GROUND-WATER LEVELS AND RIVER-AQUIFER INTERACTIONS IN THE UPPER ARKANSAS RIVER CORRIDOR IN SOUTHWEST KANSAS

Presentation for
Upper Arkansas CREP Educational Meetings

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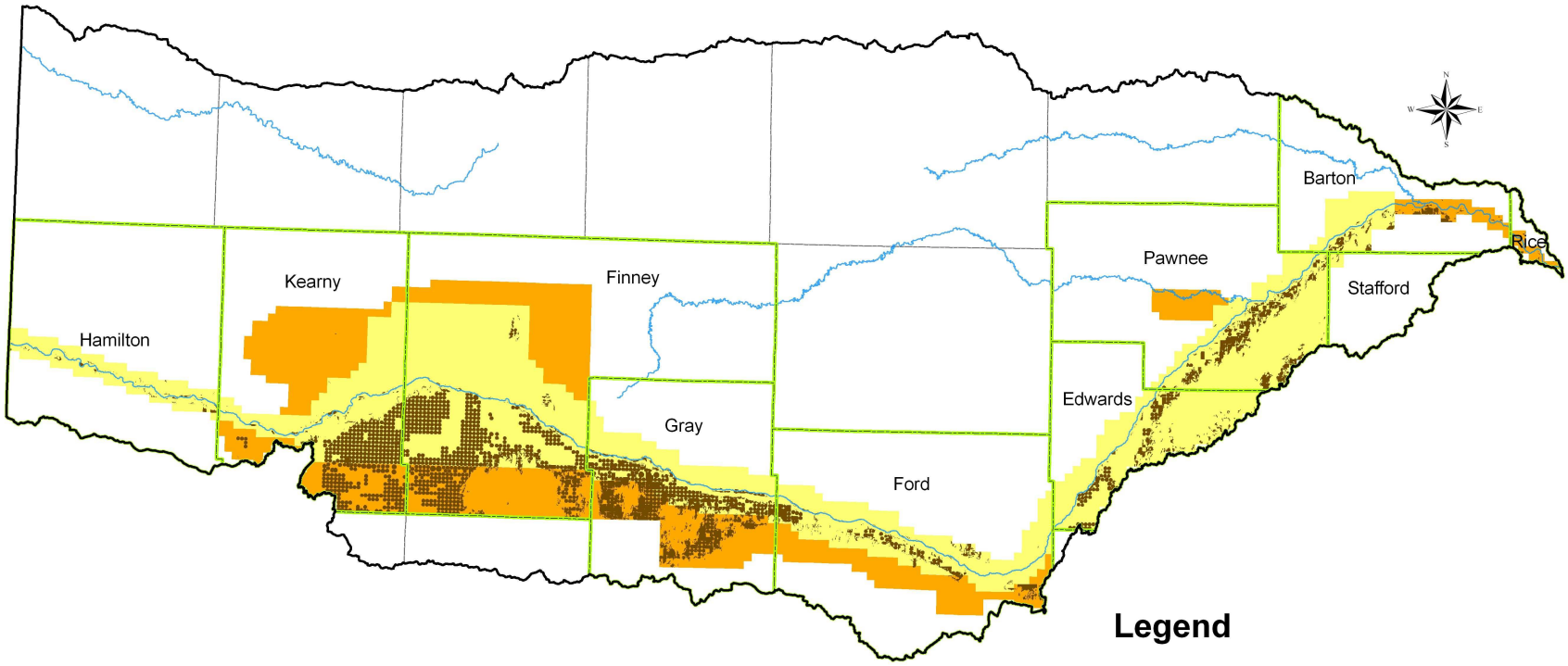
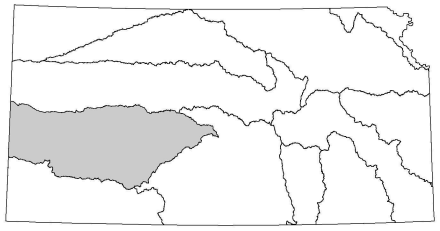
University of Kansas
Lawrence, Kansas

Information from the
Upper Arkansas River Corridor Study and
the Ogallala Aquifer Technical Support Study,
Kansas Water Plan Projects

Upper Arkansas River
Conservation Reserve Enhancement Program (CREP)





Kansas Water Office, September 2006

30 15 0 30 Miles

N
W E
S

Legend

- Upper Arkansas River Basin
- Rivers & Streams
- CREP Counties
- County

CREP Priority Areas

- Tier 1 Soils Unsuitable for Dryland Agriculture
- Tier 1
- Tier 2

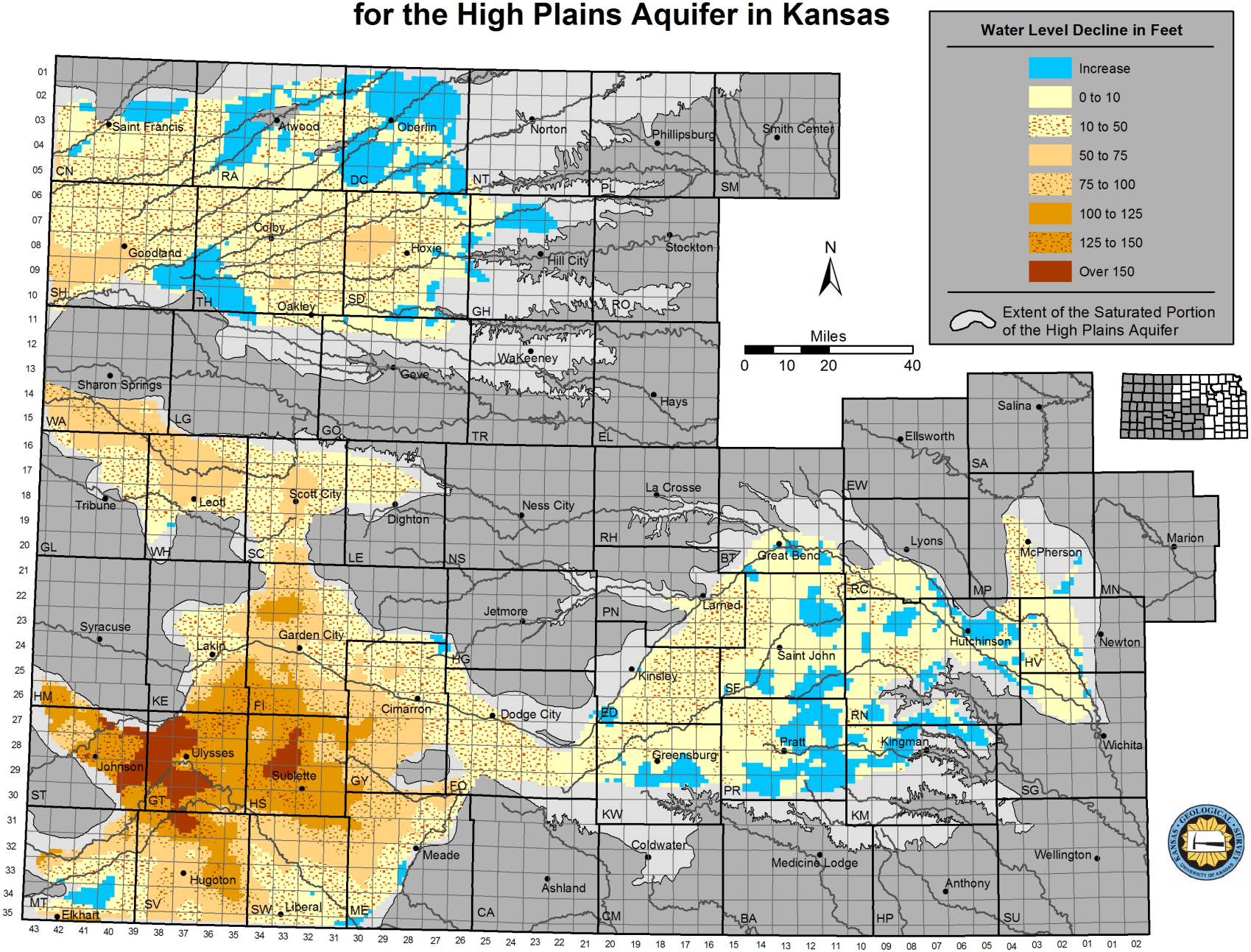
HYDROLOGIC RESPONSES TO CHANGES IN BASIN

- Ground-water levels have declined along the Upper Arkansas River corridor in southwest Kansas in response to consumptive pumping from the alluvial and High Plains aquifers.
- Water-level declines in the alluvial aquifer cause Arkansas River water to seep into the aquifer rather than flowing downstream. Only very high flows from Colorado can pass through southwestern Kansas to reach the Middle Arkansas subbasin.
- Water-level declines along the river valley have produced a downward hydraulic gradient that results in ground-water flow from the alluvial aquifer to the underlying High Plains aquifer.
- Regional water-level declines have produced a ground-water ridge along the river corridor such that ground-water flow is changing from a west to east direction during predevelopment time towards north and south directions away from the river valley.

