~~BORING~~ REALLY EXCITING ENGINEERING METHODS, EQUATIONS AND OTHER NERDY THINGS

Hunter Freeman, PE

North Carolina Coastal Federation
Working Together for a Healthy Coast

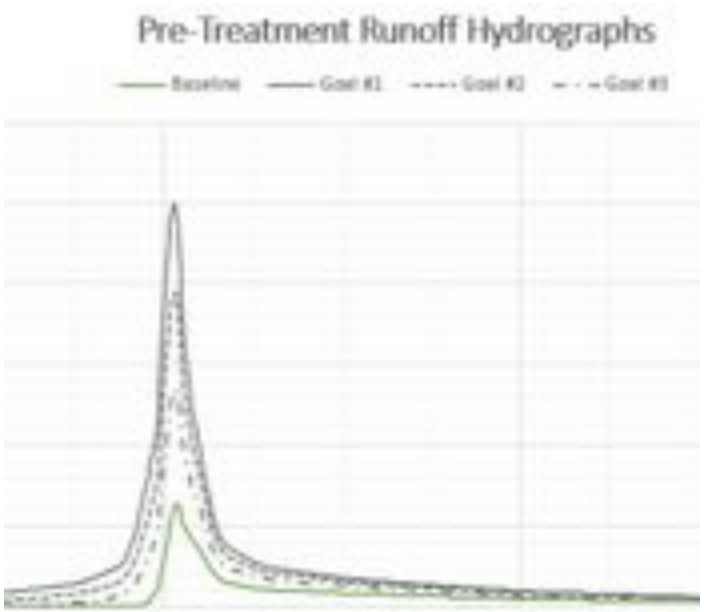
WithersRavenel
Our People. Your Success.

So we have 2 land use scenarios, how do we quantify runoff volume?

Watershed EZ Tool

South Atlantic Alliance Watershed Plan

Project Information	
Project Name:	South Atlantic Alliance
Project Address:	Wrightsville Beach, NC
Contact Information:	
Watershed Information	
Description:	
Total Site Area (Ac):	
Total Baseline Impervious Area (Ac):	
River Basin:	



Baseline Conditions

Description:

Total Drainage Area (ac): 100.00

HSG	Land Use	CN	Area (acres)	%
Land Use				
B	Open Space	61	55.00	55%
B	Open Space	61	45.00	45%
User Defined Land Uses				

Baseline Composite Curve Number = 61

Baseline T_c

User Defined T_c (hours): 0.12

Summary | Watershed Data | Volume Reduction | References

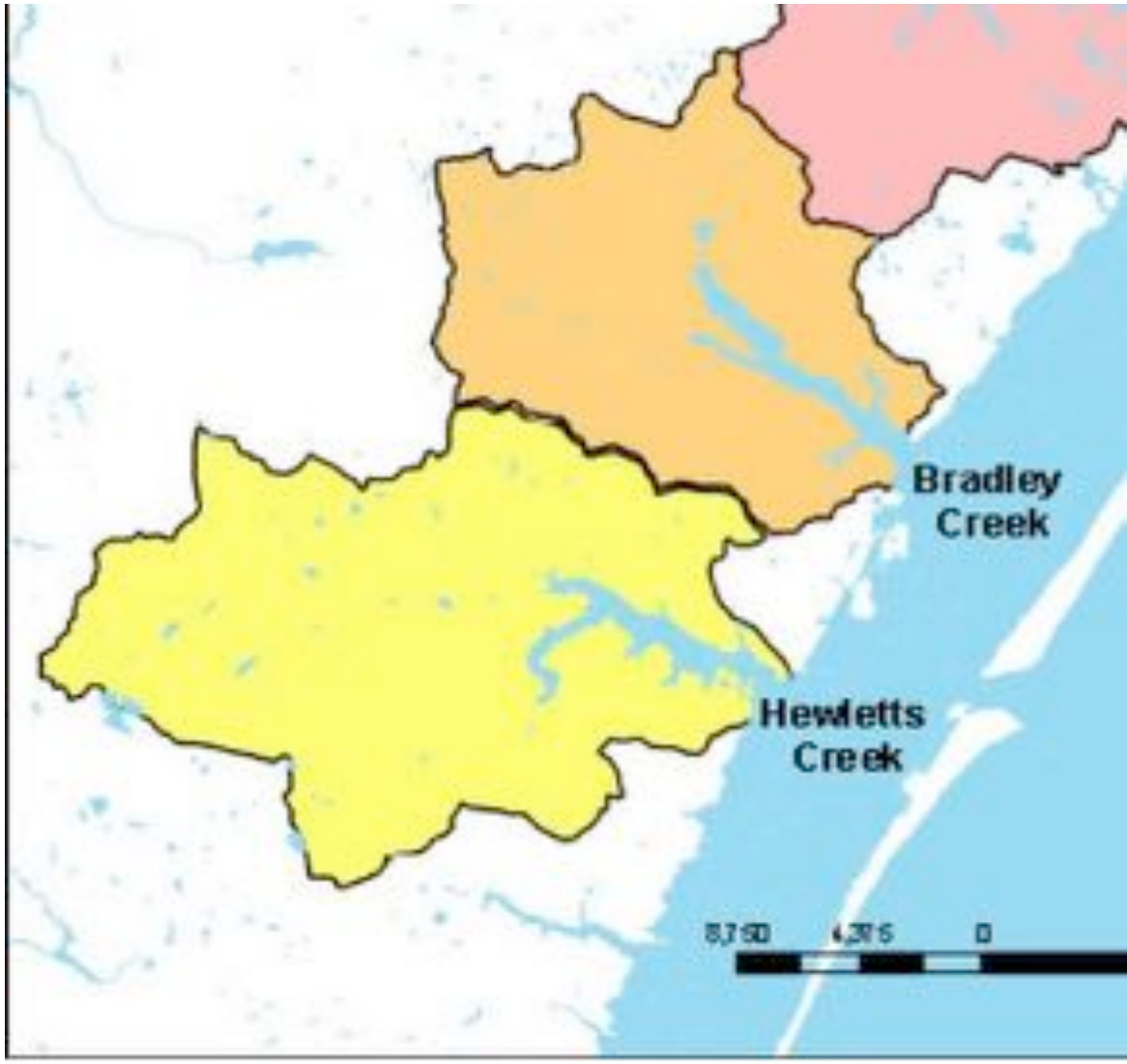
Data Collection

Watershed Boundary

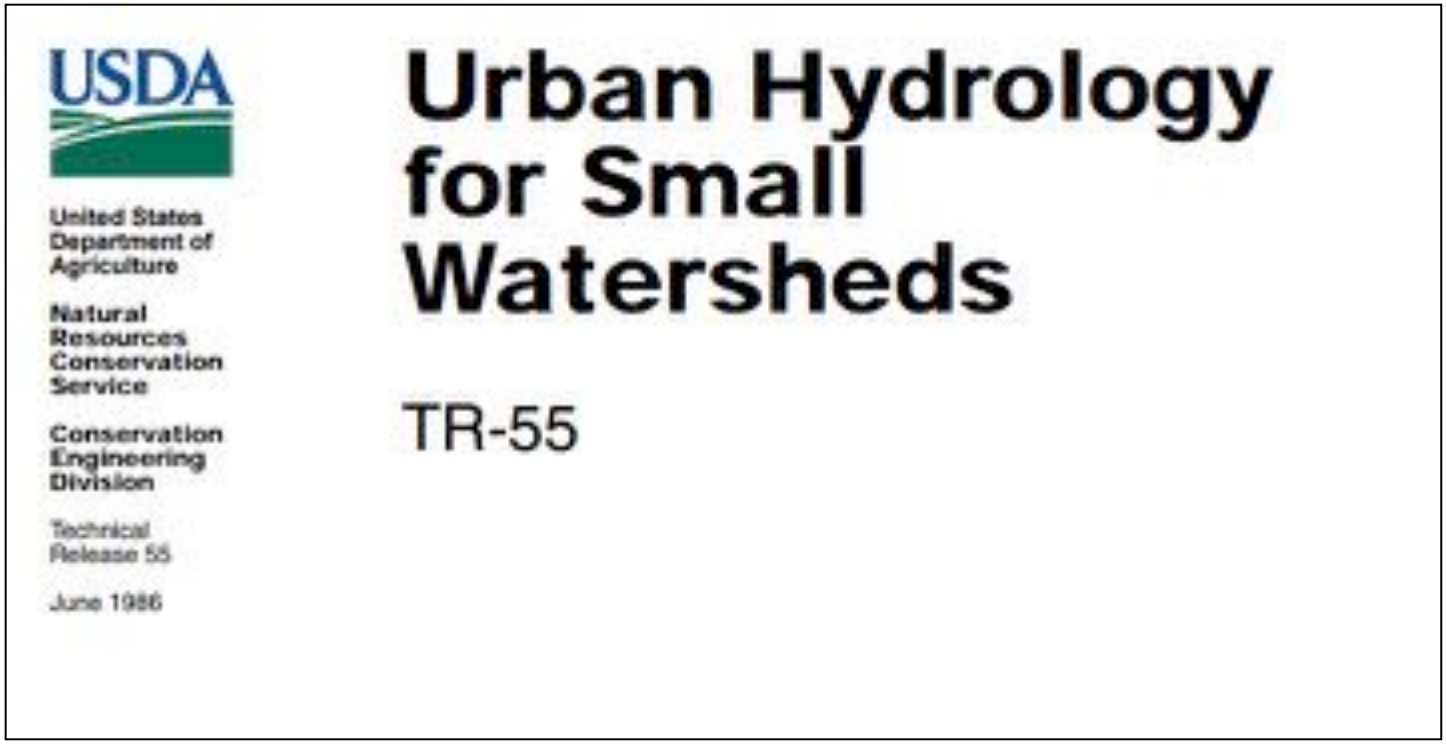
Land Use
- Impervious cover
- Open space
- Woods
- Others?

