscape Architecture and Community Planning - URI
- ▣ 18 years experience in the field of landscape maintenance and construction
- ▣ Maintained parks, installed rain gardens, curb cut tree pits, walkways, patios, native planting designs lead abatement, green infrastructure installation, and full landscape site construction
- ▣ Director of the GroundCorp crew and project management
- ▣ Manages and develops plans with both private sector and municipalities from the planning phase to the construction phase
- ▣ Worked closely with RI Housing, WBNA, One Builders, West Elmwood Housing Authority, Southside Landtrust, Pawtucket Foundation, City Of Providence, City Of Warwick, City Of Central Falls, and the City Of Pawtucket to utilize urban planning and green infrastructure projects and put them into action

Groundwork RI's Programs

- ▶ Adult Job Training
- ▶ GroundCorp Landscaping
- ▶ Green Team Summer Youth Employment
- ▶ Hope Tree Nursery
- ▶ Ring Street Community Garden
- ▶ Prairie Avenue Greenhouse
- ▶ Community Education and Engagement



GroundCorp Groundwork RI's landscape design-build and maintenance service.

- Employs graduates of job training program
- Engages in both small-scale residential and larger-scale community landscape design and installation projects
- Projects demonstrate urban landscape restoration and stormwater management best practices, contributing to the health and vitality of the people and places in Rhode Island's urban communities



GroundCorp Services

- Green Infrastructure Installs
- Landscape Design
- Landscape Construction
- Landscape Maintenance
- Depaving
- Rain Barrels
- Rain Gardens
- Raised Gardens
- Compost/Mulch/Stone Install
- Mobile Watering Service
- Lead-Safe Yard Retrofits



What Can We Do?

Health Advisories Issued for Roger Williams Park Pond & Mashpaug Pond



77°

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GroundCorp Green Infrastructure Projects



RI Food Bank Rain Gardens



Westminster Street Fruit Orchard



GroundCorp Green Infrastructure Projects



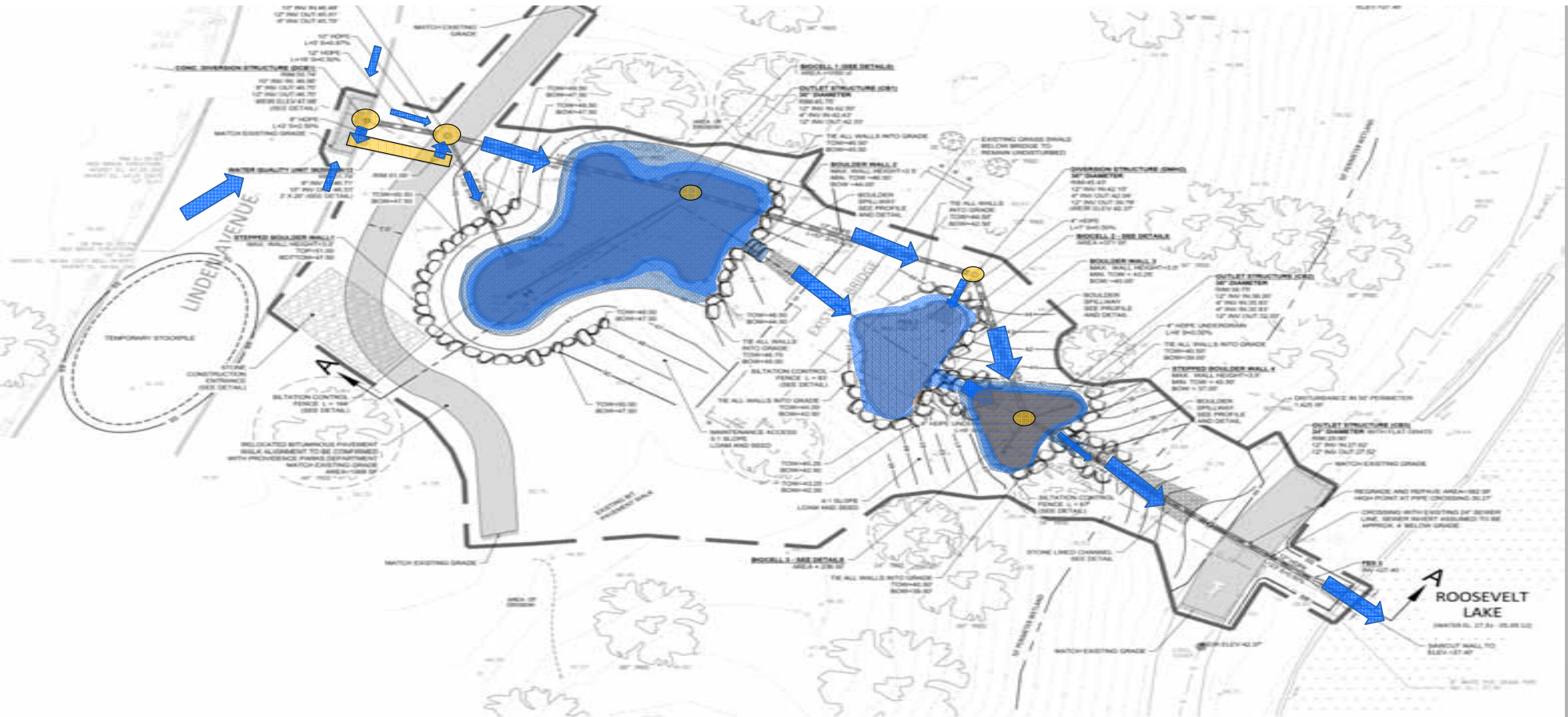
Dexter
Street Curb
Cuts and
Tree Pits



Community
Gardens



How Do They Work?



