

# Development Sustainability & Stormwater Master Planning



## *Stormwater Master Planning for Urban Settings*



# Objective of today's talk

- **Focus on ultra urban settings**
- **Define stormwater master planning**
- **Describe why they are useful**
- **Describe how they can provide sustainability**
- **Discuss what other communities are doing**

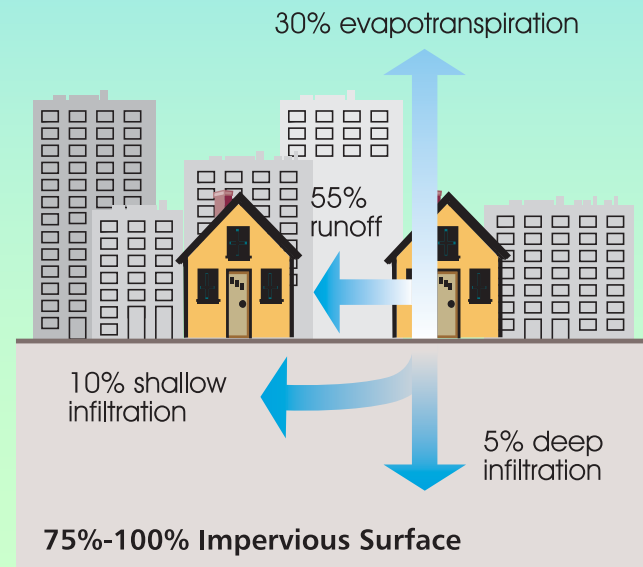
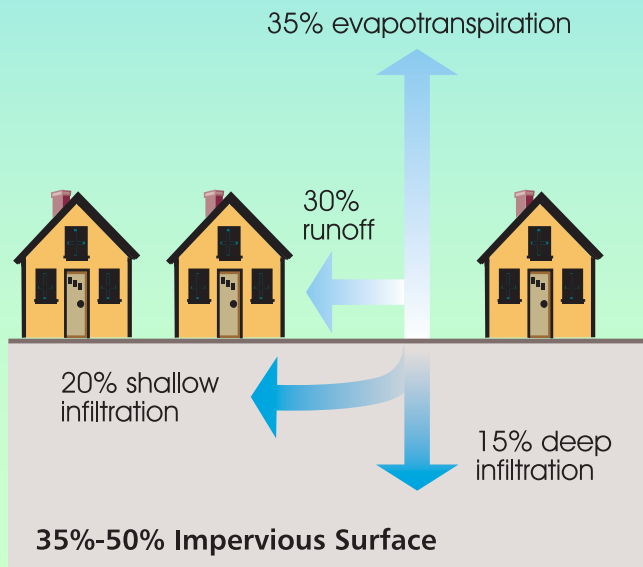
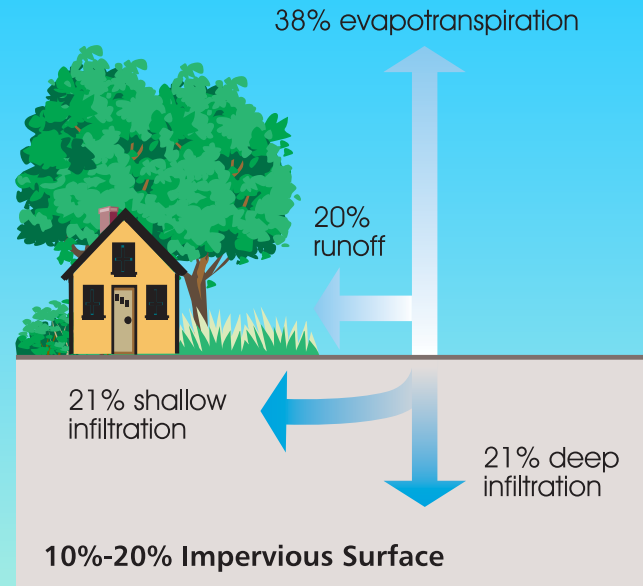
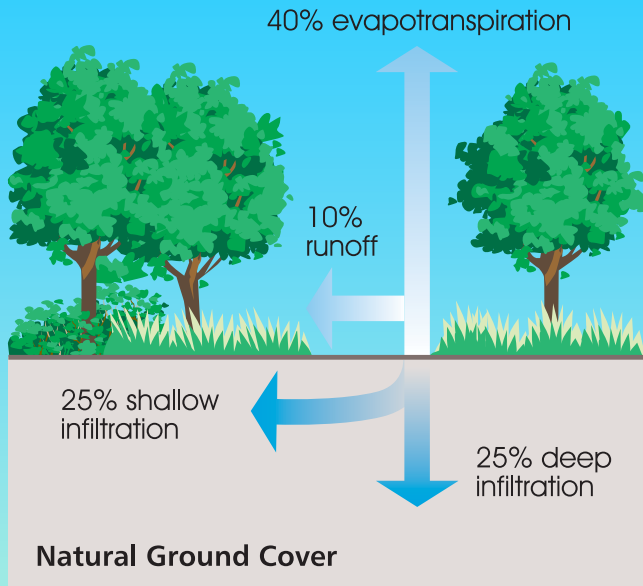
# Urban Development Often Predates Stormwater Management Requirements



# Definition

- **Stormwater master planning** - identifies and assesses the stormwater related needs of a municipality, identifies constraints and opportunities, prioritizes selected opportunities, estimates costs, and develops a plan to implement projects to address those needs. The stormwater master plan should continuously be reviewed and updated to reflect changing land uses and innovative stormwater best management practices.

# Development modifies hydrology



Development increases runoff; restoring green space and retention reduces runoff

**For a 1-year, 24-hour storm (2.63")**

- **Pre-developed condition**

- **Forested** **0.8" runoff**

- **Developed conditions**

- **>75% impervious w/ no SWM** **2.1" runoff**

- **Convert 25% to green parks** **1.8" runoff**

- **Retain 1" of runoff** **1.1" runoff**

# Hydrologic and water quality problems

- **Floods**
- **Water pollution**
- **Erosion & Sedimentation**
- **Habitat degradation**

# Regulatory drivers of stormwater planning

- **NPDES MS4**
- **Total Maximum Daily Loads (TMDLs)**
- **Combined sewer overflows (LTCs)**
- **Brownfields**
- **Floodplain management**



