Balancing the Books:
Kansas' Water Past, Present, and Future

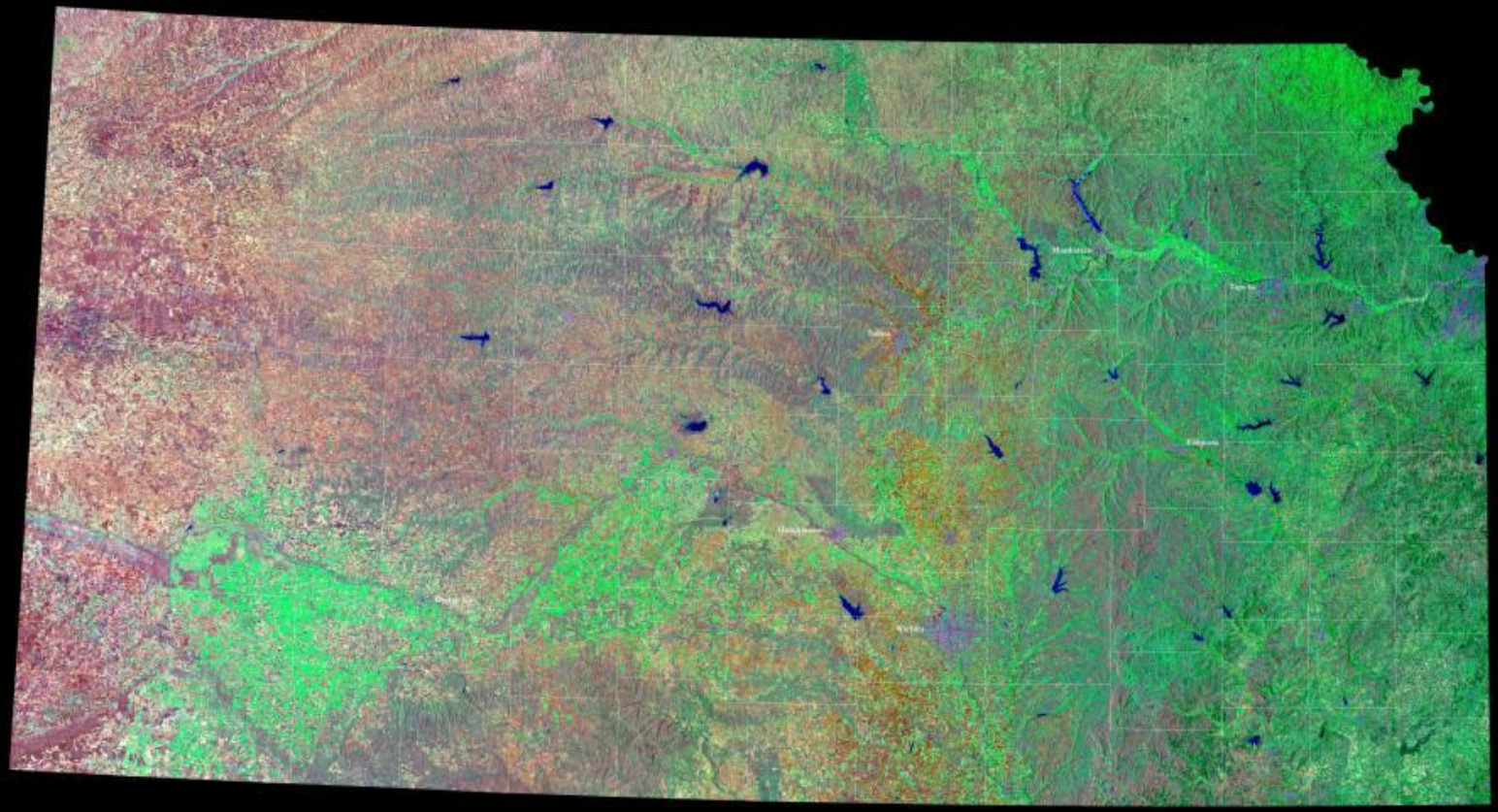


Image courtesy of USGS Earth Resources Observation and Science website, 2007

KANSAS DEPARTMENT OF AGRICULTURE
Division of Water Resources

David Barfield, Chief Engineer

KSU Sustainability Conference
January 23, 2009

DWR Programs

- Water Appropriation
- Water Structures
  - Dam permitting and Dam safety, Levee and Stream obstruction permitted, floodplain regulation
- Interstate Water Issues
  - Compacts: Republican River, Arkansas River, Big Blue
  - Missouri River

Water Agencies and Coordination

1. State natural resources agencies:

- **KS Dept of Agriculture with DWR**
- **Kansas Water Office**
- **KS Dept of Health and Environment**
- **State Conservation Commission**
- **KS Dept. of Wildlife and Parks**
- **Local district: GMD's and more**

2. **Federal agencies :** USGS, Corps, Bureau of reclamation, more

3. Coordination through: State water planning process (KWA), NR Sub-cabinet

Outline

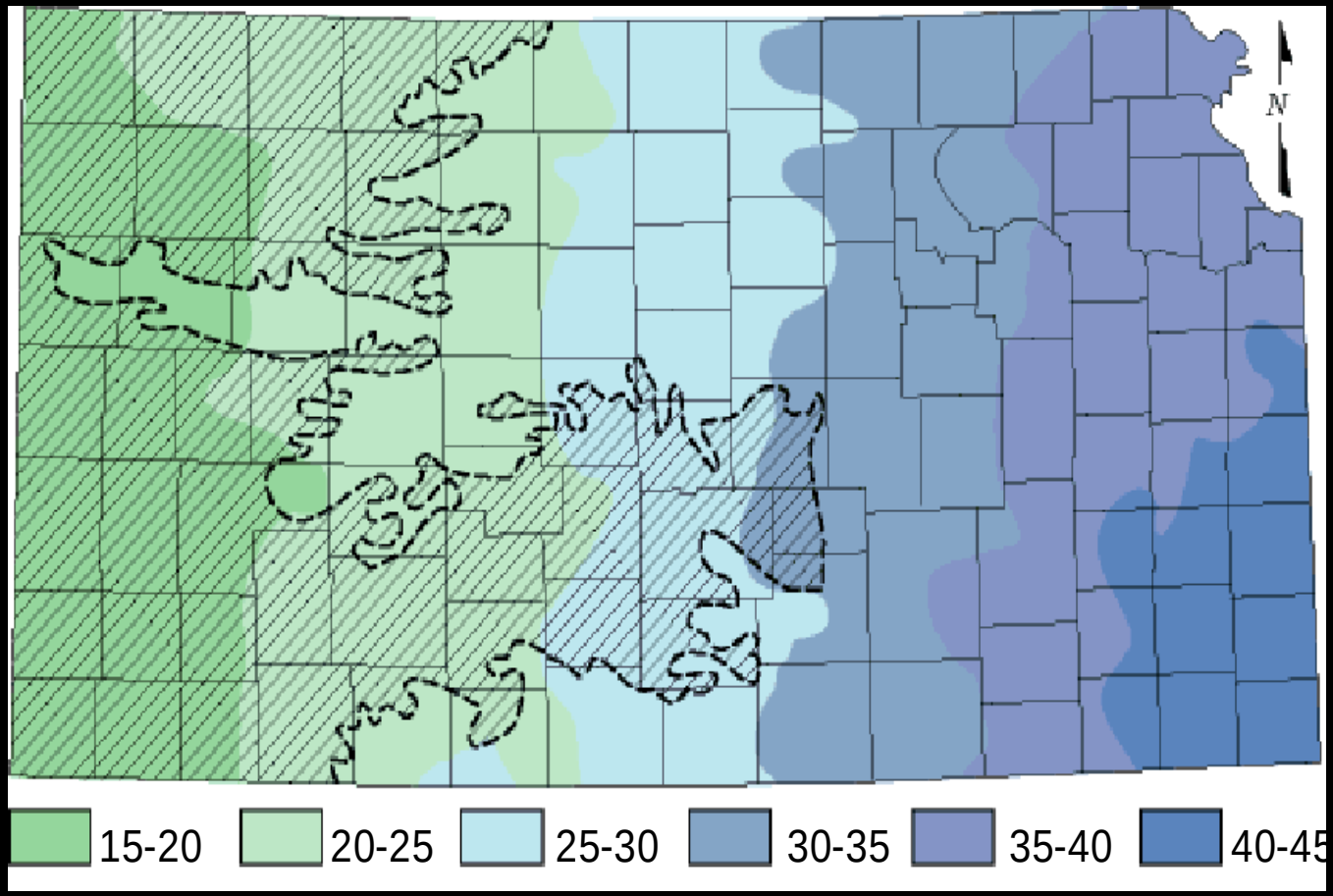
- Kansas water resources
- Historical progression of, and correlation between:
  - Water law
  - Water development
  - Water resources management
- Perspectives on sustainability
- What are we doing / Where do we go from here?
- Closing thoughts

Kansas Water Resources key descriptor: variability

- Kansas: variability in hydrologic conditions across the state
  - Average precipitation ranges from 16 inches in western Kansas to 40 inches in eastern Kansas
  - Droughts can be persistent
- Western Kansas
  - Primarily relies on the Ogallala-High Plains aquifer for its water supply
- Eastern Kansas
  - Primarily relies on surface water supplies
- Central Kansas
  - Relies on a mixture of surface and groundwater

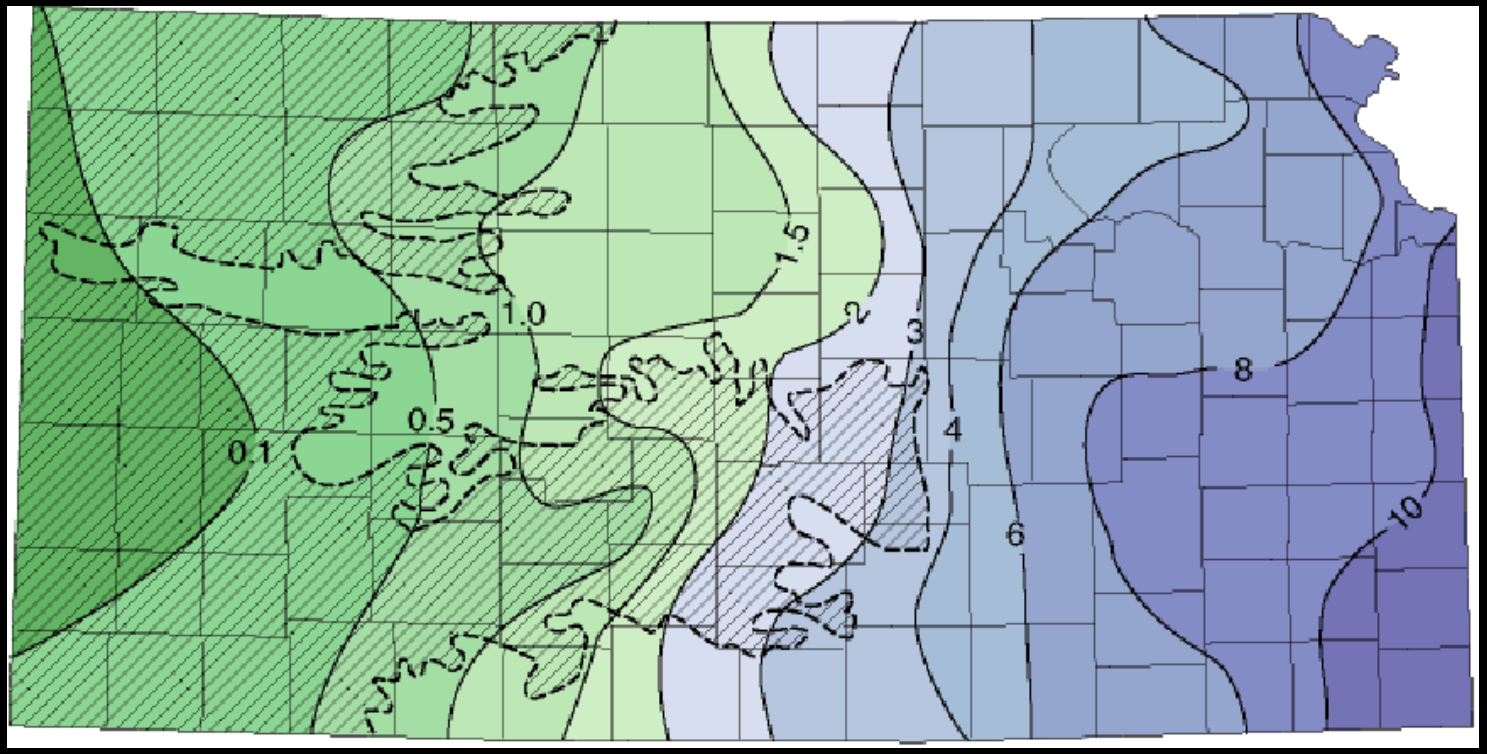
Normal annual precipitation (1961-1990) in Kansas.

The area west of the dashed line shows the extent
of the High Plains aquifer in Kansas (from Goodin et al., 1995).

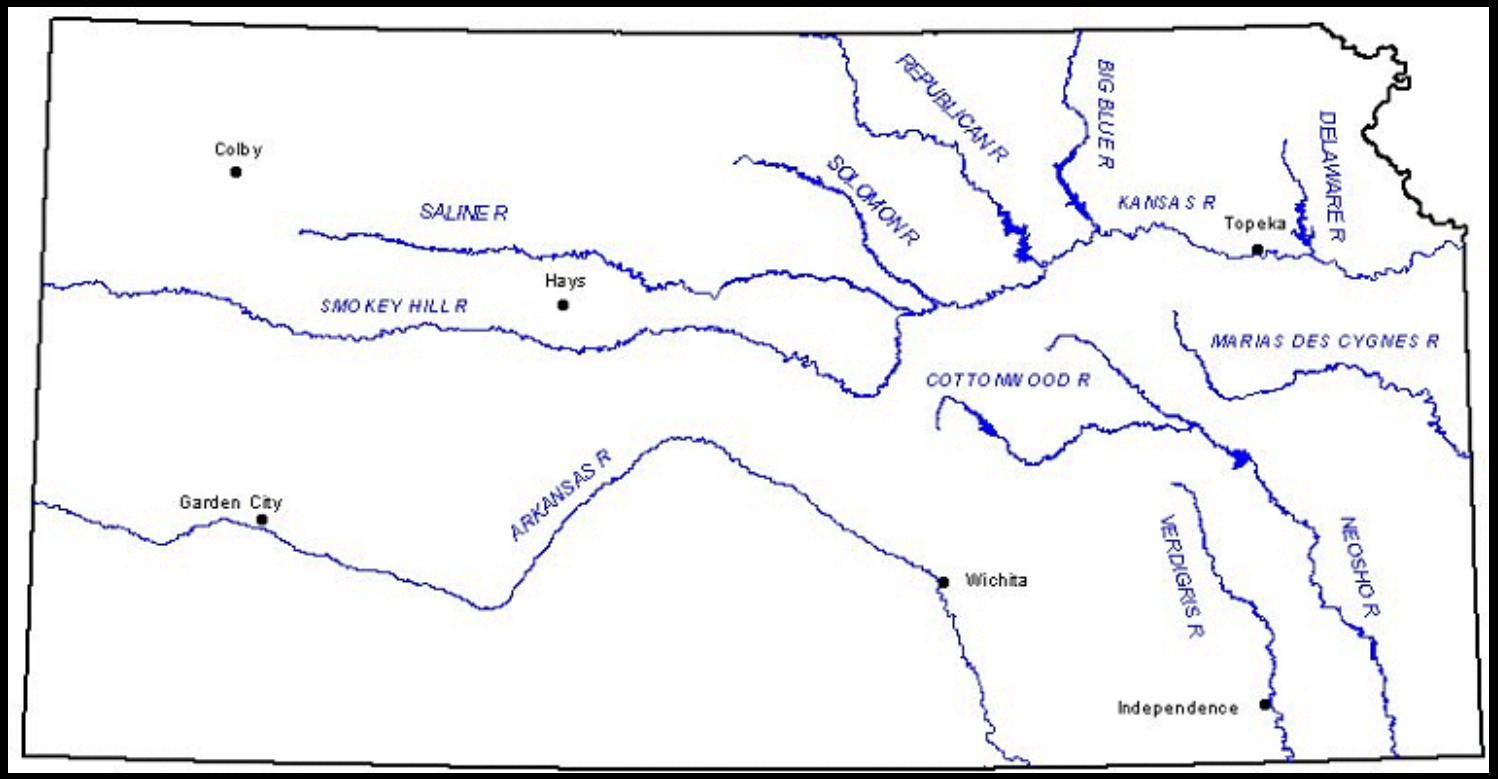


The mean annual runoff (in inches) in Kansas.

