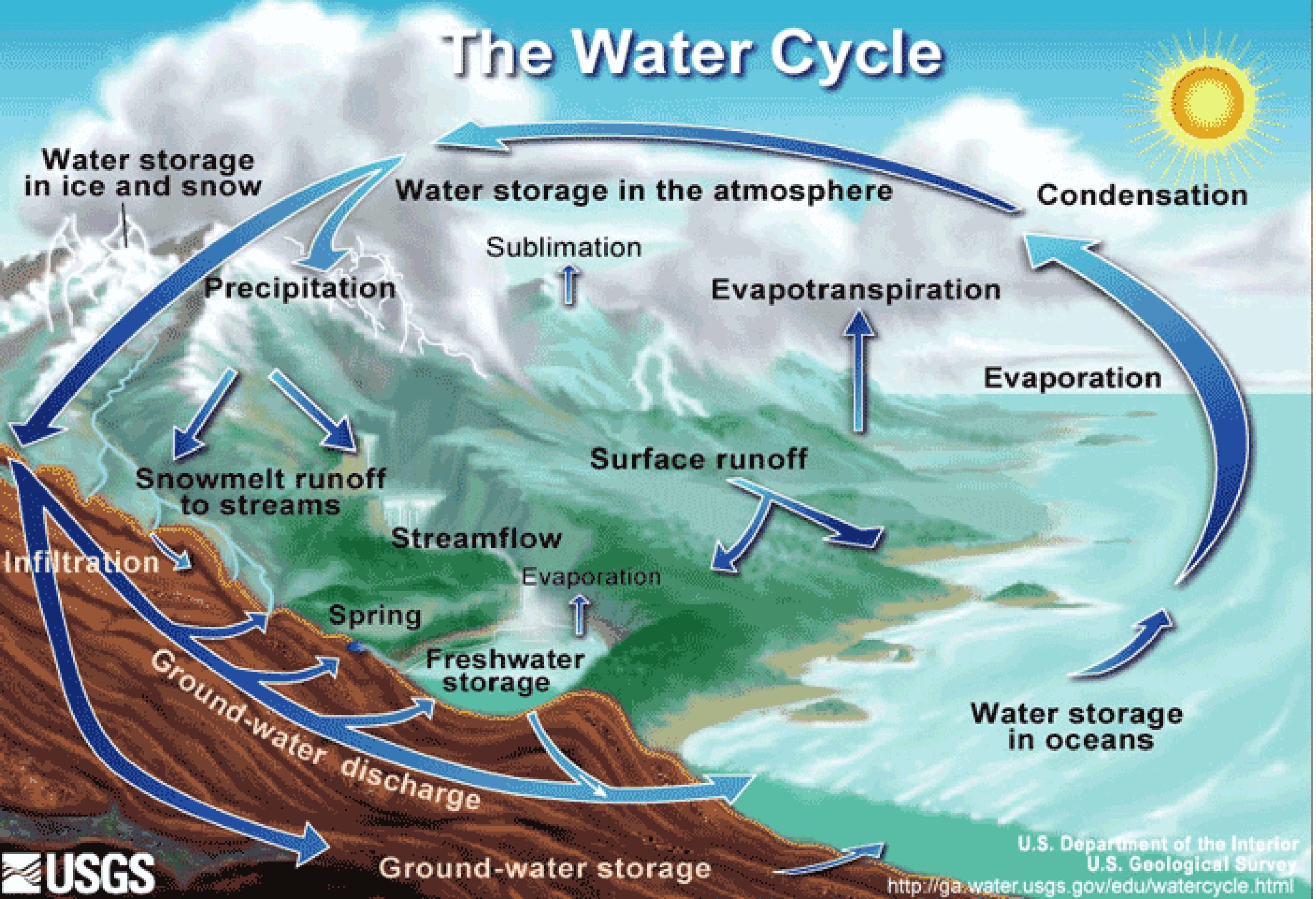
Anne Arundel County Clean Water Program

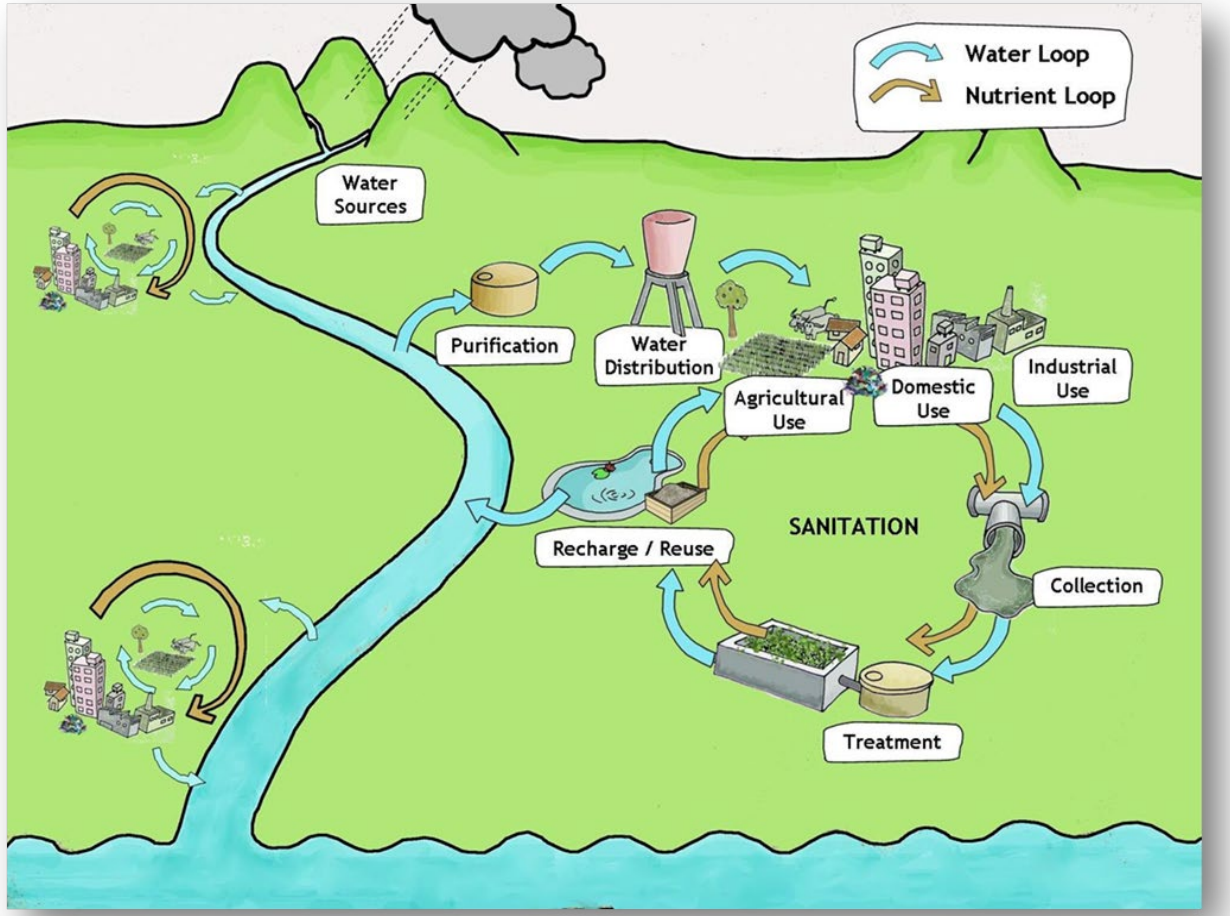
Our wAAter Managed Aquifer Recharge

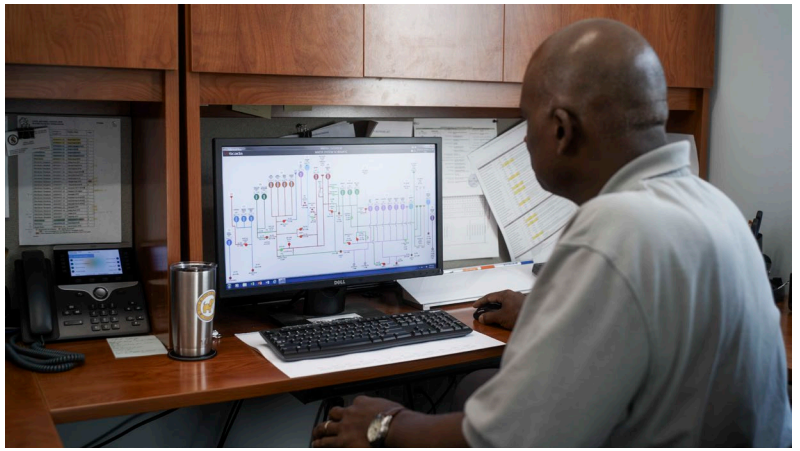
COG Water Resources Technical Committee Meeting
March 13, 2026

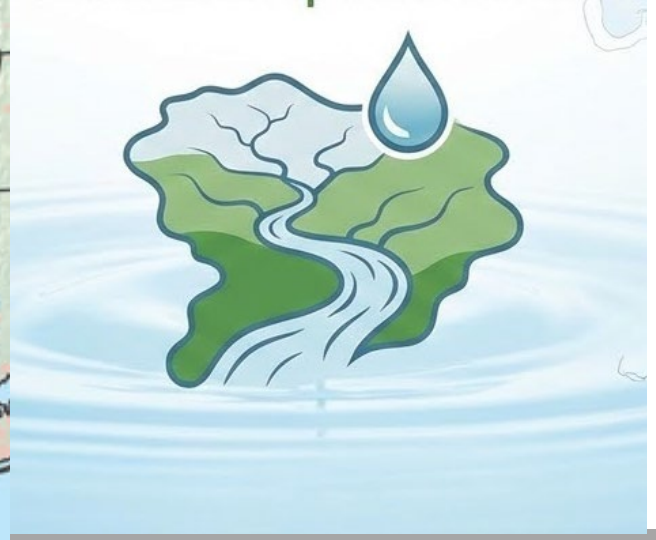


Water (Hydraulic) Cycle

Water & Wastewater Treatment Cycle







MARYLAND
Department of the Environment

- Chesapeake Cleanup Center Home
- Progress and Reports
- Maryland's Bay Cleanup Plan
- Bay Basics
- Maryland's Strategies to Reduce Nutrients in Wastewater
- Chesapeake Bay Spending
- The Future of Chesapeake Bay Restoration (leaving MDE)

