



FUSS & O'NEILL

Presentation to  
**Land & Water Summit**

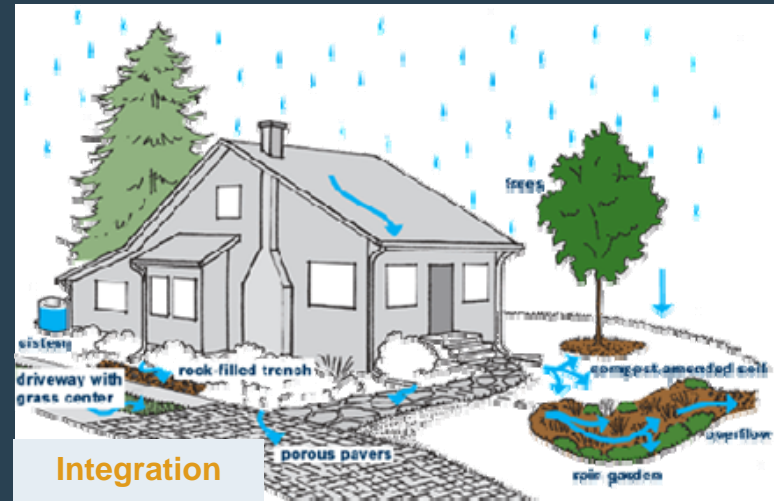
**Opportunities in Green  
Infrastructure**

March 9, 2013

# What is "Green Infrastructure"?



Open Space



Integration



Vegetative BMPs



Multifunction

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# What is "Green Infrastructure"?

## Means many things to many people

- *A comprehensive planning approach*
  - *Limiting ecological harm*
  - *Mimicking natural conditions*
  - *Multifunctional landscapes*
- *Small-scale controls with vegetation, infiltration, and filtration*

# Overview

- State, Regional and Federal Context (Eric, 20 minutes)
- Municipal Land Development Policy (Jim, 10 minutes)
- Retrofits at the Local Level (Jim, 10 minutes)
- Green Infrastructure in Warren (Caroline, 20 minutes)
- Q&A (Caroline, Eric and Jim, 10 minutes)

# The RHODE to Green Infrastructure

Encouraging LID in RI Communities: Focus  
on Stormwater Management Practices

Eric A. Beck, P.E.

RI DEM Office of Water Resources

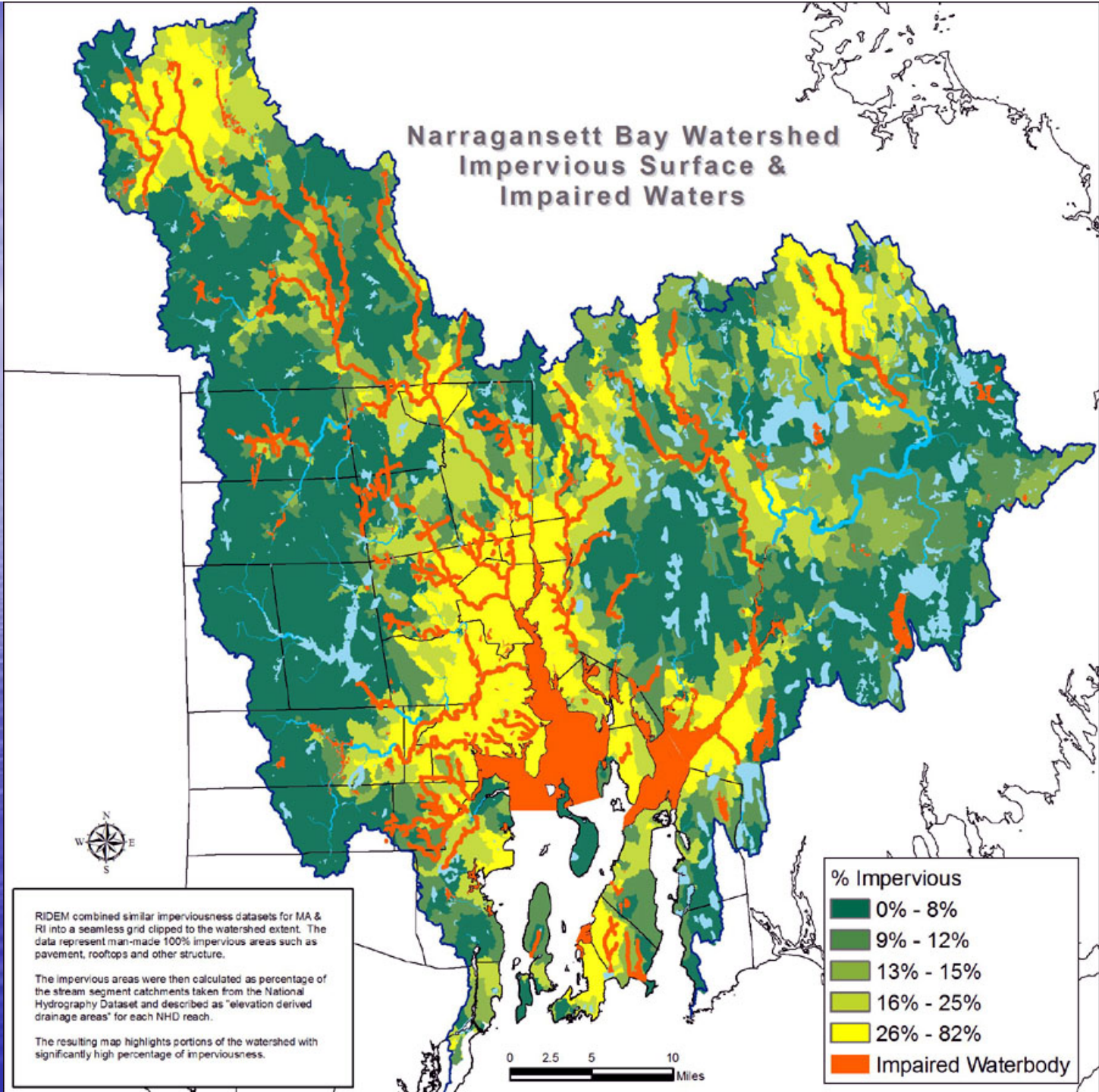
March 9, 2013

# Legislative Mandate

Rhode Island General Law, Section 45, Chapter 61.2, entitled "The Smart Development for a Cleaner Bay Act of 2007" states that "stormwater, when not properly controlled and treated, causes pollution of the waters of the state..." and "development often results in increased stormwater runoff by increasing the size and number of paved and other impervious surfaces..." The Bay Act of 2007 requires DEM and CRMC to amend the 1993 Stormwater Design and Installation Standards Manual to:

- a) Maintain groundwater recharge to predevelopment levels;
- b) Maintain post-development peak discharge rates to not exceed pre-development rates; and
- c) Use LID techniques as the primary method of stormwater control to the maximum extent practicable.

# Narragansett Bay Watershed Impervious Surface & Impaired Waters



RIDEM combined similar imperviousness datasets for MA & RI into a seamless grid clipped to the watershed extent. The data represent man-made 100% impervious areas such as pavement, rooftops and other structure.

The impervious areas were then calculated as percentage of the stream segment catchments taken from the National Hydrography Dataset and described as "elevation derived drainage areas" for each NHD reach.

The resulting map highlights portions of the watershed with significantly high percentage of imperviousness.

# Stormwater Impacts



At > 10% impervious we begin to see:

- Water quality issues
- Impacts to biological communities
- Increased flooding
- Stream erosion
- Loss of recreational uses
- Shellfish bed closures
- Reduced baseflow and recharge



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# **RHODE ISLAND STORMWATER DESIGN AND INSTALLATION STANDARDS MANUAL**

**DECEMBER 2010**



**RHODE ISLAND DEPARTMENT OF ENVIRONMENTAL  
MANAGEMENT AND**



**COASTAL RESOURCES MANAGEMENT COUNCIL**



# 11 Stormwater Management Standards

1. Low Impact Development Site Planning and Design
2. Groundwater Recharge
3. Water Quality
4. Conveyance and Channel Protection
5. Overbank Protection
6. Redevelopment Projects
7. Pollution Prevention
8. Land Uses with Higher Potential Pollutant Loads (LUHPPLs)
9. Illicit Discharges
10. Construction Erosion and Sedimentation Control
11. Stormwater Management System Operation and Maintenance