The areas west of the dashed line shows the extent
of the High Plains aquifer in Kansas (adapted from Wetter, 1987).

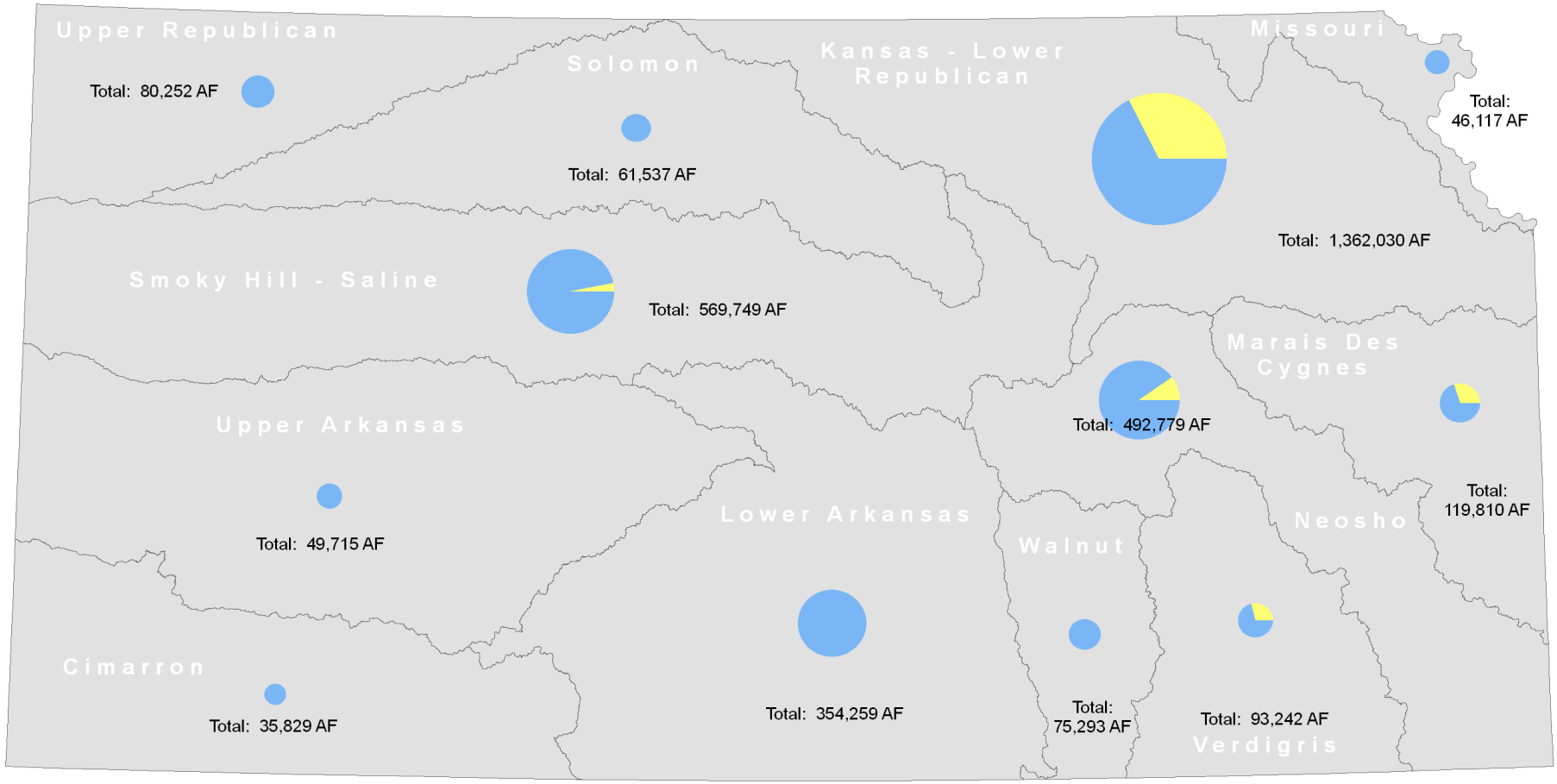


Surface Water supplies



Estimated Annual Volume of Reliable Surface Water Supplies* in Kansas

**Not including the Missouri River main stem due to its unique interstate characteristics and location on the state line.*



Reservoir yields are based on data from the Kansas Water Office for thirteen reservoirs in which the state of Kansas owns storage from which releases can be made.

Streamflow volumes were calculated based on USGS streamflow statistics, 75% exceedance flows for the period of record.

Statewide Totals: Reservoir Yield: 570,488 AF, Basin Outflows: 2,770,122 AF

To avoid double-counting supplies, Solomon and Smoky Hill-Saline basin outflow volumes were subtracted from the Kansas-Lower Republican outflow; and Upper Arkansas basin outflow volume was subtracted from the Lower Arkansas outflow.

Legend

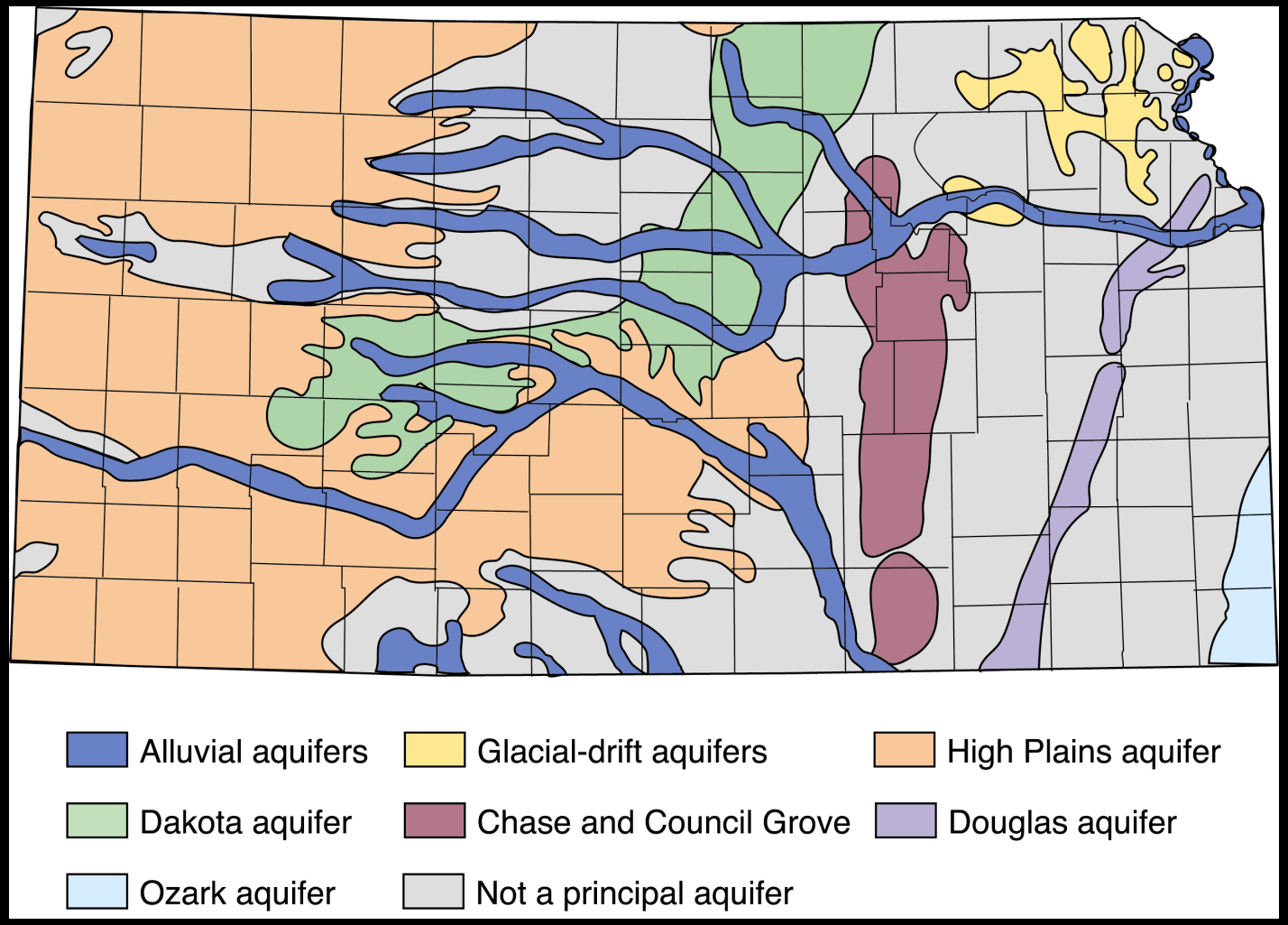
Reservoir Yield

Basin Outflows

0 37.5 75 150 Miles

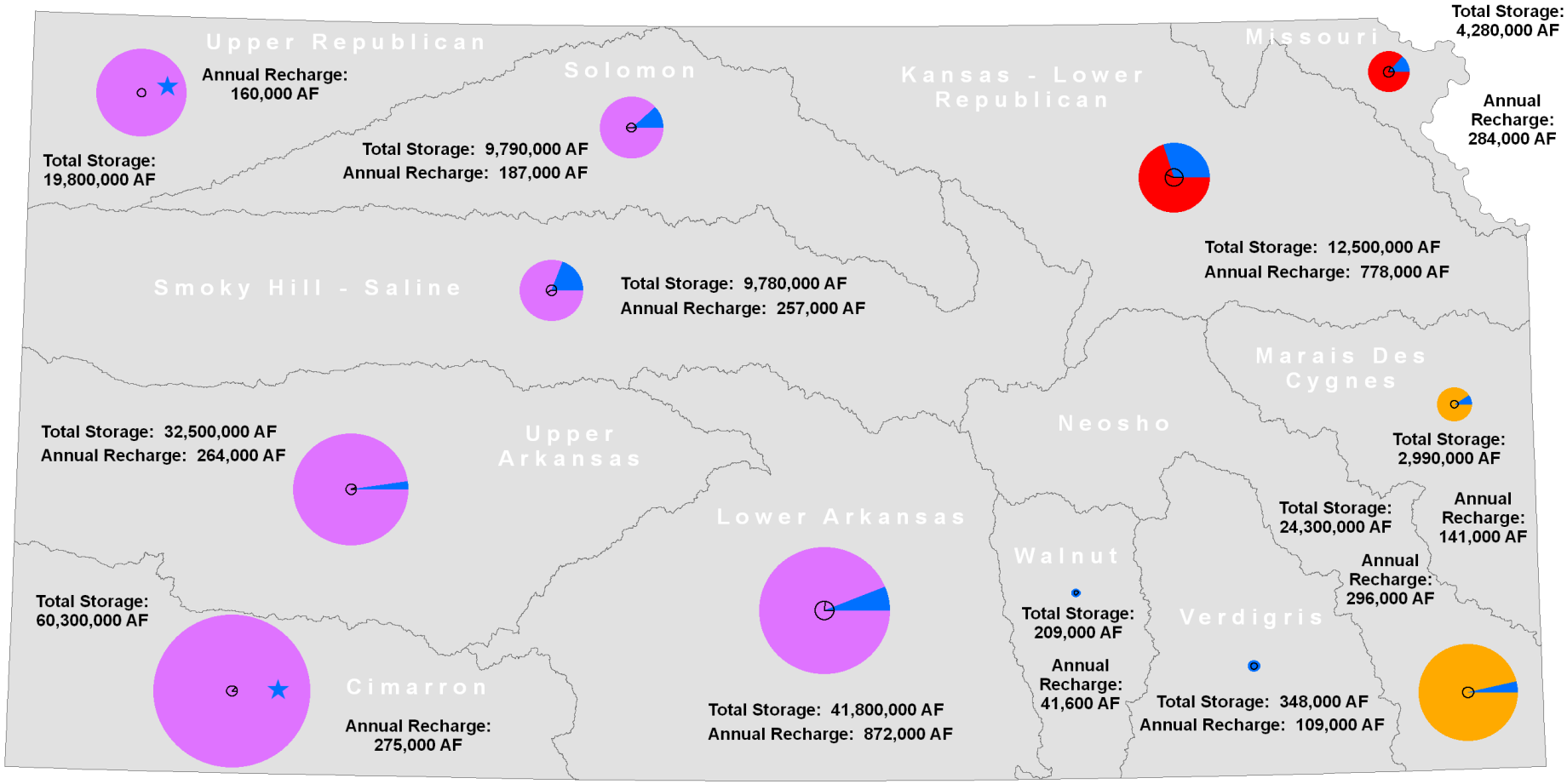
Kansas Department of Agriculture
April 20, 2007

Groundwater supplies



Estimated Freshwater Storage in Principal Aquifers* and Estimated Annual Potential Recharge in Kansas

**Not including the Great Plains aquifer system due to physical limitations on utilization of that water*



Data from USGS Report 87-4230, Cristi Hansen
Estimates were multiplied by two-thirds (2/3) assuming that fraction would be recoverable from storage.

High Plains storage values were adjusted based on declines since 1987, per KGS.

Kansas Department of Agriculture
April 20, 2007

0 30 60 120 Miles

Statewide totals
Storage: 219,000,000 AF, Annual Recharge: 3,660,000 AF

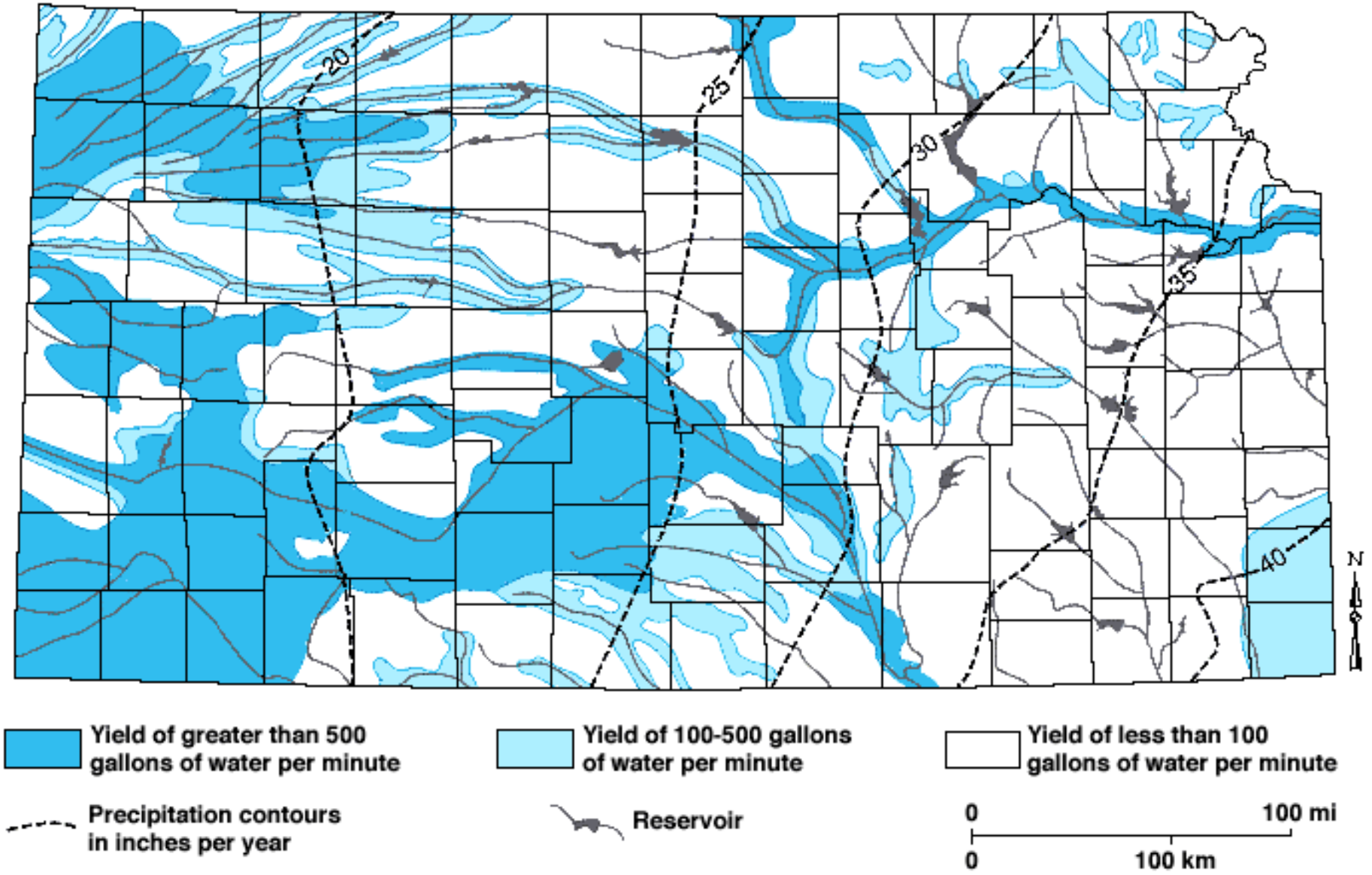
Where Alluvium overlays High Plains, the storage in Alluvium is shown as storage in the High Plains.

