Low Impact Development and Sustainable Landscapes: Bioretention

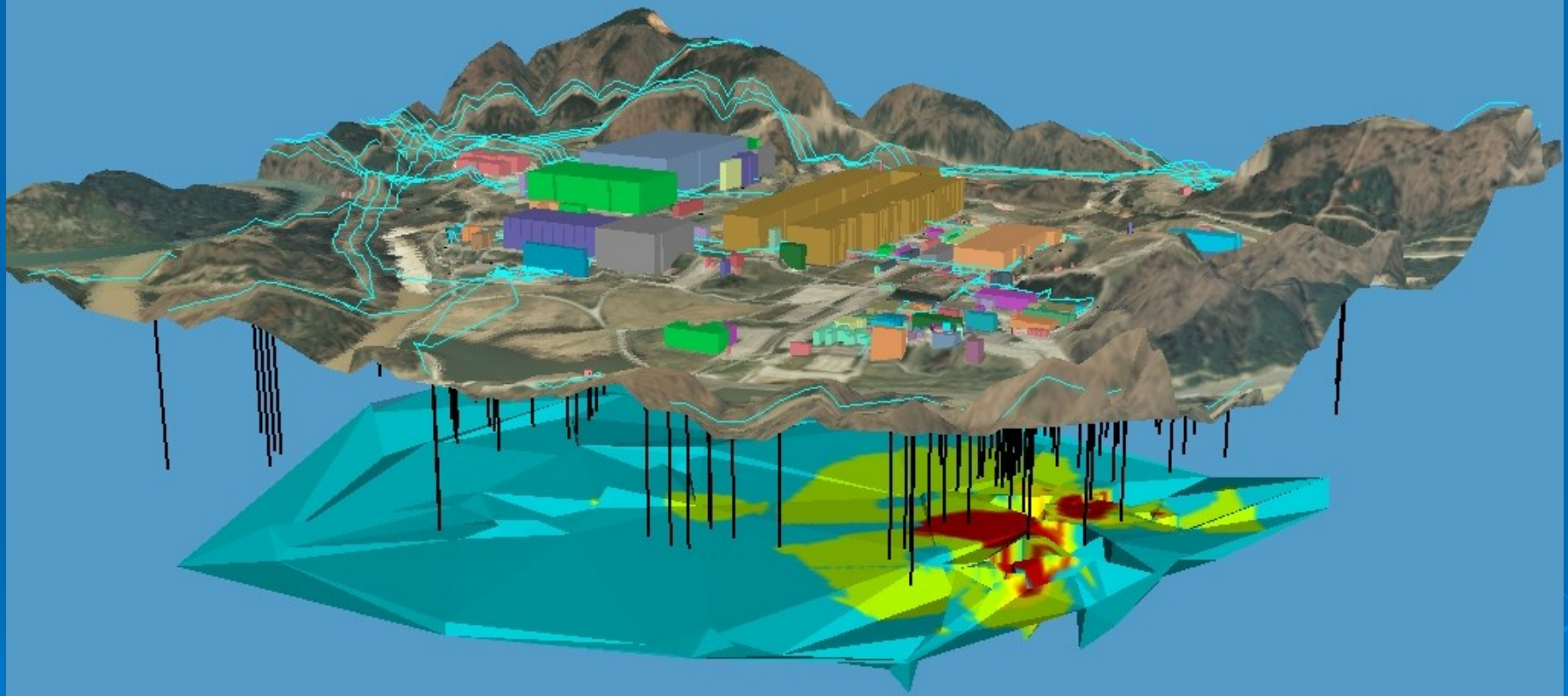
The Low Impact Development Center, Inc.

Balancing Growth and Environmental Integrity

The Good Old Days!

Stahre, 2006

Groundwater model of a contaminant plume beneath an Industrial Site by GeoAnalysis, Inc.



Courtesy Geoanalysis


Stormwater
Drinking Water
Decentralized
Controls are
Holistic and
Watershed Based
Wastewater

Foundations

- Performance Metrics, Not Prescriptive!
- Cycles and “Closing the Loop”
- Cross Cutting and “Leveraged”
- Watershed Vision and Integrated Infrastructure
- “Ethics” Based

Obstacles

- Training and Education and Specialization
- Minimum Standards and Points
- Mass Production/Permit Environment
- Short Course and Certification Empowerment

Sustainable Concepts/Pillars

r^4

- **Reduce**
- **Recycle**
- **Reuse**
- **Restore**

t^2

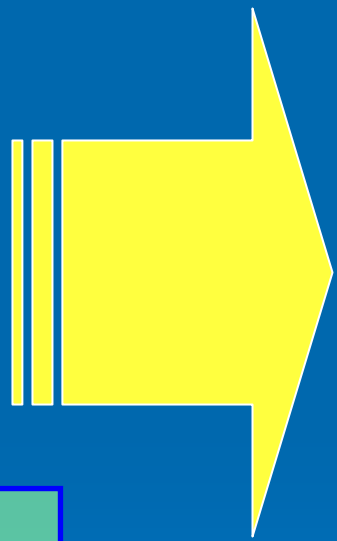
- **Tools**
- **Techniques**

Builder/Developer/Institution

Land Use Economic and Design Requirements

Industry Recognized Standards

Local Community Codes/Ordinances and Watershed Requirements



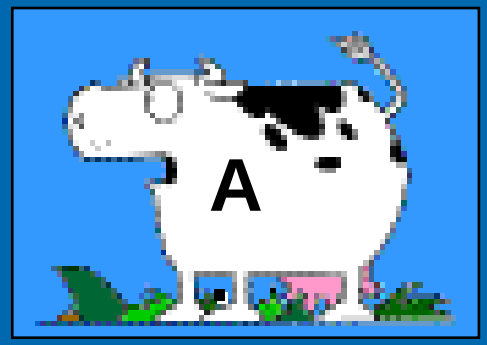
Localized Sustainable Development


Pilot Projects are the Key!

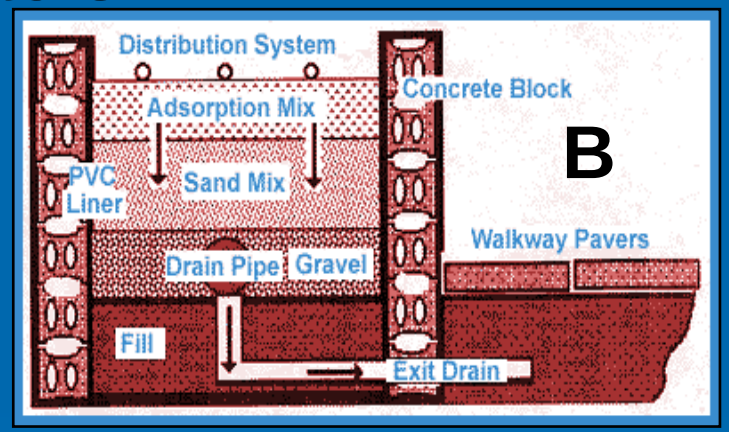
Rain Garden in an office building project along the G.W. Parkway. (Looking East)

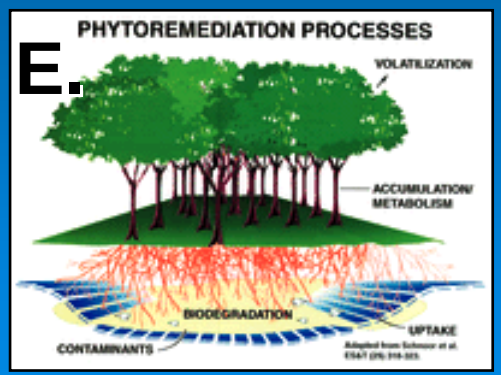
Rain Gardens

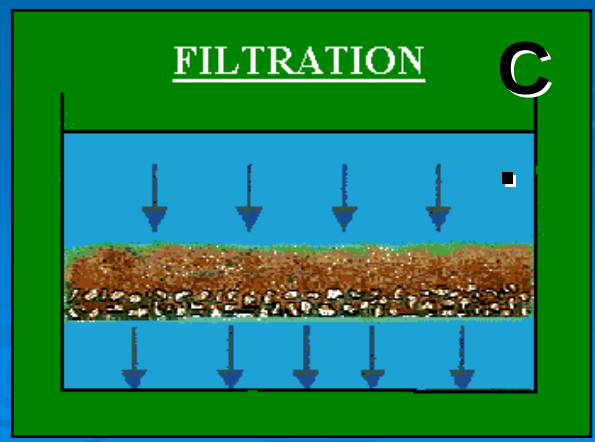
Background



- Historical Use of Plant / Soil Filters
  - Agriculture (1 cow / 1.17ac)
  - Wastewater Treatment
  - Water Supply
  - Bioremediation
  - Phytoremediation







