LID Cost Analysis
Savings and Profitability

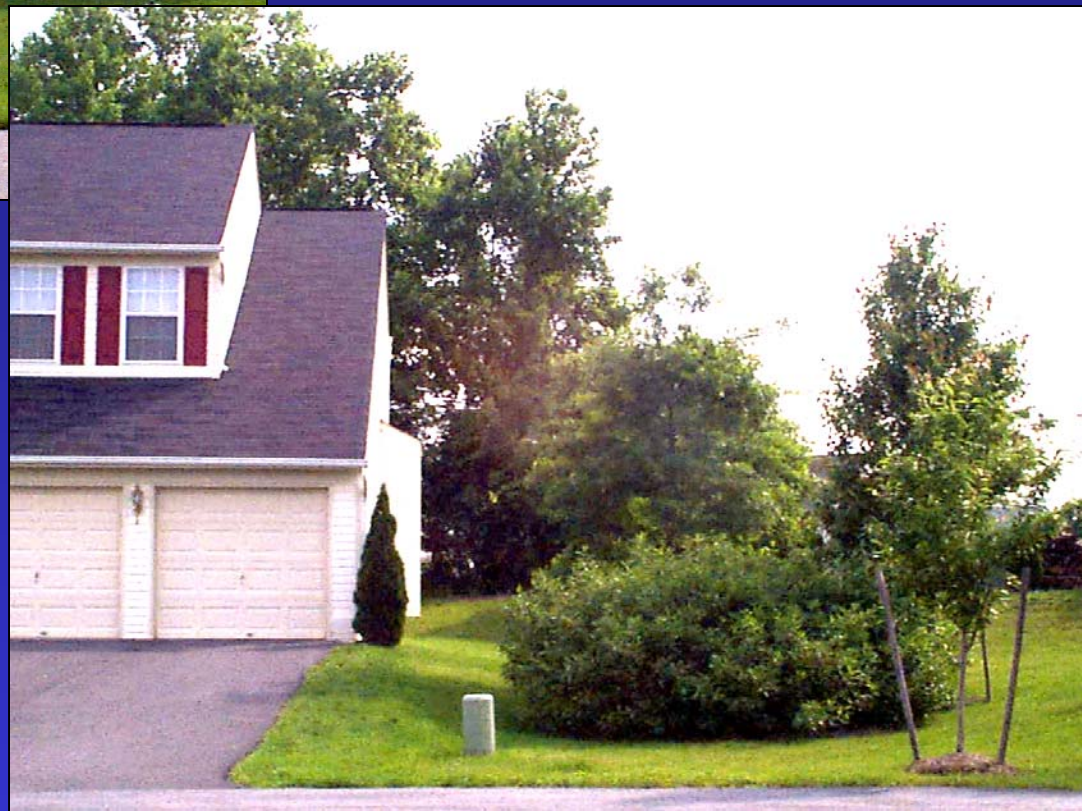
LID is a comprehensive holistic technology involving new philosophies, principles, practices and processes.

No Cost Stuff

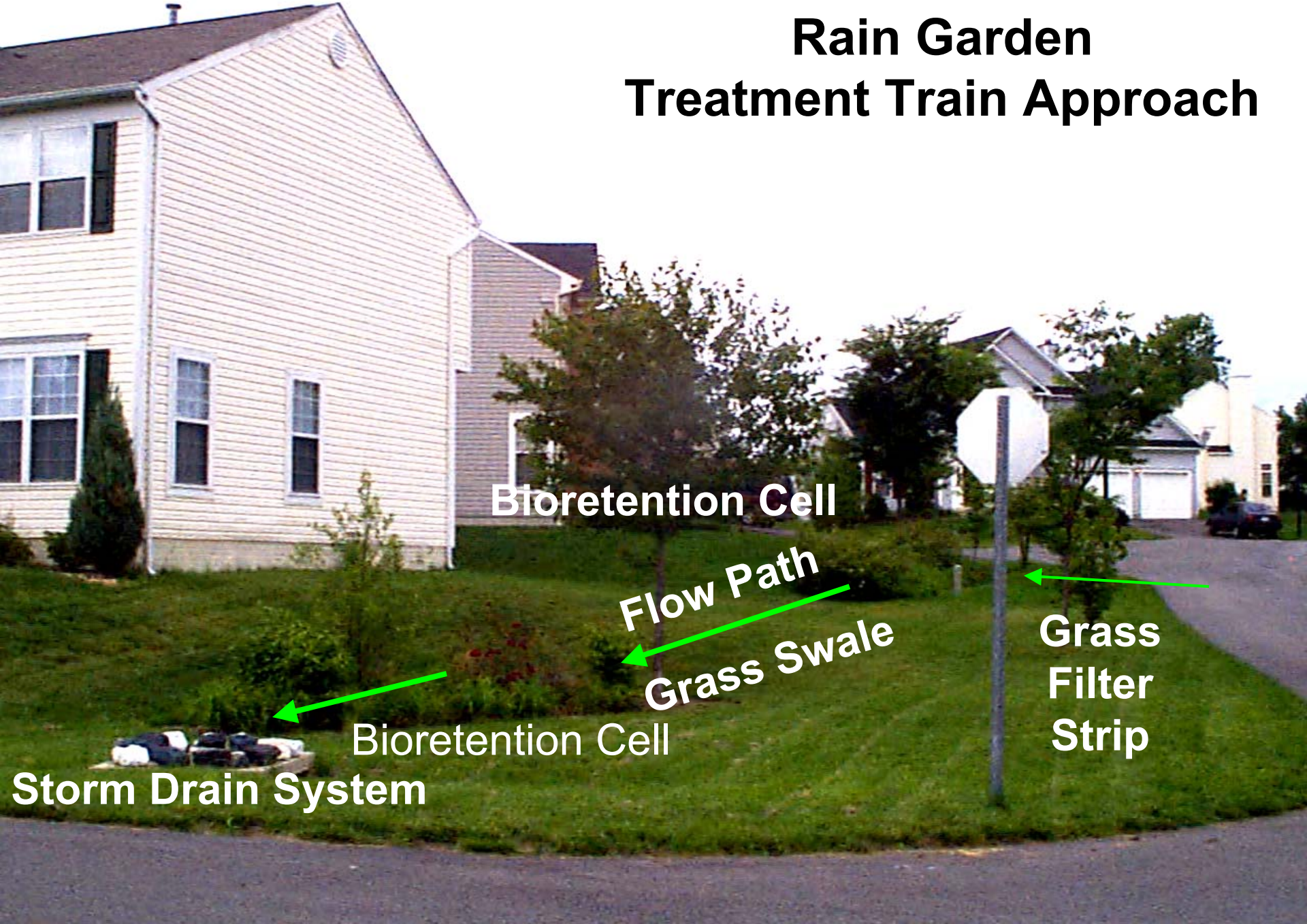
1. Site Design to Conserve Terrestrial Functions
2. Disconnection
3. Grading Techniques
4. Distributed Controls
5. Multifunctional Use of Space
6. Less Grading and Clearing

"Optimize the use of these smart design techniques"

Rain Gardens



Rain Garden
Treatment Train Approach



Somerset Cost Savings

- $780,000 Total Cost Savings
  - Eliminated
    - Curb / Gutter $350,000
    - 4 stormwater ponds $650,000
    - Pipes / Structures $150,000
  - Added
    - $370,000 for Rain Gardens

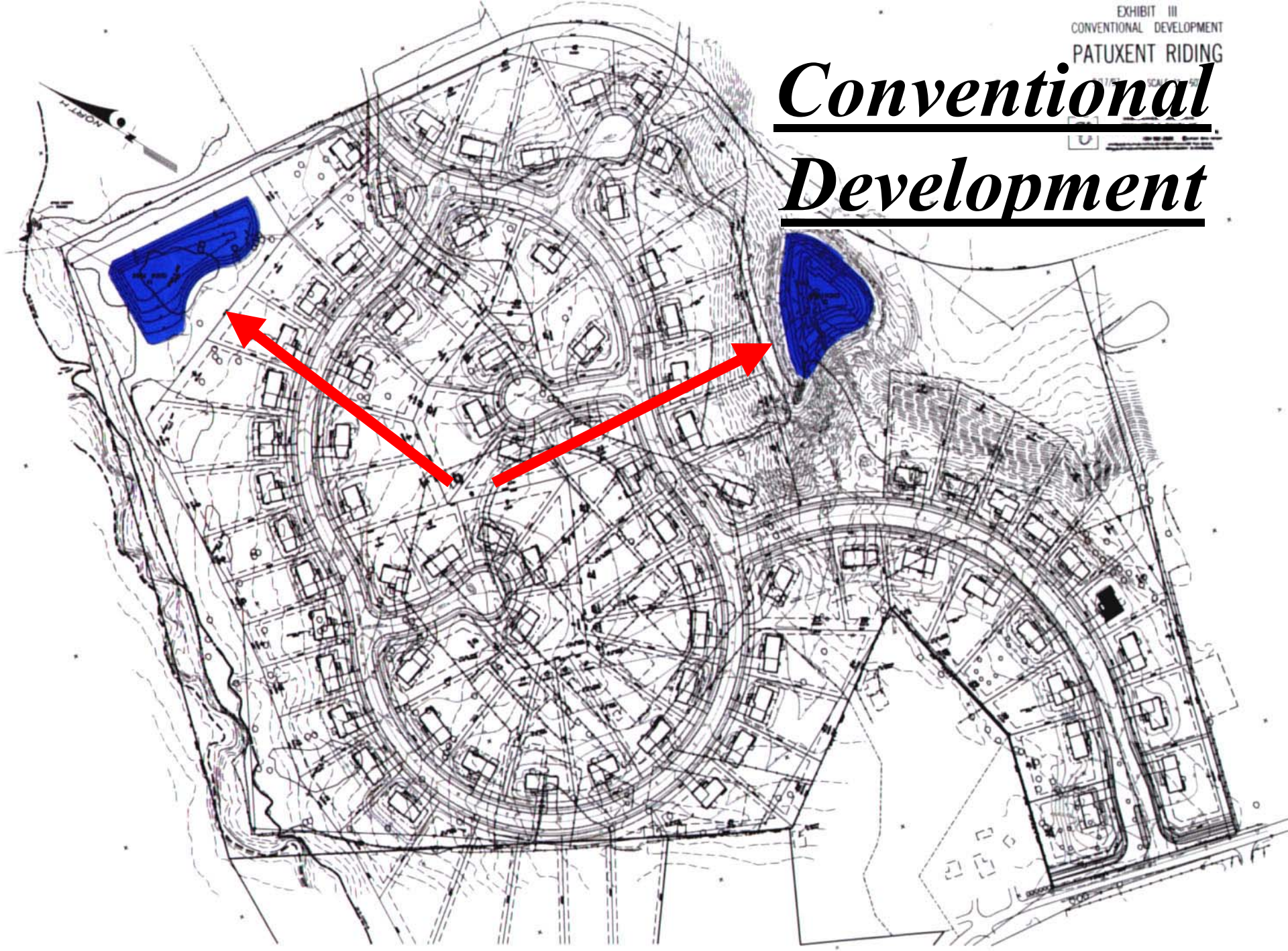
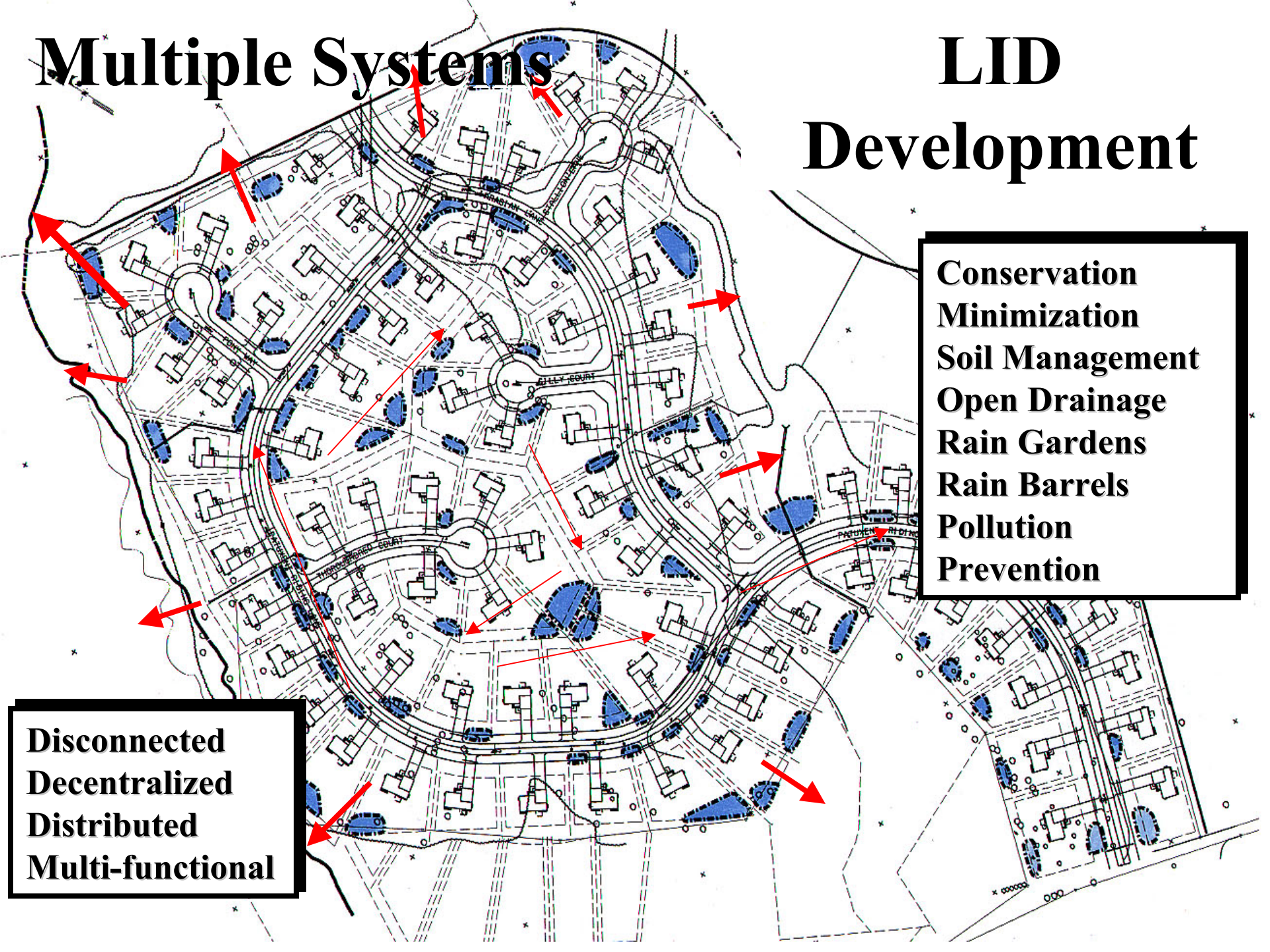


