

Groundwater Occurrence & Movement: *An Introductory Discussion with Application to Northeastern Illinois*

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- Kane County Water Resources Department



Topical Presentation Outline

Basic Concepts and Definitions

- **The Hydrologic Cycle**

What is groundwater?

- **Concepts & Definitions**

Porous Flow vs. Fractured Flow

Aquifers vs. Aquitards

Artesian vs. Water Table Conditions

- **Regional Groundwater Flow Systems**

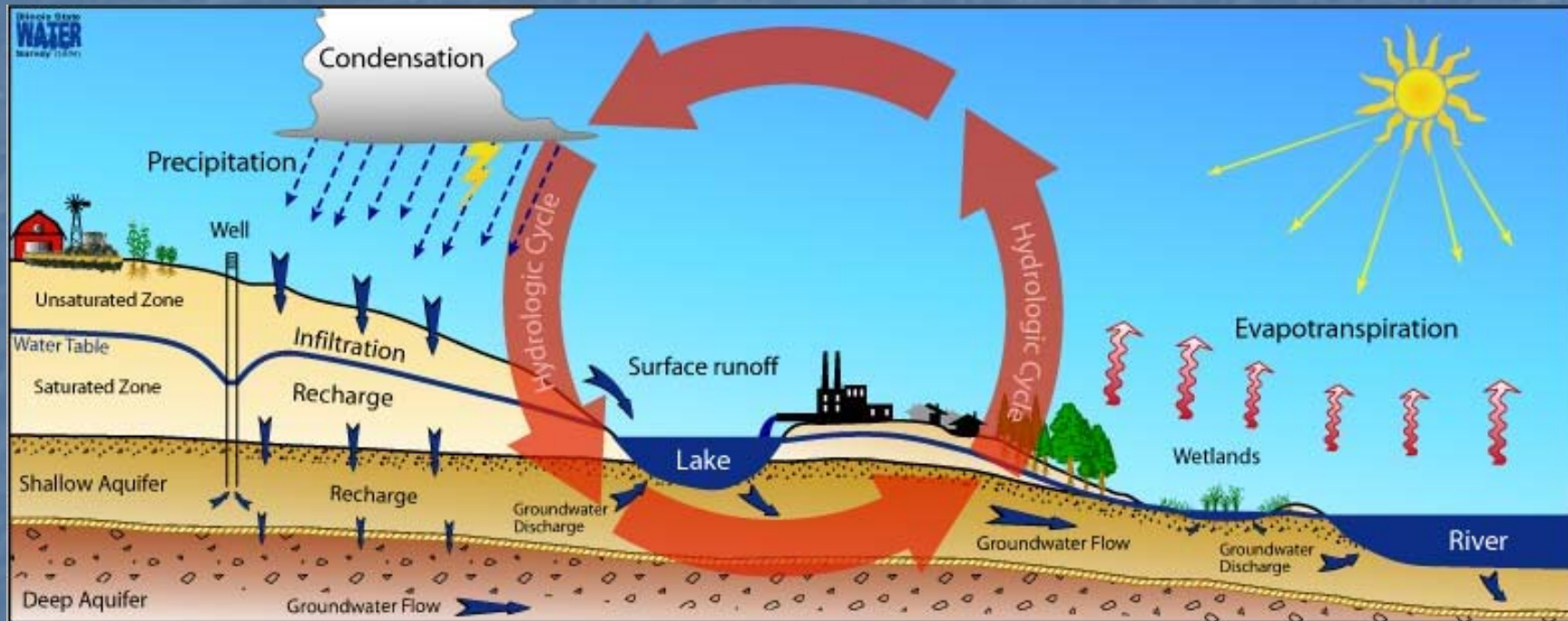
- **Well & Aquifer Hydraulics**

- **Groundwater Modeling**

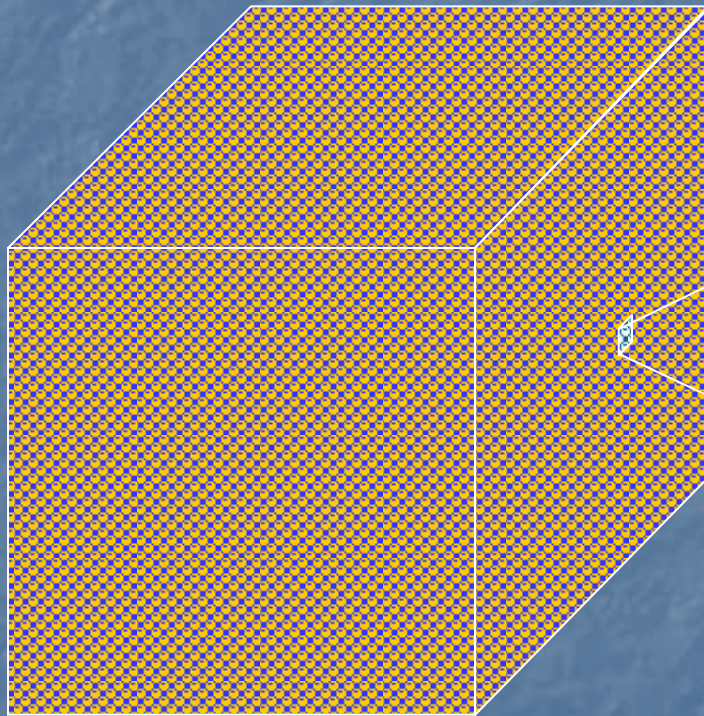


The Hydrologic Cycle

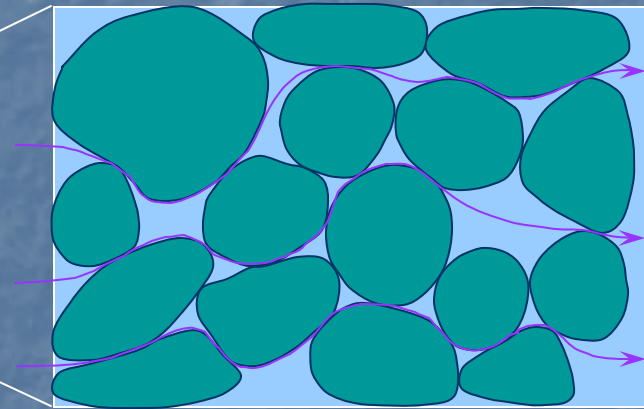
Climate, surface water, and groundwater are linked



Porous Systems



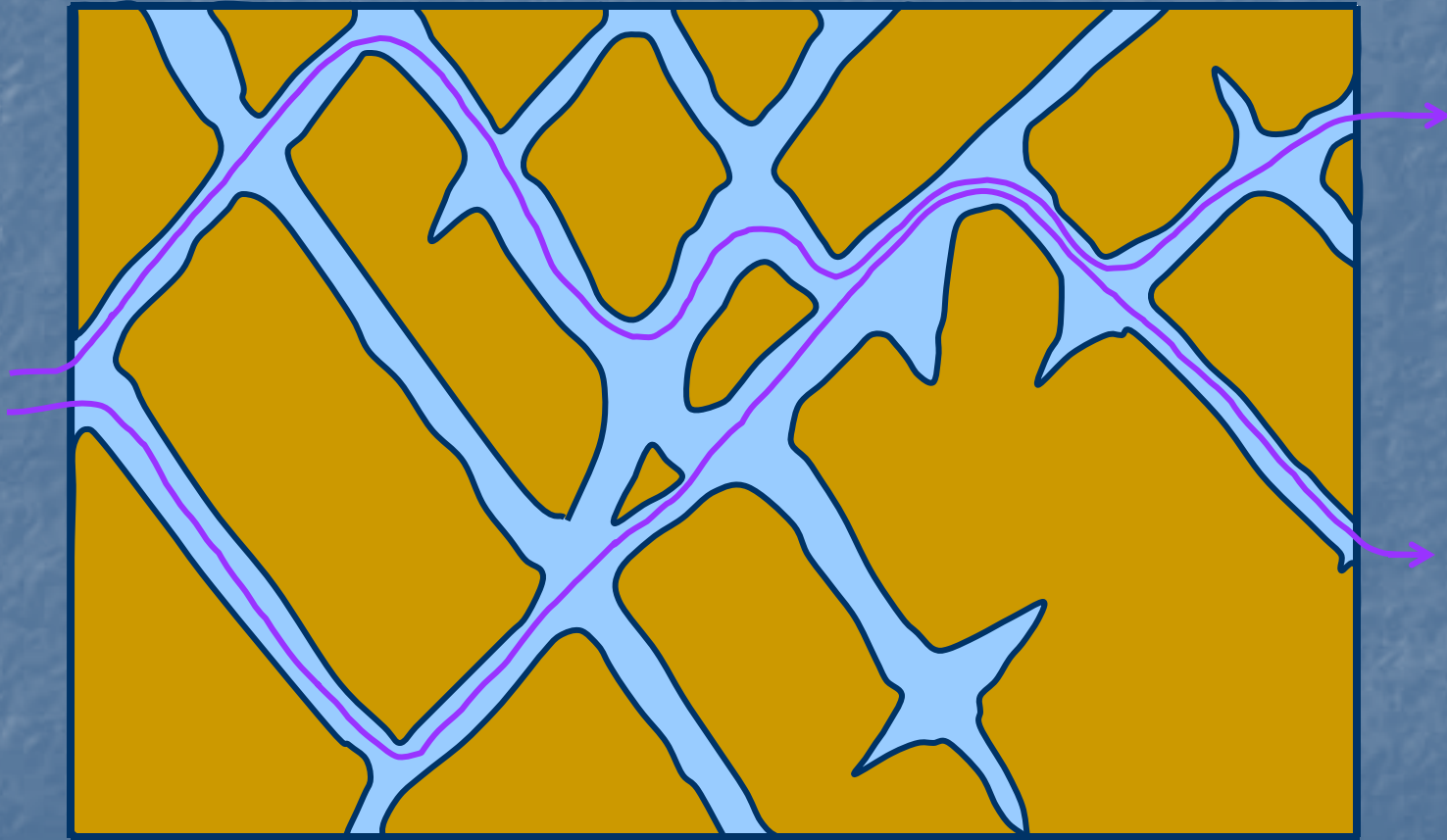
Groundwater flows through pore spaces between grains



Porosity & Effective Porosity Ranges

| Material | Porosity (%) | Eff. Porosity (%) |
|--------------------|--------------|-------------------|
| Silt | 34 - 61 | 0.1 – 10 |
| Clay | 34 - 60 | 0.1 – 10 |
| Sand/Gravel | 24 – 55 | 10 - 55 |
| Limestone/dolomite | 5 - 15 | 0.1 – 5 |
| Shale | 1 - 10 | 0.5 – 5 |
| Sandstone | 5 - 15 | 0.5 – 10 |

Fractured Systems





Fractured Limestone or Dolomite



Aquifers vs. Aquitards

An **aquifer** is a saturated bed, formation, or group of formations which yields water in sufficient quantity to be of consequence as a source of supply.

An **aquitard** yields *inappreciable* quantities of water to wells compared to an aquifer but through which *leakage* of water is possible. Aquitards often act as confining beds.



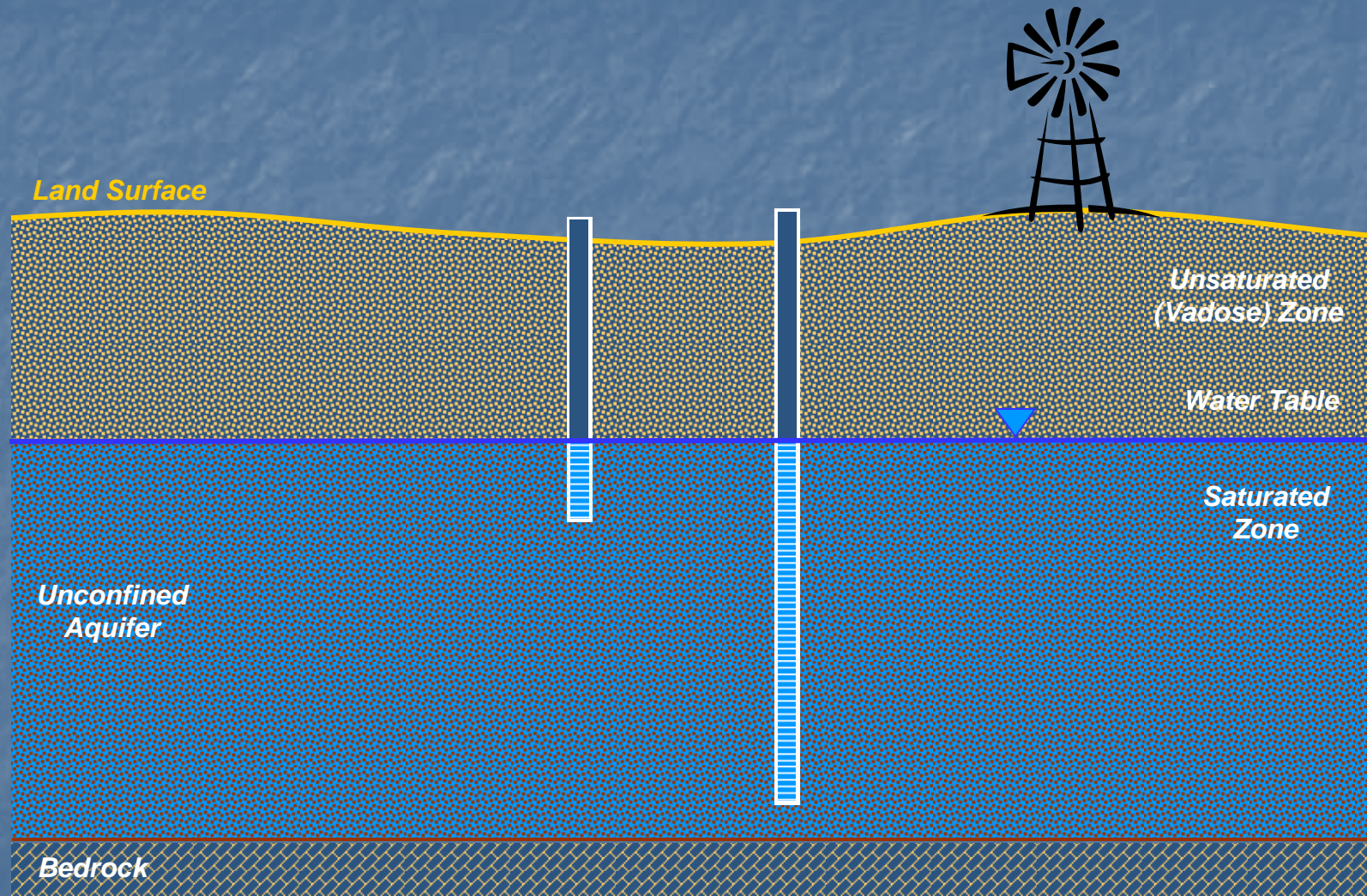
Unconfined vs. Confined Groundwater

An **unconfined** aquifer is one in which groundwater possesses a free surface open to the atmosphere. The upper surface of the zone of saturation is called the **water table**.

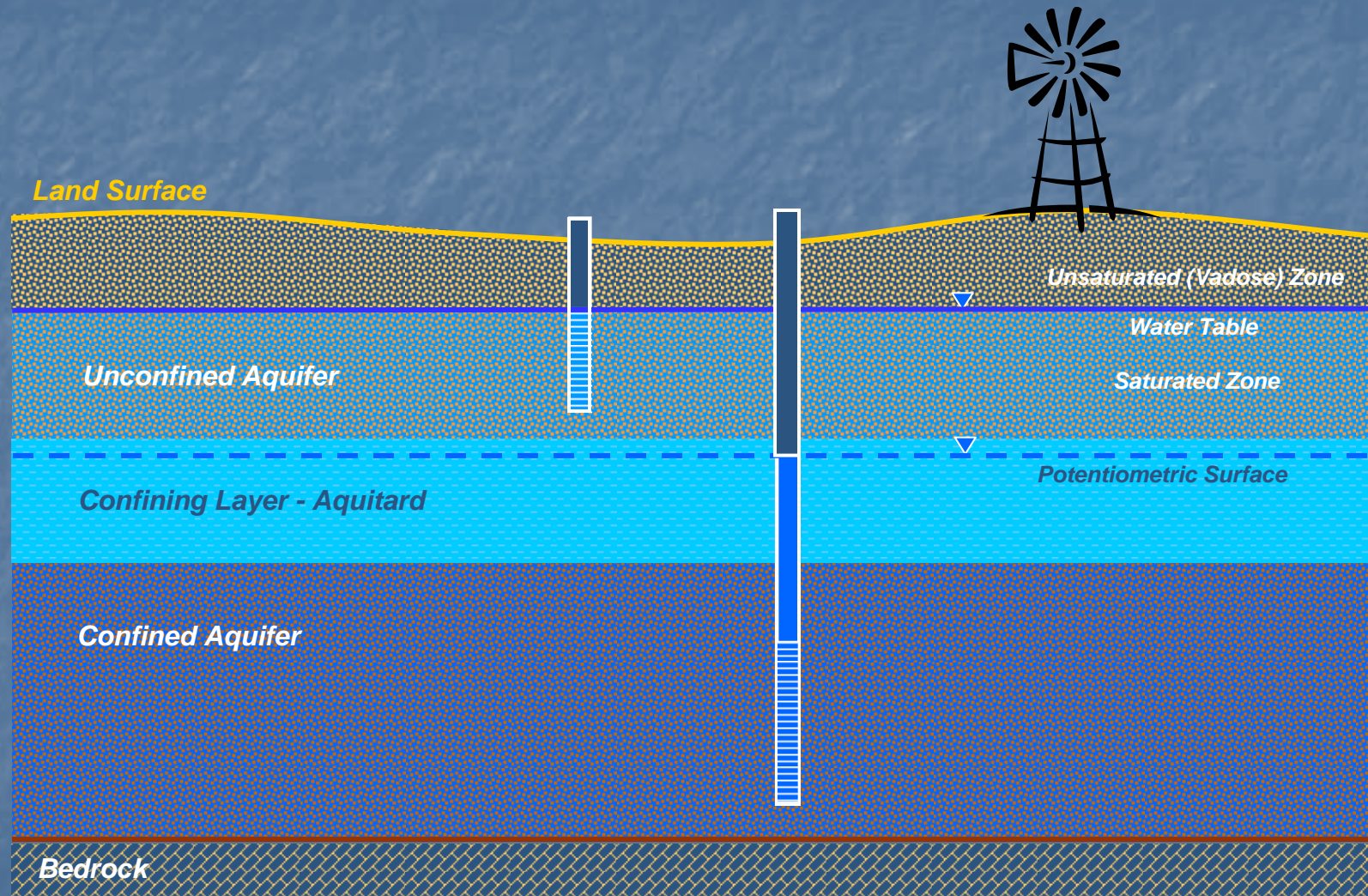
A **confined** aquifer is one in which groundwater is confined under pressure by overlying and underlying aquitards or aquicludes and water levels in wells rise above the top of the aquifer. Also called an **artesian** aquifer.



