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
Wastewater
Drinking Water

Decentralized Controls are Holistic and Watershed Based
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

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- Reduce
- Recycle
- Reuse
- Restore

- 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

- Air
- Mulch
- Input Water
- Output Water

Dr. Davis Inglewood Study - 6/9/99
United States Navy Yard
Tree box filter at the Washington, DC Navy Yard

Tree box filter at the Pentagon

Normal flow into tree box

High flow bypass to conventional inlet
The Future of the Urban America
Appearance = Acceptance

Burnsville, MN
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

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

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

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

7. Little Grapevine Daylily (Hemerocallis 'Little Grape')
   Height: 18 inches
   Space: 12 inches
   Blooms: May to June with interesting foliage all Summer

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

   Height: 4-5 feet
   Space: 2 feet
   Blooms: Midsummer to frost

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

The Sunny Border Garden Layout
29 Sat May 2004

Burnsville Rainwater Garden Retrofit
Post-Construction Runoff - May 29, 2004

Control (35106.6 gal)  Treatment (992.5 gal)  Rainfall (0.70 in)

CFS

3AM  6AM  9AM  12PM
5/29/2004 2:30:00 AM - 5/29/2004 12:30:00 PM
UMD Bioretention Hydrograph, July 28-29, 2003

- Input
- Cell A
- Cell B
Village Homes
Davis, CA

Natural drainage swales

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

http://www.energy2000.ee.doe.gov/
- Increase flow paths
- Increase timing
- Increase ET/Recharge

Green Highways Initiative
Advanced Highway BMP
2005 Great American Main Street Award™ Winner
Barracks Row
Washington, District of Columbia

Environmental Infrastructure is Community Development
Anacostia Waterfront
Transportation Architecture Design Standards

Element: Low Impact Development (LID)
Item: Gutter Filter - Designated Curbside Parking
Classification: Principal Arterials, Minor Arterials, and Collectors; Local
Location: Curb along sidewalk

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

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.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Volume</th>
<th>Frequency</th>
<th>Duration</th>
<th>Peak Discharge</th>
<th>Water Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness</td>
<td>N/A</td>
<td>N/A</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
</tr>
</tbody>
</table>

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 where 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

Diagram:
[Diagram showing gutter filter installation and dimensions]

Note: "Typical" dimensions and materials may vary based on specific site conditions and jurisdictional requirements.
**Anacostia Waterfront**

**Transportation Architecture Design Standards**

**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

**Type:** Concrete-enclosed infiltration device

**Purpose**
Tree box filters are concrete boxes filled with bioretenion 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 bioretenion 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.

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<tr>
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<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
</tbody>
</table>

**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 acres.
  - To treat 90% of the annual runoff volume, the tree box filter surface area should be at least 0.35% 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 across the tree box inlet (e.g. left-to-right), rather than directly into it as in a sump. Do not 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 (bioretenion 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**
- Amerifilt (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)