Maryland's Phase III Watershed Implementation Plan (WIP)

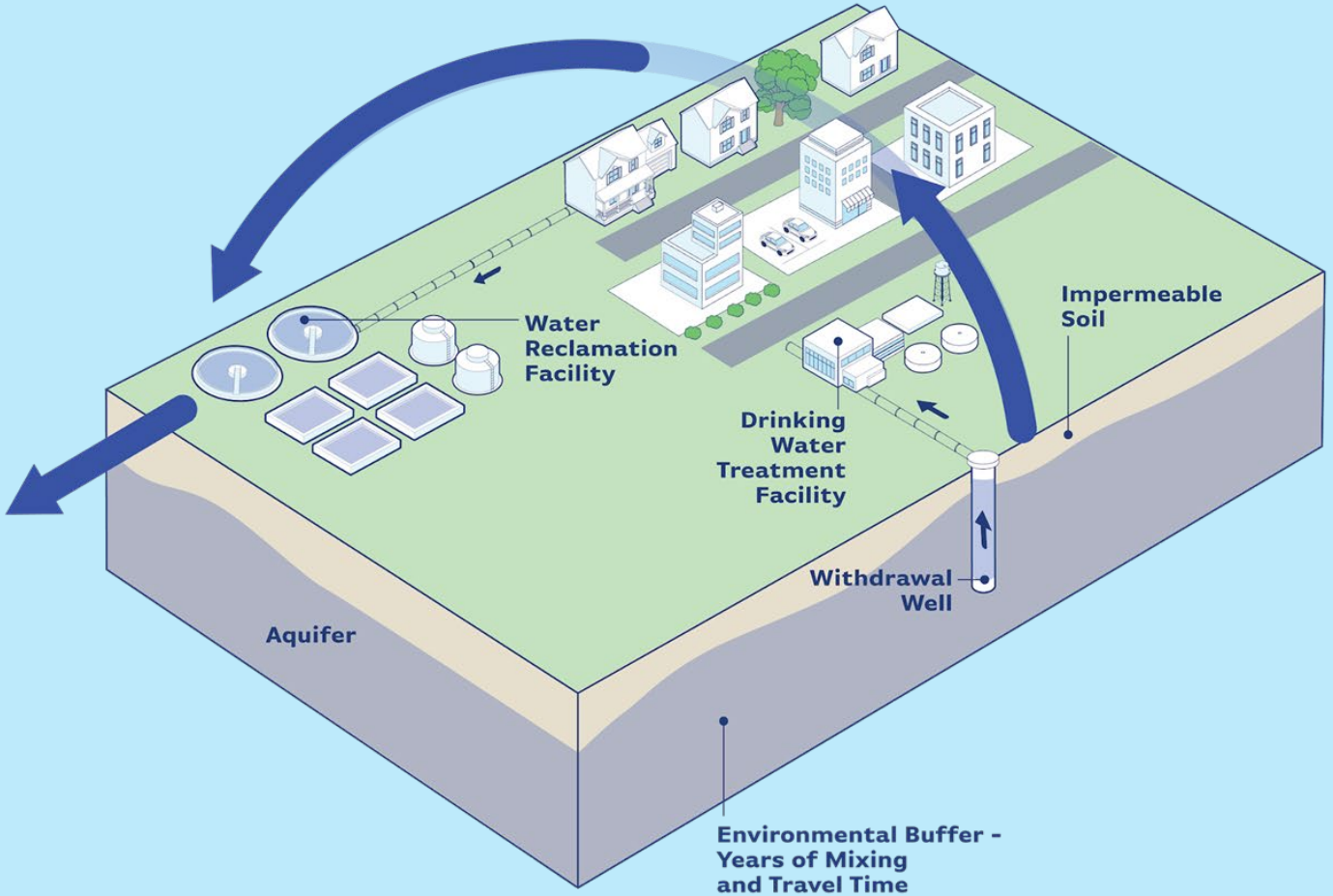
What Happens Next?

The Our wAAter Program

DPW has initiated an applied scientific research program for Managed Aquifer Recharge as a part of the Our wAAter Program.

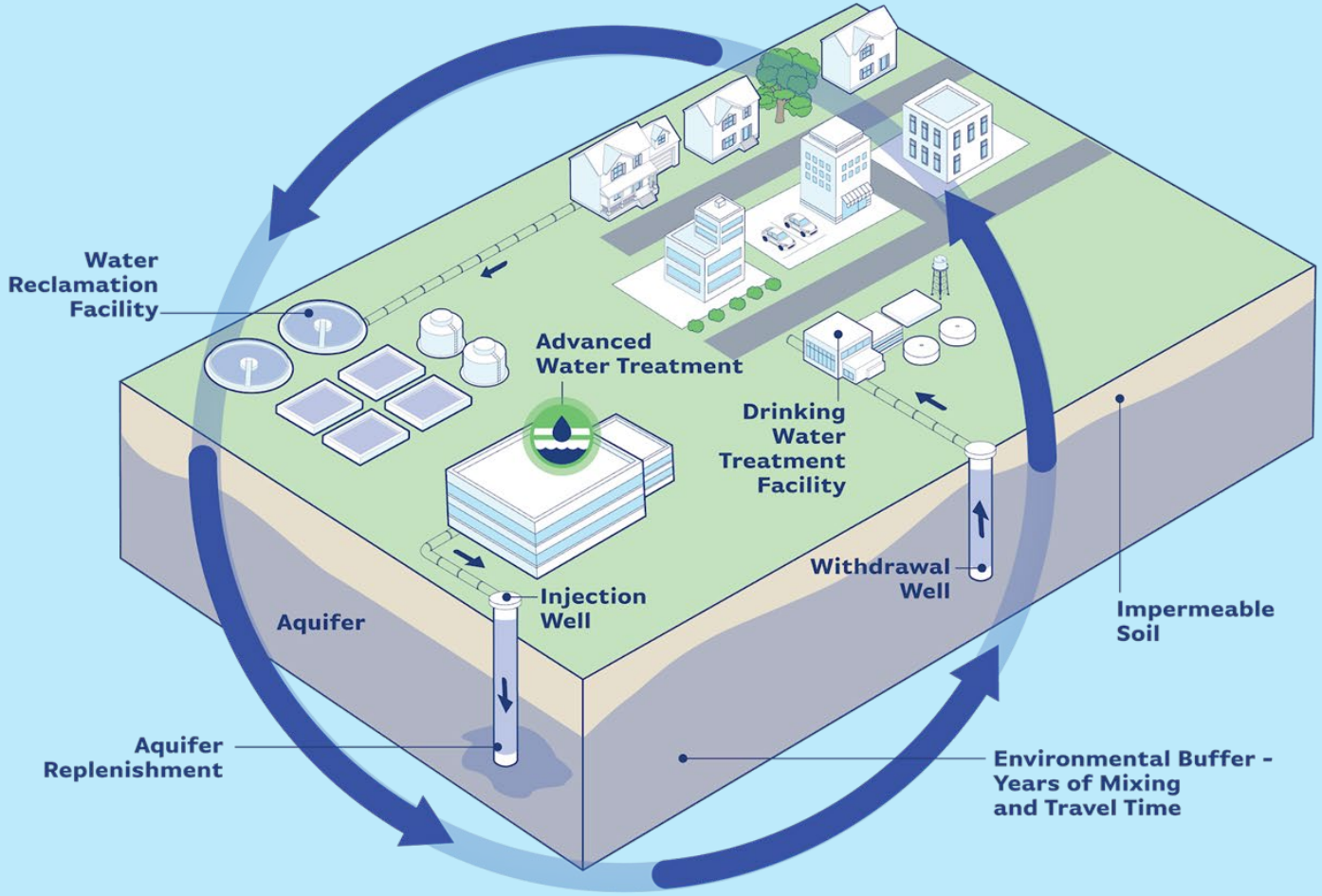
5 initiatives | one strategy

Current Water Treatment Cycle



The County currently withdraws about 36 MGD of water from three separate aquifers and discharges approximately 40 MGD of treated effluent into the Chesapeake Bay

Future Water Treatment Cycle with Managed Aquifer Recharge (MAR)



In the future the County would like to replenish the aquifers with as much water as we remove for drinking to complete the hydraulic cycle in less time because natural replenishment of the aquifers takes a long time. MAR would also be beneficial with slowing salt water intrusion and reduction of land subsidence.