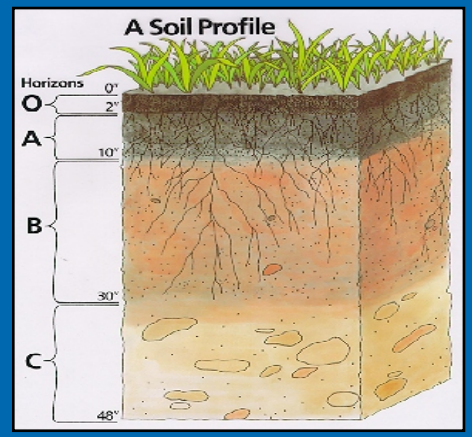
Soil Ecosystem Functions

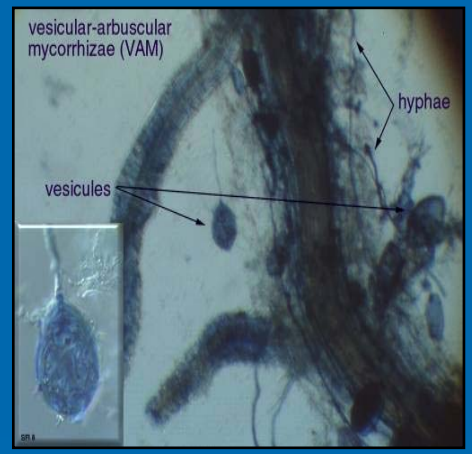
Physical / Chemical / Biological

1. *Hydrology*
   storage / evaporation / recharge / detention
2. *Storing Cycling Nutrients (bacteria / fungi)*
   phosphorous / nitrogen / carbon
3. *Plant Productivity (vigor)*
4. *Water Quality*

   filter / buffer / degrade / immobilize
   detoxify organic and inorganic materials

"Most diverse ecosystem in the world"

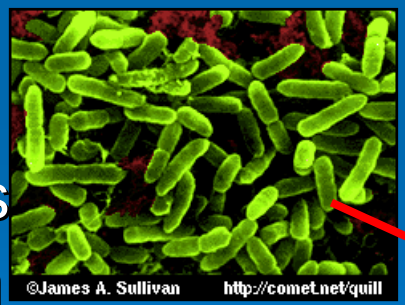


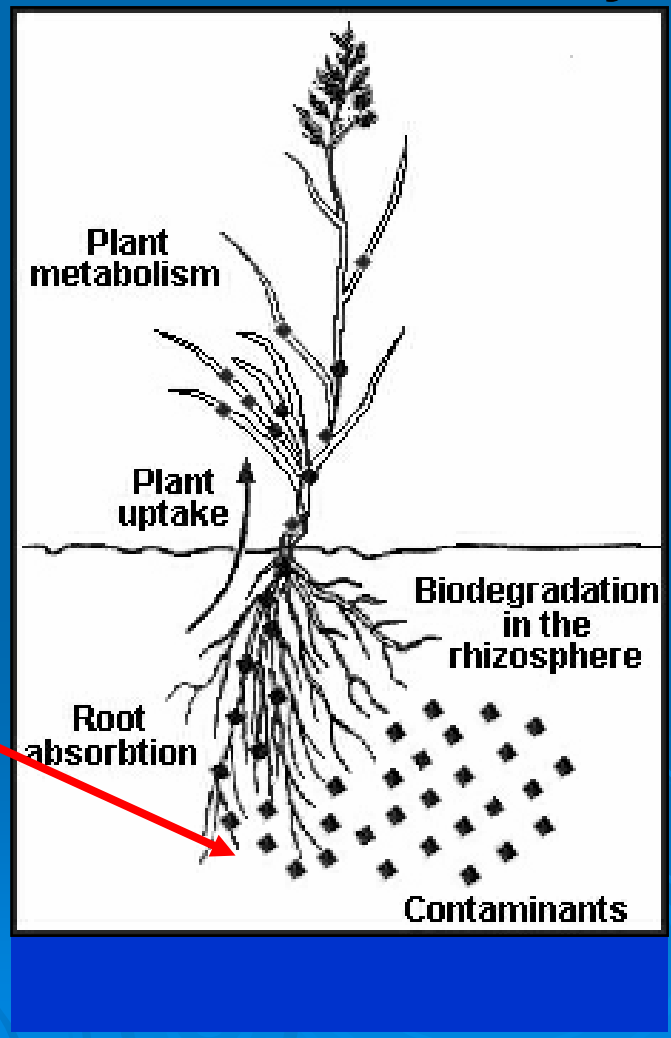


Uplands Pollutant Removal

Plants / Soil Flora -Fauna / Soil Chemistry

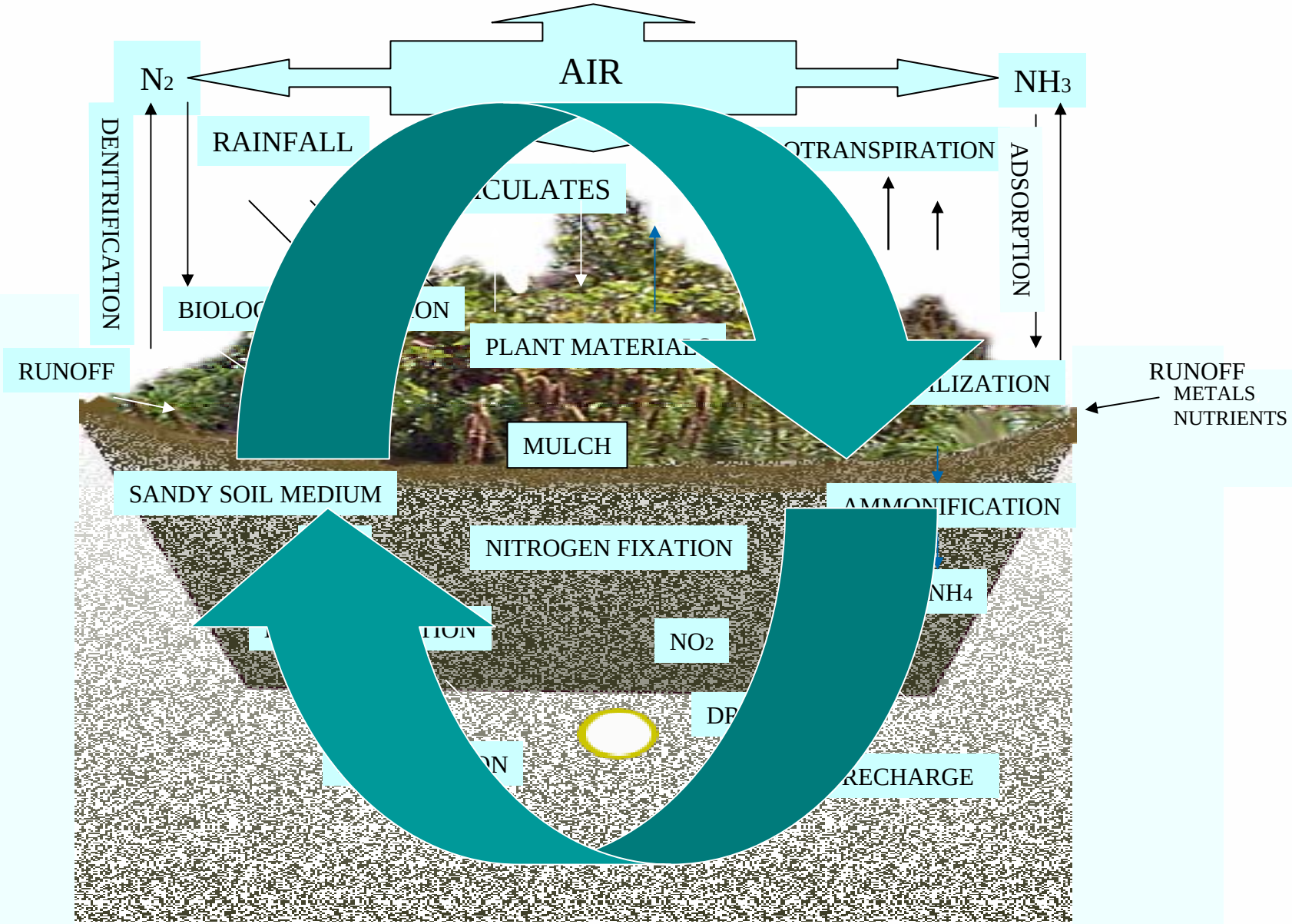
- Phytoremediation
  - Translocate
  - Accumulate
  - Metabolize
  - Volatilize
  - Detoxify
  - Degrade
    - Exudates
- Bioremediation
- **Soils**
  - **Capture / Immobilize Pollutants**





