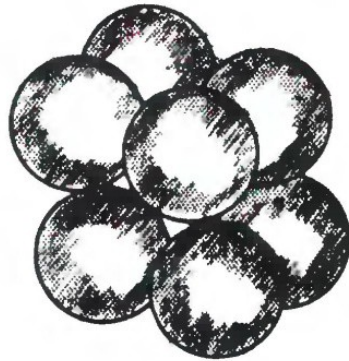


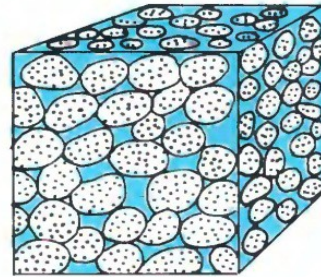


Groundwater Usually Occurs In Porous Materials Or In Rock Fractures

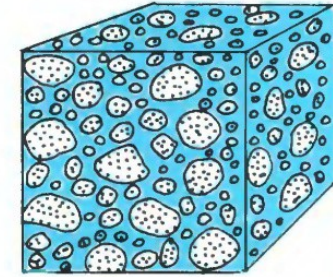


POROUS MATERIAL

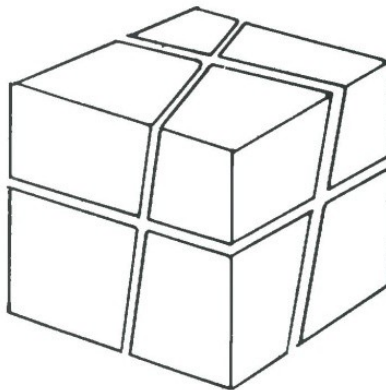
PRIMARY OPENINGS



WELL-SORTED SAND



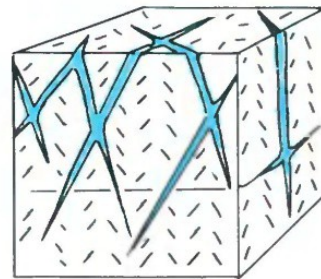
POORLY-SORTED SAND



FRACTURED ROCK

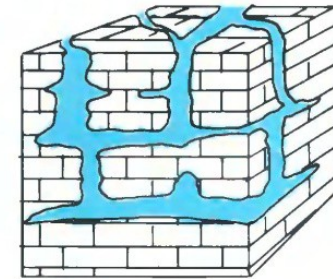
(1)

SECONDARY OPENINGS



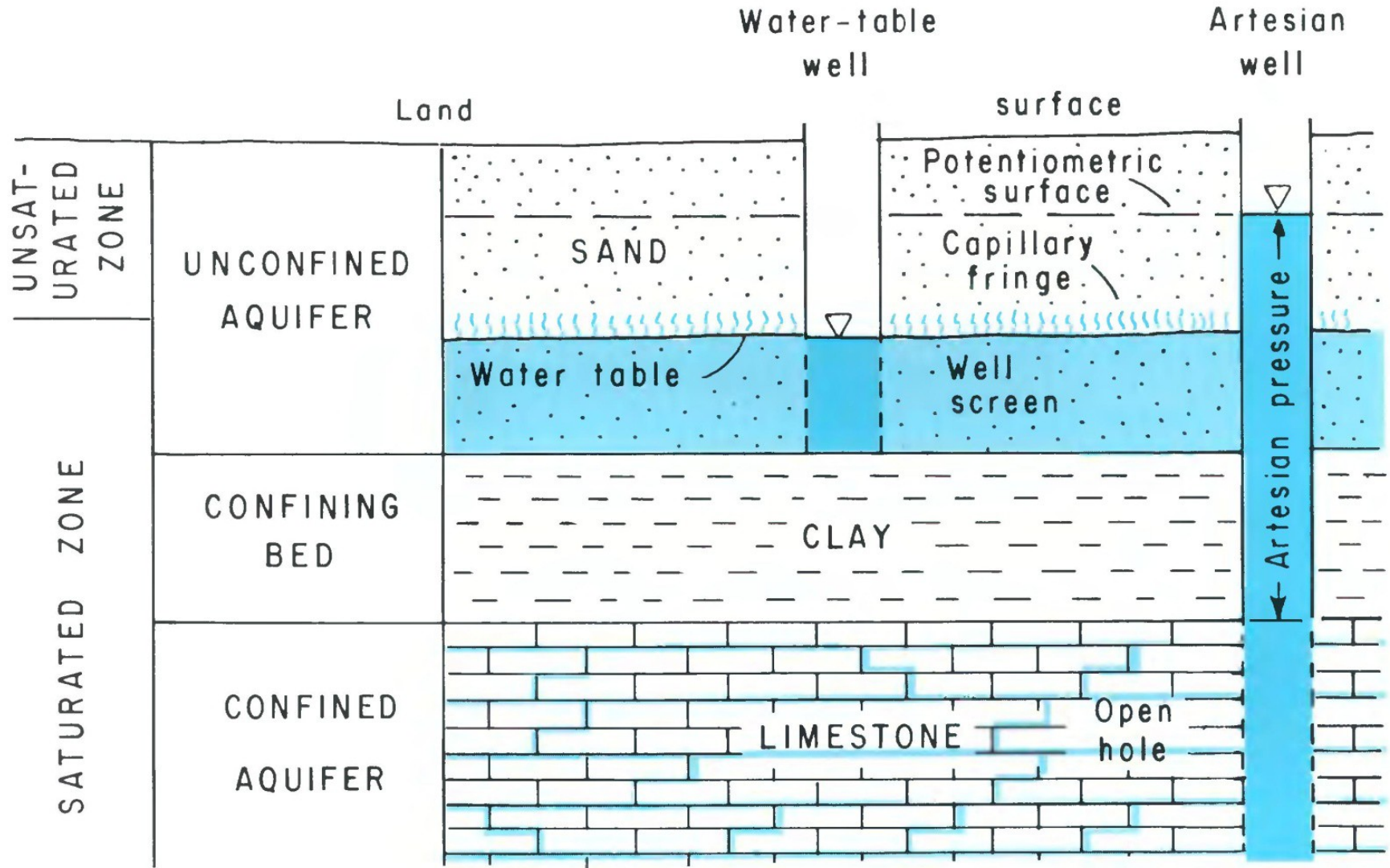
FRACTURES IN
GRANITE

(2)



CAVERNS IN
LIMESTONE

Aquifers and Confining Beds



North Carolina Coastal Plain Hydrogeology

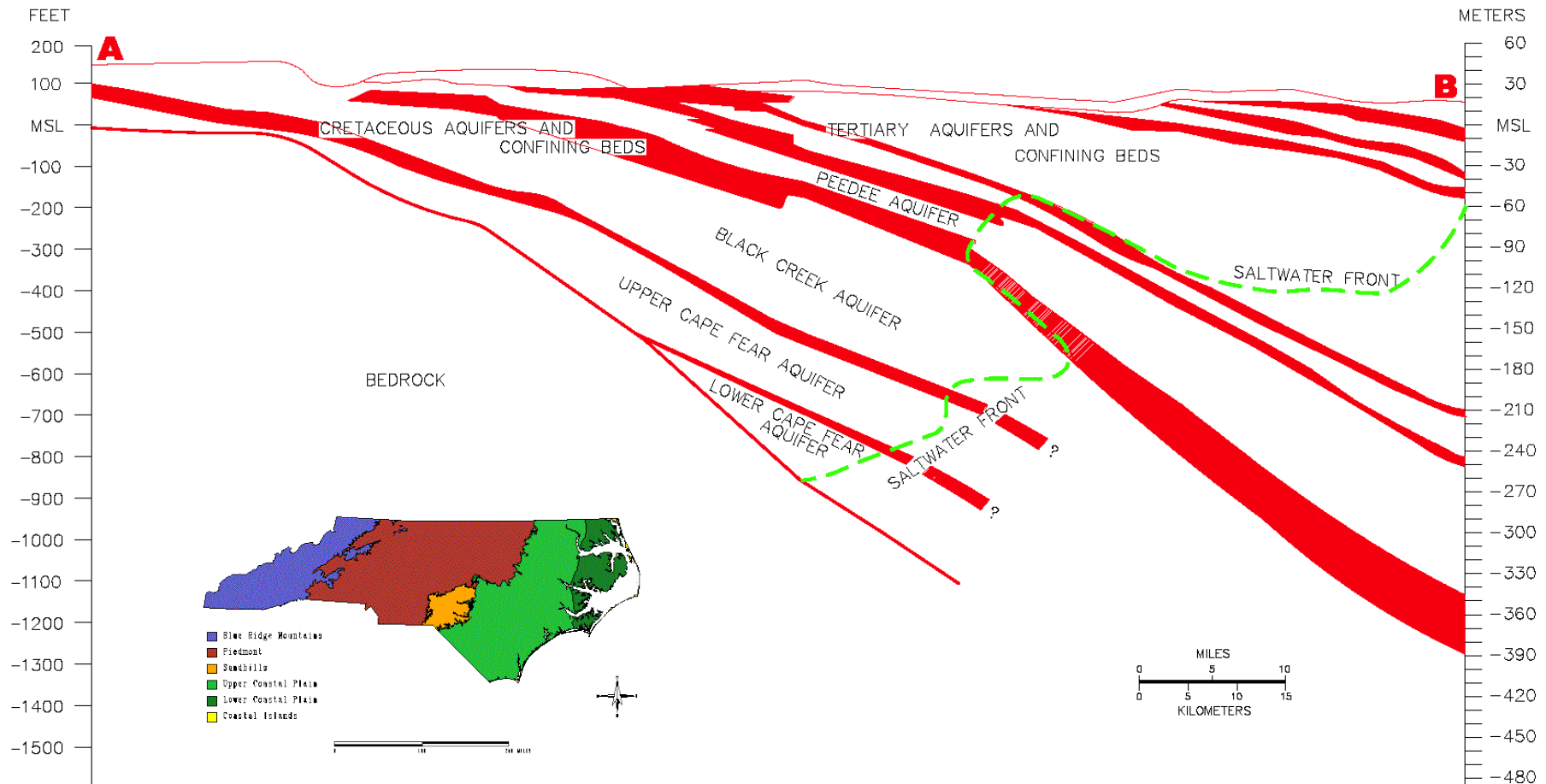


FIGURE 2. Hydrogeologic section through the central Coastal Plain showing the Cretaceous aquifers and confining beds and the position of the saltwater front. (Adopted from Winner and Coble, 1996, Plate 6)

North Carolina Coastal Plain Hydrogeology

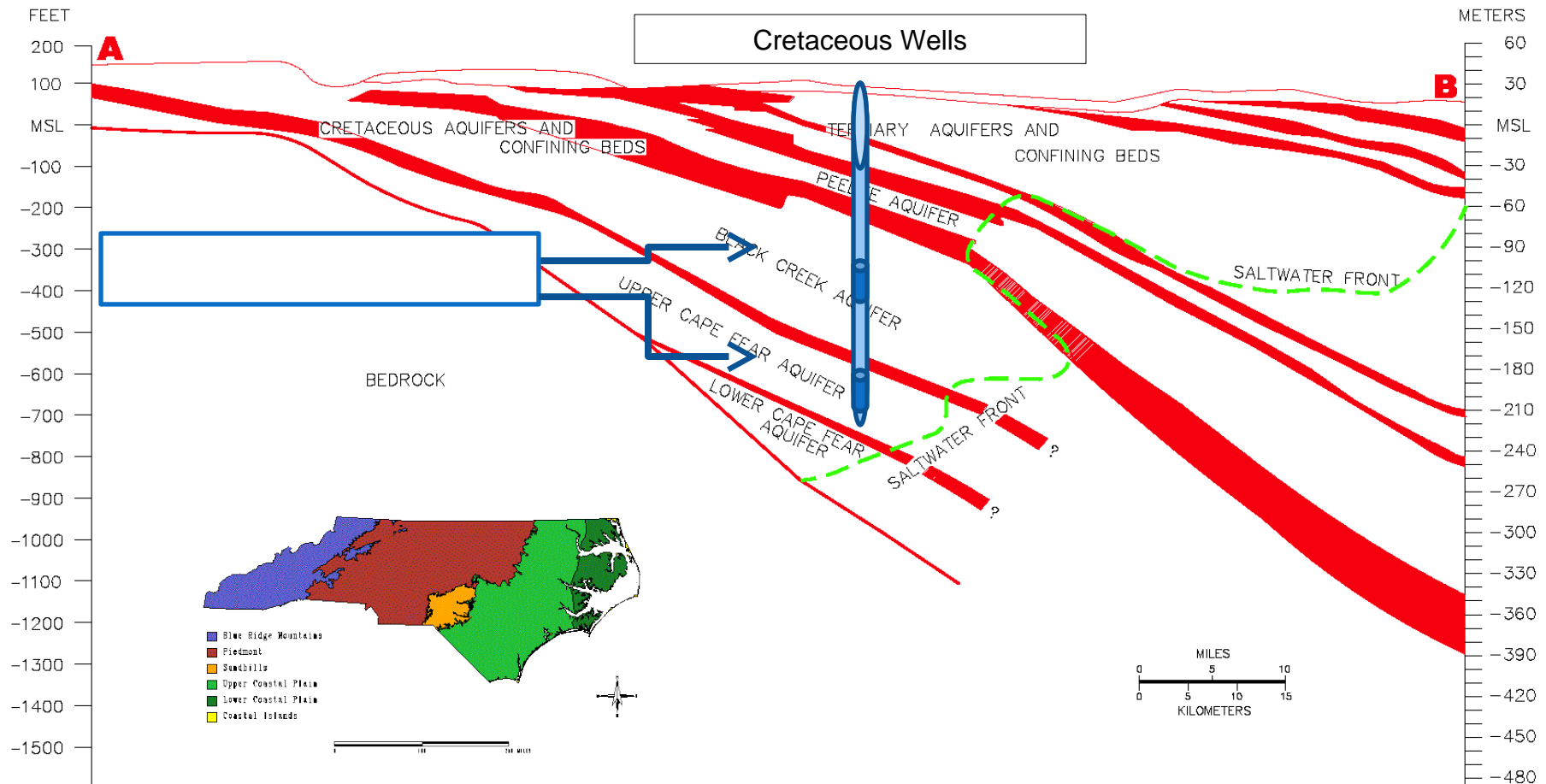


FIGURE 2. Hydrogeologic section through the central Coastal Plain showing the Cretaceous aquifers and confining beds and the position of the saltwater front. (Adopted from Winner and Coble, 1996, Plate 6)

North Carolina Coastal Plain Hydrogeology

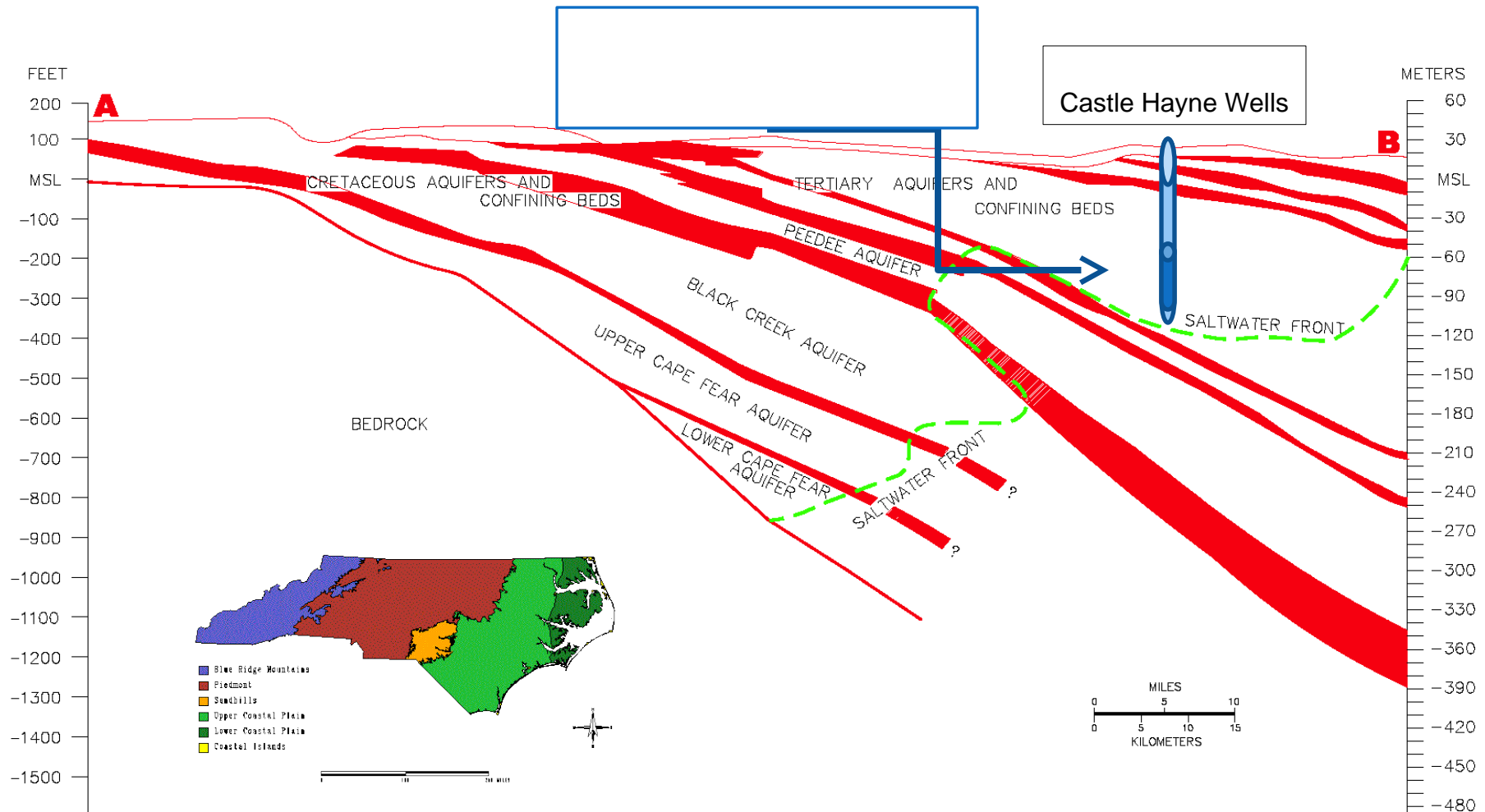


FIGURE 2. Hydrogeologic section through the central Coastal Plain showing the Cretaceous aquifers and confining beds and the position of the saltwater front. (Adopted from Winner and Coble, 1996, Plate 6)

