Low Impact Development Technology

Sponsored by Filterra

Ecologically Functional Stormwater Management Technology

“Multi-functional site design, streetscapes and architecture that maintains and restores vital terrestrial ecologically processes necessary to protect the ecological integrity of our receiving waters”

“Lower Costs / Lower Impacts / Added Values”

Presented by:
Low Impact Development Center

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LNSB, LLLP Stormwater Services
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301-580-6631

Balancing Growth and Environmental Integrity

Advance Stormwater Technology

Pilot Projects / Research / Monitoring / Modeling, Manuals / Training / Education

The Low Impact Development Center

Neil Weinstein, Executive Director – Phone: 301.982.5559

http://www.lowimpactdevelopment.org/

WHY IS LID SO ATTRACTIVE?

- Universally Applicable (Arid, Clays, Karst, Cold, Coastal… .)
- Economically Sustainable
- Ecologically Sustainable
- Lower Costs (Construction, Maintenance & Operation)
- Multiple Benefits (air / water / energy / property values)
- Silent on Growth Management
- Ideal for Urban Retrofit (quality and quantity)
- Public Acceptance

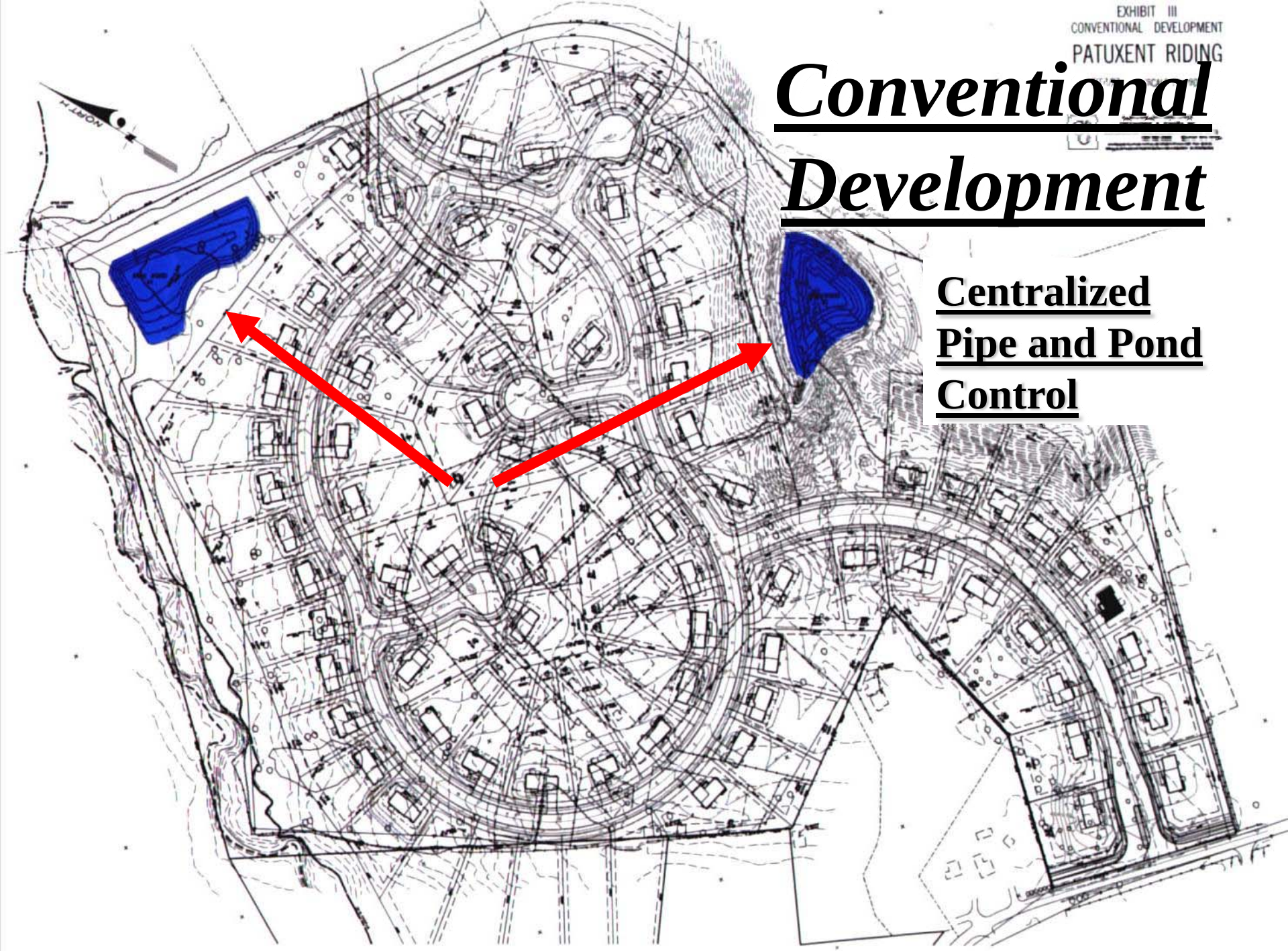
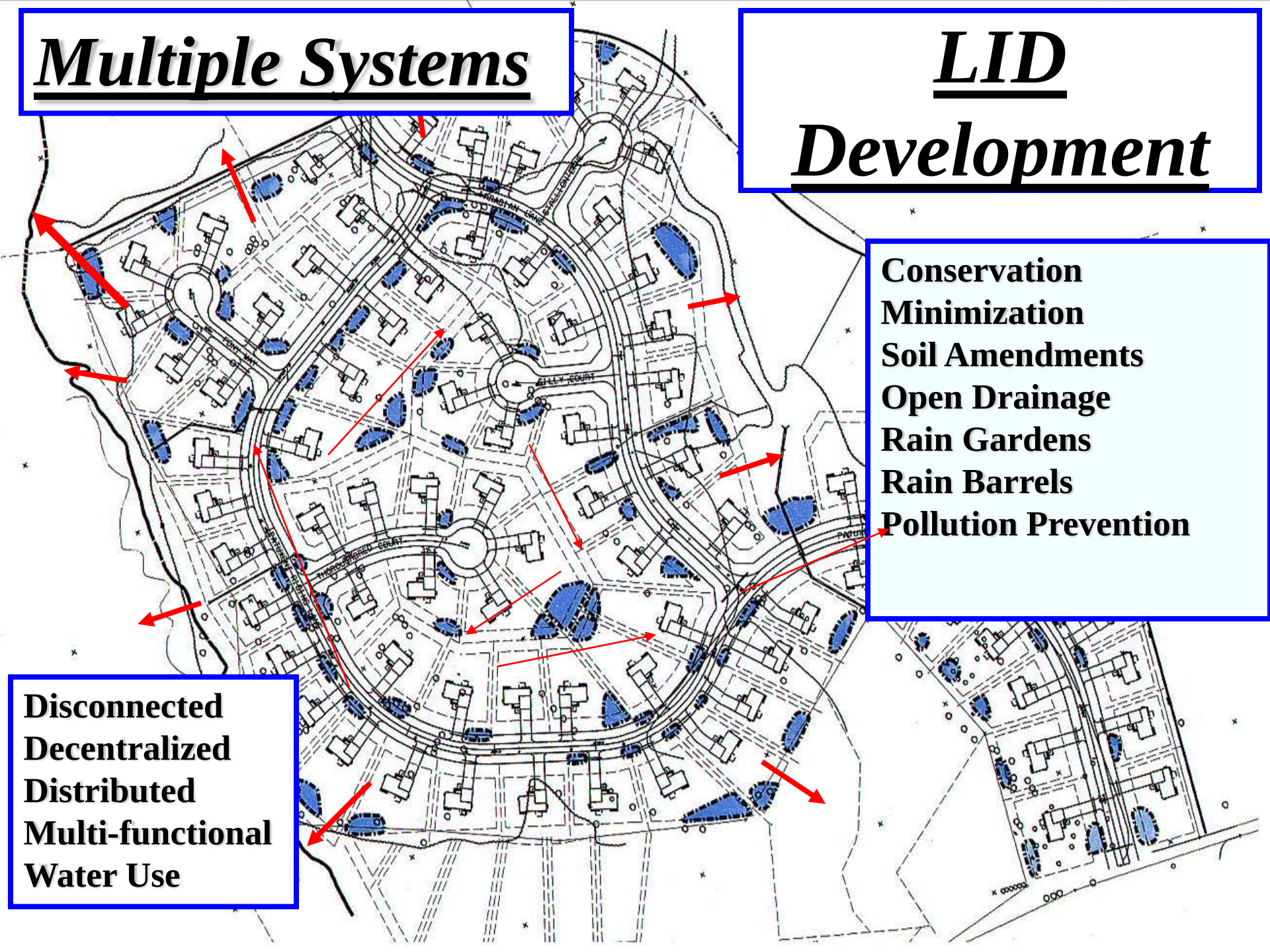


EXHIBIT III
CONVENTIONAL DEVELOPMENT
PATUXENT RIDING
NORTH
Conventional Development
Centralized Pipe and Pond Control

Multiple Systems

LID Development



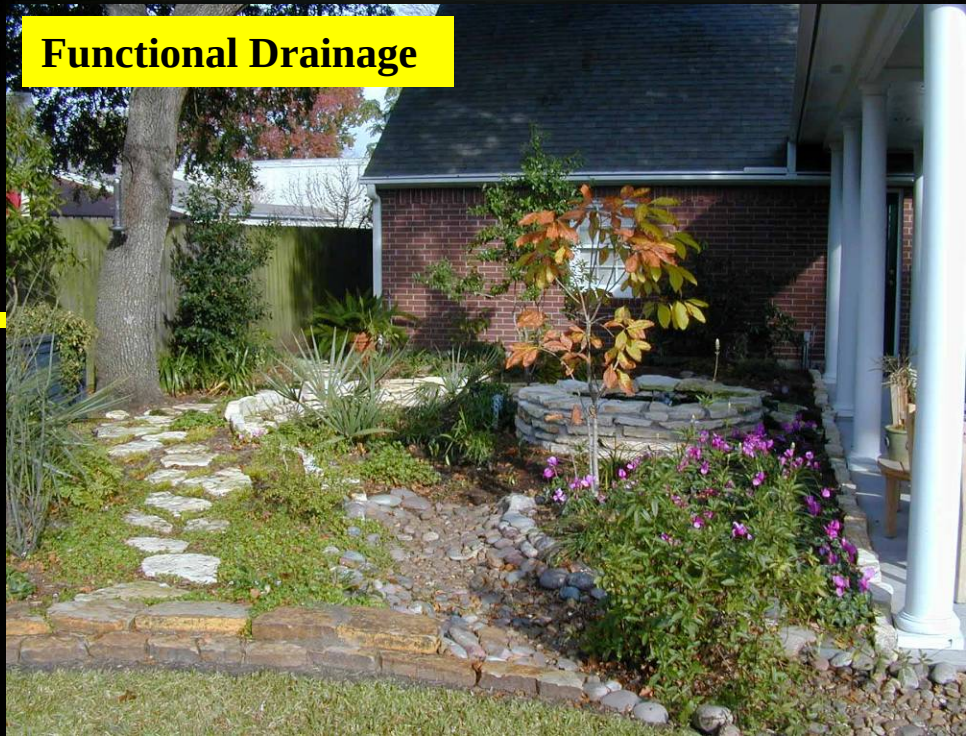
Conservation
Minimization
Soil Amendments
Open Drainage
Rain Gardens
Rain Barrels
Pollution Prevention

