LID Planning and Design

Presentation Highlights

- LID Concepts (Issues/Principles/Practices)
- Hydrologic Concepts
- Analysis Procedures
- Demonstration

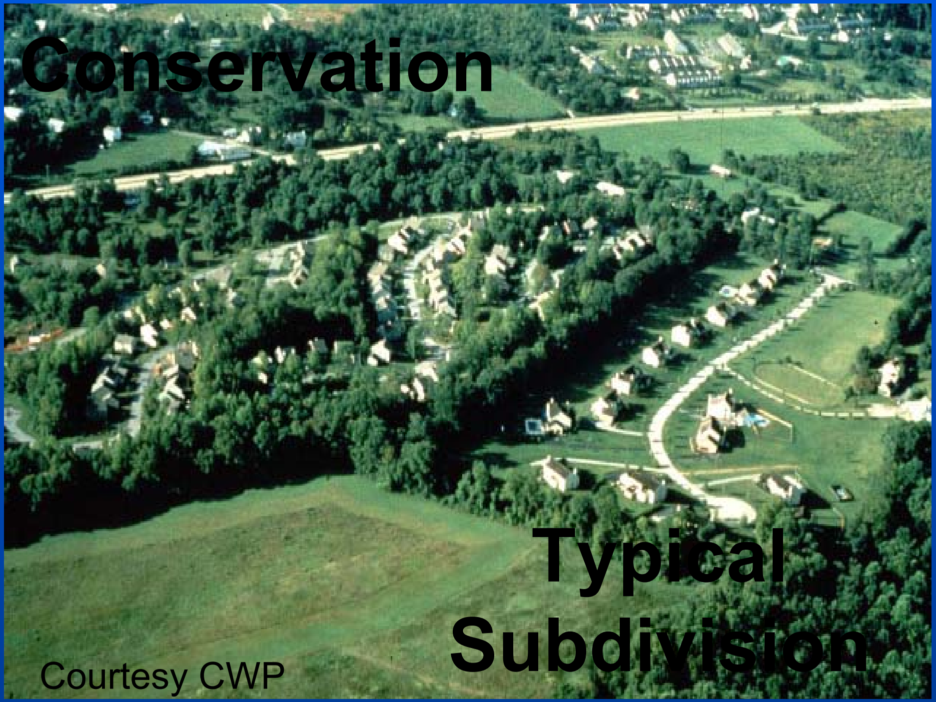
Low-Impact Development (LID)

- A sustainable stormwater management technology that combines precision engineering with micro-scale controls that are <u>engineered, designed and integrated</u> into every site feature in order to maintain, restore or closely mimic pre-development watershed hydrologic <u>functions</u> (volume, recharge, evaporation and runoff).
- Opportunities to create a “customized” functional watershed to address specific regulatory or aquatic resource protection goals
- Not a land use control, but a management and design strategy that is integrated into the proposed land use

Basic Guiding LID Principles

1. Conserve natural areas
2. Minimize development impacts
3. Maintain site runoff rate
4. Use integrated management practices
5. Implement pollution prevention, proper maintenance and public education programs

1. Conserve Natural Areas



- Conservation of drainages, trees & vegetation
- Land use planning
- Watershed planning
- Habitat conservation plans
- Stream & wetland buffers

2. Minimize Development Impacts

- Reduce storm pipes, curbs and gutters
- Preserve sensitive soils
- Cluster buildings and reduce building footprints
- Reduce road widths
- Minimize grading
- Limit lot disturbance
- Reduce impervious surfaces
- Better Site Design Techinques

3. Maintain Site Runoff Rate

- Maintain natural flow paths
- Use open drainage
- Flatten slopes
- Disperse drainage
- Lengthen flow paths
- Save headwater areas
- Maximize sheet flow

4. Integrated Management Practices

- Small-scale stormwater controls
- Distributed throughout site
- Maintain flow patterns, filter pollutants and re-create or maintain hydrology

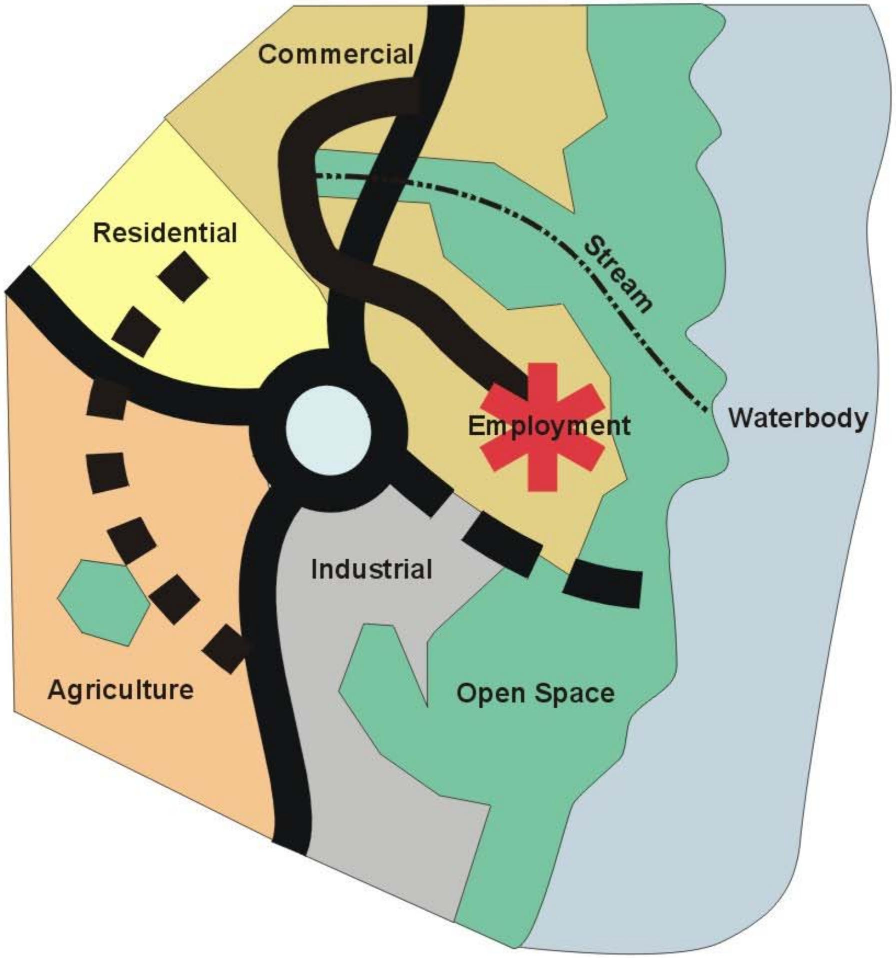
Common Integrated Management Practices

- **Disconnectivity**
- **Bioretention**
- **Open Swales**
- **Permeable and Porous Pavements**

- Green Roofs
- Planter Boxes
- Soil Amendment
- Sand Filters
- Inlet Retrofits

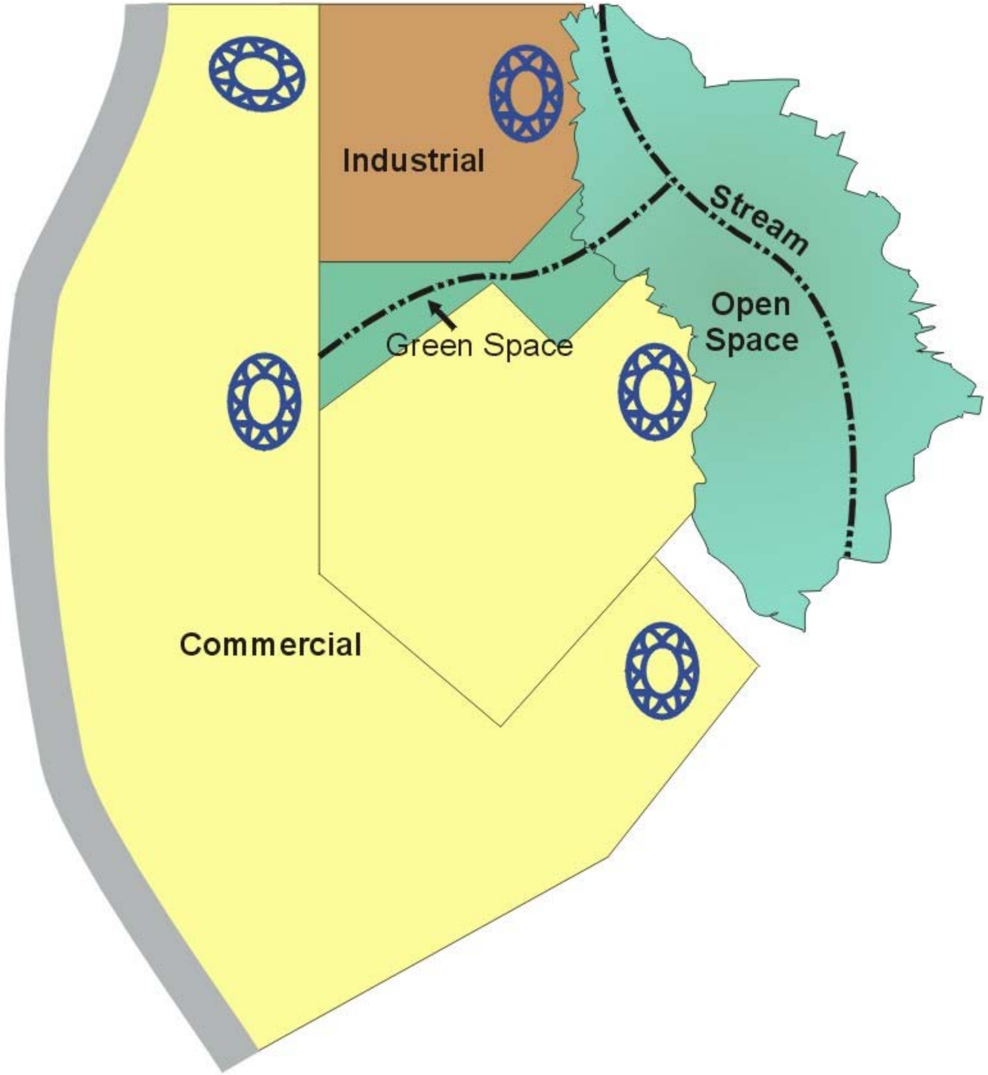
Basic LID Principles

1.) Conserve Natural Areas
2.) Minimize of Development Impacts
3.) Maintain Site Runoff Rate
4.) Use Integrated Management Practices
5.) Implement Pollution Prevention and Proper Maintenance



Traditional Master Plan

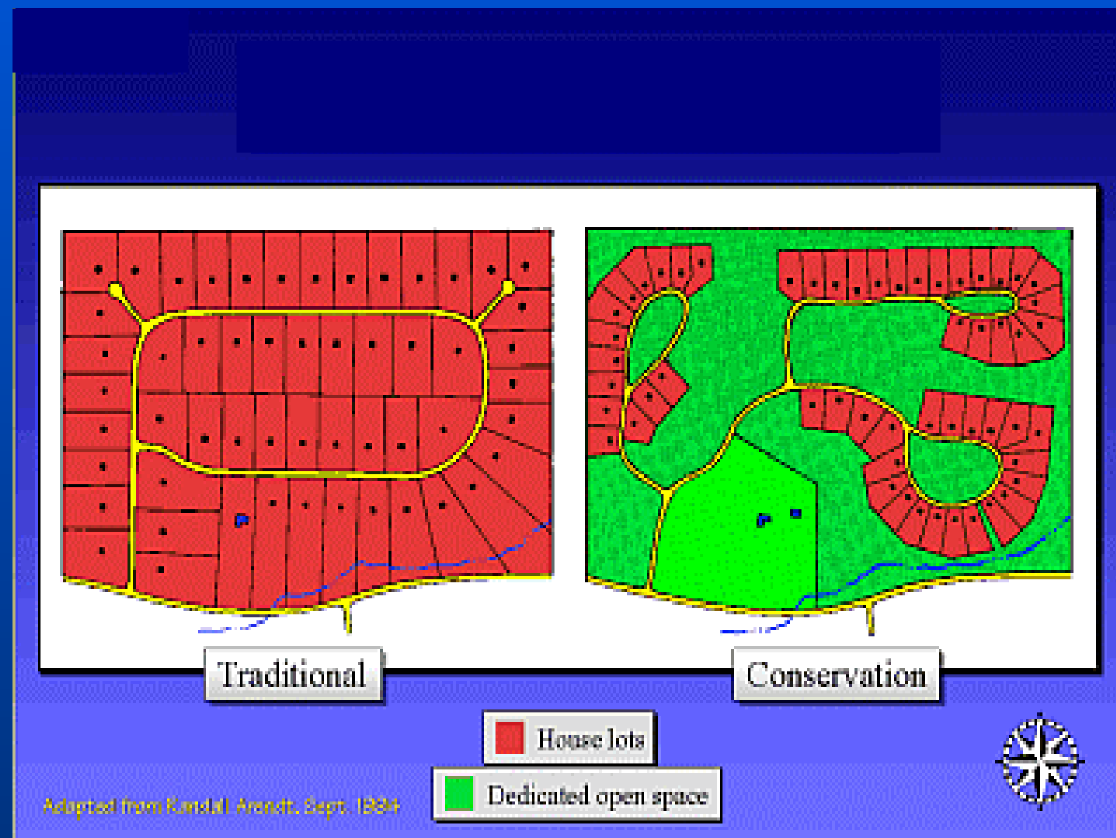
- Uncoordinated BMP's
- Isolation of Resouces
- Large Impervious Areas