WATER-QUALITY RESPONSES TO CHANGES IN BASIN

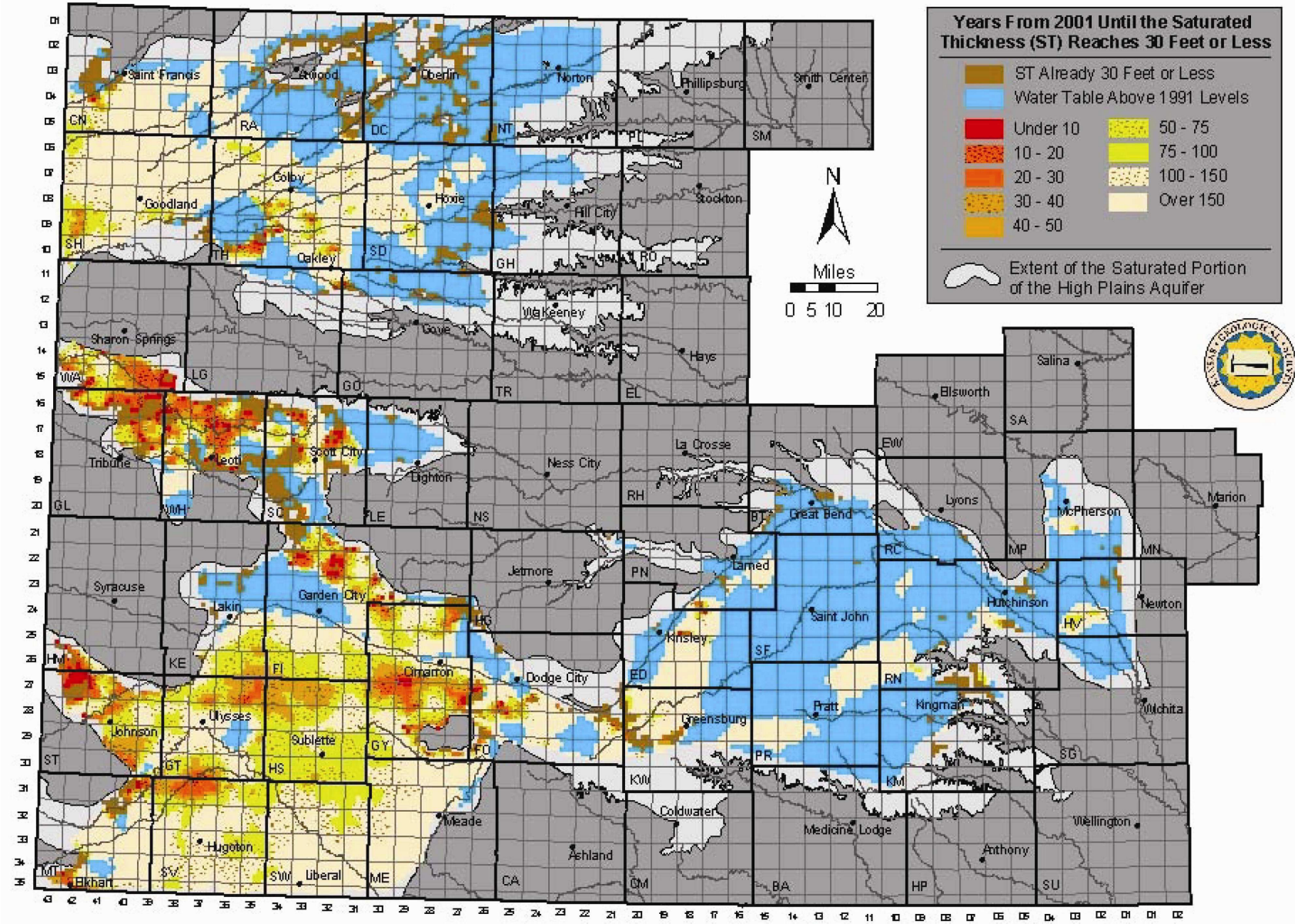
- Ground water in the alluvial aquifer has become saline because Arkansas River water, which is saline during both low and high flows, seeps into the aquifer. The dissolved solids concentration in the ground water is greatest in Hamilton and Kearny counties and decreases in a downstream direction.
- Ground water in the High Plains aquifer underlying the river valley has become saline due to downward flow of water from the overlying alluvial aquifer.
- Ground water in the High Plains aquifer underlying the area irrigated with diverted Arkansas River water has become saline due to downward seepage of water from the irrigated fields. Recycling of the saline ground water pumped from the High Plains aquifer for irrigation is increasing the water salinity.
- Saline ground water in the High Plains aquifer is flowing outwards from the Arkansas River valley. The outward flow rate is greatest in Kearny, Finney, and Gray counties.

Change in Water Level Elevations, Predevelopment to Average 2004-2006, for the High Plains Aquifer in Kansas



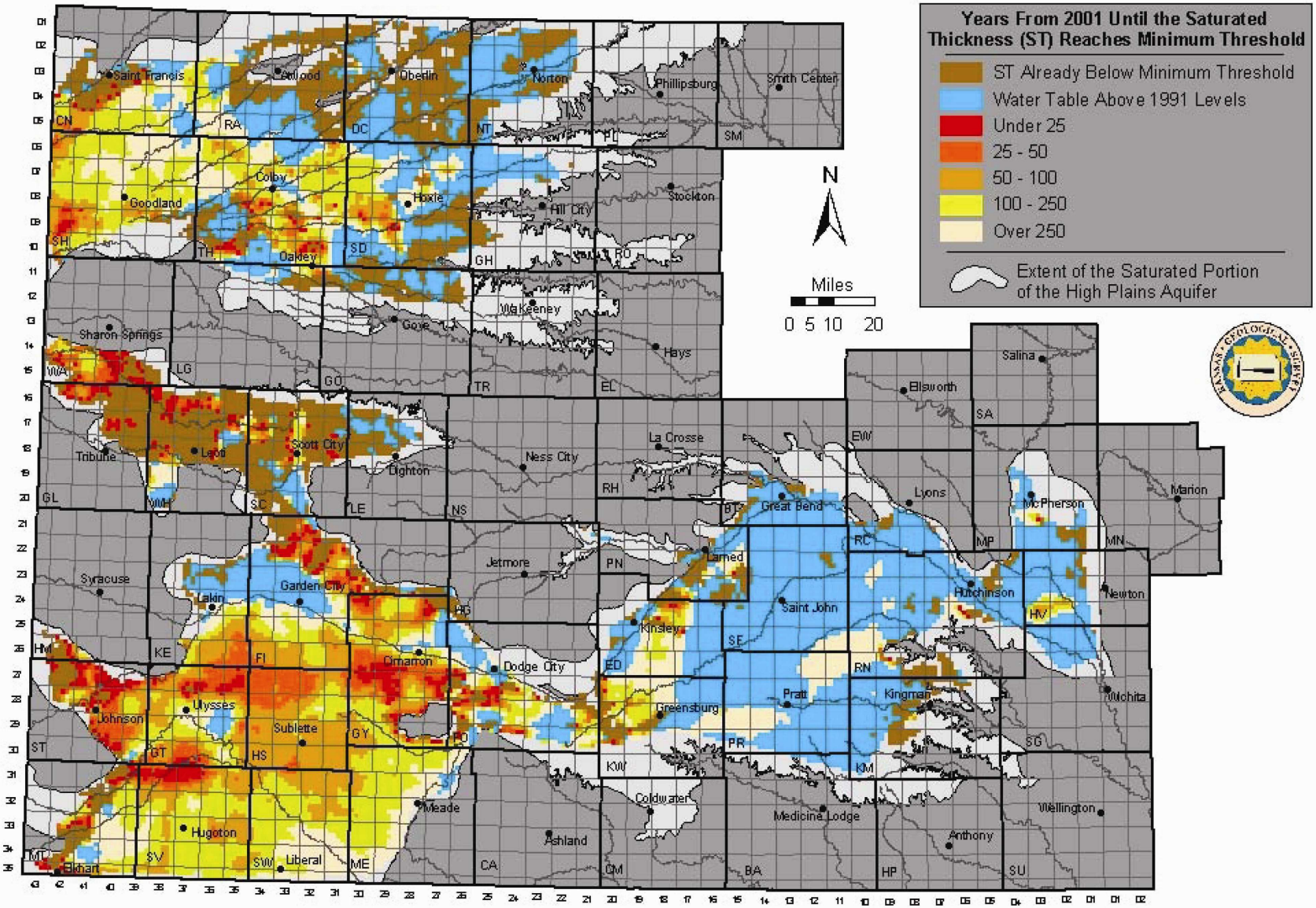
Kansas Geological Survey

Estimated Usable Lifetime for the High Plains Aquifer in Kansas
(Based on ground water trends from 1991 to 2001 and 30 feet saturated thickness threshold)



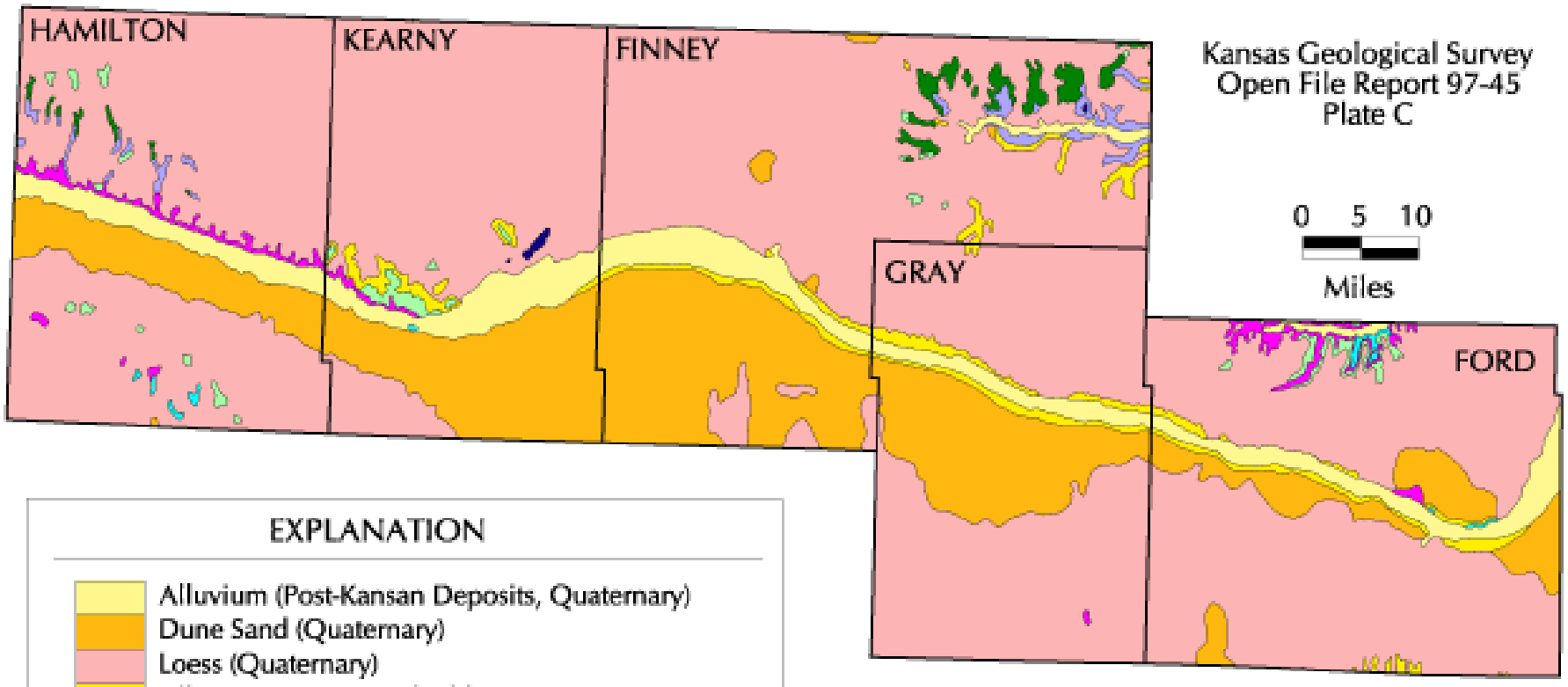
From Kansas Geological Survey Open-File Report 2002-25D: www.kgs.ku.edu/HighPlains/OHP/2002_25D.pdf

Estimated Usable Lifetime for the High Plains Aquifer in Kansas
(Based on ground water trends from 1991 to 2001 and the minimum saturated thickness required to support well yields at 400 gpm under a scenario of 90 days of pumping with wells on 1/4 section)



From Kansas Geological Survey Open-File Report 2002-25D: www.kgs.ku.edu/HighPlains/OHP/2002_25D.pdf