North Carolina Coastal Plain Hydrogeology

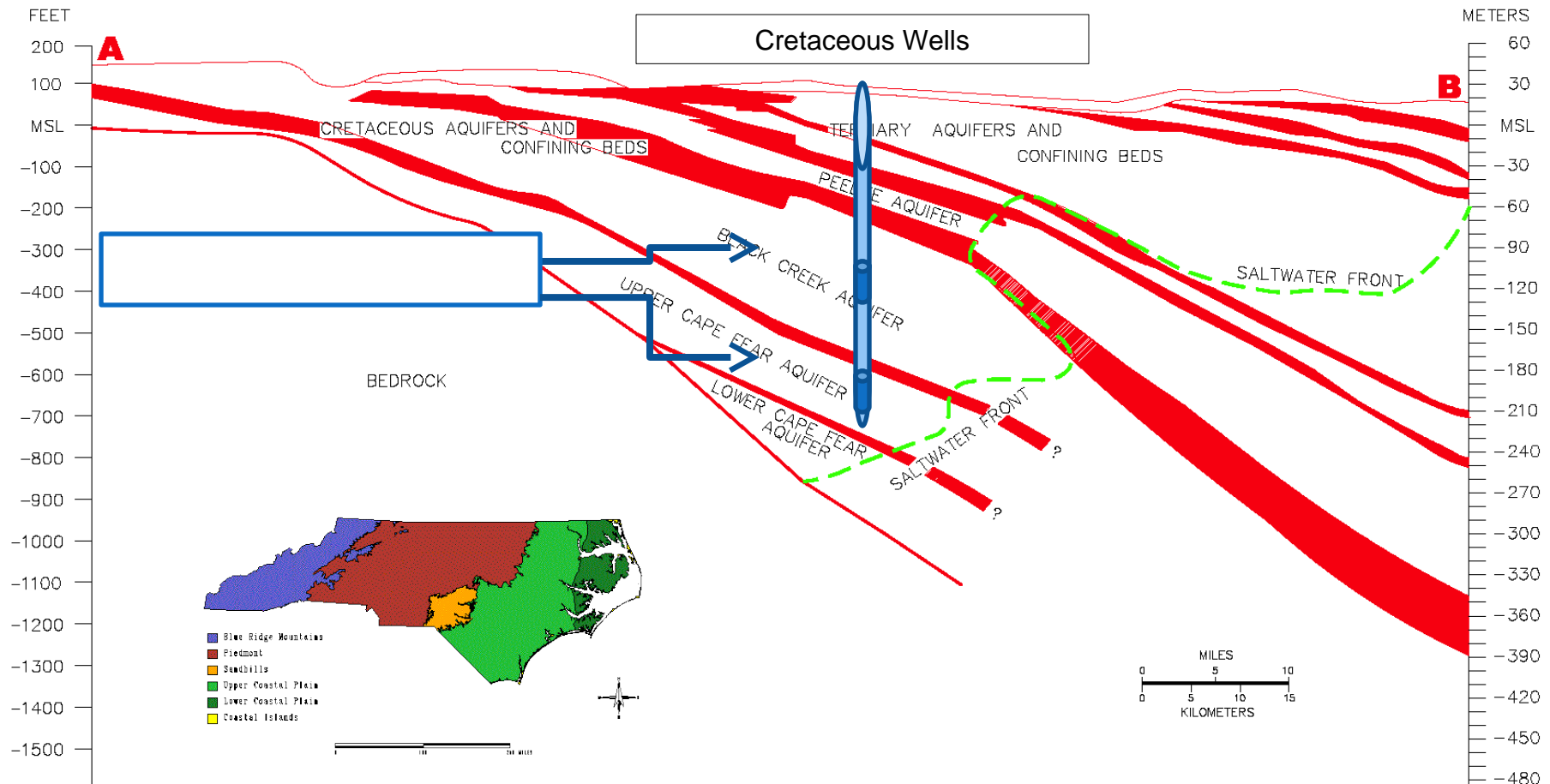
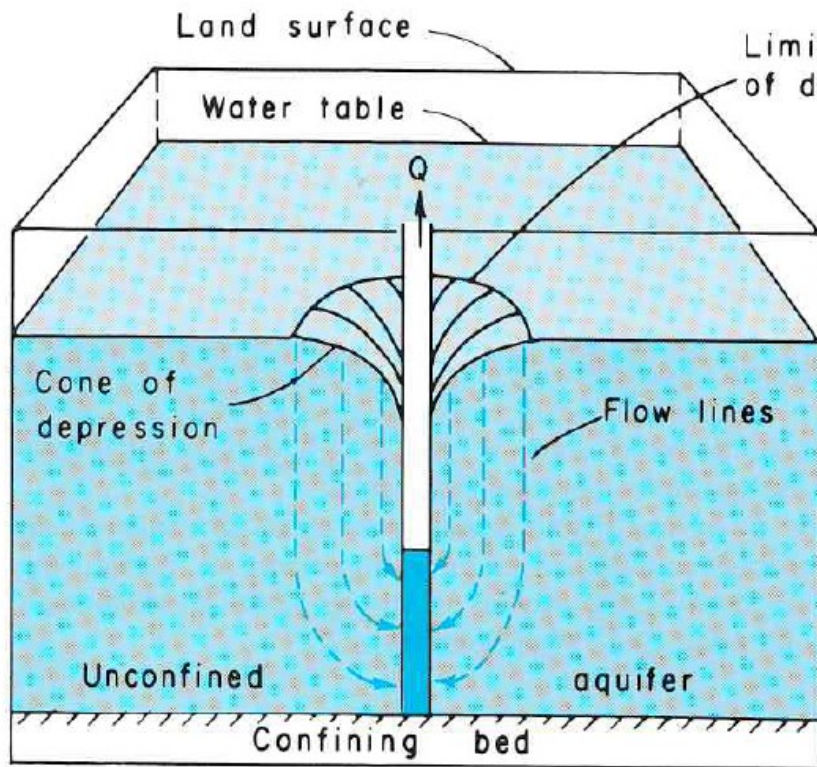


FIGURE 2. Hydrogeologic section through the central Coastal Plain showing the Cretaceous aquifers and confining beds and the position of the saltwater front. (Adopted from Winner and Coble, 1996, Plate 6)

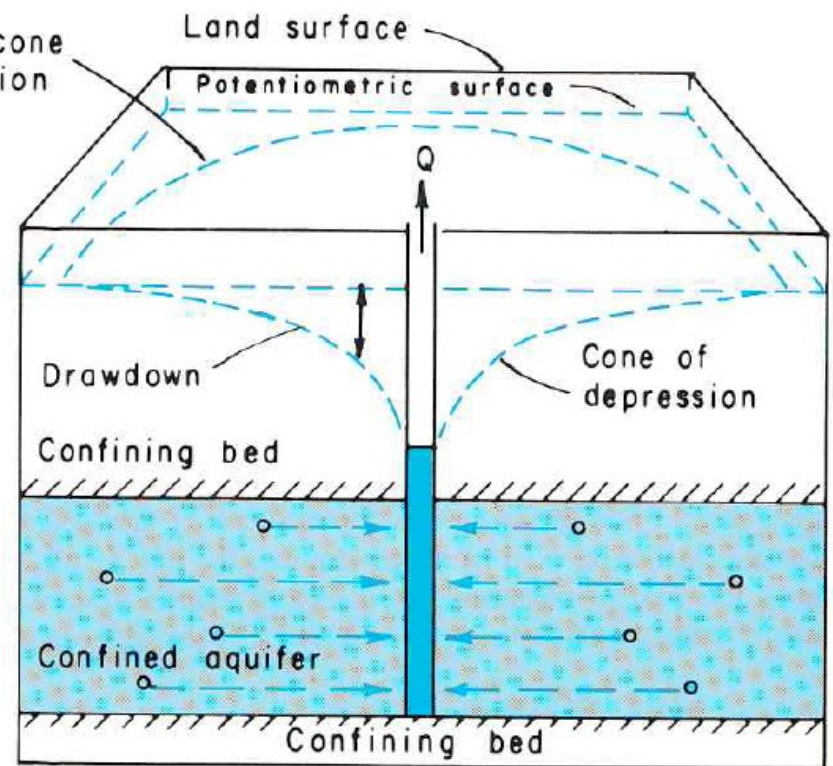
Aquifer Use in the Central Coastal Plain

- Deep confined aquifers of the Cretaceous Aquifer System produce high-quality water that requires little or no treatment.
- Large-scale withdrawals from the Cretaceous Aquifers began in the 1950 and increased until 2002.
- Over-pumping caused water levels to decline by as much as 195 feet, leading to dewatering, land subsidence, and saltwater intrusion.

Cone of Depression

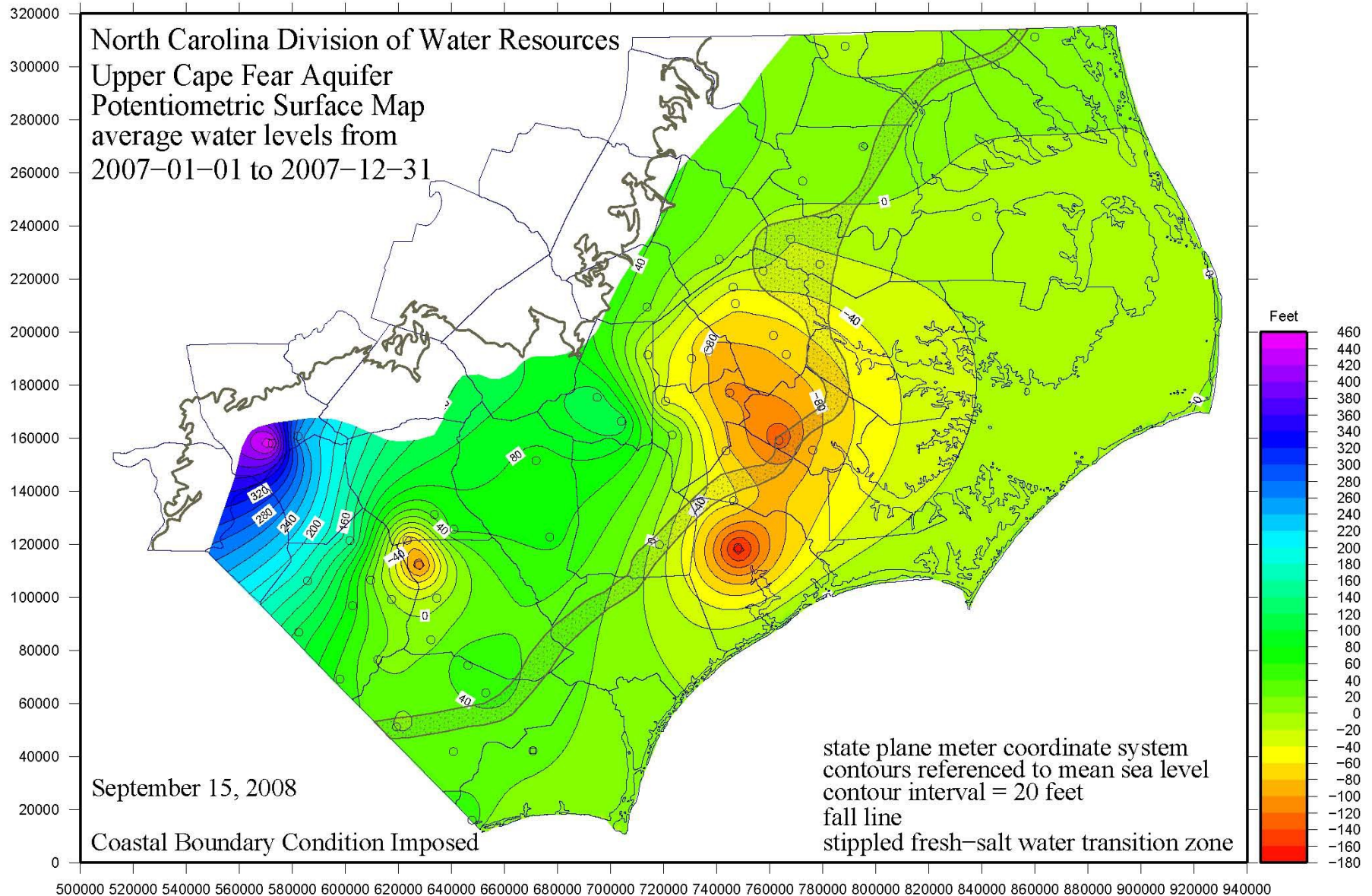


(1)

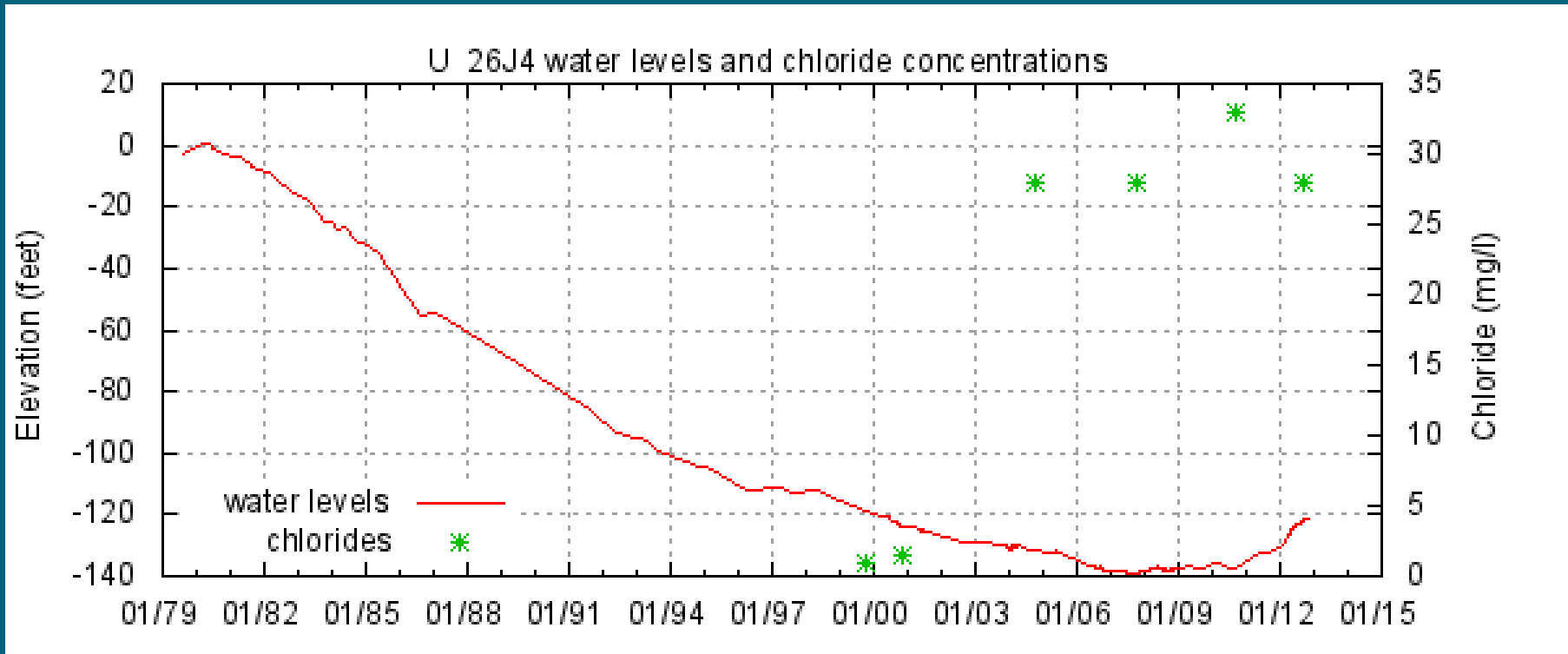


(2)

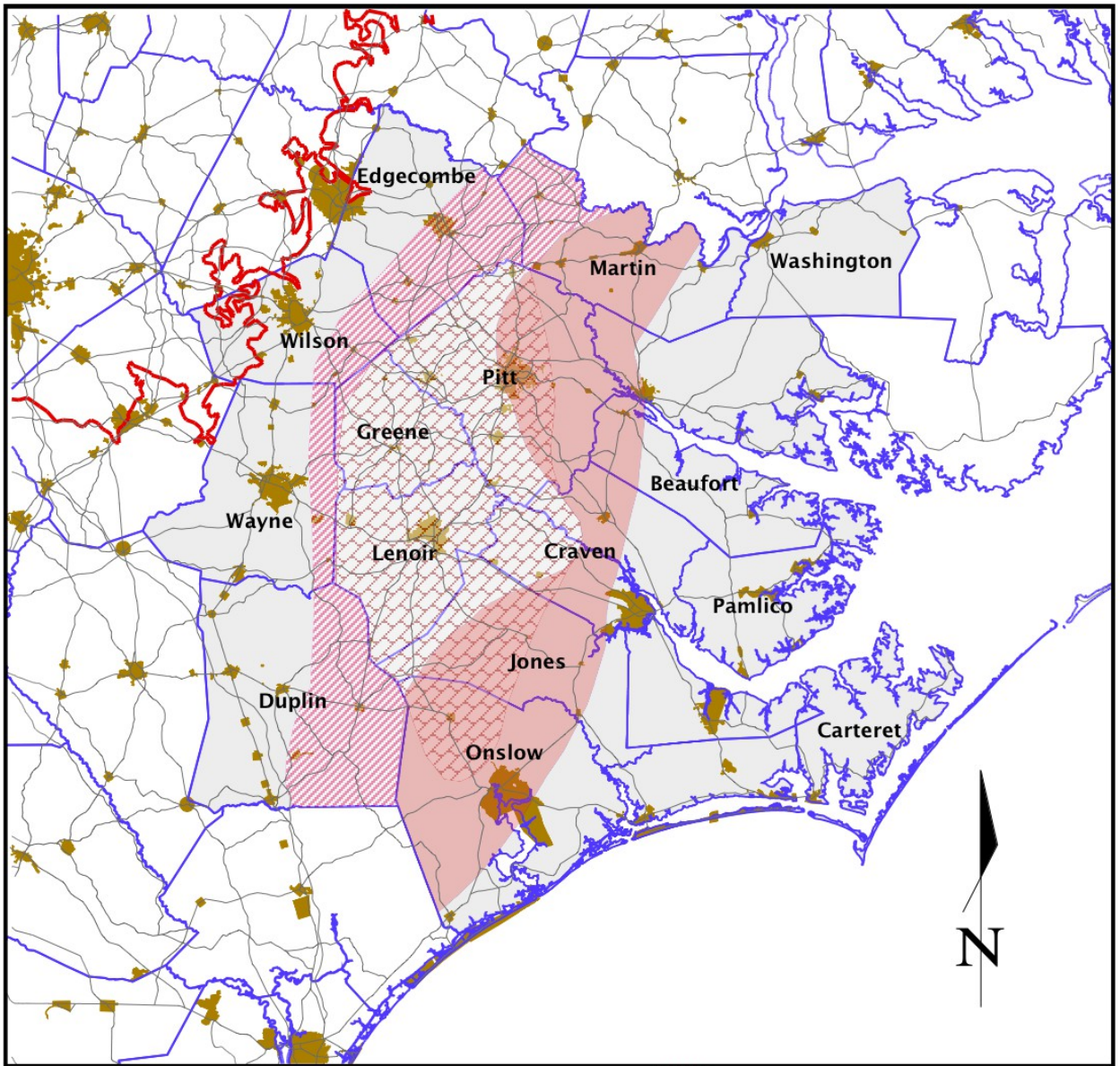
Regional Cone of Depression in the Cretaceous Aquifer System