Disconnected
Decentralized
Distributed
Multi-functional
Water Use


Conventional

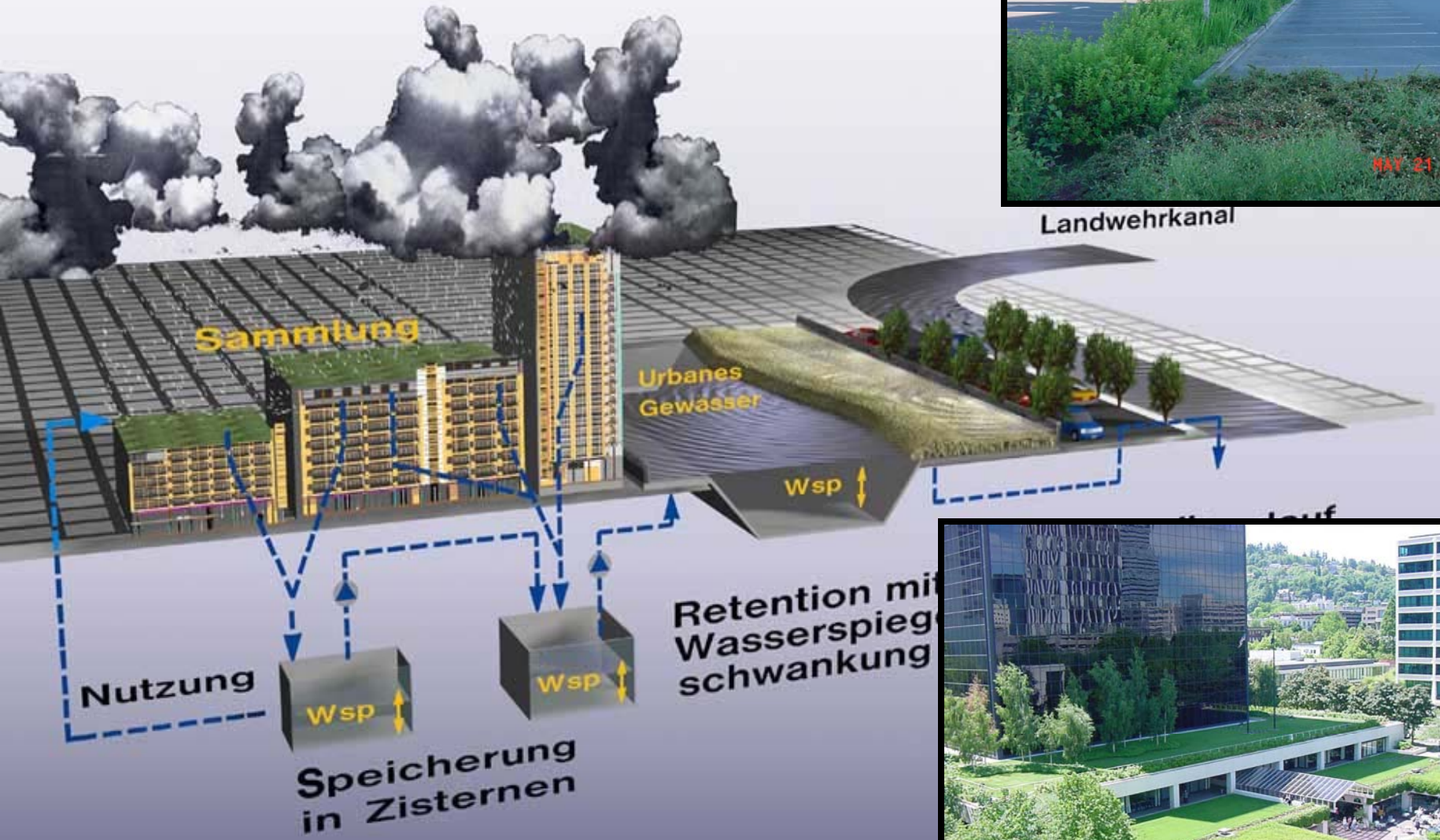

Low Impact


Good Drainage


Functional Drainage

Berlin Potsdamer Platz Regenwasse

Landwehrkanal



Limitations of Conventional Stormwater Approaches

- Economics
  - Reduce Infrastructure Maintenance
  - Growing & Aging Infrastructure
- New Objectives (Public Health / Ecological)
  - Source Water / CSO's / Living Resources
  - Regulations
    - NPDES / TMDL's / ESA

Maintenance Burdens

Underground BMPs Problems

Out of Sight Out of Mind

Training

Inspection

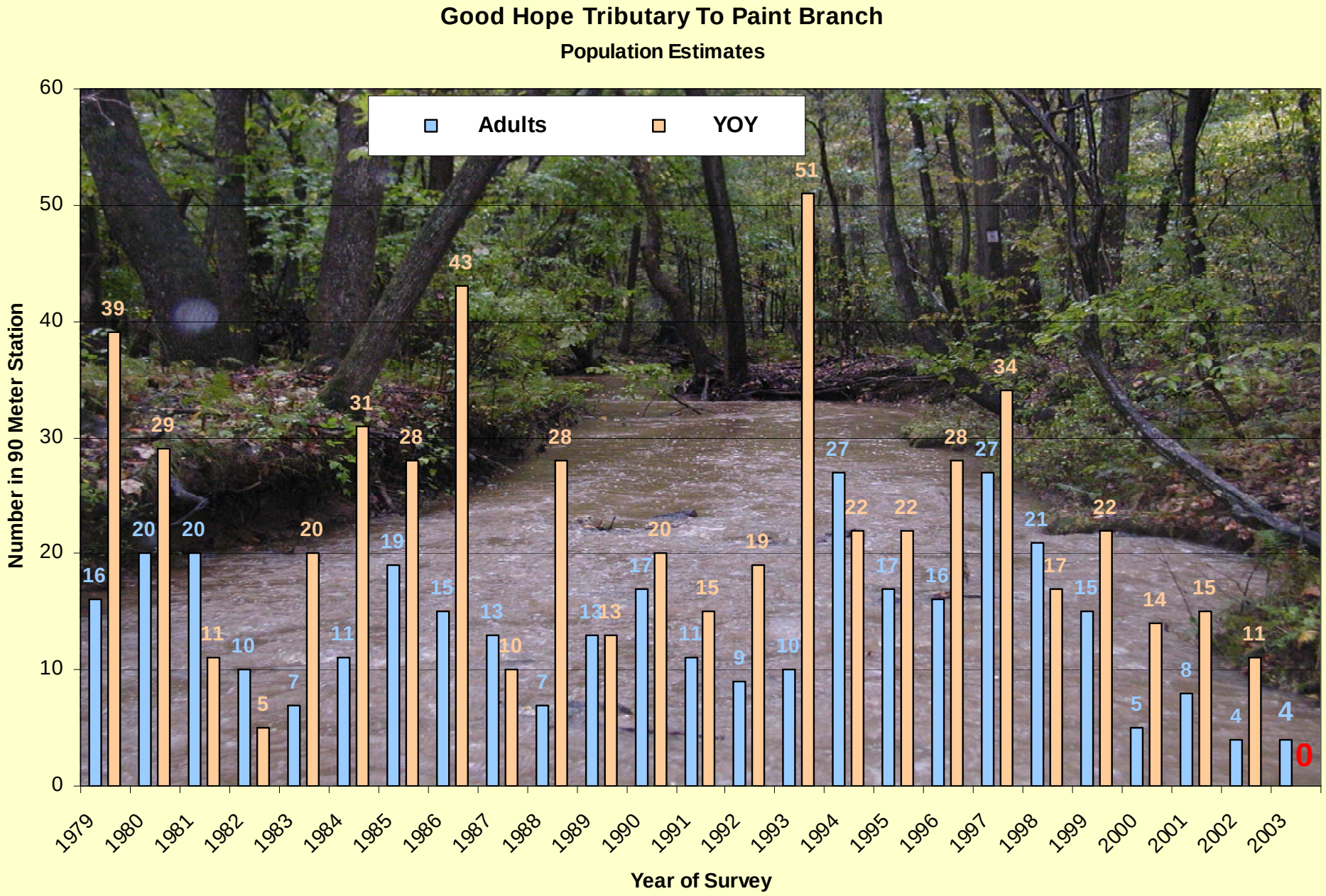
Enforcement

Maintenance

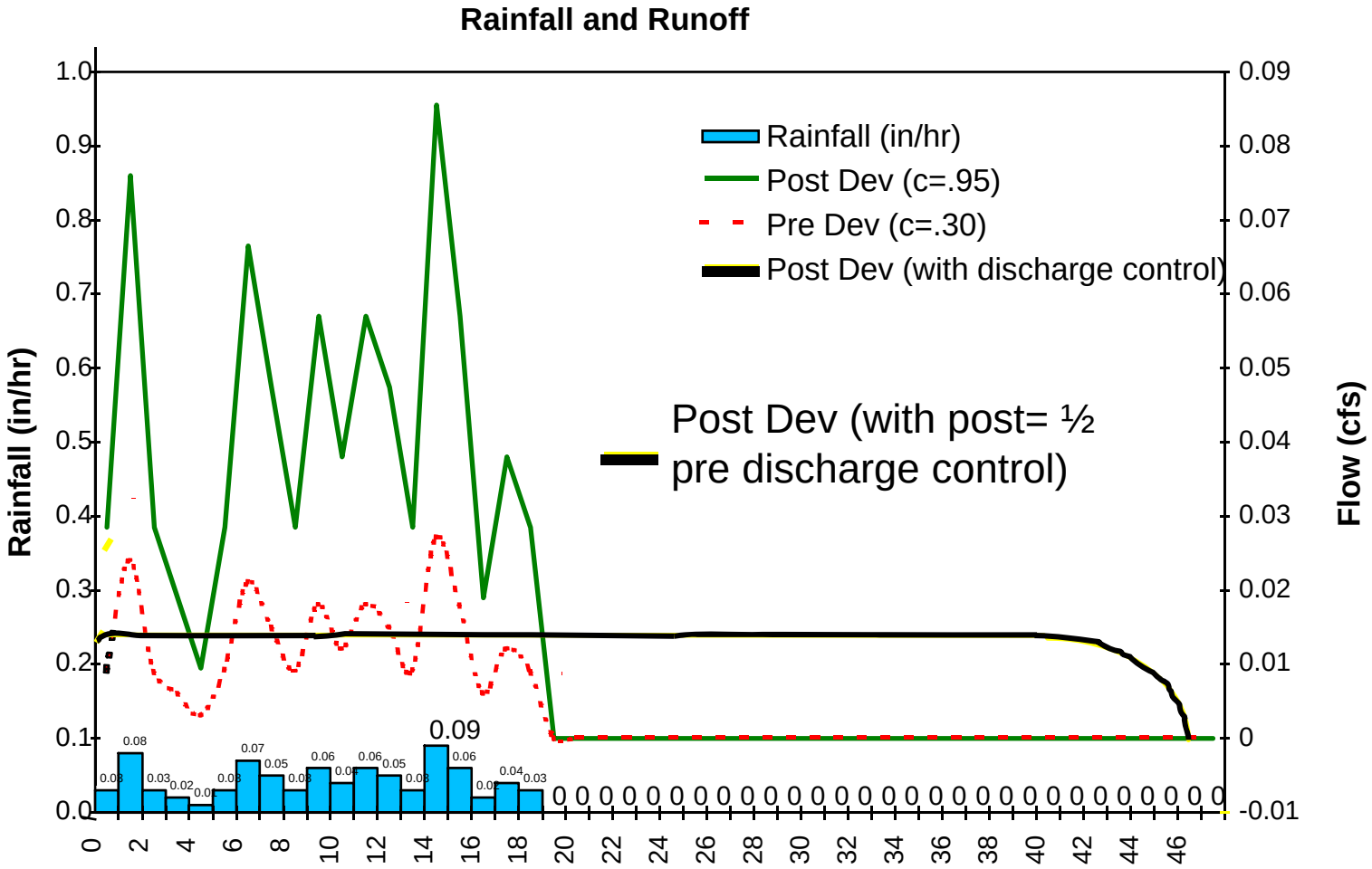
Limitations

- Environmental Impacts
- Loss of Space
- Costs
- Safety & Health Issues
- Maintenance Burdens
- Effectiveness ?

Conservation and Impact reduction Alone is Not Enough!



