Groundwater on the Eastern Shore

Eastern Shore Master Gardeners
November 4, 2020

Jessica Steelman
Coastal Planner
Accomack-Northampton Planning District Commission
jsteelman@a-npdc.org
757-787-2936 ext.114

A-NPDC Overview and Purpose

- Commonwealth created 21 PDCs in 1970 to address regional issues by fostering cooperation amongst localities and cooperation between state & localities
- Accomack-Northampton District:
  - Members: 2 Counties and Town of Chincoteague
  - Also provides services to 18 other towns
- Affiliate Organizations:
  - A-N Regional Housing Authority→ provides privately or authority-owned rental housing
  - ESV Housing Alliance→ improving housing for homeowners
  - A-NPDC→
    - Community Development
    - Economic Development
    - Transportation Planning
    - Environmental Planning → **Ground Water Committee**; Climate Adaptation Working Group; GreenWorks

Eastern Shore of Virginia Ground Water Committee

- Formed in 1990 by Accomack & Northampton Counties
- 11-members:
  - 2 County Administrators, 4 County Supervisors, 4 County-appointed members, A-NPDC Executive Director
- Contracts consulting hydrogeologist to advise Committee: Britt McMillan, ARCADIS
- ESVA Ground Water Resource Protection and Preservation Plan
  - Original 1992; Updated 2013; 2020/2021 update in progress
  - Regional plan to ensure adequate & safe drinking water for citizens
- Water Supply Plans – Accomack & Northampton Counties
  - Regulations: 9 VAC 25-780
  - Adopted in 2011
  - Updates were submitted to VDEQ in late 2018

Presentation Overview

1. **Eastern Shore Formation and Geology**
2. What is Groundwater?
3. Local Groundwater Conditions
4. Trends in Groundwater Use
5. Threats to Our Groundwater Quality
6. Groundwater Management and Planning

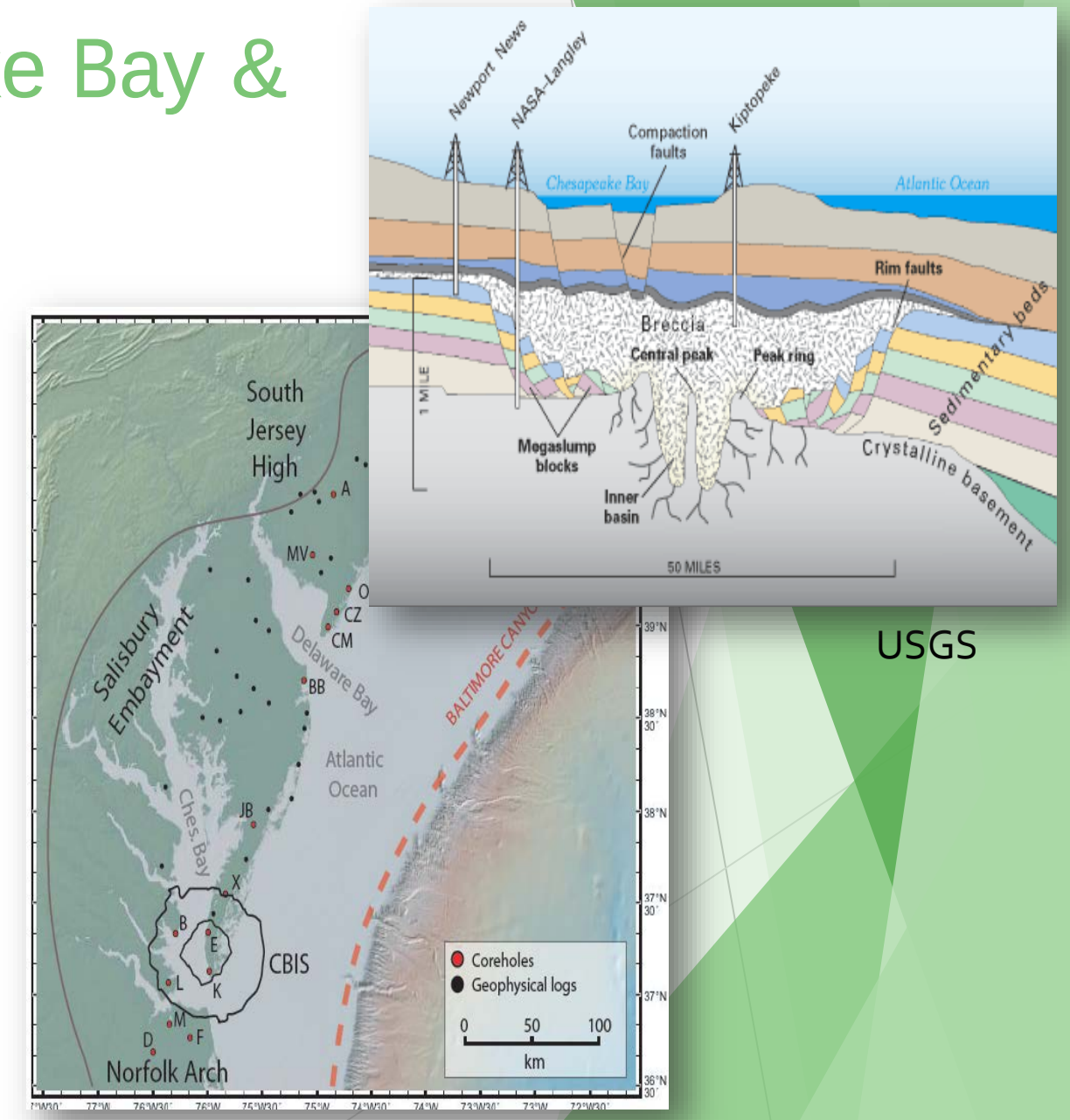
Evolution of the Chesapeake Bay & Eastern Shore

- Timeline:

i. Opening of Atlantic Ocean & Salisbury Embayment – **≈180 Million Years Ago (MYA)**

ii. Bolide impact & removal of pre-impact sediments – **≈35.5 MYA**

iii. Deposition of post-impact sediments **– ≈35.5 MYA – Present**



USGS

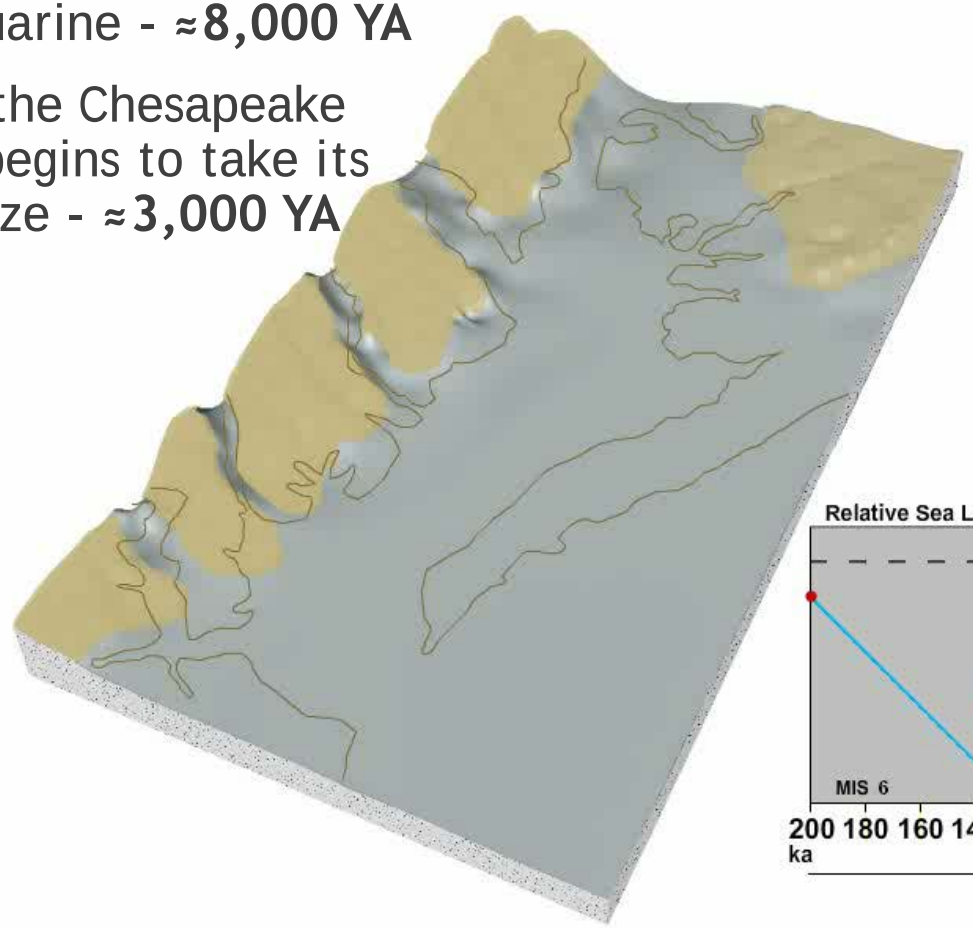
Olsson (1980), Powars & Bruce (1999), Owens & Gohn, 1985), Kolwecz (2008)

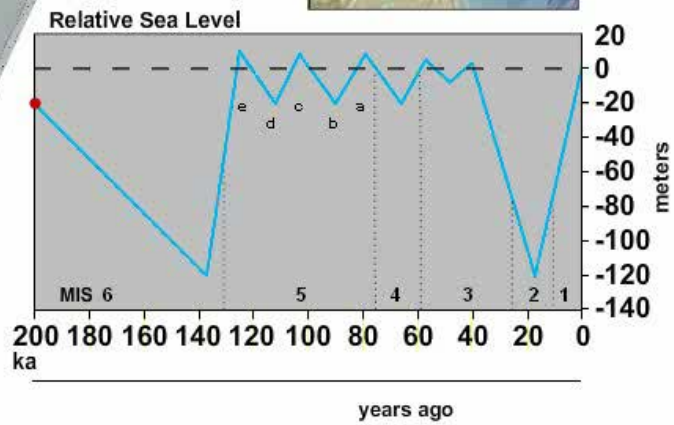
- Timeline continued:

iv. Reworking of surficial sediments & progradation of peninsula – **≈200,000 YA – Present**

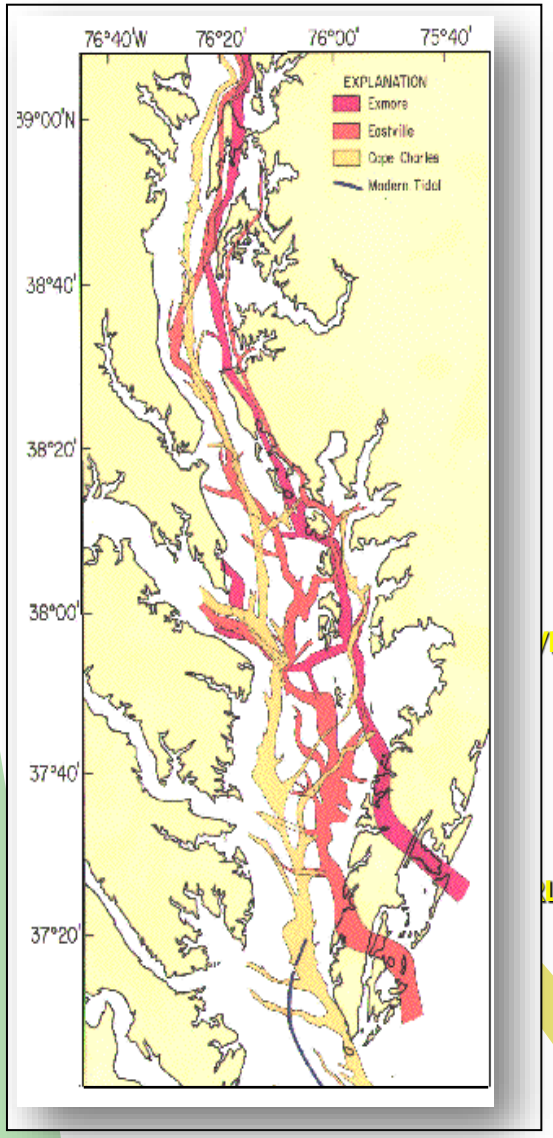
v. Sea level reaches elevation of modern Chesapeake Bay transitioning system from riverine to estuarine - **≈8,000 YA**

vi. Sea level continues to rise and inundate the Chesapeake Bay watershed and the Chesapeake Bay begins to take its modern appearance we currently recognize - **≈3,000 YA**