Significant Declines in Cretaceous Aquifer Water Levels



140 feet of Water Level Decline
in the Black Creek Aquifer at
Comfort, North Carolina
in Jones County



Scale 1 : 1300000
 10 0 10 20 30 40 50 miles

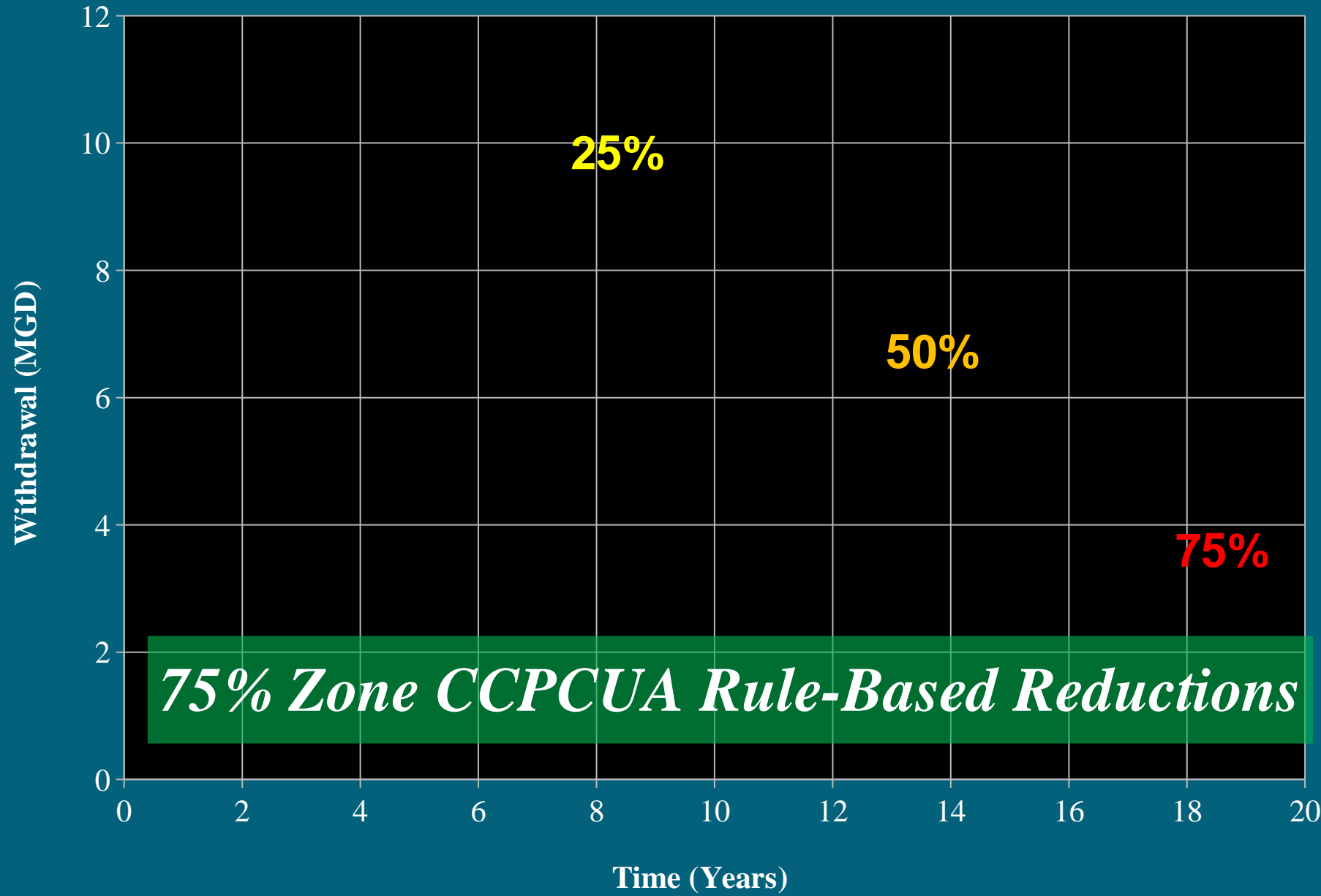
-  Declining Water Level Zone
-  Dewatering Zone
-  Salt Water Encroachment Zone

Central Coastal Plain Capacity Use Area

Central Coastal Plain Capacity Use Area Rules

- Registration for all withdrawals >0.01 MGD
- Permits required for all withdrawals >0.1 MGD
- Set limits on withdrawals from the Cretaceous Aquifers (Approved Base Rates)
- Established permit zones to apply staged reductions in withdrawals
- Provided for water banking and credits for ASR stored water

ABR



75% Zone CCPCUA Rule-Based Reductions

North Carolina Coastal Plain Hydrogeology

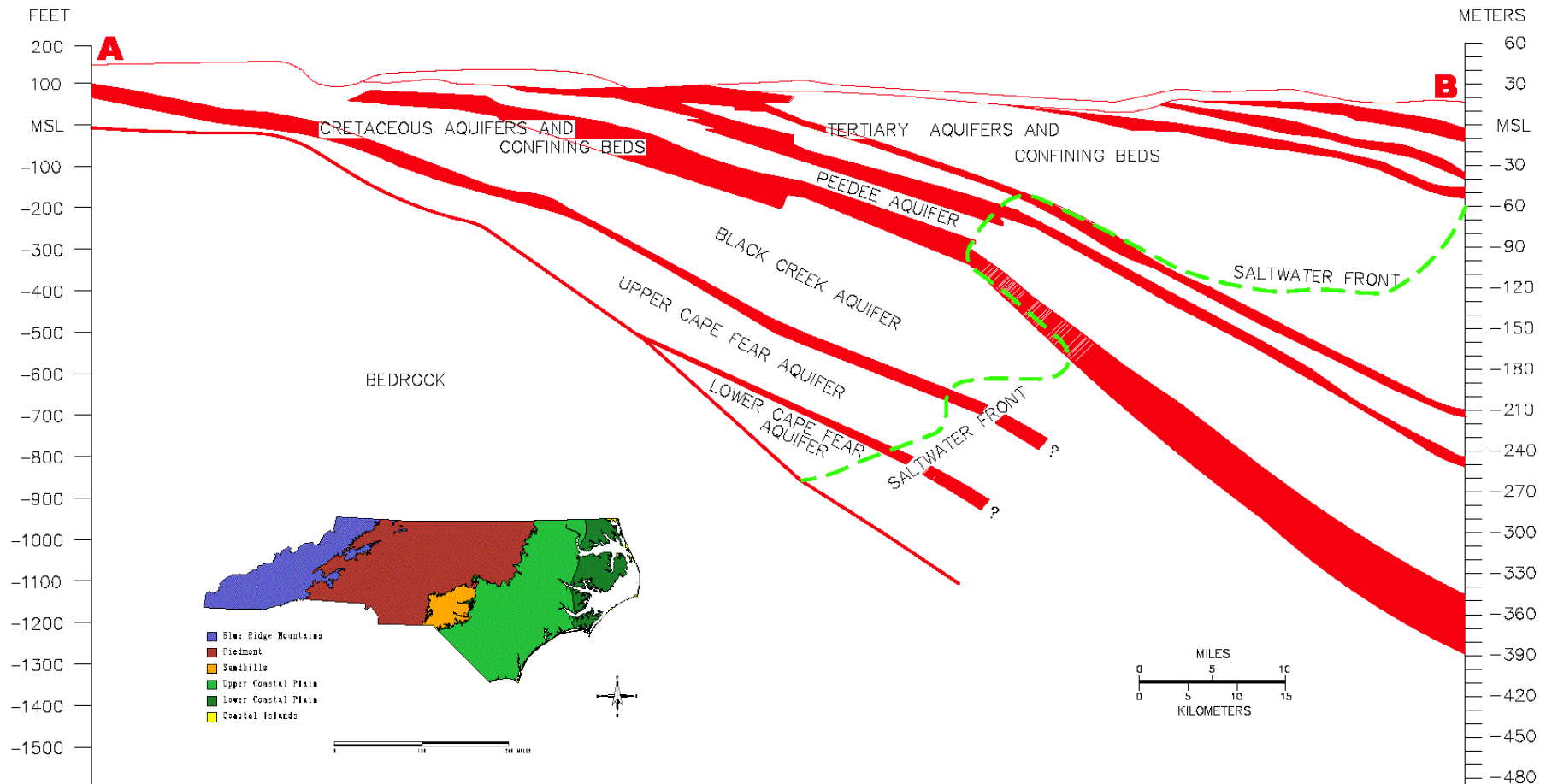


FIGURE 2. Hydrogeologic section through the central Coastal Plain showing the Cretaceous aquifers and confining beds and the position of the saltwater front. (Adopted from Winner and Coble, 1996, Plate 6)

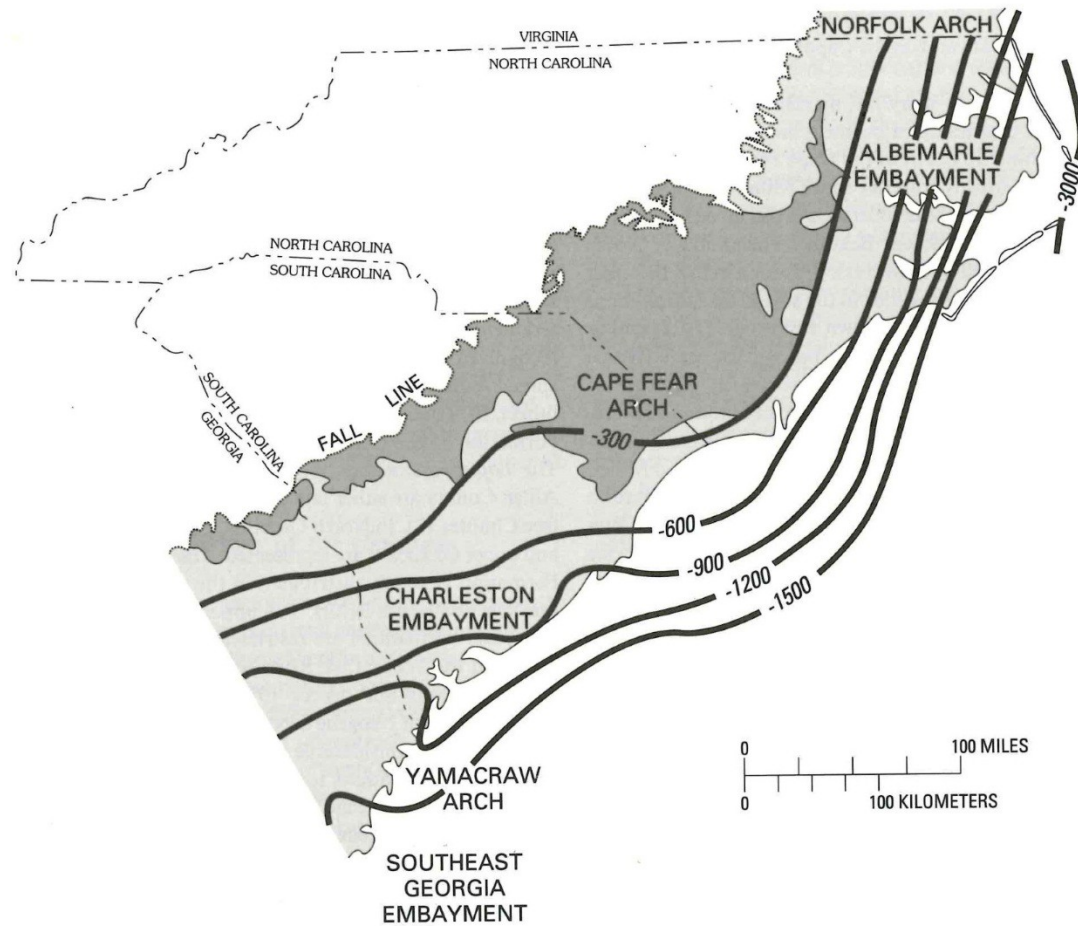


Fig. 1-3. Generalized map of the Coastal Plain in the Carolinas. Structure contours (meters) indicate depth below sea level to the Fall Line unconformity, which separates Cretaceous and younger sediments of the Atlantic Coastal Plain from the older, underlying rocks shown on Fig. 1-2. Shaded areas represent exposed Cretaceous deposits (darker) and Cenozoic deposits (lighter). Modified from Gohn (1988, Fig. 1), Popenoe and Zietz (1977, Fig. 2), and North Carolina Geological Survey (1985).

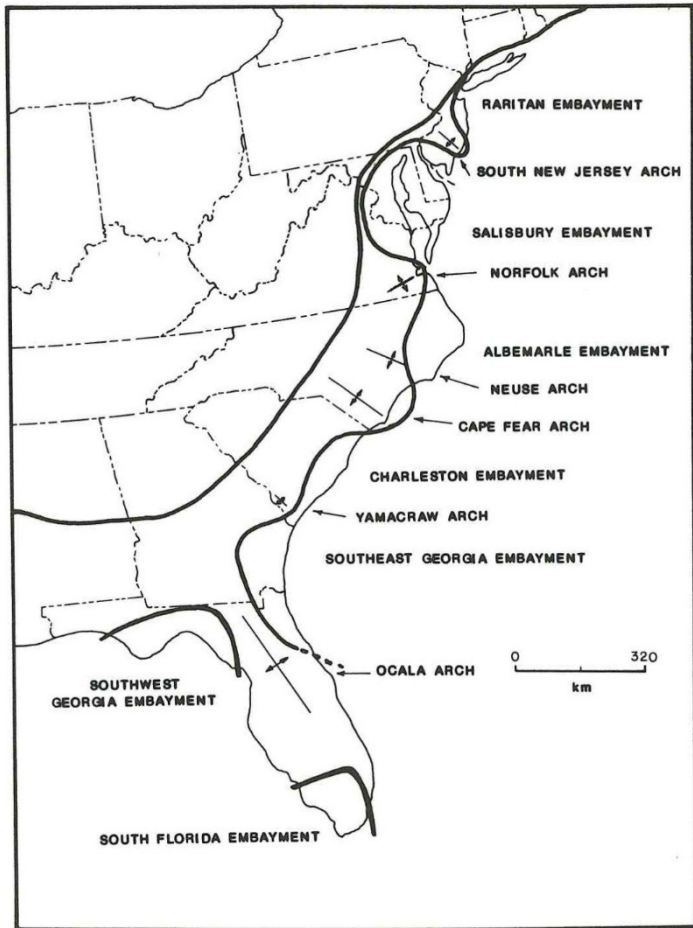


Fig. 16-1. Major structural features of the Atlantic Coastal Plain.

