8 – Example Applications of the Runoff Reduction Method

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amec

Example Types

- Small Commercial
- Single Family Residential
- Single Family Residential with Limitations to Runoff Reduction
- Large Commercial Redevelopment

Small Commercial Development

8a. Small Commercial

- Small Mixed Use Building
- Urban

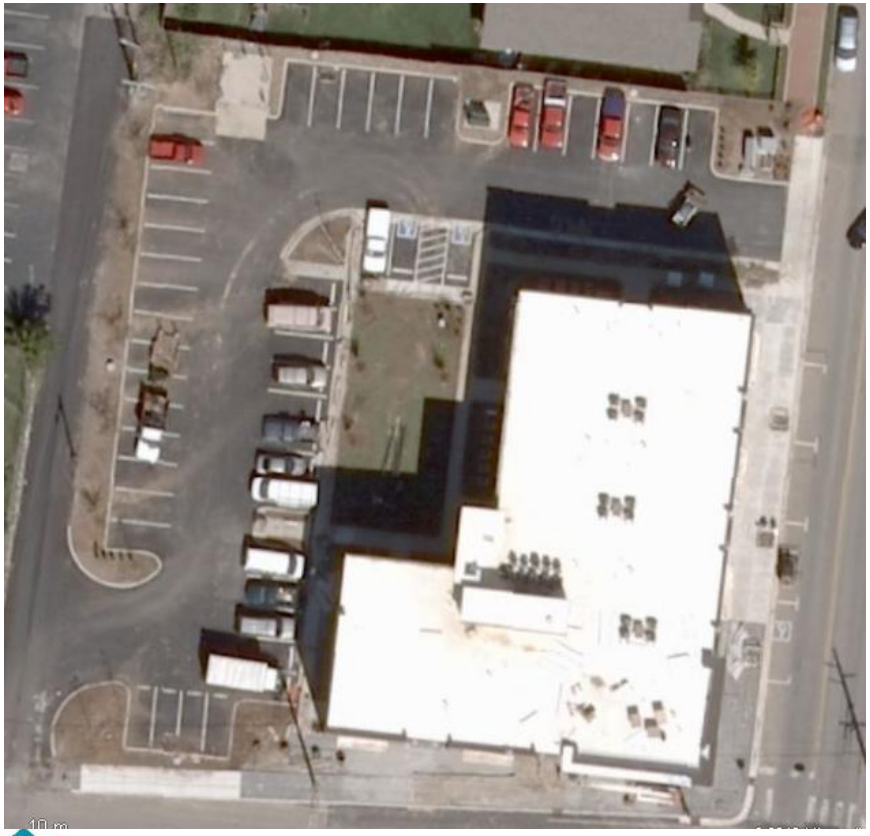
8a. Small Commercial

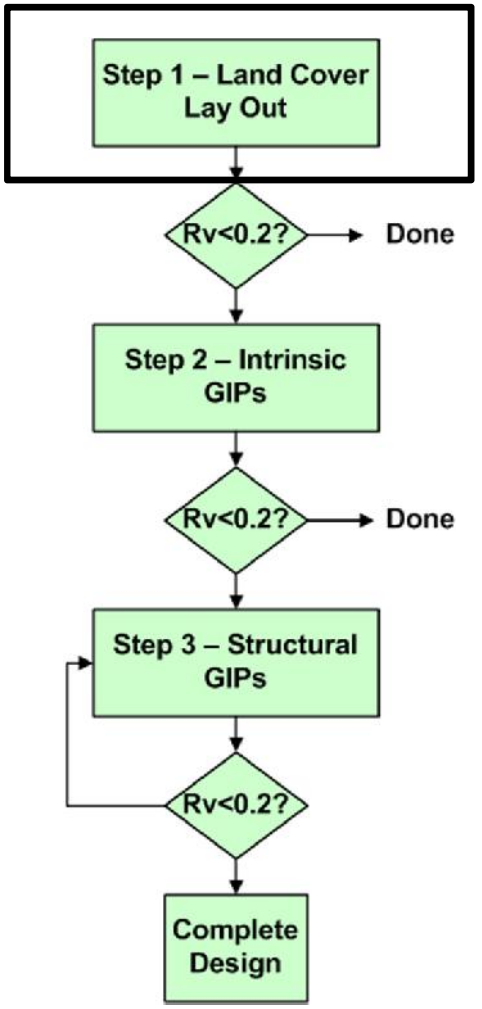
- 1 Acre Site
- 88% Impervious
- Goal: Site composite of Rv = 0.20

Challenge:

- Space – Small Lot, Large Impervious

8a. Small Commercial





8a. Small Commercial Calculate Weighted Rv

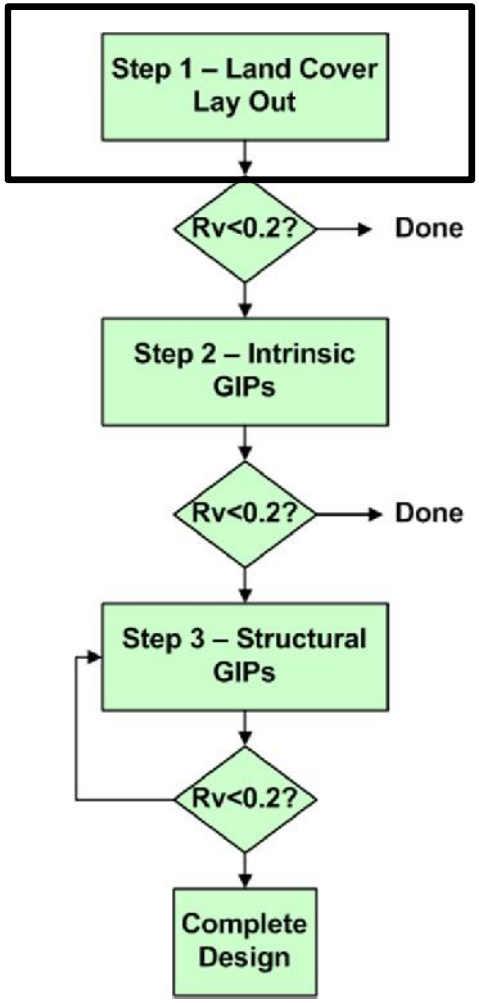
- Impervious = 0.88 ac
- Turf C Soil = 0.12 ac

Table 4 - Site Cover Runoff Coefficients				
Soil Condition	Volumetric Runoff Coefficient (R_v)			
IMPERVIOUS COVER	0.95			
HYDROLOGIC SOIL GROUP	A	B	C	D
FOREST COVER	0.02	0.03	0.04	0.05
TURF	0.15	0.18	0.20	0.23

$$Rv = \frac{(0.88\ ac \times 0.95) + (0.12ac \times 0.20)}{(0.88ac + 0.12ac)}$$

$$\underline{Rv = 0.86 \gg 0.20}$$

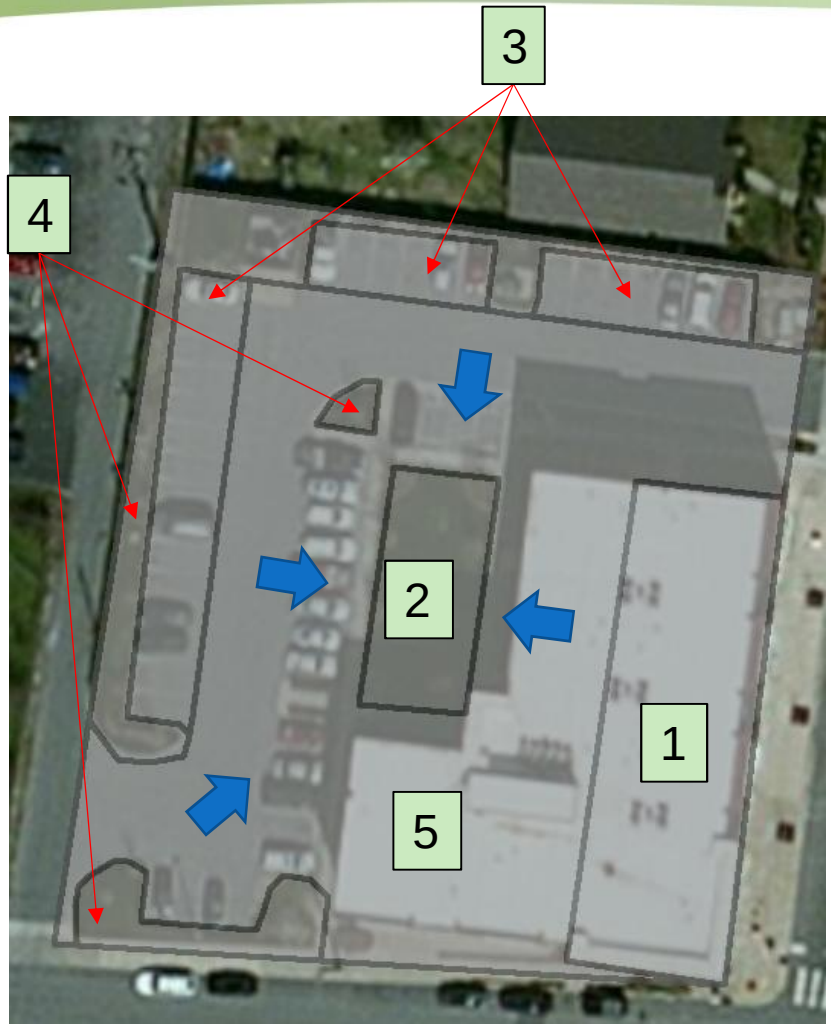
8a. Small Commercial
Design Steps 1 and 2 – Layout and Intrinsic