Soil Type

Rainfall Data

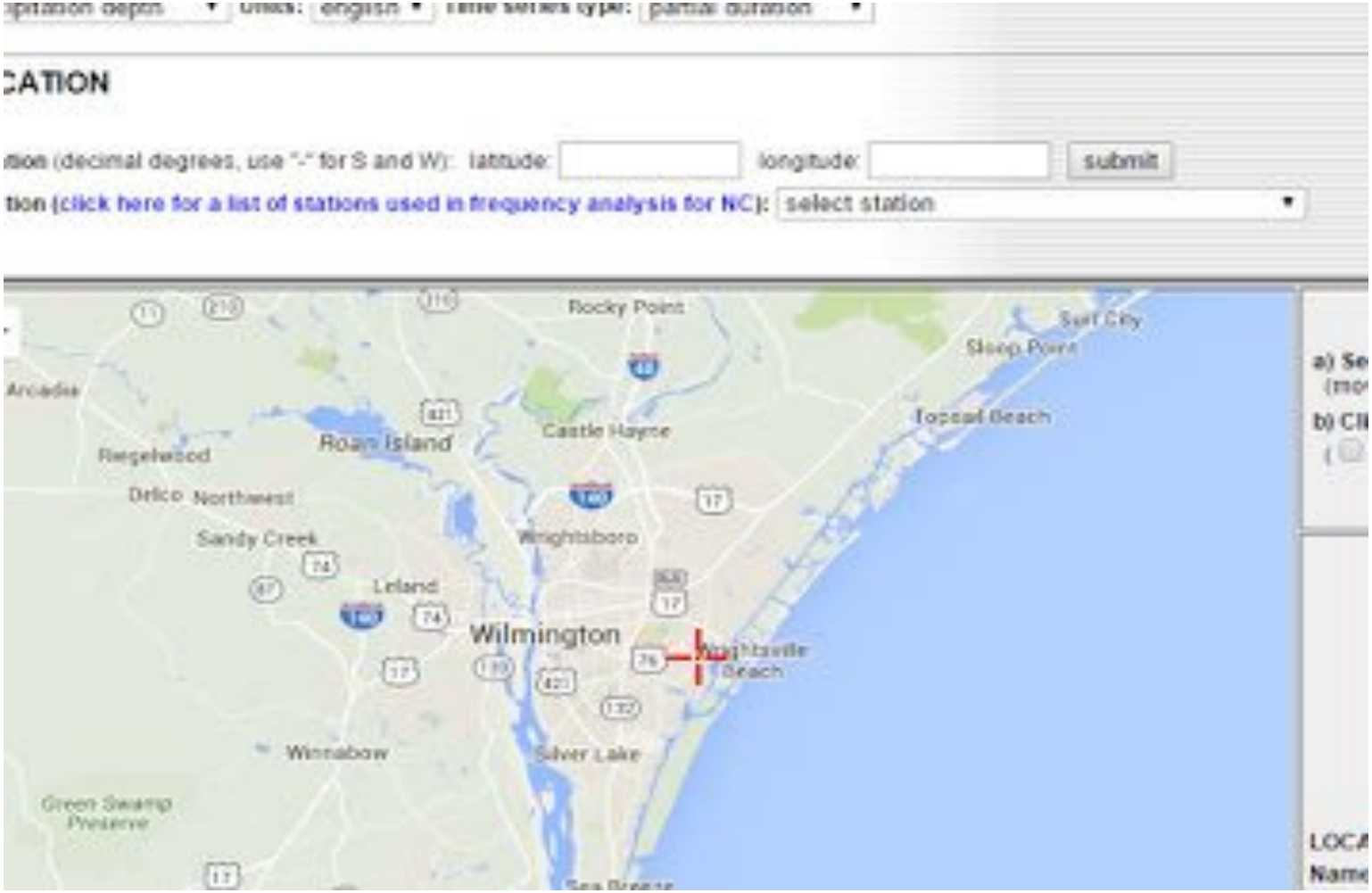


CN Method


USDA
United States Department of Agriculture
Natural Resources Conservation Service
Conservation Engineering Division
Technical Release 55
June 1986
Urban Hydrology for Small Watersheds
TR-55

