

Low Impact Development Site Planning and Design

Scott Millar

Planning and Development Office

RIDEM

Smart Development for a Cleaner Bay Act

Use LID as the primary method of
stormwater management

Stormwater Manual Standard No. 1

“LID Site Planning and Design Strategies must be used to the maximum extent practicable...”

Goal 1: Avoid the impacts to natural features and predevelopment hydrology

Objective 1. Protect open space to maintain hydrology

Objective 2. Protect surface waters, wetlands, and buffers

Objective 3. Minimize clearing and grading

Objective 4. Reduce soil compaction

Goal 2: Reduce runoff volume and increase groundwater recharge

Objective 5. Maintain native vegetation to minimize lawns, fertilizers, and pesticides

Objective 6. Minimize impervious surfaces

Goal 3: Manage the impacts at the source

Objective 7. Infiltrate precipitation as close as possible to the point it reaches the ground

Objective 8. Break up or disconnect the flow of runoff over impervious surfaces



Goal 3: Manage the impacts at the source

Objective 9. Provide source controls to minimize stormwater pollutants



Objective 10. Revegetate previously cleared areas

Past Stormwater Management





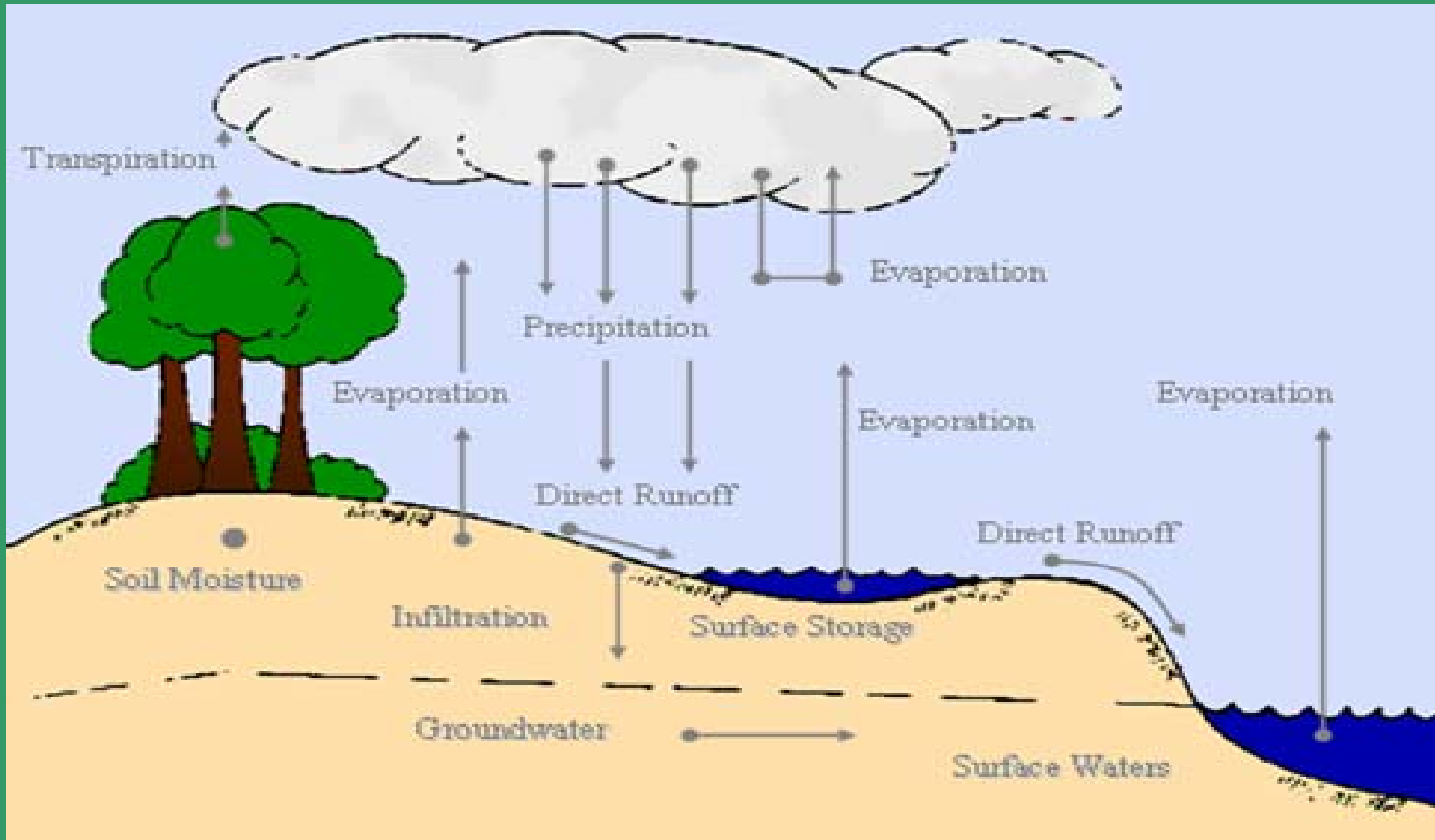
AVOID

REDUCE MANAGE

Why should communities avoid and reduce impacts?

- Community character is preserved
- Local flooding is reduced
- Saves money

Natural Hydrology



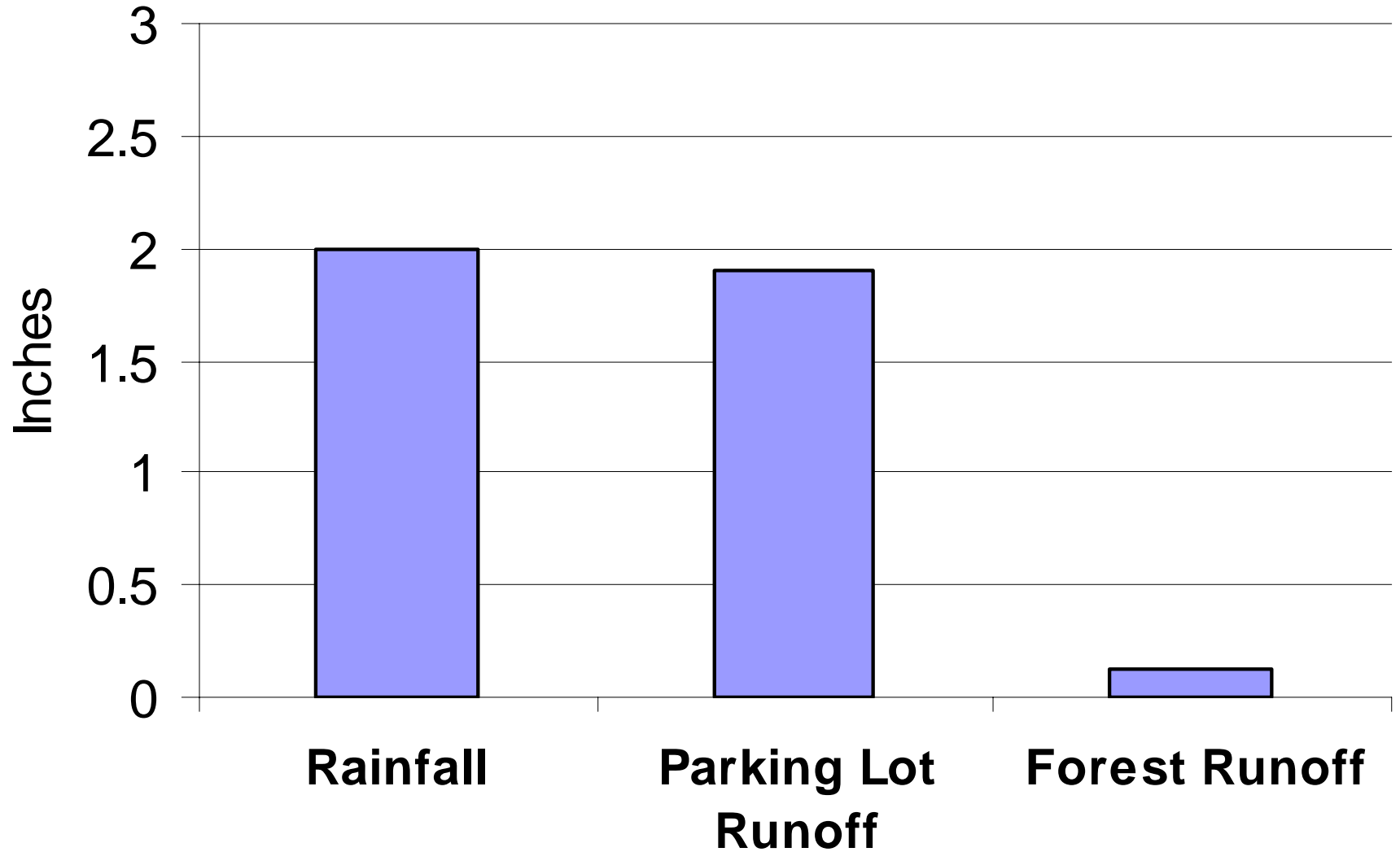
Maintain Pre-development Hydrology



Altered Hydrology



Center for Watershed Protection



Impervious Cover Impacts

- 1. Hydrology Impacts**
- 2. Physical Impacts**
- 3. Biological / Habitat Impacts**
- 4. Water Quality Impacts**
- 5. Health Impacts**

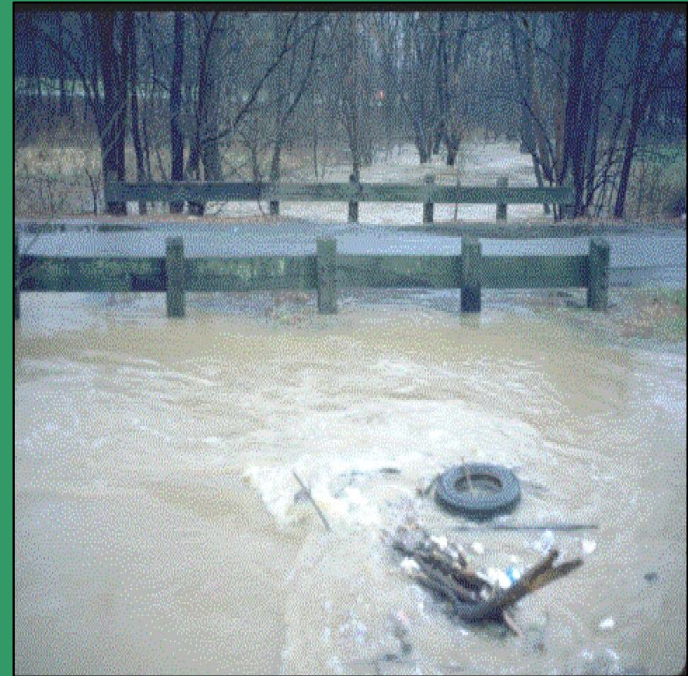
Impervious Cover Influences Wet Weather Stream Flow



Impervious Cover Influences Wet Weather Stream Flow



More Frequent Flooding



Higher Flood Levels


Impervious Cover Influences Dry Weather Stream Flow




Impervious Cover

Physical Impacts

- Channel enlargement
- Riparian cover reduced
- Warmer stream temperatures




Watershed with
less than 5%
impervious cover.

