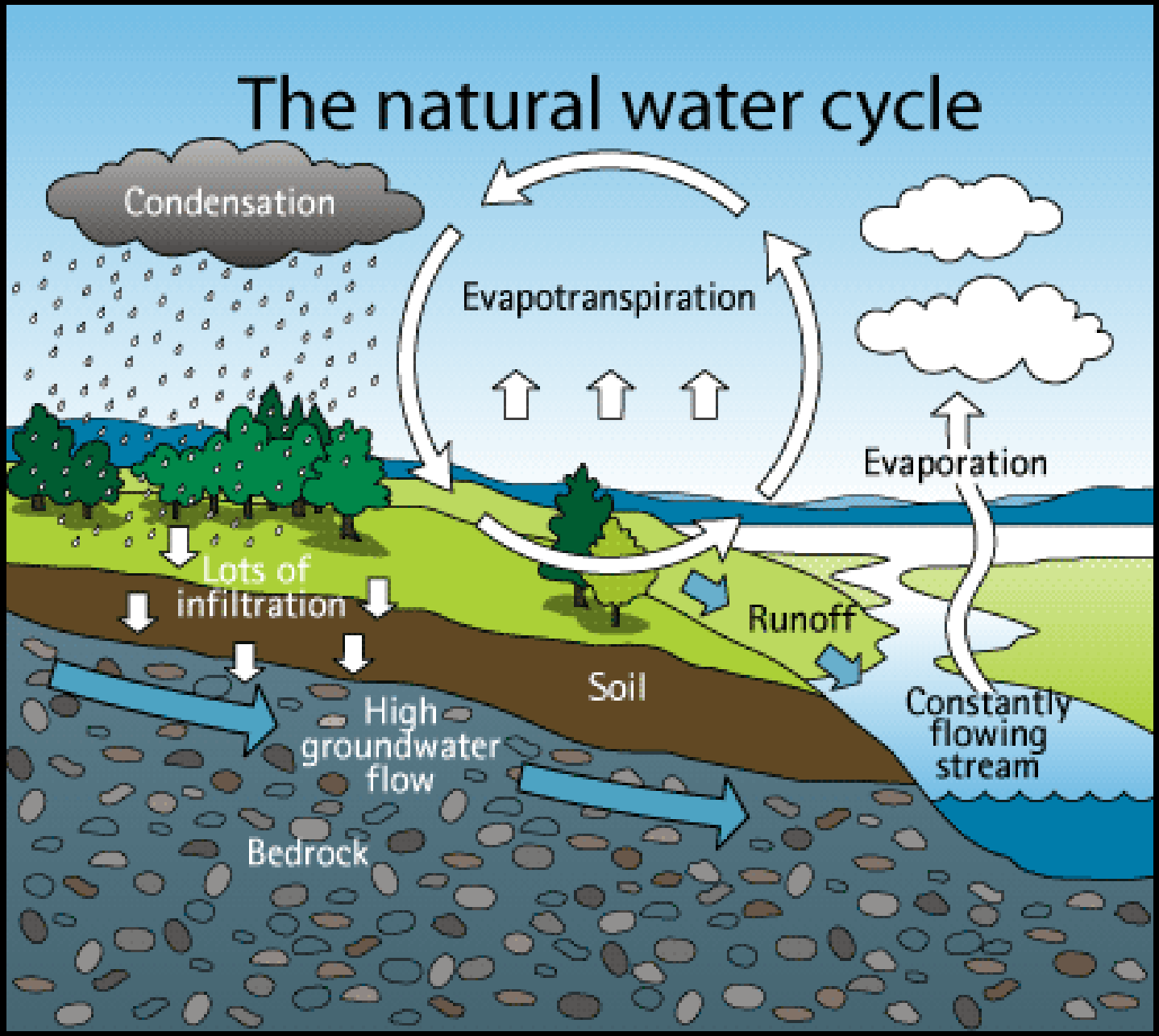
The Land Use – Water Quality Connection

Whitney Jenkins
Coastal Training Program Coordinator
North Carolina Coastal Reserve &
National Estuarine Research Reserve


The natural water cycle
Condensation
Evapotranspiration
Evaporation
Lots of infiltration
Runoff
Soil
High groundwater flow
Constantly flowing stream
Bedrock

We have changed the natural hydrology.

