ARCADIS Design & Consultancy for natural and built assets

MAINTAINING A SUSTAINABLE GROUNDWATER RESOURCE IN THE MULTI-AQUIFER COLUMBIA AND YORKTOWN-EASTOVER AQUIFER

February 2018

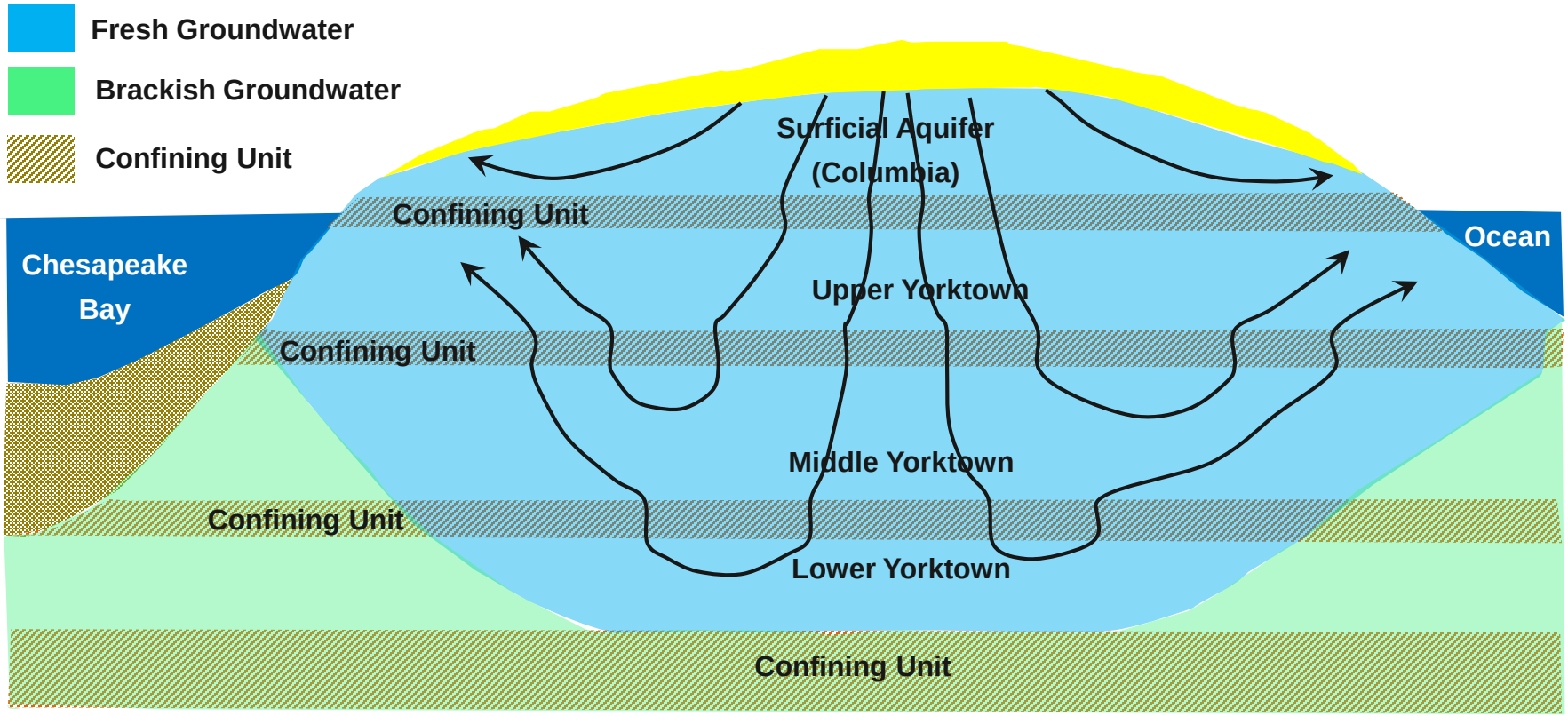
Definitions of Sustainable Development

- *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.*

Why is Sustainable Development Important for Groundwater on the Eastern Shore?

Fresh Water is Limited:

- **Designated by the USEPA as a Sole Source Aquifer: no significant fresh water from streams or rivers.**
- **Fresh groundwater restricted to a "lens" less than 350 feet thick.**

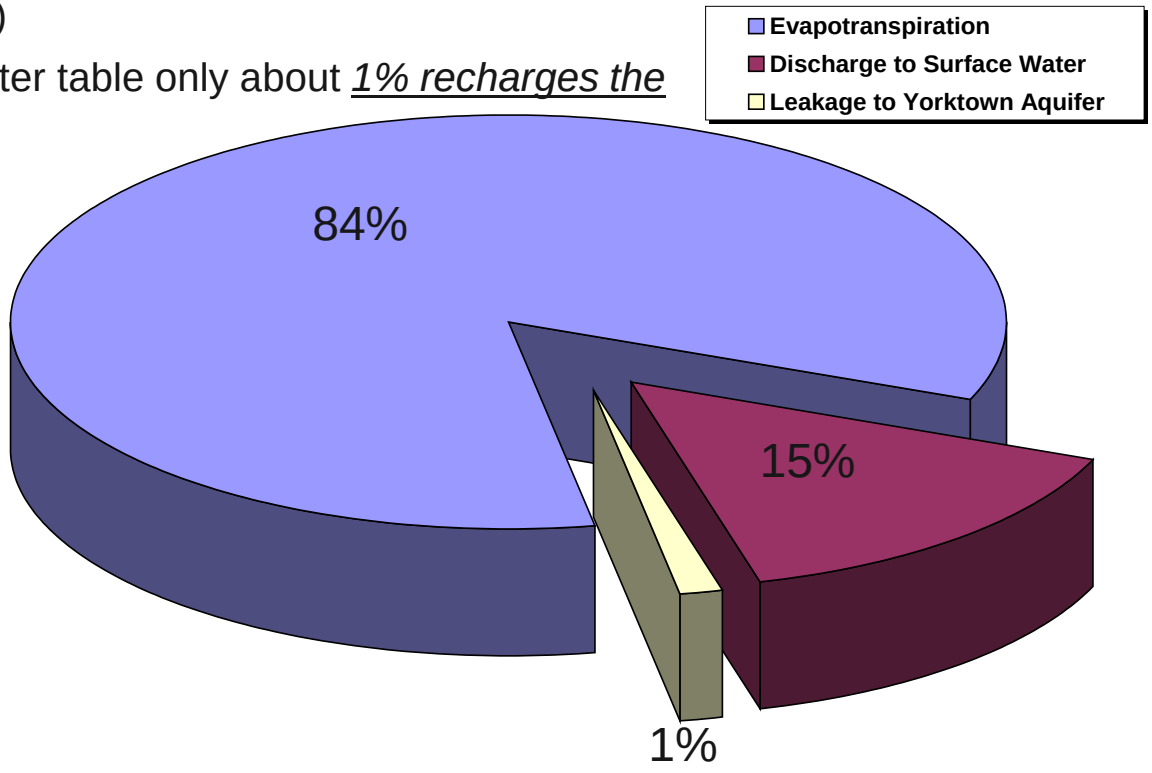


Why is Sustainable Development Important for Groundwater on the Eastern Shore?

