2018-2019 Annual Simulation of Potentiometric Groundwater Surface Elevations of Reported and Total Permitted Use

November 6, 2019
Office of Water Supply
Water Withdrawal Permitting and Compliance
Water Planning Division

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

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1. The VAHydroGW-VCPM Model Background

The Virginia Coastal Plain Model[1] (VCPM) is a SEAWAT[2] groundwater model which encompasses all of the Coastal Plain within Virginia and parts of the Coastal Plain in northern North Carolina and southern Maryland. The original groundwater model was created by the USGS and simulated water levels within the aquifers and confining units of the coastal plan from 1890 through 2003 based upon historic pumping records. The VCPM incorporated an updated conceptualization of the Virginia Coastal Plain hydrogeologic framework – including the Chesapeake Bay impact crater and consolidation of the Upper, Middle, and Lower Potomac aquifers and confining units into a single Potomac aquifer and confining unit.

For aquifers near coastal areas the increase in density across a transition zone from fresh groundwater to seawater significantly affects the direction of groundwater flow. The capacity of SEAWAT to simulate the variable-density form of the groundwater flow equation increases the accuracy of simulated water levels in the Coastal Plain aquifers. The groundwater density distribution was established for the VCPM by a separate 108,000-year solute transport simulation of Pleistocene freshwater flushing around the Chesapeake Bay impact crater during transient sea-level changes. The resulting water density distribution is used for the duration of the VCPM simulation. The water density distribution remains unchanged during the simulation since the VCPM does not simulate solute transport.

The original VCPM was updated and adapted for use in the DEQ well permitting process in 2013 and is referred to as VAHydroGW-VCPM. The updating process included adding historic pumping records from 2003 to 2012. As a result, the VAHydroGW-VCPM then simulated water levels from 1890 to 2012 – this portion of the model is referred to as the historic portion of the model. The updating process also included modifying the VCPM to simulate water levels for 50 years beyond the end of the historic portion of the model (2012) – this portion of the model is referred to as the predictive portion of the model. The predictive portion of the model was based upon two scenarios: the *Total Permitted* scenario and the *Reported Use* scenario. The 2013 *Total Permitted* scenario simulated water levels for 50 years beyond 2012 by using the then current total permitted withdrawal rates established for withdrawal permits issued by the DEQ together with the 2012 reported use values for un-permitted wells within unregulated portions of Virginia and estimated usage from 2003 for domestic wells, wells in Maryland, and wells in North Carolina. The 2013 *Total Permitted* scenario represented the estimated water levels 50 years into the future if all permittees within the Coastal Plain were to pump at their authorized maximum withdrawal rates for the duration of the 50-year period. The 2012 *Reported Use* scenario simulated water levels for 50 years using the 2012 reported pumping

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[1] Heywood and Pope, Simulation of Groundwater Flow in the Coastal Plain Aquifer System of Virginia, Scientific Investigation Report 2009-5039.

[2] Langevin, C.D., Thorne, D.T., Jr., Dausman, A.M., Sukop, M.C., and Guo, Weixing, 2008, SEAWAT Version 4: A Computer Program for Simulation of Multi-Species Solute and Heat Transport: U.S. Geological Survey Techniques and Methods Book 6, Chapter A22, 39 p.

rates for wells permitted by the DEQ or located within Virginia. Estimates for Maryland and North Carolina withdrawals were based upon 2003 estimated use. The *Reported Use* simulation represents the best available estimate of water levels within the Coastal Plain aquifers over the next 50 years if pumping were to continue at the currently reported pumping rates for the permitted wells within the Coastal Plain.

In September 2015 the VAHydroGW-VCPM was updated again. The reported pumping for the wells within the Virginia portion of the model for 2013 and 2014 was incorporated into the historic portion of the model. The historic portion of the model then simulated water levels from 1890 through 2014. The final water levels from the historic model were then inserted as starting water levels for both predictive versions of the VAHydroGW-VCPM. The 50-year predictive 2012 *Reported Use* simulation was replaced with the 2014 *Reported Use* simulation by averaging the reported pumping for all simulated wells from 2010 through 2014. The average pumping value for each well was then repeated for each year of the 2014 *Reported Use* simulation. Additionally, the 2013 *Total Permitted* simulation was replaced with the 2015 *Total Permitted* simulation by using the then current total permitted withdrawal rates established for withdrawal permits issued by the DEQ together with the 2014 reported use values for un-permitted wells within unregulated portions of Virginia and estimated usage from 2003 for domestic wells, wells in Maryland, and wells in North Carolina.

In a similar manner, in October 2016 the VAHydroGW-VCPM was updated with Virginia reported use pumping data from 2015-2016 and total permitted pumping values from 2017. Again, in November 2018 the VAHydroGW-VCPM was updated with Virginia reported use pumping data from 2017 and total permitted pumping values from 2018. During this annual update process precipitation records for the original four sites used to create the VAHydroGW-VCPM were obtained and inserted into the historic portion of the model. The average precipitation simulated in the updated historic model was then used in the predictive portions of the model.

In early 2019 the hydrogeologic framework of the VAHydroGW-VCPM was updated with borehole data from two USGS reports and from data collected by the DEQ as part of the groundwater permitting process[3]. The model was then updated with reported pumping from wells within Maryland. The VAHydroGW-VCPM model was also updated with observed water levels from 2004 through 2018 and a number of hydraulic parameters of the VAHydroGW-VCPM were recalibrated[4]. Prior to the recalibration, the simulated water levels were, in general, higher than those observed, especially in the Potomac aquifer. As a result, recalibrating the model generally resulted in lower simulated water levels. Consequently, lower water levels were simulated even though the amount of pumping did not change. These lower simulated water levels better reflect the actual observed water levels. The lower water levels resulted in additional simulated critical cells. This should be taken into consideration

[3] See "*Automated Update of the Hydrogeologic Unit Flow Package of the VAHydroGW-VCPM"* on file with the VA-DEQ.
[4] See "*2019 Update and Re-Calibration of the VAHydroGW-VCPM"* on file with the VA-DEQ.

when comparing the results of the annual model simulations from 2019 and any subsequent years to results from those in years prior to 2019.

The remainder of this report outlines the process of updating the VAHydroGW-VCPM with reported use pumping data from 2018 and total permitted pumping values from 2019.

2. 2018 Reported Use Simulation

2.1 Model Preparation

The VAHydroGW-VCPM 2018 *Reported Use* simulation was created by representing the groundwater withdrawals reported to the DEQ. Data was obtained from the DEQ VAHydro database for all reporting wells within the Virginia portion of the model. The DEQ VAHydro database houses water use reported under the Water Withdrawal Reporting Regulation. This regulation requires annual reporting of monthly surface and groundwater withdrawals exceeding an average of 10,000 gallons per day. The DEQ Office of Water Supply receives water use data from Groundwater Withdrawal Permit holders as a condition of their permits – this data is also stored in the VAHydro database.

The VAHydroGW-VCPM encompasses all of the Coastal Plain within Virginia and parts of the Coastal Plain in northern North Carolina and southern Maryland. Row and column assignments for new withdrawals reported within Virginia were made using well locations (latitude and longitude) to plot the position on a GIS coverage of the VAHydroGW-VCPM finite-difference grid. Model layers for withdrawals within the original Eastern Virginia Groundwater Management Area (GWMA) were assigned based upon the top and bottom elevation of the withdrawal screens - using a land surface Digital Elevation Model (DEM) and the depths of the withdrawal screens. Layer assignments for withdrawals within the newly expanded portion of the GWMA were made based upon existing layer assignments for wells in the original VCPM; and, if well screen information was not available, wells not currently in the VAHydroGW-VCPM were assigned to model layers based upon the assignments of nearby wells and the USGS report, *Private Domestic-Well Characteristics and the Distribution of Domestic Withdrawals among Aquifers in the Virginia Coastal Plain*[5]. Adjustments to model layer assignments were made based upon the documentation - *Regulatory Implementation of the Virginia Coastal Plain Model*, which is on file with the DEQ. These adjustments were made to ensure that withdrawals were assigned to layers containing an adequate portion of the withdrawal aquifer(s).

The historic portion of the VAHydroGW-VCPM was updated by adding reported use pumping records from 2018. For each year, the reported withdrawals were simulated at a constant rate (cfd) equivalent

[5] Pope, McFarland, and Banks, Private Domestic-Well Characteristics and the Distribution of Domestic Withdrawals among Aquifers in the Virginia Coastal Plain, U.S. Geological Survey Scientific Investigations Report 2007-5250.

to the annual average for that year. The predictive portion of the VAHydroGW-VCPM was then executed for a 50-year simulation period. For this 2018 *Reported Use* simulation, withdrawals from Virginia were simulated for the duration of the 50-year simulation using the average reported pumping for the 5 years from 2014 through 2018.

Withdrawal data was obtained from the Maryland Department of Environment and used to update the pumping rate for each Maryland well in the model from 2003 through 2018. However, the data did not contain coordinate locations for the wells; as a result, only wells already in the model were updated. No new Maryland wells were added. For the 2018 *Reported Use* simulation, withdrawals from Maryland were simulated at the 2018 rates. Withdrawals from North Carolina were simulated at the 2003 rates (the most recent year available at the time of the model execution).

Boundary conditions representing underflow to Maryland and underflow from the Piedmont Province were simulated at the 2003 rates specified by the USGS in the original VCPM for the duration of the simulation. Domestic withdrawals were also repeated at the 2003 rates for each year of the simulation. Precipitation records for the original sites used to create the VAHydroGW-VCPM were obtained for 2018. These values were inserted into the historic portion of the model. The average precipitation simulated in the updated historic model (1890 through 2018) was then used in the predictive portions of the model.

A total use of 84.6 million gallons per day (MGD) was assigned to all withdrawals in the 2018 *Reported Use* simulation. A total use of 66.7 MGD was assigned to withdrawals within the Virginia Coastal Plain. Total use assigned to Maryland and North Carolina withdrawals was 8.6 and 9.3 MGD, respectively. A breakdown of the Virginia reported water use data by county appears in Table 1.

Table 1. Average 2014-2018 Water Use Report -Withdrawals Modeled by City/County

City/County	Use Allocated to Model (MGD)	Use Allocated to Model (%)
Caroline	0.92	1.38%
Charles City	0.06	0.09%
City of Chesapeake	1.98	2.97%
Chesterfield	0.00	0.00%
Essex	0.44	0.67%
Franklin City	3.37	5.05%
Gloucester	0.64	0.97%
City of Hampton	0.01	0.01%
Hanover	0.45	0.67%
Henrico	0.23	0.34%
Isle of Wight	13.61	20.41%
James City	6.08	9.13%
King and Queen	0.05	0.08%
King George	1.12	1.67%
King William	17.45	26.17%
Lancaster	0.37	0.56%
Mathews	0.01	0.01%
Middlesex	0.22	0.33%
New Kent	2.01	3.02%
City of Newport News	0.39	0.59%
City of Norfolk	0.07	0.10%
Northumberland	0.34	0.52%
City of Portsmouth	0.21	0.32%
Prince George	0.31	0.46%
Richmond County	0.35	0.52%
Southampton	3.45	5.18%
Spotsylvania	0.03	0.04%
City of Suffolk	8.48	12.73%
Surry	0.50	0.76%
Sussex	0.82	1.23%
City of Virginia Beach	0.18	0.28%
Westmoreland	0.85	1.28%
City of Williamsburg	1.24	1.86%
York	0.42	0.64%
TOTAL	**66.67**	**100.00%**

The reported use amount allocated to each aquifer is shown in Table 2.

Table 2. Reported Use - Total Simulated by Aquifer

Aquifer	Use Allocated to Model (MGD)	Use Allocated to Model (%)
Surficial	0.66	0.99%
Yorktown-Eastover	0.84	1.26%
St. Mary's	0.0	0.00%
Piney Point	2.43	3.64%
Aquia	0.36	0.54%
Virginia Beach	0.13	0.19%
Potomac	62.3	93.38%
TOTAL	**66.7**	**100.0%**

The model outputs (potentiometric water levels) are generated by the MODFLOW Hydrogeologic-Unit Flow Package (HUF) for each hydrogeologic unit. For each confined, regulated aquifer the water levels were assigned to corresponding one-mile square Geographic Information System (GIS) grid cells then converted to an ArcView shapefile. The head values were then contoured using ESRI's Spatial Analyst Spline tool. Smoothest contours were generated using the spline method (20 neighbors). Contour intervals were selected consistent with the graphics produced for previous annual simulations (see Attachment A).

2.2 VAHydroGW-VCPM Cells Violating the 80% Drawdown Criterion

The 2018 *Reported Use* simulation shows areas of the Coastal Plain for the Potomac, Virginia Beach, Aquia, Piney Point, and Yorktown-Eastover aquifers where the predicted water levels (at the end of the 50-year simulation) are below the critical surface for those aquifers. In a number of the cells with water levels predicted to be below the critical surface, the predicted water levels are also below the aquifer top represented in the model framework. Maps of all areas not in compliance with the 80% drawdown criterion are presented in Attachment B. Areas with water levels also predicted to be below aquifer tops are noted on these maps.

3. 2019 Total Permitted Simulation

3.1 Withdrawals Simulated

9VAC25-610-110(D) ("Evaluation Criteria for permit applications") of the Groundwater Withdrawal Regulations requires the evaluation of proposed withdrawals in combination with all existing lawful withdrawals within the GWMA. On January 1, 2014 the Eastern Virginia GWMA was expanded to include the counties north of the York River and east of I-95. Since that time a number of permits

have been issued to existing withdrawals in this expanded area. The 2017 *Total Permitted* simulation was the first simulation to include withdrawals from the expanded area at the withdrawal's permitted amounts (as opposed to the reported use amount). As a result, the overall pumping simulated in the expanded area increased by 1.65 MGD in the 2017 *Total Permitted* simulation as reported use values for a number of wells in the 2015 *Total Permitted* simulation were replaced with total permitted amounts in the 2017 *Total Permitted* simulation. As additional permits have been granted, the 2018 *Total Permitted* simulation simulated an increase of 0.3 MGD from the 2017 *Total Permitted* simulation - in the expanded groundwater management area. The total simulated withdrawal from the expanded groundwater management area in the 2018 *Total Permitted* simulation was 7.3 MGD. The total simulated withdrawal from the expanded groundwater management area dropped to 6.6 MGD for the 2019 *Total Permitted* simulation.

As part of the Virginia Coastal Plain Groundwater Initiative (VACPGWI) the maximum permitted withdrawal amounts for a number of the largest withdrawals were reduced through negotiation. These withdrawals are listed in Attachment E. A number of the negotiated reductions in permitted withdrawal amounts involved a tiered or fluctuating pumping schedule – as opposed to constant pumping amounts used in previous total permitted simulations. The negotiated pumping schedules for the reduced VACPGWI withdrawals are included in Attachment E. The VAHydroGW-VCPM discretization file was modified to accommodate quarter-year stress periods and the schedule included in Attachment E was used as the pumping amounts for the VACPGWI wells in the 2019 *Total Permitted* simulation. The total withdrawal amount for these wells in the 2015 *Total Permitted* simulation was 119.2 MGD. As a comparison, the withdrawal amount from the pumping schedule averaged over the 50-year period for the 2018 *Total Permitted* simulation for these wells was 61.2 MGD. These VACPGWI negotiated withdrawal amounts resulted in a significant reduction in simulated critical cells. For the 2019 *Total Permitted* simulation, the VACPGWI withdrawal amount from the pumping schedule averaged over the 50-year period results in a combined average pumping amount of 60.6 MGD.

For the remaining GWMA permitted withdrawals, the reported use amounts of the predictive portion of the 2018 *Reported Use* simulation were replaced with the maximum annual withdrawal limit allowed under the terms of the active permits. All other withdrawals from the 2018 *Reported Use* simulation were not changed. For the GWMA permit holders the individual permit amount was evenly divided between the active and proposed wells of the permit. Additionally, Chickahominy Power Plant was simulated at 0.08 MGD for 7 years – at which point the plant is scheduled to switch to a surface water source. Consequently, Chickahominy Power Plant was not included in the last 43 years of the 2019 *Total Permitted* simulation.

Model layers for new withdrawals within the GWMA were assigned based upon the top and bottom elevation of the withdrawal screens - using a land surface DEM and the depths of the withdrawal screens. Adjustments to model layer assignments were made based upon the documentation - *Regulatory Implementation of the Virginia Coastal Plain Model*, which is on file with the DEQ. These adjustments were made to ensure that withdrawals were assigned to layers containing an

adequate portion of the withdrawal aquifer(s). The VAHydroGW-VCPM utilizes the MODFLOW Multi-Node Well (MNW) package. The MNW package allows withdrawals to be assigned to multiple, consecutive (single aquifer withdrawals) or non-consecutive (multi-aquifer withdrawals) model layers. Modeled water extraction is allocated by the MNW package among assigned model layers based upon the layer hydrogeologic properties.

All of the permitted withdrawals simulated in the *2019 Total Permitted* simulation are listed in Attachment F. Table 3 outlines the withdrawal amounts in the 2019 *Total Permitted* simulation. The total simulated withdrawal of 112.5 MGD is 27.9 MGD greater than the total amount reported as actual use.

Table 3. Total Permitted - Withdrawals Simulated

Withdrawal Source	Use Allocated to Model (MGD)	Use Allocated to Model (%)
VACPGWI Average Withdrawal	60.6	53.9%
Remaining GWMA Maximum Permitted	32.3	28.7%
Non-Permitted GWMA Reported Use	1.7	1.5%
Maryland Reported Use	8.6	7.6%
North Carolina Reported Use	9.3	8.3%
TOTAL	**112.5**	**100.0%**

Contour maps of the *Total Permitted* simulation appear as Attachment C in this document. These maps depict the water level elevations for each confined aquifer predicted to occur if all permitted users were to withdrawal at their maximum permitted limit for the duration of the 50 year simulation. These maps were contoured consistent with the process for the 2005 *Reported Use* simulation and other previous water use reports.