Lover's Retreat

Site 12



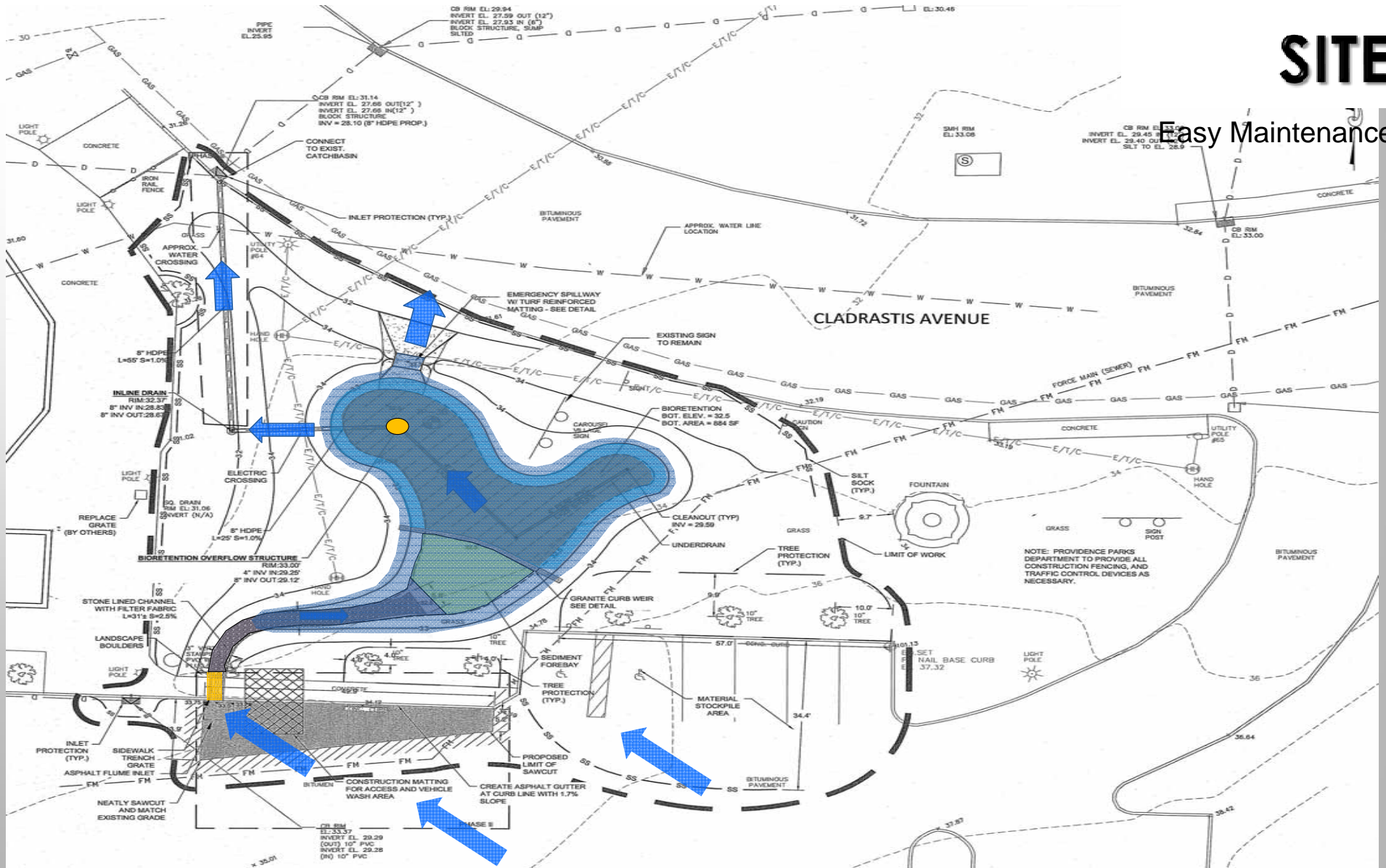
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SITE 12