Methodology

Rainfall Data

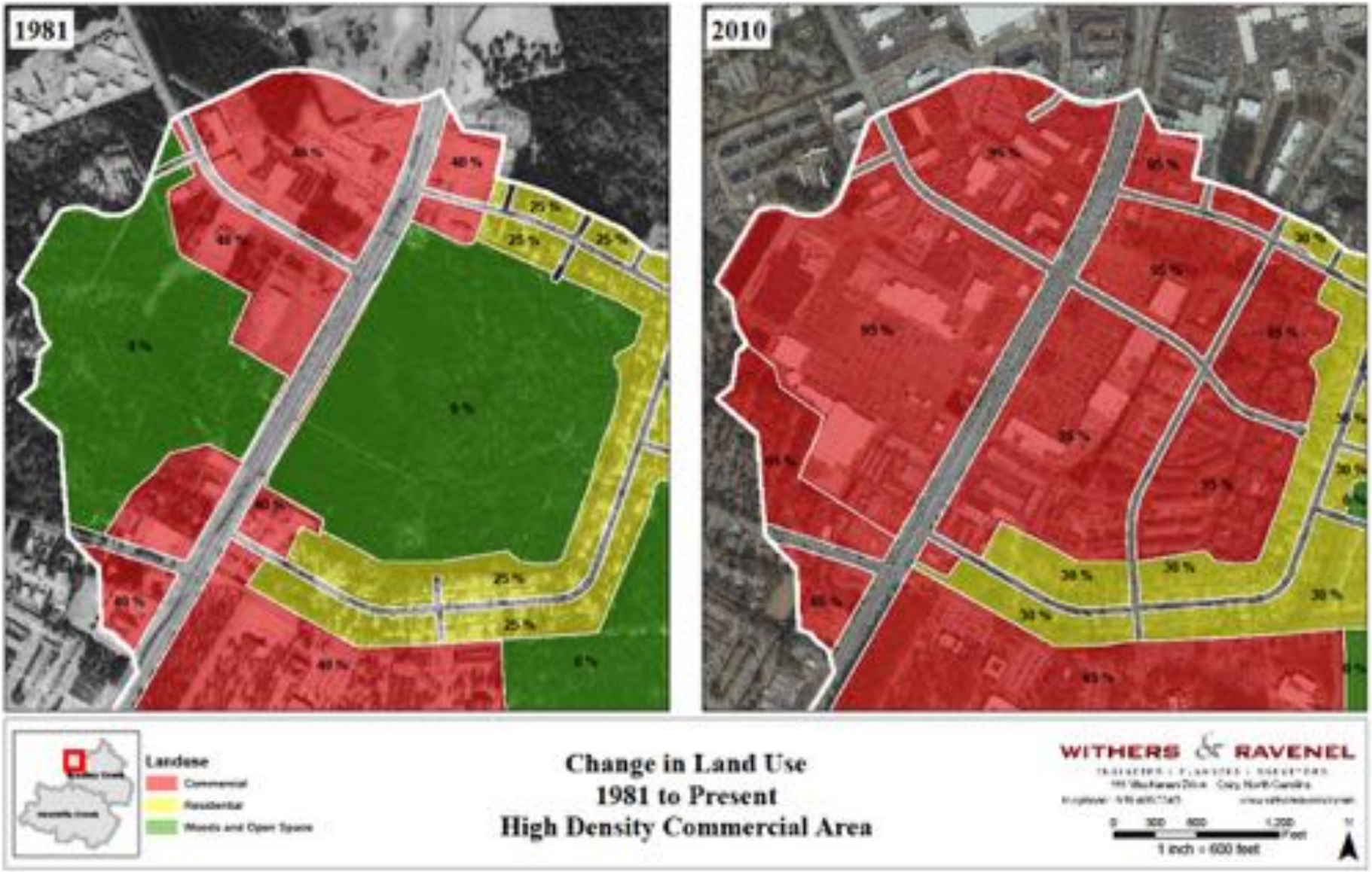


Rainfall Data

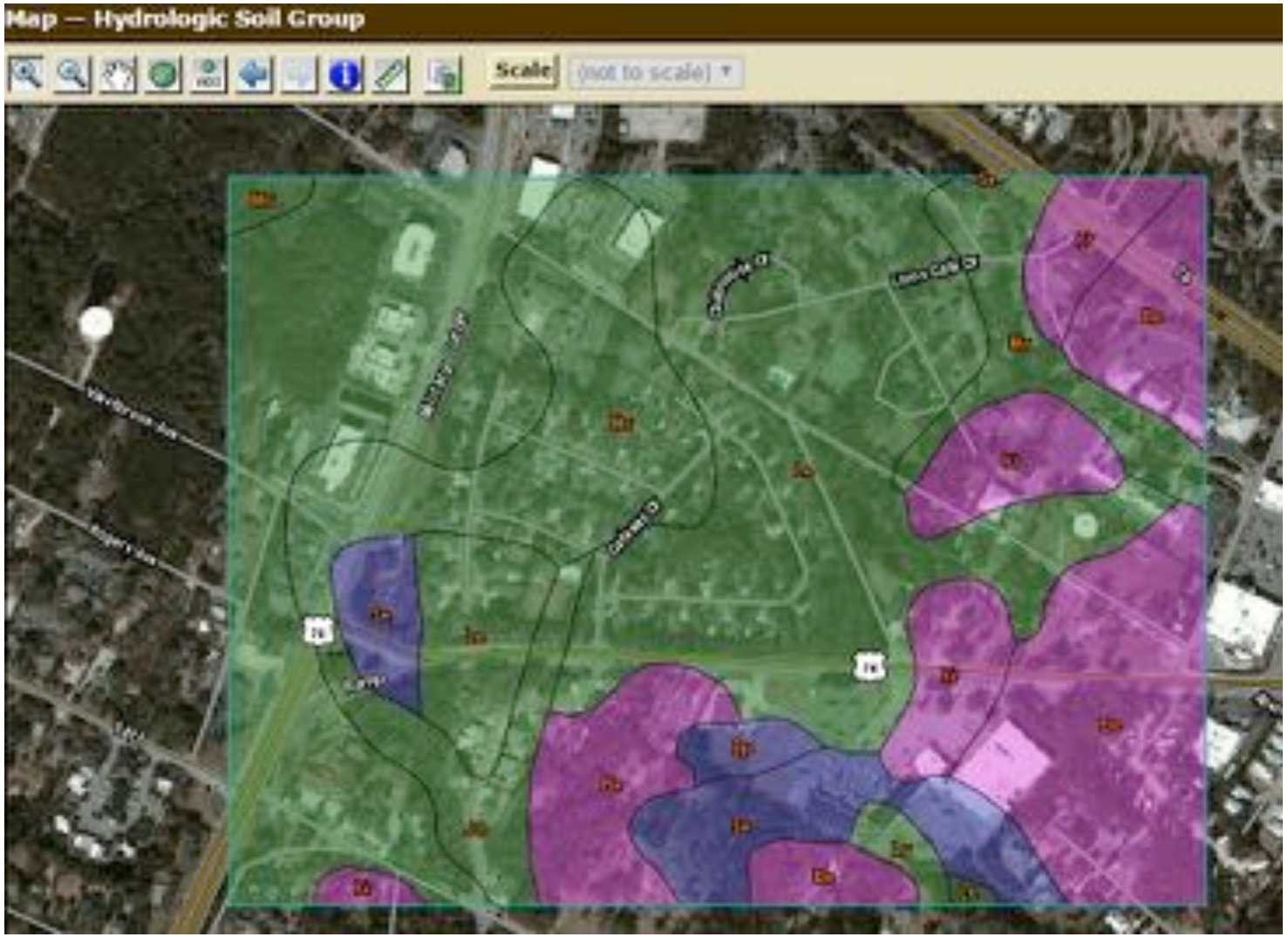
PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.525 (0.489-0.566)	0.624 (0.581-0.672)	0.729 (0.678-0.785)	0.812 (0.752-0.874)	0.917 (0.845-0.984)	0.995 (0.914-1.07)	1.08 (0.983-1.16)	1.16 (1.05-1.25)	1.26 (1.13-1.36)	1.35 (1.20-1.46)
10-min	0.839 (0.782-0.904)	0.997 (0.929-1.07)	1.17 (1.09-1.26)	1.30 (1.20-1.40)	1.46 (1.35-1.57)	1.58 (1.46-1.70)	1.71 (1.56-1.84)	1.83 (1.66-1.97)	2.00 (1.79-2.15)	2.12 (1.89-2.29)
15-min	1.05 (0.977-1.13)	1.25 (1.17-1.35)	1.48 (1.37-1.59)	1.64 (1.52-1.77)	1.85 (1.71-1.99)	2.01 (1.84-2.16)	2.16 (1.98-2.32)	2.31 (2.10-2.49)	2.51 (2.26-2.71)	2.67 (2.37-2.88)
30-min	1.44 (1.34-1.55)	1.73 (1.61-1.87)	2.10 (1.95-2.26)	2.38 (2.21-2.56)	2.74 (2.53-2.94)	3.02 (2.78-3.25)	3.31 (3.02-3.56)	3.60 (3.27-3.88)	4.00 (3.59-4.32)	4.32 (3.84-4.67)
60-min	1.79 (1.67-1.93)	2.17 (2.02-2.34)	2.69 (2.50-2.90)	3.10 (2.87-3.33)	3.65 (3.37-3.92)	4.10 (3.76-4.40)	4.56 (4.17-4.90)	5.05 (4.58-5.44)	5.74 (5.15-6.19)	6.30 (5.61-6.81)
2-hr	2.12 (1.95-2.31)	2.58 (2.37-2.82)	3.28 (3.02-3.58)	3.87 (3.55-4.22)	4.71 (4.30-5.14)	5.43 (4.93-5.92)	6.22 (5.61-6.77)	7.08 (6.34-7.69)	8.34 (7.39-9.09)	9.42 (8.29-10.3)
3-hr	2.26 (2.08-2.48)	2.75 (2.53-3.01)	3.52 (3.23-3.85)	4.18 (3.82-4.57)	5.16 (4.69-5.62)	6.01 (5.43-6.55)	6.95 (6.24-7.58)	8.01 (7.12-8.71)	9.60 (8.44-10.4)	11.0 (9.55-12.0)
6-hr	2.81 (2.59-3.09)	3.42 (3.15-3.77)	4.38 (4.03-4.82)	5.22 (4.77-5.72)	6.46 (5.87-7.07)	7.55 (6.81-8.26)	8.77 (7.86-9.58)	10.1 (8.98-11.1)	12.2 (10.7-13.3)	14.1 (12.1-15.4)
12-hr	3.29 (3.00-3.65)	4.01 (3.65-4.44)	5.17 (4.70-5.72)	6.18 (5.60-6.83)	7.71 (6.92-8.49)	9.07 (8.10-9.97)	10.6 (9.39-11.6)	12.3 (10.8-13.5)	15.0 (13.0-16.5)	17.4 (14.8-19.1)
24-hr	3.89 (3.54-4.33)	4.72 (4.31-5.27)	6.11 (5.56-6.81)	7.34 (6.65-8.18)	9.22 (8.27-10.2)	10.9 (9.69-12.1)	12.8 (11.3-14.2)	15.0 (13.0-16.7)	18.4 (15.6-20.8)	21.4 (17.8-24.1)
2-day	4.61 (4.22-5.10)	5.58 (5.10-6.17)	7.16 (6.53-7.93)	8.54 (7.75-9.45)	10.6 (9.56-11.8)	12.5 (11.1-13.9)	14.6 (12.8-16.2)	16.9 (14.7-18.9)	20.6 (17.5-23.1)	23.8 (19.8-26.9)
3-day	4.91 (4.50-5.42)	5.93 (5.43-6.55)	7.55 (6.90-8.35)	8.96 (8.16-9.91)	11.1 (9.99-12.3)	12.9 (11.6-14.3)	15.0 (13.3-16.7)	17.3 (15.1-19.3)	20.9 (17.9-23.5)	24.0 (20.2-27.2)

Natural Volume Reduction


1981
2010
Landuse
Commercial
Residential
Woods and Open Space
Change in Land Use
1981 to Present
High Density Commercial Area
WITHERS & RAVENEL
0 300 600 1,200 Feet
1 inch = 600 feet

Soil Type



CN Method

From NEH-4, Chapter 10, NRCS (SCS) 1985

S = Maximum Soil Storage (inches)

$$S = \frac{1000}{CN} - 10$$

CN Method

From NEH-4, Chapter 10, NRCS (SCS) 1985

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

$$I_a = 0.2S$$

$$S = \frac{1000}{CN} - 10$$

where

Q = runoff (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in) and
I_a = initial abstraction (in)

Volume Reduction

Rainfall Volume	-	Natural Losses	=	Surface Runoff
P x Area		S & Ia		Q x Area

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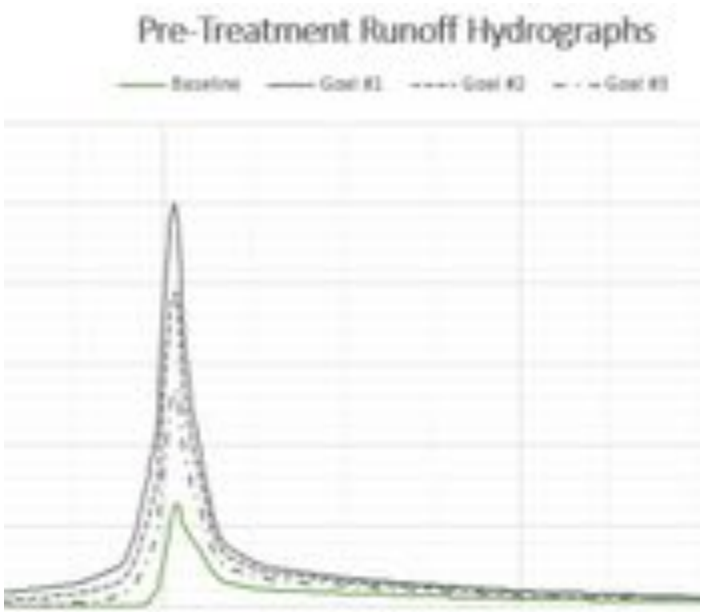