Groundwater is replenished at a limited rate:

Groundwater is recharged only by precipitation that falls directly on the Shore and infiltrates into the ground – there is no contribution of water outside the Shore:

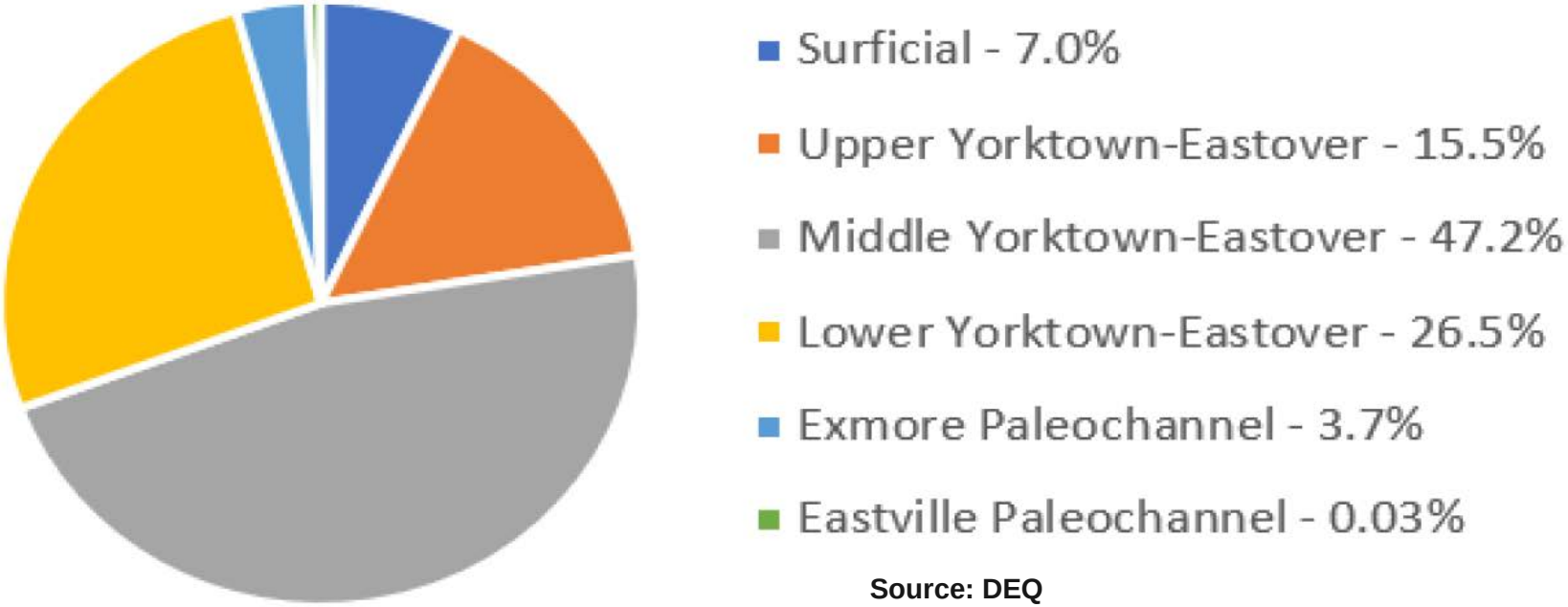
- Of the 44-inches of annual precipitation only about *12% infiltrate to the water table* (≈ 200 B gal/yr average)
- Of the water that makes it to the water table only about *1% recharges the confined aquifer* (≈ 3 B gal/yr)



