



January 10, 2018

Department of Environmental Quality



Low-Flow Statistics

EMC Water Allocation Committee
January 10, 2018

Tom Fransen
Division of Water Resources
Department of Environmental Quality



When does dry become drought?

The two U.S. agencies that are recognized experts don't agree.

USGS Percentile Classes

Below Normal	10 - 24
Moderate Drought	6 - 9
Severe Drought	≤ 5
Extreme Drought	Low

US Drought Monitor Percentile Classes

Abnormally Dry (D0)	21 - 30
Moderate Drought (D1)	11 - 20
Severe Drought (D2)	6 - 10
Extreme Drought (D3)	3 - 5
Exceptional Drought (D4)	Low - 2

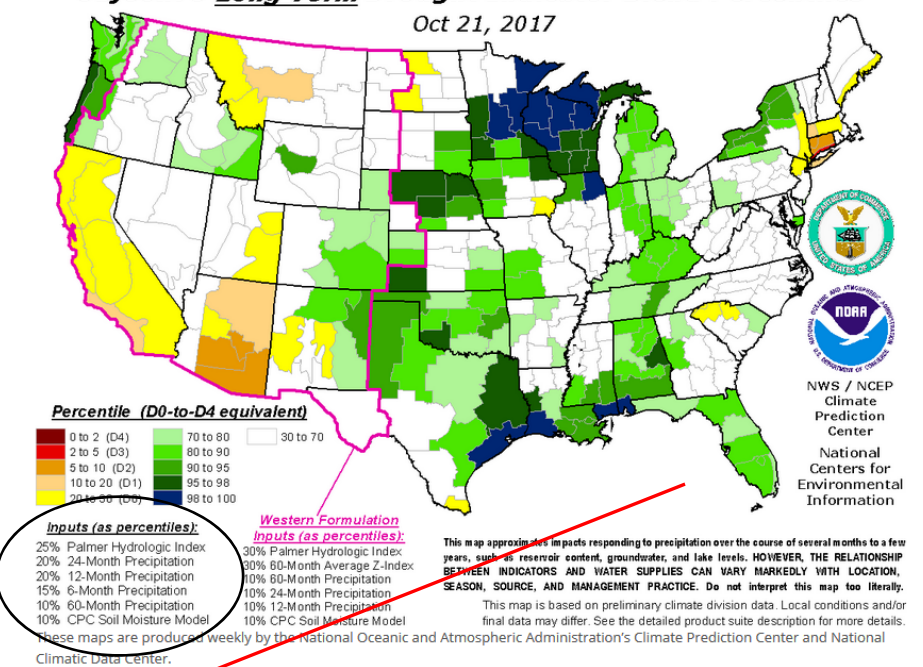
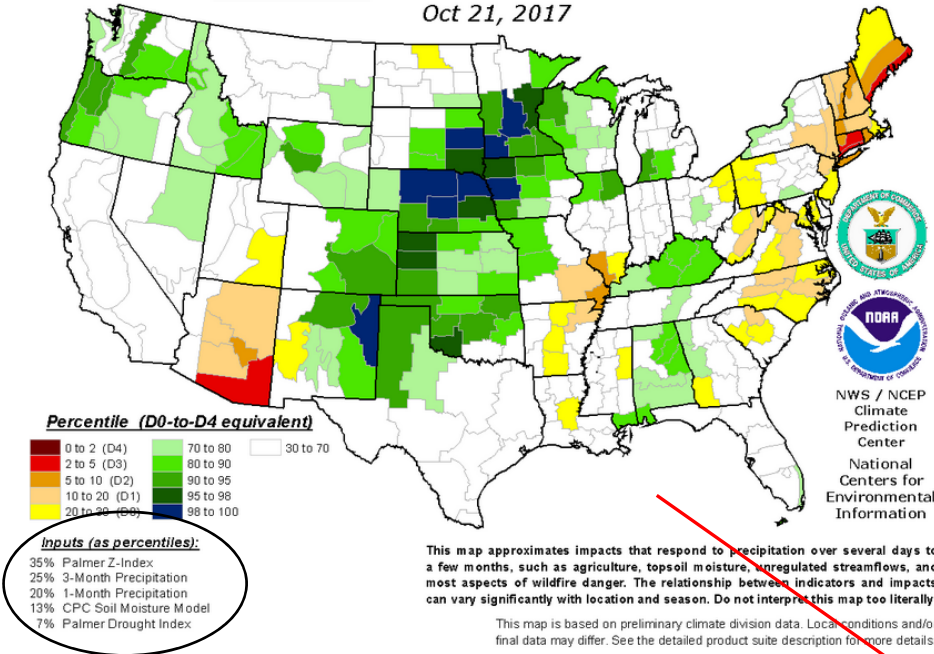


US Drought Monitor

Impacts are the key between dry vs. drought.

