

NEBRASKA WATER

want amidst wealth



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UNIVERSITY OF
Nebraska
Lincoln®

“...the **WANT OF...WATER** for the necessities of life render it an unfit residence for any but a nomad population”

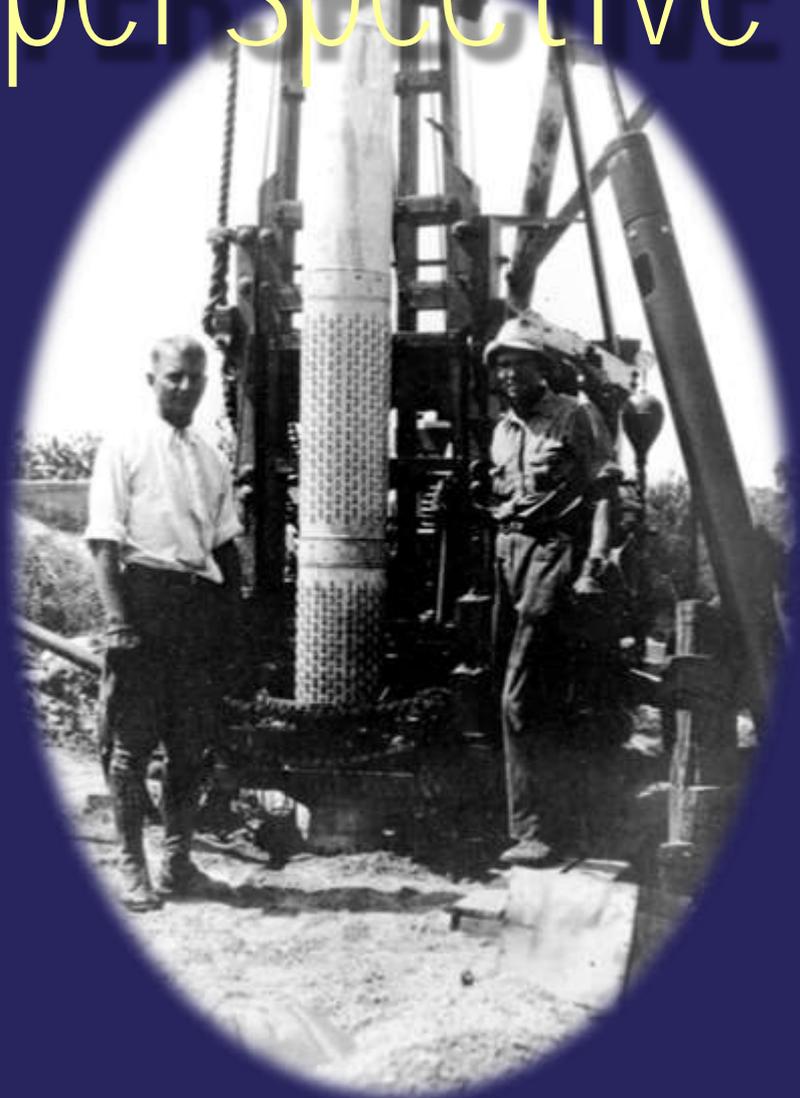
Edwin James, 1820, describing the Great Plains

1. Historical perspective

2. Hydrogeology

3. Water balance

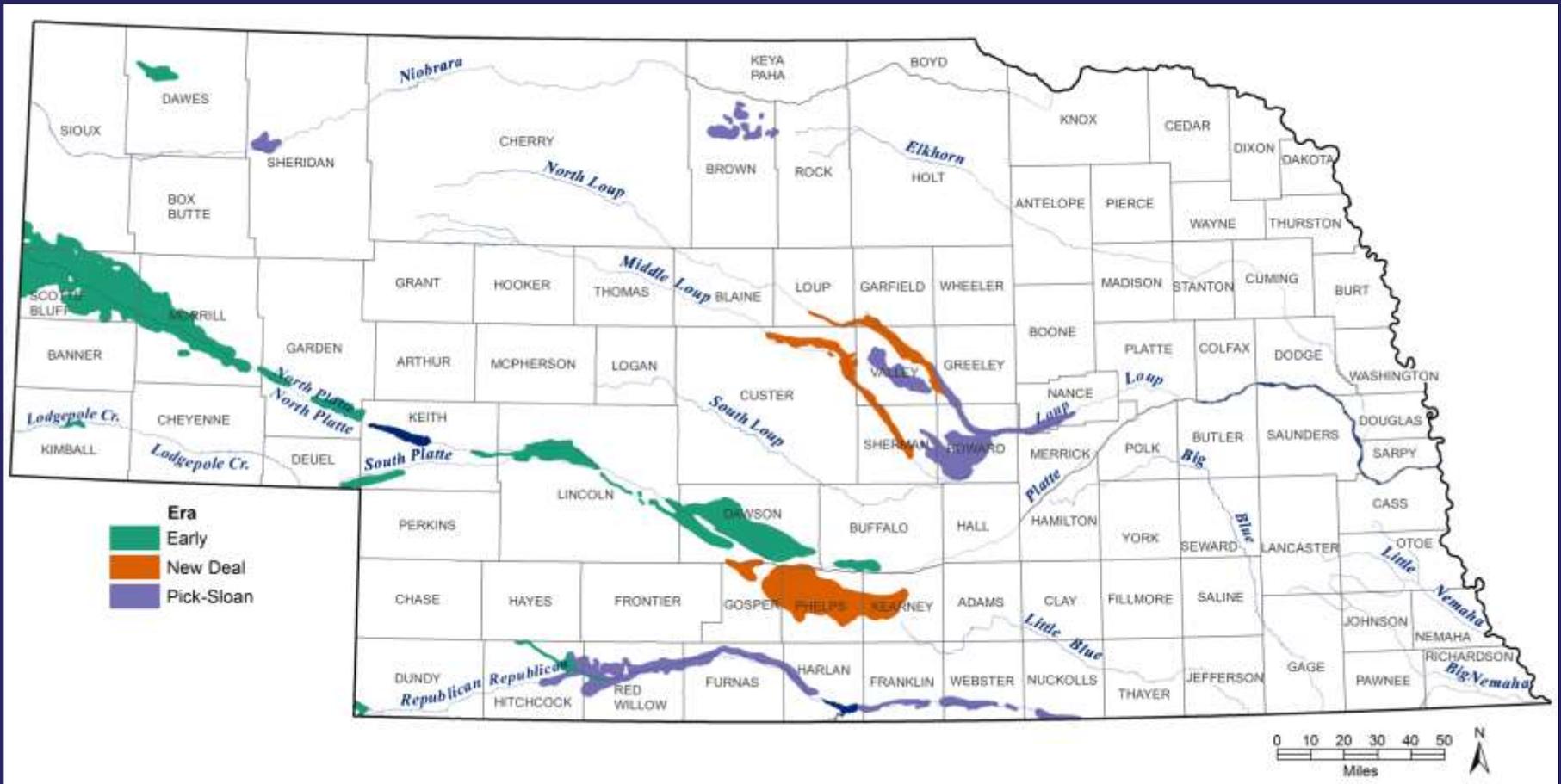
4. Water quality



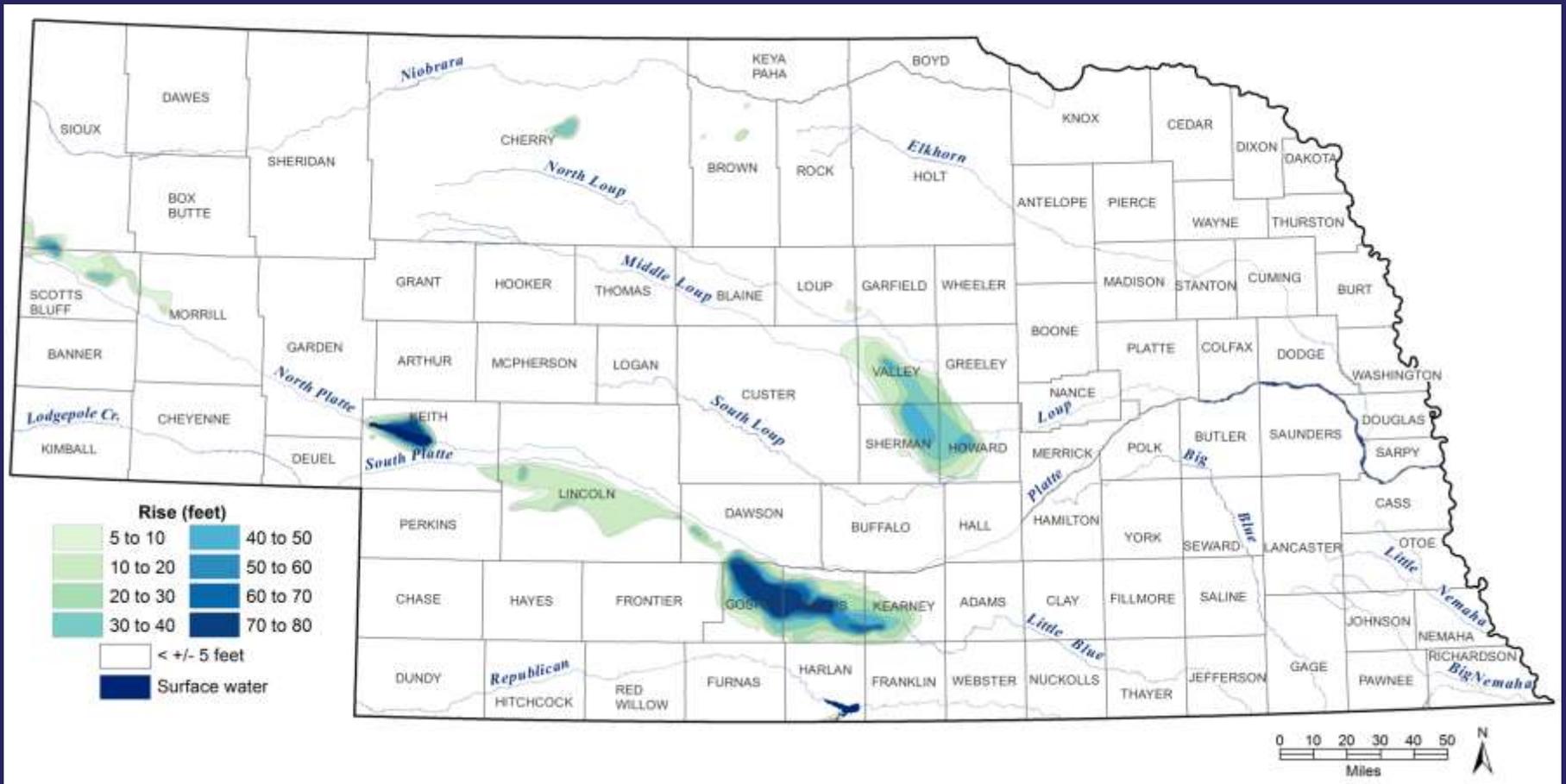
Early development began with surface water diversions and artesian wells



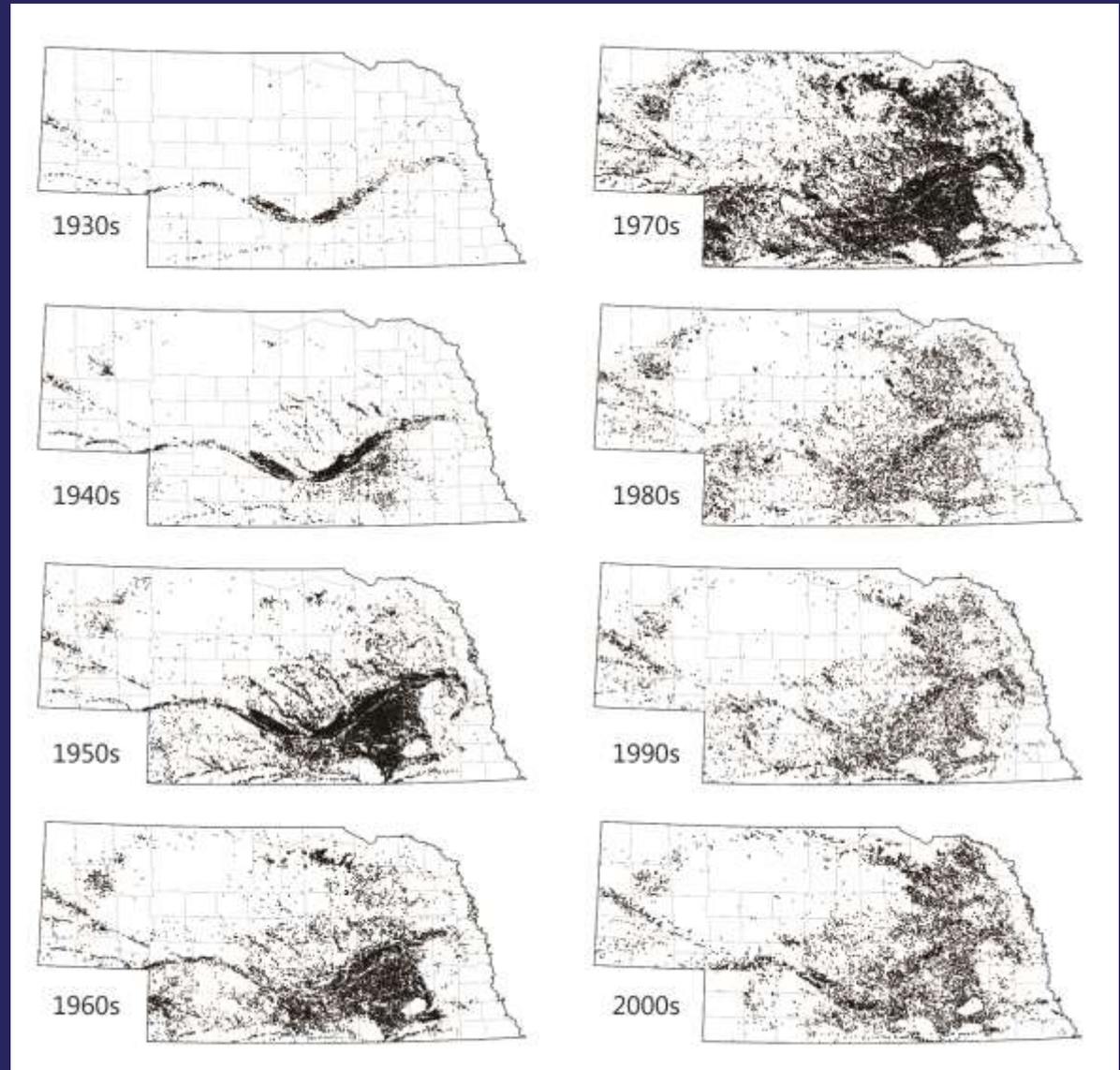
Surface water projects were constructed in phases from the 1850s until 1992



Seepage from canals and reservoirs has created artificially high water tables in some areas



Groundwater development began in the 1930s and continues today



Dots show irrigation wells drilled during each decade

Irrigation has transformed LIVELIHOODS...

