Determining Project Requirements & Rules

H&H Analysis and Design

Proper Documentation

6. Basin Delineation & BMP Selection
   May 2017

7. Enhanced Dry Swale Design
   July 2017

8. Bioretention Basin Design
   August 2017

9. Following PDP and PPG for MS4
   September 2017
BASIN DELINEATION & BMP SELECTION
Rachel Jones, PE
Sr. Water Resources Engineer
Rachel.Jones3@aecom.com
WHY ARE WE HERE?

...to discuss process of delineating a typical roadway project basin & selecting appropriate post-construction stormwater BMPs
BASIN DELINEATION PROCESS

- **Delineation**: creating a boundary that represents the contributing area for a particular outlet

- **Necessary to determine:**
  - Flow direction
  - Design flow rates, volume
  - Runoff hydrograph
  - Impacts due to development
  - Sizing of BMPs
BASIN DELINEATION

1. Obtain required data
2. Identify existing basin outfalls
3. Locate ridge lines, high points & connect
OBTAIN REQUIRED DATA

- **Existing Topography**
  - project survey
  - LiDAR data
  - USGS quad maps

- **Proposed contours (if available)**
  - design software: CAD / GIS
  - cross sections
  - cut | fill limits

- **Concept drainage layout**

  Note drainage system runoff may flow differently than topo
IDENTIFY EXISTING OUTFALLS

- Most downstream point in a MS4 basin where runoff:
  - leaves GDOT ROW
  - discharges to waters of the State

- Does not include:
  - cross-drain structures
  - culverts functioning only to maintain natural flow of surface waters & drainage
IDENTIFY EXISTING OUTFALLS

- Descending contour hooks (swale pattern)
- Draining to outfall at project R/W
- Locate key points
  - local ridge lines,
  - roadway high points
  - roadway low points
- Follow to outfall
- Stay perpendicular to contours
Survey data will provide the most accurate basin delineations
Other Considerations:
Survey data will provide the most accurate basin delineations.

BASIN AREA BASED ON USGS
CONSIDER ALIGNMENT

- Check survey aligns to aerial & USGS
CONDUCT A SITE VISIT

- Verify
  - Flow routing
  - Basin delineation
  - Drainage structures
  - Swales / berms

- Document condition of downstream structures

- Alternative: use street view software
OTHER CONSIDERATIONS

- **Basin Area**
  - include all areas flowing to outfall
  - could be different from BMP’s drainage area

- **BMP Placement**
  - GDOT calculates WQ vol. based on new imperv. area
  - not required at outfall of each drainage basin
  - can be upstream of outfall

- **Runoff Received by BMP**
  - does not need to originate from new impervious area
  - runoff volume received by BMP ≥ calculated WQ vol. from new impervious area
CONSIDER SOFTWARE INACCURACIES
DRAINAGE BASIN SELECTION

- **Same pre & post outfalls**
  - Calculation of pre and post impervious areas
  - Determination of detention analysis point

- **Different pre & post outfalls**
  - Calculation of pre and post impervious areas
  - Determination of detention analysis point
SAME OUTFALL: IMPERVIOUS AREA

- Use pre/post impervious area within post-developed basin delineation
- Use post-developed area for calculating % impervious

\[
\% Imp_{pre} = \frac{Imp_{pre}}{Area_{Post}} = \frac{0.9}{4.0} = 29\%
\]
SAME OUTFALL: IMPERVIOUS AREA

- Use pre/post impervious area within post-developed basin delineation
- Use post-developed area for calculating % impervious

\[
\% \text{Imp}_{pre} = \frac{\text{Imp}_{pre}}{\text{Area}_{post}} = \frac{0.9}{4.0} = 29\%
\]

\[
\% \text{Imp}_{post} = \frac{\text{Imp}_{post}}{\text{Area}_{post}} = \frac{2.9}{4.0} = 73\%
\]
SAME OUTFALL: DETENTION ANALYSIS

Use same outfall location for comparing pre- and post-developed flows
OUTFALL CHANGES: IMPERVIOUS AREA

- Use pre/post impervious area within post-developed basin delineation
- Use post-developed area for calculating % impervious
OUTFALL CHANGES: IMPERVIOUS AREA

\[
\% \text{ Imp}_{\text{pre}} = \frac{\text{Imp}_{\text{pre}}}{\text{Area}_{\text{post}}} = \frac{2.5}{8.8} = 28\%
\]
OUTFALL CHANGES: IMPERVIOUS AREA

\[
\% \text{Imp}_{\text{pre}} = \frac{\text{Imp}_{\text{pre}}}{\text{Area}_{\text{post}}} = \frac{2.5}{8.8} = 28\%
\]

\[
\% \text{Imp}_{\text{post}} = \frac{\text{Imp}_{\text{post}}}{\text{Area}_{\text{post}}} = \frac{4.9}{8.8} = 56\%
\]
If location changes: how do you compare pre- & post-developed flows at new outfall?