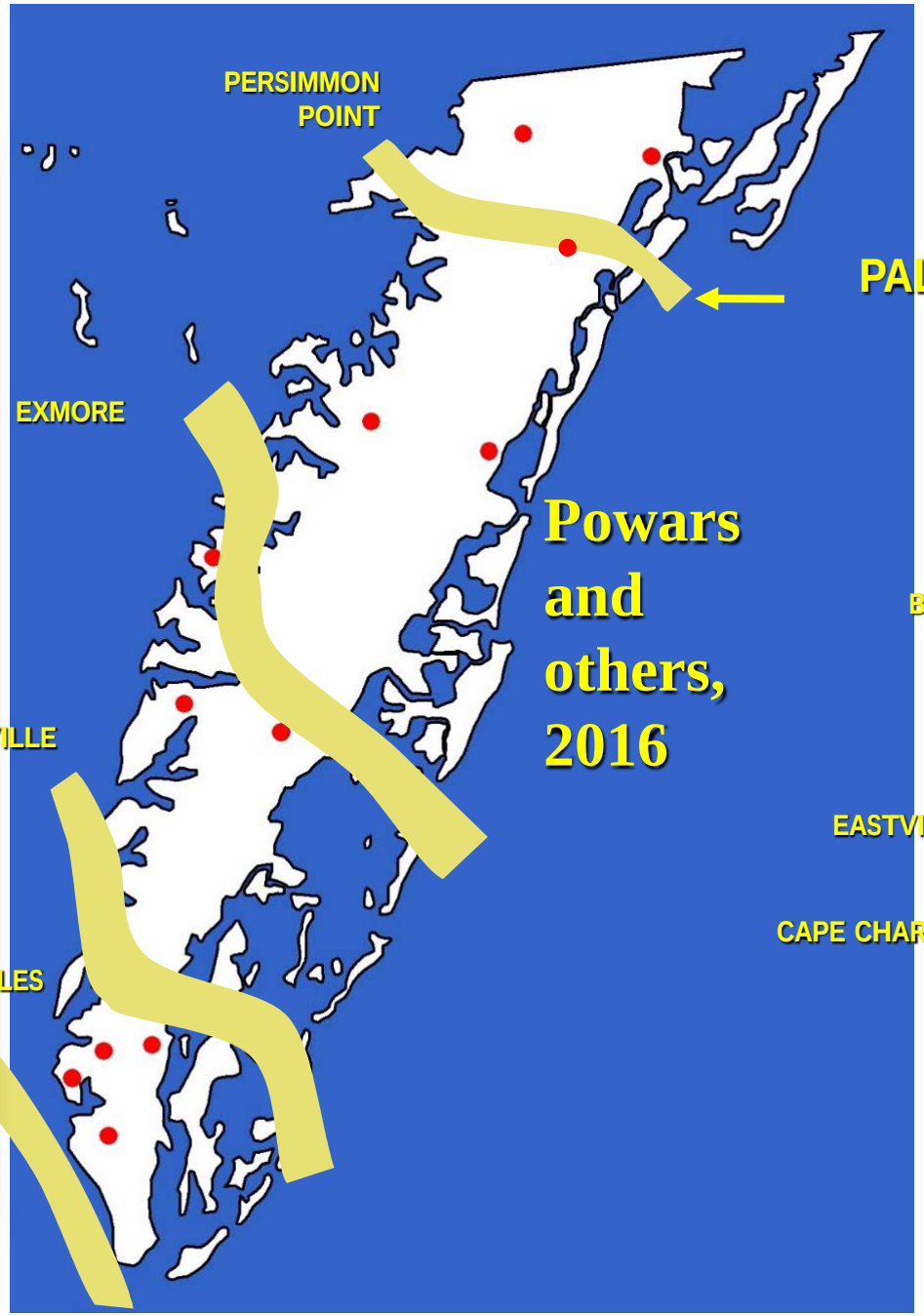




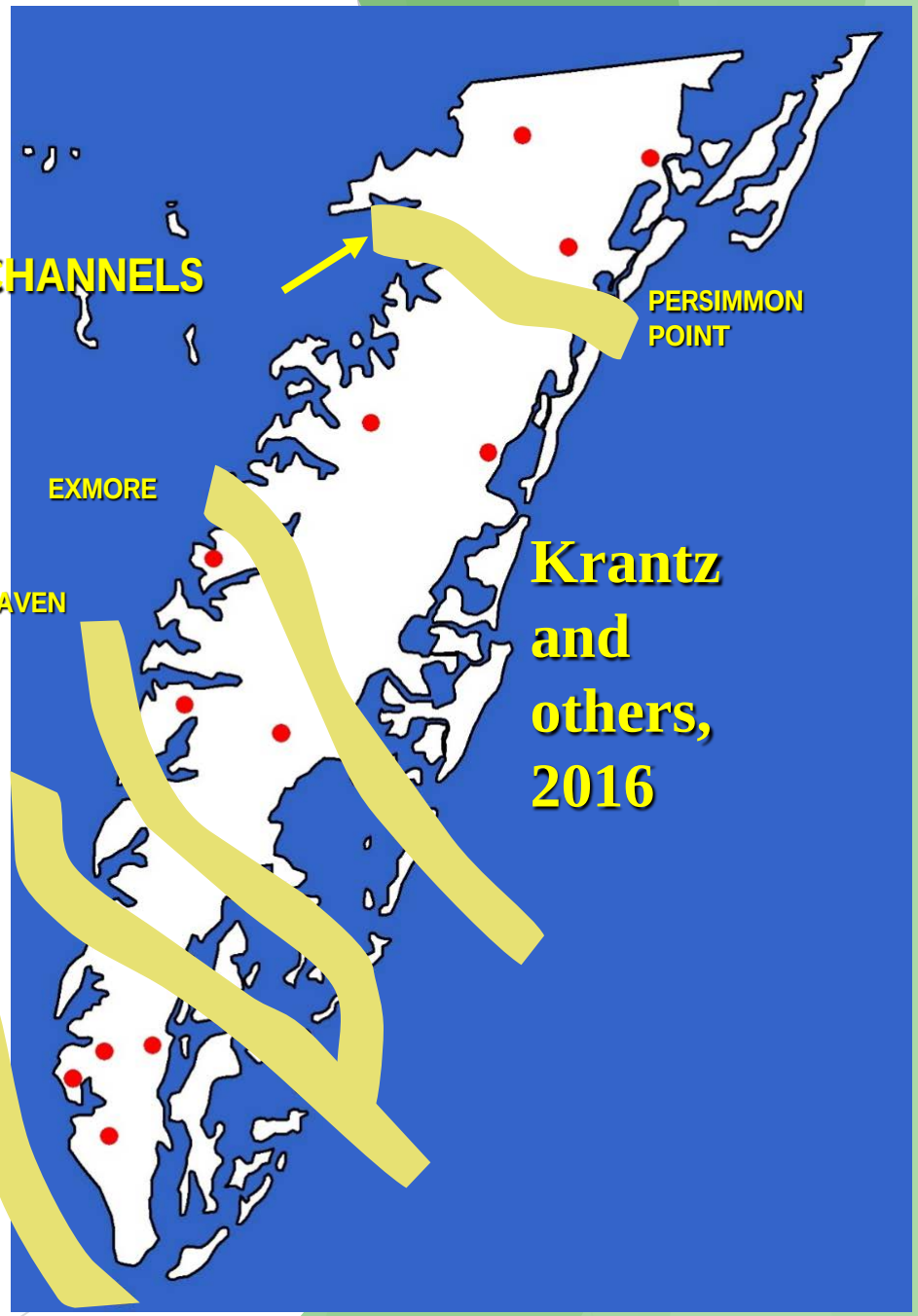
Video courtesy of John F. Bratton, USGS



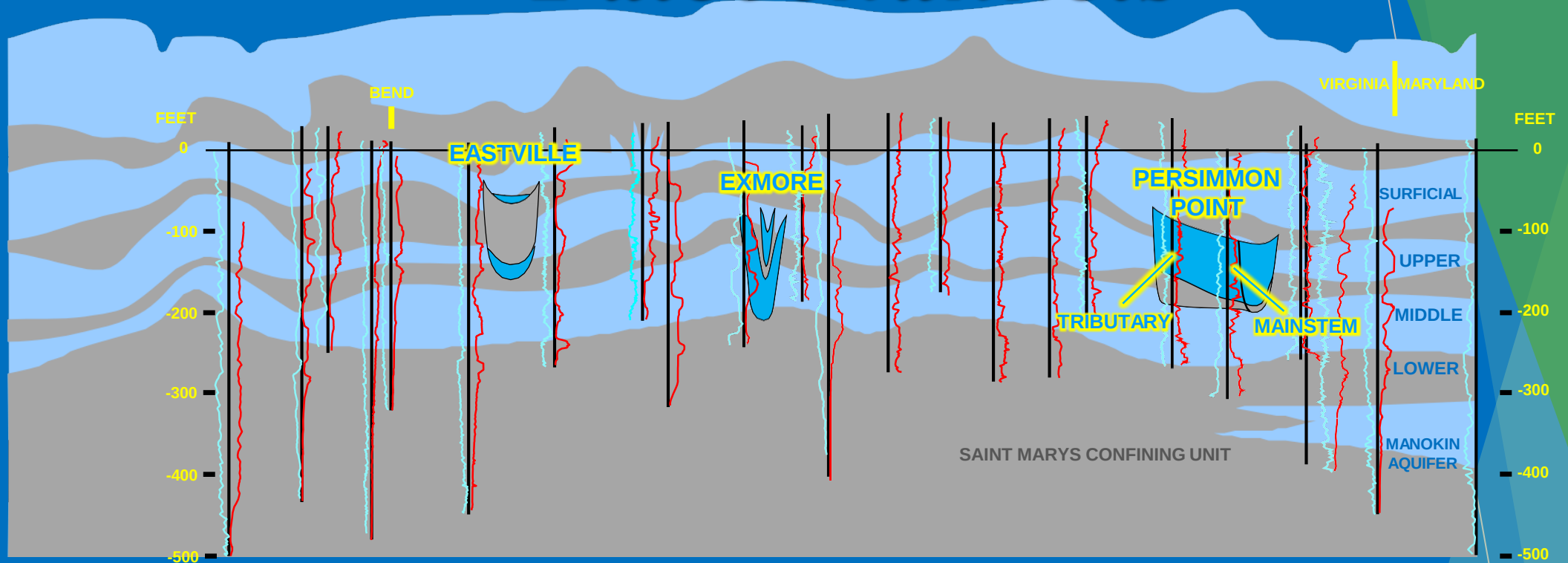
Colman et al (1990)

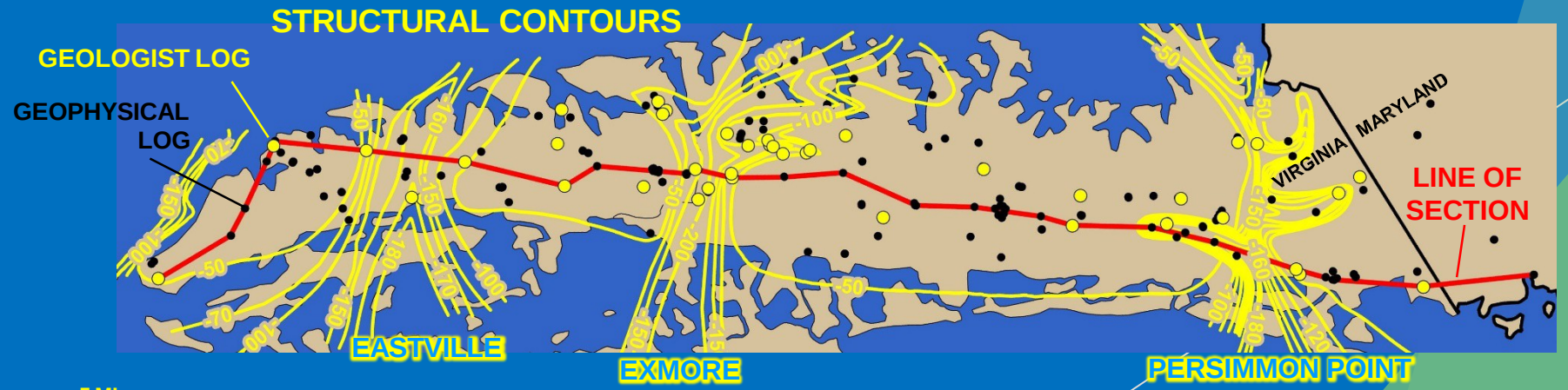


PALEOCHANNELS

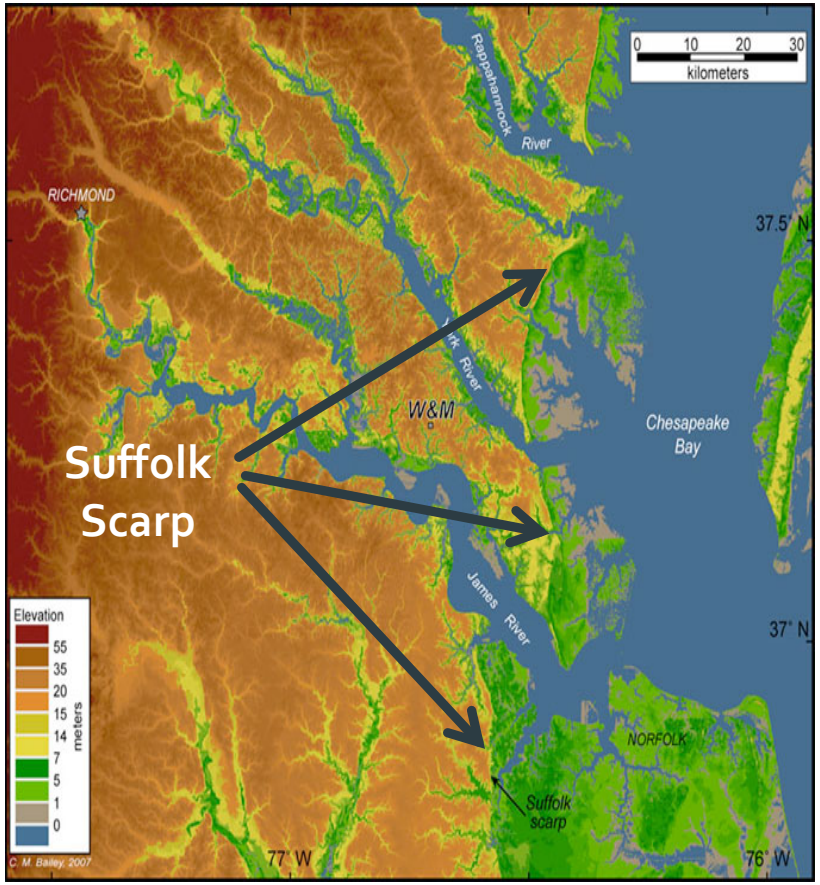


Paleochannels

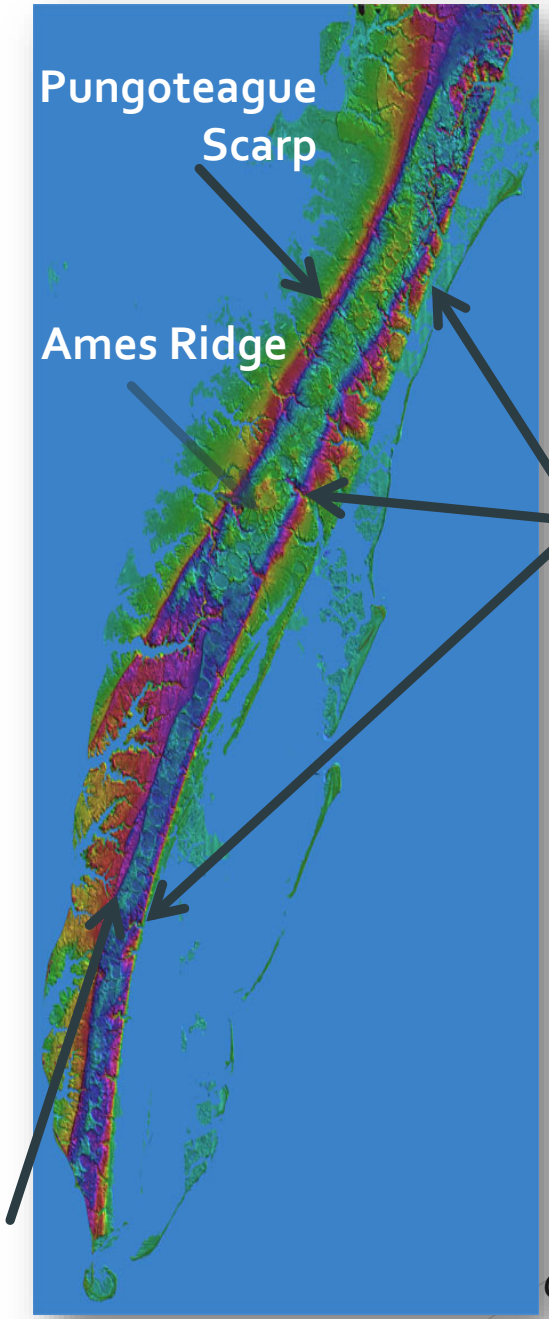




Surficial Features:
Relict Shorelines



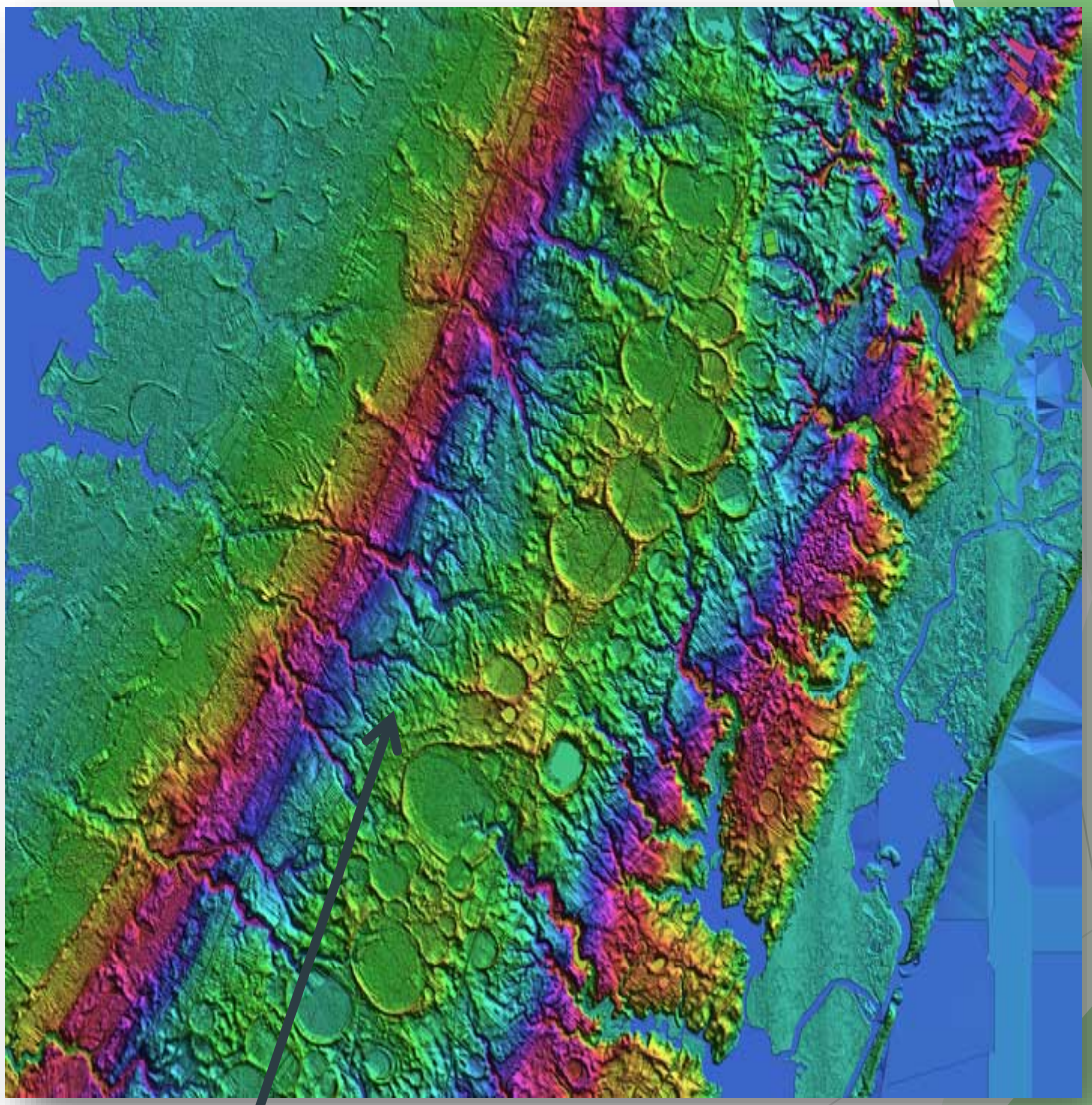
Bailey (2009)



Cintos (2012)

Surficial Features: Carolina Bays

- Over 700 shallow, elliptical depressions on the ESVA
  - Similar orientation (NW-SE)
  - Variable size (1 – 1,000 acres)
  - Some overlapping
  - Coarse-grained rims
  - Fine-grained floors
- Variable ages (100,000-<5,000 years)
- Debated origin
  - Wind & Water
  - Shock wave from bolide explosion



Cintos (2012)

Satellite Images of Carolina Bays

Geologic Mystery!

Cintos (2014)

Presentation Overview

1. Eastern Shore Formation and Geology
2. **What is Groundwater?**
3. Local Groundwater Conditions
4. Trends in Groundwater Use
5. Threats to Our Groundwater Quality
6. Groundwater Management and Planning

What is Groundwater?

- Groundwater is water that moves under the earth's surface through pores and spaces in soil and through tiny cracks in rocks.
  - Think of the land beneath our feet as being like a sponge through which groundwater moves.