EXHIBIT III
CONVENTIONAL DEVELOPMENT
PATUXENT RIDING
Conventional
Development

Multiple Systems

LID Development



Conservation
Minimization
Soil Management
Open Drainage
Rain Gardens
Rain Barrels
Pollution Prevention

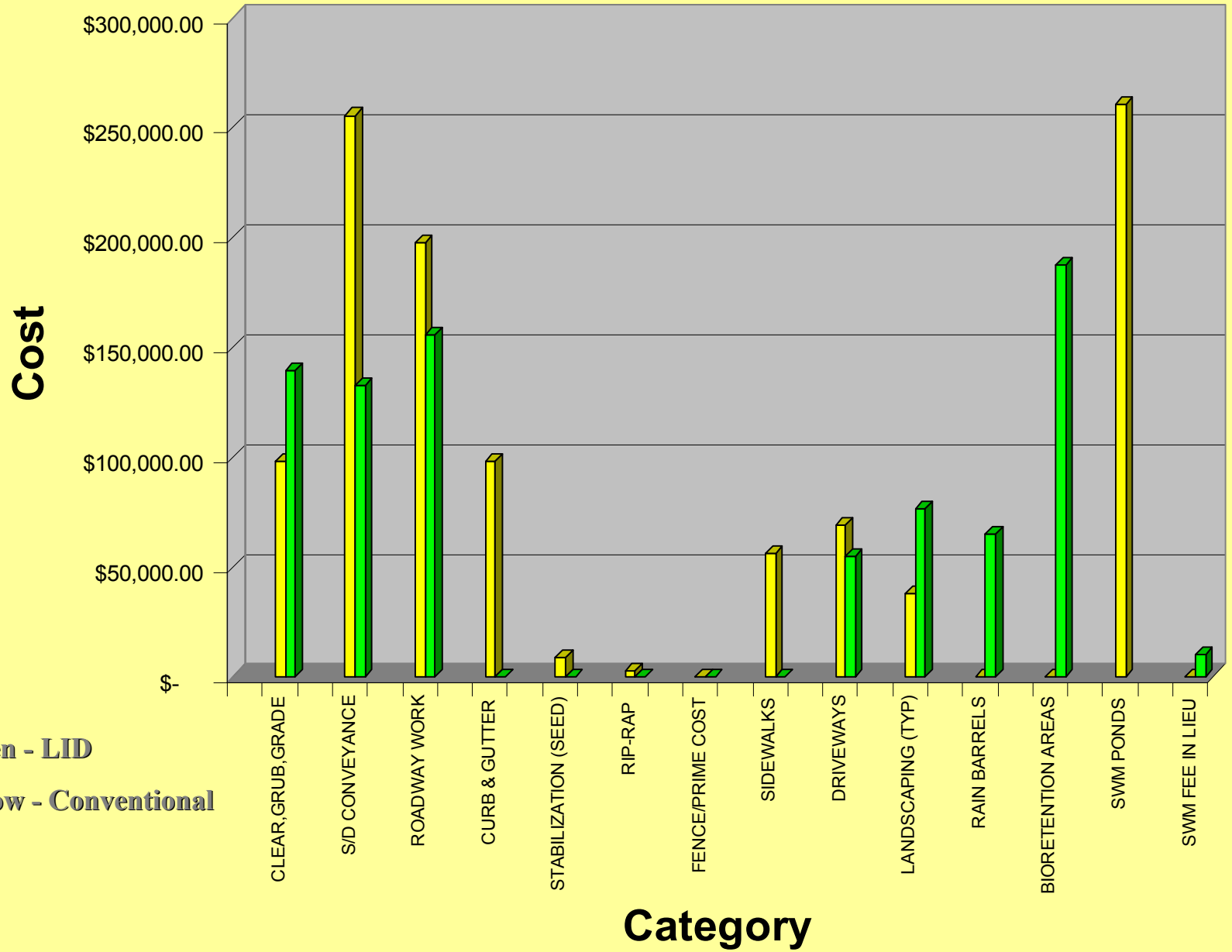
Disconnected
Decentralized
Distributed
Multi-functional

Construction Cost Comparison

Patuxent Riding

	Conventional	Low Impact
Grading /Roads	$ 569,698	$ 426,575
StormDrains	$ 225,721	$ 132,558
SWM Pond / Fees	$ 260,858	$ 10,530
Bioretention / Micro	$ -	$ 175,000
Total	$ 1,086,277	$ 744,663
Unit Cost	$ 14,679	$ 9,193

SWM Construction Cost Comparison



Green - LID

Yellow - Conventional

A Comparison of Two Different Land Plans

PROJECTED RESULTS FROM TOTAL DEVELOPMENT

Total Site	**Conventional Plan**	**Revised Green Plan**
Lot Yield	358	375
Linear Feet - Street	21,770	21,125
Linear Feet - Collector Street	7,360	0
Linear Feet - Drainage Pipe	10,098	6,733
Drainage Sections (Inlets, Boxes, Headwalls)	103	79
Estimated Total Cost	**$4.6 million**	**$3.9 million**

ACTUAL RESULTS FROM PHASE ONE

Total Site (engineer's estimate)	**Conventional Plan**	**Green Plan**
Lot Yield	63	72
Total Cost	$1,028,544	828,523
Cost Per Lot	**$16,326**	**$11,507**

ECONOMIC AND OTHER BENEFITS FROM LOW-IMPACT DEVELOPMENT

Higher Lot Yield	17 additional lots
Higher Lot Value	$3,000 more per lot than competition
Lower Cost per Lot	$4,800 less per lot
Enhanced Marketability	80 percent of lots sold in the first year
Added Amenities	23.5 acres of green space/parks
Recognition	National, state, and professional groups

TOTAL ECONOMIC BENEFIT	**More than $2.2 million in savings.**

LID Practices (No Limit!)

"Creative Techniques to Treat,Use, Store, Retain, Detain and Recharge"

- Bioretention / Rain Gardens
- Strategic Grading
- Site Finger Printing
- Resource Conservation
- Flatter Wider Swales
- Flatter Slopes
- Long Flow Paths
- Tree / Shrub Depression
- Turf Depression
- Landscape Island Storage
- Rooftop Detention /Retention
- Roof Leader Disconnection
- Parking Lot / Street Storage
- Smaller Culverts, Pipes & Inlets
- Alternative Surfaces
- Reduce Impervious Surface
- Surface Roughness Technology
- Rain Barrels / Cisterns / Water Use
- Catch Basins / Seepage Pits
- Sidewalk Storage
- Vegetative Swales, Buffers & Strips
- Infiltration Swales & Trenches
- Eliminate Curb and Gutter
- Shoulder Vegetation
- Maximize Sheet flow
- Maintain Drainage Patterns
- Reforestation
- Pollution Prevention……..

Suburban Development

- Bioretention / Rain Gardens
- Strategic Grading
- Site Finger Printing
- Resource Conservation
- Flatter Wider Swales
- Flatter Slopes
- Long Flow Paths
- Tree / Shrub Depression
- Turf Depression
- Landscape Island Storage
- Roof Leader Disconnection
- Smaller Culverts, Pipes & Inlets
- Alternative Surfaces
- Reduce Impervious Surface
- Surface Roughness Technology
- Rain Barrels / Cisterns / Water Use
- Catch Basins / Seepage Pits
- Vegetative Swales, Buffers & Strips
- Infiltration Swales & Trenches
- Eliminate Curb and Gutter
- Shoulder Vegetation
- Maximize Sheet flow
- Maintain Drainage Patterns
- Reforestation……..
- Pollution Prevention……..

"Creative Techniques to Treat,Use, Store, Retain, Detain and Recharge"

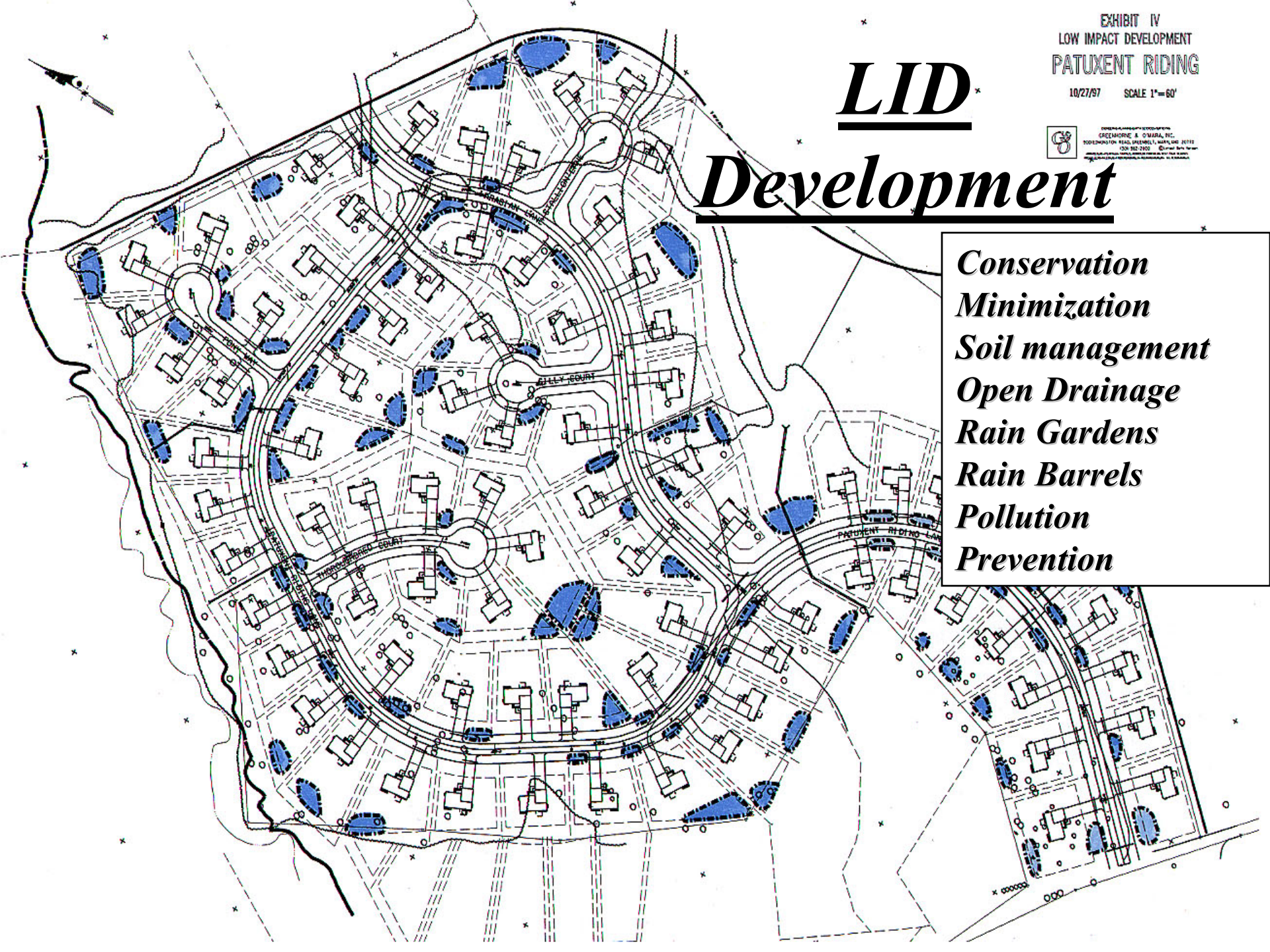
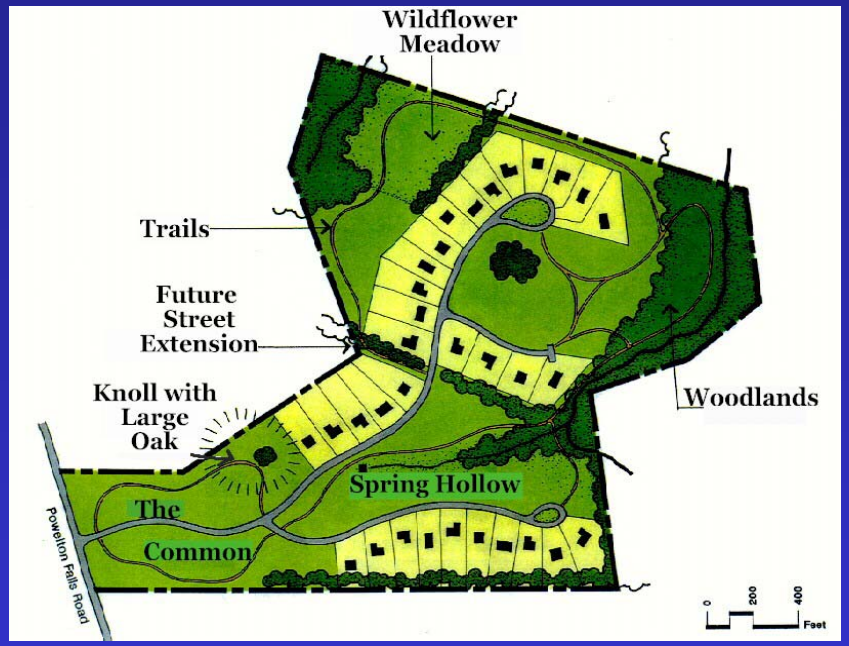


