Presentation Topics

1. Introduction to stormwater management
2. City legal requirements for stormwater management
3. Stormwater management practices in use today
4. How we can do a better job in the City
5. Using stormwater master planning to achieve these gains
Development impacts on hydrology

Natural Ground Cover
- 25% shallow infiltration
- 25% deep infiltration
- 40% evapotranspiration
- 10% runoff

10%-20% Impervious Surface
- 21% shallow infiltration
- 21% deep infiltration
- 38% evapotranspiration
- 20% runoff

35%-50% Impervious Surface
- 20% shallow infiltration
- 15% deep infiltration
- 35% evapotranspiration
- 30% runoff

75%-100% Impervious Surface
- 10% shallow infiltration
- 5% deep infiltration
- 30% evapotranspiration
- 55% runoff
The City of Alexandria has requirements to manage stormwater impacts

- Manage peak runoff for the 2- and 10-year frequency storms
  - Post development peak runoff will not exceed predevelopment peak runoff
  - Excess runoff is to be detained on site
- Phosphorous loads are to be reduced
  - Capture a specified water quality volume
  - Select from defined best practices
- State is currently revising laws and is considering increasing stormwater volume, infiltration, and water quality requirements
The City uses a tool box approach to meet stormwater requirements

- A sample of options in the tool box include:
  - Stormwater BMPs (LID practices, ponds, underground storage, filter strips, etc.)
  - Stream restoration
  - Daylighting of streams
  - Buffer restoration
  - Buffer enhancement
  - Separation of combined sewers
  - Etc.
Appropriate precipitation analysis will result in correct sizing of stormwater best management practices (BMPs) and stream protection.

- **Appropriate BMP treatment volumes:**
  - Maximize pollutant load reduction
  - Provide groundwater recharge

- **Evaluate impacts on floodplains, channel stability, erosion potential, and water supplies**

1-year, 24-hour rainfall depth = 2.6 inches
2-year, 24-hour rainfall depth = 3.2 inches

97% of storms are less than 1-year, 24-hour storm
Conventional pipe and pond uses centralized control

“Efficiency”
Low Impact Development uses uniform distribution of micro controls
LID practices  *(No Limit!)*

*“Creative techniques to use, store, detain and recharge”*

- Bioretention
- Strategic Grading
- Site Finger Printing
- Resource Conservation
- Flatter Wider Detention Swales
- Flatter Slopes
- Long Flow Paths
- **Tree / Shrub Depression**
- Turf Depression
- **Landscape Islands Storage**
- **Rooftop Detention /Retention**
- **Roof Leader Disconnection**
- **Parking Lot / Street Storage**
- Smaller Culverts, Pipes & Inlets
- **Alternative Surfaces**
- Reduce Impervious Surface
- Surface Roughness Technology
- Rain Barrels / Cisterns / Water Use
- Catch Basins / Seepage Pits
- **Sidewalk Storage**
- Vegetative Swales, Buffers & Strips
- Infiltration Swales & Trenches
- Eliminate Curb and Gutter
- Shoulder Vegetation
- Maximize Sheet flow
- Maintain Drainage Patterns
- Reforestation
- **Pollution Prevention…………..**
Treatment chain - urban BMPs
Vegetated roofs

Duncan Library

Health Department
Green islands
Green infrastructure solutions are limited only by your creativity
THE BIG IDEA is to interconnect a series of devices...
AND create a livable city.
Baker’s experience in developing green infrastructure guidelines – AWI Manual

Major Urban Streets & Local Roads
Elements and Items

<table>
<thead>
<tr>
<th>SIDEWALK</th>
<th>ROADWAY</th>
<th>MEDIAN (optional)</th>
<th>ROADWAY</th>
<th>SIDEWALK</th>
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</thead>
<tbody>
<tr>
<td>Width varies</td>
<td>Number of lanes varies</td>
<td>Width varies</td>
<td>Number of lanes varies</td>
<td>Width varies</td>
</tr>
</tbody>
</table>

- **Mixed Use**

  - Sidewalk: width varies
  - Roadway: number of lanes varies
  - Median (optional): width varies

- **Residential**

  - Sidewalk: width varies
  - Roadway: number of lanes varies
  - Median (optional): width varies