Most Reported Groundwater Use is from the Deeper Yorktown-Eastover aquifer

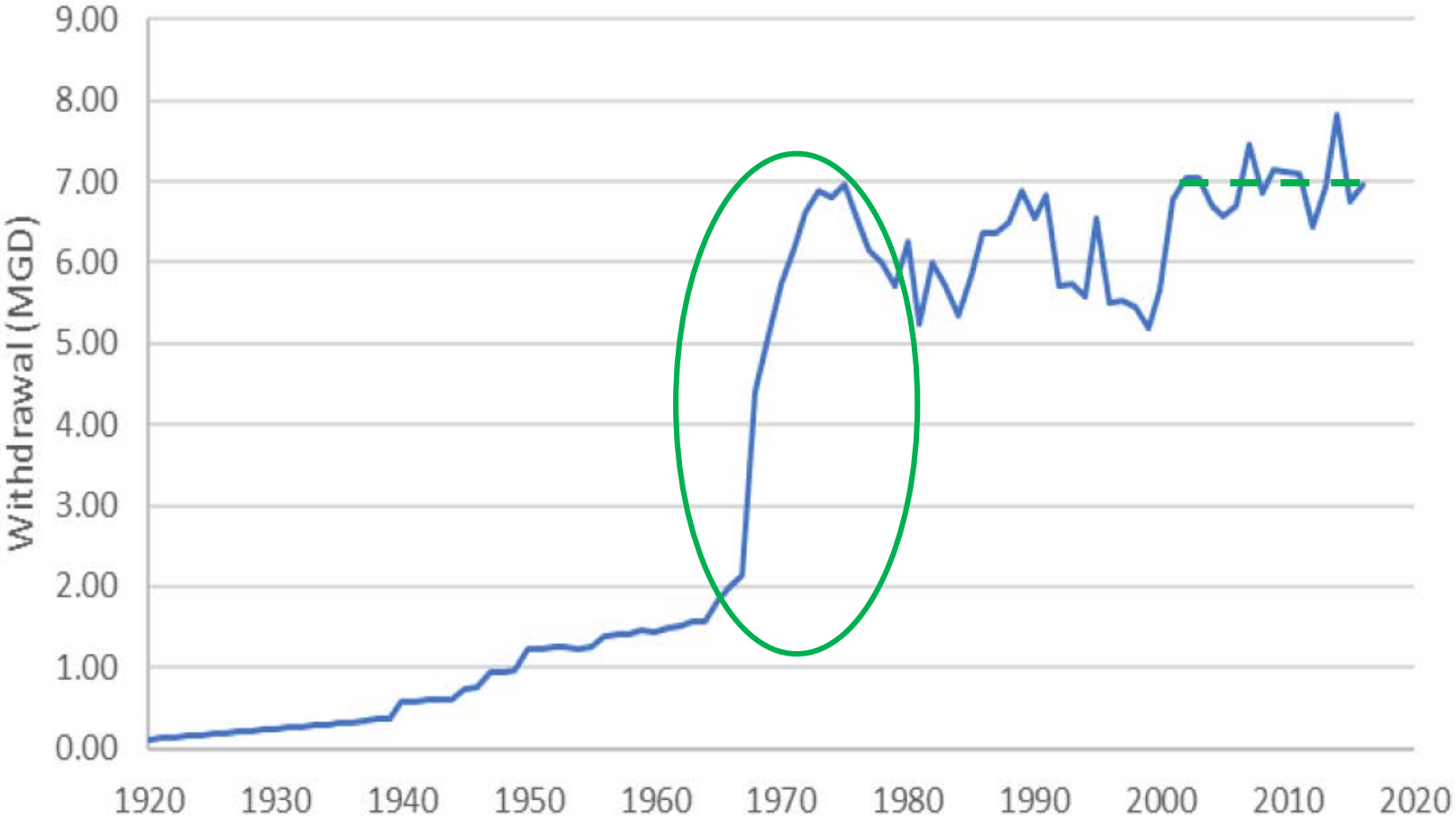
≈90% is from the confined Yorktown-Eastover aquifer

The remainder is from the Surficial aquifer and Paleochannels



Source: DEQ

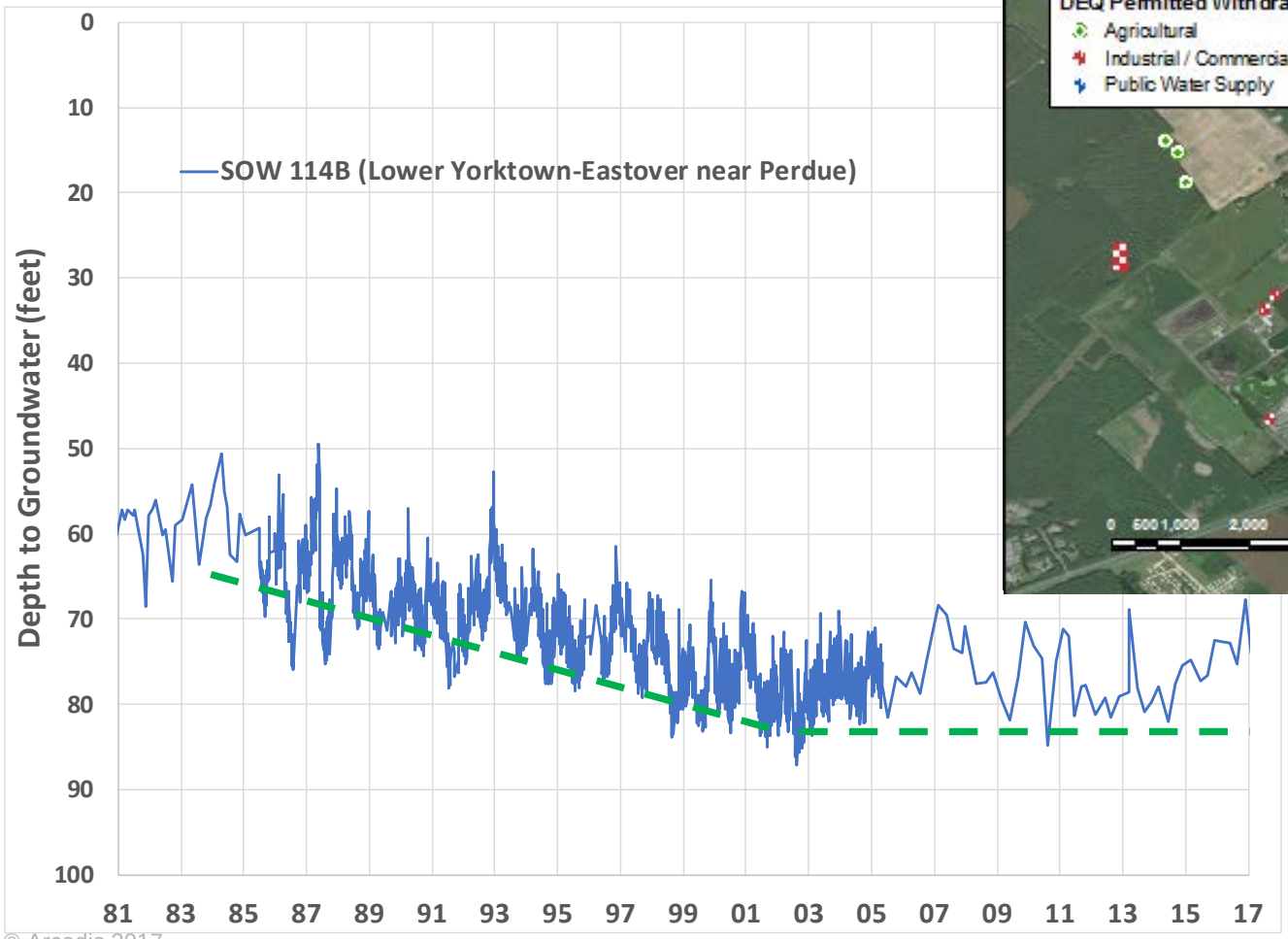
Reported groundwater use more than tripled in the 1970's. Recent reported use has been steady.