LEGEND

- Annual Recharge
- Storage
  - Alluvium
  - High Plains
  - Glacial-drift
  - Ozark
- ★ Small percentage of alluvial storage

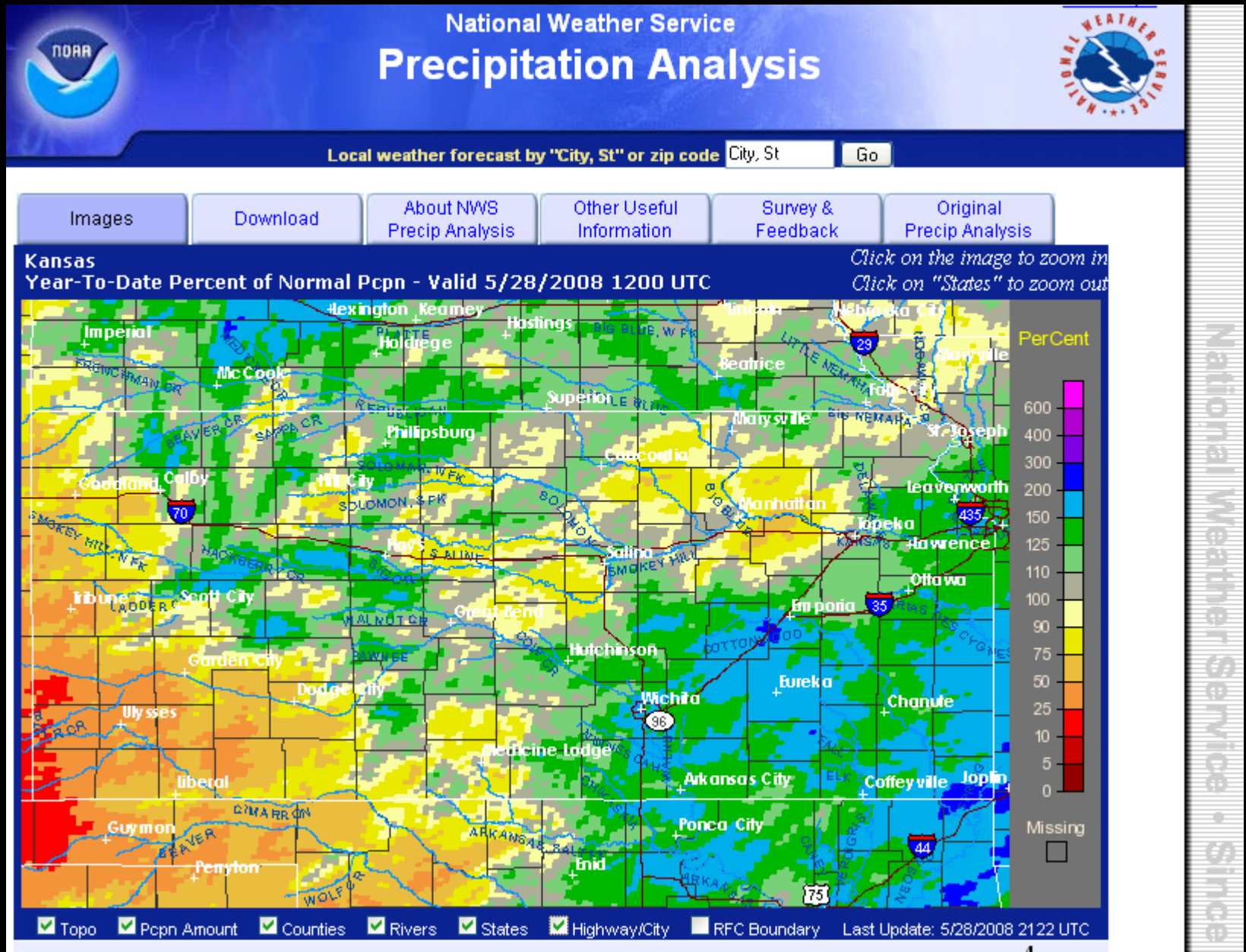
AF = acre-feet

Two States in One



http://www.kgs.ku.edu/Hydro/hydraSheetMap.html

Annual variability in water availability



Kansas water resources development

- It did not start with the first ditch or well, but the first plow

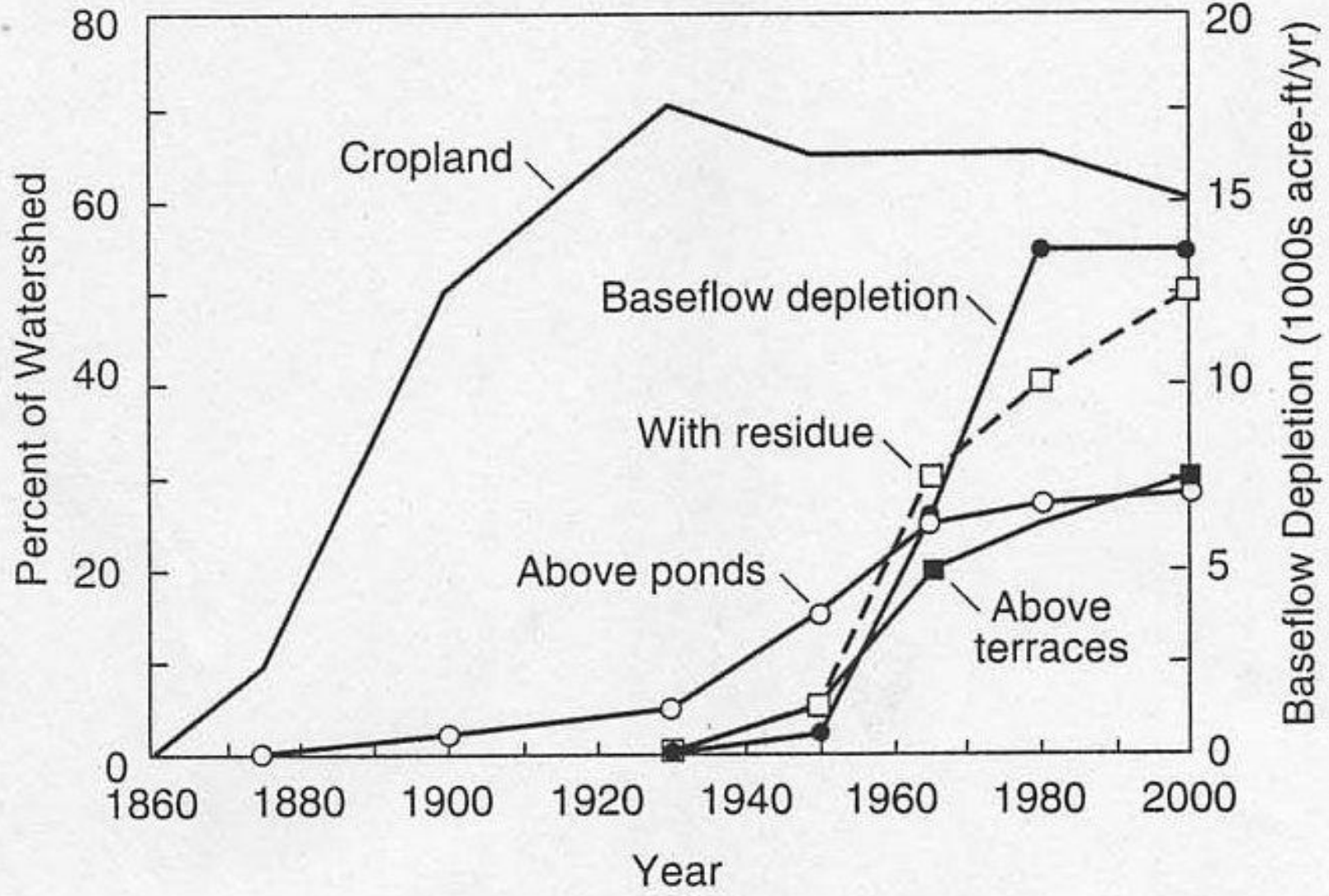


FIGURE 7.4—HISTORICAL AMOUNTS OF CROPLAND, CONSERVATION PRACTICES, AND BASEFLOW DEPLETIONS IN THE SOUTH FORK SOLOMON BASIN ABOVE WEBSTER RESERVOIR (adapted from Koelliker, 1984).

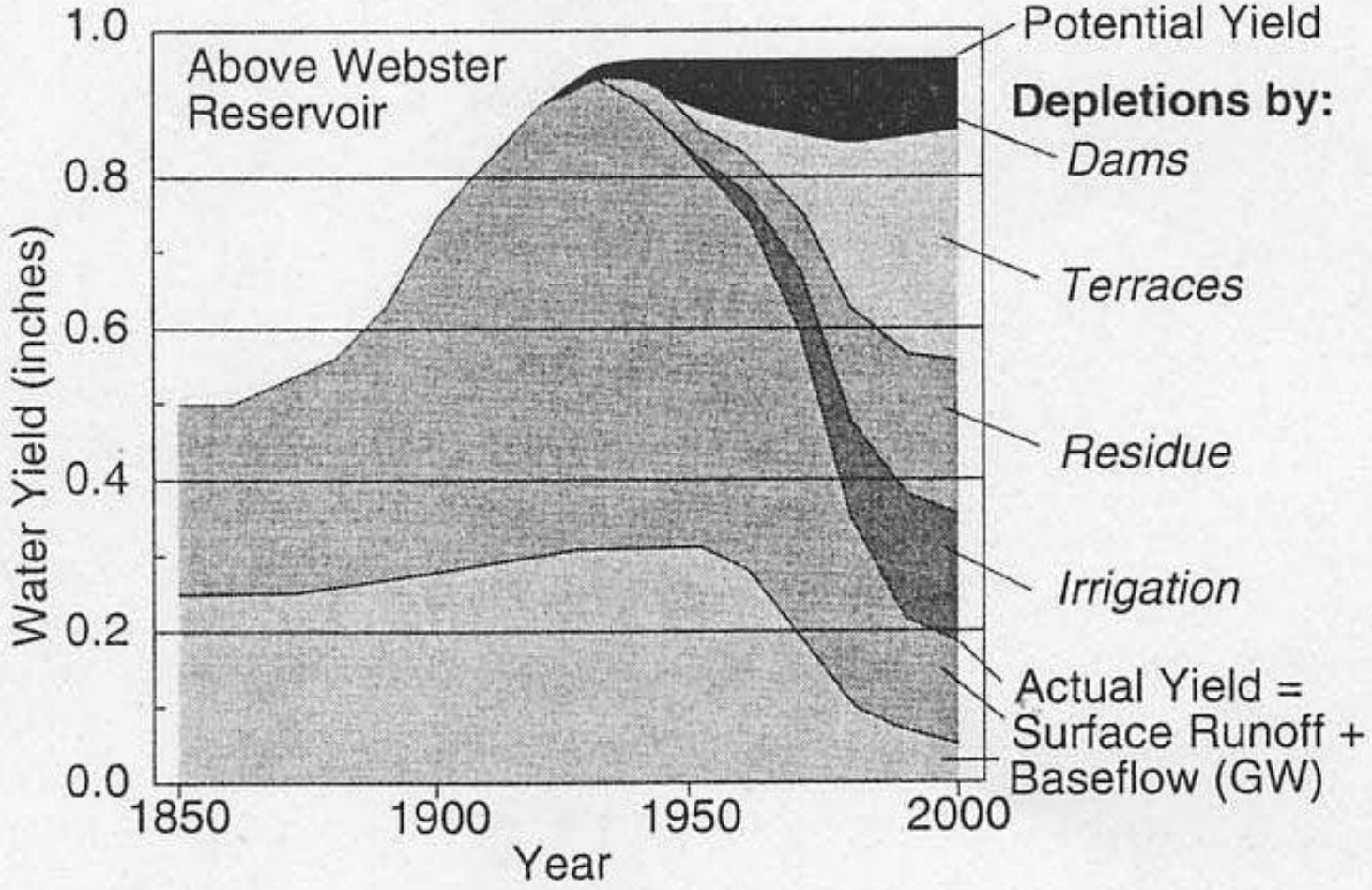


FIGURE 7.3—HISTORICAL PERSPECTIVE OF THE EFFECT OF AGRICULTURAL TECHNOLOGY ON WATER YIELD ABOVE WEBSTER RESERVOIR showing increases caused by conversion to cropland and depletions caused by various soil- and water-conservation practices and changes in agricultural technology (adapted from Koelliker, 1984).

Water development institutional structure

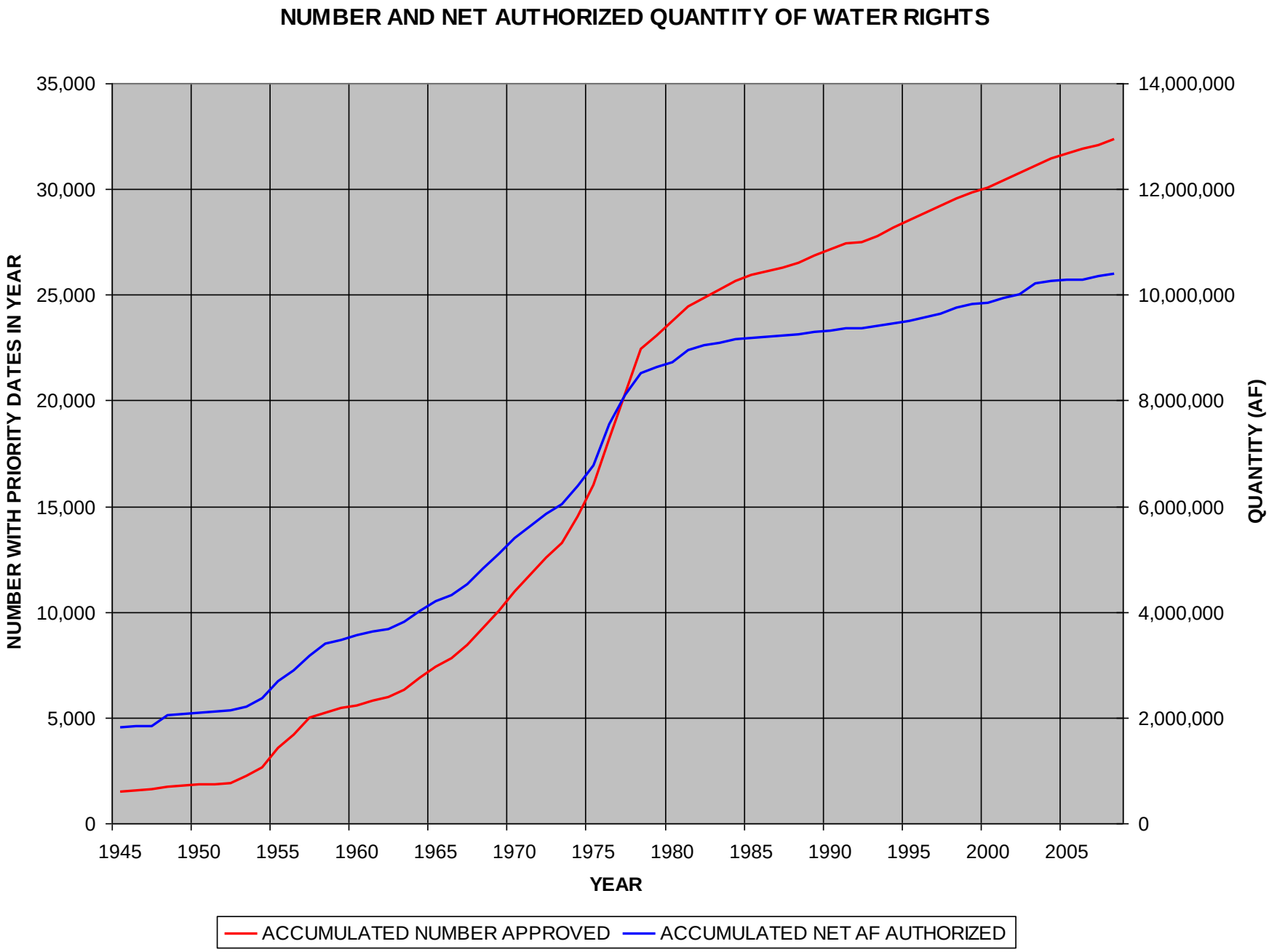
- Early development under common (riparian) law
- DWR formed from KS Water Commission and Division of Irrigation (1927)
- Water Appropriation Act, 1945, administered by Chief Engineer
- Groundwater Management District Act, 1972. Motivated by declines in Western KS and desire for local input
- KWAA regulatory teeth, 1978
- Current water planning process, KWO/KWA, early 1980's, MDS and more
- Additional KWAA amendments, 70's & 80's