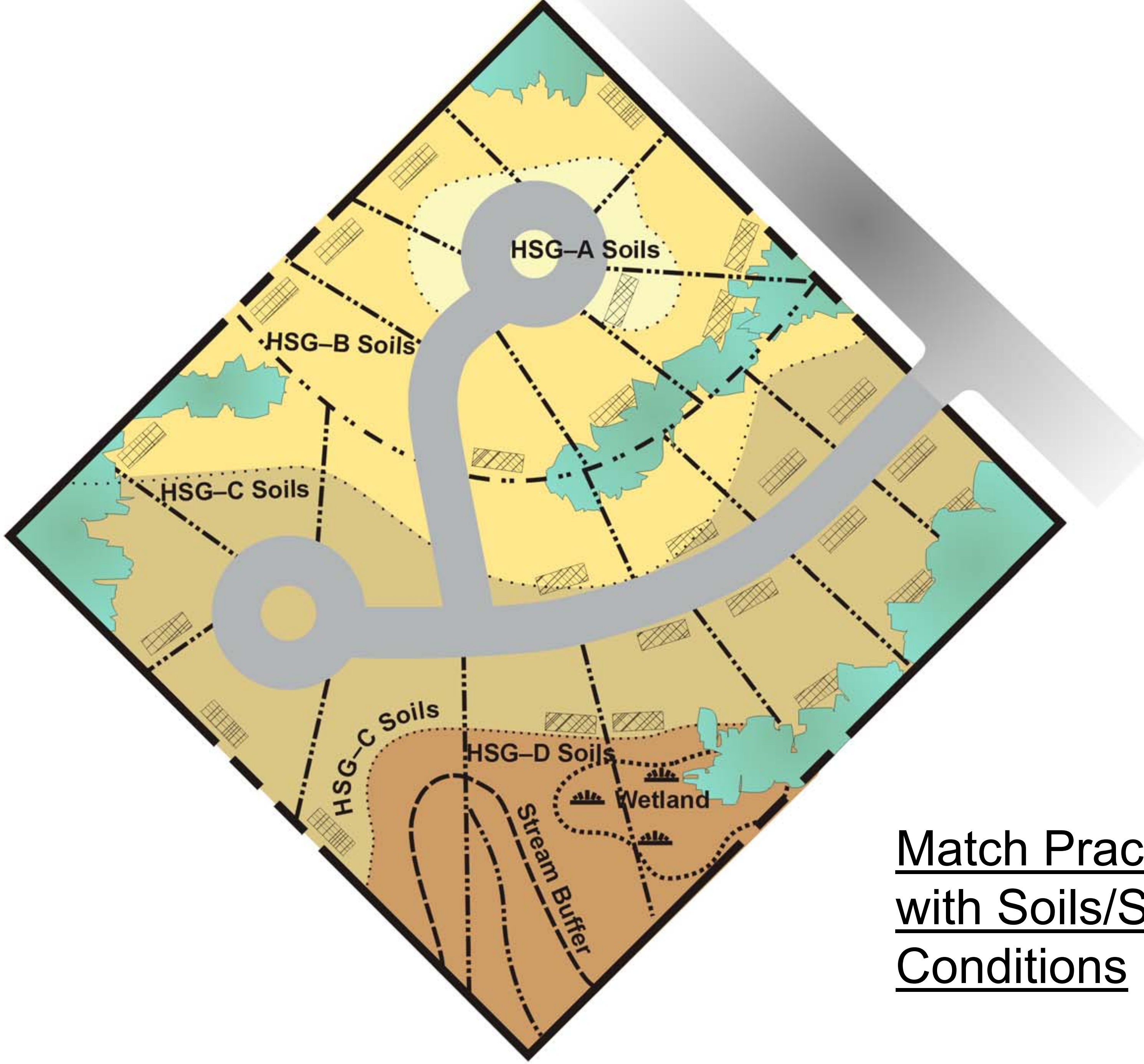


Traditional SWM Approaches

1. Conservation Plans Regulations

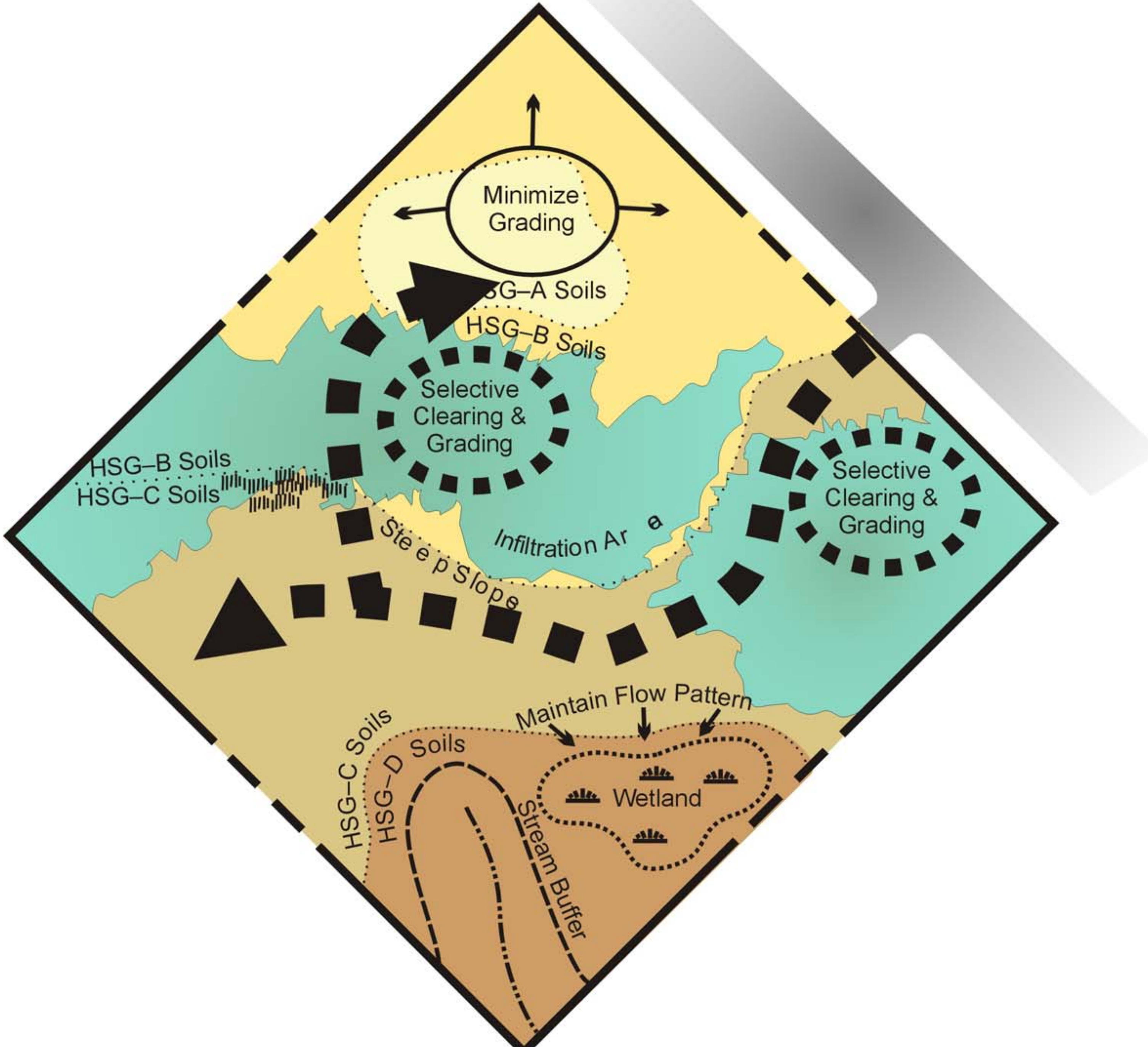
- Local Watershed Plans
- Conservation
  - Forest
  - Streams
  - Wetlands
  - Slopes
  - Buffers
  - Special Areas



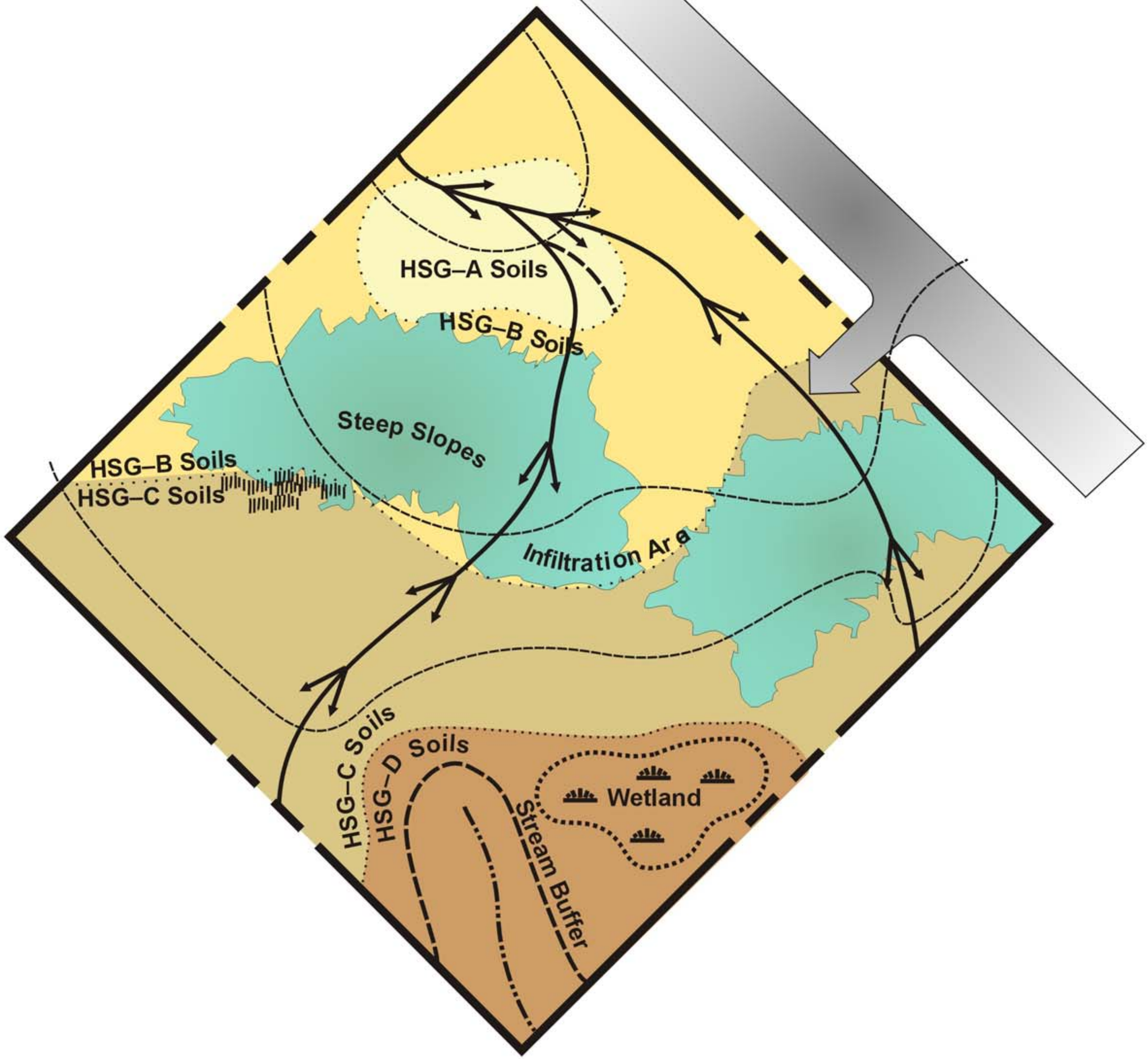


Low-impact Development Design

Match Practice with Soils/Site Conditions



Low-Impact Development Design Strategies



Low-impact Development Design Analysis

LID HYDROLOGIC ANALYSIS PROCEDURES

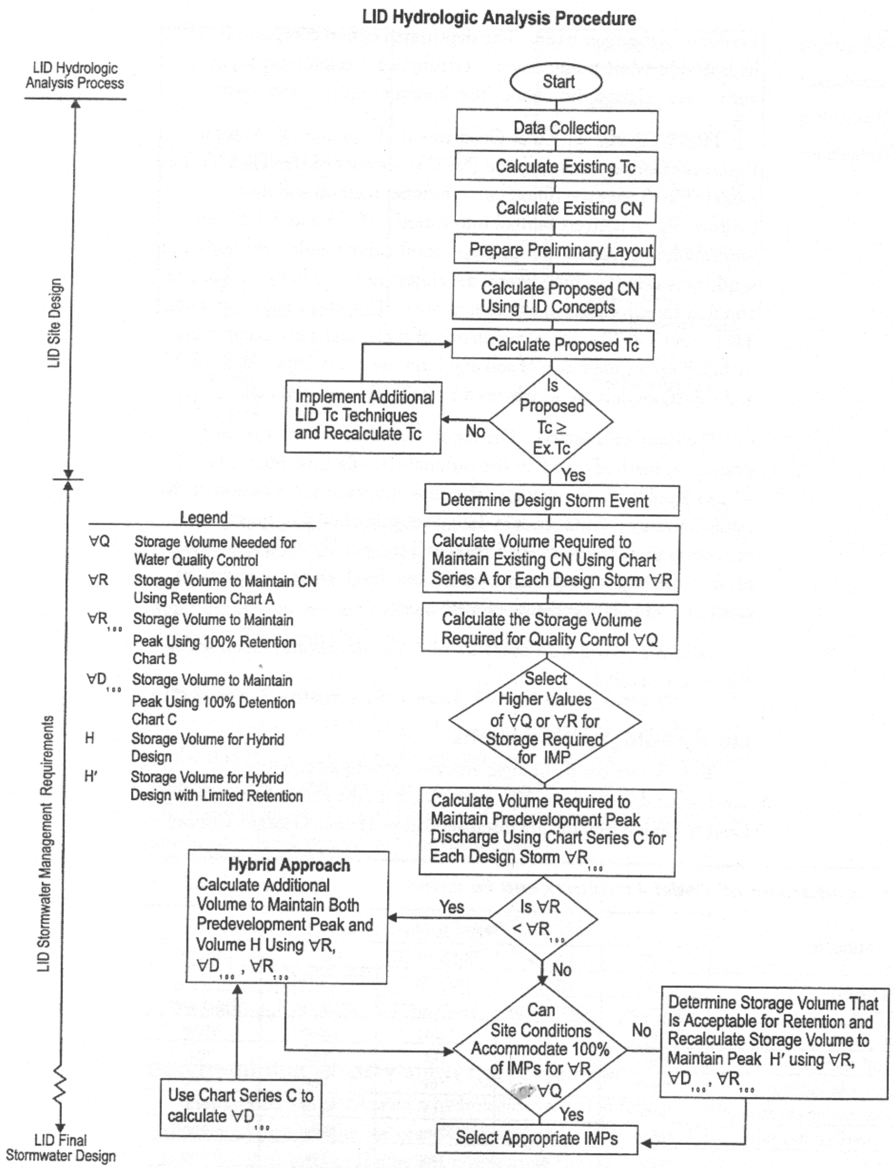
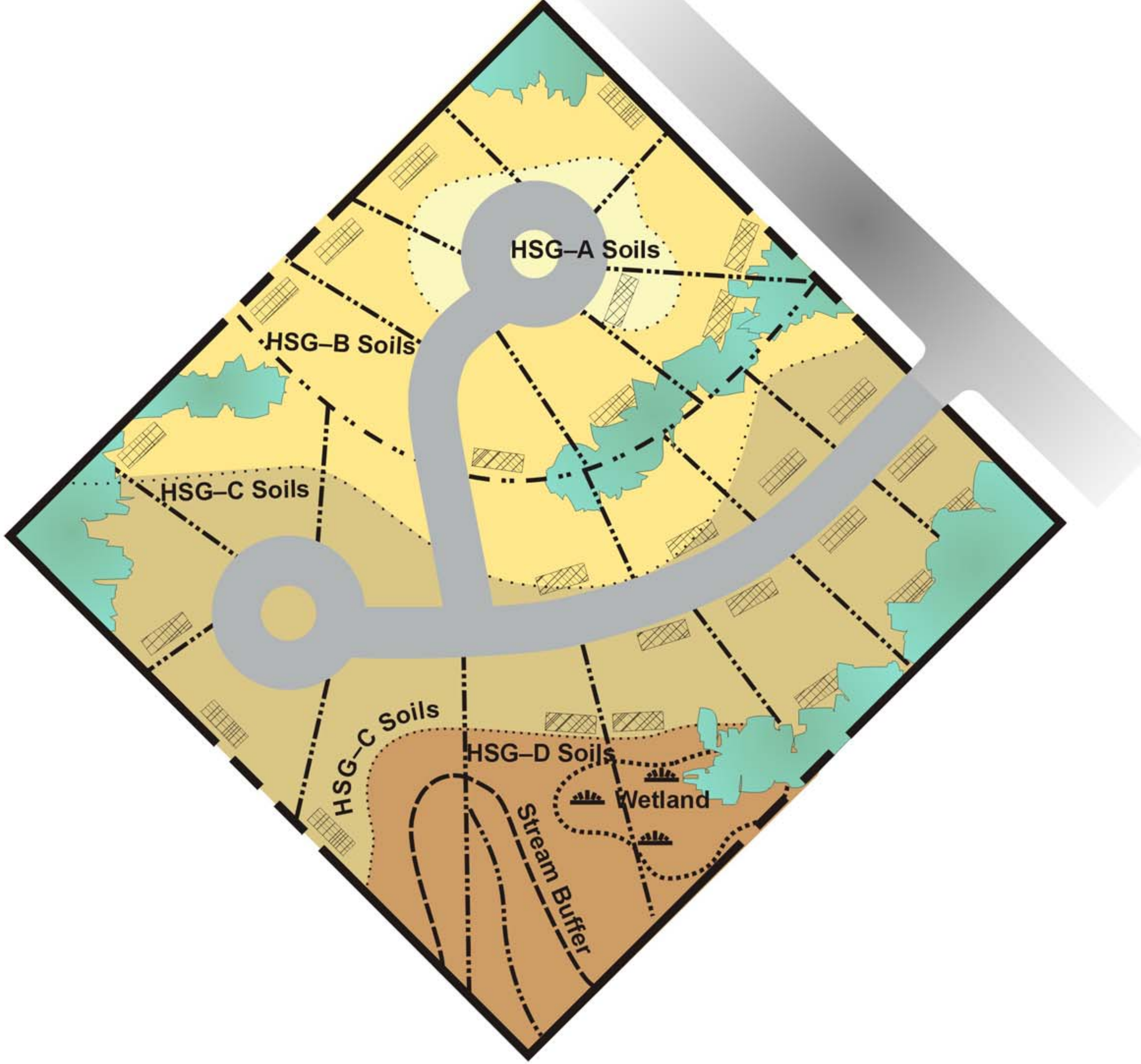