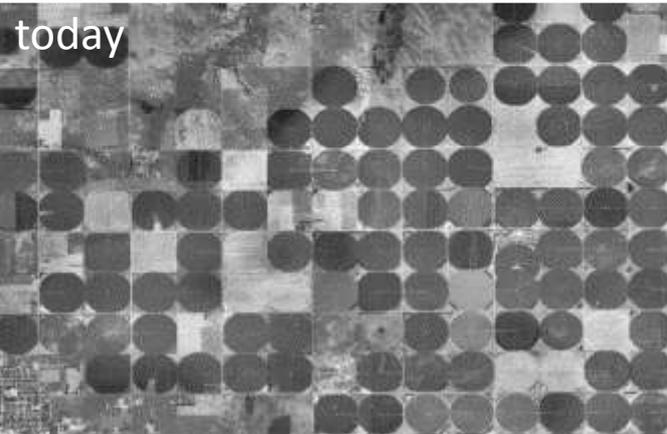


...as well as LANDSCAPES

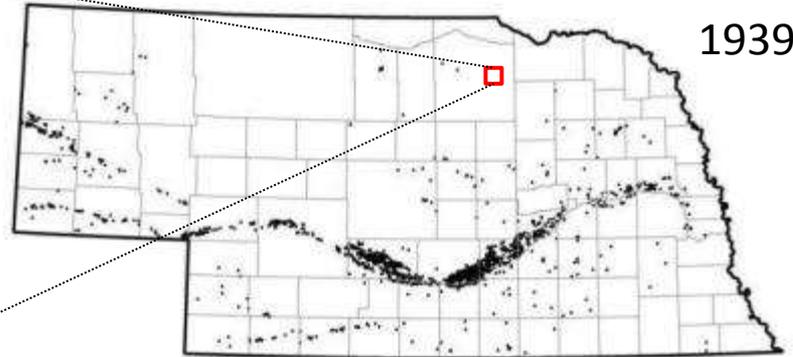
1939



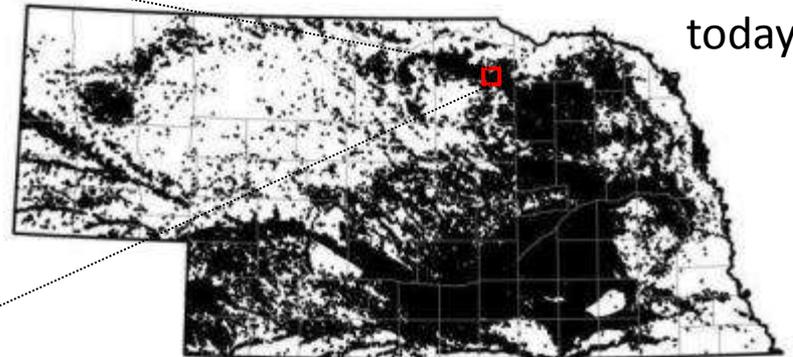
today



1939

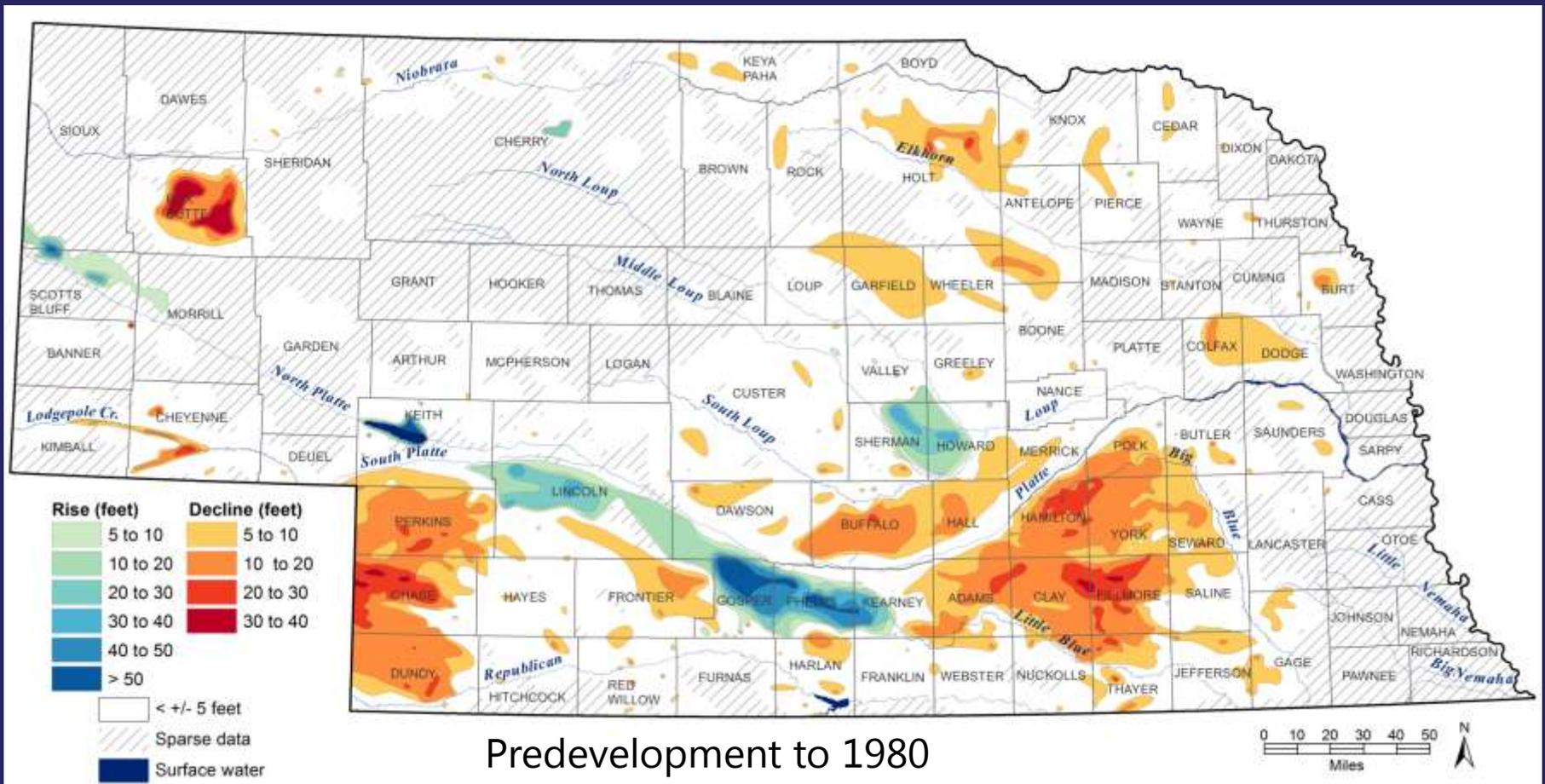


today



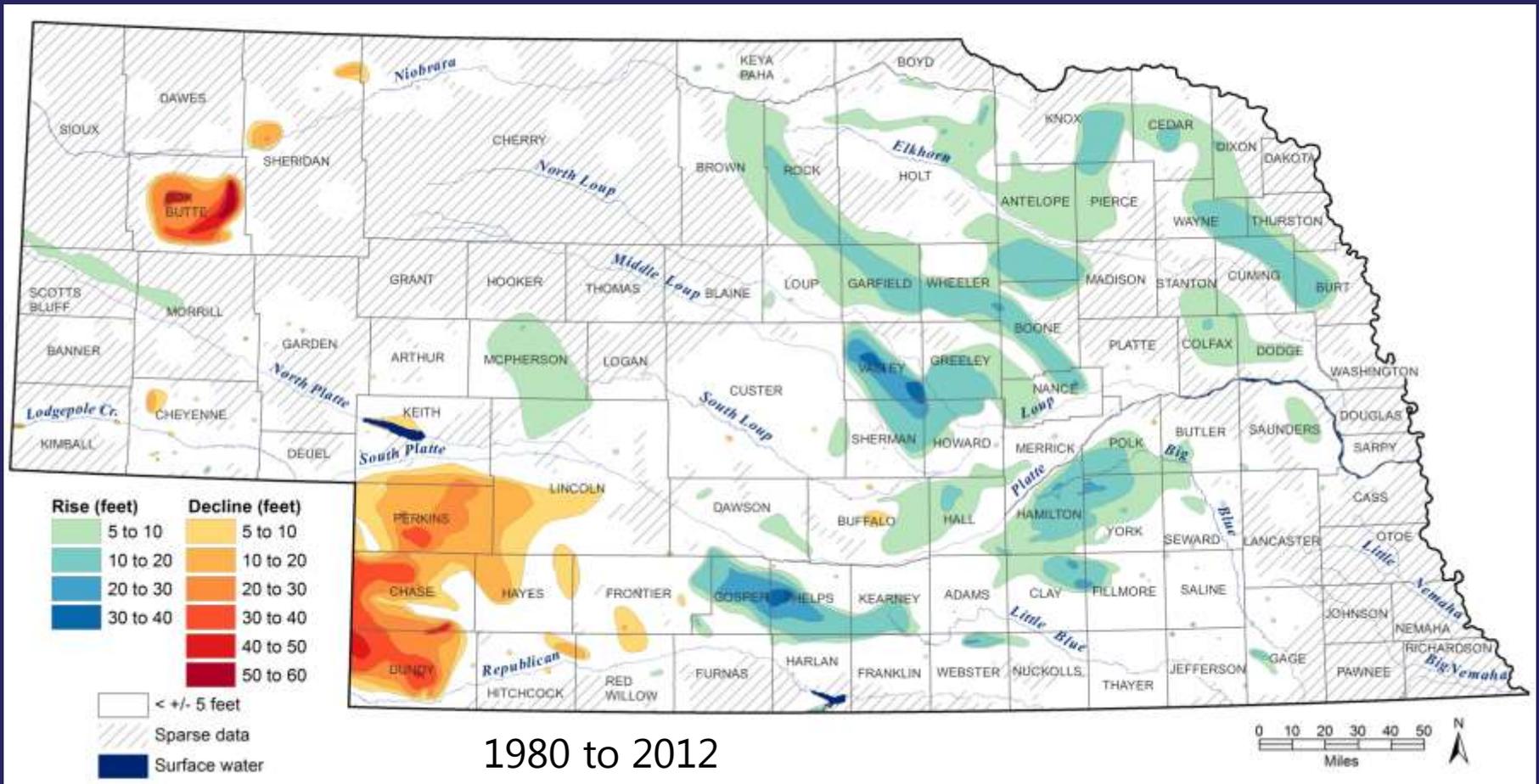
irrigation wells

By 1980, groundwater levels had declined under most areas of heavy pumping

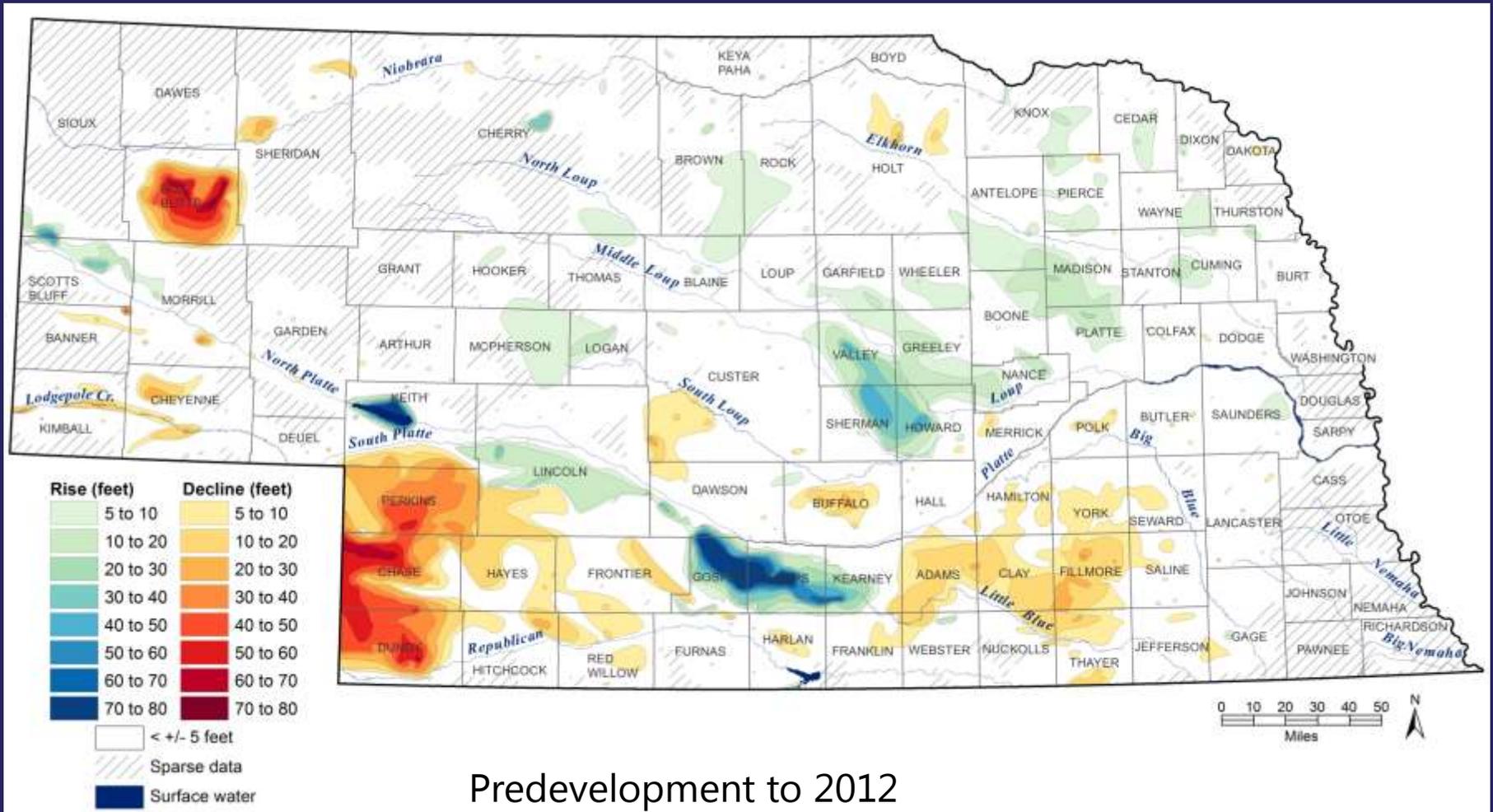


Predevelopment to 1980

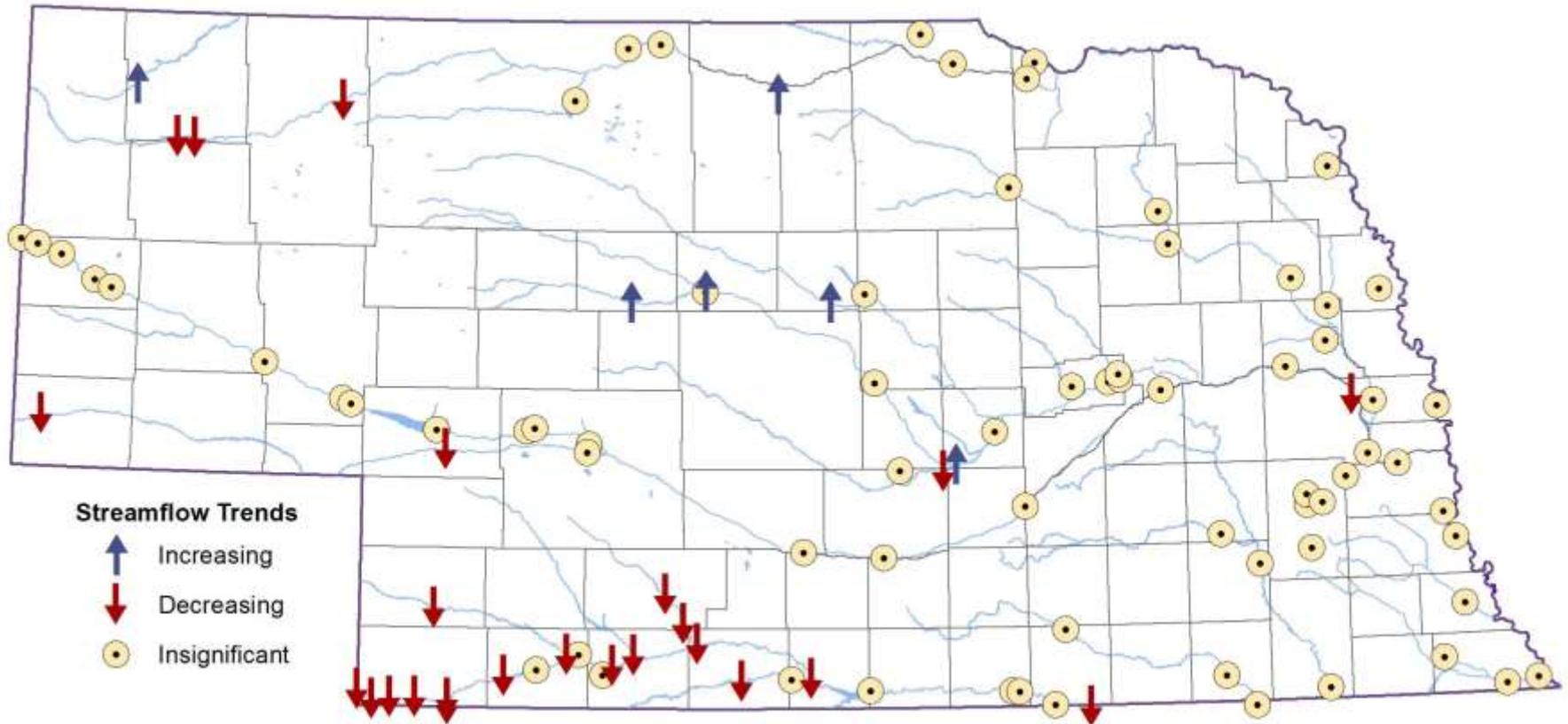
After 1980, declines continued in the west, but rises occurred in the central and east