**AVOID**

**AVOID**

**REDUCE MANAGE**

**REDUCE**

**MANAGE**

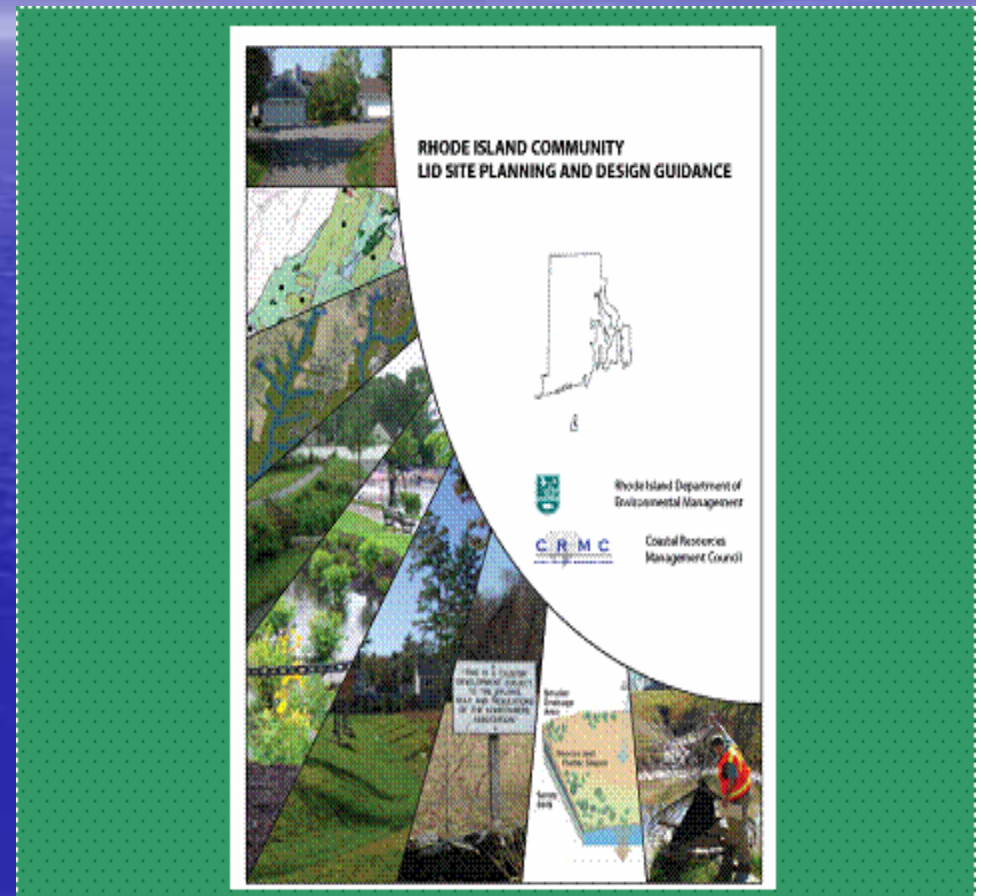
# RI Community LID GUIDE

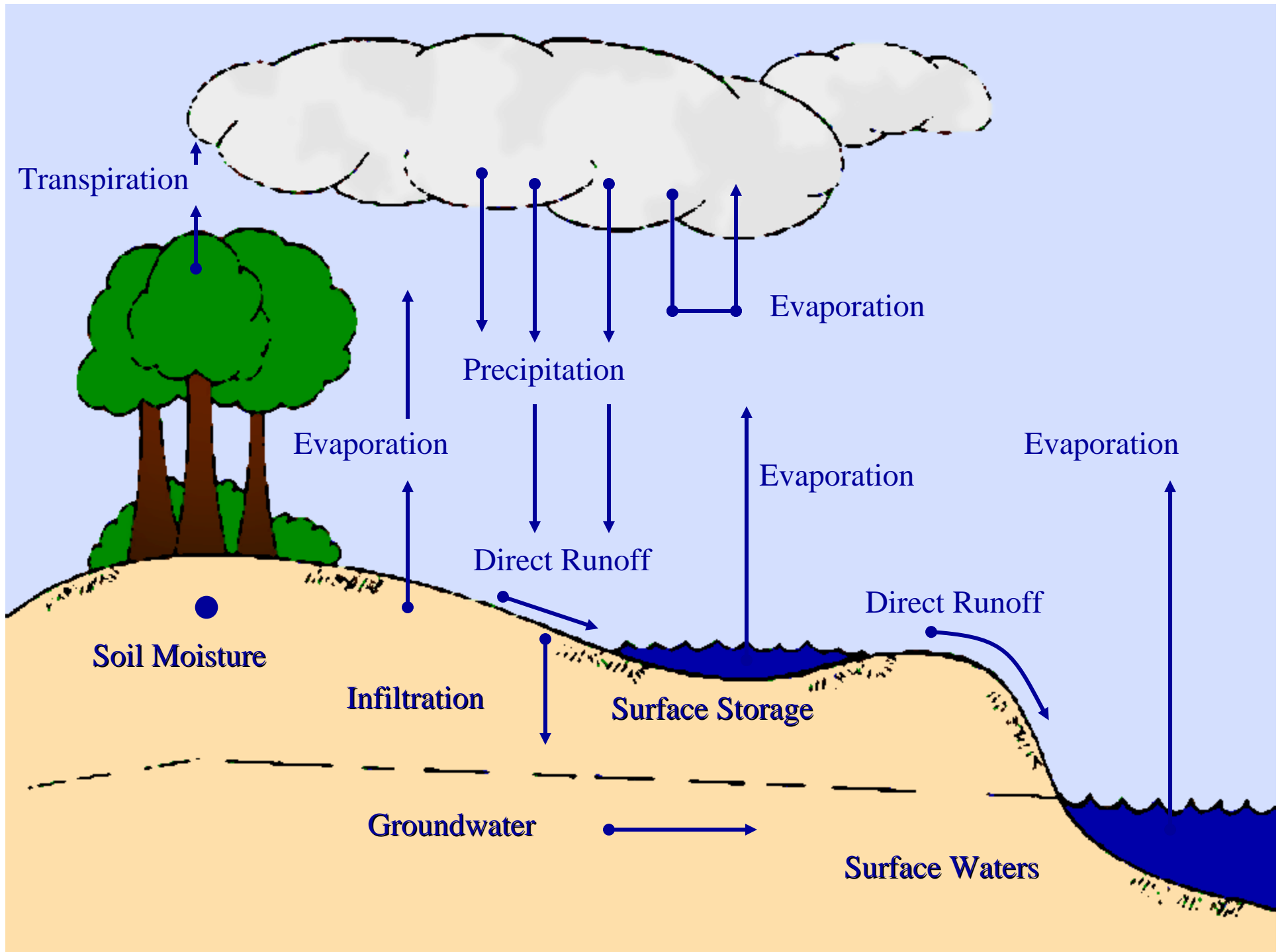
1. Guidance Manual Chapters
2. Conservation Development
3. Buffer Standards
4. Site Clearing and Grading
5. Roadway Standards
6. Parking Requirements
7. Compact Development
8. LID Landscaping
  - Appendix A Ordinance Checklist for LID Stormwater Site Planning and Design Techniques
  - Appendix B Incorporating LID into the Local Land Use Regulations

