L.I.D. Site Planning Concepts

What is L.I.D. ?

- "The goal of L.I.D. is to develop techniques, strategies, BMPs, and criteria to store, infiltrate, transpire, retain, and detain runoff on the site to replicate the pre-development runoff characteristics and mimic the natural and unique hydrology of the site."
- "With the L.I.D. approach, receiving waters experience little change in the volume, frequency, or quality of runoff or in base flows fed by ground water."

Key Considerations for LID Site Planning

Examples of the LID site planning techniques include, but are not limited to:

- **Maintaining natural drainage ways and patterns. Disperse runoff, do not concentrate it.**
- **Preserving as many trees as possible. Design with existing topography.**
- **Reducing the percentage of impervious area**
- **Locating BMPs in soils with the highest permeability**
- **Disconnecting impervious areas. Discharge runoff from paved surfaces onto vegetated areas.**
- **Limiting clearing and grading on individual lots**

Key Considerations for LID Site Planning

Examples of the LID site planning techniques include, but are not limited to:

- **Locate impervious areas on less permeable soils to minimize change in CN value.**
- **Maintain existing natural topography and terrain, work with the topography, don't re-engineer it.**
- **Limit clear-cutting and mass grading of site. Save time and money on site work**
- **Flatten slopes only within existing cleared and graded areas. Minimize major cuts and fills.**
- **Revegetate areas that have been cleared and graded**

Mass Clearing

Mass Grading

Small Lots

Separate Garag

Alleys

25% More Impe

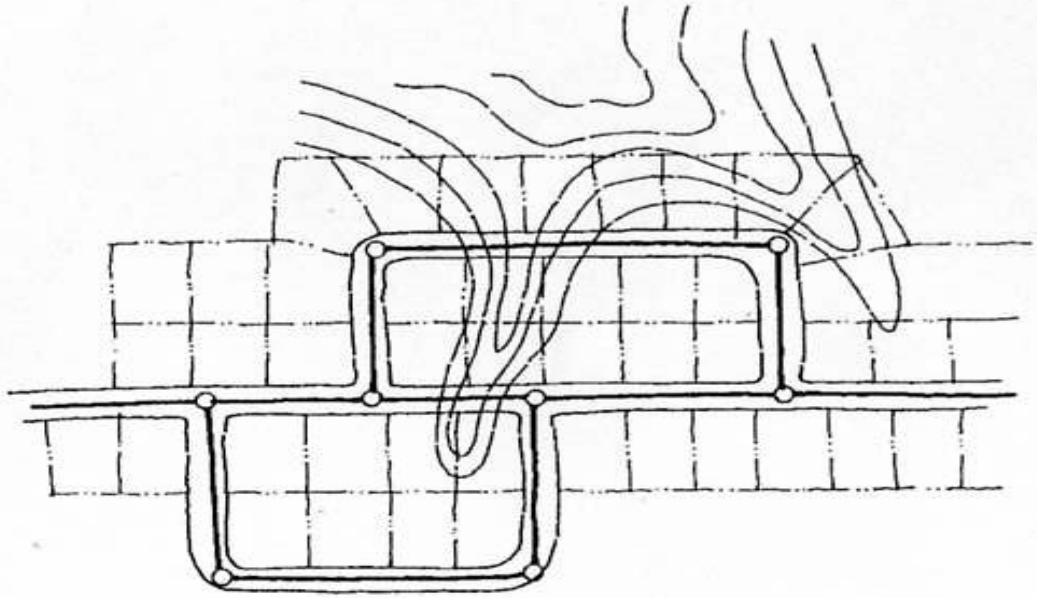
L.I.D. IS NOT "CLEAR CUTTING AND MASS GRADING"


Tree Save


LID Development
Conventional Development

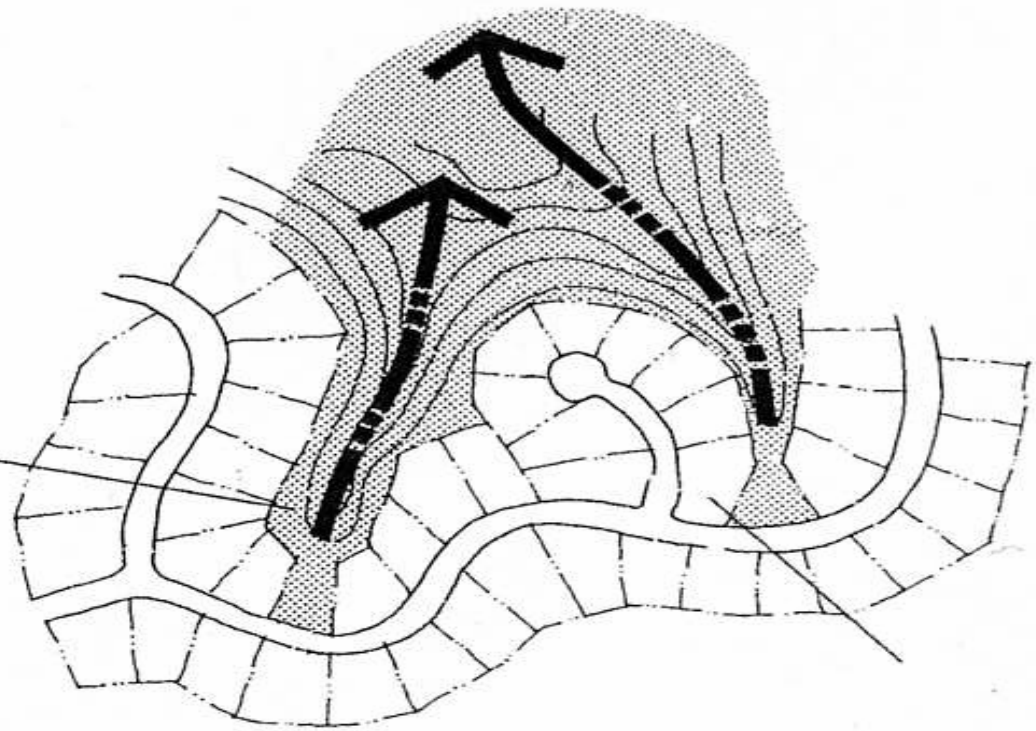
Traditional Approach

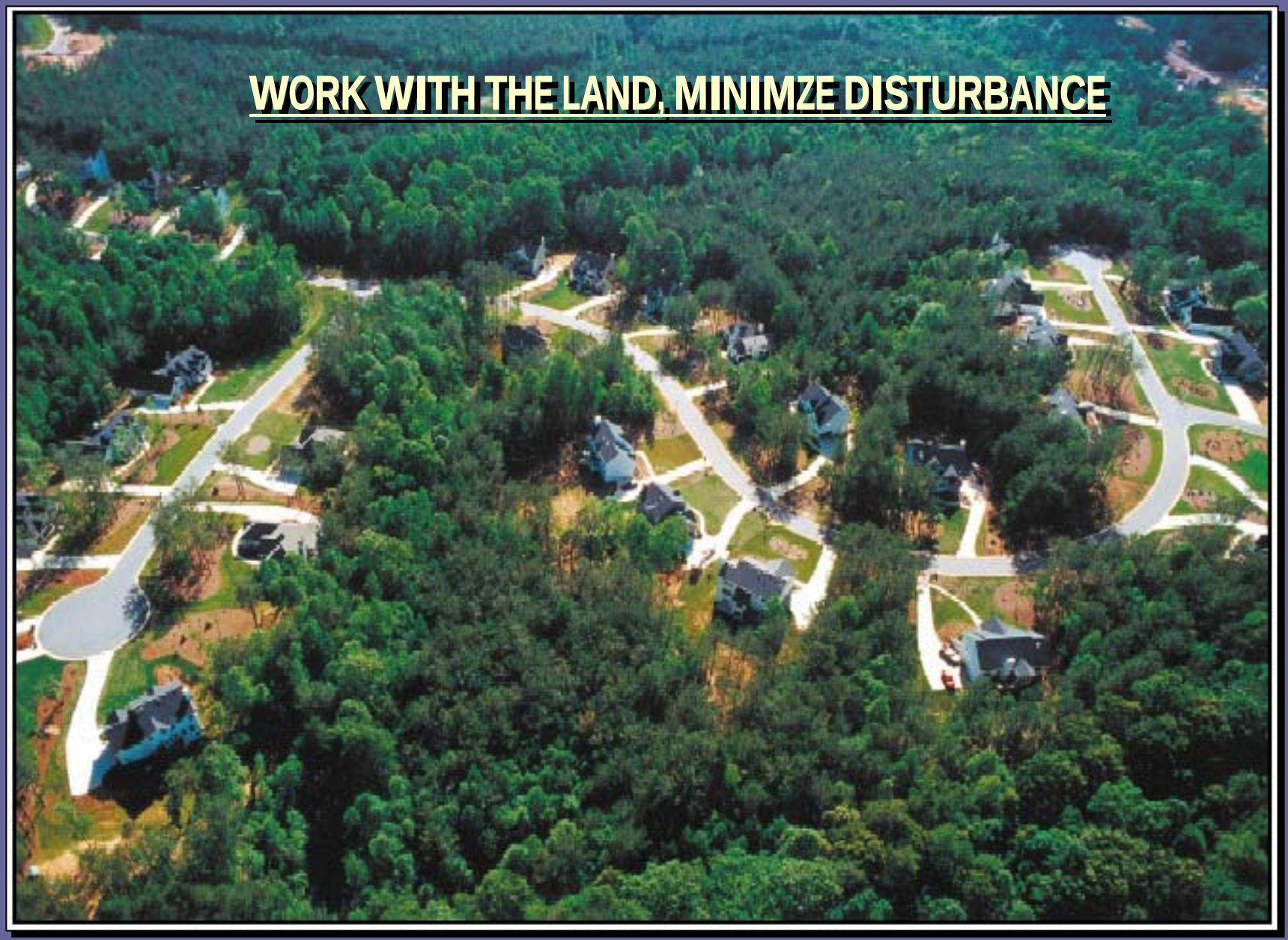
Typical lotting requires extensive storm sewers and earthwork.



Preferred Approach

Maintain natural drainageways and enhance as open-space corridors.




WORK WITH THE LAND, MINIMZE DISTURBANCE

Conventional Parking Lot

L.I.D. Parking Lot

B.M.P. "Big Muddy Pond"


RETRO-FIT RAIN GARDEN


LINEAR RAIN GARDEN
F150
TRD OFF ROAD


INFILTRATION TRENCHES

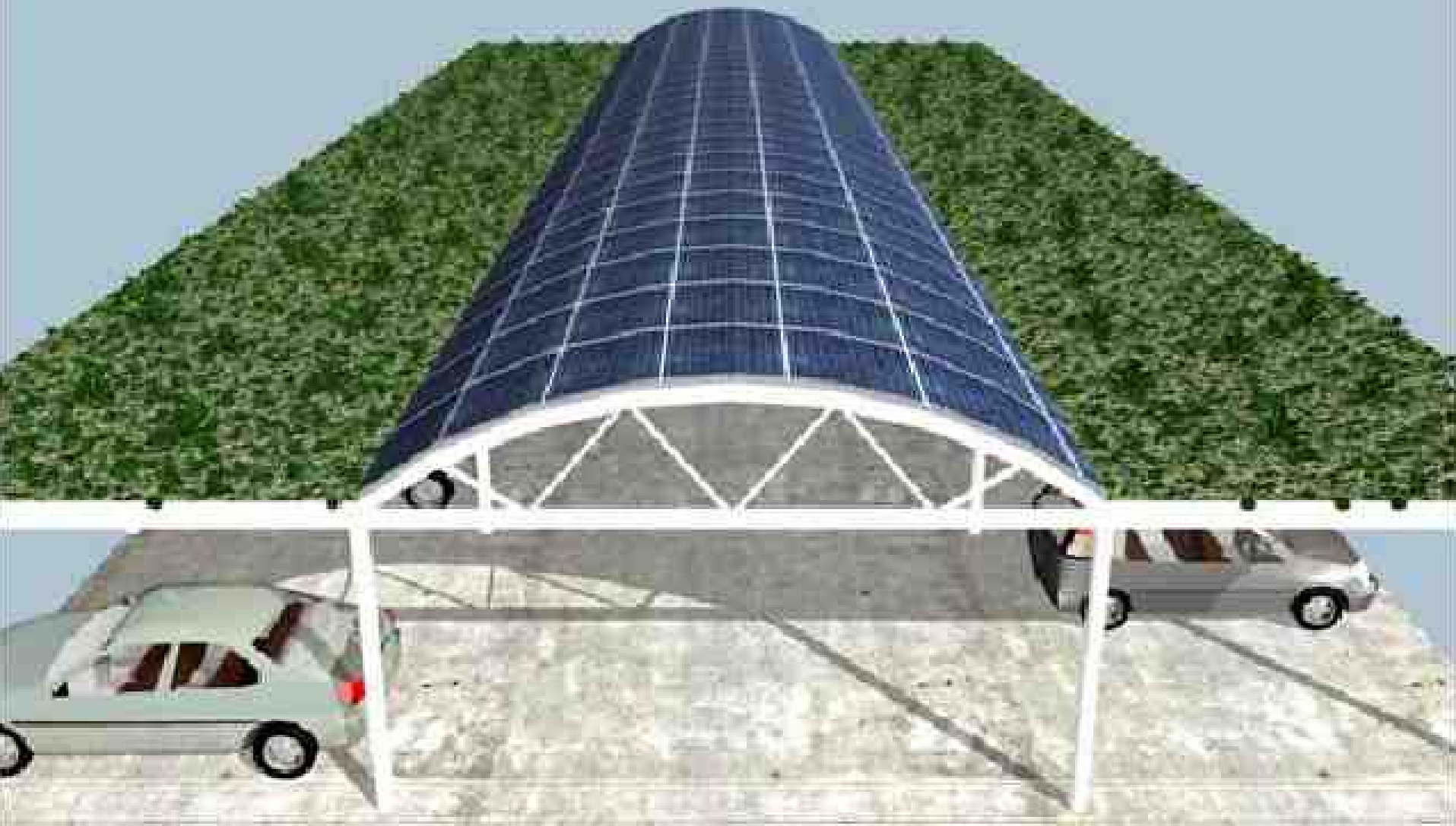
Rain Gardens In Multi-Family Residential


