Northeastern Illinois Streams:

Factors that Affect the Distribution and Availability of Streamflow for Water Supply and Instream Needs

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This presentation will:

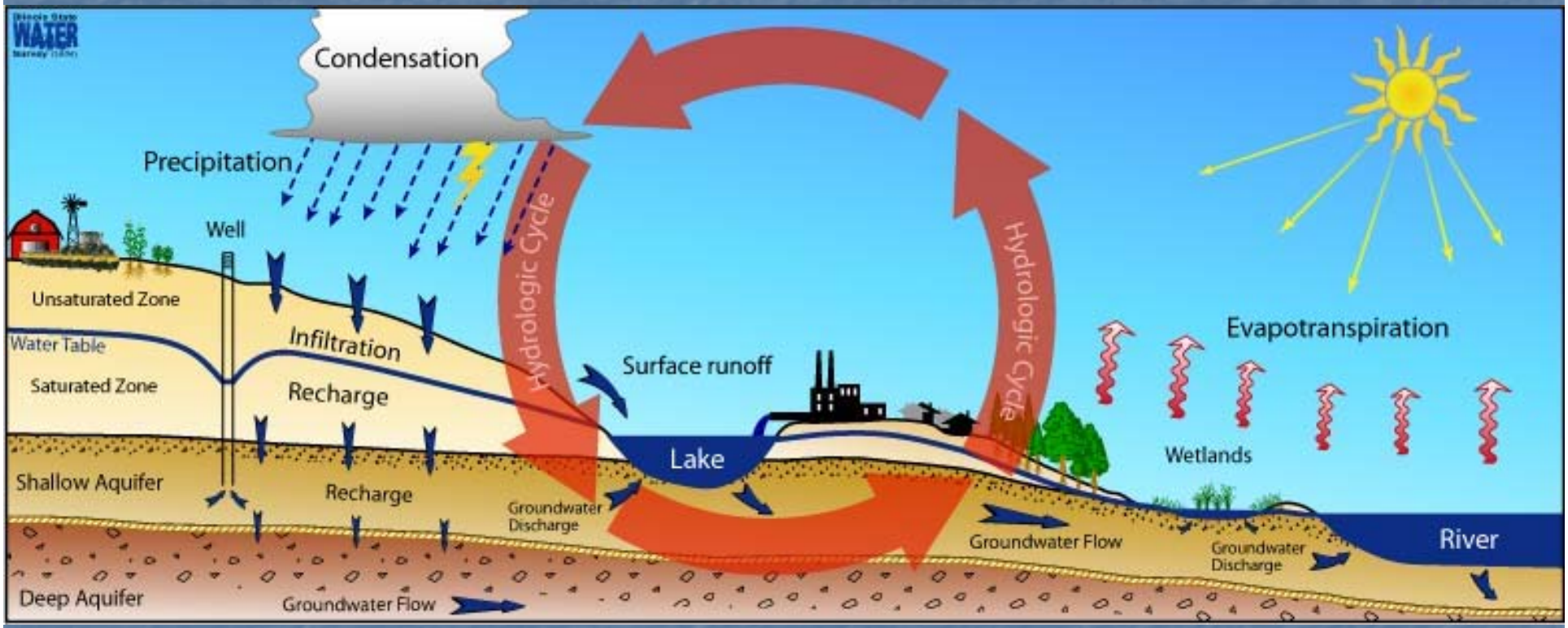
- Not address Lake Michigan
- Focus on water quantity
- Discuss factors affecting availability of streamflows for:
  - Maintaining healthy streams & instream needs
  - Evaluating potential and limitations for obtaining water supply from major rivers

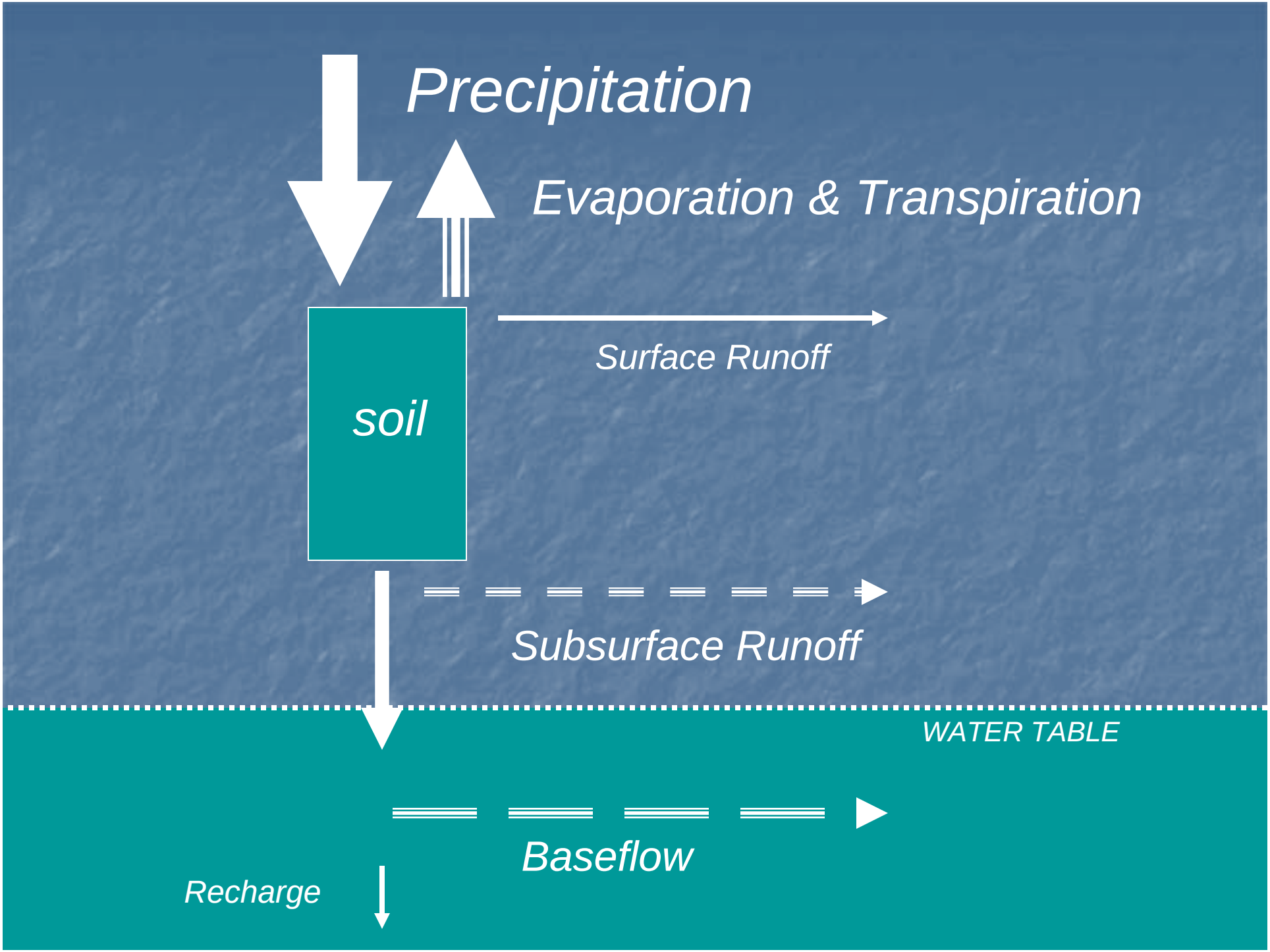
Presentation Outline

- **The Hydrologic Cycle**
  - Sources of natural flow in rivers and streams
- **Surface Water Supply Sources**
  - Statewide and Northeastern Illinois
- **Factors Affecting Surface Water Availability**
  - Climate variability & change
  - Water use (withdrawals and return flows)
  - Reservoirs, diversions, navigation works
  - Indirect impacts on baseflow (e.g. land use)
- **Instream Flow and Water Supply**
  - Fox River example

The Hydrologic Cycle

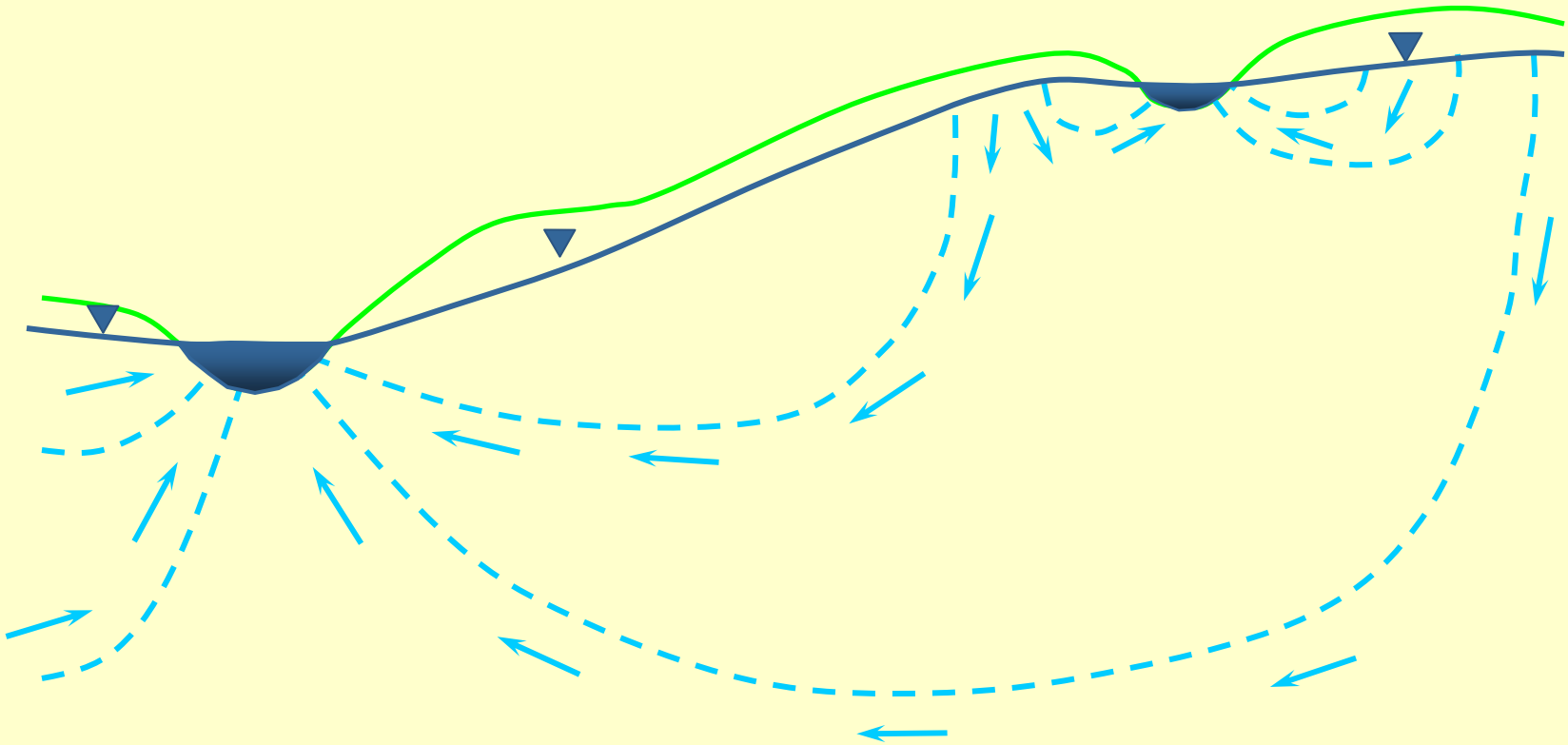
Climate, surface water, and groundwater are linked