Look at outfall routing
OUTFALL CHANGES: DETENTION ANALYSIS

Flows routed to different location:

- Analysis point: flow from pre & post outfall join
CONVEYANCE CAPACITY

- Check conveyance capacity of receiving system to analysis point
  - Flooding
  - Streambank stability & Erosion
  - Downstream structure capacity
OTHER CONSIDERATIONS

Existing 2-lane: normal crown
Proposed 4-lane: fully superelevated
EXISTING CONDITION

**Outfall 1A**
Area = 1.04 ac
Impervious Area = 0.92 ac

**Outfall 1B**
Area = 0.96 ac
Impervious Area = 0.90 ac
**PROPOSED WIDENING**

**OUTFALL 1A - OLE #6**

**OUTFALL 1 - WILL LIKELY REQUIRE DETENTION**

### Outfall 1

**Area:** 3.75 ac  
**I_{pre}:** 1.82 ac = 48.5%  
**I_{post}:** 3.60 ac = 96.0%

**R_v net:** $0.914 - 0.487 = 0.427$

$$WQ_v = \frac{1.2 \times 0.427 \times 3.75 \times 43560}{12} = 6,975 \text{ ft}^3$$
OFFSITE AREAS

GDOT’s MS4 Permit:
Stormwater runoff that must be retained or treated does not apply to flows that originate outside of GDOT’s right of way or diverted flows from undisturbed areas.

- First, try to bypass offsite area
- If offsite area can’t be bypassed...
OFF-SITE DRAINAGE

- $WQ_v$: Off-site drainage areas should be included in the calculation

- $CP_v$: A BMP located “on-line” will need to safely pass off-site flows

- $Q_{p25}$: A BMP located “on-line” will need to safely pass off-site flows

- $Q_f$: A BMP located “on-line” will need to safely pass off-site flows
BMP SELECTION PROCESS

- Iterative Process
- Requires evaluation of all BMPs
- Utilize materials in Ch. 10 of Drainage Manual
- Not an exact science - engineering judgment required
BMP SELECTION PROCESS

Determine pre- and post-developed composite CN for each basin

- Create areas for different land use
  - pre- and post-developed impervious areas, residential, commercial, woods, grassed open spaces, etc.

- Determine HSG using USDA Web Soil Survey
  (https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm)
LAND USE AND SOIL TYPES
## BMP Selection Process

**Document as you go…**

<table>
<thead>
<tr>
<th>Drainage Basin 1 (Pre)</th>
<th>Area (ac)</th>
<th>CN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open space - Good condition (grass cover &gt; 75%) (Soil Group B)</td>
<td>0.25</td>
<td>61</td>
</tr>
<tr>
<td>Open space - Good condition (grass cover &gt; 75%) (Soil Group C)</td>
<td>0.13</td>
<td>74</td>
</tr>
<tr>
<td>Impervious</td>
<td>1.35</td>
<td>98</td>
</tr>
<tr>
<td>Woods - Good condition (Soil Group B)</td>
<td>0.42</td>
<td>55</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2.15</strong></td>
<td><strong>84</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drainage Basin 1 (Post)</th>
<th>Area (ac)</th>
<th>CN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open space - Good condition (grass cover &gt; 75%) (Soil Group B)</td>
<td>0.02</td>
<td>61</td>
</tr>
<tr>
<td>Impervious</td>
<td>1.71</td>
<td>98</td>
</tr>
<tr>
<td>Woods - Good condition (Soil Group B)</td>
<td>0.42</td>
<td>55</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2.15</strong></td>
<td><strong>89</strong></td>
</tr>
</tbody>
</table>
BMP SELECTION PROCESS

Determine time of concentration

- Determine pre- and post-developed time of concentration \( (T_c) \) via TR-55 method identifying:
  - Sheet flow
  - Shallow concentrated flow
  - Channelized flow (including pipe flow)
BMP SELECTION PROCESS
TIME OF CONCENTRATION

- **Travel time** $T_t$: time for water to flow from point A to point B
- **Time of concentration** $T_c$: time for water to travel from the hydraulically most distant point