## Planning efforts that overlap

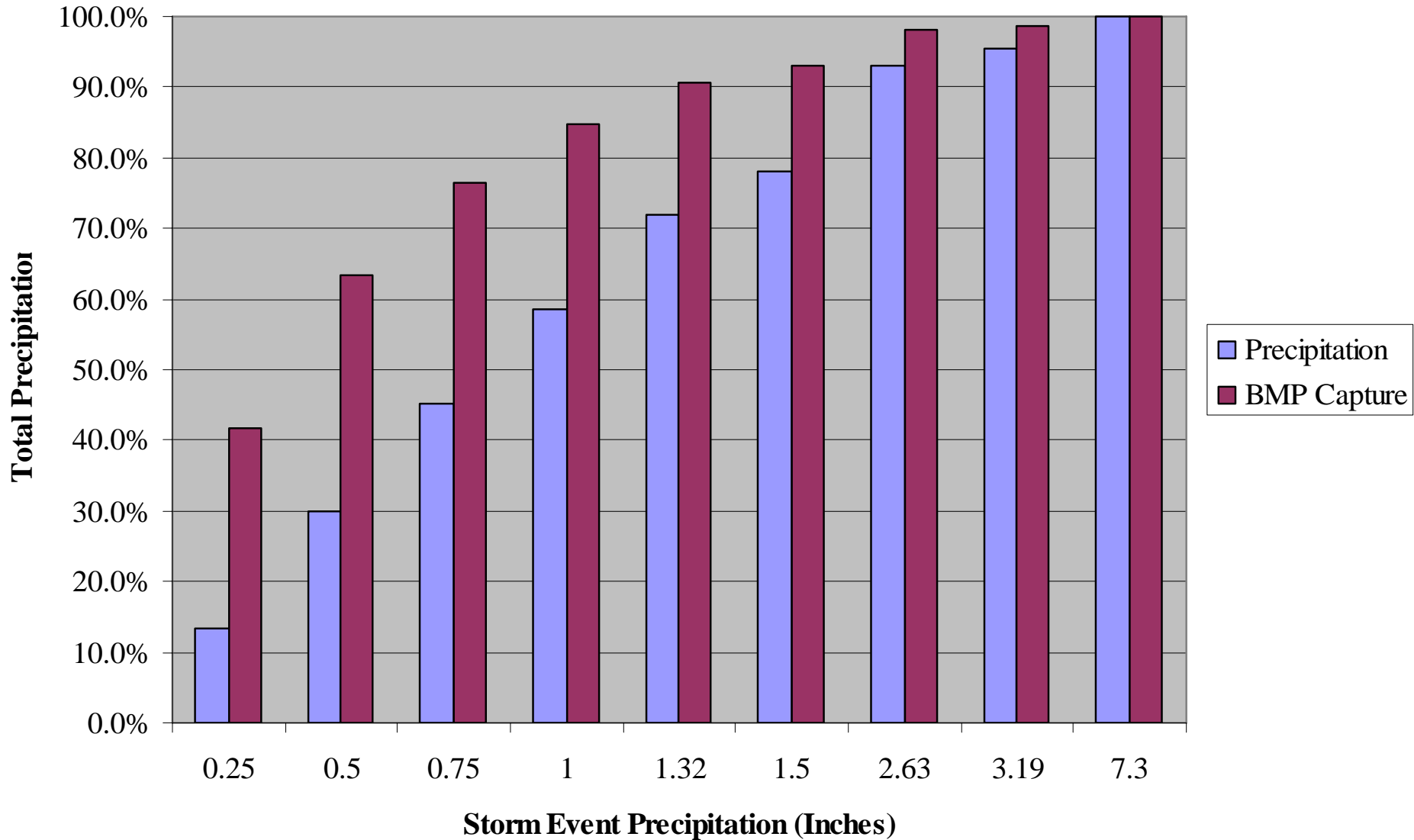
- **Stormwater master plans**
- **Floodplain management and mapping**
- **Transportation management plans**
- **Open space plans**
- **Water and wastewater master plans**
- **Land use master plans**
- **Redevelopment master plans**

# Additional reasons for stormwater management

- **Establish goals and develop actions**
- **Environmental restoration/protection**
- **Identify and prioritize CIP projects**
- **Opportunities to decrease infrastructure costs**
  - Sewer improvements
  - LTCP
  - Water conservation
  - Energy conservation
  - Drought management
- **Community activity**
- **Improve likelihood of grant awards**

# Summary of Storm Event Data For Reagan National Airport

Period of Record is 5/1/1948 through 2/1/2006



Large ultra urban cities are taking action now to meet what will be required in the future

- **Chicago**
- **Detroit**
- **Seattle**
- **San Diego**
- **Philadelphia**
- **District of Columbia**
- **Alexandria**



# DC has developed a sustainable stormwater management program

- **Environmental standards**

- Retain/detain and treat 1” of runoff
- Use LID practices
- Use green roofs as feasible
- Promote sustainable stormwater management