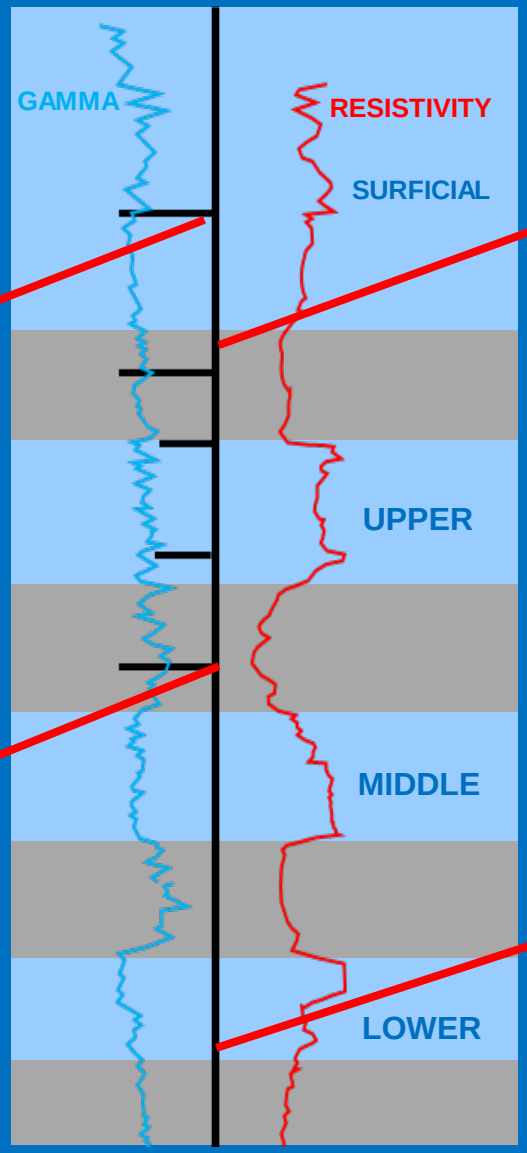
Borehole Geophysical Log and Lithology

(report figure 5)

SAND AND GRAVEL

2 INCHES

SILT AND CLAY

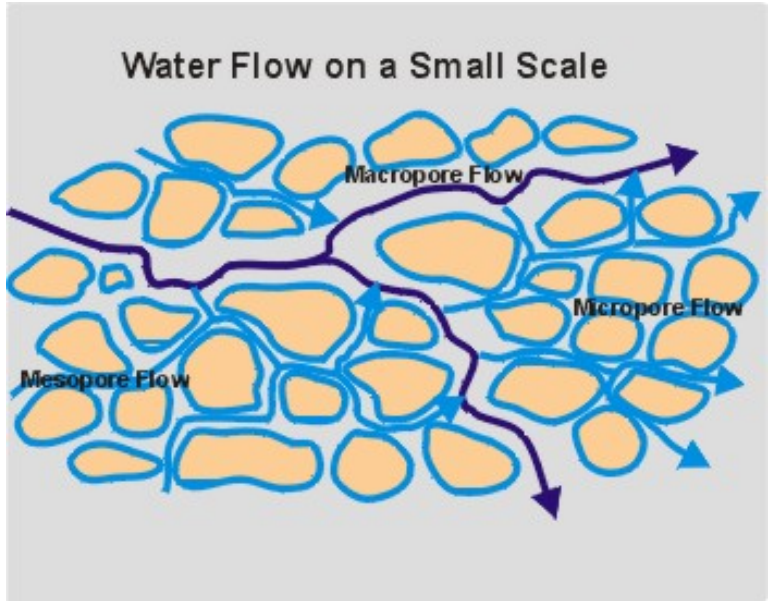


SILTY FINE SAND

SHELLS AND SAND

Groundwater is not like an underground river!

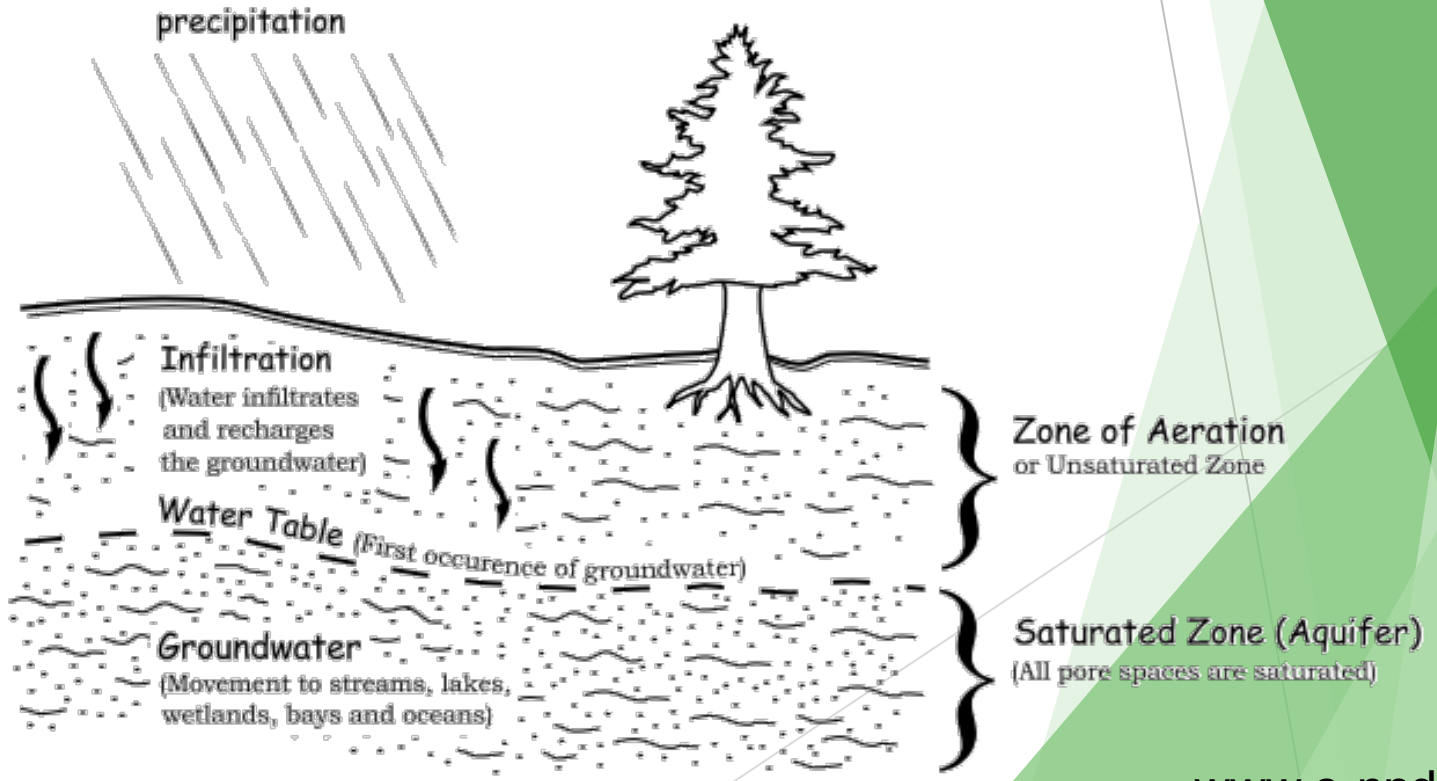
- Groundwater flows through porous soils and sediment that includes gravels, sands, silts, and clay.



How far below the surface is groundwater?

- On the Eastern Shore groundwater is shallow and can be found just under the ground surface, a few feet down in some areas. The first occurrence of groundwater is known as the ***water table***.

- During the rainy season, the groundwater level rises, coming up closer to the surface and often to the surface, causing ponding in yards.



What is an **Aquifer**?

- Any course grained material (sand, gravel) that can supply sufficient water for a beneficial use.

What is a **Confining Unit**?

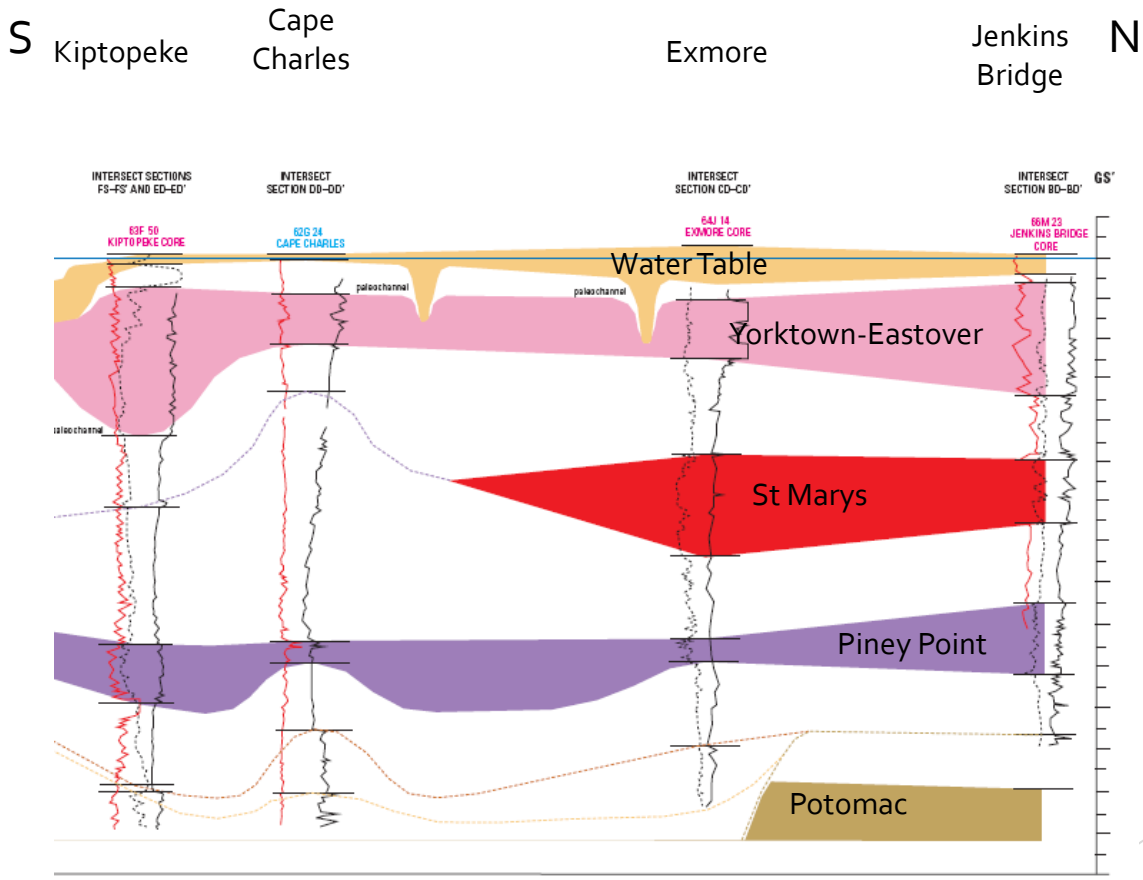
- Any fine grained material (silt, clay) that can significantly restrict vertical movement of groundwater such that the resulting groundwater is under pressure.

Presentation Overview

1. Eastern Shore Formation and Geology
2. What is Groundwater?
3. **Local Groundwater Conditions**
4. Trends in Groundwater Use
5. Threats to Our Groundwater Quality
6. Groundwater Management and Planning

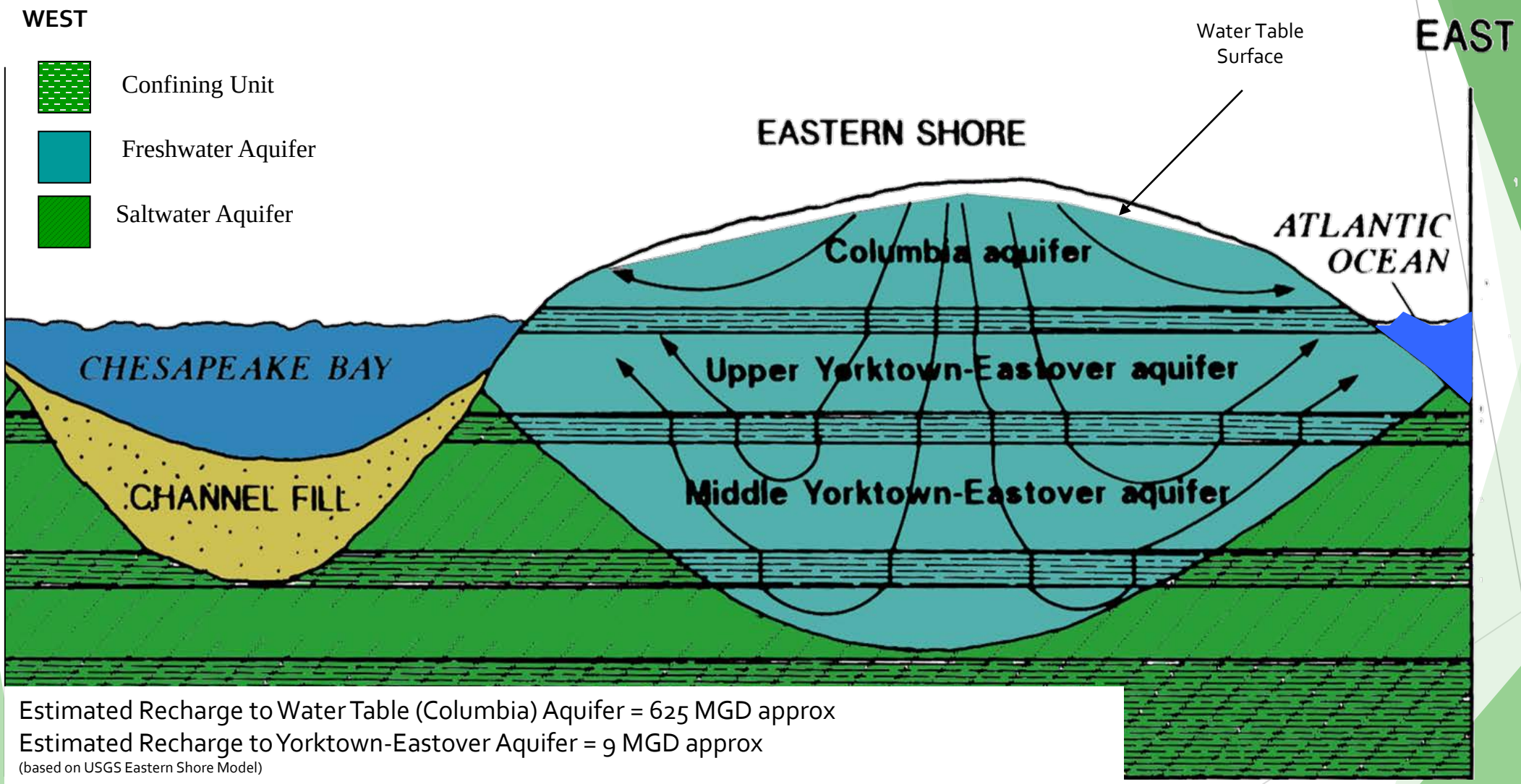
All Groundwater Aquifers on the Eastern Shore

- **Fresh Groundwater is restricted to the Columbia (Water Table) aquifer and significant portions of the Yorktown-Eastover aquifer**
- **Brackish groundwater is found in portions of the Yorktown-Eastover, all of the St. Marys Aquifer, Piney Point, and Potomac aquifers**
- **The Columbia, Yorktown-Eastover, and Piney Point aquifers are found throughout the Eastern Shore**
- **St. Marys and Potomac Aquifers are absent in the southern portion of the Shore**



Source: McFarland and Bruce, 2006

Eastern Shore Groundwater



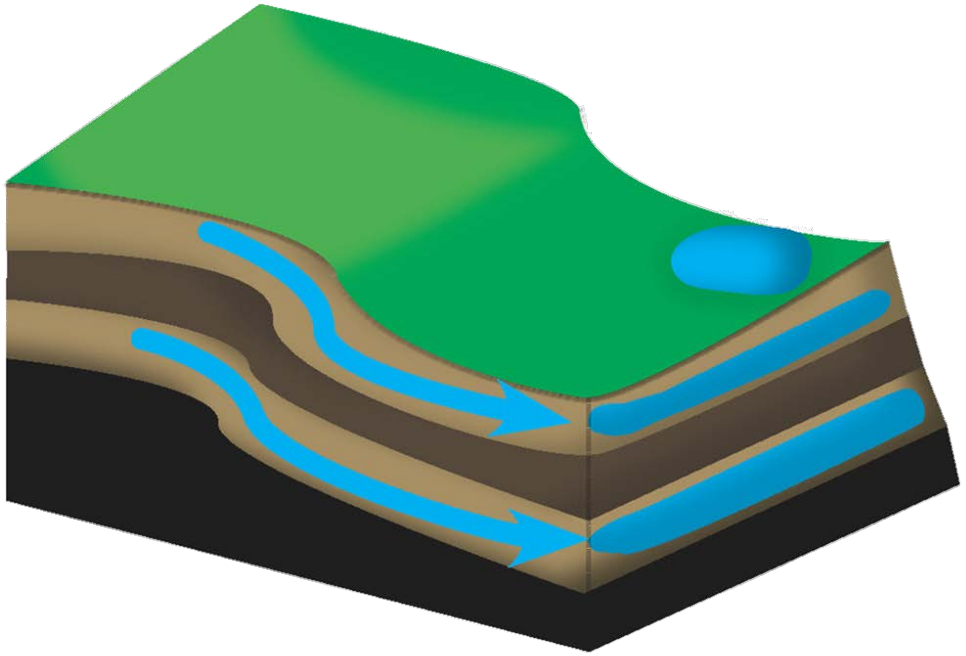
Estimated Recharge to Water Table (Columbia) Aquifer = 625 MGD approx
Estimated Recharge to Yorktown-Eastover Aquifer = 9 MGD approx
(based on USGS Eastern Shore Model)