Parking Lots

Parking Lots Continued

Parking Lot & Street Runoff

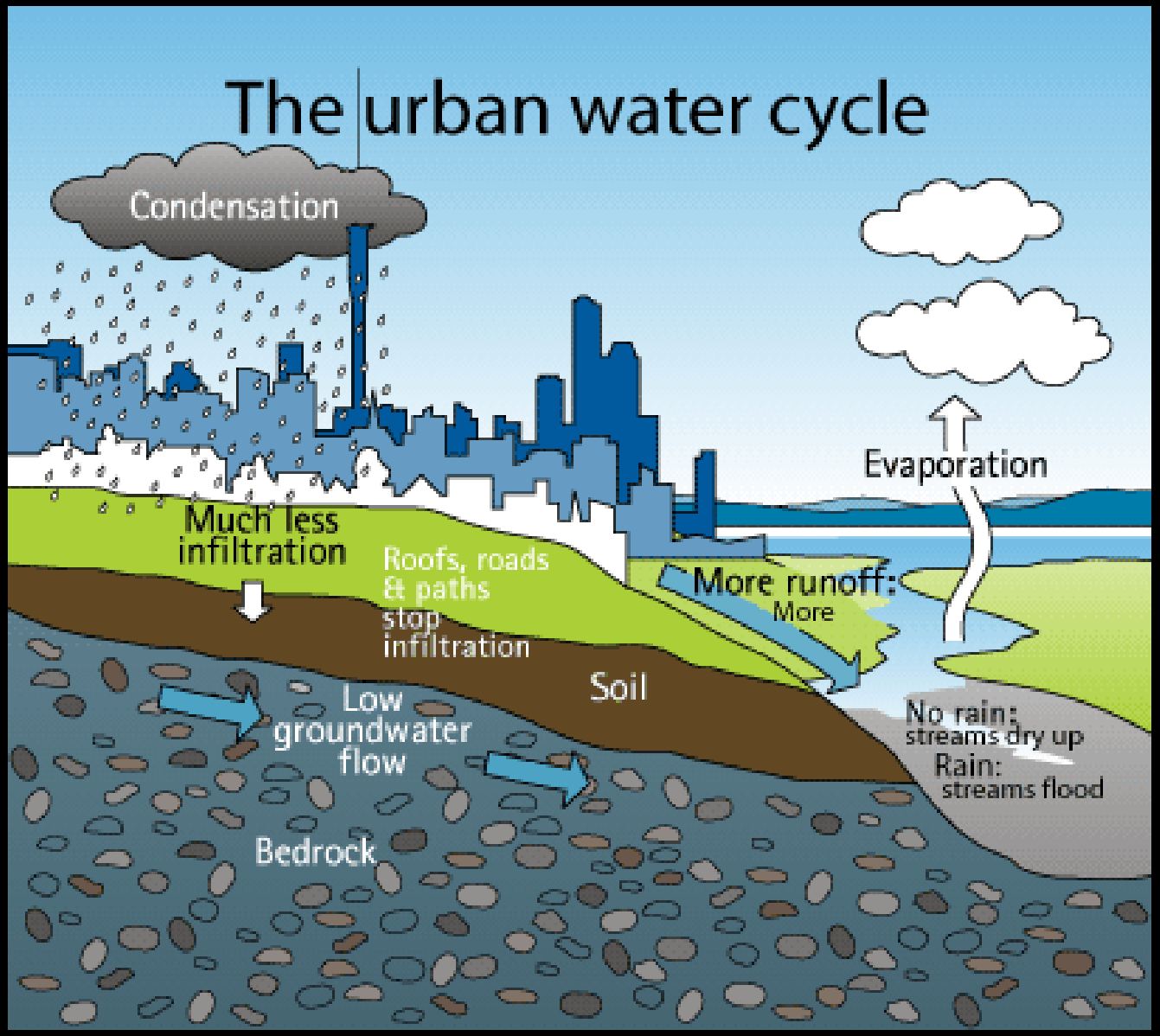

Ditching

Cul-De-Sacs

Rooftop Runoff

Curbs and Gutters

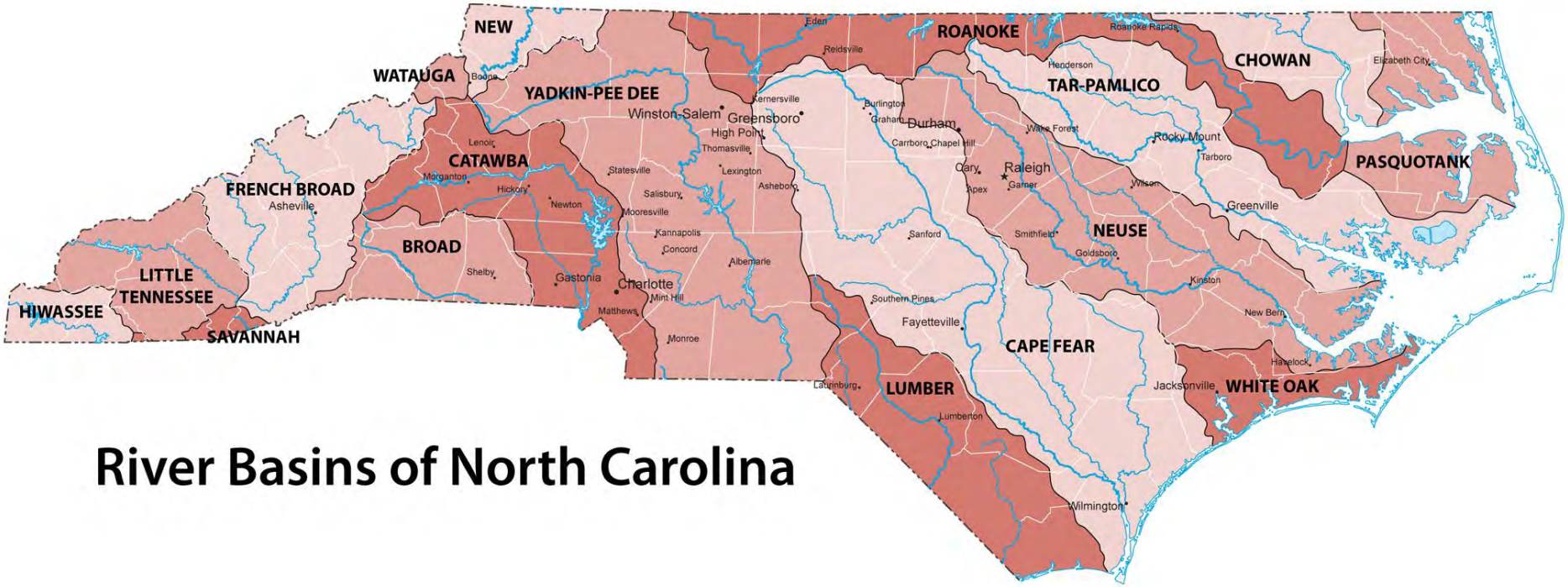
Vegetated Buffers & Living Shorelines


The urban water cycle
Condensation
Evaporation
Much less infiltration
Roofs, roads & paths stop infiltration
More runoff: More
Soil
Low groundwater flow
No rain: streams dry up
Rain: streams flood
Bedrock

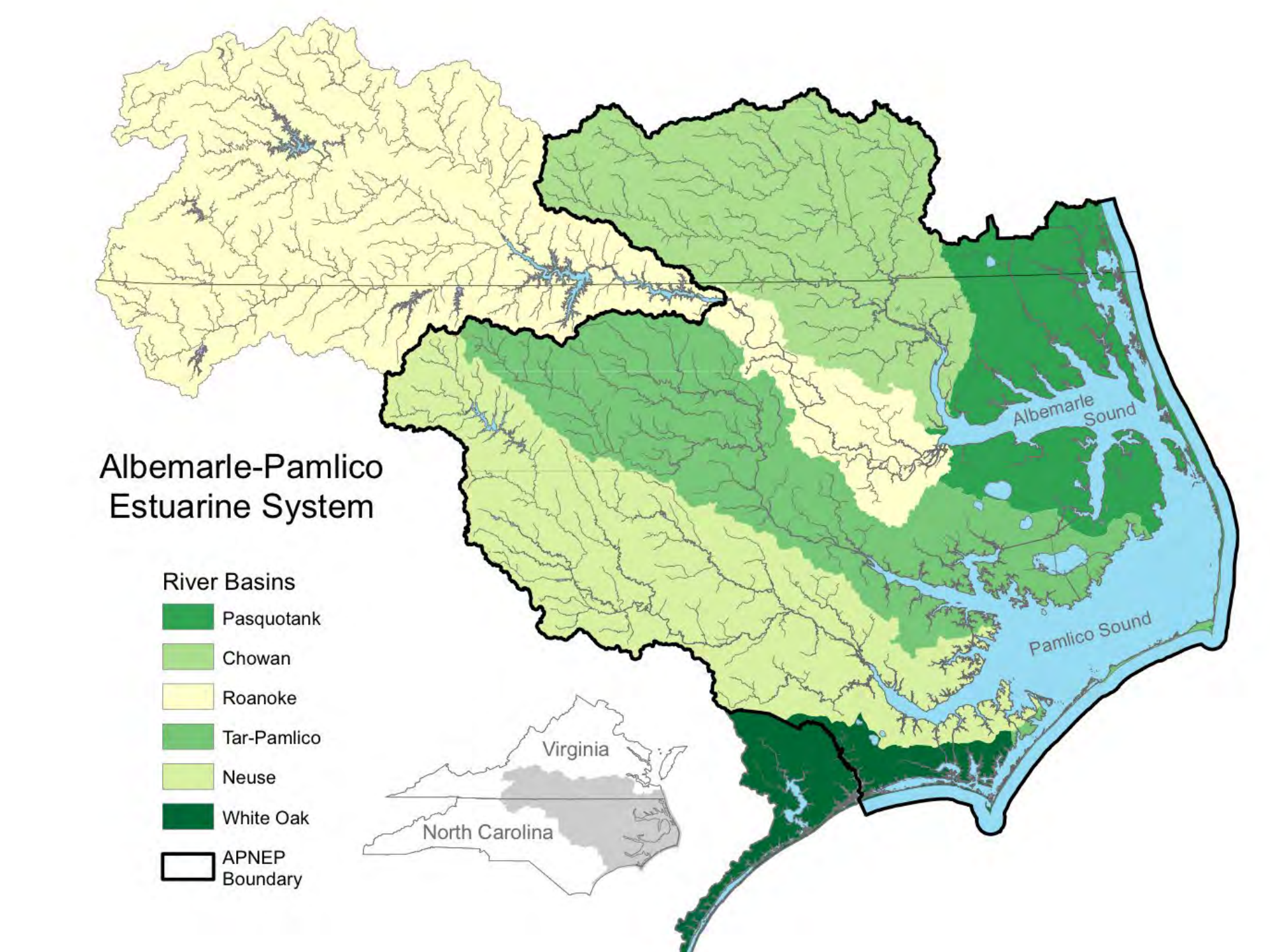
What is a Watershed?

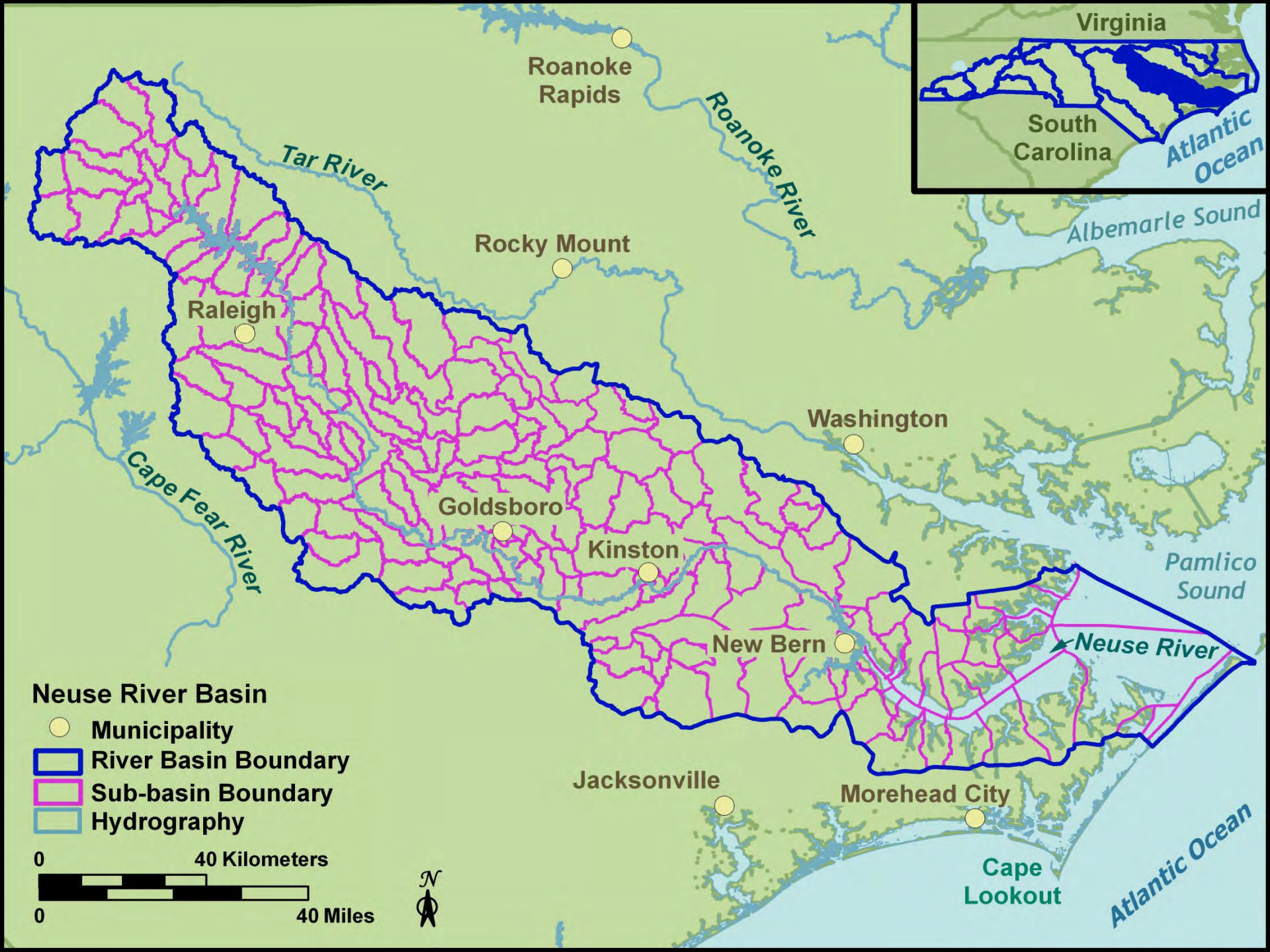
What is a Watershed?

