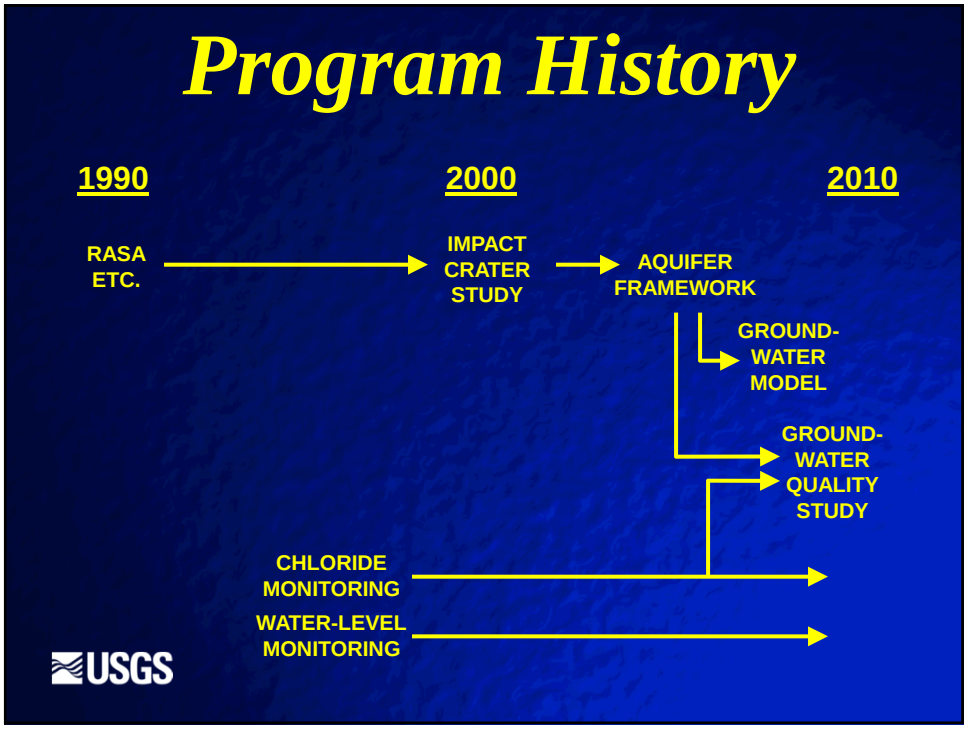
*HRPDC Utility Directors' Meeting*
*-June 14,2012*

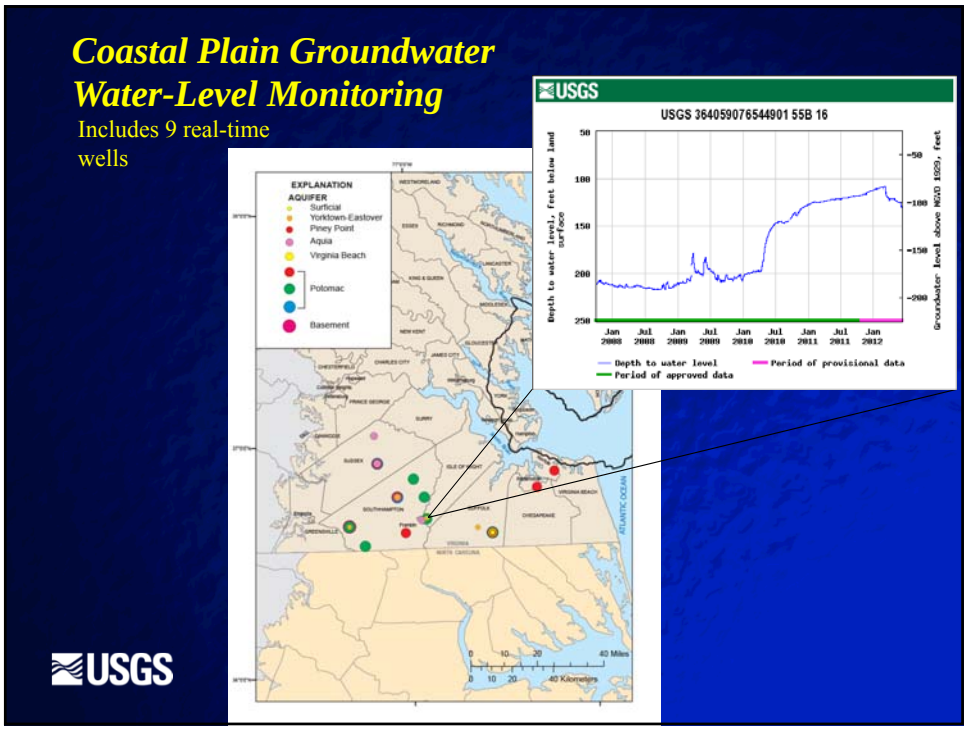
USGS

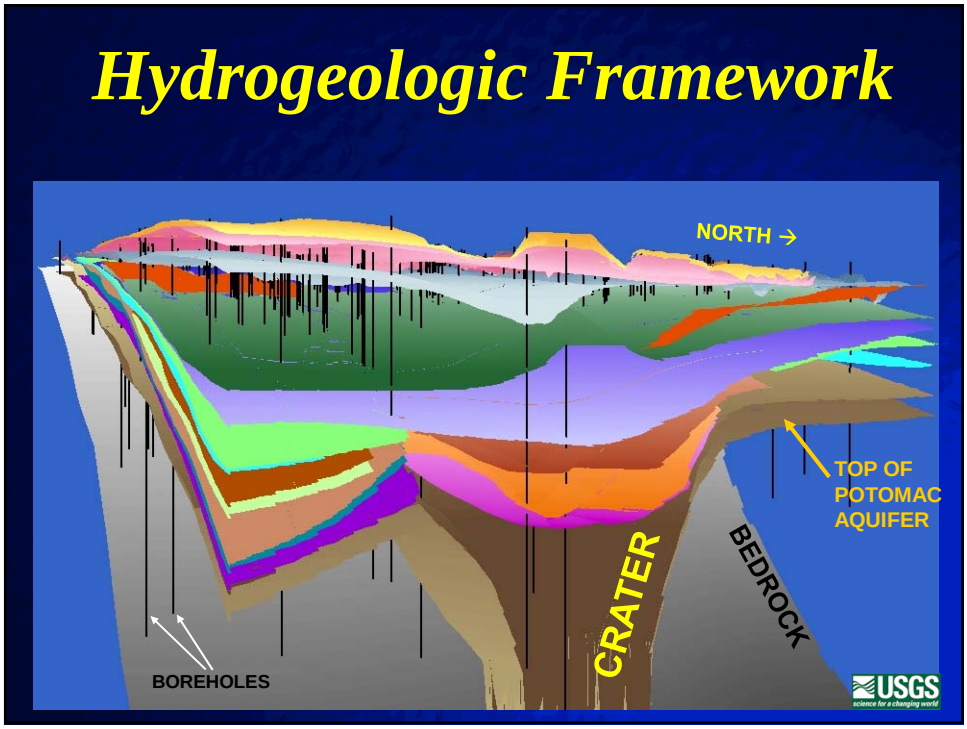
***Fiscal Year 2013***
***HRPDC-USGS Cooperative***
***Investigation of Coastal Plain Groundwater***