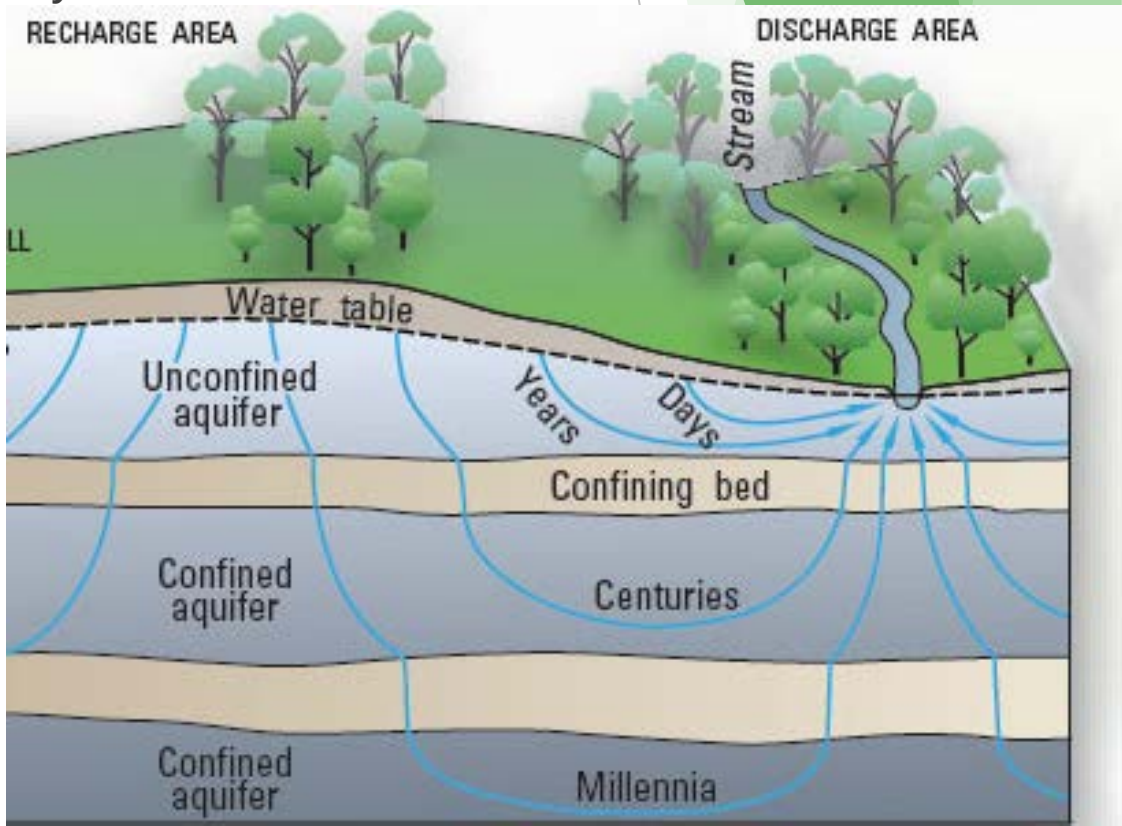
Columbia Aquifer –vs- Yorktown-Eastover (Confined) Aquifer

- Columbia Aquifer
  - Water is not ‘under pressure’
  - Well yield often thought to be lower than comparable confined aquifers
  - Recharged directly by precipitation
  - More vulnerable to contamination from surface activities
- Yorktown-Eastover Aquifer
  - Water is under pressure, confined by overlying layer(s) of silt and clay
  - Recharged from slower vertical flow through the confining unit
  - More vulnerable to salt water intrusion

How does groundwater move?

- Like water on the land surface moves downhill, groundwater tends to move downhill with the direction of the land surface due to gravity and pressure.
- It moves very slowly, though its speed varies with different types of soil or rock. In most soils, groundwater only moves a few inches a day, as it needs to move in the spaces between rocks and soil.

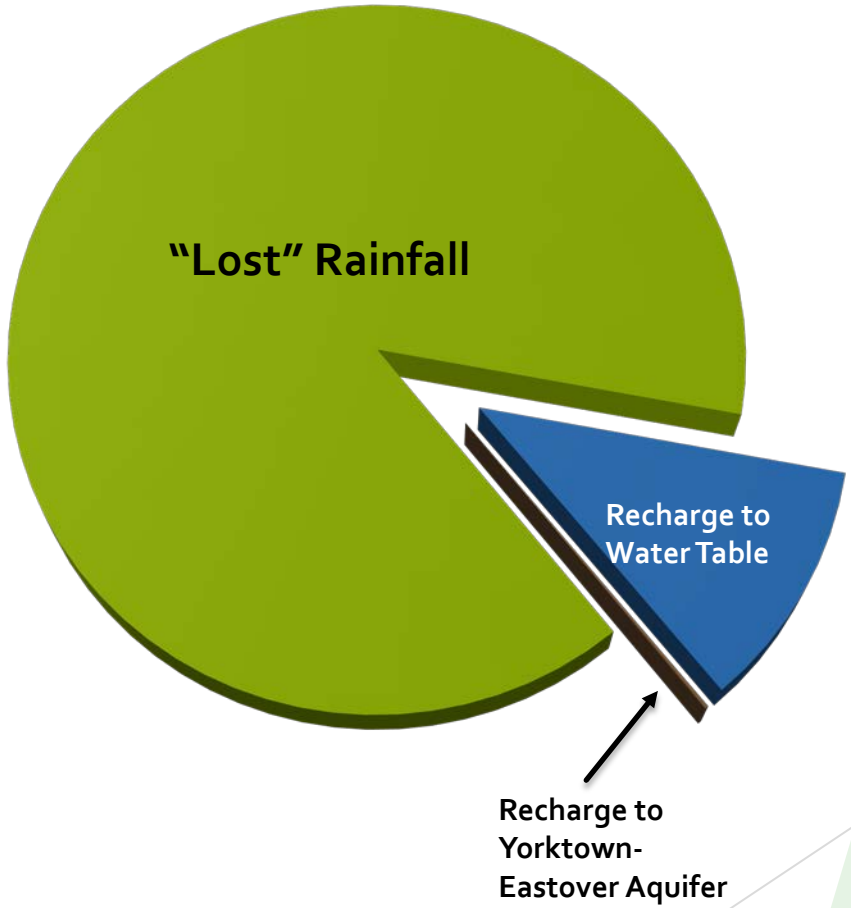




How Much Water Recharges the Aquifers?

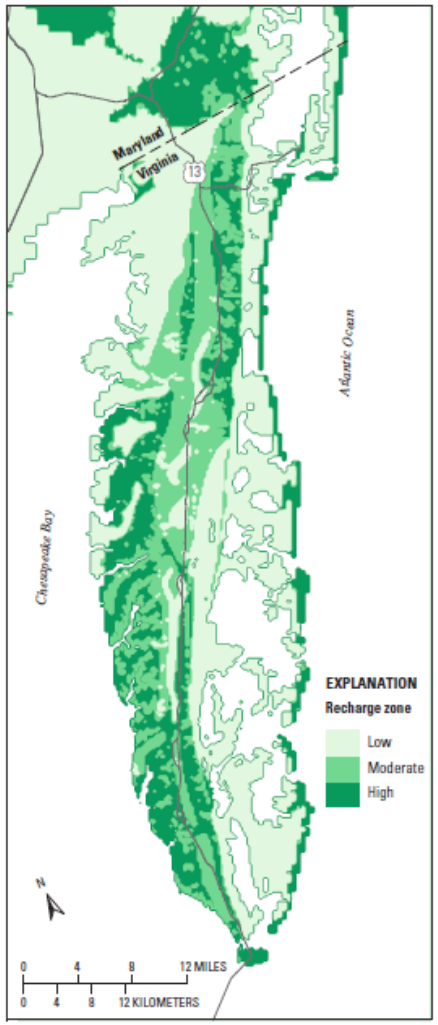
- All fresh water comes from precipitation falling directly on the Shore
- About 84% of the precipitation never infiltrates to the groundwater

- Limited Recharge:
  - Of the 44-inches of annual precipitation only 12% infiltrates to the water table (~200 B gal/yr avg)
  - Of the water that makes it to the water table, only about 1% regarges the confined aquifer (~3 B gal/yr)



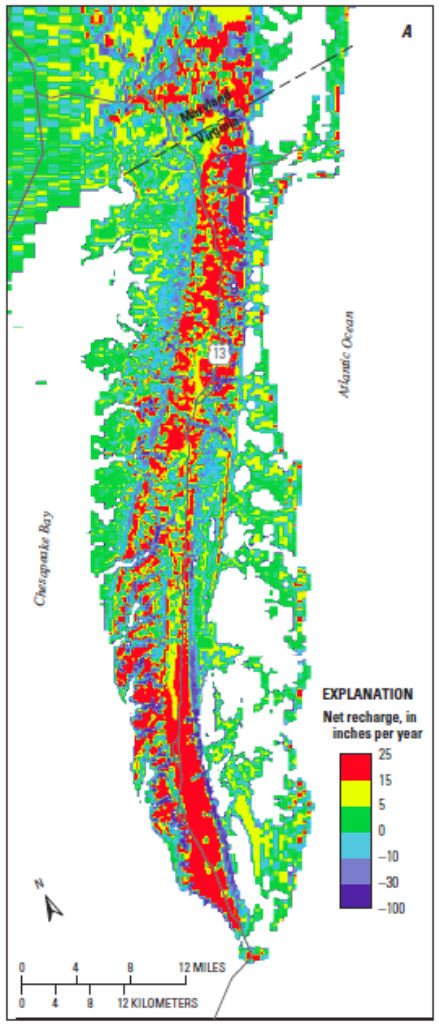
Recharge to the water table is a function of soil type, slope, and location

Potential Recharge areas (based on soil type and slope)



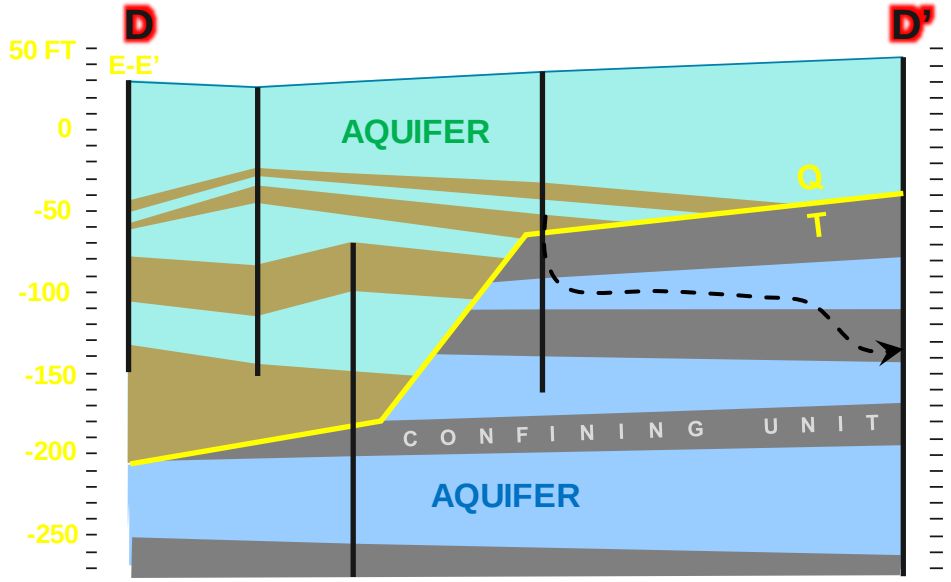
Source: USGS

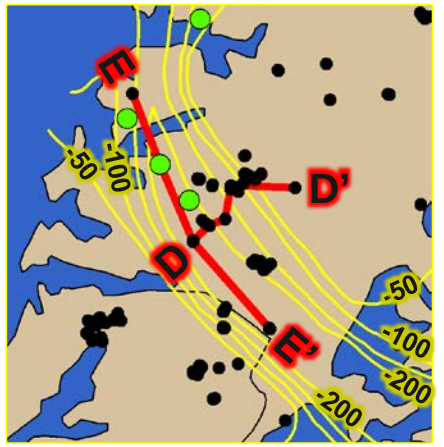
Estimated Recharge Rates



Source: USGS

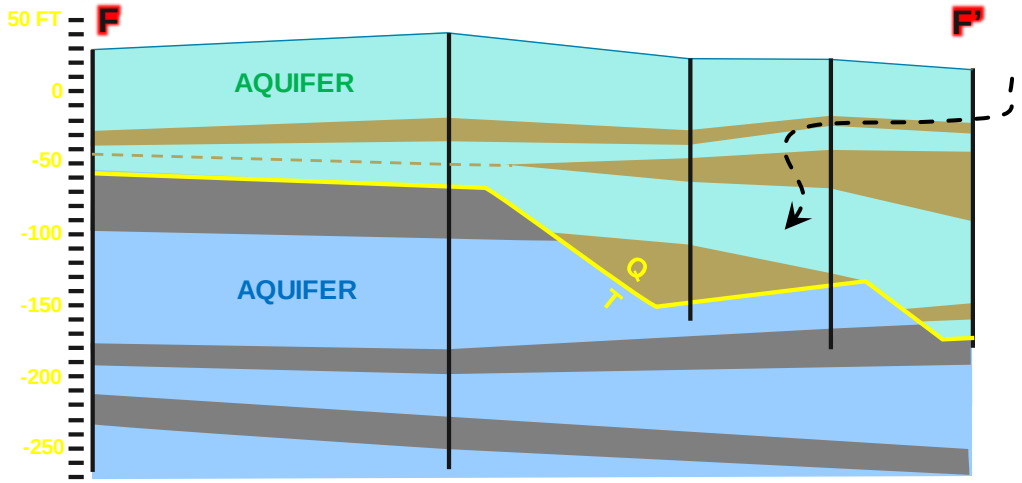
Influence on recharge is not yet well understood, but the paleochannels appear to increase recharge where present

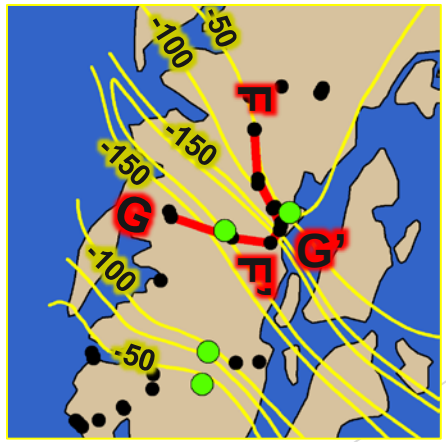




1 MILE

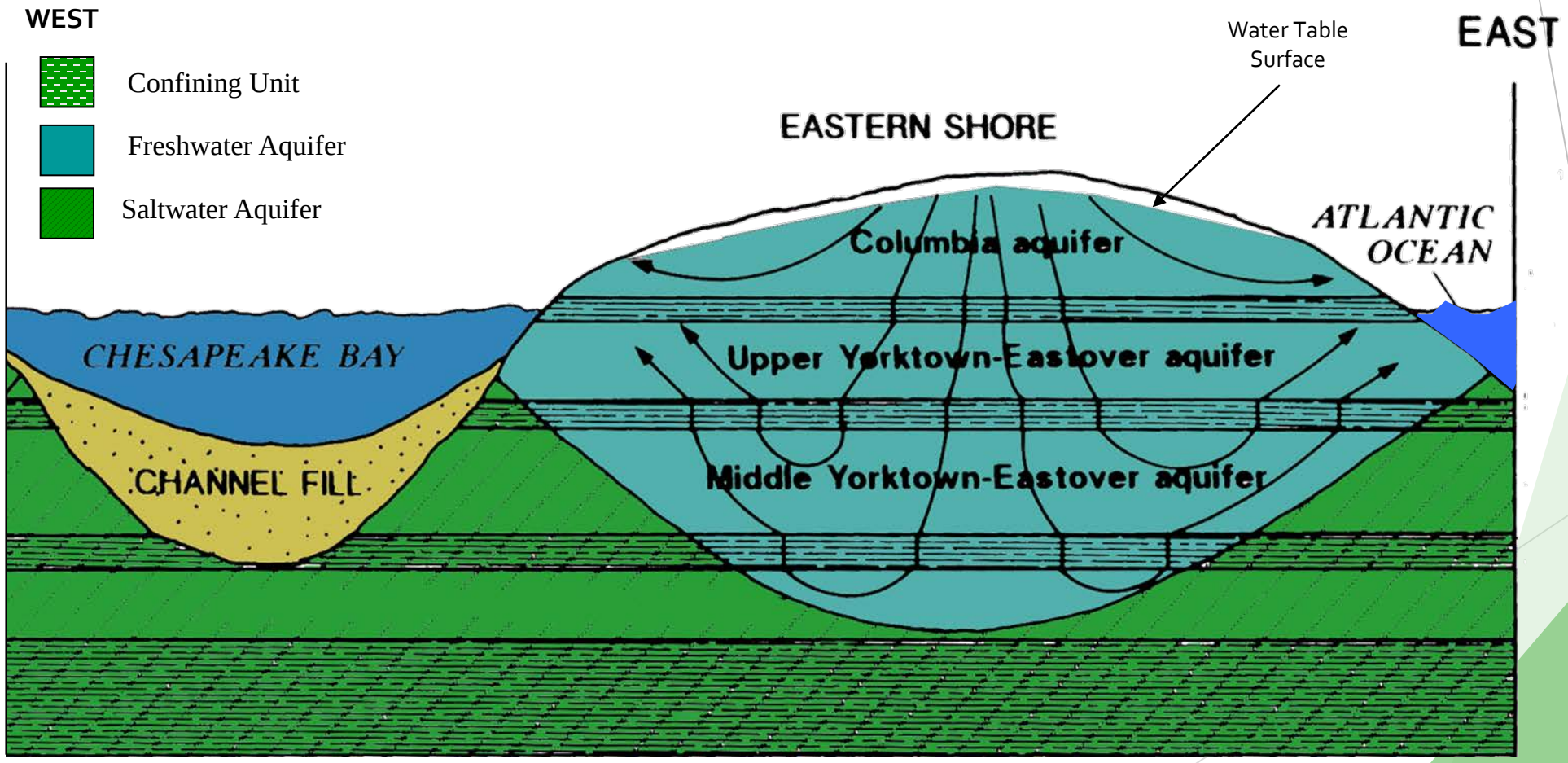
VERTICAL





Water Table and Fresh Water Confined Aquifers on the Eastern Shore - Sole Source Aquifer