What North Carolina river basin do you live in?

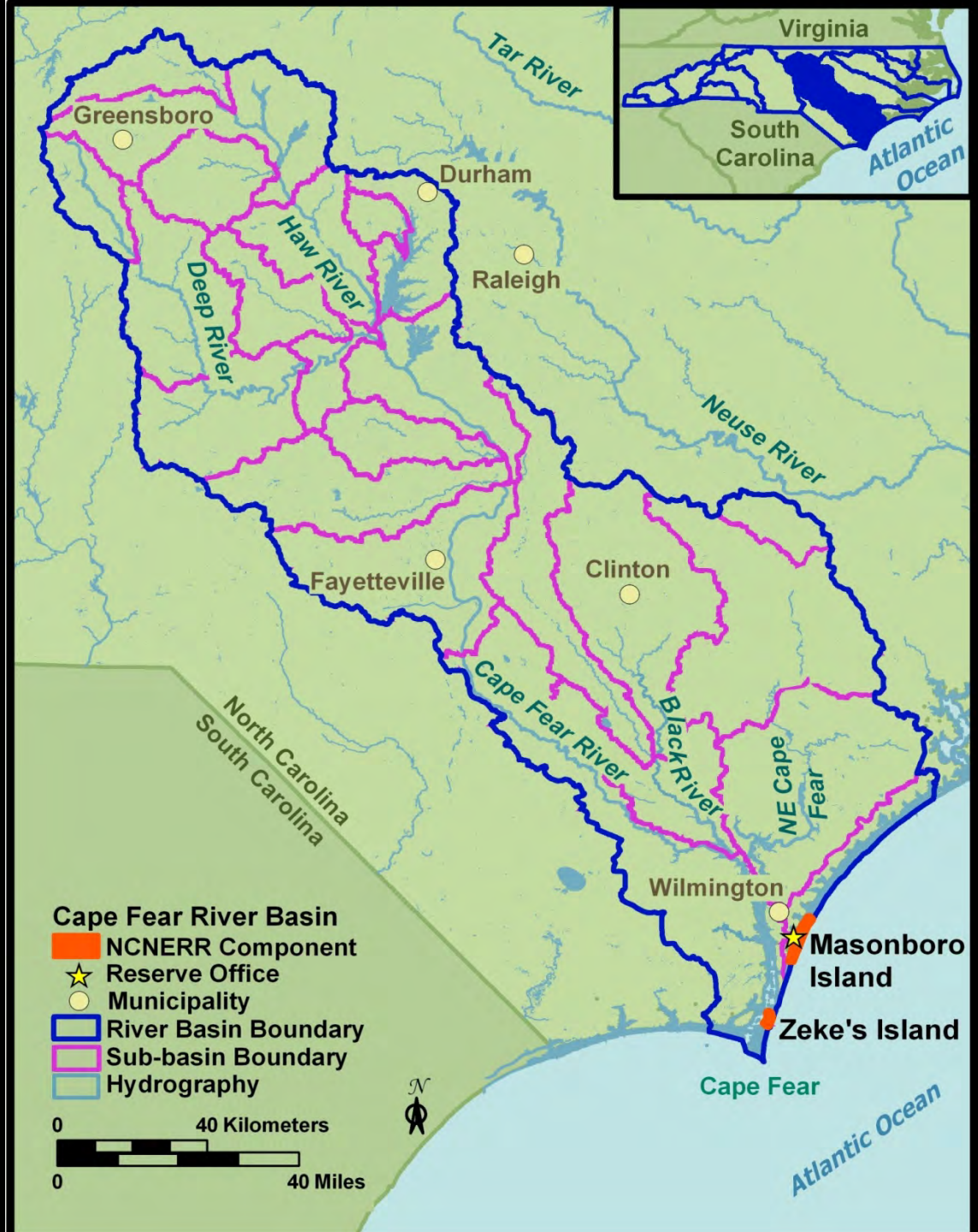


River Basins of North Carolina


Albemarle-Pamlico
Estuarine System
River Basins
Pasquotank
Chowan
Roanoke
Tar-Pamlico
Neuse
White Oak
APNEP
Boundary
Albemarle
Sound
Pamlico Sound
Virginia
North Carolina


Virginia
South Carolina
Atlantic Ocean
Roanoke Rapids
Roanoke River
Tar River
Albemarle Sound
Rocky Mount
Raleigh
Washington
Cape Fear River
Goldsboro
Kinston
Pamlico Sound
New Bern
Neuse River
Jacksonville
Morehead City
Cape Lookout
Atlantic Ocean
Neuse River Basin
Municipality
River Basin Boundary
Sub-basin Boundary
Hydrography
0
40 Kilometers
0
40 Miles
N


Virginia
South Carolina
Atlantic Ocean
New Bern
Pamlico Sound
Neuse River
Jacksonville
Swansboro
Morehead City
Core Sound
Bogue Sound
White Oak River
Cape Lookout
New River
White Oak River Basin
Municipality
River Basin Boundary
Sub-basin Boundary
Hydrography
0
20 Kilometers
0
20 Miles
N
Atlantic Ocean


Virginia
South Carolina
Atlantic Ocean
Tar River
Greensboro
Durham
Haw River
Deep River
Raleigh
Neuse River
Fayetteville
Clinton
Cape Fear River
Black River
NE Cape Fear
North Carolina
South Carolina
Wilmington
Masonboro Island
Zeke's Island
Cape Fear
Atlantic Ocean
Cape Fear River Basin
NCNERR Component
Reserve Office
Municipality
River Basin Boundary
Sub-basin Boundary
Hydrography
0
40 Kilometers
0
40 Miles
N

What are the intended uses of our water resources?

Intended Uses of Water Resources

- Aquatic life habitat
- Drinking water
- Swimming
- Fishing

What is a Water Quality Impairment?

The inability of a water resource to meet its intended uses.

For example, an estuary is impaired when high levels of bacteria ban the harvesting of oysters.

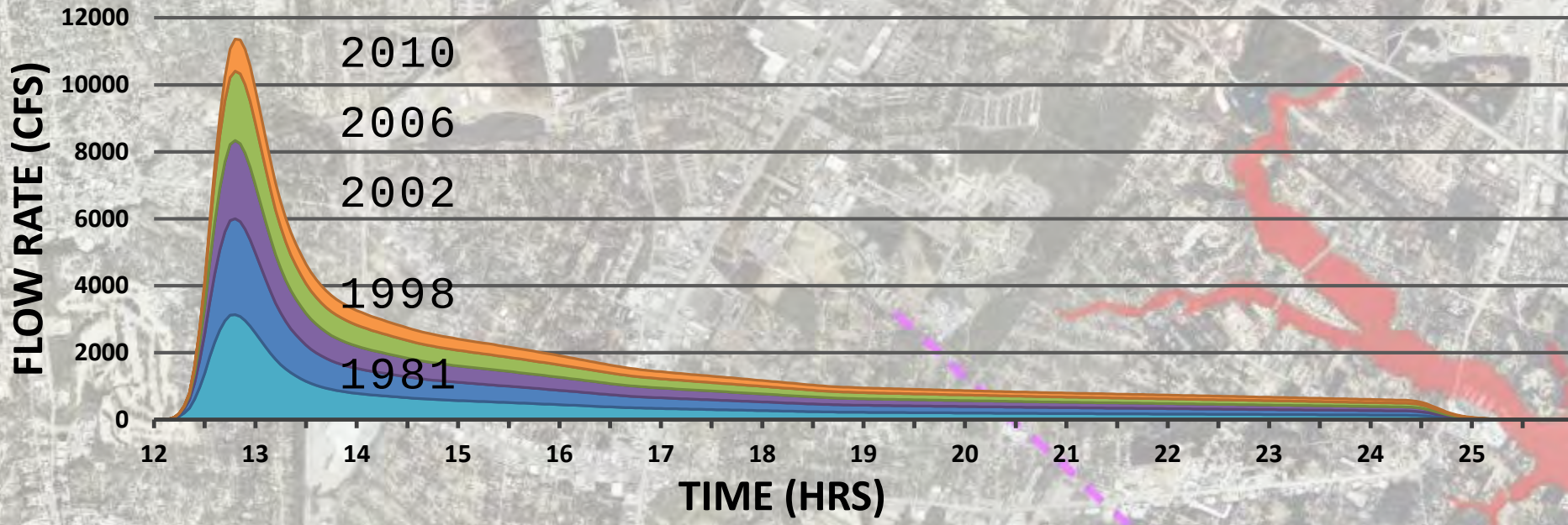
Shellfish Harvest Closure Map

https://ncdenr.maps.arcgis.com/apps/webappviewer/index.html?id=5759aa19d7484a3b82a8e440fba643aa

