New and Watauga River Basin Hydrologic Model Inflow Development

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Advancing the Management of Water Resources

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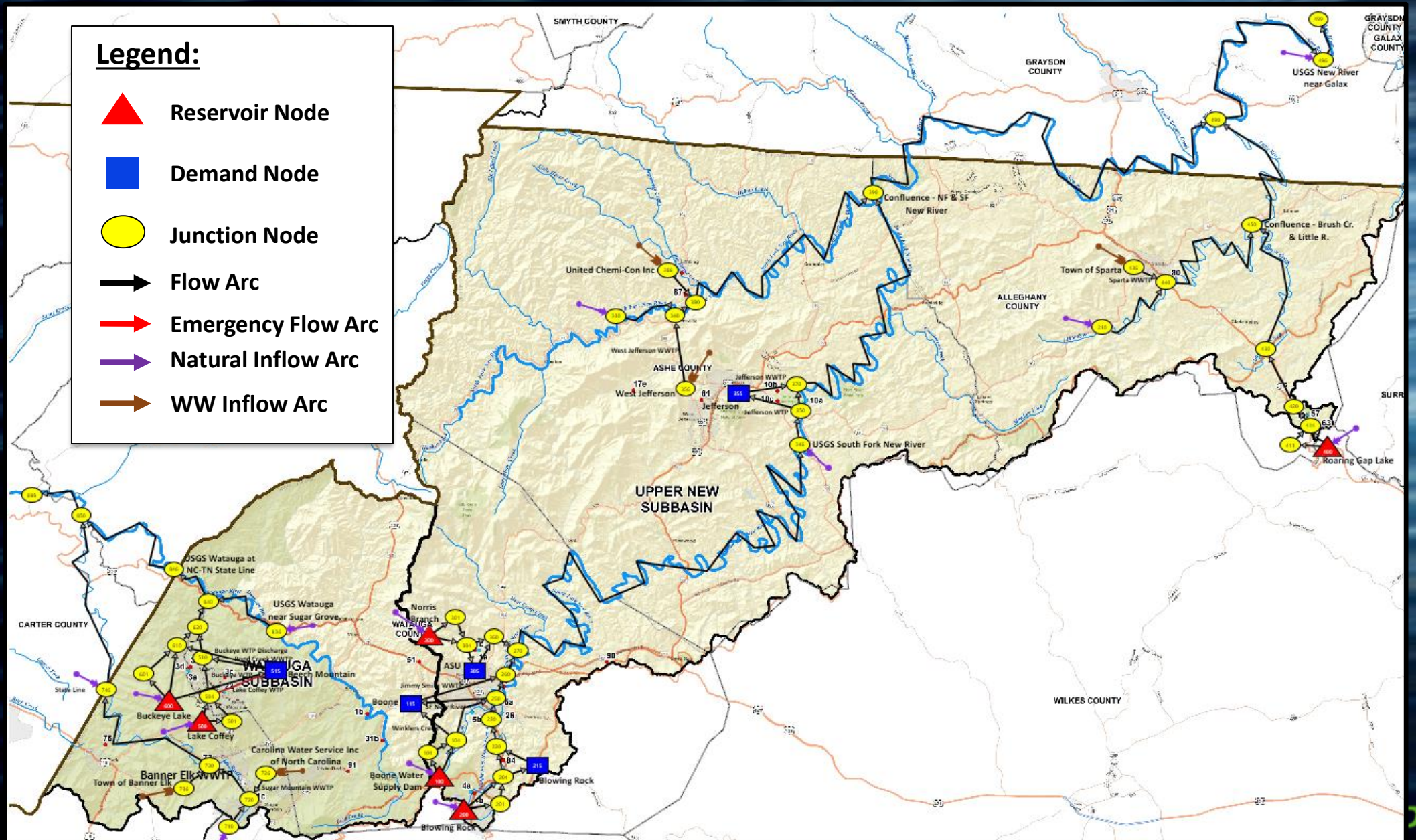
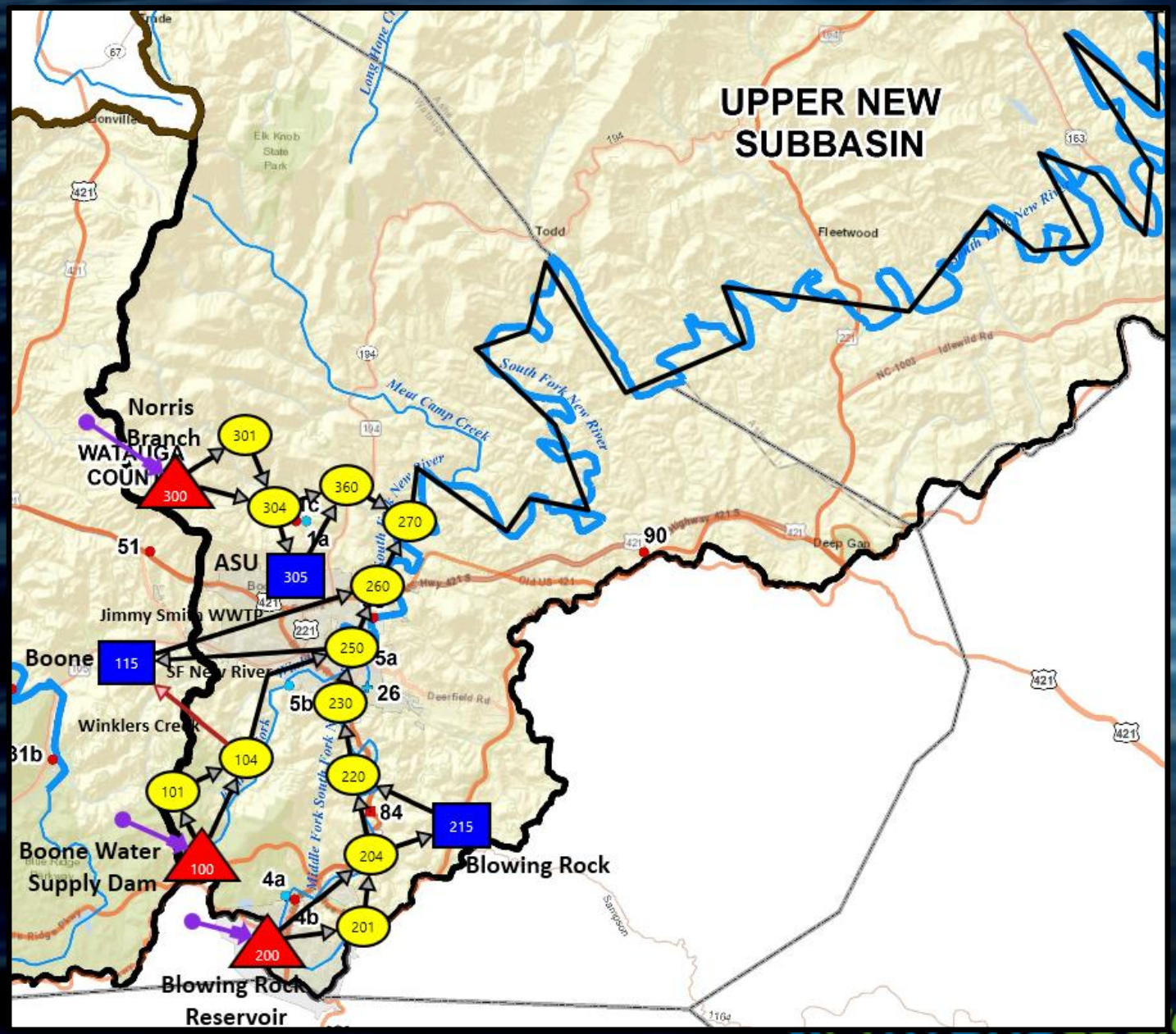
Geographic Scope of Model