Surface Geology in the Upper Arkansas River Corridor Study Area



Kansas Geological Survey
Open File Report 97-45
Plate C

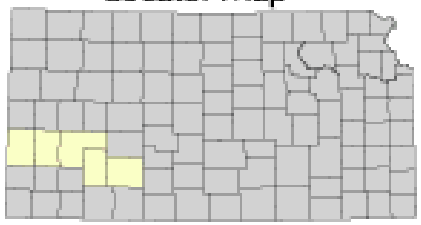
0 5 10
Miles

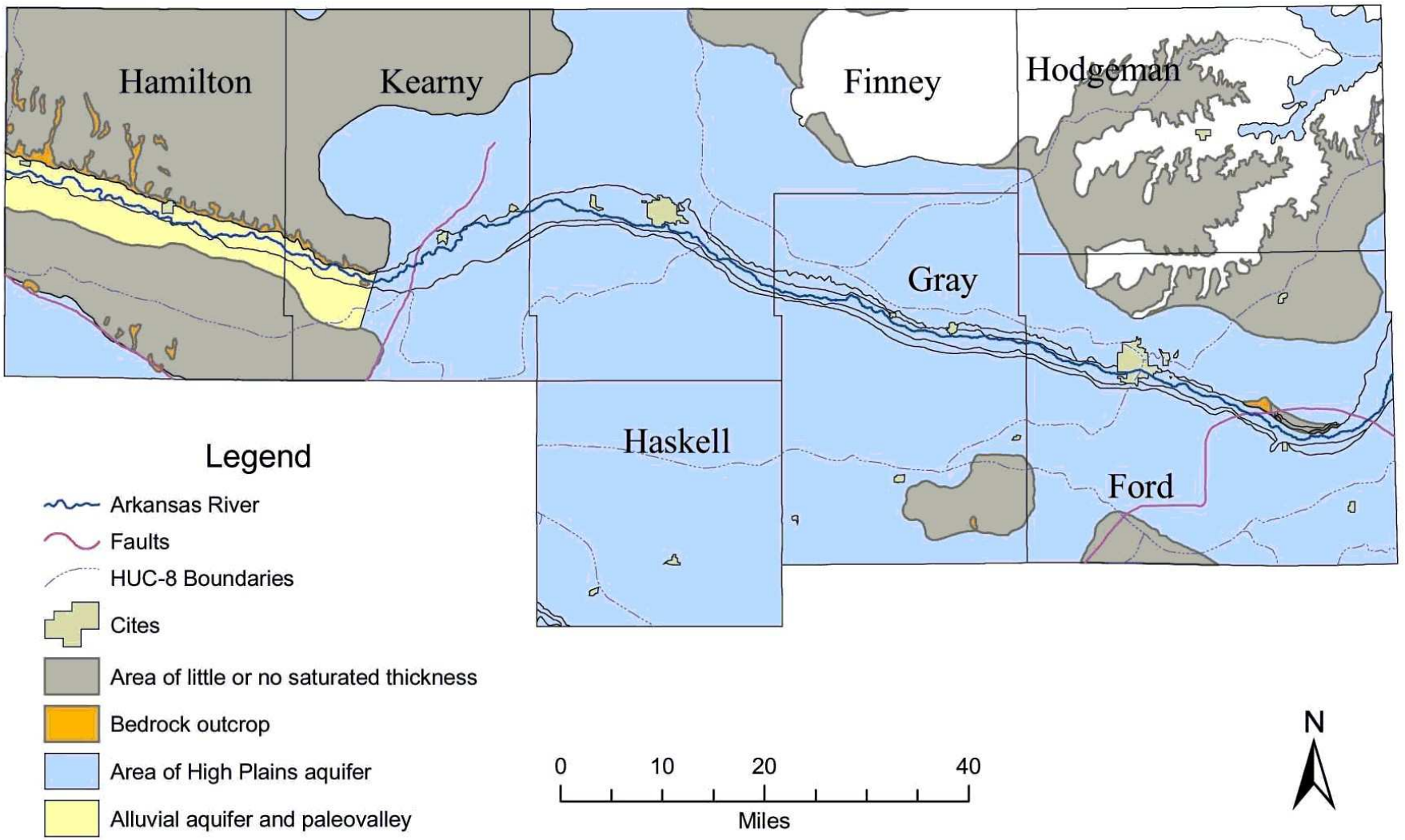
EXPLANATION

- Alluvium (Post-Kansan Deposits, Quaternary)
- Dune Sand (Quaternary)
- Loess (Quaternary)
- Alluvium (Kansan and Older Deposits, Quaternary)
- Ogallala (Tertiary)
- Niobrara Chalk (Cretaceous)
- Carlile Shale (Cretaceous)
- Greenhorn Limestone (Cretaceous)
- Dakota Formation (Cretaceous)
- Water