Swimming Advisory Map

http://portal.ncdenr.org/web/mf/testing-sites

HEWLETTS CREEK WATERSHED 1-YR STORM HYDROGRAPHS



CHANGES IN SHELLFISH CLOSURE BOUNDARIES

Pollution Sources: Point Source

Pollution Sources: Nonpoint Source

Pollutants of Concern

- **Nutrients**- nitrogen and phosphorus can lead to algal blooms, eutrophication, and fish kills
- **Microbes**- public health risk, can lead to closure of fishing areas and loss of revenue (i.e. bacteria, viruses, parasites)
- **Sediment**- clogs drainageways, clouds rivers, and degrades aquatic habitat

Nutrients

Nutrients

Eutrophication

Nutrients & Microbes

Nutrients & Microbes

Nutrients & Microbes

Nutrients & Microbes


Nutrients & Microbes

Nutrients & Microbes


Nutrients & Microbes


Nutrients & Microbes


CLOSED AREA
UNLAWFUL TO TAKE OYSTERS,
CLAMS, OR MUSSELS.
SHELLFISH MAY CAUSE
SERIOUS ILLNESS IF EATEN.
NC MARINE FISHERIES

ATTENTION

SWIMMING IN THIS AREA IS NOT RECOMMENDED. BACTERIA TESTING INDICATES LEVELS OF CONTAMINATION THAT MAY BE HAZARDOUS TO YOUR HEALTH. THIS ADVISORY AFFECTS WATERS WITHIN 200' OF THIS SIGN.

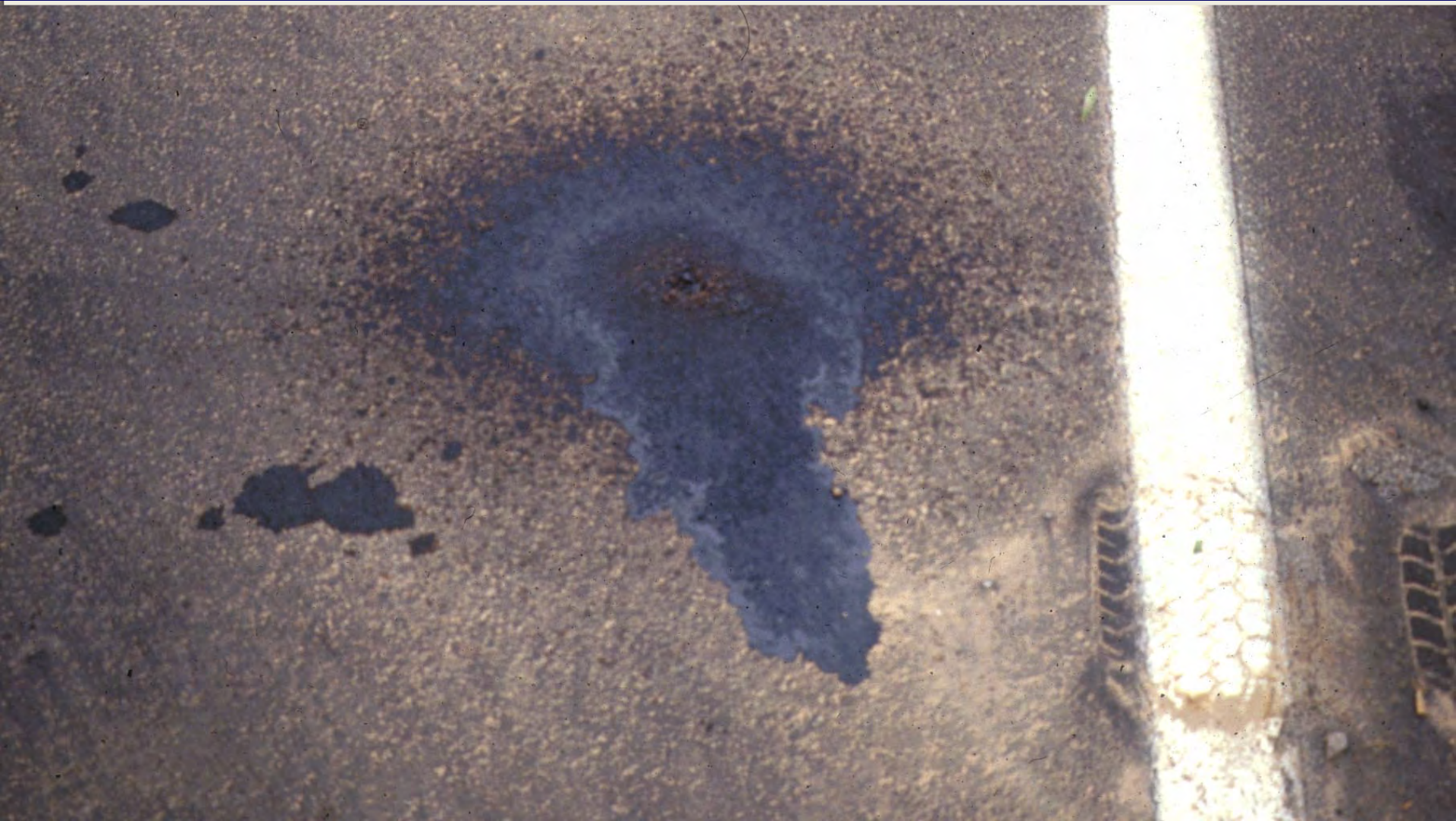
OFFICE OF THE STATE HEALTH DIRECTOR


Sediment
CAT
315C
CAT

Sediment


Sediment

Stormwater pollutants also include any materials that can build up on impervious surfaces: oil, grease, trash, auto fluids, dirt, etc.



So what's the bottom line...

- Everything is connected
- What we do on the land affects...
  - Water quality
  - Animal habitat
  - Our economy (i.e. tourism, commercial fishing)
  - Our quality of life
- It has been proven that conventional development does not protect water quality
- We can develop the land AND protect water quality


Towards a more sustainable urban water cycle
Condensation
Evaporation
Contaminated runoff
Soil
Stream
Much better infiltration
Wetland treatment
Bedrock

Final Quiz!

Algal Blooms

Submerged Aquatic Vegetation

Oyster Beds

Introduction to Low Impact Development

Borrowed from Dwane Jones

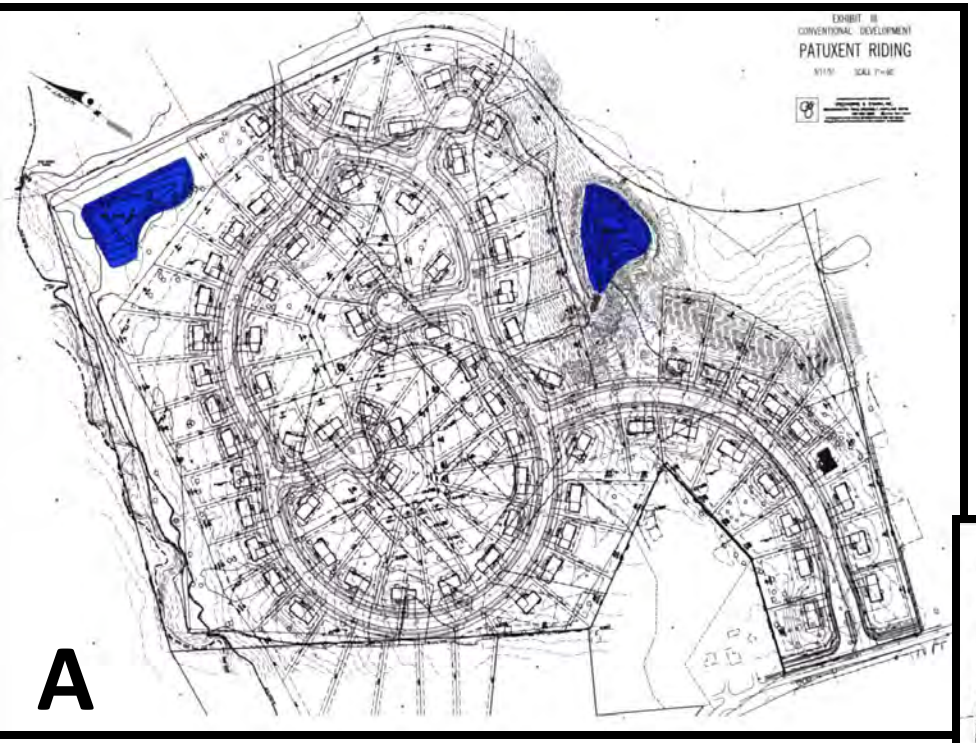
What is Low Impact Development (LID)?