Objective Short-Term Drought Indicator Blend Percentiles
Oct 21, 2017

Objective Long-Term Drought Indicator Blend Percentiles
Oct 21, 2017



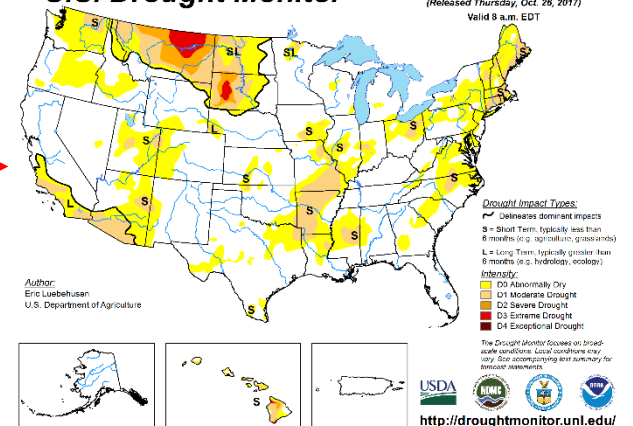
Drought Severity Classification

Category	Description	Possible Impacts	Ranges				
			Palmer Drought Severity Index (PDSI)	CPC Soil Moisture Model (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	Objective Drought Indicator (Percentiles)
D0	Abnormally Dry	<ul style="list-style-type: none"> Go into drought: • cropland dryness slowing planting, growth of crops or pastures • coming out of drought: • some lingering water deficits • pastures or crops not fully recovered 	-1.0 to -1.9	21 to 30	21 to 30	-0.5 to -0.7	21 to 30
D1	Moderate Drought	<ul style="list-style-type: none"> • Some damage to crops, pastures • Streams, reservoirs, or wells low, some water shortages developing or imminent • Voluntary water use restrictions requested 	-2.0 to -2.9	11 to 20	11 to 20	-0.8 to -1.2	11 to 20
D2	Severe Drought	<ul style="list-style-type: none"> • Crop or pasture losses likely • Water shortages common • Water restrictions imposed 	-3.0 to -3.9	6 to 10	6 to 10	-1.3 to -1.5	6 to 10
D3	Extreme Drought	<ul style="list-style-type: none"> • Major crop/pasture losses • Widespread water shortages or restrictions 	-4.0 to -4.9	3 to 5	3 to 5	-1.6 to -1.9	3 to 5
D4	Exceptional Drought	<ul style="list-style-type: none"> • Exceptional and widespread crop/pasture losses • Shortages of water in reservoirs, streams, and wells creating water emergencies 	-5.0 or less	0 to 2	0 to 2	-2.0 or less	0 to 2

Short-term drought indicator blends focus on 1-3 month precipitation. Long-term blends focus on 6-60 months. Additional indices used, mainly during the growing season, include the USDA/NASS Topsoil Moisture, Keetch-Byram Drought Index (KBDI), and NOAA/NESDIS satellite Vegetation Health Indices. Indices used primarily during the snow season and in the West include snow water content, river basin precipitation, and the Surface Water Supply Index (SWSI). Other indicators include groundwater levels, reservoir storage, and pasture/range conditions.

U.S. Drought Monitor

October 24, 2017
(Released Thursday, Oct 26, 2017)
Valid 8 a.m. EDT



Catawba-Wateree LIP

A good drought plan needs to evaluate multiple drought indices.

Summary of LIP Trigger Points

Stage	Storage Index ¹		Drought Monitor ² (3-month average)		Monitored USGS ³ Streamflow Gages
0 ⁴	90% < SI < 100% TSI		3mo Ave DM ≥ 0		AVG ≤ 85% LT 6mo Ave
1	75% TSI < SI ≤ 90% TSI	and	3mo Ave DM ≥ 1	or	AVG ≤ 78% LT 6mo Ave
2	57% TSI < SI ≤ 75% TSI	and	3mo Ave DM ≥ 2	or	AVG ≤ 65% LT 6mo Ave
3	42% TSI < SI ≤ 57% TSI	and	3mo Ave DM ≥ 3	or	AVG ≤ 55% LT 6mo Ave
4	SI ≤ 42% TSI	and	3mo Ave DM = 4	or	AVG ≤ 40% LT 6mo Ave

¹ The ratio of Remaining Useable Storage to Total Usable Storage at a given point in time.

