

Groundwater Sources, Well Design, and Permitting

March 6, 2018

All About Irrigation Workshop

Tidewater Agricultural Research
and Extension Center
Suffolk, VA

Presented by:
Curtis Consolvo, P.G.
GeoResources, Inc.



Permitting Requirements (VA & NC)

State-wide in Virginia and North Carolina:

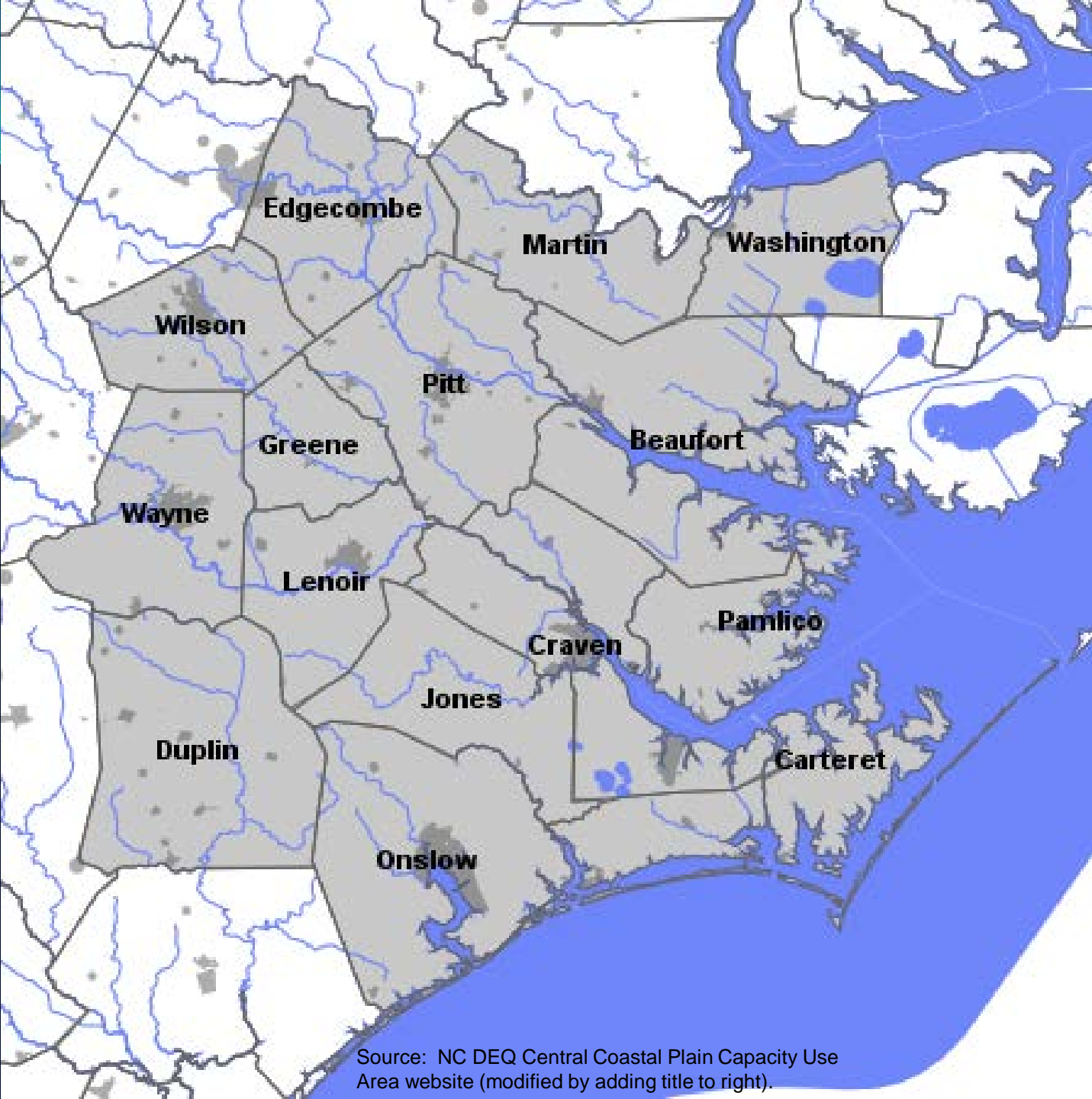
- Health Department Permit for each well (well driller typically handles).

Virginia Groundwater Management Areas (Coastal Plain):

- Groundwater Withdrawal Permit for total withdrawal (via one or more wells) if > 300,000 gallons in any calendar month.

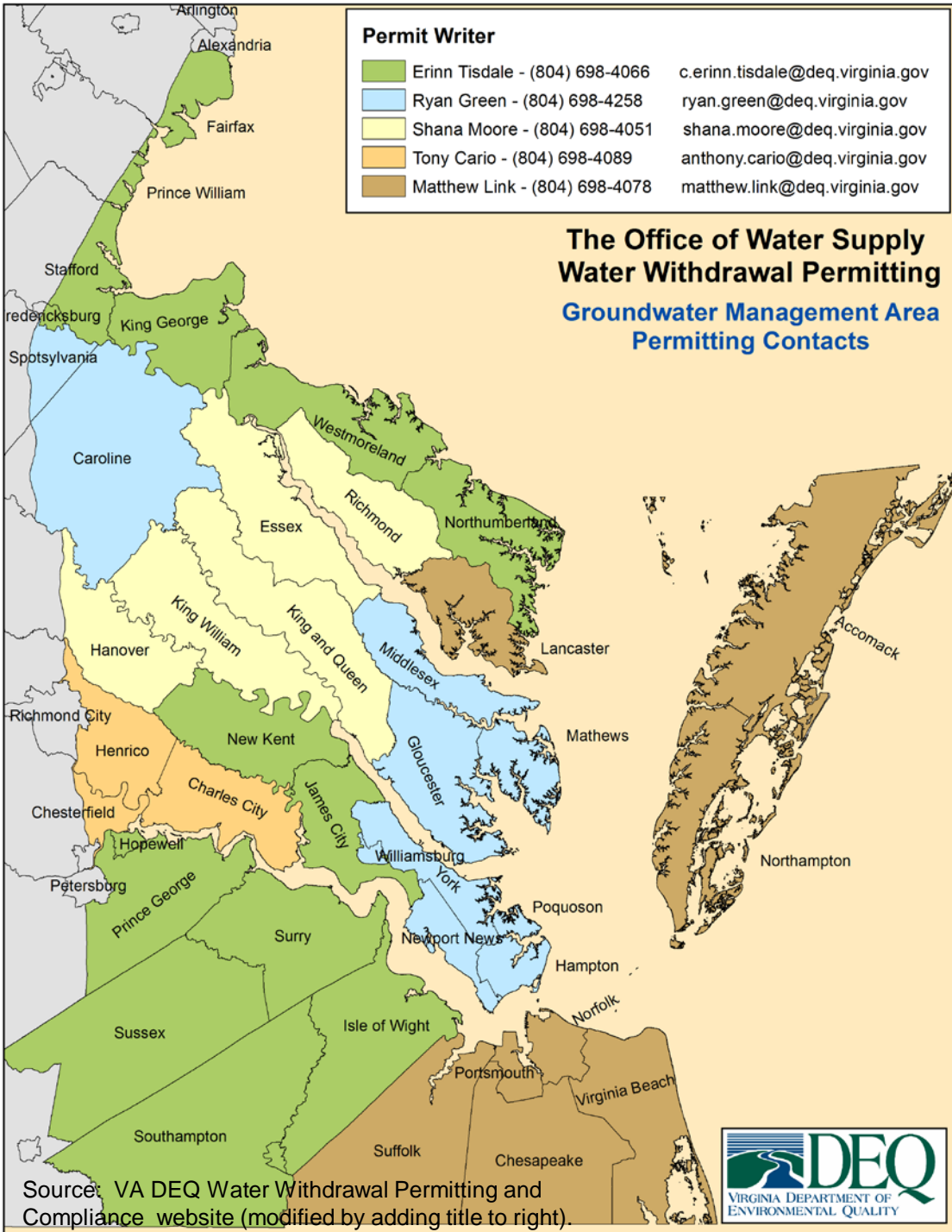
North Carolina:

- State Well Construction Permit for wells with design capacity > 100,000 gpd.
- If located in Central Coastal Plain Capacity Use Area (15-county area), registration and reporting requirements start at 10,000 gpd, and Water Use Permit required if > 100,000 gpd.



NC Central Coastal Plain Capacity Use Area

Source: NC DEQ Central Coastal Plain Capacity Use
Area website (modified by adding title to right).



VA DEQ

Groundwater Management Areas

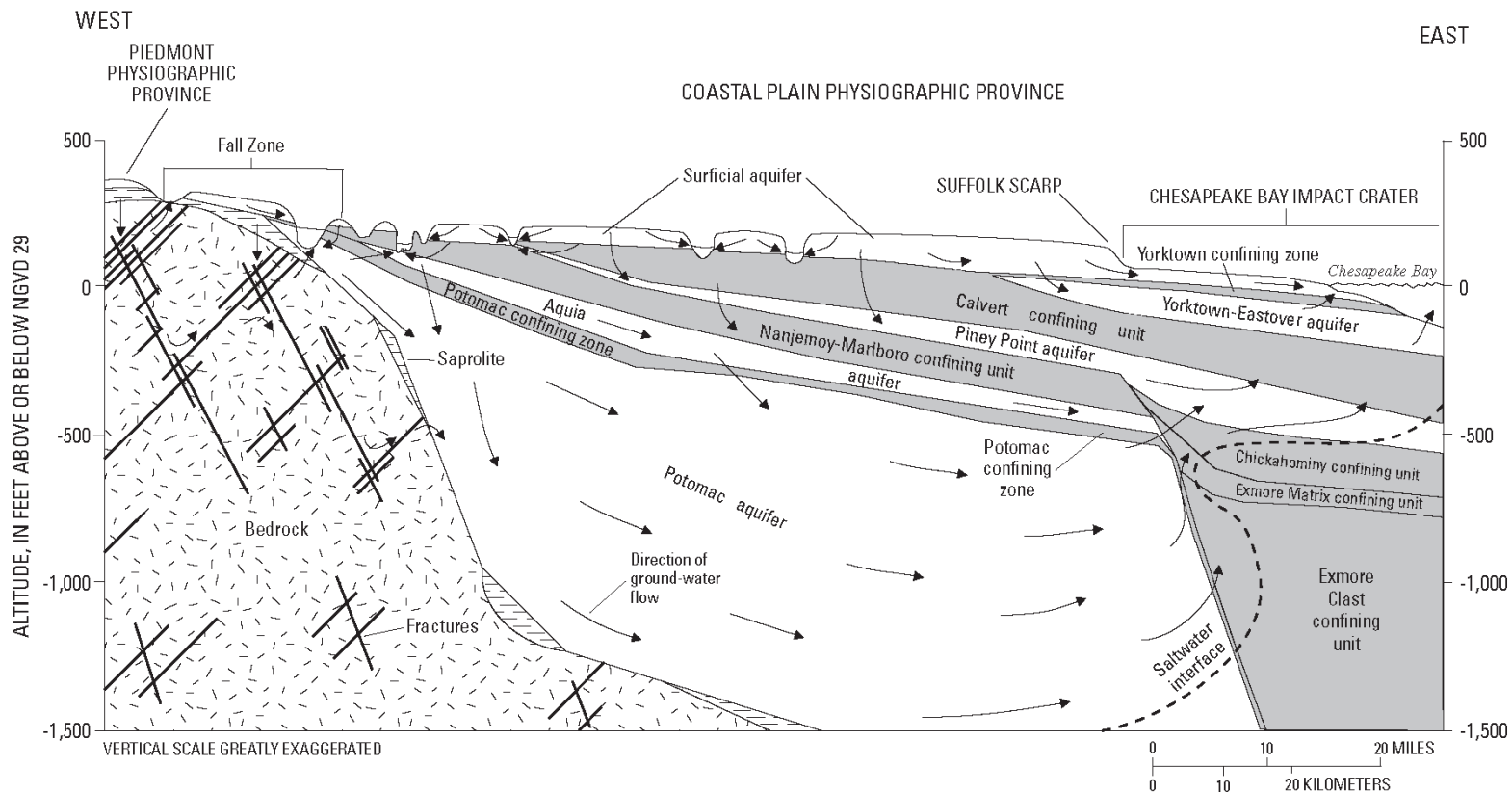
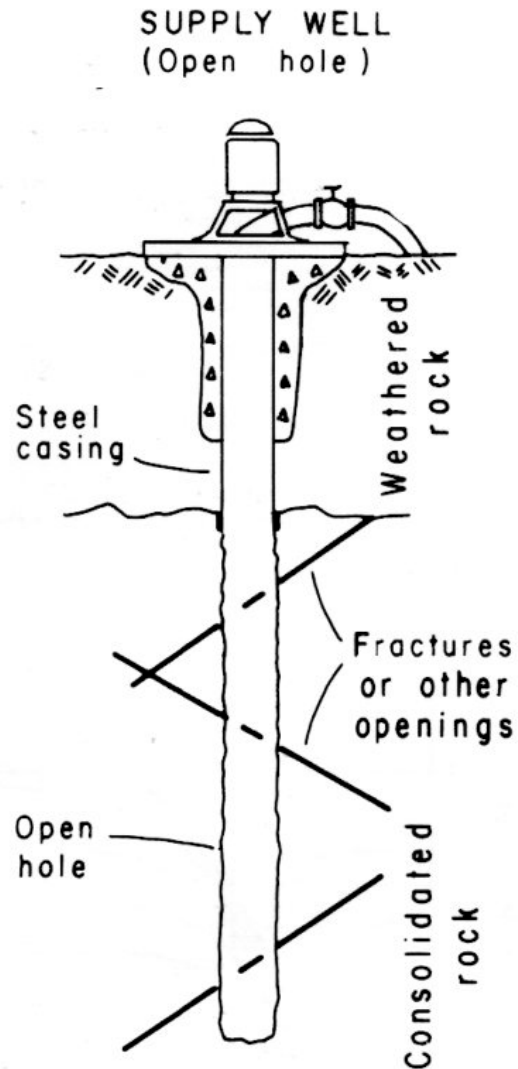


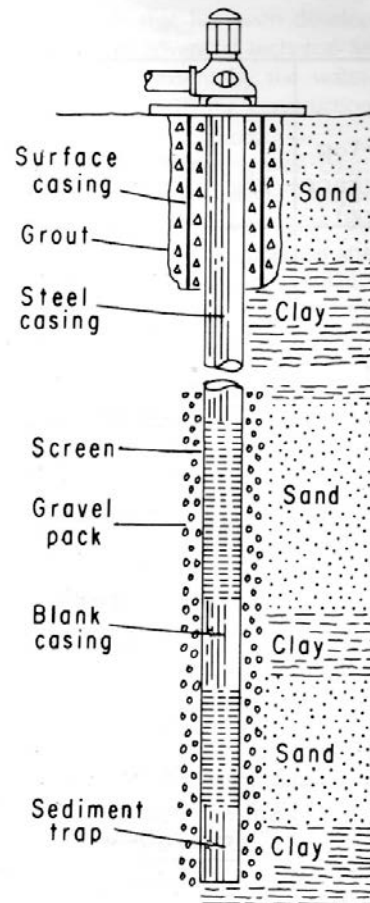
Figure 2. Generalized hydrogeologic section and directions of ground-water flow in the Virginia Coastal Plain (altitude relative to National Geodetic Vertical Datum of 1929).

