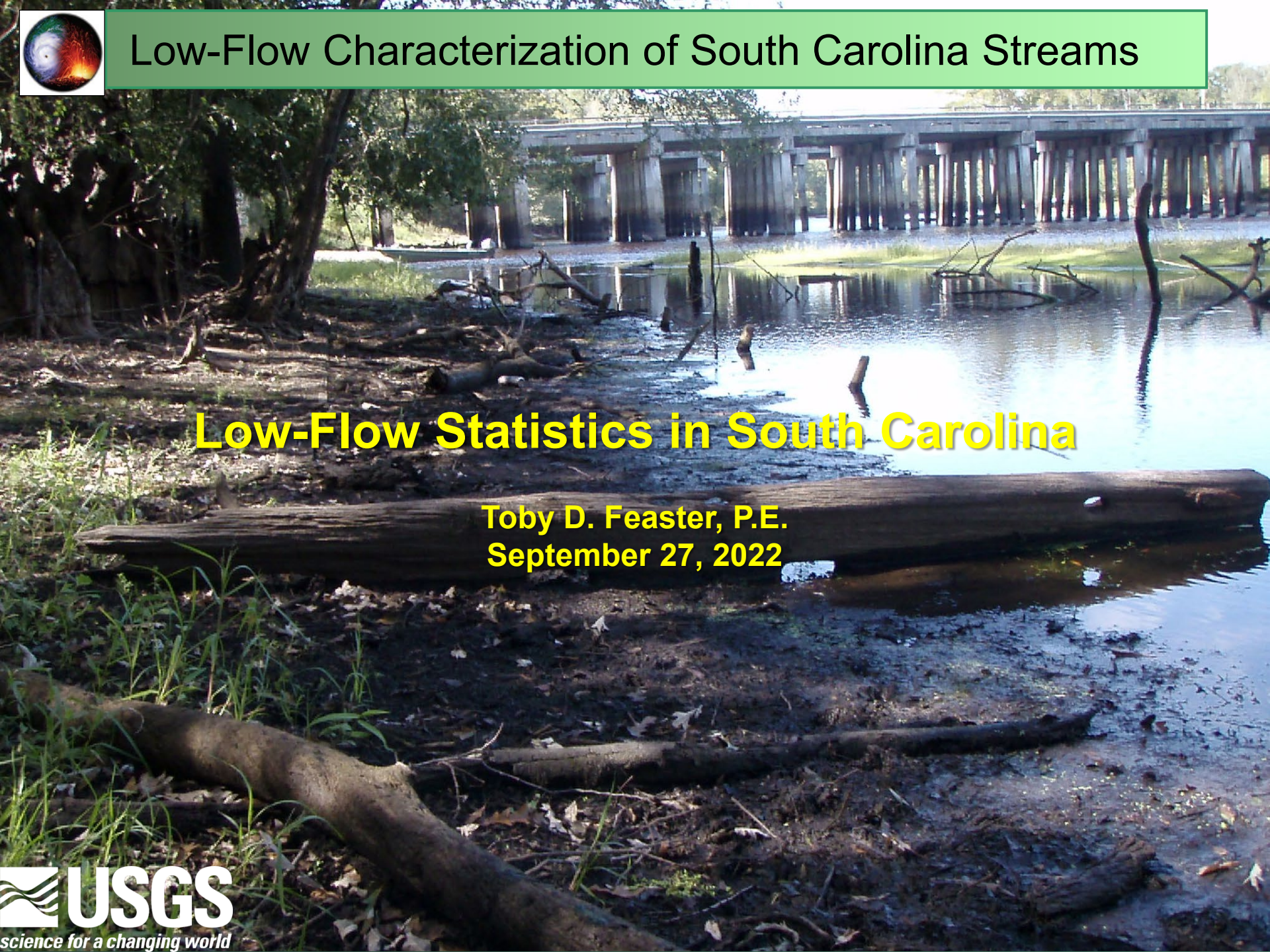
Low-Flow Characterization of South Carolina Streams



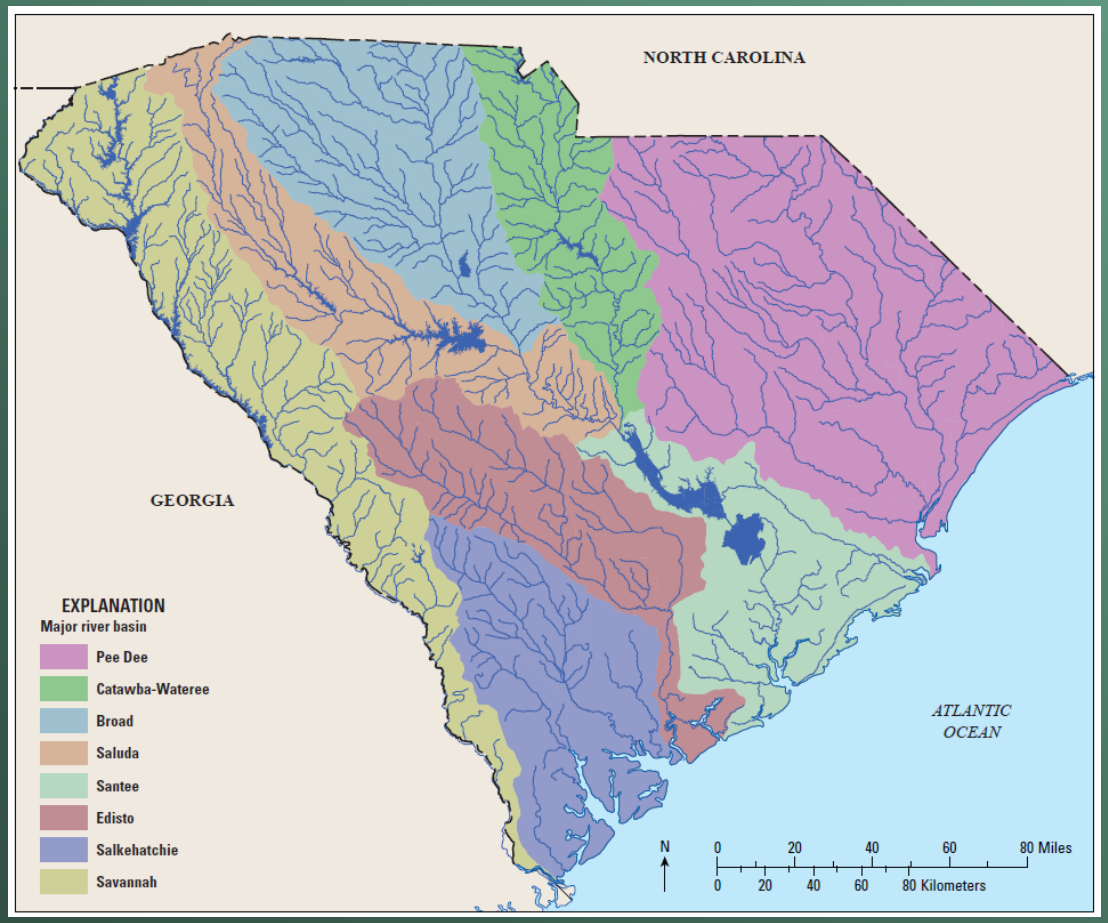
Low-Flow Statistics in South Carolina

Toby D. Feaster, P.E.

September 27, 2022

USGS
science for a changing world

Low-Flow Characterization of South Carolina Streams



South Carolina Low-Flow Updates

Between 2007 and 2014, the U.S. Geological Survey, in cooperation with the South Carolina Department of Health and Environmental Control, updated low-flow statistics at continuous-record streamgaging stations.

Prior to that, low-flow statistics had not been updated on a state-wide basis since 1987.

USGS

The USGS has been computing low-flow statistics in SC since the 1960s.

Low-Flow Characterization of South Carolina Streams

- Pee Dee River (March 2007)
- Broad River (March 2008)
- Saluda, Congaree, and Edisto Rivers (March 2009)
- Catawba-Wateree and Santee Rivers (March 2012)
- Savannah and Salkehatchie Rivers (March 2014)
- Summary report published in 2017

https://pubs.er.usgs.gov/

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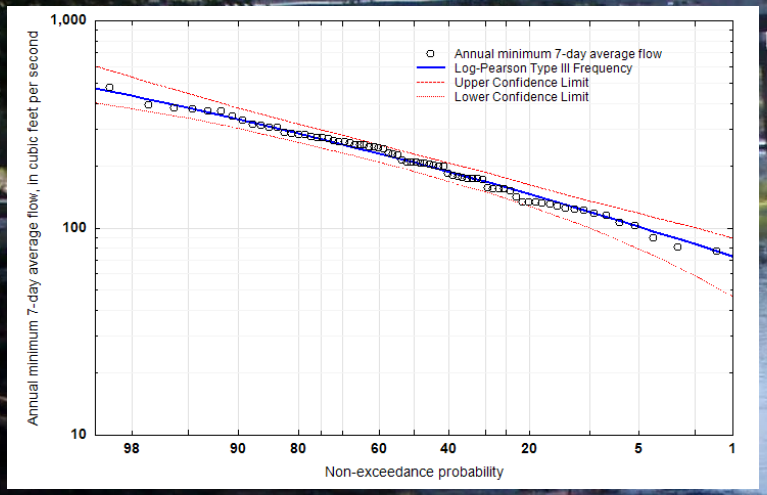
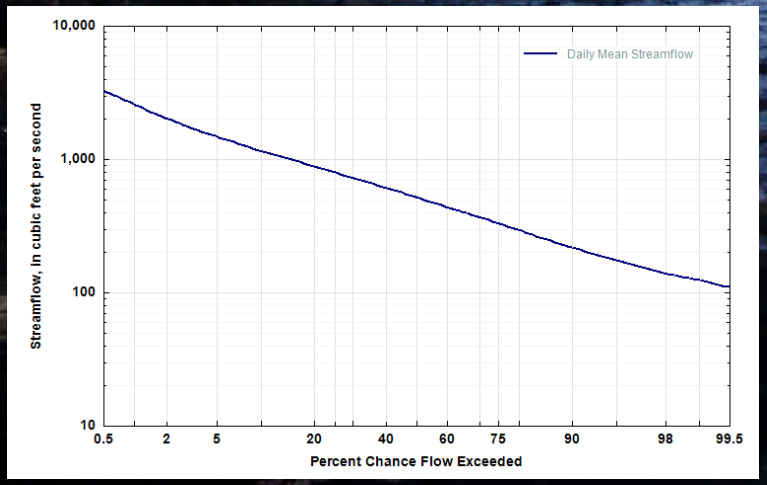
Low-Flow Characterization of South Carolina Streams





