

# Development of an Aquifer Information System for Assessment and Allocation of Ground-Water in the Atlantic Coastal Plain

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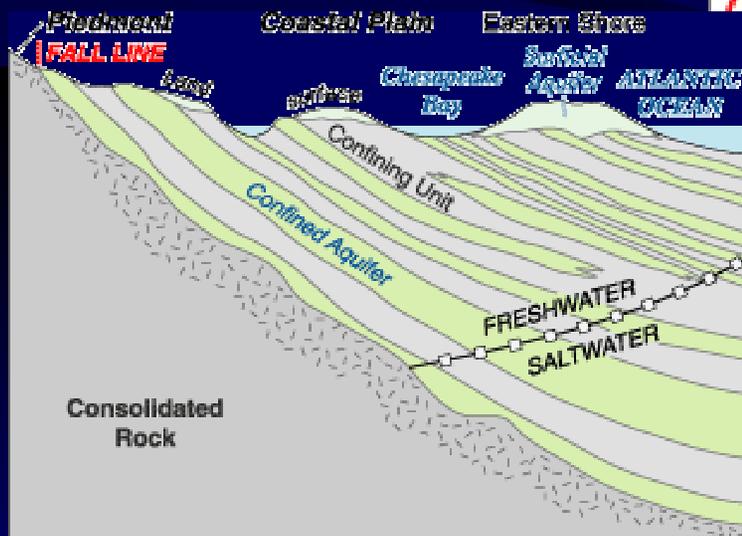
# CPAIS Science Partners

## A collaborative effort

- Maryland Department of the Environment (MDE)
  - **Matthew Pajerowski**, John Grace, John Smith, *Saeid Kasraei*
- Maryland Geological Survey (MGS)
  - **David Bolton**, Dave Andreasen, Jon Achmad, Dave Drummond, *Emery Cleaves*
- U.S. Geological Survey (USGS)
  - **Bob Shedlock**, Mark Nardi, Bradley Garner, Joel Blomquist, Jeff Raffensperger, Wendy McPherson, Dan Soeder, Doug Yeskis, *Jim Gerhart*

# Aquifer Information System Extents

(Study Area)



# Coastal Plain Aquifer Information System

## (Our Definition)

- A system that brings aquifer data and analytical tools together in a single suite of computer applications that will empower resource managers to make informed timely decisions
- A Geographic Information System (GIS) based data system
  - Stores feature geometry and attributes
  - Enables spatial analysis and feature interaction
  - Provides direct data support to various hydraulic models

# Aquifer Information System

## -Project Goal-

To create a versatile information system tool that allows a user to access, display, manipulate, and eventually port to models, hydrogeologic and water use data for the Atlantic Coastal Plain of Maryland. Output will include maps and various views (including 3 dimensional) of hydrogeologic data, including logs, cross sections, aquifer configurations, head distributions, and areal distribution of wells in the various aquifers.

# CPAIS

## Major Data Components

### – Aquifer and related maps

- Test-well locations, cross-section locations, aquifer top contacts, simulated pre-pumping head maps, simulated 2002 head maps, and aquifer extents, and 80% surfaces
- Existing aquifer maps and data (USGS PP's 822, 1404-E, & 1404-K some digitized by A. LaMotte)
- Re-visitation of coastal plain system mapping and hydraulic characteristics by MGS

### – Geologic Setting

- Surficial Framework – USGS PP 1680 Ator et al 2005

### – Existing geophysical logs

- Mapped log locations for easy reference
- For Digital or Digitized logs, investigating different existing software systems including Waterloo Hydrogeologic, Rock Works, and View Log

# CPAIS Data Components

-Continued-

## – USGS Databases

- *GWSI* (Steve Predmore California Water Science Center, San Diego)
- *SWUDS* and *AWUDS*
- *QWDATA*
- *ADAPS*

## – Permitting and pumping data

- MDE permitting and pumping datasets (*RAMS*)
- Public Drinking Water Information System (*PDWIS*)

## – Water Quality Data

- USGS *QWData*
- State Data Sources

# Where Do Our Data Come From, and Where are They Going?

- Mandatory questions when the datasets, timelines, and interagency cooperation are large.
- Data and its flow can be thought of in terms of the ETL model:
  - Extractable sources
  - Transformations
  - Loaded products

# MCPAIS datasets

“Loadable” Product

Transformation Process

Final Loaded Product

GWSI

SWUDS

Digital GeoPhy Log  
format importable  
into ArcHydro.

Digital Aquifer Tops  
& Bottoms  
Importable into  
ArcHydro

Nat'l Hydro  
Dataset

State, County Maps

N.E.D.