Unconfined Aquifers



Confined Aquifers

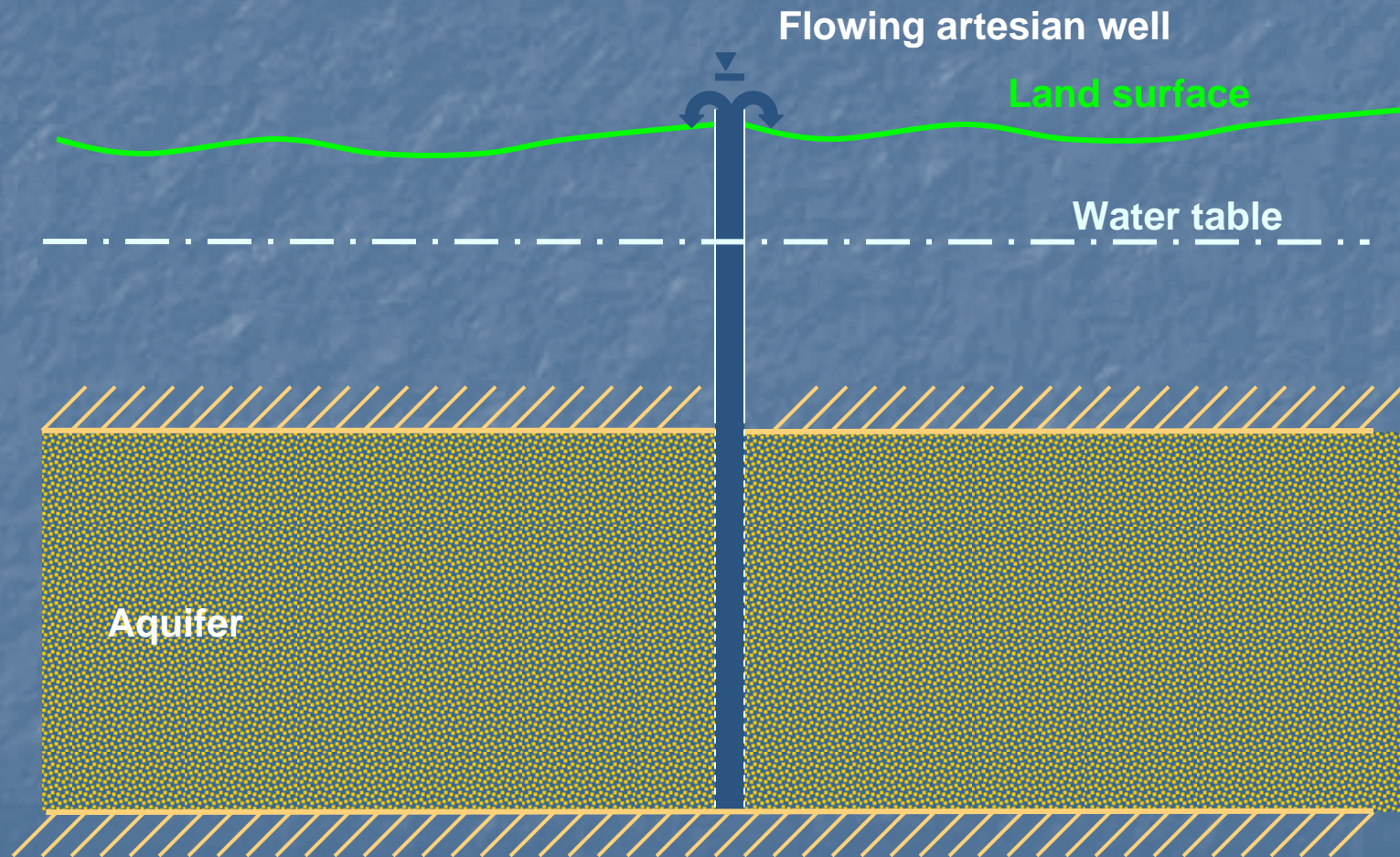


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SURVEY

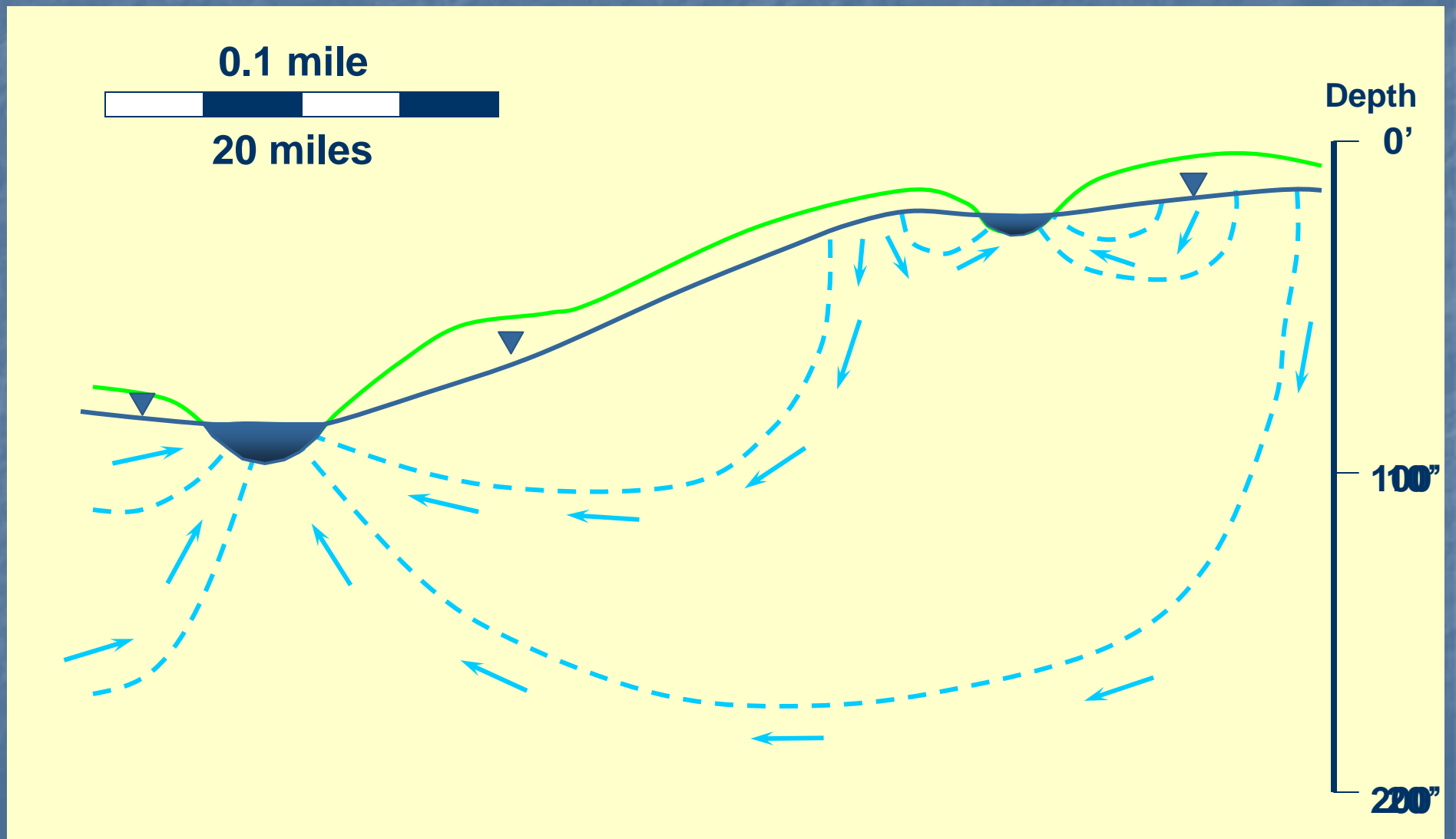


ILLINOIS

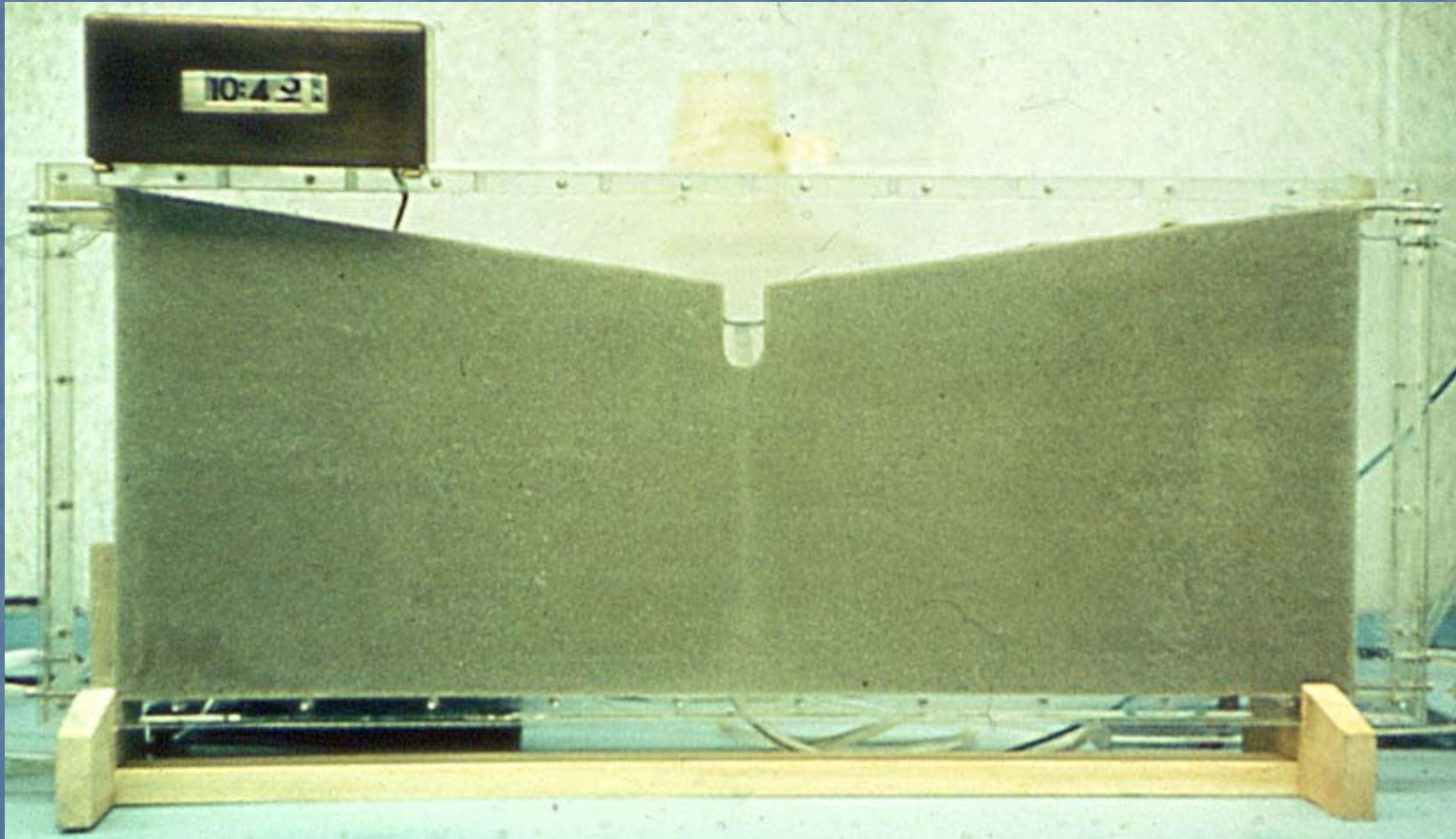
Confined Aquifers & Artesian Wells



Regional Groundwater Flow Systems



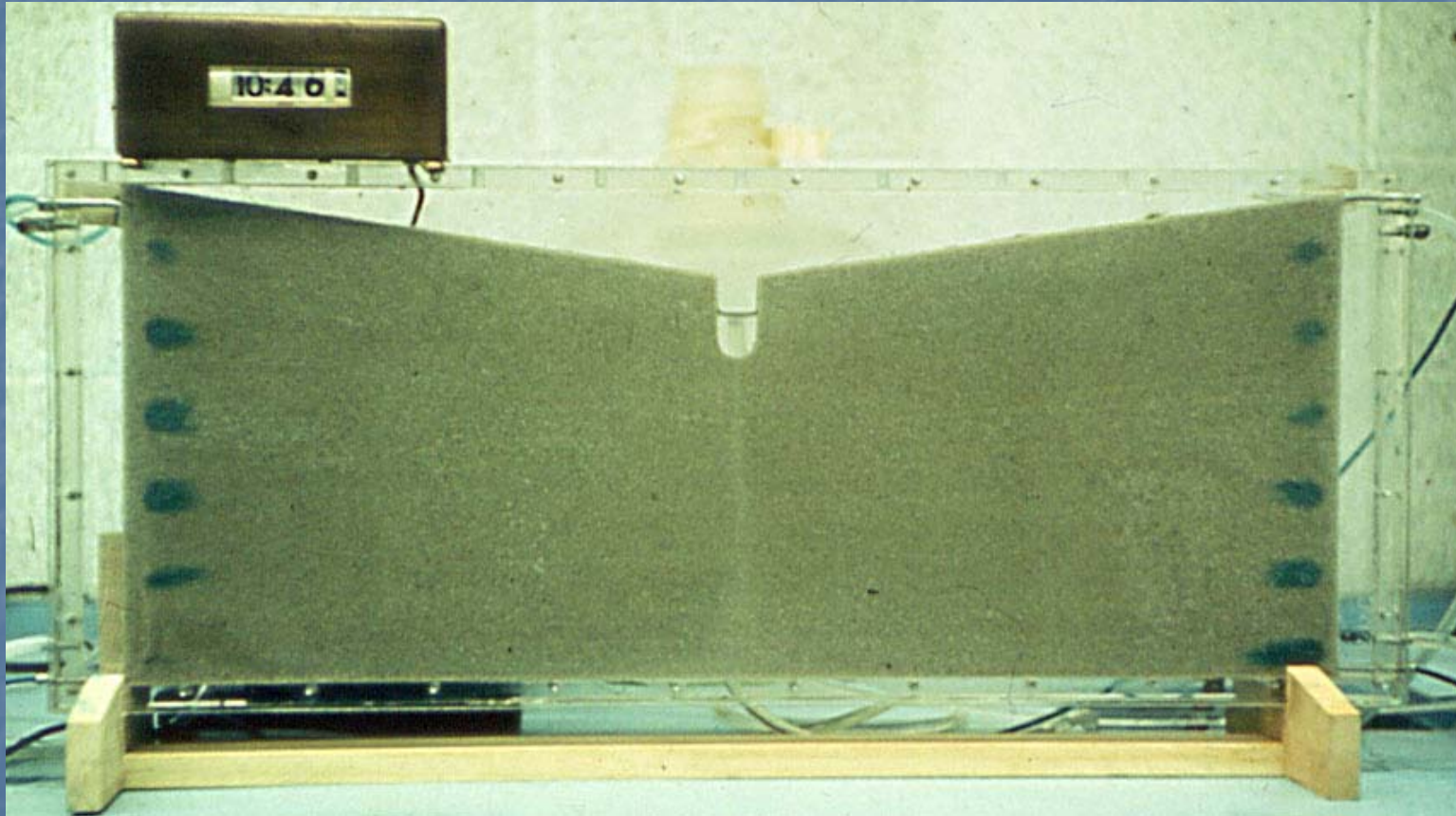
Groundwater – Stream Interaction



Regional Flow Systems



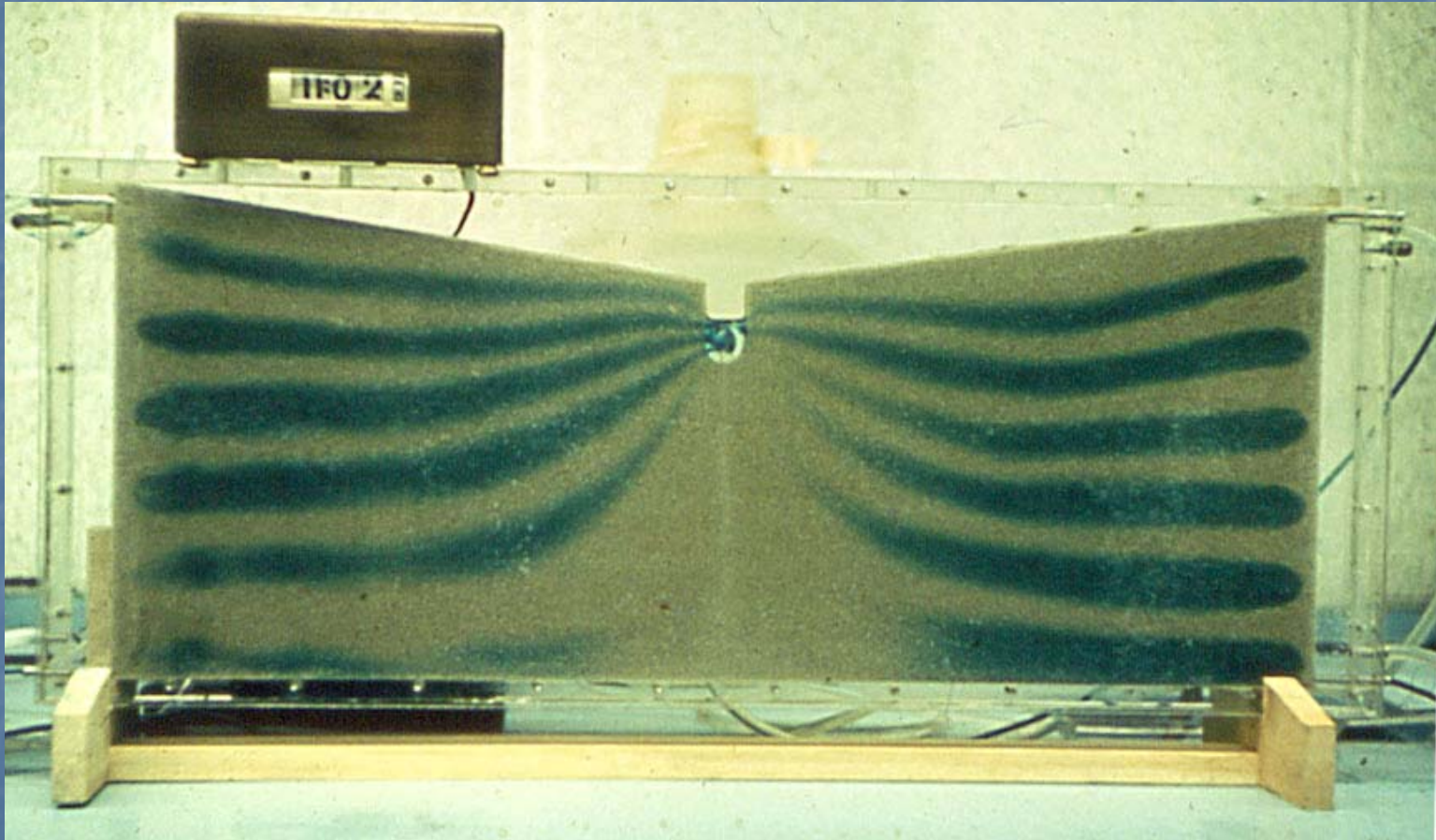
Groundwater – Stream Interaction



Regional Flow Systems



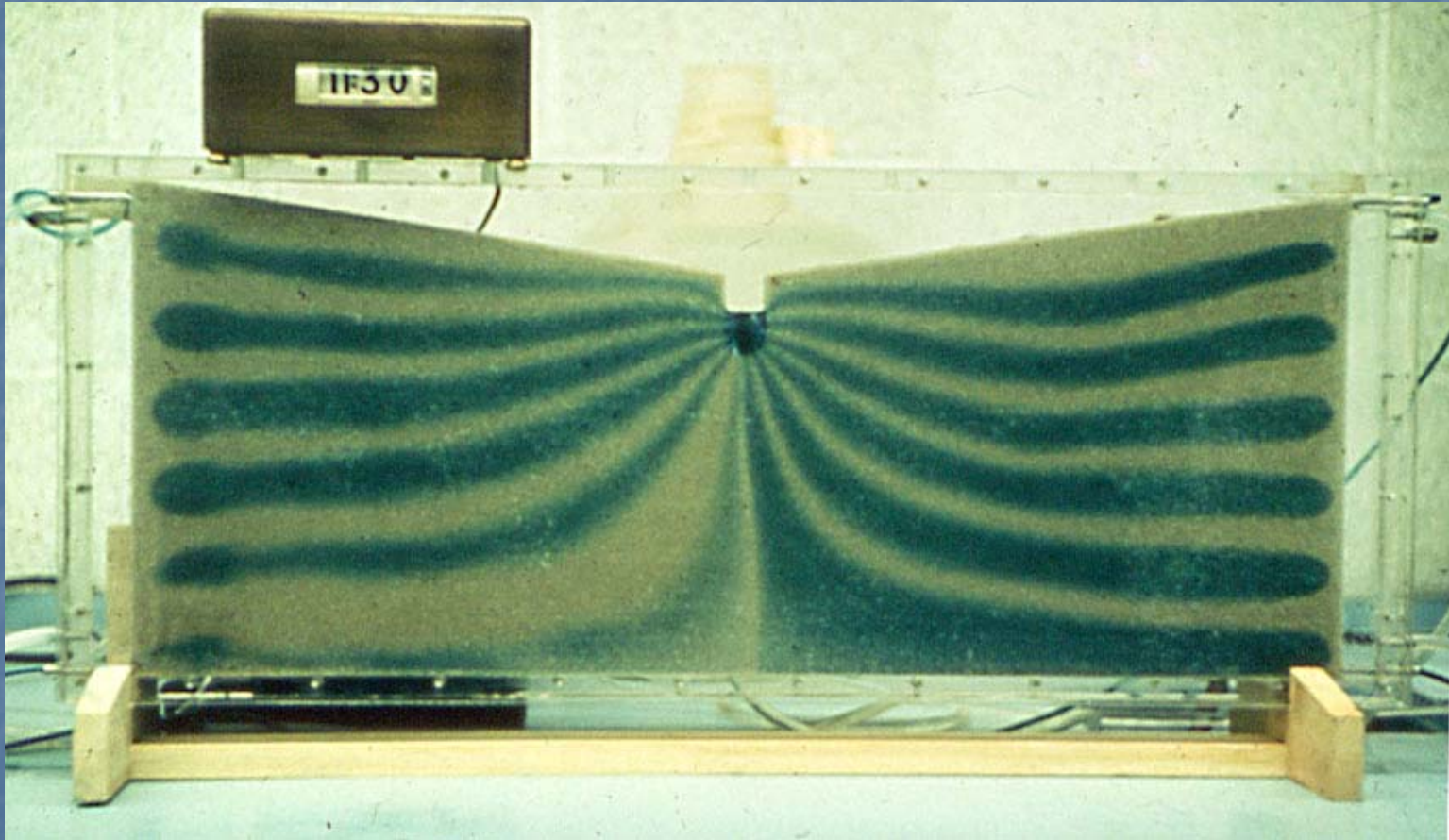
Groundwater – Stream Interaction



Regional Flow Systems



Groundwater – Stream Interaction



Regional Flow Systems



Groundwater Flow Velocities

| Material | Velocity |
|----------------------------|--------------------------|
| Gravel | 5-10 feet per day |
| Clean sand | 1 – 5 feet per day |
| Clayey sand | 0.1 – 0.5 feet per day |
| Clay | < 0.1 feet per day |
| Sandstone | < 0.5 feet per day |
| Highly fractured limestone | 10 – 1000's feet per day |




IL Geology— glacial materials

Quaternary Deposits of Illinois


revised by
Ardith K. Hansel and W. Hilton Johnson
1996

Hudson and Wisconsin Episodes

Mason Group and Cahokia Fm