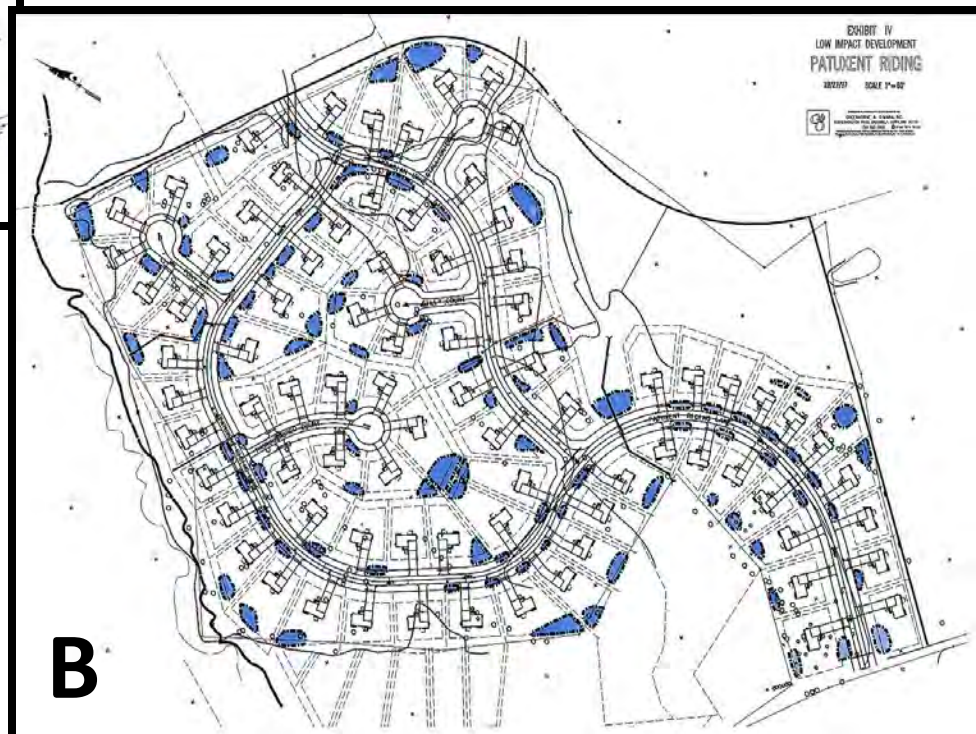
- Plan, design, construct, & manage each development site to protect, or restore, the natural hydrology of the site so that the overall integrity of the watershed is protected.

What is Low Impact Development (LID)?

- Hydrologically functional landscape
- Disconnecting impervious surfaces
- Reducing stormwater volume

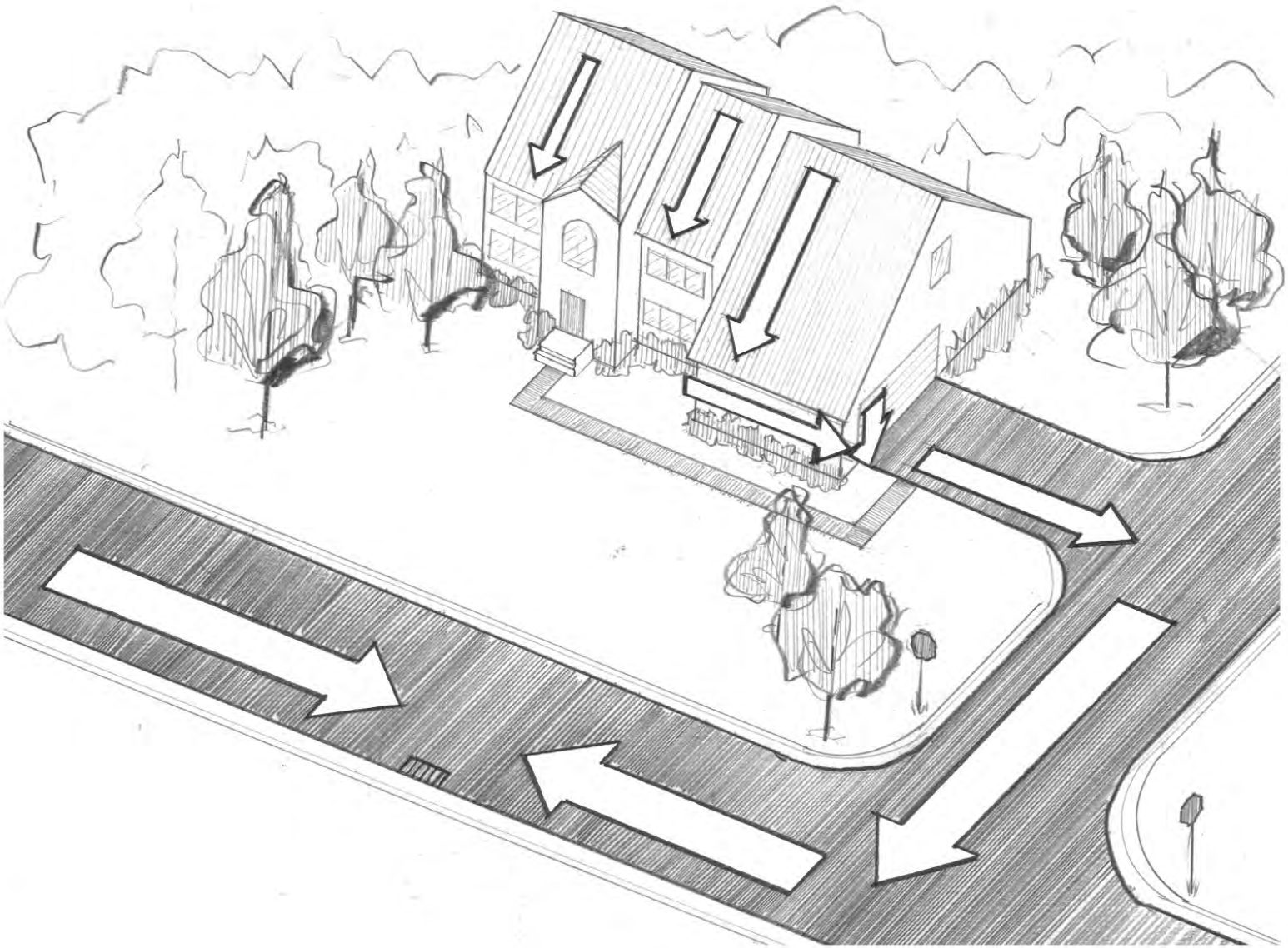
Which illustration accurately depicts LID?



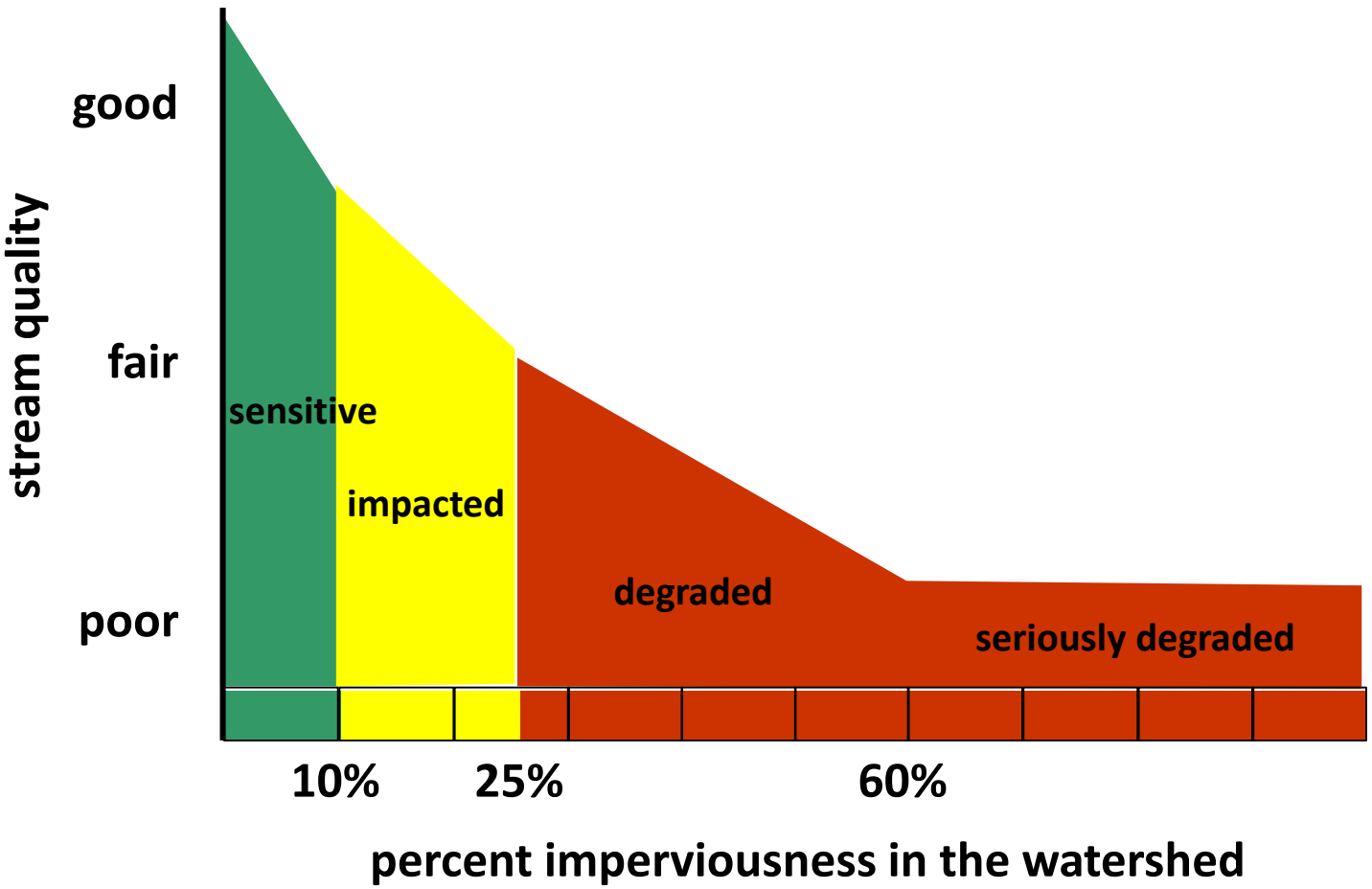


Conventional Development

The Stormwater “Super-Highway”



