Groundwater Recharge in Northeastern Illinois

NE Illinois Regional Water Supply Planning Committee
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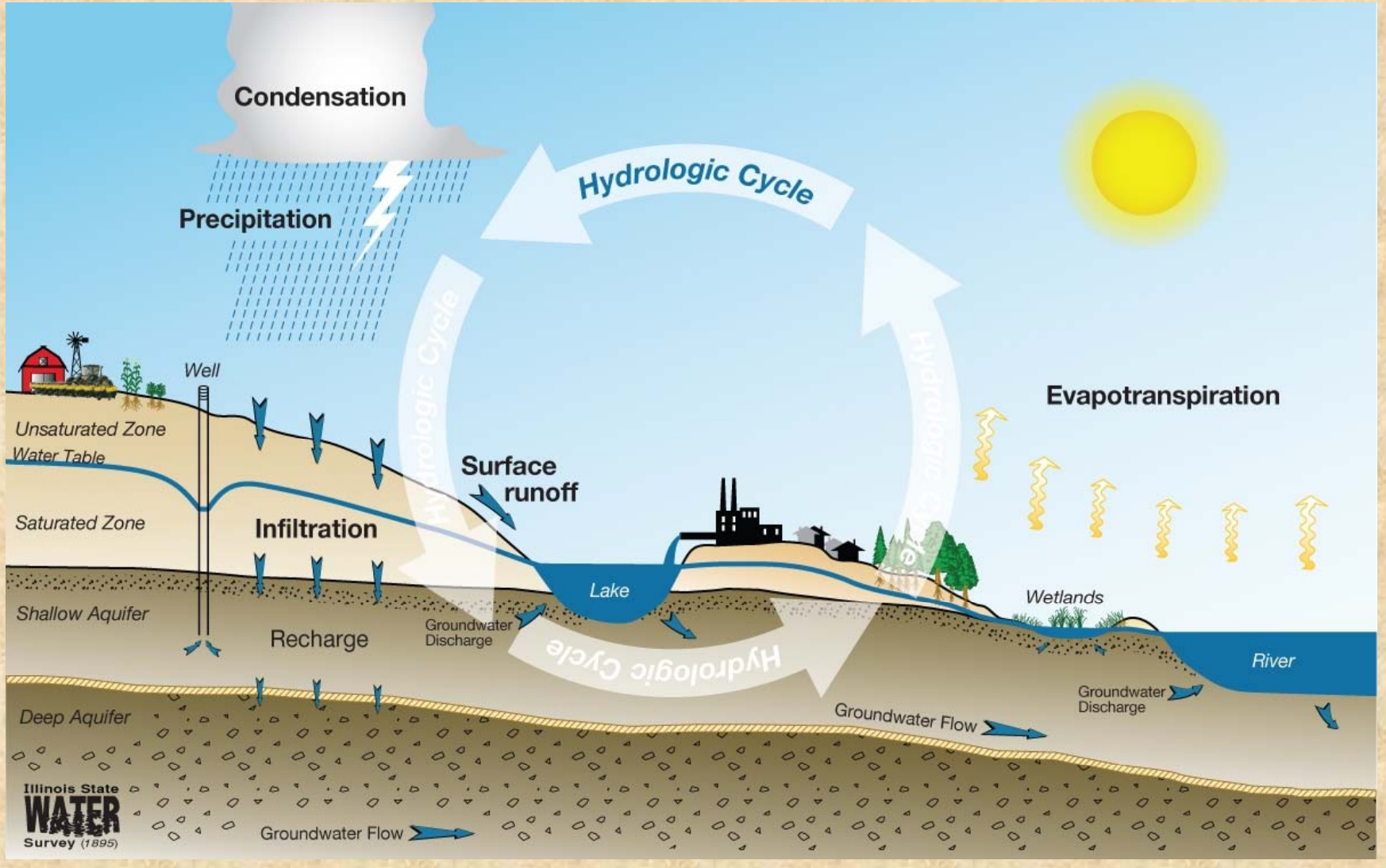
Illinois State WATER SURVEY

ILLINOIS

ISGS Illinois State Geological Survey

The Water Cycle

Climate, surface water, and groundwater are linked



Key Concepts

- Infiltration
- Recharge
  - Groundwater Recharge
  - Aquifer Recharge
- Discharge
- Recharge Zone
- Discharge Zone
- Local Flow System

Natural Recharge of Groundwater in Illinois, Bruce Hensel, 1992. Illinois State Geological Survey, EG142.
www.isgs.uiuc.edu

Factors Affecting Infiltration and Recharge

- Rainfall intensity and duration
- Texture and permeability of soil/geologic materials
- Soil moisture/depth to water table
- Slope and landscape position
- Land cover
  - Vegetation (row crop, grasses, trees, etc.)
  - Impervious surface (building footprint, streets, driveways, sidewalks, parking lots, etc.)
  - Retention/detention basins
- Presence and type of water sources or sinks (e.g., leaky water supply pipes, storm sewers)

Methods to Estimate Recharge

- Point Measurements
  - Lysimeter
  - Water-table fluctuation (specific yield required)
  - Soil-moisture budgets
- Areal Estimates
  - Geologic map analysis
  - Water budgets
  - Flow-net analysis
  - Baseflow separation
  - Geochemistry
  - Numerical/digital flow models

Geologic Mapping Approach

- Originally developed to predict likelihood of uppermost aquifers to contamination from surface or near-surface sources
- Surrogate for estimate of aquifer recharge potential
- Screening tool for prioritizing resources and guiding planning (e.g., IEPA, Winnebago County Health Dept.)