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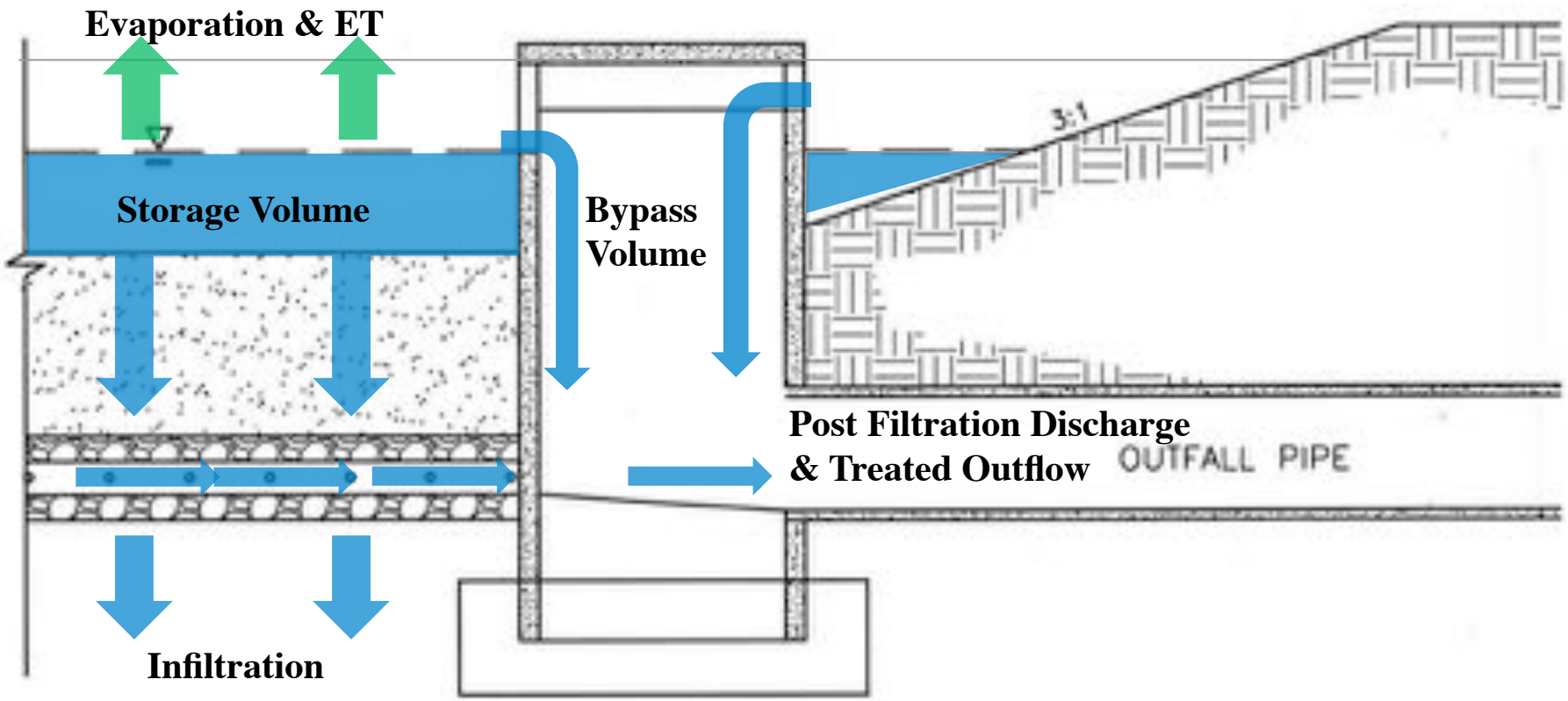
Summary | Watershed Data | Volume Reduction | References