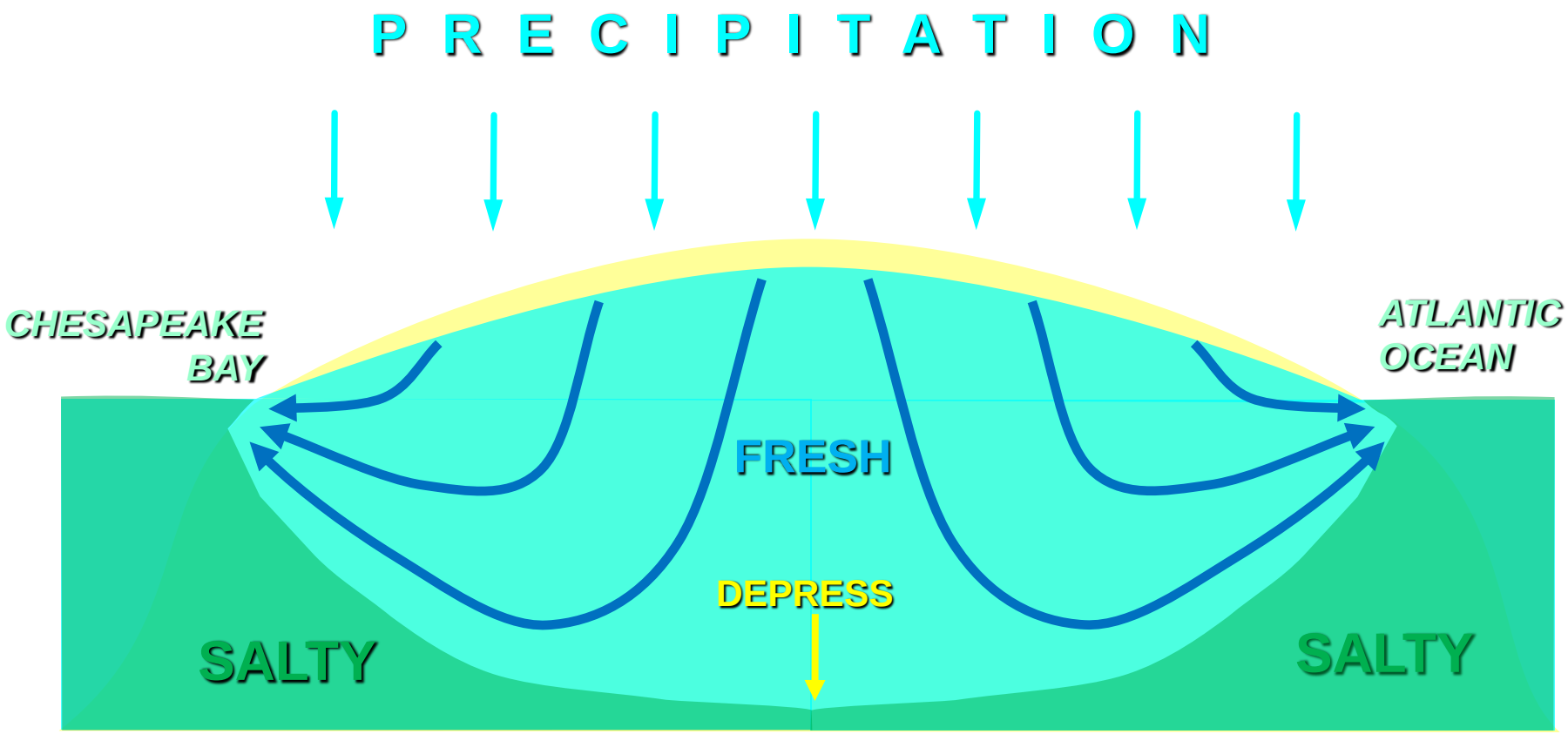
Fresh ground water is restricted to depths less than 350 feet



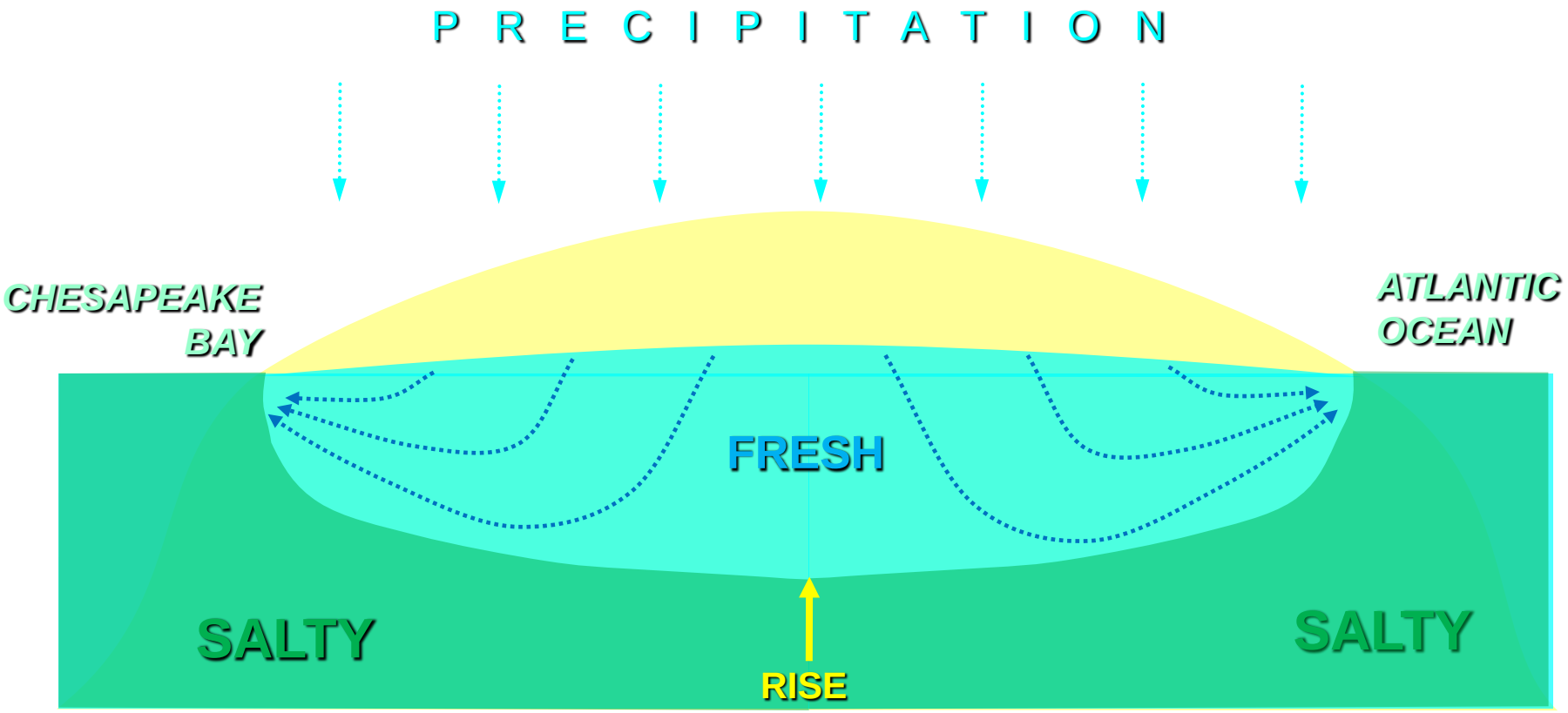
Why Measure Groundwater Levels?

- Groundwater use:
  - Lowers ground water levels, reducing available water to other ground water users
  - Reduces the size of the freshwater lens (less fresh water, more salt water)
- Impact of groundwater use can be evaluated:
  - Indirectly using models
  - Measured directly from pumping wells and observation wells

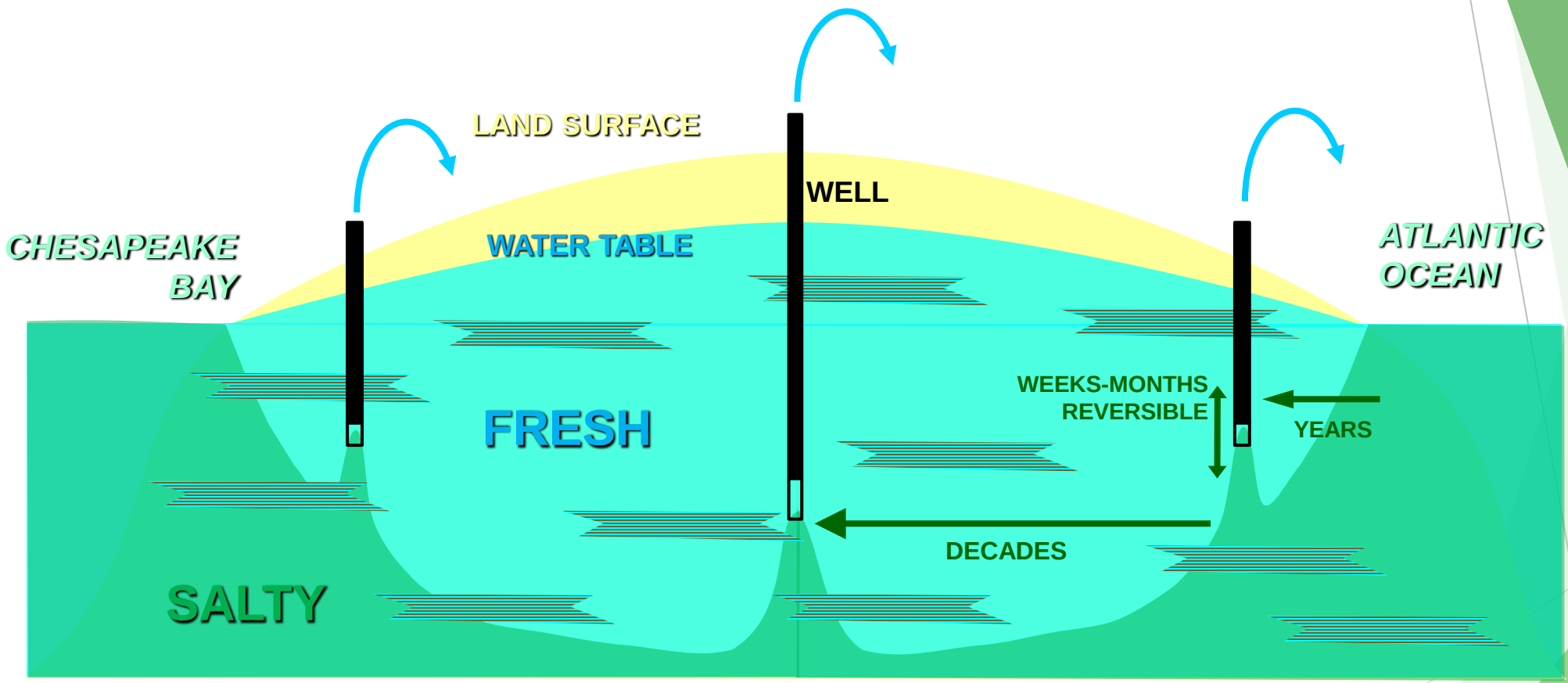
High Recharge or Low Withdrawal



Low Recharge or High Withdrawal



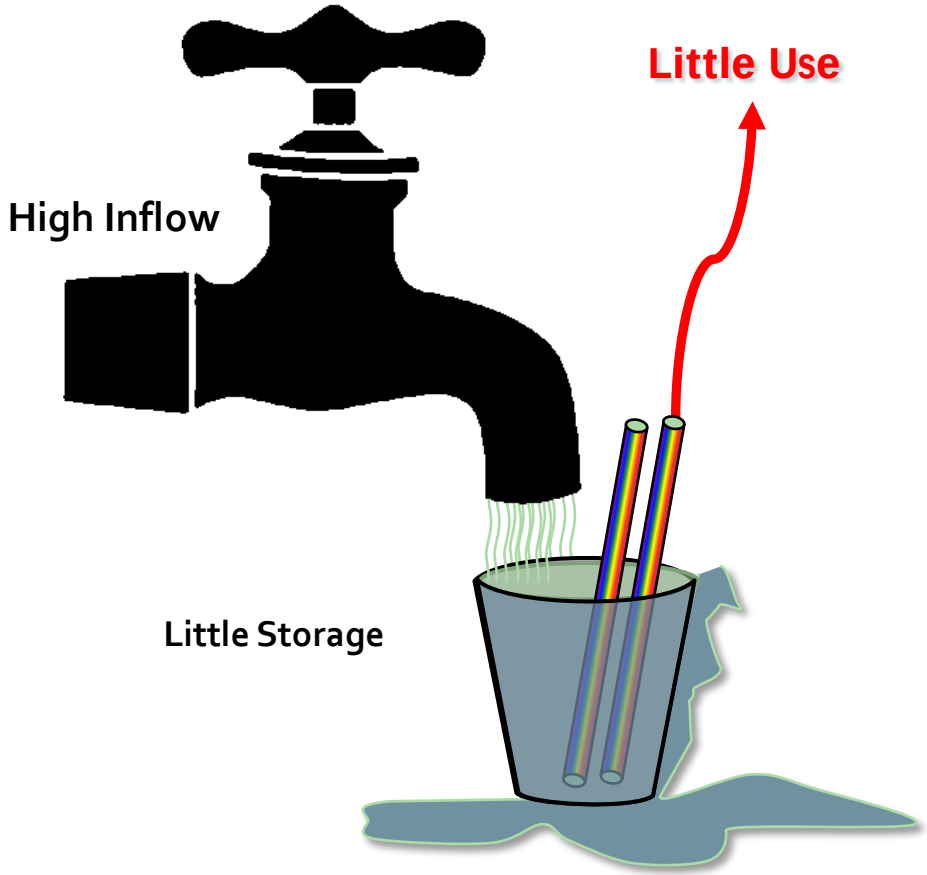
Pumping-Induced Saltwater Movement



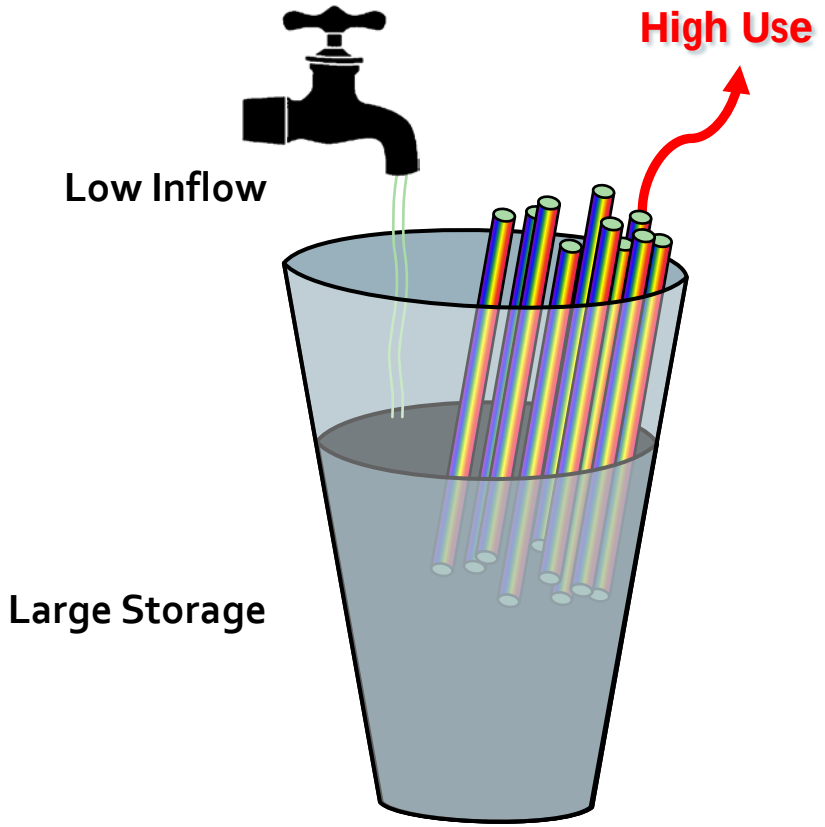
Presentation Overview

1. Eastern Shore Formation and Geology
2. What is Groundwater?
3. Local Groundwater Conditions
4. **Trends in Groundwater Use**
5. Threats to Our Groundwater Quality
6. Groundwater Management and Planning