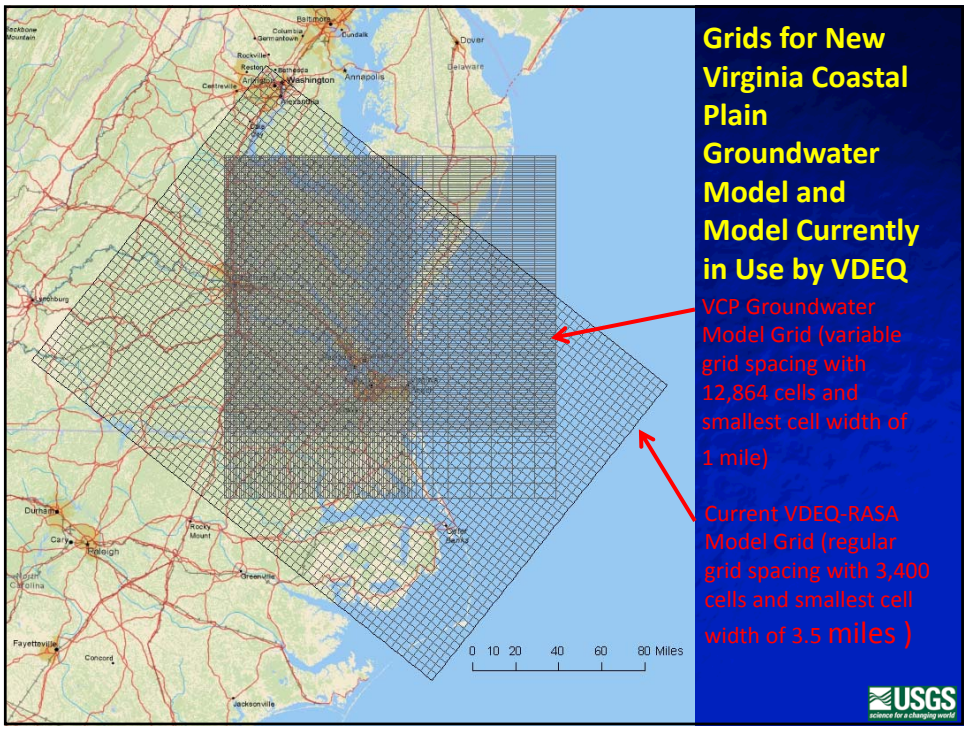
# A Brief Re-cap of our Recent Cooperative Work…

