Ground-Water Model and Pumping Scenarios for the Middle Arkansas River Subbasin

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Kansas Geological Survey

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HydroGeoLogic Inc.

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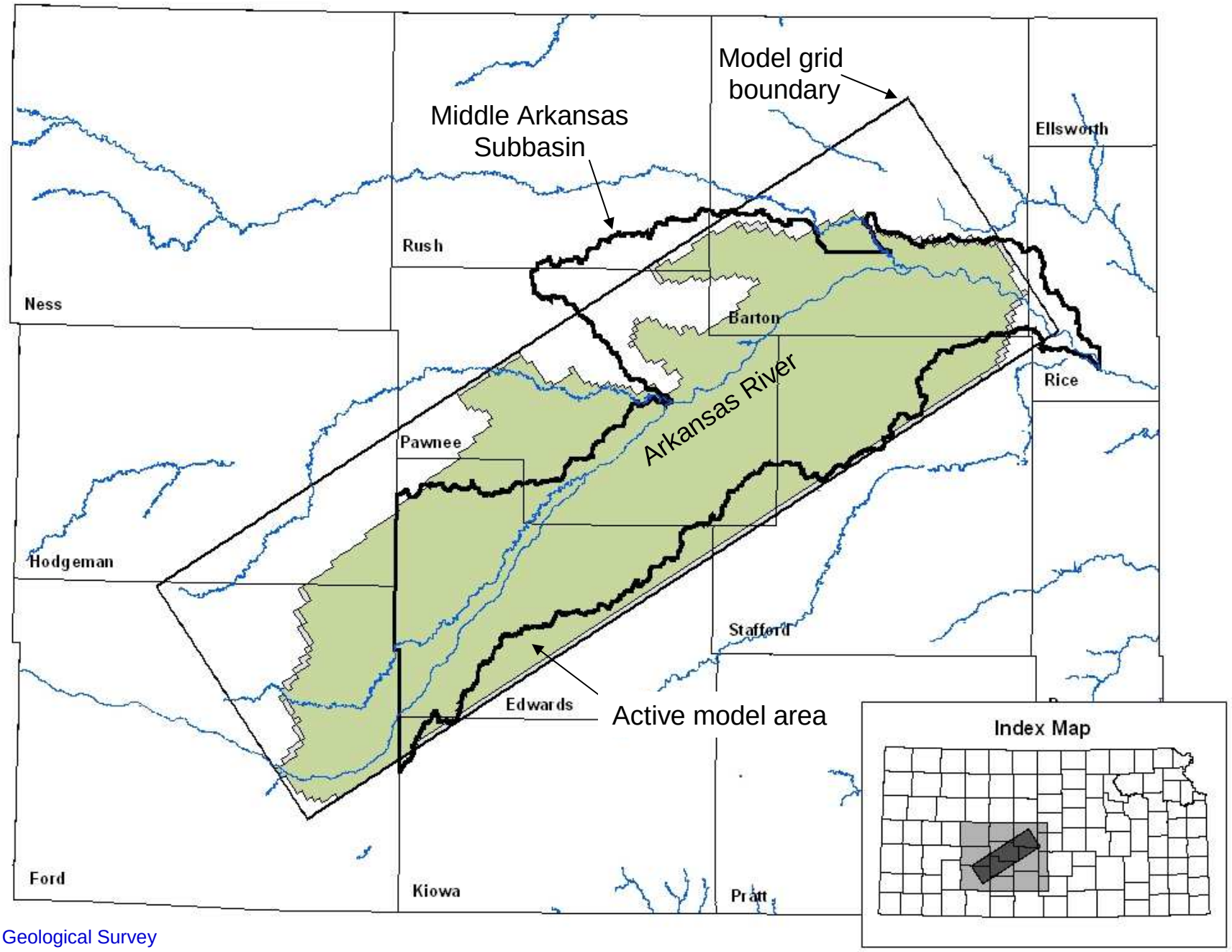
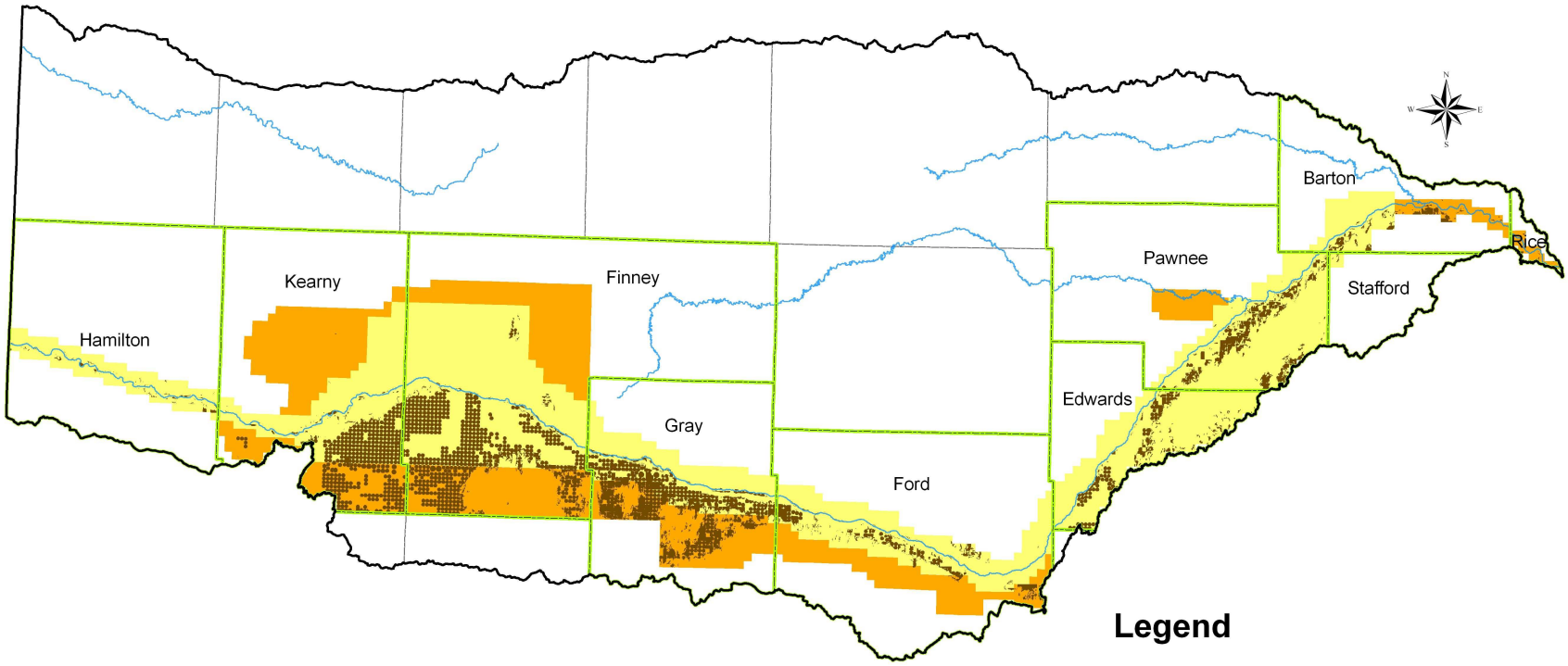
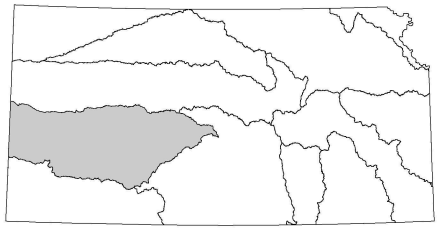

Model grid boundary
Middle Arkansas Subbasin
Ellsworth
Rush
Ness
Barton
Rice
Arkansas River
Pawnee
Hodgeman
Stafford
Edwards
Active model area
Index Map
Ford
Kiowa
Pratt