POROUS CONCRETE PEDESTRIAN PLAZA

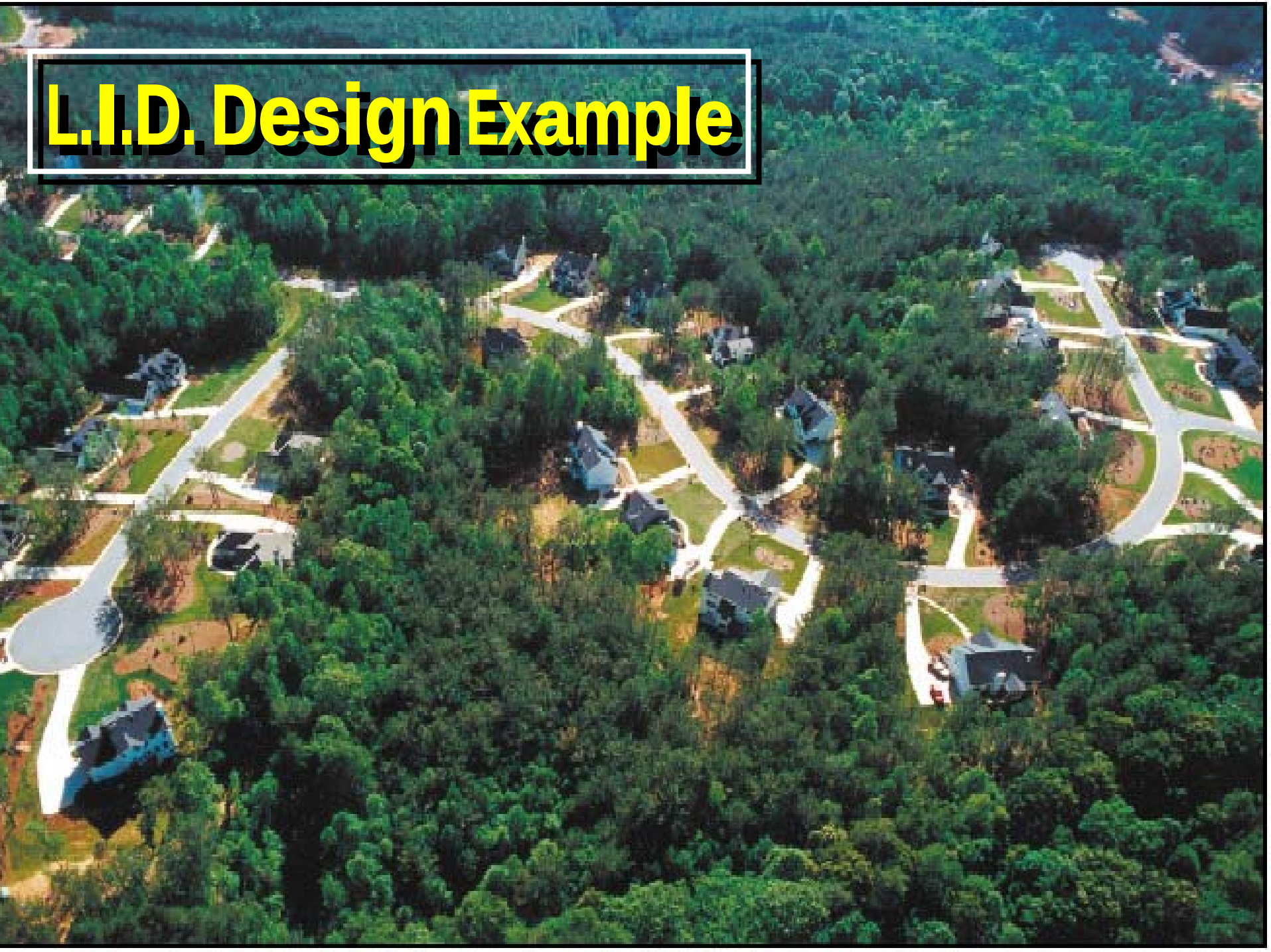
URBAN RAIN GARDEN


RESERVED
PARKING

PARKING LOT CANOPY - RAIN GARDEN



L.I.D. Design Example



Performance Criteria

- 6 Basic Elements Need to be addressed:
  - 85% TSS removal
  - Using LID to treat the runoff from the first 1 inch of rainfall
  - In addition (if necessary) use LID alone or in combination with conventional practices to treat the difference in runoff from pre versus post conditions for the 2 year 24 hour storm in the Rural and Transitional Zoning Districts. Everywhere else use the 1 year 24 hour storm
  - Any temporary water quality storage pools must drawdown in 48 to 120 hours.
  - Peak storm water runoff rates shall be controlled for development above 12% impervious (1 dwelling/acre)
  - No one BMP shall receive runoff from an area greater than 5 acres.

Steps in Preparation of a Conceptual Plan:

Site Analysis

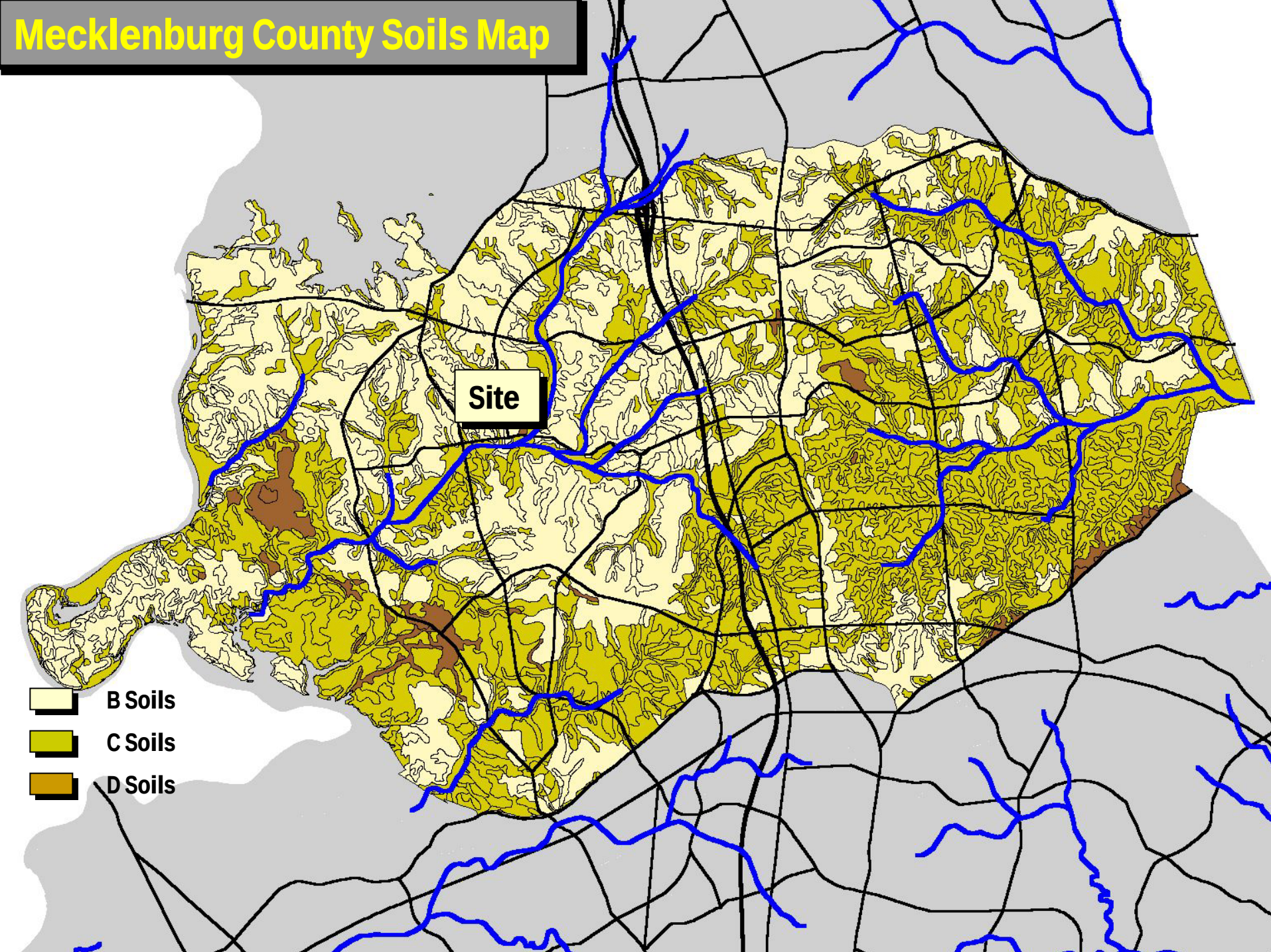
Preliminary Sketch

S.E.T. Calculations

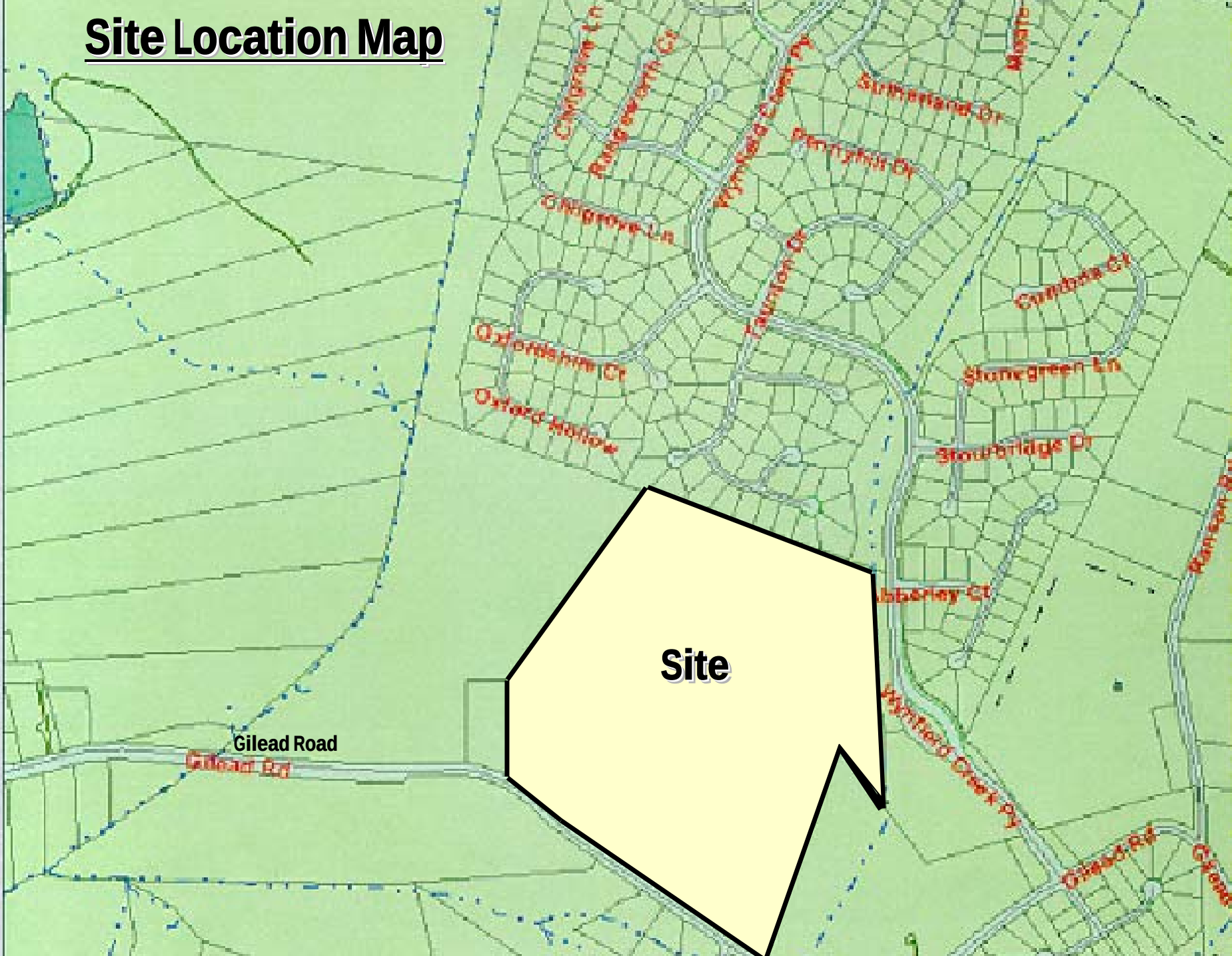
Hydrologic Analysis

Final Conceptual Plan

Mecklenburg County Soils Map



Site Location Map



Site Analysis

Site Analysis

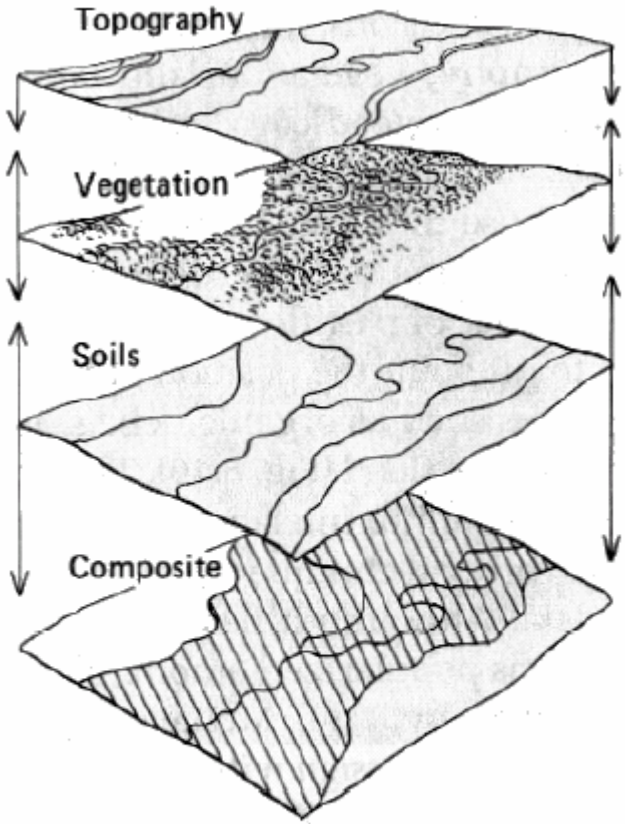
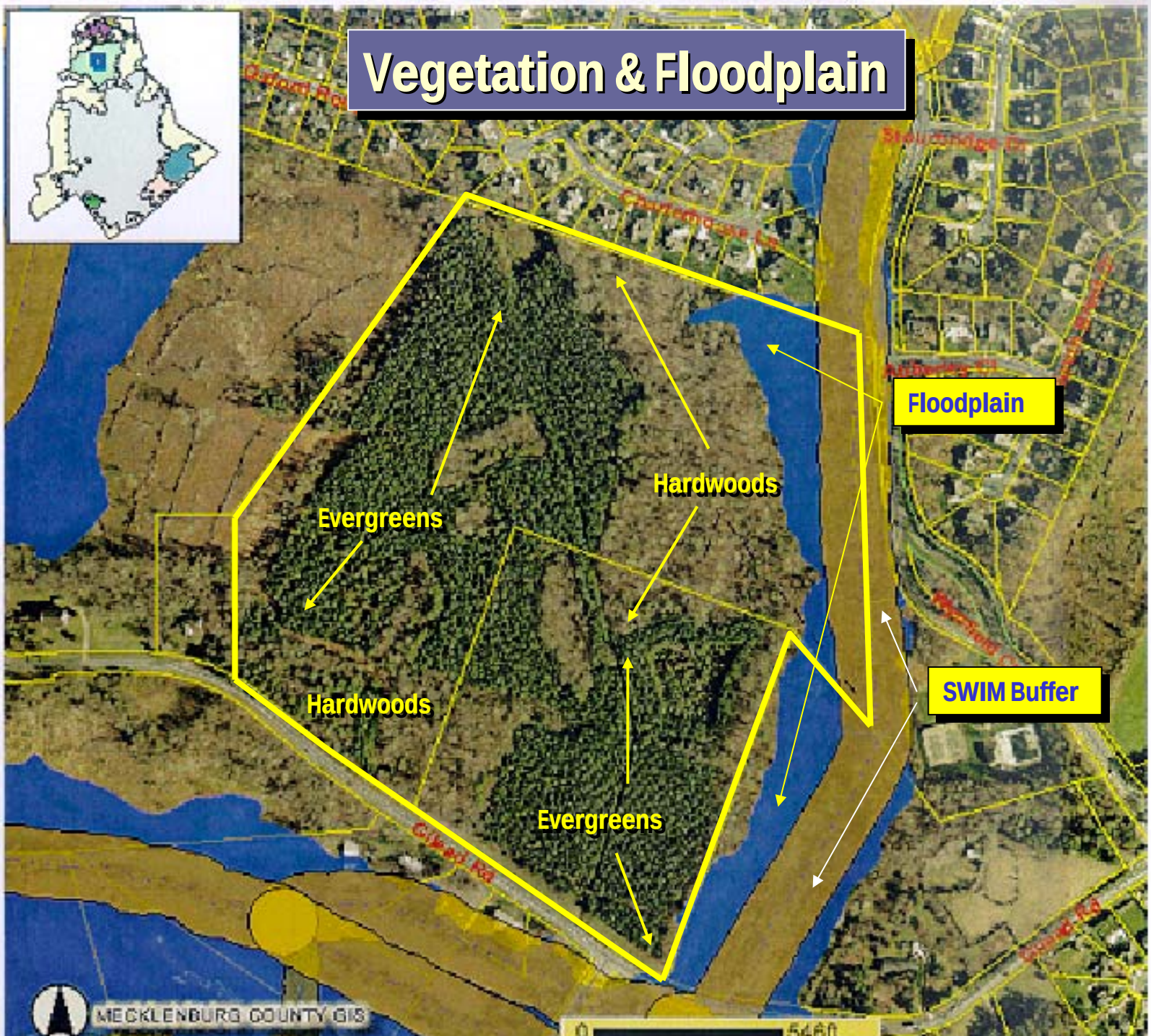
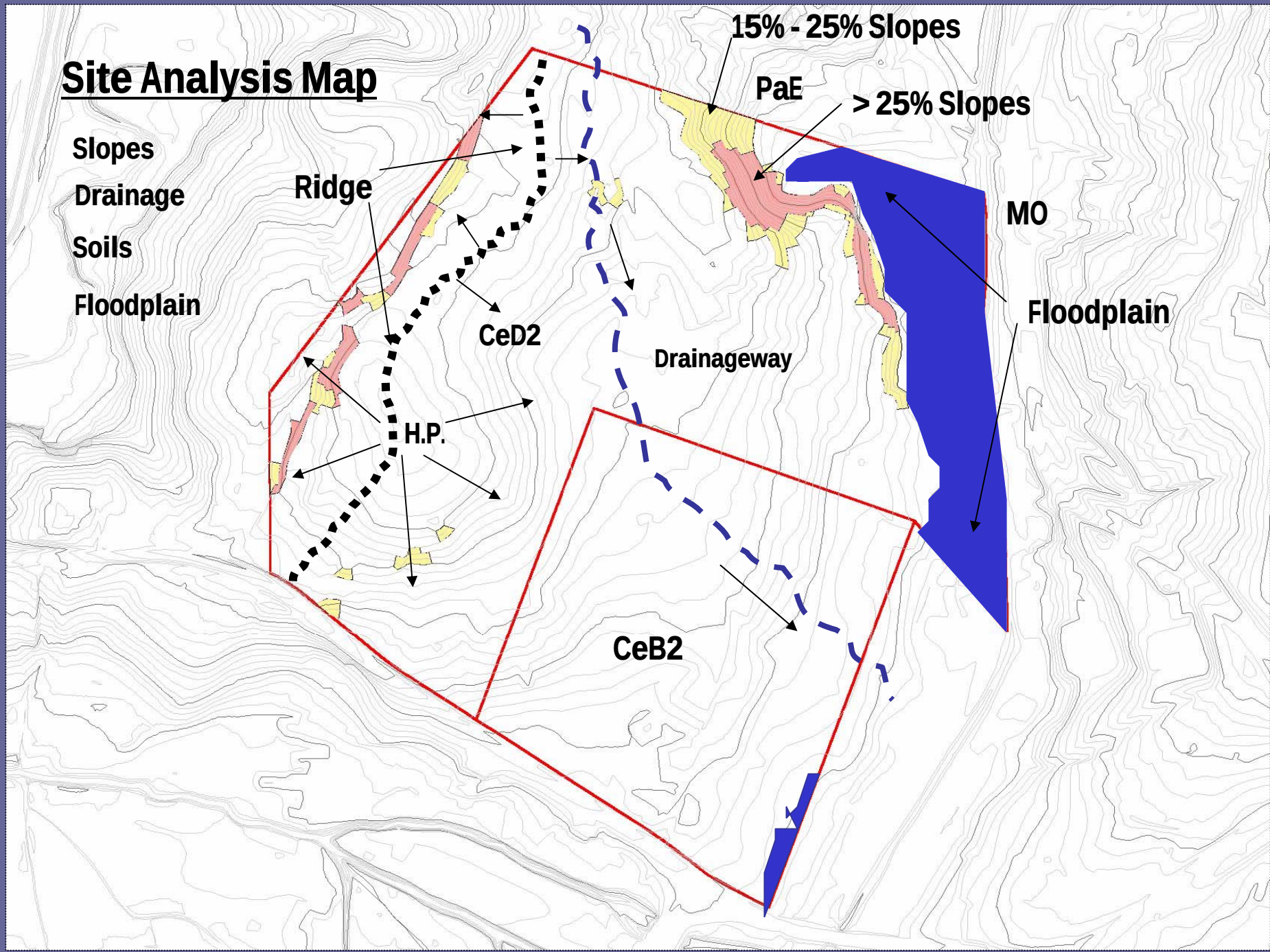


Figure 1.5.2-1
Composite Analysis
(Source: Marsh, 1983)

- Topography (2' Contours)
- Natural Drainage Patterns
- Ridges and Valleys
- Vegetation (Meadow, Mature trees)
- Soils (HSG A, B, C, D)
- Hydrology (CN, Tc)
- Groundwater Depth
- Wetlands
- Floodplains
- S.W.I.M. Buffers
- Steep Slopes (> 15%)
- Access and Connectivity
- Utilities (Sanitary, Water etc.)
- Easements (Duke Power, Sanitary, etc.)
- Zoning (Setbacks, Density, Open Space)


Vegetation & Floodplain
Floodplain
Hardwoods
Evergreens
Hardwoods
SWIM Buffer
Evergreens
MECKLENBURG COUNTY GIS


Site Analysis Map
Slopes
Drainage
Soils
Floodplain
15% - 25% Slopes
PaE
> 25% Slopes
Ridge
MO
Floodplain
CeD2
Drainageway
H.P.
CeB2


Site Location

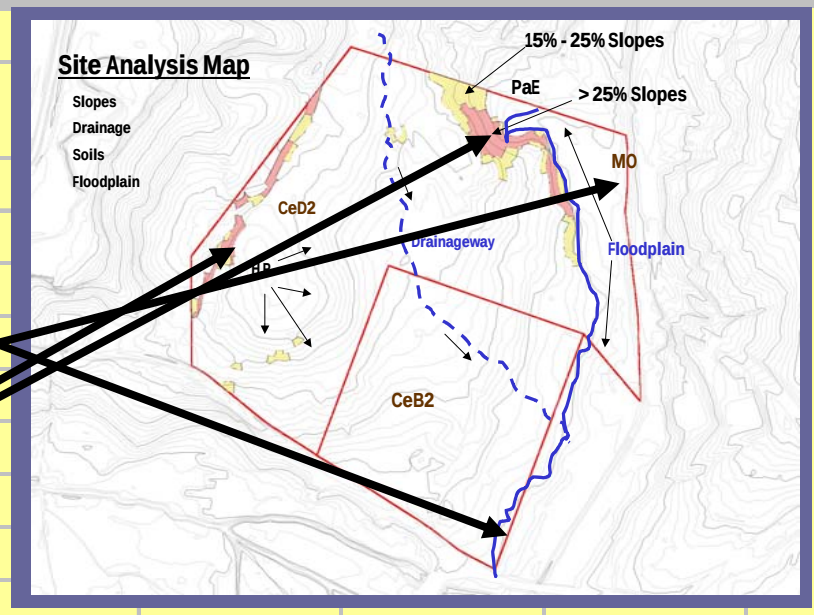

Existing Entry Road


Evergreens
Thick Ground Cover


Hardwoods
Secondary Growth


Main Drainage Channel

Site Analysis Worksheet



Total Site Area:	61.194 Acres
Floodway	4.472 Acres (0.0% Credit)
Floodplain	1.722 Acres (0.50 Credit)
Slope >25%	1.555 Acres (0.25 Credit)

61.194	Gross Acres
- 4.472	Floodway
- 0.861	Floodplain (0.50 x 1.722)
- 1.167	Steep Slope (0.25 x 1.555)
54.694	Net Buildable Area

Huntersville Transitional Zone Options:

1	0.80 Units / acre with 25% Open Space = 43 Lots on 45.90 Ac
2	2.00 Units / acre with 40% Open Space =109 Lots on 36.72 Ac

Assume 20% for roads = 0.85 Acre Lots (37,000 SF) for Option 1

= 0.28 Acre Lots (12,000 SF) for Option 2

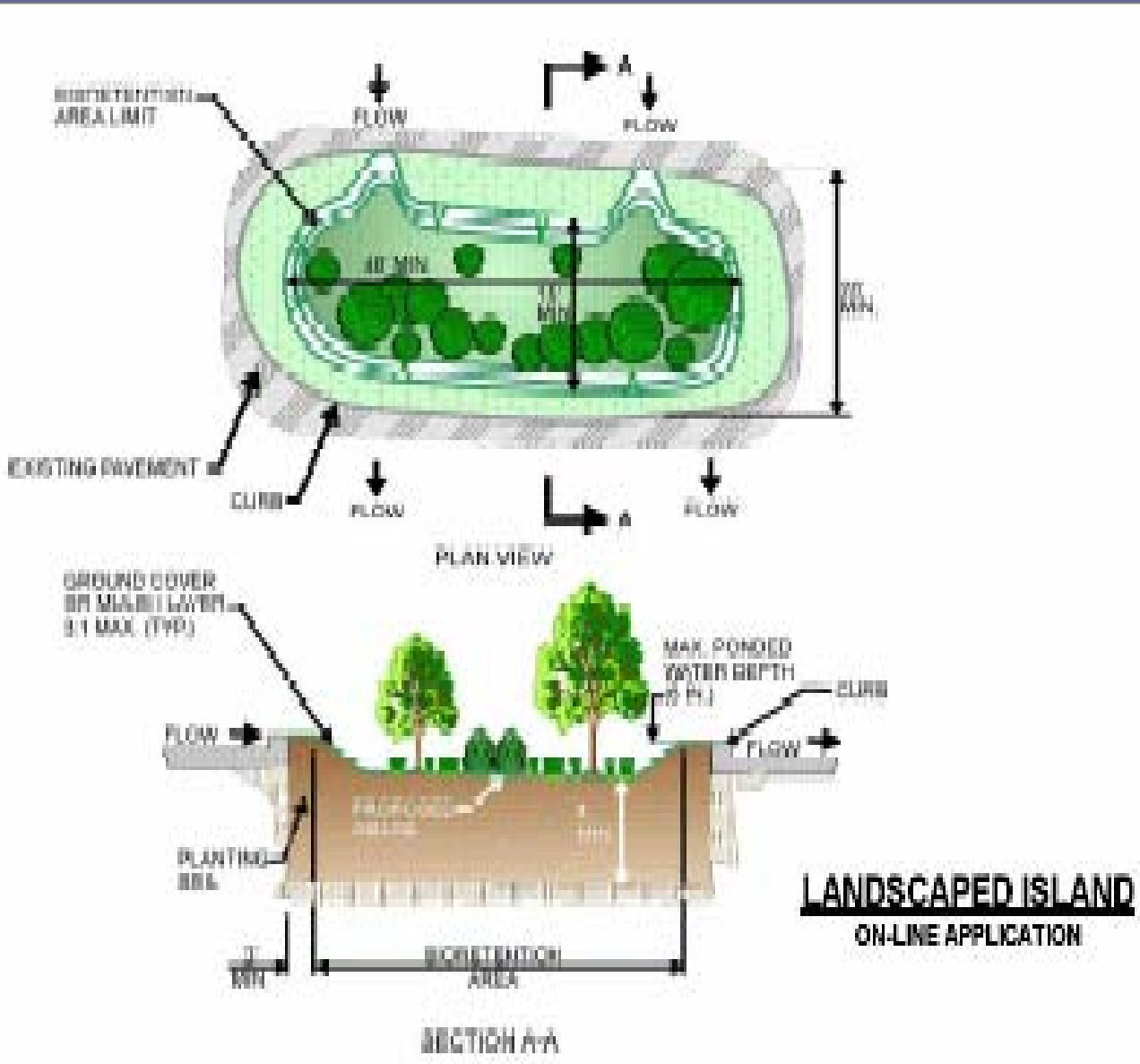
SELECT OPTION 2, 109 LOTS 40% OPEN SPACE

L.I.D. Best Management Practices

BMPs for Use in Huntersville (Tables 6.1 and 6.2, Pages 48 and 49)				
BMP	**Applicable Zoning Districts(1)**	**Applicable Performance Criteria (2)**	**Design Function(3)**	**Function(4) (WQ, VC, PC)**
Strategic Clearing & Grading	U, T, R	3(a)		WQ, VC, PC
Reduce Impervious Surfaces	U, T, R	3(a)		WQ, VC, PC
Bioretention (Rain Garden)	U, T, R	3(a), 3(b)	Section 4.0	WQ, VC, PC
Infiltration Trench	U, T, R	3(a), 3(b)	Section 8.0	WQ, VC, PC
Infiltration Swale	U, T, R	3(a), 3(b)	Section 8.0	WQ, VC, PC
Swales	U, T, R	3(a)	Section 5.0	WQ, VC
Swales with Outlet Control	T, R	3(a), 3(a)	Section 5.0	WQ, VC, PC
Vegetative Filter Strips & Buffers	U, T, R	3(a)	Section 7.0	WQ, PC
Dry Well, Cistern & Rainbarrel	U, T, R	3(b)		WQ, VC, PC
Porous Paving	U, T, R	3(b)		WQ, VC
Curb & Gutter Elimination	R	3(b)		WQ, PC
Rooftop Storage	U, T, R	3(b)		VC, PC
Wet Pond	U, T, R	3(b), 3(d)	Section 1.0	WQ, VC, PC
Extended Dry Pond	T, R	3(b), 3(d)	Section 6.0	VC, PC
Storm Water Wetlands	T, R	3(b)	Section 2.0	WQ, VC, PC
Sand Filter	T, R	3(a)	Section 3.0	WQ, VC, PC

(1) Applicable Zoning Districts: These are the Zoning Districts where the BMP can be used including U = Urban; T = Transitional; R = Rural.
(2) Applicable Performance Criteria: These are the Performance Criteria Section numbers (see Section 3) that the BMP can be used to satisfy.
(3) Design Function: All BMP designs are contained in the N.C. Department of Environment & Natural Resources, Storm Water Best Management Practices, April 1999
(4) Functions: These are the dominate functions that the BMPs perform including WQ = Water Quality; VC = Volume Control, PC = Peak Control.