Kansas Water Appropriation Act

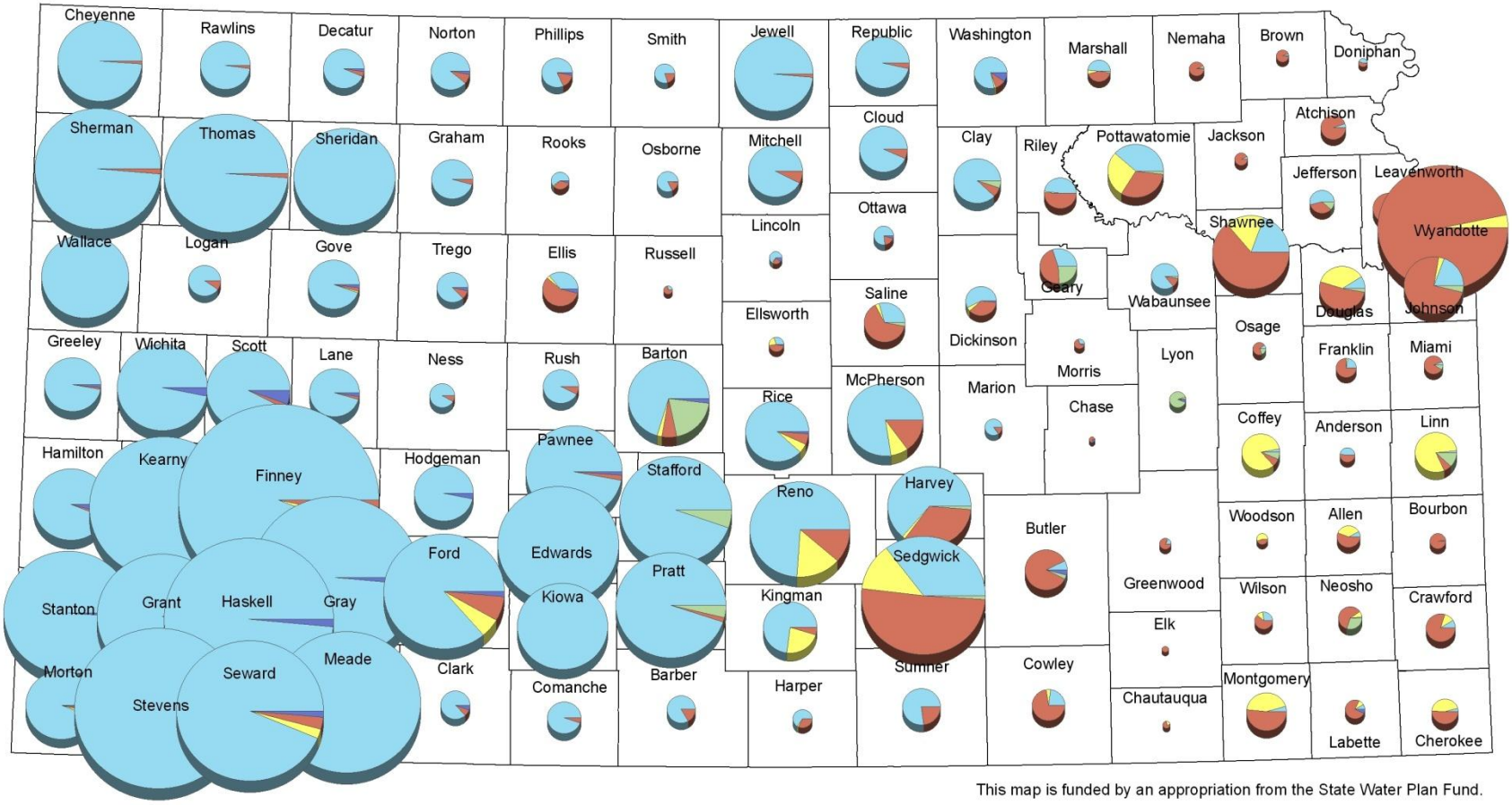
- All water dedicated to use of the people of Kansas
- Right to use water is based on **"First in time is first in right"** priority system
- Limits rights to reasonable needs
- Allows a limited resource to be allocated for beneficial use and to protect the public interest including minimum desirable streamflows
- Protects investments, property rights and the resource

Planning and management

- Studies in 1960's – water level declines
- Historic development largely unregulated before the late 1970's
- Increased management, since the late 1970's by GMD's and DWR
- Most new development highly restricted by 1980's
- KWO/KWA planning process - Ogallala Aquifer Management Plan in the late1990's


NUMBER AND NET AUTHORIZED QUANTITY OF WATER RIGHTS
NUMBER WITH PRIORITY DATES IN YEAR
QUANTITY (AF)
YEAR
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
ACCUMULATED NUMBER APPROVED
ACCUMULATED NET AF AUTHORIZED

2006 Reported Water Use, by Type of Use for Kansas Counties



This map is funded by an appropriation from the State Water Plan Fund.

Disclaimer: Features on this map represent conditions as of the date of the map and are subject to change. The user is referred to specific polices, regulations and/or orders of the Chief Engineer.

Percentages of 1.5% or less do not show up in the pie charts.

This map is intended for planning purposes only.

Pratt: 97,953 AF
McPherson: 46,281 AF
Lane: 20,163 AF

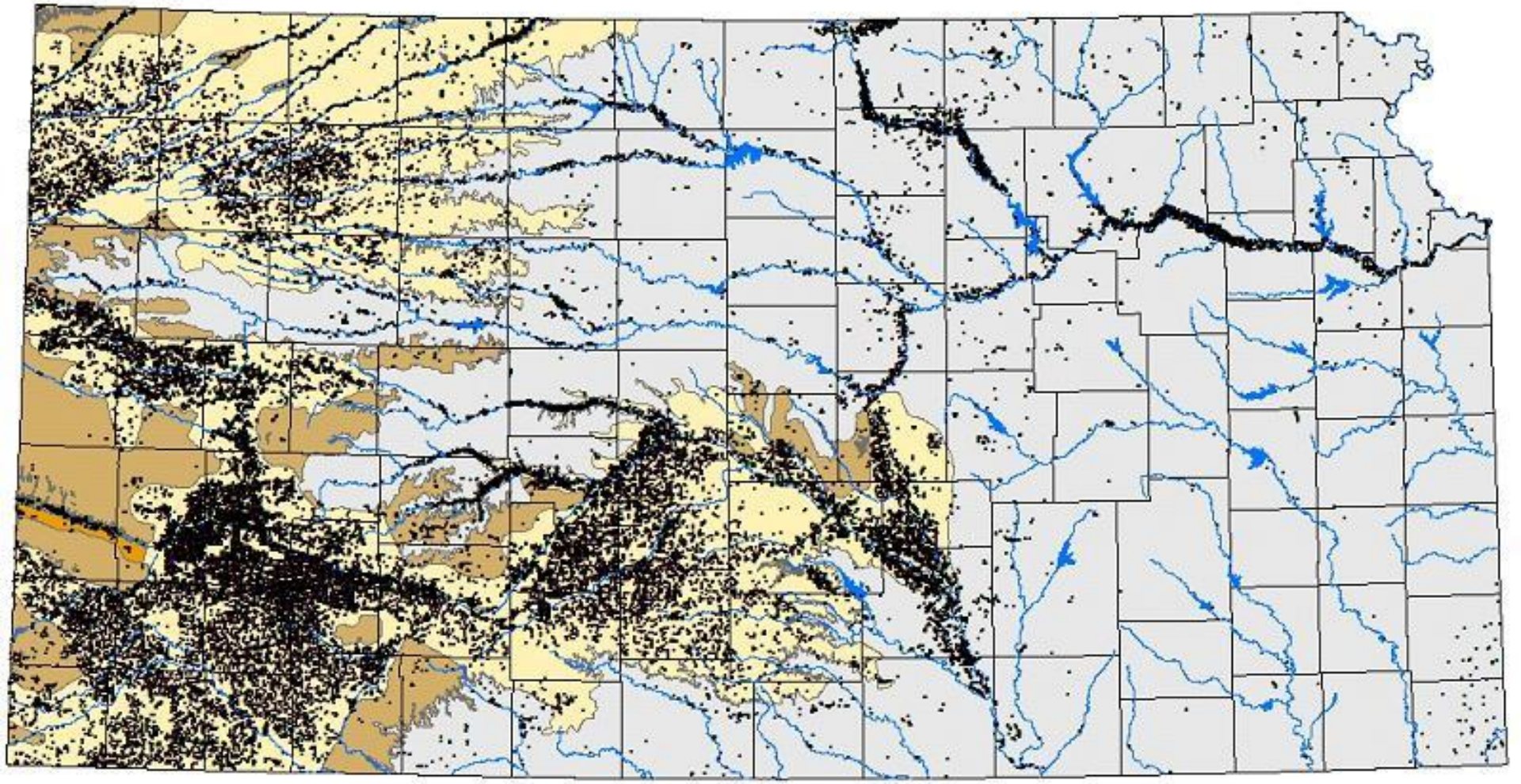
Use Made of Water

Irrigation
Municipal
Stockwater
Industrial
Recreation

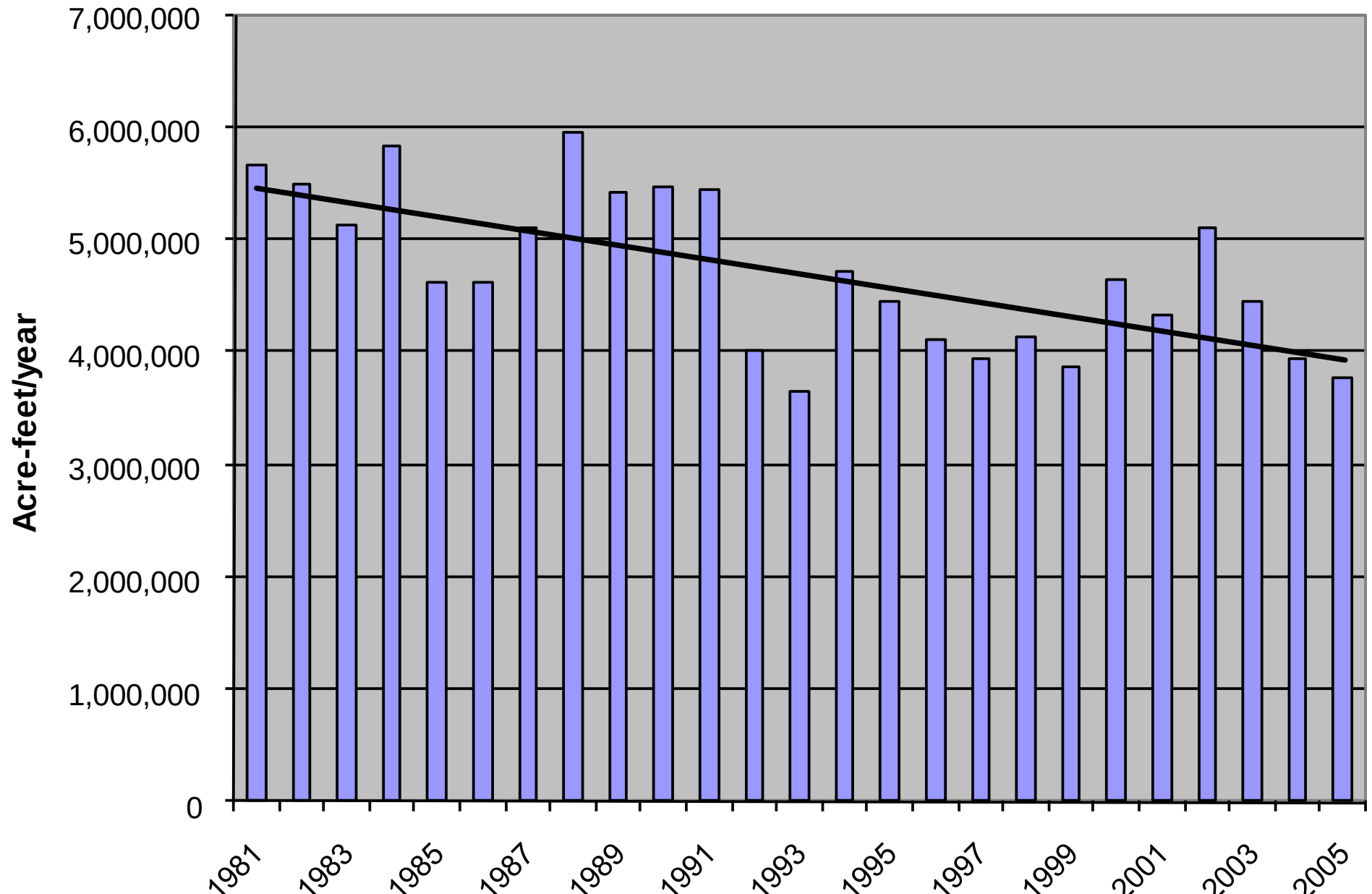
0 37.5 75 150 Miles

Kansas Department of Agriculture
Division of Water Resources
Water Use Unit
December 7, 2007

Density and Distribution of Wells



Total Statewide Water Use, 1981-2005



Sustainability

"[Meeting] the needs of the present without compromising the ability of future generations to meet their own needs."

(*Our Common Future*, United Nations/Brundtland Commission, 1987)

Sustainable Yield Management

"By 2015, achieve sustainable yield management of Kansas surface and ground water sources, outside of the Ogallala aquifer and areas specifically exempt by regulation.

Sustainable yield management would be a goal that sets water management criteria to ensure long term trends in water use will move as close as possible to stable ground water levels and maintenance of sufficient stream flows."

(Kansas Water Plan, 1998)

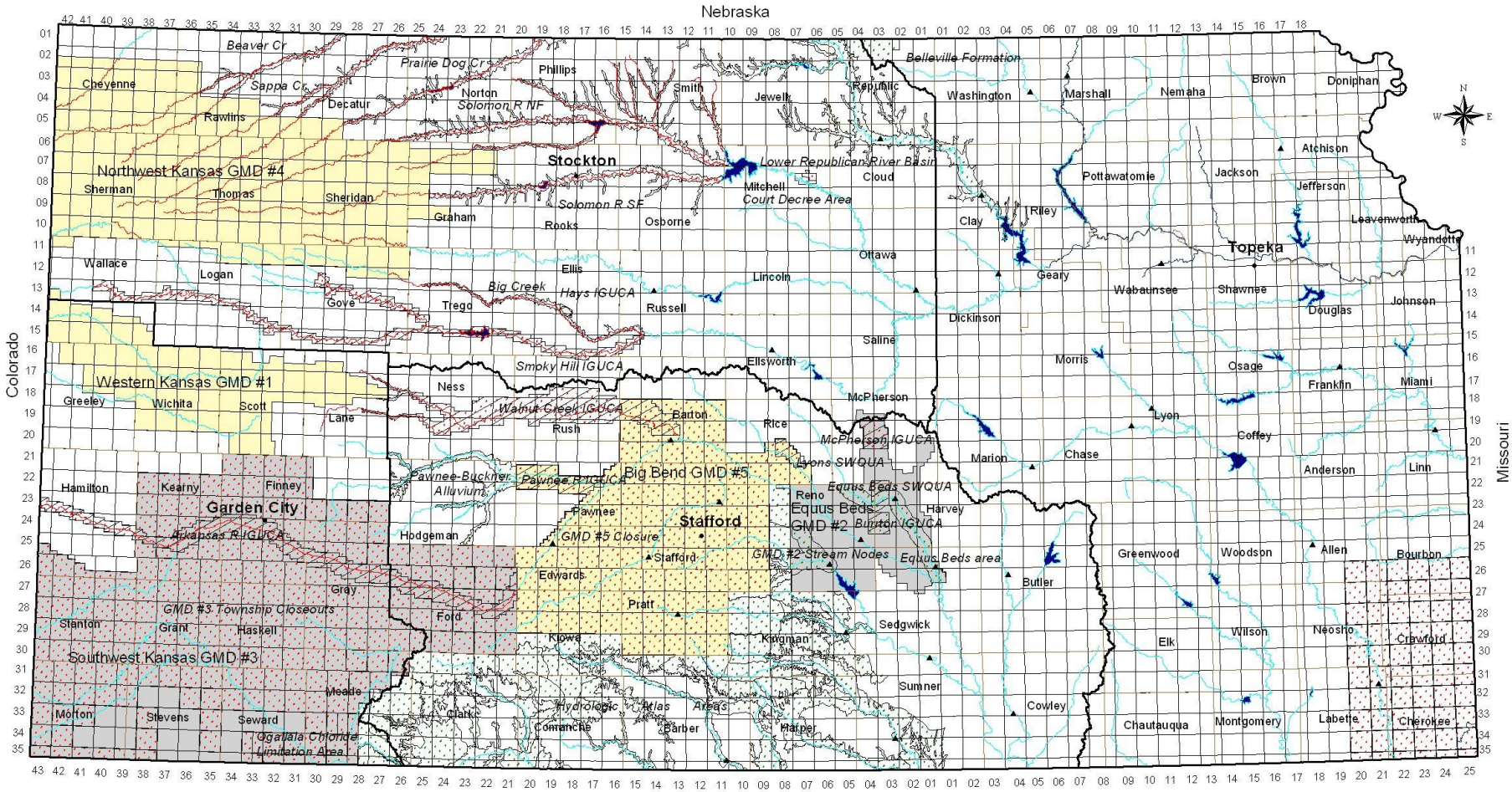
Question: So where are we in relation to sustainability of our water resources?