Other Hydro  
surfaces

Process for  
Linking common  
Sites together  
By shared site IDs.  
  
Output  
One master site ID

S  
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**AQUIFER INFORMATION SYSTEM**  
*Well, BoreLine, GeoLine*  
*TimeSeries, or framework extension*  
*BoreLine and GeoPoint*  
*GeoVolume*  
*HydroNetwork/Edge/Junction, etc*  
*Basemap*  
*GeoRasters*  
*Geovolumes, or extension to  
framework*

# CPAIS (Software/Hardware)

- Anticipated to run in ESRI's Arc environment
  - Initial Efforts in ArcMap Desktop using ESRI's ArcHydro Groundwater data model
  - Web based solution using ArcGIS Server
    - Server housed in MD district offices
- Customization programming to be done primarily in Visual Basic.NET
  - Initial programming done by district employees, later possible to have students to assist

# Datamodel



R.M. Hirsch, USGS

## Objects



Aquifer



stream



Well



Volume

(from Strassberg, 2005)

# Datamodel

## (A few definitions)

- A data model is a model that describes in an abstract way how data is represented in an information system or a database management system.
- A generalized view of data representing the real world

# ESRI Data Model Philosophy

“With the ArcGIS platform, the ESRI vision is to build many industry-specific data models. *Our basic goals are to simplify the process of implementing projects, and to promote and support standards that exist in our user communities*”

- <http://support.esri.com/index.cfm?fa=downloads.dataModels.gateway>

# What's Included in an ArcGIS Data Model

Each data model includes

- A case study implementation for a selected user site, including a small sample database
- A geodatabase template that enables users to import the data model as a template on which to base their system
- A white paper explaining the design
- A data model poster
- Tips and Tricks documents on how to employ the data model from the case study and how to employ it in your work.

# What is ArcHydro?

- ArcHydro is a data base design for storing hydrologic geospatial and temporal information within a geographic information system. The database and accompanying toolset operate within the ArcGIS environment and are public domain

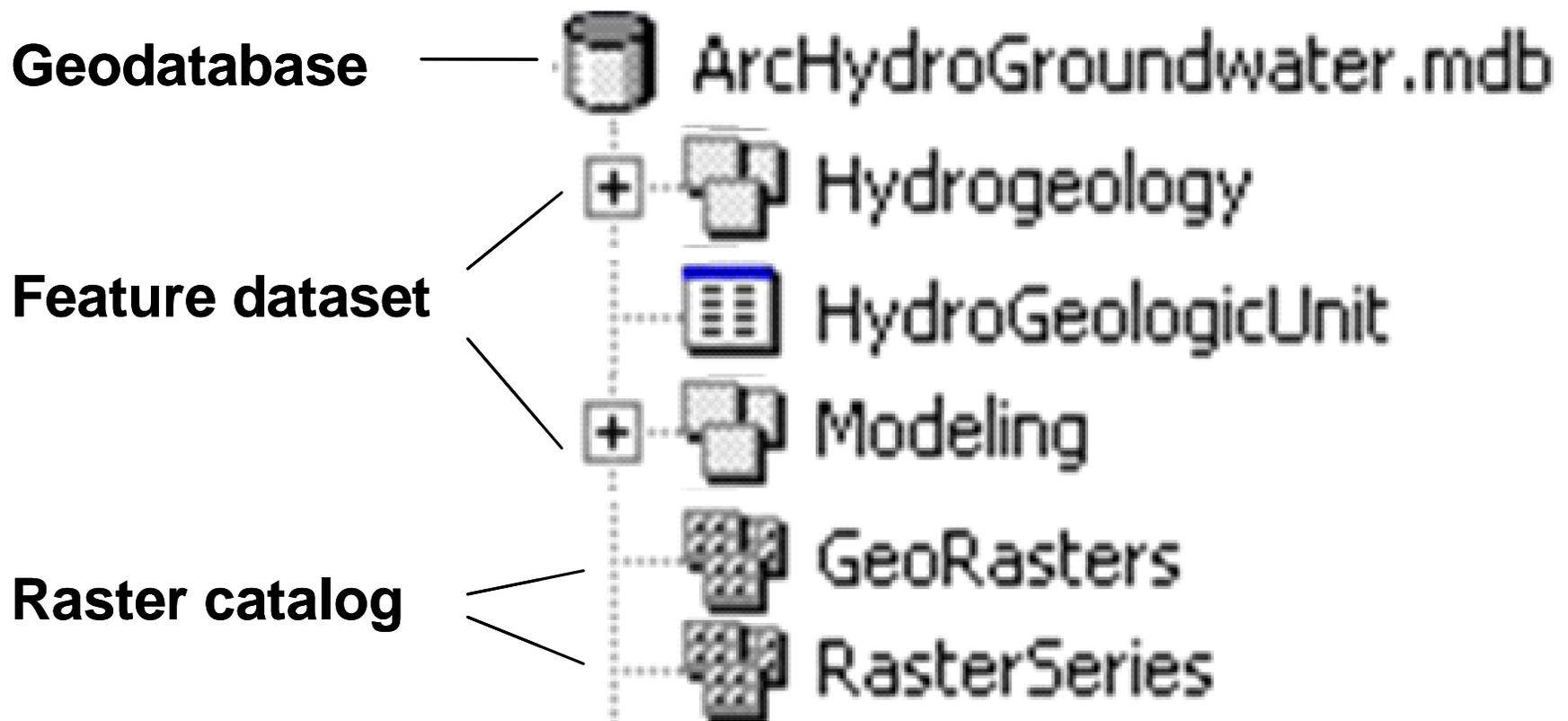
(from Strassberg, 2005)