SITE 3b

Easy Maintenance Site





Carousel Village
Site 3B

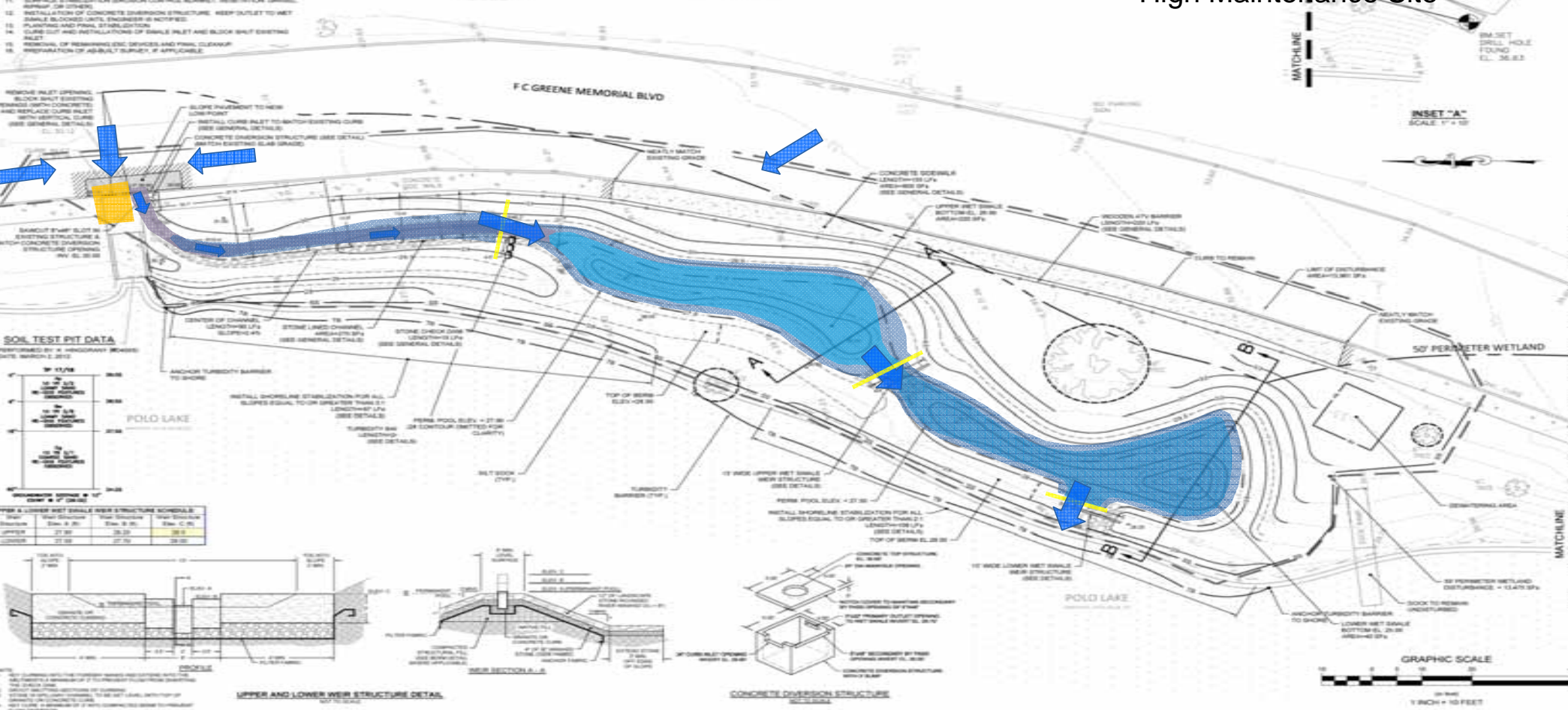
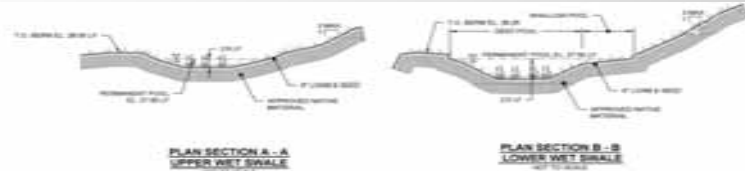
SITE 17/18

High Maintenance Site

SITE 17 & 18 BASIC CONSTRUCTION SEQUENCE

THE FOLLOWING CONSTRUCTION SEQUENCE IS TO BE USED AS A GENERAL GUIDE. THE CONTRACTOR SHALL COORDINATE WITH THE CIVIL ENGINEER AND LANDSCAPE ARCHITECTS AND SUBMIT A PROPOSED CONSTRUCTION SEQUENCE FOR REVIEW AND APPROVAL PRIOR TO CONSTRUCTION.

1. INSTALLATION OF EISC DEVICES AROUND PERIMETER OF THE PROPOSED
2. SCOURPROOF ENHANCEMENT AREAS
3. INSTALLATION OF TURBIDITY BARRIERS
4. INSTALLATION OF TREE PROTECTORS
5. SELECTIVE DEMOLITION AND TREE REMOVAL (SEE DEMO PLAN)
6. SITE CLEANING & GRUBBING
7. REMOVAL OF EXISTING CONCRETE SIDEWALK
8. REMOVE EXISTING WEIR SWALE
9. EXCAVATION OF WEIR SWALE AND CONSTRUCTION OF WEIRS AND SPILLWAYS
10. INSTALLATION OF EISC DEVICES AT SURFACE STORMWATER MANAGEMENT AREAS
11. WEIR RESTORATION
12. SURFACE STABILIZATION (EROSION CONTROL BLANKET, VEGETATION DRAPES, SPINNAK, OR OTHER)
13. INSTALLATION OF CONCRETE DIVERSION STRUCTURE. KEEP OUTLET TO WEIR SWALE BLOCKED UNTIL ENGINEER IS NOTIFIED
14. PLANTING AND FINAL STABILIZATION
15. CURB CUT AND INSTALLATIONS OF SWALE INLET AND BLOCK SHALT EXISTING INLET
16. REMOVAL OF REMAINING EISC DEVICES AND FINAL CLEANUP
17. PREPARATION OF AS-BUILT SURVEY, IF APPLICABLE