Answer: All over the map

Kansas Department of Agriculture

Closed and Restricted Areas

Division of Water Resources



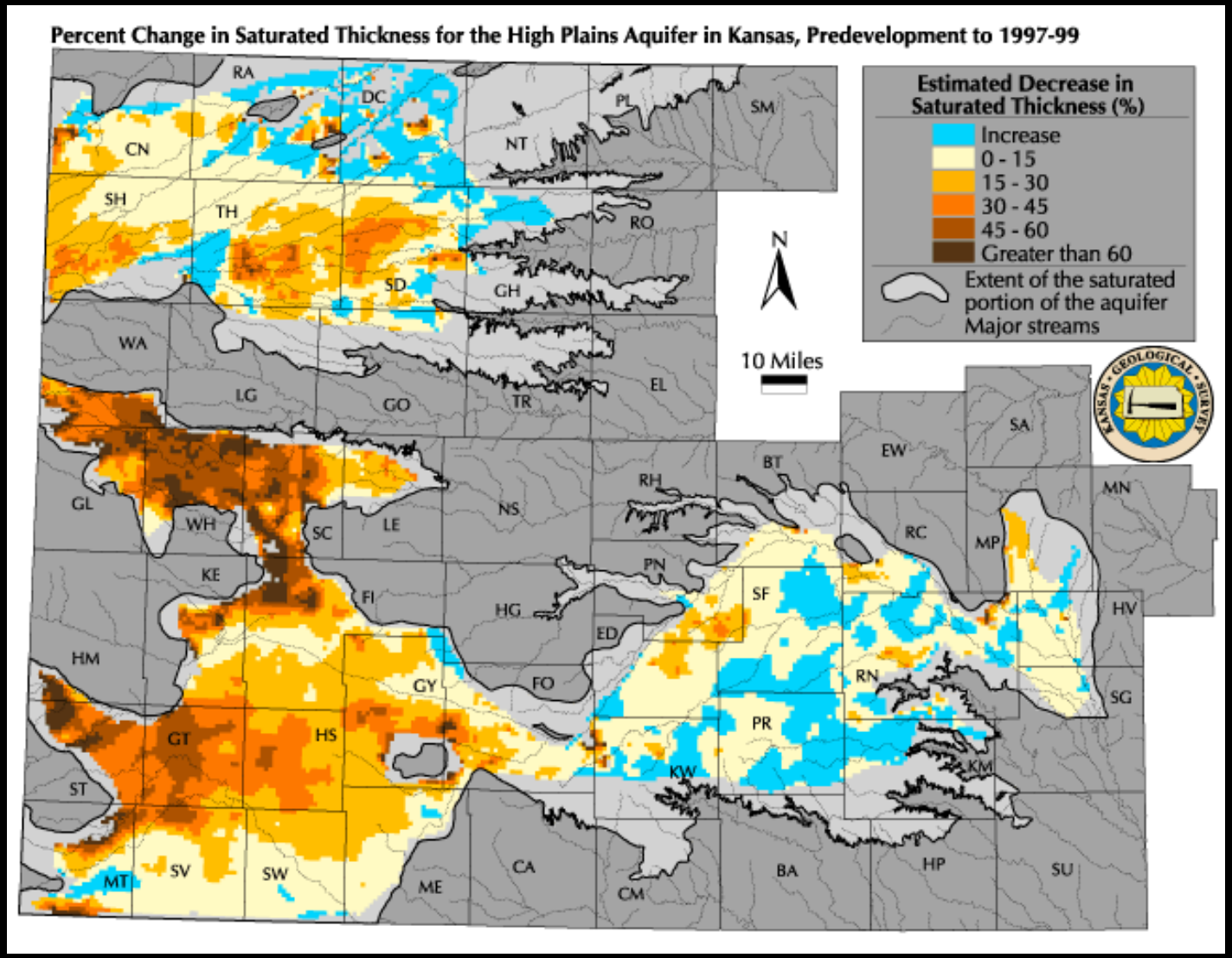
Kansas Department of Agriculture
Division of Water Resources
Technical Services Section
K. Emmons

- GMD #1, #4, #5
- GMD #2, #3
- IGUCA or SWQUA
- Closed Area, generally excluding temporary and other small uses in some cases. See regulation for details.
- Area subject to Special Restrictions. See regulation for requirements.
- Closed Streams, generally excluding temporary and other small uses in some cases. See regulation for details.
- Restricted Streams, specific restrictions for streams and alluvium given in regulation.
- Streams, surface water generally available. Includes Missouri River.
- Field Office Boundary
- Regional Field Offices
- County
- *text* Name of affected area
- MDS Gaging Stations

Disclaimer-Features on this map represent conditions as of the date of the map and are subject to change. The user is referred to specific policies, regulations, and/or orders of the Chief Engineer.

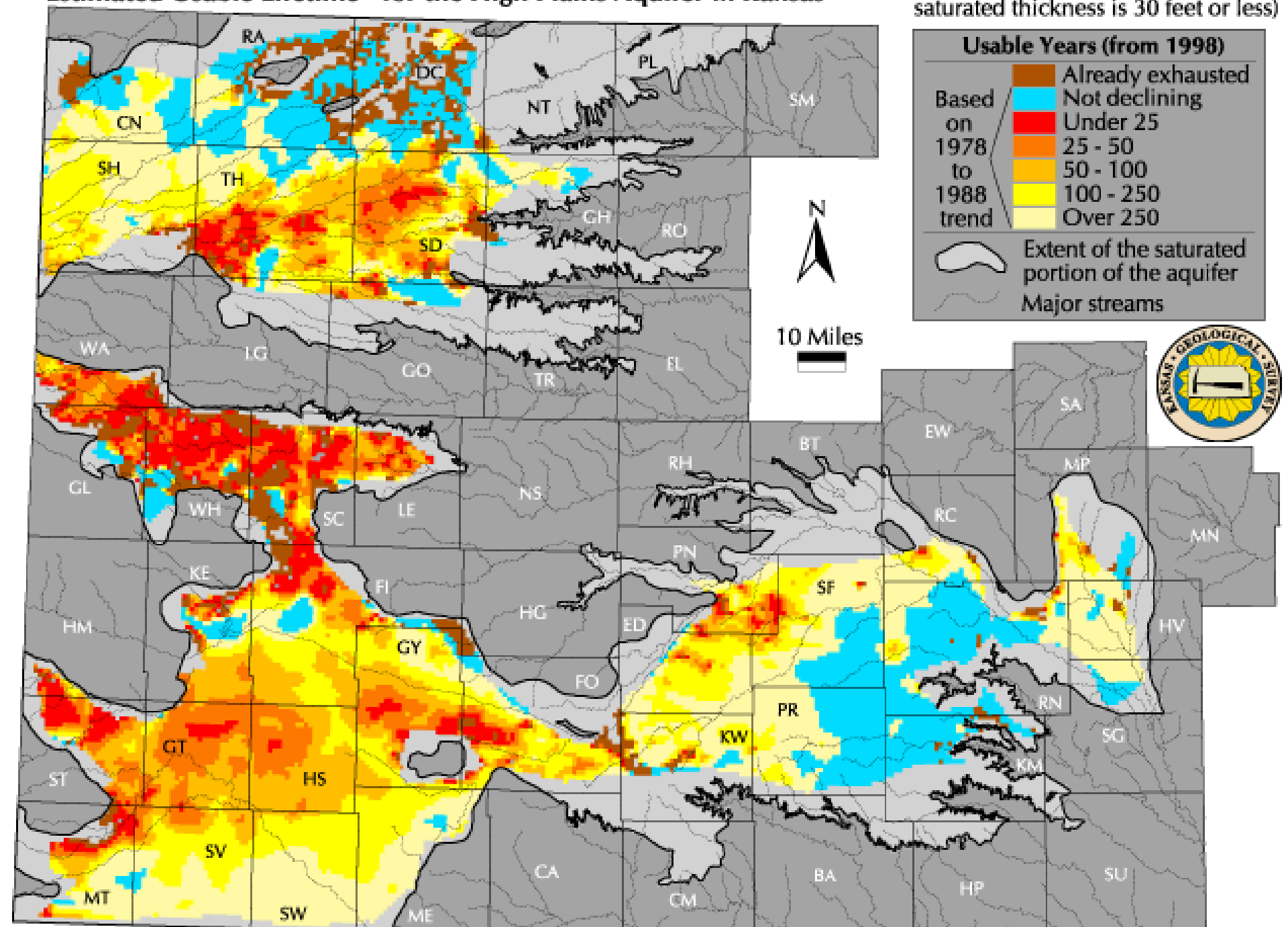
July 11, 2005

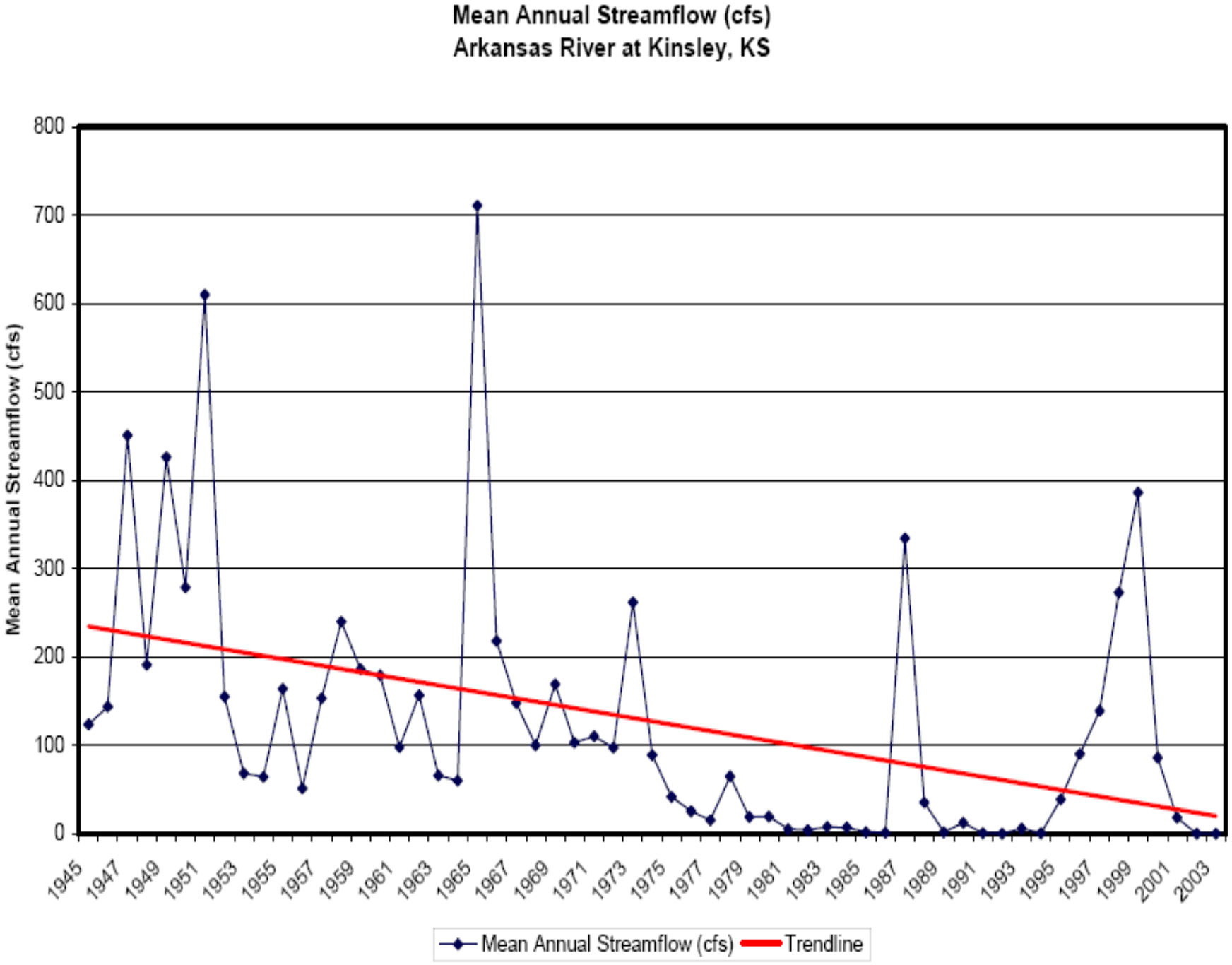
Percent Change High Plains Aquifer in Kansas