Drivers for Managed Aquifer Recharge

Program Drivers:

Long-Term Groundwater Resiliency

- Groundwater replenishment
- Long-term water supply sustainability

Reduce Pollution to Bay and Tributaries

- Nutrient reduction and future Chesapeake Bay TMDL compliance
- Water quality improvements in local waterways

Groundwater Trends Raise Resiliency Concerns

- Localized drop in water levels
- Land subsidence near production wells
- Sea-level rise

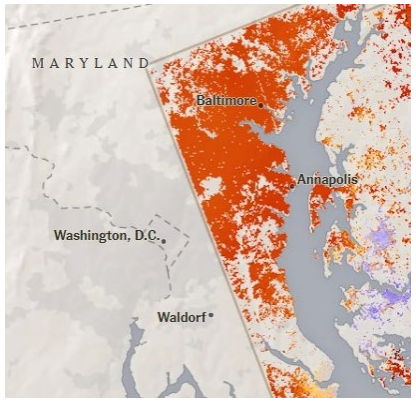
CLIMATE

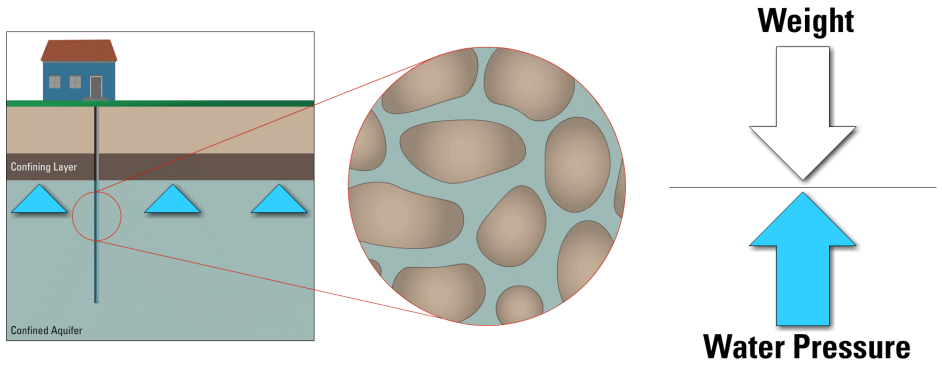
The East Coast Is Sinking

Land is slumping into the ocean, compounding the dangers from sea level rise. A major culprit: overpumping of groundwater.

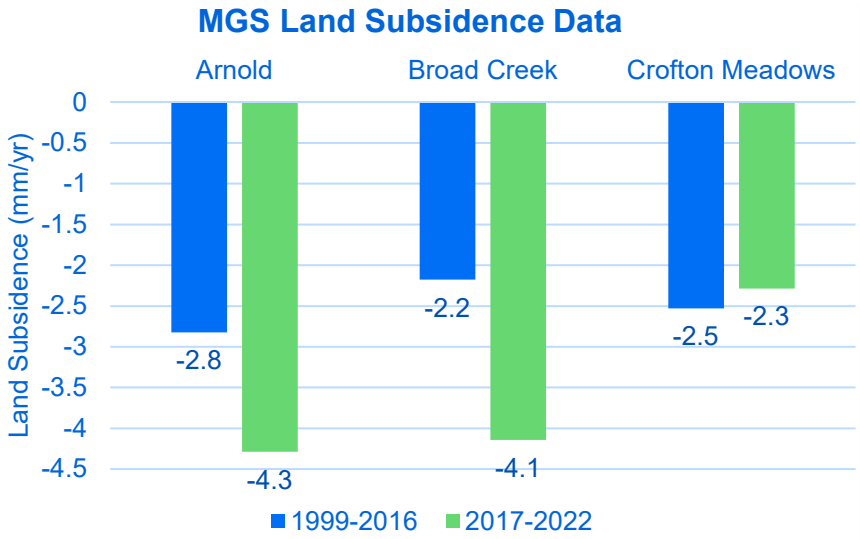
By Mira Rojanasakul and Marco Hernandez

New York Times Article, February 14, 2024





https://www.usgs.gov/media/images/aquifer-compaction-and-land-subsidence



Nutrients in the Chesapeake Bay continue to be a challenge

- *Initial strategies focused on removals by sector – i.e. stormwater, wastewater, septics, etc.*
- County desires a long-term strategy to balance growth and enhance cost effectiveness

Chesapeake Bay TMDL Fact Sheet

Map of the Chesapeake Bay Watershed. The watershed encompasses six states and the District of Columbia.

Driving Actions to Clean Local Waters and the Chesapeake Bay

On December 29, 2010, the U.S. Environmental Protection Agency established the Chesapeake Bay Total Maximum Daily Load (TMDL), a historic and comprehensive "pollution diet." This TMDL includes accountability features to guide sweeping actions to restore clean water in the Chesapeake Bay and the region's streams, creeks and rivers.

Despite extensive restoration efforts during the prior 25 years, the TMDL was prompted by insufficient progress and poor water quality in the Chesapeake Bay and its tidal tributaries. The TMDL was required under the federal Clean Water Act and responded to consent decrees in Virginia and the District of Columbia from the late 1990s. It was also a keystone commitment of a federal strategy to meet President Barack Obama's Executive Order to restore and protect the Bay.

NEW INSIGHTS ON WHY IMPROVEMENTS TO CHESAPEAKE BAY REMAIN A CHALLENGE

January 30, 2023

Horn Point Laboratory

Study finds it takes twice the effort to make a change after pollution reaches a certain level

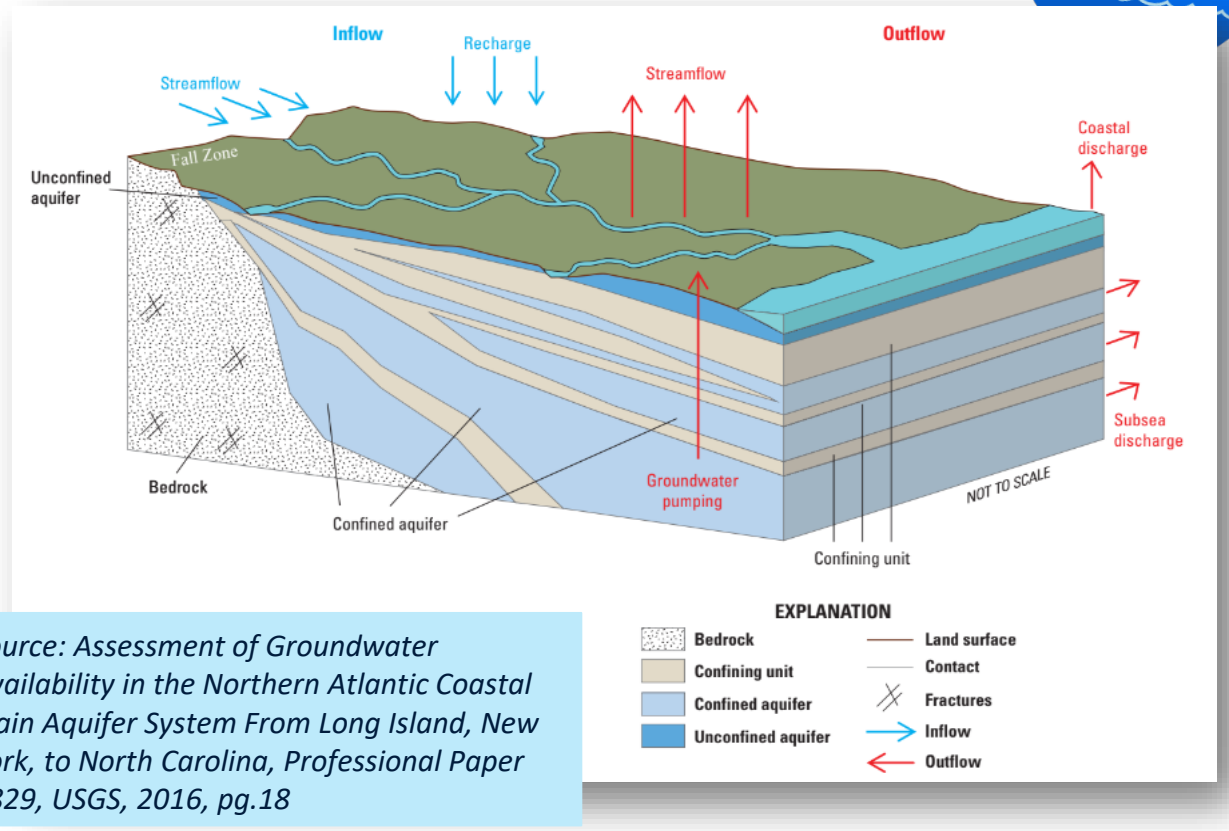
https://www.umces.edu/news/new-insights-on-why-improvements-to-chesapeake-bay-remain-a-challenge

Achieving Water Quality Goals in the Chesapeake Bay: A Comprehensive Evaluation of System Response

https://www.chesapeake.org/stac/cesr/

How can MAR Benefit the County?