Methods of Treating Runoff

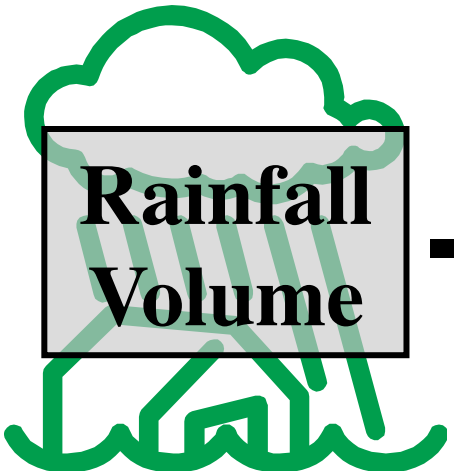
Volume Reduction BMPs

Volume Reduction BMPs

BMP Functions / Data

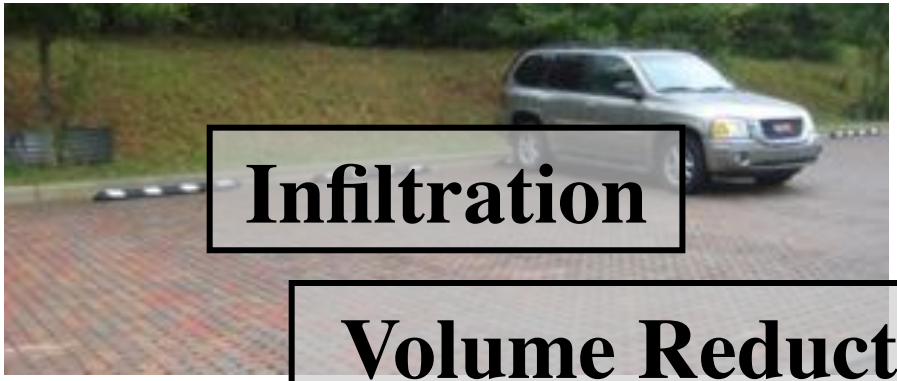


Volume Reduction Summation



Rainfall Volume

-



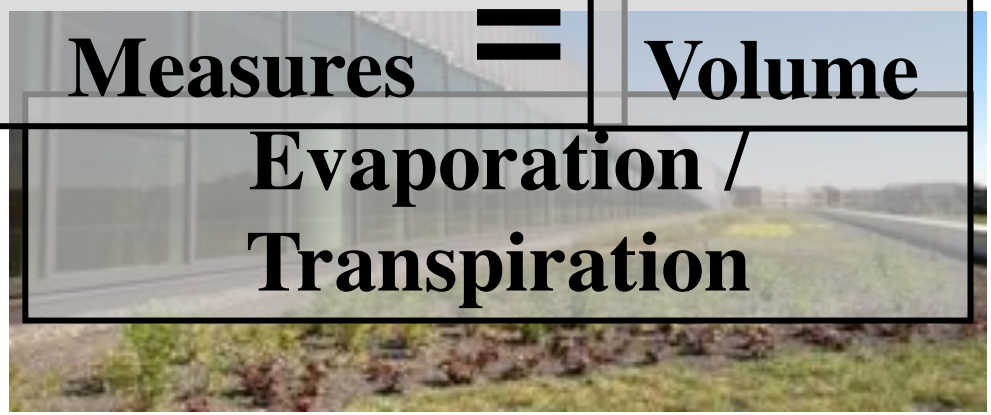
Infiltration

Reuse

DIS

Volume Reduction Measures

=



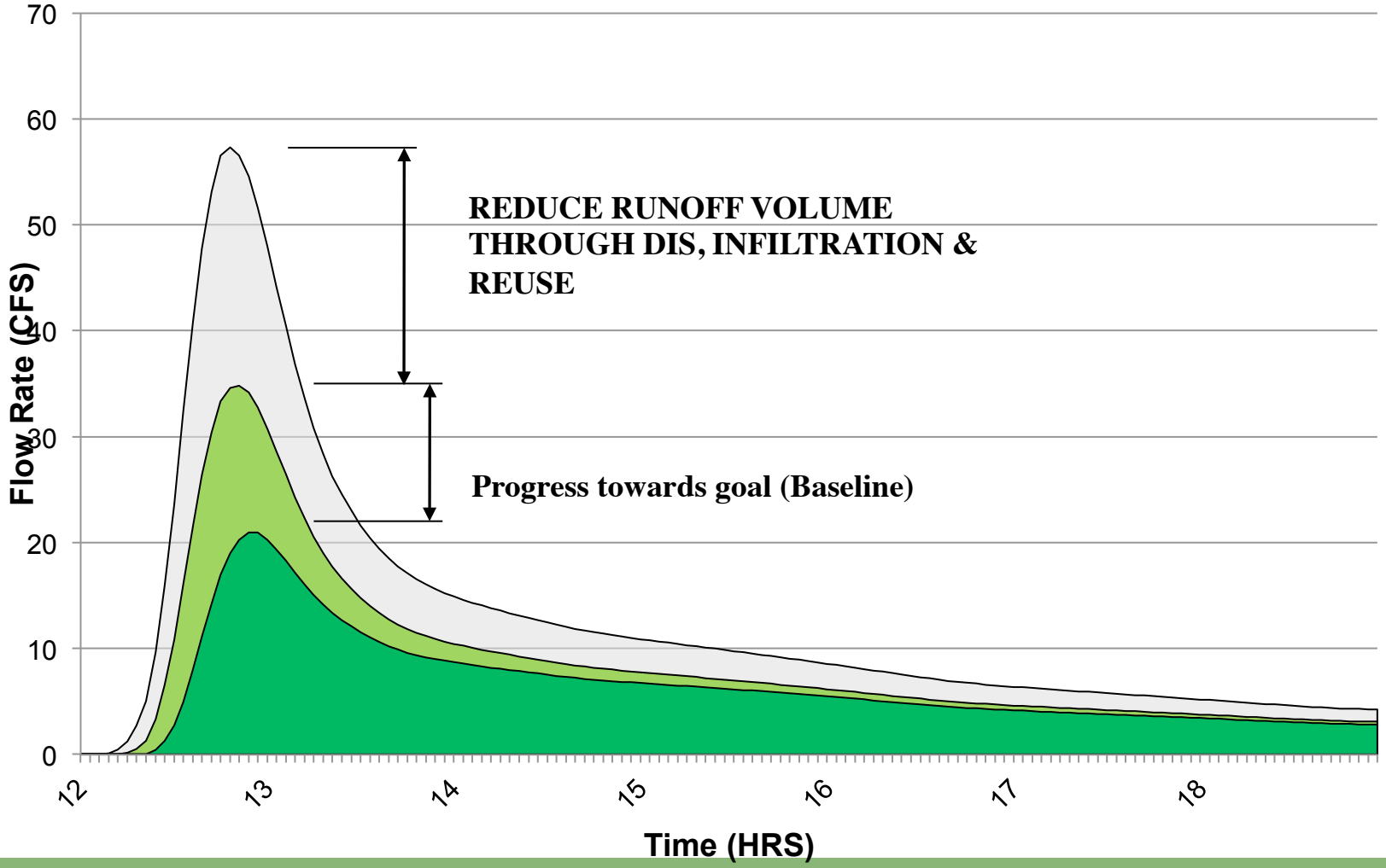
Runoff Volume

Evaporation / Transpiration

Natural Losses

Watershed EZ

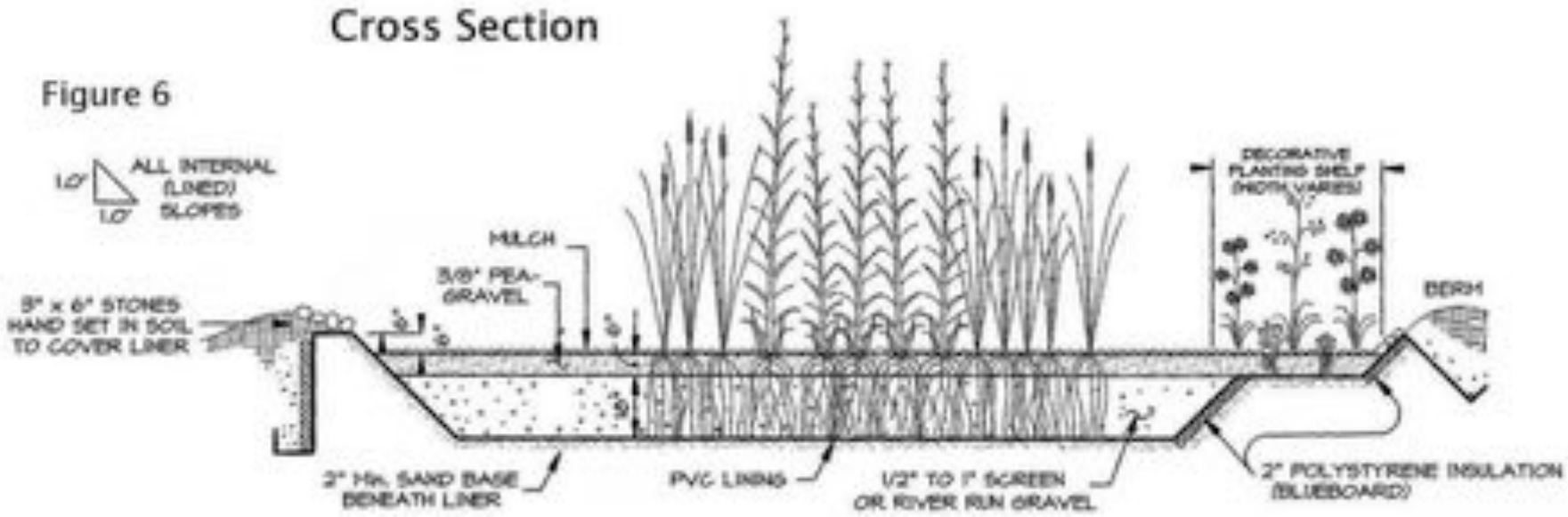
- **Easy to analyze impact of small scale BMPs**



Wet Ponds

Dry Ponds

Constructed Wetland



Constructed Wetlands

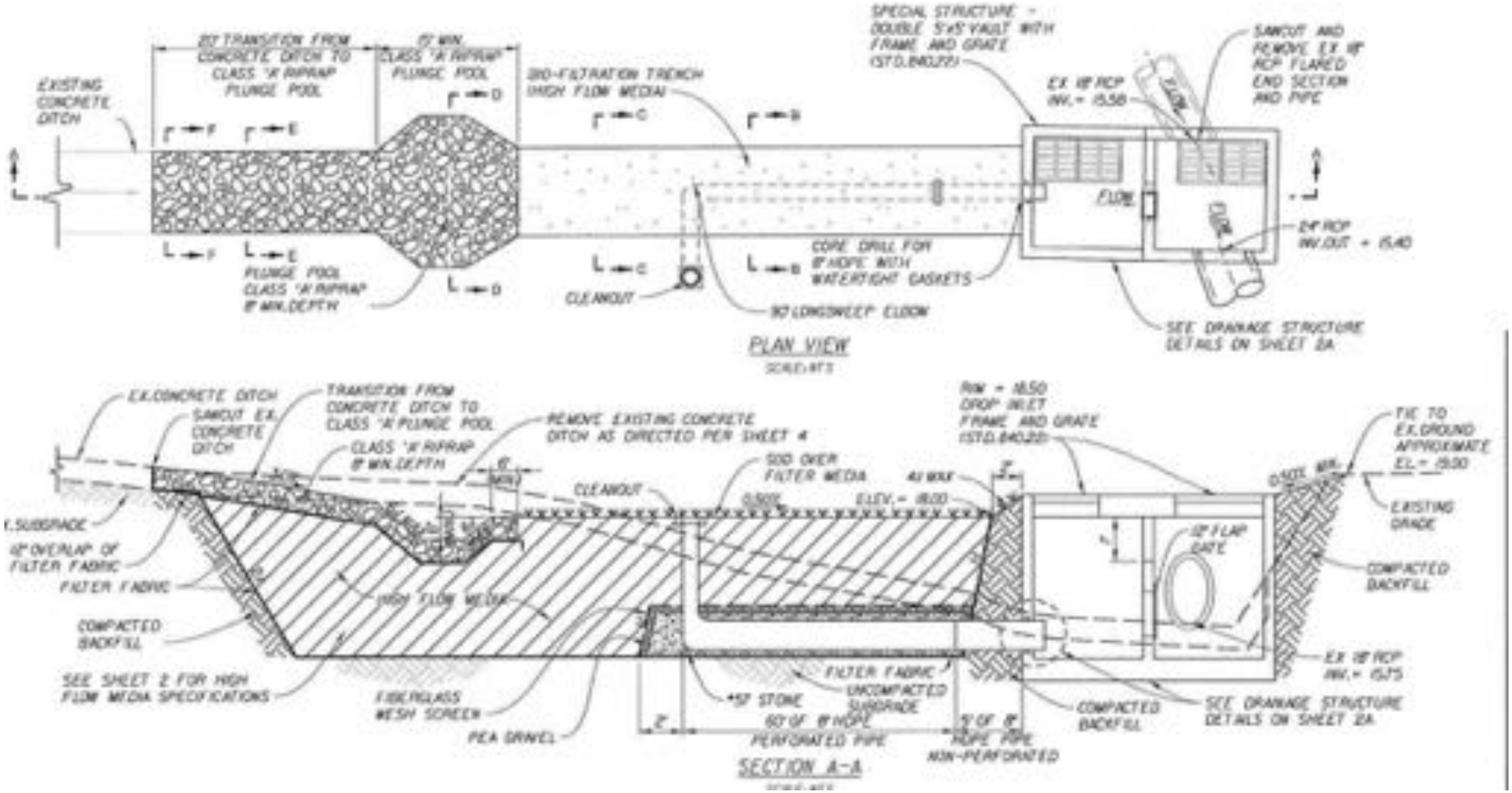
Location:
Large Footprint
Habitat
Detination