Low-Flow Statistics Published

- Annual minimum 1-, 3-, 7-, 14-, 30-, 60-, and 90-day average flows with a 2-, 5-, 10-, 20-, 30-, and 50-year recurrence interval (depending on the available length of record)
- Daily flow durations for the 5, 10, 25, 50, 75, 90, and 95 percentiles

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Low-Flow Characterization of South Carolina Streams

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Prepared in cooperation with the South Carolina Department of Health and Environmental Control

Low-Flow Frequency and Flow Duration of Selected South Carolina Streams in the Pee Dee River Basin through March 2007

Open-File Report 2009–1171

U.S. Department of the Interior
U.S. Geological Survey

https://pubs.er.usgs.gov/publication/ofr20091171

StreamStats Data-Collection Station Report

Gage Information

Name	Value
USGS Station Number	02136000 (Legacy NWIS link)
Station Name	BLACK RIVER AT KINGSTREE, SC
Station Type	Gaging Station, continuous record
Latitude	33.66127
Longitude	-79.83590448
NWIS Latitude	33.66127545
NWIS Longitude	-79.83590448
Is regulated?	false
Agency	United States Geological Survey
NWIS Discharge Period of Record	09/30/1929 - 09/17/2022

Physical Characteristics

Filter By Statistic Group: Select | Filter By Citation: Select

Basin Dimensional Characteristics

Characteristic Name	Value	Units	Citation
Drainage Area	1252	square miles	140
Drainage Area	1252	square miles	140

Regional indicators

Characteristic Name	Value	Units	Citation
Percent Area in Region 1	0	percent	140
Percent Area in Region 2	0	percent	140
Percent Area in Region 3	8	percent	140
Percent Area in Region 4	92	percent	140

Streamflow Statistics

Filter By Statistic Group: Select | Filter By Citation: Select | Show Only Preferred

Peak-Flow Statistics

Statistic Name	Value	Units	Preferred?	Years of Record	Standard Error, percent	Citation	Comments
50-percent AEP flood	5400	cubic feet per second	✔			140	

https://www.usgs.gov/tools/usgs-streamstats

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Low-Flow Characterization of South Carolina Streams

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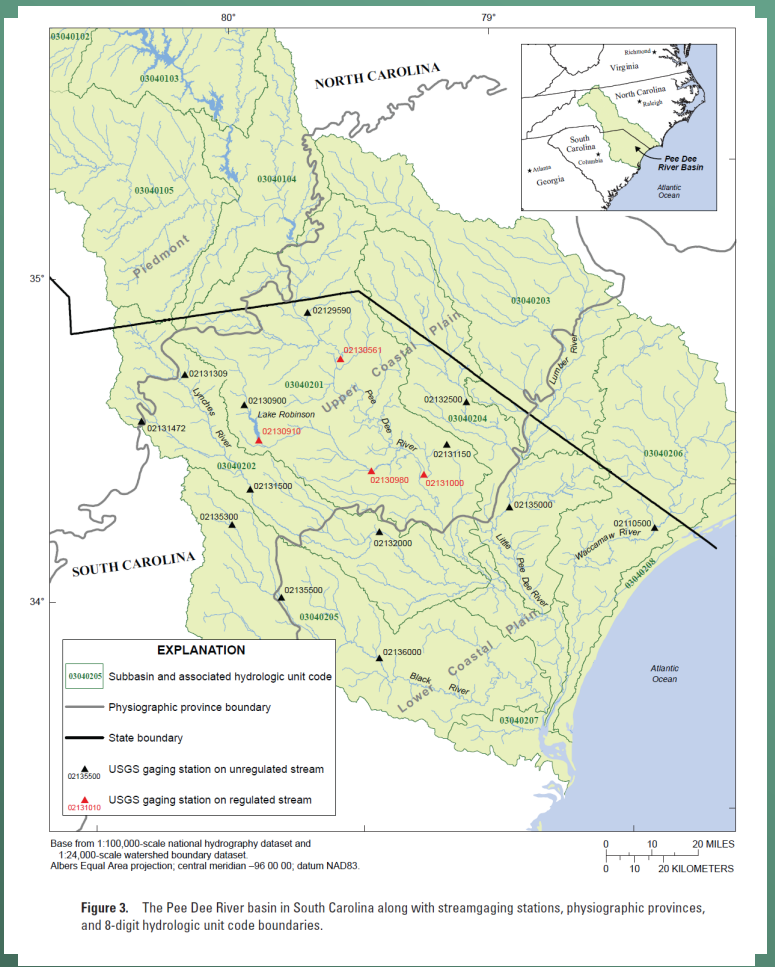
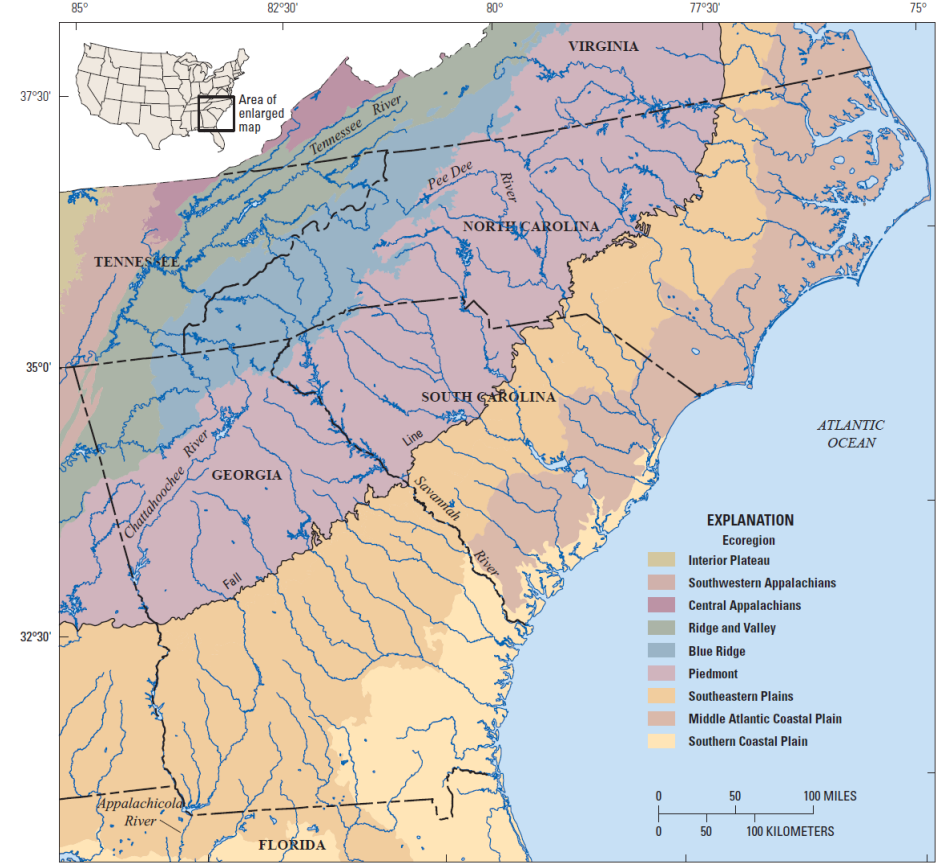


Figure 3. The Pee Dee River basin in South Carolina along with streamgaging stations, physiographic provinces, and 8-digit hydrologic unit code boundaries.

https://pubs.er.usgs.gov/publication/ofr20091171

USGS

Low-Flow Characterization of South Carolina Streams



Base modified from U.S. Geological Survey 1:100,000-scale digital data
Ecoregions from U.S. Environmental Protection Agency 1:7,500,000-scale digital data (2002; revision of Omernik, J.M., 1987)

As of April 2022, the USGS, in cooperation with SCDNR and SCDHEC, began a two-phase study to:

1) Update low-flow and mean annual flow statistics at USGS streamgages in SC, and

2) Develop regression equations that can be used to estimate low-flow and mean annual flow statistics at ungaged locations.

USGS

The USGS also has signed agreements with cooperators in NC and GA for concurrent projects in those states.

Low-Flow Characterization of South Carolina Streams

7Q10

One of the most common low-flow statistics is the 7Q10, which is the annual minimum 7-day average flow with a 10-year recurrence interval.

In terms of probability of occurrence, there is a 1 in 10 (1/10) or 10-percent probability that the annual minimum 7-day average flow at a site will be less than or equal to the estimated 7Q10.

USGS

Low-Flow Characterization of South Carolina Streams

7Q10 in SC State Regulation

7Q10 was adopted as the minimum flow for applying water quality criteria as early as the S.C. Rules and Regulations of 1967.

It is used for such things as:

- **Water Quality Standards (Reg. 61-68)**
- **Source Water Protection (Reg. 61-68)**
- **Interbasin Transfers (Reg. 121-12)**

USGS

Low-Flow Characterization of South Carolina Streams

How is the 7Q10 computed?

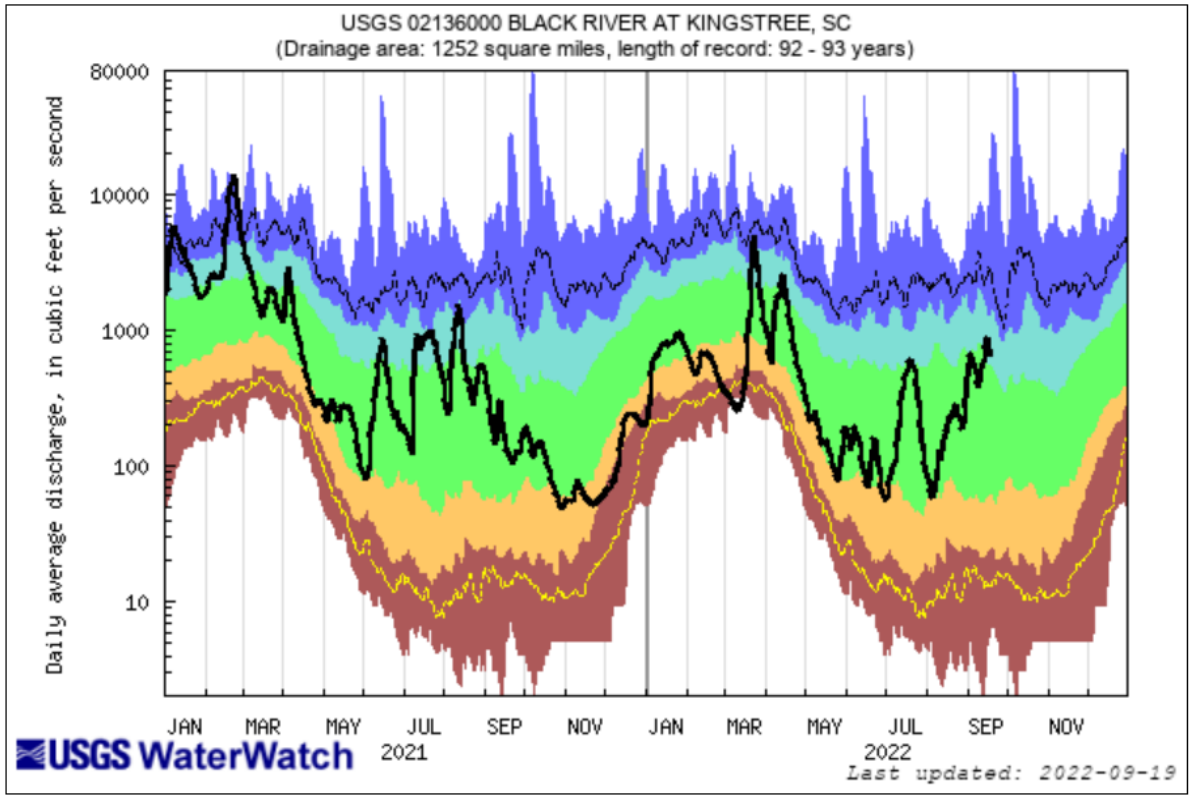
Let's look at an example at USGS station 02136000, Black River at Kingstree, SC, using climate years 1930-39 (first 10-years of record).