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

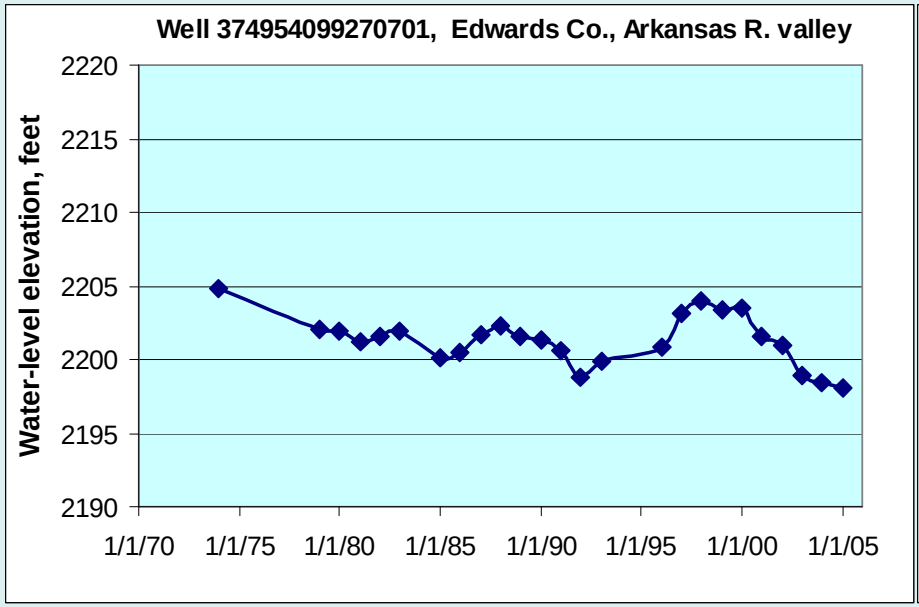
HYDROLOGIC RESPONSES TO CHANGES IN AND OUTSIDE OF SUBBASIN

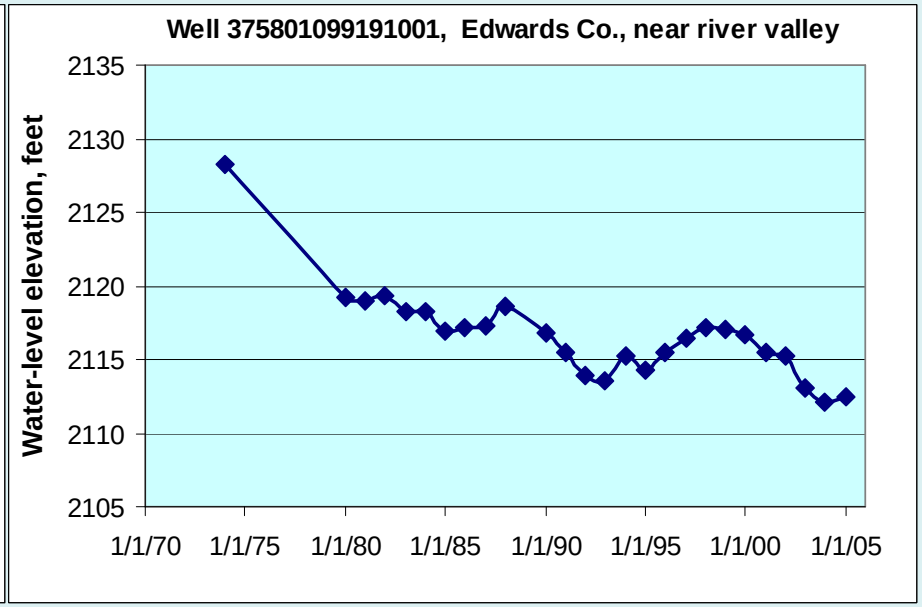
- Ground-water levels have declined in the Middle Arkansas subbasin in response to consumptive pumping from the alluvial and High Plains aquifers.
- Water-level declines have decreased the discharge of ground water into the Arkansas River. Where water levels have declined below the bottom of the river bed, river water seeps into the underlying aquifer rather than flowing downstream. As a result, river flows have decreased and a dry river bed has been present over much of the subbasin during the last few years.
- Long-term declines in the flow of the Arkansas River from southwest Kansas and of the Pawnee River into the subbasin have contributed to decreases in Arkansas River flow in the subbasin.

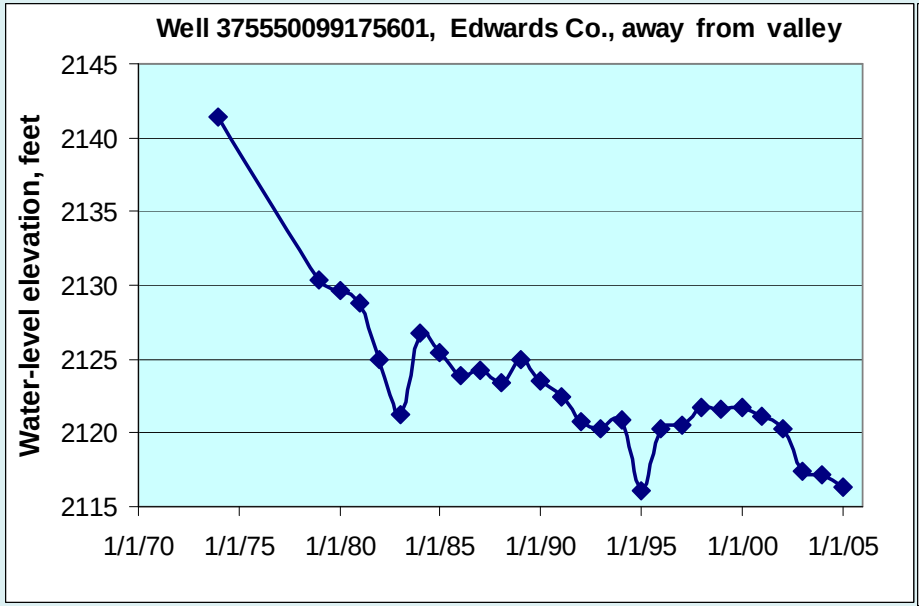
WATER-QUALITY RESPONSES TO CHANGES IN AND OUTSIDE SUBBASIN

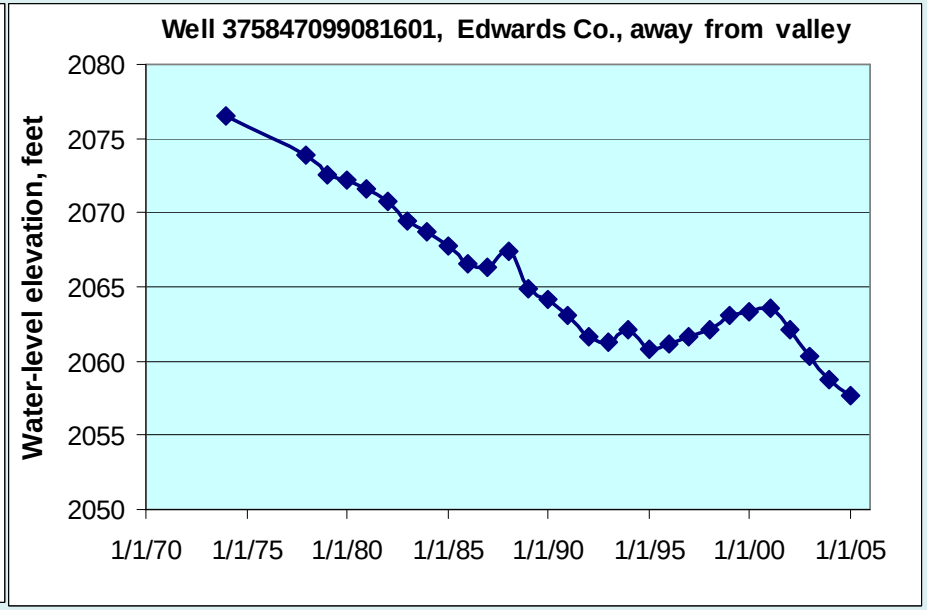
- Long-term increases in the salinity of Arkansas River water from Colorado have increased the salinity of high flows that enter the Middle Arkansas subbasin.
- The salinity of ground water in the Arkansas River valley in the subbasin increases when inflow passing through southwest Kansas from Colorado seeps into the aquifer underlying the river. The saline ground water is moving outward from the river in response to ground-water level declines.
- Long-term decreases in Pawnee River flow have decreased the amount of freshwater flow entering the Arkansas River in the subbasin at Larned.