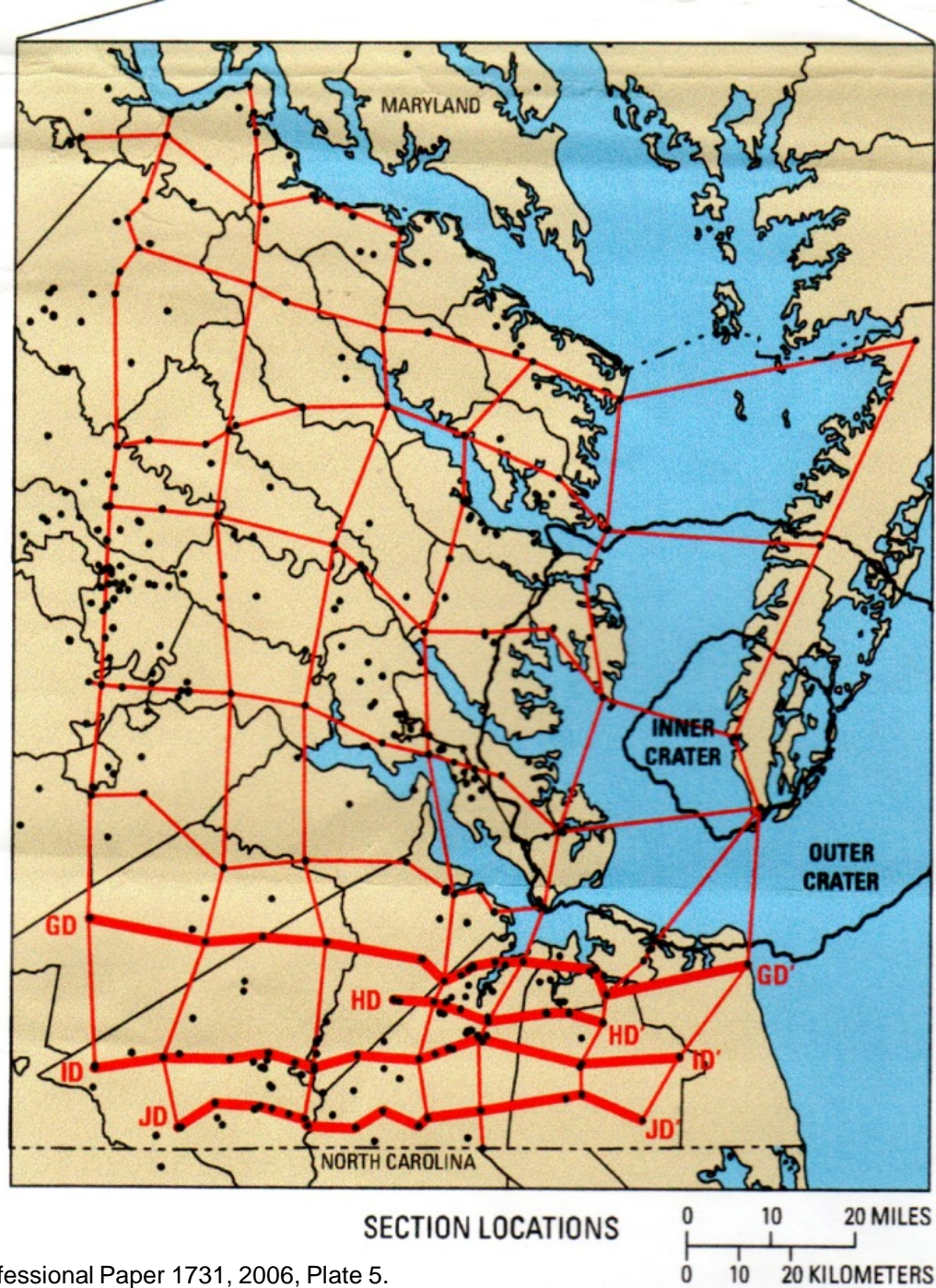
Open-Hole Well (in Bedrock)



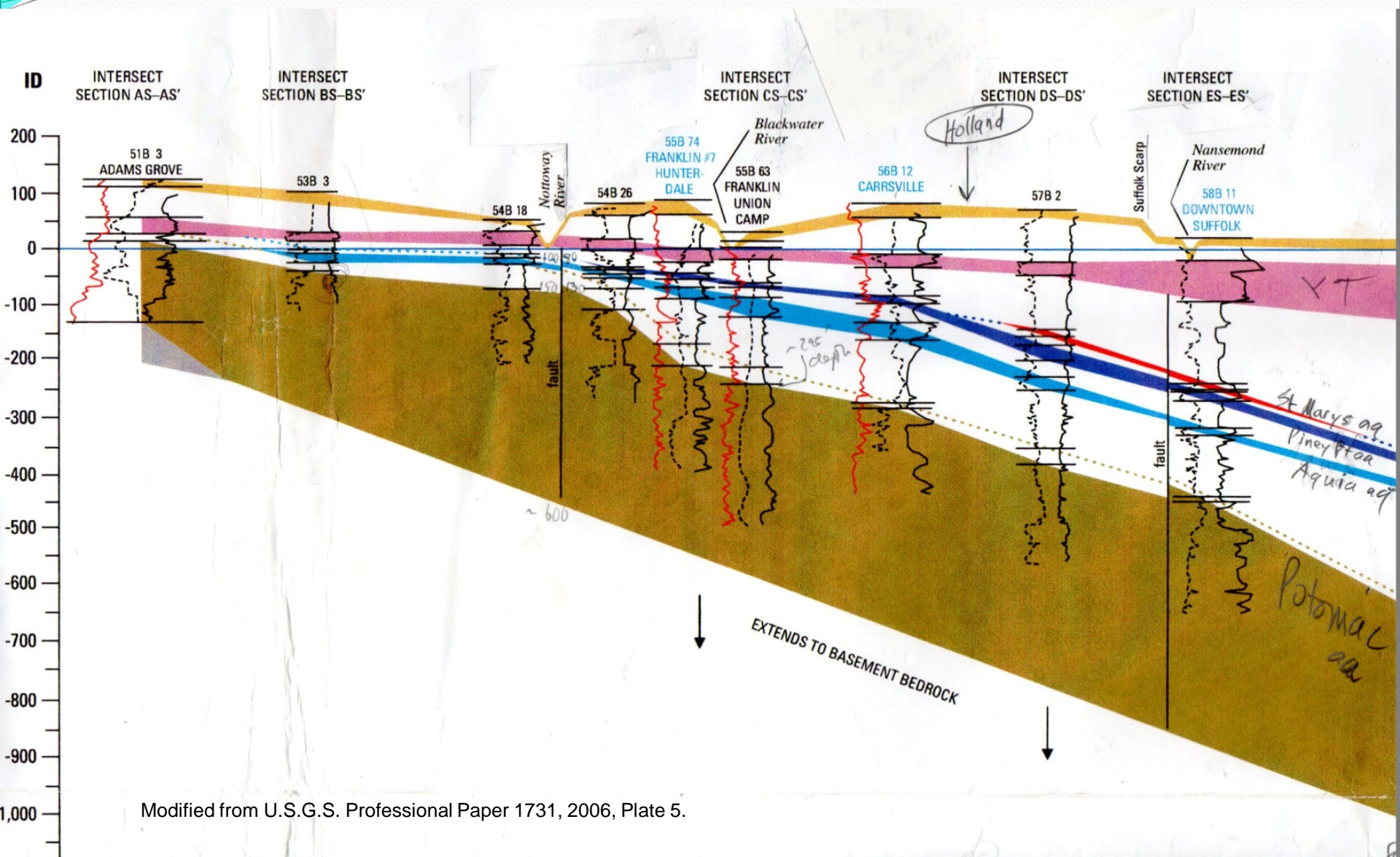
Screen and Gravel-Pack Well (in unconsolidated, Coastal Plain sediments)

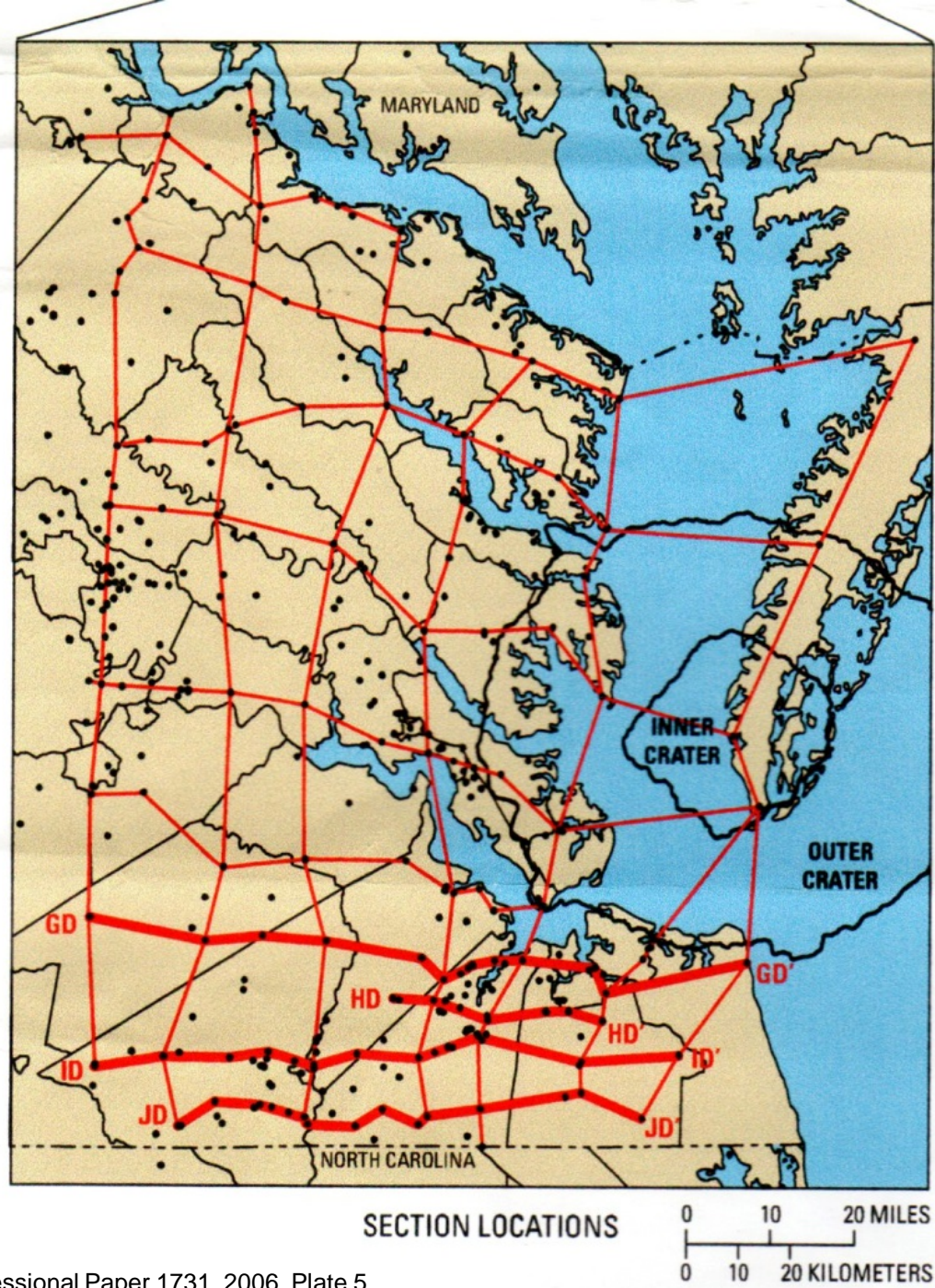
SUPPLY WELL
(Multiple screen, gravel pack)



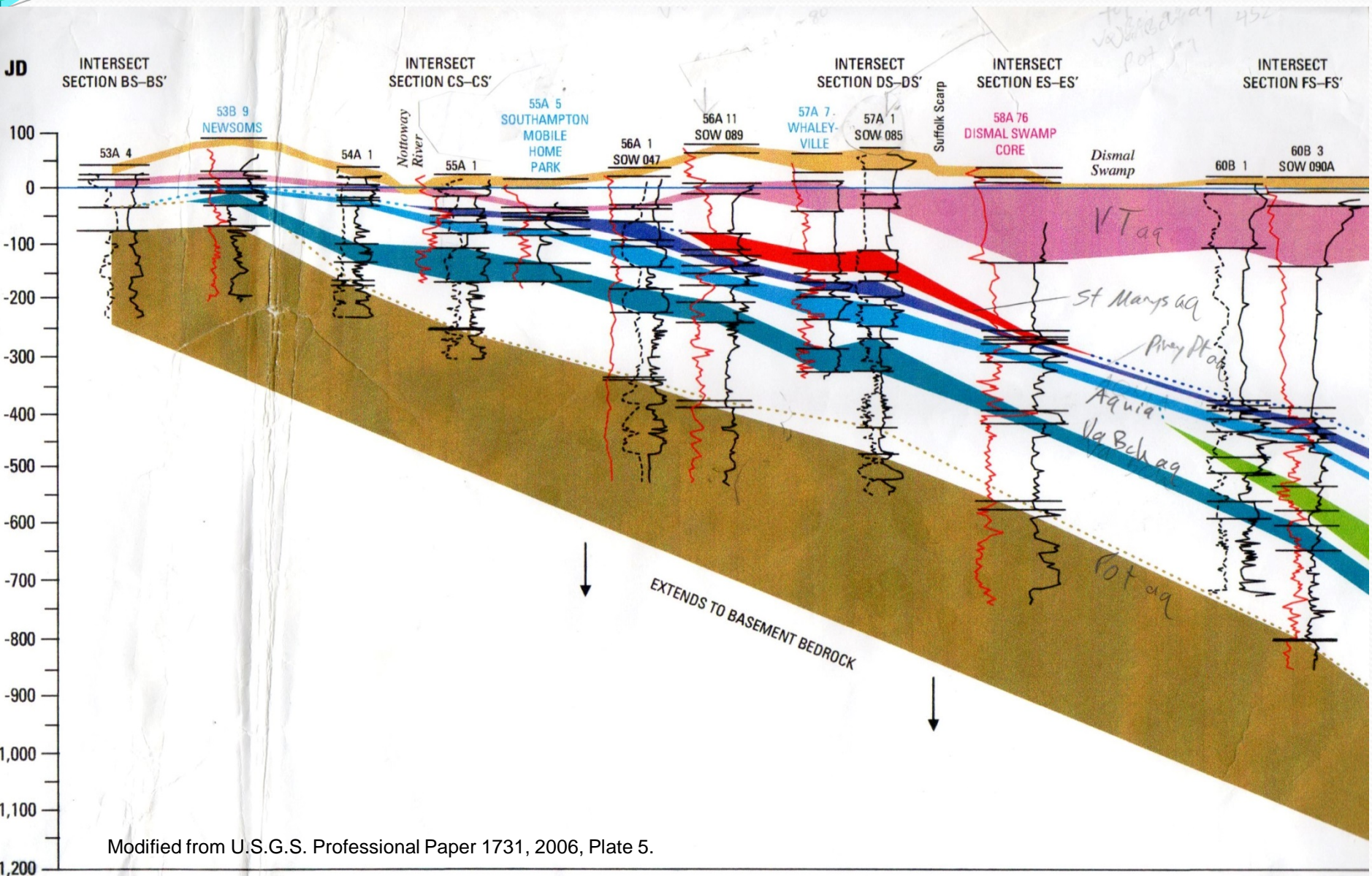


Modified from U.S.G.S. Professional Paper 1731, 2006, Plate 5.



