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Piedmont Area Groundwater Study Results

February 6, 2018

Background

- The Board requested a study of the available groundwater resources in the Piedmont area of Stafford County – generally west of I-95.
- Other studies had been completed previously, but were over 10 years old and broader in focus
- This study would examine previous reports and academic studies, and use existing data wherever possible. We also compiled data available from VDH well records
- The data available to us provided well data at the time of construction and testing – no current production information

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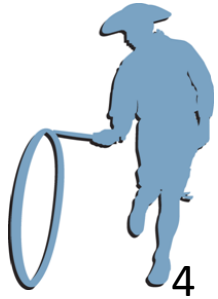
Study Goals

- Update previous study information using current population
- Determine estimate of available groundwater
- Perform modeling to identify areas of greater concern
- Examine well regulations enacted by other localities
- Investigate whether monitoring wells would be beneficial

Groundwater Aquifers in Stafford County

- Coastal Plain
  - Generally east of I-95
  - Characterized by more consistent yield, increased porosity, and greater reliability
  - High volume withdrawals regulated by state
- Piedmont
  - Generally west of I-95
  - Thin surface recharge area with transmissivity provided by fractures
  - Highly variable well yields even in localized areas
- Recent concerns are related to groundwater in the Piedmont aquifer



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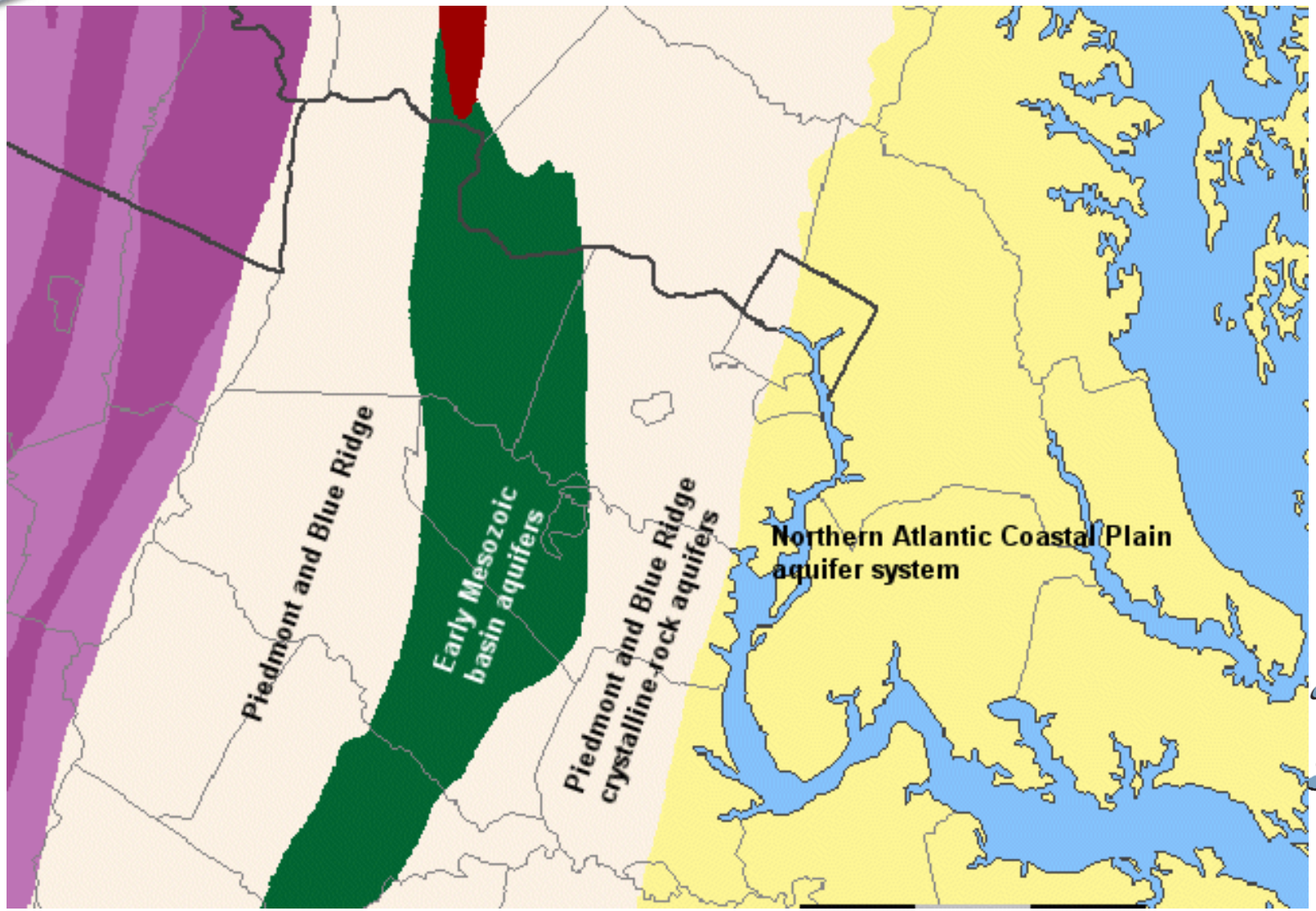
Stafford Aquifers