REMOVE INLET OPENING. BLOCK EXISTING INLET WITH VERTICAL CURB AND GENERAL. SEE GENERAL. CL. 33.12

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SOIL TEST PIT DATA

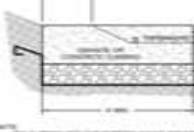
PERFORMED BY: W. HANSHAW (REVISED) DATE: MARCH 2, 2012

NO.	DEPTH (FT)	SOIL TYPE	WATER TABLE (FT)
1	0.0 - 1.0	CLAY	1.5
2	1.0 - 2.0	CLAY	1.5
3	2.0 - 3.0	CLAY	1.5
4	3.0 - 4.0	CLAY	1.5
5	4.0 - 5.0	CLAY	1.5
6	5.0 - 6.0	CLAY	1.5
7	6.0 - 7.0	CLAY	1.5
8	7.0 - 8.0	CLAY	1.5
9	8.0 - 9.0	CLAY	1.5
10	9.0 - 10.0	CLAY	1.5

UPPER & LOWER WEIR STRUCTURE SCHEDULE

ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE
UPPER WEIR	LINEAL FT	100	100.00	10,000.00
LOWER WEIR	LINEAL FT	100	100.00	10,000.00

UPPER AND LOWER WEIR STRUCTURE DETAIL



CONCRETE DIVERSION STRUCTURE



SITE 17/18-WET SWALE

Stormwater
Pretreatment

Buffer Restoration

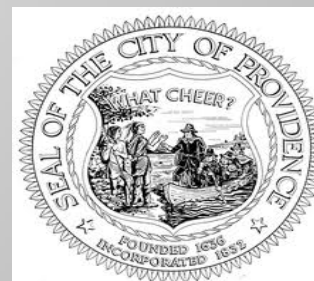
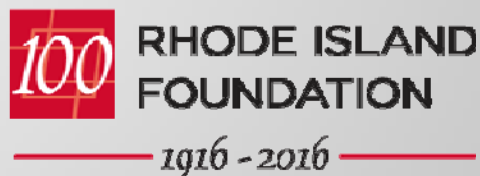




'Park'nerships That Work



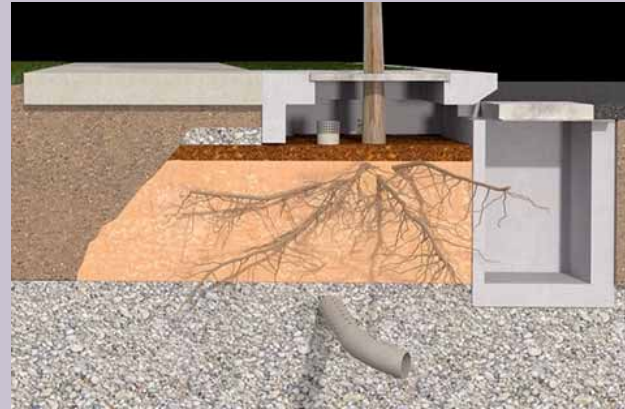
Horsley Witten Group
Sustainable Environmental Solutions



Projects with other Partners



WRWC – Olneyville and
Pleasant Valley Parkway



Rhode Island Green Infrastructure Coalition

The Green Infrastructure Coalition (GIC) is a collaborative of more than 40 non-profit organizations, businesses, and government agencies focused on using nature to reduce stormwater pollution. The GIC develops projects to demonstrate the powerful role nature can play to create healthier urban environments. Promoting policies to create sustainable funding for stormwater management and green infrastructure solutions. And connecting a wide range of partners to share lessons learned in the Providence Metro area and Aquidneck Island.

- ❖ Policy - Regional Stormwater Utility, Green Buildings Act, Green and Complete Streets
- ❖ Projects – planning, design, installation, maintenance, equity
- ❖ Communication – email newsletter, project signage, tours



BARRIERS TO GREEN INFRASTRUCTURE

- It's new technology (change is hard)
- It's more expensive (up front)
- **It takes long-term maintenance**
- It's not how we have done things
- Attitudes about pollution and flooding

MAINTENANCE



- Project aesthetics and functionality
- Crucial to building public support
- Need easy checklists to follow
- Important to consider in project design

Considerations for GI Maintenance

- Will the funding source that installs the Green Infrastructure (GI) feature allow for maintenance costs? Needs to be addressed in Grant Application.
- Who will do the maintenance? Without Funding most GI features fail within 5 years. What funding sources are available?
- Do you have access to any paid or volunteer support?
- Is the property owner willing and trained to do GI maintenance?
- How can you gain support of surrounding community, public, visitors, etc.?
- How can you overcome cultural attitudes against “unkempt” green spaces?
- How can you provide maintenance that allows for GI to grow as a living system (i.e. new plants can emerge and grow, bees are welcome, etc.)?

Budget

- System cleanings.
- Weeds/Invasive plant removal.
- Sedimentation Removal.
- Erosion.
- Mowing
- Ect....



Volunteer Effort

- Get the community involved.
- Host cleanup days.
- Local organizations.
- Local businesses in the area.
- Community service.