- **Redevelop large tracts with City support**

- Use green infrastructure
- Incorporate stormwater ubiquitously / openly

- **Insert green infrastructure on DC’s roads**

- Bioretention strips
- Pervious materials
- Trees

# Runoff Control Plaza







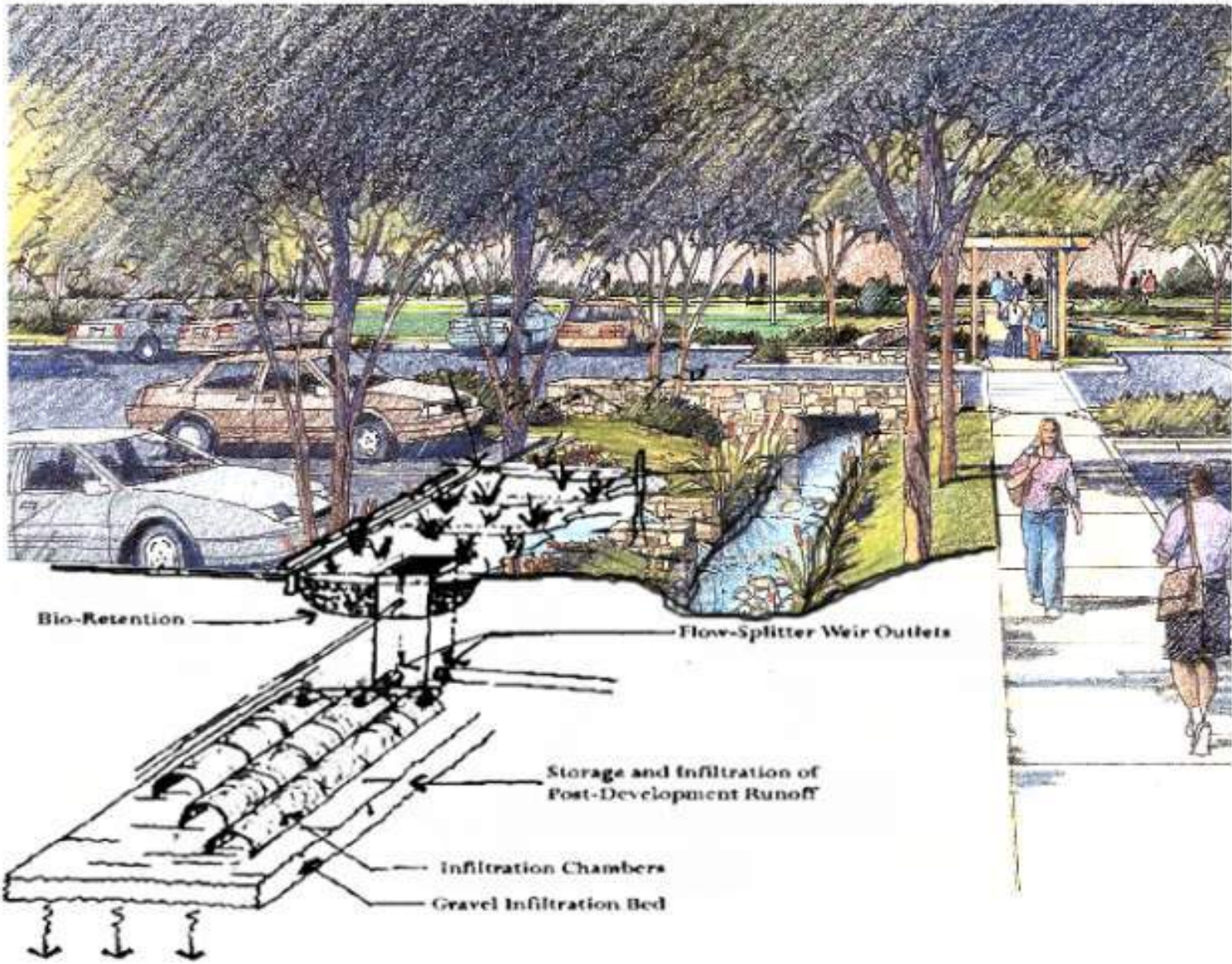


# City of College Park

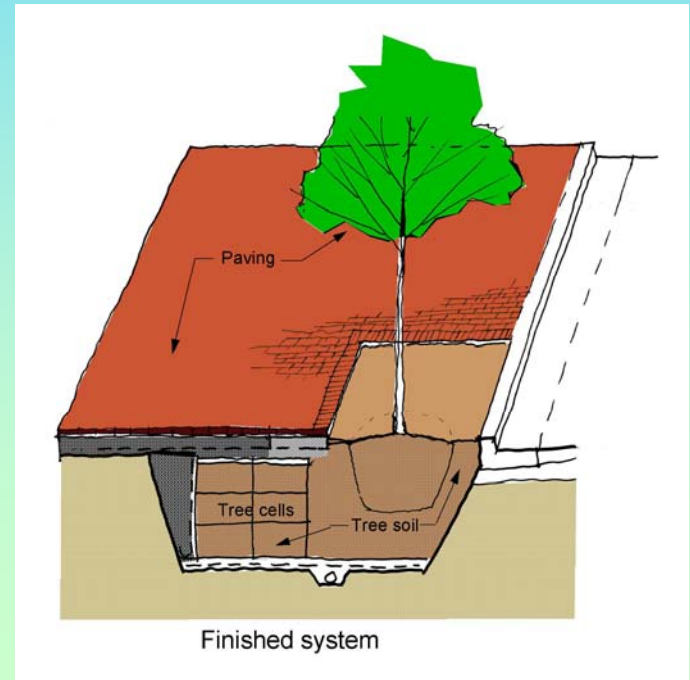
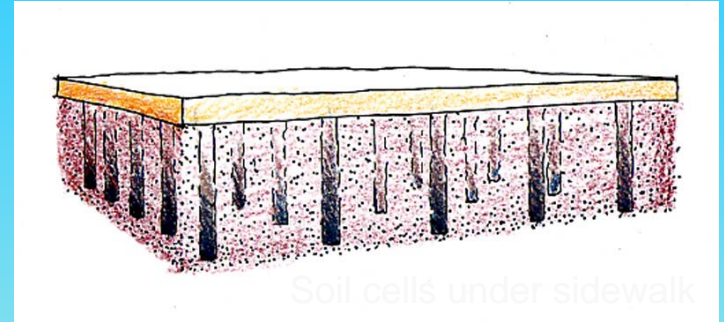
- Street Filters
- Rain Gardens







# Sustainable design is not just visual treatments, but also below ground work... Green Infrastructure



# Increasing soil volume

**Section 12: Planting Zone - Subsurface Treatments**

**Element:** Increase Planting Space **Reference:** 12.1(1)

**Item:** Contiguous Root Area with Pavers

**Classification:** Principal Arterial, Minor Arterial, Collector, Local, Symbolic Corridor, **Area Type:** Mixed Use & Residential, Designated Transit Corridor, Special Segment

**Location:** Furnishing/Planting zone within the sidewalk.

**Purpose**  
The growth and life span of urban trees is shortened due to the increased environmental stress in an urban setting. Stress on urban trees includes air pollution, lack of fertile soils, poor drainage and vandalism. A contiguous root area allows drainage in the planting zone.

**Application**  
The Furnishing/Planting Zone should provide a 4'-0" or 6'-0" wide contiguous underground root zone depending on the total width of the sidewalk between the curbline and the pedestrian clear zone to maximize the volume of soil and encourage the uninterrupted growth of tree roots. Furnishing/Planting Zone may be less than 4'-0" only if the entire sidewalk width is less than 8'-0". In general, provide 750 cubic feet of planting soil per tree.

- In addition to a contiguous root area, the following options are encouraged to provide better growing conditions for trees:
  - Option 1: Aeration Strip under sidewalk
  - Option 2: Structural Soil under sidewalk
  - Option 3: Spawning sidewalk sand Structural Cells
- Restriction:**
  - Trees should not be planted in sidewalks less than 6'6" wide.
- Option:**
  - Sidewalks 6'0" or wider: Modifications to pavements on walkway zone may be optional when sidewalks are 8'0" or wider.

**All Specific Guidelines - Refer to Chapter 6 Items 2a, 2b, and 2c for information on proposed guidelines.**

**Low Impact Development (LED) Opportunity - Refer to Chapter 5, Option 2**

*DMIT - Contents Subject to Change*

**Low Impact Development**

**Element:** Low Impact Development (LED) **Reference:** Option 7

**Item:** Permeable Grid Pavement

**Classification:** Arterial, Freeway, Freeway Arterial, Major Arterial, Collector, **Area Type:** Mixed Use & Residential, Local, Minor Arterial, Symbolic Corridor, Designated Transit Corridor, Special Segment, Residential, Park Area

**Location:** In-ground median, roadway setback, sidewalk planting zone

Permeable grid pavement systems are concrete blocks or stones with spaces in gaps between them allowing stormwater to flow through and into an underground storm storage area or a tree planting zone. The permeable pavers can be used to treat roadway or sidewalk runoff. The storm system allows stormwater infiltration into the subsurface ground layer, encourages infiltration into aquifers that store and filter pollutants improving the quality of runoff that the receiving streamways, and may provide additional underground stormwater storage if sufficient additional depth is provided. In tree planting applications permeable pavers allow water to enter the tree root zone providing an excellent water supply for trees.

Permeable grid blocks essentially function as an infiltration and retention zone that can accommodate pedestrians, vehicle parking, and transit. The composition of materials allows the following benefits:

- Promotes tree survival by providing air and water to roots.
- Increase high strength, low absorption concrete with added fibre and bonding.
- Increase micro-voids, temperature and contributes to urban heat island reduction.
- Immediately ready for traffic and walking ways for paving.

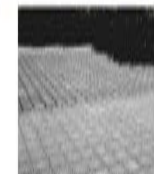
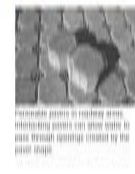
**Required Maintenance:** Street cleaning should be performed on storm areas regularly to remove debris that may plug filtering materials. Storm water filtering materials will never have to be replaced and compacted permanently.

**Applications:**

- Interlocking: The permeable pavers can be installed in medians or on periphery of road systems to reduce or reduce stormwater systems.
- Major Urban Street: Permeable pavers can be incorporated into the parking areas and sidewalk planting zones.
- Local: Permeable pavers can be incorporated into the parking areas and sidewalk planting zones.
- Any Surface treatment to allow.

**Stormwater Management Effectiveness**

Reference	LED Management Practice	Volume	Frequency	Location	Peak Discharge	Water Quality
Option 7	Permeable Pavers	●	●	●	●	●



# Sustainability Approach & Experience

## Urban Redevelopment: Master Planning experience with a unique approach.

- Whole Systems Sustainability
- Public Realm Guidelines
- Landscape Architecture
- Public and Private Green Infrastructure Planning
- TOD integrating sustainable development
- Corridor Studies

Work through multiple phases: Concept Plans to Construction Documents

Weave a sustainable development approach throughout each master plan.

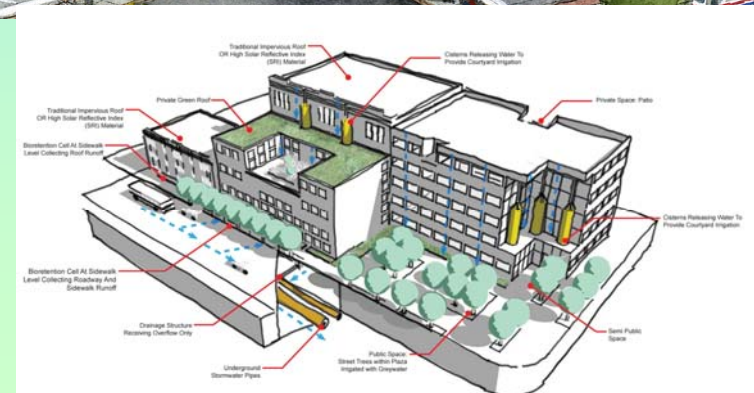
Figure 6.7 - Overall Sidewalk Layout Rendering: Sidewalk View



Furnishing/Planting Zone  
Dimensions: 6'-10'

Walkway Zone  
Dimensions: 6' (if Cafe Spill-out) -10'

Spill-out Zone  
Dimensions: 4'-5'