A photograph of a stream in a forest. The stream flows through a wooded area with many trees and fallen leaves on the ground. The water is clear and reflects the surrounding greenery. In the top right corner, there is a white text box with a black border containing the text: "Watershed with 10% impervious cover."

Watershed with 10%
impervious cover.

Watershed with 20%
impervious cover.

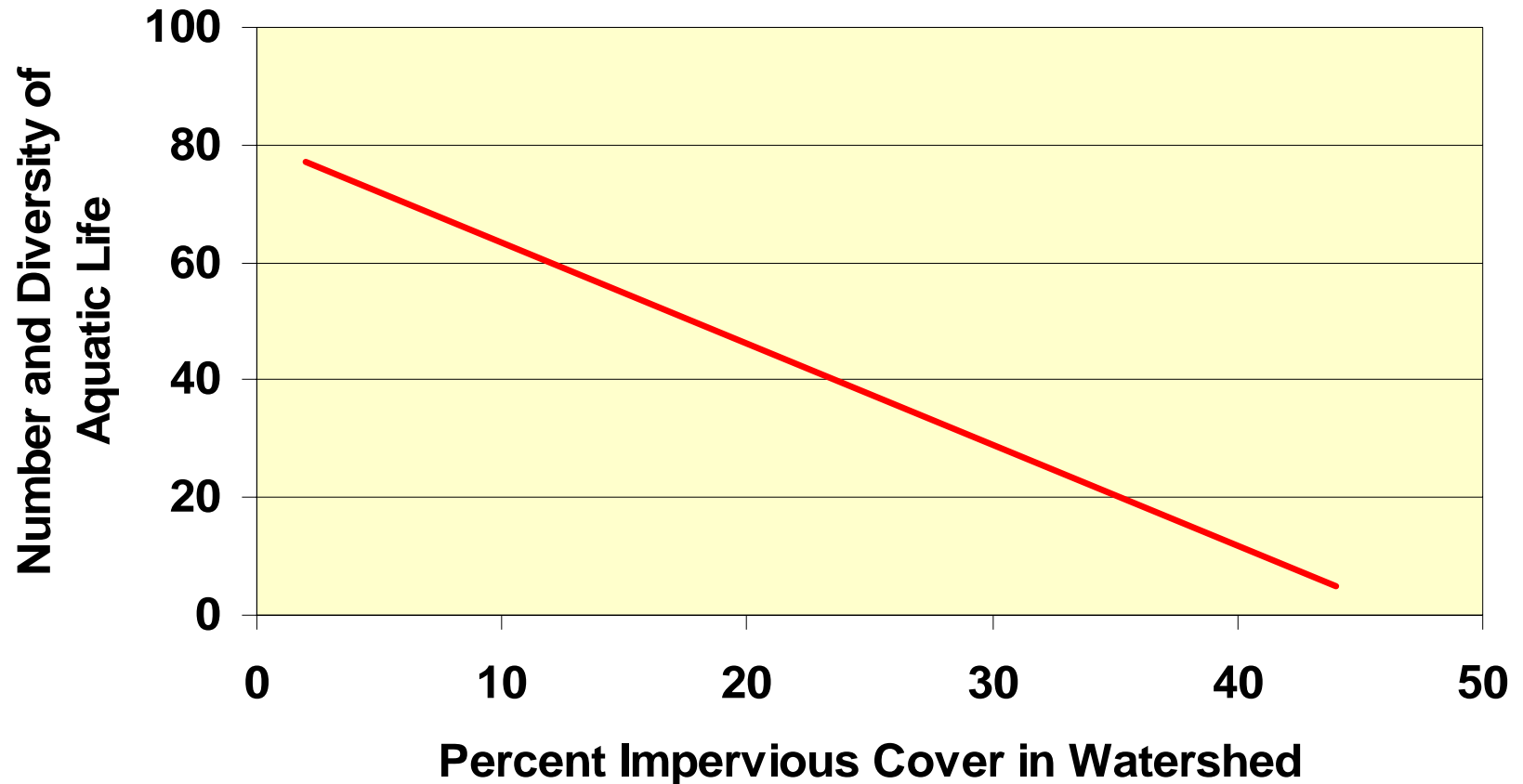


A photograph of a stream in a wooded area. The stream flows over a bed of rocks and pebbles. The water is dark and appears somewhat turbid. The surrounding forest is dense with trees, many of which are bare, suggesting a late autumn or winter setting. There is some debris, including what looks like a white plastic bag, on the rocky bank in the foreground. The overall scene depicts a natural waterway in a forested watershed.

Watershed with 30% impervious cover.

Impervious Cover Impacts

Biological / Habitat



Impervious Cover Impacts Water Quality



Impervious Cover Impacts

Health

Harmful pollutants in runoff include:

Bacteria

Nutrients

Pesticides

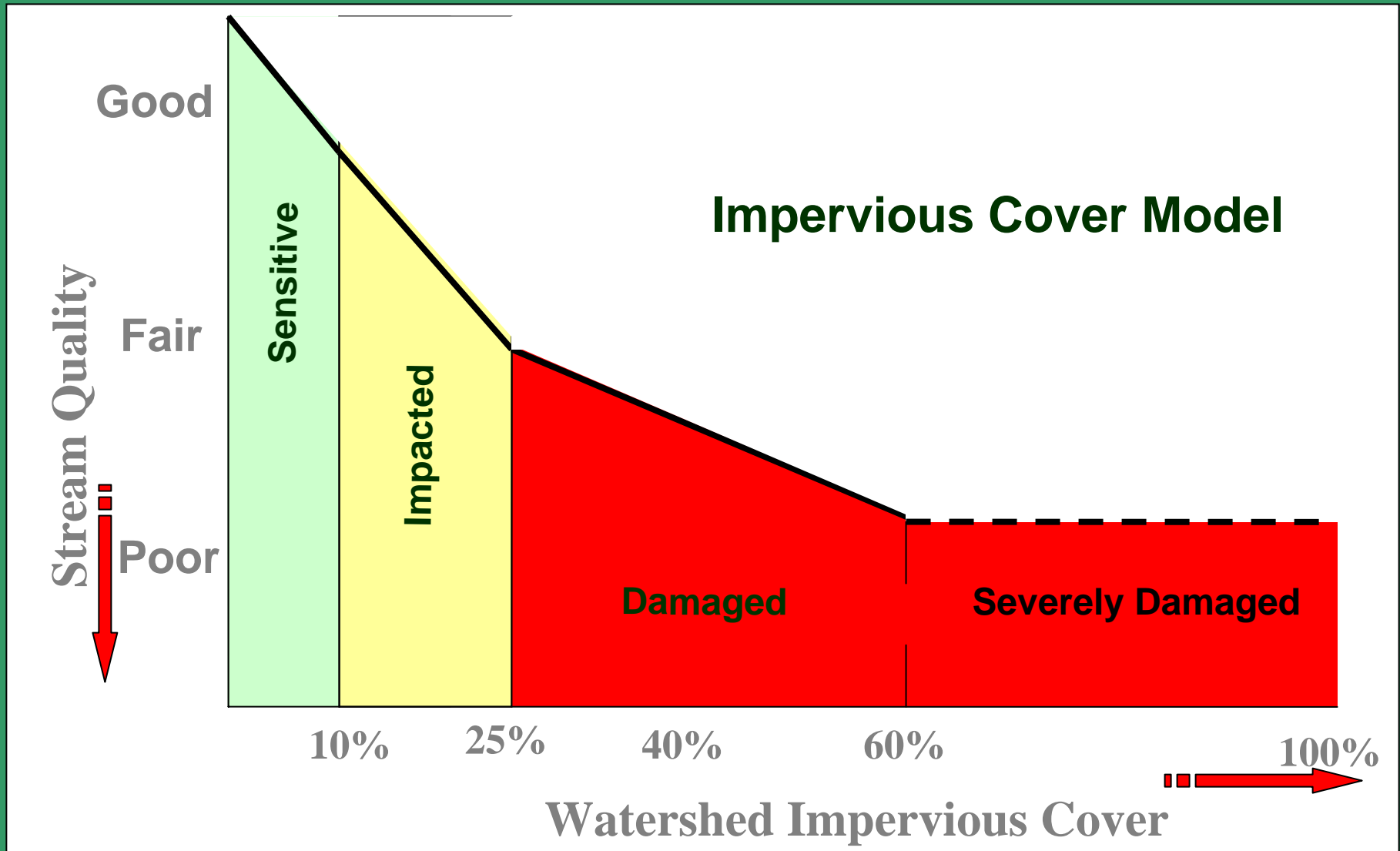
Oil & Grease

Muddy Water

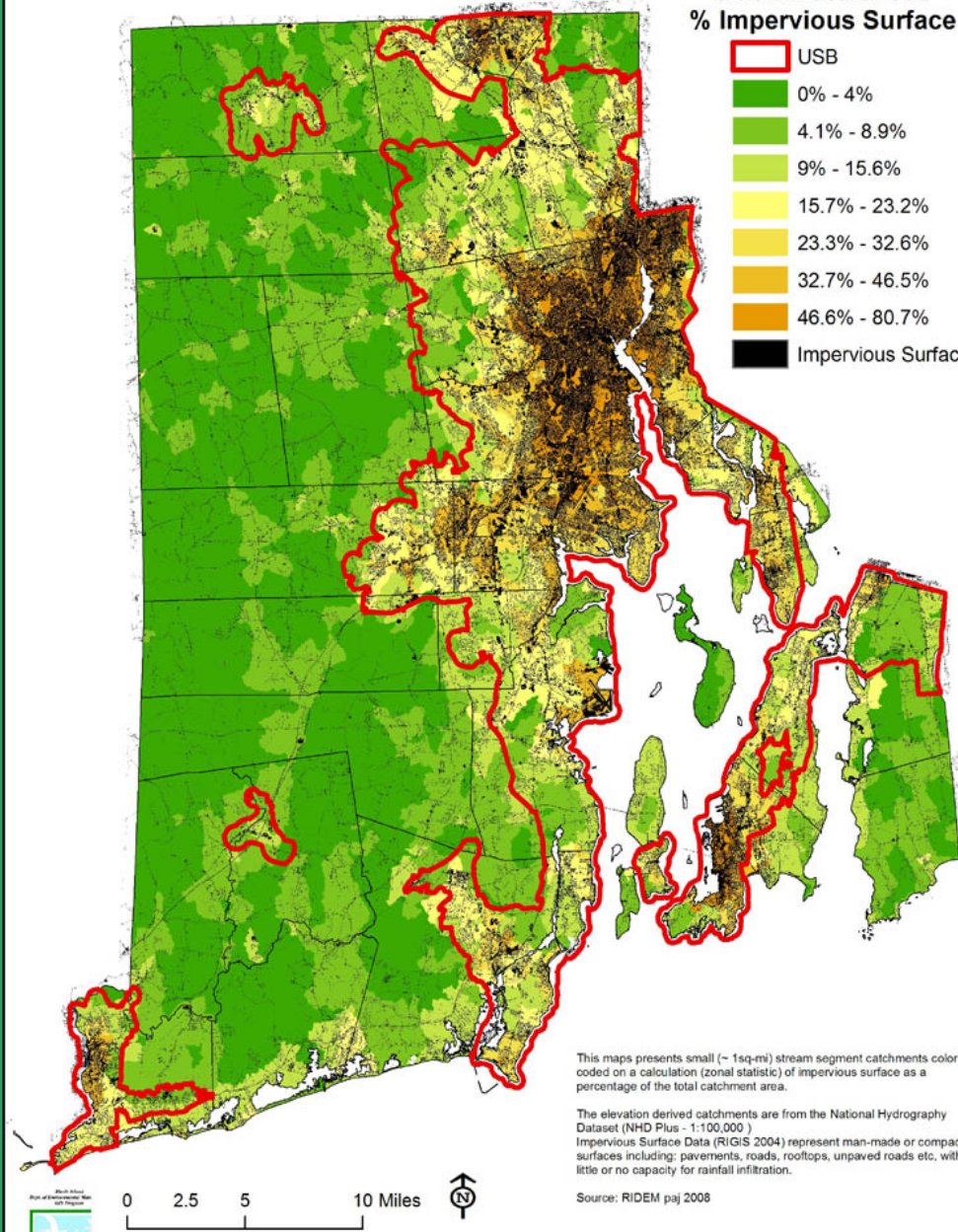
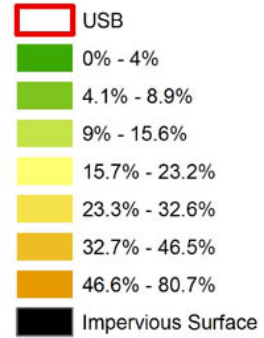
**Heavy Metals (e.g.
Zinc, Copper, Lead)**

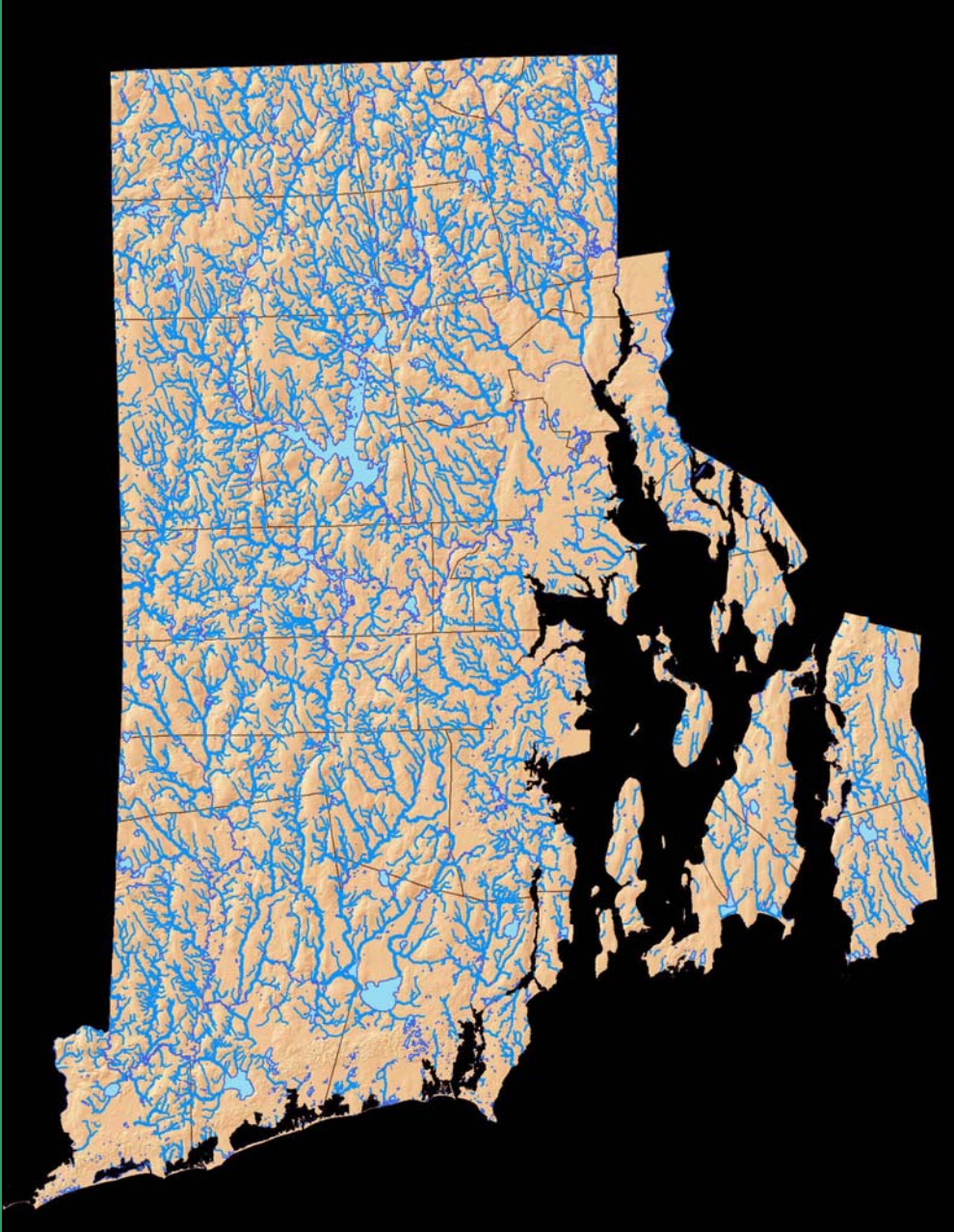


Relationship Between Impervious Cover and Stream Quality



Small Watersheds % Impervious Surface

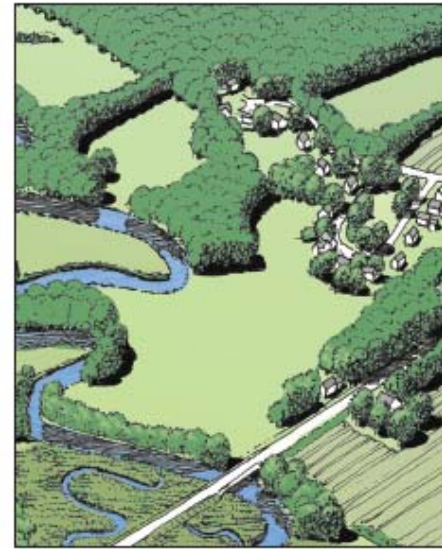




M.L. St-Sauveur



The Need to Reduce Impervious Cover to Prevent Flooding and Protect Water Quality



May, 2010

**So what should
communities do?**



RHODE ISLAND COMMUNITY LID SITE PLANNING AND DESIGN GUIDANCE



Rhode Island Department of Environmental Management



Coastal Resources Management Council

"THIS IS A CLUSTER DEVELOPMENT SUBJECT TO THE BYLAWS, RULES AND REGULATIONS OF THE HOMEOWNERS ASSOCIATION."



Guidance Manual Chapters

1. Conservation Development
2. Buffer Standards
3. Site Clearing and Grading
4. Roadway Standards
5. Parking Requirements
6. Compact Development
7. LID Landscaping
8. Special Use Ordinances
 - Stormwater Utilities
 - Impervious Cover
 - Review and Inspection Fees

45 Site Planning and Design Techniques

- Current Practice
- Recommended Practice
- Perceptions and Realities
- Economic and Stormwater Benefits
- Case Studies
- References