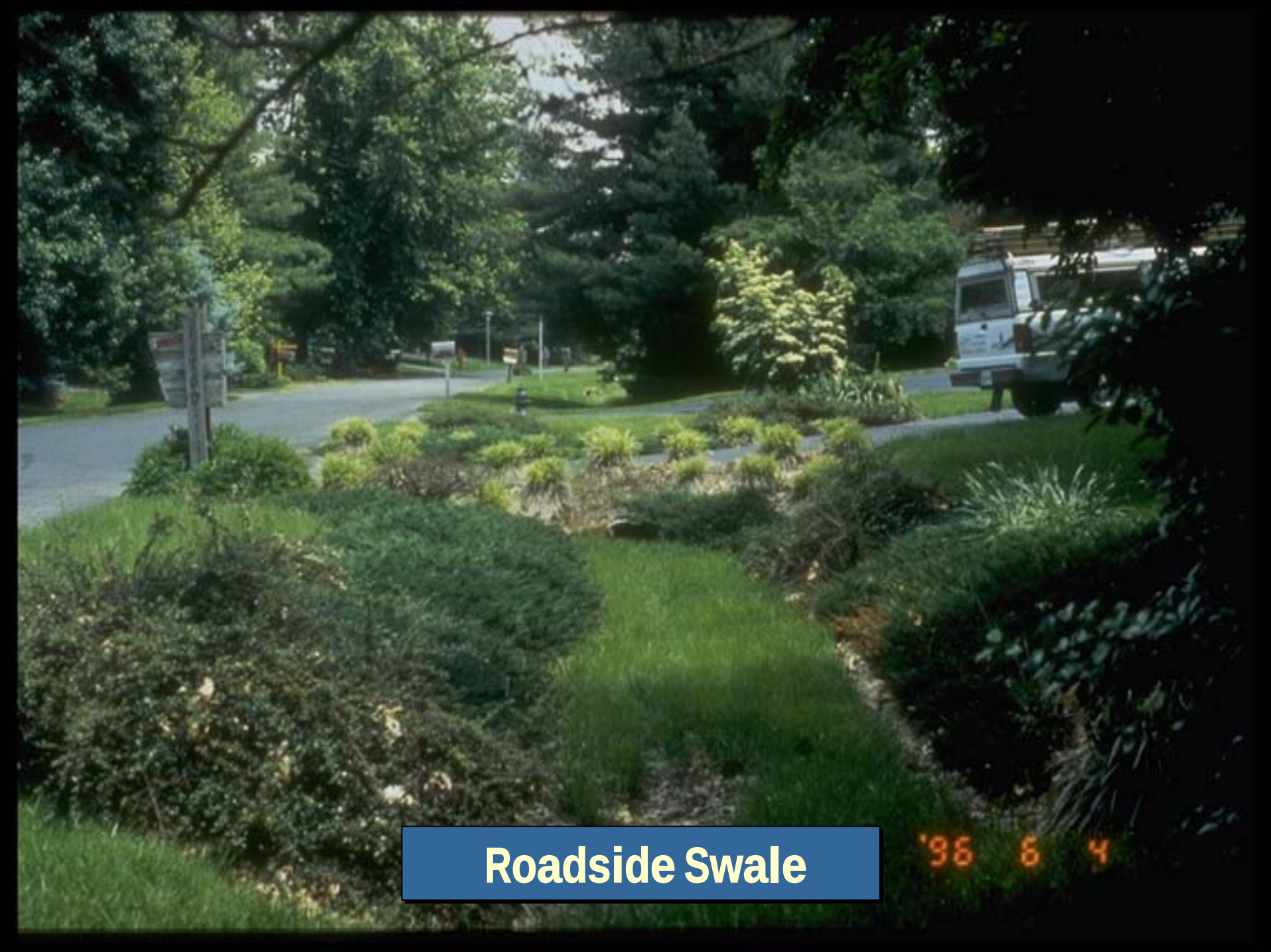
Rain Gardens

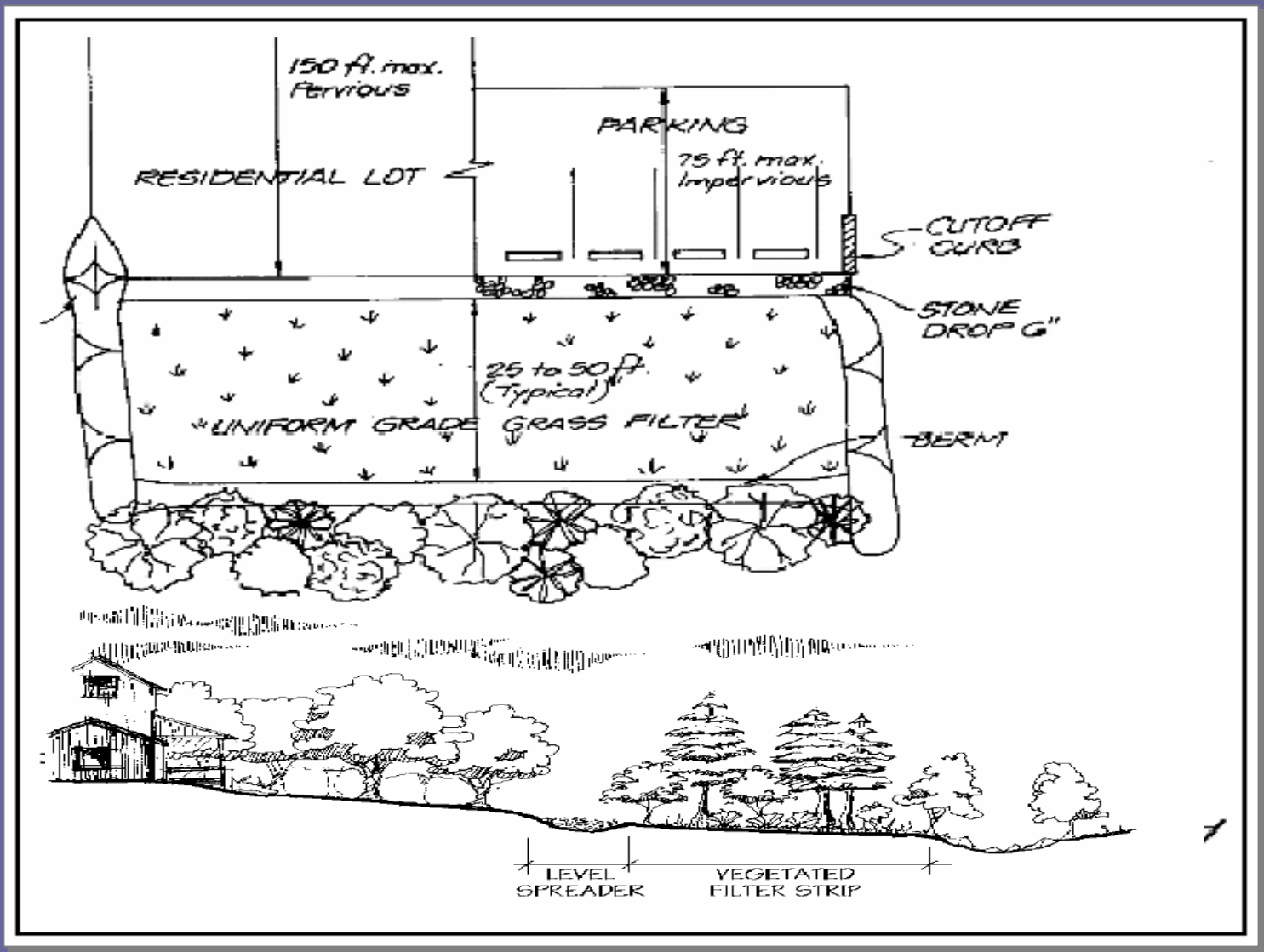

AREA LIMIT
FLOW
A
FLOW
EXISTING PAVEMENT
CURB
FLOW
A
FLOW
PLAN VIEW
GROUND COVER
MAX. PONDED
WATER DEPTH
CURB
FLOW
FLOW
PLANTING
MIN
SECTION A-A
LANDSCAPED ISLAND
ON-LINE APPLICATION

Residential Rain Gardens

Residential Rain Garden

Possible Rain Garden Locations


Roadside Swale
'96 6 4



Vegetated Filter Strip

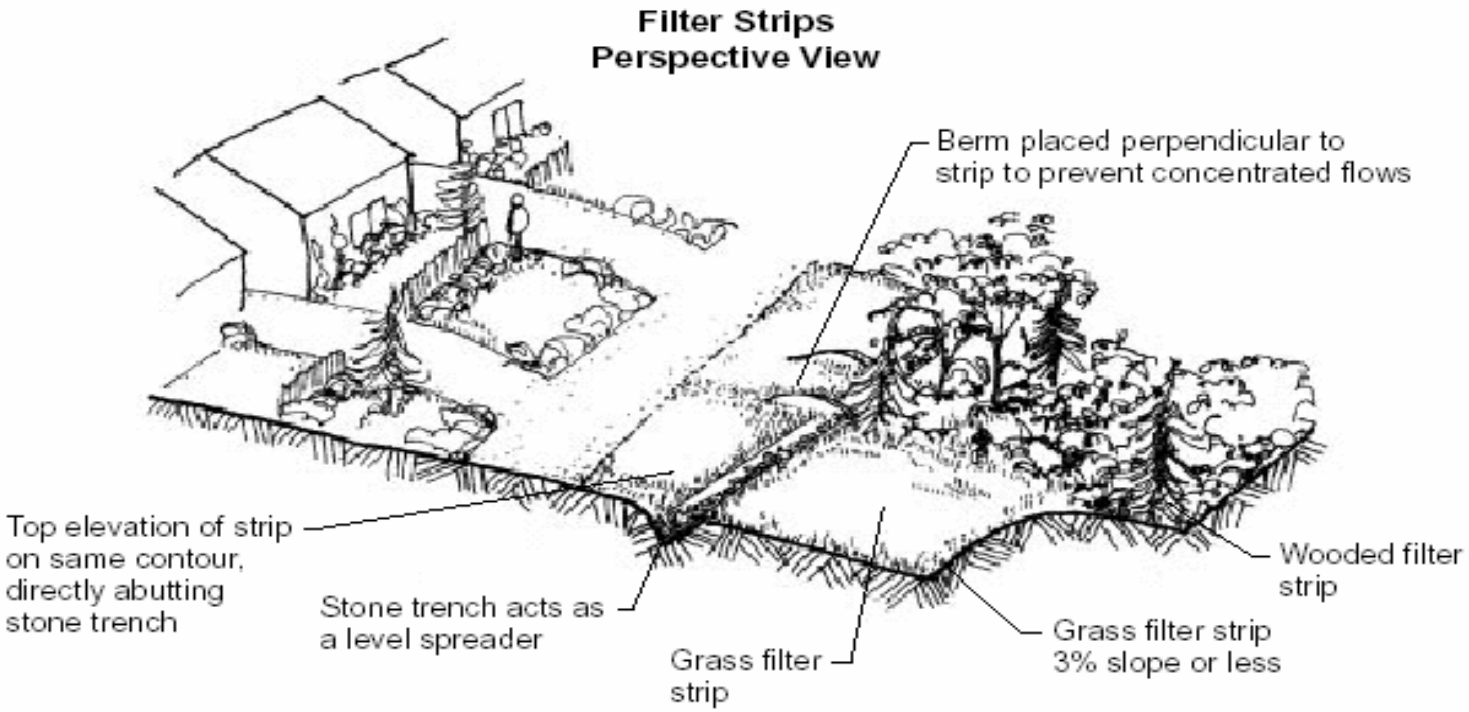
PRIMARY USE: Remove sediment and other pollutants.
ADDITIONAL USES: Reduce flow and velocity of storm water.

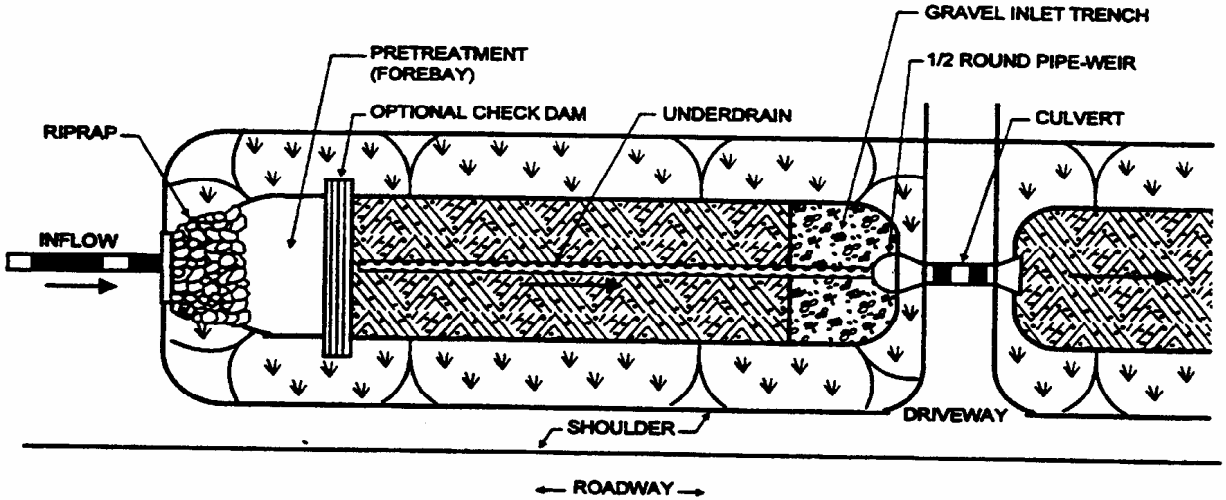
FILTER STRIPS

What is it? Gently sloping areas of natural vegetation or graded and artificially planted areas used to provide infiltration, remove sediments and other pollutants, and to reduce the flow and the velocity of storm water.