Long-term changes as of 2012 include both rises and declines



Stream flows have decreased in southwest Nebraska and the Panhandle

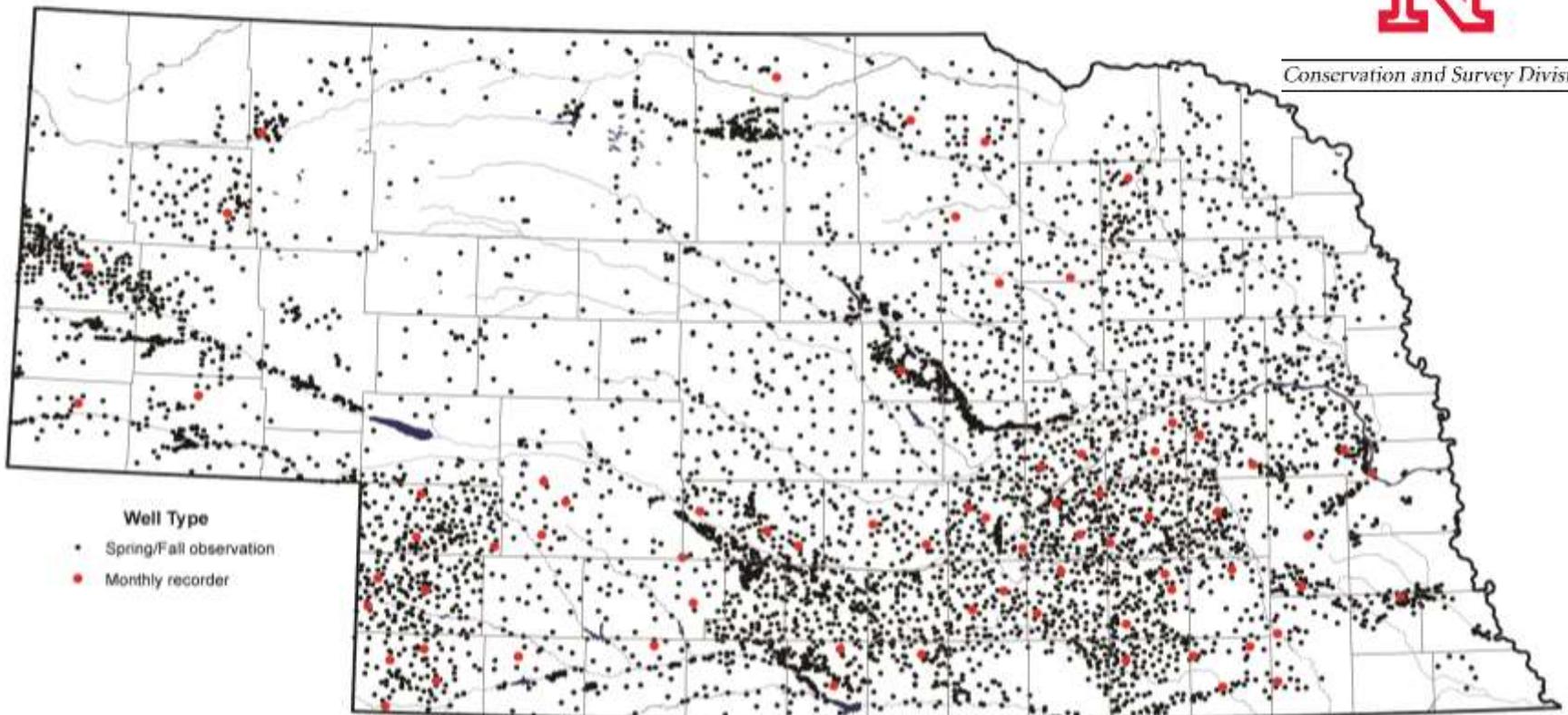


The Statewide groundwater-level monitoring network provides essential data

Location of Spring/Fall and Monthly Observation Wells



Conservation and Survey Division

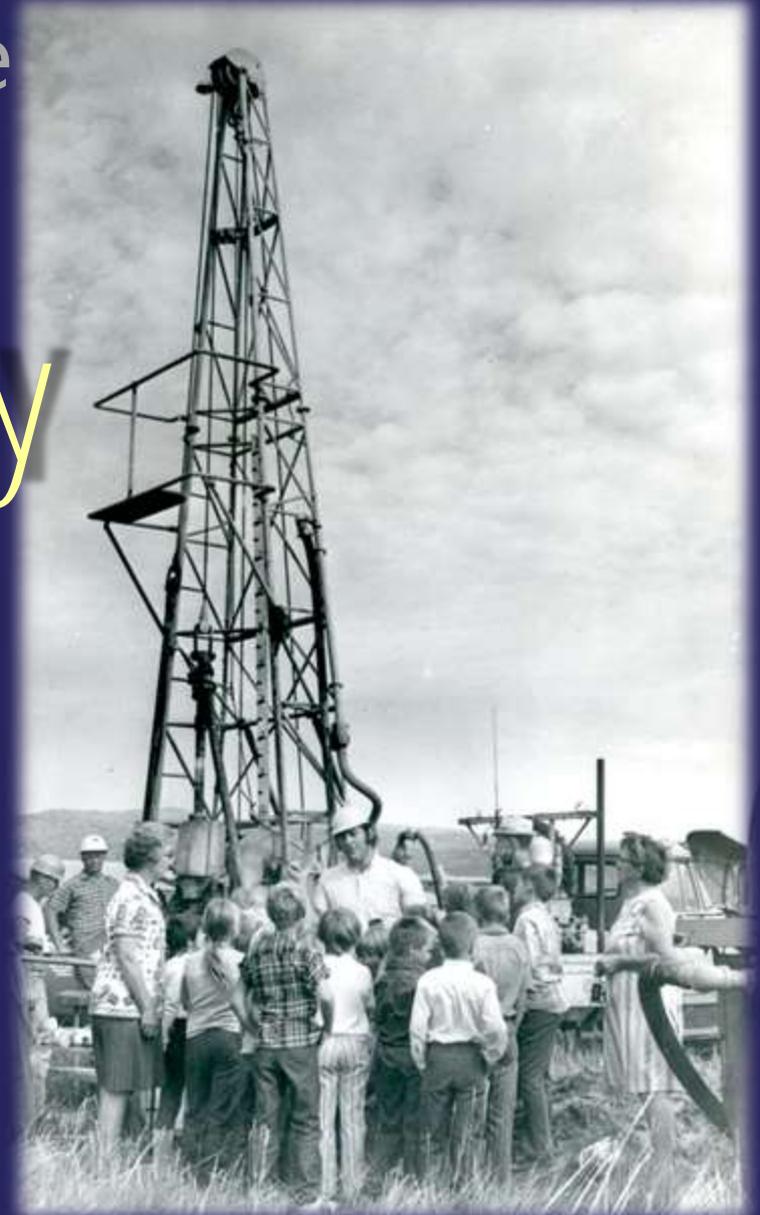


1. Historical perspective

2. hydrogeology

3. Water balance

4. Water quality



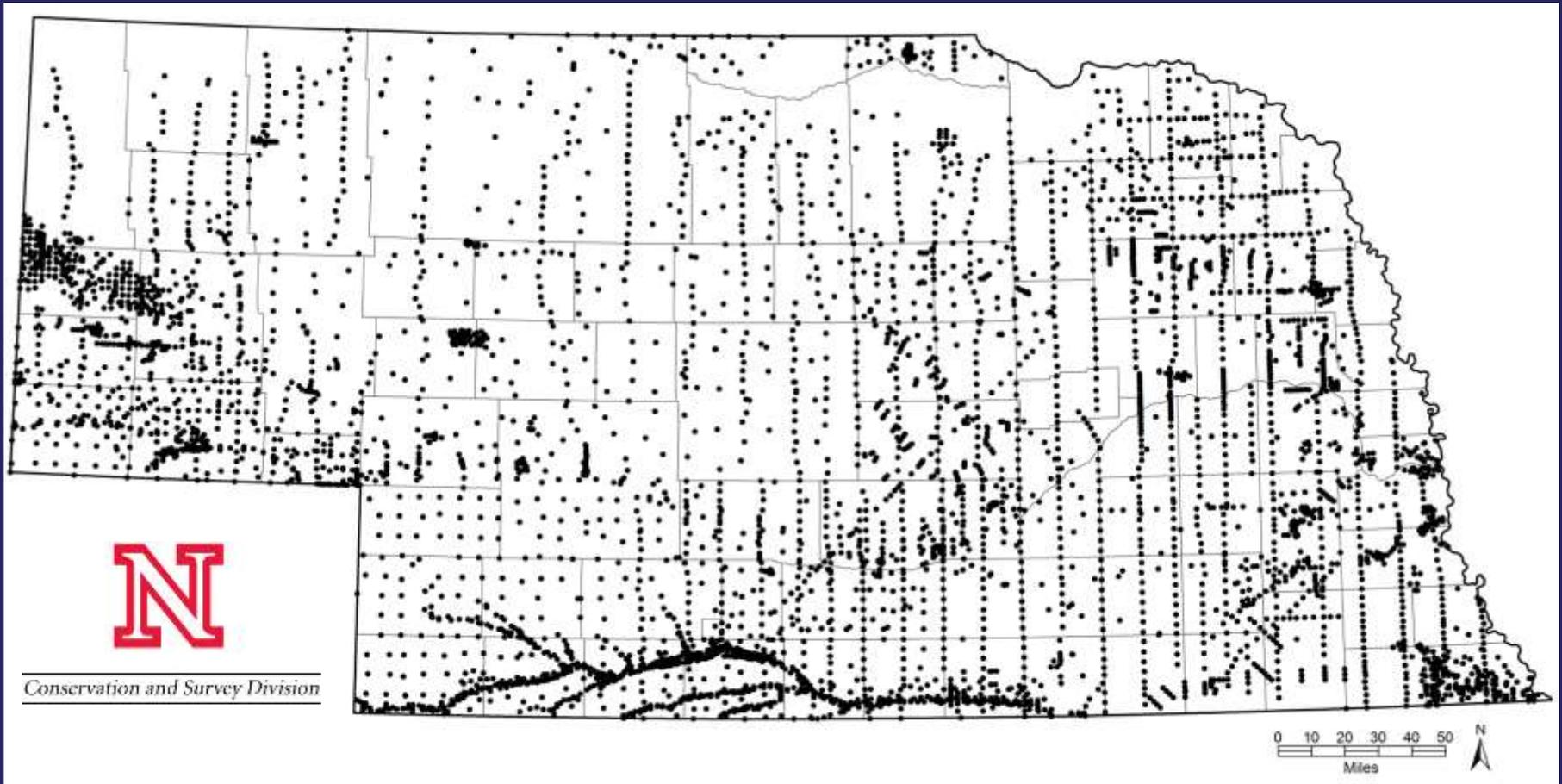


Conservation and Survey Division Hydrogeologist Jim Goeke (retired)



Conservation and Survey Division Geologist Jim Swinehart (retired)

The Conservation and Survey Division has drilled over 5,500 test holes for hydrogeologic investigation



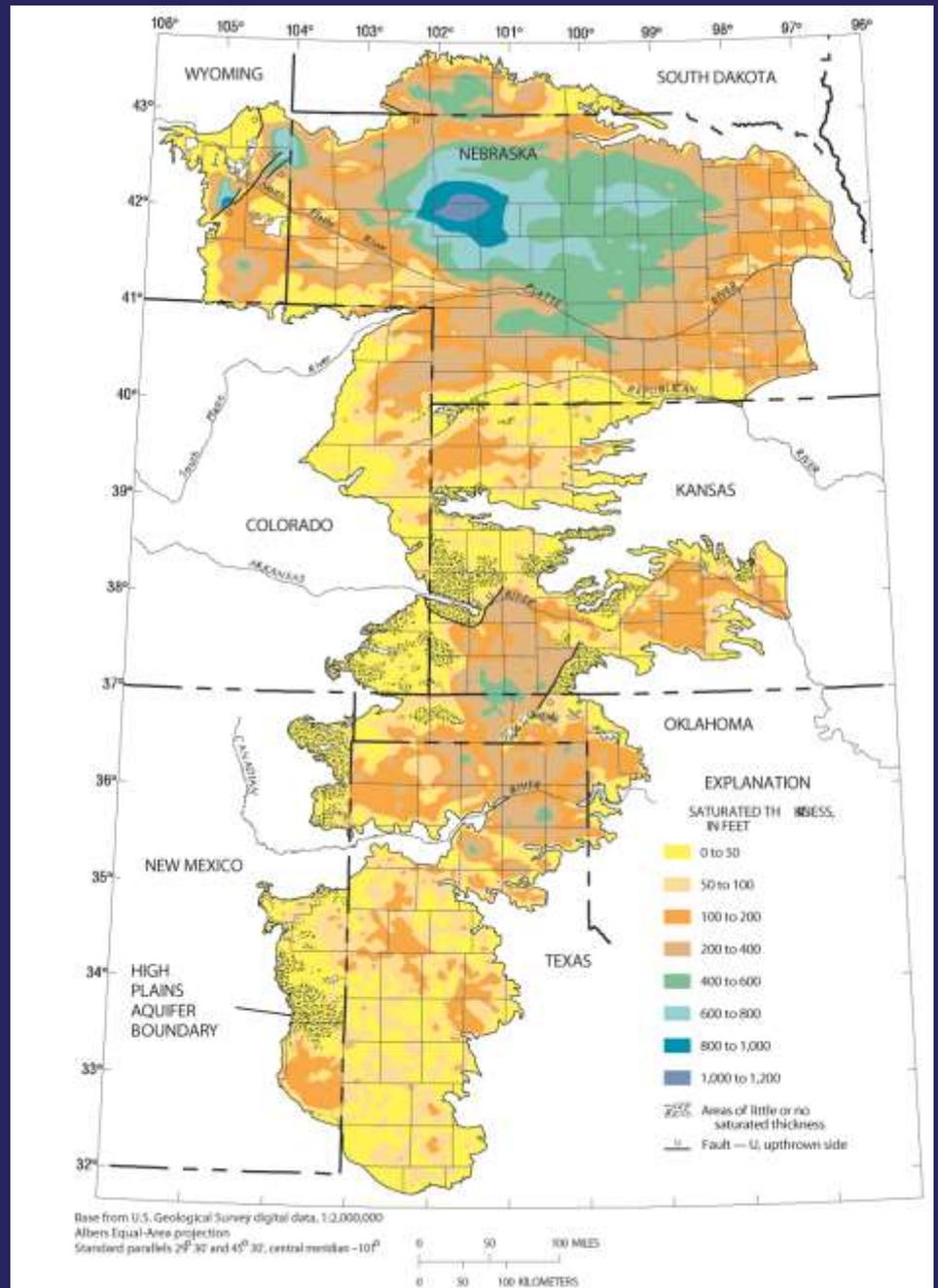
Myth: Groundwater is like an underground river



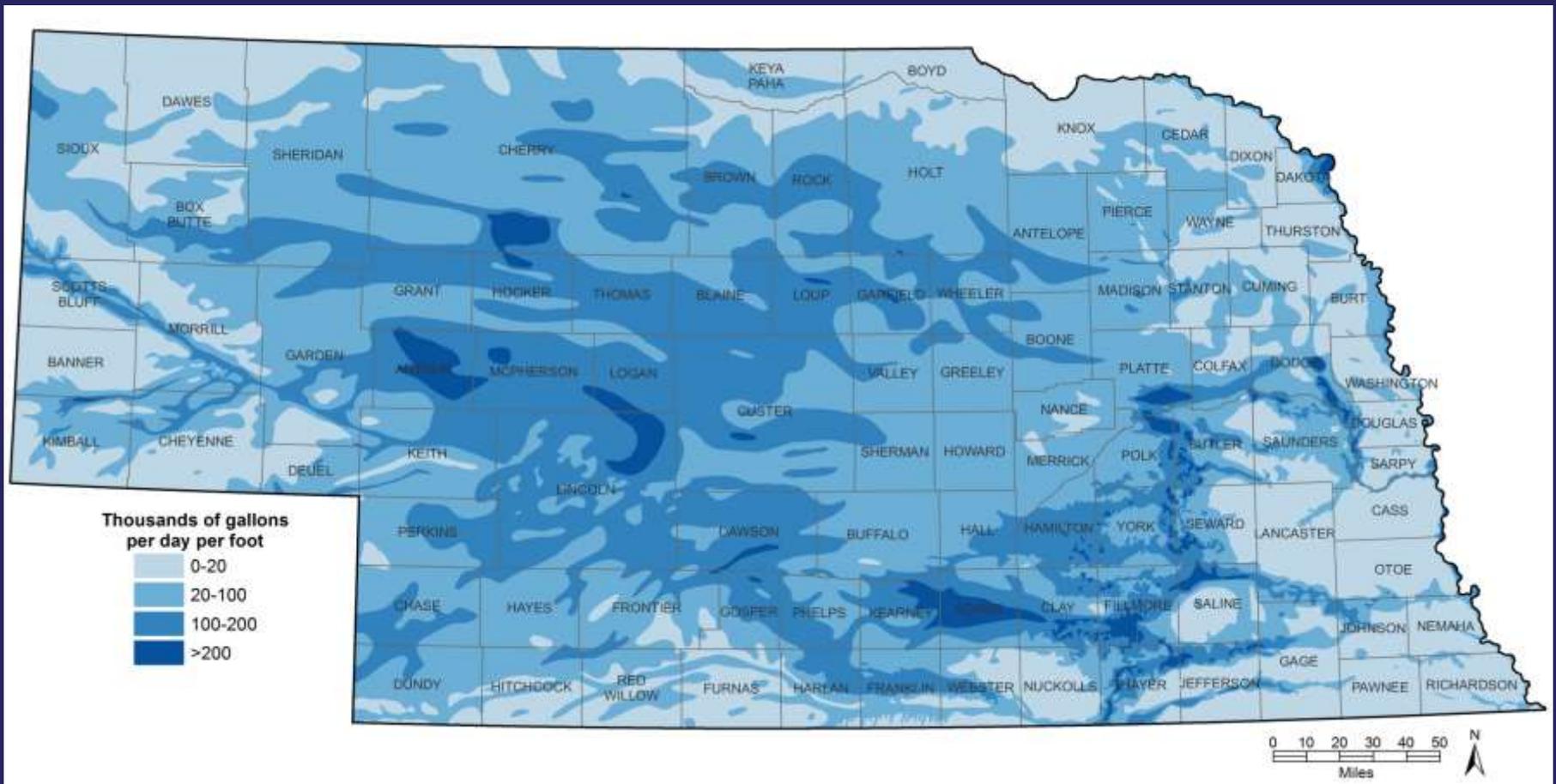
Fact: Groundwater exists in the spaces between grains. It's like water in a sponge



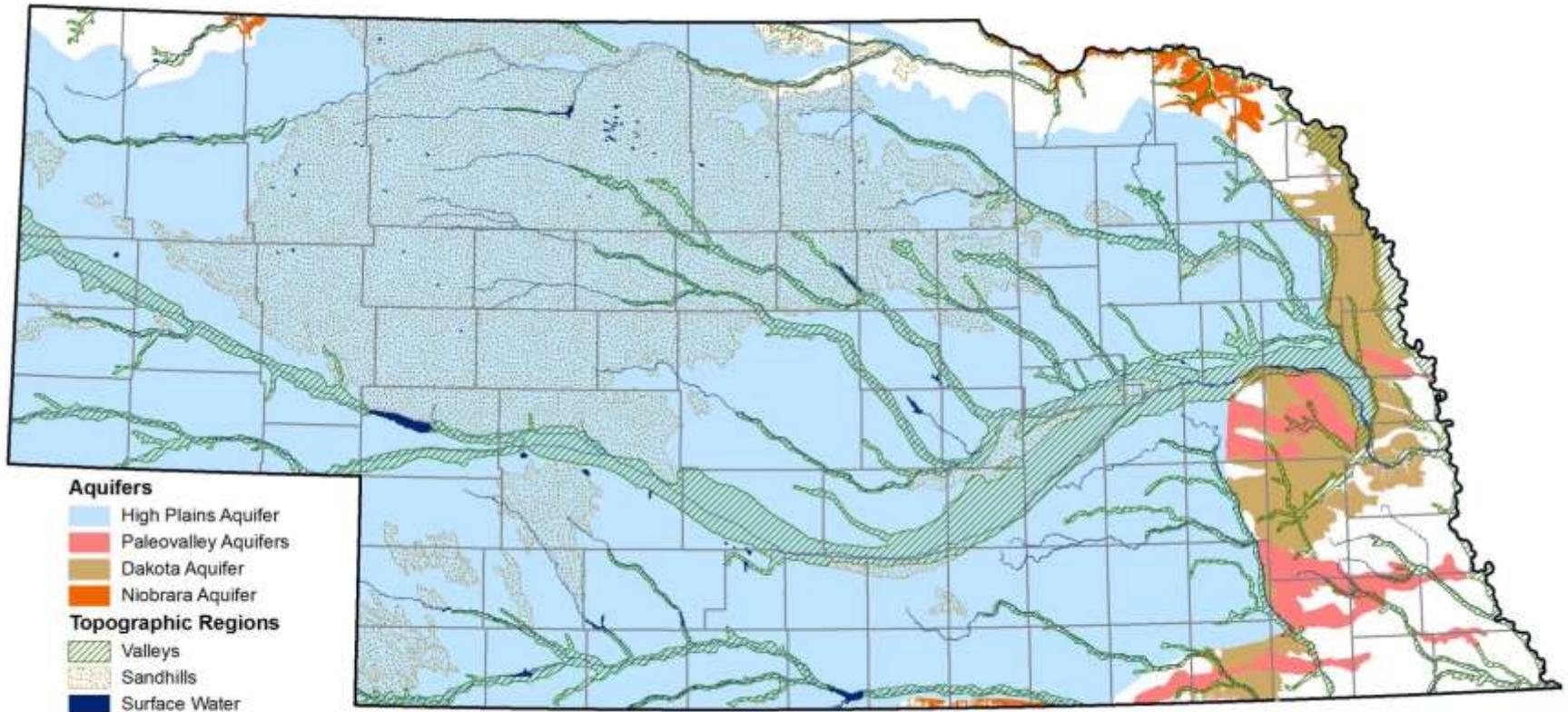
Nebraska contains
66%
of the water
in the
High Plains Aquifer



Nebraska's water wealth is not uniformly distributed



Our groundwater bounty is contained in a complex system of overlapping, discontinuous aquifers