Hydrological Control - Urban Stormwater

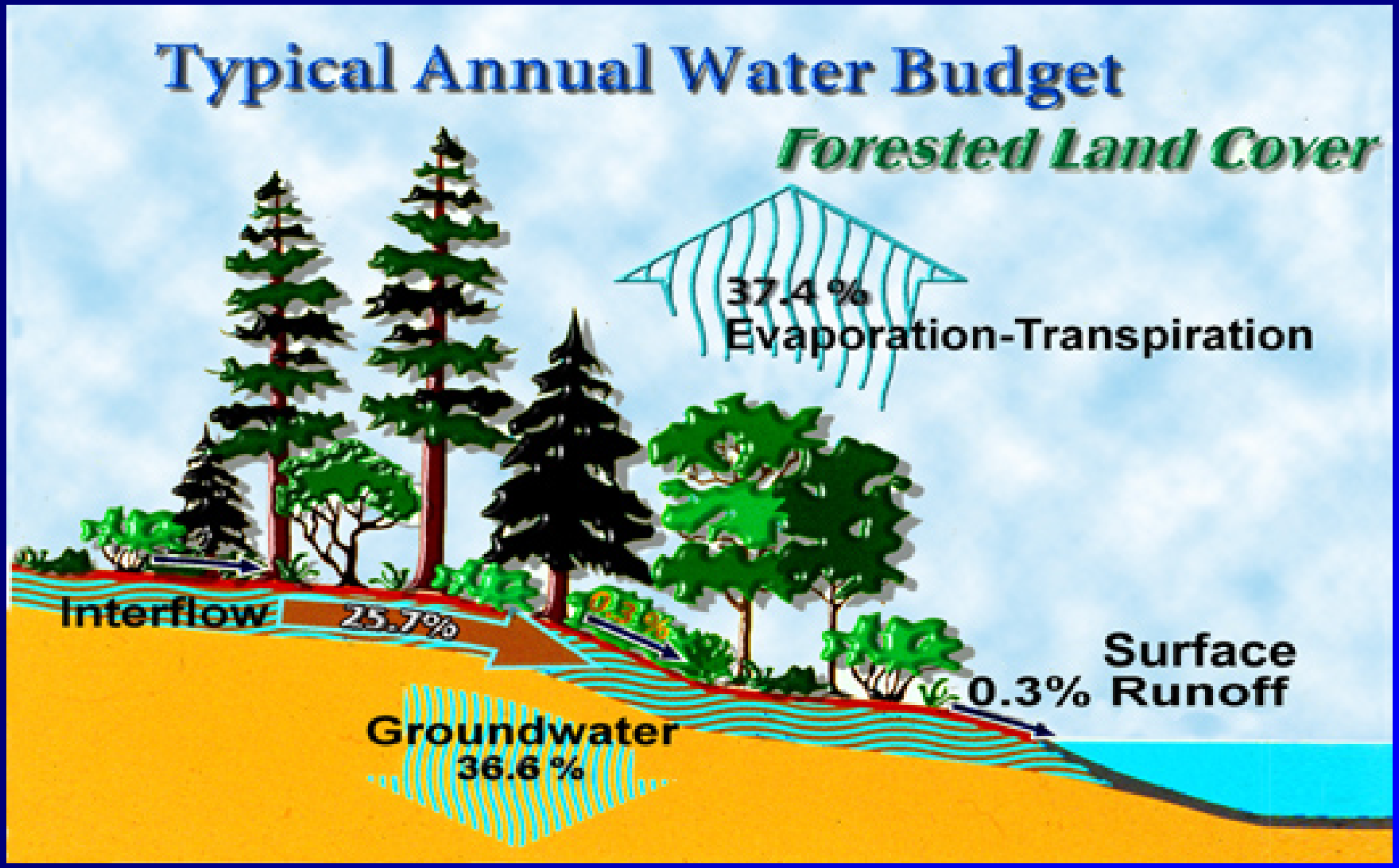


Post=1/2 Pre peak flow control for 1 to 2 year storms is also likely to worsen stream impacts!

Limitations of Conventional End-of-Pipe Stormwater Management

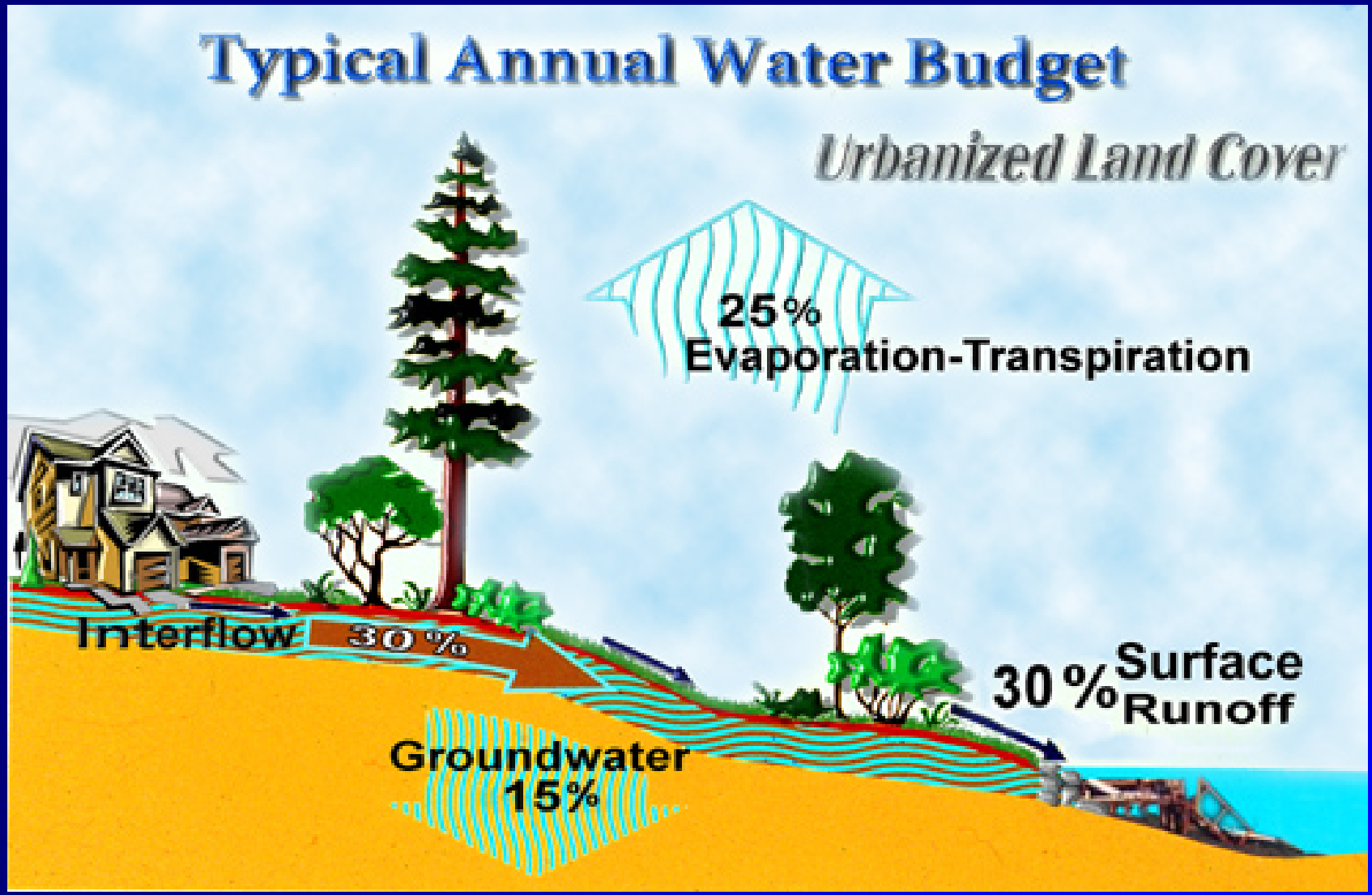
- Cumulative hydrodynamic modifications continue to cause degradation of receiving.
- Limited use for urban retrofit.

Natural Conditions



Courtesy May, U of W

Developed Conditions

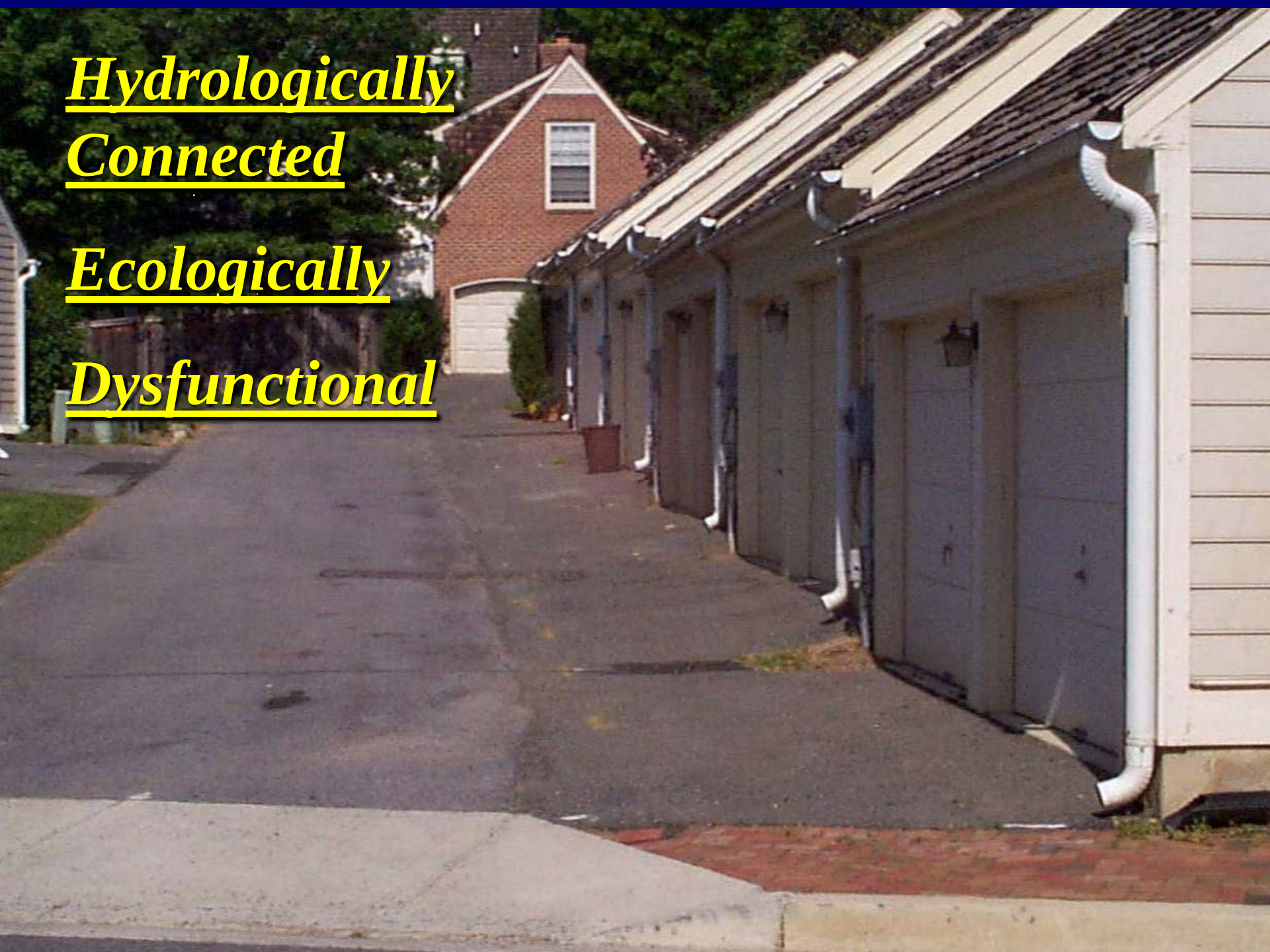


Courtesy May, U of W

The Problem: Conventional Site Design

Collect
Concentrate
Convey
Centralized
Control

Good Drainage Paradigm


Hydrologically Connected
Ecologically
Dysfunctional

Get the water away as fast as possible!