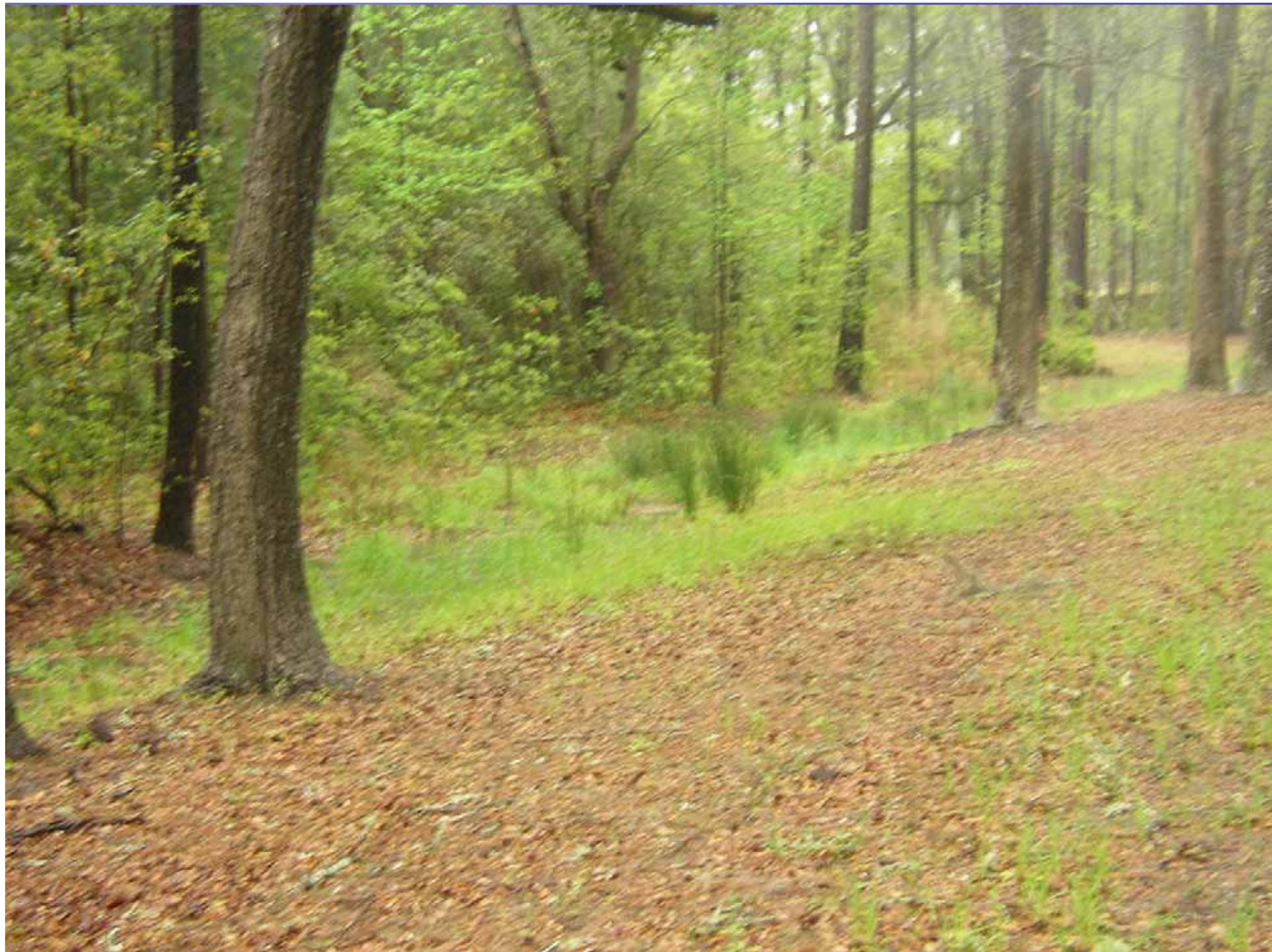
Find @

<http://www.dem.ri.gov/programs/bp/oladm/suswshed/pubs.htm>

Or google..RI Community LID Guide







Community Planning



LID Site Design



LID BMPs

Larger Conventional BMPs

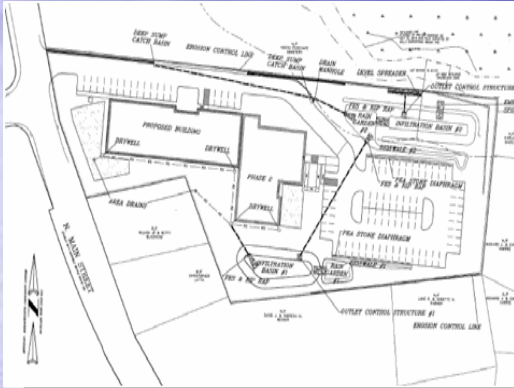


Receiving Waters



# Who Should Use the Manual?

**Designers**



**Municipal Officials**



**Property Owners**



**Regulatory Reviewers**





# Coordination of DEM Stormwater Permitting



## *Coordinated Stormwater Permitting Website*

<http://www.dem.ri.gov/programs/benviron/water/permits/swcoord/index.htm>

# Local Programs



Communities are required to adopt ordinances to implement local permitting for all sites disturbing > 1 acre.

Many have established Technical Review Committees to review stormwater management as part of the building permit and subdivision approval process

Municipalities with discharges to impaired waters with a TMDL may have to apply these standards to sites < 1 acre

# How are we restoring our waters?

## REDEVELOPMENT:

New manual establishes a Redevelopment and Infill Standard

Disconnecting or treatment of 50% of the impervious surfaces

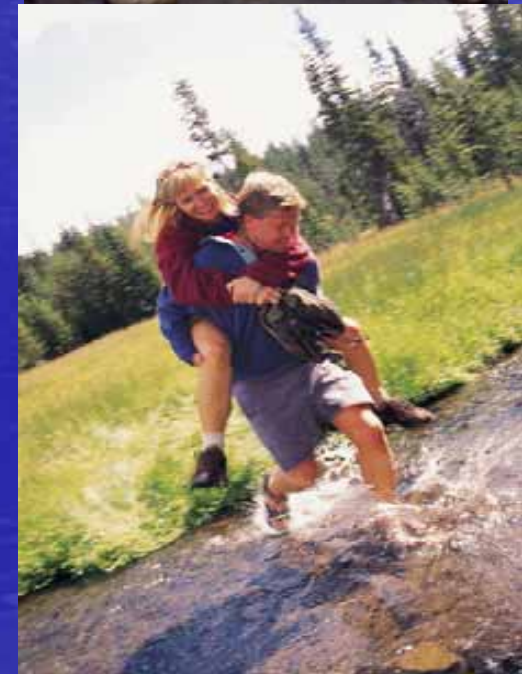
50% reduction in the load to the receiving waters

## RESTORATION:

Require additional water quality treatment to obtain the reduction

State Agencies permitting to meet the WQ goals of the receiving water - PLA

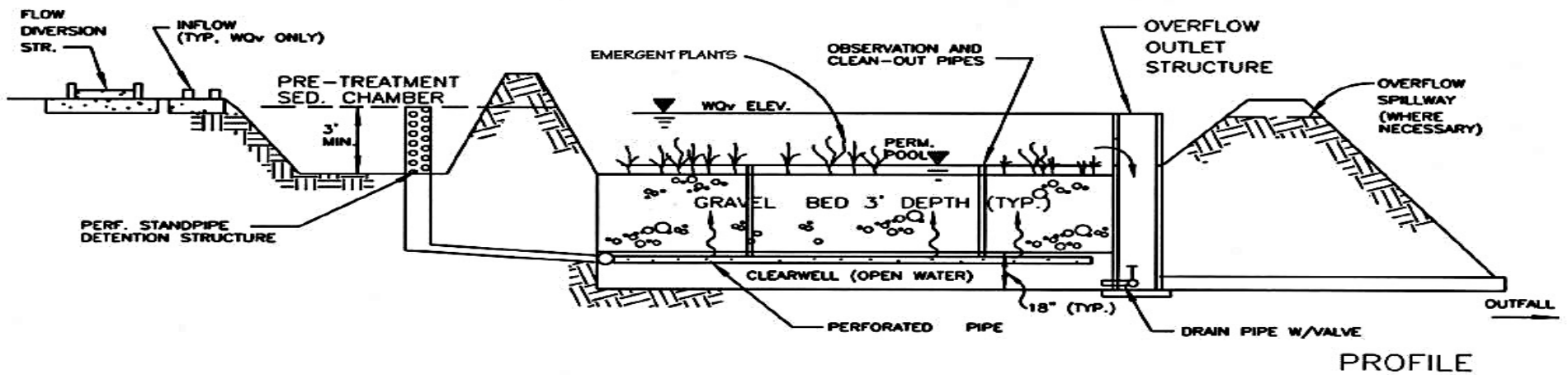
Municipality required to adopt local ordinances that establish standards for redevelopment and consider the permitting threshold that will meet restoration goals



# Wet Vegetated Treatment Systems

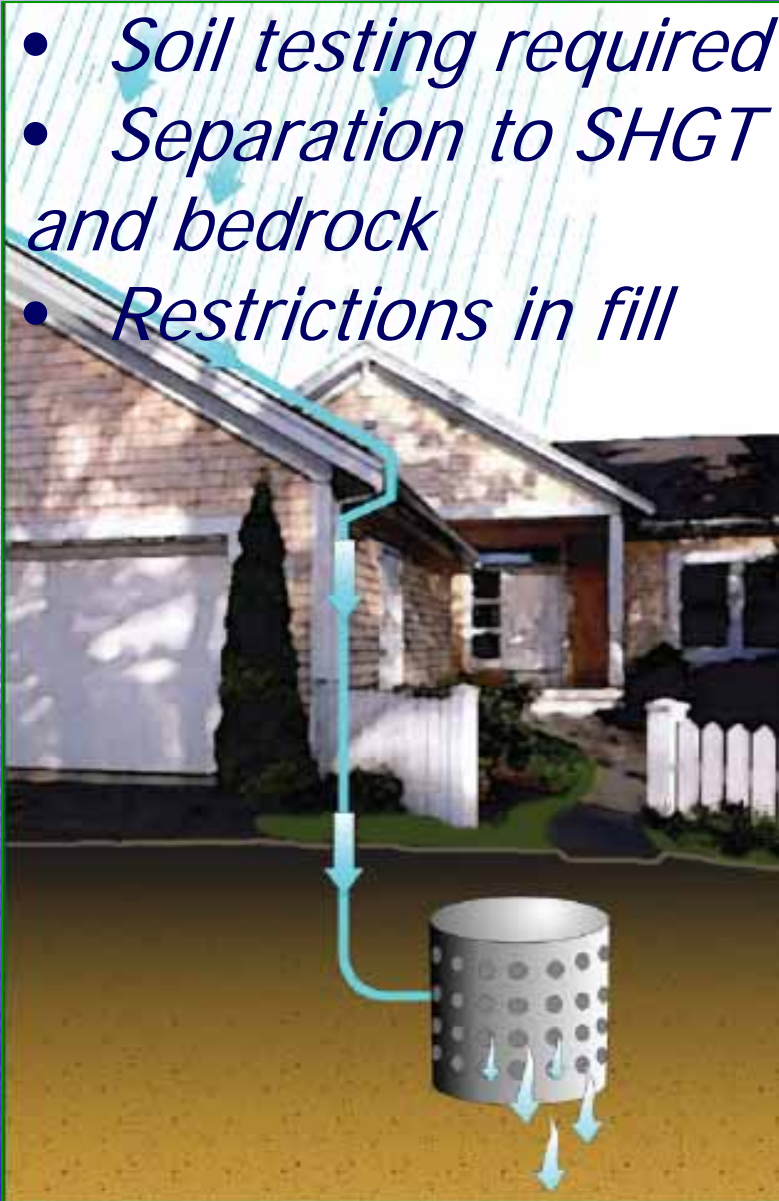
- *Designed to stay wet!*
- *Vegetation – key component*
- *Some restrictions near coldwater streams*