N

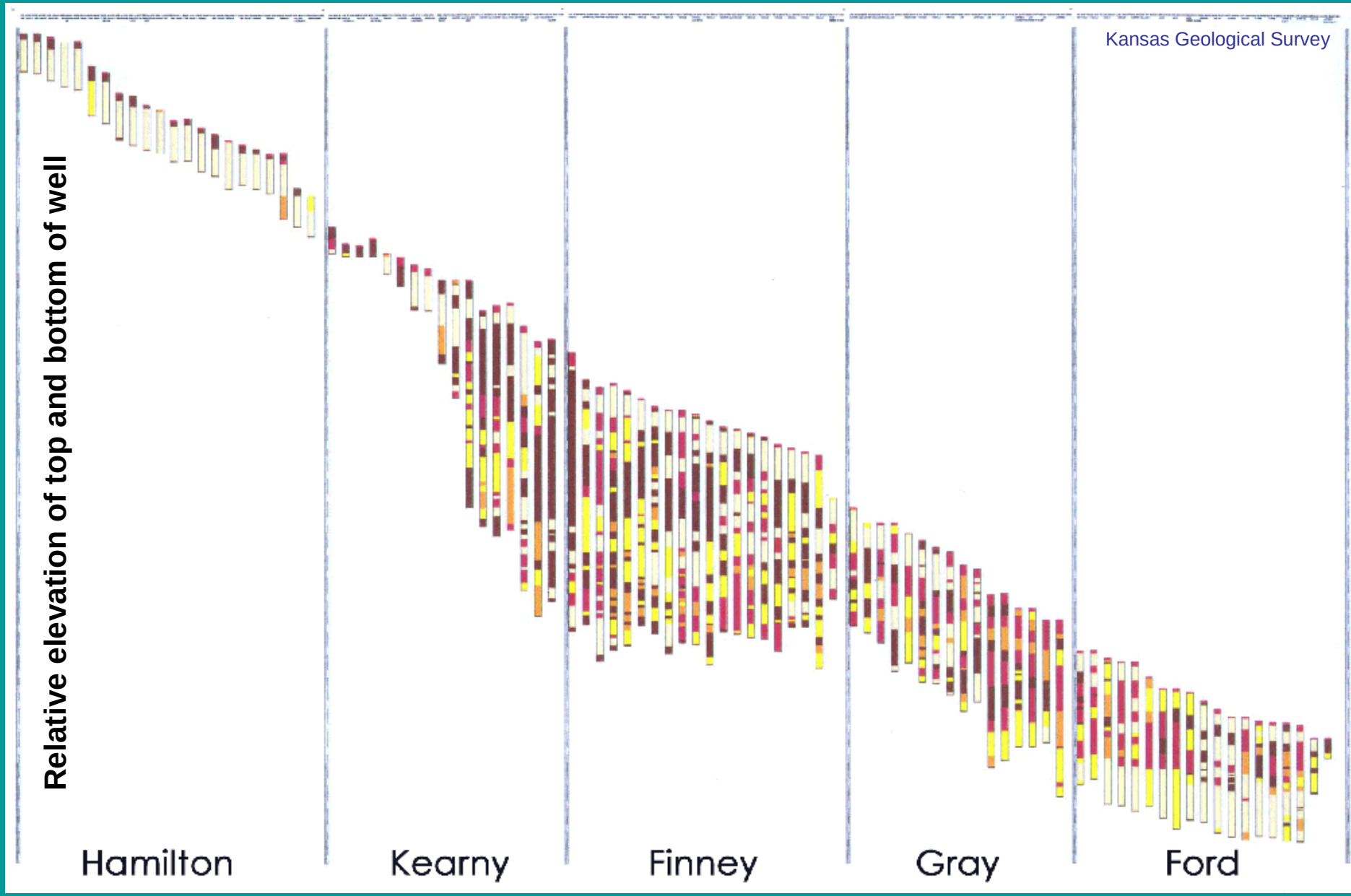
Locator Map



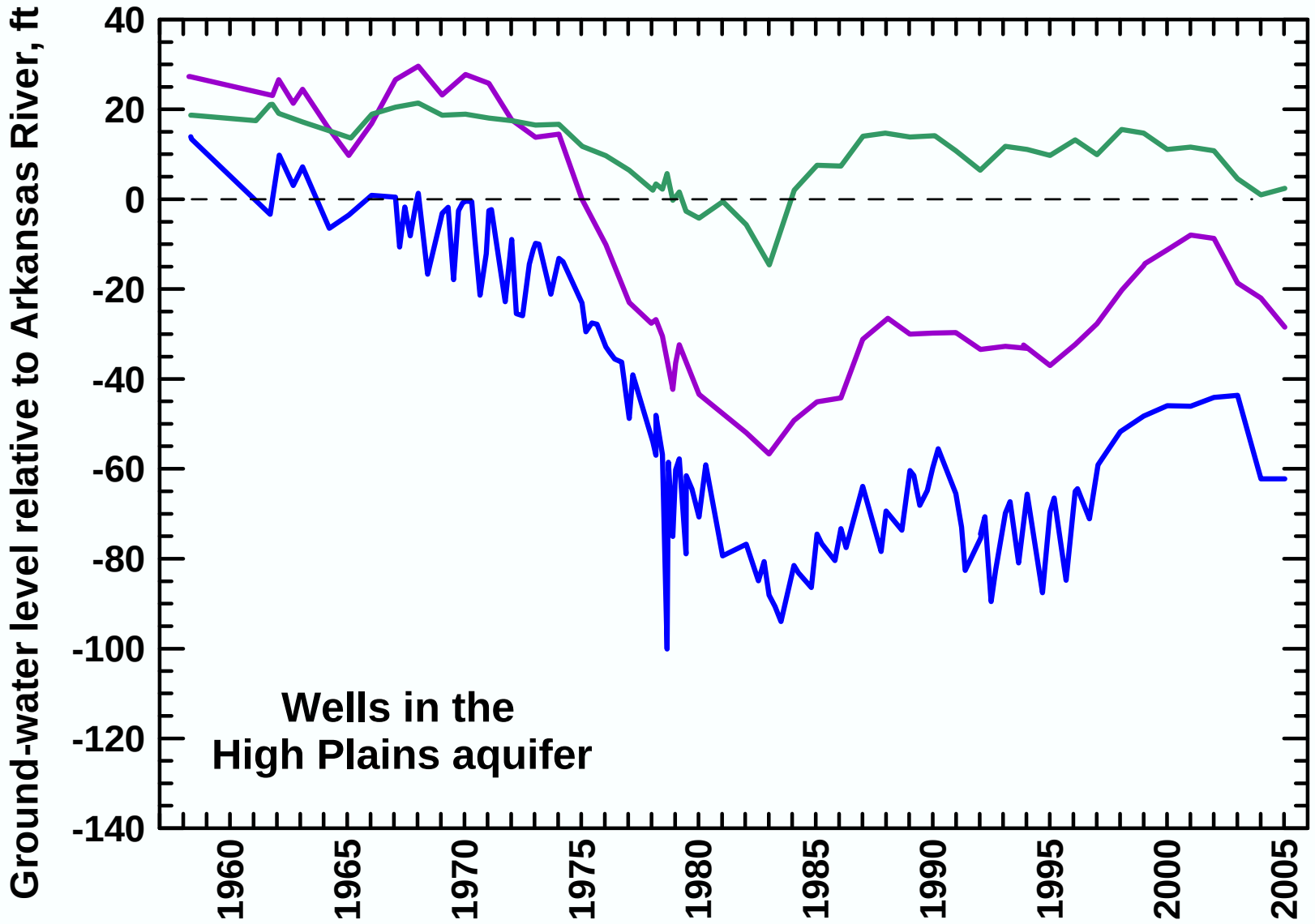


Location of the High Plains and alluvial aquifers in the area of the upper Arkansas River corridor

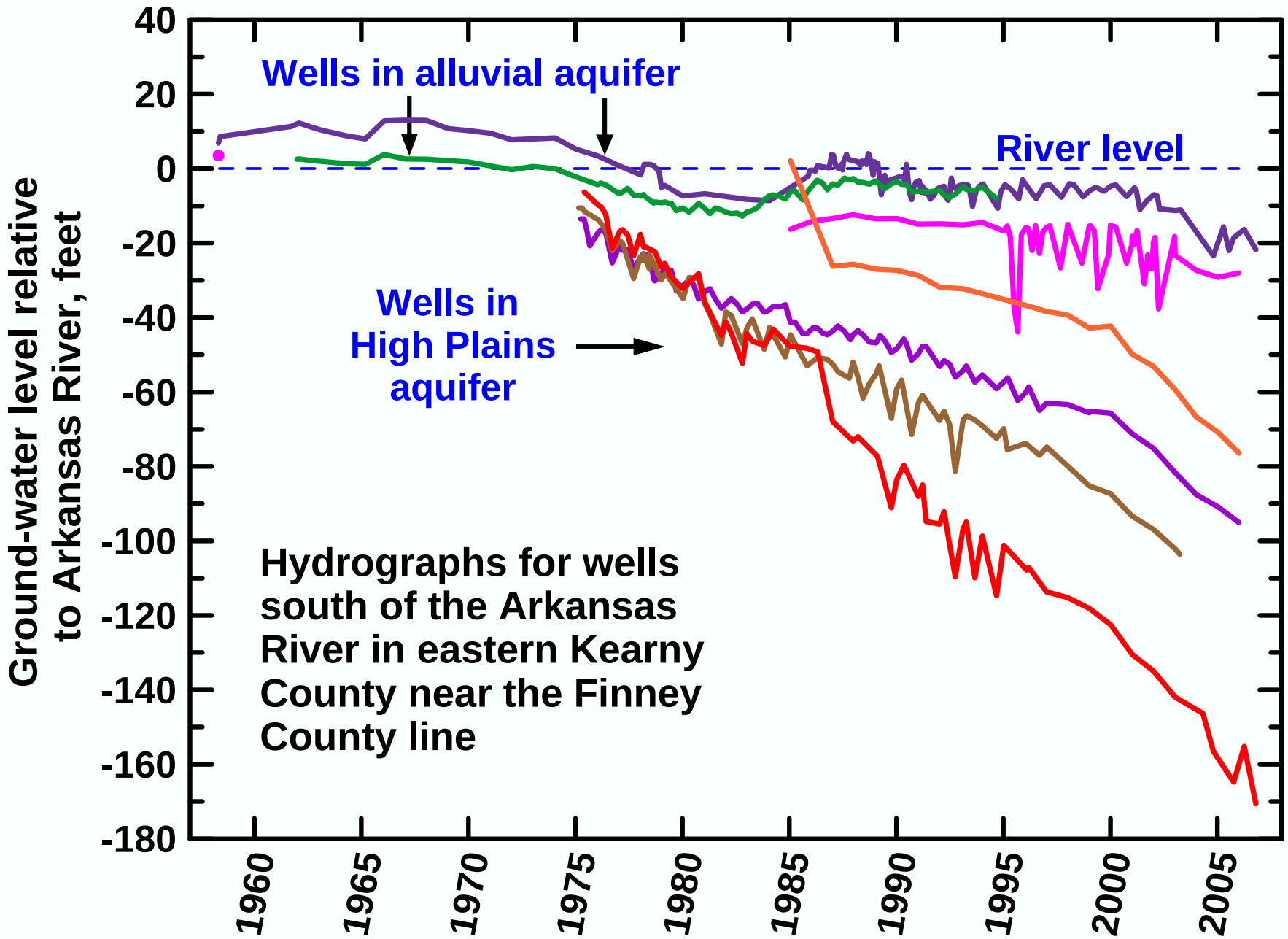
Profile of the High Plains and alluvial aquifers along the Arkansas River