Highly Compacted Soils

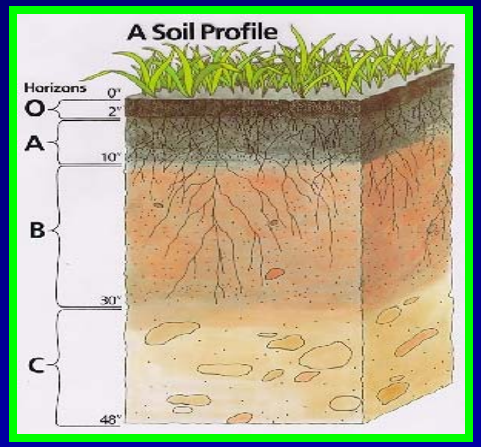
Soil Ecosystem Functions

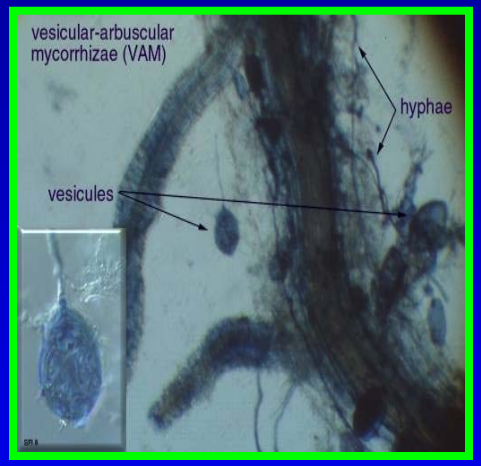
Physical / Chemical / Biological

1. **Hydrology**
   storage / evaporation / recharge / detention
2. **Storing Cycling Nutrients (bacteria / fungi)**
   phosphorous / nitrogen / carbon
3. **Water Quality**

   filter / buffer / degrade / immobilize
   detoxify organic and inorganic materials

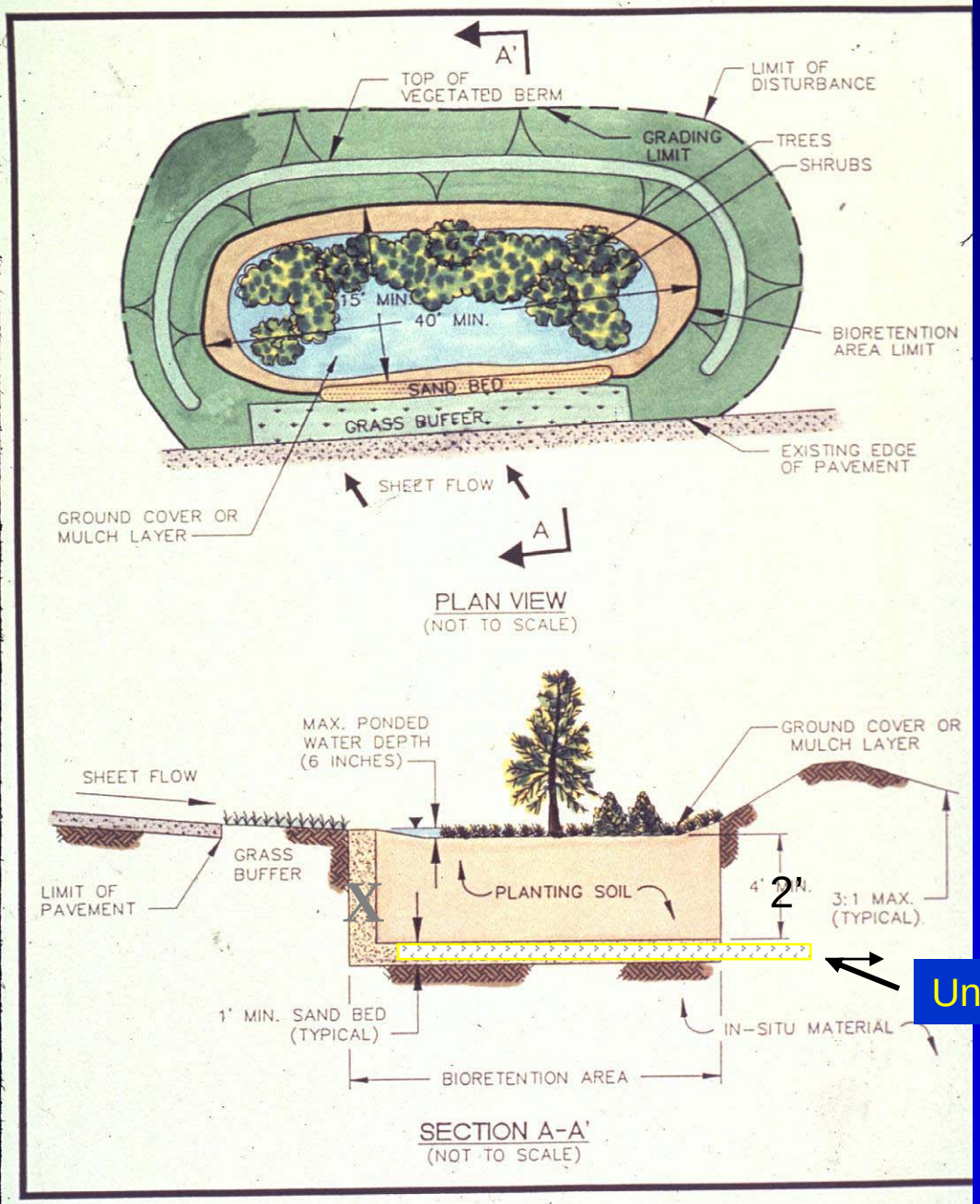
"Most diverse ecosystem in the world"





Hydrologically and Ecologically Dysfunctional

Urbanization Causes a Cumulative Loss of Terrestrial Ecological Processes and Functions Vital to the Protection of Aquatic Ecosystems.



PARKING EDGE AND PERIMETER WITHOUT CURB

Bioretention

- Shallow Ponding - 4” to 6”
- Mulch 3”
- Soil Depth 2’ - 2.5’
- Sandy Top Soil
  - 70% Sand
  - 20% Sandy Loam
  - 10% Compost
- Under Drain System
- Plant Selection

Pollutant Removal Bioretention Systems

- TSS - 95%
- Heavy Metals - 99%
- Oil and Grease - 95%
- Total Phosphorous - 80%
- Total Nitrogen - 40%
- Coliform - 80%
- Treat over 90% of total volume in less than 1% of the urban landscape.

Rain Gardens


Bioretention Urban
Quantity / Quality Control

Water Quality and Volume Control

LID Basics

Philosophy

Principles

Practices

Process

Low Impact Development Overview

- **New Philosophy**
  - **Maintaining Functional Relationships Between Terrestrial and Aquatic Ecosystems**
- **New Principles**
  - **Decentralized / At The Source Control**
  - **Distributed / Multi-functional / Multi-beneficial**
  - **Maintain the Water Balance**
- **Same Engineering Principles at Small Scale**
  - **Retain / Detain / Filter / Infiltrate / Treat / Prevent / Use**
- **New Process**

  Conserve / Minimize / Timing / Integrate Practices / Prevent

Key LID Principles ***"Volume"***

"Hydrology as the Organizing Principle "

- **Unique Watershed Design**
  - **Match Initial Abstraction Volume**
  - **Mimic Water Balance**
- **Uniform Distribution of Small-scale Controls**
- **Cumulative Impacts of Multiple Systems**
  - **filter / detain / retain / use / recharge / evaporate**
- **Decentralized / Disconnection**
- **Multifunctional Multipurpose Landscaping & Architecture**
- **Prevention**

Defining LID Technology

Major Components

1. Conservation (Watershed Scale)
2. Minimization (Lot Scale)
3. Strategic Timing (Watershed and Site Scale)
4. Integrated Management Practices (Site Scale)
   Retain / Detain / Filter / Recharge / Use
5. Pollution Prevention
   Traditional Approaches

1. Conservation Plans / Regulations

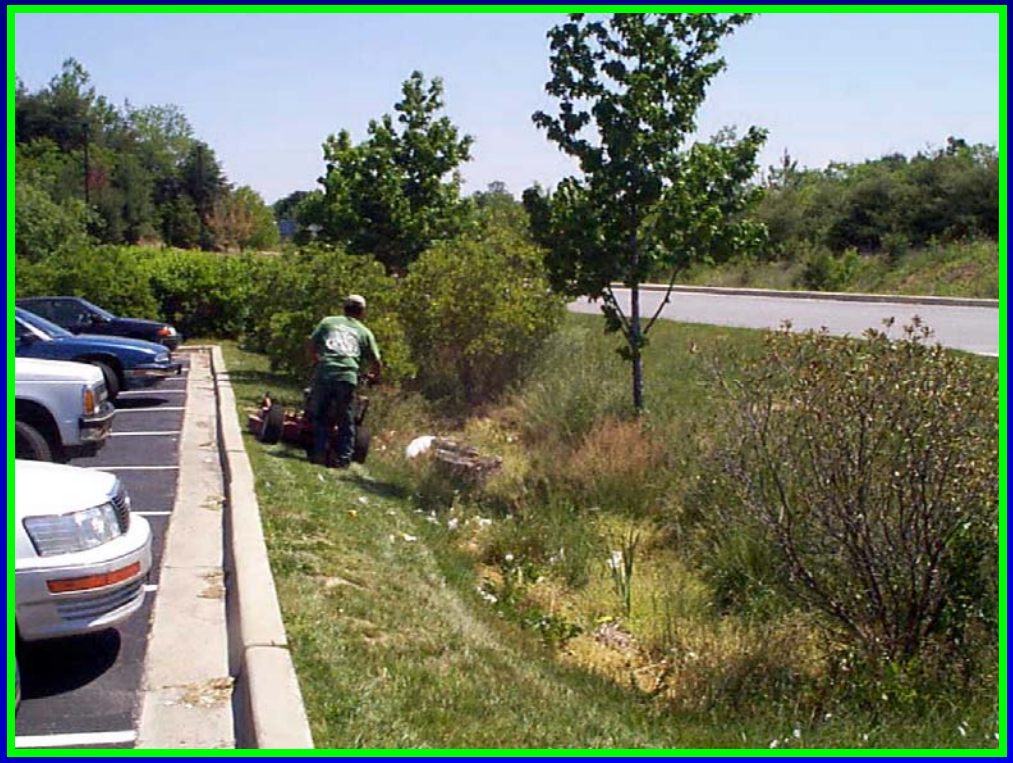
- **Local Watershed and Conservation Plans**
  - Forest (Contiguous and Interior Habitat)
  - Streams
  - Wetlands
  - Habitats
  - Step Slopes
  - Buffers
  - Critical Areas
  - Parks
  - Scenic Areas
  - Trails
  - Shorelines
  - Difficult Soils
  - Ag Lands
  - Minerals

Large and Small Scale

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

3. Maintain Time of Concentration



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

4. Storage, Detention & Filtration

"LID IMPs"