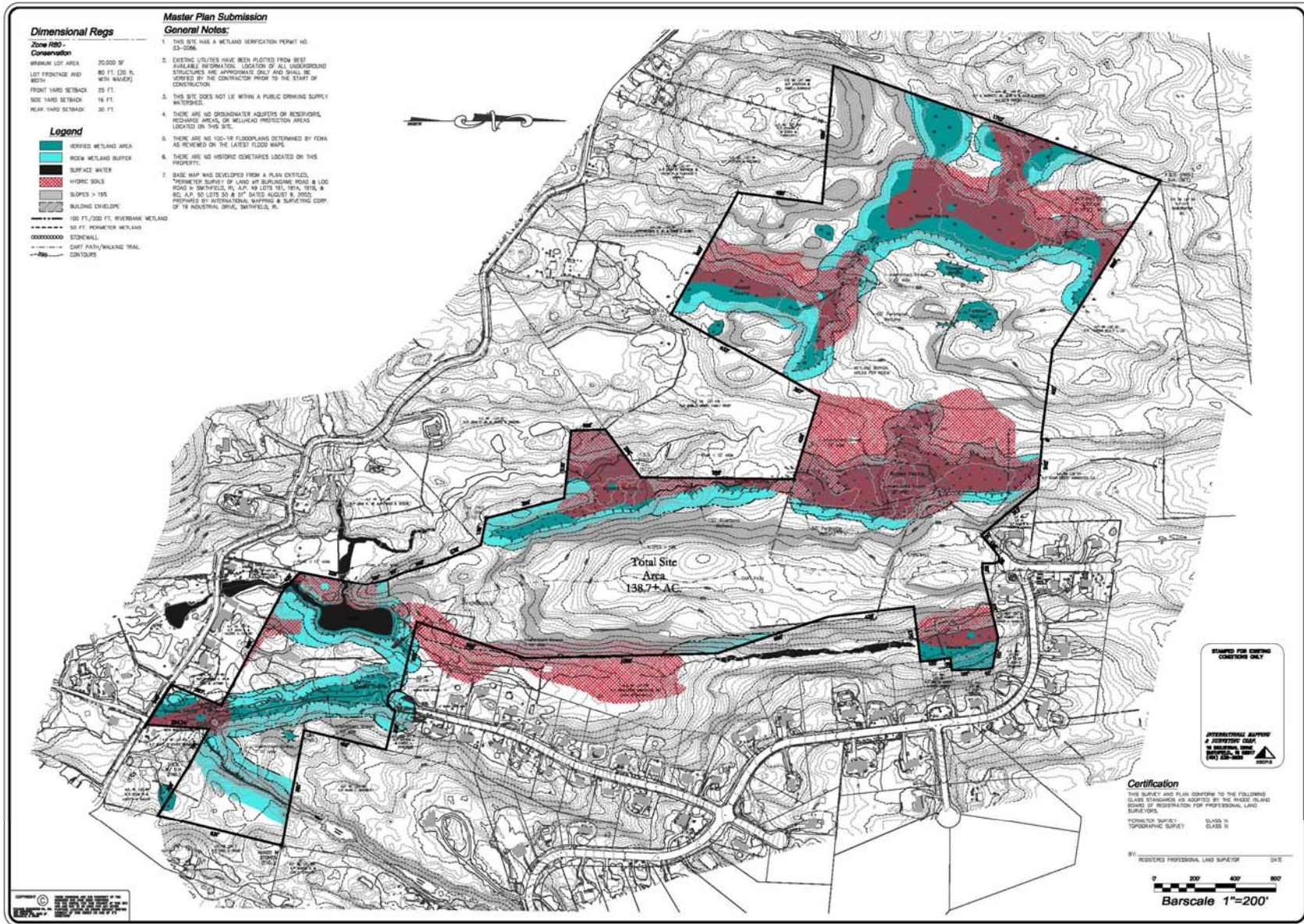
How can we Avoid the Impacts?

- Conservation Development
- Buffer standards
- Site clearing standards
- Tree protection ordinances

Conservation Development

“a creative land use technique that allows a community to guide growth to the most appropriate areas within a parcel of land to avoid impacts to the environment and to protect the character-defining features of the property.”

Existing Conditions



Yield Plan

Dimensional Regs

Zone R80

MINIMUM LOT AREA	80,000 SF
LOT FRONTAGE AND WIDTH	350 FT.
FRONT YARD SETBACK	40 FT.
SIDE YARD SETBACK	20 FT.
REAR YARD SETBACK	20 FT.

Development Data

AREA OF PARCEL	136.7 ACRES
AREA OF 8'-0" W	16.47 ACRES
OPEN SPACE AREA	1.88 ACRES
AREA OF LOTS	136.29 ACRES
# PROPOSED LOTS	42
AVERAGE LOT AREA	3.21 ACRES
LENGTH OF R.O.W.	9,008 FT.

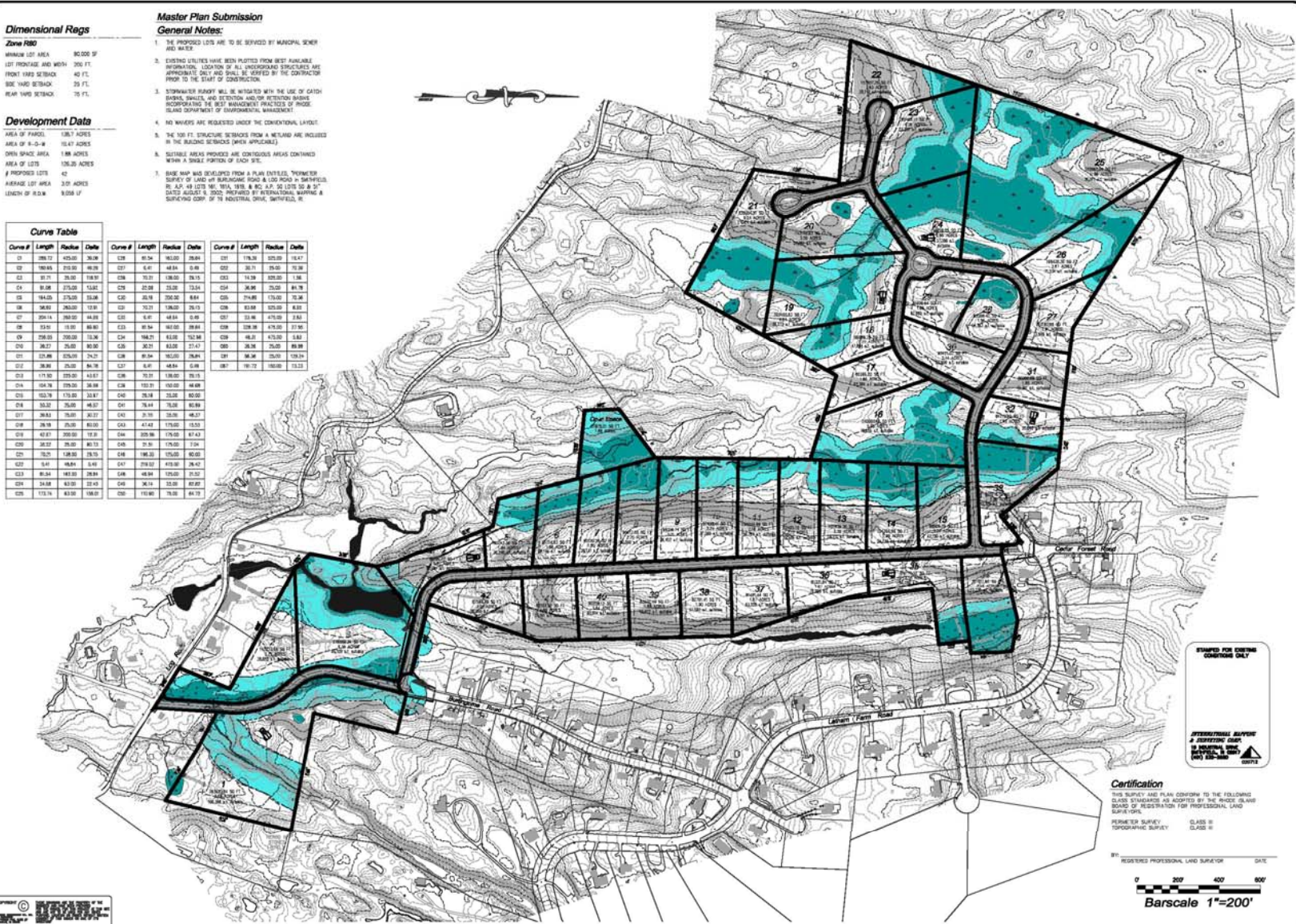
Master Plan Submission

General Notes:

1. THE PROPOSED LOTS ARE TO BE SERVICED BY MUNICIPAL SEWER AND WATER.
2. EXISTING UTILITIES HAVE BEEN PLOTTED FROM BEST AVAILABLE INFORMATION. LOCATION OF ALL UNDERGROUND STRUCTURES ARE APPROXIMATE ONLY AND SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO THE START OF CONSTRUCTION.
3. STOPWATER BARRIERS WILL BE INTEGRATED WITH THE USE OF CATCH BASINS, SWALES, AND DETENTION AND/OR RETENTION PONDAS INCORPORATING THE BEST MANAGEMENT PRACTICES OF PROGE. BASIN SIZES/DEPTH OF OVERFLOW/RETENTION MANAGEMENT.
4. NO WATERSHEDS ARE REQUESTED UNDER THE CONVENTIONAL LAYOUT.
5. THE 100 FT. STRUCTURE SETBACKS FROM A WETLAND ARE INCLUDED IN THE BUILDING SETBACKS (WHEN APPLICABLE).
6. SUITABLE AREAS PROPOSED ARE CONTIGUOUS AREAS CONTAINED WITHIN A SINGLE PORTION OF EACH SITE.
7. BASE MAP WAS DEVELOPED FROM A PLAN ENTITLED "PRELIMINARY SURVEY OF LAND AT BEARCANGINE ROAD & LOS ROAD N. SHERFIELD, MO. 637-19 LOTS 16C, 16E, 16F, & 16G, 67-50 LOTS 20 & 21" DATED AUGUST 8, 2002, PREPARED BY RESIDENTIAL MAPPING & SURVEYING CORP. OF 78 INDUSTRIAL DRIVE, SHERFIELD, MO.

Curve Table

Curve #	Length	Radius	Delta	Curve #	Length	Radius	Delta	Curve #	Length	Radius	Delta
C1	286.72	425.00	26.26	C18	81.54	163.00	26.84	C31	176.26	325.00	15.47
C2	188.65	275.00	46.76	C19	6.47	48.84	0.86	C32	26.71	15.00	70.36
C3	27.71	25.00	138.57	C20	75.00	128.00	28.15	C33	114.26	225.00	1.78
C4	81.88	275.00	1.02	C21	22.88	12.00	73.24	C34	16.86	1.00	84.78
C5	184.05	275.00	35.08	C22	26.18	250.00	8.84	C35	274.88	175.00	75.36
C6	36.85	260.00	13.91	C23	75.21	138.00	29.13	C36	83.88	325.00	8.35
C7	224.14	260.00	44.85	C24	6.47	48.84	0.86	C37	131.86	475.00	2.83
C8	13.56	1.00	84.80	C25	81.54	163.00	26.84	C38	108.38	475.00	32.85
C9	278.05	250.00	75.36	C26	184.21	63.00	152.86	C39	16.83	475.00	5.83
C10	38.27	25.00	80.30	C27	30.21	63.00	27.47	C40	38.26	25.00	88.98
C11	127.88	325.00	24.27	C28	81.54	163.00	26.84	C41	16.26	25.00	108.19
C12	28.88	125.00	84.78	C29	1.00	4.84	2.78	C42	187.72	100.00	115.13
C13	171.92	325.00	43.87	C30	75.21	138.00	29.13				
C14	134.78	275.00	38.88	C38	100.21	150.00	44.88				
C15	102.78	175.00	33.87	C40	78.18	22.00	80.00				
C16	20.32	25.00	46.37	C41	78.14	75.00	82.89				
C17	284.84	275.00	82.37	C42	27.26	22.00	46.27				
C18	28.18	25.00	80.00	C43	47.43	175.00	15.53				
C19	42.87	25.00	18.19	C44	325.98	175.00	87.43				
C20	28.32	25.00	80.13	C45	27.26	175.00	15.53				
C21	78.27	125.00	28.15	C46	148.28	125.00	60.00				
C22	5.41	184.84	0.49	C47	278.02	475.00	28.42				
C23	81.24	184.84	28.84	C48	48.84	125.00	21.52				
C24	24.88	63.00	22.18	C49	36.14	22.00	82.89				
C25	173.76	63.00	188.13	C50	103.80	25.00	64.78				