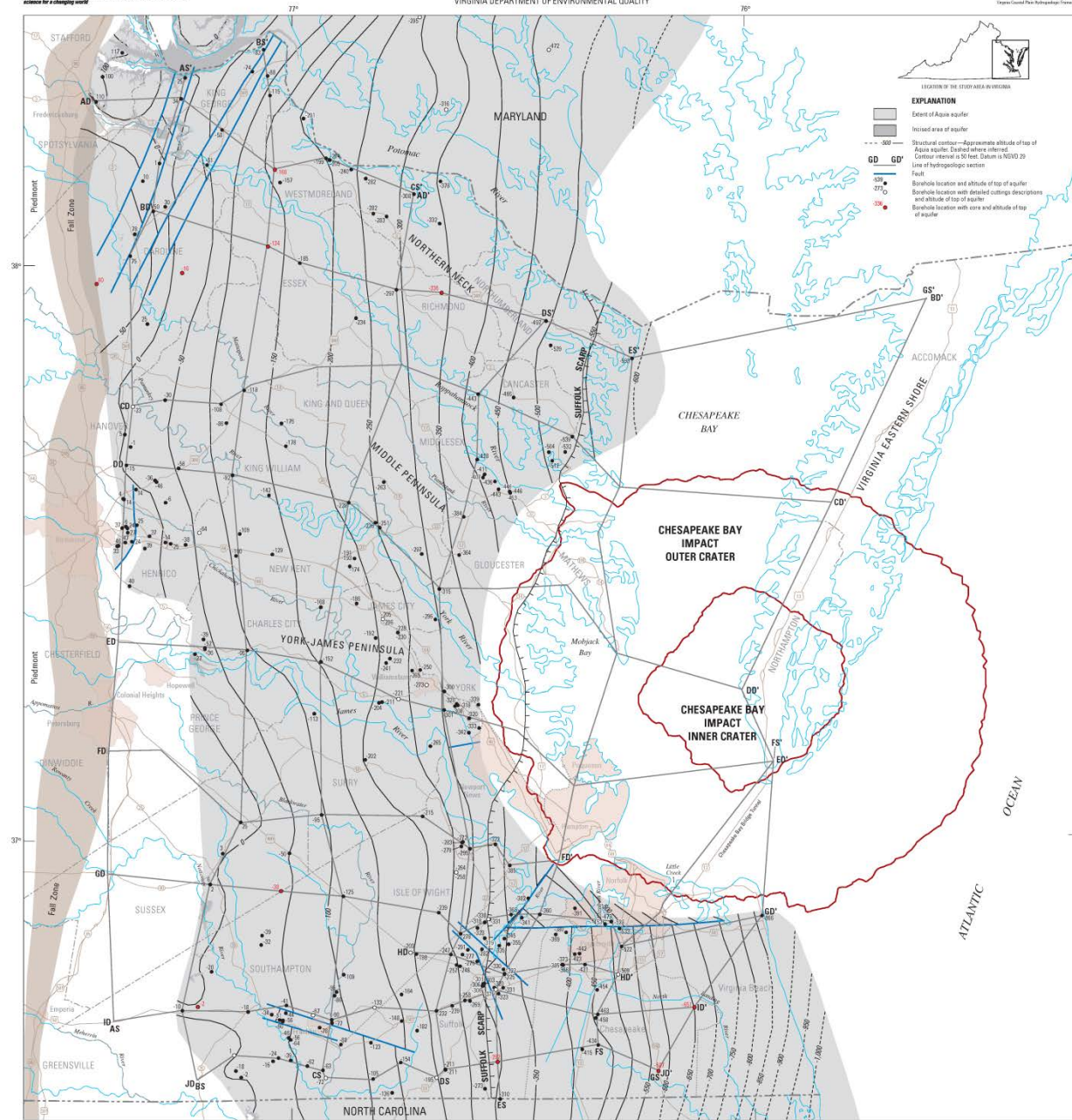


Modified from U.S.G.S. Professional Paper 1731, 2006, Plate 5.



Modified from U.S.G.S. Professional Paper 1731, 2006, Plate 5.

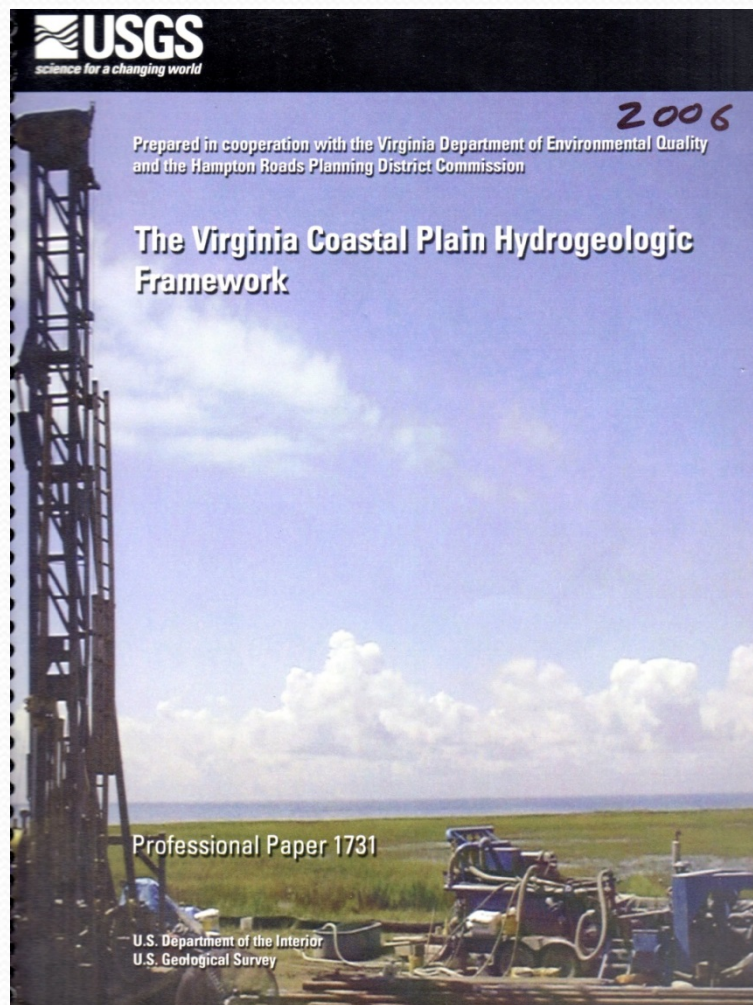




Base from U.S. Geological Survey, 1973
State of Virginia, 1:500,000

By
E. Randolph McFarland and T. Scott Bruce
2006

Hydrogeologic framework information available on-line:



3/4/2018

Virginia DEQ - Ground Water Characterization



Search

My DEQ Permits Laws & Regulations Programs Locations About Us Connect With DEQ

[Programs](#) [Water](#) [Water Supply & Water Quantity](#) [Groundwater Characterization](#)

[Geophysical Logging Program](#)

[Well Database](#)

[State Observation Well Network](#)

[Spring Database](#)

[Frequently Asked Questions](#)

[Reports & Publications](#)

[Contacts](#)

[Virginia Department of Environmental Quality](#)

Mailing Address:
P.O. Box 1105
Richmond, VA 23218

Street Address:
1111 East Main St., Suite 1400
Richmond, VA 23219

Contact Us:
1-(804) 696-4000
1-800-592-5482 (Toll Free in VA)

[View Department of Environmental Quality Response](#)



Ground Water Characterization

Legislation and funding approved by the Virginia General Assembly during the 2005 session established the DEQ Office of Ground Water Characterization in response to negative impacts experienced by many localities, businesses, and domestic well users during the drought of 2002. Two new staff positions were created and one existing position was reorganized within the Division of Water Resources to create the program under the leadership of Scott Bruce. The program has been fully staffed since mid February 2006 by three regional staff members Todd Beach-Coastal Plain, Brad White-Piedmont-Blue Ridge, and Jbel Maynard, Valley-Plateau. In 2008, the group was renamed the Ground Water Characterization Program (GWCP).

The organizational objective of the Ground Water Characterization Program is to protect Virginia's environment and promote the health and well being of its citizens by collecting, evaluating, and interpreting technical information necessary to manage ground water resources of the Commonwealth. The GWCP staff works to assure that necessary information is available to support resource management decisions, water supply planning activities, assess ground water availability, facilitate drought monitoring, and support the expansion or creation of ground water management areas.



Above Left: Acoustic Televiewer Logging of Louisa State Observation Well.
Above Right: Chesapeake Bay Impact Crater Mega-Breccia Horizon in Sediment Core.

VA DEQ Office of Groundwater Characterization

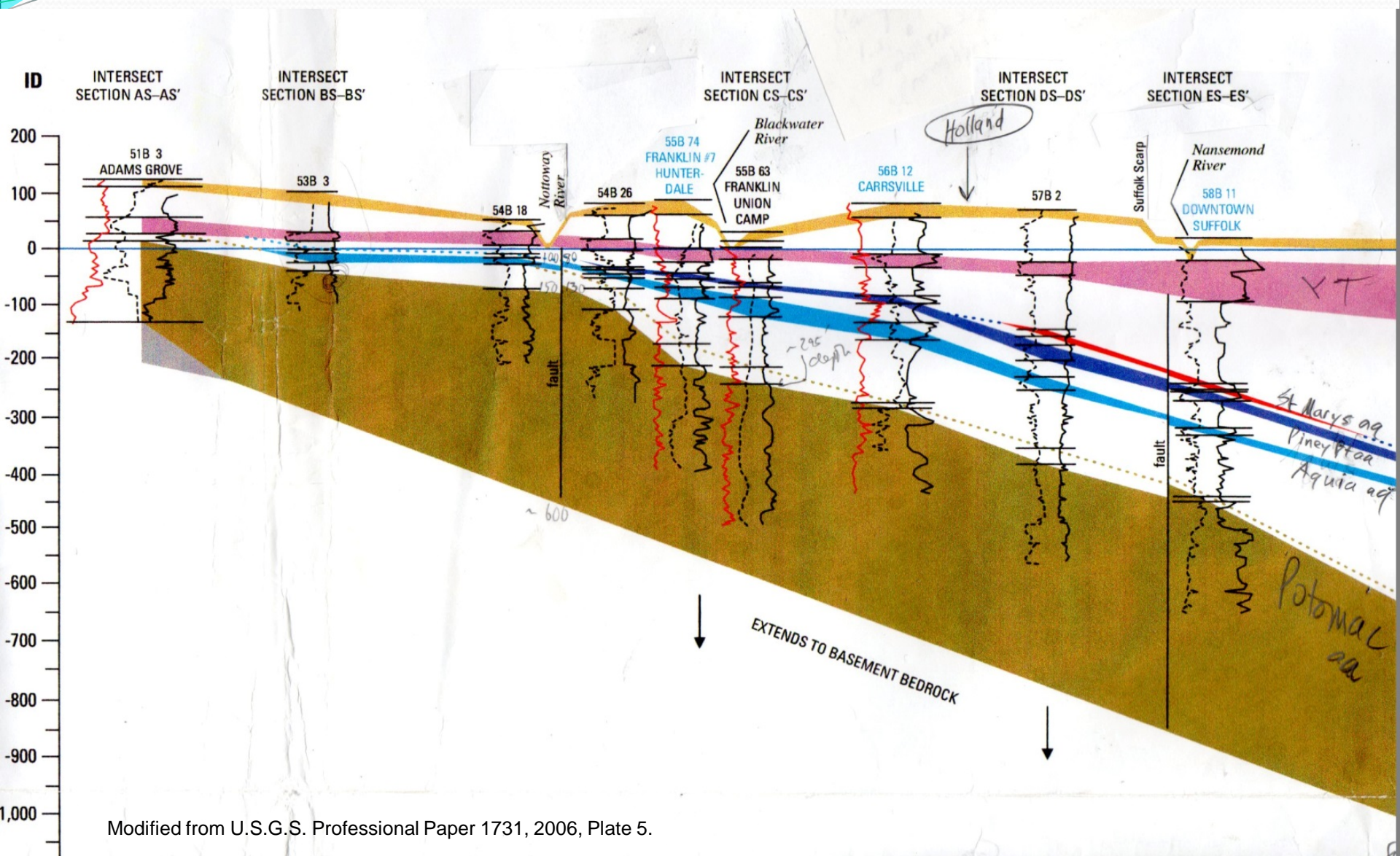
<http://www.deq.virginia.gov/Programs/Water/WaterSupply/WaterQuantity/GroundwaterCharacterization.aspx>

1/2

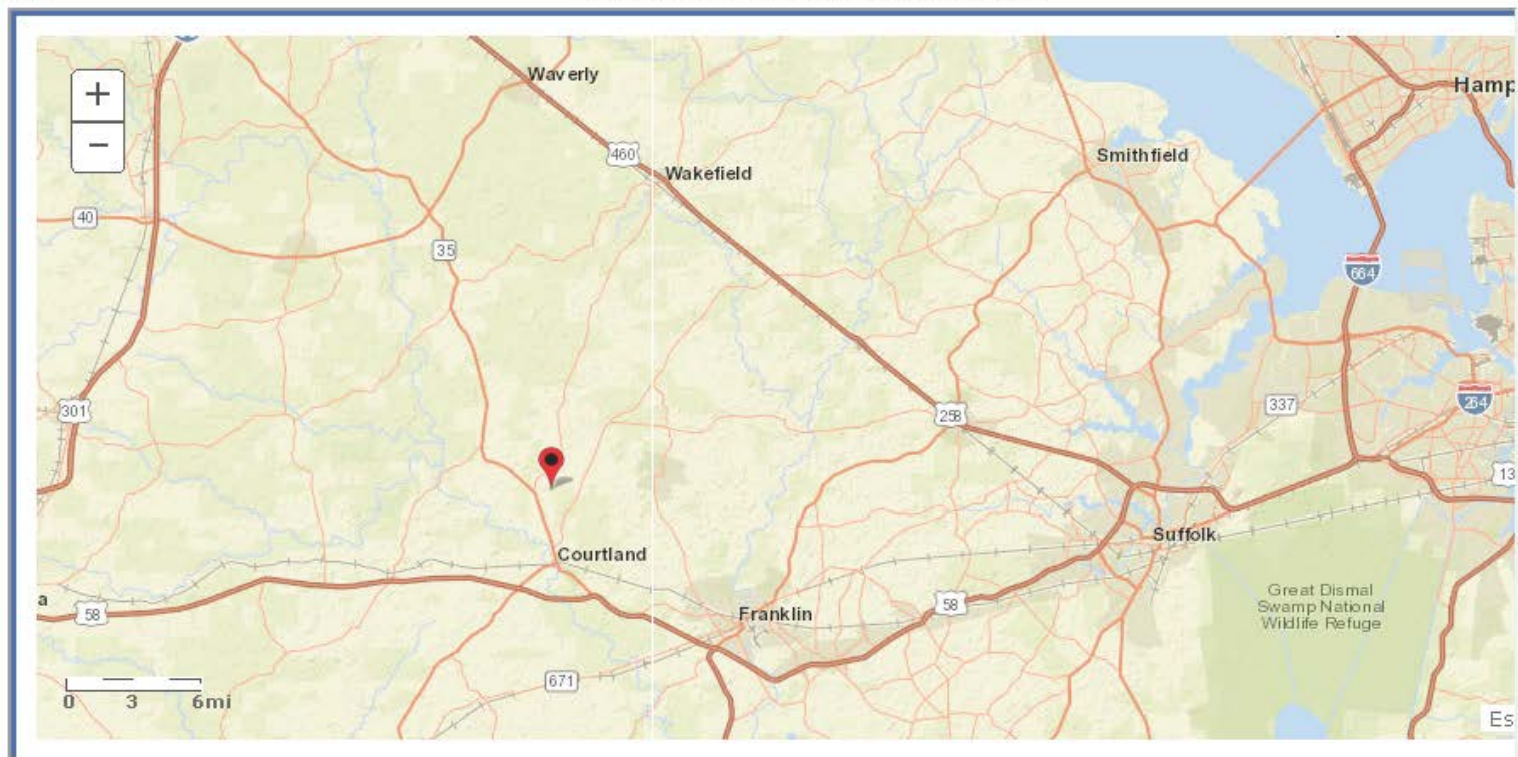
And in North Carolina, the NC Division of Water Resources, Groundwater Management Branch is an excellent source of information.