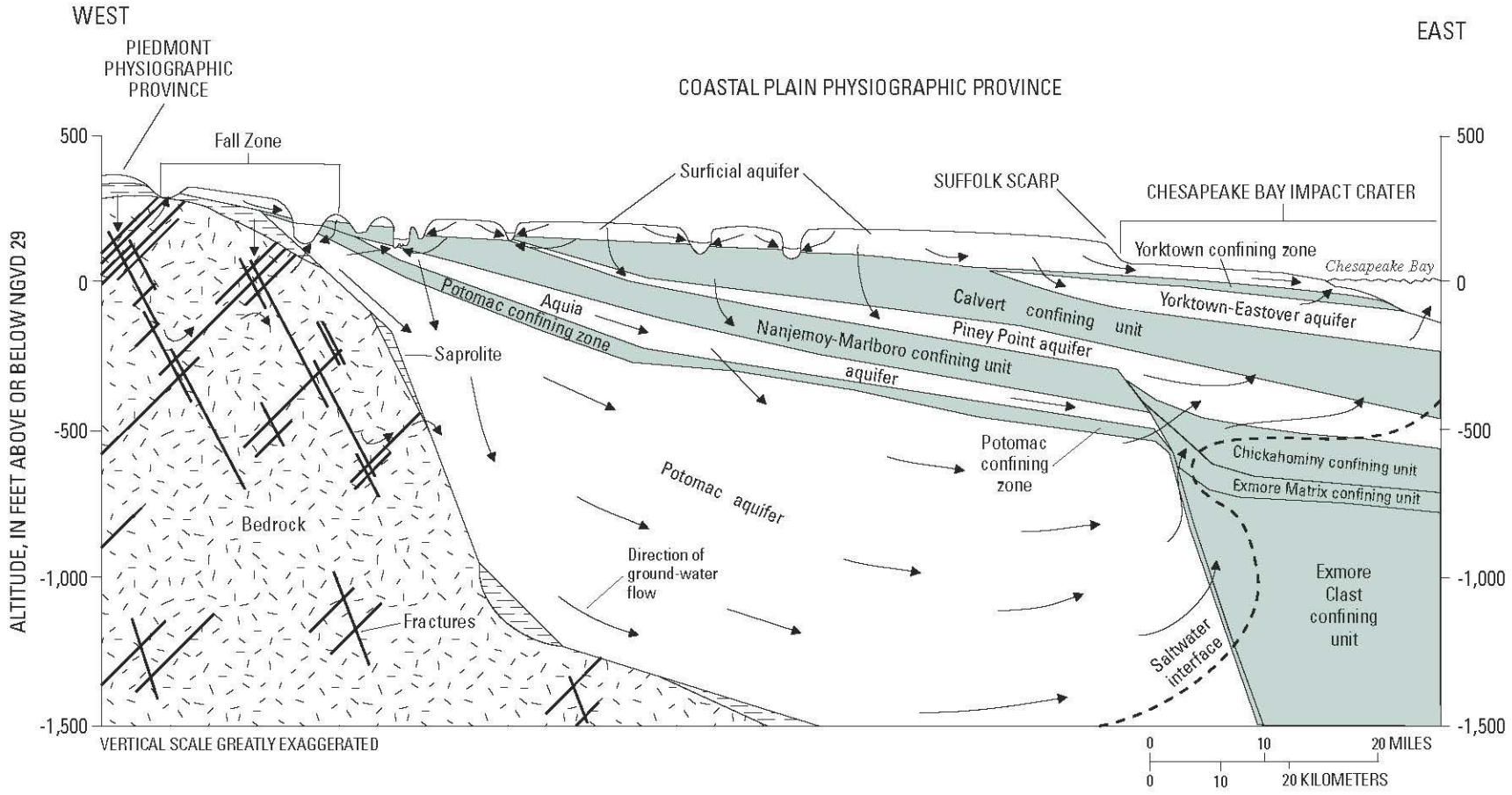


Figure 2. Generalized hydrogeologic section and directions of ground-water flow in the Virginia Coastal Plain (altitude relative to National Geodetic Vertical Datum of 1929).