Education

- Teaching about green infrastructure while having students maintain the systems.
- Teaching property owners how to maintain their own GI systems.
 - Schools
 - Adult Education Classes
 - Community Events
 - Adult Job Training Courses
 - Use Signage



Complaints

- Local neighbors, business, and people visiting area with GI projects that are not educated sometimes submit complaints.
- Education to the public along with signage will help them understand these systems that were designed to grow wild.





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 soils to 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.



Manton Avenue GI Maintenance



Affordable Housing units with GI landscaping and parking area on Manton Avenue in Providence

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.

Many Different Types of Controls



SITE 28 – Low Maintenance Site





SITE 6 – Low Maintenance Site



SITE 24 – Reconstruction Needed

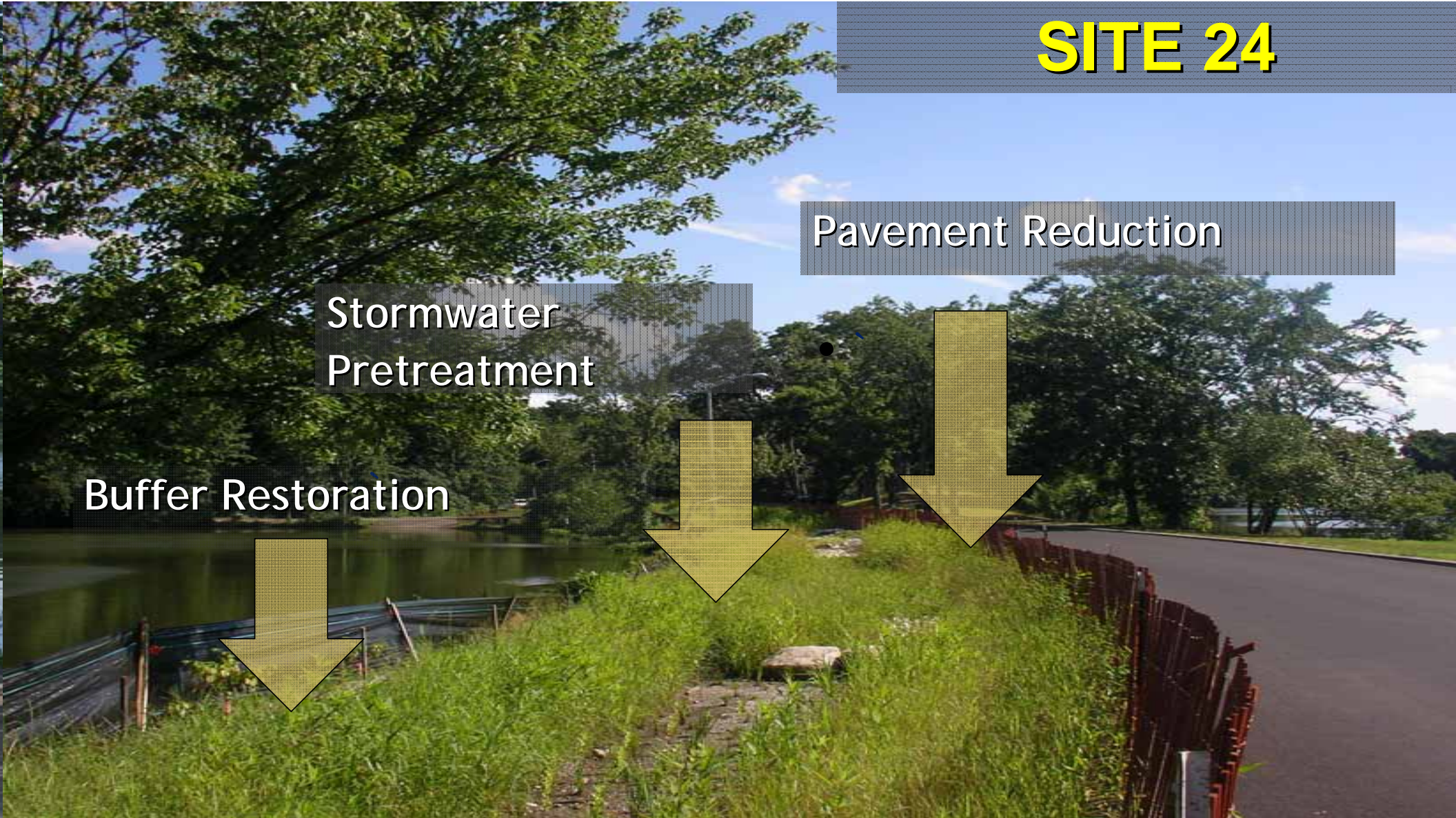


SITE 24

Pavement Reduction

Stormwater
Pretreatment

Buffer Restoration



SITE 24

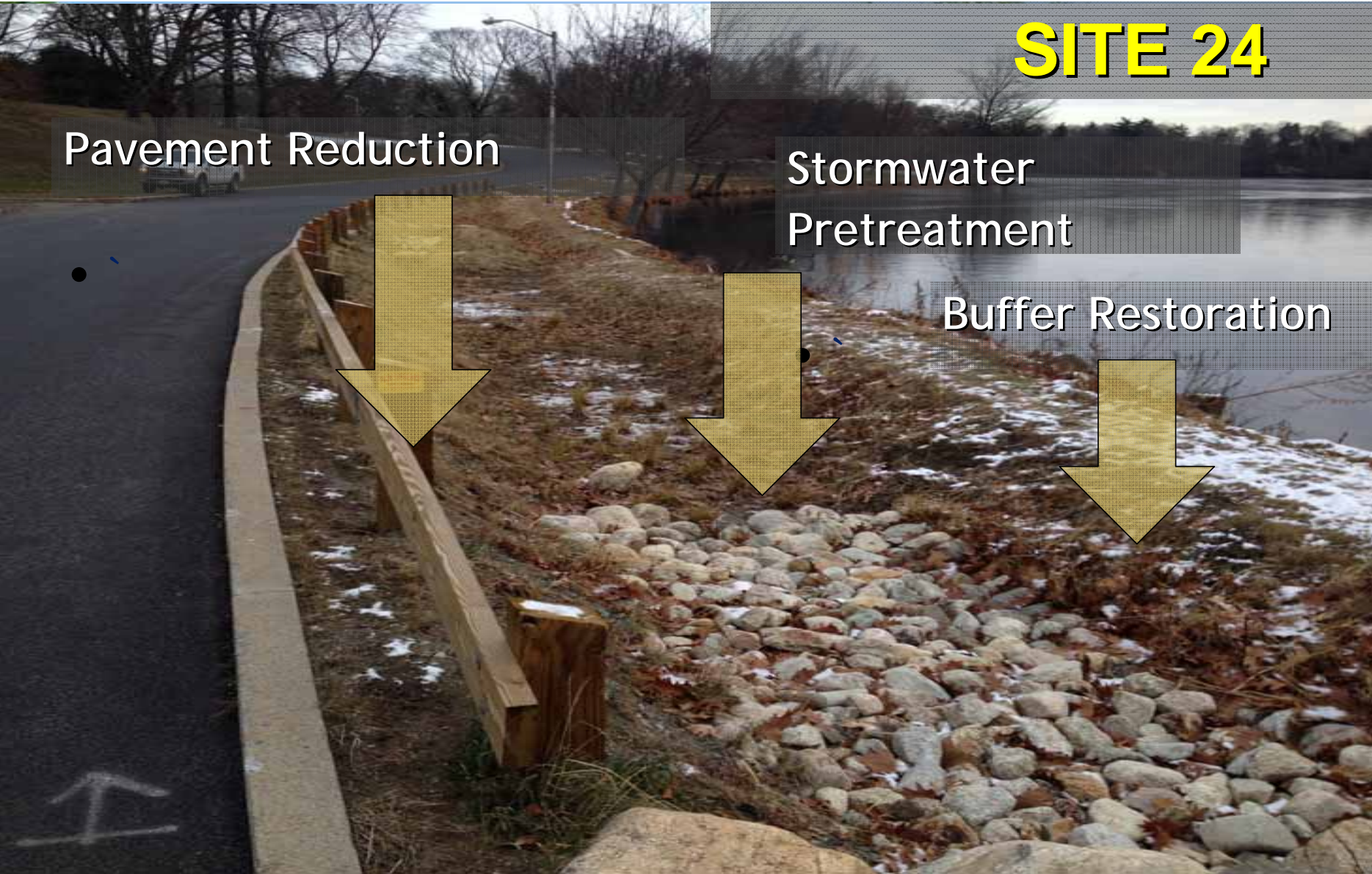
Pavement Reduction



Stormwater Pretreatment



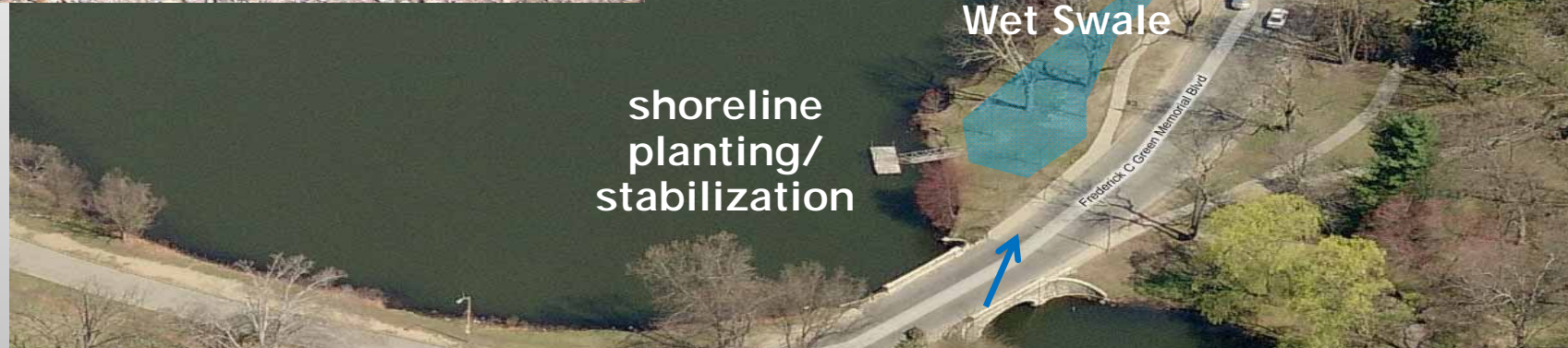
Buffer Restoration



LESSONS LEARNED – Location & Potential Use



SITE 17/18 – High Maintenance Requirements



Failing Green Infrastructure

- GI Units can fail when not maintained.
- Sedimentation can clog inlet pipes.
- Invasive plants can choke out and take over the system.
- Trash and debris can disturb flow and absorption rate.
- Weeds can kill plants and take over systems.