Modified from U.S.G.S. Professional Paper 1731, 2006, Plate 5.



[Questions about sites/data?](#)

[Feedback on this web site](#)

[Automated retrievals](#)

[Help](#)

[Data Tips](#)

[Explanation of terms](#)

[Subscribe for system changes](#)

[News](#)

[Accessibility](#)

[Plug-Ins](#)

[FOIA](#)

[Privacy](#)

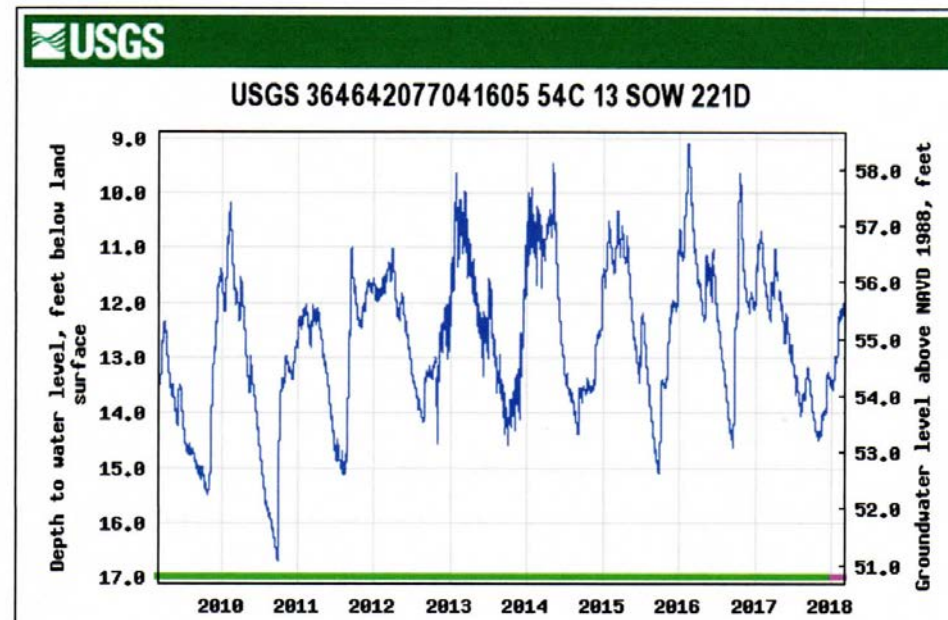
[Policies and Notices](#)

[U.S. Department of the Interior](#) | [U.S. Geological Survey](#)



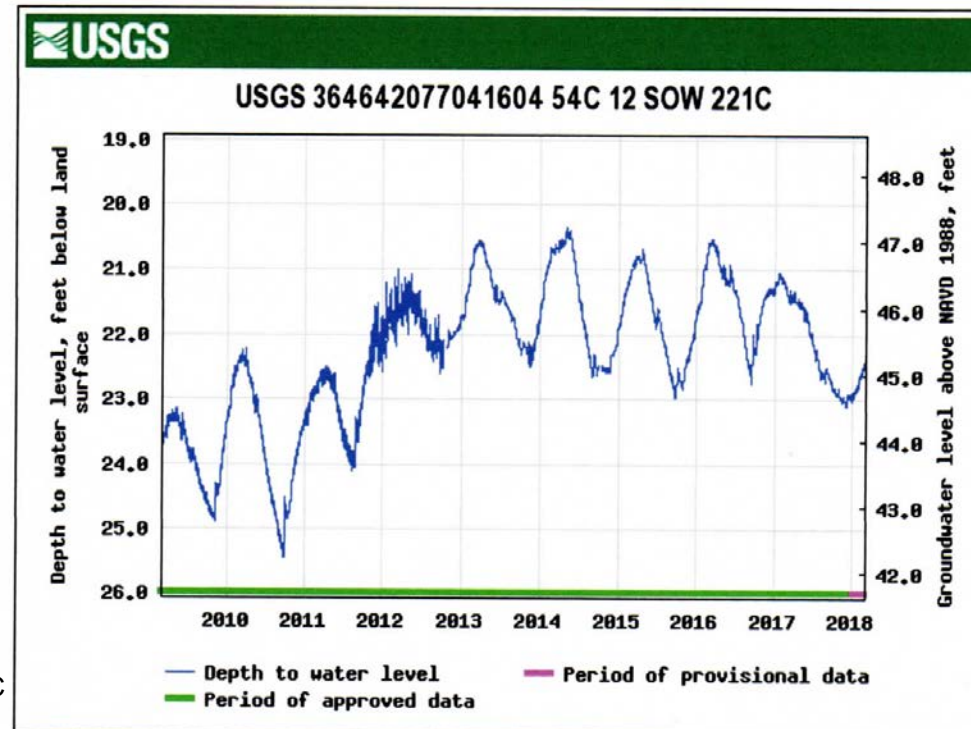
Well depth: 42 feet

Water level
depths: ~ 13 feet



Well depth: 96 feet

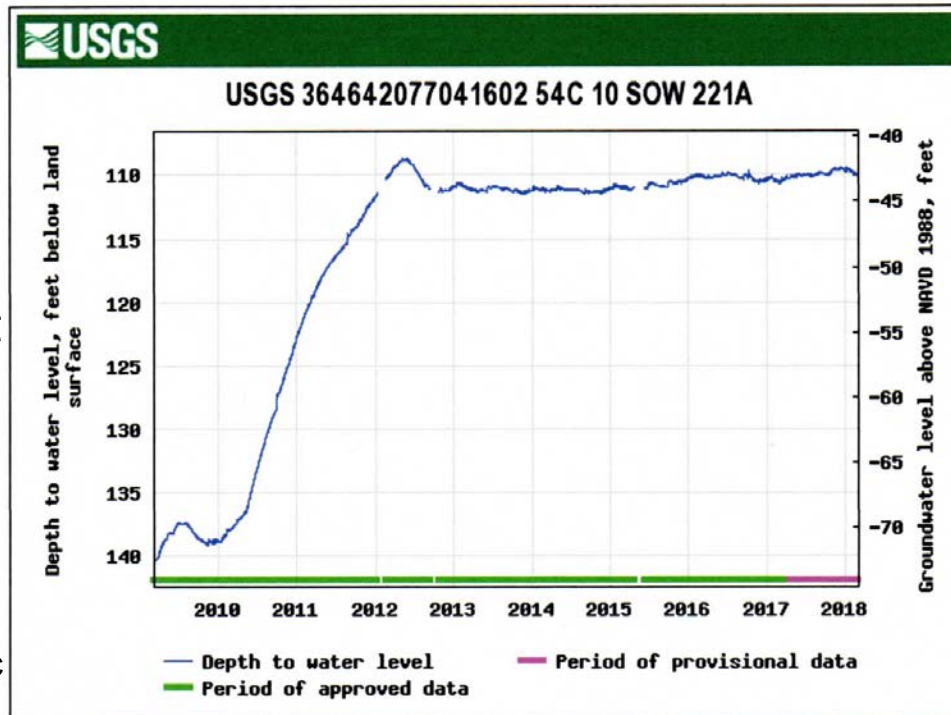
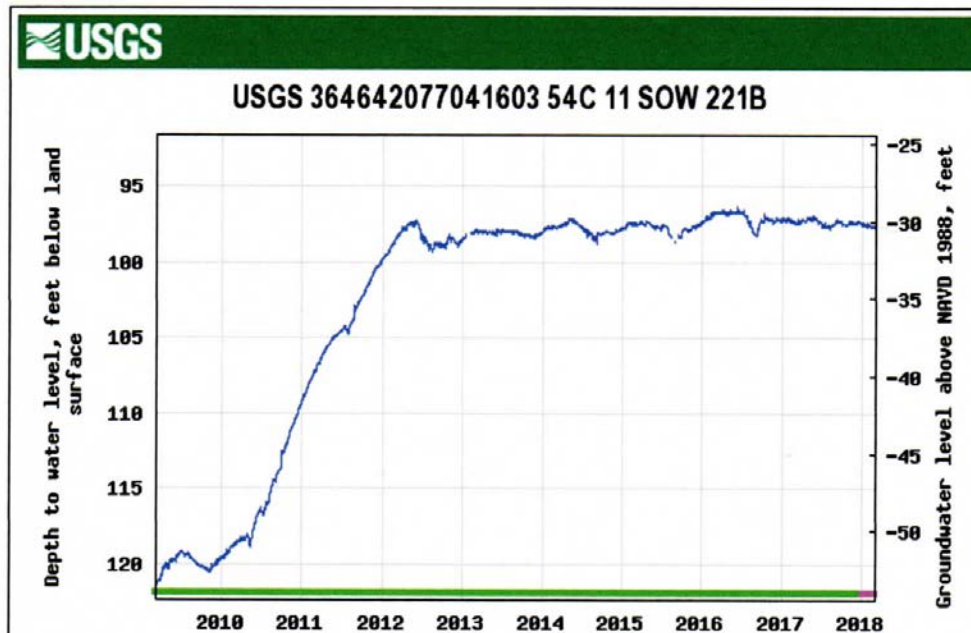
Water level
depths: ~ 22 feet



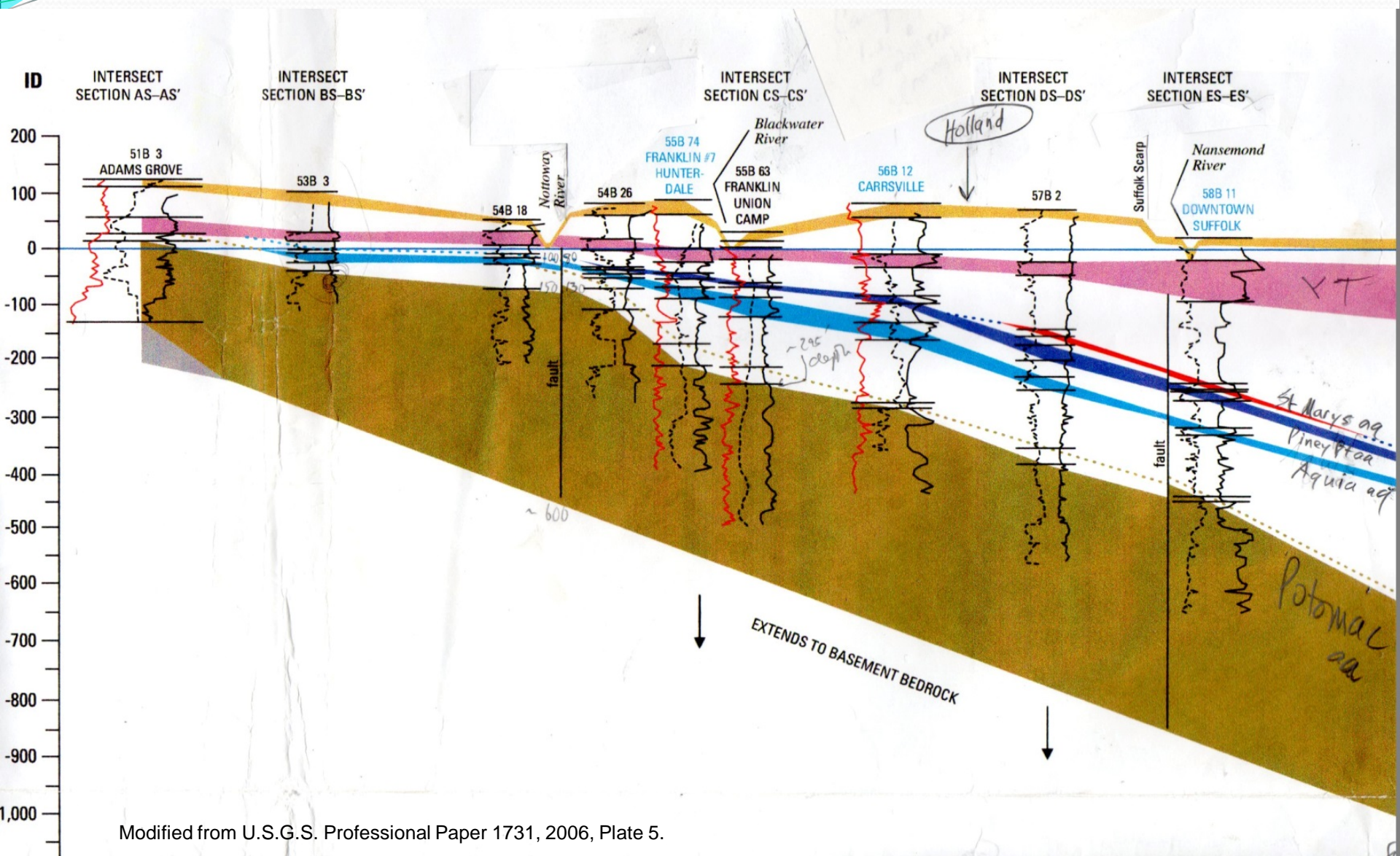
Graphs from data querying/displaying via U.S.G.S. Water Data website for wells 54C 13 SOW 221D and 54C 12 SOW 221C (modified by adding text/numbers to left).

Well depth: 178 feet

Water level depths
(recently): ~ 98 feet



Graphs from data querying/displaying via U.S.G.S. Water Data website for wells 54C 11 SOW 221B and 54C 10 SOW 221A (modified by adding text/numbers to left).

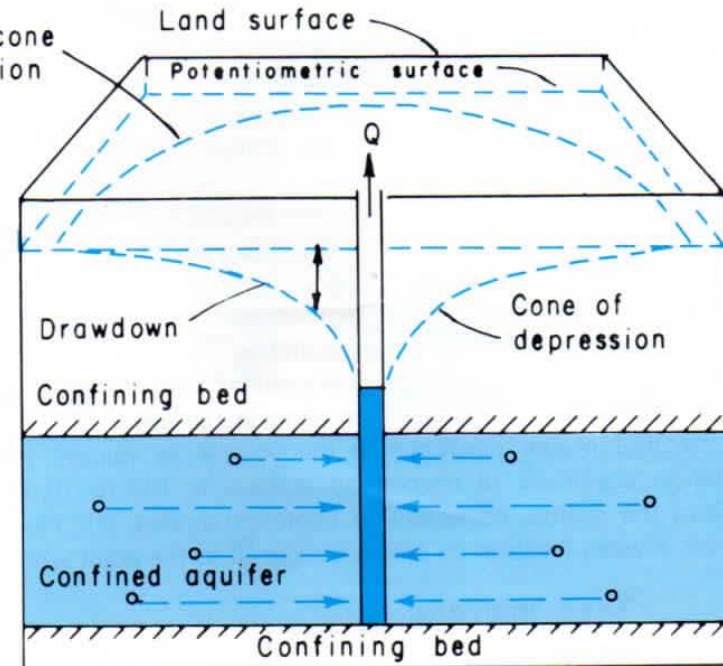
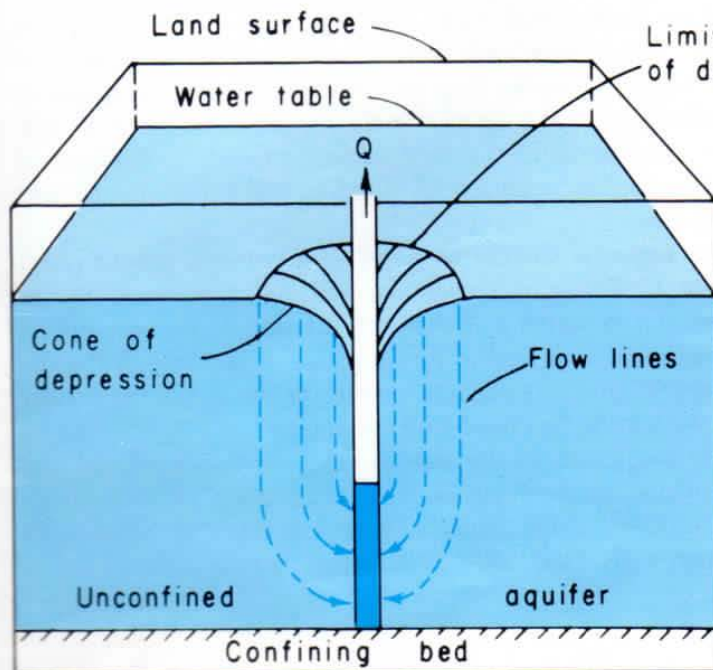


Modified from U.S.G.S. Professional Paper 1731, 2006, Plate 5.