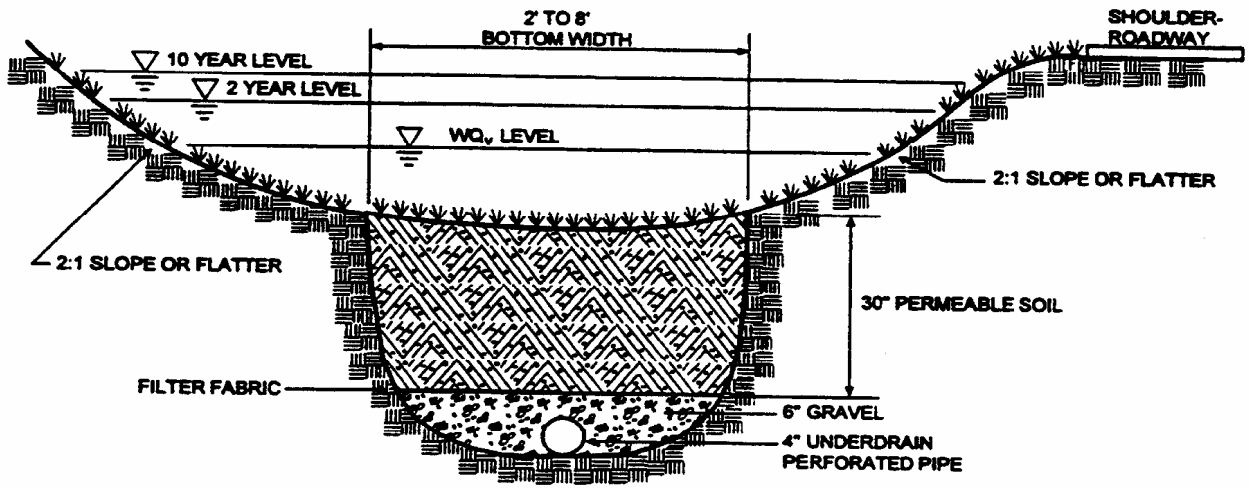
Purpose

To improve water quality by filtering runoff to remove sediment and associated insoluble contaminants, to allow increased infiltration opportunity time for soluble nutrients or pesticides to drain into the soil, to provide shade to watercourses to help maintain temperature norms of the water thereby protecting or providing habitat for aquatic life, and to provide sound barrier to or from outside areas (roads, factories, parks).



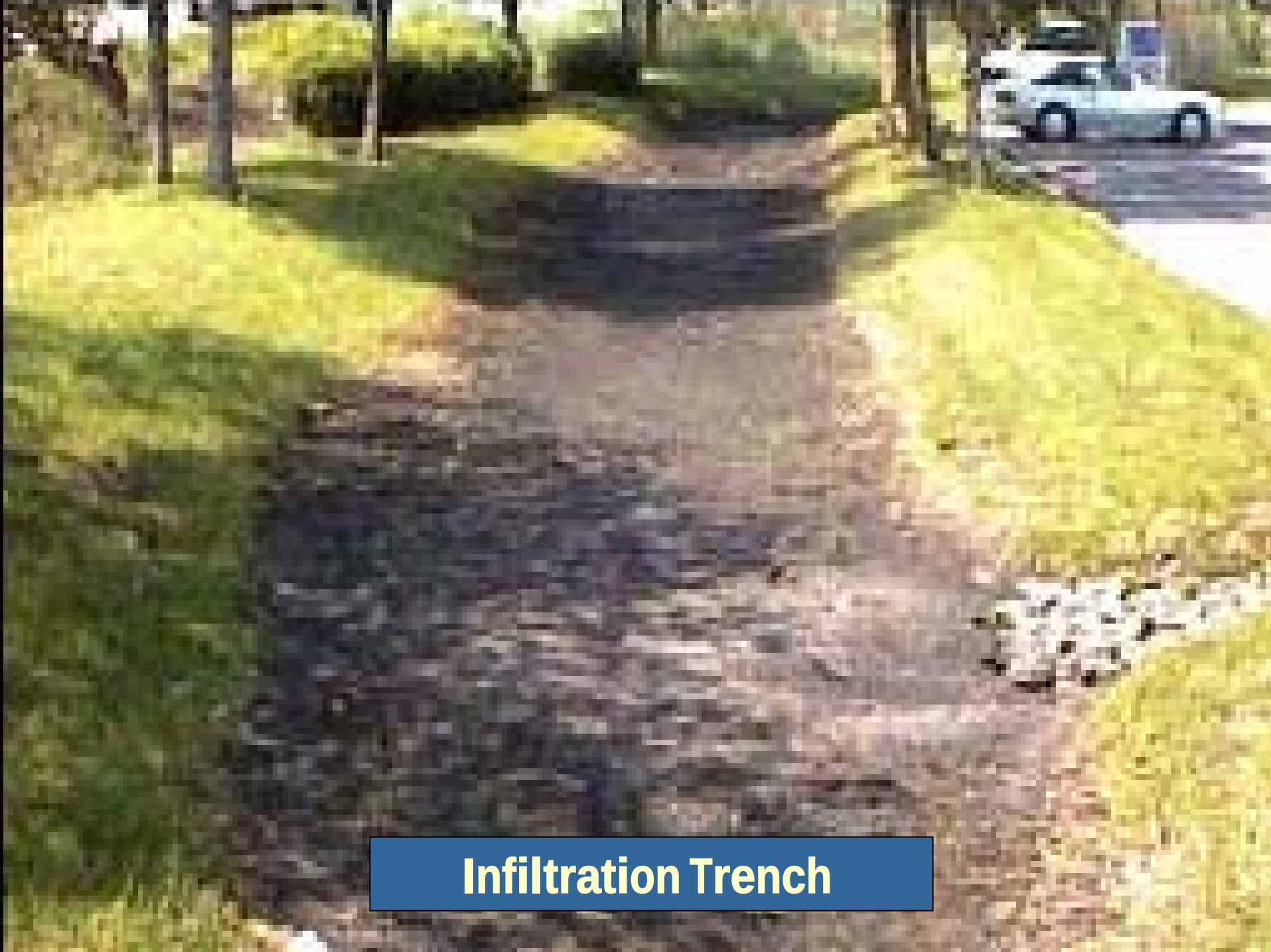


PLAN VIEW



Infiltration Trench

SECTION


Infiltration Trench


Roadside Swale


Driveway Trench Drain

Roadside Swale

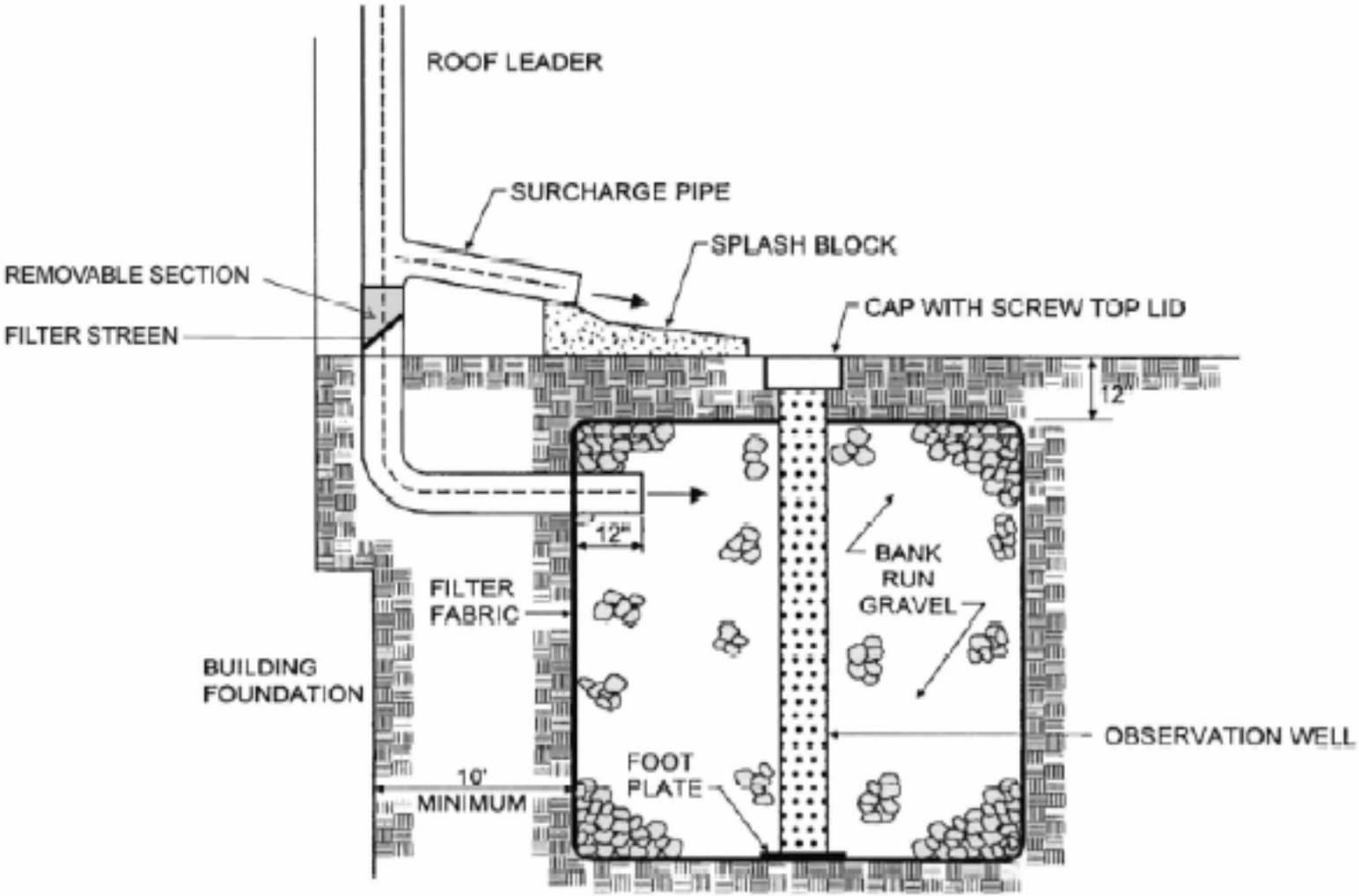


Figure 4: Soakaway Pit Profile

Source: Adapted from Maryland Department of the Environment, 1998.

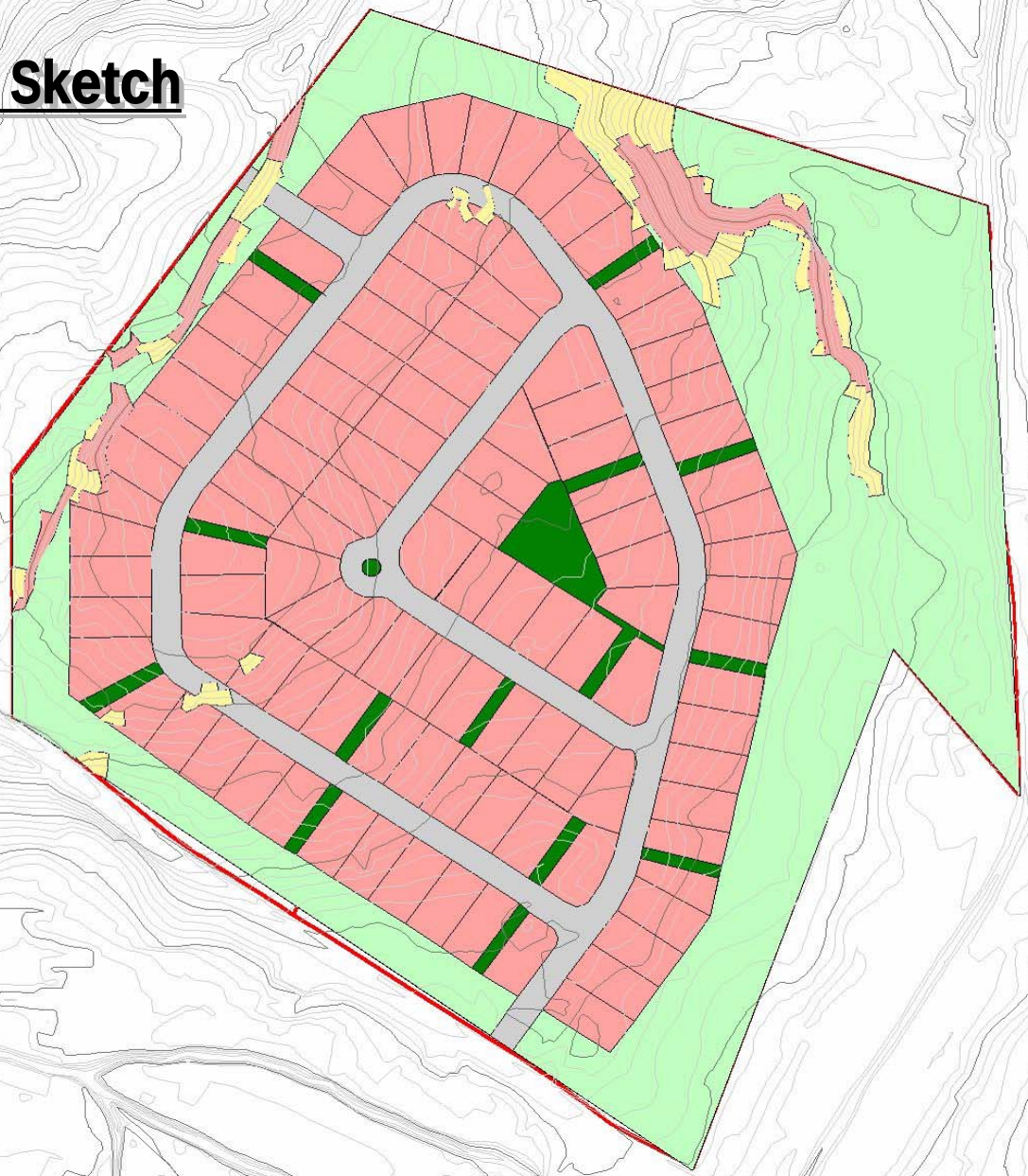
Rain Barrels

Aesthetic Dry Detention Pond

Preliminary Plan

Preliminary Sketch

109 Lots



Typical Lot 12,000 S.F.

