Water in our World

Dr. Janet MacFall
Dept. of Environmental Studies

https://www.youtube.com/watch?v=D1ZYhVpdXbQ

Why do we need water for life as we know it?

http://www.wyndham.com/hotels/ontario/niagara-falls/wyndham-garden-niagara-falls-fallsview/hotel-overview

How do we define “life”?

Why do we need water?

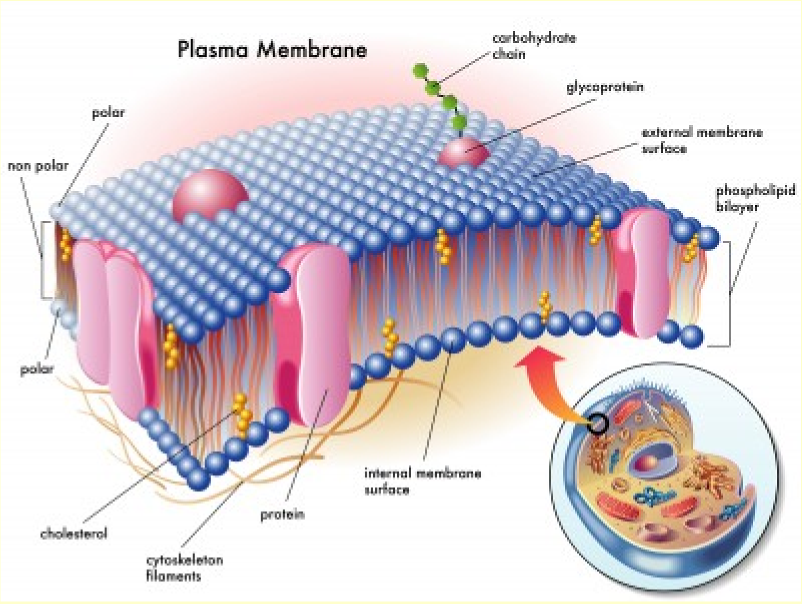
- Temperature regulation
- Solute transport into organisms and cells
- Transport out of organisms and cells
- Holding protein shape
- Photosynthesis – the foundation for food chains and energy storage/transfer for life
- Breakdown (digestion) of molecules

(http://nutrition.jbpub.com/resources/animations.cfm?id=7)

- How we define life on earth!

Life is made of CELLS!

And cells are bounded by a Membrane!



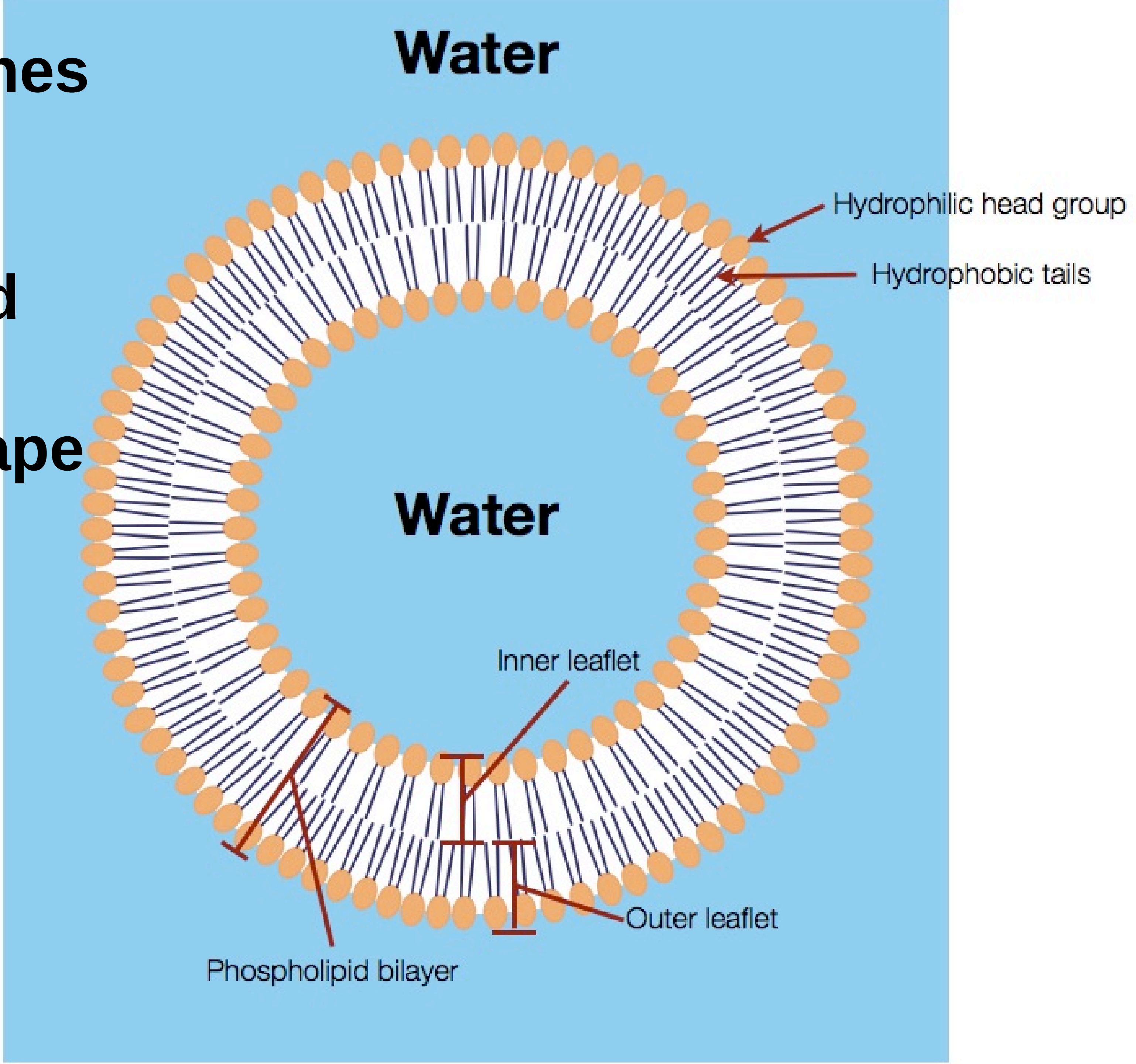
http://biology.tutorvista.com/animal-and-plant-cells/plasma-membrane.htm

Membrane video

https://www.youtube.com/watch?v=Pfu1DE9PK2w

https://www.youtube.com/watch?v=VhUIIONM6A0

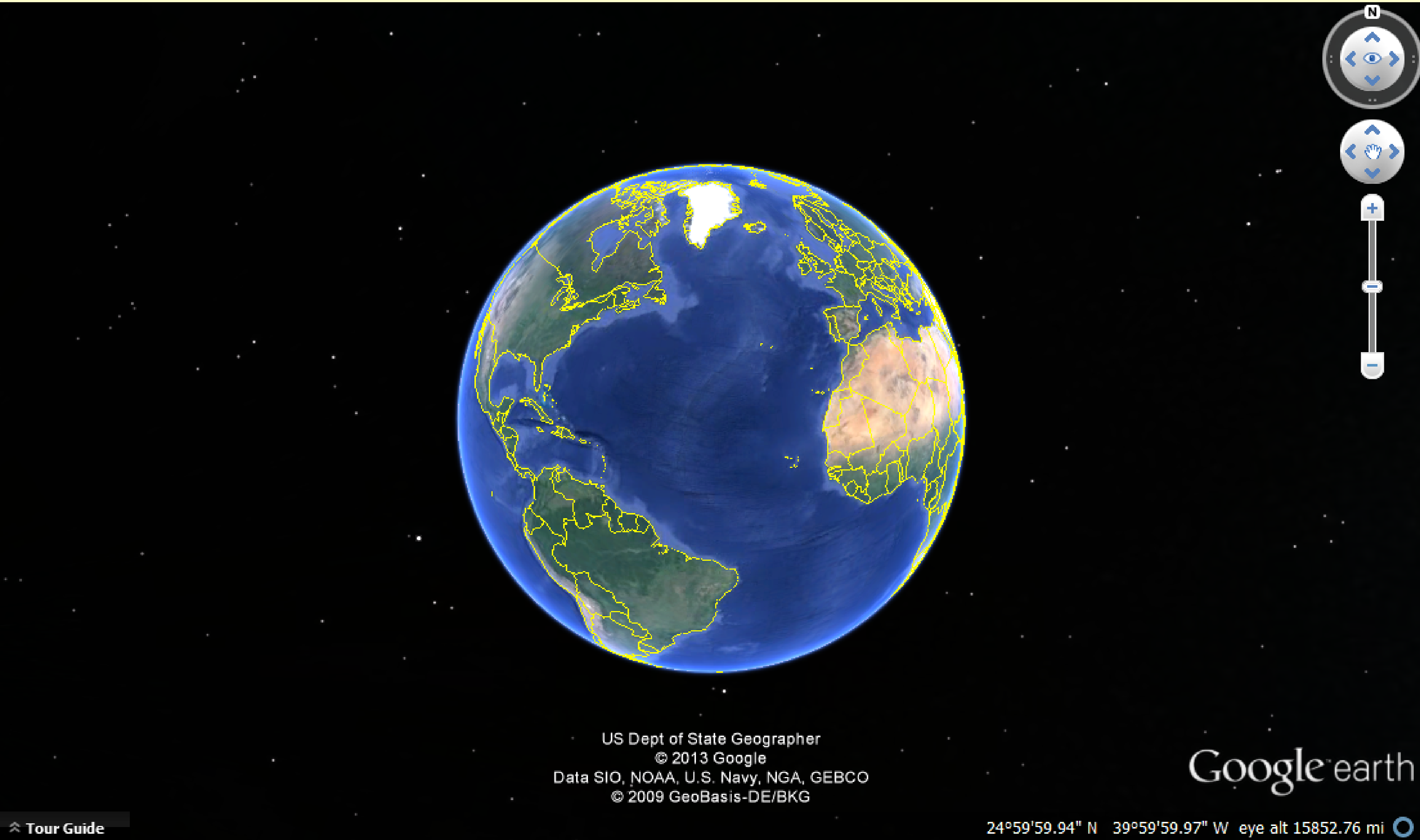
Membranes NEED Water to hold The Cell Shape



No Membranes

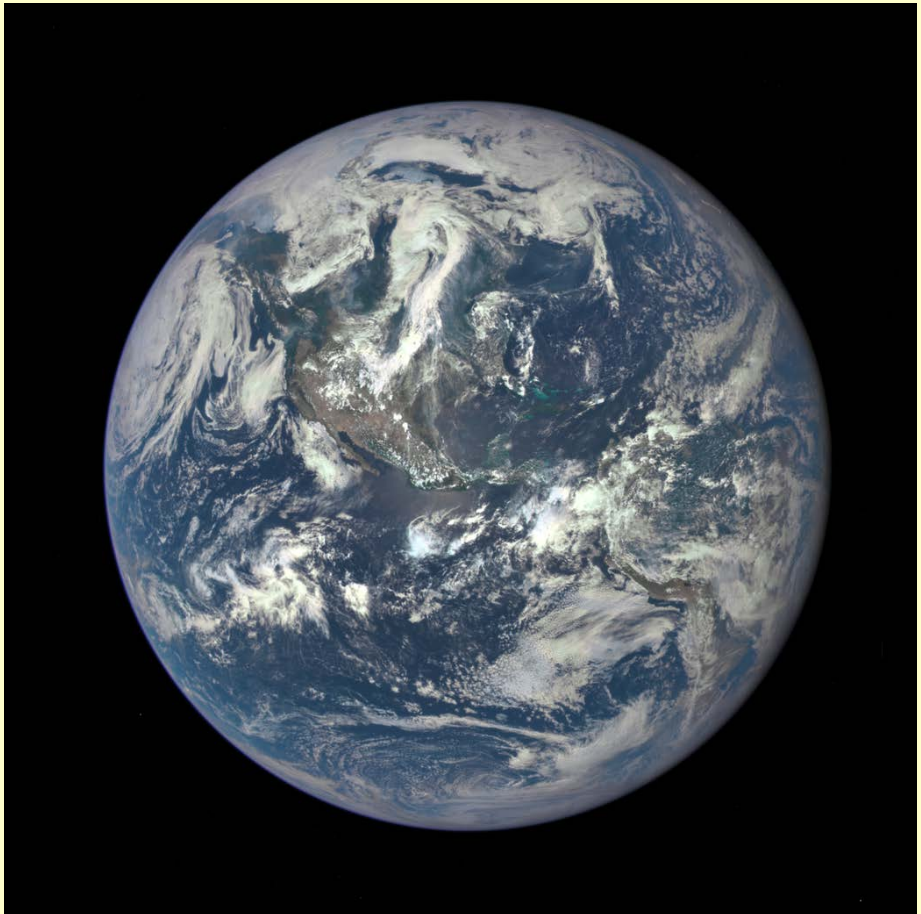
NO Life!!!

Is there **Water** in space?



Humans and Water

Human influence on watershed hydrology and water quality is extensive, global and profound



Humans and Water

Human influence on watershed hydrology
and water quality is extensive, global and profound

- Dam construction with water impoundment
- Diversion structures
- Runoff alterations
- Groundwater withdrawals
- Agricultural use/irrigation
- Interbasin transfers
- Domestic use
- Industrial use
- Addition of pollutants
- Loss of shade, temperature pollution
- Use for energy production – nuclear, coal, hydro

80% of all diseases in the developing world
are linked to unsafe water and poor sanitation

The issue?

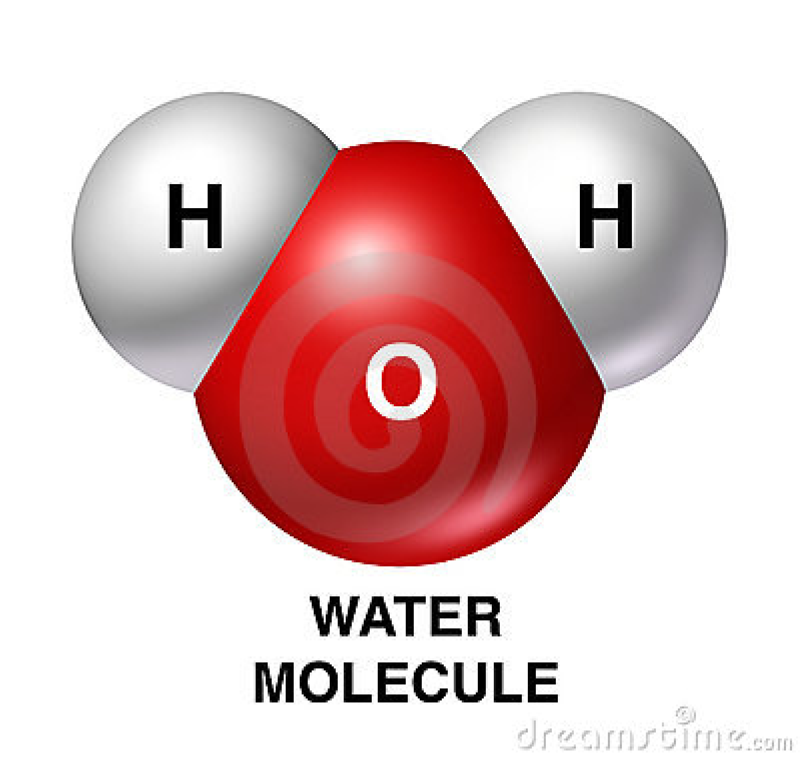
- Access to sufficient water
- Metallic contaminants
- Nutrient contaminants
- Organic contaminants
- Microbial contaminants

Result?

More than five million deaths annually
with more than half being children

Where is the water?

What are the parts of the "hydrologic cycle"?



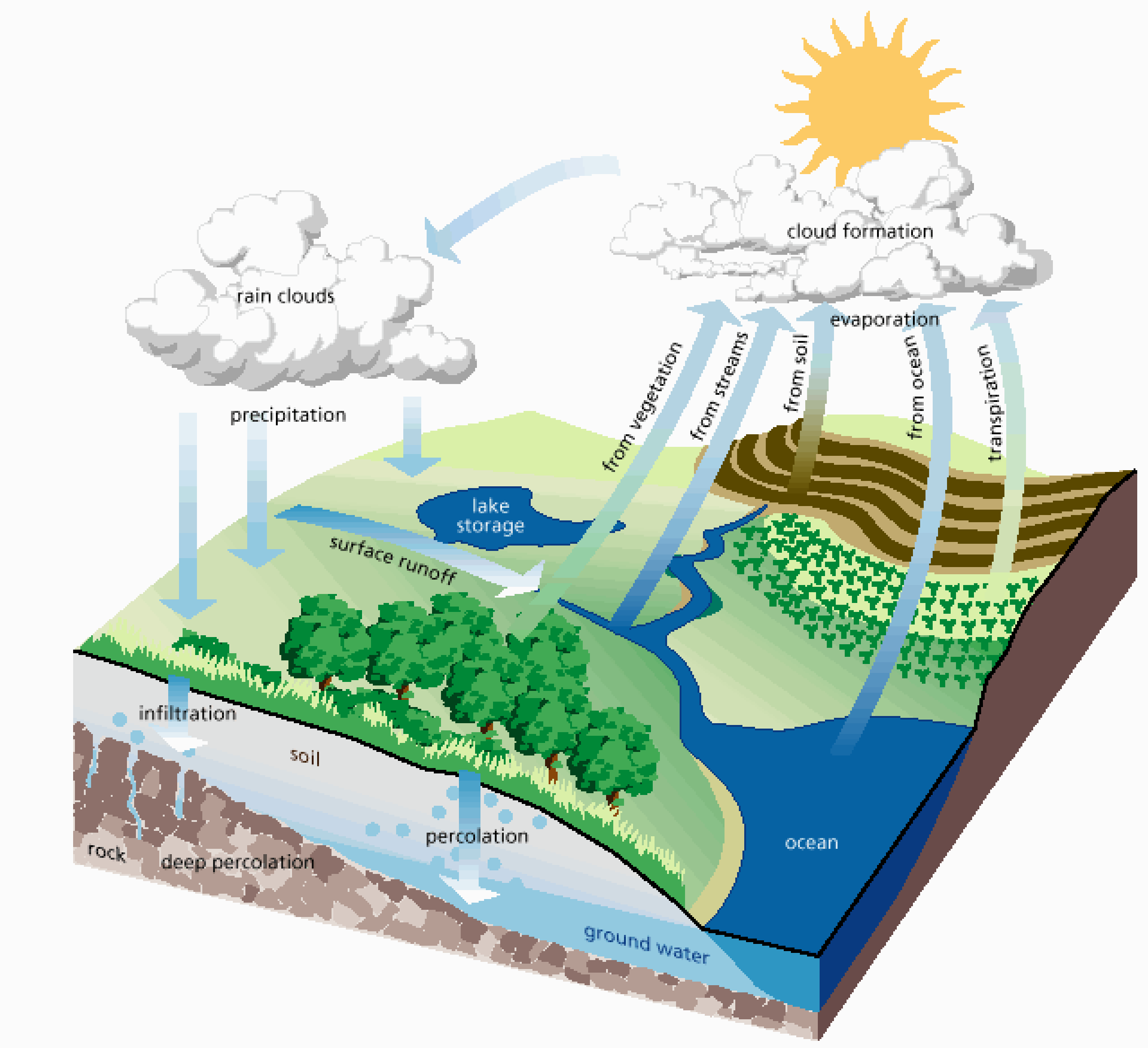
http://www.dreamstime.com/stock-images-h2o-water-molecule-image47631

Biogeochemical cycling of water

What we call the hydrologic cycle

What does it look like?

Water Cycle

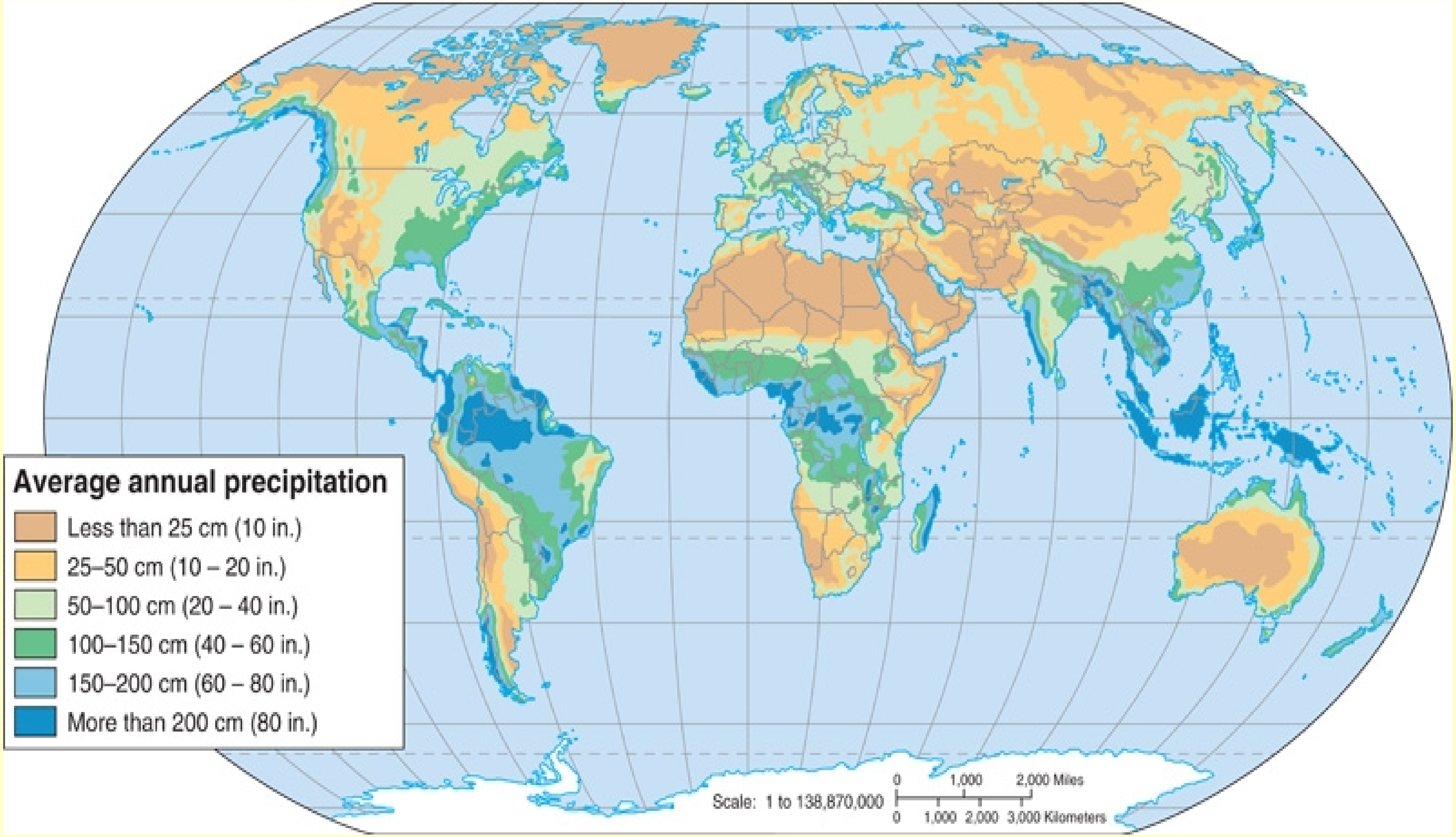

cloud formation
rain clouds
evaporation
from vegetation
from streams
from soil
from ocean
transpiration
precipitation
lake storage
surface runoff
infiltration
soil
percolation
rock
deep percolation
ocean
ground water

Hydrologic Cycle

Water moves through the:

- Hydrosphere
- Atmosphere
- Lithosphere
- Biosphere

Mean Annual Precipitation



Multi-model projected patterns of precipitation changes

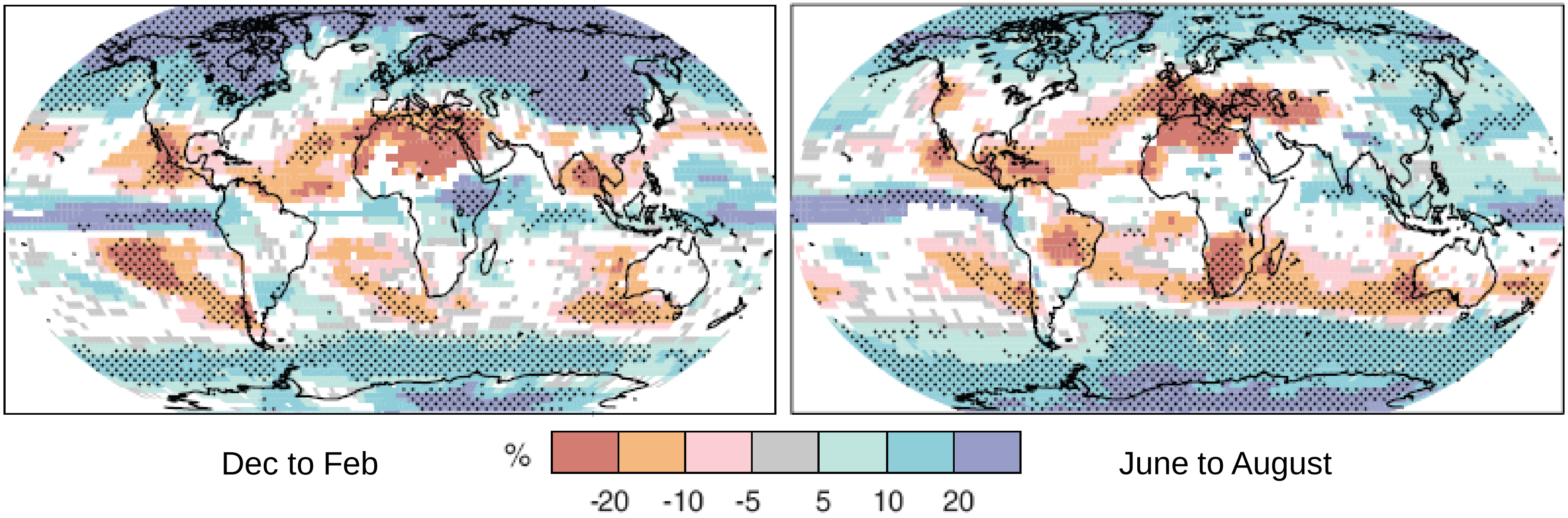
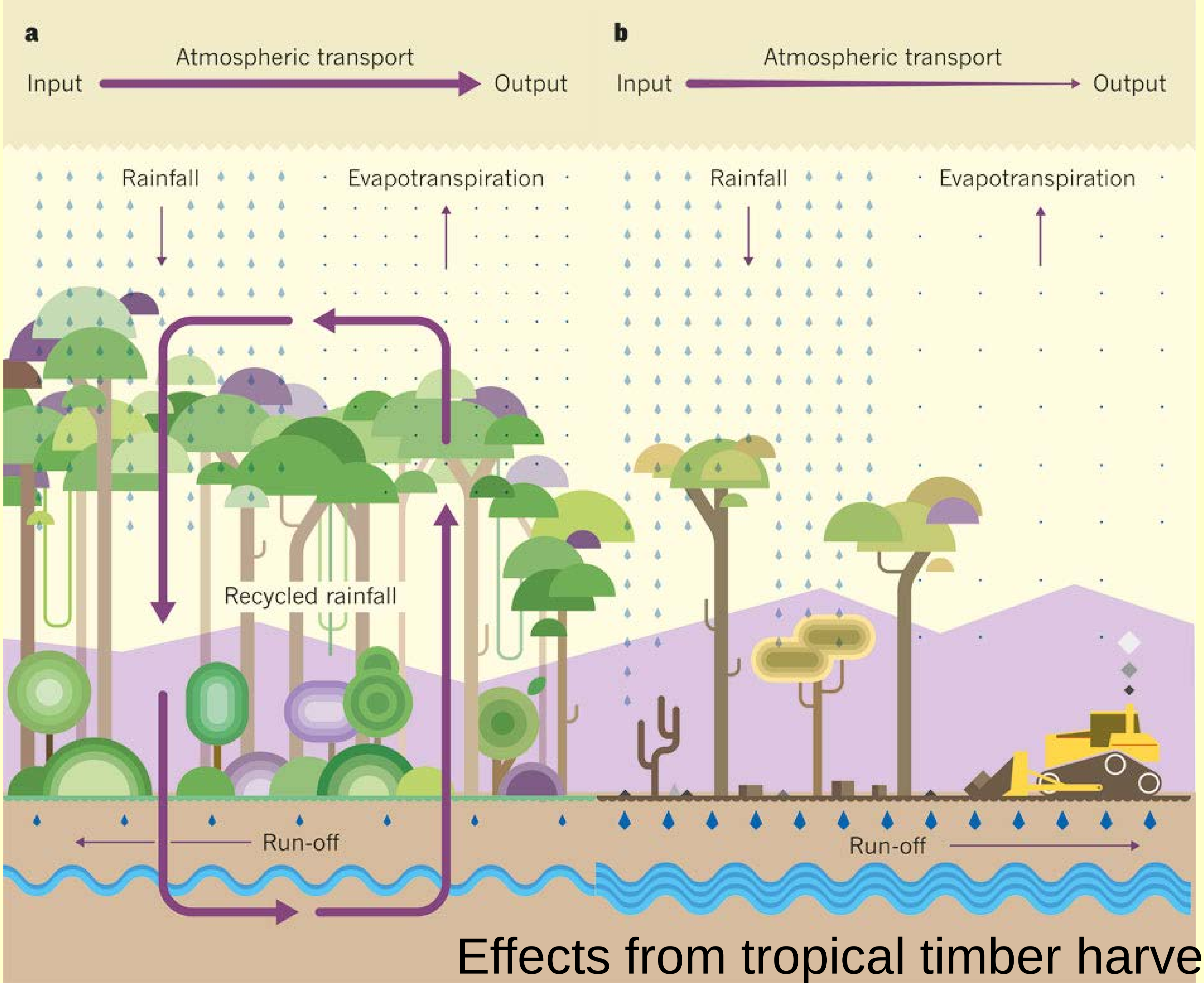


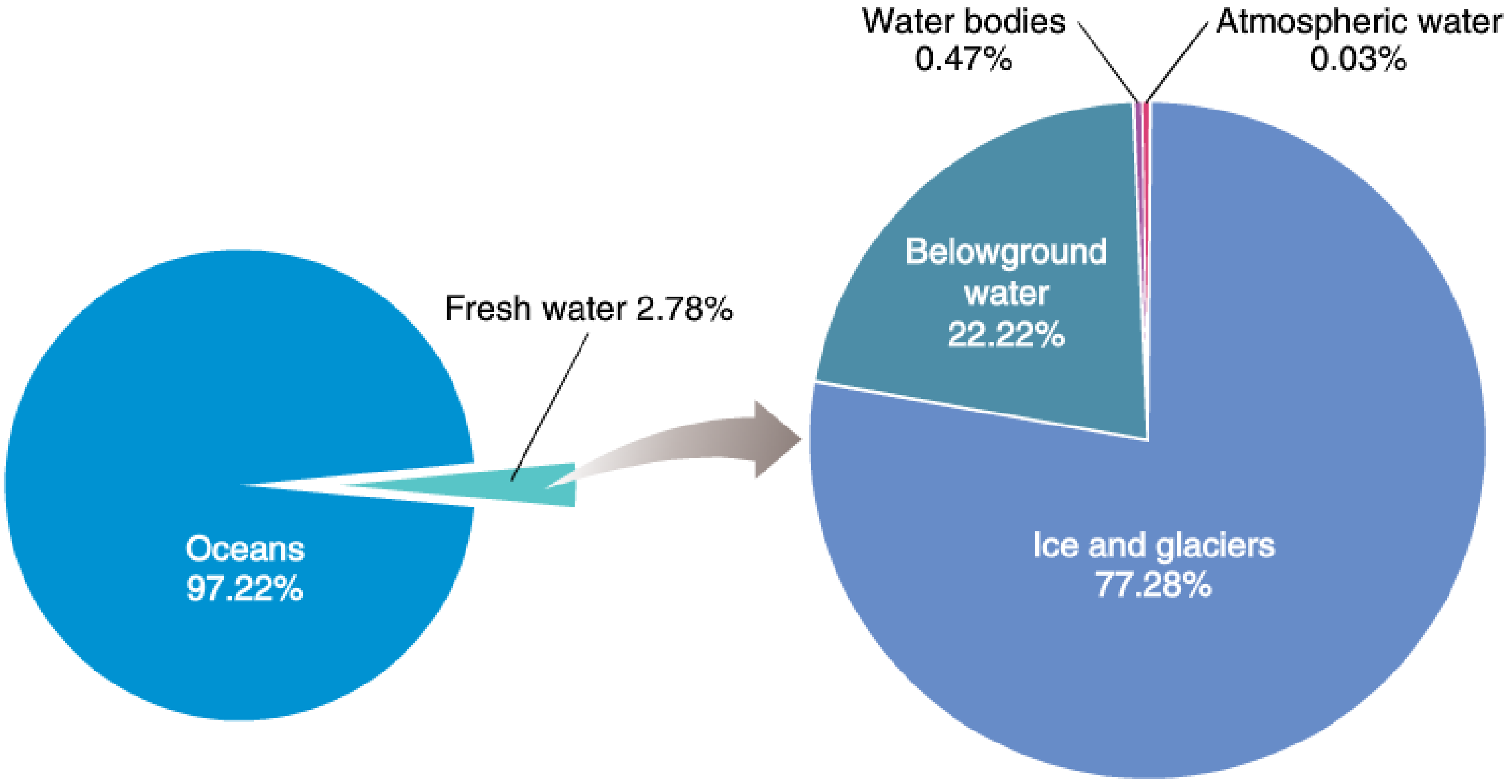
Figure 3.3. *Relative changes in precipitation (in percent) for the period 2090-2099, relative to 1980-1999. Values are multi-model averages based on the SRES A1B scenario for December to February (left) and June to August (right). White areas are where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the change. {WGI Figure 10.9, SPM}*



Effects from tropical timber harvest

Major Water Compartments

Major water sources



How much water is there?

