

# Water Availability During Extreme Droughts like the 1950s

September 21, 2012 presentation  
“Showcasing the Kaskaskia”

H. Vernon Knapp

Illinois State Water Survey

Prairie Research Institute

University of Illinois

# How do we define drought?

Droughts are defined primarily by their impacts

- Meteorological drought – pronounced deficits in rainfall; but not necessarily associated with specific impacts
- Agricultural drought – caused by shortages in soil moisture; impacting crop production
- Hydrological drought – caused by shortages in streamflow, lake storage or groundwater; impacting community and industrial water supplies, navigation, recreation, and ecosystems

This presentation focuses on hydrologic drought

# The 2012 Drought

- 2012 was a devastating agricultural drought for many southern and central Illinois locations
- In parts of south-central Illinois, rains from Hurricane Isaac and several earlier rains in August effectively ended the drought but were too late to help most crops.
- But for other regions of Illinois, 2012 remains a hydrologic drought in progress.
- Supplies for 3 community systems (Decatur, La Harpe, and the Vienna CC) are currently of concern.
- The drought will need to continue into next year before concern develops for other communities

## Severe hydrologic droughts

The most severe hydrologic impacts in Illinois are associated with multi-year drought episodes. These are normally caused by a very dry summer/fall period followed by a dry winter/spring during which reservoirs and groundwater supplies do not have a chance to become replenished.

Such extreme droughts occur infrequently. For example, we have identified only 4 historical drought episodes (1894-95, 1930-31, 1933-34, and 1953-54) such that – if they occurred again – Lake Shelbyville and Carlyle Lake might not be expected to refill during the spring of the 2<sup>nd</sup> year. For the Kaskaskia region, the 1953-54 drought is considered the worst of these droughts (the drought of record).

# Occurrence of an 'early-season' drought

- During a drought with an early (April/May) onset, there is the possibility that Lake Shelbyville and Carlyle Lakes might not fully transition from winter pool and could start a drought below full summer pool.
- The likelihood of this happening is much greater for Lake Shelbyville than Carlyle Lake. The 1936, 1976, 1988 drought years are the only historical droughts we identified for which Carlyle Lake could potentially start slightly below 445'.
- However, most droughts start later in the summer, including all of the multi-year droughts experienced (so far) in the Kaskaskia region.

# Water Supply Availability during a drought like the 1950s

This presentation will touch on 4 topics:

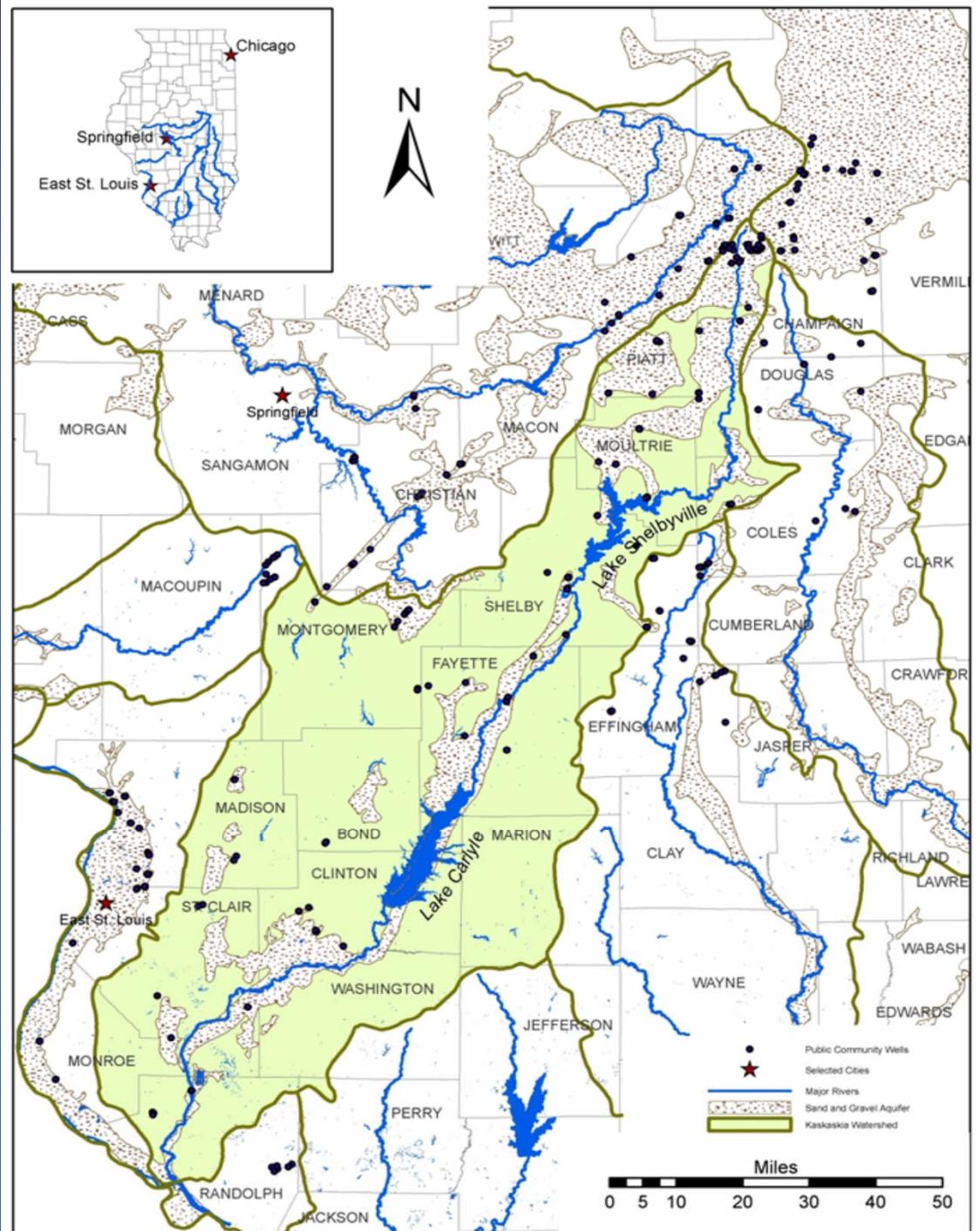
1. Groundwater supplies
2. Community water supply reservoirs
3. Allocation yield for Lake Shelbyville and Carlyle Lake
4. Water needs for the Navigation Channel