EXHIBIT IV
LOW IMPACT DEVELOPMENT
PATUXENT RIDING
10/27/97 SCALE 1"=60'
GREENHORNE & O'MARA, INC.
LID
Development
Conservation
Minimization
Soil management
Open Drainage
Rain Gardens
Rain Barrels
Pollution
Prevention

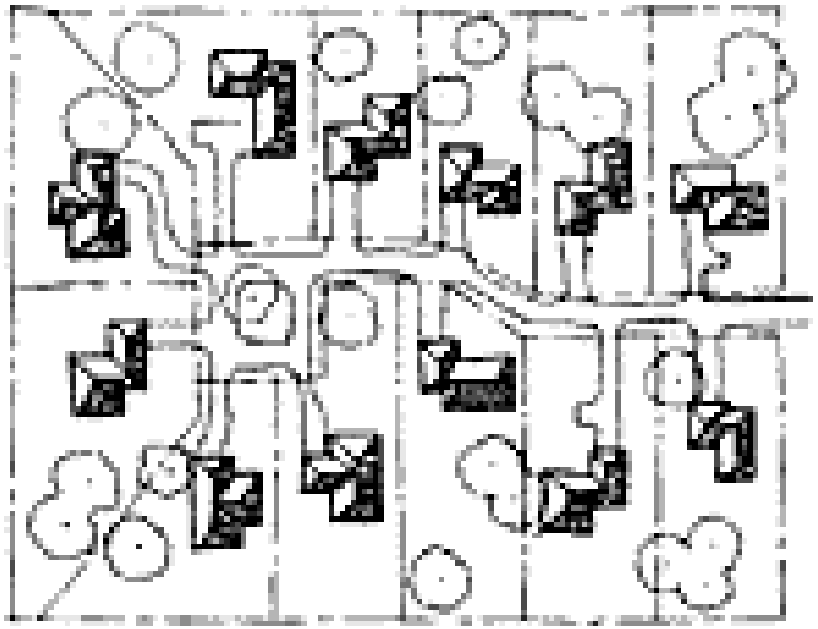
1. Conservation

- Local Watershed and Conservation Plans
  - Forest (Contiguous and Interior Habitat)
  - Streams (Corridors)
  - Wetlands
  - Habitats
  - Step Slopes
  - Buffers
  - Critical Areas
  - Parks
  - Scenic Areas
  - Trails
  - Shorelines
  - Difficult Soils
  - Ag Lands
  - Minerals

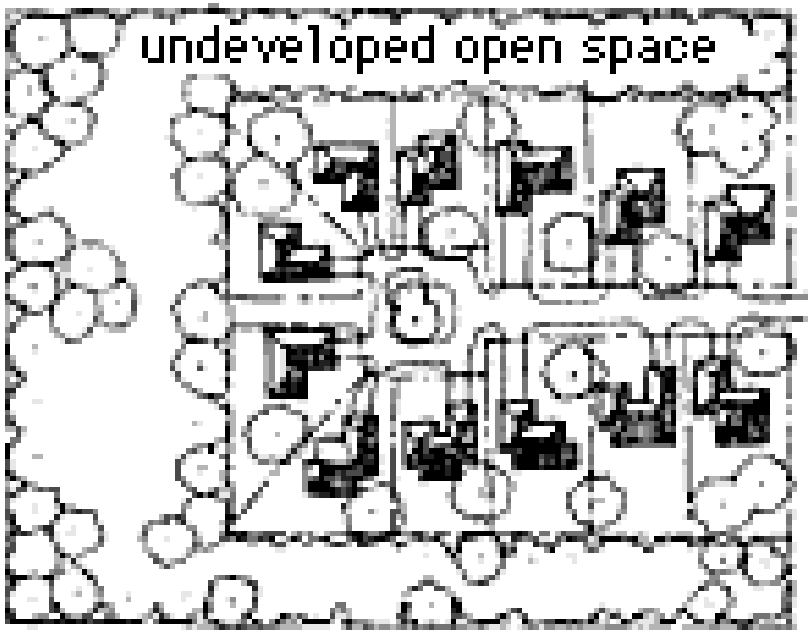


Cluster Development

Conservation Design



2 dwelling units/acre gross density
2 dwelling units/acre net density
12 dwelling units on 6 acres

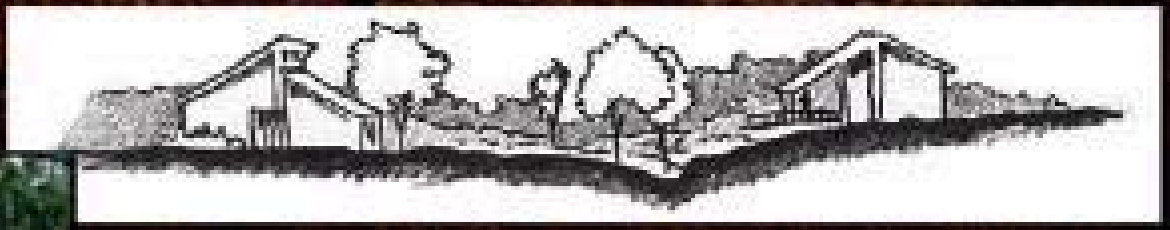


2 dwelling units/acre gross density
4 dwelling units/acre net density
12 dwelling units on 3 acres

http://www.extension.umn.edu/distribution/naturalresources/

Village Homes

Davis, CA



Natural drainage swales

Savings: $800/lot leveraging green space, crop sales, coolth, quality of life, market value.

http://www.energy2000.ee.doe.gov/

Prairie Crossing

- $1.4 M saved in infrastructure
  - Narrower streets
  - Natural drainage

- 50% reduction in energy
- % of each home sale goes to Liberty Prairie Foundation

Prairie Crossing

Grayslake, Illinois

- Reduced density from 1500 lots to 317
- 150 acres of farmland
- 3 land planning types:
  - Large lot
  - Cluster
  - Neo-traditional

2. Minimize Impacts

- Minimize Clearing
- Minimize Grading
- Save A and B soils
- Limit lot Disturbance
- Soil Amendments
- Alternative Surfaces
- Reforestation
- Disconnect
- Reduce pipes, curb and gutters
- Reduce Impervious Surfaces

Save Trees

Limited Lot Disturbance

Site Finger Printing

Conventional Approach

LID

The National Arbor Day Foundation

The National Association of Home Builders

Building *With* Trees

Kelly Woods by Residential Development Group Crystal Lake, Ill.

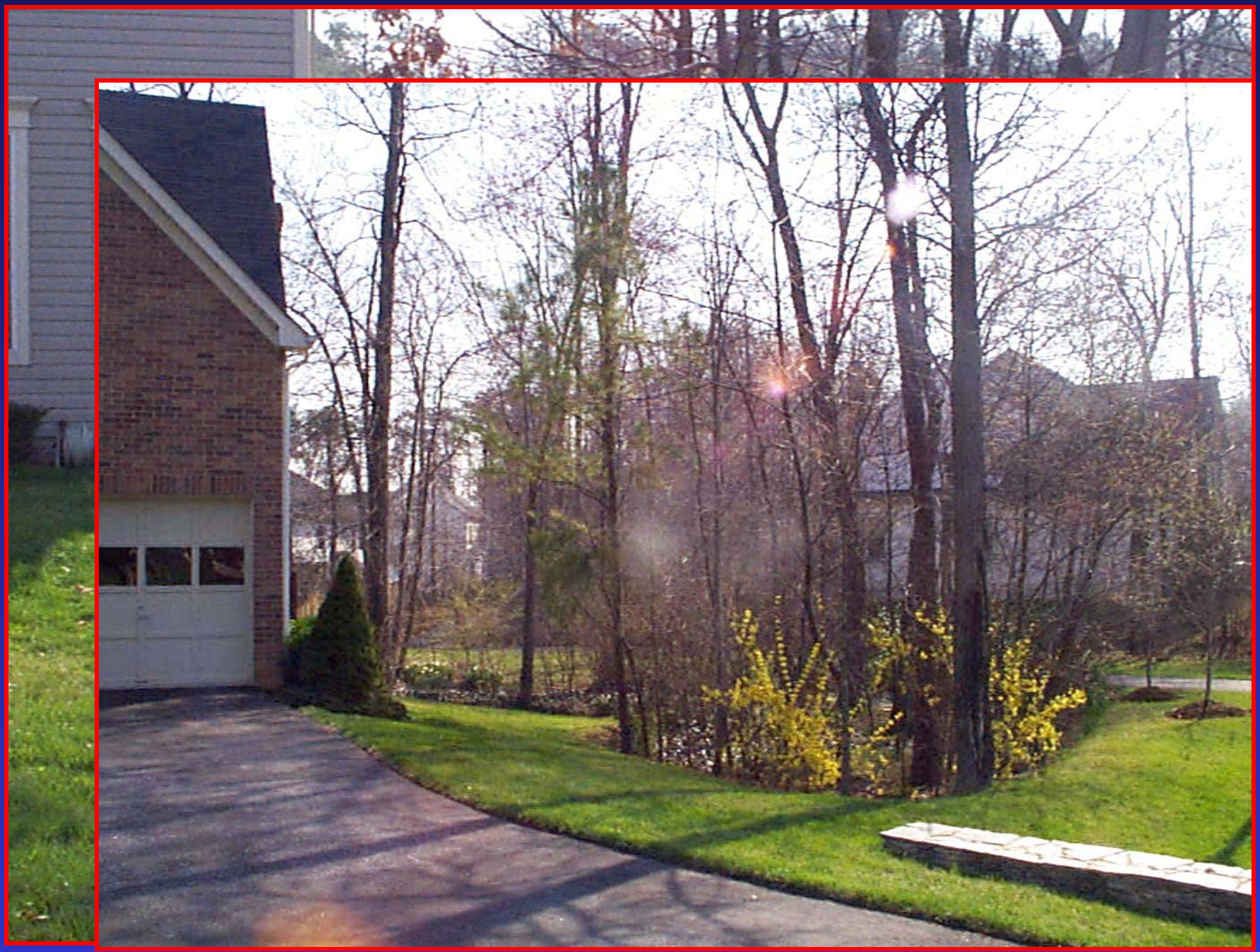
Save Trees

Limited Lot Disturbance

Site Finger Printing

Conventional Approach

LID



On-lot Conservation Issues
Vegetation / Soils / Drainage / etc.

- Infrastructure Conflicts
  - Roadway Requirements
    - Min. / Max Grades and Slopes
    - Right-of-Way
  - Utility Easements
  - Driveway Slopes / Locations
  - Setbacks (Buildings / Septic Systems
  - Drainage Courses (Location and Safety)

On-lot Conservation Issues
Vegetation / Soils / Drainage / etc.