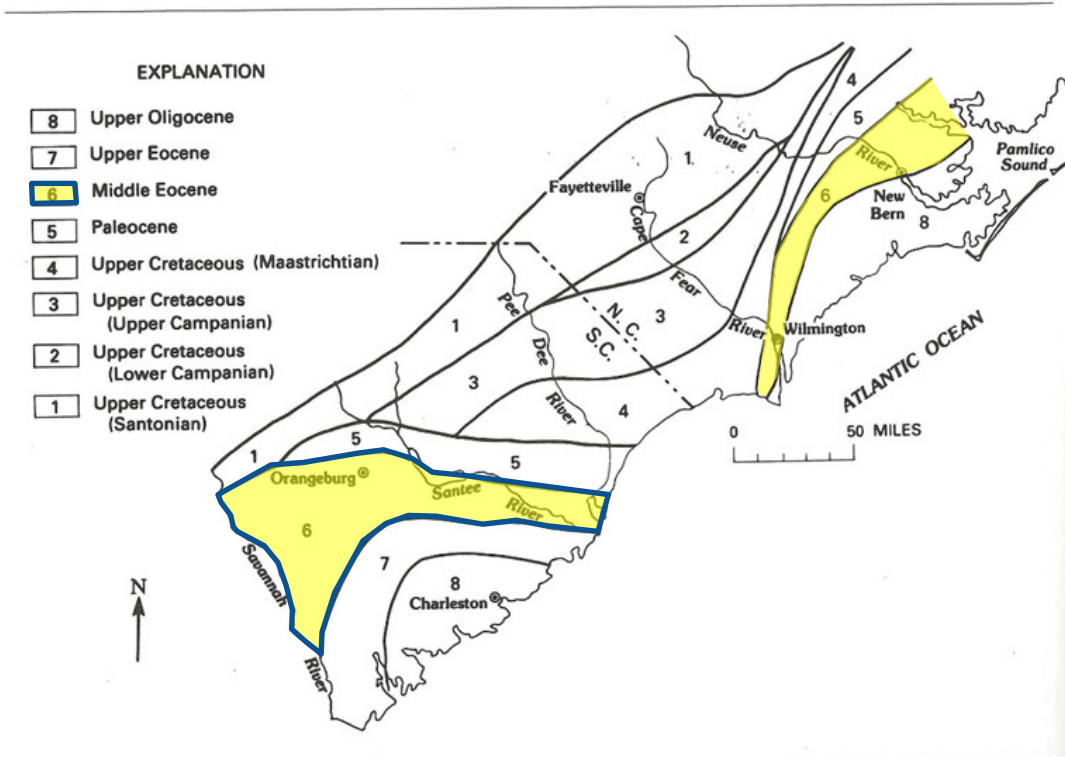
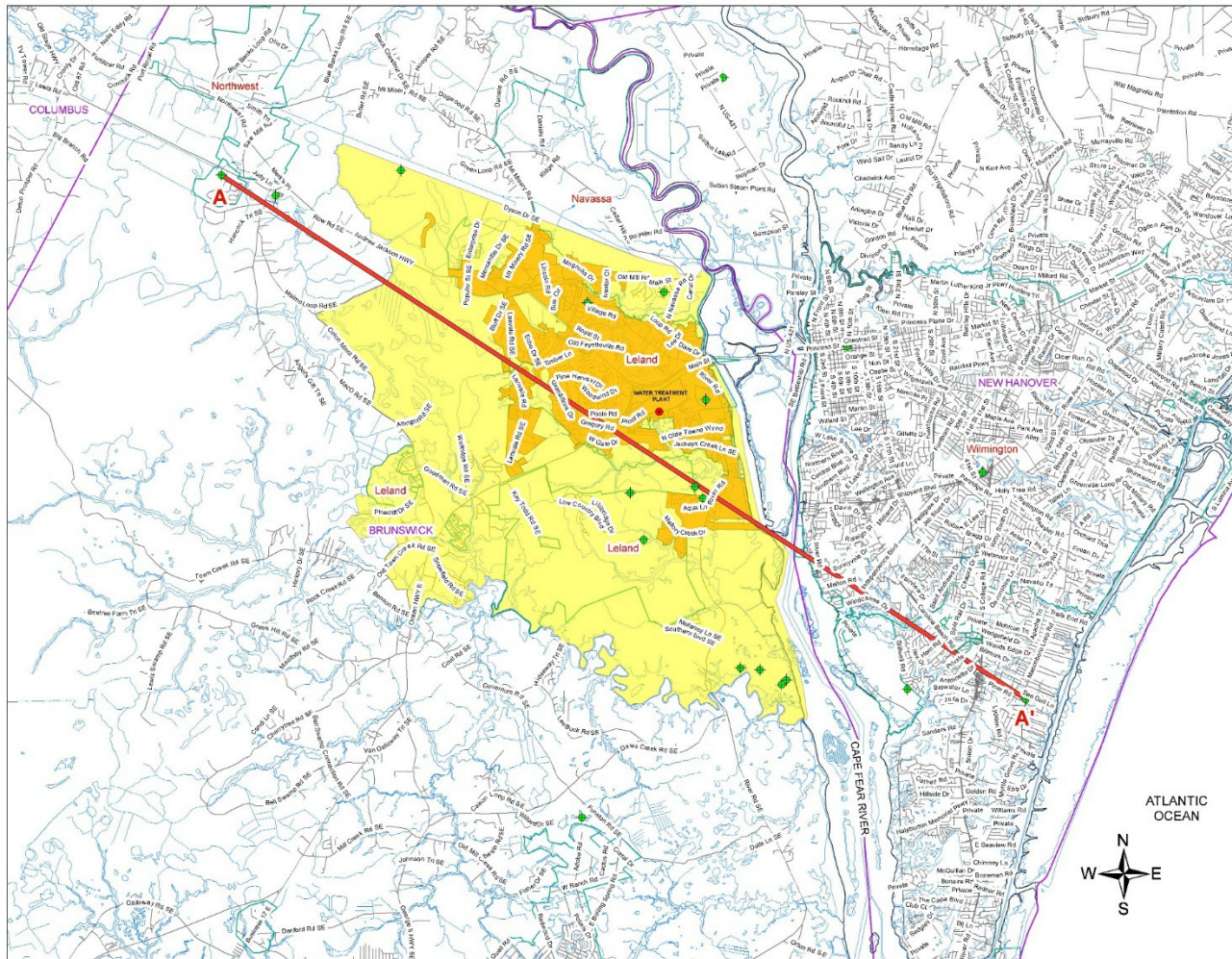


Fig. 18-2. Configuration of the Cape Fear arch as defined by the distribution of Upper Cretaceous and Tertiary strata in the Carolinas (J.P. Owens, written communication, 1988).



- LEGEND -

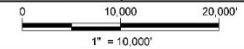
- ◆ TEST WELL/BOREHOLE LOCATION
- WATER TREATMENT PLANT
- PROJECTED WATER SERVICE AREA
- CURRENT WATER SERVICE AREA
- COUNTY BOUNDARY
- MUNICIPAL BOUNDARY
- WATER FEATURE
- TRACE

**CROSS SECTION
TRACE A-A'**

PROJECT: 50518

BRUNSWICK REGIONAL WATER AND SEWER
H2GO STUDY AREAS

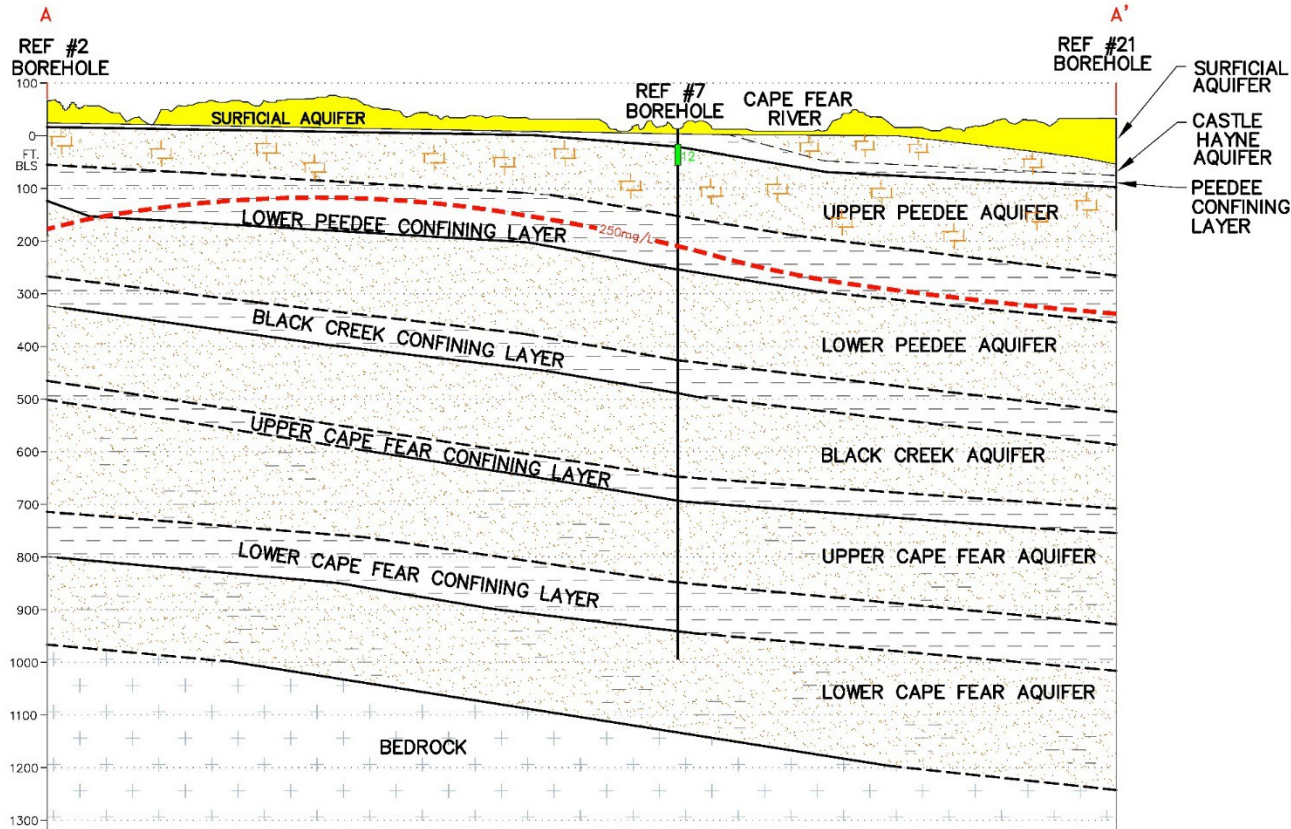
FIGURE 13 DATE 1/17/2012









BRUNSWICK REGIONAL WATER AND SEWER
BRUNSWICK COUNTY, NORTH CAROLINA

ATLANTIC
OCEAN






-LEGEND-

-  SURFICIAL AQUIFER
-  CLAY
-  LIMESTONE
-  SAND
-  BEDROCK
-  ESTIMATED LOCATION OF THE FRESH WATER/SALT WATER INTERFACE

**HYDROGEOLOGIC
CROSS SECTION A-A'**

FIGURE 14 DATE 1/17/2012

SCALE
HORIZONTAL 1"=10,000'
VERTICAL 1"=200'