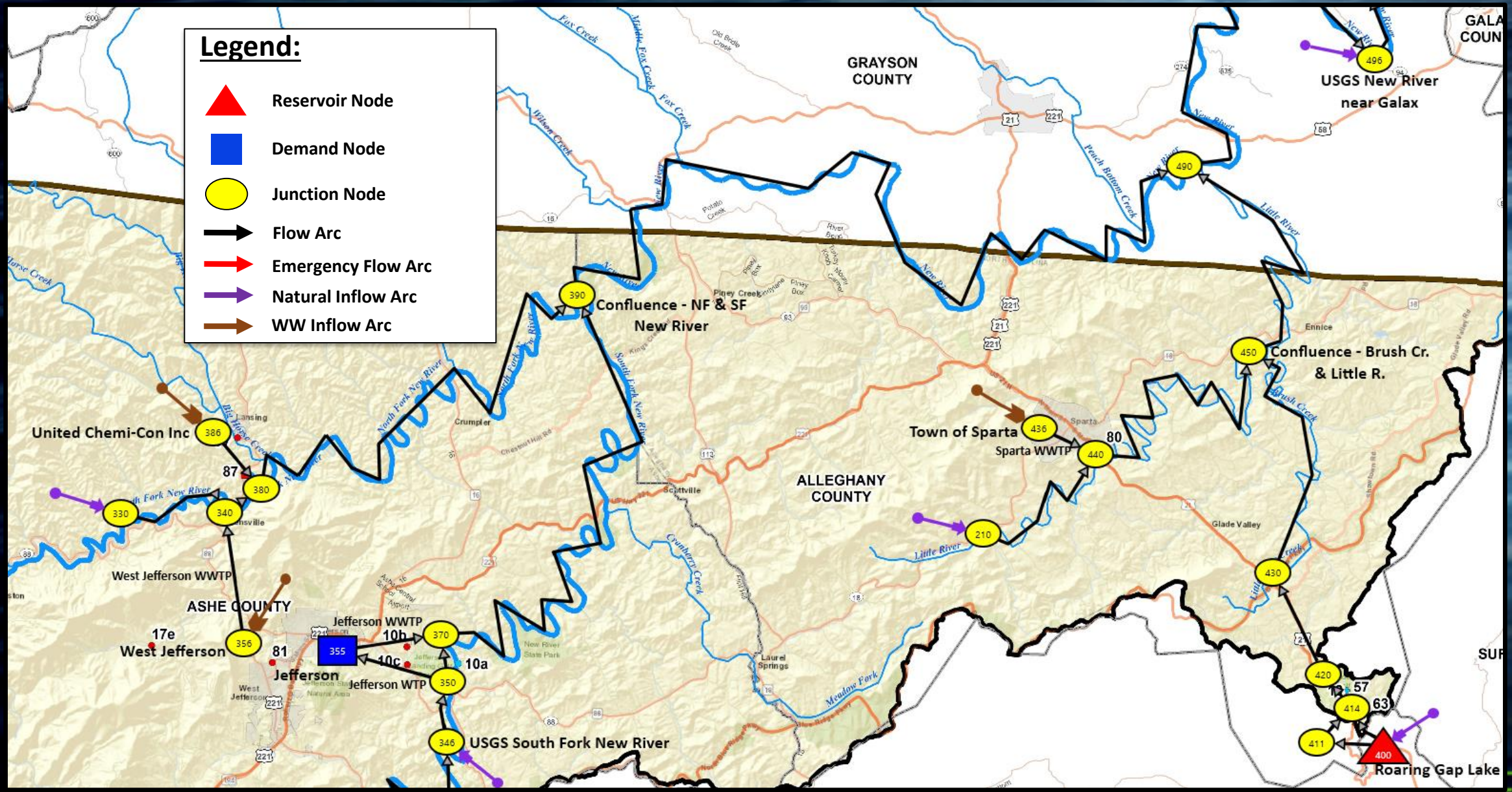
Upper New Sub-Basin

Legend:

- Reservoir Node
- Demand Node
- Junction Node
- Flow Arc
- Emergency Flow Arc
- Natural Inflow Arc
- WW Inflow Arc



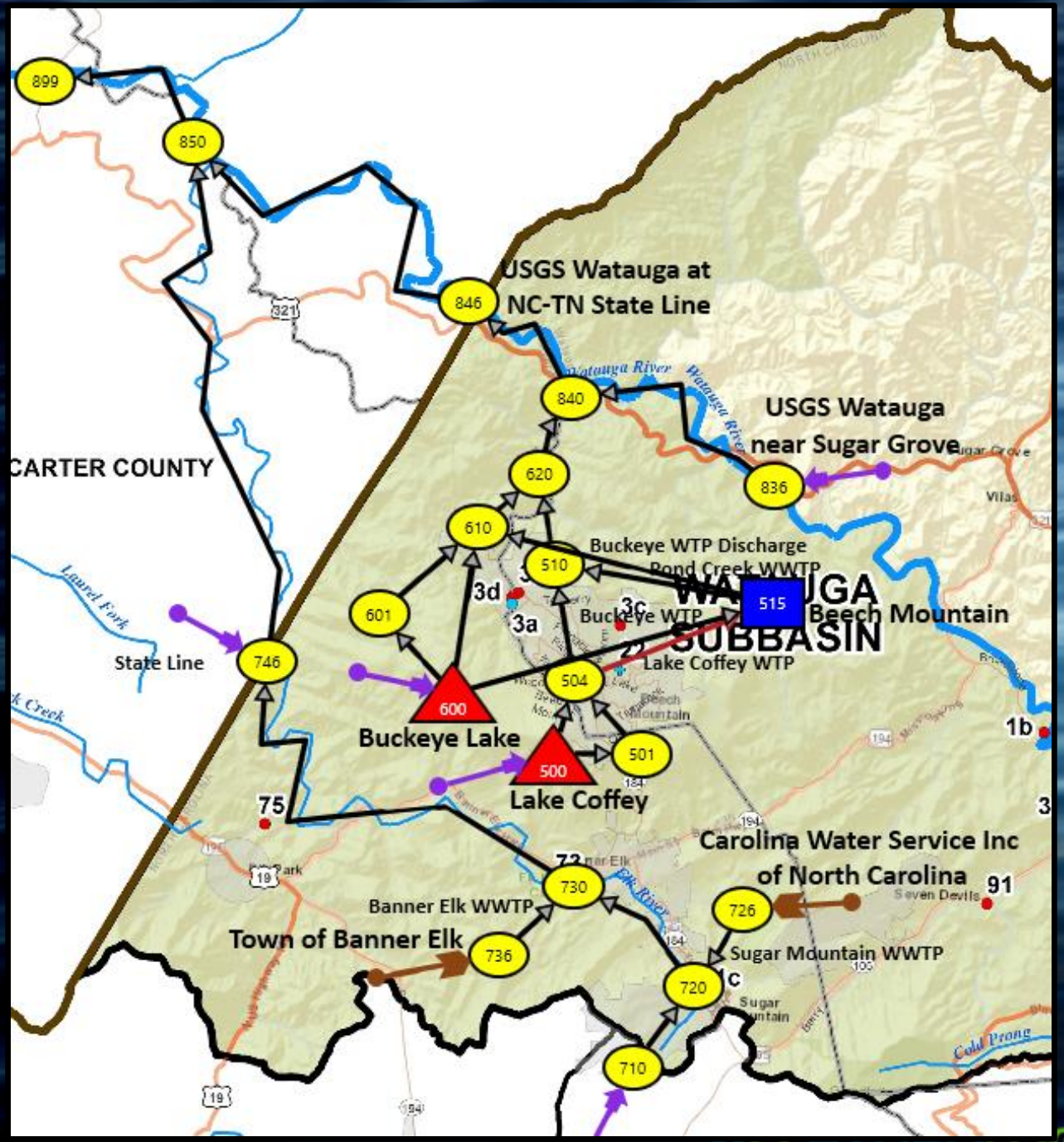
Upper New Sub-Basin Continued



Watauga Sub-Basin

Legend:

- Reservoir Node
- Demand Node
- Junction Node
- Flow Arc
- Emergency Flow Arc
- Natural Inflow Arc
- WW Inflow Arc



Unimpairment

- Unimpaired (or “naturalized”) inflows necessary for testing impacts of alternative operating policies and demand levels
- Impairments include water withdrawals/discharges and reservoir regulation (including net evaporation)
- Goal: Force inflows to match monthly unimpaired gage flows, meaning measurement error is embedded in impairments and not gage flows
  - USGS gage data is treated as ground truth

Gages Used

	USGS Number	Description	Period of Record	Drainage Area (mi^2)
Upper New	03164000	New River near Galax, VA	1/1930 – Present	1141.0
Upper New	03161000	South Fork New River near Jefferson, NC	1/1930 – Present	205.0
Watauga	03481000	Elk River Near Elk Park, NC	10/1934 – 9/1955	42.0
Watauga	03479500	Watauga R at North Carolina-Tennessee State Line	10/1942 – 6/1955	152.0
Watauga	3480000	Watauga River At Stump Knob, TN	1/1930 – 9/1931; 6/1934 – 9/1945	171.0
Watauga	03479000	Watauga River near Sugar Grove, NC	4/1940 - Present	92.1