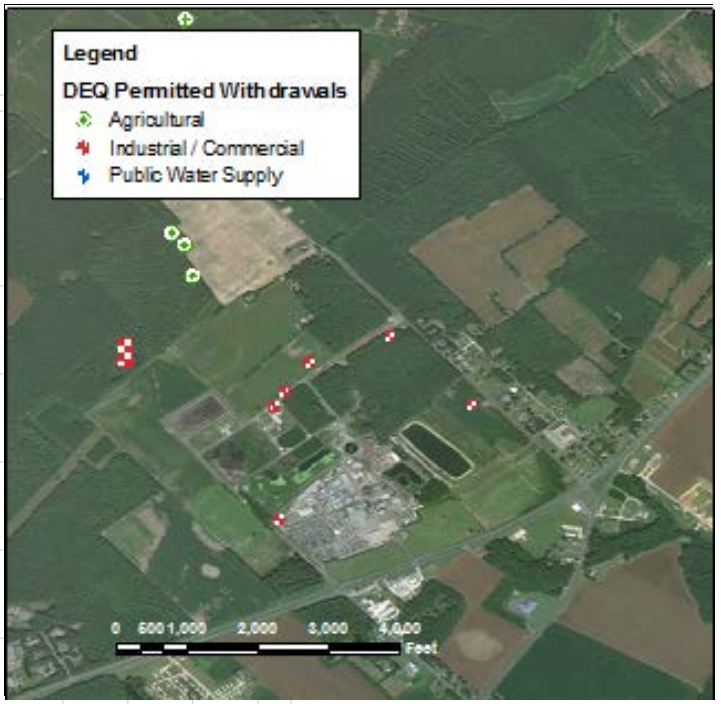


Source: DEQ

Groundwater levels declined as use increased.

With recent steady use, groundwater declines have stabilized.

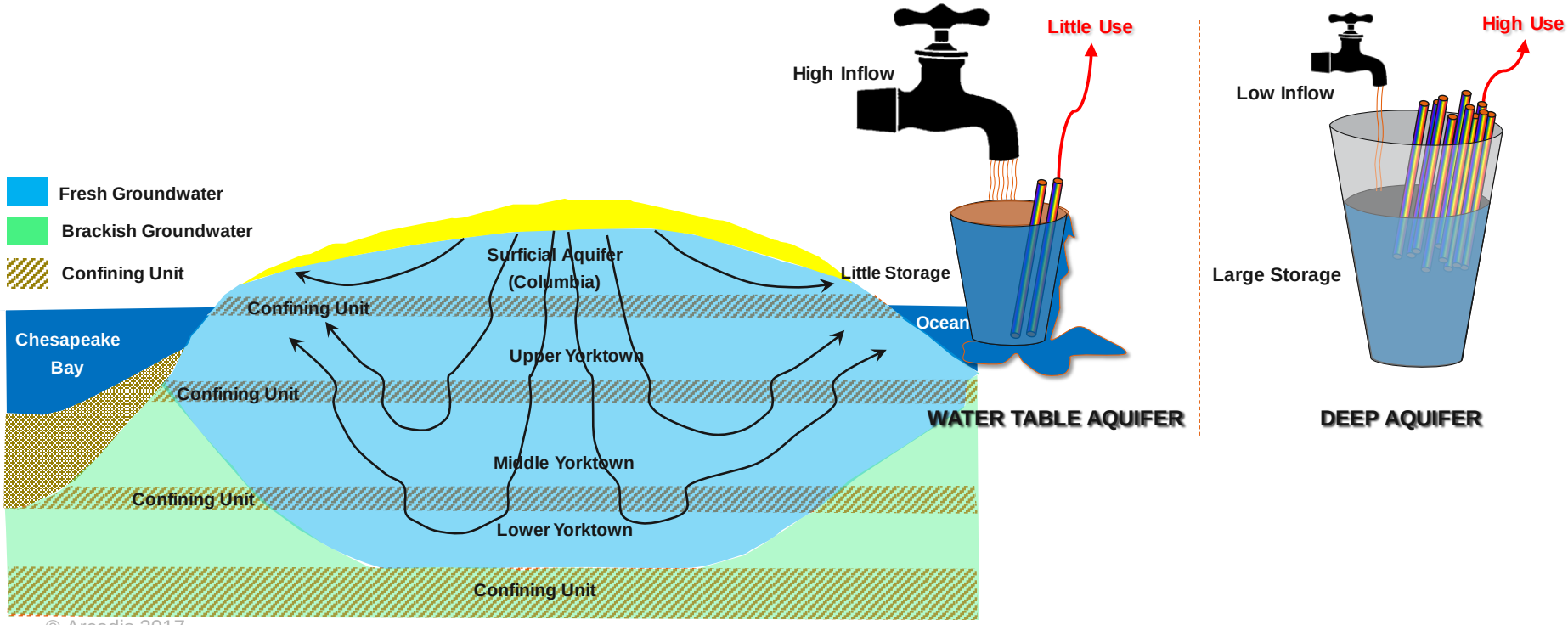




Example: Measured water levels from a VDEQ observation well in the area with the highest water use on the Eastern Shore.