- **Three types of flow**
  - Sheet flow (max. 100 - 300 ft)
  - Shallow concentrated flow
  - Channelized flow

- **Influencing factors:**
  - Surface cover (roughness)
  - Travel length

$$T_c = Tt_1 + Tt_2 + ... T_{tn}$$
where,

\[ T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}S^{0.4}} \]

\( T_t \) = travel time (hr)
\( n \) = Manning’s roughness coefficient
\( L \) = flow length (ft) – max. 100 to 300 ft
\( P_2 \) = 2-yr, 24-hr rainfall (in.)
\( S \) = slope of hydraulic grade line (ft/ft)
Shallow Concentrated Flow
\( V = 16.1345 (s)^{0.5} : \textbf{Unpaved} \)

\( V = 20.3282 (s)^{0.5} : \textbf{Paved} \)

\[ T_t = \frac{L}{3,600V} \]

where,
\( T_t = \text{travel time (hr)} \)
\( s = \text{slope of hydraulic grade line (ft/ft)} \)
\( V = \text{average velocity (ft/s)} \)
Channelized Flow

\[ V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \]

\[ T_t = \frac{L}{3,600V} \]

where,

- \( T_t \) = travel time (hr)
- \( n \) = Manning’s roughness coefficient
- \( L \) = flow length (ft)
- \( r \) = hydraulic radius \([A/P](ft)\)
- \( s \) = slope of hydraulic grade line (ft/ft)
- \( V \) = average velocity (ft/s)

Manning’s n Link: Click Here
Using the NOAA website, determine the precipitation depths for the 1, 2, 25 and 100-yr, 24-hr storm events.

![Weighted CNs Table](image)
NOAA Atlas 14

Data Type
- Precipitation depth
- Partial duration

Select Location
- Lat / Long
- Address
- Search Map
- Use project midpoint

Atlas 14 Link: Click Here
BMP SELECTION PROCESS

Determine peak flow rates

- Use basin data to compute pre- & post-developed basin hydrographs & peak flow rates

<table>
<thead>
<tr>
<th>Hyd. No.</th>
<th>Hydrograph type</th>
<th>Peak flow (cfs)</th>
<th>Time interval (min)</th>
<th>Time of conc. To (min)</th>
<th>Volume (cfs)</th>
<th>Inflow hydro(s) (cubit)</th>
<th>Maximum Elevation (ft)</th>
<th>Maximum Storage (cubit)</th>
<th>Hydrograph description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SCS Runoff</td>
<td>22.03</td>
<td>2</td>
<td>20.00</td>
<td>724.00</td>
<td>69.068</td>
<td></td>
<td></td>
<td>FRE</td>
</tr>
<tr>
<td>2</td>
<td>SCS Runoff</td>
<td>31.38</td>
<td>2</td>
<td>18.00</td>
<td>722.00</td>
<td>88.263</td>
<td></td>
<td></td>
<td>POST</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Reservoir</td>
<td>21.23</td>
<td>2</td>
<td>730.00</td>
<td>89.243</td>
<td>2</td>
<td>107.49</td>
<td>30.908</td>
<td>Routed Pond</td>
</tr>
</tbody>
</table>

Weighted CNs

$T_c$

Rainfall

Peak Flows
### BMP Selection Process

**Document as you go...**

<table>
<thead>
<tr>
<th></th>
<th>1-Year (cfs)</th>
<th>25-Year (cfs)</th>
<th>100-Year (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Development</td>
<td>4.84</td>
<td>14.69</td>
<td>17.69</td>
</tr>
<tr>
<td>Post-Development</td>
<td>5.99</td>
<td>15.93</td>
<td>18.89</td>
</tr>
<tr>
<td>Change (Post - Pre)</td>
<td>1.15</td>
<td>1.24</td>
<td>1.20</td>
</tr>
<tr>
<td>Percent Change</td>
<td>23.76%</td>
<td>8.44%</td>
<td>6.78%</td>
</tr>
</tbody>
</table>
BMP SELECTION PROCESS

Identify receiving waterbodies

- Identify if waterbody is impaired/has a TMDL
- Identify pollutant(s) of concern