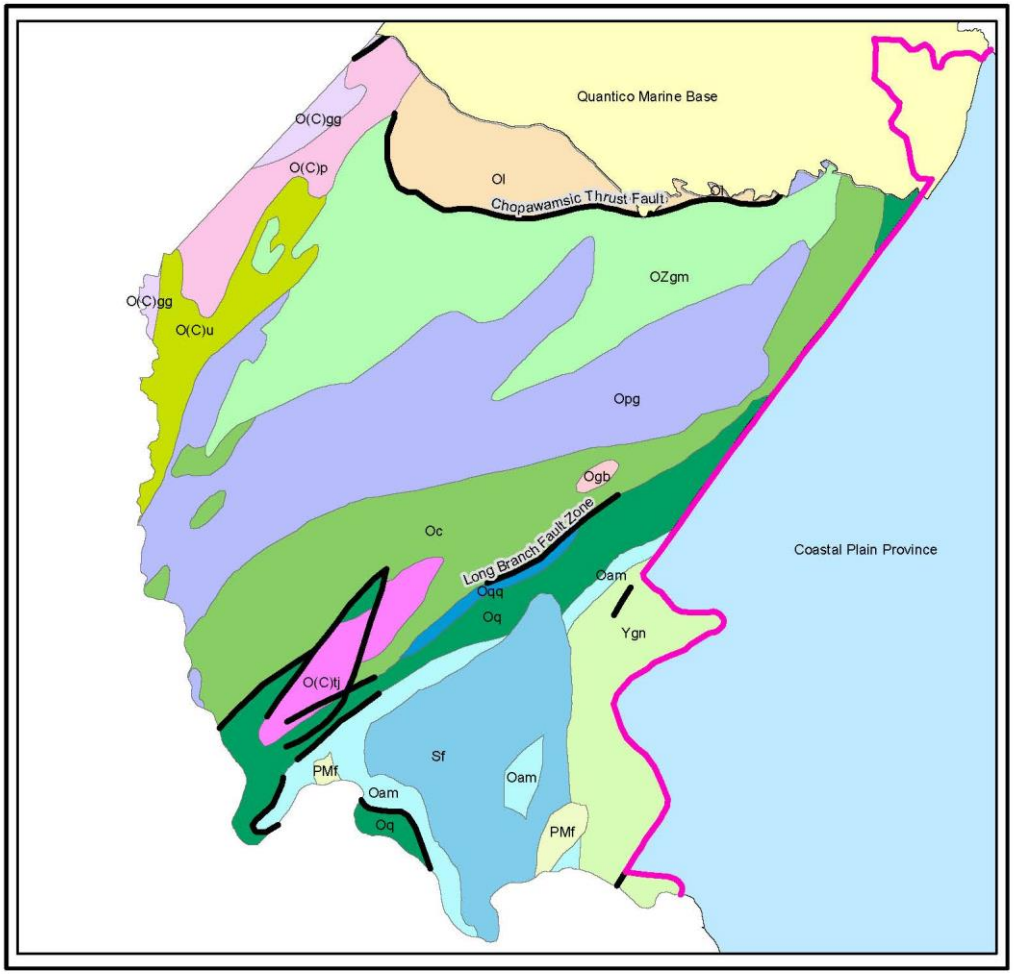


Figure 13: Consolidated Bedrock Geologic Mapping

Legend

- Fall Line
- Quantico Marine Base
- Coastal Plain Province
- Fault

0 1.25 2.5 5 Miles

Groundwater Resources Evaluation
Piedmont Province
Stafford County, VA

Map Notes:
(1) Mapping by Rader and Evans (1993) and Mixon et al. (2005) was modified by ECS to remove unconsolidated formations and to infer contacts of the underlying consolidated bedrock units; as such, the map only contains consolidated bedrock geologic units;
(2) See Table 1 within Groundwater Resource Evaluation Report for geologic unit descriptions.