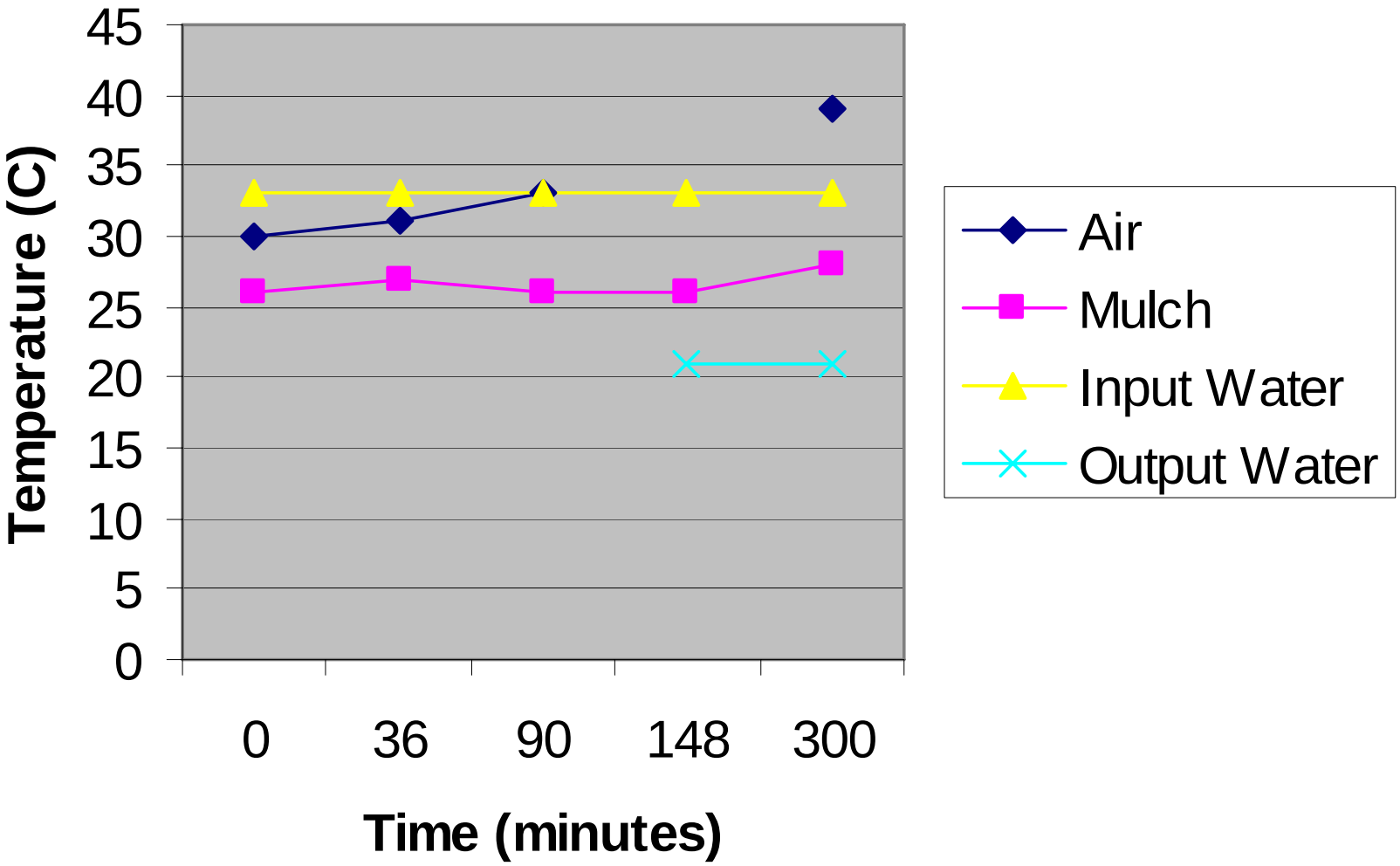
Pollutant Removal Mechanisms

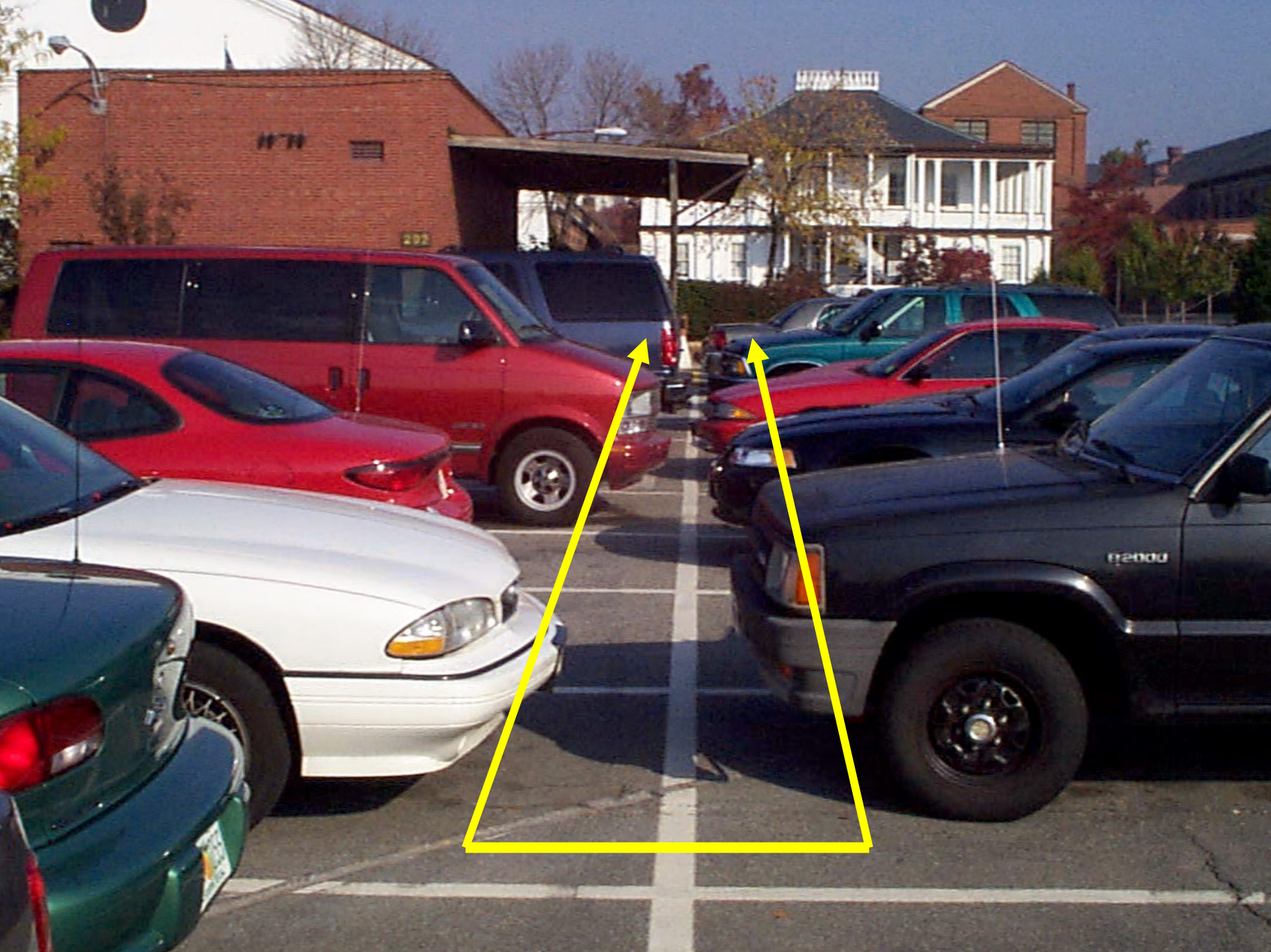
- Soil / Physical / Chemical
  - Sedimentation
  - Filtration
  - Adsorption
  - Precipitation
  - Humic / Clays / Silts
    - Electrostatic / Ion Exchange