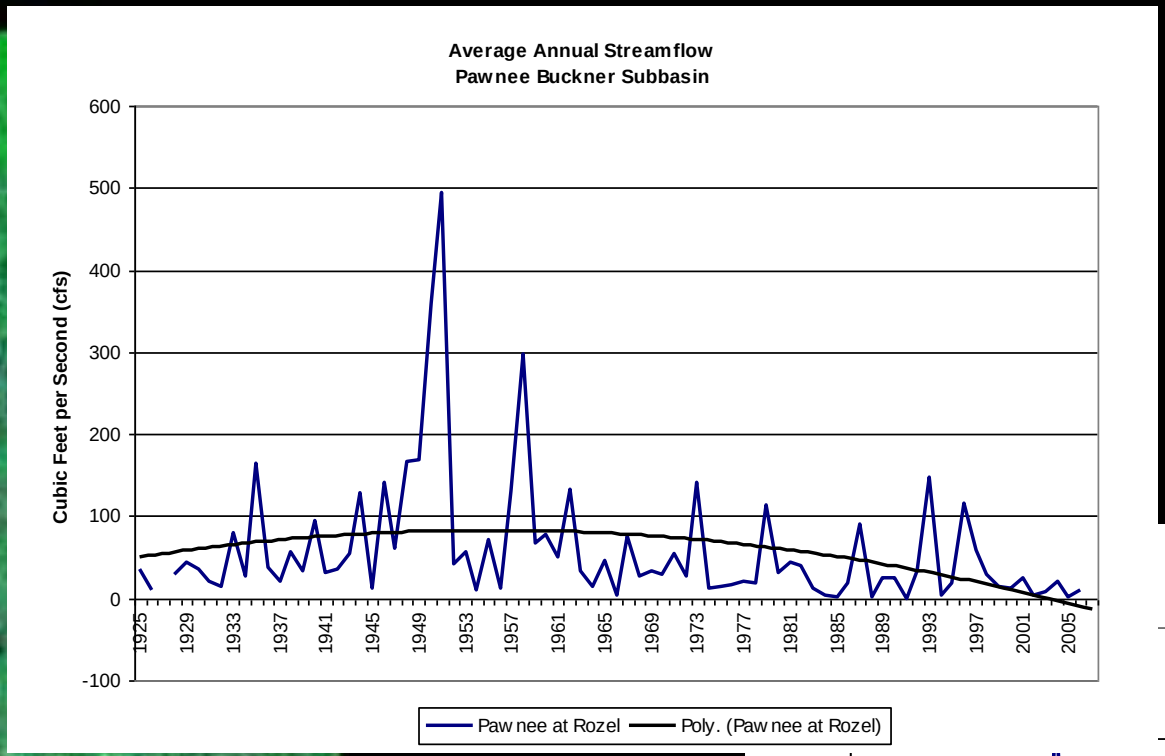


Estimated Usable Lifetime* for the High Plains Aquifer in Kansas

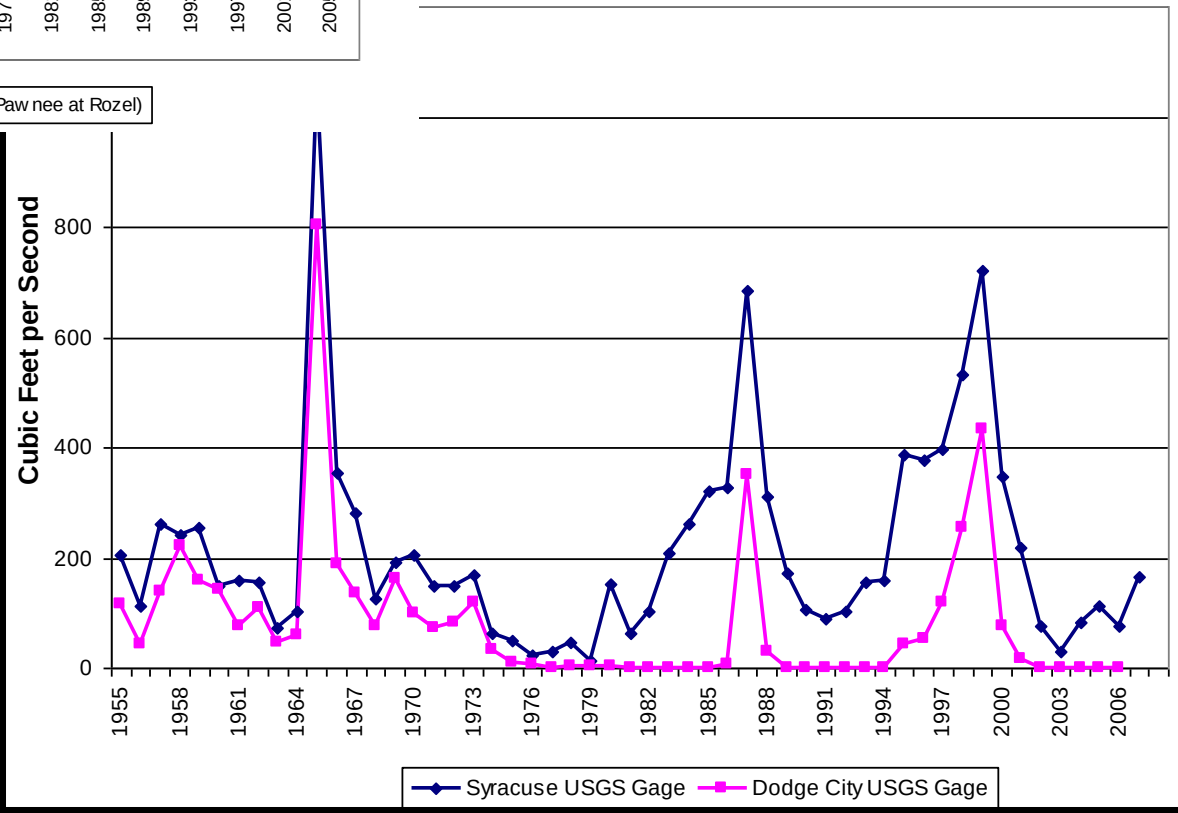
(* Usable lifetime is exhausted when saturated thickness is 30 feet or less)

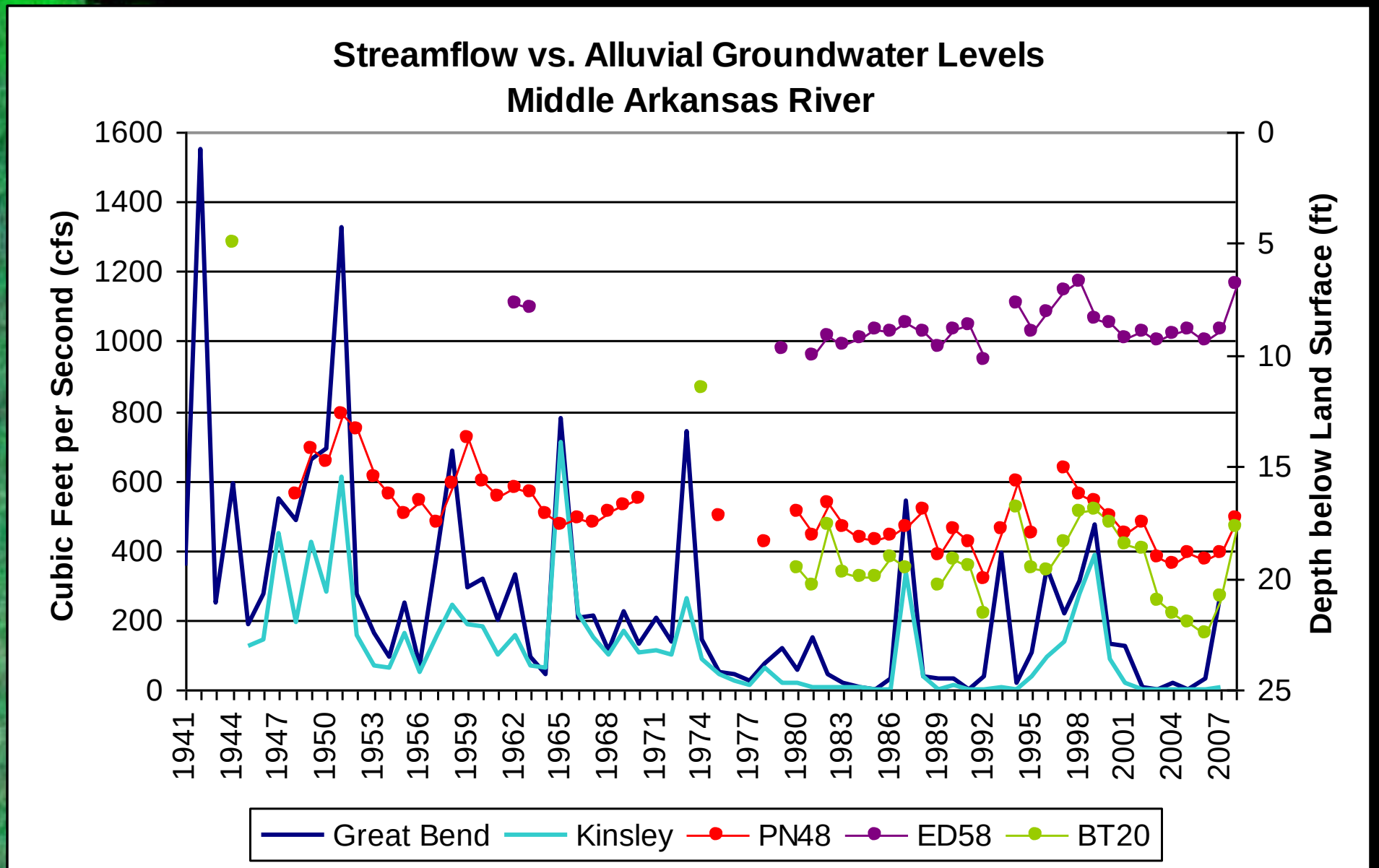


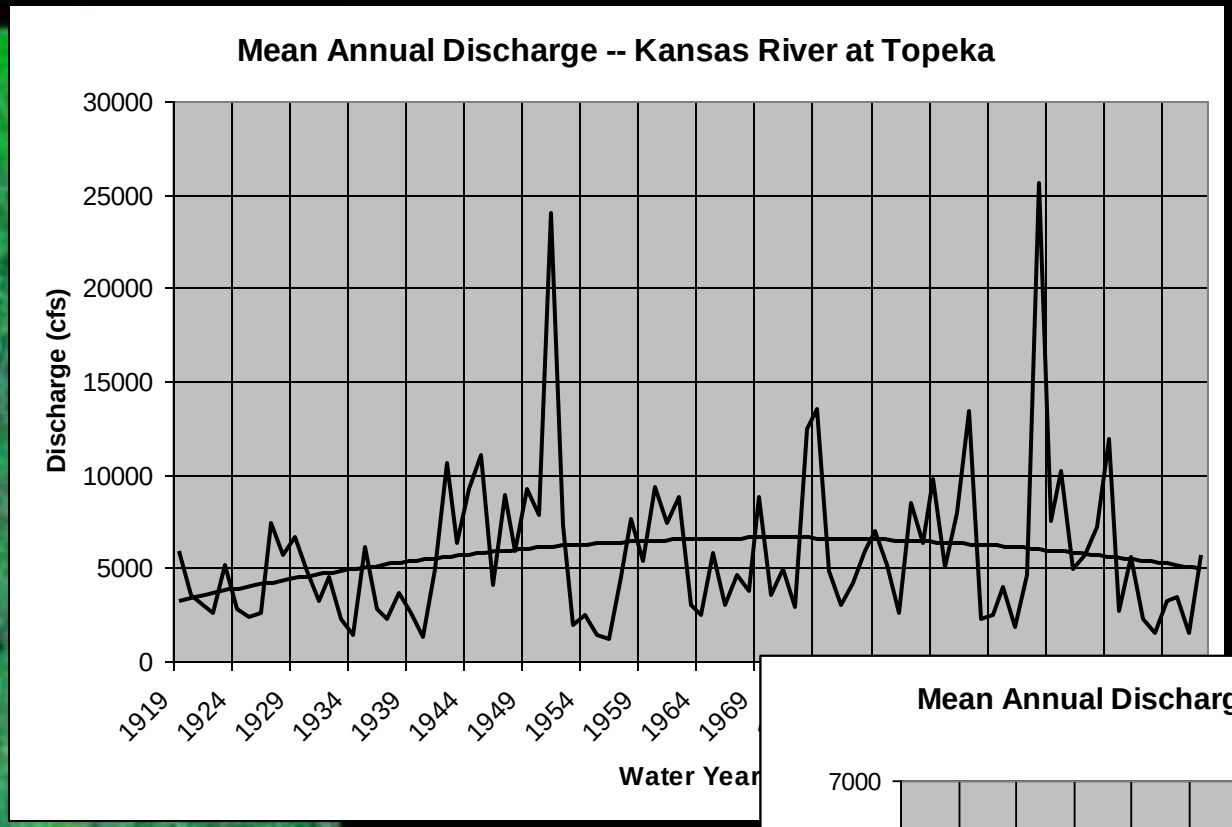

Mean Annual Streamflow (cfs)
Arkansas River at Kinsley, KS
Mean Annual Streamflow (cfs)
800
700
600
500
400
300
200
100
0
1945
1947
1949
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
Mean Annual Streamflow (cfs)
Trendline

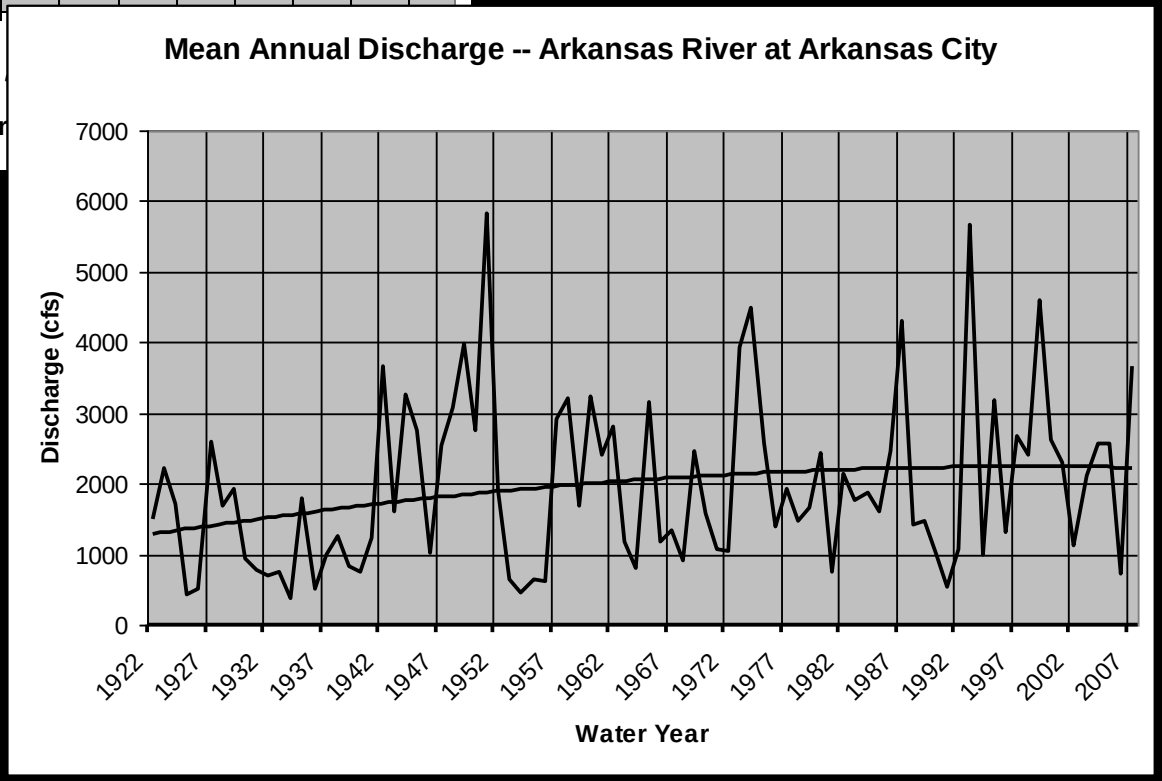


Streamflow
Upper Arkansas River

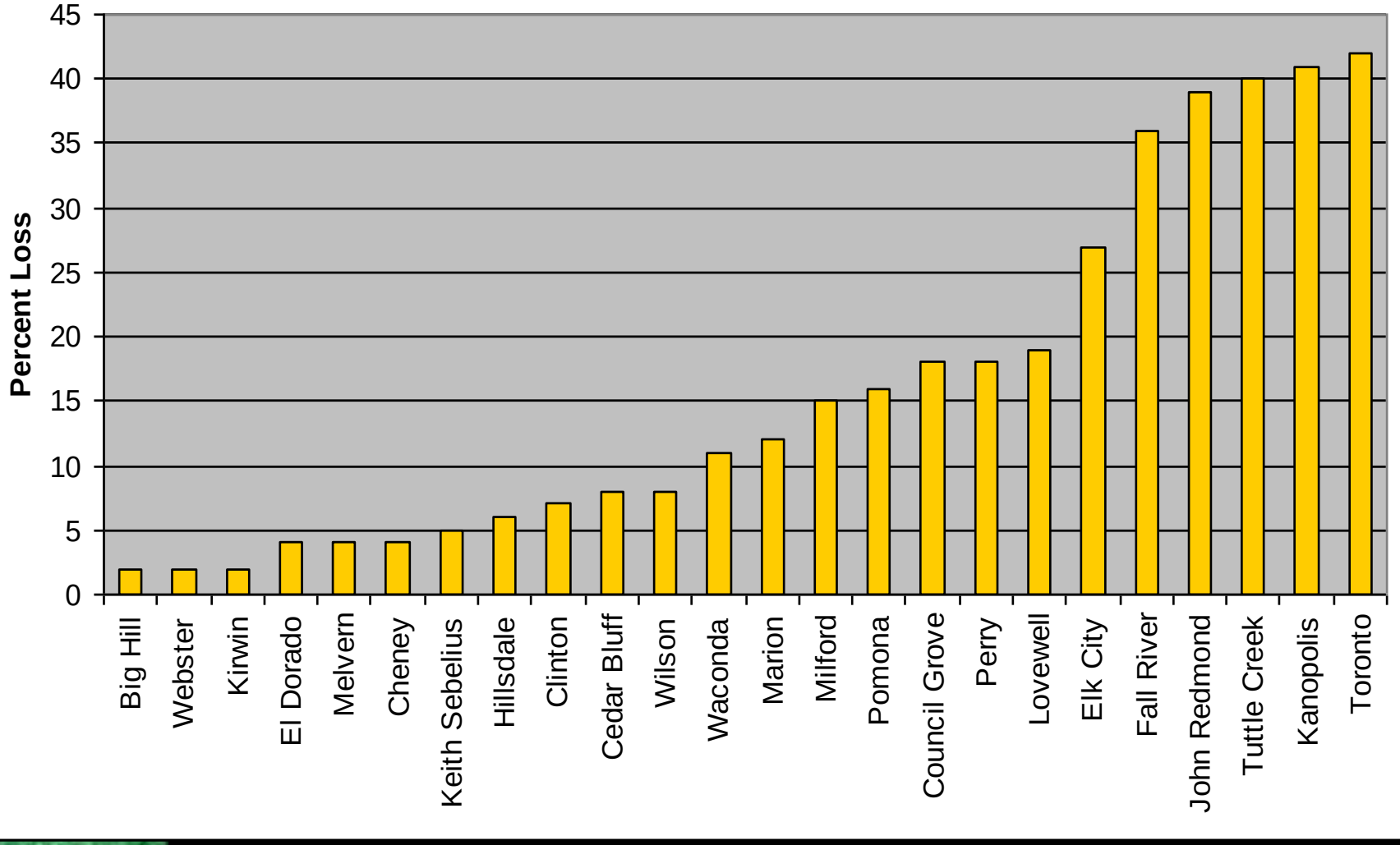



Streamflow vs. Alluvial Groundwater Levels
Middle Arkansas River
Cubic Feet per Second (cfs)
Depth below Land Surface (ft)
1600
1400
1200
1000
800
600
400
200
0
0
5
10
15
20
25
1941
1944
1947
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
Great Bend
Kinsley
PN48
ED58
BT20