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Piedmont Aquifer Characteristics

- Three zones
  - Shallow surface aquifer (≤ 55')
  - Bedrock fracture zone (≤ 300')
  - Bedrock zone w/o fractures (> 300')
- Surface zone use common in older homes (bored wells)
  - Low yield (< 15 gpm)
  - Susceptible to drought and indications are they can be influenced by nearby high volume withdrawals (Augustine GC ~300 gpm)
  - Susceptible to contamination
  - Rarely used in new construction
- Bedrock fracture zone (drilled wells)
  - Low yield (< 15 gpm, although there are exceptions)
  - Variability in quality (hardness, sulfur, etc.)
  - Most common for SFD outside public water service area

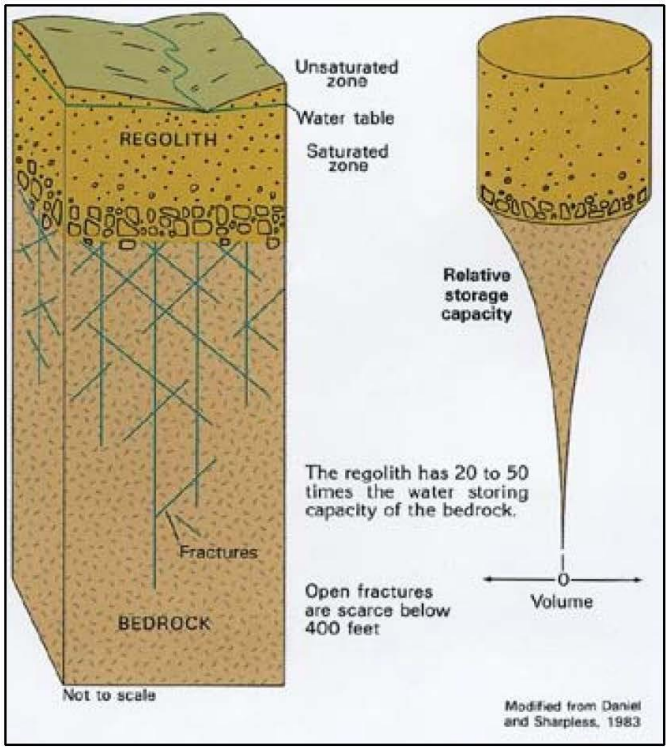

Figure 7: Cross-sectional diagram showing typical hydrogeologic conditions in Virginia's Piedmont Province. Groundwater is stored in the unconsolidated regolith, or saprolite, layer and percolates to fractures within the underlying consolidated bedrock aquifer. Bedrock fracturing is most prevalent at shallow depths and is largely absent below depths of approximately 400 feet. The cross-sectional diagram is unmodified from the USGS's Hydrologic Investigations Atlas 730-G (Miller, 1990).

Calculating Groundwater Usage

- GIS mapped all parcels with structures and without a public water account in study area
- Identified a total of 6,741 Piedmont wells in 2017
- Estimated between 220 and 231 gpd per dwelling
- Current use – 1.48 to 1.56 mgd