Imperviousness effects stream quality



Conventional Development

- Removal of all vegetation

Conventional Development

- Removal of all vegetation
- Compacting the soil

Conventional Development

- Removal of all vegetation
- Compacting the soil
- Putting in large areas of hard (impervious) surfaces

Conventional Development

- Removal of all vegetation
- Compacting the soil
- Putting in large areas of hard (impervious) surfaces
- Reduced infiltration

Conventional Development

- Removal of all vegetation
- Compacting the soil
- Putting in large areas of hard (impervious) surfaces
- Reduced infiltration
- Increased in surface runoff

Conventional Development

- Removal of all vegetation
- Compacting the soil
- Putting in large areas of hard (impervious) surfaces
- Reduced infiltration
- Increased in surface runoff
- Stormwater runoff overwhelms streams:
  - Causing flooding
  - Damaging public and private property
  - Polluting waterbodies and wildlife habitat

Conventional Development

Collect and convey stormwater runoff through storm drains and pipes

Conventional Development

This typically requires extensive use of pipes and sometimes large, costly, stormwater control measures.

Low Impact Development

The LID “Toolbox”

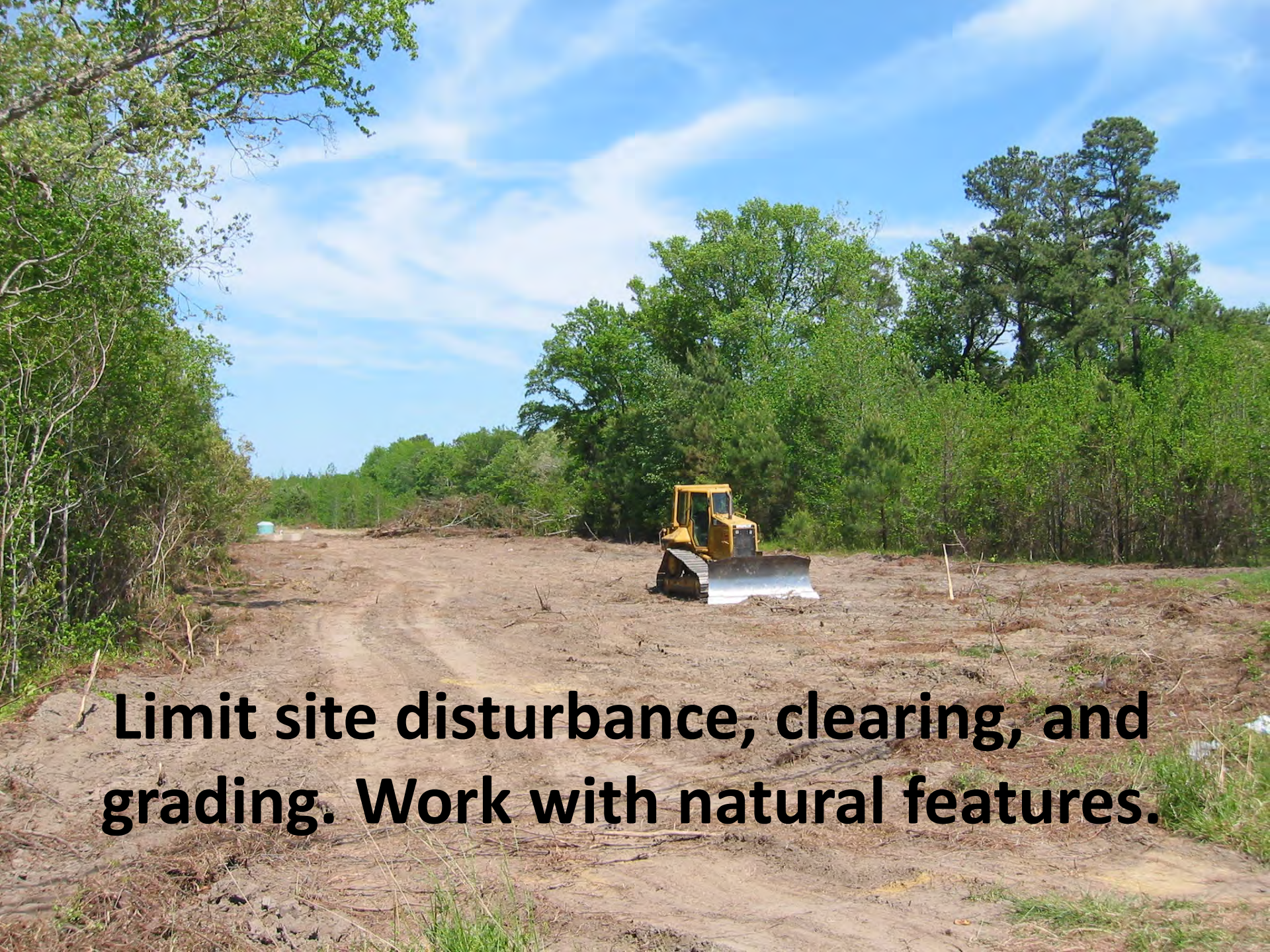
- There are many practices that make up LID

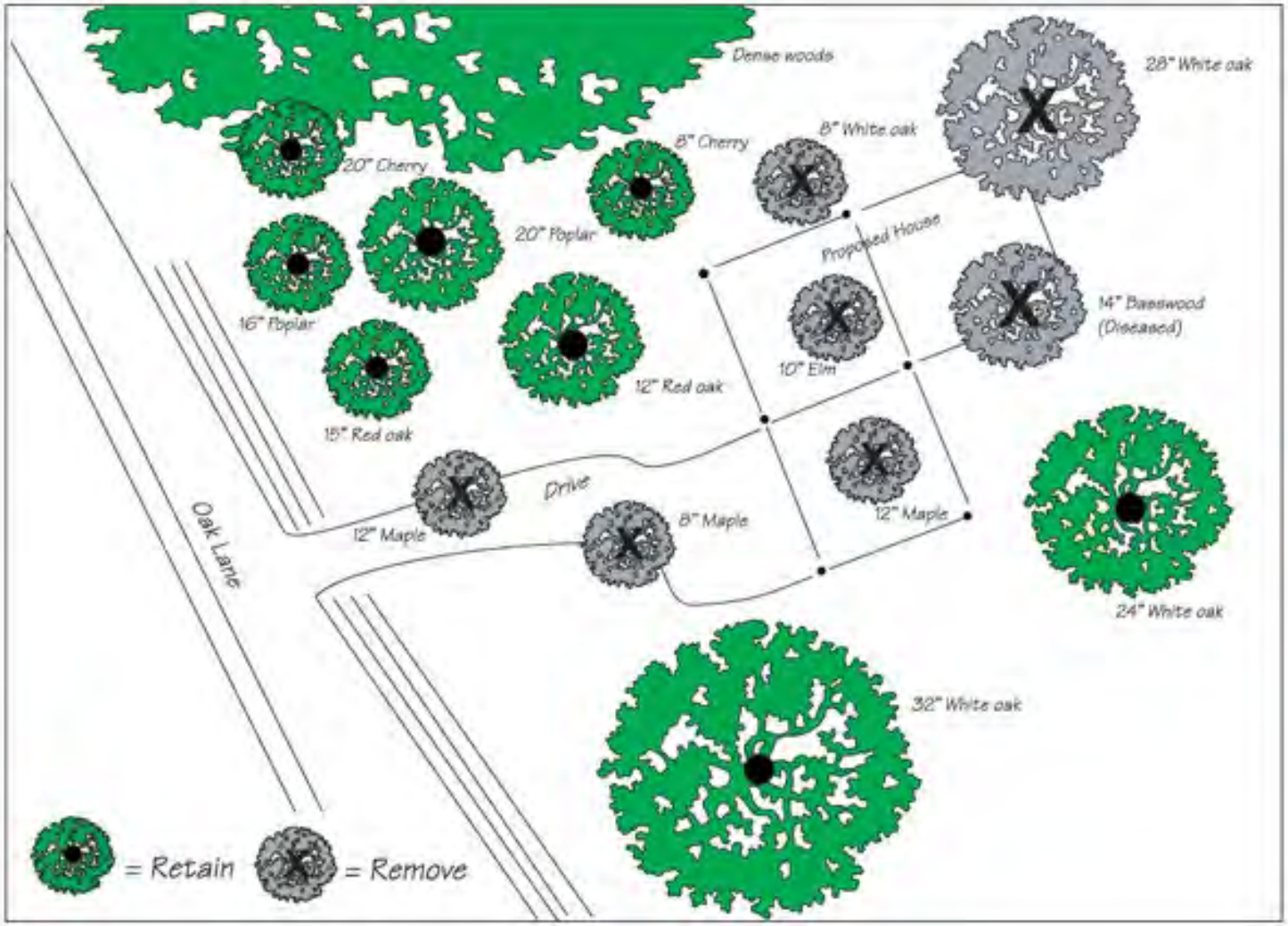
The LID "Toolbox"

- There are many practices that make up LID
- LID is not a one-size-fits-all approach

The LID "Toolbox"

- There are many practices that make up LID
- LID is not a one-size-fits-all approach
- Local conditions matter
  - High water table?
  - Clay soils?