GDOT MicroStation TMDL Tool:
BMP SELECTION PROCESS

DOCUMENT AS YOU GO…

<table>
<thead>
<tr>
<th>Outfall Area (Drainage Basin)</th>
<th>Receiving Water</th>
<th>Impaired (Yes/No)</th>
<th>Impairment</th>
<th>Is there a TMDL approved? (Yes/No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basin 1</td>
<td>Lovely Creek</td>
<td>Yes</td>
<td>FC</td>
<td>No</td>
</tr>
<tr>
<td>Basin 2</td>
<td>Lovely Creek</td>
<td>Yes</td>
<td>FC</td>
<td>No</td>
</tr>
<tr>
<td>Basin 3</td>
<td>Right Creek</td>
<td>No</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Basin 4</td>
<td>Right Creek</td>
<td>No</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Basin 5</td>
<td>Jones Creek</td>
<td>Yes</td>
<td>TP</td>
<td>Yes</td>
</tr>
<tr>
<td>Basin 6</td>
<td>Curvy Creek</td>
<td>No</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Basin 7</td>
<td>Curvy Creek</td>
<td>No</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
BMP SELECTION PROCESS

Determine unified sizing criteria applicability

$Q_{p25}$ & $Q_f$ may be required regardless of MS4 to prevent adverse downstream impacts

Weighted CNs
- $T_c$
- Rainfall
- Peak Flows
- Waterbodies
- POCs
- Unified Sizing
## BMP Selection Process

### The Unified Sizing Criteria is Applicable Unless...:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$WQ_v$</td>
<td>- Outfall Level Exclusion is applicable</td>
</tr>
<tr>
<td>$CP_v$</td>
<td>- Outfall Level Exclusion is applicable</td>
</tr>
<tr>
<td></td>
<td>- Basin discharges to a waterbody with drainage area $&gt;5$ mi$^2$</td>
</tr>
<tr>
<td></td>
<td>- Proposed 1-yr, 24-hr peak discharge $&lt;2$ ft$^3$/s</td>
</tr>
<tr>
<td>$Q_{p25}$</td>
<td>- Basin discharges directly to waterbody with drainage area $&gt;5$ mi$^2$</td>
</tr>
<tr>
<td></td>
<td>- Analysis showed insignificant flow increase for basin</td>
</tr>
<tr>
<td>$Q_f$</td>
<td>- Basin discharges directly to waterbody with drainage area $&gt;5$ mi$^2$</td>
</tr>
<tr>
<td></td>
<td>- Analysis showed insignificant flow increase for basin</td>
</tr>
</tbody>
</table>
**BMP SELECTION PROCESS**

**DOCUMENT AS YOU GO…**

<table>
<thead>
<tr>
<th>Applicable MS4 Requirements</th>
<th>WQv (✓ or X)</th>
<th>CPv (✓ or X)</th>
<th>Qp25 (✓ or X)</th>
<th>Qf (✓ or X)</th>
<th>Outfall Level Exclusion (Yes/No) (If yes, see Note 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✔</td>
</tr>
</tbody>
</table>

*Note: The table indicates that all criteria are met, with the outfall level exclusion marked as yes.*
BMP SELECTION PROCESS

LET’S REVIEW...
OUTFALL LEVEL EXCLUSIONS

OLEs that do not require post-construction measures:

1. BMP causes change in alignment that creates a safety concern
2. BMP install (not project) causes re-alignment | piping of stream
3. BMP install (not project) impacts a stream buffer or wetland
4. Discharges exit ROW as sheet flow
5. Flows originating offsite
6. Reduction (or negligible increase) in impervious area
Outfall Level Exclusions include the following:

1. Cases where the project would require an existing roadway alignment change solely to allow for BMPs. This exclusion applies only to existing roadway alignment changes that would create a safety concern. A written explanation of the safety concern(s) must be included with the post-construction stormwater report for all uses of this exclusion.

2. Instances where the installation of post-construction BMPs would require the re-alignment and/or piping of a stream.

3. When a project would impact existing vegetated stream buffers or wetlands solely for the purposes of installing BMPs. See state requirements for additional information on stream buffers.

4. Where stormwater discharges from the project site are designed to exit the right-of-way as sheet flow (non-point source discharges). Sheet flow should be designed in a manner to ensure that the flow will not cause instability, erosion, or flooding. The designer should determine if this is possible by visiting the site prior to design, and providing a written explanation with supporting evidence for this drainage area.

5. As stated in section 4.2.5.1(a) of the GDOT MS4 permit, “Stormwater runoff that must be treated does not apply to flows that originate outside of GDOT’s right-of-way or diverted flows from undisturbed areas.” If feasible, direct all offsite stormwater around the project site to the cross drain or stream such that it does not combine with stormwater from the project’s impervious surfaces or conveyance systems. This redirection allows the BMPs to only treat or detain the stormwater that originates from GDOT’s site, and stormwater that originates off-site to pass through the right of way unimpeded.