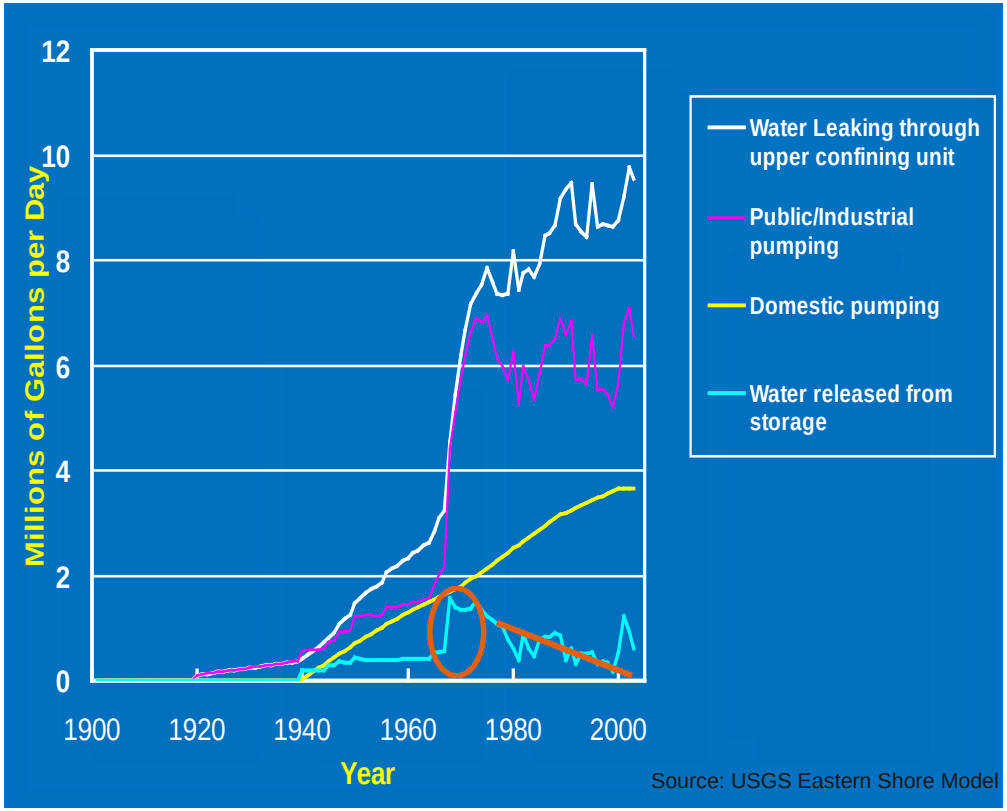
Most groundwater is stored in the Yorktown-Eastover aquifer. But the Yorktown-Eastover aquifer is replenished at a rate 100x less than the Columbia aquifer.

- This makes the Yorktown-Eastover aquifer a valuable source for groundwater, but vulnerable to overuse.
- High recharge protects the Columbia aquifer from overuse.



Increased use from the Yorktown-Eastover is balanced by increased recharge and reduced stored water

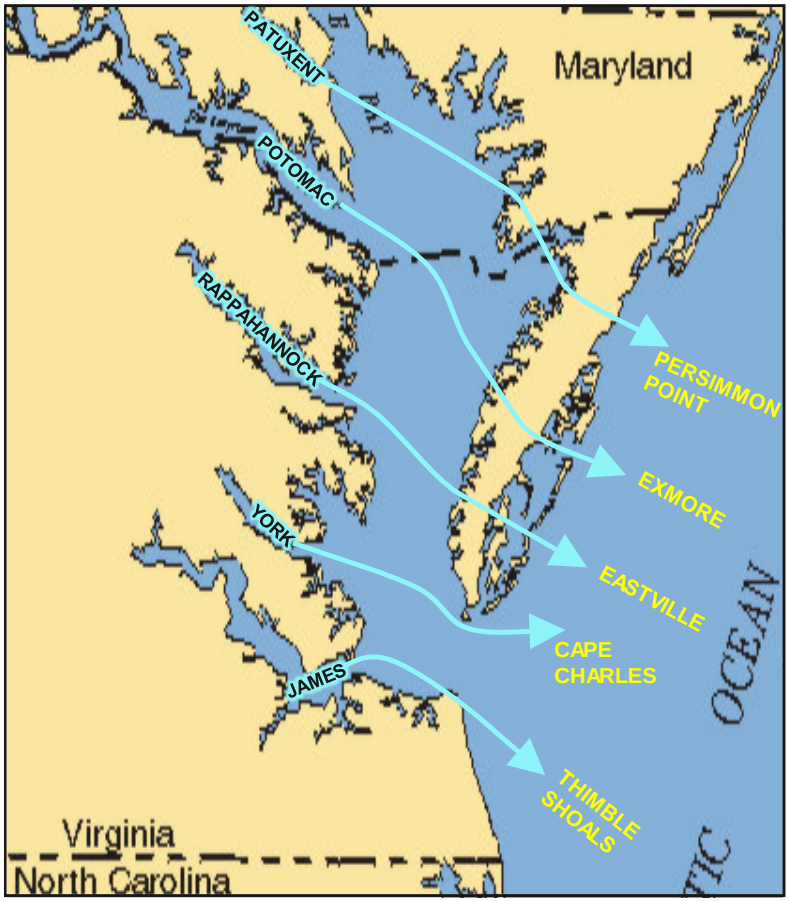
- Reduced stored water is expressed as a slightly smaller freshwater lens.
- With the current steady withdrawal rate, the freshwater lens has stabilized at the current (reduced) size.
- The freshwater lens still extends into the bay and ocean. The smaller freshwater lens has not, to date, adversely affected the overall resource.
- Adverse impacts to the overall resource will occur when the lens no longer extends into the bay and ocean.



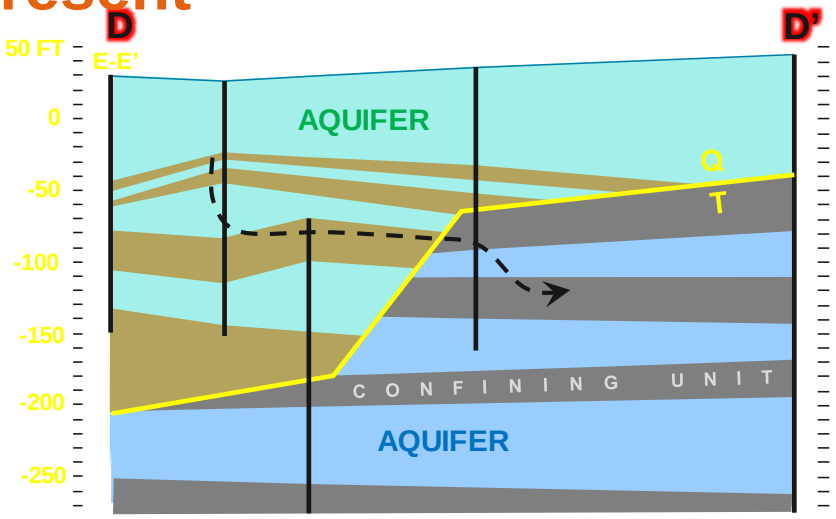
Presence of Paleochannels Influences Recharge to the Yorktown-Eastover aquifer