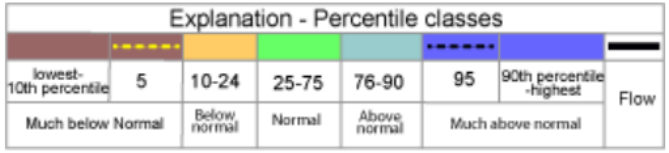
Note: A climate year begins on April 1 and ends on March 31 and is designated by the beginning year.

Why do we use the climate year as opposed to the water year, which begins on October 1 and ends on September 30 and is designated by the ending year?

USGS

Low-Flow Characterization of South Carolina Streams





Climate year

(Apr 1 to Mar 31)

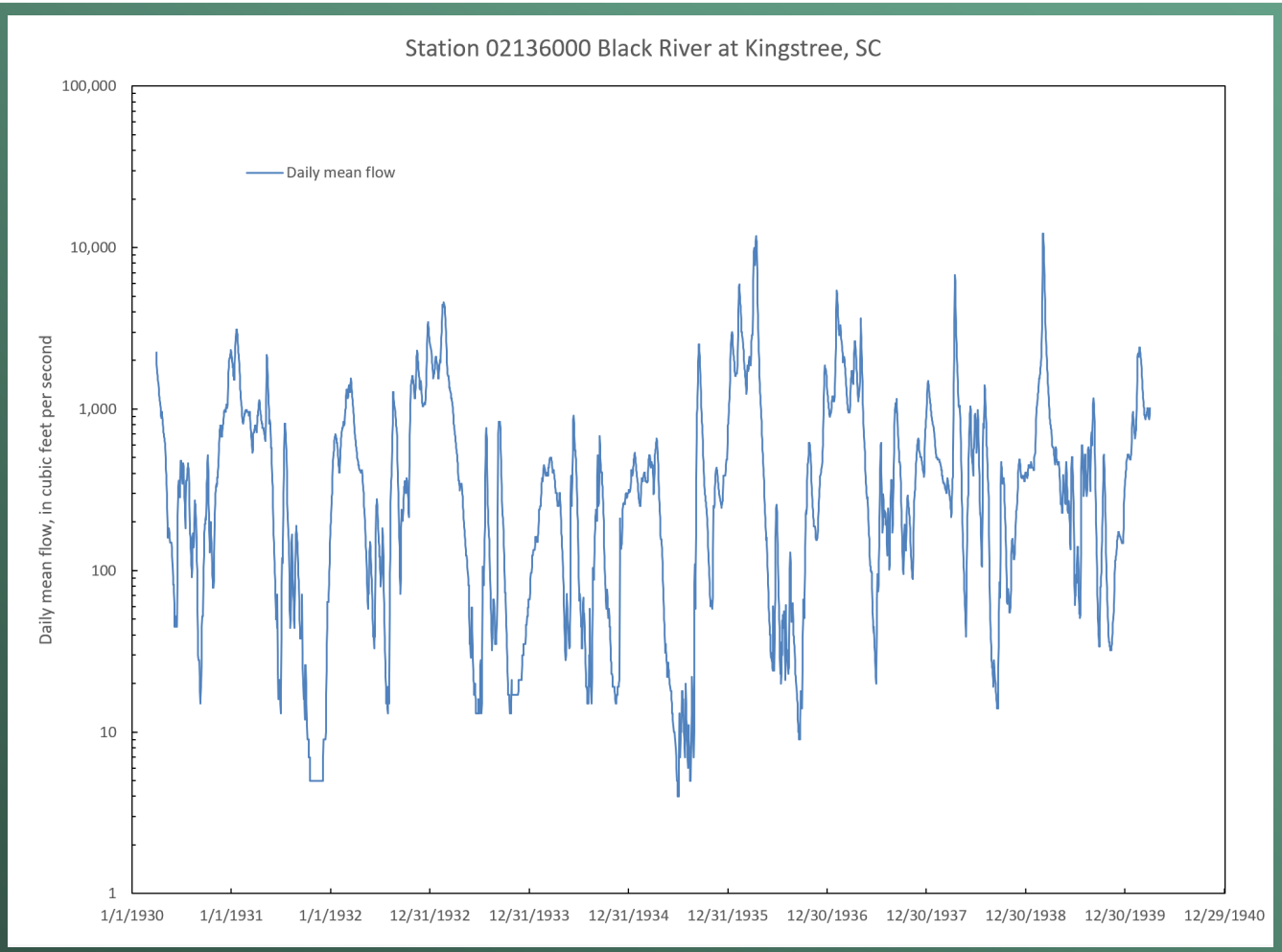
Water year

(Oct 1 to Sep 30)