6. As stated in section 4.2.5.1(a) of the GDOT MS4 permit, for outfalls along linear roadway projects whereby the net impervious surface area within that outfall’s drainage area has been reduced or remains the same as pre-developed conditions, post-construction stormwater requirements will not apply. Special consideration from the Department may be given to those projects with a minimal increase in impervious area. In such cases, the designer will be required to provide supporting calculations showing that the increase in stormwater runoff and/or volume required to be treated for water quality is negligible with respect to the drainage area in question. Exclusions should be noted on Attachment B within the “Applicable MS4 Requirements” section. For simplicity, record the number from the list above corresponding to the exclusion being claimed.
BMP SELECTION PROCESS

Calculate applicable unified sizing criteria volumes

**WQ_v**  
**Water Quality Volume**  
- Treat 1.2 in. rainfall event to remove 80% TSS

**CP_v**  
**Channel Protection Volume**  
- 24-hour extended detention storage of 1-yr, 24-hr storm event

**Q_{p25}**  
**Overbank Flood Protection**  
- Attenuate post-developed flows back to pre-developed rates

**Q_f**  
**Extreme Flood Protection**  
- Control 100-yr, 24-hr event such that flooding is not exacerbated

---

**Weighted CNs**  
- $T_c$

**Rainfall**  
- Peak Flows

**Waterbodies**  
- POCs

**Unified Sizing**  
- Target Volumes
### BMP Selection Process

<table>
<thead>
<tr>
<th>Filter Strip</th>
<th>Sand Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass Channel</td>
<td>Bioretention Basin</td>
</tr>
<tr>
<td>Enhanced Dry Swale</td>
<td>Dry Detention Pond</td>
</tr>
<tr>
<td>Enhanced Wet Swale</td>
<td>Wet Detention Pond</td>
</tr>
<tr>
<td>Infiltration Trench</td>
<td>Stormwater Wetland</td>
</tr>
<tr>
<td>Bioslope</td>
<td>Open Graded Friction Course (OGFC)</td>
</tr>
</tbody>
</table>

Included in the designer’s “tool box” to meet MS4 and other stormwater requirements.
BMP SELECTION PROCESS
Identify the possible basin constraints
Evaluate ALL BMPs for “appropriateness”
# BMP Selection Process

Eliminate BMPs not appropriate for the basin.

## Table 10.3-2 BMP Screening Criteria (adapted from the GSMM)

<table>
<thead>
<tr>
<th>BMP</th>
<th>Stormwater Treatment</th>
<th>Site Applicability</th>
<th>Cost Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WQI / TSS</td>
<td>CPs</td>
<td>Oqts / Gr</td>
</tr>
<tr>
<td>Filter Strips</td>
<td>60%</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Grassed Channels</td>
<td>50%</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Enhanced Dry Swales</td>
<td>80%</td>
<td>?</td>
<td>X</td>
</tr>
<tr>
<td>Enhanced Wet Swales</td>
<td>60%</td>
<td>?</td>
<td>X</td>
</tr>
<tr>
<td>Infiltration Trenches</td>
<td>80%</td>
<td>?</td>
<td>X</td>
</tr>
<tr>
<td>Bioslopes</td>
<td>85%</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sand Filters</td>
<td>60%</td>
<td>?</td>
<td>X</td>
</tr>
<tr>
<td>Bioretention Basins</td>
<td>85%</td>
<td>?</td>
<td>X</td>
</tr>
<tr>
<td>Dry Detention Basins</td>
<td>65%</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Wet Detention Ponds</td>
<td>80%</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Stormwater Wetlands – Level 2</td>
<td>65%</td>
<td>?</td>
<td>X</td>
</tr>
<tr>
<td>Stormwater Wetlands – Level 1</td>
<td>80%</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>OOGS</td>
<td>50%</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
**BMP SELECTION PROCESS**

Evaluate appropriate BMPs for feasibility

**Infeasibility:**
- Each criteria ($WQ_v, CP_v, Q_{25}, Q_f$) is evaluated individually
- Meet as many of the criteria as feasible
- A BMP is feasible only if you can meet all requirements of at least one criteria
INFEASIBILITY CRITERIA

1. Cost exceeds 10% of project costs
2. Schedule delay (> 90 days)
3. Impact to endangered or threatened species
4. Cultural or community resource damage
   - historical, archeological, cemetery, park, wildlife refuge, nature trail, or school
5. Residence or business displacement
6. Violation of a federal or state law or regulation
INFEASIBILITY CRITERIA