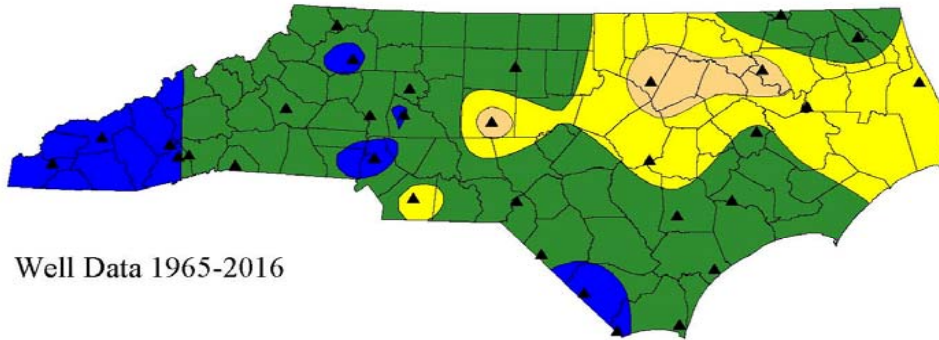
² The three-month numeric average of the published U.S. Drought Monitor (DM).

³ The sum of the rolling sixth-month average for the Monitored USGS Streamflow Gages as a percentage of the period of record (i.e., long-term (LT)) rolling average for the same six-month period for the Monitored USGS Streamflow Gages.

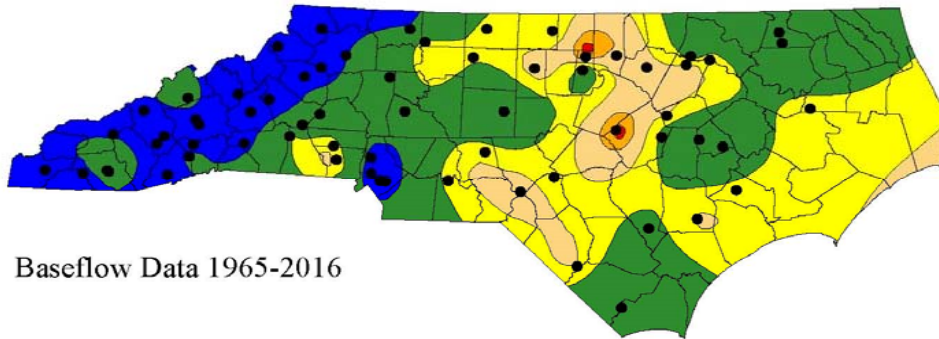
⁴ Stage 0 is triggered when any two of the three trigger points are reached.



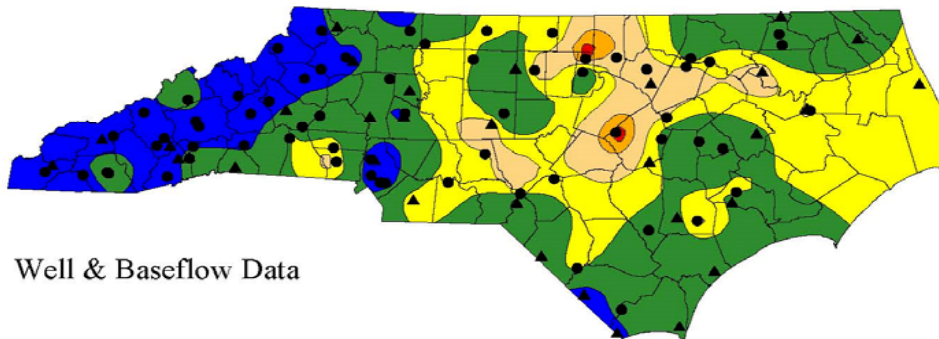
Unique DWR Drought Indices



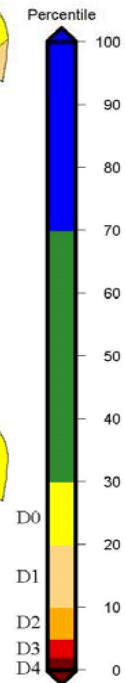
Well Data 1965-2016



Baseflow Data 1965-2016



Well & Baseflow Data





Neuse River Example



How 7Q10 Varies Over Time

Figure: Observed Annual Minimum and Estimated 7-day, 10-yr Low-Flow Discharge at Little River near Princeton (USGS 02088500)