USGS

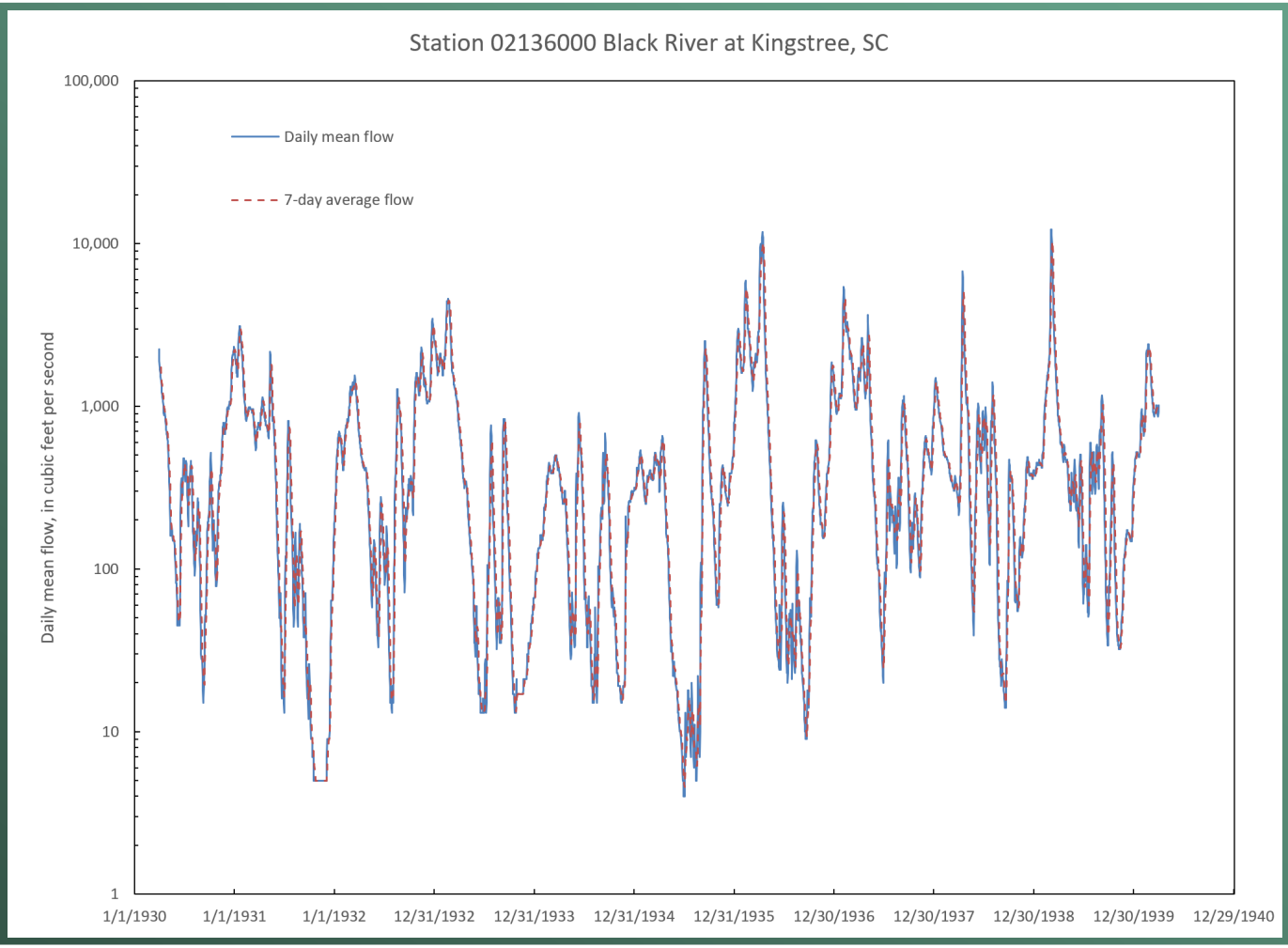
https://waterwatch.usgs.gov/

Low-Flow Characterization of South Carolina Streams



USGS

Low-Flow Characterization of South Carolina Streams



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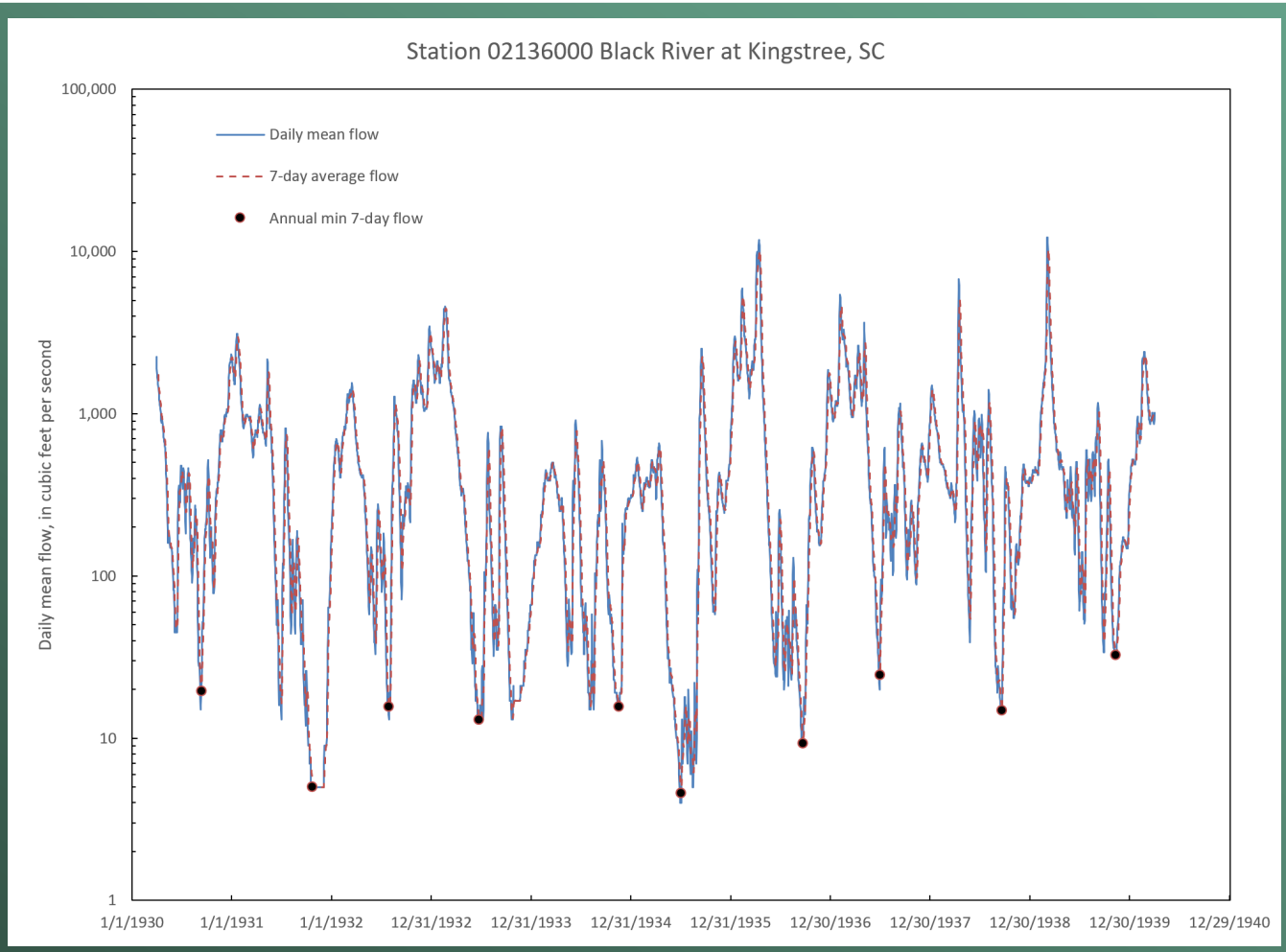
Low-Flow Characterization of South Carolina Streams



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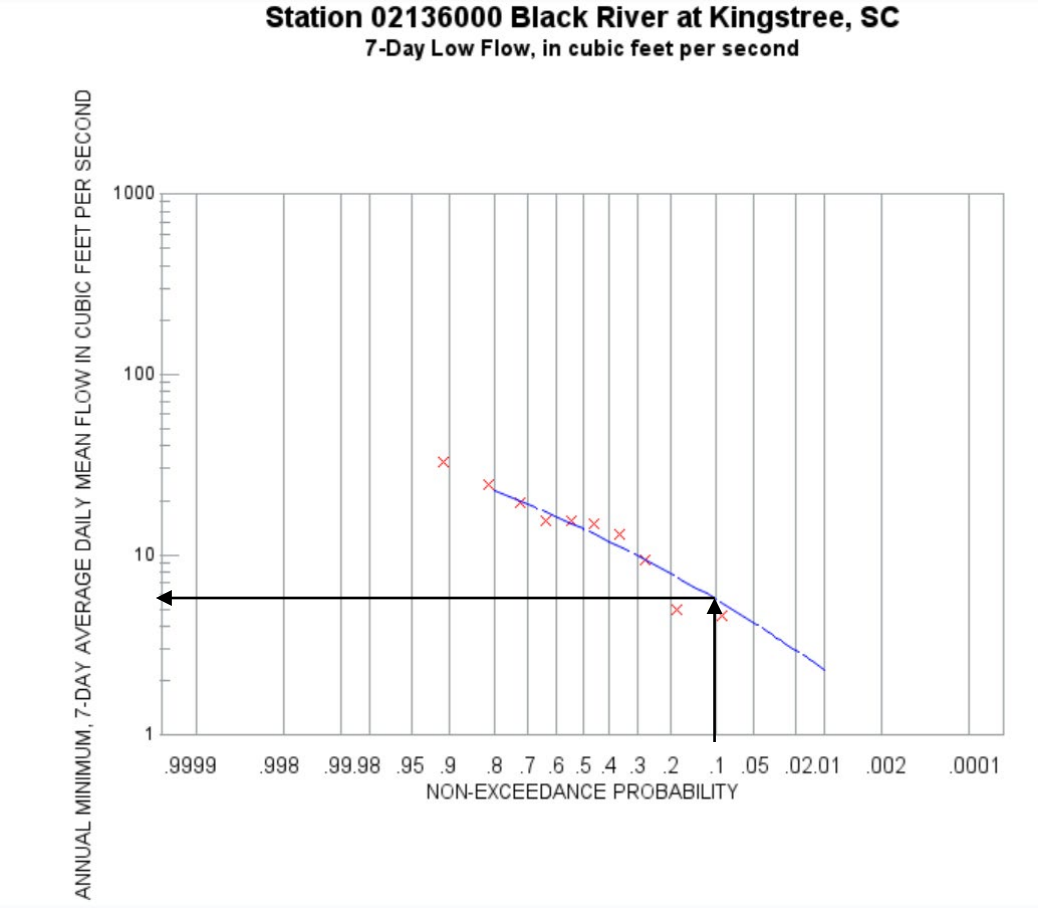
Low-Flow Characterization of South Carolina Streams



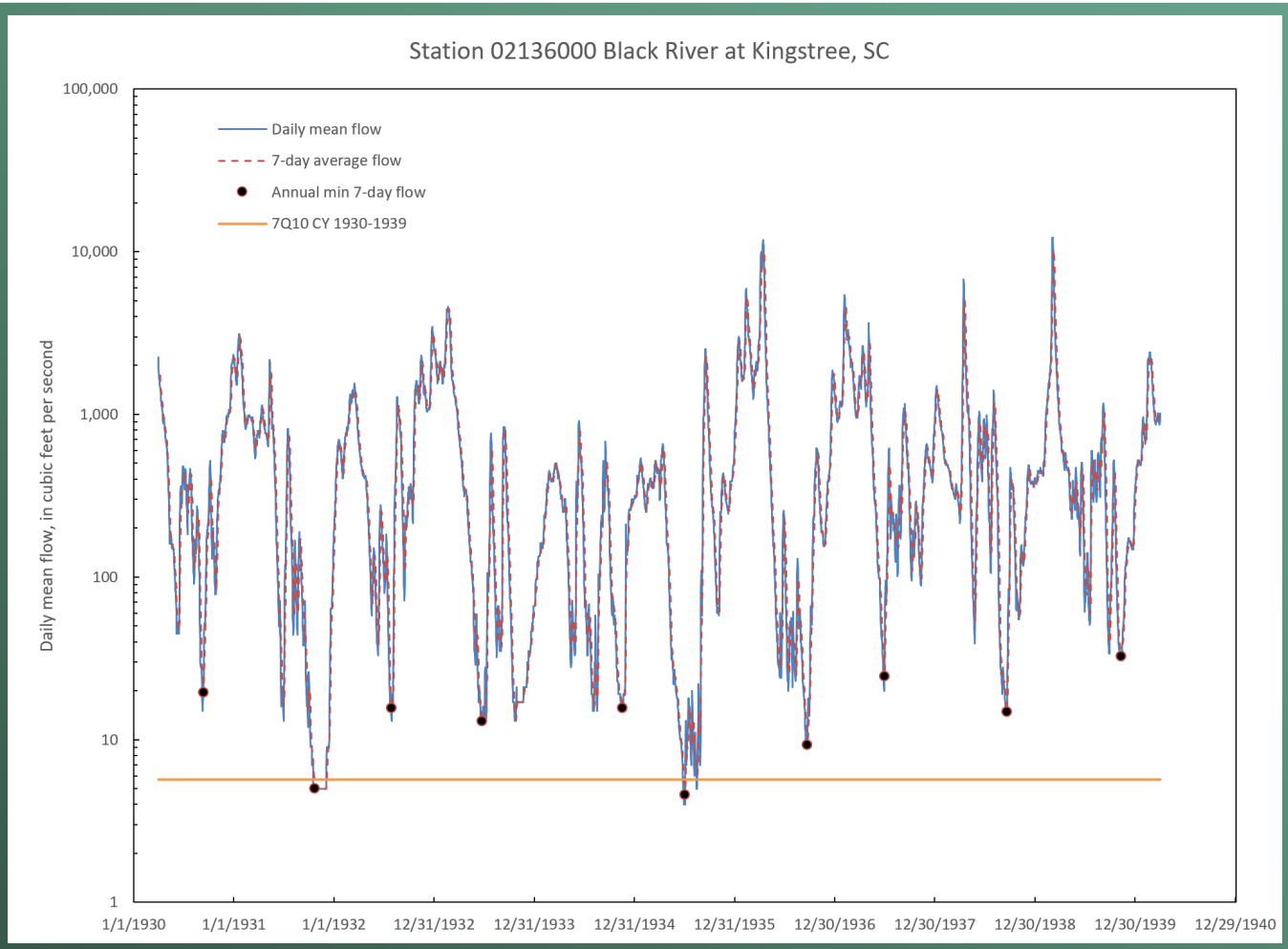
$$\log Q_T = \bar{X} + KS$$

From the log Pearson Type III statistical distribution, the 7Q10 for this period of record is 5.67 cubic feet per second (ft^3/s).