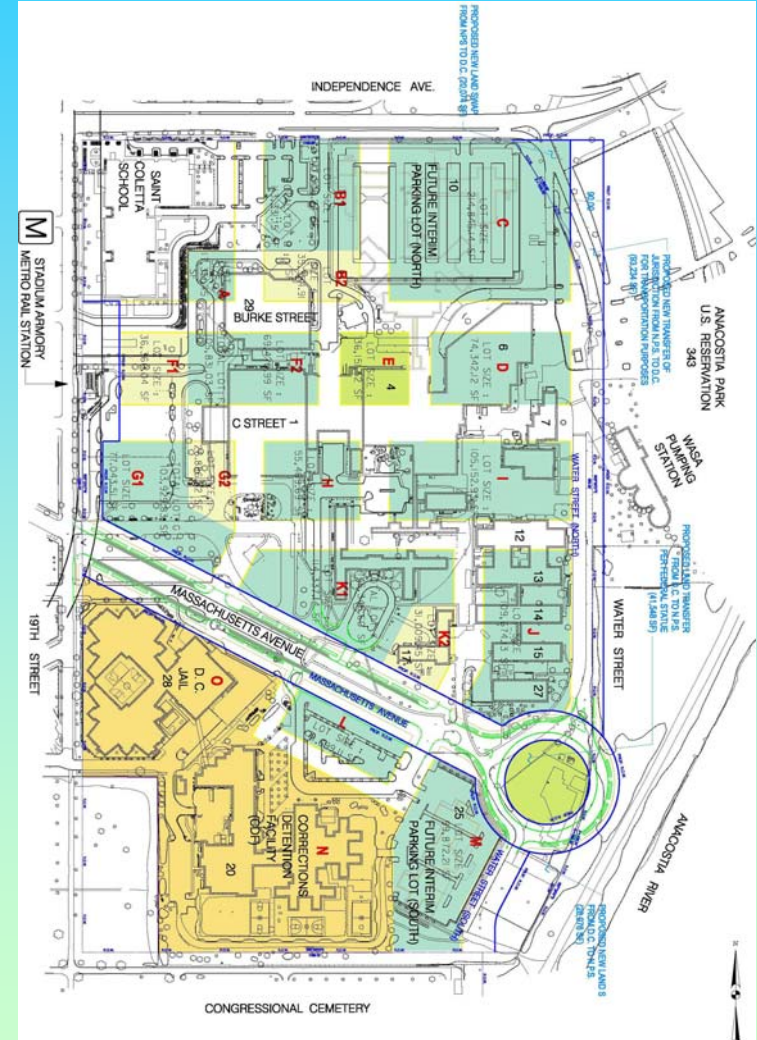
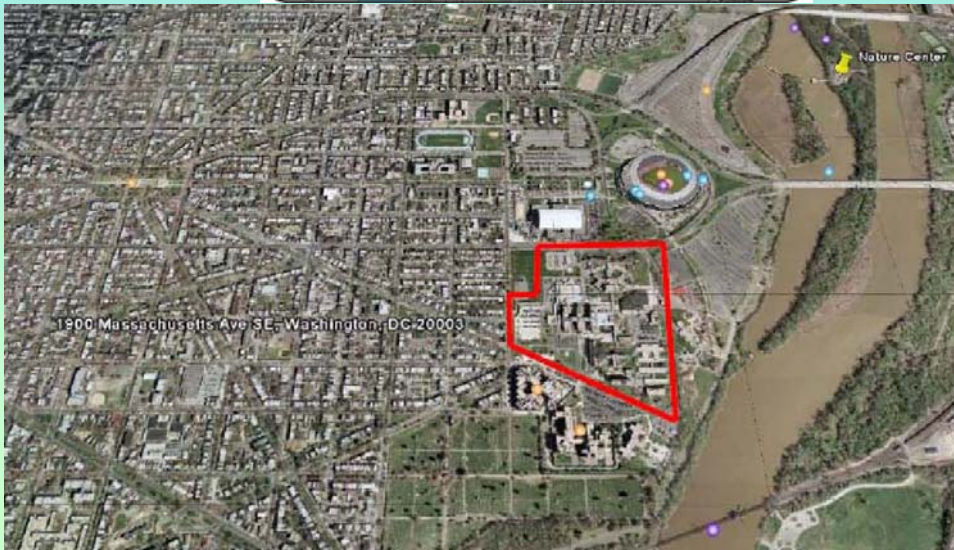


# The Anacostia Waterfront, Washington DC



- Create a livable urban waterfront
- Restore water quality
- Enhance natural beauty of the river
- Connect neighborhoods to each other
- Promote sustainable development

# Hill East Waterfront Redevelopment Bridging Planning and Stormwater



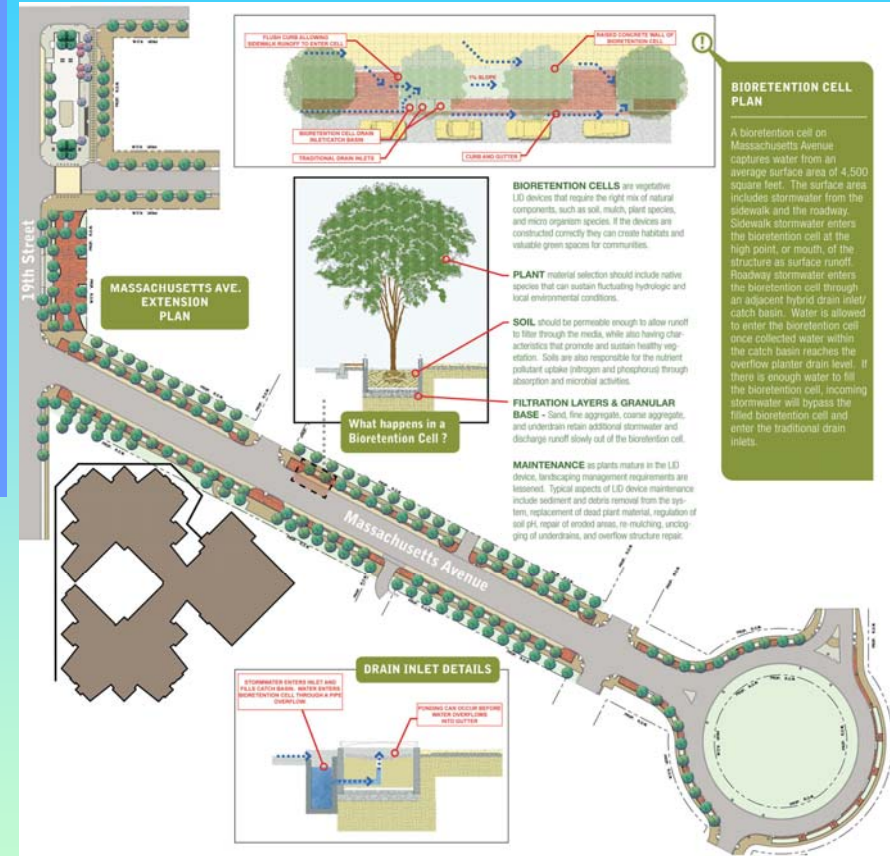


# Sustainability Approach & Experience

## Urban Redevelopment with a focus on specialty planning

### Hill East Waterfront Redevelopment

- Provided green infrastructure public realm designs for an ultra-urban redevelopment site.
- Developed a public outreach signage system explaining the importance of a sustainable community.
- From Planning to Final Design Services