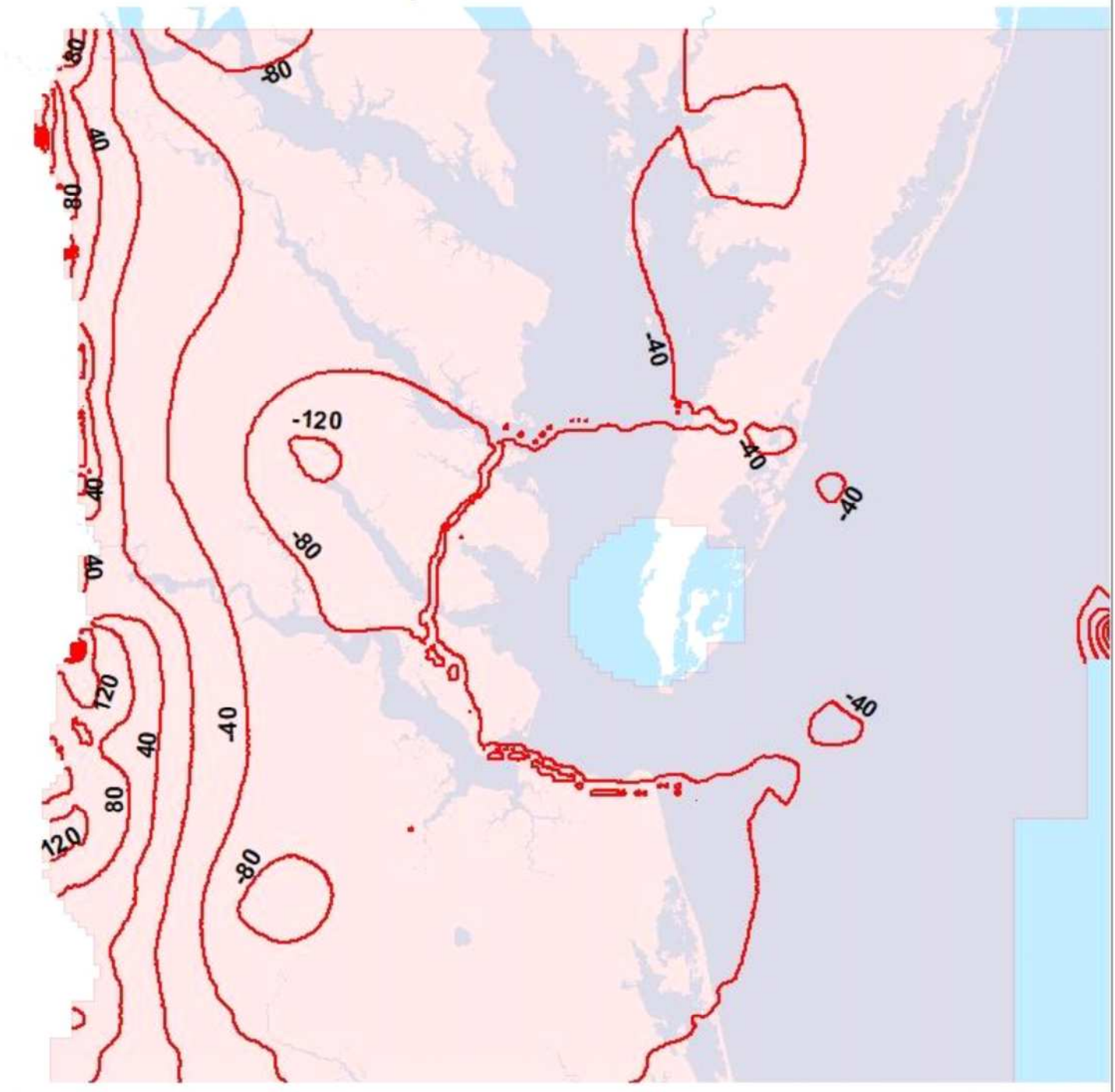
3.2 VAHydroGW-VCPM Cells Violating the 80% Drawdown Criterion

The *2019 Total Permitted* simulation shows areas of the Coastal Plain for the Potomac, Virginia Beach, Aquia, Piney Point, and Yorktown-Eastover aquifers where the predicted water levels (at the end of the 50-year simulation) are below the critical surface for those aquifers. In a number of the cells with water levels predicted to be below the critical surface, the predicted water levels are also below the aquifer top represented in the model framework. Maps of all areas not in compliance with the 80% drawdown criterion are presented in Attachment D. Areas with water levels also predicted to fall below aquifer tops are noted on these maps.

Attachment A

Simulated Potentiometric Contours
2018 Reported Use Simulation

Simulated Potentiometric Contours
Potomac Aquifer
2018 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
November 2, 2019

Potentiometric Water Level Contours

Potomac Aquifer Model Boundary

0 15 30 60 Miles

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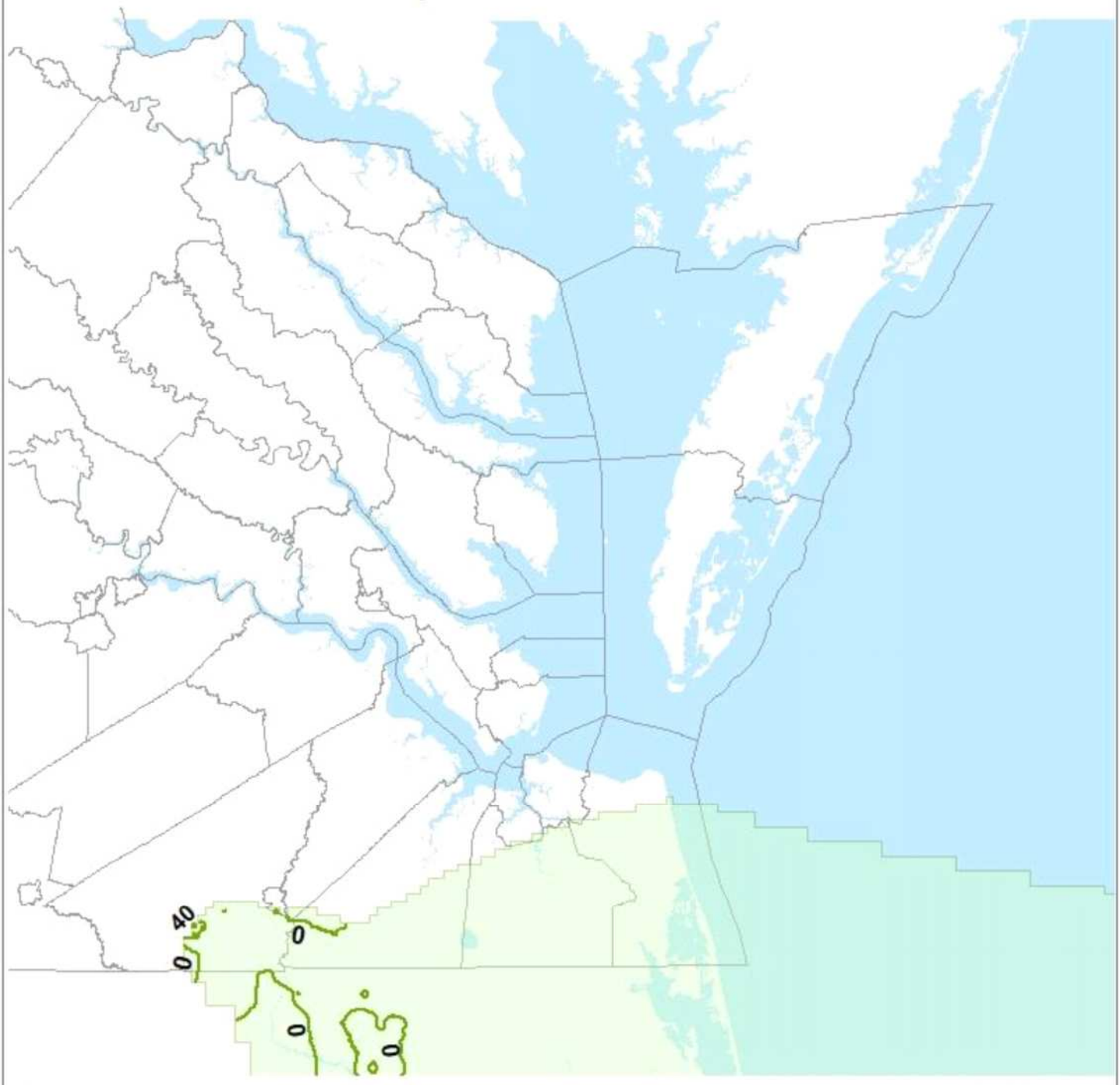
Simulated Potentiometric Contours
Virginia Beach Aquifer
2018 Reported Use Simulation



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
November 2, 2019

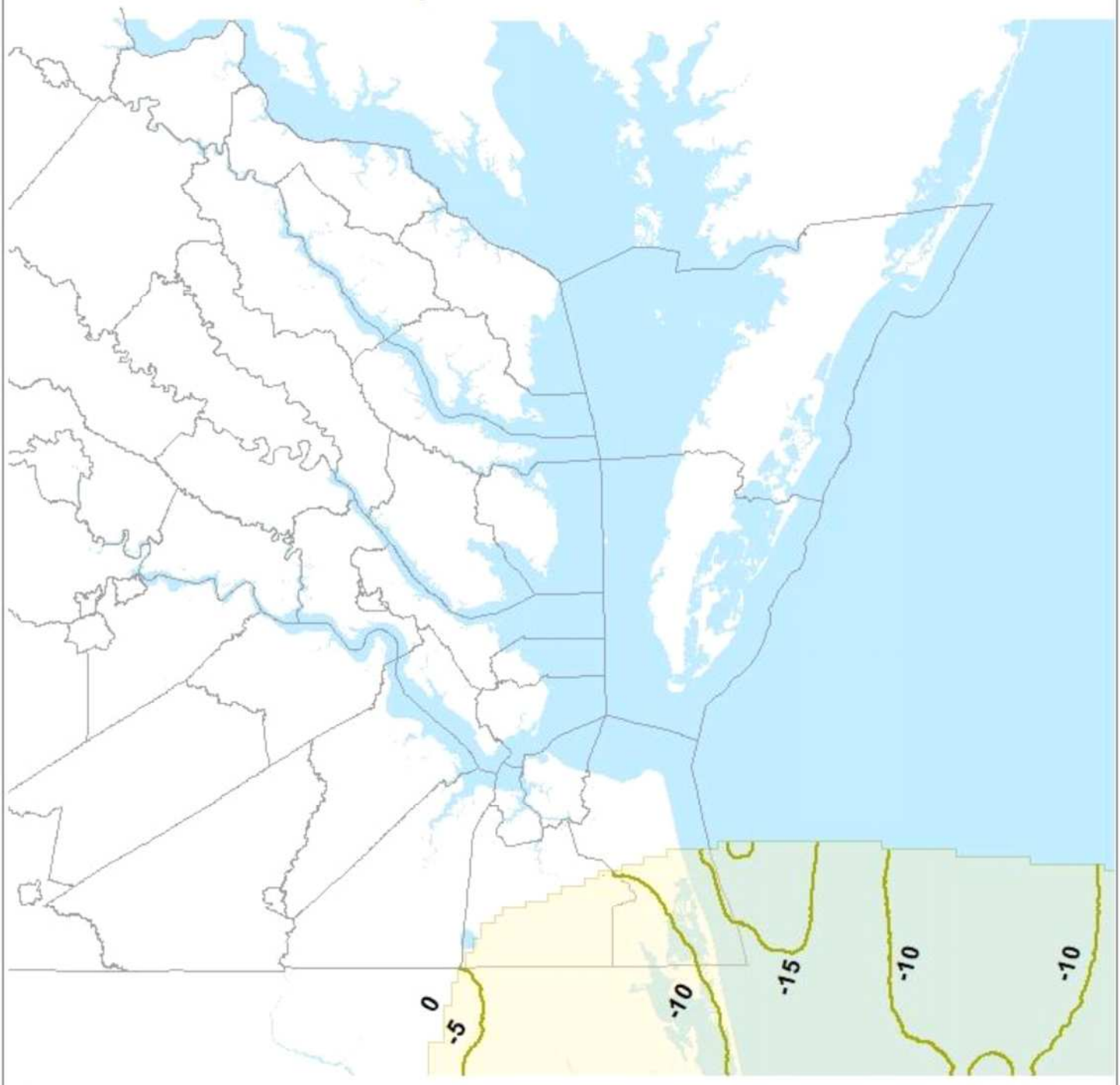
Potentiometric Water Level Contours

Virginia Beach Model Boundary

0 15 30 60 Miles

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Simulated Potentiometric Contours
Pee Dee Aquifer
2018 Reported Use Simulation



Contour elevations are in feet relative to mean sea level (msl) and at 5 ft intervals.

Prepared by Aquaveo, LLC for the Virginia DEQ, Office of Water Supply
November 2, 2019

Potentiometric Water Level Contours

Pee Dee Model Boundary

0 15 30 60 Miles

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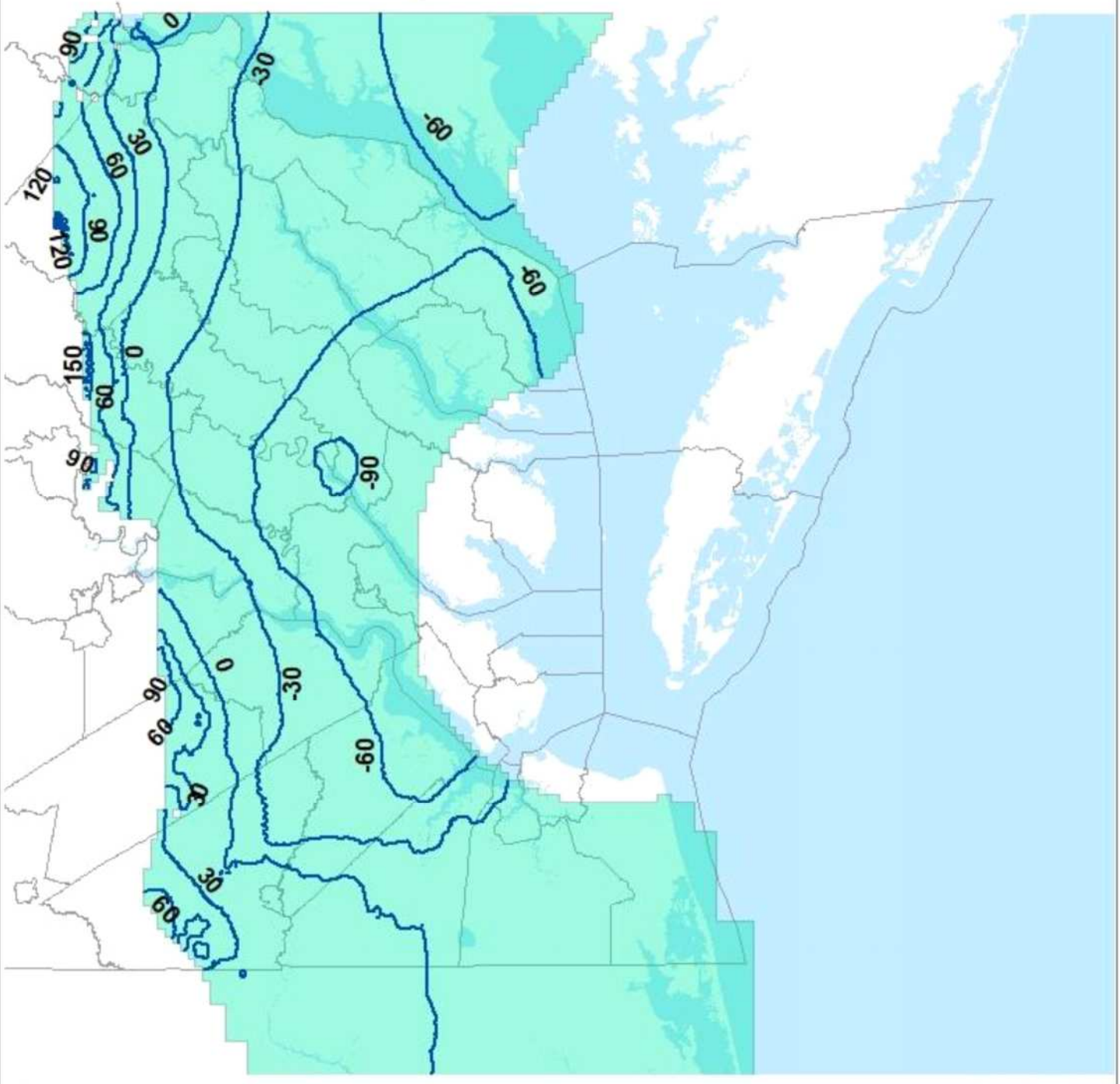
Simulated Potentiometric Contours
Aquia Aquifer
2018 Reported Use Simulation