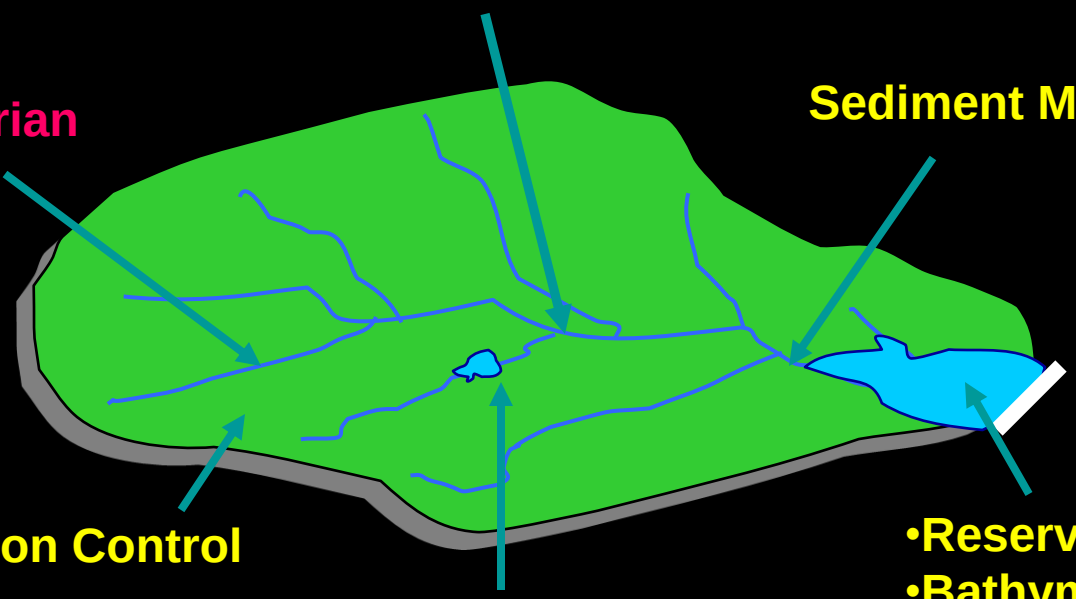

Mean Annual Discharge -- Kansas River at Topeka
Discharge (cfs)
30000
25000
20000
15000
10000
5000
0
1919
1924
1929
1934
1939
1944
1949
1954
1959
1964
1969
Water Year


Mean Annual Discharge -- Arkansas River at Arkansas City
Discharge (cfs)
7000
6000
5000
4000
3000
2000
1000
0
1922
1927
1932
1937
1942
1947
1952
1957
1962
1967
1972
1977
1982
1987
1992
1997
2002
2007
Water Year

Sustainability of reservoir yields impacted by storage lost to sedimentation



Sediment Mgmt for Reservoir Watersheds



Stream Channel Stabilization

Wetland & Riparian Protection

Sediment Monitoring

Erosion Control

•Reservoir Restoration
•Bathymetric Surveys

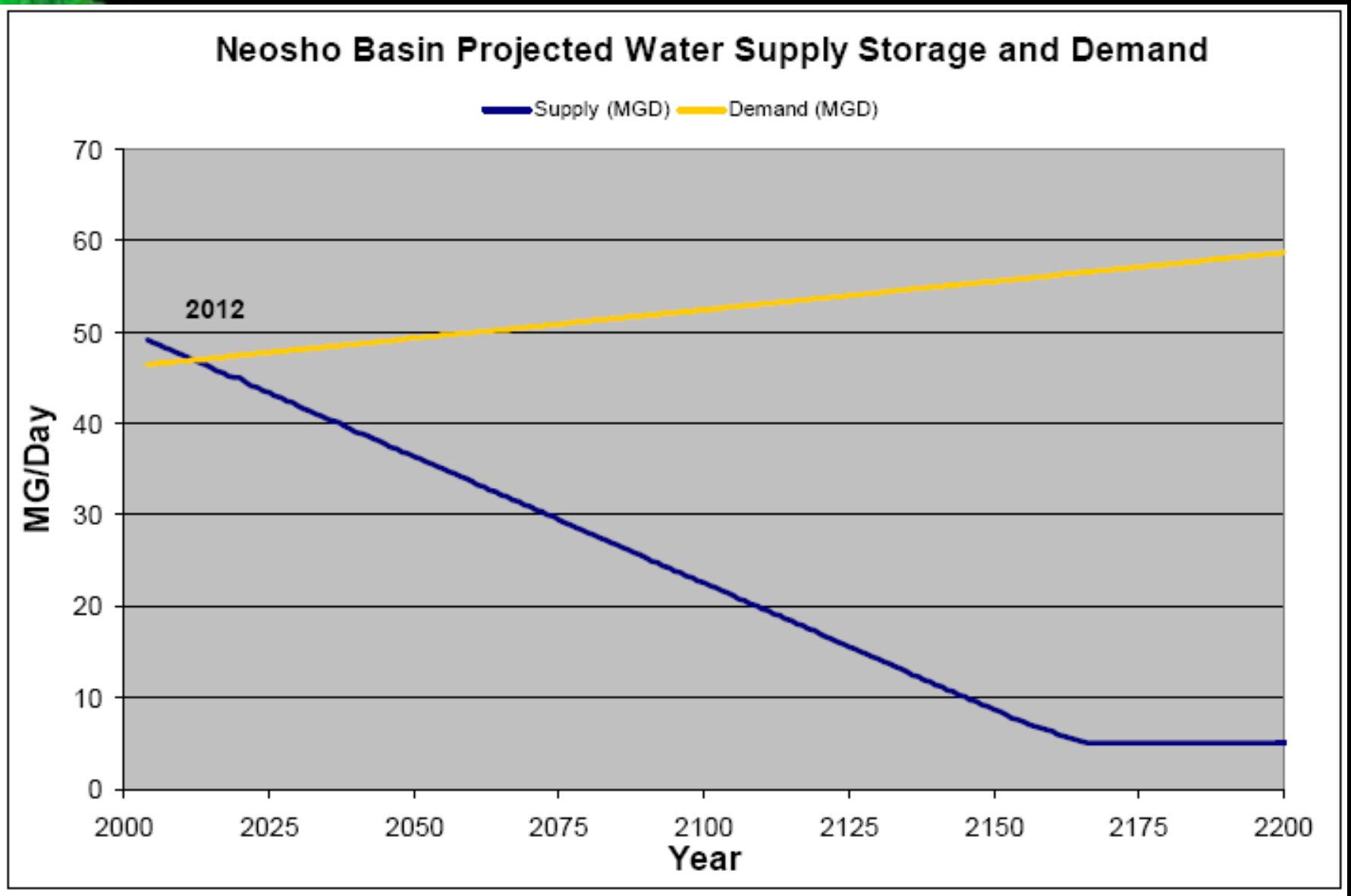
Watershed Structures

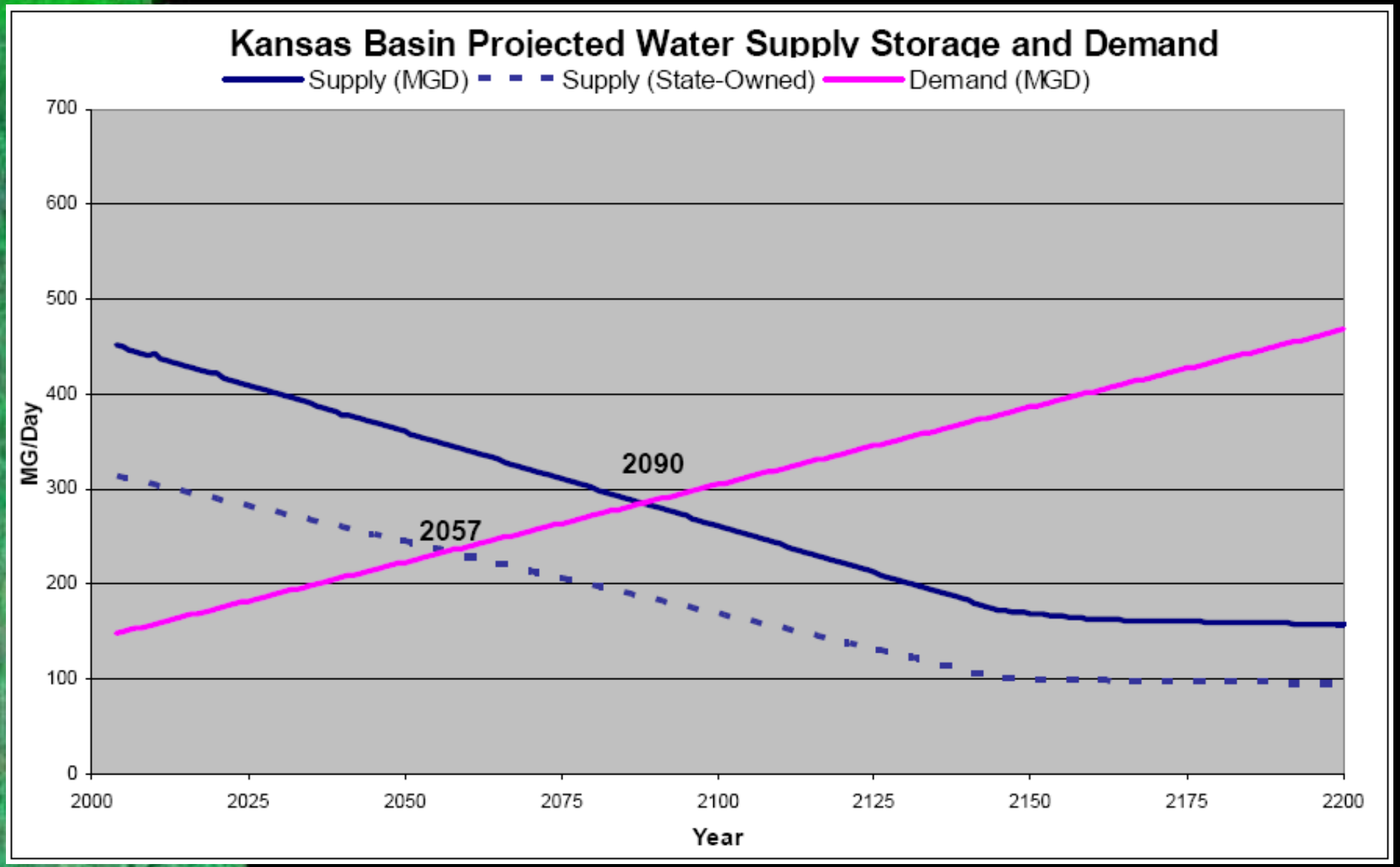
What are we doing about this? Where do we go from here?

Working to understanding the Problem

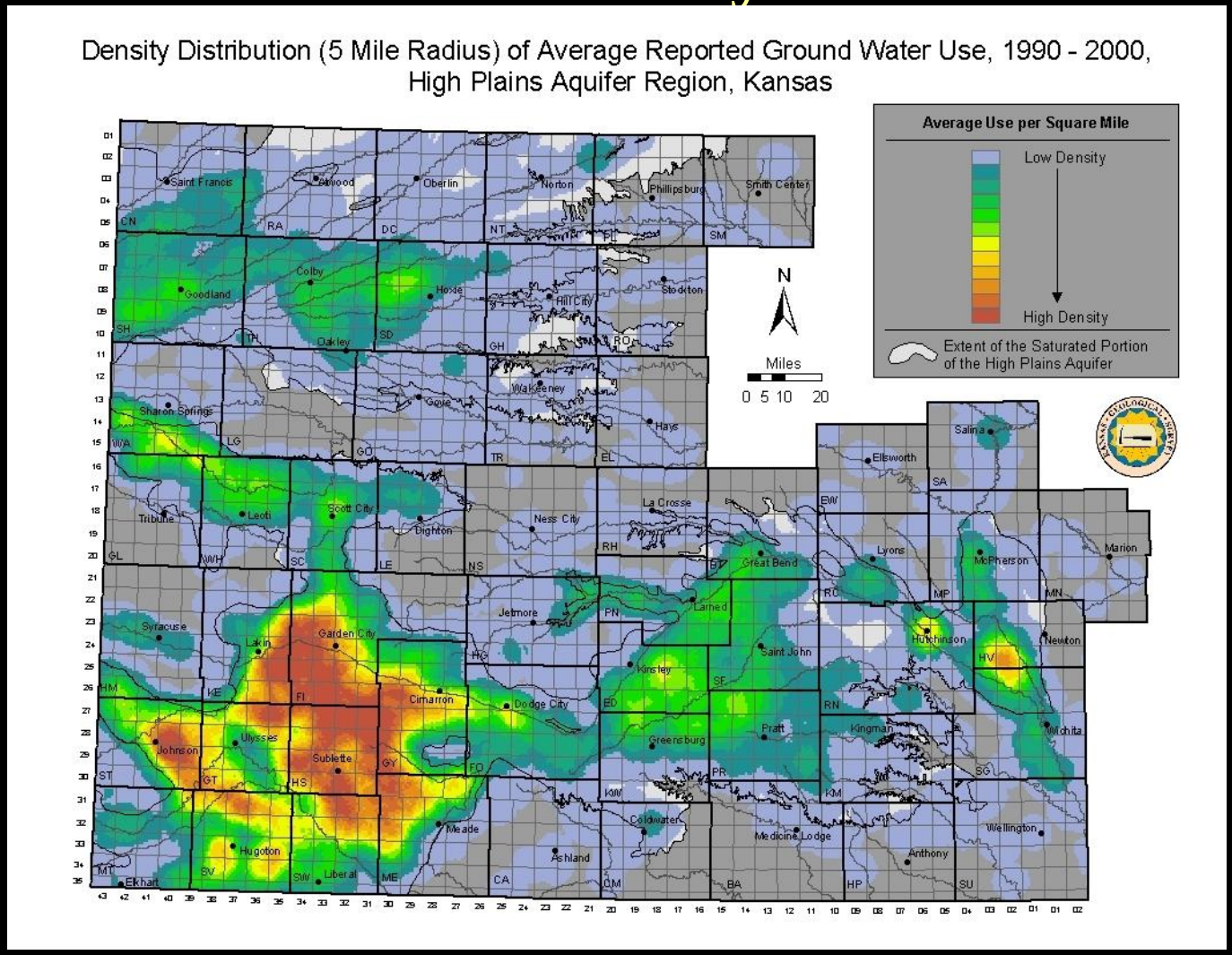
- Data collection
- Analysis / modeling
- Stakeholder input
- Management options
- Integrated solutions