 Cahokia and Henry Fms; sorted sediment including waterlain river sediment and windblown and beach sand

 Equality Fm; fine grained sediment deposited in lakes


 5 Thickness of Peoria and Roxana Silts; silt deposited as loess (5-foot contour interval)

Wedron Group (Tiskilwa, Lemont, and Wadsworth Fms) and Trafalgar Fm; diamicton deposited as till and ice-marginal sediment

 End moraine

 Ground moraine


Illinois Episode

 Winnebago Fm; diamicton deposited as till and ice-marginal sediment


 Glasford Fm; diamicton deposited as till and ice-marginal sediment

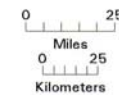
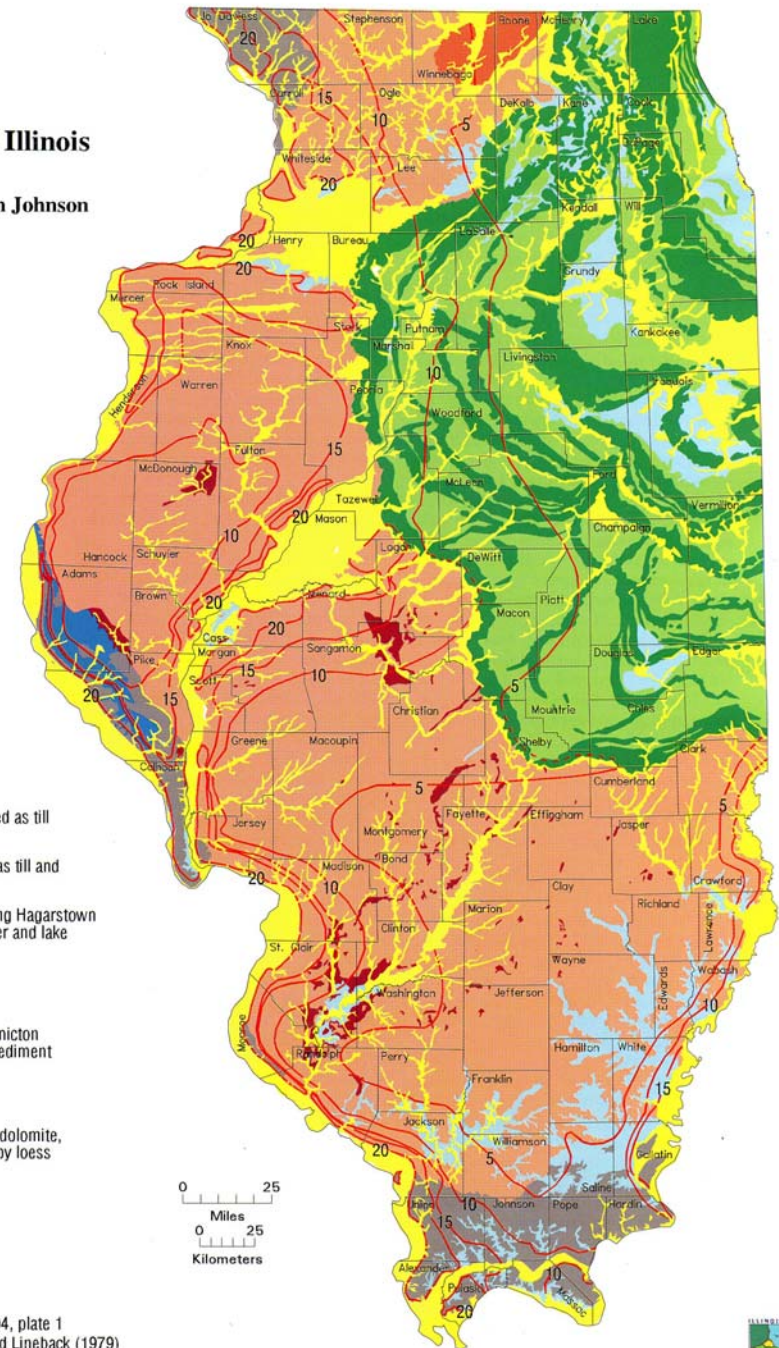
 Teneriffe Silt and Pearl Fm, including Hagarstown Mbr; sorted sediment including river and lake deposits and wind-blown sand

Pre-Illinois Episodes

 Wolf Creek Fm; predominantly diamicton deposited as till and ice-marginal sediment

Paleozoic, Mesozoic, and Cenozoic

 Mostly Paleozoic shale, limestone, dolomite, or sandstone; exposed or covered by loess and/or residuum

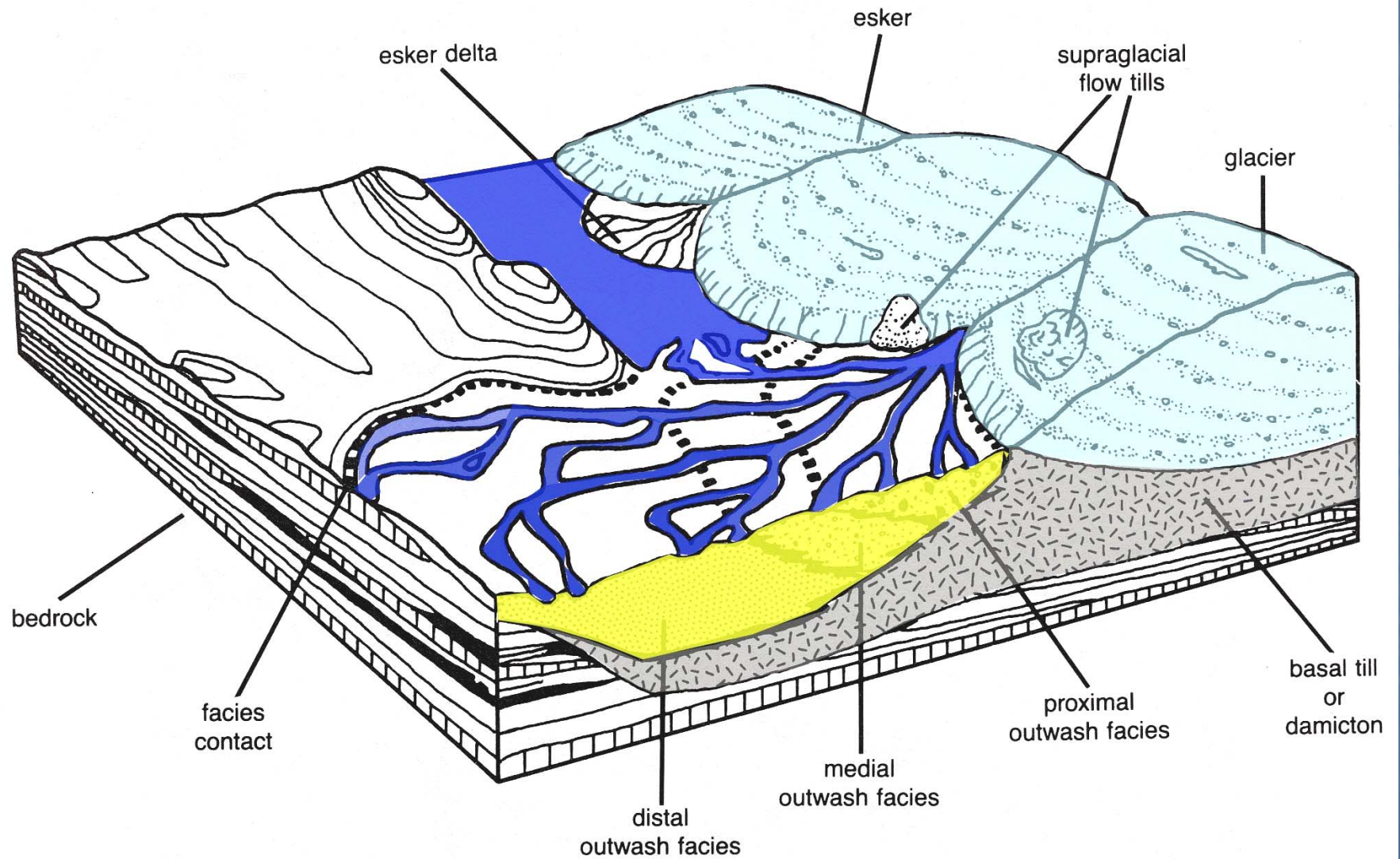


Illinois State Geological Survey Bulletin 104, plate 1
revised from Willman and Frye (1970) and Lineback (1979)
digital compilation by B.J. Stoff