**Key Elements**

- **Sidewalks**: Granite Curb & Brick Gutter
- **Roadway**: Number of lanes varies
- **Median**: Width varies

**Green Infrastructure Guidelines**

- **Paving**: Concrete or Brick (Masonry Block)
- **Furnishings**: Safety Posts, Hawker barriers, pedestrian safety
- **Planting**: Street Trees, Shrubs
- **Groundwork**: Sidewalk Construction, Median Construction

**Arboriculture**

- **Curb & Gutter**: Granite Curbs, Brick Gutter
- **Roadway Surfacing**: Concrete, asphalt, asphalt concrete, sustainable materials

**Surface Treatments**

- **Drainage Systems**: City of Alexandria

**Figure 4.3**: Typical Elements

City of Alexandria
Green infrastructure integrated in the public realm - parking lanes


Section 1: Roadway Paving & Treatment Materials

<table>
<thead>
<tr>
<th>Element</th>
<th>Reference</th>
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</thead>
<tbody>
<tr>
<td>Designated Parking Lanes</td>
<td>1.4.1</td>
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</table>

Item: Unit Pavers

Classification: Principal Arterial, Minor Arterial, Collector, Local, Alley, Symbolic Corridor, Designated Transit Corridor, Special Segment, Park Road

Area Type: Mixed-Use & Residential

Location: Curbside designated parking lanes

Purpose
Designated parking lanes should be clearly defined. Distinctive materials, such as unit pavers, can be used to achieve this. A change in material between travel lanes and parking lanes visually reduces the roadway width. Color of pavers for Designated Parking Lanes should comply with the latest laws and regulations of the Americans with Disabilities Act. Installation should be coordinated with utilities to avoid conflicts.

Application
- **Restriction:** Restricted parking lanes that become travel lanes during peak hours should not be given this treatment.
- **Color:** Salmon/charcoal blend.
- **Size:** 6” x 9”

References
- Unit pavers should be used in accordance with ASTM C 935-01 "Standard Specification for Solid Concrete Interlocking Paving Units".

Additional: Refer to CDOT Standard Specifications and Standard Drawings for Highways and Structures 2007 - Specification Section 906.02

Refer to Chapter 6 Item 3b. For additional information on proposed guideline.

Low Impact Development (LID) Opportunity
- Refer to Chapter 5, Option 7
Green infrastructure integrated in the public realm - street trees


<table>
<thead>
<tr>
<th>Element</th>
<th>Classification</th>
<th>Area Type</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>Cobblestone</td>
<td>Mixed-Use &amp; Residential</td>
<td>T1.201</td>
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<tr>
<td>Unit Paver</td>
<td>Principal Arterial, Minor Arterial, Collector, Local, Alley, Symbolic Corridor, Designated Transit Corridor, Special Segment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Furnishing/planting zone</td>
<td></td>
<td></td>
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</tbody>
</table>

**Purpose**

Unit Pavers set over the contiguous root zone maximize the planting soil area allowing for better root growth. Using cobblestone in the Furnishing/Planting Zone promotes stormwater percolation and discourages pedestrians from walking over the planting zone, therefore reducing the possibility for compaction.

**Application**

- Color: Light gray or as determined by DDOT on a project-by-project basis from the manufacturer’s standard colors, reducing the possibility for compaction.

**Low Impact Development (LID) Opportunity**

- Refer to Chapter 5, Options 1, 2, 7

**AWI Specific Guidance** - Refer to DDOT Standard Specifications and Standard Drawings for Highways and Structures 2007 - Specification Section 606

Refer to Chapter 8 Item 26 and 5a for additional information on proposed guidelines.
Green infrastructure integrated in the public realm – increase soil volume


Section 12: Planting Zone - Subsurface Treatments

<table>
<thead>
<tr>
<th>Element:</th>
<th>Increase Planting Space</th>
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<tbody>
<tr>
<td>Item:</td>
<td>Continuous Root Area with Pavers</td>
</tr>
<tr>
<td>Classification:</td>
<td>Principal Arterial, Minor Arterial, Collector, Local, Symbolic Corridor, Designated Transit Corridor, Special Segment, Mixed-Use &amp; Residential</td>
</tr>
<tr>
<td>Location:</td>
<td>Furnishings/planting zone within the sidewalk</td>
</tr>
</tbody>
</table>