Geology is the layered framework for our ground water

Dominant Soil Parent Materials

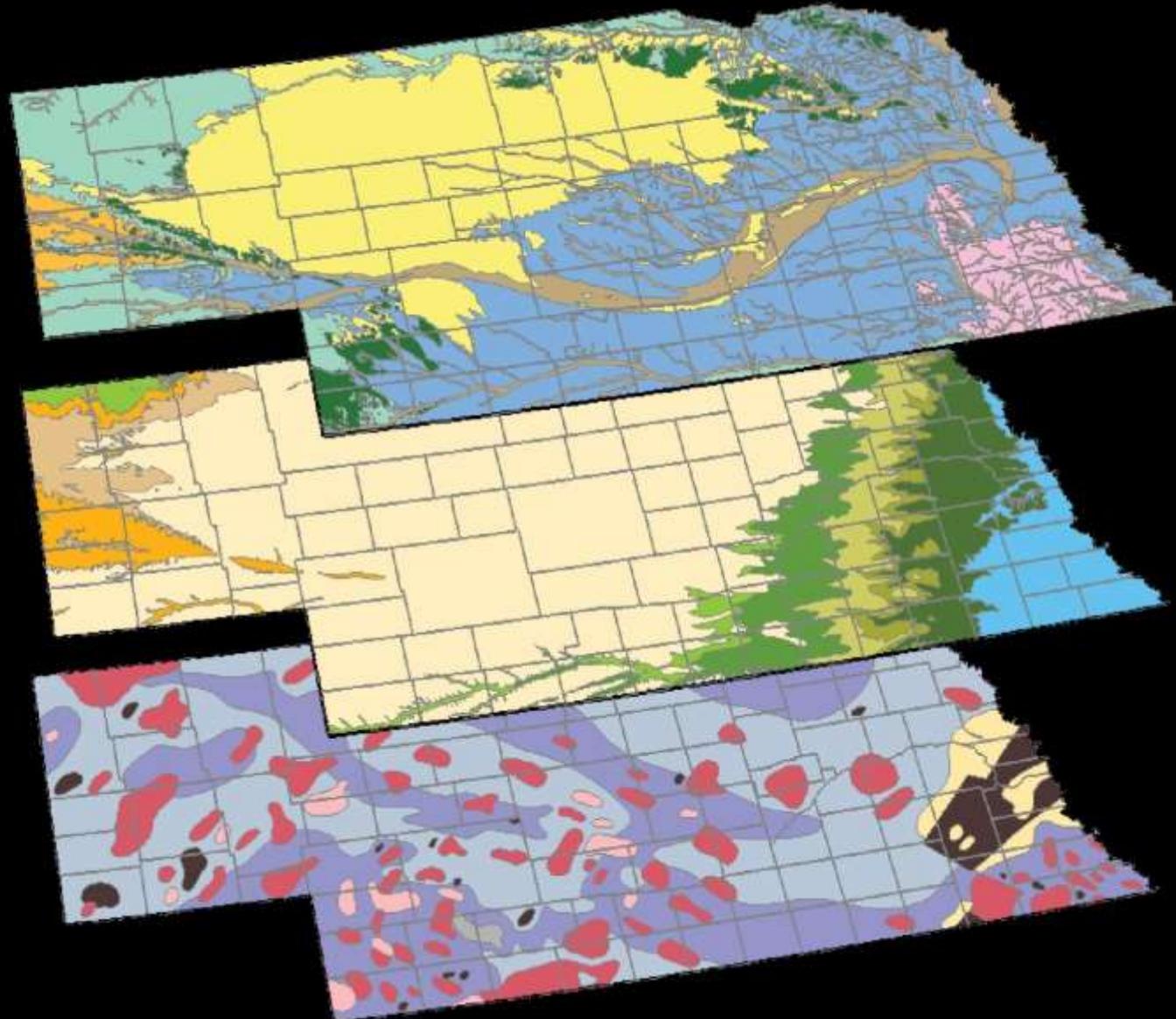
- Alluvium
- Colluvium and alluvium
- Eolian sand
- Loess
- Mixed silt, sand and gravel
- Till and loess
- Weathered sedimentary rocks

Bedrock

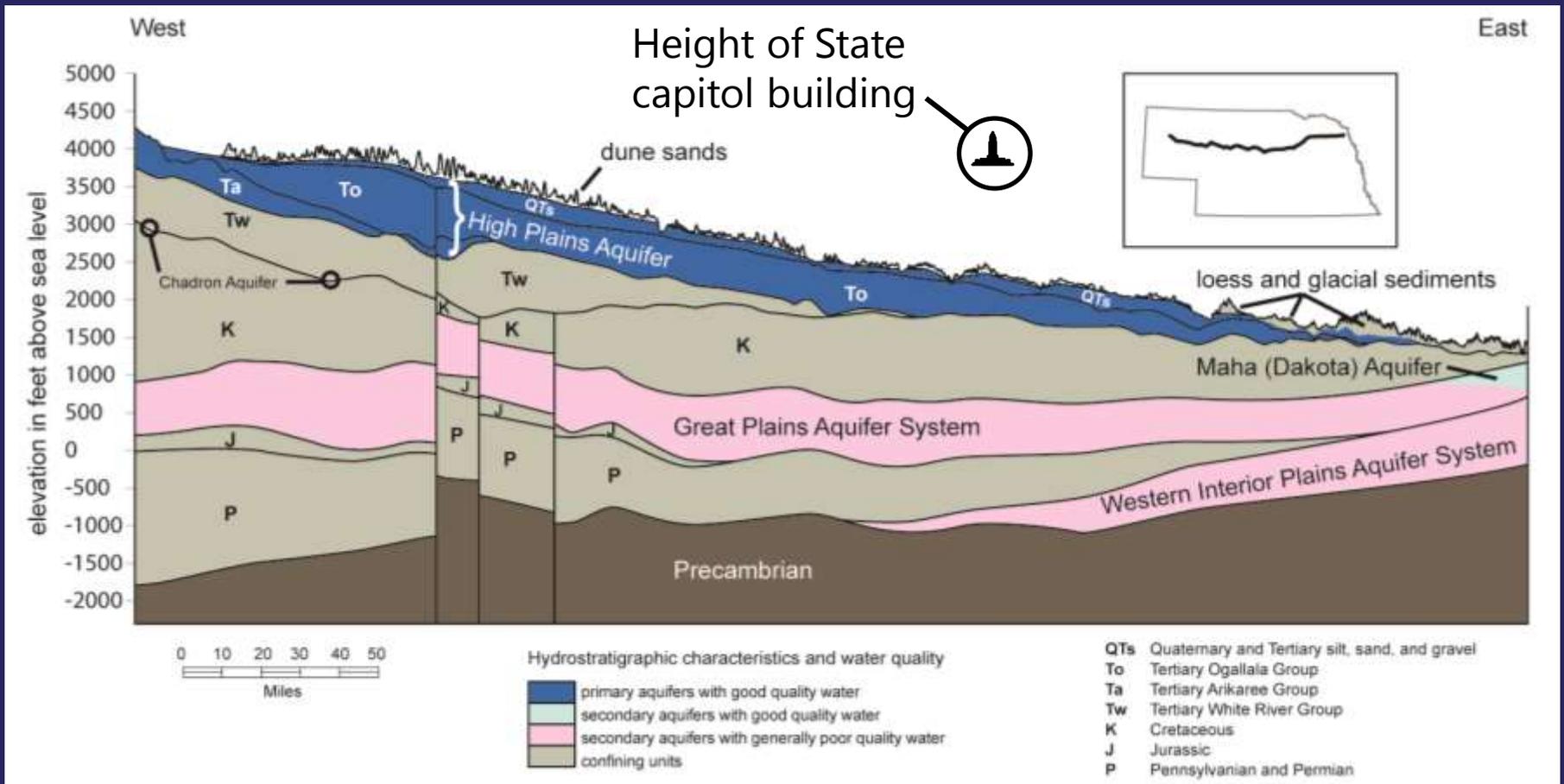
- Ogallala Group
- Arikaree Group
- White River Group
- Fox Hills Formation
- Pierre Shale
- Niobrara Formation
- Carlile Shale
- Greenhorn Limestone & Graneros Shale
- Dakota Formation
- Pennsylvanian and Permian Shale

Basement

- Anorthosite
- Basalt
- Gneiss
- Granite
- Quartzite
- Schist
- Sedimentary rocks



Unique geological conditions provided great thicknesses of easily accessible, permeable materials



The Ogallala Group is exposed in the spillway of Kingsley Dam in Keith County



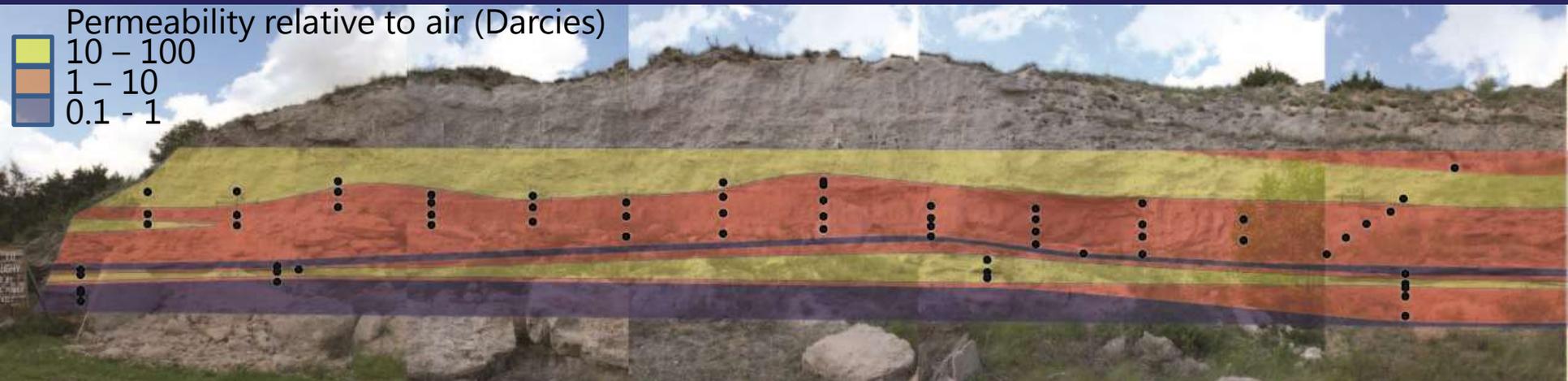
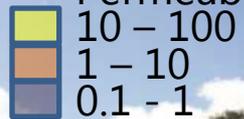
“...the Ogallala Formation is homogeneous in its heterogeneity”

Frank C. Foley, Kansas State Geologist, 1961

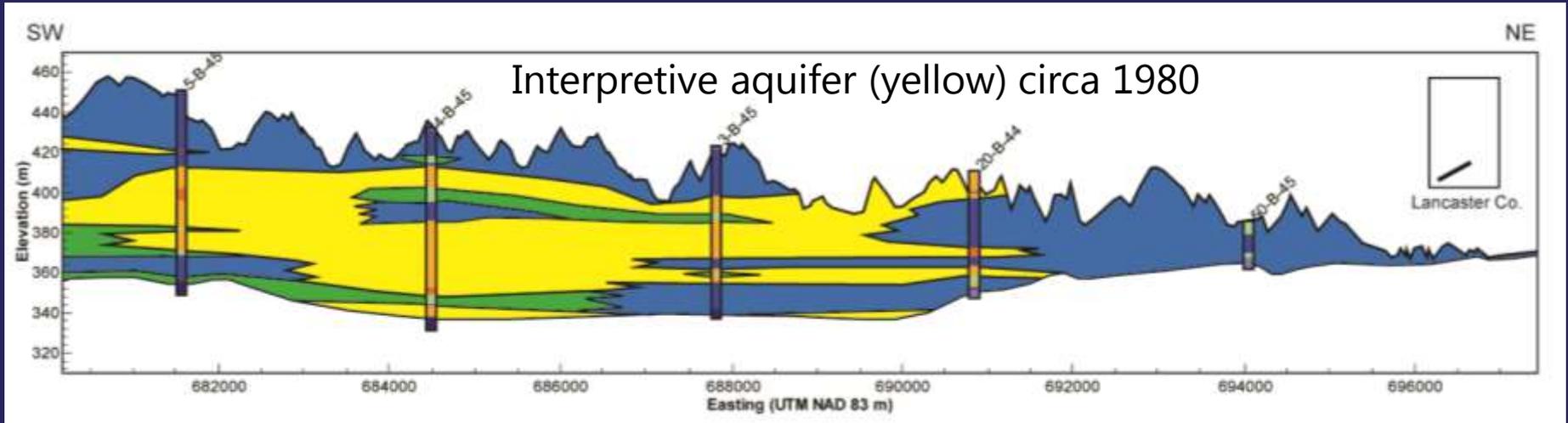
Pink dots are locations of samples



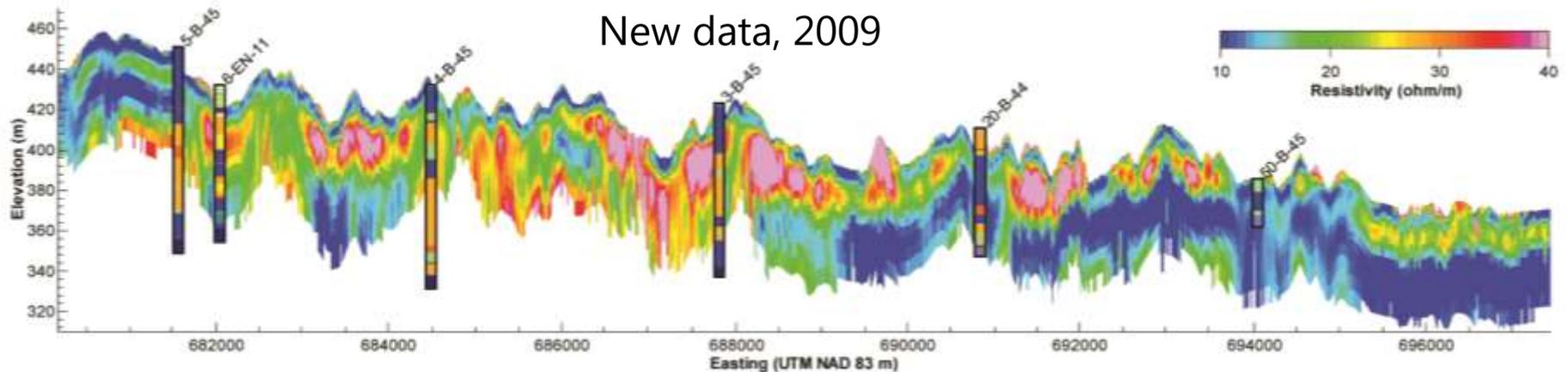
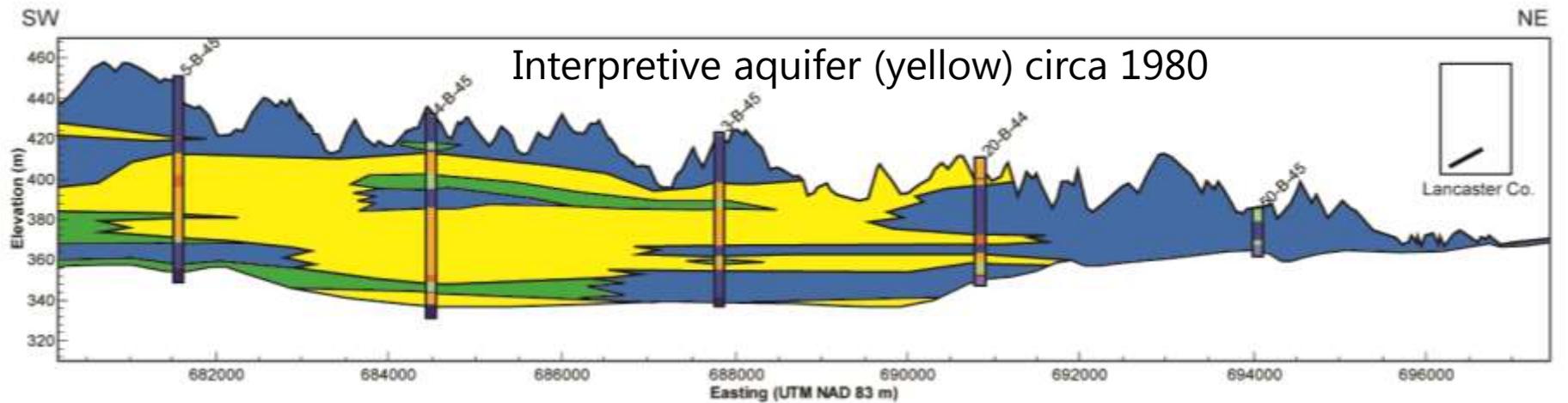
Permeability relative to air (Darcies)