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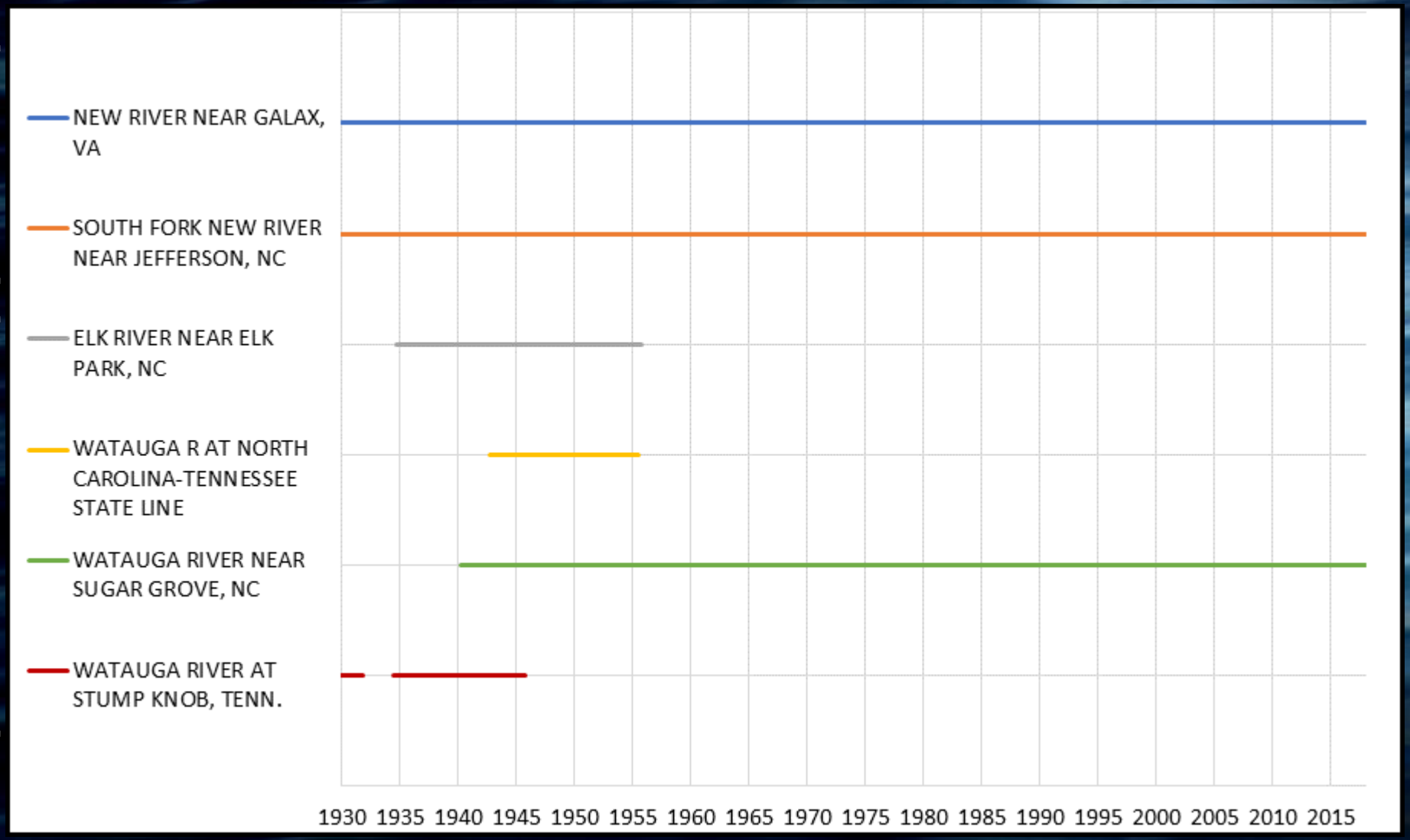
Upper New & Watauga Sub-Basins - Gage Timeline

Upper New

Watauga



Reference gages outside of basin used for inflow development are not shown

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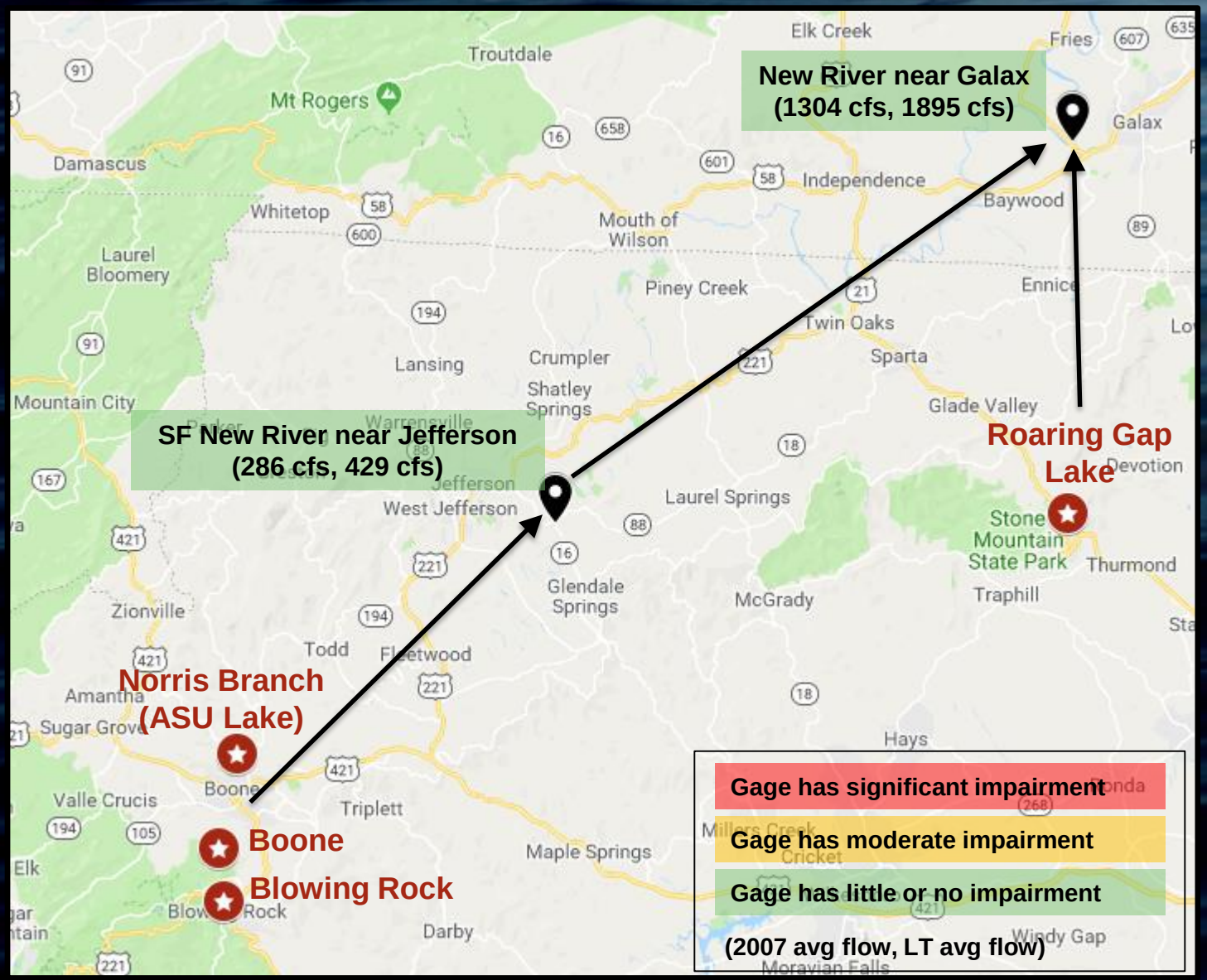
Upper New Sub-Basin – Gage Map



Legend

- Reservoirs
- USGS Gages
- Flow Direction

- Level of impairment determined by gage flow relative to upstream impairments.
- If gage flow is:
  - Less than 10x u/s impairments → Little/None
  - 10-25x u/s impairments → Moderate
  - Greater than 25x u/s impairments → Significant