# Gravel WVTS



# Infiltration

- *Soil testing required*
- *Separation to SHGT and bedrock*
- *Restrictions in fill*



# *Porous Pavements*



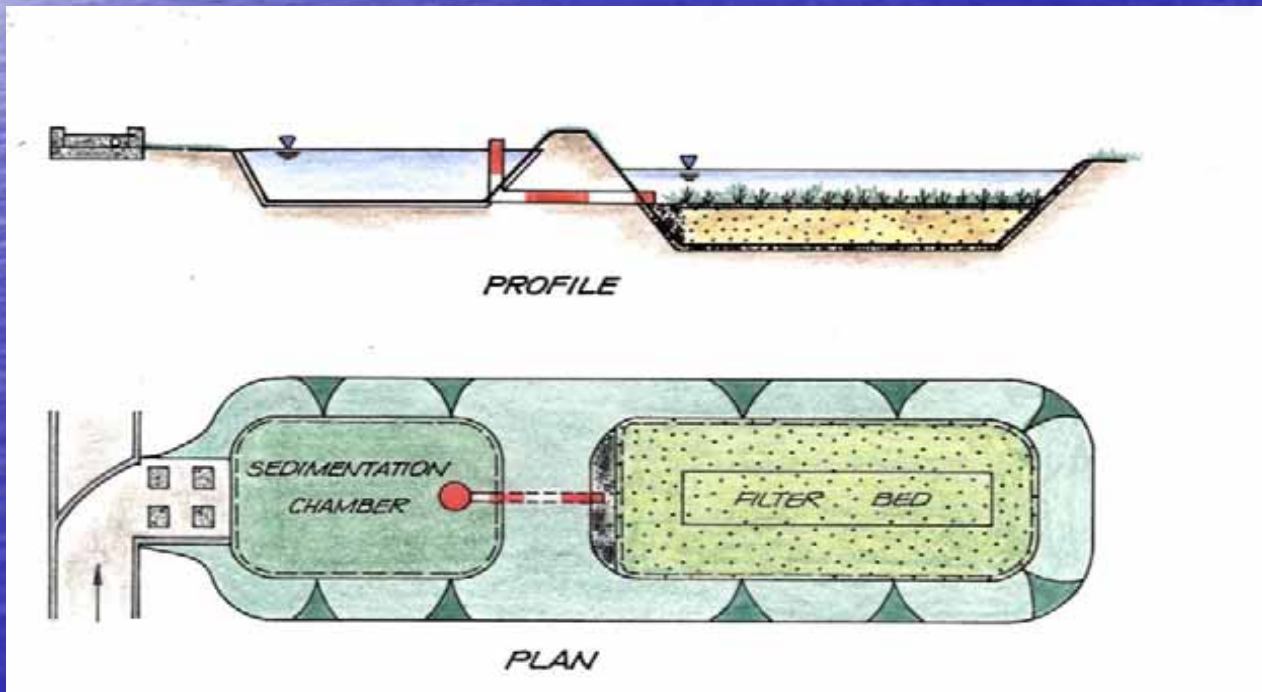
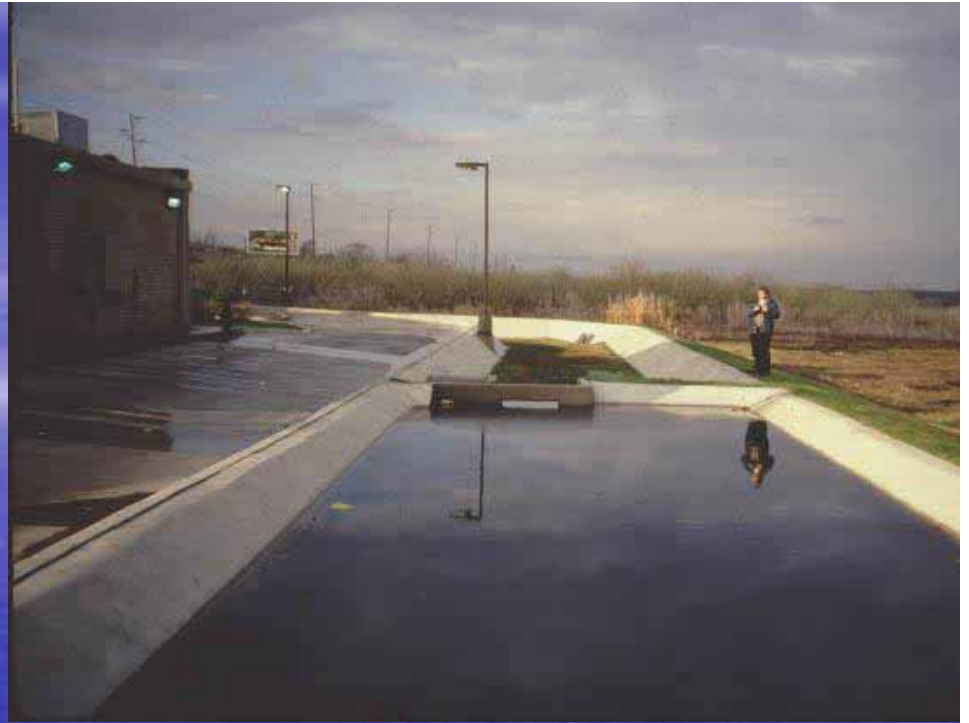
# *Permeable Pavers*





# Filtering Practices

- Sand/organic filters
- Bioretention areas/Tree filters



# *Sand Filters*



# *Bioretention – Many*



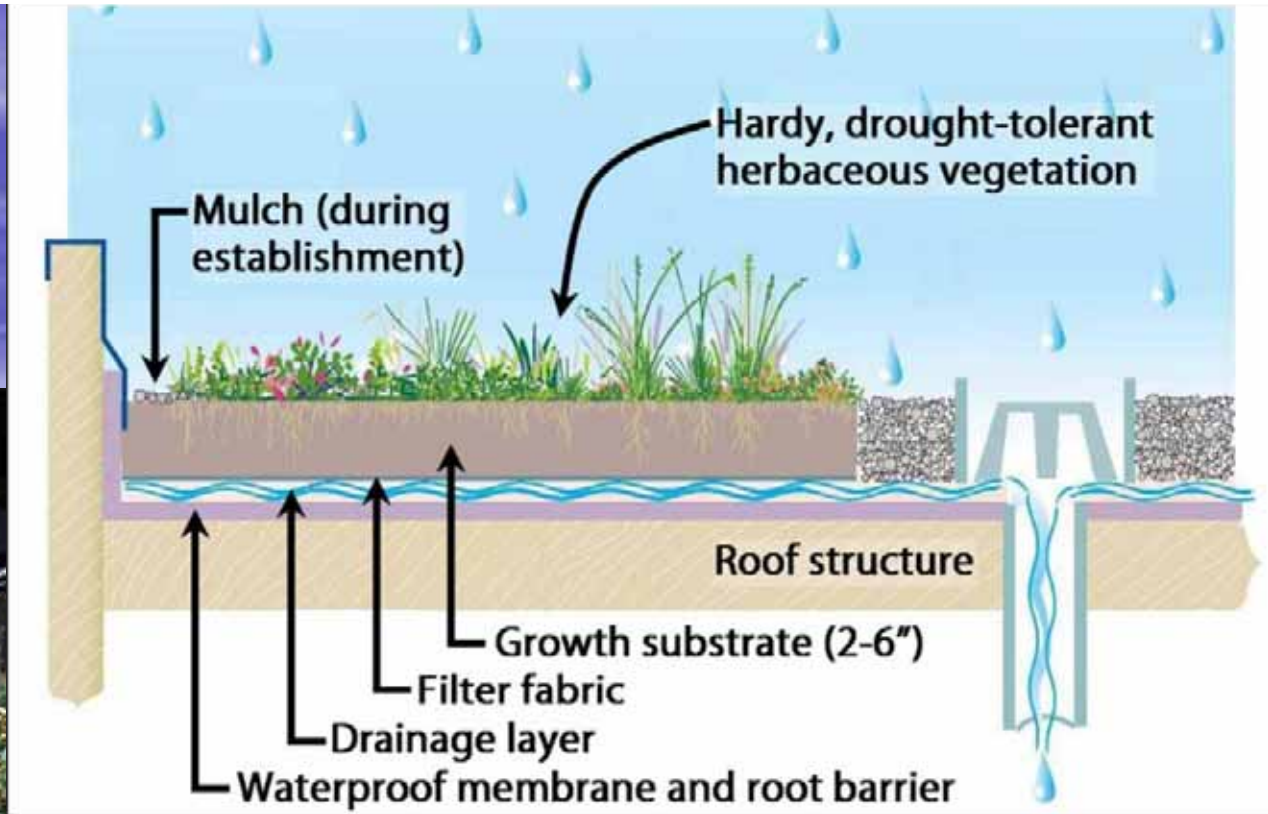


# *Tree pits*



# Green Roofs

Extensive



Intensive

# Open Channels





Dry Swale





Wet Swale

# Design Challenges

## Linear or small sites



Many green infrastructure features require land area to allow stormwater to infiltrate into the soil. This can pose a challenge when space is limited, for instance in a retrofit project or in a right-of-way. Designers have developed many strategies, however, for overcoming this challenge:

**Use features that serve multiple purposes:** Swales and bioretention areas can be integrated into landscaped areas, medians, or parking strips. Similarly, permeable pavements provide volume reduction and water quality treatment without requiring any additional space.