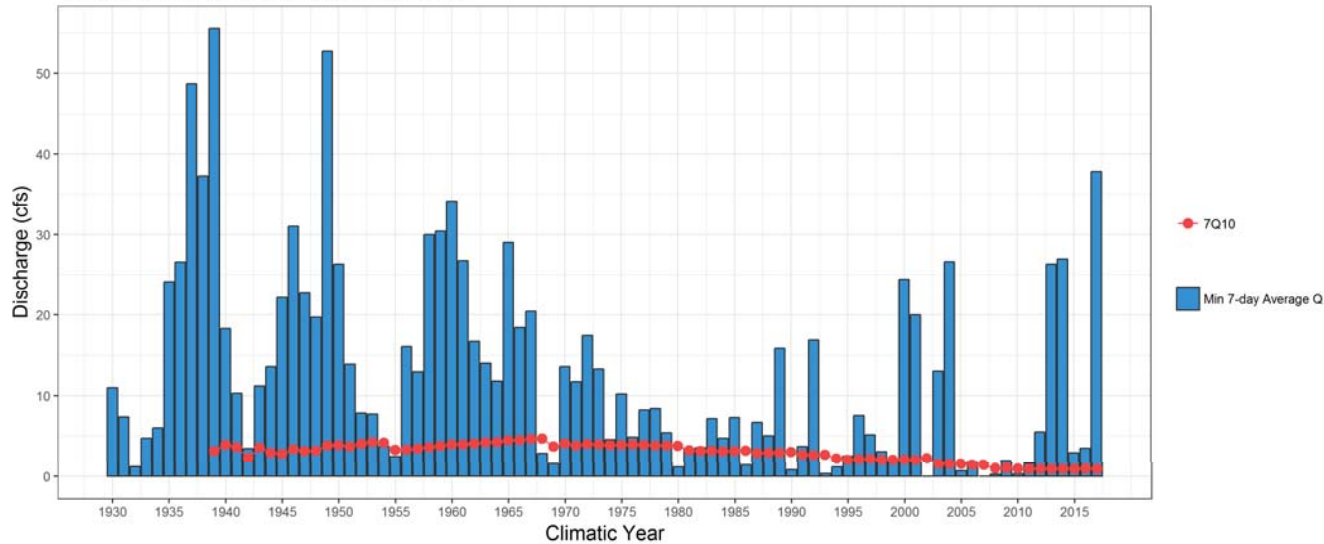
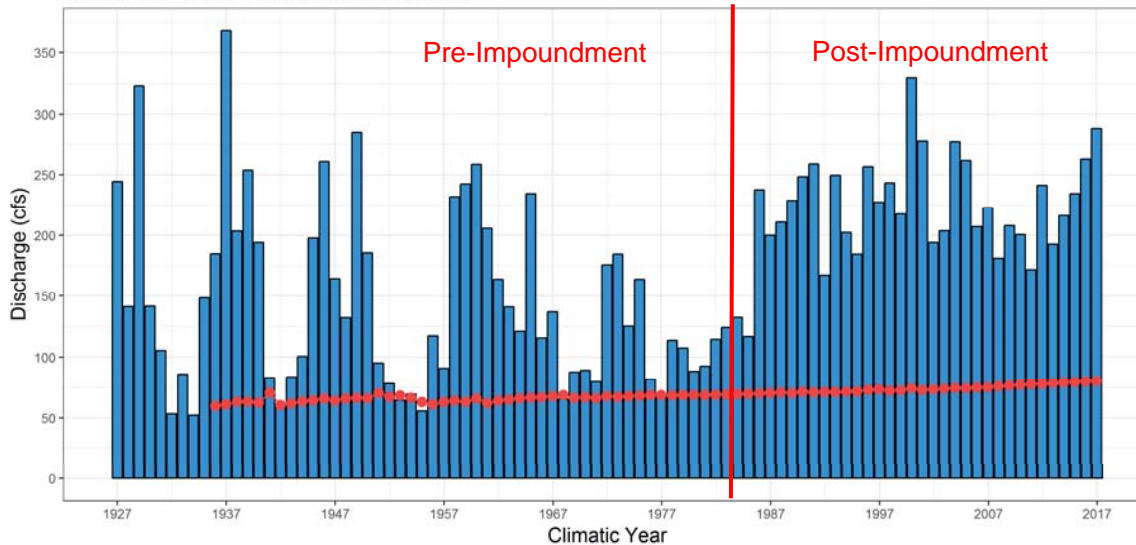


Figure: Observed Annual Minimum and Estimated 7-day, 10-yr Low-Flow Discharge at Neuse River near Clayton (USGS 02087500)