Columbia Aquifer / Yorktown-Eastover Dilemma

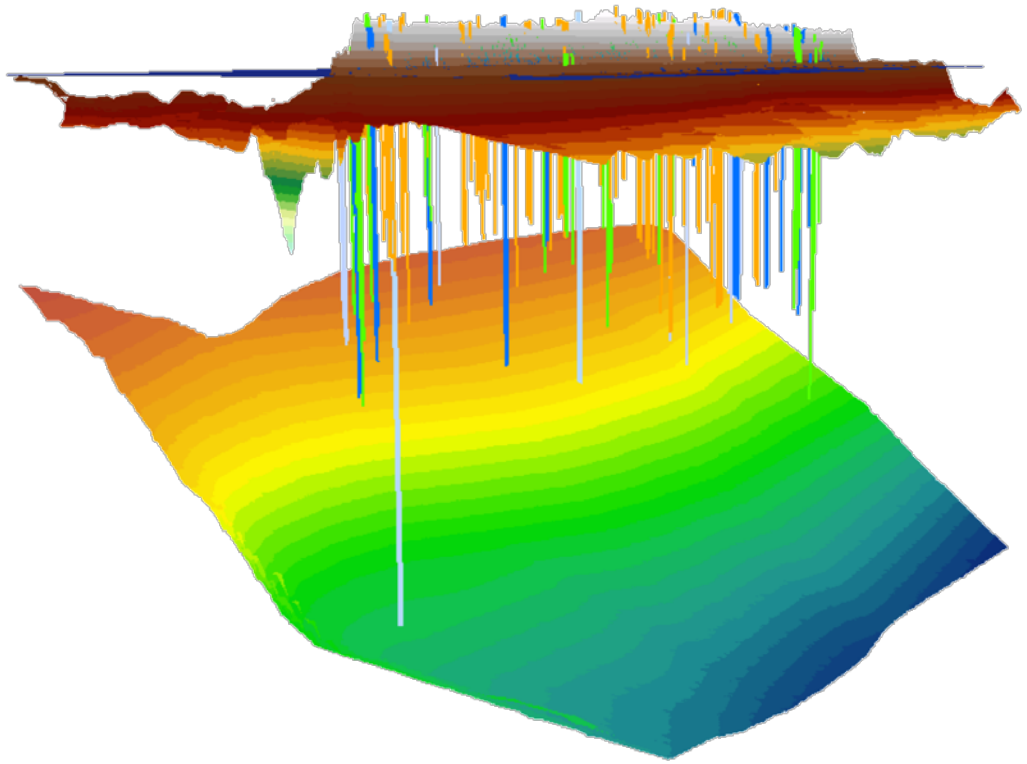


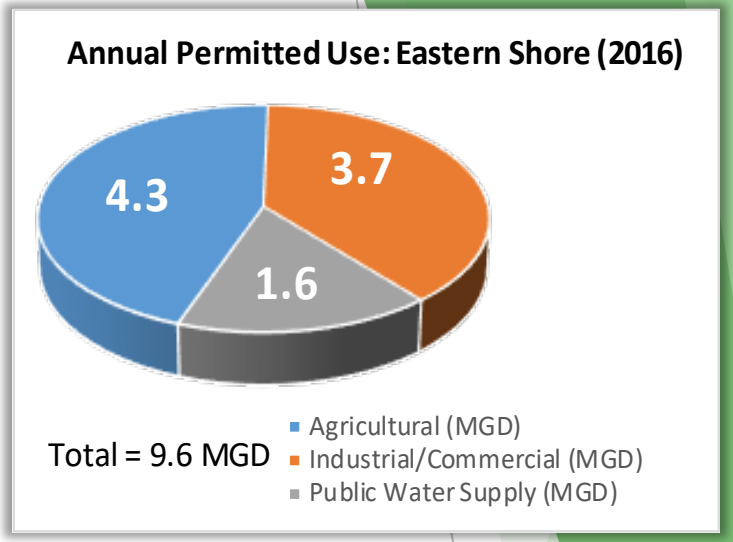
COLUMBIA AQUIFER (WATER TABLE)

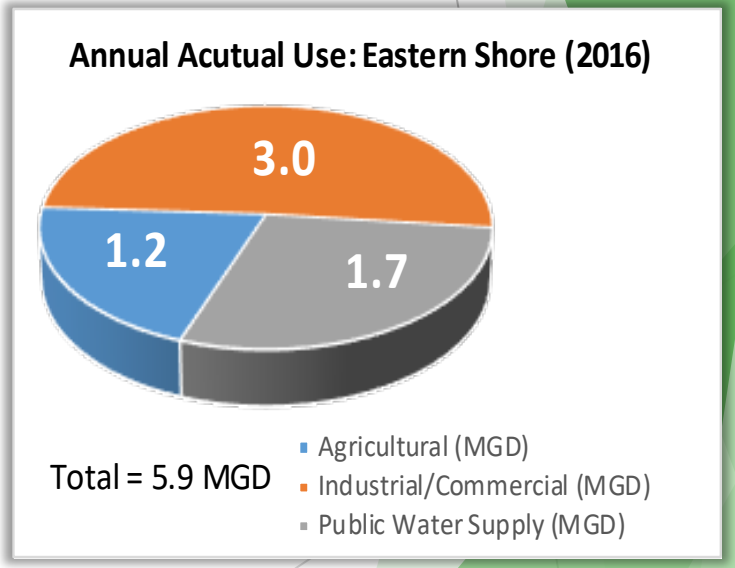


YORKTOWN-EASTOVER AQUIFER (DEEP)

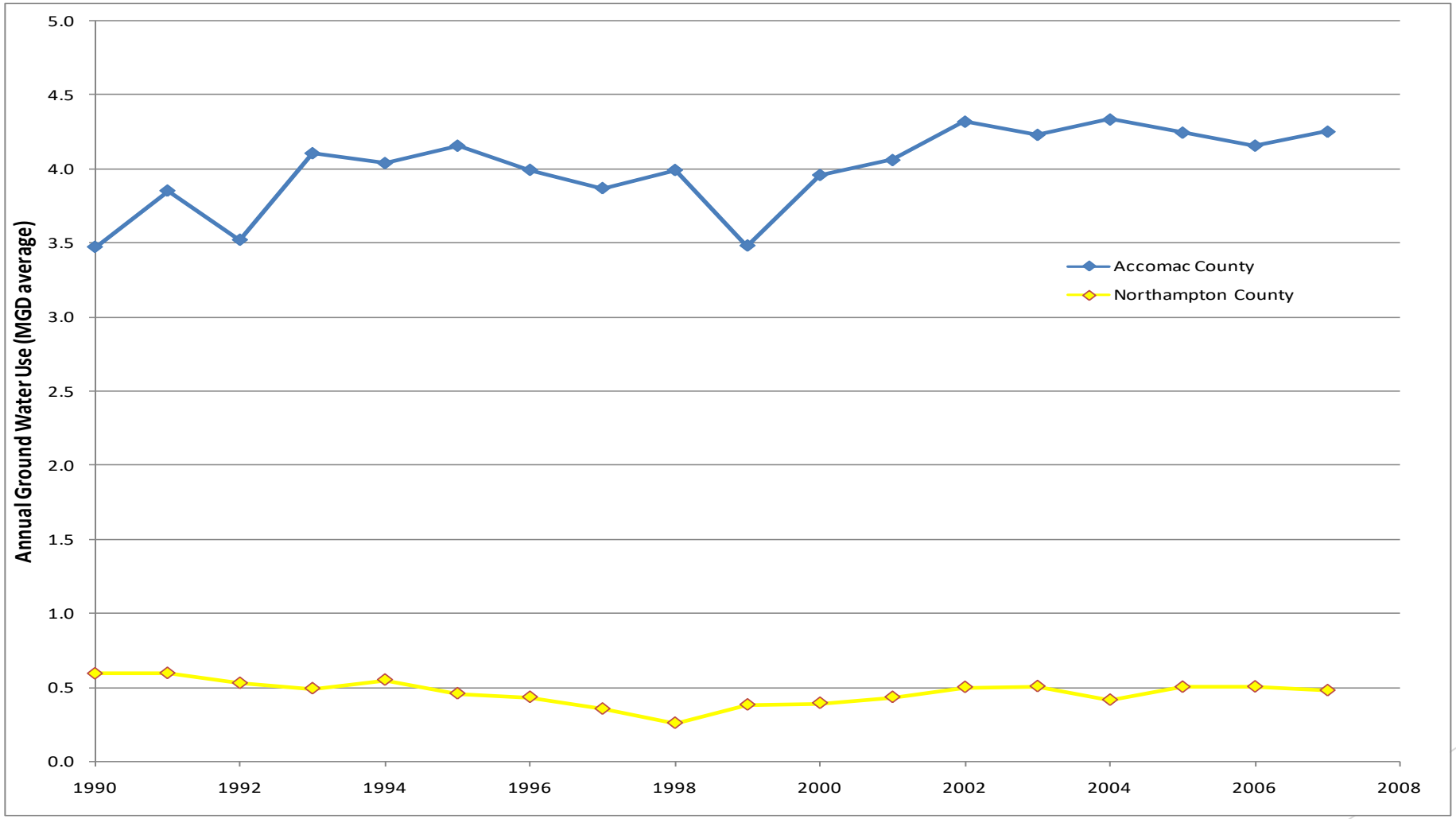
Groundwater Use on the Eastern Shore



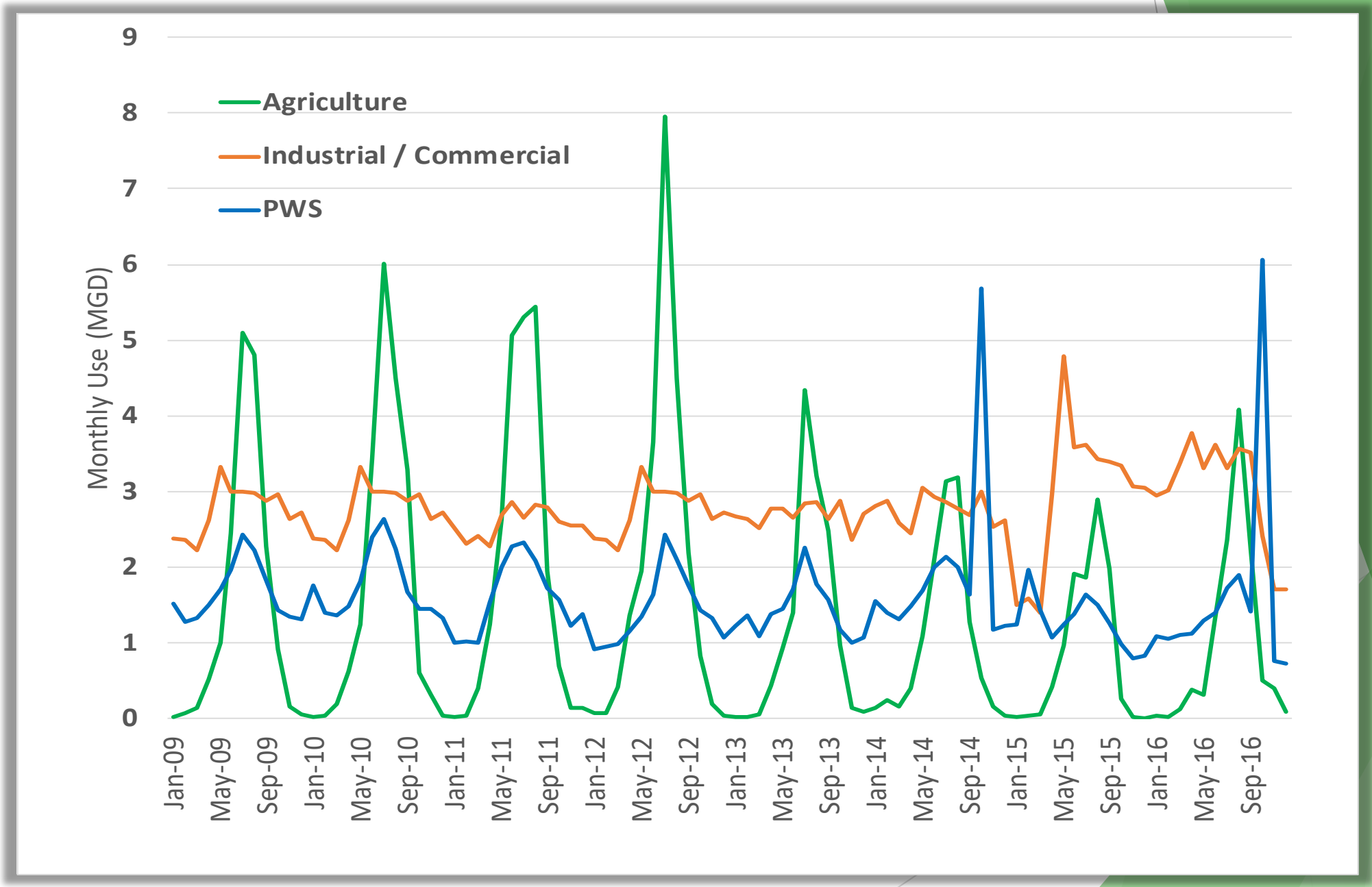




Non-Agricultural Groundwater Use Trends

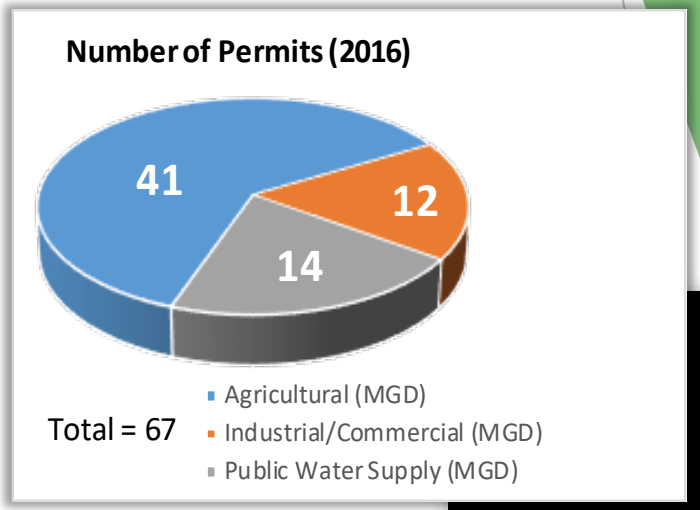


Seasonal Water Use



Ground Water Use and Groundwater Level Measurements

- Ground Water Use for permitted wells (wells pumping greater than 300,000 gallons-per-month) are submitted to Virginia Department of Environmental Quality (VDEQ)
- Ground Water Levels are routinely measured in Observation Wells by the United States Geological Survey (USGS)



Presentation Overview

1. Eastern Shore Formation and Geology
2. What is Groundwater?
3. Local Groundwater Conditions
4. Trends in Groundwater Use
5. **Threats to Our Groundwater Quality**
6. Groundwater Management and Planning

Threats to Ground Water Quality & Quantity on the Eastern Shore

- Water Table Aquifer
  - Quality → Surface Activities
  - Quantity → Drought
- Confined Aquifers
  - Quality → Over-pumping
  - Quantity → Over-pumping

Potential Threats to Water Table Water Quality

Sources:

Agriculture / Livestock

- **Nutrients (Fertilizers)**
- **Pesticides / Herbicides**
- **On-site waste disposal**

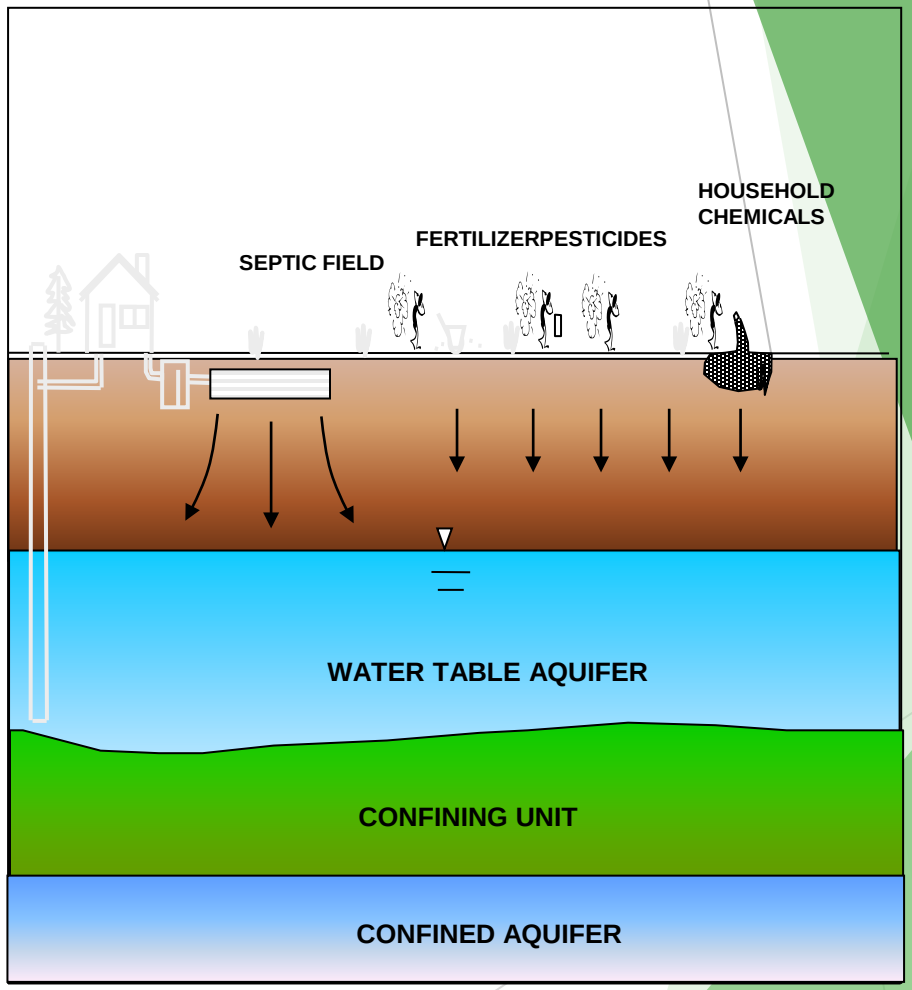
Waste Units

- ***Septic Systems / Drain Fields***
- Public Sewers
- Underground Storage Tanks (USTs)