# Data Model Objectives

- Support representation of regional groundwater systems
- Support the representation of site scale groundwater data.
- Enable the integration of surface water and groundwater data.
- Facilitate the Integration of groundwater simulation models with  
GIS

(from Strassberg, 2005)

# Arc Hydro Ground Water Data Model Framework



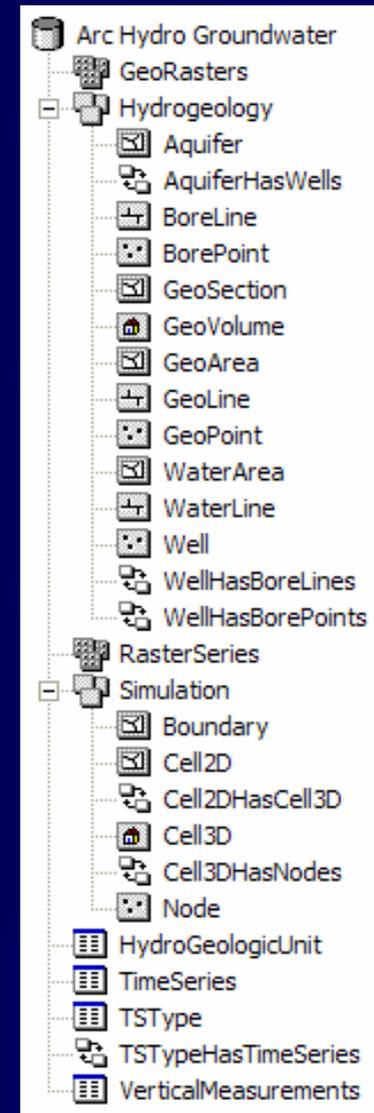
(from Strassberg, 2005)

# Full groundwater data model

## Three conceptual components:

- Hydrogeology – 2D and 3D features such as wells, aquifers, sections, volumes, streams, etc.
- Simulation – Objects for georeferencing grids/meshes of simulation models.
- Time Series – Temporal information stored in tables and as rasters.

(from Strassberg, 2005)



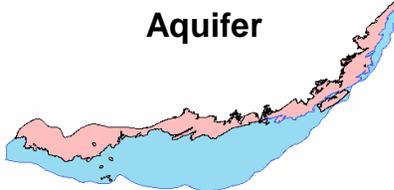
# Hydrogeology Feature Data Set

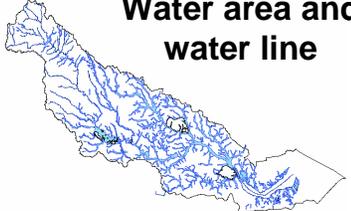
**Hydrogeology**

-  Aquifer (*Polygon*)
-  BoreLine (*PolylineZ*)
-  GeoArea (*Polygon*)
-  GeoLine (*PolylineZ*)
-  GeoPoint (*PointZ*)
-  GeoSection (*PolygonZ*)
-  GeoVolume (*Multipatch*)
-  Surface/WaterArea (*Polygon*)
-  Surface/WaterLine (*Polyline*)
-  Well (*PointZ*)