USGS

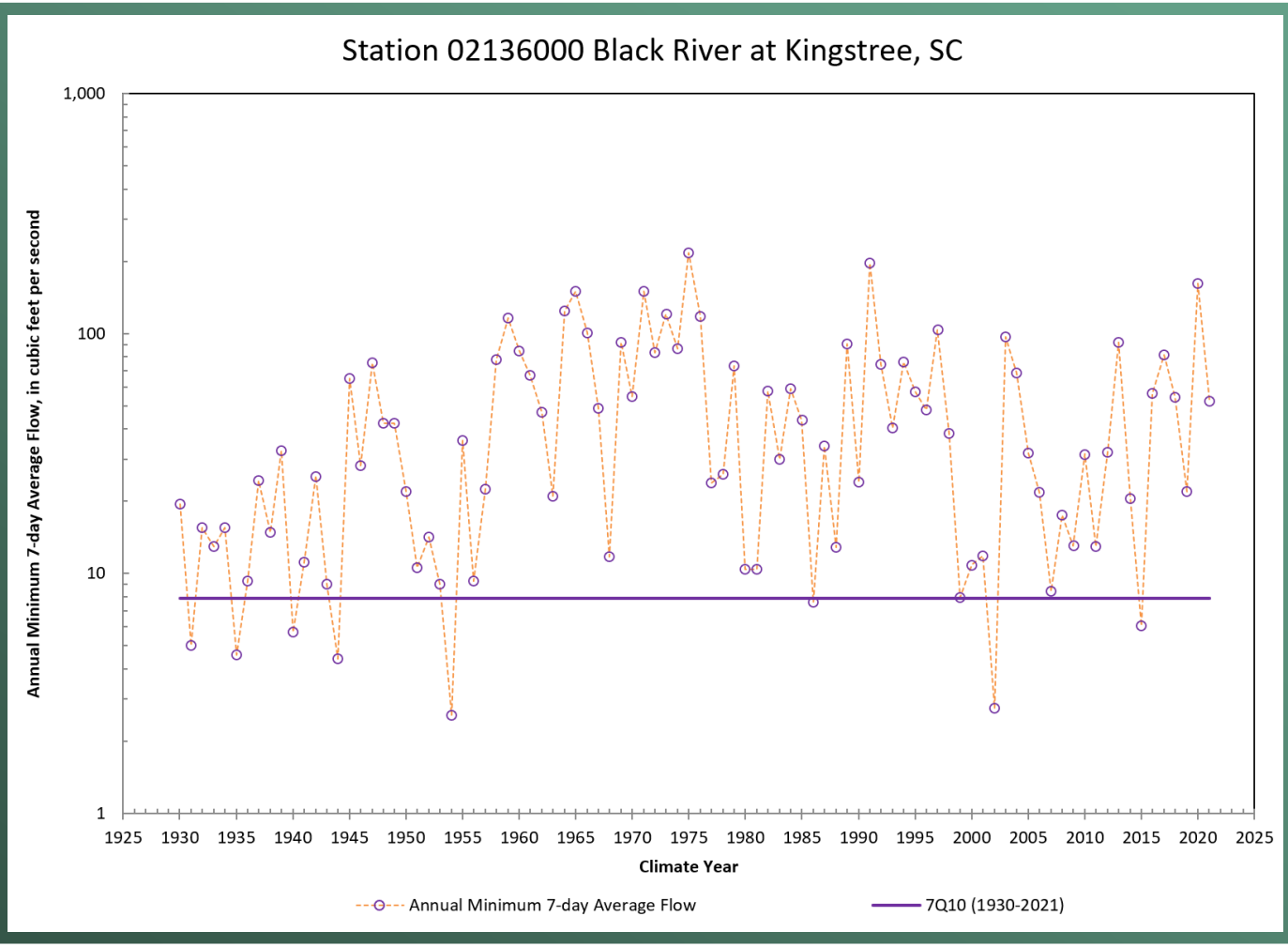
Low-Flow Characterization of South Carolina Streams

7Q10 = 5.67 ft^3/s



USGS

Low-Flow Characterization of South Carolina Streams



USGS

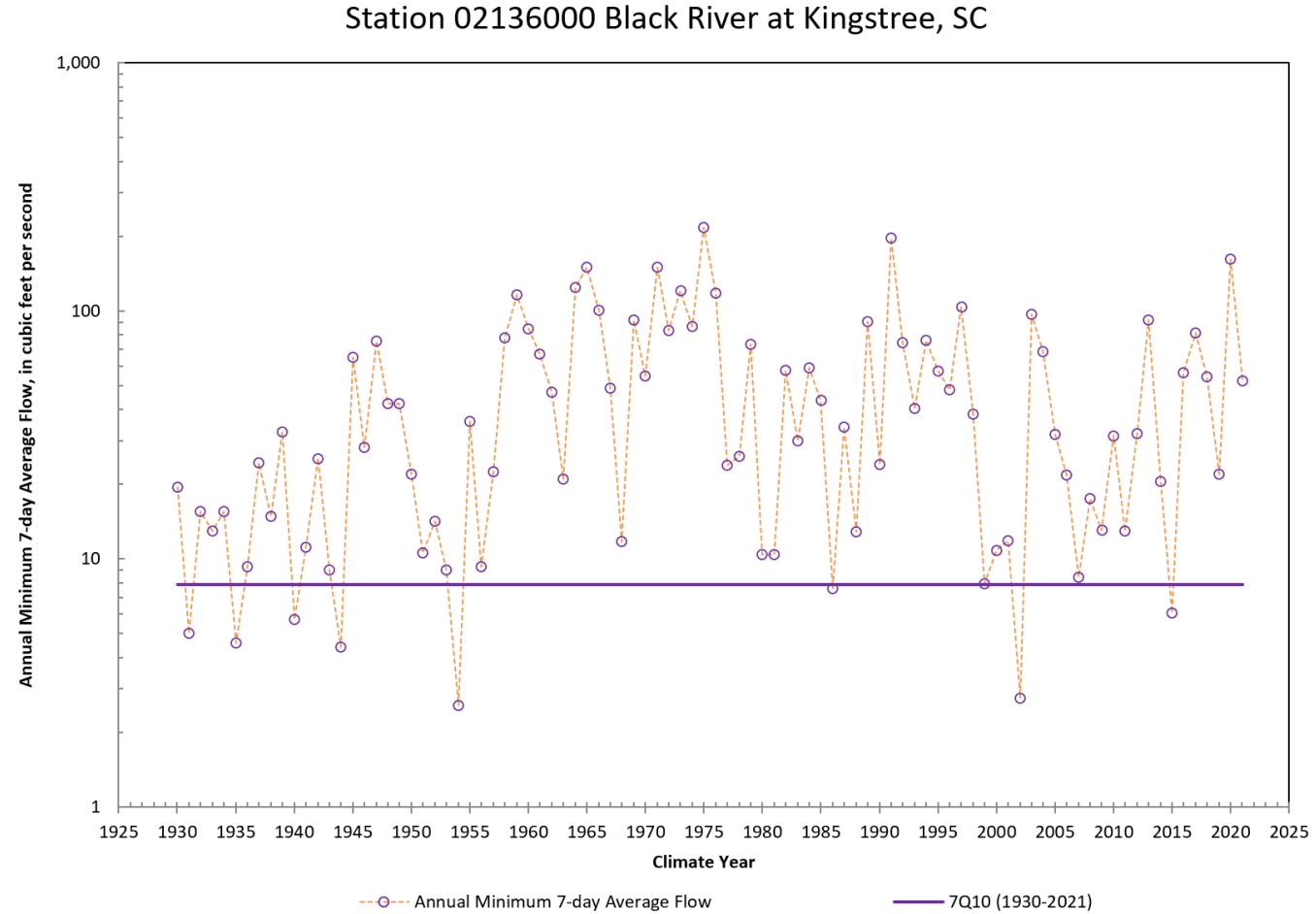
For the period from climate years 1930 to 2021, the 7Q10 = 7.86 ft^3/s

USGS

Streamflow statistics are not static values but are strongly influenced by length of record and hydrologic conditions captured in that record.

Low-Flow Characterization of South Carolina Streams

Let's take a look at how the 7Q10 changes through time at 02136000.



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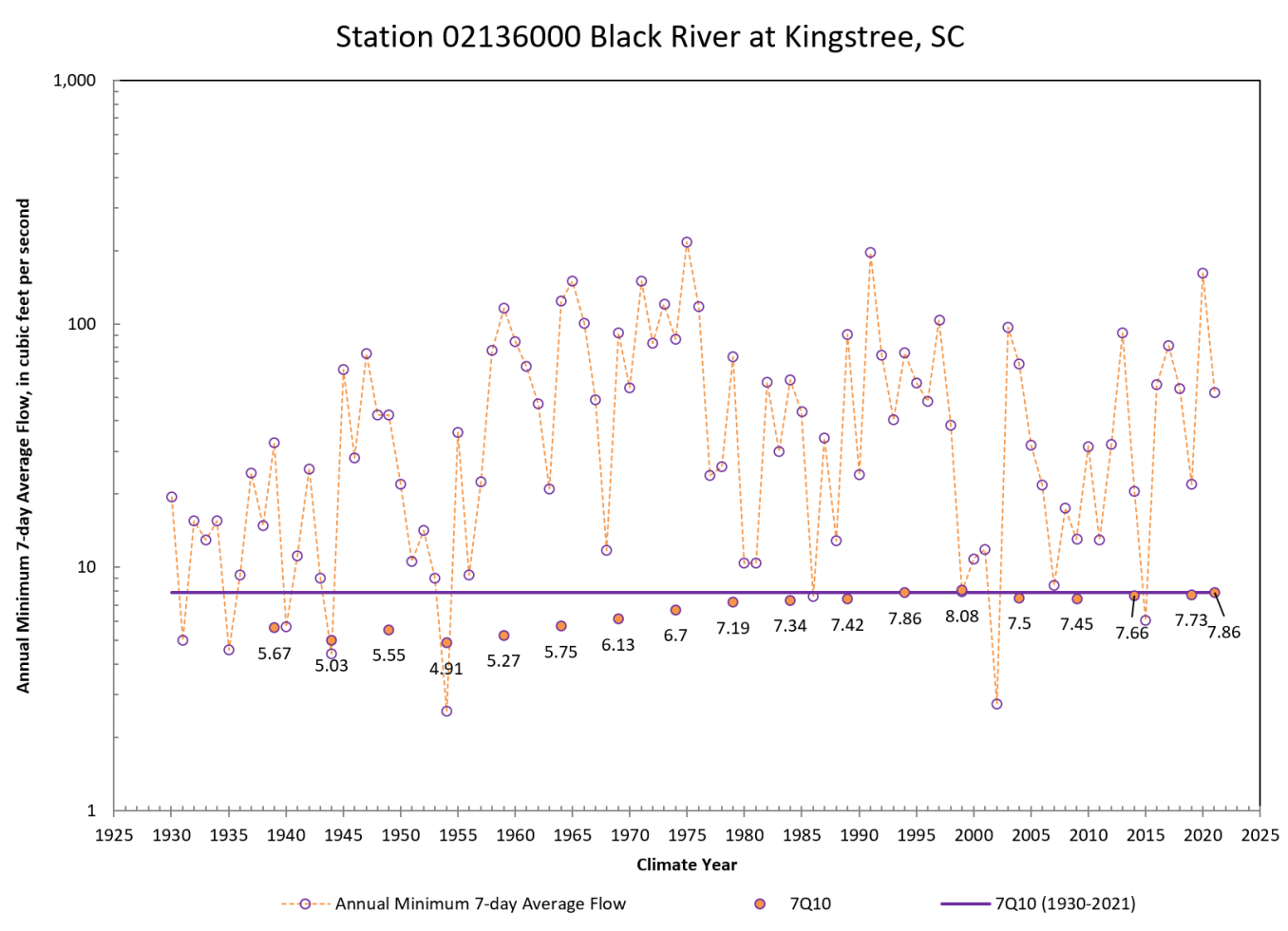
Low-Flow Characterization of South Carolina Streams

Let's take a look at how the 7Q10 changes through time at 02156500.