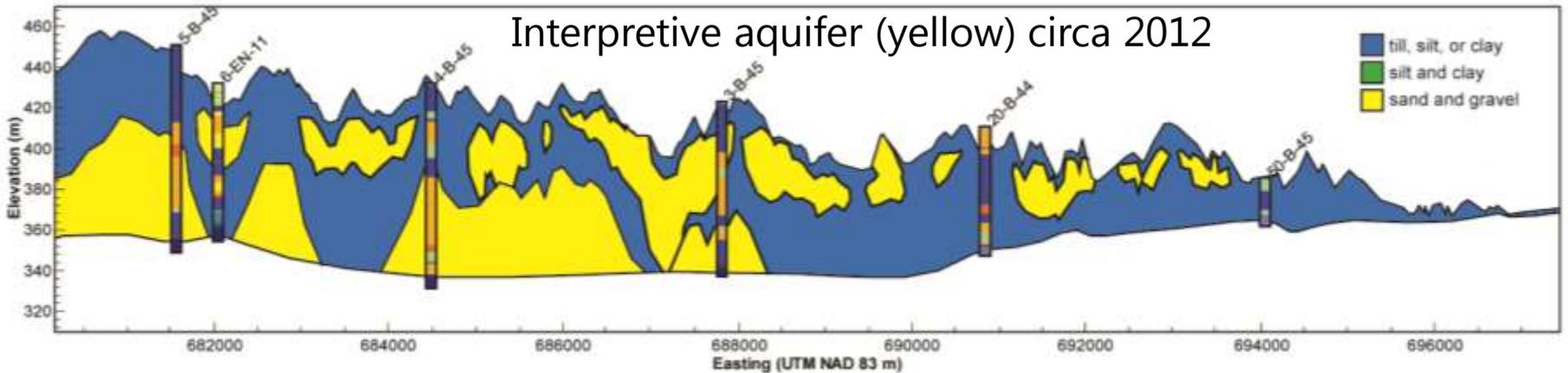
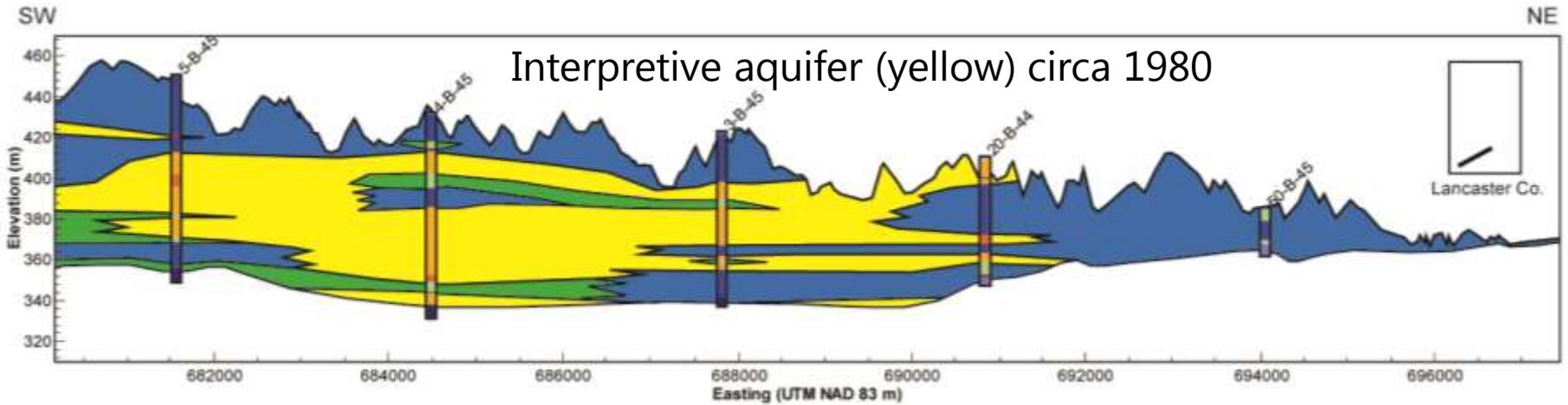
Our understanding of geology has progressed



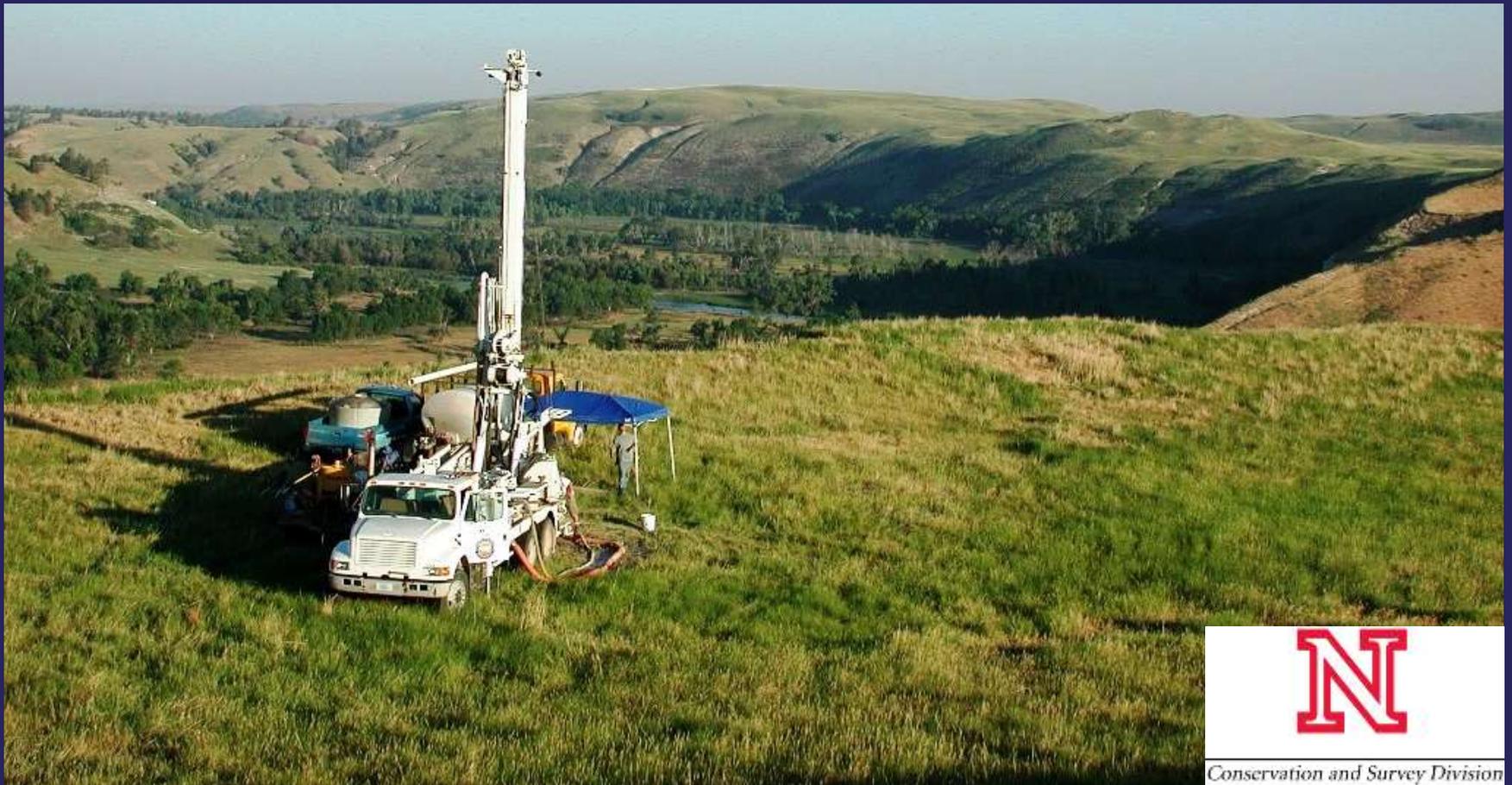
New technologies bring new insights...



...and drastically different interpretations



Test-hole drilling and geologic research remains critically important to understanding our groundwater



1. Historical perspective

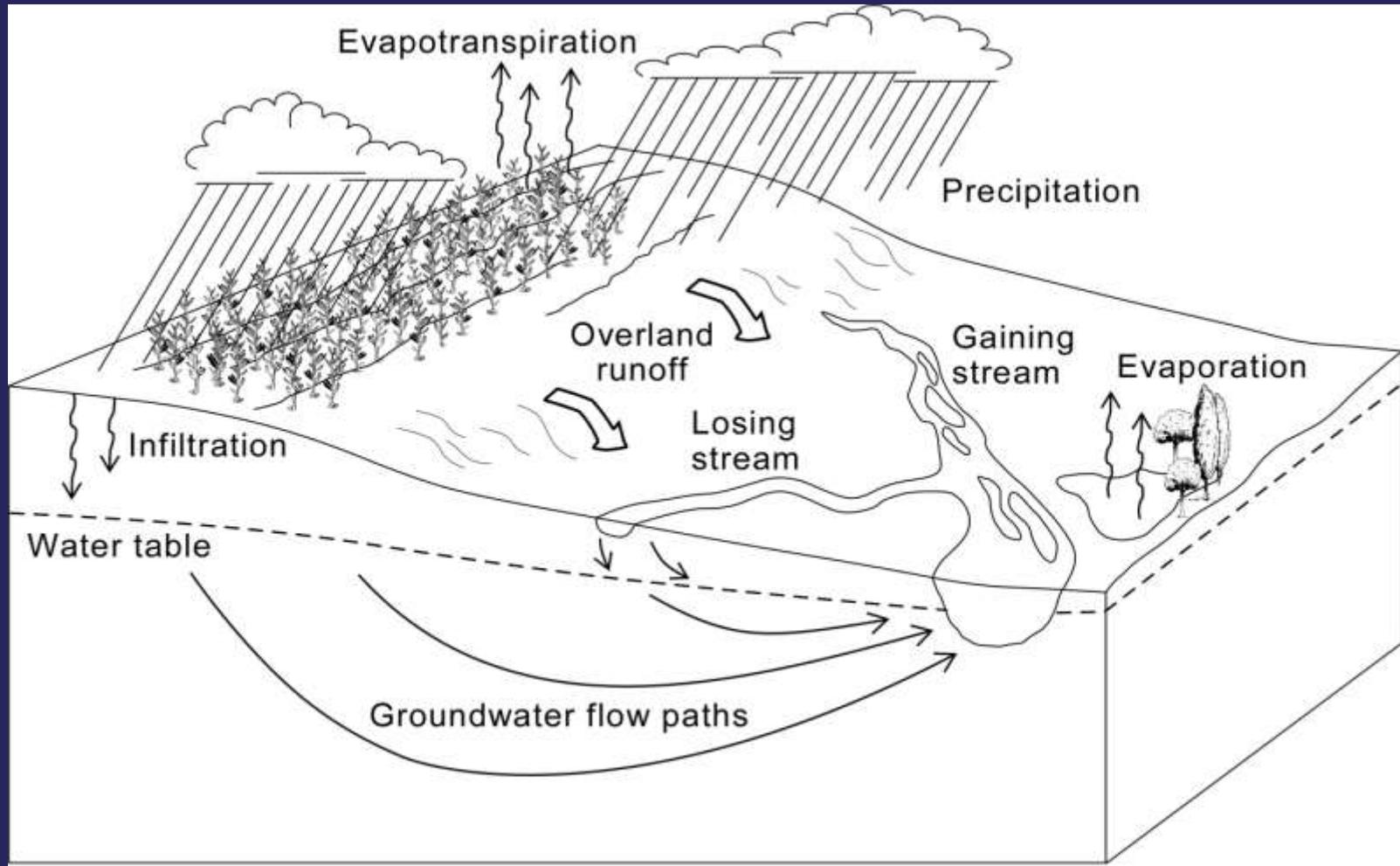
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3. Water balance

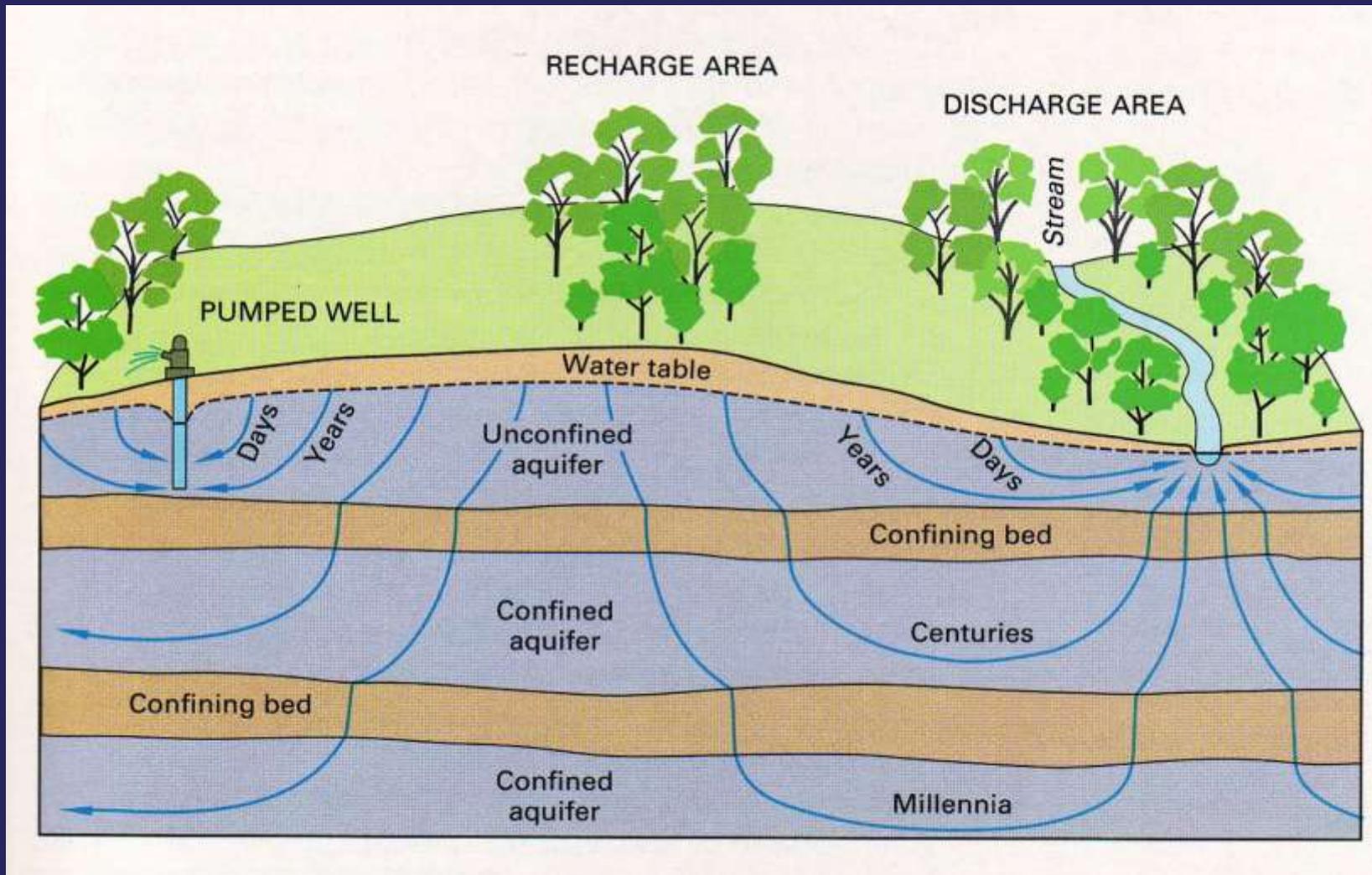
4. Water quality



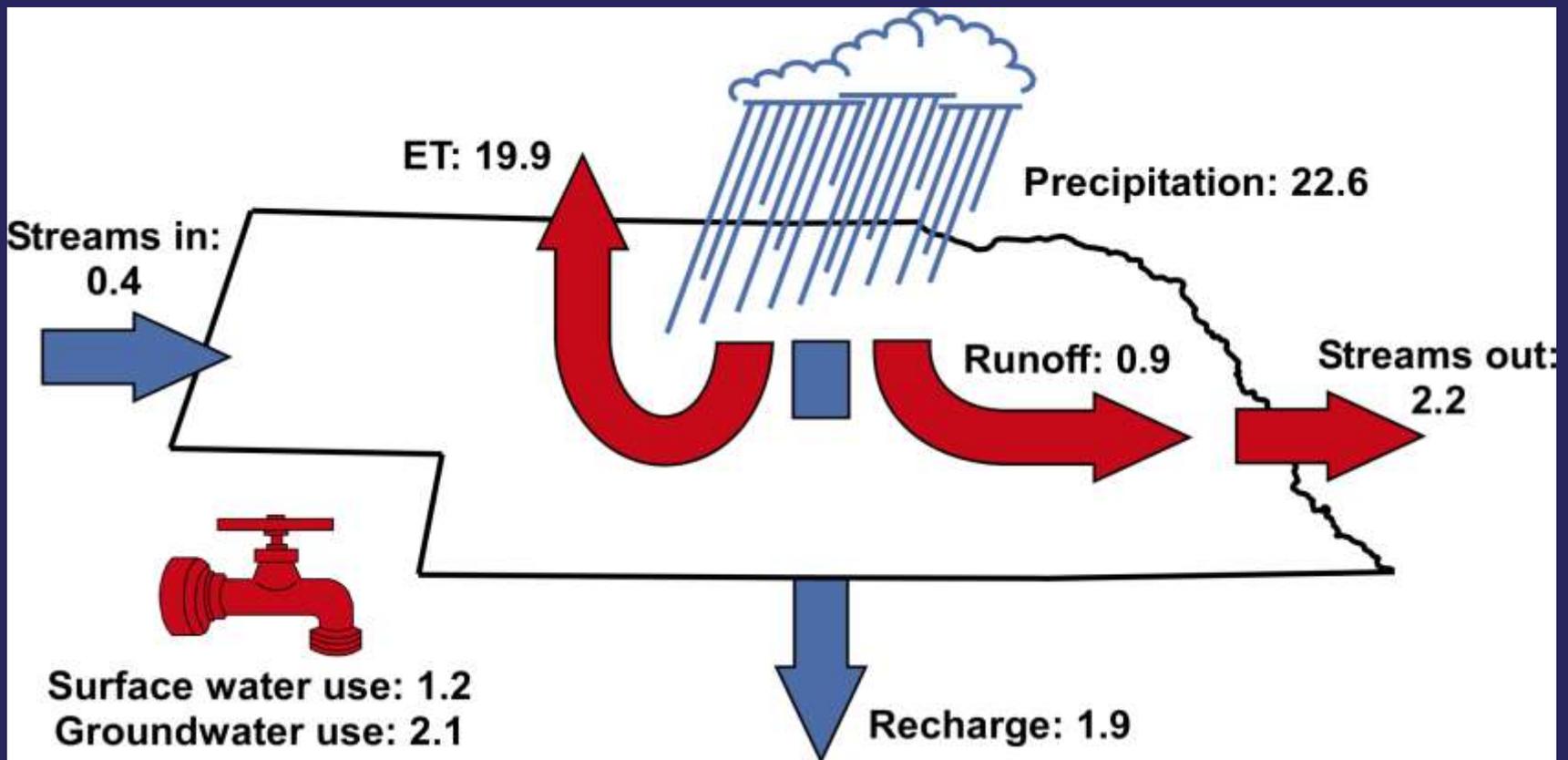
The concept of water balance begins with the WATER CYCLE