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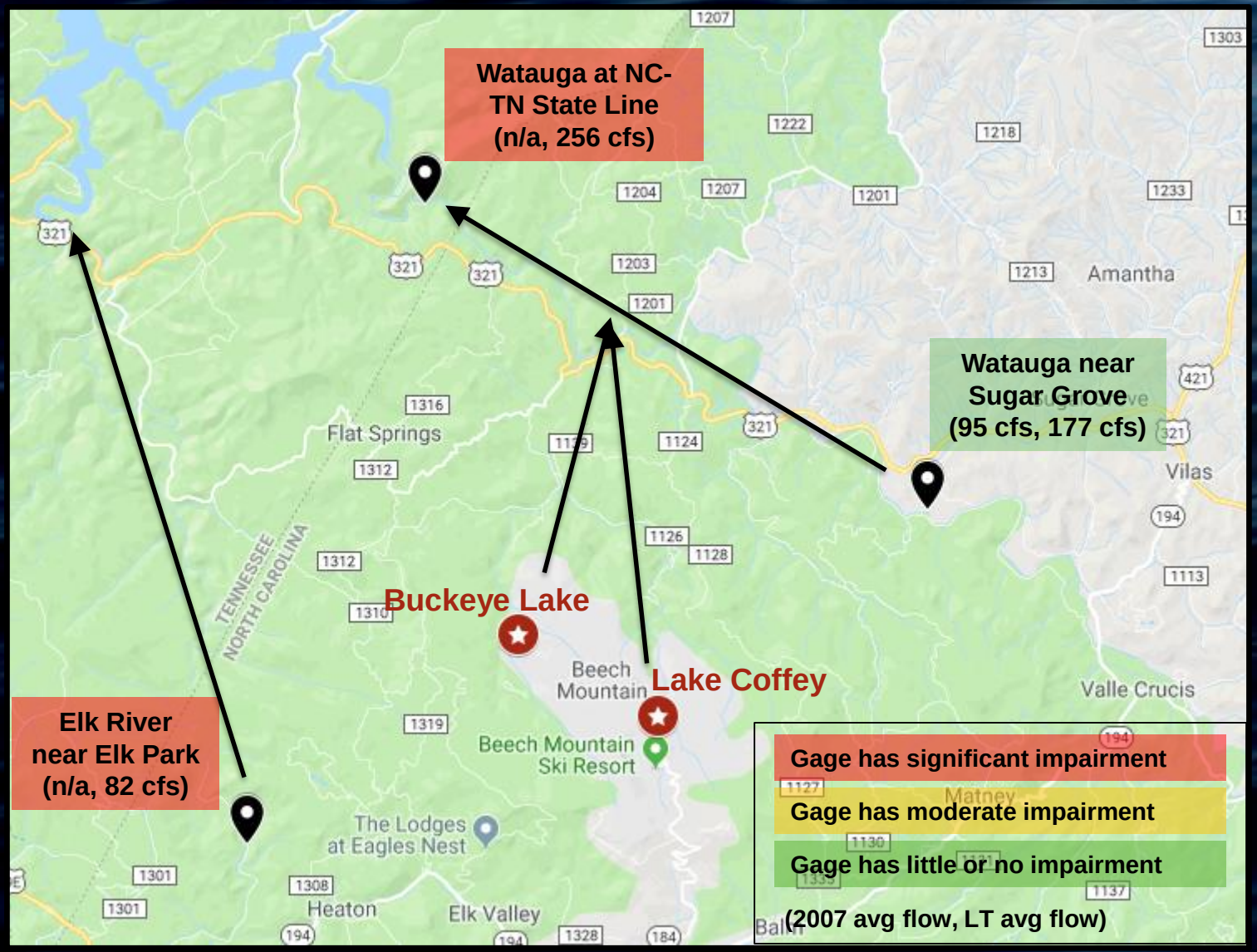
Watauga Sub-Basin – Gage Map



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Reservoir Summary

	Year Constructed	Drainage Area (mi^2)	Usable Storage (MG)
Norris Branch	1974	0.34	300
Boone	1957	0.91	
Blowing Rock	1958	0.53	47
Roaring Gap	1927	1.12	
Buckeye	1987	3.19	29
Coffey	1968	0.05	7

Year Constructed Source: “Dams_June_2008” GIS files
Drainage Area and Usable Storage Source: “Dams_June_2008” GIS files and “03 LWSP Data.xlsx”
Buckeye Lake Source: Beech Mountain Consultant: WEST, PLLC

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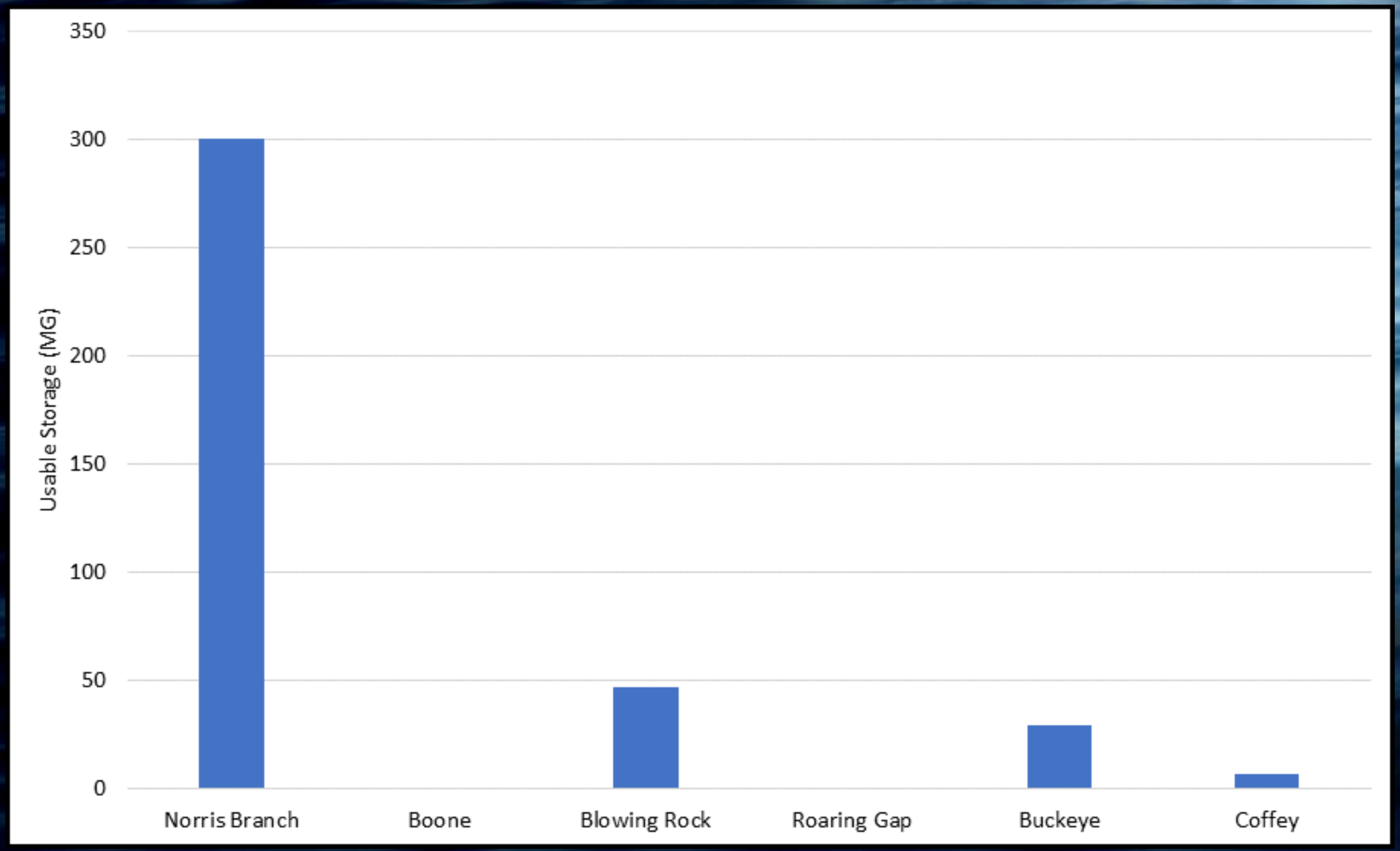
Reservoir Storage



Inflow Development Methodology

- 1. Unimpair major basin gages (mainstem and tributary) by adding back historic upstream impairments
- 2. Compute flows and gains on a monthly basis
- 3. Extend flow and gains with incomplete records using monthly and annual correlations with other gages using USGS software *Fillin*
- 4. Scale filled-in flows and gains to ensure total inflow to downstream points matches actual unimpaired gage flows.
- 5. Disaggregate monthly filled in flows to daily using local unimpaired gage to preserve natural variation
  - Impairment data is often only available on a monthly average, and can cause noise on a daily basis
  - **Goal: to build daily flows whose variation is representative of history while preserving monthly gage flows as ground truth**