Geologic Mapping Approach

- Depth to uppermost aquifer material is primary criteria
- Geologic materials viewed as either aquifer or non-aquifer material
- Assumed vertical flow through non-aquifers
- Assumed generalized permeability for all materials

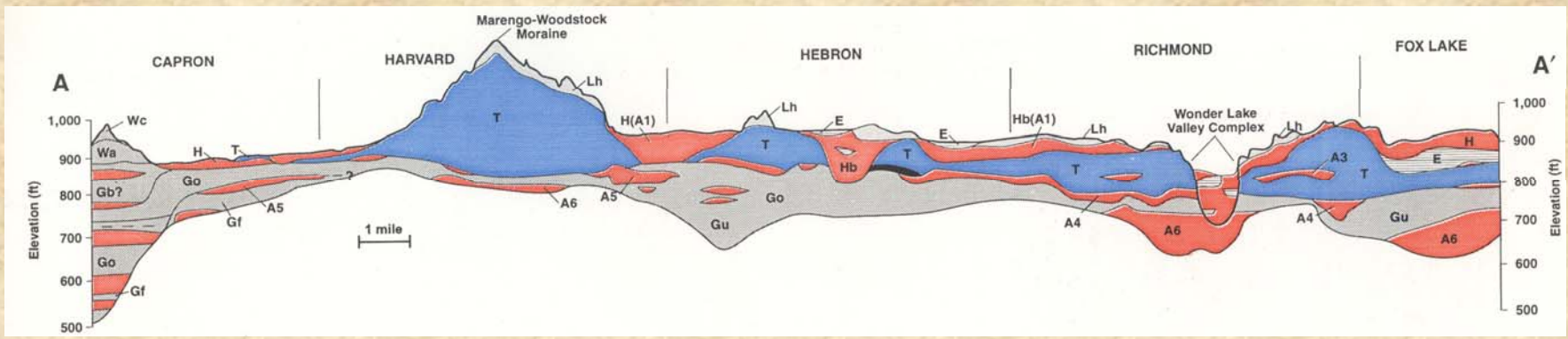
Commonly used permeabilities for typical geologic materials in Illinois

Determine what constitutes aquifer material

Geologic material	cm/sec	Comments
Clean sand & gravel	1×10^{-3}	Highly permeable
Fine sand and silty sand	1×10^{-5} to 1×10^{-3}	
Silt (loess, colluvium, etc.)	1×10^{-6} to 1×10^{-4}	
Gravelly dm, <10% clay	1×10^{-7} to 1×10^{-5}	Sand lenses common
Loamy dm, 10-25% clay	1×10^{-8} to 1×10^{-6}	Sand lenses common
Clayey dm, >25% clay	1×10^{-9} to 1×10^{-7}	Sand lenses common
Sandstone	$>1 \times 10^{-4}$	
Cemented fine sandstone	1×10^{-7} to 1×10^{-4}	Some fracturing
Fractured rock	$>1 \times 10^{-4}$	Highly fractured
Shale	1×10^{-11} to 1×10^{-7}	Some fracturing
Unfractured carbonates	1×10^{-11} to 1×10^{-8}	

Geologic Settings of NE Illinois

- Variations across region
- Many areas of thick clay
- Many areas with thick sand
- Surface water / ground water interactions vary in importance across region
- Groundwater recharge and shallow aquifer recharge vary across region