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

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November 2, 2019

Potentiometric Water Level Contours

Aquia Aquifer Model Boundary

0 15 30 60 Miles

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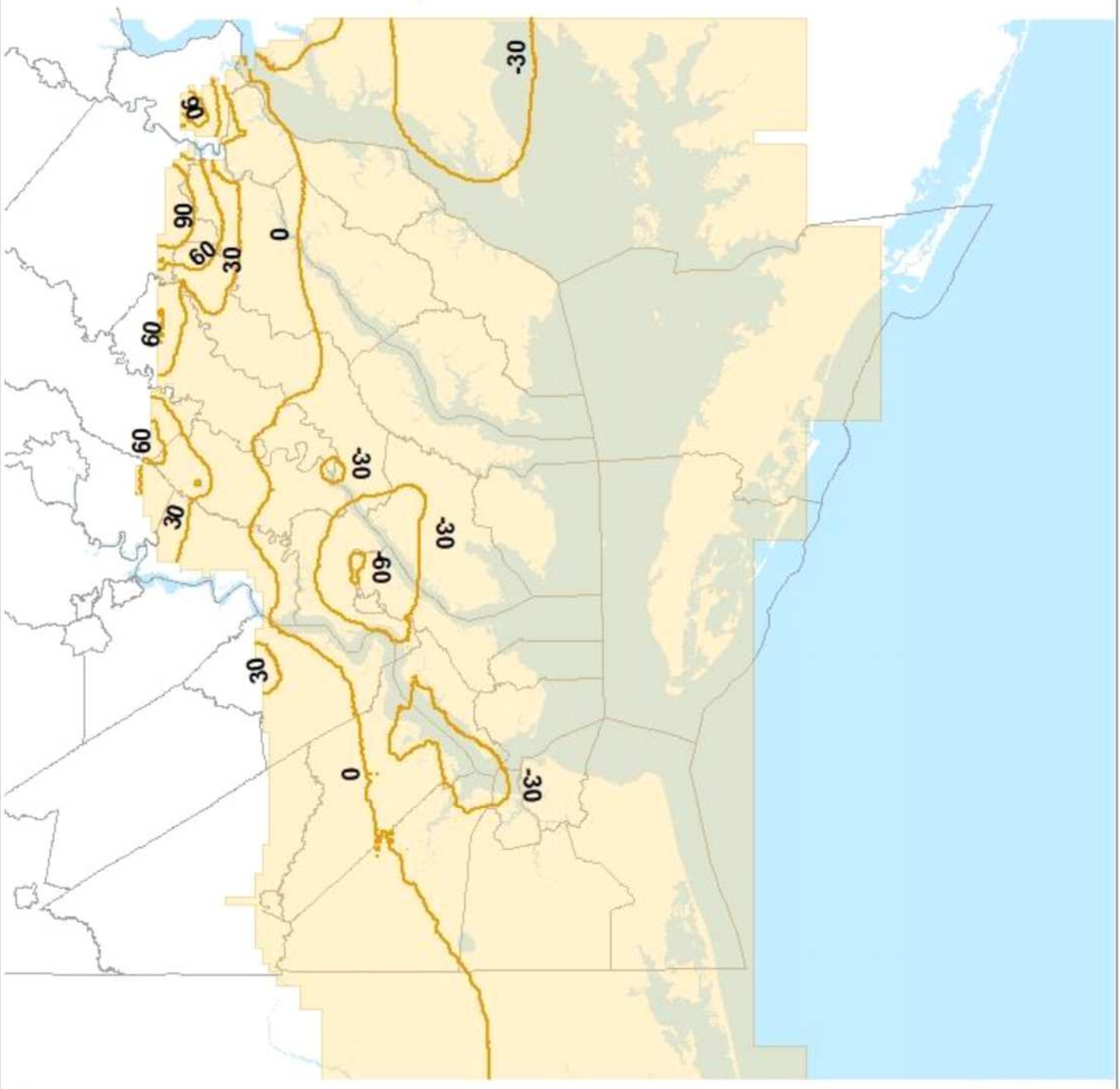
Simulated Potentiometric Contours
Piney Point Aquifer
2018 Reported Use Simulation



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

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November 2, 2019

Potentiometric Water Level Contours

Piney Point Aquifer Model Boundary

0 12.5 25 50 Miles

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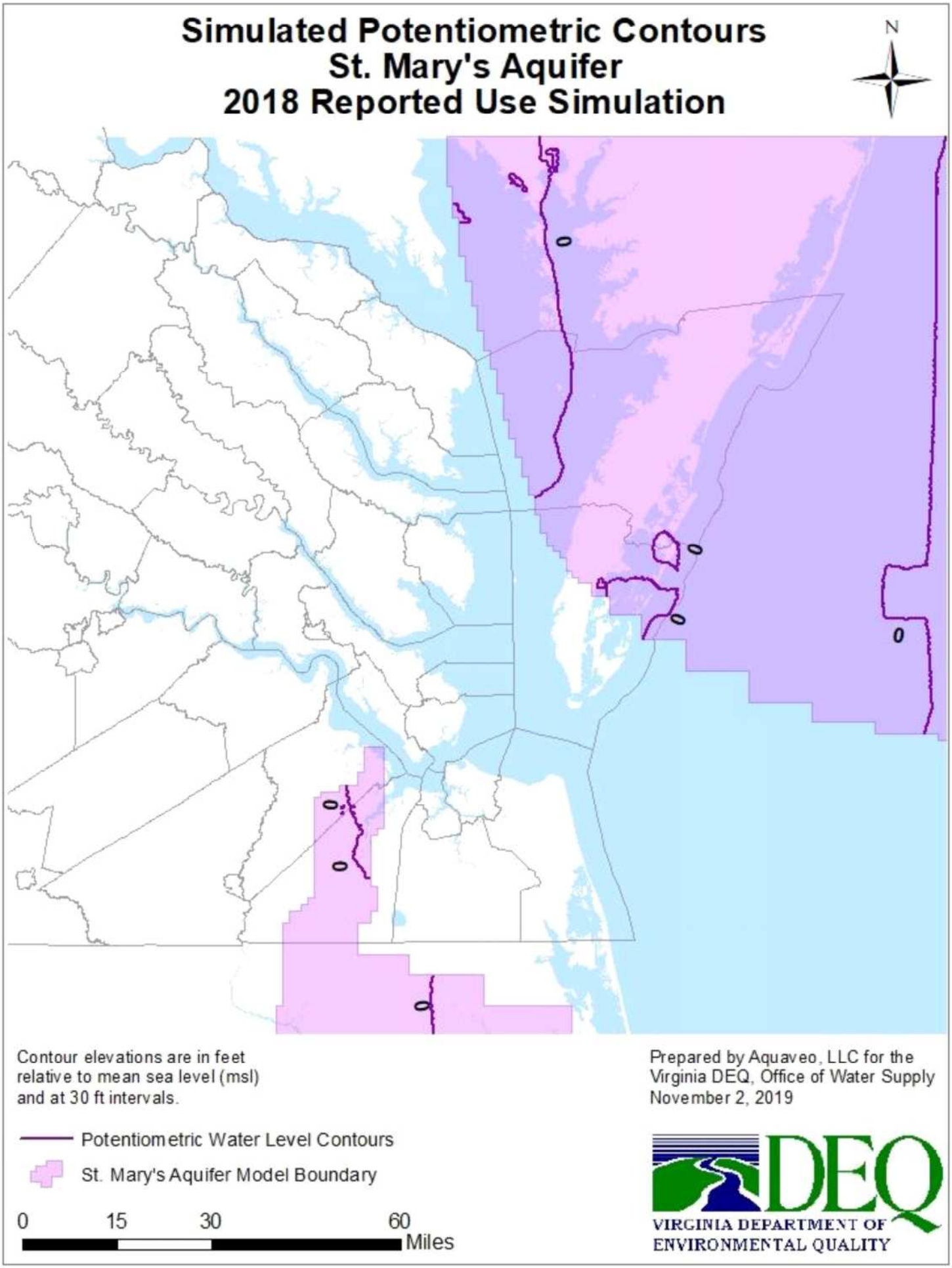
Simulated Potentiometric Contours
St. Mary's Aquifer
2018 Reported Use Simulation
N
0
0
0
0
0
0
Contour elevations are in feet relative to mean sea level (msl) and at 30 ft intervals.
Prepared by Aquaveo, LLC for the Virginia DEQ, Office of Water Supply
November 2, 2019
Potentiometric Water Level Contours
St. Mary's Aquifer Model Boundary
0
15
30
60
Miles
DEQ
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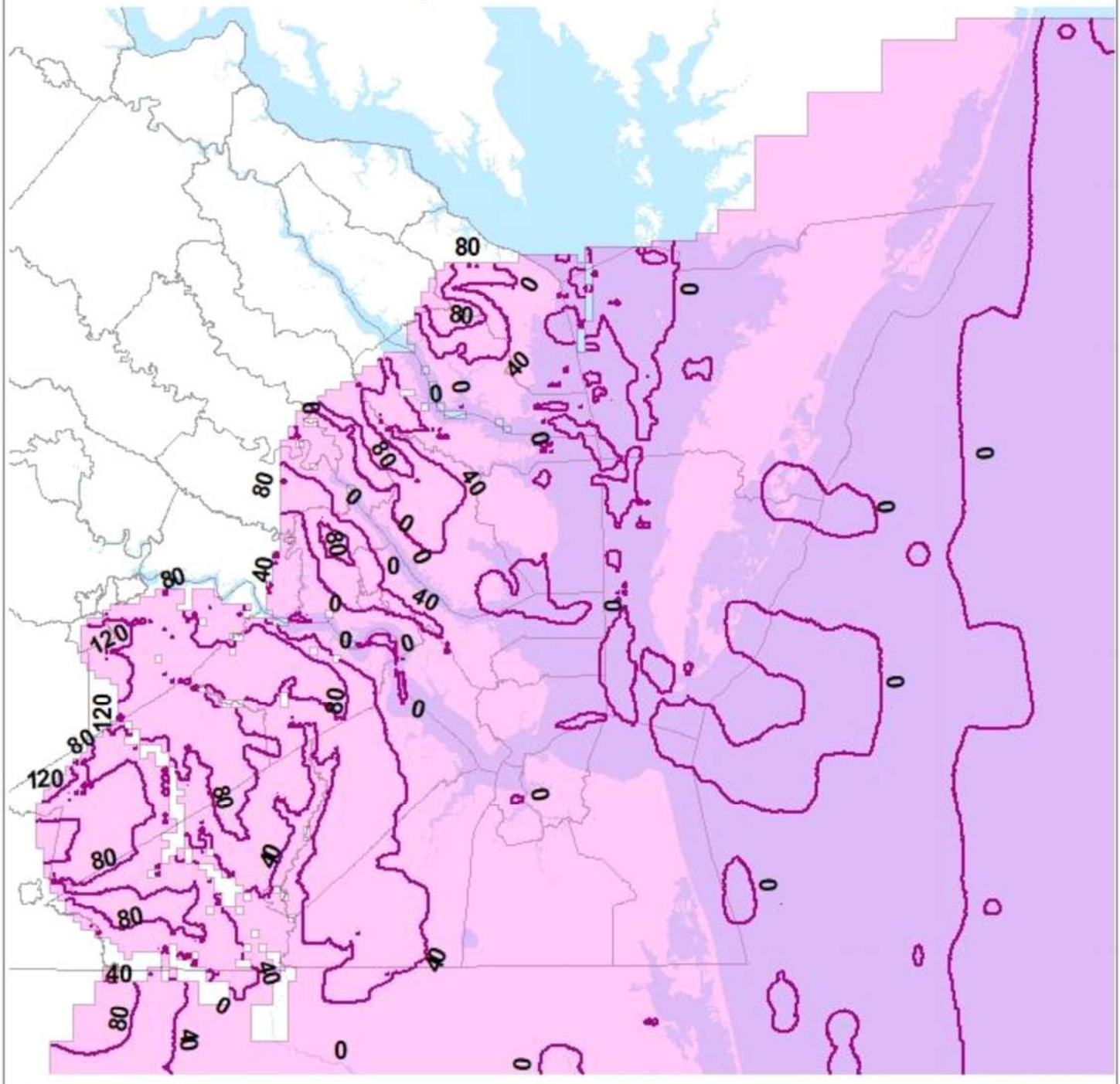
Simulated Potentiometric Contours
Yorktown-Eastover Aquifer
2018 Reported Use Simulation



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

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November 2, 2019

Potentiometric Water Level Contours

Yorktown-Eastover Aquifer Model Boundary

0 15 30 60 Miles

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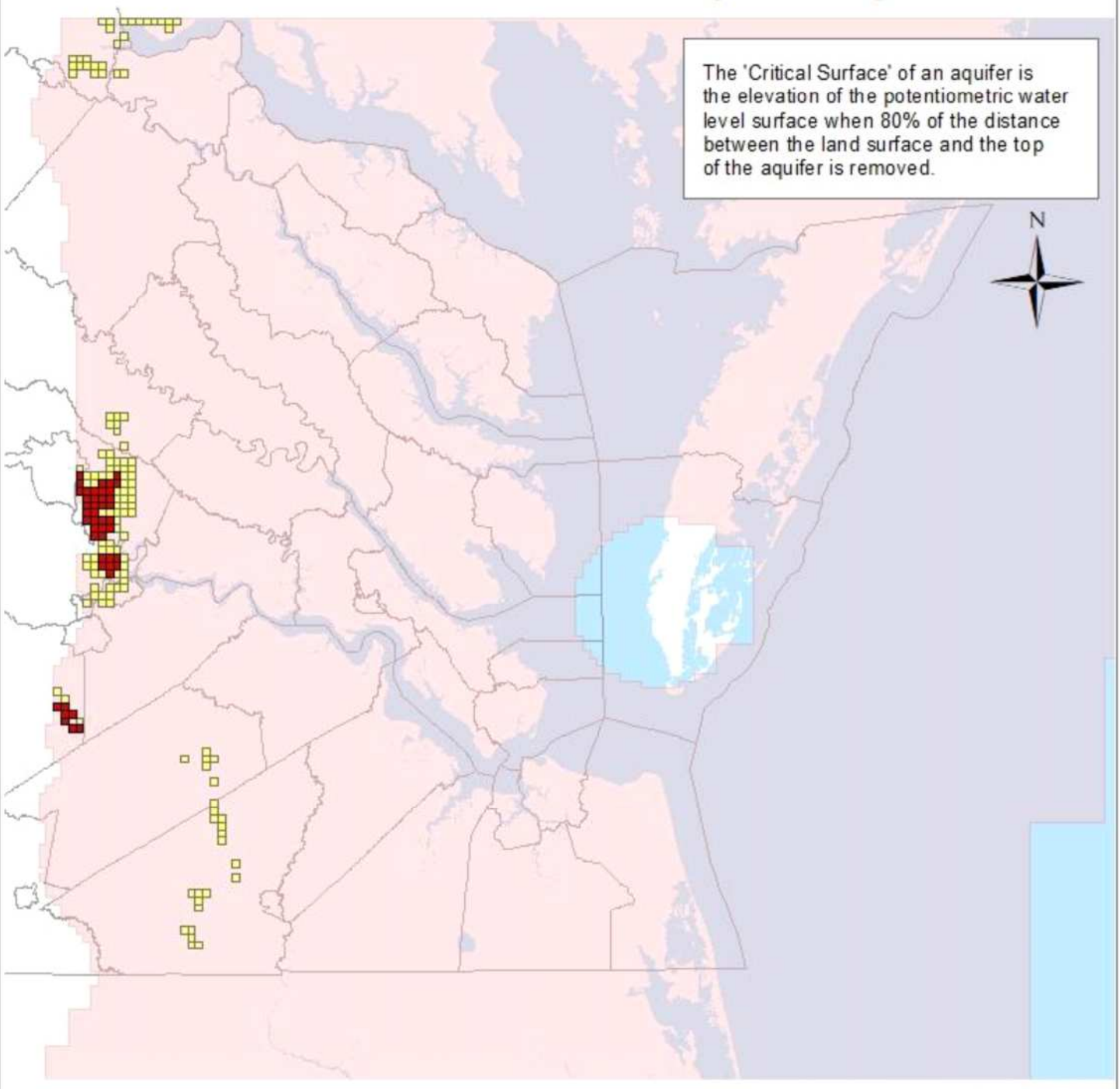
Attachment B

Simulated Water Levels
Below the Critical Surface and Below the Aquifer Top
2018 Reported Use Simulation

2018 Reported Use Simulation - Potomac Aquifer Simulated Water Levels Below the Critical Surface and Below the Aquifer Top



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November 2, 2019

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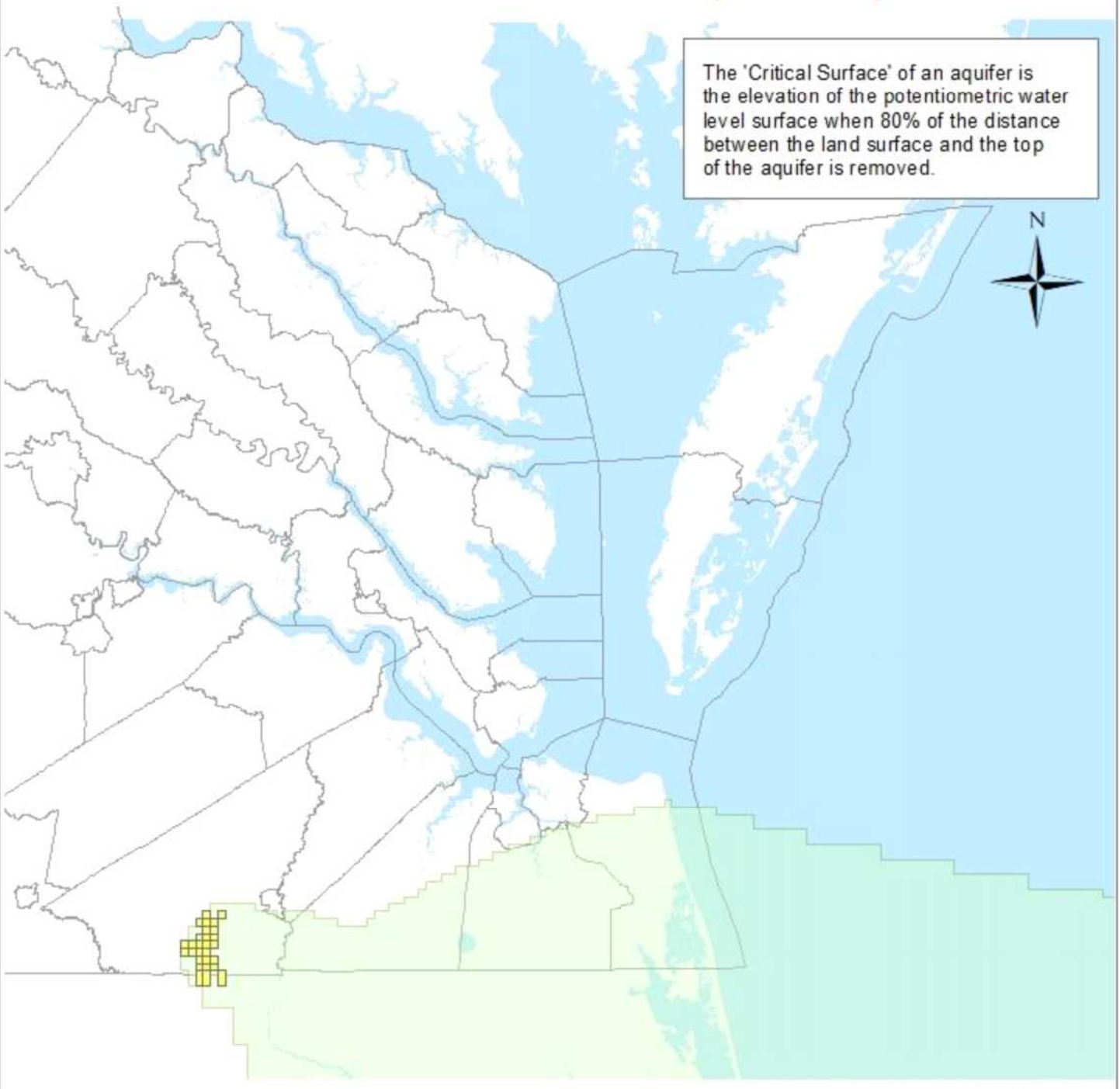
2018 Reported Use Simulation - Virginia Beach Aquifer Simulated Water Levels Below the Critical Surface and Below the Aquifer Top