Spreadsheet Showing Gage Unimpairment

	A	D	E	F	G	H	I	J	K	N
1		*node 400*								
2										
3		Irrigation	Jefferson	Sparta	United	West Jefferson	Impairments	Total u/s	#03164000	Unimpaired
4		u/s Roaring Gap	WWTP	WWTP	Chemi-Con	WWTP	u/s	Impairments,	New River	New River
5		Withdrawal	Return	Return	Return	Return	New River	this reach	near Galax, VA	near Galax, VA
6	Date	mgd	mgd	mgd	mgd	mgd	mgd	mgd	Discharge cfs	Discharge cfs
32092	11/5/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1870.00	1868.73
32093	11/6/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1880.00	1878.73
32094	11/7/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1680.00	1678.73
32095	11/8/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1680.00	1678.73
32096	11/9/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1790.00	1788.73
32097	11/10/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1740.00	1738.73
32098	11/11/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1610.00	1608.73
32099	11/12/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1520.00	1518.73
32100	11/13/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1480.00	1478.73
32101	11/14/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1430.00	1428.73
32102	11/15/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1380.00	1378.73
32103	11/16/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1360.00	1358.73
32104	11/17/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1320.00	1318.73
32105	11/18/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1280.00	1278.73
32106	11/19/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1290.00	1288.73
32107	11/20/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1380.00	1378.73
32108	11/21/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1340.00	1338.73
32109	11/22/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1270.00	1268.73
32110	11/23/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1220.00	1218.73
32111	11/24/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1170.00	1168.73
32112	11/25/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1150.00	1148.73
32113	11/26/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1140.00	1138.73
32114	11/27/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1110.00	1108.73
32115	11/28/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1080.00	1078.73
32116	11/29/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1070.00	1068.73
32117	11/30/2017	0.00	0.24	0.35	0.01	0.22	-0.24	-0.82	1060.00	1058.73

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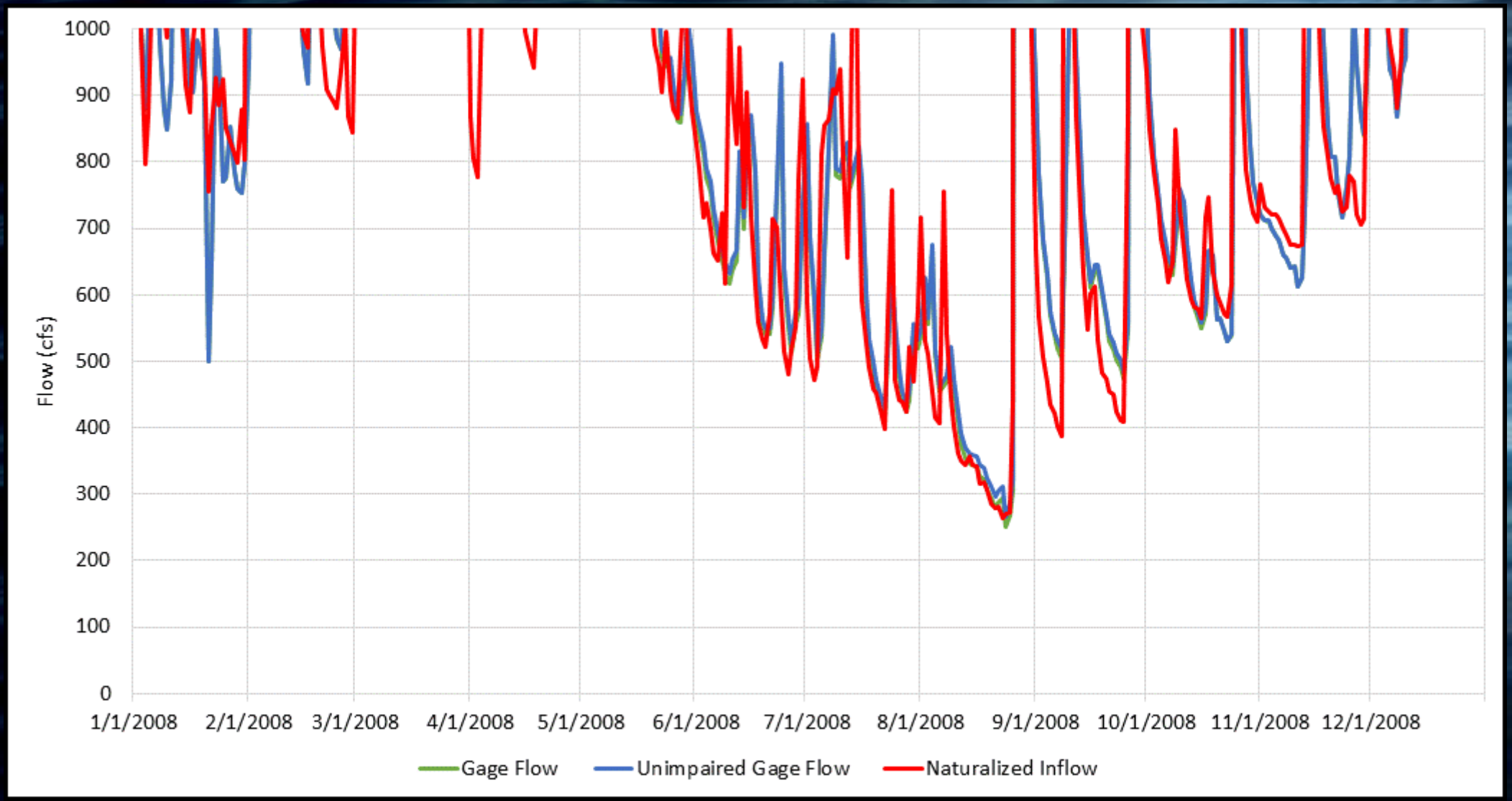
Flow Comparison: New River near Galax, daily



Unimpaired Gage = daily gage flow adjusted for impairments upstream
Naturalized Inflow = monthly cumulative inflow disaggregated to daily to preserve natural variation

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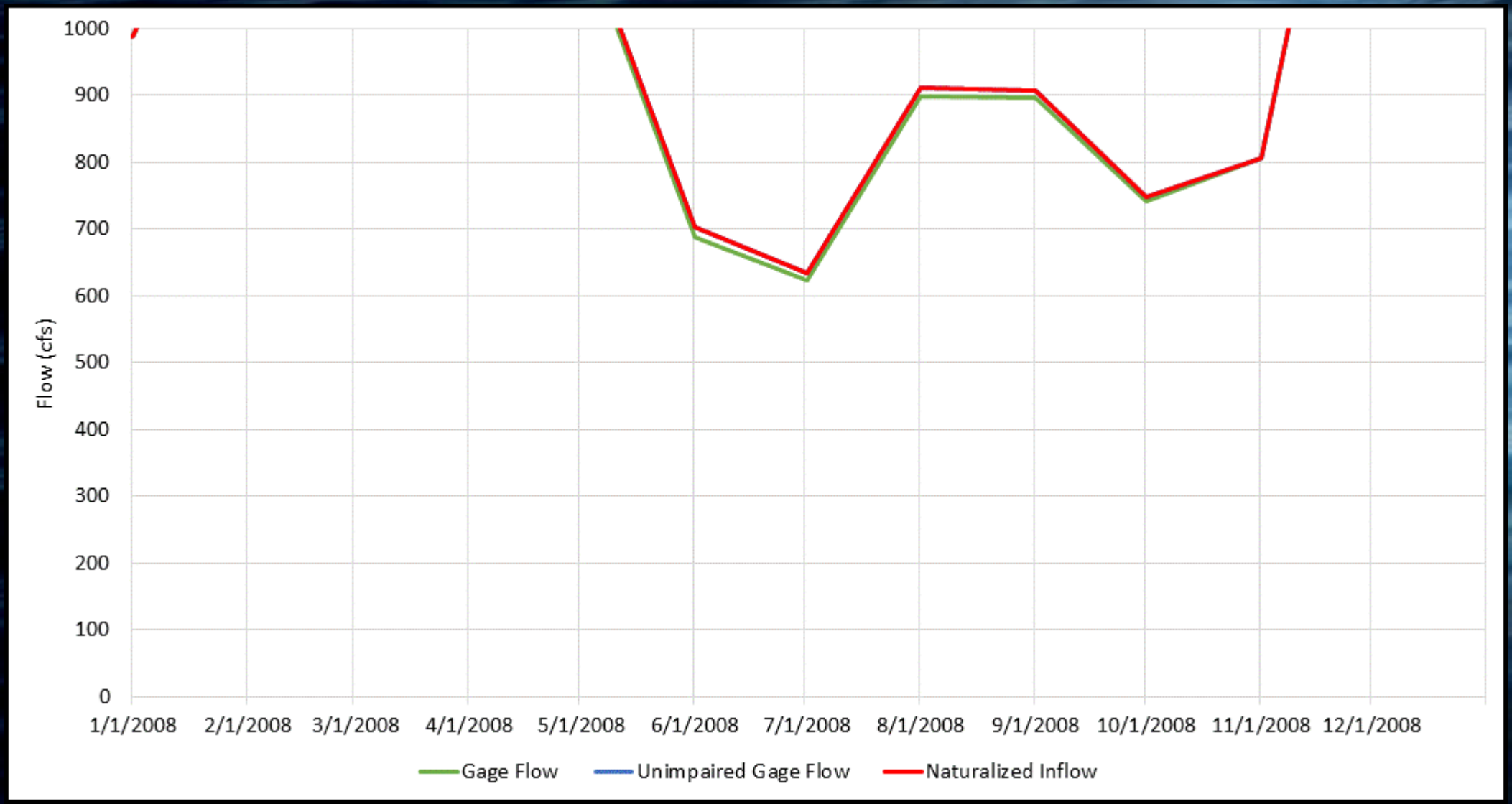
Flow Comparison: New River near Galax, monthly