A
A′
CAPRON
HARVARD
HEBRON
RICHMOND
FOX LAKE
Marengo-Woodstock Moraine
Wonder Lake Valley Complex
Elevation (ft)
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800
700
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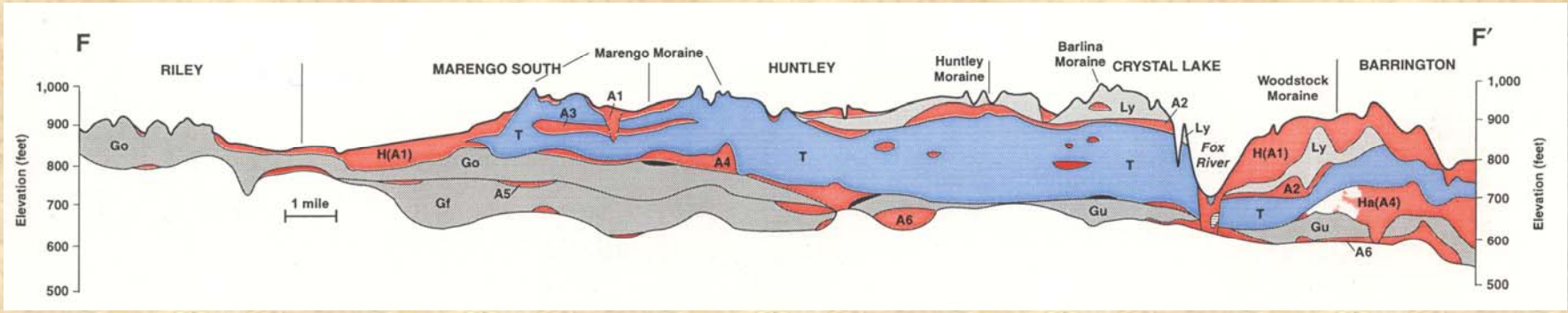
F
F′
RILEY
MARENGO SOUTH
HUNTLEY
CRYSTAL LAKE
BARRINGTON
Marengo Moraine
Huntley Moraine
Barlina Moraine
Woodstock Moraine
Fox River
Elevation (feet)