- When aquifer withdrawals increase, aquifer pressures and levels decline
  - Reduces long-term storage potential and may cause damage to the aquifer
- MAR can “re-pressurize” the aquifer
  - Benefits future withdrawals
  - Can counteract subsidence
  - Protects against saltwater intrusion
- MAR also safely and cost-effectively avoids nutrient discharges to the Bay

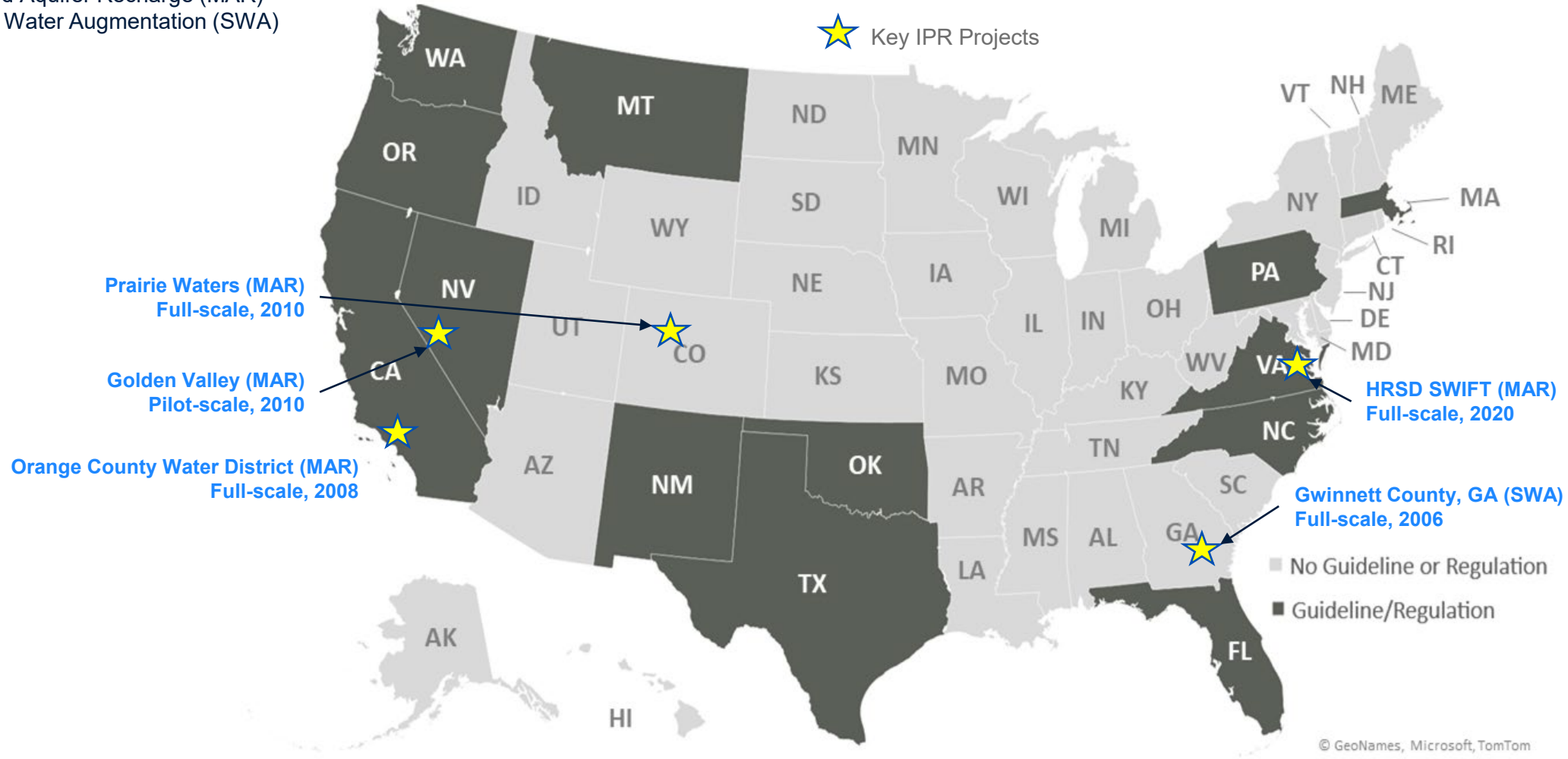


Source: Assessment of Groundwater Availability in the Northern Atlantic Coastal Plain Aquifer System From Long Island, New York, to North Carolina, Professional Paper 1829, USGS, 2016, pg.18

Identify environmentally balanced and cost-effective solutions to address water resiliency challenges before they become an emergency

Potable Reuse Nationwide

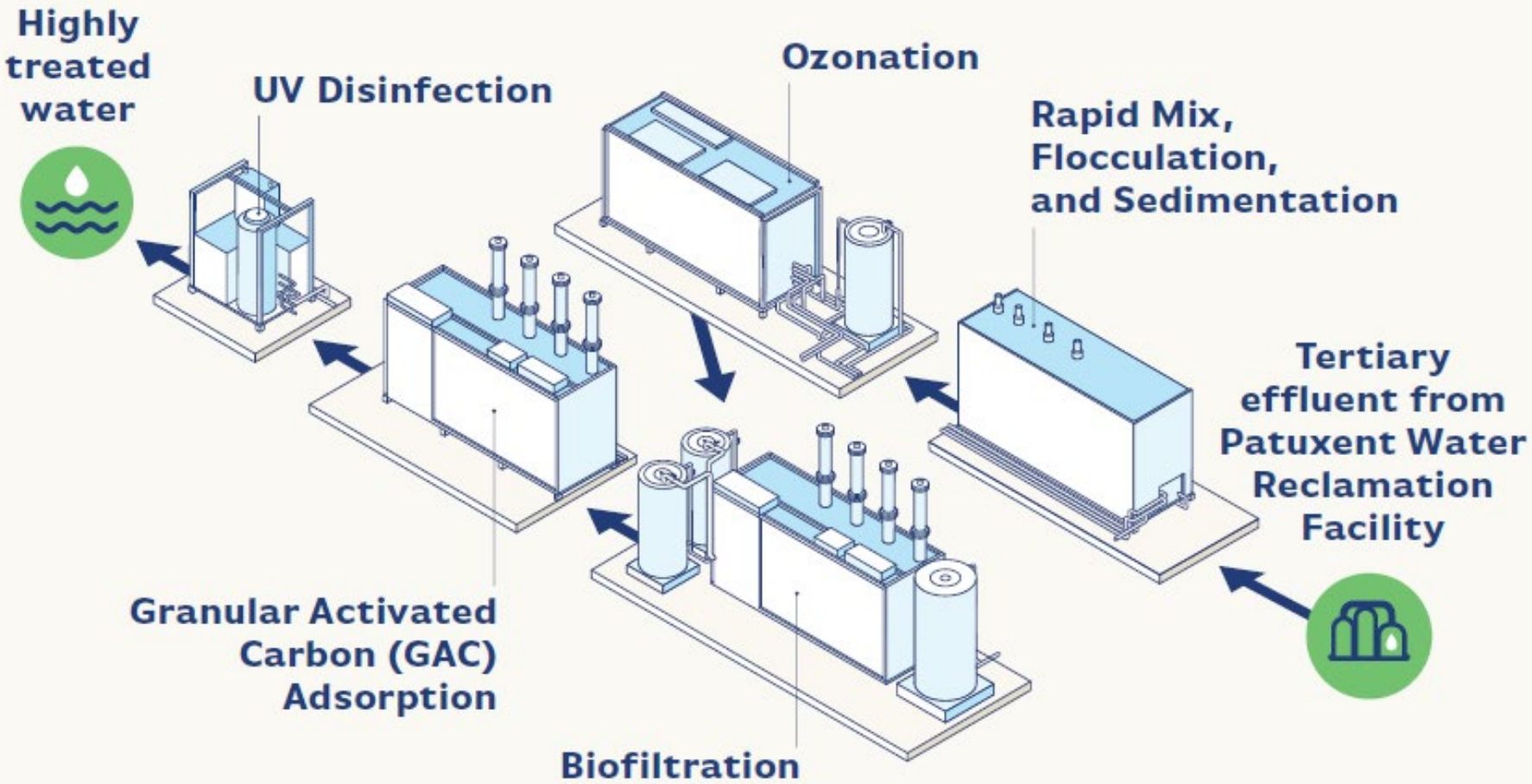
Managed Aquifer Recharge (MAR)
Surface Water Augmentation (SWA)