STAMPED FOR EXISTING
CONTINGENT ONLY

REGISTERED PROFESSIONAL
& SURVEYOR
RESIDENTIAL MAPPING & SURVEYING CORP.
1000 N. 10TH ST.
SHERFIELD, MO 63703

Certification

THIS SURVEY AND PLAN CONFORM TO THE FOLLOWING
STATE STATUTES AS ADOPTED BY THE MISSOURI BOARD OF REGISTRATION FOR PROFESSIONAL LAND SURVEYORS.
PLANNING SURVEY CLASS III
TOPOGRAPHIC SURVEY CLASS III

BY: REGISTERED PROFESSIONAL LAND SURVEYOR DATE



Conservation Plan

Dimensional Regs

Zone R10 - Conservation
 MINIMUM LOT AREA 20,000 SF
 80 FT (20.1 M) WITH FRONT YARD SETBACK 33 FT
 300 YD (274 M) WITH REAR YARD SETBACK 18 FT
 300 YD (274 M) WITH REAR YARD SETBACK 30 FT

Development Data

AREA OF PARCEL 136.7 ACRES
 AREA OF 8-0-R 4.25 ACRES
 OPEN SPACE AREA 114.48 ACRES
 SUITABLE OPEN SPACE 45.84 ACRES
 AREA OF PROPOSED LOTS 79.86 ACRES
 # PROPOSED LOTS 38
 AVG. LOT AREA 0.52 ACRES
 LENGTH OF ROADWAY 3.730 LF

Master Plan Submission

General Notes:

- THE PROPOSED LOTS ARE TO BE SERVICED BY MUNICIPAL SEWER AND WATER.
- EXISTING UTILITIES HAVE BEEN NOTED FROM BEST AVAILABLE INFORMATION. LOCATION OF ALL UNDERGROUND STRUCTURES ARE APPROXIMATE ONLY AND SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO THE START OF CONSTRUCTION.
- STORMWATER RUNOFF WILL BE MANAGED WITH THE USE OF CATCH BASINS, SWALES, AND A SERIES OF SHALLOW DETENTION-BETWEEN-BASINS ACCORDING TO THE BEST MANAGEMENT PRACTICES OF LOCAL GOVERNMENT DEPARTMENT OF ENVIRONMENTAL MANAGEMENT.
- THIS PROJECT IS PROPOSED TO BE BUILT IN TWO PHASES.
- THIS PLAN FALLS UNDER THE LATEST UNIFIED LAND DEVELOPMENT AND SUBDIVISION REVIEW REGULATIONS FOR CONSERVATION DEVELOPMENT.
- WINNERS ARE RESPECTFULLY REQUESTED FOR THE FOLLOWING:
 - LOT FRONTAGE FOR LOTS 1, 2, & 18
 - THE 100 FT. STRUCTURE SETBACK TO A WETLAND IS INCLUDED WITHIN THE BUILDING FOOTPRINTS AS SHOWN.
- BASE MAP WAS DEVELOPED FROM A PLAIN EXISTING "FORMER SURVEY OF LAND SHY BURGAMME ROAD & LOT ROAD IN BATHURST, IN A.P. 60 LOTS 101, 102A, 102B, 102C, 102D, 102E, 102F, 102G, 102H, 102I, 102J, 102K, 102L, 102M, 102N, 102O, 102P, 102Q, 102R, 102S, 102T, 102U, 102V, 102W, 102X, 102Y, 102Z, 102AA, 102AB, 102AC, 102AD, 102AE, 102AF, 102AG, 102AH, 102AI, 102AJ, 102AK, 102AL, 102AM, 102AN, 102AO, 102AP, 102AQ, 102AR, 102AS, 102AT, 102AU, 102AV, 102AW, 102AX, 102AY, 102AZ, 102BA, 102BB, 102BC, 102BD, 102BE, 102BF, 102BG, 102BH, 102BI, 102BJ, 102BK, 102BL, 102BM, 102BN, 102BO, 102BP, 102BQ, 102BR, 102BS, 102BT, 102BU, 102BV, 102BW, 102BX, 102BY, 102BZ, 102CA, 102CB, 102CC, 102CD, 102CE, 102CF, 102CG, 102CH, 102CI, 102CJ, 102CK, 102CL, 102CM, 102CN, 102CO, 102CP, 102CQ, 102CR, 102CS, 102CT, 102CU, 102CV, 102CW, 102CX, 102CY, 102CZ, 102DA, 102DB, 102DC, 102DD, 102DE, 102DF, 102DG, 102DH, 102DI, 102DJ, 102DK, 102DL, 102DM, 102DN, 102DO, 102DP, 102DQ, 102DR, 102DS, 102DT, 102DU, 102DV, 102DW, 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102ZY, 102ZZ

Conservation Development Calculation:

SUITABLE LAND AREA = TOTAL SITE - WETLANDS - WETLAND BUFFERS - 15% SLOPES AND GREATER = 85.49 ACRES
 SUITABLE OPEN SPACE TO BE PROVIDED = 60% X 85.49 ACRES = 51.29 ACRES
 SUITABLE LAND FOR DEVELOPMENT = 85.49 AC. - 29.29 AC. = 56.20 ACRES

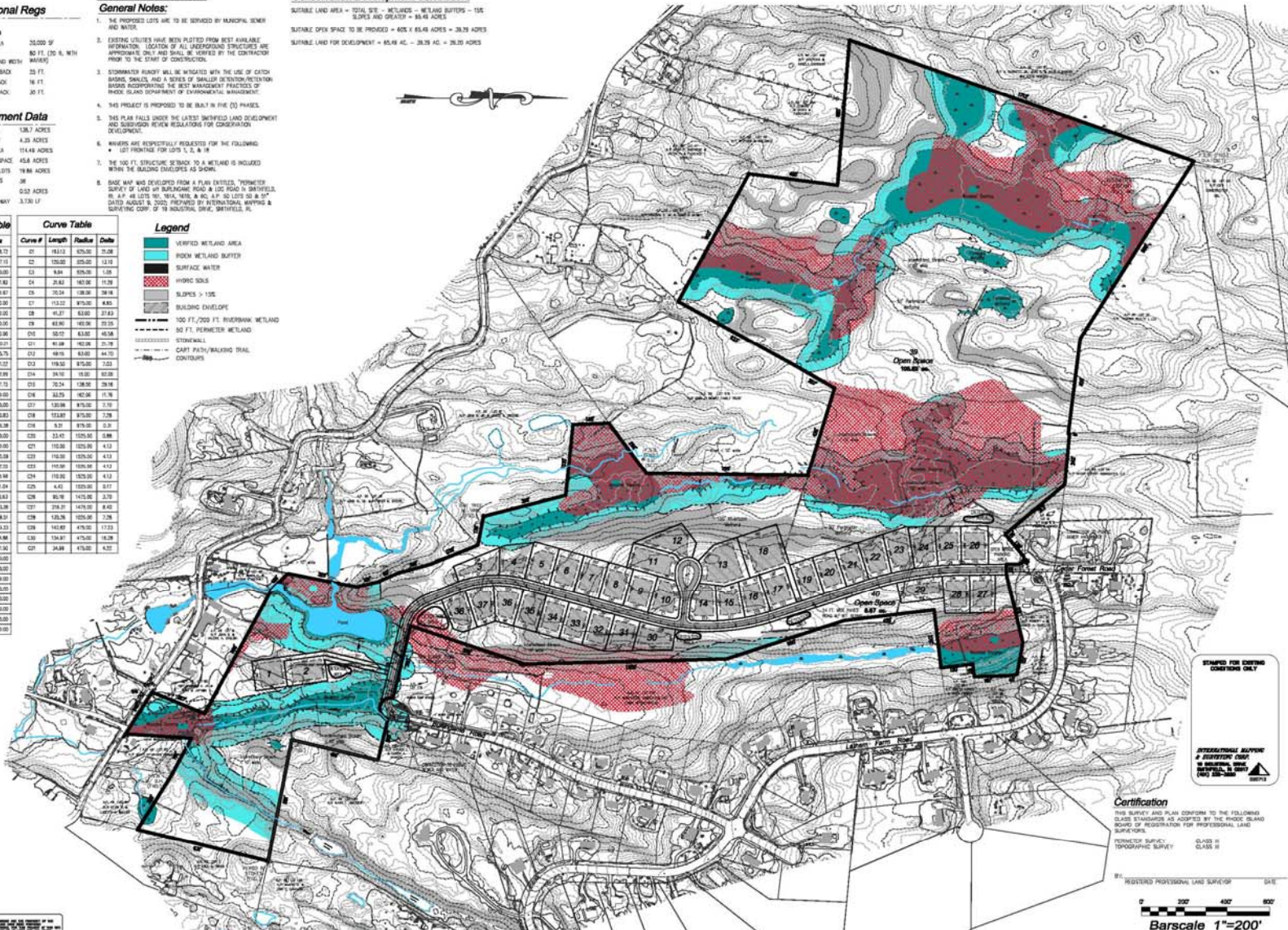
Parcel Table

Parcel #	Area
1	2308.72
2	1884.17
3	10000.00
4	3087.82
5	2188.87
6	2188.87
7	2188.87
8	2188.87
9	2188.87
10	2188.87
11	2188.87
12	2188.87
13	2188.87
14	2188.87
15	2188.87
16	2188.87
17	2188.87
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29	2188.87
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31	2188.87
32	2188.87
33	2188.87
34	2188.87
35	2188.87
36	2188.87
37	2188.87
38	2188.87