- 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****

1992 Somerset, Maryland - Rain Gardens
First Residential Application

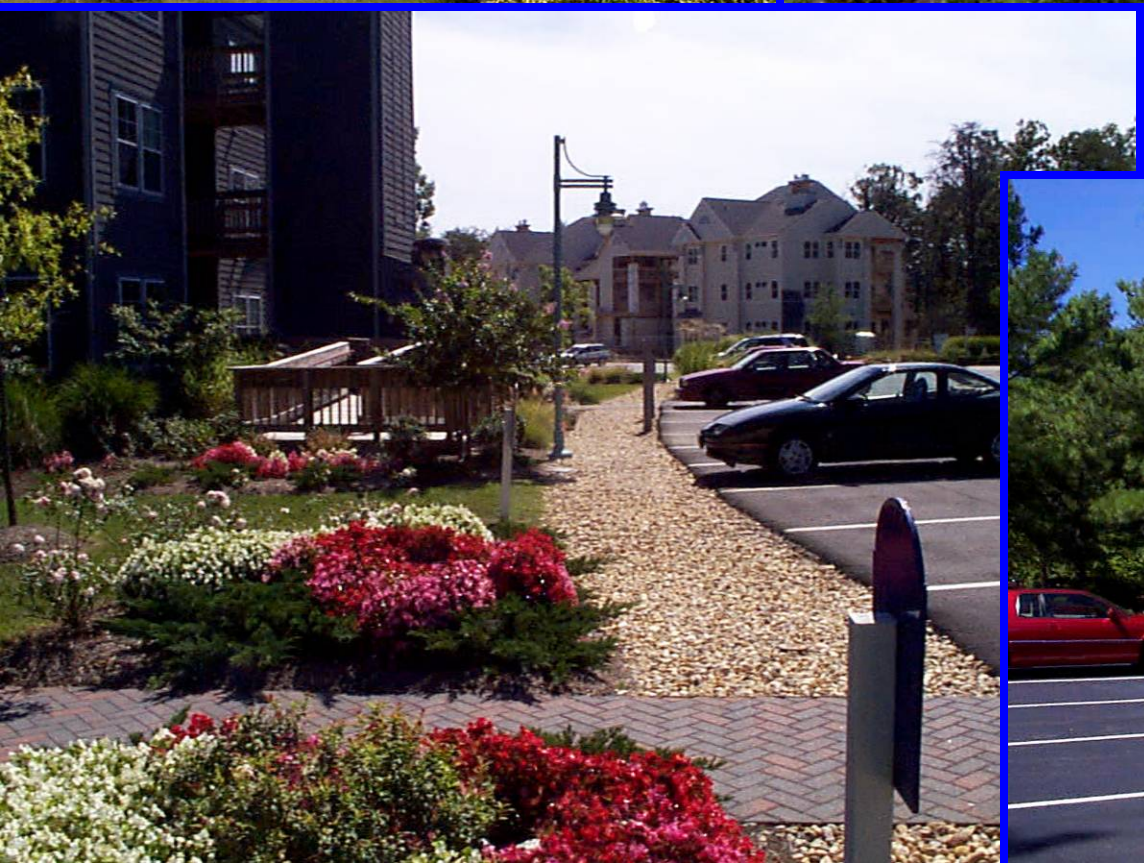
2008 Somerset, Maryland - Rain Gardens

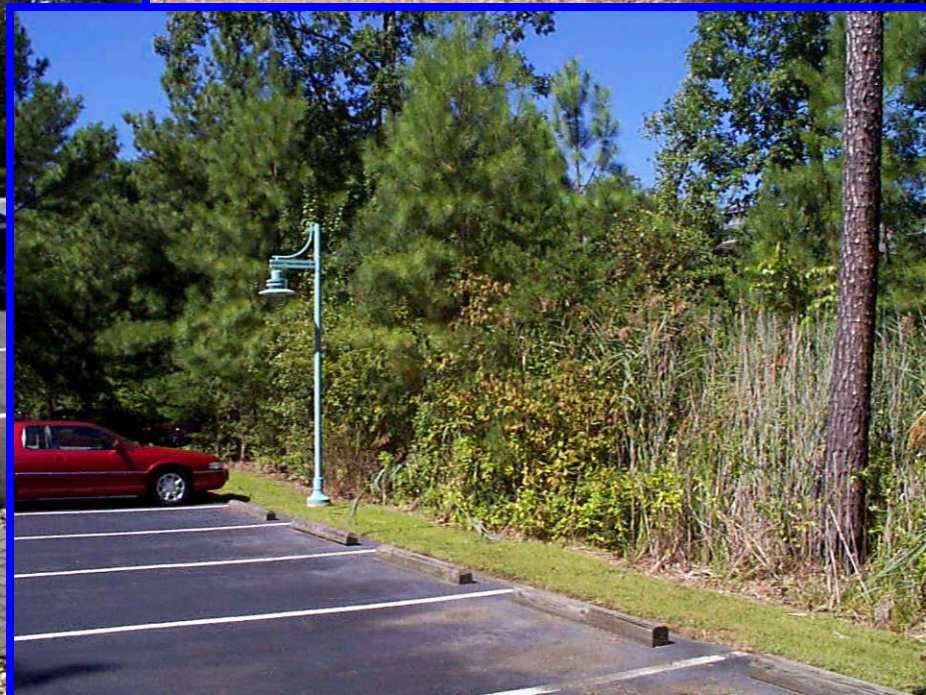
1992 Somerset, Maryland - Rain Gardens
First Residential Application

2008 Somerset, Maryland - Rain Gardens

VIEW OF LOT WITH STORAGE AND BIORETENTION


SOLOMON'S
LANDING





Rain is Resource

Capture & Use

Toilet Flushing
Car washing
Irrigation
Mixing
Washing
Gardening
Recharge

Benefits

Reduce Demand
Self-sufficiency
Save Money

Capture and Use

Manage Demand

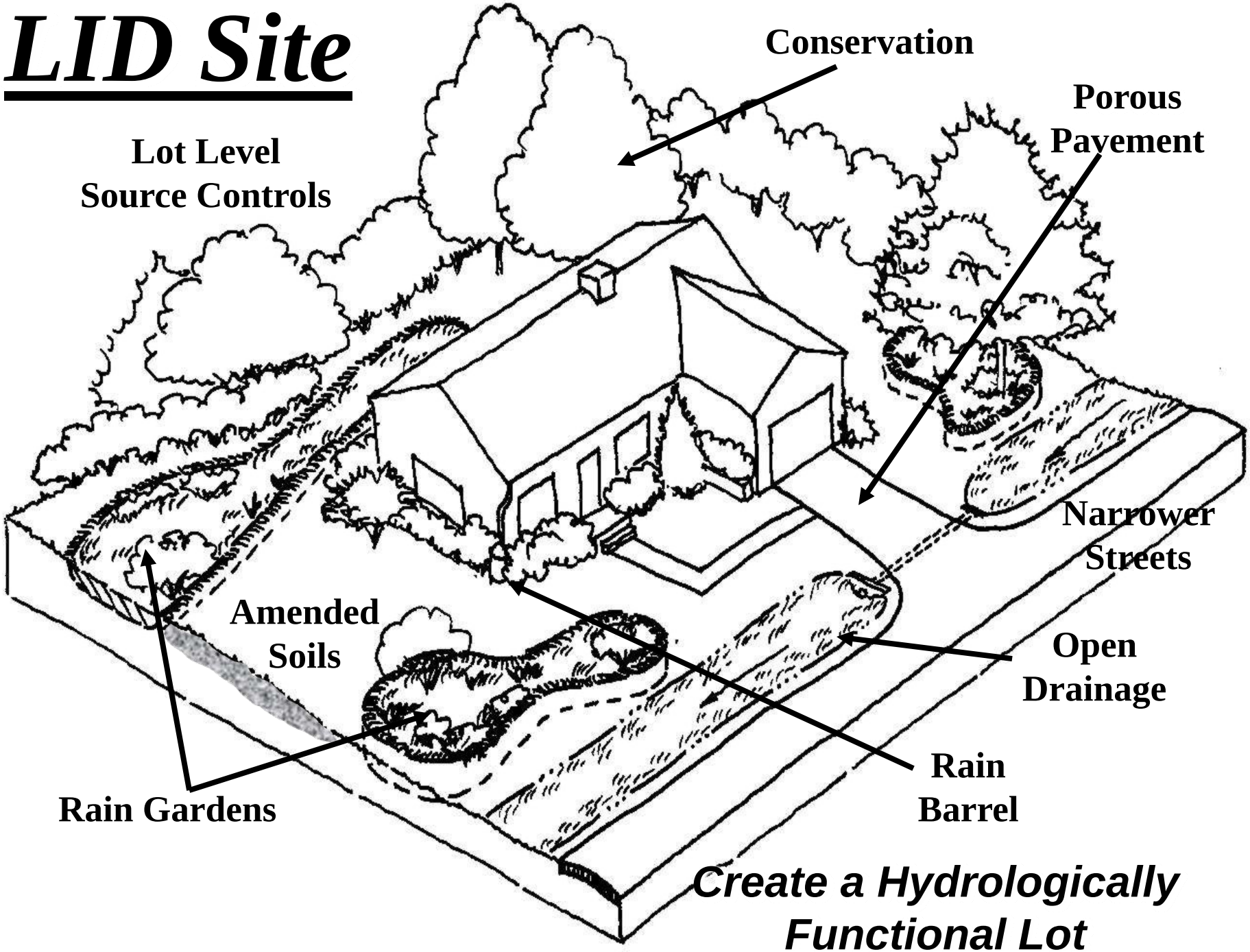
5. Pollution Prevention

30 - 40% Reduction in N&P

Kettering Demonstration Project

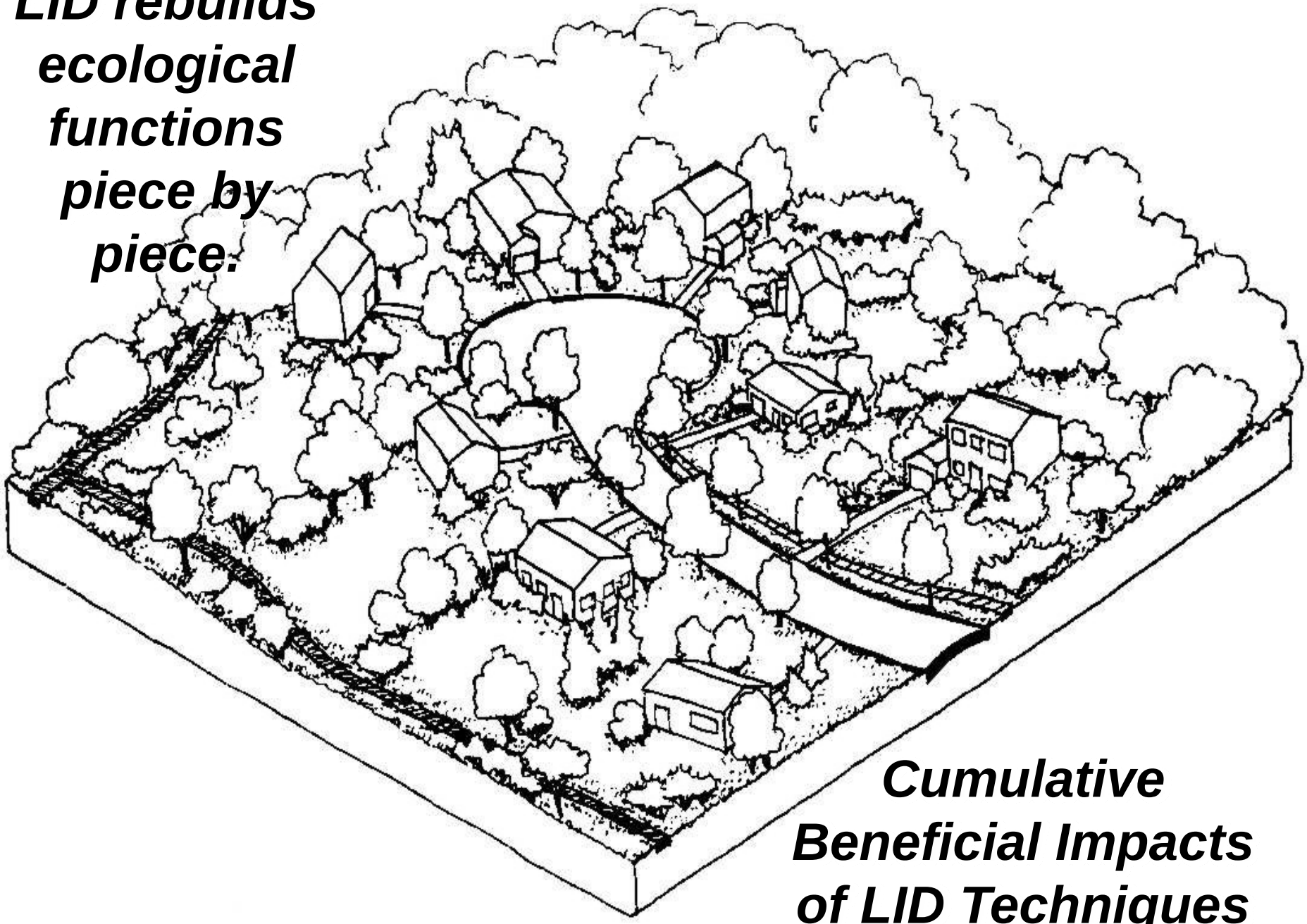
- Maintenance
- Proper use, handling and disposal
  - Individuals
    - Lawn / car / hazardous wastes / reporting / recycling
  - Industry
    - Good house keeping / proper disposal / reuse / spills
  - Business
    - Alternative products / Product liability

LID Site



Create a Hydrologically Functional Lot

LID rebuilds ecological functions piece by piece.