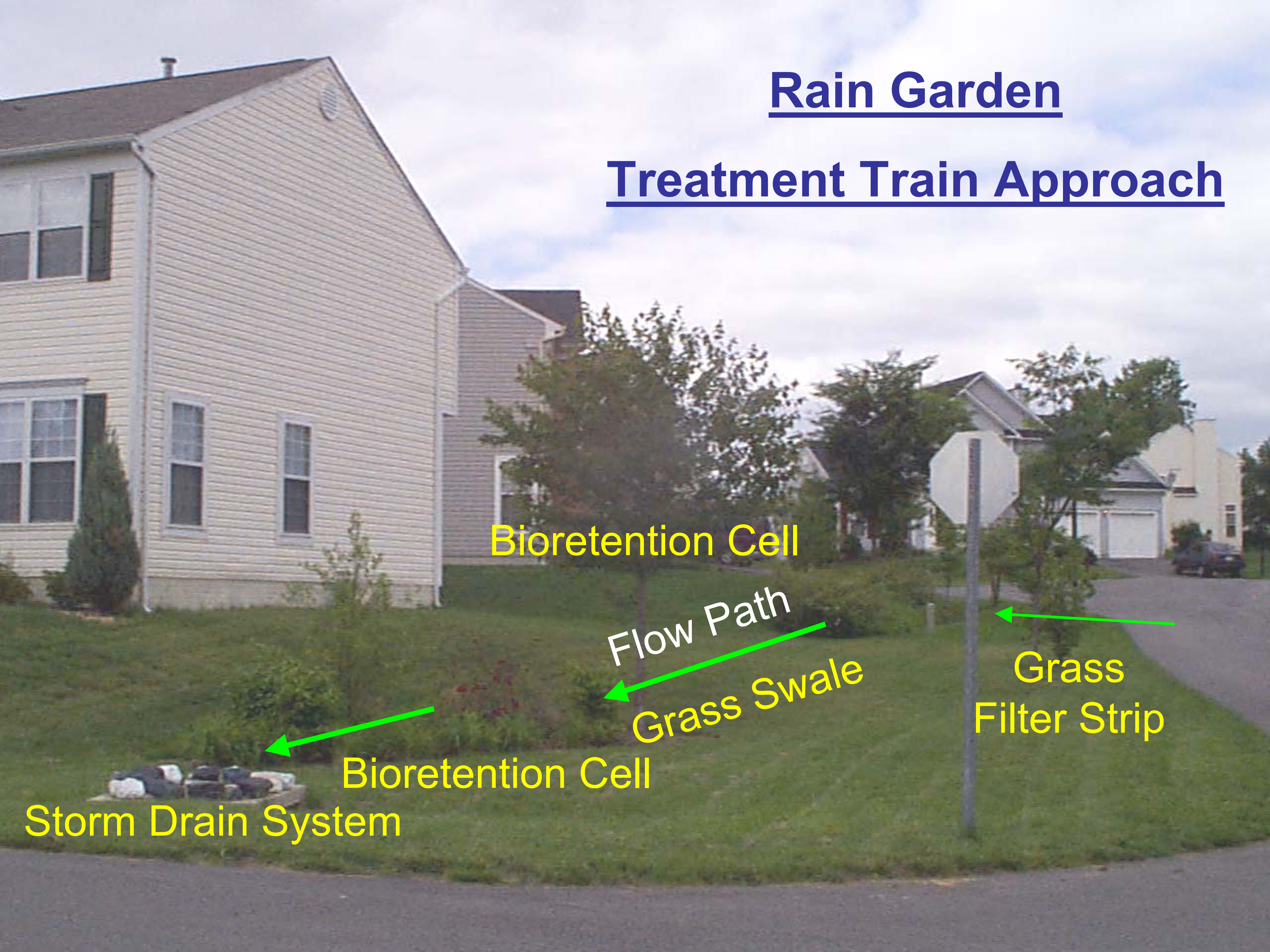
Figure 3-7. Prince George's County, Maryland, example of low-impact development analysis procedure (Prince George's County, 1997)

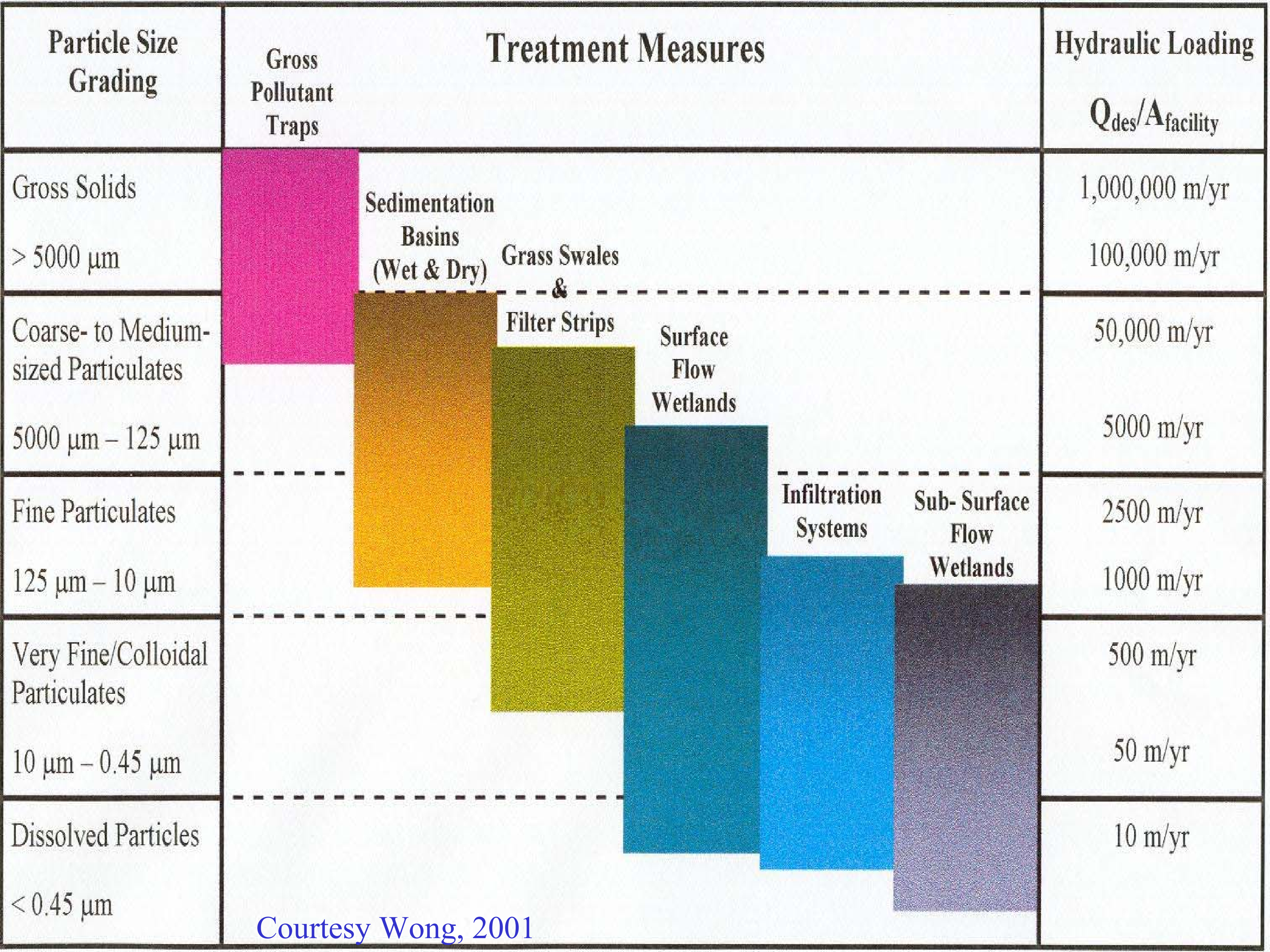


Low-impact Development Design

Rain Garden

Treatment Train Approach





Courtesy Wong, 2001

Treatment Train Approach

Benefits

100% Load

1. Pollution Prevention — 20%
2. Minimize — 70%

- Infiltration / Retention — 60%
- Filtration / Use (BMP's) — 70%, 10%
- Evaporation

Resultant Load — 4%

Projected Pollutant Reductions

Example

P lbs./ac./year

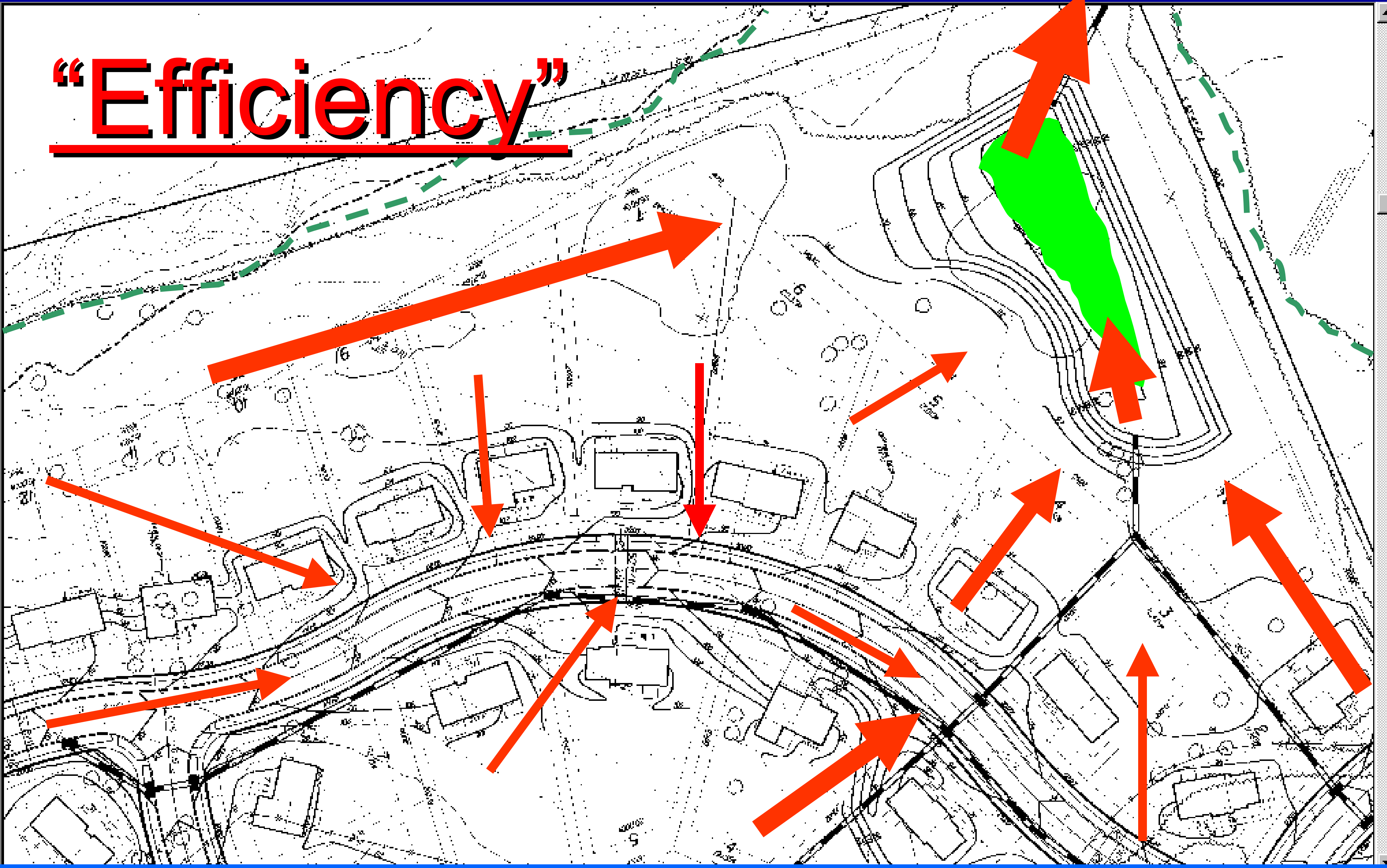
Forest 0.18

NC / LID

Suburban 0.58 / 0.023

Urban 1.82 / 0.073

Conventional Pipe and Pond Centralized Control



LID Uniform Distribution of Micro Controls

LID Techniques and Objectives

Low-Impact Development Technique

Low Impact Development Objective	Flatten Slope	Increase Flow Path	Increase Sheet Flow	Increase Roughness	Minimize Disturbance	Larger Swales	Flatten Slopes on Swales	Infiltration Swales	Vegetative Filter Strips	Constricted Pipes	Disconnected Impervious Areas	Reduce Curb and Gutter	Rain Barrels	Rooftop Storage	Bioretention	Re-Vegetation	Vegetation Preservation
Increase Time of Concentration	X	X	X	X					X	X	X	X	X	X	X		
Increase Detention Time							X			X			X	X			
Increase Storage						X		X	X						X	X	X
Lower Post Development CN					X						X				X	X	X

Maintain Time of Concentration (Tc)

Low-Impact Development Technique

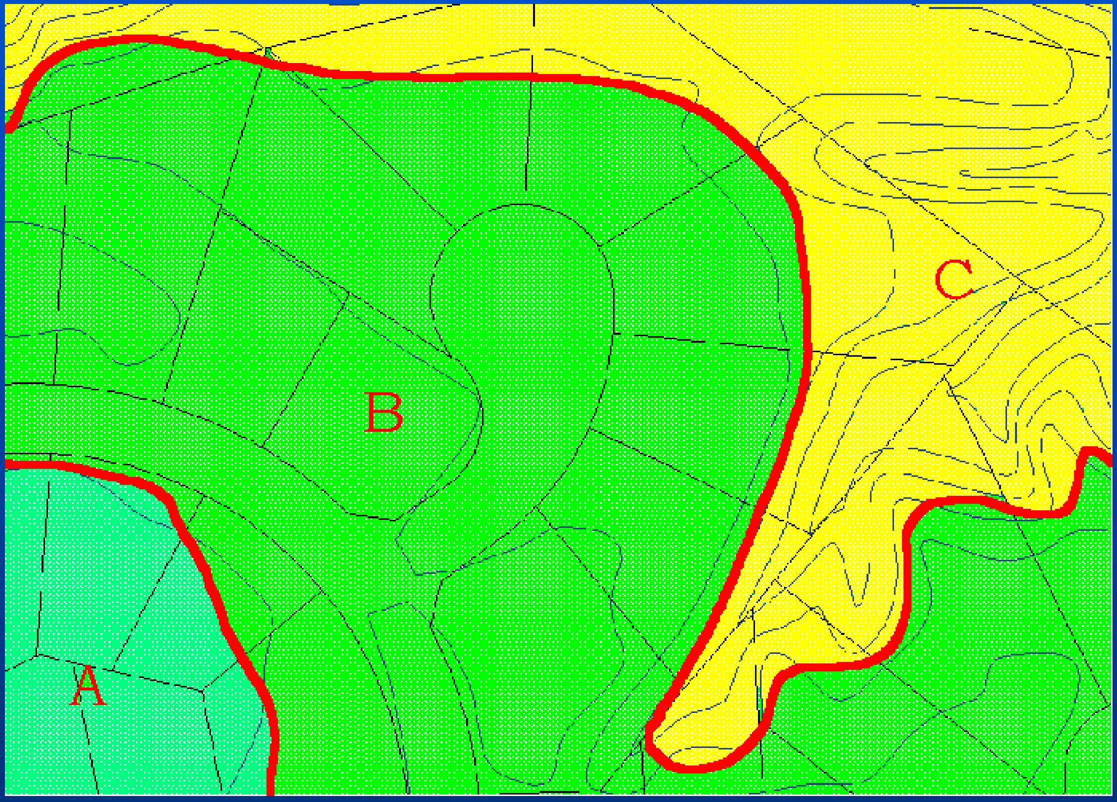
Low Impact Development objective to Maintain Time of Concentration (Tc)	Balance cut and fill on lot.	Network Smaller Swales	Clusters of Trees and Shrubs in Flow Path	Provide Tree Conservation on Lots	Eliminate Storm Drain Pipes	Disconnect Impervious Areas	Save Trees in Smaller Clusters	Terrace Yards	Drain from House and then Reduce Grades
Minimize Disturbance	X		X	X	X	X	X	X	
Flatten Grades		X			X			X	X
Reduce Height of Slopes					X			X	X
Increase Flow Path (Divert and Redirect)		X	X		X	X	X		X
Increase Roughness “n”			X	X	X	X	X		