Oceans & seas – 97.41%

Freshwater – 2.59%

- Ice – 1.984%
- Available fresh water – 0.606%
  - Groundwater - .592%
  - Lakes - .007%
  - Soil moisture - .005%
  - Rivers - .0001%
  - Biota - .0001%
- Accessible available water - .003%

Major Water Compartments

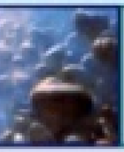
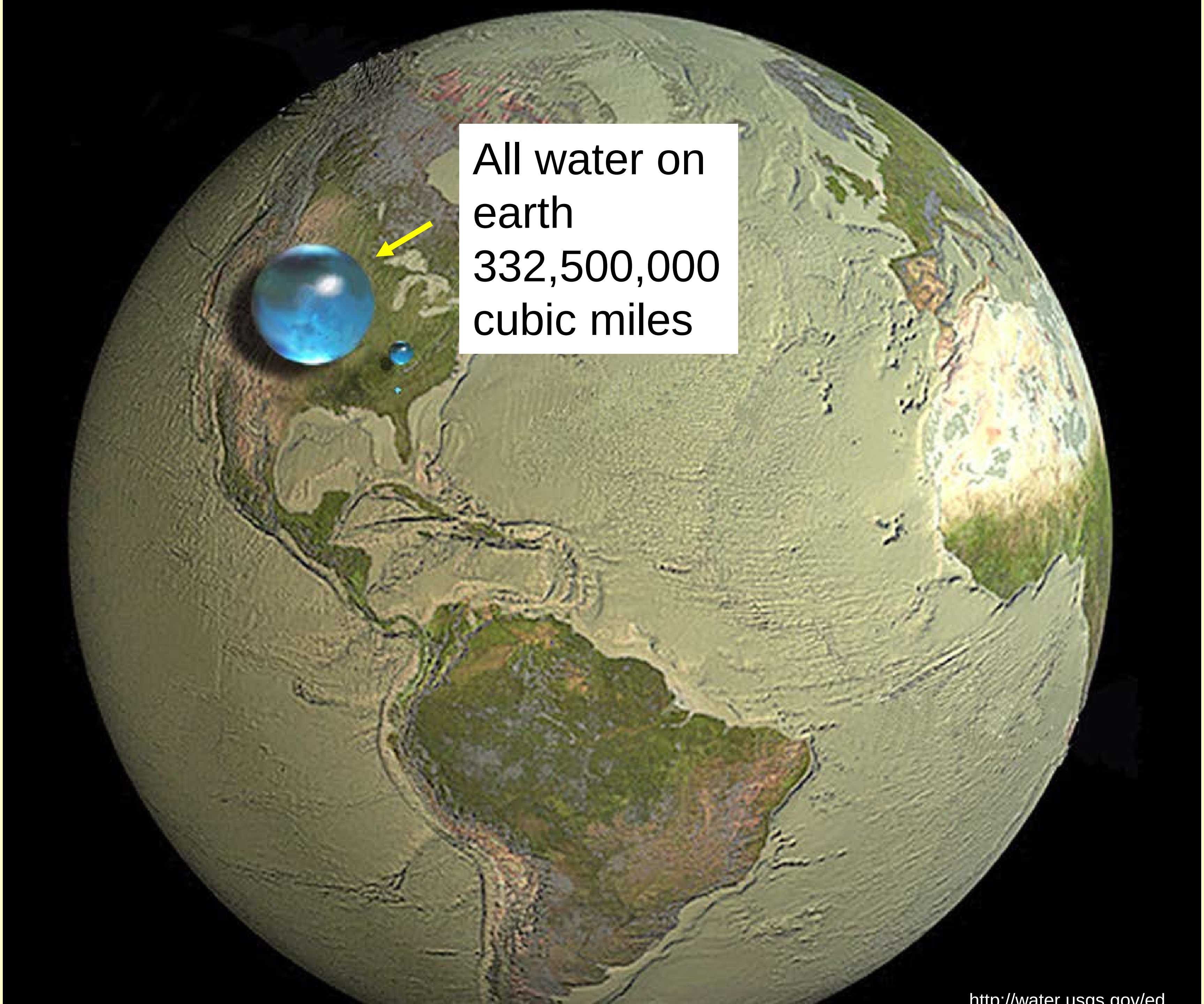


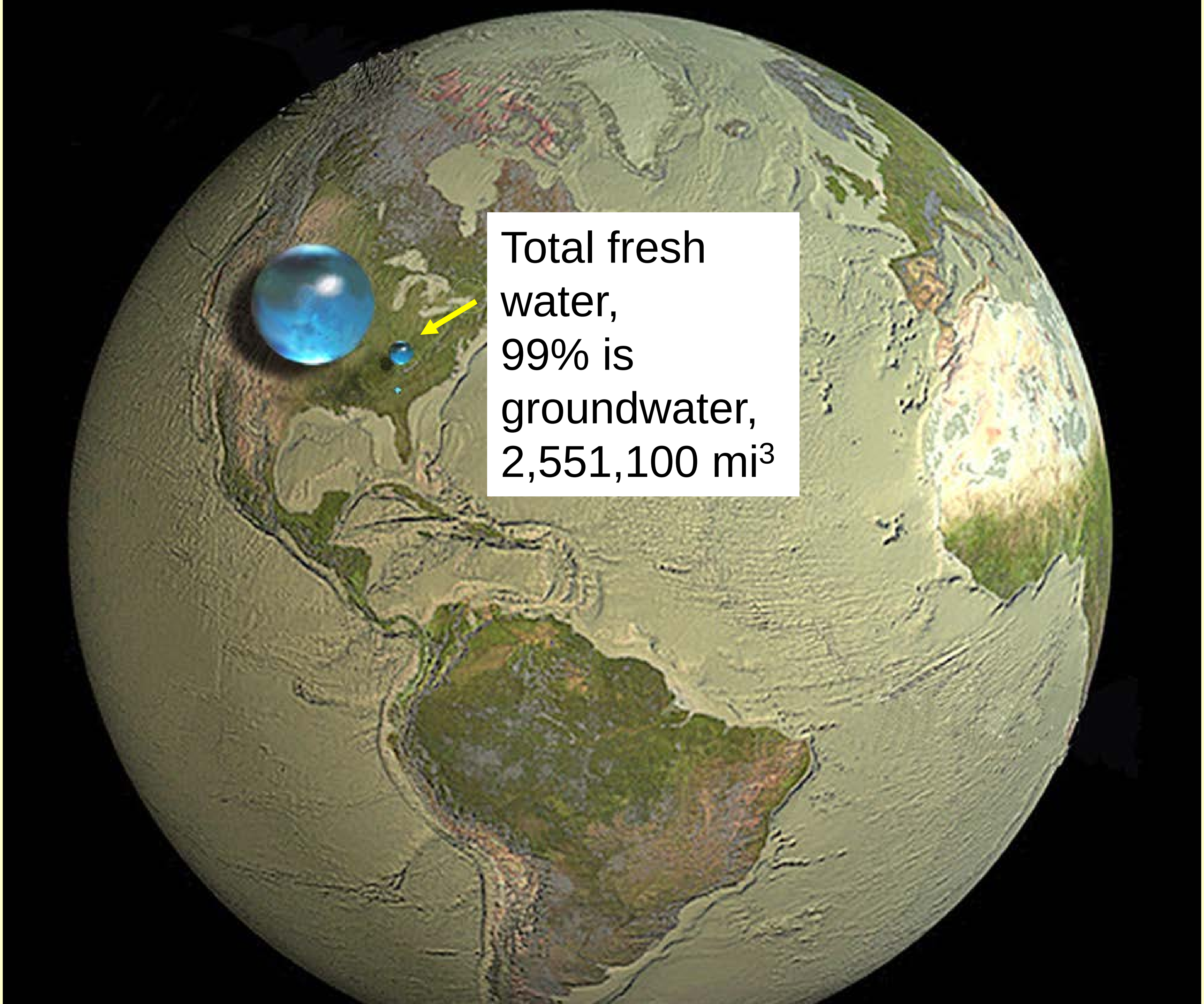
TABLE 10.2 Earth's Water Compartments

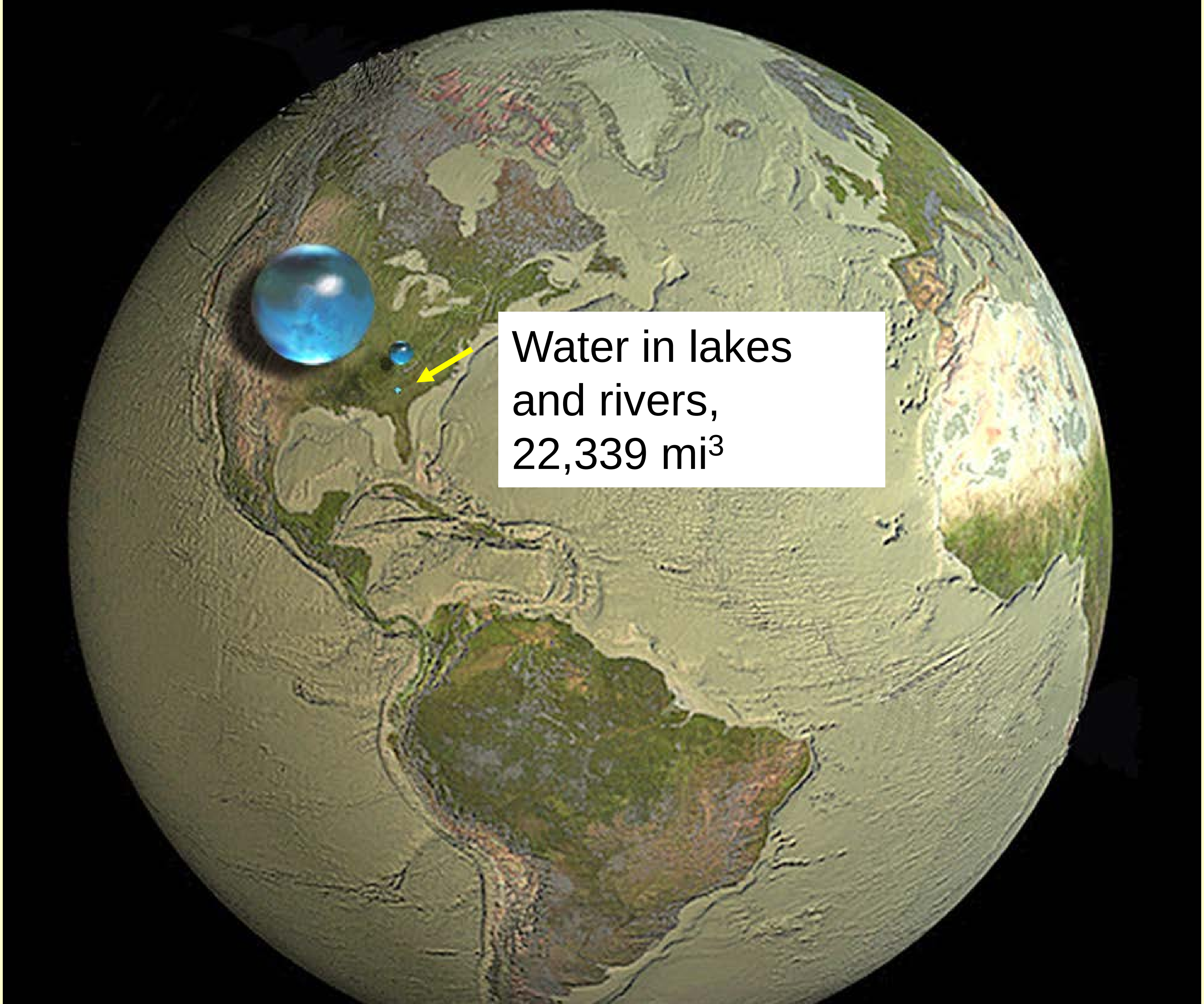
COMPARTMENT	VOLUME (1,000 KM^3)	PERCENT OF TOTAL WATER	AVERAGE RESIDENCE TIME
Total	1,386,000	100	2,800 years
Oceans	1,338,000	96.5	3 ,000 to 30,000 years*
Ice and snow	24,364	1.76	1 to 100,000 years*
Saline groundwater	12,870	0.93	Days to thousands of years*
Fresh groundwater	10,530	0.76	Days to thousands of years*
Fresh lakes	91	0.007	1 to 500 years*
Saline lakes	85	0.006	1 to 1,000 years*
Soil moisture	16.5	0.001	2 weeks to 1 year*
Atmosphere	12.9	0.001	1 week
Marshes, wetlands	11.5	0.001	Months to years
Rivers, streams	2.12	0.0002	1 week to 1 month
Living organisms	1.12	0.0001	1 week

*Depends on depth and other factors

Source: UNEP, 2002.


All water on earth 332,500,000 cubic miles
http://water.usgs.gov/ed


Total fresh
water,
99% is
groundwater,
2,551,100 mi^3


Water in lakes
and rivers,
22,339 mi^3

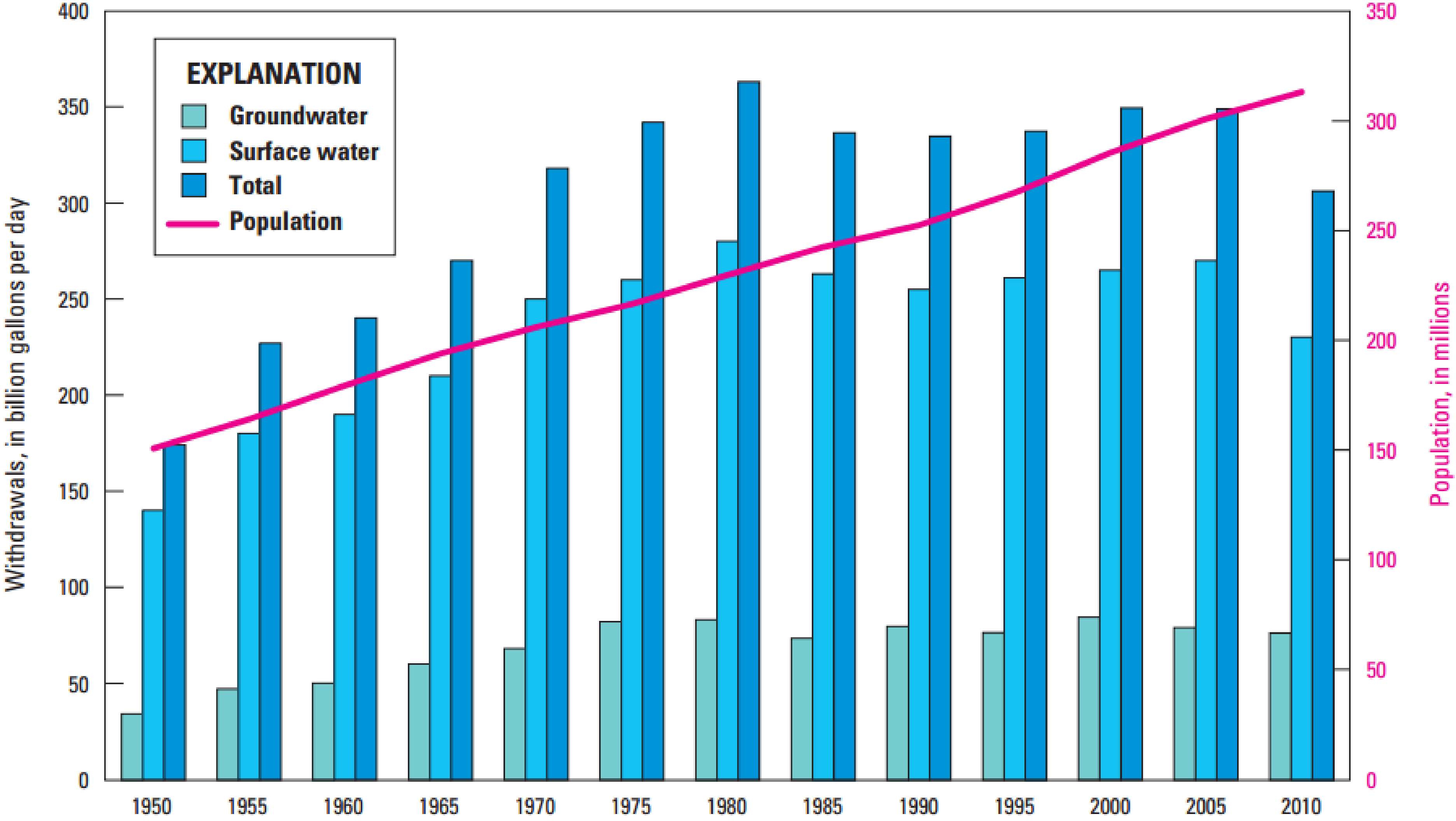


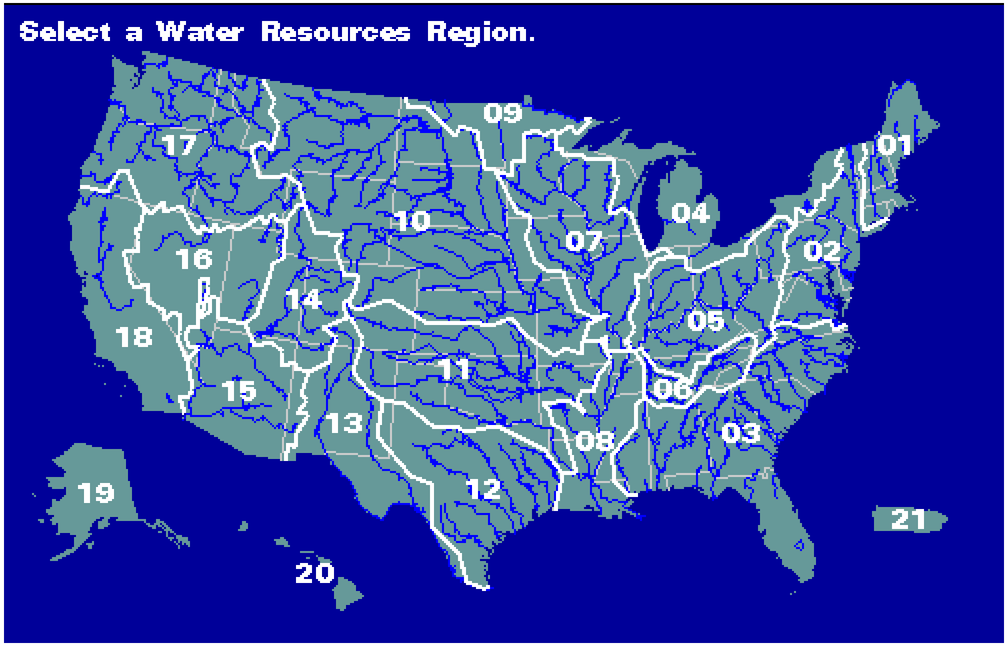
Figure 13. Trends in population and freshwater withdrawals by source, 1950–2010.

What is a River Basin?
A watershed?

A river basin is the portion of land drained by a river and its tributaries. It encompasses all of the land surface dissected and drained by many streams and creeks that flow downhill into one another, and eventually into one <u>river</u>.

The final destination is an estuary or an ocean. As a bathtub catches all the water that falls within its sides, a river basin sends all the water falling on the surrounding land into a central river and out to the sea.

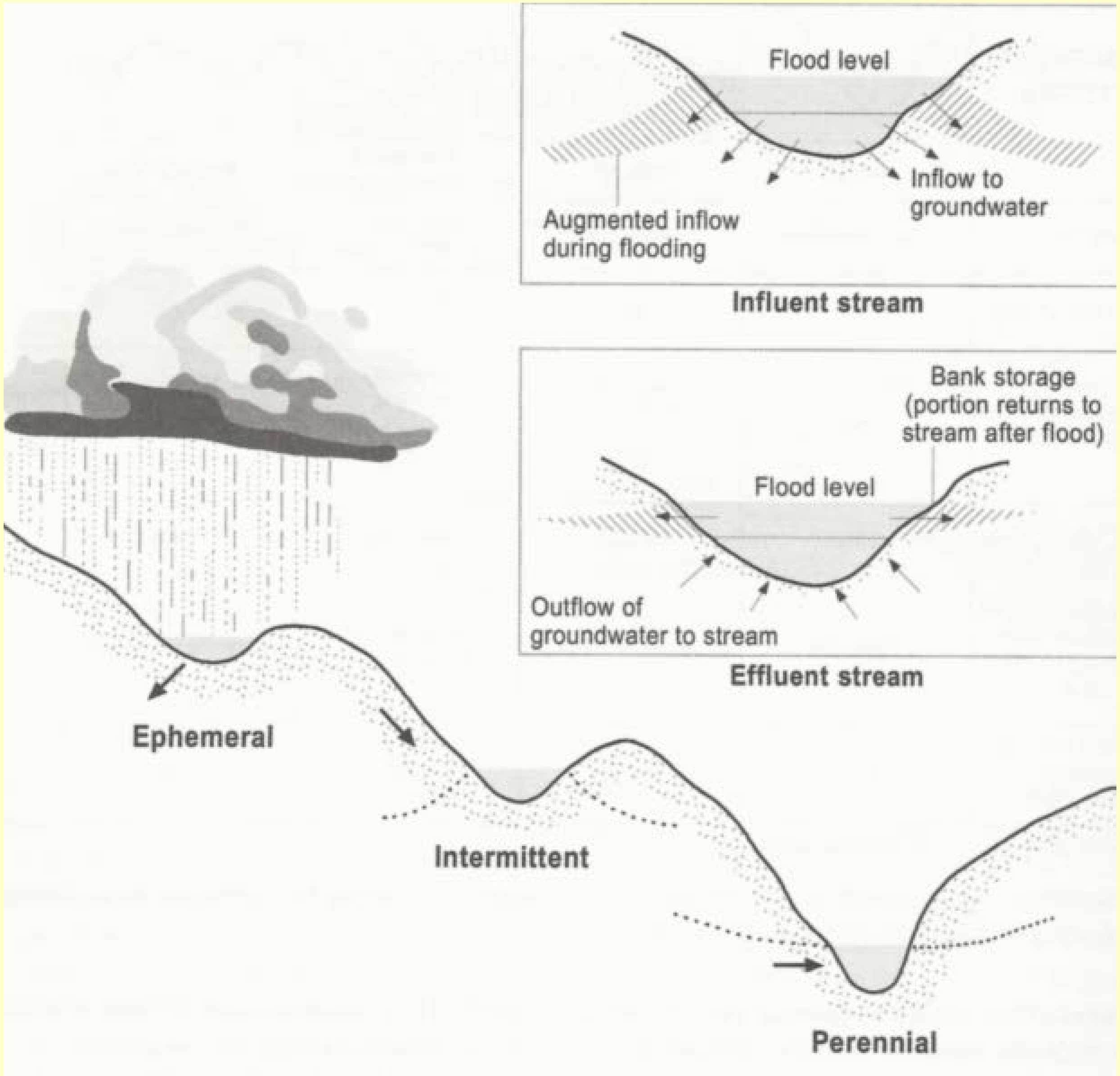
Hydrologic Unit Map
(Based on Data from USGS Water-Supply Paper 2294)



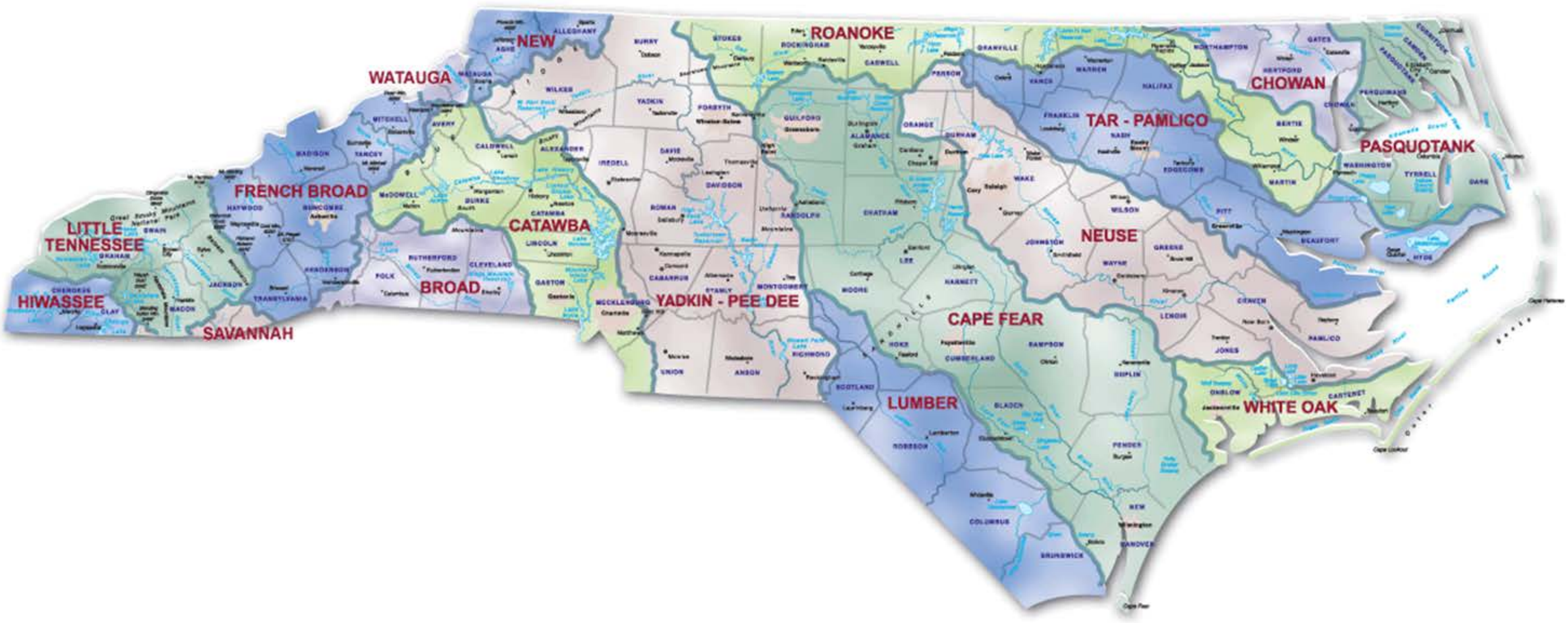
The gray lines are state lines, the blue lines are major rivers, and the white lines are water-resources region boundary lines.

The United States is divided and sub-divided into successively smaller hydrologic units which are classified into four levels: regions, sub-regions (river basins), accounting units, and cataloging units. The units are called HUCs.

Stream Classifications

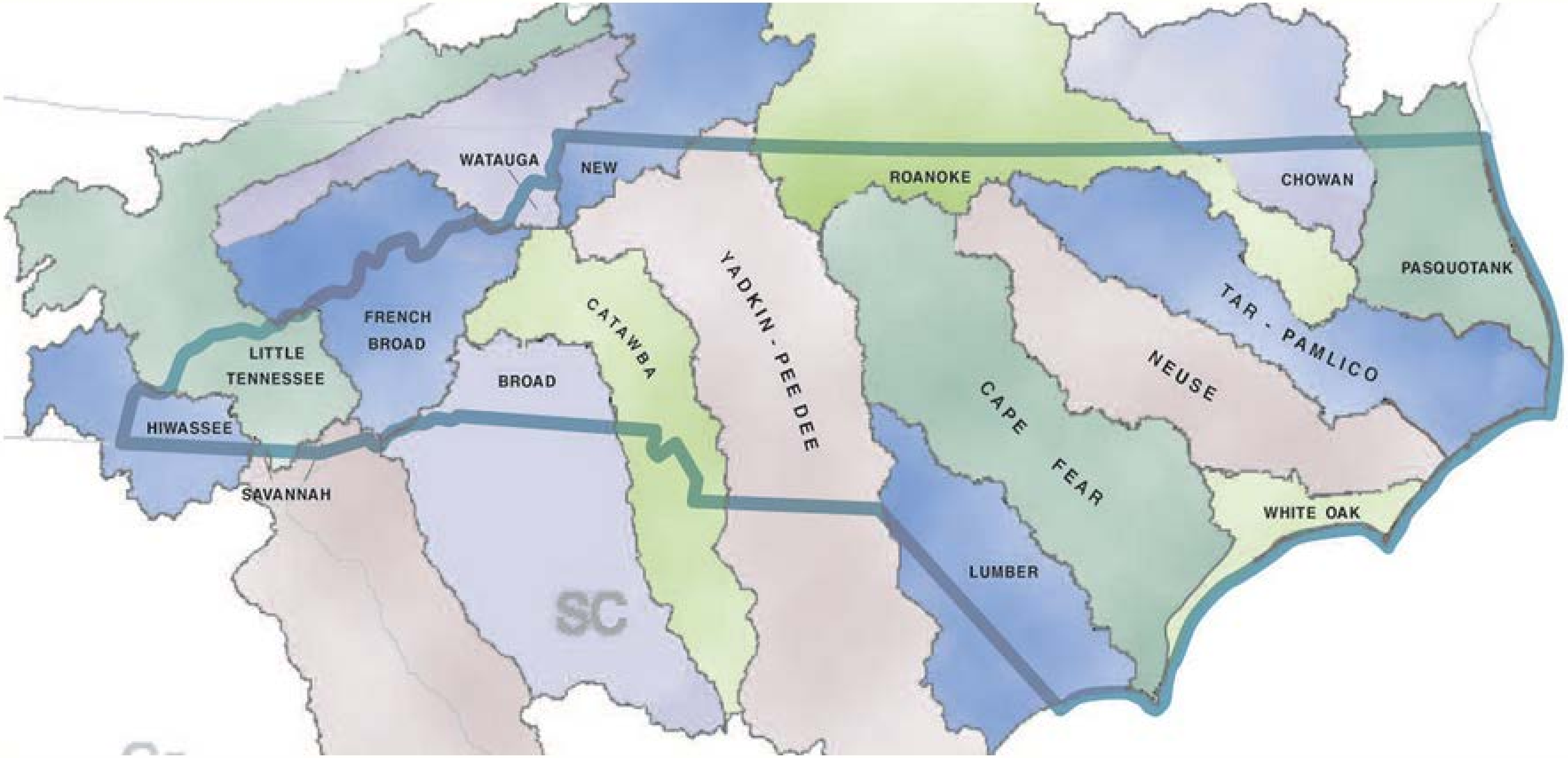


Our home is
Sub-Region 0303 – Cape Fear River Basin
Who lives downstream from us?



RIVER BASIN INTERACTIVE MAP

Click on a River Basin to learn more...



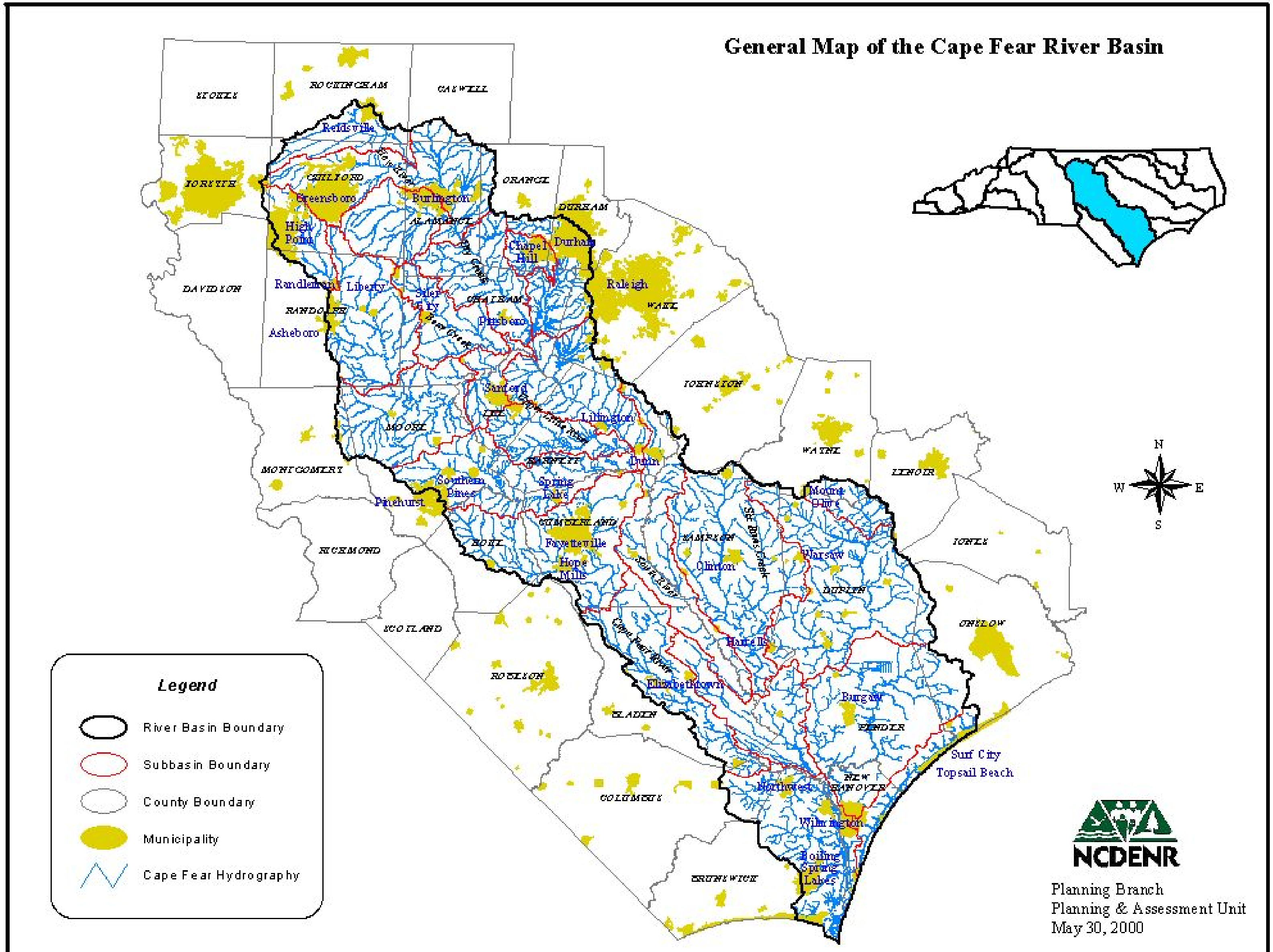
http://www.eenorthcarolina.org/riverbasins-interactive.html

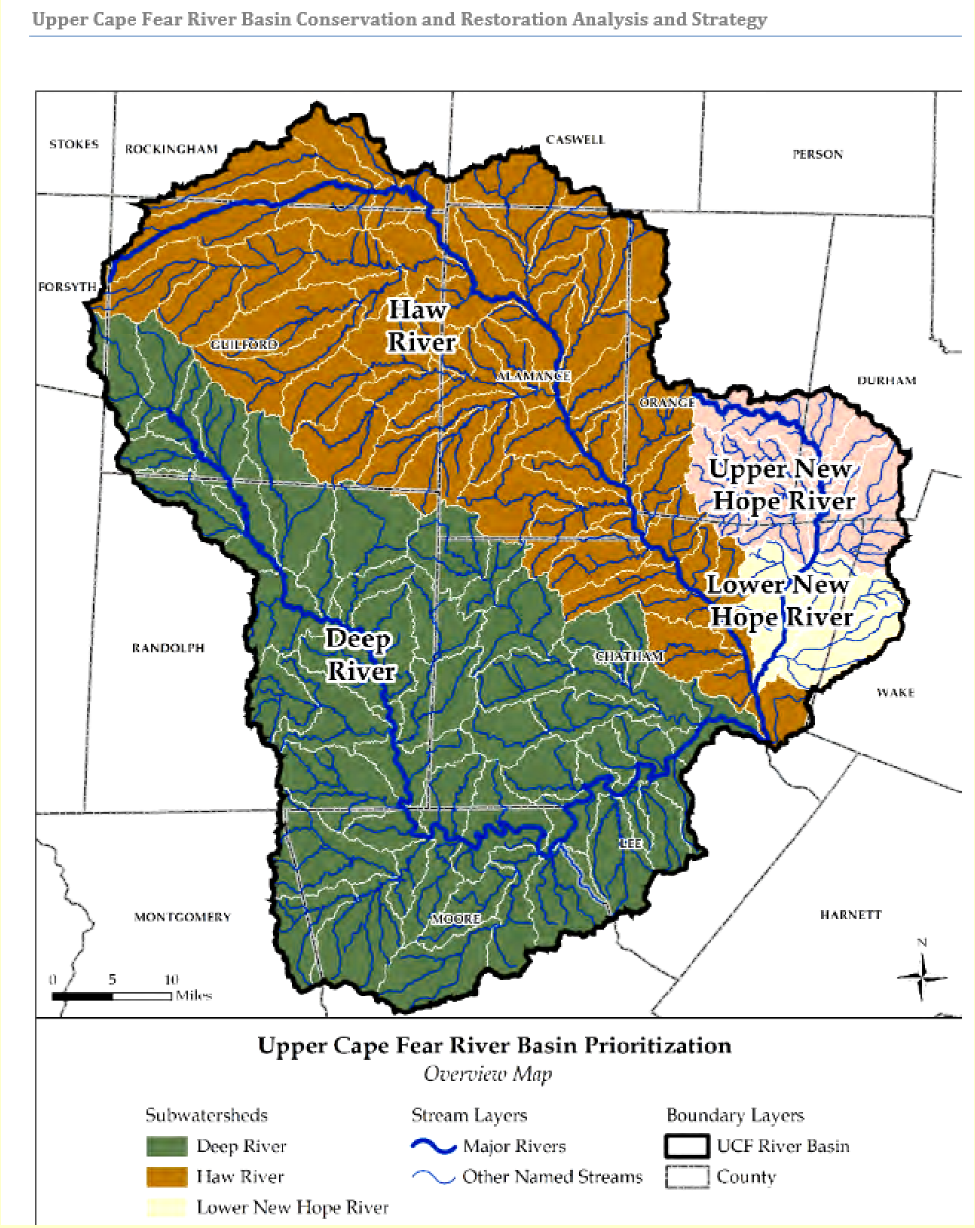
Cape Fear River Basin

Historically used as a major transportation route, the Cape Fear River Basin is the largest in North Carolina, covering 9, 324 square miles.