# 1. Sand and Gravel Aquifers

## ● Active Public Supply Wells

Sand and gravel aquifers are the primary source of groundwater.

Except for where these aquifers occur along the river, the geology is largely limited and unfavorable for developing sizable water supply systems



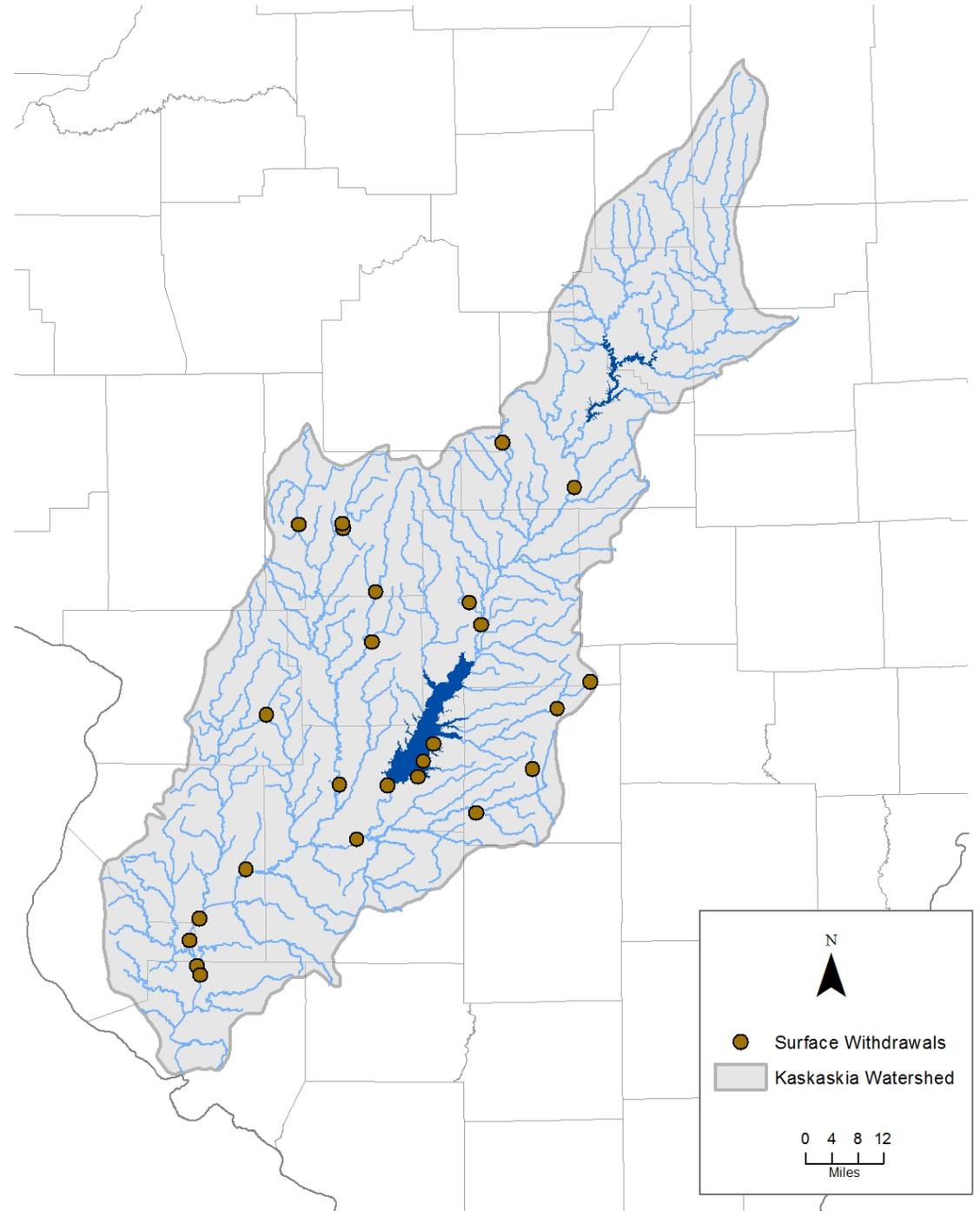
## 2. Community surface water supplies

- 23 communities in the Kaskaskia watershed provide their own water from surface water sources. An additional 6 community systems from the greater region were also evaluated.
- 4 of these community systems have water allocated from Carlyle and Shelbyville
- Another 7 systems have intakes on the Kaskaskia River
- The remaining systems have reservoirs
- A large number of small towns purchase water from these systems

# Surface Water Withdrawal Locations

With the exception of withdrawals from the Kaskaskia River and allocations from the federal reservoirs, all surface water systems in the region require reservoir storage.