Hydrographs of Wells in Edwards County within CREP Area









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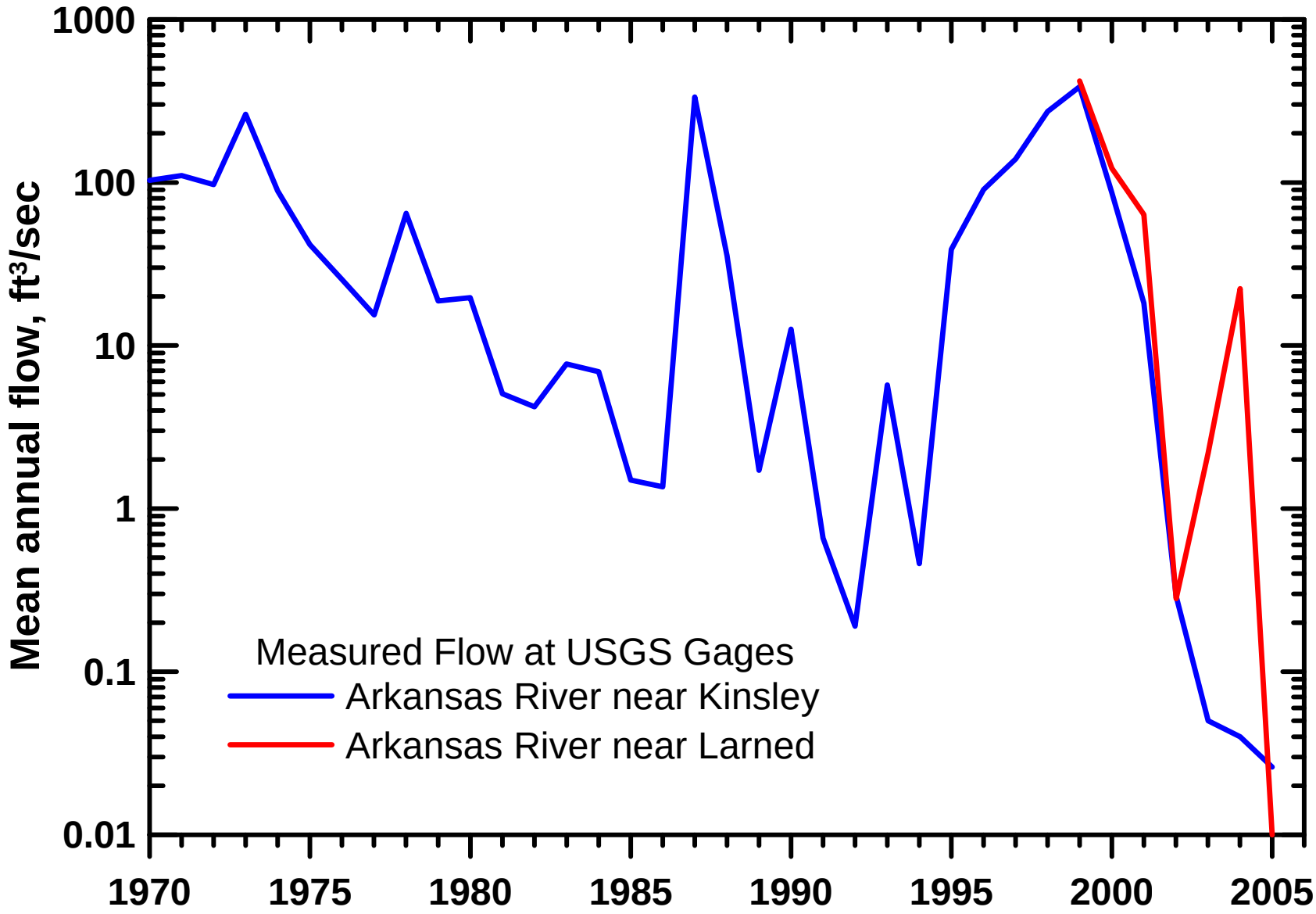
1000
100
10
1
0.1
0.01
Mean annual flow, ft³/sec
1970
1975
1980
1985
1990
1995
2000
2005
Measured Flow at USGS Gages
Arkansas River near Kinsley
Arkansas River near Larned


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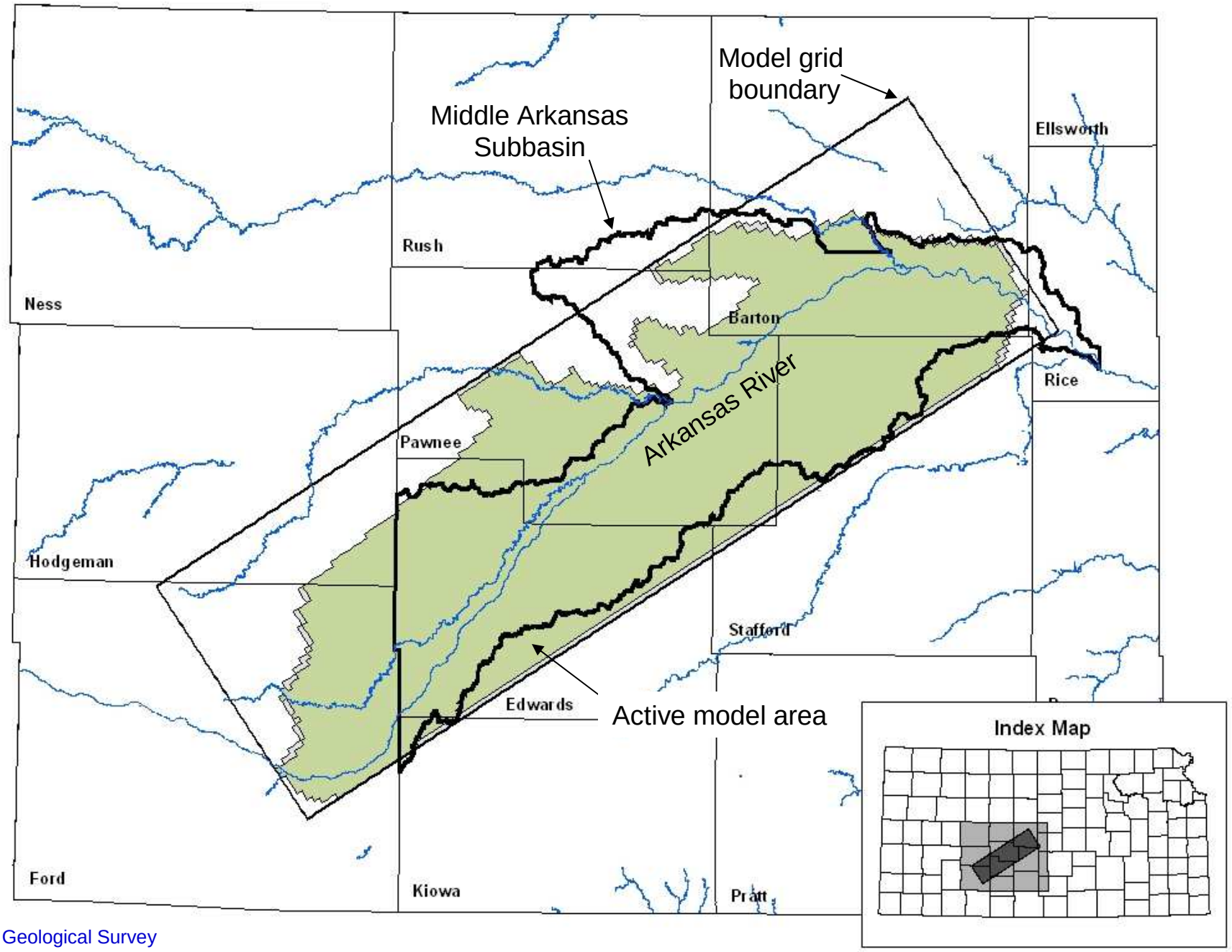
WHAT DOES THE GROUND-WATER FLOW MODEL DO?

Mathematically simulates ground-water flow and stream-aquifer interactions in the Middle Arkansas subbasin for 1944-2004 and future scenarios

Components of the model include:

- Areal precipitation recharge
- Stream inflow to the model area
- Ground-water flow into, within, and out of model area
- Ground-water flow to streams and leakage of water from streams and canals to ground water
- Pumping of ground water
- Recharge of applied irrigation water to ground water
- Loss of water from evapotranspiration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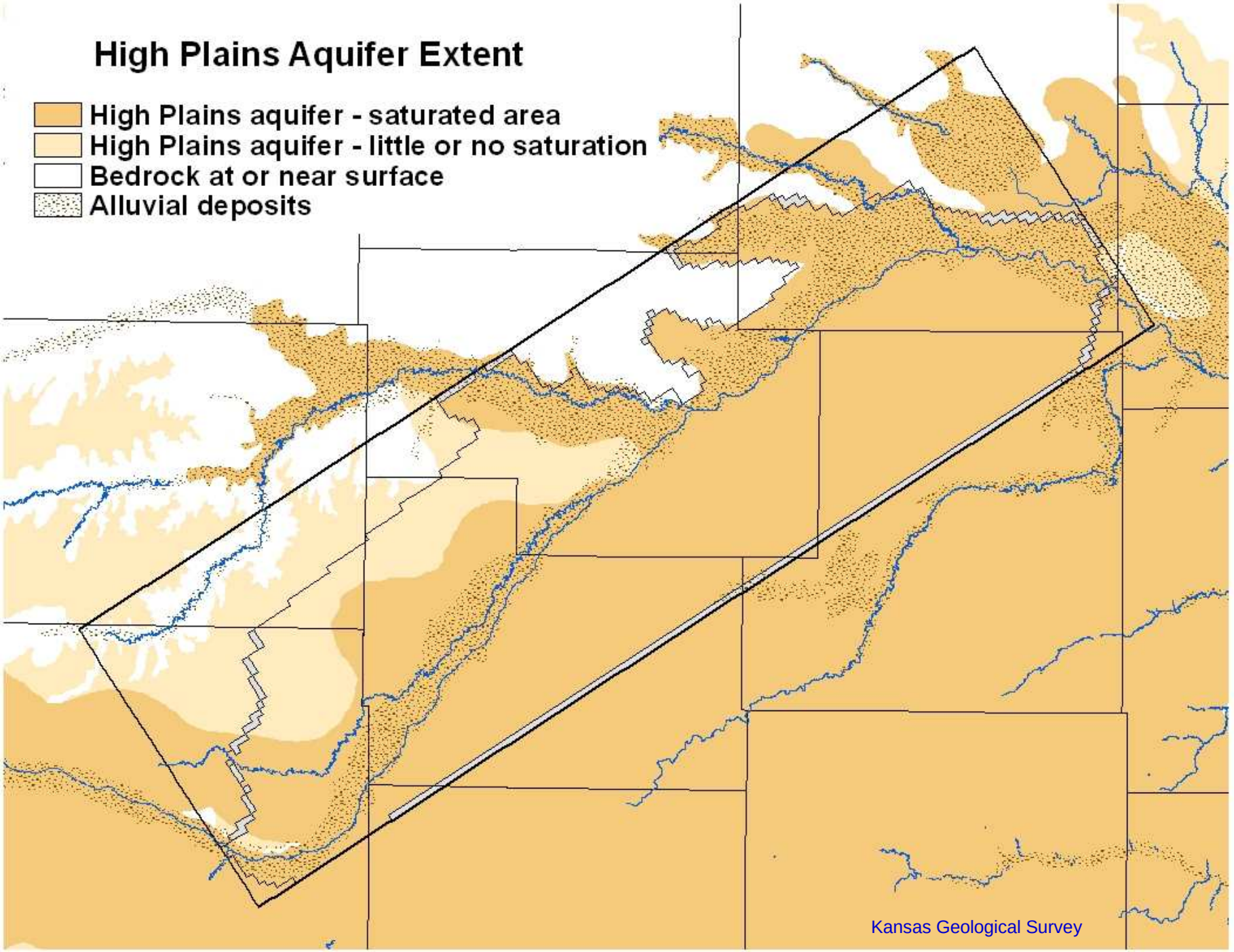
High Plains Aquifer Extent
High Plains aquifer - saturated area
High Plains aquifer - little or no saturation
Bedrock at or near surface
Alluvial deposits
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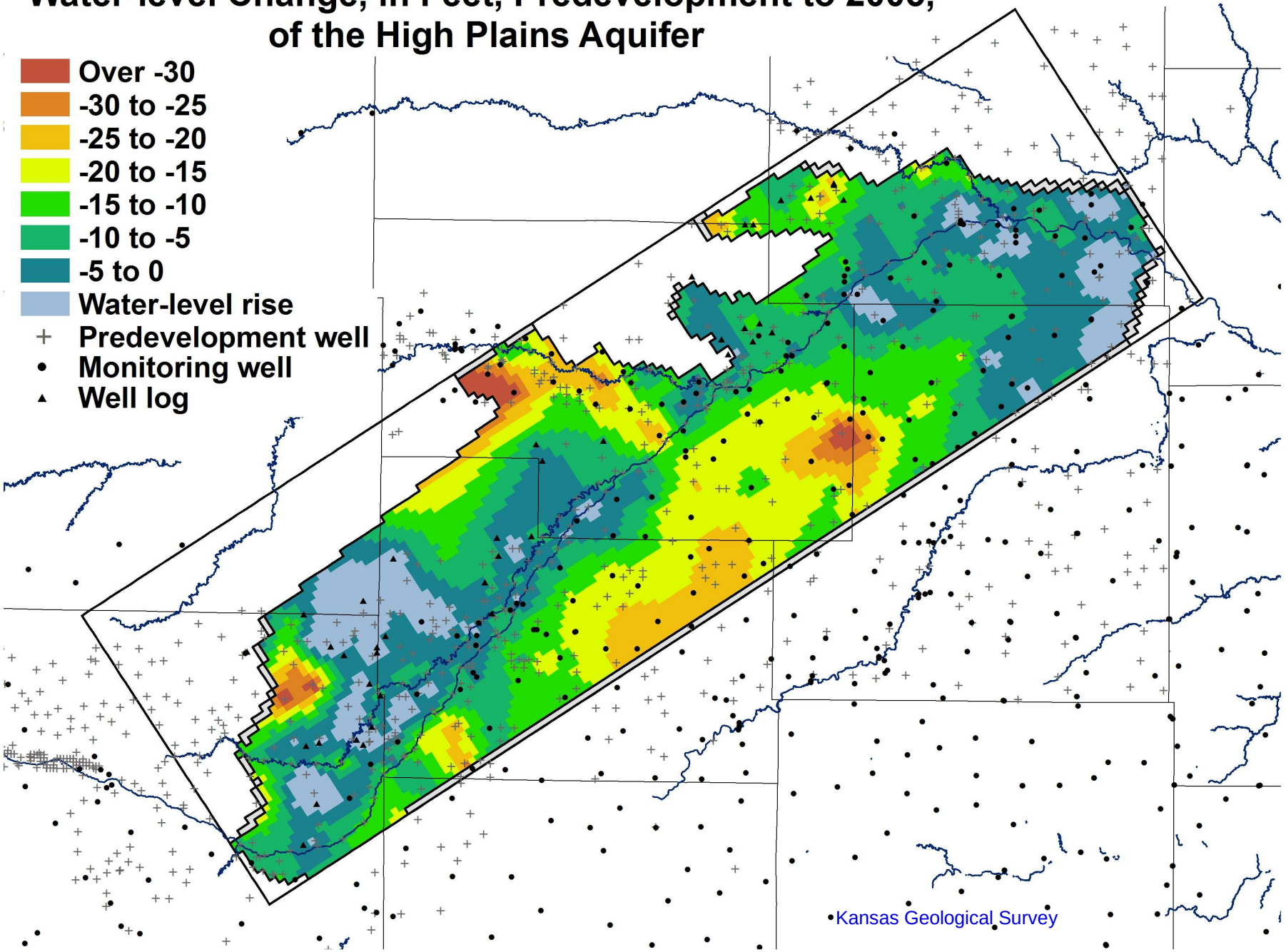
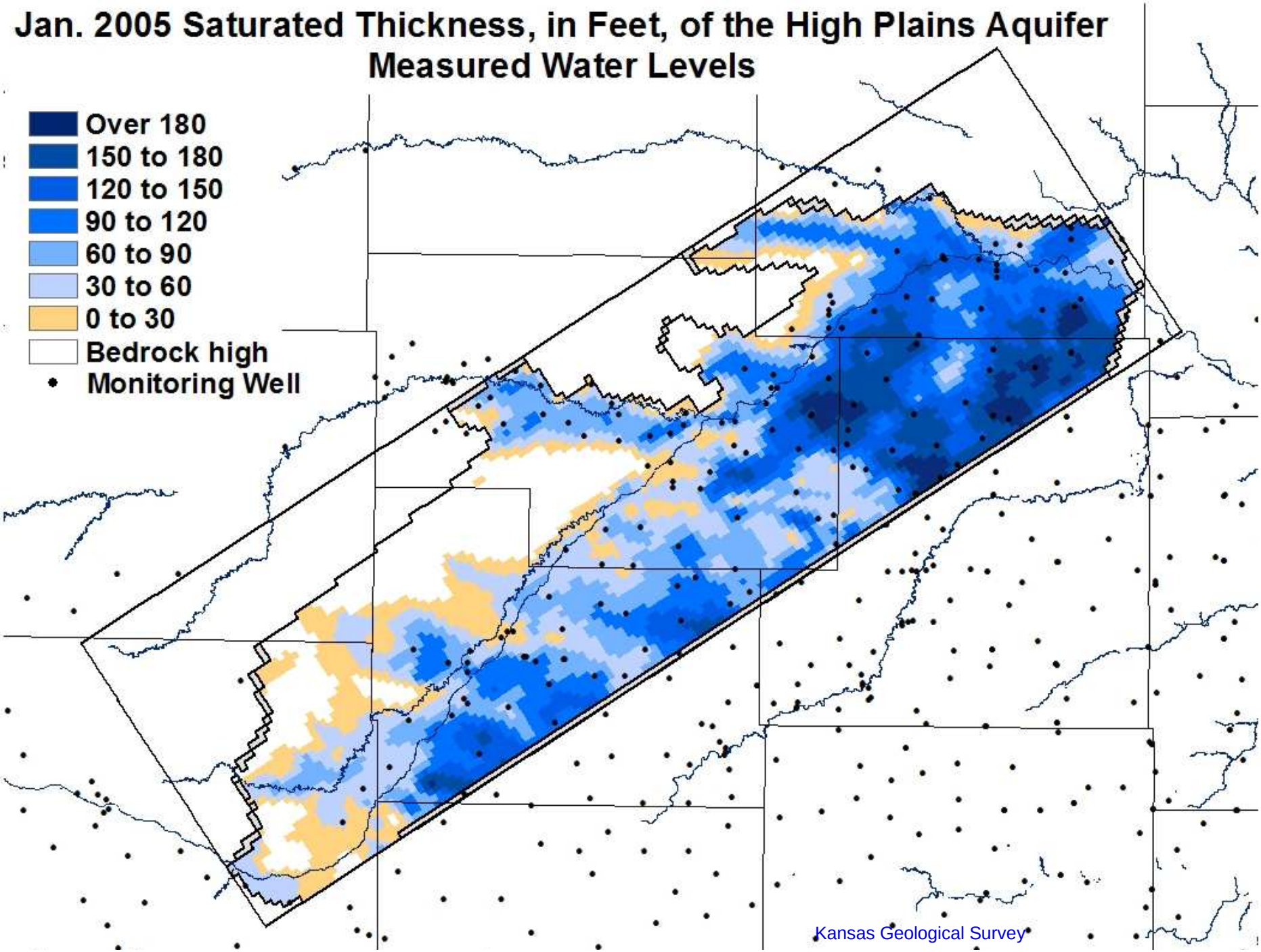
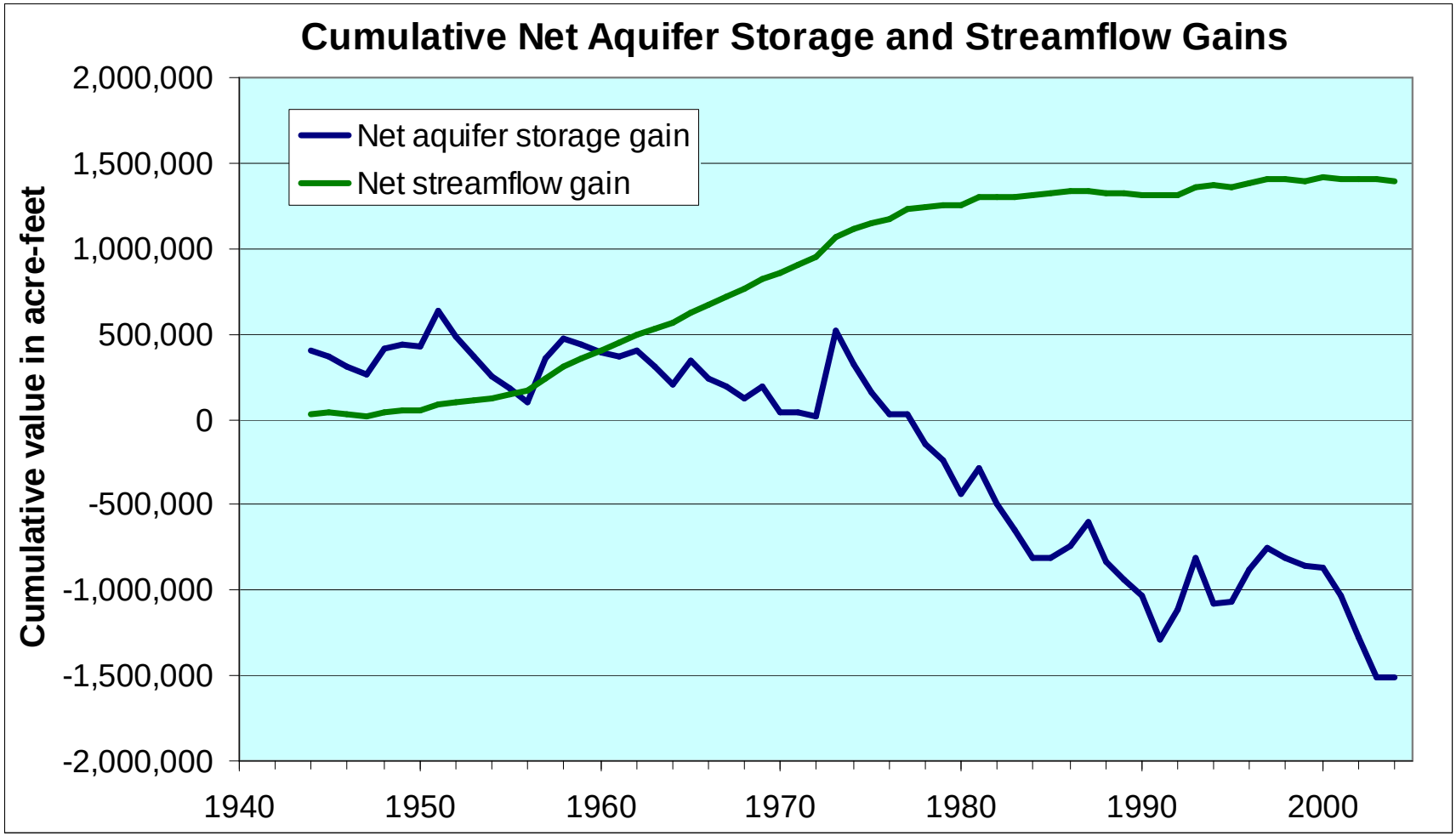
Water-level Change, in Feet, Predevelopment to 2005, of the High Plains Aquifer