Source: EPA

Advanced Water Treatment Pilot

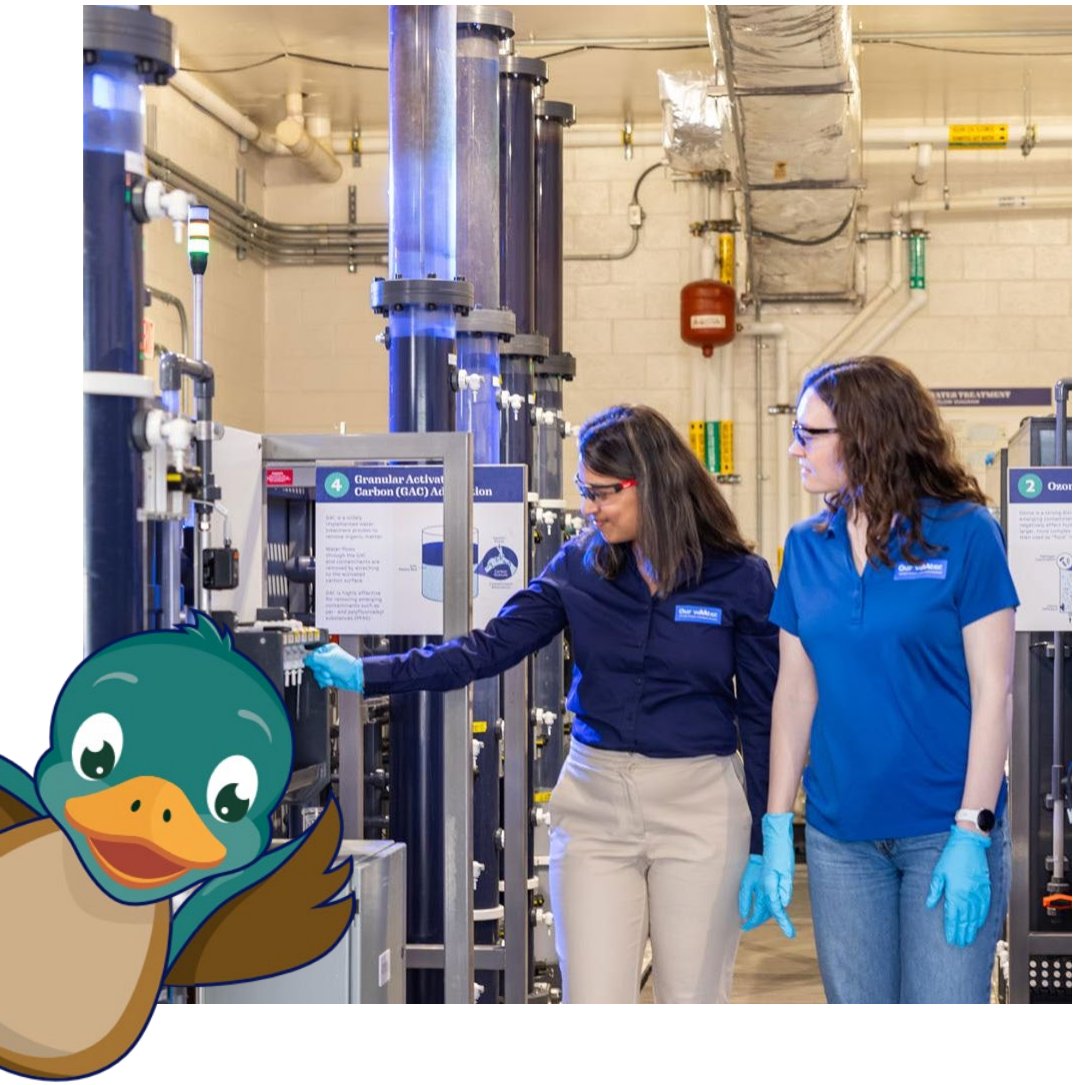
MAR Pilot



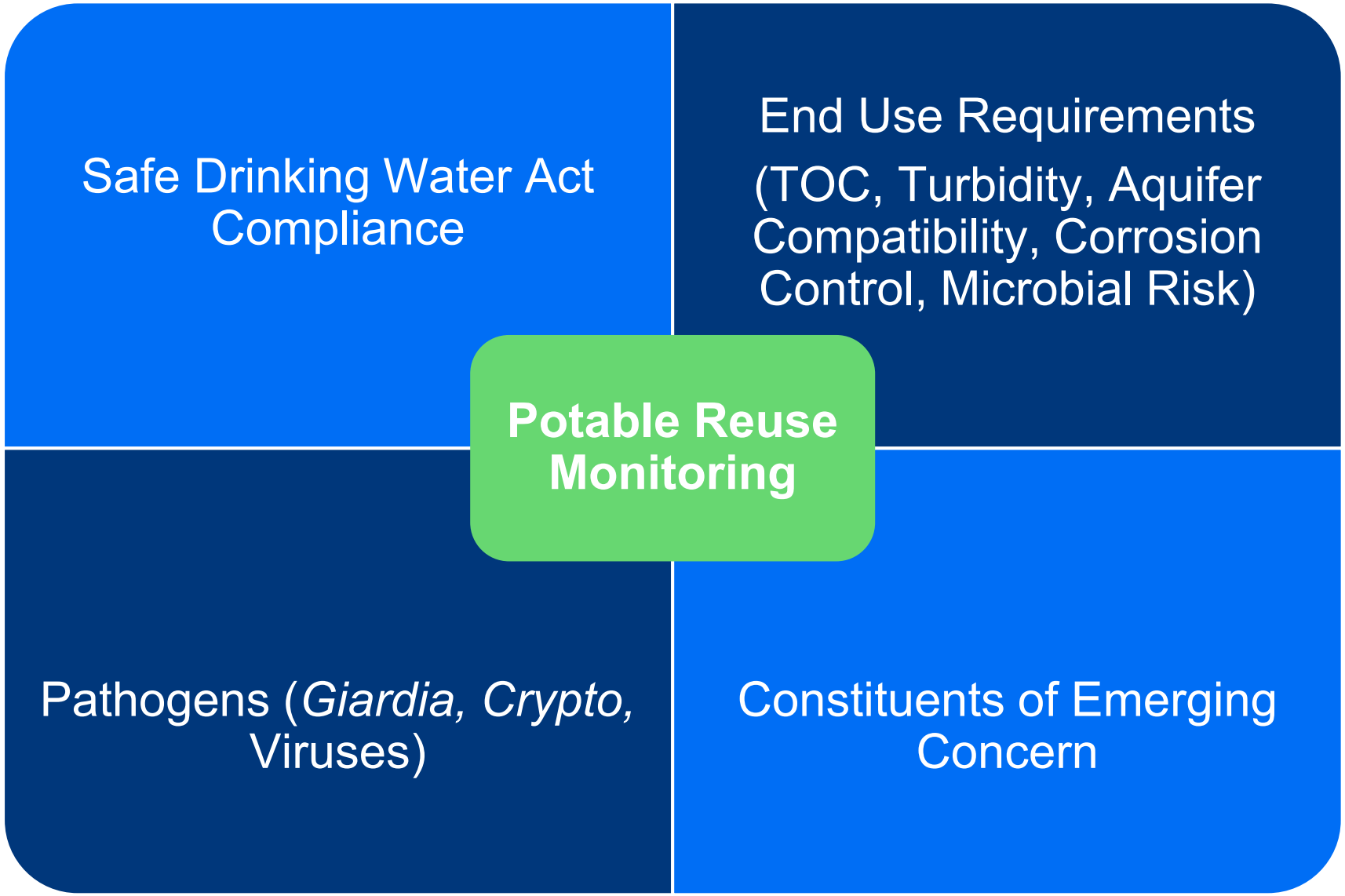
Converting high quality wastewater effluent to *beyond* drinking water quality