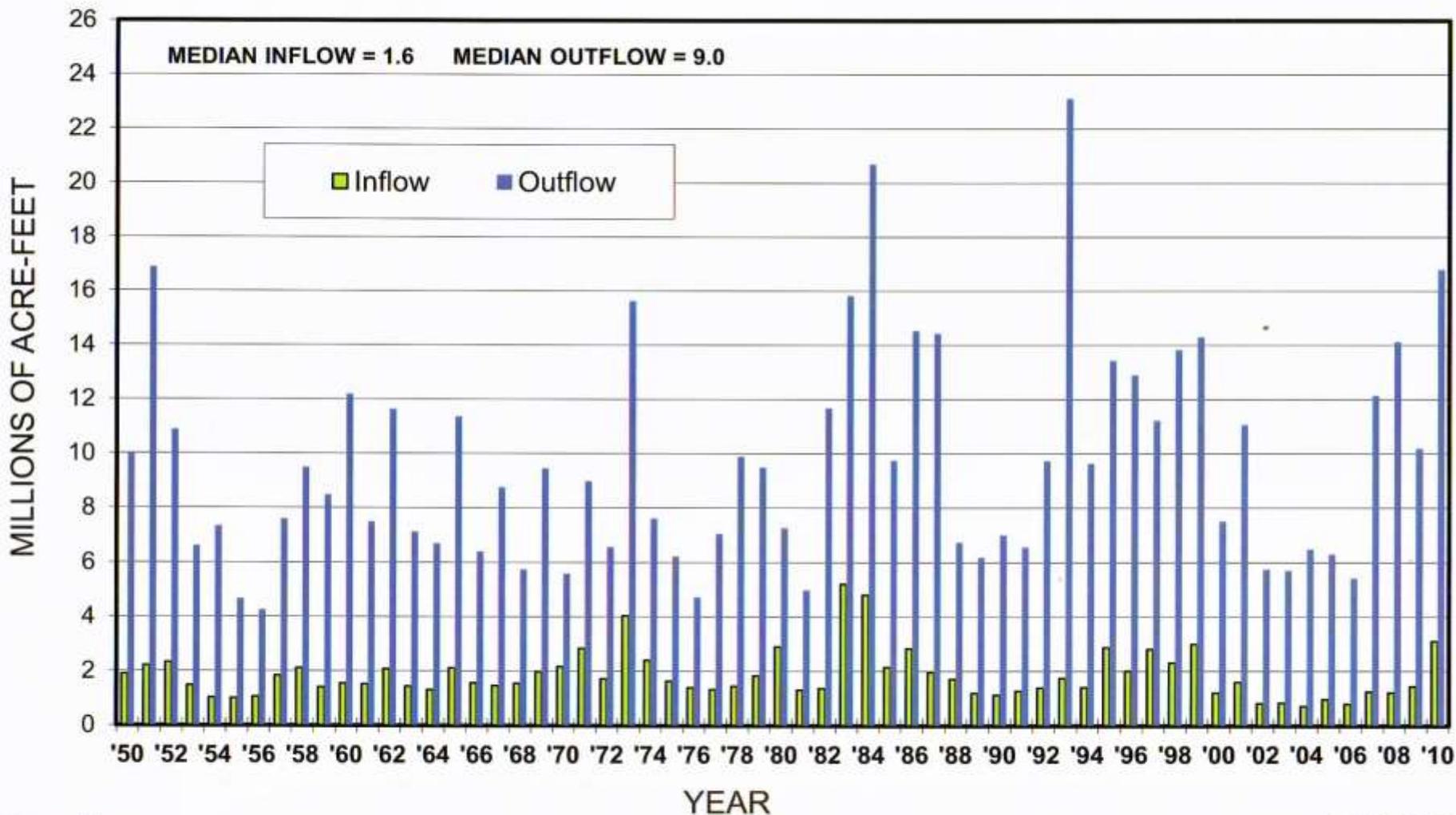
Streams and aquifers are connected – albeit by varying degrees



A water budget is an accounting of all inflows and outflows



ANNUAL INFLOW OF WATER TO NEBRASKA AND ANNUAL OUTFLOW OF WATER FROM NEBRASKA 1950-2010



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School of Natural Resources
Institute of Agriculture and Natural Resources
University of Nebraska—Lincoln

October 2011

Data sources:
U.S. Geological Survey
Nebraska Department of Natural Resources

For more information:
<http://snr.unl.edu/data/water/annual-inflow-outflow.asp>

The concept of water balance is analogous to a CHECKING ACCOUNT



Base income
\$200

Income = Expenses



Base expenses
\$200



Cash Reserve
\$1,000

Arrival of a new expense disrupts your cash flow



Base income
\$200

Income = Expenses



Base expenses
\$200

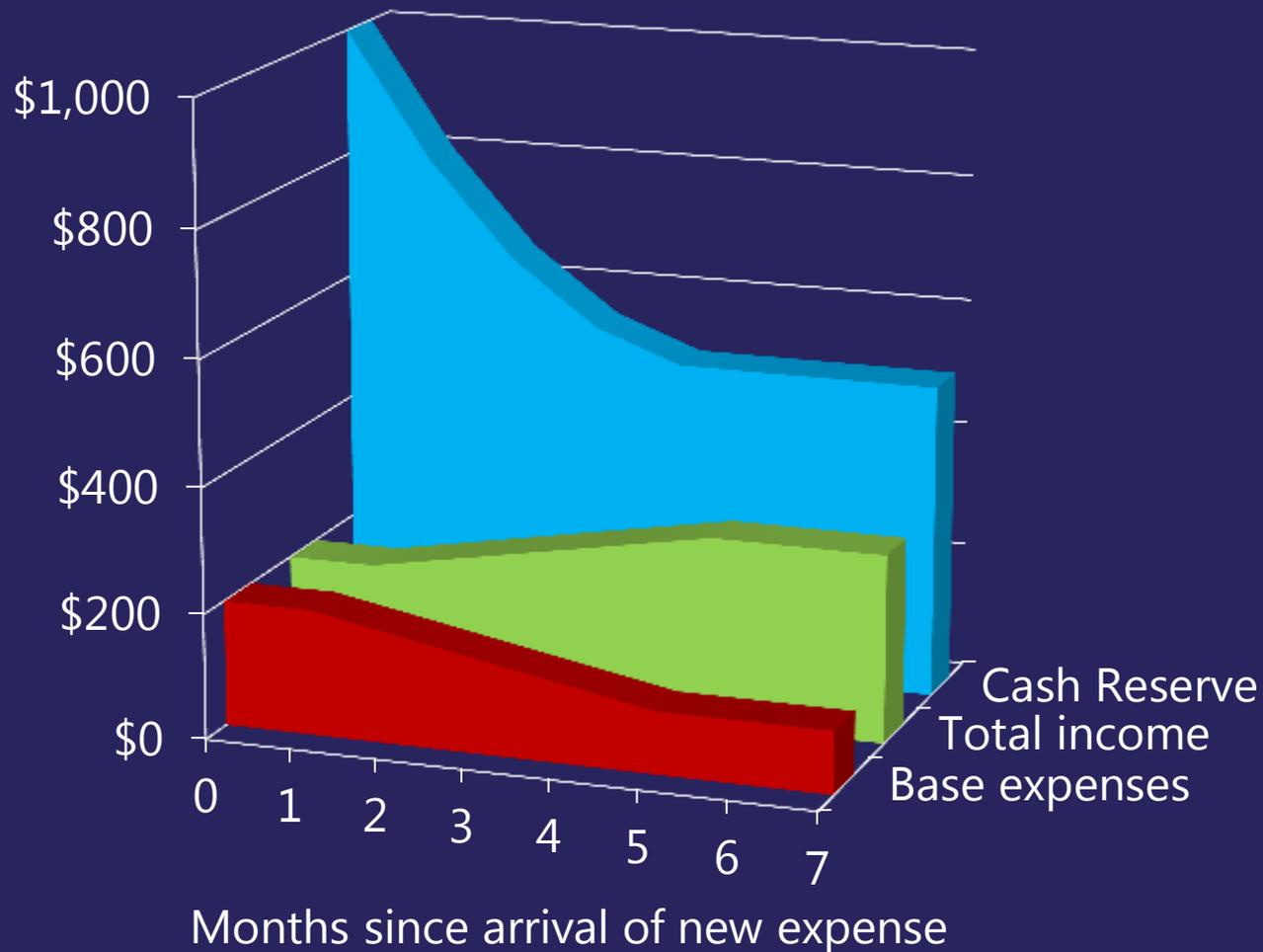


Cash Reserve
\$1,000

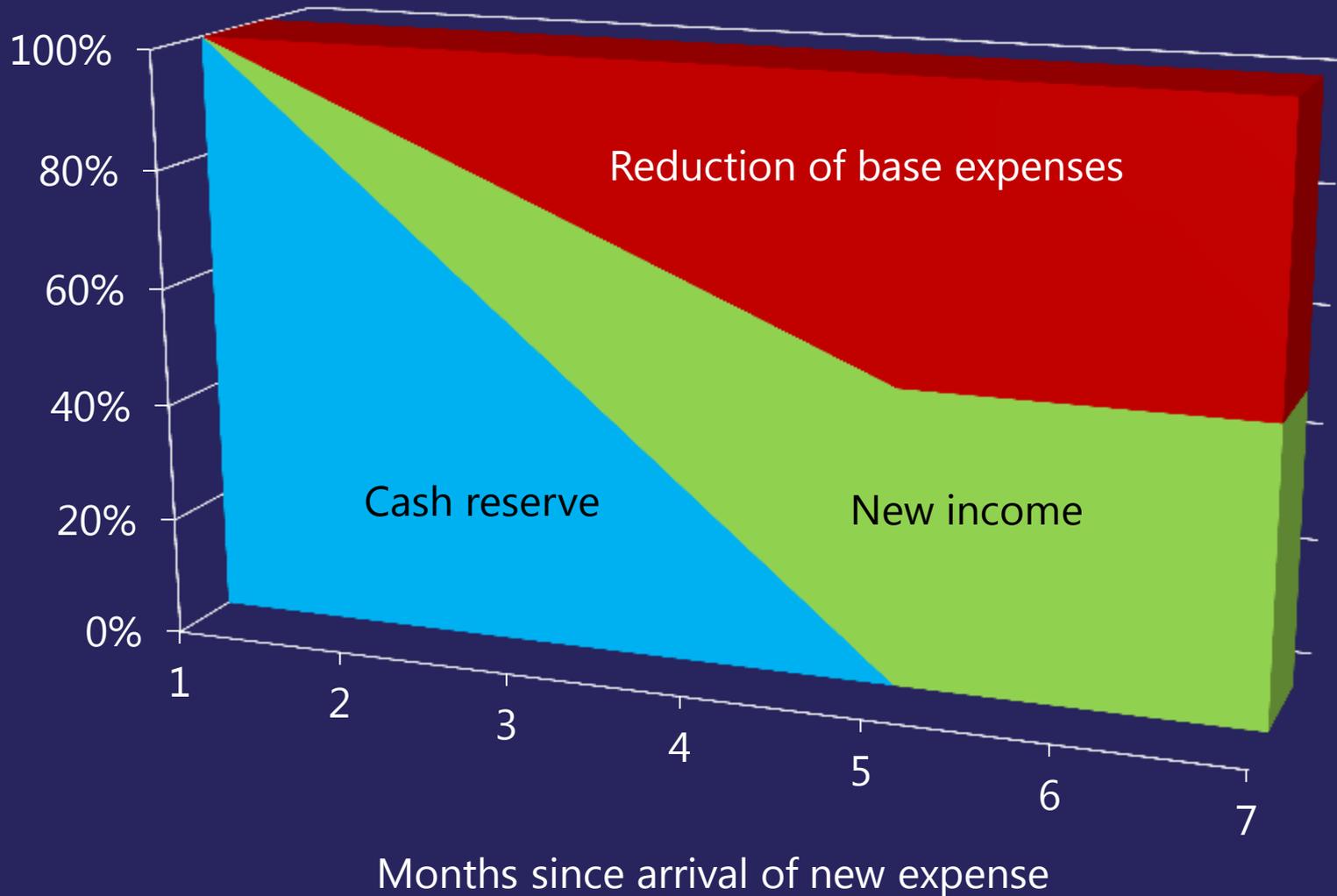


New expense
\$200

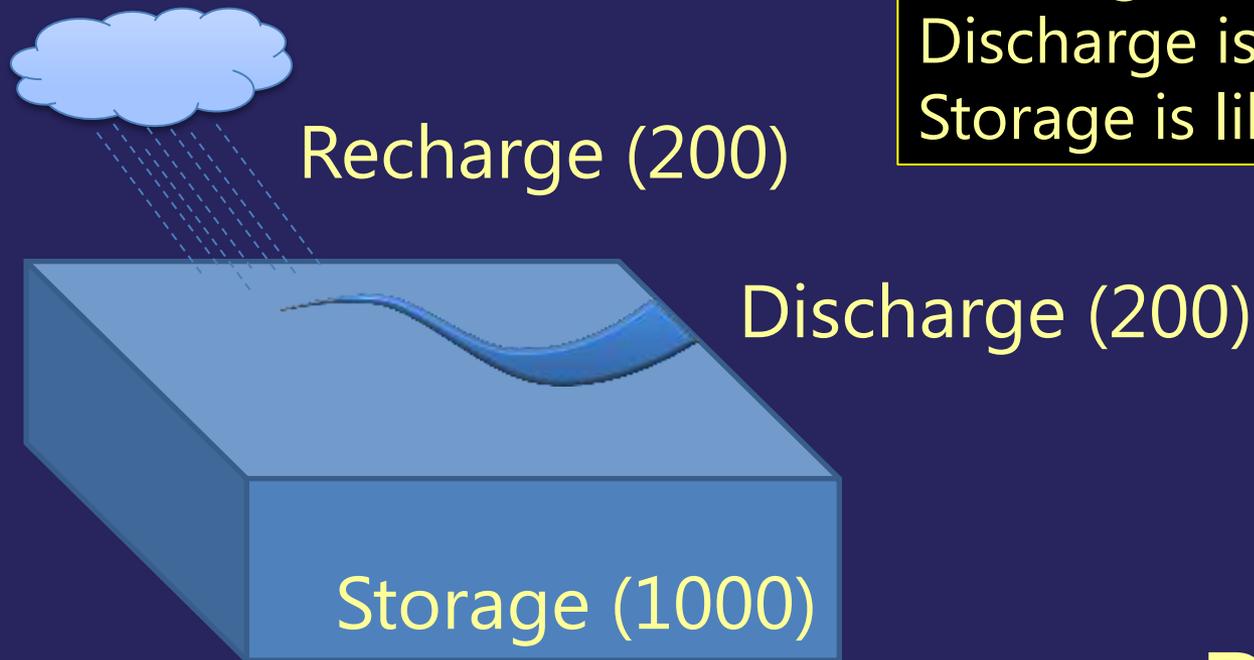
This chart shows the gradual adjustment of your cash flow to account for your new expenses