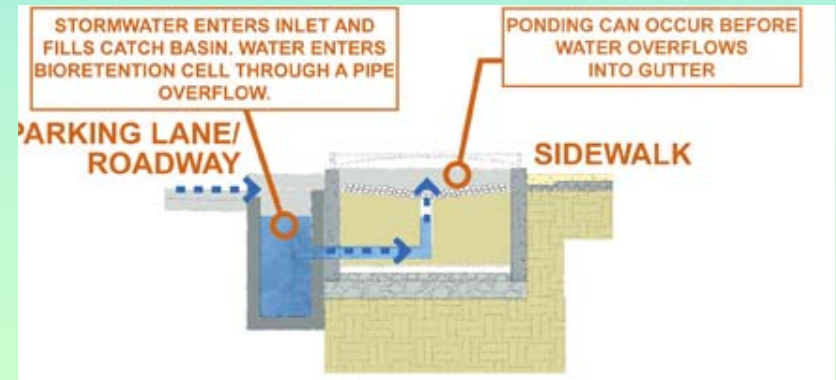
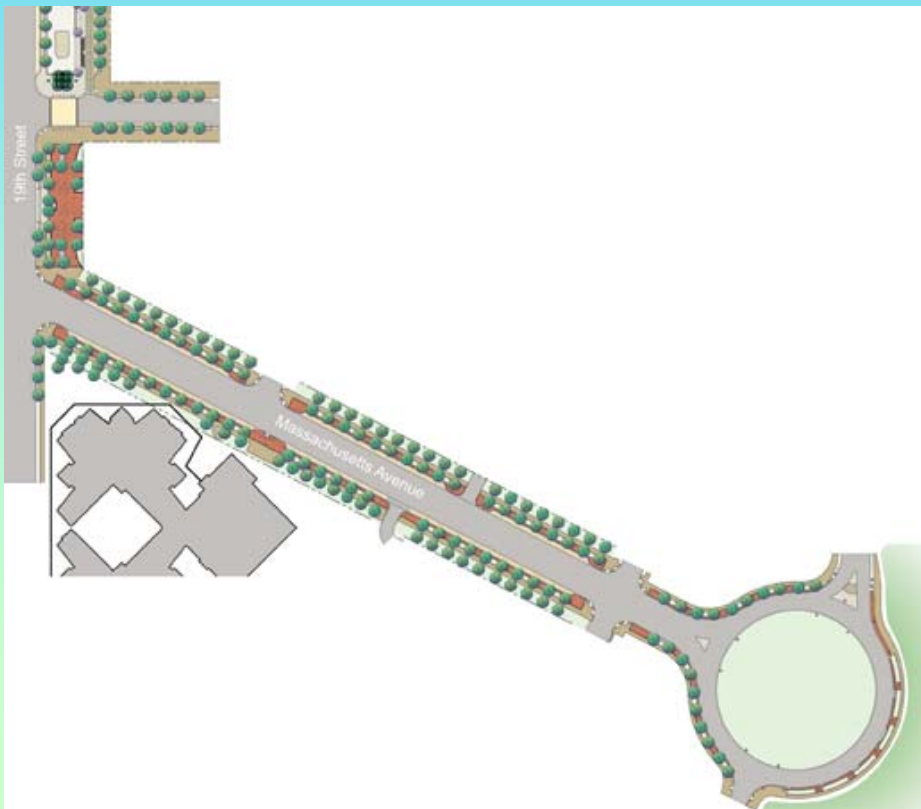
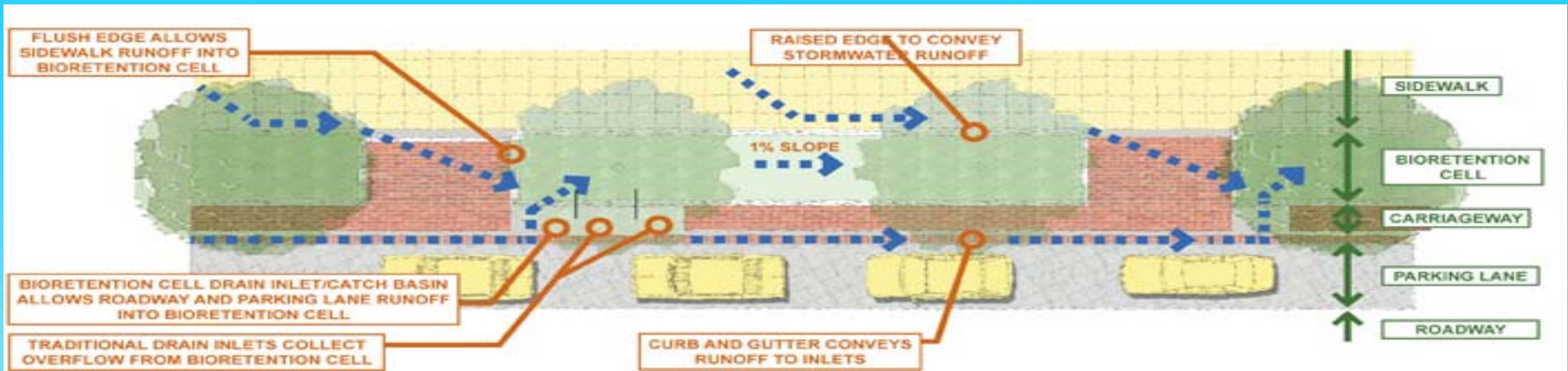
NEIGHBORHOOD DEVELOPMENT (IN PILOT)



# Green Infrastructure: Design for entire site and Interim Parking Lots.



# The Mass. Ave. bioretention cell final design



# Sustainability Approach & Experience



## Incorporate Sustainable Infrastructure within the Public Right-of-Way: Low Impact Development (LID)

**Planting Vegetation**  
Reduce stormwater runoff and erosion – precipitation is caught by tree canopies and increases the likelihood of evapotranspiration. This interception lessens the force of storms and reduces runoff and erosion – approximately 100,000 gallons of rainfall per year are intercepted by 100 mature trees.

**Permeable Unit Pavers**  
Permeable unit paver systems are concrete blocks/stones with spaces or gaps between them allowing stormwater to flow through and into an underground stone storage area or a tree planting area. The paver system allows stormwater infiltration into the subsurface gravel base, encourages infiltration into subsols that filter and trap pollutants improving the quality of runoff and the receiving waterway, and may provide significant underground stormwater storage if sufficient subbase depth is provided.

**Bioretention Gull**  
Bioretention cells are small-scale soil and plant-based devices located in shallow depressions. They remove pollutants and control runoff volume and peak rates through a variety of physical, biological, and chemical treatment processes. Bioretention cells improve water quality for small, frequently occurring storms by filtering stormwater runoff through the soil media, biological and chemical reactions in the soil and root zone, plant uptake, and infiltration into the lower soil layers.

Stormwater Management Effectiveness Summary Table

Reference	LID Management Practice	Volume	Frequency	Duration	Peak Discharge	Water Quality
Option 1	Conservation	●	●	●	●	●
Option 2	Planting Vegetation	●	●	●	●	●
Option 3	Reforestation	●	●	●	●	●
Option 4	Disconnectivity	●	●	●	●	●
Option 5	Permeable Concrete	●	●	●	●	●
Option 6	Permeable Asphalt	●	●	●	●	●
Option 7	Permeable Unit Pavers	●	●	●	●	●
Option 8	Soil Amendments	●	●	●	●	●
Option 9	Inlet Controls	○	○	○	○	○
Option 10	Underground Storage Chamber	●	●	●	●	●
Option 11	Gutter Filters	●	○	○	●	●
Option 12	Infiltration Trench	○	●	●	●	●
Option 13	Surface Sand Filter	○	●	●	●	●
Option 14	Vegetated Filter Strip	●	●	●	●	●
Option 15	Bioswale	●	●	●	●	●
Option 16	Bioslope	●	●	●	●	●
Option 17	Bioretention Cell	●	●	●	●	●

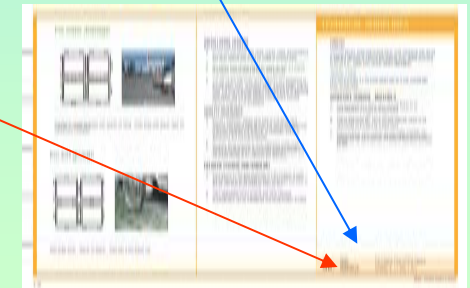
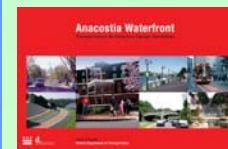
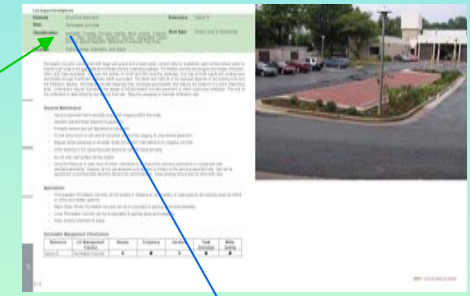
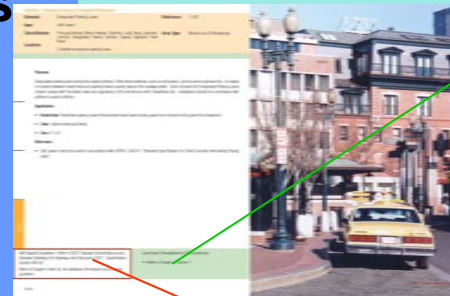
Effectiveness Key: ● High ○ Medium ○ Low Blank = No Impact

**Gutter Filter**  
Gutter filters are pre-cast concrete gutter vaults containing gravel, finer filter media and an underdrain. Gutter filters capture trash and other debris capable of passing through the surface grate and remove suspended solids and other pollutants.