Most streams go dry during extended drought periods.



# Categories of Drought Vulnerability

- **Adequate System** = 90% confidence that the system will meet expected demands during a drought of record without substantial threat of shortage
- **Inadequate System** = Greater than 50% chance that the system will not meet expected demands during the drought of record
- **At Risk System** = 10% to 50% chance that the system will not meet expected demands (confidence < 90%)
- **Marginal System** = Meets expected demands of the drought of record with 90% confidence; however, the threat of shortages in the later stages of drought may lead the community to adopt extraordinary measures.

## Inadequate and At-Risk Systems in the Kaskaskia region

- Altamont, Coulterville & Farina are classified by the ISWS as inadequate
- Fairfield, Mt. Olive & Staunton were classified as at risk
- Two other systems, Hillsboro and Litchfield, could become at risk by 2050 depending on their rate of growth and sedimentation to their lakes
- But with expected rates of growth, most systems have supplies that will be adequate for years to come (unless they try to take on large industries or sell large amounts of their supply)

### 3. Water Supply Allocations from Carlyle and Shelbyville Lakes

- The State of Illinois has been granted water supply rights to roughly 14% of the joint-use storages in Lake Shelbyville and Carlyle Lake.
- Prior to 2000 the water was in essence unallocated
- But by 2004, the water supply storage had been fully allocated, with agreements amounting to an potential average water use of 44.7 million gallons per day. Most (80%) of the allocated water is for power plants located downstream of the reservoirs.
- Although a small portion of the allocated amount is withdrawn for community systems on a daily basis, to date there have been no requests for downstream releases from the reservoirs

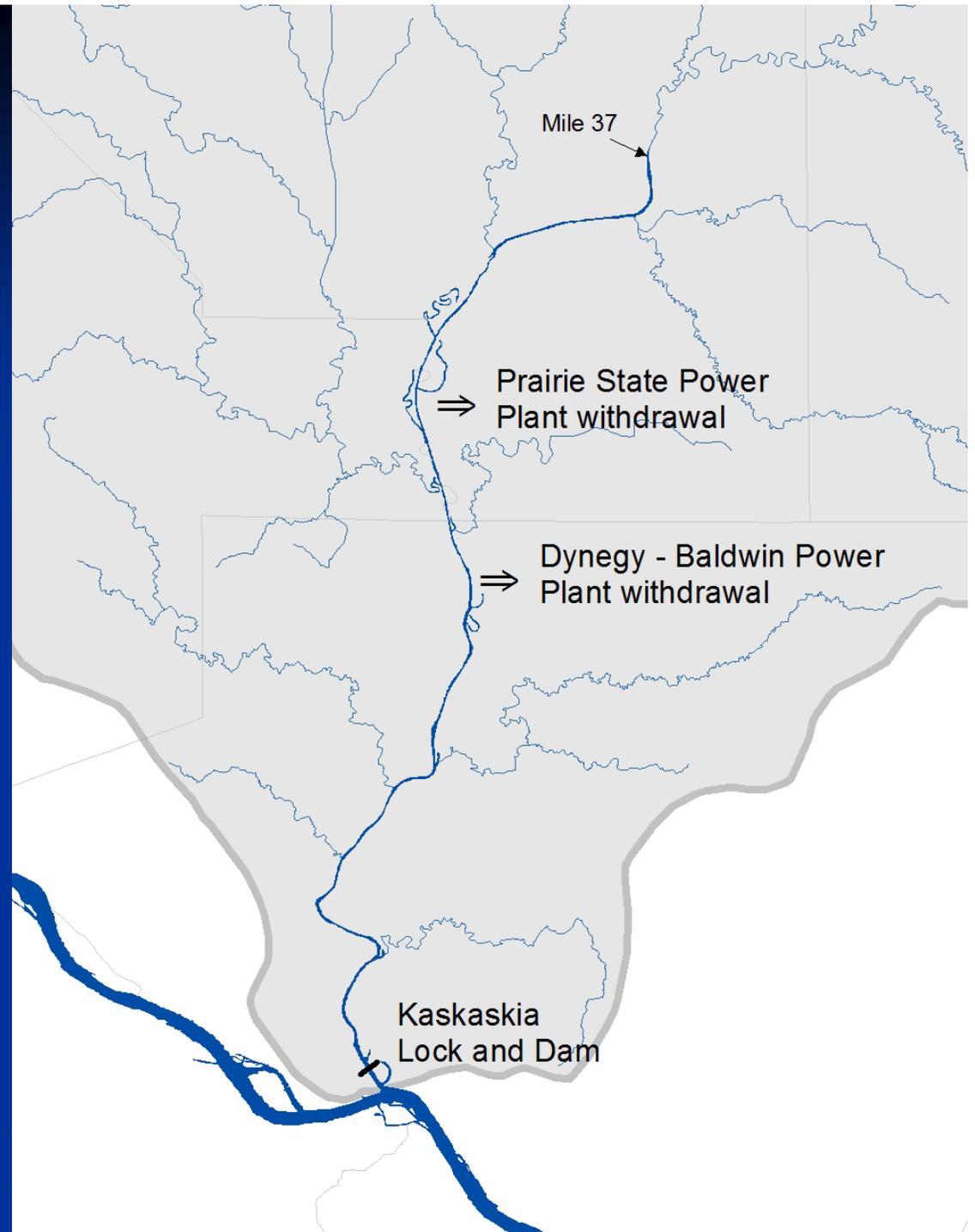
# Estimated yield of the water supply storage in Carlyle and Shelbyville