Precipitation
Evaporation & Transpiration
soil
Surface Runoff
Subsurface Runoff
WATER TABLE
Baseflow
Recharge

Groundwater to Surface Flow Diagram:

Surface Water and Shallow Groundwater are a Common Resource



Regional differences in surface runoff and baseflow

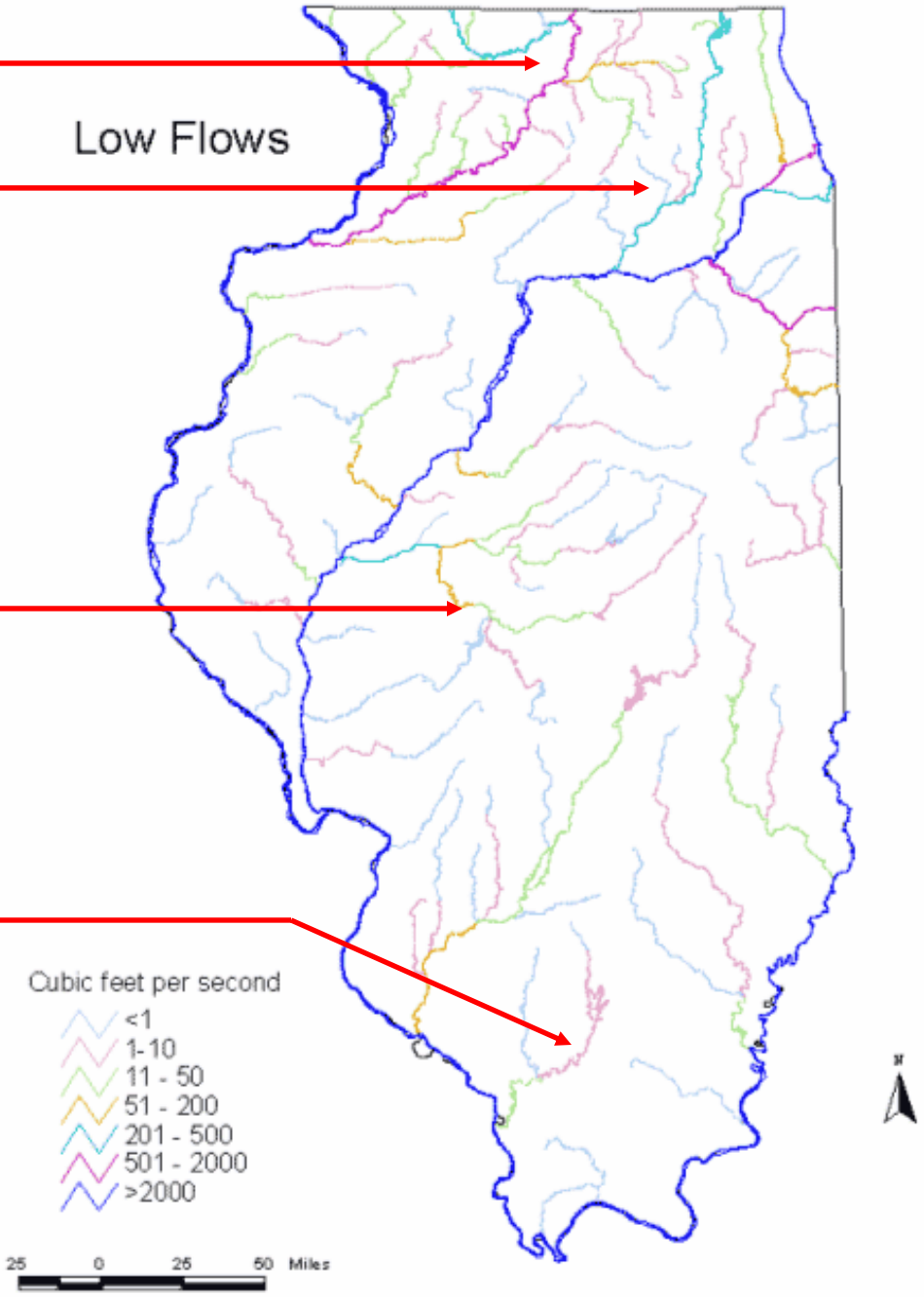
- Northern Illinois rivers typically have high amounts of baseflow. However, there are substantial differences in baseflow within the Northeastern Illinois area.
- Sustained low streamflows during dry periods are usually dependent on the presence of permeable shallow groundwater (sands and gravels).

Rock River *> 1000 cfs*

Fox River *200 – 300 cfs*

Sangamon River *30 – 50 cfs*

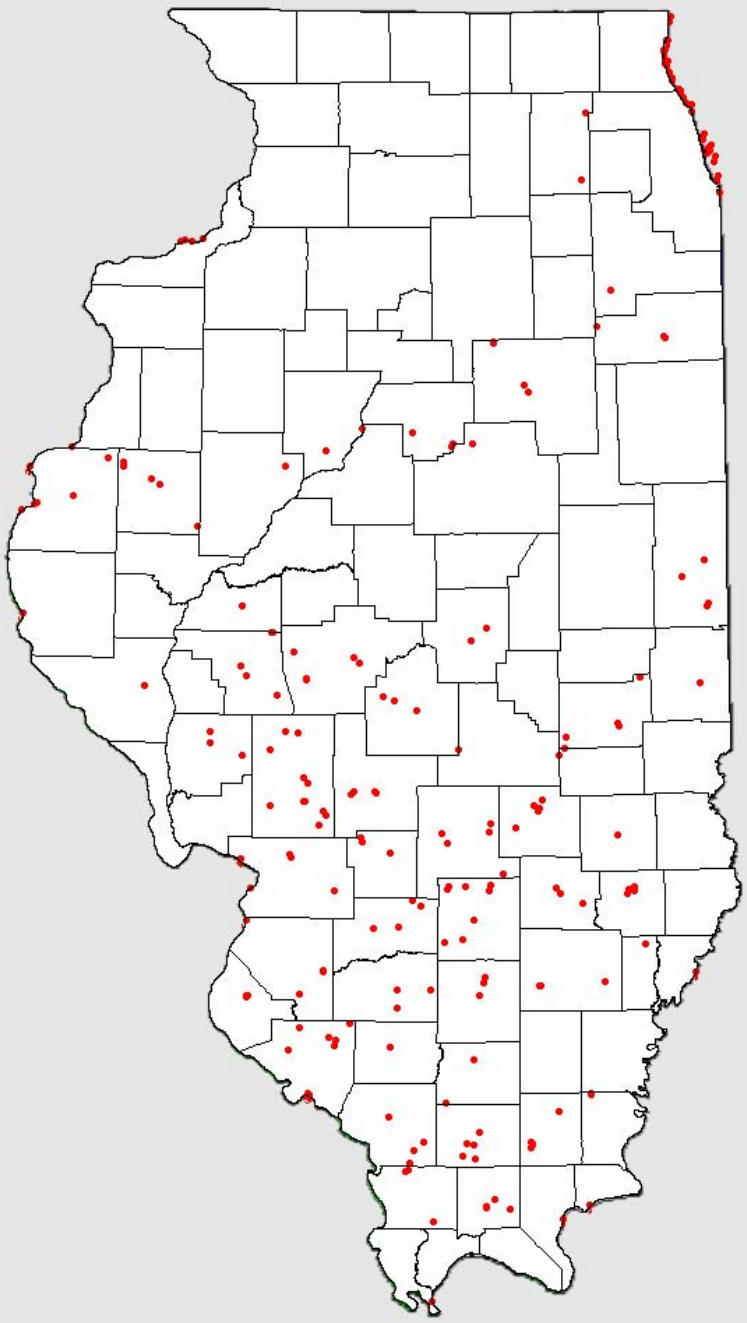
Big Muddy River *1 – 10 cfs*



5-year low flows

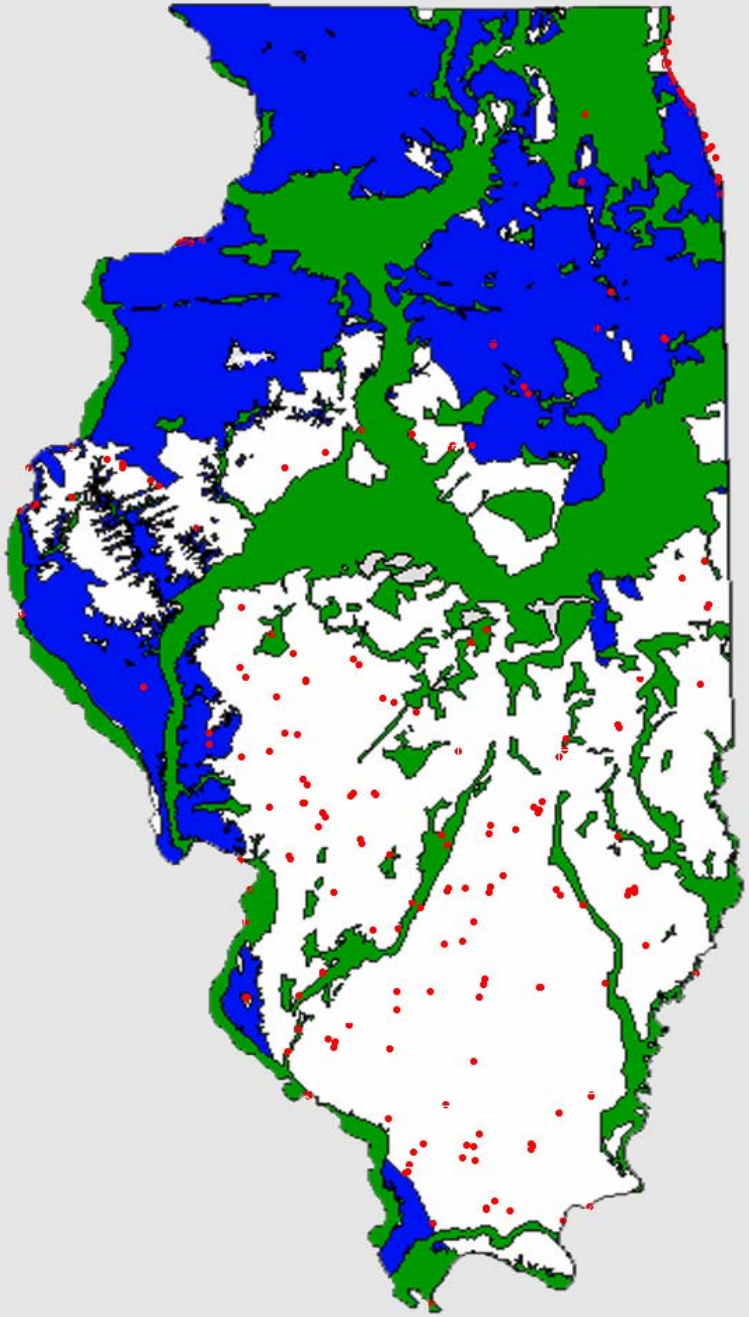
Public Surface Water Supplies

- Surface Water Intakes
  (public water supplies)