## Urban Redevelopment with a focus on specialty planning

### Anacostia Waterfront Transportation Architecture Design Guidelines

- Provided guidelines for a cohesive pedestrian friendly network in the public right of way.
- Developed sustainable infrastructure planning through Low Impact Development (LID).

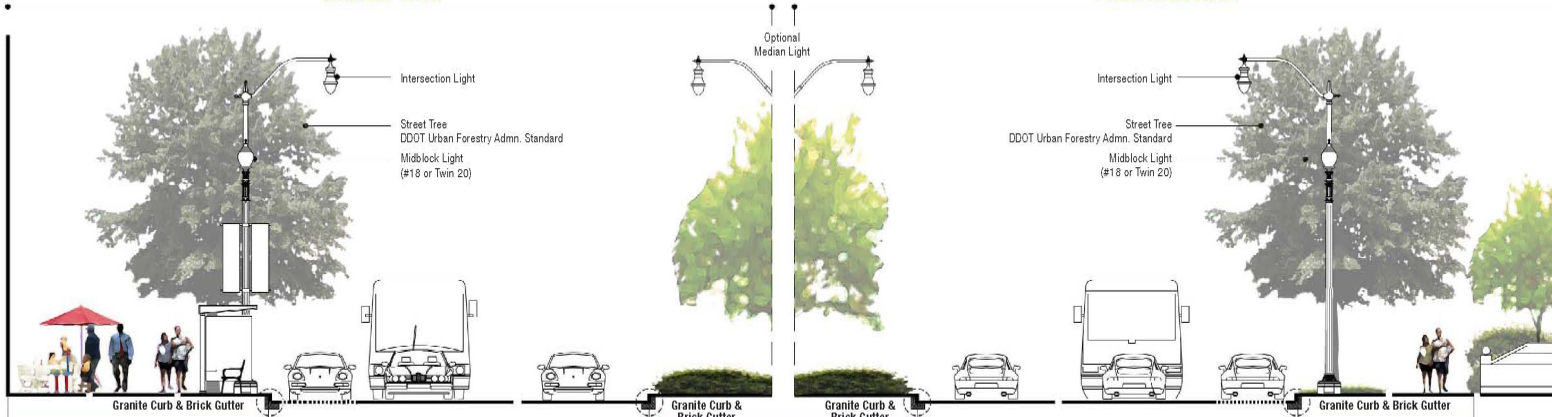


# A Library of visual guidelines for improvements to the public right of way

## Major Urban Streets & Local Roads Elements and Items

### MIXED USE

### RESIDENTIAL

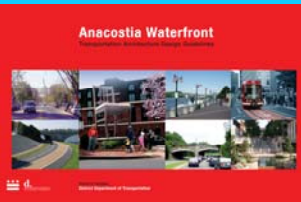


Sidewalk - width varies			Roadway - number of lanes varies		Median (optional) - width varies	Roadway - number of lanes varies		Sidewalk - width varies	
Spill Zone (min. 2'-0")	Walkway Zone Minimum 5'-0"	Furnishing/ Planting Zone Minimum 4'-0"			-MAJOR URBAN STREETS ONLY-			Furnishing/ Planting Zone Minimum 4'-0"	Walkway Zone Minimum 5'-0"
Priority 3	Priority 1	Priority 2						Priority 2	Priority 1
<b>Paving</b> Concrete or Brick (Historic only)	<b>Paving</b> Concrete or Brick (Historic only)	<b>Surface Treatments</b> Unit Pavers to match sidewalk color	<b>Paving</b> Bridges/Underpass - Concrete/Asphalt Bus Stop Pads - Integrally colored concrete to match roadway paving Bike Lane - Painted Lane Markings Designated Parking Lane - Unit Pavers Crosswalk - Regular or Thermo plastic "piano striping"		<b>Main Zone</b> Hardscape and softscape treatments	<b>Paving</b> Bridges/Underpass - Asphalt or concrete Bus Stop Pads - Integrally colored concrete to match roadway paving Bike Lane - Painted Lane Markings Designated Parking Lane - Unit pavers Crosswalk - Regular or Thermo plastic "piano striping"		<b>Surface Treatments</b> Undersory Planting Unit Pavers Turf Area	<b>Paving</b> Concrete or Brick (Historic only)
<b>Furnishings</b> Safety Posts Seating & Planter boxes provided by businesses	<b>Furnishings</b> Access Cover	<b>Furnishings</b> Seating Trash Bin Bike Rack Safety Posts	<b>Pedestrian &amp; Traffic Safety</b> Sidewalk Extension Traffic Diversion Rotary		<b>Refuge Zone</b> Crosswalk to be continued (ADA Accessible, Minimum 4' wide)	<b>Pedestrian &amp; Traffic Safety</b> Sidewalk Extension Traffic Diversion Rotary		<b>Furnishings</b> Trash Bin Bike Rack Safety Posts	<b>Furnishings</b> Access Cover
		<b>Landscaping</b> Street Trees Undersory Planting Mulch Contiguous Tree Root Zone	<b>Curb &amp; Gutter</b> Granite Curb Brick Gutter Curb Cuts & Driveways - Concrete ramps, contiguous sidewalk finish ADA Ramps - Concrete ramps with truncated dome		<b>Protection Zone</b> Safety posts Planter boxes less than 3' in height	<b>Curb &amp; Gutter</b> Granite Curb Brick Gutter Curb Cuts & Driveways - concrete ramps, contiguous sidewalk finish ADA Ramps - Concrete ramps with truncated dome		<b>Landscaping &amp; LID</b> Street Trees Undersory Planting Planter Edging Mulch Contiguous Tree Root Zone	
		<b>Signage</b> Wayfinding Street Attachments	<b>Other Construction</b> Wall Cladding - Ashlar/Regular Pattern Masonry			<b>Other Construction</b> Wall Cladding - Ashlar/Regular Pattern Masonry			

Figure 4.3. Typical Elements/Items of Major Urban Streets and Local Roads

DRAFT - Contents Subject to Change

Items



# From the AWI Manual Tree planting in the sidewalk

**Section 11: Planting / Furnishing Zone - Surface Treatments**

**Element:** Vegetation **Reference:** 11.1(1)

**Item:** Understory Plantings

**Classification:** Interhigh, Freeway, Principal Arterial, Minor Arterial, Collector, Local, Alley, Cemetery, Impassioned Transit Corridor, Special Treatment, Waterfront Access Treatment, Waterfront Promenade, Park Trail

**Location:** Sidewalk, median, green space, roadway setbacks

**Purpose:**  
Understory plantings should include, but are not limited to ornamental grasses, groundcover, shrubs, and perennials. Such plantings add aesthetic value to the streetscape, reduce stormwater runoff, and provide visual and physical barriers for pedestrians and cyclists. Understory plantings also help create a neighborhood identity.

All planting design and separation distances should be in accordance with DD01 Design & Engineering Manual.

**AWI Specific Guidance** Refer to DD01 Standard Specifications and Standard Drawings for Highways and Structures 2007 - Specification Section 611.02  
Refer to Chapter 6 Item 2), for additional information on proposed guidelines.