**Use features that fit into small spaces:** Planter boxes and tree pits are examples of green infrastructure features that may be designed to fit into small spaces.

**Subsurface storage or infiltration:** Subsurface storage or infiltration tanks provide an alternative when space is too limited for any surface practices.









# Design Solutions



**SITE CONSTRAINTS** - skepticism that green infrastructure is appropriate for particular context. Limited site space, poor draining soils, and depth to the water table or bedrock.

**Green infrastructure** is often perceived to be limited to sandy or loamy soils. Green infrastructure practices are extremely versatile, however, and strategies exist to overcome most design challenges.

Key – Recharge (Re) is required to the extent it is feasible, Water Quality (WQv) to the MEP

Many new practices are shallow and can be sub-drained to allow to function as a filter. Practices can be adapted to narrow spaces.



# Success!!???!!



- LID being incorporated to some extent in State permits for new and redevelopment– limitations on A and R, good examples of M
- Best examples of LID BMPs in retrofits and restorations
- Great examples of LID at municipal parks and recreational facilities
- Gaining momentum with LID BMPs in roadway reconstruction and municipal projects

# Federal Stormwater Rule Making

- EPA Proposing National Rulemaking to Strengthen the Stormwater Program

<http://cfpub.epa.gov/npdes/stormwater/rulemaking.cfm> or google "EPA Stormwater Rulemaking":

Develop performance standards from newly developed and redeveloped sites

Expanding the municipal separate storm sewer systems (MS4) program;

–Municipal program to reduce discharges from existing development;

–Establishing a single set of minimum measures requirements for regulated MS4s

–Explore options for establishing specific requirements for transportation facilities; and

EPA intends to propose a rule to strengthen the national stormwater program by June 10, 2013 and complete a final action by December 10, 2014.



# Future of the municipal stormwater programs in RI?

RI 's General Permit is scheduled to be re-issued

Must be consistent with EPA Region I issued permits

- **State of New Hampshire:** The 2013 draft New Hampshire small general permit is available on EPA's "[Draft New Hampshire Small MS4 General Permit](#)" webpage.
- For more information on the 2013 draft general permit, public meeting and public hearing information as well as information on the previous draft general permit (2008 draft general permit) see: [http://www.epa.gov/region1/npdes/stormwater/MS4\\_2013\\_NH.html](http://www.epa.gov/region1/npdes/stormwater/MS4_2013_NH.html)

# Contact Information

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*Web:* <http://www.state.ri.us/dem/programs/benviron/water/permits/ripdes/stwater/index.htm>

# Municipal Policy

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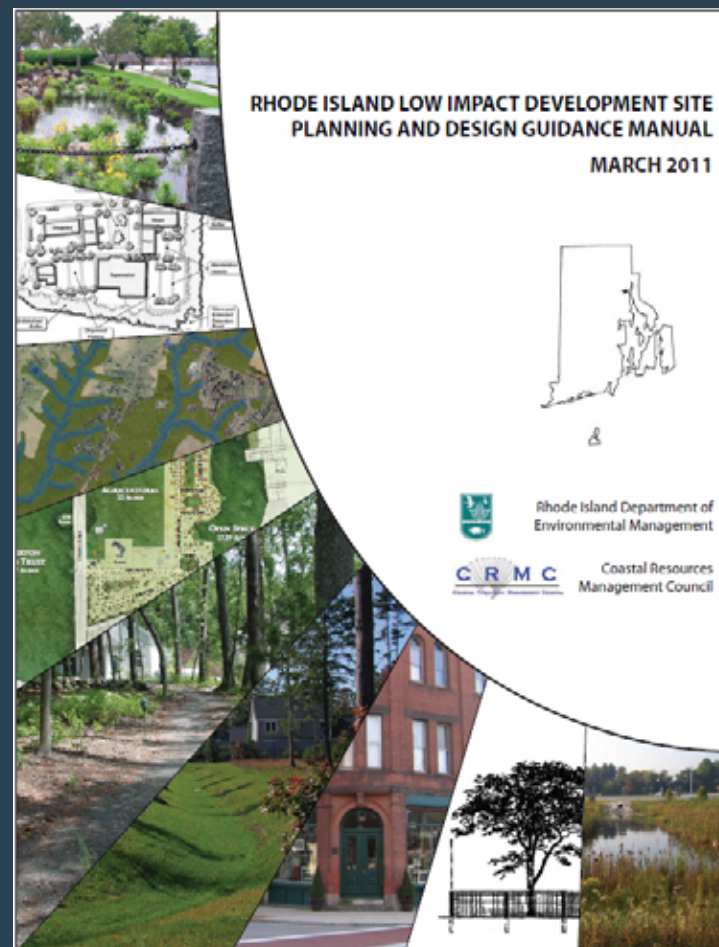
# Overview

- Approaches to Adopting Green Infrastructure Policy
- Case Study—Vernon, CT

# Adopting Green Infrastructure

- Document Reference
- Post-Construction or Stormwater Ordinance
  - *RI Stormwater Manual* is a good starting point!
- However, existing policy may contain conflicts:
  - Oversized parking requirements
  - Prescriptive dimensional standards
  - Use limitations on open space
  - Curb and gutter requirements

# Local Policy Evaluation Tools



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Case Study  
**Vernon, CT**

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# Where we looked

- *Town of Vernon Zoning Regulations* (revised November 17, 2010)
- *Town of Vernon Inland Wetlands and Watercourses Regulations* (revised October 1, 2010)
- *Subdivision Regulations of the Town of Vernon* (last amended April 7, 2003)
- *Vernon Draft Plan of Conservation and Development* (May 2011)
- *Town of Vernon Code of Ordinances*



# Candidate Options

- Preservation of Natural Resources
- Tree Protection
- Landscaping Islands for Stormwater
- Limits of Disturbance
- Open Space and Cluster Development
- Street and Driveways
- Parking Areas
- Sidewalks
- Disconnect Impervious Surfaces
- Vegetated Open Channels

# Options Selected During Workshop 1

- Preservation of Natural Resources
- Tree Protection
- Landscaping Islands for Stormwater
- Limits of Disturbance
- Open Space and Cluster Development
- Street and Driveways
- Parking Areas
- Sidewalks
- Disconnect Impervious Surfaces
- Vegetated Open Channels

# Proposed Policy Revisions

Topic	Regulation	Key Points
Preserve natural areas and riparian buffers	Subdivision Zoning	<ul style="list-style-type: none"><li>• Map resources</li><li>• Use natural areas to disconnect impervious surface</li></ul>
Landscaping islands	Zoning	<ul style="list-style-type: none"><li>• Add bioretention, filtration, and other BMPs to landscape islands</li></ul>
Open space	Subdivision	<ul style="list-style-type: none"><li>• Use open space to disconnect impervious surface</li></ul>
Impervious surface and disconnection	Subdivision Zoning	<ul style="list-style-type: none"><li>• Reduce impervious surface where practicable</li><li>• Incorporate permeable surfaces where practicable</li></ul>

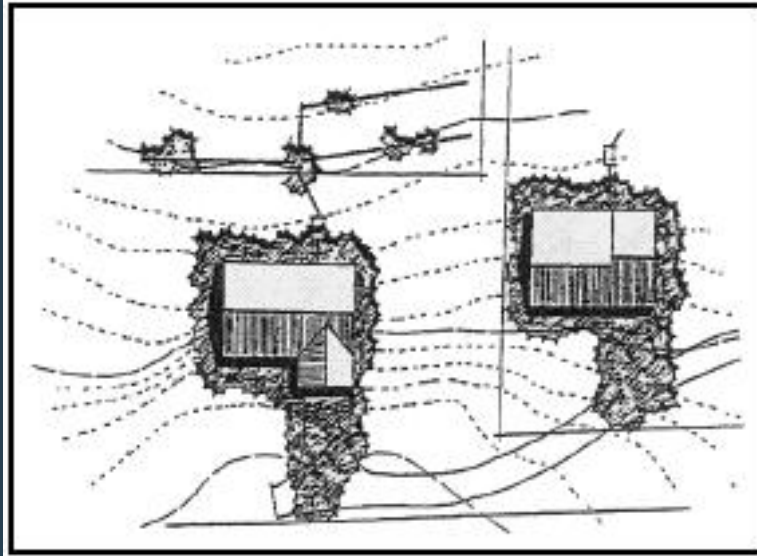
# Vernon LID Stormwater Quality Manual

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# Vernon LID Stormwater Quality Manual