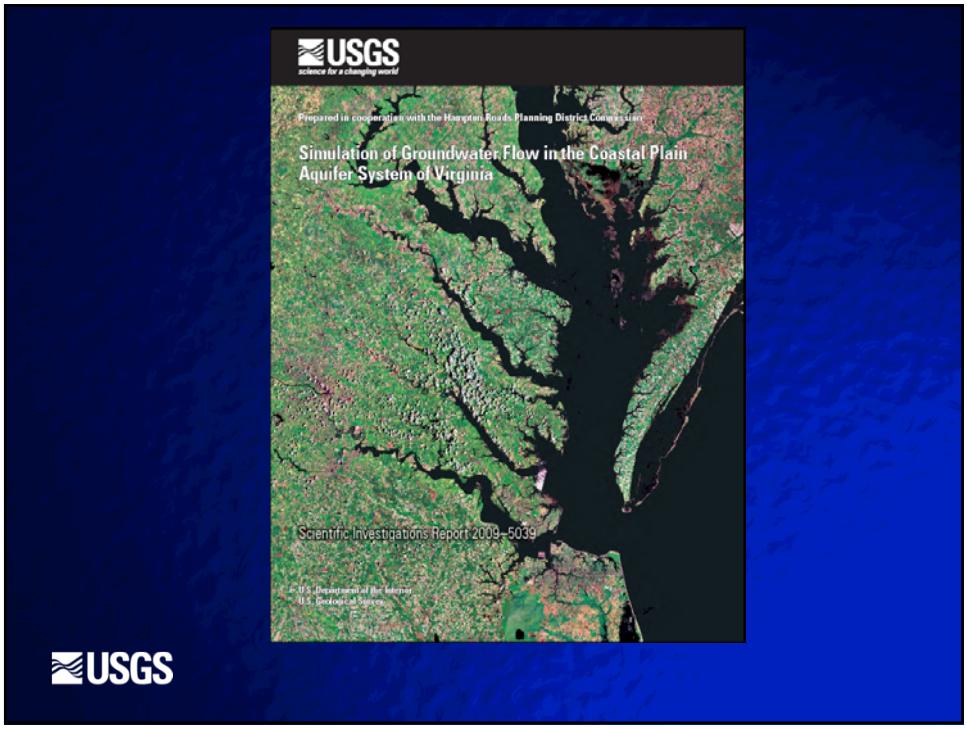
USGS

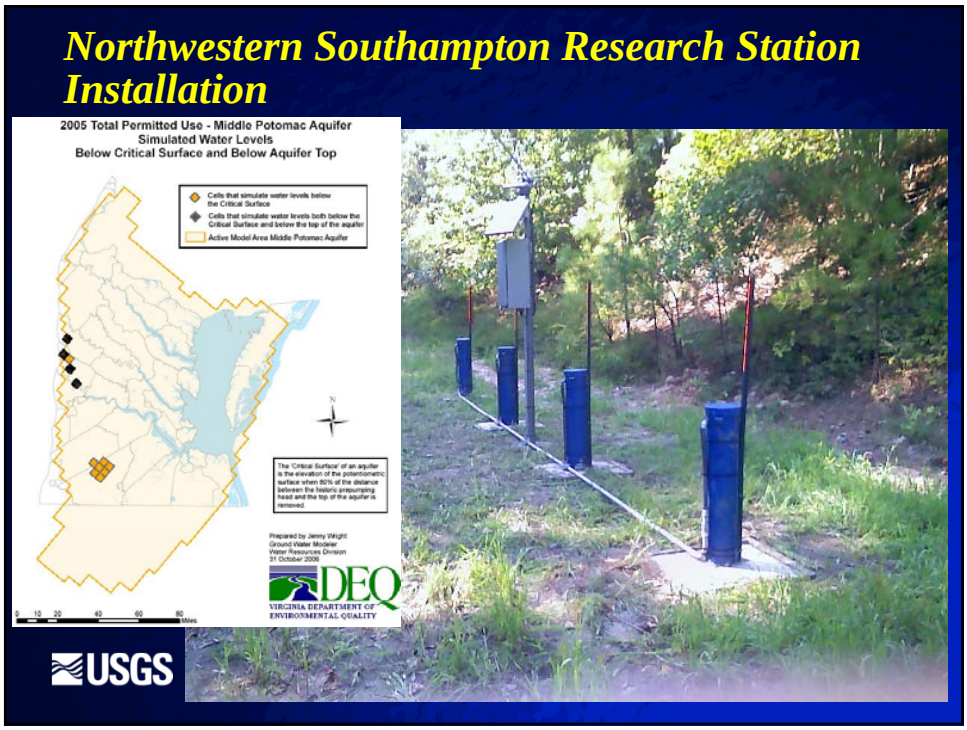

Program History
1990
2000
2010
RASA ETC.
IMPACT CRATER STUDY
AQUIFER FRAMEWORK
GROUND-WATER MODEL
GROUND-WATER QUALITY STUDY
CHLORIDE MONITORING
WATER-LEVEL MONITORING
USGS


Coastal Plain Groundwater Water-Level Monitoring
Includes 9 real-time wells
EXPLANATION
AQUIFER
Surficial
Yorktown-Eastover
Piney Point
Aquia
Virginia Beach
Potomac
Basement
USGS
USGS 364059076544901 55B 16
Depth to water level, feet below land surface
Groundwater level above NGVD 1929, feet
Depth to water level
Period of approved data
Period of provisional data
USGS


Hydrogeologic Framework
NORTH →
TOP OF POTOMAC AQUIFER
CRATER
BEDROCK
BOREHOLES
USGS


Grids for New Virginia Coastal Plain Groundwater Model and Model Currently in Use by VDEQ
VCP Groundwater Model Grid (variable grid spacing with 12,864 cells and smallest cell width of 1 mile)
Current VDEQ-RASA Model Grid (regular grid spacing with 3,400 cells and smallest cell width of 3.5 miles )
0 10 20 40 60 80 Miles
USGS


USGS
science for a changing world
Prepared in cooperation with the Hampton Roads Planning District Commission
Simulation of Groundwater Flow in the Coastal Plain Aquifer System of Virginia
Scientific Investigations Report 2009–5039
U.S. Department of the Interior
U.S. Geological Survey
USGS

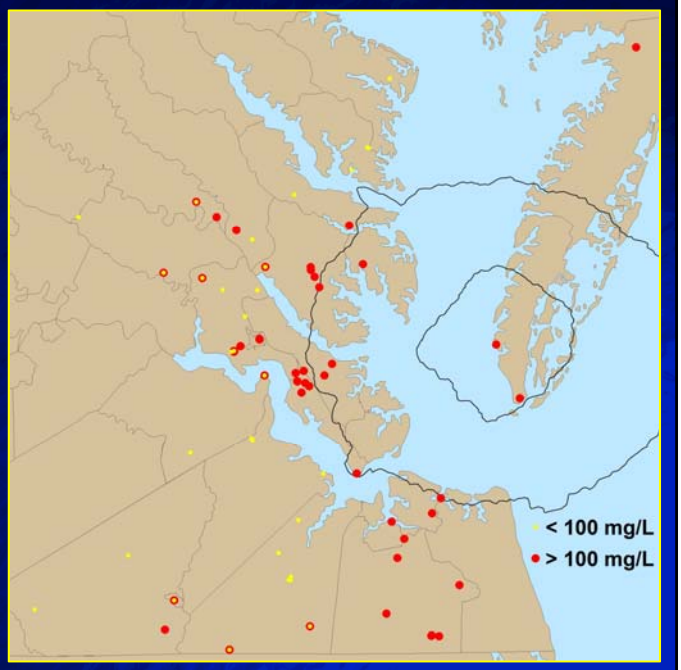

Northwestern Southampton Research Station Installation
2005 Total Permitted Use - Middle Potomac Aquifer
Simulated Water Levels
Below Critical Surface and Below Aquifer Top
Cells that simulate water levels below the Critical Surface
Cells that simulate water levels both below the Critical Surface and below the top of the aquifer
Active Model Area Middle Potomac Aquifer
N
The 'Critical Surface' of an aquifer is the elevation of the potentiometric surface when 90% of the distance between the historic prepumping head and the top of the aquifer is removed.
Prepared by Jenny Wright
Ground Water Modeler
Water Resources Division
31 October 2006
DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY
0 10 20 40 60 80 Miles
USGS

# *Chloride Monitoring Well Network*

- currently 129 production and observation wells
- 68 wells with Chloride > 100 mg/L
- variable sampling records
- several or more years between samples