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November 2, 2019

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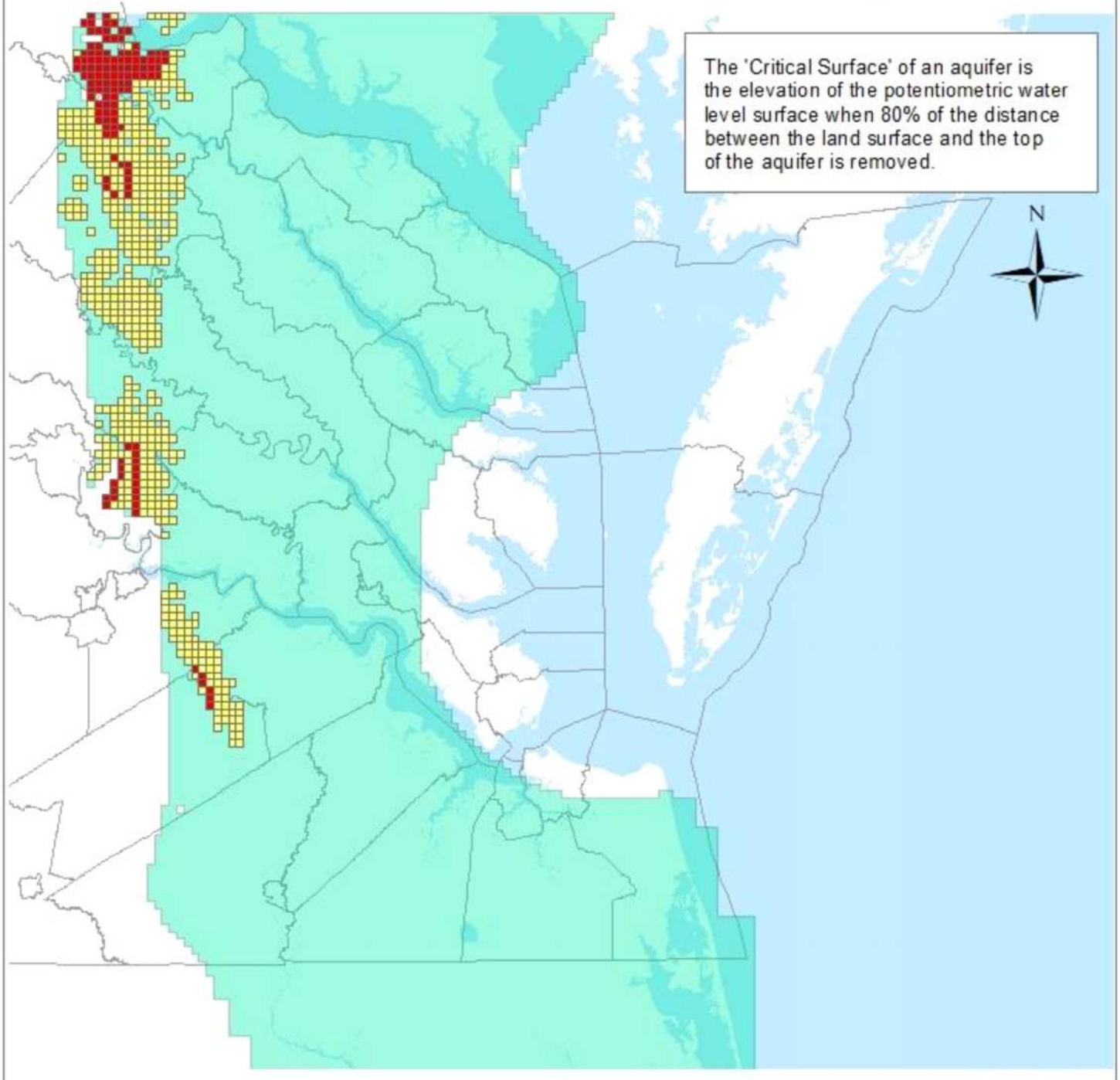
2018 Reported Use Simulation - Aquia Aquifer Simulated Water Levels Below the Critical Surface and Below the Aquifer Top



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November 2, 2019

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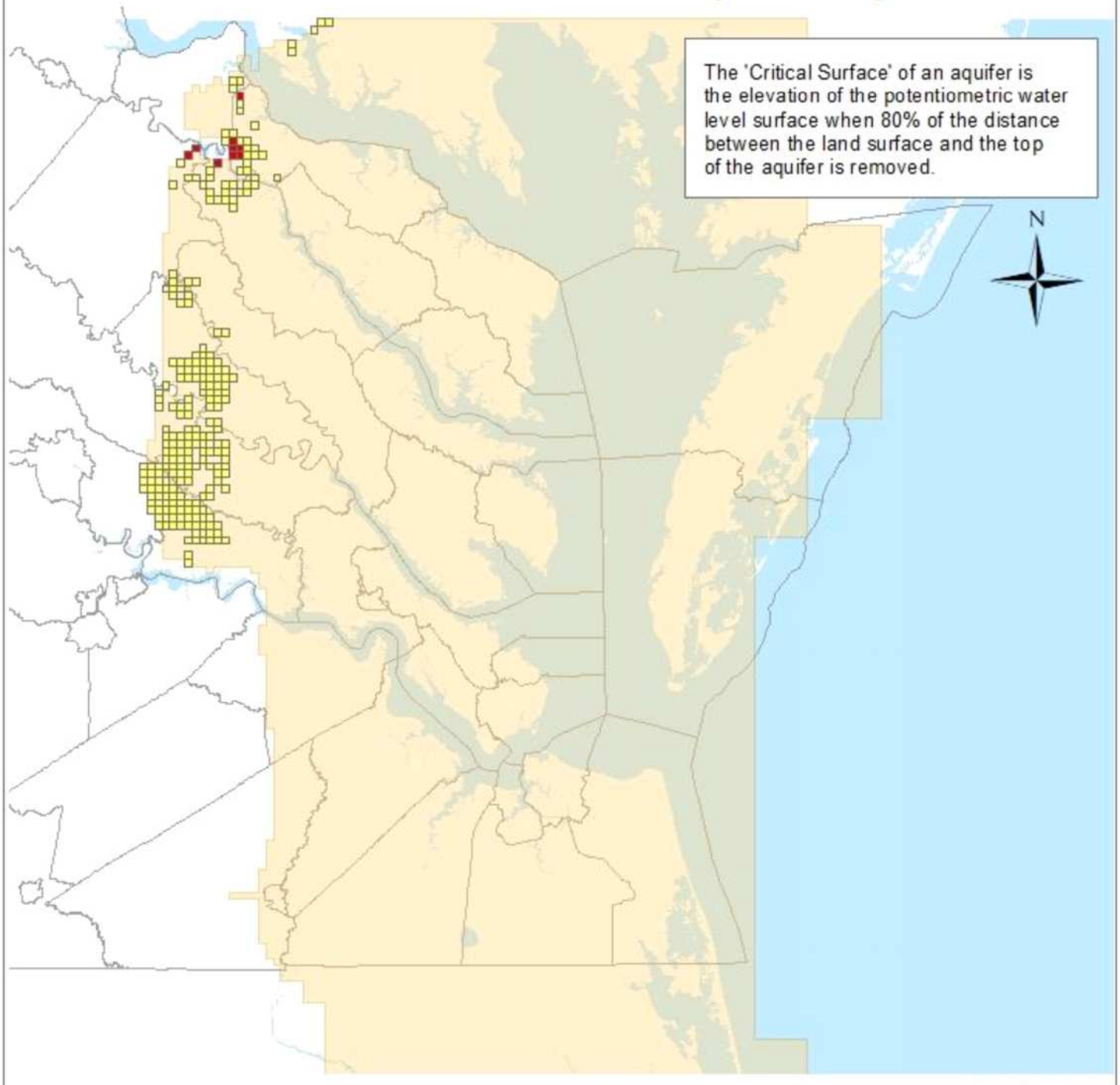
2018 Reported Use Simulation - Piney Point Aquifer Simulated Water Levels Below the Critical Surface and Below the Aquifer Top



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November 2, 2019

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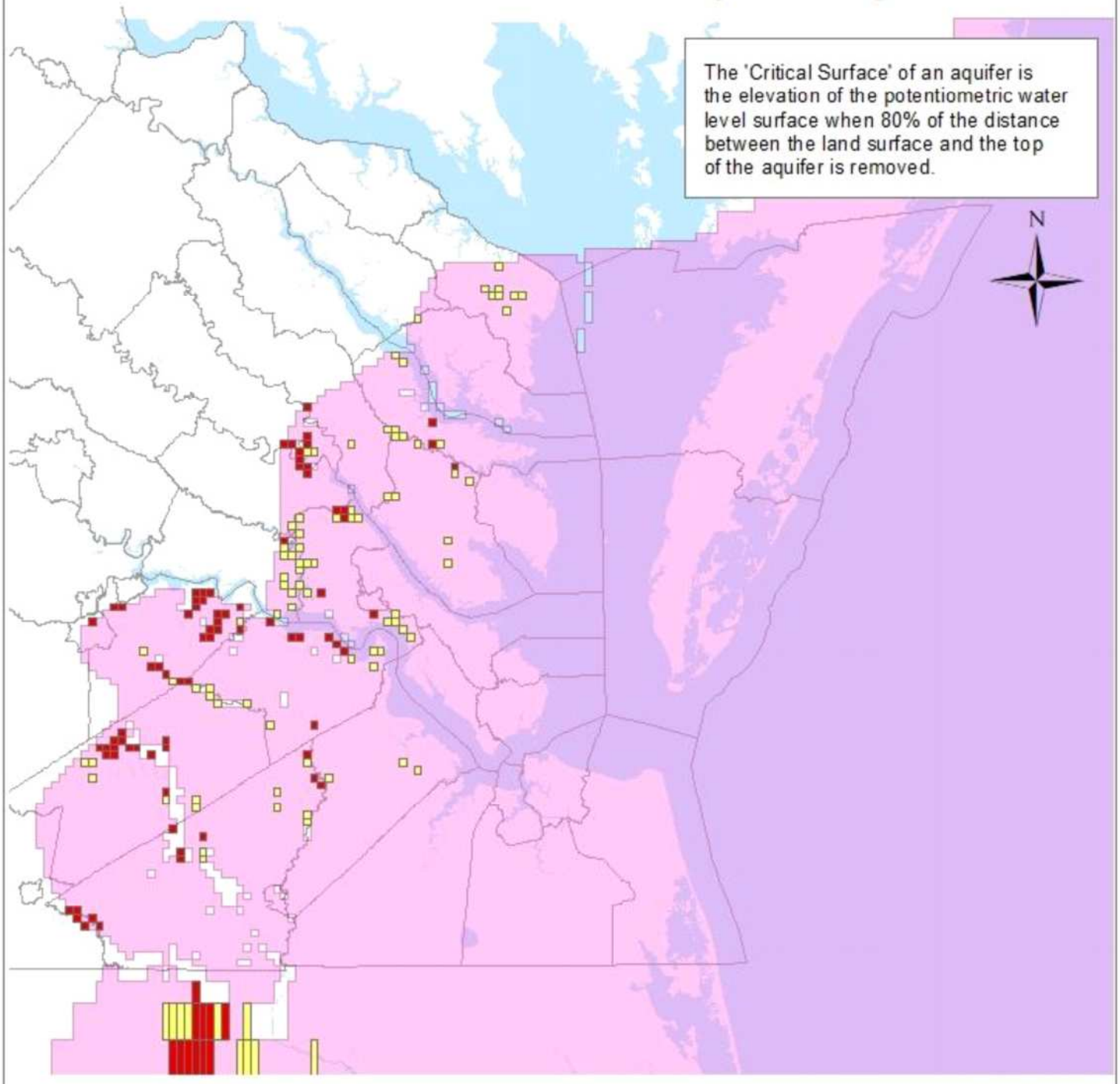
2018 Reported Use Simulation - Yorktown-Eastover Aquifer
Simulated Water Levels Below the Critical Surface and Below the Aquifer Top



Prepared by Aquaveo, LLC for the Virginia DEQ, Office of Water Supply
November 2, 2019

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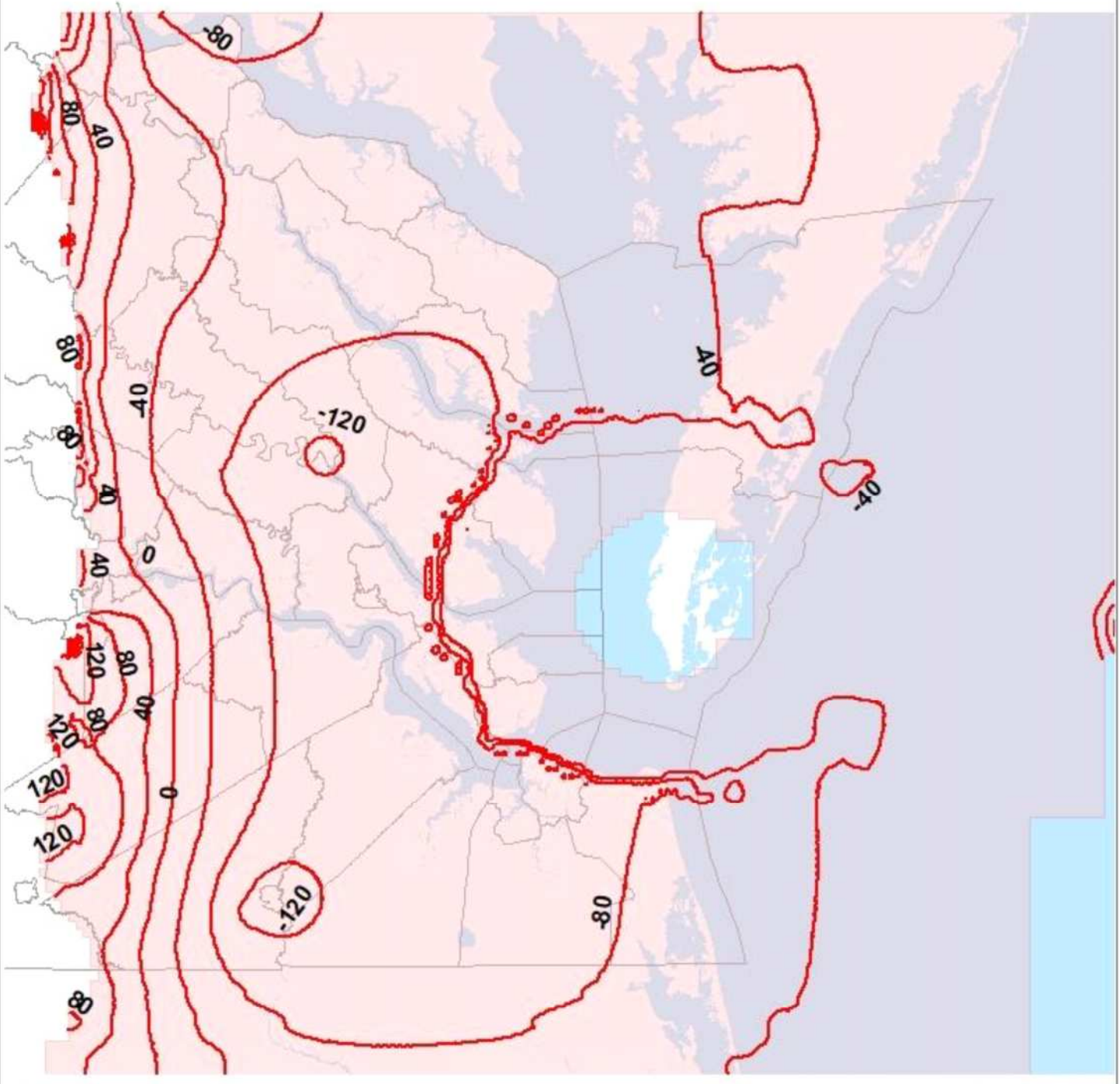
Attachment C

Simulated Potentiometric Contours
2019 Total Permitted Simulation

Simulated Potentiometric Contours
Potomac Aquifer
2019 Total Permitted Simulation