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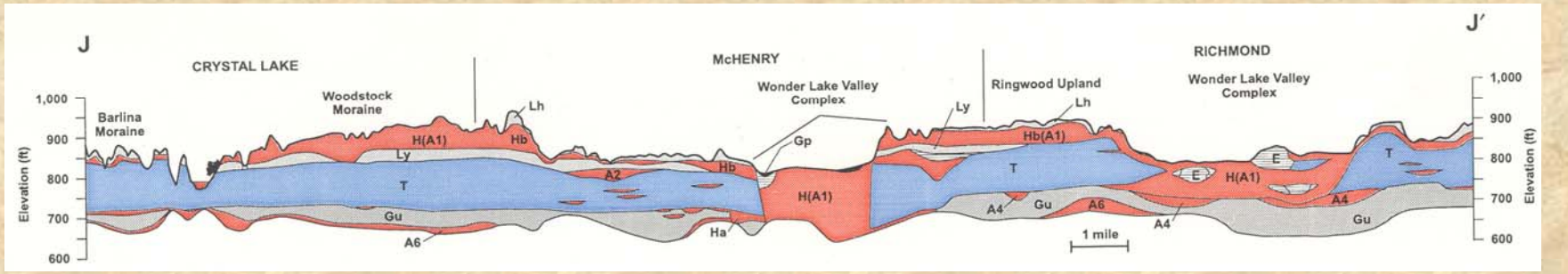
J
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CRYSTAL LAKE
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Barlina Moraine
Woodstock Moraine
Wonder Lake Valley Complex
Ringwood Upland
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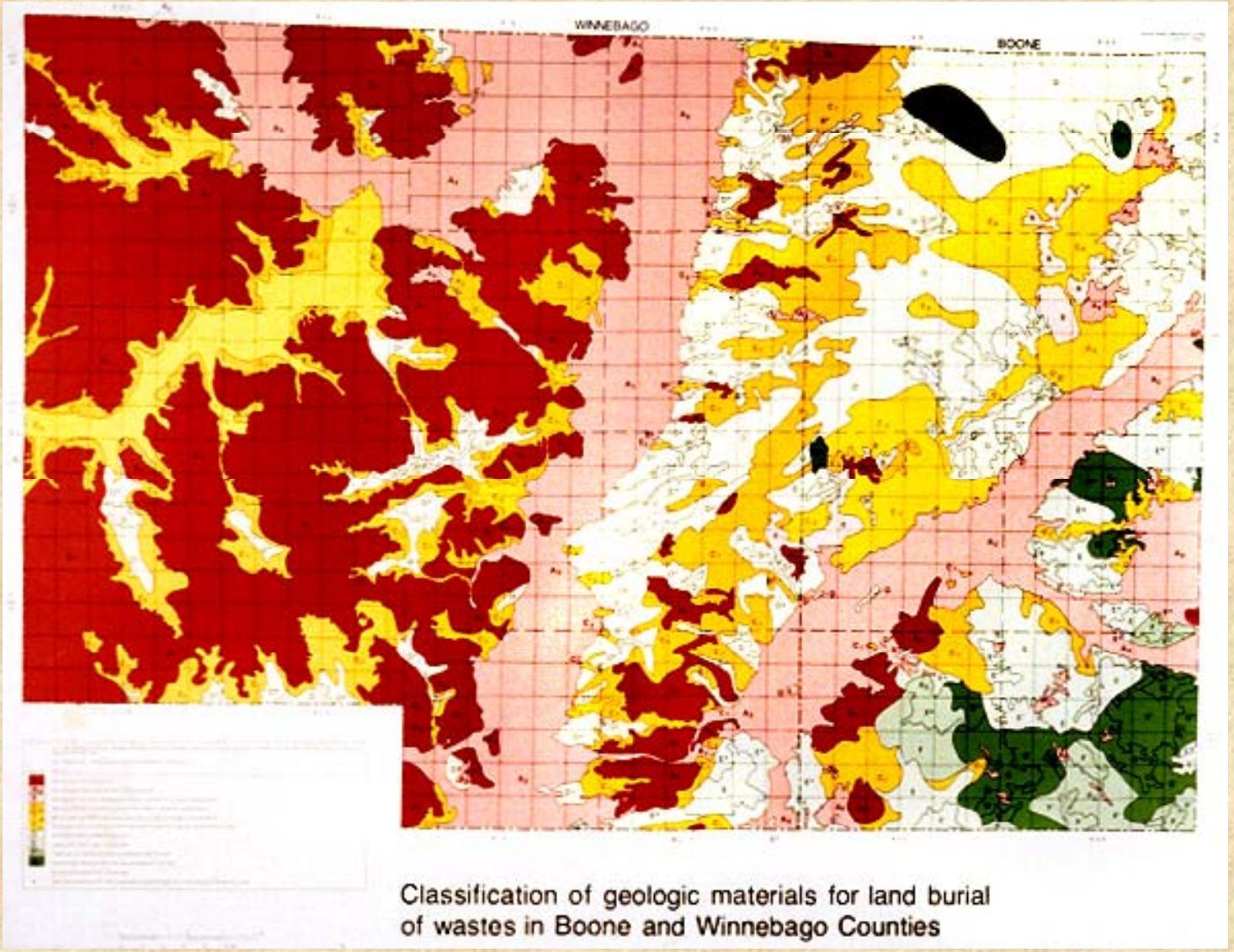
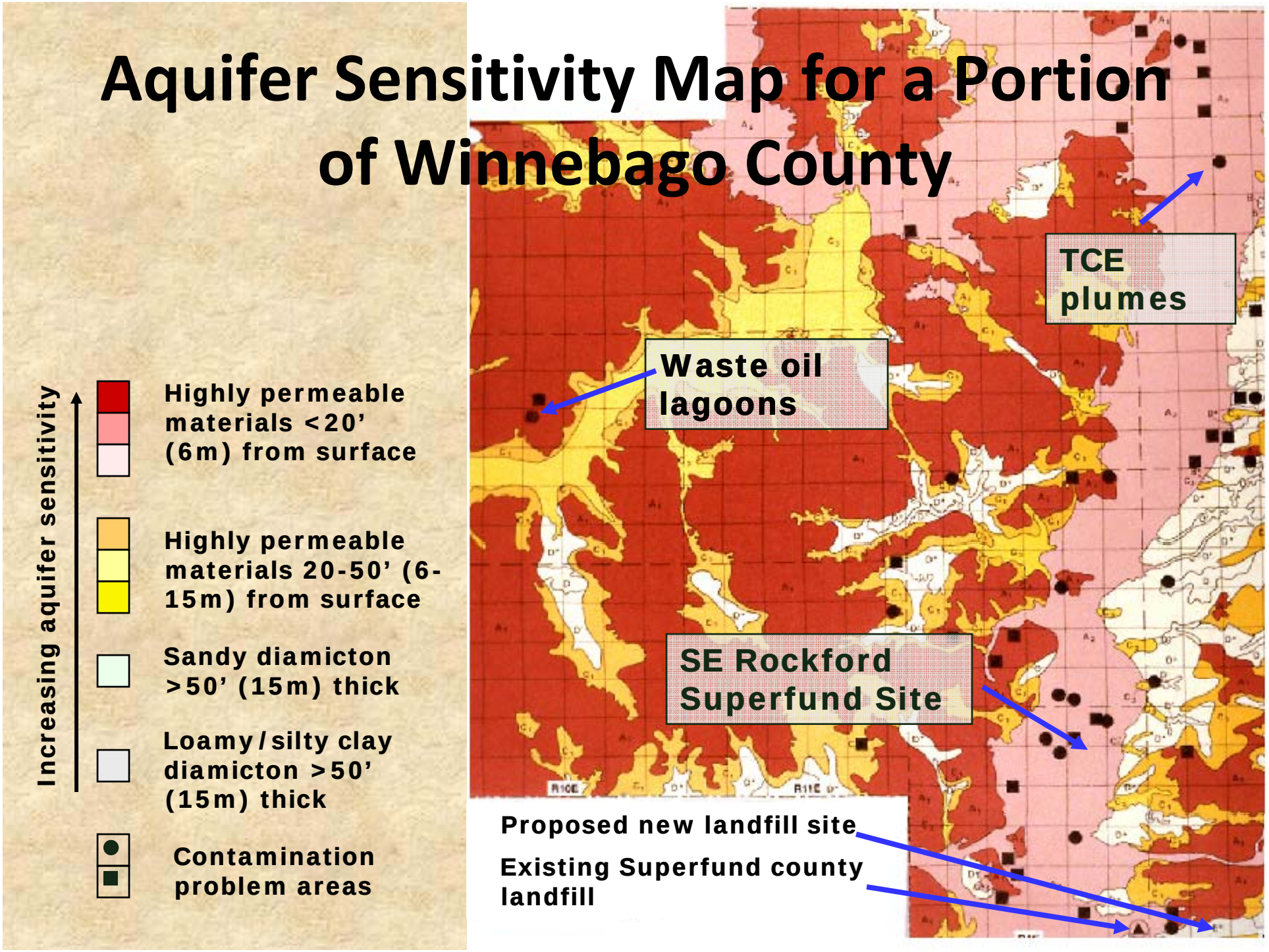
Aquifer Sensitivity