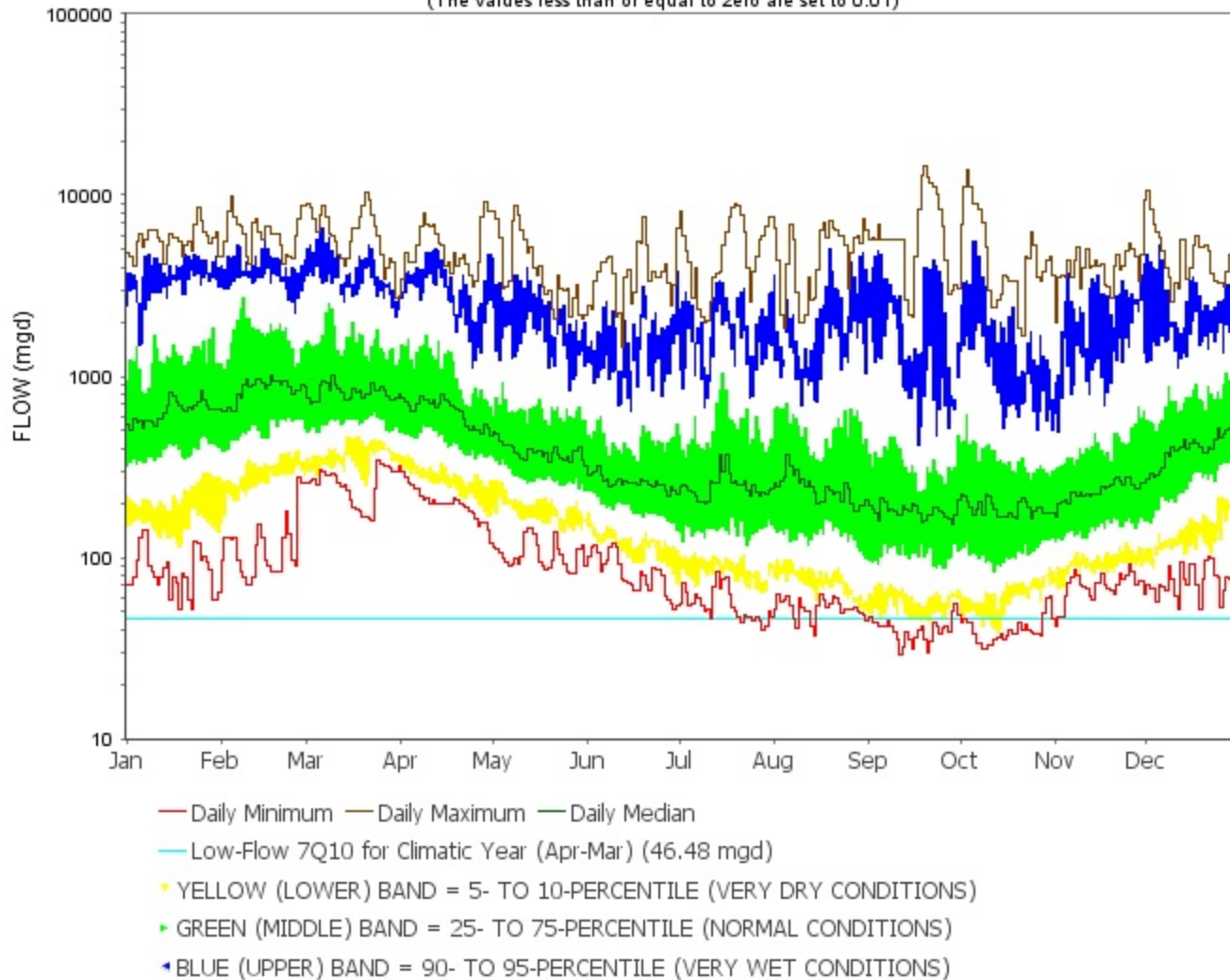
Neuse River at Clayton (02087500)

	7Q10 cfs
Falls Lake Pre-Impoundment Prior 1/1983	71
Falls Lake Post-Impoundment Since 12/1983	167
Falls Lake Post-Impoundment Without 1985 "stress test" data	184