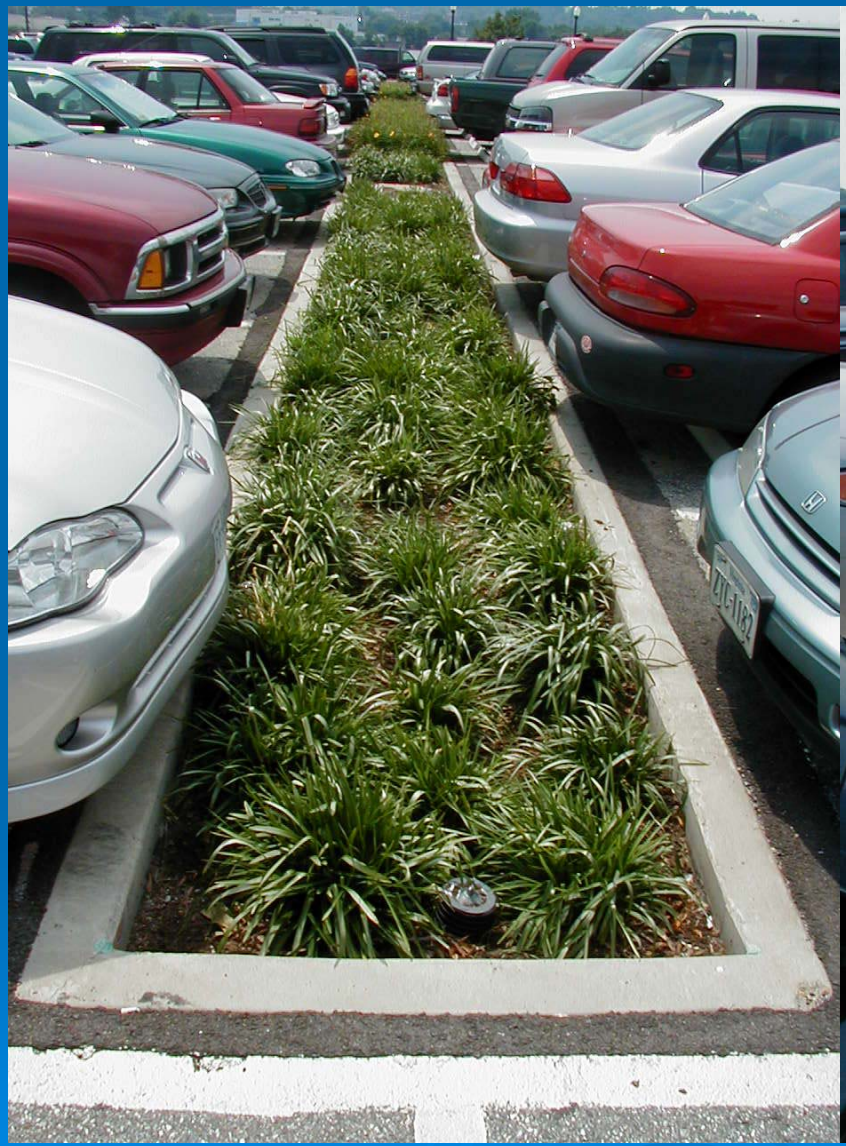
NITROGEN CYCLE FOR BIORETENTION

Bioretention Temperature Data





United States Navy Yard



Tree box filter at the
Washington, DC
Navy Yard

Tree box filter
at the Pentagon

The Future of the Urban America


Sanijohn
800-348-1576
LONG & FOSTER
Under Contract

Appearance = Acceptance

Burnsville, MN

The Sunny Border Garden Layout

10 Happy Returns Daylily
(Hemerocallis 'Happy Returns')
Height: 18 inches
Space: 12 inches
Blooms : June to frost

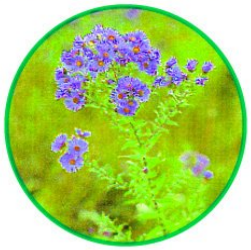
1 Blue Flag Iris
(Iris versicolor)
Height: 2 feet
Space: 1 foot
Blooms: May - June

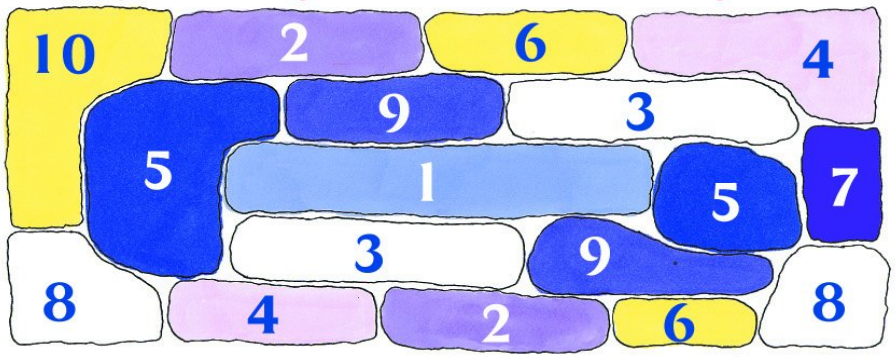
2 Johnson's Blue Geranium
(Geranium X 'Johnson's Blue')
Height: 15-18 inches
Space: 12 inches
Blooms: May to frost

3 White Coneflower
(Echinacea purpurea alba)
Height: 2-3 ft
Space: 18 inches
Blooms: June to frost

Bonestroo
Rosene
Anderlik &
Associates
Engineers & Architects
Garden & Brochure Design

9 New England Aster
(Aster Novae-Angliae)
Height: 4-5 Feet
Space: 2 Feet
Blooms: Midsummer to frost





4 Purple Leaf Sedum
(Sedum x 'Vera Jameson')
Height: 12 inches
Space: 12 inches
Blooms: June to frost

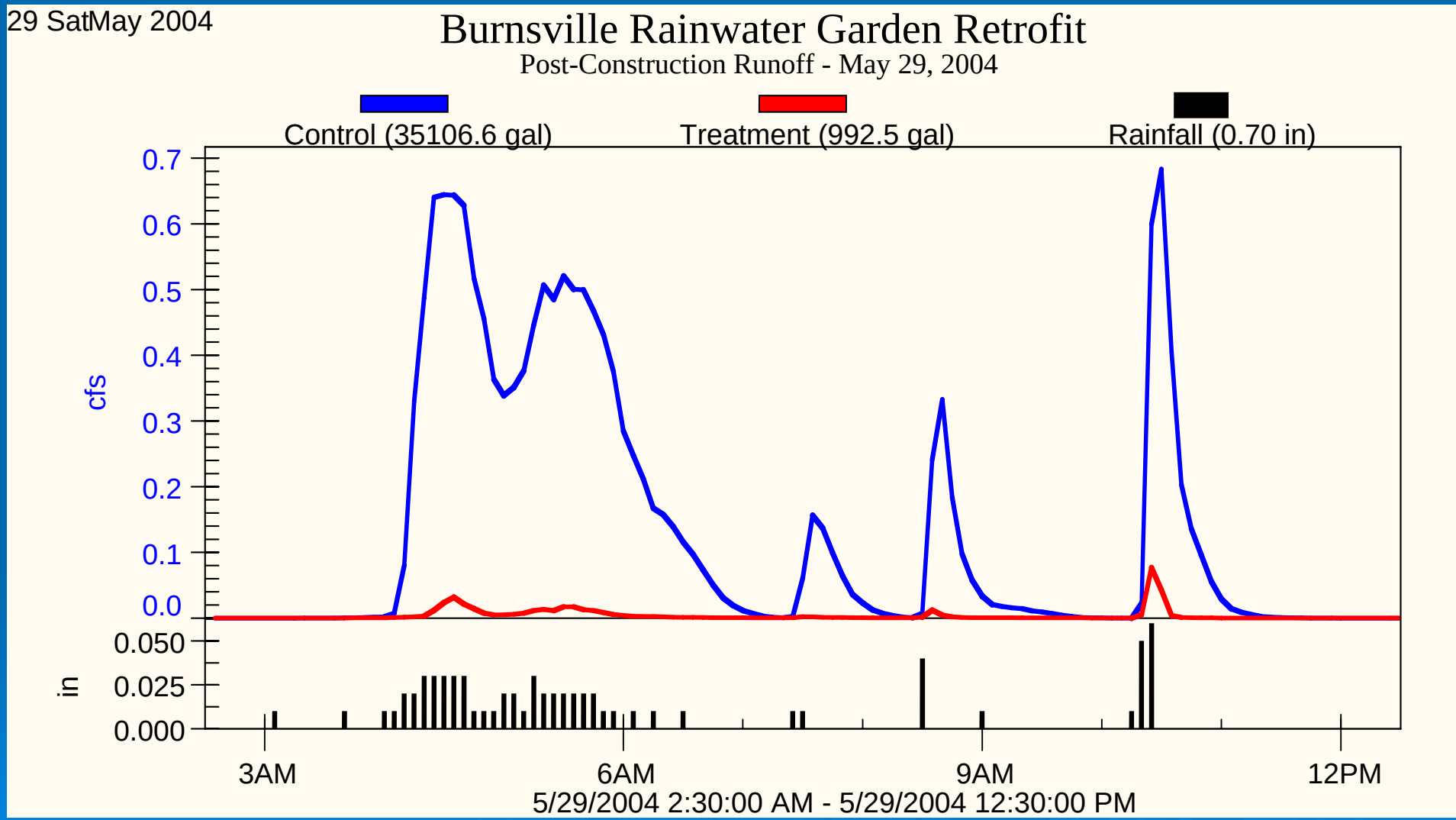
8 Lambs Ears
(Stachys lanata)
Height: 12 inches
Space: 12 inches
Blooms: May to June with
interesting foliage all Summer