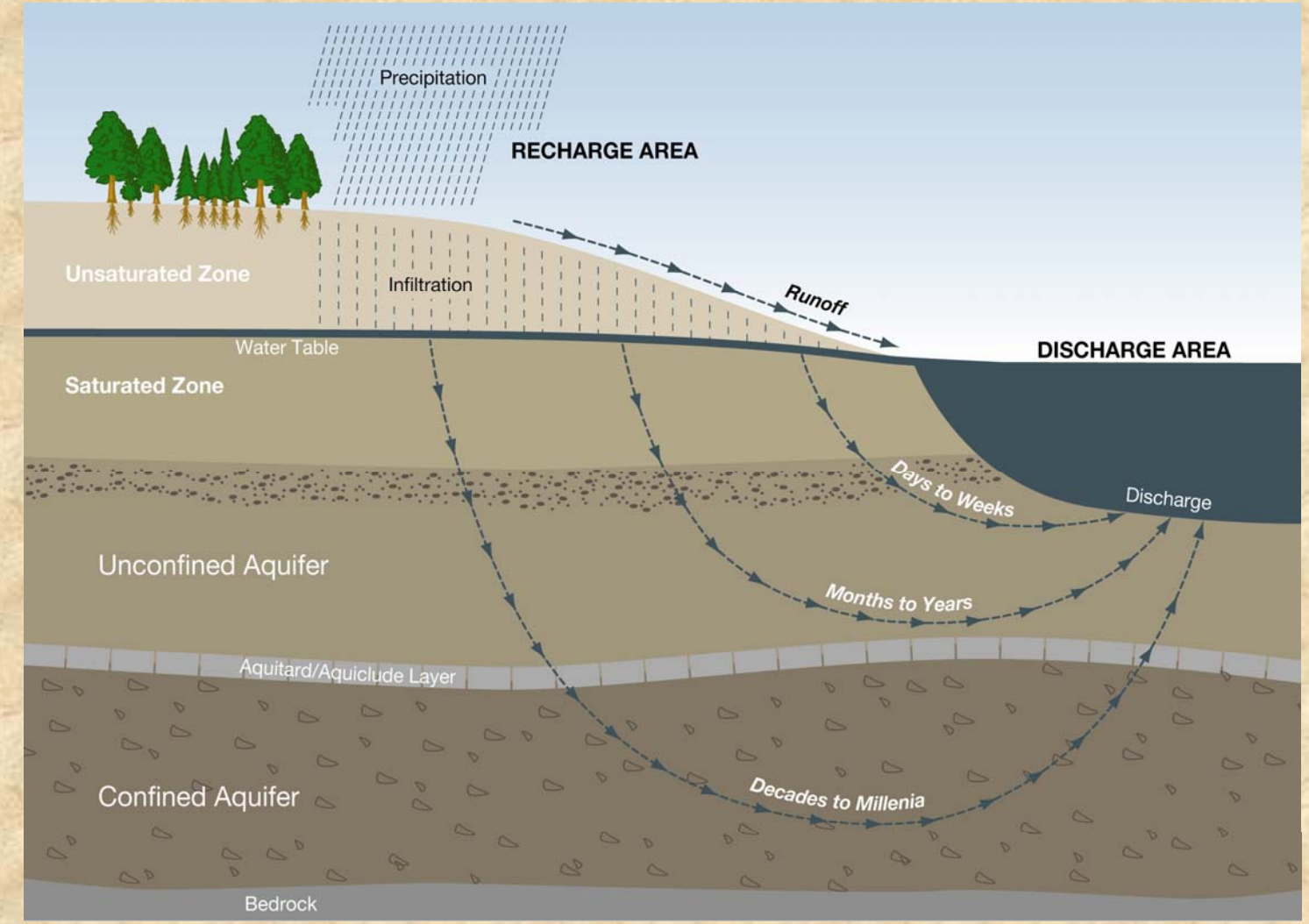


Classification of geologic materials for land burial of wastes in Boone and Winnebago Counties

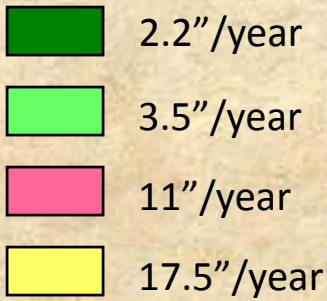
Aquifer Sensitivity Map for a Portion of Winnebago County