This chart shows the Sources of funds for your new expenses



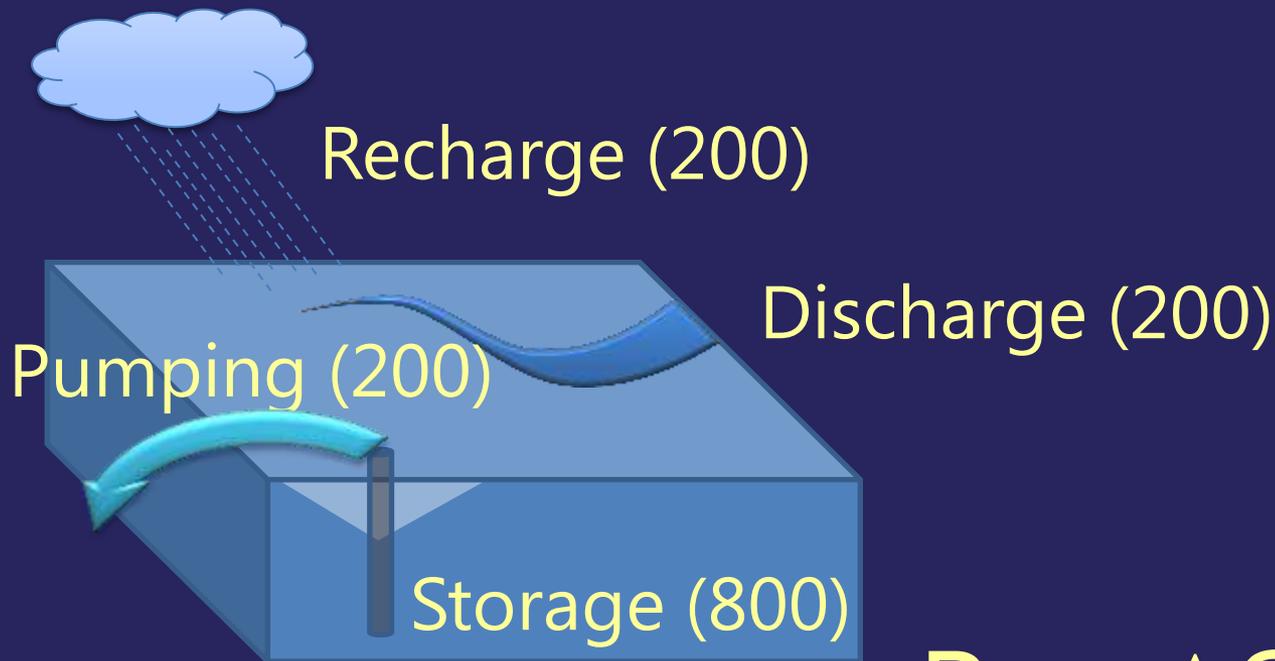
Let us now consider WATER BALANCE



Recharge is like Income
Discharge is like Expenses
Storage is like Cash Reserve

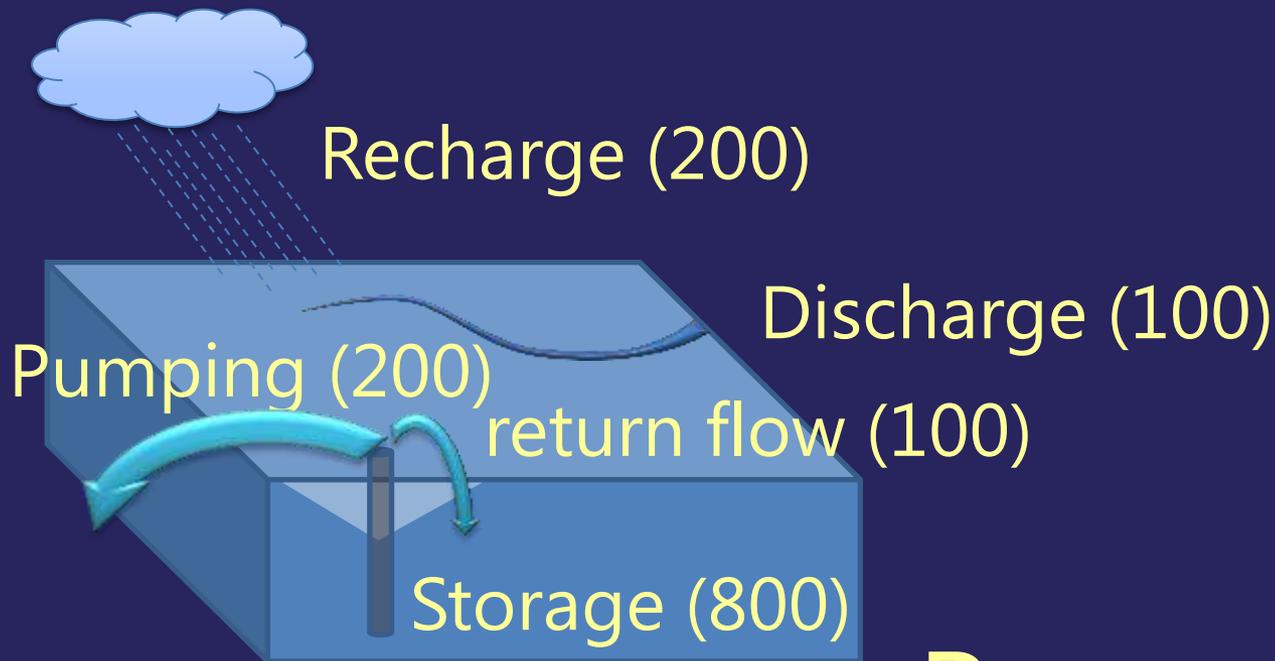
$$R = D$$

Pumping initially draws water out of storage



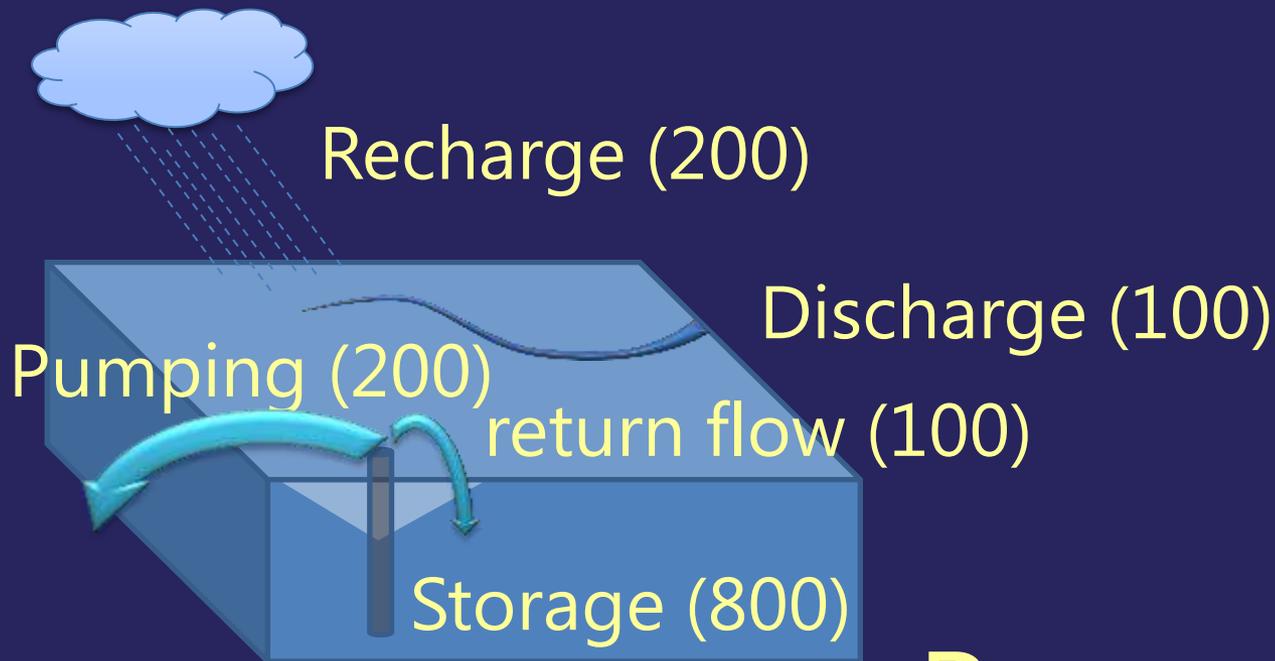
$$R + \Delta S = D + P$$
$$200 + 200 = 200 + 200$$

With time, pumping is offset by increased recharge and decreased discharge



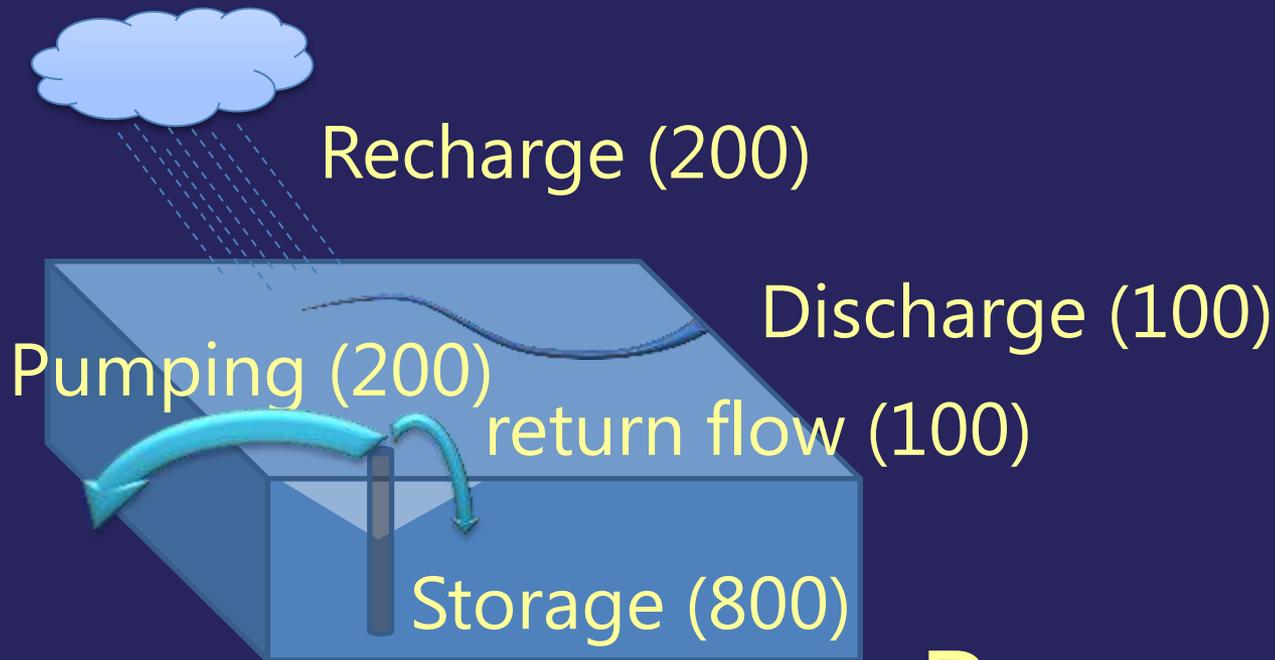
$$R + r = D + P$$
$$200 + 100 = 100 + 200$$

Sustainability is not about balancing inflows and outflows – that balance is already inherent to the system



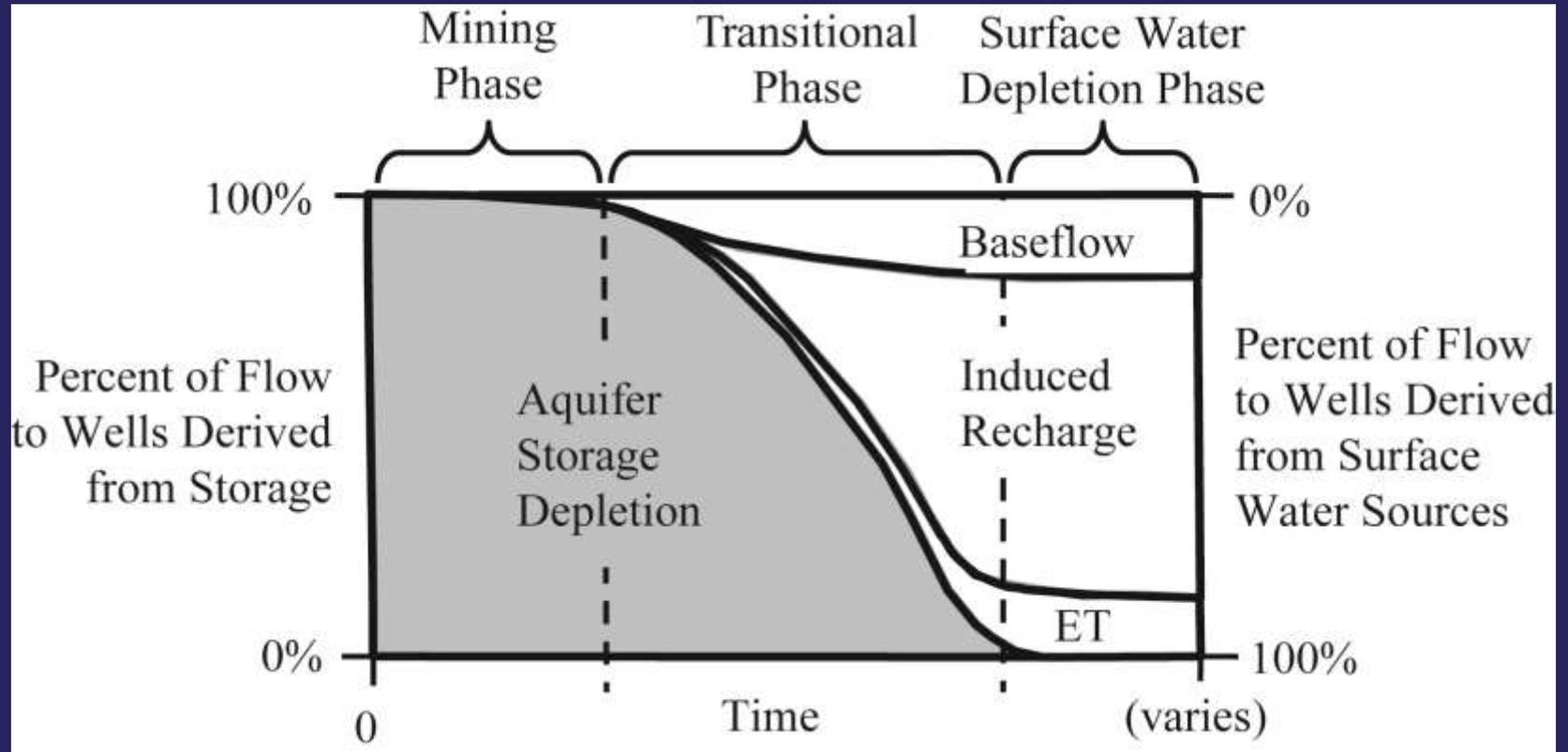
$$R + r = D + P$$
$$200 + 100 = 100 + 200$$

Sustainability is about meeting water demands without overdrawing the account

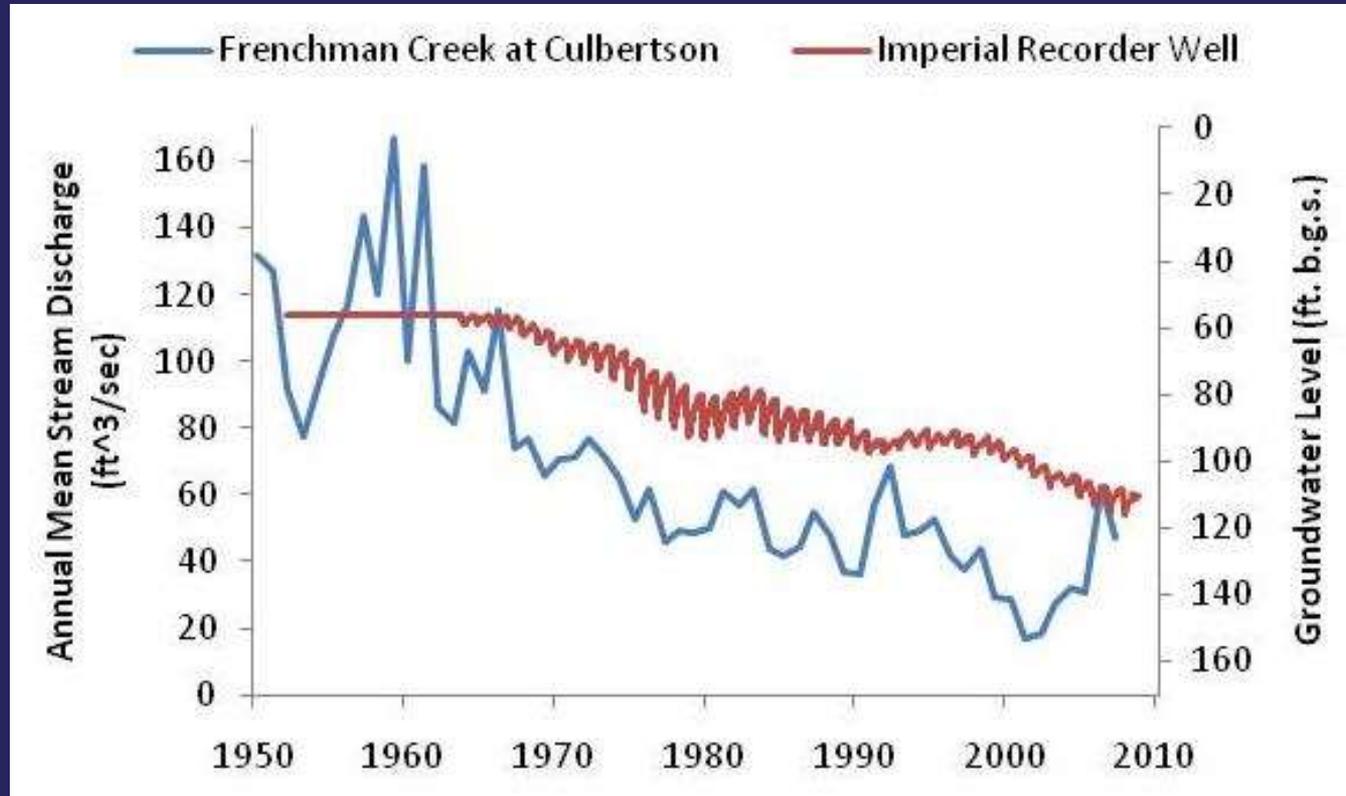


$$R + r = D + P$$
$$200 + 100 = 100 + 200$$

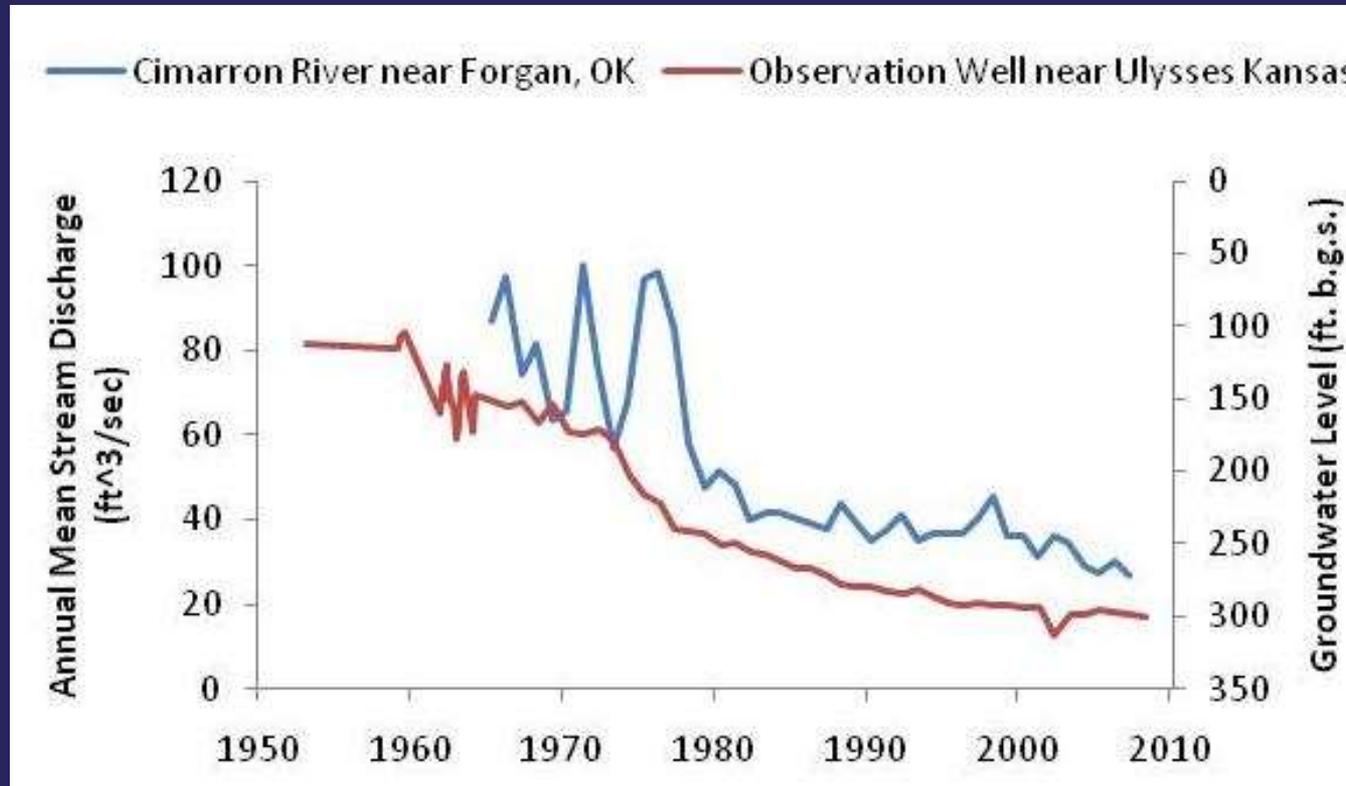
This chart shows the Sources of water for pumping