7 Little Grapette Daylily
(Hemerocallis 'Little Grapette')
Height: 18 inches
Space: 12 inches
Blooms: June to frost

6 Moonbeam Coreopsis
(Coreopsis verticillata 'Moonbeam')
Height: 12 inches
Space: 12 inches
Blooms: All Summer

MAPLEWOOD
Together We Can

5 Great Blue Lobelia
(Lobelia Siphilitica)
Height: 2 feet
Space: 1 foot
Blooms: August - September

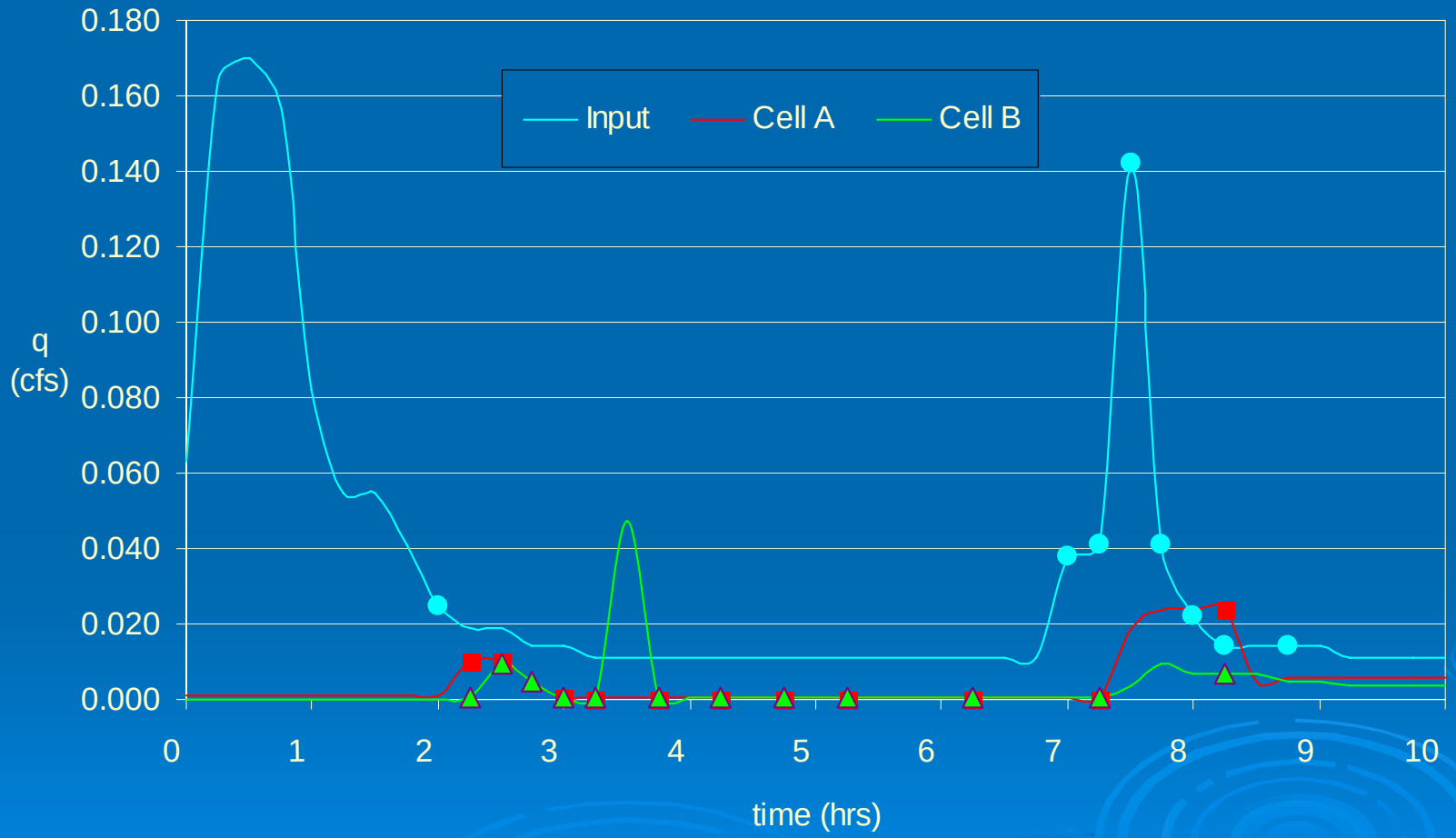

29 SatMay 2004
Burnsville Rainwater Garden Retrofit
Post-Construction Runoff - May 29, 2004
Control (35106.6 gal)
Treatment (992.5 gal)
Rainfall (0.70 in)
cfs
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
in
0.050
0.025
0.000
3AM
6AM
9AM
12PM
5/29/2004 2:30:00 AM - 5/29/2004 12:30:00 PM