- At the request of IDNR, which administers the allocations, the ISWS has twice analyzed the available yield of the water supply storage in the 2 reservoirs.
- In 2001, the collective yield of the 2 reservoirs during a 50-year drought was estimated to be 41.5 mgd. This included subtractions for the State's obligated share of water quality releases (5.5 mgd) and the estimated loss of storage caused by sedimentation through 2040 (5 mgd).
- In 2011, the ISWS conducted a new analysis, which resulted in a slight increase in the estimated 50-year yield – 44.0 mgd.
- Note that the new estimate is roughly equivalent to the amount of water that has already been allocated.

## 4. Water availability in the Kaskaskia Navigation Channel during drought

The “third” federal reservoir in the region – developed originally for coal transportation

Lockages and power plants need considerable amounts of water



# The summer of 2012

## Rough Estimates of Average Daily Supply & Use

### Inflow to the Navigation Channel

- Water quality release from Carlyle 97 mgd (150 cfs)
  - Inflow from tributaries 40 mgd
- 137 mgd (213 cfs)

### Uses of water from the Navigation Channel

- Lockages for navigation 34 mgd (4 lockages/day)
  - Pool Evaporation 25 mgd
  - Baldwin net withdrawal 30 mgd
  - Prairie State withdrawal 7 mgd
- 96 mgd (149 cfs)

# During a very dry summer

## Rough Estimates of Average Daily Supply & Use

### Inflow to the Navigation Channel

- Water quality release from Carlyle 97 mgd (150 cfs)
- Inflow from tributaries 27 mgd  
124 mgd (192 cfs)

### Uses of water from the Navigation Channel

- Lockages for navigation **40** mgd (4 lockages/day)
- Pool Evaporation 25 mgd
- Baldwin net withdrawal 30 mgd
- Prairie State withdrawal 7 mgd  
102 mgd (158 cfs)

# With Prairie State at Full Capacity

## Rough Estimates of Average Daily Supply & Use

### Inflow to the Navigation Channel

- Water quality release from Carlyle 97 mgd (150 cfs)
  - Inflow from tributaries 27 mgd
- 124 mgd (192 cfs)

### Uses of water from the Navigation Channel

- Lockages for navigation 40 mgd (4 lockages/day)
  - Pool Evaporation 25 mgd
  - Baldwin net withdrawal 30 mgd
  - Prairie State withdrawal 26 mgd
- 121 mgd (188 cfs)