8a. Small Commercial
Step 3 – Structural

- 1. Green Roof
- 2. Bioretention
- 3. Pervious Pavers

8a. Small Commercial Drainage Areas



1. Green Roof (0.13 Ac)
2. Bioretention (0.05 Ac)
3. Pervious Pavers (0.1 Ac)
4. Turf (C Soil) (0.07 Ac)
5. Impervious (0.65 Ac)

8a. Small Commercial - Rv Calculations

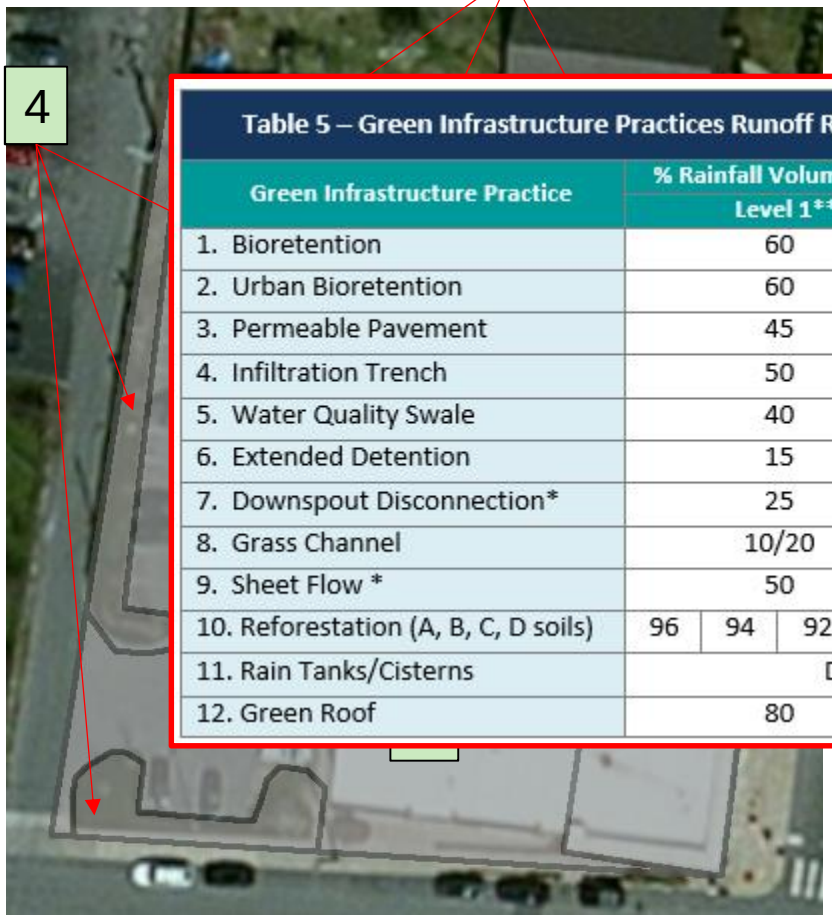


Table 5 – Green Infrastructure Practices Runoff Reduction Credit Percentages								
Green Infrastructure Practice	% Rainfall Volume Removed/Captured – RR Credit							
	Level 1**				Level 2**			
1. Bioretention	60				80			
2. Urban Bioretention	60				N/A			
3. Permeable Pavement	45				75			
4. Infiltration Trench	50				90			
5. Water Quality Swale	40				60			
6. Extended Detention	15				N/A			
7. Downspout Disconnection*	25				50			
8. Grass Channel	10/20				20/30			
9. Sheet Flow *	50				75			
10. Reforestation (A, B, C, D soils)	96	94	92	90	98	97	96	95
11. Rain Tanks/Cisterns	Design dependent							
12. Green Roof	80				90			

1. Green Roof (0.13 Ac)

$Rv = 0.95 \times (1 - 0.80)$

$= \mathbf{0.19}$

on (0.05 Ac)

$= \mathbf{0.04}$

avers (0.1 Ac)

$\times (1 - 0.75)$

$= \mathbf{0.24}$

il) (0.07 Ac)

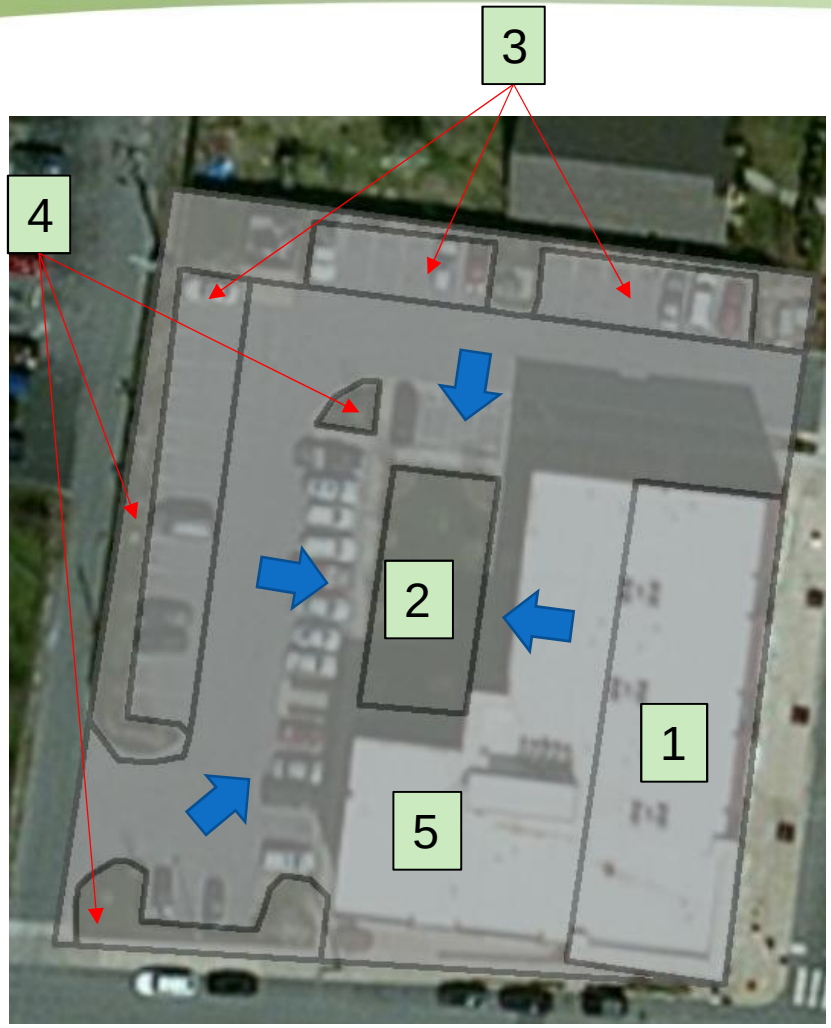
$= \mathbf{0.20}$

5. Impervious (0.65 Ac)

$Rv = 0.95 \times (1 - 0.80)$

$\boldsymbol{Rv = 0.19}$

8a. Small Commercial - Rv Calculations



Weighted Rv =

$$\frac{\begin{array}{l}1.\ (0.19 \times\ 0.13\ ac)\ + \\ 2.\ (0.04 \times\ 0.05\ ac)\ + \\ 3.\ (0.24 \times\ 0.10\ ac)\ + \\ 4.\ (0.20 \times\ 0.07\ ac)\ + \\ 5.\ (0.19 \times\ 0.65\ ac)\end{array}}{1\ \text{ac}}$$