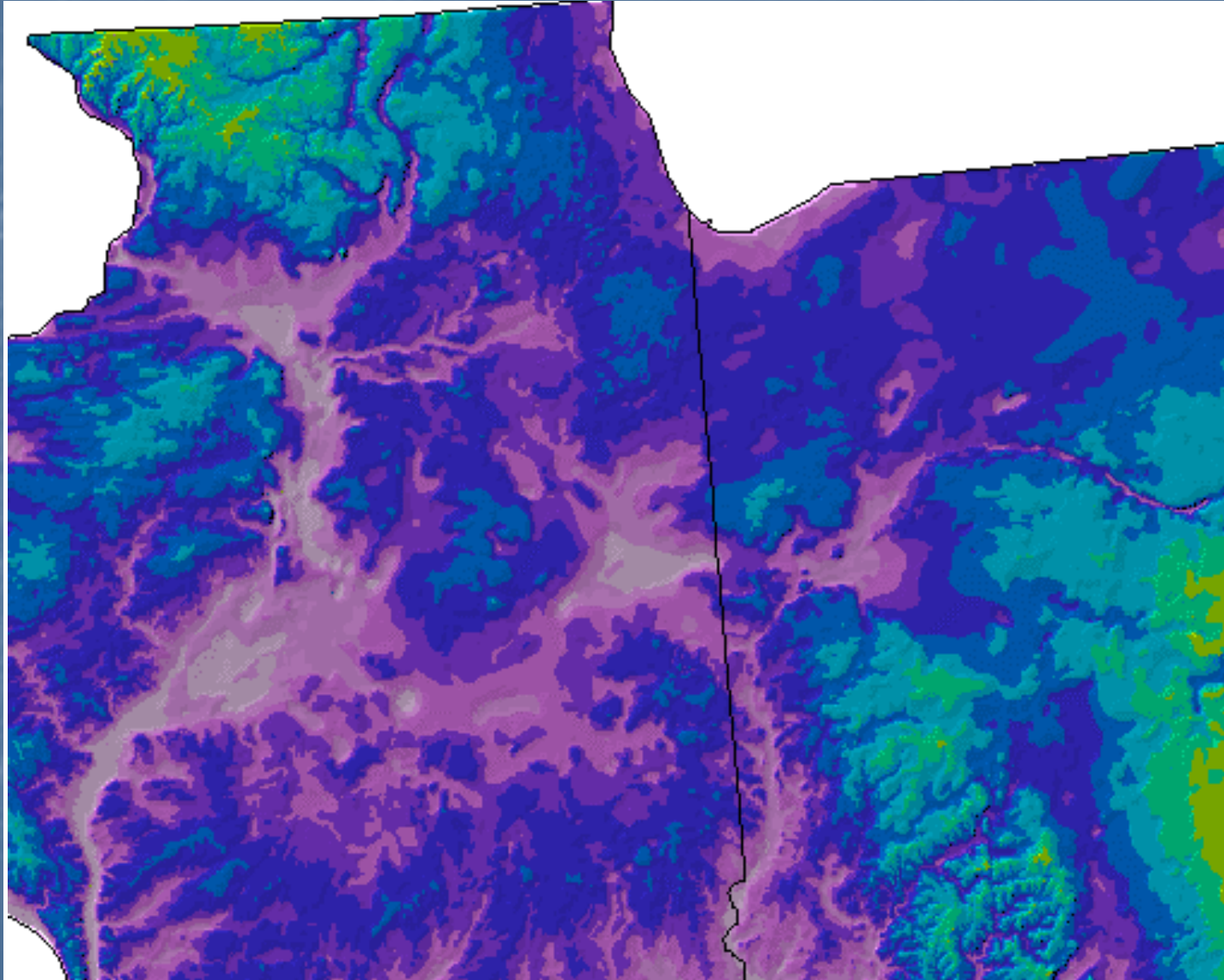
Printed by the authority of the State of Illinois/1996/3000



Glacial depositional processes

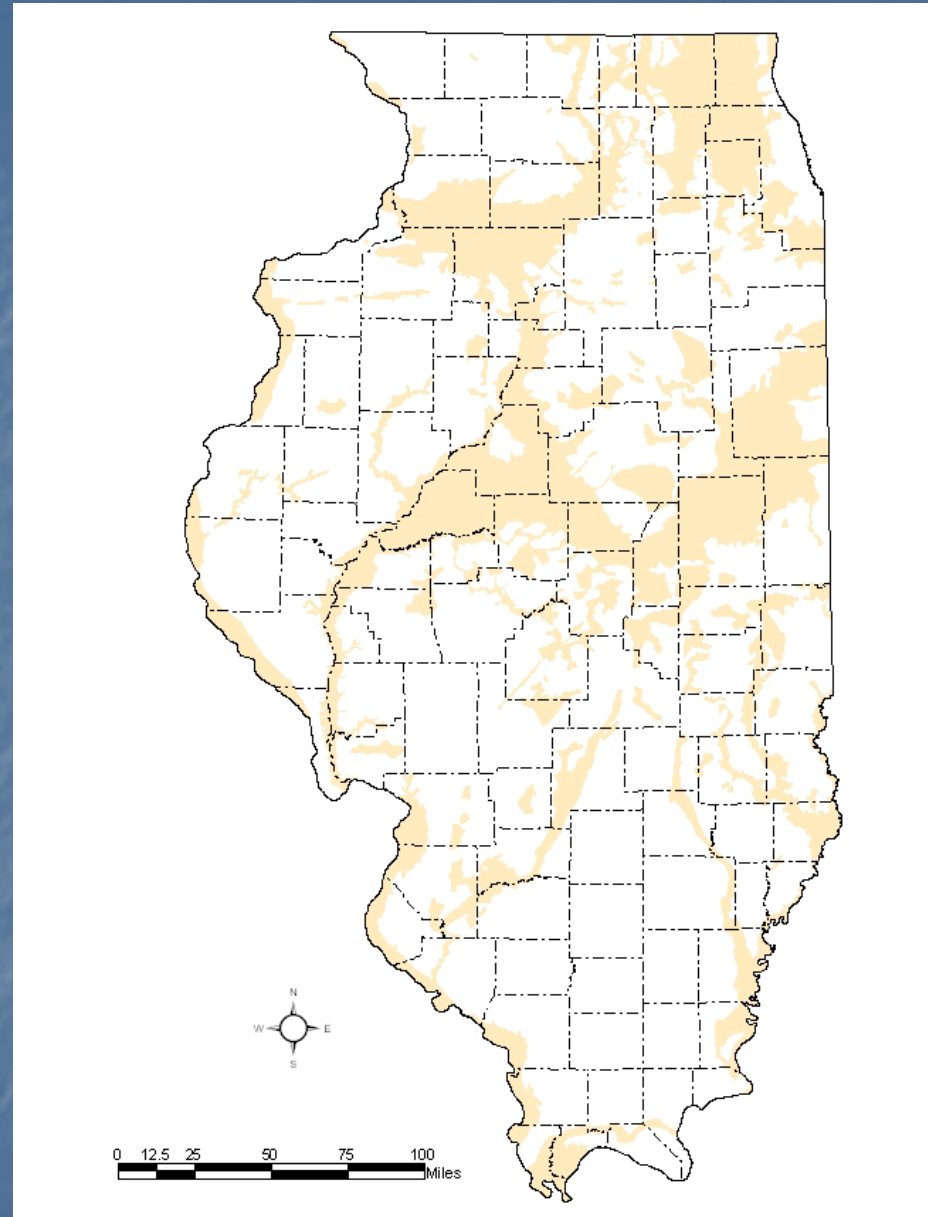


Regional Bedrock Topography



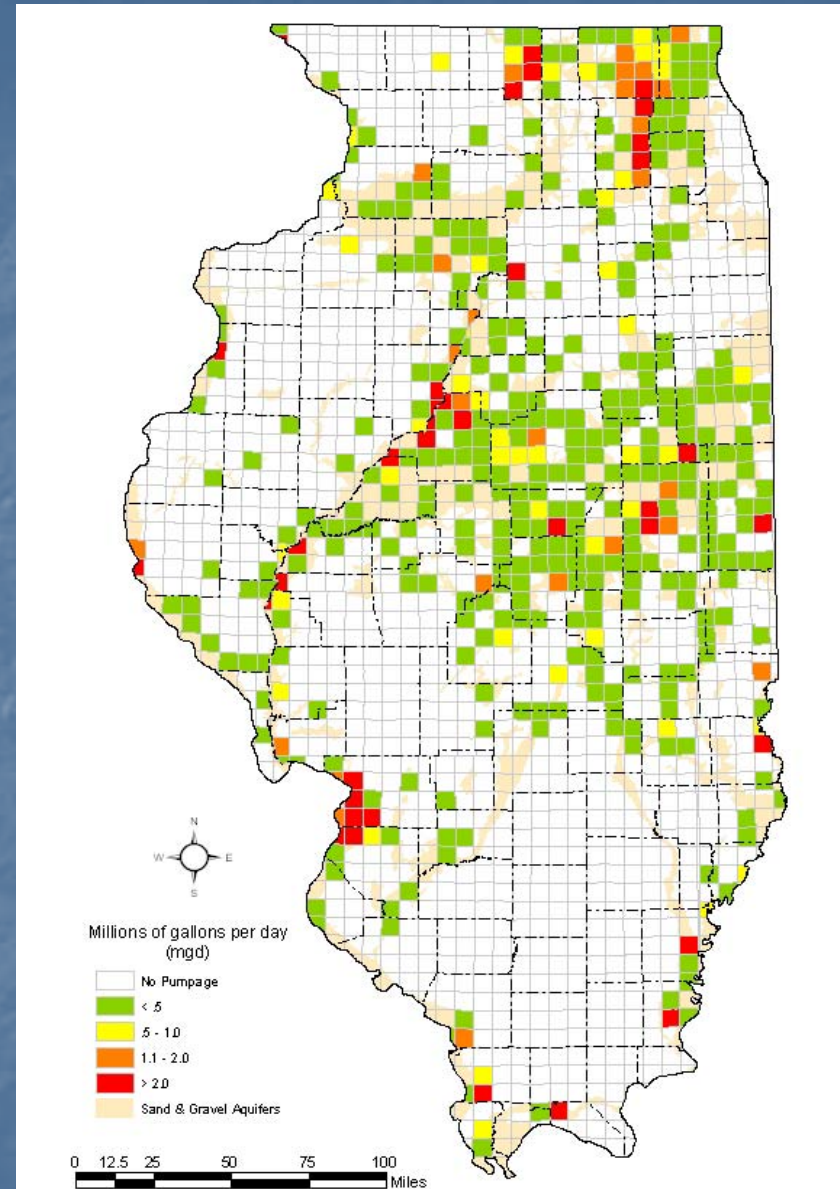
Green= higher elevations; Light violet= lower elevations

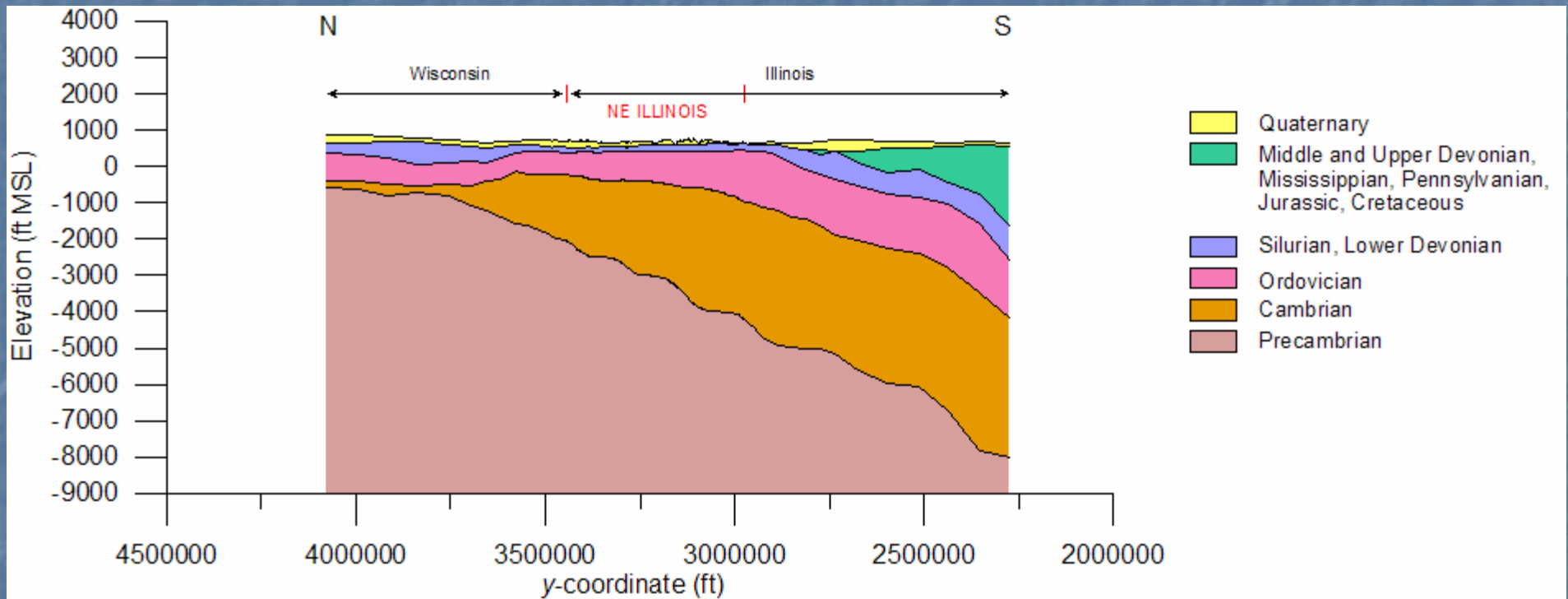
Major Sand & Gravel Aquifers



Withdrawals from Sand and Gravel Aquifers

Total use ~ 350 mgd
+ ~200 mgd for irrigation

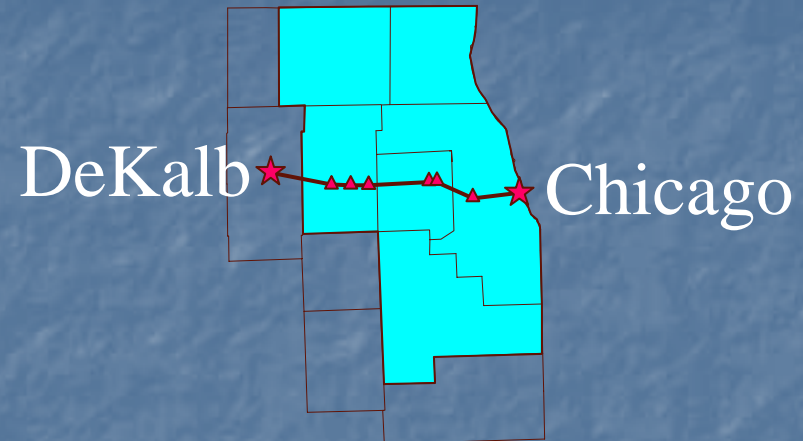
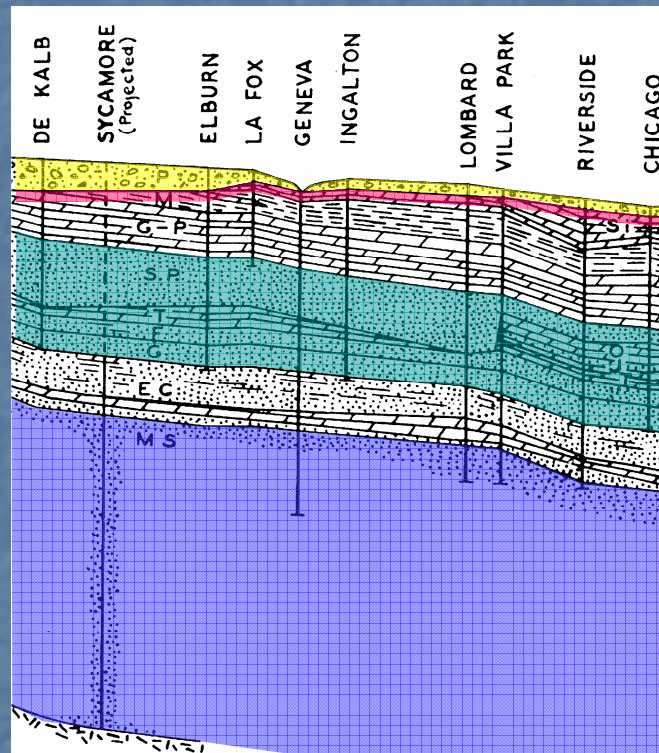


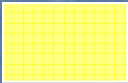

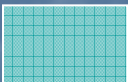



Aquifers of Northeastern Illinois

West

East



-  Unconsolidated Aquifer System
-  Shallow Bedrock Aquifer
-  Deep Bedrock Aquifer System
-  Elmhurst-Mt. Simon Aquifer