Overhead View of the Site

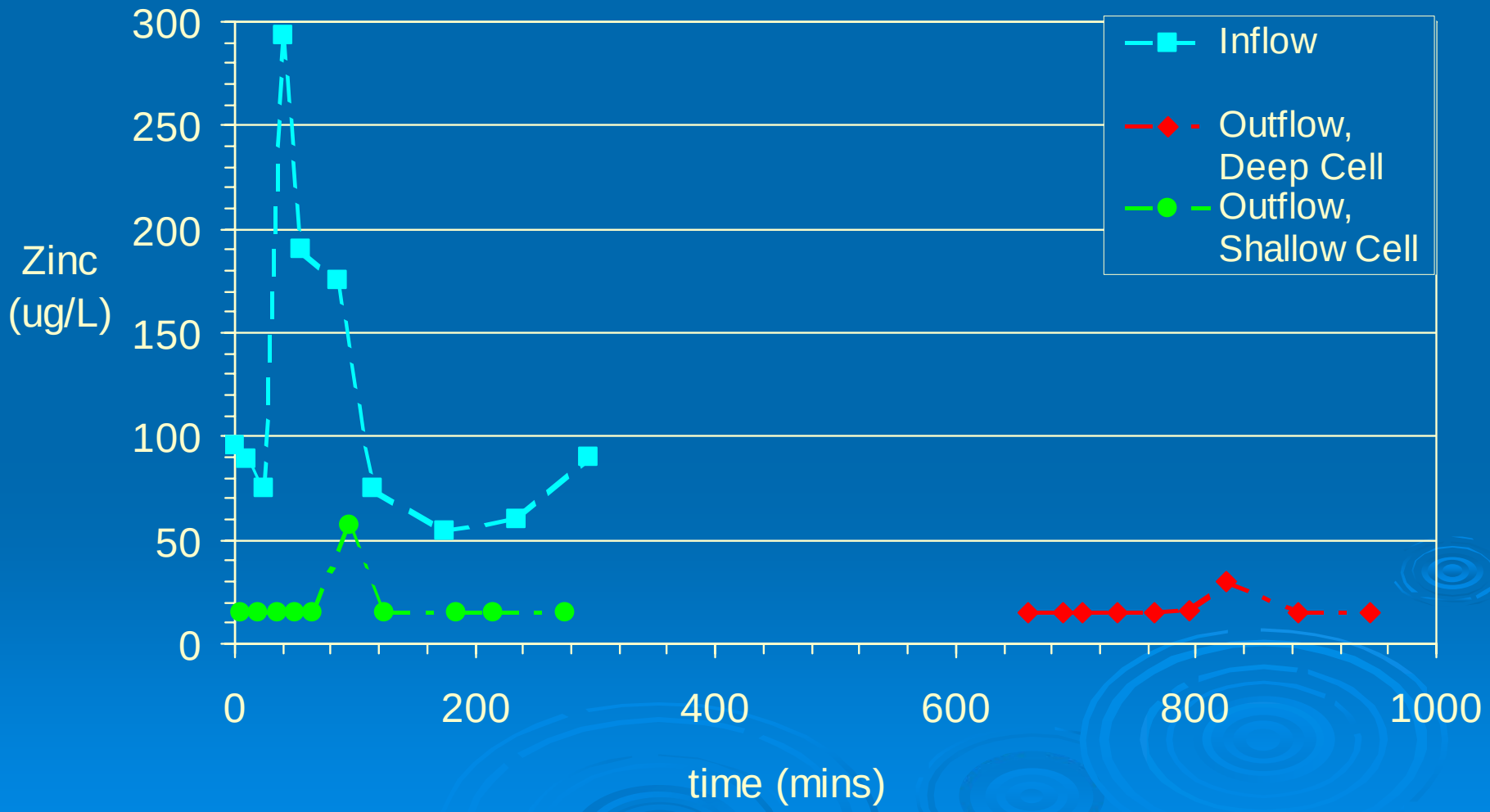
Cell A

Cell B

UMD Bioretention Hydrograph, July 28-29, 2003

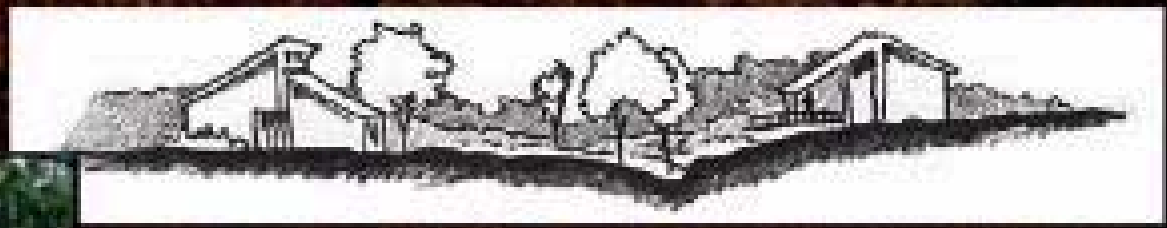


Total Zinc, November 28, 2003



Village Homes

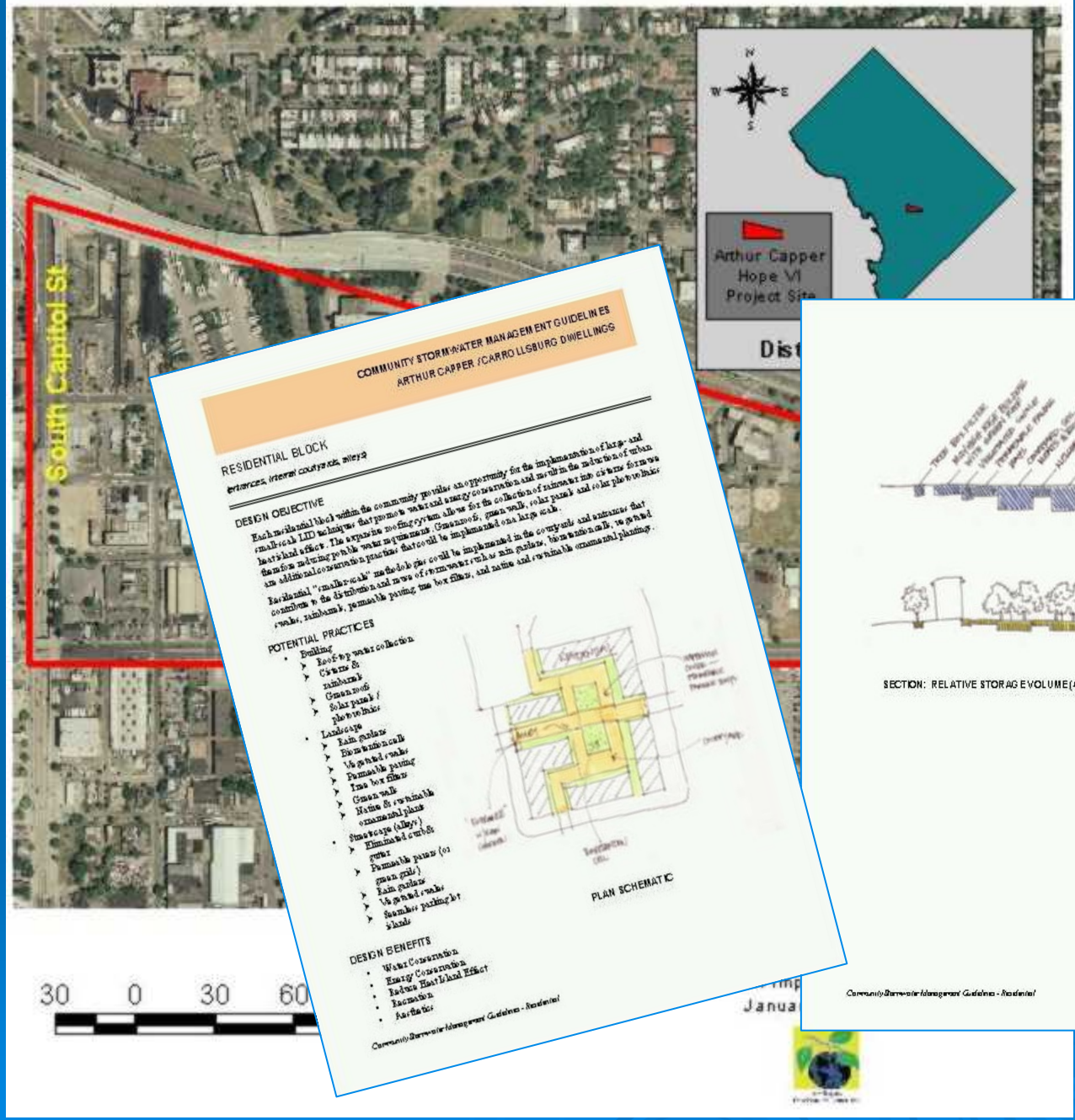
Davis, CA



Natural drainage swales

Savings: $800/lot leveraging green space, crop sales, coolth, quality of life, market value.

http://www.energy2000.ee.doe.gov/



COMMUNITY STORMWATER MANAGEMENT GUIDELINES
ARTHUR CAPPER /CARROLLSBURG DWELLINGS

RESIDENTIAL BLOCK

(entrances, interior courtyards, alleys)

DESIGN OBJECTIVE

Each residential block within the community provides an opportunity for the implementation of large- and small-scale LID techniques that promote water and energy conservation and mediate the urban heat island effect. The expansive roofing system allows for the collection of rainwater into cisterns for reuse and other non-potable water requirements (Greenroofs, green walls, solar panels and solar photovoltaics). An additional conservation practice that could be implemented on a large scale.

Residential "small-scale" methods that could be implemented in the courtyards and entrances that contribute to the distribution and reuse of rainwater include rain gardens, bioretention cells, vegetated swales, rainbarrels, permeable paving, tree box filters, and native and sustainable ornamental plantings.

POTENTIAL PRACTICES

- Building
  - Rooftop water collection
  - Cisterns &
  - rainbarrels
  - Greenroofs
  - Solar panels / photovoltaics
- Landscape
  - Rain gardens
  - Bioretention cells
  - Vegetated swales
  - Permeable paving
  - Tree box filters
  - Green walls
  - Native & sustainable ornamental plants
- Streetscape (Alley)
  - Eliminate curbs & gutter
  - Permeable pavers (or green grid)
  - Rain gardens
  - Vegetated swales
  - Stormwater pathogen islands

PLAN SCHEMATIC

DESIGN BENEFITS

- Water Conservation
- Energy Conservation
- Reduce Heat Island Effect
- Recreation
- Aesthetics

