Previous Groundwater Studies

1994 USGS MODEL
• first numerical simulation
• 1982 SWCB framework

2009 USGS MODEL
• increased resolution
• 1982-94 framework
USGS-DEQ

Eastern Shore Study

• 2017 part-time “scoping effort”

• 2018 hydrogeologic framework revision

• 2019 publication
USGS
SIR 2019-5093

- body (text, figures, tables)
- 13 plates
  - borehole locations
  - hydrogeologic section
  - structural contour maps
  - 250 mg/L chloride surface contour map
- 3 online data appendixes
  - aquifer altitudes at boreholes
  - aquifer hydraulic properties
  - chloride concentrations
Terms

FRAMEWORK

• static description of subsurface
  – configuration of aquifers/confining units
  – sediment composition/hydraulic properties
  – configuration of saltwater interface

• direct observation/measurement

• exact

• incomplete coverage

MODEL

• simulation of flow
  – sources/sinks
  – rates of movement
  – changes over time

• complete coverage

• approximation

• theoretical representation
**Terms**

**FRAMEWORK**
- static description of subsurface
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**MODEL**
- simulation of flow
  - sources/sinks
  - rates of movement
  - changes over time
- complete coverage
- approximation
- theoretical representation
Groundwater Flow
Pumping-Induced Effects

*** VERTICAL SCALE GREATLY EXAGGERATED ***
Groundwater Levels

(report figure 3)

SIMULATED

1900

2000

OBSERVED

2016
Hydrogeologic Section
(report plate 2)

SOUTH

BEND

EASTVILLE

EXMORE

PERSIMMON POINT

VIRGINIA MARYLAND

GEOPHYSICAL LOG

LITHOLOGIC LOG

LINE OF SECTION

VIRGINIA MARYLAND

VERTICAL EXAGGERATION 260X
Borehole Geophysical Log and Lithology
(report figure 5)
**Structural Contouring**

- Eastville
- Exmore
- Persimmon Point
- Saint Marys Confining Unit (Report Plate 3)

**Legend**
- Lower
- Middle
- Upper
- Surficial
- Manokin Aquifer

**Map**
- Line of Section
- Borehole

**Vertical Exaggeration** 260x
Structural Contouring

INNER CRATER
CENTRAL PEAK
OUTER CRATER
DISRUPTION ZONE

FEET
0
-100
-200
-300
-400
-500

VERTICAL EXAGGERATION 260X

SAINT MARYS CONFINING UNIT
(REPORT PLATE 3)

LINE OF SECTION
BOREHOLE

INNER CRATER
CENTRAL PEAK
OUTER CRATER
DISRUPTION ZONE

VERTICAL EXAGGERATION 260X
Mid-Pleistocene
Low
Sea-Level Stand

adapted from Hobbs, 2004
Channel Inundation and Filling

TIME 1
CHANNEL INCISION

TIME 2
SEA LEVEL -200 FT

TIME 3
SEA LEVEL -160 FT

TIME 4
SEA LEVEL -140 FT

TIME 5
SEA LEVEL -50 FT

NORTH
Previous Paleochannel Studies

- positions of channels approximately known
- channel-fill sediments poorly known
- original borehole data mostly unavailable

adapted from Mixon, 1985; Powars 2011
Previously Documented Paleochnannel Sediments

(Mixon, 1985)
Previous Modeling

1994 MODEL

CONSTANT HEAD BOUNDARY

SURFICIAL

LOWER

LEAKANCE

MIDDLE

LEAKANCE

UPPER

NO FLOW BOUNDARY

* PALEOCHANNEL LESS PERMEABLE THAN CONFINED AQUIFERS

2009 MODEL

CONFINING UNIT

* PALEOCHANNEL MORE PERMEABLE THAN CONFINED AQUIFERS

1994 MODEL

2009 MODEL

NORTH
Revised Hydrogeologic Framework

CONFINING UNIT

NORTH

UPPER SAND

EXMORE

LOWER SAND

PERSIMMON POINT

EASTVILLE

CONFINED SYSTEM

NORTH

5 MI

VERTICAL EXAGGERATION 260X
Exmore Paleochannel

Confining Unit

North

Upper Sand

Confining Unit

Lower Sand

Confined System
Confined System Incision

CONFINING UNIT

UPPER AQUIFER

MIDDLE AQUIFER

LOWER AQUIFER

NORTH
Aquifer Tests
(report figure 6)

- VA DEQ permit files
- 36 tests
- 58 wells
- 133 analyses
Transmissivity

Mean ($\text{ft}^2/\text{D}$)

<table>
<thead>
<tr>
<th>Layer</th>
<th>Lower</th>
<th>Middle</th>
<th>Upper</th>
<th>Paleo-Channels</th>
<th>Surficial</th>
</tr>
</thead>
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<tr>
<td>Mean</td>
<td>133</td>
<td>30</td>
<td>143</td>
<td>1820</td>
<td>214</td>
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<td>Ranges</td>
<td>2080</td>
<td>4360</td>
<td>8270</td>
<td>20340</td>
<td>20290</td>
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<tr>
<td>Min FT$^2$/D</td>
<td></td>
<td></td>
<td></td>
<td>20340</td>
<td>20290</td>
</tr>
<tr>
<td>Max FT$^2$/D</td>
<td></td>
<td></td>
<td></td>
<td>20340</td>
<td>20290</td>
</tr>
</tbody>
</table>
Abstract

Introduction
  Purpose and Scope
  Description of the Study Area
  Geologic Setting
  Groundwater Conditions
  Methods of Investigation
  Previous Investigations

Hydrogeologic Framework
  Geologic Relations
    Stratigraphy
    Depositional History
  Hydrogeologic-Unit Descriptions
    Composition
    Configuration
    Yorktown-Eastover Aquifer System
      Top-Surface Undulations
      Paleochannel Incision
      Upper Confining Unit
    Surficial Aquifer
      Hydrogeologic Units Within Paleochannels

Aquifer Hydraulic Properties
  Saltwater-Transition Zone
    Groundwater Chloride Concentrations
    Configuration
    Saltwater Ridge

Information Uses and Limitations
  Digital Model Improvement
  Limitations

Summary and Conclusions

References Cited
3-D View

PREDEVELOPMENT WATER LEVELS

PALEOCHANNELS

250 mg/L CHLORIDE SURFACE

ESTIMATED GROUNDWATER AGE
Saltwater-Ridge Formation (report figure 7)
Groundwater Chloride

**WELL MEAN CONCENTRATIONS mg/L**
- < 100
- 100 – 250
- 250 – 1,000
- > 1,000

**250 mg/L CHLORIDE SURFACE**

**REPORT PLATE 13**

**VERTICAL EXAGGERATION 260X**
Revised Model

- Jason Pope project chief
- aligned with USGS national model grid
- 8 layers
- 300 columns x 540 rows
- 250 m cells confined
- surficial aquifer detail
  - 50-175 m cells
  - hi-res LiDAR DEM
- 1900 - 2020
Acknowledgements

- Todd Beach, Scott Bruce – borehole data
- Bundick Well & Pump – borehole logs
- Ryan Green – chloride data
- Matt Link – aquifer-test data
- Scott Kudlas – program support