The County has been running the MAR/AWT Pilot for more than 3 years

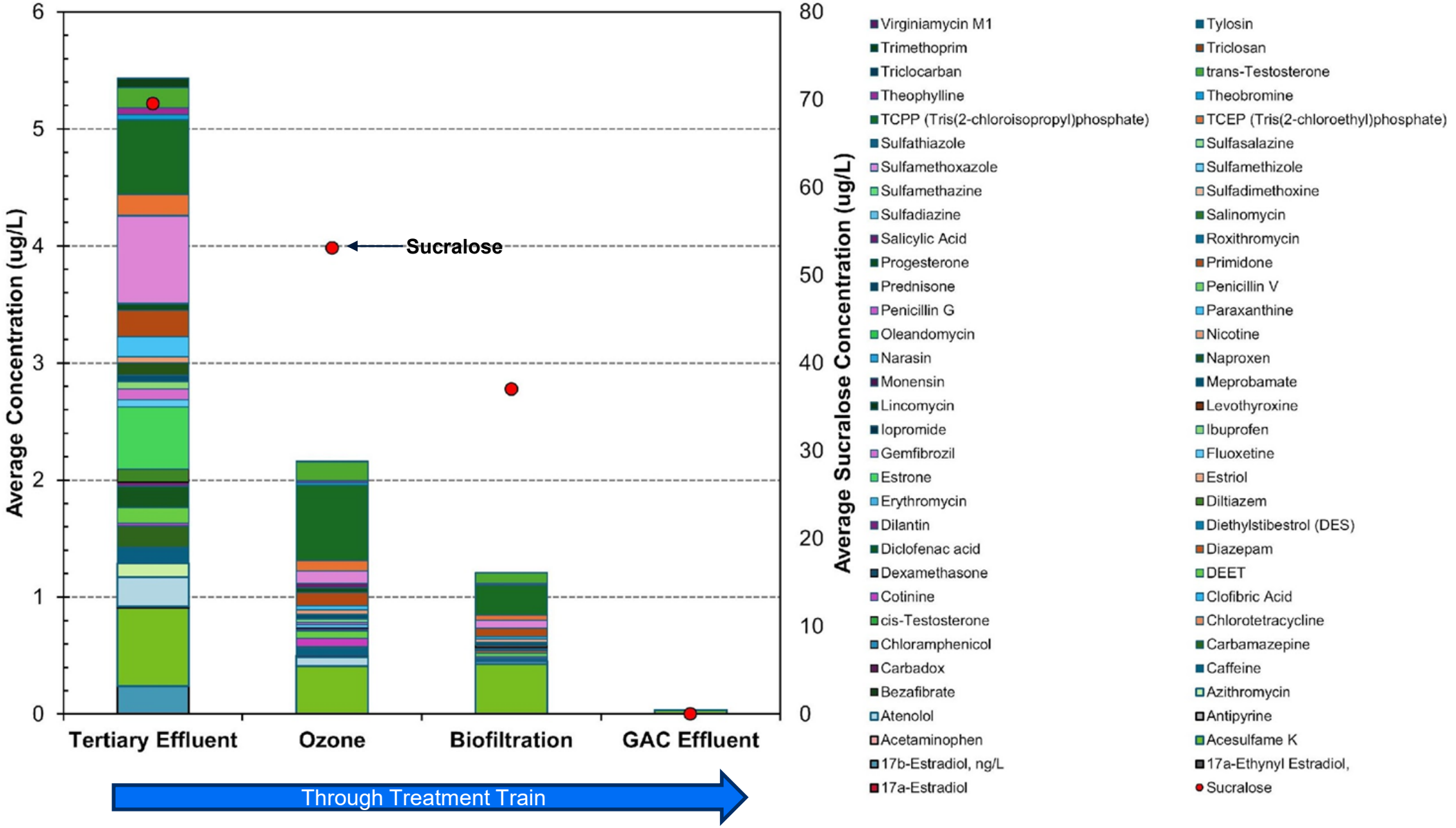
Pilot Facility



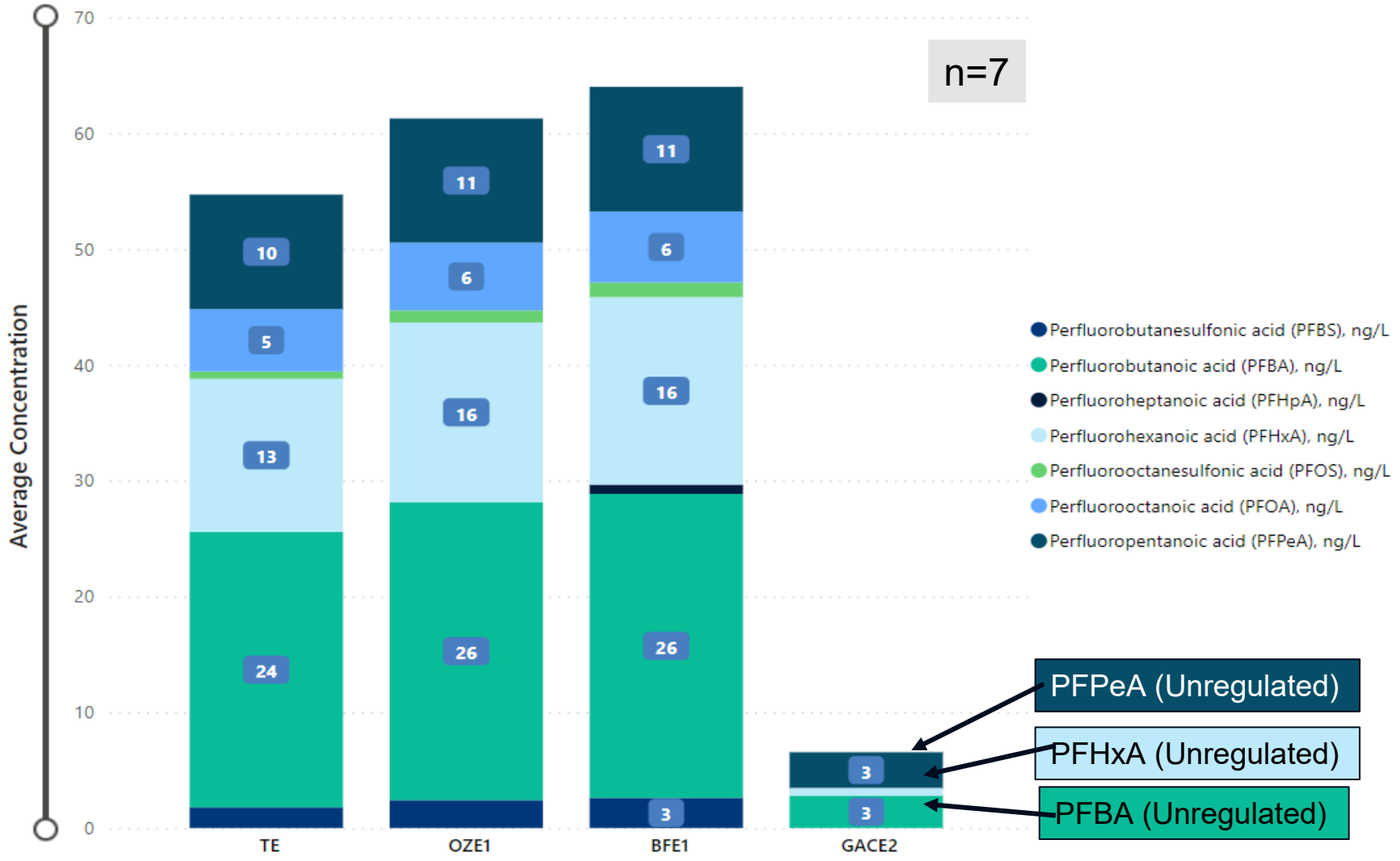
Our wAAter Treatment Goals for Piloting



Pharmaceuticals and Personal Care Products

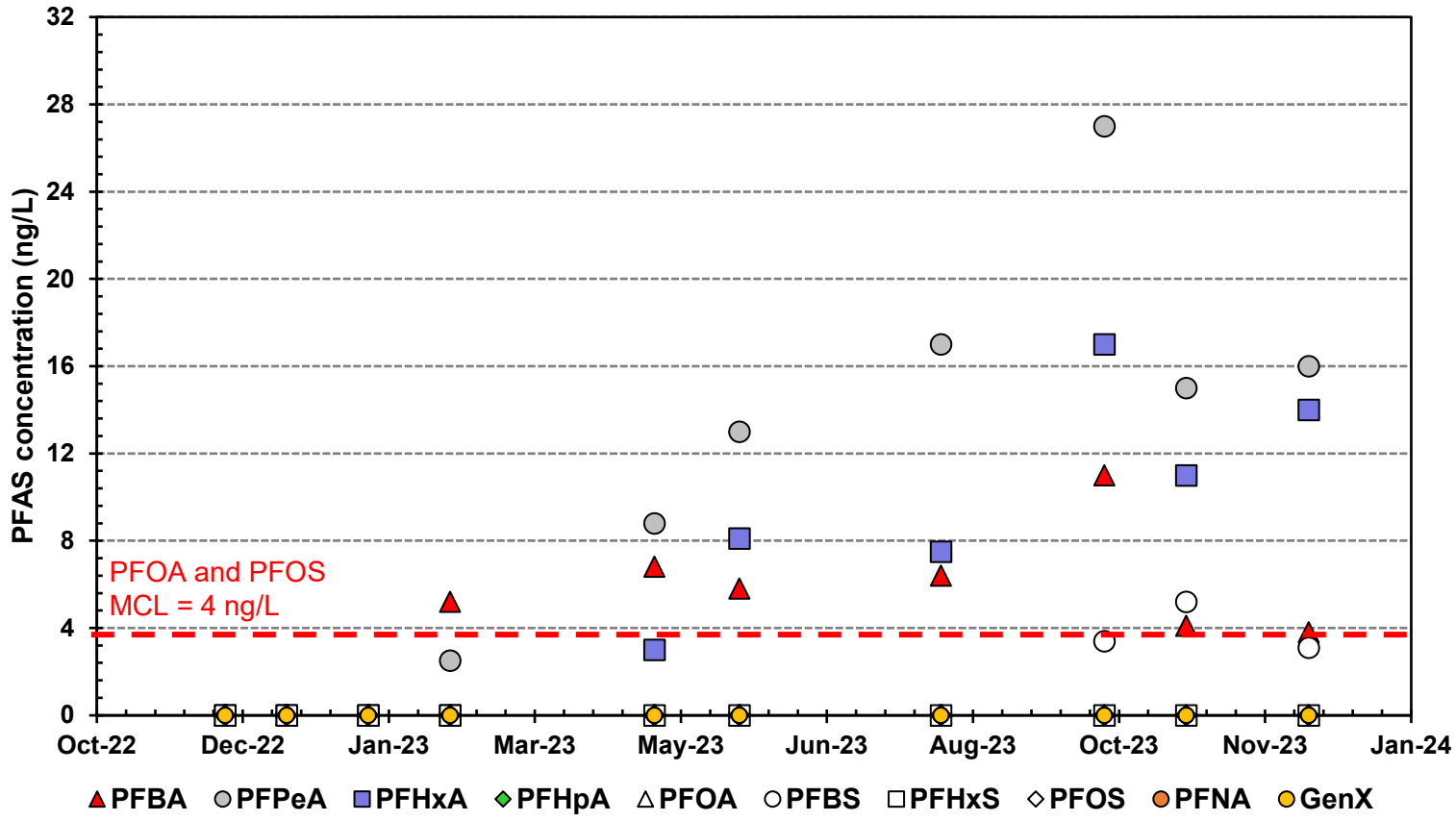


Typical Water Quality Results - PFAS



PFAS in Finished Water

- All drinking water regulated PFAS are below detection in finished water except PFBS (2.8 ng/L) which has a health-based guidance limit of 2,000 ng/L
- No PFAS detected for first 4-months of pilot operation



Pathogen Data

Parameter	Log Reduction Credits						
	Floc/Sed*	BAF	Ozone (5-6 mg/L)	GAC	UV disinfection (200-300 mJ/cm^2)	Chlorine disinfection	Total
Enteric Viruses	0	2	3	0	4	3	12
Cryptosporidium	0	4	0	0	6	0	10
Giardia	0	2.5	1.5	0	6	0	10

*BAF log reduction credits include those achieved by floc/Sed. Floc/Sed contributes to log reduction credits only when it is in combination with biofiltration.