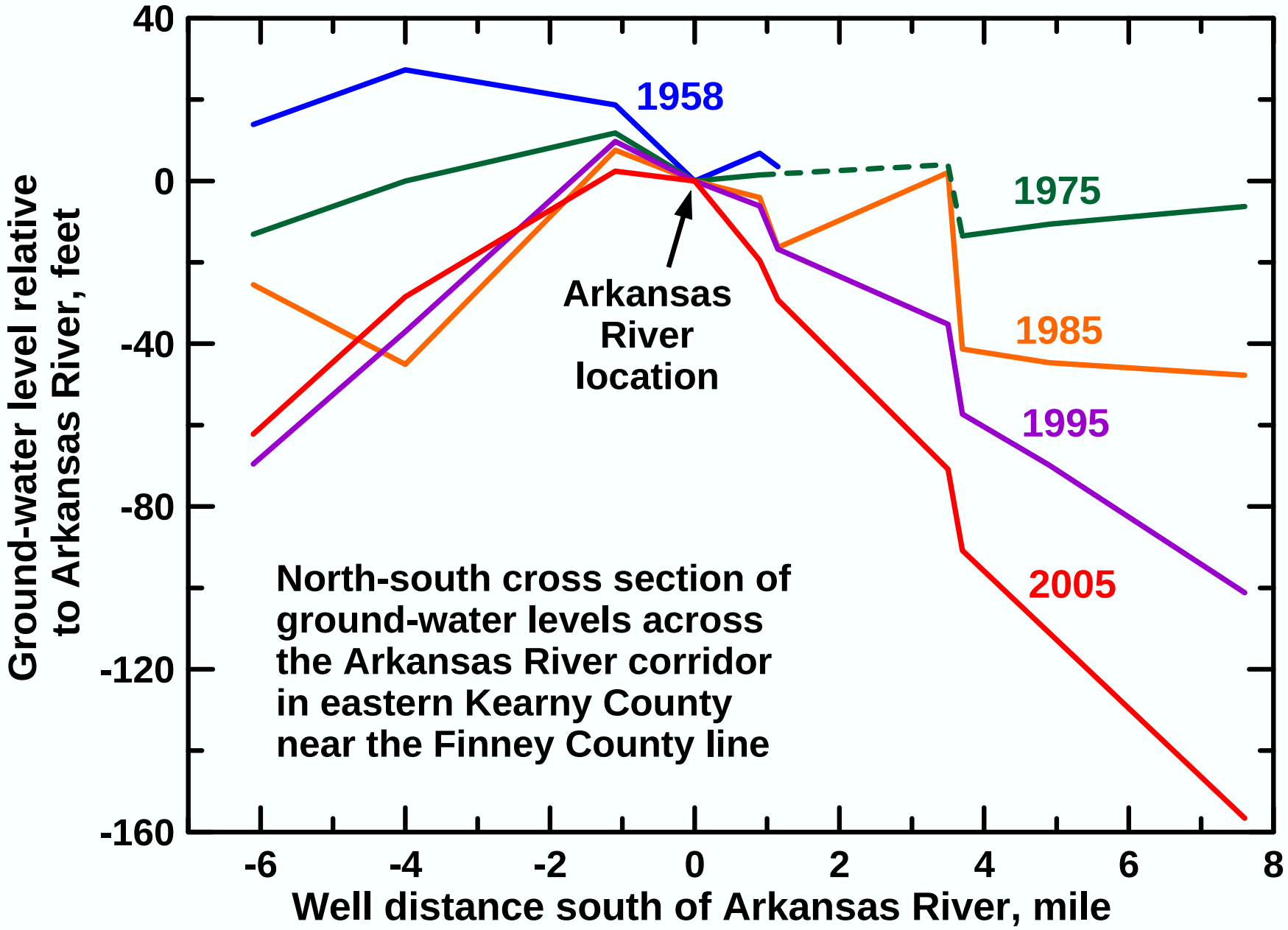


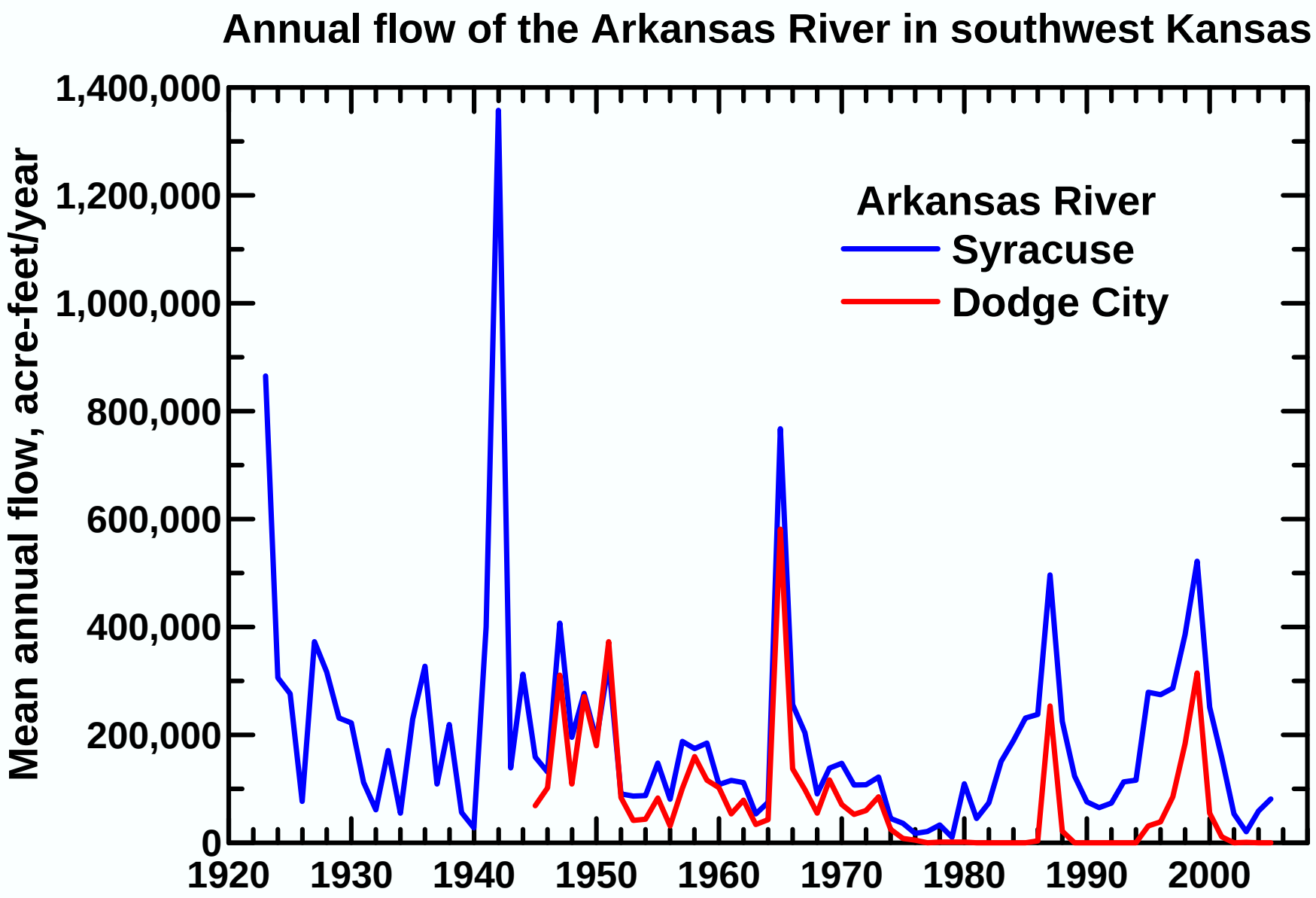
Each column represents the sediment recorded during drilling of a well



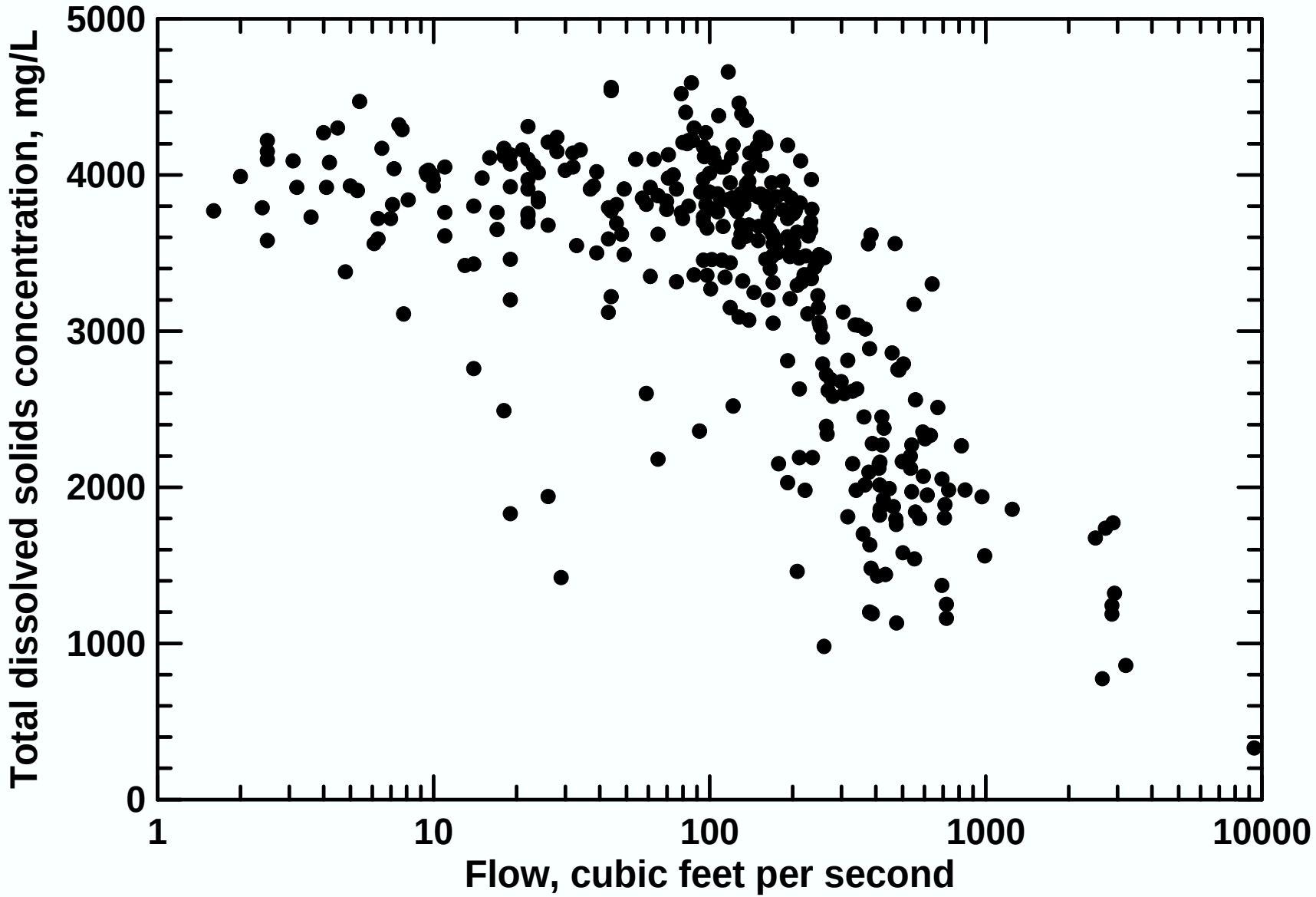
Hydrographs for wells north of the Arkansas River in eastern Kearny County near the Finney County line.


Wells in alluvial aquifer
River level
Wells in
High Plains
aquifer
Hydrographs for wells
south of the Arkansas
River in eastern Kearny
County near the Finney
County line
Ground-water level relative
to Arkansas River, feet
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005

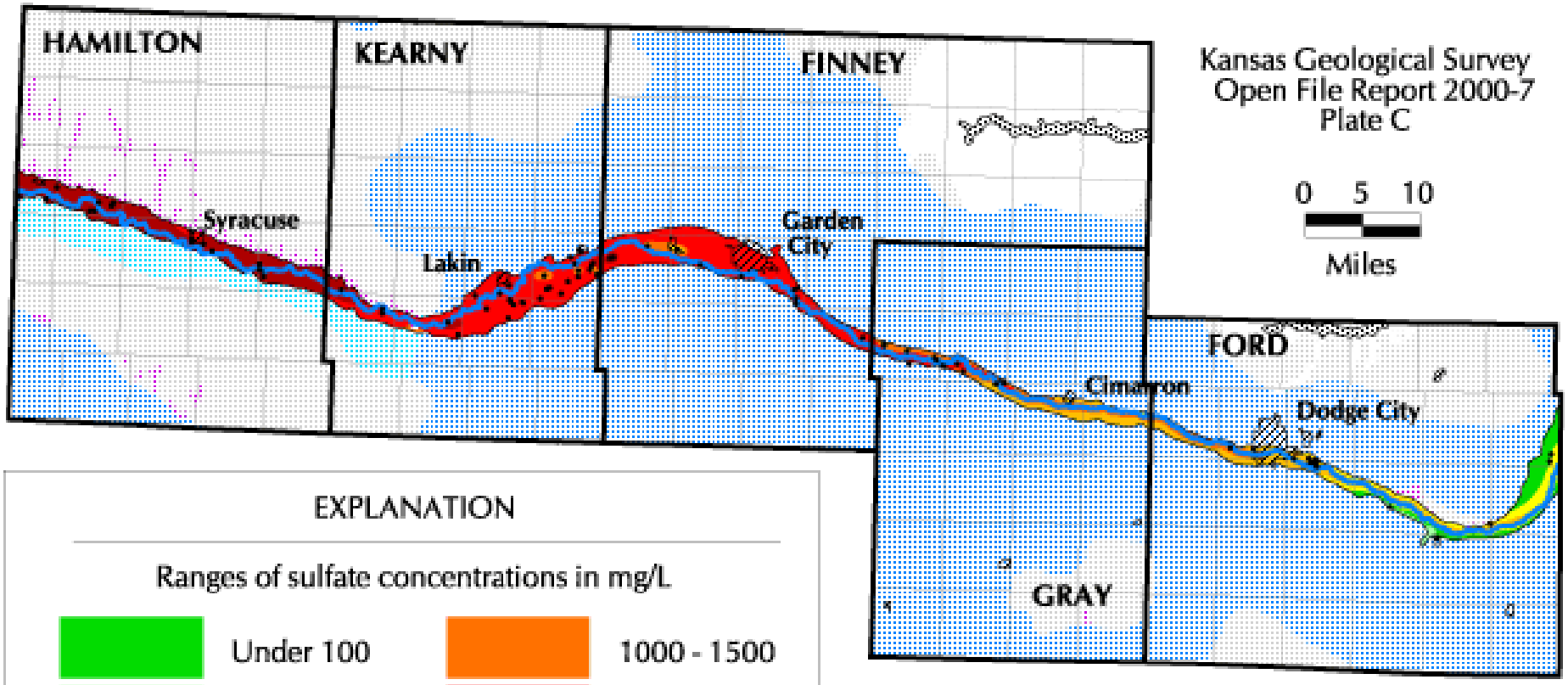

40
0
-40
-80
-120
-160
-6
-4
-2
0
2
4
6
8
Ground-water level relative to Arkansas River, feet
Well distance south of Arkansas River, mile
1958
1975
1985
1995
2005
Arkansas River location
North-south cross section of ground-water levels across the Arkansas River corridor in eastern Kearny County near the Finney County line


Annual flow of the Arkansas River in southwest Kansas
Mean annual flow, acre-feet/year
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1920
1930
1940
1950
1960
1970
1980
1990
2000
Arkansas River
Syracuse
Dodge City