Pre-Development Conditions

Woodland Attributes

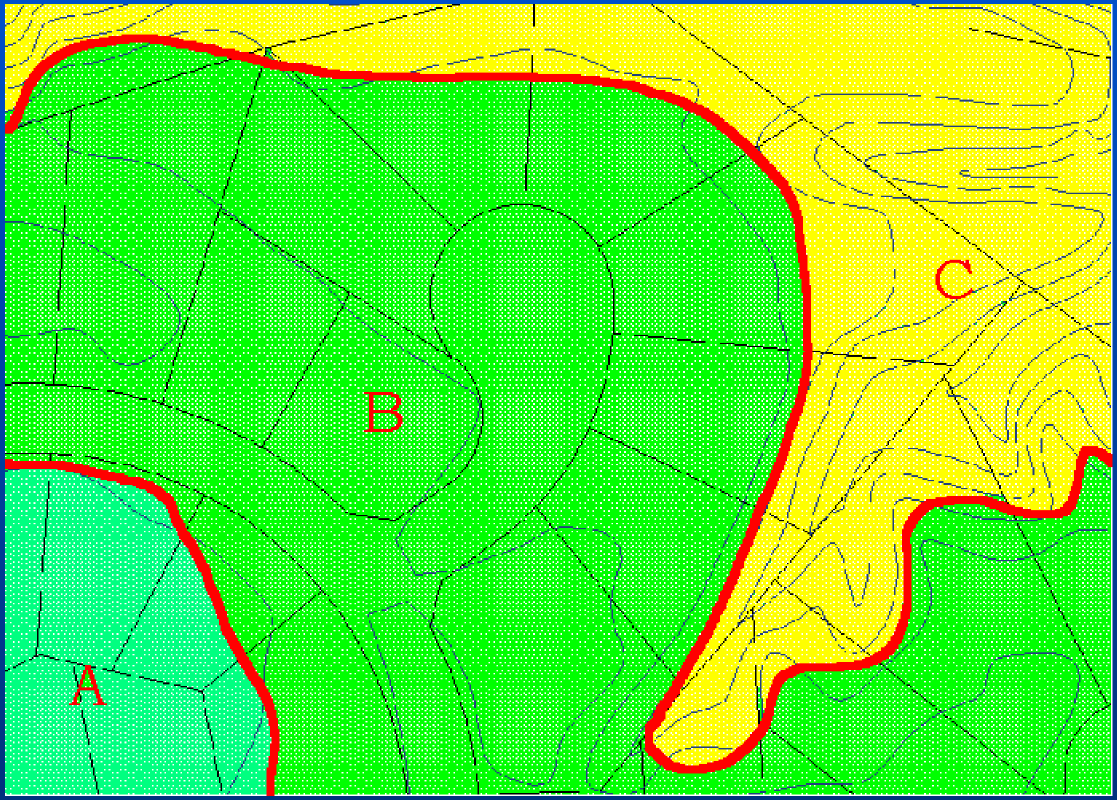
- Runoff amounts low and delayed
- Stable hydrology
- Habitat undisturbed
- CN- woods in good cond

Soils Map Analysis



Hydrologic Soils Groups

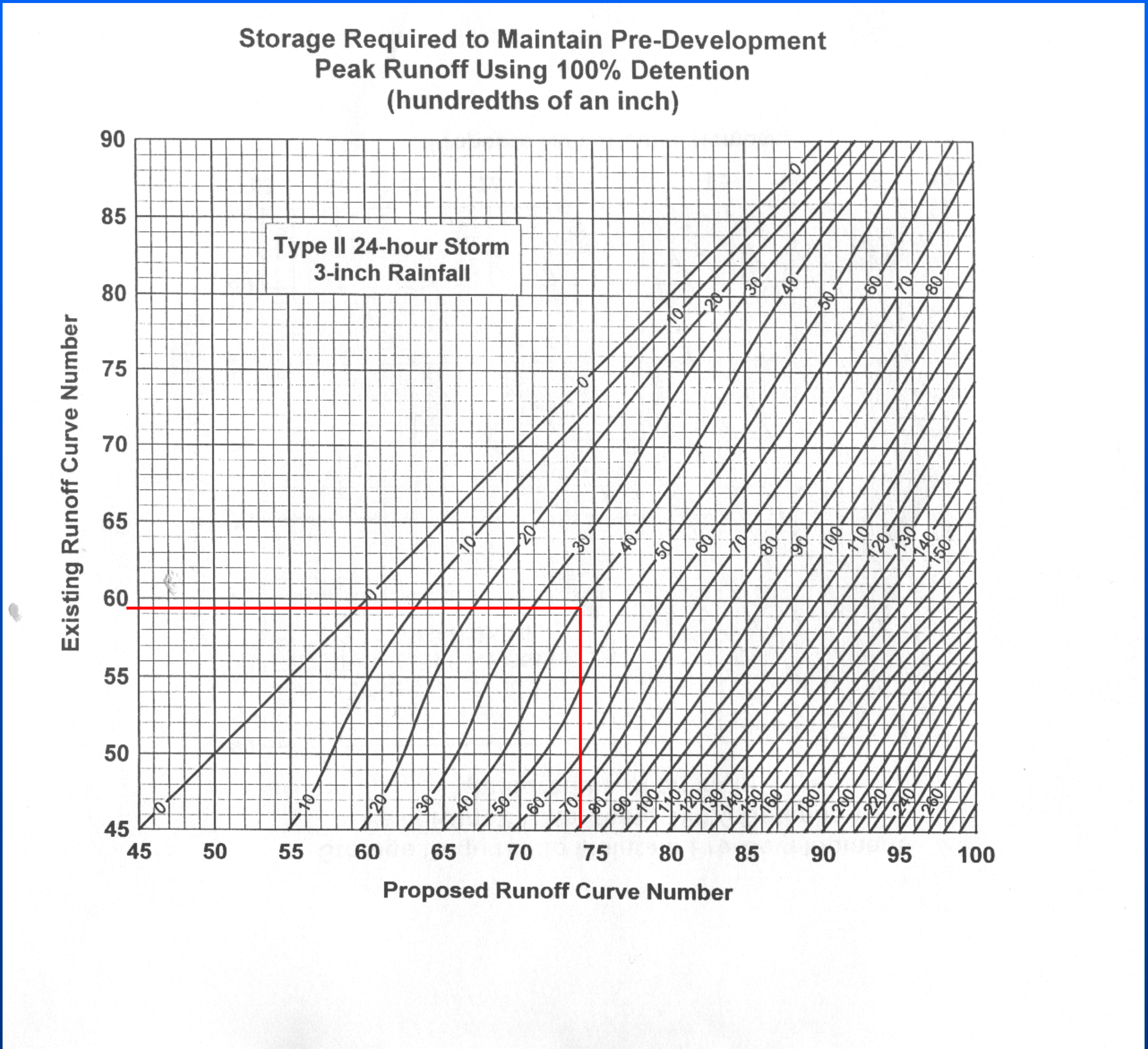
- D soils - CN = 77
- C soils - CN = 70
- B soils - CN = 55
- A soils - CN = 30



Given:
- 50 acre tract
- Zoned 1/2 acre residential
- Environmental constraints present (wetlands, steep slopes, tree conservation)

<u>Conventional Calculations</u>

25% of site C soils = 875
58% of site B soils = 1595
17% of site A soils = 255
weighted CN = **54.5**



Storage Required to Maintain Pre-Development
Peak Runoff Using 100% Detention
(hundredths of an inch)
Type II 24-hour Storm
3-inch Rainfall
Existing Runoff Curve Number
Proposed Runoff Curve Number
45
50
55
60
65
70
75
80
85
90
95
100

Developed Conditions- Conventional SWM Design

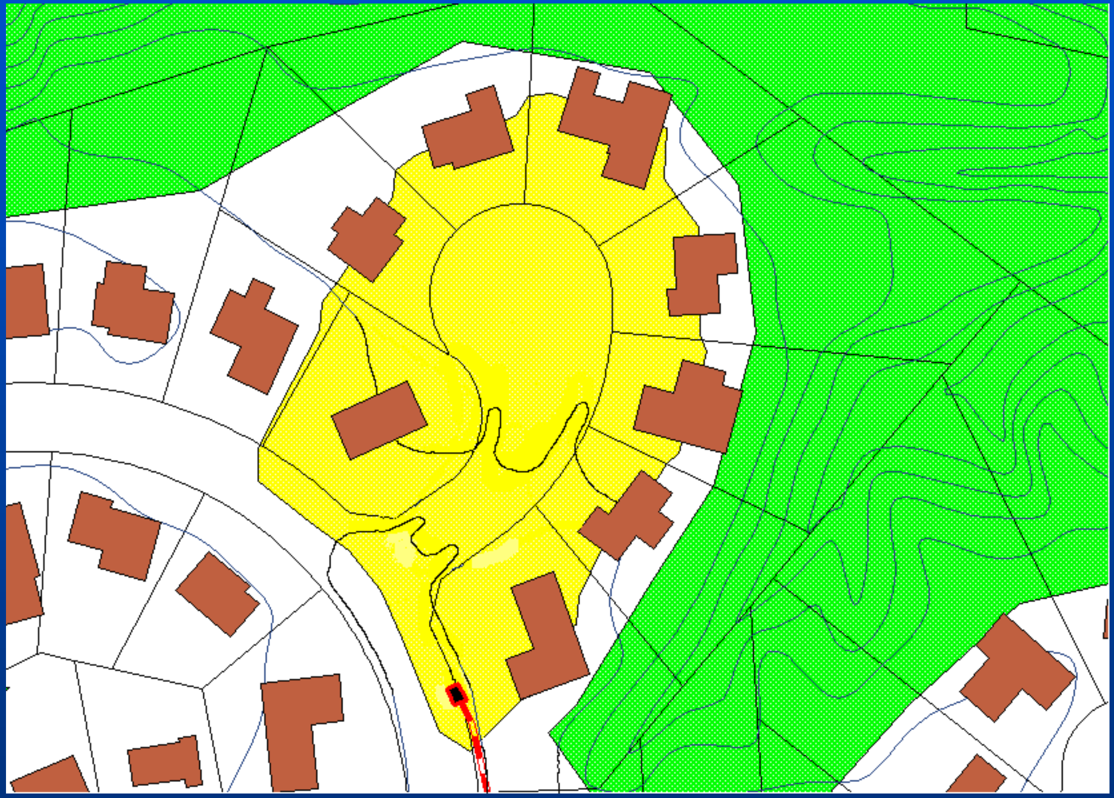
Conventional SWM Design Concepts

- Pipe and pond conveyance system
- Connected flowpaths
- Mass grade to one collection point

Determining CN Values

<u>Conventional Calculations</u>
25% of site C soils = 1000
58% of site B soils = 2030
17% of site A soils = 459
From TR55 (table 2-2a:
weighted CN = **69.8**