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# Limits of Disturbance

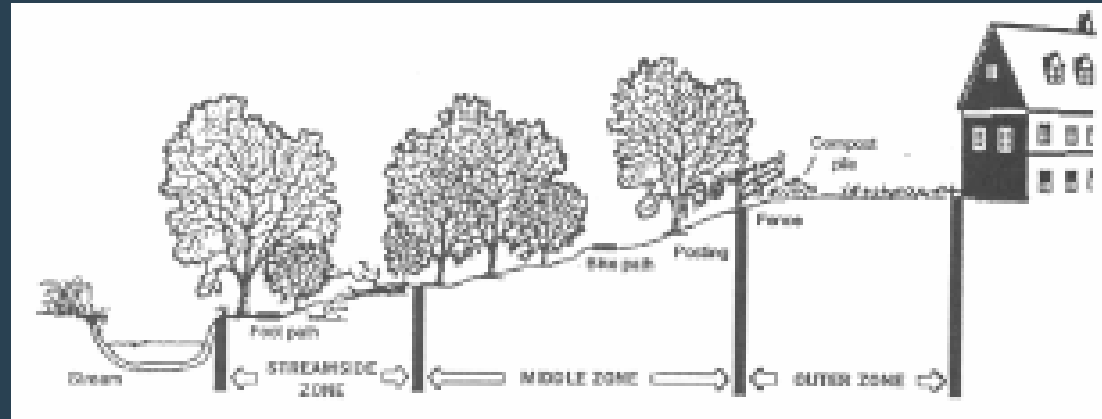


## Standards

Generally speaking, limits of disturbance are recommended to be not more than:

- a) Area of the building pad and utilities (e.g., onsite wastewater treatment systems and wells) plus 25 feet.
- b) Area of a roadbed and shoulder plus 9 feet. (This is not intended to limit lawn areas.)

# Preserving Natural Areas



- No disturbance to preservation areas.
- Clearly show limits of disturbance.
- Preservation areas must be in an easement.
- Preservation area min 10,000 sqft and 50-foot setback from wetlands.
- Create sheet flow, bypass higher flows.
- Maintain in natural unmanaged condition accept for debris removal.

# Mimic Natural Water Balance



## Standards

### *Time of Concentration*

The postdevelopment time of concentration ( $T_c$ ) should approximate the predevelopment  $T_c$ .

### *Travel Time*

The travel time ( $T_t$ ) throughout individual lots and areas should be approximately constant.

### *Flow Velocity*

Flow velocity in areas that are graded to natural drainage patterns should be kept as low as possible to avoid soil erosion.

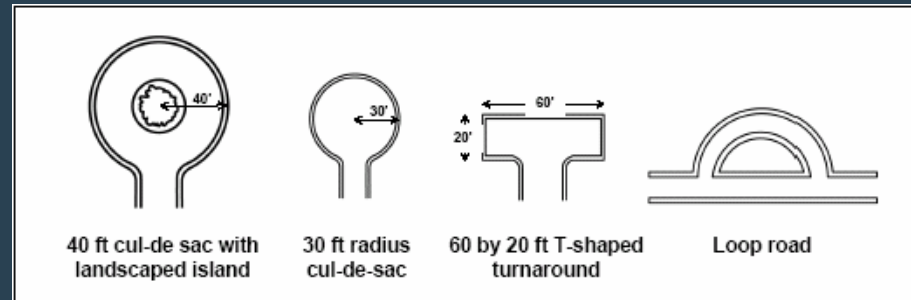


# Linear Projects



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# Minimizing and Disconnecting Impervious Surface Roadways



**Table 4.3**  
**Roadway Design Standards for Five Street Types**

Design Factor	Access	Local	Collector	Arterial
ADT	0 – 500	500 – 5,000	2,500 – 10,000	7,500 – 20,000+
Number of Lanes	2	2	2	2 – 4
Turn lanes	None	None	Left (when needed)	Left and Right (when needed)
Lane Width (feet)	9 – 10	10 – 11	10 – 12	11 – 12
On-Street Parking (feet)	None	7 (parallel)	8 (parallel) 16 – 18 (angle)	None except for CBD
Drainage	Swale or curb/gutter	Swale or curb/gutter	Swale or curb/gutter	Swale or curb/gutter
Target Speed (MPH)	15 – 20	25	25 – 35	30 – 45
Bicycle Lanes	None	Shared	Shared or separate	Yes
Sidewalks	None or one-side	Two side	Two side	One side
Frontage Lots	Yes (may be rear)	Yes	Yes	Some

# Buildings



- Reduce building setbacks to 20 – 30 feet and driveways to 18 feet wide.
- Reduce frontages to 60 feet.

# Parking Footprints

**Table 4.4**  
**Recommended Maximum Number of Parking Spaces for Certain Land Uses**

Land Use	Maximum Parking Spaces
Single Family House	2 per DU <sup>a</sup>
Shopping Center	5 per 1000 ft <sup>2</sup> GFA <sup>b</sup>
Convenience Store	3.3 per 1000 ft <sup>2</sup> GFA
Industrial	1 per 1000 ft <sup>2</sup> GFA
Medical Dental	5.7 per 1000 ft <sup>2</sup> GFA

- Minimize parking stall size.
- Use parking decks.
- Encourage shared parking.

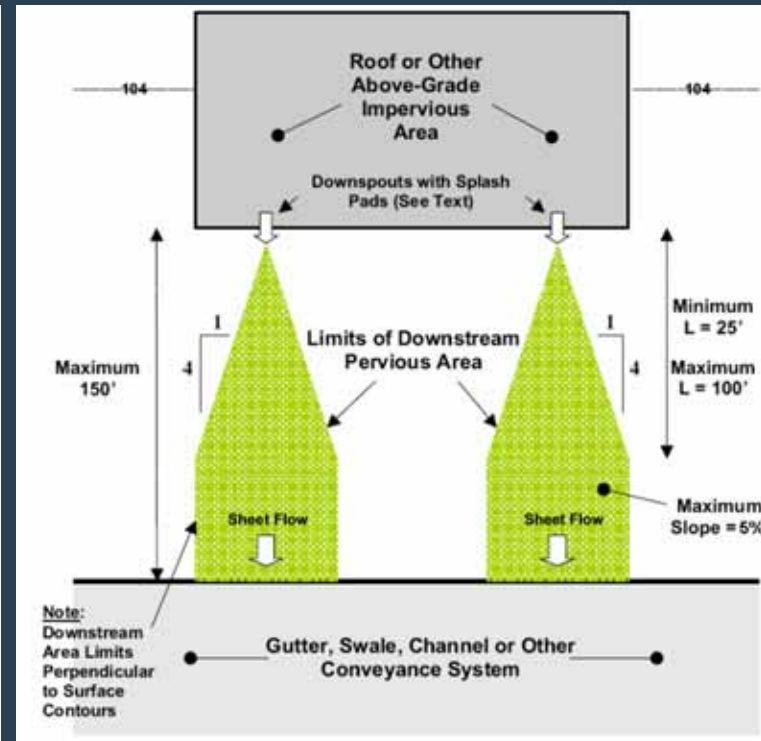
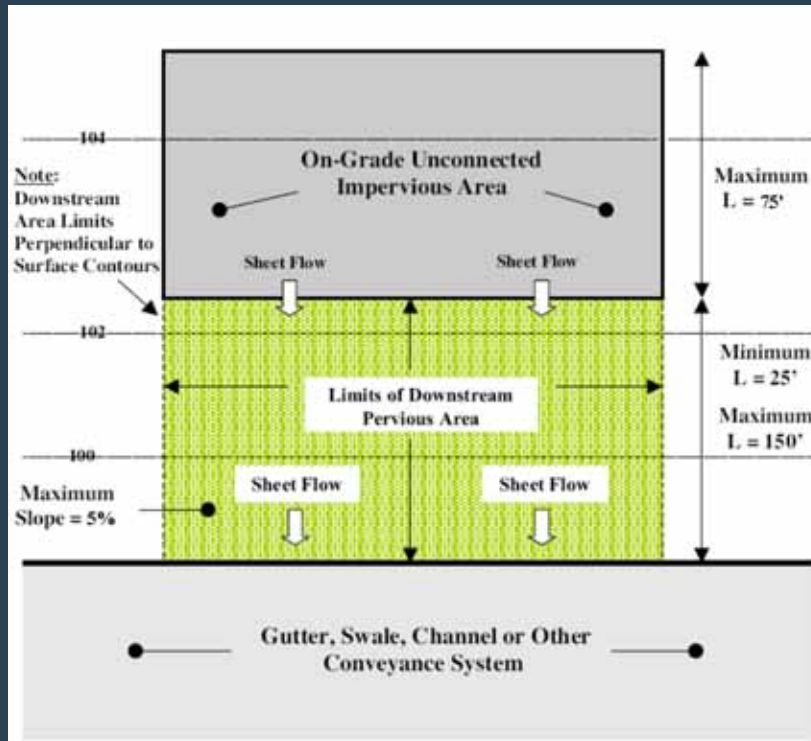


# Parking Lot Islands



- Be at least 8 feet wide.
- Be constructed with sub-surface drainage.
- Incorporate compaction resistant soil.