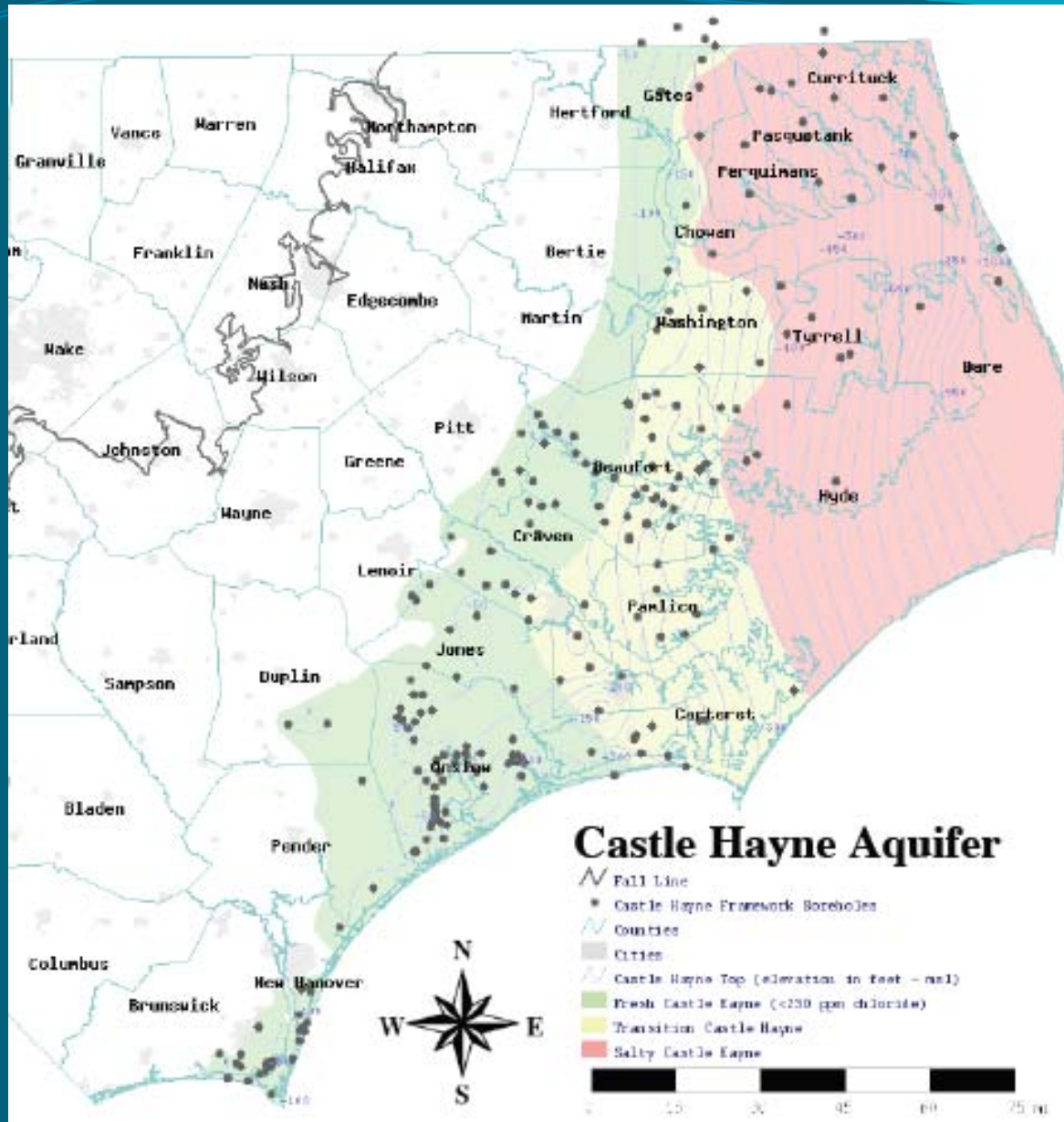


BRUNSWICK REGIONAL
WATER AND SEWER

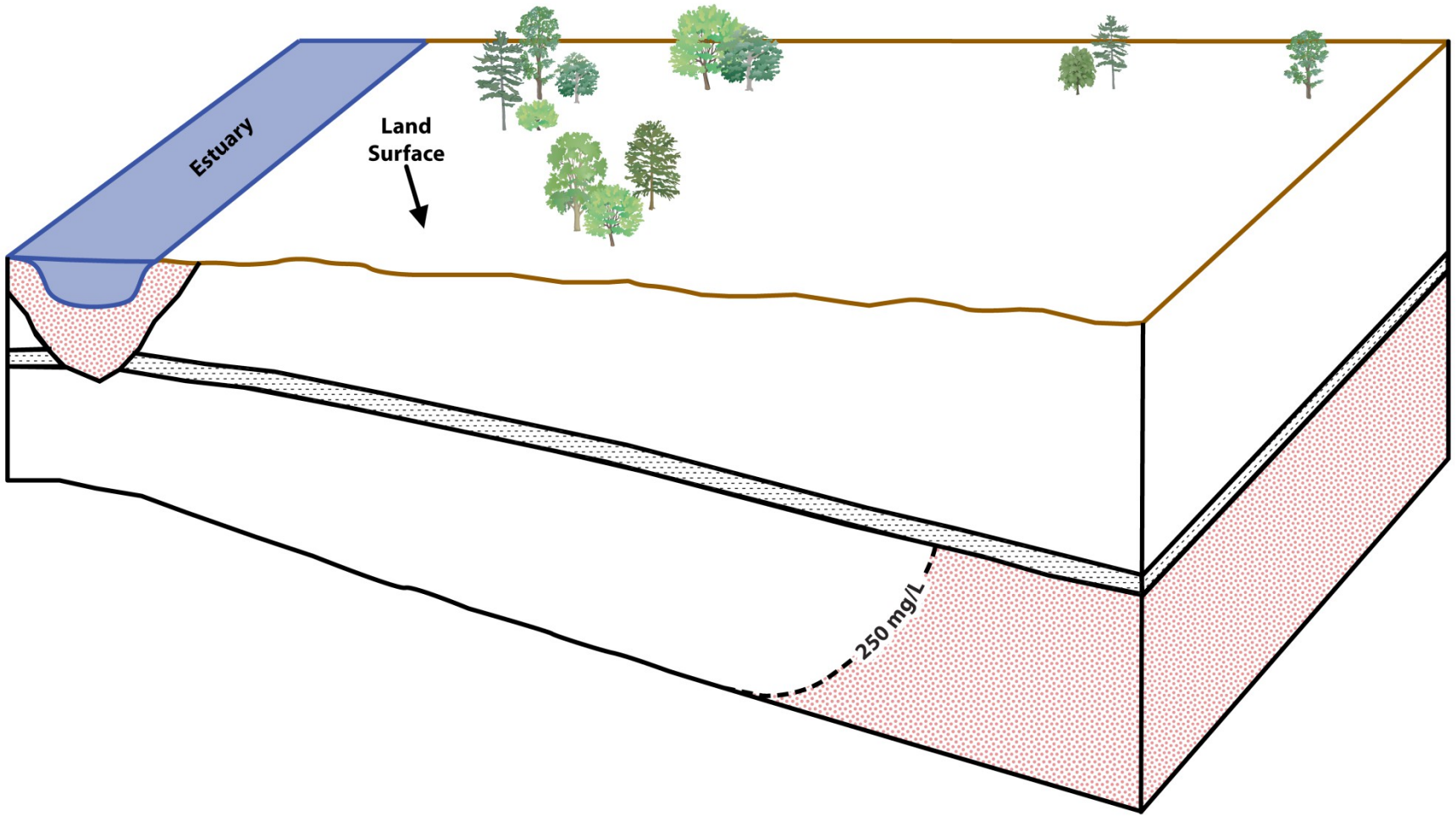


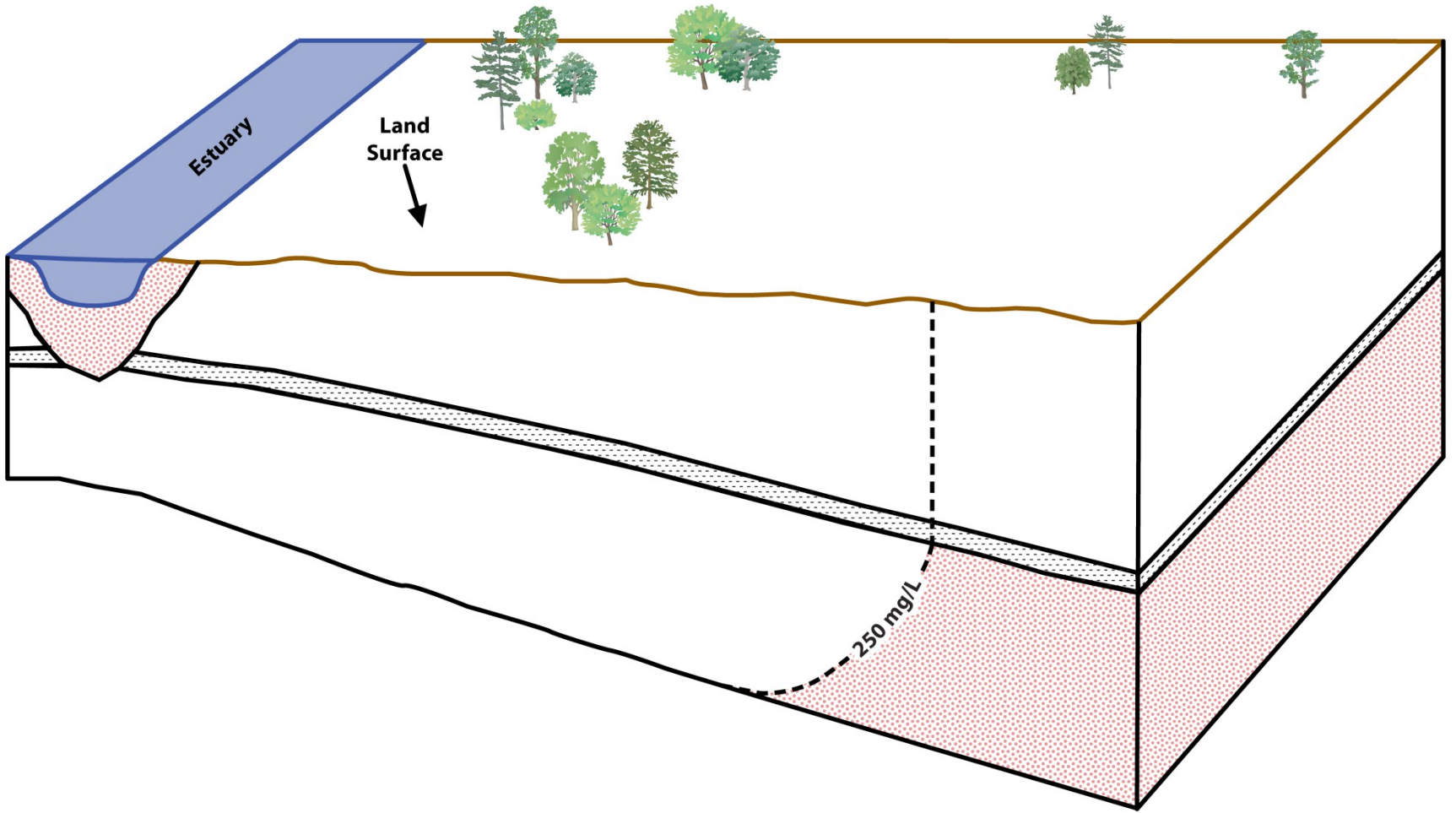
Black Creek Aquifer

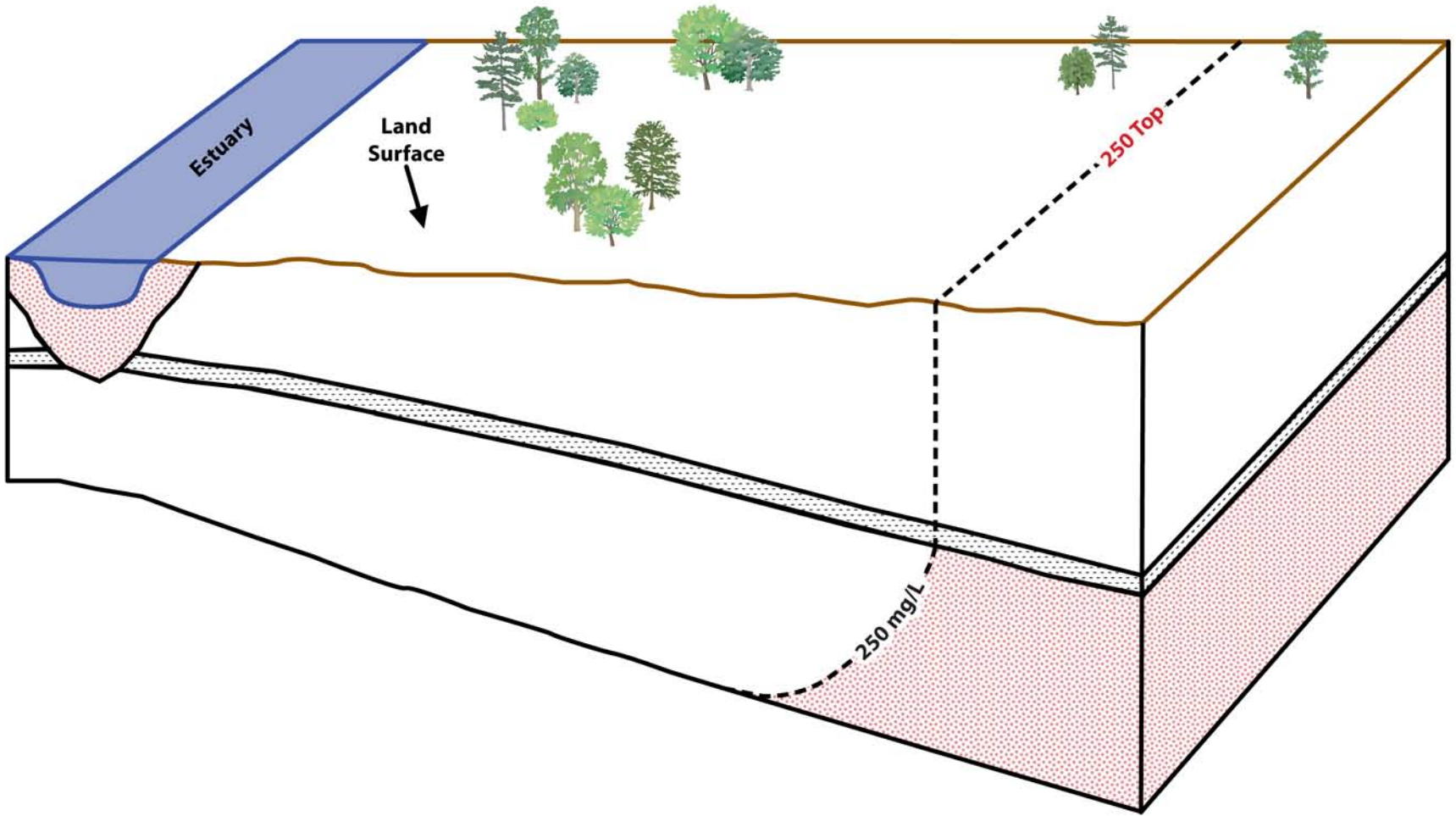


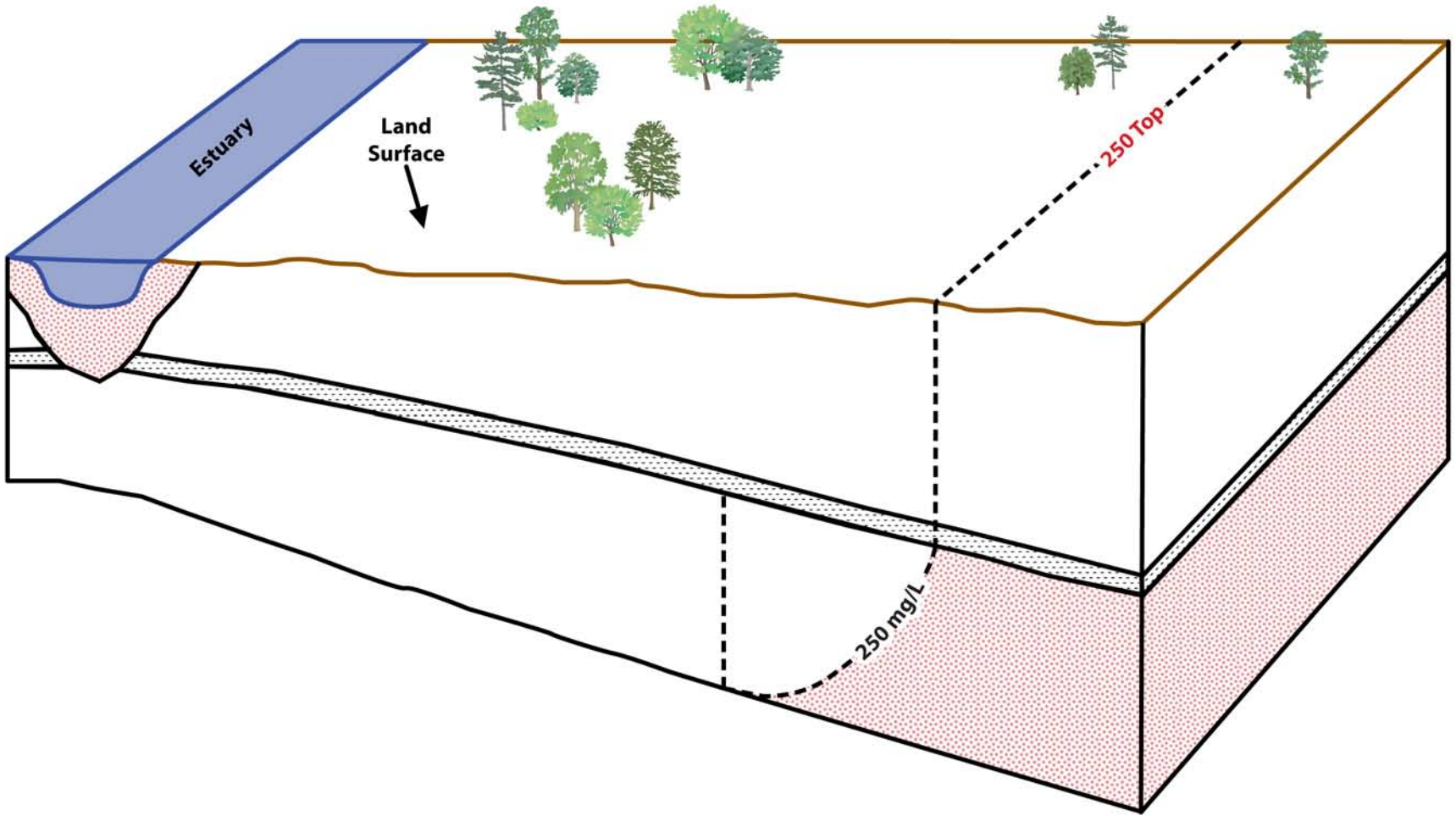


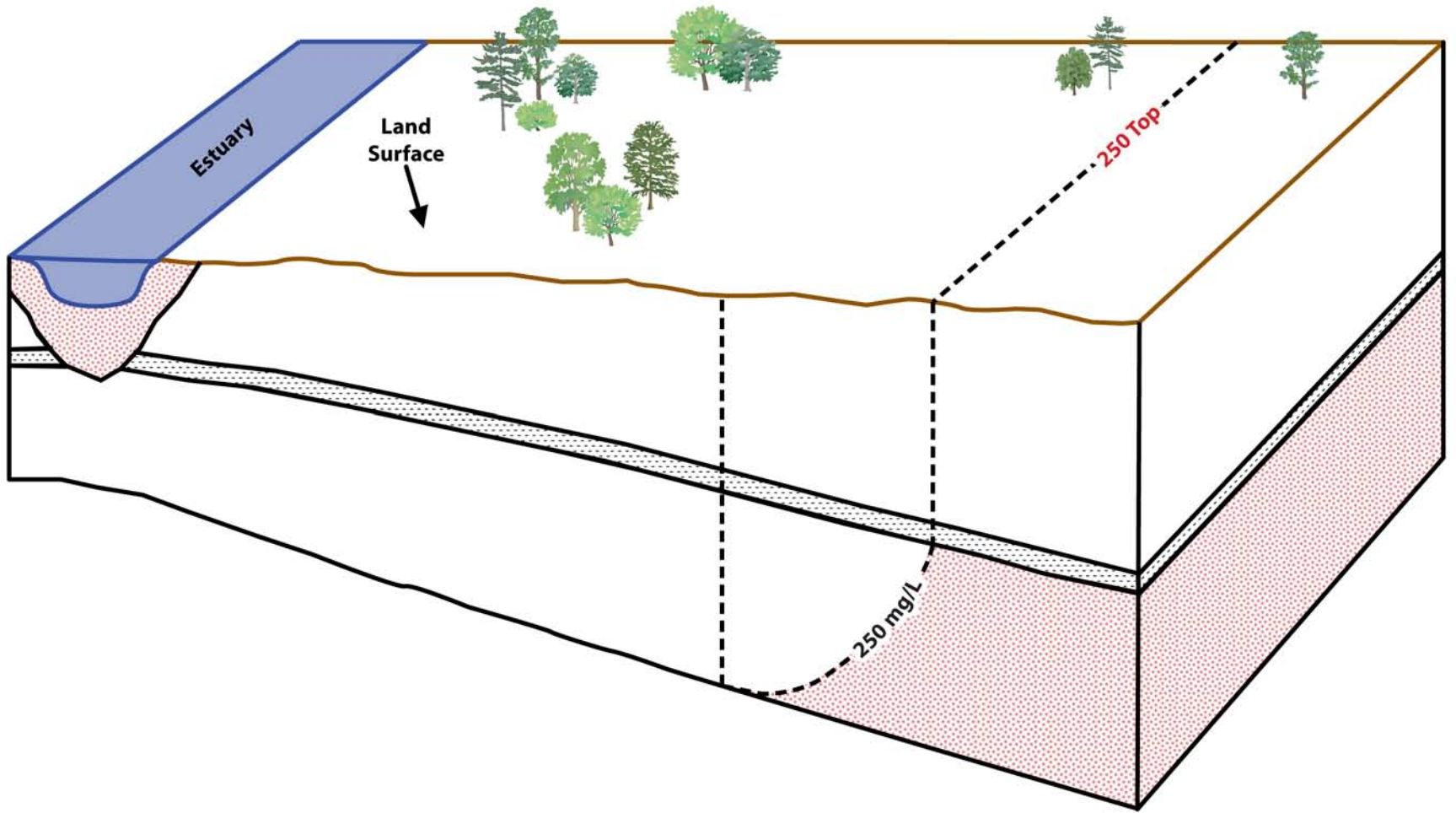
From the
 NCDWR's
 Central
 Coastal Plain
 Capacity Use
 Area Status
 Report 2009