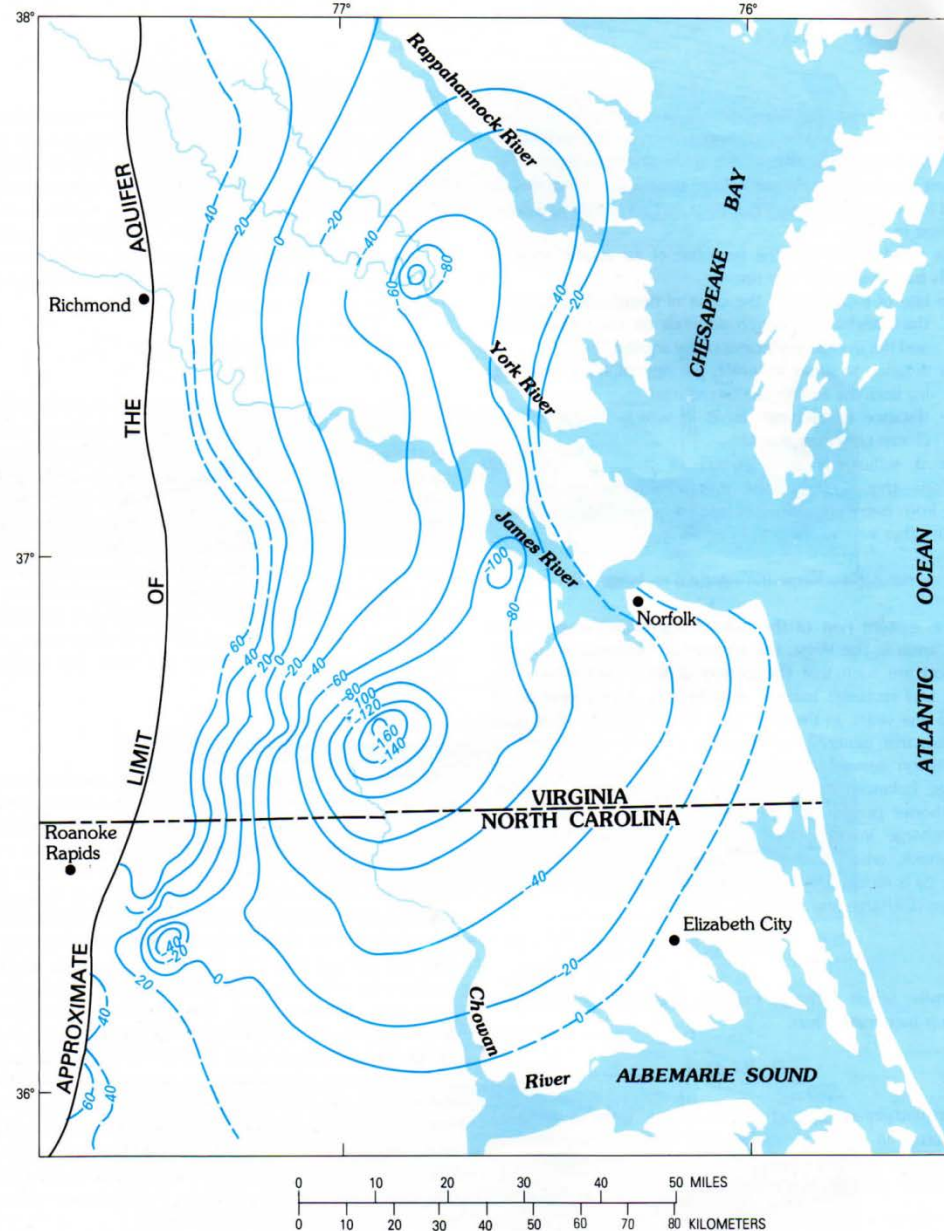
Unconfined versus Confined aquifers

In confined aquifers:

- > water levels represent *potentiometric* levels;
- > drawdown impacts are far-reaching and shared.



POTENTIOMETRIC SURFACE OF THE LOWERMOST CRETACEOUS
AQUIFER IN SOUTHEASTERN VIRGINIA AND NORTHEASTERN NORTH CAROLINA



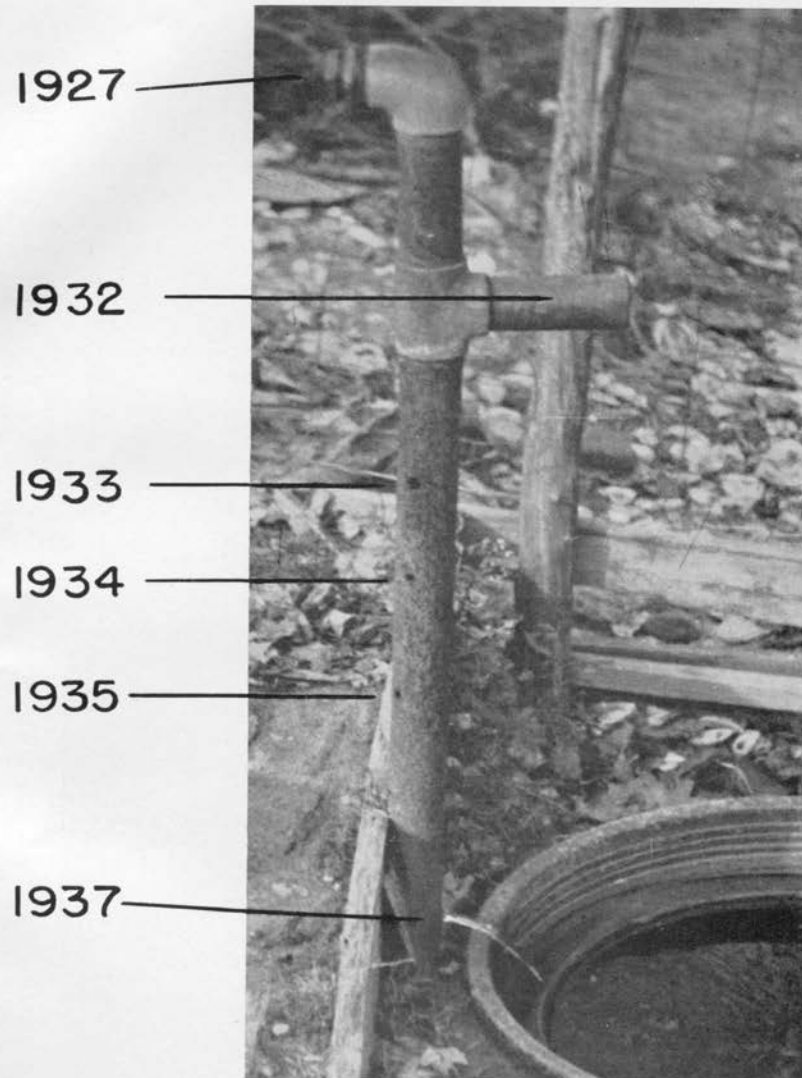
EXPLANATION

Water levels are in feet

NATIONAL GEODETIC VERTICAL DATUM 1929

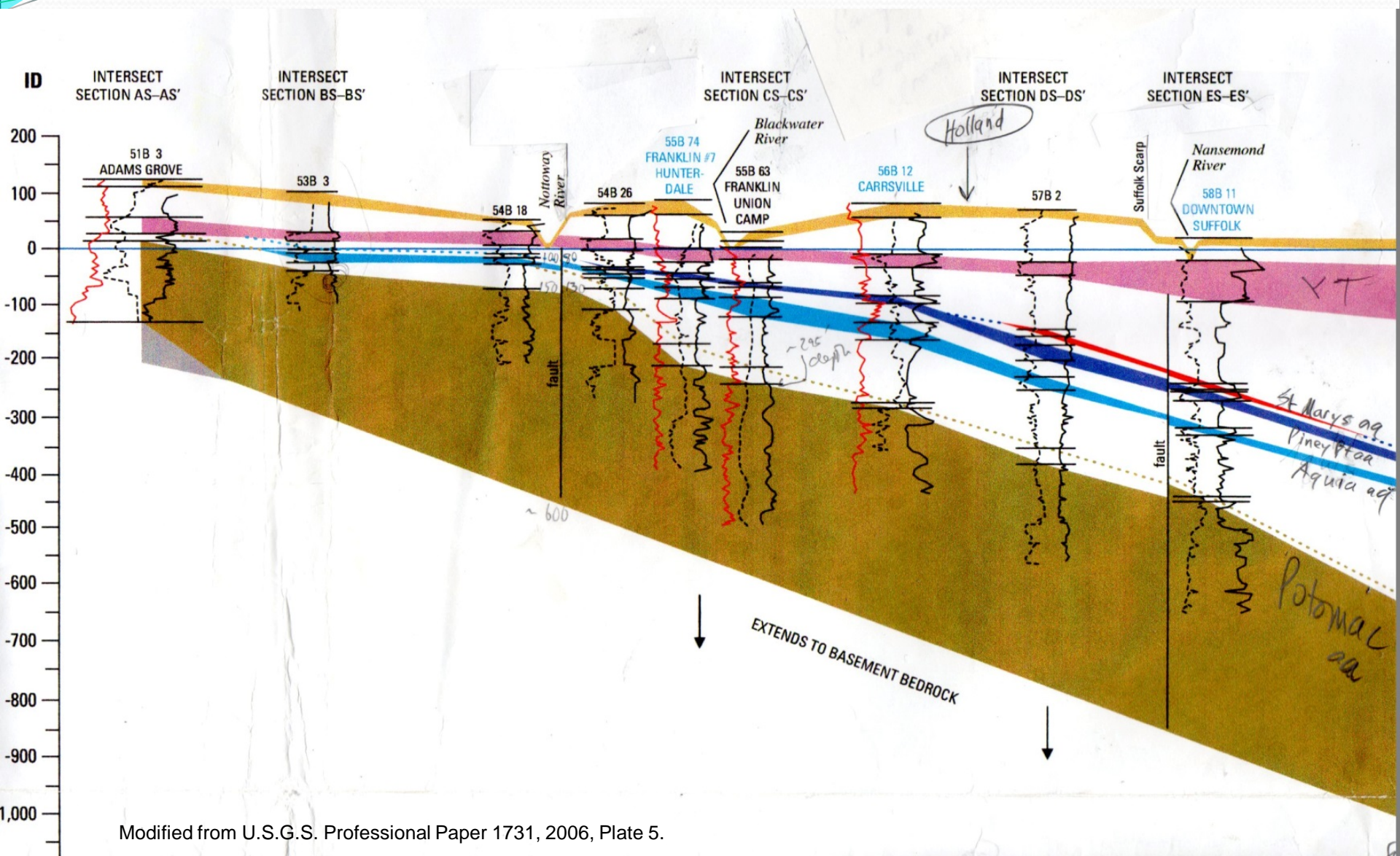
(3)

Source: U.S.G.S. Water-Supply Paper 2220, 1983.



Well with casing perforated at successively lower points in order to maintain a flow as artesian pressure declines; Isle of Wight County.

Potentiometric Surface Declines in Confined Aquifers of the Coastal Plain



Modified from U.S.G.S. Professional Paper 1731, 2006, Plate 5.



COMMONWEALTH of VIRGINIA
DEPARTMENT OF ENVIRONMENTAL QUALITY
APPLICATION FOR A GROUNDWATER WITHDRAWAL PERMIT

1. APPLICANT INFORMATION:

FIN _____

Owner: _____ Phone: _____

Owner Address: _____
 (Street, City, State, Zip Code)

Email: _____

2. FACILITY INFORMATION:

Facility/System Name: _____

Facility Address: _____
 (Street, Road, or Route location, City, State, Zip Code)

Contact Name: _____ Title: _____ Phone: _____

Email: _____

Location of Withdrawal Well or Well System: _____
 (County/City)**3. PREAPPLICATION MEETING DATE:** _____**4. TYPE OF APPLICATION:**

- ☐ Existing withdrawal, not previously permitted
☐ New or expanded withdrawal
☐ Modification of permit Number _____
☐ Reapplication for existing permit Number _____ with modification
☐ Reapplication for existing permit Number _____ without modification

For Reapplications:

Existing withdrawal permit amount _____ gallons per _____ (Day, Month, Year)

Date of expiration of existing Groundwater Withdrawal Permit _____

5. REQUESTED WITHDRAWAL AMOUNT:

_____ Maximum gallons per year,

_____ Maximum gallons per month

_____ Maximum gallons per 10 year permit term*

(*For seasonal or occasional withdrawal applications such as irrigation or drought relief)

6. TYPE OF USE:

- | | |
|--|--|
| <input type="checkbox"/> Public Water Supply – Municipal | <input type="checkbox"/> Commercial |
| <input type="checkbox"/> Public Water Supply – Non Municipal | <input type="checkbox"/> Agriculture (Irrigation, Livestock) |
| <input type="checkbox"/> Non Public Water Supply Potable Use | <input type="checkbox"/> Supplemental Drought Relief |
| <input type="checkbox"/> Industrial | <input type="checkbox"/> Surface Water and Groundwater Conjunctive Use |

Does the requested volume include a portion for irrigation? Yes ☐ No ☐**7. FEE SUBMITTED:** \$ _____ **DATE** _____ ☐ Agricultural Application – No Fee**OFFICE USE ONLY**

Date Application Received _____ Application No. _____

Date Fee Received _____ Amount _____ Date LGOF Received _____



COMMONWEALTH OF VIRGINIA
DEPARTMENT OF ENVIRONMENTAL QUALITY

Quarter 1 2 3 4
Page 1 of 1

Quarterly Ground Water Withdrawal Report

Name of Facility _____

Name of Operator _____

Owner _____

Position/Title _____

Address _____

Signature _____ Date _____

Phone _____

Permit # _____

County/City _____

Meter readings are in _____ (gallons, 100's or 1000's of gallons, cubic feet, etc.)