Failing Green Infrastructure

System failing due to invasive plants



Before



After

Failing Green Infrastructure

System failing due blocked inlets



Before



After

Failing Green Infrastructure

System failing due weeds and debris



Before



After

GI Maintenance

Post Installation Check - Up

Watering Plants

1st Year - Regularly
2nd Year - Dry Weather Only
3rd Year + - Drought Only

Weeding and Inspection

1st Year - Once a Month
2nd Year - Every 2 Months
3rd Year + - Every 2 Months

Fall/Spring Cleanups

1st Year - Light
2nd Year - Moderate
3rd Year + - Heavy

Routine Maintenance Includes:

Mulching
Debris Cleanout
Seed Runoff
Plant Replacement
Invasive Plant Removal

Pruning and Thinning
Weeding
Watering
Fertilizing
Pest Management

Pet Waste
Sedimentation

GI Maintenance

Mulching: Rain garden areas should receive a protective layer of mulch over root areas, similar to that provided by leaf litter in a natural forest. Mulch depth should not exceed 2-3 inches around trees shrubs and perennials. Avoid blocking inflow entrance points with mounded mulch or raised plantings. The use of aged mulch is recommended and should consist of the shredded type rather than the chip type to minimize floating wood chips. **DO NOT** use fresh grass clippings, animal waste or compost for mulch.

Debris Cleanout: Debris should be cleaned out weekly to ensure that inlets do not become blocked and to keep the area from becoming unsightly. Inspect rain garden areas after rainstorms to ensure drainage paths are free from blockages.

Seed Run Off: Some seed run off, especially grass seed, may enter the rain garden during rainstorms. These seedlings, once germinated, need to be pulled at a early stage. Leaving the unwanted seedlings in the rain garden can cause the roots of the seeding and other plants to become interlocked and will not be able to be removed.

Plant Replacement: You should expect to lose 10-20% of plants during the first 3 years after installation of a rain garden. Dead plants should be removed immediately and replaced in case of pest infestation. Inspect why the plant did not survive and do not be afraid it install the same species of plant that was removed.

GI Maintenance

Invasive Plant Removal: The rain garden should be inspected monthly for invasive plants. Invasive plants can overcome a rain garden quickly due to the conditions that exist. If you have a severe problem with invasive plants, removing plants that may have tangled roots with invasive plants may become necessary.

Pruning and Thinning: Trimming, pruning, and thinning will occur twice a year in a rain garden. Dead, dying, and diseased branches should be trimmed and removed as they occur. Trees and shrubs may be pruned to maximize fruit production or for aesthetic values. Shrubs, flowers, and perennials should be pruned, thinned, and dead headed during the growing season to encourage more flowering, a more dense plant, and to remove tangled branches. Pruning of shrubs and flowers should be done after the plant has finished a blooming cycle.

Weeding: Weeding should be completed on a monthly basis. The first few years after the rain garden has been installed, the weeds will be more aggressive and more prominent.

GI Maintenance

Watering: Watering is most critical during the first few weeks after planting and during the hot weather season, and during dry spells during the first 2 years of planting. Once the plants are established, further watering is usually not needed. In severe drought cases, some plants may be present if the soil becomes too dry.

Fertilizing: Rain gardens are designed to absorb excess nutrients into the soil. It is unlikely that a rain garden will need fertilization during its life time.

Pest Management: All plants should be monitored on a regular basis for pests and disease. It is important to keep in mind that insects and microorganisms perform a vital role in maintaining soil structure. This being said, pesticides should be avoided to keep from harming needed insects and microorganisms.

GI Maintenance

Pet Waste: Always clean up pet waste from your lawn and rain garden to reduce this source of pollution. Studies show that pet waste is a leading source of disease, causing harmful bacterial to end up in our waterways, making them unsafe for human recreation use.

Sedimentation: A monthly inspection for sedimentation, such as silt, should be performed to make sure that it is not entering the rain garden. If a rain garden is taking on sediment, dig small pits in the garden and remove the soil from those areas. Over time these pits will naturally fill in and the plants will grow over the settled sedimentation. This is the least invasive way to control sedimentation and not disturb the plants and soil composition.