Two-Story House

Width 60'

Depth 40'

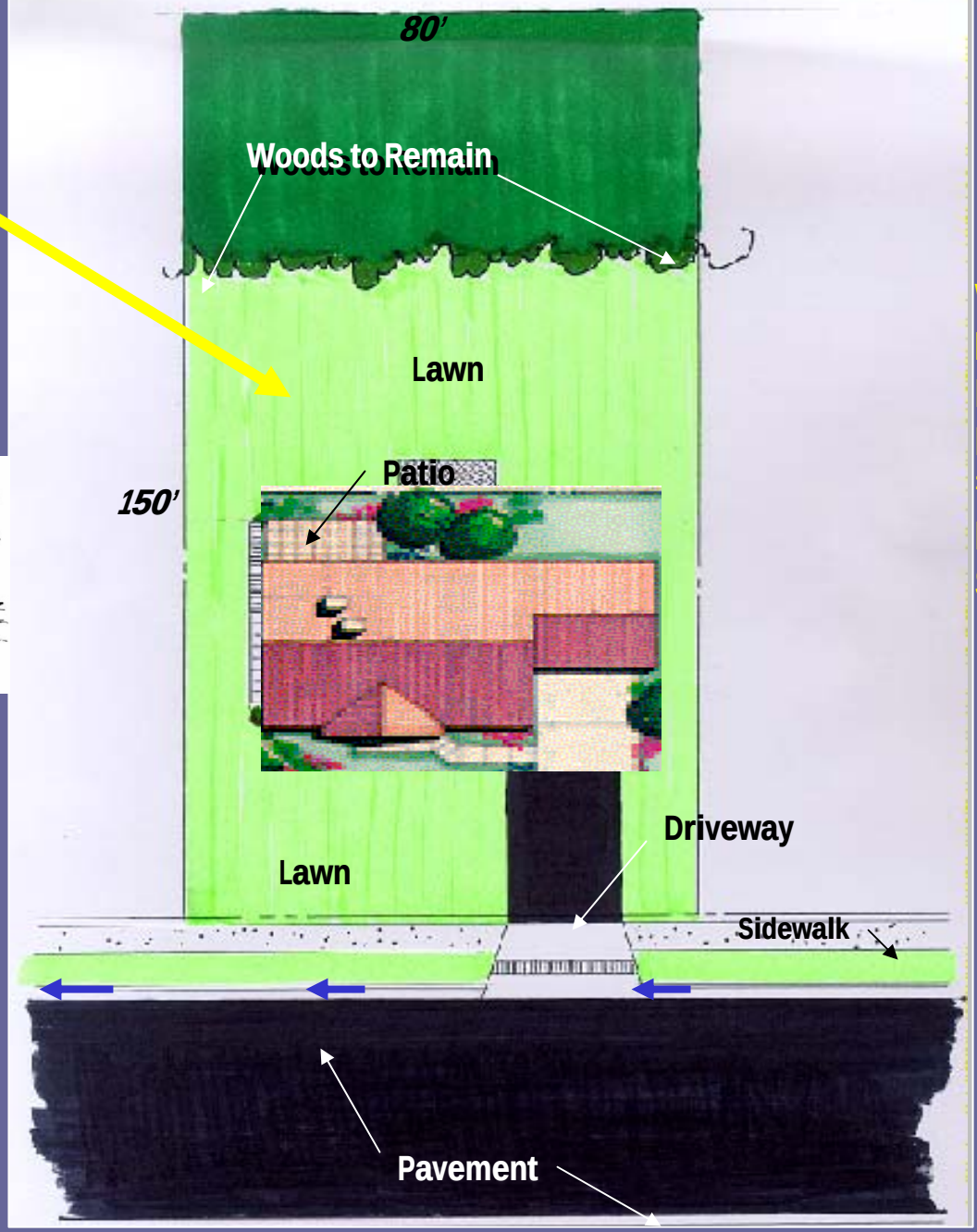
4 Bedrooms

3-1/2 Baths

1st Floor 1456 SF

2nd Floor 1280 SF

Total Heated 2736 SF



	CN	SF
Woods	55	3200
Lawn	61	5830
House	98	2000
Drive	98	670
½ Street	98	1120
Patio	98	300
Sidewalk	98	400

Typical Lot
12,000 S.F.

Two-Story House

Width 60'

Depth 40'

4 Bedrooms

3-1/2 Baths

1st Floor 1456 SF

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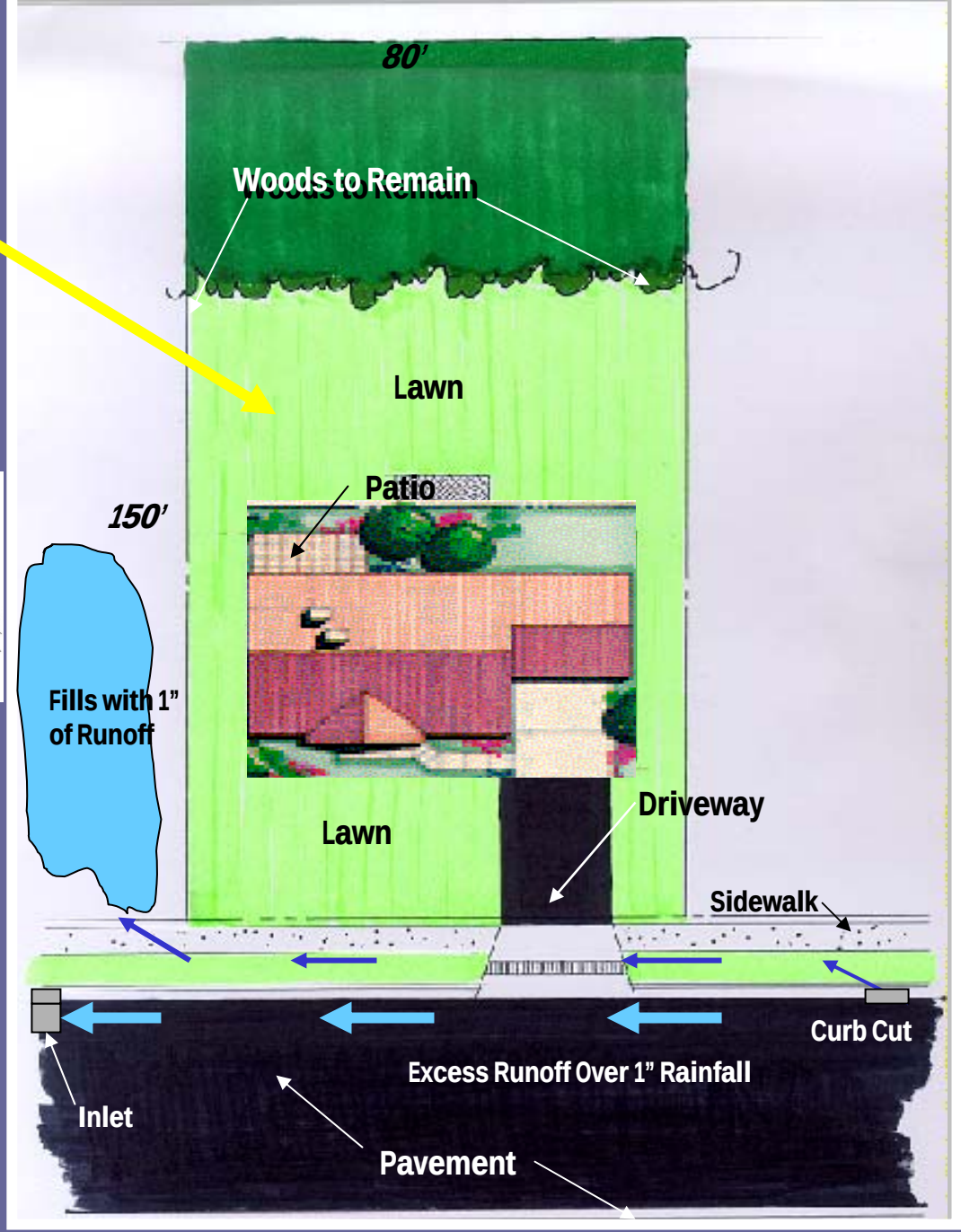

	CN	SF
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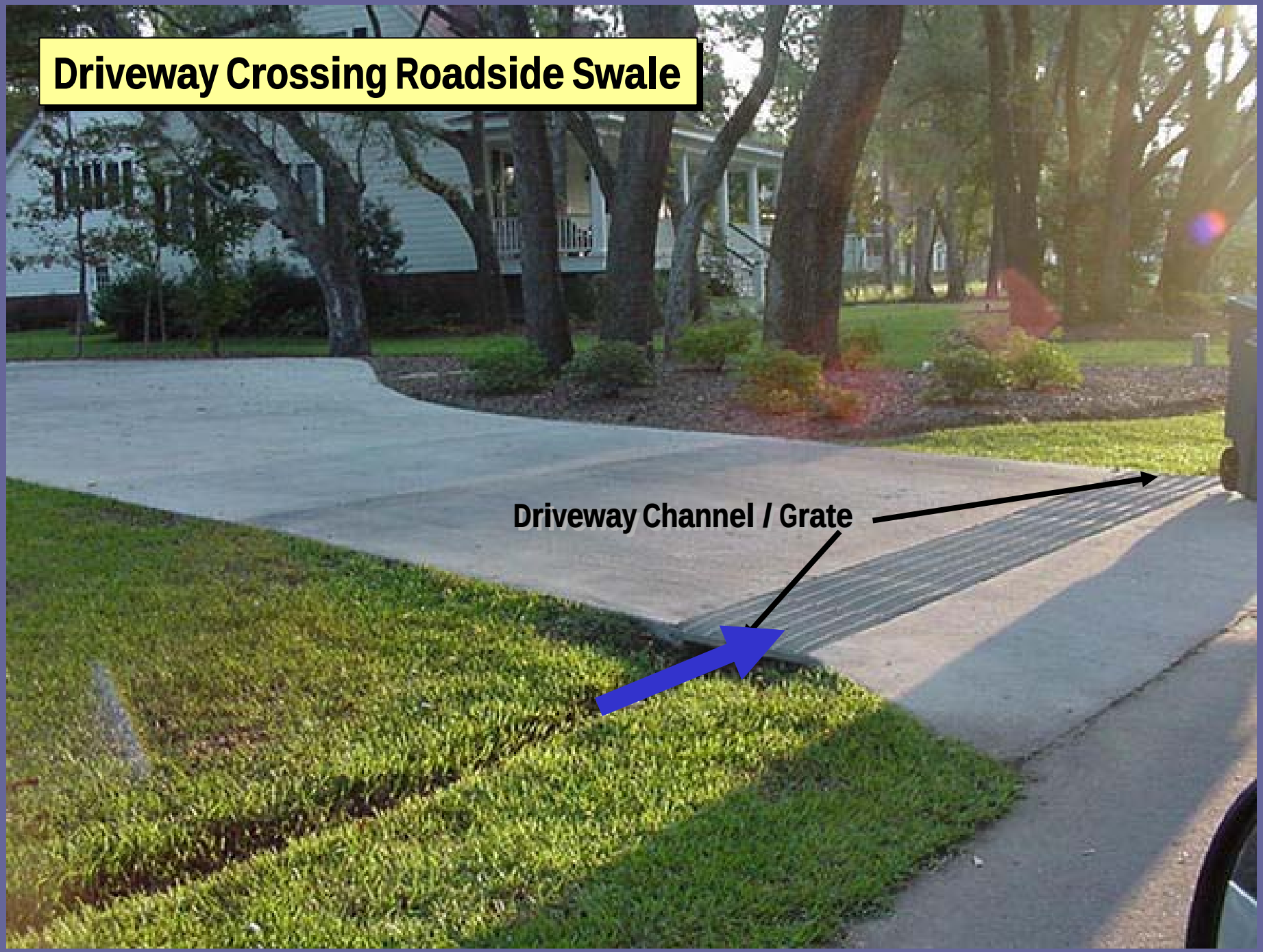
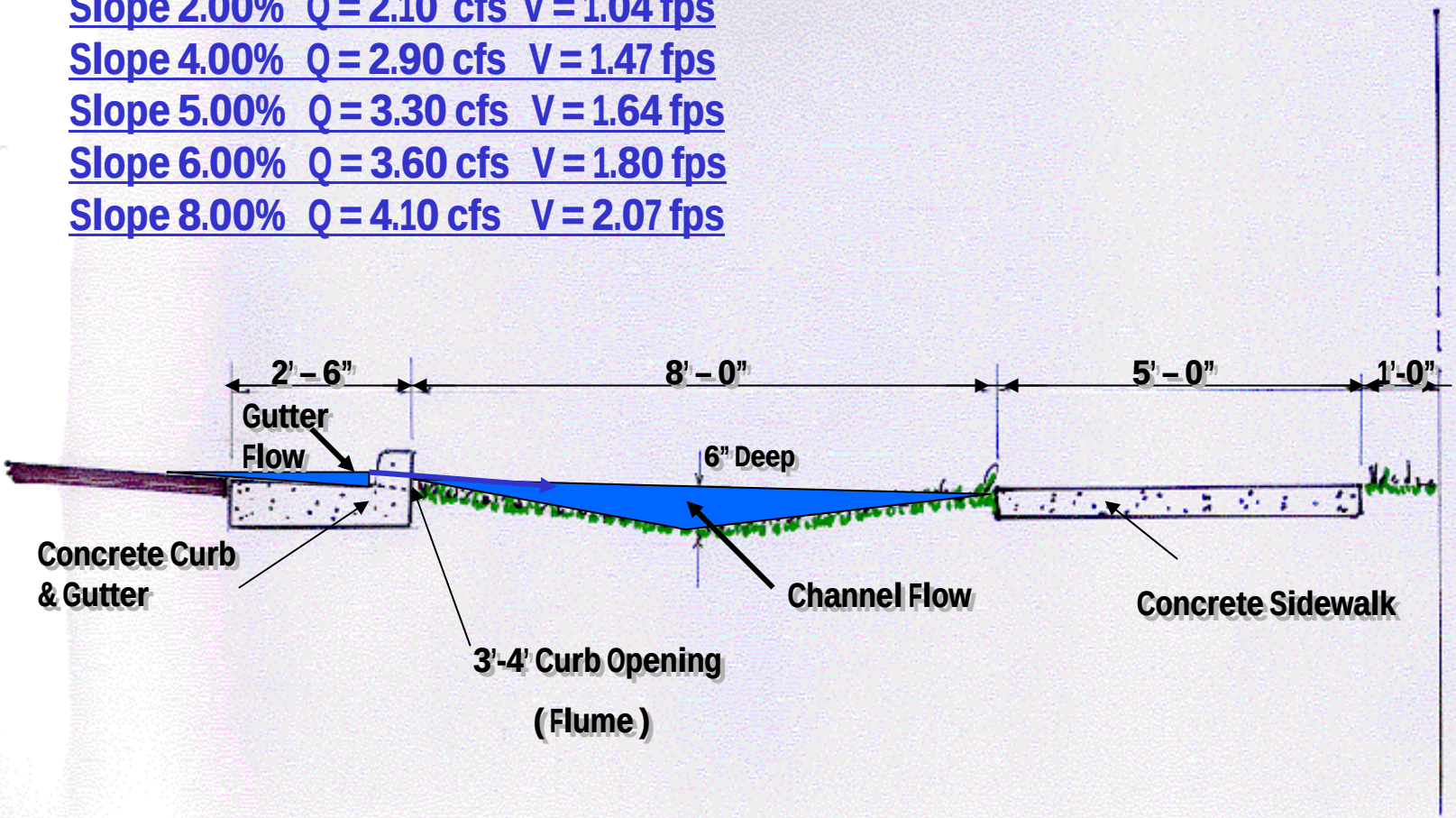

Driveway Crossing Roadside Swale
Driveway Channel / Grate

Roadside Swale Capacities

Slope 0.50% Q = 1.00 cfs V = 0.51 fps
Slope 1.00% Q = 1.50 cfs V = 0.73 fps
Slope 2.00% Q = 2.10 cfs V = 1.04 fps
Slope 4.00% Q = 2.90 cfs V = 1.47 fps
Slope 5.00% Q = 3.30 cfs V = 1.64 fps
Slope 6.00% Q = 3.60 cfs V = 1.80 fps
Slope 8.00% Q = 4.10 cfs V = 2.07 fps



Water Quality Swale

S.E.T. Calculations

S.E.T. Analysis

1. Enter Site Data Here

Show/Hide Calculation Sheets

"Site Data" and "BMPs" worksheets require user inputs.
"User BMP" requires user input if the site has a BMP not listed on the "BMPs" sheet
Blue colored cells indicate user input fields.
Model results are summarized in the "Model Output" worksheet.