7. Shallow bedrock, contaminated soils, high groundwater, and utilities or other underground facilities

8. Soil infiltration capacity limited

9. Site is too small to infiltrate significant volume

10. Site does not allow for gravity flow to BMP
BMP SELECTION PROCESS

Iterative process based on basin characteristics & constraints
BMP SELECTION PROCESS

Evaluate appropriate BMPs for feasibility

Verify feasible BMP designs do not exceed 10% of the project costs in the basin
OTHER CONSIDERATIONS

- Coordinate w/ drainage design
- Target BMPs meeting multiple criteria
  - $WQ_v$, $CP_v$, $Q_{p25}$ & $Q_f$
  - Basins, ponds, & stormwater wetlands
- Design BMPs in series to achieve 80% TSS reduction (treatment train)
- Transition temporary construction BMPs
  - swales to enhanced swales
  - sediment basins to detention
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drainage Area</strong></td>
<td>4.82 acres</td>
</tr>
<tr>
<td><strong>Section</strong></td>
<td>Urban</td>
</tr>
<tr>
<td><strong>Outfall</strong></td>
<td>Discharges into an existing junction box and 30-inch CMP that discharges to a private, closed system</td>
</tr>
<tr>
<td><strong>OLE</strong></td>
<td>Assume no OLE applies</td>
</tr>
<tr>
<td><strong>Applicable MS4 Criteria</strong></td>
<td>???</td>
</tr>
</tbody>
</table>
EXAMPLE: ROADWAY WIDENING PROJECT
ADDITIONAL IMPERVIOUS AREA
PRE-CONSTRUCTION DELINEATION

Basin C: 4.32 ac
Basin B: 0.15 ac
Basin A: 0.71 ac

Existing Drainage
DELINEATE DRAINAGE BASIN (POST-CONSTRUCTION)

Existing Drainage
New Drainage
DELINEATE DRAINAGE BASIN (POST-CONSTRUCTION)

Basin A: 2.88 ac

Basin C: 3.16 ac

Existing Drainage

New Drainage

GRAPHIC SCALE

(IN FEET)
IDENTIFY POTENTIAL BMP LOCATIONS
REFINED POST-CONSTRUCTION DELINEATION

Basin A: 2.88 ac
Basin C-2: 1.20 ac
Basin C: 3.16 ac
Basin C-1: 0.74 ac

BMP

GRAPHIC SCALE

( IN FEET )
### BMP Selection Example

<table>
<thead>
<tr>
<th>Pre-Development</th>
<th>Area (ac)</th>
<th>CN</th>
<th>Post-Development</th>
<th>Area (ac)</th>
<th>CN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basin A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open space – Fair (HSG B)</td>
<td>0.43</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impervious</td>
<td>0.28</td>
<td>98</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Basin B</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impervious</td>
<td>0.15</td>
<td>98</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Basin C</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woods – Good (HSG B)</td>
<td>1.61</td>
<td>55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impervious</td>
<td>2.71</td>
<td>98</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>5.18</td>
<td>82</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-Development</th>
<th>Area (ac)</th>
<th>CN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basin A</td>
<td>2.88</td>
<td>98</td>
</tr>
<tr>
<td>Basin C-1</td>
<td>0.74</td>
<td>69</td>
</tr>
<tr>
<td>Basin C-2</td>
<td>1.20</td>
<td>98</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>4.82</td>
<td>94</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1-yr, 24-hr (ft&lt;sup&gt;3&lt;/sup&gt;/s)</th>
<th>25-yr, 24-hr (ft&lt;sup&gt;3&lt;/sup&gt;/s)</th>
<th>100-yr, 24-hr (ft&lt;sup&gt;3&lt;/sup&gt;/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Development flow rate</td>
<td>13.6</td>
<td>32.9</td>
<td>42.9</td>
</tr>
<tr>
<td>Post-Development flow rate</td>
<td>19.3</td>
<td>37.2</td>
<td>46.3</td>
</tr>
<tr>
<td>Change (post-pre) flow rate</td>
<td>+5.7</td>
<td>+4.3</td>
<td>+3.4</td>
</tr>
<tr>
<td>Percent Change</td>
<td>+42%</td>
<td>+13%</td>
<td>+7.9%</td>
</tr>
</tbody>
</table>
### BMP SELECTION: EXAMPLE