Performance:
Low Volume Removal
Flood Control
Evaporation
High Water Table

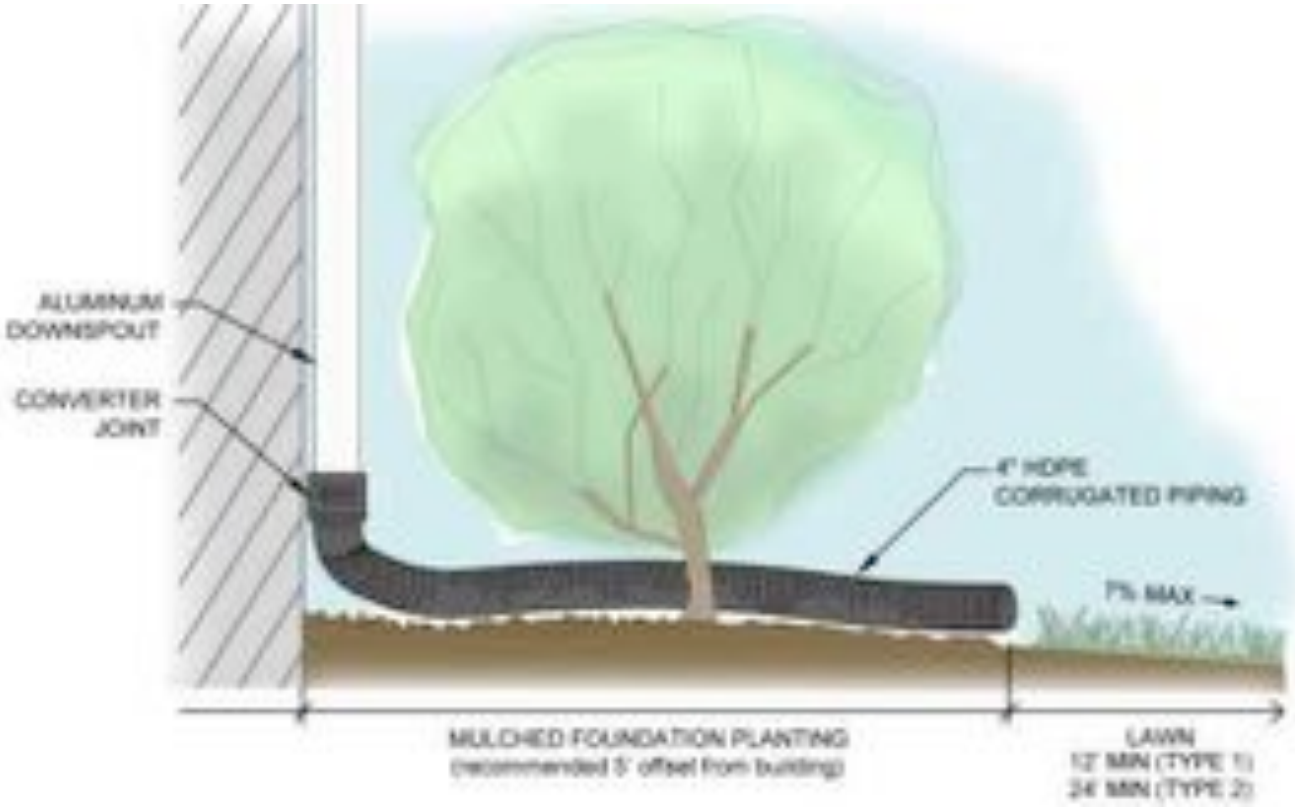
Bioretention

Location:
Great for Urban Areas
Infiltration for Bad Soils

Performance:
High Pollutant Removal
- but not always runoff reduction
Low Water Table
High Cost


EXISTING CONCRETE DITCH
20' TRANSITION FROM CONCRETE DITCH TO CLASS 'A' RIPRAP PLUNGE POOL
15' MIN. CLASS 'A' RIPRAP PLUNGE POOL
PLUNGE POOL CLASS 'A' RIPRAP 18" MIN. DEPTH
200-FILTRATION TRENCH (HIGH FLOW MEDIA)
CLEANOUT
CORE DRILL FOR 18" HDPE WITH WATERTIGHT GASKETS
90° LONGSWEEP ELBOW
SPECIAL STRUCTURE - DOUBLE 5'x5' VAULT WITH FRAME AND GRATE (STD.840.22)
EX 18" RCP INV.= 15.58
SAWCUT AND REMOVE EX 18" RCP FLARED END SECTION AND PIPE
FLOW
24" RCP INV.OUT = 15.40
SEE DRAINAGE STRUCTURE DETAILS ON SHEET 8A
PLAN VIEW
EX.CONCRETE DITCH
SAWCUT EX. CONCRETE DITCH
TRANSITION FROM CONCRETE DITCH TO CLASS 'A' PLUNGE POOL
CLASS 'A' RIPRAP 18" MIN. DEPTH
REMOVE EXISTING CONCRETE DITCH AS DIRECTED PER SHEET 4
SOD OVER FILTER MEDIA
CLEANOUT
ELEV.= 18.00
RIM = 18.50 DROP INLET FRAME AND GRATE (STD.840.20)
TIE TO EX.GROUND APPROXIMATE EL.= 19.30
EXISTING GRADE
12" FLAP GATE
COMPACTED BACKFILL
EX.SUBGRADE
12" OVERLAP OF FILTER FABRIC
FILTER FABRIC
HIGH FLOW MEDIA
COMPACTED BACKFILL
SEE SHEET 2 FOR HIGH FLOW MEDIA SPECIFICATIONS
FIBERGLASS MESH SCREEN
PEA GRAVEL
#57 STONE
6" OF 18" HDPE PERFORATED PIPE
FILTER FABRIC
UNCOMPACTED SUBGRADE
5' OF 18" HDPE PIPE NON-PERFORATED
EX 18" RCP INV.= 15.75
SEE DRAINAGE STRUCTURE DETAILS ON SHEET 8A
SECTION A-A

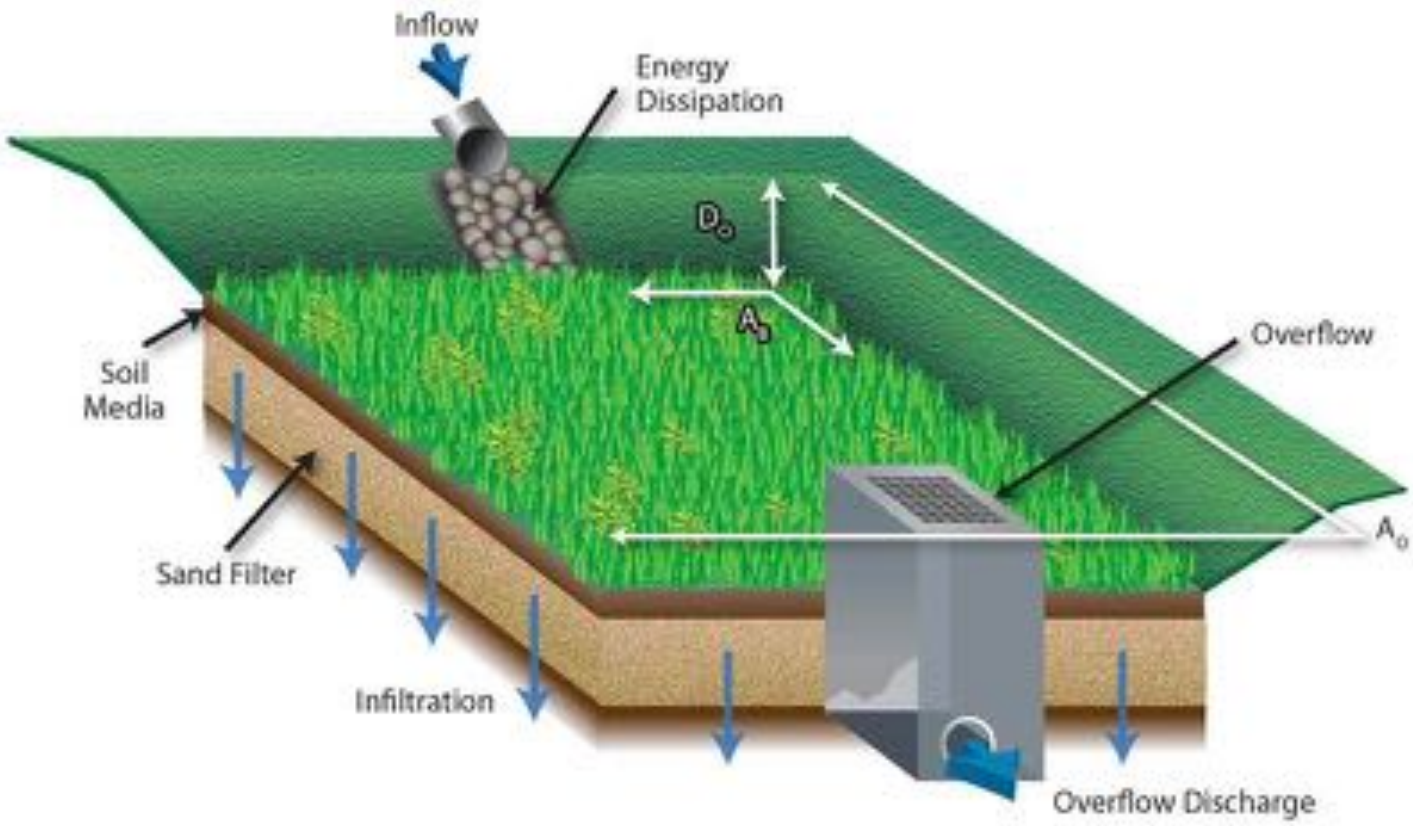
Downspout Disconnection



Location:
Low Impact
Blends In
Small Footprint

Performance:
Highly Efficient
High Water Table OK
Low Cost

Infiltration Basin / Rain Gardens



Location:
Any setting
Any Size
Underground?