It touches 27 counties and 114 municipalities .

The basin is home to 2,072,305 people and 45 rare aquatic species.

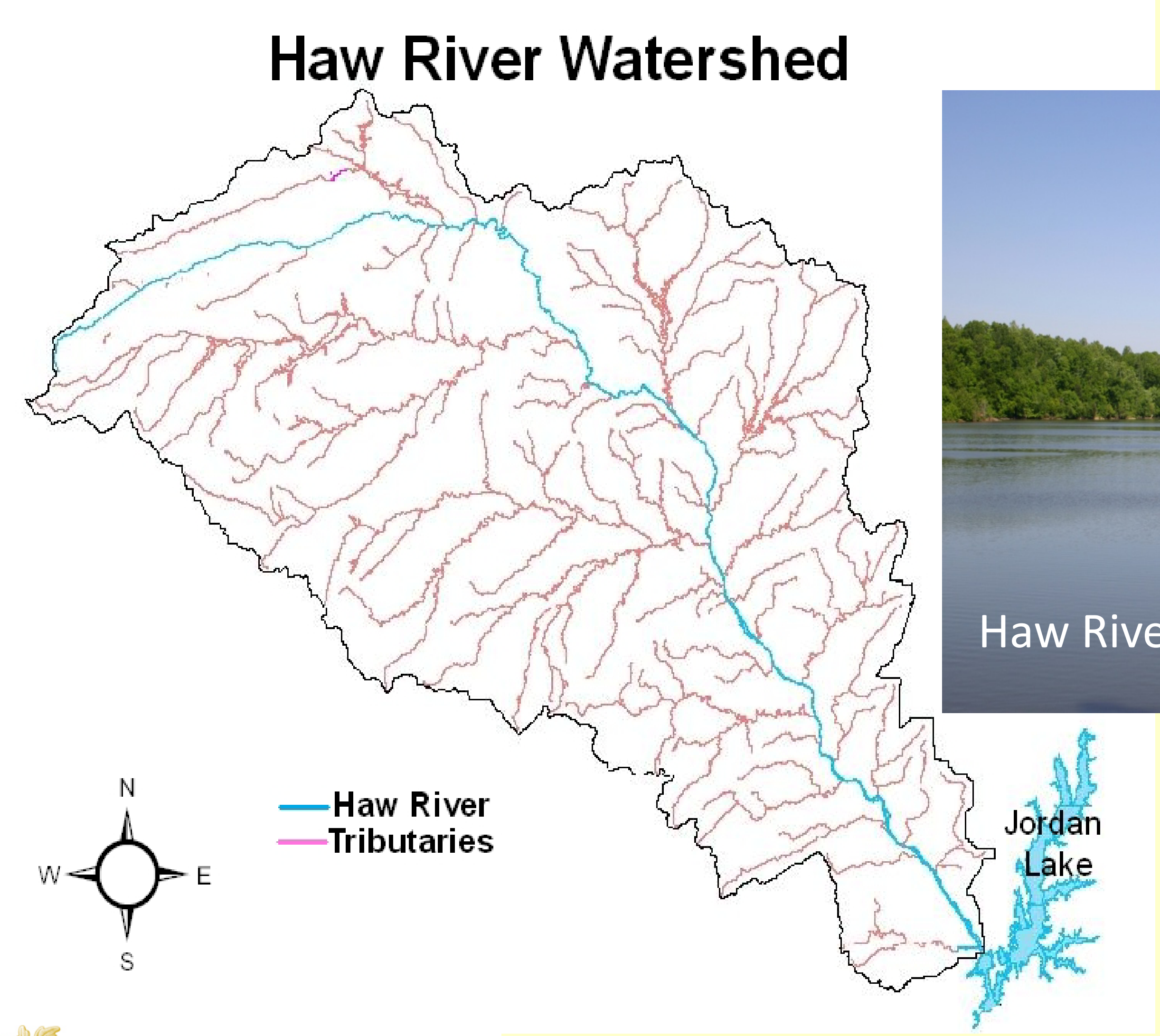

General Map of the Cape Fear River Basin
Legend
River Basin Boundary
Subbasin Boundary
County Boundary
Municipality
Cape Fear Hydrography
N
S
E
W
ROCKINGHAM
CASWELL
STOKES
FORSYTH
GUILFORD
ORANGE
DURHAM
ALAMANCE
DAVIDSON
RANDOLPH
CHATHAM
WAKE
JOHNSTON
LEE
MOORE
HARNETT
MONTGOMERY
WAYNE
LENOIR
CUMBERLAND
SAMPSON
HOKE
RICHMOND
SCOTLAND
JONES
DUPLIN
ONSLOW
ROBESON
BLADEN
PENDER
NEW HANOVER
COLUMBUS
BRUNSWICK
Reidsville
Greensboro
Burlington
High Point
Chapel Hill
Durham
Randleman
Liberty
Siler City
Raleigh
Asheboro
Pittsboro
Sanford
Lillington
Dunn
Southern Pines
Pinehurst
Spring Lake
Fayetteville
Hope Mills
Clinton
Mount Olive
Warsaw
Elizabethtown
Burgaw
Surf City
Topsail Beach
Northwest
Wilmington
Boiling Spring Lakes
NCDENR
Planning Branch
Planning & Assessment Unit
May 30, 2000



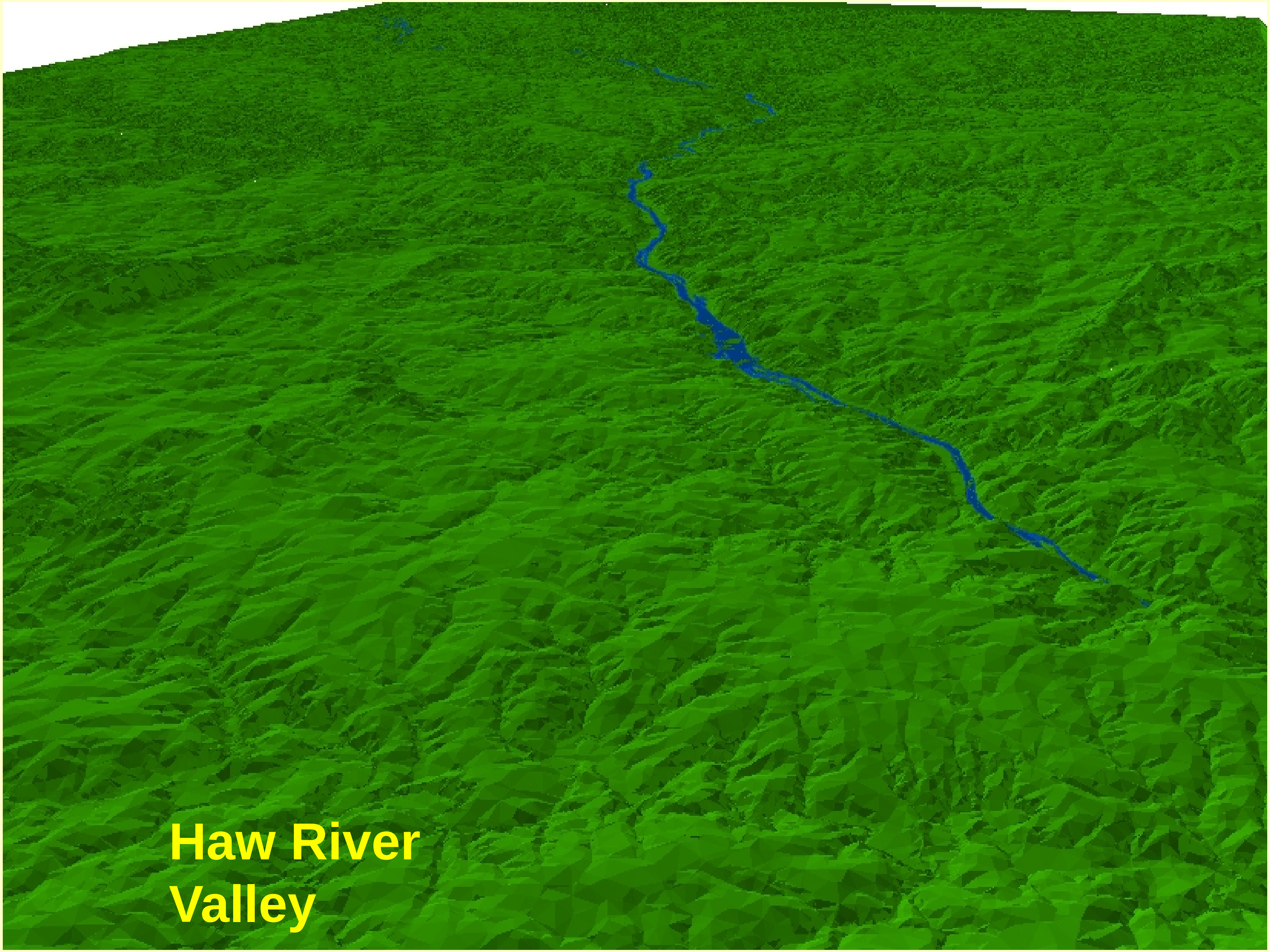
Upper Cape Fear

The river forms at the confluence of the Deep and Haw Rivers at Moncure, NC

Haw River Watershed

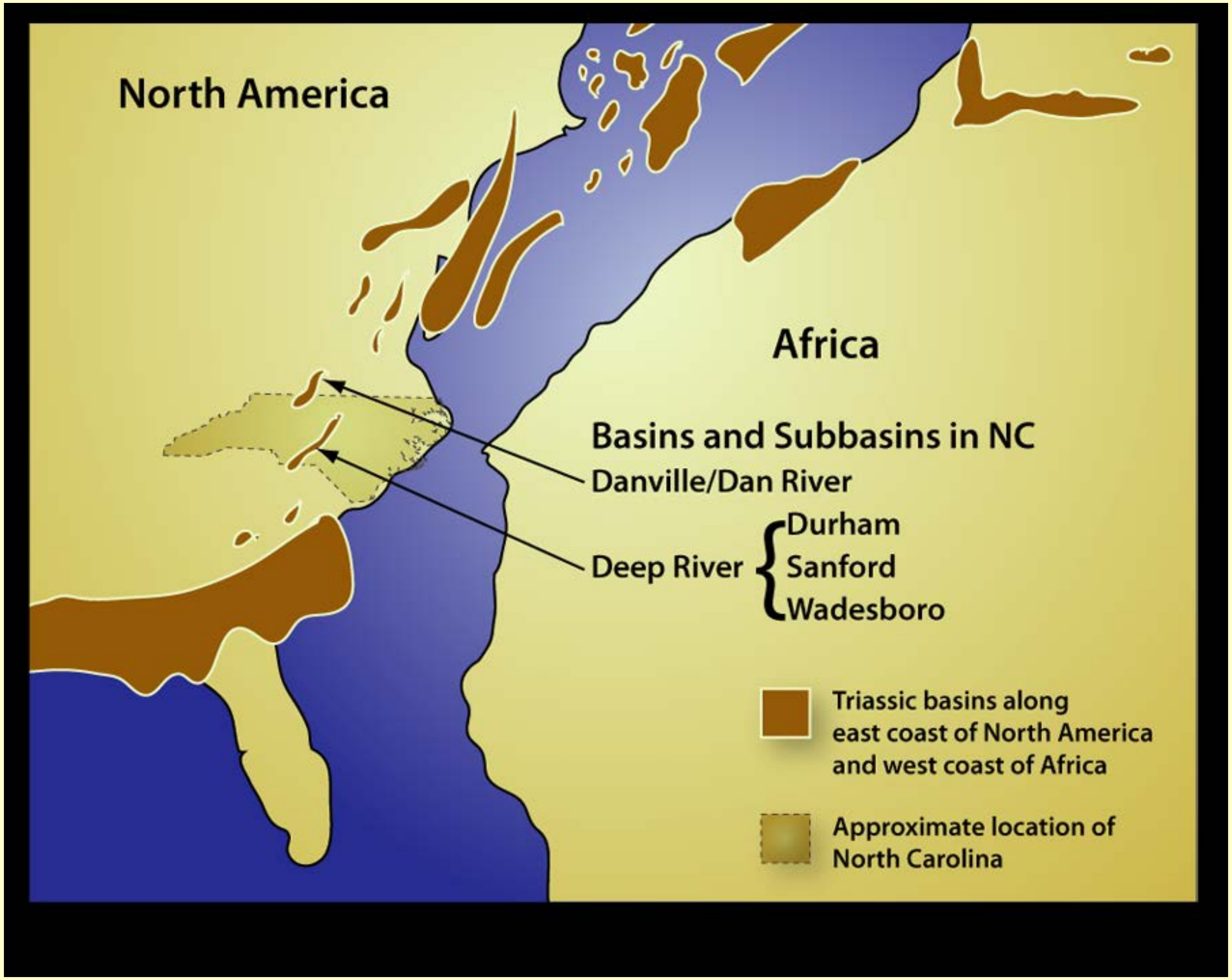


ELON UNIVERSITY


Haw River
Valley

What did the Haw look like?

The Haw River is likely an ancient river, resulting from the rift valleys formed when Pangea split apart 245 million years ago



What did the Haw look like?

Chestnut

http://masschestnut.org/images/openGrownTree.jpg

Beaver

http://castorid.com/technologies/xhtml/

Gentle banks with floodplains

http://www.jessstryker.com/national-parks/rocky-mountains/images/ColoradoRiver1.jpg

History of the Haw River

The fur trade and trapping

History of the Haw River

The fur trade and trapping –

Beavers once lived throughout the European wilderness and the Brish Isles. Scotland's beaver trade dried up by 1350, by which time a beaver pelt could cost up to a hundred and twenty times as much as a lambskin.

By the mid 1500's, only the remote reaches of Siberia and Scandinavia had ponds still abundant in beavers.

What was the role of beavers on the Haw –

They are Nature's Hydrologists, shaping the landscape more than any mammal other than humans.

History of the Haw River

Farming – row crops (tobacco, cotton, corn) cattle

History of farming within the Haw River watershed.

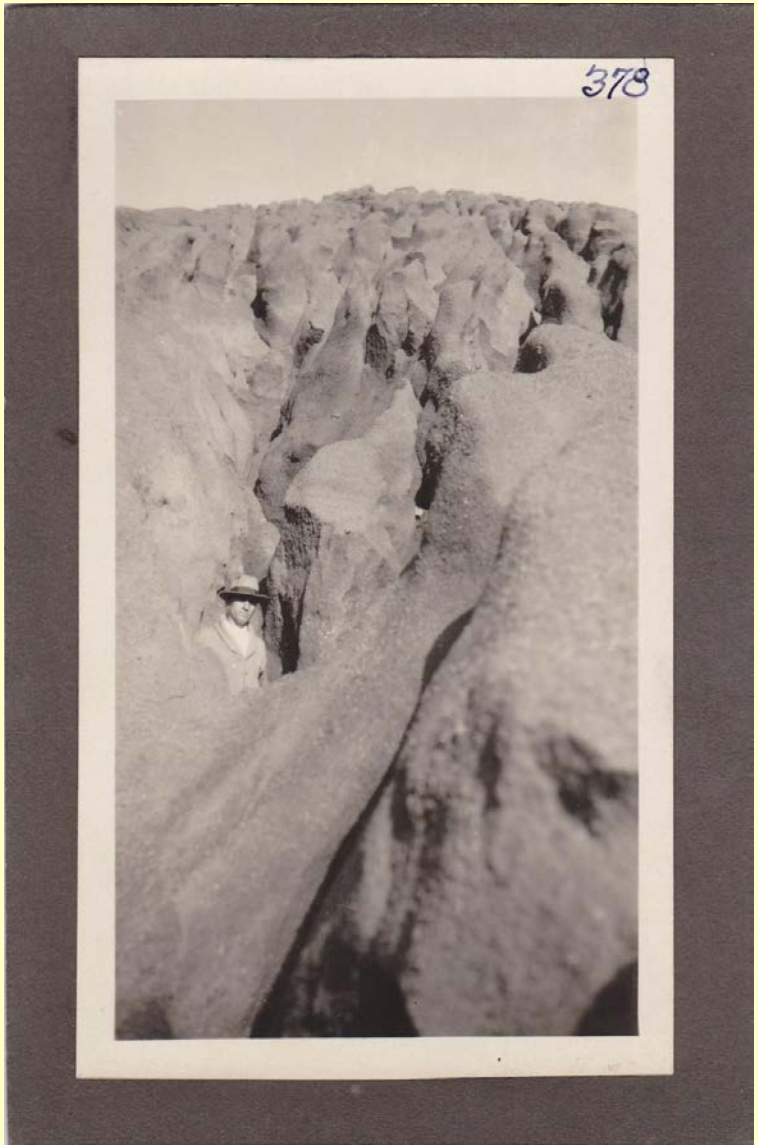
Year		Alamance	Chatham	Orange
1910	Number of farms	2508	3640	1957
	% of county in agriculture	80	85	84
1950	Number of farms	2940	2977	2038
	% of county in agriculture	79	66	70
2007	Number of farms	753	1089	604
	% of county in agriculture	32	24	24

History of the Haw River

What is our farming legacy?

Loss of soil – about 12 inches of topsoil have been lost, leaving sediment along the floodplain and in the river all the way to Wilmington

Fostered the creation of the U.S. Soil Conservation Service in 1935. Created to combat the "soil erosion menace".



History of the Haw River

The first mill was a grist mill built in 1748, and by 1800 there were 17 gristmills directly on the Haw River.

Cotton mills were constructed beginning in 1838, with the first mill constructed by John Trollinger near Burlington. This was soon followed by a mill built in 1848 by the Quaker John Newlin near present day Saxapahaw.

History of the Haw River

Textile Mills and the dams that powered them

http://ncmuseumofhistory.org/workshops/The_1930s_in_North_Carolina/Session1.html

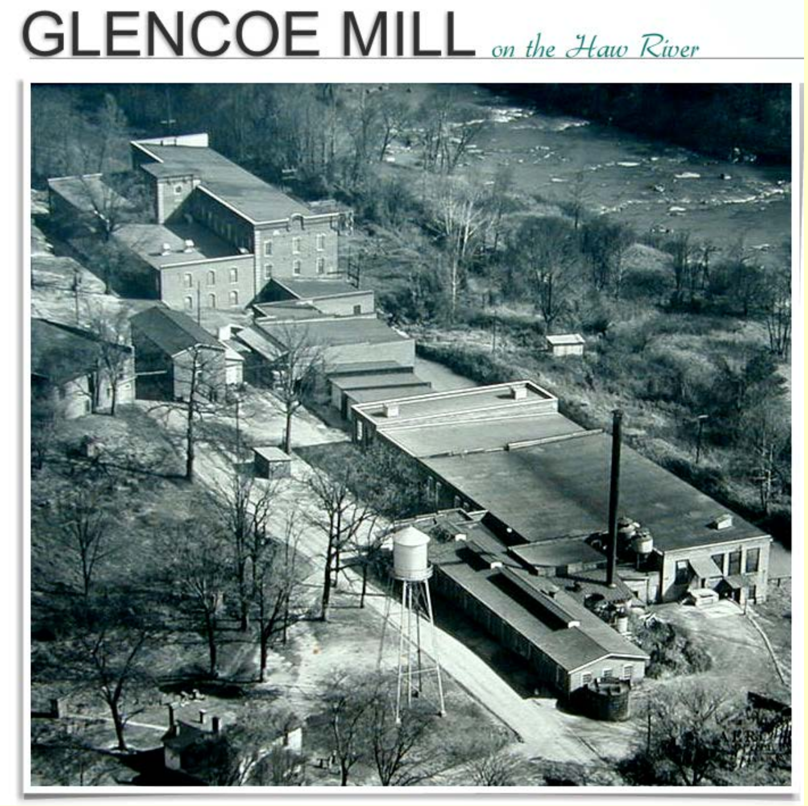
At least 11 textile mills were constructed along the Haw River.

History of the Haw River

Current textile mill sites:

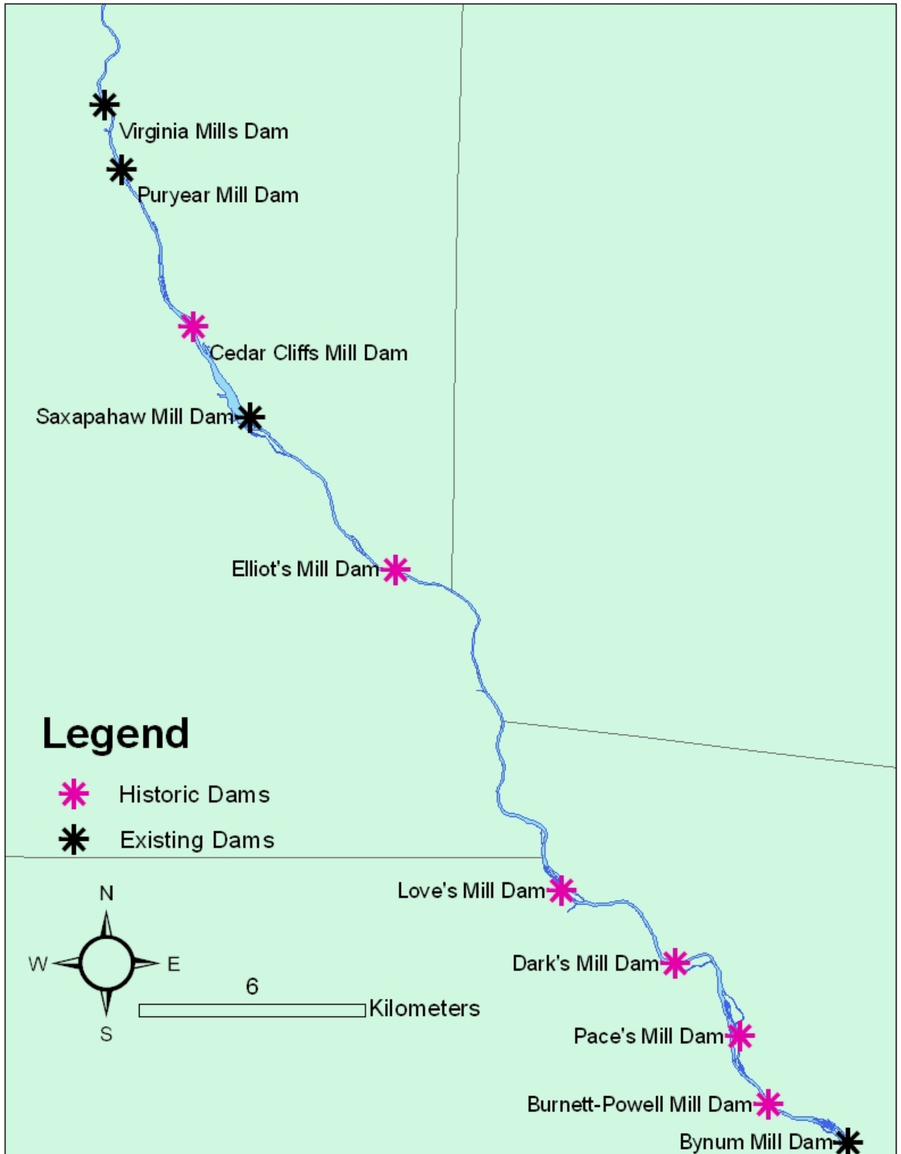
Glencoe Mills-

restored mill village



Saxapahaw Mill – restored for residential use

Dams of the Haw



- Total of 10 Dams
- 6 Historic Dams
- 4 Existing Dams
  - 2 Currently Hydroelectric

Haw River Today

Documented wildlife sightings include:

Bobcat, river otter, beaver, white deer, bald eagles

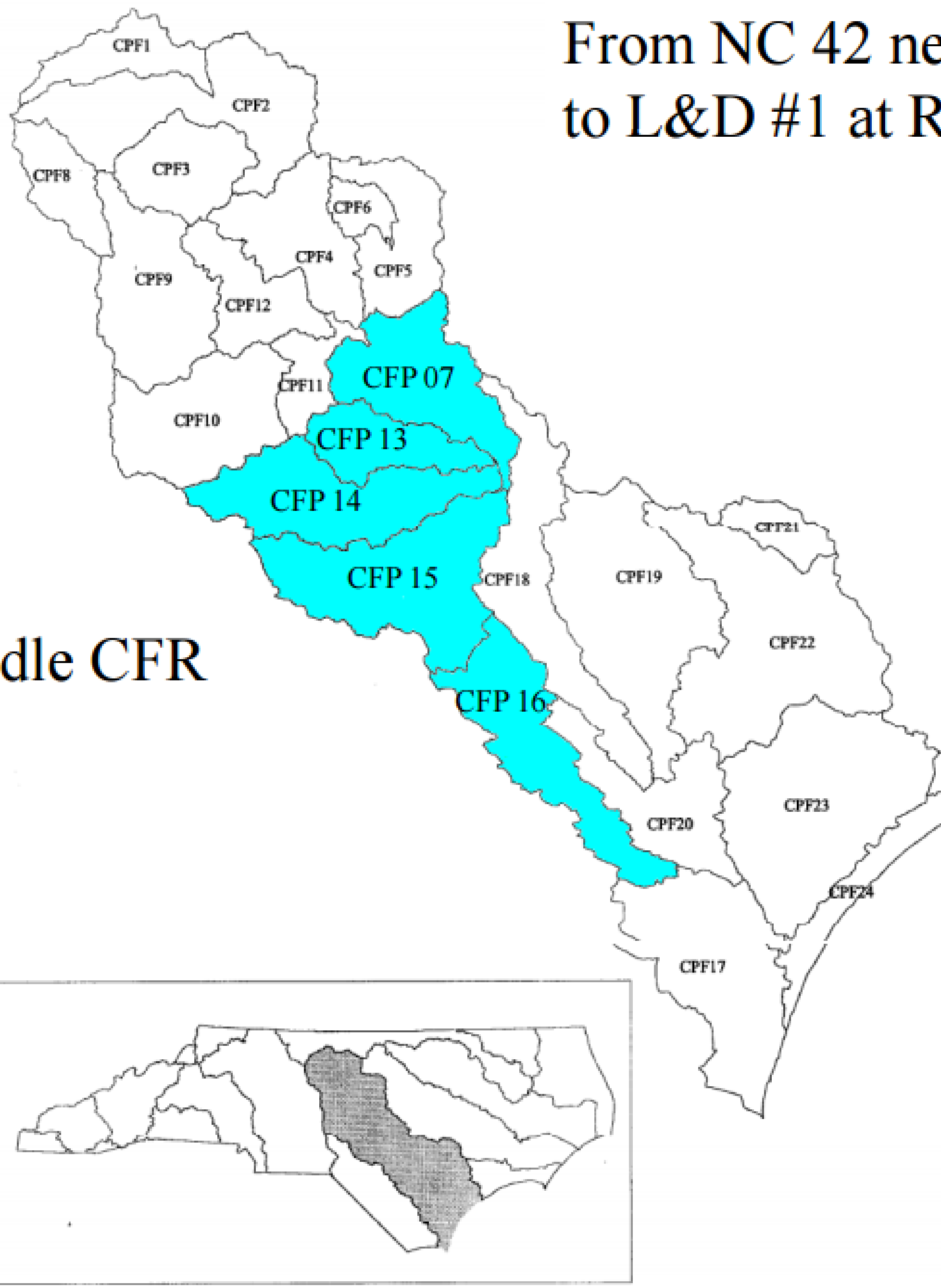
Haw River Today

Documented wildlife sightings

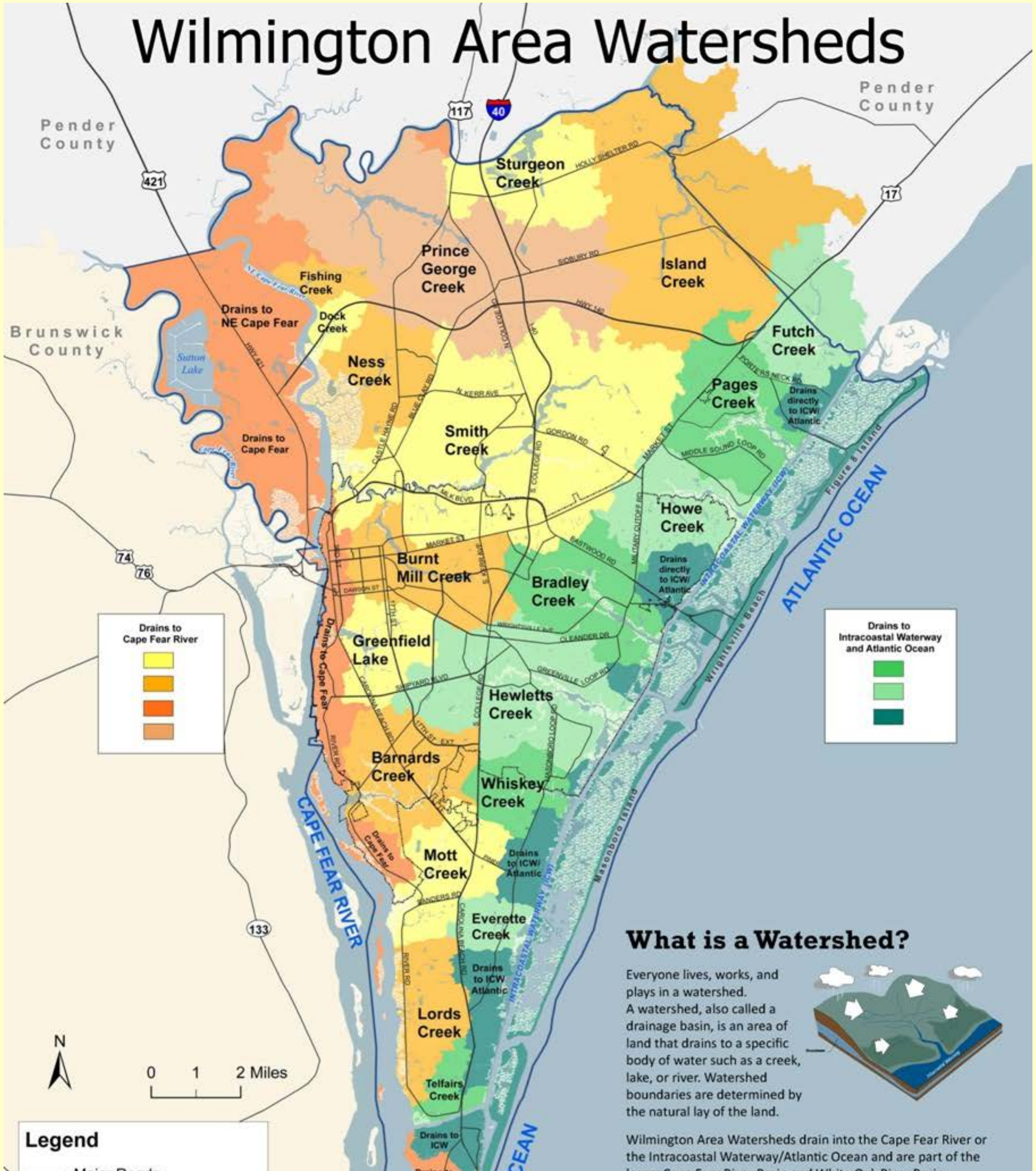
Bobcat

From NC 42 near Moncure to L&D #1 at Riegelwood

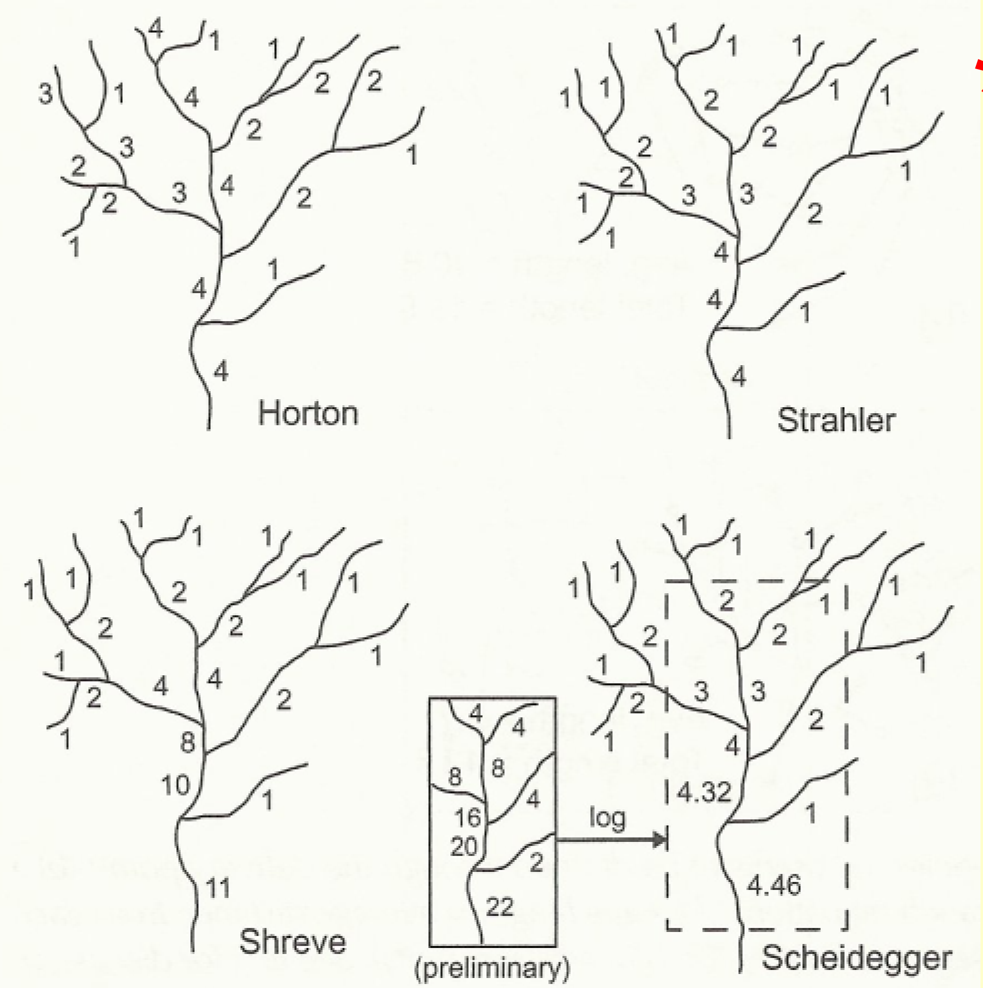
Middle CFR



Downstream in the Cape Fear Watershed



Stream Ordering System



*

Figure 4.11. *Stream ordering systems. Strahler's method is most widely applied*

Hydrologic Unit Map
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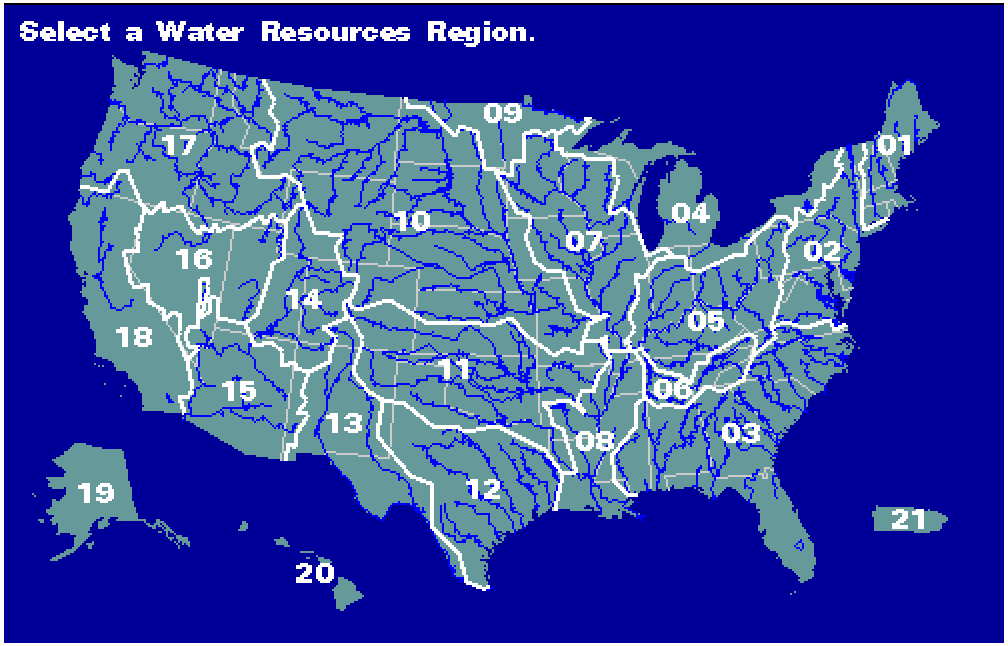