Developed Condition-Conventional SWM Design



Stormdrain Calculations

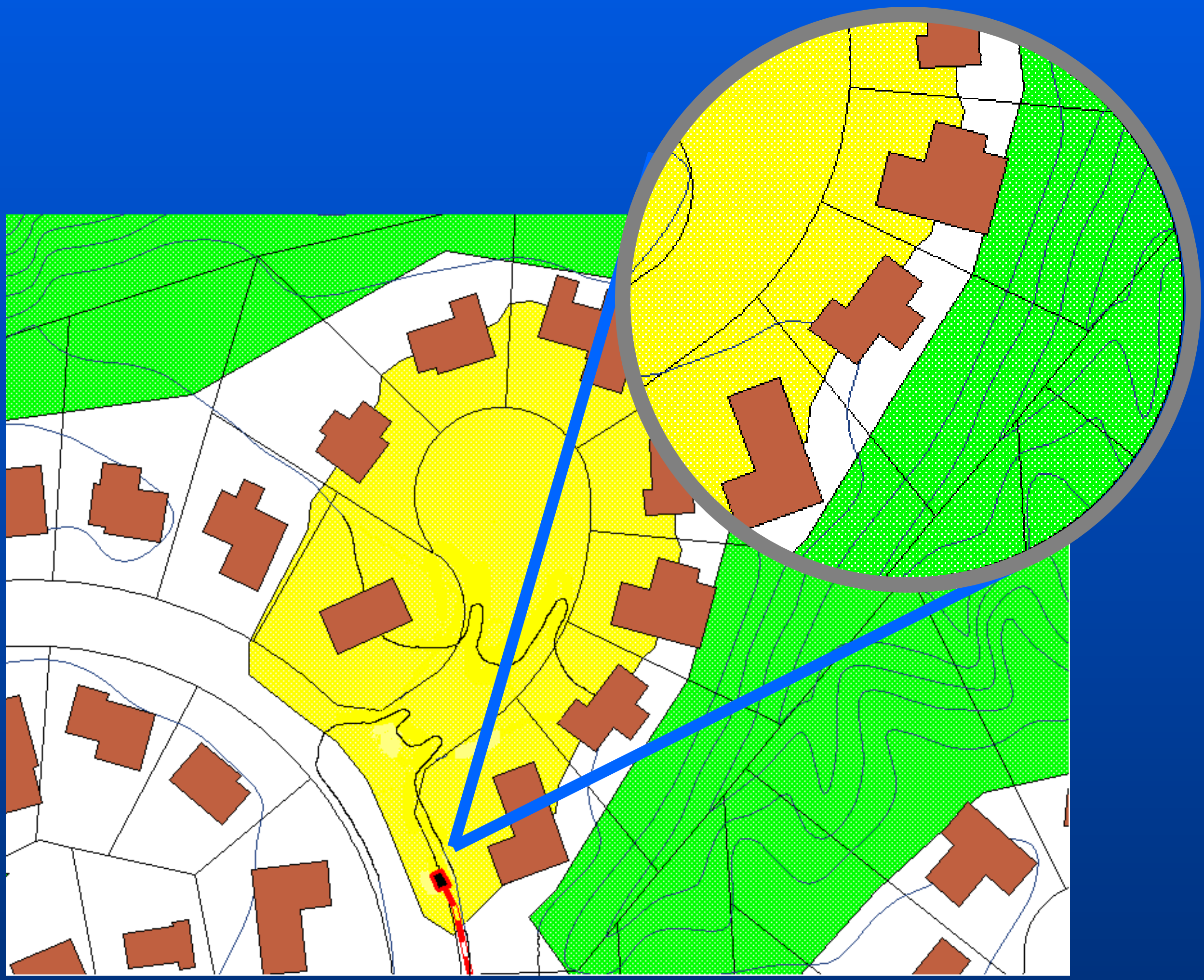
$Q_{10} = C\ I_{10}\ A$

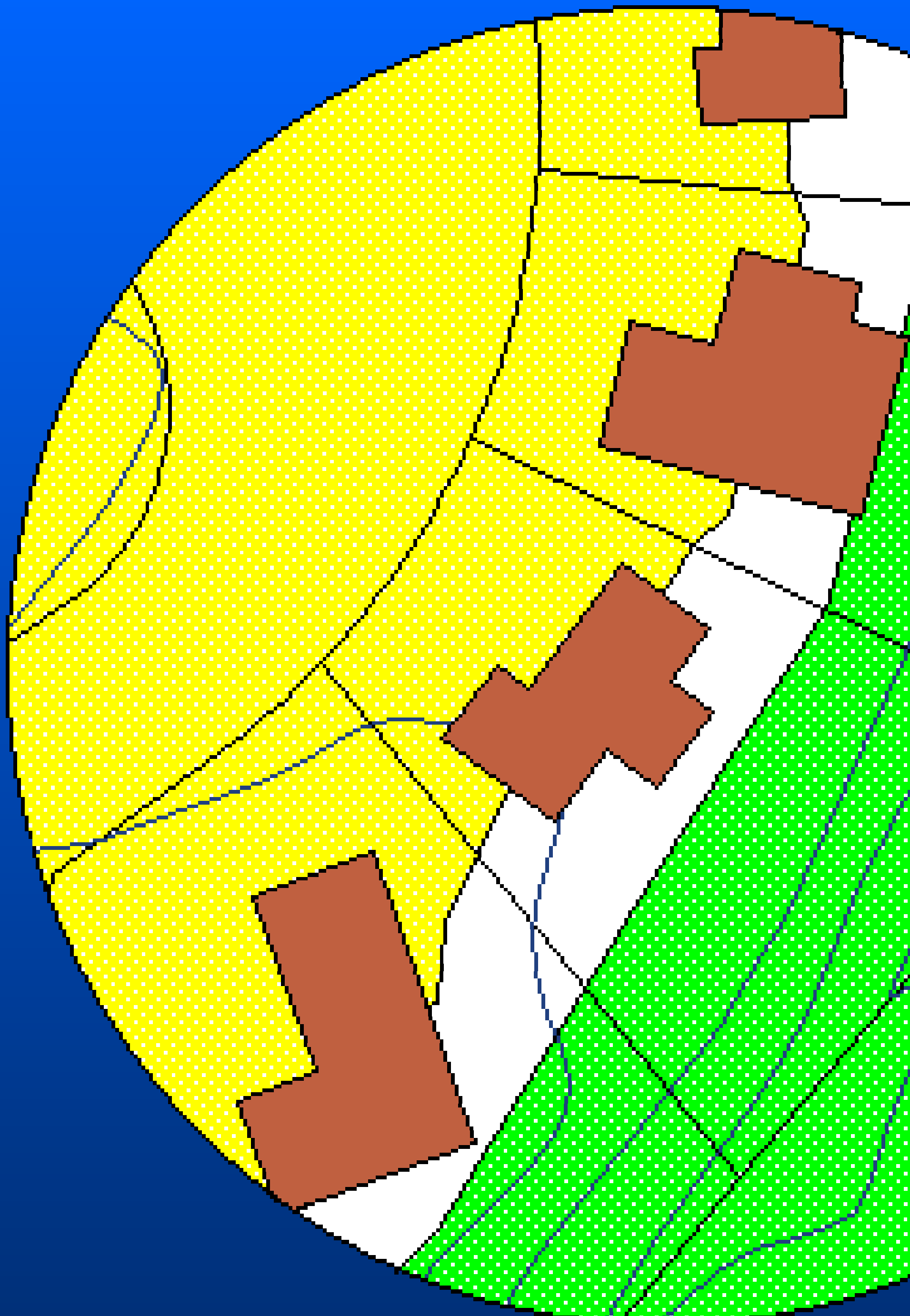
$Q_{10} = .38 * 5.88 * 2$

$Q_{10} = 4.47\text{cfs}$

DA = 1.9ac

Exploded View of Lot





Closer look at lot
reveals that the density is lower than typical 1/2 acre zoning used in TR55 *CN* values (20% imperv

In this case:

30% of woods are preserved
Average impervious area =15%

Developed Condition *CN* =

Impervious Connected =
5% - 98
Impervious Unconnected= 10% 98
Open Space (good cond.)= 55% 61
Woods (good cond) = 30%63

735+1373+945= 3053

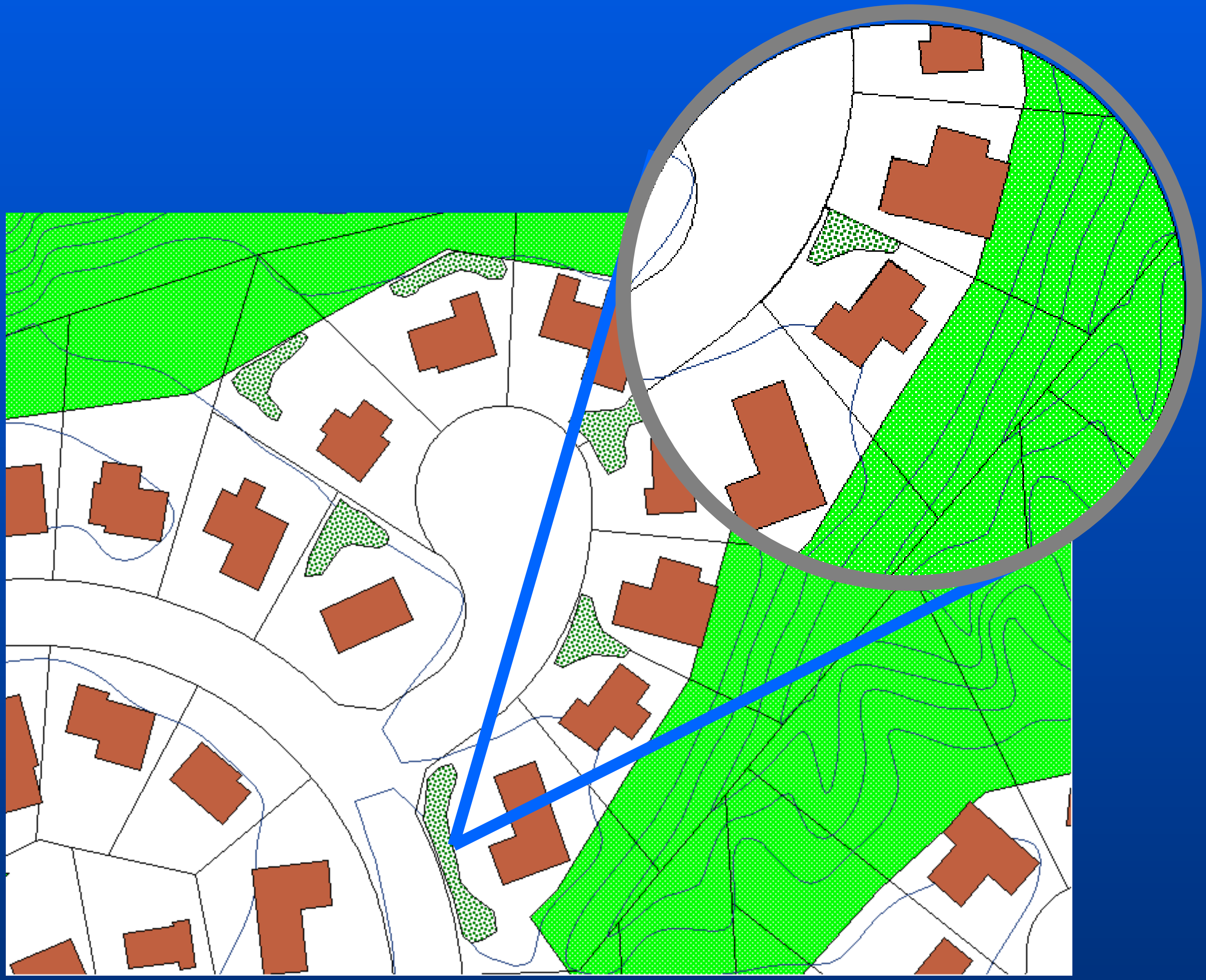
<u>Custom LID *CN*</u>
weighted *CN* = **62**

Site has < 30% imperv area.
Composite *CN* = **61**

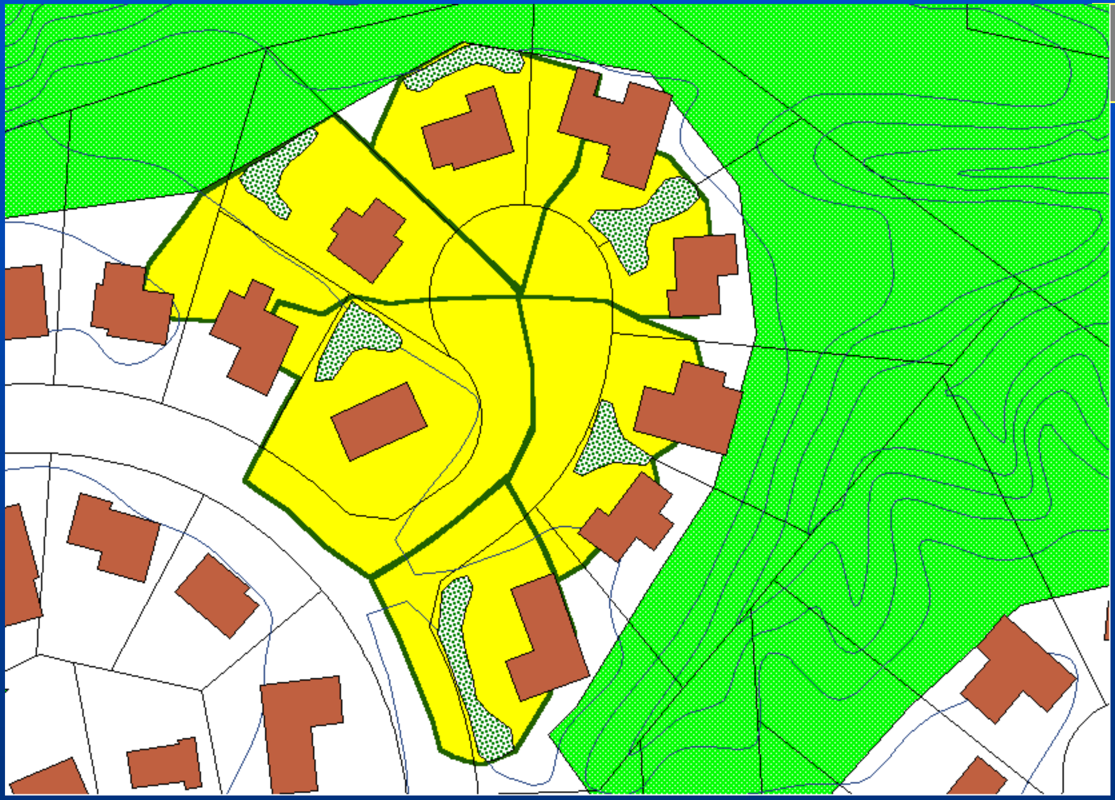
LID Post Development Conditions

LID Components

- On-lot SWM BMP's
- Multifunctional landscaping integration
- Open-section roadways
- Disconnected flowpaths
- Grading refinement



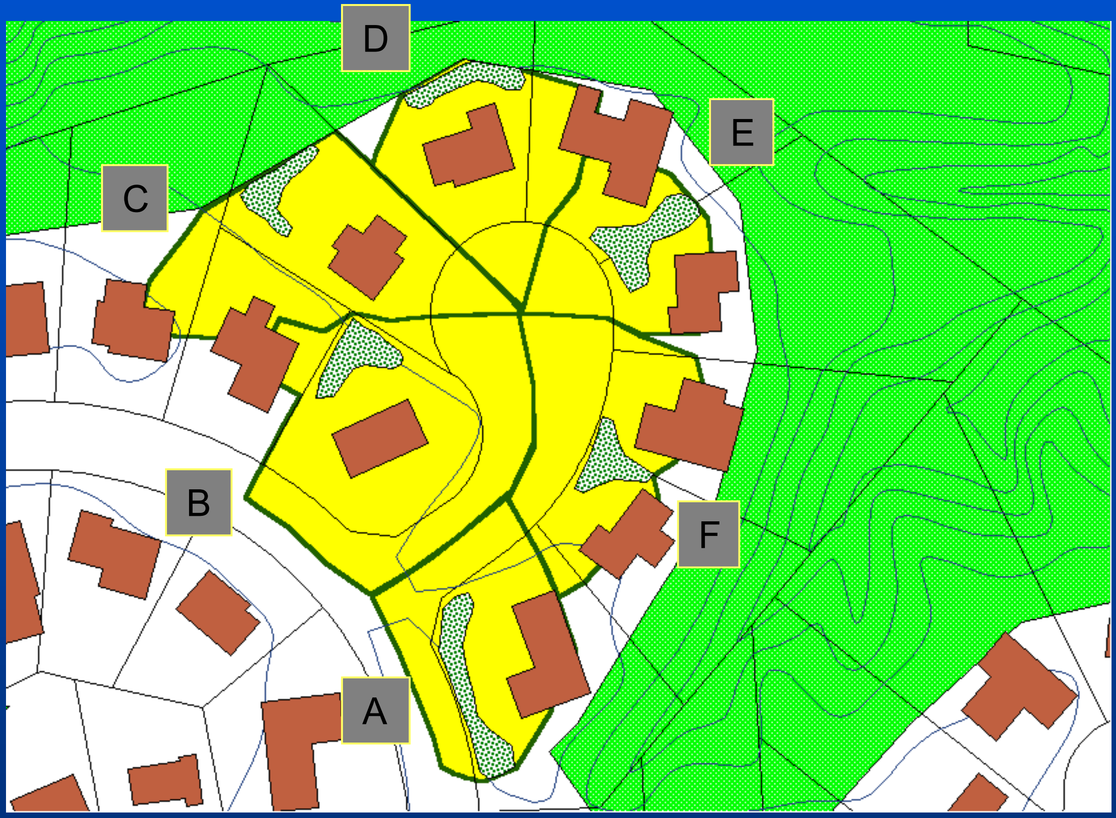
LID Post Development w/ Drainage Divides



LID Site Layout Concepts

- Pre-existing drainage divides preserved
- *No* net runoff
- Storm drainage infrastructure reduced
- Development potential maintained