Performance:
Checks all the boxes
Good soils
Low Water Table

Infiltration Systems

Urban Options

Location:

Small Footprints

Multi Functional Spaces

Get What You Can

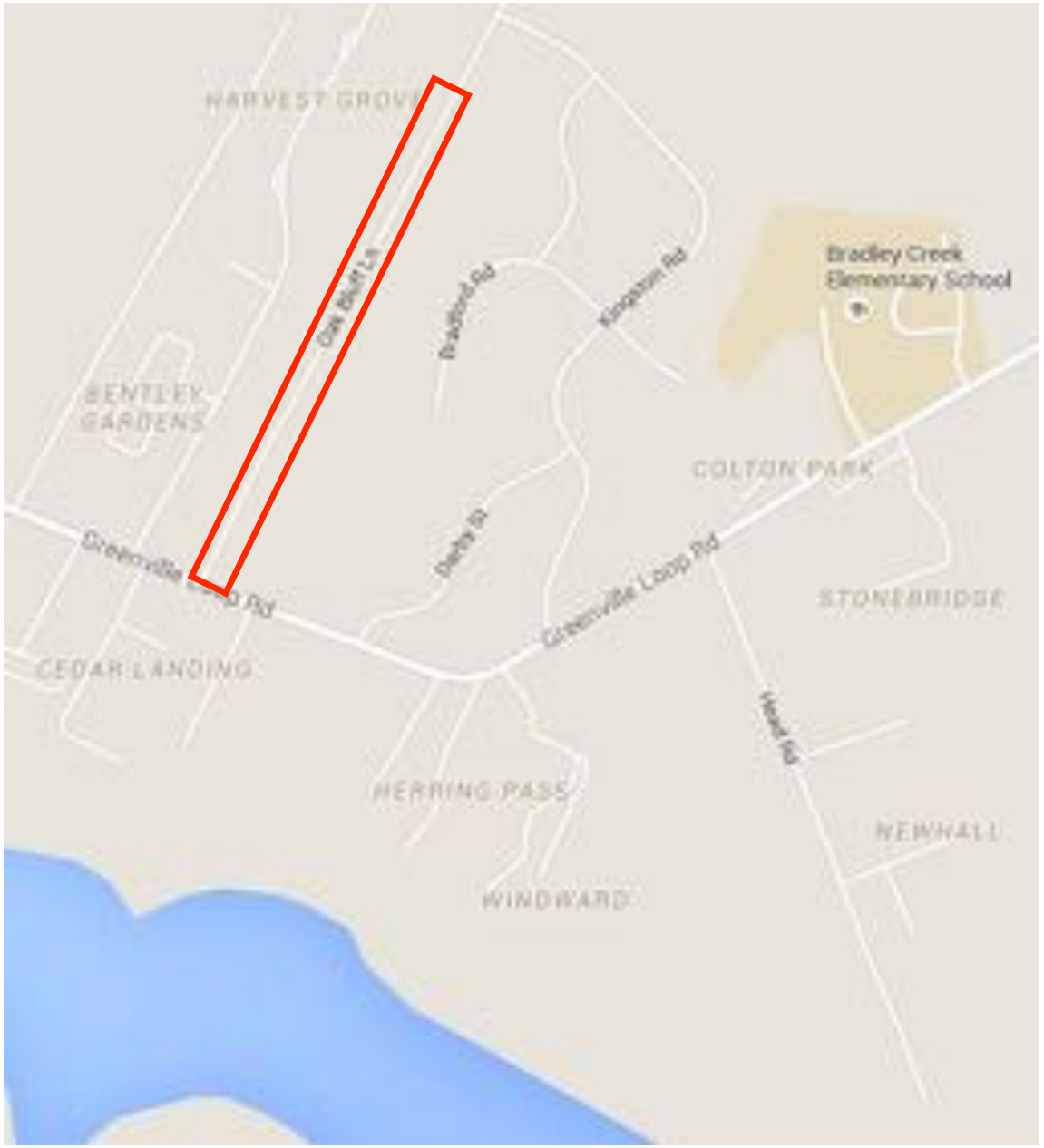
Urban Options

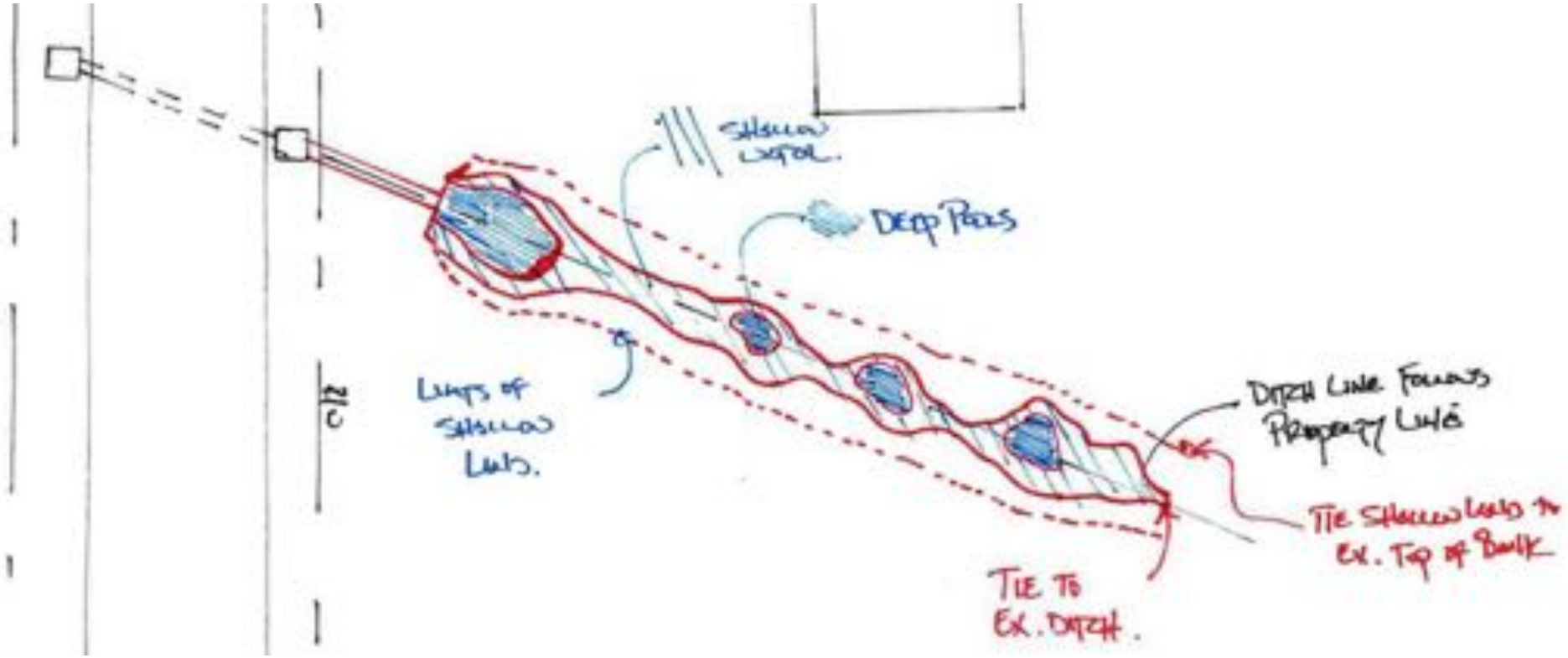
Easy to find….if you’re looking

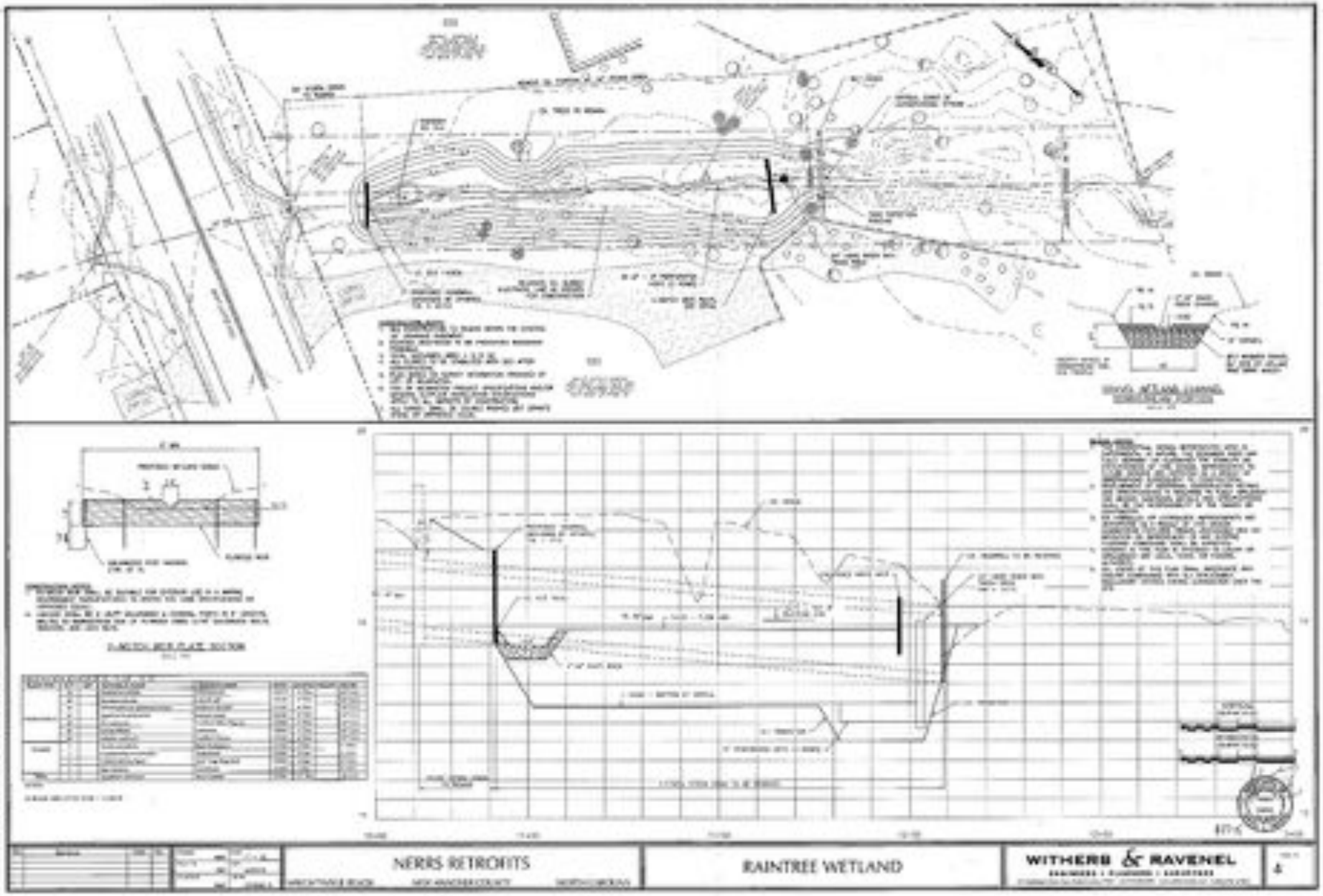
Raintree Retrofit Sites

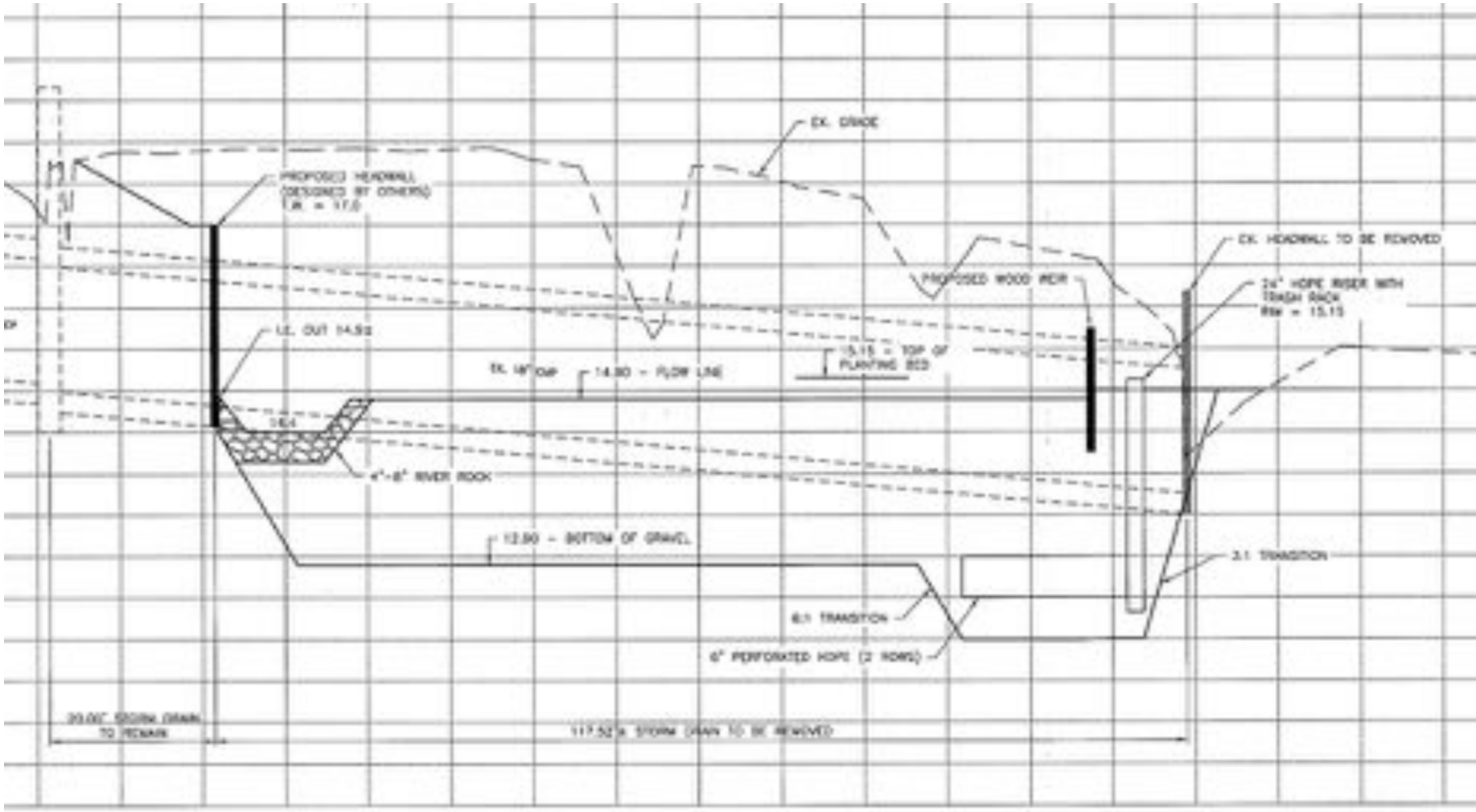
Residential Subdivison

- Cisterns
- Permeable Driveways
- Infiltration Trenches
- Subsurface Gravel Wetland




DEEP PODS
LIMITS OF SHALLOW LOTS.
DITCH LINE FOLLOWS PROPERTY LINE
TIE TO EX. DITCH.


NERRS RETROFITS
RAINTREE WETLAND
WITHERS & RAVENEL


EX. DIKE
PROPOSED HEADWALL
(DESIGNED BY OTHERS)
I.E. OUT 14.93
EX. 18" CMP
14.80 - FLOW LINE
15.15 = TOP OF
PLANTING BED
PROPOSED WOOD WEIR
EX. HEADWALL TO BE REMOVED
24" HDPE RISER WITH
TRASH RACK
Rim = 15.15
4'-8" RIVER ROCK
12.80 - BOTTOM OF GRAVEL
3:1 TRANSITION
6:1 TRANSITION
6" PERFORATED HDPE (2 ROWS)
20.00' STORM DRAIN
TO REMAIN