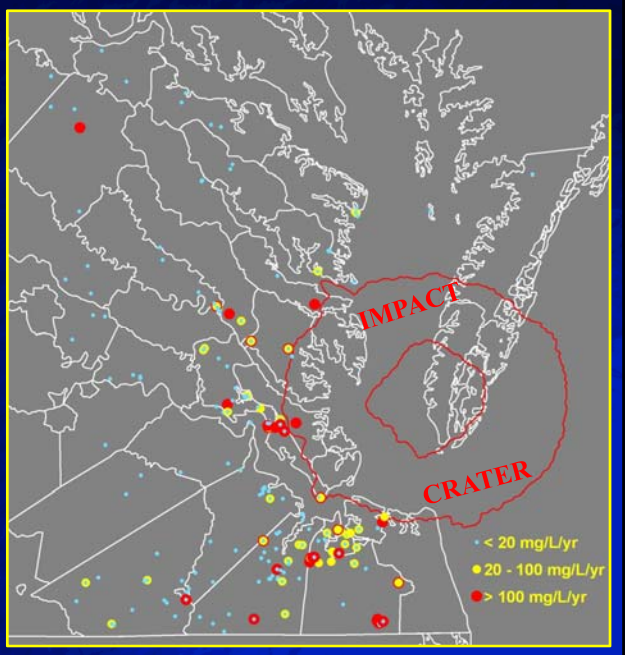
USGS

## *Chloride Monitoring Well Network*



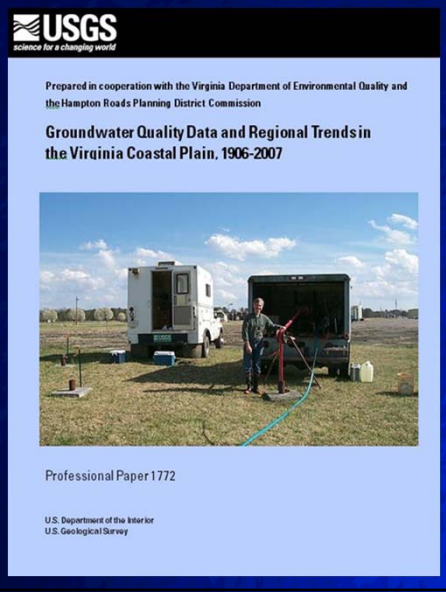

USGS

# *Historical Increases in Groundwater Chloride*




USGS

# *Groundwater Quality Study*




***Prof. Paper 1772***

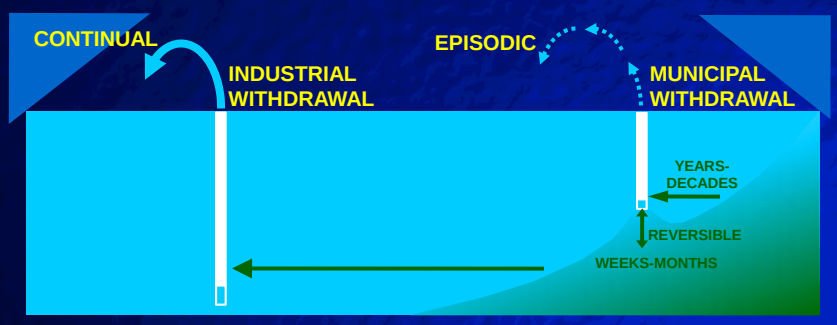
USGS

# *Future Directions*

- analysis of the existing chloride network
- area of impact analysis
- projected groundwater levels and storage analysis