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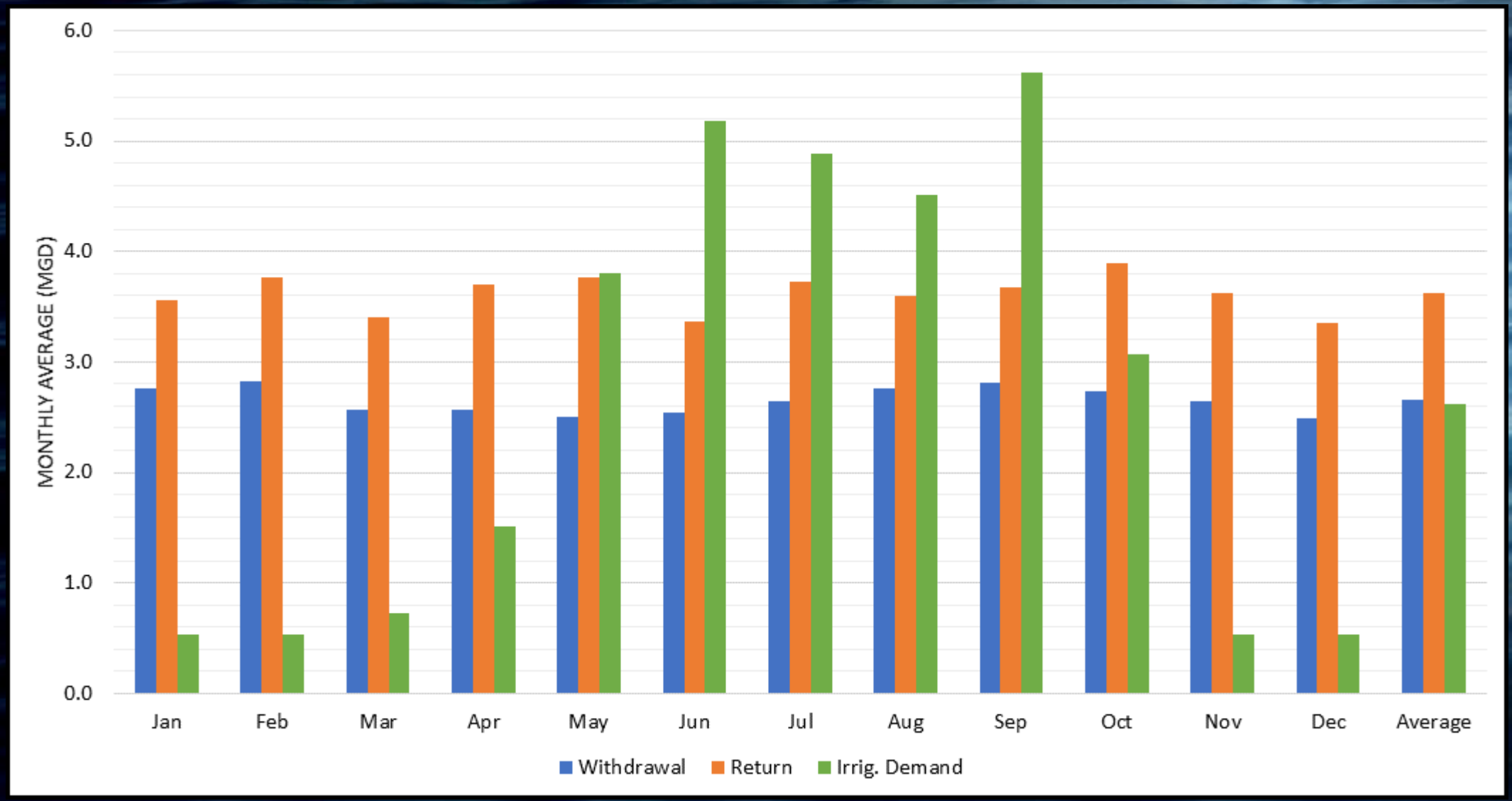
Upper New Withdrawals and Discharges (2013-17)