Curve Table

Curve #	Length	Radius	Delta
01	18.13	875.00	20.88
02	130.00	225.00	121.01
03	9.88	875.00	1.28
04	21.83	145.00	15.28
05	25.24	138.00	28.16
06	113.22	875.00	8.83
07	14.07	875.00	27.83
08	83.80	145.00	25.25
09	18.13	875.00	20.88
10	18.13	875.00	20.88
11	18.13	875.00	20.88
12	18.13	875.00	20.88
13	18.13	875.00	20.88
14	18.13	875.00	20.88
15	18.13	875.00	20.88
16	18.13	875.00	20.88
17	18.13	875.00	20.88
18	18.13	875.00	20.88
19	18.13	875.00	20.88
20	18.13	875.00	20.88
21	18.13	875.00	20.88
22	18.13	875.00	20.88
23	18.13	875.00	20.88
24	18.13	875.00	20.88
25	18.13	875.00	20.88
26	18.13	875.00	20.88
27	18.13	875.00	20.88
28	18.13	875.00	20.88
29	18.13	875.00	20.88
30	18.13	875.00	20.88
31	18.13	875.00	20.88
32	18.13	875.00	20.88
33	18.13	875.00	20.88
34	18.13	875.00	20.88
35	18.13	875.00	20.88
36	18.13	875.00	20.88
37	18.13	875.00	20.88
38	18.13	875.00	20.88

- Legend**
- VERIFIED WETLAND AREA
 - WETLAND BUFFER
 - SURFACE WATER
 - HYDRAIC SOILS
 - SLOPES > 15%
 - BUILDING ENVELOPE
 - 100 FT./200 FT. BUFFER/WETLAND
 - 50 FT. PERIMETER WETLAND
 - STAKEWALL
 - CARP PATH/WALKING TRAIL
 - CONTOURS



STAMP FOR EXISTING CONDITIONS ONLY

INTERNATIONAL SURVEY & DESIGN CO. INC.
 1000 W. 10TH ST., SUITE 100
 DENVER, CO 80202

Certification
 THIS SURVEY AND PLAN CONFORMS TO THE FOLLOWING CLASS STANDARDS AS ADOPTED BY THE INDIANA BOARD OF REGISTRATION FOR PROFESSIONAL LAND SURVEYORS.

DOMESTIC SURVEY CLASS II
 TOPOGRAPHIC SURVEY CLASS II

BY REGISTERED PROFESSIONAL LAND SURVEYOR DATE

0 200' 400' 800'
 Barscale 1"=200'

Comparisons

	Conventional	Conservation
Wetland Lots:	24	0
Average Lot:	3 acres	.52 acres
Street Length:	9,059	3,720
Open Space:	1.4%	82%

Goal 1: Avoid the impacts to natural features and predevelopment hydrology

- ✓ **Objective 1.** Protect open space to maintain hydrology
- ✓ **Objective 2.** Protect surface waters, wetlands, and buffers
- ✓ **Objective 3.** Minimize clearing and grading
- ✓ **Objective 4.** Reduce soil compaction

Buffer Standards





Buffer Benefits

- Decreases watershed impervious cover
- Flood control
- Provides habitat
- Reduces stream warming
- Greenway corridors
- Increases property values
- Protects water quality

Buffer Encroachment



Site Clearing Standards



<http://croptechnology.unl.edu/>





Limited Disturbance Zone

Owner Discretion Zone

Construction staging area

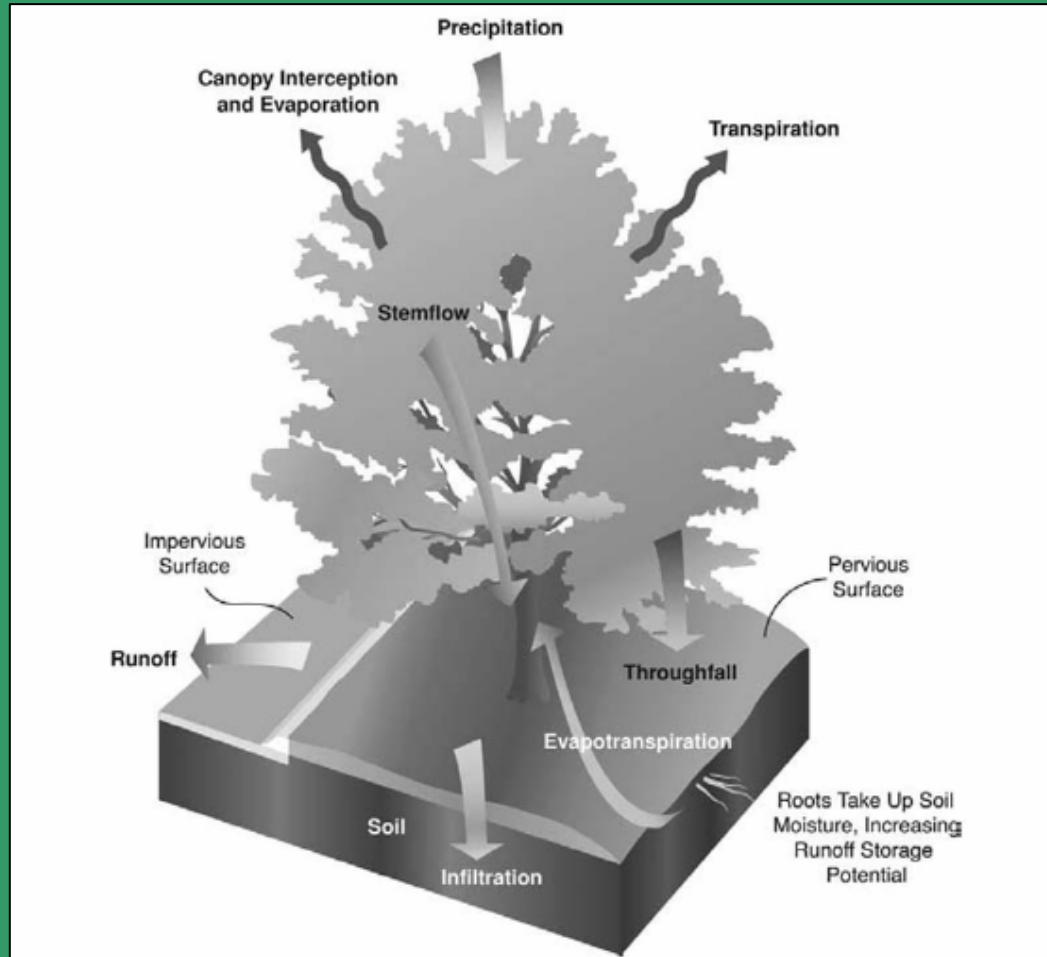
Driveway Disturbance Zone



Forest Conservation and Tree Protection Ordinances



Trees Reduce Stormwater Runoff

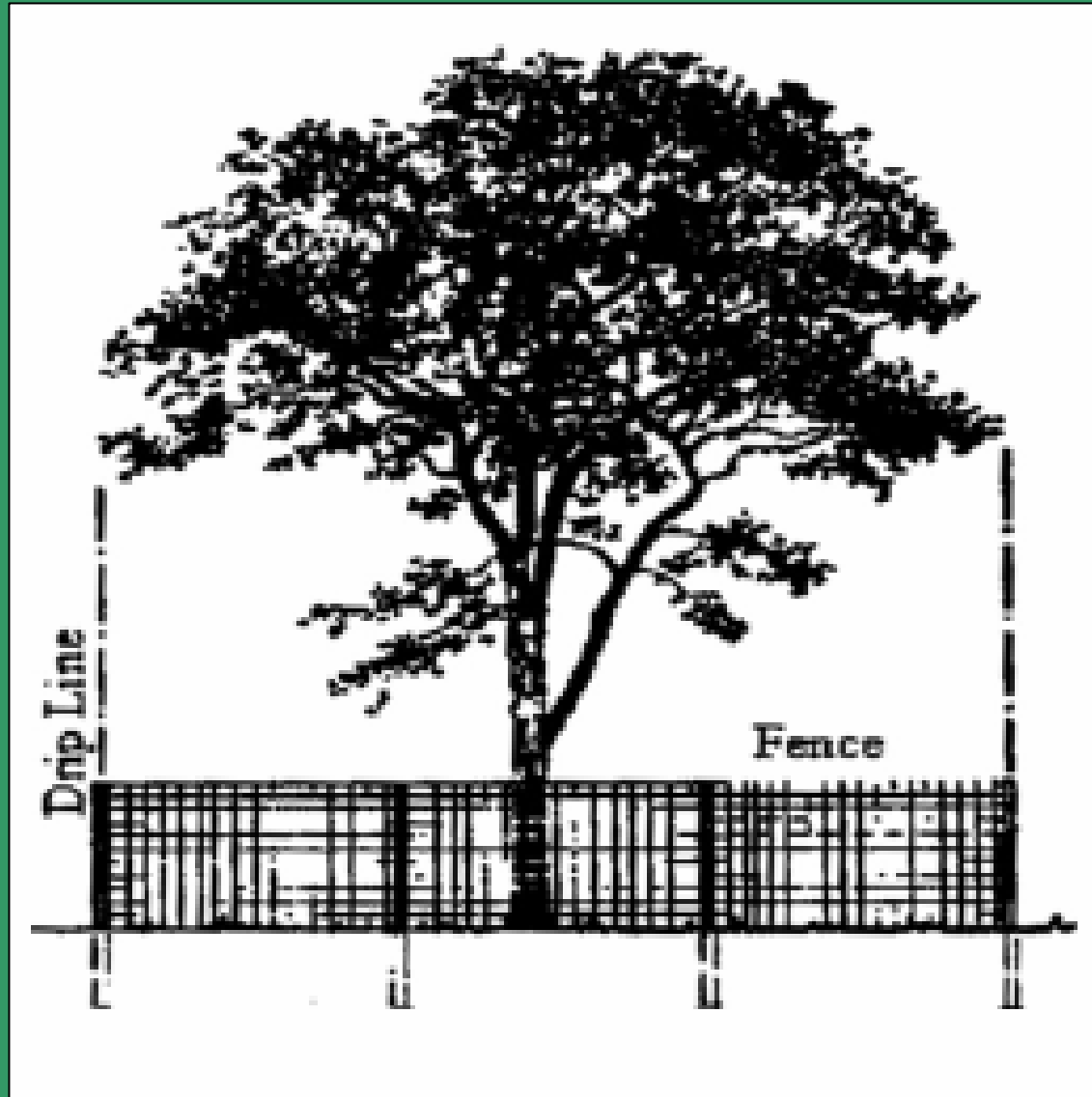


One mature beech tree can intercept over 2,000 gallons of runoff annually

Recommended Ordinance Requirements

- Trees should be identified and protected
- Require percent tree canopy cover
- Require bonds to cover tree replacement

- Fence off the crown



How can we Reduce the Impacts?