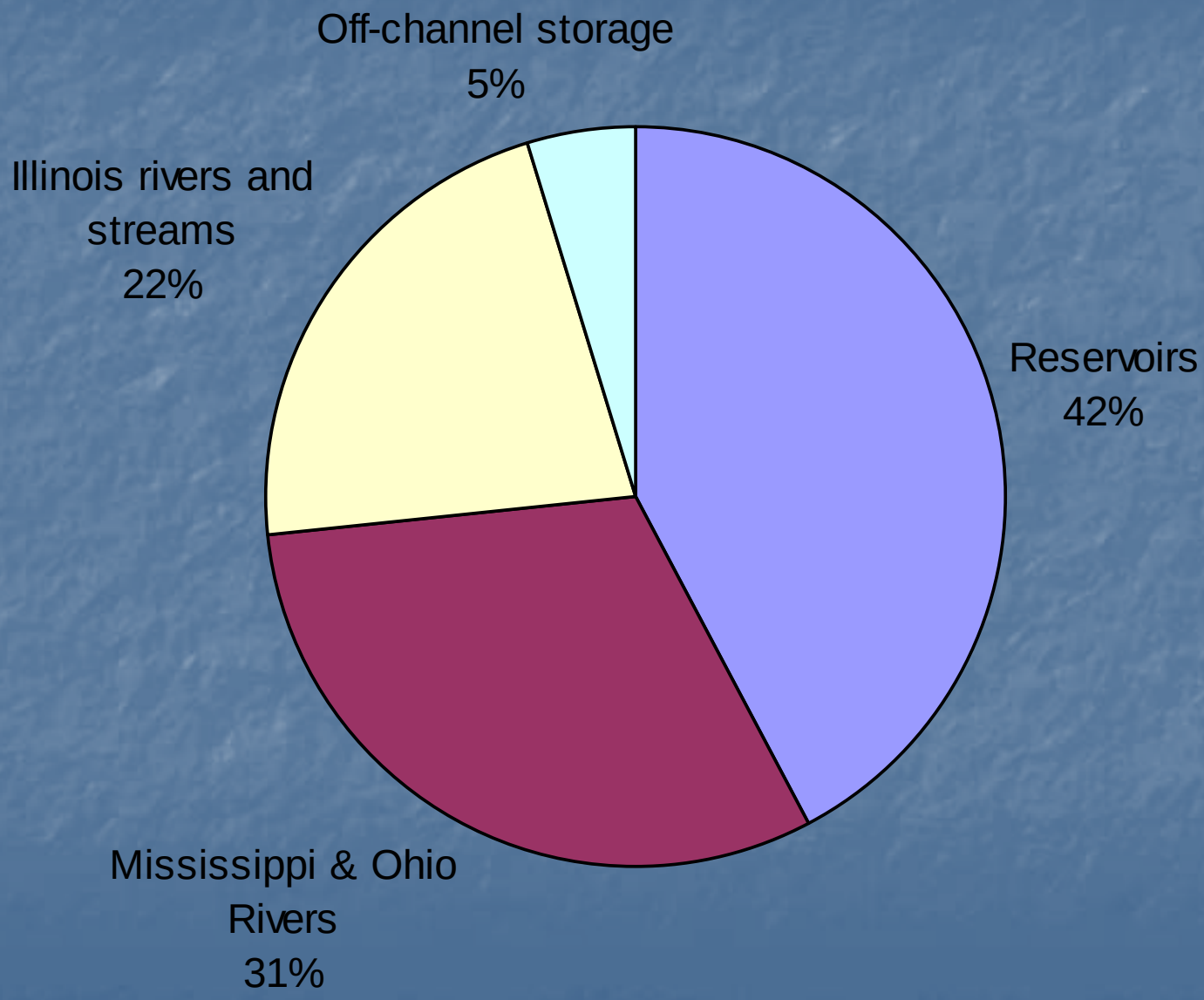


Surface and Ground-Water Resources

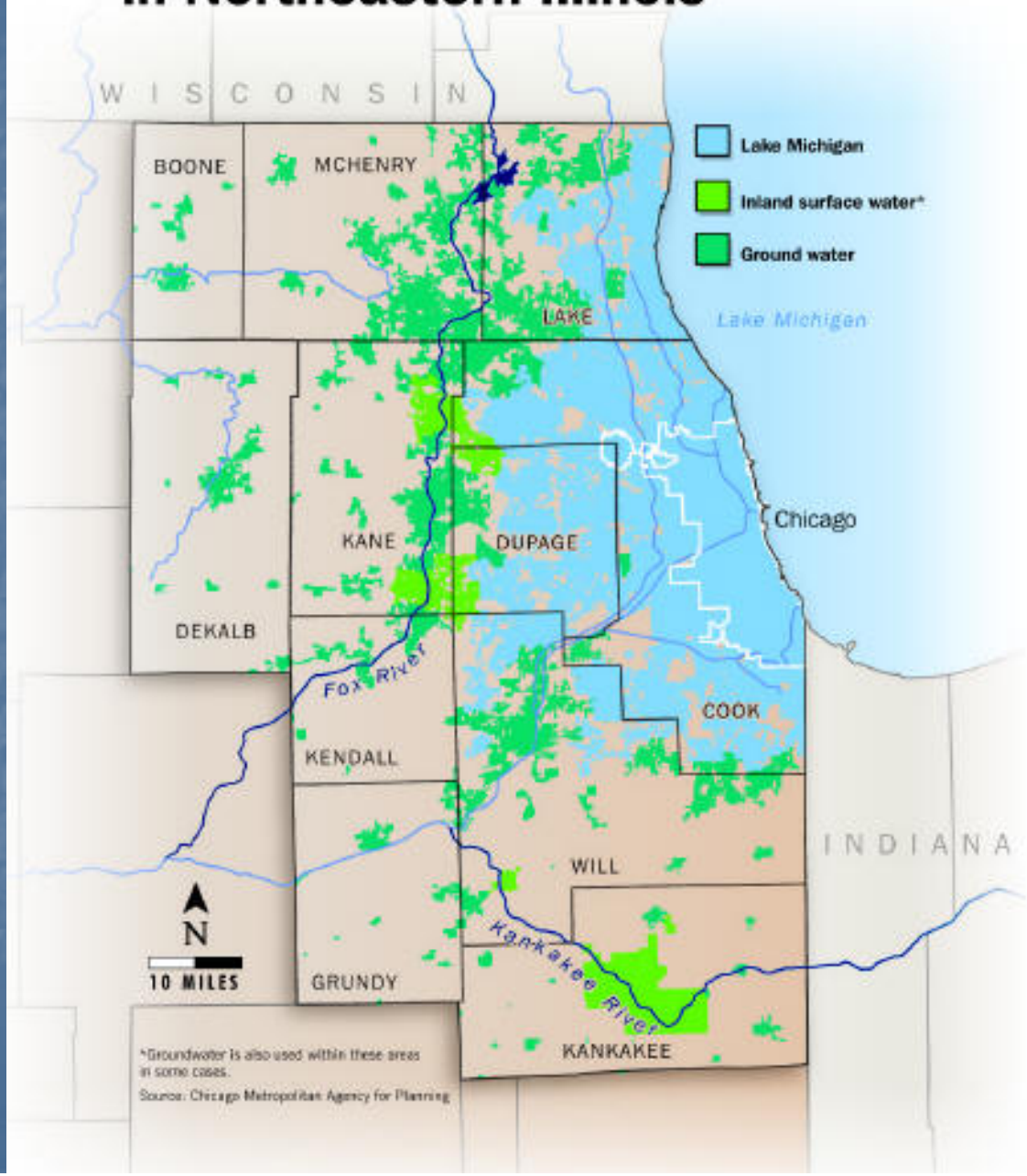
- Surface Water Intakes *(public water supply)*
- Major sand/gravel aquifers
- Bedrock aquifers (<500 feet deep)



Surface water sources other than Lake Michigan



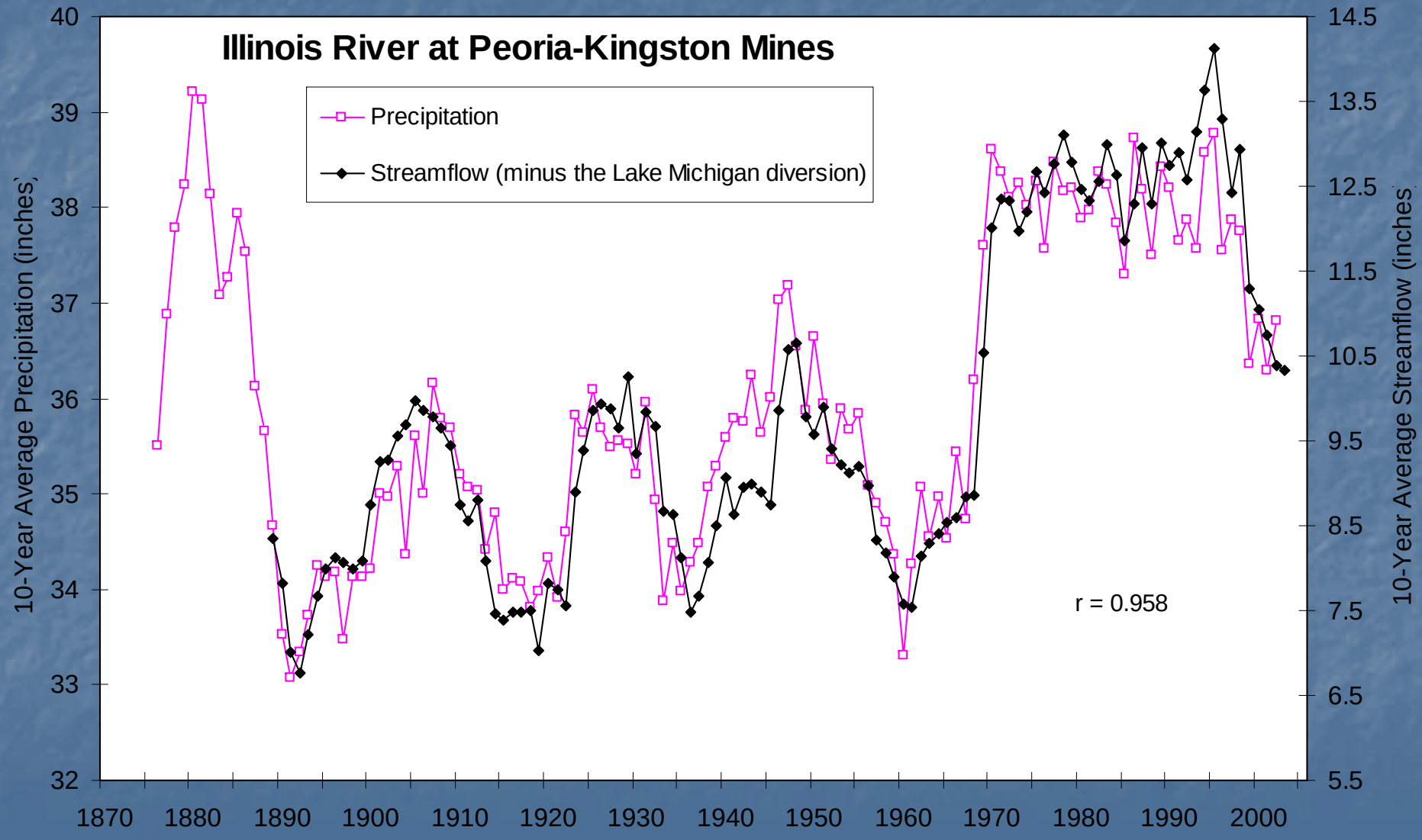
Water Sources for Public Supply in Northeastern Illinois



Factors affecting surface water availability (low flows)

1. Climate variability & change
2. Water use (withdrawals and wastewater effluents)
3. Reservoirs, diversions, navigation works
4. Indirect impacts on baseflow (groundwater-surface interactions, land use)