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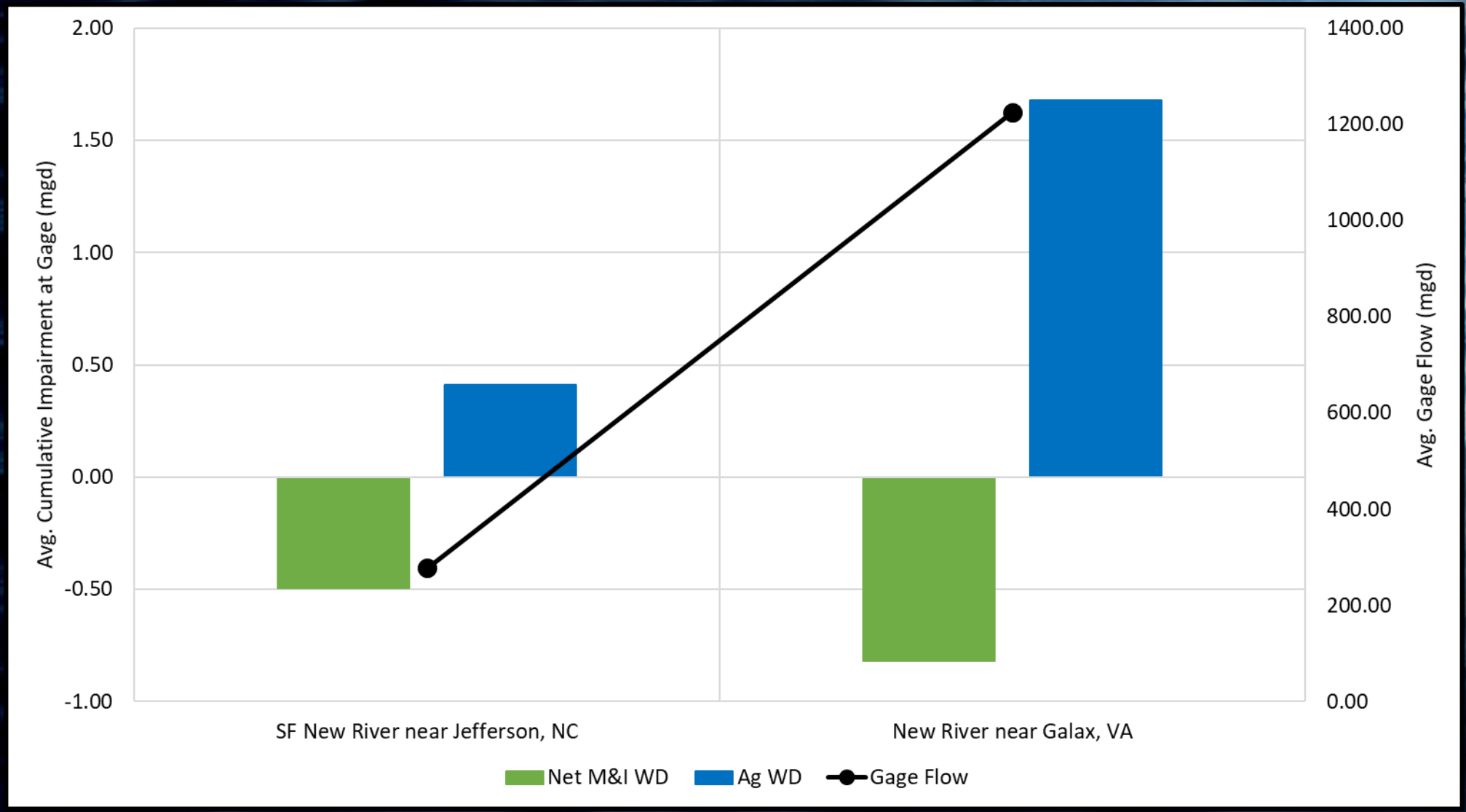
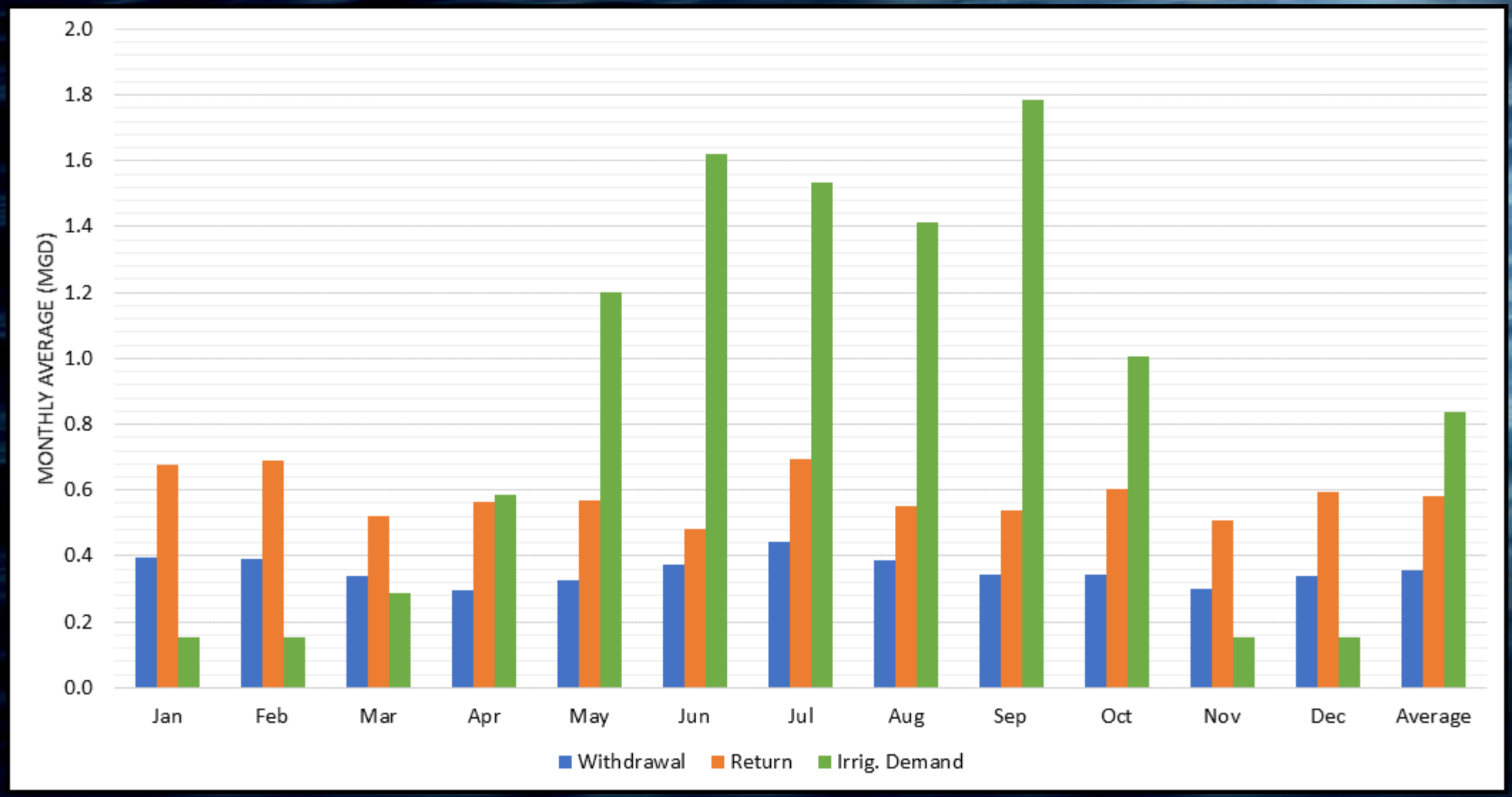
Impairments in Upper New Basin (1930-2017)



Watauga Withdrawals and Discharges (2013-17)



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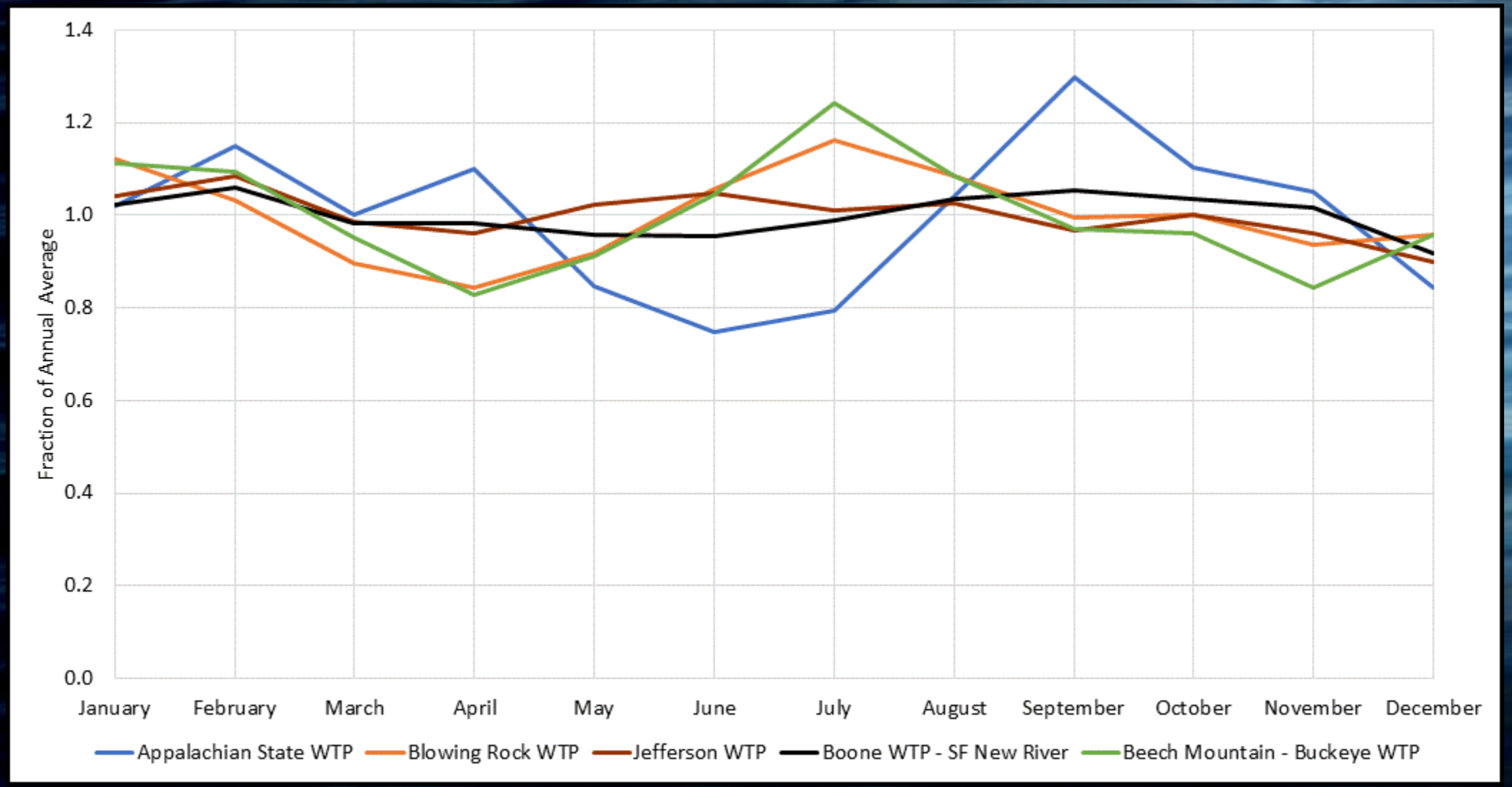
Upper New and Watauga Utility Withdrawals



Winklers Creek (Upper New) and Lake Coffey (Watauga) WD not shown (Emergency sources)