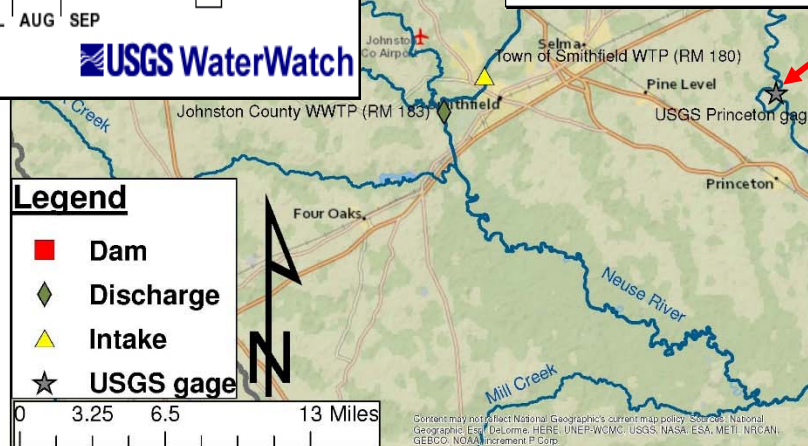
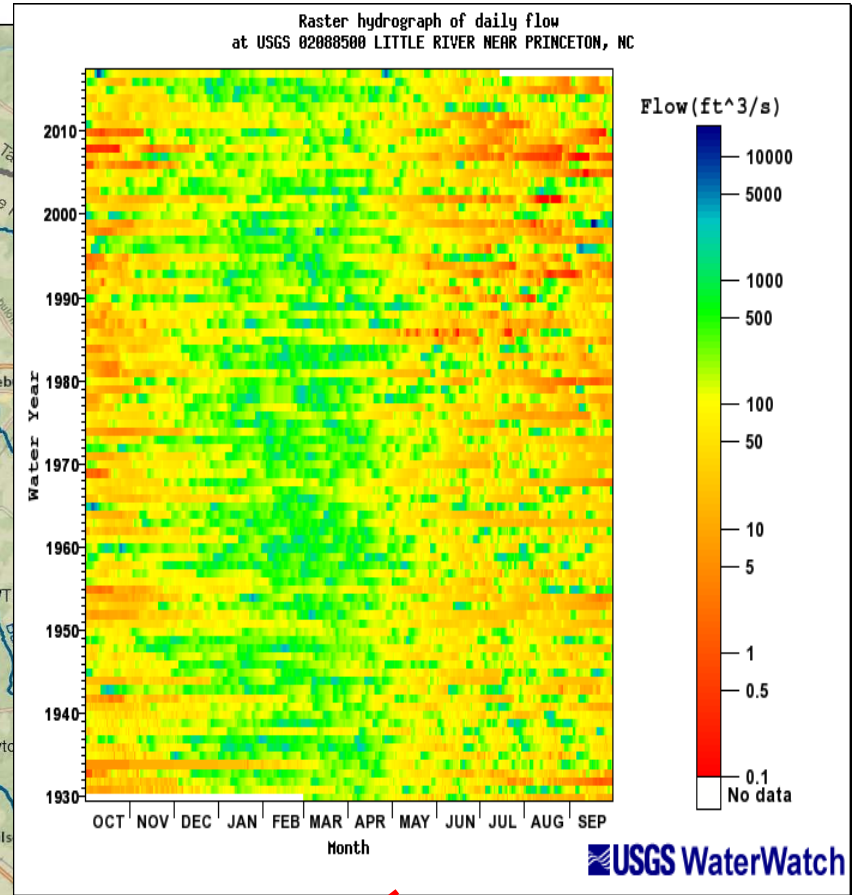
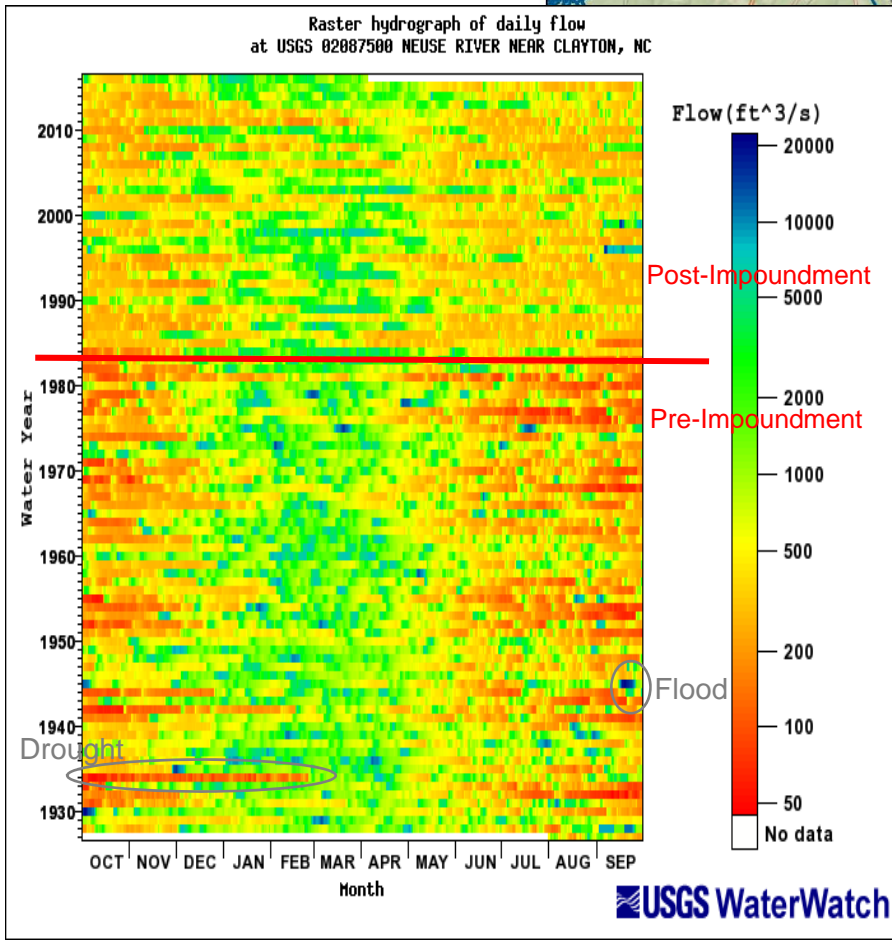
When Do Low-Flows Occur?