Weighted Rv = $0.19 \leq\ 0.20$

8a. Small Commercial Summary

1. Green Roof, Level 1
2. Bioretention, Level 2
3. Pervious Pavers, Level 2

$$Rv = 0.86 \gg 0.20$$
$$Rv = 0.19 < 0.20$$

8a. Small Commercial Volume Calculations

1. Green Roof, Level 1

$$Tv = P \times Rv \times A$$

$$Tv = 1.0in \times 0.95 \times 0.13ac$$

$$Tv = 448\ ft^3$$

2. Bioretention, Level 2

$$Tv = 1.25 \times P \times Rv \times A$$

$$Tv = 1.25 \times 1.0in \times 0.95 \times 0.65ac$$

$$Tv = 2{,}802\ ft^3$$

3. Pervious Pavers, Level 2

$$Tv = 1.1 \times P \times Rv \times A$$

$$Tv = 1.1 \times 1.0in \times 0.95 \times 0.1ac$$

$$Tv = 379\ ft^3$$

8a. Small Commercial Volume Calculations

2. Bioretention, Level 2

$$Tv = 1.25 \times P \times Rv \times A$$

$$Tv = 1.25 \times 1.0in \times 0.95 \times 0.65ac$$

$$Tv = 2{,}802\ ft^3$$

Bioretention Surface Area

= 0.03 ac or 1,334 ft^2

= 3% of Site Area

Challenge:

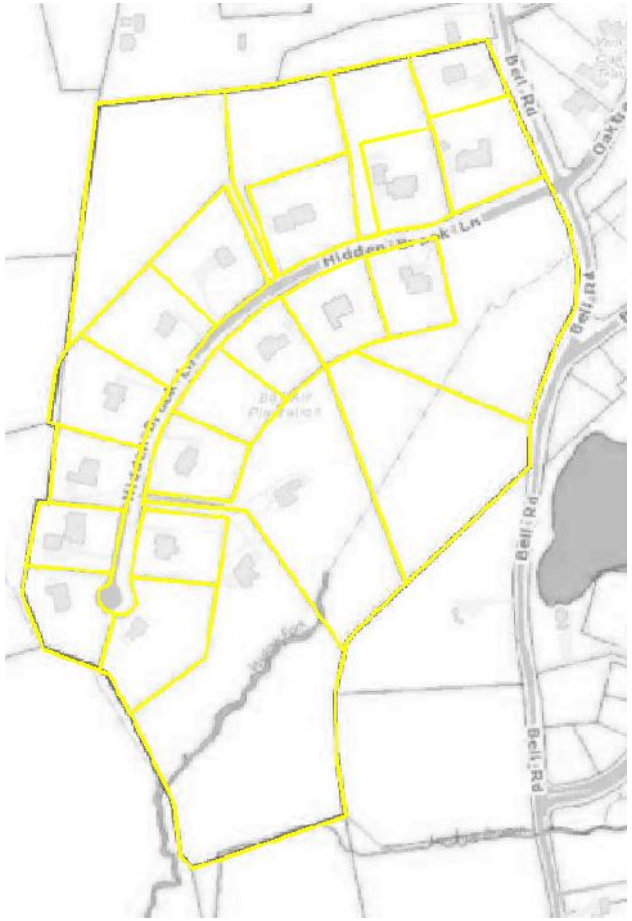
- Space – Small Lot, Large Impervious

Benefit:

- Incorporated BMPs with Landscaping

Single Family Residential

8b New Single Family Residential



- Large Lots
- New Development
- 57 Acres

- Traditional layout
- Alternate layout

Challenge:
- Maximizing Land Use
- Maintain Number of Lots

8b New Single Family Residential

- 57 Acres
- New Development
- IA = 8.5 ac
- Turf B =22.4 ac
- Turf C = 26.1 ac

- Got forest?

8b New Single Family Residential

- IA = 8.5 ac
- Turf B = 22.4 ac
- Turf C = 26.1 ac
- Weighted Rv:

Table 4 - Site Cover Runoff Coefficients				
Soil Condition	Volumetric Runoff Coefficient (R_v)			
IMPERVIOUS COVER	0.95			
HYDROLOGIC SOIL GROUP	A	B	C	D
FOREST COVER	0.02	0.03	0.04	0.05
TURF	0.15	0.18	0.20	0.23

$$Rv = \left(\frac{(8.5ac \times 0.95) + (22.4ac \times 0.18) + (26.1ac \times 0.20)}{8.5ac + 22.4ac + 26.1ac}\right)$$

$$Rv = 0.30$$

8b New Single Family Residential – Alternate Layout

- IA = 8.5 ac
- Turf B = 11.7 ac
- Turf C = 13.6 ac
- Forest B = 10.7 ac
- Forest C = 12.5 ac

Table 4 - Site Cover Runoff Coefficients

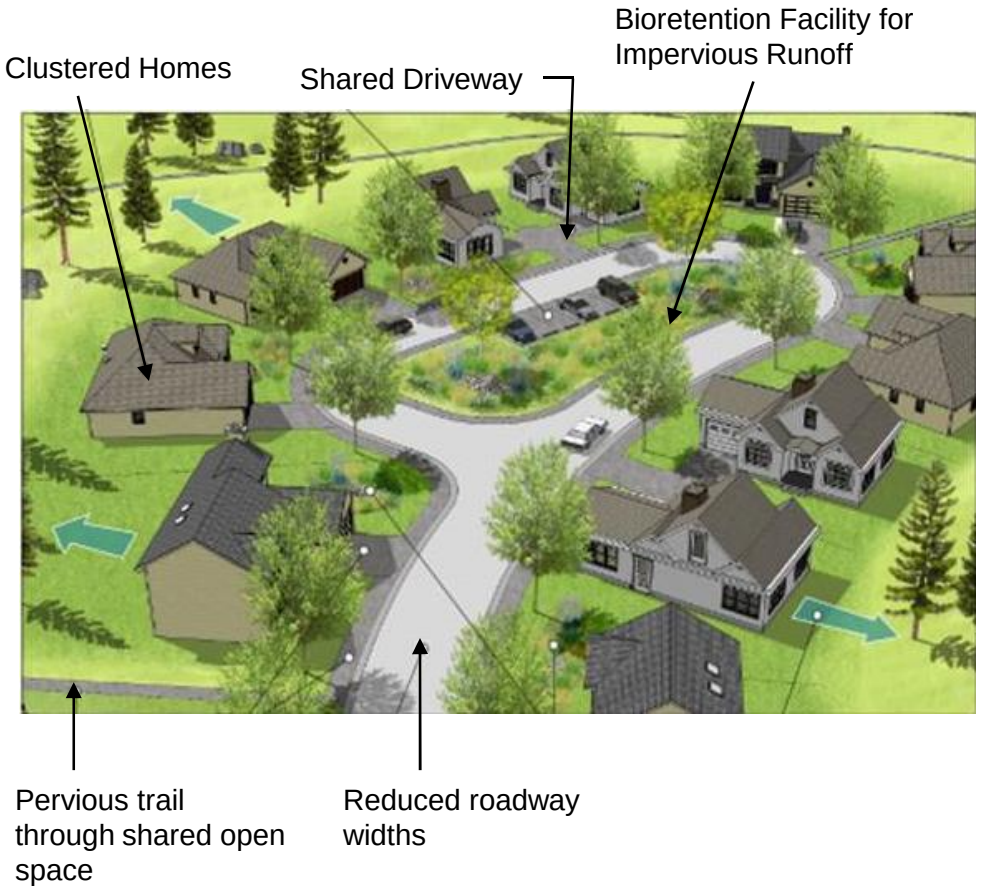
Soil Condition	Volumetric Runoff Coefficient (R_v)			
IMPERVIOUS COVER	0.95			
HYDROLOGIC SOIL GROUP	A	B	C	D
FOREST COVER	0.02	0.03	0.04	0.05
TURF	0.15	0.18	0.20	0.23

$$Rv = \frac{\left((8.5ac\times 0.95)+ (11.7ac\times 0.18)+ (13.6ac\times 0.20)+ (10.7ac\times 0.03)+ (12.5ac\times 0.04)\right)}{8.5ac + 11.7ac + 13.6ac + 10.7ac + 12.5ac}$$

$$\boldsymbol{Rv = 0.25}$$

Rv =0.30

8b New Single Family Residential



8b New Single Family Residential

- IA_{street} = 1.4 ac → Bioretention
- IA_{lot} = 2.3 ac → Bioretention
- IA_{lot} = 4.8 ac
- Turf B = 11.7 ac
- Turf C = 13.6 ac
- Forest B = 10.7 ac
- Forest C = 12.5 ac

$$Rv = 0.19$$

Challenge:
- Maximizing Land Use
- Maintain Number of Lots

Benefits:
- Aesthetic Lot Layouts
- Community Features
- BMPs Incorporated with Landscaping
- Low Maintenance Investment