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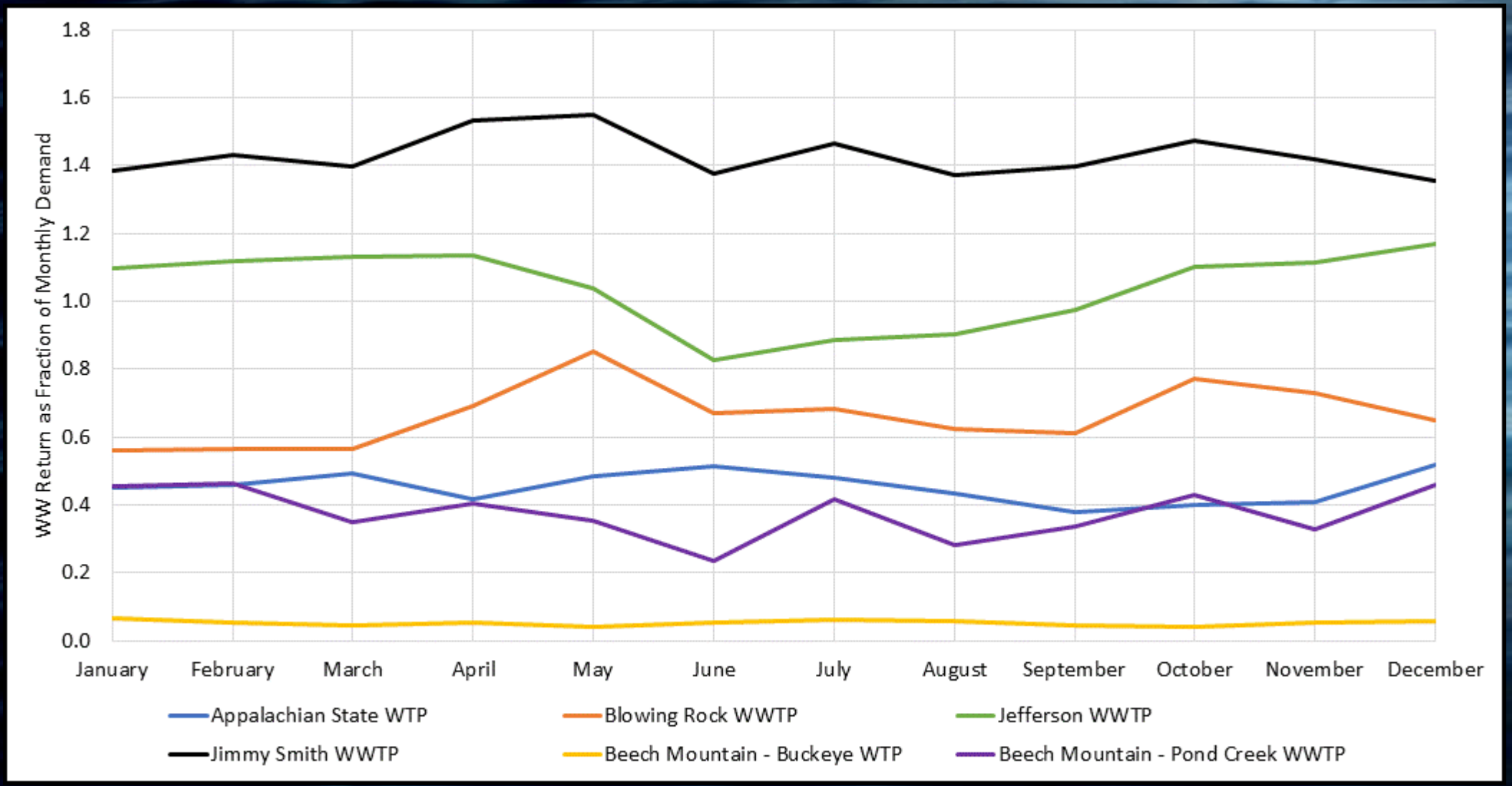
Upper New and Watauga Utility Returns



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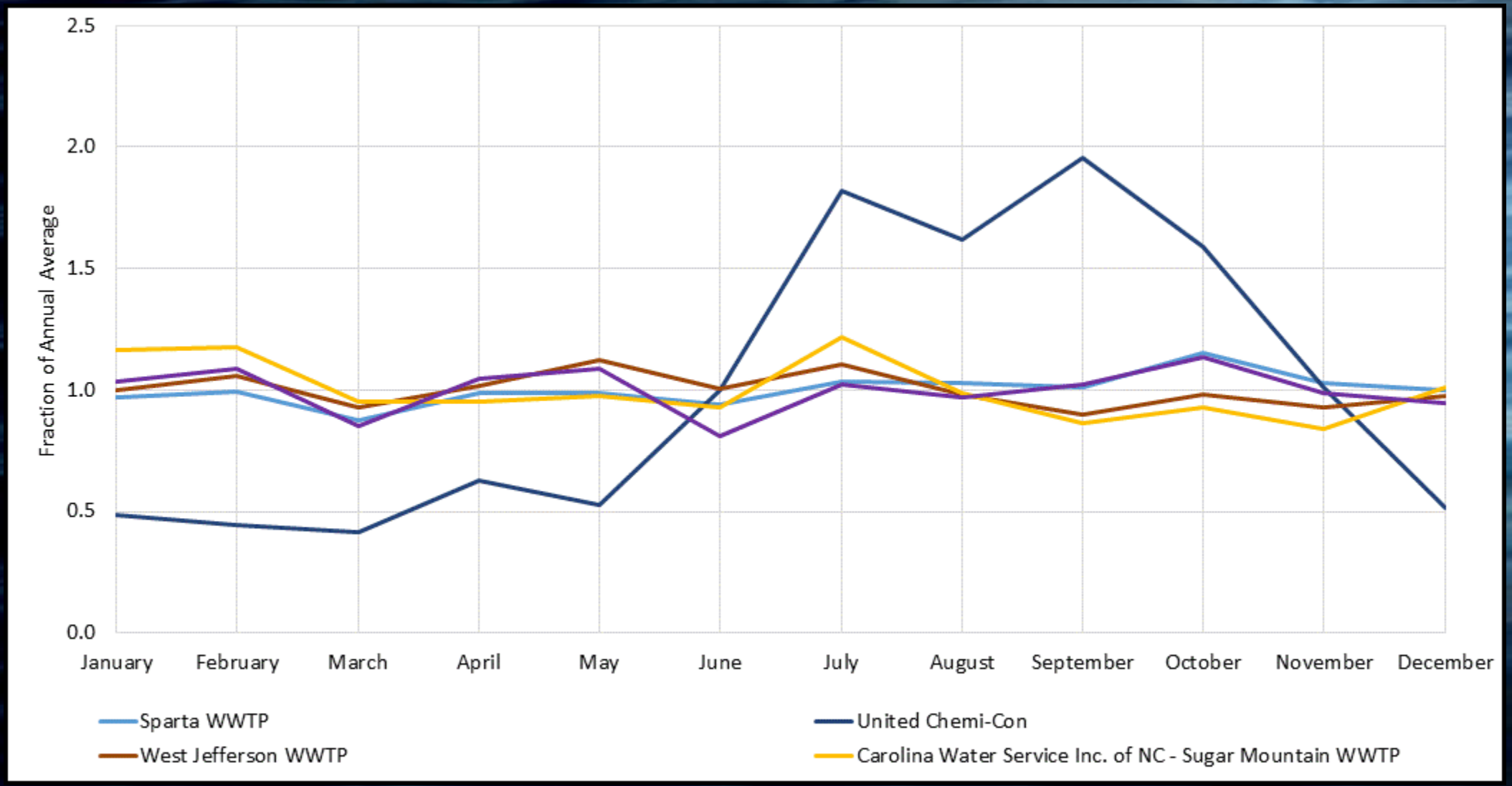
Upper New and Watauga Other Returns



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Upper New & Watauga Sub-Basins – Data Needs

- SAE and Historic Reservoir Data:
  - Upper New Sub-Basin
    - Roaring Gap Lake
    - Norris Branch (ASU Lake)
    - Blowing Rock
    - Boone Water Supply Dam
    - Roaring Gap
  - Watauga Sub-Basin
    - Lake Coffey

Next Step – Model Simulation

- Basecase and alternative scenarios to be developed
- For each scenario, test a given set of facilities, operating policies, and demands over the historic inflow record
- Basecase
  - Use recent demand levels and patterns
  - Incorporate drought plans on file with DWR
- Alternatives
  - Adjust facilities, operating policies, and demands
- Documentation
- Training