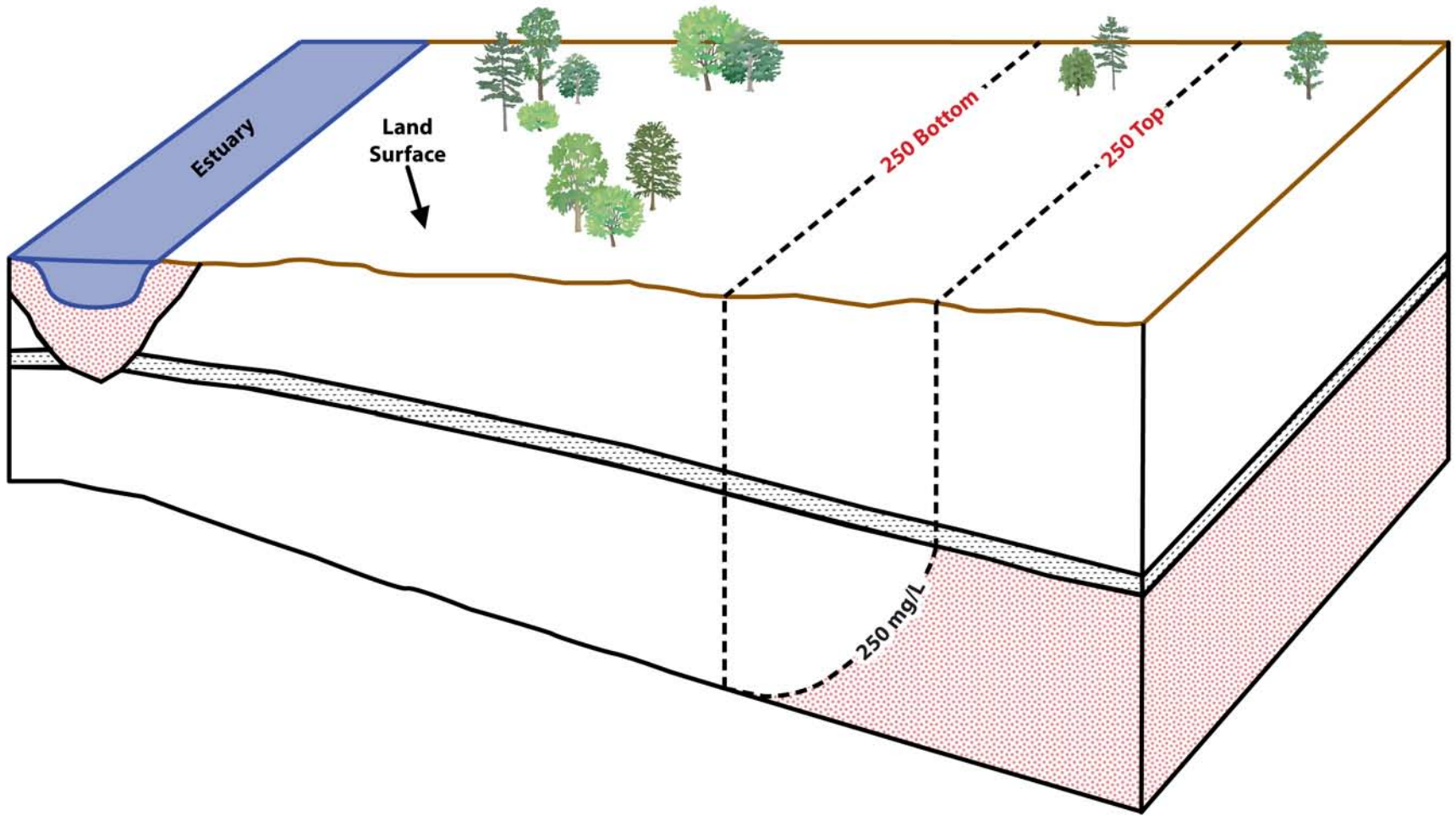


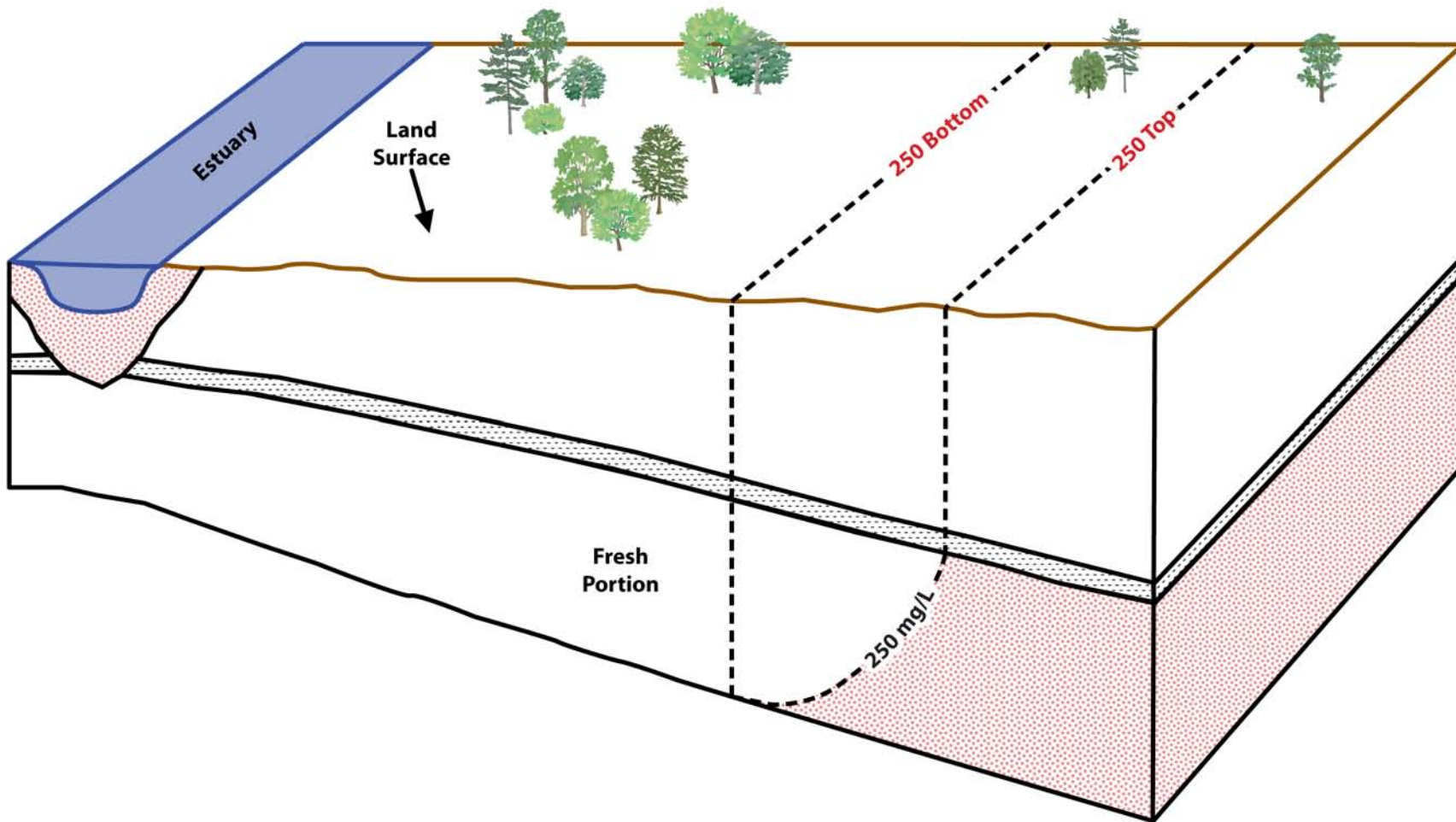


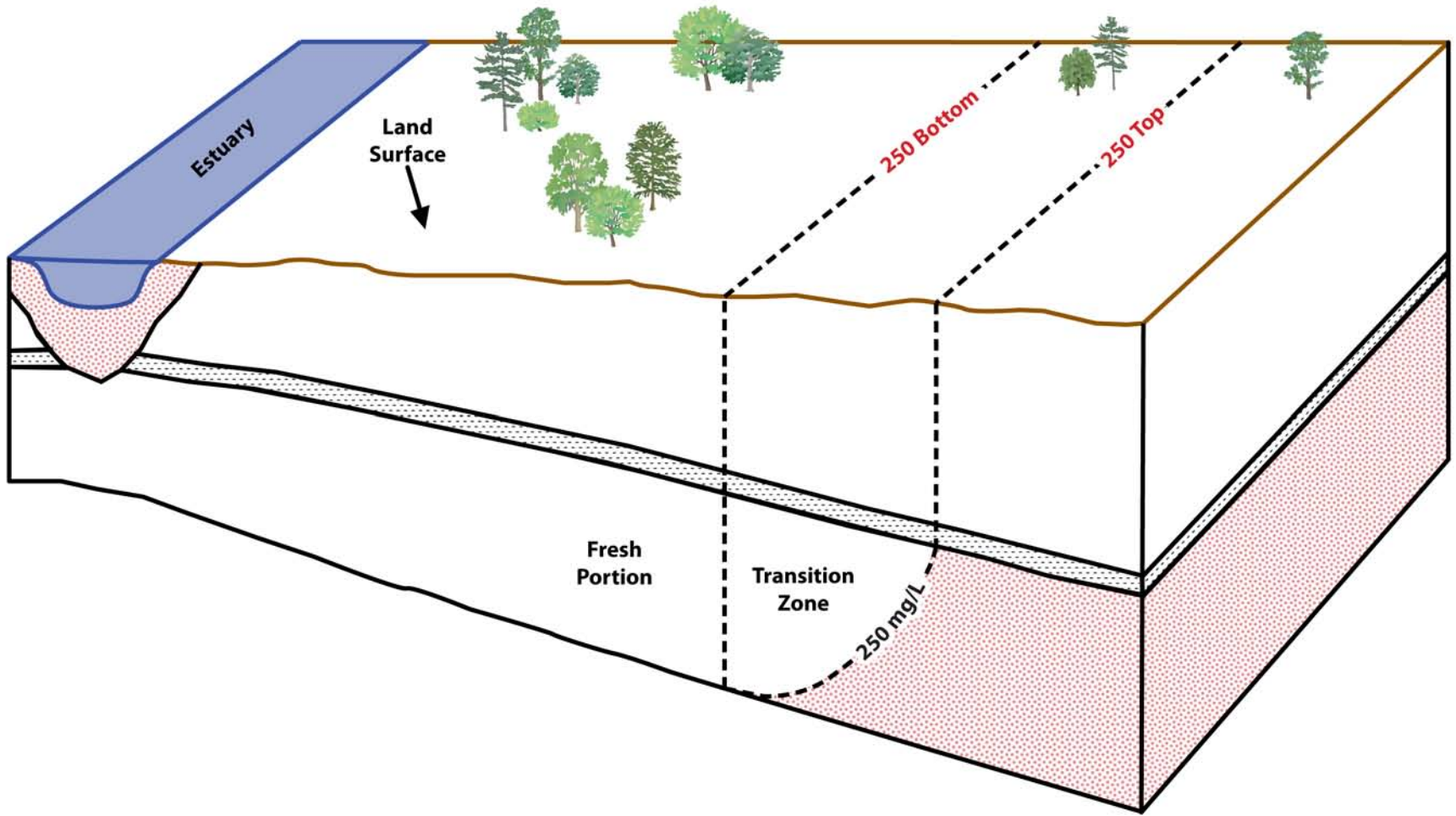


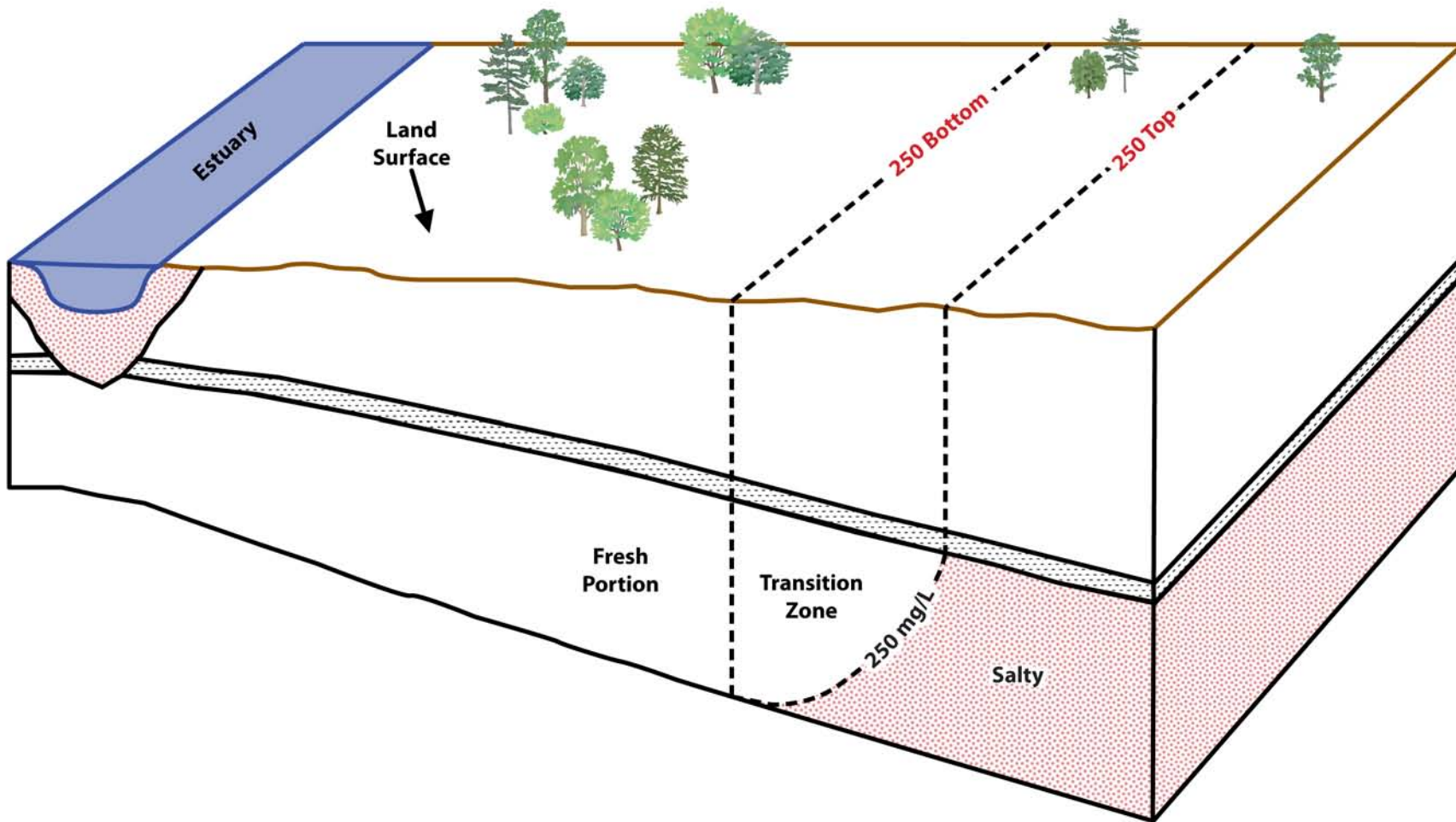


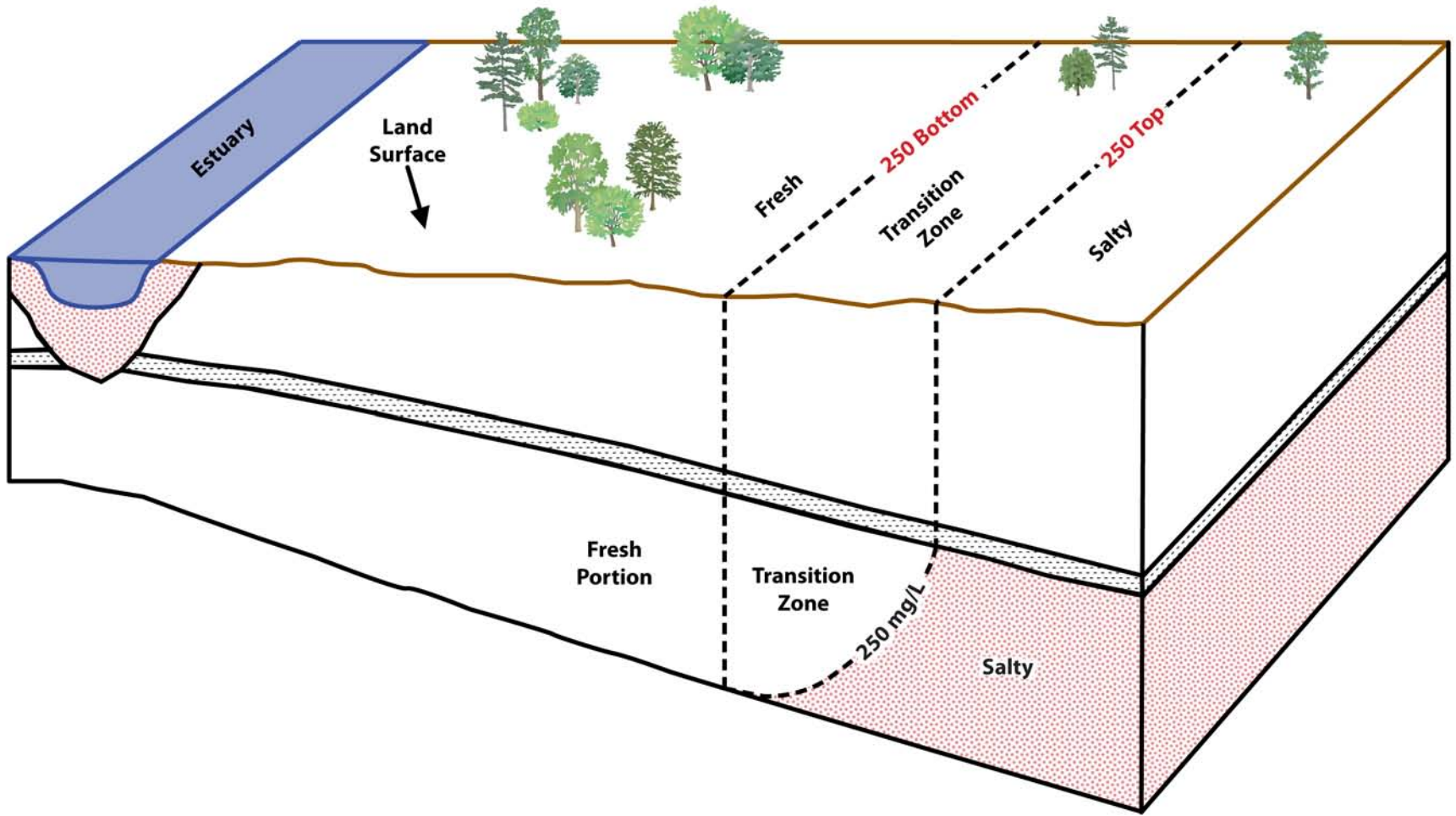


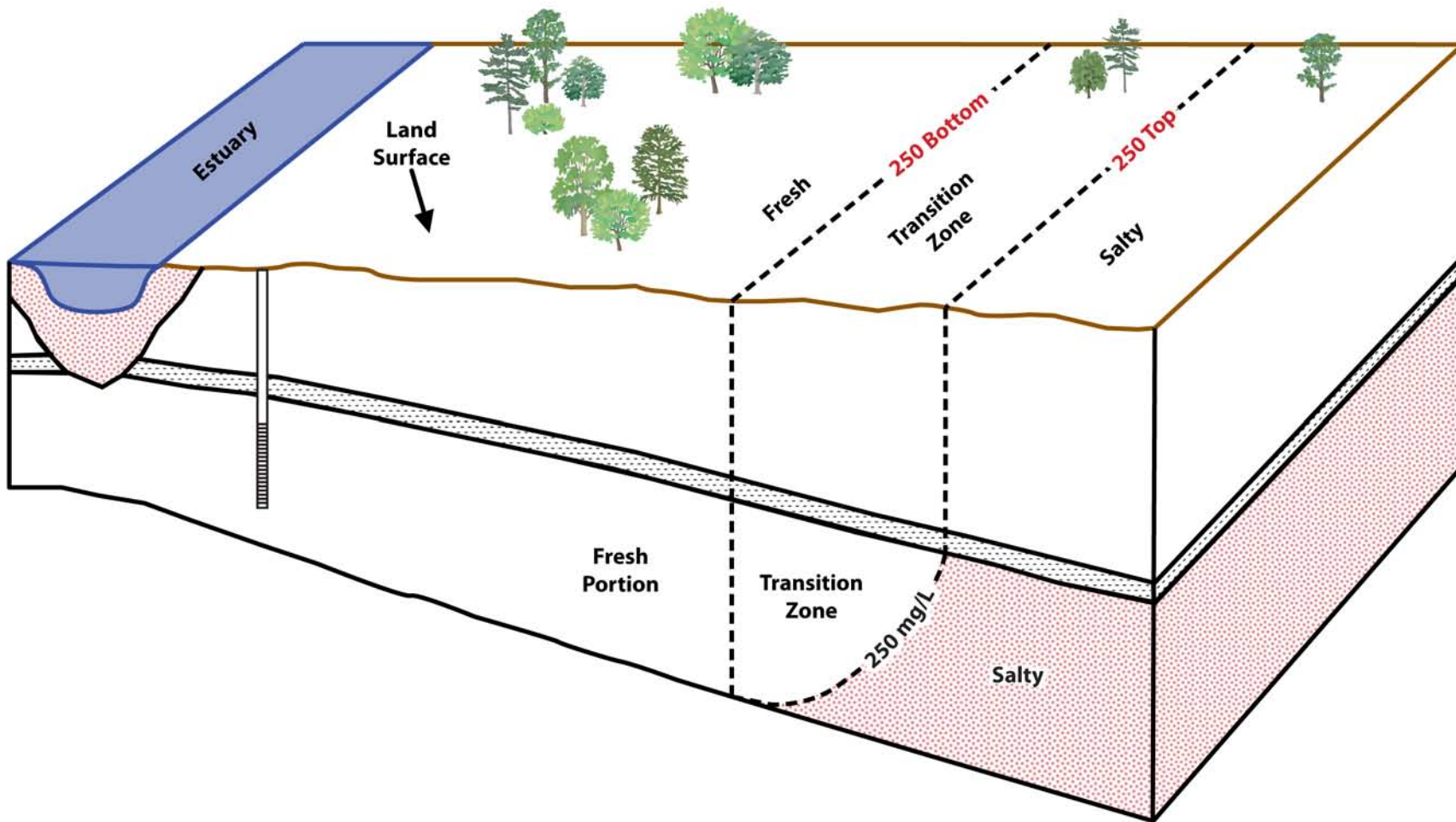


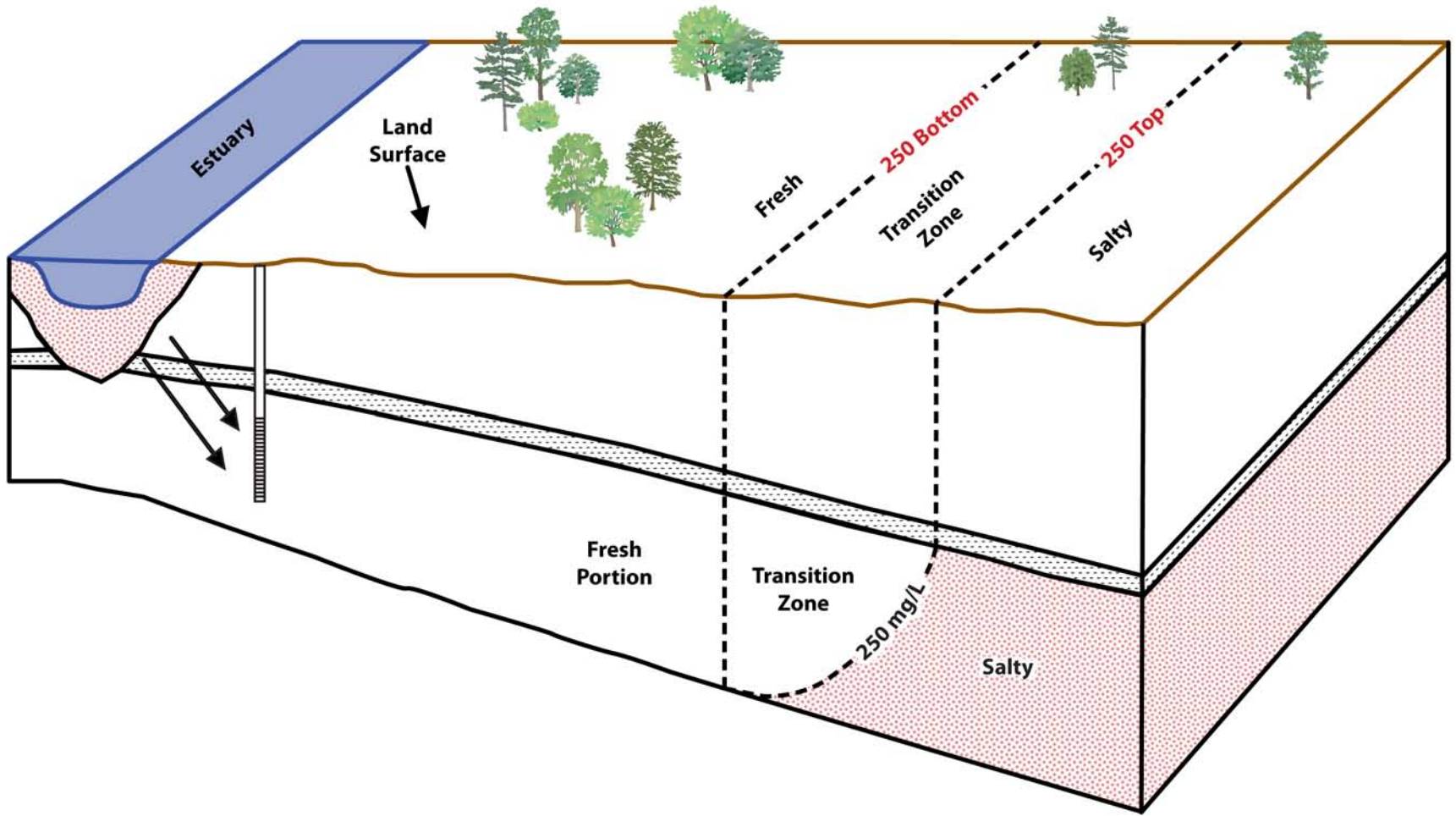











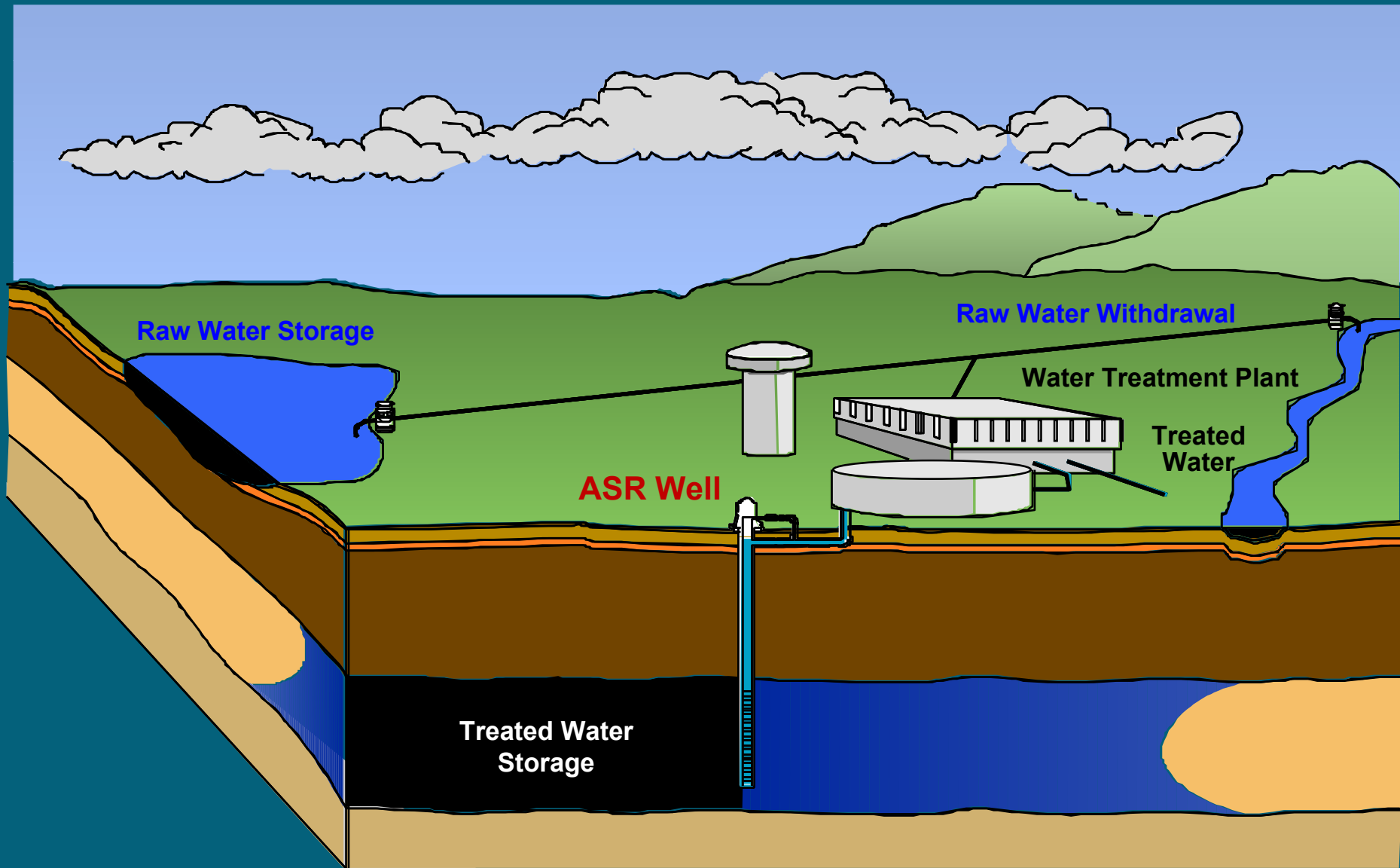


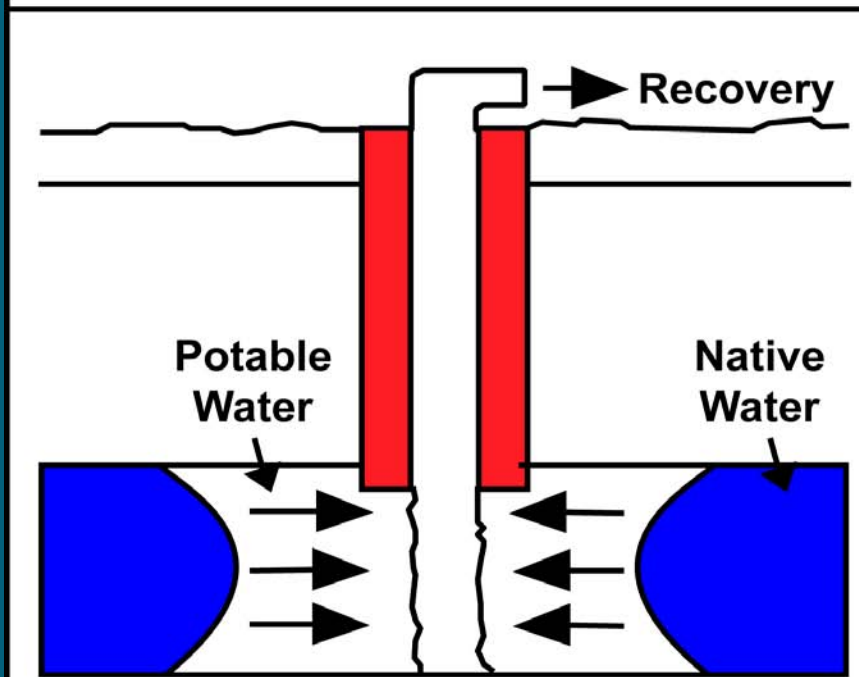
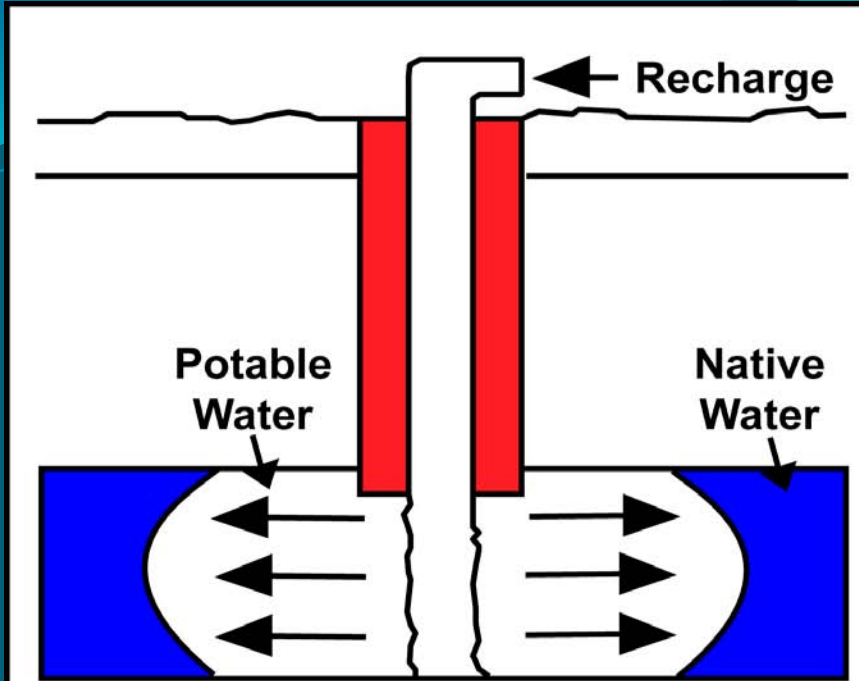
A photograph showing a large, dark pipe on the left side of the frame, discharging a thick, white, turbulent stream of water into a