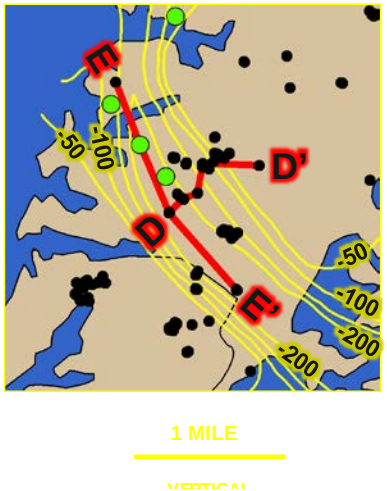
Three major paleochannels have been identified on the Shore

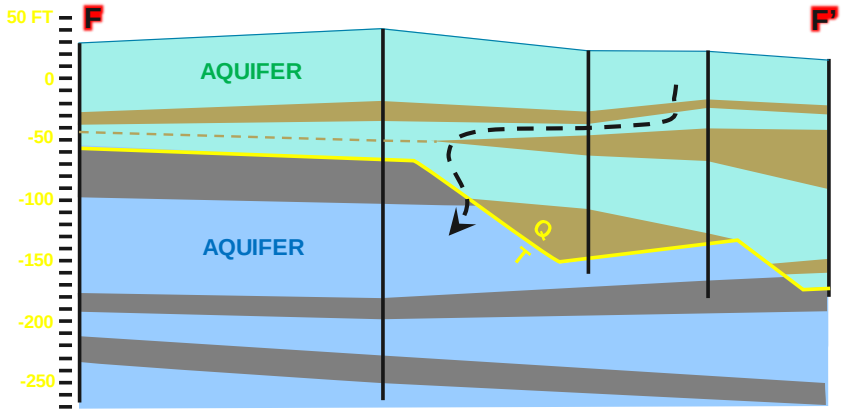
There may be others that have not been discovered

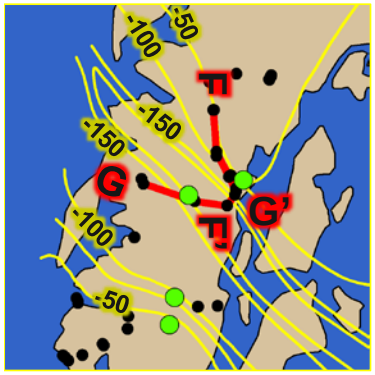


Influence on recharge is not yet well understood, but the paleochannels appear to increase recharge where present