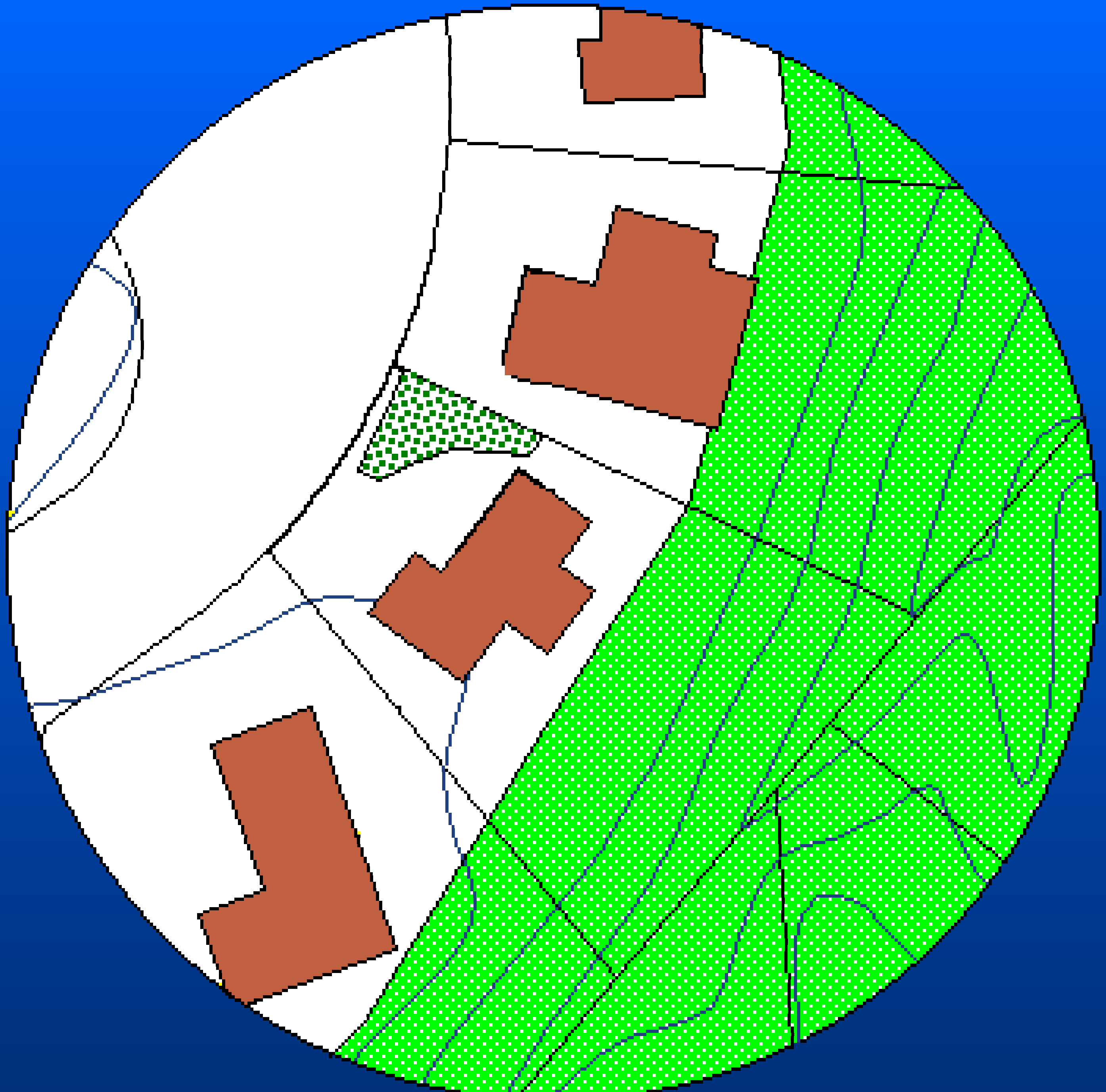
Post Development Peak Flow- LID SWM Integration

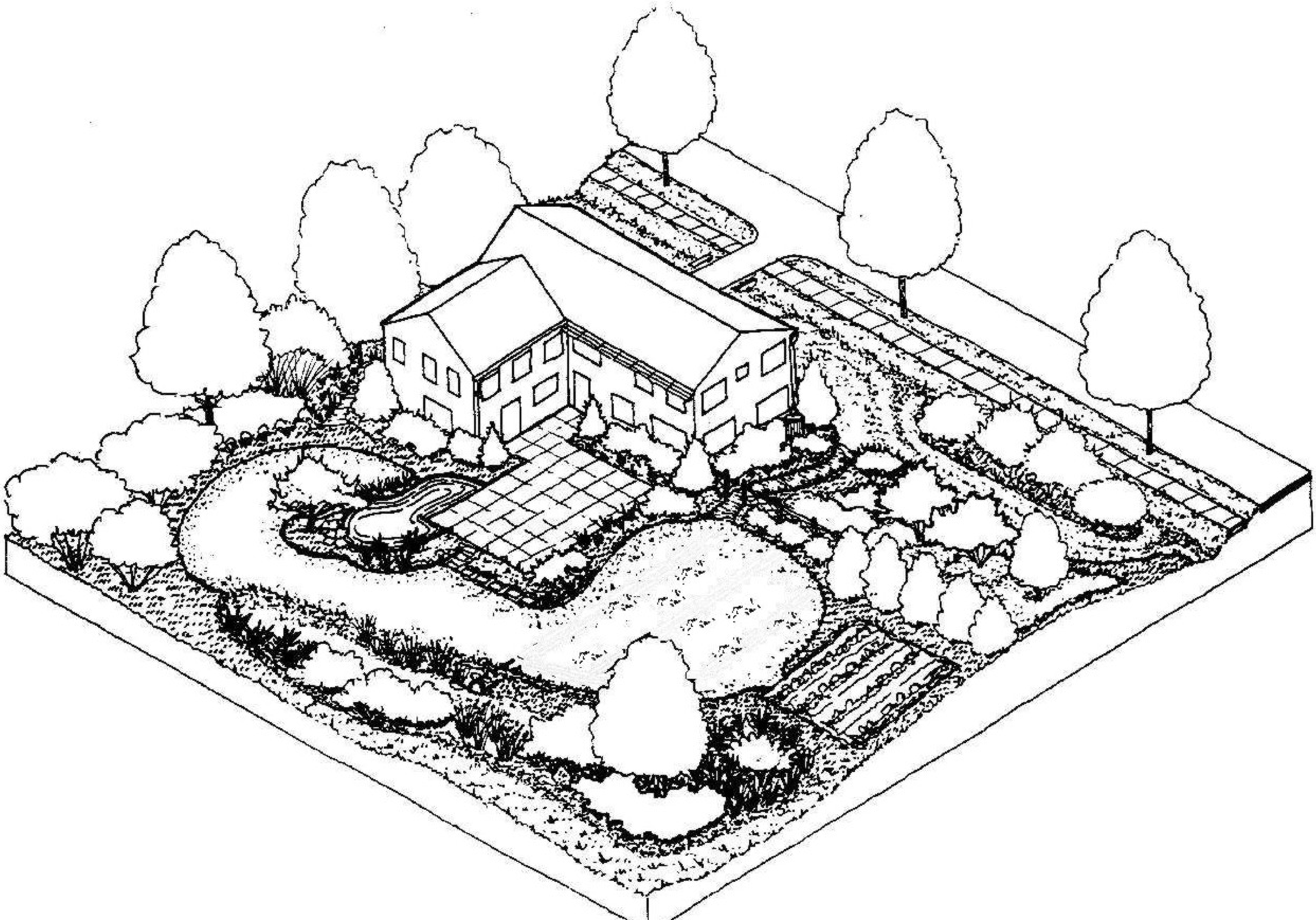


Peak Flow Rates*:

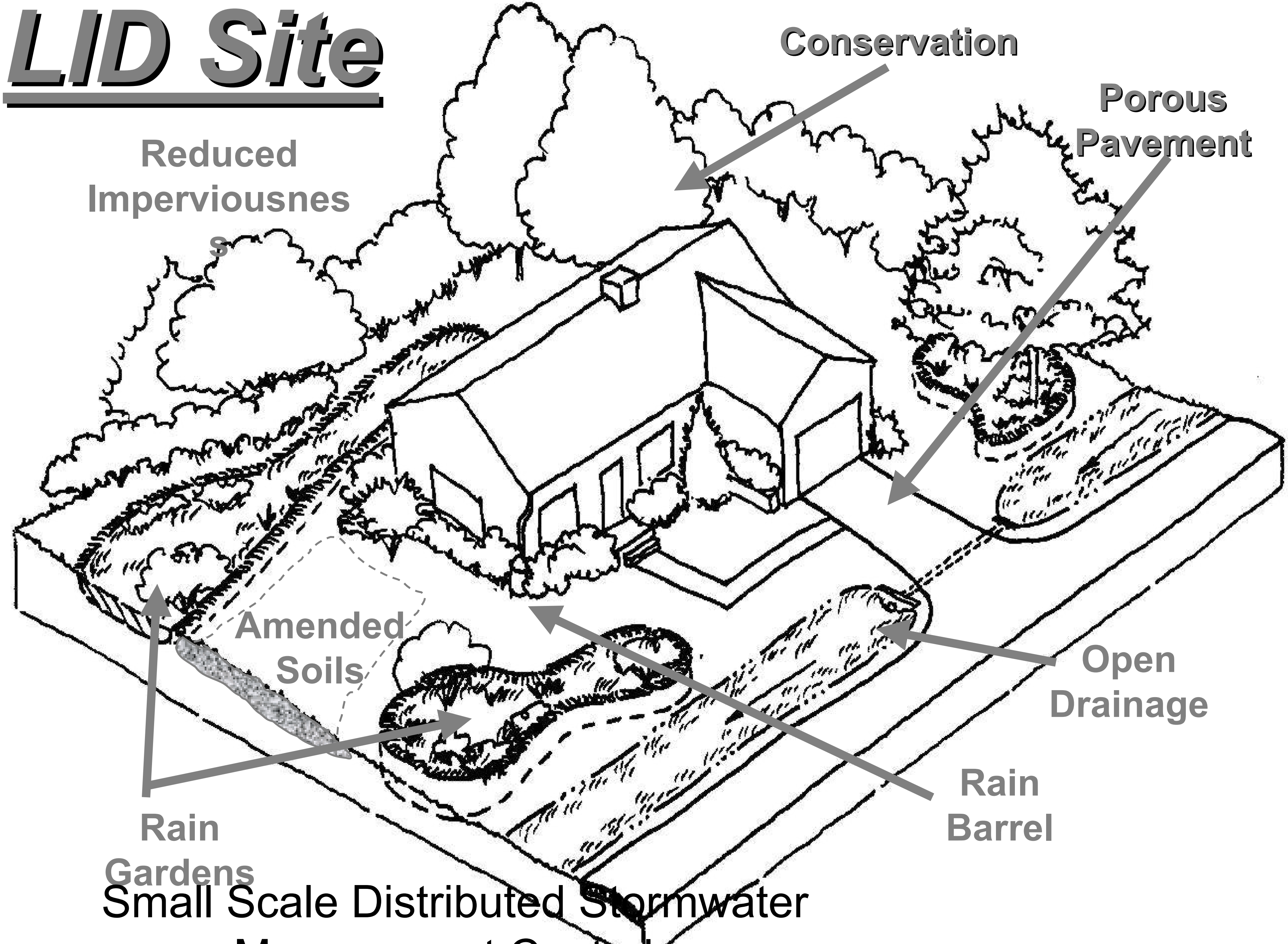
A = 1.18cfs
B = 0.65cfs
C = 0.39cfs
D = 0.41cfs
E = 0.45cfs
F = 0.45cfs
Total = 4.09cfs
DA = 2.47ac