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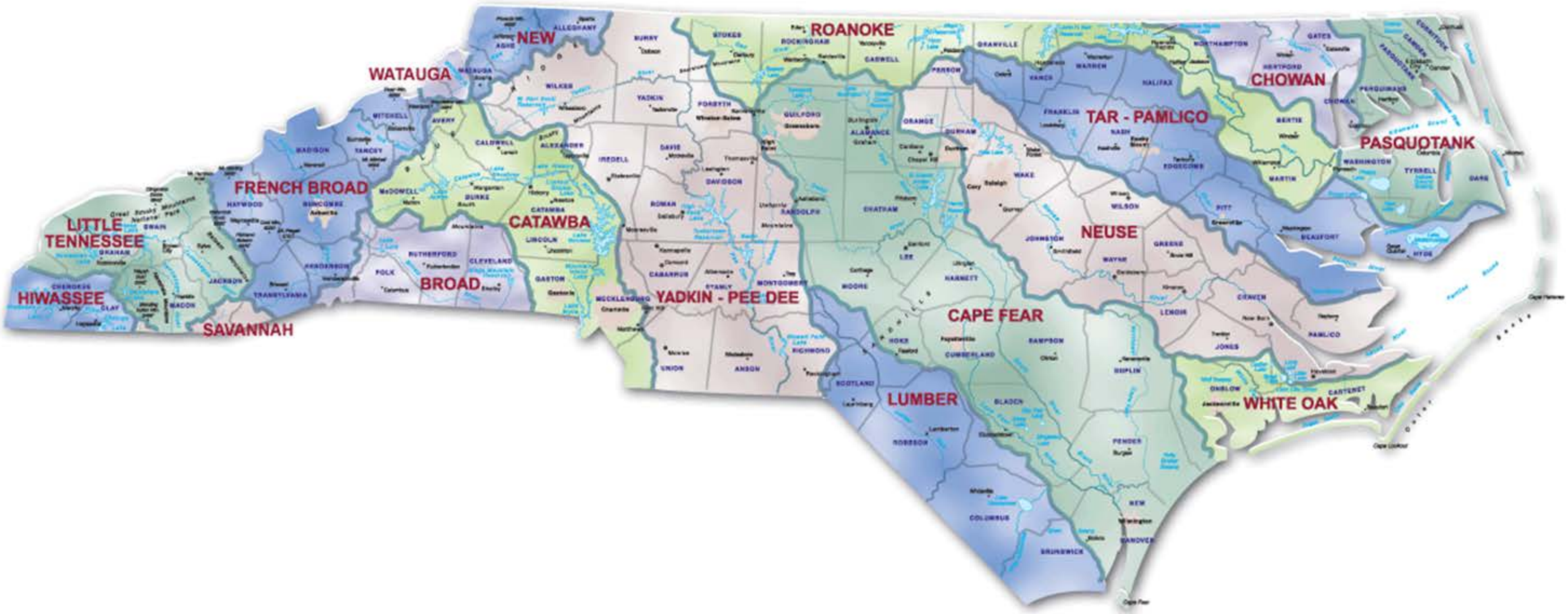
Subregion 0302 -- Neuse-Pamlico:
The coastal drainage and associated waters from Oregon Inlet to Browns Inlet. North Carolina.
Area = 13100 sq.mi.



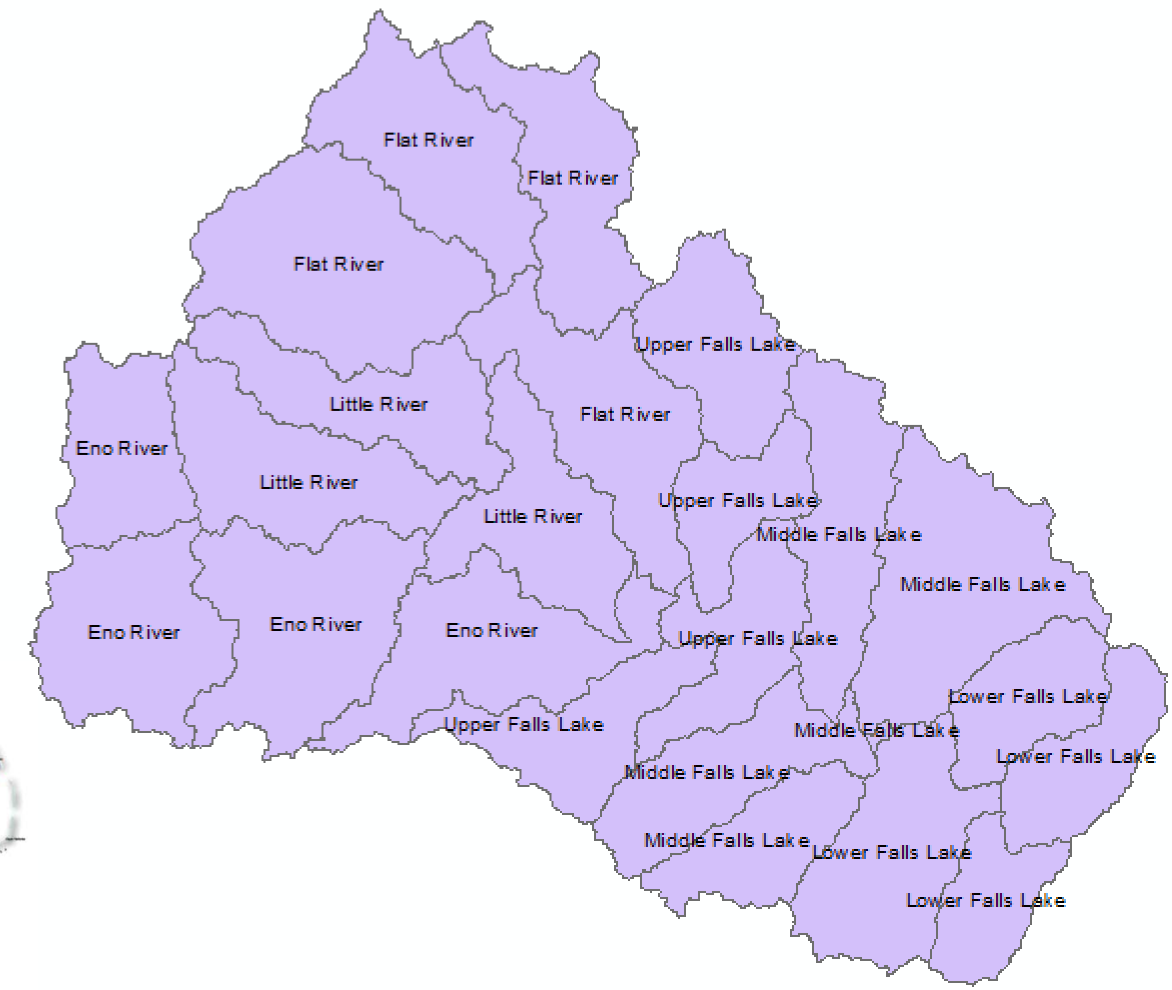
Subregion 0302 -- Neuse-Pamlico:
The coastal drainage and associated waters from Oregon Inlet to Browns Inlet, North Carolina.
Area = 13100 sq.mi.

Cataloging Units 03020201 -- Upper Neuse. North Carolina.
Area = 2380 sq.mi.

Subwatershed (WBD-12 Number) 030202010302--Eno River
Area – 150 sq. mi.

Sub-Watersheds in the Upper Neuse Watershed

Subwatershed (WBD-12 Number) 030202010302 Eno River



FALLS LAKE WATERSHED

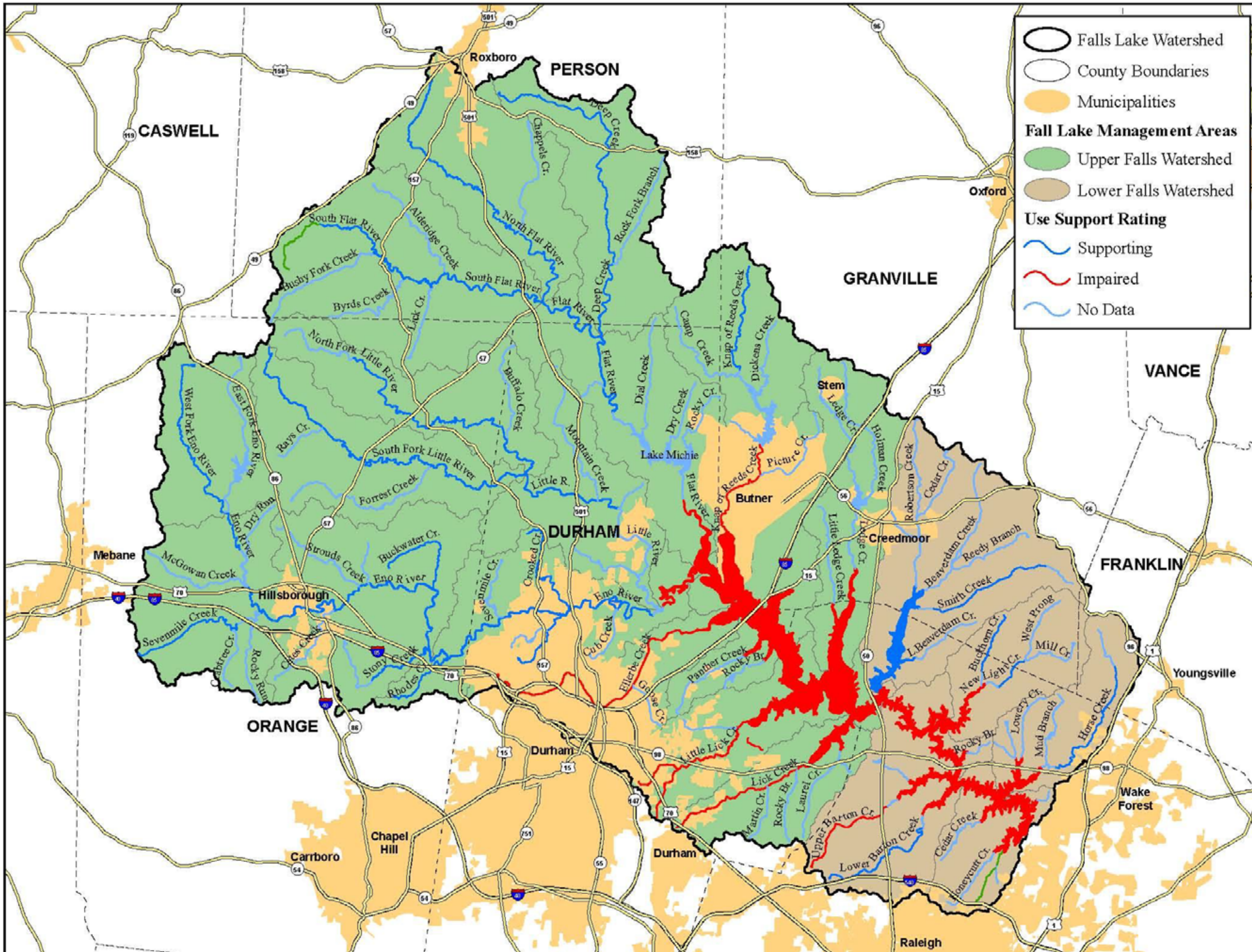
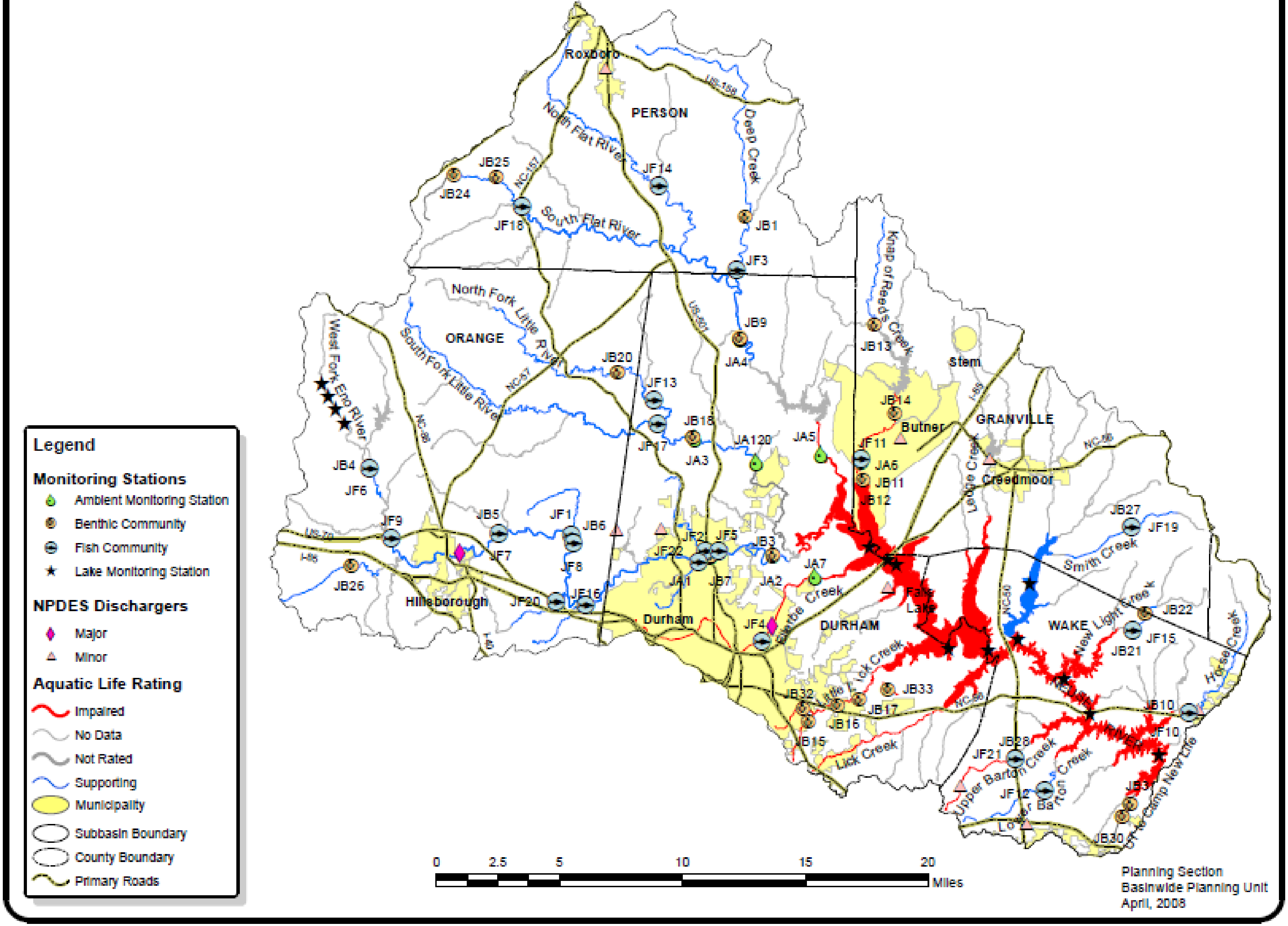
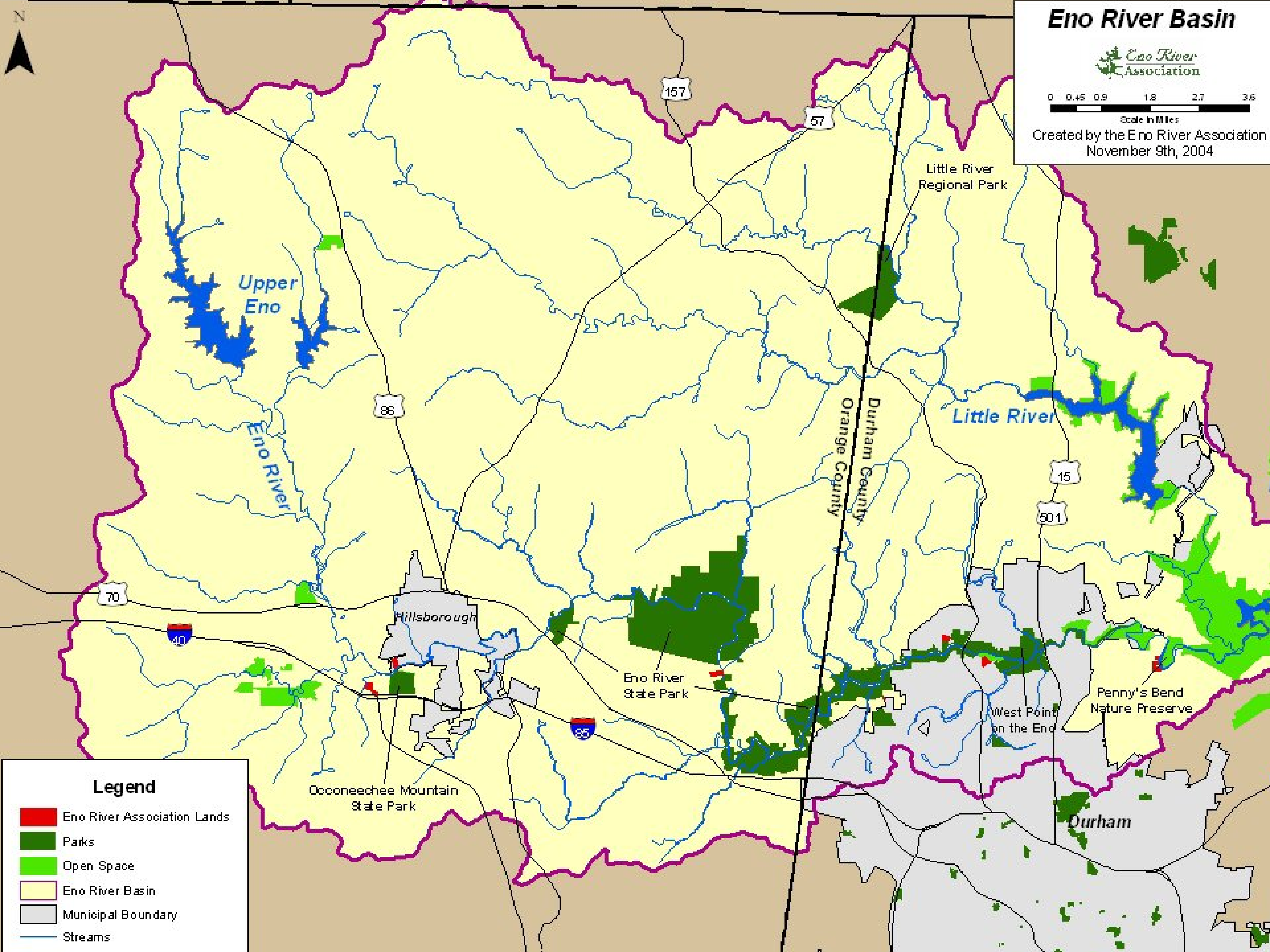


Figure 3 Neuse River Basin 03-04-01





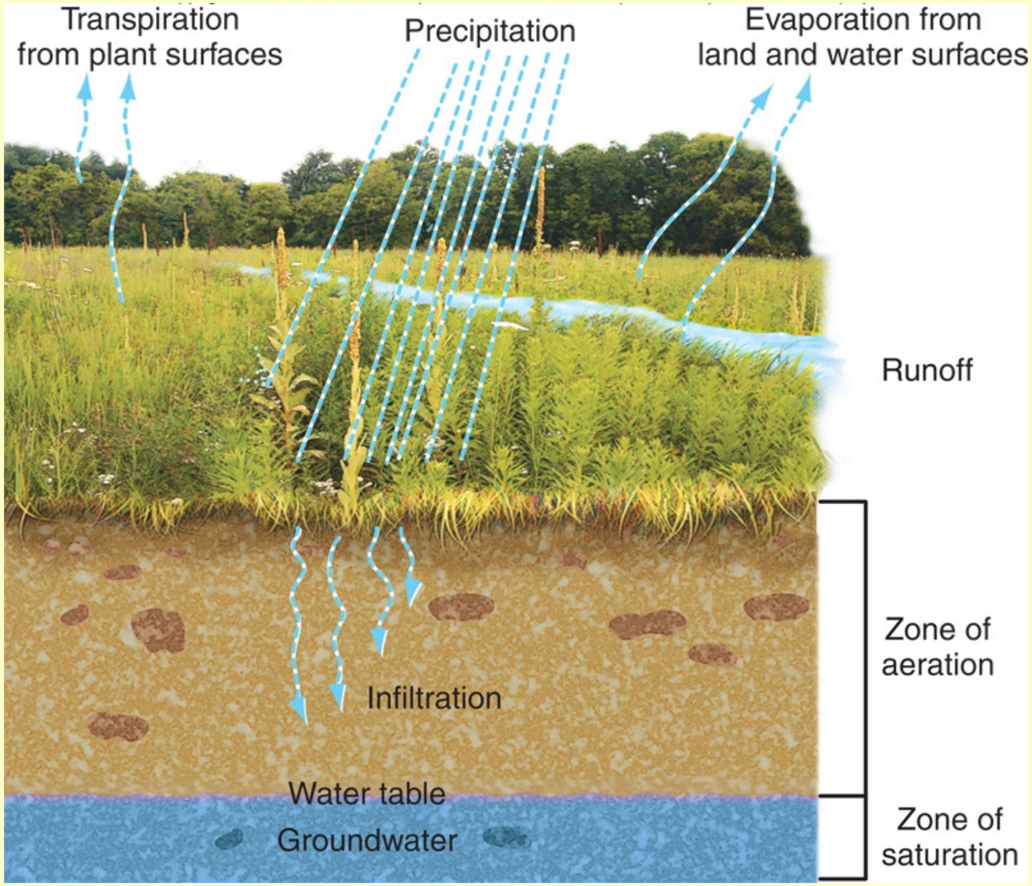
Eno River Basin
Eno River Association
0 0.45 0.9 1.8 2.7 3.6
Scale in Miles
Created by the Eno River Association
November 9th, 2004
N
Little River Regional Park
Upper Eno
Eno River
Little River
Orange County
Durham County
Hillsborough
Eno River State Park
Occoneechee Mountain State Park
West Point on the Eno
Penny's Bend Nature Preserve
Durham
157
57
86
15
501
70
40
85
Legend
Eno River Association Lands
Parks
Open Space
Eno River Basin
Municipal Boundary
Streams

Underground Water

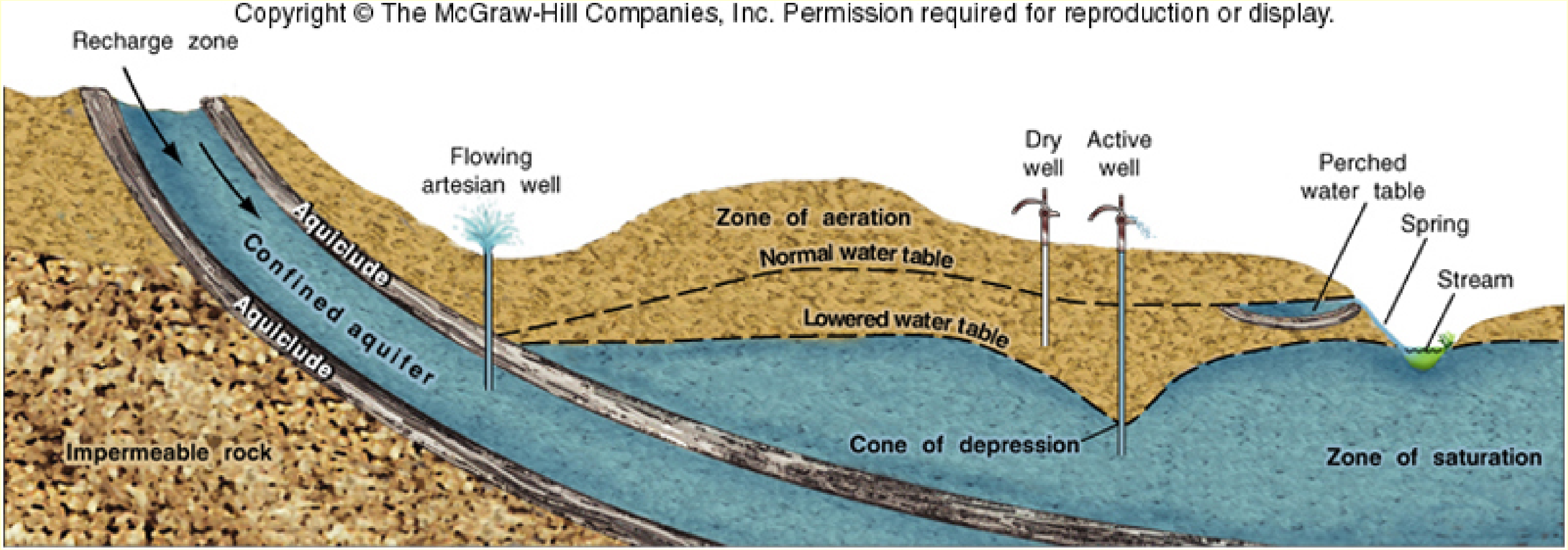
Our hidden wealth

Interactions of water with soil.

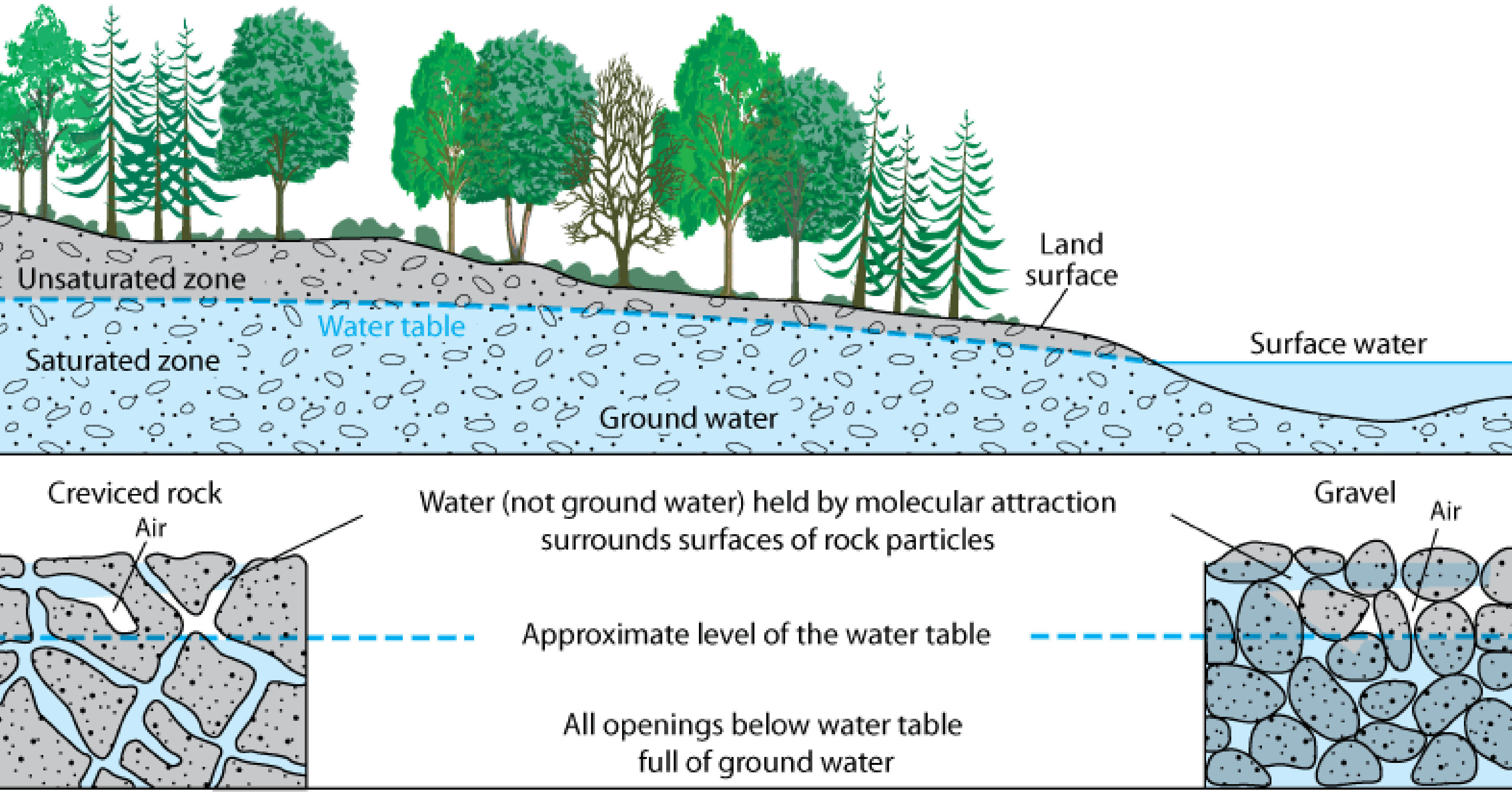
- Infiltration - Process of water percolating through the soil and into fractures and permeable rocks.
  - Zone of Aeration - Upper soil layers that hold both air and water.
  - Zone of Saturation - Lower soil layers where all spaces are filled with water.
  - Water Table is at the top of the Zone of Saturation



Groundwater



Groundwater Demonstration



Note the connection between the groundwater and the surface water. Most streams/rivers in NC are supplied from groundwater.

Groundwater and Drinking water Pollution

- About half the US population, and 95% of rural residents, depend on underground aquifers for drinking water.
  - For decades, groundwater was assumed impervious to pollution. It was considered the gold standard for water quality.
    - An estimated 1.5 million Americans fall ill from fecal contamination annually.
      - Cryptosporidium outbreaks

Depleting Groundwater

- Groundwater provides nearly 40% of the fresh water for agricultural and domestic use in the United States. In many areas in the U.S., groundwater is being withdrawn from aquifers faster than natural recharge can replace it.
- Ogallala Aquifer (large aquifer in the Central Plains) - water usage here is the similar to mining for a nonrenewable resource and the water resource is being depleted rapidly.
- San Joaquin Valley, California – ground surface is sinking due to excessive groundwater pumping.