Limit site disturbance, clearing, and grading. Work with natural features.


Dense woods
28" White oak
8" White oak
8" Cherry
20" Cherry
20" Poplar
Proposed House
16" Poplar
14" Basswood
(Diseased)
10" Elm
12" Red oak
15" Red oak
Drive
12" Maple
8" Maple
12" Maple
Oak Lane
24" White oak
32" White oak
= Retain
= Remove


Minimize Lot Clearing &
Promote Tree Conservation

Bioretention

- Many applications, including:
  - Parking lot islands
  - Median strips
  - Residential lots (e.g. rain gardens)
  - Office parks
- Landscape amenities, not just plumbing

Bioretention

Bioretention

Source: Chatham County Cooperative Extension - NC State University

Bioretention

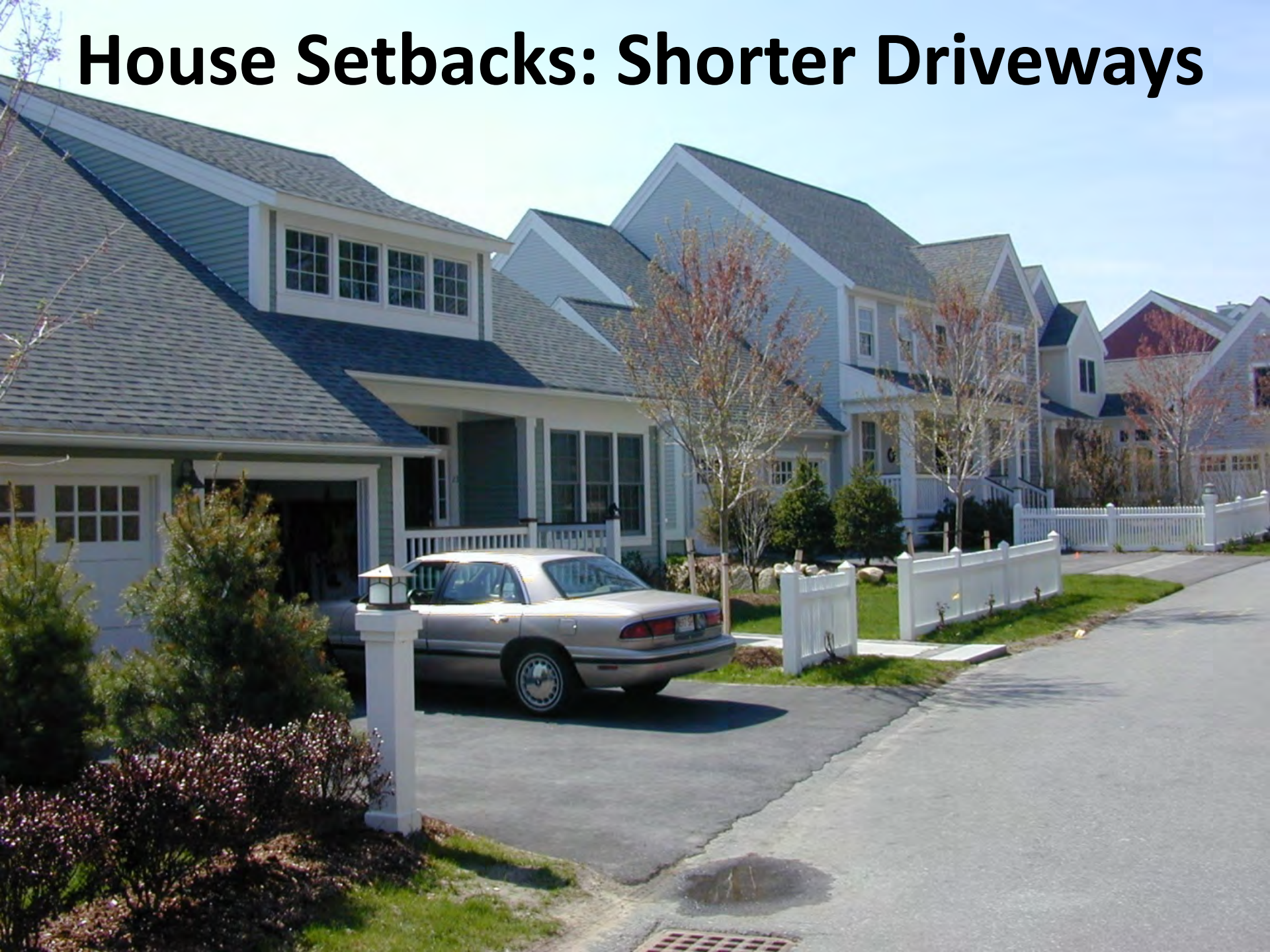
Bioretention

Shared Driveway

House Setbacks

- Relax side yard setbacks and allow narrow frontages to reduce total road length
- Relax front setback requirements to minimize driveway lengths