Jan. 2005 Saturated Thickness, in Feet, of the High Plains Aquifer
Measured Water Levels





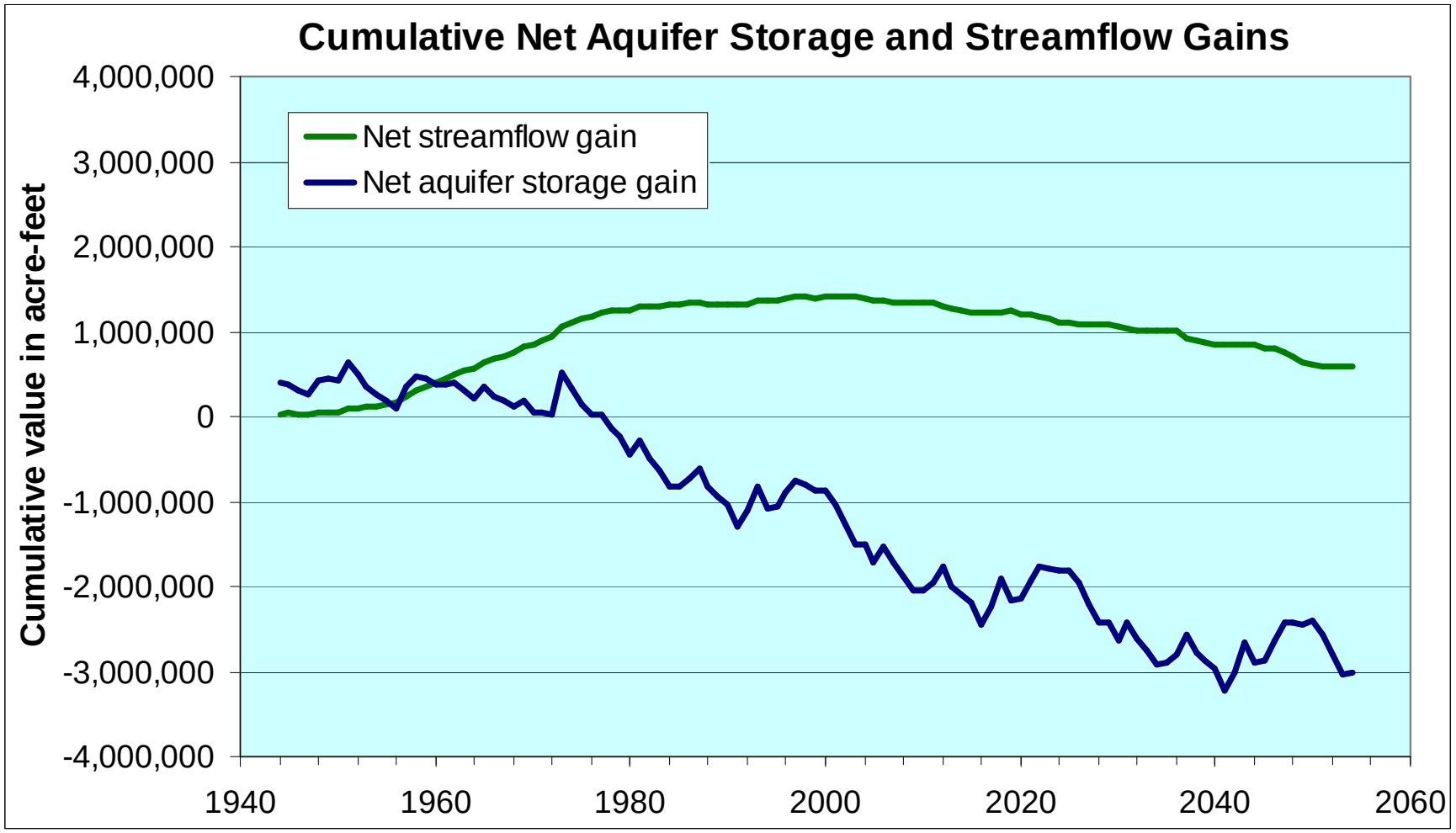
Net aquifer storage gain = storage accumulation minus storage depletion
Net streamflow gain = stream gain from ground water minus stream loss to ground water