* No net Runoff- All runoff volume is contained in the bioretention facilities





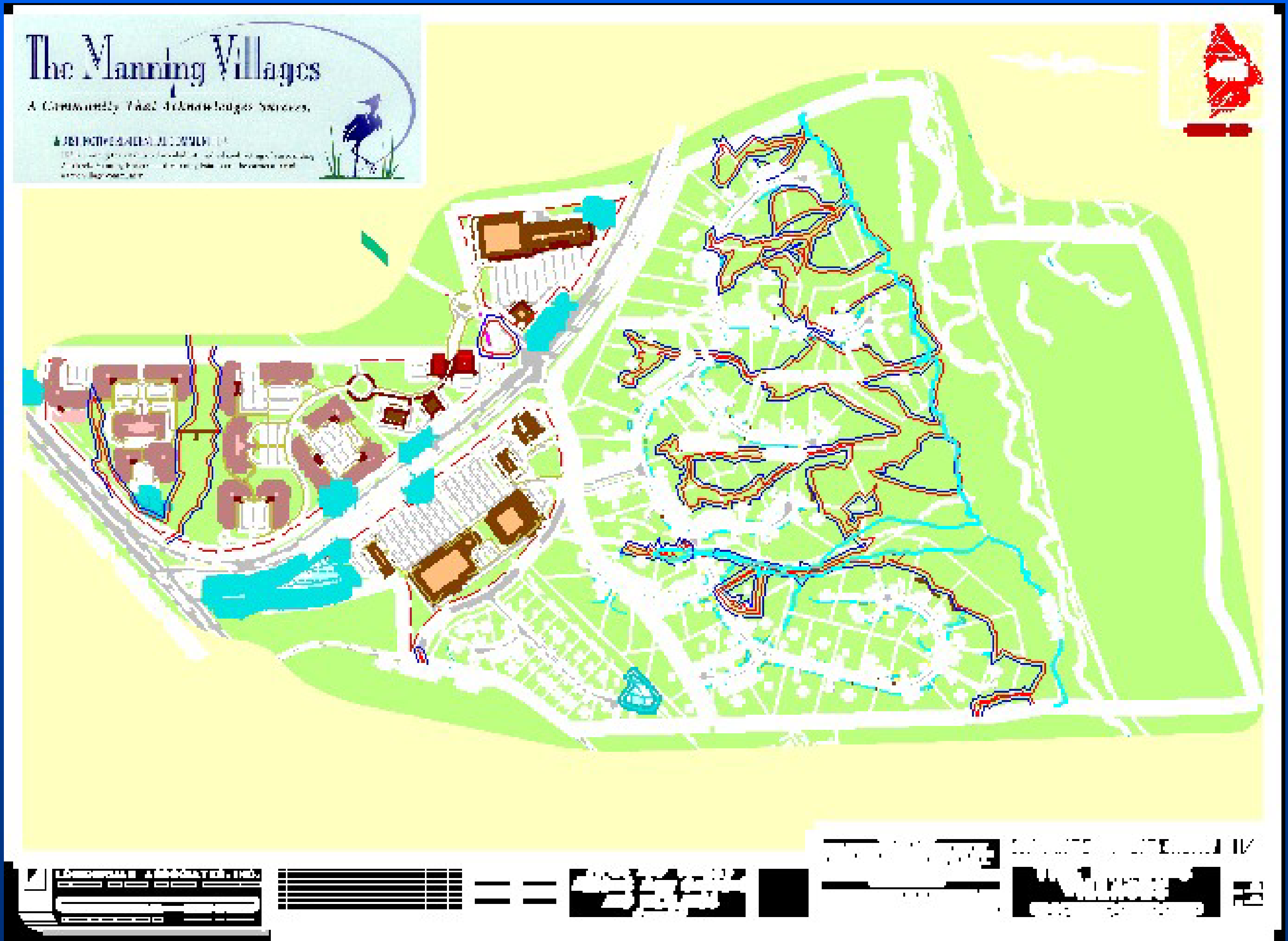
LID Site



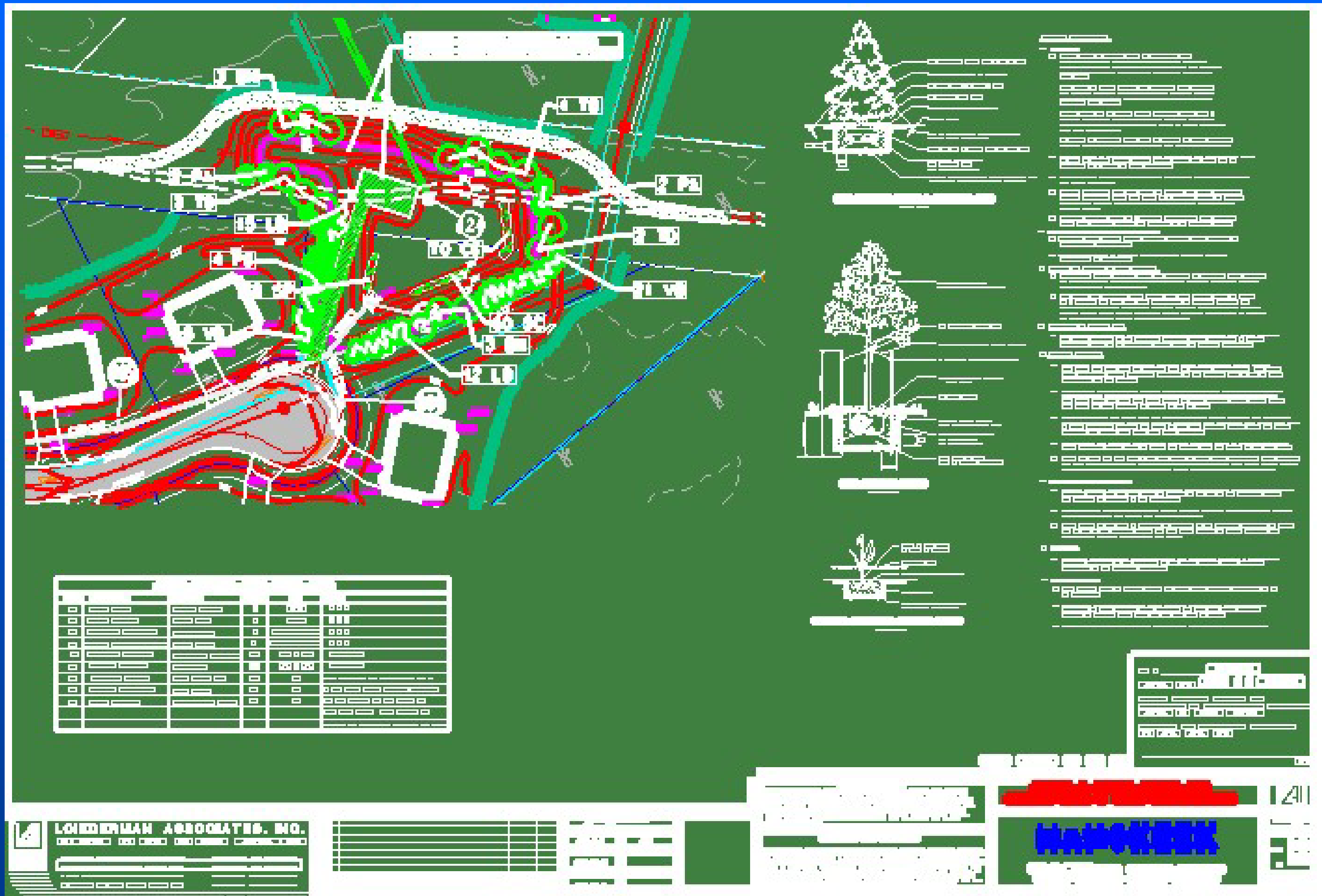
Small Scale Distributed Stormwater Management Controls

Design Concept

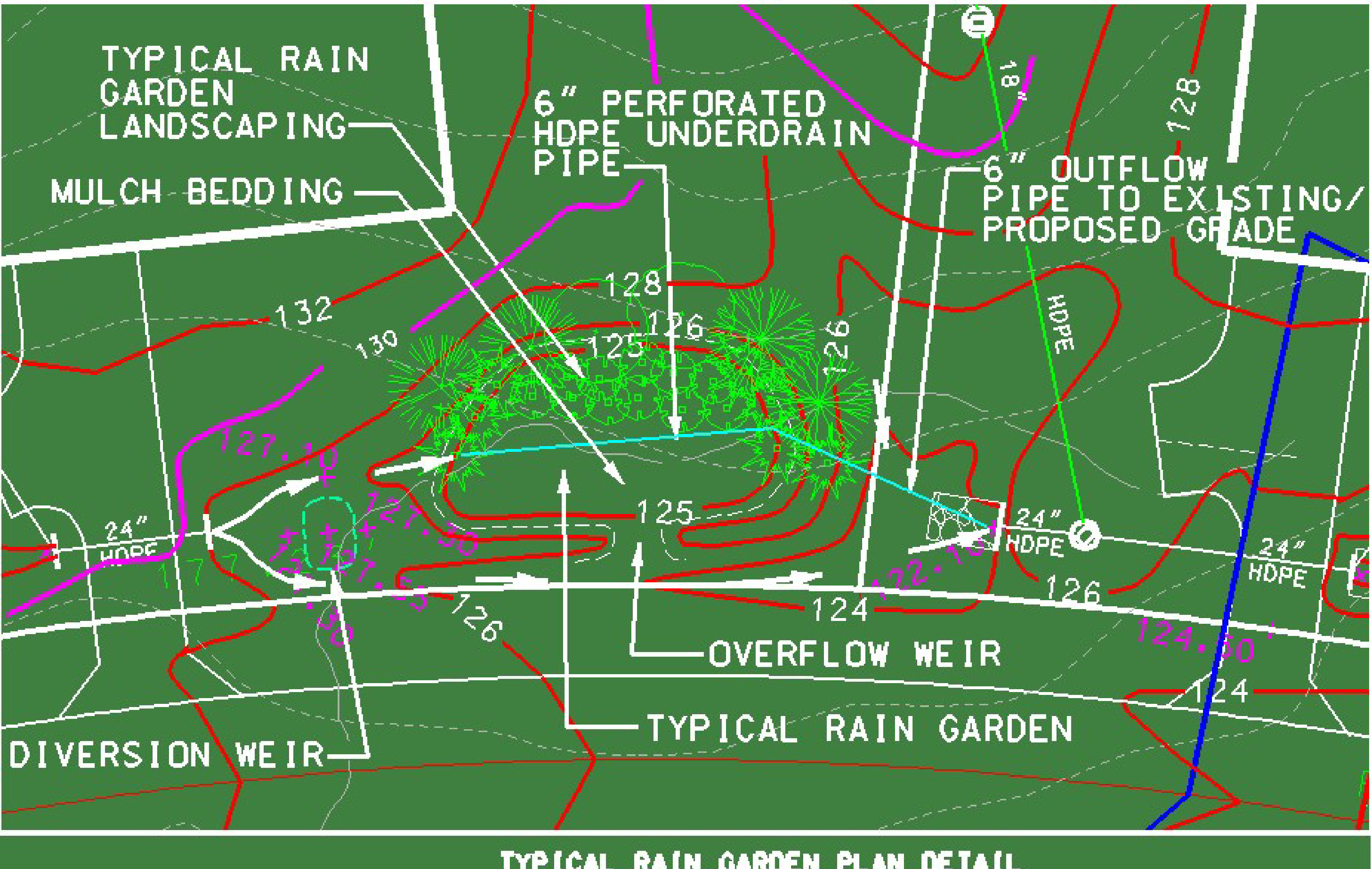
Loiderman Soltesz

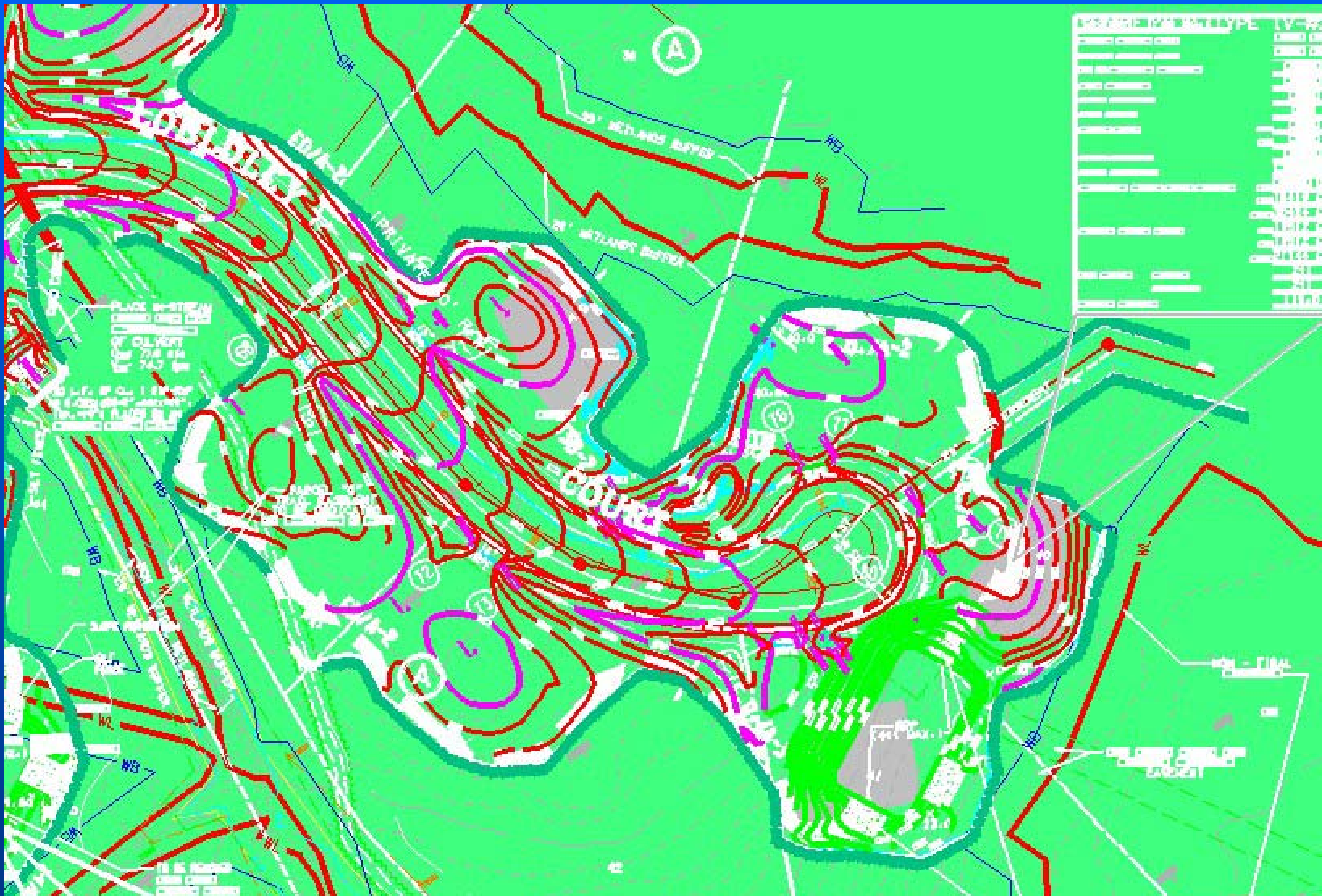


Landscape Walls in Swales


LOIEDERMAN ASSOCIATES, INC.

Detailed Engineering of Gardens

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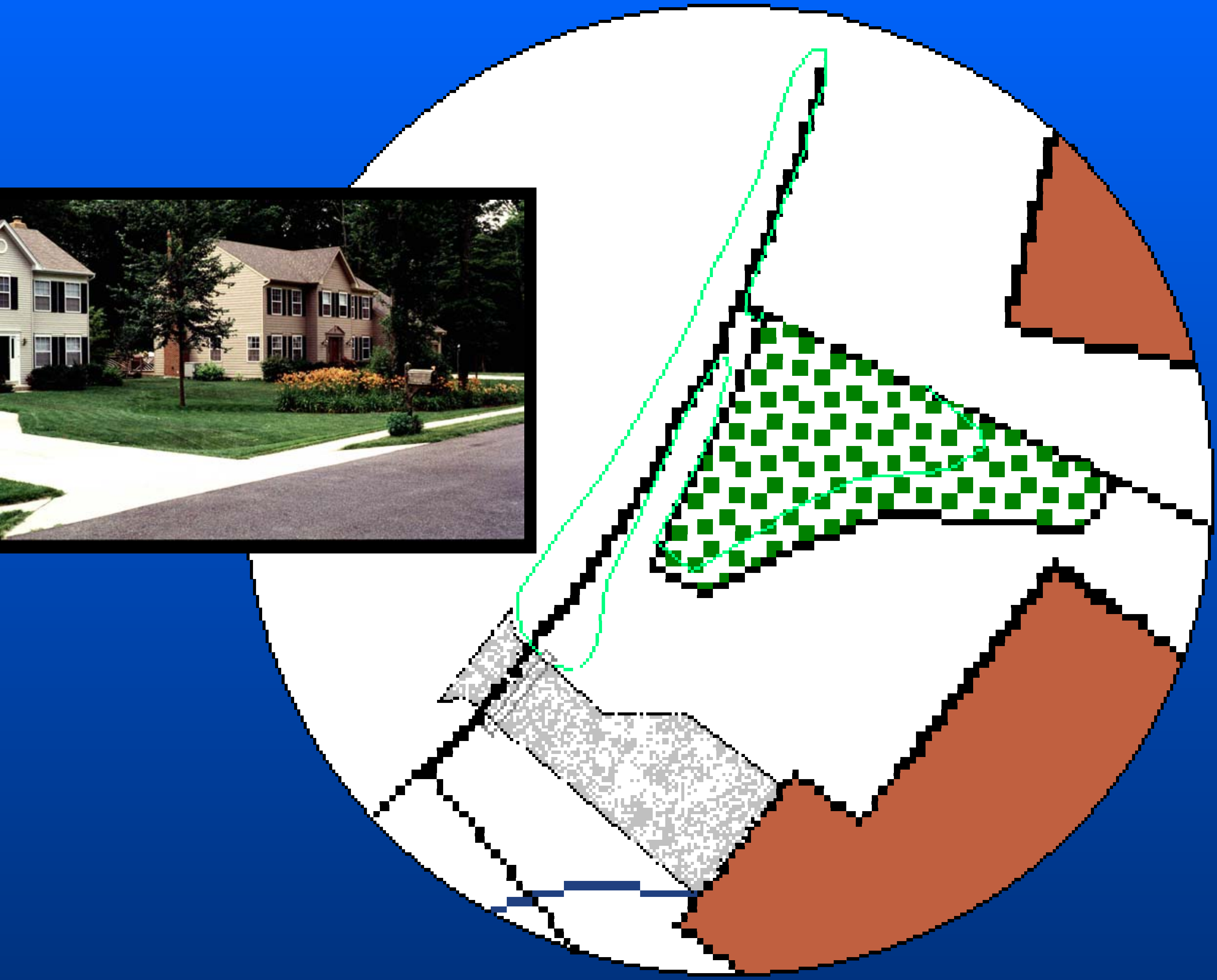