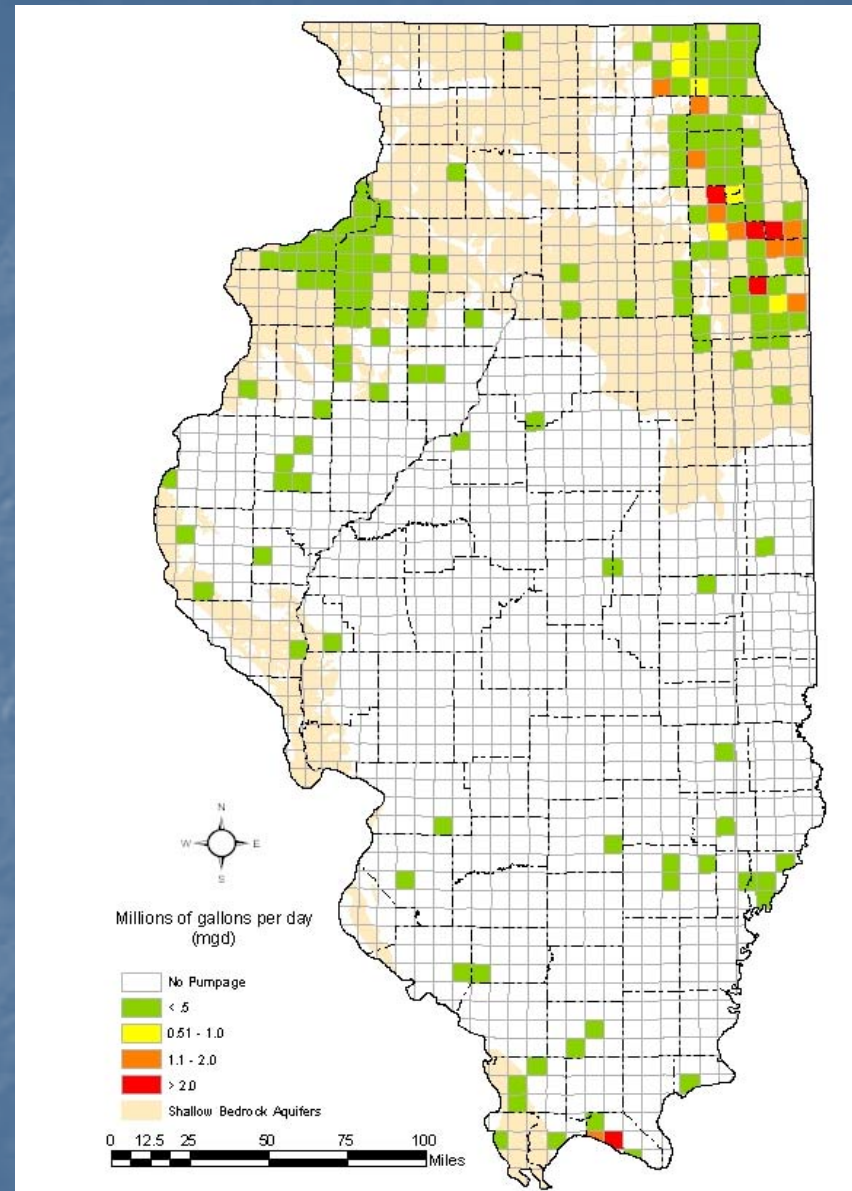
Cross-Section Modified from Bretz (1939)