# Scenario: Projected Increases in Navigation

## Rough Estimates of Average Daily Supply & Use

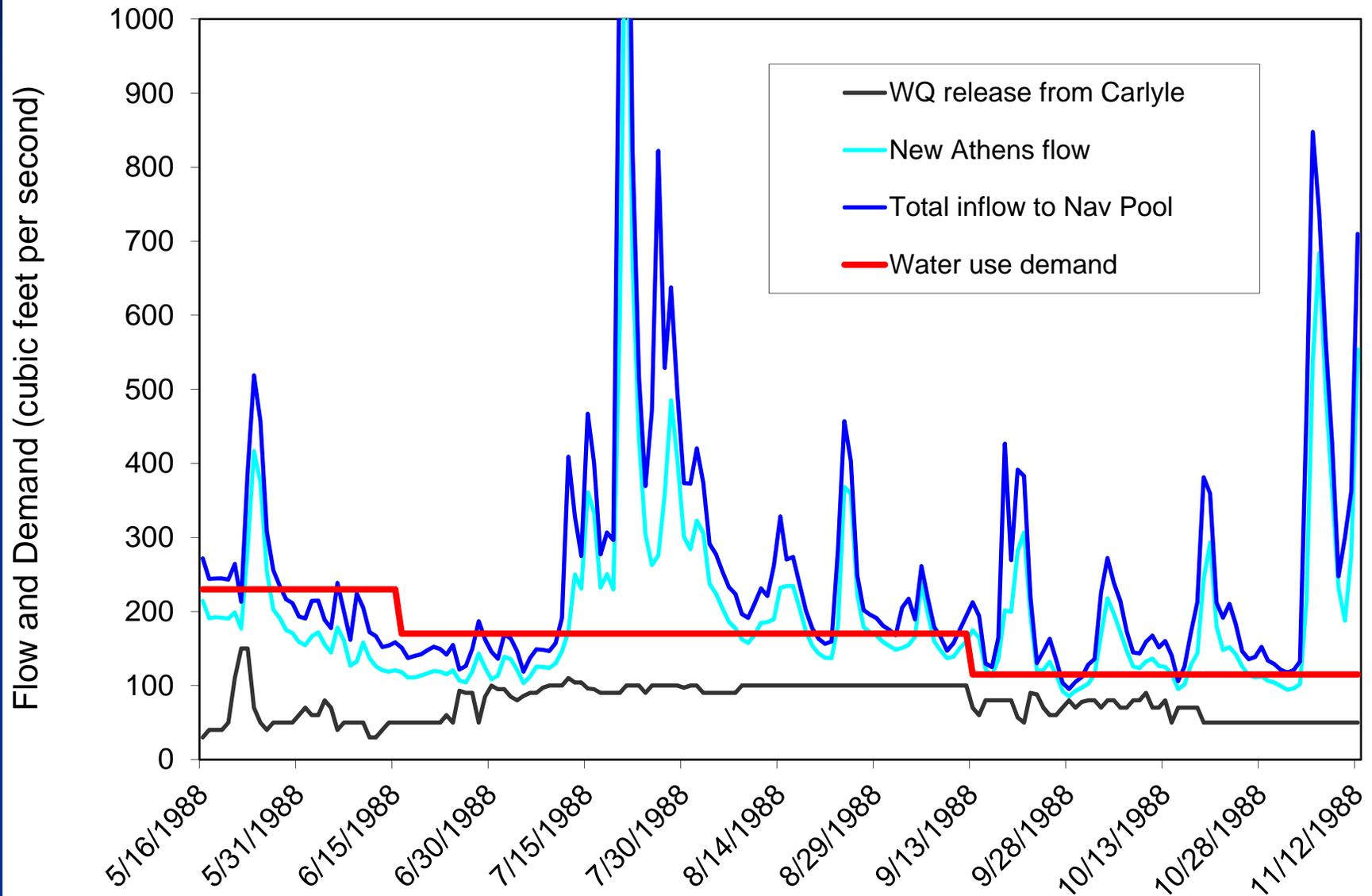
### Inflow to the Navigation Channel

- Water quality release from Carlyle 97 mgd (150 cfs)
  - Inflow from tributaries 27 mgd
- 124 mgd (192 cfs)

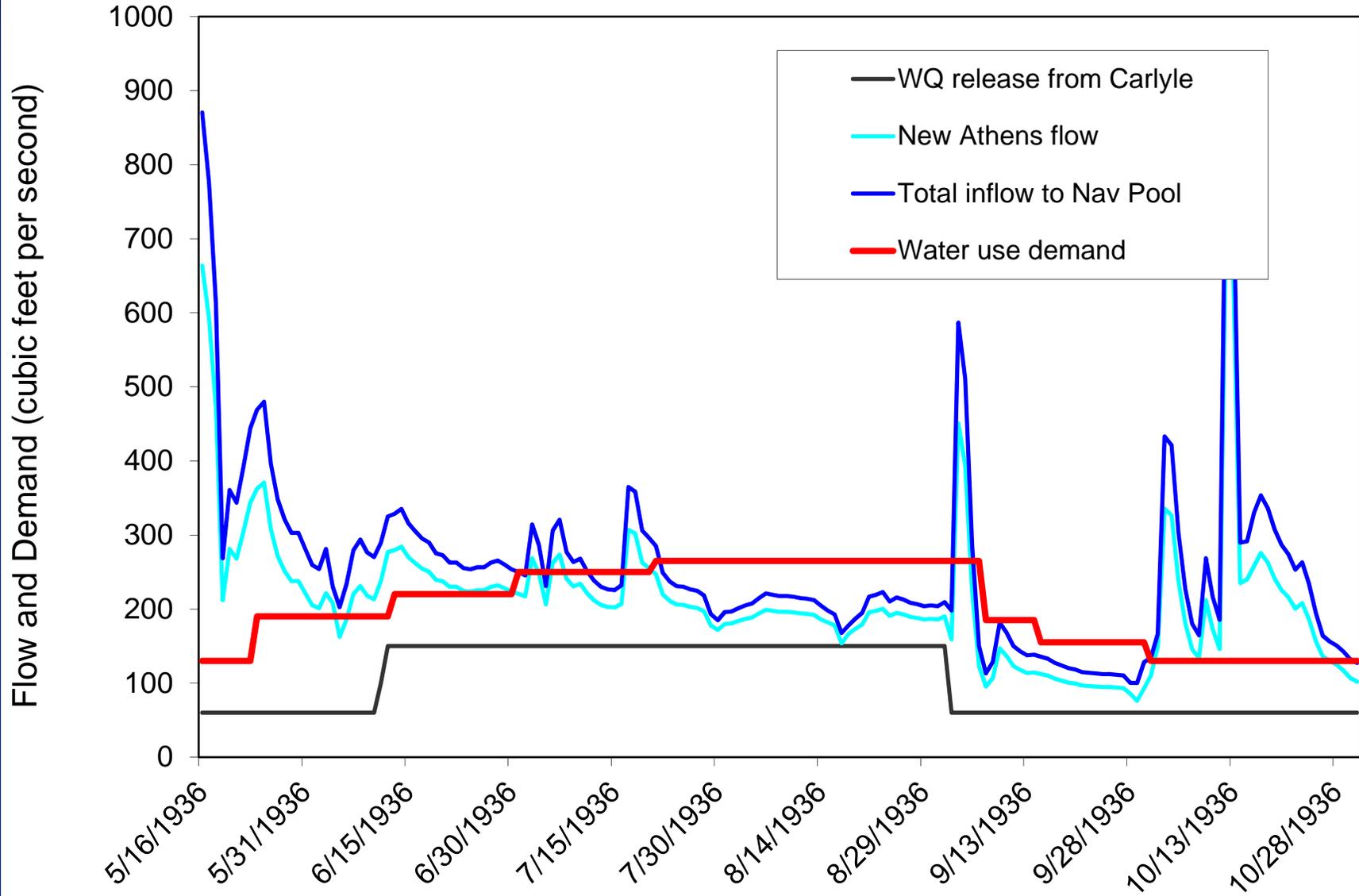
### Uses of water from the Navigation Channel