<table>
<thead>
<tr>
<th>The Unified Sizing Criteria is Applicable Unless...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WQ_v</strong></td>
</tr>
<tr>
<td>• Outfall Level Exclusion is applicable</td>
</tr>
<tr>
<td><strong>CP_v</strong></td>
</tr>
<tr>
<td>• Outfall Level Exclusion is applicable</td>
</tr>
<tr>
<td>• Basin discharges to a waterbody w/ drainage area &gt;5 mi²</td>
</tr>
<tr>
<td>• Proposed 1-yr, 24-hr peak discharge &lt; 2 ft³/s</td>
</tr>
<tr>
<td><strong>Q_p25</strong></td>
</tr>
<tr>
<td>• Basin discharges directly to waterbody w/ drainage area &gt;5 mi²</td>
</tr>
<tr>
<td>• Analysis showed insignificant flow increase for basin</td>
</tr>
<tr>
<td><strong>Q_f</strong></td>
</tr>
<tr>
<td>• Basin discharges directly to waterbody w/ drainage area &gt;5 mi²</td>
</tr>
<tr>
<td>• Analysis showed insignificant flow increase for basin</td>
</tr>
</tbody>
</table>
### BMP SELECTION: EXAMPLE

<table>
<thead>
<tr>
<th><strong>Drainage Area</strong></th>
<th>4.82 ac</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section</strong></td>
<td>Urban</td>
</tr>
<tr>
<td><strong>Outfall</strong></td>
<td>Discharges into existing junction box and 30 in. CMP that discharges to a private, closed system</td>
</tr>
<tr>
<td><strong>Applicable MS4 Criteria</strong></td>
<td>WQ_v, C_P_v, Q_p25, Q_f</td>
</tr>
<tr>
<td><strong>Soil Type</strong></td>
<td>MgB2 (HSG B)</td>
</tr>
<tr>
<td><strong>Infiltration Rate</strong></td>
<td>0.57-1.98 in./hr</td>
</tr>
<tr>
<td><strong>Groundwater Depth</strong></td>
<td>&gt;6 ft</td>
</tr>
<tr>
<td><strong>Basin Topography</strong></td>
<td>≈ 4% slopes</td>
</tr>
<tr>
<td><strong>Receiving Waterbody</strong></td>
<td>Unnamed Tributary to Receiving Arm of Lake Acworth</td>
</tr>
<tr>
<td><strong>Impaired Waters/TMDL</strong></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Available R/W</strong></td>
<td>≈ 60 ft wide along roadway length</td>
</tr>
<tr>
<td><strong>ESAs</strong></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Underground Utilities</strong></td>
<td>N/A</td>
</tr>
</tbody>
</table>
**BMP SELECTION: EXAMPLE**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage Area</td>
<td>4.82 ac</td>
</tr>
<tr>
<td>Pre-Developed Impervious Area</td>
<td>3.14 ac</td>
</tr>
<tr>
<td>Post-Developed Impervious Area</td>
<td>4.08 ac</td>
</tr>
<tr>
<td>Pre-Developed % Impervious</td>
<td>60.6%</td>
</tr>
<tr>
<td>Post-Developed % Impervious</td>
<td>84.6%</td>
</tr>
<tr>
<td>$R_v$ pre</td>
<td>0.595</td>
</tr>
<tr>
<td>$R_v$ post</td>
<td>0.811</td>
</tr>
<tr>
<td>Net $R_v$</td>
<td>0.216</td>
</tr>
<tr>
<td>$WQ_v$</td>
<td>4,535 ft³</td>
</tr>
<tr>
<td>$CP_v$</td>
<td>32,198 ft³</td>
</tr>
<tr>
<td>Filter Strip</td>
<td>Typical section is urban. No sheet flow from impervious area present within drainage limits. Therefore, filter strip is not an appropriate BMP for this basin.</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Grass Channel</td>
<td>Grass channel in combination with dry detention basin will provide required 80% TSS removal. Appropriate BMP for this basin.</td>
</tr>
<tr>
<td>Infiltration Trench</td>
<td>Appropriate BMP for this basin (only WQ + CP).</td>
</tr>
<tr>
<td>Sand Filter</td>
<td>Appropriate BMP for this basin (only WQ + CP).</td>
</tr>
<tr>
<td>Bioretention Area</td>
<td>Appropriate BMP for this basin (only WQ + CP).</td>
</tr>
<tr>
<td>Dry Detention Basin</td>
<td>Appropriate BMP for this basin.</td>
</tr>
<tr>
<td>Wet Detention Pond</td>
<td>Drainage area &lt; 10 acres. Not an appropriate BMP for this basin.</td>
</tr>
<tr>
<td>Stormwater Wetland</td>
<td>Drainage basin &lt; 5 acres. Not an appropriate BMP for this basin.</td>
</tr>
<tr>
<td>Bioslope</td>
<td>Typical section is urban. No sheet flow from impervious areas present within the drainage limits. Not an appropriate BMP for this basin.</td>
</tr>
<tr>
<td>Enhanced Dry Swale</td>
<td>Appropriate BMP for this basin (only WQ + CP).</td>
</tr>
<tr>
<td>Enhanced Wet Swale</td>
<td>Groundwater is likely too deep to maintain permanent pool.</td>
</tr>
<tr>
<td>OGFC</td>
<td>OGFC is not being used in this project.</td>
</tr>
<tr>
<td>BMP</td>
<td>Detention</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Filter Strips</td>
<td>No</td>
</tr>
<tr>
<td>Grass Channels</td>
<td>No</td>
</tr>
<tr>
<td>Enhanced Dry Swales</td>
<td>Low</td>
</tr>
<tr>
<td>Enhanced Wet Swales</td>
<td>Low</td>
</tr>
<tr>
<td>Infiltration Trenches</td>
<td>Low</td>
</tr>
<tr>
<td>Bioslopes</td>
<td>No</td>
</tr>
<tr>
<td>Sand Filters</td>
<td>Low</td>
</tr>
<tr>
<td>Bioretention Basins</td>
<td>Low</td>
</tr>
<tr>
<td>Dry Detention Basins</td>
<td>Yes</td>
</tr>
<tr>
<td>Wet Detention Ponds</td>
<td>Yes</td>
</tr>
<tr>
<td>Stormwater Wetlands – Level 2</td>
<td>No</td>
</tr>
<tr>
<td>Stormwater Wetlands – Level 1</td>
<td>Yes</td>
</tr>
<tr>
<td>OGFC</td>
<td>No</td>
</tr>
</tbody>
</table>
### BMP SELECTION EXAMPLE: TABLE 10.3-2