Major Shallow Bedrock Aquifers

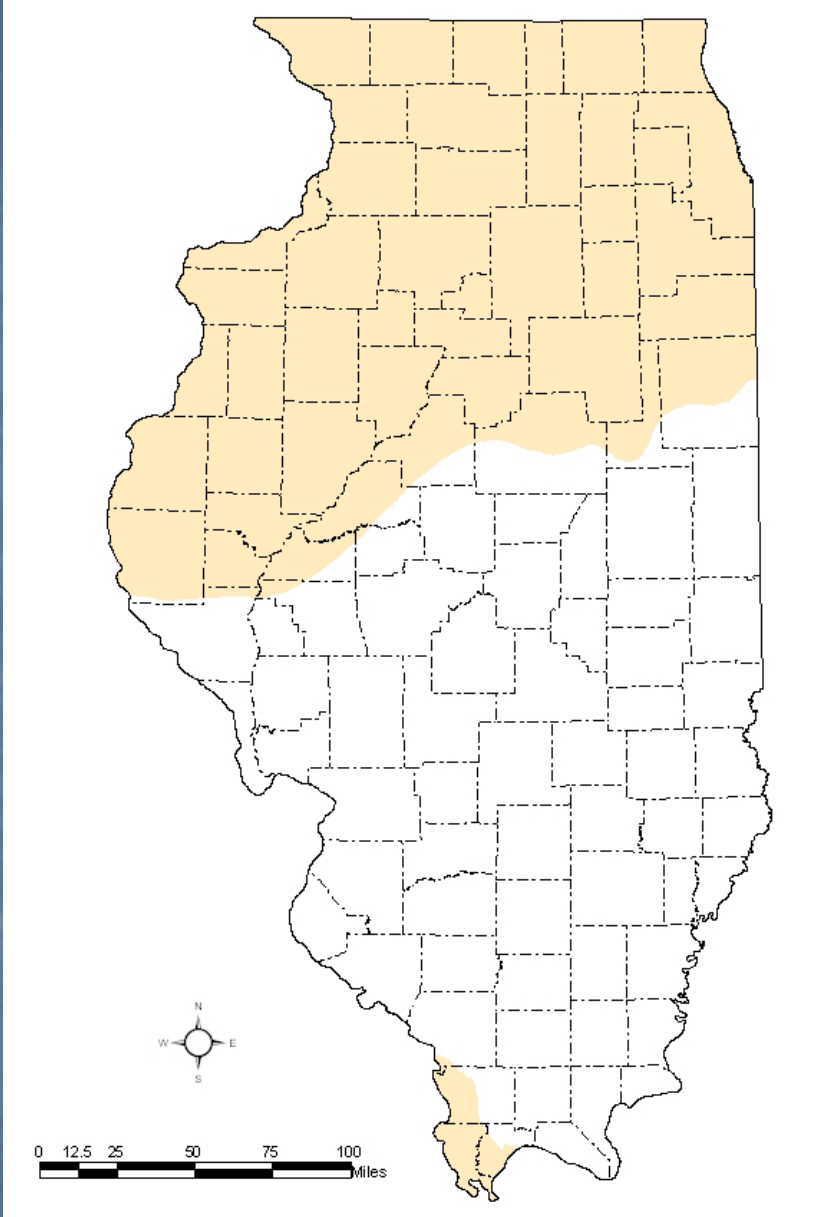


Withdrawals from Shallow Bedrock Aquifers

Total use > 200 mgd

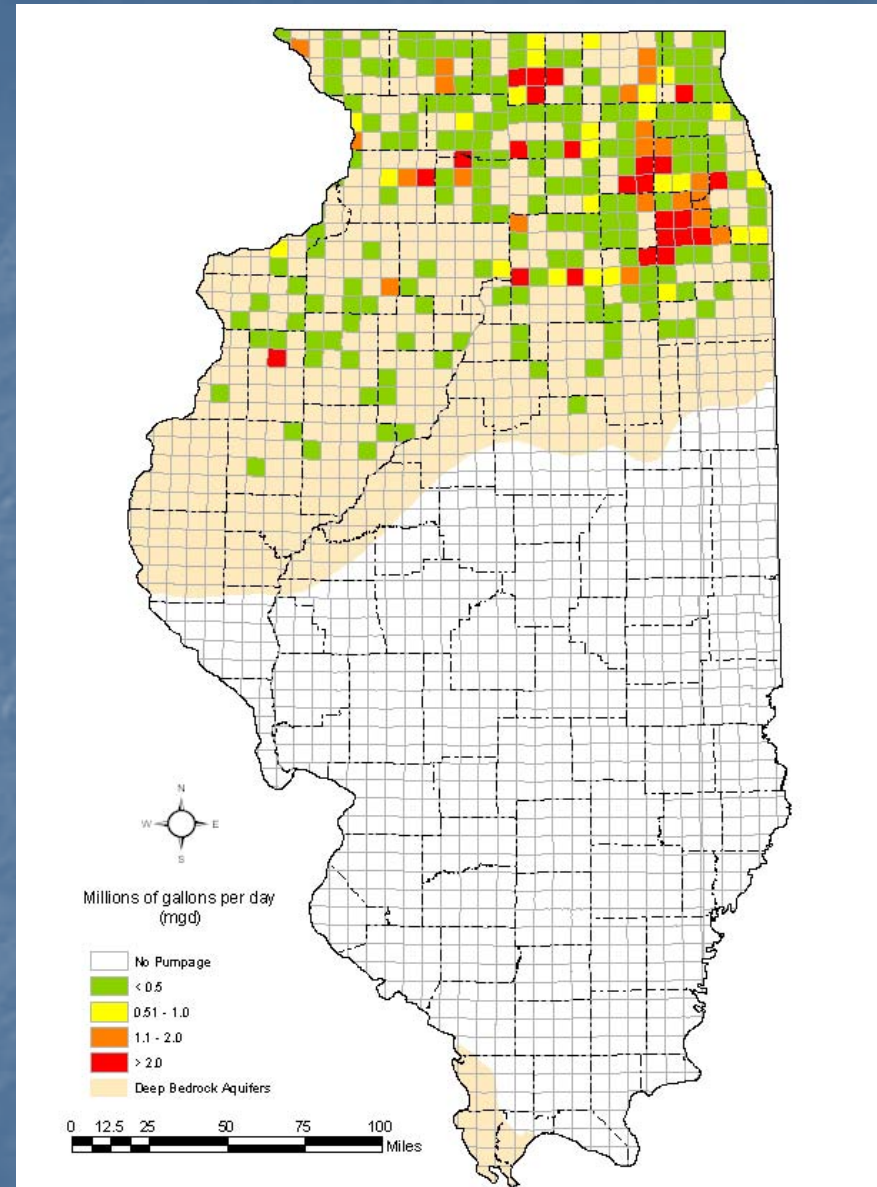


Major Deep Bedrock Aquifers

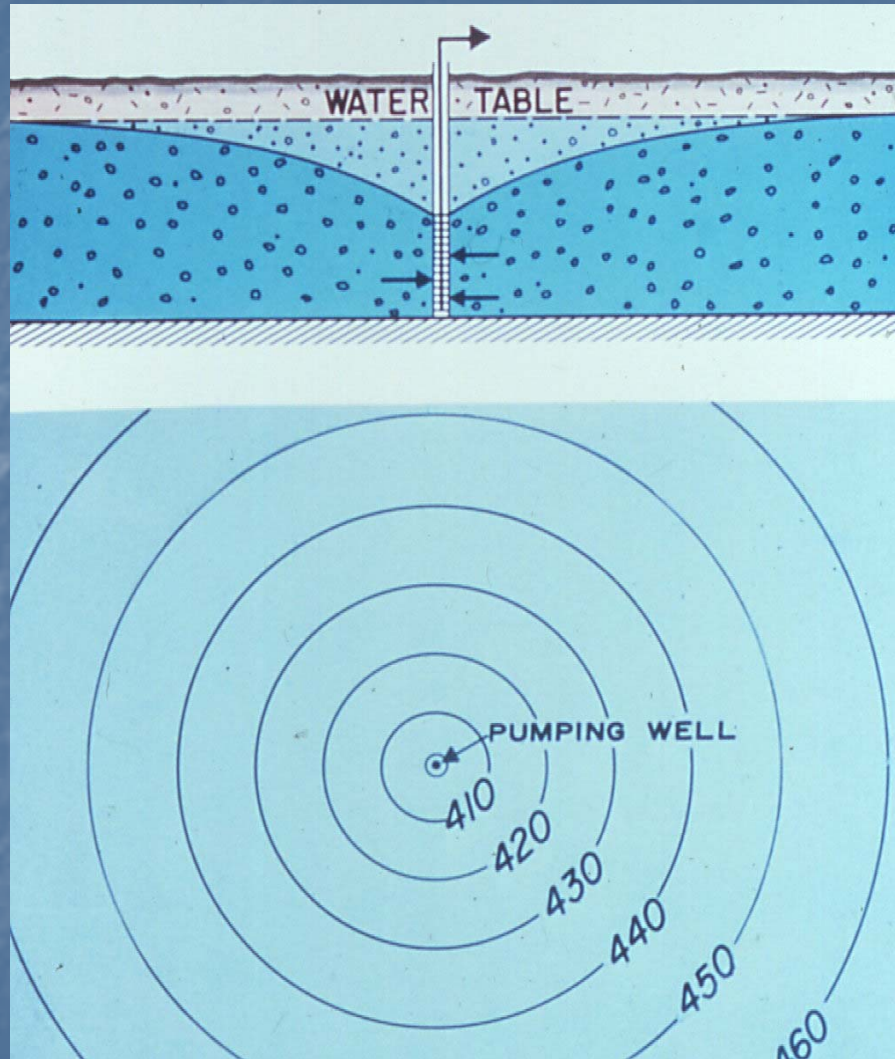


Withdrawals from Deep Bedrock Aquifers

Total use ~ 100 mgd



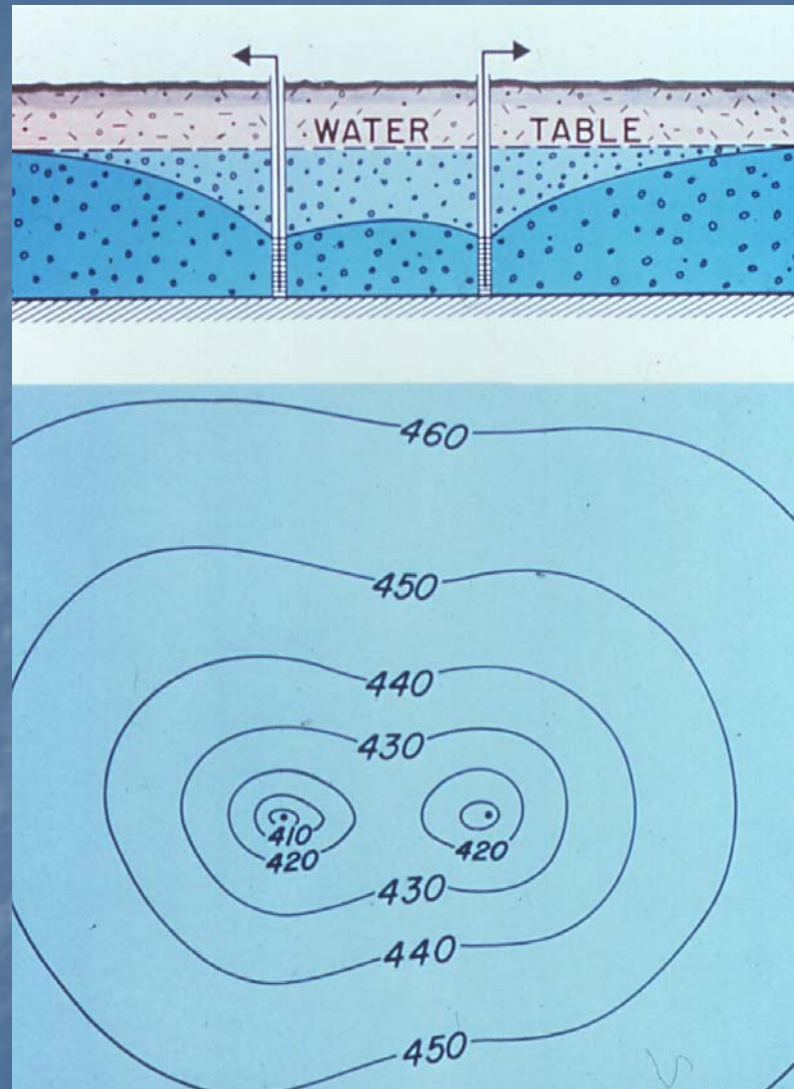
Cone of Depression



Well/Aquifer Interactions



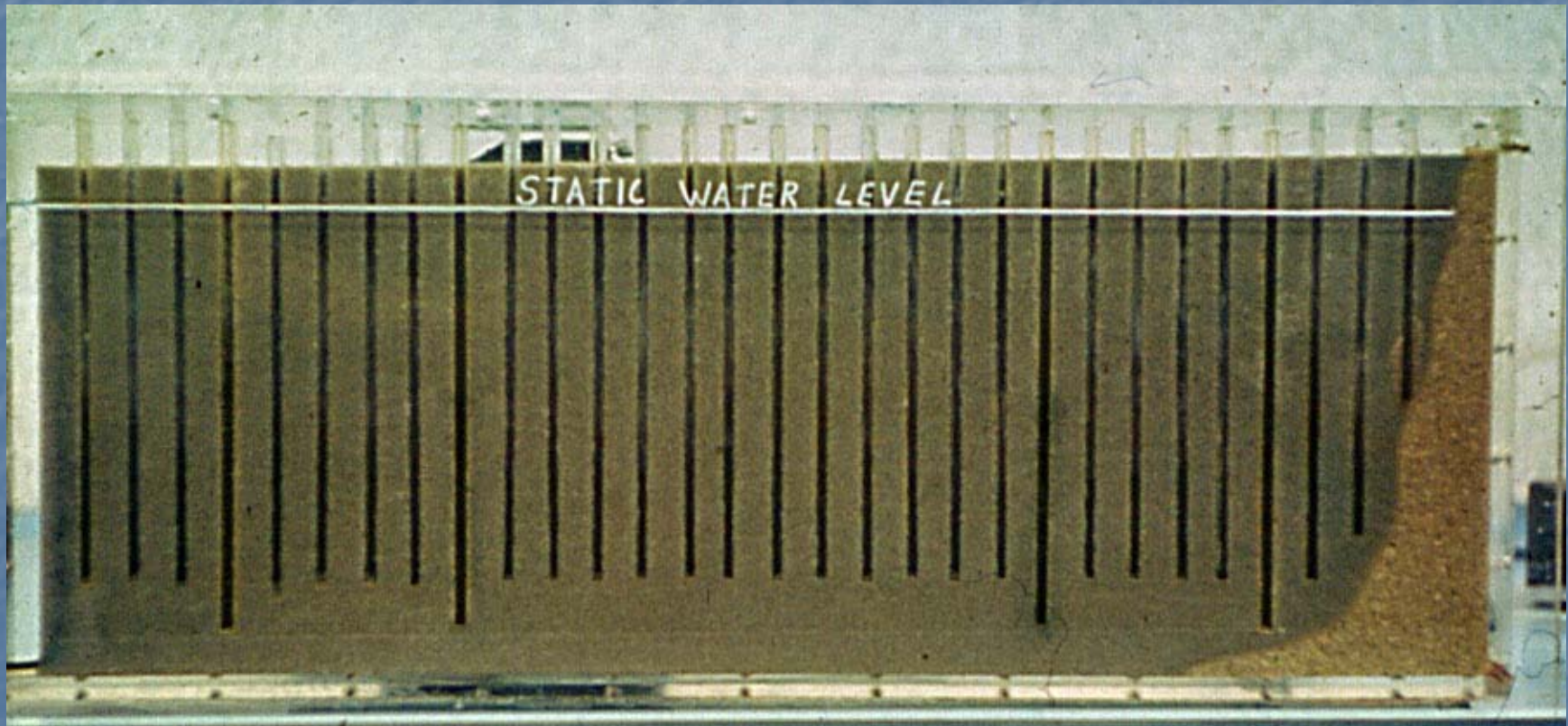
Overlapping Cones of Depression



Well/Aquifer Interactions



Overlapping Cones of Depression – Well Interference



Well/Aquifer Interactions



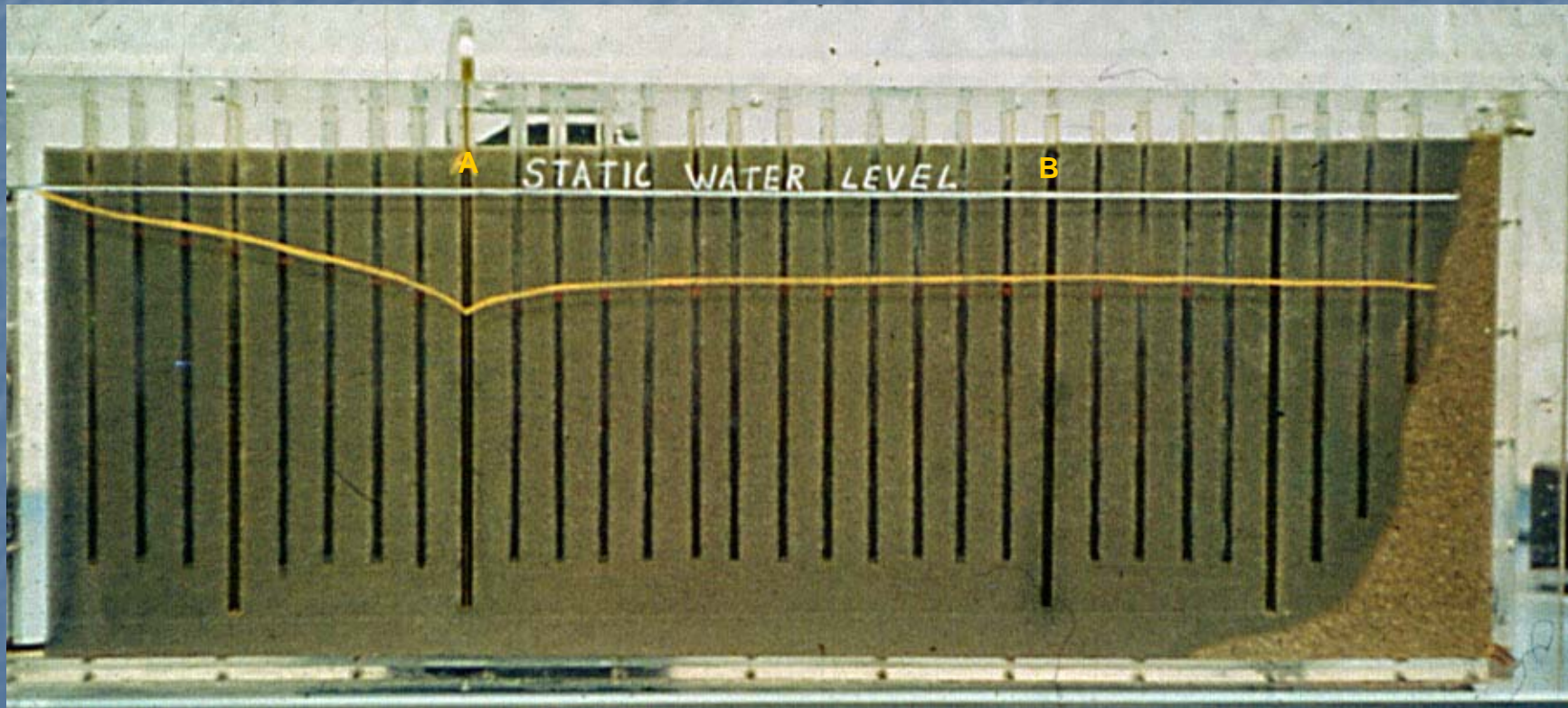
Overlapping Cones of Depression – Well Interference



Well/Aquifer Interactions



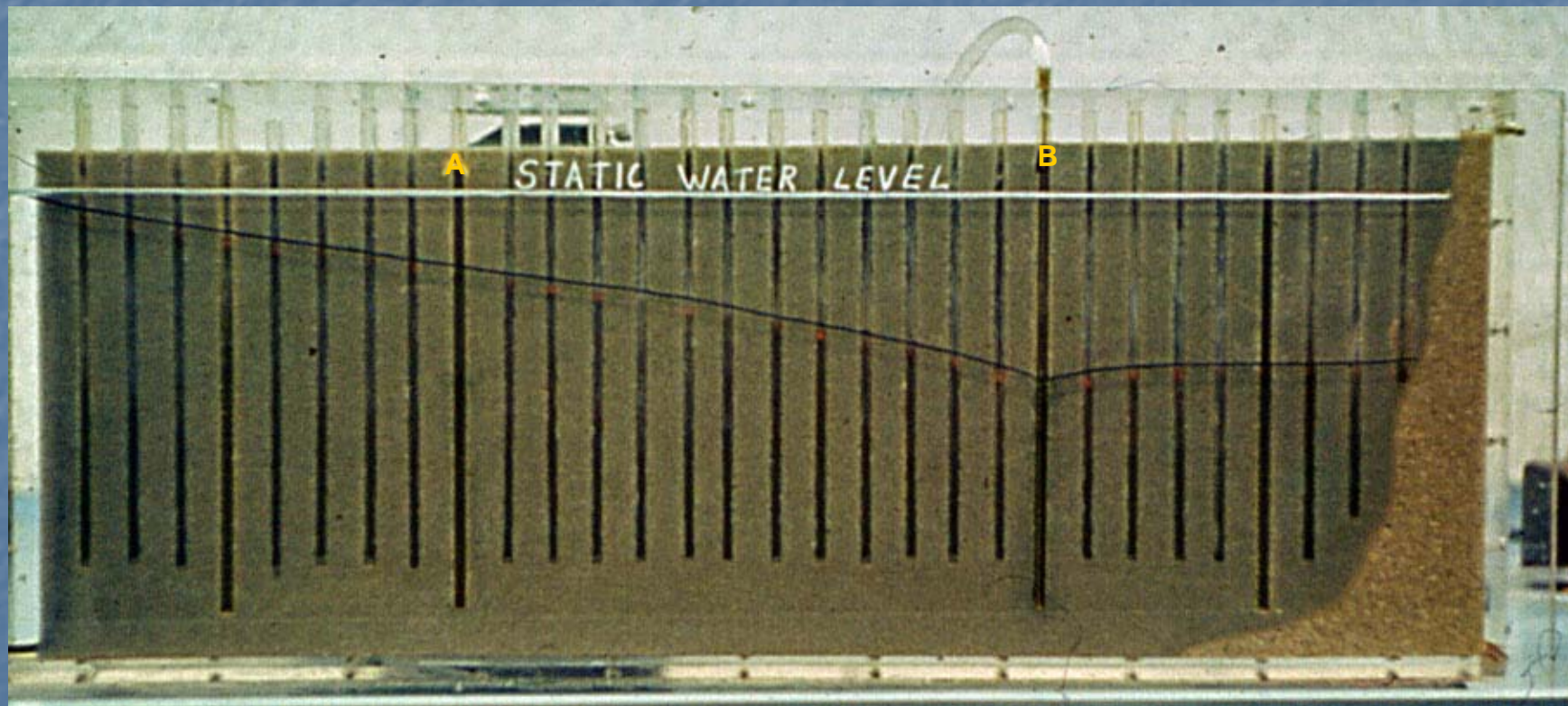
Overlapping Cones of Depression – Well Interference



Well/Aquifer Interactions



Overlapping Cones of Depression – Well Interference



Well/Aquifer Interactions



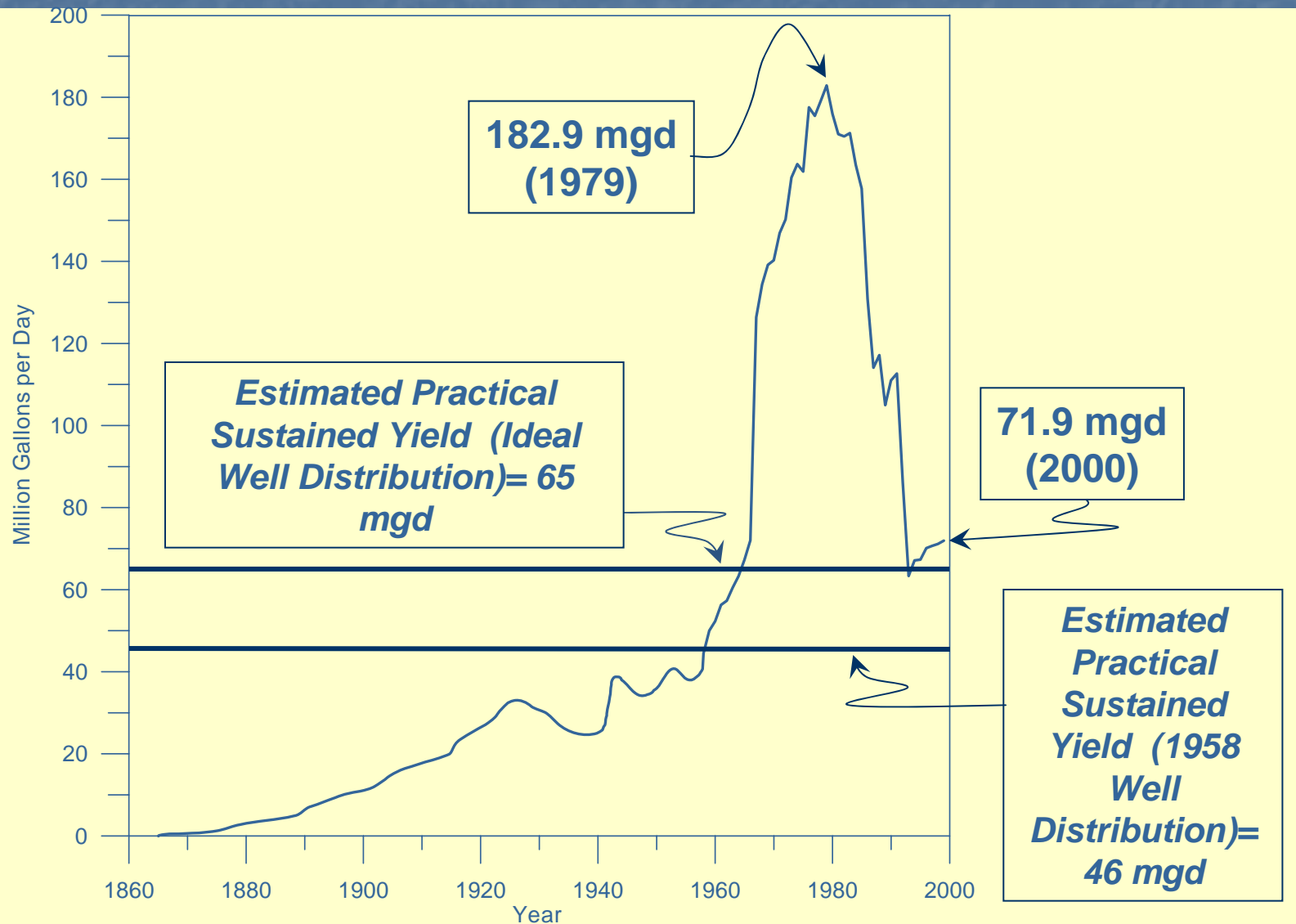
Overlapping Cones of Depression – Well Interference