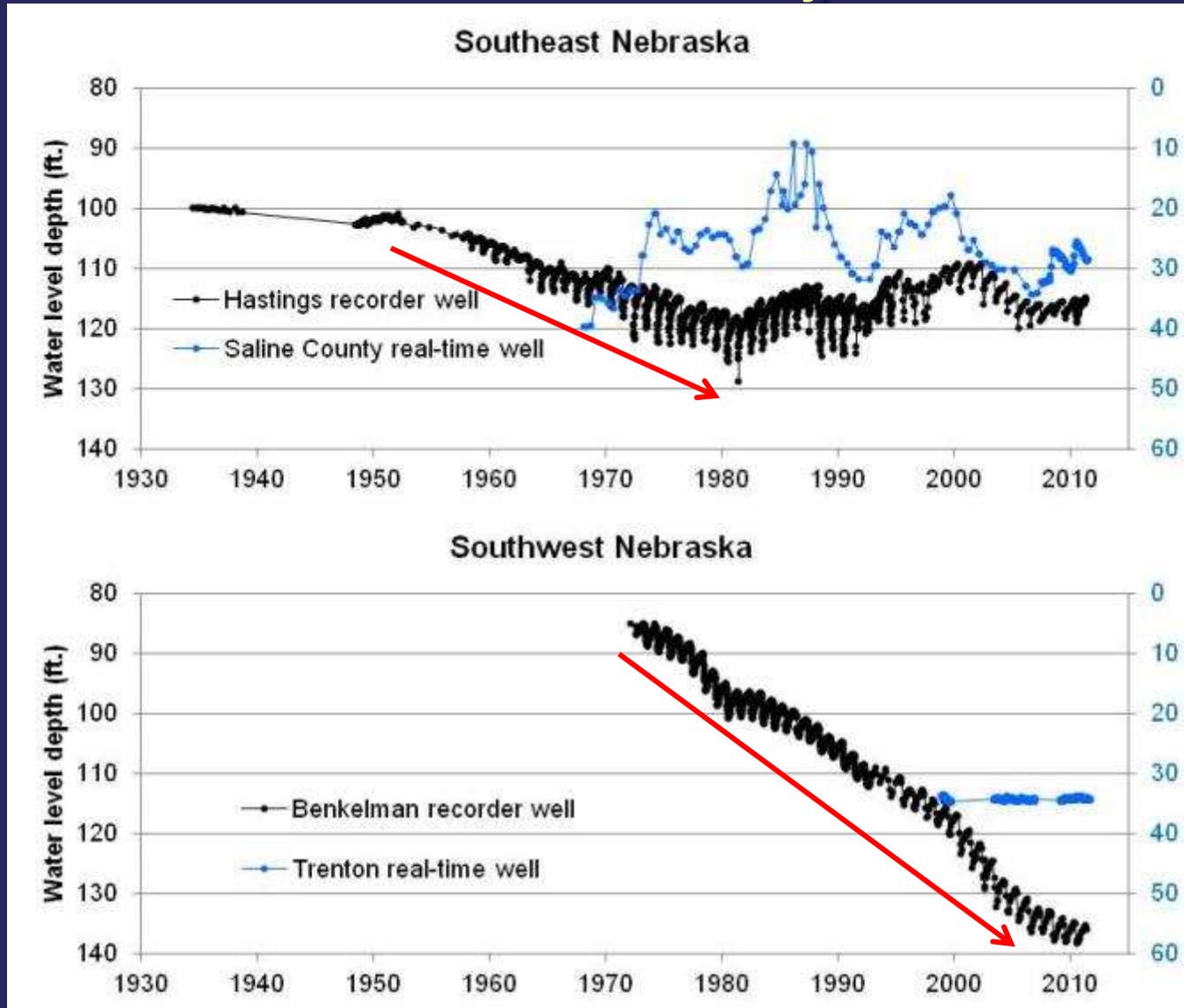
Changes in stream flows and groundwater levels in the Republican River basin illustrate this concept



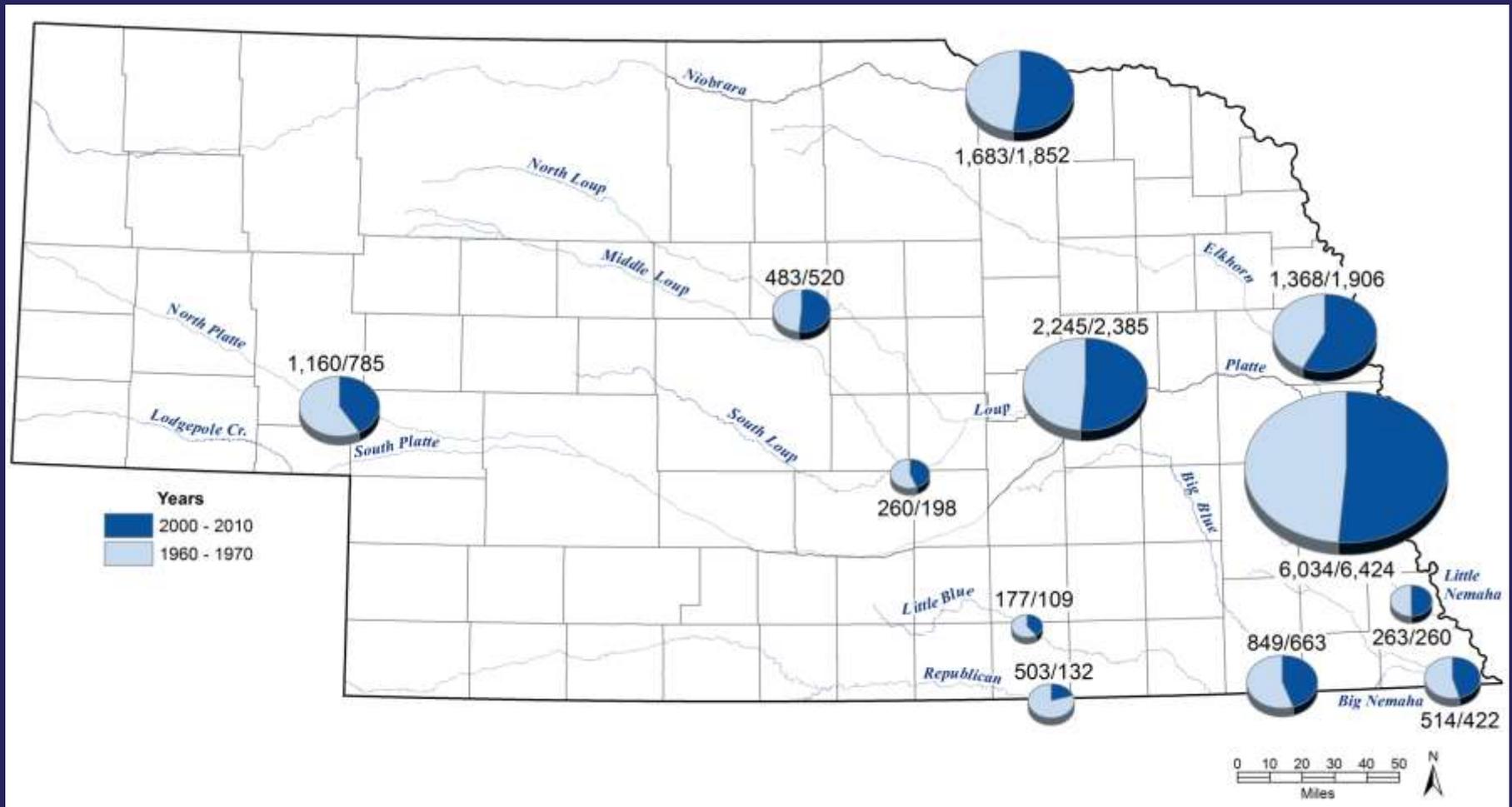
Changes in stream flows and groundwater levels in Kansas and Oklahoma also illustrate this concept



Unlike the southeast, declines continue in the southwest – Why?



Streams with the lowest flows have been impacted the most

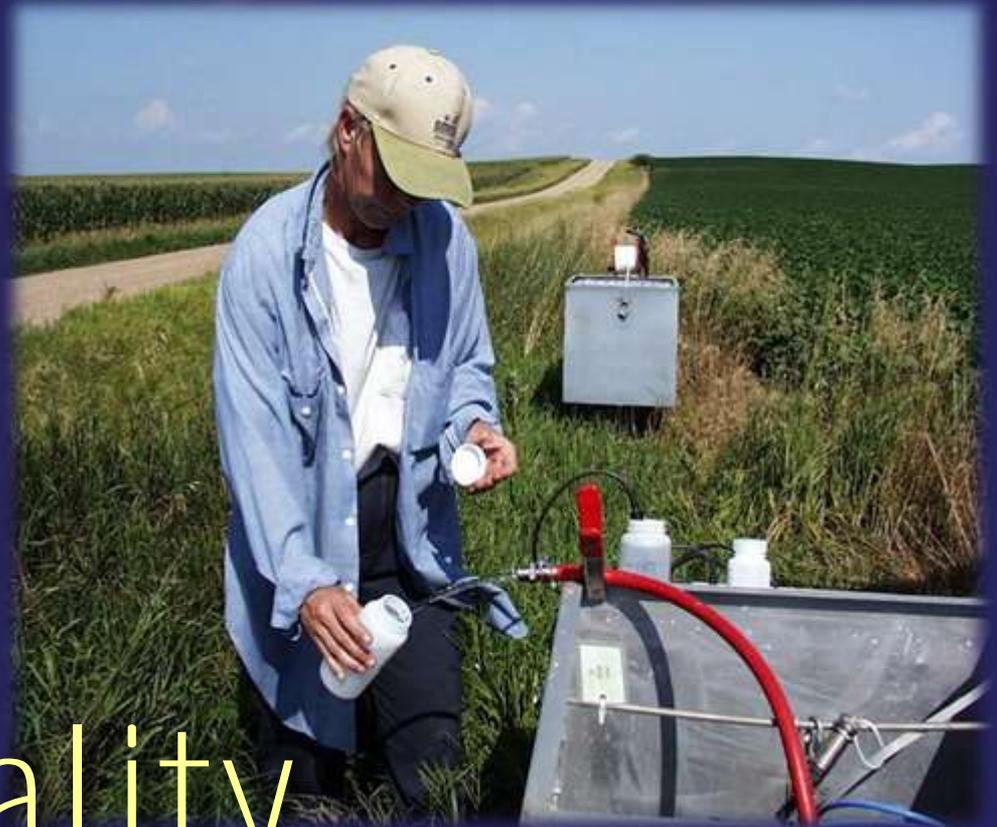


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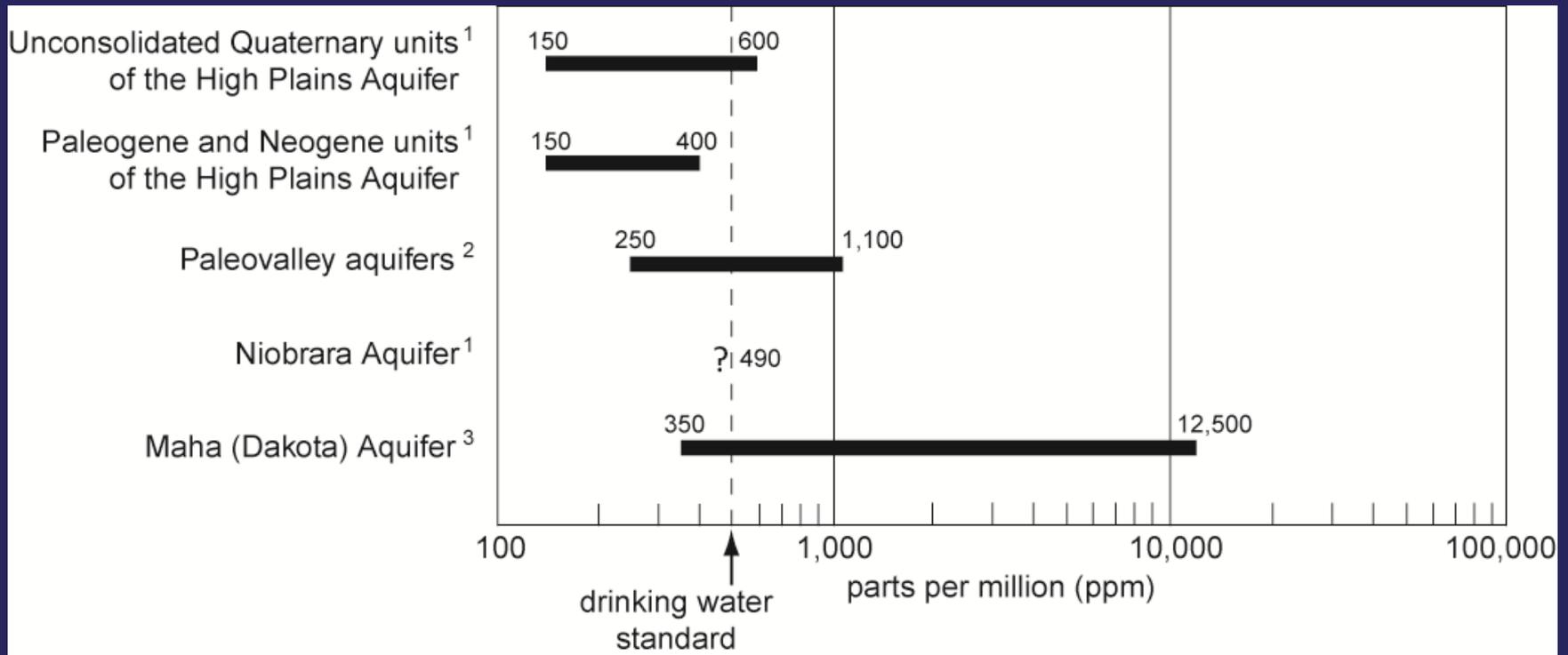
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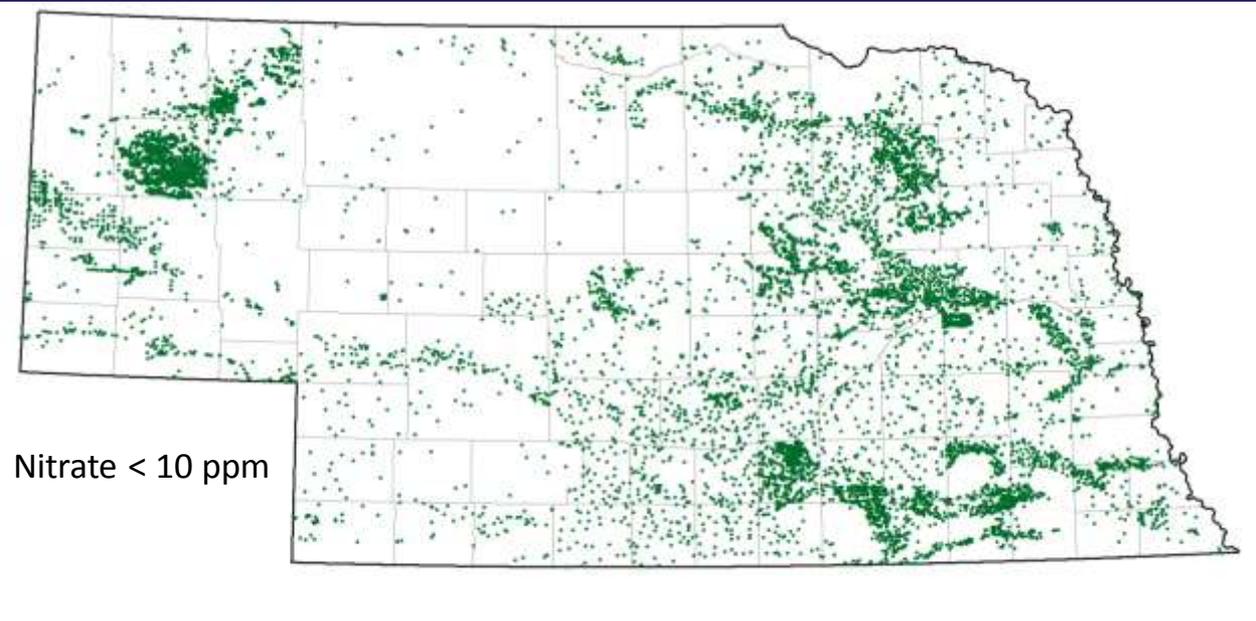
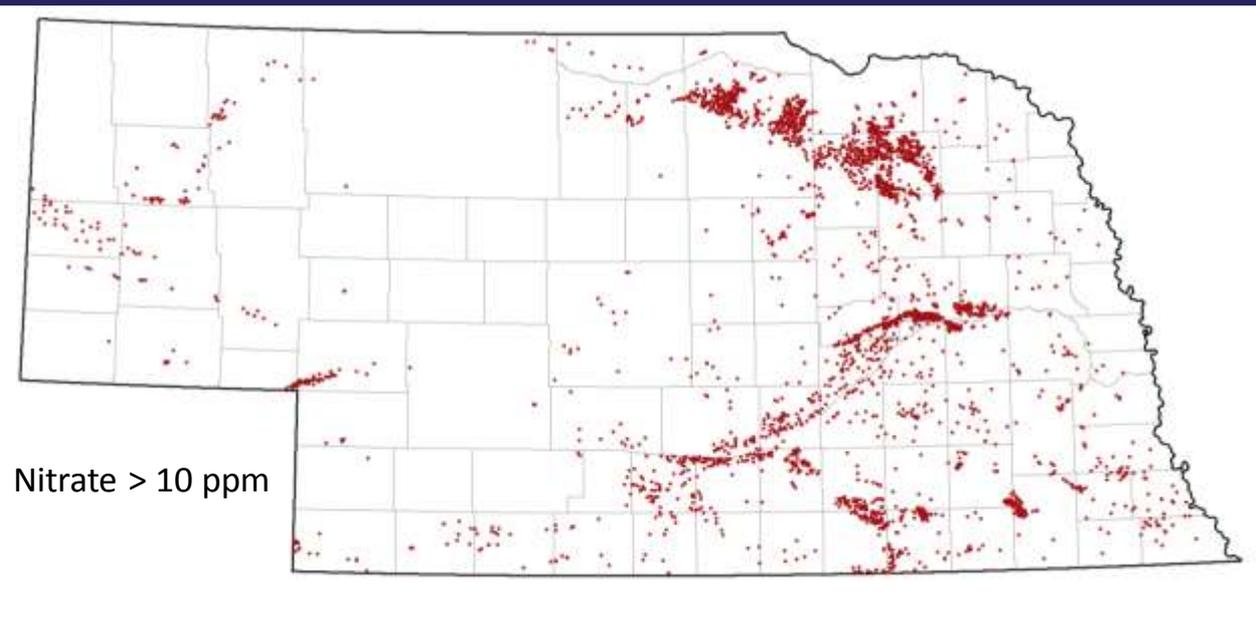
4. Water quality



Natural water quality is generally best in shallowest, youngest aquifers



Nitrate
contamination
is problematic
in some areas





What
is the

VALUE

of water?