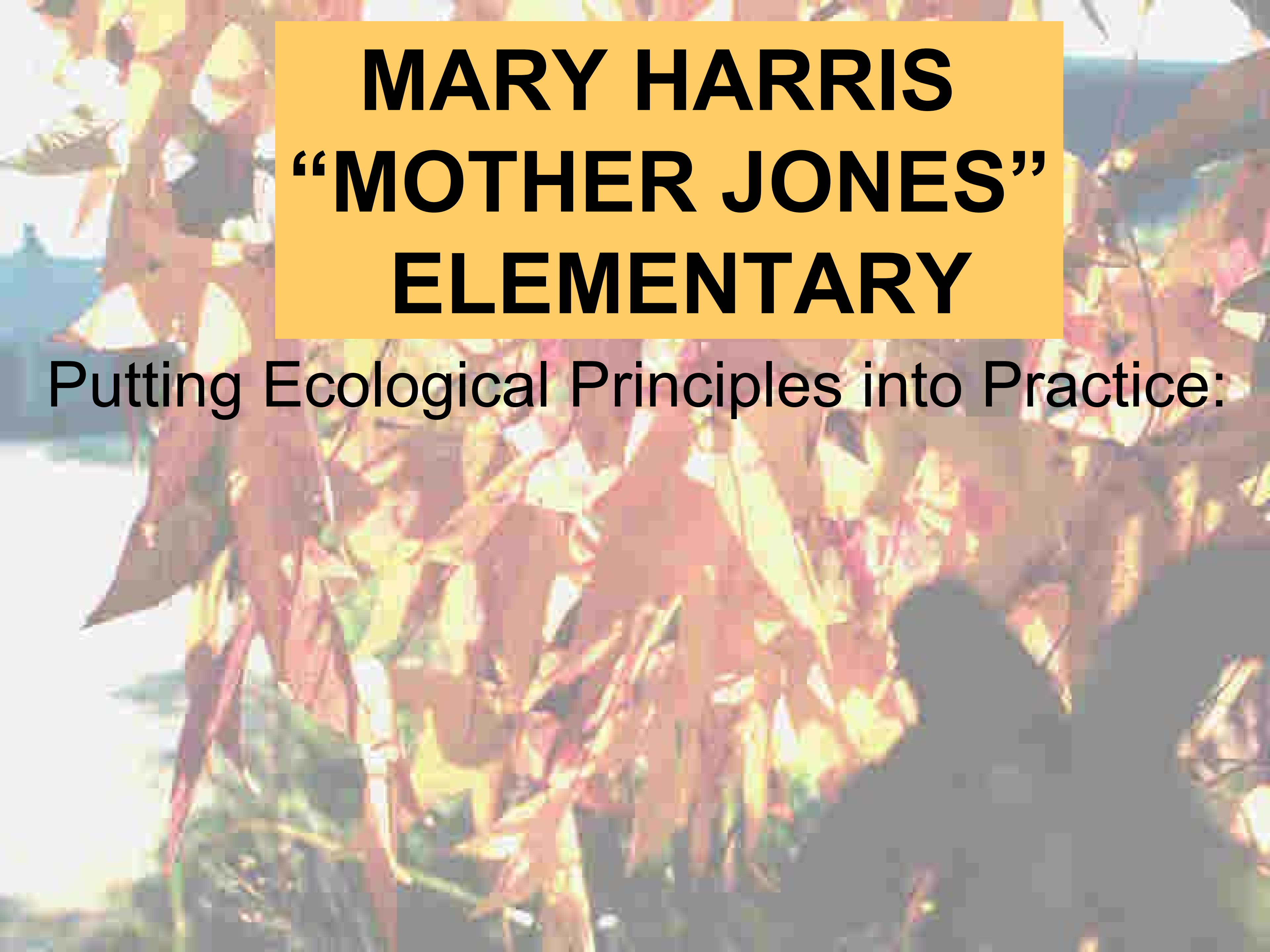
SIDE VIEW OF LOT 22/23 BIORETENTION

Alternative Surfaces

Rain Barrels, Cisterns and Storage Tanks

MARY HARRIS “MOTHER JONES” ELEMENTARY

Putting Ecological Principles into Practice:



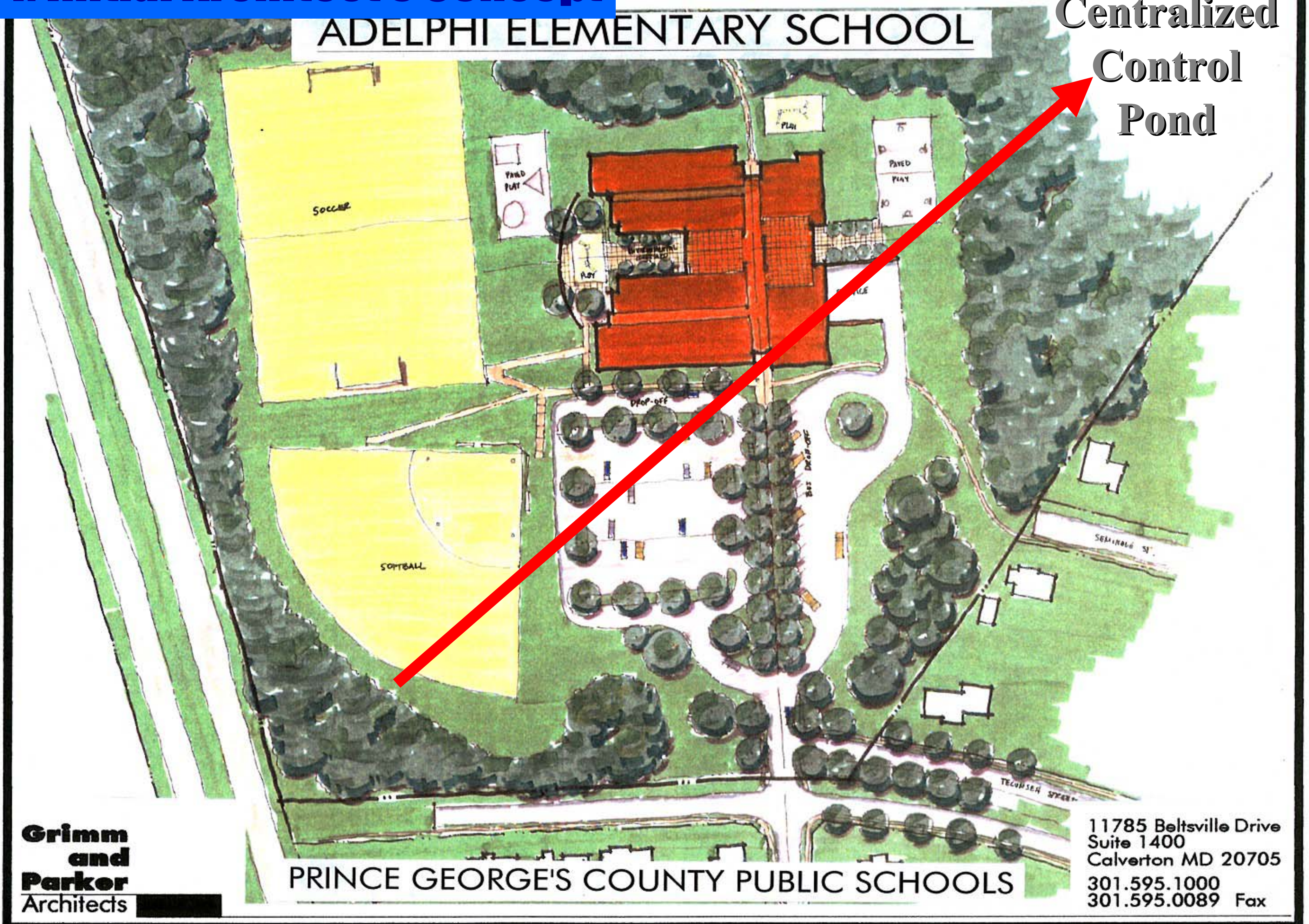
Putting Ecological Principles into Practice:

- **LID Principles**
- **BayScapes Principles**
- **Environmental Education Goals**

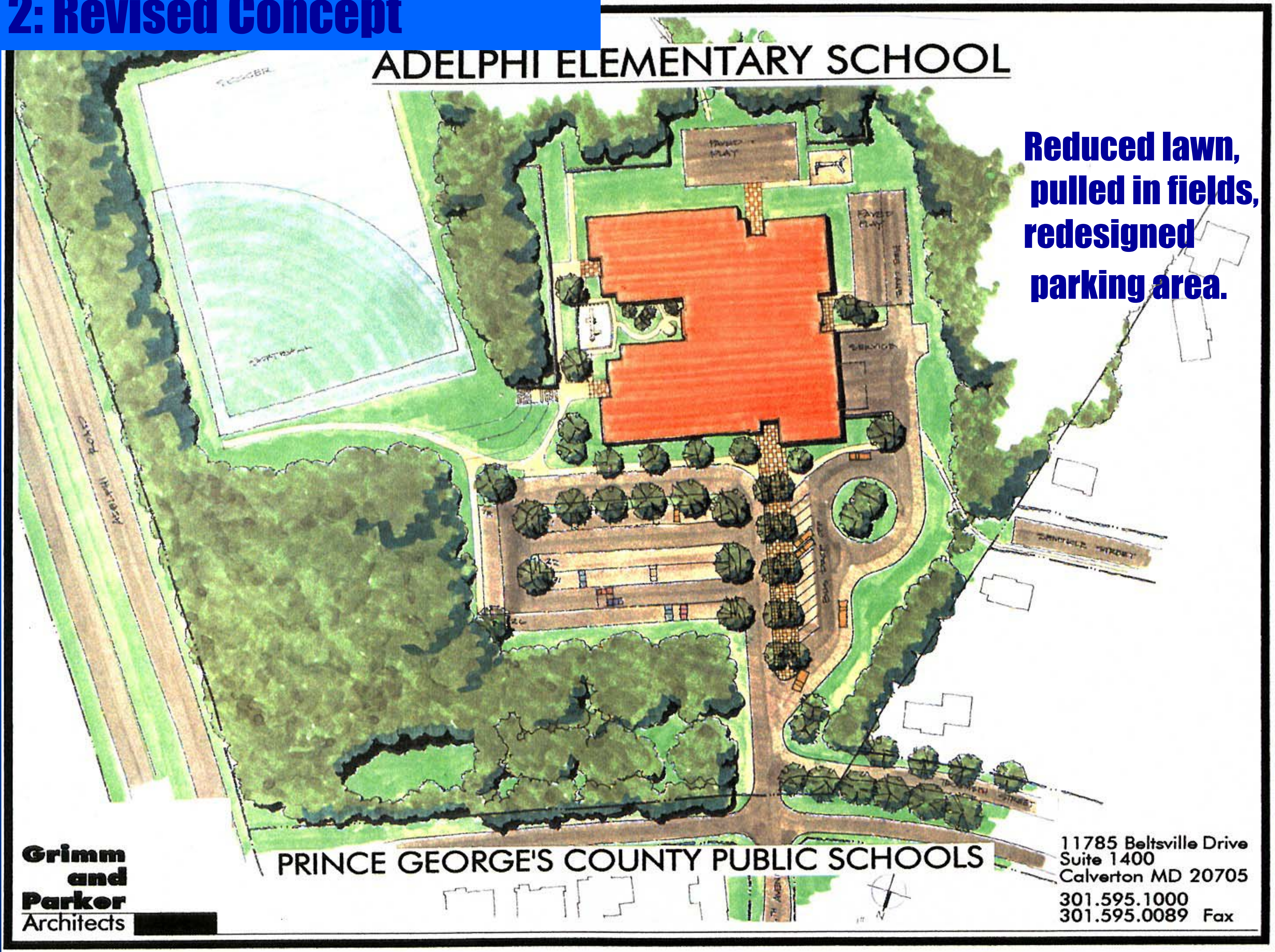
GOALS

- Preserve existing vegetation
- Disconnect drainage flows
- Utilize bioretention
- Design low-input landscapes
- Maximize biodiversity
- Design habitats for wildlife
- Provide outdoor classrooms
- Involve students as stewards
- Demonstrate stewardship

1: Initial Architect's Concept



2: Revised Concept

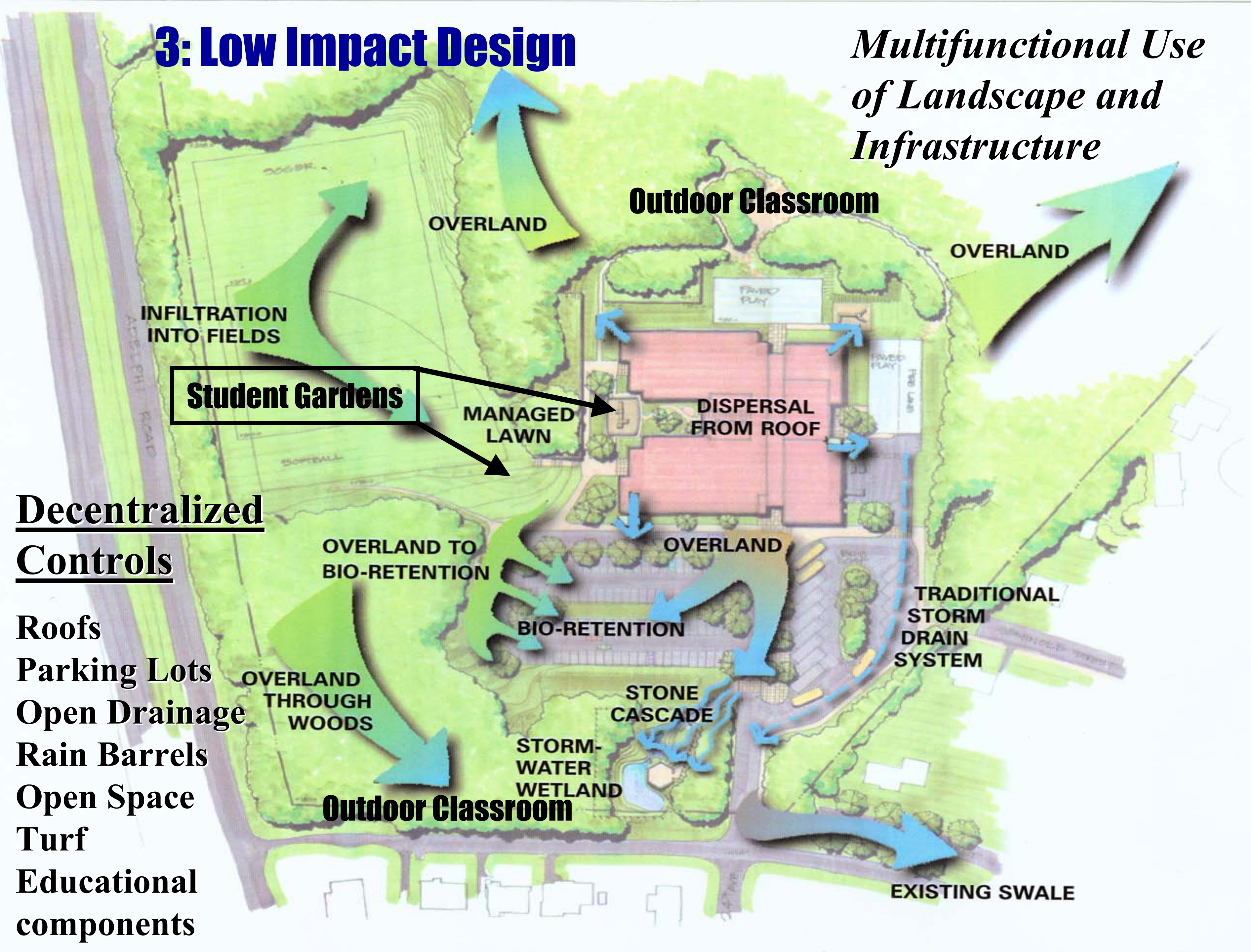


Reduced lawn, pulled in fields, redesigned parking area.

RESULT: 5 Acres of Trees Saved

3: Low Impact Design

Multifunctional Use of Landscape and Infrastructure



Decentralized Controls

Roofs
Parking Lots
Open Drainage
Rain Barrels
Open Space
Turf
Educational components

School Under Construction

Retaining Walls Minimize Grading

Extensive Use of Native Plants

Rain barrel for watering student garden

Existing Vegetation Preserved

Outdoor Classroom

Path to Undeveloped Woods / Stream

First Wetland Visitor

Utility Right of Way / Meadow

KEYS TO SUCCESS

- Assemble an interdisciplinary team involving all the project stakeholders.

- Consider stormwater management, landscaping, and educational goals at the conceptual design phase.

- Look for creative ways to turn site challenges into educational resources and environmental opportunities.

Summary of LID Techniques

(1) Recalculate Postdevelopment CN based on LID land use.

(2) Increase Travel Time (TT) using LID techniques to achieve the same Tc as Existing conditions.

(3) Retention: Provide permanent storage (Infiltration/Retention) using LID techniques to maintain the CN and runoff volume of existing conditions.

(4) Detention: Provide additional detention storage to maintain the same peak discharge as existing conditions.