river. The water is splashing and creating white foam as it enters the river. The background is a dense forest of green trees under a clear blue sky. The overall scene is outdoors and appears to be a water treatment or discharge point.

**Providers have Three Main
Options to deal with Water
Resource Issues:**

- 1) Cooperation**
- 2) Diversification**
- 3) Interconnection**

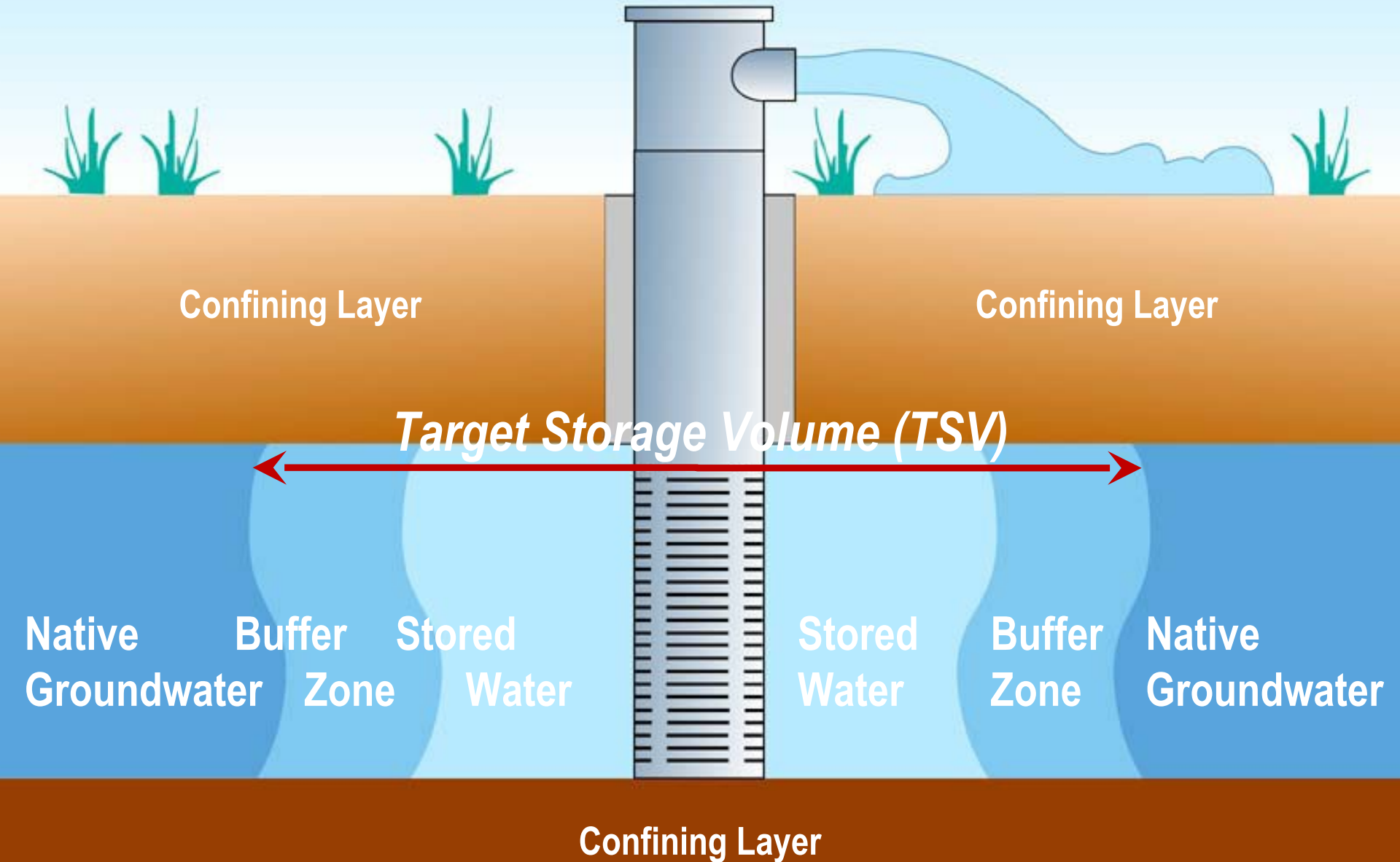
Integration of ASR and Surface Water





Conceptually, ASR technology is simple: *Inject and store excess capacity, and recover it when needed.*