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

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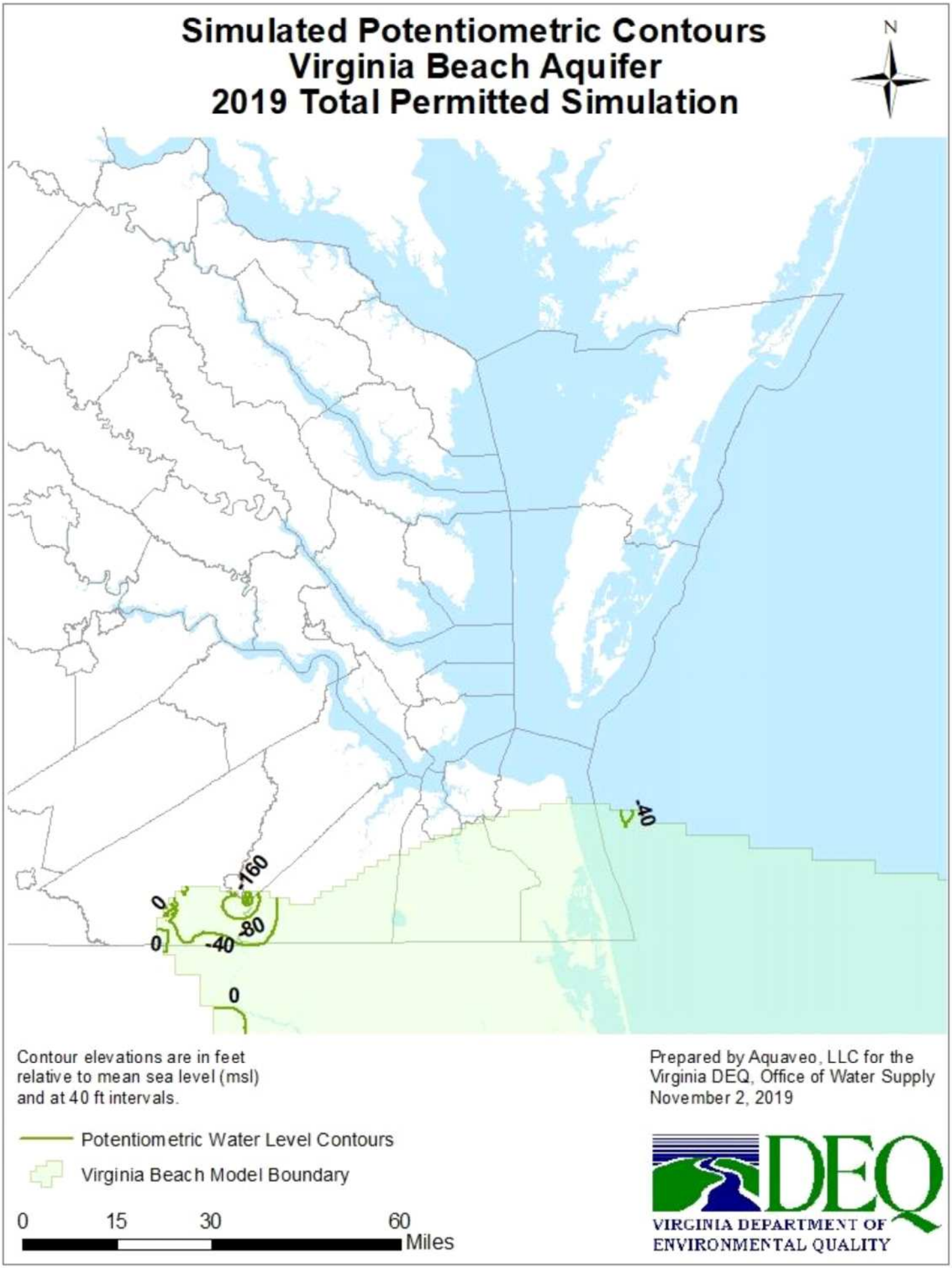
November 2, 2019

Potentiometric Water Level Contours

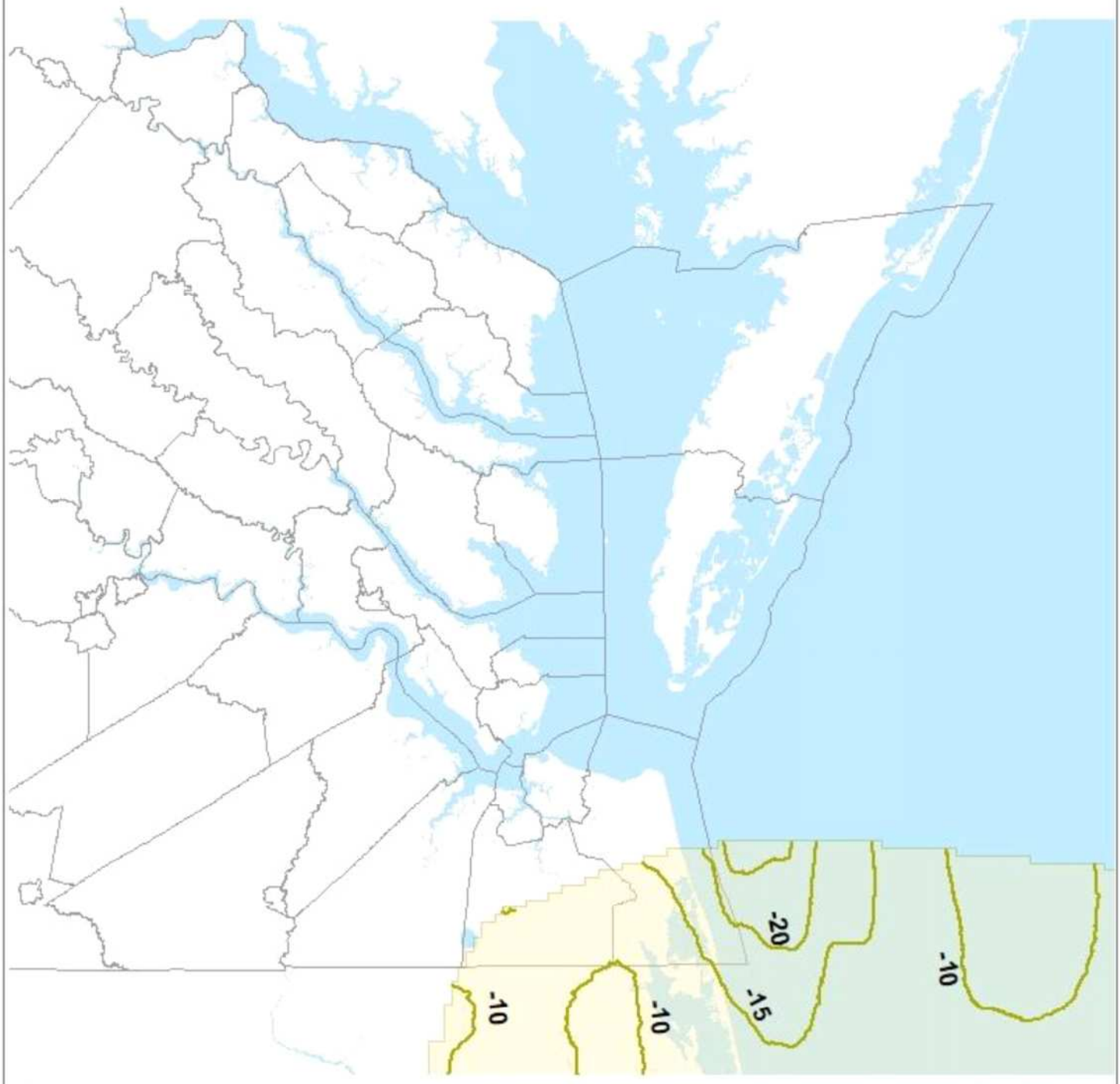
Potomac Aquifer Model Boundary

0 15 30 60 Miles

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY


Simulated Potentiometric Contours
Virginia Beach Aquifer
2019 Total Permitted Simulation
N
-40
-160
0
-80
0
-40
0
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 November 2, 2019
Potentiometric Water Level Contours
Virginia Beach Model Boundary
0 15 30 60
Miles
DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Simulated Potentiometric Contours
Pee Dee Aquifer
2019 Total Permitted Simulation



Contour elevations are in feet relative to mean sea level (msl) and at 5 ft intervals.

Prepared by Aquaveo, LLC for the Virginia DEQ, Office of Water Supply
November 2, 2019

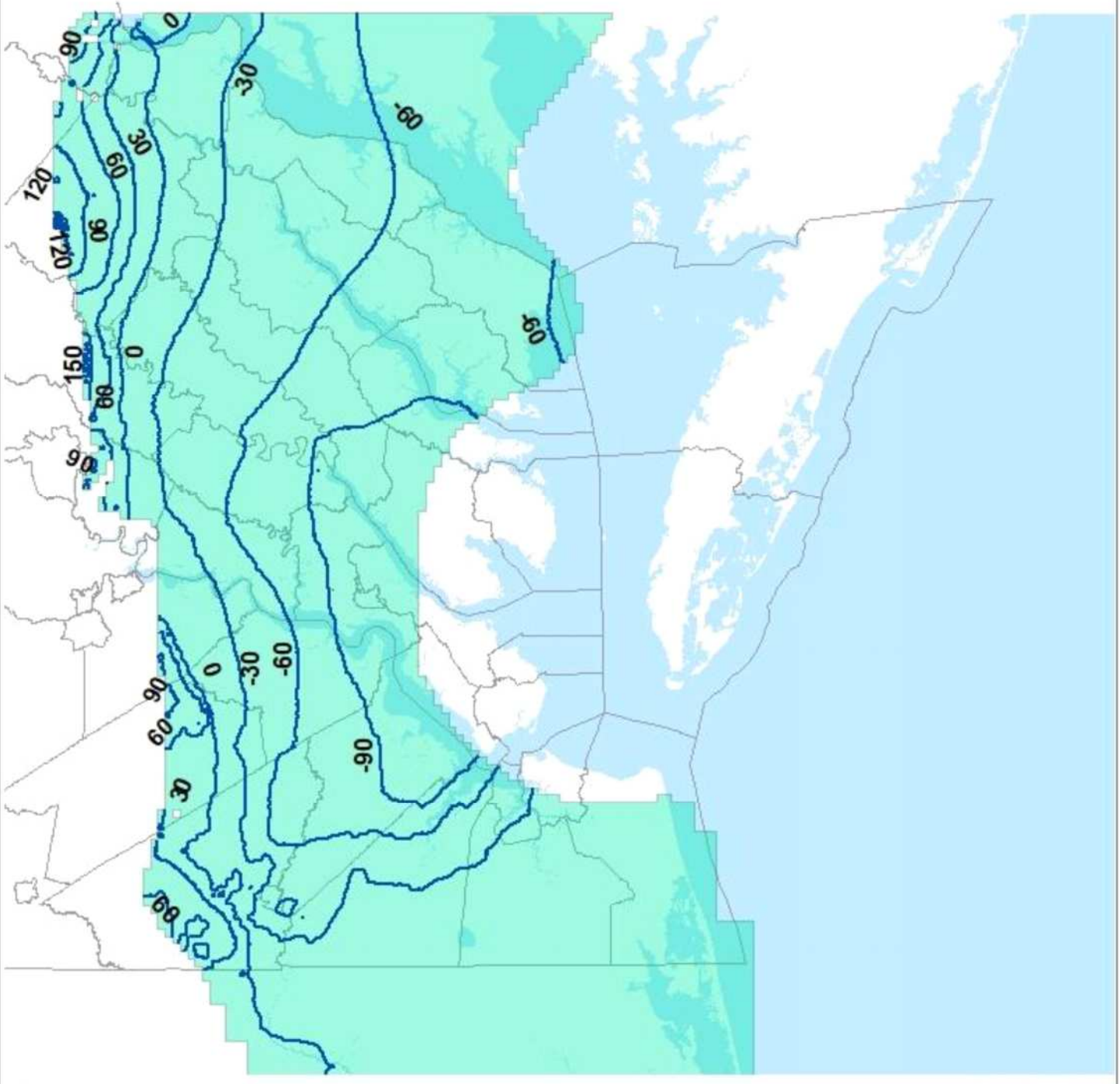
Potentiometric Water Level Contours

Pee Dee Model Boundary

0 15 30 60 Miles

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Simulated Potentiometric Contours
Aquia Aquifer
2019 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
November 2, 2019

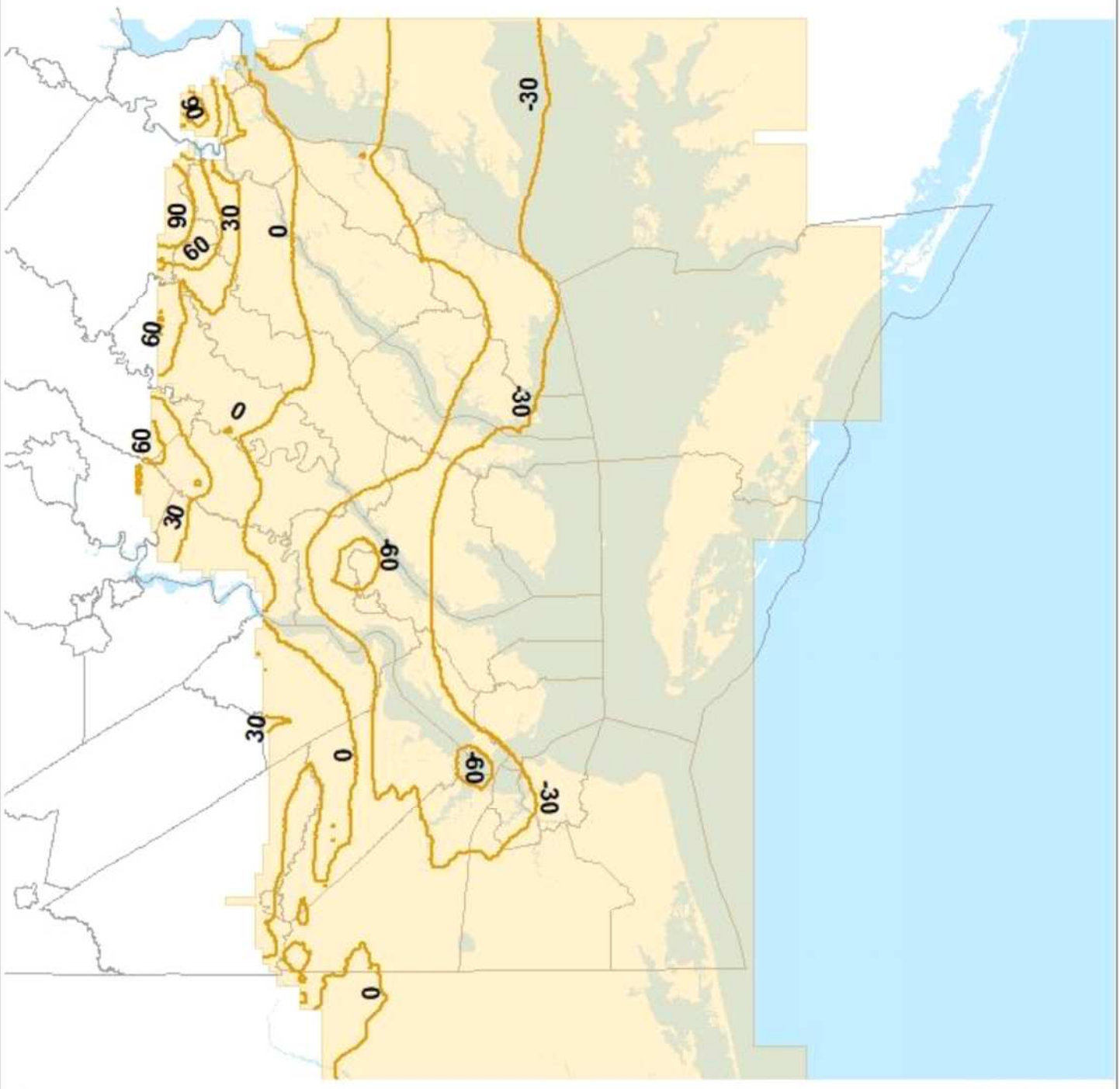
Potentiometric Water Level Contours

Aquia Aquifer Model Boundary

0 15 30 60 Miles

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Simulated Potentiometric Contours
Piney Point Aquifer
2019 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
November 2, 2019

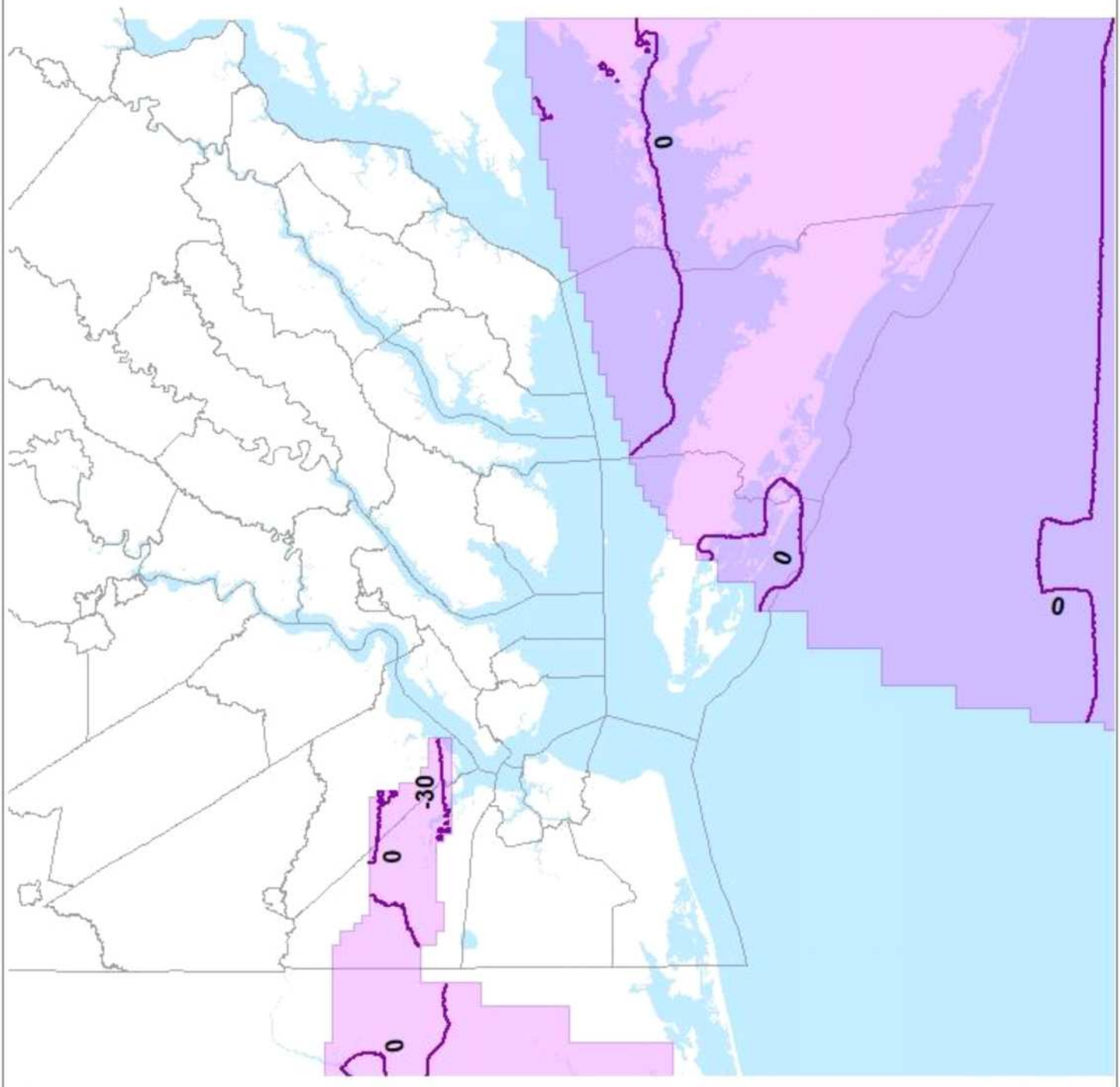
Potentiometric Water Level Contours

Piney Point Aquifer Model Boundary

0 15 30 60 Miles

DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Simulated Potentiometric Contours
St. Mary's Aquifer
2019 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
November 2, 2019