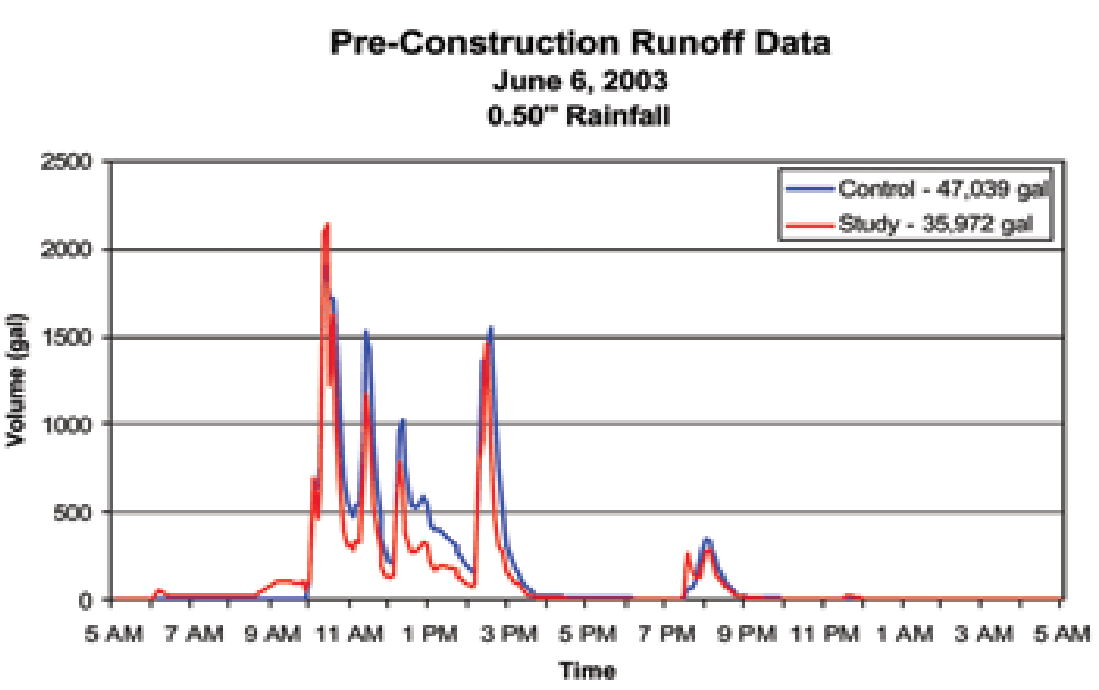


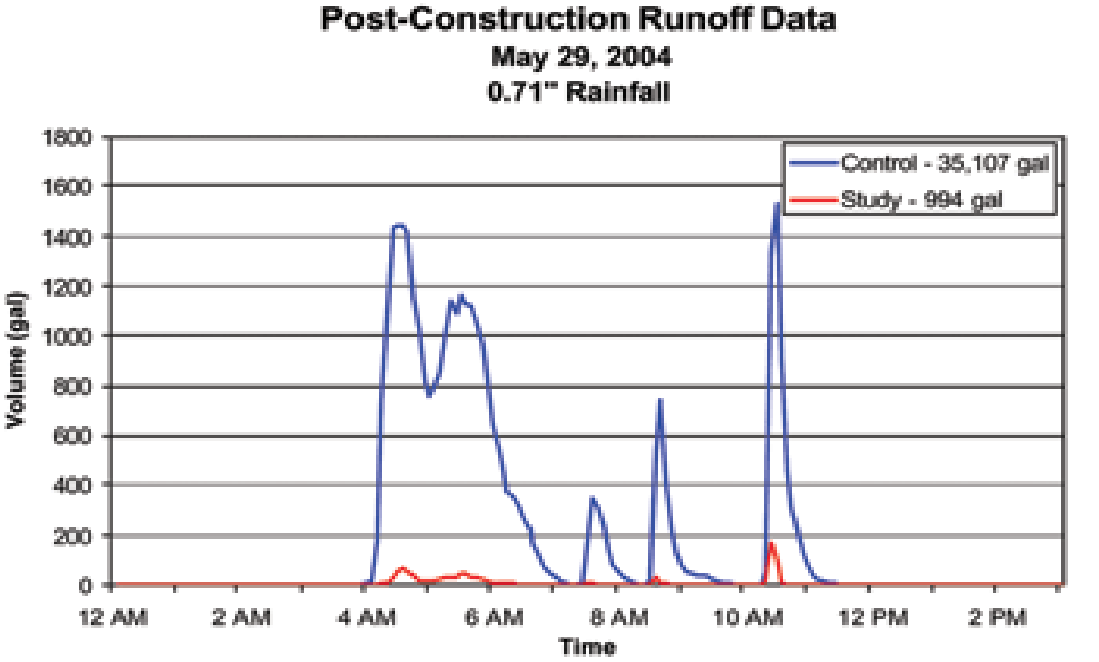
Cumulative Beneficial Impacts of LID Techniques

Burnsville, MN Rainwater Gardens

- **Urban Retrofit**
- **90% Runoff Reduction**
- **85% Participation**

For more information, contact Barr Engineering Company, 4700 W. 77th St., Suite 200, Minneapolis, MN 55435, (952)832-2600 or (800)632-BARR or Fax (952)832-2601.






Urban Development
Washington D.C.
Potomac River
Anacostia River

Urban LID Lot Level Control Opportunities

- Roofs
- Buildings
- Down Spouts
- Yards
- Sidewalks
- Parking Lots
- Landscape Areas
- Open space
- Amended Soils

Multifunctional Infrastructure

Retention

Detention

Filtration

Infiltration

Timing

Water Use

Prevention


MAY 29 2001

Buildings Design

Downspouts Disconnect / Water Use

Navy Yard Rain Garden

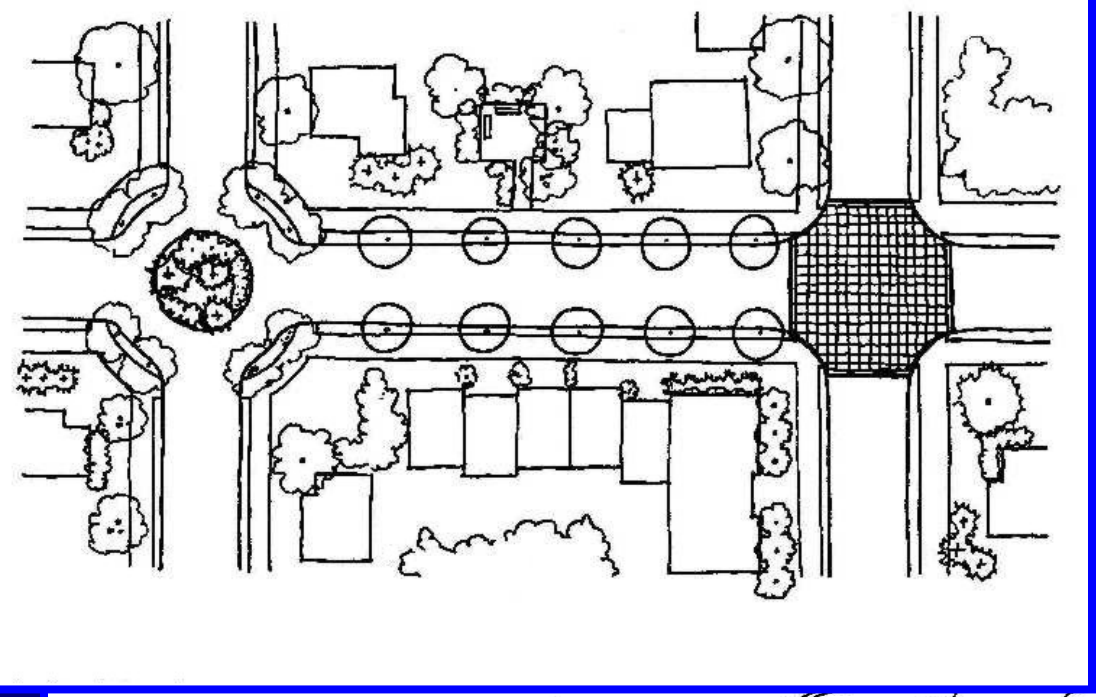
Buckman Heights courtyard with infiltration garden

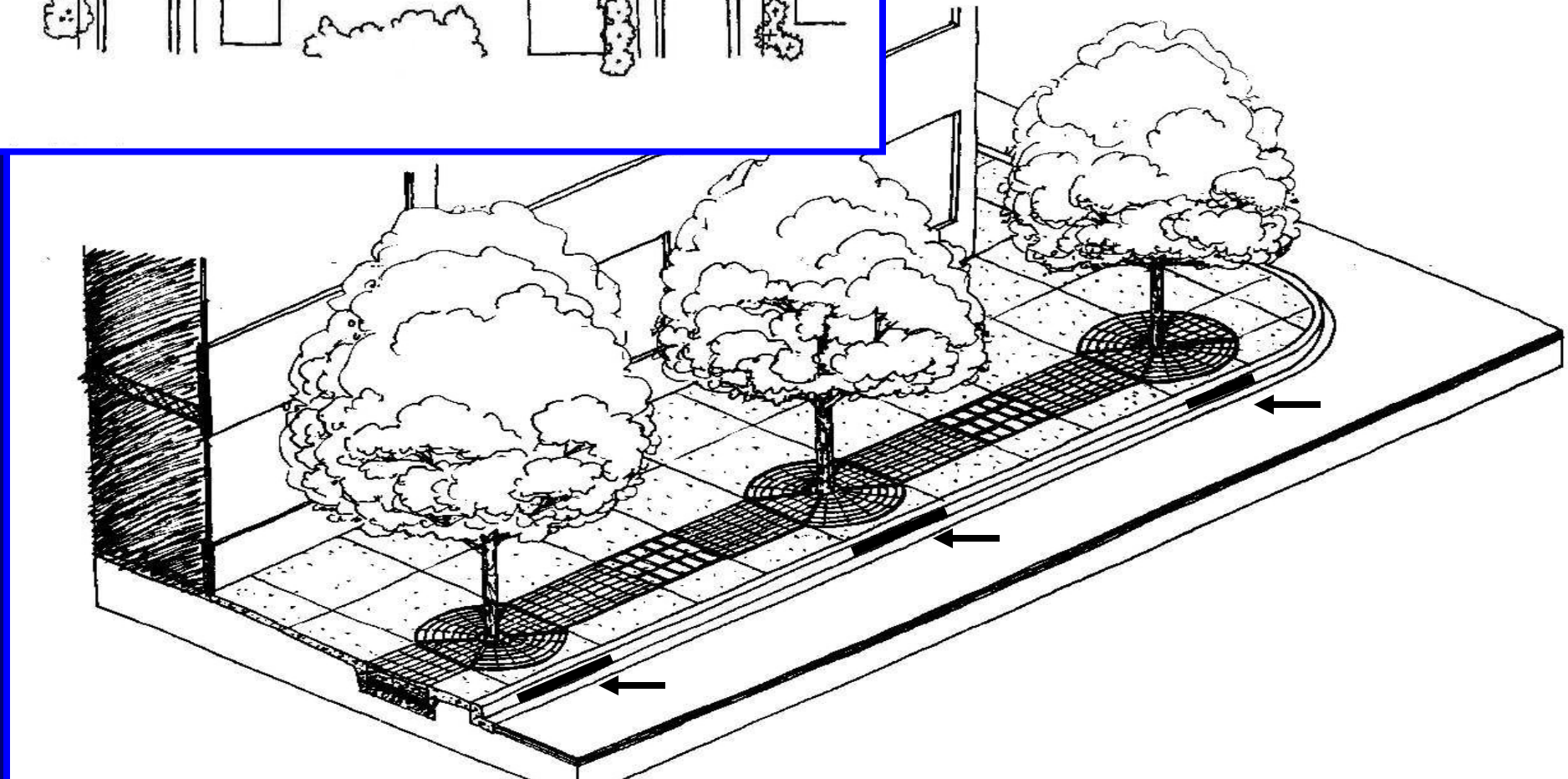
Buckman Heights Apartments – Infiltration garden

Rain Garden with turf grass alongside a parking lot in a highly urbanized area with an overflow device in the background.