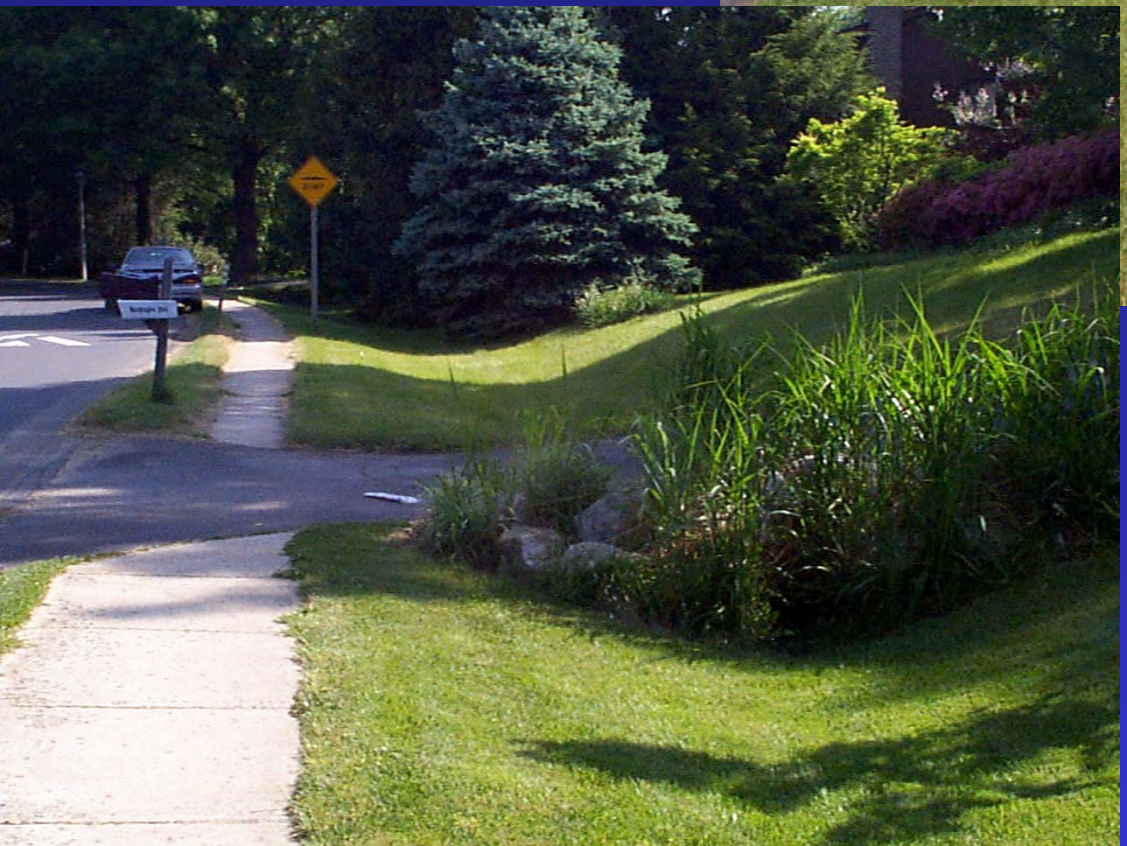
- Construction Techniques
  - Avoid Construction Damage
    - Protect roots
    - Type and Age of Trees
    - Hydrology

3. Maintain Time of Concentration

- Open Drainage
- Use green space
- Flatten slopes
- Disperse drainage
- Lengthen flow paths
- Save headwater areas
- Vegetative swales
- Maintain natural flow paths
- Increase distance from streams
- Maximize sheet flow


Saving Existing Forested Areas To Treat Runoff
Berms
Depressions
Sheet flow


1601



4. Storage, Detention & Filtration
"LID IMP's"

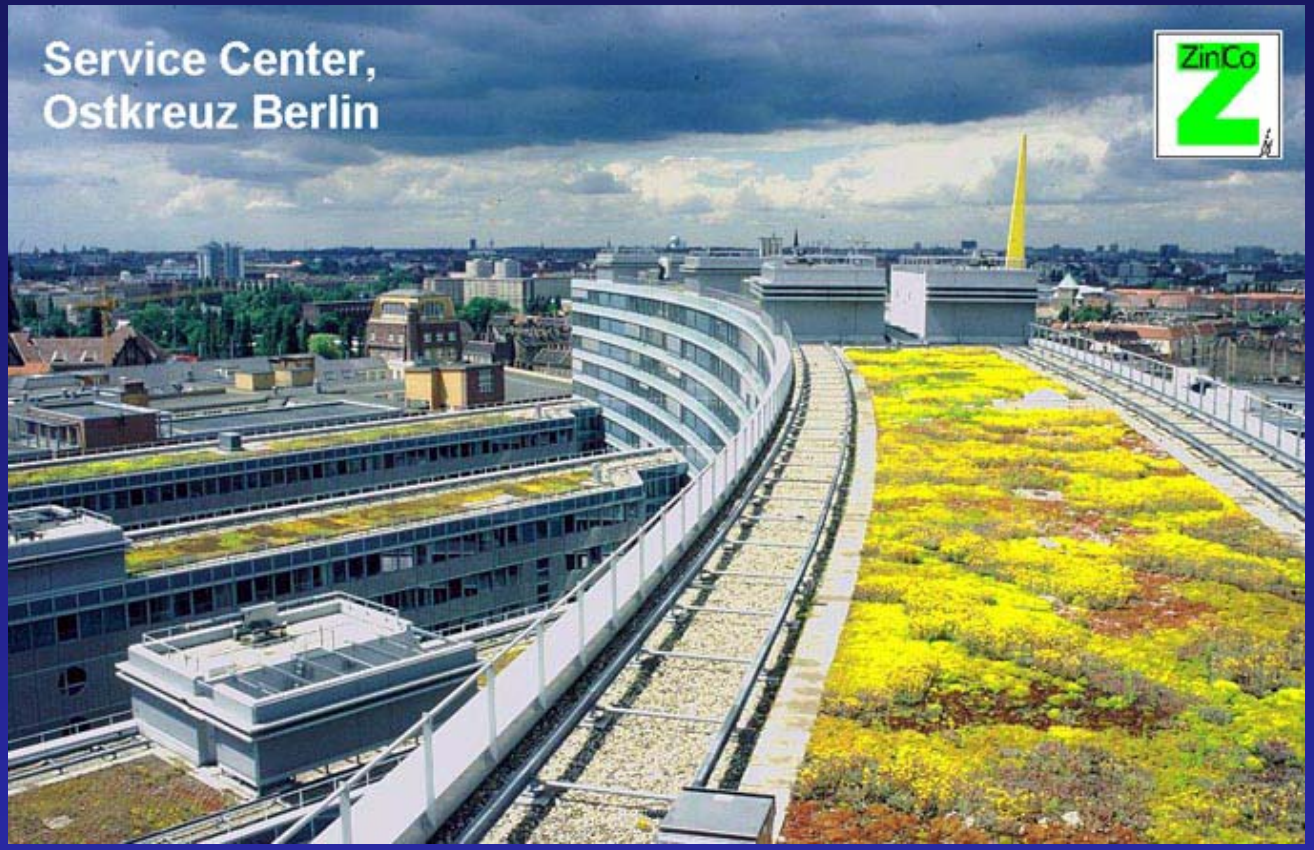
- Uniform Distribution at the Source
  - **Open drainage swales**
  - **Rain Gardens / Bioretention**
  - **Smaller pipes and culverts**
  - **Small inlets**
  - **Depression storage**
  - **Infiltration**
  - **Rooftop storage**
  - **Pipe storage**
  - **Street storage**
  - **Rain Water Use**
  - **Soil Management****

Project Data:

- **Size: 12,850 sqf**
- **Soil depth: 3”-8”**
- **Plant level: sedum with semi-intensive planting-islands**
- **Construction year: 1990**

Project Data:

- **Total size: about several 10,000 sq. ft. extensive and intensive roof vegetation**
- **Soil depth: 3”-25”**
- **Plant level: from sedum, shrubs and grasses up to large bushes and trees**
- **Construction year: 1996**



Project Data:

- **Size: 84,500 sqf**
- **Soil depth: 4”**
- **Plant level: sedum, shrubs, grasses**
- **Construction year: 1998**

Benefits of a Green Roof

(from ZinCo Roofgardens, The Green Roof Planning Guide)

Ecological Benefits

- Improvement of microclimate
- New habitat for plants, animals, and humans
- Retention of storm water reduces load on domestic drainage system
- Reduction of noise level due to less sound reverberation and improved sound insulation
- Retention of dust particles and nutrients from air and rain

Benefits of a Green Roof

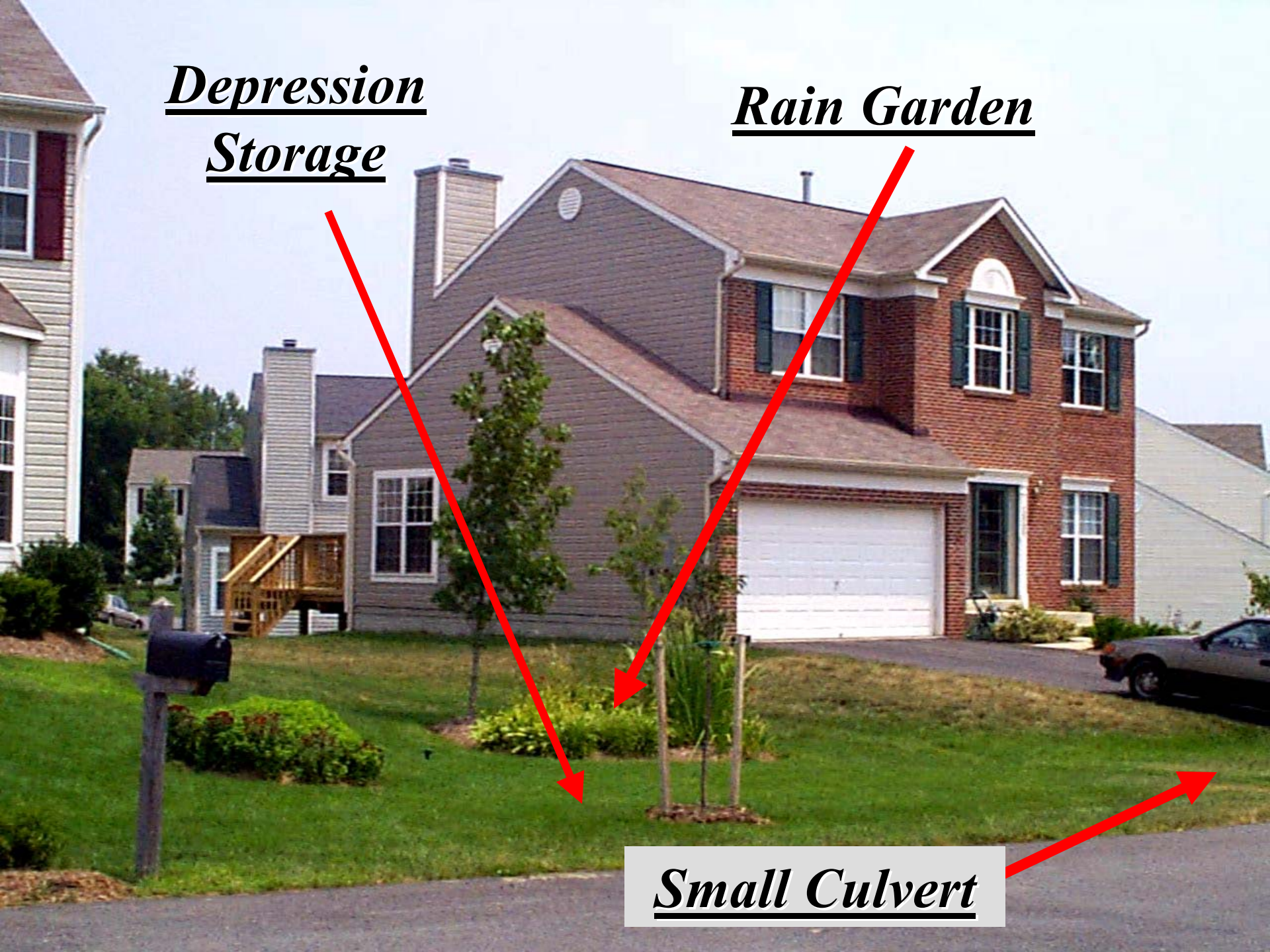
(from ZinCo Roofgardens, The Green Roof Planning Guide)