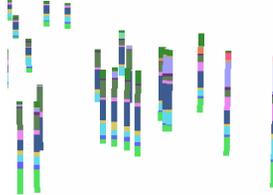
**Two dimensional features**

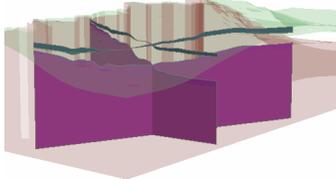
**Well** 

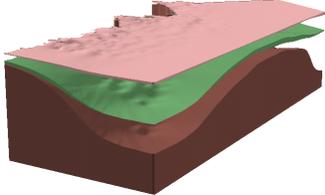
**Aquifer** 

**Water area and water line** 

**Three dimensional features**

**BoreLine** 

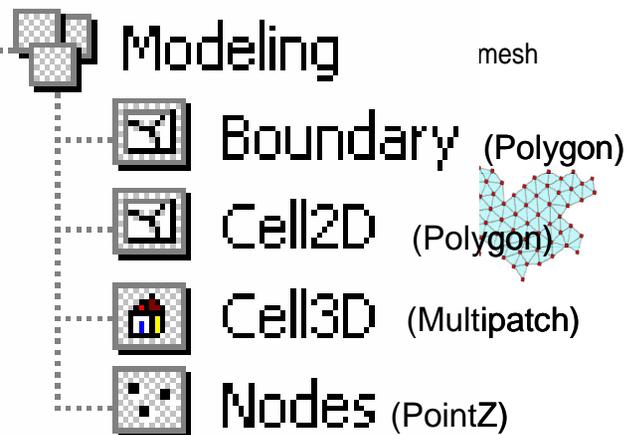
**GeoSection** 

**GeoVolume** 

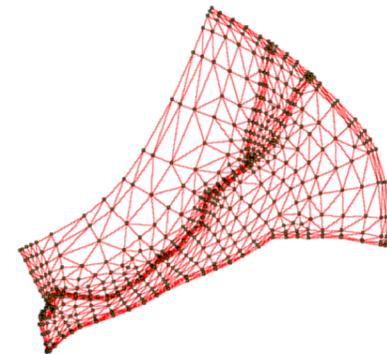
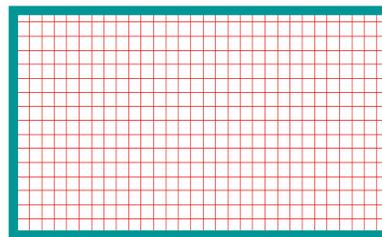
Polygon, Polyline and Point are 2D features. PolygonZ, PolylineZ and PointZ can contain Z values on the geometry of the features. Multipatch is a set of 3D triangles which can represent surfaces or solids.

(from Strassberg, 2005)

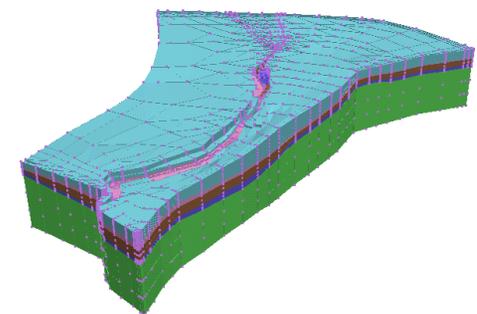
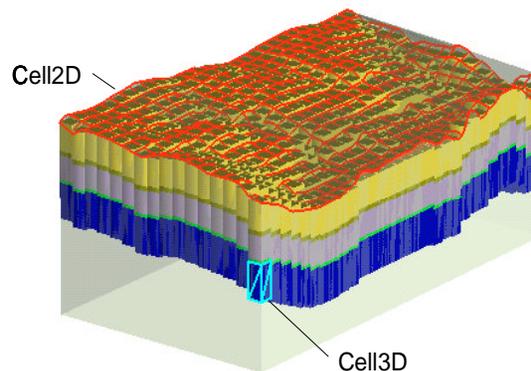
# Modeling Feature Dataset



## Cell 2D for finite difference and finite element models



## Cell 3D for finite difference and finite element models



(from Strassberg, 2005)

# Thorns

- Development of seamless links in ArcMap to external databases and development of tools associated with these DB's, especially water use and MDE permitting
- Quantification (estimation) of unreported withdraws (>10k gal/day)
- The necessity of and our ability to QA/QC internal/external databases
- Lack of formalized DB design and relationship definitions

# CPAIS

## (Upcoming Tasks)

- Migrate existing geophysical and time series data into the ArcHydro datamodel, extending the data model as required.
  - Geologic Framework (aquifer extents, head surfaces, physical surfaces, contacts, logs...)
  - Links to external databases such as SWUDS, GWSI, PDWIS, etc.
  - Stream models (for example NHD)
  - Topography (DEM and Bathymetry)
- Customize and create user interface tools
  - Beta version of CPAIS will run as a stand alone ArcMap/ArcScene workstation, data and custom tools
  - Develop static data views with corresponding tools to simplify redundant tasks and queries