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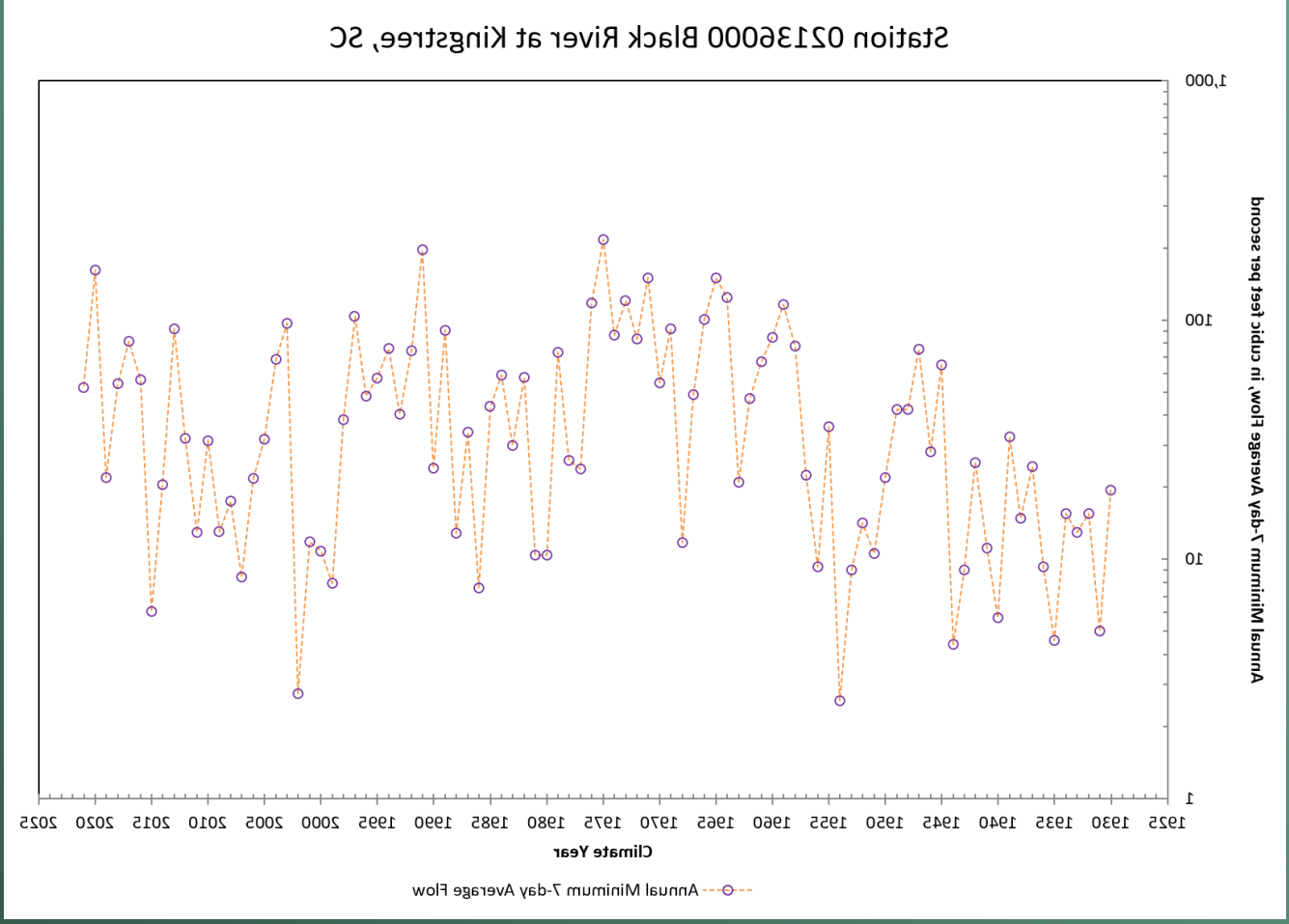
Low-Flow Characterization of South Carolina Streams

What if the record had been collected in reverse order?



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Low-Flow Characterization of South Carolina Streams

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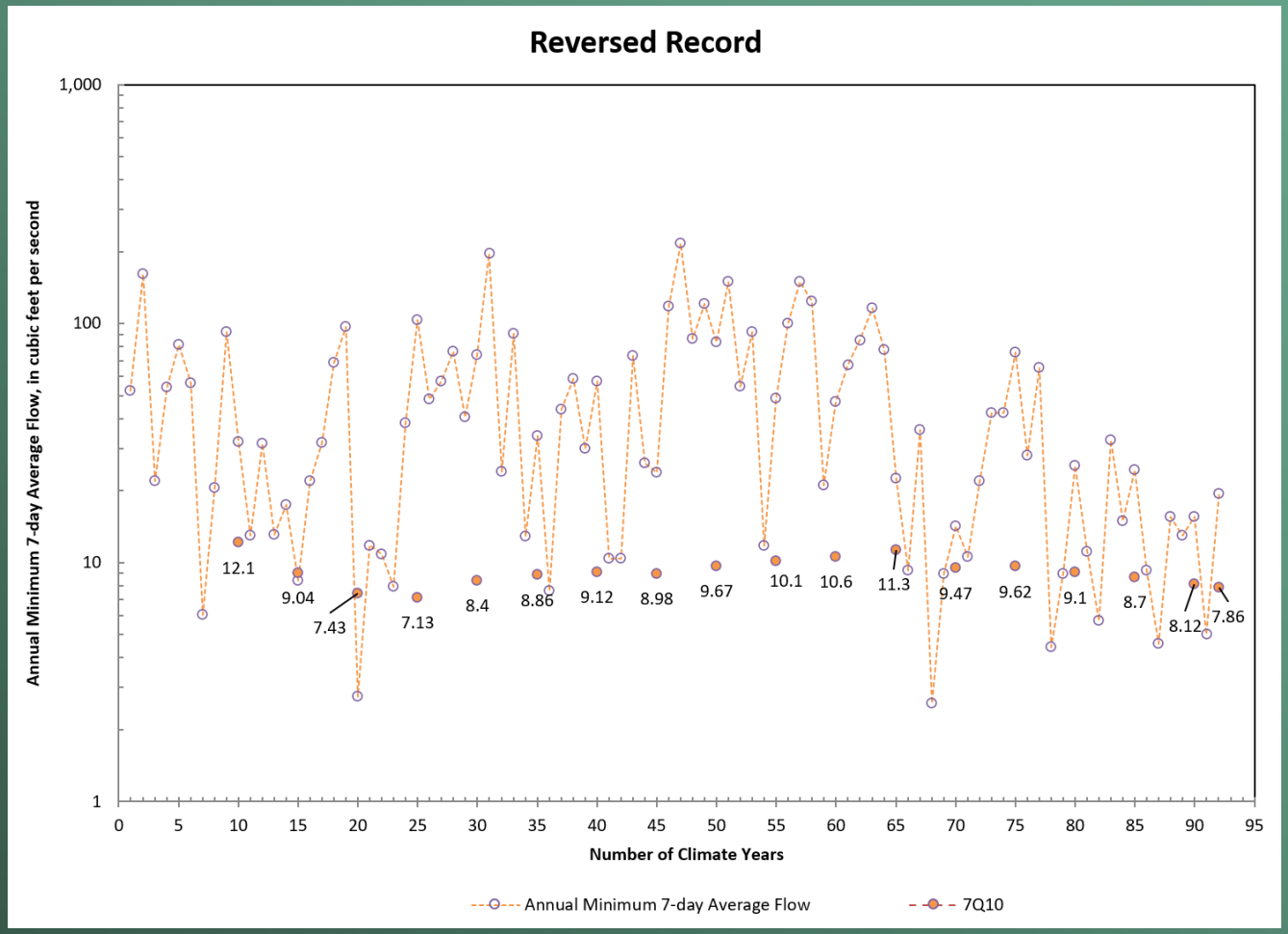