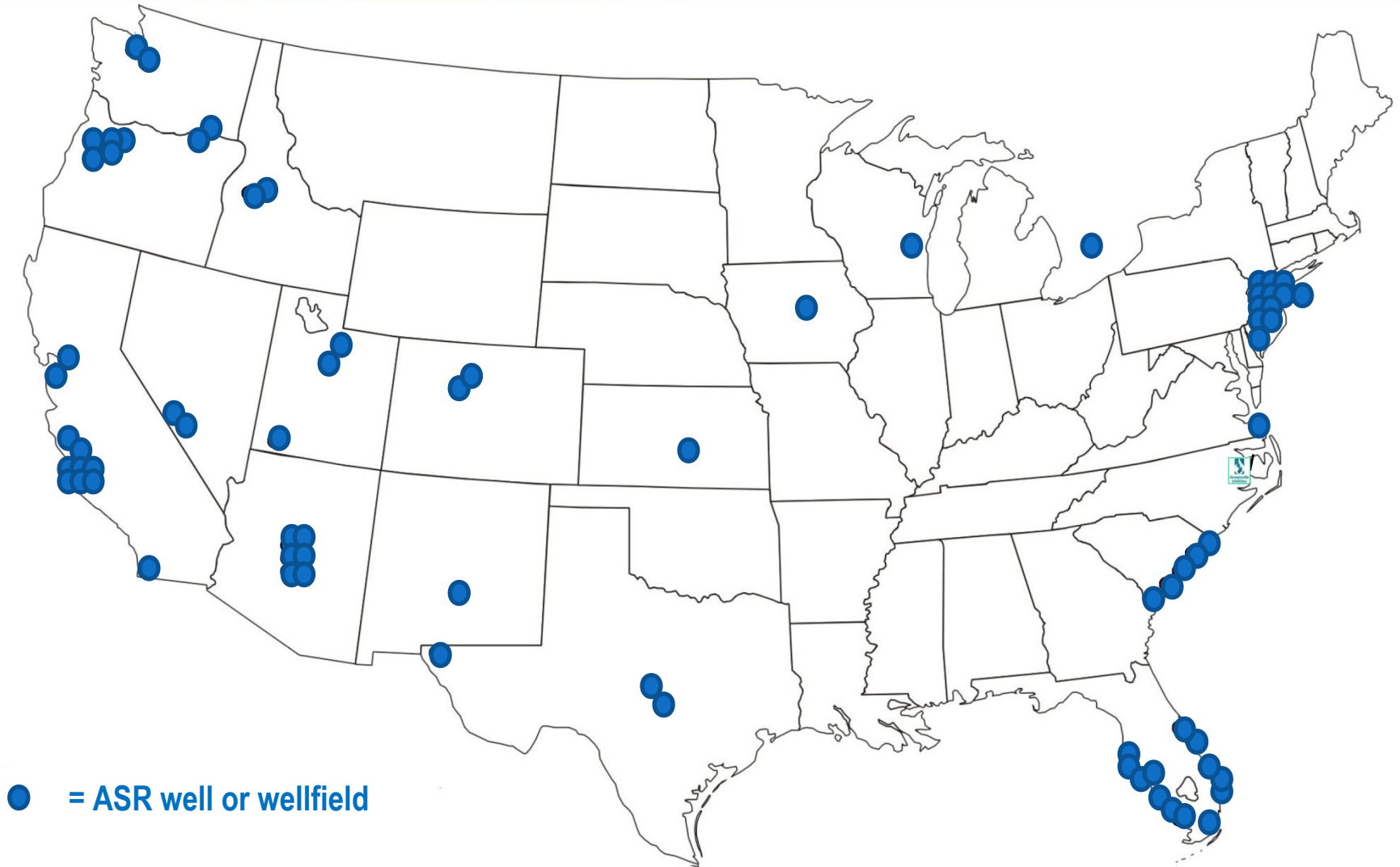
(modified from Pyne, 2005)

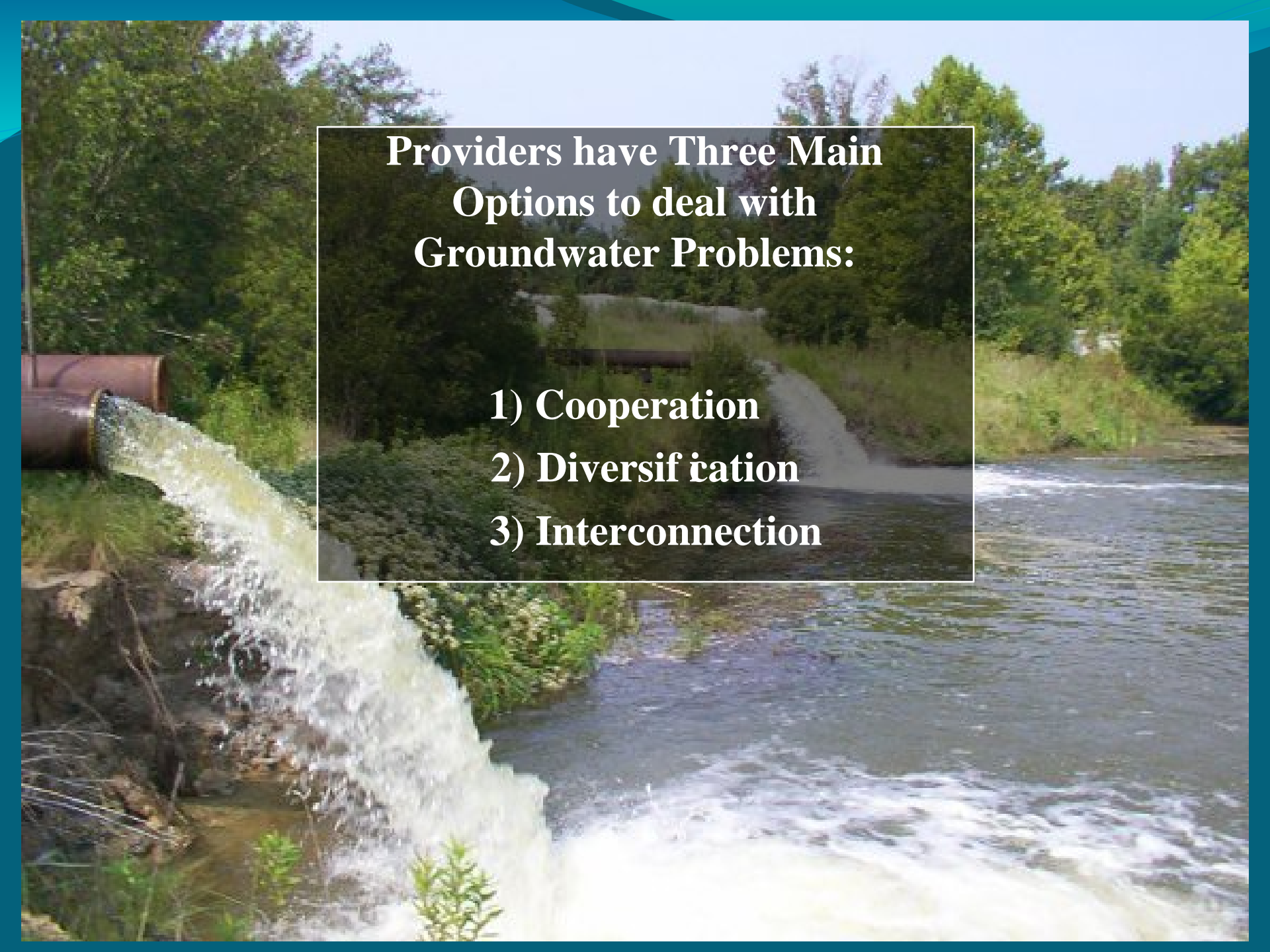


72 Operational ASR Wellfields in the United States

December 2005

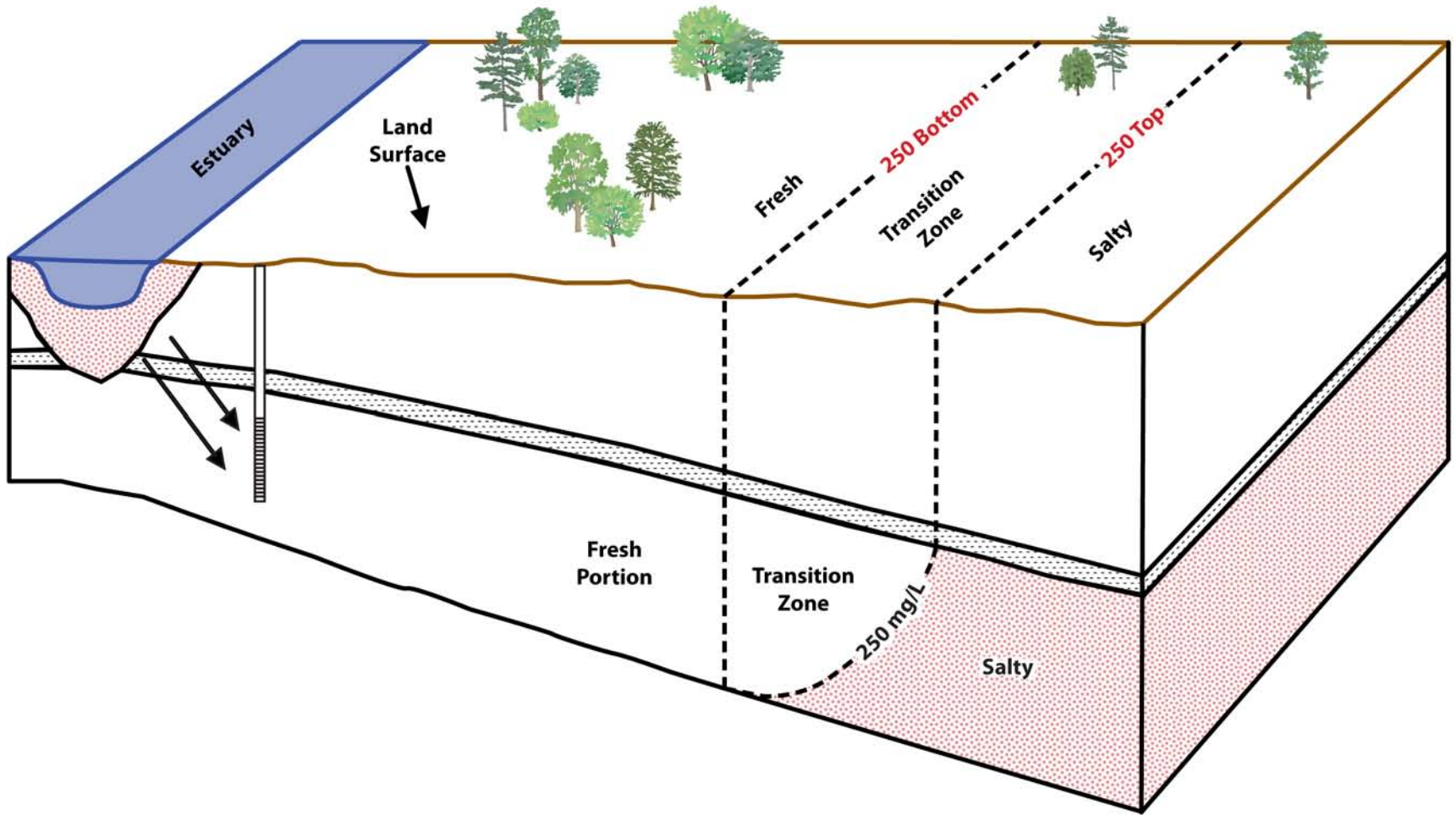
(currently, ~95)

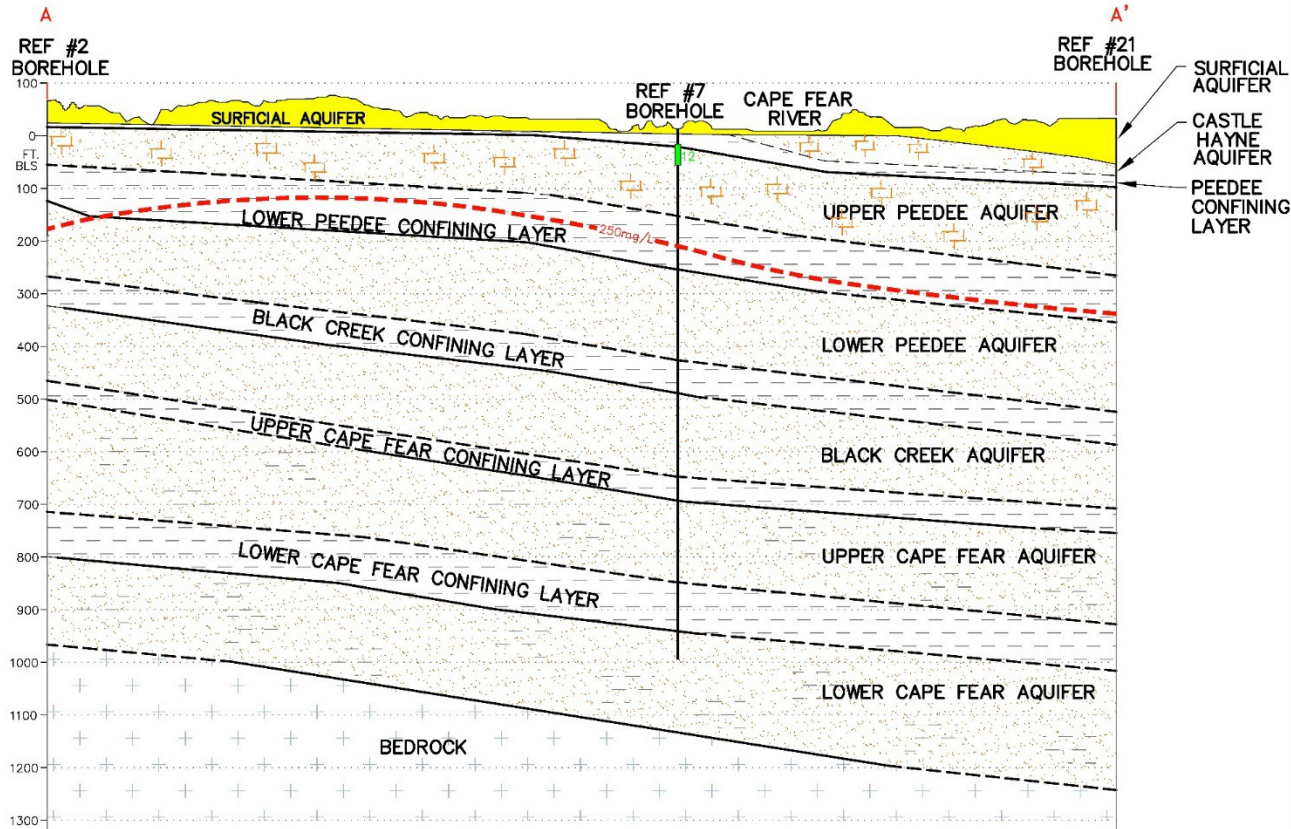


A photograph showing a large, dark pipe on the left side of the frame, discharging a thick, white, turbulent stream of water into a river. The river flows from the bottom left towards the right. The background is filled with dense green trees and foliage under a clear blue sky. A semi-transparent white text box with a thin black border is centered over the image, containing text in a bold, white, serif font.







**Providers have Three Main
Options to deal with
Groundwater Problems:**

- 1) Cooperation**
- 2) Diversification**
- 3) Interconnection**






-LEGEND-

-  SURFICIAL AQUIFER
-  CLAY
-  LIMESTONE
-  SAND
-  BEDROCK
-  ESTIMATED LOCATION OF THE FRESH WATER/SALT WATER INTERFACE

**HYDROGEOLOGIC
CROSS SECTION A-A'**

FIGURE 14 DATE 1/17/2012

SCALE
HORIZONTAL 1"=10,000'
VERTICAL 1"=200'



BRUNSWICK REGIONAL
WATER AND SEWER



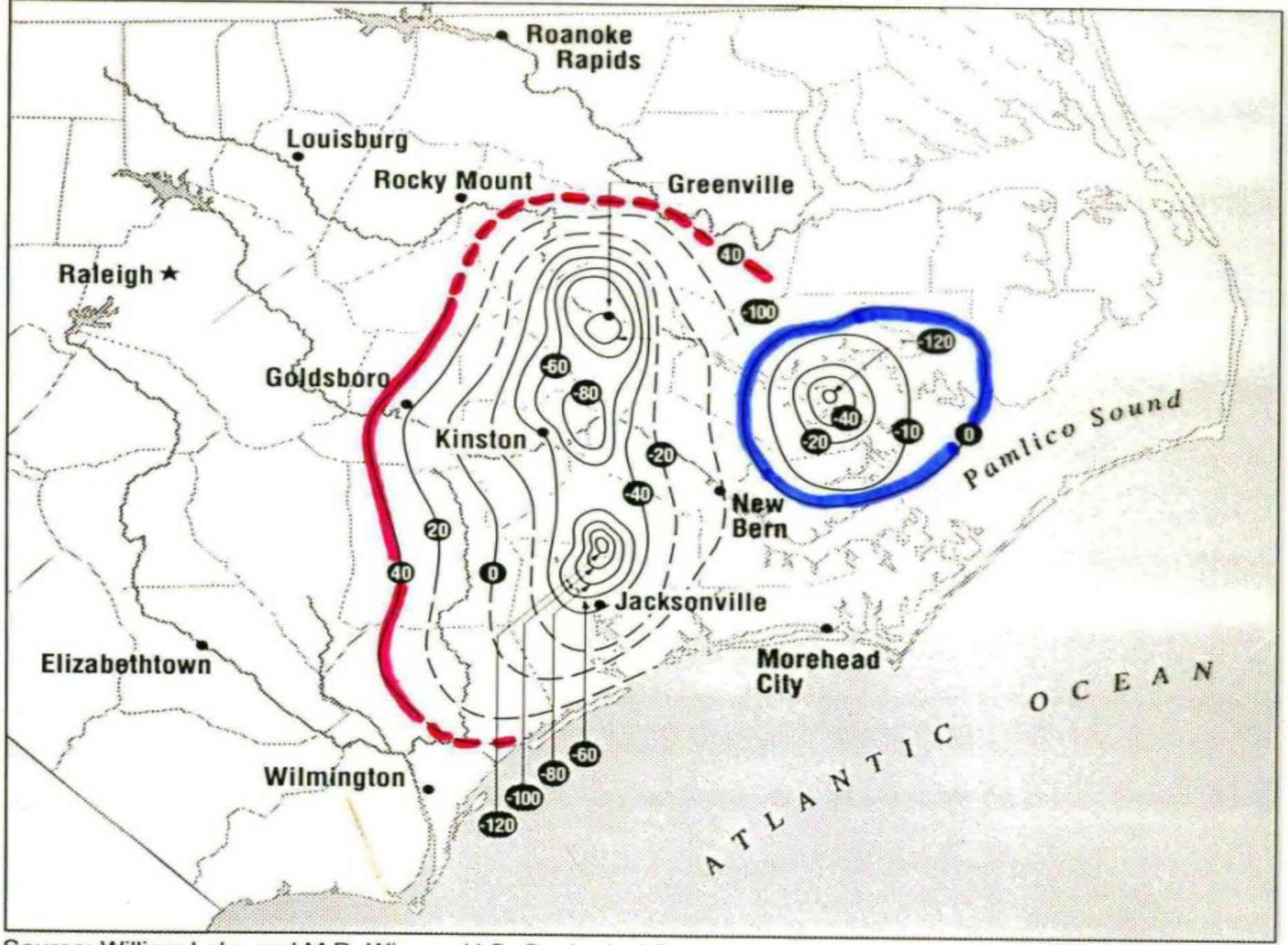
The RO Plant



Room to grow

Questions?





Source: William Lake and M.D. Winner, U.S. Geological Survey