Design Professionals/Developer Group Meeting

August 6, 2012

Crystal Piper, City of Franklin
Andy Reese, AMEC
Sara Johnson, AMEC
Please write questions on the cards available for end-of-presentation discussion
EPA is saying:

TSS removal is cute… just not powerful enough…
The regulatory goal can be stated as “volume mimicry”

How much rainfall did nature keep from running off?

OK, do that...
“Green Infrastructure” to the rescue
**Green Infrastructure is…**

- Parks
- Walking trails
- Open space plans
- Conservation areas
- Urban forests
- Water features
- Stream preservation
- Recharge zones

- Cisterns
- Bioretention
- Tree planters
- Reforestation
- Infiltration practices
- Permeable pavement
- Green roofs
- Rain gardens
Green Infrastructure: What are the drivers?

- TDEC – MS4: Post Construction Water Quality Treatment
- TMDL Requirements
- Rainwater Reuse
- Water Supply Protection
- Groundwater Replenishment
- Pollution Removal
- Sustainable Cities
- LEED and other Ratings
- Public and Political Popularity
...built and maintained to infiltrate, evapotranspire, harvest and/or use... the stormwater runoff generated at a site by the first inch of every rainfall event preceded by 72 hours of no measurable precipitation... no runoff

Section 4.2.5.2.1
This sort of boils down to:

“For Franklin’s program, we must retain on site the right volume”
Why should I Retain?

“For Franklin’s program...”
Franklin’s MS4 Permit - Approach to Green Infrastructure (GI)

- Implementation of Runoff Reduction using Green Infrastructure Practices
  - NOC July 29, 2011
  - Runoff Reduction required by July 29, 2015
  - Same approach as in Metro Nashville’s Stormwater Management Manual LID Vol. 5
What does “retain” mean and how do I do it?

“…must be retained on site”
“retain” means...

Evapotranspiration (“up”)

Infiltration (“down”)

Alternate Use (“out”)
How much should I retain?

“...the right volume...”
Why Is Volume Reduction Important?

- **Why Volume**
  - Groundwater recharge, maintain baseflow, reduce bank erosion
  - Volume is surrogate for pollution
  - Volume carries pollutants

- **Controls that remove volume are “golden”**

Old way = 40% TSS removal

New way = 82% TSS removal also accounts for volume removal
New Standard = Old Standard

1.1 Inches 80+% Efficiency

1.0 Inch 100% Efficiency
Does a storm depth or percent storm make sense anyway?

Can nature capture 1” of rain instantly?

Nope not without a pond.

Is it “hydrologic mimicry”?
In Savannah 1.2” capture is the 85% storm
In Chattanooga it is the 87% storm
In Phoenix it is the 98% storm
Nature has lots of scatter and does not capture the same depth for each soil type or storm. It might be wise to match the criteria to the soil type and to allow for "trends" not instantaneous depths... like nature.
Choice of C Soil as Standard

- 72 hr IEDP Storms
- \( R_v = \frac{\text{runoff}}{\text{rainfall}} \)
- C Soil with some trees and turf demonstrates an ability to:
  - Capture the first inch of most storms
  - Give an overall \( R_v \) of 0.20
- “It is your back yard”
Rainfall Capture

1” capture ≈ Rv of 0.20 ≈ 80% Volume
The Standard

- Capture values based on national data and the Chesapeake Bay approach, modified by local analysis, and simplified
- One single criteria: \( R_v \leq 0.20 \) is compliance
  - If the site has an \( R_v \leq 0.20 \) then on average the site captures the first inch of rainfall
  - Structures are designed to capture the right volume to bring about an \( R_v \leq 0.20 \)

So – defining a site with an annual \( R_v \) of 0.20 is like saying we will capture one inch
So this ends up looking just like a C Factor or CN calculation on a site:

The land-use weighted $R_v$ must be $\leq 0.20$

$$\sum \frac{R_{v_i} \ast A_i}{A_{site}} \leq 0.20$$
A three-step process to mimic nature and treat 1"
Green Infrastructure
Design Steps Generalized Example
40\% \text{ Directly Connected Impervious Area (DCIA)}, \text{ HSG-C}, 2.5 \text{ Acres}
Step 1 – Land Cover Layout

1. Landcover lay out

Goal:
(1) minimize impervious cover and mass site grading
(2) maximize the retention of forest and vegetative cover, natural areas and undisturbed soils; especially those most conducive to landscape-scale infiltration.