General Information	
Name of Applicant:	MC Development Co.
Name of Project:	Forest Lake Estates
Scenario Name*:	109 Lot LID
# Homes on Septic Systems	
Unsewered Commercial Systems (gal/yr)	
Development Site Area (acres):	36.720
Development Site Area (calculated, ft^2):	1,599,523

* Use *Scenario Name* when multiple BMP configurations are being tested for a given project. Save each scenario as a separate file.

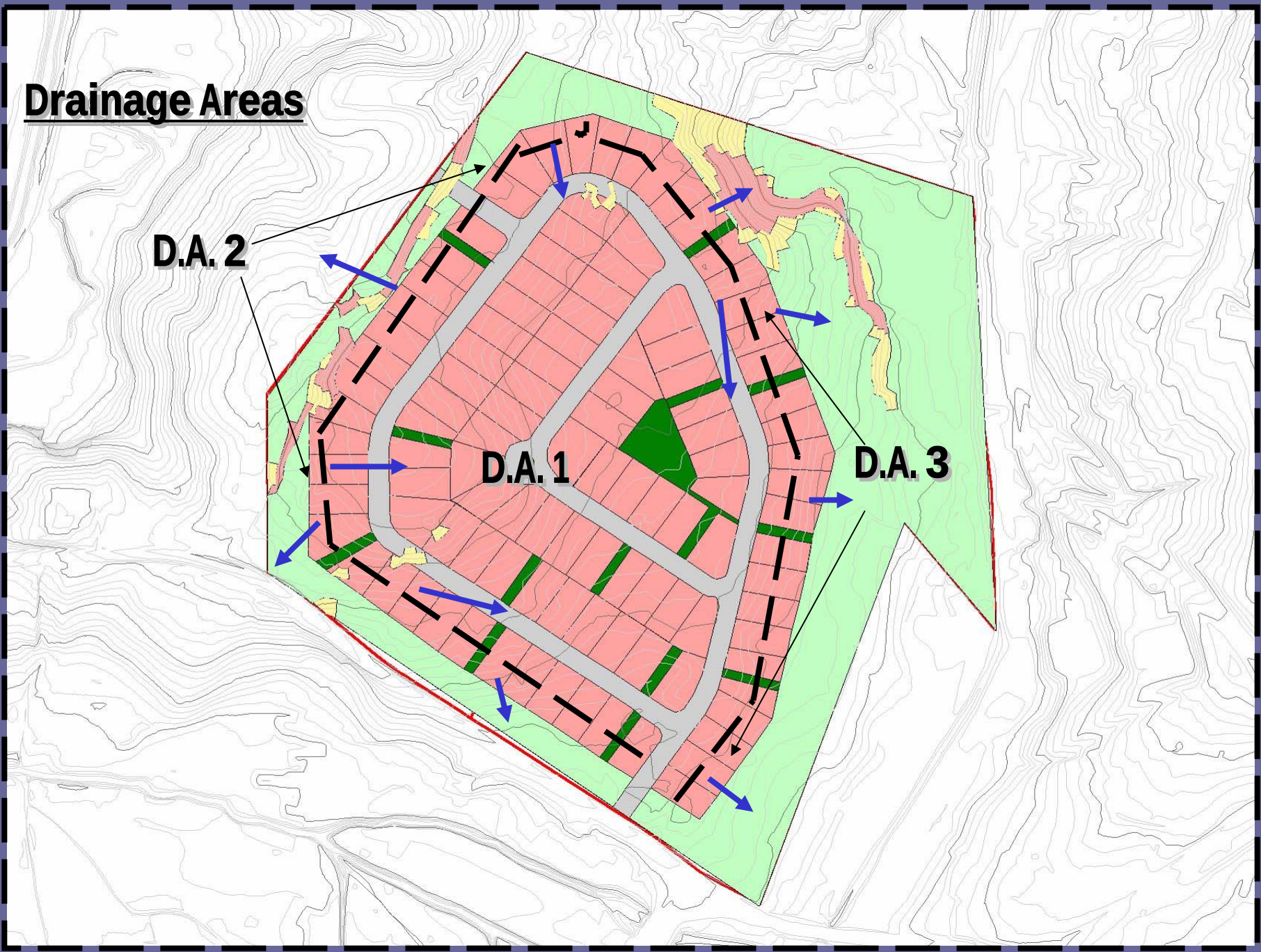
Soil Hydrologic Groups (Percent of Site Area)	
Group A	
Group B	100.00%
Group C	
Group D	

Check on Soil Group Sums — Totals OK

Areas assigned in this table must sum to the total development site area.
"Pasture" has livestock, while "Meadow" means unmanaged herbaceous cover without livestock.
"Driveways and Parking Lots" include curb and gutter.
"Rooftops" include canopies.

Land Use/Cover Data	Existing Land Use		Proposed Land Use	
	Area (ft^2)	% of Site	Area (ft^2)	% of Site
Pervious Areas				
Row Crops	0	0.0%	0	0.0%
Pasture	0	0.0%	0	0.0%
Forest	1,599,523	100.0%	435,773	27.2%
Wetland	0	0.0%	0	0.0%
Meadow	0	0.0%	0	0.0%
Lawn	0	0.0%	635,500	39.7%
Impervious Areas				
Residential & Light Industrial				
Rooftops		0.0%	218,000	13.6%
Driveways & Parking Lots		0.0%	70,850	4.4%
Other Impervious Area		0.0%	32,700	2.0%
Road		0.0%	153,700	9.6%
Sidewalk		0.0%	53,000	3.3%
Commercial & Heavy Industrial				
Rooftops		0.0%		0.0%
Parking Lot		0.0%		0.0%
Other Impervious Area		0.0%		0.0%
Road		0.0%		0.0%
Sidewalk		0.0%		0.0%
Storm Water Management Facilities				
Pond/Wetland Surface Area	0	0.0%	0	0.0%
Swales/Channels/Infiltration		0.0%		0.0%
Site Totals:	1,599,523	100.0%	1,599,523	100.0%
Total Site Impervious Cover[1]	1.0%		33.7%	

Drainage Areas



2. Assign Project Areas Here

Assign project area to specific land uses in drainage areas (DA) associated with a specific set of BMPs
Hint: Assign land area to the Drainage Areas until all entries in the "Unassigned" category equal 0.

Proposed Land Use/ Cover Data by DA						
	Project Areas (ft^2)	Unassigned Area (ft^2)	Drainage Areas (DA) associated with B			
			DA1	DA2	DA3	DA4
Pervious Areas						
Row Crops	0	0				
Pasture	0	0				
Forest	435,773	0	253,773	82,000	100,000	
Wetland	0	0				
Meadow	0	0				
Lawn	635,500	0	466,900	84,100	84,500	
Impervious Areas						
Residential & Light Industrial						
Rooftops	218,000	0	218,000			
Driveways & Parking Lots	70,850	0	70,850			
Other Impervious Area	32,700	0	32,700			
Road	153,700	0	153,700			
Sidewalk	53,000	0	53,000			
Commercial & Heavy Industrial						
Rooftops	0	0				
Parking Lot	0	0				
Other Impervious Area	0	0				
Road	0	0				
Sidewalk	0	0				
Storm Water Management Facilities						
Pond/Wetland	0	0				
All Other BMPs (except Forested Buffer)	36,000	0	36,000			
Total Area	1,635,523	0	1,284,923	166,100	184,500	

Proposed Drainage Area (DA) assignments match Proposed Land Use.

3. Assign BMPs Here

a. Click on a box to associate a BMP with a specific DA. BMPs should serve the entire DA.

b. Enter storage volume (if applicable) of BMP in acre-ft.

BMPs Applied to DA	DA1	DA2	DA3	---
Wet Pond	☐	☐	☐	☐
Dry Detention	☑	☐	☐	☐
Stormwater Wetland	☐	☐	☐	☐
Sand Filter	☐	☐	☐	☐
Bioretention (Rain Garden)	☑	☐	☐	☐
Enhanced Grass Swale	☐	☐	☐	☐
Grass Swale	☑	☐	☐	☐
Infiltration Trench	☐	☐	☐	☐
User-defined BMP (Sequential with other assigned BMPs)	☐	☐	☐	☐
Forested Buffer	☐	☑	☑	☐
Enter Buffer Width for each DA with Forested Buffer (feet):		140	140	
Percent of DA within treatment zone:		100.0%	100.0%	
Storage volume for 2 yr, 24 hr storm (acre-ft)	2.3			

Notes: Grass channels do not receive removal credit when used in combination with water quality dry swales.

Forested Buffers cannot be used with Wet Ponds, Dry Detention Basins, or Stormwater Wetlands in the same drainage area.

BMP Performance

Net Reductions	DA1	DA2	DA3	---
Flow converted to infiltration by BMPs	48.0%	10.0%	10.0%	
Total Nitrogen	97.4%	36.1%	36.1%	
Total Phosphorus	96.7%	45.0%	45.0%	
TSS	99.5%	69.4%	69.4%	
Fecal Coliform	97.3%	5.0%	5.0%	

DEVELOPMENT PERFORMANCE ANALYSIS

MC Development Co.
Forest Lake Estates
109 Lot LID

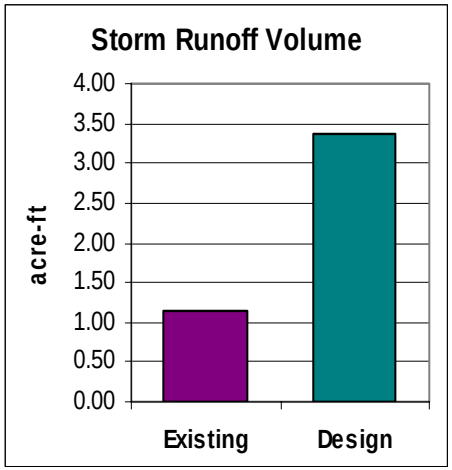
Land Use Summary

Total Site Area (acres)	36.72
Pre-development impervious percentage	1.0%
Post-development impervious percentage	33.7%

Annual Hydrology Summary

	Existing Landuse	Design without BMPs	Design with BMPs
Annual Surface Runoff (inches/yr)	2.32	13.91	7.43
Annual Infiltration (inches/yr)	12.00	7.08	13.57

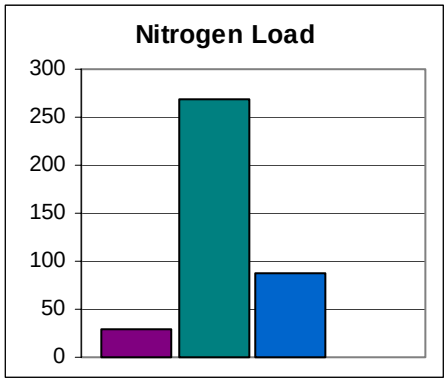
2-year, 24-hour Storm Event Runoff Volume Summary

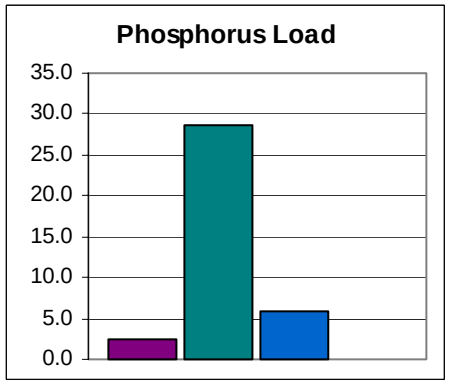


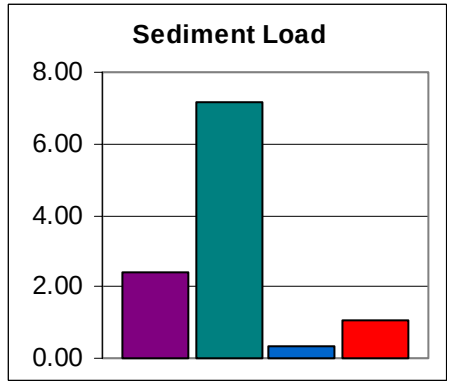
Storm Event Runoff Volume (acre-ft)	
Existing Landuse	1.16
Design without BMPs	3.38
2-yr, 24-hr BMP Storage	2.25
Target Storage [1]	2.22
Meets Goal?	YES

Pollutant Load Summary

	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	29	268	87		
Total Phosphorus (lb/yr)	2.5	28.6	5.9		
Sediment [2] (ton/yr)	2.41	7.16	0.36	1.07	YES

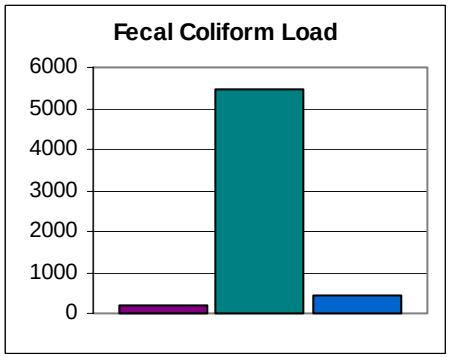






BMPs Meet Sediment Load Reduction and Runoff Control Targets

Fecal Coliform Load Summary



Fecal Coliform Load (count x 10^9/yr)	
Existing Landuse	205
Design without BMPs	5484
Design with BMPs	418

[1] Target storage volume is the difference between pre-development runoff and design runoff with no BMPs.