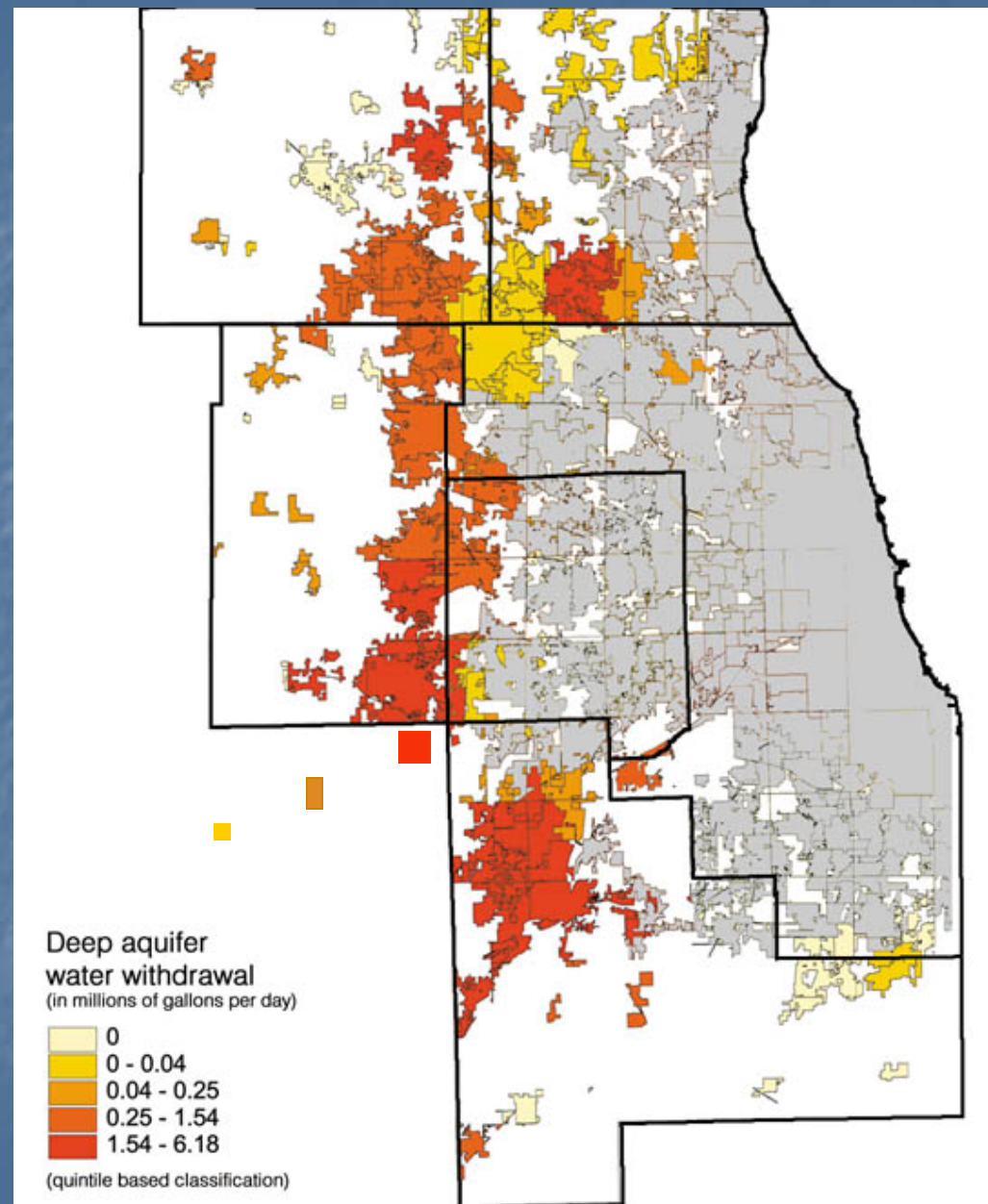
Well/Aquifer Interactions



NE Illinois Deep Bedrock Withdrawals, 1900-2000

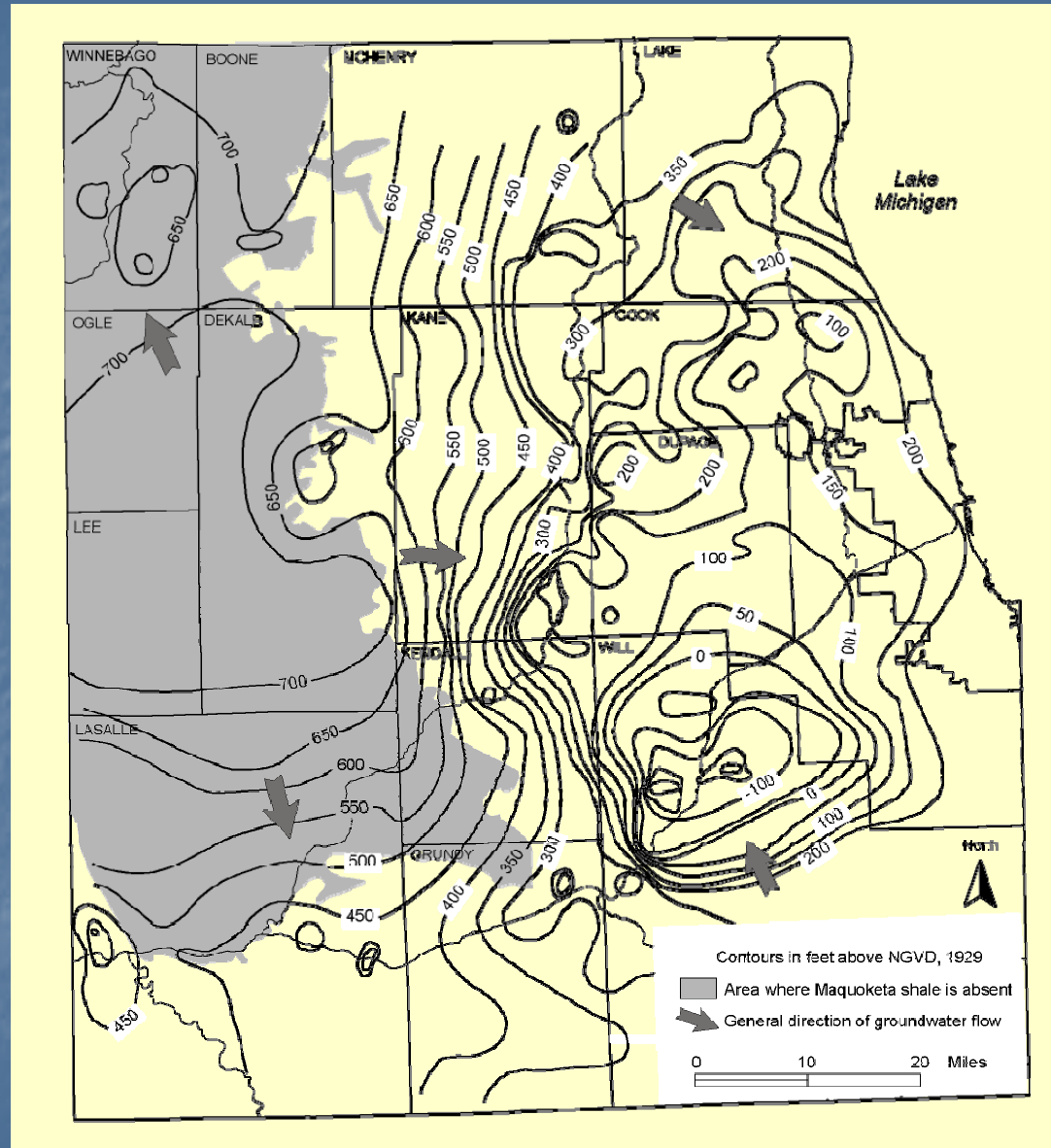


Distribution Of Deep Bedrock Aquifer Pumpage

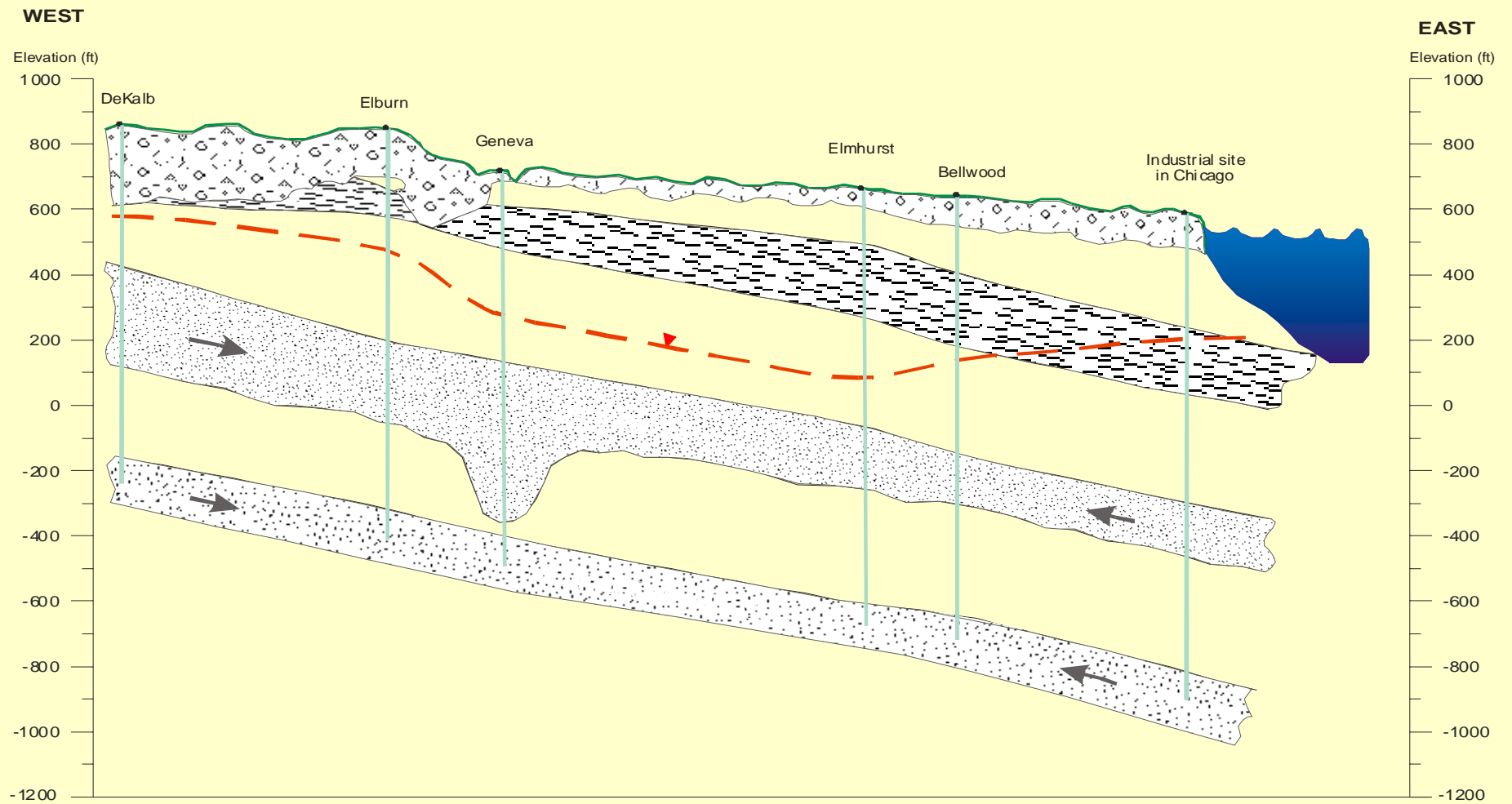


Source: Jaffe

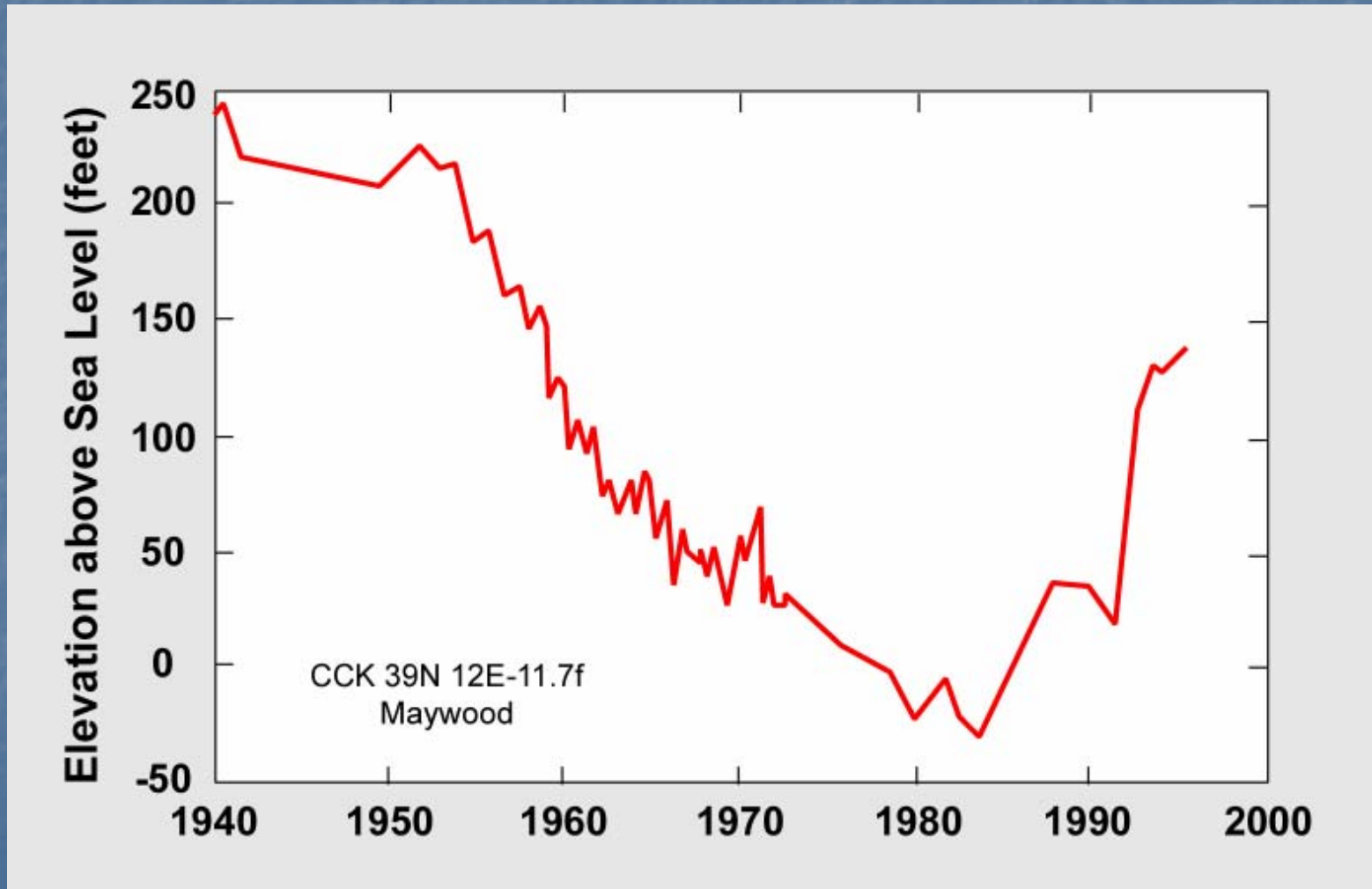
Potentiometric Surface of the Deep Bedrock Aquifer System, Fall 2000



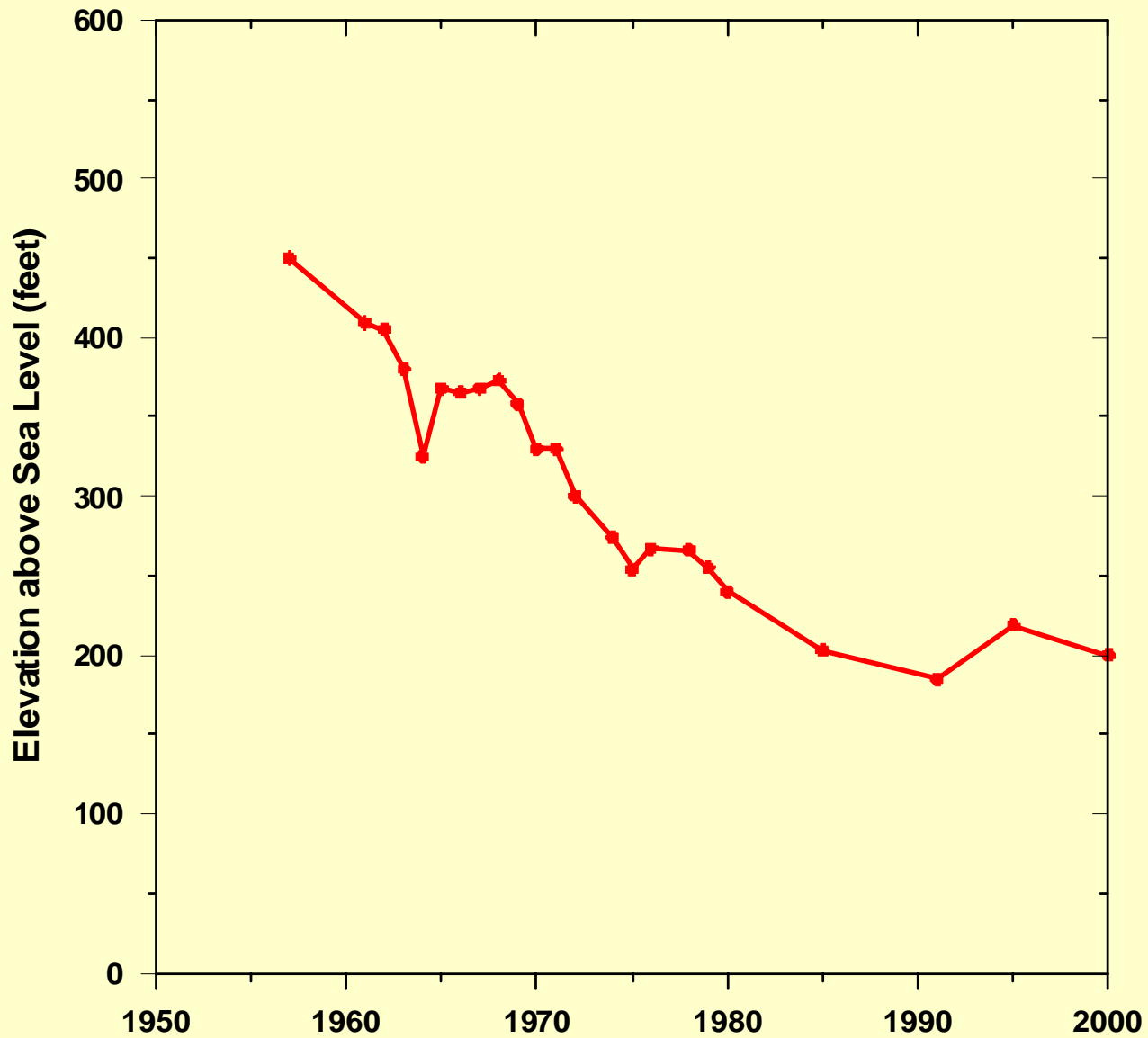
Potentiometric Surface Across NE Illinois