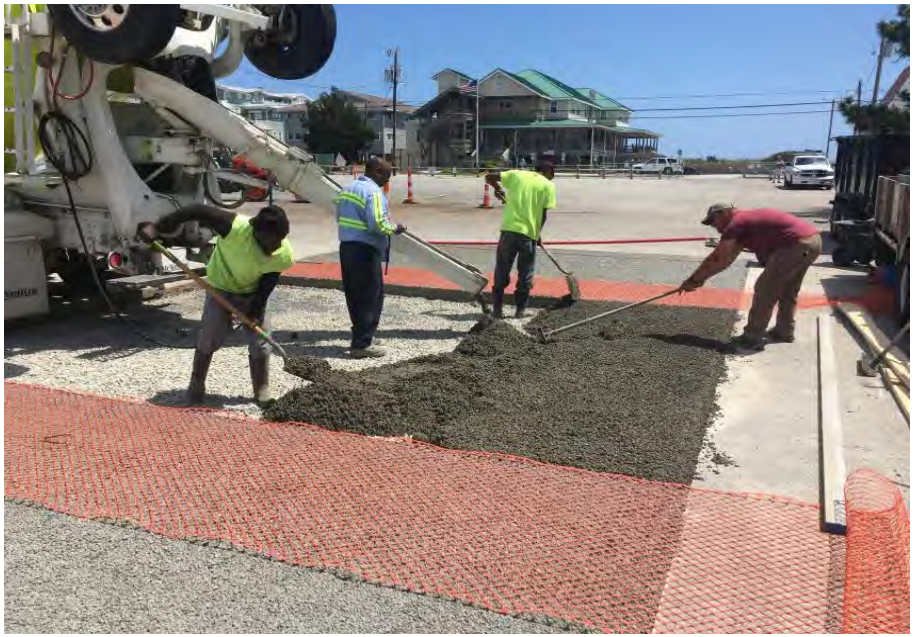
House Setbacks: Shorter Driveways



House Setbacks:
Room for Open Space

Permeable Paving

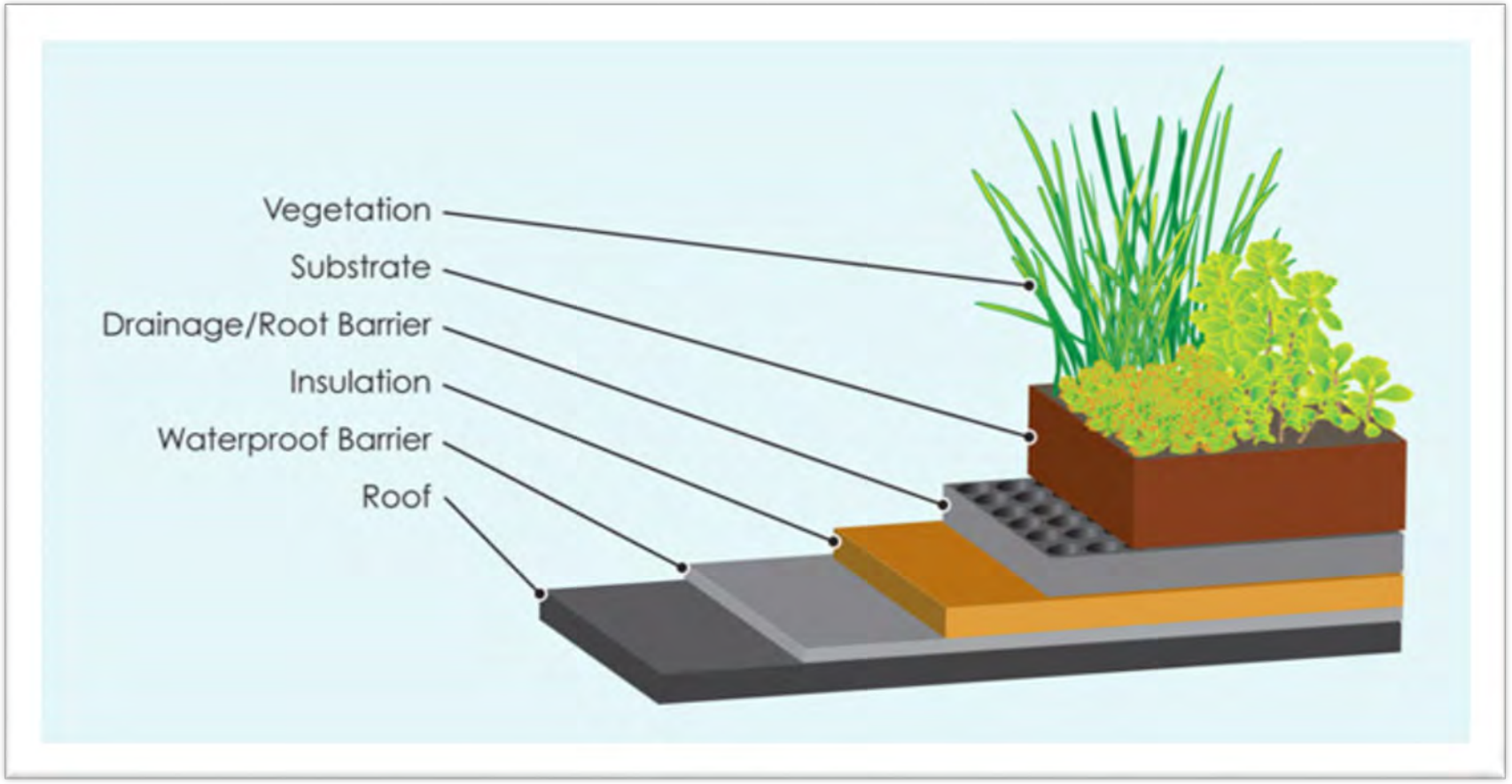
- Parking stalls
- Overflow parking
- Driveways
- Walkways




Pervious Concrete
Parking Lot
Storm Water Soaks Through Concrete
Less Runoff - Cleaner Water
NC STATE UNIVERSITY
STORM WATER SERVICES
Partners: City of Wilmington Storm Water Services and Parks & Landscape
Department, NC State University Cooperative Extension Service

Rooftop Runoff: Green Roofs

Green Roof Cross-Section



Source: www.greensulate.com/green_roofs.php

Rainwater Harvesting

- Irrigation
- Vehicle washing (fire trucks)
- Street sweepers
- Toilet flushing

Rainwater Harvesting

Retrofit Opportunities

Retrofit: Bioretention


Retrofit: Curb Cuts

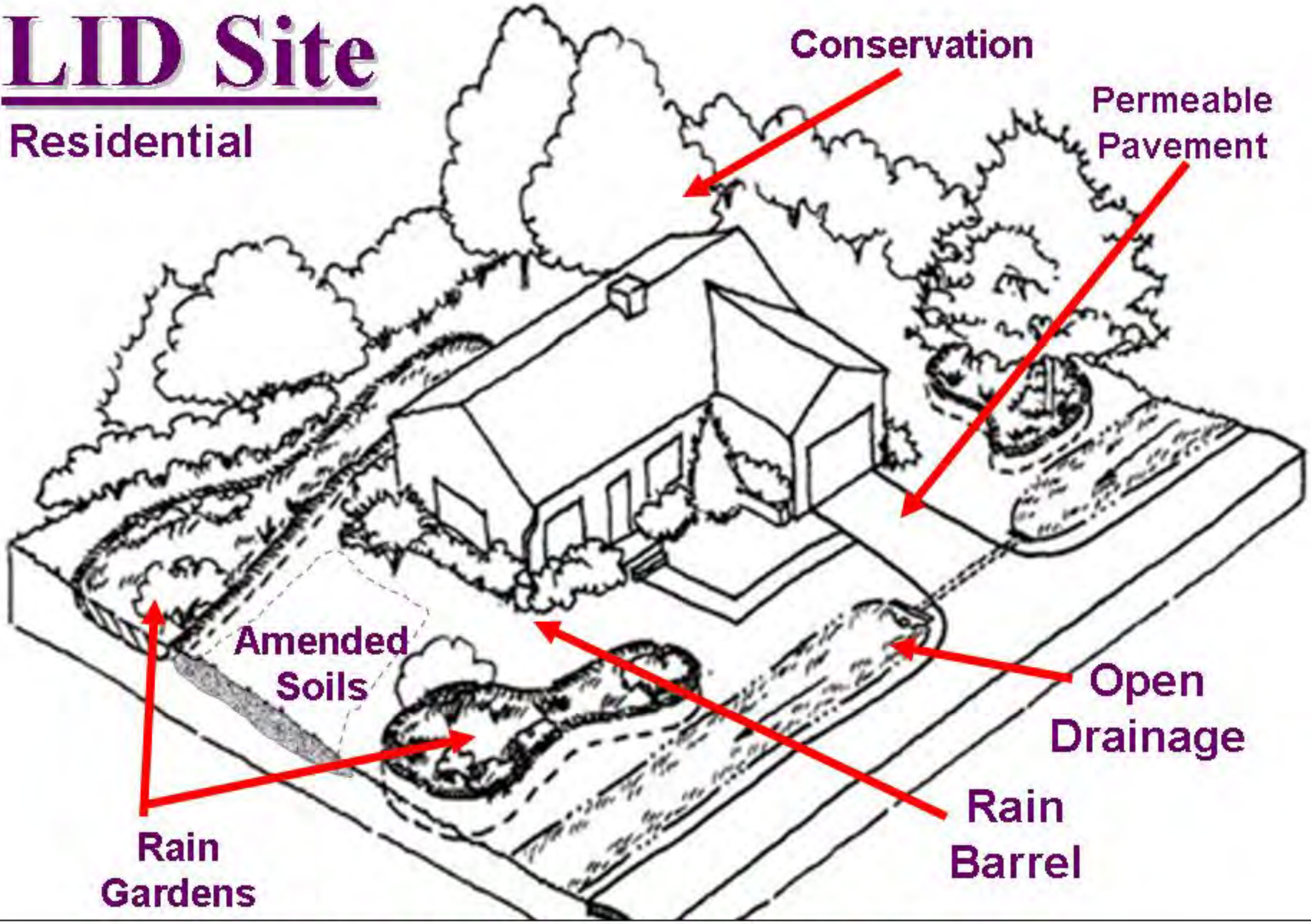
Retrofit: Stormwater Wetland

Retrofit: Stormwater Wetland

Retrofit: Stormwater Wetland

LID Site

Residential



Create a Hydrologically Functional Lot

Let's Compare…

LID	Conventional Development
Minimize land clearing	Removal of most or all native vegetation
Amended soils	Compacted soils
Minimize use of impervious surfaces	Excessive use of impervious surfaces
Infiltration	Costly Infiltration
Natural hydrology	Severely altered hydrology

Why LID?

- Reduced capital costs
- Reduced operating costs
- Marketing benefits
- Increased value
- Health & productivity gains
- Water quality benefits over conventional development
- Personal satisfaction through stewardship

Why Not LID?

- Outdated development codes
- Developers often not interested in "experimentation"
- Lawsuits? Lawsuits are often based on a deviation from standard practice
- Developers build what is selling; consumers buy what is on the market
- Some benefits not easily quantified or measured

Where can I get more information?

Low Impact Development
A Guidebook for North Carolina

North Carolina State University • June 2009 • Published by North Carolina Cooperative Extension

Low Impact Development
A Guidebook for North Carolina

www.onsiteconsortium.org/npsdeal/NC_LID_Guidebook.pdf

Low Impact Development in Coastal South Carolina

Project Description

The ACE Basin and North Inlet-Winyah Bay National Estuarine Research Reserves, the Center for Watershed Protection, and South Carolina Sea Grant Consortium were funded through a NERRS Science Collaborative grant to create a Low Impact Development Guide for Coastal South Carolina. This two-year project has provided local decision-makers with stormwater engineering specifications, land use planning resources, and site design practices that are tailored to the conditions of the South Carolina coast. Continue to check back to this page for more information as the project progresses.

- Project Decription

Low Impact Development in Coastal South Carolina: A Planning and Design Guide

Below are PDF files of the final document completed in September 2014. Chapter 4 is included as the full chapter, and separate PDFs for each specification.

Low Resolution Version
(good for viewing online)
Full Low Resolution Document

Indvidual Chapters

Introduction

Chapter 1

Chapter 2

Chapter 3

Chapter 4 (full)

4.1 Introduction

4.2 Bioretention

High Resolution Version
(good for printing)
Full High Resolution Document

Individual Chapters

Introduction

Chapter 1

Chapter 2

Chapter 3

Chapter 4 (full)

4.1 Introduction

4.2 Bioretention

Low Impact Development in Coastal South Carolina

www.northinlet.sc.edu/lid/

Summary

As our state continues to develop, the need for effective stormwater management will also grow.

Summary

Water quality regulations are often reactive measures to degraded environmental conditions. As responsible citizens, we should focus on preventative actions to safeguard our natural resources.

Summary

In the long run, doing what is good for the environment is good for the economy. Clean water and healthy habitats makes coastal real estate more desirable.