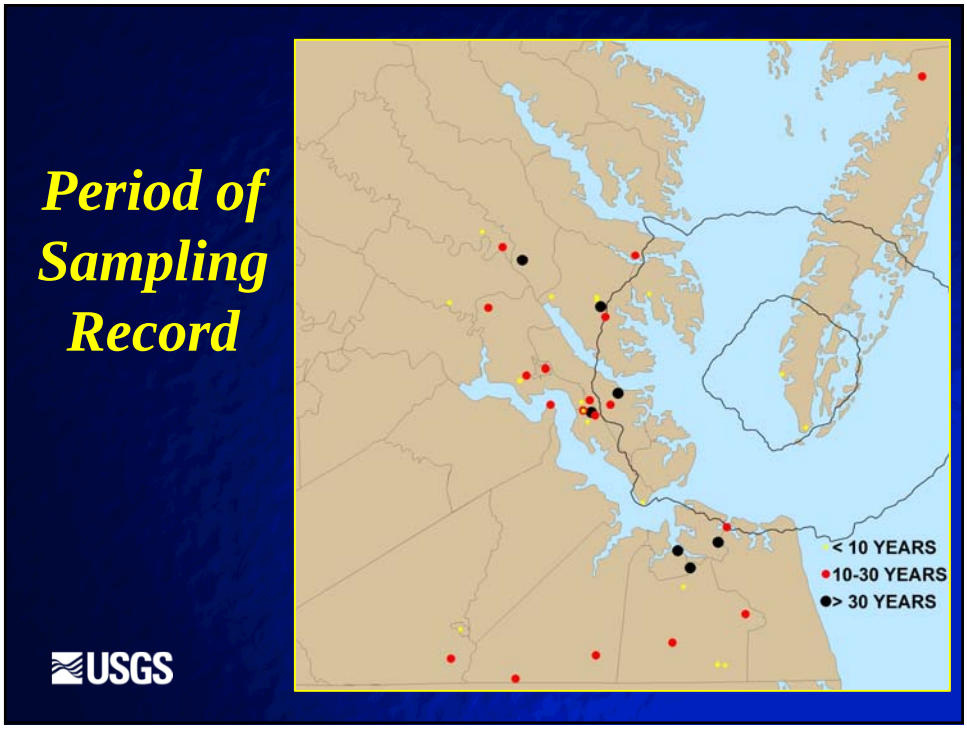
USGS

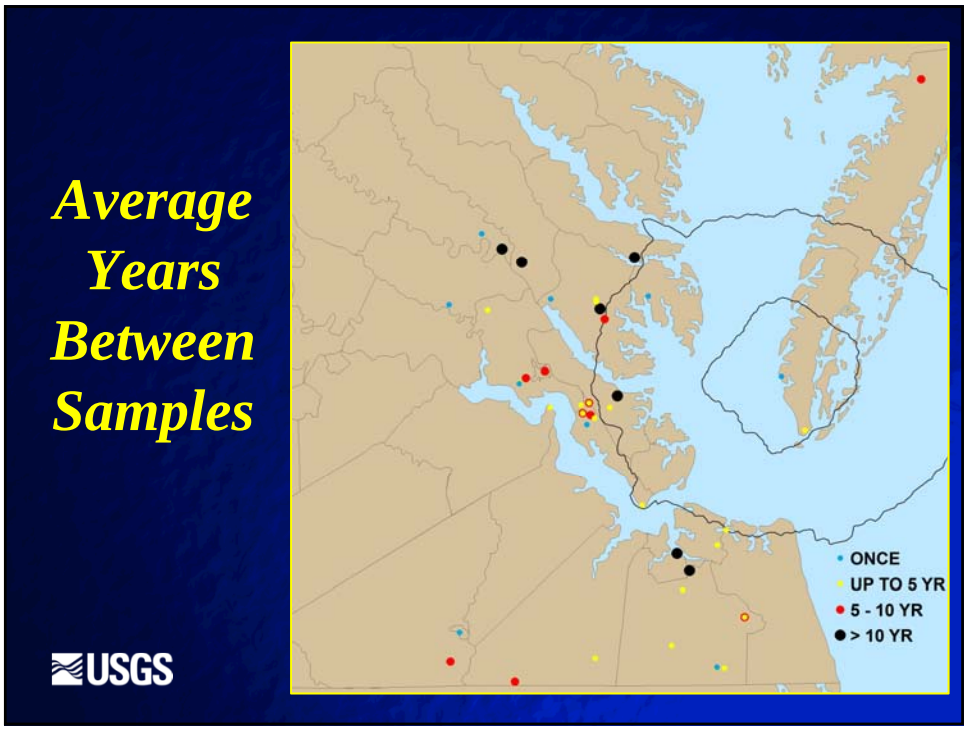
# *Lateral Intrusion and Upconing*

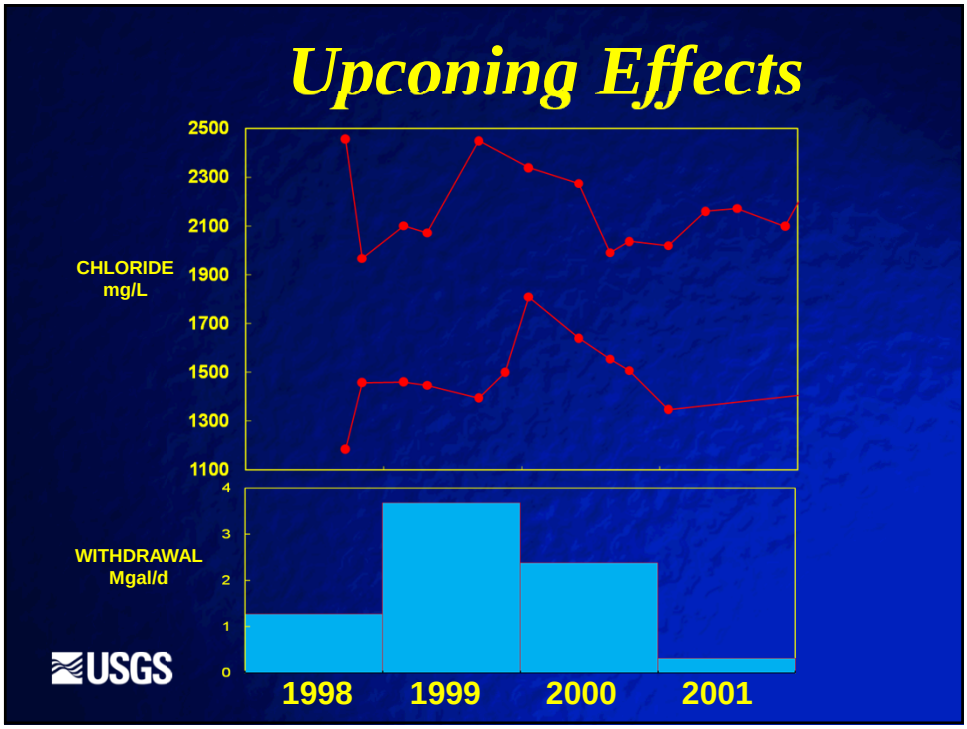


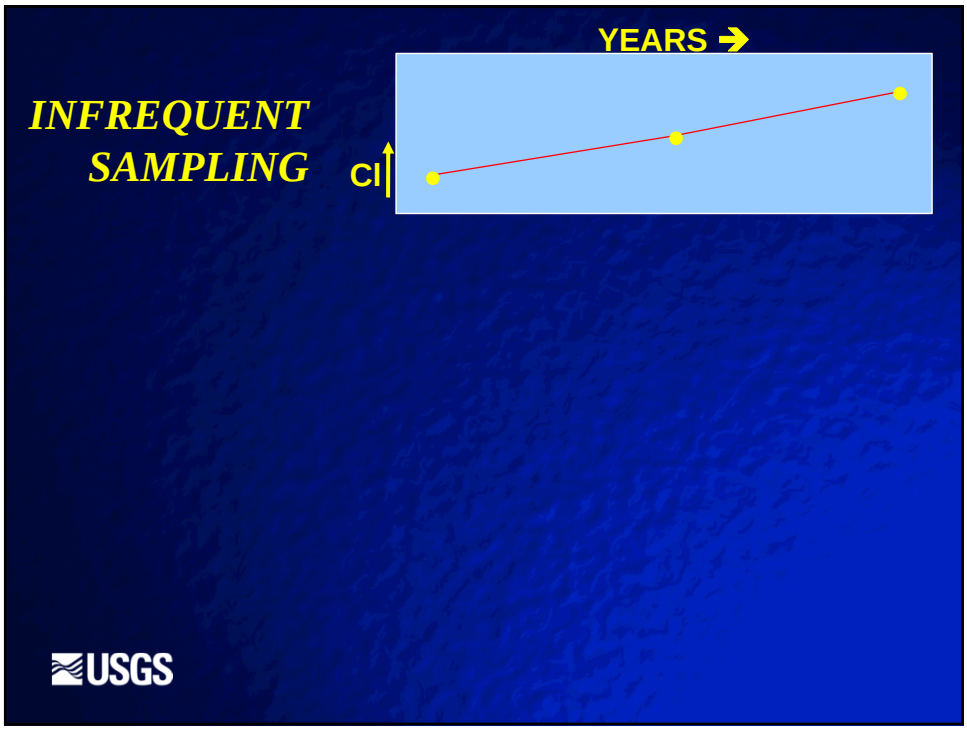

USGS

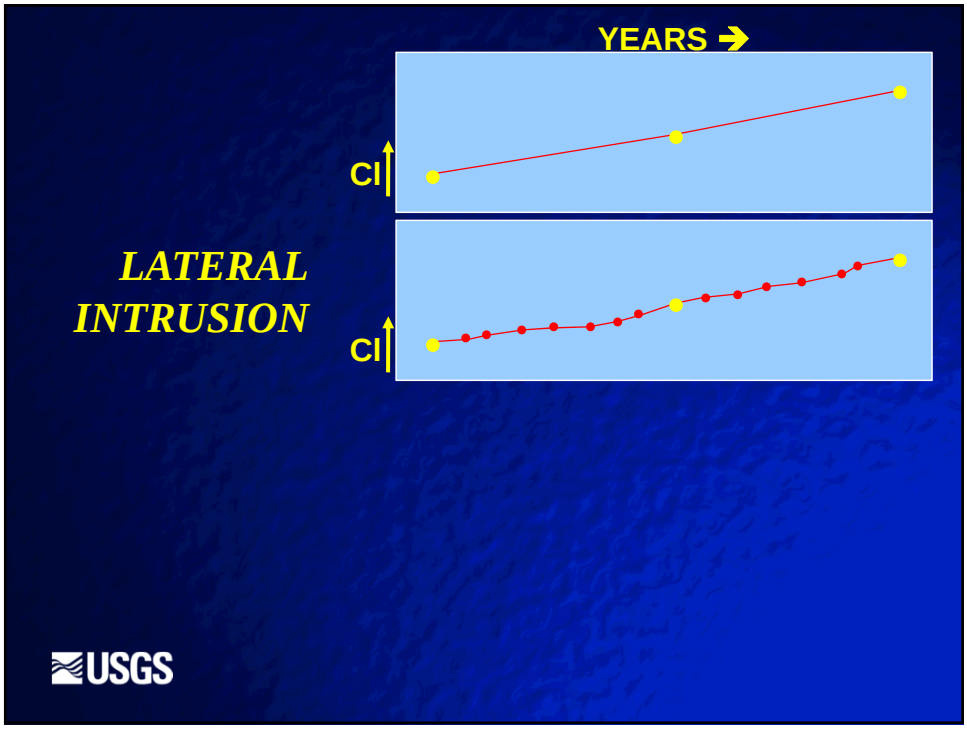
VERTICAL GREATLY EXAGGERATED

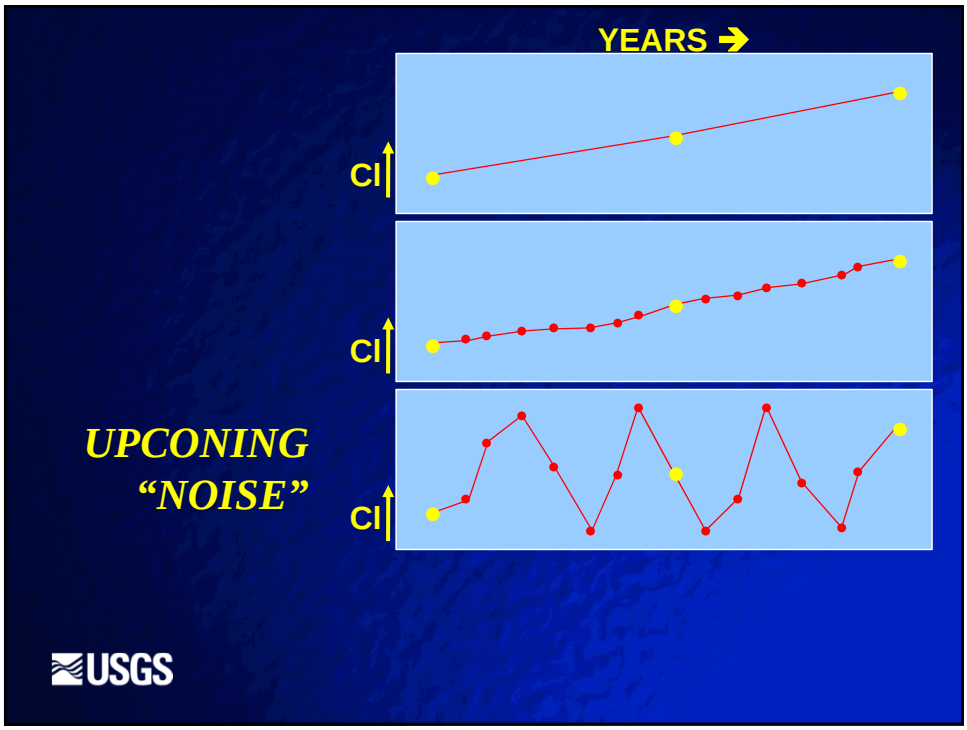

Period of Sampling Record
< 10 YEARS
10-30 YEARS
> 30 YEARS
USGS

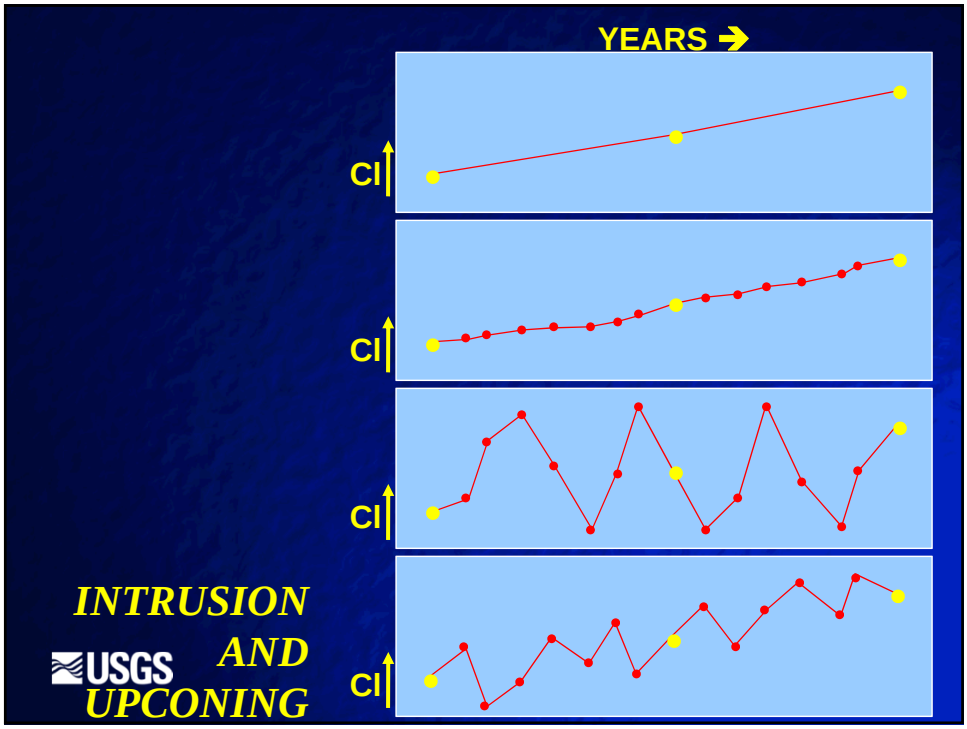

Average Years Between Samples
ONCE
UP TO 5 YR
5 - 10 YR
> 10 YR
USGS

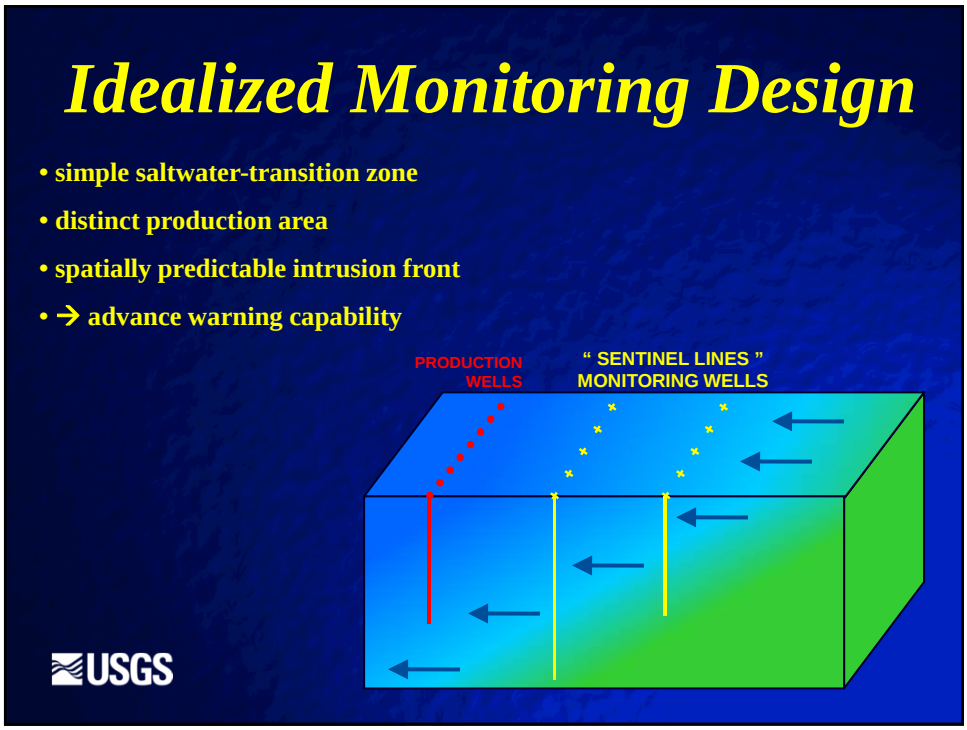

Upconing Effects
CHLORIDE mg/L
2500
2300
2100
1900
1700
1500
1300
1100
WITHDRAWAL Mgal/d
4
3
2
1
0
1998
1999
2000
2001
USGS


INFREQUENT SAMPLING
YEARS
Cl
USGS


YEARS →
Cl
Cl
LATERAL INTRUSION
USGS

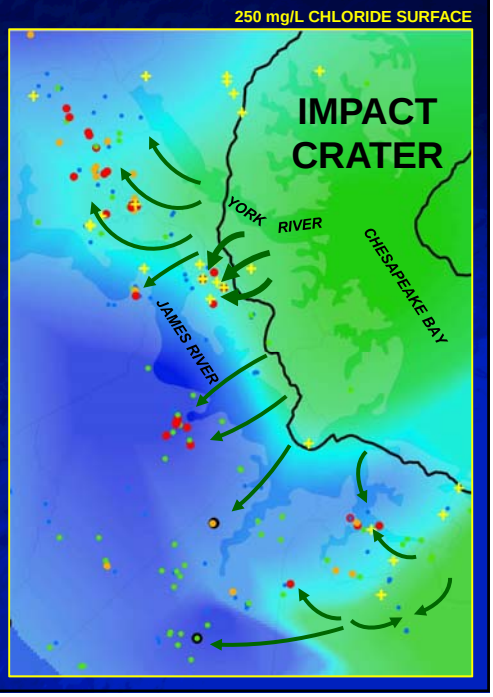

YEARS →
Cl
Cl
Cl
UPCONING "NOISE"
USGS


YEARS →
Cl
Cl
Cl
Cl
INTRUSION
AND
UPCONING
USGS


Idealized Monitoring Design
• simple saltwater-transition zone
• distinct production area
• spatially predictable intrusion front
• → advance warning capability