Community Stormwater Management Guidelines - Residential

SECTION: RELATIVE STORAGE VOLUME (#) POTENTIAL OF LID TECHNIQUES

Community Stormwater Management Guidelines - Residential *Page 1 of 2*

apper
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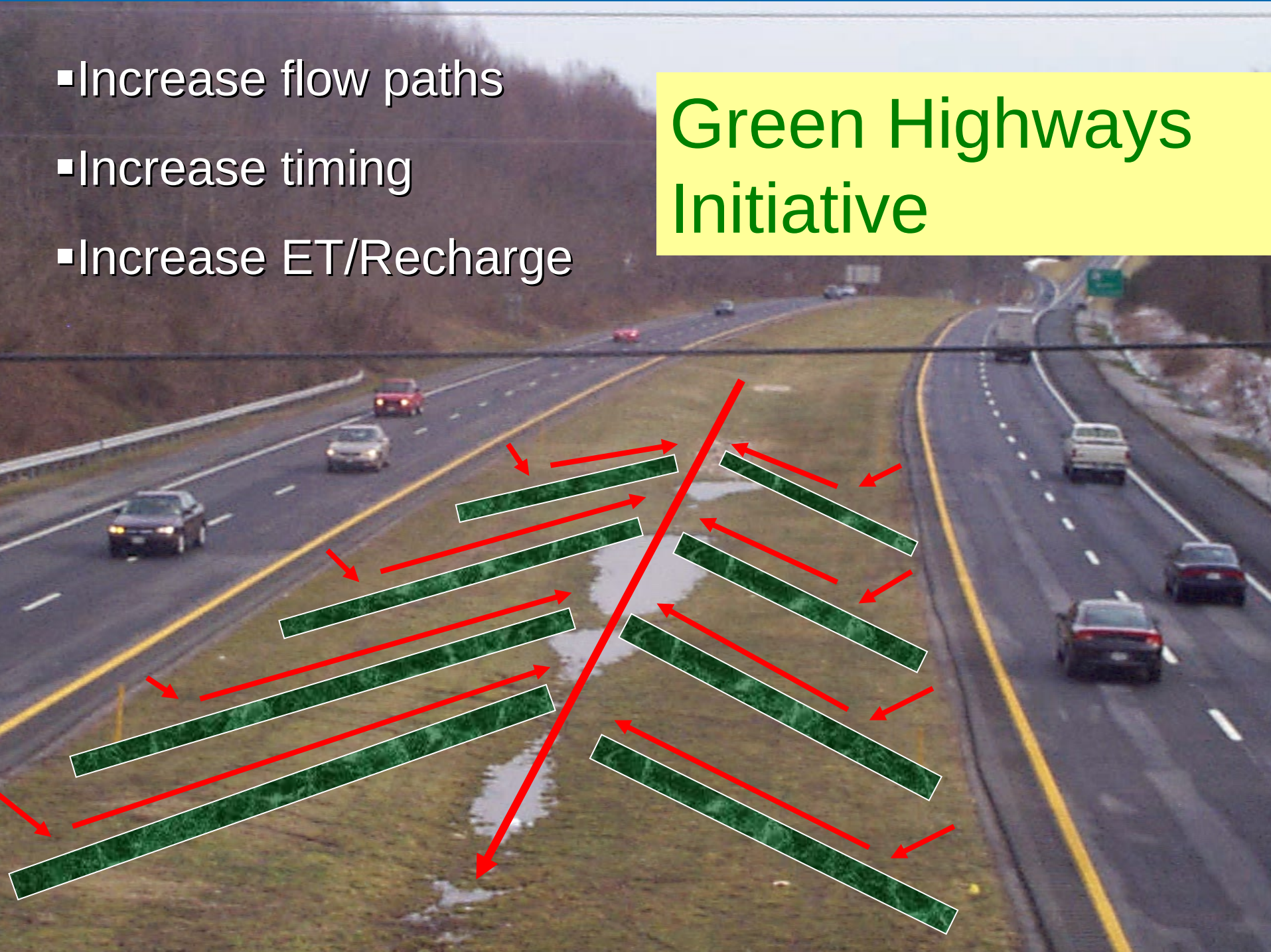
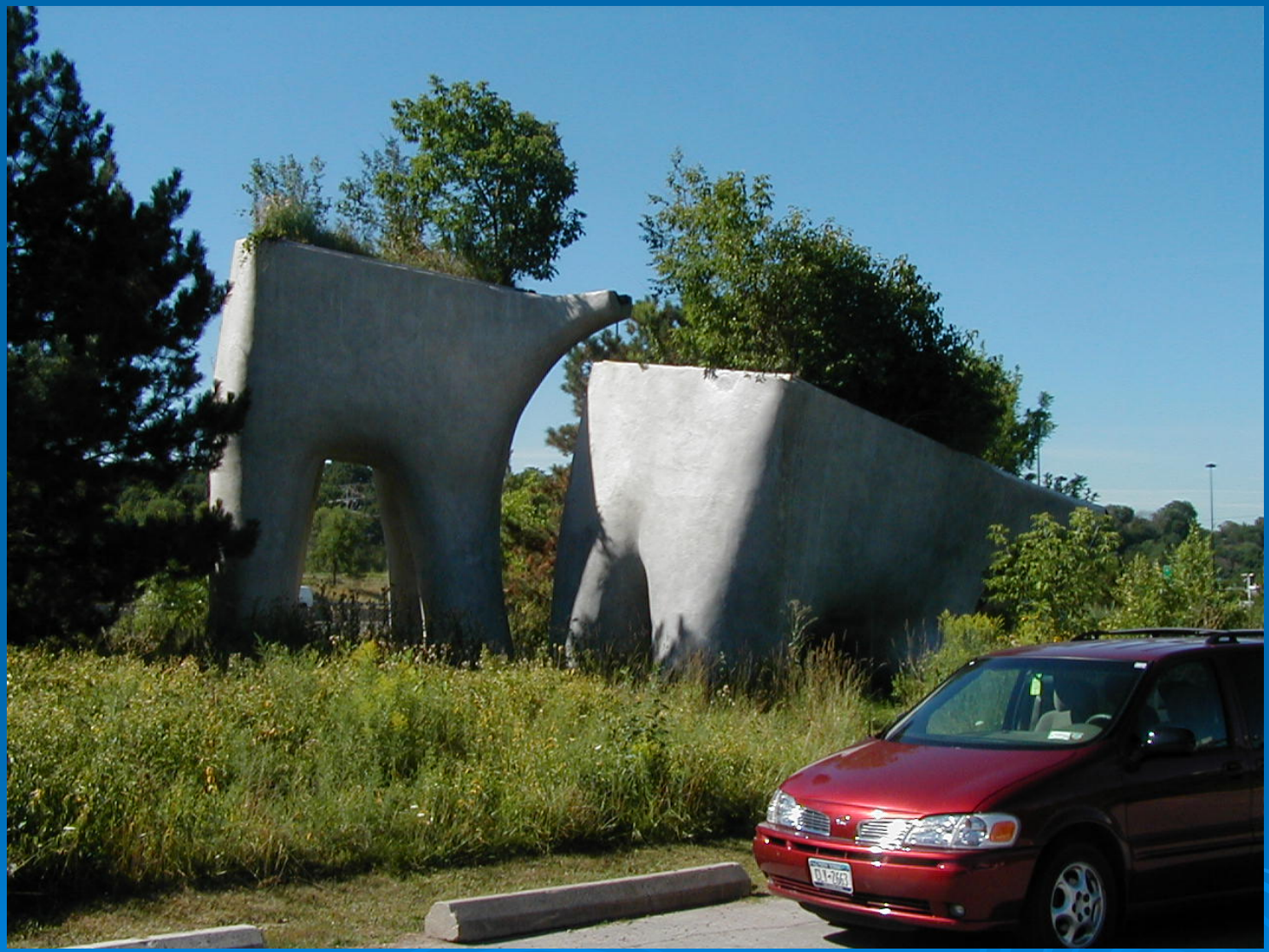
- Increase flow paths
- Increase timing
- Increase ET/Recharge

Green Highways Initiative





Advanced Highway BMP

Anacostia Waterfront

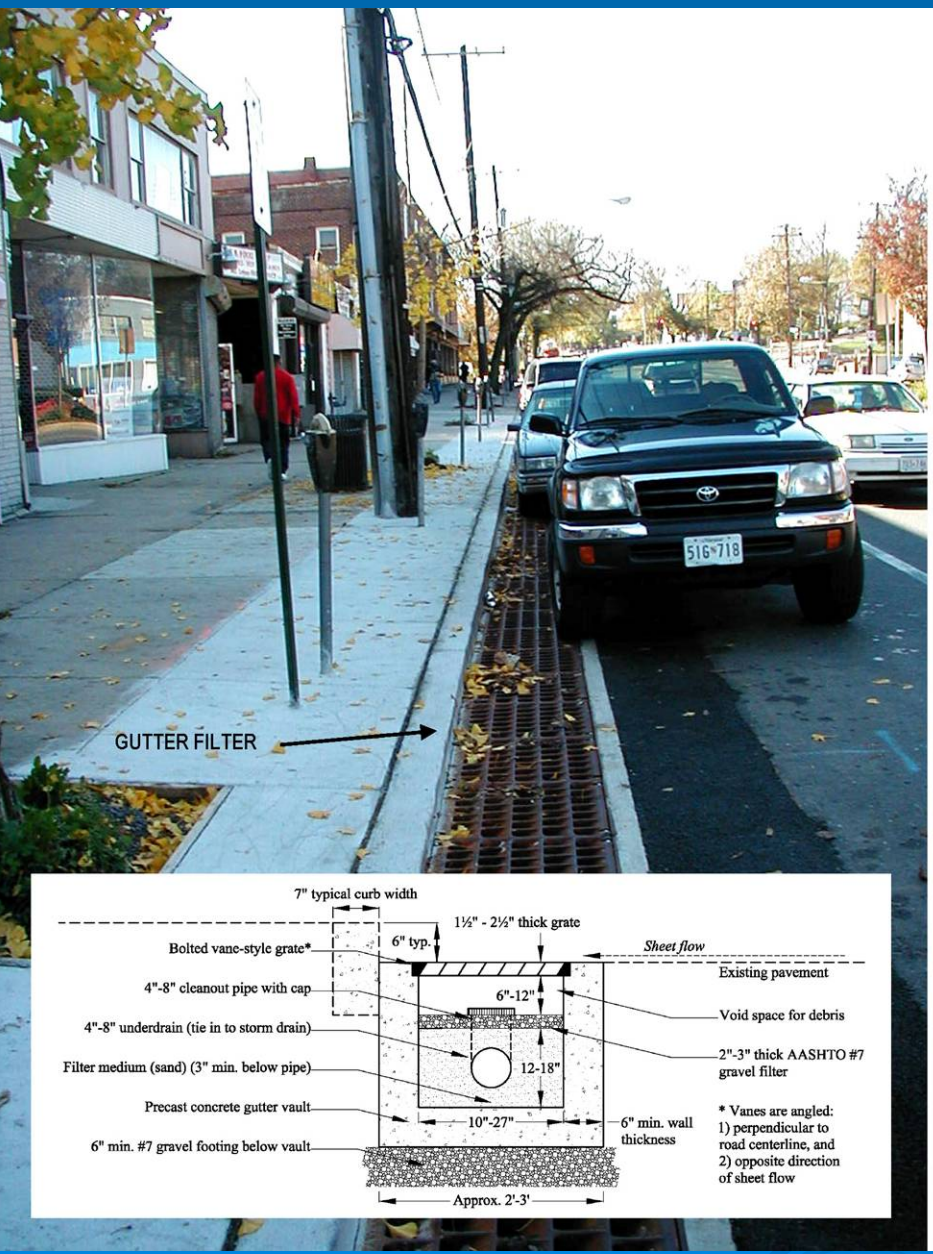
Transportation Architecture Design Standards

District of Columbia
District Department of Transportation

Infrastructure Project Management Administration

2005 Great American Main Street Award™ Winner
Barracks Row
Washington, District of Columbia

Environmental Infrastructure is Community Development



Element: Low Impact Development (LID)	**Reference:** x.y.z
Item: Gutter Filter – Designated Curbside Parking	**AWI Guideline**
Classification: Principal Arterials, Minor Arterials, and Collectors; Local	**Area Type:** Mixed-Use & Residential
Location: Curb along sidewalk	

Type: Water quality device

Purpose

Gutter filters are pre-cast concrete gutter vaults containing gravel and finer (typically sand) filter media and an underdrain installed below grade at the curb line. A void space above the filter material captures trash and other debris that is able to pass through the surface grate while the gravel and sand filter media remove suspend solids and other pollutants. Filtered stormwater is conveyed by the underdrain from the gutter filter to the stormwater collection system. Gutter filters may be a stand-alone BMP or used in concert with other measures as part of a stormwater control strategy.