- Lockages for navigation **70** mgd (**7** lockages/day)
  - Pool Evaporation 25 mgd
  - Baldwin net withdrawal 30 mgd
  - Prairie State withdrawal 26 mgd
- 151 mgd (235 cfs)

# 1988 Drought – actual demands



# Simulation of Extreme (1936) w/ 7 lockages/day



## **Need for water supply and navigation releases from Carlyle Lake (summer)**

- With a summer water quality release of 150 cfs, water supply and navigation releases from Carlyle Lake might not be needed until commercial navigation increases.
- On the other hand, water supply and navigation releases would likely be required in a very dry year if the water quality release was not to be maintained at the 150 cfs level.

# Navigation Channel water needs during a fall/winter/spring period similar to 1954

## Rough Estimates of Average Daily Supply & Use

### Inflow to the Navigation Channel

- Minimum flow release from Carlyle 33 mgd (50 cfs)
- Inflow from tributaries 27 mgd  
60 mgd (93 cfs)

### Uses of water from the Navigation Channel

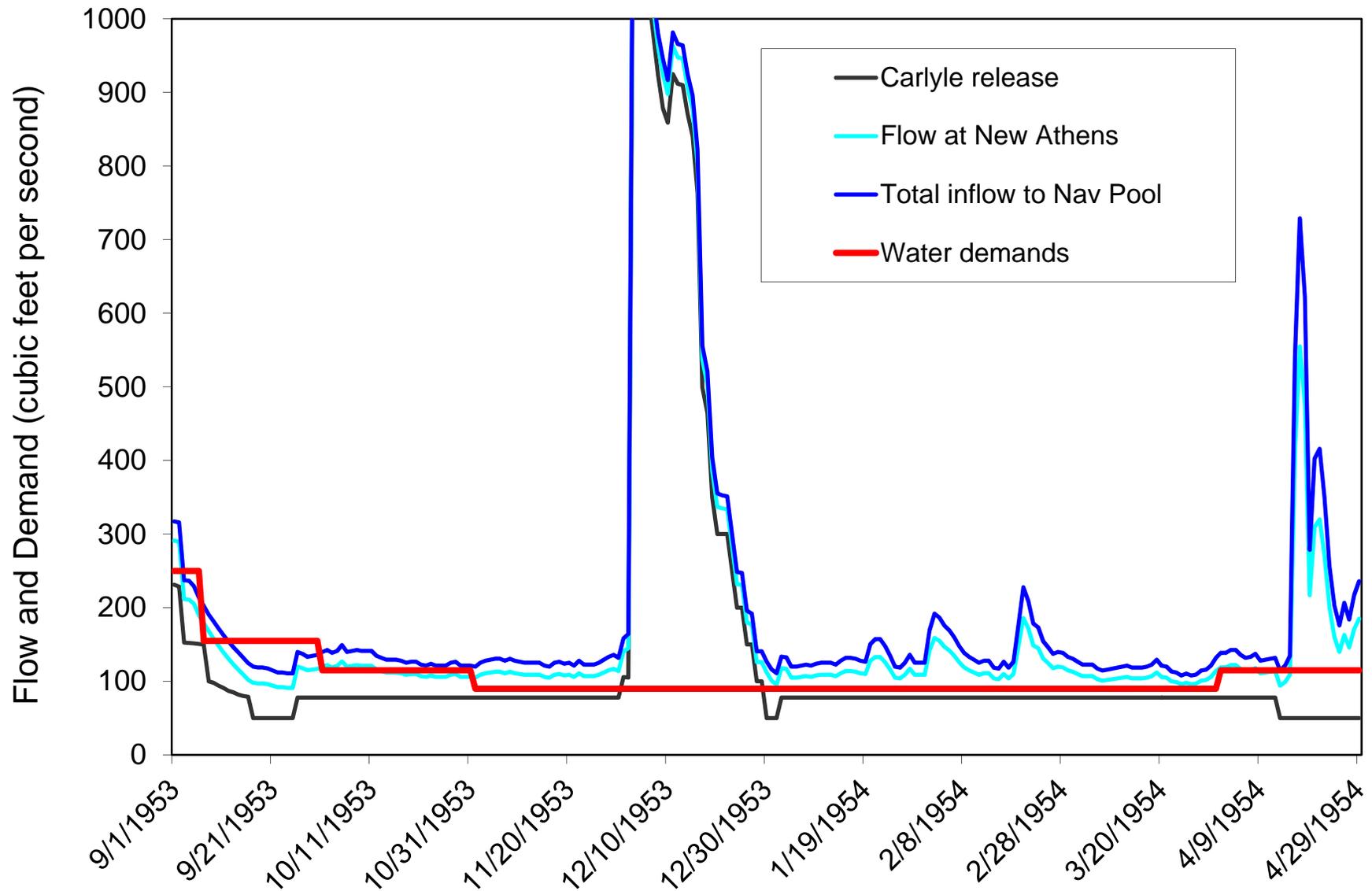
- Lockages for navigation 18 mgd (2 lockages/day)
- Pool Evaporation+ Precipitation 0 mgd
- Baldwin net withdrawal 20 mgd
- Prairie State withdrawal 18 mgd  
56 mgd (87 cfs)

