# Green Development: The Case of Water Management

綠開發:論水環境之管理

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# Impact of Urbanization on the Environment

- Hydrology Higher flood peaks, larger runoff volume, faster flood flows, less evaporation, less groundwater recharge
- Water Quality Stormwater runoff pollution, larger wastewater volumes
- Air Quality
- Other Effects e.g., Temperature







#### Water Management 水環境之管理

 Quantity Management – Drainage, Flood Control, Low Flow Management 量的管理:排水、防洪、低流管理

 Quality Management – Urban Streams, Ponds and Lakes, etc.

質的管理:都市河川、水池、人工湖等

Integrated Water Resource Management 整體性水資源管理

 Water Supply 給水(上水)

Wastewater

污廢水(下水)

 Stormwater – Quantity, Quality and Ecological Considerations

雨水—量與質以及生態之考量

#### Stormwater Management

#### Stormwater Management Objectives

- Peak Flow Rate Control
- Water Quality Control
- Volume Control

Groundwater Recharge



- 洪峰控制
- 水質保護
- 水量控制

#### Stormwater Management Practices (BMP)

- Detention/Storage Ponds, Tanks
- Infiltration Trenches, Porous Pavement
- Filtration Sand Filters
- Vegetative Buffer Strips, Swales,
- Combined storage/filtration/vegetative Constructed Wetlands, Bioretention Cells

#### 雨水管理技術

- 滯流/蓄流:水池、水槽
- 入滲:入滲溝、透水性路面
- 植物性:緩衝帶、草溝
- 整合性:人造濕地、植生滯流槽

# Examples of Stormwater Practices -- BMPs

Some Pictures

# Dry and Wet Detention Ponds

\*Reduce peak flows \*Pollutant removal mainly by gravitational settling and decay







# Infiltration Practices

\*Reduce runoff volume \*Pollutant removal mainly by filtration and mass reduction

#### **Permeable Pavement**



# **Filtration Practices**

\*Space-limited applications \*Pollutant removal mainly by filtration including adsorption, etc.

## Sand Filters



# **Vegetative Practices**

\*Landscape features, low cost \*Removal by infiltration and vegetative uptake of, e.g., nutrients



#### Combined Storage/Filtration/Vegetative Practices

\*Constructed Wetlands \*Bioretention Cells – Can be integrated into the landscape



## Rte. 288 Outlet Zone







An aerial shot shows the gardens under construction.



### What is Bioretention?

"Filtering stormwater runoff through a terrestrial aerobic (upland) plant / soil / microbe complex to remove pollutants through a variety of physical, chemical and biological processes."

The word "bioretention" was derived from the fact that the biomass of the plant / microbe (flora and fauna) complex retains or uptakes many of the pollutants of concern such as N, P and heavy metals.

It is the optimization and combination of bioretention, biodegradation, physical and chemical that makes this system the most efficient of all BMP's





#### NITROGEN CYCLE FOR BIORETENTION



#### -Media Tank with plants





# Examples of Bioretetnion and Rain Gardens



Rain Garden in a median strip of a townhouse project just inside the beltway. Please note the depressed curb and grate inlet structure,

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Rain-Garden (in use) located in the entrance median to a town house Project.

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The first Rain Garden in Virginia, located in a turning circle in front of St. Stephens School, Alexandria.



#### **NEW 50' RIGHT-OF-WAY** SERVICE UP TO 25 RESIDENCES



LOW IMPACT RESULTS

- 17% LESS ASPHALT SURFACE
- 5-8% STORM WATER RUNOFF REDUCTION
- 86% INCREASE IN GREEN SPACE







Urban LID -- Rooftop Storage, Bioretention Landscaping, Parking Lot Storage, Longer Flow Paths, Swales, Water Use, Pollution <u>Prevention ......</u>



# Bioretention Facility Site

Note: Green shapes approximate location of facility. <u>The facility extends off the</u> <u>photo to the left as well</u>. UNITED STATES POSTAL SERVICE

**Stormwater Inlet Point** 



Facility to be located in large grass island between roadway and parking lot. Facility has drainage area of 0.29 acres, nearly all impervious.

#### **Bioretention Facility Design**

#### • Estimated Costs:

- Piping & Drainage \$1,500
- Grading & Soil Preparation: \$695
- Plants & Planting Costs: \$1,500
- TOTAL ESTIMATED COST: \$3,695
- Cost is \$12,741 per acre of drainage area served
- Estimated flow reductions to storm sewer of 25+% in average summer rainstorms
- Flow storage provided for 400 cf. of water, which is approximately the expected volume of runoff from an average summer rainshower producing 0.4" of precipitation
- In heavy storms, flow will fill bioretention and then bypass to existing storm sewer system



# **Bioretention Benefits**

- **Restores Hydrologic Functions**
- Economically Sustainable
  - Efficient Use of Space / Reduced Infrastructure
  - Property Value
  - Scale of Maintenance Burdens
  - Reduces Development Costs
- New Tool for Urban Retrofit
- Practical / Simple / Universally Applicable

# Maintenance and Management

- Cost-sharing
- Cleaning
- Replacement of Parts or Whole
- Cost-effectiveness
- BMPs in a Watershed
- Public Education
- Motivation

# Issues for Full Watershed BMP Implementation

Regulatory Framework

- Cost Construction and Maintenance
- Technical Issues: Design Specifications, Water Quality Goals, etc.
- Watershed Partnerships
- Public Education
- Other Issues Motivation, etc.