MODEL SCENARIOS

Sensitivity to increased stream inflows during 1980-2004

Future pumping during 50 years, 2005-2054

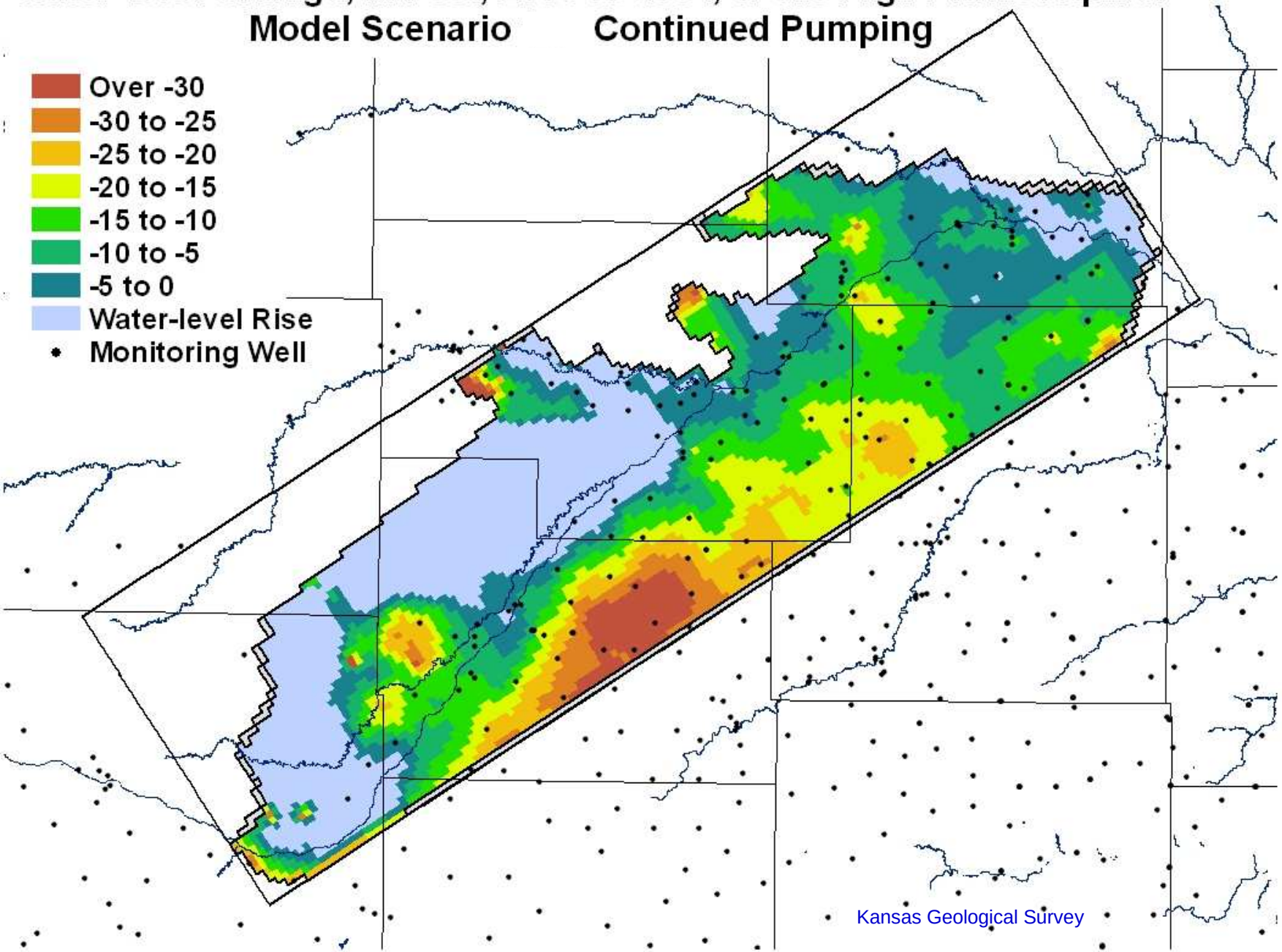
- Pumping at current levels
- No pumping
- Reduction of 24% of pumping in CREP areas
  - Equivalent to 14.5% reduction in model area
  - Reduction of 25,287 acre-ft/yr in net pumpage
- Retirement of Circle K Ranch water rights