117.52'± STORM DRAIN TO BE REMOVED

Runoff Reduction Scenario Tool

Project Name		Scenario Name	

Scenario	Description	Runoff Vol	Vol Reduction	% Complete (from Baseline)
Baseline			0.00 ac-ft	-
Goal #1			0.00 ac-ft	
Goal #2			0.00 ac-ft	
Goal #3			0.00 ac-ft	

Design Rainfall Depth
3.88 in

Structural BMP Details

BMP Type	Soil Type	#	Avg Storage	Total Volume Reduction	Est Cost
Constructed Wetland	A	1	0 cf	0 cf	$0

Non Structural BMP Details

Downspout Disconnection		Volume Reduction	Estimated Cost
Over A & B Soils:			
# of Downspouts	0	0 cf	$0
Avg Roof Area per DS	0 sf		
Over C & D Soils:			
# of Downspouts	0	0 cf	
Avg Roof Area per DS	0 sf		
Green Roof Conversions			
Roof Area	0 sf	0 cf	$0
Impervious Area Removal			
Over A Soils	0 sf	0 cf	$0
Over B Soils	0 sf	0 cf	
Over C Soils	0 sf	0 cf	
Over D Soils	0 sf	0 cf	
Stream Restoration			
New Floodplain Area	0 sf	0 cf	$0
Tree Planting			
# of Trees	0	0 cf	$0
Avg Canopy Diameter	0 ft		

Total Volume Removed	0 cf	0.00 ac-ft	Estimated Cost =	$0