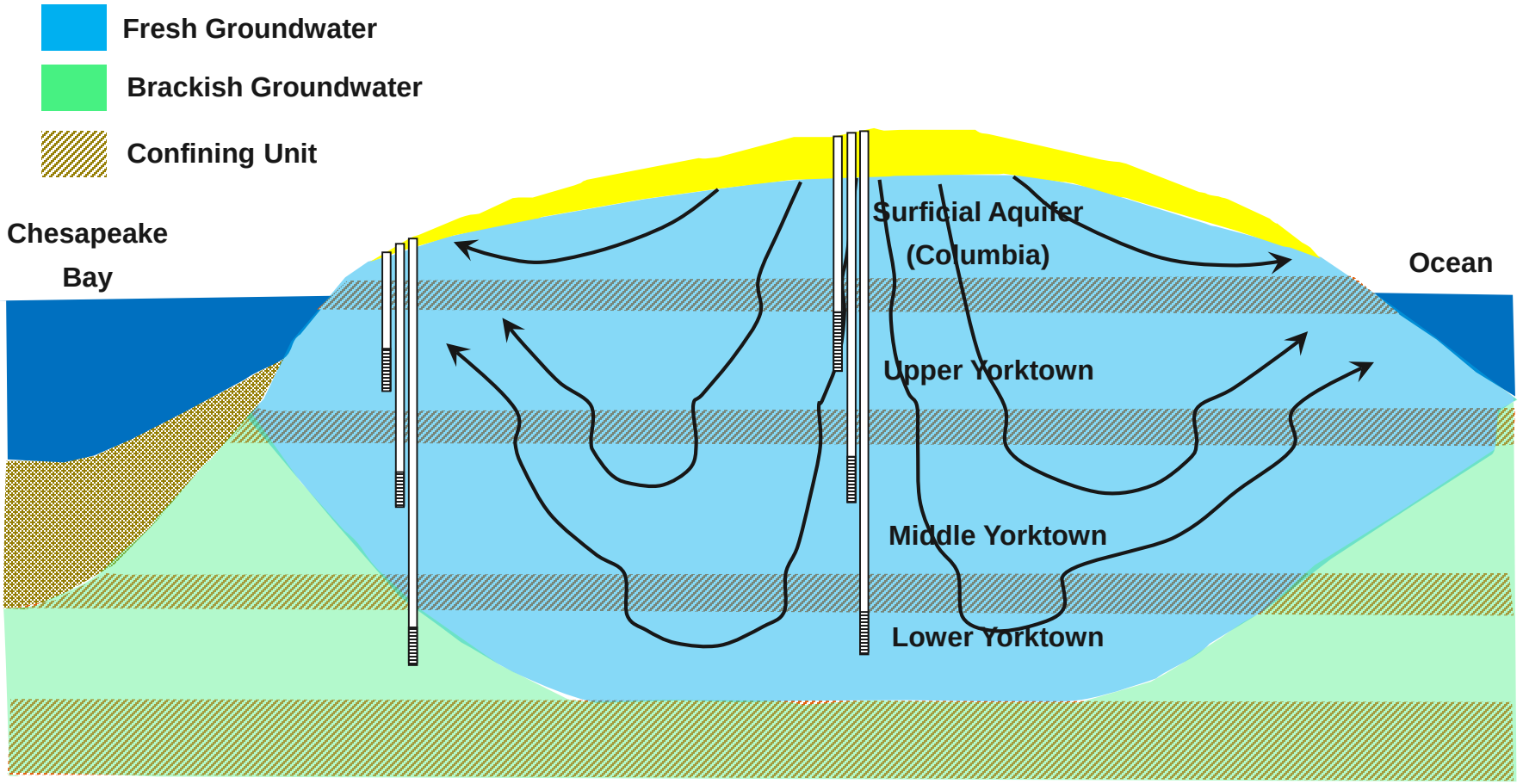




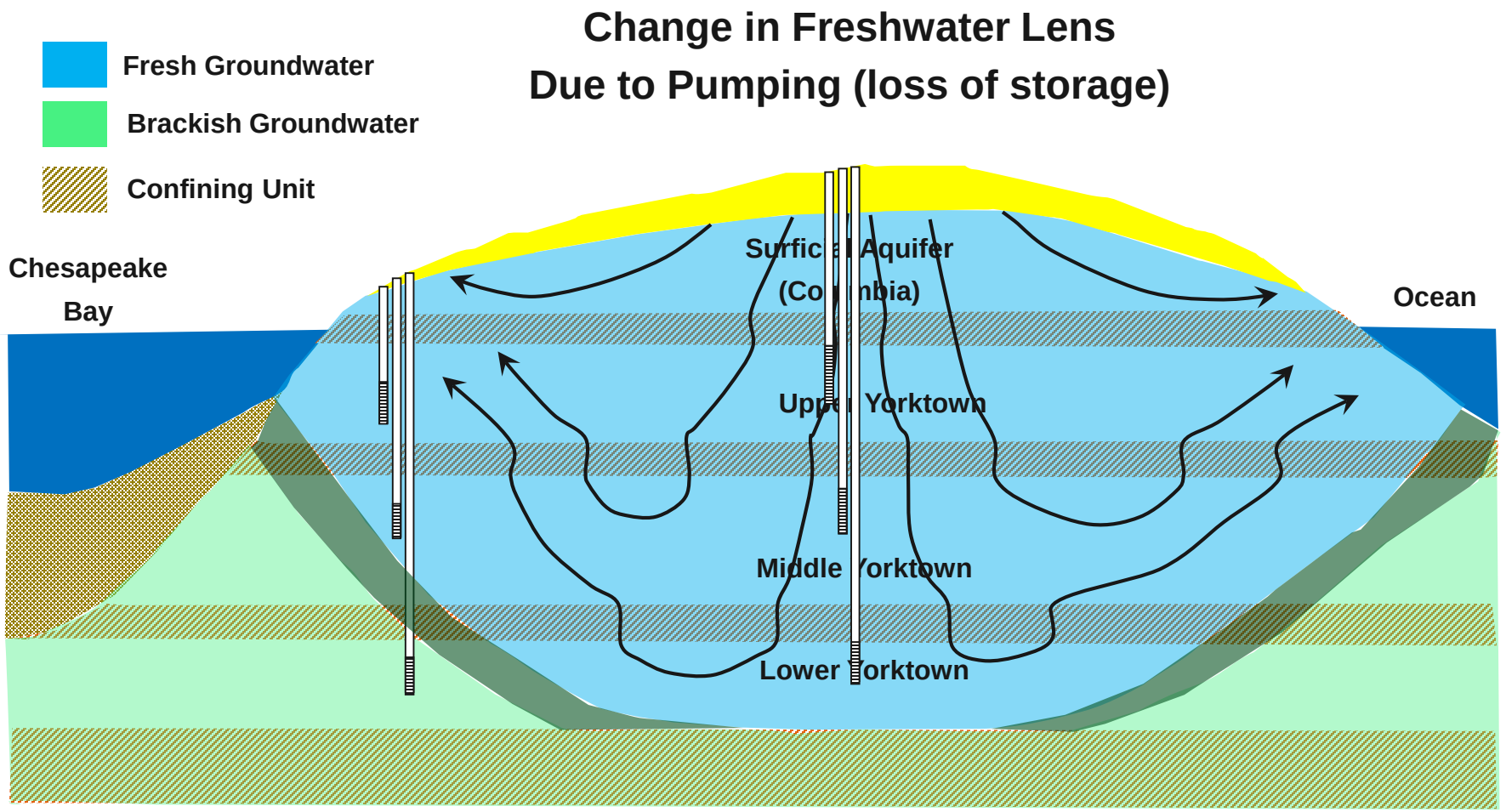




The most significant threat on the Shore due to over pumping is Saltwater Intrusion