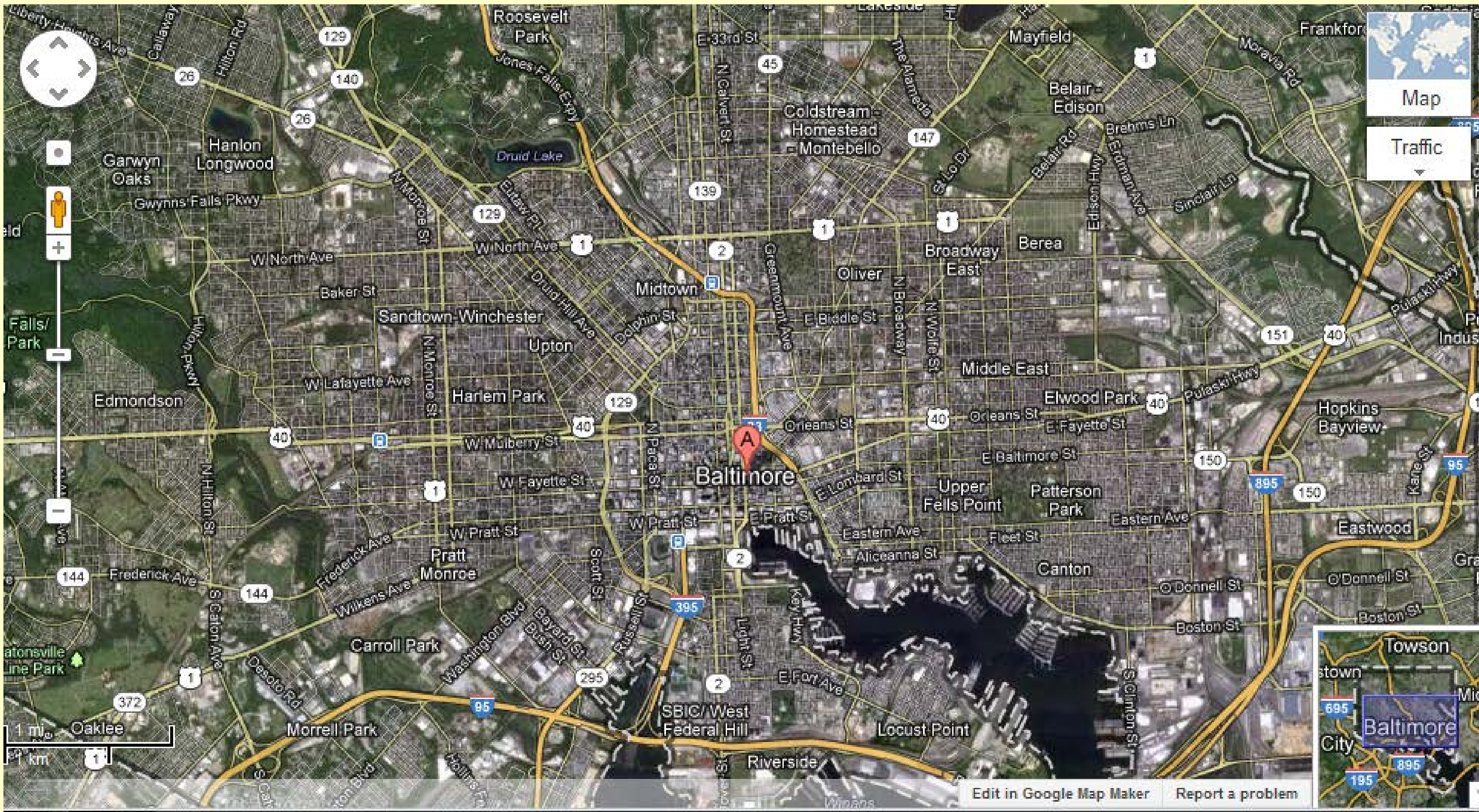
Groundwater Withdrawal

- Withdrawing large amounts of groundwater in a small area causes porous formations to collapse, resulting in subsidence.
  - Sinkholes form – like this one in NC

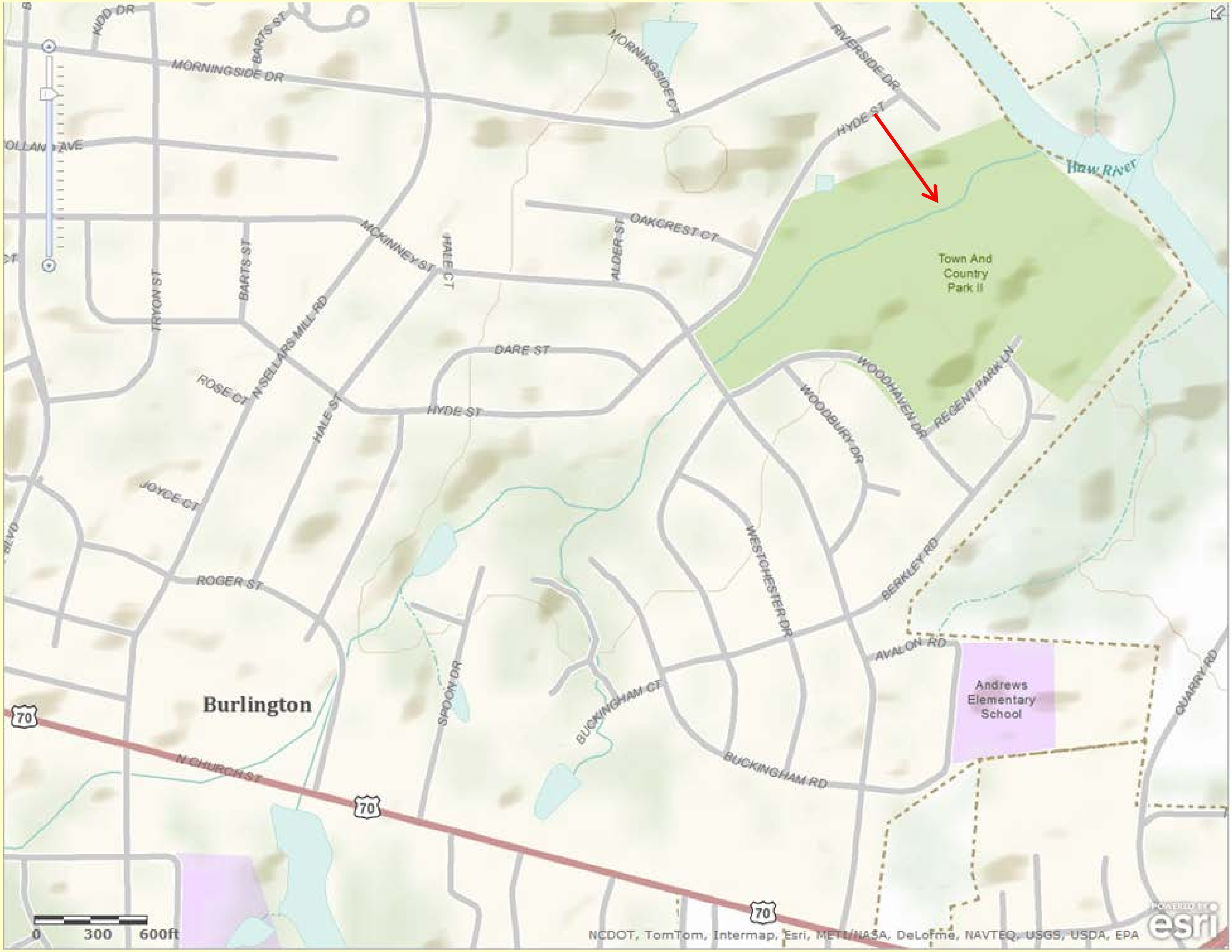
http://www.ncwater.org/Education_and_Technical_Assistance/Ground_Water/Sinkholes/

Stupid Kitchen Humor

What happens when water cannot infiltrate the ground?
How does stormwater affect an urban stream?



Let's look at a stream in Burlington, North Carolina



Town and Country Park Watershed Analysis

The city of Burlington, N.C. has been very proactive in the protection of green space and natural areas within the city limits. One of their parks is the Town and Country Park. In this exercise you are going to analyze a portion of an urban watershed that borders the Haw River, a major river that is part of the headwaters for the Cape Fear River.

This park is a lovely jewel in an urban setting. It is surrounded by a moderate income housing development constructed in the 1960’s. Lots are compact, municipal water and sewer service is provided. There is an elementary school in the community. A stream flows through the community into the park, and then into the Haw River. A canoe launch is an attraction to residents.

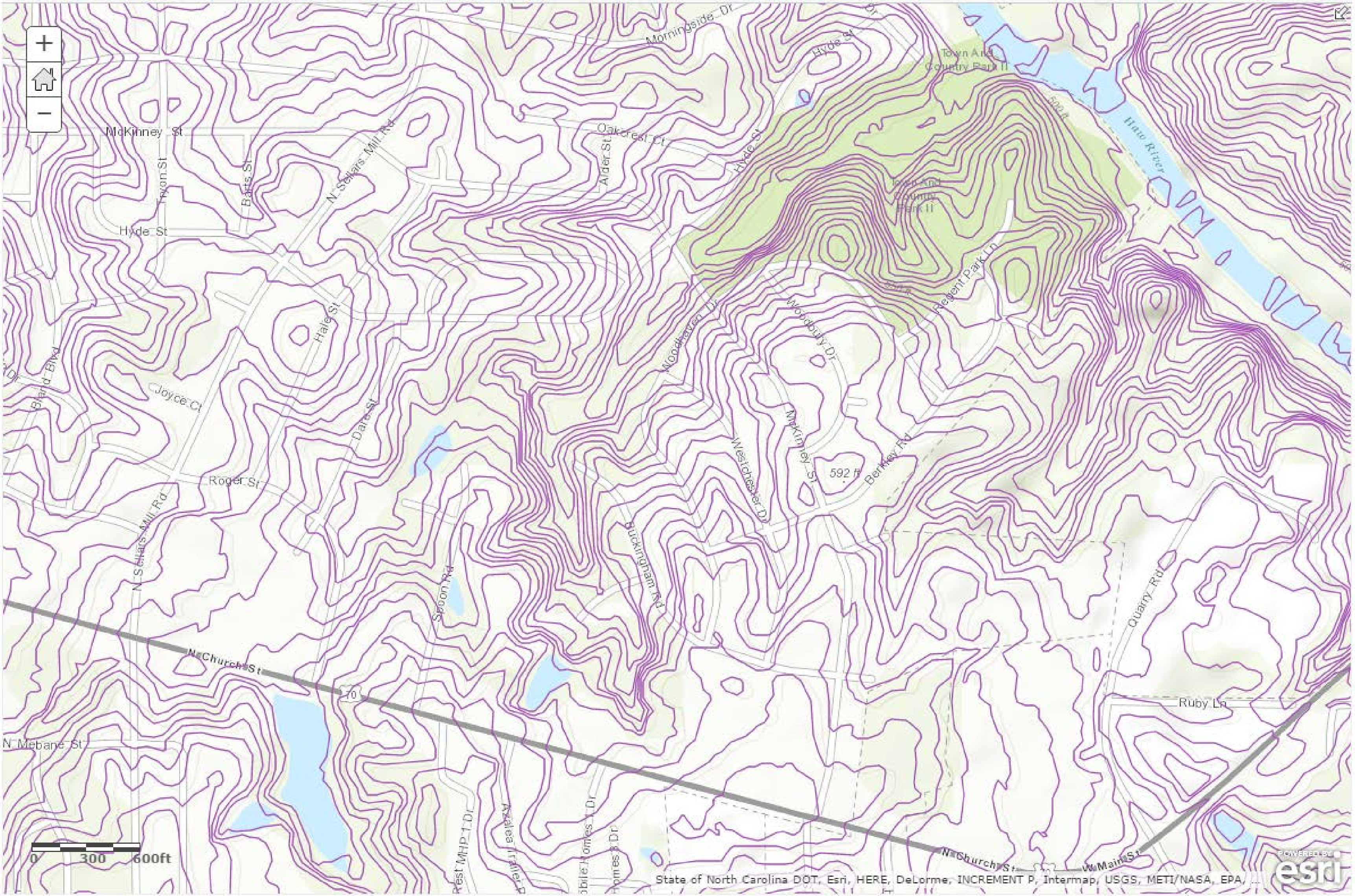

USDA FSA, Microsoft
POWERED BY
esri

Look at the maps showing the roadways and the aerial view of the community and park.

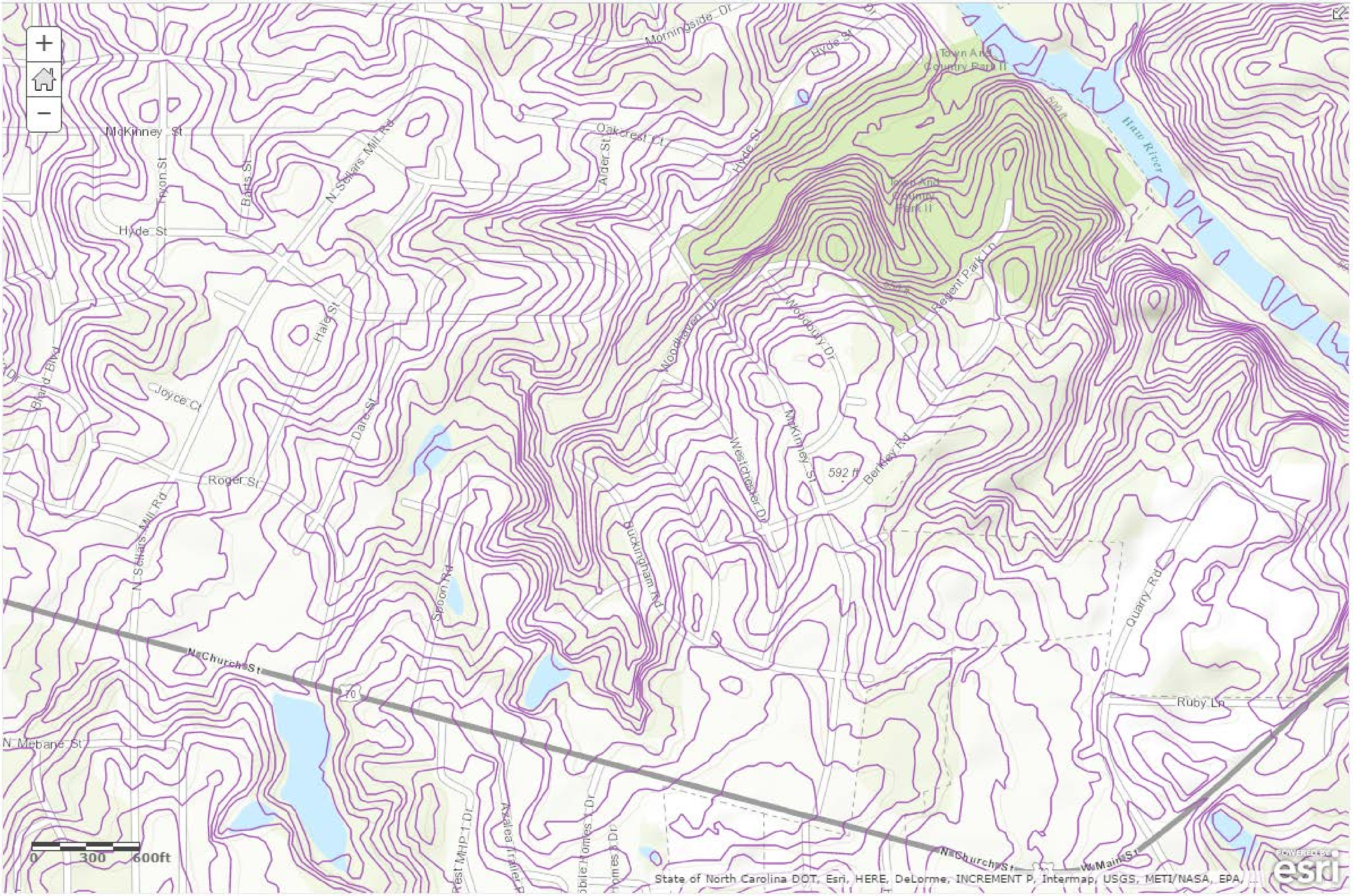
What are some of the characteristics of this park and its surroundings?

Now lets look at the watershed for the stream which flows through the neighborhood and the park. What are some of the traits of the landscape that might influence the health of the stream?

What do you predict the stream will look like as it flows through the park? Why?



Mapping the watershed – in your packet you have a topographc map showing the geography and heights of the land in the park and surrounding community. Each line on the map represents a 5 ft. change in the height of the land.



What features on the map suggest the highest points in the landscape?

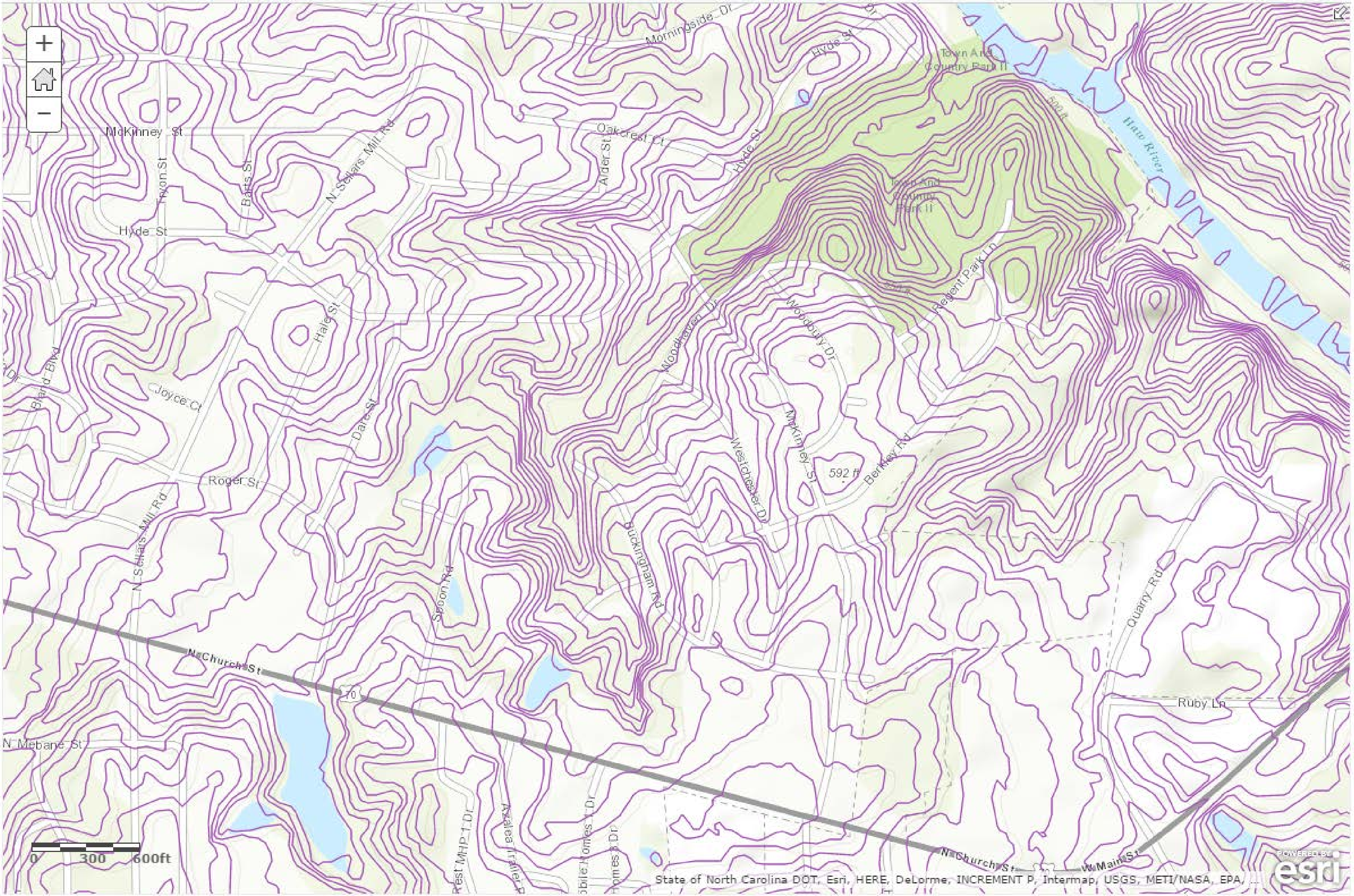
How could the topographic map be used to identify boundaries of the watershed for the stream?

What are some techniques we can use to draw the boundaries of the watershed?

Lay the clear plastic sheet over the topographic map. With your dri erase pen, draw the boundaries of the watershed.

We are only doing about 2/3 rds of the watershed with our upstream boundary at Hwy 70 (Church St.).

Just erase lines as you need to until you get an approximate watershed boundary.



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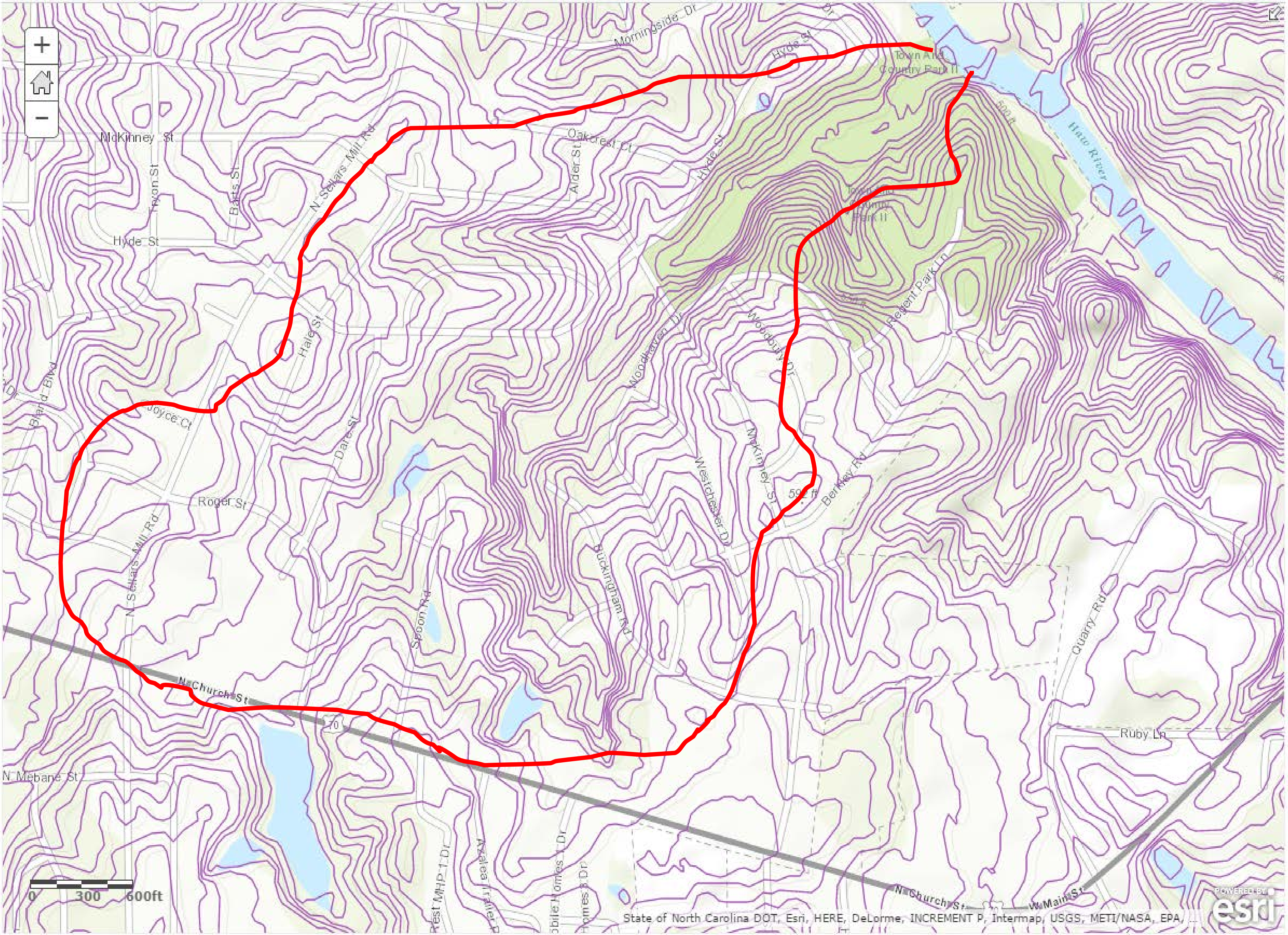
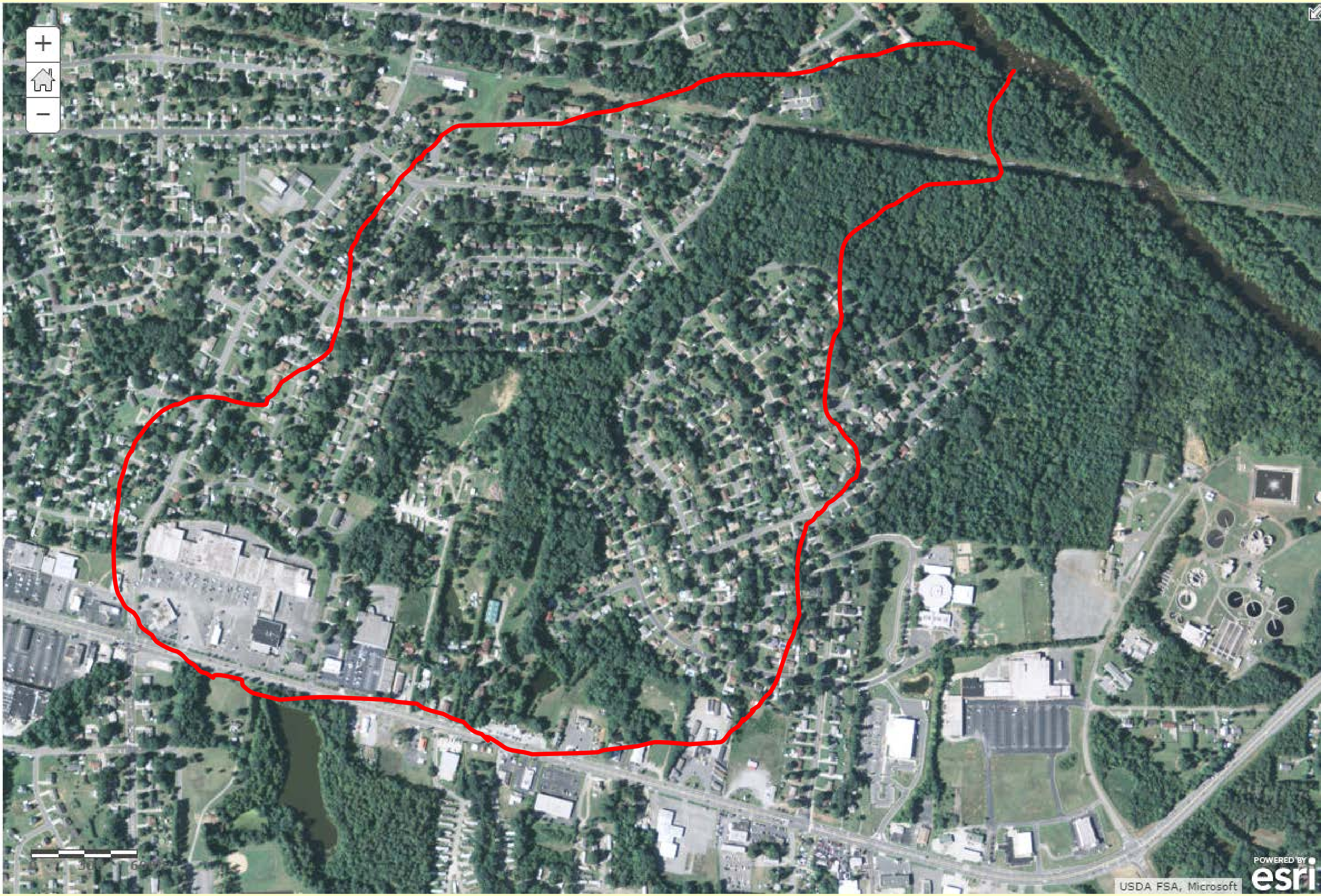

Morningside Dr
Hyde St
McKinney St
Oakcrest Ct
Alder St
Hyde St
Tryon St
Barts St
N Sellars Mill Rd
Hyde St
Haw River
Regent Park Ln
Woodbury Dr
Woodhaven Dr
Hale St
Bland Blvd
Joyce Ct
Dare St
Roger St
McKinney St
Westchester Dr
Berkley Rd
N Sellars Mill Rd
Buckingham Rd
Spoon Rd
Quarry Rd
N Church St
70
Ruby Ln
N Mebane St
N Church St
W Main St
0 300 600ft
State of North Carolina DOT, Esri, HERE, DeLorme, INCREMENT P, Intermap, USGS, METI/NASA, EPA, ...
esri

Place the clear plastic sheet with the watershed drawing overtop the aerial view of the park and community.


USDA FSA, Microsoft
POWERED BY
esri

How can we measure the area of the watershed? You are going to use a grid with a defined area for each block of the grid.

Place the clear sheet over the piece of graph paper.

If each side of the block represents 1440 m of land surface, how much area does each block represent?

How can we measure the area of the watershed? You are going to use a grid with a defined area for each block of the grid.

If each side of the block represents 50 m of land surface, how much area does each block represent?

We are going to round up, so each block represents

$2500\ m^2$.

Count the blocks. What is the total area of the watershed?

Now lets think about water in that watershed

A one inch rainfall = 0.025 m of rain. If an area of ground equivalent to one square on the graph paper receives 1 inch of rainfall, what is the volume of water in m^3 that has fallen on the ground?

Remember, volume is calculated length * width * height.

Now lets think about water in that watershed

A one inch rainfall = 0.025 m of rain. If an area of ground equivalent to one square on the graph paper receives 1 inch of rainfall, what is the volume of water in m^3 that has fallen on the ground?

Remember, volume is calculated length * width * height.

62 m^3

What do you think the stream in the park looks like?

Why?

Urban and Healthy Streams

Urban

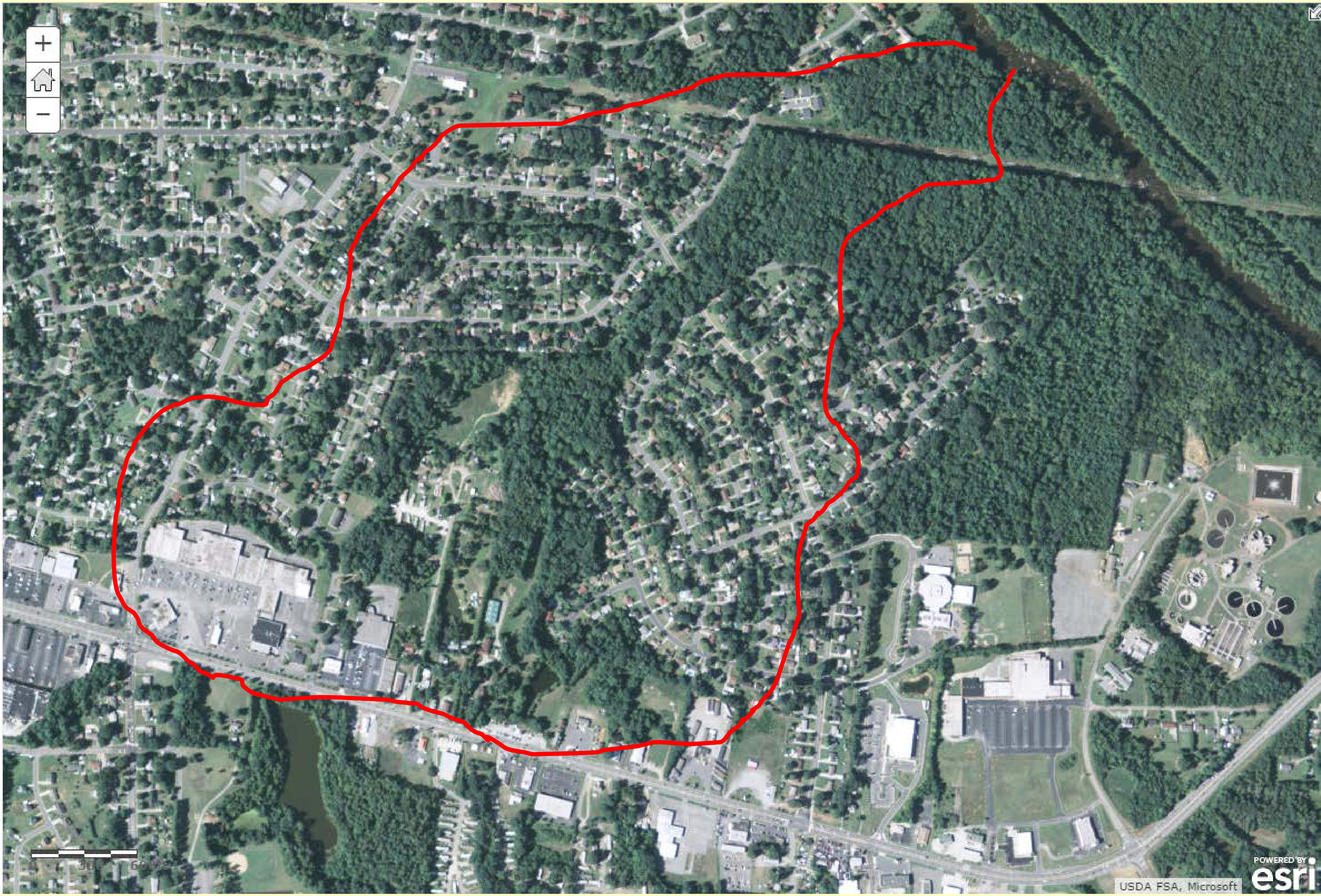
Healthy

Urban Stream in Town and Country Park, Burlington, NC

What could be the cause?

Lets look at the watershed

Homes adjacent to Town and Country Park.
Note the curb and gutter water collection.