## Conditions requiring a release from water supply storage

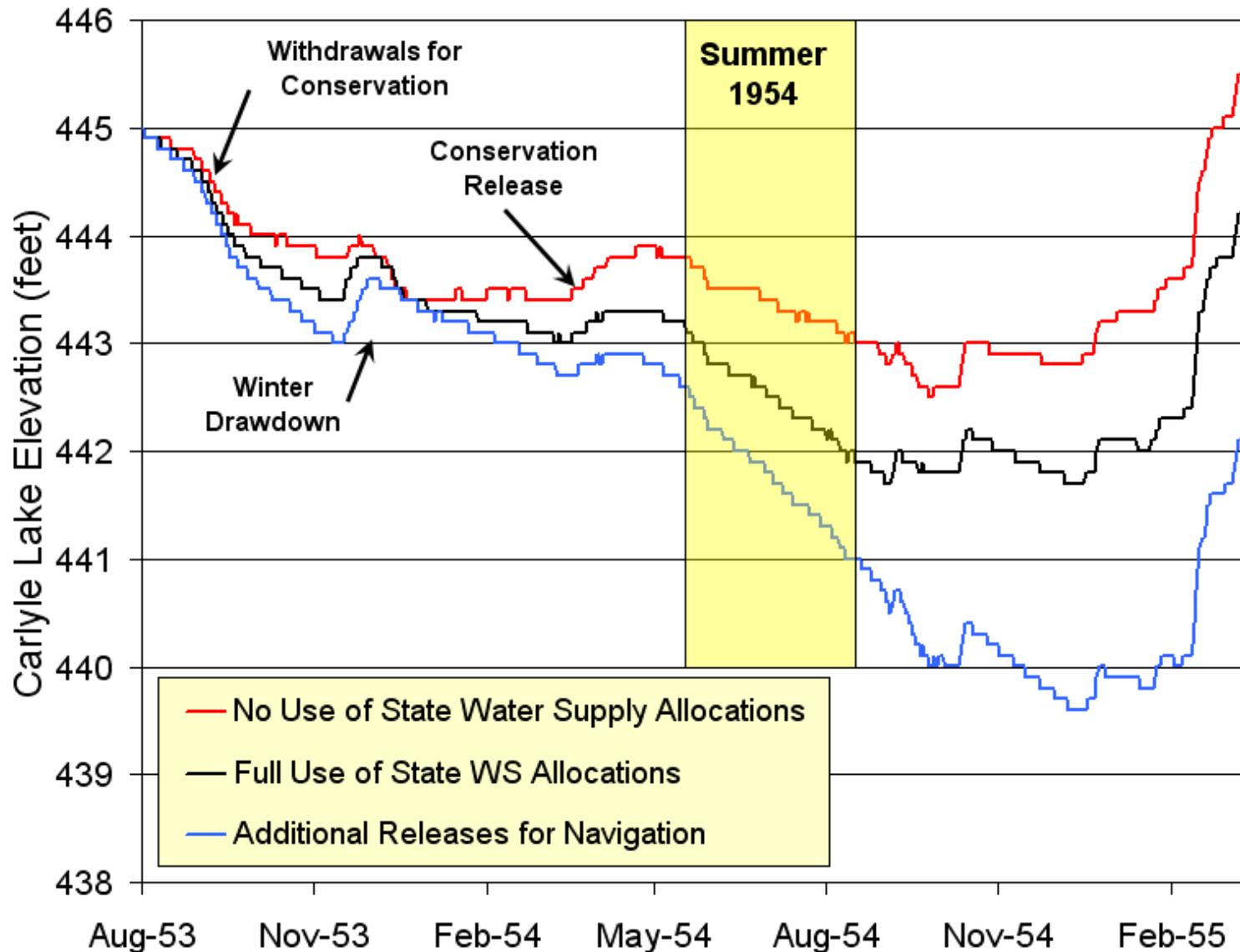
- If the flow at New Athens is 92 cfs or less, to withdraw water from the navigation pool Prairie State and Dynegey must request a release amount equal to or greater than their respective withdrawals.
- Each company must further “restrict their withdrawals ... to the extent necessary which ensures the protection of the quantity of flow released for (other) purpose(s).” In essence, this means that if there is the need for a navigation release, then both companies would likely also need to request a release for their own withdrawals to avoid interference.