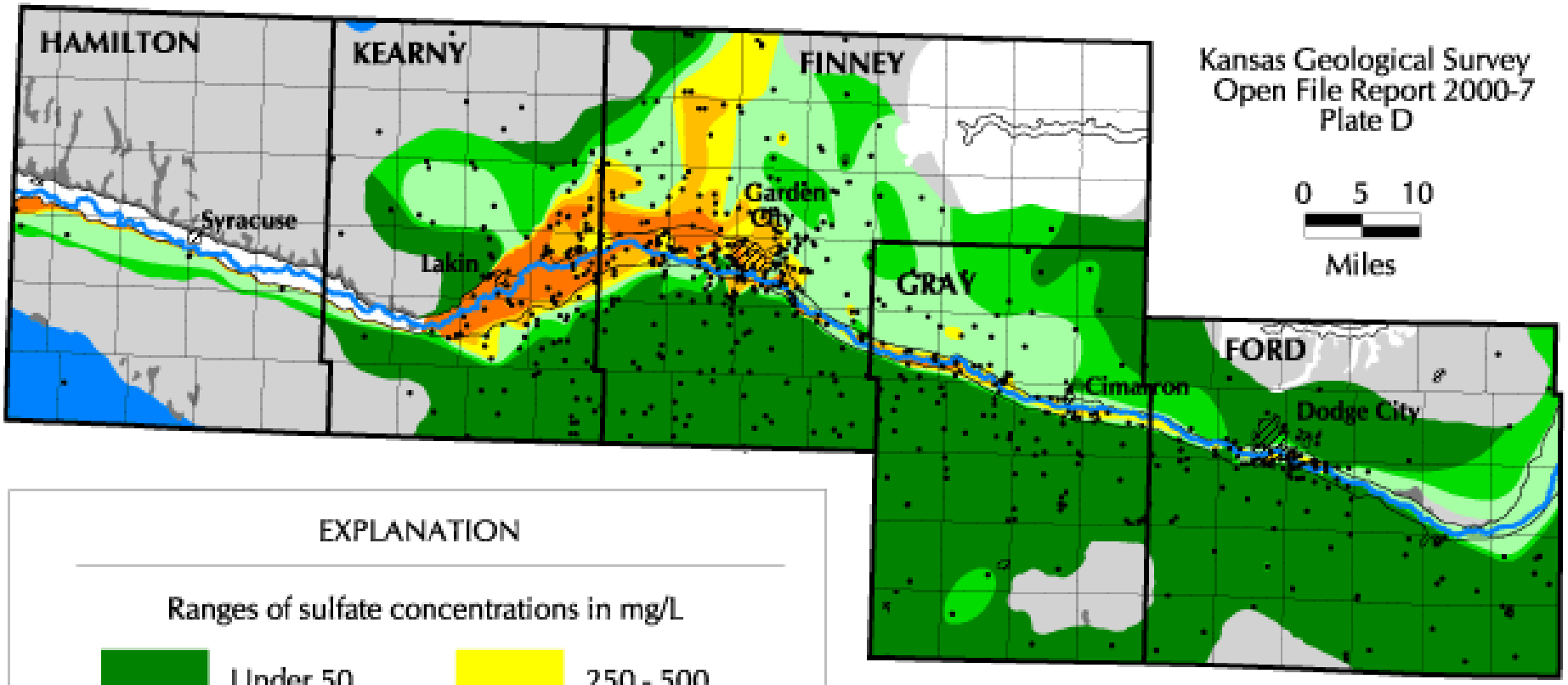
Water quality of the Arkansas River at the Colorado-Kansas state line



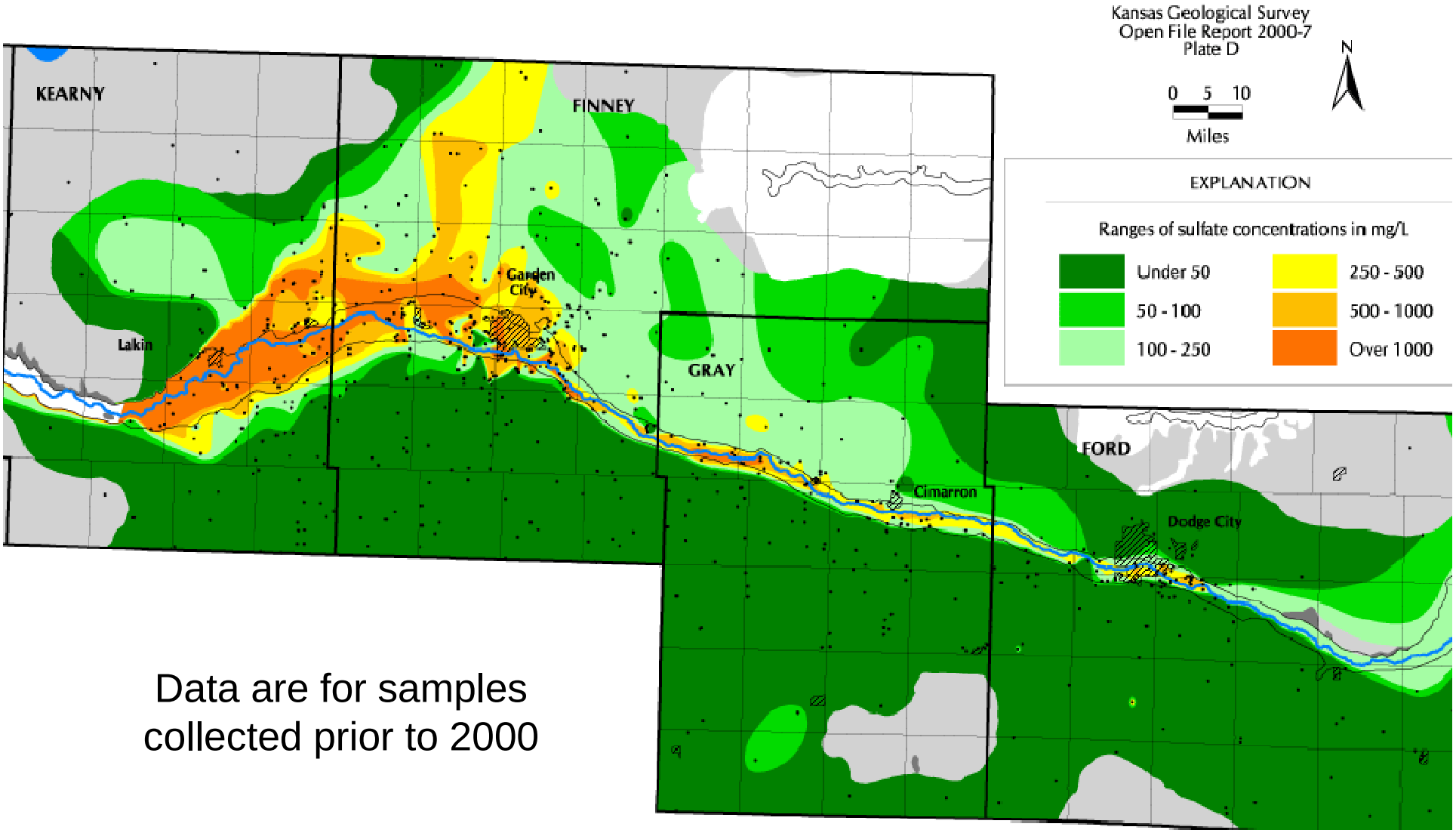
Sulfate Concentration in Ground Water in the Alluvial Aquifer in the Upper Arkansas River Corridor, Southwest Kansas



Sulfate Concentration in Ground Water in the High Plains Aquifer in the Upper Arkansas River Corridor, Southwest Kansas



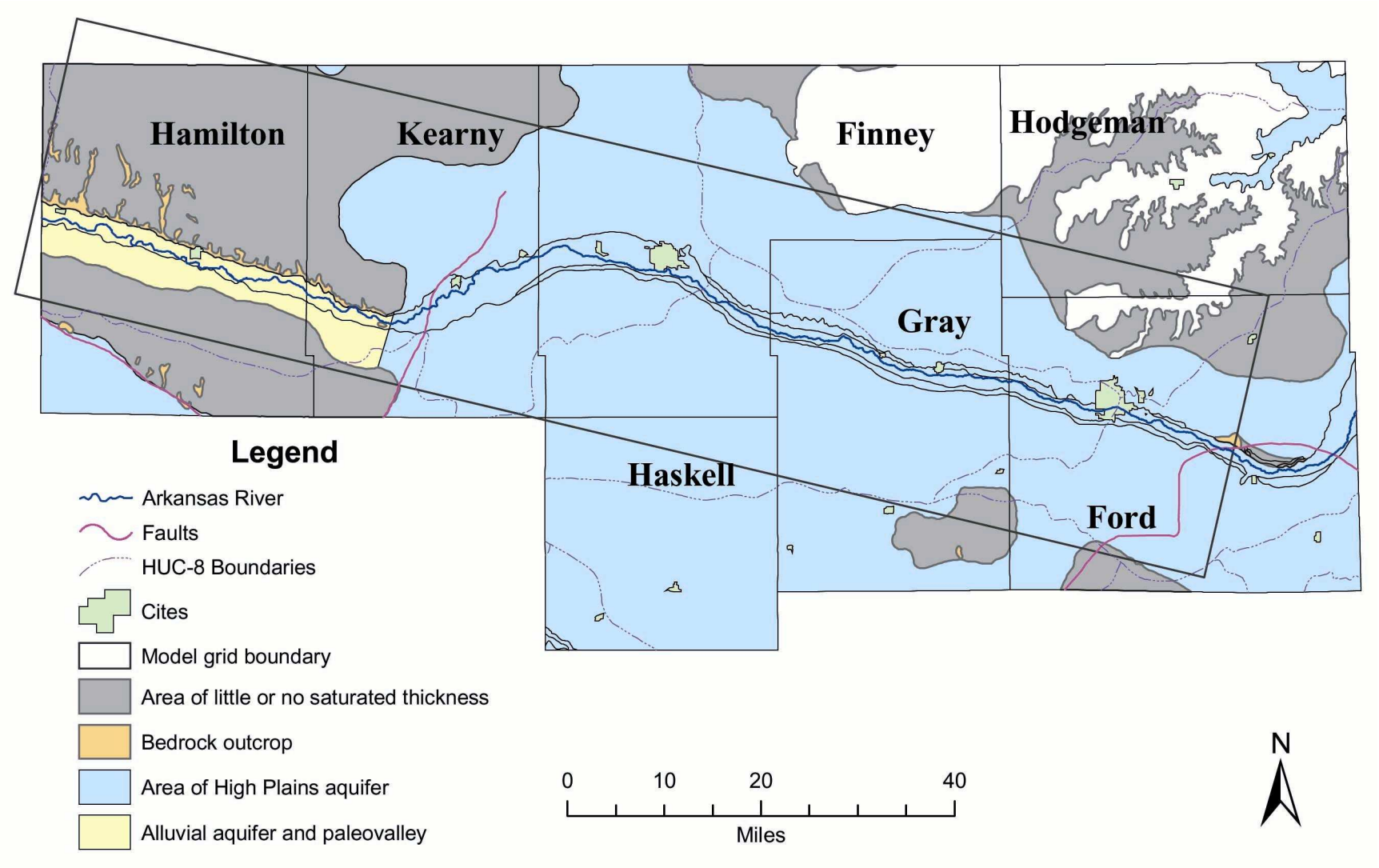
Sulfate Concentration in Ground Water in the High Plains Aquifer in the Upper Arkansas River Corridor in Southwest Kansas