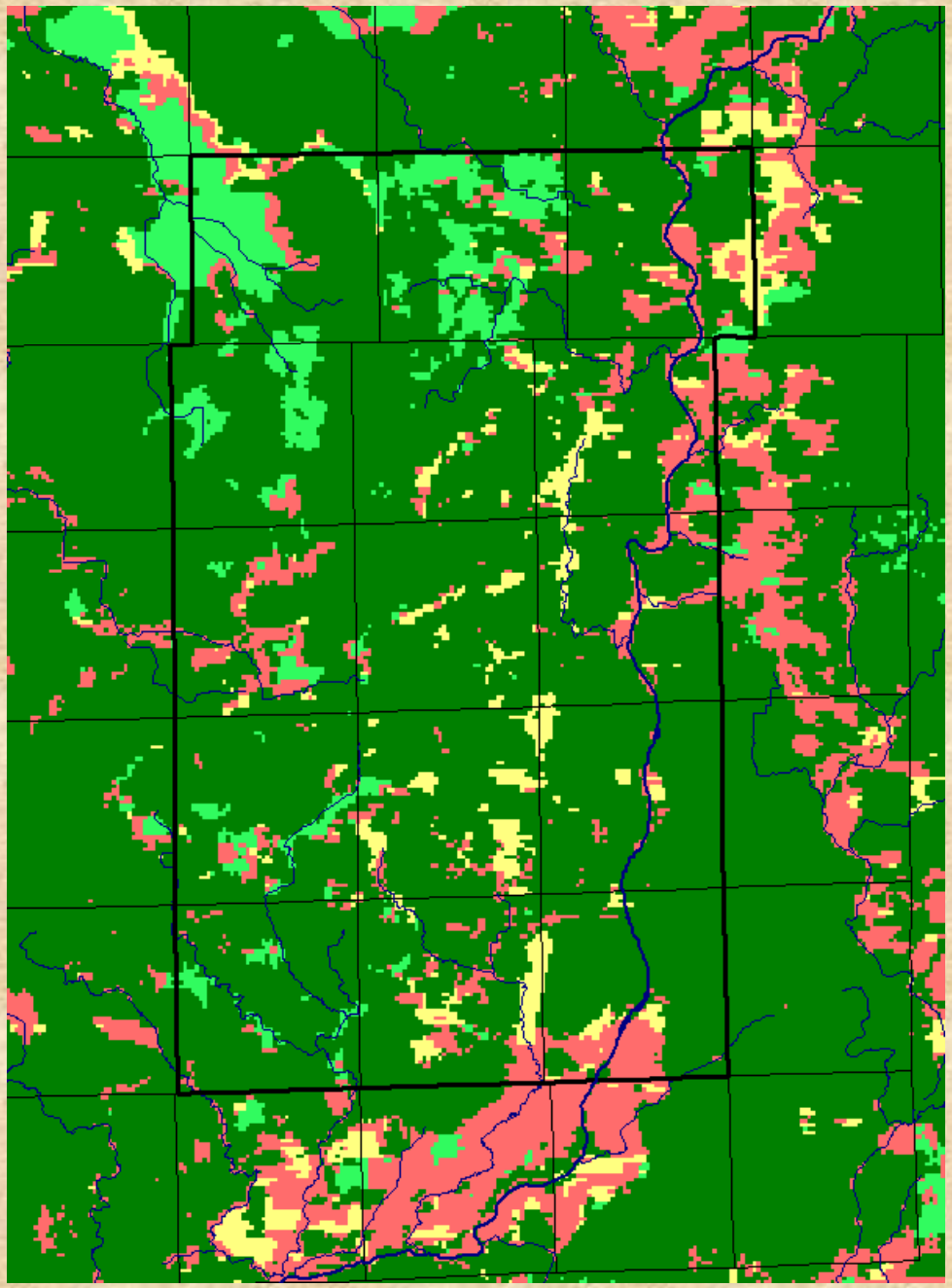


Groundwater Linkages to Surface Waters



Kane County Model Groundwater Recharge Zonation





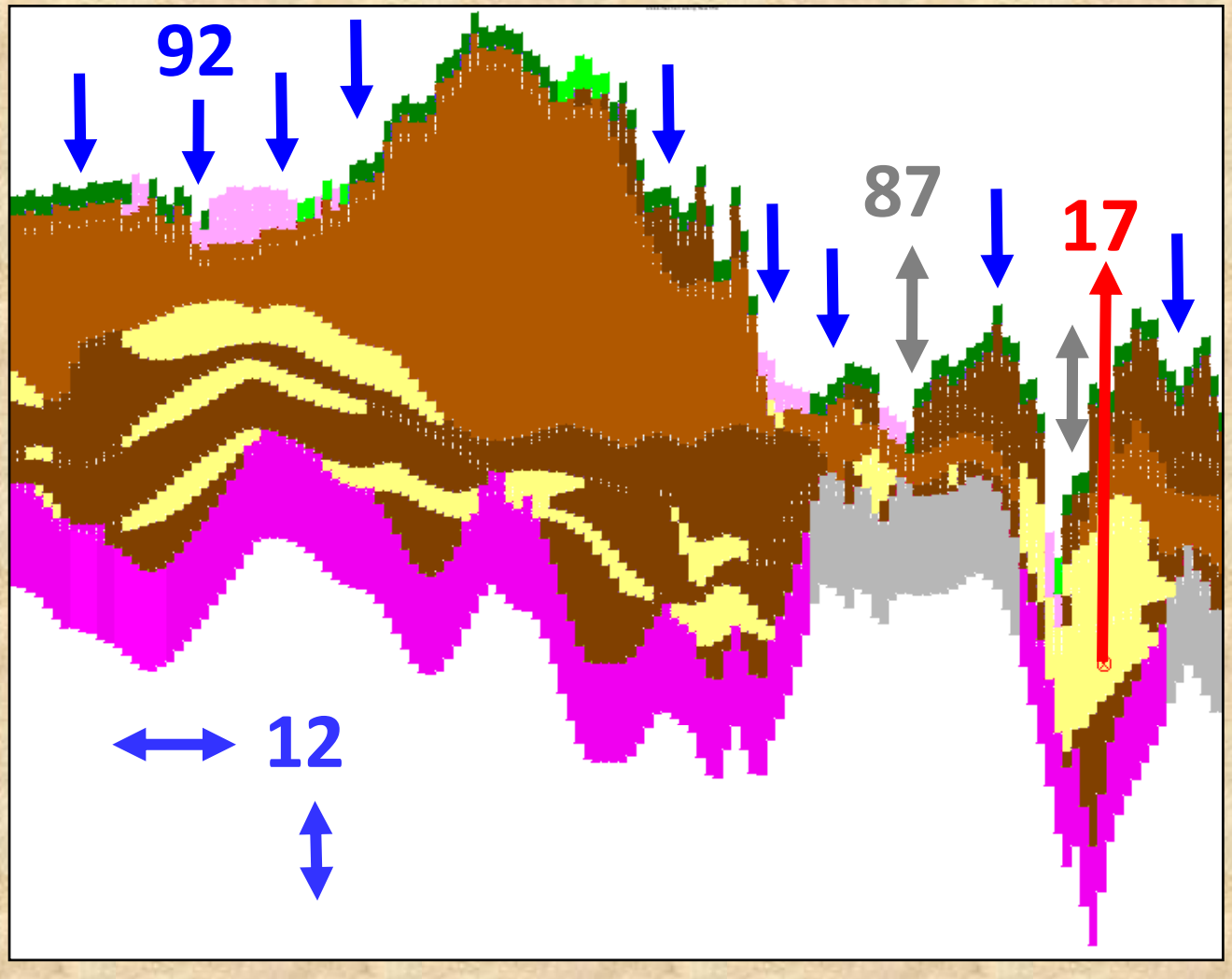
Kane County Shallow Aquifer Model

Kane County

Flow Budget

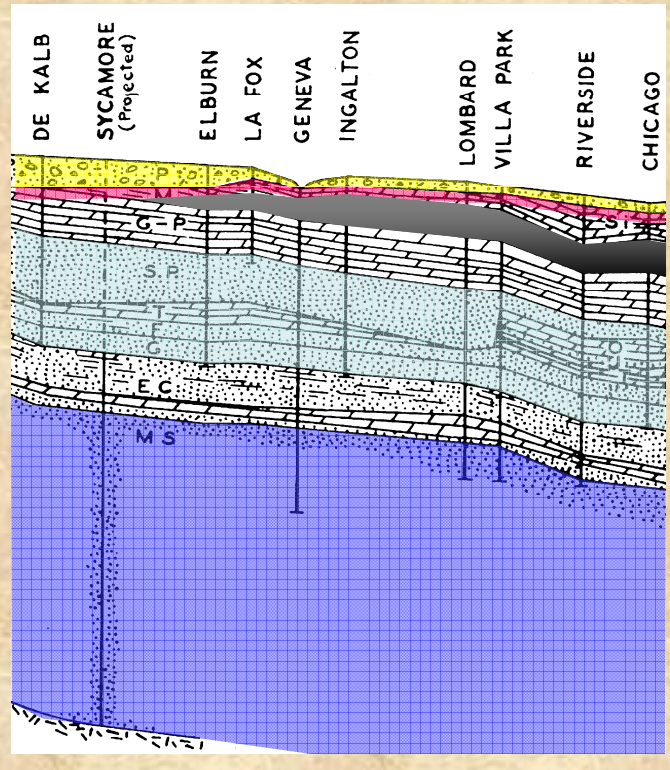
Inflows (MGD)	
Recharge	92
Lat/vert flow	12
Total	104