# Disconnecting Impervious Surfaces



- Disconnect impervious surfaces to the extent practicable.
- Up to the first inch of runoff from an impervious surface may be disconnected to a pervious surface such as a lawn.

# Other Management Practices

- Standards refer back to Chapter 4 and Chapter 11 of the DEEP Stormwater Manual.
- Management practices include:
  - Permeable pavement
  - Vegetated filter strips
  - Natural and vegetated drainage ways
  - Green roofs and facades
  - Cisterns and rain barrels
  - Dry wells
  - Bioretention and rain gardens
  - Infiltration trenches

# Common Developer Incentives

Incentive by Type	Proposed Approach
<b>Enhanced Marketability</b>	
Allow open space or other conservation areas to be used for LID BMPs	<ul style="list-style-type: none"> <li>Allow in zoning and subdivision regulations (see "preservation of natural areas and riparian buffers" and "open spaces.")</li> <li>Standards provided in "Vernon LID Stormwater Quality Manual."</li> </ul>
Allow green roofs to be used for open space credit	<ul style="list-style-type: none"> <li>Consider including; however, this may require changes to existing regulations.</li> </ul>
Allow increased densities for projects that utilize LID	<ul style="list-style-type: none"> <li>Increased density is already allowed under cluster zoning.</li> <li>Standards provided in "Vernon LID Stormwater Quality Manual."</li> </ul>
Flexible bulk, dimensional, and height restrictions for projects that utilize LID	<ul style="list-style-type: none"> <li>Flexible dimensions are allowed currently under cluster zoning.</li> <li>Standards provided in "Vernon LID Stormwater Quality Manual."</li> </ul>
Public recognition	<ul style="list-style-type: none"> <li>Not currently being considered.</li> </ul>



# Common Developer Incentives

Incentive by Type	Proposed Approach
<b>Improved Profitability</b>	
Funding demonstration projects	<ul style="list-style-type: none"><li>• Not currently being considered.</li></ul>
Eliminating permitting fees	<ul style="list-style-type: none"><li>• May provide a good tool for negotiation.</li></ul>
Eliminating fees-for-service	<ul style="list-style-type: none"><li>• May provide a good tool for negotiation.</li></ul>
Eliminating taxes	<ul style="list-style-type: none"><li>• May provide a good tool for negotiation.</li></ul>

# Common Developer Incentives

Incentive by Type	Proposed Approach
<b>Reduced Time for Project Initiation</b>	
Prioritize review of LID projects	<ul style="list-style-type: none"><li>Removed from consideration.</li></ul>
Commit to an expedited permitting timeframe	<ul style="list-style-type: none"><li>Removed from consideration.</li></ul>
Administratively approve LID projects	<ul style="list-style-type: none"><li>Removed from consideration.</li></ul>

Green Infrastructure Retrofits

# At the Local Level

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# Value of Identifying Sources



## Which Source is it Really?

Source identification provides clear direction on how to manage water pollution sources.

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# Water Street Sampling Program

## High Bacteria

- Beach
- Groundwater
- Stormwater

## Confirmed Sources

- Wet-Weather Sampling
- Dye Testing

## Recommendations

- Replace Sewer
- Install Green Infrastructure
- Address Pedestrian-Traffic Conflicts



# Water Street at a Glance

## Goals:

- Pathogens
- Manage Drainage
- Manage Wastewater
- Improve Beach Water Quality
- Improve Traffic Management

## Original project (feasibility):

- Conceptual stormwater and transportation planning

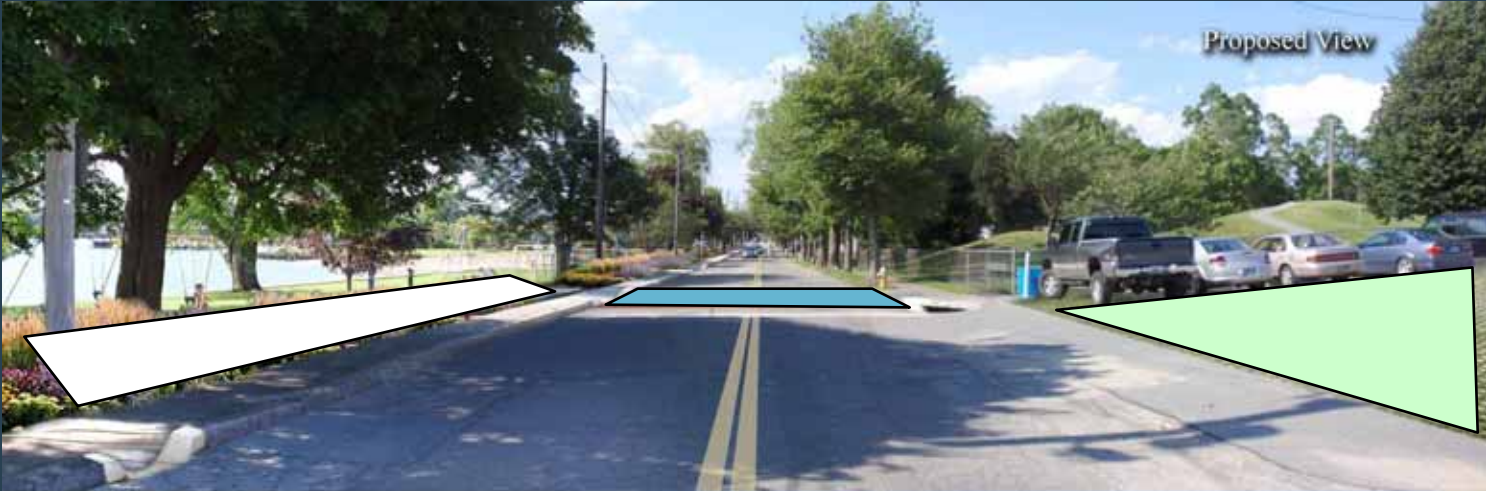
## Second Phase (design and permit):

- “Green” and wastewater design

## Construction (build)



# Feasibility Study - Conceptual Design



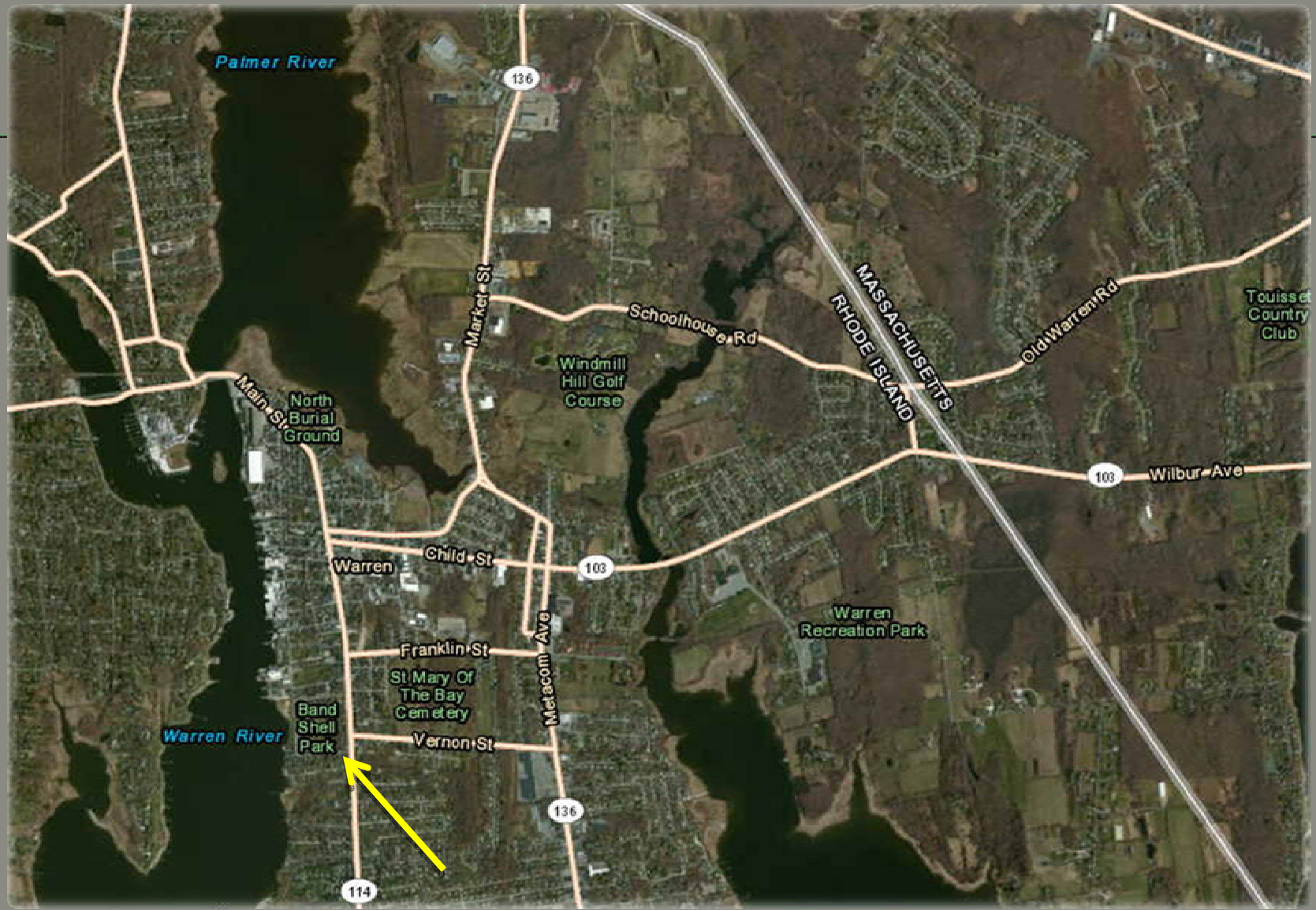
# Green Infrastructure: Warren

## Water Street @ Town Beach



- First designed Green Street in Rhode Island
- Retrofitting an urban park area
- Main bypass of Main Street for drivers
- Runs through culturally significant heritage site
- Exemplifies challenge into opportunity