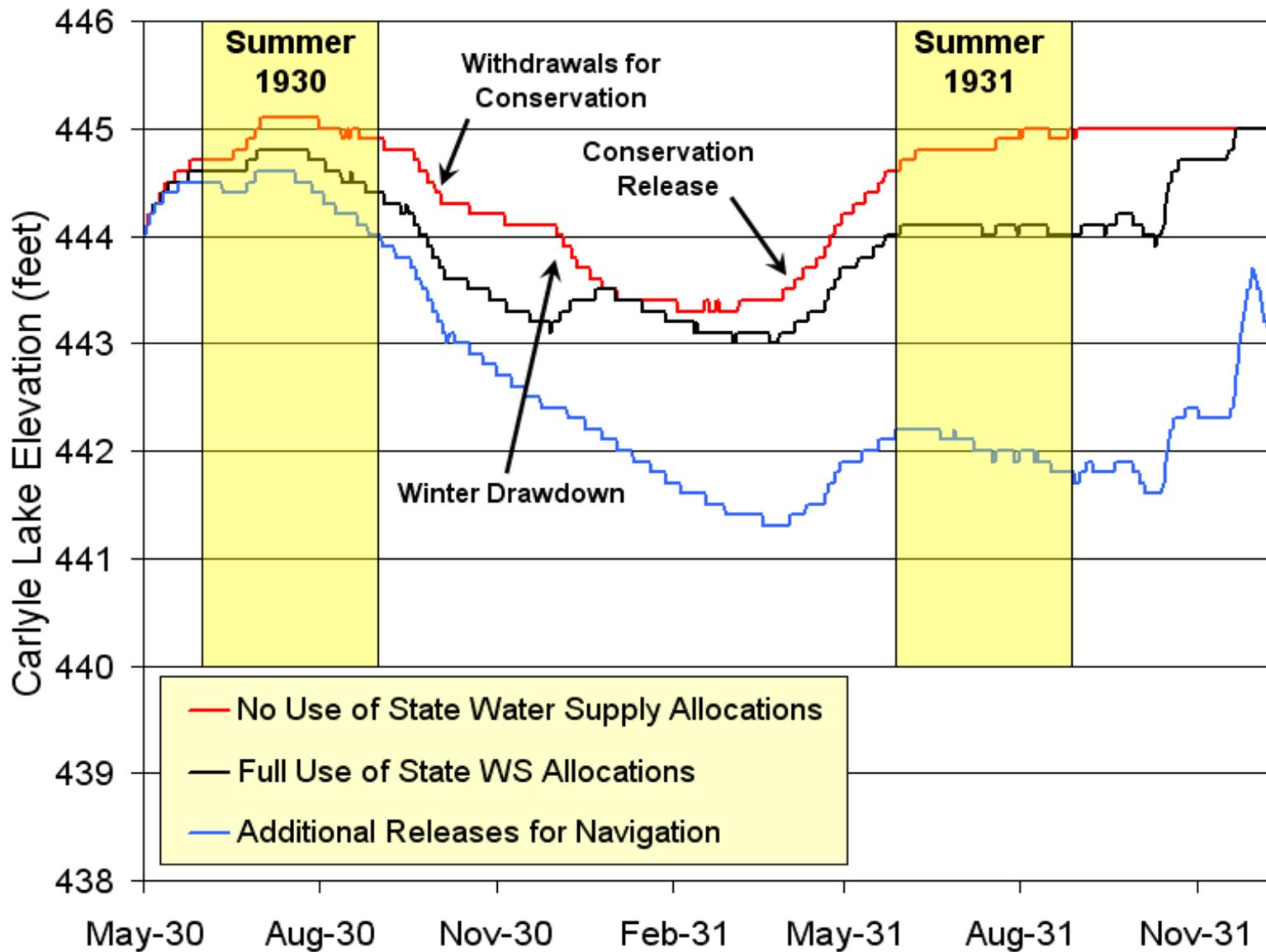
Thus, when severe multi-year (infrequent) droughts occur, winter allocations would likely be needed.

# 1953-54 flows with additional Carlyle release



# Impacts of releases on Carlyle Lake levels





# Conclusions

- Groundwater is primarily available near the river and in limited quantities.
- For the most part, community reservoir supplies appear to be in good shape for the next 40 years, although a handful of smaller systems are inadequate or at risk.
- The water supply storage from Shelbyville and Carlyle is fully allocated. While current needs and moderate growth to 2050 will be met, there is no available source should a new large water use want to locate to the area.
- Water quality or navigation/water supply releases will result in low water levels in the federal reservoirs, especially during the second year of infrequent multi-year drought episodes.