PRODUCTION WELLS
" SENTINEL LINES "
MONITORING WELLS
USGS

# *Actual Conditions*

- complex saltwater-transition zone
- indistinct production area
- incomplete withdrawal information
- spatially diverse intrusion potential




MONITORING NETWORK WELL

2003 REPORTED WITHDRAWALS
- < 0.01 MGD
- 0.01 – 0.05 MGD
- 0.05 – 0.1 MGD
- 0.1 – 1 MGD
- > 1 MGD

USGS

# *Chloride Monitoring Challenges*

- mounded, convoluted saltwater-transition zone
- complex, poorly known production area
- → inadequate spatial network coverage
- upconing "noise" overlays intrusion signal
- → inadequate sample-collection frequency

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## *Potential Project Directions*

- maintain current network for ambient monitoring

USGS

## *Potential Project Directions*

- maintain current network for ambient monitoring
- assess data collected by users (DEQ SWIM program)
  - spatial coverage
  - sampling frequency

USGS

## *Potential Project Directions*

- maintain current network for ambient monitoring
- assess data collected by users (DEQ SWIM program)
  - spatial coverage
  - sampling frequency
- assess user-specific spatial coverage and frequency

USGS

## *Potential Project Directions*

- maintain current network for ambient monitoring
- assess data collected by users (DEQ SWIM program)
  - spatial coverage
  - sampling frequency
- assess user-specific spatial coverage and frequency
- design a series of local scale well sub-networks and recommended frequency for sampling

USGS

# Potential Project Directions

- assess area of impact for permitted municipal withdrawals
  - assess at 30, 50, and 100 years instead of steady-state

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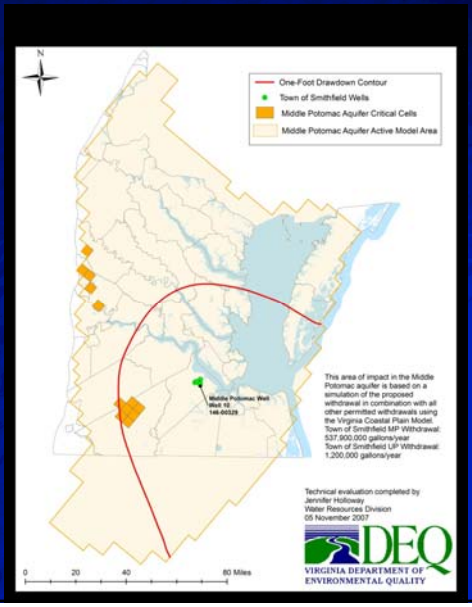
# Potential Project Directions

Compare one-foot drawdown contour in current permit with projected drawdown with VCP Model




USGS

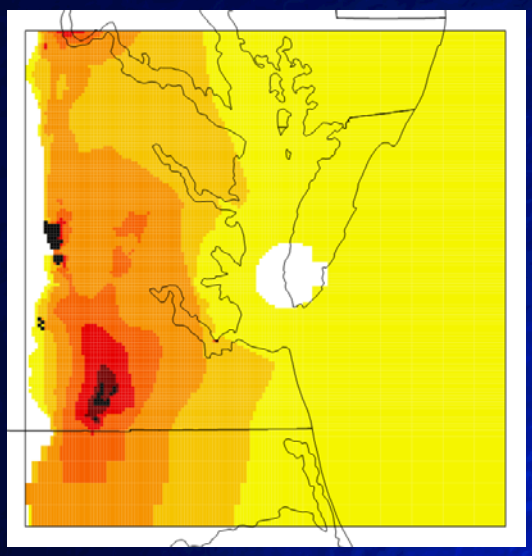
# Potential Project Directions

- assess area of impact for permitted municipal withdrawals
  - assess at 30, 50, and 100 years instead of steady-state