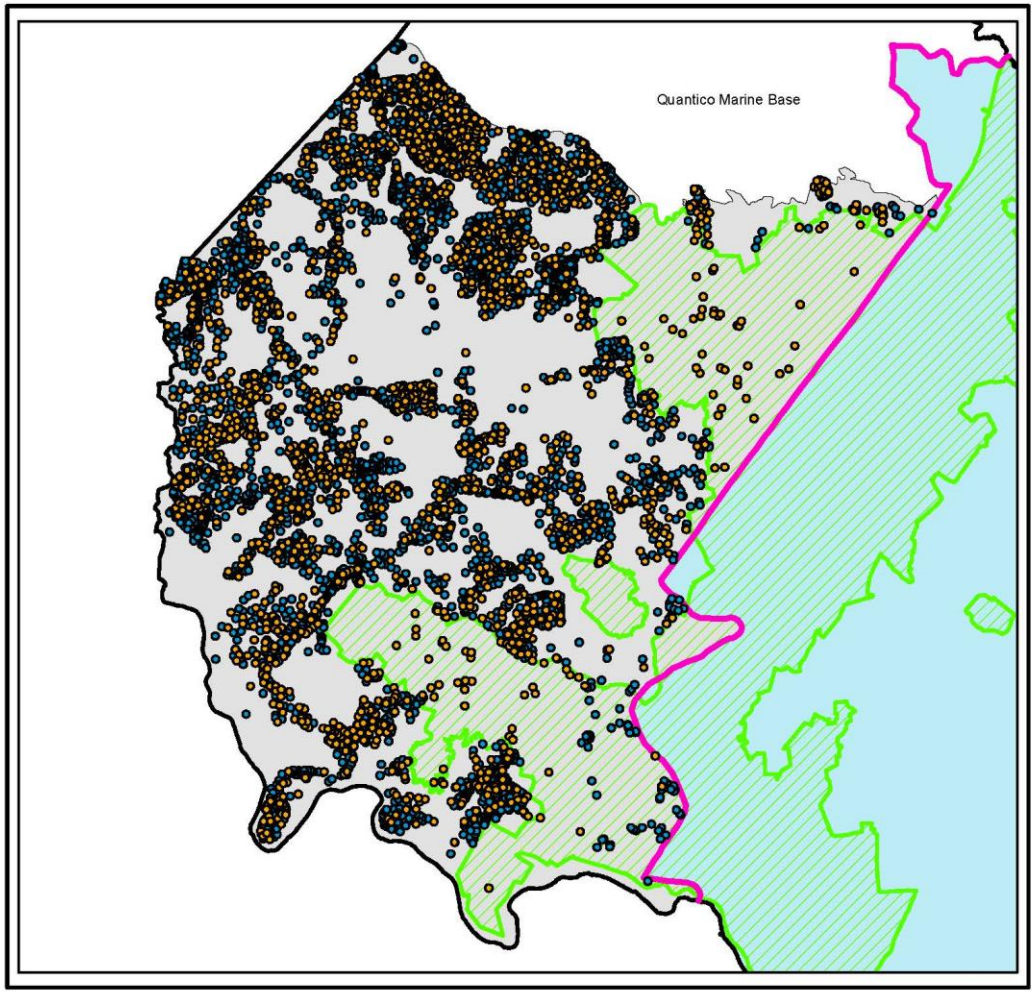

Figure 8: Well Database Records

Groundwater Resources Evaluation
Piedmont Province
Stafford County, VA

Legend

- Stafford County Boundary
- Study Area
- Coastal Plain Province
- Fall Line
- Municipal Service Area
- Stafford County Attribute Data Well Database Record (with attribute data; 1,801 records)
- Non-Attribute Data Well Database Record (without attribute data; 4,940 records)

N

0 1 2 4 Miles

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Available Groundwater

- Study calculated available groundwater for normal and drought year – drought year 65% of normal
- Subtracted out runoff, stream flow, use by vegetation, etc.
- Current use – 1.62 mgd (includes all uses)
- Groundwater available – 1.43 mgd
- <u>Could supply an additional 6,500 homes</u>

Areas of Specific Concern

- Looked at geologic areas, topography, proximity to water bodies, well density, when well was drilled and surface casing depth to see if there was a correlation to well productivity
- Used 3 gpm as threshold for low yielding well
- Used data from 1,800 well records collected in 2004 and 2017
- Strong correlation to geologic unit and casing depth
- No correlation to topography, well density
- Study also looked at when wells were drilled and found a trend that newer wells were slightly more productive