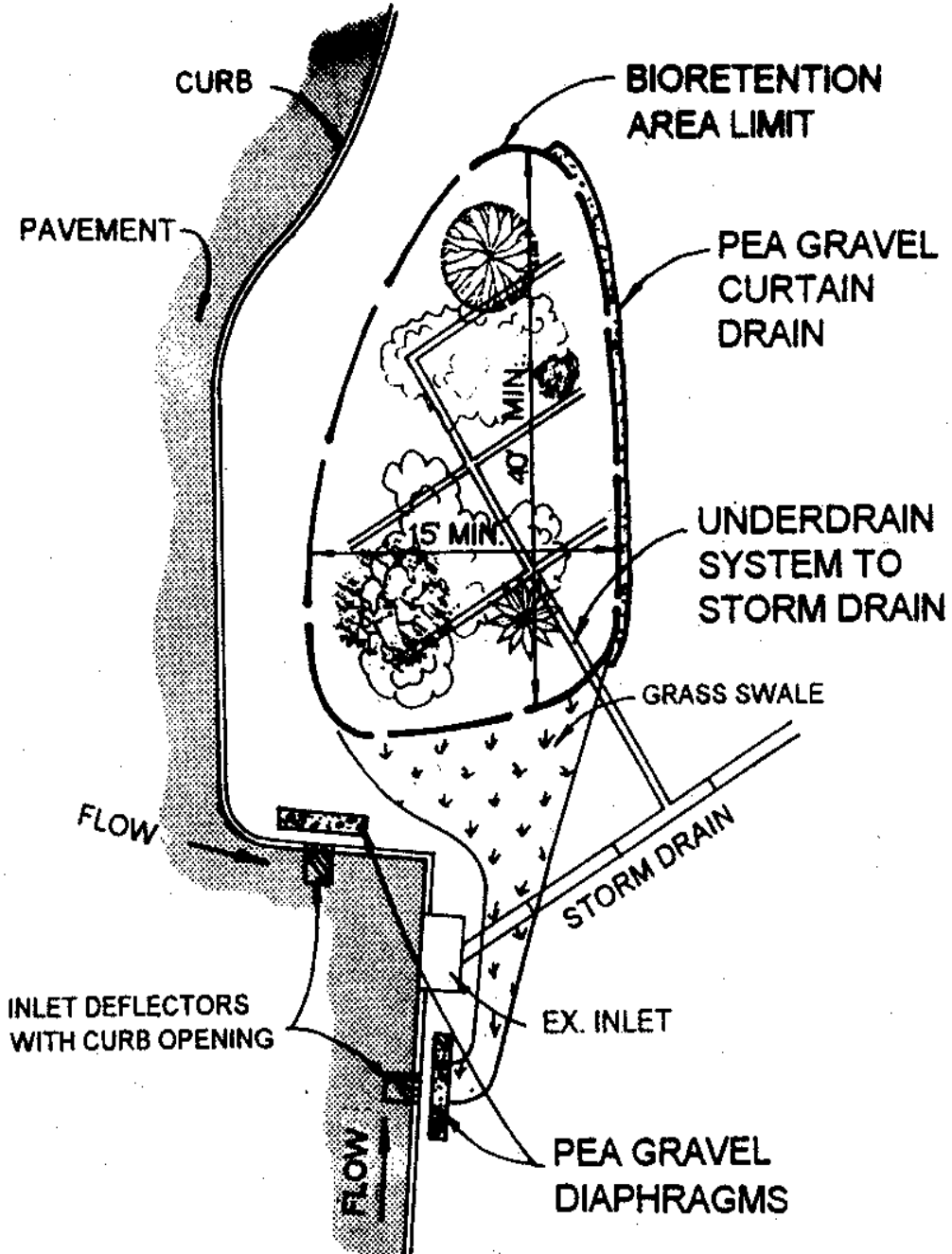
Economic Benefits

- **Increase in life expectancy of waterproofing by providing protection against temperature extremes and ultra-violet light**
- **Saving energy costs by improving by improving thermal insulation and ensuring more economical functioning of air-conditioning**
- **Better use of building plot (a green roof increases recreational area**
- **Increase in property value**

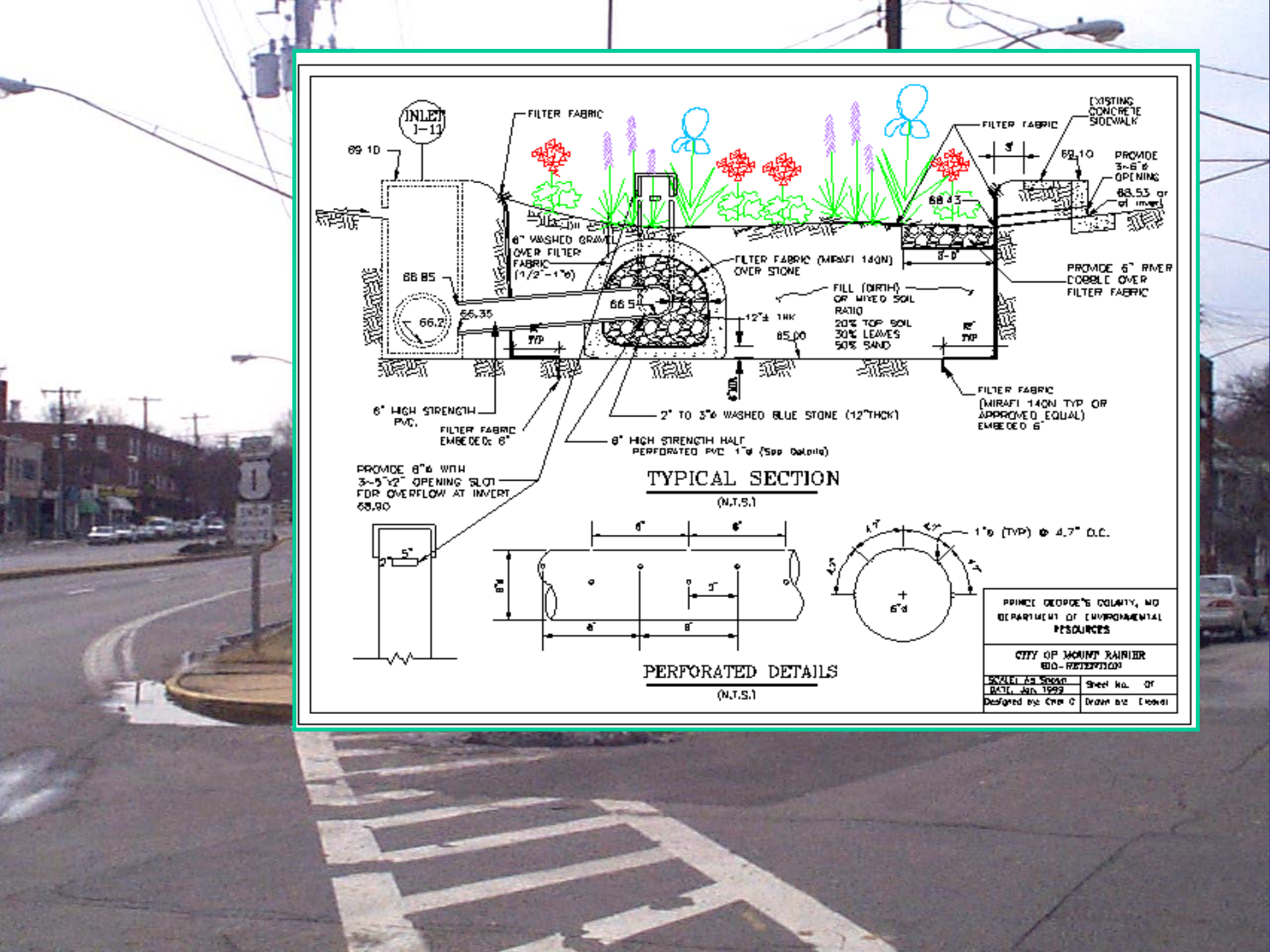
Rain Gardens

Typical Landscape Maintenance Practices

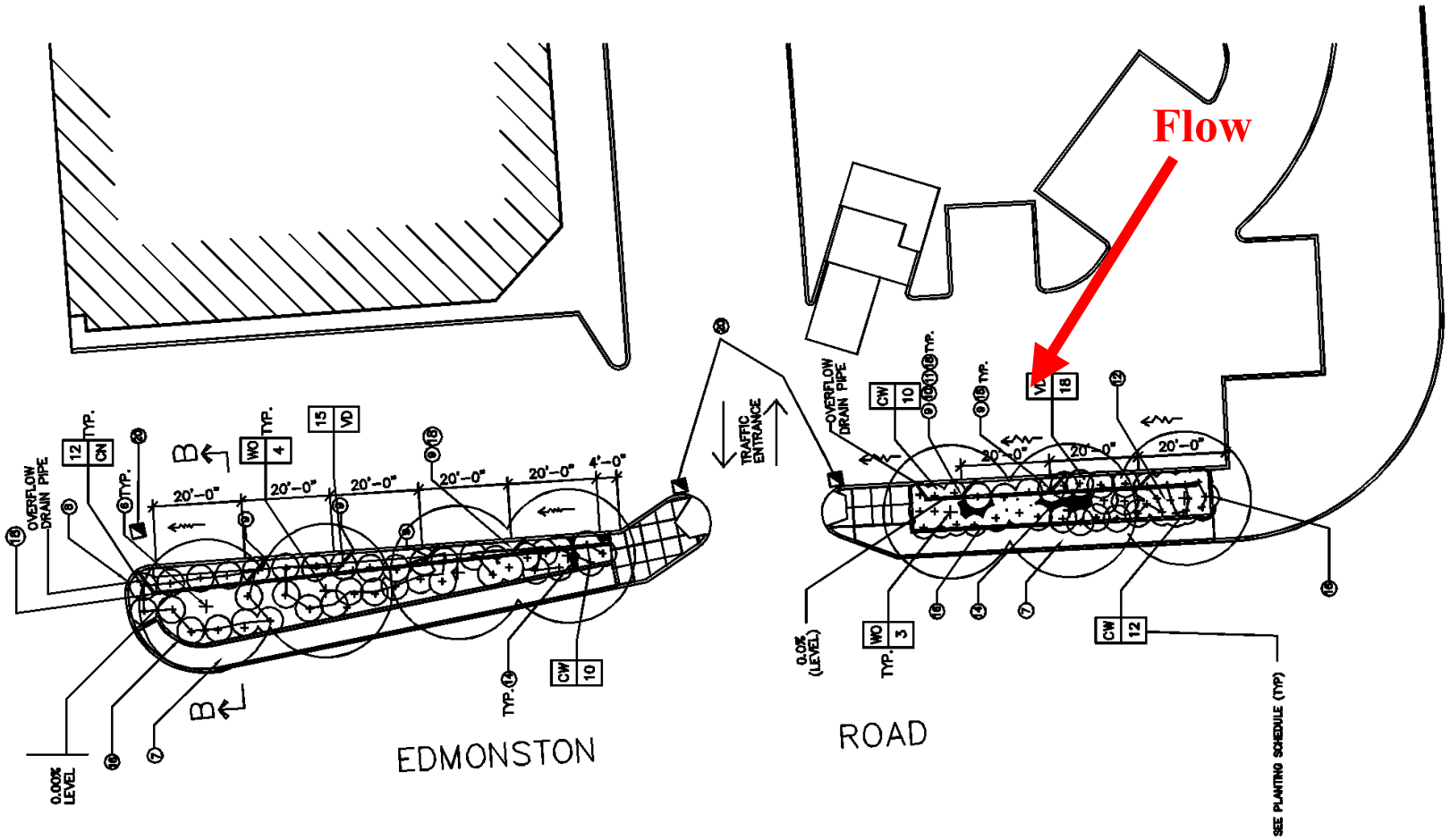

Depression Storage
Rain Garden
Small Culvert



All green space can be designed to be hydrologically functional and treat runoff.