+
−
300
600
USDA FSA, Microsoft
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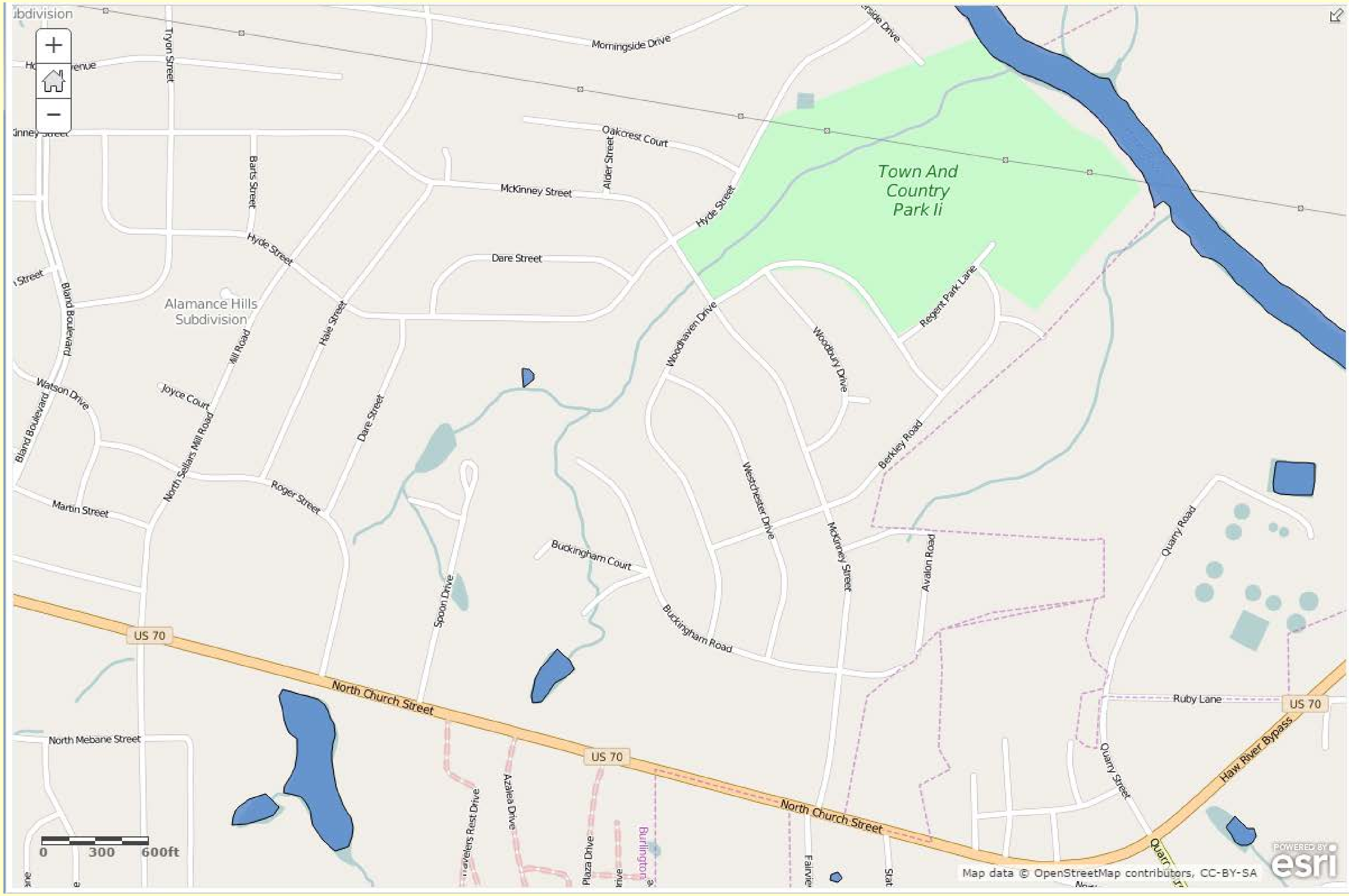
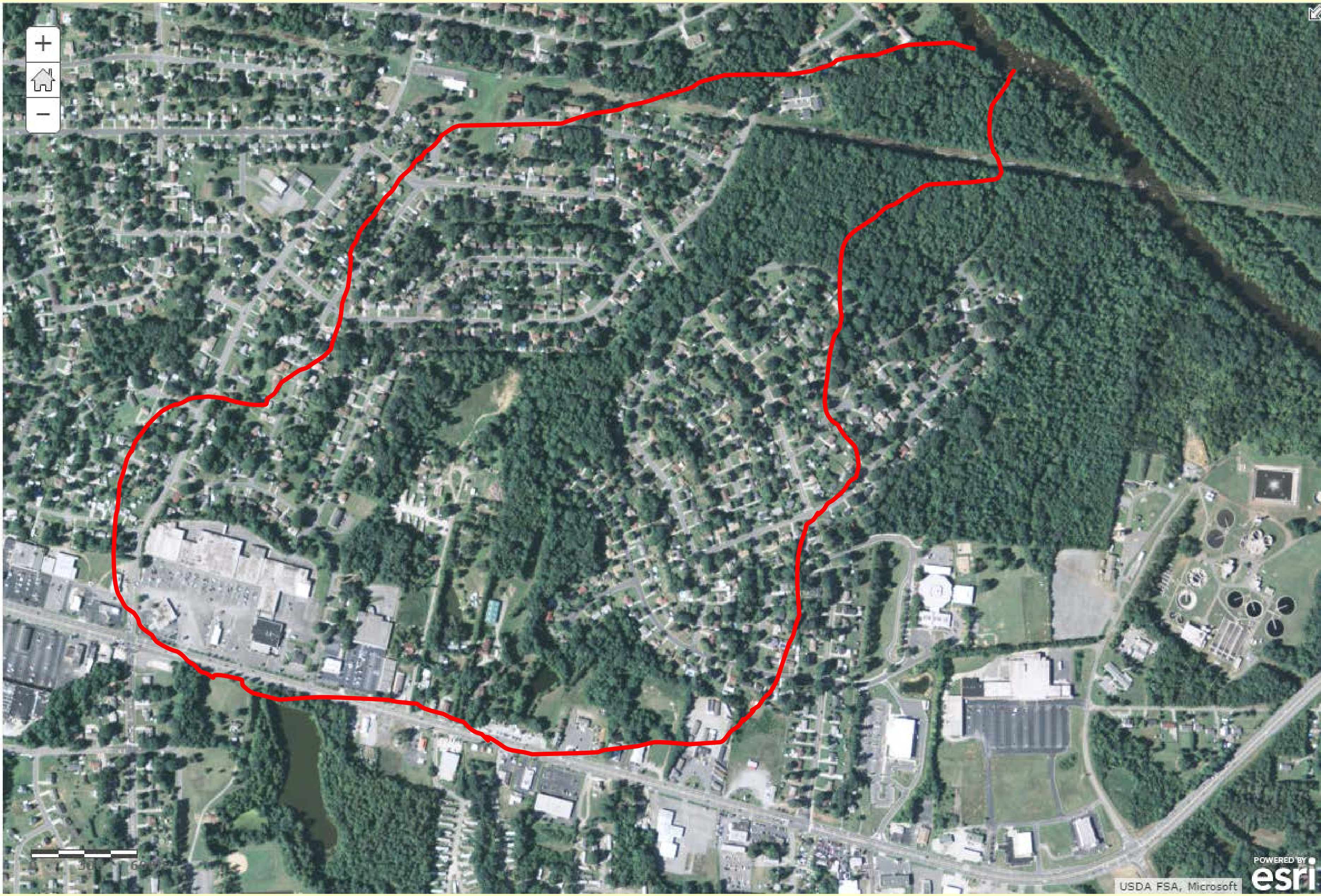


Morningside Drive
Oakcrest Court
Alder Street
McKinney Street
Town And Country Park Ii
Hyde Street
Barts Street
Dare Street
Alamance Hills Subdivision
Hale Street
Bland Boulevard
Regent Park Lane
Woodhaven Drive
Woodbury Drive
Watson Drive
Joyce Court
North Sellars Mill Road
Berkley Road
Westchester Drive
Roger Street
Martin Street
Buckingham Court
McKinney Street
Avalon Road
Quarry Road
Spoon Drive
Buckingham Road
US 70
North Church Street
Ruby Lane
Haw River Bypass
North Mebane Street
Azalea Drive
Travelers Rest Drive
Plaza Drive
Quarry Street
Burlington
0 300 600ft
Map data © OpenStreetMap contributors, CC-BY-SA
POWERED BY esri



USDA FSA, Microsoft
POWERED BY esri

What is the area of the parking lot in blocks?

If a one inch rain occurs, how much water lands on the parking lot?

A one inch rainfall = 0.025 m of rain. If an area of ground equivalent to one square on the graph paper receives 1 inch of rainfall, what is the volume of water in m^3 that has fallen on the ground?

5,1840 m^3

A one inch rainfall = 0.025 m of rain. If an area of ground equivalent to one square on the graph paper receives 1 inch of rainfall, what is the volume of water in m^3 that has fallen on the ground?

5,1840 m^3

How much water is on the parking lot?

If the rain happens in one hour, what is the flow to the stream in **m^3**
per minute?

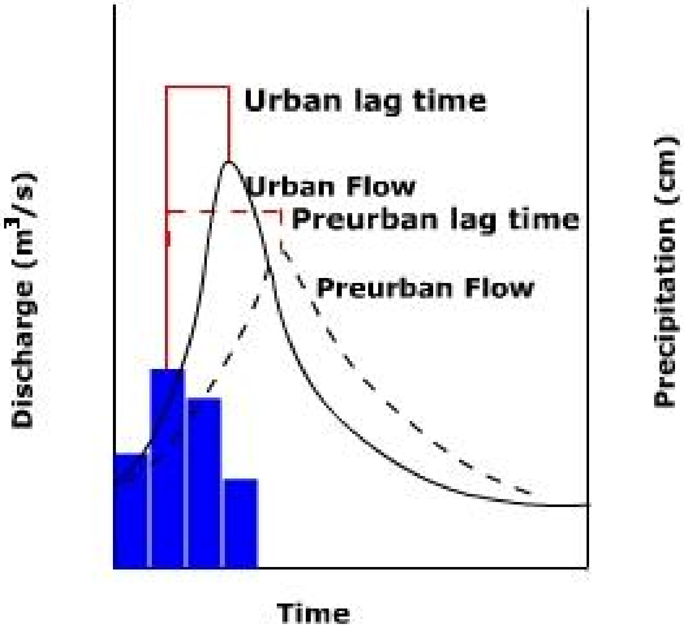


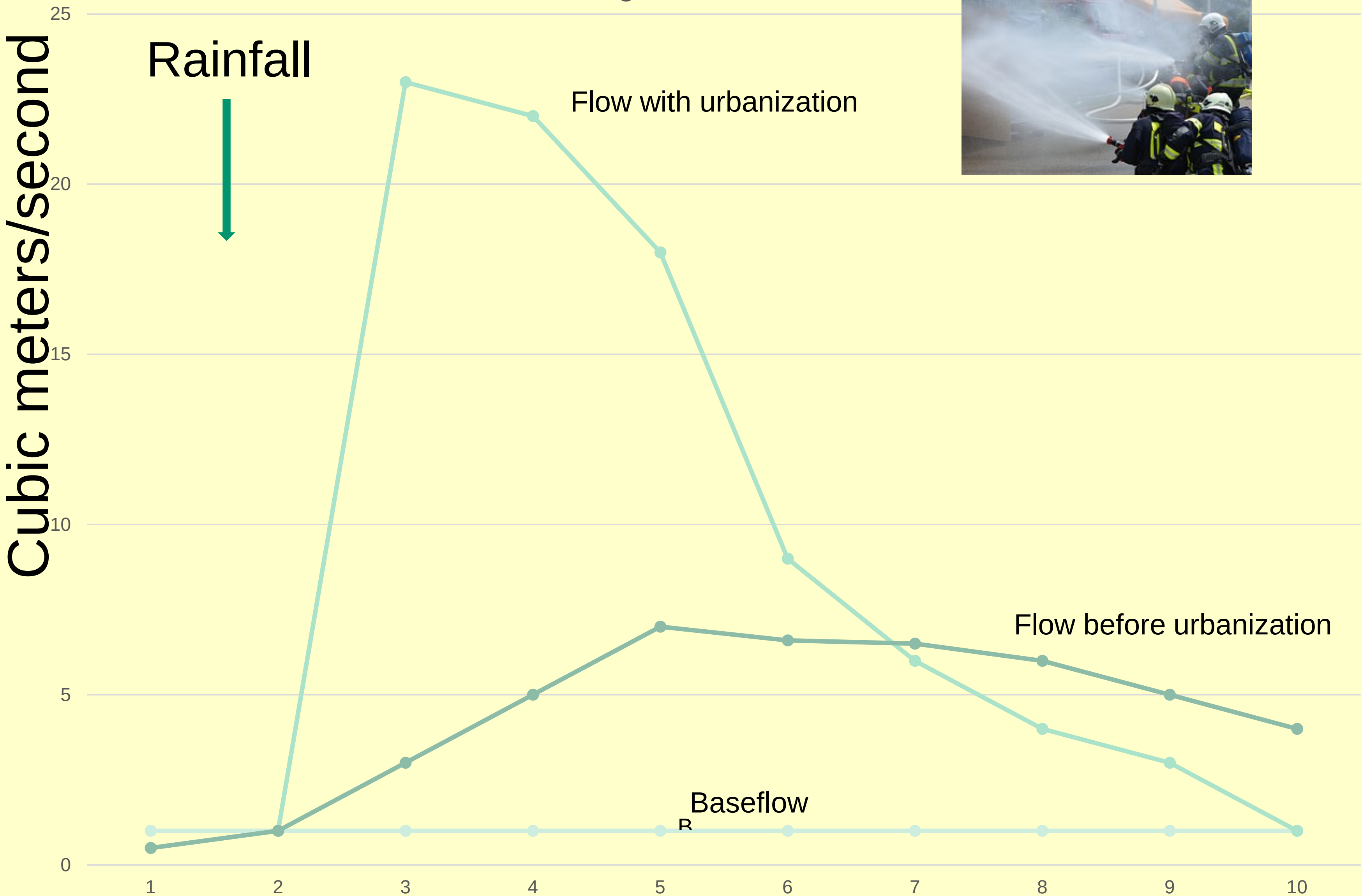
Figure 18.18 Comparison of pre-urban and post-urban watershed discharge.

Land cover is another important control over the shape of a stream hydrograph. Under natural conditions, vegetation slows surface runoff and encourages infiltration. As a result, the hydrograph is less peaked and the lag time is longer than a basin with little vegetation. Urbanization of a watershed can have a drastic effect on runoff, discharge, and the resulting hydrograph. Urbanization replaces permeable surface with impermeable ones, streets, parking lots, buildings etc. Water runs off the surface more efficiently and is diverted to nearby streams by the construction of storm sewers. Storm sewers effectively increase the urbanized watershed drainage density. As a result, urbanized watersheds tend to exhibit more peaked hydrographs with shorter lag periods.

Changes in a stream hydrograph with urbanization.
Note the change in lag times and width of peak flow.

http://www4.uwsp.edu/geo/faculty/ritter/geog101/textbook/fluvial_systems/channel_geometry_and_flow.html

Flow in Creek, Burlington, NC following a 1 in. rain



How do we evaluate water quality?

- Chemistry
  - pH, nitrates, phosphates, dissolved oxygen
- Physical traits
  - Temperature, suspended solids, flow rate
- Biological Communities
  - Macroinvertebrates, fish, chlorophyll a, algae, aquatic plants (invasion of the non-natives?)

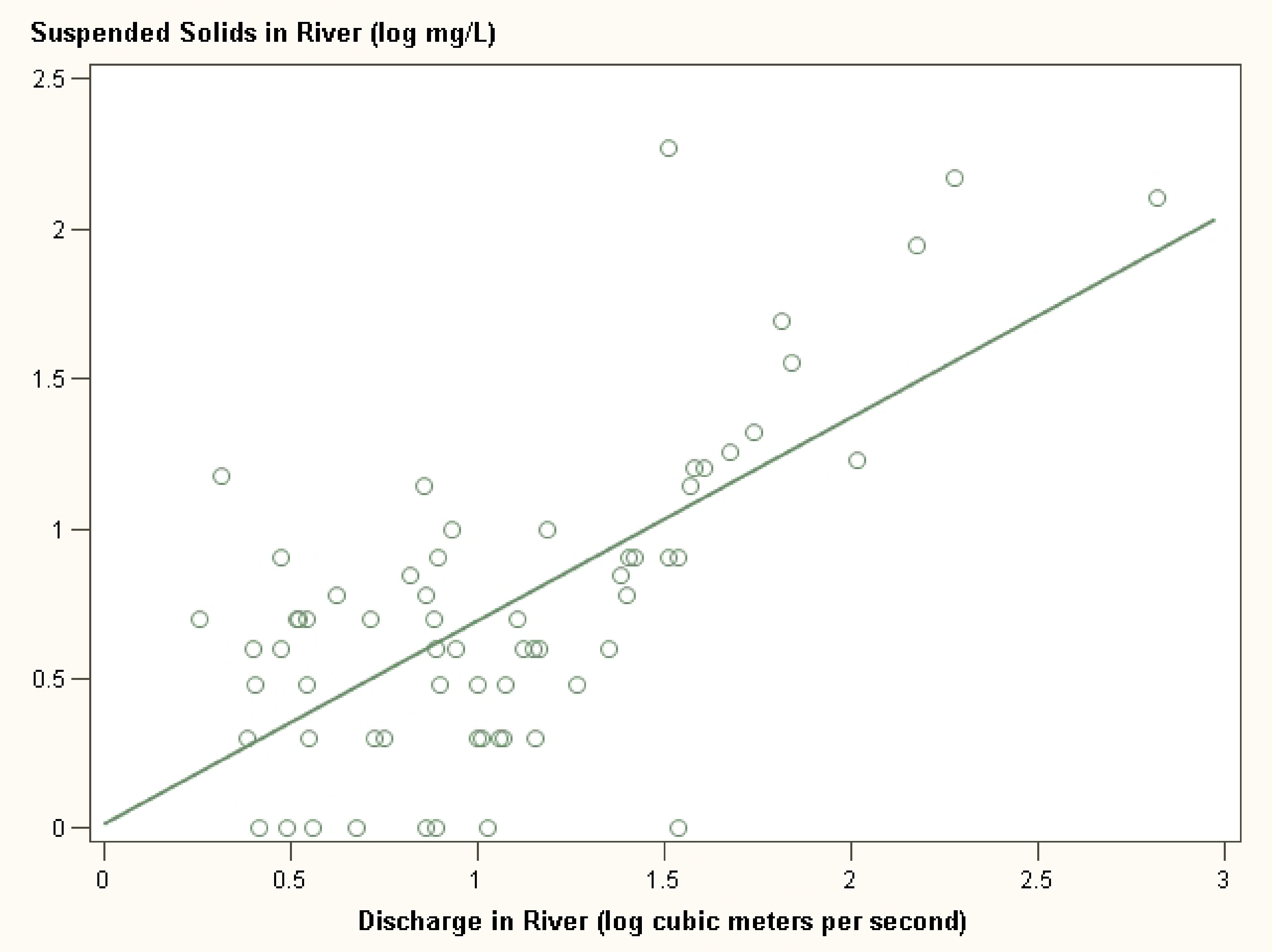
Pollution

– adding sediment to the river

Sediment

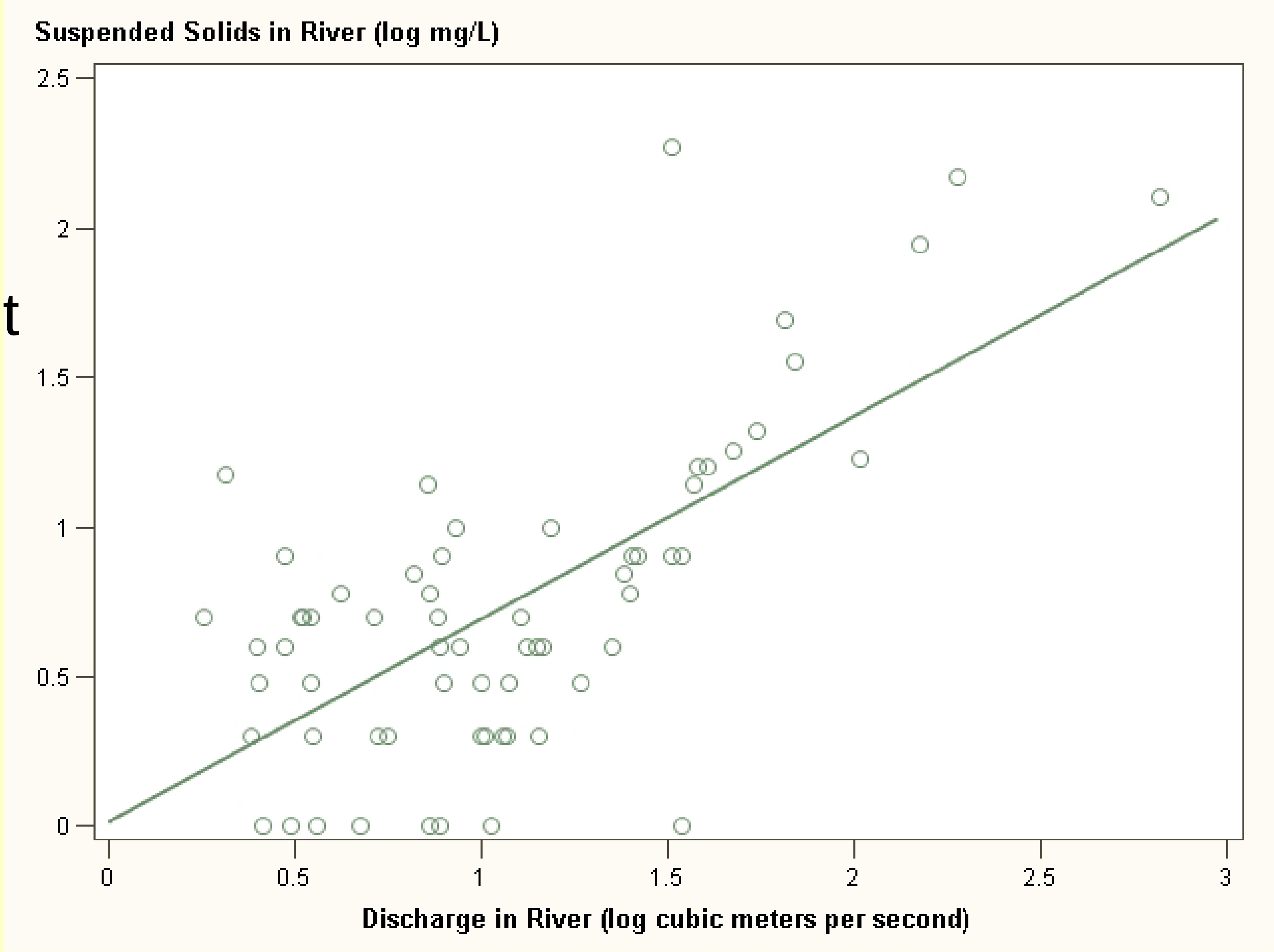
- Human activities have accelerated erosion rates in many areas.
  - Cropland erosion contributes about 25 billion metric tons of suspended solids to water bodies each year. (Agriculture in SE US)
  - Runoff from development
- Sediment can either be beneficial (nourish floodplains) or harmful (smother aquatic life).

Sediment in the Haw River at Bynum



Sediment in the Haw River at Bynum

How are flow and sediment loading related?



Who are the major water users?

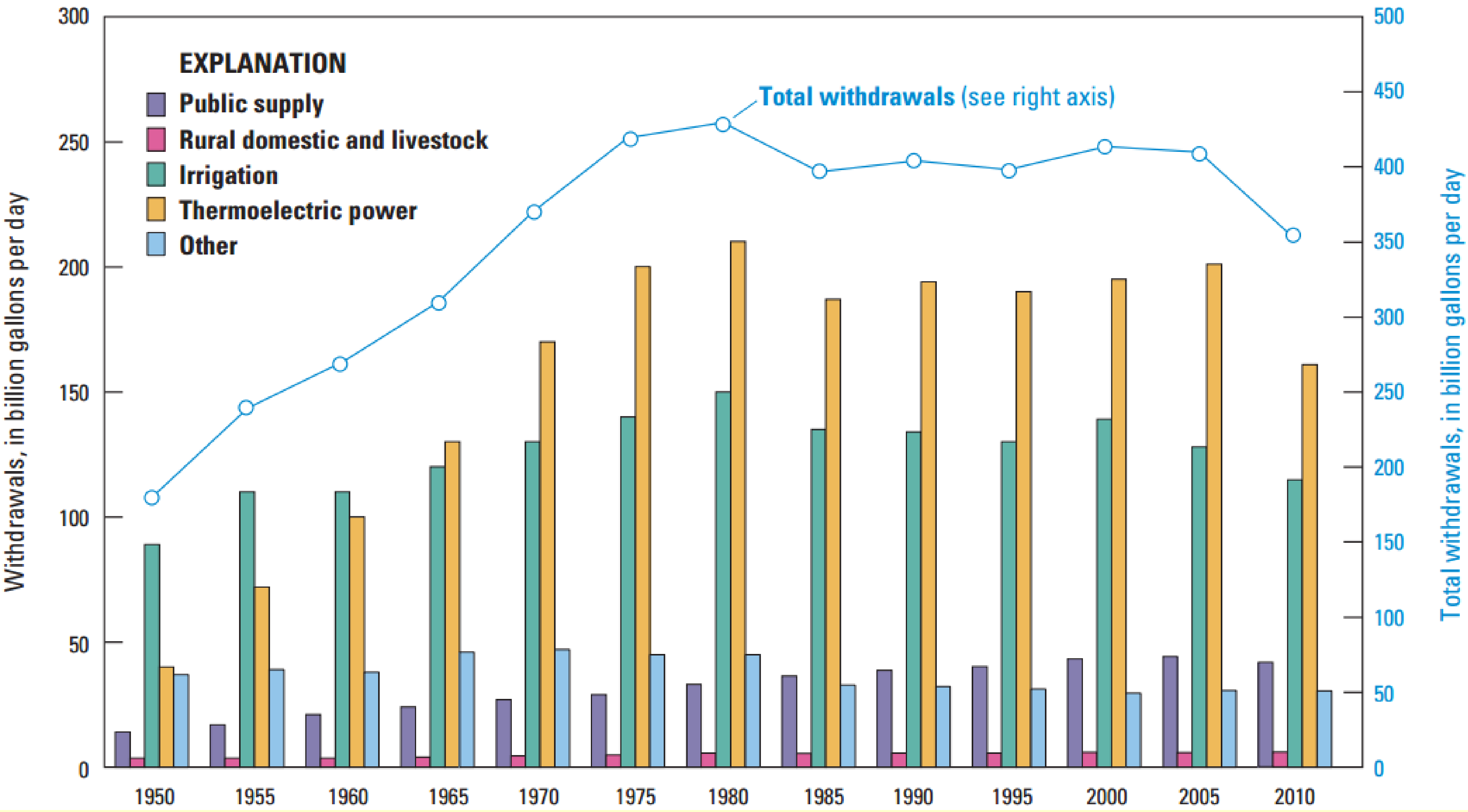
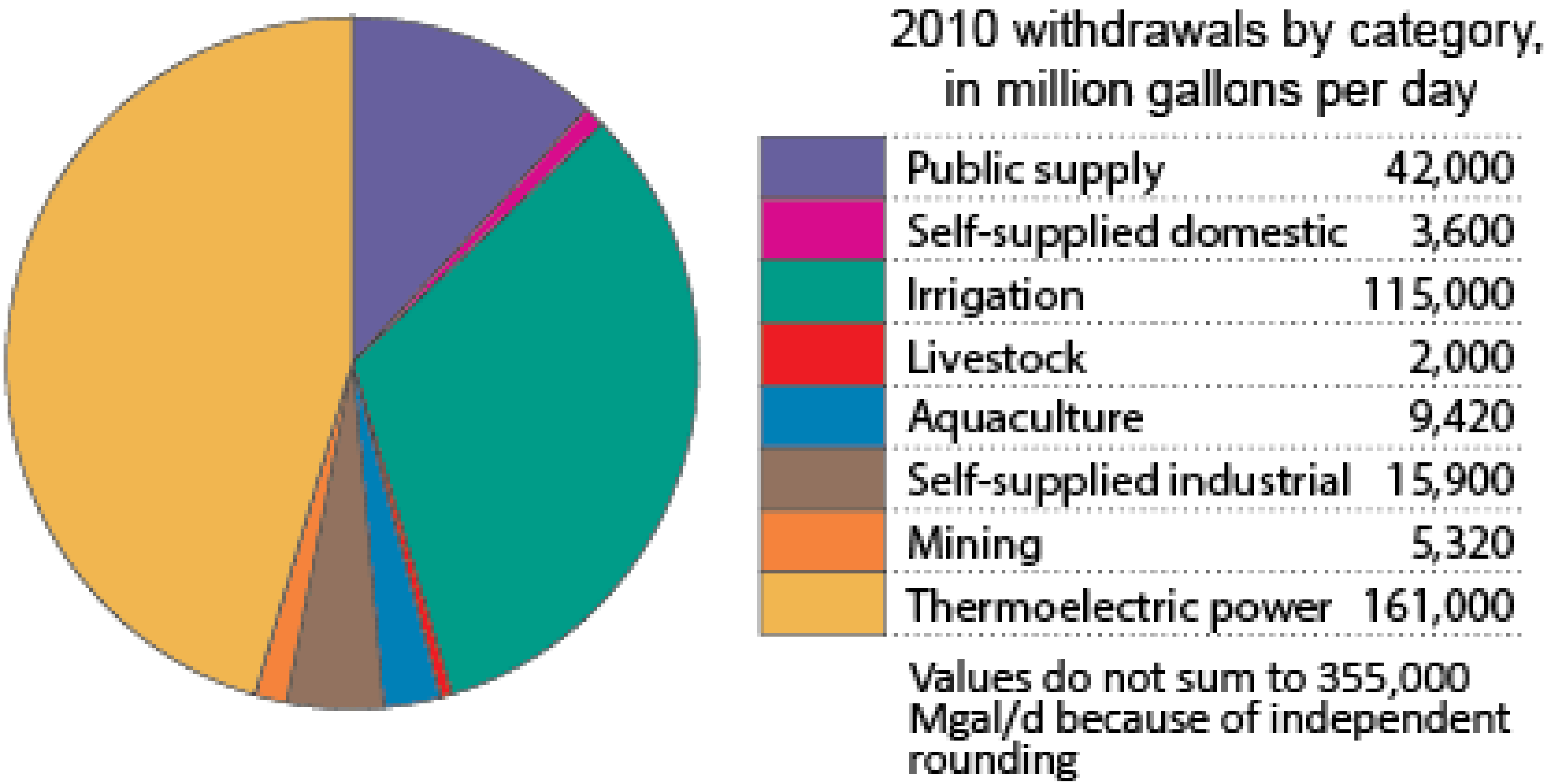
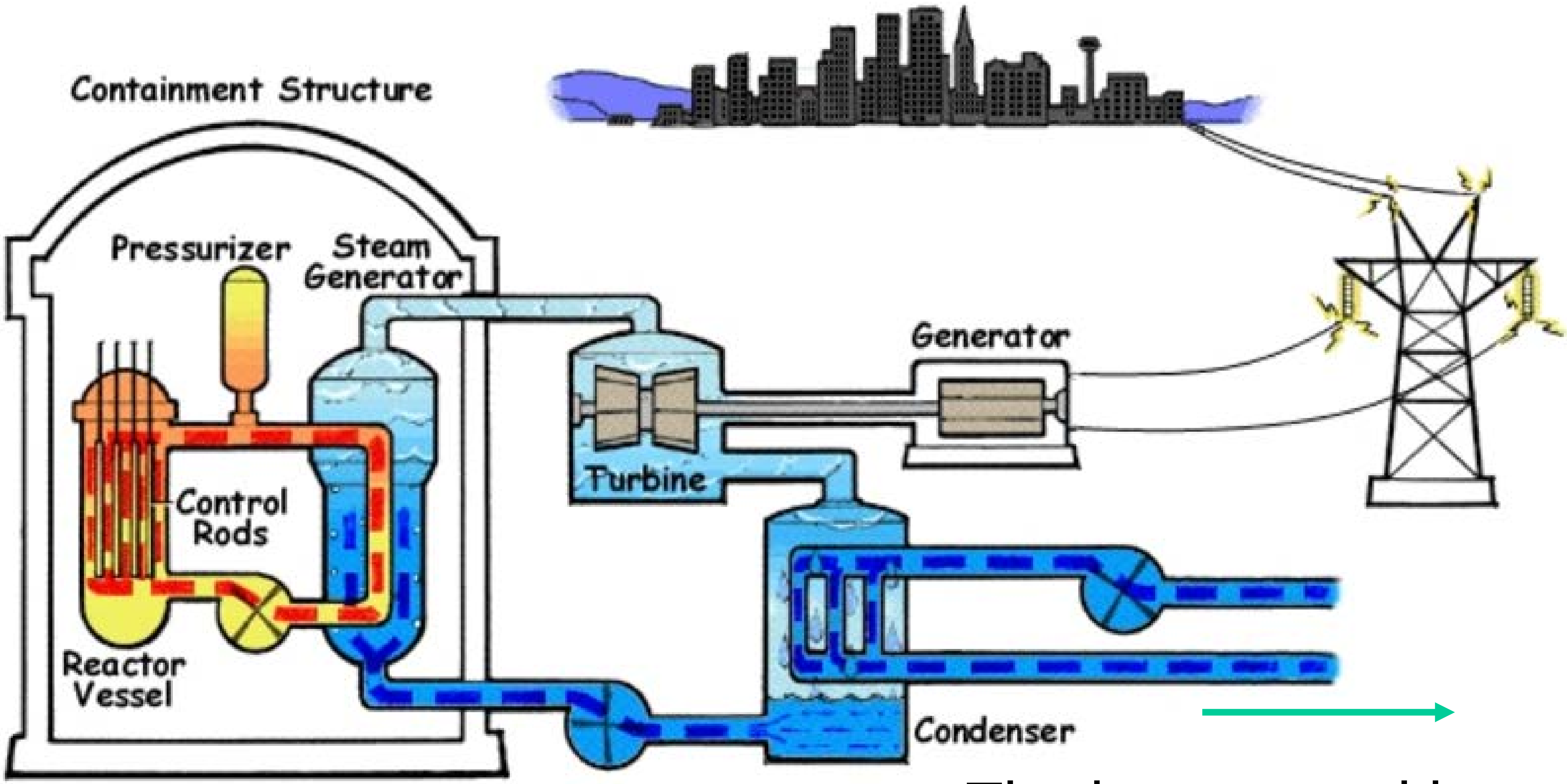