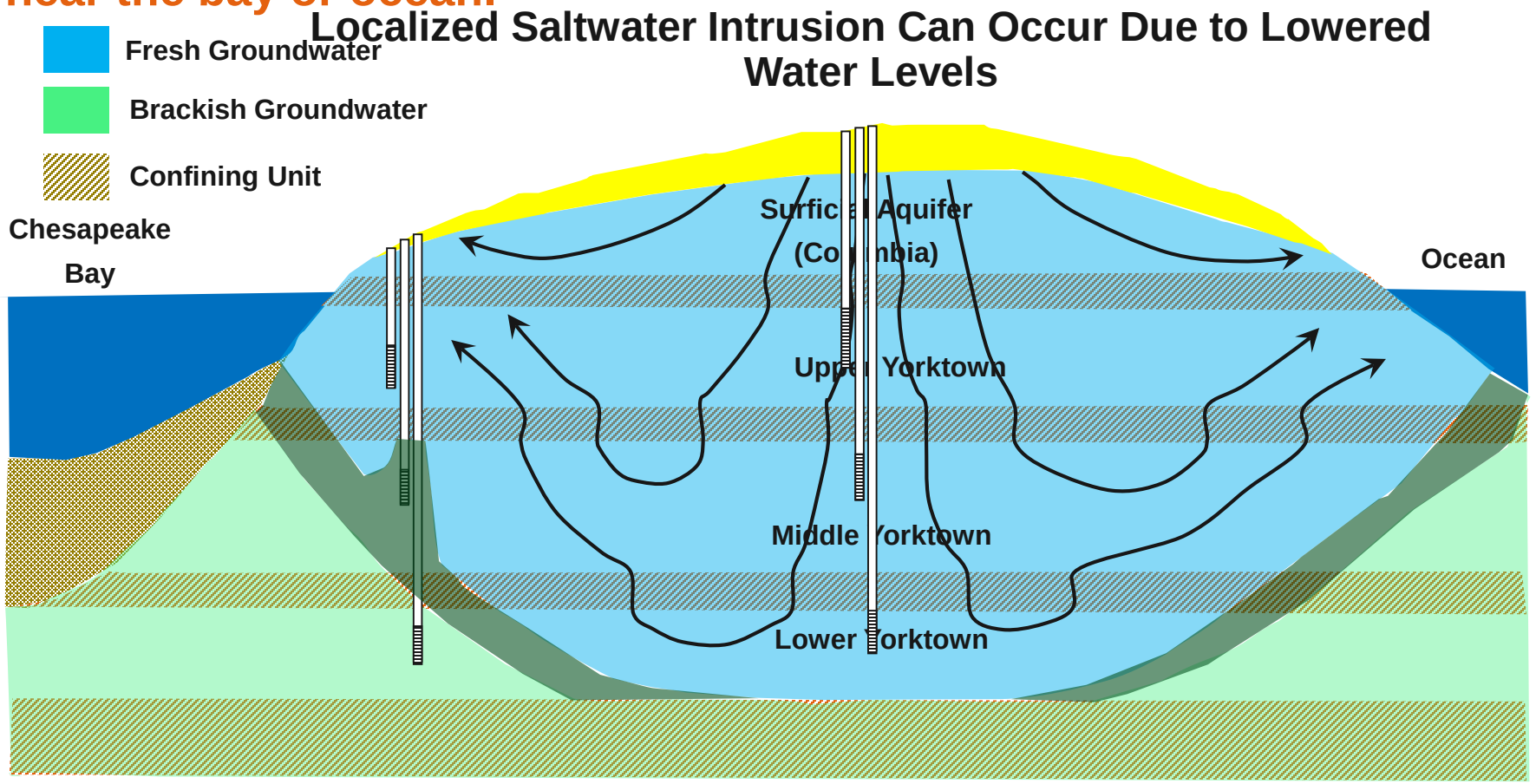


Regionally, a smaller freshwater lens is the greatest threat. Currently, a smaller freshwater lens has not adversely affected the groundwater resource



Locally, saltwater intrusion from upconing due to lowered water levels is a greater threat.

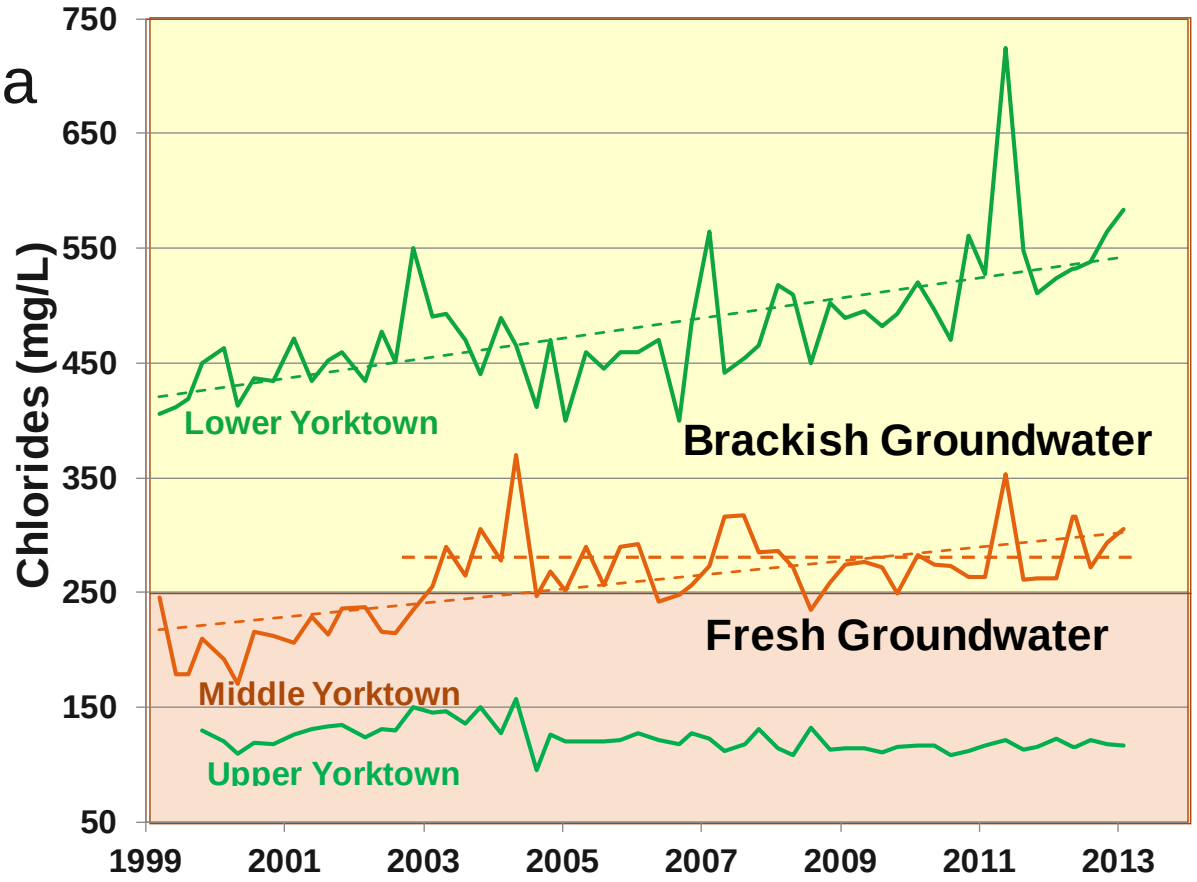
Upconing has occurred is some areas of the Shore, along the coast near the bay or ocean.



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.

Cape Charles area



Past Research has been Key to Maintaining a Sustainable Resource

- Research by VDEQ, the USGS, and Universities, including research sponsored by the Groundwater Committee has significantly improved understanding of the process that effect stainability. Some of the more notable recent research include:
  - VDEQ:
    - Groundwater withdrawal program (on-going)
    - Groundwater monitoring program (on-going)
  - USGS:
    - Update for the Eastern Shore of Virginia Groundwater Model
    - Update understanding of the aquifer system (on-going)
    - Investigate hydraulic function of the paleo-channels (on-going)
    - Monitor for saltwater intrusion (on-going)
  - Universities
    - Household Water Quality Program (periodic – funded by the State)
    - Various class and advanced degree studies by local universities (periodic)

Future research needs are focused based on past research results

- Focus on the significant “data gaps” in our knowledge:
  - Hydraulic function of the paleochannels.
  - Spatial variability in groundwater quality and yield for the Columbia (surficial) aquifer.
  - Position and movement of the fresh-water / saltwater interface for the Yorktown-Eastover aquifer.
  - Unpermitted water use.
  - Sea level rise.

Summary

- Fresh water is limited: Restricted to a groundwater lens less than 350-feet thick and recharged by direct precipitation on the shore.
- 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 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