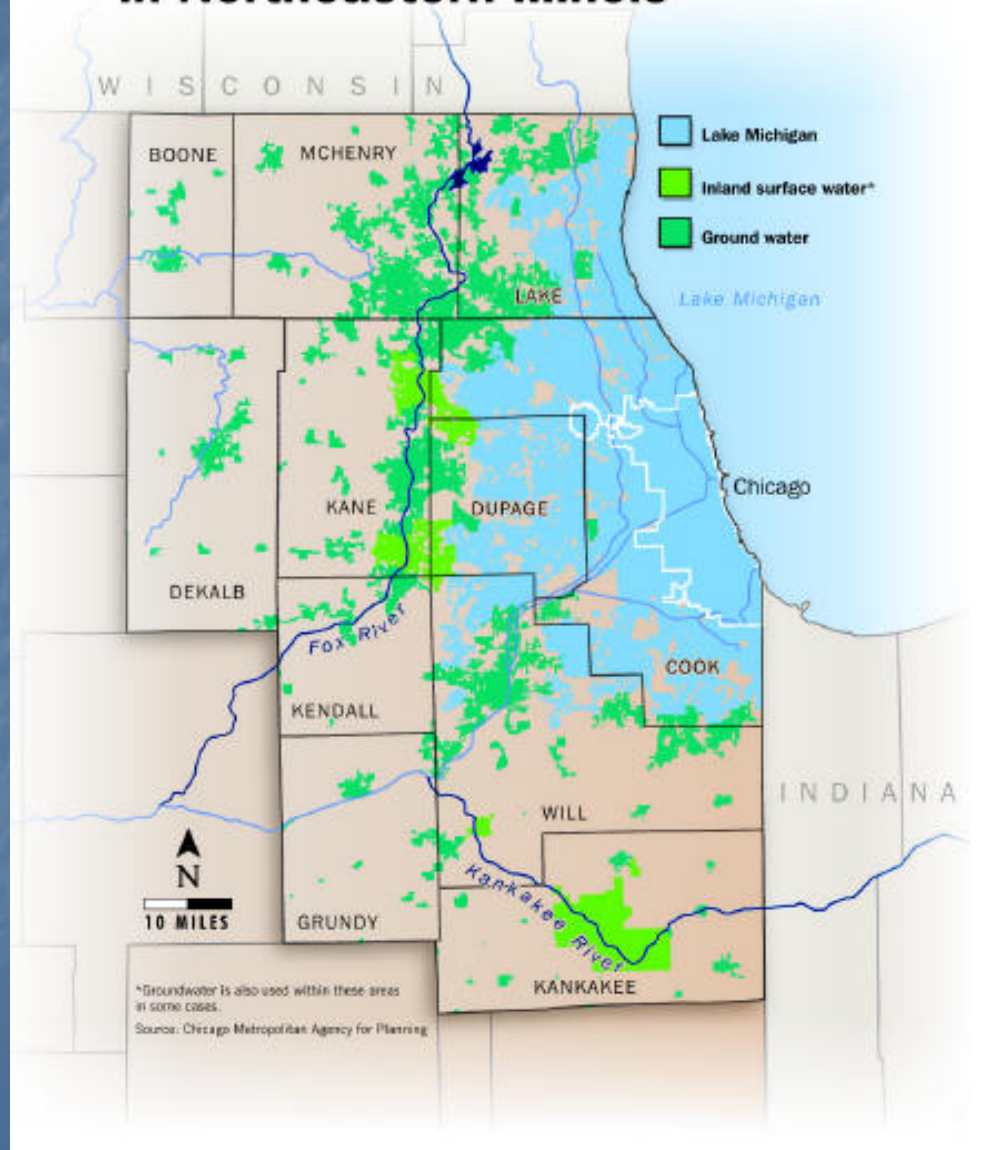
Deep Well Water Levels, Cook County

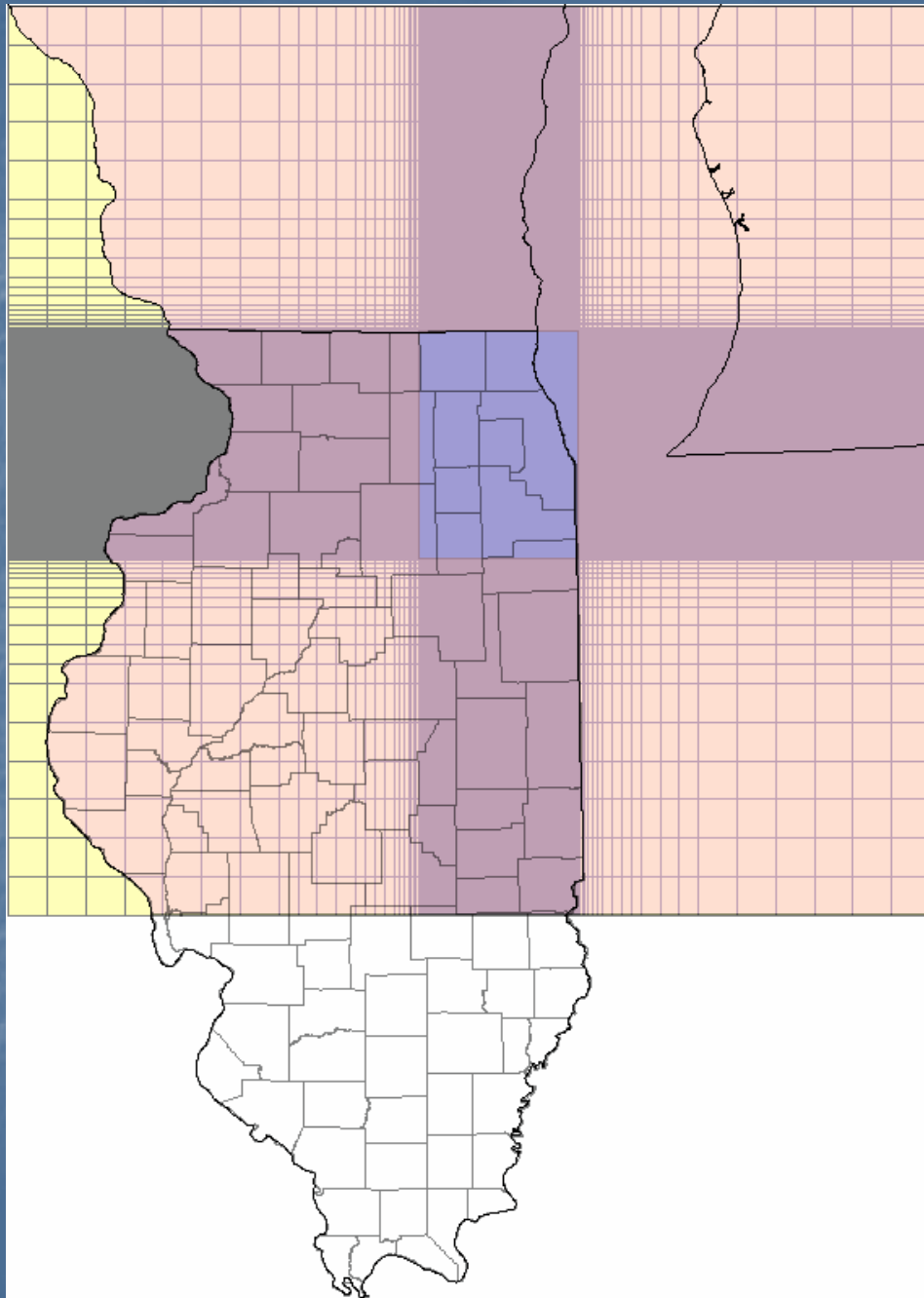


Oswego #3 (Kendall County)



Water Sources for Public Supply in Northeastern Illinois

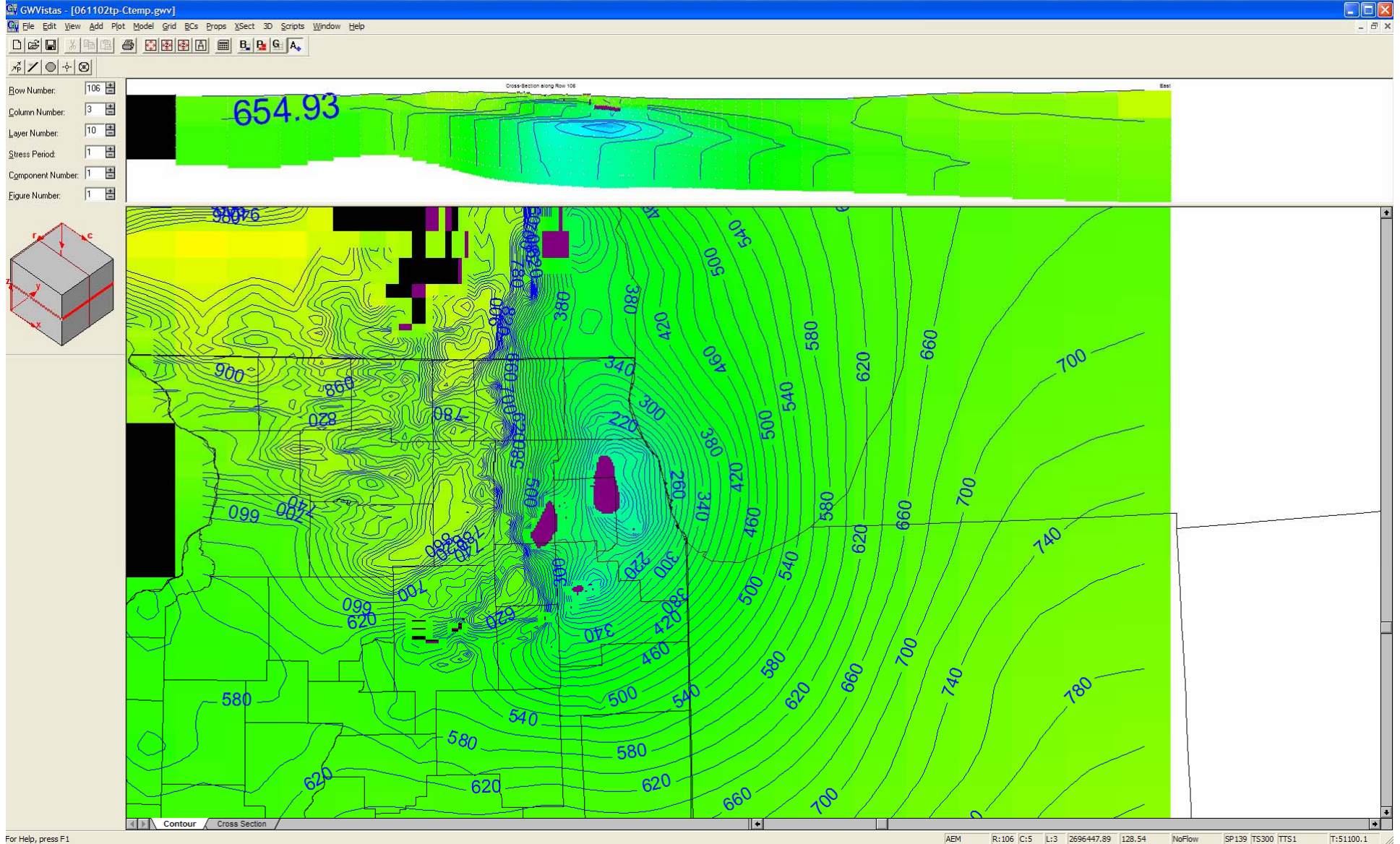




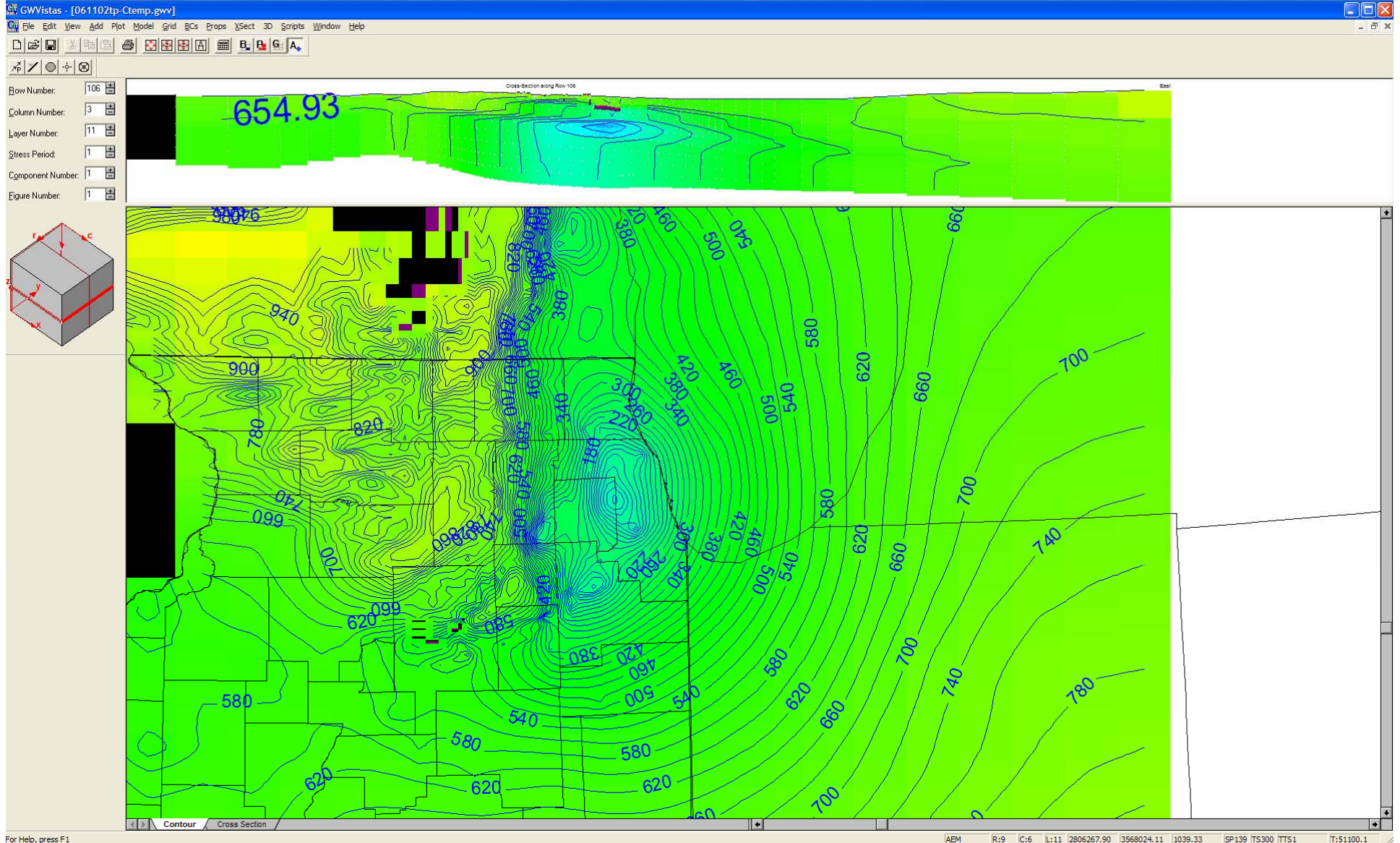
Groundwater Flow Modeling: NE Illinois Regional Model Grid

- 226 rows
- 174 columns
- 18 layers
- 707,832 nodes
- Minimum grid spacing of 2500'
- Maximum grid spacing of 80,000'

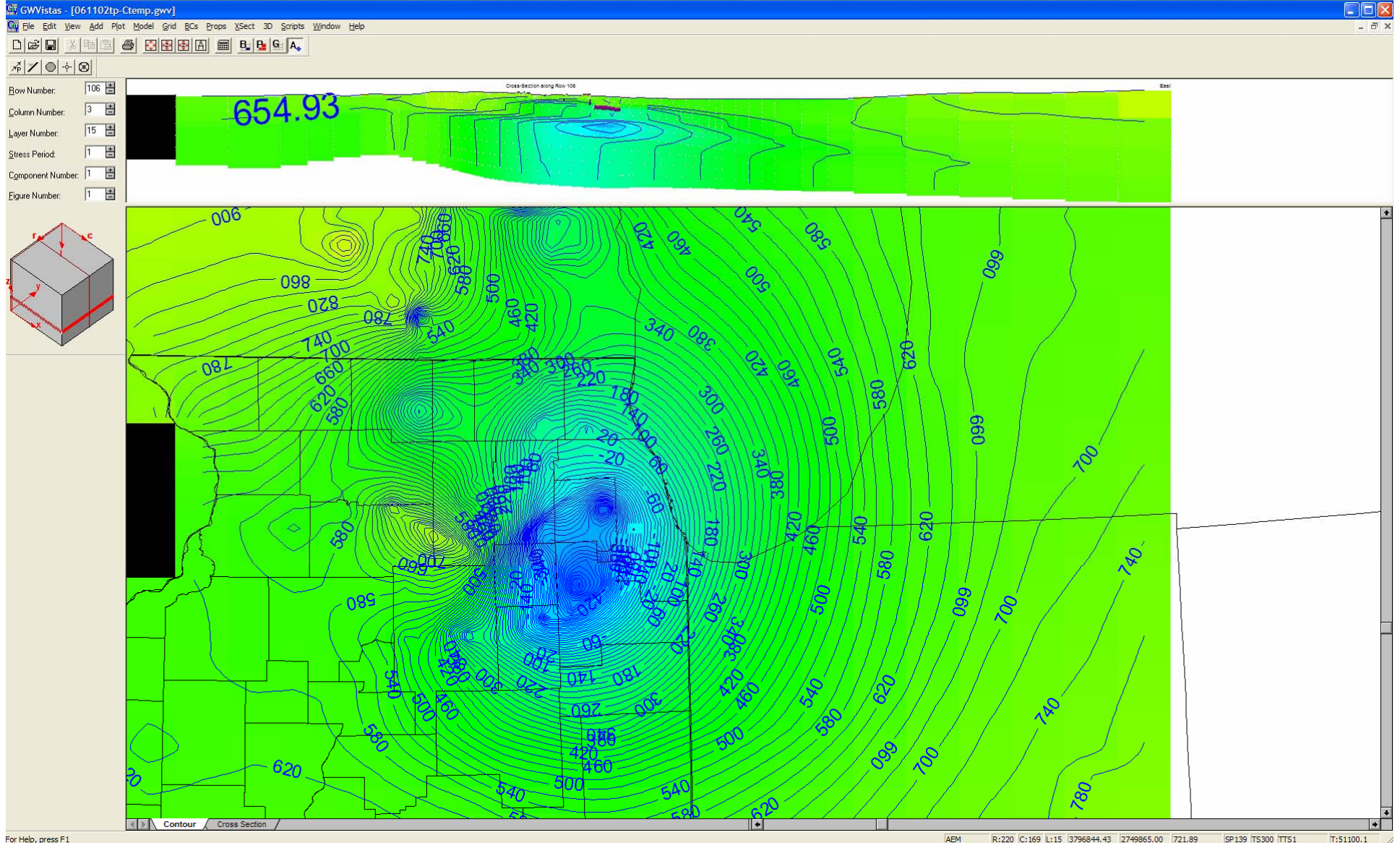
Modeled Heads in upper Galena-Platteville - 2002



Modeled Heads in lower Galena-Platteville - 2002



Modeled Heads in Ironton-Galesville - 2002



Thanks!

Look for more information and updates:

<http://www.sws.uiuc.edu/wsp>

E-mail me with questions:

alex@uiuc.edu