- Compact development
- Roadway standards
- Parking requirements
- LID landscaping

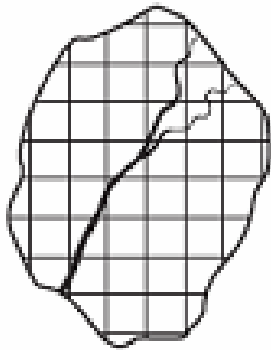
Compact Development



Impervious Cover Associated with Residential Lot Sizes

Lot Size	Dwelling Units/Acre	% Impervious Cover
10 Acres	0.1	2.4%
5 Acres	0.2	5%
3 Acres	0.333	8%
2 Acres	0.5	12%
1 Acre	1	20%
.5 Acre	2	25%
.25 Acre	4	38%

Scenario A

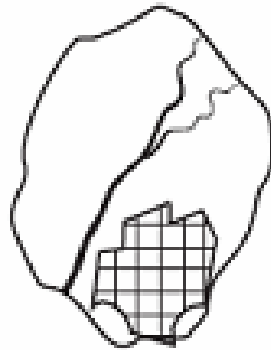


1 unit per acre

Site: 20%
impervious cover

Watershed: 20%
impervious cover

Scenario B

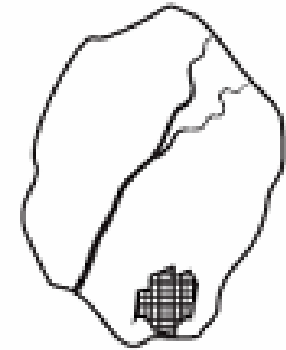


4 units per acre

Site: 38%
impervious cover

Watershed: 9.5%
impervious cover

Scenario C



8 units per acre

Site: 65%
impervious cover

Watershed: 8.1%
impervious cover





Roadway Design

- Pavement length and width
- ROW width
- Cul-de-sac radius
- Sidewalk design
- Curb requirements
- Driveway design