[2] Upland sediment load only, does not include sediment from stream bank erosion/channel instability. Sediment target reflects 85% removal of annual sediment load under design conditions without BMPs.

Removal Efficiencies:

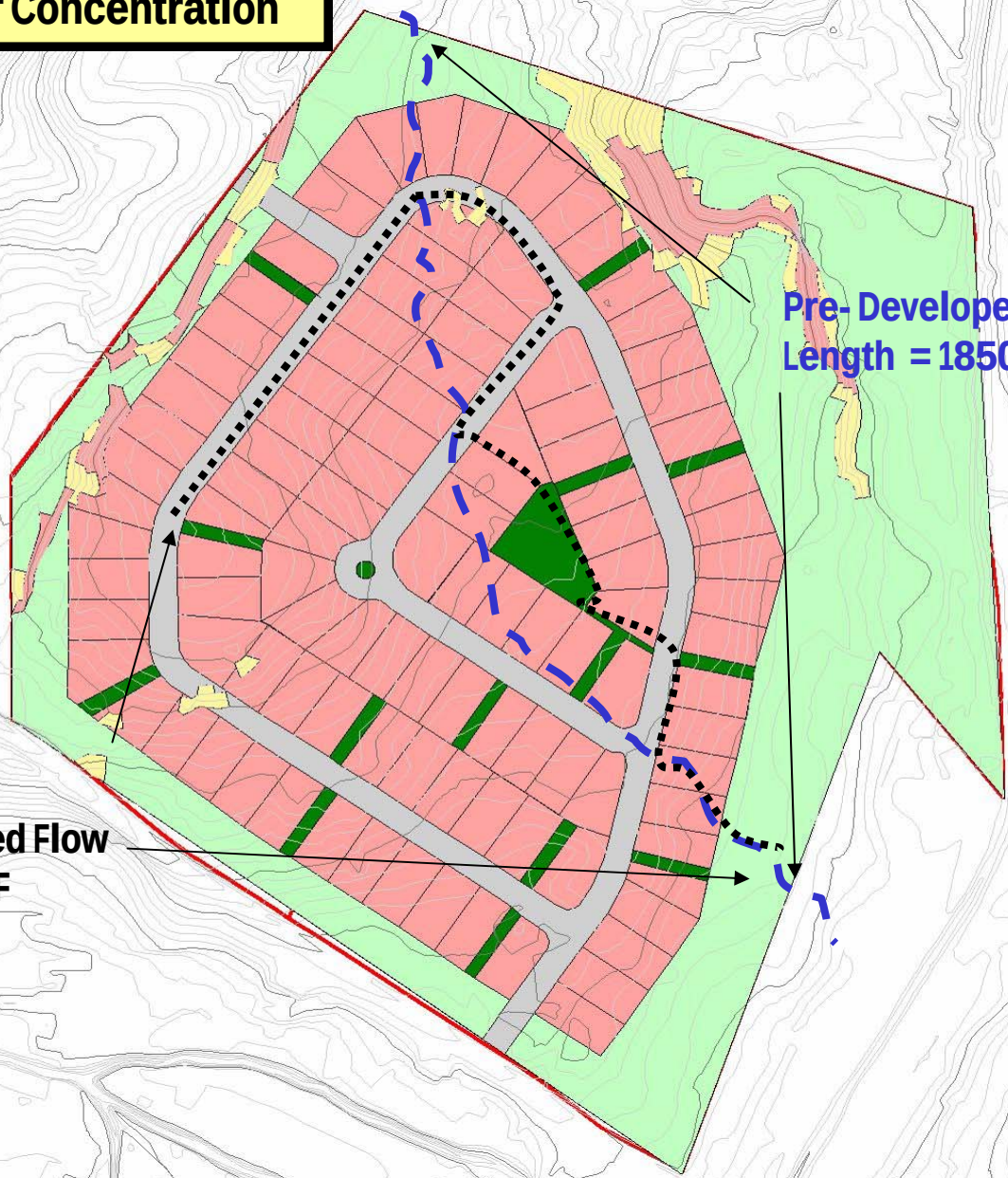
Total Nitrogen: 1.42 lb./acre per year = 67.5% Removal

Total Phosphorus: 0.10lb./acre per year = 79.4% Removal

Total Suspended Solids: 0.006 Tons/acre per year = 95% Removal

Hydrologic Analysis

Increase Time of Concentration



1. **Determine storage volume for Water Quality volume requirements.** Determine the storage volume required for quality control BMPs. Use larger of volumes to maintain CN (Step 1, Example 5.2) or water quality volume. (Example 5.3).

2. **Determine storage volume required to maintain runoff volume or CN.** Use Chart Series A: Storage Volume Required to Maintain the Pre-development Runoff Volume Using Retention Storage (Example 5.2).

3. **Determine storage volume required to maintain predevelopment peak runoff rate using 100% retention**. Use Chart Series B: Storage Volume Required to Maintain the Predevelopment Peak Runoff Rate Using 100% Retention.

4. **Determine whether additional detention storage is required to maintain pre-development peak runoff rate.** Compare the results of Steps 1 and 2 to the results of Step 3. If the storage volume in Steps 1 and 2 is determined to be greater than that in Step 3, the storage volume required to maintain the predevelopment CN also controls the peak runoff rate. No additional detention storage is needed. If the site area in Step 1 is less than that in Step 3, additional detention storage is required to maintain the peak runoff rate (Example 5.4).

5. **Determine storage volume required to maintain predevelopment peak runoff rate using 100% detention.** Use Chart Series C: Storage Volume Required to Maintain the Predevelopment Peak Runoff Rate Using 100% Detention. This is used in conjunction with Chart Series A and B to determine the hybrid volume in Step 6.

6. **HYBRID approach.** Use results from Chart Series A, B, and C to determine storage volume s to maintain both the predevelopment peak runoff rate and runoff volume. Refer to Equations 5.5 and 5.6 as found in Example 5.4.

7. **Determine appropriate storage volume available for retention practices.** If the storage volume available for retention practices is less than the storage determined in Step 3, recalculate the amount of BMP area required to maintain the peak runoff rate while attenuating some volume using the procedure in Example 5.6 using Equations 5.7 and 5.8.

Summary

Volume to maintain pre-developed volume = 0.49". 1.50 Ac.Ft. (2 year storm)

Water Quality Volume (Impervious Area) =0.79", 0.798 Ac. Ft. (1" Rainfall)

Retention storage to maintain Peak Rate of Runoff = 0.99", 3.03 Ac. Ft. (10 Yr. Storm)

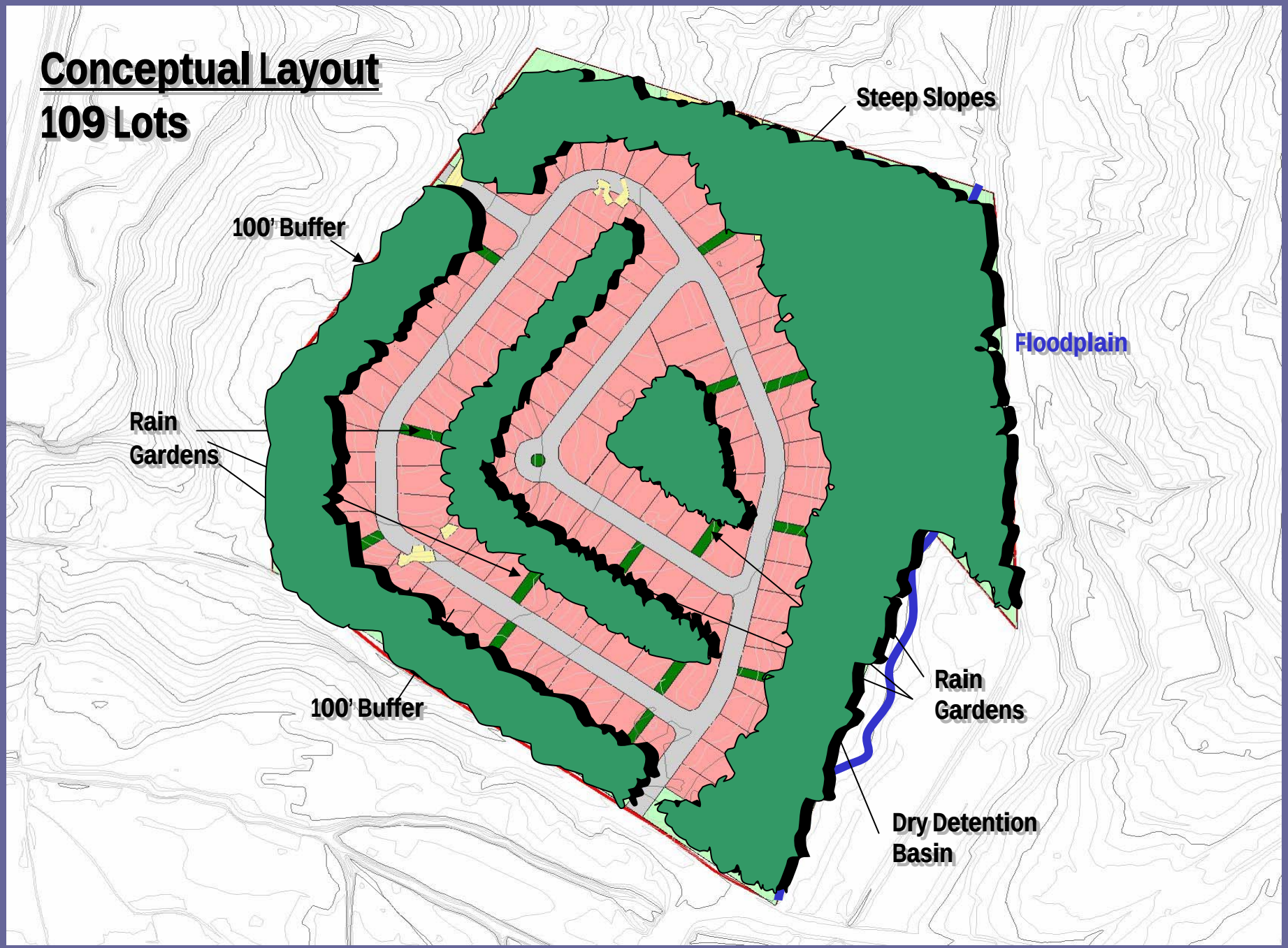
Detention storage to maintain Peak Rate of Runoff = 0.83", 2.54 Ac. Ft (10 Yr. Storm).

Total Volume required to maintain Peak Rate of runoff = 0.726". 2.222 Ac. Ft (HYBRID).

Therefore: Use 0.798 Ac. Ft in "Rain Gardens" and 1.424 Ac. Ft. in Dry Detention

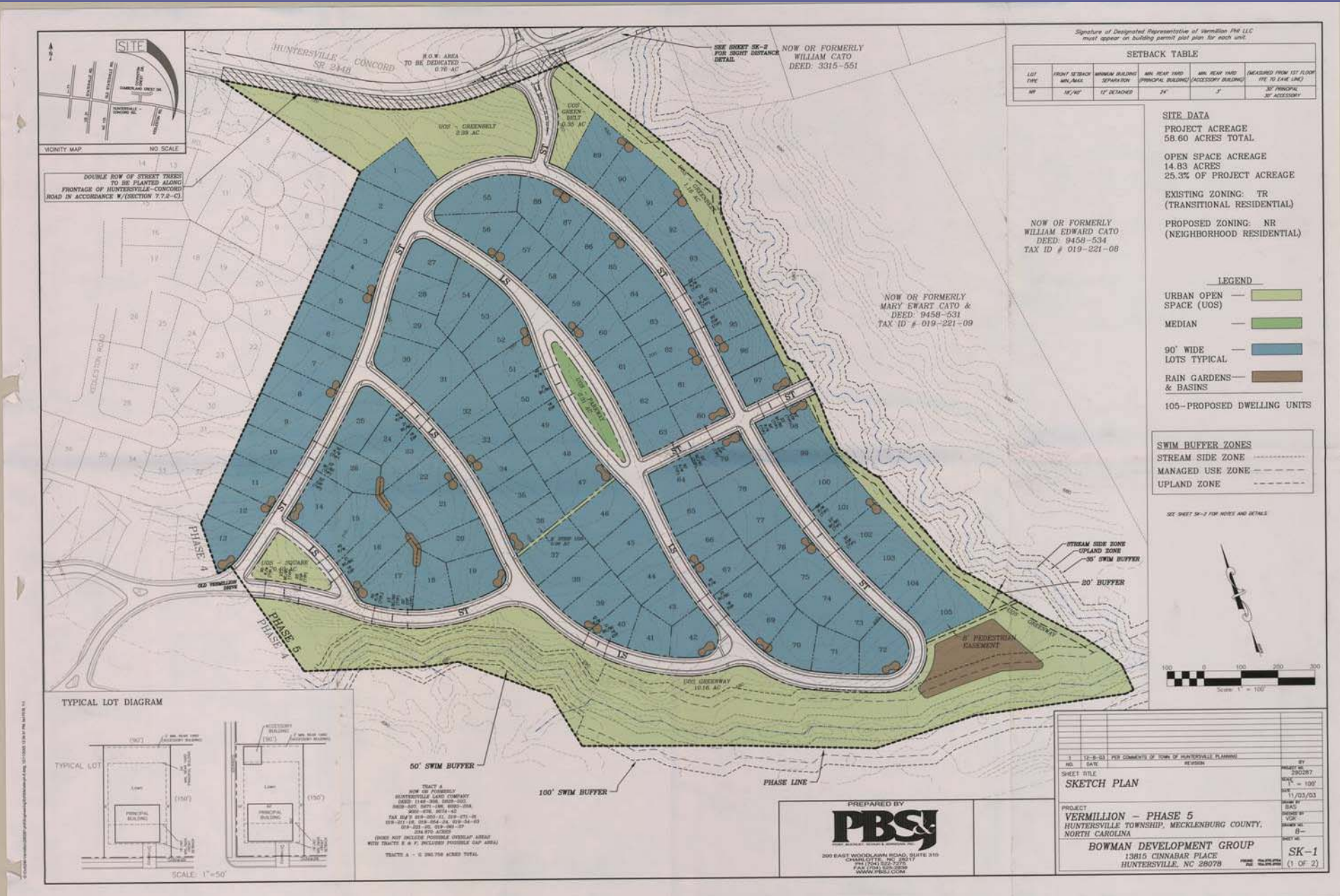
Final Conceptual Plan

Conceptual Layout
109 Lots



Forest Lake Estates

Vermillion Phase 5



Any Questions ?