- assess groundwater levels and storage change by aquifer
  - based on new withdrawals projected in regional water supply plan

USGS

*Estimated Change in Storage of Water in the Potomac Aquifer from Pre-development to 2008*



Available Storage Used

- 0-10%
- 10-25%
- 26-50%
- 51-75%
- 76-100%
- 100+%
- Head Below Unit Top

USGS

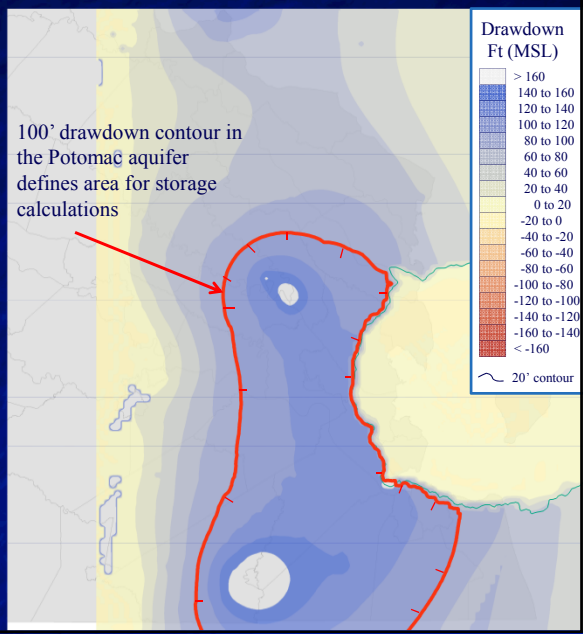
*Available Storage calculated from water level above 80% criteria*

## *Groundwater Storage Calculation*

For each model cell, changes in compressible storage are calculated by:

Change in Storage = Specific Storage x Cell Volume x Change in Water Level

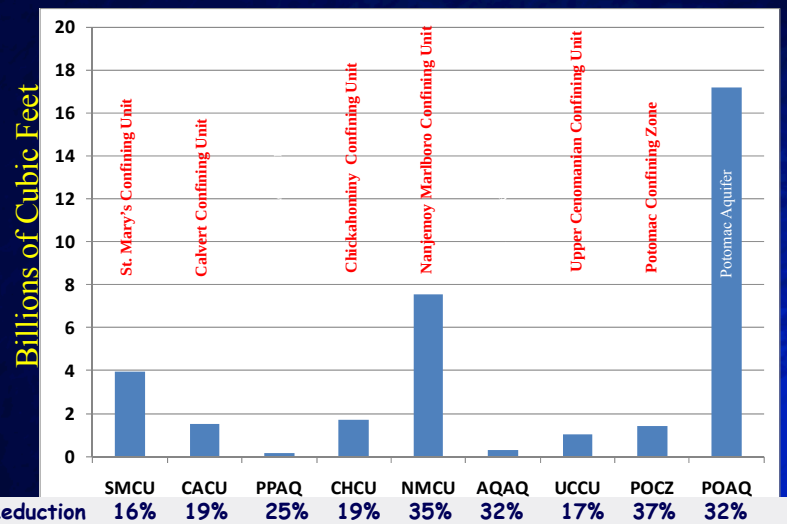
Aquifer compaction and land subsidence are not simulated.




USGS

September, 2011

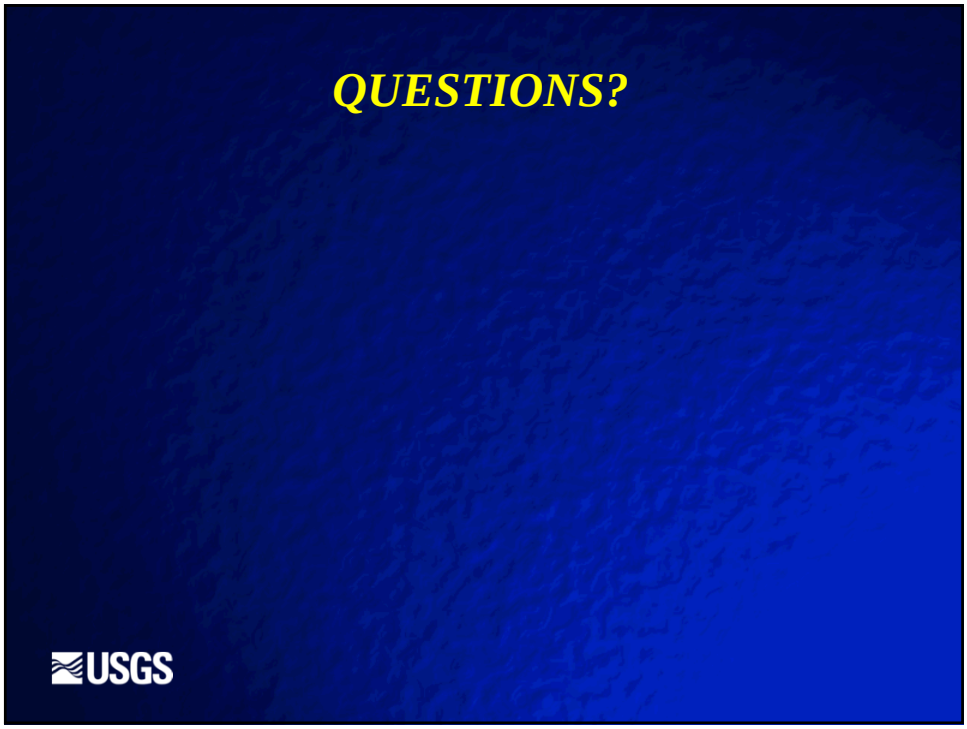
## *Reductions in Aquifer Storage, Pre-Development to 2008*




| % Reduction | 16% | 19% | 25% | 19% | 35% | 32% | 17% | 37% | 32% |
|---|---|---|---|---|---|---|---|---|---|

- *Storage coefficients have relatively high uncertainty*
- *Total storage decline in system is 26% (22% in confining units/zones)*
- *"Available" means volume from head decline to 80% criterion in the 100' drawdown area of the Potomac Aquifer (shown in previous slide)*
- ***Loss of Storage is Non-Recoverable in Confining Units***

USGS


QUESTIONS?
USGS