Microorganism	LRV
12-10-10 Criteria Microorganisms	
Enteric Viruses	Below Detection Limit in Feed Water
Giardia	Below Detection Limit in Feed Water
Cryptosporidium	Below Detection Limit in Feed Water
Other Microorganisms Frequently Tracked	
Coliphage	Below Detection Limit in Feed Water
Fecal Coliform/E. Coli	>3.38
Heterotrophic Plate Count	>2.11
Legionella	0.45[1]
Pepper Mild Mottle Virus	>3.08
Total Coliform	>3.38

Notes:

1. Legionella data requires additional testing due to contamination event during sampling.

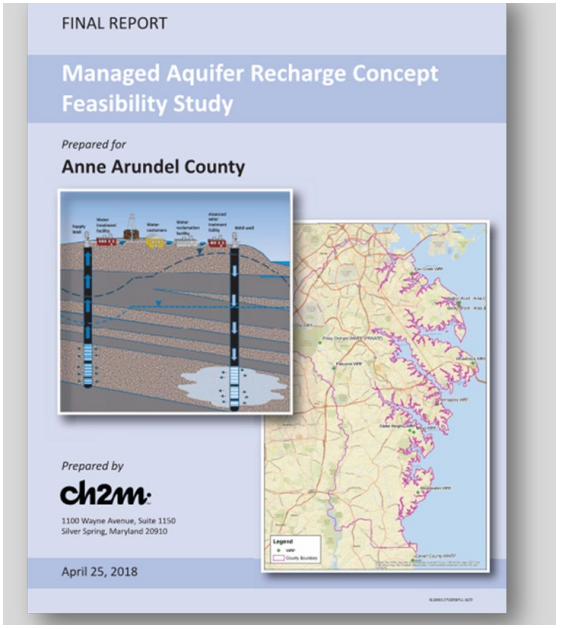
- 12-10-10 pathogen removal credits through the AWT train
- LRV monitoring results to date
- UV target is 186 mJ/cm^2

Site Tours - Outreach

Hosted Tours of Pilot for:

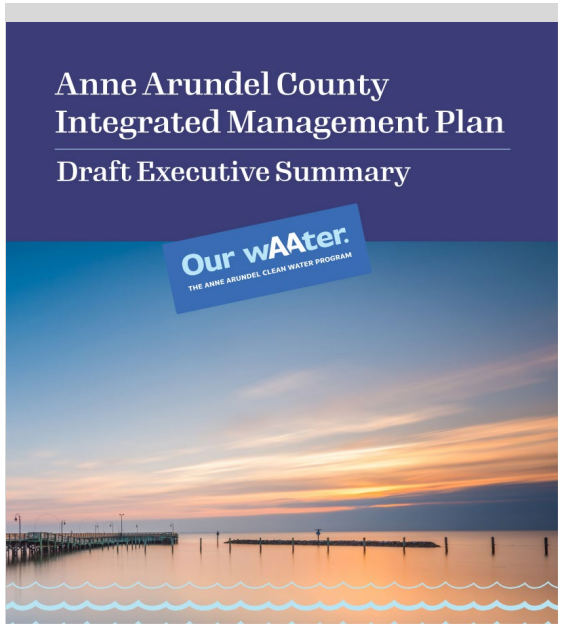
- MD Department of Environment
- US EPA
- Chesapeake Bay Foundation
- Philadelphia Water Department
- Charles County
- City of Annapolis
- City of Bowie
- Local River Keepers and Watershed Stewards

Historical Regulator Engagement



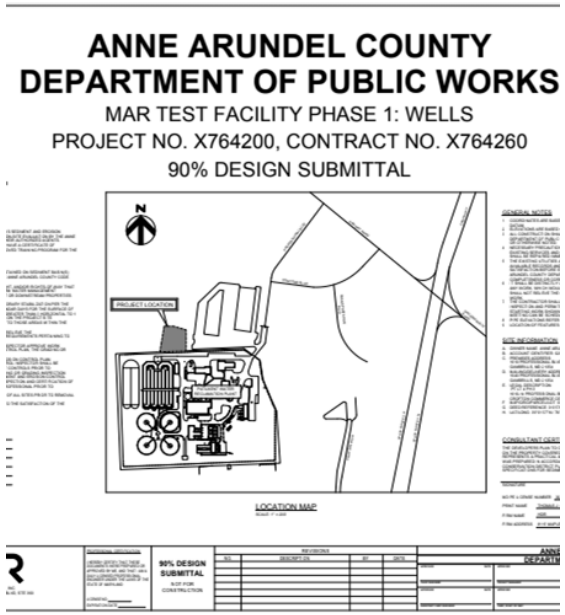
MAR Feasibility Study

- Report – Apr 2018
- MDE Comments – Dec 2018
- County Response – Mar 2019



Integrated Planning

- MDE Meeting – May 2019
- Management Plan – Aug 2019
- IPR/DPR Workshop – Feb 2020
- ISAP Panel – Feb 2021
- Water Supply Eval – Apr 2021
- Draft Integrated Plan – Apr 2021



MAR Test Well

- Siting Study – May 2019
- BODR – Aug 2019
- MDE Meeting – Aug 2019
- MDE Comments – Nov 2019
- MDE Meeting – Nov 2019
- Plans and Specs – Jun 2020
- MDE Meeting – May 2021
- UIC Permit App – Jun 2021

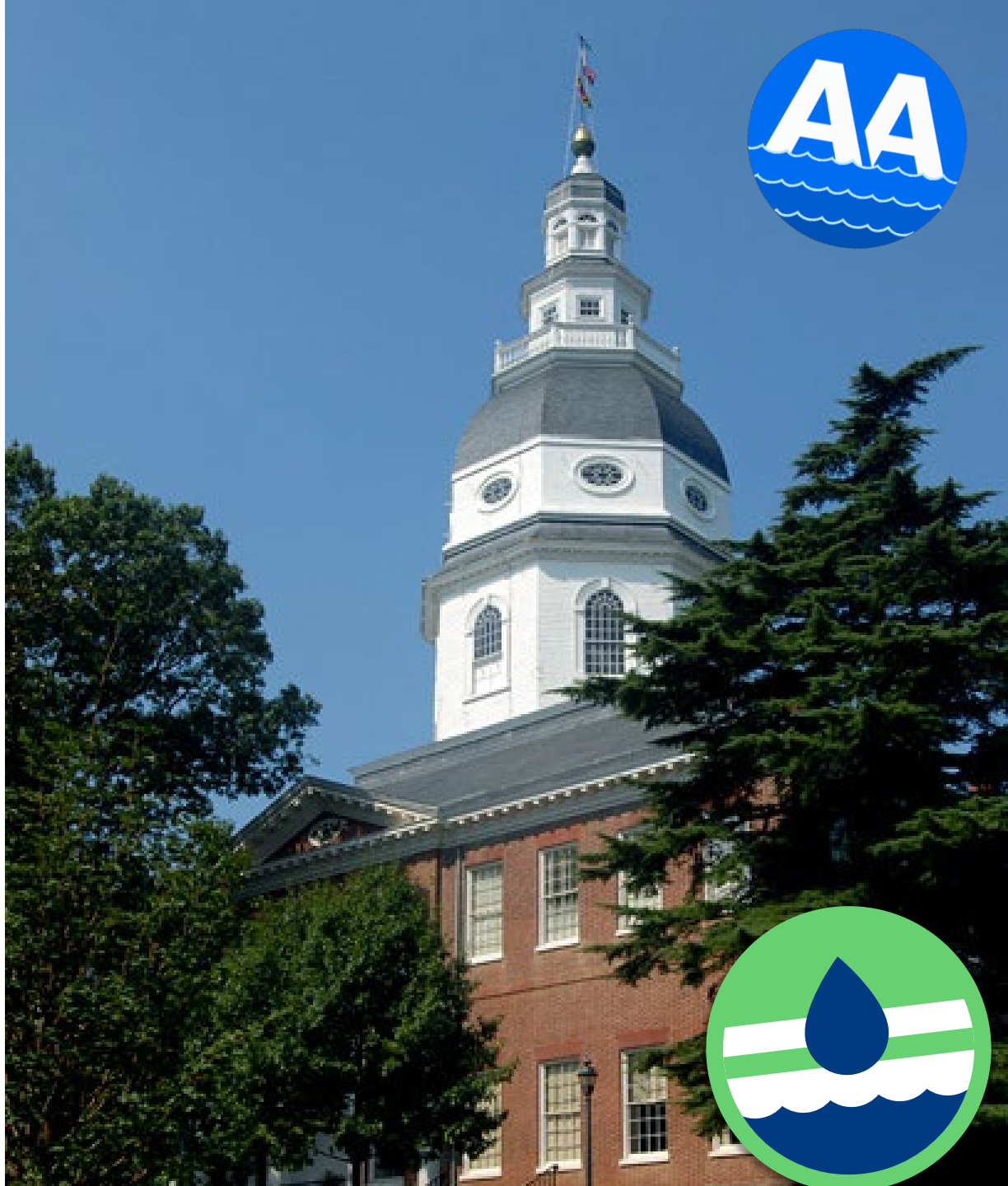
AWT Evaluations

- MDE Meeting – Dec 2019
- WW Effluent Sampling – Aug 2020
- Pilot TM – Oct 2020
- Pilot Test Plan – Sep 2021
- Pilot Procurement – Oct 2021
- Pilot Operations – Oct 2022-current

Establishment of MAR Pilot Program (SB930)

Purpose and Need:

- Establishes a Managed Aquifer Recharge Pilot Program to authorize and evaluate the use of treated reclaimed water as a source for groundwater augmentation
- Limited to one permit overall
- Requires that the program addresses a groundwater supply or water quality problem that is reasonably expected to occur within the next 25 years, including
  - Land subsidence
  - Saltwater Intrusion