Data are for samples collected prior to 2000

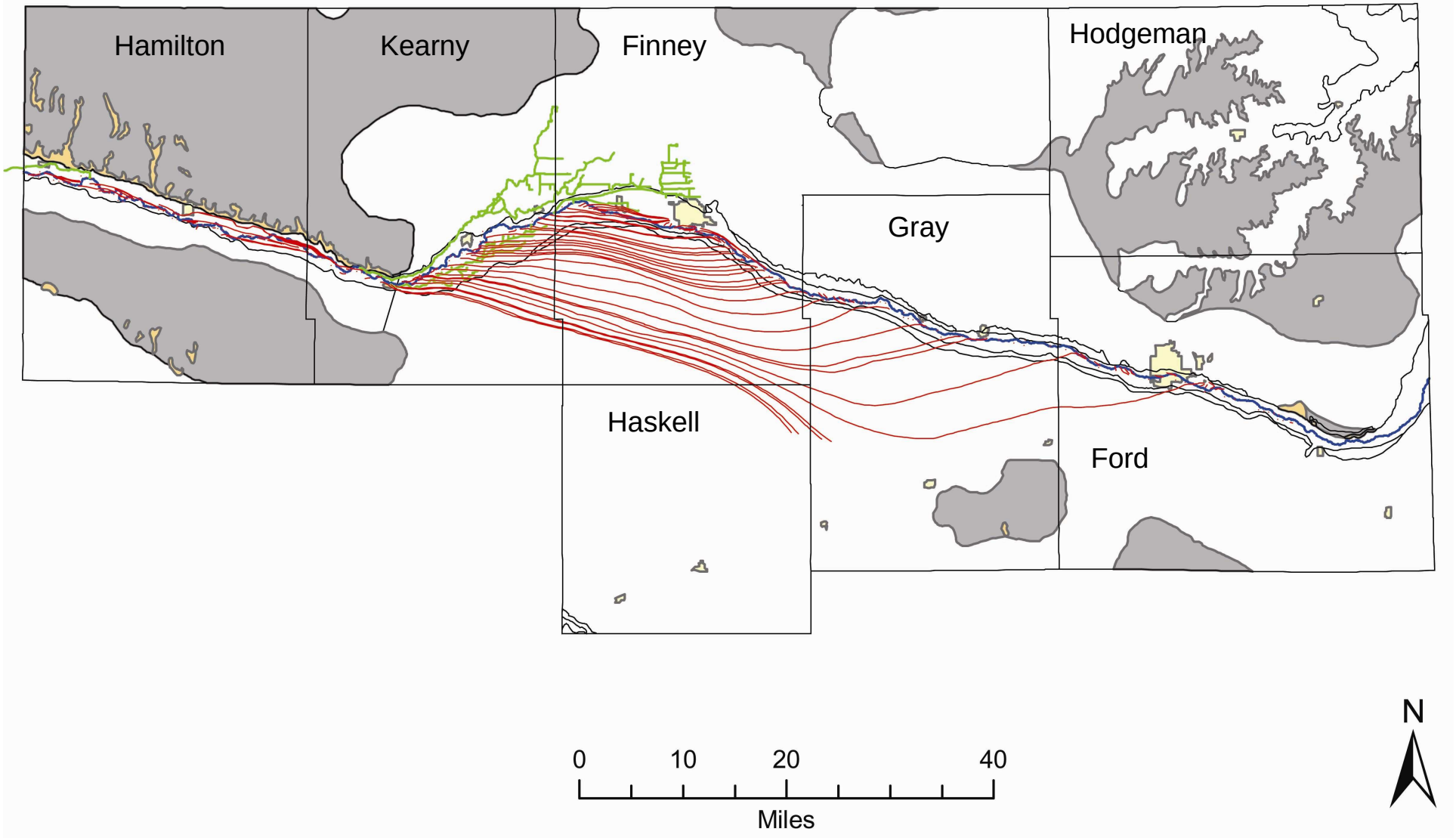
Ground-Water Flow Simulations
Upper Arkansas River Corridor Study

Particle paths during flow of ground water that show direction and distance of ground-water flow and movement of dissolved conservative constituents under different conditions

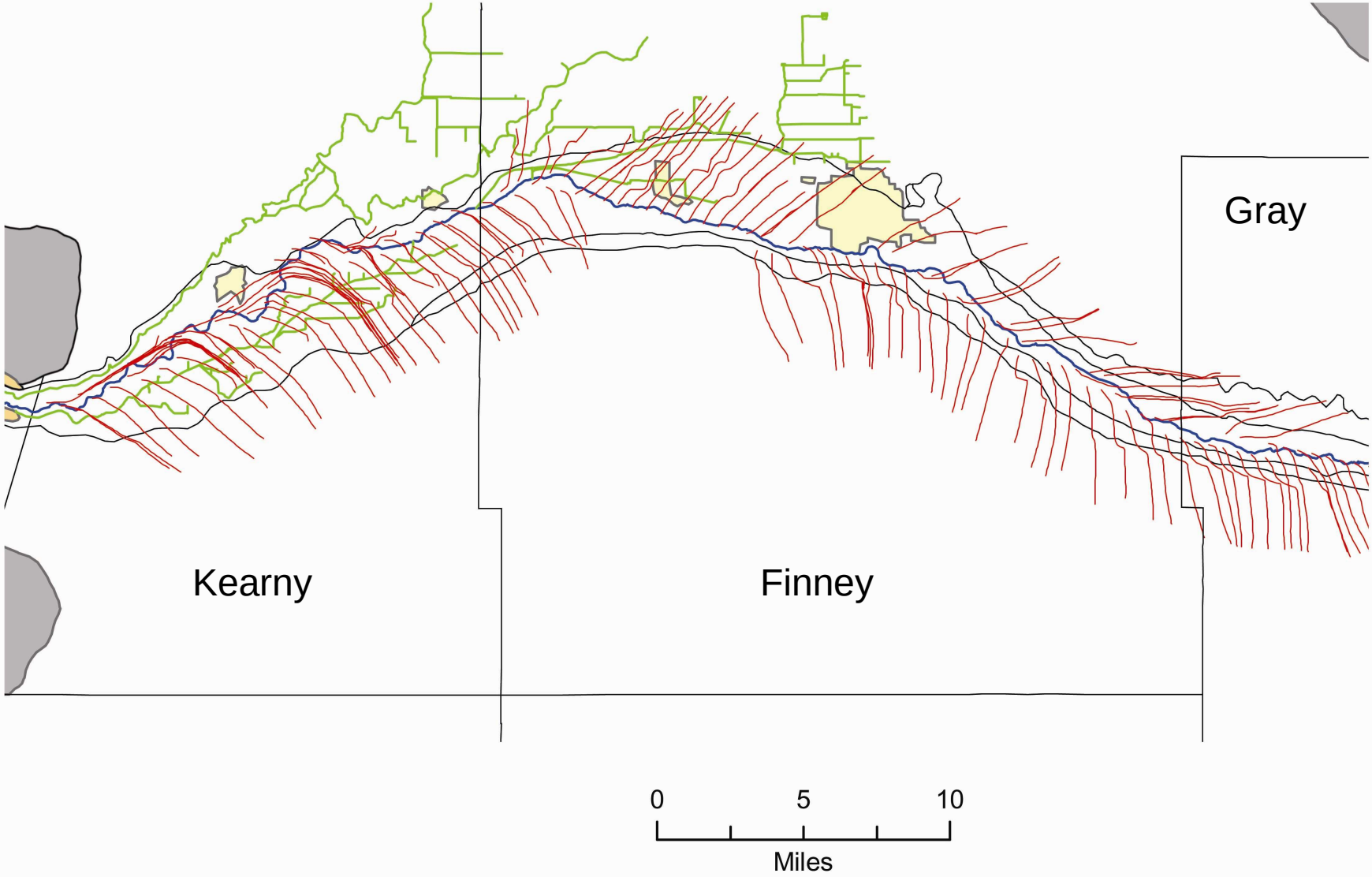


Location of regional model of upper Arkansas River corridor

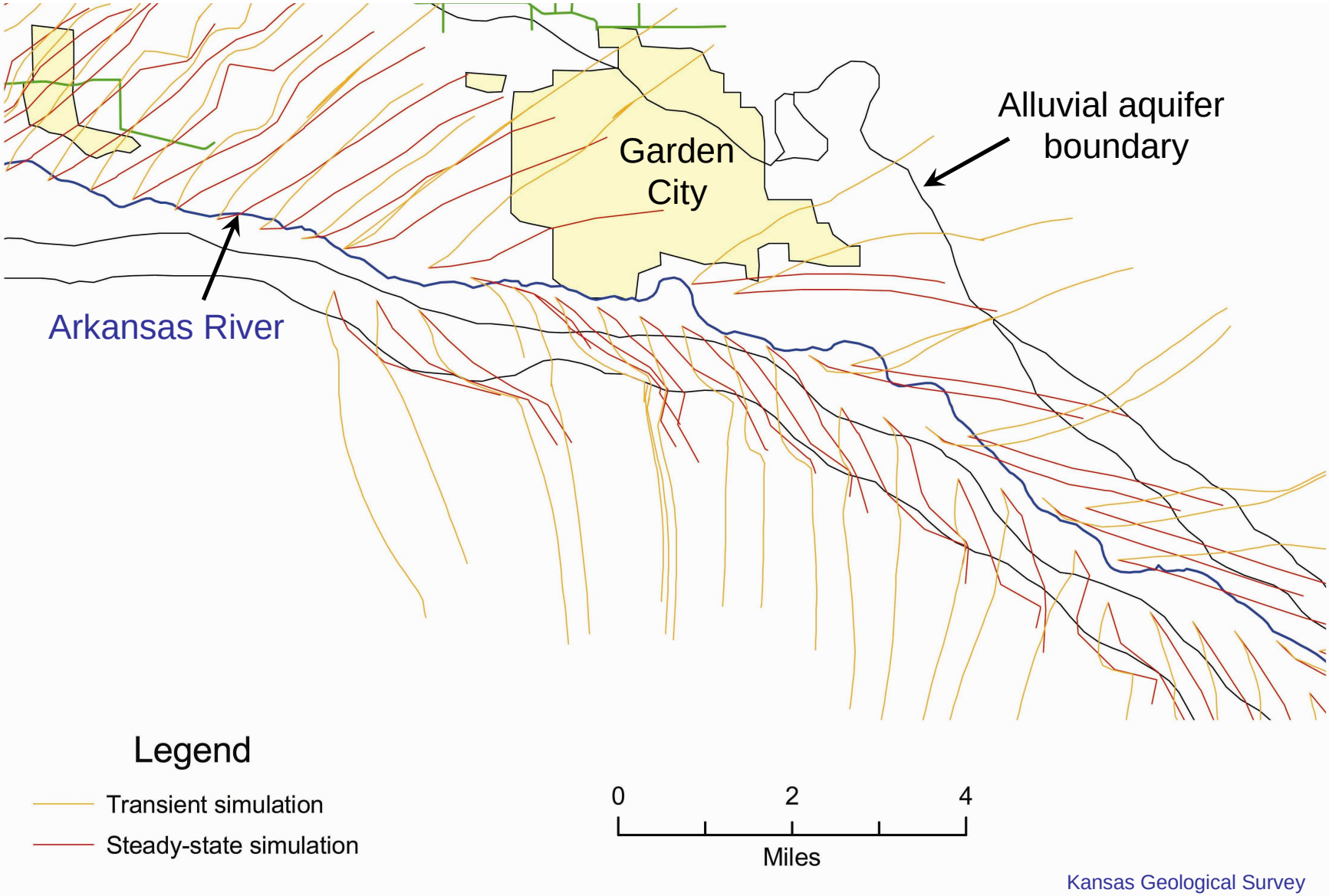
Particle flow paths for predevelopment (1940) steady-state simulation with particle origins in model cells along the Arkansas River



