Low Impact Development in Houston – A Conference

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Introduction

• Overview of the Conference

• Academic Experts from the East Coast – several years of experience with LID sampling/evaluation

• Engineers, Planners, and Architects from the Houston area and other concerned citizens

• How well does LID work in general in Houston’s clay soils & heavy rainfalls? – Case Studies

• Rice Campus as a LID Demonstration Laboratory
Impacts of Traditional Storm Water

• Water quantity:
  – High levels of runoff

• Water quality:
  – Increased amounts of pollutants

• Costs:
  – Solutions are capital intensive

• Environmental:
  – Loss in habitat

Flooding, Suspended Sediment, and Water Quality Loads
Impervious Cover Model

- Infiltration & ET
- Drainage volume & speed
- Pollutant load

Increased impact of Stormwater
The Essential Problem

Increased Infiltration
Added storage
Improved water quality
Residential LID

An approach to land development that manages stormwater runoff at the source.
LID Goal

Emulate predevelopment hydrology and water quality
Motivating Factors for LID

- Environmental
  - Reduce loads of non-point source pollution
  - Wildife habitats maintained
  - Promotes watershed health
  - Aid with water pollution requirements

- Economic
  - Reduced capital costs
  - Reduced O & M costs
  - May increase property values

- Social
  - Increased aesthetic appeal
  - Multi-purpose land use (parks)
Cottage Grove LID Street Project – City of Houston

- Swales, tree boxes, and other methods
- Center for Civic Engagement - Rice Univ - Summer 2012
- LID benefits to water quality in an urbanizing area of Houston
Cottage Grove LID Features

- Increased Infiltration with Engineered Soil: acts as “bio-filter”
- Storage is created to decrease runoff
- Pipes for emergency overflow of system
A Large Basin Example

Green Infrastructure systems at the Woodlands, TX
Woodlands Development

- Maximize green space
- Minimize amount of runoff
- Increase the tc of subareas
- Increase infiltration
- Reduce pollutant loadings
- Manage storm water impact
Vflo™ Inputs

Developed by Vieux, Inc.

Land Use

Soils

DEM

Vflo™ Model
Vflo™ 60 Meter Grid

Flow Characteristics
- Overland
- Channel
- Direction

Infiltration Excess Calculated at Each Cell
- Rainfall Rate
- Infiltration Rate
- Runon From Upslope
Calibrated Model for Hurricane Ike

- 4% volume difference
- 3% peak flow difference
- 2.3 hr time to peak difference
- 8,000 cfs peak

Avg. channel n = 0.026
Avg. land n = 0.038
Avg. In. Sat. = 9%
Avg. K = 2.12 in/hr
Modeled Three 1974 Storms

- Undeveloped model matches observed flows well
  - Channel $n = 0.032$
  - Overland $n = 0.066$
2006 Development Conditions

- 2006 development allows only about 20% increase in peak flow
- Earlier shift in timing
- Design of The Woodlands does minimize the effects of dev’m’t on existing hydrology
Fully Developed – Concrete Ch.

- Drastic change in timing and peak flow
  
  About 260% increase in peak flow
## Comparison of Development Scenarios

### Peak Flow Comparisons (cfs)

<table>
<thead>
<tr>
<th>Date</th>
<th>Undeveloped</th>
<th>2006 Development (% diff.)</th>
<th>Intense Development (% diff.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/28/1974</td>
<td>375</td>
<td>573 (53%)</td>
<td>1,543 (312%)</td>
</tr>
<tr>
<td>11/10/1974</td>
<td>825</td>
<td>952 (15%)</td>
<td>3,301 (300%)</td>
</tr>
<tr>
<td>11/24/1974</td>
<td>755</td>
<td>807 (7%)</td>
<td>2,102 (178%)</td>
</tr>
<tr>
<td>12/10/1974</td>
<td>500</td>
<td>491 (2%)</td>
<td>NA</td>
</tr>
<tr>
<td>Hurricane Ike</td>
<td>6,112</td>
<td>8,119 (33%)</td>
<td>17,017 (178%)</td>
</tr>
<tr>
<td>100 yr. Storm</td>
<td>10,270</td>
<td>8,106 (-21%)</td>
<td>24,516 (139%)</td>
</tr>
</tbody>
</table>

### Time to Peak Comparisons (hrs)

<table>
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<tr>
<th>Date</th>
<th>Undeveloped</th>
<th>2006 Development</th>
<th>Intense Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/28/1974</td>
<td>20</td>
<td>14.67</td>
<td>7.5</td>
</tr>
<tr>
<td>11/10/1974</td>
<td>15</td>
<td>5.0</td>
<td>2.8</td>
</tr>
<tr>
<td>11/24/1974</td>
<td>26</td>
<td>13.3</td>
<td>5.5</td>
</tr>
<tr>
<td>12/10/1974</td>
<td>27.3</td>
<td>5.33</td>
<td>NA</td>
</tr>
<tr>
<td>Hurricane Ike</td>
<td>16.8</td>
<td>5.66</td>
<td>1.5</td>
</tr>
<tr>
<td>100 yr. Storm</td>
<td>24</td>
<td>19.5</td>
<td>13.5</td>
</tr>
</tbody>
</table>

### Average % Diff.

| Avg.% Diff.       | -        | 15%               | 221%               |

### Average - No 100 yr.

| Average - No 100 yr. | 19.5 | 9.7 hrs | 4.8 hrs |
Low Impact Development at Rice

Rice University serves as Houston’s premiere research university and home to the SSPEED Center. It is located in the heart of the city and adjacent TMC, the museum district, and Brays Bayou. It is only 3 miles from downtown Houston.
Low Impact Development at Rice

As the campus continues to expand its facilities, green space management will become more important.

Benefits from LID on Rice campus would:

- Reduce flooding and pollutant loads both on campus and in neighboring areas
- Compliment campus sustainability goals
- Create educational outreach for LID in Houston
- Create cooperative center (City, County, and Private Sector) to evaluate integrated LID technology
HARRIS GULLY STORMWATER SYSTEM
Vegetated Roof Research

• Retention Research on an Extensive Vegetated Roof
  – 4” soil depth
  – Optimum performance @ 1-2.0 in/hr RF intensity

• Data collected from summer 2010-2011 with Center for Civic Engagement Fellows
Rainfall Event Results - 2011

- Results showed that vegetated roofs play a major role in managing rooftop runoff from Rice U.

Much more work is needed to evaluate overall benefits of LID to Rice campus.

<table>
<thead>
<tr>
<th>Storm Date</th>
<th>Retention Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 21st 2011</td>
<td>172-46%</td>
</tr>
<tr>
<td>July 6th 2011</td>
<td>80%-68%</td>
</tr>
<tr>
<td>July 14th 2011</td>
<td>95%-73%</td>
</tr>
<tr>
<td>July 15th 2011</td>
<td>175%-61%</td>
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</table>
What's Next?

Rendering of the Future D. Kent and Linda C. Anderson and Robert L. and Jean T. Clarke Center for Continuing Studies
Considerations for Rice

1. Evaluate benefits of existing green roofs on the Rice campus

2. Incorporate bioswales into future campus plans

3. Consider lowering intramural fields to increase storage capacity
Rice University LID Demonstration Lab

Take advantage of the opportunities to monitor various LID strategies for quantity and water quality.

Utilize various models including SWMM to evaluate the existing and proposed LID Rice projects and others in Houston.