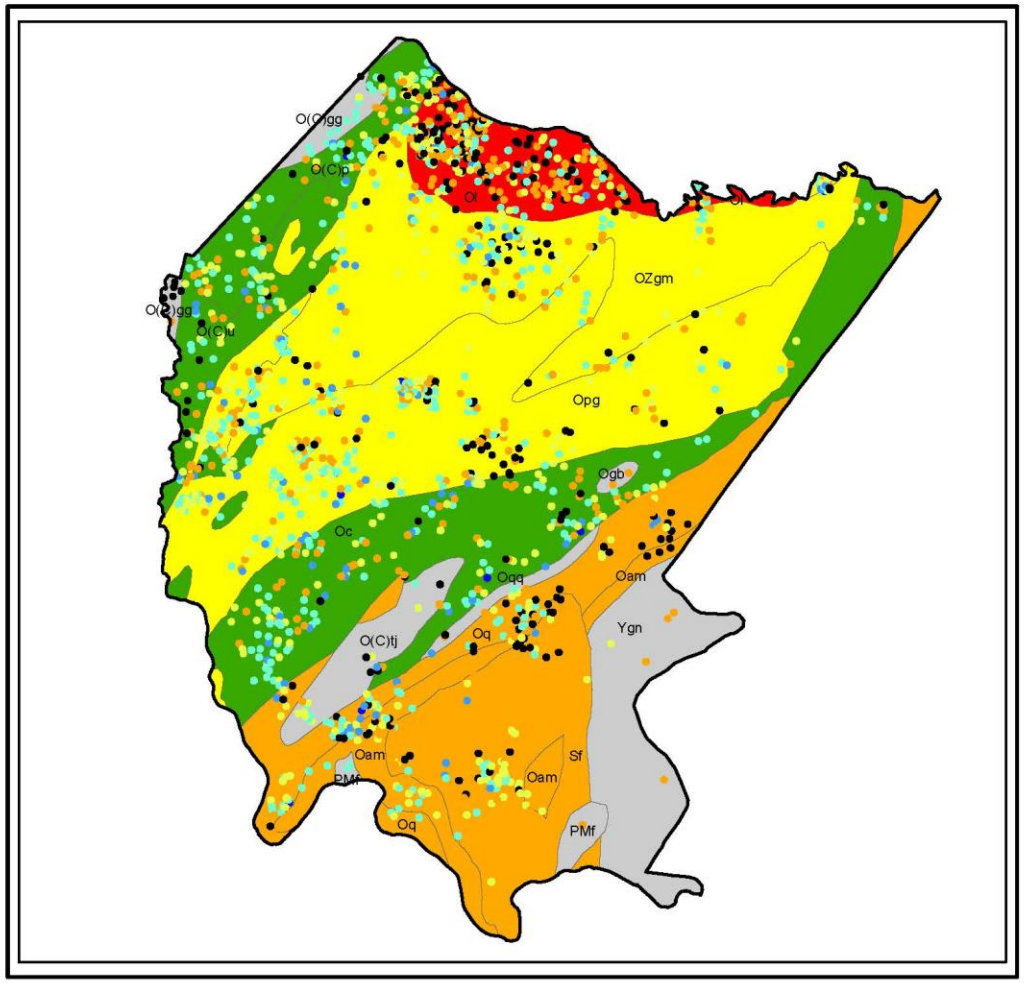

Figure 15a: Median Well Yields By Geologic Unit

Legend

Study Area Boundary

Median Well Yield (gpm)

- 15
- 12
- 10
- 6
- Not Classified

Supply Well Yield (gpm)

- 0.00 - 3.50
- 3.51 - 9.00
- 9.01 - 18.00
- 18.01 - 35.00
- 35.01 - 80.00
- 80.01 - 160.00