Benefits

- Improves quality of stormwater runoff and, consequently, of the receiving waterway
- Application in highly urban areas with little available open space

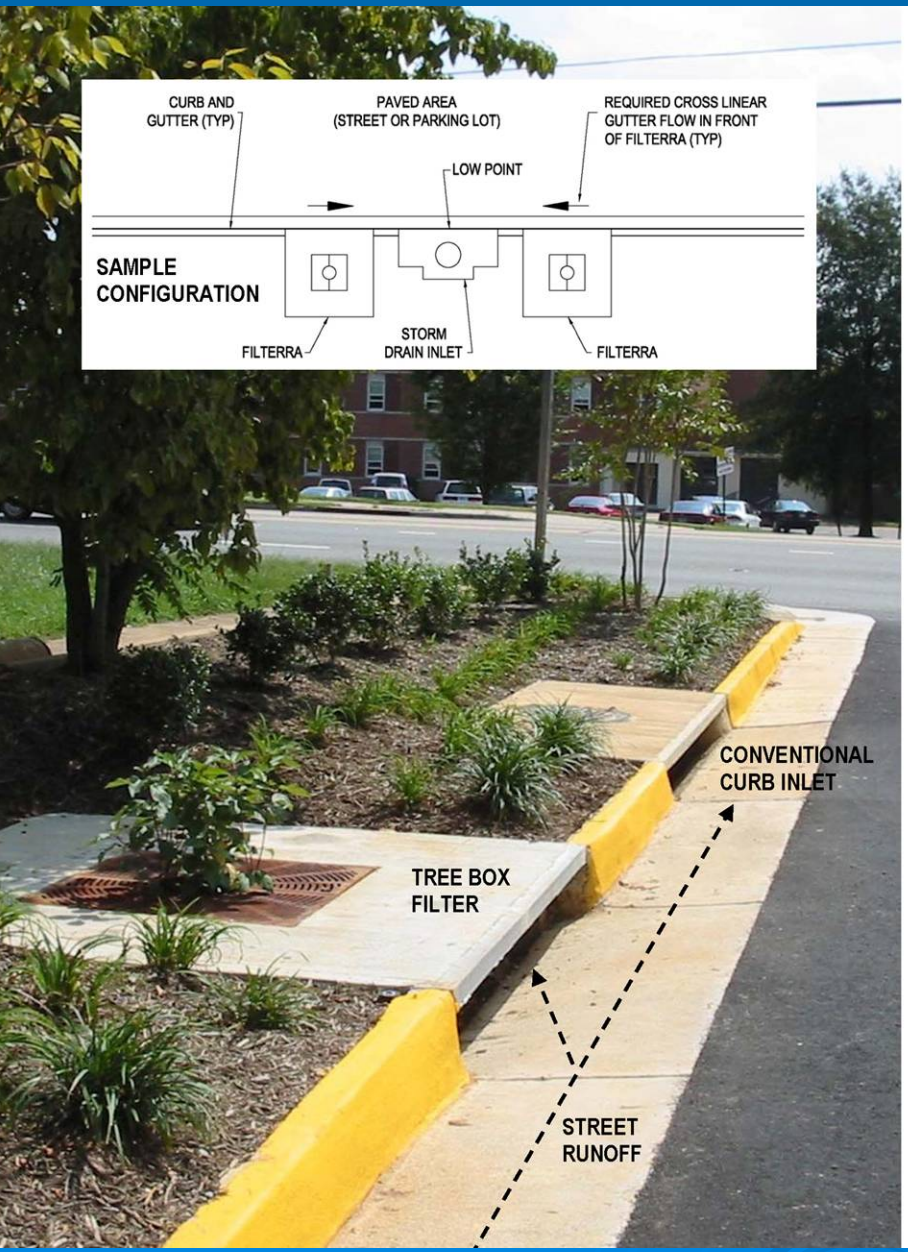
Effectiveness

Gutter filters improve water quality by removing urban pollutants from stormwater and preventing them from being conveyed to receiving waterways. As with any stormwater filter, proper upkeep and maintenance is required to ensure optimum operation and pollutant removal efficiency. Gutter filters provide efficient removal of gross particulate matter typical of urban transportation corridors.

Objective	Volume	Frequency	Duration	Peak Discharge	Water Quality
Effectiveness	N/A	N/A	Low	Low	Medium

Design Standards

- **Dimensions:**
  - A typical gutter filter will be 12 – 24 inches wide and 20 – 30 inches deep. The top 6 – 12 inches of the filter is open space to capture larger debris; 2 – 3 inches of gravel are below the open space to capture large suspended solids; the remaining 12 – 18 inches of the filter is filled with fine filter media to remove smaller suspended solids.
  - An underdrain in the bottom of the structure conveys filtered stormwater to the collection system.
- **Placement:**
  - Gutter filters are a viable option in highly urban areas, which may preclude the use of larger more land intensive BMPs.
  - These devices are a treatment option for any urban transportation corridor when placed upstream of the conventional stormwater collection system.
- **Material:**
  - Pre-cast concrete gutter vault
  - 3 – 6 inches of gravel filter media
  - 12 – 18 inches of fine (sand) filter media
  - Perforated underdrain pipe



Element: Low Impact Development (LID)
Item: Tree Box Filter – Sidewalk-Furnishing Zone
Classification: Principal Arterials, Minor Arterials, and Collectors; Local
Location: Sidewalk, adjacent to curb

Reference: x.y.z
AWI Guideline
Area Type: Mixed-Use & Residential

Type: Concrete-enclosed infiltration device

Purpose
Tree box filters are concrete boxes filled with bioretention soil and installed below grade at the curb line. A standard street tree is planted in the box, which resembles a curbside planter. Tree box filters are located upstream of a standard curb inlet. For low to moderate flows, stormwater enters through the tree box's inlet, filters through the soil, and exits through an underdrain into the storm drain. For high flows, stormwater will bypass the tree box filter if it is full and flow directly to the downstream curb inlet.

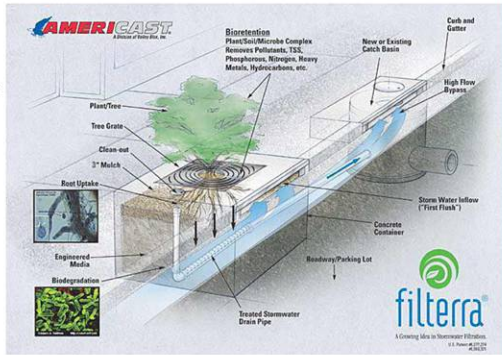
Benefits
- Reduce runoff volume, reduce peak discharge rate, and improve water quality for small, frequently-occurring storms
- Potentially reduce maintenance costs for existing stormwater infrastructure

Effectiveness
Because they are a related technology, tree box filters provide many of the same water quality and quantity benefits as bioretention cells, and effectively treat the "first flush" of stormwater. They can treat over 90% of the annual runoff volume. Removals of several common urban pollutants range from 75 to 95%. The street tree provides aesthetic and habitat benefits.

Objective	Volume	Frequency	Duration	Peak Discharge	Water Quality
Effectiveness	Medium	Medium	Medium	Medium	High

Design Standards
- **Dimensions:**
  - Standard tree box area is 6' x 6' (treats 0.25 acres). Other sizes are available. Max. drainage area for one box is 0.5 ac.
  - To treat 90% of the annual runoff volume, the tree box filter surface area should be at least 0.33% of the drainage area.
- **Placement:**
  - Tree boxes must be regularly spaced along the length of a corridor as appropriate to meet the annual treatment target.
  - The site grading must allow runoff to flow <u>across</u> the tree box inlet (e.g. left-to-right), rather than directly into it as in a sump. Do <u>not</u> place the tree box at the low point. A standard inlet must be present downstream to accept bypass flow.
- **Material:**
  - Pre-cast concrete container (standard sizes)
  - Mulch layer (typically 3")
  - Up to 3.5' of filter media (bioretention soil mix)
  - Observation/cleanout pipe and underdrain pipes
  - One street tree or other suitable plant(s)
  - Grate landscape cover
  - Downstream curb inlet *must* be present

Manufacturer
- Americast (Product: Filterra®)
- Approved Equal



Rain garden in commercial parking lot

Resources

- Rooftops to Rivers (NRDC)
- LID for Big Boxes (USEPA)
- DOD LID Design Manual (Navy)
- Decentralized CSO Phase I and II (WERF)
- PG LID Design Manual (USEPA)
- LID for Western Builders (USEPA)
- NCHRP LID Design Manual (USEPA)
- LID Western Transportation (USEPA)
- Arthur Capper (NFWF)
- Bayscapes Templates (NFWF)


Building 166 Permeable Pavement


Local
One Way
PENSKE
Truck Rental