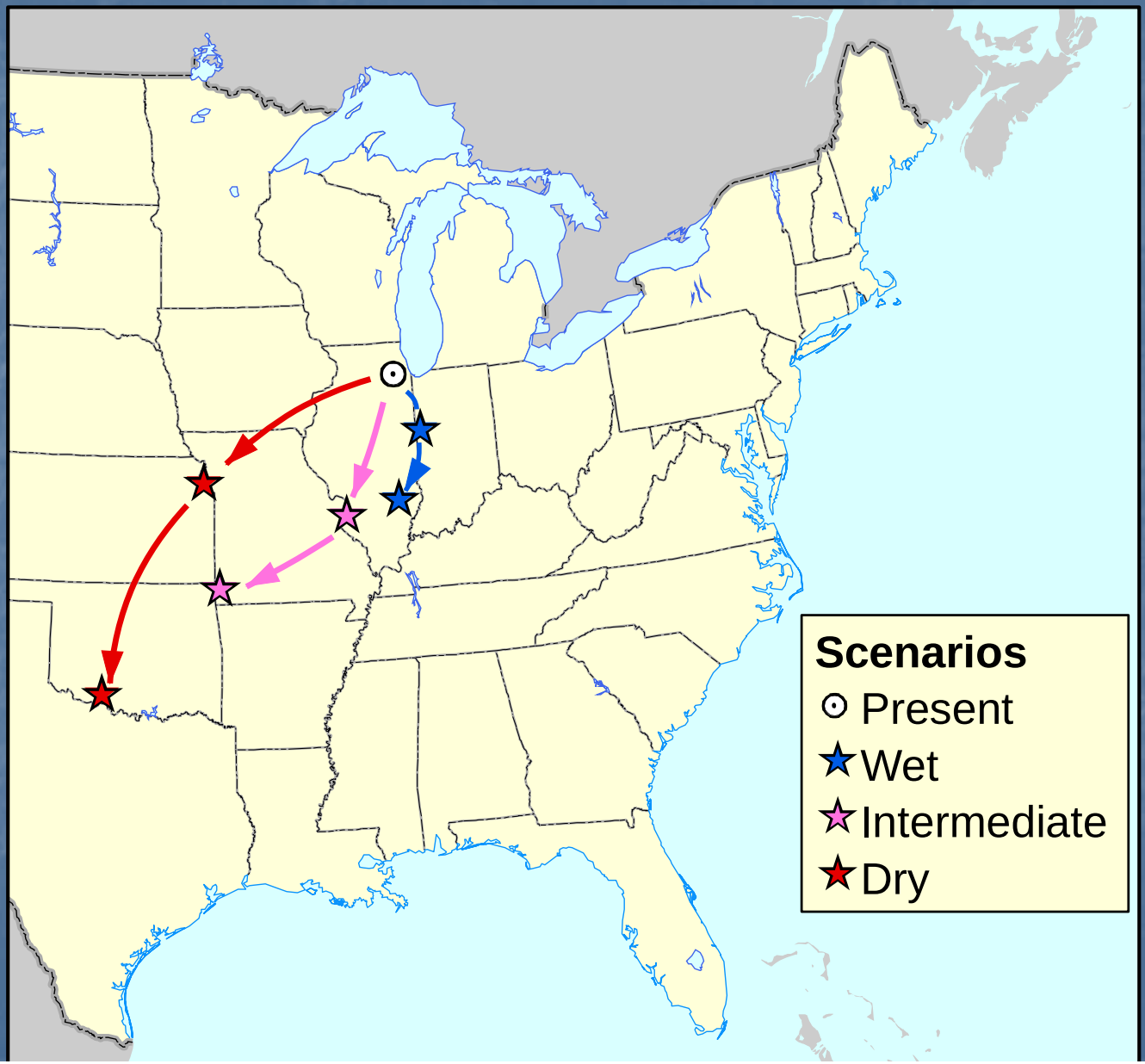
1. Effects of Climate Variability



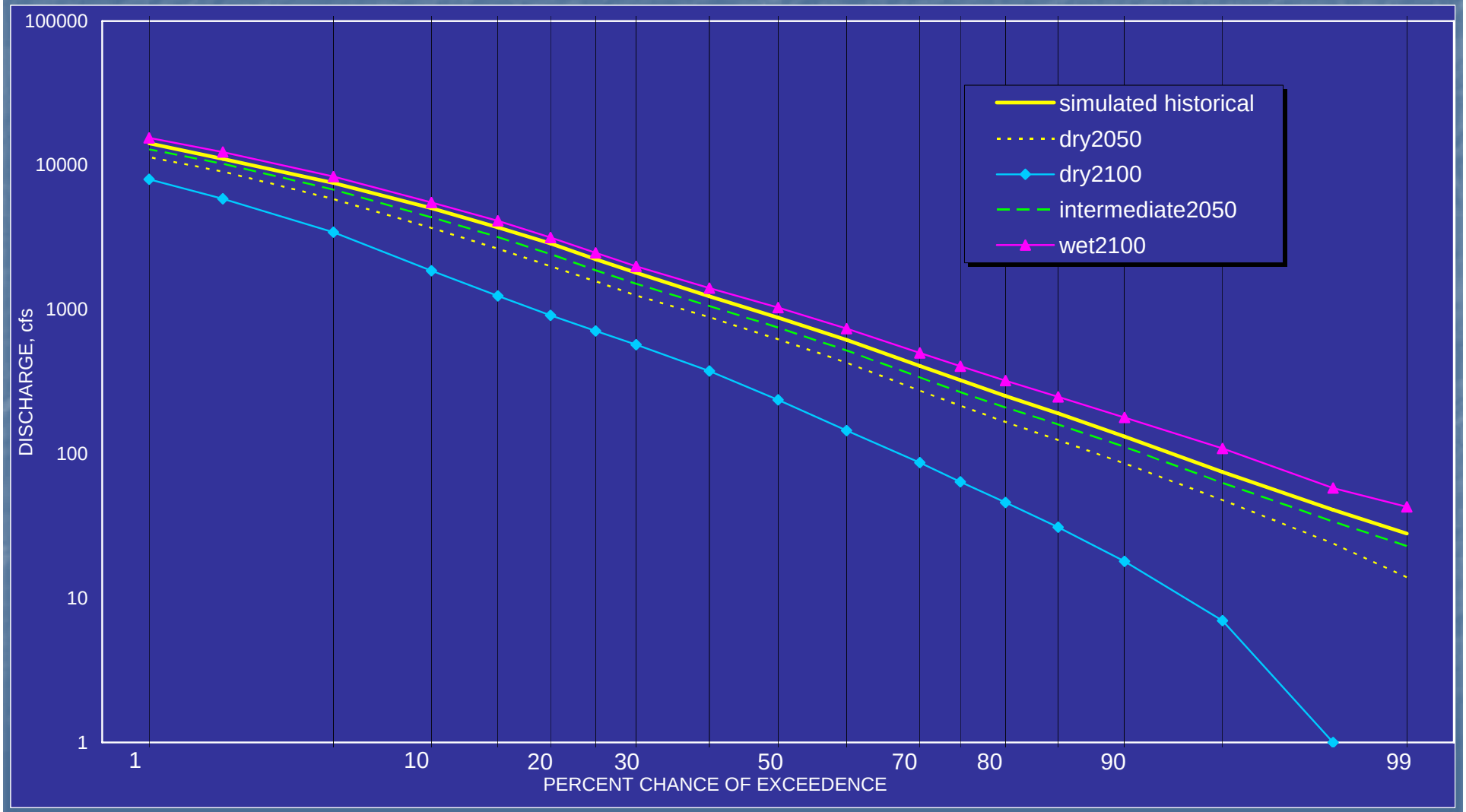
Variability in Climate and Streamflow

- A nearly 10 percent increase in precipitation in NE Illinois since 1970 has produced a 35-40% increase in average streamflow amount.
- Low flows and medium flows have also increased; throughout the Upper Midwest their increases have been proportional to the increase in average flows (caused by precipitation)
- There has been a decrease in the frequency and severity of drought conditions