Wet Swale

Wet Swale Maintenance Schedule

General Maintenance

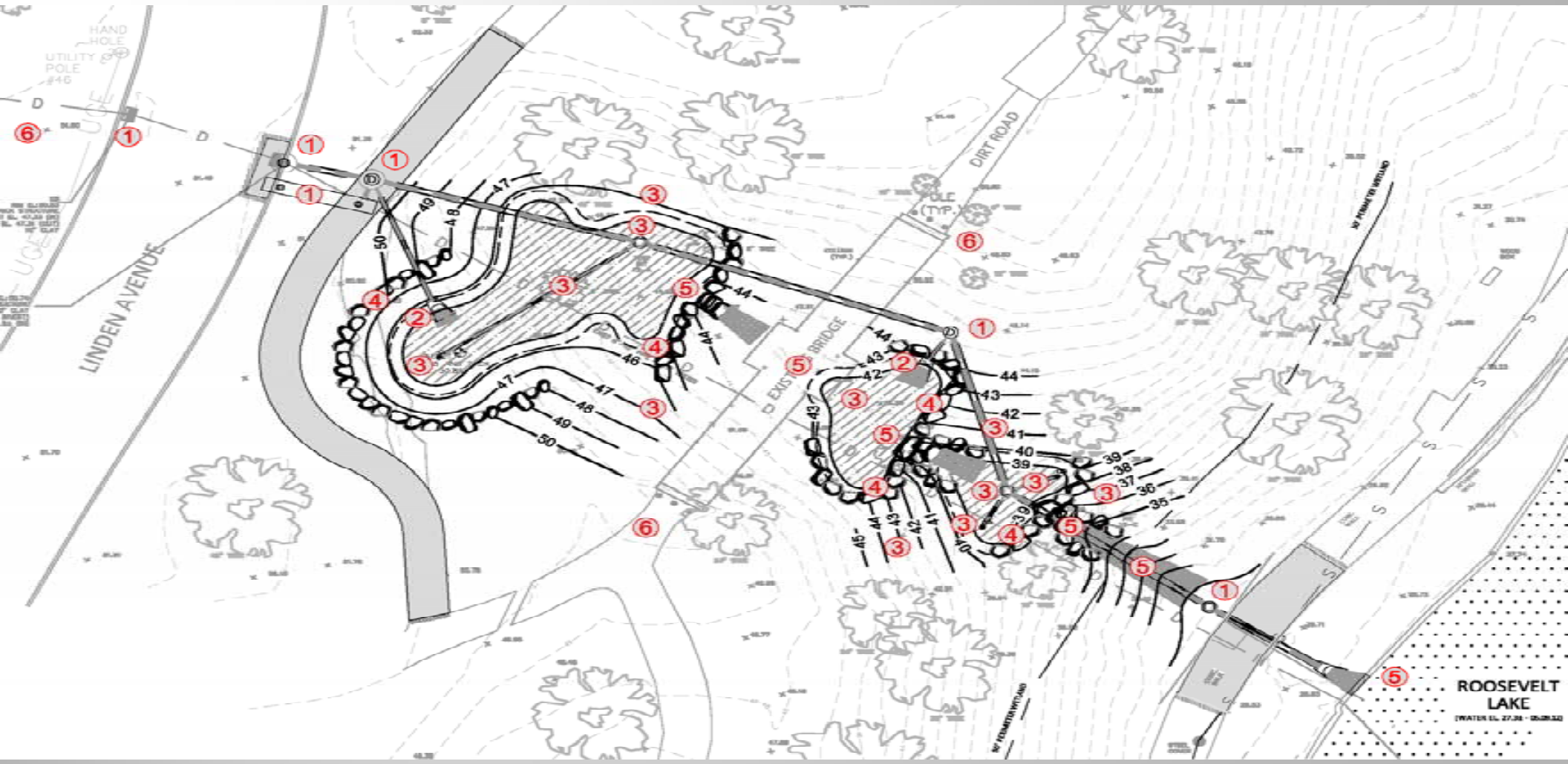
Task	Frequency	Time of the Year
Site Inspection	<u>Min. once per year & after major storm events.</u>	Spring thru Fall
Debris removal	<u>Min. once per year & after major storm events.</u>	Spring thru Fall
Sediment removal	Min. once per year or when sediment is > 3" in stone-lined swale/sediment forebay; Ensure sediment does not cause blockage of flume inlet	April

Landscape Maintenance

Task	Frequency	Time of the Year
Mowing	<u>Min. Twice or year or as necessary. Maintain 4"-6" grass height</u>	Spring thru fall
Watering	Drought conditions only	July-August
Overseeding	As required	Spring or Fall preferred
Fertilizing	Not required	

Filter Bed Maintenance

Task	Frequency	Time of the Year
Tilling	As needed	If standing water does not drain after 48 hours
Soil Media Replacement	As needed	If standing water does not drain after tilling (see above)
Snow Removal	Not required	Not required



**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. <u>Schedule cleaning.</u> Check for leaf litter and inlet clogging and clear.	
ADS Water Quality Unit	<u>Per manufacturers recommendations.</u> See Appendix D of O&M manual.	
Drainage Network	Check contributing and associated 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. <u>Remove</u> 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. <u>Schedule cleaning.</u> 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:

Lessons Learned

Considerations in Designing Green Infrastructure Elements

- Location, Location, Location
 - Most Effective Location
 - Public Safety
- Perception
 - Lack of Maintenance – Not Cutting the Grass
 - Wildlife, Rodents and Insects
- Materials
 - Re-Purpose – Granite Curbing Etc.
- Maintenance
 - Accessibility for Crews and Equipment
 - Types of Sediment Controls
 - High Maintenance vs. Low Maintenance (Size)
 - Plant Varieties – Limited Whenever Possible
- What is the Goal?
 - Controlling Sediment, Pollutants

Coming Soon to Roger Williams Park Stormwater Training Center

- Training and Research Opportunities
- Education Programs
- Monitoring Effectiveness of Different Elements
- Over (29) Green Infrastructure Elements will be Constructed in the next (18) months
- Classroom and 'Hands-on' Training



Thank You



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www.facebook.com/GroundworkRI