Month of _____ Year of _____

Owner Well Number	DEQ Well Number and MPID Number	Present Reading	Previous Reading	Total Gallons
Total Gallons			(this month)	
Total Gallons			(year to date)	

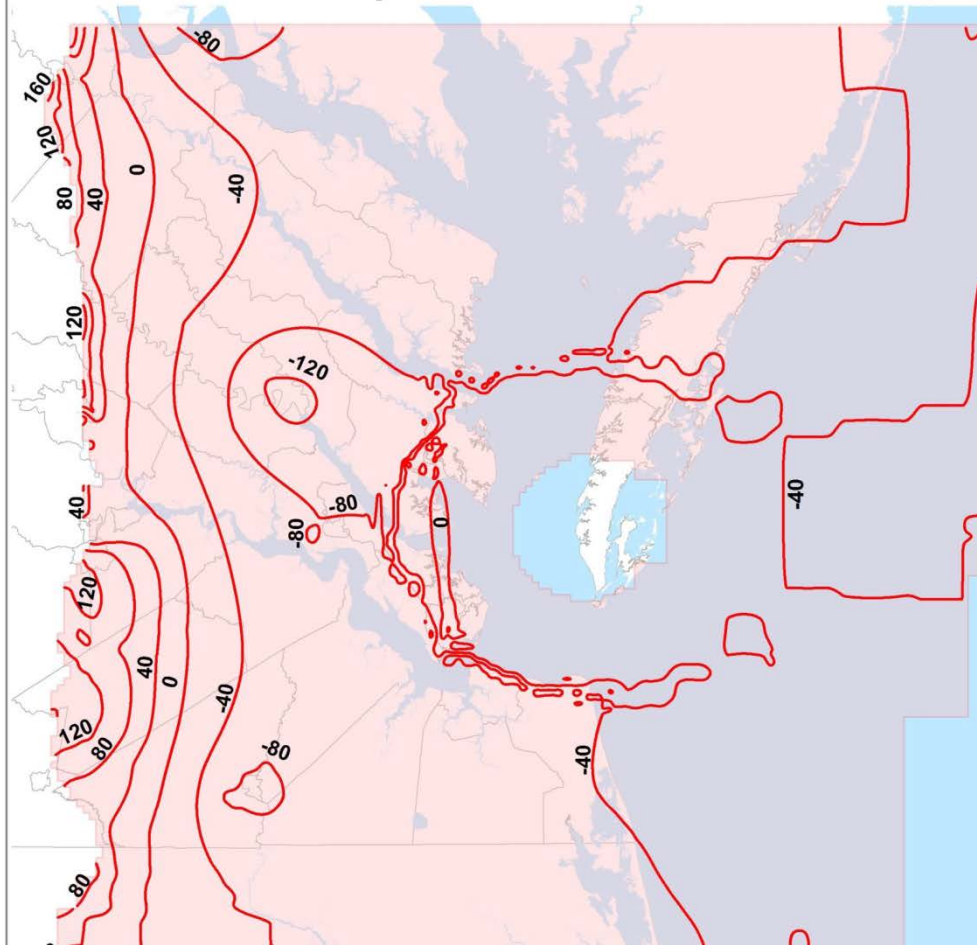
Month of _____ Year of _____

Owner Well Number	DEQ Well Number and MPID Number	Present Reading	Previous Reading	Total Gallons
Total Gallons			(this month)	
Total Gallons			(year to date)	

Month of _____ Year of _____

Owner Well Number	DEQ Well Number and MPID Number	Present Reading	Previous Reading	Total Gallons
Total Gallons			(this month)	
Total Gallons			(year to date)	

Simulated Potentiometric Contours Potomac Aquifer 2016 Reported Use Simulation



Contour elevations are in feet
relative to mean sea level (msl)
and at 40 ft intervals.

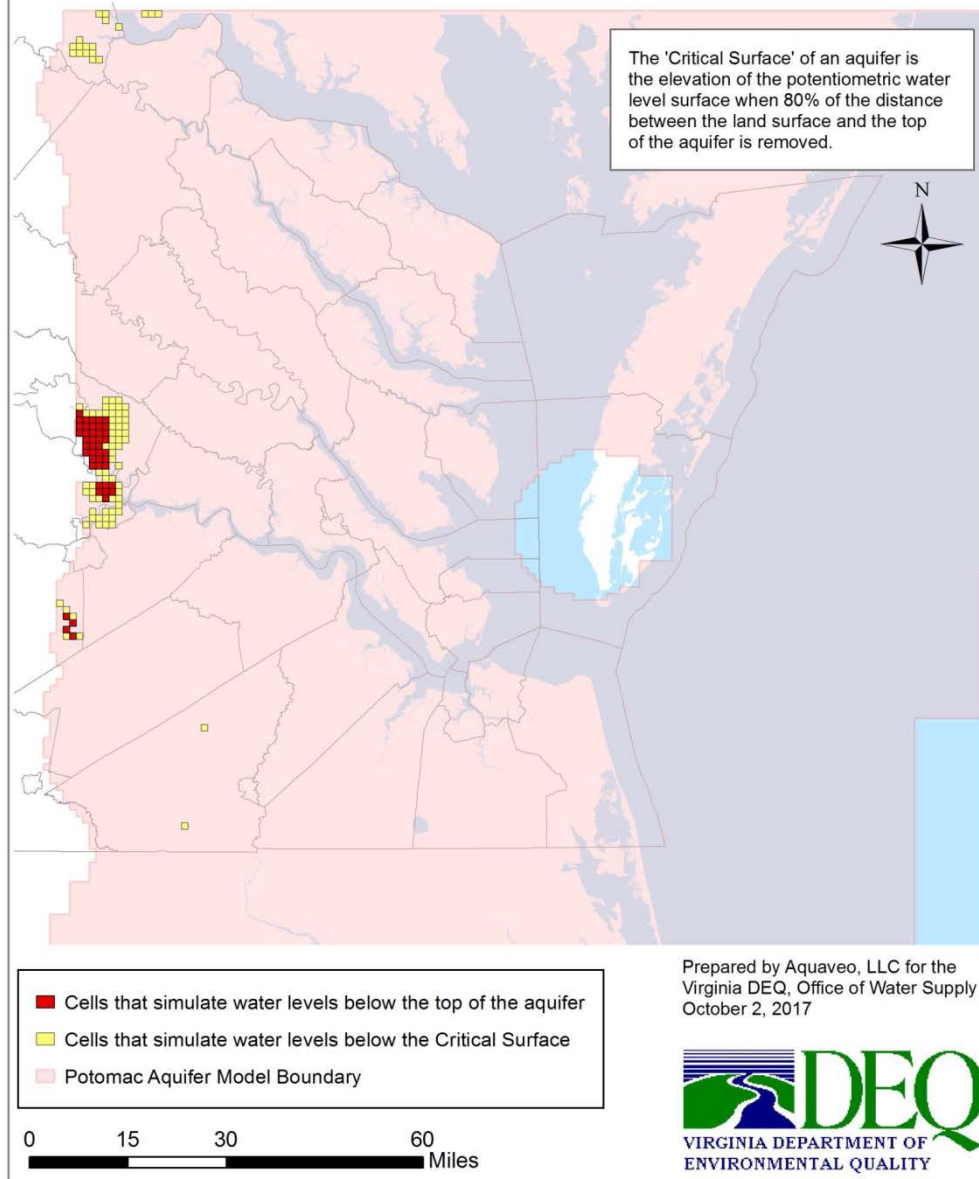
Prepared by Aquaveo, LLC for the
Virginia DEQ, Office of Water Supply
October 2, 2017

- Potentiometric Water Level Contours
- Potomac Aquifer Model Boundary

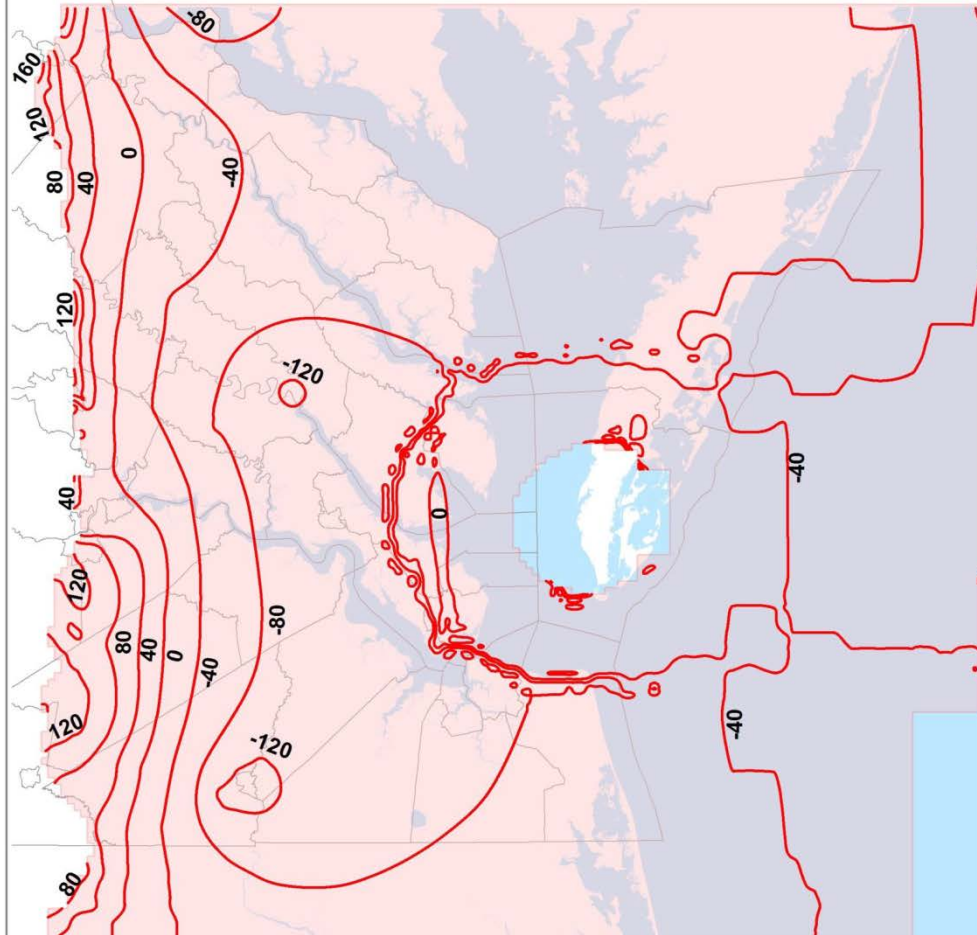
0 15 30 60
Miles



2016 Reported Use Simulation - Potomac Aquifer Simulated Water Levels Below the Critical Surface and Below the Aquifer Top



Simulated Potentiometric Contours Potomac Aquifer 2017 Total Permitted Simulation



Contour elevations are in feet
relative to mean sea level (msl)
and at 40 ft intervals.

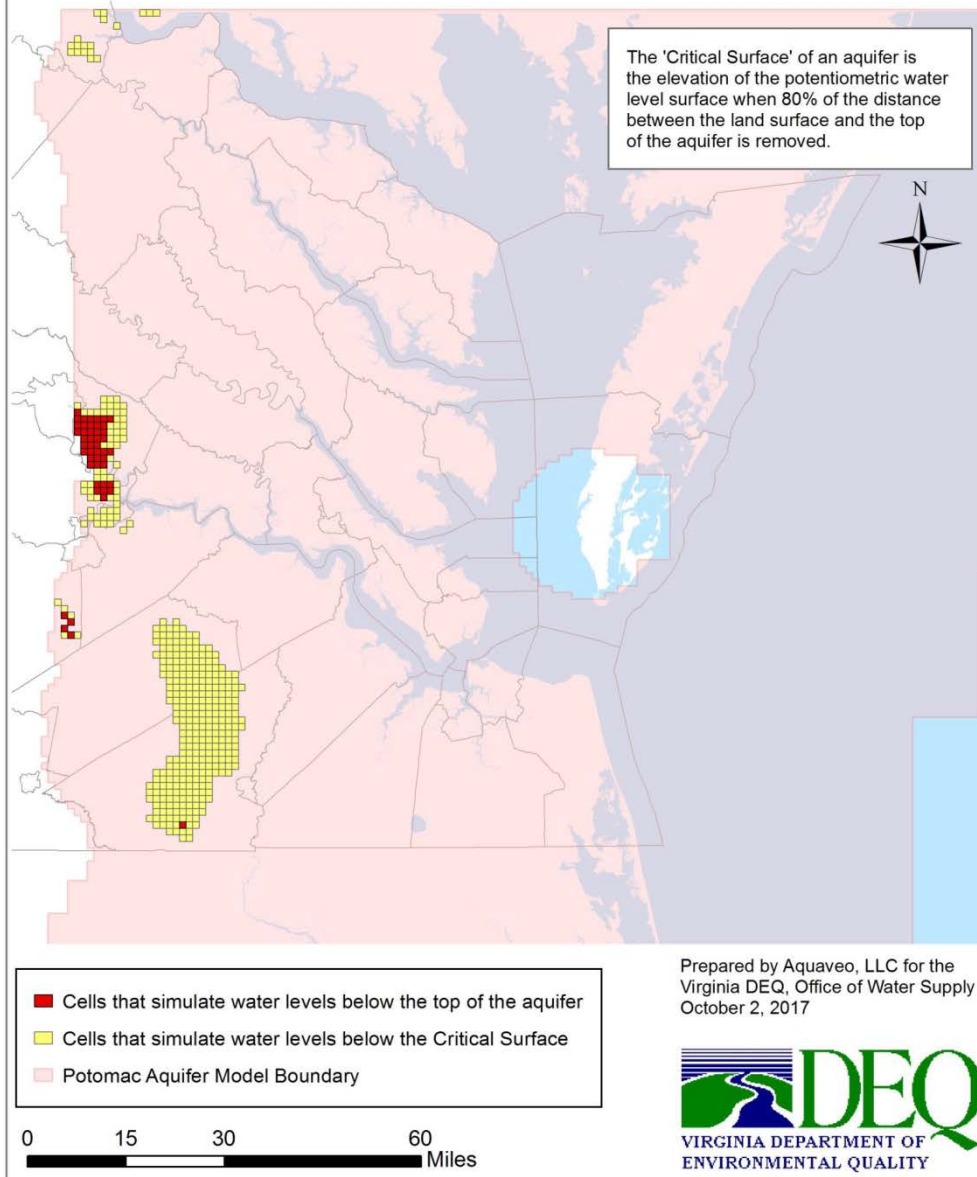
Prepared by Aquaveo, LLC for the
Virginia DEQ, Office of Water Supply
October 2, 2017

- Potentiometric Water Level Contours
- Potomac Aquifer Model Boundary

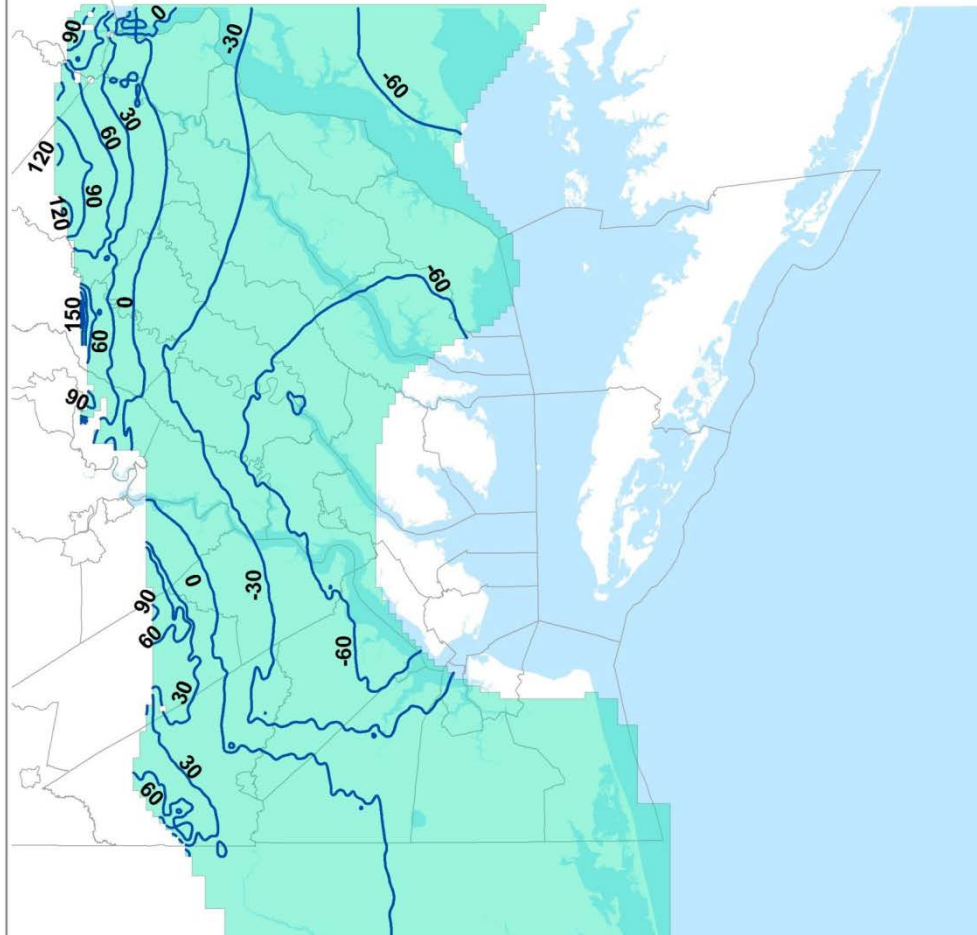
0 15 30 60
Miles



2017 Total Permitted Simulation - Potomac Aquifer Simulated Water Levels Below the Critical Surface and Below the Aquifer Top



Simulated Potentiometric Contours Aquia Aquifer 2016 Reported Use Simulation



Contour elevations are in feet
relative to mean sea level (msl)
and at 30 ft intervals.