INLET
I-11
69.10
FILTER FABRIC
EXISTING CONCRETE SIDEWALK
PROVIDE 3-6"ø OPENING
68.53 or at invert
68.43
6" WASHED GRAVEL OVER FILTER FABRIC (1/2"-1"ø)
FILTER FABRIC (MIRAFI 140N) OVER STONE
FILL (DIRT) OR MIXED SOIL RATIO
20% TOP SOIL
30% LEAVES
50% SAND
PROVIDE 6" RIVER COBBLE OVER FILTER FABRIC
66.85
66.35
66.2
66.5
12"± THK
65.00
8'-0"
TYP
6" HIGH STRENGTH PVC.
FILTER FABRIC EMBEDDED 6"
2" TO 3"ø WASHED BLUE STONE (12"THCK)
6" HIGH STRENGTH HALF PERFORATED PVC 1"ø (See Details)
FILTER FABRIC (MIRAFI 140N TYP OR APPROVED EQUAL) EMBEDDED 6"
PROVIDE 6"ø WITH 3-5"x2" OPENING SLOT FOR OVERFLOW AT INVERT 65.90
TYPICAL SECTION
(N.T.S.)
6"
3"
1"ø (TYP) @ 4.7" O.C.
6"ø
PERFORATED DETAILS
(N.T.S.)
PRINCE GEORGE'S COUNTY, MD
DEPARTMENT OF ENVIRONMENTAL RESOURCES
CITY OF MOUNT RAINIER
BIO-RETENTION
SCALE: As Shown
DATE: Jan 1999
Designed by: Chm C
Sheet No. of
Drawn by: Checked

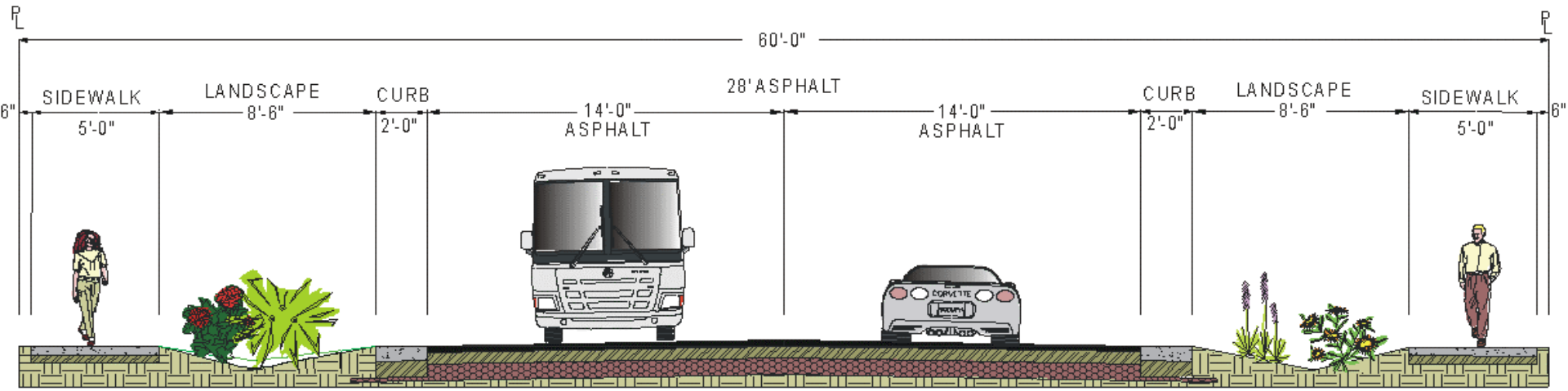
Port Towns Shopping Center



0.94 Acres @ $29,000
$30,000 / Ac.

NEW 60' RIGHT-OF-WAY

SERVICE 26 TO 75 RESIDENCES

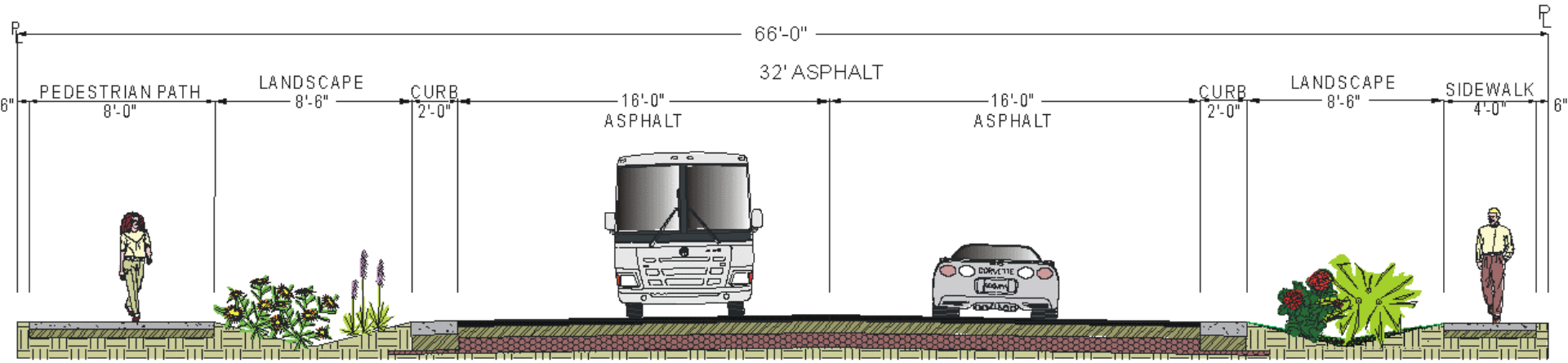


LOW IMPACT RESULTS

- 28% LESS ASPHALT SURFACE
- 10-14% STORM WATER RUNOFF REDUCTION
- 125% INCREASE IN GREEN SPACE

NEW 66' RIGHT-OF-WAY

SERVICE MINIMUM 3000 AVERAGE DAILY TRIPS



LOW IMPACT RESULTS

- 26% LESS ASPHALT SURFACE
- 12-15% STORM WATER RUNOFF REDUCTION
- 125% INCREASE IN GREEN SPACE

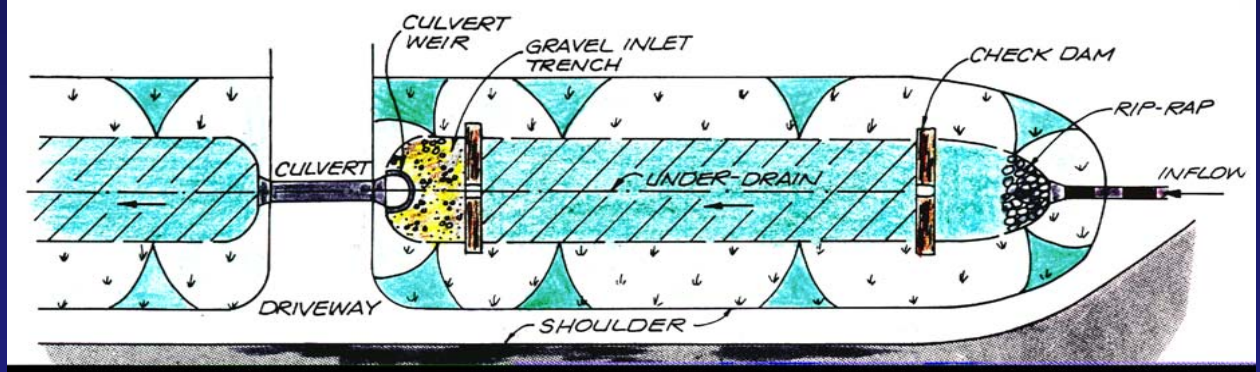
Many of the features of the proposed standards are shown in Table 6-1. The table also includes features associated with the current standards being used in North Logan City for comparison purposes.

Table 6-1. Design Information for Existing and Proposed Roadway Standards in North Logan City, Utah.

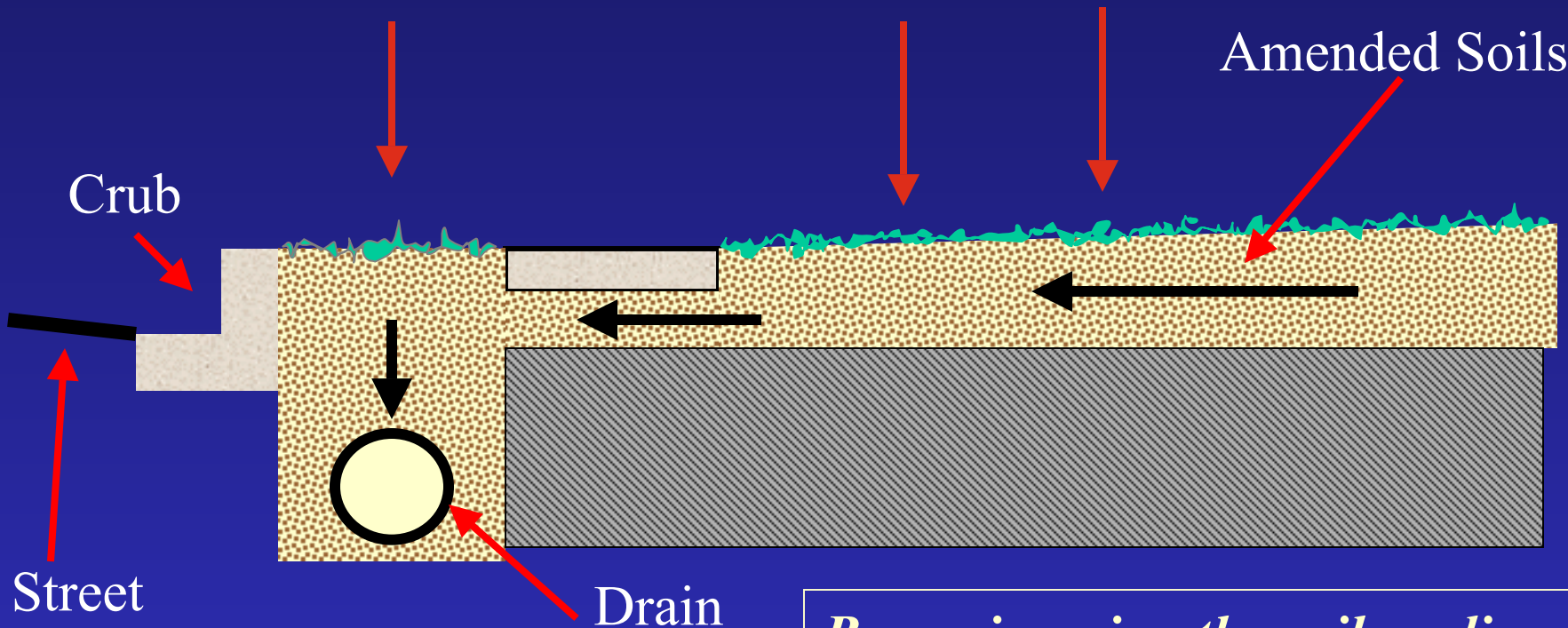
Road Type	Collector (existing)	Collector (proposed)	Major residential (existing)	Major residential (proposed)	Minor residential (existing)	Minor residential (proposed)
ROW Width	66 '	66'	60'	60'	50'	50'
Street Width	43'	32'	39'	28'	30'	25'
Landscape Area	NA	8.5' Each side	NA	8.5' Each side	NA	6' Each side
Drainage	Curb and gutter	Flat curb and swale (optional high-back curb)	Curb and gutter	Flat curb and swale	Curb and gutter	Flat curb and swale
Pedestrian Walkway	5' both sides	4' one side, 8' other side	4' both sides	5' both sides	4' both sides	4' both sides

Estimated costs associated with implementation of each of the proposed roadways are contained in Appendix D.

6.2 Standards

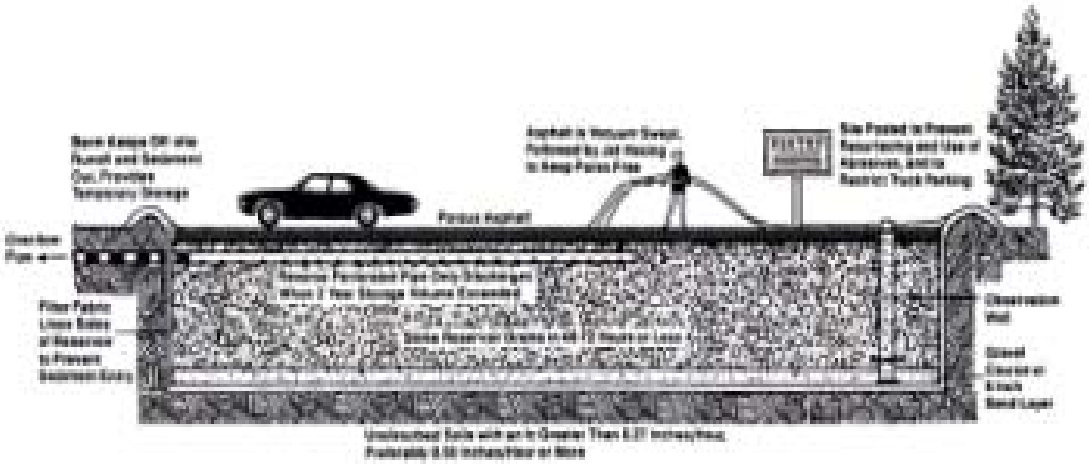

CULVERT WEIR
GRAVEL INLET TRENCH
CHECK DAM
RIP-RAP
CULVERT
UNDER-DRAIN
INFLOW
DRIVEWAY
SHOULDER

Optimizing Urban Soil Functionality

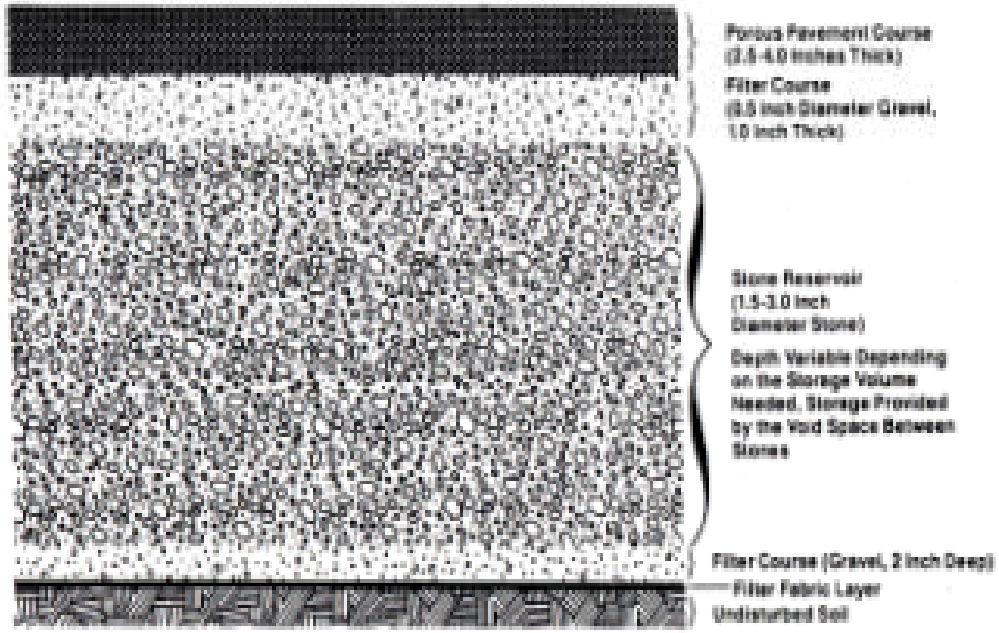


Cross Section of Urban Curb / Gutter / Yard

By engineering the soil media composition, void space and depth we can store, treat, recharge and release runoff at predevelopment levels.