8b New Single Family Residential Alternate Ending – Pervious Pavers

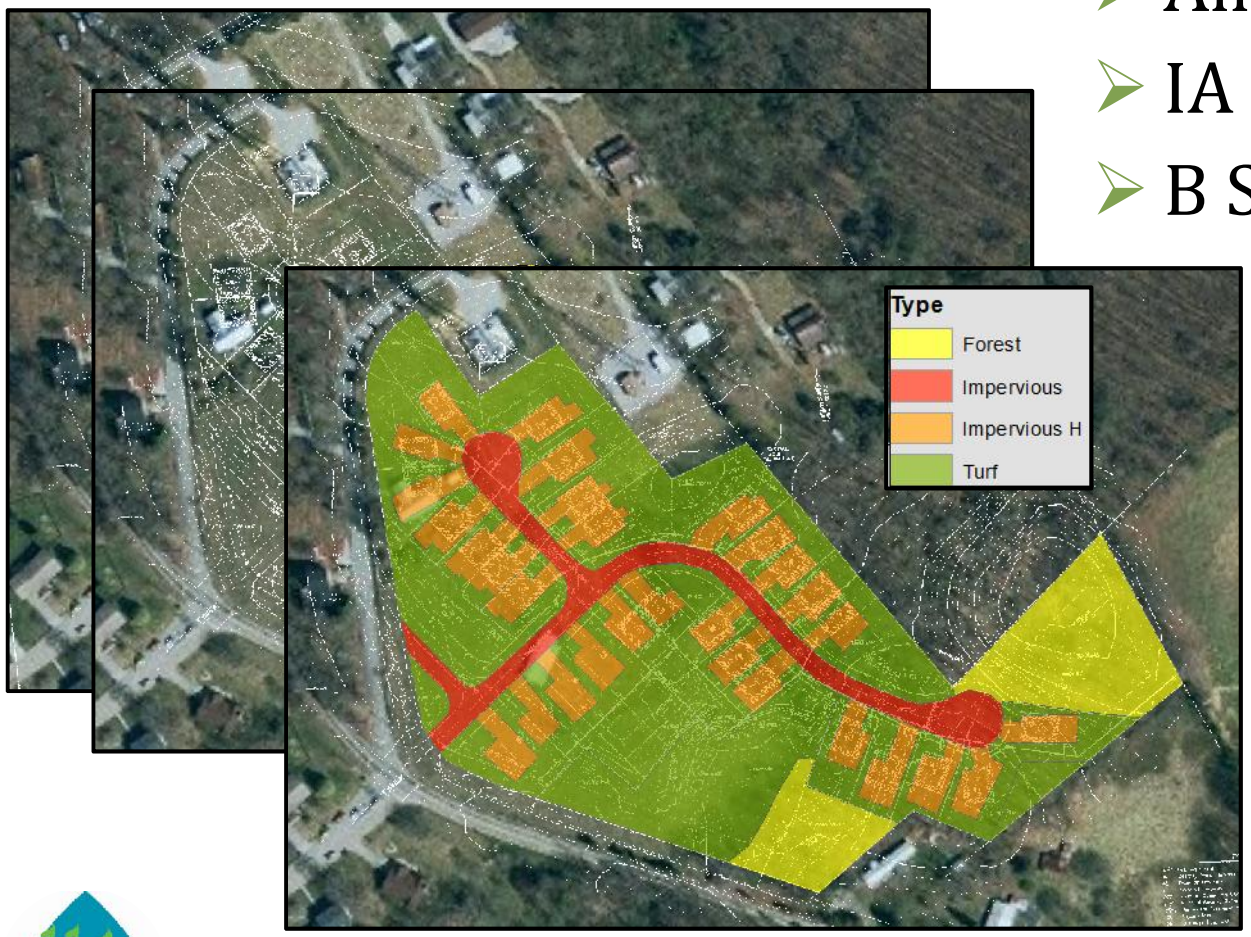
- Ia_{street} = 1.4 ac →Pervious Pavers
- IA_{lot} = 3.2 ac →Pervious Pavers
- IA_{lot} = 3.9 ac
- Turf B = 11.7 ac
- Turf C = 13.6 ac
- Forest B = 10.7 ac
- Forest C = 12.5 ac

$$Rv = 0.18$$

Single Family Residential with Limitations to Runoff Reduction

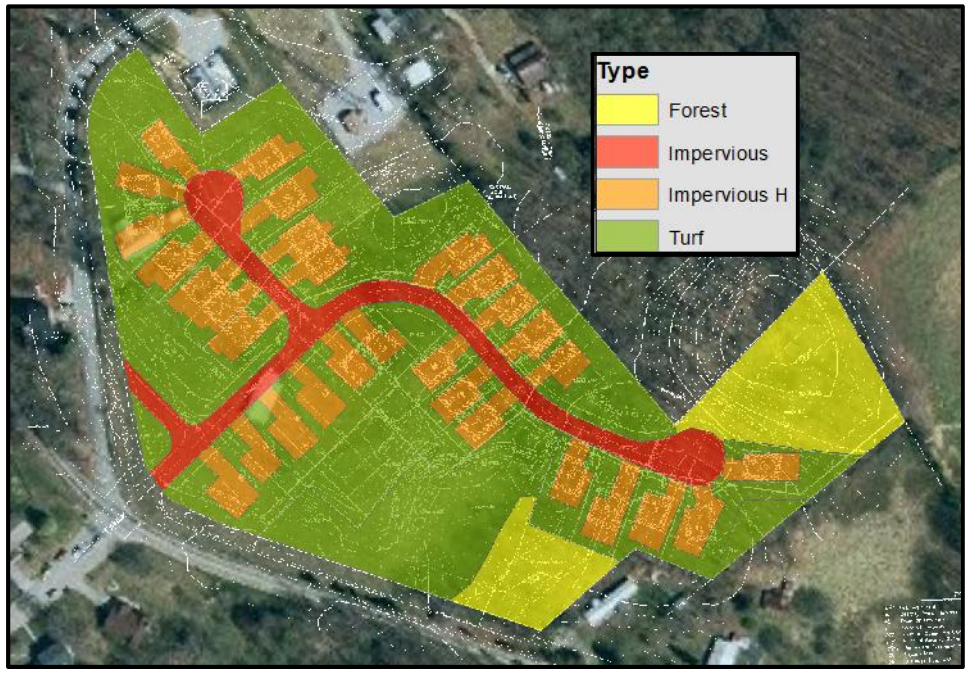
8c. Single Family Residential Limited

- 9.9 Acres
- All lots built
- IA = 3.2 ac
- B Soils



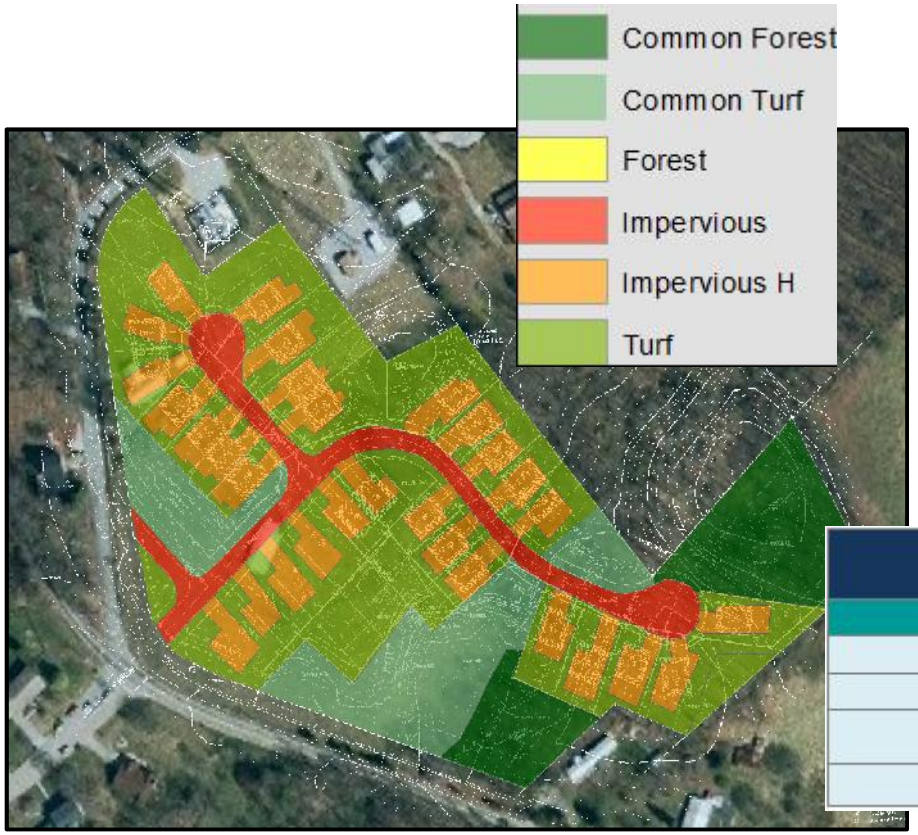
Challenge:
- Developable Space
- Sinkhole Limitations