Prepared by Aquaveo, LLC for the
Virginia DEQ, Office of Water Supply
October 2, 2017

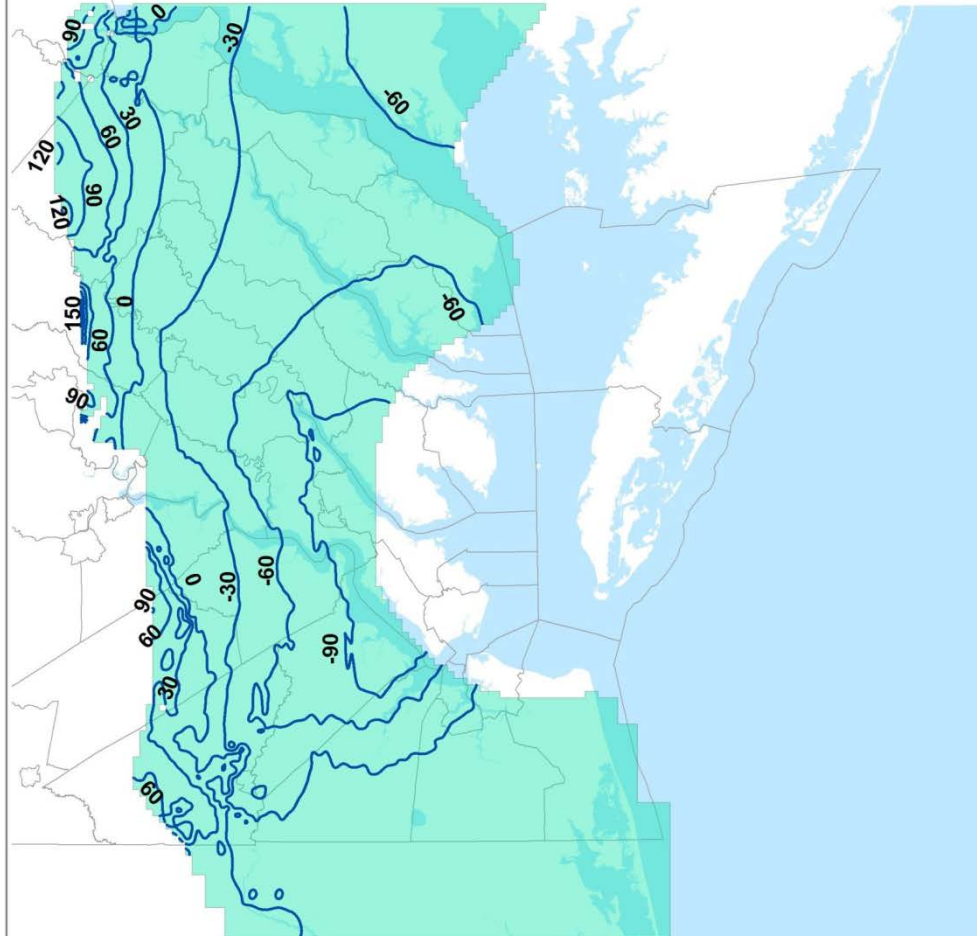
— Potentiometric Water Level Contours

— Aquia Aquifer Model Boundary

0 15 30 60
Miles



Simulated Potentiometric Contours Aquia Aquifer 2017 Total Permitted Simulation



Contour elevations are in feet
relative to mean sea level (msl)
and at 30 ft intervals.

Prepared by Aquaveo, LLC for the
Virginia DEQ, Office of Water Supply
October 2, 2017

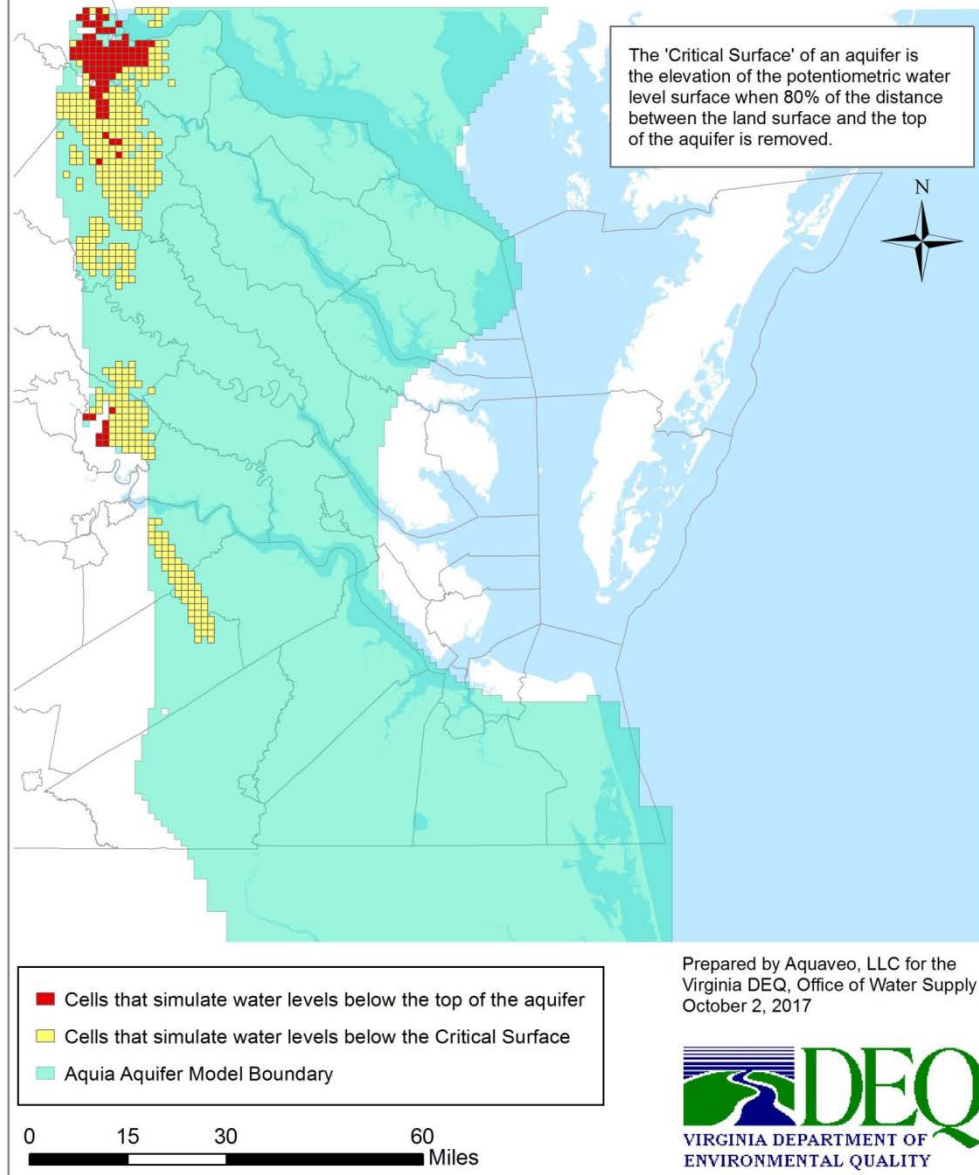
— Potentiometric Water Level Contours

■ Aquia Aquifer Model Boundary

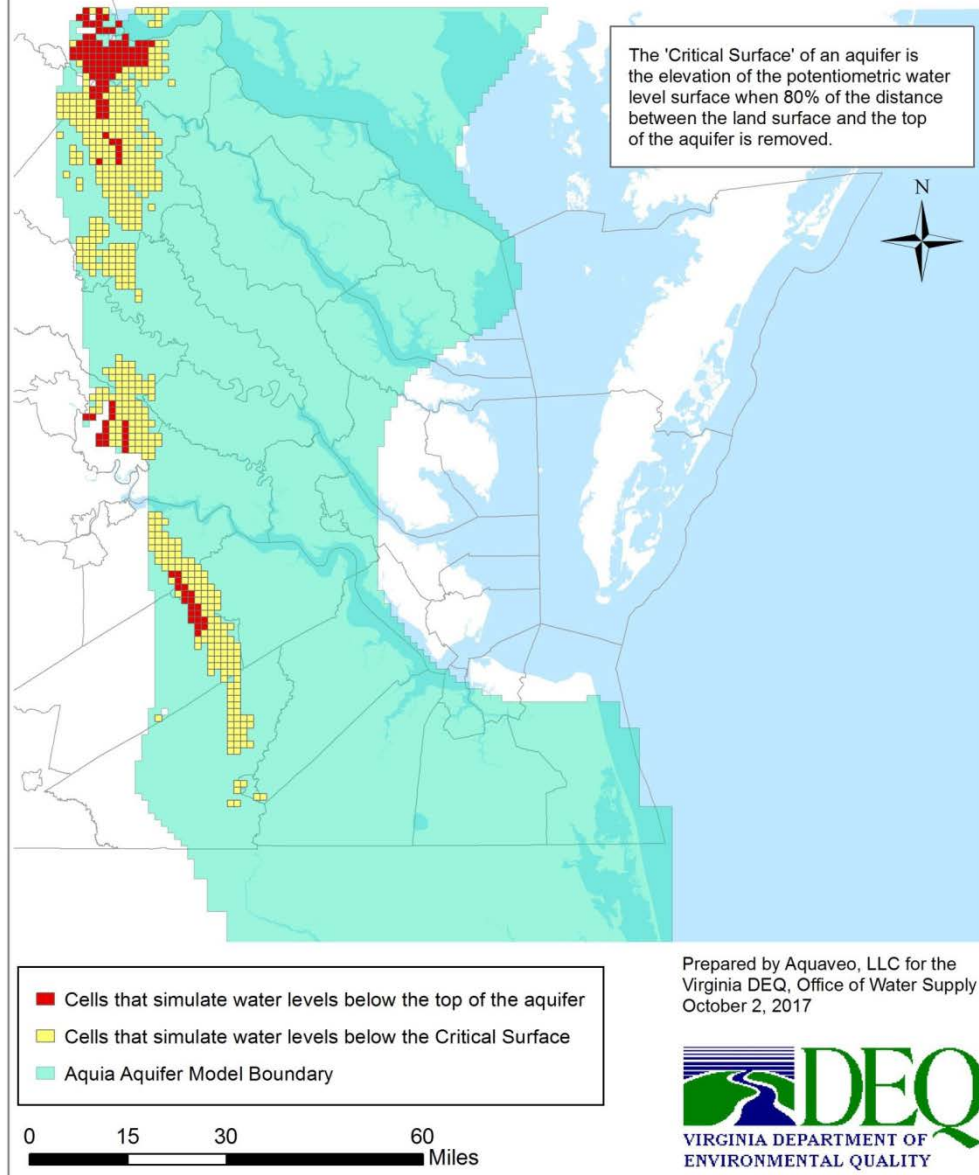
0 15 30 60
Miles



2016 Reported Use Simulation - Aquia Aquifer Simulated Water Levels Below the Critical Surface and Below the Aquifer Top

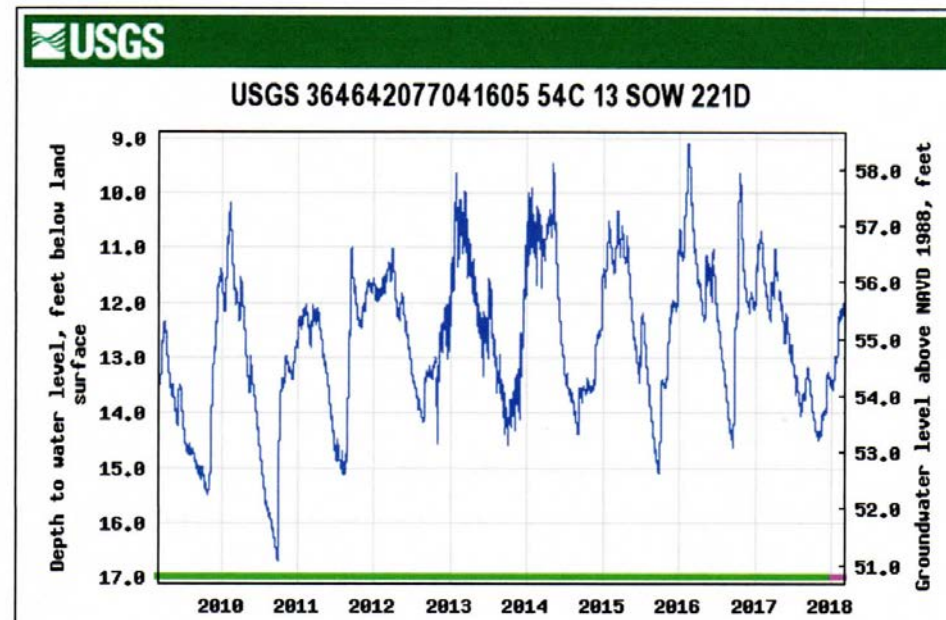


2017 Total Permitted Simulation - Aquia Aquifer Simulated Water Levels Below the Critical Surface and Below the Aquifer Top