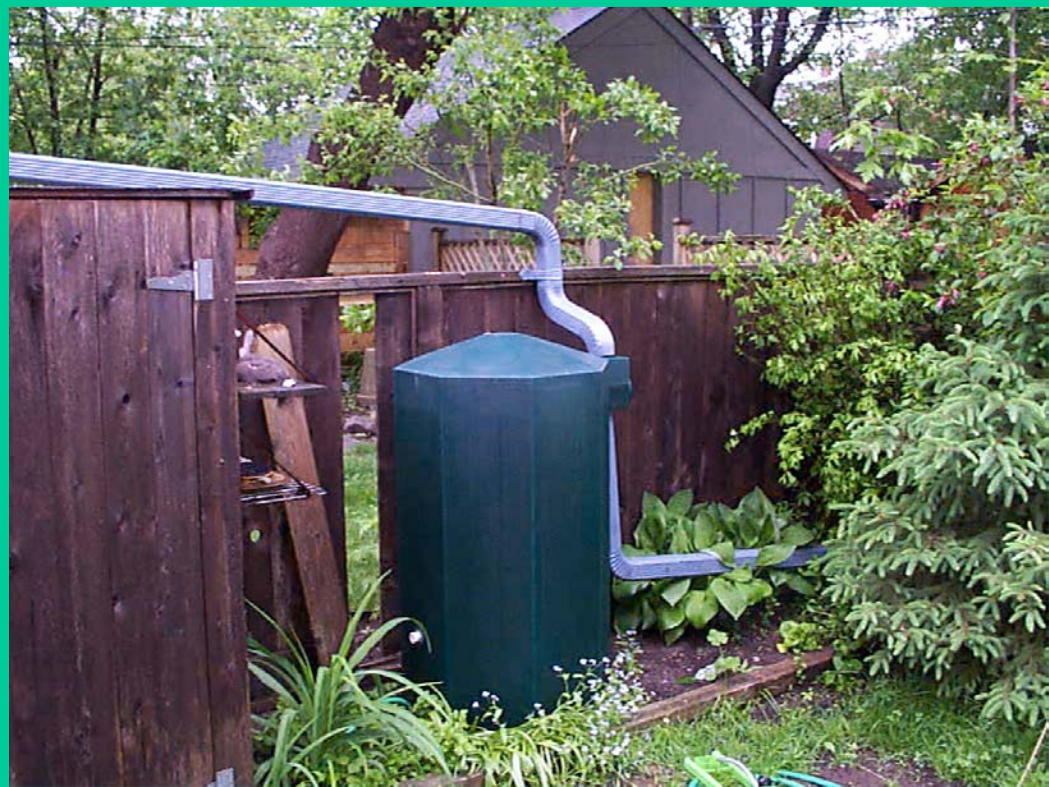


Side View


Porous Pavement Course
(3.5-4.0 Inches Thick)
Filter Course
(0.5 Inch Diameter Gravel,
1.0 Inch Thick)
Stone Reservoir
(1.5-3.0 Inch
Diameter Stone)
Depth Variable Depending
on the Storage Volume
Needed. Storage Provided
by the Void Space Between
Stones
Filter Course (Gravel, 2 Inch Deep)
Filter Fabric Layer
Undisturbed Soil


Local
One Way
PENSKE
Truck Rental

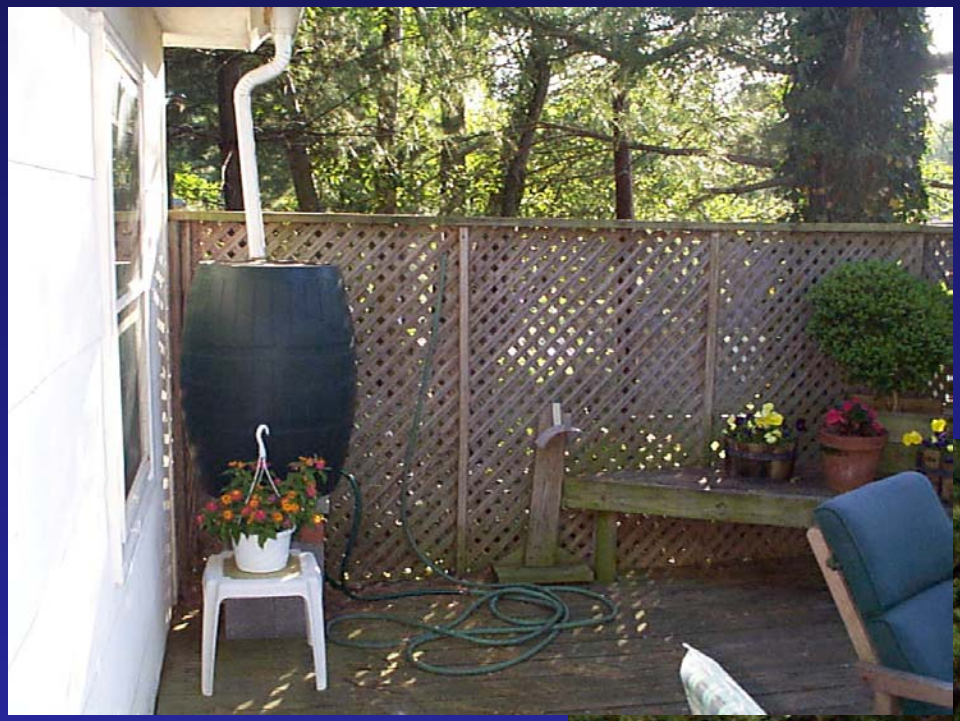
Total Water Management



Runoff Use

Consumption Reduction

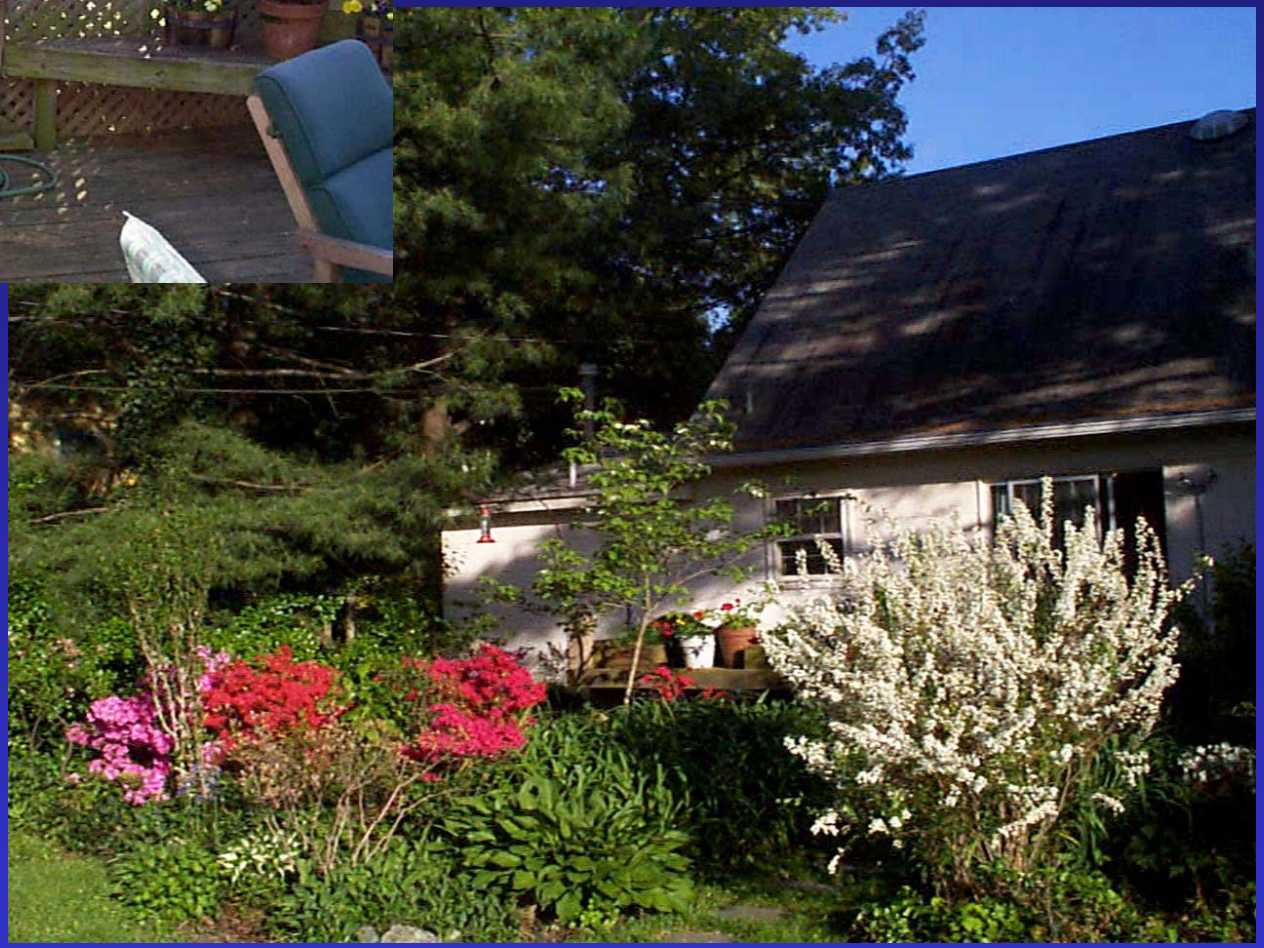
Save $100 / yr.

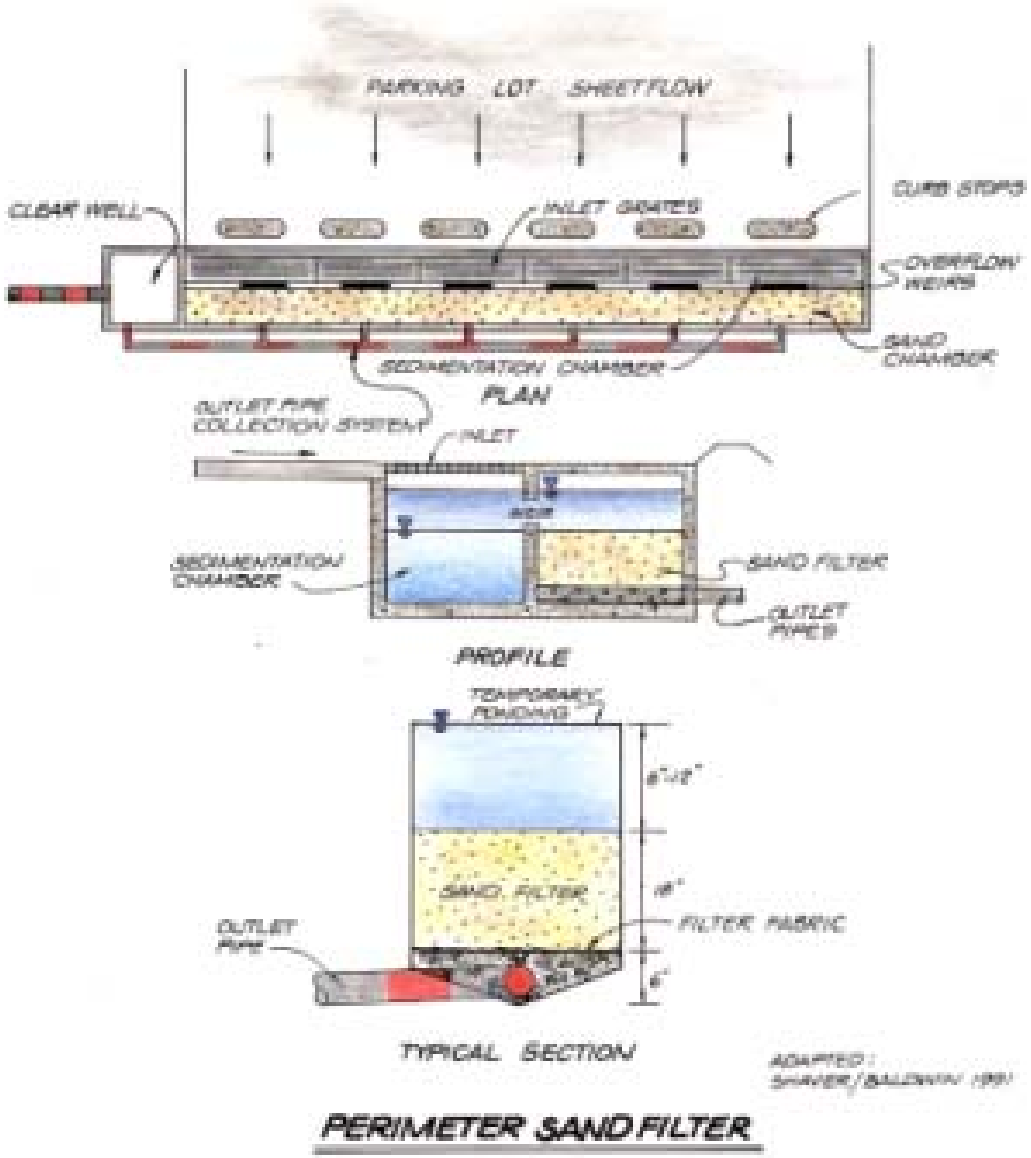


My House

Rain Barrel

Rain Gardens





PERIMETER SAND FILTER

THE BIOENGINEERING GROUP, INC.