8c. Single Family Residential with Limitations



- IA = 3.2 ac
- Turf B = 5.3 ac
- Forest B = 1.4 ac

8c Single Family Residential Limitations



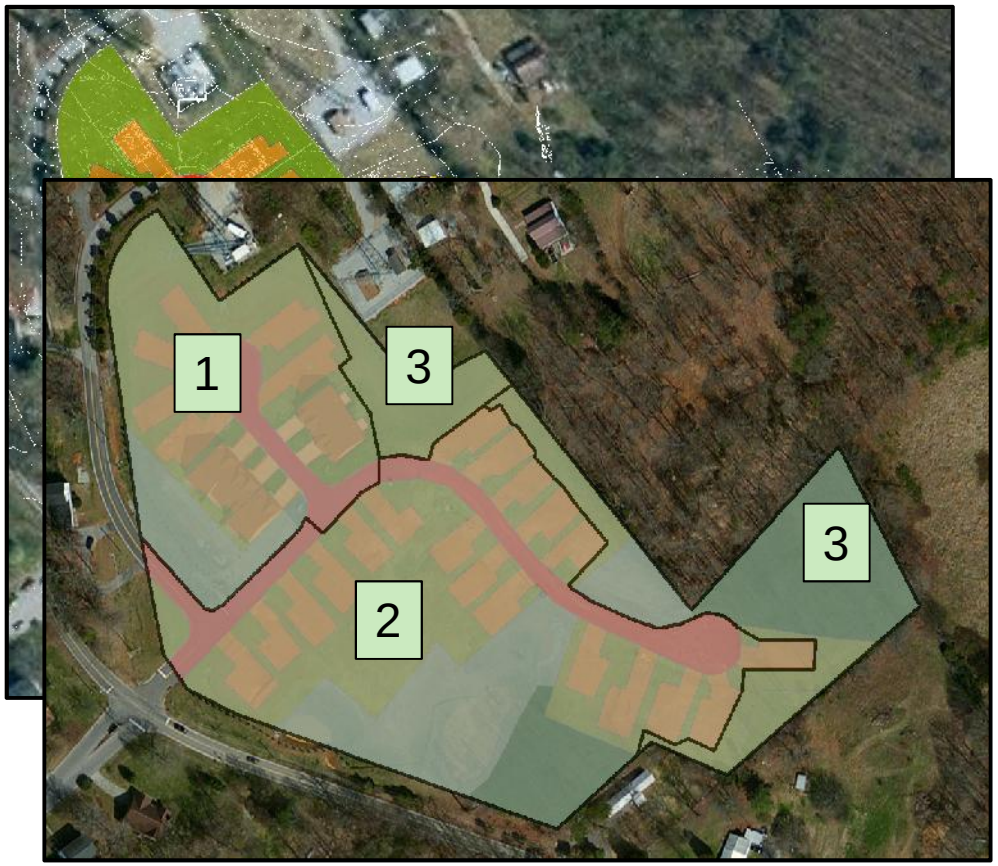
- IA = 3.2 ac
- Turf B = 5.3 ac
- Forest B = 1.4 ac

Table 4 - Site Cover Runoff Coefficients				
Soil Condition	Volumetric Runoff Coefficient (R_v)			
IMPERVIOUS COVER			0.95	
HYDROLOGIC SOIL GROUP	A	B	C	D
FOREST COVER	0.02	0.03	0.04	0.05
TURF	0.15	0.18	0.20	0.23

$$Rv = \frac{((3.2ac \times 0.95) + (5.3ac \times 0.18) + (1.4ac \times 0.03))}{3.2ac + 5.3ac + 1.4ac}$$