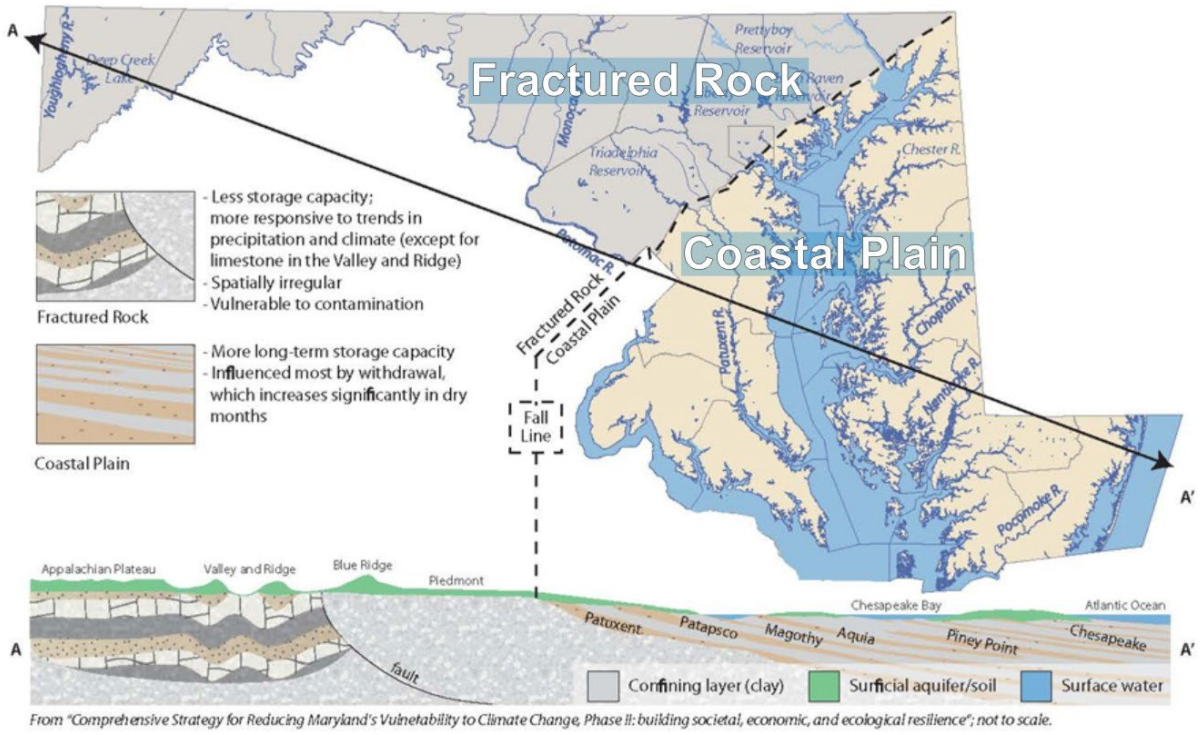
Permit Application Requirements Summary

- Alternative analyses supporting MAR
- Mitigation plan in response to off-spec water
- Identify all wells within 2-year travel time of injection
- Detailed hydrogeologic investigation
  - Existing hydrogeology and stratigraphy along with predicted impacts
  - Groundwater elevation contours, vector flows and calculated gradients
  - Quarterly samples of TN, TOC and other constituents as required
  - Monitoring wells >= 14 days and <=180 travel time downgradient
  - Monitoring well within 30 days travel time upgradient of closest pvt. well
- Tracer Study within 3 months of start of injection

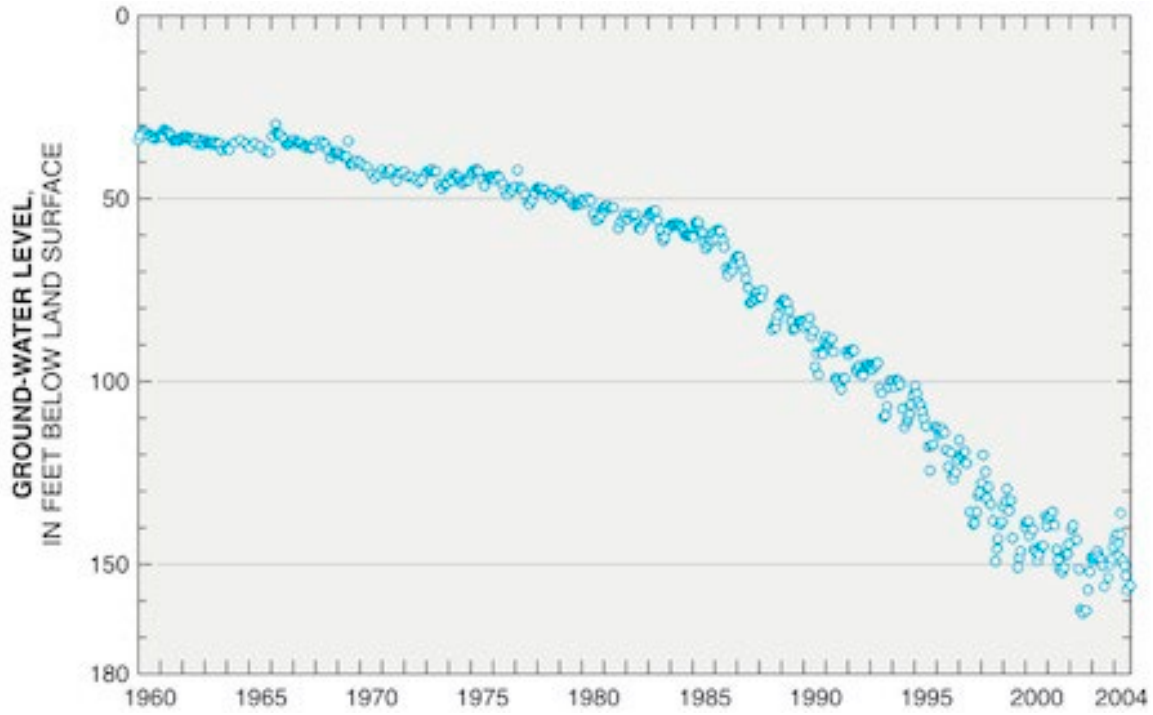
Demonstration Facility – Next Steps

- Anne Arundel County will continue to work on getting the location, purpose and need approved by MDE.
- The County is collaborating with MDE, USGS, and MGS to perform a saltwater intrusion evaluation on the Broadneck Peninsula.
- This evaluation should provide the necessary data to determine the purpose and need as well as an approximate location for the demonstration facility.
- The County will continue to run the AWT pilot until an application has been approved by MDE for a MAR demonstration facility.
- The County does not anticipate moving forward with a detailed design until MDE has granted a permit.

What are the groundwater issues?



From "Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change, Phase II: building societal, economic, and ecological resilience"; not to scale.

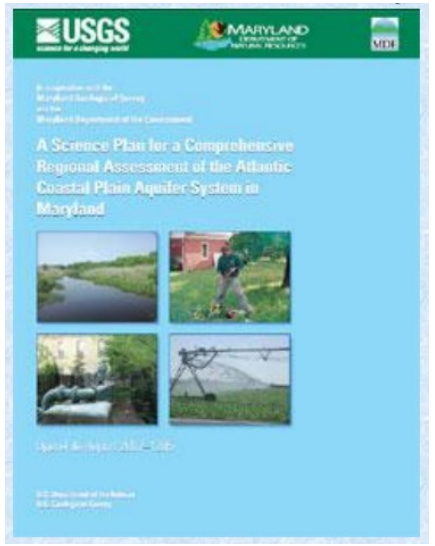


Hydrograph showing water level decline in a well in the Aquia aquifer near Solomons, Calvert County, Maryland, 1960-2004.

Need for Regional Coastal Plain Model

A Science Plan for a Comprehensive Regional Assessment of the Atlantic Coastal Plain Aquifer System in Maryland

1. Document the geologic and hydrologic characteristics of the aquifer system in the Maryland Coastal Plain and adjacent areas of neighboring states;
2. Construct a **regional groundwater-flow model**, incorporating detailed studies of water budgets in recharge areas and confining bed hydraulic characteristics;
3. Improve documentation of patterns of water quality in all Coastal Plain aquifers, including the distribution of saltwater;
4. Enhance groundwater-level, streamflow, and water-quality-monitoring networks in the Maryland Coastal Plain; and
5. **Develop science-based tools** to facilitate sound management of the groundwater resources in the Maryland Coastal Plain.

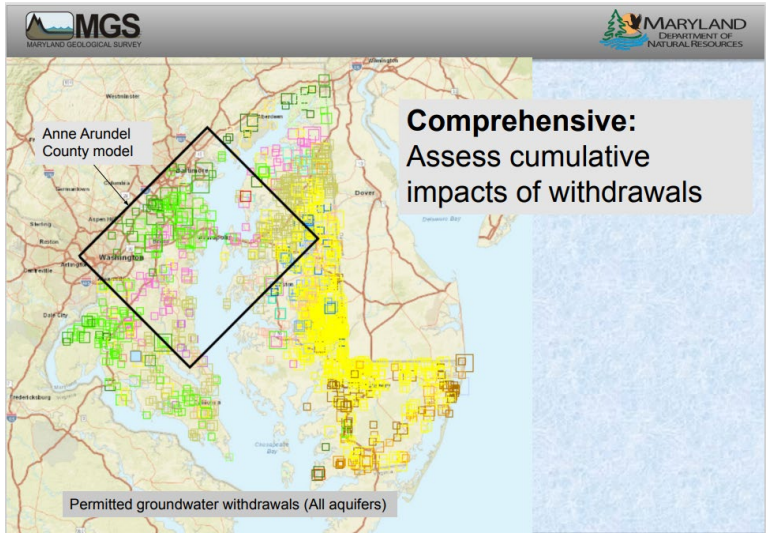


http://www.mgs.md.gov/wss/pages/cp_home.html

Regional Coastal Plain Model

Regional Coastal Plain GW-flow model Need and Benefit

1. Comprehensive: Assess cumulative impacts of withdrawals
2. Increase efficiency : Eliminate need for multiple, independent models
3. Represent the entire water budget (recharge, GW-SW interaction, leakage between aquifers, confining bed storage)
4. Consistent aquifer framework
5. “Living” model: maintained on a regular basis
6. Accessible for a range of “local” purposes (water-supply, saltwater intrusion, MAR, etc.)



Moving Forward

- Anne Arundel County met with MGS and USGS in 2026, the model is moving forward with funds from the County and MDE.

http://www.mgs.md.gov/wss/pages/cp_home.html

Our wAAter.

THE ANNE ARUNDEL CLEAN WATER PROGRAM

Thank you!