Pre-Impoundment

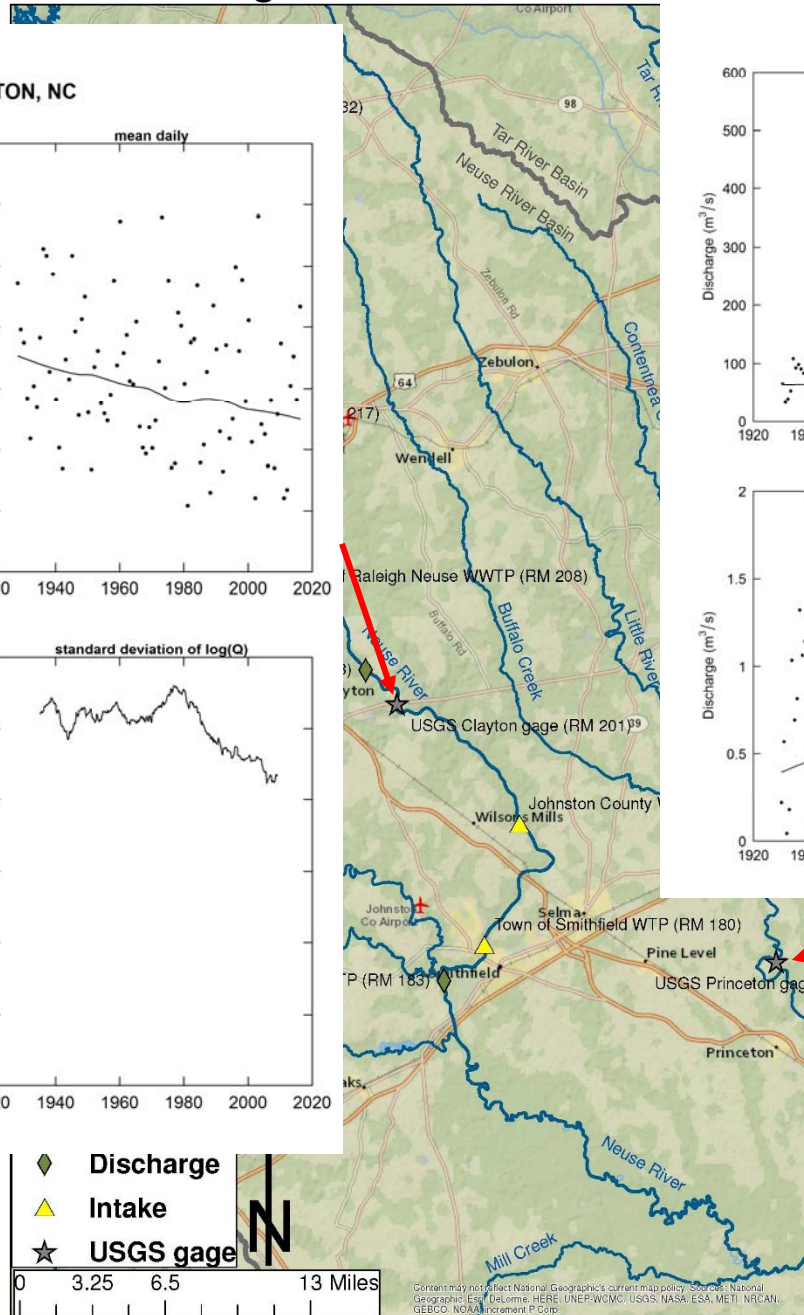
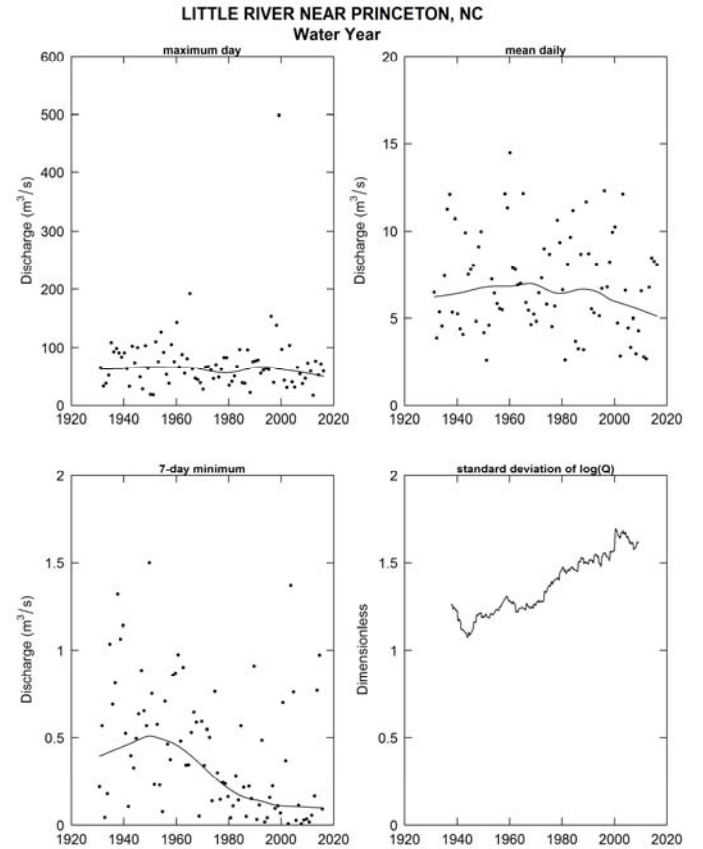
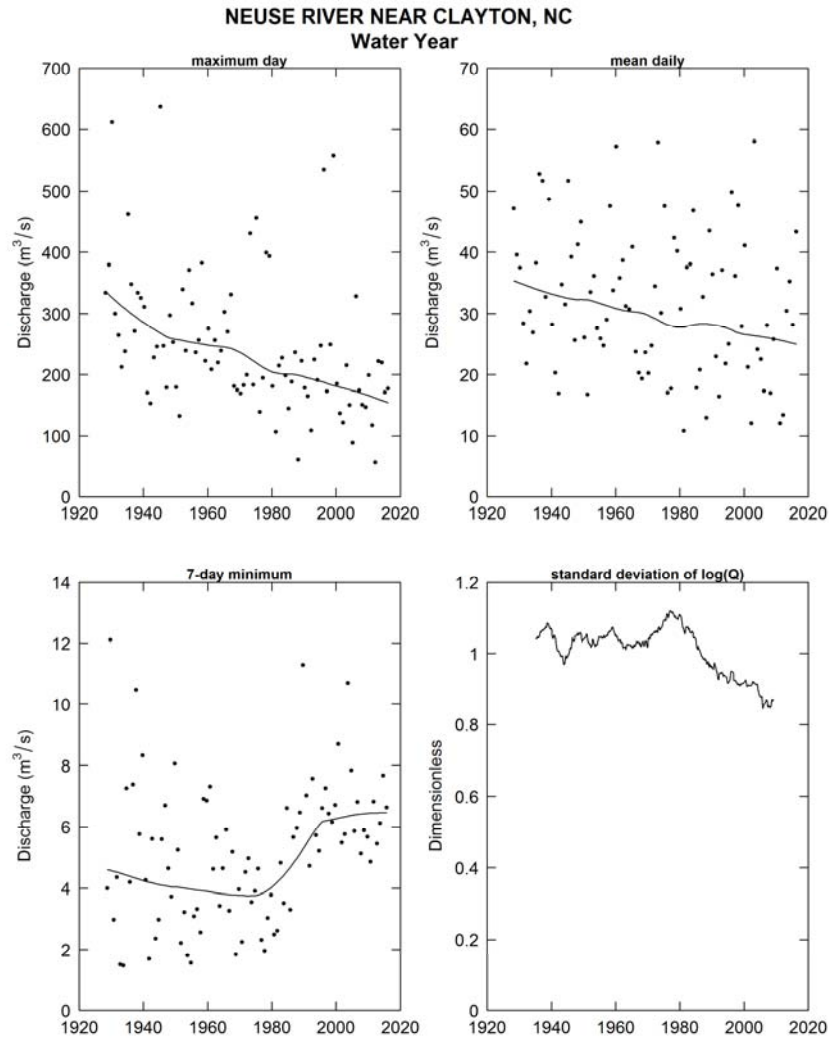
NEUSE RIVER - CLAYTON, NC - FLOW
BASED ON DATA FROM 08/01/1927 TO 12/31/1981
(The values less than or equal to zero are set to 0.01)



Impact of Regulation



Long-Term Trends



Questions?



Tom Fransen
Chief, Water Supply Planning Section
Division of Water Resources
919-707-9015
tom.fransen@ncdenr.gov

Department of Environmental Quality