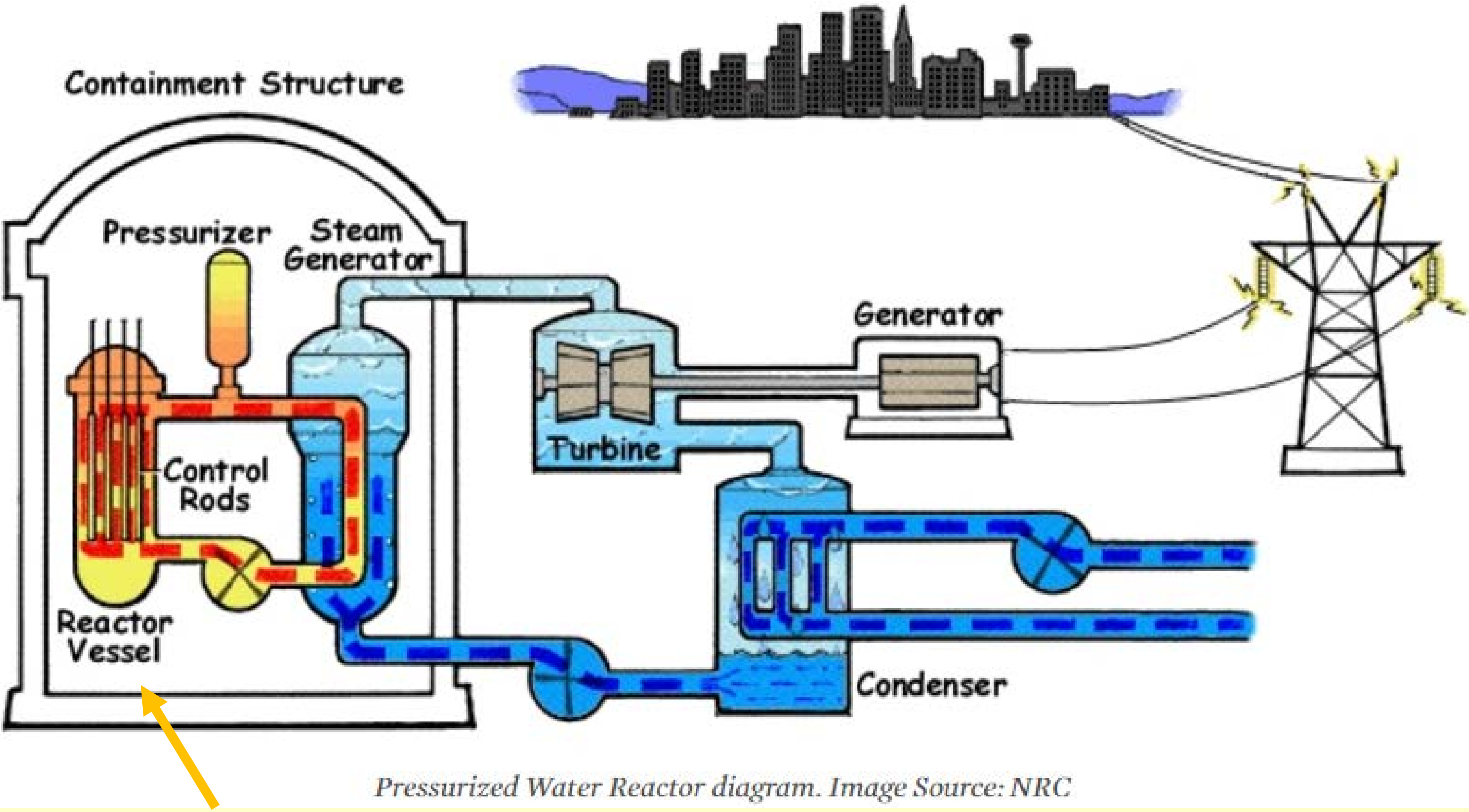
Figure 14. Trends in total water withdrawals by water-use category, 1950–2010.



http://water.usgs.gov/wat



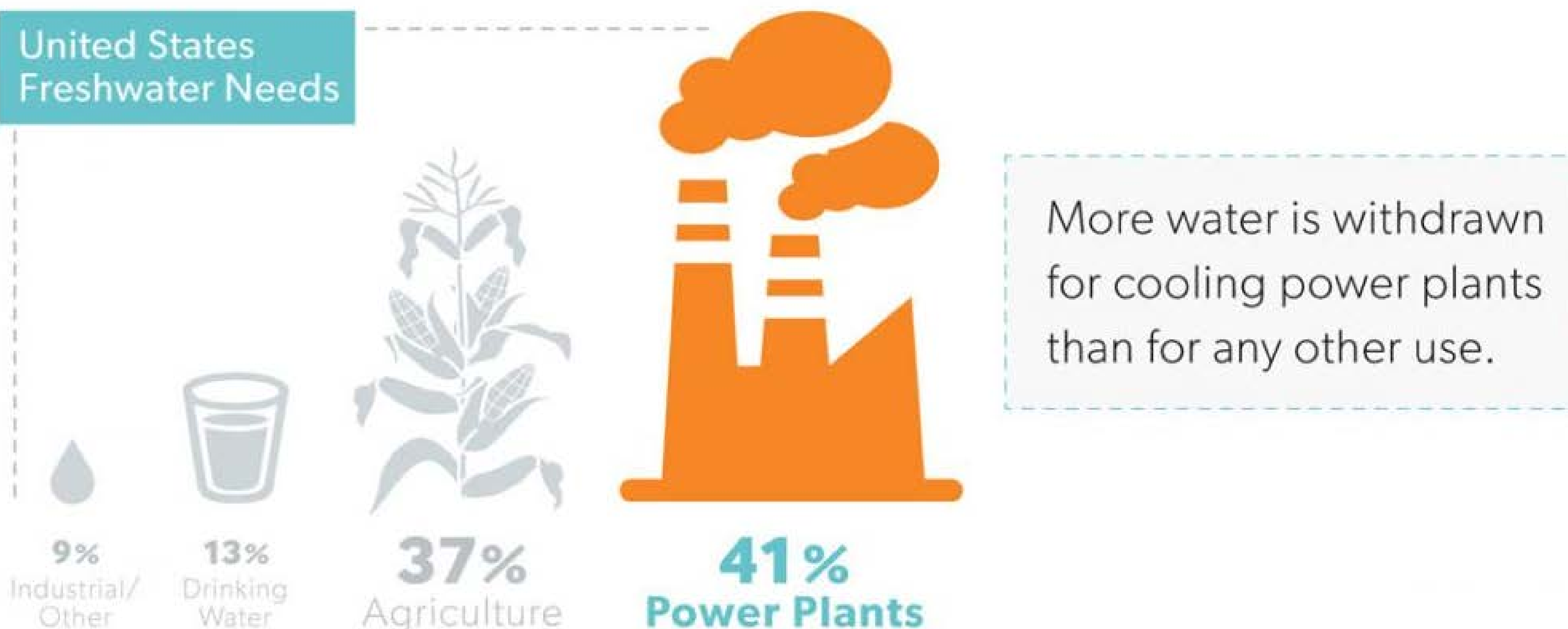
The hot water either goes out the cooling towers as steam, is re-circulated in



Pressurized Water Reactor diagram. Image Source: NRC

Coal plants work in a similar operation – burning coal produces heat to generate

Today's power plants depend on **massive** amounts of water for cooling.



If generating 1 kilowatt hour requires 600 gallons of water

(Union of Concerned Scientists)

Burning a 60 watt lightbulb for 10 hours each day, for 7 days
uses 4.2 kilowatt hours of electricity

If generating 1 kilowatt hour requires 600 gallons of water

(Union of Concerned Scientists)

Burning a 60 watt lightbulb for 10 hours each day, for 7 days uses 4.2 kilowatt hours of electricity

==> 2520 gallons of water are used

The Plant Bowen coal-fired powerplant outside Euharlee in Bartow County, Georgia. Photo by Alan Cressler, USGS.

Types and Results of Water Pollution

- Infectious agents - 25 million deaths a year
- Plant nutrients – algal blooms, toxic tides
- Metals - mercury and lead poisoning
- Acids and bases –
- Organic chemicals
- Sediments - clogged estuaries, death of coral reefs
- Thermal pollution - thermal plume

Water Pollution

Point source pollution - source is from drain pipes, ditches, sewer outfalls, factories and power plants - easy to monitor and regulate

Nonpoint source pollution - runoff from farm fields and feedlots, lawns and gardens, golf courses, construction sites, atmospheric deposits –
no specific location so harder to monitor and regulate

How do materials from point sources and non-point sources disperse into the environment?

Non-Point Source Pollution

- Runoff from the land surface
- Frequently carrying with it plant nutrients such as lawn fertilizers

Outcome = Algal Blooms!!!

What can algae do?

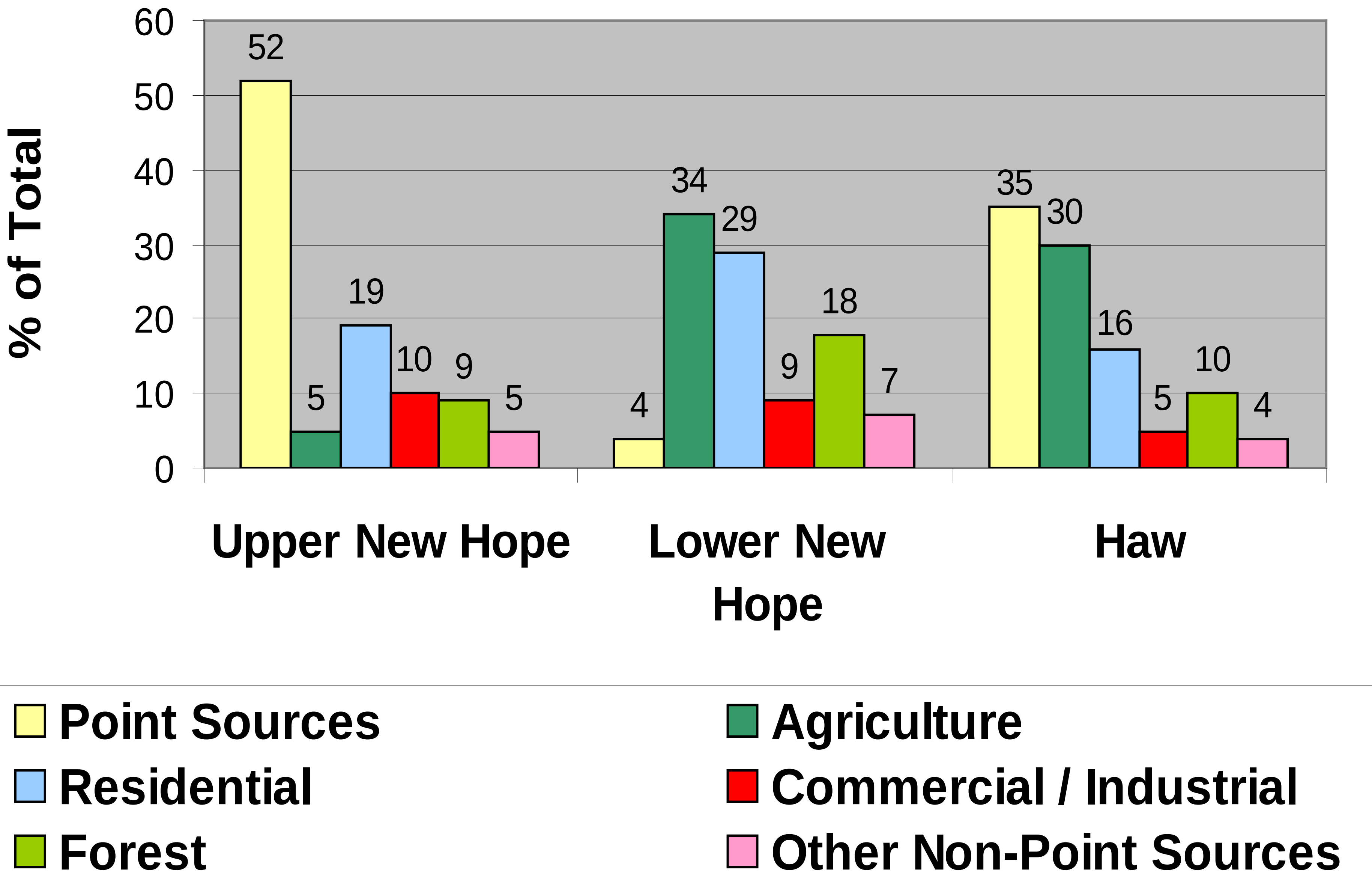
Produce toxins, die and decompose to reduce the oxygen in the water

Filamentous Algal Mat on Haw River at Bynum, Dec 7, 2001

Benefits of Jordan Reservoir

- Recreation 1.1 – 1.5 million visitors / yr.
- Drinking Water – 460,000 people, 6 communities
- Habitat – aquatic and water-dependent
- Boon to local economy and property values

Sources of Nitrogen to Jordan Reservoir



Algal blooms in Jordan Lake

Public Health concern-
Possible toxins
Eutrophication

What pollutants come from waste water treatment plants?

What are waste water plants designed to do?

What pollutants could come from waste water treatment plants?

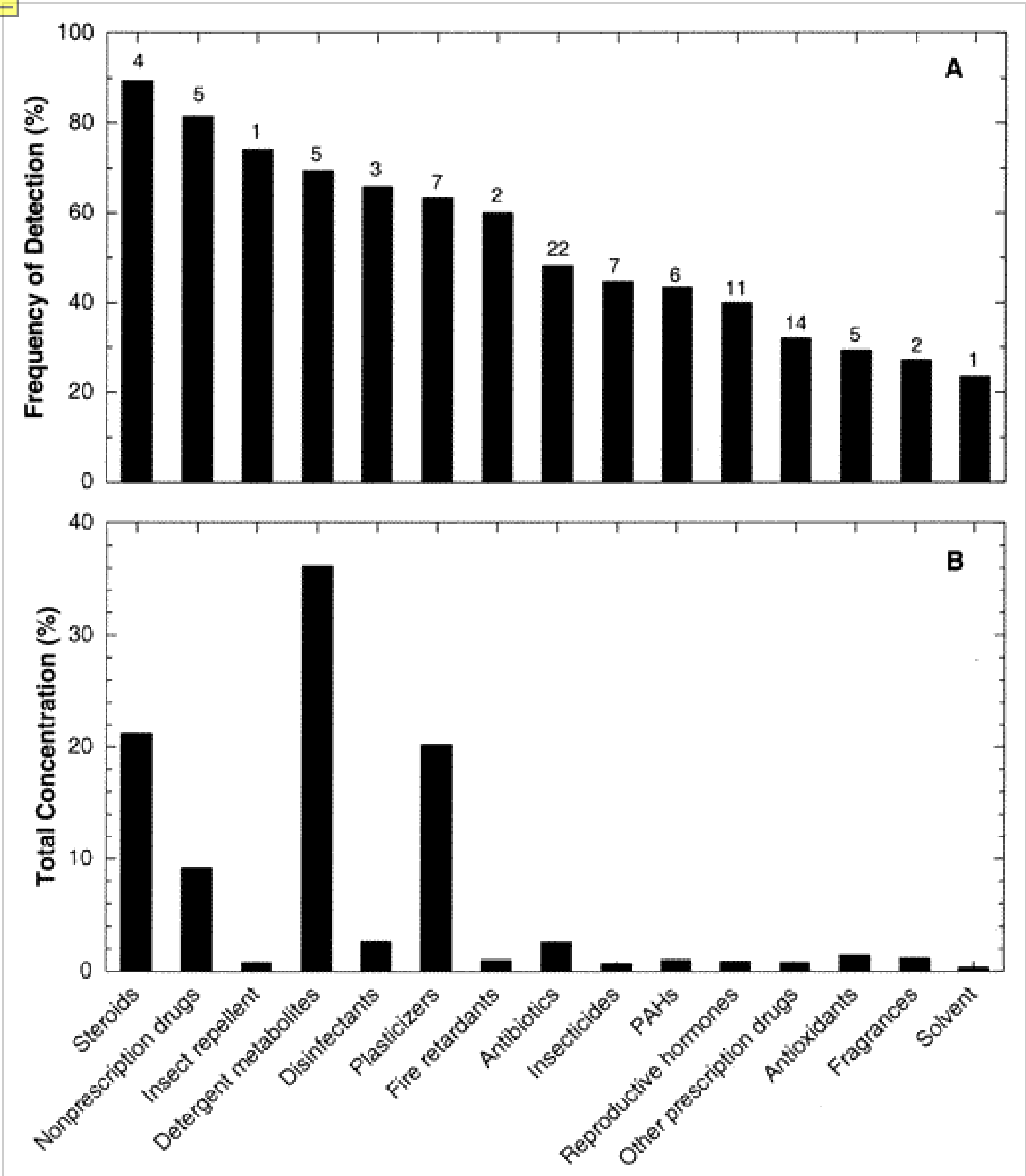
Waste water treatment plants are designed to remove solids, nutrients (nitrogen and phosphorus), and to kill disease causing organisms.

And they accomplish these goals very well!

What could be in the waste water that comes from your homes?

Organic Chemicals

- Thousands of natural and synthetic organic chemicals are used to make pesticides, plastics, pharmaceuticals, pigments, etc.
- Important sources of organic chemicals from humans are:
  - Improper disposal of industrial wastes.
  - Household wastes
    - **Caffeine**
    - **Fabric brighteners and cleaners**
    - **Pharmaceuticals – birth control, anti-depressants**
  - Runoff of pesticides from high-use areas.
    - Fields, roadsides, golf courses



Detected in river water

Water from 139 streams was tested. Contaminants were found in 80% of the water samples tested.

Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999−2000: A National Reconnaissance

Dana W. Kolpin *
U.S. Geological Survey, 400 S. Clinton Street, Box 1230, Iowa City, Iowa 52244
Edward T. Furlong
U.S. Geological Survey, Box 25046, MS 407, Denver, Colorado 80225-0046
Michael T. Meyer
U.S. Geological Survey, 4500 SW 40th Avenue, Ocala, Florida 34474
E. Michael Thurman
U.S. Geological Survey, 4821 Quail Crest Place, Lawrence, Kansas 66049
Steven D. Zaugg
U.S. Geological Survey, Box 25046, MS 407, Denver, Colorado 80225-0046
Larry B. Barber
U.S. Geological Survey, 3215 Marine Street, Boulder, Colorado 80303
Herbert T. Buxton

U.S. Geological Survey, 810 Bear Tavern Road, West Trenton, New Jersey 08628
Environ. Sci. Technol., 2002, 36 (6), pp 1202–1211
DOI: 10.1021/es011055j
Publication Date (Web): March 13, 2002

"National Reconnaissance of Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in Streams" Named as One of the Top 100 Science Stories of the Year

Other Issues in the News

Coal Ash from our electrical generating stations

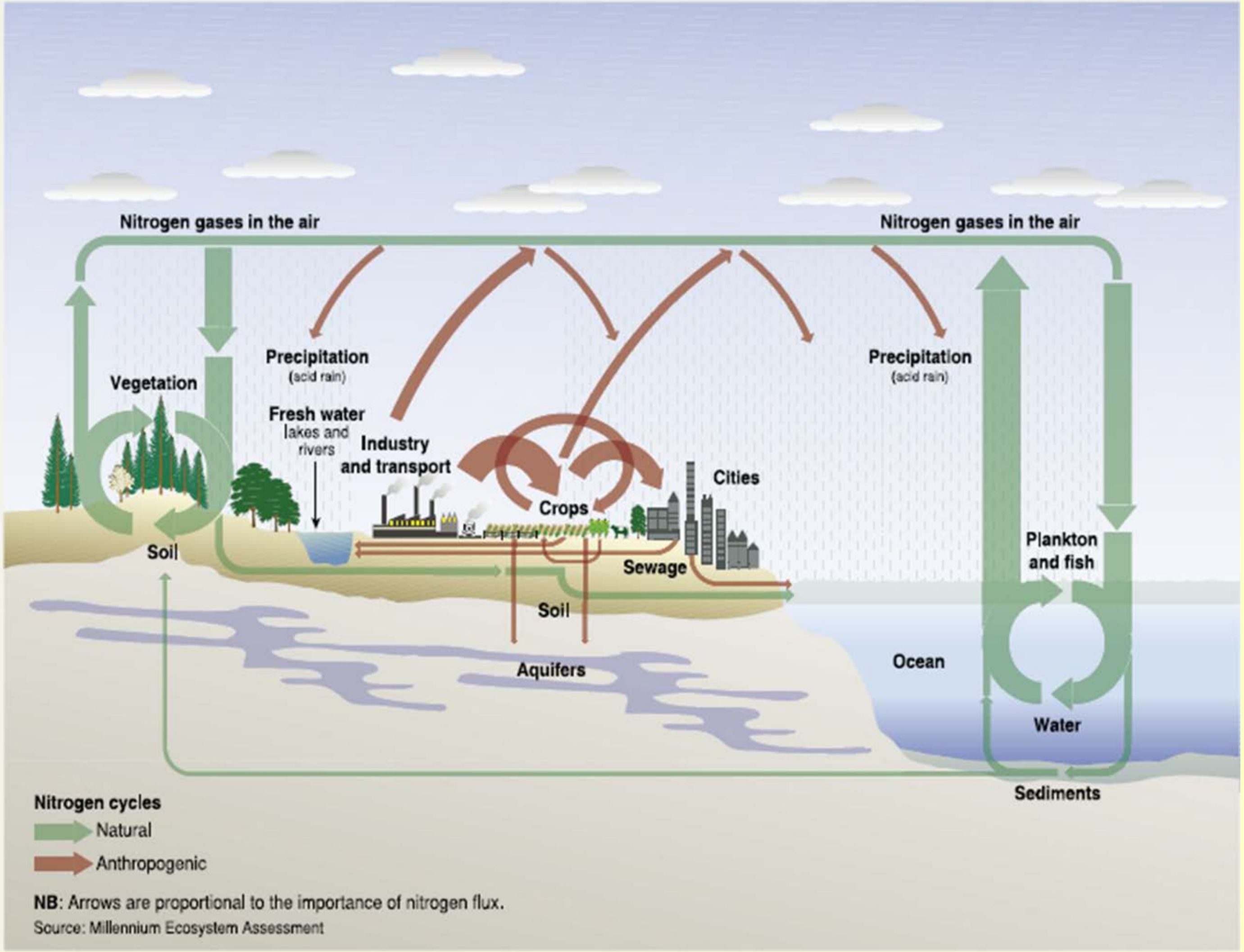
- 14 coal fired electrical generating stations
- Capacity to hold 19 billion gallons of ash
- Annually North Carolina power plants generate 5.5 million tons of ash

Fracking for natural gas extraction

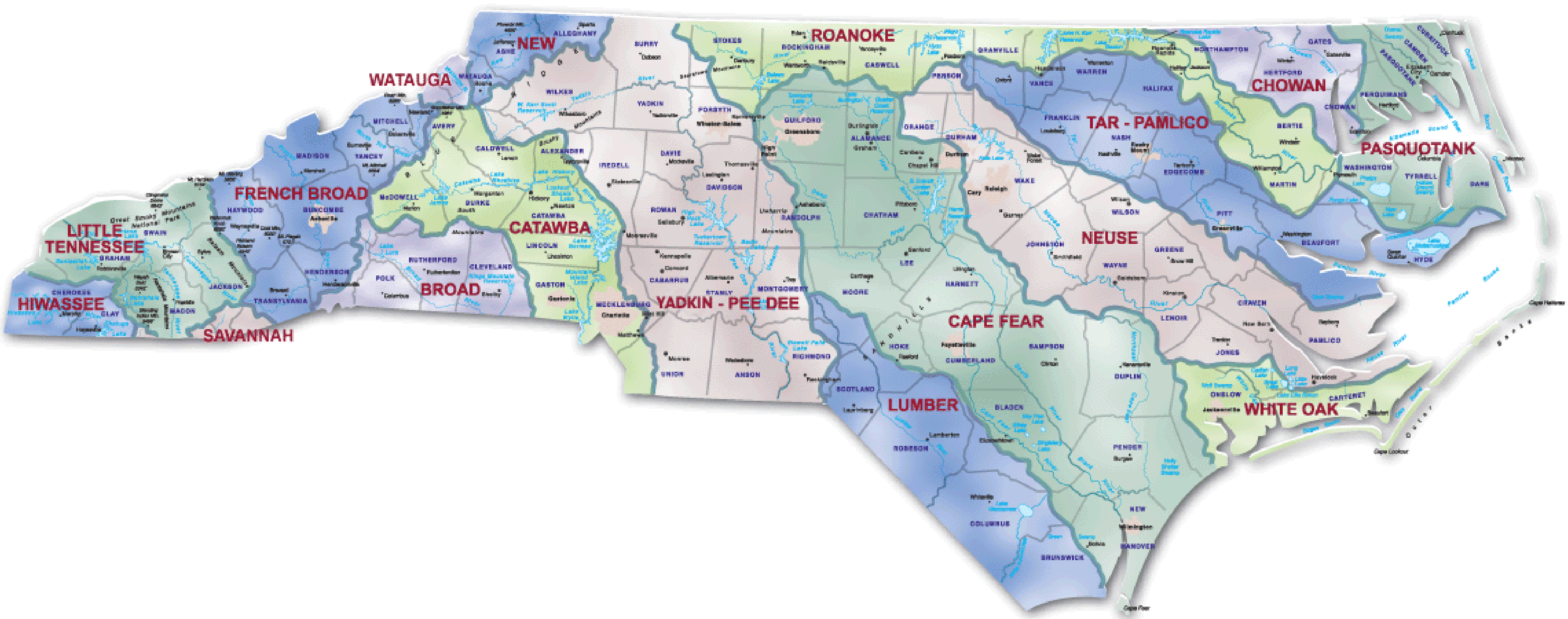
- North Carolina has some shale deposits, generally within 1000 feet of the surface
- Water wells are typically 100 – 700 ft. deep

Are pollutants flowing from the parking areas into the lake?

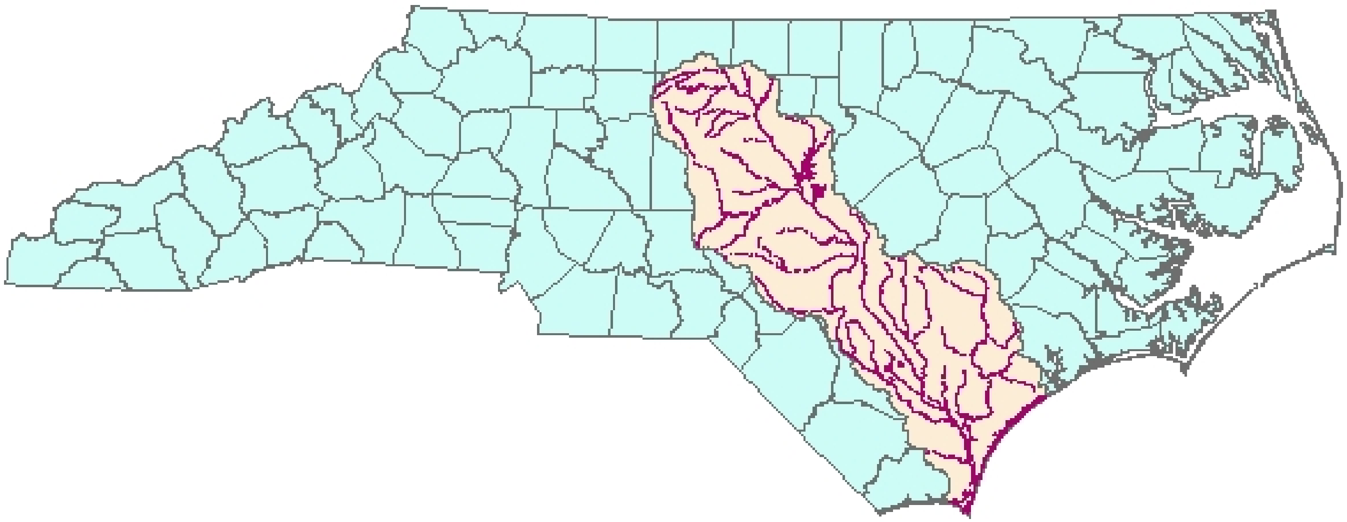
Human activities, including farming and industry, have greatly increased the cycle of nitrogen through soils, water courses, and the atmosphe
By accumulating more nitrogen in a form that can be taken up by plants, the balance of ecosystems can be seriously upset.