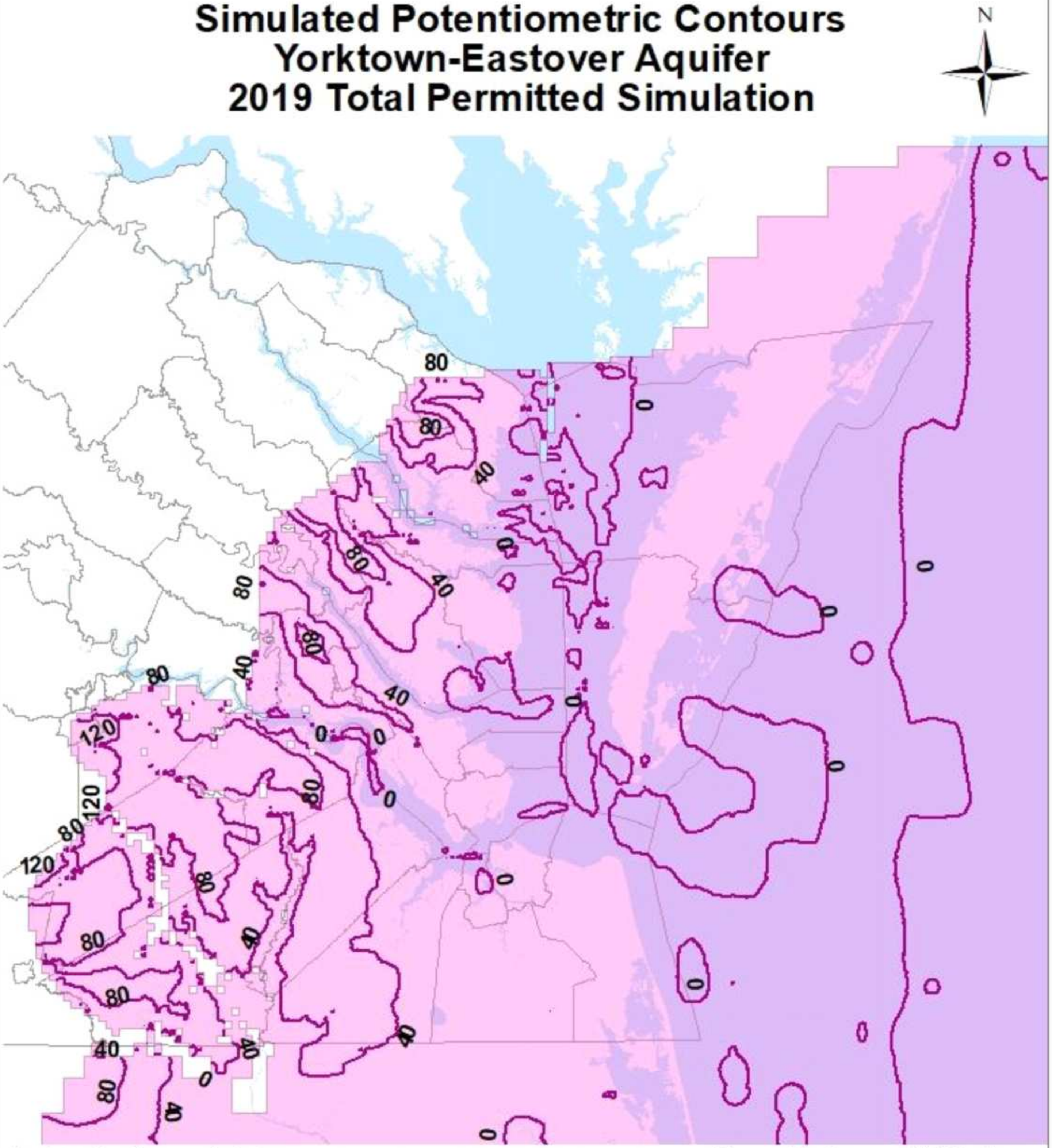
Potentiometric Water Level Contours

St. Mary's Aquifer Model Boundary

0 15 30 60 Miles

DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Simulated Potentiometric Contours
Yorktown-Eastover Aquifer
2019 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 November 2, 2019

Potentiometric Water Level Contours

Yorktown-Eastover Aquifer Model Boundary

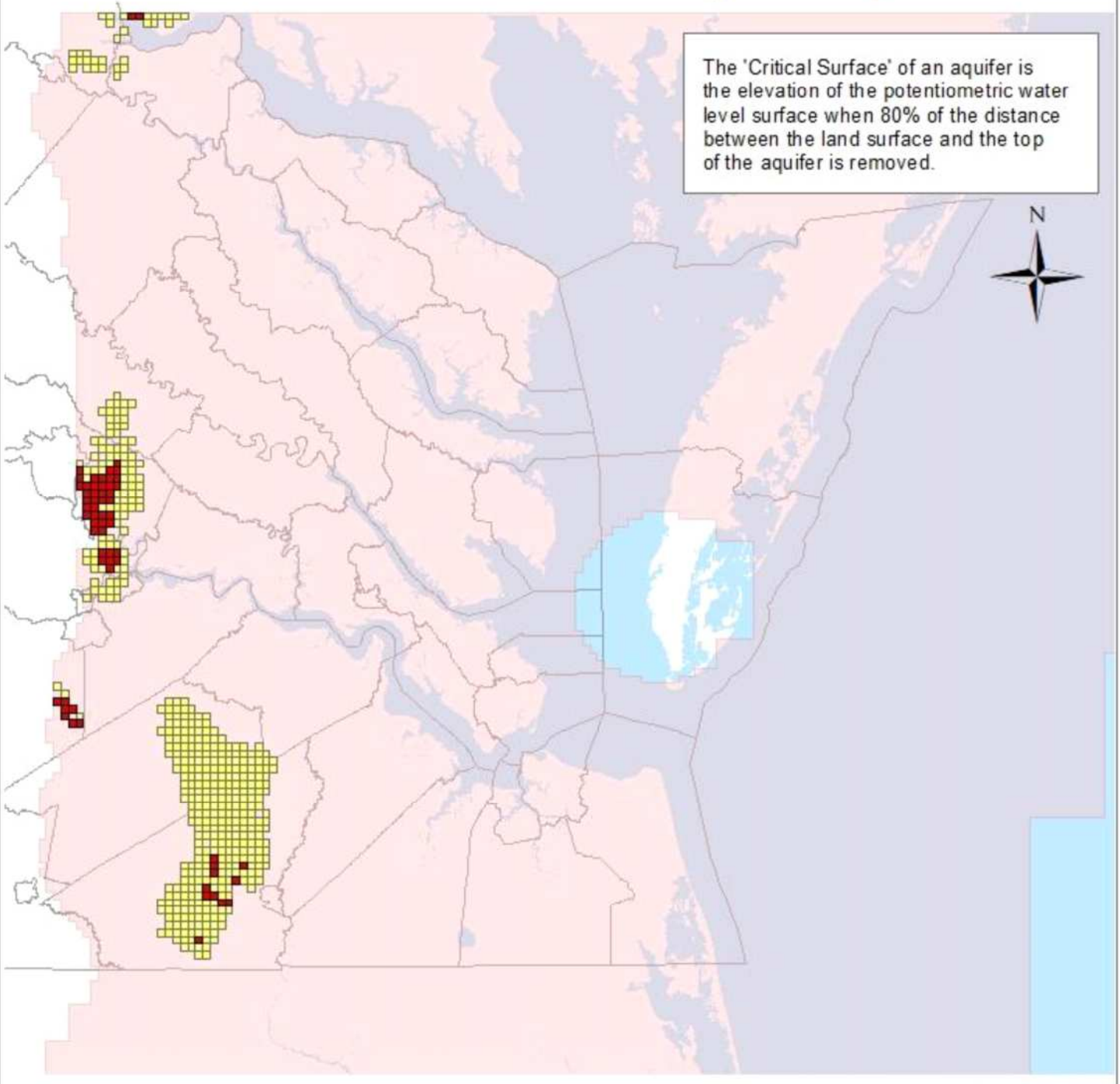
0 15 30 60 Miles

DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Attachment D

Simulated Water Levels
Below the Critical Surface and Below the Aquifer Top
2019 Total Permitted Simulation

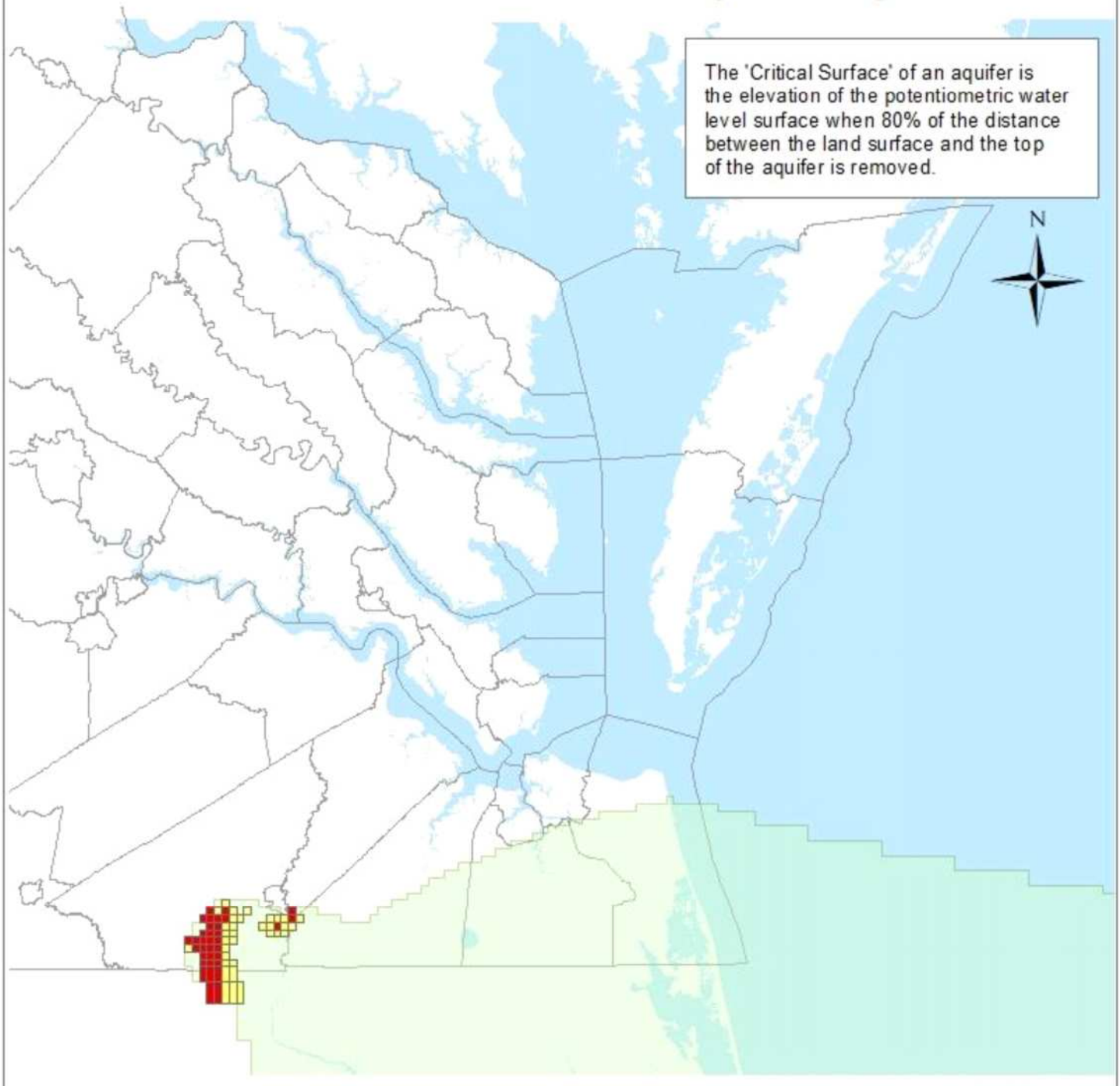
2019 Total Permitted Simulation - Potomac Aquifer Simulated Water Levels Below the Critical Surface and Below the Aquifer Top



Prepared by Aquaveo, LLC for the Virginia DEQ, Office of Water Supply
November 2, 2019

DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

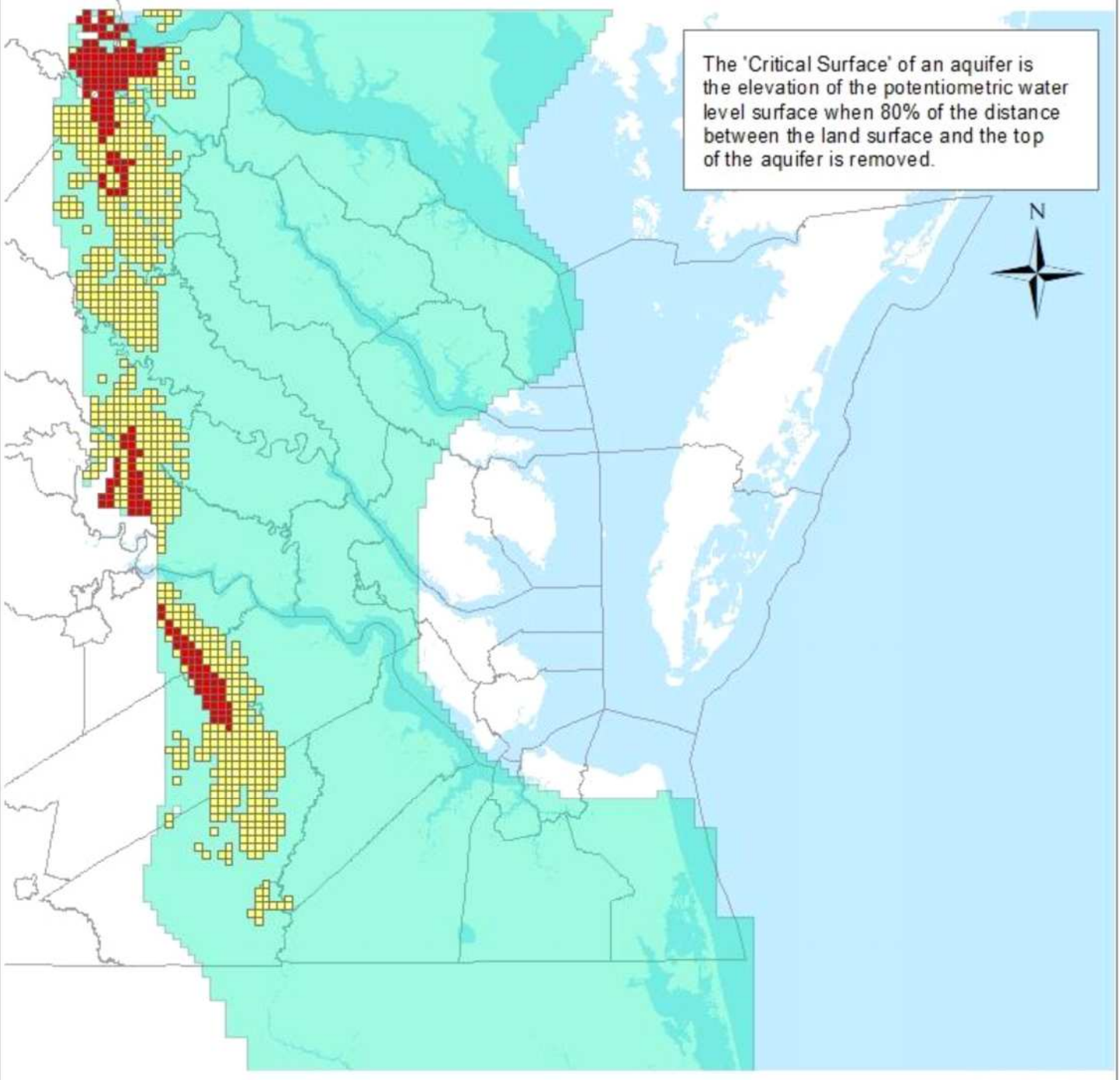
2019 Total Permitted Simulation - Virginia Beach Aquifer Simulated Water Levels Below the Critical Surface and Below the Aquifer Top



Prepared by Aquaveo, LLC for the Virginia DEQ, Office of Water Supply
November 2, 2019

DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

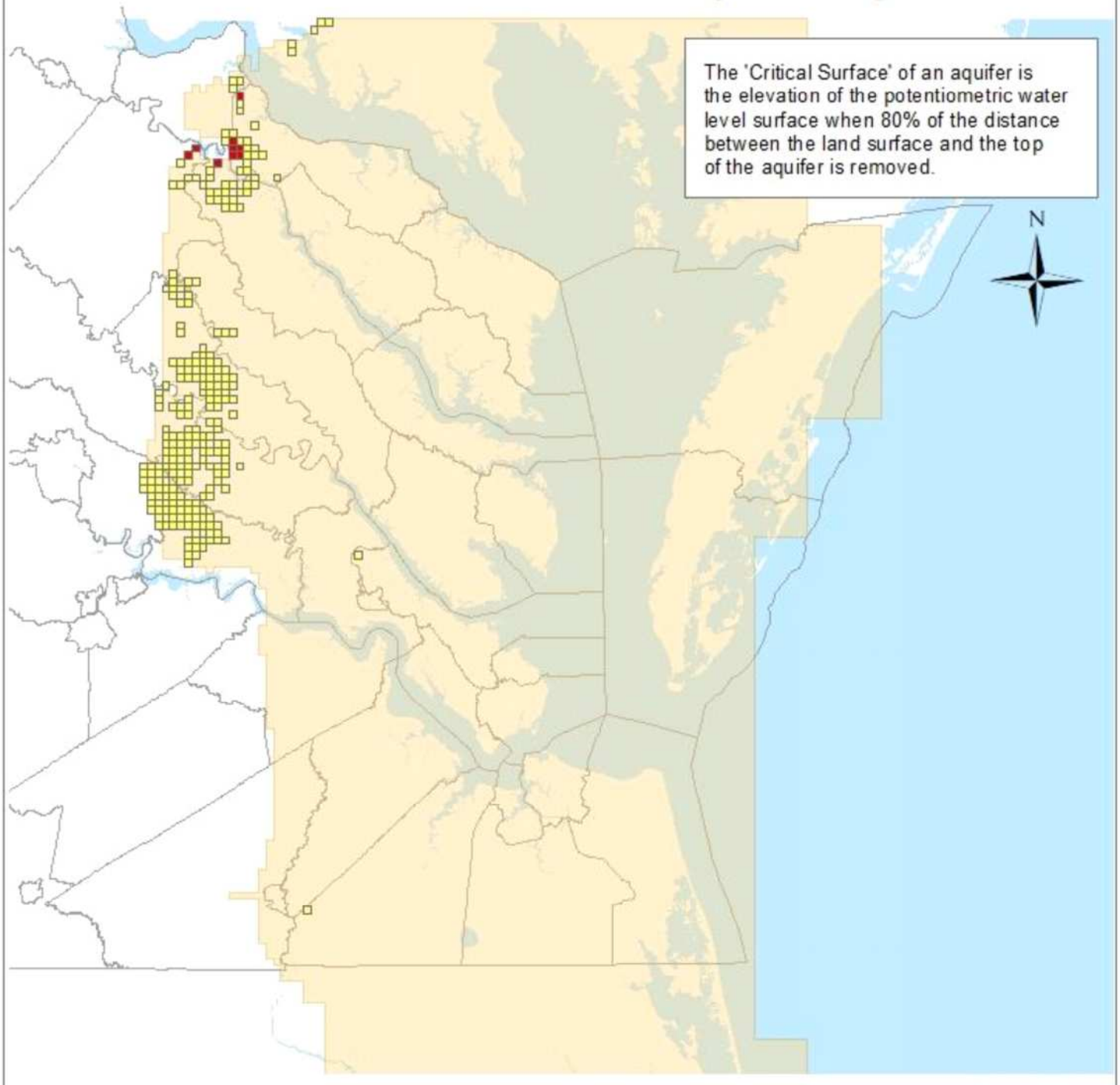
2019 Total Permitted Simulation - Aquia Aquifer Simulated Water Levels Below the Critical Surface and Below the Aquifer Top



Prepared by Aquaveo, LLC for the Virginia DEQ, Office of Water Supply
November 2, 2019

DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

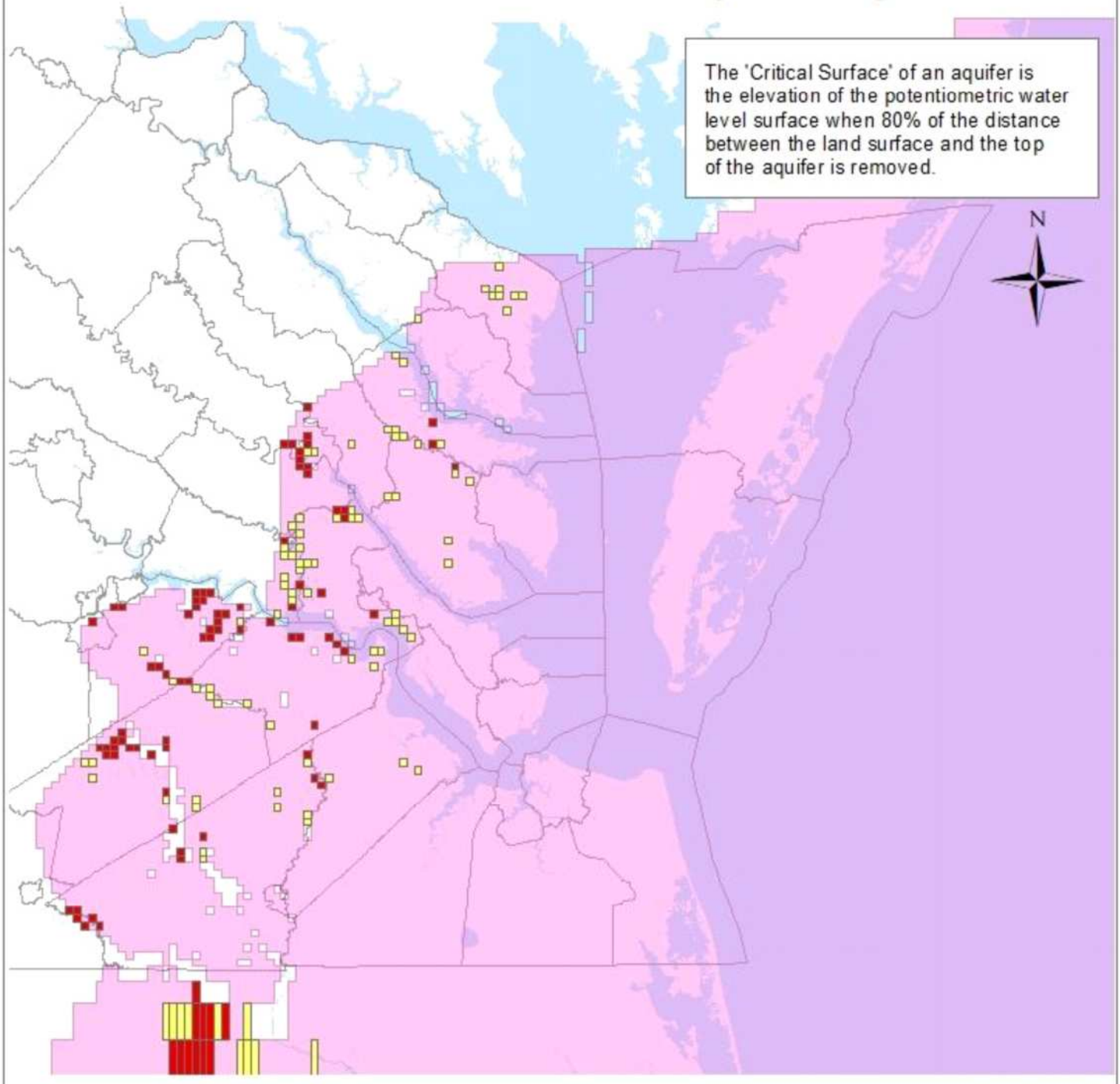
2019 Total Permitted Simulation - Piney Point Aquifer Simulated Water Levels Below the Critical Surface and Below the Aquifer Top



Prepared by Aquaveo, LLC for the Virginia DEQ, Office of Water Supply
November 2, 2019

DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

2019 Total Permitted Simulation - Yorktown-Eastover Aquifer
Simulated Water Levels Below the Critical Surface and Below the Aquifer Top



Prepared by Aquaveo, LLC for the Virginia DEQ, Office of Water Supply
November 2, 2019

DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Attachment E

VACPGWI Permits Simulated - 2019 Total Permitted Simulation

VACPGWI Negotiated Pumping Schedules (MGD)

		2019	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028-31	2032-68
GWID	Owner	Q1-3	Q4	Q1-Q4	Q1-Q4	Q1-Q4	Q1-Q4	Q1-Q4	Q1-Q4	Q1-Q4	Q1-Q4	Q1-Q4	Q1-Q4
GW0037601	Solenis, LLC	3.2	3.2	4	4	4	4	4	4	4	4	4	4
GW0042901	City of Franklin	1.4	1.4	1.4	1.4	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
GW0036301	Virginia Renewable Power - Portsmouth, LLC	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
GW0047400	City of Portsmouth Department of Public Utility	5.015	5.015	5.015	5.015	5.015	5.015	5.015	5.015	5.015	5.015	5.015	5.015
GW0043901	City of Chesapeake Public Utilities Department	3.709	3.709	5.849	5.849	7.989	6.919	6.919	6.919	6.919	6.71	5.64	3.5
GW0005101	WestRock CP, LLC	20	20	20	17.5	17.5	17.5	16	16	16	16	16	11.5
GW0042001	International Paper Company	20	20	20	20	20	20	20	20	18	18	18	18
GW0043401	James City Service Authority	6.4	6.4	6.4	7.4	7.4	7.4	7.4	8.4	8.4	8.4	8.4	3.8
GW0045801	Western Tidewater Water Authority	6.6	4.2	4.2	4.2	6.6	6.6	6.6	7.6	7.6	7.6	7.6	4.2
GW0047100	Norfolk City of Department of Utilities	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74
GW0030201	Newport News City of Public Utilities	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
GW0031801	Smithfield Town of	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
GW0041301	Colonial Williamsburg Foundation	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
GW0042201	Smithfield Packing Company, Incorporated	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6

Attachment F

Permits Simulated
2019 Total Permitted Simulation

PERMIT	OWNER	FACILITY	PERMITTED Q (MGD)	PERMITTED Q (%)
GW0043501	AEC Virginia	AEC Virginia	0.14	0.15%
GW0047700	Alsco	Alsco	0.05	0.05%
GW0008100	Aqua Virginia, In	Venter Heights Water System	0.03	0.03%
GW0002401	Aqua Virginia, Inc.	Avondale Robin Ridge	0.09	0.09%
GW0002601	Aqua Virginia, Inc.	Walnut Grove	0.02	0.02%
GW0002801	Aqua Virginia, Inc.	Cherrydale	0.06	0.07%
GW0002901	Aqua Virginia, Inc.	Hanover Farms	0.03	0.03%
GW0003001	Aqua Virginia, Inc.	Rural Point	0.06	0.07%
GW0003101	Aqua Virginia, Inc.	Burnside Farms Mayfield Ellerson	0.06	0.07%
GW0003201	Aqua Virginia, Inc.	Colonial Forest	0.02	0.02%
GW0003301	Aqua Virginia, Inc.	High Point Farms	0.02	0.03%
GW0003401	Aqua Virginia, Inc.	Spring Meadows and Meadowgate Water System	0.13	0.14%
GW0007800	Aqua Virginia, Inc.	Oak Springs Subdivision	0.07	0.08%
GW0008600	Aqua Virginia, Inc.	Five Lakes #1 Water System	0.02	0.02%
GW0009800	Aqua Virginia, Inc.	Brookwood Manor	0.01	0.02%
GW00127EU	Aqua Virginia, Inc.	Elsinore Public Water System	0.01	0.01%
GW00128EU	Aqua Virginia, Inc.	Cedar Pointe	0.01	0.01%
GW00130EU	Aqua Virginia, Inc.	Gwynnfield Subdivision	0.03	0.03%
GW00132EU	Aqua Virginia, Inc.	Town of Saluda	0.07	0.07%
GW00133EU	Aqua Virginia, Inc.	Luttrellville Water System	0.01	0.01%
GW00150EU	Aqua Virginia, Inc.	Foxwells Community Water System	0.02	0.02%
GW00151EU	Aqua Virginia, Inc.	Irvington	0.08	0.09%
GW00152EU	Aqua Virginia, Inc.	Lancaster Courthouse	0.02	0.02%
GW00153EU	Aqua Virginia, Inc.	Lively Public Water System	0.02	0.03%
GW00154EU	Aqua Virginia, Inc.	Tartan (Kingsland & Green)	0.02	0.03%
GW00155EU	Aqua Virginia, Inc.	Weems Public Water System	0.04	0.04%
GW00156EU	Aqua Virginia, Inc.	White Stone Public Water System	0.06	0.06%
GW00157EU	Aqua Virginia, Inc.	Burgess Public Water Supply	0.01	0.01%
GW00158EU	Aqua Virginia, Inc.	Callao Public Water System	0.03	0.03%
GW00159EU	Aqua Virginia, Inc.	Chesapeake Bay Estates	0.01	0.01%
GW00160EU	Aqua Virginia, Inc.	Heathsville Public Water System	0.02	0.02%
GW00161EU	Aqua Virginia, Inc.	Indian Creek Estates Public Water System	0.01	0.02%
GW00162EU	Aqua Virginia, Inc.	Lottsburg Public Water System	0.01	0.01%
GW00163EU	Aqua Virginia, Inc.	Mallard Bay Public Water System	0.01	0.01%

GW00164EU	Aqua Virginia, Inc.	Reedville Public Water System	0.03	0.03%
GW00165EU	Aqua Virginia, Inc.	Rivers Bend Estates	0.01	0.01%
GW00166EU	Aqua Virginia, Inc.	Kinsale	0.01	0.02%
GW00167EU	Aqua Virginia, Inc.	Nomini Bay Farms	0.01	0.01%
GW00168EU	Aqua Virginia, Inc.	Presidential Lakes #14 Public Water System	0.07	0.07%
GW0035101	BASF Corporation	BASF Corporation	0.03	0.03%
GW0038101	BASF Corporation	BASF Corporation	0.14	0.15%
GW00184EU	Bevans Oyster Company, Inc	Bevans Oyster Company	0.07	0.08%
GW00181EU	BGM Services. Inc.	Locksley Hall Estates	0.01	0.01%
GW00187EU	Birchwood Power Partners, L.P.	Birchwood Power Facility	0.02	0.02%
GW0045200	Bracey Enterprises Clydes Dale Mobile Home Park	Clydes Dale Mobile Home Park	0.04	0.04%
GW00142EU	Bush Park Mobile Home Park, Inc.	Bush Park Mobile Home Park	0.01	0.01%
GW0042301	C & P Isle of Wight Water Company	Scottswood Subdivision Water System	0.04	0.04%
GW0076200	Calvin Haile	Haile Farm	0.07	0.08%
GW0048300	Capital Concrete Incorporated	Capital Concrete Inc Stapleton Street Plant	0.04	0.04%
GW0054800	Capron Town of	Capron Town of	0.03	0.03%
GW00204EU	Caroline County Department of Public Works	Milford Sanitary District Water System	0.06	0.06%
GW00205EU	Caroline County Department of Public Works	PoorhouseTract/Caroline High School	0.01	0.02%
GW0046601	Cavalier Golf and Yacht Club	Cavalier Golf and Yacht Club	0.03	0.04%
GW00137EU	Cedar Ri	Cedar Ridge Mobile Home Park	0.01	0.01%
GW0049000	CF Broad Bay Arcis LLC	The Tradition Golf Club at Broad Bay	0.07	0.08%
GW0004600	Charles City County of	Wayside Well System	0.02	0.03%
GW0004900	Charles City County of	Mt Zion Rustic Public Water System	0.02	0.03%
GW0008500	Charles City County School Board	Charles City County School Complex	0.01	0.01%
GW0078700	Chickahominy Power LLC	Chickahominy Power Plant	0.08	0.09%
GW00149EU	Christchurch School Foundation	Christchurch School	0.02	0.02%
GW0037401	Cintas Corporation No. 2	Cintas, Portsmouth #391	0.06	0.07%
GW0043901	City of Chesapeake Public Utilities Department	Northwest River/Western Branch Systems	4.20	4.50%
GW0042901	City of Franklin	Franklin Water System	1.59	1.70%
GW0047400	City of Portsmouth Department of Public Utility	Lake Kilby Water Treatment Facility	5.02	5.38%
GW0000801	Claremont Town of	Claremont Town of Water System	0.04	0.04%
GW0036101	Colonial Williamsburg Foundation	Colonial Williamsburg -New Golf Course	0.09	0.10%
GW0041301	Colonial Williamsburg Foundation	Colonial Williamsburg	1.25	1.34%
GW0042801	Continental Automotive Systems US, Inc.	Continental Automotive Systems US, Inc.	0.04	0.05%
GW00179EU	County of Westmoreland	Westmoreland Industrial Park Water System	0.02	0.02%
GW0036200	Courtland Town of	Courtland Town of	0.15	0.16%
GW00185EU	Curley Packing Company	Monroe Bay Estates and Trailer Park	0.02	0.02%
GW0045501	Dominion Terminal Associates	Dominion Terminal Associates	0.09	0.10%