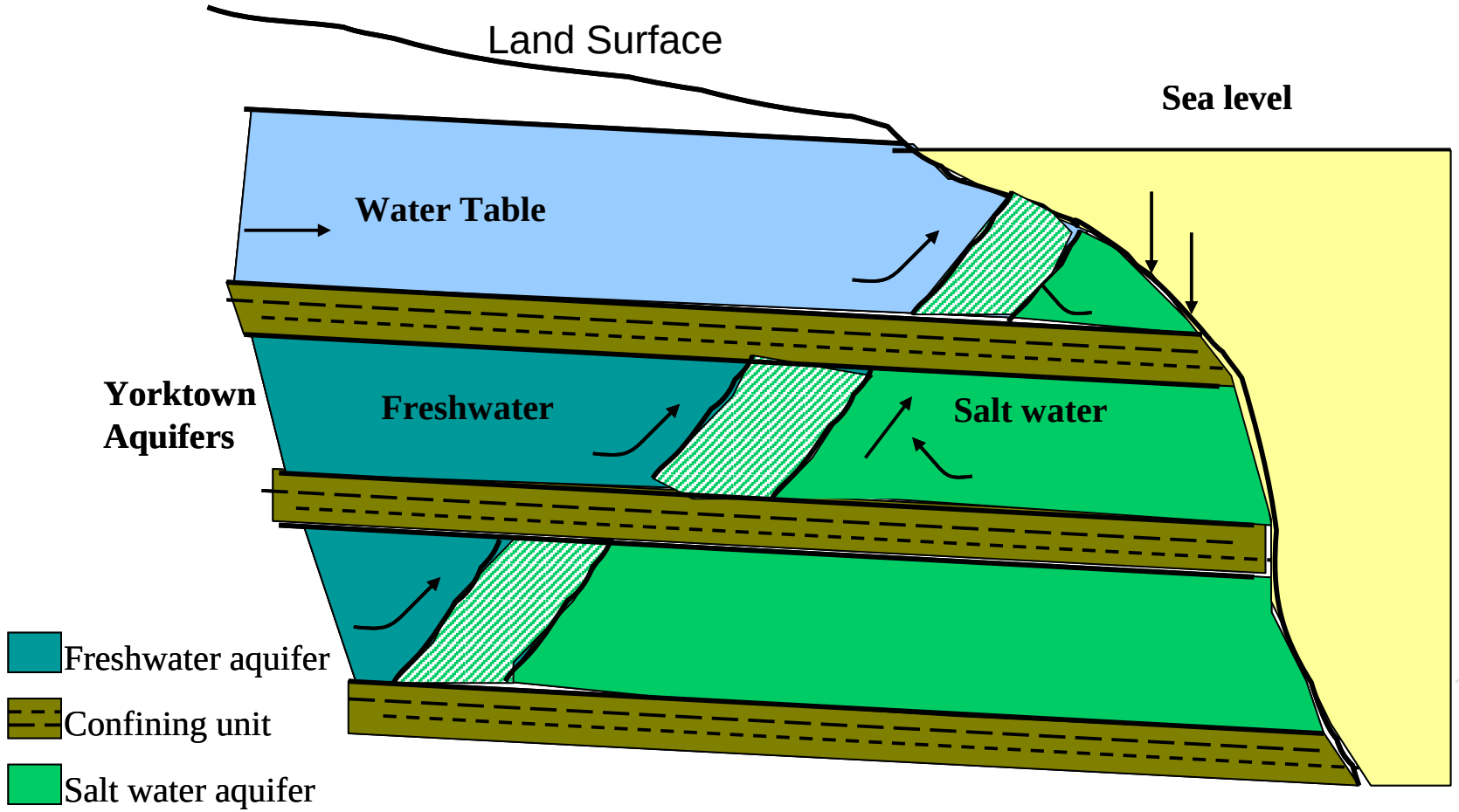
Residential

- ***Nutrients / Pesticides - Herbicides***
- ***Petroleum and solvents***

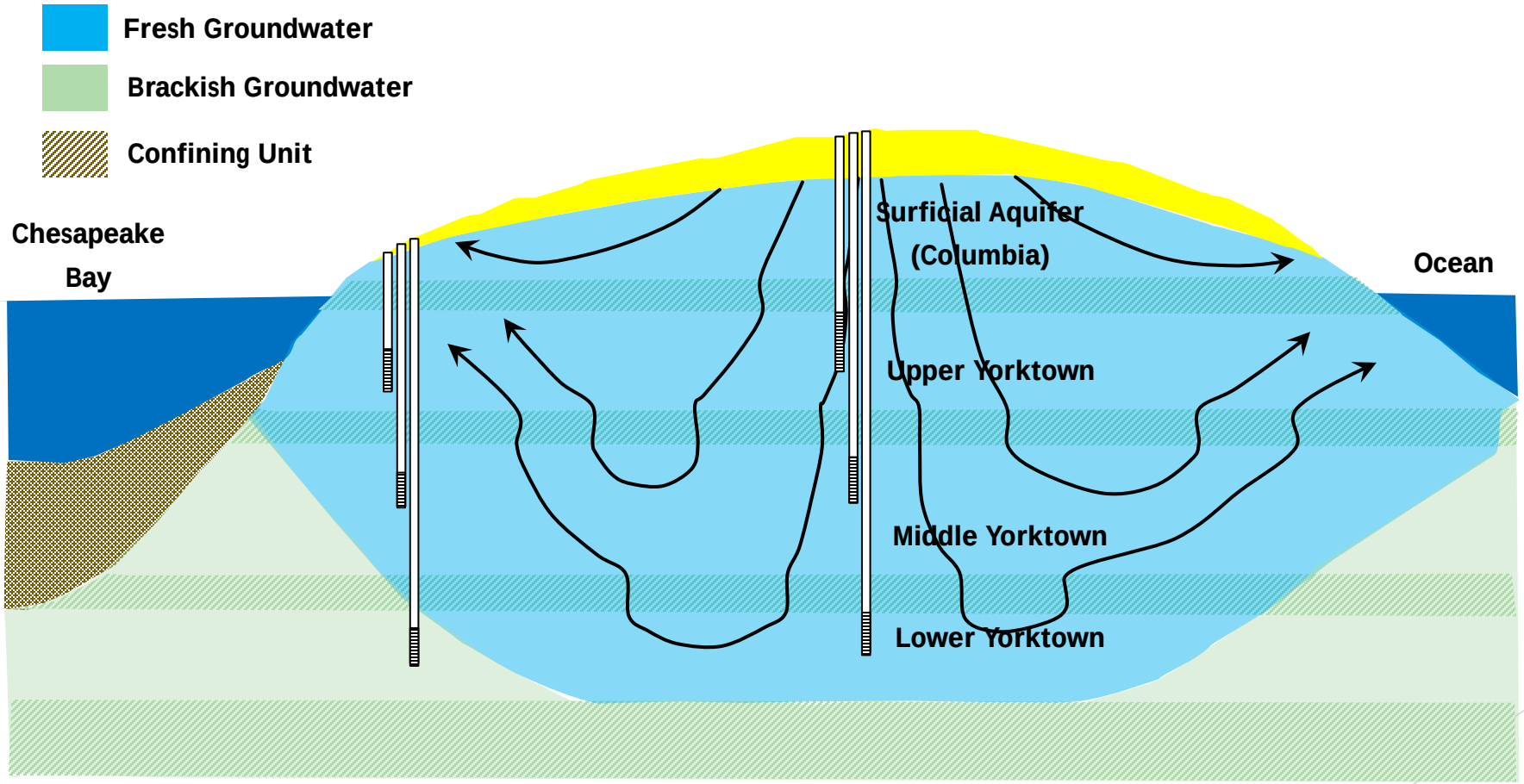
Function of amount (loading) and area of application



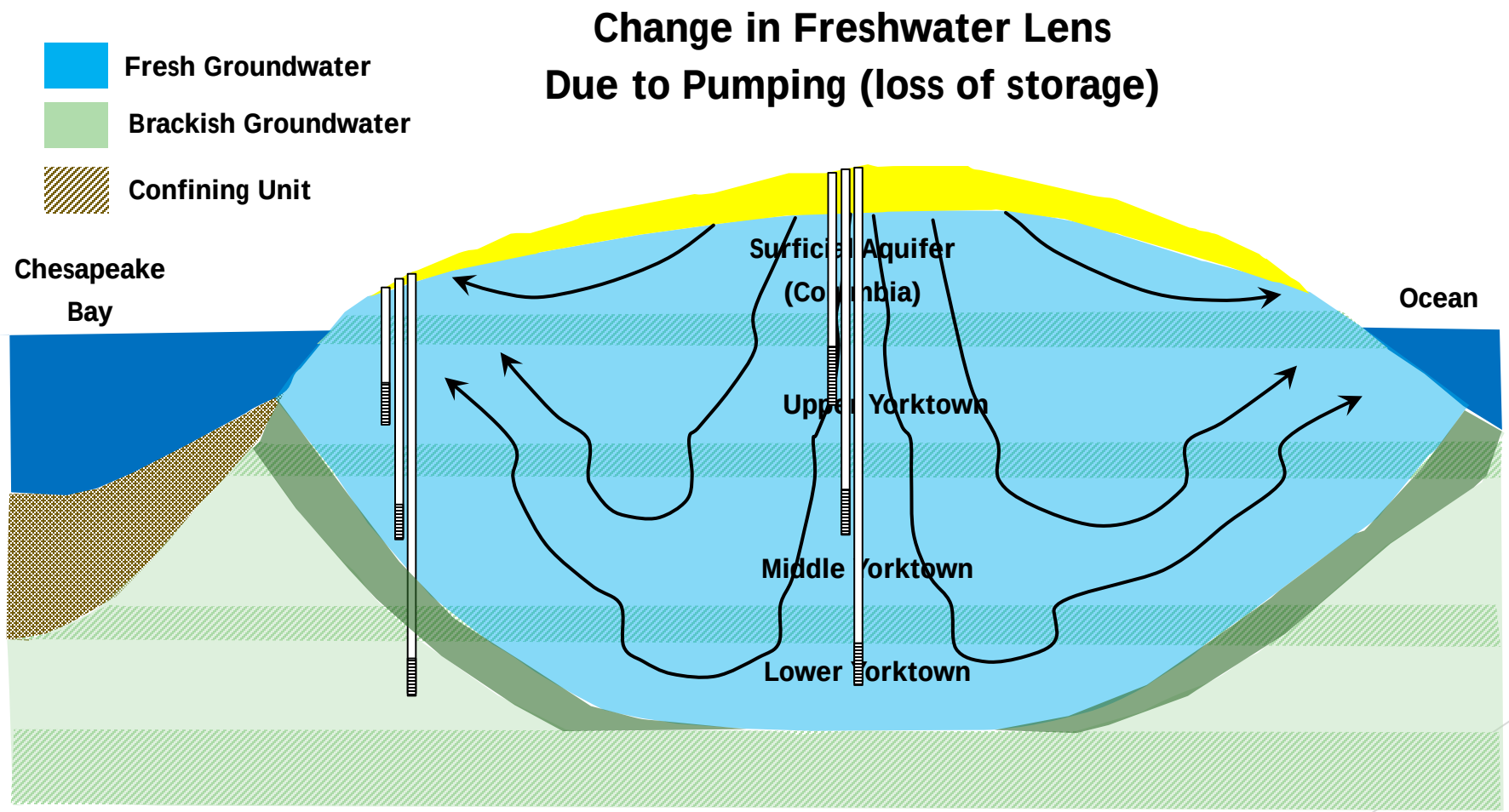
Potential Threats to Yorktown-Eastover Aquifer Water Quality



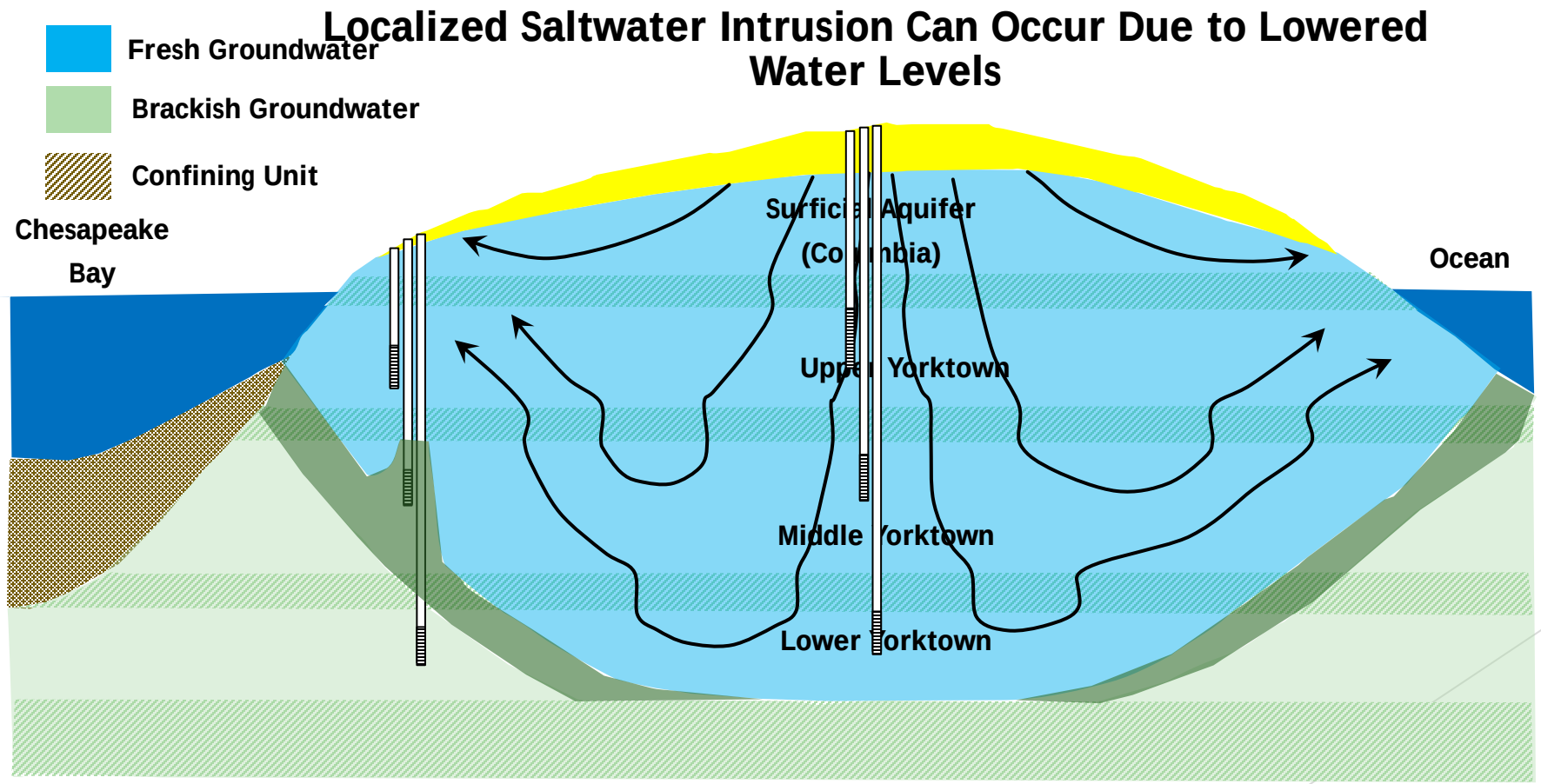
The most significant threat on the Shore due to over pumping is Saltwater Intrusion



Regionally, a smaller freshwater lens is the greatest threat. Currently, a smaller freshwater lens has not adversely affected the groundwater resource