**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'-6" or 6'-6" wide contiguous underground root zone depending on the total width of the sidewalk between the curbside and the pedestrian clear zone to maintain the volume of soil and encourage the uninterrupted growth of tree roots. Continuous/Planting Zone may be less than 4'-6" wide if the entire sidewalk width is less than 6'-0". In general, a 50'-0" cutout 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: Spacing sidewalk (and Structural Cell)
- Restrictions:
  - Trees should not be planted in sidewalks less than 6'-0" wide.
- Options:
  - Sidewalks 8'-0" or wider; Modifications to pavements or walkway zones may be optional when sidewalks are 8'-0" or wider.
Green infrastructure integrated in the public realm – bioretention cells


Bioretention cells are small scale soil and plant-based devices located in shallow depressions. The bioretention cells remove pollutants and control runoff volume and peak rates through a variety of physical, biological, and chemical treatment processes. The primary elements of a bioretention cell are vegetation that can withstand fluctuating soil moisture and temporary ponding, a highly permeable engineered soil media, a gravel layer, and an underdrain that is connected to the main storm drain system. Bioretention cells improve water quality for small, frequently occurring storms by filtering stormwater runoff through the soil media, biological and chemical reactions in the cell and root zone, plant uptake, and infiltration into the lower soil layers. In addition, bioretention cells can contribute to neighborhood and roadway beautification, habitat creation, reduce heat island effects, and can potentially reduce maintenance costs for existing stormwater infrastructure. To this end, bioretention cells can enhance the livability 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:
- Thoroughfare: Bioretention cells can be incorporated along the side of roadways, curb extensions, and adjacent public space.
- Major Urban Street: Bioretention cells can be incorporated into the sidewalk planting zone or roadway edges.
- Local: Bioretention cells can be incorporated into the sidewalk planting zone.
- Alley: PER

Stormwater Management Effectiveness: Bioretention cells are especially useful for treating the “first flush” of stormwater. They can remove 75-90% of common urban pollutants.

<table>
<thead>
<tr>
<th>Reference</th>
<th>LID Management Practice</th>
<th>Volume</th>
<th>Frequency</th>
<th>Duration</th>
<th>Peak Discharge</th>
<th>Water Quality</th>
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<tbody>
<tr>
<td>Option 17</td>
<td>Bioretention Cell</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
</tbody>
</table>
Hill East interim parking lots
Washington, DC

Permeable pavers in the northern lot
Vegetative devices in the southern lot
Hill East Waterfront: The Mass. Ave. bioretention cell final design
There are achievable gains when stormwater is considered early in the master planning process

- Green space can serve multiple purposes
- Stormwater can be aesthetically woven into roads, rights-of-way and open space
- Areas of increased and decreased opportunities for stormwater management can be identified early
- Balances can be defined to address variable stormwater management opportunities
- City guidelines and land use practices can be developed to accommodate change
- Phased development can be linked
- Flexibility is increased for future site planning
Baker’s is to incorporate stormwater planning into the master planning process

- Deliverables will include:
  - Existing conditions plan
  - Site analysis plan
  - Phasing plan
  - Conceptual implementation plan for green infrastructure
  - Conceptual image library for green infrastructure elements
QUESTIONS?
Use Precipitation Analysis to Guide Sizing of BMPs and Protection of Streams

- Appropriate BMP treatment volumes:
  - Maximize pollutant load reduction
  - Provide groundwater recharge

- Evaluate impacts on floodplains and channel stability

*Summary of Storm Event Data For Reagan National Airport*
Period of Record is 5/1/1948 through 2/1/2006

- Precipitation
- BMP Capture

- Storm Event Precipitation (Inches)
Urban Street Retrofit
(Seattle, WA)
How much water is collected?

• The system collects the 1 inch of runoff.
• Each bioretention cell collects sidewalk and roadway runoff and can retain 600 cf of water.
• That’s enough water to fill 60 regular bathtubs each time it rains more than one inch.
• There are 45 bioretention cells on Mass. Ave.
• That’s a total of 27,000 cubic feet of water!!!!