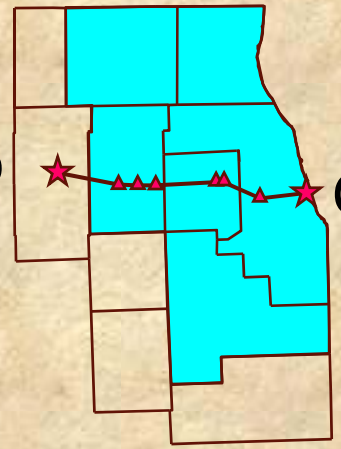
Outflows (MGD)	
Streams	87
Wells	17
Total	104



Aquifers of Northeastern Illinois

West East





Unconsolidated Aquifer System

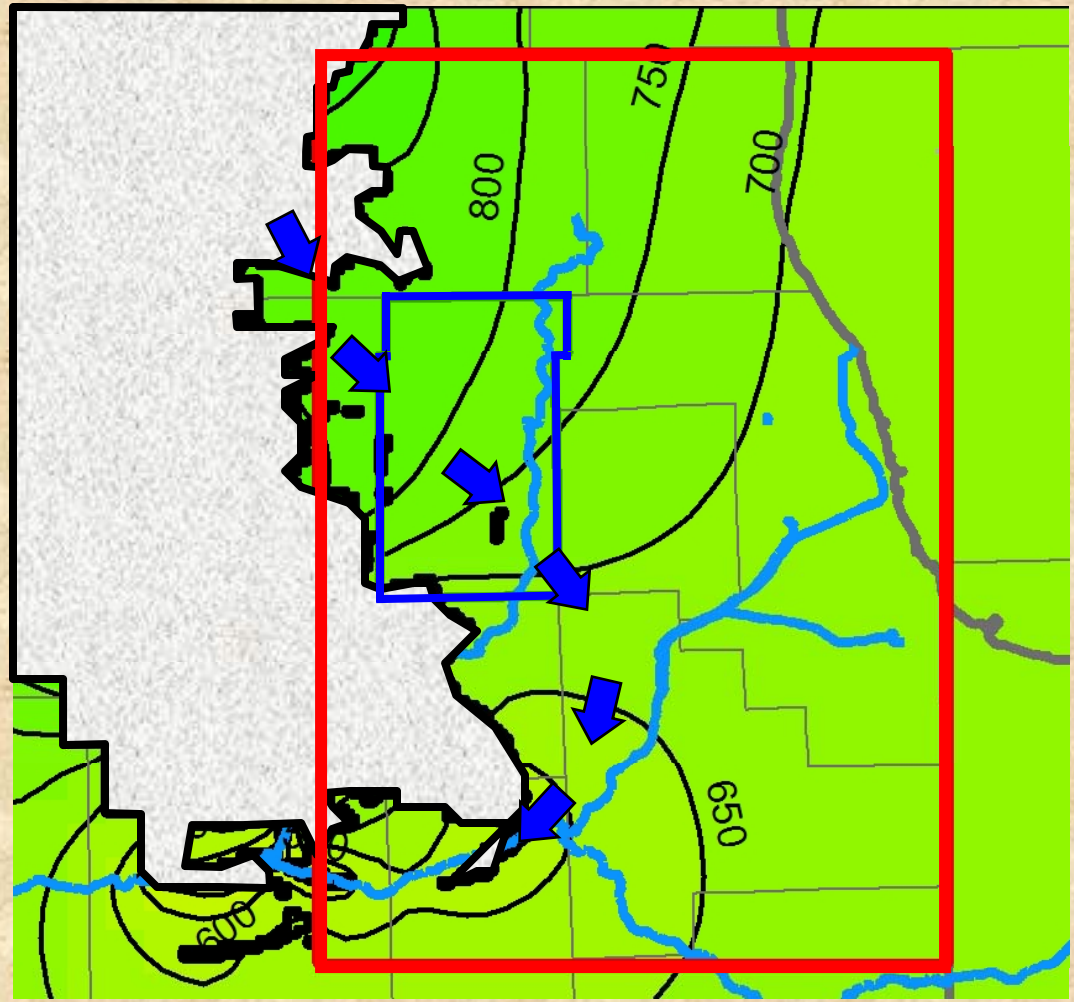
Shallow Bedrock Aquifer

Deep Bedrock Aquifer System

Elmhurst-Mt. Simon Aquifer

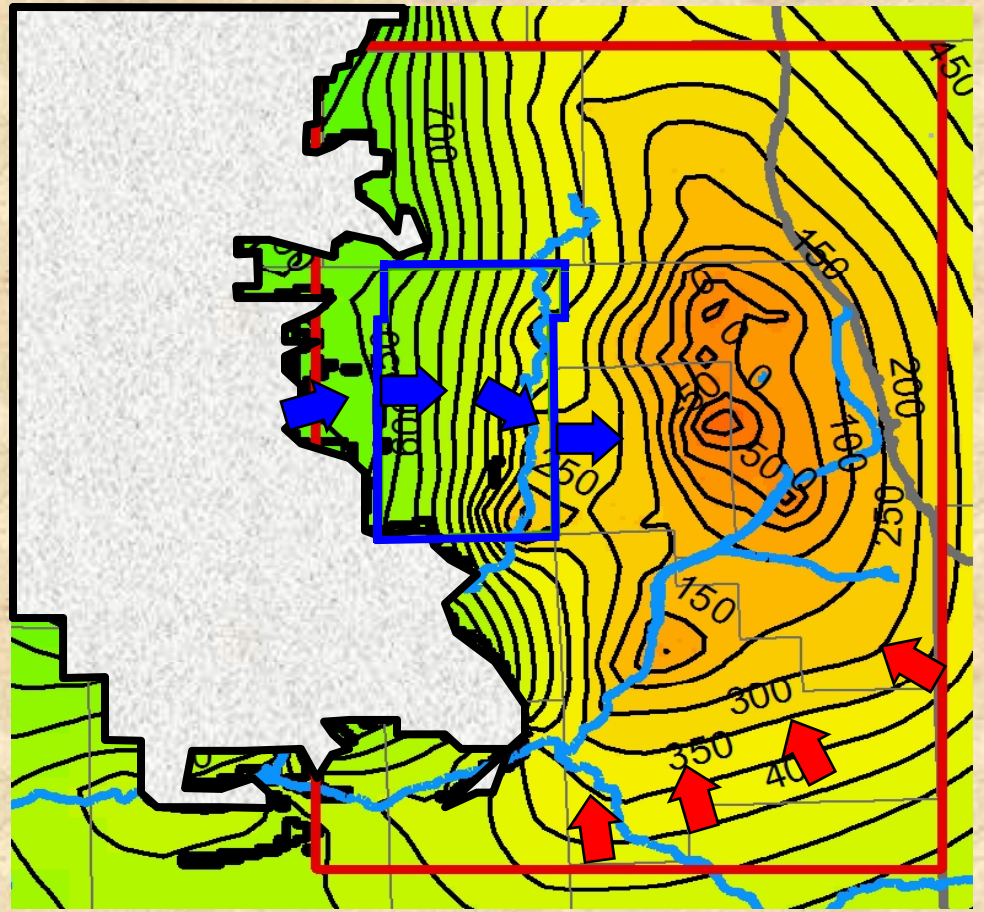
Cross-Section Modified from Bretz (1939)

Regional Model: Ancell Aquifer Predevelopment



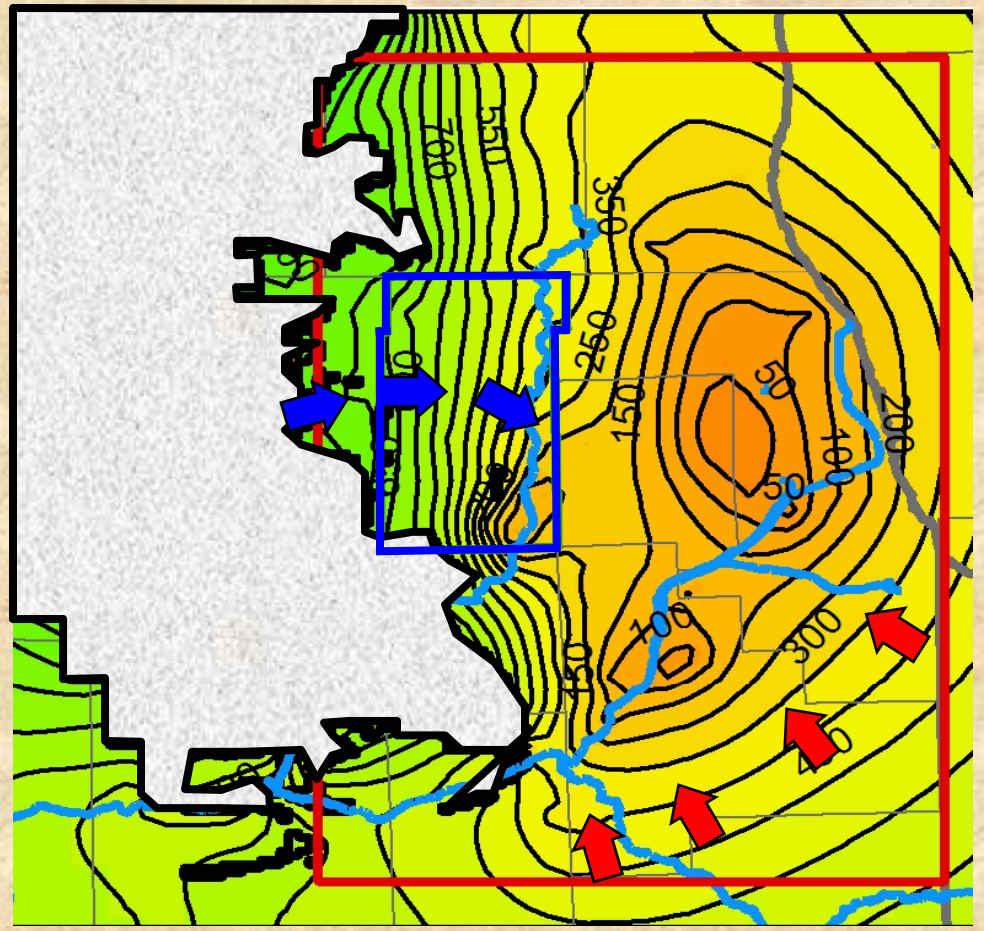
- Recharge where Maquoketa is absent
- Flow from central Wisconsin and DeKalb Co. to Illinois River
- Flowing artesian conditions in Chicago

Ancell Aquifer: 1985



- Steep cone of depression
- Flow eastward to Cook and DuPage Counties
- Northward flow from saltwater regions
- Similar cone of depression surrounding Milwaukee

Ancell Aquifer: 2002



- Cone of depression flattens, shifts west with pumping
- Flow eastward to Cook and DuPage Counties
- Northward flow from saltwater regions
- Upper layers dewatering (Galena-Platteville overlying the Ancell)