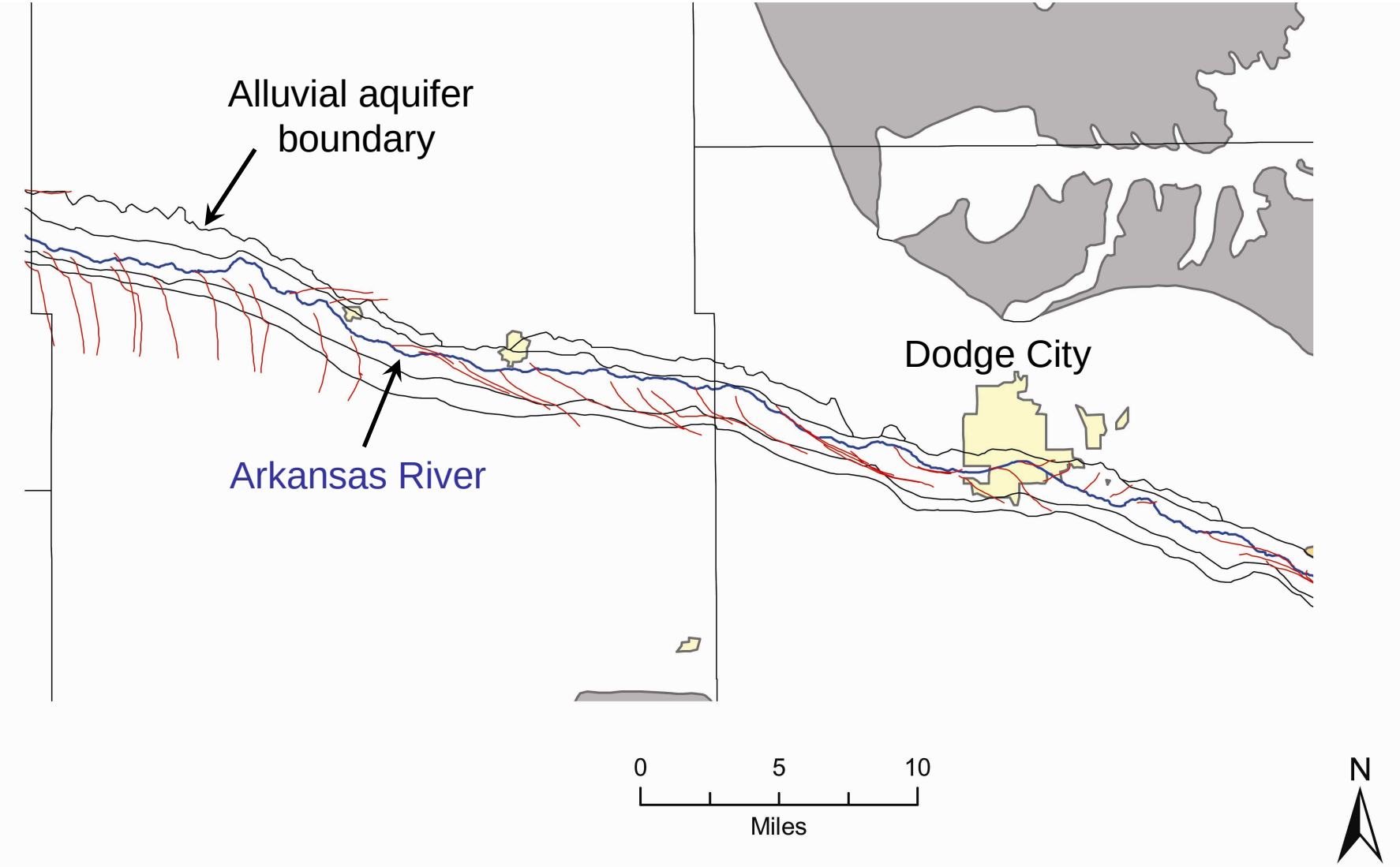
Particle flow paths for 40-year simulation of average 1990s water-use conditions with particle origins in model cells along the Arkansas River

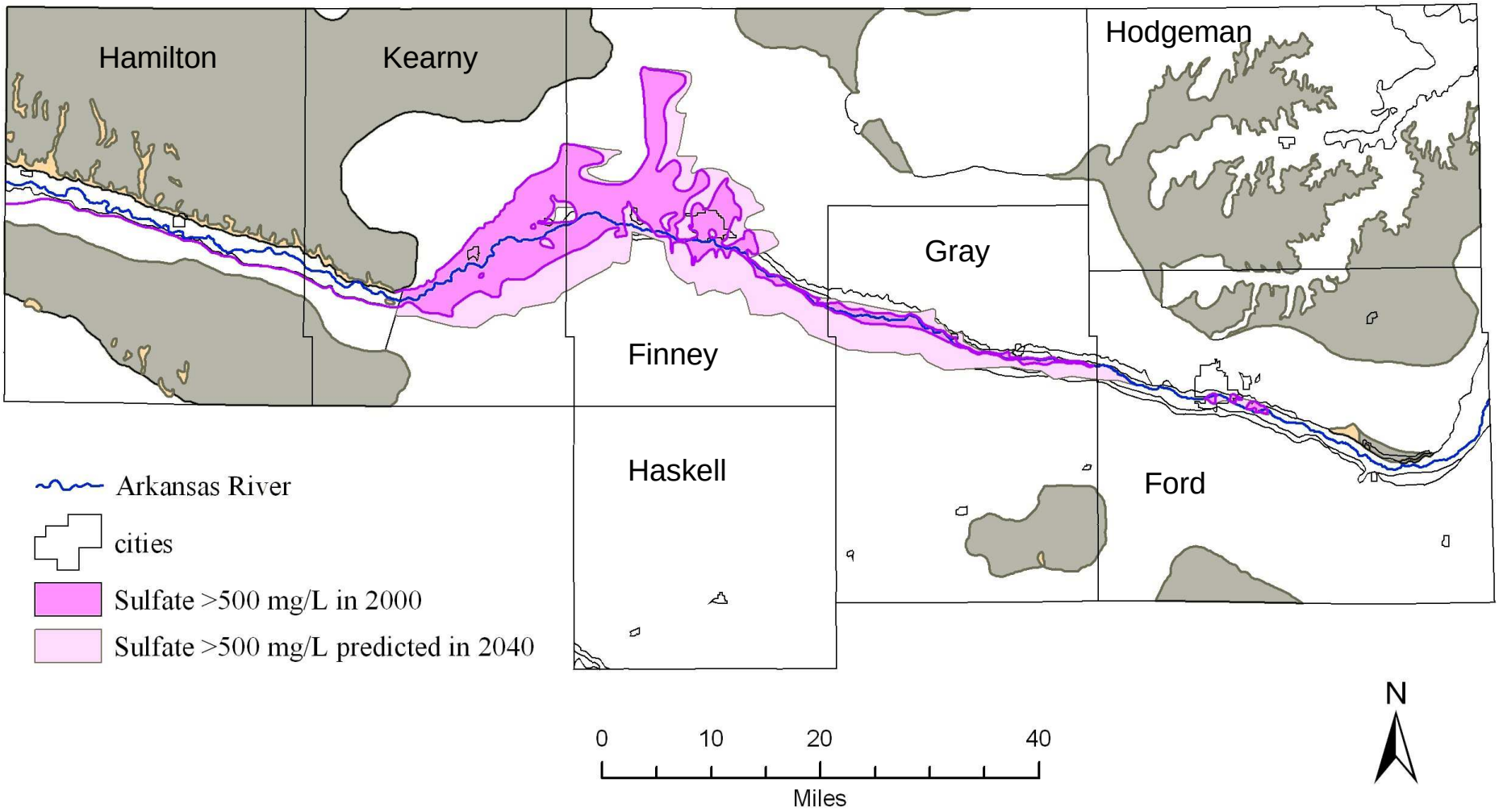


Comparison of particle flow paths for simulations based on 1990s water-use (red lines) and constant 1990s water levels (orange lines).



Particle paths (red lines) for simulation based on 1990s water use.





Predicted migration of saline ground-water in the High Plains aquifer along the Arkansas River corridor in 2040 based on average 1990's water use

From Kansas Geological Survey Open-File Report 2002-30: www.kgs.ku.edu/HighPlains/OHP/2002_30.pdf

HYDROLOGIC AND SALINITY RESPONSES TO FUTURE CHANGES IN THE ARKANSAS RIVER CORRIDOR

- Ground-water levels will continue to decline along the Upper Arkansas River corridor in southwest Kansas unless there are substantial reductions in consumptive pumping.
- Continuing water-level declines will increase the rate of Arkansas River water loss into the alluvial aquifer and underlying High Plains aquifer. This will decrease the river flow reaching the Middle Arkansas subbasin for a similar, past high flow from Colorado. More saline water from the Arkansas River will enter the alluvial and High Plains aquifers.
- Continuing water-level declines will increase the slopes of the ground-water ridge along the river corridor such that ground-water flow directions will continue to shift to directions away from the river. This will increase the flow rate of saline water in the High Plains aquifer outwards from the river valley.

Water resources future

Cloudy or bright?

Wet or dry?

Web sites – Home pages

High Plains/Ogallala Aquifer Information

http://www.kgs.ku.edu/HighPlains/index.htm

Upper Arkansas River Corridor Study

www.kgs.ku.edu/Hydro/UARC/index.html