No “one size fits all” approach

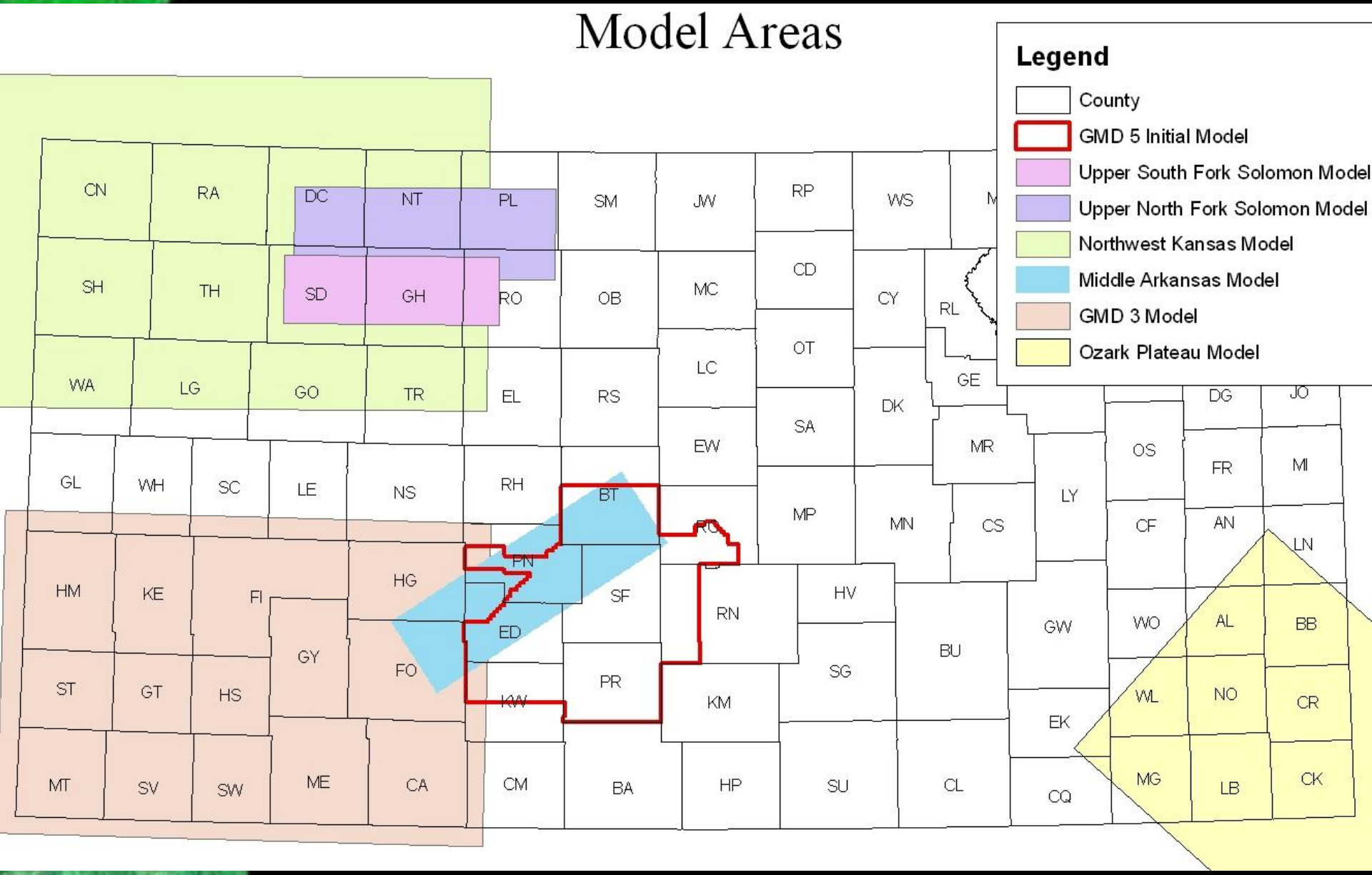

Neosho Basin Projected Water Supply Storage and Demand
Supply (MGD)
Demand (MGD)
2012
70
60
50
40
30
20
10
0
MG/Day
2000
2025
2050
2075
2100
2125
2150
2175
2200
Year


Kansas Basin Projected Water Supply Storage and Demand
Supply (MGD)
Supply (State-Owned)
Demand (MGD)
700
600
500
400
300
200
100
0
MG/Day
2090
2057
2000
2025
2050
2075
2100
2125
2150
2175
2200
Year

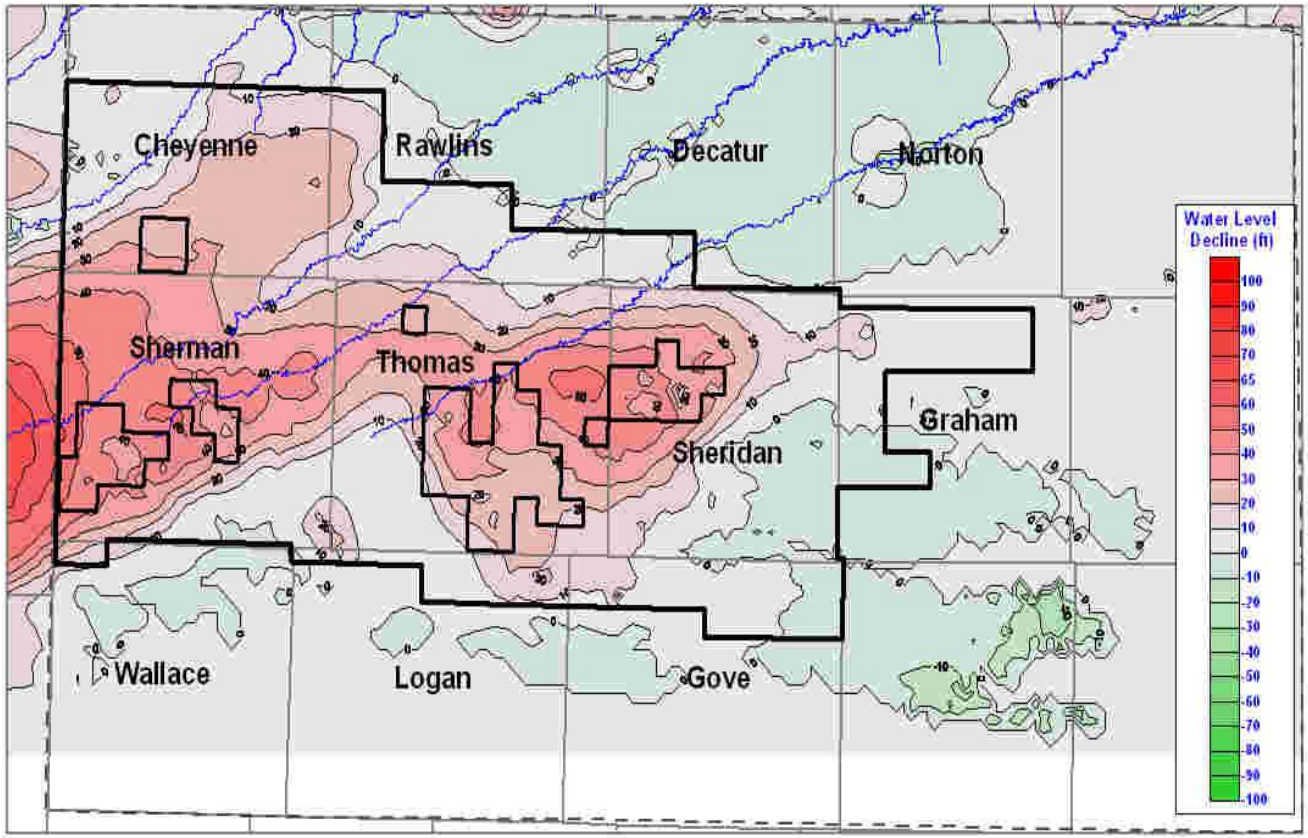
Define Priority Aquifer Subunits e.g. by Projected Useful Lifetime & Water Use Density



Model Areas


Legend
County
GMD 5 Initial Model
Upper South Fork Solomon Model
Upper North Fork Solomon Model
Northwest Kansas Model
Middle Arkansas Model
GMD 3 Model
Ozark Plateau Model
CN
RA
DC
NT
PL
SM
JW
RP
WS
SH
TH
SD
GH
RO
OB
MC
CD
CY
RL
WA
LG
GO
TR
EL
RS
LC
OT
GE
DG
JO
SA
DK
EW
MR
OS
FR
MI
GL
WH
SC
LE
NS
RH
BT
MP
MN
CS
LY
CF
AN
LN
HM
KE
FI
HG
PN
SF
RN
HV
GW
WO
AL
BB
GY
ED
BU
ST
GT
HS
FO
PR
SG
WL
NO
CR
KW
KM
EK
MT
SV
SW
ME
CA
CM
BA
HP
SU
CL
CQ
MG
LB
CK

Northwest Kansas
Water Level Changes in High Priority Areas



Scenario 3 30% reduction in HPA only

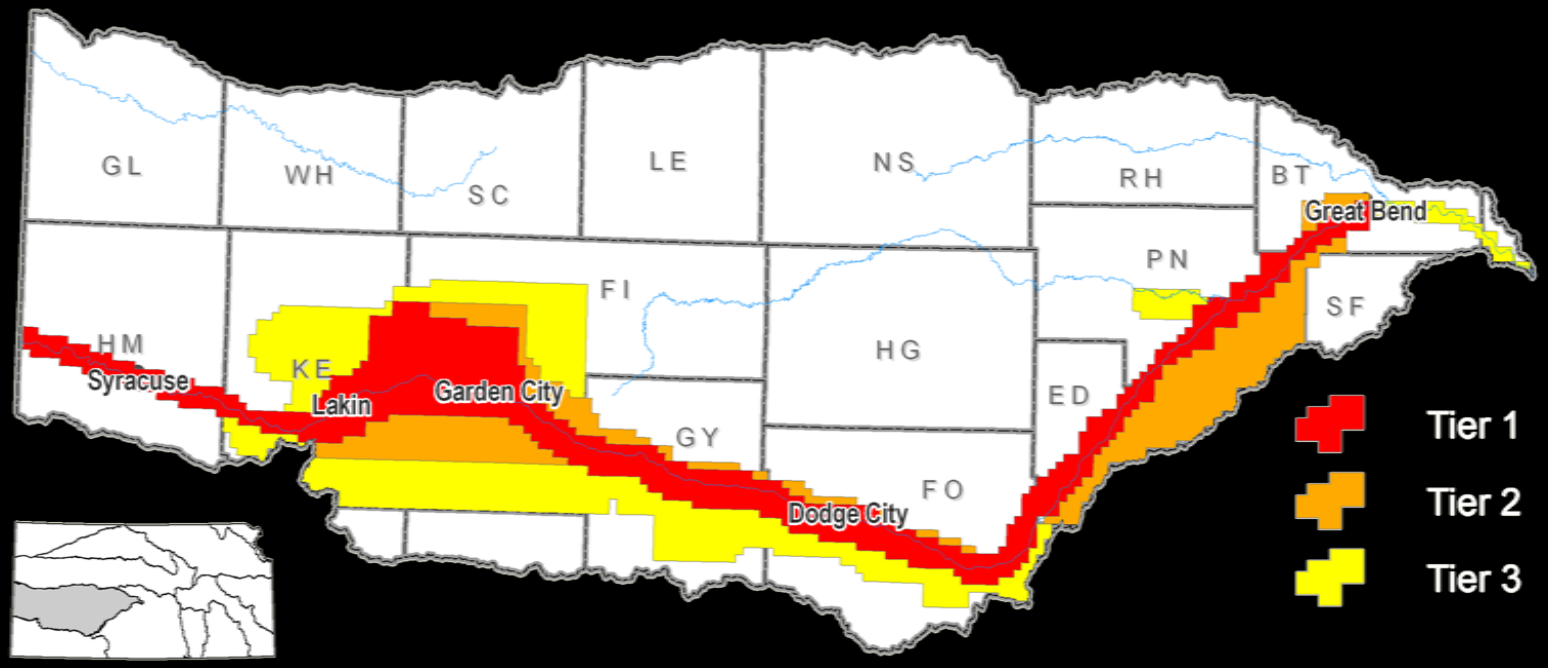
Research activities / needs

- Identify / deal with barriers to true water conservation, e.g., crop insurance disincentives to limited irrigation
- More precise definition of our water resources:
  - recharge
  - practical saturated thickness (GMD 3)
- Explore alternative sources of supply
- Review economic models

Market-Driven Approach

- Mining concluding with sustainability for numerous small uses (GMD 1 scenario)
- Private entities, cities and corporations dealing with it – finding new supplies

Targeted water use retirement programs



- Conservation Reserve Enhancement Program (CREP)
- Water Transition Assistance Program (WTAP)

Enhanced Recharge

- Increase recharge from stormwater runoff, high flow events, treated wastewater
- Increasing the “inflows” term in the mass balance equation to support outflows with less mining of water in storage

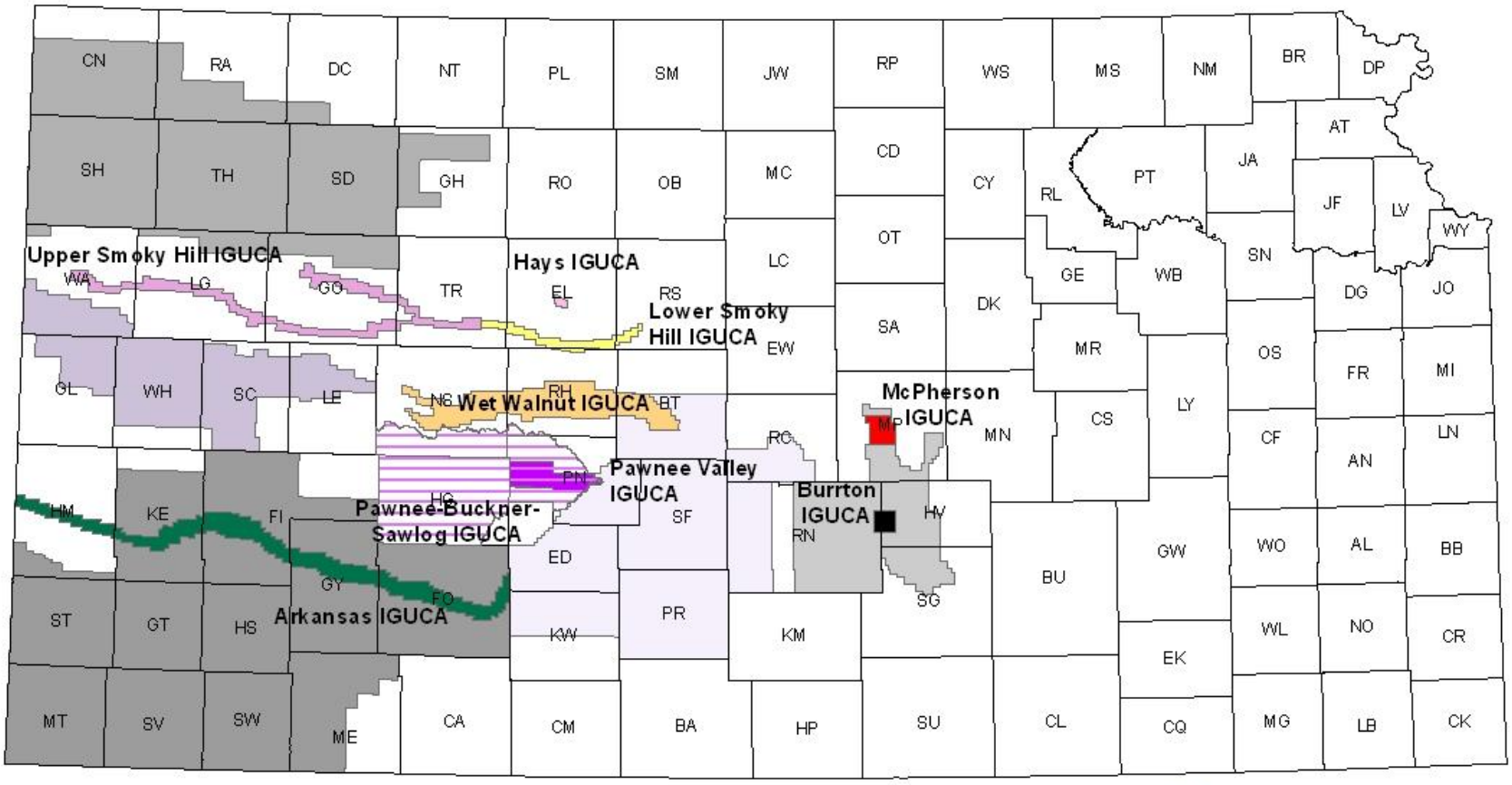
Explore innovation solutions

- Aquifer Storage and recovery (Wichita) – an option for high value uses. Are there other locations where this could work?
- City of Hutchinson – cleanup of contaminated water for municipal use.

Regulatory approaches

- Increased compliance and enforcement of water rights
- Explore full range of potential GMD and/or State actions to reduce allocations/use while maintaining maximum economic use
- Improved processes for involving stakeholders in discussions

Intensive Groundwater Use Control Areas in Kansas



GMD

- Western Kansas GMD #1
- Equus Beds GMD #2
- Southwest Kansas GMD #3
- Northwest Kansas GMD #4
- Big Bend GMD #5

IGUCA

- Arkansas IGUCA
- Burrton IGUCA
- Hays IGUCA
- Lower Smoky Hill IGUCA
- McPherson IGUCA
- Pawnee Valley IGUCA
- Pawnee-Buckner-Sawlog IGUCA
- Upper Smoky Hill IGUCA
- Wet Walnut IGUCA

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Kansas Department of Agriculture
Division of Water Resources
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All of the above and more

- Many solutions will combine local and regional action
- What works in one area may not in another
- Like dealing with a budget out of balance
- No silver bullets; just a lot of hard work

Parting Thoughts

- Are sustainable water resources possible in Kansas?
  - Yes, but expensive and not easy
  - Solid framework in our laws, water planning processes, significant coordination
- When should we start?
  - It will only become more costly and difficult the longer we wait
- “Water resources professional job security act” – with “fixed” resource and increasing demand, there will always be work to do

Questions?