Kettering Demonstration Project

"A Comprehensive Urban Retrofit and Outreach Program"

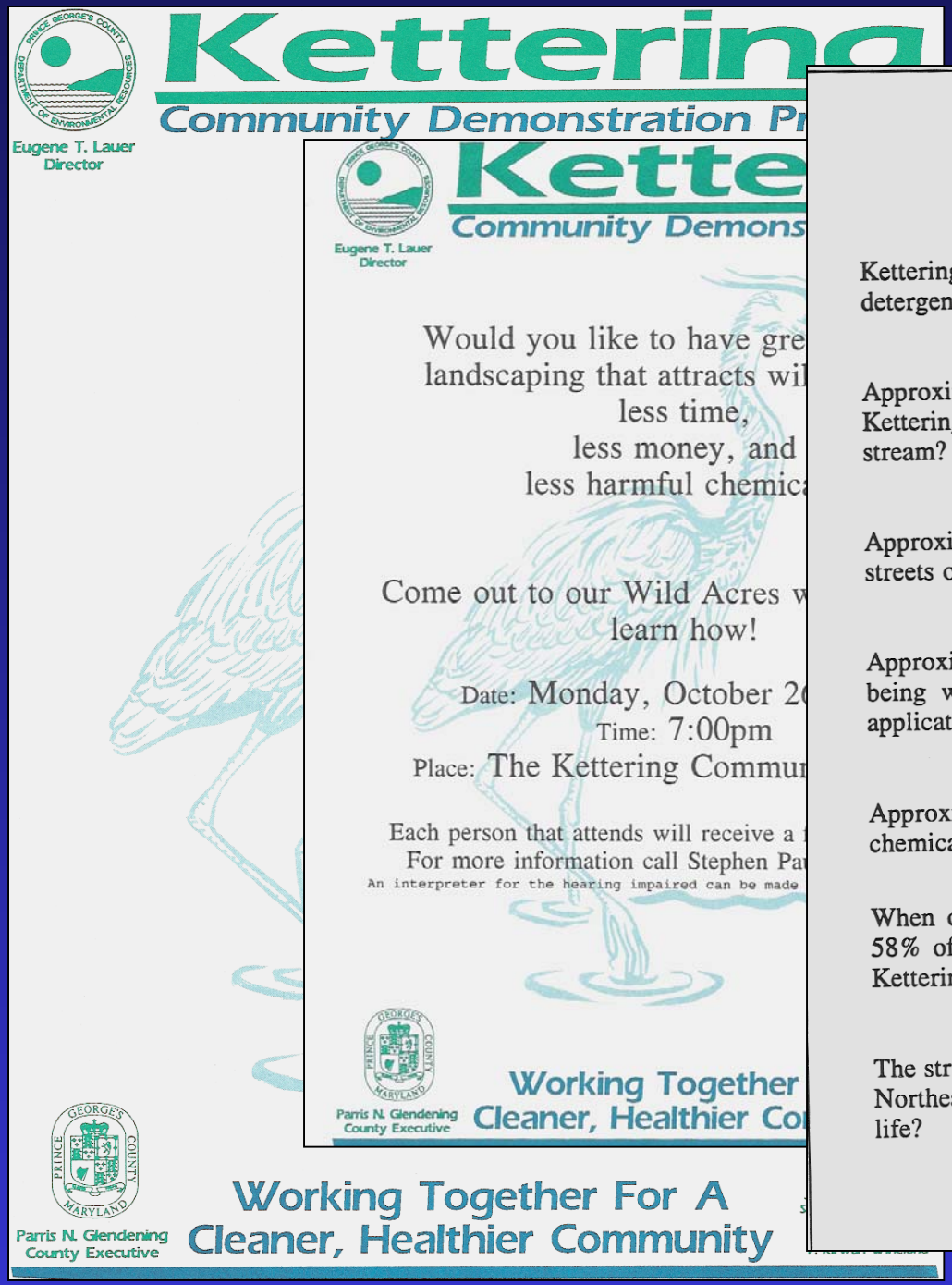
- **Project Overview**
  - Goals / Objectives
    - » Learning and understanding how to develop an effective public education program.
  - Program Components
    - » Partnerships
    - » Structural Measures
    - » Educational Units
    - » Monitoring
    - » Modeling

Educational Components

- Project Introduction
- Pre-program Survey
- Lawn Care
- Backyard Habitat
- Reporting Pollution Problems
- Recycling
- House hold Hazardous Wastes
- Care Care
- Tree Planting
- Adopt a Stream
- Pollution Prevention

Media Used

- Direct Mailings
  - Letters / Brochures
- Library
- Community News Letters / Meetings
- Signs
- Community Organizations
- Workshops
- News Papers
- Other Public Announcements



Did You Know:

Kettering residents discharge approximately 1,277 quarts of detergents each year to the local stream from car washing alone?

Approximately 2,533 quarts of oil are disposed of improperly in Kettering each year and have the potential to contaminate the stream?

Approximately 2,992 quarts of antifreeze are drained onto the streets of Kettering where it then runs directly into the stream?

Approximately 23,643 pounds of nitrogen have the potential of being washed off of Kettering lawns each year from fertilizer applications?

Approximately 80% of Kettering residents apply some form of chemical pesticides to their yards each year?

When our environmental education program began last summer, 58% of Kettering residents did not know that neighborhoods like Kettering cause water pollution?

The stream that flows through the eastern part of Kettering into the Northeast Branch is so polluted that it can support almost no aquatic life?


Caring For Your Car Without Harming The Environment
ANTI-FREEZE
OIL
Rain Gardens
THE NATURAL SOLUTION
Green Lawns — The Smart Way
pollution prevention
it's everyone's business


Corbis.com


LITTER


ANTIFREEZE

Kettering Survey Response		
Questions	Pre Program	Post Program
	%	%
Is urban Runoff a Problem?	58	40
Use Pesticides?	41	42
Use Herbicides?	30	56
Fertilize?		
Spring	43	46
Fall	40	44
Don’t Recycle Antifreeze	25	24
Don't know how to report problems	72	55
Response Rate	36	15
Are you likely to adopt the programs?		94
Where Do You Get Your Information?	Lables	
	News Media	

Comparison of EMC at Site K3 for 1993 and 1996-1997		
Pollutant	1993 Median	1996-1997 Median
Lead	11	10.7
Zinc	60	41.4
NH3	ND	0.12
BOD5	5.5	10.44
No2/NO3	0.45	0.26
TP	0.45	0.31
TKN	1.6	1.16
TSS	45	93
40% reduction in N02 / N03		
31% Reduction in TP		

Mean Monthly Nitrogen Concentration

(Est. from HSPF for 8-yr simulation)

Education Program Costs

Community Planner……	$41,616
Other Support Staff ……..	$11,250
Consultant Services …….	$15,500
Publications / Copies ……	$ 5,852
Mailings……..	$ 7,818
Total	$82,036

What We Learned About Public Educational Programs

- Socio-economic Factors
- Value of Reconnaissance Study
- Value and Use of Media
- Costs and Level of Effort
- Large Scale Applications
- Motivational Factors (Complex)
- Long Term Success
- Conclusions

How We Applied the Lessons

- New Focus and Goals for Outreach Programs
  - Stream Teams "Train the Trainers"
  - Targeted
  - Organizations / Institutions
- New Technology to Engage the Public
  - Low Impact Development
    - Onsite Controls / Rain Gardens

Current Education Programs

- Stream Teams
  - Community / Organizational Based Outreach
  - Program Components
  - Promote with Interested Parties
- Organizational Training and Programs
  - Environmental Groups
  - Institutions
    - Changing the way they do business

Stream Teams

Stream Survey Form

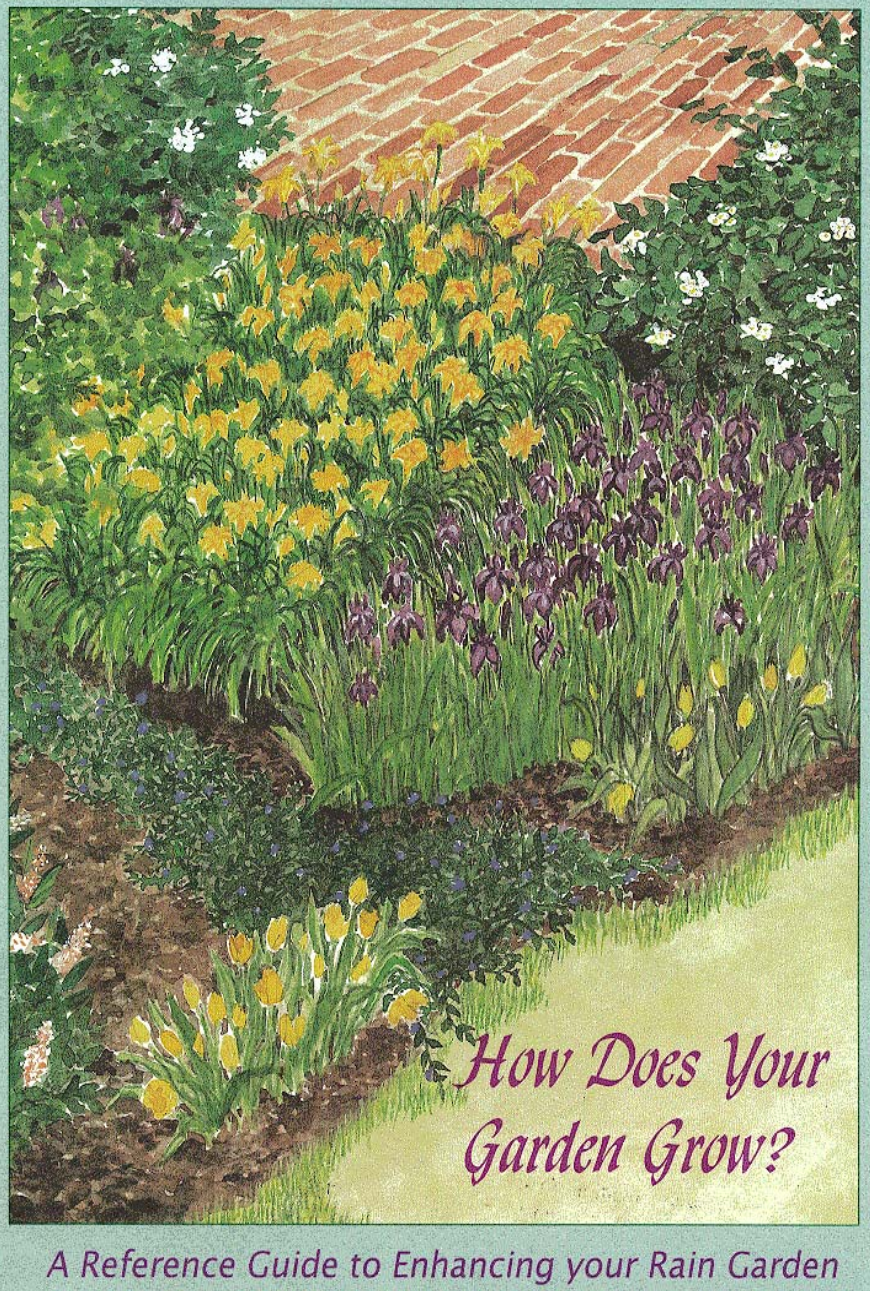
Schools

Community Organizations

Environmental Groups

Homeowners Associations

Garden Clubs



- **Education**
  - **Responsibility**
  - **Function**
  - **O & M**
- **Enforcement**
  - **Easements**
  - **HOA**
  - **Community Standards**
- **Economics**
  - **Property Values**
  - **Added Value**
  - **Ease of Maintenance**