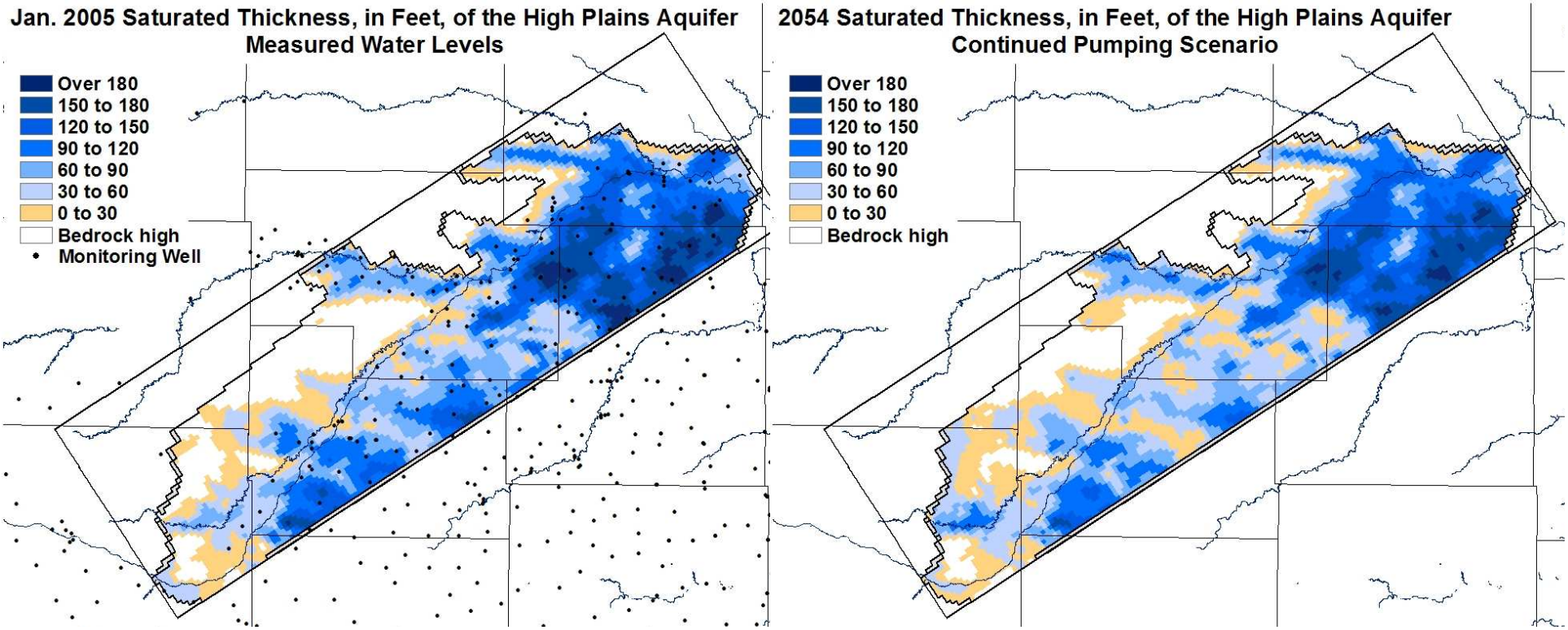


Scenario: Continued Pumping at Current Levels

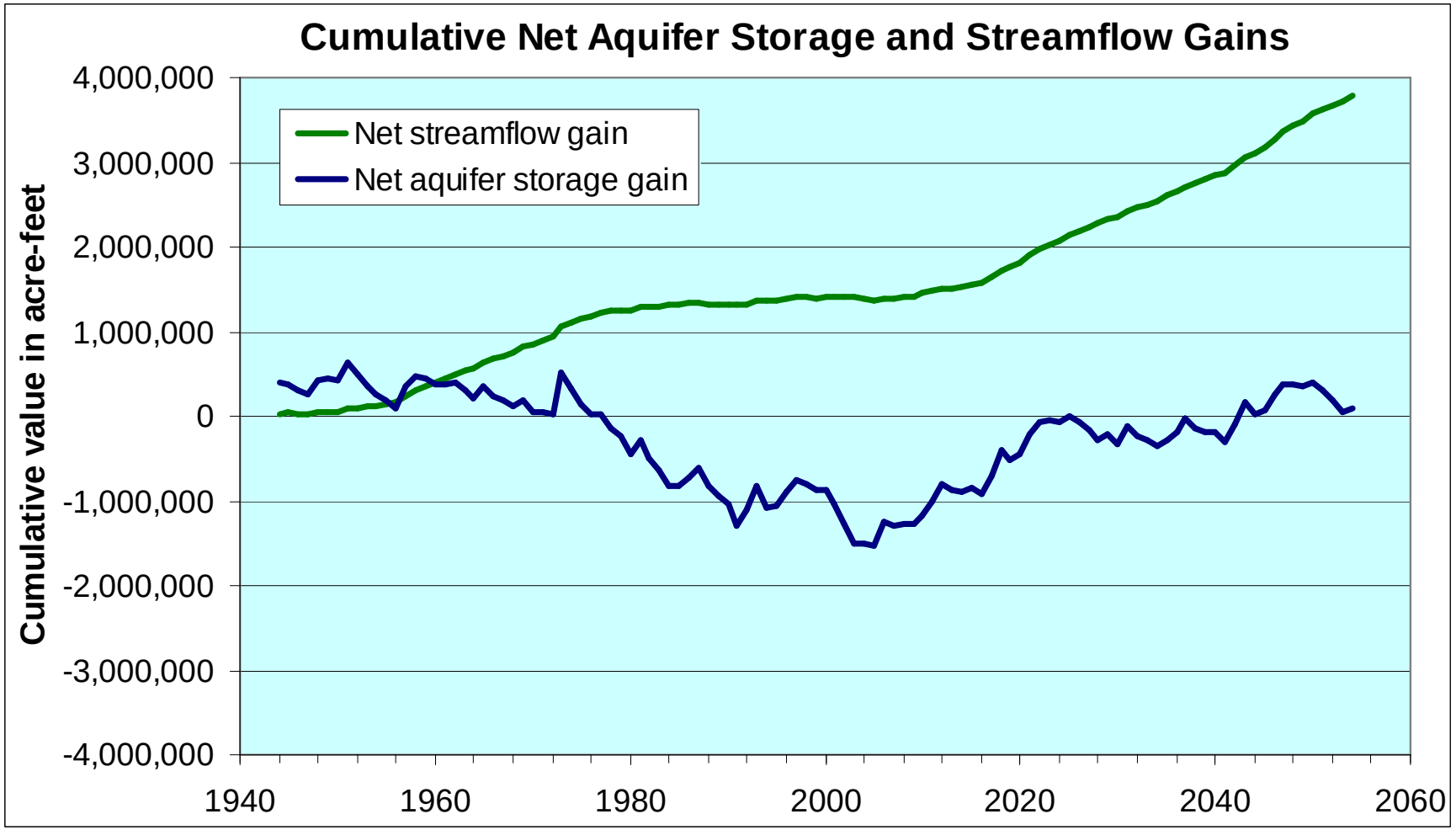
Water-level Change, in Feet, 2005 to 2054, of the High Plains Aquifer

Model Scenario Continued Pumping

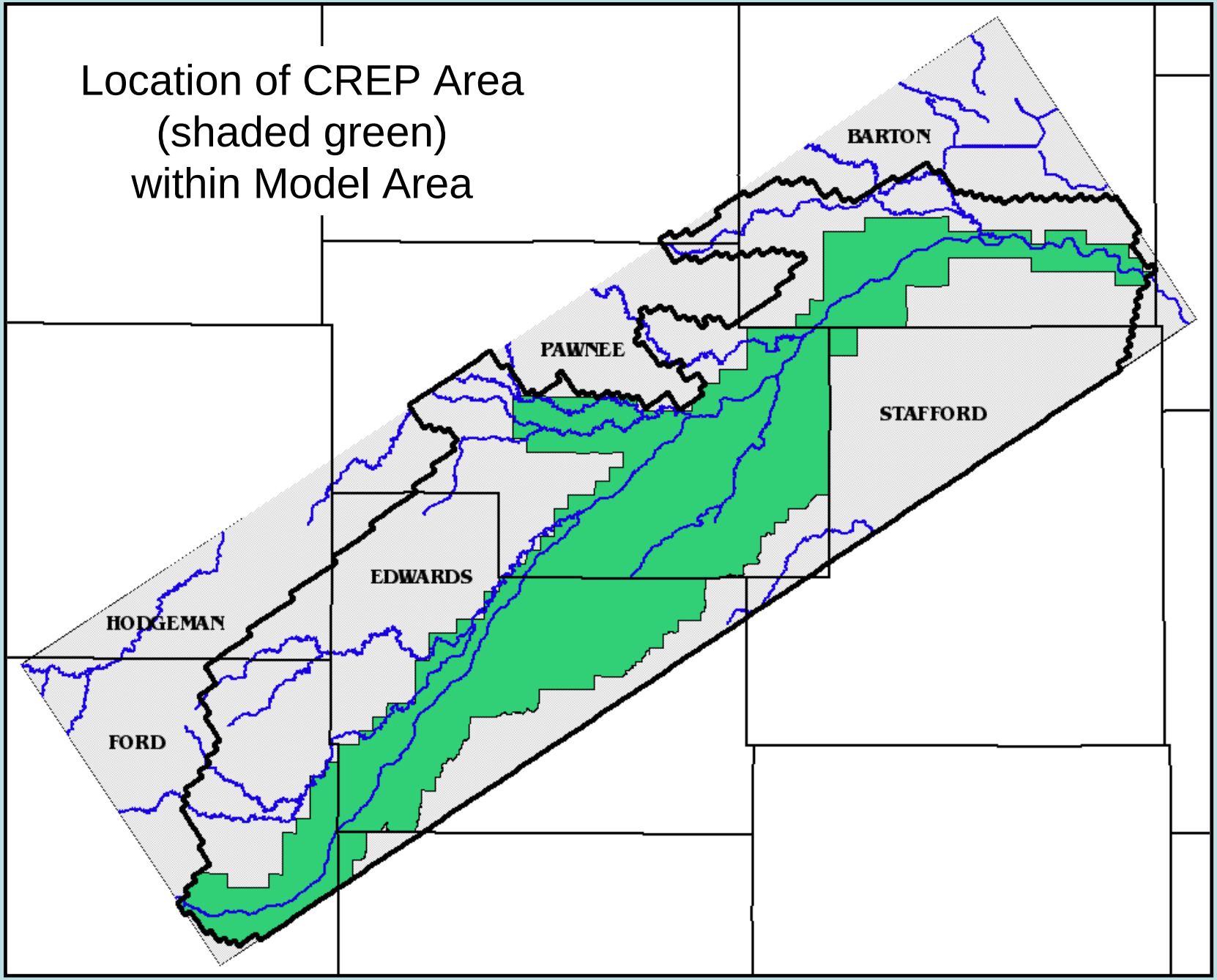


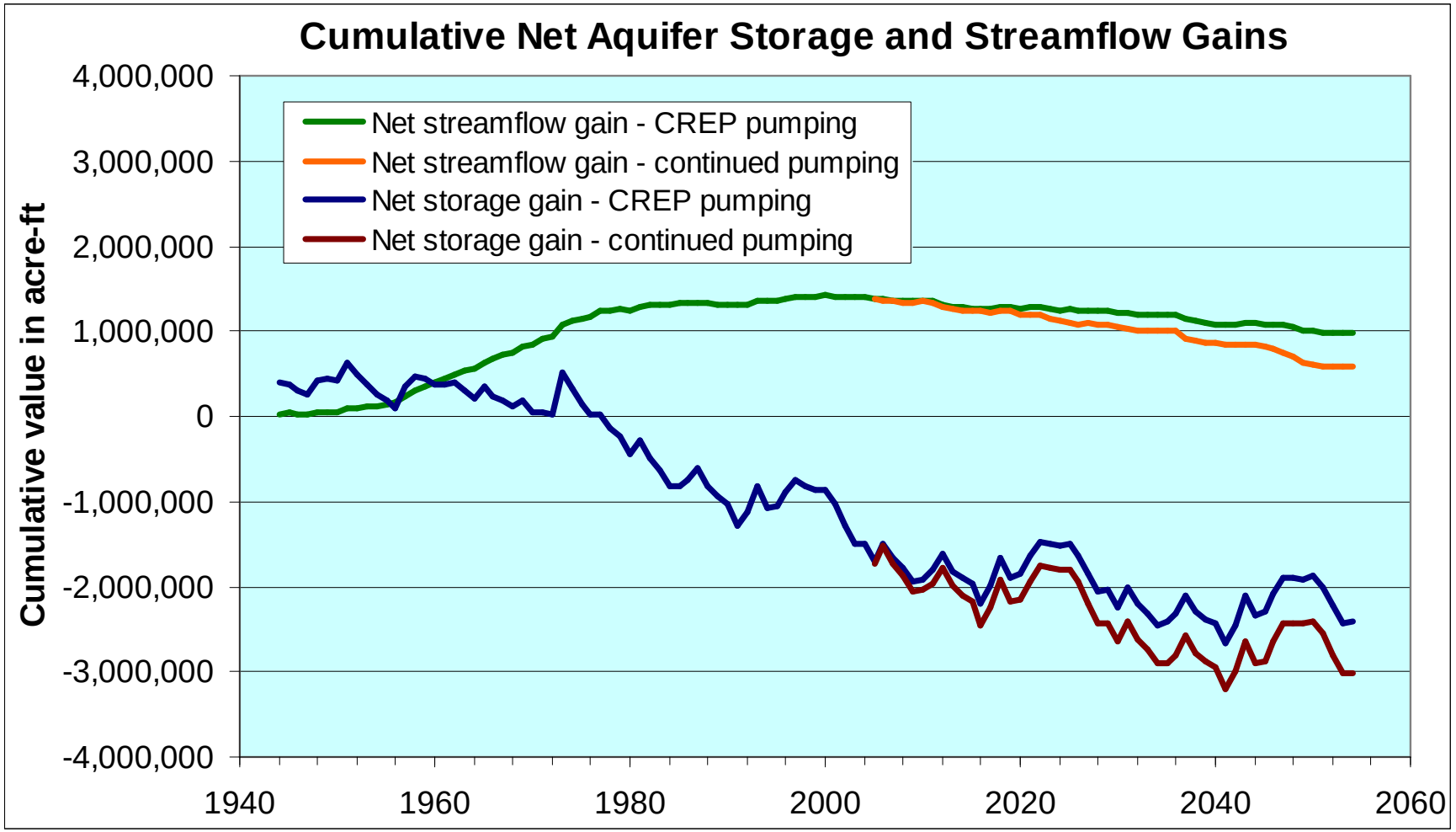


Comparison of Saturated Thickness Observed in 2005
and Simulated for the Continued Pumping Scenario for 2054