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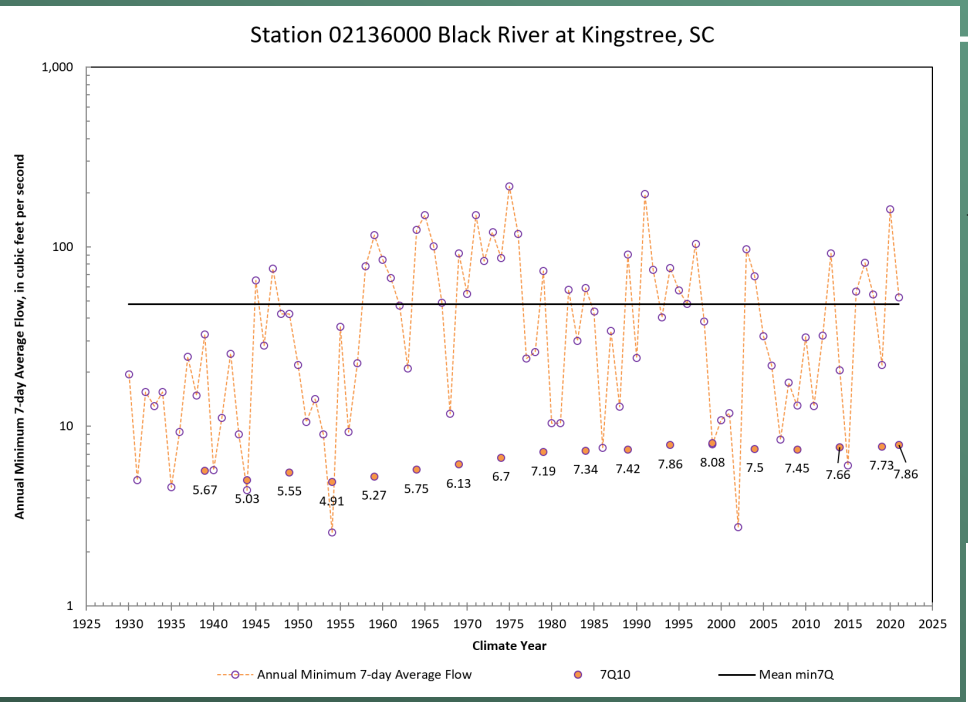
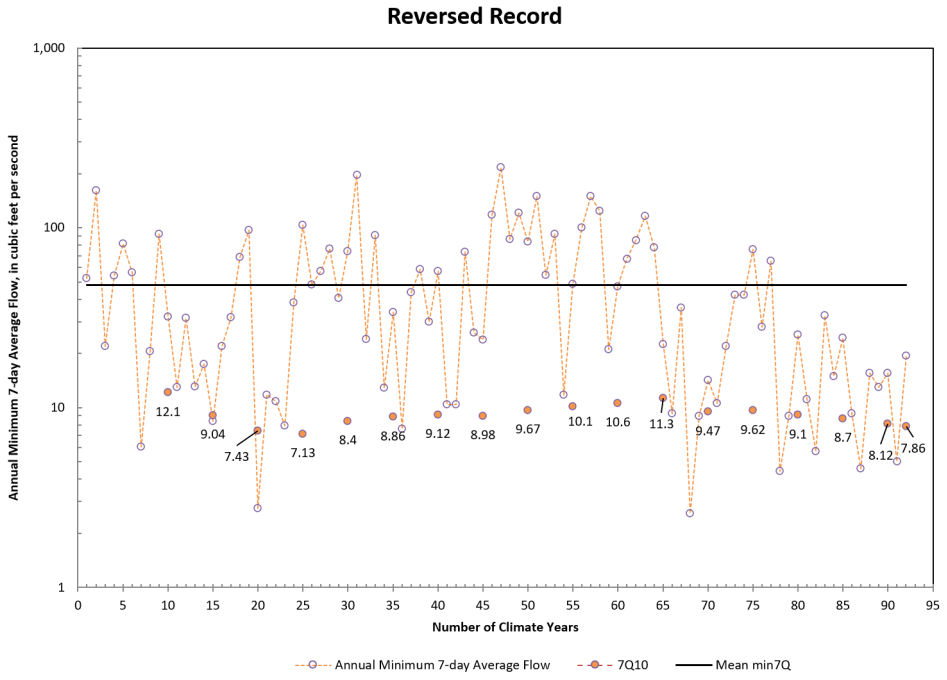
Low-Flow Characterization of South Carolina Streams



Record beginning in a relatively dry period.

Record beginning in a normal/above normal period.



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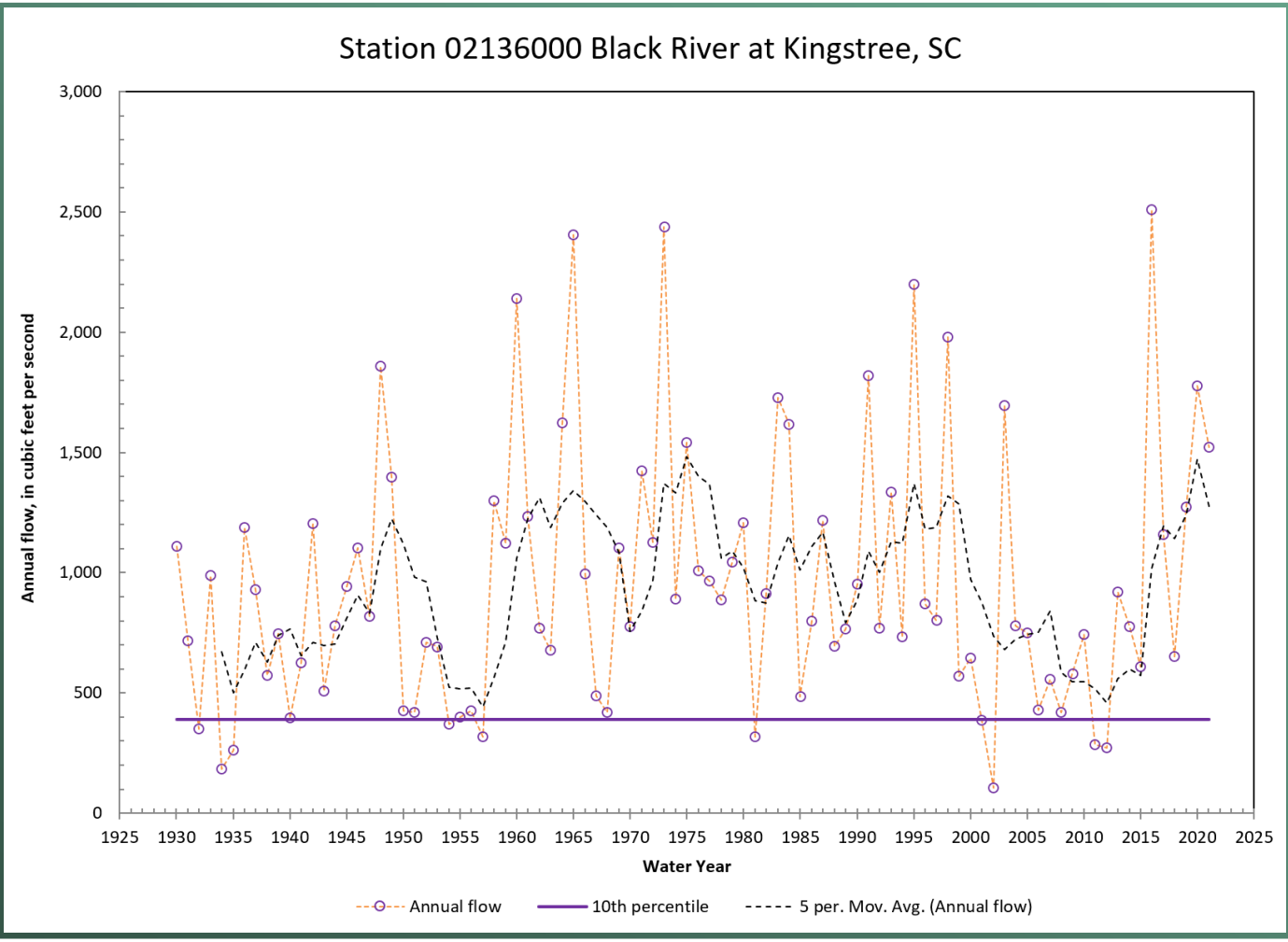
Low-Flow Characterization of South Carolina Streams

Annual flow

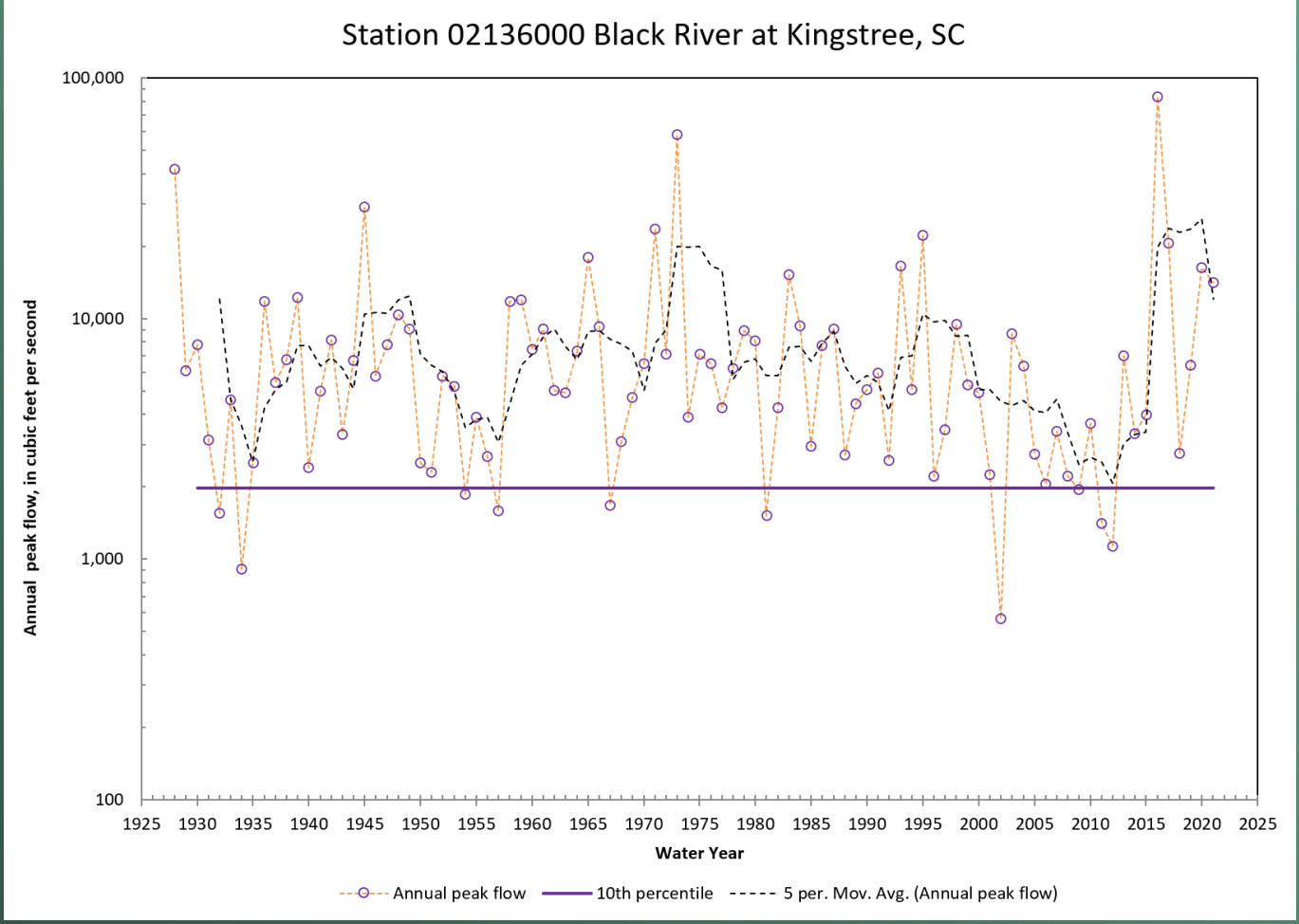


USGS

Annual flow is the mean of the daily flows for the water year.