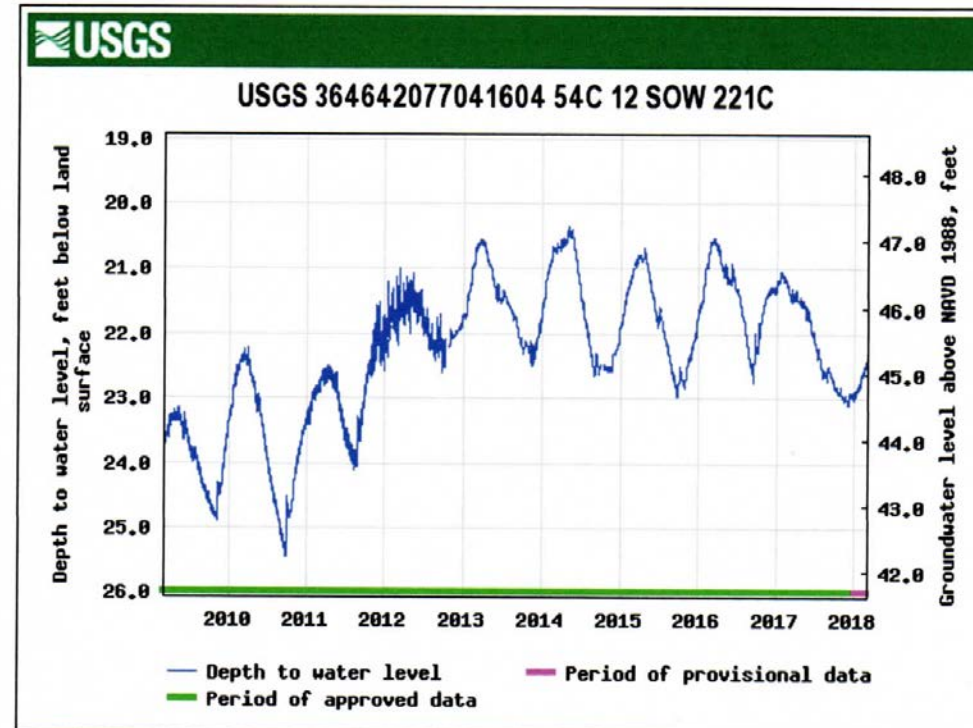
Well depth: 42 feet

Water level
depths: ~ 13 feet



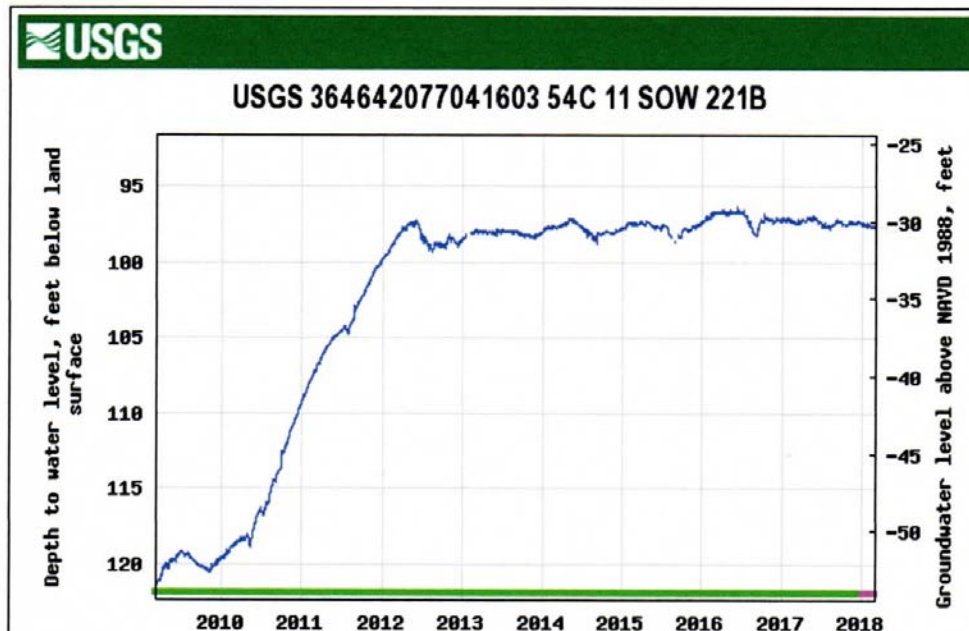
Well depth: 96 feet

Water level
depths: ~ 22 feet



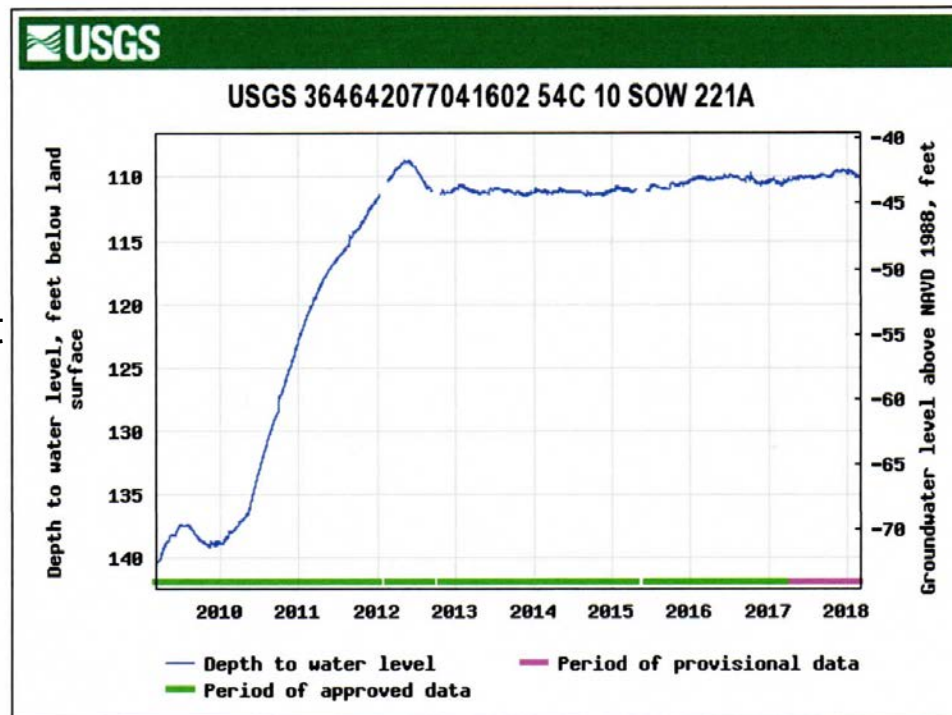
Well depth: 178 feet

Water level depths
(recently): ~ 98 feet

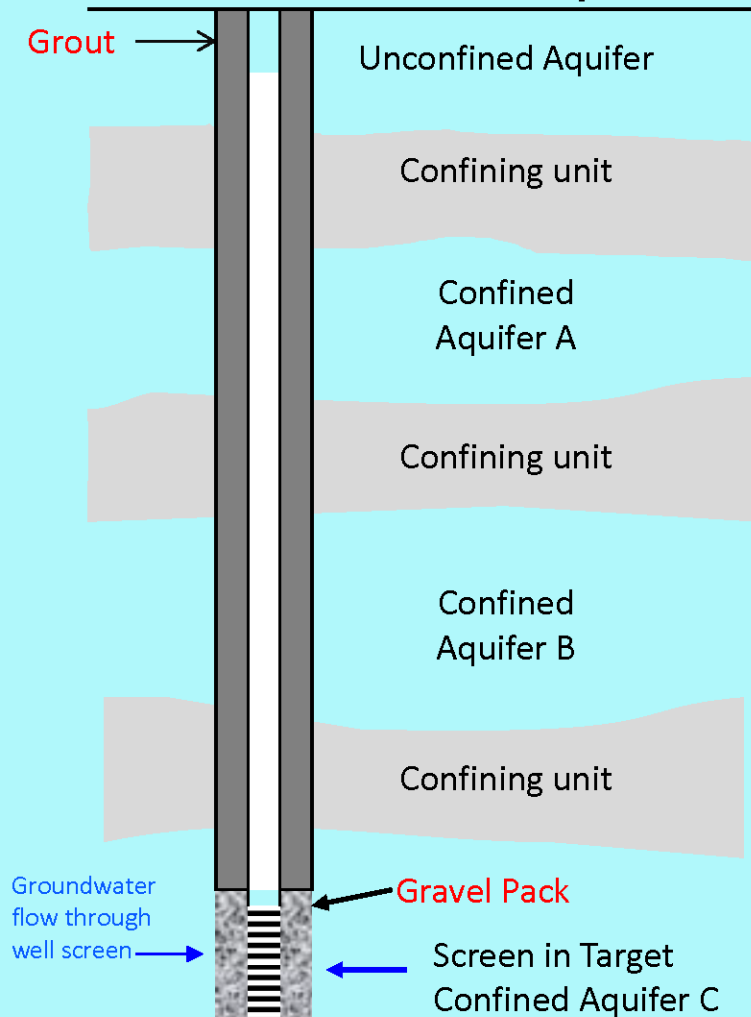


Well depth: 537 feet

Water level depths
(recently): ~ 110 feet



Well Construction Example 1



Note: This construction is recommended even if your facility or public system, etc. does not currently need a withdrawal permit since it can prevent future permitting problems.

Proper Well Construction Requirements

In addition to the Virginia Department of Health requirements.

> **Conduct Geophysical logging** (Spontaneous Potential, Single Point Resistance, 16/64 Short and Long Normal, Natural Gamma) and complete geologist's logs during well drilling (required for all permitted wells)

> **Install gravel packs and grout for observation wells and production wells in a manner that prevents leakage between aquifers.** Gravel pack should be terminated close to the top of well screens and should not extend above the top of the target aquifer as shown in Example 1.

Bentonite plugs between screened intervals should be used. DEQ staff need to review the geophysical logs and driller's logs to determine the gravel pack intervals prior to well construction (See contacts below.)

> Ensure that **Well Completion forms (GW2s)** are completed by the driller and retained by owner and driller.

> **Document Pump intake settings and do not set the pump intake (1) below the top of the uppermost screened confined aquifer or (2) below the bottom of an unconfined aquifer.** Evaluate the effect of the allowable pump intake level on needed production and pumping water levels in the well as part of the well performance evaluation. DEQ should be contacted to help evaluate the geophysical logs and determine the aquifer top and allowable pump intake limit. Two weeks notification of the drilling schedule is needed to schedule DEQ assistance.

-Collect the GPS location for the well and include the Lat/Long and reference datum (i.e. WGS 84, NAD 27) on the Well Completion Form

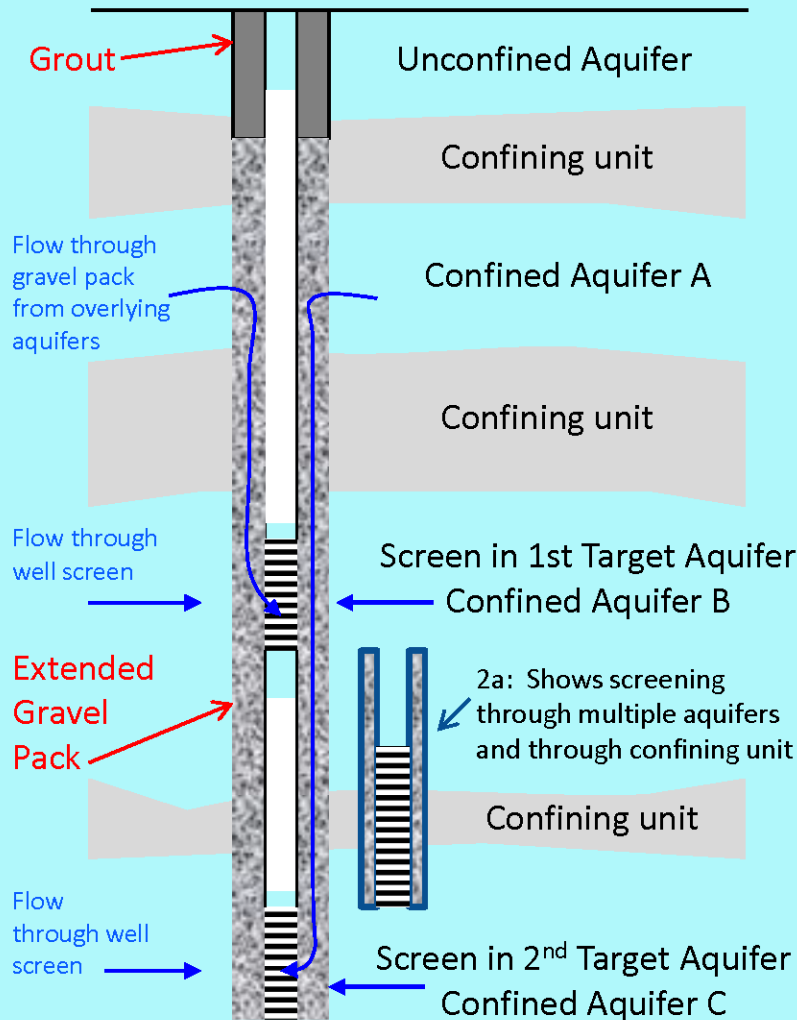
Who to Contact for Additional Information:

Ground Water
Characterization:
Scott Bruce
(804) 698-4041

Groundwater Withdrawal Permitting:
Erinn Tisdale
(804) 698-4066

DEQ Factsheet: Groundwater Well Installation in Groundwater Management Areas

Well Construction to Avoid - Example 2



Improper Well Construction

- Extending the Gravel pack beyond the top of the screened interval and/or extending the gravel pack into other aquifers as shown in Example 2
- Including multiple aquifers in the well screen or extending the well screen through multiple aquifers or as shown in Example 2 and 2a
- Wells with this type of construction often do not meet regulatory requirements due to the unintended impact on overlying aquifers and the pump intake limit may be impacted limiting capacity. This means the well may have to be abandoned and a new well constructed.*** Even if the wells may be usable, this construction can cause the need for expensive and complex aquifer testing in order to obtain a permit, and for the pump intake limit to be shallow (above Aquifer A in Example 2)

Other Common Well Construction Problems

-No geophysical log : Geophysical logging data is necessary for permit issuance in almost every case. *Collection of geophysical and geologist's logs must be performed during well drilling and cannot be collected once the well is completed. Drilling an additional bore hole and conducting geophysical logging may be necessary if geophysical data is not available for the location.*

-No well completion form : *This information is necessary to issue a permit. If the depth of the well, the screened intervals, the grout depth, and the gravel pack extent are not documented, a **camera survey** may be necessary to determine the basic well construction.*

-No documentation of the Pump Intake depth
It is illegal for a pump intake to be set (1) below the top of the uppermost confined aquifer in use or (2) below the bottom of an unconfined aquifer. If the pump depth is not documented, the pump may have to be pulled to determine the depth or to raise the pump. Raising the pump can reduce the well yield, sometimes significantly.

If you're in a VA DEQ Groundwater Management Area and will be using wells (or already are) for > 300,000 gallons in any calendar month,

Start the permitting process as soon as possible:

- It can take years for permits to be issued.
- Forecast is for enforcement.
- 300,000 gallons/month isn't much: equivalent to 11 acre inches.

Get the DEQ involved BEFORE drilling wells:

- The DEQ wants to be notified and to make site-specific calls on aquifer depths, grouting and pump setting depth requirements.
- Avoid costs of meeting requirements after-the-fact.
- Gain key information for making best well-design decisions:
 - Which aquifer(s) more/less likely to be permitted for withdrawal rates needed;
 - Proximity to permitted withdrawals/permits in progress;
 - Depth limit for pump (rough idea – actual determination made from drilling/logging results).

Consider the surficial (Columbia) aquifer:

- Depending on location, can have high yields and good water quality.
- For example, at a site where coarse sands extend to nearly 80 feet, we're getting 150 gpm from each of two wells, with excellent water quality.
- Withdrawal impacts minimal (unconfined aquifer).
- The VA DEQ is considering a fast-track permitting process for groundwater withdrawals from the surficial aquifer.

If you need a Groundwater Withdrawal Permit and your wells are already constructed.....

In the past (from my experiences), requirements have included/ranged from:

- Pulling pumps to confirm depths (and raising if necessary), running down-hole camera, and geophysical logging (inside well via EM-induction);
- Drilling borehole next to well(s) for drill logging, obtaining samples (of drilling returns), and geophysical logging;
- Permit issued with condition requiring replacement of well(s) within the term of the permit.

Going forward, requirements will include.....?

Summary Recommendations:

- In the Coastal Plain, you've got choices when it comes to the source of your groundwater supply.
- Make that choice with the DEQ on-board and in light of their input to streamline requirements and help ensure a viable (and sustainable) supply.

And if already using groundwater above limits without a permit, contacting DEQ sooner probably better than later.



2006

Prepared in cooperation with the Virginia Department of Environmental Quality
and the Hampton Roads Planning District Commission

The Virginia Coastal Plain Hydrogeologic Framework

Professional Paper 1731

U.S. Department of the Interior
U.S. Geological Survey

Review of Groundwater Resources