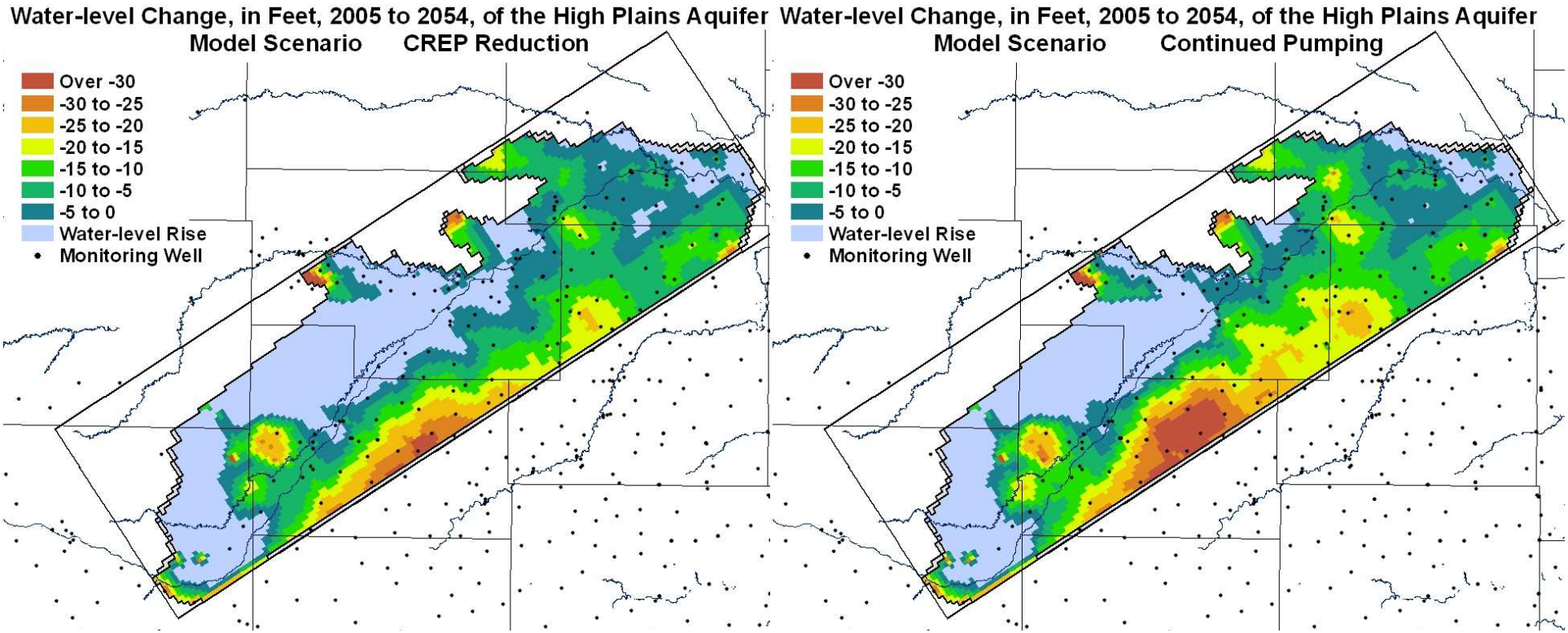


Scenario: No Pumping

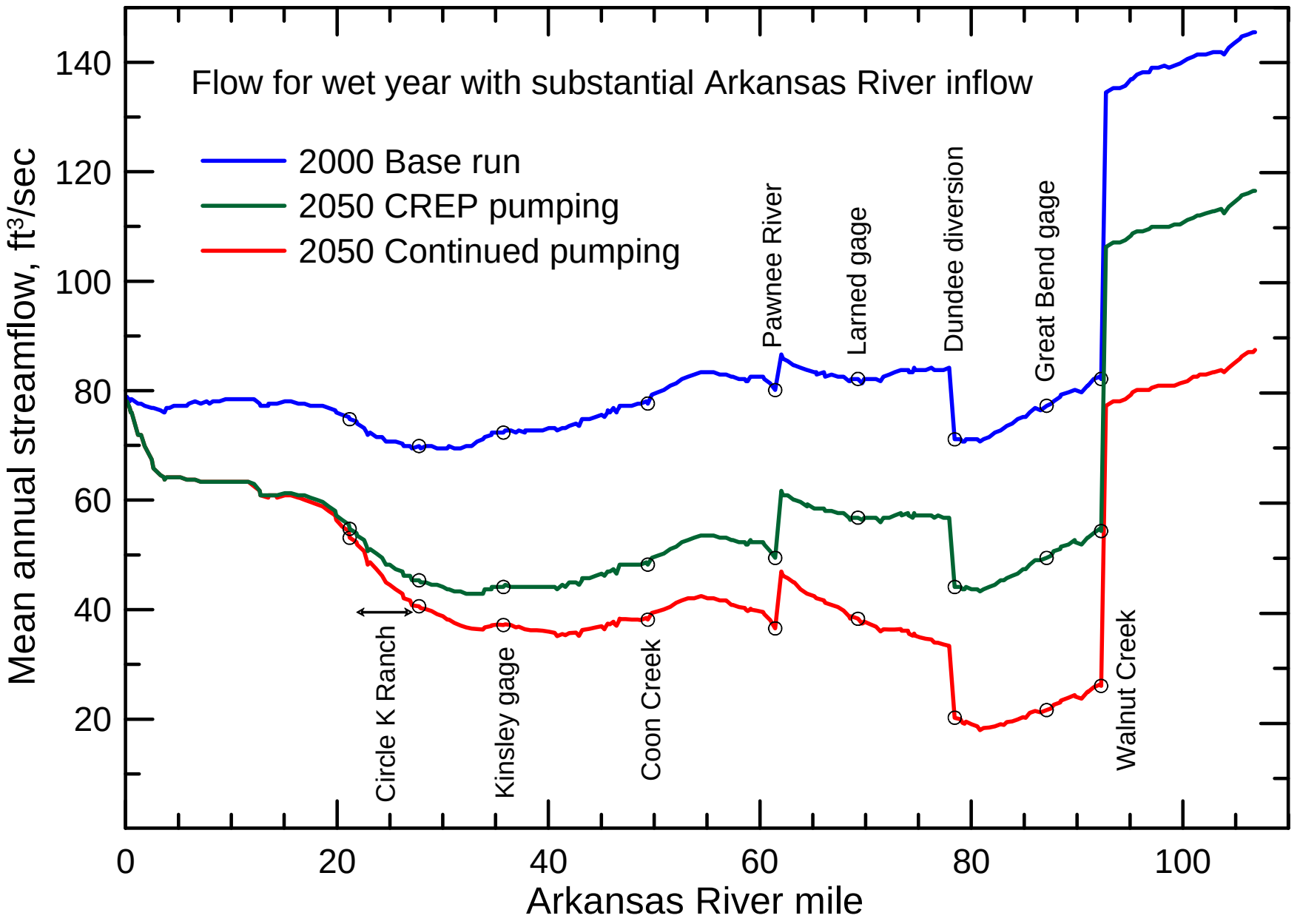

Location of CREP Area
(shaded green)
within Model Area
BARTON
PAWNEE
STAFFORD
EDWARDS
HODGEMAN
FORD



Comparison of CREP Pumping and Continued Pumping Scenarios



Comparison of CREP Pumping and Continued Pumping Scenarios



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

- Ground-water levels will continue to decline in the Middle Arkansas subbasin unless there are substantial reductions in consumptive pumping.
- Continuing water-level declines will increase the seepage rate of high flows in the Arkansas River from southwest Kansas (when they occur) into the alluvial aquifer and underlying High Plains aquifer. This will decrease the amount of river flow reaching the Lower Arkansas basin for a similar, past high flow entering the subbasin. More saline water from high Arkansas River inflows will enter the alluvial and High Plains aquifers.
- Continuing water-level declines will increase the movement of saline ground water in the aquifer outward from the river valley.
- Continuing decreases in Pawnee River flow will decrease the amount of freshwater flow entering the Arkansas River at Larned.

Water resources future

Cloudy or bright?

Wet or dry?