<table>
<thead>
<tr>
<th>BMP</th>
<th>TSS</th>
<th>Max. Drainage Area (ac)</th>
<th>Space Req’d (% of Imperv. Area)</th>
<th>Max Site Slope</th>
<th>Min. Head (ft)</th>
<th>Depth to Water Table</th>
<th>Construction Cost</th>
<th>Maintenance Burden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass Channel</td>
<td>50%</td>
<td>5</td>
<td>10%</td>
<td>4%</td>
<td>&lt;1 ft</td>
<td>2 ft</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Infiltration Trench</td>
<td>80%</td>
<td>5</td>
<td>2-3%</td>
<td>6%</td>
<td>1 ft</td>
<td>4 ft</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Sand Filter</td>
<td>80%</td>
<td>10</td>
<td>2-3%</td>
<td>6%</td>
<td>5 ft</td>
<td>2 ft</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Bioretention Basin</td>
<td>85%</td>
<td>5</td>
<td>3-6%</td>
<td>20%</td>
<td>3 ft</td>
<td>2 ft</td>
<td>Med-High</td>
<td>High</td>
</tr>
<tr>
<td>Dry Detention</td>
<td>65%</td>
<td>75</td>
<td>N/A</td>
<td>15%</td>
<td>3 ft</td>
<td>2 ft</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>
## Complete Downstream Analysis:

<table>
<thead>
<tr>
<th></th>
<th>25-yr, 24-hr w/ BMP</th>
<th>25-yr, 24-hr w/o BMP</th>
<th>100-yr, 24-hr w/ BMP</th>
<th>100-yr, 24-hr w/o BMP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Development</strong></td>
<td>N/A</td>
<td>402</td>
<td>N/A</td>
<td>567</td>
</tr>
<tr>
<td>Peak Flow (ft³/s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Post-Development</strong></td>
<td>390</td>
<td>405</td>
<td>553</td>
<td>572</td>
</tr>
<tr>
<td>Peak Flow (ft³/s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>-12.0</td>
<td>+3.0</td>
<td>-14.5</td>
<td>+5.0</td>
</tr>
<tr>
<td>(ft³/s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>% Change</strong></td>
<td>-3.0%</td>
<td>+0.5%</td>
<td>-2.6%</td>
<td>+0.9%</td>
</tr>
</tbody>
</table>
Any Questions?
Please complete the course feedback forms before leaving so this course can continue to be improved!
CONTACT INFORMATION

Brad McManus, PE
MS4 Program Manager
Office of Design Policy and Support

bmcmanus@dot.ga.gov