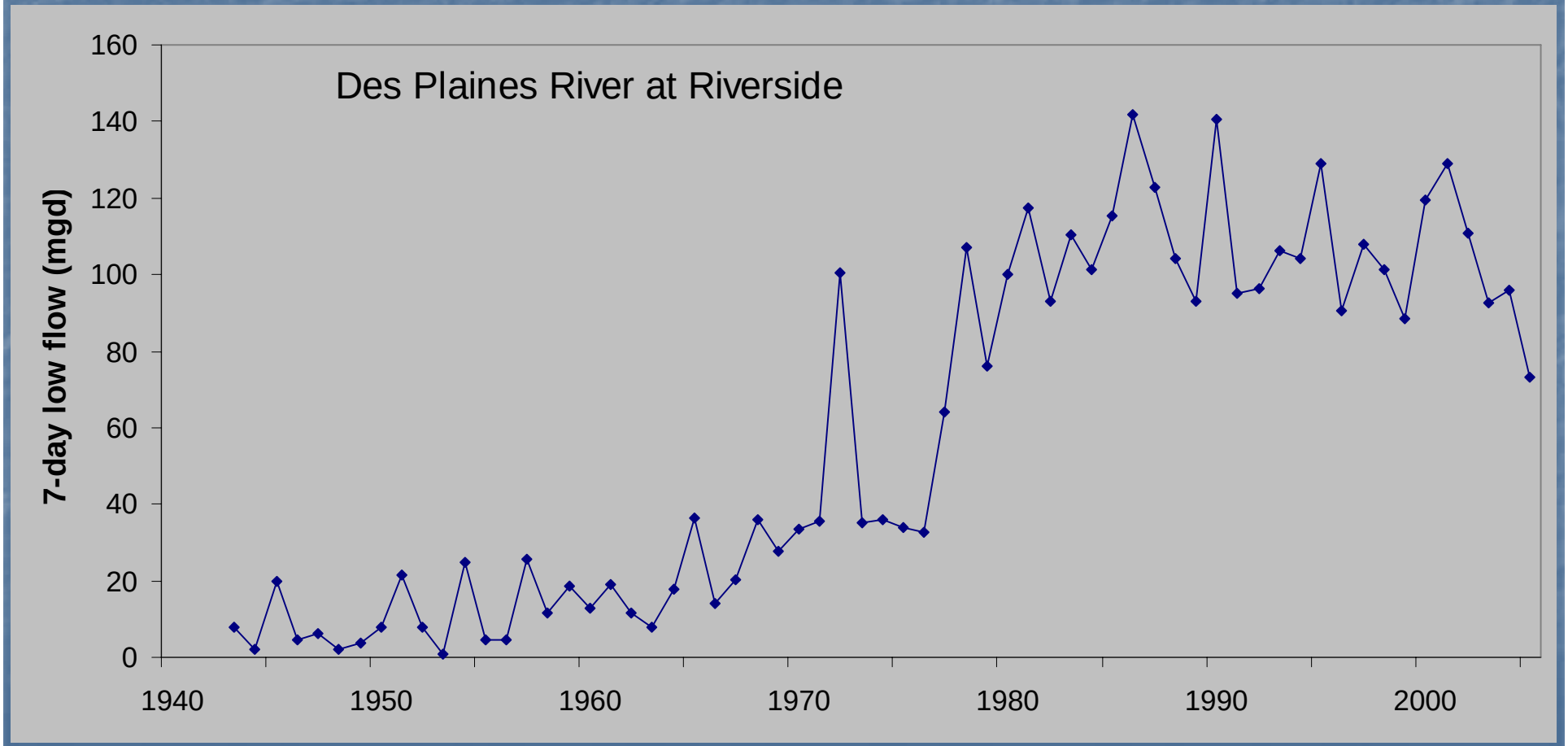
Climate Change Scenarios

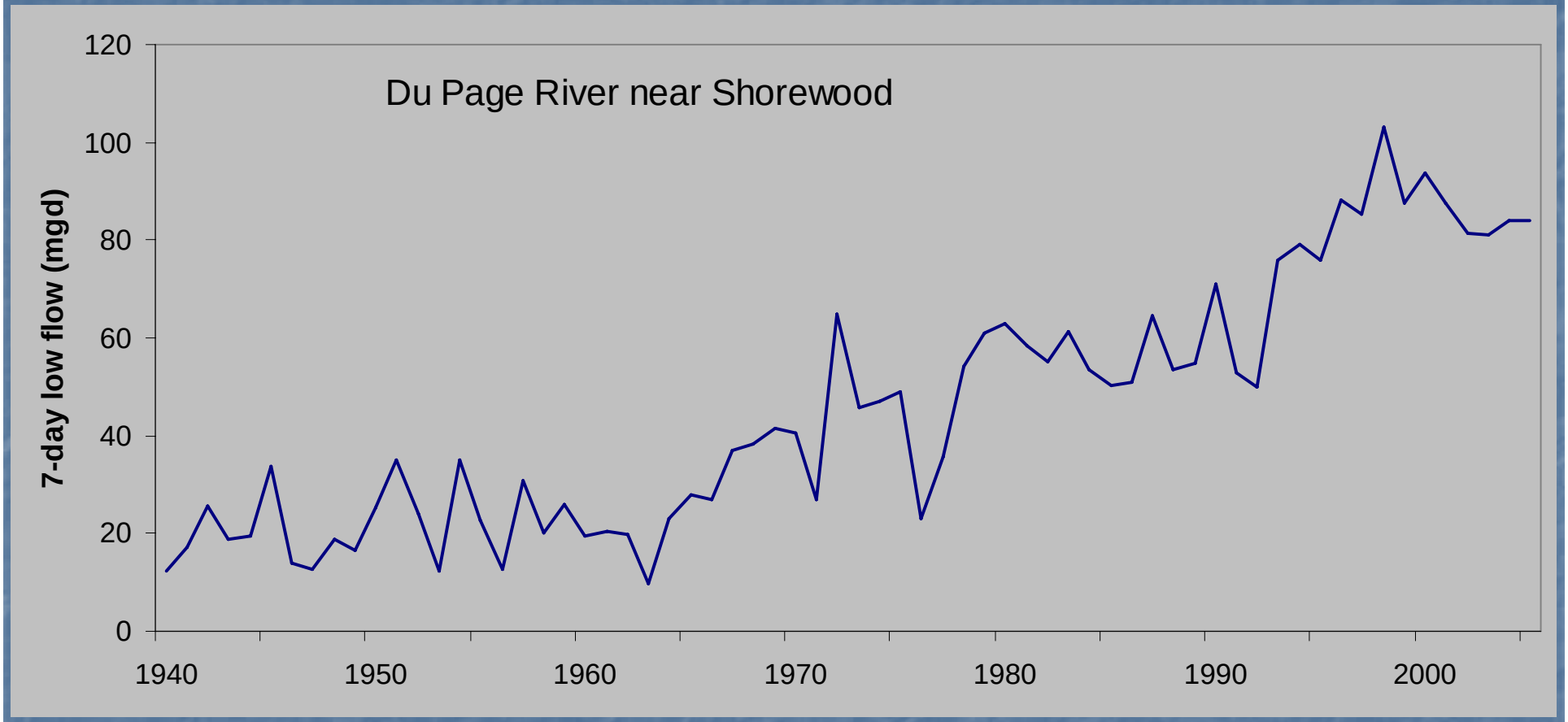


Developing hydrologic models for simulation of climate change impacts



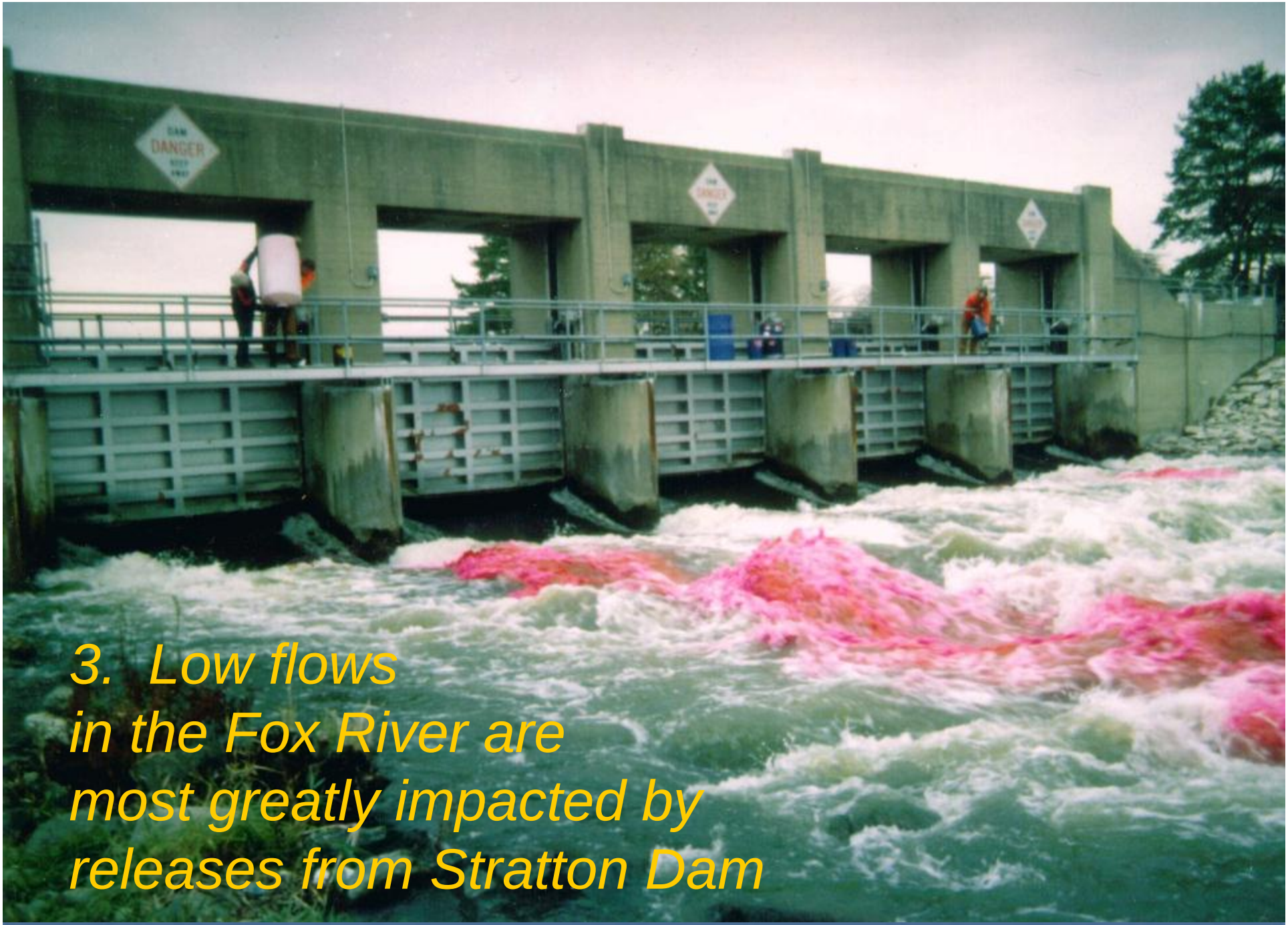
2. Effects of water use on streamflow (withdrawals and wastewater discharges)



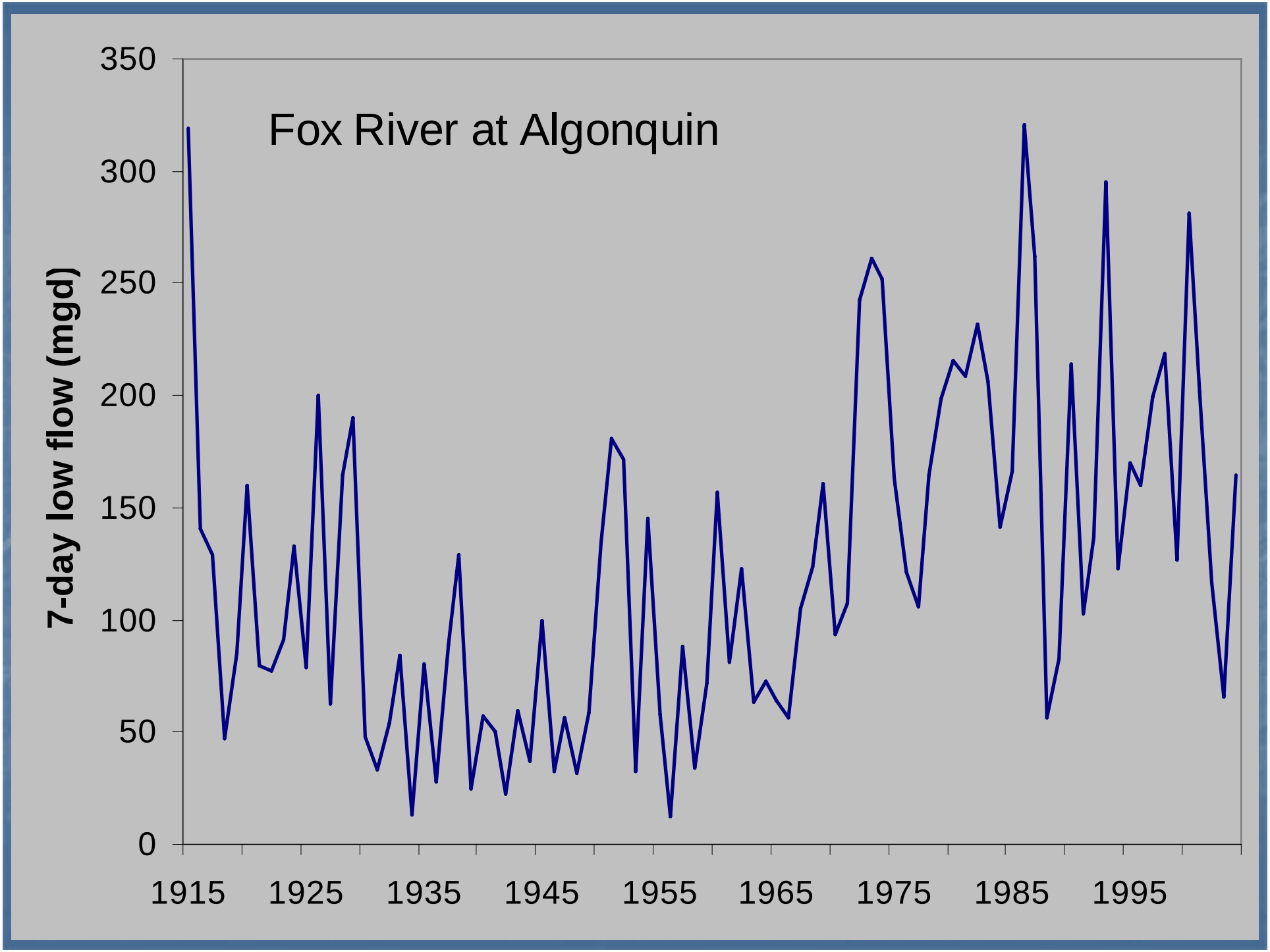

Du Page River near Shorewood
7-day low flow (mgd)
120
100
80
60
40
20
0
1940
1950
1960
1970
1980
1990
2000

Source of low flow in NE Illinois rivers
(10-year low flows in million gallons per day)

	Baseflow	Wastewater	Withdrawals
Des Plaines River	3	80	0
Du Page River	15	70	0
Fox River	80	40	-20
Kankakee River	300	15	-15



3. Low flows in the Fox River are most greatly impacted by releases from Stratton Dam


Fox River at Algonquin
7-day low flow (mgd)
350
300
250
200
150
100
50
0
1915
1925
1935
1945
1955
1965
1975
1985
1995