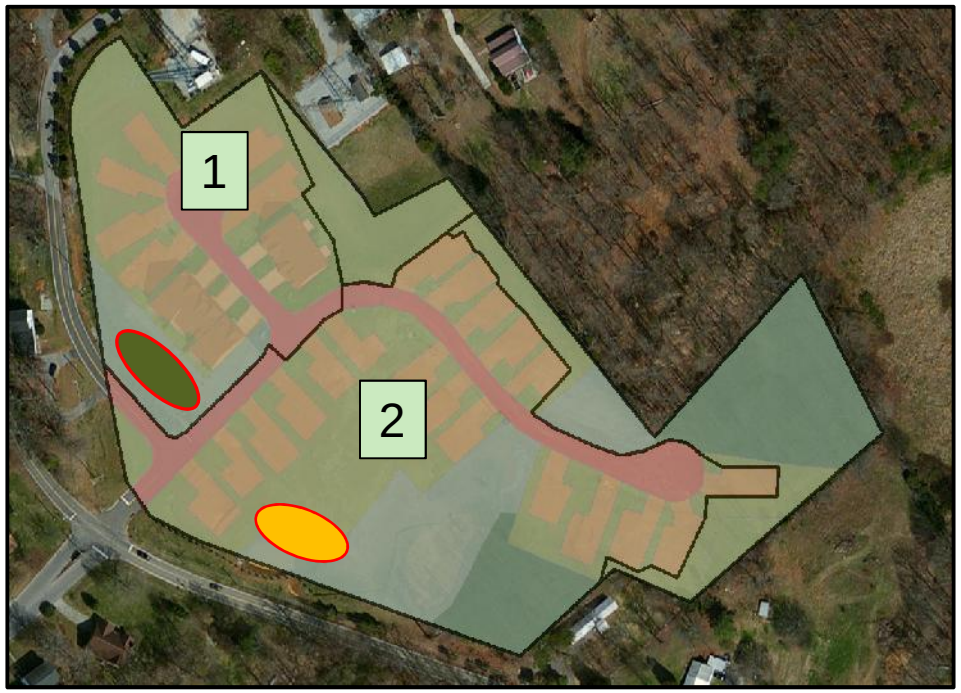
$$Rv = 0.41$$

8c Single Family Residential Limitations
Drainage Area



1. Green Infrastructure
2. Total Suspended Solids
3. Off Site

8c Single Family Residential Limitations
Structural



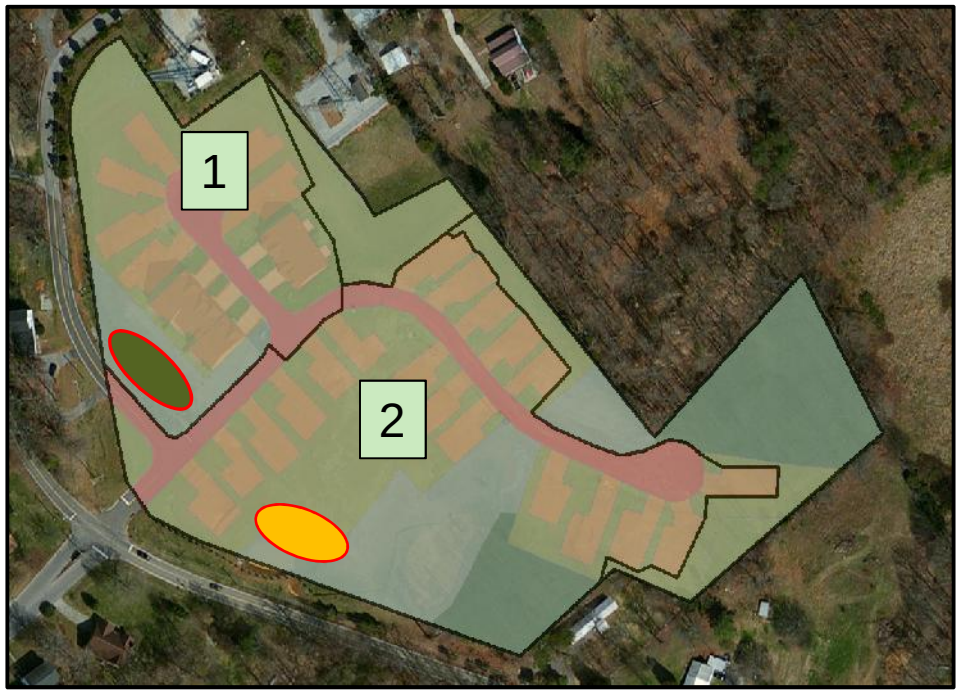
1. Green Infrastructure

Bioretention Cell (Level 1) in Common Area

2. 80% TSS

Grass Channel → Dry Pond

8c Single Family Residential Limitations
Structural



1. Green Infrastructure

Bioretention

Level 1 -RR Credit 60%

2. 80% TSS

Grass Channel – 50% TSS

Dry Pond – 60% TSS

$$TRM\%_{total} = TSS_A + TSS_B - \frac{(TSS_A \times TSS_B)}{100}$$

$$80\% = 50 + 60 - \frac{(50 \times 60)}{100}$$

$$Rv = \frac{\left((2.6ac \times 0.51\,(1 - 0.60)) + (5ac \times 0.49(1 - 0.80)) + (1.4ac \times 0.18) + (0.9ac \times 0.03)\right)}{2.6ac + 5ac + 1.4ac + 0.9ac}$$

$$Rv = 0.13$$

8c Single Family Residential Limitations Summary

1. Green Infrastructure

Bioretention, Level 1

Surface Area

= 0.085 ac or 3,702 ft^2

2. 80% TSS

Grass Channel

Dry Pond

$Rv = 0.41$

$Rv = 0.13$

Challenge:
- Developable Space
- Sinkhole Limitations

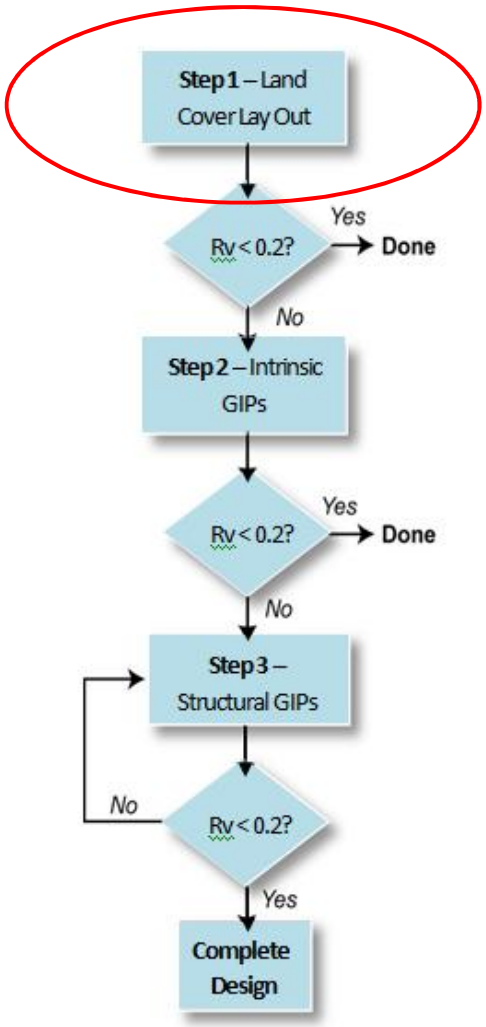
Benefit:
- Landscaping Aesthetics
- Multi-objective use of detention space for water quality

Large Commercial Redevelopment

8d – Large Commercial Development

- Existing large commercial shopping center
- Built in the late 1970's
- 24.4 acres
- Nearly 100 percent impervious
- No on-site BMPs
- Primarily HSG D soils (urban)
- Commercial redevelopment with the addition of some new retail businesses

8d – Large Commercial Development



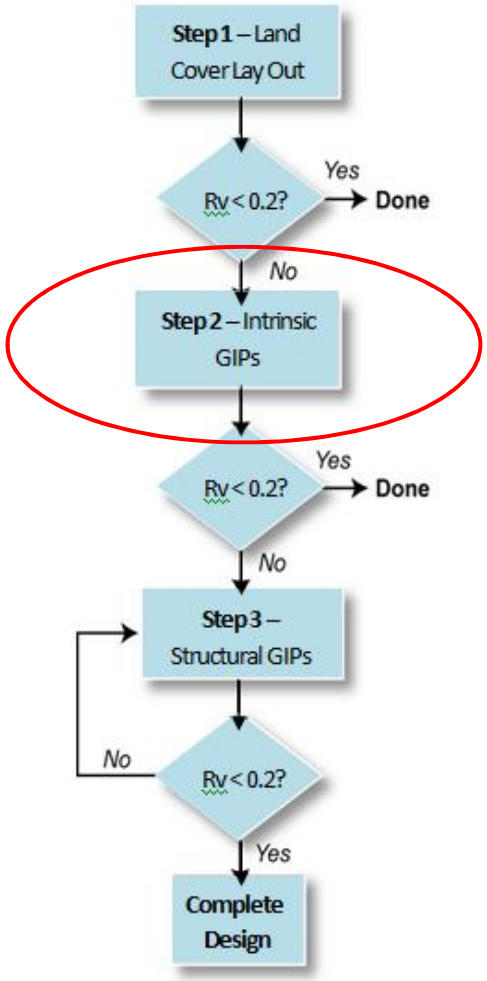
Challenges:

- High imperviousness, with no available space for stormwater controls
- Initial Investment for stormwater upgrades
- Tight urban soils

8d – Large Commercial Development

- Total Site Acreage
  - 24.4 acres
- Turf D
  - 0.9 acres
  - Rv = 0.23
- Impervious
  - 23.5 acres
  - Rv = 0.95
- Existing Condition
  - Weighted Rv = 0.92
  - 0.92 >> 0.20

8d – Large Commercial Development



- Can we take advantage of existing natural landscape to meet the design Rv goal of 0.20?
  - Increase pervious areas
  - Shorten drainage flow paths to encourage sheet flow
  - Redevelopment must still meet zoning requirements
  - No large natural landscape areas available to take advantage of

8d – Large Commercial Development

Table 1 – Effectiveness of BMPs in Meeting Stormwater Management Objectives			
Practices	**Volume**	**Peak Discharge**	**Water Quality**
Bioretention	●	●	●
Urban Bioretention	◉	◉	●
Permeable Pavement	●	●	◉
Infiltration Trench	●	●	●
Water Quality Swales (Dry)	◉	◉	●
Extended Detention	○	●	○
Downspout Disconnection	◉	◉	◉
Grass Channels	○	○	○
Sheet Flow	●	●	◉
Reforestation	●	●	●
Rain Tanks/Cisterns*	◉	○	○
Green Roofs	◉	●	●

* A single cistern typically provides greater volume reduction than a single rain tank

● - Well suited for land use applications or high relative dedicated land area required.
◉ - Average suitability for land use applications or moderate relative dedicated land area required.
○ - Low relative dedicated land area required.

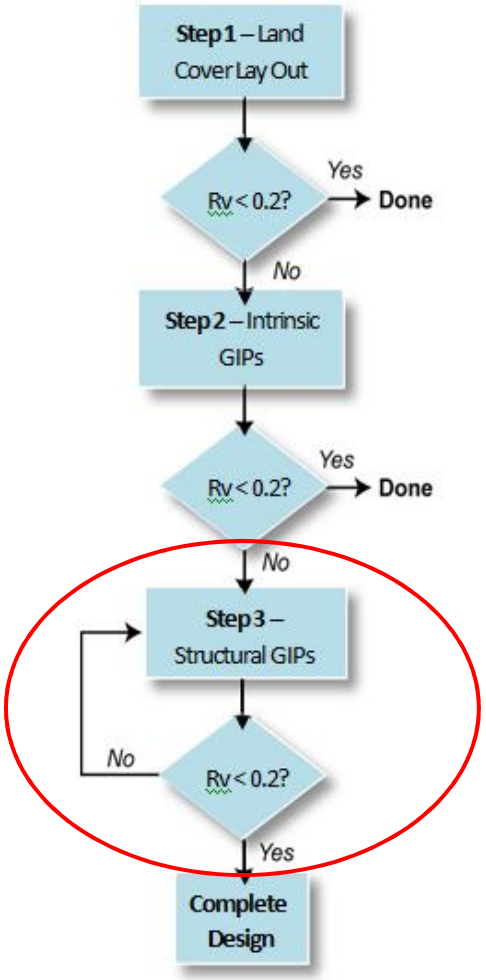
8d – Large Commercial Development

Table 2 – Green Stormwater Infrastructure Land Use and Land Area Selection Matrix

Practices	Criteria							
	Land Use							Land Area Required
	Schools	Com.	Indust.	SF Res.	MF Res.	Parks/Open Space	Roads/ Roadside	
Bioretention	●	●		●	●	●	●	◉
Urban Bioretention	◉	●			●	●	●	○
Permeable Pavement	●	●	◉	●	●	●	●	○
Infiltration Trench	●	●		●	●	●	◉	○
Water Quality Swales (Dry)	●	●			●		●	◉
Extended Detention	●	●	●		●		●	○
Downspout Disconnection	●	◉		●	●	●		○
Grass Channels	●	●		●	●	◉	●	◉
Sheet Flow	●	●		●	●	◉	●	◉
Reforestation	◉		◉	◉	◉	●	●	○/●
Rain Tanks/Cisterns	●	◉	◉	●	●			○
Green Roofs	●	●	●		●			○

● - Well suited for land use applications or high relative dedicated land area required.
◉ - Average suitability for land use applications or moderate relative dedicated land area required.
○ - Low relative dedicated land area required.
Blank – Not applicable for land use.