# South Water Street



Town of Warren / Department of Planning and  
Community Development

## Site Conditions

# Contamination: Why was Warren Beach closing?

- sewer line? cruise line?
- fowl on the beach?
- upriver contaminants?
- stormwater runoff?



## Site Conditions

# Contamination

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- Investigations indicated that sewer line leaking and that past repairs were failing
- Stormwater considered a contributor to bacterial spikes as slope of streets directly flows into the street and the beach
- Adjacent shipyard/cruise line repaired pump station and connections, so this was ruled out

Site Conditions

# Stormwater Runoff & Flooding

- How do we prevent frequent flooding?



Between the park and beach

Flooding impedes to walking and working in the area....



Between Blount Boats and their employee parking lot

## Site Conditions

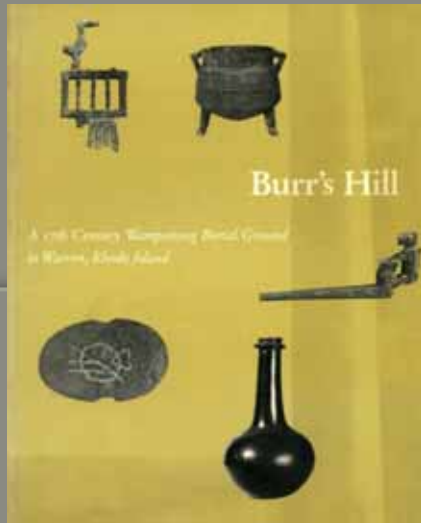
# Traffic and Pedestrian Conflicts



- Neighborhood setting
- Traffic cut through
- Children at the beach, playground and camp
- Tourists
- Summer activities (concerts, festivals, etc.)

## Site Conditions

# Cultural Heritage and Site Sensitivity



- Native American burial mound (now called Burr's Hill), dates at least to the 1500s
- Possible burial of Massasoit and Wampanoag leadership
- Native American presence involved the EPA



Site Conditions

# Aesthetics

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- Chain link fencing
- Asphalt sidewalks
- Dead and diseased trees
- Old streetscaping
- No curbing





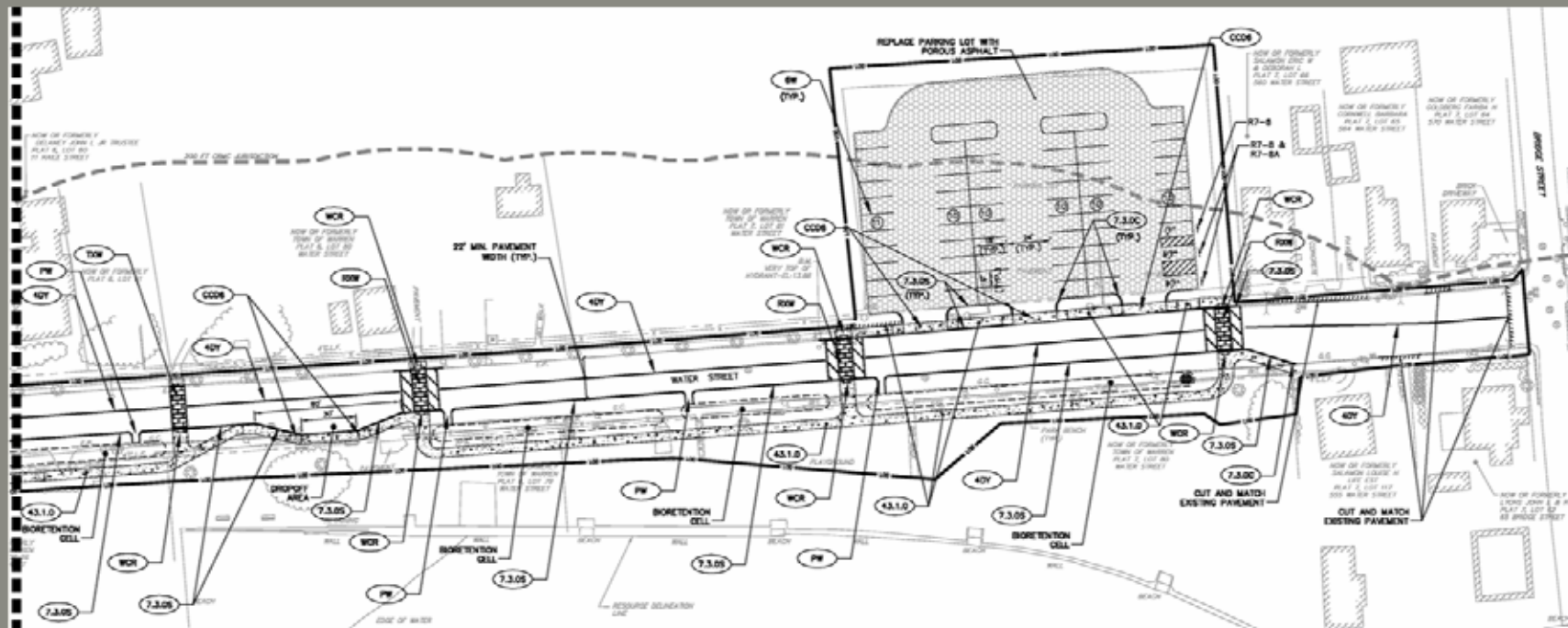
# Planning Process

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- Sewer Line replacement needed (bond)
- Integrating stormwater abatement with improved aesthetics for the area
- 2009: ARRA stimulus funding became available for green infrastructure
- Applied and received funding for sewer line, stormwater improvements as long as they were part of the overall green design

# Green Street Design

Workshop attended by 75 people to discuss design options for the street (speed, aesthetics, green elements)



# Pervious pavement

- Pervious asphalt to control accumulation of water and runoff
- Roads deemed cost prohibitive
- Disrupts sensitive ground-procedure spelled out



# Bioretention Cells

- 6 cells located on one side of the street (on the downgrade of the slope before the beach area).
- Drought tolerant, RI native species
- Moved between road and sidewalk to catch stormwater flow



## Traffic Controls

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- Workshop residents stated they wanted traffic controls, so included were:
  - Narrowing of the street overall
  - Addition of curbs
  - Traffic bumps before areas where children cross (which also funnel water to bioretention cells)
  - Crosswalks with differentiated pavement
- *Complete Streets and Green Streets are very compatible*

## Green Street Design

# Aesthetics

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- New trees designed for site (height, root structure)
- Chain link fence removed (bioretention cells create barrier)
- Curbing defines the street
- Bioretention cells planted with flowers to create roadside gardens along beach
- Old streetscape benches, etc. removed

## Cultural Heritage & Site Sensitivity

- Intergovernmental review brought concerns from RI Historical Preservation & Heritage Commission
- Nearly 2 years meeting with Wampanoag Confederacy and Narragansett Tribes—EPA mediated conversations as the federal agent
- Internal conversations broke down and EPA declared environmental conditions an emergency
- Archaeologists, monitors from tribes on site



Opportunities

# Funding

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## Funding

- ◉ Federal stimulus provided the path
- ◉ Flexibility through state from RI Dept. of Environmental Management and Clean Water Finance Agency
- ◉ Piggyback funding creates a bigger project with more possibilities



Opportunities

# Integrated Planning

- Two engineering firms (sewer and green infrastructure) on team
- Federal, state, local and tribes working closely to understand mutual interests
- Public involvement through presentations and workshops



Opportunities

# Innovation

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- Project enables Town to test green technology in order to integrate it into other streetscape projects
- Provides a visible education project for residents and a reference for future projects

Opportunities

# Applications in Warren



- Metacom Plan (Route 136)
  - New mixed use zoning district that incorporates low impact development standards and guidelines for redevelopment
- Complete Street project – all transportation modes for all ages
- Reduce impervious surface

Opportunities

# Applications in Warren

- North Water Street Streetscape planning began in February
- Dense, touristy
- Colonial era
- Sidewalk treatments, tree plantings, infiltration