Increased low flows from Stratton Dam

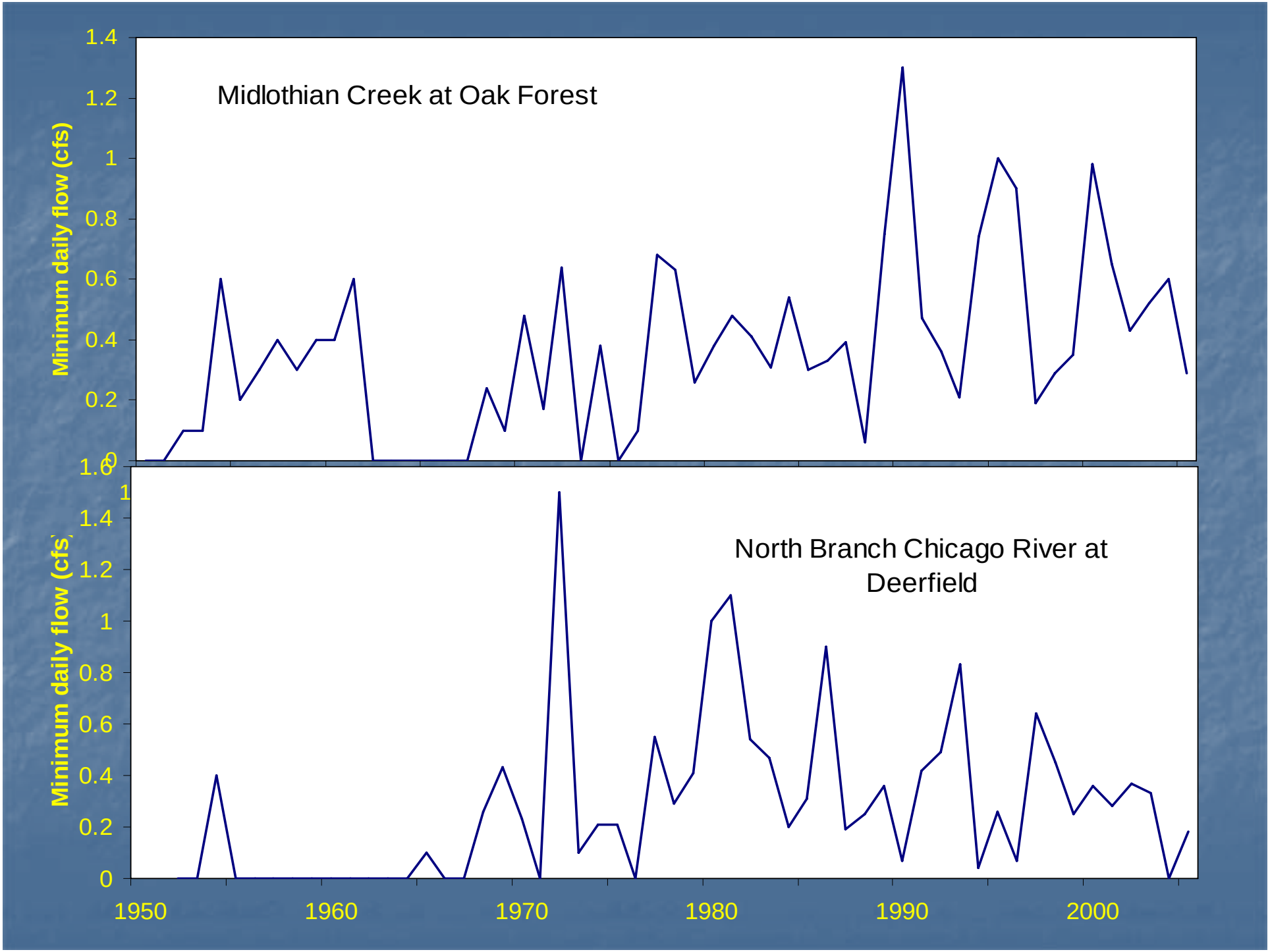
- Flow into the Chain of Lakes has been augmented by 30 mgd of effluents, most coming from the Waukesha, WI area.
- Raising the summer pool elevation since 1965 has greatly reduced the frequency of low flows occurring downstream.
- A minimum gate opening, releasing 57 mgd (90 cfs) was established in 1988.
- Can additional releases help augment Fox River low flows? Chain of Lakes water levels?
- Dependent on Waukesha's continued release of effluents to the Fox River

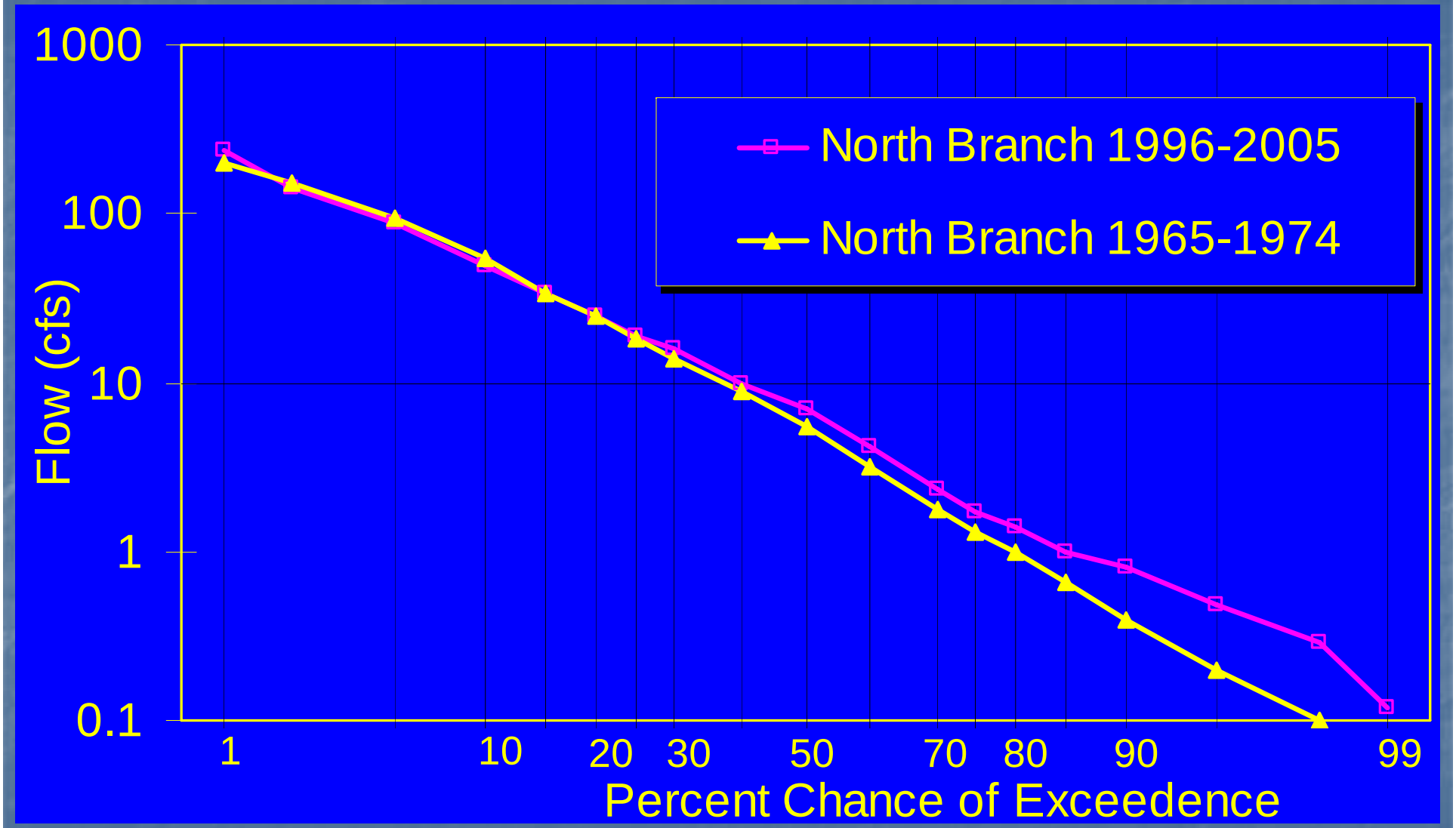
4. Indirect impacts on baseflows

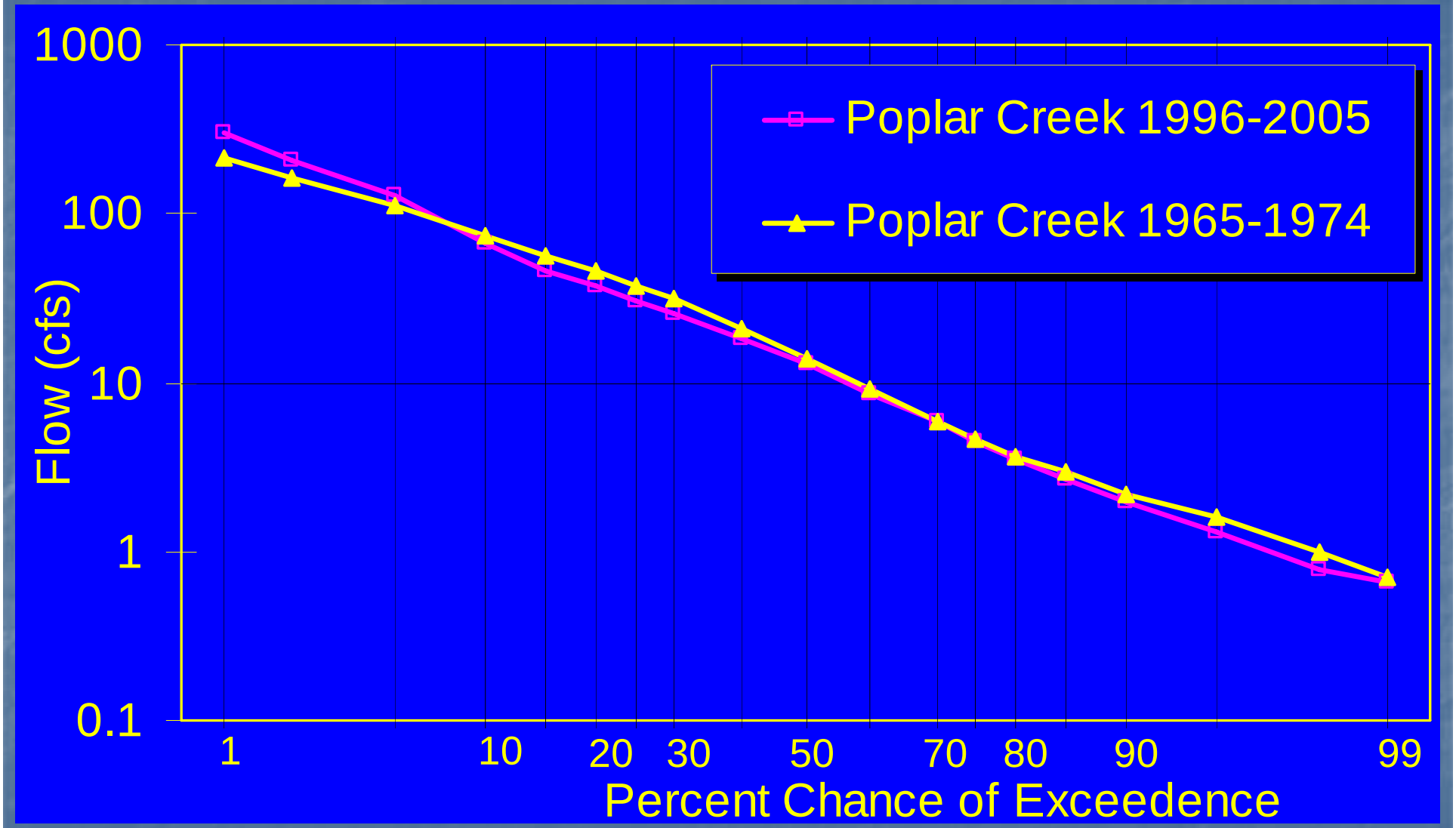
- Changes in GW-SW interactions caused by urbanization or other land use factors
- Reduction in low flows caused by pumping from nearby shallow aquifers