8d – Large Commercial Development



- Structural GIP selection.
  - Multiple bioretention cells, both small and large
  - Multiple permeable pavement areas with both pavers and porous asphalt
  - Small infiltration trenches where possible
- Size and layout GIPs to achieve design Rv = 0.20
  - Iterative process

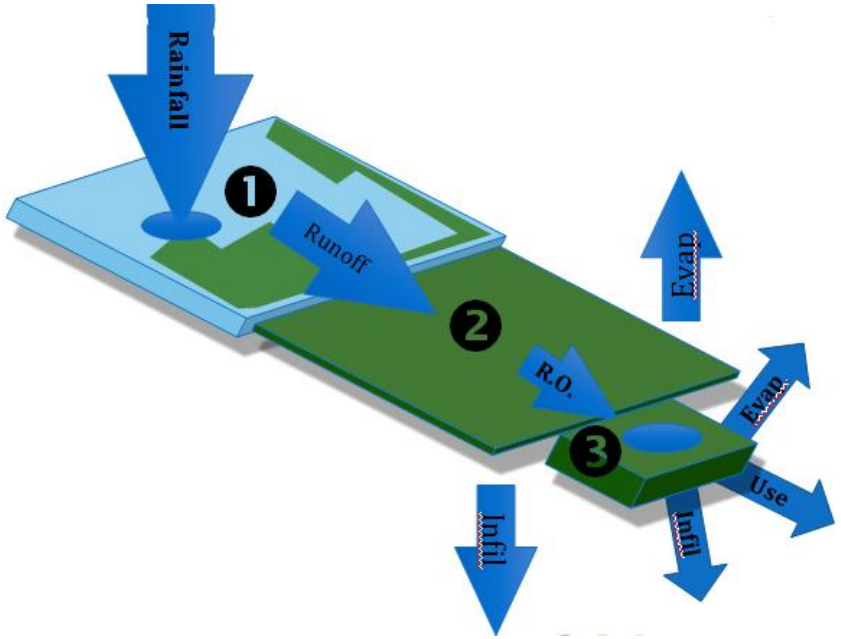
8d – Large Commercial Development

- Final Design Summary
  - Decreased impervious surfaces by adding pervious pavements and bioretention areas.
  - Decreased flow paths to promote sheet flow.
  - Added infiltration trench.
  - Routed all impervious areas to Level 2 GIPs.

Table 5 – Green Infrastructure Practices Runoff Reduction Credit Percentages								
Green Infrastructure Practice	% Rainfall Volume Removed/Captured – RR Credit							
	Level 1**				Level 2**			
1. Bioretention	60				80			
2. Urban Bioretention	60				N/A			
3. Permeable Pavement	45				75			
4. Infiltration Trench	50				90			
5. Water Quality Swale	40				60			
6. Extended Detention	15				N/A			
7. Downspout Disconnection*	25				50			
8. Grass Channel	10/20				20/30			
9. Sheet Flow *	50				75			
10. Reforestation (A, B, C, D soils)	96	94	92	90	98	97	96	95
11. Rain Tanks/Cisterns	Design dependent							
12. Green Roof	80				90			

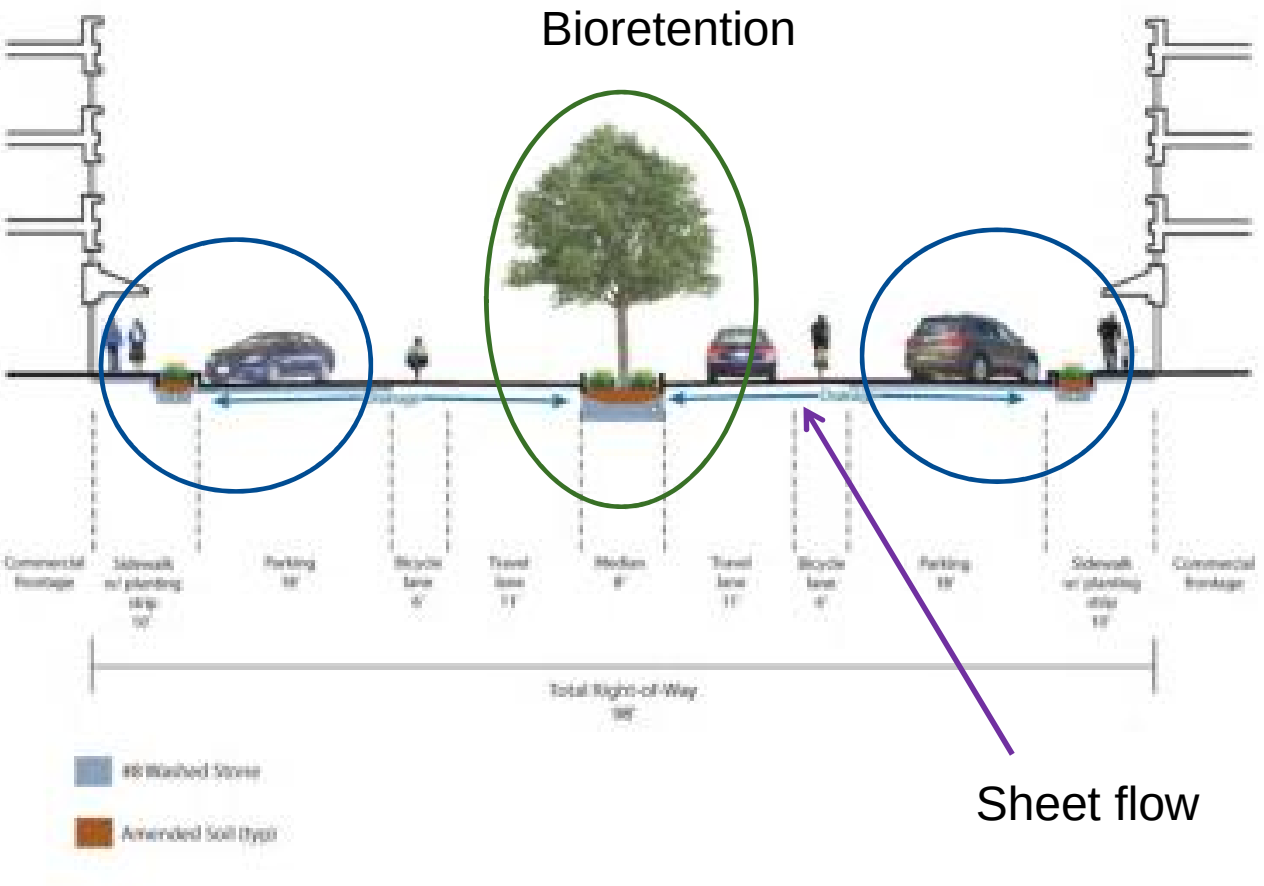
*See GIP for additional RR credits.