N

0 1 2 4 Miles

Groundwater Resources Evaluation
Piedmont Province
Stafford County, VA

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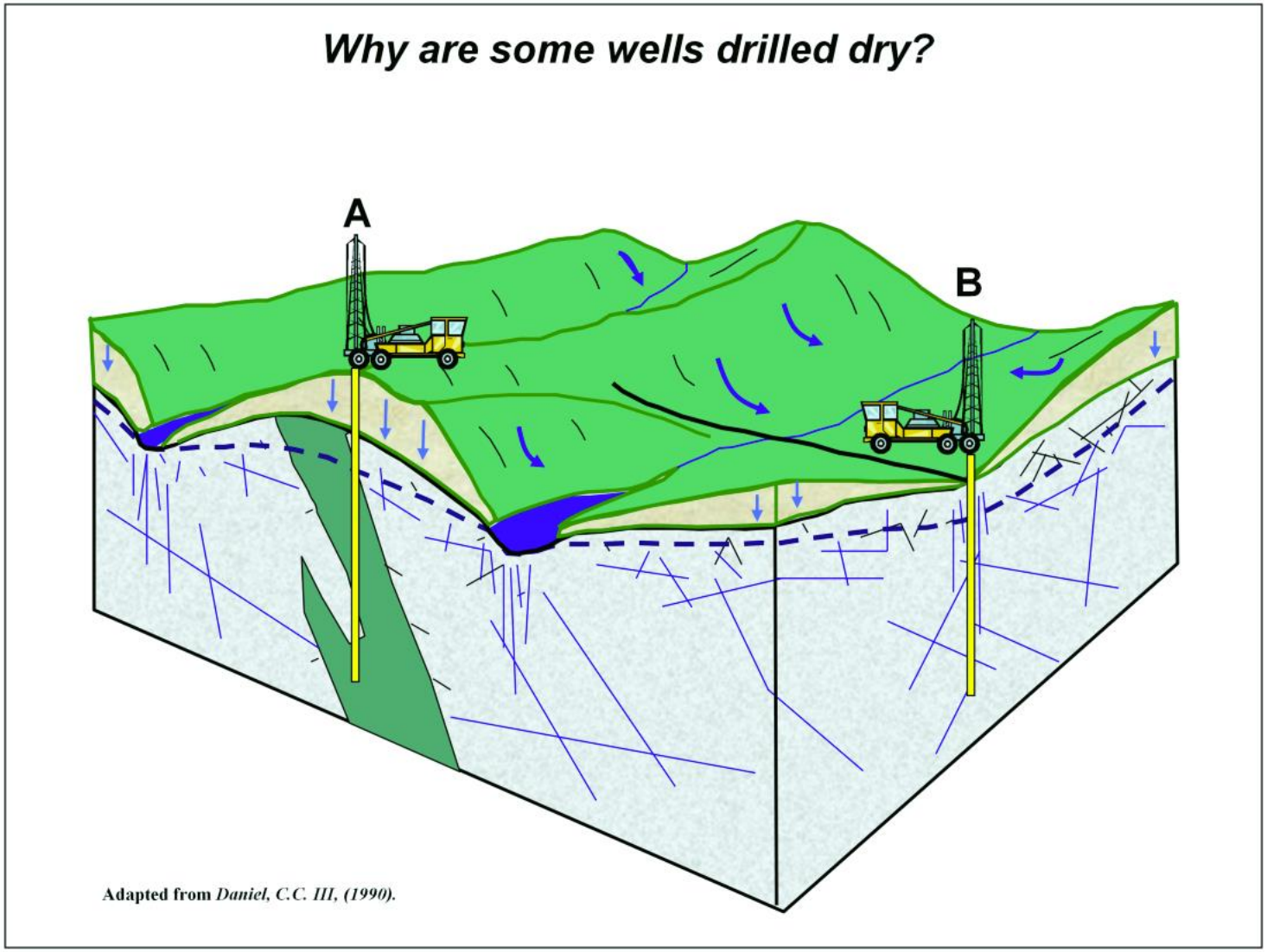
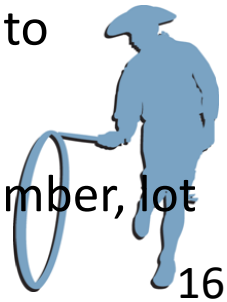
Localized Conditions



Well Regulations

- Stafford was given specific legislative authority to regulate wells based on water quality, not for well construction and abandonment
- Seven localities have this authority currently; Fairfax, Loudoun, Prince William, Goochland, James City, Powhatan and the City of Suffolk
- Study looked at six counties that have adopted well regulations for wells in the Piedmont; Fairfax, Loudoun, Fauquier, Albemarle, Rappahannock and Orange.
- Each passed ordinances requiring hydrogeologic assessments for new developments to be supplied by groundwater resources.
- These localities cite various authority for implementing these regulations; subdivision, zoning, stormwater, E&S and CBA, although citations vary by jurisdiction
- Not all cite specific state authority, although some cite state code delegating to localities authority to manage orderly development
- Adopted requirements range from drilling and testing for every lot prior to receiving a building permit (Albemarle & Fairfax), to sample testing for subdivisions
- Testing parameters are wide ranging and vary by locality based on lot number, lot size, etc.



Monitoring Wells

- The study found that monitoring wells would allow us to detect short and long term changes in groundwater levels
- Nineteen sites were evaluated based on certain criteria, and four sites were determined to provide the best locations for monitoring wells.
- An additional site could be considered to monitor the densely populated area adjacent to Quantico, and known to be in a low yielding geologic area
- Each site would cost ~$20k to construct, and another ~$3k for monitoring equipment; there is an annual O&M cost of ~$13k associated with this as well

Next Steps

- The study is in draft final form, pending input from the public, Planning Commission and the Board.
- The study will be presented to the Planning Commission for comment, and then to the Board

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Questions?