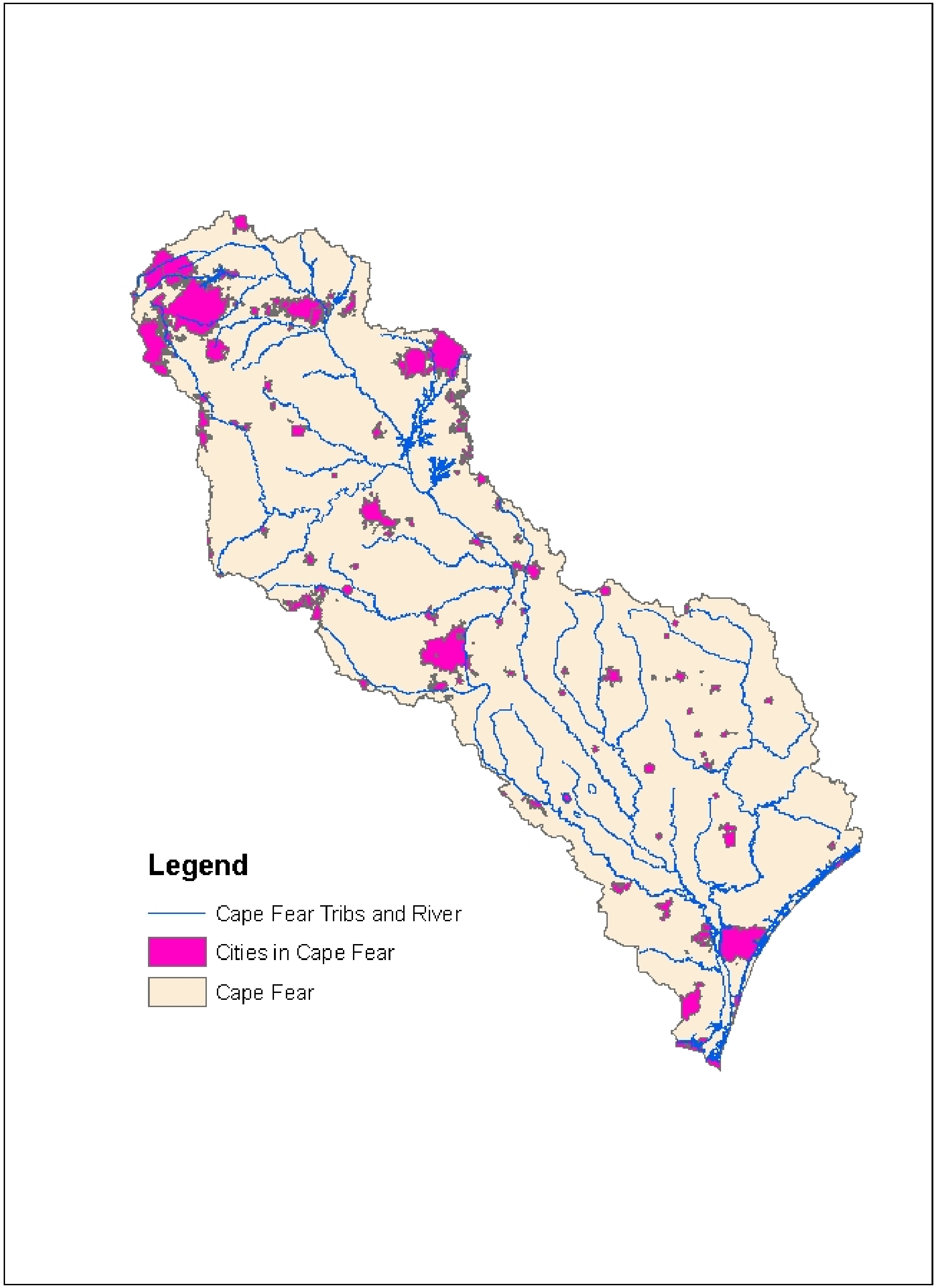
Watersheds of North Carolina



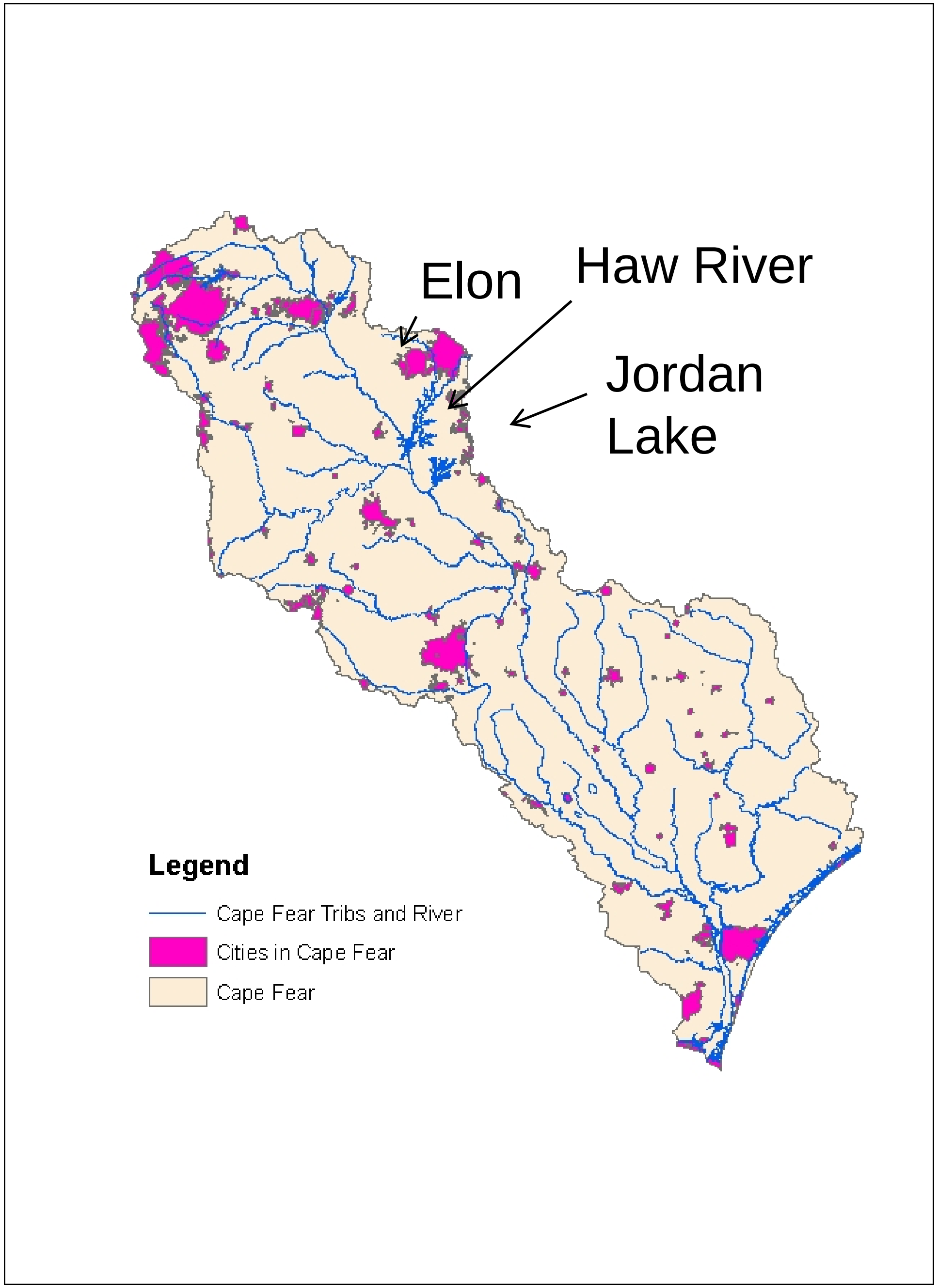
Cape Fear River Basin



Cape Fear River Basin



Cape Fear River Basin



Benefits of Jordan Reservoir

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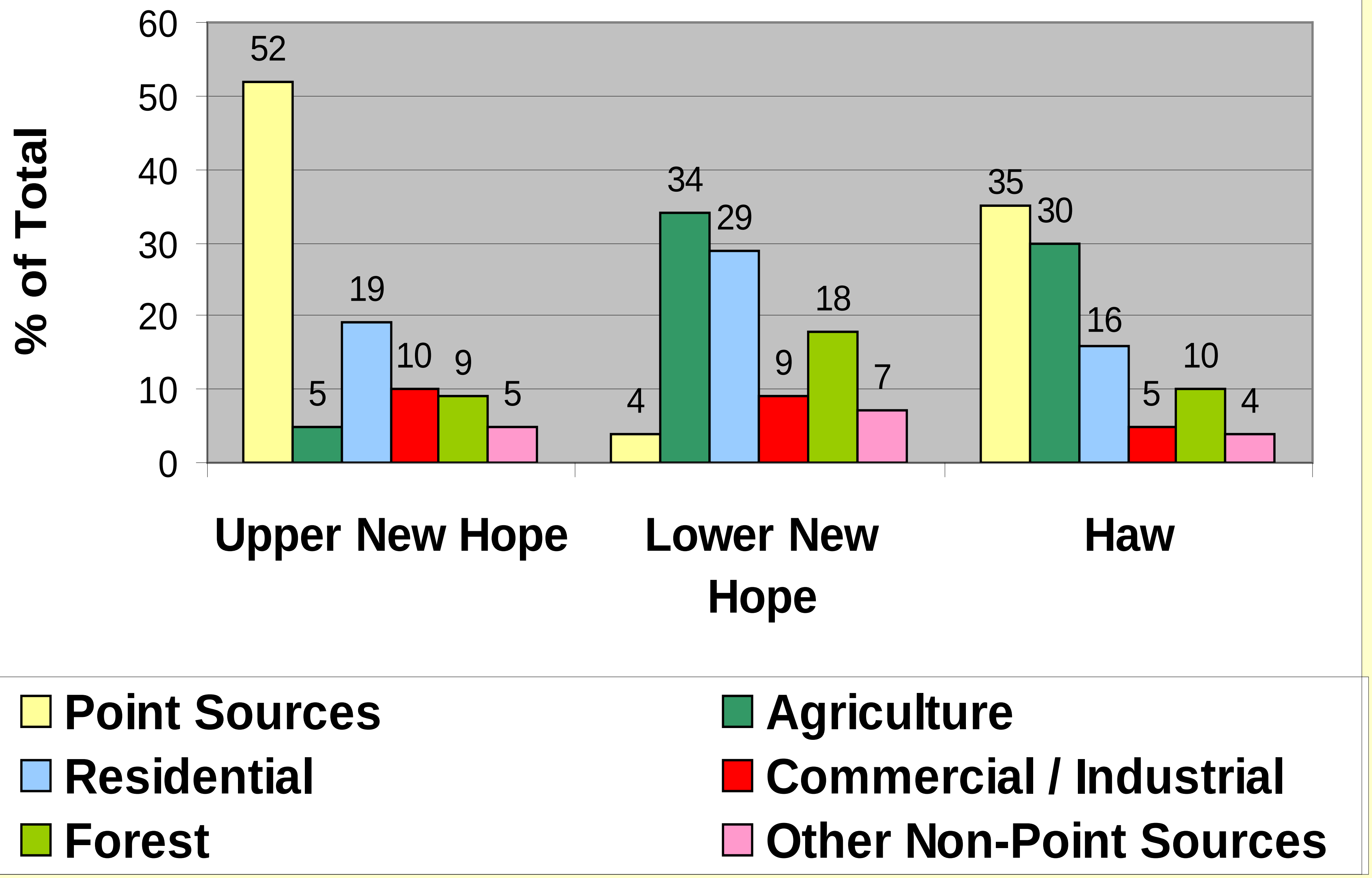
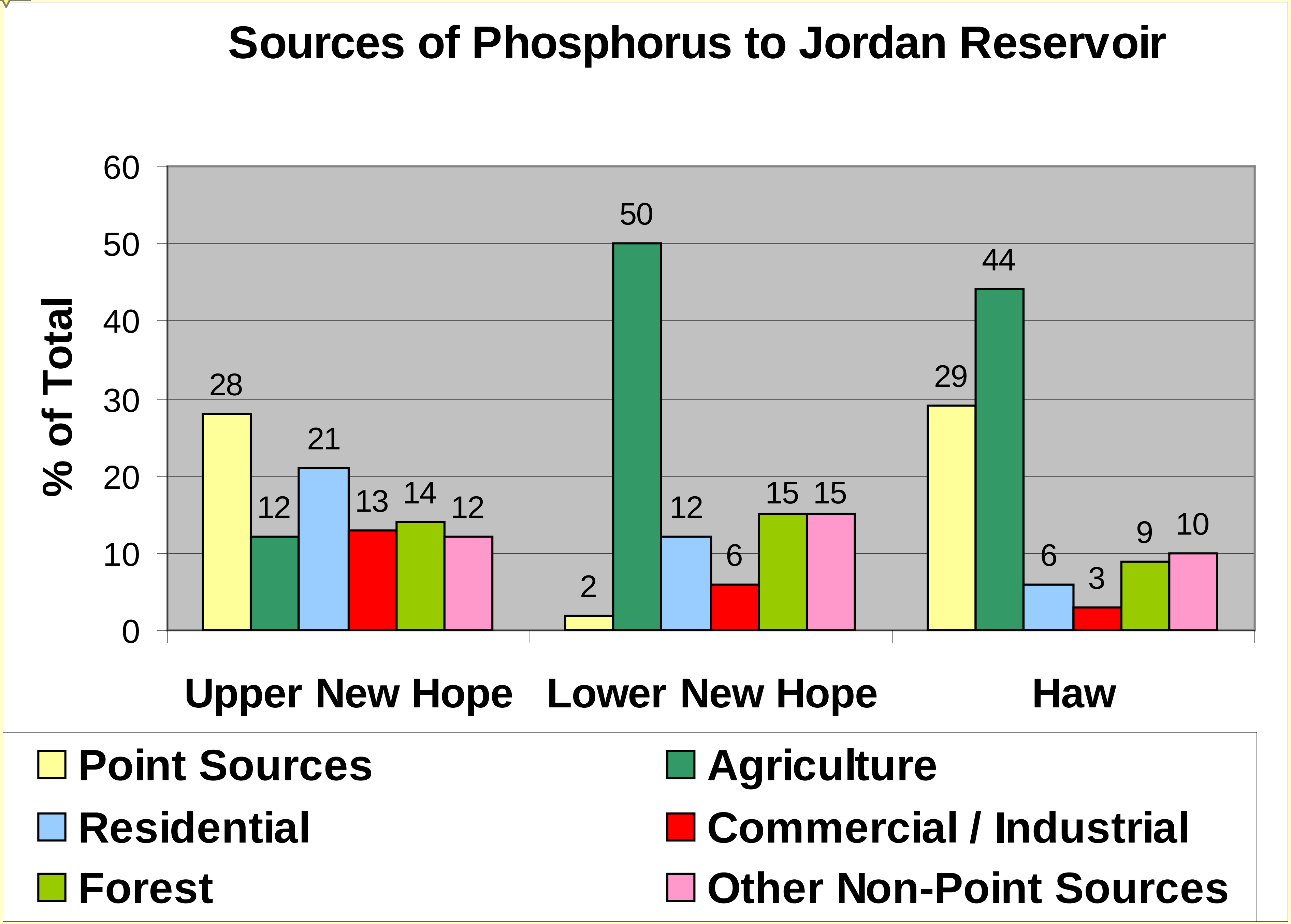
Filamentous Algal Mat on Haw River at Bynum, Dec 7, 2001

Sources of Nitrogen to Jordan Reservoir



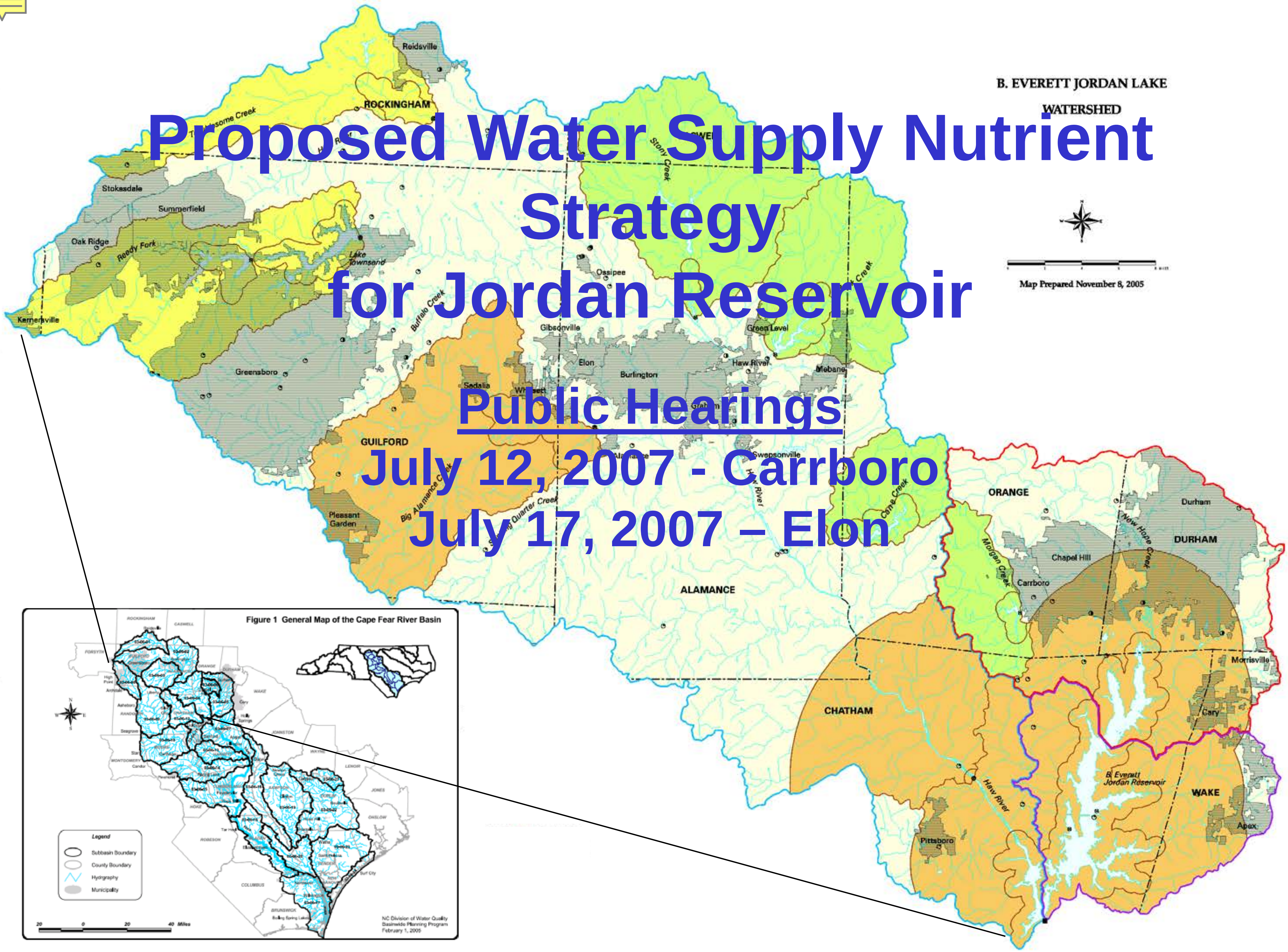

Sources of Phosphorus to Jordan Reservoir
% of Total
0
10
20
30
40
50
60
28
12
21
13
14
12
2
50
12
6
15
15
29
44
6
3
9
10
Upper New Hope
Lower New Hope
Haw
Point Sources
Agriculture
Residential
Commercial / Industrial
Forest
Other Non-Point Sources

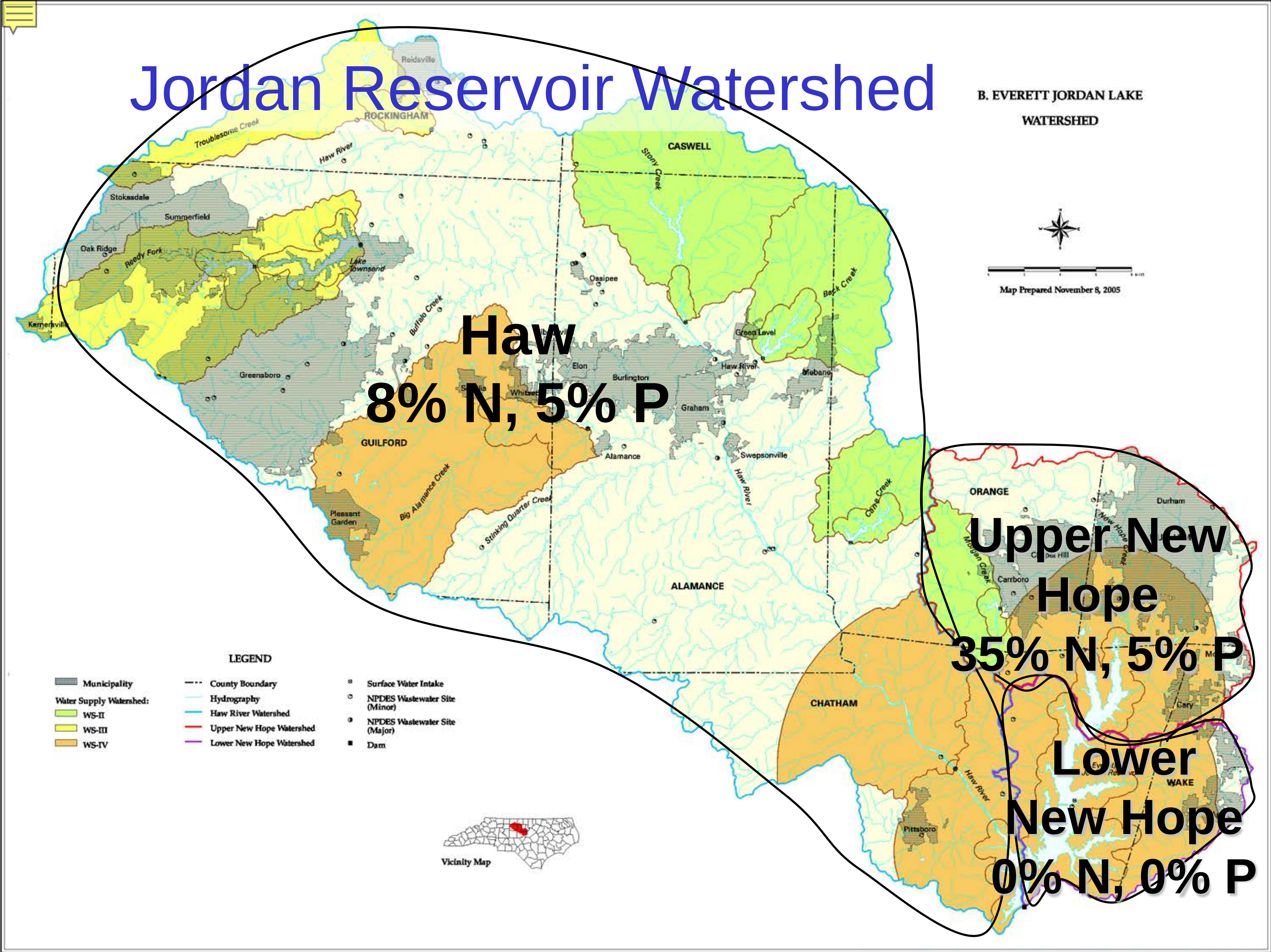
Proposed Water Supply Nutrient Strategy for Jordan Reservoir

Public Hearings

July 12, 2007 - Carrboro

July 17, 2007 – Elon



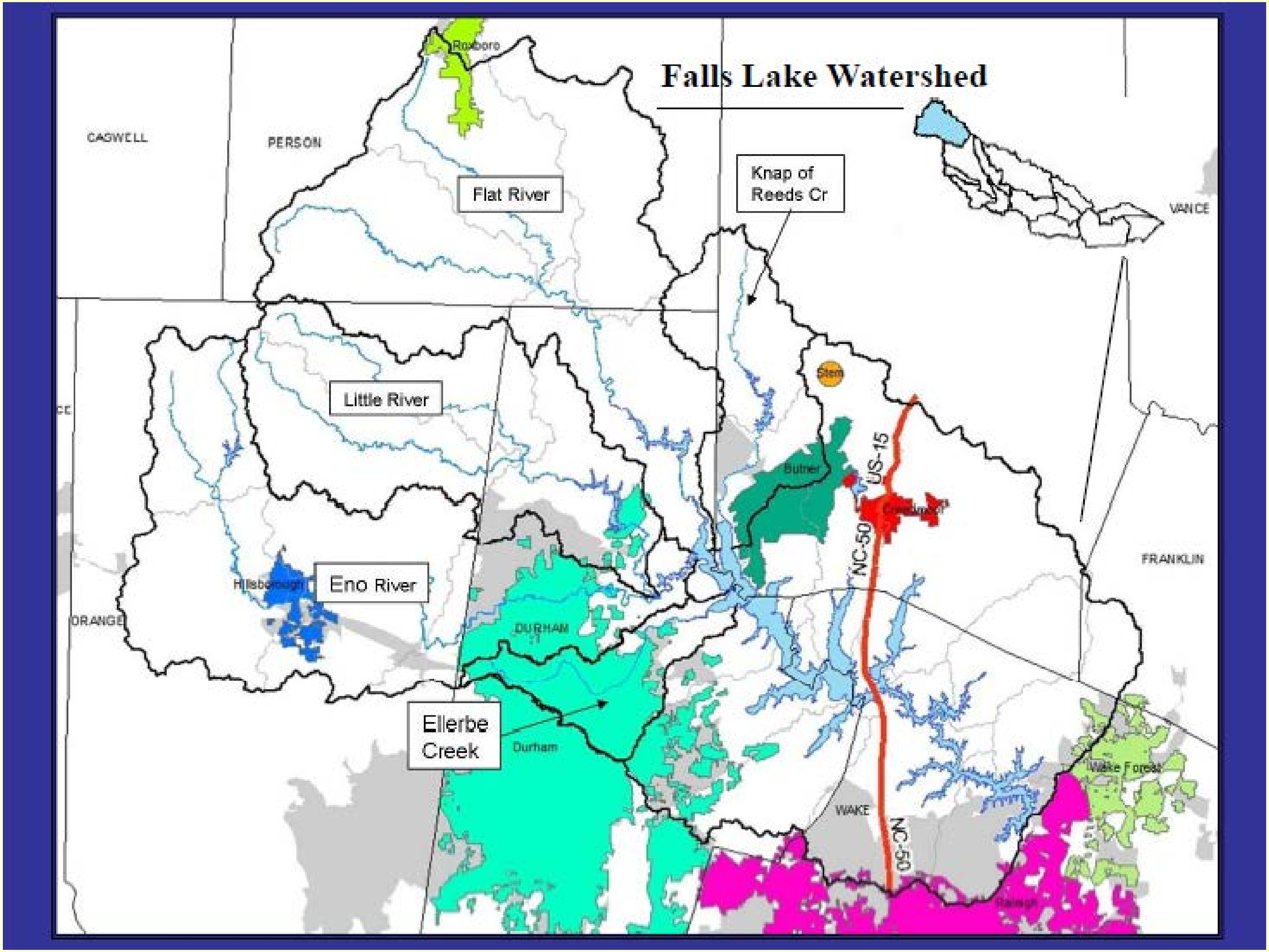


Jordan Reservoir Watershed
B. EVERETT JORDAN LAKE
WATERSHED
Map Prepared November 8, 2005
Haw
8% N, 5% P
Upper New
Hope
35% N, 5% P
Lower
New Hope
0% N, 0% P
ROCKINGHAM
CASWELL
GUILFORD
ALAMANCE
ORANGE
CHATHAM
WAKE
Reidsville
Stokesdale
Summerfield
Oak Ridge
Kernersville
Greensboro
Elon
Burlington
Graham
Haw River
Mebane
Green Level
Ossipee
Alamance
Swepsonville
Pleasant Garden
Carrboro
Durham
Cary
Pittsboro
Troublesome Creek
Haw River
Stony Creek
Back Creek
Reedy Fork
Lake Townsend
Buffalo Creek
Big Alamance Creek
Stinking Quarter Creek
Cane Creek
Morgan Creek
New Hope Creek
LEGEND
Municipality
Water Supply Watershed:
WS-II
WS-III
WS-IV
County Boundary
Hydrography
Haw River Watershed
Upper New Hope Watershed
Lower New Hope Watershed
Surface Water Intake
NPDES Wastewater Site (Minor)
NPDES Wastewater Site (Major)
Dam
Vicinity Map

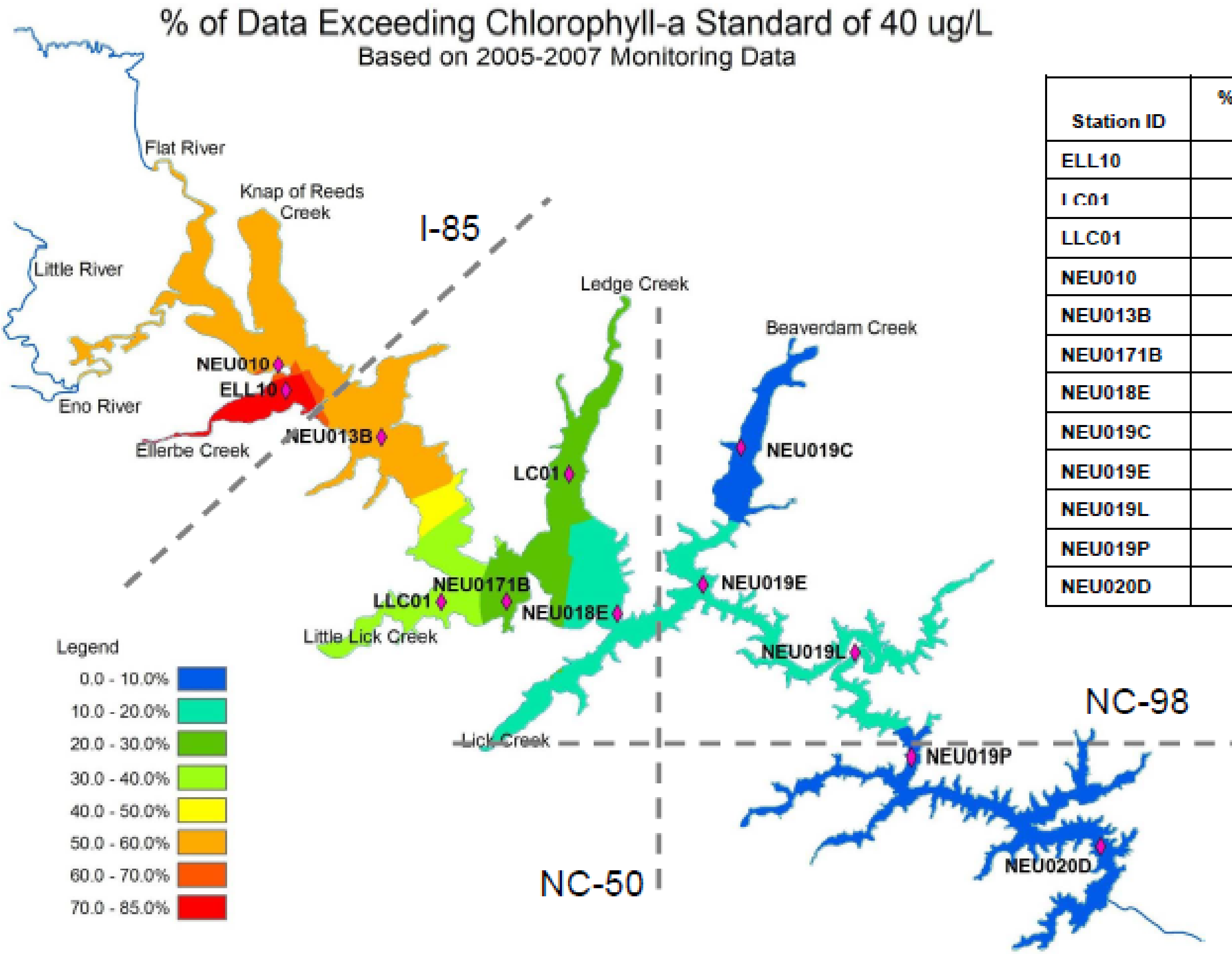
Proposed Jordan Nutrient Rules

15A NCAC 2B

- **.0262** Goals
- **.0263** Nutrient Management
- **.0264** Agriculture
- **.0265** Stormwater - New Development
- **.0266 Stormwater - Existing Development**
- **.0267** Riparian Buffers - Protection
- **.0268** Riparian Buffers - Mitigation
- **.0269 Options for Offsetting (Trading)**
- **.0270** Wastewater Discharge
- **.0271 Stormwater - State and Federal Entities**
- .0272 Riparian Buffer Mitigation Fees
- .0311 Cape Fear River Basin (Schedule of Classifications)


Falls Lake Watershed
CASWELL
PERSON
Roxboro
Flat River
Knap of
Reeds Cr
VANCE
Little River
Butner
US-15
Creedmoor
NC-50
Eno River
Hillsborough
ORANGE
FRANKLIN
DURHAM
Ellerbe
Creek
Durham
WAKE
Wake Forest
Raleigh

Percent of Data Exceeding Chl-a Standard in Falls Lake



Station ID	% over 40 ug/L
ELL10	84.0%
LC01	21.1%
LLC01	39.0%
NEU010	53.0%
NEU013B	53.0%
NEU0171B	25.0%
NEU018E	16.0%
NEU019C	4.0%
NEU019E	16.0%
NEU019L	12.0%
NEU019P	9.9%
NEU020D	9.9%

Draft Falls Lake Rules

(15A NCAC 2B)

- .0275 Purpose and Scope (Goals)
- .0276 Definitions
- .0277 Stormwater – New Development
- .0278 Stormwater – Existing Development
- .0279 Wastewater Discharges
- .0280 Agriculture
- .0281 Stormwater State & Federal Entities
- .0282 Trading
- .0283 Fertilizer Management

Purpose and Scope .0275

- Reduction Goals (40% TN 77% TP)
  - Baseline (2006)
- Critical Water Supply Watershed Designation
- Staged Adaptive Mgt. Approach
  - Stage 1 (10 years)
    - Nutrient reduction controls watershed-wide
    - Measures intended to achieve WQ standards in lower lake
  - Stage 2 (Stage 1 + 15 years)
    - Additional reductions in upper watershed
    - Achieve overall reductions needs to max extent feasible

What can we do?

http://dikechukwumerije.blogspot.com/2016/01/last-last-is-definition-of-hope.html

WATER LEGISLATION

- Clean Water Act (1972)

  Goal was to return all U.S. surface waters to "fishable and swimmable" conditions.

  - For Point Sources, Discharge Permits and Best Practicable Control Technology are required.
    - Set zero discharge for 126 priority toxic pollutants.

The Haw River, a high order river in the southeastern United States, is characterized by severe bank erosion and geomorphic change from historical conditions of clear waters and connected floodplains.

In 2014 it was named one of the 10 most threatened rivers in the United States by American Rivers.


The Haw River Trail
HAW RIVER
TRAIL
Conservation
Through
Recreation
Janet MacFall, Elon University

Haw River Trail Partnership
“Conservation Through Recreation”

- **Provide Safe, Legal Access** to the Haw Through Haw River Trail/Mountains to Sea Trail and the Haw River Paddle Trail.

- **Improve Community Attitudes** Towards the River Through Increased Exposure.

- **Preserve a Scenic Corridor** for the Trail Through Conservation of a 500 Foot Buffer.

- **Create a Sustainable, Non-Depleting Economic Engine** that brings dollars from outside Alamance County into the local economy.

Initial Progress 2006-2013 Paddle Trail

Alamance County Alone

- Grown from 4 “Formal” Paddle Accesses to 11
  - 1 More in Construction
- Added 18 miles and 4 Dam Portages to Paddle Trail
- Working to Become the First State-Designated Paddle Trail in North Carolina.

Initial Progress 2006-2013 Conservation Efforts

- River-wide:
  - 1,250 Acres Conserved
  - 22,500 Linear ft. of River Frontage

- Alamance County
  - 250 Acres Conserved
  - 15,000 Linear ft. of River Frontage

Initial Progress 2006-2013 Economic Benefits

- 7 New “River Focused” Businesses Have Opened Since 2006
- $2 million in Grant Funds Expended in Alamance County
- $125,000 in Property Donations to Local Governments
- Elon University Study

Yee-Haw! River Paddle brings 200 people to paddle on the Haw River each April.

Quarterly Attendance at Haw River Trail Sites

December 1, 2014 through February 30, 2015

Altamahaw Paddle Access:
2,490

Shallow Ford Natural Area:
5,106

Great Bend Park:
2,214

Glencoe Paddle Access:
1,905

Red Slide Park:
4,265

Graham Paddle Access:
3,037

Swepsonville River Park-Upper:
5,742

Swepsonville River Park-Lower:
5,834

Great Alamance Creek Access
2,177

Sax. Lake Paddle Access:
9,557

Sax. Mill Race Paddle Access:
2,555

Total Attendance For Period:
44,882

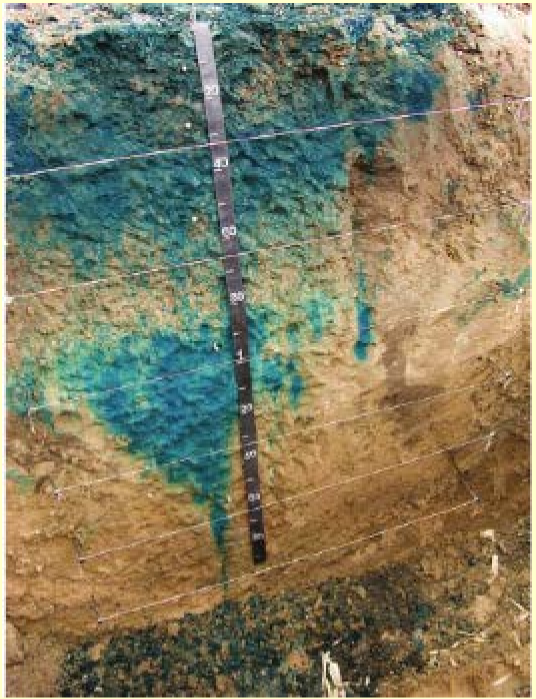
Plant a tree!

Preserve forest buffers along ALL waterways!

AT LEAST 50 ft. wide

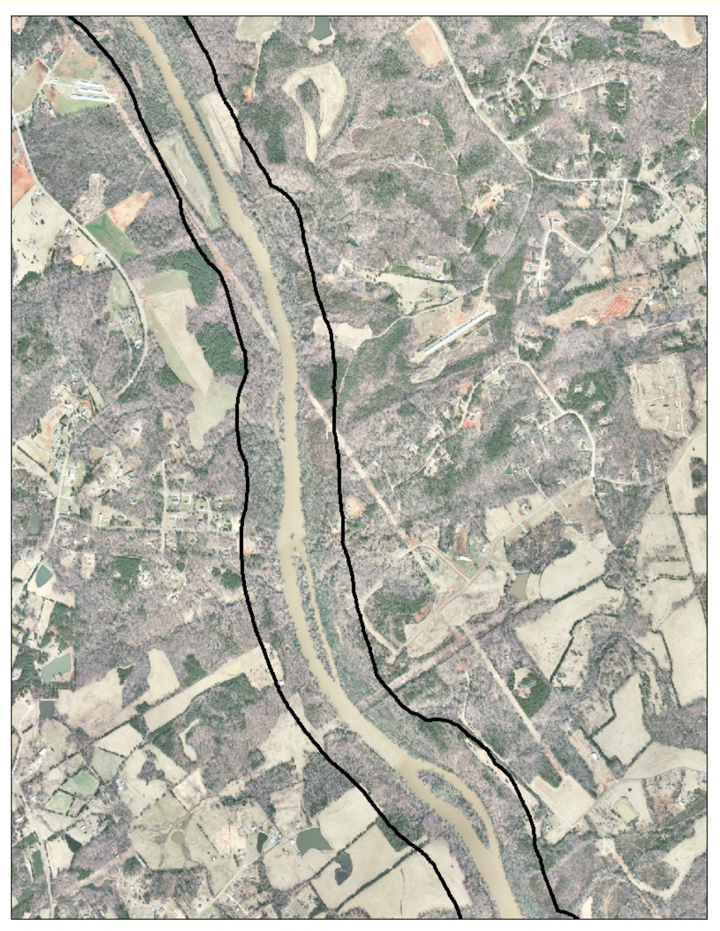
Why do we care about plants?

- Improves the permeability of soil to water
- Improves the permeability of soil to air
- The rhizosphere (surrounding roots) forms a unique, reactive environment



Blue tracers infiltrating prairie soil, showing channels left by roots even 80 cm below the surface

Haw River Today: Land Cover



Land Cover Analysis

	Percent
Forest	78.7
Open	13.5
Shrubland	5.7
Impervious	0.9
Water	1.2

ELON UNIVERSITY

Remember who owns the water

Remember who owns the water
YOU DO!!

Thank You!!!

https://www.youtube.com/watch?v=nigHnWSUevU