GW0000401	DuPont Teijin Films	DuPont Hopewell Plant	0.25	0.27%
GW0053100	Elizabeth Manor Golf and Country Club	Elizabeth Manor Golf and Country Club	0.06	0.06%
GW00718EU	Emmett C. Snead,III	Sneads Asparagus Farm	0.32	0.34%
GW00219EU	Essex Mobile Home Park	Essex Mobile Home Park	0.01	0.01%
GW00121EU	Glenwood MHC,LLC	Glenwood Mobile Home Park	0.02	0.02%
GW00105EU	Gloucester County Water System	Gloucester County Public Utilities	0.91	0.97%
GW0003501	Golden Cat Division of Ralston Purina	Golden Cat Division of Ralston Purina	0.09	0.09%
GW0054100	Governors Land Associates	Two Rivers Country Club	0.09	0.10%
GW00721EU	Greenhost, Inc.	Greenhost Incorporated	0.18	0.19%
GW0001402	Hanover County of	Georgetown	0.02	0.02%
GW0001702	Hanover County of	Sinclair Manor	0.01	0.01%
GW0001902	Hanover County of	Strawhorne	0.02	0.02%
GW0002301	Hanover County of	Hanover Courthouse	0.07	0.07%
GW00107EU	Heritage Point Association, Inc.	Heritage Point Water Works	0.02	0.02%
GW0032900	Higgerson-Buchanan, Inc.	Higgerson-Buchanan	0.04	0.05%
GW0022300	Hyponex Coporation	Scotts Company Waverly	0.01	0.01%
GW0022400	INGENCO (Industrial Power	King and Queen Landfill Gas to Energy Facility	0.04	0.05%
GW0007501	INGENCO (Industrial Power Generating Company, LLC.)	INGENCO Charles City Peaking Facility	0.03	0.03%
GW00720EU	Ingleside Plantation Inc	Ingleside Plantation Nurseries	0.08	0.08%
GW0042001	International Paper Company	Franklin Virginia Mill	18.28	19.61%
GW0032501	Isle of Wight Department of Public Utilities	Rushmere	0.02	0.02%
GW0036000	Isle of Wight Department of Public Utilities	Days Point	0.02	0.02%
GW0047000	Isle of Wight Department of Public Utilities	Lawnes Point	0.04	0.05%
GW0051800	Isle of Wight Department of Public Utilities	Carrsville Water System	0.02	0.02%
GW0051900	Isle of Wight Department of Public Utilities	Smithfield Heights Sandy Mount Manor	0.04	0.05%
GW00140EU	James C May	Endfield Nursery	0.02	0.03%
GW0043401	James City Service Authority	JCSA -Central System	4.84	5.19%
GW0031001	James City Service Authority	JCSA -Racefield Subdivision W 29	0.01	0.01%
GW0031401	James City Service Authority	JCSA -Ware Creek Manor Number 1 and 2 W 36	0.01	0.01%
GW0045001	James City Service Authority	JCSA -Kings Village Subdivision W 31	0.01	0.01%
GW0049400	James City Service Authority	JCSA -Wexford Hills Subdivision	0.04	0.04%
GW0051701	James City Service Authority	Liberty Ridge Subdivision	0.04	0.04%
GW0055000	James City Service Authority	JCSA -The Retreat	0.02	0.02%
GW00124EU	James K. Tucker	Tucker's Recreation Park	0.01	0.01%
GW0037001	James River Country Club	James River Country Club	0.03	0.03%
GW0010000	John A. Franklin	Pooles Mobile Home Park	0.01	0.01%
GW00122EU	Kilmer's Point Home Owner's Association	Kilmer's Point	0.01	0.01%

GW0044701	Kinder Morgan Bulk Terminals	Pier IX/X Terminals	0.06	0.06%
GW00193EU	King George County Service Authority	Fairview Beach (and Potomac Landing)	0.06	0.06%
GW00195EU	King George County Service Authority	Canterbury Subdivision CWS	0.02	0.02%
GW00196EU	King George County Service Authority	Circle Community Water System	0.02	0.02%
GW00197EU	King George County Service Authority	Courthouse CWS	0.34	0.36%
GW00198EU	King George County Service Authority	Oakland Park	0.07	0.08%
GW00199EU	King George County Service Authority	St. Paul's Church CWS	0.02	0.02%
GW00200EU	King George County Service Authority	Dahlgren CWS	0.31	0.34%
GW0007400	King William County	King William County - Central Garage Water System	0.47	0.50%
GW0009100	King William County of Public Schools	Acquinton Elementary School and Hmltn Holmes School	0.01	0.01%
GW00176EU	Lake Packing Company, Inc./Cowart Seafood Corp./Cowart Properties	Lake Packing Company, Inc.- Processing	0.07	0.07%
GW00186EU	Laurel Point Property Owners Association, Inc.	Laurel Point Subdivision	0.01	0.01%
GW00220EU	Laurel Wood E	Laurel Wood Estates	0.01	0.02%
GW0022100	Legacy Park Homeow	Legacy Park Subdivision	0.02	0.02%
GW0006600	Lundie Utilities Incorporated	Wildwood Farms	0.08	0.08%
GW00212EU	Mattox Development Company, Inc.	Placid Bay Estates	0.08	0.09%
GW00719EU	Maxie Broaddus	Sunnyside Farm	0.18	0.19%
GW00134EU	McFarland Cascade Holdings, Inc.	McFarland Cascade Holdings, Inc.	0.02	0.02%
GW00126EU	MHC Grey's Point LLC	Grey's Point Campground	0.03	0.03%
GW00141EU	MHC TT Inc.	Thousand Trails (Chesapeake Bay Rv Resort)	0.01	0.01%
GW0056900	MHC Williamsburg LLC	Outdoor World Williamsburg	0.02	0.02%
GW0076500	Middlesex County	Eastern Middlesex County Regional Water System	0.29	0.31%
GW0071300	Miller Partnership	Camp Farm	0.17	0.19%
GW00139EU	Mizpah Nursing Home	Mizpah Nursing Home	0.01	0.02%
GW00180EU	Mount Vernon Country Club	Mount Vernon Country Club	0.03	0.03%
GW00118EU	Mount Vernon Ladies Association	Mount Vernon Estate	0.04	0.04%
GW0066100	Murphy-Brown LLC Smit	Smithfield Hog Production Farms 1 through 5	0.15	0.16%
GW0066200	Murphy-Brown LLC Smit	Smithfield Hog Production Farms 6-8	0.08	0.09%
GW0066300	Murphy-Brown LLC Smit	Smithfield Hog Production Farms 9,10 & 21	0.10	0.10%
GW0066400	Murphy-Brown LLC Smit	Smithfield Hog Production Farm 12	0.03	0.03%
GW0066500	Murphy-Brown LLC Smit	Smithfield Hog Production Farms 13 & 14	0.05	0.05%
GW0066600	Murphy-Brown LLC Smit	Smithfield Hog Production Farm 15	0.03	0.03%
GW0066700	Murphy-Brown LLC Smit	Smithfield Hog Production Farms 16 & 17	0.06	0.06%
GW0066800	Murphy-Brown LLC Smit	Smithfield Hog Production Farm 18	0.03	0.03%
GW0066900	Murphy-Brown LLC Smit	Smithfield Hog Production Farms 19 & 20	0.06	0.06%
GW0067000	Murphy-Brown LLC Smit	Smithfield Hog Production Feedmill	0.02	0.02%
GW0000601	New Kent County of	Route 33 Corridor Water System	0.23	0.25%
GW0001301	New Kent County of	Colonial Downs Public Water System	0.62	0.67%

GW0002201	New Kent County of	Woods Edge Dispatch Station Water System	0.01	0.01%
GW0006700	New Kent County of	Farms of New Kent Water System	0.66	0.70%
GW0007300	New Kent County of	Bottoms Bridge	0.49	0.53%
GW0007600	New Kent County of	New Kent Courthouse	0.16	0.17%
GW0007700	New Kent County of	Colonies	0.05	0.05%
GW0008900	New Kent County of	Whitehouse Farms	0.01	0.01%
GW0030201	Newport News City of Public Utilities	Newport News City of Waterworks Lee Hall	7.00	7.51%
GW0052200	Newport News Waterworks	Combined Skimino Banbury and Lightfoot Systems	0.70	0.75%
GW0047100	Norfolk City of Department of Utilities	Norfolk City of Utilities Four Suffolk Wells	3.74	4.01%
GW0060001	Norfolk City of Nursery	Norfolk City of Nursery	0.01	0.01%
GW00108EU	Northern Neck Water	Bells Cove Water System	0.01	0.01%
GW00112EU	Northern Neck Water	Chesapeake Cove	0.01	0.01%
GW00113EU	Northern Neck Water	White Sands Harbor	0.01	0.01%
GW00111EU	Northumberland County Schools	Northumberland County Schools	0.01	0.01%
GW00119EU	Omega Protein, Inc.	Omega Protein	0.15	0.16%
GW00147EU	Patrick Henry Hospital, Inc.	Riverside Convalescent Center - Mathews	0.02	0.02%
GW00120EU	Peumansend CreekRegional Jail Authority	Caroline Detention Center	0.03	0.03%
GW00125EU	Phillips Management Group Inc.	Bush Park Camping Resort	0.02	0.02%
GW00178EU	Pineview Park, LLC	Pineview Mobile Home Park	0.03	0.03%
GW00117EU	Potomac Supply LLC.	Potomac Supply LLC.	0.05	0.05%
GW0001201	Prince George County of	Cedarwood Subdivision Water System	0.02	0.02%
GW0003601	Prince George County of	Rivers Edge	0.03	0.03%
GW0004700	Prince George County of	Food Lion Industrial Water Supply	0.07	0.07%
GW0008700	Prince George County of	Route 301 Water System	0.12	0.13%
GW0009000	Prince George County of	Beechwood Manor	0.14	0.15%
GW0046701	Princess Anne Country Club	Princess Anne Country Club	0.06	0.06%
GW00182EU	Quinton Oaks Golf, L.C.	Quinton Oaks Golf Club	0.06	0.07%
GW00110EU	Rappahannock Westminster-Canterbury	Rappahannock Westminster - Canterbury	0.03	0.03%
GW0053700	Rescue Water Works	Rescue Water Works	0.01	0.01%
GW0039001	Richmond Cold Storage Incorporated	Richmond Cold Storage - Smithfield Plant	0.01	0.01%
GW00174EU	Robert E. Lee Memorial Association	Stratford Hall Plantation	0.01	0.01%
GW0053000	Robert Finch	Sedley Water Company	0.04	0.04%
GW0009900	Rockahock Campground, Inc.	Rockahock Campground	0.03	0.03%
GW0068600	Samuel N Perry Junior	Perry Minnow Farm Incorporated	0.11	0.12%
GW0047801	SeaWorld Parks & Entertainment, LLC d/b/a Busch Gardens Williamsb	Busch Gardens Williamsburg Operations Dept	0.09	0.10%
GW0050700	SHODON	Mobile Estates	0.01	0.01%
GW0042201	Smithfield Packing Company, Incorporated	Smithfield Farmland	2.60	2.79%
GW0031801	Smithfield Town of	Smithfield Town of	1.28	1.38%

GW0037601	Solenis, LLC	Solenis, LLC	3.98	4.27%
GW0056300	Southampton County o	Turner Tract	0.08	0.08%
GW0033801	Southampton County of	Agri-Business Industrial Park	0.08	0.08%
GW0039501	Southampton County of	Branchville Boykins	0.15	0.16%
GW0039601	Southampton County of	Drewryville	0.02	0.02%
GW0039701	Southampton County of	Edgehill	0.02	0.03%
GW0043201	Southampton County of	Newsoms Town of	0.06	0.07%
GW0044400	Southampton Group	Southampton Mobile Home Park	0.07	0.08%
GW0006401	Southeast 4H Educational Center	Southeast 4 H Educational Center	0.01	0.01%
GW0048200	Suffolk City of Department of Public Utilities	Village of Whaleyville	0.10	0.10%
GW0008200	Surry County	Dendron Town of Community Water System	0.02	0.03%
GW0022200	Surry County Public Schools	Surry County Educational Complex	0.01	0.01%
GW0007900	Surry Town of	Surry Town of	0.06	0.06%
GW0008800	Sussex Service Authority	Stony Creek Town of Municipal Water Supply System	0.13	0.14%
GW0010100	Sussex Service Authority	Northeastern Regional Water System	0.74	0.79%
GW0007100	Sydnor Hydro, Inc.	Scot's Landing Subdivision	0.04	0.04%
GW0007200	Sydnor Hydro, Inc.	Cedar Crest Subdivision	0.03	0.03%
GW0002001	Sydnor Hydrodynamics Incorporated	Woodruff Public Water System	0.01	0.01%
GW00106EU	Tauxemont Community Association, Inc.	Tauxemont Community Water System	0.03	0.03%
GW00123EU	The Coves At Wilton Creek Owner's Association	The Coves at Wilton Creek	0.01	0.01%
GW00218EU	The Four Winds Club, Inc.	Four winds Clubhouse and Campground	0.03	0.03%
GW0068100	Thomas O Peace Junior	Peace Nurseries Turkey Hill Farm	0.01	0.02%
GW0048400	Tidewater Area Central Hospital Laundry Inc	Shared Hospital Services	0.12	0.13%
GW0049800	Titan Virginia Ready-Mix LLC	Rip Rap Road Ready Mix Plant Well 1 2 and 3	0.03	0.03%
GW0050500	Titan Virginia Ready-Mix LLC	Campostella Ready Mix Plant	0.04	0.04%
GW0052300	Titan Virginia Ready-Mix LLC	Oceana Plant	0.02	0.02%
GW00138EU	Town of Bowling Green	Town of Bowling Green Water System	0.19	0.20%
GW00214EU	Town of Colonial Beach	Colonial Beach, Town of	0.63	0.68%
GW0052100	Town of Ivor	Town of Ivor	0.05	0.06%
GW00103EU	Town of Kilmarnock	Town of Kilmarnock	0.22	0.24%
GW00114EU	Town of Montross	Town of Montross	0.08	0.09%
GW00202EU	Town of Port Royal	Town of Port Royal Municipal Water System	0.02	0.02%
GW00136EU	Town of Tappahannock	Town of Tappahannock	0.38	0.40%
GW00135EU	Town of Warsaw	Town of Warsaw	0.19	0.21%
GW00104EU	Urbanna Service Area	Town of Urbanna	0.11	0.12%
GW0055100	US Army -Army Transport Center	Fort Eustis	0.12	0.13%
GW0005201	US Army CASCOM and Fort Lee	Cardinal Golf Course at Fort Lee	0.04	0.04%

GW0047201	US DOE - Thomas Jefferson National Accelerator Facility	Thomas Jefferson National Accelerator Facility	0.02	0.02%
GW0050100	USA Waste of Virginia Landfills, Inc.	Bethel Landfill	0.23	0.25%
GW00213EU	Va. Dept. of Conservation and Rec	WESTMORELAND STATE PARK	0.01	0.01%
GW0008400	Va. Dept. of Conservation and Recreation	Chippokes Plantation State Park	0.02	0.02%
GW0047500	Valley Proteins Incorporated	Valley Proteins Incorporated Emporia Plant	0.03	0.03%
GW10171EU	Virginia American Water	Stratford Harbour	0.06	0.06%
GW00109EU	Virginia American Water	Bay Quarter Shores	0.02	0.02%
GW00115EU	Virginia American Water	Corrotoman by the Bay Water System	0.02	0.02%
GW0011601	Virginia American Water	Berkley and Ebb Tide Beach Water System	0.06	0.06%
GW00169EU	Virginia American Water	Potomac and Westmoreland Shores	0.07	0.08%
GW00170EU	Virginia American Water	Bleak Hall	0.01	0.01%
GW00172EU	Virginia American Water	Sherwood Forest System	0.02	0.02%
GW00173EU	Virginia American Water	Cabin Point & Glebe Harbor	0.05	0.05%
GW0044001	Virginia Beach City of	Kempsville Greens Golf Course	0.03	0.03%
GW0054600	Virginia Beach City of	Bow Creek Golf Course	0.01	0.01%
GW0055600	Virginia Beach City of	Princess Anne Athletic Complex	0.09	0.10%
GW0041401	Virginia Beach Development Authority	Virginia Beach National Golf Course	0.13	0.14%
GW00722EU	Virginia Cooperative Crop Improvement Association	Foundation Seed Farm	0.04	0.04%
GW00143EU	Virginia Department of Corrections	Caroline Correction Unit #2	0.02	0.02%
GW00145EU	Virginia Department of Corrections	Haynesville Correctional Center	0.14	0.15%
GW0040101	Virginia Department of Corrections	VDOC -Saint Brides / Indian Creek Correctional Center	0.33	0.36%
GW0049100	Virginia Department of Corrections	VDOC -Southampton Correctional Complex	0.33	0.35%
GW0046800	Virginia Department of Veterans Services	Albert G. Horton, Jr. Memorial Veterans Cemetery	0.02	0.02%
GW0003901	Virginia Electric & Power Company	Surry Power Station	0.42	0.45%
GW0022500	Virginia Institute	Virginia Institute of Marine Science - Gloucester Point Campus	0.07	0.08%
GW0036301	Virginia Renewable Power - Portsmouth, LLC	Virginia Renewable Power - Portsmouth, LLC	1.20	1.29%
GW0036501	Vulcan Constructio	Bayshore Concrete Products/Chesapeake, Inc.	0.02	0.02%
GW0004301	Wakefield Town of	Wakefield Town of Municipal Water Supply System	0.12	0.13%
GW00189EU	Walkerton Water System, Inc.	Walkerton Service Area	0.01	0.01%
GW0009200	WAP MHC I, LLC	Bexley Mobile Home Park	0.02	0.02%
GW0008000	Waverly Town of	Waverly Town of Municipal Water Supply System	0.30	0.33%
GW0005001	West Point Town of	West Point Public Water System	0.51	0.54%

GW0005600	West Point Veneer, LLC	West Point Veneer Mill Water Supply	0.06	0.06%
GW0045801	Western Tidewater Water Authorit	Western Tidewater Water Authority	4.86	5.21%
GW0005101	WestRock CP, LLC	West Point Mill Water System	12.92	13.86%
GW0004801	Whispering Winds LLC	Whispering Winds Mobile Home Park	0.01	0.01%
GW0009600	Whispering Winds LLC	Oak Shades Mobile Home Park	0.01	0.01%
GW0057000	White Tail Park	White Tail Park	0.02	0.02%
GW0051300	Williamsburg Country Club	Williamsburg Country Club	0.02	0.02%
GW0042701	Windsor Town of	Windsor Public Water System	0.47	0.50%
GW0001001	Woodhaven Water Company Incorporated	Woodhaven Water Company Incorporated	0.09	0.10%