**See GIP for additional information of the distinction between Level 1 and Level 2 design.



8d – Large Commercial Development

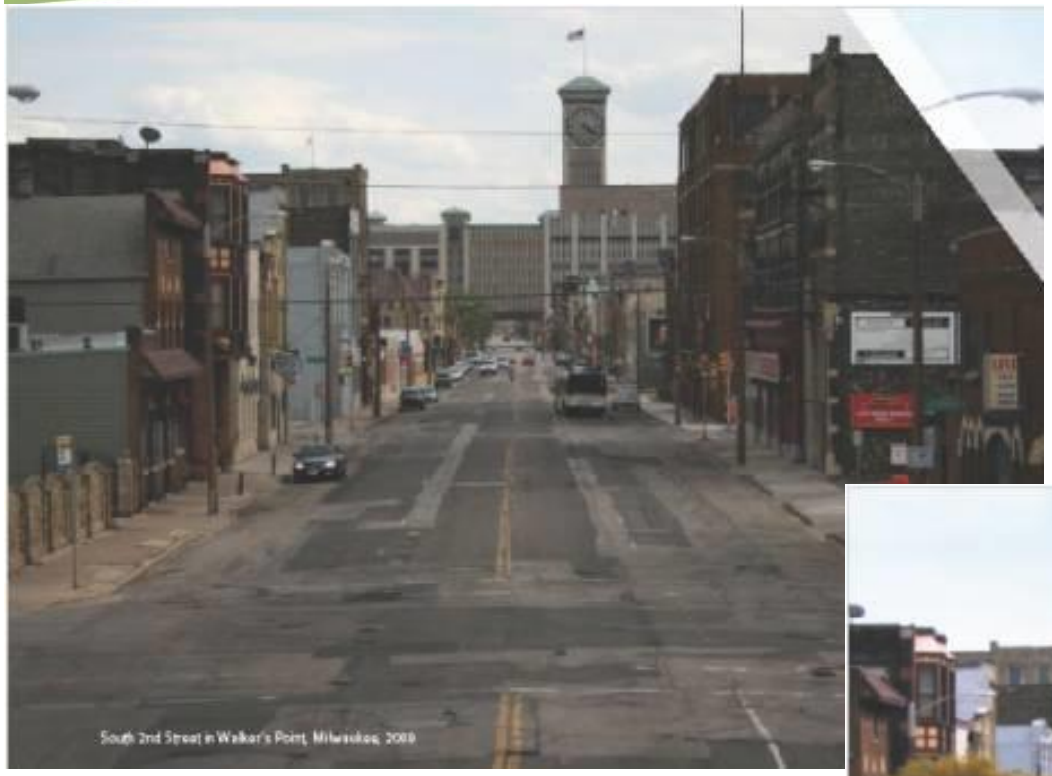
- Typical Section



Strong Curb Appeal Thru Multi-Functional Landscape

B

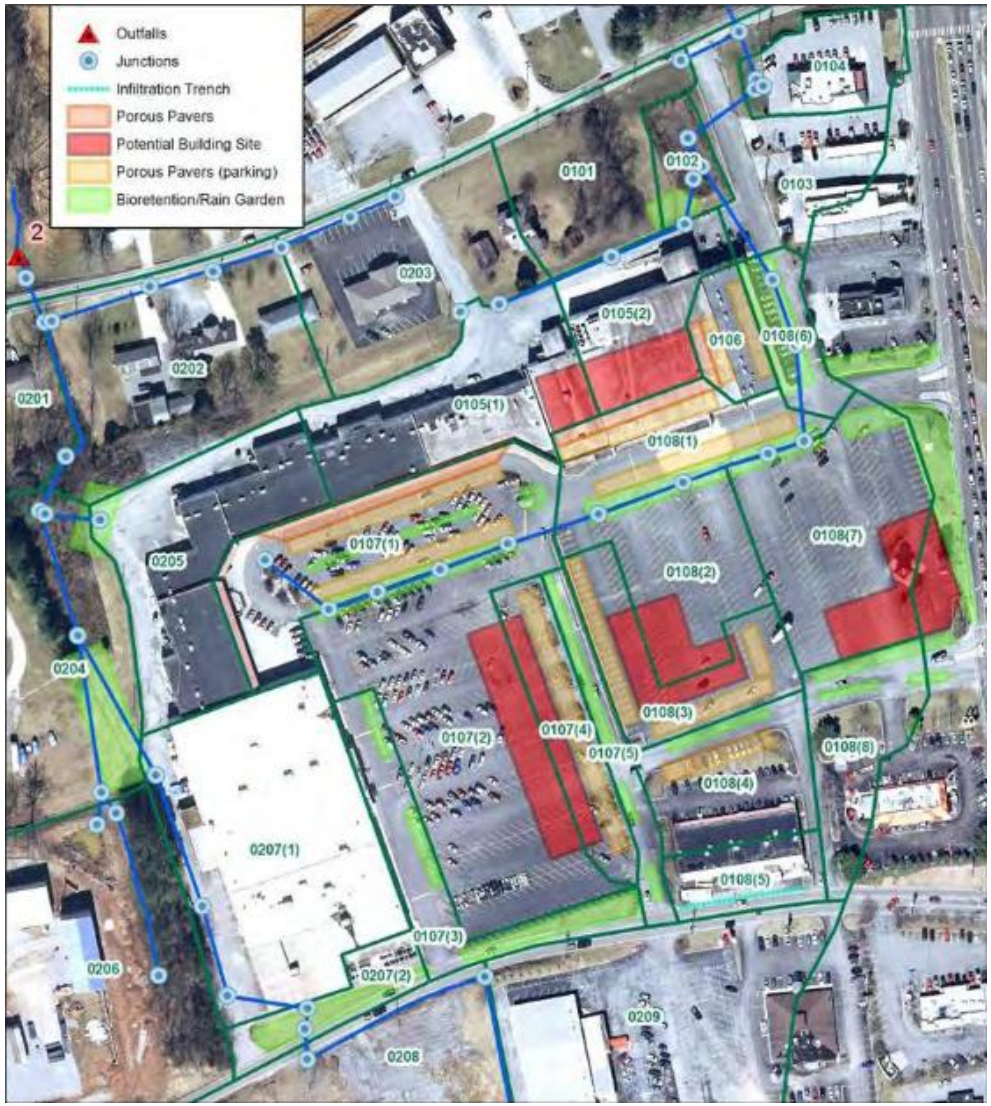
Increasing Curb Appeal (GI Concepts)



Before GIPs

After GIPs

8d – Large Commercial Development

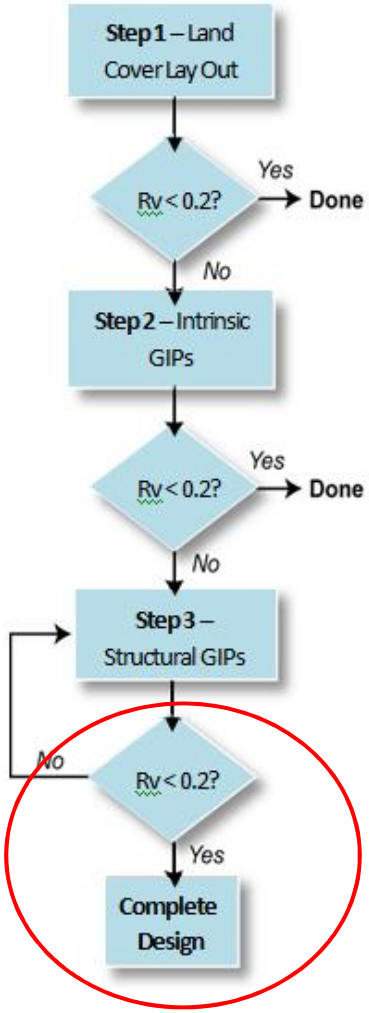


- Final Design
  - Total Site Acreage
    - 24.4 acres
  - Bioretention Cells (L2)
    - RR Credit = 80%
    - Acreage = 14.9
  - Pervious Pavements (L2)
    - RR Credit = 75%
    - Acreage = 8.4 (23.3)
  - Infiltration Trenchs (L2)
    - RR Credit =90%
    - Acreage = 0.56
  - Turf D Soils
    - Acreage = 0.45
  - Impervious Area
    - Acreage = 0.12
- Proposed Plan
  - Weighted Rv = 0.20
  - 0.20 = 0.20

Comparison with Traditional Methods (ED Pond)

- Total Site Acreage
  - 24.4 acres
- Pond Surface Area
  - 1.7 acres (approx.)
- Loss of parking and probably an out-lot
- Missed opportunity for multi-functional landscape
- Landscape $ won't also be stormwater maintenance $

8d – Large Commercial Development



Challenges:

- High imperviousness, with little space for stormwater controls
- Initial Investment for stormwater upgrades
- Tight urban soils

Benefits:

- Long-term maintenance investment is relatively low
- Use of less land space for stormwater as compared to large single-structure (extended detention)
- Reduce needs for runoff detention, if required
- Multi-functional landscaping aesthetics can meet WQ requirements and improve curb appeal/aesthetic
- Additional rental/tenant space in new out-lot buildings

Questions?