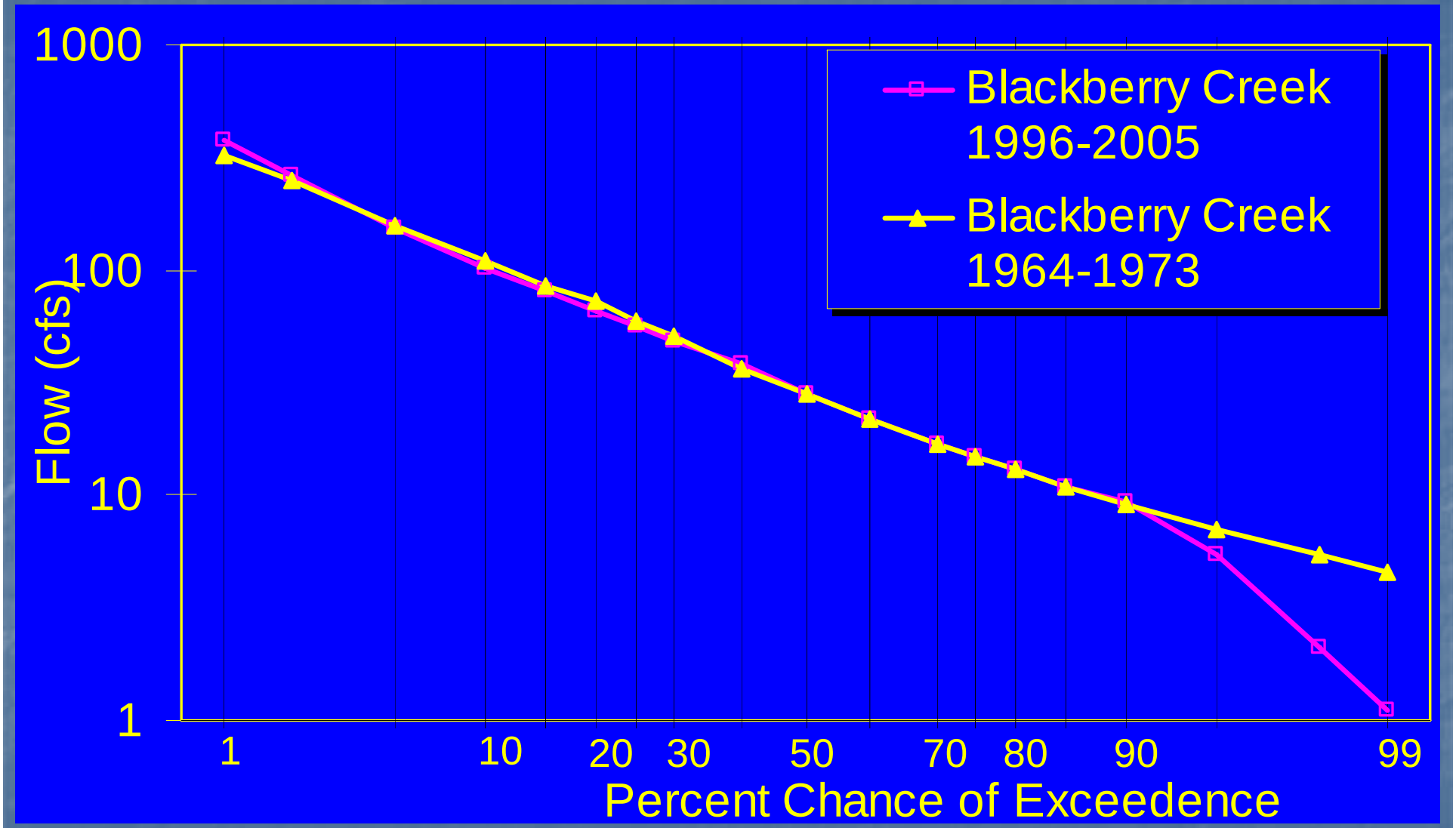
Urban Effects on Baseflows in Streams

- Impervious areas alter the hydrology, including runoff, infiltration, and evapotranspiration
- It is commonly accepted that baseflows in urban streams are also reduced, however studies regarding urban low flow trends are a mixed bag (Hejazi and Moglen, 2006)
- Most flow records for small urban Northeastern Illinois streams show increases in the lowest flows
- There is incomplete explanation behind observed trends (leakages from water distribution systems, lawn watering?)


Midlothian Creek at Oak Forest
Minimum daily flow (cfs)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
North Branch Chicago River at Deerfield
Minimum daily flow (cfs)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1950
1960
1970
1980
1990
2000


1000
100
10
1
0.1
Flow (cfs)
North Branch 1996-2005
North Branch 1965-1974
1
10
20
30
50
70
80
90
99
Percent Chance of Exceedence


1000
100
10
1
0.1
Flow (cfs)
Poplar Creek 1996-2005
Poplar Creek 1965-1974
1
10
20
30
50
70
80
90
99
Percent Chance of Exceedence


1000
100
10
1
Flow (cfs)
Blackberry Creek 1996-2005
Blackberry Creek 1964-1973
1
10
20
30
50
70
80
90
99
Percent Chance of Exceedence

Groundwater-Surface Water Interactions

- Gaging records on smaller streams can provide good indicators of potential changes in baseflow and thus shallow groundwater impacts
- A threat to baseflows in some areas may come from use of nearby shallow aquifers

What are Instream Flow Needs?

- Aquatic habitat / biological health
- Assimilation of waste waters
- Recreation/Aesthetics
- Navigation (larger rivers)

Note that there can be conflicts between different uses of instream flow

Assimilation of wastewaters: Fox River example

Largest withdrawals:

Elgin, 13.5 mgd

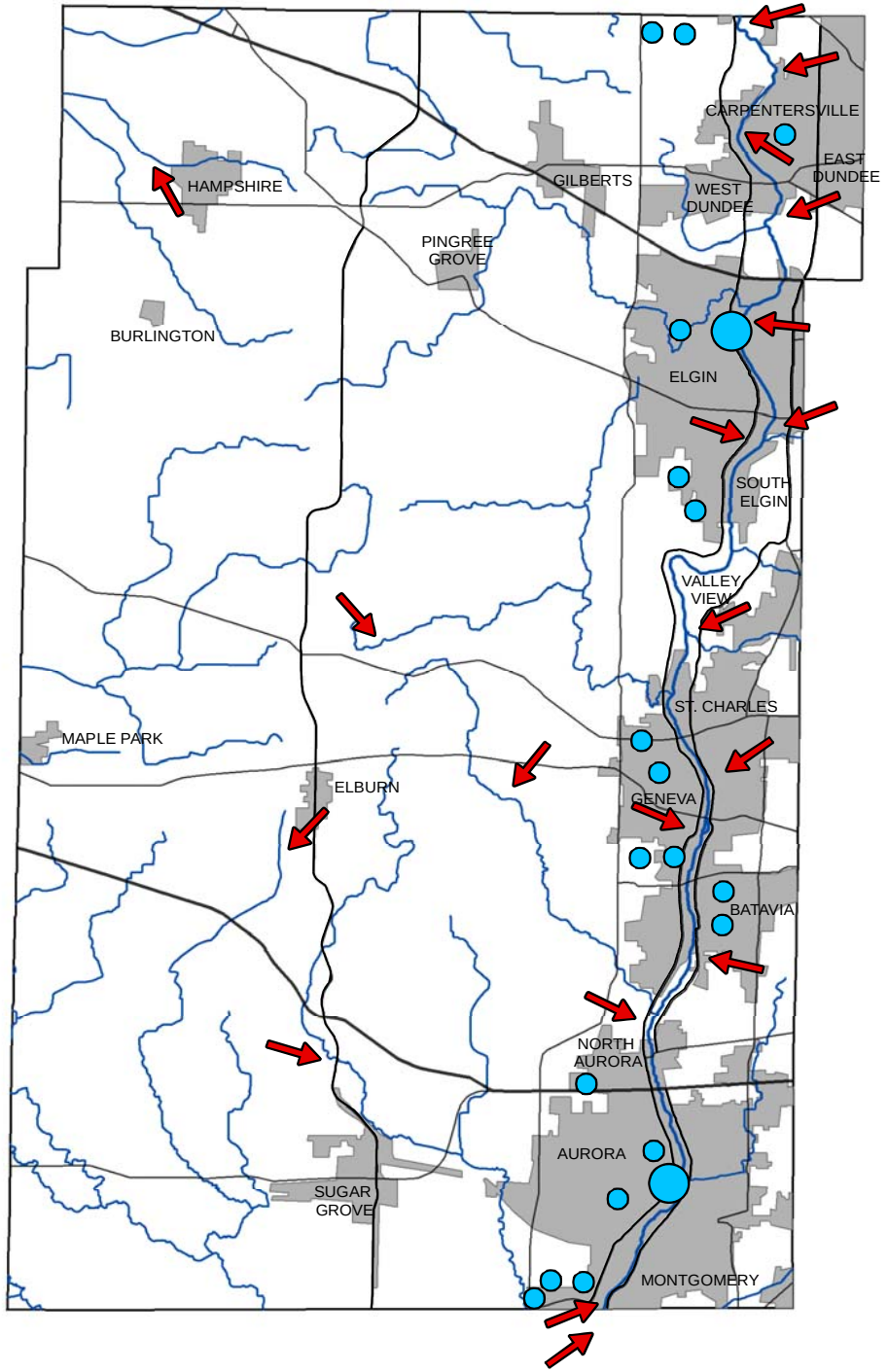
- 1.0 Groundwater
- 12.5 Fox River

Aurora, 18 mgd

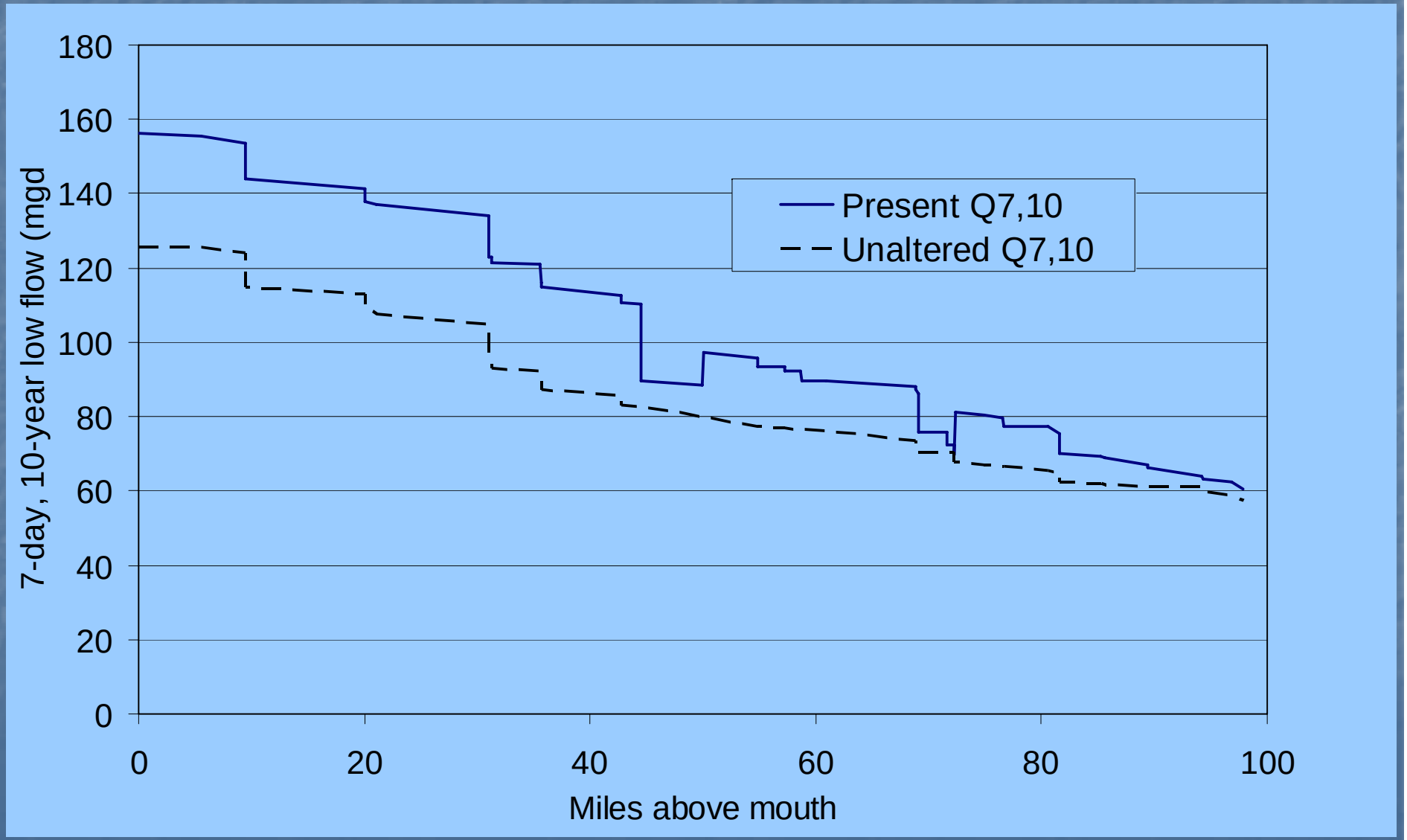
- 12 Groundwater
- 8 Fox River

Major wastewater discharge sites

40 mgd during low flows



Low flows along the length of the Fox River showing effects of joint SW-GW use

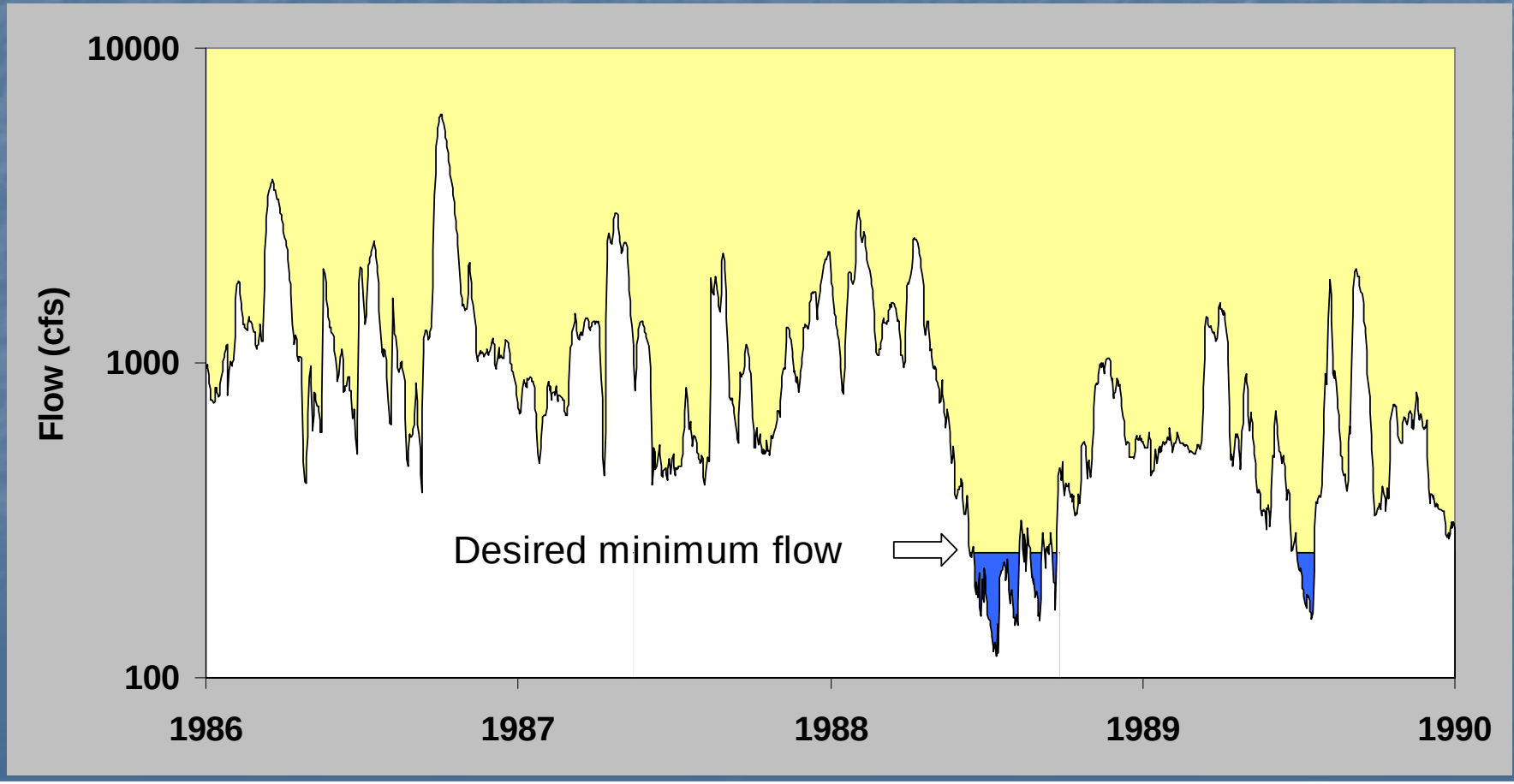


Issues for the Fox River

- The Fox River will receive substantial increases in wastewater discharges as water use in the watershed increases. Low flow quantity is expected to increase as a result.
- Assimilation of wastewaters and improving wastewater treatment technology will likely define to what degree the Fox River can be a source for additional water withdrawals.
- As the use of shallow groundwater increases, there is a potential for low flows to be impacted by GW-SW interactions, particularly tributary flows that feed into the river

Protecting instream flows

Streamflow is usually abundant and its use for water supply is not a concern in most years. But during low flows, instream flow uses become a priority issue.

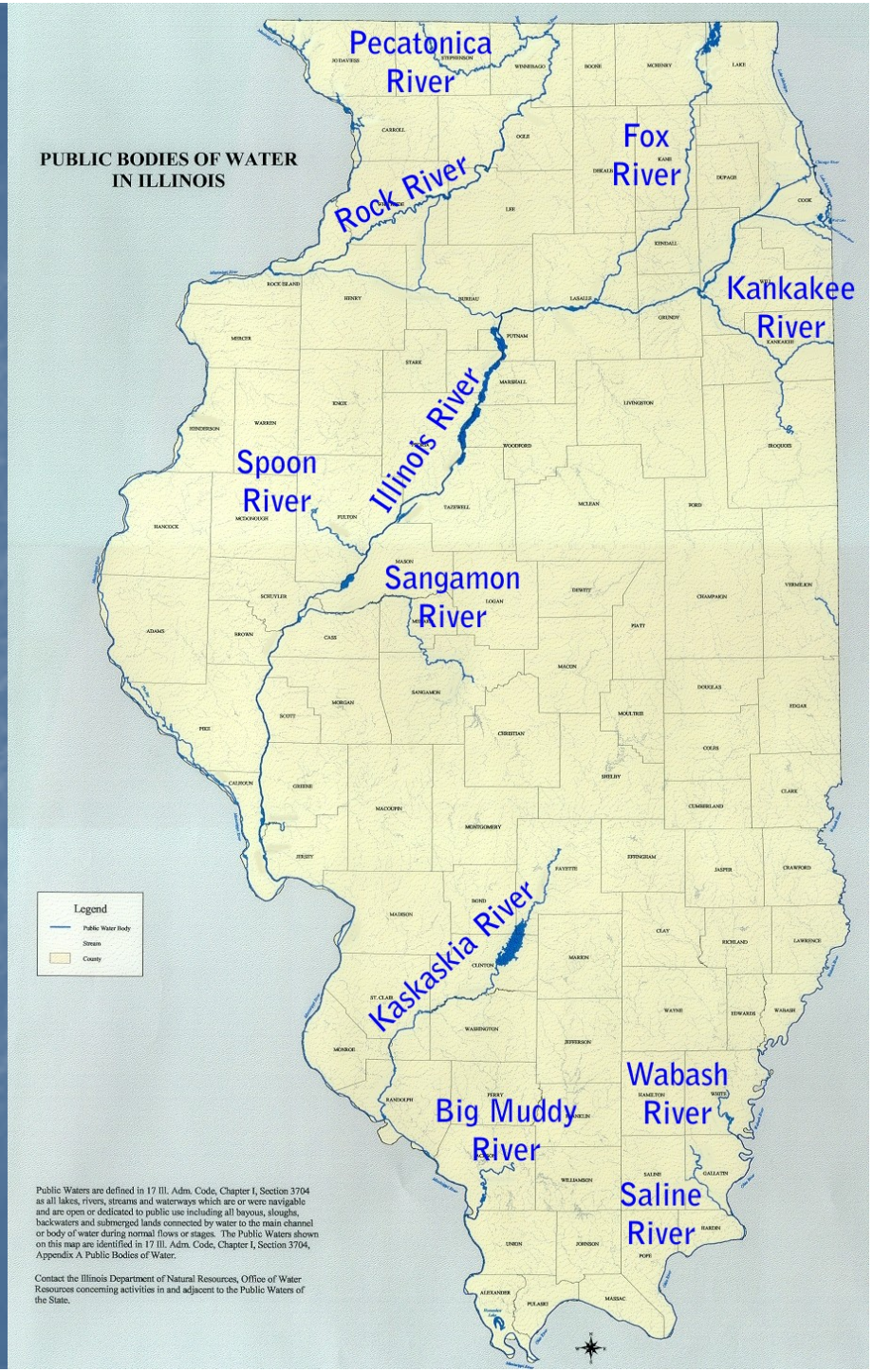


Protected instream flows

- In 1984 IDNR adopted the use of the 7-day 10-year low flow (Q7,10) as a protected flow level for Public Waters of the State.
- The Q7,10 protected flow is considered an interim surrogate value where there is insufficient information to define instream flow needs.

Public Bodies of Water in Illinois

The State's authority to protect low flows extends only to these rivers



How would the protected flow affect the potential of the Fox River for water supply?

- New water withdrawals should not cause reduction in the flow level below the Q7,10.
- Off-channel storage could theoretically provide an alternative source when flows fall below the protected level, but are sites available?
- Return flows of a similar quantity immediately downstream of a new withdrawal would potentially be considered as “no net reduction”
- If new surface withdrawals replaced existing groundwater use: lead to a net flow reduction

Surface Water Accounting Tool for the Fox River Basin

- Evaluates flow quantity
- Provides the ability to examine the impacts of future water use scenarios on streamflows.
- Future applications might include impacts from climate change scenarios and surface–groundwater impacts as they become better understood.
- Initial development of the accounting tool was supported by Kane County Water Resources Dept

Look for more information and updates:

http://www.sws.uiuc.edu/wsp

E-mail me with questions:

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