**Low Impact Development (LID) Opportunity**  
Refer to Chapter 6, Option 2, 8, 14, 15, 16, 17



**Low Impact Development**

**Element:** Structural Approach **Reference:** Option 17

**Item:** Infiltration Cell

**Classification:** Interhigh, Freeway, Principal Arterial, Minor Arterial, Collector, Local, Cemetery, Impassioned Transit Corridor, Special Treatment, Waterfront Access Treatment, Park Trail

**Location:** Impassioned Transit, roadway setbacks, sidewalk planting zone, green space

Infiltration cells are small rock and plant-based devices located in shallow depressions. The infiltration cells collect pollutants and control runoff volume and peak rates through a variety of physical, biological, and chemical treatment processes. The primary objective of an infiltration cell can vary depending on site conditions. In some instances, the primary goal is to provide a highly permeable engineered soil media, a gravel layer, and an underdrain that is connected to the main storm drain system. Infiltration cells improve water quality for reuse, frequently occurring storm by filtering stormwater runoff through the soil media, biological and chemical processes in the soil and rock cover, plant debris, and bacteria that inhabit the soil and rock layers. In addition, infiltration cells can contribute to neighborhood and roadway beautification, habitat creation, reduce heat island effects, and can potentially reduce maintenance costs for existing stormwater infrastructure. In this regard, infiltration cells can enhance the beauty of the urban environment and may increase property values by beautifying open spaces.

**Required Maintenance:**

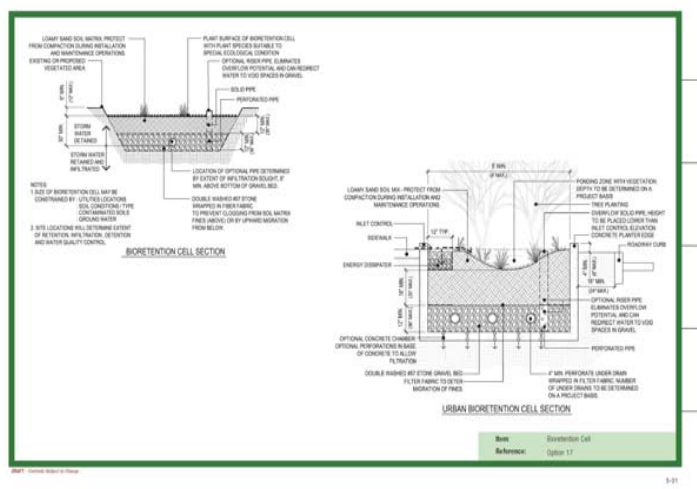
- Trash removal
- Weeding and removal of invasive plants
- Periodic removal of sediments around vegetation
- Replacement of dead vegetation

**Applications:**

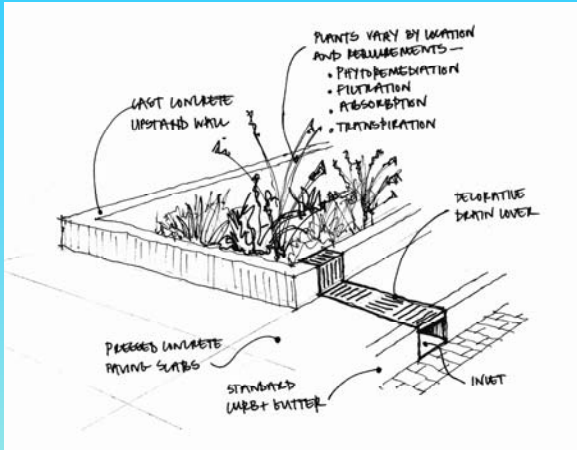
- Transitways: Infiltration cells can be incorporated along the side of sidewalks, curb extensions, and adjacent public space.
- Major Urban Street: Infiltration cells can be incorporated into the sidewalk planting zone or roadway edges.
- Local: Infiltration cells can be incorporated into the sidewalk planting zone.
- Alley: N/A.

**Stormwater Management Effectiveness** Infiltration cells are especially useful for treating the "first flush" of stormwater. They can remove 75-80% of common urban pollutants.

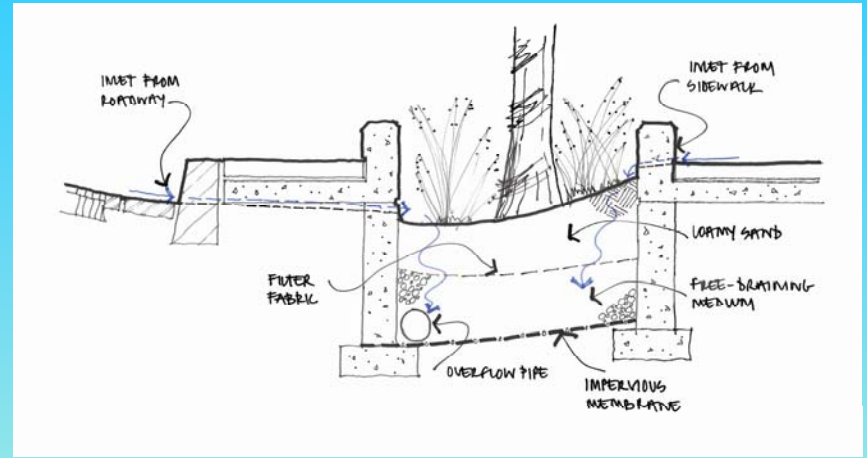
Reference	LID Management Practice	Volume	Frequency	Location	Peak Discharge	Water Quality
Option 17	Infiltration Cell	●	●	●	●	●



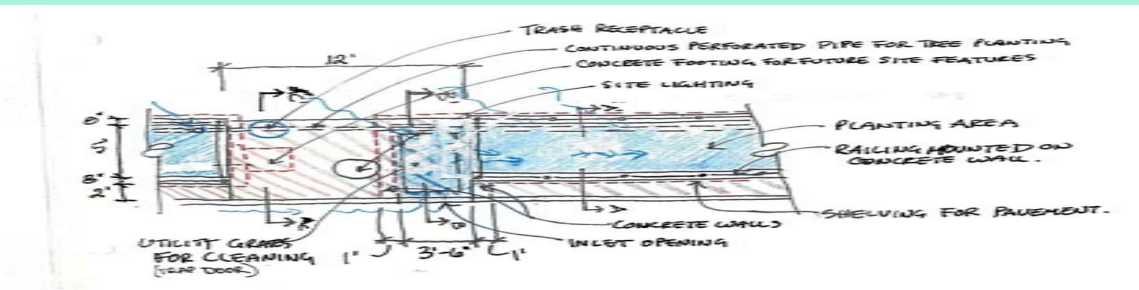
# Refinement of bioretention cell concept designs



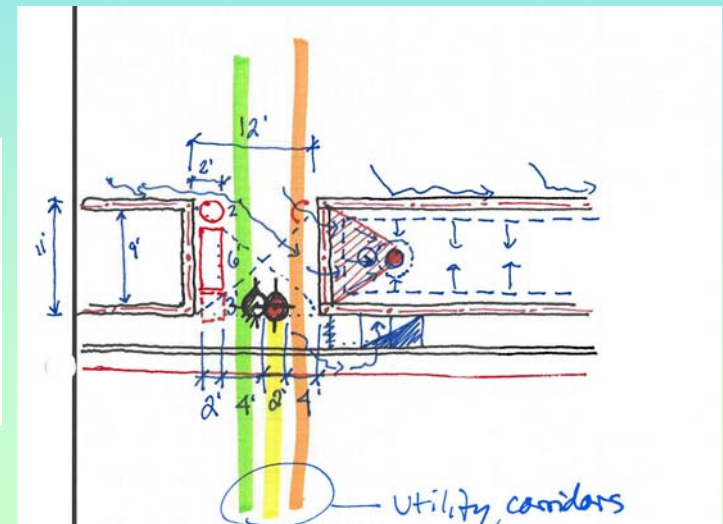
How does the water enter?



How to prevent people from falling in...