Design activities: impervious area minimization, reduced soil disturbance, forest preservation, etc.
Establish Site Weighted Rv

### Step 1 - Site Cover Runoff Coefficients

<table>
<thead>
<tr>
<th>Soil Condition</th>
<th>Runoff Coefficient (Rv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impervious Cover</td>
<td>0.95</td>
</tr>
<tr>
<td>Hydrologic Soil Group</td>
<td></td>
</tr>
<tr>
<td>Forest Cover</td>
<td>0.02 0.03 0.04 0.05</td>
</tr>
<tr>
<td>Turf</td>
<td>0.15 0.18 0.20 0.23</td>
</tr>
</tbody>
</table>

\[
R_v = \frac{\text{Runoff}}{\text{Rainfall}} \leq 0.2
\]
### Step 1 - Rv Calculation

<table>
<thead>
<tr>
<th>Area</th>
<th>Acres</th>
<th>Rv</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>1</td>
<td>0.95</td>
</tr>
<tr>
<td>Turf C</td>
<td>1.5</td>
<td>0.20</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>2.5</strong></td>
<td><strong>0.50</strong></td>
</tr>
</tbody>
</table>

Weighted Rv Goal is to get this $\leq 0.20$
Step 1a & 2 – Intrinsic Green Infrastructure Practices (GIPs)

1. Landcover lay out
2. Intrinsic GIPs

Goal: enhance the ability of the background land cover to reduce runoff volume

Design activities: disconnection of impervious areas (e.g. rooftops) to sheet flow, amended soils, green roofs, and reforestation.
### Step 2 Design Information

**Soil Condition**

<table>
<thead>
<tr>
<th>Practice</th>
<th>Level 1</th>
<th>Level 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disconnection – downspout</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Grass Channel</td>
<td>10/20</td>
<td>20/40</td>
</tr>
<tr>
<td>Disconnection – sheet flow</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>Reforestation (A, B, C, D soils)</td>
<td>96</td>
<td>94</td>
</tr>
<tr>
<td>Green Roof</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>

**Percent Capture**

\[
\text{Percent Capture} = 1 - Rv
\]

*Level 2 is a higher capture standard*
Step 2 - Rv Calculation

Reforestation and Sheet Flow

New Rv = 0.322 > 0.20

Almost there…
If we could sheet flow it all – annual results
Step 3 Structural GIPs

1. Landcover lay out
2. Intrinsic GIPs
3. Structural GIPs

Goal: Use GIPs to attain 1” capture and $R_v \leq 0.20$

Design activities: infiltration trench, bioretention, permeable pavement, cisterns, water quality swales and dry pond.
### Step 3 - Green Infrastructure Practices

<table>
<thead>
<tr>
<th>Soil Condition</th>
<th>Percent Capture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level 1</td>
</tr>
<tr>
<td>Bioretention/Bioinfiltration</td>
<td>60</td>
</tr>
<tr>
<td>Urban Bioretention</td>
<td>60</td>
</tr>
<tr>
<td>Permeable Pavement</td>
<td>45</td>
</tr>
<tr>
<td>Infiltration Trench</td>
<td>50</td>
</tr>
<tr>
<td>Water Quality Swale</td>
<td>40</td>
</tr>
<tr>
<td>Dry Pond (Extended Det.)</td>
<td>0</td>
</tr>
</tbody>
</table>

Percent Capture = 1-Rv

\[ T_v = \frac{PR_v A}{12} \]
Sizing of Infiltration GIPs

Simplified sizing based on continuous simulation modeling results

Depth* SA

Equals Runoff Volume

Media Depth* n * SA

CN is reduced for flood control predictions
Can do controls in series
## Design Modifications for Volume

### Table 2. Level 1 and Level 2 Design Summaries

<table>
<thead>
<tr>
<th>Control</th>
<th>Level 1</th>
<th>Level 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioretention</td>
<td>C or D soils with Underdrain depth, less than 4 ft.</td>
<td>4 in/hr or stone lined, drain depth, less than 4 ft.</td>
</tr>
<tr>
<td>Tree Planter Boxes*</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Permeable Pavement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infiltration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Swale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grass Channel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extended Detention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Amendment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disconnection – do not redirect grassy areas C/D soils</td>
<td>To grassy areas A/B soils</td>
<td>50</td>
</tr>
<tr>
<td>- To amended soak area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- To rain garden</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disconnection – sheet flow</td>
<td>C or D soils</td>
<td>A or B soils</td>
</tr>
<tr>
<td>Reforestation (A, B, C, D soils)</td>
<td>96</td>
<td>94</td>
</tr>
<tr>
<td>- With amended soils below</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rain Tanks/Cisterns</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Green Roof</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

*Level 2 is a higher capture standard*
Rainwater Tanks/Cisterns

Tie to design usage
No rain barrel credit Use Cistern Design Tool
Step 3 - Rv Calculation

Reforestation, Sheet Flow, and Structural GIPs

New $R_v = 0.184 < 0.20$

You have arrived
C Soil + Sheet Flow and Green Infrastructure

- C Soil
- 40% Sheet + Gl

Runoff (in) vs Rainfall (in) plot.
Runoff Reduction Implementation

- **Ordinance Updates**
  - Review Period Aug – Sept
  - 9/17/13 Stormwater Appeals Board
  - 10/8/13 BOMA Worksessions
  - 10/22/13 First Reading
  - 11/26/13 Second/Final Reading

- **BMP Manual Updates**
  - 8/6/13 Design Professionals Meeting
  - 11/13 Manual Updated
  - 12/13 Training for Design Professionals
  - Implementation 1/1/14
Questions and Discussion