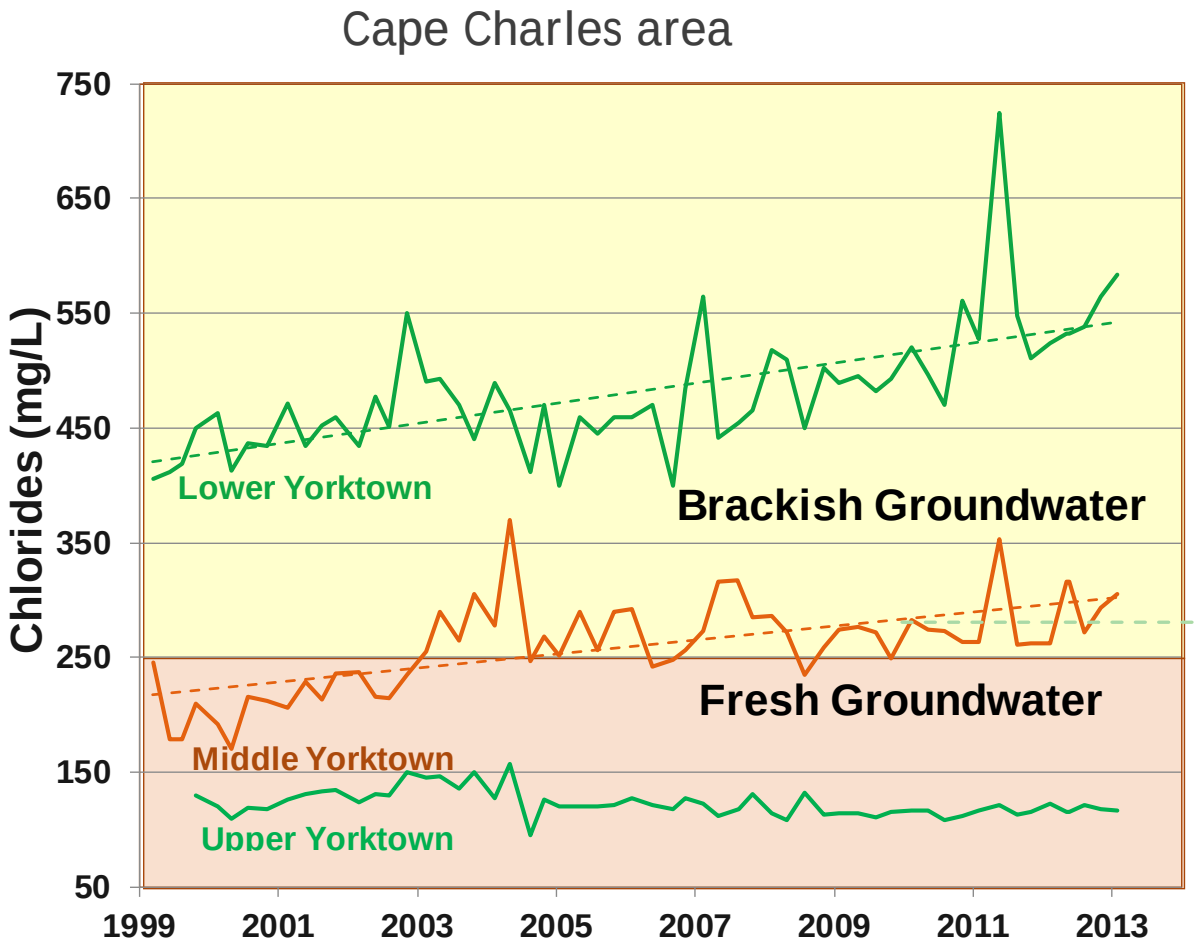


Locally, saltwater intrusion from upconing due to lowered water levels is a greater threat.
Upconing has occurred is some areas of the Shore, along the coast near the bay or ocean.



Salt levels in the deeper parts of the Yorktown-Eastover have increased near Cape Charles due to upconing from increased local groundwater use.

The shallow portions have remained fresh.



Groundwater Management and Water Supply Planning

Definitions of Sustainable Development

- *Our operating definition: "…development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* (United Nation's World Commission on Environment and Development 1987)
- *And older definition for meeting the following conditions:*
  - *1. " Renewable resources such as fish, soil, and groundwater must be used no faster than the rate at which they regenerate."*
  - *2. "Pollution and wastes must be emitted no faster than natural systems can absorb them, recycle them, or render them harmless."* (Herman E. Daly, 1971)
- *For groundwater, "used no faster than the rate at which they regenerate" is not practical unless taken into context with a complex water balance.*

Eastern Shore of Virginia Ground Water Committee

Ground Water Award

- Established the Award Program in 2004 to publicize local projects, individuals, and entities working towards water conservation, recharge area protection/preservation, aquifer preservation, recycling/reuse of water, pollution prevention and public education/community outreach.

- 2018 Recipient: Home and Fitchett Farms. Senator Lewis and Delegate Bloxom
  - Senator Lewis worked with DEQ to draft SB1599, which directing the SWCB to adopt regulations providing incentives to withdrawal water from the surficial (Columbia) aquifer. The incentives include: a. extending permit terms as long as 20 years, b. an accelerated permit process, c. discounted permit fees, d. other subsidies, or e. other incentives.
  - Delegate Bloxom supported the bill through the House

- 2017 Recipient: Mr. John Lauer. Mr. Lauer, the Accomack County Regulatory Compliance Specialist received the award for his efforts at the Northern Landfill
  - All water is treated and sprayed, allowing it to recharge the Columbia aquifer
  - His attention to detail and protocol minimize impacts to our groundwater resources

Water Supply Plans

- A-NPDC prepares for each County
- Previously submitted in 2011, last updates submitted to DEQ in late 2018

Reported Use & Projected Demands

LOCALITY/TYPE	2010 Reported Use (MGD)	2040 Projected Demand (MGD)	Percent Change (2010-2040)
Northampton			
Community Water Systems	0.35	0.69	97%
Large Self-Supplied >300,000	0.04	0.06	50%
Small Self-Supplied <300,000	0.94	0.78	- 17%
Agricultural >300,000	1.65	1.65	0%
Subtotal	**2.98**	**3.18**	**7%**
Accomack (includes Chincoteague)			
Community Water Systems	0.94	1.45	54%
Large Self-Supplied >300,000	2.88	3.14	9%
Small Self-Supplied <300,000	3.09	2.86	- 7%
Agricultural >300,000	3.89	3.89	0%
Subtotal	**10.80**	**11.34**	**5%**
Eastern Shore Total	**13.78**	**14.52**	**5%**

ESVA Ground Water Resource Protection and Preservation Plan

- Originally adopted in 1992 and Updated in 2013
- Purpose:
  - Ensure that adequate and safe drinking water is available to all citizens of the commonwealth
  - Encourage, promote, and protect all other beneficial uses
  - Encourage, promote, and develop incentives for alternative water sources, included but not limited to desalinization
- Components of Plan
  - Water Resources: Current understanding of water resources. Will periodically update as new research is available.
  - Land and Water Resource Use: Water use will be updated annually.
  - Resource Vulnerability:
  - Saltwater Intrusion: Water quality trends updated annually. Modeling and other research updated periodically.
  - Water Level Declines: Updated annually.
  - Land Use Activities: Updated periodically based on research.
  - Sustainability Plan

Recently Completed: Groundwater Hydrology of the Virginia Coastal Plain – USGS & VDEQ 2017-2019

3 Tasks on the Eastern Shore

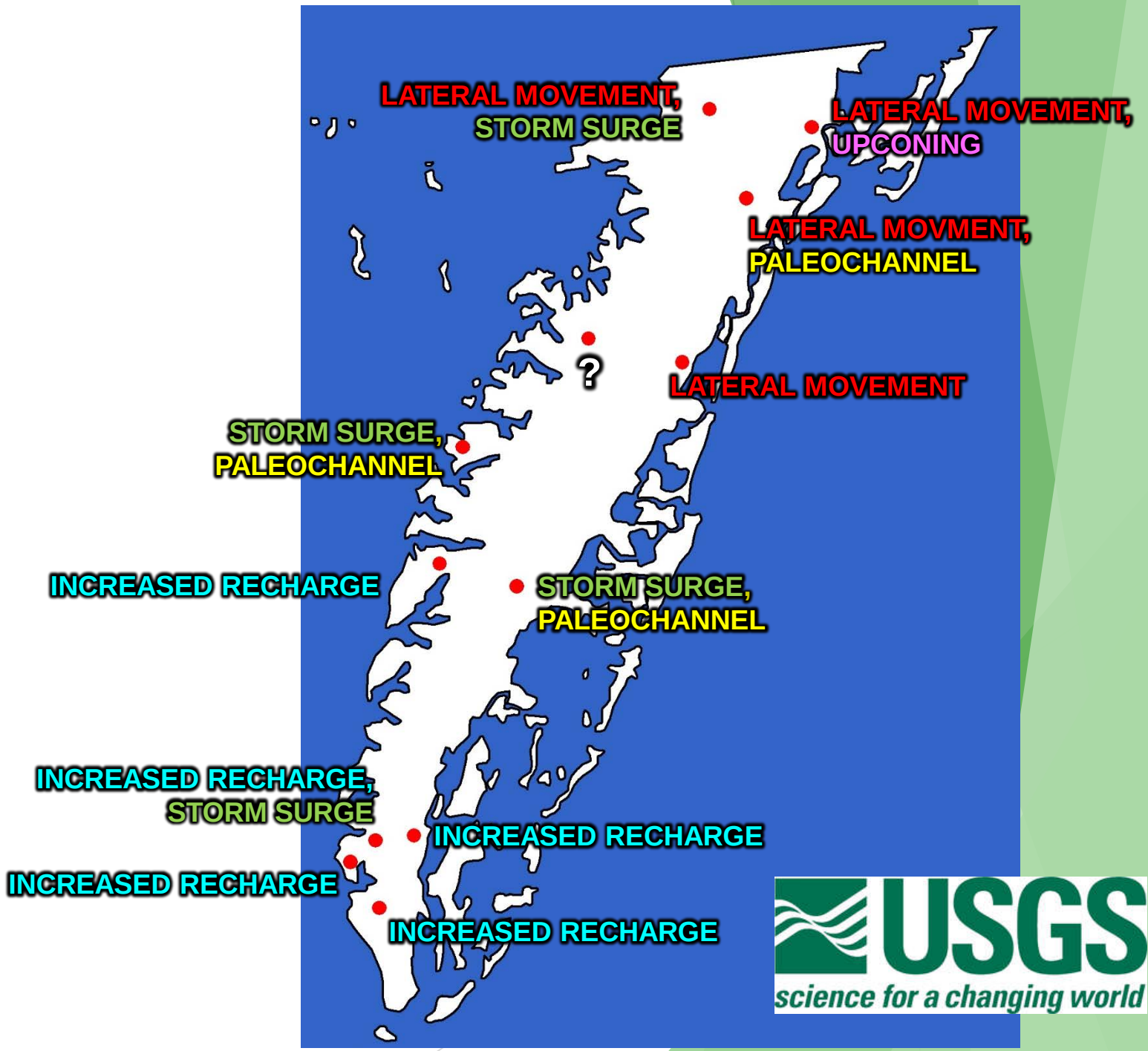
- Evaluation of the hydrogeologic framework
- Characterization of paleochannels
- Delineation of the saltwater-transition zone

Monitoring Saltwater by Conductivity Well Logging – USGS & A-NPDC 2008-ongoing

- Network of 12 wells (6 in each County)
- Logging August 2008, 2016, 2017, 2018, 2019, 2020
- Monitor changes from saltwater movement

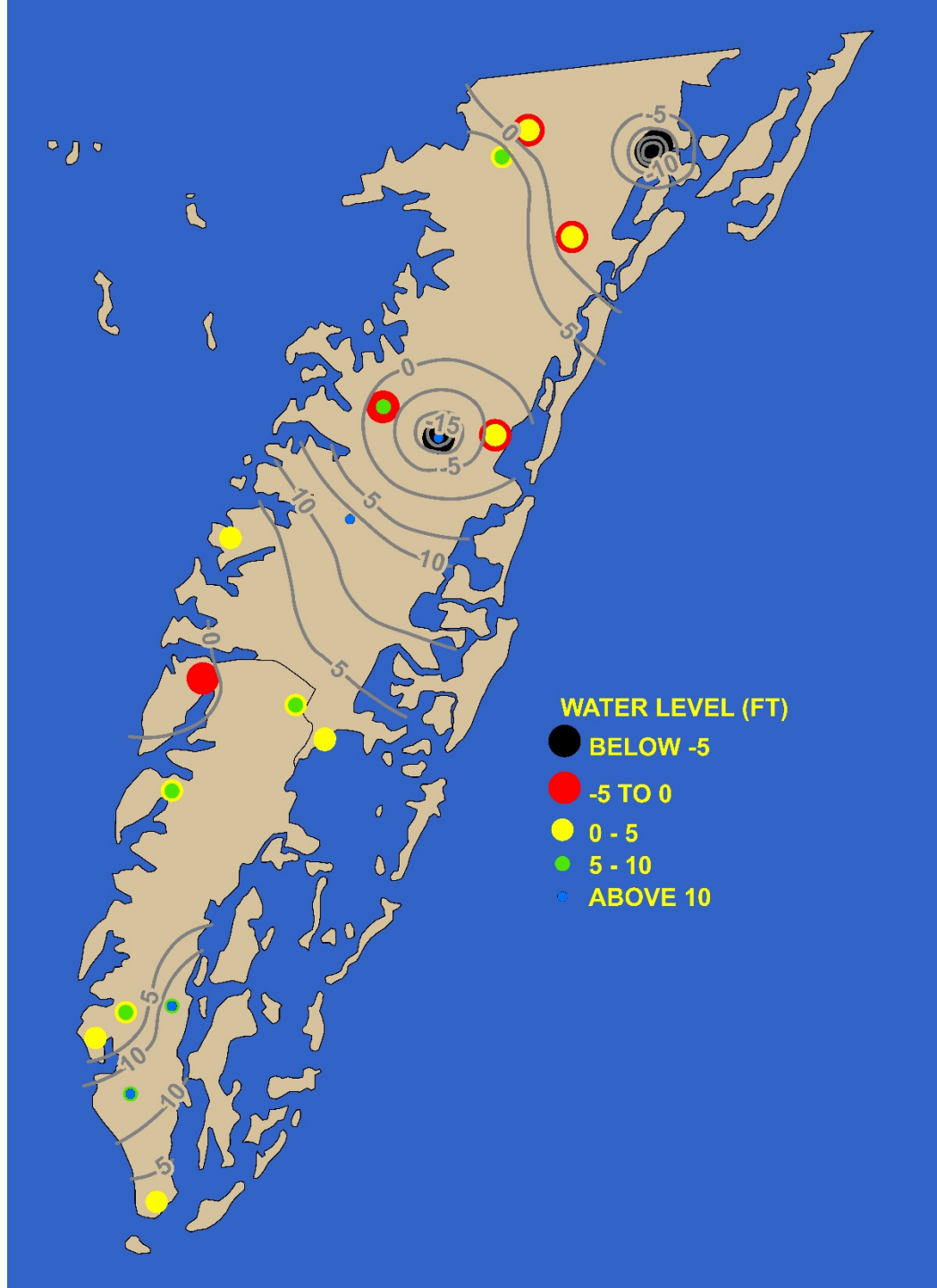
Recent Research

- USGS logged 12 wells with the same method in August of 2008 & 2016
  - Small salinity changes in most wells
- Intend to contract USGS to sample annually for at least the next 5 years to get a better understanding of trends and causes of salinity changes



The State of Confined Groundwater Wells in the Eastern Shore

- Eastern Shore confined water levels are mostly above sea level
- There are three areas (shown in red) where confined water levels are at, or below sea level



General Permit for Use of the Surficial Aquifer on the Eastern Shore Regulatory Advisory Panel

- Purpose:
  - "The purpose of the proposed action is to authorize the development of a general permit and create a new general permit regulation to promote use of the surficial aquifer on the Eastern Shore for nonpotable purposes."
- Regulation Development:
  - Regulatory Advisory Panel (RAP) formed 1Q 2020.
  - Four (public meetings) were held between February and October 2020.
  - The draft regulations will be presented to the SWCB for approval, tentatively at their December 2020 meeting.

Summary

- Fresh water is limited: Restricted to a groundwater lens less than 350-feet thick and recharged by direct precipitation on the shore and a sole source aquifer.
  - There is more research needed to accurately predict the effects of groundwater withdrawal
  - Efficient use of water is important for adjacent users and the longevity of our fresh water aquifer
  - Proper maintenance of septic systems is important to ensure safe drinking water and clean surface waters
- Freshwater lens is susceptible to over use:
  - Regionally the smaller lens has not adversely affected the resource.
  - Lowered water levels has resulted in some very localized saltwater intrusion (upconing).
- Use over the past 10-years has been fairly steady:
  - Water levels and size of freshwater lens appears to have stabilized.
  - Based on our current understanding of the aquifers, overall use appears to meet the United Nations definition of “sustainable use”.
- Effects of additional use on the resource will depend on:
  - Location of the withdrawal and
  - Aquifer used (with the Columbia aquifer being far more sustainable).

Ways to reduce potential for saltwater intrusion

- **Most effective**: maximize use of the water table aquifer and surface water ponds.
- Where possible withdrawal closer to the center spine where the freshwater lens is thickest.
- Reduce water use through:
  - Low flow/Ultra low flow plumbing and high water efficiency systems
  - Xeriscape landscaping
  - Maintaining green space that does not require irrigation (cluster development, etc)
  - LIDD stormwater controls that increase recharge

www.a-npdc.org

Accomack-Northampton
Planning District Commission

www.a-npdc.org

~Thank you!~

Jessica Steelman

Coastal Planner

Accomack-Northampton Planning District Commission

jsteelman@a-npdc.org

757-787-2936 ext.114