Pavement length and width

Wide Street



9 houses

\$ 40,400 to repave

\$4,500/house

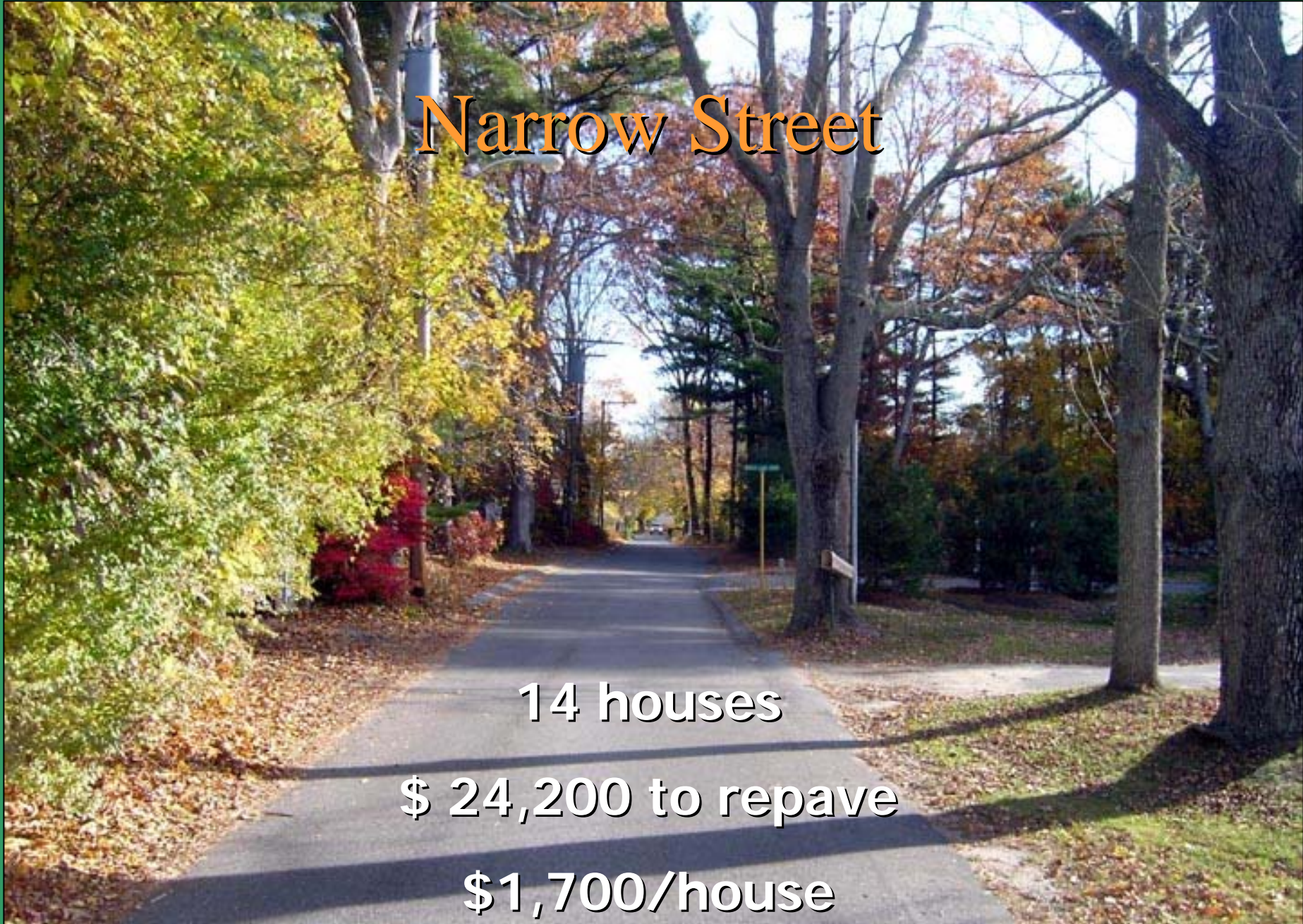
Pavement length and width

Narrow Street

14 houses

\$ 24,200 to repave

\$1,700/house



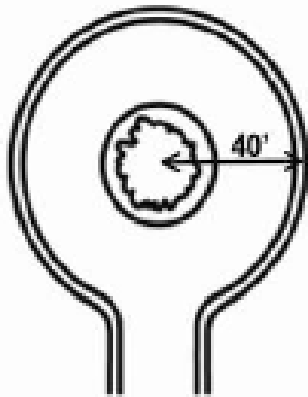
Pavement length and width



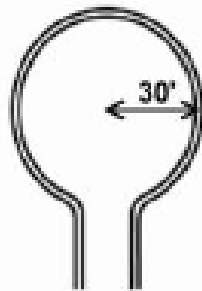
Cul-de-sac Radius



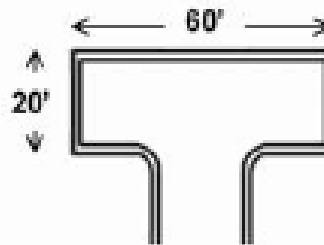
Alternative Designs



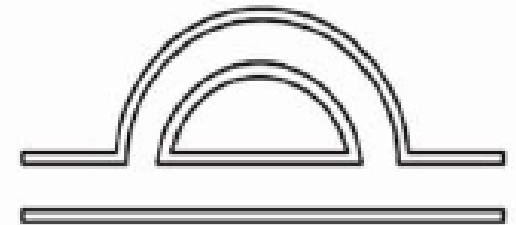
40 ft cul-de sac with landscaped island



30 ft radius cul-de-sac



60 by 20 ft T-shaped turnaround



Loop road

Cul-de-sac Radius



Sidewalk Design



Sidewalk Design



Curb Requirements







Driveway Design



Shared Driveway

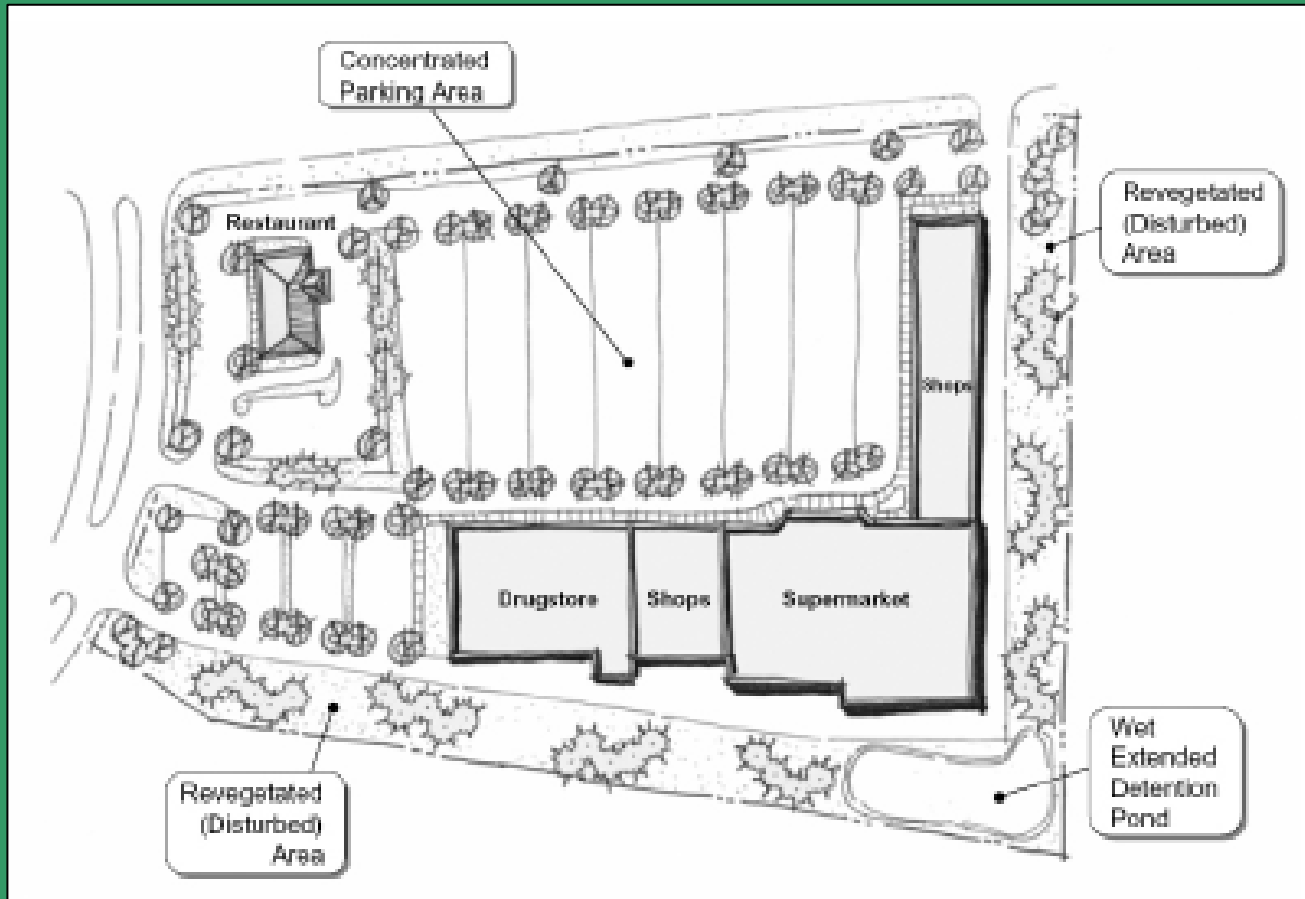


Parking Guidance

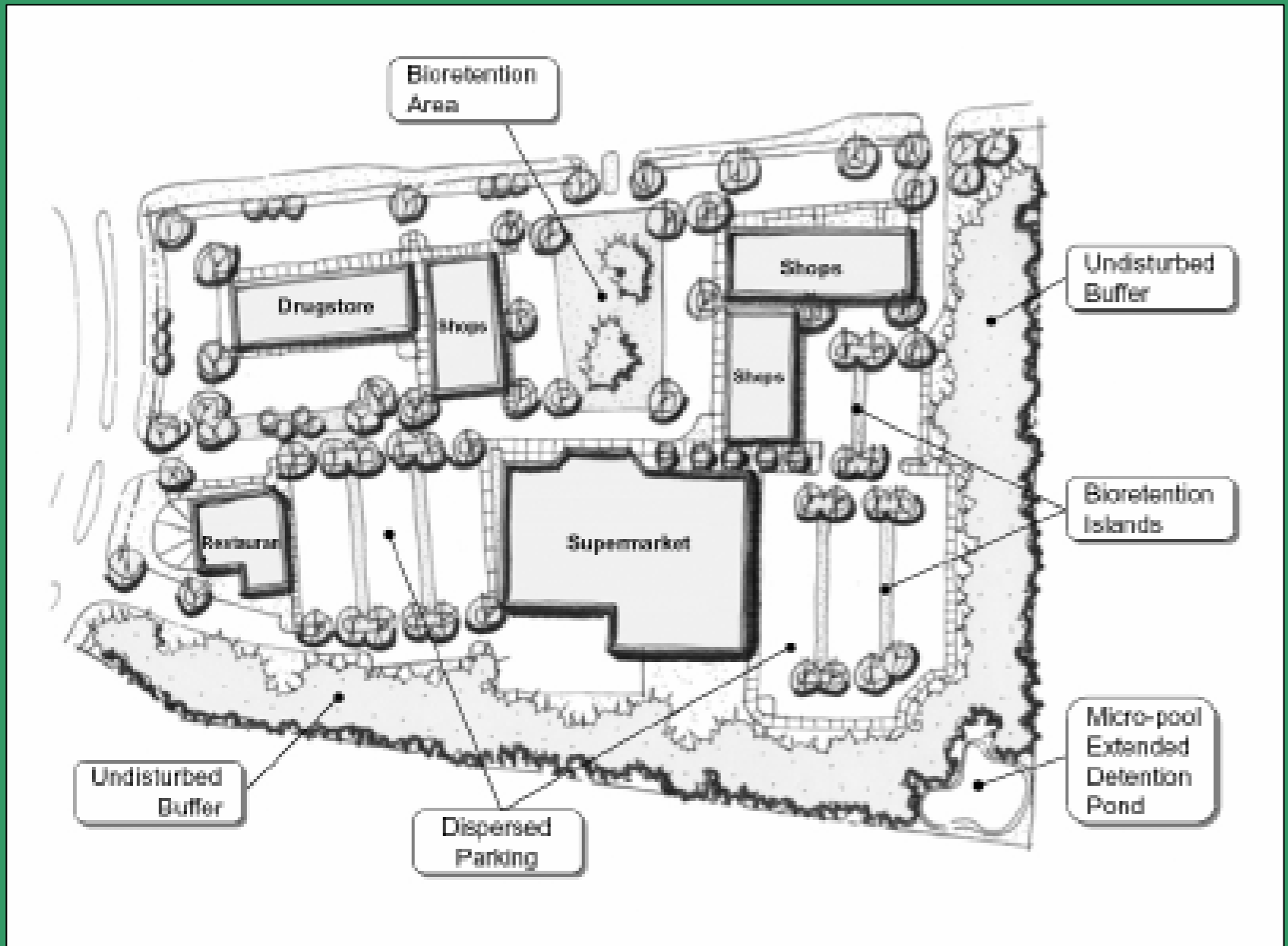


Parking Guidance

- Establish both minimum and maximum parking ratios



Conventional parking layout



Parking Layout Using LID Techniques

- **Encourage shared parking**



- Allow off-site parking, where practical
- Reduce parking stalls



LID Landscaping

- Require natural vegetation and encourage native landscaping



Goal 2: Reduce stormwater volume and increase groundwater recharge

- ✓ **Objective 5.** Maintain native vegetation to minimize lawns, fertilizers, and pesticides
- ✓ **Objective 6.** Minimize impervious surfaces

Ordinance Checklist for 45 LID Site Planning and Design Techniques

Objective VI: *Minimize impervious surfaces*

15. Did your community adopt compact growth ordinances such as conservation development, planned development or mixed use development?
16. Are residential streets required to be as narrow as possible to accommodate traffic volumes without compromising safety?
 - a. Do you require road widths of 22 feet or less for subdivisions of 40 or fewer homes or average daily trips less than 400?
 - b. Do you require road widths of 26 feet or less for subdivisions of 40-200 homes or average daily trips of 400-2,000?
17. Are street right-of-way widths required to be less than 45 feet?
18. Driveway lengths and widths are required to be reduced to the extent possible, pervious surfaces and shared driveways are encouraged wherever appropriate?
 - a. Do you require driveways to be 9 feet or less (one lane) and 18 feet or less (two lanes)?
 - b. Do you allow pervious surfaces to be used for residential driveways?
 - c. Do you allow shared driveways to be used in residential developments?
19. Do you allow the flexibility with curbs in residential streets to encourage side of the road drainage into vegetated open swales, where possible?.....

Incorporating LID into Comprehensive Plans

Goal: Avoid the Impacts

Objective 1: Protect undisturbed open space

Action 1.1 Adopt Conservation Development

Action 1.2 Require limits of disturbance on site plans

Summary

- LID: A R M
- Avoid & Reduce: Municipal Responsibility
- LID Community Benefits

Questions?

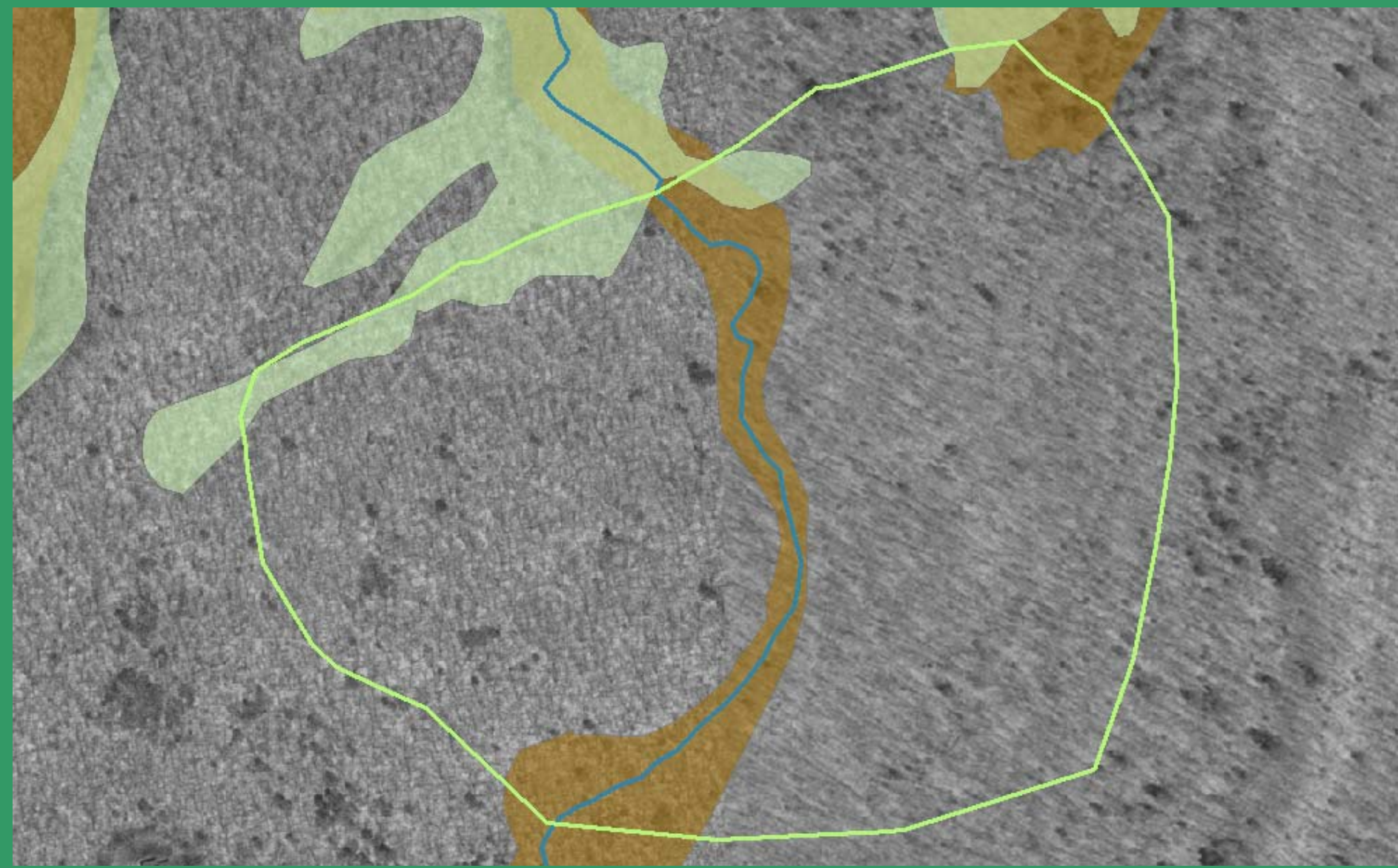
For more information

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RIDEM

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* SW BMP

Curb and gutter
drainage system

Avg lot size=just over 1 acre
ROW=60 ft

Road width=30 ft
Cul-de-sac radius=38 ft