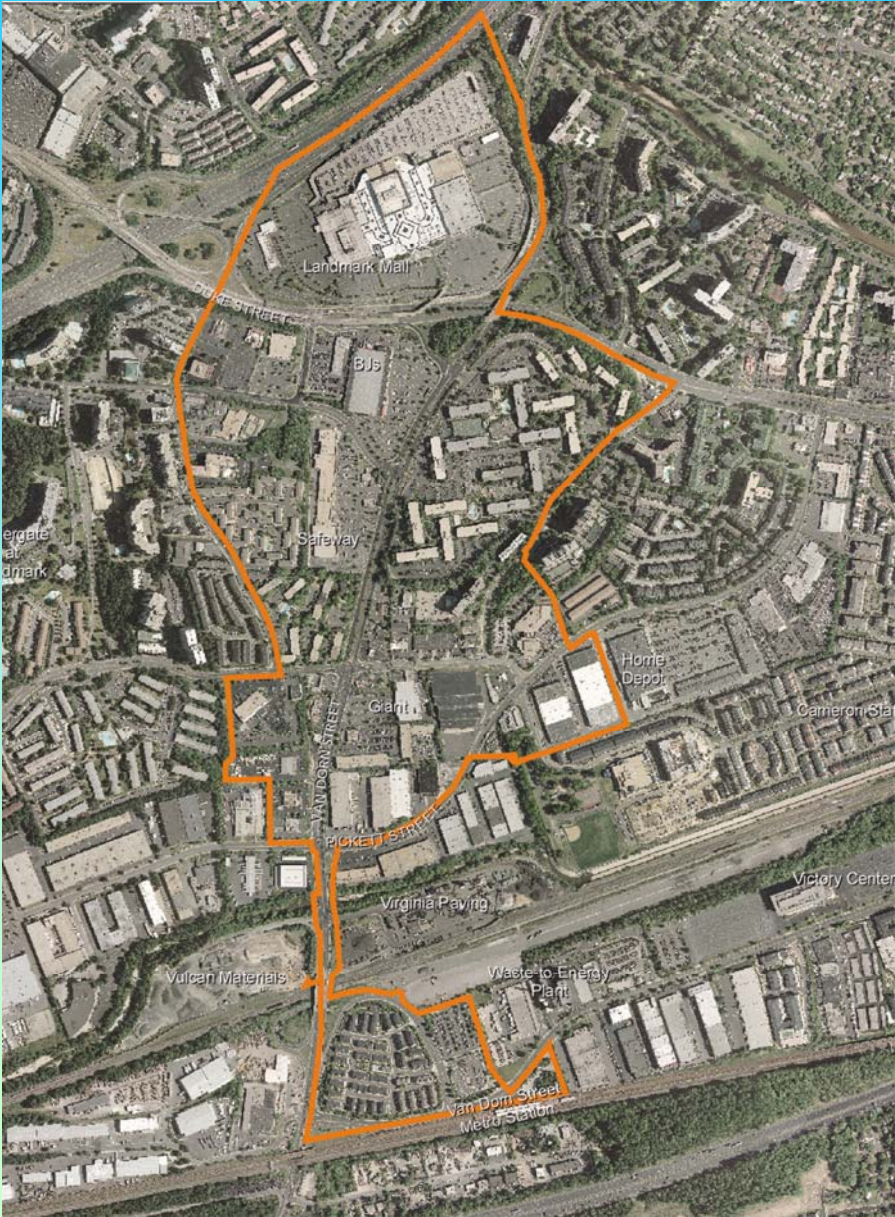


Designing a custom inlet



Opportunity for Utility Corridors

# Landmark/Van Dorn Green Infrastructure Master Plan







# The benefits of stormwater master planning

- **Identifies causes of stormwater impacts**
- **Establishes stormwater & ecological baseline**
- **Provides means to establish sustainable standards**
- **Can prioritize CIP projects**
- **Can identify redevelopment priorities**
- **Big picture solutions for related programs (e.g., TCLP, TMDL, MS4, etc.)**
- **Identifies funding needs**
- **Critical for successful funding**

# QUESTIONS?



# Sustainability Approach & Experience

## Corridor Studies

- Streetscape Design
- Multi-modal Transportation Studies
- Visual Design Guidelines

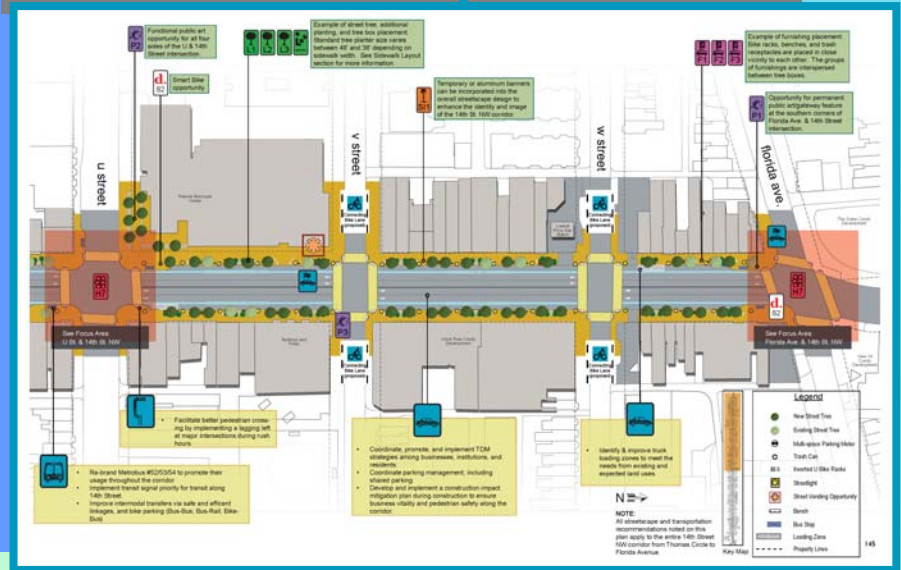
Complete corridor design using an economic, social and environmental approach to sustainability.

Streetscape designs and plans incorporate LID techniques. Promote walkable neighborhoods and connections between key urban locations. Encourage a variety of transportation choices.

### 14th STREET EXISTING CONDITIONS ASSESSMENT (EXTRACT)



### IMPROVEMENT RECOMMENDATIONS



### Green Space in Bulb-outs

#### Option 1:

Bulb-outs (see H7) create usable public open space. Once sufficient ADA compliant walkways, streetlights, and other amenities are accommodated, the remaining space should be allocated to landscaping. Plantings should not interfere with the line of sight and be approved by the Urban Forestry Administration. A maintenance plan should be established in cooperation with DDOT, possibly including property owners and/or business organizations.

#### Option 2:

Creative and sustainable solutions may include a combination of LID devices and furnishings, such as seating opportunities.



Davis, CA (PPS Image)



Anderson, SC (PPS Image)



Docklands, Melbourne

Flexible Green Space

Bioretention Cell

# Create Bioretention

Parking Area  
Retrofits

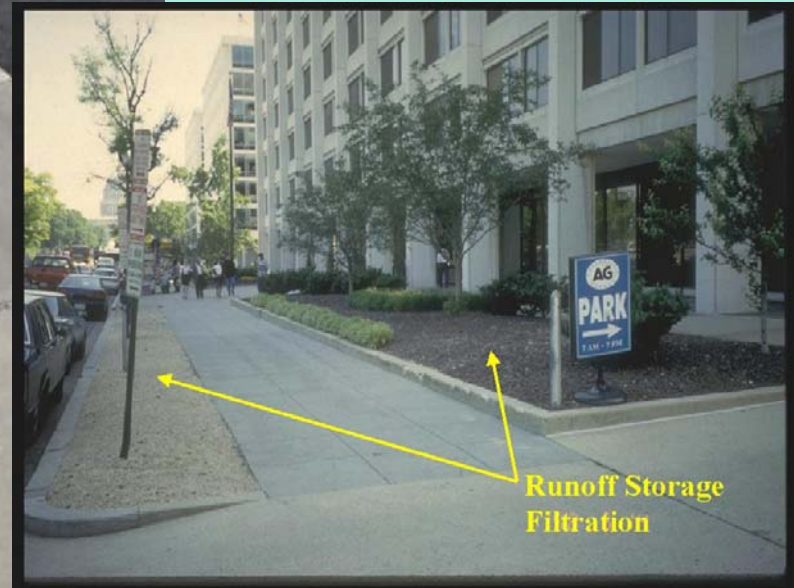


# Porous Paving





# Road-side Improvement



Runoff Storage  
Filtration

# Disconnect Impervious Area



After





# Create Bioretention