Porous Pavement / Surfaces

Street Tree / Shrub Filters





Low Flow

Bioretention

High Flow

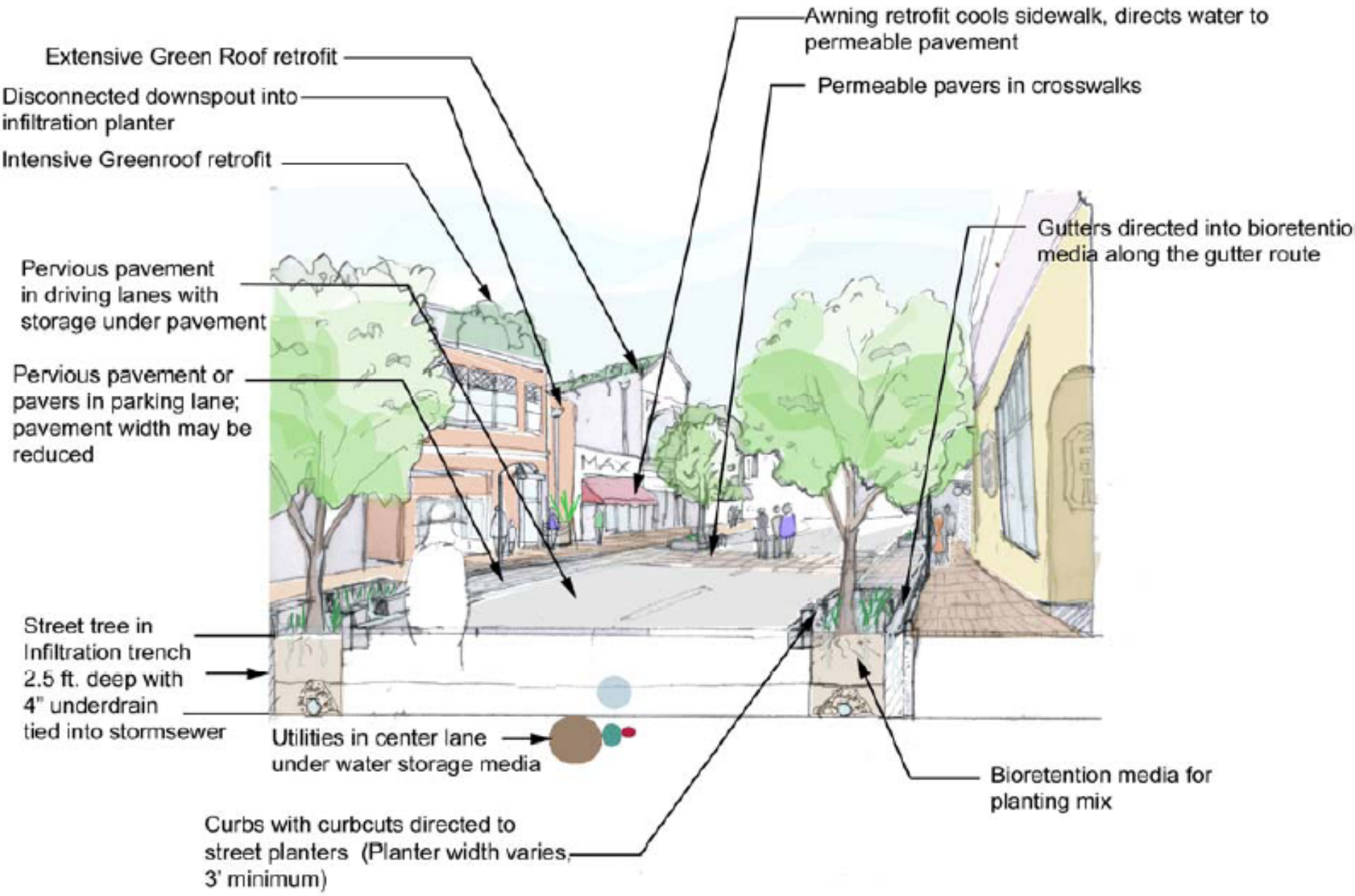
Bioretention


Navy Yard Tree Box

Disconnection

Capture

Use



Decentralized Stormwater Controls in Urban Retrofit Streetscape

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
- Amended soils
- Alternative materials
- Tree Box Filters
- Alternative Impervious 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
- Green Roofs
- Reforestation
- Pollution Prevention……..

Runoff Use

Possibilities & Opportunities

BIELINSKI DEVELOPMENT

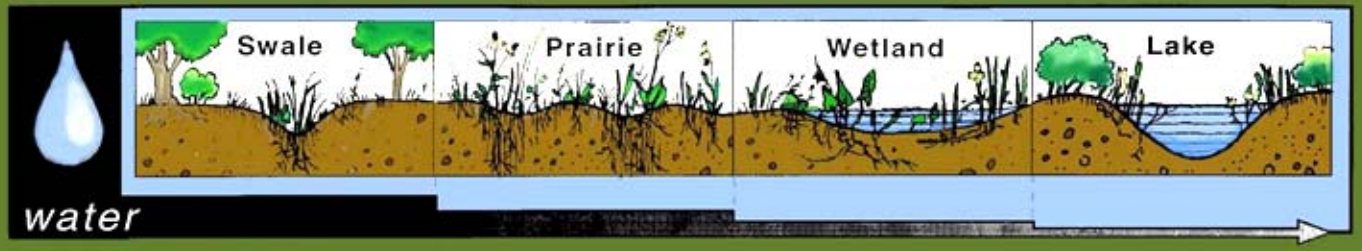
Perspectives on Implementing Low-Impact Developments since 1998

Waukesha, Wisconsin

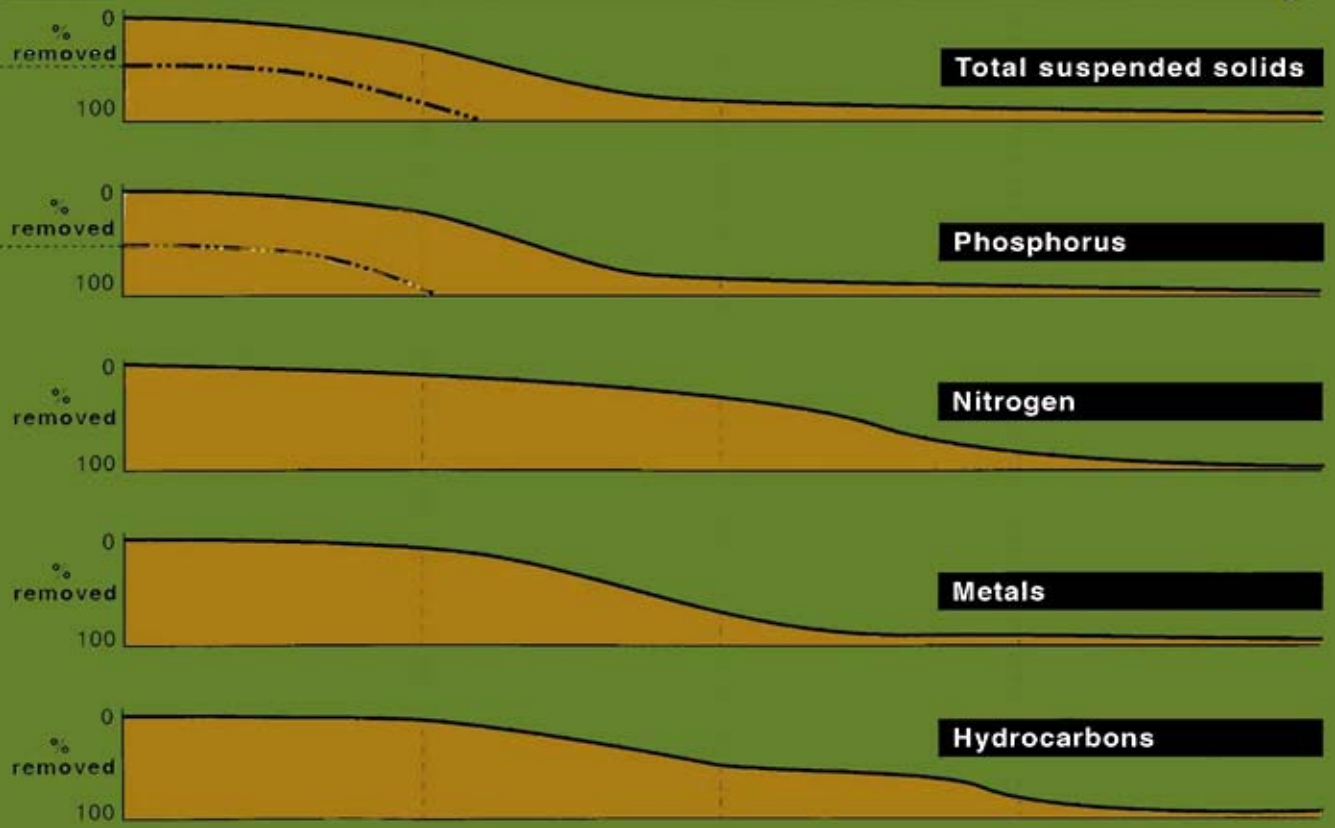
BIELINSKI
DEVELOPMENT

Use native species in restoring open spaces and in lot bioretetnion landscaping

Stormwater Treatment Train



Source management



BIELINSKI DEVELOPMENT

Home and Lot Sales

Conventional

Village of Jackson

Lot Size: 7,000 – 8,000 ft^2

Price: low-mid **$40,000**

Low Impact

Prairie Meadows

Lot Size: 7,000 – 8,000 ft^2

Price: mid-high **$50,000**

BIELINSKI DEVELOPMENT

Advantages of LID Over Conventional Design

Added Value of LID Results in:

- ***Lot Premiums***
- ***Increased Sales Velocity***
- ***Increased Sales Volume***
- ***Reduced Debt Service***
- ***Reduced Infrastructure Costs***

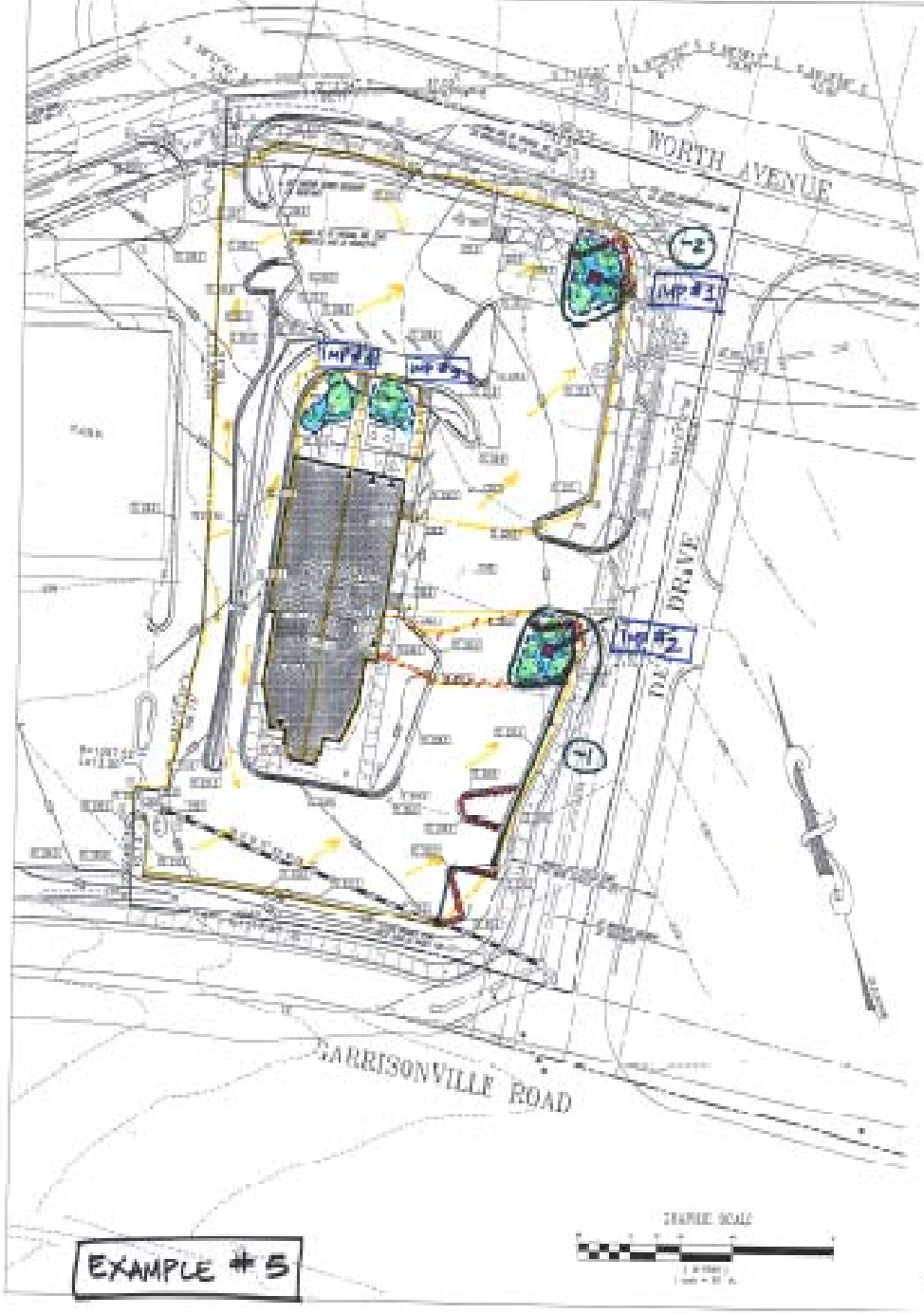
BIELINSKI DEVELOPMENT

Lessons Learned Nature Sells!