Low-Flow Characterization of South Carolina Streams

Annual peak flow

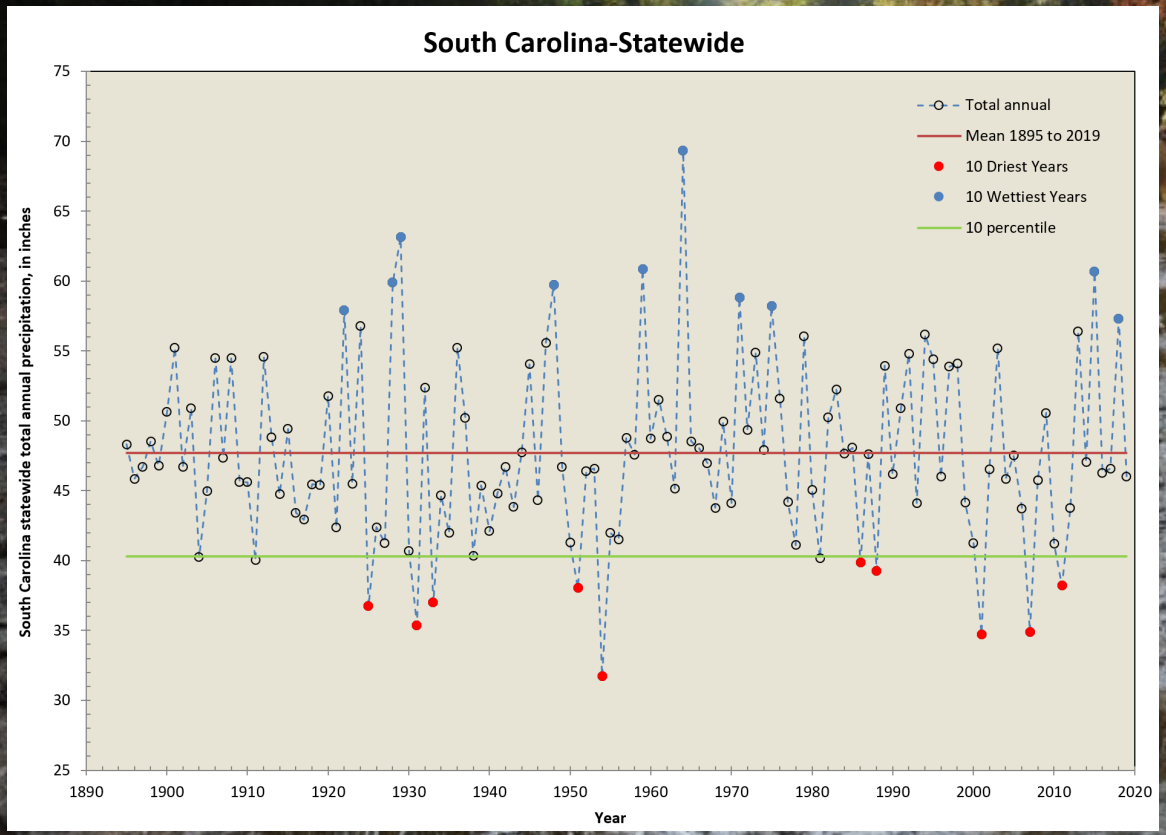


USGS

Annual peak flow is the largest instantaneous flow for the water year.

Low-Flow Characterization of South Carolina Streams

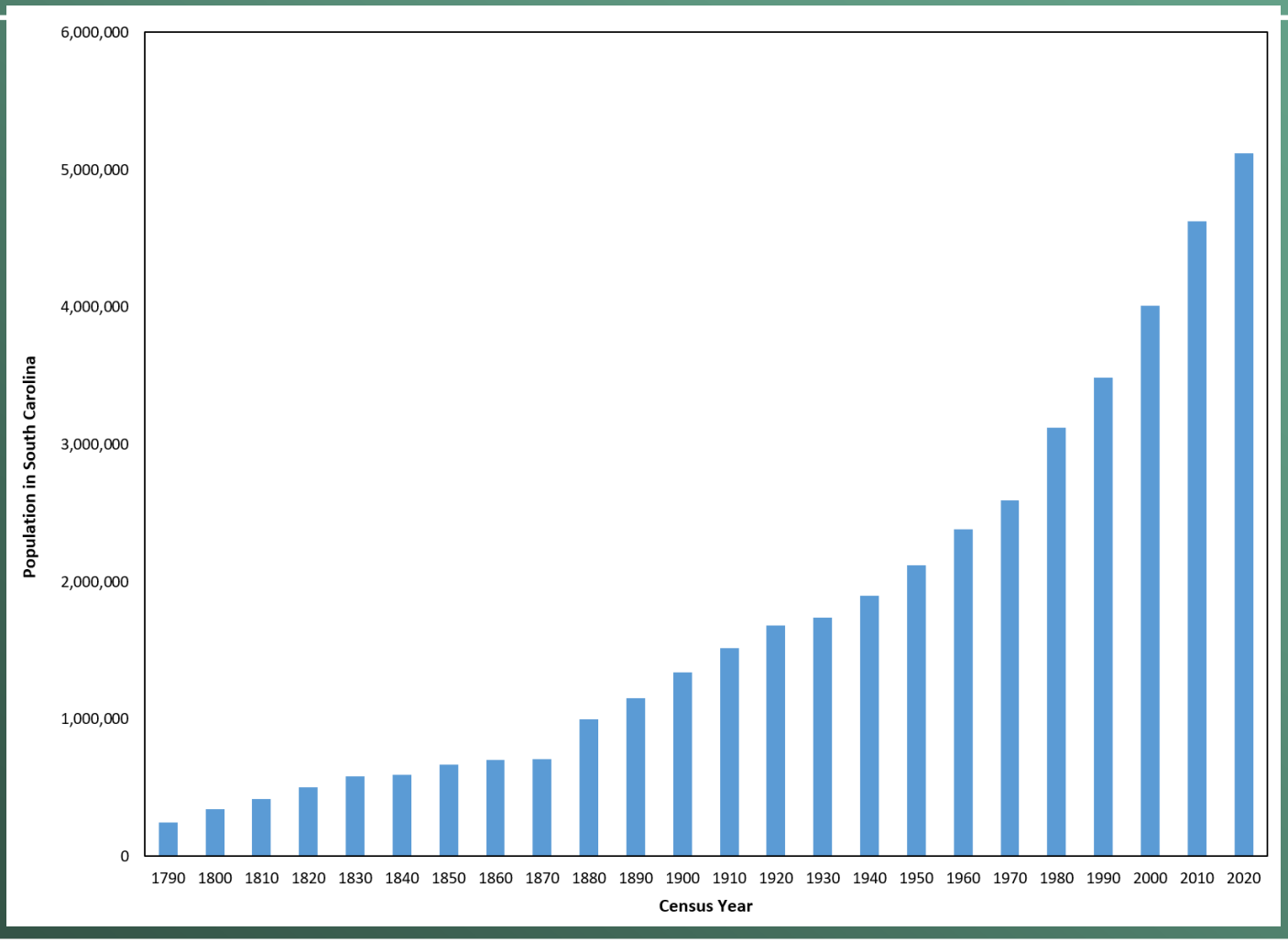
With respect to long-term statewide annual precipitation from 1895 to 2021



Wettest		Driest	
Year	Average total annual precipitation (inches)	Year	Average total annual precipitation (inches)
1964	69.32	1954	31.72
1929	63.14	2001	34.72
1959	60.86	2007	34.9
2015	60.66	1931	35.37
1928	59.89	1925	36.73
2020	59.87	1933	36.99
1948	59.74	1951	38.04
1971	58.82	2011	38.21
1975	58.23	1988	39.26
1922	57.9	1986	39.88

USGS

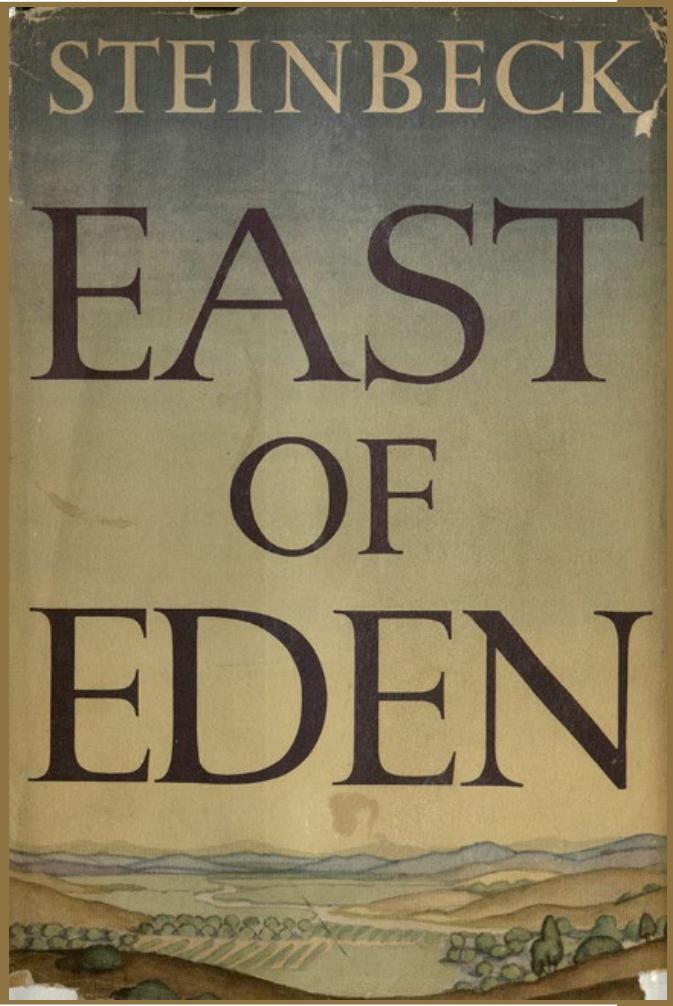
Low-Flow Characterization of South Carolina Streams



USGS

"And it never failed that during the dry years the people forgot about the rich years, and during the wet years, they lost all memory of the dry years. It was always that way."
–John Steinbeck *East of Eden*

"The reason we need long-term records is because we have short-term memories."--TDF



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tfeaster@usgs.gov