BIELINSKI DEVELOPMENT

Biggest Obstacles to LID

Local Ordinances
and
Knowledge / Experience
of
Local Building Officials
&
Consultants!



EXAMPLE #5

GRADING NOTES:

LEGEND

C3

Celebrate Virginia North
Low Impact Development
Design Scenario Calculations

10/10/2005

Site:	**Chick-Fil-A - Doc Stone**	
Example #:	5	
Site Classification	Restaurant	
Total Site Area (ac.)	1.2237	
Total Site Area (s.f.)	44,304	*to face of curb - does not include internal roac
Site Open Space (s.f.)	9,154	
% Open Space	20.7%	
Site Imperviousness (s.f.)	35,150	
Building Area (s.f.)	4,211	
Non-Bldg Impervious Area (s.f.)	30,939	

	IMP#1	IMP#2	IMP#3	IMP#4
Non-Bldg Area Draining to IMP (s.f.)	16,150	10,600	875	875
Non-Bldg Impervious Draining to IMP (s.f.)	14,858	9,540	150	150
1XWQV (cu.ft.)	619	398	6	6
2XWQV (cu.ft.)	1,238	795	13	13
IMP Treatment Area (s.f.)	616	560	150	150
Required Depth (1xWQV) (in.)	12.1	8.5	0.5	0.5
Required Depth (2xWQV) (in.)	24.1	17.0	1.0	1.0
Building Area Draining to IMP (s.f.)	0	0	2,105	2,105
Required Depth (1xWQV) (in.)	12.1	8.5	7.5	7.5
Required Depth (2xWQV) (in.)	24.1	17.0	15.0	15.0
Total IMP Area (s.f.)	1,326			
Total Imperviousness Treated (s.f.)	28,908			
% Site Treated	73.8%			
% Imperviousness Treated	82.2%			
% Parking/Loading Area Treated	92.1%			

Cost Reductions

	Quantity	Unit	Unit Cost	Cost
Curb	40	l.f.	$13.50	$540.00
Storm Piping	0	l.f.	$25.00	$0.00
Roof Drain Piping	0	l.f.	$12.50	$0.00
Inlets	0	ea.	$1,200.00	$0.00
Stormceptor	1	ea.	$12,000.00	$12,000.00
Subtotal				**$12,540.00**

Cost Additions

	Quantity	Unit	Unit Cost	Cost
Curb	0	l.f.	$13.50	$0.00
Curb Blocks	0	ea.	$40.00	$0.00
Storm Piping	20	l.f.	$25.00	$500.00
Inlets	0	ea.	$800.00	$0.00
Underdrains	50	l.f.	$12.50	$625.00
Soil	123	c.y.	$25.00	$3,069.44
Mulch	13	c.y.	$25.00	$331.50
Vegetation	1,326	s.f.	$1.75	$2,320.50
Subtotal				**$6,846.44**

Net Cost Difference		**($5,693.56)**
Increased Property Area (ac.)		0
Land Cost		**$0.00**
Net Change in Parking Spaces	-3	

LID Case Study: The Madera Subdivision

Glenn Acomb, ASLA
Department of Landscape Architecture
Program for Resource Efficient Communities
University of Florida

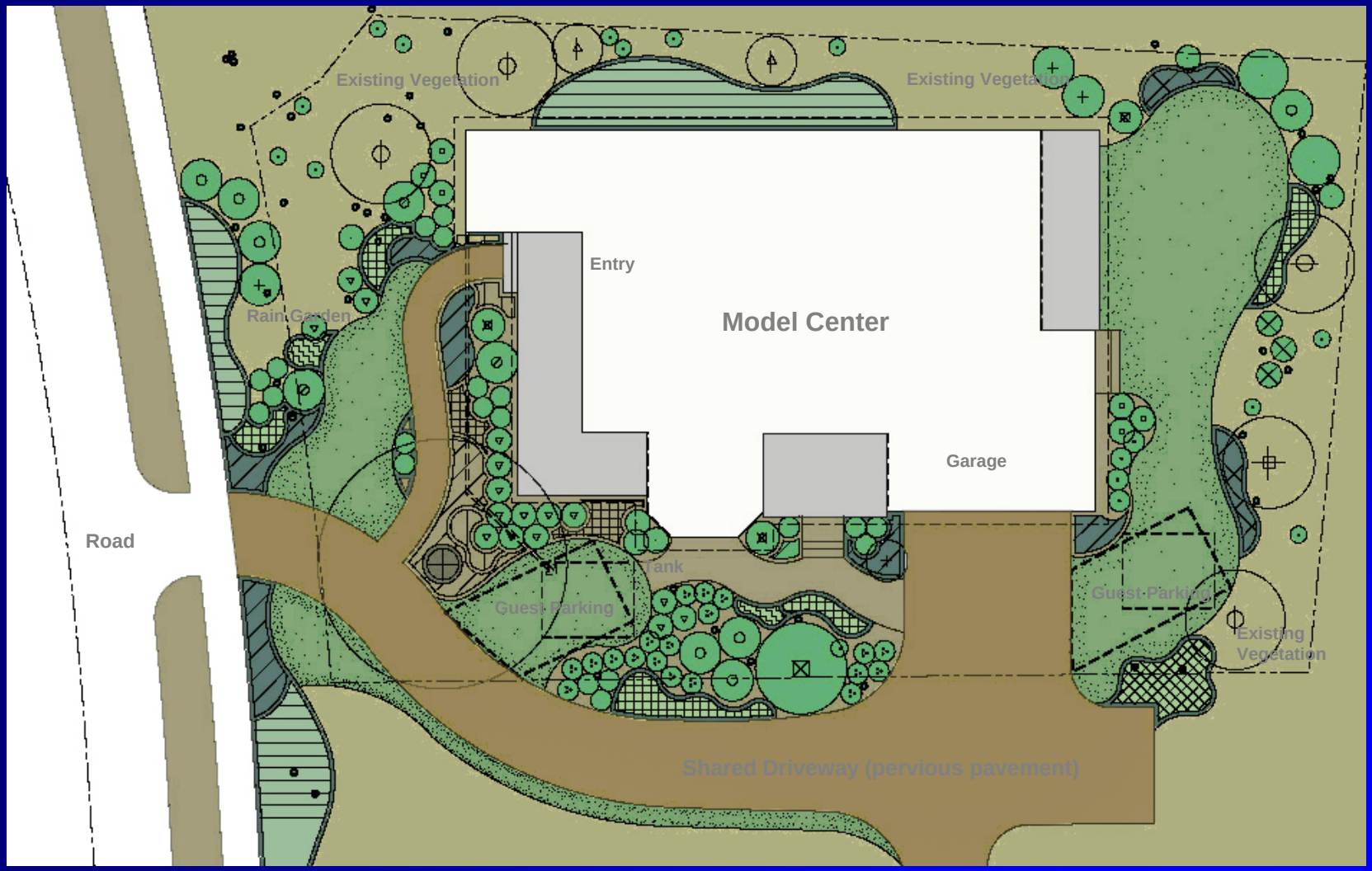
April 5, 2007

Sustainable Design Techniques for the Lot:

Design Techniques of the Model

- Limited clearing of site
- Limited turf (35% of conventional)
- Limited irrigation (50%); low-volume design
- Limited impervious cover (encouraged) - Pervious pavers for driveway & sidewalk and shared driveway for some lots
- Zero discharge of stormwater – Capture of 1/3 roof stormwater to an infiltration tank; water garden in front yard natural area
- Use of natives and “Florida Friendly” plants; SJRWMD & Florida Yards & Neighborhood support
- Retained snags in rear yard buffer
- Model home displays an array of green products

Madera Model Center Landscape Design



Madera Model Center

Shared driveway and pavers

Permeable pavers

Model front yard

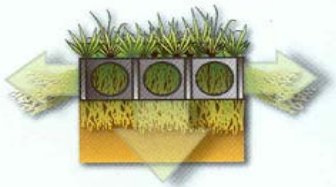
Native plant information

Madera Site Details

Turf reinforcing in spare parking areas

Benefits...

- **Surface Temperature**
  Reduces surface temperature around buildings.
- **Permeable Surface**
  Permits surface water filtration / drainage.
- **No Surface Drains Required**
  e.g. concrete pits, grated trench drains.
- **High Load Bearing**
  148.58 t /m² Unconfined.
- **Recharges Water Table**
  Replenishes water supply to landscaped areas.
- **Easy to Install**
- **Rigid Clipping System**
  Unique easy to use interlocking system.



Turf Cell® grass reinforcement structure allows horizontal & vertical root growth.

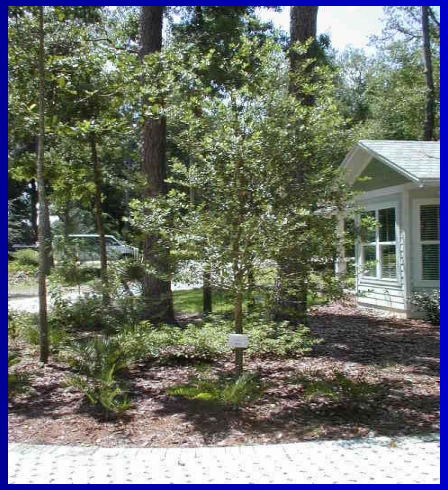
Eco-Stone pervious pavers in driveway

Roof stormwater infiltration tank under spare parking

Madera Model Center

Front yard and Shumard Oak

Rain Garden



Model side yard

Water conservation information

Madera Home 2005

Front-loading garage; very limited turf; extensive mulch; rain garden

Comparison with Conventional:

Site Design Techniques for the Lot

Capital Costs: **(2003/2004 dollars)**

Task	Sustainable	Conventional	Sustainable Savings
Clearing/Grading	$1,612.00	$2,016.00	$400.00
Utility Connection	same	same	--0--
Natural Area Mulch	$245.00	$90.00	($155.00)
Landscape Area Mulch	$665.00	$406.00	($259.00)
Landscaping	$6,485.00	$6,485.00	--0--
Turf	$720.00	$2,331.00	$1,611.00
Irrigation	$1,275.00	$1,500.00	$225.00
Driveway*	$6,084.00	$7,584.00	varies with material
Infiltration Tank	$1,032.00	--0--	($1,032.00)
Turf Reinforcing for Parking	$845.00	--0--	($845.00)
SUB TOTAL	$18,963.00	$20,412.00	*

** Note:*

The driveway, if not shared, would cause an advantage of $5,294 in favor of the Conventional. If so, only in the maintenance per annum can the costs be recovered (in less than 3 years). Also, there should also be an adjustment of capital cost of the project-wide stormwater savings of reduced pond size due to the zero discharge at the lot (approx. $1,000 saved per lot).

Comparison with Conventional:

Site Design Techniques for the Lot

Maintenance Costs: (annual costs, 2003/2004 dollars)

Task	Sustainable	Conventional	Sustainable Savings
Landscape service (incl. mowing)	$1,470.00	$3,150.00	$1,680.00
Pesticide applications by service	$200.00 (IPM)	$300.00	$100.00
Irrigation	$71.84 [31,602 gal.]	$167.51 [74,120 gal.]	$115.67
SUB TOTAL	**$1,721.84**	**$3,617.51**	**$1,895.67**

Result: *The approach to the maintenance considers 42 landscape maintenance visits to the residential site and 5 visits for application of pesticide. Also there would be increased maintenance of the project-wide stormwater pond due to the greater depth of pond and greater accumulation of silt, debris and noxious plants in the bottom.*